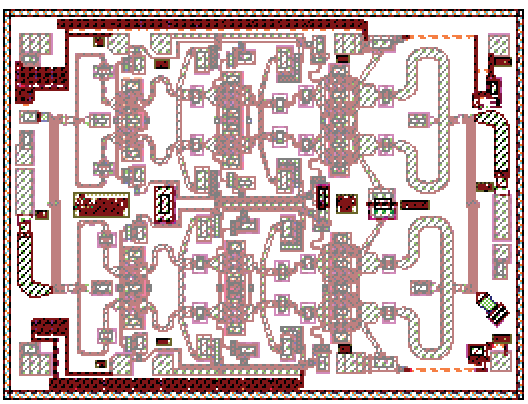
AMMC-6425
18-28 GHz 1W Power Amplifier MMIC

Data Sheet

Description

The AMMC-6425 is an MMIC power amplifier designed for use in wireless transmitters that operate within an 18GHz to 28GHz range. At 28GHz, it provides 30dBm of output power (P1dB) and 24dB of small-signal gain from a small easy-to-use device. This MMIC is optimized for linear operation with an output third order intercept point (OIP3) of 38dBm. The device has input and output matching circuitry for use in 50Ω environments. The AMMC-6425 also has integrated, temperature compensated, RF power detection circuitry that enables power detection of 0.3V/Watt at 28GHz.



Chip Size: 2500 x 1870µm (100 x 74ils)
Chip Size Tolerance: ± 10µm (±0.4 mils)
Chip Thickness: 100 ± 10µm (4 ± 0.4 mils)
Pad Dimensions: 100 x 100µm (4 x 4 ±0.4)mils)

RoHS - Exemption

Please refer to Hazardous substances table on page 9

Features

- High Gain: 24dB
- 1-watt output power (P-1)
- 50 Ω match on input and output
- Integrated RF power detector
- ESD protection (50V MM, and 250V HBM)

Specifications (Vd=5V, Idsq=0.65A)

- Frequency range 18 to 28 GHz
- Small signal Gain of 24dB
- Output power @P-1 of 29dBm (Typ.)
- Input/Output return-loss of -13dB/-13dB

Applications

- Microwave Radio systems
- Satellite VSAT, Up/Down Link
- LMDS & Pt-Pt mmW Long Haul
- Broadband Wireless Access (including 802.16 and 802.20 WiMax)
- WLL and MMDS loops
- Commercial grade military

Note:
1. This MMIC uses depletion mode pHEMT devices. Negative supply is used for DC gate biasing.

Attention: Observe precautions for handling electrostatic sensitive devices.
ESD Machine Model (Class A): 50V
ESD Human Body Model (Class 0): 250V
Refer to Avago Application Note A004R: Electrostatic Discharge, Damage and Control.

Absolute Maximum Ratings [1,2,3,4, 5]

Symbol	Parameters	Unit	Max	Notes
V_d	Positive Supply Voltage[2]	V	6	2/
V_g	Gate Supply Voltage	V	-3 to 0.5	
P_D	Power Dissipation[2,3]	W	5.5	2/3/
P_{in}	CW Input Power[2]	dBm	23	2/
T_{ch}	Operating Channel Temp.[4,5]	°C	+150	4/5/
T_{stg}	Storage Case Temp.	°C	-65 to +155	
T_{max}	Maximum Assembly Temp (30 sec max)	°C	+320	

Note:

1. Operation in excess of any one of these conditions may result in permanent damage to this device.
2. Combinations of supply voltage, drain current, input power, and output power shall not exceed P_D.
3. When operate at this condition with a base plate temperature of 85°C, the median time to failure (MTTF) is significantly reduced.
4. These ratings apply to each individual FET
5. The operating channel temperature will directly affect the device MTTF. For maximum life, it is recommended that junction temperatures be maintained at the lowest possible levels

DC Specifications/ Physical Properties [1]

Symbol	Parameters and Test Conditions	Units	
I_d	Drain Supply Current(V_d=5 V, V_g set for I_d Typical)	mA	650
V_g	Gate Supply Operating Voltage($I_{d(Q)}$ = 650 (mA))	V	-1.0
$R_{\theta jC}$	Thermal Resistance[1](Channel-to-Backside)	°C/W	17.8
T_{ch}	Channel Temperature	°C	132

Note:

1. Assume AuSn soldering to an evaluation RF board at 85 °C base plate temperatures. Worst case is at saturated output power when DC power consumption rises to 5.5W with 1.57W RF power delivered to load. Power dissipation is 3.93W and the temperature rise in the channel is 57 °C. In this condition, the base plate temperature must be remained below 93 °C to maintain maximum operating channel temperature below 150°C.

