Modification Yaesu FT-847 for 70MHz band

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The inspiration of this study was the FT847 mod project of Hellar ES1II /8.

The following description applies to modify the transceiver Yaesu FT -847 serving dramatically improved noise performance and sensitivity of the receiver, as well as TX efficiency, increased power output and spectral purity in 4m band.

Particular emphasis was given on the purity of the signal emitted in the range of 4m and removing unwanted signals and LO mixing products below 4m band which are present in the TX spectrum after simple unlocking FT847 to gain 70MHz band. In addition, we believe that this modification protects the 54- 76MHz band pass filter against L5022 self desoldering and SMD capacitors burn out.

Both RX and TX chain is modified in this case. As in original idea of Hellar ES1II the solution is to replace the existing factory filters, in range 54- 76MHz – with band-pass filters made in hybrid technology.

The original filter in the 847 has bandwith of 54-76 MHz, which should give reasonable RX quality. But it's not. Receiver sensitivity varies from about 0.3 to 0.5uV depending on the production model and Year of production. Probably it depends on minor changes in component values used by Yaesu, and/or destination model.

In addition, broad band response of these filters are also less resistant on intermodulation products caused by near 4m OIRT stations. Some on air test with two different 847 on same antenna proved that unmodified radio even on quiet band receiving more of broadcast harshes even on Meteor Scatter burst than modified one, needless to say that unmodified one was less sensitive. This could be another advantage of limited bandwith of new filter. Of course we cannot expect that with this dimensions of L, new filter response will be very sharp e.t.c, but limited filter bandwith (as shown below in RX mod part) is doing good job.

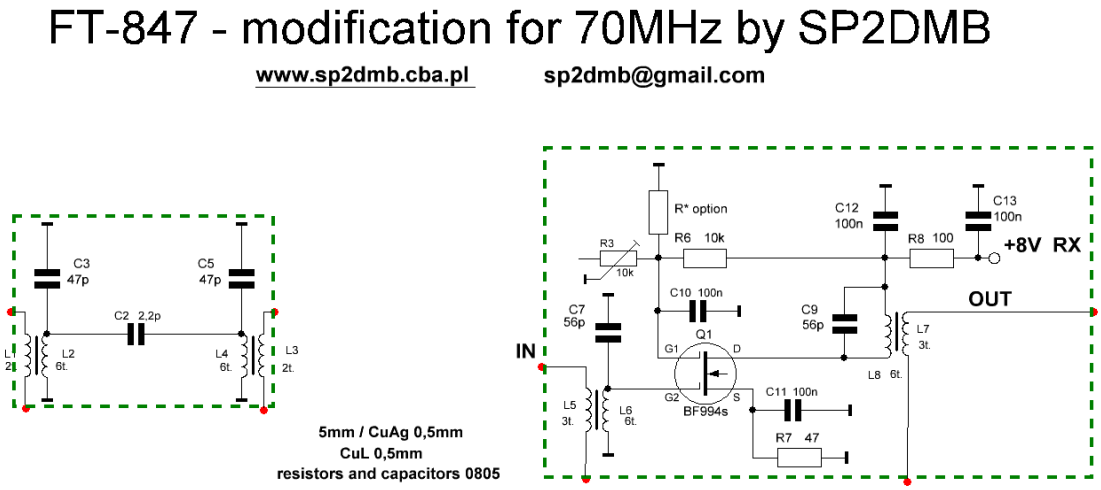
After more than 1 year of using first full modified 847 we can confirm that doing this mod will give You increased resistance to spurs modulation of OIRT, improved sensitivity and at last will improve total RX NF.

After this mod use of built-in amplifier is not necessary and even not recommended.

This project is estabilished on the basis of initial modifications of FT847 by our colleagues in the Estonia - Hellar ES1II and Arvo ES1CW - mni TNX guys! Well done.

At the moment, the original version of the modification includes more than 30 TRX across the EU and probably worldwide, which can assure that the solution is repeatable and effective.

To achieve these results, filters should be made according to the diagrams below:

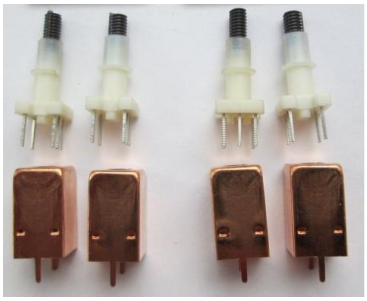


What you will need:

