SG150A/SG250A/SG350A
SG150/SG250/SG350

3 AMP POSITIVE ADJUSTABLE REGULATOR

DESCRIPTION

The SG150/150A series are adjustable 3-terminal positive voltage regulators capable of supplying in excess of 3A over a 1.2V to 33V output range. They are exceptionally easy to use and require only 2 external resistors to set the output voltage. The SG150/150A series offers full overload protection available only in IC's. Included on the chip are current limit, thermal overload protection and safe operating area protection.

Since the regulator is "floating" and sees only the input-to-output differential voltage, supplies of several hundred volts can be regulated as long as the maximum input to output differential is not exceeded.

Supplies needing electronic shutdown can be achieved by clamping the adjustment terminal to ground, which programs the output to 1.2V where most loads draw little current. Reference voltage, which is trimmed to be within ±1% at room temperature, is guaranteed to be within ±2% over all operating conditions for the "A" version and ±4% for the standard version. They are packaged in the hermetic TO-3 and TO-220 (Isolated and Non-Isolated).

FEATURES

- **Trimmed ±1% reference voltage**
- **Adjustable output down to 1.2V**
- **Guaranteed 3A output current**
- **Line Regulation typically 0.1%**
- **Guaranteed thermal regulation**
- **Current limit constant with temperature**
- **86 dB ripple rejection**
- **Standard 3-lead transistor package**

HIGH RELIABILITY FEATURES - SG150A / SG150

- **Available to MIL-STD-883 AND DESC SMD**
- **SG level "S" processing available**

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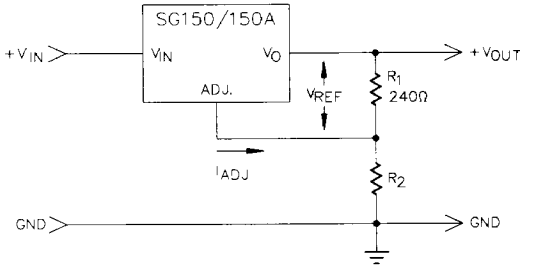
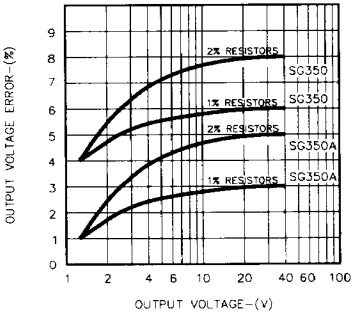
PRECISION REGULATOR



OUTPUT VOLTAGE ERROR



April 1990

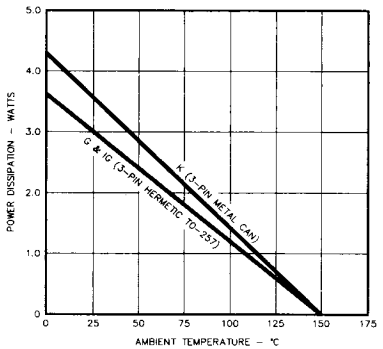
ABSOLUTE MAXIMUM RATINGS (Note 1)

Power Dissipation ..... Internally Limited
Input-Output Voltage Differential 35V
Storage Temperature Range ..... -65°C to 150°C

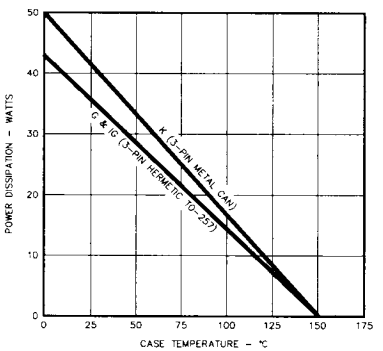
Operating Junction Temperature
Hermetic (K, G, IG-Packages) ..... 150°C
Lead Temperature (Soldering, 10 Seconds) ..... 300°C

Note 1. Exceeding these ratings could cause damage to the device.

THERMAL DERATING CURVES



MAXIMUM POWER DISSIPATION vs AMBIENT TEMPERATURE



MAXIMUM POWER DISSIPATION vs CASE TEMPERATURE

RECOMMENDED OPERATING CONDITIONS (Note 2)

Input Voltage Range ..... 3.0V to 30V

Operation Junction Temperature Range
SG150A/150 ..... -55°C to 150°C
SG250A/250 ..... -25°C to 150°C
SG350A/350 ..... 0°C to 125°C

Note 2. Range over which the device is functional.

