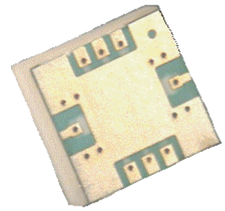
AMMP-5024

30kHz – 40 GHz Traveling Wave Amplifier

AVAGO TECHNOLOGIES

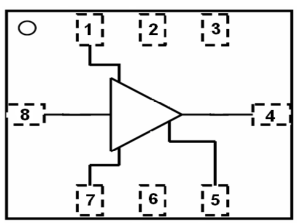
Data Sheet



Description

Avago Technologies' AMMP-5024 is a broadband PHEMT GaAs MMIC TWA designed for medium output power and high gain over the full 30 KHz to 40 GHz frequency range. The design employs a 9-stage, cascade-connected FET structure to ensure flat gain and power as well as uniform group delay. E-beam lithography is used to produce uniform gate lengths of 0.15um and MBE technology assures precise semiconductor layer control.

Pin Connections (Top View)



Pin	Function
1	V_{aux}
2	Not Used
3	Not Used
4	RF_{out} / Vdd
5	V_{g1}
6	Not Used
7	V_{g2}
8	RF_{in}

RoHS-Exemption

Please refer to Hazardous substances table on page 11.

Features

- Surface Mount Package 5.0 x 5.0 x 2.0 mm
- Wide Frequency Range 30kHz – 40GHz
- High Gain: 14.8 dB Typical @ 22GHz
- Output P1dB: 22 dBm Typical @ 22GHz
- 50 Ohm Input and Output Match

Applications [1]

- Broadband Test and Measurement Applications

Notes:
1. Use in hermetic assemblies only.

Attention:
Observe precautions for handling electrostatic sensitive devices.

ESD Machine Model (Class A): 40V
ESD Human Body Model (Class 0): 150V
Refer to Avago Application Note A004R: Electrostatic Discharge Damage and Control.

Table 1. Absolute Maximum Ratings[1]

Symbol	Parameters and Test Conditions	Unit	Minimum	Maximum
V_{dd}	Positive Drain Voltage	V	-	10
I_{dd}	Total Drain Current	mA	-	380
V_{g1}	First Gate Voltage	V	-9.5	0
I_{g1}	First Gate Current	mA	-38	1
V_{g2}	Second Gate Voltage	V	-3.5	4
I_{g2}	Second Gate Current	mA	-20	-
P_{in}	CW Input Power	dBm	-	17
T_{ch}	Operating Channel Temperature	°C	-	+150
T_{stg}	Storage Case Temperature	°C	-65	+150
T_{max}	Maximum Assembly Temperature (20 sec max)	°C	-	+260

Note:
1) Operation in excess of any one of these conditions may result in permanent damage to this device. The absolute maximum ratings for DC and Power parameters were determined at an ambient temperature of 25°C unless noted otherwise.

Table 2. DC Specifications

(V_{dd} = 7V, V_{g2} = Open, T_A = 25°C, otherwise specified)

Symbol	Parameters and Test Conditions	Unit	Minimum	Typical	Maximum
V_{dd}	Recommended Drain Supply Voltage	V	-	7	-
I_{dd}	Total Drain Supply Current (V_{g1} set for typical I_{dd})	mA	-	200	-
V_{g1}	First Gate Voltage (V_{dd} = 7V, I_{dd} = 200mA)	V	-2.5	-3.0	-3.5
I_{dss}	Saturated Drain Current (V_{g1} = 0V)	mA	-	350	-
I_{dsmin} (V_{g1})	First Gate Minimum Drain Current (V_{g1} = -7V)	mA	-	80	-
θ_{ch-b}	Thermal Resistance [1]	°C/W	-	14.5	-

Note:
1) Channel-to-board Thermal Resistance is measured using Infrared Microscopy method.

Table 3. RF Specifications [1]

(Freq = 22GHz, V_{dd} = 7V, I_{dd} = 200mA, T_A = 25°C, Zin = Zo = 50Ohm)

Symbol	Parameters and Test Conditions	Unit	Minimum	Typical	Maximum
Gain	Small Signal Gain [2]	dB	12.5	14.8	16.5
ISO	Reverse Isolation	dB	-	30	-
RLin	Input Return Loss	dB	-	13	-
RLout	Output Return Loss	dB	-	14	-
NF	Noise Figure	dB	-	4.6	-
P1dB	Output Power at 1dB Gain Compression	dBm	-	22	-
OIP3	Output 3rd Order Intercept Point [3]	dBm	-	25	-

Notes:
1) Specifications are derived from measurements in a 50 Ohm test environment. Aspects of the amplifier performance may be improved over a narrower bandwidth by application of additional conjugate, linearity, or low noise matching.
2) All tested parameters guaranteed with measurement accuracy ± 0.5 dB for gain.
3) RFin1 = RFin2 = -5 dBm, Freq = 22GHz, Δf = 100MHz

Table 4. RF Specifications [1]

(Freq = 22GHz, V_{dd} = 4V, I_{dd} = 160mA, T_A = 25°C, Zin = Zo = 50Ohm)

Symbol	Parameters and Test Conditions	Unit	Minimum	Typical	Maximum
Gain	Small signal Gain	dB	-	15	-
ISO	Reverse Isolation	dB	-	27	-
RLin	Input Return Loss	dB	-	13	-
RLout	Output Return Loss	dB	-	14	-
NF	Noise Figure	dB	-	4.6	-
P1dB	Output Power at 1dB Gain Compression	dBm	-	19	-
OIP3	Output 3rd Order Intercept Point [3]	dBm	-	18.5	-

Notes:
1) Specifications are derived from measurements in a 50 Ohm test environment. Aspects of the amplifier performance may be improved over a narrower bandwidth by application of additional conjugate, linearity, or low noise matching.
2) RFin1 = RFin2 = -5 dBm, Freq = 22GHz, Δf = 100MHz

