1.0 – 4.2 GHz LOW NOISE AMPLIFIER WHM1045AE[1]

WHM1045AE LNA is a low noise figure, wideband, and high linear SMT packaged amplifiers with unconditional stable design. The amplifier offers typical 1.30 dB noise figure and 25 dBm output IP_3 at the frequency range from 1.0 GHz to 4.2 GHz of DCS, PCS, 3G, ISM, S, and C bands.

WHM1045AE LNA is most suitable for cellular base stations, wireless data communications, tower top receiver amplifiers, last-mile wireless communication systems, and wireless measurement applications.

WHM13-3530AE is designed to meet the rugged standards of MIL-STD-202, and MIL-STD-883.

Preliminary

Key Features:

Impedance:	50 Ohm
MTBF[2]:	>600,000 hrs (68 Years)
LGA (land grid array) package:	6-pin
Unconditional Stable:	$k > 1$
Low Noise:	1.30 dB
Output IP_3:	25 dBm
Gain:	25.0 dB
P_{1dB}:	13.0 dBm
Single Power Supply:	50 mA @ +5V
Frequency Range:	1.0 ~ 4.2 GHz
Operating Temperature:	-40 ~ +85 ºC
VSWR:	1.6:1 maximum
Small Size:	0.30" x 0.30" x 0.060" (7.62 mm x 7.62 mm x 1.52 mm)
Built-in Functions:	DC blocks at input and output, temperature compensation circuits, and auto DC biases.

Absolute Maximum Ratings[3]:

Symbol	Parameters	Units	Absolute Maximum
V_{dd}	DC Power Supply Voltage	V	7.0
I_{dd}	Drain Current	mA	70
P_{diss}	Total Power Dissipation	mW	400
$P_{In,Max}$	RF Input Power	dBm	10
T_{ch}	Channel Temperature	°C	150
T_{STG}	Storage Temperature	°C	-65 ~ 150
$T_{O,MAX}$	Maximum Operating Temperature	°C	-55 ~ 100
$R_{th,c}$	Thermal Resistance	°C/W	215

[1] Specifications are subject to change without notice.
[2] MTBF: Mean Time Between Failure, Per TR-NWT-000332, ISSUE 3, SEPTEMBER, 1990, T=40℃
[3] Operation of this device above any one of these parameters may cause permanent damage.

Specifications:

a) Table 1 Summary of the electrical specifications WHM1045AE at room temperature

Index	Testing Item	Symbol	Test Constraints	Nom (RT)	Min	Max	Unit
1	Gain	S_{21}	1.0 – 4.0 GHz	25	24	26	dB
2	Gain Variation	ΔG	1.0 – 4.0 GHz	+/- 1		+/- 1.5	dB
3	Input VSWR	$VSWR_1$	1.0 – 4.0 GHz	1.35		1.5	
4	Output VSWR	$VSWR_2$	1.0 – 4.0 GHz	1.5		1.6	
5	Reverse Isolation	S_{12}	1.0 – 4.0 GHz	50	45		dB
6	Noise figure	NF	1.0 – 4.0 GHz	1.30		1.5	dB
7	Output Power 1dB compression Point	P_{1dB}	1.0 – 4.0 GHz	14	12		dBm
8	Output-Third-Order Interception point	IP_3	Two-Tone, P_{out} +0 dBm each, 1 MHz separation	25	24		dBm
9	Current Consumption	I_{dd}	V_{dd}= +5 V	50	45	55	mA
10	Power Supply Voltage	V_{dd}		+5	+4.7	+5.3	V
11	Thermal Resistance	$R_{th,c}$	Junction to case			215	$^oC/W$
12	Operating Temperature	T_o			-40	+85	^oC
13	Maximum Average RF Input Power	$P_{IN, MAX}$	1.0 – 4.0 GHz			10	dBm

b) Passband Frequency Response

As shown in **Figure 1**, the typical gain of the WHM1045AE is 25.0 dB across 1.0 to 4.0 GHz. The typical input and output return losses are 18 dB across the frequency of 1.0 to 4.0 GHz.

Figure 2 shows the measured P_{1dB} and IP_3 of the WHM1045AE. The typical P_{1dB} and IP_3 are 13 dBm and 25 dBm in the frequency range of 1.0 to 4.0 GHz, respectively.

Figure 3 illustrates the measured noise figure performance at full temperature. The measured results include the test fixture loss of approximately 0.10 dB. The noise figure is 1.30 ~ 1.50 dB across the frequency range of 1.0 to 4.0 GHz at room temperature. At 85 ^{0}C, WHM1045AE only has 0.35 dB noise increases. At –40 ^{0}C, WHM1045AE offers approximately 0.25 dB less noise figure than that at room temperature.

