



WHM02AE

100 kHz - 3.0 GHz LOW NOISE WIDE BAND

REV C
July 2022

Key Features



- 100 kHz ~ 3.0 GHz
- 0.70 dB Noise Figure
- 27.0 dBm Output IP₃
- 13.0 dB ~ 22.0 dB Gain
- 14.0 dBm P_{1dB}
- 1.35:1 VSWR
- Single Power Supply
- >68 Years MTBF
- RoHS Compliant
- MSL-1 Moisture Sensitivity Level

Product Description

WHM02AE is integrated with WanTcom proprietary low noise amplifier technologies, high frequency micro electronic assembly techniques, and high reliability designs to realize optimum low noise figure, wideband, and high performances together. With single +2.0V~+3.0V DC operation, the amplifier has optimal input and output matching in the specified frequency range at 50-Ohm impedance system. The amplifier has standard 0.12" x 0.12" x 0.06" surface mount package.



Applications

- Mobile Infrastructures
- GPS
- CATV/DBS
- Security System
- Measurement
- Fixed Wireless



Specifications

Table 1 Summary of the electrical specifications WHM02AE without external matching components at room temperature

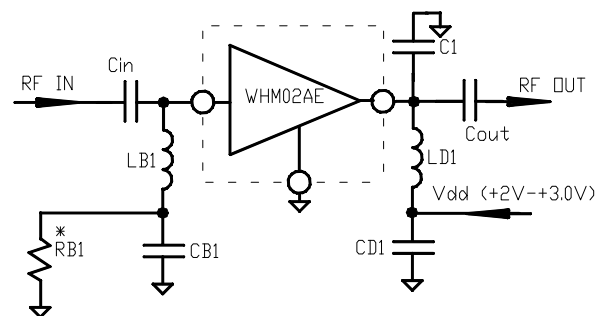
Index	Testing Item	Symbol	Test Constraints	Min	Nom	Max	Unit
1	Gain	S ₂₁	100 kHz – 3.0 GHz	10		23	dB
2	Gain Variation	ΔG	Every 100 MHz		+/-0.2		dB
3	Input Return Loss	S ₁₁	100 kHz – 1.0 GHz		15		dB
4	Output Return Loss	S ₂₂	100 kHz – 1.0 GHz		16		dB
5	Reverse Isolation	S ₁₂	100 kHz – 3.0 GHz	15	20		dB
6	Noise Figure	NF	0.10 – 3.0 GHz		0.70	0.90	dB
7	Output Power 1dB Compression Point	P _{1dB}	100 kHz – 3.0 GHz, 30 mA @ 3.0V		15		dBm
8	Output-Third-Order Interception Point	IP ₃	Two-Tone, P _{out} = 0 dBm each, 1 MHz separation		27		dBm
9	Current Consumption	I _{dd}	V _{dd} = +2.0V ~ +3.0V	5		40	mA
10	Power Supply Voltage	V _{dd}		+2.0		+4.0	V
11	Thermal Resistance	R _{th,c}	Junction to case			220	°C/W
12	Operating Temperature	T _o		-40		+85	°C
13	Maximum Input RF CW Power	P _{IN, MAX}	DC – 6.0 GHz			10	dBm

Absolute Maximum Ratings

Parameters	Units	Ratings
DC Power Supply Voltage	V	5
Drain Current	mA	50
Total Power Dissipation	mW	125
RF Input Power	dBm	10
Junction Temperature	°C	150
Storage Temperature	°C	-65 ~ 125
Operating Temperature	°C	-54 ~ +100
Thermal Resistance	°C/W	220

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

Application Schematic



WHM02AE Application Schematic

* Adjust RB1 value to get desired DC bias current for optimum designed NF, P_{1dB}, or IP₃, etc.

Ordering Information

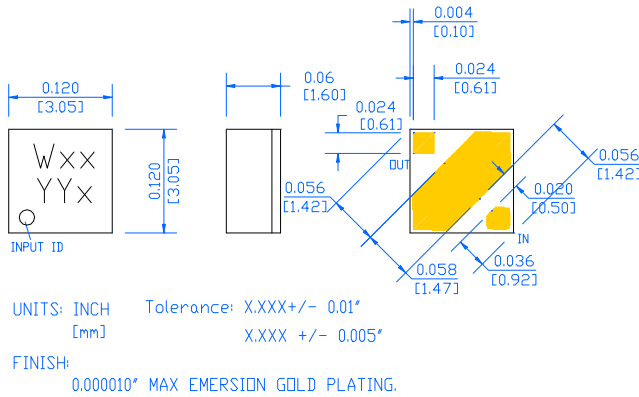
Model Number	WHM02AE
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Waffle pack with the capacity of 100 pieces (10 x 10) is used for the packing. Contact factory for tape and reel packing option for higher volume order. Contact factory for tape and reel packing option.

