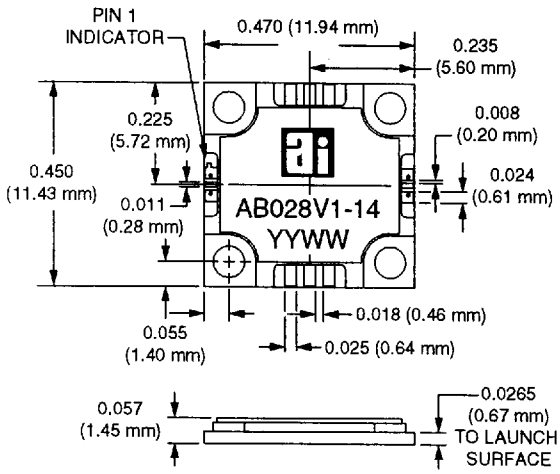
23–30 GHz Variable Gain Amplifier

Alpha

AB028V1-14

Features

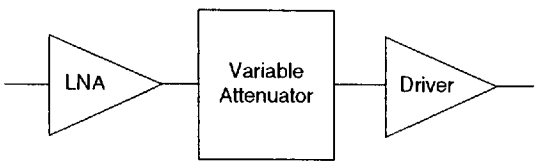
- 30 dB Gain
- 30 dB Attenuation Range
- +16 dBm Output Power
- 3 dB Noise Figure
- Rugged, Reliable Package
- 100% RF and DC Testing



Description

The AB028V1-14 is a broadband millimeterwave variable gain amplifier in a rugged package. The amplifier is designed for use in millimeterwave communication and sensor systems as the receiver front-end or transmitter gain stage when high gain, wide dynamic range, and low noise figure are required. The robust ceramic and metal package provides excellent electrical performance, excellent thermal performance, and a high degree of environmental protection for long-term reliability. A single supply voltage simplifies bias requirements. All amplifiers are screened at the operating frequencies prior to shipment for guaranteed performance. Amplifier is targeted for millimeterwave point-to-point and point-to-multipoint wireless communications systems.

Block Diagram



Electrical Specifications at 25°C ($V_{D1} = V_{D2} = V_{D3} = +5.5$ V)

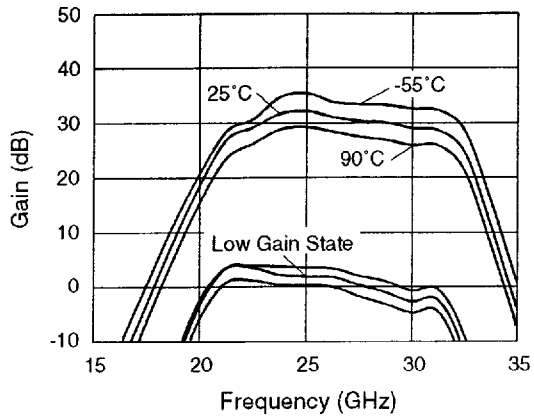
RF

Parameter	Symbol	Min.	Typ.	Max.	Unit
Bandwidth	BW	23	22–33	32	GHz
Small Signal Gain - Max Gain State (V_C = -1.5 V)	G	27	30		dB
Noise Figure - Max Gain State (V_C = -1.5 V)	NF		3	3.6	dB
Output Power at 1 dB Gain Comp. - Max Gain State (V_C = -1.5 V)	$P_{1\ dB}$	14	16		dBm
Input Return Loss	RL_I		15		dB
Output Return Loss	RL_O		15		dB
Attenuation Range	G_{RANGE}	25	30		dB
Temperature Coefficient of Gain	dG/dT		-0.035		dB/C