Figure 4 demonstrates the stability factor ***k*** of the amplifier. It is greater than 1.0 in any frequency band and the amplifier is unconditional stable.

Figure 5 is the block diagram of internal circuit of WHM1045AE. It is a two-stage amplifier with the DC block capacitors at the input and output RF ports. All the RF matching networks, DC bias circuitries, and temperature compensation circuits are built in.

Figure 6 demonstrates the application schematic diagram of WHM1045AE. It may require one external decoupling capacitor of 0.01 uF to build a LNA with WHM1045AE. The +5V DC can be applied at Pin 3. No DC block capacitor is required for both input and output RF ports. The NC pins connected to ground are recommended. For +5V line trace length being longer than 6 inch without a decoupling capacitor, an additional 0.01 ~ 0.1 uF decoupling capacitor with minimum rating voltage of 10V may be needed across the +5V line to ground. The capacitor must be rated in the temperature range of -40 ^{0}C to 85 ^{0}C to ensure the entire circuit working in the specified temperature range.

Figure 7 shows the mechanical outline and recommended motherboard layout of WHM1045AE. Plenty of ground vias on the motherboard are essential for the RF grounding. The width of the 50-Ohm lines at the input and output RF ports may be different for different property of the substrate.

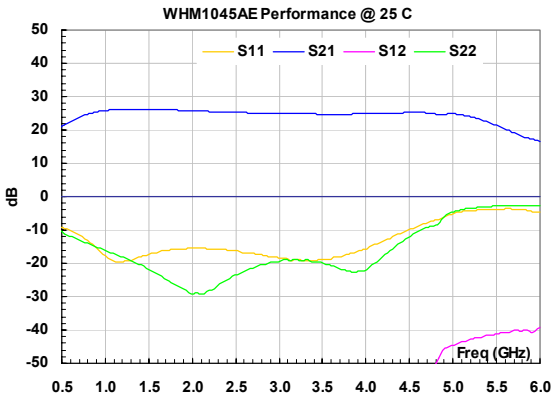

FIG. 1 Typical small signal performance.

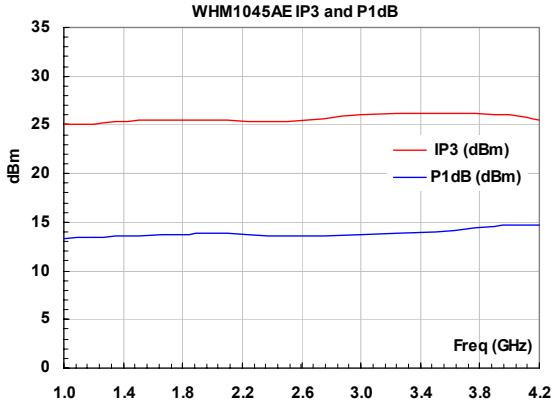

FIG. 2 Typical P_{1dB} and IP_3 at room temperature.

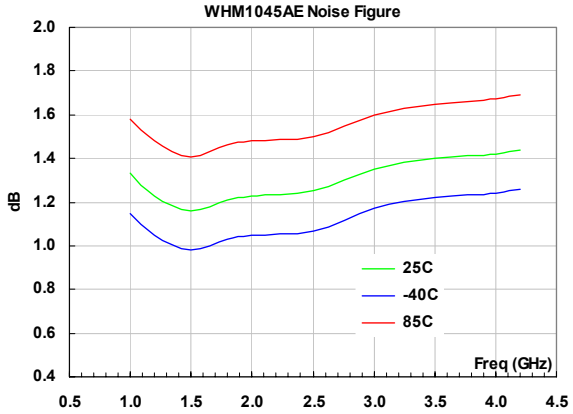

FIG. 3 Noise figure performance at full temperature

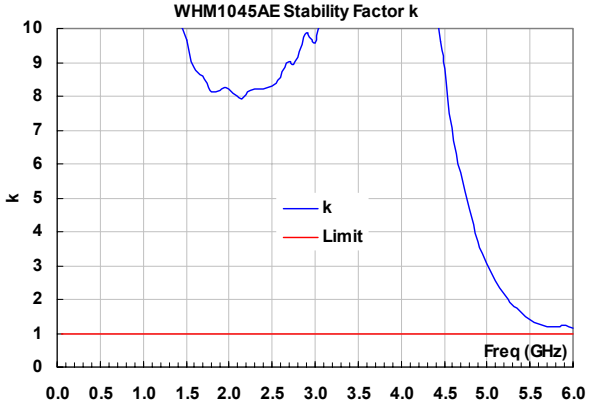

FIG. 4 Measured stability factor ***k***

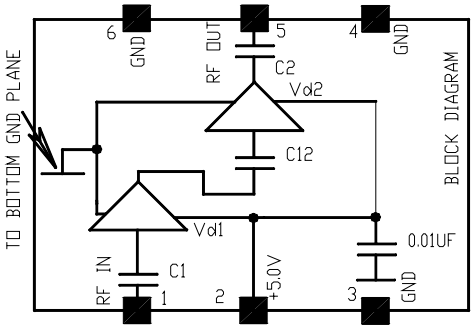

FIG. 5 Block diagram of internal circuit.

