A 1-GHz Highpass PHEMT Low-Noise Amplifier (Rev. 1)

Steven W. Ellingson*

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This report documents the design of a low-cost broadband low-noise amplifier (LNA). This LNA is designed to provide robust performance at L-band and above even in the presence of strong interference from broadcast signals in lower-frequency bands. The completed LNA is shown in Figure 1 and its specifications are summarized in Figures 2 and 3. The materials cost of the LNA is about $25 in small quantities.

It should be noted that the LNA is a minor modification to a previous design [1]. The difference from [1] is that the PCB has been reduced in size and the enclosure has been modified to reduce cost. Also, in this document, we have verified the noise figure and input VSWR by measurement.

Figure 4 shows a schematic of the LNA electrical design. The design uses Agilent's ATF-34143 low-noise pseudomorphic high-electron-mobility transistor (PHEMT) [2], following a design strategy described in [3]. DC power is accepted through the RF output connector using the "bias-tee" method. A parts list is given in Figure 5.

The PCB was obtained from ExpressPCB*. The PCB was designed using ExpressPCB's proprietary PCB layout software. The laminate is 0.062-in FR-4 epoxy glass with a dielectric constant specified to be between 4.2 and 5.0. The PCB also serves as one side of the enclosure; see Figure 6.

*The Ohio State University, ElectroScience Laboratory, 1320 Kinnear Road, Columbus, OH 43210, USA. Email: ellingson.1@osu.edu.

