SILICON GENERAL

LINEAR INTEGRATED CIRCUITS

HIGH FREQUENCY VIDEO AMPLIFIER

DESCRIPTION

A monolithic integrated voltage amplifier useful over a frequency range from DC to 200 MHz. Internal emitter followers are used to achieve high input and low output impedances, allowing simple capacitor coupling. Biasing and gain-setting resistors are internally diffused, eliminating external resistor networks. The gain may be externally varied through the use of AGC diodes which are included in the circuit.

The SG1401 will operate over the full military ambient temperature range of -55°C to 125°C while the SG2401 and SG3401 are designed for 0°C to 70°C applications.

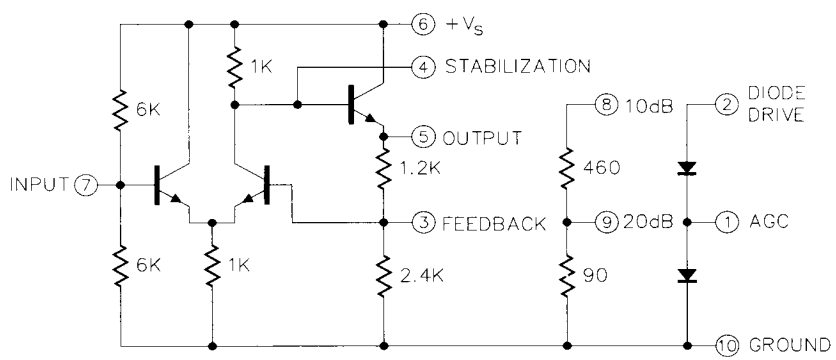
FEATURES

- **20dB voltage gain at 100MHz**
- **5ns rise and fall times**
- **Fixed or variable gain**
- **Single power supply voltage**
- **Minimum external components**
- **Symmetrical limiting**

HIGH RELIABILITY FEATURES -SG1401

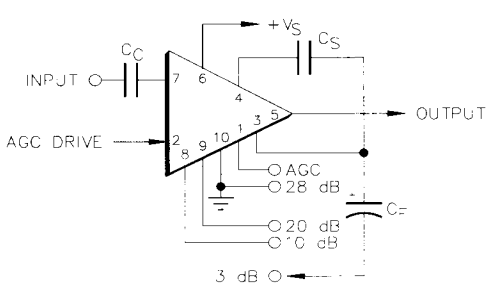
- **Available to MIL-STD-883**
- **SG level "S" processing available**

SCHEMATIC DIAGRAM



(Pin numbers correspond to T-package)

BLOCK DIAGRAM



(Pin numbers correspond to T-package)

$C_F = \frac{1}{2\pi f_c R}$ where f_c is Low Frequency corner and R is the Gain setting.

C_S = 0 to 10pF to minimize high frequency peaking.

10

April 1990

See Application Notes for additional information.

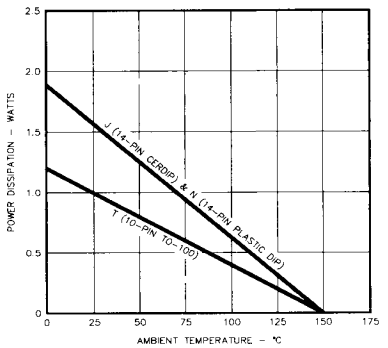
ABSOLUTE MAXIMUM RATINGS (Note 1)

Supply Voltage 20V
AGC Diode Current 5mA
Lead Temperature (Soldering, 10 Seconds) ..... 300°C

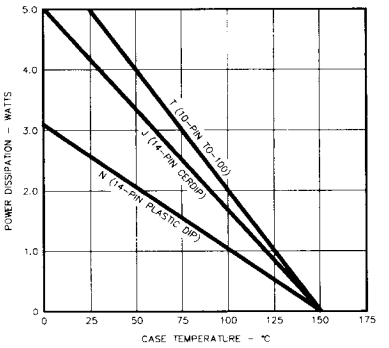
Operating Junction Temperature
Hermetic (J, T-Packages) ..... 150°C
Plastic (N-Packages) ..... 150°C
Storage Temperature Range ..... -65°C to 150°C

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)

Supply Voltage ..... 8V to 18V

Operation Ambient Temperature Range
SG1401 ..... -55°C to 125°C
SG2401/SG3401 ..... 0°C to 70°C

Note 2. Range over which the device is functional.

