Microsemi

500mA Negative Adjustable Regulator

Description

The SG137A family of negative adjustable regulators deliver up to 500mA output current over an output voltage range of -1.2 V to -37 V. The device includes significant improvements, such as better line and load regulation, and a maximum output voltage error of 1%. The SG137 family uses the same chip design and guarantees maximum output voltage error of ±2%.

Every effort is made to make these devices easy to use and difficult to damage. Internal current and power limiting coupled with true thermal limiting prevents device damage due to overloads or shorts even if the regulator is not fastened to a heat sink.

The SG137A/137 family of products are ideal complements to the SG117A/117 adjustable positive voltage regulators.

Features

- 1% Output Voltage Tolerance
- 0.01%/V Line Regulation
- 0.5% Load Regulation
- 0.02%/W Thermal Regulation

High Reliability Features - SG137A/SG137

- Available to MIL-STD-883
- MSC-AMS Level "S" Processing Available
- Available to DSCC
  – Standard Microcircuit Drawing (SMD)
- SGR137A/SGR137 Rad-Tolerant Version Available

Typical Application

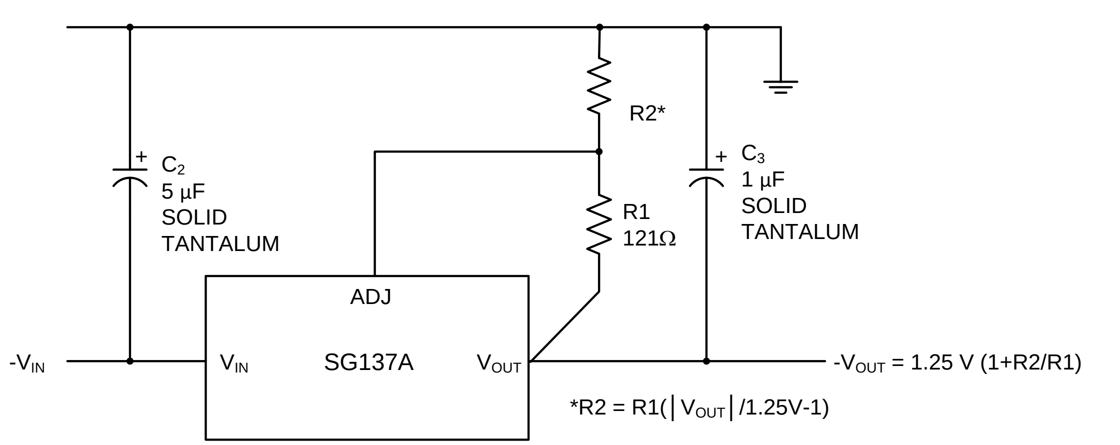


Figure 1 · Typical Application

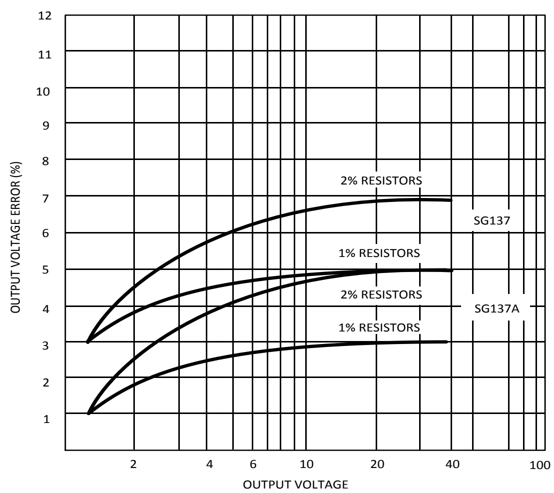
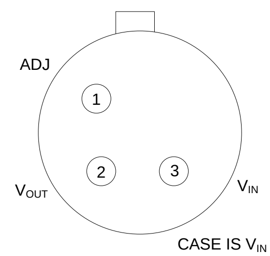
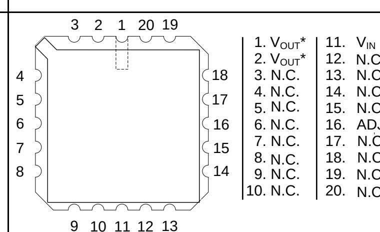