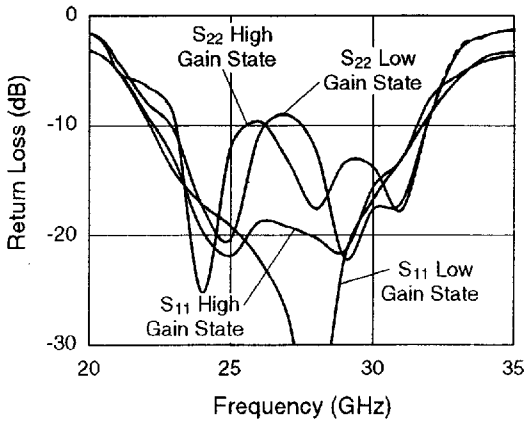
DC

Parameter	Symbol	Min.	Typ.	Max.	Unit
Drain Current 1	I_{D1}		20		mA
Drain Current 2	I_{D2}		22		mA
Drain Current 3	I_{D3}		70		mA
Total Drain Current	$I_{D1} + I_{D2} + I_{D3}$		112	160	mA
Control Current	I_C		< 1		µA

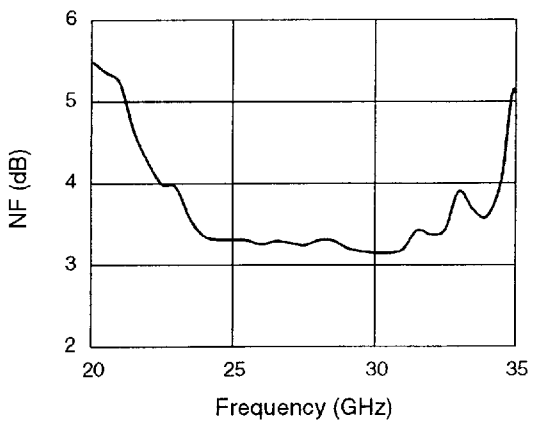
Typical Performance Data



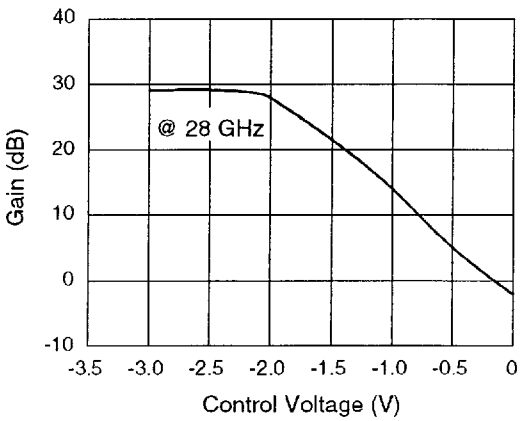
Gain vs. Frequency



Return Loss vs. Frequency

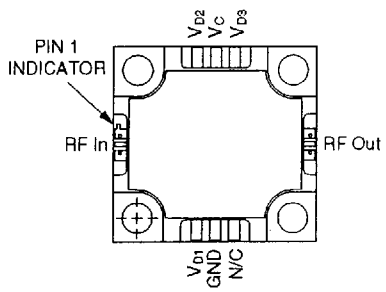


Noise Figure vs. Frequency



Gain vs. V_C

Pin Out



Absolute Maximum Ratings

Characteristic	Value
Operating Temperature (T_{OP})	-55°C to +90°C
Storage Temperature (T_{ST})	-65°C to +150°C
Bias Voltage (V_{D1})	6 V_{DC}
Bias Voltage (V_{D2})	6 V_{DC}
Bias Voltage (V_{D3})	7 V_{DC}
Control Voltage (V_C)	-7 V_{DC}
Power In (P_{IN})	0 dBm

