

# Modification Yaesu FT-847 for 70MHz band v 1.0

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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 bandwidth 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, broadband 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 bandwidth 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 bandwidth (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 established on the basis of initial modifications of FT847 by our colleagues in the Estonia - Hellar ES1II and Arvo ES1CW - mni TNX guys! Well done.**

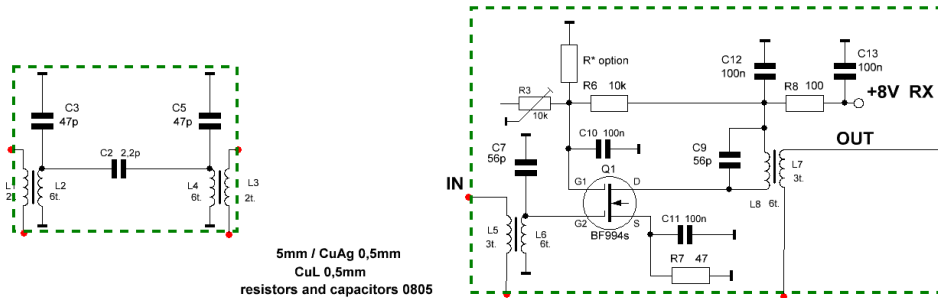
At the moment, the original version of the modification includes more than 30 TRX across the EU and probably worldwide, which can assure that the solution is repeatable and effective.

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

## FT-847 - modification for 70MHz by SP2DMB

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What you will need:

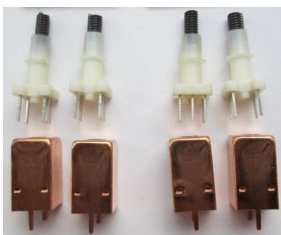
1. PCB's ( [sp2dmb@gmail.com](mailto:sp2dmb@gmail.com) )
2. Wire CuAg 0,5mm



3. Cu wire 0,5 mm in isolation:



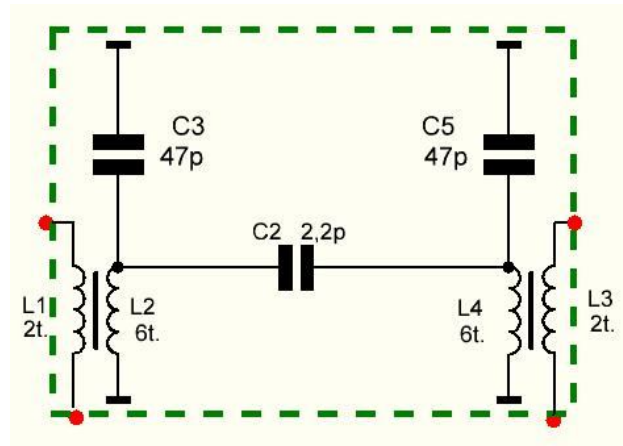
4. Tuned filters 7V1S:



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

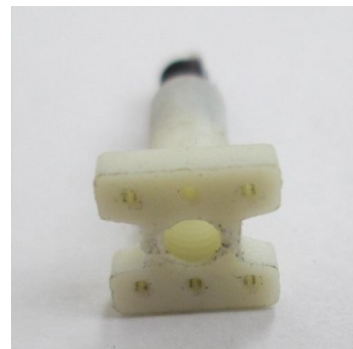
## 1. Modifiyng TX chain

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.



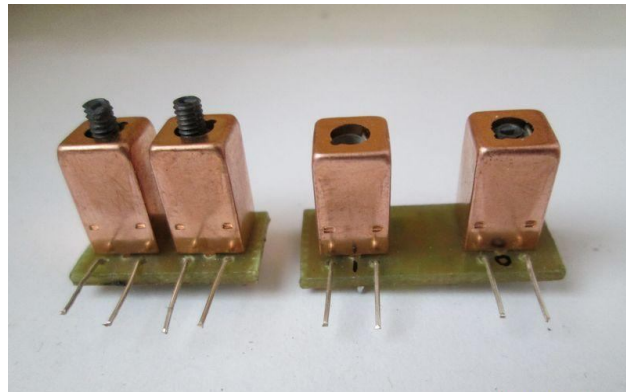
First winding CuAg primary coil, then coupling one as shown below:



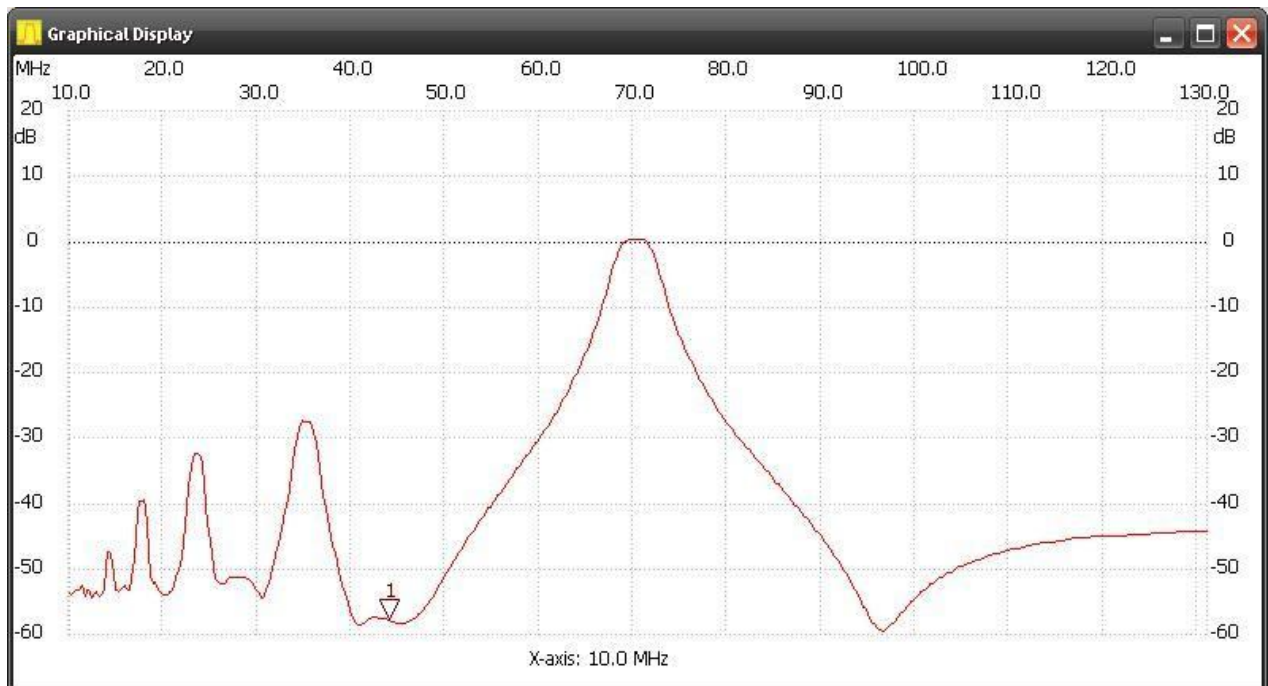
After installing in the PCB the filter looks like this ( coupling green wire should have two turns ):



