Wan7com, Inc.

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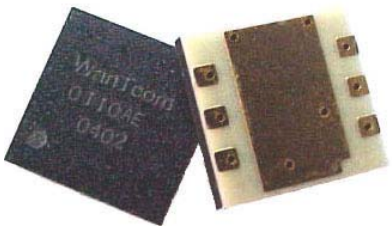
0.1 – 2.0 GHz LOW NOISE AMPLIFIER WHM0110AE[1]

WHM0110AE LNA is a low noise figure, wideband, and high linearity SMT packaged amplifiers. The amplifier offers typical noise figure of 0.65 dB and output IP_3 of 34 dBm at the frequency range from 0.1 GHz to 1.1 GHz and extendable to 2.0 GHz of VHF, UHF, Cellular, GSM, GPS, DCS, PCS, and 3G bands. WHM0110AE LNA is most suitable for cellular base stations, wireless data communications, tower top receiver amplifiers, last-mile wireless communication systems, and wireless measurement applications.



Key Features:

Impedance:	50 Ohm
MTBF[2]:	>2,500,000 hrs (300 Years)
LGA (land grid array) package:	6-pin
Low Noise:	0.65 dB
Output IP_3:	34 dBm
Gain:	20.0 dB
P_{1dB}:	17.0 dBm
Single power supply:	60 mA @ +5V
Frequency Range:	0.1 ~ 1.1 GHz Extendable to 2.0 GHz
Operating Temperature:	-40 ~ +85 ºC
Return Losses:	16 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.

Specifications:

a) Table 1 Summary of the electrical specifications WHM0110AE at room temperature

Index	Testing Item	Symbol	Test Constraints	Nom (RT)	Min	Max	Unit
1	Gain	S_{21}	0.1 – 1.1 GHz		17.5	23	dB
2	Gain Variation	ΔG	0.1 GHz Bandwidth	+/- 0.25		+/- 0.4	dB
3	Input Return Loss	S_{11}	0.1 – 1.1 GHz	20	18		dB
4	Output Return Loss	S_{22}	0.1 – 1.1 GHz	18	16		dB
5	Reverse Isolation	S_{12}	0.1 – 1.1 GHz	22	20		dB
6	Noise figure	NF	0.1 – 1.1 GHz	0.65		0.80	dB
7	Output Power 1dB compression Point	P_{1dB}	0.1 – 1.1 GHz	17	16		dBm
8	Output-Third-Order Interception point	IP_3	Two-Tone, P_{out} +0 dBm each, 1 MHz separation	34	32		dBm
10	Current Consumption	I_{dd}	V_{dd}= +5 V	60	55	70	mA
11	Power Supply Voltage	V_{dd}		+5	+4.7	+5.3	V
12	Thermal Resistance	$R_{th,c}$	Junction to case			215	°C/W
13	Operating Temperature	T_o			-40	+85	°C
14	Maximum Average RF Input Power	$P_{IN, MAX}$	0.1 – 2.0 GHz			10	dBm

[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

b) Passband Frequency Response

As shown in **Figure 1**, the typical gain of the WHM0110AE is from 18.0 dB to 22.5 dB across 0.1 GHz to 1.1 GHz. The typical input and output return losses are 20 dB and 18 dB across the frequency of 0.1 to 1.1 GHz. The return losses and gain are usable up to 2.0 GHz. **Figure 2** shows the full band performance up to 2.0 GHz.

Figure 3 shows the measured P_{1dB} and IP_3 of the WHM0110AE. The typical P_{1dB} and IP_3 are 17 dBm and 34 dBm in the frequency range of 0.10 GHz to 2.0 GHz, respectively.

Figure 4 illustrates the measured noise figure performance at full temperature. The measured results include the test fixture loss of approximately 0.05 dB to 0.10 dB depending on the frequency. The noise figure is 0.60 dB to 0.75 dB across the frequency range of 0.1 to 1.1 GHz at room temperature. The noise figure is below 1.0 dB at 2.0 GHz. At 85 ^{0}C, WHM0110AE only has 0.35 dB noise increases. At –40 ^{0}C, WHM0110AE offers approximately 0.25 dB less noise figure than that at room temperature.