ELECTRICAL SPECIFICATIONS

(Unless otherwise specified, these specifications apply over the operating ambient temperatures for SG150A/SG150 with -55°C ≤ T_A ≤ 150°C, SG250A/SG250 with -25°C ≤ T_A ≤ 150°C, SG350A/SG350 with 0°C ≤ T_A ≤ 125°C and V_{IN} - V_{OUT} = 5V, and I_{OUT} = 1.5A. Specifications are applicable for power dissipations up to 30W for the K package. Power dissipation is guaranteed at these values up to 15V input-output differential. Above 15V input-output differential power dissipation is limited by device internal protections circuitry. Low duty cycle pulse testing techniques are used which maintains junction and case temperature equal to the ambient temperature.)

Parameter	Test Conditions	SG150A/SG250A			SG150			Units
		Min.	Typ.	Max.	Min.	Typ.	Max.	
Reference Voltage	**I_{OUT} = 10mA T_J = 25°C**	**1.238**	**1.250**	**1.262**				**V**
	3V ≤ (V_{IN} - V_{OUT}) ≤ 35V, P ≤ 30W,							
	10mA ≤ I_{OUT} ≤ 3A	**1.225**	**1.250**	**1.270**	**1.20**	**1.25**	**1.30**	**V**
Line Regulation	3V ≤ (V_{IN} - V_{OUT}) ≤ 35V, I_L = 10mA,		0.02	0.05		0.02	0.05	%/V
	T_A = 25°C		**0.005**	**0.01**		**0.005**	**0.01**	**%/V**
Load Regulation (Note 3)	10mA ≤ I_{OUT} ≤ 3A							
	V_{OUT} ≤ 5V, T_A = 25°C		**5**	**15**		**5**	**15**	**mV**
	V_{OUT} ≥ 5V, T_A = 25°C		0.1	0.3		0.1	0.3	%
	V_{OUT} ≤ 5V		**15**	**50**		**20**	**50**	**mV**
	V_{OUT} ≥ 5V		0.3	1		0.3	1	%
Thermal Regulation	**T_A = 25°C, 20ms pulse**		**0.002**	**0.01**		**0.002**	**0.01**	**%/W**
Ripple Rejection	V_{OUT} = 10V, f =120Hz							
	C_{ADJ} = 0		**65**			**65**		**dB**
	C_{ADJ} = 10µF	66	86		66	86		dB
Adjust Pin Current			**50**	**100**		**50**	**100**	**µA**
Adjust Pin Current Change	10mA ≤ I_L ≤ 3A, 3V ≤ (V_{IN} - V_{OUT}) ≤ 35V		0.2	5		0.2	5	µA
Minimum Load Current	**(V_{IN} - V_{OUT}) = 35V**		**3.5**	**5**		**3.5**	**5**	**mA**
Current Limit	(V_{IN} - V_{OUT}) ≤ 10V	3	4.5		3	4.5		A
	(V_{IN} - V_{OUT}) = 30V	**0.3**	1		**0.3**	1		**A**

ELECTRICAL SPECIFICATIONS (continued)

Parameter	Test Conditions	SG150A/SG250A			SG150			Units
		Min.	Typ.	Max.	Min.	Typ.	Max.	
Temperature Stability (Note 4)			1			1		%
Long Term Stability (Note 4)	T_A = 125°C		0.3	1		0.3	1	%
RMS Output Noise (% of V_{OUT})	**T_A = 25°C, 10Hz ≤ f ≤ 10KHz**		0.001			0.001		%

Parameter	Test Conditions	SG350A			SG350			Units
		Min.	Typ.	Max.	Min.	Typ.	Max.	
Reference Voltage	**I_{OUT} = 10mA, T_J = 25°C**	1.238	1.250	1.262				V
	3V ≤ (V_{IN} - V_{OUT}) ≤ 35V, P ≤ 30W,							
	10mA ≤ I_{OUT} ≤ 3A	1.225	1.250	1.270	1.20	1.25	1.30	V
Line Regulation	3V ≤ (V_{IN} - V_{OUT}) ≤ 35V, I_L = 10mA		0.02	0.05		0.02	0.07	%/V
	T_A = 25°C		0.005	0.01		0.005	0.03	%/V
Load Regulation (Note 3)	10mA ≤ I_{OUT} ≤ 3A							
	V_{OUT} ≤ 5V, T_A = 25°C		5	15		5	25	mV
	V_{OUT} ≥ 5V, T_A = 25°C		0.1	0.3		0.1	0.5	%
	V_{OUT} ≤ 5V		15	50		20	70	mV
	V_{OUT} ≥ 5V		0.3	1		0.3	1.5	%
Thermal Regulation	**T_A = 25°C, 20ms pulse**		0.002	0.01		0.002	0.03	%/W
Ripple Rejection	V_{OUT} = 10V, f =120Hz							
	C_{ADJ} = 0		65			65		dB
	C_{ADJ} = 10µF	66	86		66	86		dB
Adjust Pin Current			50	100		50	100	µA
Adjust Pin Current Change	10mA ≤ I_L ≤ 3A, 3V ≤ (V_{IN} - V_{OUT}) ≤ 35V		0.2	5		0.2	5	µA
Minimum Load Current	**(V_{IN} - V_{OUT}) = 35V**		3.5	10		3.5	10	mA
Current Limit	(V_{IN} - V_{OUT}) ≤ 10V	3	4.5		3	4.5		A
	(V_{IN} - V_{OUT}) = 30V	0.25	1		0.25	1		A
Temperature Stability (Note 4)			1	2		1		%
Long Term Stability (Note 4)	**T_A = 125°C**		0.3	1		0.3	1	%
RMS Output Noise (% of V_{OUT})	T_A = 25°C, 10Hz ≤ f ≤ 10KHz		0.001			0.001		%

