BUILDING DESCRIPTION OF THE 144 MHz HIGH IIP3 LNA, by P.C. Hoefsloot, PA3BIY

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This description contains the following parts:

1. Building procedures;
2. Test and Tune;
3. Casing and Moisture considerations;
4. Component listing;
5. Schematic;
6. PCB layout.

1. BUILDING PROCEDURES

The 144 MHz Low Noise Amplifier is a single E-Phemt amplifier, utilising Surface Mount Devices (SMD). The amplifier can be build by non-experts, as long as some rules are taken into account:

- Non-static environment;
- Grounding of solder iron and work bench;
- Clean solder tip;
- Good solder quality.

The active device (ATF-54143) is very sensitive to static voltages, so every measure must be taken in order to prevent premature loss.

A proper solder contact is somewhat hollow, and it "shines" (see figure 1). If you have used too much solder, remove it using the solder wick that is supplied.

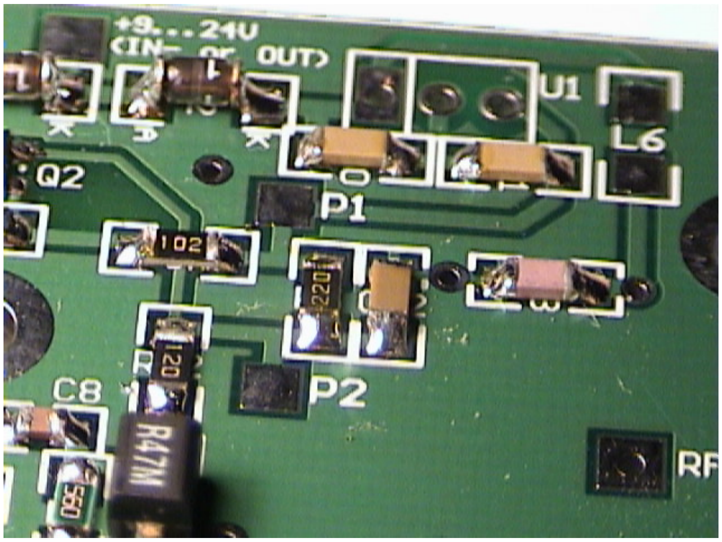


Figure 1: Shiny contacts!

Coaxial relay switching and feeding the pre-amp

The pre-amp can be fed in 2 ways: using the centre conductor of the RX feedline, or the external feed on the capacitor feed-through.

When you use the coax for feeding the LNA and driving the coax relay, make sure that the relay surges less than 400 mA, as the SMD inductors (L6 and L7) are current limited. Diodes D1 and D2 protect the LNA against mis-polarisation and from negative surges from the coax relay, at switch off.

(Non-) Static environment

A static environment is easily demonstrated. When one pulls out a woollen vest, you will see sparks igniting in the dark. The voltages involved can amount to several thousands of Volts: *Deadly to any semiconductor*. However, even a chair and some synthetic or Woollen material that one wears, may set a high voltage potential to oneself. The voltage may be too low to ignite large sparks when touching earth, but enough to kill an active device.

Preventing Static

1. Don’t wear woollen clothing;
2. Don’t rub your back against the (synthetic!) rug of the chair, because you will be charging yourself!
3. Make sure that there is a proper earth on your work bench, and touch it before you touch any components, in order to make sure that all charge flows to ground;
4. Earth the solder Iron. You can do this by clamping a wire, with a 10....100 kOhm resistor in series, between Ground and the metal of the solder Iron. The series resistor makes sure that no charge can build on the solder Iron, and it will prevent high short circuit currents if you happen to touch a life voltage contact.

Building procedure

Use a solder iron with 2 kind of tips (or 2 different solder irons). One tip needs to be tiny and sharp, and is needed to solder the SMD components. The other must be sturdy tip, and is needed to solder the tuning capacitor (C2), the input coil (L1) and the coupling inductor between C2 and the FET (L2). Figure 2 shows how the series circuit of R13 and C3 is connected across L2.