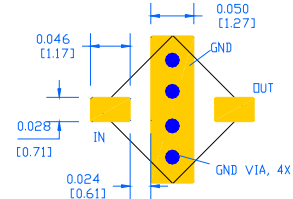
Specifications and information are subject to change without notice.



Outline

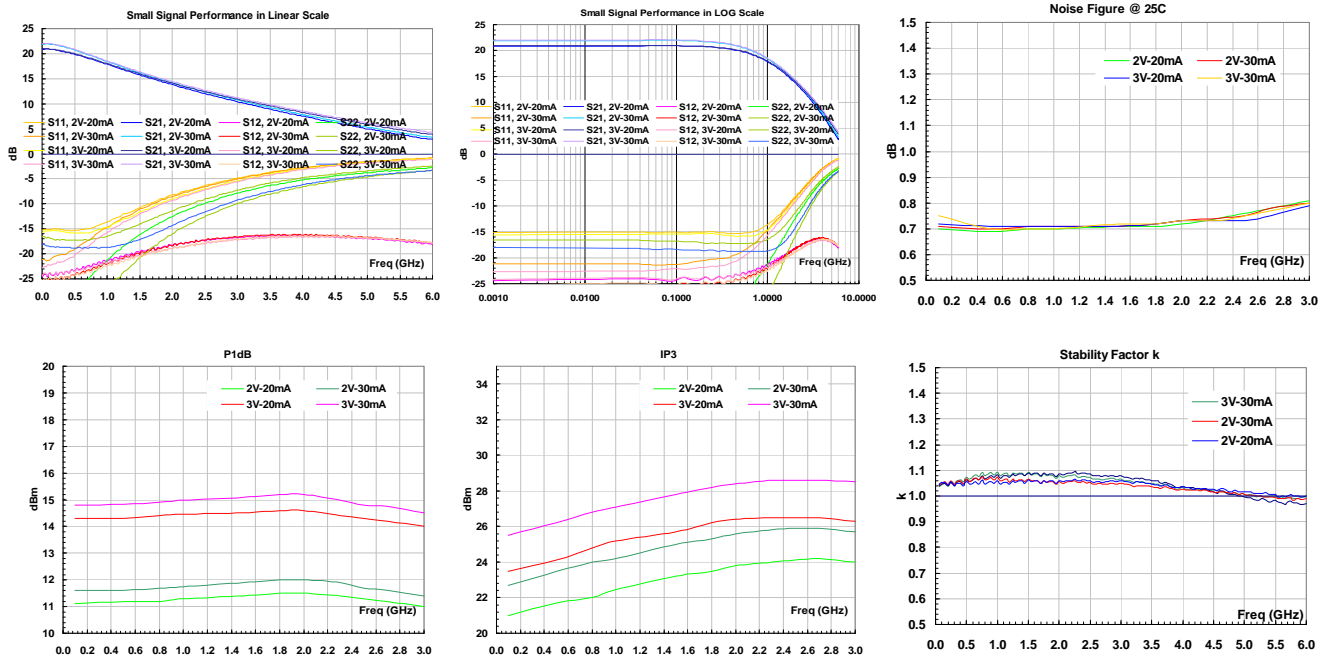


Foot Print



Typical Data Without External Components

Table 1 summarizes the WHM02AE electrical performance without any external matching components. The amplifier is biased through vector network analyzer (VNA) internal bias-T at port 1 and port 2. The data are measured using the internal bias-T of Agilent 8753ES VNA and WanTcom test fixture, WTRF-10, with de-embedded LRM calibration.



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Typical Applications:

FIG. 1 shows the universal LNA test schematic for WHM02AE. It is the modification of the application schematic to use one test board for different band LNA assemblies. In the schematic, there are several components for L_{B1} , L_{D1} , R_{B1} , C_{B1} , and C_{D1} which are created for different band LNA applications. For 100 MHz to 3 GHz LNA, only L_{B1a} , C_{B1a} , R_{B1a} , L_{D1a} , C_{D1a} , and R_{D1} are used due to smaller inductor sizes. For below 100 MHz band applications, larger value inductors are needed in order to extend the lower frequency operation. In this case, L_{B1b} , C_{B1b} , R_{B1b} , L_{D1b} , and C_{D1b} etc are used and bridge L_{B1a} and L_{D1a} .