1. PCB's (sp2dmb@gmail.com)
2. Wire CuAg 0,5mm

3. Cu wire 0,5 mm in isolation:

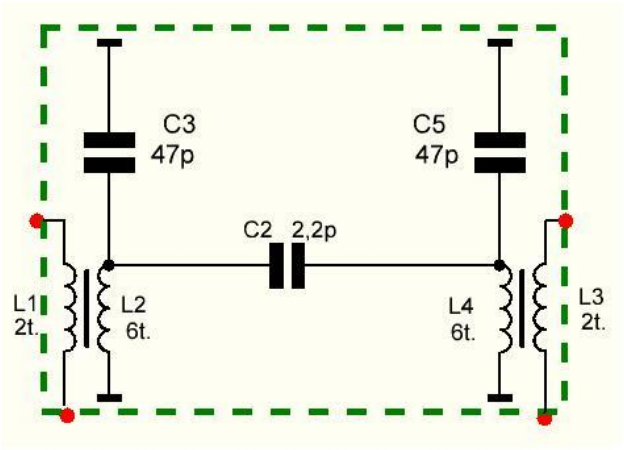
4. Tuned filters 7V1S:



5. The elements of the list is located at the end.

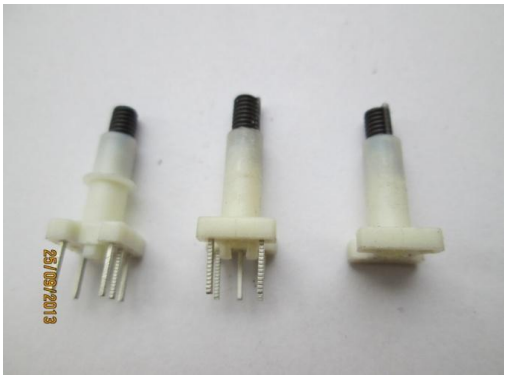
1. Modifiyng TX chain

Dual-circuit 70Mhz band-pass filter. Made on filters 7V1S.



L2 and L3 coils are wound with wire CuAg 0.5 mm. Coupling coils L1 and L3 are wound with isolated Cu wire 0.5mm dia. FTP ethernet cable should be good idea to get this wire in good isolation.

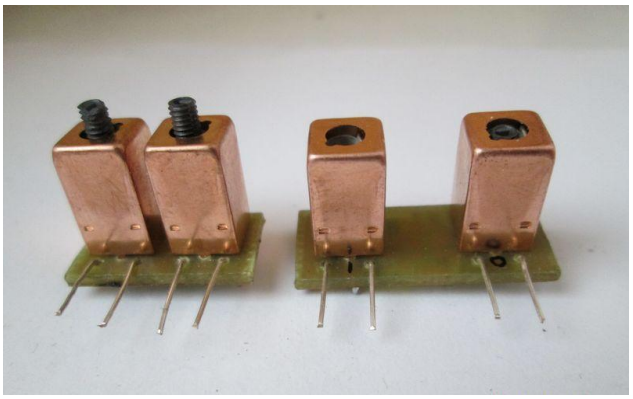
Filters base should be prepared in advance. This should be done by removing the legs, cutting any flanges and drilling holes for the coil wires.



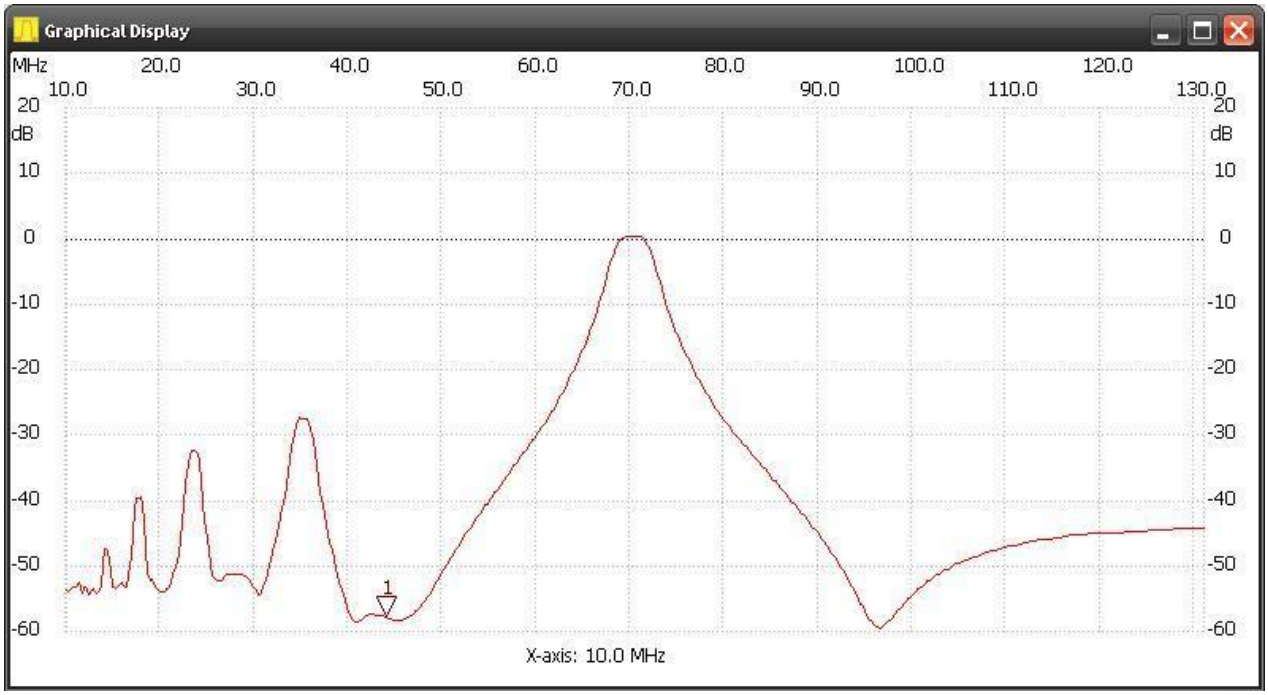
First wounding CuAg primary coil, then coupling one as shown below:

After installing in the PCB the filter looks like this (coupling green wire should have two turns):

If inspected against short circuit we can put the screens and solder terminals
Final result can look like this:

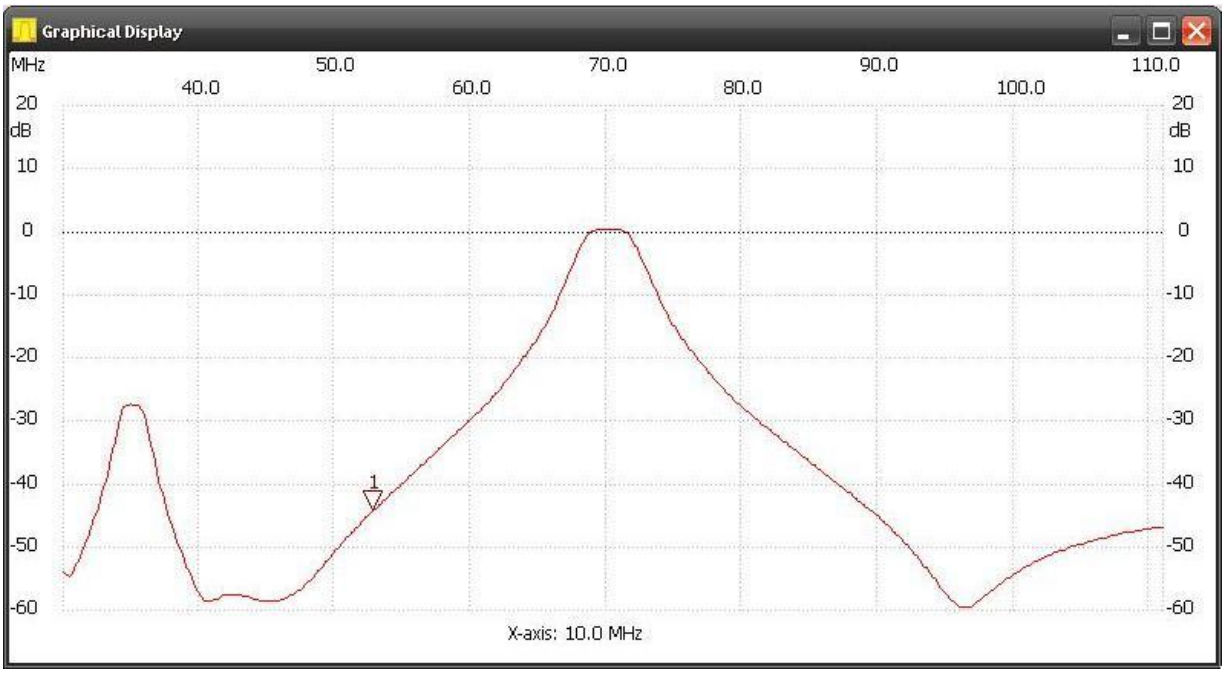


On the project stage I had made some measurements using NWT500:

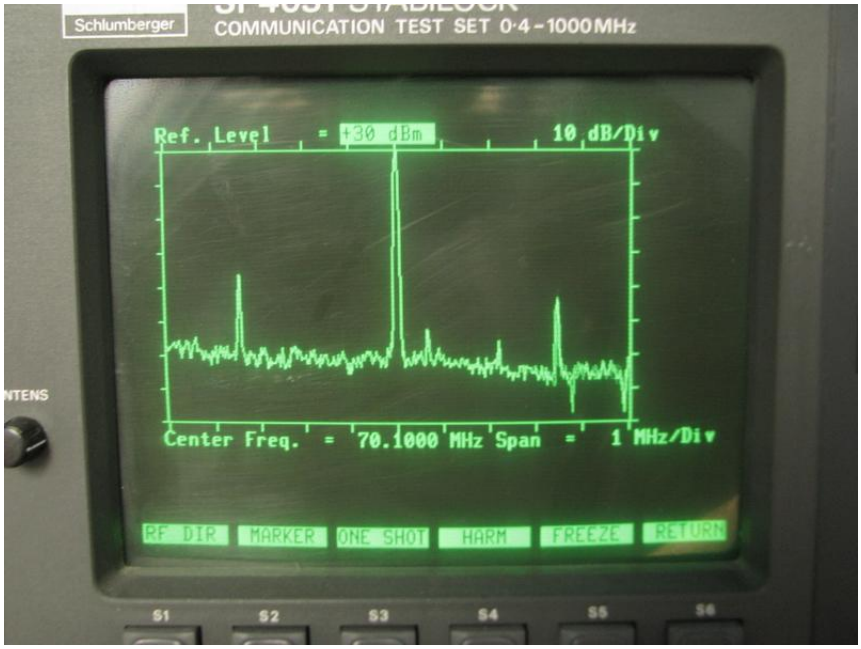


Please note the attenuation frequency 45MHz !

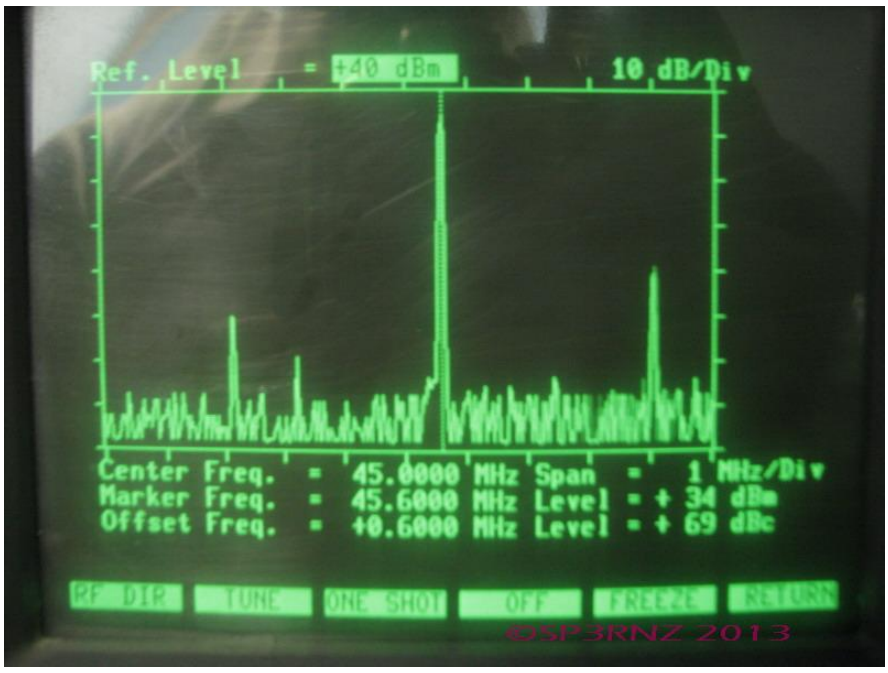
Close-up image:



And this is the screen from measurement taken prior to filter modification – FT847 signal spectrum with 10W output power



And more interesting below 70 MHz ;-)

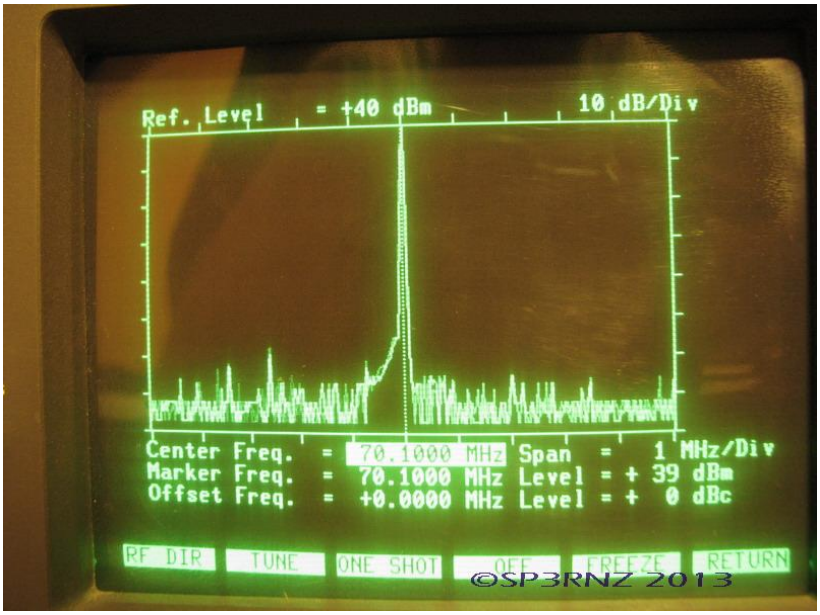


Visible 45.600MHz signal peak just 3dB below the main carrier on 70.100MHz below You can see 21 and 35 Mhz peaks, just above the marker more right of spectrum we can see big one at 49.035Mhz. It has peaking level of -2dBm.

