Wan7com, Inc.

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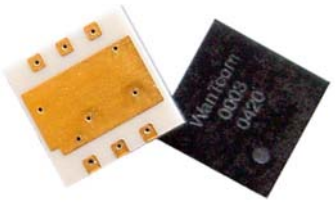
20 – 500 MHz LOW NOISE AMPLIFIER WHM0003AE[1]

WHM0003AE LNA is a low noise figure, wideband, and high linear SMT packaged amplifier with exceptional gain flatness design. The amplifier offers typical 0.70 dB noise figure, 22.0 dB gain, and 30.0 dBm output IP_3 at the frequency range from 20 MHz to 500 MHz of short wave, low VHF, FM, high VHF, and paging bands. WHM0003AE LNA is most suitable for wireless base stations, wireless data communications, tower top receiver amplifiers, last-mile wireless communication systems, and wireless measurement applications.



Key Features:

ESD Sensitive Component!!

Impedance:	50 Ohm
MTBF[2]:	>1,500,000 hrs (171 Years)
LGA (land grid array) package:	6-pin
Low Noise:	0.70 dB
Output IP_3:	30 dBm
Gain:	22.0 dB
P_{1dB}:	16.0 dBm
Single power supply:	40 mA @ +3.0V
Frequency Range:	20 ~ 500 MHz
Operating Temperature:	-40 ~ +85 ºC
Return Losses:	20 dB Typical
Small size:	0.25” x 0.25” x 0.060” (6.35 mm x 6.35 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	5.0
I_{dd}	Drain Current	mA	80
P_{diss}	Total Power Dissipation	mW	350
$P_{In,Max}$	RF CW 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
$T_{Re,MAX}$	Maximum Reflow Temperature	°C	210[4]
$R_{th,c}$	Thermal Resistance	°C/W	220

[1] Specifications are subject to change without notice.
[2] MTBF: Mean Time Between Failure, Per TR-NWT-000332, ISSUE 3, SEPTEMBER, 1990, T=40°C
[3] Operation of this device above any one of these parameters may cause permanent damage.
[4] Refer to WanTcom’s AN-109 for correct solder reflow temperature profile.

Specifications:

a) Table 1 Summary of the electrical specifications WHM0003AE at room temperature

Index	Testing Item	Symbol	Test Constraints	Nom (RT)	Min	Max	Unit
1	Gain	S_{21}	20 – 500 MHz	22	20		dB
2	Gain Variation	ΔG	20 – 500 MHz	+/- 0.8		+/- 1.2	dB
3	Input Return Loss	S_{11}	20 – 300 MHz	22	18		dB
			300 – 500 MHz	20	16		dB
4	Output Return Loss	S_{22}	20 – 500 MHz	20	18		dB
5	Reverse Isolation	S_{12}	20 – 500 MHz	25	22		dB
6	Noise figure	NF	50 – 500 MHz	0.70		0.85	dB
	Noise figure	NF	20 – 30 MHz	0.85		1.1	dB
7	Output Power 1dB compression Point	P_{1dB}	20 – 500 MHz	16	15		dBm
8	Output-Third-Order Interception Point	IP_3	Two-Tone, P_{out} +0 dBm each, 1 MHz separation	30	28		dBm
9	Current Consumption	I_{dd}	V_{dd}= +3.0 V	40	35	45	mA
10	Power Supply Voltage	V_{dd}		+3.0	+2.90	+3.10	V
11	Thermal Resistance	$R_{th,c}$	Junction to case			215	$^oC/W$
12	Operating Temperature	T_o			-40	+85	^oC
13	Maximum RF CW Input Power	$P_{IN, MAX}$	20 – 500 MHz			10	dBm

b) Passband Frequency Response

As shown in **Figure 1** of the measured parts in the production test fixture, the typical gain of the WHM0003AE is 22 dB across 20 to 500 MHz. The typical input and output return losses are 22 dB and 20 dB across the frequency of 20 to 500 MHz. The gain variation is less than 0.70 dB (+/- 0.35 dB) from the frequency from 20 to 300 MHz and less than 2.0 dB from 20 to 500 MHz. The amplifier has excellent consistent performance between each part from the same lot. For instance, at 64 pieces sampling size at 250 MHz, the amplifiers have the nominal gain of 21.70 dB with the standard deviation of 0.04 dB, the nominal input return loss of 19.10 dB with the standard deviation of 0.36 dB, and the nominal output return loss of 22.13 dB with the standard deviation of 1.28 dB. The actual performance may vary slightly for a soldered WHM0003AE on a test board comparing to the test results on the test fixture.