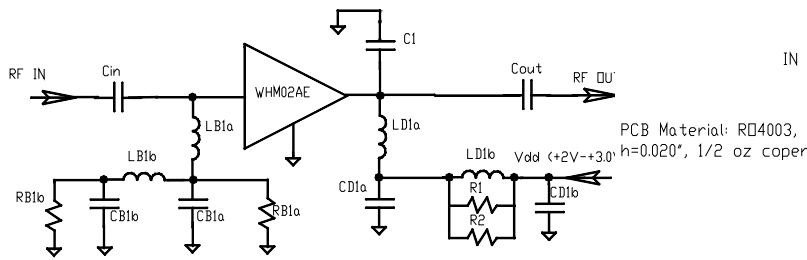


FIG. 1 Universal LNA test schematic for WHM02AE

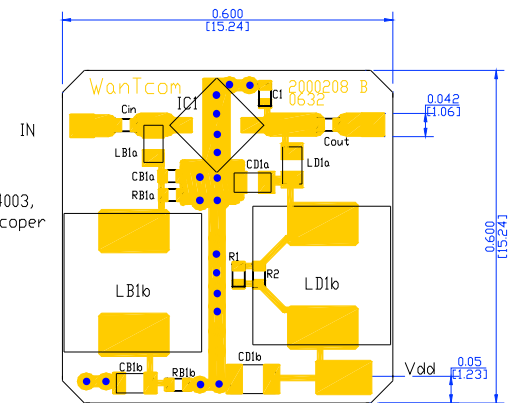


FIG. 2 Universal LNA test board for WHM02AE.

FIG. 2 shows the universal LNA test board for WHM02AE. In the test board, various footprints for L_{B1} , L_{D1} , R_{B1} , C_{B1} , C_{D1} , R_1 , R_2 , and C_1 are created for different band LNA applications. The test board is a microstrip based design and all the components are on the same layer. The backside of the board is ground plane. The blue color dots are the metallic plated ground vias to connect the signal layer ground to the ground plane.

C_{in} and C_{out} are the input and out DC block capacitors. The 0402 size ceramic capacitor is used for low loss and high frequency performance consideration. For 100 MHz or higher LNA applications, L_{B1a} and L_{D1a} are the input and output RF chokes to provide the DC bias paths. C_{B1a} and C_{D1a} are the decoupling capacitors. R_{B1a} is used for adjusting the DC bias current of the amplifier. The higher R_{B1a} value, the higher total DC bias current will be.

For lower band operations, leave C_{B1a} , R_{B1a} , C_{D1a} , R_1 , and R_2 empty. Bridge L_{B1a} and L_{D1a} and use L_{B1b} and L_{D1b} for the RF chokes. The C_{B1b} and C_{D1b} are used for the de-coupling capacitors and R_{B1b} for adjusting the DC bias current.

1 MHz – 200 MHz Low Noise Amplifier:

With larger value L_{B1} and L_{D1} for the RF chokes in the DC bias paths and higher value DC block capacitors C_{in} and C_{out} , wide band low frequency low noise amplifier can be formed simply using WHM02AE. **Table 2** is the bill of material (BOM) for the 1 – 200 MHz LNA. **FIG. 3** is the measured passband frequency response, noise figure, P_{1dB} , and IP_3 . With proper selection of the bias current and drain voltage, the LNA can be configured to have excellent gain flatness, superior return losses, and low noise figure.

In the last column of the BOM table, the specified manufacture with “/” means the component can be substituted by other manufacturer’s equivalent part. The specified manufacturer’s components are recommended with the bolded components. For example, C_{in} capacitor can be substituted with other vender’s 0.1uF capacitor instead of Murata as long as the other vender’s capacitor is equivalent to the specified one. However, IC_1 needs to be WanTcom’s OEM part.