AMMP-5024 Typical Performance

(V_{dd} = 7V, I_{dd} = 200mA, V_{g2} = Open, T_A = 25°C, Zin = Zo = 50Ohm)

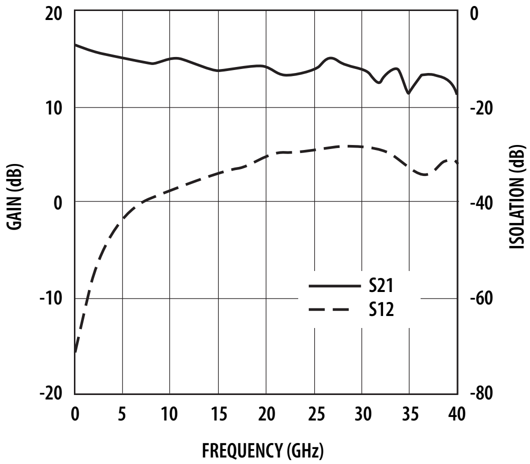


Figure 1. Gain and Reverse Isolation.

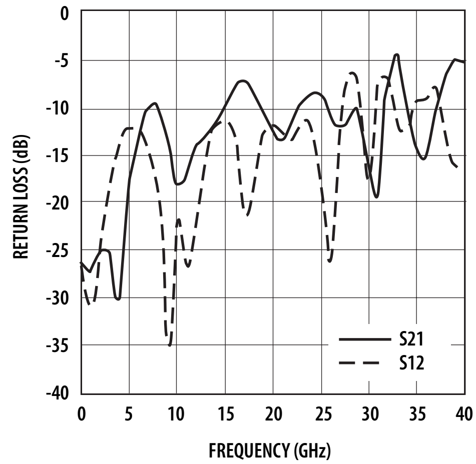


Figure 2. Return Loss (Input and Output).

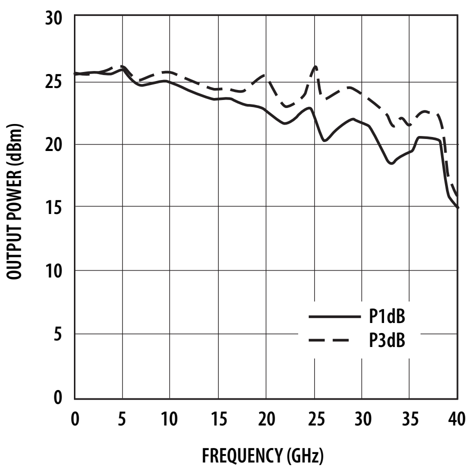


Figure 3. Output Power (P1dB and P3dB).

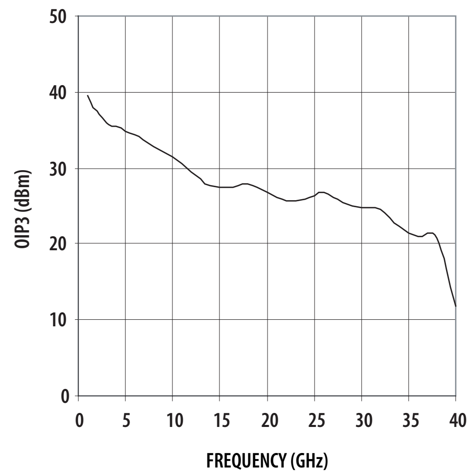


Figure 4. Output IP3.

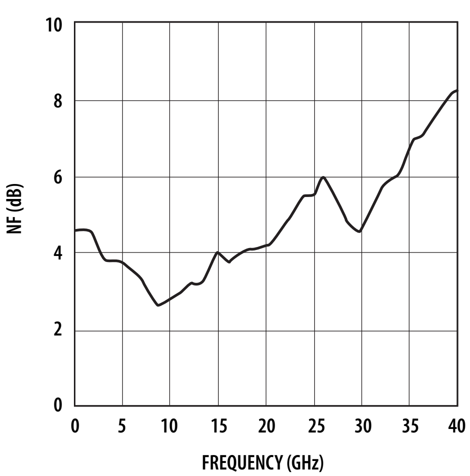


Figure 5. Noise Figure.

AMMP-5024 Typical Scattering Parameters

(V_{dd} = 7V, I_{dd} = 200mA, T_A = 25°C, Zin = Zo = 50Ohm)