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

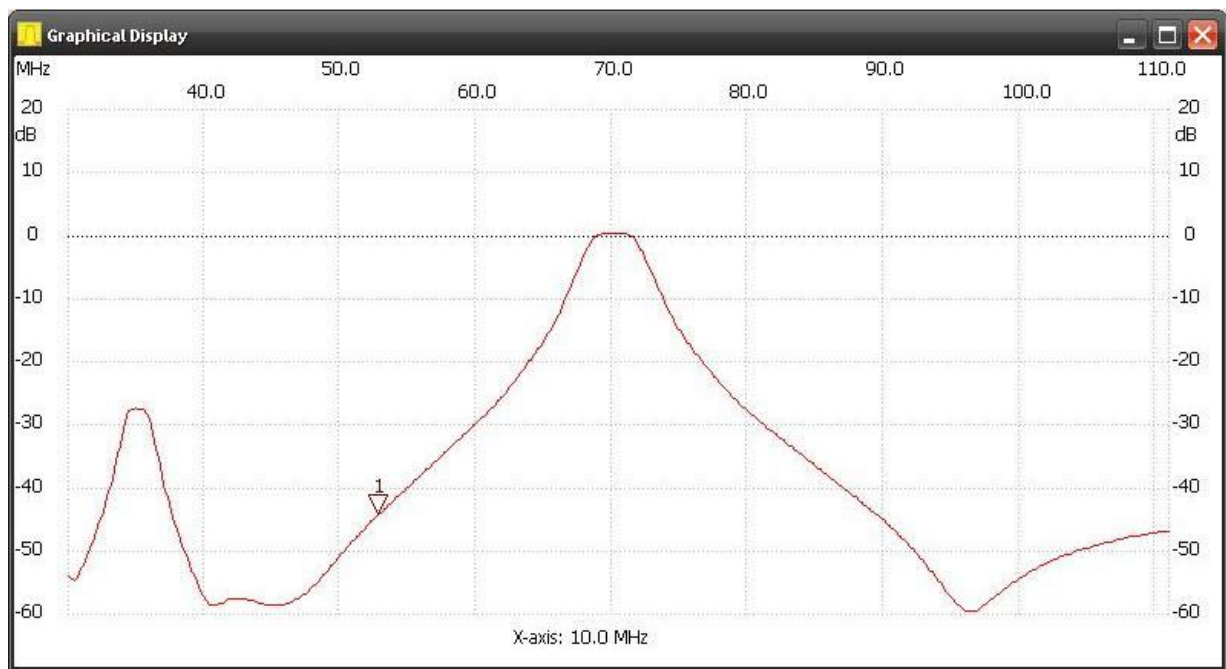


On the project stage I had made some measurements using NWT500:

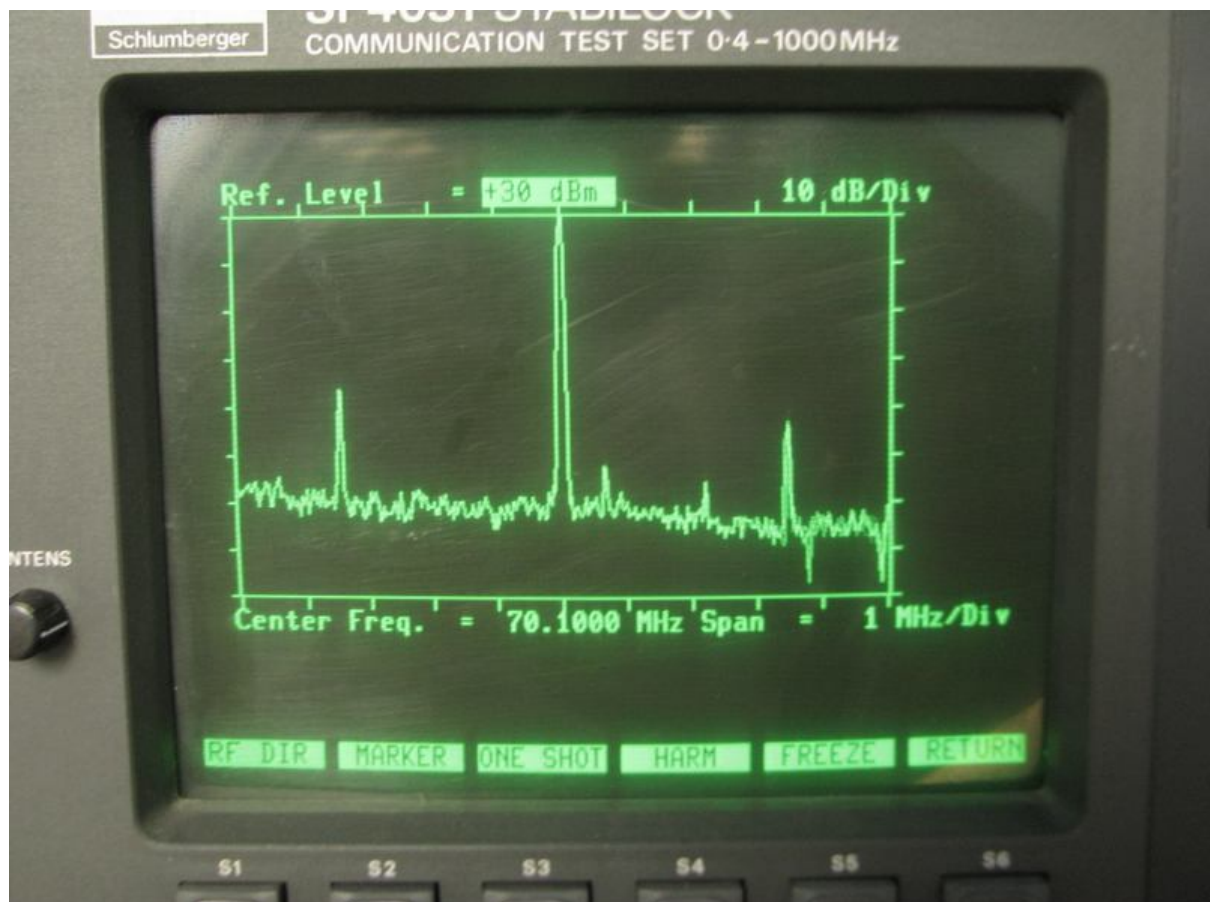


**Please note the attenuation frequency 45MHz !**

Close-up image:

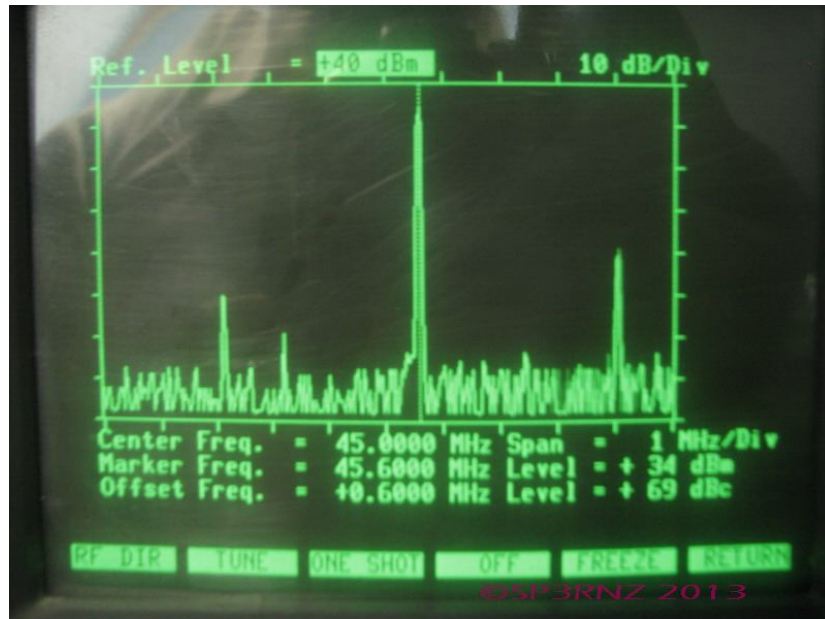


And this is the screen from measurement taken prior to filter modification – FT847 signal spectrum with 10W output power





And more interesting below 70 MHz ;-)

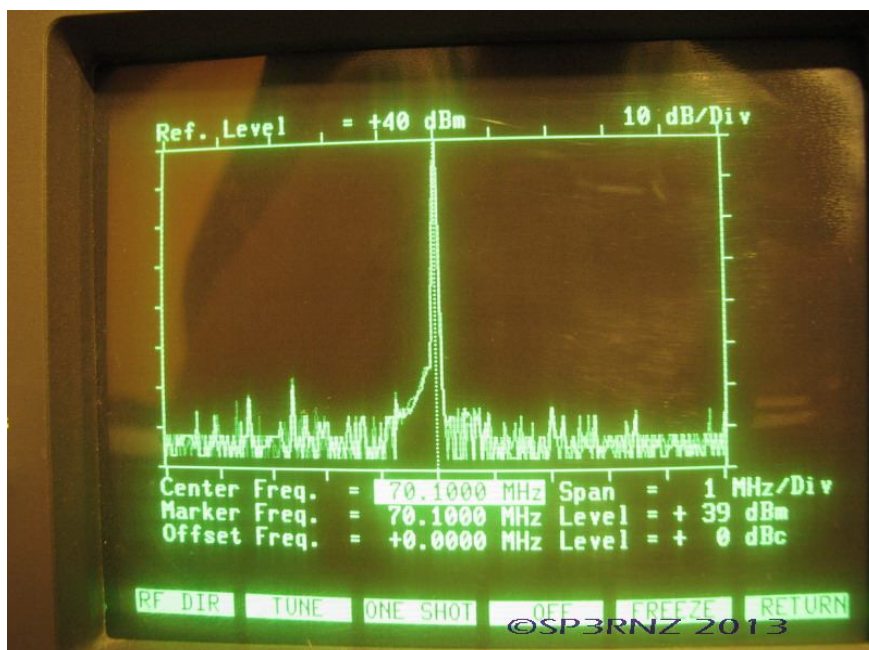


Visible 45.600MHz signal peak just 3dB below the main carrier on 70.100MHz below. You can see 21 and 35 Mhz peaks, just above the marker more right of spectrum we can see big one at 49.035Mhz. It has peaking level of -2dBm.