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Table 2 BOM of 1 – 200 MHz LNA

Site	QTY	Description	Pkg	Mfgr Part No.	Mfgr
Cin, Cout, CB1b, CD1b	4	CAP, 0.1uF 10V 10%X5R	0402	GRM155R61A104KA01D	Murata/
C1, CB1a, CD1a, RB1a, R1, R2	6	EMPTY	0402	--	--
LB1a, LD1a	2	RES, 0.00 OHM	0603	9C06031A0R00JLHFT	Phylcom/
LB1b, Ld1b	2	470 UH	--	875FU-221M	ToKo
* RB1b	1	RES, 169 OHM 1% 1/16W	0402	ERJ-2RKF1690X	Panasonic/
IC1	1	LNA	M3	WHM02AE	WanTcom
PCB	1	WHM02AE MB	--	--	WanTcom/

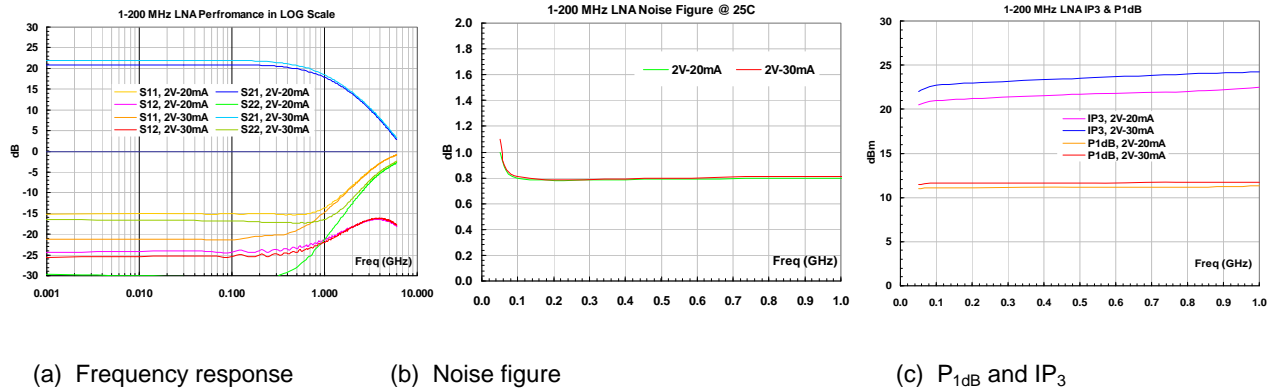


FIG. 3 1-200 MHz LNA performance.

0.1 GHz – 1.6 GHz Low Noise Amplifier

With proper setting L_{B1} and L_{D1} for the RF chokes for the DC bias paths, wide band high frequency low noise amplifier can be formed simply using WHM02AE. **Table 3** is the bill of material (BOM) for the 0.1 GHz – 1.6 GHz LNA. **FIG. 4** is the measured passband frequency response, P_{1dB} , IP_3 , noise figure, and k performance with the drain voltage of 3.0 V and drain current of 30 mA. The k value is slightly less than 0 is due to the parasitic resonance of the inductors, L_{B1a} and L_{D1a} .

For +5.0V DC power supply, R_1 is 68 Ohm and R_2 is empty in order to get 3.0 V drain bias voltage. This configuration will help less sensitivity of the drain DC bias current to the RB_1 value and temperature. Different R_1 value can be calculated for different drain DC bias current and voltage settings. For 2.0V drain voltage and 30 mA current selection with +5.0V power supply, the total voltage drop on R_1 is 3.0V and R_1 value is 100 Ohm. A regular 0402 size 100 Ohm resistor does not have enough power rating for that. Thus, R_1 and R_2 of 200 Ohm each are in parallel to share the power dissipation.

Table 3 BOM of 0.1 GHz – 1.6 GHz LNA

Site	QTY	Description	Pkg	Mfgr Part No.	Mfgr
Cin, Cout, CB1a, CD1a	4	CAP, 0.01uF 25 V 5% X7R	0402	ECJ-0EB1E103K	Panasonic/
C1	1	CAP, 1.0pf 50V 0402 SMD	0402	ECJ-0EC1H010C	Panasonic/
CB1b, CD1b, LB1b, LD1b, RB1b, R2	6	EMPTY	--	--	--
LB1a	1	IND, 220 nH 110MA	0603	LQW18ANR27J00D	Murata
LD1a	1	IND, 220 nH 110MA	0603	LQW18ANR27J00D	Murata
* RB1a	1	RES, 169 OHM 1% 1/16W	0402	ERJ-2RKF1690X	Panasonic/
R1	1	RES, 0 OHM	0402	MCR01MZPJ000	ROHM/
IC1	1	LNA	M3	WHM02AE	WanTcom
PCB	1	WHM02AE MB	--	--	WanTcom