RF Specifications [1,2, 3] (T_A= 25°C, V_d=5, $I_{d(Q)}$=650 mA, Z_o=50 Ω)

Symbol	Parameters and Test Conditions	Units	Minimum	Typical	Maximum
Freq	Operational Frequency	GHz	18		28
Gain	Small-signal Gain [3, 4]	dB	22	24	
P_{-1dB}	Output Power at 1dB[3] Gain Compression	dBm	27.5	29	
OIP3	Output Third Order Intercept Point	dBm		38	
RL_{in}	Input Return Loss	dB		13	
RL_{out}	Output Return Loss	dB		13	
Isolation	Reverse Isolation	dB		50	

Notes:

1. Small/Large -signal data measured in on-wafer environment at T_A = 25°C.
2. This die part performance is verified by a functional test correlated to actual performance at one or more frequencies
3. Pre-assembly into package performance verified 100% on-wafer published specifications at Frequencies=18, 23, and 28GHz
4. The Gain and P1dB tested at 23GHz guaranteed with measurement accuracy ± 1.5 dB for gain and ±1.6dB for P1dB.

Typical Performances (Data obtained from on-wafer environment. $T_A = 25°C$, $V_d = 5$ V, $I_{d(q)} = 650$ mA, $Z_{in} = Z_{out} = 50\ \Omega$)

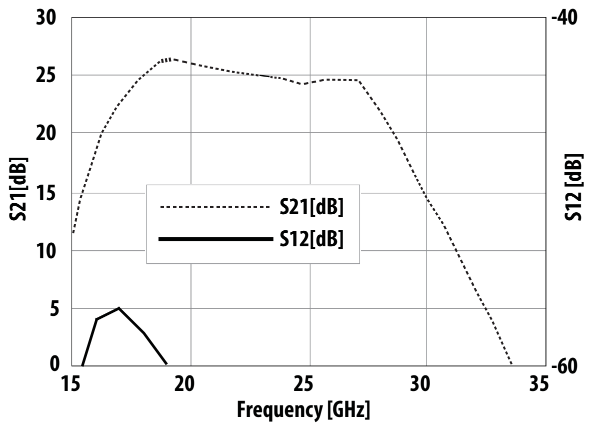


Figure 1. AMMC-6425 Typical Gain and Reverse Isolation

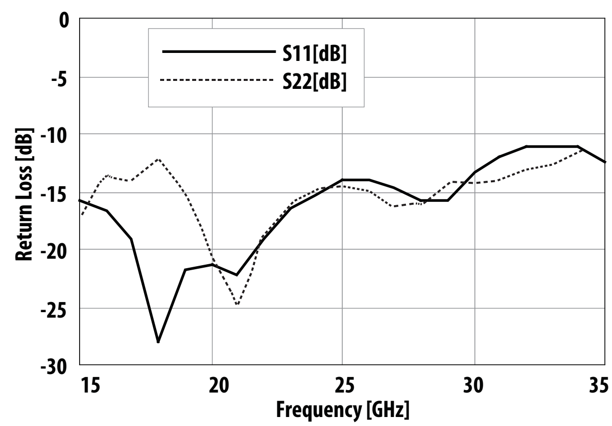


Figure 2. AMMC-6425 Typical Return Loss (Input and Output)

