A 1-GHz Highpass PHEMT Low-Noise Amplifier

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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.

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) [1], following a design strategy described in [2]. DC power (6-15 VDC) is accepted through the RF output connector using the "bias-tee" method. A parts list is given in Figure 5. Figure 6 shows the assembled circuit on its printed circuit board (PCB).

The enclosure is constructed from PCB material. The PCB was obtained from ExpressPCB*. The PCB was designed using ExpressPCB's proprietary PCB layout software. The PCB layout is shown in Figures 7 and 8. Note that the raw PCB consists of four sections: (1) The main PCB for the electronics, which doubles as the top cover, (2) The bottom cover, which is mostly ground plane, and (3) two identical sections which are used as spacers between (1) and (2). The dimensions of the dimensions of the raw PCB are 3.8-in by 2.5-in, which allows ExpressPCB's low-cost "MiniBoard" service to be used. The laminate is 0.062-in FR-4 epoxy glass with a dielectric constant specified to be between 4.2 and 5.0.

The LNA is assembled as follows:

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

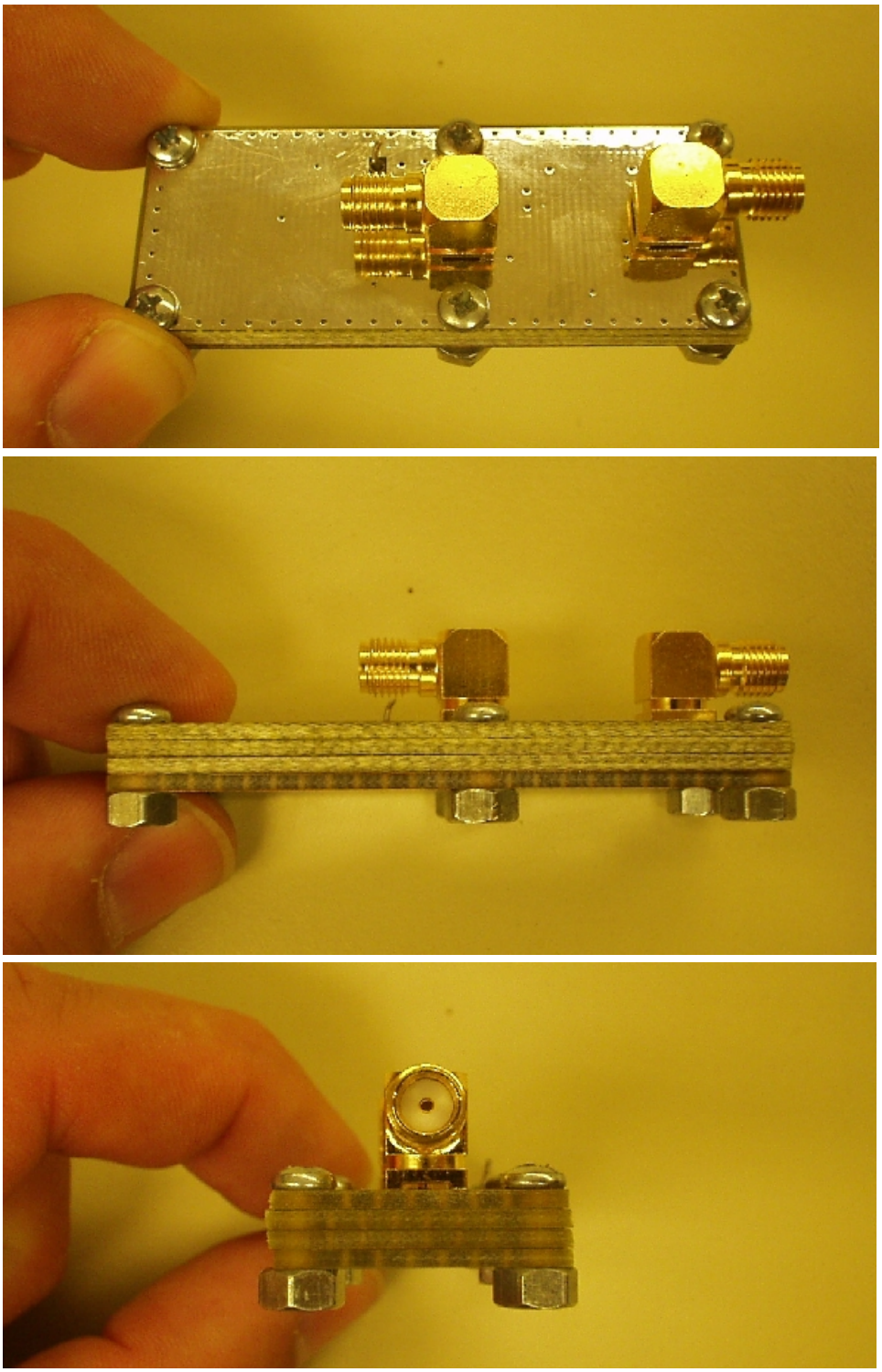

Figure 1: The LNA, as tested.