Figure 2 · Resistor Precision vs. Output Voltage Error

Connection Diagrams and Ordering Information

Ambient Temperature	Type	Package	Part Number	Packaging Type	Connection Diagram
-55°C to 125°C	T	3-Terminal Metal Can	SG137AT-883B	TO-39	
			SG137AT-DESC		
			SG137AT		
			SG137T-883B		
			SG137T-DESC		
			SG137T		
-55°C to 125°C	L	20-Pin CERAMIC Leadless Chip Carrier	SG137AL-883B	CLCC	 **L PACKAGE** (Top View) PbSn Lead Finish * Both V_{OUT} pins must be externally connected together at the device terminals.
			SG137AL-DESC		
			SG137AL		
			SG137L-883B		
			SG137L-DESC		
			SG137L		

Absolute Maximum Ratings1

Parameter	Value	Units
Power Dissipation	Internally Limited	-
Input to Output Voltage Differential	40	V
Storage Temperature Range	-65 to 150	°C
Operating Junction Temperature	150	°C
Lead Temperature (Soldering, 10 Seconds)	300	°C
ESD Rating (Human Body Model)	2	kV

Notes:

1. *Stresses above those listed in "ABSOLUTE MAXIMUM RATINGS", may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. All voltages are with respect to Ground. Currents are positive into, negative out of specified terminal.*

Thermal Data

Parameter	Value	Units
T Package:		
Thermal Resistance-Junction to Leads, θ_{JC}	15	°C/W
Thermal Resistance-Junction to Ambient, θ_{JA}	120	°C/W
L Package:		
Thermal Resistance-Junction to Leads, θ_{JC}	35	°C/W
Thermal Resistance-Junction to Ambient, θ_{JA}	120	°C/W

Notes:

- *Junction Temperature Calculation:* $T_J = T_A + (P_D \times \theta_{JA})$.
- *The above numbers for* θ_{JC} *are maximums for limiting the thermal resistance of the package in a standard mounting configuration. The* θ_{JA} *numbers are the guidelines for the thermal performance of the device/pcboard system. All of the above assume no ambient airflow.*

Recommended Operating Conditions[2,3]

Symbol	Parameter	Recommended Operating Conditions			Units
		Min	Typ	Max	
V_{OUT}	Input Voltage Range	$-(\lvert V_{OUT} \rvert +3.5V)$		-36	V
Operating Junction Temperature Range					
	SG137A/137	-55		150	°C

Note:

2. *Range over which the device is functional.*
3. *These ratings are applicable for junction temperatures of less than 135°C.*

Electrical Characteristics

Unless otherwise specified, these specifications apply over full operating ambient temperatures for SG137A/SG137 with -55°C ≤ T_J ≤ 150°C, $|V_{IN} - V_{OUT}|$ = 5.0V, and for I_{OUT} = 100mA. Although power dissipation is internally limited, these specifications are applicable for power dissipations of 2W, and I_{MAX} = 0.5A. Low duty cycle pulse testing techniques are used which maintains junction and case temperatures equal to the ambient temperature.