So without any doubt, having good power readings on reflectometer is unfortunately not enough. The measured FWD power voltage is the sum of all the "junk" that TX produces after simple unlocking our transceiver.

Although this has not been proven empirically, and many rumours are about is it true or not - the authors of this article after hearing about four or more different cases of damage to the TX HPF - tend to conclude that the main reason of self desoldering coil L5022 in the filter output and even damage/burnout of the PCB and SMD capacitors is this second harmonic signal of 45MHz as it falls outside the range of the bandpass filter and could produce lot's of heat. Last test prove that after 10minutes of transmitting on 10W causes temperature rise as measured on L5022.

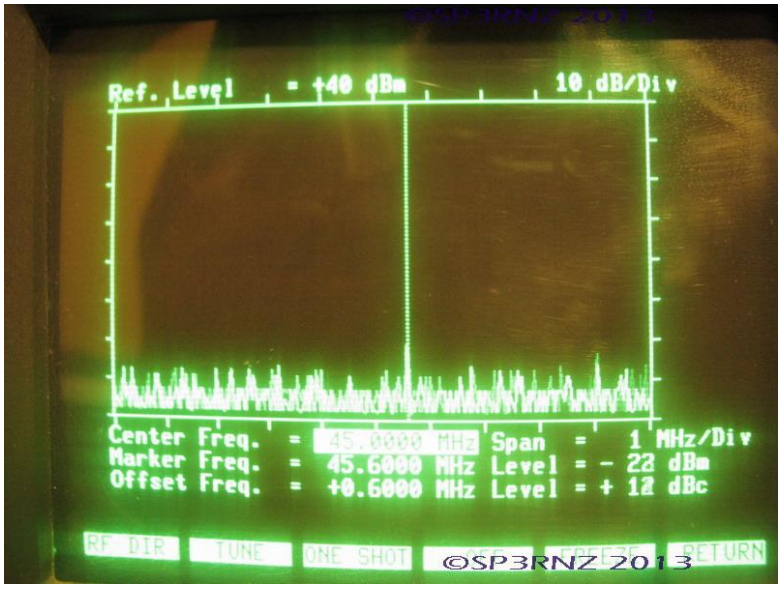
Below are some screenshots of the modified TX filter



At first glance, you can see a significant reduction in the base level of the transmitted 70MHz signal, as well as minimal increase in power output.

Other spurious/unwanted frequencies seen before modification, including 45.6MHz and 49.035MHz and 21MHz almost completely gone, or are suppressed more than 50dB compared to the basic +39dBm signal on 70MHz.

It is worth to note, that the 49.035MHz also disappeared!



In summary:

Transmitter measurements taken before modification:

Power **10W out, QRG 70.100MHz = +37 dBm**

Unwanted signals 45.600MHz = 34 dBm! 49.035 MHz =-2dBm

Transmitter measurements made after the modification of the track TX:

10W power out, QRG 70.1MHz: QRG 70.100MHz = +39 dBm

Unwanted signal 45.600MHz =-22dBm below 70MHz Carrier Point

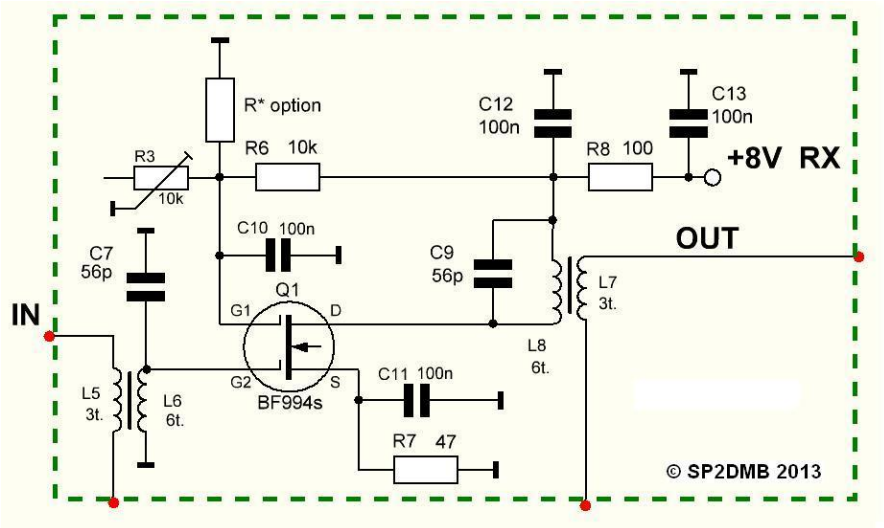
Thus, suppression of unwanted signals is about 55-60dB which is more than adequate.
Now your FT847 should have output about 60W, with a supply voltage of 13.8 V and a current of ~ 13A.

Of course, getting this effects in efficiency/performance would not be possible without prior modification of the PA stage described in outstanding professional article about 847 filters written by Marc PA1O. Kudos Marc!