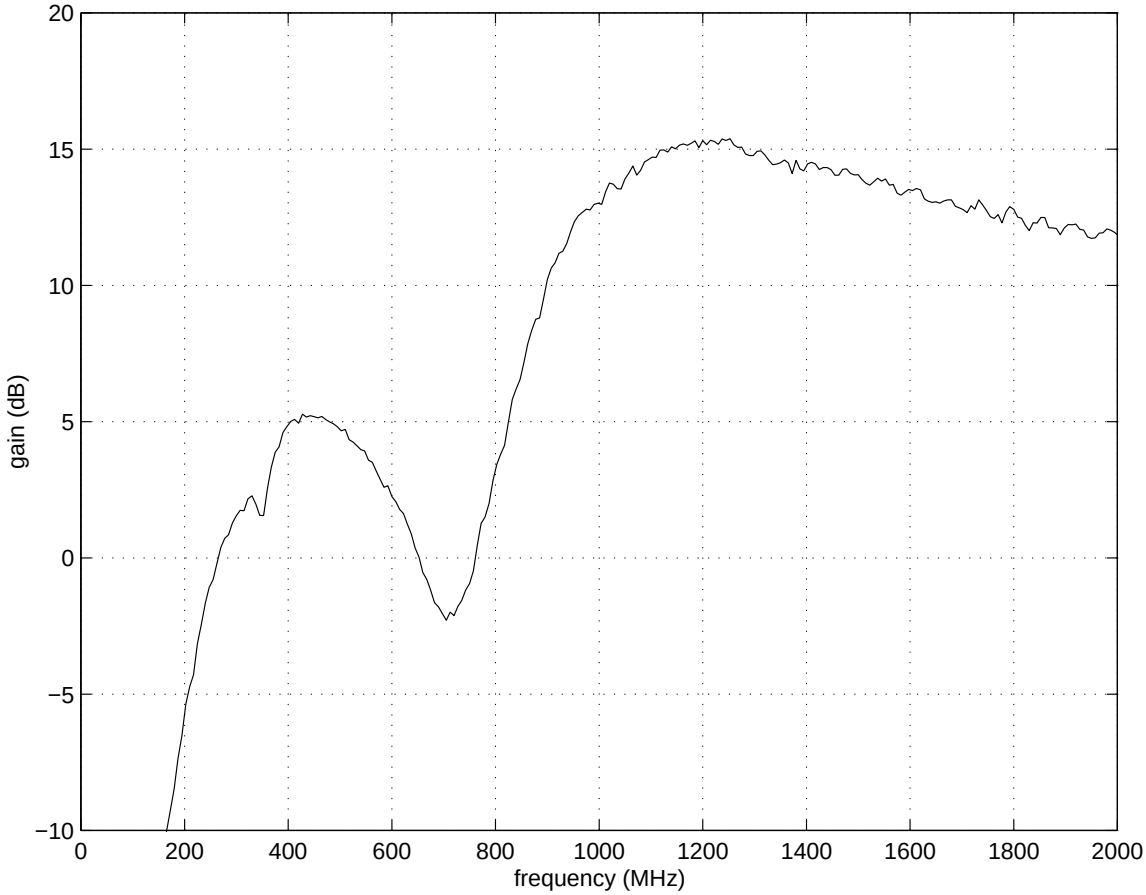

Figure 2: Measured frequency response.

Peak Gain	15.4 dB @ 1253 MHz
3 dB Passband	953 MHz to 1838 MHz
Noise Figure	<1.5 dB @ 1600 MHz *
1 dB Compression Point	≈ -5 dBm input @ 1253 MHz
Dimensions	74 mm × 25 mm × 20 mm
Connectors	SMA female
Power	mA @ 15 VDC
	(6–15 VDC accepted)

* Estimated from component specifications.

Figure 3: LNA Specifications

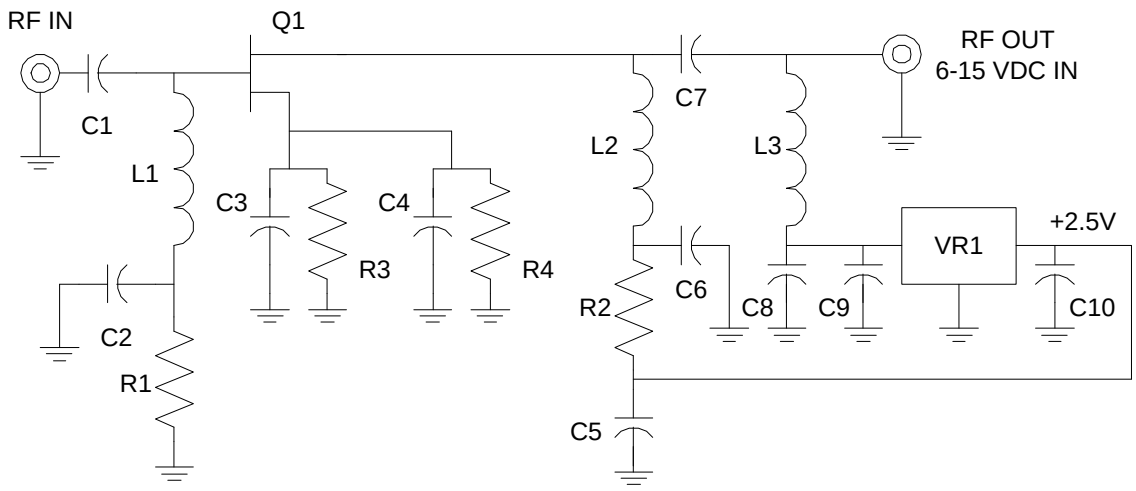

Figure 4: LNA schematic.

Value	Unit	Description	Qty	ID	Distributor	Part Number	Unit Cost
51	Ω	Res, 1/10W, 0805	1	R1	Digikey	P51ACT-ND	
12	Ω	Res, 1/10W, 0805	1	R2	Digikey	P12ACT-ND	
24	Ω	Res, 1/10W, 0805	2	R3,R4	Digikey	P24ACT-ND	
2.7	nH	Ind	1	L1	Digikey	TKS2356CT-ND	
3.3	nH	Ind	1	L2	Digikey	TKS2357CT-ND	
39	nH	Ind	1	L3	Digikey		
8.2	pF	Cap, 1206, ceramic	3	C1,C2,C6	Digikey	PCC8R2CCT-ND	
27	pF	Cap, 0603, ceramic	3	C3,C4,C8	Digikey	PCC270ACVCT-ND	
0.01	μF	Cap, ceramic	1	C5	Digikey	PCC103BCT-ND	
6.8	pF	Cap, ceramic	1	C7	Digikey		
0.1	μF	Cap, 0805, X7R	1	C9	Digikey	PCC1812CT-ND	
10	μF	Cap, Tant, 16V	1	C10	Digikey	PCS3106CT-ND	
		Agilent ATF-34143	1	Q1			
2.5	V	Voltage Reg.	1	VR1	Digikey	LM2937IMP-2.5CT-ND	
		PCB	1		ExpressPCB		$59.00/3
		Connector, SMA(F)	2		Jameco	188525	$4.95
		4-40 screws	6		Digikey		
		4-40 nuts	6				