*`http://www.expresspcb.com`

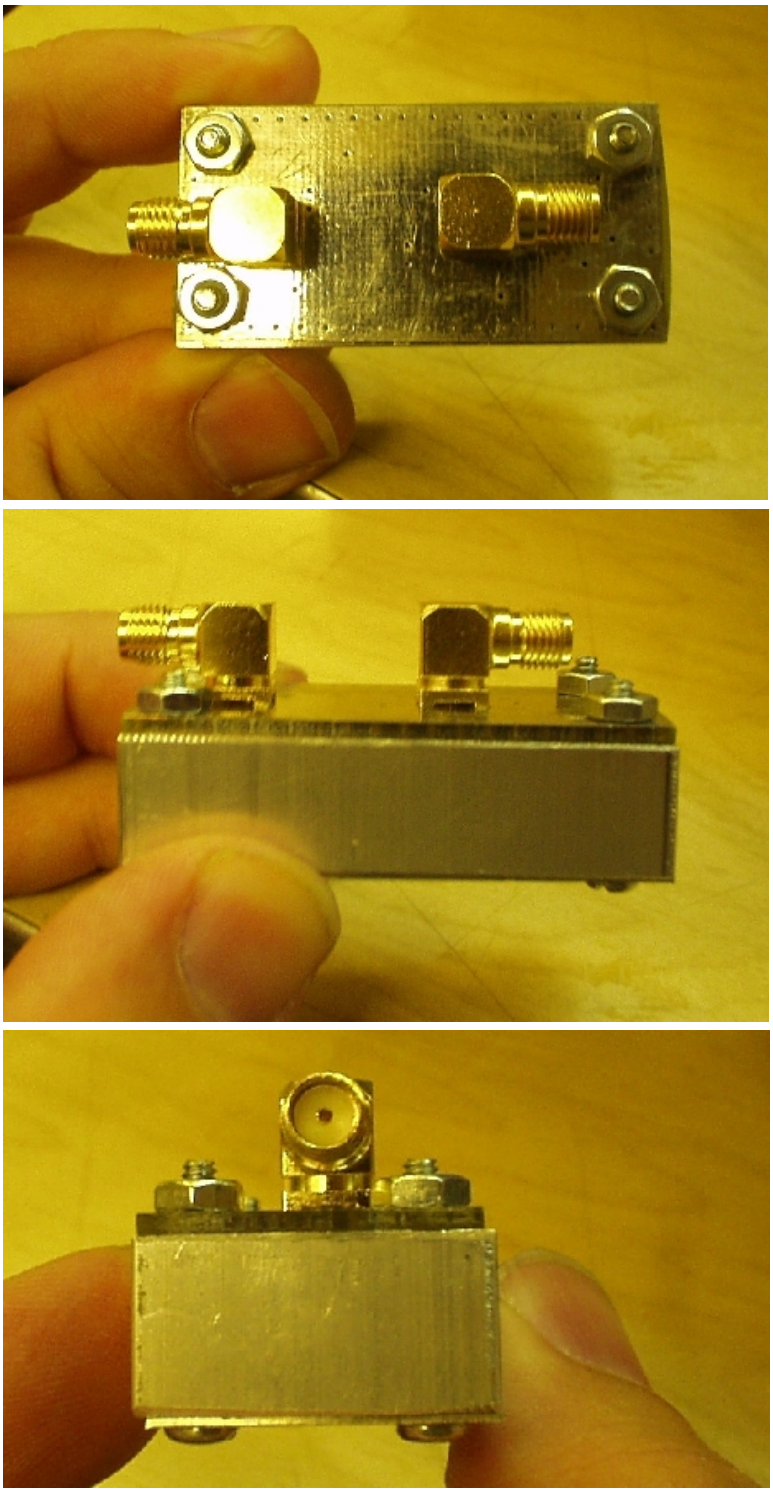

Figure 1: The LNA, as tested.