Note 3. Regulation is measured at a constant T_A. Changes in output due to heating must be taken into account seperately. Pulse testing with low duty cycle is used.

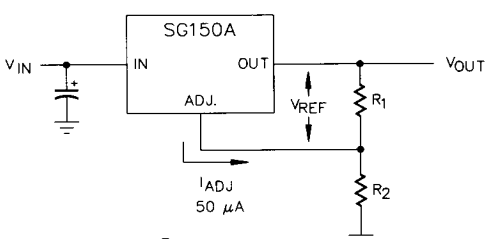
Note 4. These parameters, although guaranteed are not tested in production.

APPLICATIONS INFORMATION

GENERAL

The SG150A develops a 1.25V reference voltage between the output and the adjustable terminal (see Figure 1). By placing a resistor, R_1, between these two terminals, a constant current is caused to flow through R_1 and down through R_2 to set the overall output voltage. Normally this current is the specified minimum load current of 5mA or 10mA.

Because I_{ADJ} is a very small and constant when compared with the current through R_1, it represents a small error and can usually be ignored. It is easily seen from the equation, that even if the resistors were of exact value, the accuracy of the output is limited by the accuracy of V_{REF}. Earlier adjustable regulators had a reference tolerance of ±4% which is dangerously close to the ±5% supply tolerance required in many logic and analog systems. Further, even 1% resistors can drift 0.01%/°C, adding additional error to the output voltage tolerance.



$$V_{OUT} = V_{REF}\left(1+\frac{R_2}{R_1}\right) + I_{ADJ}R_2$$

FIGURE 1 - BASIC ADJUSTABLE REGULATOR

APPLICATIONS INFORMATION

BYPASS CAPACITORS

Input bypassing using a 1μF tantalum or 25μF electrolytic is recommended when the input filter capacitors are more than 5 inches from the device. Improved ripple rejection (80dB) can be accomplished by adding a 10μF capacitor from the adjust pin to ground. Increasing the size of the capacitor to 20μF will help ripple rejection at low output voltage since the reactance of this capacitor should be small compared to the voltage setting resistor, R_2. For improved AC transient response and to prevent the possibility of oscillation due to unknown reactive load, a 1μF capacitor is also recommended at the output. Because of their low impedance at high frequencies, the best type of capacitor to use is solid tantalum.

LOAD REGULATION

Because the SG150A is a three-terminal device, it is not possible to provide true remote load sensing. Load regulation will be limited by the resistance of the wire connecting the regulator to the load. The data sheet specification for load regulation is measured at the bottom of the package. Negative side sensing is a true Kelvin connection, with the bottom of the output divider returned to the negative side of the load. Although it may not be immediately obvious, best load regulation is obtained when the top of the resistor divider (R_2) is connected directly to the case, not the load.

This is illustrated in Figure 2. If R_1 were connected to the load, the effective resistance between the regulator and the load would be:

$$R_P \times \left(\frac{R_2 + R_1}{R_1}\right),\ R_P = \text{Parasitic Line Resistance.}$$

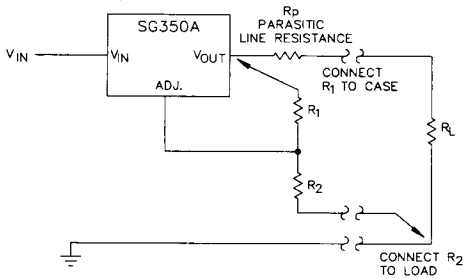


FIGURE 2 - CONNECTIONS FOR BEST LOAD REGULATION

Connected as shown, Rp is not multiplied by the divider ratio. Rp is about 0.004Ω per foot using 16 gauge wire. This translates to 4mV/ft. at a 1A load current, so it is important to keep the positive lead between regulator and load as short as possible, and use large wire or PC board traces.

