PLESSEY
Semiconductors

T-79-07-10

SL550G

LOW NOISE WIDEBAND AMPLIFIER WITH EXTERNAL GAIN CONTROL

The SL550 is a silicon integrated circuit designed for use as a general-purpose wideband linear amplifier with remote gain control. At a frequency of 60MHz, the SL550G noise figure is 1.8dB (typ.) from a 200 ohm source, giving good noise performance directly from a microwave mixer. The SL550 has an external gain control facility which can be used to obtain a swept gain function and makes the amplifier ideal for use either in a linear IF strip or as a low noise preamplifier in a logarithmic strip.

External gain control is performed in the feedback loop of the main amplifier which is buffered on the input and output, hence the noise figure and output voltage swing are only slightly degraded as the gain is reduced. The external gain control characteristic is specified with an accuracy of ±1dB, enabling a well-defined gain versus time law to be obtained.

The input transistor can be connected in common emitter or common base and the quiescent current of the output emitter follower can be increased to enable low impedance load to be driven.

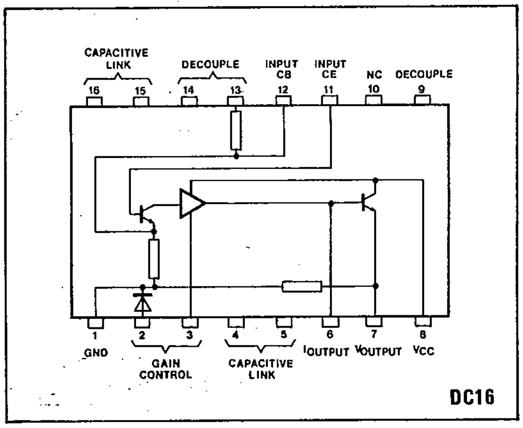


Fig. 1 Pin connections (top view)

FEATURES

- 200 MHz Bandwidth
- Low Noise Figure
- Well-Defined Gain Control Characteristic
- 25dB Gain Control Range
- 40dB Gain
- Output Voltage 0.8Vp-p (Typ.)

APPLICATIONS

- Low Noise Preamplifiers
- Swept Gain Radar IFs

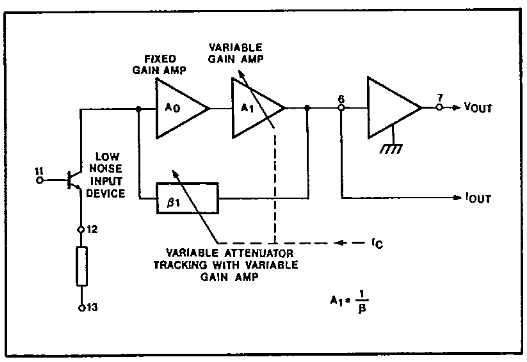


Fig. 2 Functional diagram

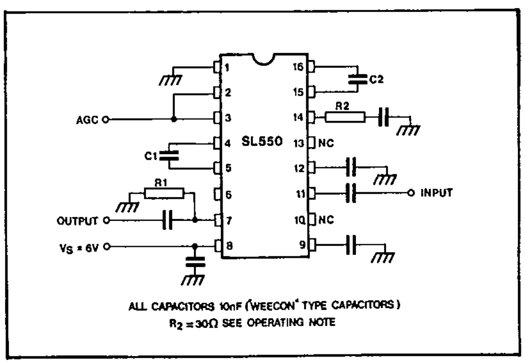


Fig. 3 Test circuit

T-79-07-10

ELECTRICAL CHARACTERISTICS

Test conditions (unless otherwise stated):
f = 30MHz, Vs = +6V, R_L = 200Ω, Ic = 0, R_1 = 750Ω, T_{amb} = +25°C

