Wan7com, Inc.

1.2 – 1.6 GHz SMT LOW NOISE AMPLIFIER WHM14-3020AE/LE[1]

WHM14-3020AE is a super low noise figure, wideband, and unconditional stable SMT packaged amplifier with exceptional low input and output VSWR. The amplifier offers typical 0.50 dB noise figure, 20 dB input and output return losses, 31.0 dB gain, and 10 dB output P_{1dB} at the frequency range from 1.2 GHz to 1.6 GHz GPS and DGPS bands. WHM14-3020LE has built-in limiter that provides the LNA protection up to 30 dBm continuous input power. WHM14-3020AE/LE is most suitable for GPS receivers, wireless data communications, and wireless measurement applications.

WHM14-3020AE/LE is designed to meet the rugged standards of MIL-STD-202, MIL-STD-883, and MIL-STD-810F.

Preliminary

Key Features:

Impedance:	50 Ohm
MTBF[2]:	>600,000 hrs (68 Years)
Low Noise:	0.50 dB, 0.70 dB for LE version
Gain:	31.0 dB
P_{1dB}:	10.0 dBm
Single Power Supply:	40 mA @ +3.3V low power consumption
Frequency Range:	1.2 ~ 1.6 GHz, extended operating band, 1.0 ~ 1.8 GHz.
Operating Temperature:	-40 ~ +85 ºC
VSWR:	1.22:1
Small Size:	WHM – 4 SMT 6-Pin package
Built-In Functions:	DC blocks at input and output, DC-DC converter, temperature Compensation circuits, and auto DC biases.

Absolute Maximum Ratings[3]:

Symbol	Parameters	Units	Absolute Maximum
V_{dd}	DC Power Supply Voltage	V	4.5
I_{dd}	Drain Current	mA	70
P_{diss}	Total Power Dissipation	mW	350
$P_{In,Max}$	RF Input Power	dBm	10, AE version 30, LE version
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	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℃
[3] Operation of this device above any one of these parameters may cause permanent damage.

Specifications:

a) Table 1 Summary of the electrical specifications WHM14-3020AE/LE at room temperature

Index	Testing Item	Symbol	Test Constraints	Nom (RT)	Min	Max	Unit
1	Gain	S_{21}	1.2 – 1.6 GHz	31	30.5	33.5	dB
2	Gain Variation	ΔG	1.2 – 1.6 GHz	+/- 1.0		+/- 1.3	dB
3	VSWR	$VSWR_{1,2}$	1.2 – 1.6 GHz	1.17:1		1.22:1	
	VSWR LE Version		1.2 – 1.6 GHz	1.25:1		1.38:1	
4	Reverse Isolation	S_{12}	1.2 – 1.6 GHz	37	35		dB
5	Noise figure, AE Version	NF	1.2 – 1.6 GHz	0.50		0.65	dB
	Noise figure, LE Version			0.70		0.85	
6	Output Power 1dB compression Point	P_{1dB}	1.2 – 1.6 GHz	10	9		dBm
7	Current Consumption	I_{dd}	V_{dd}= +3.3 V	40	35	45	mA
8	Power Supply Voltage	V_{dd}		+3.3	+3.0[4]	+3.7	V
9	Thermal Resistance	$R_{th,c}$	Junction to case			215	^{o}C/W
10	Operating Temperature	T_o			-40	+85	^{o}C
11	Maximum Average RF Input Power, AE Version	$P_{IN, MAX}$	1.2 – 1.6 GHz			10	dBm
	Maximum Average RF Input Power, LE Version					30	

b) Passband Frequency Response

As shown in **Figure 1**, the typical gain of the WHM14-3020AE is 31.0 dB across 1.2 to 1.6 GHz. The typical input and output return losses are 22 dB across the frequency of 1.2 to 1.6 GHz. The gain and return losses change very little at extreme temperatures.

Figure 2 shows the measured P_{1dB} of the WHM14-3020AE. The typical P_{1dB} is 10.0 dBm in the frequency range of 1.2 to 1.6 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 actual typical noise figure is 0.45 dB across the frequency range of 1.2 to 1.6 GHz at room temperature. At 85 ^{0}C, WHM14-3020AE only has 0.12 dB noise increases. The noise figure at 85 ^{0}C is below 0.60 dB typically. At –40 ^{0}C, WHM14-3020AE offers approximately 0.10 dB less noise figure than that at room temperature.

Figure 4 demonstrates the stability factor *k* of the amplifier. All the *k* values are greater than 1.0. The amplifier is unconditional stable.

