

1.0 – 2.0 GHz LOW NOISE AMPLIFIER WHM13-3530AE¹

WHM13-3530AE LNA is a low noise figure, wideband, and high linear packaged amplifier with unconditional stable design. The amplifier offers typical noise figure of 0.90 dB and output IP₃ of 25 dBm at the frequency range from 1.0 GHz to 2.0 GHz of GPS, DCS, PCS, and 3G bands. WHM13-3530AE LNA is most-suitable for cellular base stations, wireless data communications, tower top receiver amplifiers, last-mile wireless communication systems, and wireless measurement applications.



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

Key Features:

Impedance:	50 Ohm
MTBF ² :	>600,000 hrs (68 Years)
LGA (land grid array) package:	6-pin
Unconditional Stable:	$k \ge 1$
Low Noise:	0.90 dB
Output IP ₃ :	25 dBm
Gain:	33.5 dB
P _{1dB} :	13.0 dBm
Single power supply:	40 mA @ +3V
Frequency Range:	1.0 ~ 2.0 GHz
Operating Temperature:	$-40 \sim +85 \text{ °C}$
Return Losses:	16 dB Typical
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 Ratings³:

Symbol	Parameters	Units	Absolute Maximum
V_{dd}	DC Power Supply Voltage	V	5.0
l _{dd}	Drain Current	mA	70
P _{diss}	Total Power Dissipation	mW	300
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°C

³ Operation of this device above any one of these parameters may cause permanent damage.



Specifications:

a) Table 1 Summary of the electrical specifications WHM13-3530AE at room temperature

Index	Testing Item	Symbol	Test Constraints	Nom (RT)	Min	Мах	Unit
1	Gain	S ₂₁	1.0 – 2.0 GHz	33.5	32	35	dB
2	Gain Variation	ΔG	1.0 – 2.0 GHz	+/- 1.0		+/- 1.3	dB
3	Input Return Loss	S ₁₁	1.0 – 2.0 GHz	18	16		dB
4	Output Return Loss	S ₂₂	1.0 – 2.0 GHz	18	16		dB
5	Reverse Isolation	S ₁₂	1.0 – 2.0 GHz	45	40		dB
6	Noise figure	NF	1.0 – 2.0 GHz	0.9		1.2	dB
7	Output Power 1dB compression Point	P _{1dB}	1.0 – 2.0 GHz	13.5	12.5		dBm
8	Output-Third-Order Interception point	IP ₃	Two-Tone, P _{out} +0 dBm each, 1 MHz separation	26	24		dBm
9	Current Consumption	l _{dd}	V _{dd} = +3 V	40	35	45	mA
10	Power Supply Voltage	V _{dd}		+3	+2.8	+3.3	V
11	Thermal Resistance	R _{th,c}	Junction to case			215	°C/W
12	Operating Temperature	To			-40	+85	°C
13	Maximum Average RF Input Power	P _{IN, MAX}	1.0 – 2.0 GHz			10	dBm

b) Passband Frequency Response

As shown in **Figure 1**, the typical gain of the WHM13-3530AE is 33.5 dB across 1.0 to 2.0 GHz. The typical input and output return losses are 18 dB across the frequency of 1.0 to 2.0 GHz.

Figure 2 shows the measured P_{1dB} and IP_3 of the WHM13-3530AE. The typical P_{1dB} and IP_3 are 13.5 dBm and 25.0 dBm in the frequency range of 1.0 to 2.0 GHz, respectively.

Figure 3 illustrates the measured noise figure performance at full temperature. The measured results include the test fixture loss of approximately 0.05 dB. The noise figure is $0.90 \sim 1.0$ dB across the frequency range of 1.0 to 2.0 GHz at room temperature. At 85 $^{\circ}$ C, WHM13-3530AE only has 0.30 dB noise increases. At -40 $^{\circ}$ C, WHM13-3530AE 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 1.5 in any frequency band and the amplifier is unconditional stable.

Figure 5 shows the frequency response in the extended frequency band.

Figure 6 demonstrates the frequency response vs. DC biases of 2.8V, 3.0V, and 3.3V.

Figure 7 is the block diagram of internal circuit of WHM13-3530AE. 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 8 demonstrates the application schematic diagram of WHM13-3530AE. It may require one external decoupling capacitor of 0.01 uF to build a LNA with WHM13-3530AE. The +3V DC is 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 +3V line trace length being longer than 6 inch without a decoupling capacitor, an additional 0.01 \sim 0.1 uF de-coupling capacitor with minimum rating voltage of 10V may be needed across the +3V line to the ground. The capacitor must be rated in the temperature range of -40 $^{\circ}$ C to 85 $^{\circ}$ C to ensure the entire circuit working in the specified temperature range.

Figure 9 shows the mechanical outline and recommended motherboard layout of WHM13-3530AE. 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.



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FIG. 1 Typical small signal performance.



FIG. 3 Noise figure performance at full temperature



FIG. 5 Small signal performance at extended band



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



FIG. 4 Measured stability factor k



FIG. 6 Small signal performance vs. Vdd



FIG. 7 Block diagram of internal circuit.