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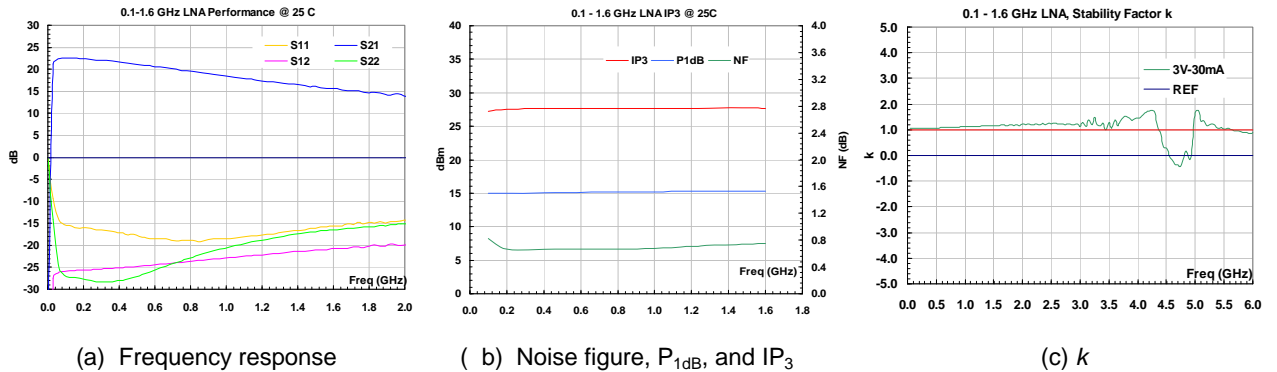


FIG. 4 0.1 GHz – 1.6 GHz LNA performance.

1.1 GHz – 1.6 GHz Low Noise Amplifier

With proper selecting values of L_{B1}, L_{D1}, C_{in}, and C_{out}, wide band high frequency low noise amplifier can be formed simply using WHM02AE for 1.1 GHz – 1.6 GHz band applications. **Table 4** is the BOM. **FIG. 5** is the measured passband frequency response, P_{1dB}, IP₃, noise figure, and k performance with the drain voltage of 3.0 V and drain current of 30 mA.

Table 4 BOM of 1.1 GHz – 1.6 GHz LNA

Site	QTY	Description	Pkg	Mfgr Part No.	Mfgr
Cin	1	CAP, 15pF 50V 0402 SMD	0402	C0402C150J5GACTU	KEMET /
Cout	1	CAP, 6.8pF 50V 0402 SMD	0402	0402N6R8D500NT	BC /
CB1a, CD1a	2	CAP, 0.01uF 25 V 5% X7R	0402	ECJ-0EB1E103K	Panasonic/
C1	1	CAP, 0.5 pF 50V +/- 0.25 pF NPO	0402	GRM1555C1HR50CZ01D	Murata/
CB1b, CD1b, LB1b, LD1b, RB1b	5	EMPTY	--	--	--
LB1a	1	IND, 220 nH 110MA	0603	LQW18ANR22J00D	Murata/
Ld1a	1	IND, 27 nH 440MA	0603	LQW18AN27NJ00D	Murata/
* RB1a	1	RES, 169 OHM 1% 1/16W	0402	ERJ-2RKF1690X	Panasonic/
RD1	1	RES, 0 OHM	0402	MCR01MZPJ000	ROHM/
IC1	1	LNA	M3	WHM02AE	WanTcom
PCB	1	WHM02AE MB	--	--	WanTcom