The description of the implementation of this PA mod (by SP3RNZ) will be in the second part of the study.

2. Modifying RX

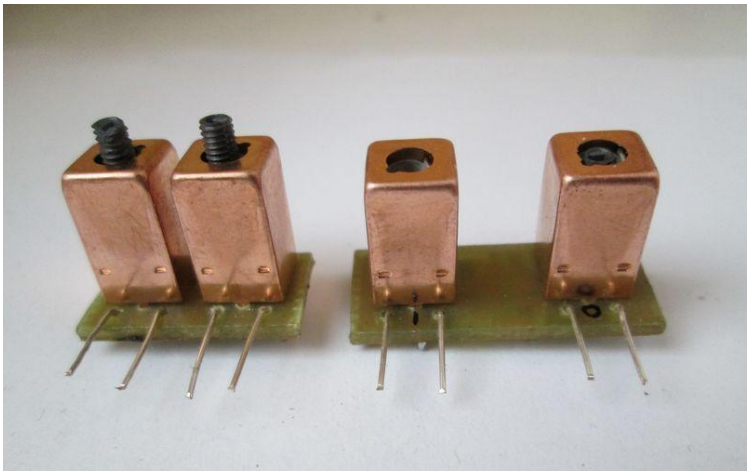
Amplifier and bandpass filter 70MHz diagram:



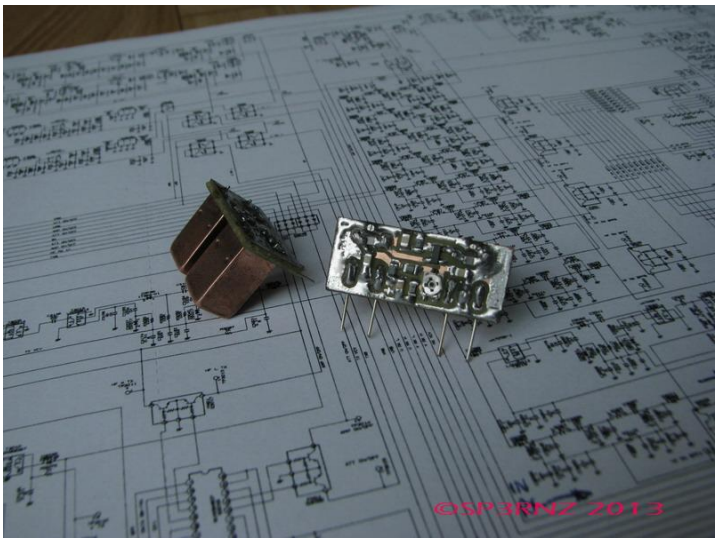
Amplifier circuit is a classic and needs no further explanation. The application includes possibility of adjustable gain by changing the bias voltage of the first gate G1 by small potentiometer, which may be replaced by a fixed resistor in some cases.

Coupling coil consist of 3 turns of 0.5 mm insulated wire (one more than in the TX filter) to get proper filter response.

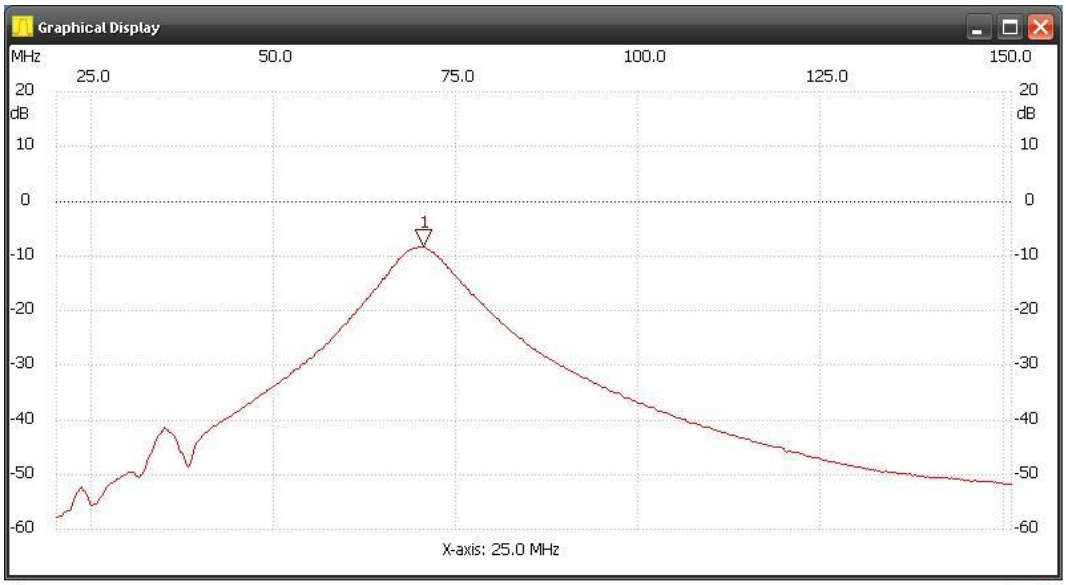
Filters set ready to install in the TRX:

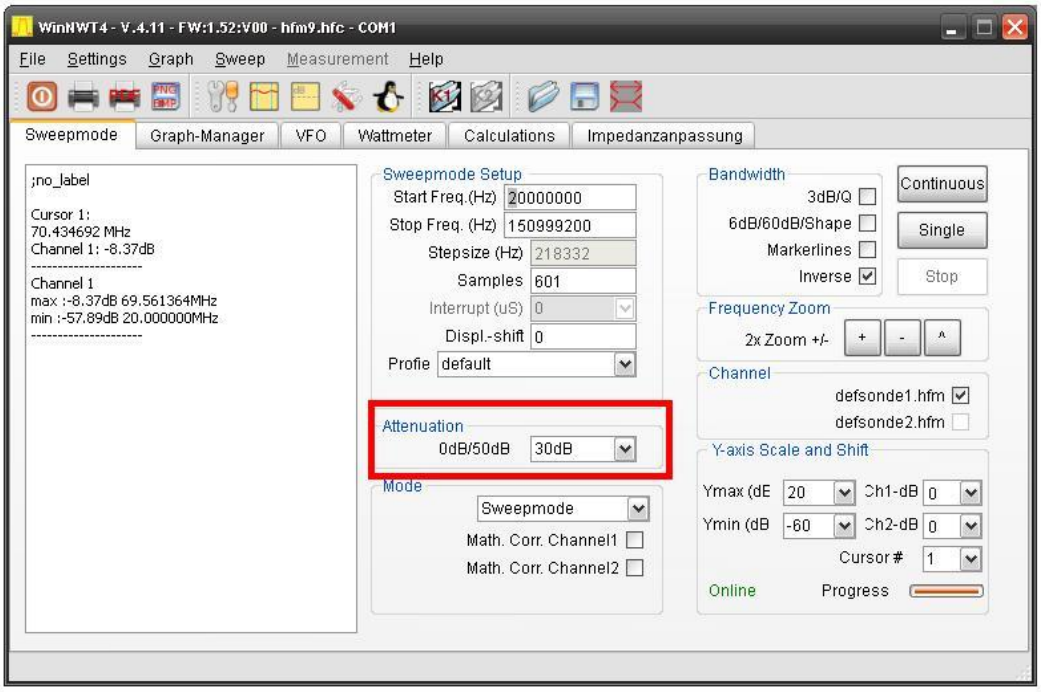


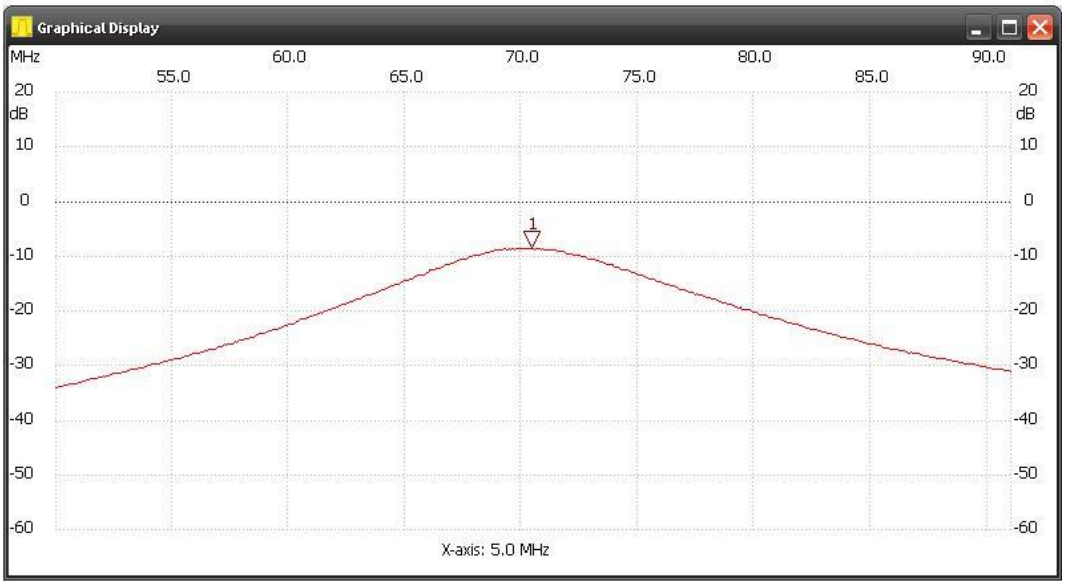
And here's a prototype amplifier before installing:



Measured response of amplifier with 30dB attenuator
(NWT500 - not calibrated)