FIG. 8 Typical application schematic for WHM13-3530AE

WHM13-3530AE Mechanical Outline, WHM-2:



FIG. 9 WHM13-3530AE outline



Ordering Information

Model Number WHM13-3530AE

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

Small Signal S-Parameters:

!WHM13-3530AE !s-parameters at Vdd=3V, Idd=40 mA, including the test board. !Last updated 03/02/04.

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	0.914	169.8	0.011	81.4	0.000091	31.9	0.991	-25.4
0.1	0.873	132.8	0.183	61.6	0.000128	69.9	0.963	-44.1
0.2	0.870	65.7	3.451	-55.5	0.000540	38.9	0.576	-94.1
0.3	0.838	15.1	11.861	-136.2	0.001005	-71.2	0.694	-84.1
0.4	0.758	-29.0	24.498	157.8	0.001805	-136.5	0.787	-135.1
0.5	0.615	-67.9	38.667	102.9	0.003139	176.5	0.638	179.1
0.6	0.436	-99.2	49.697	53.7	0.004446	136.4	0.415	140.4
0.7	0.302	-121.3	55.376	11.4	0.005139	107.0	0.227	114.9
0.8	0.217	-134.7	56.859	-25.0	0.005541	83.7	0.118	111.8
0.9	0.167	-144.7	56.500	-56.2	0.005750	64.4	0.088	132.0
1	0.136	-153.6	55.042	-84.0	0.005827	48.5	0.103	139.5
1.1	0.120	-163.2	53.207	-109.1	0.005878	35.5	0.119	135.5
1.2	0.107	-173.9	51.455	-132.3	0.005771	23.2	0.131	126.1
1.3	0.095	171.3	49.776	-153.9	0.005739	12.5	0.141	116.2
1.4	0.085	157.7	48.364	-174.9	0.005712	2.1	0.143	105.4
1.5	0.072	142.0	47.308	164.8	0.005511	-7.4	0.142	94.5
1.6	0.057	122.9	46.427	144.8	0.005346	-17.6	0.137	84.1
1.7	0.043	99.9	45.736	124.6	0.005140	-27.0	0.128	72.7
1.8	0.023	73.9	45.025	104.3	0.005032	-37.4	0.105	63.6
1.9	0.008	-60.7	44.498	83.1	0.004812	-50.0	0.072	59.9
2	0.041	-119.0	43.779	60.9	0.004579	-62.5	0.039	101.8
2.1	0.083	-151.0	42.373	37.6	0.004445	-78.9	0.098	149.4
2.2	0.131	-180.0	40.013	13.2	0.004183	-95.1	0.211	139.0
2.3	0.179	154.1	36.215	-12.1	0.003906	-118.3	0.340	120.4
2.4	0.218	128.7	31.376	-37.7	0.003725	-143.9	0.464	99.2
2.5	0.256	104.3	26.322	-61.8	0.003708	-170.1	0.571	78.6
2.6	0.277	83.5	21.438	-83.4	0.003624	162.4	0.651	58.9
2.7	0.291	63.7	16.943	-102.0	0.004099	139.6	0.707	40.6
2.8	0.299	45.7	13.104	-120.5	0.004399	121.0	0.748	24.2
2.9	0.308	30.0	10.165	-137.9	0.005054	105.1	0.777	8.5
3	0.312	14.5	7.961	-153.6	0.005339	91.5	0.797	-6.0
3.1	0.321	1.1	6.155	-167.9	0.006045	80.0	0.814	-19.4
3.2	0.322	-11.9	4.688	178.5	0.006683	70.0	0.825	-32.4
3.3	0.332	-25.0	3.625	166.3	0.007274	61.9	0.834	-44.9
3.4	0.337	-37.8	2.748	155.3	0.007694	52.4	0.839	-57.0
3.5	0.342	-49.7	2.032	145.6	0.008366	45.0	0.845	-68.8
3.6	0.350	-60.9	1.477	136.7	0.009007	38.3	0.849	-80.2
3.7	0.356	-72.5	1.044	128.8	0.009634	32.2	0.853	-91.3
3.8	0.370	-83.8	0.710	123.7	0.010000	25.0	0.855	-102.2
3.9	0.384	-94.6	0.445	122.6	0.011000	19.0	0.856	-112.7
4	0.397	-106.4	0.252	133.6	0.011000	12.3	0.860	-123.2
4.1	0.417	-117.8	0.163	169.4	0.012000	6.2	0.859	-133.3
4.2	0.430	-129.7	0.203	-158.0	0.013000	0.3	0.859	-143.5
4.3	0.450	-140.8	0.278	-148.9	0.013000	-6.1	0.859	-153.5
4.4	0.473	-153.3	0.342	-150.3	0.014000	-14.5	0.861	-163.4
4.5	0.492	-165.2	0.385	-155.4	0.015000	-20.5	0.861	-173.1
5	0.599	133.1	0.377	172.2	0.016000	-49.8	0.854	140.8
5.5	0.686	68.8	0.158	145.2	0.017000	-77.4	0.843	97.3
6	0.742	6.8	0.087	-109.0	0.018000	-107.3	0.834	57.3