Characteristic	Value Min.	Value Typ.	Value Max.	Units	Conditions
Voltage gain	39	42	44	dB	
Gain control characteristic		See Note 1			
Gain reduction at mid-point		10		dB	Ic = 0.24mA
Max. gain reduction	20	25		dB	Ic = 2.0mA
Noise figure		2.0	2.7	dB	Rs = 200Ω
		3.5		dB	Rs = 50Ω
Output voltage		0.15		Vrms	R_1 = ∞
		0.3		Vrms	R_1 = 750Ω
Supply current		11	13	mA	R_1 = ∞
		15		mA	R_1 = 750Ω
Gain variation with supply voltage		0.2		dB/V	Vs = 6V to 9V
Upper cut-off frequency (-3dB w.r.t. 30MHz)		125		MHz	
Gain variation with temperature (see Note 2)		±3		dB	T_{amb} = -55°C to +125°C

NOTES
1. The external gain control characteristic is specified in terms of the gain reduction obtained when the control current (Ic) is increased from zero to the specified current.
2. This can be reduced by using an alternative input configuration (see operating note: 'Wide Temperature Range').

OPERATING NOTES

Input Impedance

The input capacitance, which is typically 12pF at 60MHz, is independent of frequency. The input resistance, which is approximately 1.5k at 10MHz, decreases with frequency and is typically 500 ohms at 60MHz.

Control Input

Gain control is normally achieved by a current into pin 2. Between pin 2 and ground is a forward biased diode and so the voltage on pin 2 will vary between 600 mV at Ic = 1 µA to 800 mV at Ic = 2 mA. The amplifier gain is varied by applying a voltage in this range to pin 3. To avoid problems associated with the sensitivity of the control voltage and with operation over a wide temperature range the diode should be used to convert a control current to a voltage which is applied to pin 3 by linking pins 2 and 3.

Minimum Supply Current

If the full output swing is not required, or if high impedance loads are being driven, the current consumption can be reduced by omitting R_1 (Fig. 3). The function of R_1 is to increase the quiescent current of the output emitter follower.

High Output Impedance

A high impedance current output can be obtained by taking the output from pin 6 (leaving pin 7 open-circuit). Maximum output current is 2 mA peak and the output impedance is 350 Ω.

Wide Temperature Range

The gain variation with temperature can be reduced at the expense of noise figure by including an internal 30 Ω resistor in the emitter of the input transistor. This is achieved by decoupling pin 13 and leaving pin 12 open-circuit. Gain variation is reduced from ±3dB to ±1dB over the temperature range —55°C to +125°C (Figs. 6 and 7).

Low Input Impedance

A low input impedance (≃25 Ω) can be obtained by connecting the input transistor in common base. This is achieved by decoupling pin 11 and applying the input to pin 12 (pin 13 open-circuit).

High Frequency Stability

Care must be taken to keep all capacitor leads short and a ground plane should be used to prevent any earth inductance common between the input and output circuits. The 30 Ω resistor (pin 14) shown in the test circuit eliminates high frequency instabilities due to the stray capacitances and inductances which are unavoidable in a plug-in test system. If the amplifier is soldered directly into a printed circuit board then the 30 Ω resistor can be reduced or omitted completely.