Figure 5: Parts List.

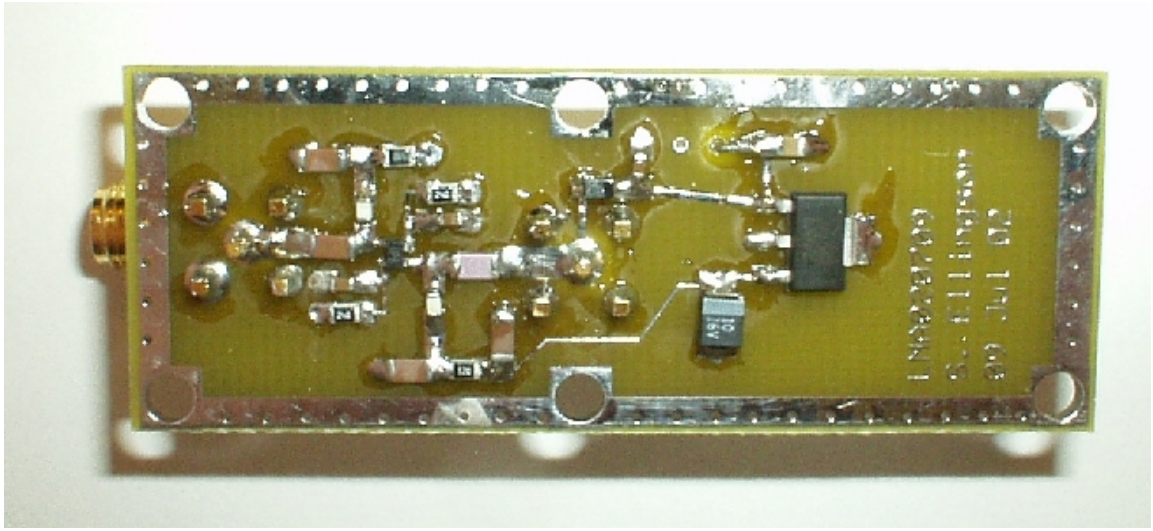

Figure 6: Circuit assembled on PCB.