Freq.		S_{11}			S_{21}			S_{12}			S_{22}	
GHz	dB	Mag	Ang	dB	Mag	Ang	dB	Mag	Ang	dB	Mag	Ang
0.05	-25.978	0.050	173.710	16.186	6.446	174.640	-72.335	0.000	141.290	-26.454	0.048	-42.740
1	-26.744	0.046	117.220	15.721	6.110	100.990	-58.370	0.001	-165.550	-33.252	0.022	-90.950
2	-26.571	0.047	61.340	15.557	5.996	24.710	-53.860	0.002	-99.050	-23.888	0.064	-155.950
3	-26.930	0.045	12.940	15.263	5.797	-52.010	-49.134	0.004	15.990	-17.895	0.127	115.270
4	-29.254	0.035	6.460	15.395	5.885	-129.670	-47.270	0.004	55.720	-14.298	0.193	33.330
5	-19.848	0.102	-6.580	15.123	5.704	155.170	-44.616	0.006	-127.830	-12.123	0.248	-39.310
6	-14.255	0.194	-58.160	14.695	5.429	78.790	-42.263	0.008	158.680	-12.138	0.247	-104.940
7	-11.138	0.277	-115.080	14.510	5.315	3.360	-40.891	0.009	85.780	-14.387	0.191	-159.490
8	-10.433	0.301	179.950	15.543	5.335	-71.300	-39.546	0.011	13.470	-18.374	0.121	153.100
9	-12.506	0.237	104.570	14.512	5.316	-147.300	-38.049	0.013	-57.350	-35.109	0.018	124.870
10	-17.570	0.132	5.780	14.440	5.272	137.020	-37.511	0.013	-135.610	-22.144	0.078	-172.790
11	-17.725	0.130	-99.610	14.711	5.439	59.010	-36.835	0.014	152.110	-24.802	0.058	116.650
12	-14.873	0.180	173.320	14.513	5.317	-20.030	-36.316	0.015	77.930	-23.867	0.064	174.450
13	-13.815	0.204	100.170	15.232	5.148	-97.380	-35.782	0.016	6.700	-15.395	0.170	94.380
14	-12.745	0.231	25.400	13.791	4.893	-172.930	-35.242	0.017	-69.860	-12.660	0.233	-3.190
15	-10.716	0.292	-51.690	13.598	4.785	110.940	-34.507	0.019	-139.850	-11.701	0.260	-99.380
16	-8.667	0.369	-128.150	13.624	4.800	32.800	-34.278	0.019	145.780	-13.556	0.210	175.490
17	-7.590	0.417	153.760	14.037	5.034	-43.060	-33.476	0.021	70.520	-20.200	0.098	118.490
18	-8.199	0.389	74.850	13.957	4.987	-120.390	-32.375	0.024	-5.160	-19.304	0.108	138.190
19	-10.463	0.300	-1.090	14.036	5.033	161.010	-31.781	0.026	-85.970	-13.297	0.216	71.230
20	-12.461	0.238	-78.400	14.291	5.183	81.230	-31.169	0.028	-162.750	-11.796	0.257	-24.200
21	-13.659	0.208	-165.110	14.069	5.052	-2.200	-30.415	0.030	116.180	-13.161	0.220	-149.100
22	-12.899	0.227	116.340	13.220	4.582	-82.050	-30.291	0.031	35.000	-13.817	0.204	65.510
23	-10.155	0.311	34.530	13.003	4.468	-157.240	-29.612	0.033	-39.830	-11.899	0.254	-33.300
24	-8.977	0.356	-42.090	13.722	4.854	126.770	-30.071	0.031	-110.330	-11.948	0.253	-129.100
25	-8.885	0.360	-126.570	13.578	4.774	50.130	-28.925	0.036	174.660	-16.071	0.157	132.130
26	-10.631	0.294	125.640	14.768	5.475	-33.080	-28.294	0.039	88.570	-31.606	0.026	-122.730
27	-12.342	0.242	22.190	15.031	5.643	-122.180	-28.914	0.036	15.030	-11.365	0.270	112.700
28	-11.834	0.256	-49.790	14.375	5.233	159.050	-28.375	0.038	-65.960	-6.919	0.451	12.770
29	-10.876	0.286	-119.600	13.914	4.963	72.680	-28.988	0.036	-143.090	-8.057	0.396	-88.900
30	-15.263	0.173	132.230	13.992	5.008	-13.290	-28.236	0.039	135.300	-19.323	0.108	78.600
31	-20.051	0.099	11.090	13.096	4.517	-97.250	-28.635	0.037	48.910	-8.293	0.385	-54.660
32	-8.785	0.364	-45.770	12.628	4.279	-176.240	-29.742	0.033	-34.570	-7.399	0.427	-121.060
33	-4.750	0.579	-131.440	13.436	4.697	104.860	-29.755	0.033	-104.760	-11.404	0.269	-171.520
34	-9.580	0.332	158.370	13.170	4.555	10.340	-30.895	0.029	154.650	-13.866	0.203	-149.510
35	-13.936	0.201	78.060	11.457	3.740	-67.360	-35.014	0.018	79.650	-9.981	0.317	133.420
36	-16.029	0.158	-43.060	13.131	4.535	-153.950	-32.535	0.024	-6.350	-9.601	0.331	-8.060
37	-11.205	0.275	-128.410	12.777	4.354	115.460	-34.865	0.018	-102.940	-8.479	0.377	-142.750
38	-7.265	0.433	159.220	13.000	4.467	23.260	-33.033	0.022	154.830	-12.795	0.229	111.160
39	-5.714	0.518	58.020	13.086	4.511	-75.620	-31.534	0.027	87.970	-17.081	0.140	-48.940
40	-5.580	0.526	-52.120	11.090	3.585	-179.700	-34.663	0.019	-5.950	-15.054	0.177	-87.100

Notes:

1) S-parameters are measured on R&D Evaluation Board with 50 Ohm traces at input and output. Effects of connectors and board traces are included in results.

AMMP-5024 Typical Performance

(V_{dd} = 4V, I_{dd} = 160mA, V_{g2} = Open, T_A = 25°C , Zin = Zo = 50Ohm)

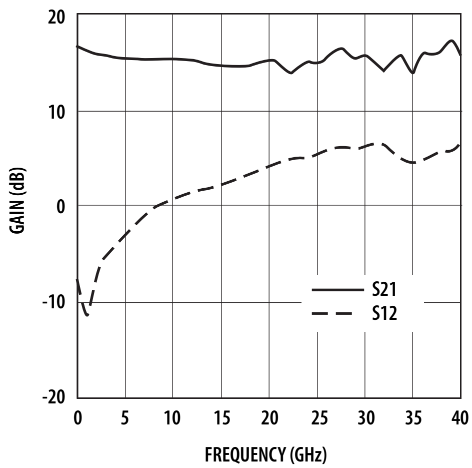


Figure 6. Gain and Reverse Isolation.