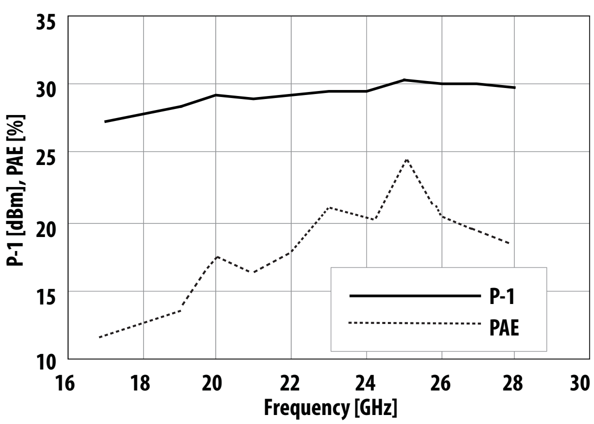


Figure 3. AMMC-6425 Typical Output Power (P-1) and PAE at 1dB gain compression

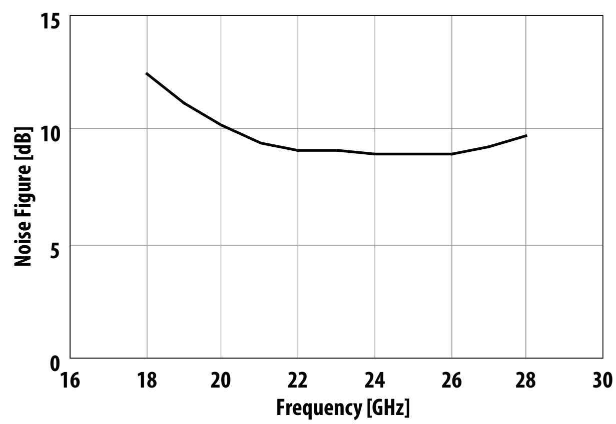


Figure 4. AMMC-6425 Typical Noise Figure

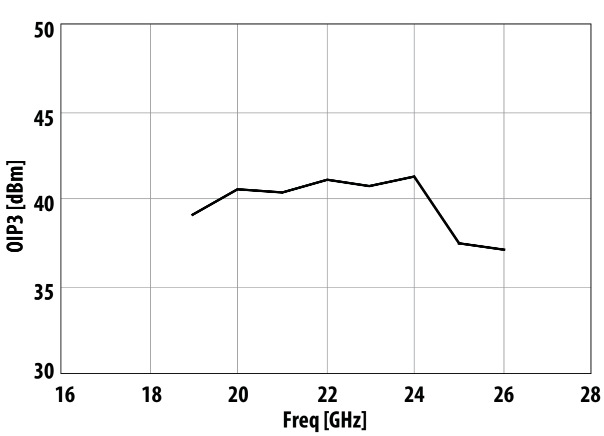


Figure 5. AMMC-6425 Typical IP3

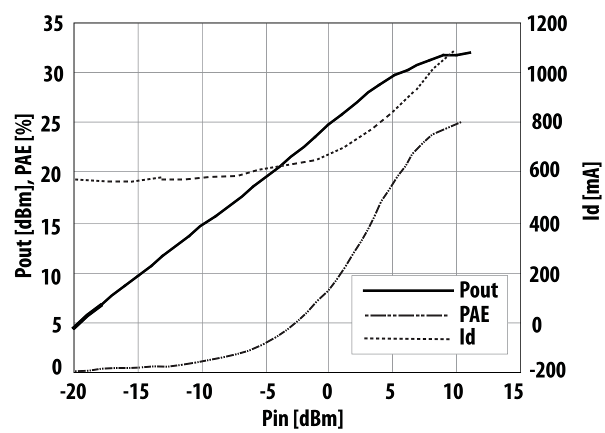


Figure 6. AMMC-6425 Typical Output Power, PAE, and Total Drain Current versus Input Power at 25GHz

Typical over temperature dependencies ($T_A = 25°C$, $V_d = 5$ V, $I_{d(q)} = 650$ mA, $Z_{in} = Z_{out} = 50\ \Omega$)