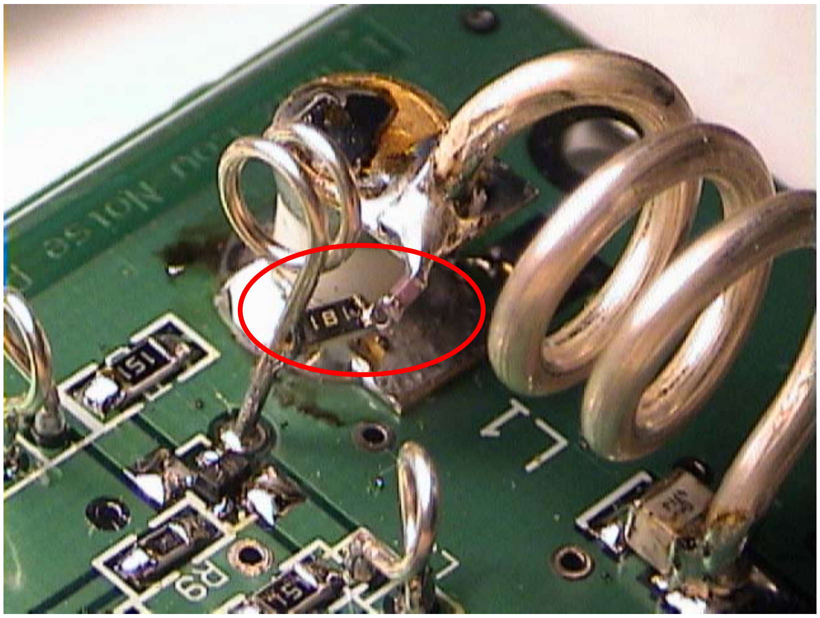


Figure 2:   R13 and C3 across L2

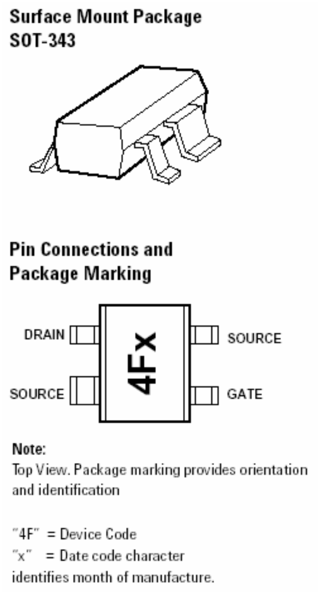
The building is not very critical for most of the parts. Just make sure that Q1 (the E-Phemt: ATF-54143) is soldered in as one-but-last of the components!

1. Solder all resistors, capacitors, diodes, inductors and Q2 (except Q1 and U1). Use the fine tip;
2. Solder C2, L1 and L2. Use the sturdy tip;
3. Solder C5 “head up” and attach it to C2, using a short piece of wire. Use the sturdy tip;
4. Place the series circuit of R13 and C3 across L2 (figure 2). Use the fine tip;
5. Make sure that all is grounded, and solder Q1 into the circuit, using the fine tip;
6. Place the PCB in the Aluminium milled box and attach it to the bottom with 5 M3 type screws. Next, bend the wires of U1 into the right shape and adjust the length. Fix the regulator (U1) to the side of the box with an M3 type screw and only *then* solder U1 at the PCB.

C1 is a lead-less very high Q capacitor and needs to be connected between the centre tip of the input N-connector and C5/C2. Use the supplied 0.8mm silvered copper wire for this purpose.

The output can be connected using a short (!) wire between “RF OUT” and the centre pin of the output N-connector.

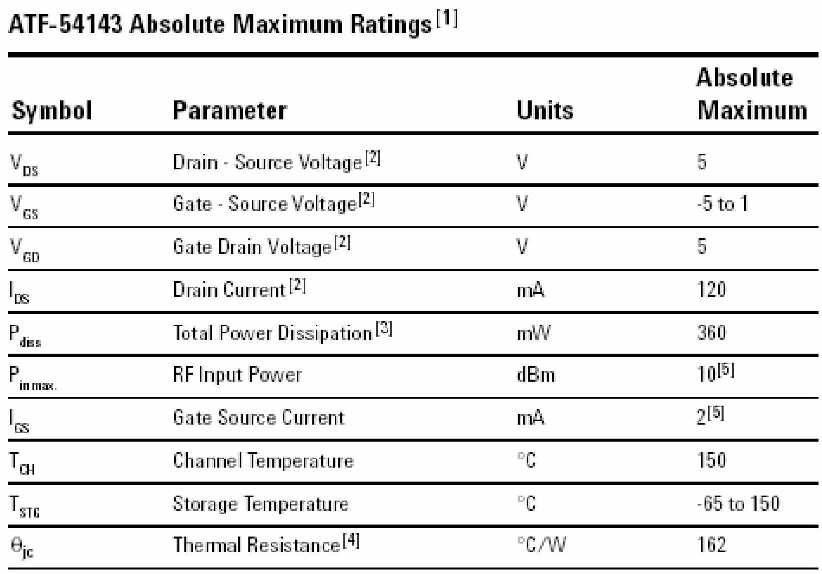
Finally, the Feed-through capacitor must be connected to “+9...24V In-or-Out” (may be used as output for coax relay, when power is supplied through the output coax). **MAX DC = 20V!**



Note:
Top View. Package marking provides orientation and identification

“4F” = Device Code
“x” = Date code character identifies month of manufacture.

