ANALOG DEVICES

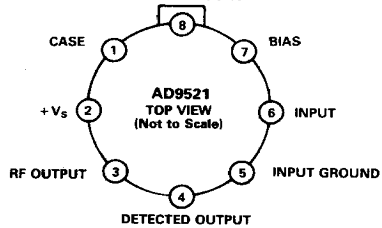
250MHz Wideband Logarithmic Amplifier

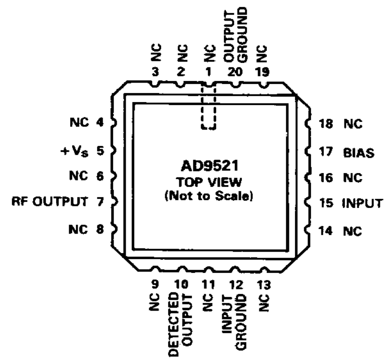
AD9521

FEATURES
250MHz Bandwidth
Monolithic Construction
Low Noise Figure 4.7dB
Excellent Detected Output Matching
Direct Replacement for SL521/SL1521

APPLICATIONS
Missile Guidance
Electronic Warfare (ECM, ECCM, ESM)
Miniaturized LOG Strips
Nuclear Instrumentation

PIN DESIGNATIONS





GENERAL DESCRIPTION

The AD9521 is a wideband amplifier stage with a logarithmic detected output. The high-performance bipolar process used to construct the AD9521 allows operation from 10MHz to 250MHz with minimal gain variation. The AD9521 is pin compatible with the SL521 and the SL1521.

The AD9521 is constructed in a well controlled monolithic process which provides very good gain tolerance (±1.5dB) over the full performance range. An added benefit of the high gain tolerance is a high degree of detected output current matching from device to device. The matching combined with the low 4dB noise figure allows the construction of 80dB to 90dB dynamic range LOG strips with better than ±1dB linearity.

The AD9521 is offered in two gain tolerance grades as both a commercial temperature range device, 0 to +70°C, and as an extended temperature range device, −55°C to +125°C. All grades are available packaged in 8-pin TO-99 metal cans with the military grades also available packaged in ceramic LCC.

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ORDERING INFORMATION

Device	Detected Output Matching	Temperature Range	Description	Package Options*
AD9521JH	0.2mA	0 to +70°C	8-Pin Can, Industrial	H-08A
AD9521KH	0.1mA	0 to +70°C	8-Pin Can, Industrial	H-08A
AD9521SE	0.2mA	−55°C to +125°C	20-Pin LCC, Extended Temperature	E-20A
AD9521SH	0.2mA	−55°C to +125°C	8-Pin Can, Extended Temperature	H-08A
AD9521TE	0.1mA	−55°C to +125°C	20-Pin LCC, Extended Temperature	E-20A
AD9521TH	0.1mA	−55°C to +125°C	8-Pin Can, Extended Temperature	H-08A

*See Section 20 for package outline information.

SPECIFICATIONS

ABSOLUTE MAXIMUM RATINGS[1]

Supply Voltage ($+V_S$) . . . . +9V
Differential Voltage Between Grounds 0.5V
Maximum Input Before Overload . . . . 1.9V rms
Instantanious Voltage at the Detected
  Video Output 12V
RF Output Current 10mA
Power Dissipation 500mW

Operating Temperature Range[2]
  AD9521JH/KH . . . . 0 to +70°C
  AD9521SE/SH/TE/TH . . . . −55°C to +125°C
Storage Temperature Range . . . . −55°C to +150°C
Junction Temperature . . . . +175°C
Lead Soldering Temperature (10sec) . . . . +300°C

ELECTRICAL CHARACTERISTICS (Supply Voltages = +6V; INPUT connected to BIAS pin; R_S = 50Ω; $C_L \leq$ 8pF, unless otherwise stated)