Symbol	Test Conditions	SG137A			SG137			Units
		Min.	Typ.	Max	Min.	Typ.	Max	
Reference Voltage[6]	I_{OUT} = 10mA, T_J = 25°C	-1.238	-1.250	-1.262	-1.225	-1.250	-1.275	V
	3V ≤ $\|V_{IN} - V_{OUT}\|$ ≤ 40V, 10mA ≤ I_{OUT} ≤ I_{MAX}	-1.220	-1.250	-1.280	-1.200	-1.250	-1.300	V
Line Regulation [4,6]	3V ≤ $\|V_{IN} - V_{OUT}\|$ ≤ 40V, I_{OUT} ≤ I_{MAX}							
	T_J = 25°C		0.005	0.01		0.01	0.02	%/V
Load Regulation[4]	10mA ≤ I_{OUT} ≤ I_{MAX}							
	$\|V_{OUT}\|$ ≤ 5V, T_J= 25°C		5	25		15	25	mV
	$\|V_{OUT}\|$ ≥ 5V, T_J = 25°C		0.1	0.5		0.3	0.5	%
	$\|V_{OUT}\|$ ≤ 5V		10	50		20	50	mV
	$\|V_{OUT}\|$ ≥ 5V		0.2	1		0.3	1	%
Thermal Regulation[5]	T_J= 25°C, 10ms pulse		0.002	0.02		0.002	0.02	%/W
Ripple Rejection	V_{OUT} = -10V, f =120Hz							
	C_{ADJ} = 0, T_J = 25°C	60	66			60		dB
	C_{ADJ} = 10µF	70	80		66	77		dB
Adjust Pin Current	T_A = 25°C		65	100		65	100	µA
Adjust Pin Current Change[6]	3V ≤ $\|V_{IN} - V_{OUT}\|$ ≤ 40V		1.0	5		2	5	µA
	10mA ≤ I_{OUT} ≤ I_{MAX}		0.2	2		0.5	5	µA
Minimum Load Current	$\|V_{IN} - V_{OUT}\|$ ≤ 40V		2.5	5.0		2.5	5.0	mA
	$\|V_{IN} - V_{OUT}\|$ ≤ 10V		1.2	3		1.2	3.0	mA
Current Limit	$\|V_{IN} - V_{OUT}\|$ ≤ 15V	0.5	0.8	1.5	0.5	0.8		A
	$\|V_{IN} - V_{OUT}\|$ ≤ 40V, T_J = 25°C	0.15	0.25	0.5	0.15	0.25		A

Electrical Characteristics

Unless otherwise specified, these specifications apply over full operating ambient temperatures for SG137A/SG137 with -55°C ≤ T_J ≤ 150°C, $|V_{IN} - V_{OUT}|$ = 5.0V, and for I_{OUT} = 100mA. Although power dissipation is internally limited, these specifications are applicable for power dissipations of 2W, and I_{MAX} = 0.5A. Low duty cycle pulse testing techniques are used which maintains junction and case temperatures equal to the ambient temperature.

Symbol	Test Conditions	SG137A			SG137			Units
		Min.	Typ.	Max	Min.	Typ.	Max	
Temperature Stability[5]			0.6	1.5		0.6		%
Long Term Stability[5]	T_J = 125°C, 1000 Hours		0.3	1		0.3	1	%
RMS Output Noise (% of V_{OUT})	T_J = 25°C, 10Hz ≤ f ≤ 10kHz[5]		0.003			0.003		%

Notes:

4. *Regulation is measured at constant junction temperature, using pulse testing with a low duty cycle. Changes in output voltage due to heating effects are covered under the specification for thermal regulation.*
5. *These parameters, although guaranteed, are not tested in production*
6. I_{MAX} *is* $V_{IN} - V_{OUT}$ *= 3V / 500mA and* $V_{IN} - V_{OUT}$ *= 40V / 150mA.*