ELECTRICAL SPECIFICATIONS

(Unless otherwise specified, these specifications apply for the operating ambient temperatures of T_A = 25°C, V_S = +12V, and f = 1MHz. Low duty cycle pulse testing techniques are used which maintains junction and case temperatures equal to the ambient temperature.)

Parameter	Test Conditions	SG1401/SG2401			SG3401			Units
		Min.	Typ.	Max.	Min.	Typ.	Max.	
Supply Voltage		6	12	20	6	12	20	V
Power Consumption	No AGC Voltage		90	110		90	120	mW
DC Output Voltage			8.7			8.7		V
Peak-to-Peak Output	Pin 3(4) to AC Ground (Note 3)		4			3		V
Voltage Gain	Pin 3(4) open (Note 3)	2.2	2.7	3.2	2.2	2.7	3.2	dB
	Pin 3(4) coupled to pin 8(11) (Note 3)	9	10	11	9	10	11	dB
	Pin 3(4) coupled to pin 9(12) (Note 3)	18	20	21	18	20	21	dB
	Pin 3(4) to AC Ground (Note 3)	26	28	31	24	26	31	dB
Unity Gain Frequency	Pin 3(4) to AC Ground (Note 3)		200			200		MHz
Input Resistance	20dB Gain		2.5			2.5		KΩ
Output Resistance	20dB Gain		25			50		Ω
Input Capacitance	20dB Gain		5			5		pF
Maximum Power Gain	20dB Gain, R_L = 50Ω		30			30		dB
Temperature Stability (Note 4)	20dB Gain, $T_A = T_{MIN}$ to T_{MAX}		±0.5	±1		±1	±2	dB
AGC Range	20dB Gain, R_S = 1K	20	22			22		dB
Noise Figure			6	8		6		dB

Note 3. Numbers in parenthesis refer to dual-in-line package.
Note 4. These parameters, although guaranteed, are not tested in production.

CHARACTERISTIC CURVES (Pin Numbers correspond to T - Package)