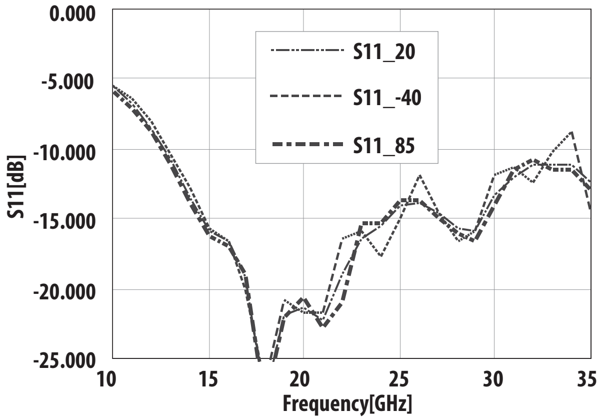


Figure 7. AMMC-6425 Typical S11 over temperature

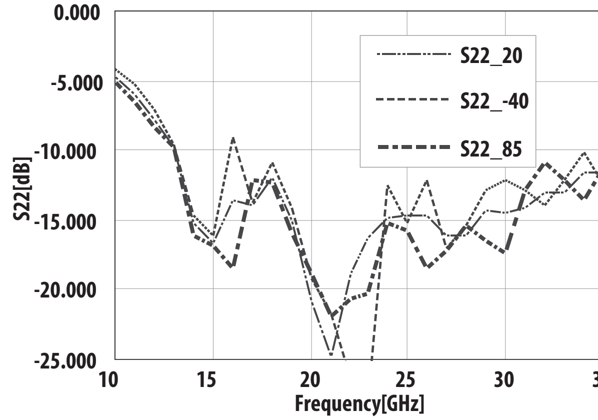


Figure 8. AMMC-6425 Typical S22 over temperature

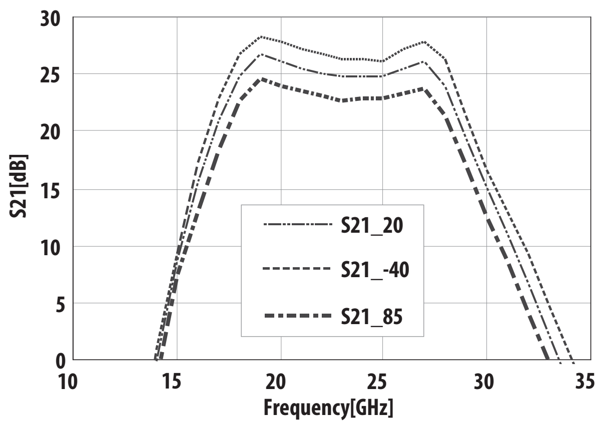


Figure 9. AMMC-6425 Typical Gain over temperature

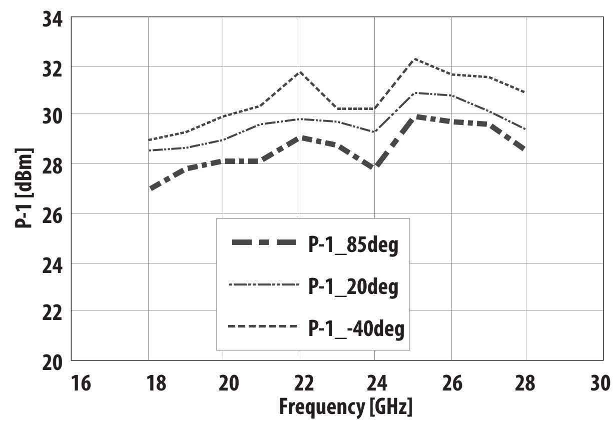


Figure 10. AMMC-6425 Typical P-1 over temperature

Typical Scattering Parameters [1] ($T_A = 25°C$, $V_d = 5$ V, $I_D = 650$ mA, $Z_{in} = Z_{out} = 50\ \Omega$)