Characteristic Curves

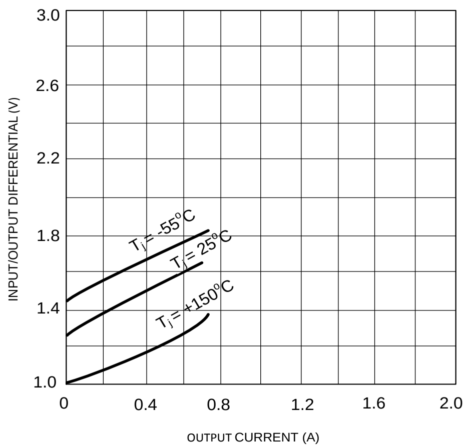


Figure 3 · Input/Output Differential vs. Output Current

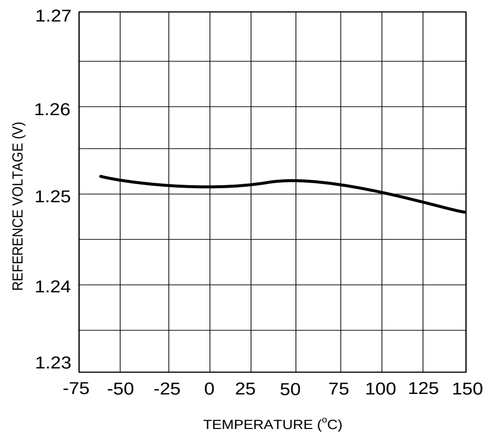


Figure 4 · Reference Voltage Vs. Temperature

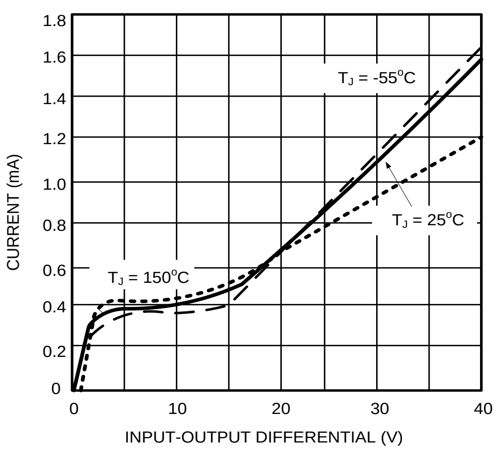


Figure 5 · Current Vs. Input/Output Differential

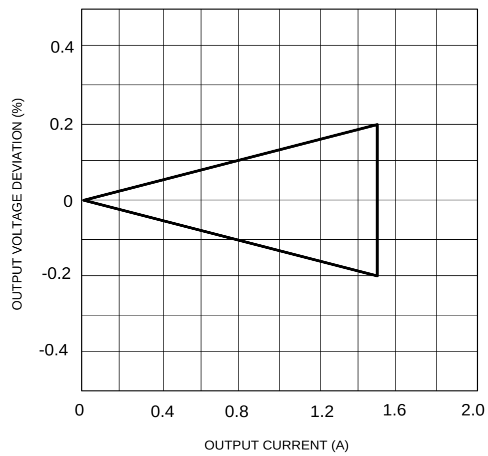


Figure 6 · Output Voltage Deviation Vs. Output Current*

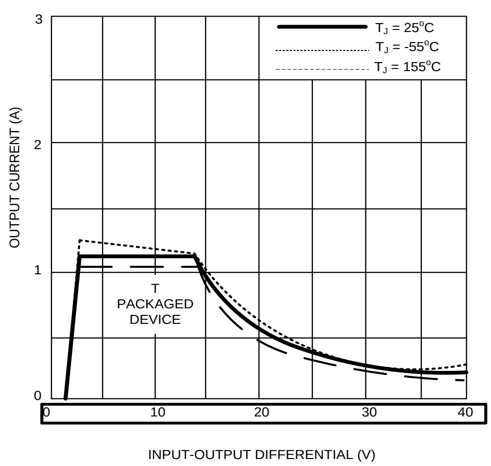


Figure 7 · Input/Output Differential Vs. Output Current

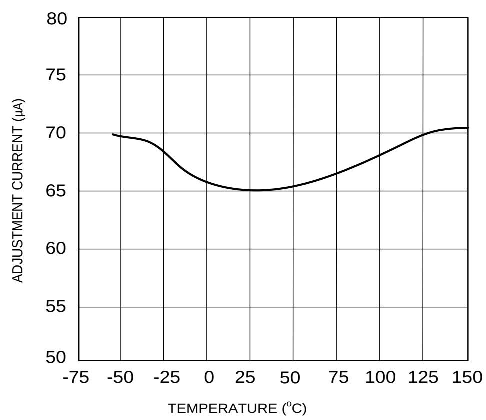


Figure 8 · Adjustment Current Vs. Temperature

*Notes: *The SG137A has load regulation compensation which makes the typical unit read close to zero. This band represents the typical production spread.*

Application Information

Output Voltage

The output voltage is determined by two external resistors, R_1 and R_2

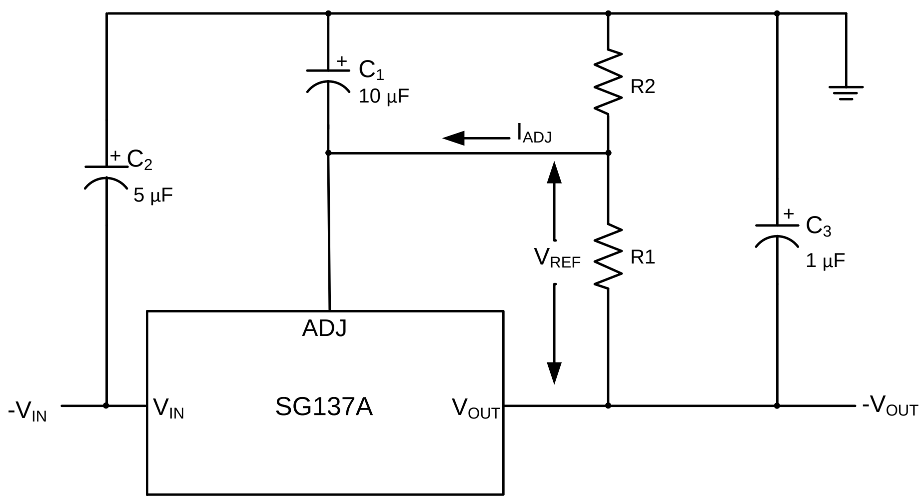


Figure 9 · Output Voltage

The exact formula for the output voltage is:

$$V_{OUT} = V_{REF}\left(\frac{R_2 + R_1}{R_1}\right) + I_{ADJ}\,(R_2)$$

Where: V_{REF} = Reference Voltage and I_{ADJ} = Adjustment Pin Current. In most applications, the second term is small enough to be ignored, typically about 0.5% of V_{OUT}. In more critical applications, the exact formula should be used, with I_{ADJ} equal to 65 µA. Solving for R_2 yields:

$$R_2 = \frac{V_{OUT} - V_{REF}}{\frac{V_{REF}}{R_1} + I_{ADJ}}$$

Smaller values of R_1 and R_2 reduce the influence of I_{ADJ} on the output voltage, but the no-load current drain on the regulator is increased. Typical values for R_1 are between 100 Ω and 300 Ω, giving 12.5mA and 4.2mA no-load current. There is an additional consideration in selecting R_1 the minimum load current specification of the regulator. The operating current of the SG137A flows from input to output. If this current is not absorbed by the load, the output of the regulator rises above the regulated value. The current drawn by R_1 and R_2 is normally high enough to absorb the current, but care must be taken in no–load situations where R_1 and R_2 have high values. The maximum value for the operating current, which must be absorbed, is 5mA for the SG137A. If input and output voltage differential is less than 10V, the operating current that must be absorbed drops to 3mA.