Figure 2 shows the measured P_{1dB} and IP_3 of the WHM0003AE soldered on the test board. The typical P_{1dB} and IP_3 are 16.0 dBm and 30.0 dBm in the frequency range of 20 to 500 MHz, respectively.

Figure 3 illustrates the measured noise figure performance at full temperature. The noise figure is 0.65 dB to 0.70 dB across the frequency range of 50 to 500 MHz and less than 1.0 dB from 20 MHz to 30 MHz at room temperature. At 85 ^{0}C, WHM0003AE only has 0.35 dB noise increases. At – 40 ^{0}C, WHM0003AE offers approximately 0.25 dB less noise figure than that at room temperature.

Figure 4 demonstrates the stability factor ***k*** of the amplifier. The amplifier is conditional stable since the stability factor ***k*** is less than 1 at the frequency from 1.0 GHz to 1.7 GHz.

Figure 5 shows frequency responses of WHM0003AE in full temperature from –55 ^{0}C to +125 ^{0}C.

Figure 6 demonstrates the application schematic diagram of WHM0003AE. It requires two (2) external high Q 6.8 uH inductors for the extended low frequency operation. The example of the inductor is FSLM2520-6R8J from TDK. Other brand inductors can be used as long as it is high Q and the lowest self-resonance frequency is beyond 500 MHz. A 169-Ohm resistor, R_{B1}, is used to adjust the DC bias current of the amplifier. The higher the R_{B1}, the larger the DC bias current. R_{B1} value can be from 150 Ohm to 200 Ohm depending on the predetermined DC bias current. For higher IP3 applications, the DC bias current can be set at 60 mA. A R_{D1} may be needed if the DC power supply is higher than +3.0V. For example, R_{D1} is 50 Ohm if the bias current is 40 mA and the DC source is +5.0V. This R_{D1} has 2.0 V voltage-drop, which makes the V_{dd} to be +3.0 V of the nominal operation voltage of the amplifier. The two (2) decoupling capacitors of 0.01 uF are used. All these external components 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 WHM0003AE. 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.