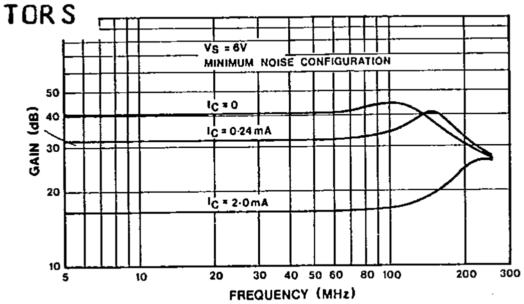


Fig. 4 Frequency response

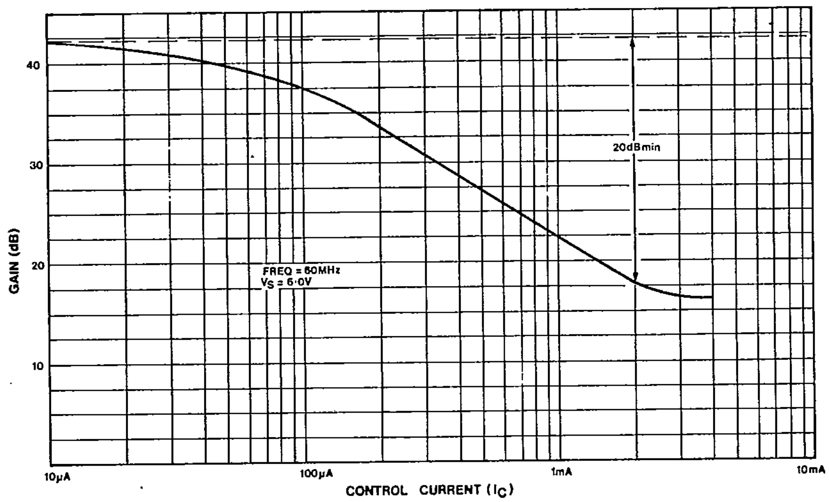


Fig. 5 Gain control characteristic

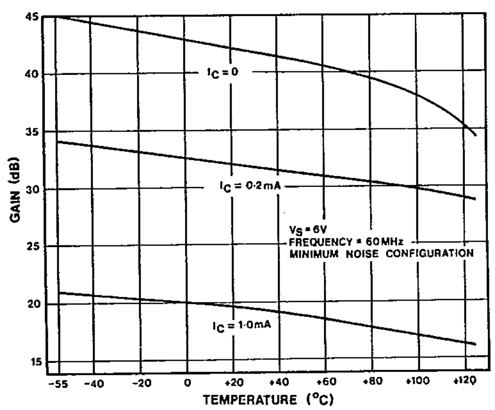


Fig. 6 Voltage gain v. temperature (pin 12 decoupled, standard circuit configuration)

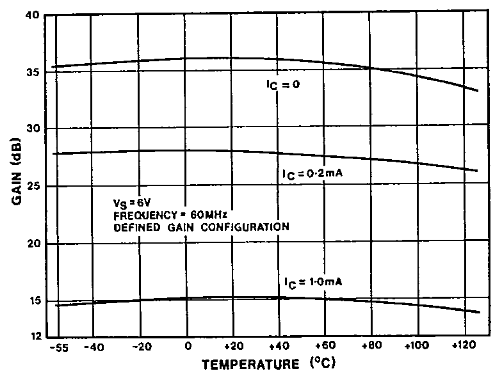


Fig. 7 Voltage gain v. temperature (pin 13 decoupled for improved gain variation with temperature – see operating notes)