Examples:

1. A precision 10V regulator to supply up to 1 Amp load current.
   a. Select R_1 = 100Ω to minimize effect of I_{ADJ}
   b. Calculate $R_2 = \frac{V_{OUT} - V_{REF}}{(V_{REF}/R_1) + I_{ADJ}} = \frac{10V - 1.25V}{(1.25V/100\ ohms) + 65\mu A} = 704\ ohms$

A 15 V regulator to run off batteries and supply 50mA. $V_{IN\ MAX}$ = 25V

   c. To minimize battery drain, select R1 as high as possible

   $R_1 = \frac{1.25V}{3mA} = 417\Omega$, Use 404Ω, 1%

Typical Application Circuits

The output stability, load regulation, line regulation, thermal regulation, temperature drift, long term drift, and noise can be improved by a factor of 6.6 over the standard regulator configuration. This assumes a zener whose drift and noise is considerably better than the regulator itself. The LM329B has 20PPM/°C maximum drift and about 10 times lower noise than the regulator.

In the application as shown figure 11, regulators #2 to #N tracks regulator #1 to within ±24 mV initially, and to ±60 mV over all load, line, and temperature conditions. If any regulator output is shorted to ground, all other outputs drop to -2V. Load regulation of regulators #2 to #N are improved by V_{OUT}/1.25 V compared to a standard regulator, so regulator #1 should be the one which has the lowest load current.