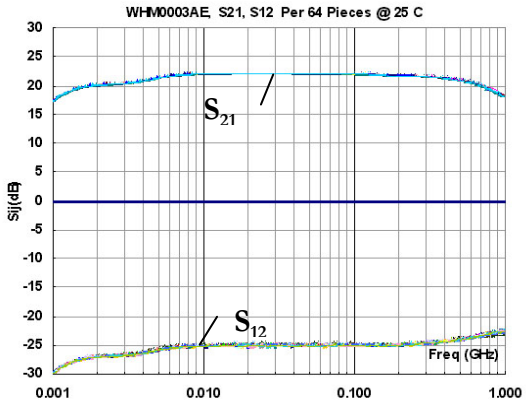


FIG. 1-(a) Typical small signal performance, S_{21},S_{12}

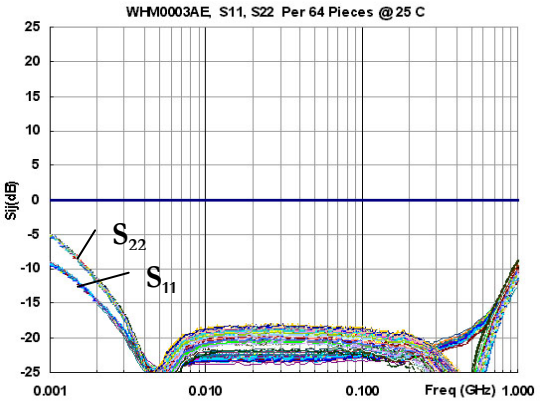


FIG. 2-(b) Typical small signal performance, S_{11},S_{22}

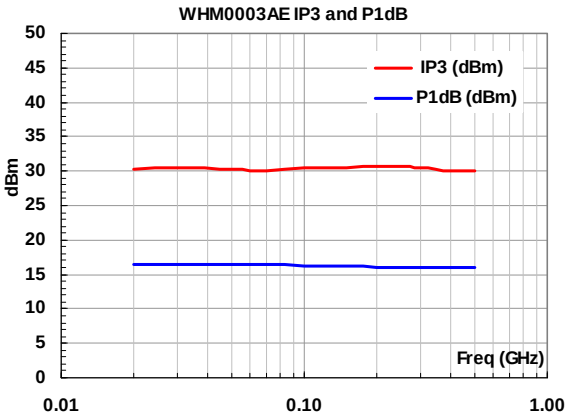


FIG. 3 Typical P_{1dB} and IP_3 at room temperature.

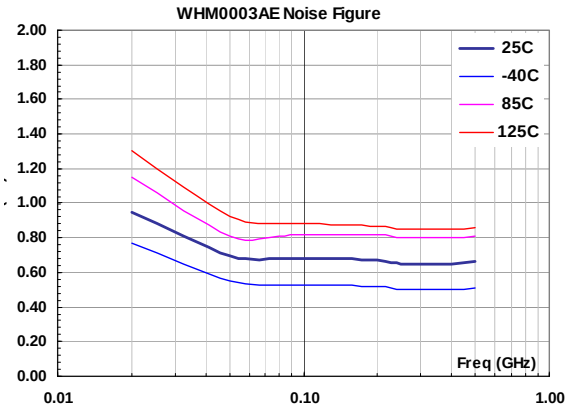


FIG. 3 Noise figure performance at full temperature

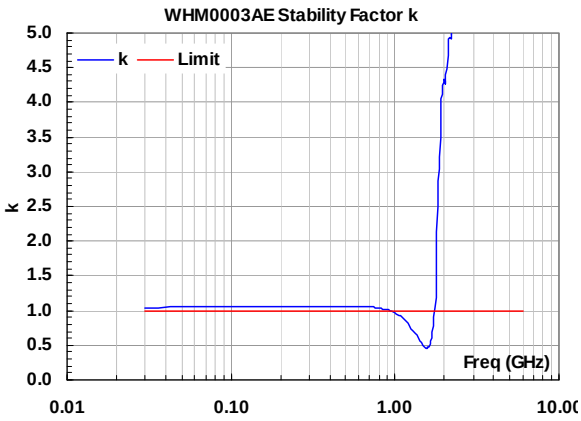


FIG. 4 Measured stability factor ***k***

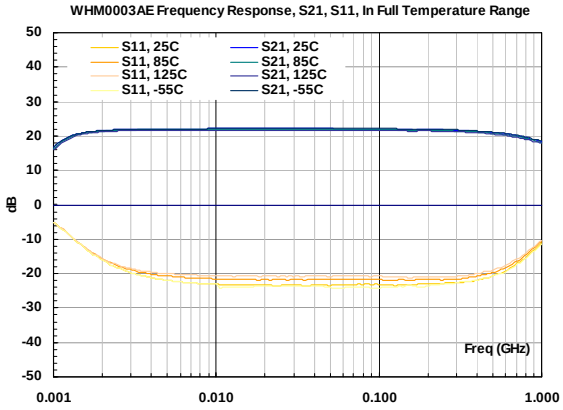


FIG. 5-(a) S_{21} and S_{11} in full temperature.

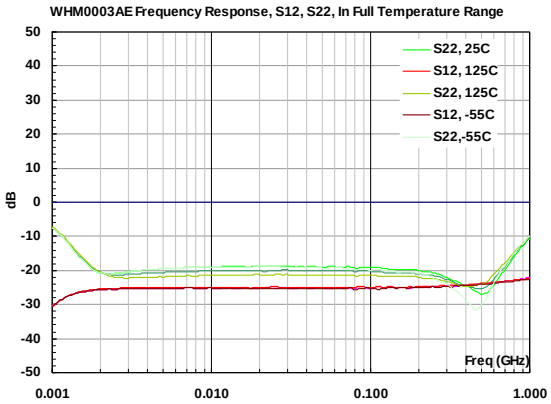


FIG. 5-(b) S_{12} and S_{22} in full temperature.