Typical S-Parameters

High Gain State

Frequency (GHz)	S_{11}		S_{21}		S_{12}		S_{22}	
	Mag. (dB)	Ang. (Deg.)	Mag. (dB)	Ang. (Deg.)	Mag. (dB)	Ang. (Deg.)	Mag. (dB)	Ang. (Deg.)
10.0	-0.5	38.9	-48.1	-107.1	-48.2	-78.5	-0.4	19.5
15.0	-0.6	-82.0	-28.3	-33.3	-46.4	-81.5	-0.6	-86.4
20.0	-3.1	166.3	18.7	-129.6	-42.1	-82.0	-1.6	165.6
21.0	-5.0	138.7	26.6	104.9	-42.5	-84.3	-5.1	137.9
22.0	-8.9	113.7	29.1	-22.9	-42.7	-86.0	-6.4	131.1
23.0	-13.0	98.6	31.1	-135.0	-42.3	-85.9	-9.1	90.0
24.0	-19.6	92.4	32.7	110.1	-42.3	-92.1	-25.3	11.8
25.0	-21.9	120.1	32.8	-2.6	-42.4	-90.4	-12.0	177.5
26.0	-18.8	116.3	31.8	-109.1	-42.5	-76.9	-9.6	130.3
27.0	-19.2	56.8	31.1	153.4	-42.0	-81.9	-13.1	83.1
28.0	-20.2	-50.7	30.9	54.7	-42.5	-79.1	-17.6	124.0
29.0	-21.4	-140.6	30.1	-49.3	-41.6	-70.8	-13.3	71.0
30.0	-15.6	175.7	29.6	-151.4	-40.2	-64.8	-13.8	49.1
31.0	-13.0	169.2	29.3	99.4	-39.7	-62.8	-17.7	-82.5
32.0	-7.6	104.6	28.3	-33.3	-36.7	-73.1	-9.1	130.4
33.0	-5.4	66.5	21.1	-178.9	-34.5	-85.9	-3.0	61.5
34.0	-4.1	29.9	8.9	64.9	-37.8	-112.1	-1.9	18.4
35.0	-3.6	-1.2	-3.9	-24.0	-40.3	-94.7	-1.3	-16.1
38.0	-3.0	-72.9	-36.1	177.7	-41.1	-76.7	-1.3	-82.8
40.0	-3.1	-106.0	-32.8	-47.4	-39.6	-61.3	-1.5	-112.3

Low Gain State

Frequency (GHz)	S_{11}		S_{21}		S_{12}		S_{22}	
	Mag. (dB)	Ang. (Deg.)	Mag. (dB)	Ang. (Deg.)	Mag. (dB)	Ang. (Deg.)	Mag. (dB)	Ang. (Deg.)
10.0	-0.6	33.6	-49.3	-66.4	-48.3	-84.4	-0.4	19.6
15.0	-0.6	-81.9	-45.9	-52.0	-46.4	-82.2	-0.6	-86.4
20.0	-2.9	165.9	-3.5	-126.1	-41.8	-82.2	-1.6	166.6
21.0	-5.0	137.6	3.3	97.3	-42.4	-82.6	-4.2	137.3
22.0	-9.3	113.0	4.8	-39.5	-42.4	-83.8	-7.8	124.1
23.0	-14.1	106.4	3.9	-155.3	-42.0	-86.5	-10.4	106.8
24.0	-17.1	112.2	3.0	101.7	-42.4	-91.7	-17.4	82.9
25.0	-19.1	103.2	2.5	3.9	-42.6	-88.7	-20.3	-168.5
26.0	-22.1	84.8	2.3	-92.7	-42.8	-80.9	-10.8	159.4
27.0	-27.2	46.6	1.8	167.8	-42.2	-80.1	-9.0	110.2
28.0	-37.6	-62.5	0.5	66.8	-41.6	-81.7	-12.3	60.5
29.0	-22.0	-151.1	-1.0	-31.9	-42.2	-72.9	-22.1	48.6
30.0	-16.7	-178.0	-2.2	-129.0	-40.5	-64.5	-17.6	87.0
31.0	-13.0	150.2	-2.1	118.0	-39.9	-66.3	-17.0	20.8
32.0	-9.0	112.4	-5.5	-31.5	-37.0	-72.2	-9.2	145.6
33.0	-5.8	70.6	-17.7	-153.3	-34.6	-85.3	-3.3	65.1
34.0	-3.7	33.4	-37.4	71.7	-37.7	-108.6	-1.8	18.4
35.0	-3.3	-0.8	-34.4	-70.0	-39.9	-98.7	-1.3	-16.2
38.0	-3.1	-73.3	-41.6	-96.0	-41.0	-76.7	-1.3	-82.7
40.0	-3.2	-105.9	-38.6	-68.8	-38.5	-55.2	-1.5	-112.2

Co-Planar Millimeterwave Package Handling/Mounting

Co-planar packages (Figure 1) require careful mounting design to maintain optimal performance and to minimize VSWR interactions. A connection to the ground pads on either side of the RF line is optional and will depend on the type of material and geometry of the interface at the RF ports.