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 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.

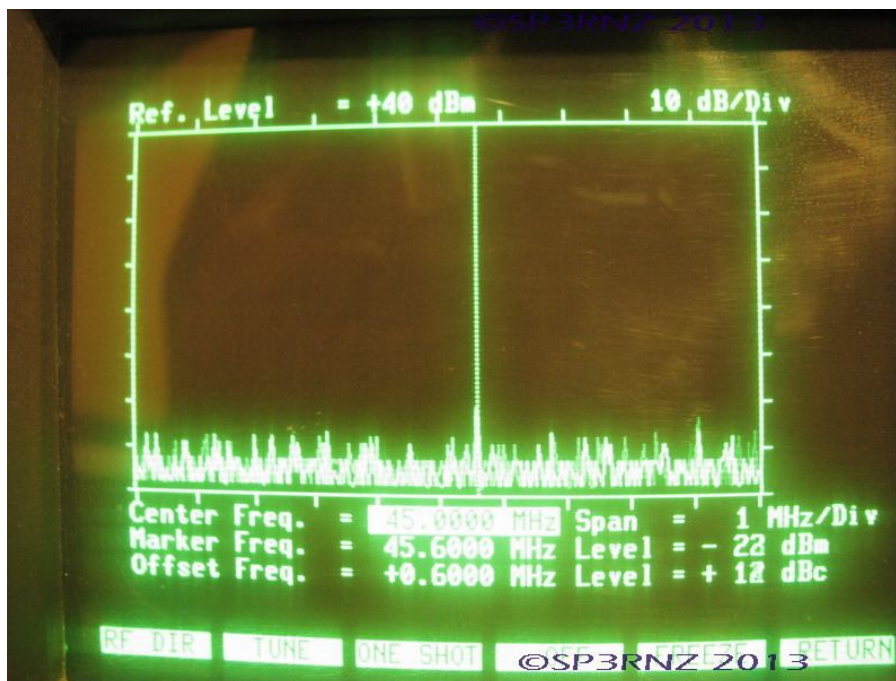
Below are some screenshots of the modified TX filter



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.

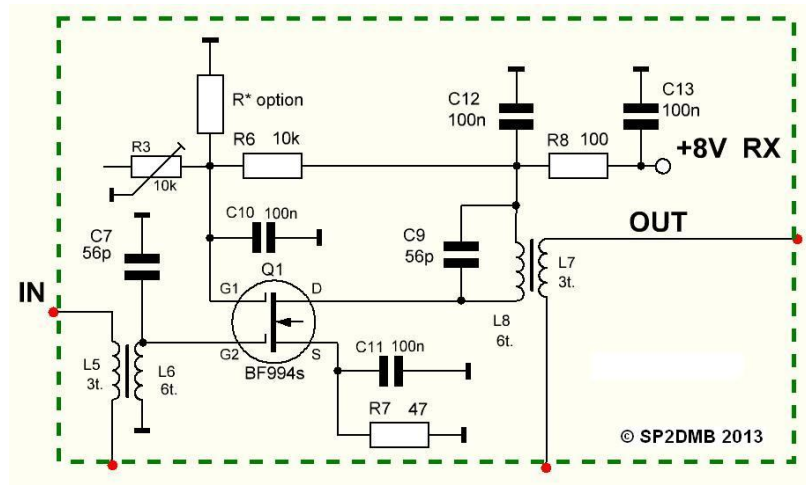
Now your FT847 should have output about 60W, with a supply voltage of 13.8 V and a current of ~ 13A.