Parameter	Mil[3] Sub Group	Temp	Industrial Temp. Range 0 to +70°C						Military Temp. Range −55°C to +125°C						Units
			AD9521JH			AD9521KH			AD9521SE/SH			AD9521TE/TH			
			Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
AC PERFORMANCE															
Voltage Gain (f_{IN} = 30MHz)	7	+25°C	11.5	12.2	12.5	11.5	12.2	12.5	11.5	12.2	12.5	11.5	12.2	12.5	dB
	8	Full	11.0		13.0	11.0		13.0	11.0		13.0	11.0		13.0	dB
Voltage Gain (f_{IN} = 60MHz)	7	+25°C	12.0	12.8	13.0	12.0	12.8	13.0	12.0	12.8	13.0	12.0	12.8	13.0	dB
	8	Full	11.7		13.7	11.7		13.7	11.7		13.7	11.7		13.7	dB
Voltage Gain (f_{IN} = 120MHz)	7	+25°C	12.2	13.0	13.8	12.2	13.0	13.8	12.2	13.0	13.8	12.2	13.0	13.8	dB
	8	Full	11.5		14.5	11.5		14.5	11.5		14.5	11.5		14.5	dB
Voltage Gain (f_{IN} = 160MHz)	7	+25°C	12.7	13.4	14.2	12.7	13.4	14.2	12.7	13.4	14.2	12.7	13.4	14.2	dB
	8	Full	11.5		14.5	11.5		14.5	11.5		14.5	11.5		14.5	dB
Input Capacitance		+25°C		6			6			6			6		pF
Noise Figure[4]	12	+25°C		4.7	4.9		4.7	4.9		4.7	4.9		4.7	4.9	dB
Gain Variation vs. Temperature[5]		Full		0.67			0.67			0.67			0.67		dB
Gain Variation vs. Supply[6]	7, 8			0.74	1.15		0.74	1.15		0.74	1.15		0.74	1.15	dB/V
Frequency Response															
Upper Cutoff Frequency	7	+25°C	230	245		230	245		230	245		230	245		MHz
	8	Full	200			200			200			200			MHz
Lower Cutoff Frequency	7, 8	Full		7	10		7	10		7	10		7	10	MHz
DETECTED VIDEO OUTPUT															
Output Current @ 60MHz (Max)[7]	7	+25°	0.90	1.02	1.10	0.95	1.02	1.05	0.90	1.02	1.10	0.95	1.02	1.05	mA
	8	Full	0.80		1.20	0.85		1.15	0.80		1.20	0.85		1.15	mA
(80% Input Level)[8]	7	+25°C	0.70	0.82	0.90	0.75	0.82	0.85	0.70	0.82	0.90	0.75	0.82	0.85	mA
(No Input)[9]	7	+25°C		0.02	0.04		0.02	0.04		0.02	0.04		0.02	0.04	mA
Output Current @ 120MHz (Max)[7]	7	+25°C	0.51	0.70	0.90	0.62	0.70	0.85	0.51	0.70	0.90	0.62	0.70	0.85	mA
	8	Full	0.40		0.91	0.51		0.90	0.40		0.91	0.51		0.90	mA
(80% Input Level)[8]	7	+25°C	0.50	0.68	0.86	0.60	0.68	0.81	0.50	0.68	0.86	0.60	0.68	0.81	mA
(No Input)[9]	7	+25°C		0.02	0.04		0.02	0.04		0.02	0.04		0.02	0.04	mA
Detected Output Variation vs. Supply[6]	7	+25°C		28	30		28	30		28	30		28	30	%/V
Detected Output vs. Temperature[5]		Full		9			9			9			9		%
RF OUTPUT[5,7]															
Maximum RF Output Voltage		+25°C		1.6			1.6			1.6			1.6		V p-p
RF Output Propagation Delay		+25°C		1.4			1.4			1.4			1.4		ns
POWER SUPPLY[10]															
Supply Current (+6.0V)	1	+25°C		14.0	16.0		14.0	16.0		14.0	16.0		14.0	16.0	mA
	2, 3	Full			16.5			16.5			16.5			16.5	mA
Nominal Power Dissipation		+25°C		84			84			84			84		mW