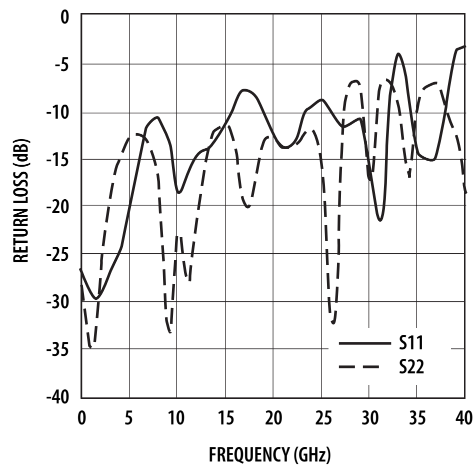


Figure 7. Return Loss (Input and Output).

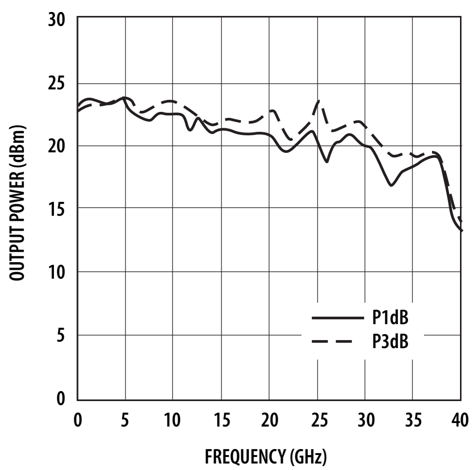


Figure 8. Output Power (P1dB and P3dB).

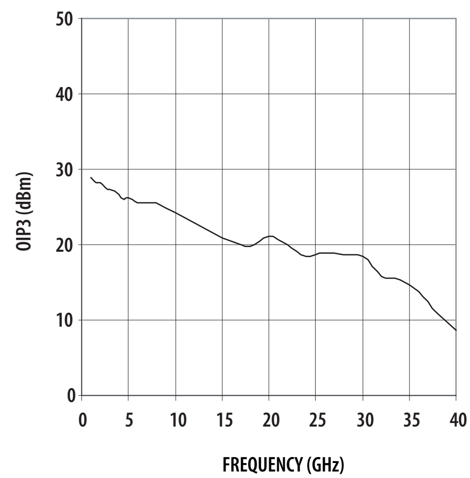


Figure 9. Output IP3.

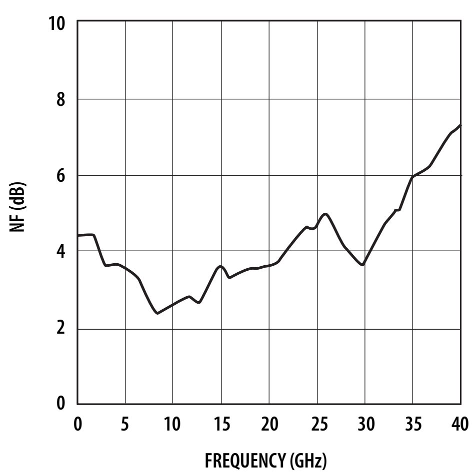


Figure 10. Noise Figure.

AMMP-5024 Typical Scattering Parameters

(V_{dd} = 4V, I_{dd} = 160mA, T_A = 25°C, Zin = Zo = 50Ohm)