Freq	S11			S21			S12			S22		
[GHz]	dB	Mag	Phase	dB	Mag	Phase	dB	Mag	Phase	dB	Mag	Phase
1	-0.18	0.98	-31.00	-50.91	0.00	172.26	-80.52	9.42E-05	161.39	-0.14	0.98	-27.36
2	-0.50	0.94	-60.57	-46.71	0.00	-119.81	-74.86	1.81E-04	-20.97	-0.42	0.95	-53.39
3	-0.89	0.90	-88.63	-45.77	0.01	133.49	-74.75	1.83E-04	-151.39	-0.66	0.93	-78.93
4	-1.35	0.86	-115.64	-43.43	0.01	80.97	-72.03	2.50E-04	101.75	-1.10	0.88	-103.74
5	-1.86	0.81	-140.94	-47.59	0.00	-36.53	-74.43	1.90E-04	-61.03	-1.44	0.85	-125.74
6	-2.44	0.76	-165.06	-52.20	0.00	-83.32	-78.78	1.15E-04	-162.35	-1.81	0.81	-149.44
7	-3.06	0.70	171.33	-62.73	0.00	-112.45	-70.47	3.00E-04	-177.29	-2.29	0.77	-172.28
8	-3.82	0.64	148.56	-61.78	0.00	-159.19	-70.96	2.83E-04	142.99	-2.84	0.72	165.52
9	-4.71	0.58	125.47	-64.62	0.00	102.00	-66.03	5.00E-04	137.46	-3.43	0.67	142.63
10	-5.84	0.51	102.90	-54.25	0.00	12.77	-63.10	7.00E-04	110.85	-4.14	0.62	118.72
11	-7.34	0.43	79.40	-42.17	0.01	-16.36	-63.11	6.99E-04	83.54	-5.08	0.56	91.98
12	-9.18	0.35	57.15	-27.52	0.04	-49.47	-64.29	6.10E-04	51.91	-6.40	0.48	62.37
13	-11.85	0.26	36.72	-14.09	0.20	-100.12	-66.04	4.99E-04	51.77	-8.57	0.37	26.29
14	-14.61	0.19	18.79	-1.42	0.85	-162.63	-66.27	4.86E-04	61.73	-11.83	0.26	-19.97
15	-17.29	0.14	11.16	11.13	3.60	114.96	-62.22	7.74E-04	80.54	-17.73	0.13	-96.22
16	-18.59	0.12	-3.90	19.39	9.32	0.47	-57.32	1.36E-03	43.30	-20.07	0.10	114.52
17	-18.18	0.12	-21.68	22.36	13.12	-97.26	-56.62	1.48E-03	5.66	-23.13	0.07	2.66
18	-19.99	0.10	-62.71	25.12	18.04	174.40	-58.17	1.23E-03	-22.91	-35.25	0.02	-81.56
19	-25.56	0.05	-111.19	26.50	21.14	83.81	-59.81	1.02E-03	-58.29	-32.08	0.02	-4.28
20	-28.70	0.04	-72.75	26.07	20.11	2.80	-65.66	5.21E-04	-58.26	-24.22	0.06	-64.07
21	-24.85	0.06	-112.17	25.60	19.06	-69.33	-62.29	7.68E-04	-51.21	-20.28	0.10	-120.87
22	-21.69	0.08	-133.66	25.28	18.36	-138.46	-61.95	7.99E-04	-78.62	-18.47	0.12	-148.19
23	-22.36	0.08	-172.96	24.93	17.63	153.57	-63.22	6.90E-04	-96.75	-17.01	0.14	173.91
24	-21.48	0.08	163.66	24.49	16.76	87.35	-65.75	5.16E-04	-142.75	-17.42	0.13	152.07
25	-23.59	0.07	146.36	24.34	16.49	21.96	-63.00	7.08E-04	-167.89	-18.48	0.12	122.77
26	-24.27	0.06	126.41	24.61	17.01	-46.70	-61.05	8.87E-04	107.89	-21.50	0.08	104.97
27	-29.23	0.03	165.25	24.62	17.03	-125.11	-60.13	9.85E-04	45.28	-27.76	0.04	-178.20
28	-26.07	0.05	150.75	22.38	13.15	150.42	-63.02	7.07E-04	-23.51	-19.90	0.10	147.42
29	-22.54	0.07	140.36	18.42	8.33	75.77	-65.92	5.06E-04	-89.51	-18.54	0.12	127.22
30	-23.20	0.07	133.08	14.45	5.28	9.65	-74.10	1.97E-04	119.51	-20.64	0.09	111.91
31	-23.96	0.06	97.50	10.68	3.42	-53.32	-73.92	2.01E-04	84.14	-19.81	0.10	105.34
32	-28.29	0.04	142.55	6.86	2.20	-115.03	-79.54	1.05E-04	72.59	-23.10	0.07	108.32
33	-25.07	0.06	123.16	2.75	1.37	-174.97	-66.14	4.93E-04	96.41	-20.62	0.09	90.40
34	-22.55	0.07	102.78	-1.52	0.84	127.51	-65.92	5.06E-04	80.40	-20.14	0.10	97.27
35	-42.73	0.01	167.89	-5.81	0.51	72.35	-74.96	1.79E-04	-176.00	-21.03	0.09	84.93
36	-23.68	0.07	-128.70	-10.14	0.31	18.88	-70.18	3.10E-04	98.04	-19.75	0.10	80.65
37	-14.11	0.20	179.93	-14.68	0.18	-33.49	-66.20	4.90E-04	177.04	-20.77	0.09	92.20
38	-11.27	0.27	157.39	-19.33	0.11	-83.71	-60.89	9.03E-04	118.94	-22.27	0.08	60.59
39	-8.96	0.36	117.64	-24.11	0.06	-139.37	-57.08	1.40E-03	94.41	-22.14	0.08	69.96
40	-8.29	0.39	91.80	-29.14	0.03	163.76	-55.47	1.69E-03	64.07	-27.90	0.04	56.87
41	-10.18	0.31	51.89	-33.41	0.02	105.70	-54.94	1.79E-03	33.20	-24.29	0.06	51.59
42	-13.20	0.22	38.89	-40.03	0.01	47.72	-54.39	1.91E-03	-9.11	-25.85	0.05	131.67
43	-19.84	0.10	36.35	-44.99	0.01	-12.88	-53.97	2.00E-03	-23.02	-32.40	0.02	120.99
44	-15.75	0.16	50.47	-48.14	0.00	-47.19	-55.93	1.60E-03	-51.98	-18.76	0.12	127.25
45	-17.20	0.14	60.92	-48.85	0.00	-78.91	-61.91	8.03E-04	-77.54	-20.68	0.09	126.54

Note:
1. Data obtained from on-wafer measurement.