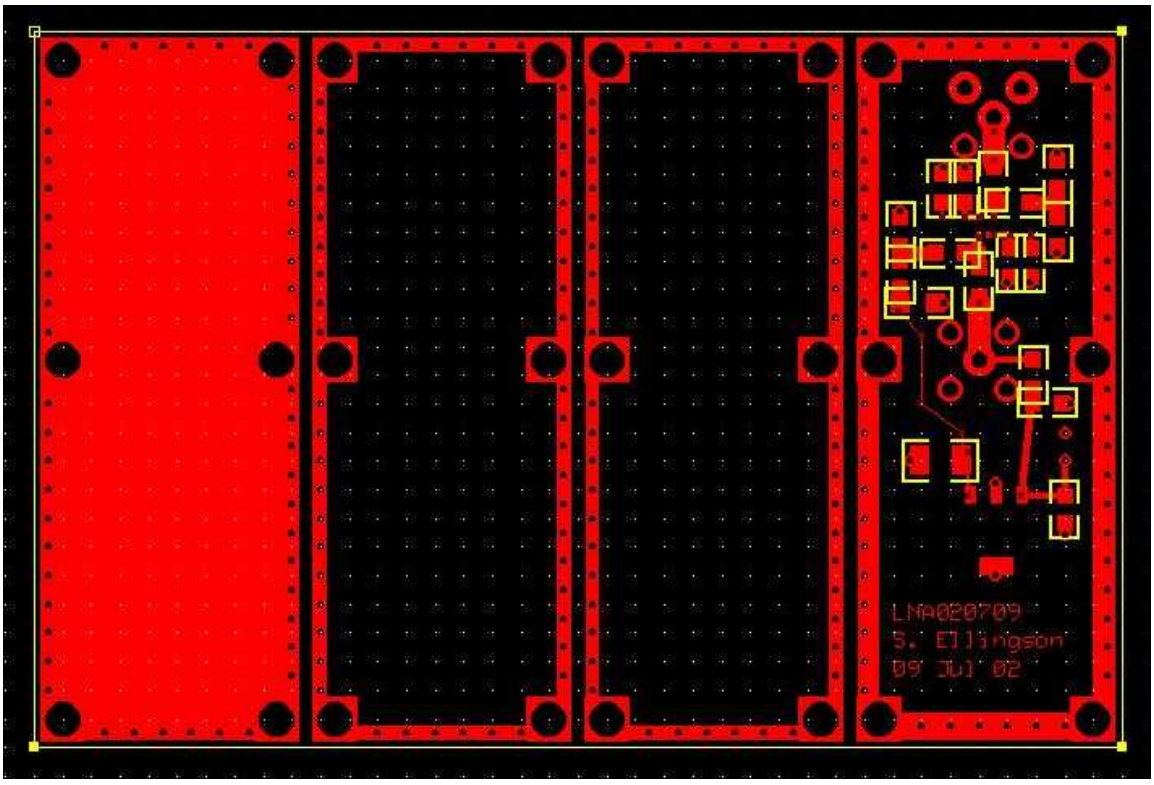

Figure 7: PCB "top" side (screen dump from layout software).

1. The raw PCB is cut into four sections. The spacer sections are milled out as shown in Figure 9.

2. The SMA connectors are installed from the reverse side (relative to the circuit traces) of the main PCB.

3. The electronic components are installed on the main PCB.

4. The spacer sections are stacked on the component side of the main PCB, followed by the ground plane section. The unit is held together with 4-40 screws and nuts.