Freq.		S_{11}			S_{21}			S_{12}			S_{22}	
GHz	dB	Mag	Ang	dB	Mag	Ang	dB	Mag	Ang	dB	Mag	Ang
0.05	-25.975	0.050	174.630	16.479	6.667	174.400	-51.615	0.003	-169.010	-27.959	0.040	-50.830
1	-28.128	0.039	108.030	16.018	6.323	101.970	-60.865	0.001	-171.660	-39.098	0.011	-114.170
2	-30.831	0.029	64.310	15.889	6.229	26.560	-54.525	0.002	95.150	-26.428	0.048	-156.480
3	-28.241	0.039	46.520	15.628	6.045	-49.400	-50.773	0.003	5.870	-19.381	0.107	116.080
4	-24.184	0.062	16.640	15.754	6.133	-126.150	-49.843	0.003	-61.360	-15.352	0.171	35.680
5	-18.702	0.116	-19.780	15.503	5.959	159.420	-46.321	0.005	-136.060	-12.753	0.230	-34.710
6	-14.730	0.183	-65.590	15.125	5.705	83.920	-43.909	0.006	150.930	-12.234	0.245	-98.940
7	-11.826	0.256	-116.980	14.965	5.601	9.010	-42.439	0.008	78.940	-13.687	0.207	-154.490
8	-10.975	0.283	-179.330	15.037	5.648	-64.980	-41.144	0.009	8.470	-17.208	0.138	152.170
9	-12.836	0.228	106.430	15.001	5.624	-140.110	-39.341	0.011	-63.760	-32.601	0.023	98.900
10	-17.716	0.130	4.850	14.909	5.565	144.780	-39.078	0.011	-142.980	-22.939	0.071	-170.310
11	-17.651	0.131	-103.900	15.229	5.774	67.790	-38.247	0.012	145.670	-25.802	0.051	120.520
12	-14.886	0.181	168.360	15.064	5.665	-10.380	-37.729	0.013	71.210	-22.851	0.072	175.400
13	-14.513	0.196	93.980	14.860	5.534	-86.830	-37.172	0.014	2.890	-15.068	0.177	93.210
14	-13.644	0.208	20.670	14.476	5.294	-161.820	-36.737	0.015	-76.640	-12.603	0.234	-3.800
15	11.754	0.258	-52.750	14.332	5.207	122.500	-36.010	0.016	-144.320	-11.888	0.255	-99.180
16	-9.429	0.338	-125.910	14.399	5.248	44.800	-35.110	0.018	141.280	-13.870	0.203	178.870
17	-7.942	0.401	157.230	14.751	5.465	-30.410	-34.558	0.019	66.320	-19.273	0.109	130.040
18	-8.189	0.390	78.110	14.623	5.384	-106.690	-33.641	0.021	-9.190	-18.342	0.121	123.910
19	-10.225	0.308	0.470	14.727	5.449	176.060	-32.688	0.023	-89.470	-14.080	0.198	64.290
20	-12.340	0.242	-79.400	15.088	5.680	97.170	-31.995	0.025	-167.210	-12.706	0.232	-25.240
21	-13.992	0.200	-167.590	14.916	5.570	14.300	-30.988	0.028	111.200	-13.899	0.202	-148.040
22	-13.705	0.206	115.700	14.032	5.030	-64.320	-30.770	0.029	30.820	-14.245	0.194	64.620
23	-10.932	0.284	36.140	13.956	4.986	-137.590	-30.052	0.031	-44.140	-12.565	0.235	-29.680
24	-9.671	0.328	-37.330	14.892	5.554	146.220	-30.344	0.030	-115.840	-12.021	0.251	-122.900
25	-9.069	0.352	-118.940	14.529	5.327	69.630	-29.491	0.034	169.820	-15.400	0.170	146.520
26	-10.111	0.312	133.920	15.764	6.140	-10.430	-28.633	0.037	87.000	-30.816	0.029	95.370
27	-11.661	0.261	25.300	16.279	6.515	-97.400	-28.601	0.037	10.560	-13.237	0.218	111.780
28	-11.753	0.258	-53.360	15.868	6.214	-176.310	-28.074	0.040	-69.280	-7.465	0.423	17.340
29	-11.212	0.275	-118.650	15.610	6.032	96.880	-28.302	0.038	-149.580	-7.579	0.418	-83.330
30	-15.324	0.171	125.850	15.777	6.150	11.950	-27.638	0.042	130.670	-18.770	0.115	101.450
31	-21.074	0.088	-36.080	14.830	5.514	-72.680	-27.784	0.041	40.680	-8.175	0.390	-51.180
32	-11.267	0.273	-33.640	14.219	5.140	-150.300	-28.440	0.038	-43.040	-7.147	0.439	-118.200
33	-4.486	0.597	-120.550	14.902	5.561	134.360	-28.513	0.038	-110.990	-9.731	0.326	-172.120
34	-8.316	0.384	156.720	15.145	5.717	43.150	-30.177	0.031	148.930	-18.714	0.116	-148.940
35	-13.961	0.200	76.250	13.772	4.882	-35.700	-31.432	0.027	67.850	-10.162	0.310	153.430
36	-15.198	0.174	-50.950	16.011	6.318	-120.610	-28.308	0.038	-21.850	-7.894	0.403	8.390
37	-13.810	0.204	-143.150	15.622	6.041	147.660	-28.977	0.036	-122.710	-6.915	0.451	-135.880
38	-8.901	0.359	179.800	15.907	6.243	58.030	-30.175	0.031	130.050	-10.529	0.298	116.150
39	-4.175	0.618	78.600	17.068	7.135	-38.810	-26.925	0.045	85.060	-12.977	0.225	-45.140
40	-3.037	0.705	-50.850	15.714	6.105	-151.620	-26.470	0.048	-35.600	-19.244	0.109	-120.650

Note:
1) S-parameters are measured on R&D Evaluation Board with 50 Ohm traces at input and output. Effects of connectors and board traces are included in results.

AMMP-5024 Typical Performance

(Over Temperature, V_{dd} = 7V, I_{dd} = 200mA, Zin = Zo = 50Ohm)

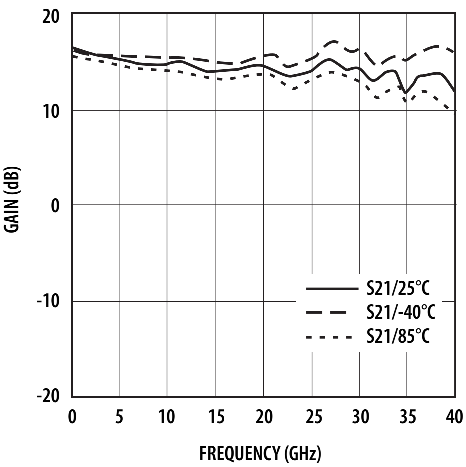


Figure 11. Gain and Temperature.

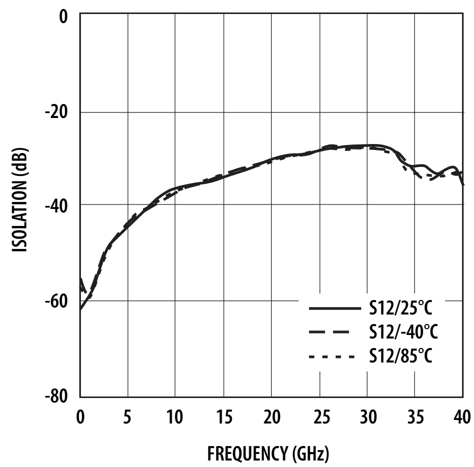


Figure 12. Isolation and Temperature.

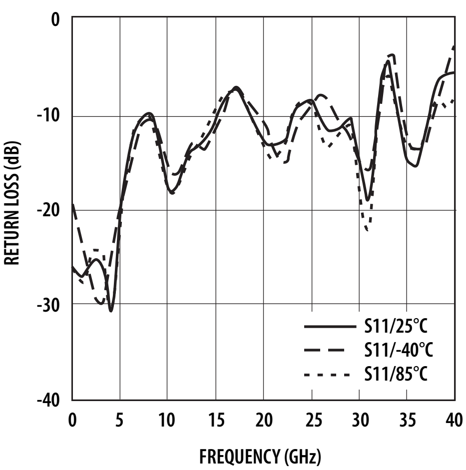


Figure 13. Input Return Loss and Temperature.