Application and Usage

Biasing and Operation

The recommended quiescent DC bias condition for optimum efficiency, performance, and reliability is Vd=5 volts with Vg set for Id=650mA. Minor improvements in performance are possible depending on the application. The drain bias voltage range is 3 to 5V. A single DC gate supply connected to Vg will bias all gain stages. Muting can be accomplished by setting Vg and /or Vg to the pinch-off voltage Vp.

An optional output power detector network is also provided. The differential voltage between the Det-Ref and Det-Out pads can be correlated with the RF power emerging from the RF output port. The detected voltage is given by :

$V = (V_{ref} - V_{det}) - V_{ofs}$

where V_{ref} is the voltage at the DET_R port, V_{det} is a voltage at the DET_O port, and V_{ofs} is the zero-input-power offset voltage. There are three methods to calculate : V_{ofs}

1) V_{ofs} can be measured before each detector measurement (by removing or switching off the power source and measuring $V_{ref} - V_{det}$). This method gives an error due to temperature drift of less than 0.01dB/50°C.
2) V_{ofs} can be measured at a single reference temperature. The drift error will be less than 0.25dB.
3) V_{ofs} can either be characterized over temprature and stored in a lookup table, or it can be measured at two temperatures and a linear fit used to calculate V_{ofs} at any temperature. This method gives an error close to the method #1.

The RF ports are AC coupled at the RF input to the first stage and the RF output of the final stage. No ground wired are needed since ground connections are made with plated through-holes to the backside of the device.

Assembly Techniques

The chip should be attached directly to the ground plane using either a flux less AuSn solder perform or electrically conductive epoxy[1]. For conductive epoxy, the amount should be just enough to provide a thin fillet around the bottom perimeter of the die. The ground plane should be free of any residue that may jeopardize electrical or mechanical attachment. Caution should be taken to not exceed the Absolute Maximum Rating for assembly temperature and time.

Thermo-sonic wedge bonding is the preferred method for wire attachment to the bond pads. The RF connections should be kept as short as possible to minimize inductance. Gold mesh[2] or double-bonding with 0.7mil gold wire is recommended. Mesh can be attached using a 2mil round tracking tool and a too force of approximately 22grams with an ultrasonic power of roughly 55dB for a duration of 76±8mS. A guided wedge at an ultrasonic power level of 64dB can be used for the 0.7mil wire. The recommended wire bonding stage temperature is 150±2˚C.

The chip is 100µm thick and should be handled with care.

This MMIC has exposed air bridges on the top surface. Handle at the edges or with a custom collet (do not pick up die with vacuum on die center).

This MMIC is also static sensitive and ESD handling precautions should be taken.

For more detailed information, see Avago Application Note 54 "GaAs MMIC ESD, Die Attach and Bonding Guide lines."

Notes:
1. Ablebond 84-1 LM1 silver epoxy is recommended.
2. Buckbee-Mears Corporation, St. Paul, MN, 800-262-3824