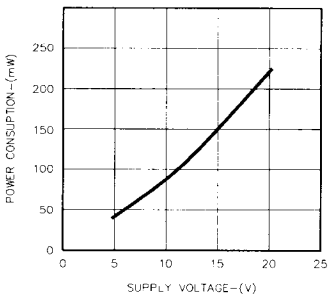


FIGURE 1.
POWER CONSUMPTION VS. SUPPLY VOLTAGE

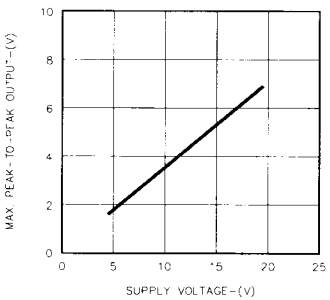


FIGURE 2.
MAXIMUM OUTPUT VS. SUPPLY VOLTAGE

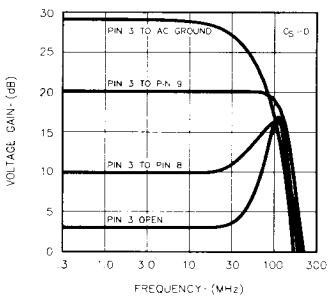


FIGURE 3.
FREQUENCY RESPONSE

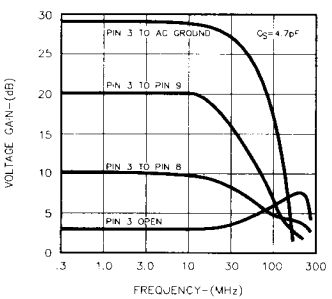


FIGURE 4.
STABILIZED FREQUENCY RESPONSE

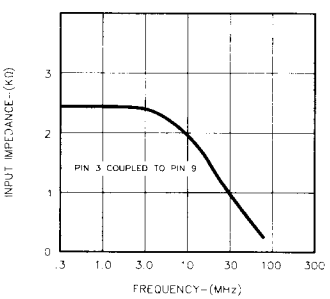


FIGURE 5.
INPUT IMPEDANCE VS. FREQUENCY

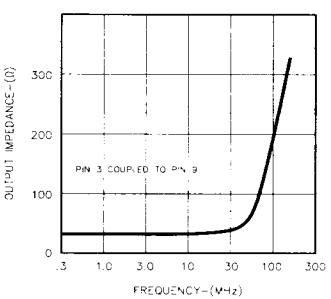


FIGURE 6.
OUTPUT IMPEDANCE VS. FREQUENCY

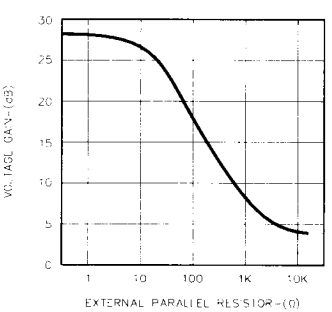


FIGURE 7.
EXTERNAL GAIN CONTROL

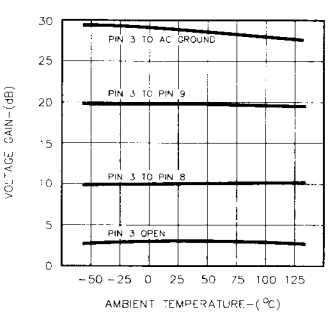


FIGURE 8.
TEMPERATURE STABILITY

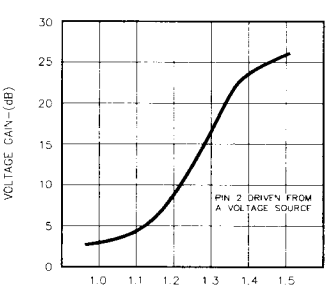


FIGURE 9.
GAIN VS. AGC DIODE VOLTAGE

10

CHARACTERISTIC CURVES (continued)

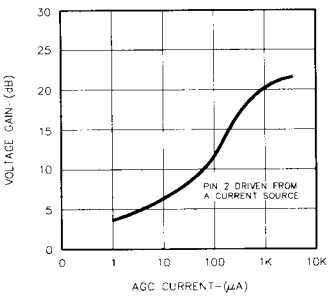


FIGURE 10.
GAIN VS. AGC DIODE CURRENT

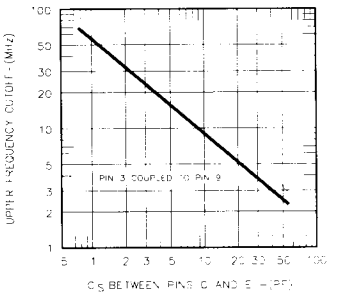


FIGURE 11.
UPPER CUTOFF FREQUENCY VS. C_S VALUE

APPLICATION INFORMATION

The SG1401 series has been designed to provide maximum versatility as a general-purpose, single-ended amplifier. With its broad frequency capability, this circuit will be useful in a wide range of applications provided that the usual considerations for high frequency circuit designs are observed. The following information is presented toward aiding in the optimization of the many possible configurations of this device.

FIXED GAIN

In the circuit configurations shown in Figure 12, the overall voltage gain is approximated by resistors R1 and the parallel combination of R_2 and R_3, as

$$A_V \approx 1 + \frac{R_1}{R} \text{ where } R = \frac{R_2 R_3}{R_2 + R_3}$$

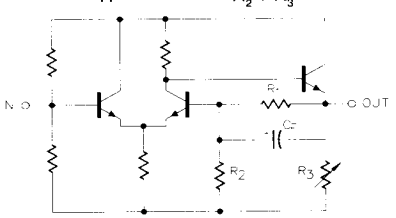


FIGURE 12

With no external connections, the voltage gain is determined solely by R_1 and R_2 and is 1½ or 3 dB. Decreasing the effective value of R_2 by capacitively coupling a lower resistor in parallel, raises the gain. Four fixed gain settings are provided internal to the circuit; however, any other setting within the maximum gain of the amplifier is possible with external resistors as shown in Figure 7.