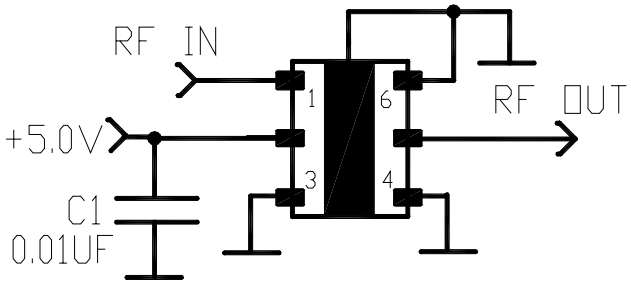

FIG. 6 Typical application schematic for WHM1045AE

WHM1045AE Mechanical Outline, WHM-2:

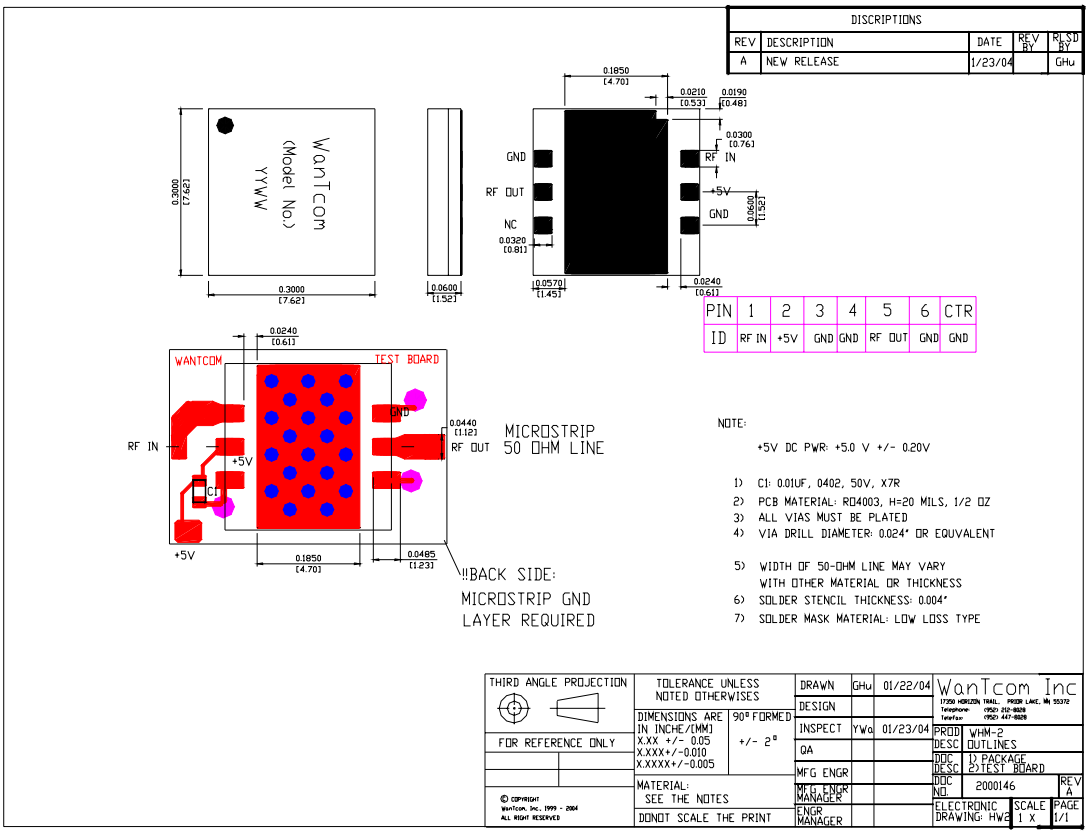

FIG. 7 WHM1045AE outline

Ordering Information

Model Number	WHM1045AE

Waffle pack with the capacity of 81 pieces (9 x 9) is used for the packing. Contact factory for tape and reel packing option for higher volume requirements.

Small Signal S-Parameters:

!WHM1045AE, Engineering Sample Demo
!s-parameters at Vdd=5V, Idd=50 mA, including the test board.
!Last updated 3/3/04.