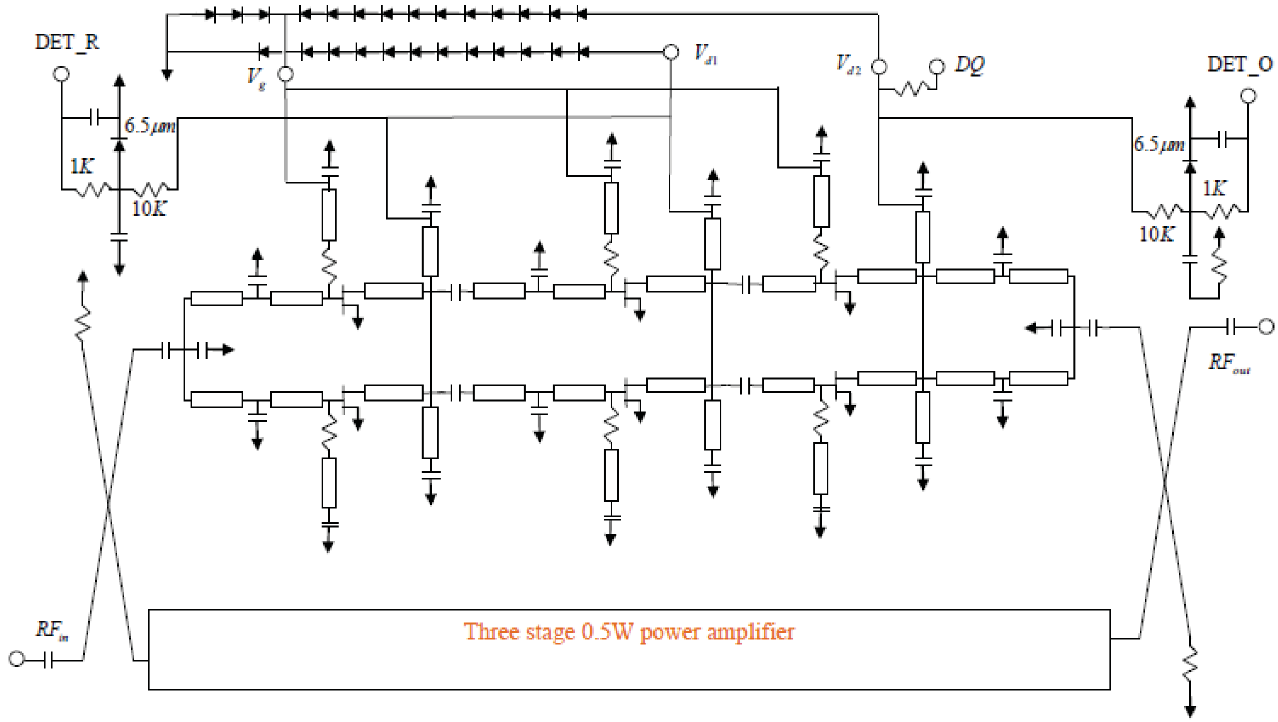


Figure 11. AMMC-6425 Schematic

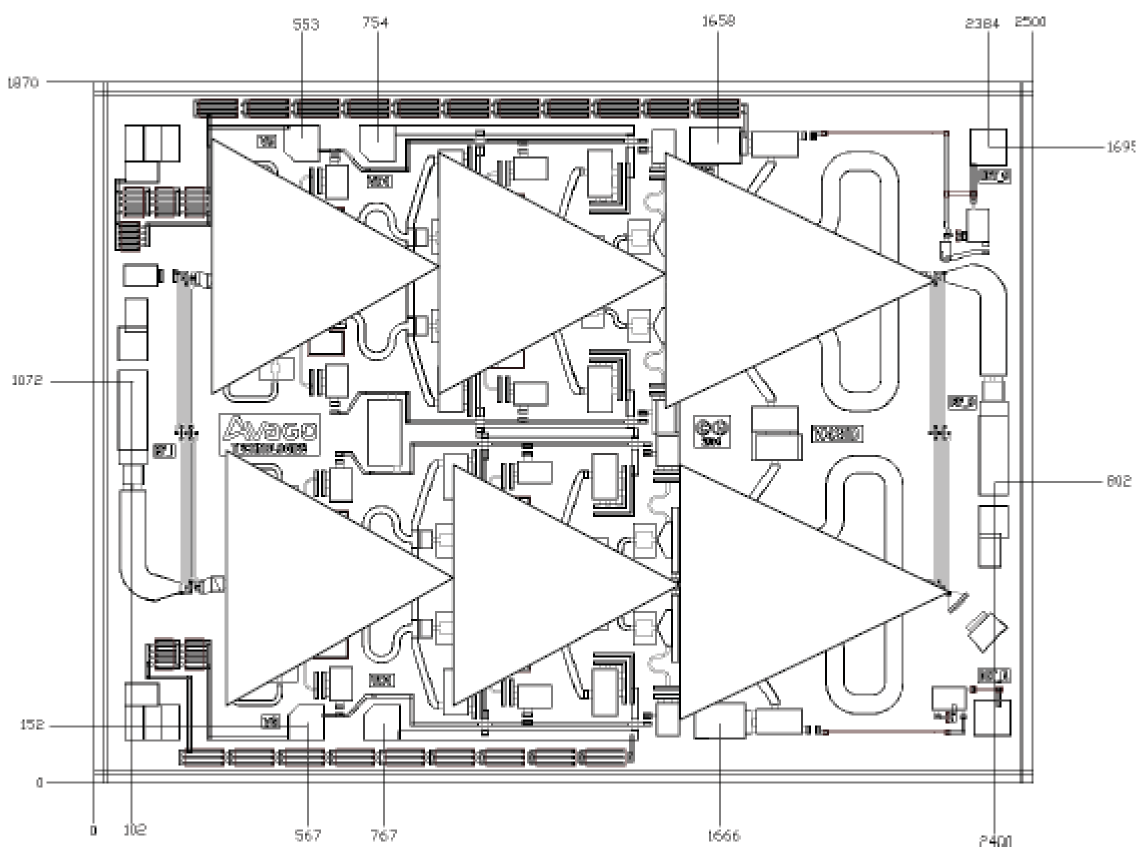
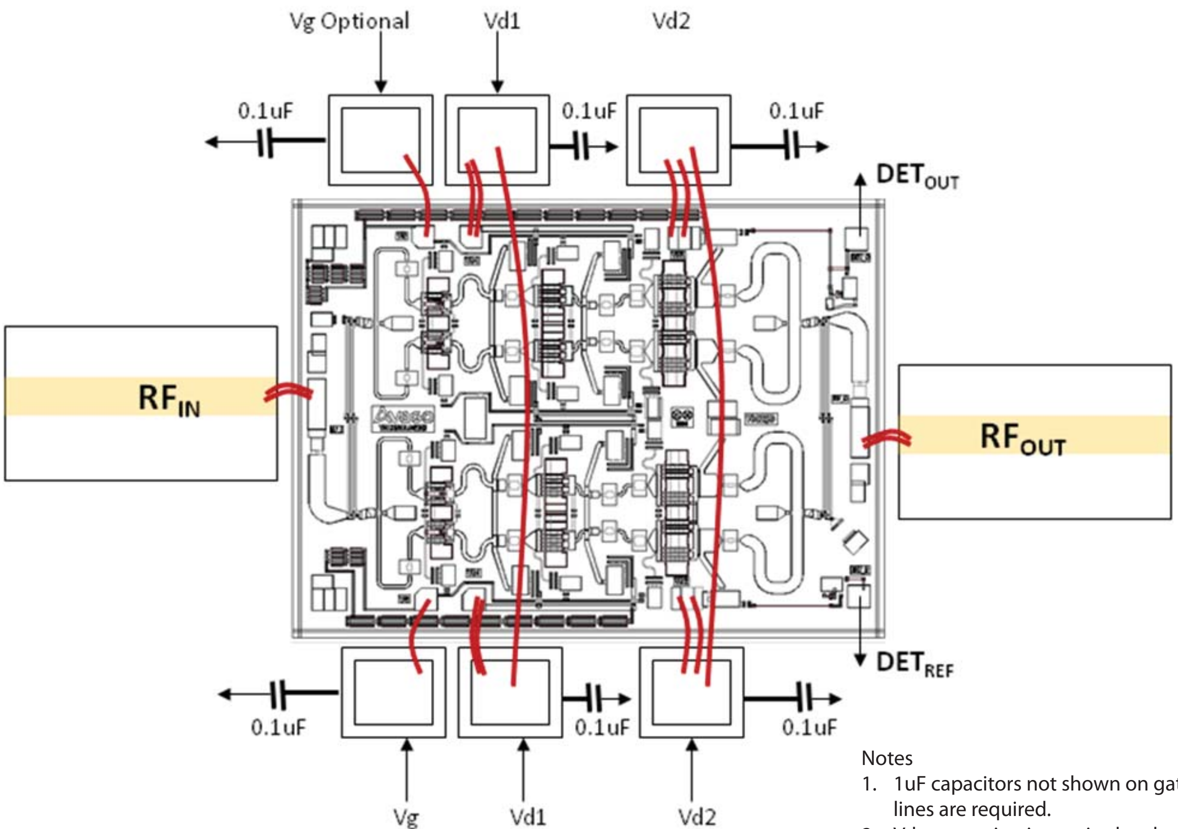