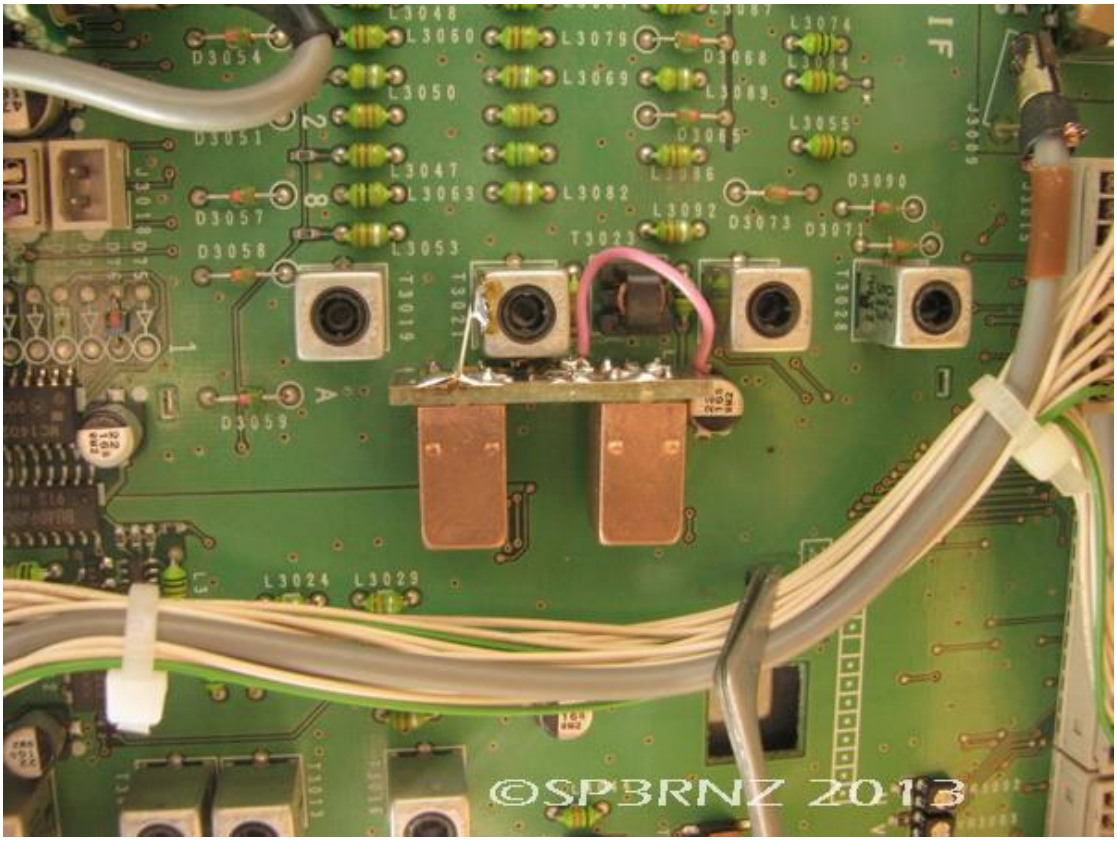




Complete RX set with LNA having about 20dB of gain - which can/should be adjusted to suit needed overall gain of receiver and keep lowest noise figure of RX.

At least we need control and/or set proper gain parameters of the receiver "RX-CHAIN" in the Service Menu of transceiver, as they may vary depending on the TRX age and production changes introduced by Yaesu.

Here's a pic of already mounted filter on the receive path FT-847:



After few mods we can say that theses prototype filters are fully useful. Obtained sensitivity of 0.12uV MDS, and the TX power at almost 60W level with dramatically improved purity of the signal spectrum and efficiency of your TX.

Disclaimer:
The following article is for information purposes only, we will be not responsible for any failures/damages of your transceiver, and we will not take part in any discussion about the superiority of the same solutions over other commercially available ham radio market.

A detailed description of the implementation of mod based on these modules is described by Greg SP3RNZ In the second part of this study.

If you have any questions, concerns, or need to improve your radio - write to me:

sp2dmb@gmail.com or visit my website: www.sp2dmb.cba.pl

73 - Peter SP2DMB, Greg SP3RNZ

Component list

C2	= 1 x 2,2p	SMD 0805
C10,C11,C12, C13	= 4 x 100n	SMD 0805
C3,C5	= 2 x 47p	SMD 0805
C7,C9	= 2 x 56p	SMD 0805
L1,L3	= 2 x 2t.	Cu 0,5mm with isolation
L2,L4,L6,L8	= 4 x 6,5t	CuAg 0,5mm
L5,L7	= 2 x 3t.	Cu 0,5mm with isolation
Q1	= 1 x BF994s	SMD SOT143
R3	= 1 x 10k PR	
R6	= 1 x 10k	SMD 0805
R7	= 1 x 47	SMD 0805
R8	= 1 x 100	SMD 0805
R* option	= 1 x 5-10k	SMD 0805