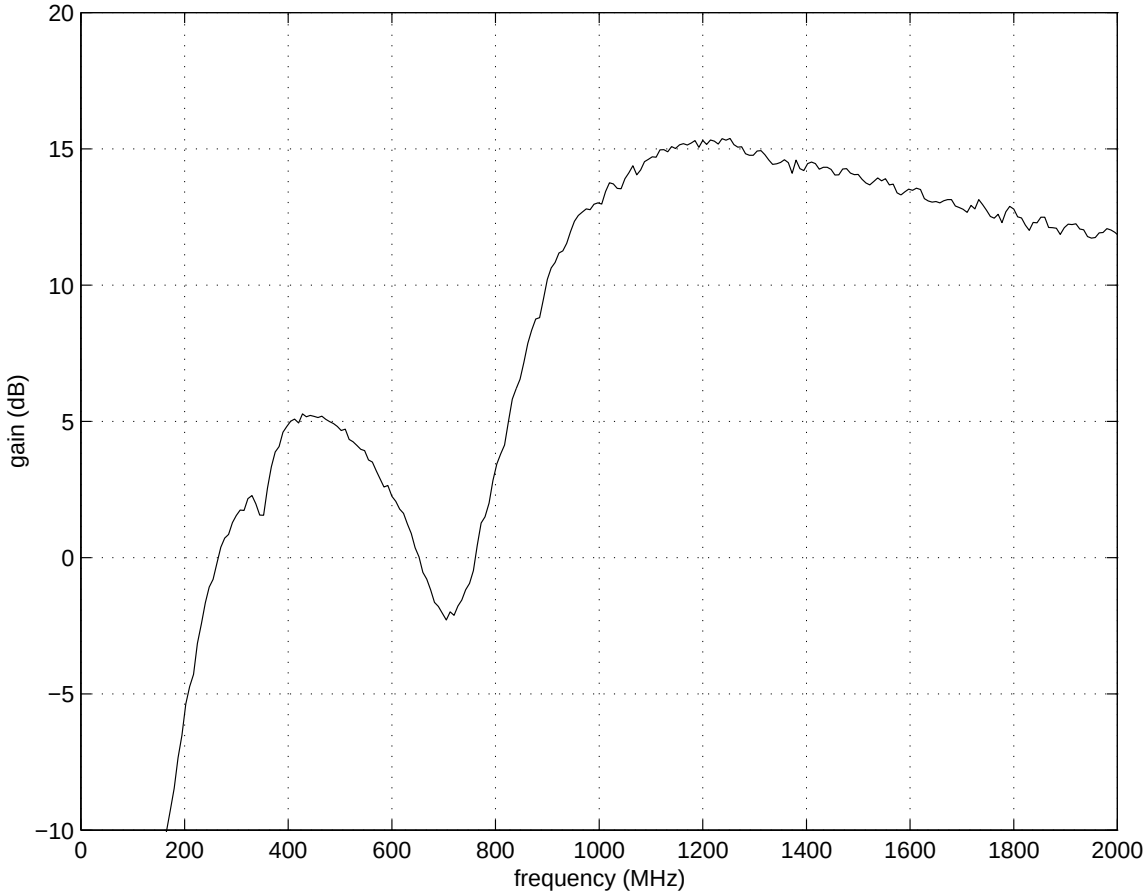

Figure 2: Measured frequency response.

Peak Gain	15.4 dB @ 1253 MHz
3 dB Passband	953 MHz to 1838 MHz
Noise Figure	<1.9 dB (170°K) @ 1420 MHz
1 dB Compression Point	≈ −5 dBm input @ 1253 MHz
Input VSWR	better than 1.9:1
Connectors	SMA female
Power	mA @ 15 VDC
	(6–15 VDC accepted)

Figure 3: LNA Specifications (measured).

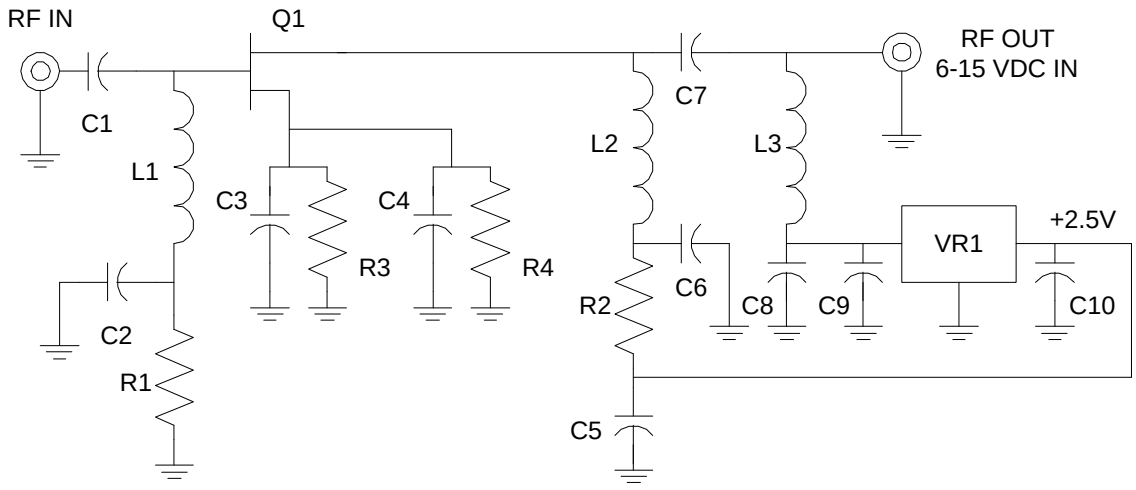

Figure 4: LNA schematic.

Value	Unit	Description	Qty	ID	Distributor	Part Number	Unit Cost
51	Ω	Res, 1/10W, 0805	1	R1	Digikey	P51ACT-ND	$0.080
12	Ω	Res, 1/10W, 0805	1	R2	Digikey	P12ACT-ND	$0.080
24	Ω	Res, 1/10W, 0805	2	R3,R4	Digikey	P24ACT-ND	$0.080
2.7	nH	Ind	1	L1	Digikey	TKS2356CT-ND	$0.675
3.3	nH	Ind	1	L2	Digikey	TKS2357CT-ND	$0.675
39	nH	Ind, 5%	1	L3	Digikey	PCD1167CT-ND	$0.764
8.2	pF	Cap, 1206, ceramic	3	C1,C2,C6	Digikey	PCC8R2CCT-ND	$0.113
27	pF	Cap, 0603, ceramic	3	C3,C4,C8	Digikey	PCC270ACVCT-ND	$0.057
0.01	μF	Cap, ceramic	1	C5	Digikey	PCC103BCT-ND	$0.147
6.8	pF	Cap, ceramic, 1206	1	C7	Digikey	399-1188-1-ND	$0.416
0.1	μF	Cap, 0805, X7R	1	C9	Digikey	PCC1812CT-ND	$0.105
10	μF	Cap, Tant, 16V	1	C10	Digikey	PCS3106CT-ND	$0.622
		Agilent ATF-34143	1	Q1			
2.5	V	Voltage Reg.	1	VR1	Digikey	LM2937IMP-2.5CT-ND	$1.800
		PCB	1		ExpressPCB		$59.00/3
		Connector, SMA(F)	2		Digikey	ARFX1232-ND	$4.400
		4-40 screws	4		Digikey	H150-ND	$0.017
		4-40 nuts	4		Digikey	H216-ND	$0.010