Figure 12. AMMC6425 Die dimension



Notes
1. 1uF capacitors not shown on gate and drain lines are required.
2. Vd connection is required on both sides.
3. Vg can be biased from either side.

Figure 13. AMMC-6425 Assembly examples

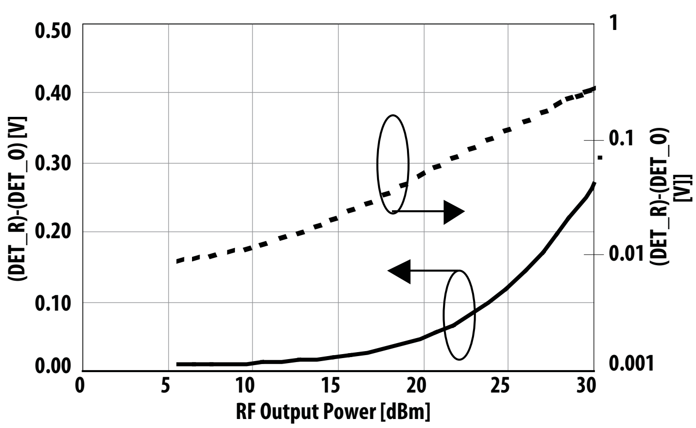


Figure 14. Typical Detector Voltage and Output Power, Freq=25GHz

Ordering Information:

AMMC-6425-W10 = 10 devices per tray

AMMC-6425-W50 = 50 devices per tray

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	×	O	O	O	O	O

O: 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.)

O：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**

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