Figure 5 demonstrates the stability factor ***k*** of the amplifier. The ***k*** values are slightly below 1 in some frequency ranges of 2.7 GHz to 3.4 GHz. **Figure 6** plots the input and output stability circles. As shows in **Figure 6,** the red circles are the input stability circles and there are some small potential unstable areas falling into the unit Smith Chart. The high inductance to open load would cause the unstable to the amplifier. The blue circles are the output stability circles and there are some small potential unstable areas falling into the unit Smith Chart. The high capacitance to open load would cause the unstable to the amplifier.

Figure 7 is the block diagram of internal circuit of WHM0110AE. It is one 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 8 demonstrates the application schematic diagram of WHM0110AE. It requires two (2) external decoupling capacitors of 0.01 uF to build a LNA with WHM0110AE. The +5V DC can be applied either at Pin 3 or Pin 5 depending on the availability of the +5.0V source location. No DC block capacitor is required for both input and output RF ports. For +5V line trace length being longer than 6 inch without a decoupling capacitor, an additional 0.01 ~ 0.1 uF de-coupling 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 9 shows the mechanical outline and recommended motherboard layout of WHM0110AE. 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.

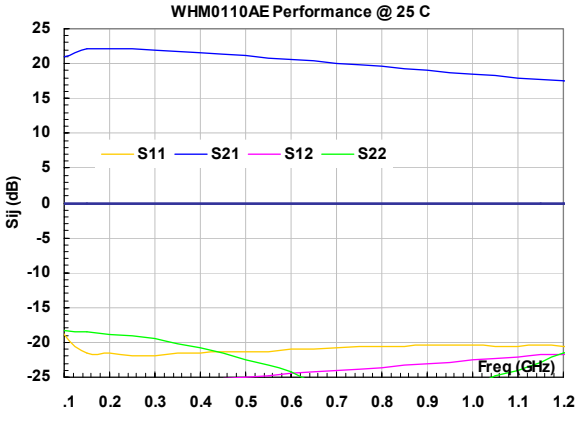


FIG. 1 Typical small signal performance.

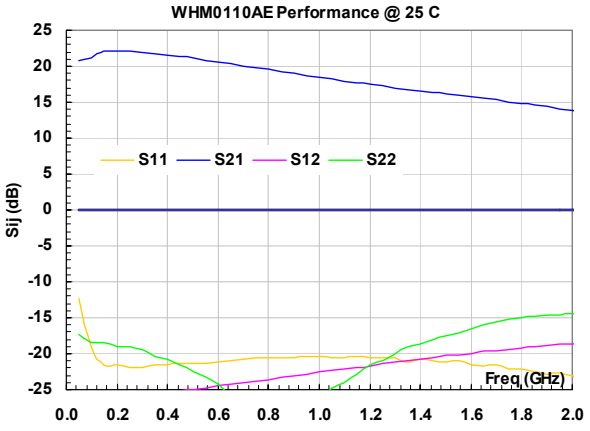


FIG. 2 Small signal performance up to 2 GHz.

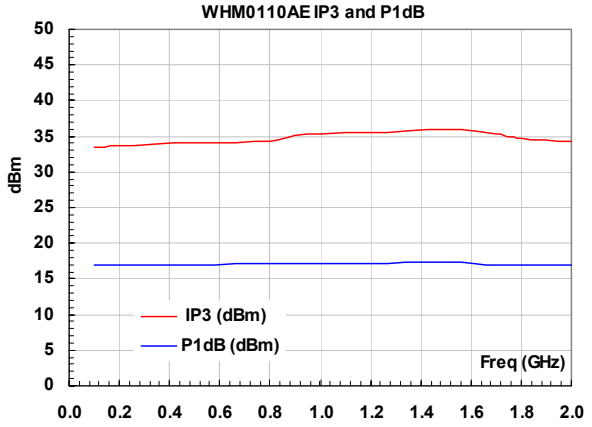


FIG. 3 Typical P_{1dB} and IP_3 at room temperature.