Handling

In general the co-planar ceramic package is quite rugged. However, due to ceramic's brittle nature one should exercise care when handling with metal tools. Do not apply heavy pressure to the lid. Vacuum tools may be used to pick and place this part.

The Cu-Mo-Cu base of this package is very durable, however, care should be exercised when attaching with screw hardware on packages which come with screw holes. Over-tightening of screws could deform the base, which could cause cracks in the ceramic walls. Only personnel trained in both ESD precautions, and handling precautions should be allowed to handle these packages.

Microstrip Mounting

An example of a co-planar microstrip launch is illustrated in Figure 2 using an equal height dielectric material. A hole is cut into the circuit board to allow the package to be mounted directly to the circuit ground plane. The hole should be cut as close to the outer dimensions of the package to minimize RF gap distances.

It is preferred to match (mirror) the geometry of the package interface to achieve best results. Three 5 x 1/4 mil ribbon bonds will complete the connection providing a minimum discontinuity connection. Multiple bondwires are also acceptable.

Surface Mounting

Mounting of the package to the surface (Figure 3) of a circuit can be accomplished by using a series of via holes to provide ground for the package. Although, this method is not preferred it can be done if careful design practices are used. Via spacing and size may have a strong effect on high frequency performance of the package.

Package Attachment

The package can be conductive epoxy attached to its mounting surface using either a paste or film media. SnPb eutectic attachment can also be used in situations were heat removal is important. Some packages allow for hardware mounting. Care should be taken to ensure good ground contact is maintained.

RF/DC Bondwire Attachment

Standard thermosonic ball or ribbon attachment is used to make the connections to the RF and DC interfaces. When designing the layout, be aware that most bonding machines have a limited reach and may require special tooling to wire/ribbon bond in center of a large circuit.

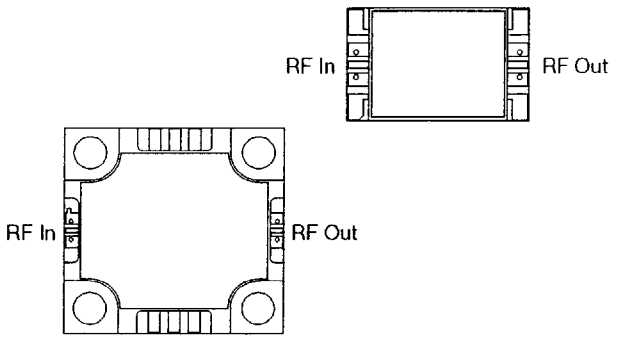


Figure 1. Co-Planar Packages

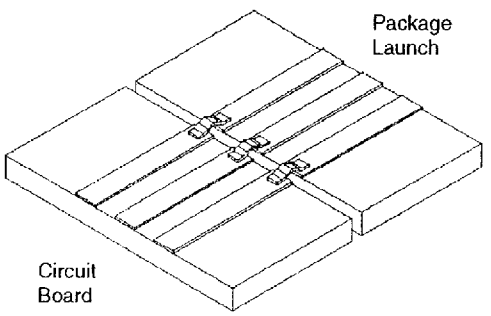


Figure 2. Microstrip Mount

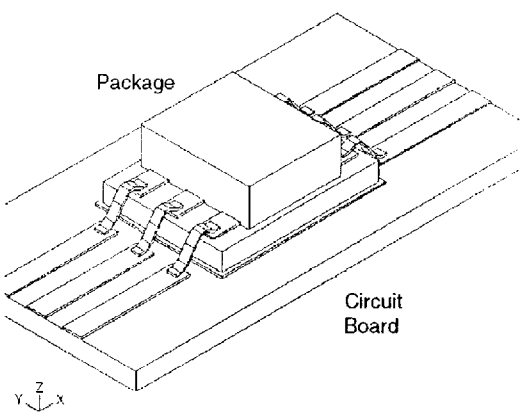


Figure 3. Surface Mount