NOTES
[1]Absolute maximum ratings are limiting values, to be applied individually, and beyond which serviceability of the circuit may be impaired. Functional operation under any of these conditions is not necessarily implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.
[2]Typical thermal impedance . . .
  AD9521 Metal Can θ_{JA} = 185°C/W; θ_{JC} = 50°C/W
  AD9521 LCC θ_{JA} = 80°C/W; θ_{JC} = 50°C/W.
[3]Military subgroups apply to military qualified devices only.
[4]R_S = 450Ω; 60MHz.
[5]A_{IN} = 60MHz.
[6]Measured at ±5% of $+V_S$; A_{IN} = 60MHz.
[7]Input = 0.5V rms.
[8]Input = 0.09V rms.
[9]Input = 0.0V rms.
[10]Supply voltage should remain stable within ±5% for normal operation.

Specifications subject to change without notice.

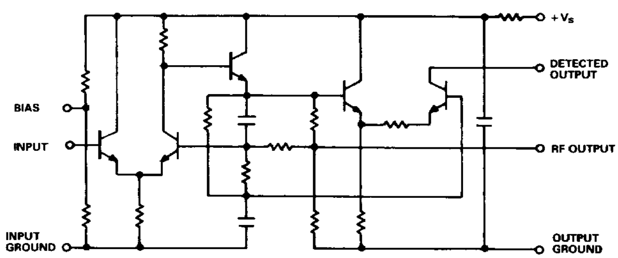
EXPLANATION OF GROUP A MILITARY SUBGROUPS

Subgroup 1 – Static tests at +25°C.
Subgroup 2 – Static tests at max rated operating temp.
Subgroup 3 – Static tests at min rated operating temp.
Subgroup 4 – Dynamic tests at +25°C.
Subgroup 5 – Dynamic tests at max rated operating temp.
Subgroup 6 – Dynamic tests at min rated operating temp.
Subgroup 7 – Functional tests at +25°C.
Subgroup 8 – Functional tests at max and min rated operating temp.
Subgroup 9 – Switching tests at +25°C.
Subgroup 10 – Switching tests at max rated operating temp.
Subgroup 11 – Switching tests at min rated operating temp.
Subgroup 12 – Periodically sample tested.

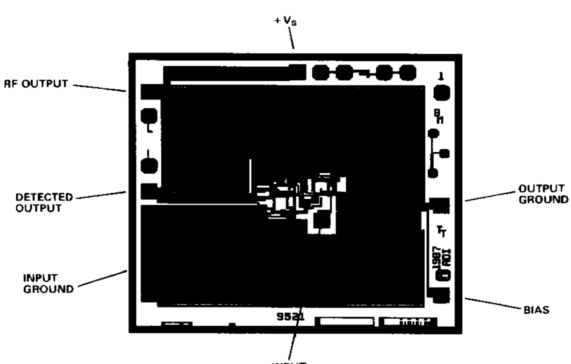
FUNCTIONAL DESCRIPTION

PIN NAME	DESCRIPTION
CASE	– Case connection for the TO-99 metal can package only.
$+V_S$	– Positive supply terminal, nominally +6.0V.
RF OUTPUT	– The RF OUTPUT is used to drive subsequent LOG detection stages. The RF OUTPUT level is roughly +12dB above the IF signal strength at the input.
DETECTED OUTPUT	– The DETECTED OUTPUT provides a dc current logarithmicly proportional to the IF signal level at the input.
INPUT GROUND	– Isolated input ground connection. The input and output grounds should be connected together near the AD9521.
INPUT	– IF signal input.
BIAS	– The BIAS connection is tied to the INPUT pin to provide an adequate biasing level between ac coupled stages. The bias connection should be omitted between direct dc coupled stages.
OUTPUT GROUND	– Isolated output ground connection. The input and output grounds should be connected together near the AD9521.