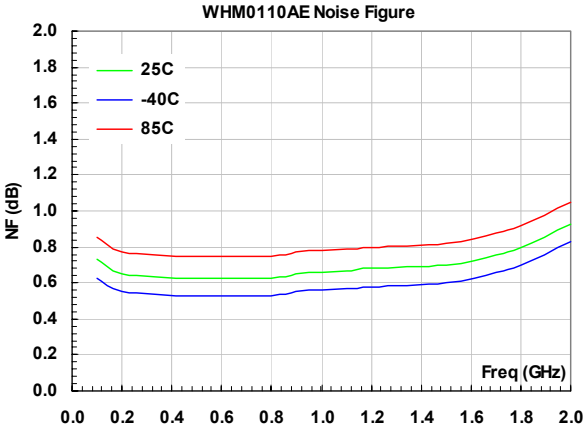


FIG. 4 Noise figure performance at full temperature

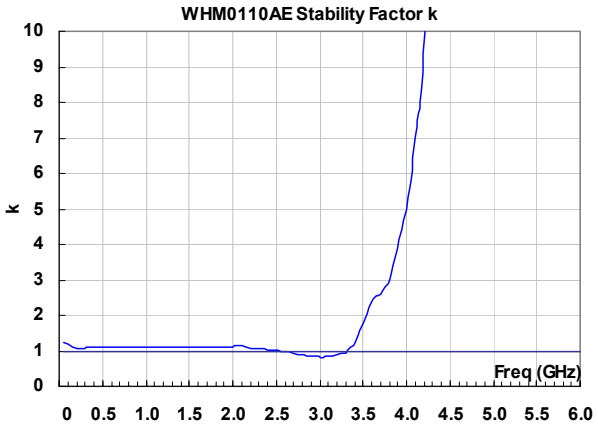


FIG. 5 Measured stability factor ***k***

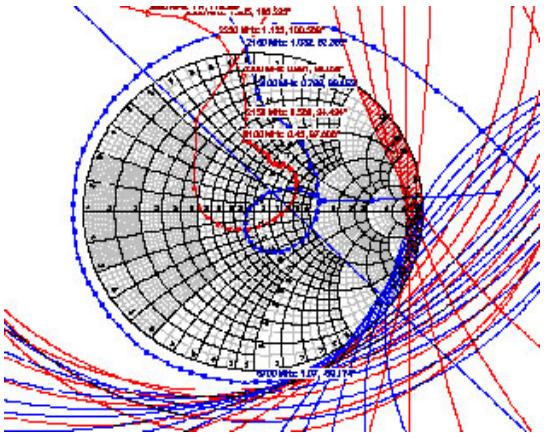


FIG. 6 Plots of Input and output stability circles

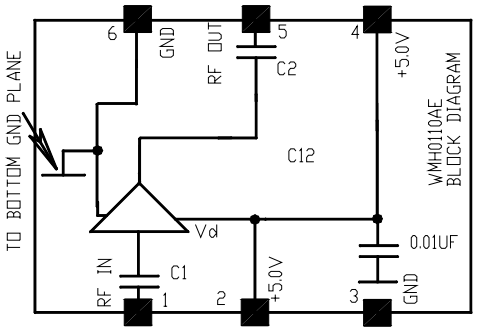


FIG. 5 Block diagram of internal circuit.