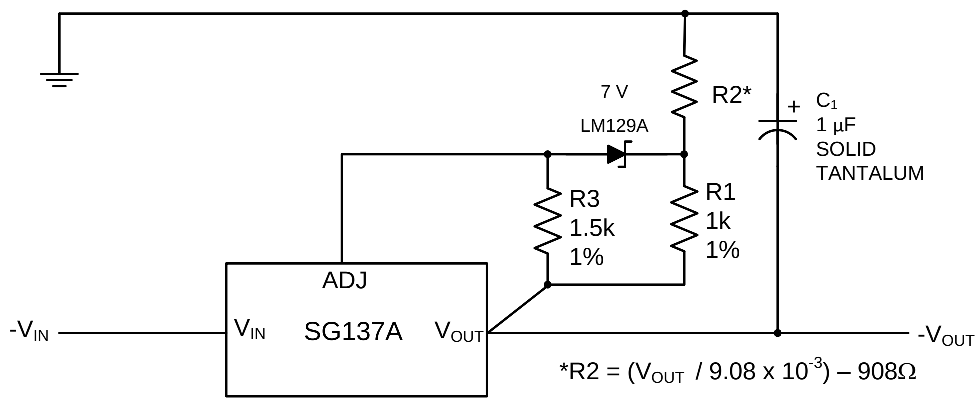


Figure 10 · High Stability Regulator

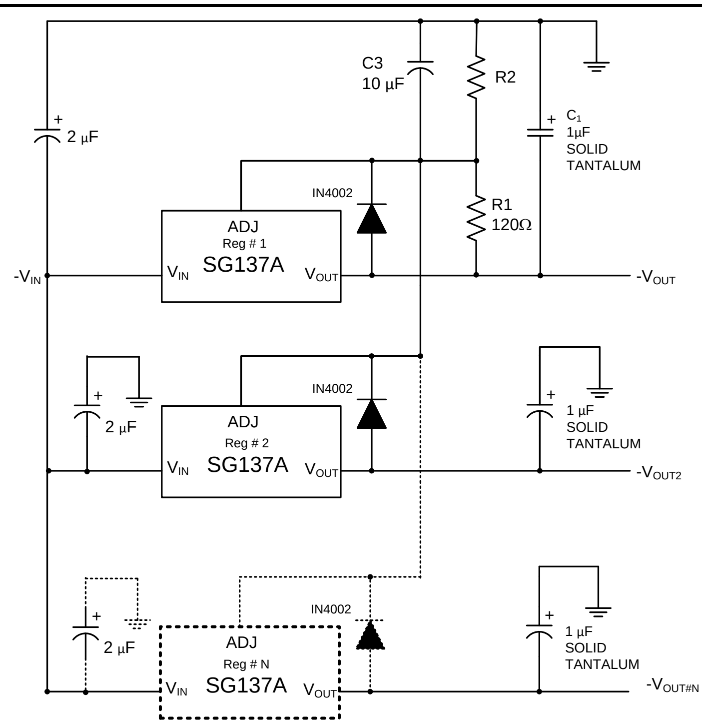


Figure 11 · Multiple Tracking Regulators

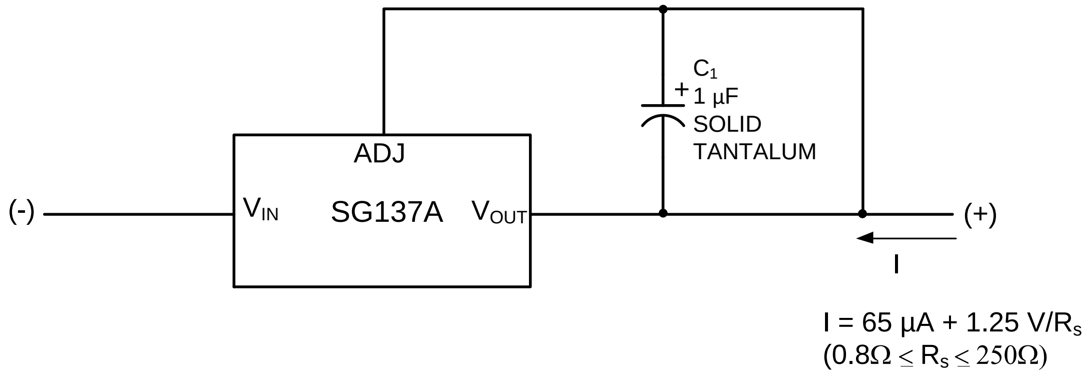


Figure 12 · Current Regulator

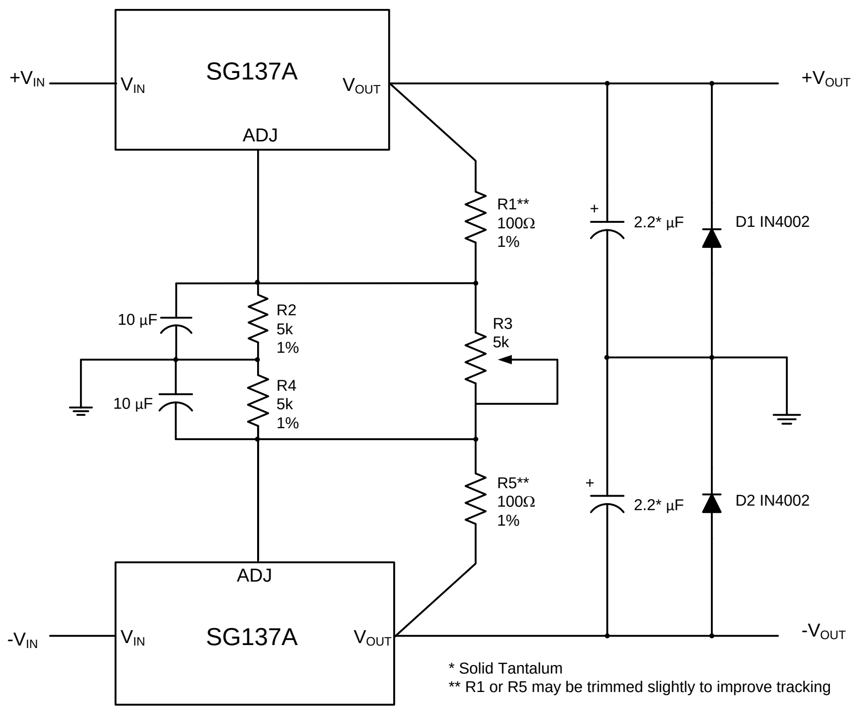
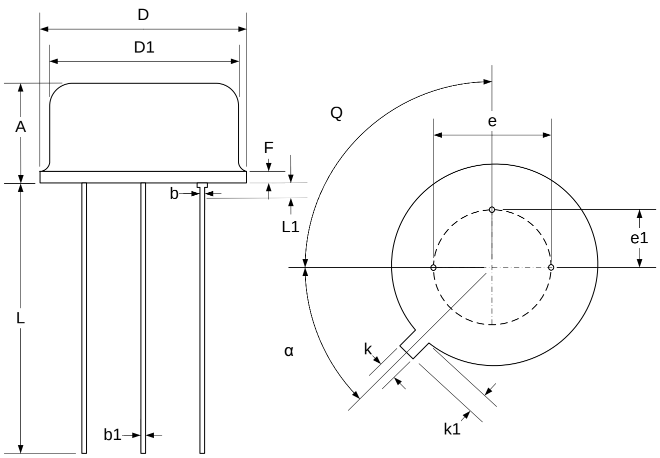