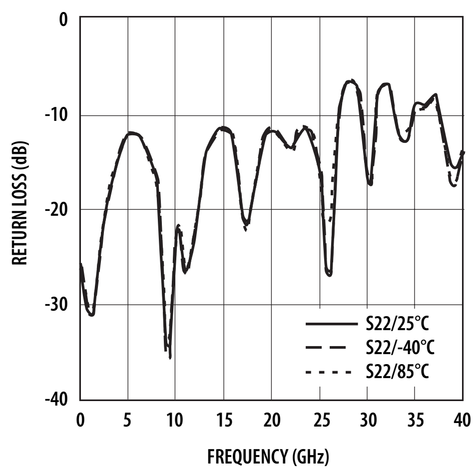


Figure 14. Output Return Loss and Temperature.

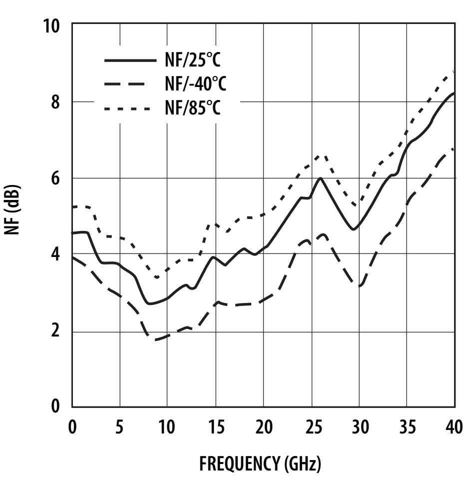


Figure 15. Noise Figure and Temperature.

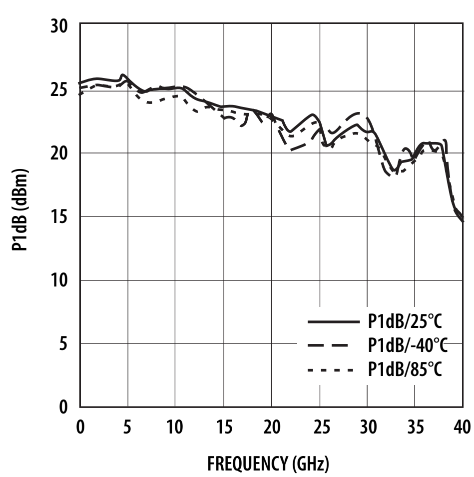


Figure 16. P1dB and Temperature.

Biasing and Operation

AMMP-5024 is biased with a single positive drain supply (Vdd) a negative gate supply (Vg1) and has a positive control gate supply (Vg2). For best overall performance the recommended bias condition for the AMMP-5024 is Vdd =7V and Idd = 200 mA. To achieve this drain current level, Vg1 is typically between –2.5 to –3.5V. Typically, DC current flow for Vg1 is –10 mA. Open circuit is the default setting for Vg2 when not utilizing gain control.

Using the simplest form of assembly, the device is capable of delivering flat gain over a 2–40 GHz range. However, this device is designed with DC coupled RF I/O ports, and operation may be extended to lower frequencies (<2 GHz) through the use of off-chip low-frequency extension circuitry and proper external biasing components. With low frequency bias extension it may be used in a variety of time domain applications (through 40 Gb/s).

When bypass capacitors are connected to the AUX pads, the low frequency limit is extended down to the corner frequency determined by the bypass capacitor and the combination of the on-chip 50 ohm load and small de-queing resistor. At this frequency the small signal gain will increase in magnitude and stay at this elevated level down to the point where the Caux bypass capacitor acts as an open circuit, effectively rolling off the gain completely. The low frequency limit can be approximated from the following equation:

$$f_{Caux} = \frac{1}{2\pi Caux\,(Ro + R_{DEQ})}$$

where:

Ro is the 50Ω gate or drain line termination resistor.

RDEQ is the small series dequeing resistor and 10Ω.

Caux is the capacitance of the bypass capacitor connected to the AUX Drain and AUX Gate pad in farads.

With the external bypass capacitors connected to the AUX gate and AUX drain pads, gain will show a slight increase between 1.0 and 1.5 GHz. This is due to a series combination of Caux and the on-chip resistance but is exaggerated by the parasitic inductance (Lc) of the bypass capacitor and the inductance of the bond wire (Ld).

Input and output RF ports are DC coupled; therefore, DC decoupling capacitors are required if there are DC paths. (Do not attempt to apply bias to these pads.)

Recommended SMT Attachment

The AMMP Packaged Devices are compatible with high volume surface mount PCB assembly processes. The PCB material and mounting pattern, as defined in the data sheet, optimizes RF performance and is strongly recommended. An electronic drawing of the land pattern is available upon request from Avago Sales & Application Engineering.

Manual Assembly

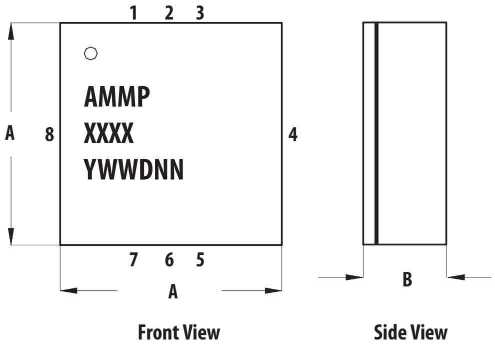
1. Follow ESD precautions while handling packages.
2. Handling should be along the edges with tweezers.
3. Recommended attachment is conductive solder paste. Please see recommended solder reflow profile. Conductive epoxy is not recommended. Hand soldering is not recommended.
4. Apply solder paste using a stencil printer or dot placement. The volume of solder paste will be dependent on PCB and component layout and should be controlled to ensure consistent mechanical and electrical performance.
5. Follow solder paste and vendor's recommendations when developing a solder reflow profile. A standard profile will have a steady ramp up from room temperature to the pre-heat temperature to avoid damage due to thermal shock.
6. Packages have been qualified to withstand a peak temperature of 260°C for 20 seconds. Verify that the profile will not expose device beyond these limits.