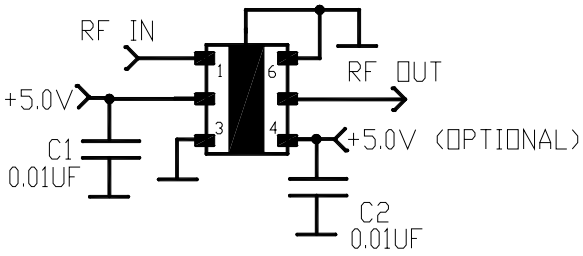


FIG. 6 Typical application schematic for WHM0110AE

WHM0110AE Mechanical Outline, WHM-1:

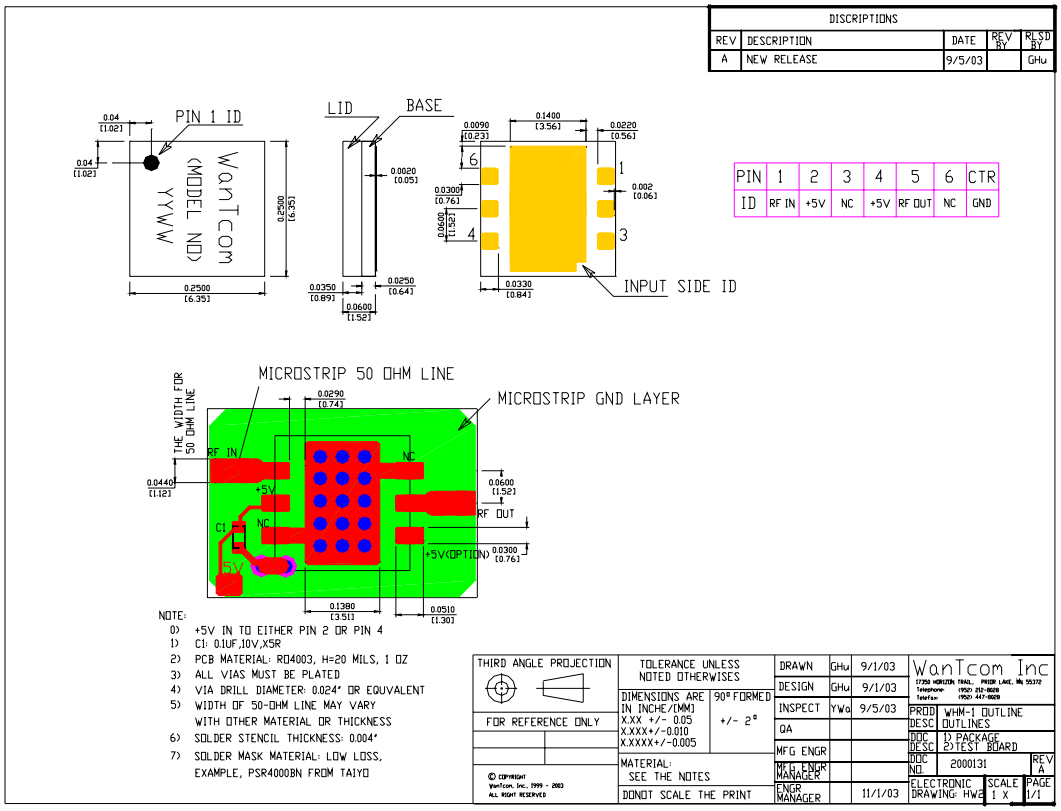


FIG. 7 WHM0110AE outline

Ordering Information

Model Number	WHM0110AE

Waffle pack with the capacity of 100 pieces (10 x 10) is used for the packing. Contact factory for tape and reel packing option for higher volume requirements.

Small Signal S-Parameters:

!WHM0110AE
!s-parameters at Vds=5V, Id=60 mA, including the test board.
!Last updated 2/2/04.