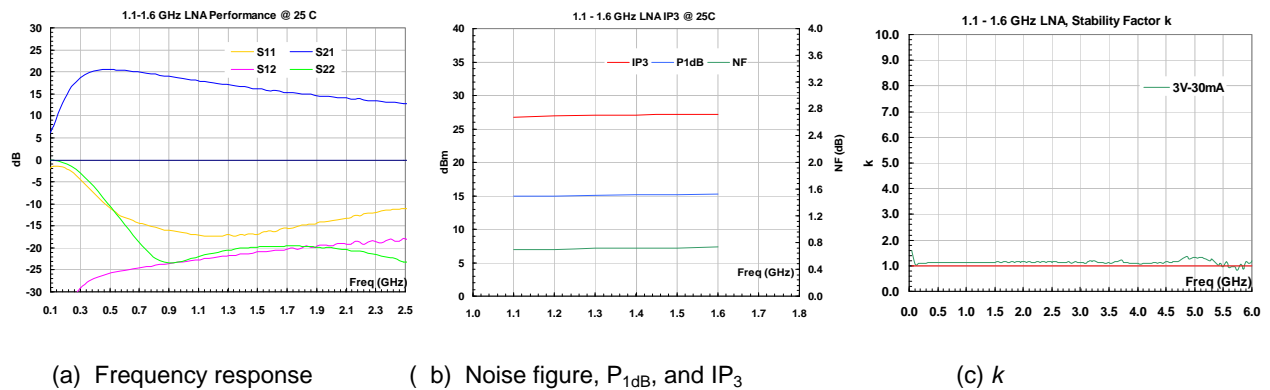


FIG. 5 0.1 GHz – 1.6 GHz LNA performance.

Specifications and information are subject to change without notice.



1.7 GHz – 2.2 GHz Low Noise Amplifier

With proper selecting values of L_{B1} , L_{D1} , C_{in} , and C_{out} , wide band high frequency low noise amplifier can be formed simply using WHM02AE for 1.7 GHz – 2.2 GHz band applications. **Table 5** is the BOM. **FIG. 6** is the measured passband frequency response, P_{1dB} , IP_3 , noise figure, and k performance with the drain voltage of 3.0 V and drain current of 30 mA.

Table 5 BOM of 1.7 GHz – 2.2 GHz LNA

Site	QTY	Description	Pkg	Mfgr Part No.	Mfgr
Cin	1	CAP, 5.0pF±0.25pF 50V SMD	0402	ECJ-0EC1H050C	Panasonic /
Cout	1	CAP, 3.0pF±0.25pF 50V SMD	0402	ECJ-0EC1H030C	Panasonic /
CB1a, CD1a	2	CAP, 0.01uF 25 V 5% X7R	0402	ECJ-0EB1E103K	Panasonic /
C1	1	CAP, 0.3pF 50V 0402 COG	0402	GRM1555C1HR30CZ01D	Murata/
CB1b, CD1b, LB1b, LD1b, RB1b, R2	5	EMPTY	--	--	--
LB1a	1	IND, 220 nH 110MA	0603	LQW18ANR22J00D	Murata/
Ld1a	1	IND, 15 nH SMD	0603	LQW18AN15NJ00D	Murata/
* RB1a	1	RES, 169 OHM 1% 1/16W	0402	ERJ-2RKF1690X	Panasonic /
R1	1	RES, 0 OHM	0402	MCR01MZPJ000	ROHM/
IC1	1	LNA	M3	WHM02AE	WanTcom
PCB	1	WHM02AE MB	--	--	WanTcom

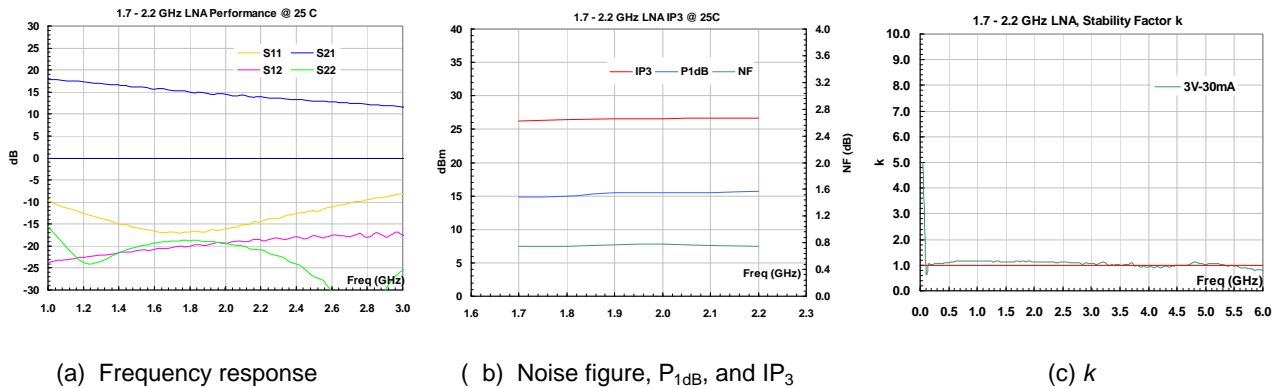


FIG. 6 1.7 GHz – 2.2 GHz LNA performance.