Figure 5 is the frequency response of WHM14-3020AE in the extended frequency range at full temperature. The amplifier is usable from 1.0 GHz to 2.0 GHz frequency range,

Figure 6 is the block diagram of internal circuit of WHM14-3020AE. It is a two-stage amplifier with the DC block capacitors at the input and output RF ports. All the RF matching networks, DC-DC converter, DC bias circuitries, and temperature compensation circuits are built in.

It may require one external decoupling capacitor of 1.0 uF at the +3.3 V DC power supply to build a LNA with WHM14-3020AE. The +3.3V DC is applied at Pin 3. No DC block capacitor is required for both input and output RF ports. The decoupling 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 WHM14-3020AE. Plenty 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 characteristics of the substrate.

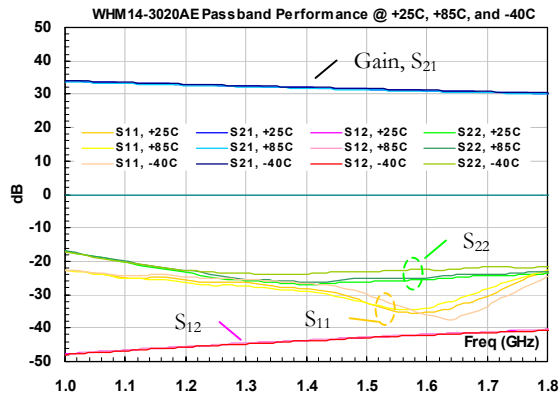[4] The lower DC supply voltage reduces the LNA performance.

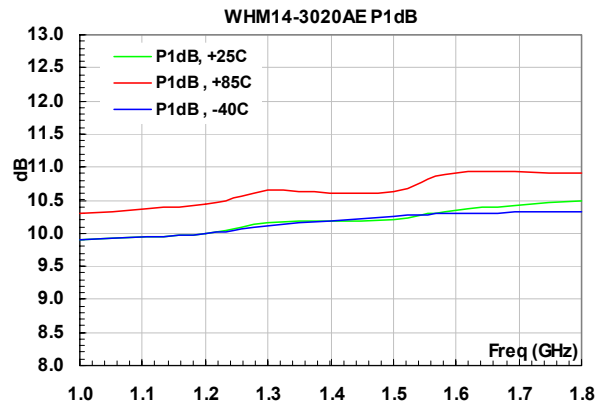**FIG. 1** Small signal performance.
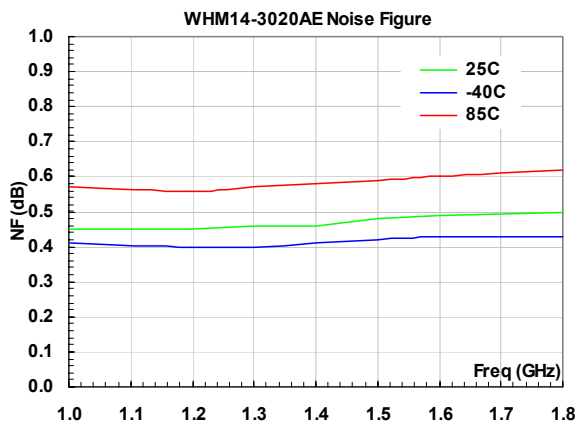

FIG. 2 P_{1dB} Performance at full temperature.

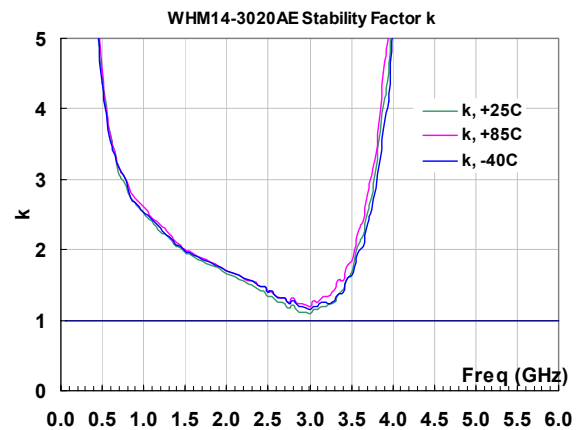**FIG. 3** Noise figure performance at full temperature
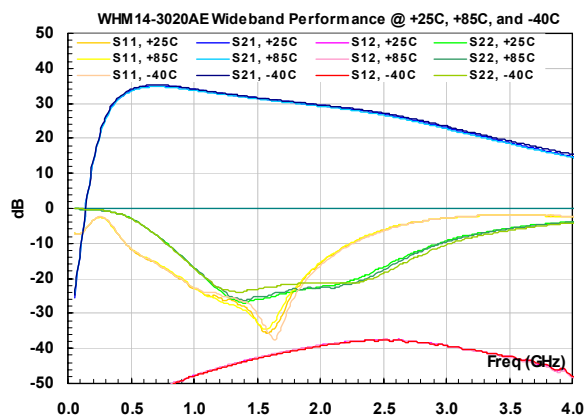