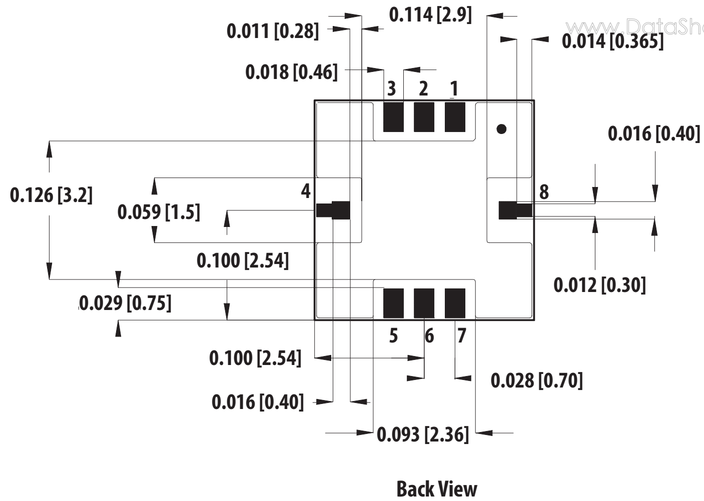
Stencil Design Guidelines

A properly designed solder screen or stencil is required to ensure optimum amount of solder paste is deposited onto the PCB pads. The recommended stencil layout is shown in Figure 19. The stencil has a solder paste deposition opening approximately 70% to 90% of the PCB pad. Reducing stencil opening can potentially generate more voids underneath. On the other hand, stencil openings larger than 100% will lead to excessive solder paste smear or bridging across the I/O pads. Considering the fact that solder paste thickness will directly affect the quality of the solder joint, a good choice is to use a laser cut stencil composed of 0.127 mm (5 mils) thick stainless steel which is capable of producing the required fine stencil outline.

The combined PCB and stencil layout is shown in Figure 20.

Outline Drawing





Symbol	Min	Max
A	0.198 (5.03)	0.213 (5.4)
B	0.0685 (1.74)	0.088 (2.25)

Dimensional tolerance for back view: 0.002" [0.05 mm]

Notes:
1. * Indicates Pin 1
2. Dimensions are in inches [millimeters]
3. All Grounds must be soldered to PCB RF Ground

Figure 17. Outline Drawing

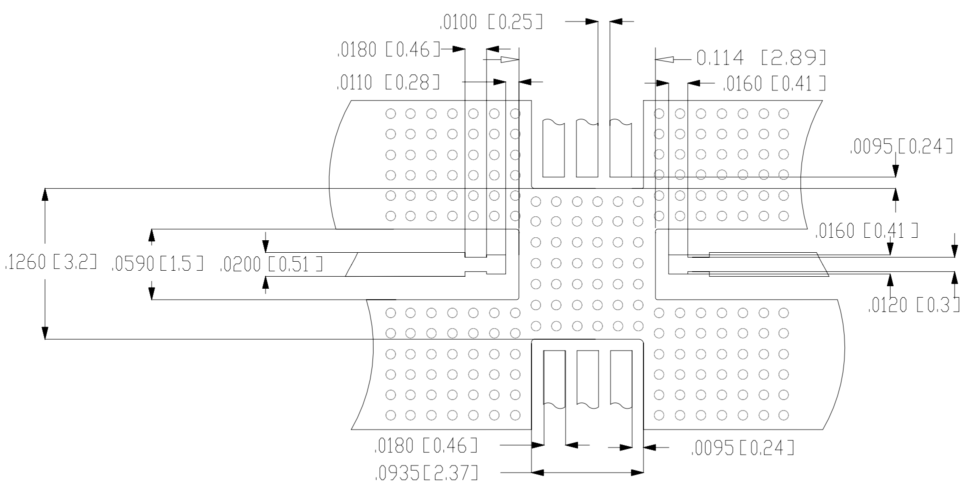


Figure 18. Suggested PCB Material and Land Pattern

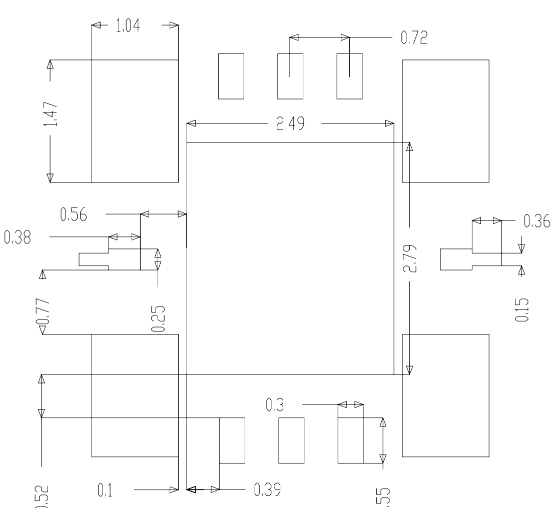


Figure 19. Stencil Outline Drawing (mm)