Figure 3



ATF-54143 Absolute Maximum Ratings[1]

Symbol	Parameter	Units	Absolute Maximum
V_{DS}	Drain - Source Voltage[2]	V	5
V_{GS}	Gate - Source Voltage[2]	V	-5 to 1
V_{GD}	Gate Drain Voltage[2]	V	5
I_{DS}	Drain Current[2]	mA	120
P_{diss}	Total Power Dissipation[3]	mW	360
$P_{in\,max.}$	RF Input Power	dBm	10[5]
I_{GS}	Gate Source Current	mA	2[5]
T_{CH}	Channel Temperature	°C	150
T_{STG}	Storage Temperature	°C	-65 to 150
θ_{jc}	Thermal Resistance[4]	°C/W	162

Table 1

2. TESTING AND TUNING THE LNA

On the PCB 2 test points are available: P1 and P2. These points can be used to measure the current that actually flows through the transistor. The voltage across R6 should amount about 1.4 V, hence a current of approximately 63 mA flows through the FET.

Tuning to minimum noise figure is rather straight forward: close the lid of the aluminium box, look for a stable signal on 2 metre, and tune for maximum gain using C2.
Opening and closing the lid, should only see a marginal change in gain. No change in supply current must be observed! If you do find a change in current between opening and closing the lid, check if the series circuit of R13 and C3 is in good order.

The LNA is ready for use!

3. CASING AND MOISTURE CONSIDERATIONS

Moisture can destroy electronic circuitry in the long run. There are several ways to prevent moisture doing harm to an electronic system.

1. Keep the box into open contact with the atmosphere, so any moisture can breath in and out;
2. Air-tighten the box, so no moisture can get in (or out);
3. Spray a protecting film over the components, preventing moisture (and salt) to reach them.

The supplied N-connectors are fairly moist proof and air-tight. Preventing moist and salt to reach the inner circuitry can be improved by adding some silicon gel to the connector base plates, and to wrap vulcanising tape around the connectors.
It is extremely difficult to insure for 100% that no moist will ever get in a box! A change of outside temperatures will cause the air inside to shrink or to expand. As a result outside air might be sucked in or pushed out.

4. COMPONENT LIST

Most components are Surface Mount Devices (SMD), but a few are Lumped Elements or Leaded. The shape of SMD resistors and capacitors is their size in Mills. For example, a 1206 shape measures 12 by 6 mills, which equals 3.048 by 1.524 mm (1 Mill = 1/100 x 25.4 [mm]).

Nr	***description***	***type***	***shape***
C1	8p2	SMD	ATC 100B
C2	1 – 16 pF, AT5453, TL246	LEADED	
C3	2.7 pF	SMD	0805
C4	1 nF	SMD	ATC 100B
C5	10 pF	SMD	ATC 100B
C6	100 nF	SMD	1206
C7	100 nF	SMD	1206
C8	1 nF	SMD	0805
C9	150 pF	SMD	1206
C10	100 nF	SMD	1206
C11	2,2 uF/10V	SMD	1210
C12	1 uF	SMD	1206
C13	1 nF	SMD	1206
D1	PRLL4002	SMD	1808
D2	PRLL4002	SMD	1808
L1	35 nH	LUMPED	
L2	12 nH, 1.25 turns, 3.5 mm diam.	LUMPED	
L3	470 nH	SMD	1710
L4	6 nH, 1,25 turn, 3 mm, 0.8 mm Ø wire	LUMPED	
L5	6 nH, 1,25 turn, 3 mm, 0.8 mm Ø wire	LUMPED	
L6	470 nH	SMD	1710
L7	470 nH	SMD	1710
Q1	ATF-54143	SMD	SOT-343
Q2	BC857b	SMD	SOT-23
R1	100 Ohm	SMD	1206
R2	10 kOhm	SMD	1206
R3	1 kOhm	SMD	1206
R4	1k8	SMD	1206
R5	1 kOhm	SMD	1206
R6	22 Ohm	SMD	1206
R7	12 Ohm	SMD	1206
R8	56 Ohm	SMD	1206
R9	10 Ohm	SMD	0805
R10	150 Ohm	SMD	1206
R11	150 Ohm	SMD	1206
R12	12 Ohm	SMD	1206
R13	180 Ohm	SMD	1206
R14	47 Ohm, 0.5 W	SMD	2010
U1	LF50CV	LEADED	TO220