FIG. 4 Stability factor **k**

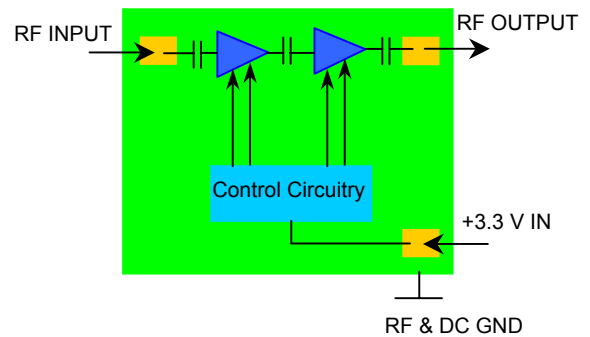**FIG. 5** Frequency response in extended frequency

FIG. 6 Block diagram of WHM14-3020AE

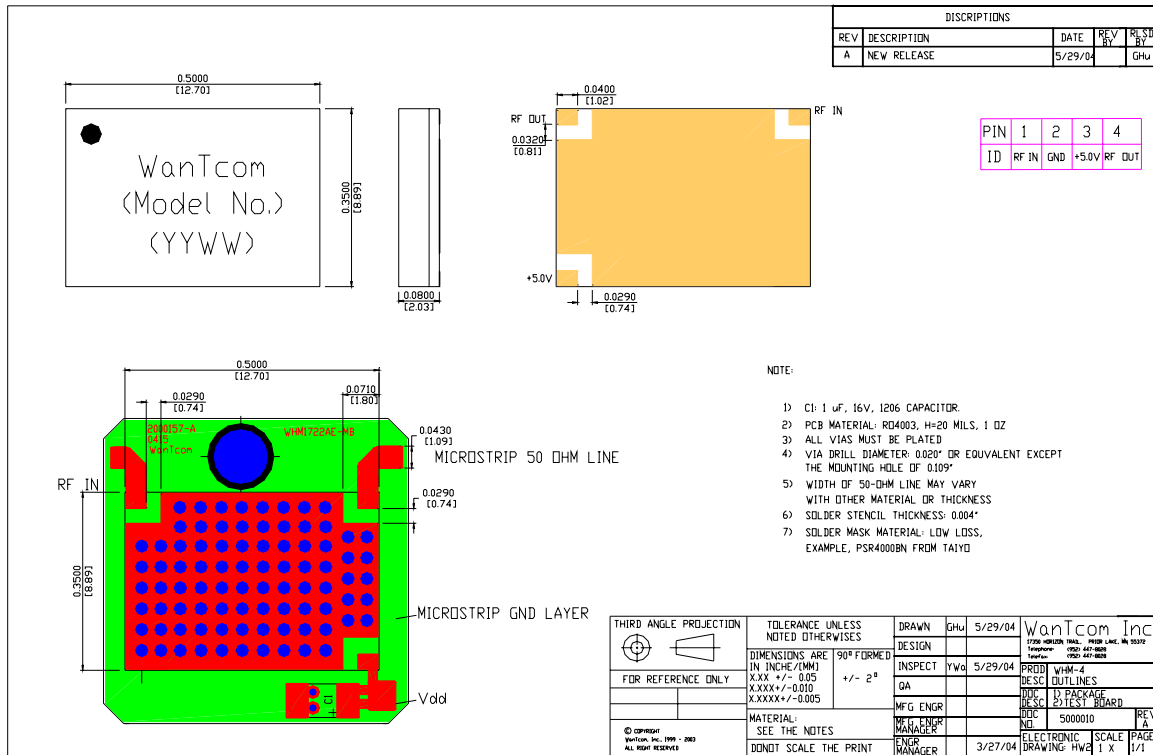## WHM14-3020AE Mechanical Outline, WHM-4 Standard Package:

FIG. 7 WHM14-3020AE outline, WHM-4 standard package.