References

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

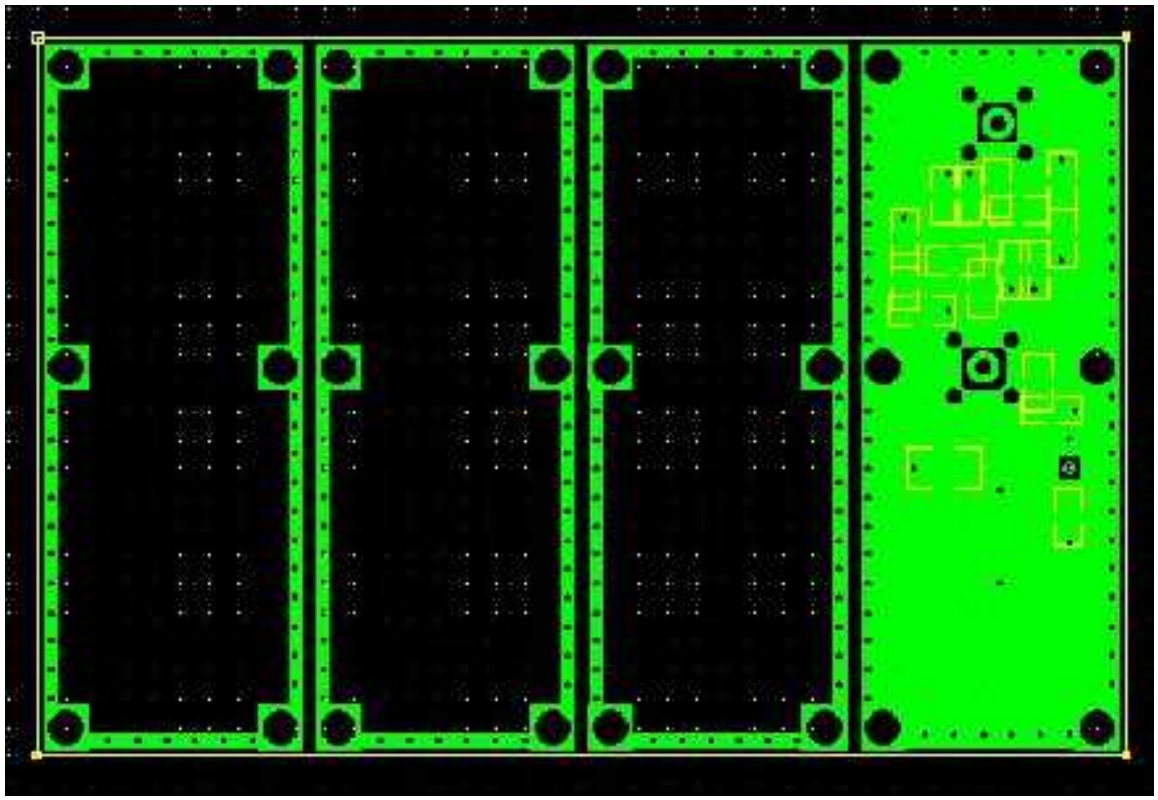

Figure 8: PCB "bottom" side (screen dump from layout software).

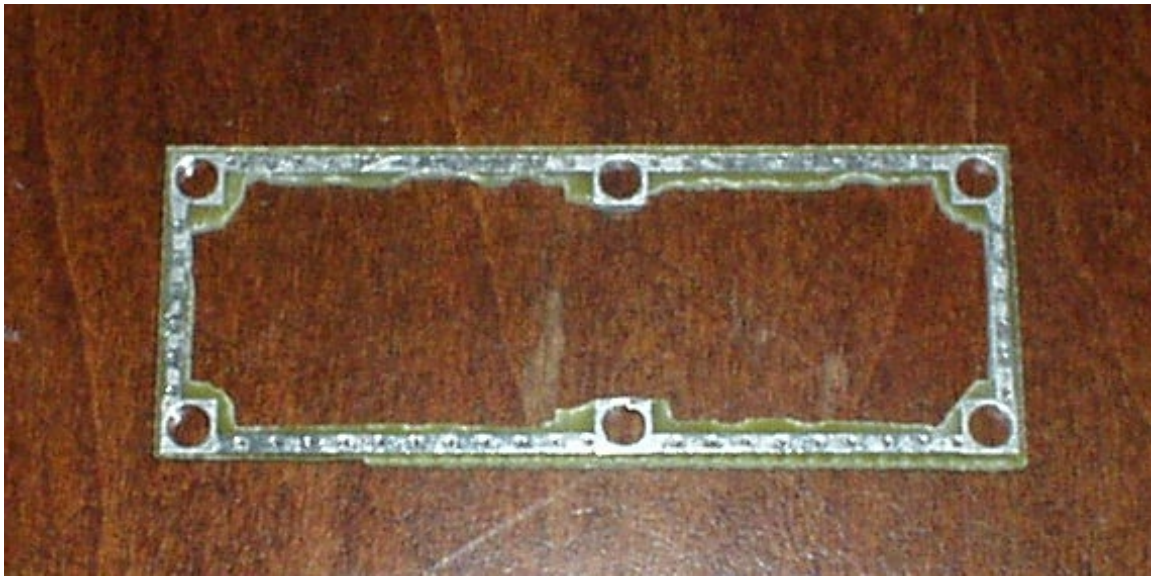

Figure 9: Spacer section, after being cut away from the raw PCB and milled out.

[2] 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.