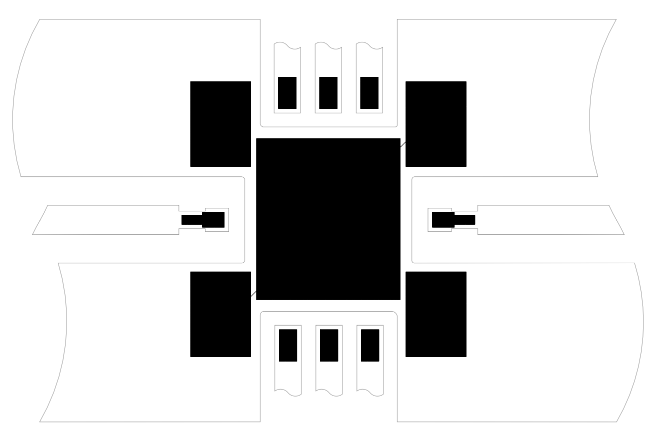
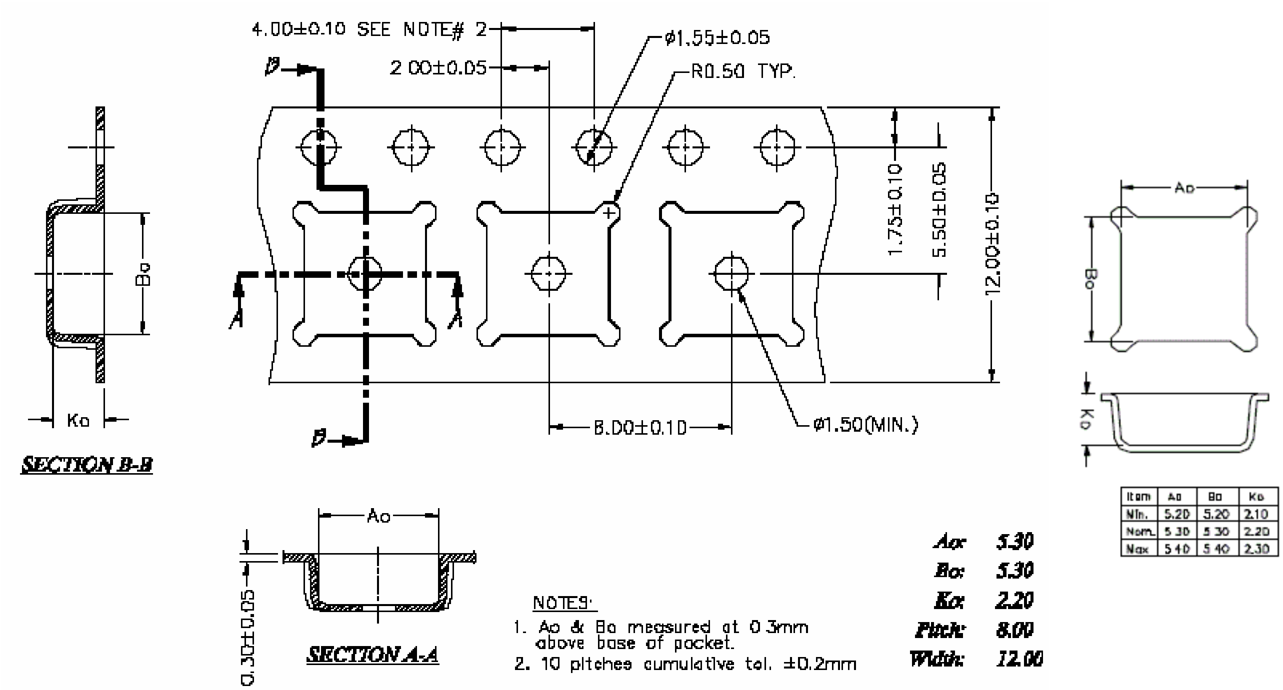
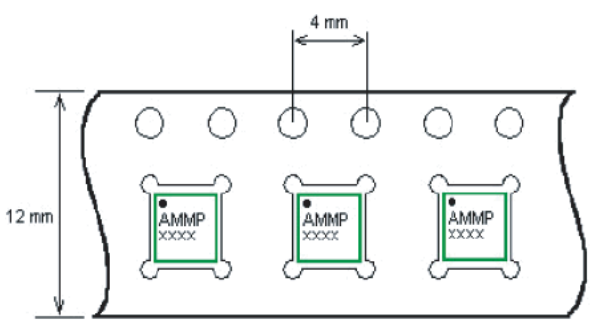


Figure 20. Combined PCB and Stencil Layouts

Carrier Tape and Pocket Dimensions



Device Orientation (Top View)



Part Number Ordering Information

Part Number	Devices per Container	Container
AMMP-5024-BLKG	10	Antistatic Bag
AMMP-5024-TR1G	100	7" Reel
AMMP-5024-TR2G	500	7" Reel

Names and Contents of the Toxic and Hazardous Substances or Elements in the Products
产品中有毒有害物质或元素的名称及含量

Part Name 部件名称	Toxic and Hazardous Substances or Elements 有毒有害物质或元素					
	Lead (Pb) 铅 (Pb)	Mercury (Hg) 汞（Hg）	Cadmium (Cd) 镉（Cd）	Hexavalent (Cr(VI)) 六价铬（Cr(VI)）	Polybrominated biphenyl (PBB) 多溴联苯（PBB）	Polybrominated diphenylether (PBDE) 多溴二苯醚（PBDE）
100pF capacitor	×	○	○	○	○	○

○: indicates that the content of the toxic and hazardous substance in all the homogeneous materials of the part is below the concentration limit requirement as described in SJ/T 11363-2006.
×: indicates that the content of the toxic and hazardous substance in at least one homogeneous material of the part exceeds the concentration limit requirement as described in SJ/T 11363-2006.
(The enterprise may further explain the technical reasons for the “x” indicated portion in the table in accordance with the actual situations.)

○：表示该有毒有害物质在该部件所有均质材料中的含量均在 SJ/T 11363-2006 标准规定的限量要求以下。
×：表示该有毒有害物质至少在该部件的某一均质材料中的含量超出 SJ/T 11363-2006 标准规定的限量要求。
（企业可在此处，根据实际情况对上表中打“×”的技术原因进行进一步说明。）

Note: EU RoHS compliant under exemption clause of “lead in electronic ceramic parts (e.g. piezoelectronic devices)”

For product information and a complete list of distributors, please go to our web site: **www.avagotech.com**

AV02-0465EN - August 29, 2007