Ordering Information

Version	Without Limiter	With Limiter
Model Number	WHM14-3020AE	WHM14-3020LE

4

Small Signal S-Parameters:

!WHM14-3020AE
!s-parameters at Vds=3.3V, Id=40 mA, including the test board.
!Last updated 09/05/04.
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	0.437	-24.9	0.104	-66.5	0.000056	-3.4	0.980	163.0
0.1	0.438	-16.9	0.560	-90.1	0.000045	54.8	0.972	150.6
0.2	0.664	-32.6	5.403	-143.6	0.000074	12.8	0.954	120.4
0.3	0.691	-81.7	18.593	152.1	0.000176	-50.4	0.916	88.7
0.4	0.427	-119.4	34.385	93.0	0.000519	-117.8	0.838	55.4
0.5	0.265	-135.1	46.045	43.4	0.001047	-157.0	0.715	21.4
0.6	0.200	-146.7	52.853	1.5	0.001688	169.2	0.565	-11.5
0.7	0.161	-164.1	55.307	-34.4	0.002378	145.9	0.421	-41.7
0.8	0.126	171.8	54.676	-65.6	0.002961	125.0	0.301	-68.9
0.9	0.097	143.1	52.437	-93.1	0.003477	108.6	0.209	-92.5
1	0.071	109.8	49.454	-117.7	0.004030	93.2	0.143	-111.9
1.1	0.056	76.3	46.518	-140.1	0.004617	80.7	0.099	-127.3
1.2	0.052	44.2	43.893	-160.8	0.005271	68.9	0.070	-137.6
1.3	0.047	16.5	41.509	179.8	0.005881	56.7	0.053	-139.6
1.4	0.037	-5.0	39.456	160.9	0.006570	45.8	0.047	-139.9
1.5	0.024	-12.2	37.396	142.7	0.007275	35.1	0.052	-145.8
1.6	0.013	23.1	35.478	124.8	0.007960	24.9	0.056	-158.6
1.7	0.029	75.2	33.786	107.3	0.008726	13.7	0.062	-173.6
1.8	0.068	73.2	32.136	90.0	0.009529	2.3	0.067	163.5
1.9	0.111	58.7	30.619	72.7	0.010000	-8.5	0.071	138.1
2	0.162	44.6	29.281	55.4	0.011000	-20.2	0.074	110.6
2.1	0.218	31.8	27.918	38.2	0.012000	-32.4	0.075	82.1
2.2	0.286	15.6	26.520	20.7	0.012000	-44.2	0.084	47.1
2.3	0.354	-0.3	25.122	3.4	0.013000	-57.1	0.098	12.5
2.4	0.419	-15.8	23.631	-14.1	0.013000	-70.4	0.117	-20.0
2.5	0.485	-31.0	22.115	-31.5	0.014000	-82.7	0.144	-50.6
2.6	0.554	-46.8	20.604	-48.9	0.013000	-94.5	0.181	-78.1
2.7	0.609	-62.5	19.075	-65.9	0.013000	-107.2	0.217	-103.3
2.8	0.654	-76.9	17.504	-82.0	0.012000	-120.5	0.252	-125.8
2.9	0.707	-91.5	16.018	-98.0	0.011000	-133.0	0.300	-146.2
3	0.737	-106.4	14.504	-113.0	0.011000	-145.2	0.346	-166.9
3.1	0.756	-119.8	13.059	-127.4	0.010000	-155.5	0.384	173.2
3.2	0.778	-132.4	11.910	-141.2	0.009658	-164.3	0.417	155.3
3.3	0.797	-145.9	10.782	-155.0	0.008932	-176.1	0.453	138.3
3.4	0.800	-158.6	9.747	-168.5	0.008370	173.9	0.489	121.3
3.5	0.803	-170.0	8.858	178.3	0.007651	166.3	0.516	105.0
3.6	0.803	178.2	8.033	165.3	0.006748	157.4	0.546	89.6
3.7	0.796	166.2	7.227	152.5	0.006171	143.7	0.573	74.2
3.8	0.787	154.9	6.502	139.5	0.005591	134.2	0.596	59.0
3.9	0.773	144.1	5.857	126.2	0.004883	126.7	0.618	44.1
4	0.756	132.2	5.304	112.8	0.003947	115.3	0.641	29.8
4.1	0.724	120.5	4.832	99.1	0.003544	99.7	0.663	15.2
4.2	0.688	110.8	4.375	84.2	0.003123	90.0	0.680	0.9
4.3	0.620	100.4	3.855	66.9	0.002420	74.5	0.694	-12.5
4.4	0.524	98.2	3.038	47.7	0.001392	42.4	0.715	-26.0
4.5	0.606	99.5	2.163	40.3	0.000422	-30.5	0.738	-39.8
5	0.549	36.6	2.077	-16.9	0.000934	-174.7	0.803	-108.3
5.5	0.256	5.5	1.728	-89.0	0.001782	176.1	0.844	-171.7
6	0.224	22.4	1.230	-143.0	0.003256	160.0	0.862	129.9

******