Figure 13 · Dual Tracking Supply ±1.25 V To ±20 V

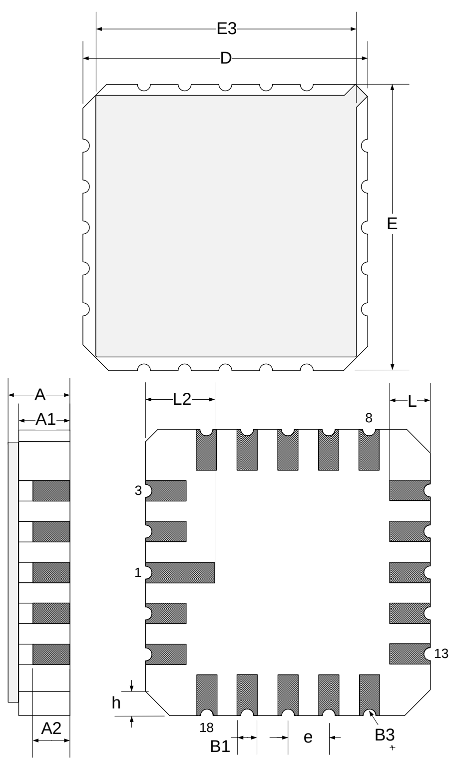
Package Outline Dimensions

Controlling dimensions are in inches, metric equivalents are shown for general information.



Dim	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
D	8.89	9.40	0.350	0.370
D1	8.13	8.51	0.320	0.335
A	4.19	4.70	0.165	0.185
b	0.41	0.48	0.016	0.019
F	-	1.02	-	0.040
e	5.08 BSC		0.200 BSC	
k	0.71	0.86	0.028	0.034
k1	0.74	1.14	0.029	0.045
L	12.70	14.48	0.500	0.570
α	45° TYP		45° TYP	
e1	2.54 TYP		0.100 TYP	
b1	0.41	0.53	0.016	0.021
Q	90° TYP		90° TYP	
L1	-	1.27	-	0.50

Figure 14 · T 3-Pin Metal Can TO-39 Package Dimensions



Dim	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
D/E	8.64	9.14	0.340	0.360
E3	-	8.128	-	0.320
e	1.270 BSC		0.050 BSC	
B1	0.635 TYP		0.025 TYP	
L	1.02	1.52	0.040	0.060
A	1.626	2.286	0.064	0.090
h	1.016 TYP		0.040 TYP	
A1	1.372	1.68	0.054	0.066
A2	-	1.168	-	0.046
L2	1.91	2.41	0.075	0.95
B3	0.203R		0.008R	

Note:

1. All exposed metalized area shall be gold plated 60 micro-inch minimum thickness over nickel plated unless otherwise specified in purchase order.

Figure 15 · L 20-Pin Ceramic Leadless Chip Carrier (LCC) Package Dimensions

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