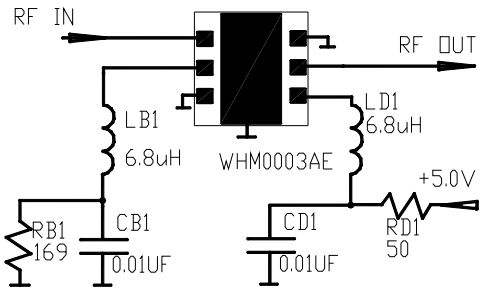


FIG. 6 Typical application schematic for WHM0003AE

WHM0003AE Mechanical Outline, WHM-1M:

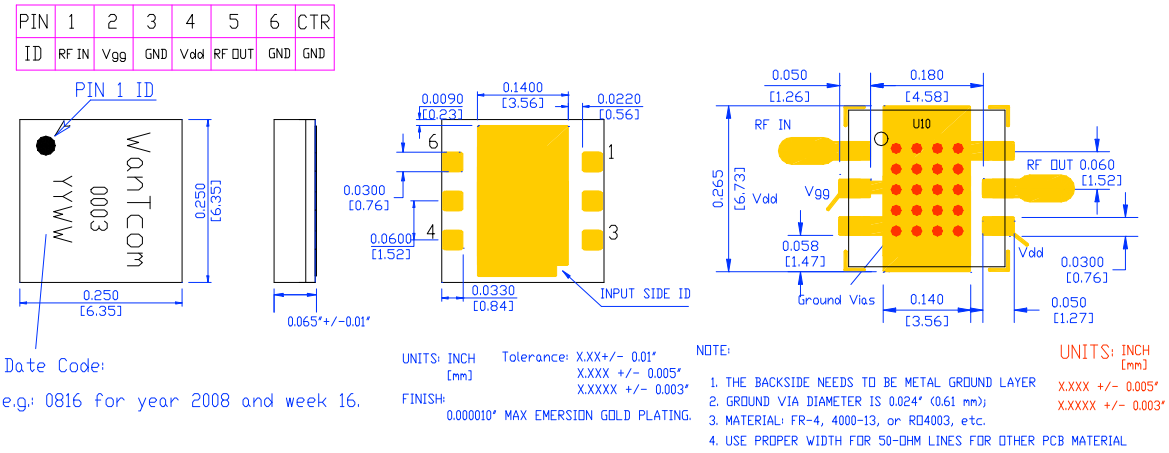


FIG. 7 WHM0003AE outline

Ordering Information

Model Number	WHM0003AE

ESD resistance tube with the capacity of 25 pieces is used for the packing. Contact factory for tape and reel packing option for higher volume requirements.

Small Signal S-Parameters:

! WLA0003AE
! Vdd = +3.0 V, Id = 40 mA
Ghz s ma r 50

0.0001	0.523	-27.1	5.315	-144.7	0.023	35.5	0.512	-38.1
0.005	0.204	-14.1	9.975	-161.5	0.043	20.3	0.124	-59.0
0.010	0.072	20.2	12.670	-171.9	0.054	10.2	0.110	-178.8
0.020	0.066	7.0	12.741	-179.3	0.055	3.6	0.114	179.3
0.03	0.076	-0.9	12.766	177.5	0.05451	1.7	0.113	178.4
0.04	0.067	-1.6	12.728	174.6	0.055	0.3	0.113	175.3
0.05	0.068	-6.2	12.646	168.5	0.0550	-1.5	0.111	172.6
0.15	0.07	-25.3	12.343	152.7	0.0550	-6.9	0.104	162.6
0.25	0.075	-43.6	12.05	134.5	0.0570	-12.2	0.088	153.1
0.35	0.079	-59.7	11.667	116.2	0.0590	-18.4	0.065	150.5
0.45	0.09	-76.1	11.238	98.1	0.0610	-24.9	0.048	164.6
0.55	0.105	-91.2	10.727	80.4	0.0640	-32.1	0.052	-162.4
0.65	0.129	-106.1	10.175	62.6	0.0670	-40.1	0.086	-148.3
0.75	0.16	-122.7	9.602	45.1	0.0710	-48.9	0.137	-151.0
0.85	0.202	-138.8	8.983	27.4	0.0730	-58.5	0.198	-160.3
0.95	0.256	-157.5	8.352	9.5	0.0750	-68.6	0.266	-172.7
1.05	0.313	-176.0	7.684	-8.2	0.0770	-79.8	0.34	172.9
1.15	0.378	165.9	6.988	-25.8	0.0770	-91.0	0.413	157.8
1.25	0.452	147.0	6.304	-43.9	0.0770	-102.9	0.492	142.2
1.35	0.529	127.6	5.582	-61.8	0.0740	-115.4	0.568	126.3
1.45	0.601	108.2	4.813	-78.5	0.0700	-128.3	0.637	109.6
1.55	0.663	88.9	4.01	-95.2	0.0660	-140.1	0.692	92.9
1.65	0.715	69.8	3.301	-111.1	0.0610	-151.0	0.734	76.3
1.75	0.752	51.0	2.693	-125.2	0.0550	-160.6	0.757	59.9
1.85	0.773	32.7	2.168	-136.3	0.0480	-169.7	0.758	44.0
1.95	0.764	14.7	1.727	-144.0	0.0420	-176.9	0.733	29.1
2.05	0.732	-1.4	1.436	-147.2	0.0370	-178.9	0.694	16.3
2.15	0.704	-15.4	1.412	-148.4	0.0380	-175.3	0.637	6.1
2.25	0.689	-29.0	1.544	-159.7	0.0470	177.2	0.608	1.8
2.35	0.68	-44.0	1.563	-179.7	0.0520	161.0	0.657	-3.2
2.45	0.65	-62.4	1.42	159.2	0.0520	141.8	0.723	-13.3
2.55	0.554	-83.7	1.172	140.5	0.0490	122.9	0.764	-25.7
2.65	0.351	-102.4	0.892	123.5	0.0440	105.1	0.775	-38.2
2.75	0.174	-78.0	0.694	108.6	0.0390	91.0	0.759	-49.4
2.85	0.286	-48.3	0.559	90.1	0.0370	74.1	0.747	-56.9
2.95	0.415	-57.8	0.388	68.8	0.0300	51.2	0.797	-64.2
3.05	0.507	-72.2	0.227	55.2	0.0210	35.3	0.855	-75.5
3.15	0.561	-87.5	0.138	51.9	0.0150	31.1	0.881	-87.8
3.25	0.578	-102.9	0.091	50.2	0.0120	33.3	0.888	-99.8
3.35	0.572	-117.2	0.062	45.6	0.0120	34.1	0.889	-111.0
3.45	0.536	-130.7	0.039	32.4	0.0130	28.8	0.885	-121.9
3.55	0.479	-140.6	0.023	-0.9	0.0140	17.7	0.879	-132.6
3.65	0.431	-144.7	0.016	-66.4	0.0140	2.1	0.868	-143.2
3.75	0.441	-146.1	0.026	-116.2	0.0120	-14.9	0.851	-153.2
3.85	0.488	-153.5	0.035	-136.1	0.0100	-25.8	0.835	-162.6
3.95	0.516	-165.2	0.041	-145.7	0.0090	-28.6	0.827	-171.5
4.05	0.519	-177.0	0.046	-154.0	0.0080	-26.1	0.826	179.3
4.15	0.5	170.8	0.047	-160.9	0.0088	-26.4	0.821	169.9
4.25	0.476	158.9	0.05	-168.8	0.0100	-30.4	0.818	160.4
4.35	0.433	148.8	0.049	-173.7	0.0110	-36.1	0.81	150.9
4.45	0.388	139.9	0.044	-178.6	0.0120	-43.8	0.801	141.7
4.95	0.333	120.6	0.027	-173.0	0.0140	-80.3	0.759	97.4
5.45	0.281	72.4	0.032	-145.0	0.0210	-96.9	0.738	54.3
5.95	0.146	54.3	0.068	-149.5	0.0360	-136.2	0.737	9.6
6	0.143	54.4	0.07	-152.1	0.0380	-140.3	0.737	6.0

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