T-79-07-10

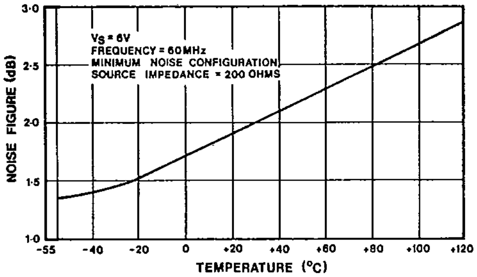


Fig. 8 Typical noise figure

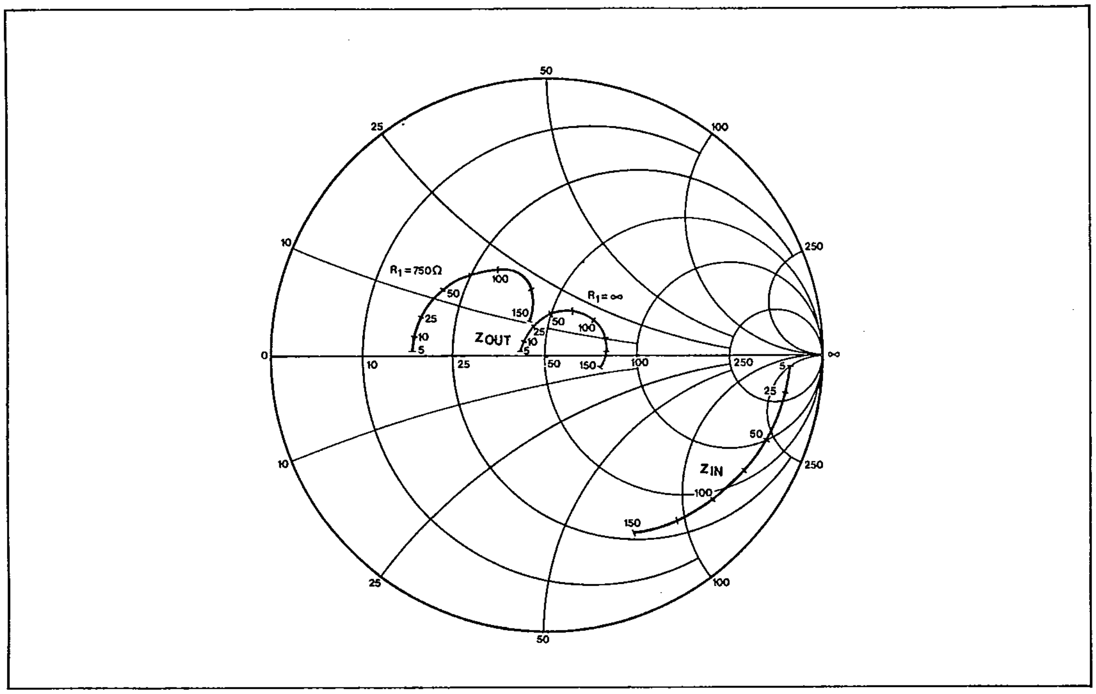


Fig.9 Input and output impedances (Vs = 6V)

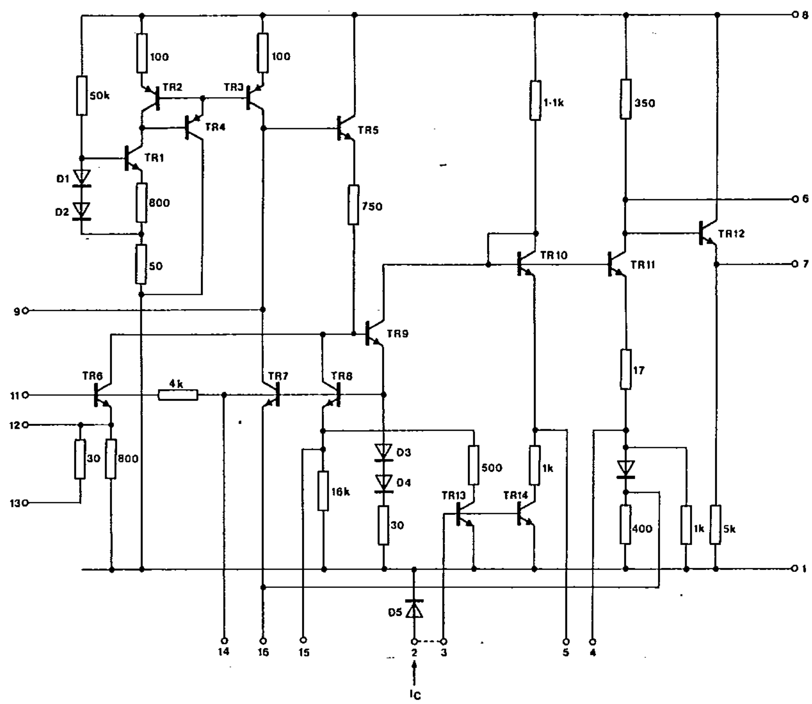


Fig.10 Circuit diagram

APPLICATION NOTES

A wideband high gain configuration using two SL550s connected in series is shown in Fig. 11. The first stage is connected in common emitter configuration, whilst the second stage is a common base circuit. Stable gains of up to 65 dB can be achieved by the proper choice of R1 and R2. The bandwidth is 5 to 130 MHz, with a noise figure only marginally greater than the 2.0 dB specified for a single stage circuit.