2.2 GHz – 2.7 GHz Low Noise Amplifier

With proper selecting values of L_{B1} , L_{D1} , C_{in} , and C_{out} , wide band high frequency low noise amplifier can be formed simply using WHM02AE for 1.7 GHz – 2.2 GHz band applications. **Table 6** is the BOM. **FIG. 7** is the measured passband frequency response, P_{1dB} , IP_3 , noise figure, and k performance with the drain voltage of 3.0 V and drain current of 30 mA.

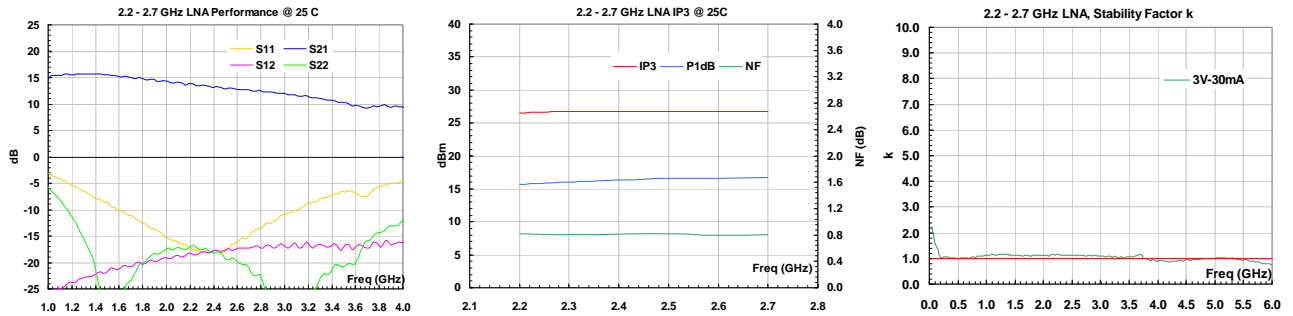
Table 6 BOM of 2.2 GHz – 2.7 GHz LNA

Site	QTY	Description	Pkg	Mfgr Part No.	Mfgr
Cin, Cout	2	CAP, 2.4pF 50V 0402 SMD	0402	GRM1555C1H2R4BZ01E	Murata/
CB1a, CD1a	2	CAP, 0.01uF 25 V 5% X7R	0402	ECJ-0EB1E103K	Panasonic/
C1	1	CAP, 0.20+0.05pF	0402	500R07S0R2AV4T	Johanson/
CB1b, CD1b, LB1b, LD1b, RB1b, R2	6	EMPTY	--	--	--
LB1a	1	IND, 220 nH 110MA	0603	LQW18ANR22J00D	Murata/
Ld1a	1	IND, 10 nH SMD	0603	LQW18AN10NJ00D	Murata/
* RB1a	1	RES, 169 OHM 1% 1/16W	0402	ERJ-2RKF1690X	Panasonic/
R1	1	RES, 0 OHM	0402	MCR01MZPJ000	ROHM/

Specifications and information are subject to change without notice.



IC1	1	LNA	M3	WHM02AE	WanTcom
PCB	1	WHM02AE MB	--	--	WanTcom



(a) Frequency response

(b) Noise figure, P_{1dB}, and IP₃

(c) k

FIG. 7 2.2 GHz – 2.7 GHz LNA performance

Application Notes:

A. Assembly

The regular SAC305 RoHS is not recommended and will cause permanent damage to the amplifier. Refers to the important application note AN-109, https://www.wantcominc.com/Application_Notes/AN-109.pdf.

B. Electrical Testing and Fine Tuning

The amplifier is designed to be fully matched at the input and output ports. Any tuning is not needed. However, when connecting the assembled amplifier to a device such as a SMA connector or a filter, the connecting point or joint point could affect mainly the return loss at the port due to the non-ideal 50-Ohm impedance of the device. By varying the connection feature size such as the solder amount to get the optimum return loss or best matching result at the interface. This fine-tuning has little affect on the other performance such as gain, noise figure, P_{1dB}, or IP₃.

During the fine-tuning process, a vector network analyzer can be used to monitoring the return loss at the port while varying the feature size of the joint point. Varying the connection feature size until the optimum return loss is achieved.