GHZ s MA R 50

!F(GHz)	MAG S11	ANG S11	MAG S21	ANG S21	MAG S12	ANG S12	MAG S22	ANG S22
0.05	0.991	-22.5	0.062	-66.8	0.000059	-79.4	0.967	-24.4
0.1	0.948	-39.8	0.359	-101.0	0.000059	-152.9	0.916	-39.9
0.2	0.598	-83.7	2.087	-169.9	0.000175	138.2	0.776	-75.8
0.3	0.324	-77.0	4.783	135.1	0.000200	100.8	0.628	-105.7
0.4	0.368	-81.4	7.135	94.4	0.000205	98.6	0.509	-131.6
0.5	0.369	-100.3	9.215	64.3	0.000231	129.0	0.418	-154.5
0.6	0.337	-121.6	11.184	38.7	0.000287	139.5	0.347	-175.5
0.7	0.296	-143.3	13.039	15.5	0.000493	130.3	0.288	165.2
0.8	0.248	-166.2	14.790	-6.4	0.000730	123.9	0.239	146.6
0.9	0.200	168.7	16.321	-27.1	0.000979	117.3	0.193	129.2
1	0.158	141.2	17.608	-47.1	0.001305	108.2	0.152	111.9
1.1	0.122	109.4	18.522	-66.3	0.001626	99.7	0.113	97.3
1.2	0.101	72.5	19.250	-84.9	0.001861	89.1	0.077	83.6
1.3	0.097	34.3	19.720	-102.6	0.002099	77.3	0.047	74.6
1.4	0.100	-0.7	19.920	-119.7	0.002425	67.8	0.017	85.0
1.5	0.112	-29.9	20.014	-136.3	0.002565	59.5	0.017	175.2
1.6	0.124	-53.7	19.898	-152.4	0.002806	49.5	0.043	-175.6
1.7	0.133	-73.8	19.677	-167.9	0.002910	42.9	0.064	173.7
1.8	0.140	-90.9	19.339	177.3	0.003109	34.9	0.087	163.8
1.9	0.143	-106.7	18.986	163.0	0.003138	27.0	0.106	152.3
2	0.148	-121.6	18.623	149.2	0.003161	17.7	0.123	141.8
2.1	0.147	-135.4	18.276	135.7	0.003302	11.4	0.138	131.4
2.2	0.146	-148.8	17.933	122.5	0.003341	3.8	0.154	119.2
2.3	0.142	-161.2	17.609	109.6	0.003307	-1.6	0.167	108.8
2.4	0.139	-172.3	17.347	96.8	0.003358	-9.8	0.177	97.7
2.5	0.129	175.0	17.200	84.2	0.003342	-15.2	0.188	87.5
2.6	0.128	164.3	17.012	71.9	0.003265	-23.3	0.198	76.7
2.7	0.119	153.3	16.769	60.1	0.003143	-29.4	0.204	65.5
2.8	0.112	142.4	16.579	47.7	0.003121	-34.2	0.211	55.5
2.9	0.103	130.8	16.494	35.2	0.002912	-41.4	0.215	43.6
3	0.095	121.5	16.495	22.9	0.003002	-47.7	0.217	33.5
3.1	0.087	108.7	16.443	10.6	0.002776	-55.8	0.219	23.2
3.2	0.083	95.7	16.386	-2.0	0.002661	-61.7	0.218	12.7
3.3	0.072	83.7	16.413	-14.2	0.002383	-65.8	0.217	1.6
3.4	0.066	68.0	16.447	-26.4	0.002206	-76.9	0.209	-8.6
3.5	0.061	51.2	16.440	-39.1	0.002105	-80.0	0.201	-18.1
3.6	0.061	30.7	16.498	-51.7	0.002118	-90.1	0.195	-28.2
3.7	0.065	12.1	16.562	-64.5	0.001884	-104.4	0.182	-37.8
3.8	0.070	-12.9	16.591	-77.5	0.001771	-116.5	0.168	-46.4
3.9	0.085	-35.2	16.617	-90.7	0.001639	-128.1	0.152	-53.4
4	0.098	-52.1	16.592	-103.9	0.001396	-147.8	0.133	-59.7
4.1	0.127	-70.2	16.564	-117.5	0.001581	-172.0	0.116	-60.7
4.2	0.156	-86.5	16.501	-131.4	0.001584	167.8	0.102	-57.6
4.3	0.195	-102.4	16.403	-145.5	0.001988	140.9	0.099	-50.6
4.4	0.236	-117.2	16.188	-159.8	0.002629	125.8	0.108	-40.7
4.5	0.283	-131.7	15.881	-174.4	0.003238	106.8	0.134	-37.3
5	0.553	156.7	13.262	111.3	0.007516	42.3	0.348	-76.8
5.5	0.759	88.3	9.341	36.2	0.011000	-8.8	0.543	-138.2
6	0.847	26.4	6.266	-32.4	0.013000	-45.3	0.642	161.4

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