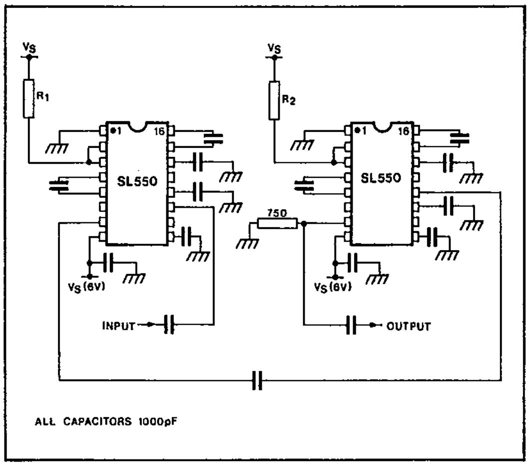


Fig. 11 A two-stage wide-band amplifier

T-79-07-10

A voltage gain control which is linear with control voltage can be obtained using the circuit shown in Fig. 12. The input is a voltage ramp which is negative going with respect to ground. The output drives the control current pins 2 and 3 directly (see Fig. 13). If two SL550s in the strip are controlled as shown in Fig. 14, with a linear ramp input to the linearising circuit, a fourth power law (power gain v. time) will be obtained over a 50 dB dynamic range.

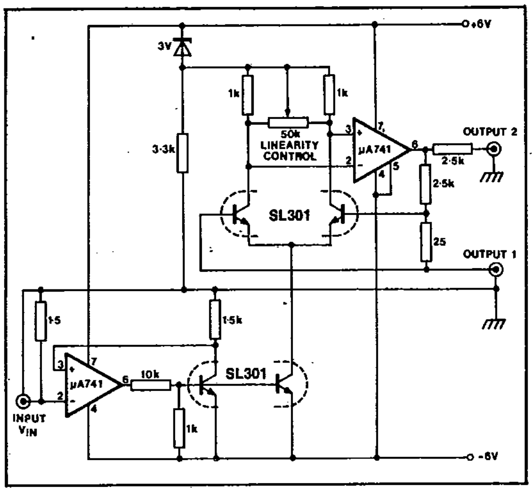


Fig. 12 Gain control linearising circuit

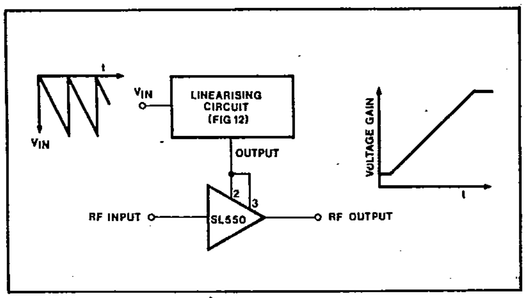


Fig. 13 Linear swept gain circuit

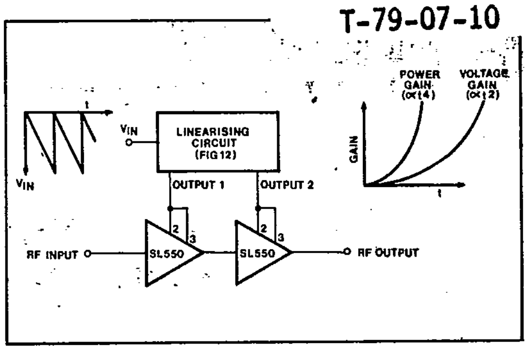
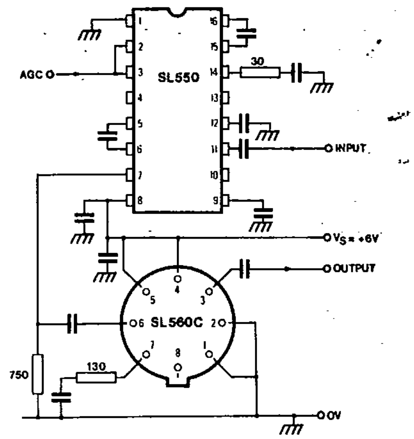


Fig. 14 Square law swept gain circuit



All Capacitors 10nF
Gain 46dB
Noise figure 2.0dB (RS = 200Ω)
Output power +5dBm (R1 = 50Ω)
Frequency response as SL550G
Dynamic range 70dB (1MHz bandwidth)

Fig. 15 Applications example of wide dynamic range: 50Ω load amplifier with AGC using SL500 series integrated circuit.

ABSOLUTE MAXIMUM RATINGS

Storage temperature	—55°C to +150°C
Ambient operating temp.	—40°C to +125°C
Max. continuous supply Voltage wrt pin 1	+9V
Max. continuous AGC current	
pin 2	10mA
pin 3	1mA