Figure 5: Parts List.

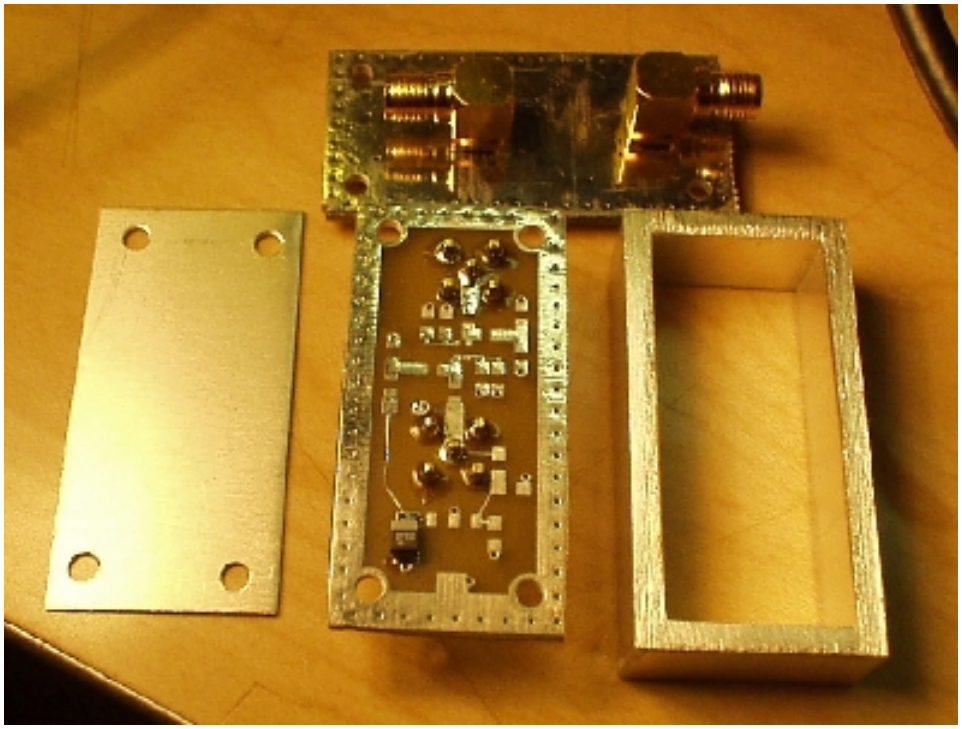

Figure 6: An unpopulated LNA circuit board and enclosure parts.

References

[1] S.W. Ellingson, "A 1-GHz Highpass PHEMT Low-Noise Amplifier," Design Report, Sep 10, 2002, available via http://esl.eng.ohio-state.edu/∼swe/argus/docserv.html.

[2] Agilent Technologies, "Low Noise Pseudomorphic HEMT in a Surface Mount Package" (ATF-34143 datasheet), 5988-4210EN, October 26, 2001.

[3] Agilent Technologies, "High Intercept Low Noise Amplifiers for 1500 MHz through 2500 MHz Using the ATF-34143 Low Noise PHEMT," Application Note 1175, 5968-6259E, December 1999.