SCHEMATIC



DIE LAYOUT AND MECHANICAL INFORMATION



Die Dimensions	86×97×15 (±2) mils
Pad Dimensions	4×4 mils
Metalization	Aluminum
Backing	None
Substrate Potential	$-V_S$
Passivation	Oxynitride
Die Attach	Gold Eutectic
Bond Wire	1.25 mil Aluminum; Ultrasonic Bonding or 1mil Gold; Gold Ball Bonding

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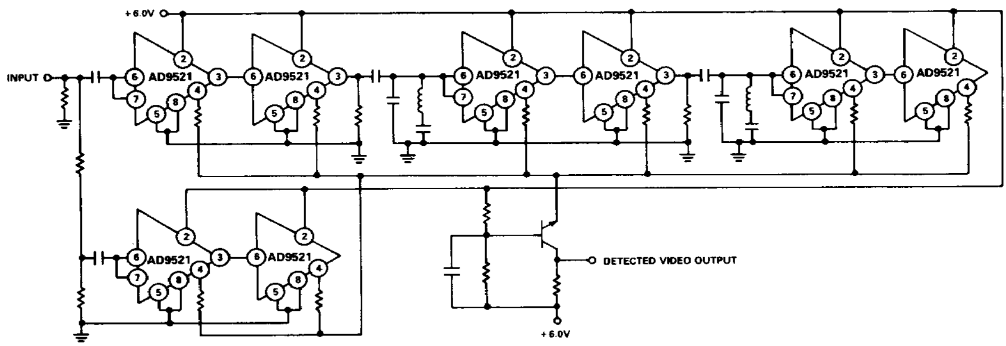
TYPICAL LOG STRIP CONFIGURATION



APPLICATIONS INFORMATION

The AD9521 is primarily designed for use in successive detection LOG strips. The application circuit above, illustrates the typical configuration for one such design with roughly 90dB of dynamic range. In operation the IF input signal level is successively amplified by each stage in the upper chain. The IF signal at each stage generates a detected output current. The detected output current from each stage is summed in the common base follower stage at the end of the strip.

The key to the circuit is the limiting quality of the AD9521 logarithmic detected output. As the IF signal at each stage drives the detected output into saturation, the output current ceases to increase. In operation, the combined gain of all of the previous stages drives the last stage into saturation first. Any further increase in signal level will not increase the detected output level of the last stage, but all of the previous stages will enter saturation one-by-one as the signal level increases.

The limiting factor to the number of stages that can be combined is the input noise level. When the gain of the entire strip is sufficient to drive the last stage into saturation on the input noise of the first stage alone, further extensions of the strip will not increase the dynamic input range.

There are, however, two methods of increasing the dynamic range of the LOG strip which include bandwidth reduction and parallel strip configurations. The dynamic range can be extended by 20dB or more by incorporating a parallel log strip with an attenuated input. The main strip functions as before, but the second strip, because of the attenuation, only contributes to the output for signals in excess of the main strip saturation level. The ultimate limitation is the maximum input signal level which the main strip will tolerate. Any further signal level increases could damage the input stage of the AD9521. This should not be a major problem since with this technique the dynamic range of the total strip can be as high as 100dB.

The dynamic range can also be increased by reducing the bandwidth of the strip itself. The noise voltage is directly proportional to the square root of the circuit bandwidth. This means that large operating bandwidths produce large amounts of noise which translates into limited dynamic range. The AD9521 is a particularly low-noise device, but even it can benefit from bandwidth reduction which has been incorporated into the circuit above. The two interstage filters limit the noise to a smaller region of frequencies and thereby allow the strip to be extended further.

Because of the high-frequency nature of the AD9521, several guidelines should be followed to insure optimum performance. The first is the use of an adequate low impedance ground plane. Just as important is the use of power supply decoupling capacitors to prevent signal feedthrough on the supply lines. Chip capacitors are highly recommended because of their reduced lead inductance. Sockets are not likely to produce the best results because of the interlead capacitance, but if they must be used, pin sockets are preferred.