The value of the coupling capacitor, C_F is determined by the low frequency response desired, as its capacitive reactance will add to the value of the resistance it couples. Therefore, the lower cutoff frequency will be

$$f_C \approx 2 \frac{1}{R_3 C_F}$$

Utilizing the internal 90 or 460 ohm resistors for higher gain settings provides the added advantage of maximum temperature stability since the close tracking of adjacent diffused resistors keeps their ratio constant. Typical temperature variation of this circuit is shown in Figure 8.

VARIABLE GAIN

Since the dynamic impedance of a forward-biased diode is inversely proportional to the current through it, a convenient gain control can be achieved by using a pair of diodes as a variable impedance. In the circuit of Figure 13, R_3 has been replaced by two diodes whose impedances act in parallel due to the decoupling of C_D. If the diodes are driven from a voltage source, a logarithim relationship between gain and control signal is achieved (see Figure 9); while if a current source is used, the relationship is linear as shown in Figure 10.

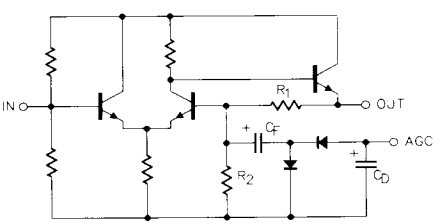


FIGURE 13

There are two limitations on this form of gain control. First, the diodes' capacitance limits their effectiveness to frequencies below 20MHz and, secondly, the signal voltage across the diodes should be held to less than 50 millivolts RMS to minimize self-modulation of amplifier gain. Additionally, the AGC current should be limited to 3mA maximum to keep the diodes out of saturation.

APPLICATION INFORMATION (continued)

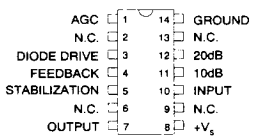
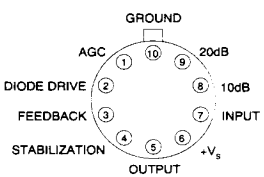
HIGH FREQUENCY STABILITY

With the capability of operation at 100MHz, the SG1401 series also has some susceptibility to external stray reactances; however, with reasonable care, complete stability may be assured. Some general precautions which should be considered include the following:

1. Power supply decoupling close to the circuit terminals (a 0.1μF capacitor is usually adequate).
2. Maintain separation of input and output lines.
3. Minimize load capacitance or insert a series resistor (up to 50Ω) in the output.
4. Purposely limit the high frequency response with a stabilizing capacitor C_S between pins 3 and 4.

Since the gain of this circuit is reduced by increasing the amount of feedback, the potential for instability is greatest when the gain is at its minimum value. This characteristic and the stabilizing effects of a 4.7 picofared capacitor between pins 4 and 3 are illustrated in the frequency response curves presented in Figures 3 & 4. The relationship between the value of C_S and the upper cutoff frequency of a 20dB gain setting is shown in Figure 11.

CONNECTION DIAGRAMS & ORDERING INFORMATION (See Notes Below)

Package	Part No.	Ambient Temperature Range	Connection Diagram
14-PIN CERAMIC DIP J - PACKAGE	SG1401J/883B SG1401J SG2401J SG3401J	-55°C to 125°C -55°C to 125°C 0°C to 70°C 0°C to 70°C	
14-PIN CERAMIC DIP N - PACKAGE	SG2401N SG3401N	0°C to 70°C 0°C to 70°C	
10-PIN METAL CAN T - PACKAGE	SG1401T/883B SG1401T SG2401T SG3401T	-55°C to 125°C -55°C to 125°C 0°C to 70°C 0°C to 70°C	

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