TYPICAL APPLICATIONS

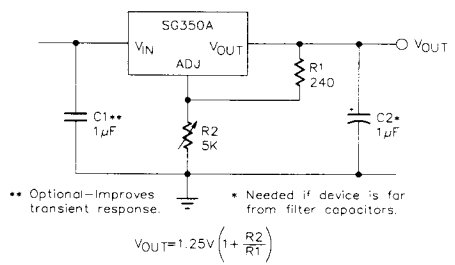


FIGURE 3 - 1.2V - 25V ADJUSTABLE REGULATOR

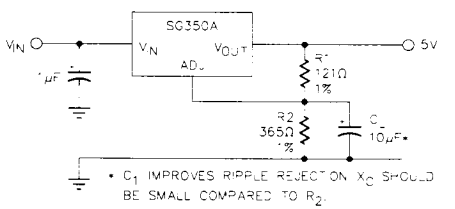


FIGURE 4 - IMPROVING RIPPLE REJECTION

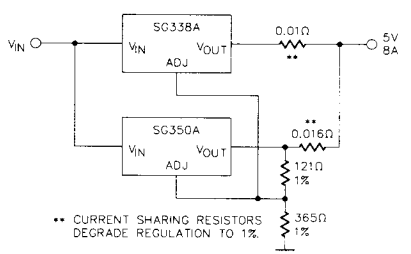


FIGURE 5 - PARALLEL REGULATORS FOR HIGHER CURRENT
(This circuit will not work with LM version devices.)

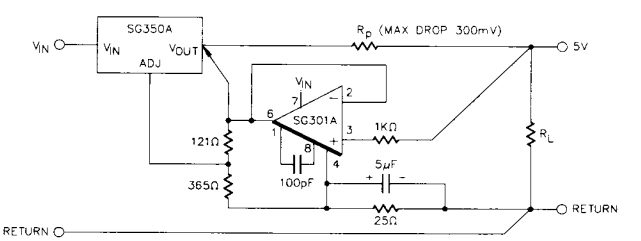


FIGURE 6 - REMOTE SENSING

TYPICAL APPLICATIONS (continued)

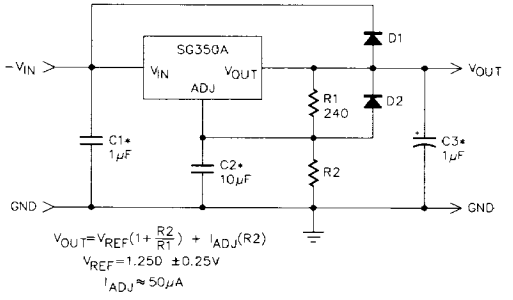


FIGURE 7 - BASIC REGULATOR WITH CAPACITORS* FOR INCREASED PERFORMANCE

* No external capacitors are required with the SG150A/150 but in some application, performance may be improved with added capacitance as follows:

C1. An input capacitor at 0.1μF will protect against problems when high impedance is present. The device can be more sensitive to input impedance when output or adjustment capacitors are used.

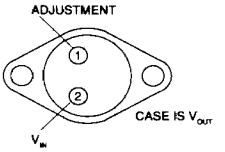
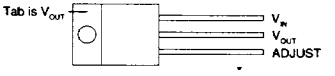
C2. Bypassing the adjustment terminal to ground with a 10μF capacitor will improve the ripple rejection by about 15dB.

C3. A 1μF tantalum capacitors on the output will improve transient response and keep the regulator from ringing due to tight capacitive loading.

In addition to external capacitors, it is sometimes good practice to add protection diodes D1 and D2 if there is a chance that a capacitor may discharge through the regulator IC.

Diode D1 protects against C3 with an input short.
Diode D2 protects against C2 with an output short.

CONNECTION DIAGRAMS & ORDERING INFORMATION (See Notes Below)

Package	Part No.	Ambient Temperature Range	Connection Diagram
3-TERMINAL TO-3 METAL CAN K-PACKAGE	SG150AK/883B SG150AK SG250AK SG350AK SG150K/883B SG150K SG250K SG350K	-55°C to 125°C -55°C to 125°C -25°C to 85°C 0°C to 70C -55°C to 125°C -55°C to 125°C -25°C to 85°C 0°C to 70°C	
3-PIN HERMETIC TO-257 G-PACKAGE (Non-Isolated) 3-PIN HERMETIC TO-257 IG-PACKAGE (Isolated)	SG150AG/883B SG150AG SG150G/883B SG150G SG150AIG/883B SG150AIG SG150IG/883B SG150IG	-55°C to 125°C -55°C to 125°C -55°C to 125°C -55°C to 125°C -55°C to 125°C -55°C to 125°C -55°C to 125°C -55°C to 125°C	

Note 1. Contact factory for JAN and DESC product availability.
2. All parts are viewed from the top.