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	0.145	84.5	11.941	-140.5	0.0440	57.3	0.124	-178.9
0.1	0.086	28.8	12.072	-161.5	0.0480	33.4	0.123	167.3
0.2	0.089	-38.1	13.016	163.9	0.0510	13.9	0.114	134.6
0.3	0.092	-73.3	12.629	144.1	0.0520	8.3	0.116	107.2
0.4	0.098	-103.0	12.125	127.4	0.0550	4.6	0.113	79.6
0.5	0.107	-127.0	11.517	112.4	0.0570	1.5	0.108	55.7
0.6	0.116	-149.6	10.873	98.3	0.0600	-1.6	0.107	31.5
0.7	0.120	-169.6	10.268	85.0	0.0640	-5.0	0.103	7.3
0.8	0.124	172.4	9.669	72.3	0.0680	-8.9	0.101	-15.7
0.9	0.129	154.9	9.088	60.1	0.0730	-13.1	0.100	-38.3
1	0.130	139.7	8.560	48.3	0.0770	-17.9	0.100	-61.9
1.1	0.132	124.7	8.072	36.7	0.0820	-23.0	0.104	-83.6
1.2	0.134	111.5	7.622	25.2	0.0870	-28.2	0.110	-106.3
1.3	0.134	98.2	7.220	13.9	0.0920	-34.1	0.114	-126.2
1.4	0.130	88.3	6.859	3.1	0.0970	-40.1	0.129	-145.7
1.5	0.129	77.7	6.546	-7.8	0.1030	-46.4	0.141	-164.9
1.6	0.129	68.0	6.210	-19.0	0.1080	-53.1	0.154	177.1
1.7	0.133	58.0	5.868	-30.2	0.1140	-60.6	0.167	160.8
1.8	0.126	43.2	5.442	-40.9	0.1200	-68.3	0.178	147.1
1.9	0.077	28.7	5.224	-49.3	0.1270	-76.1	0.199	142.0
2	0.070	85.3	5.246	-61.7	0.1270	-89.3	0.302	128.8
2.1	0.136	75.2	4.846	-74.9	0.1230	-94.2	0.321	106.2
2.2	0.180	65.2	4.512	-85.2	0.1280	-100.4	0.354	92.3
2.3	0.223	53.4	4.277	-96.1	0.1320	-108.7	0.393	78.3
2.4	0.273	41.8	4.030	-108.0	0.1370	-117.6	0.432	64.9
2.5	0.319	29.2	3.820	-120.2	0.1400	-126.8	0.472	51.4
2.6	0.372	16.4	3.597	-132.0	0.1390	-136.4	0.514	38.6
2.7	0.431	2.9	3.330	-143.2	0.1370	-147.5	0.557	25.5
2.8	0.495	-11.3	2.998	-155.6	0.1370	-158.7	0.600	12.6
2.9	0.557	-26.7	2.649	-168.2	0.1330	-169.2	0.640	-1.4
3	0.611	-43.1	2.290	-177.8	0.1230	-178.7	0.651	-16.1
3.1	0.649	-57.9	2.177	174.6	0.1170	175.0	0.612	-23.7
3.2	0.695	-71.6	2.076	160.2	0.1190	165.8	0.692	-30.0
3.3	0.736	-86.4	1.829	145.2	0.1180	155.2	0.763	-42.6
3.4	0.779	-101.4	1.550	132.9	0.1100	145.3	0.802	-55.1
3.5	0.818	-115.9	1.283	121.3	0.1040	135.5	0.834	-67.0
3.6	0.843	-130.6	1.062	110.3	0.0990	125.5	0.857	-79.0
3.7	0.855	-145.0	0.875	99.7	0.0960	115.9	0.874	-90.2
3.8	0.872	-159.0	0.711	90.3	0.0910	107.0	0.887	-101.1
3.9	0.884	-172.2	0.567	81.4	0.0850	97.0	0.897	-111.3
4	0.892	173.9	0.444	72.9	0.0810	85.6	0.908	-121.4
4.1	0.891	160.6	0.336	64.1	0.0790	74.4	0.917	-131.6
4.2	0.889	147.6	0.253	55.2	0.0770	65.5	0.926	-141.0
4.3	0.887	134.8	0.182	47.5	0.0730	56.0	0.932	-150.8
4.4	0.881	121.8	0.121	42.7	0.0690	44.3	0.936	-160.0
4.5	0.866	109.2	0.072	40.4	0.0660	32.9	0.938	-169.4
5	0.800	47.1	0.063	150.5	0.0500	-13.2	0.940	147.0
5.5	0.647	-16.7	0.081	108.9	0.0610	-48.1	0.938	104.6
6	0.603	-64.2	0.049	60.0	0.0770	-83.0	0.929	64.4