**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

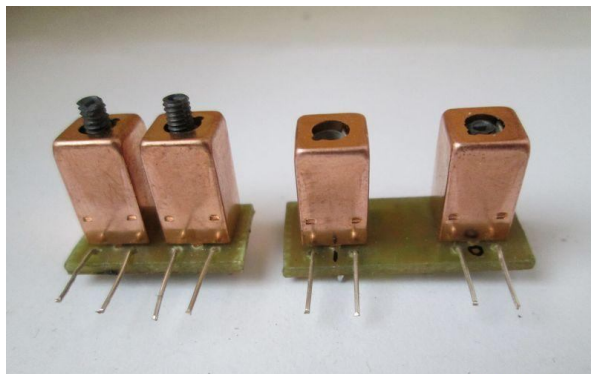
Amplifier and bandpass filter 70MHz diagram:



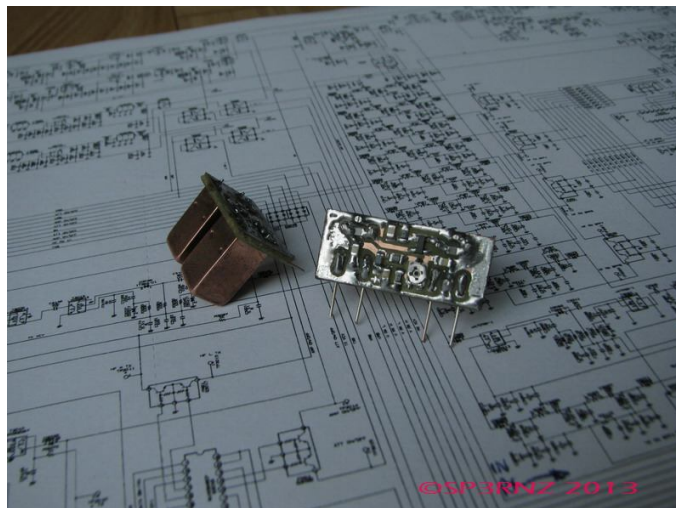
Amplifier circuit is a classic and needs no further explanation. The application includes possibility of adjustable gain by changing the bias voltage of the first gate G1 by small potentiometer, which may be replaced by a fixed resistor in some cases.

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:

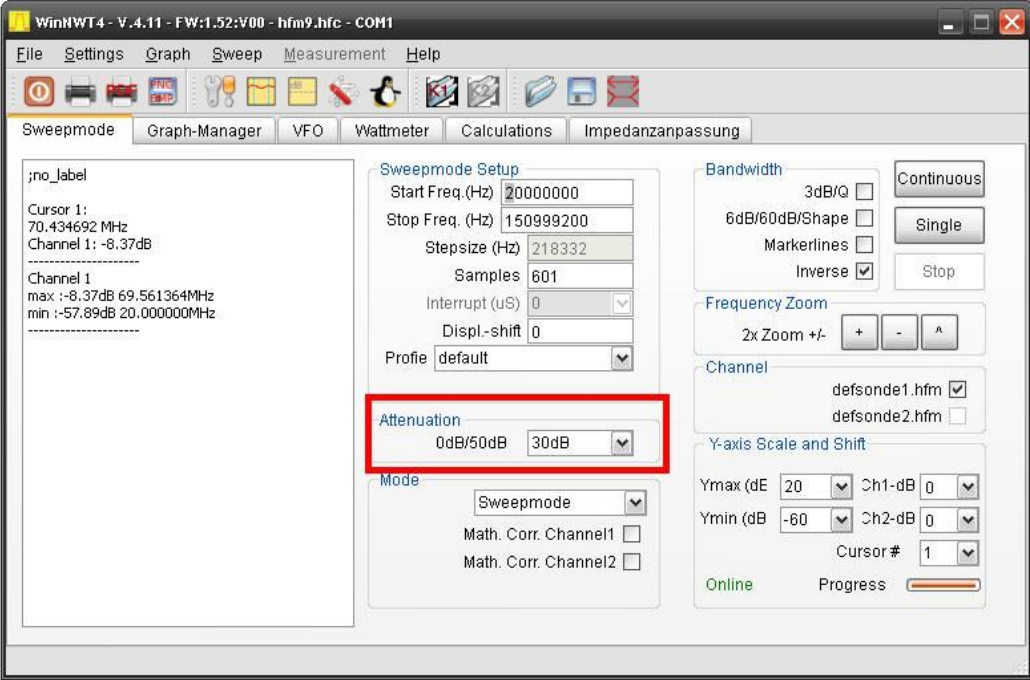
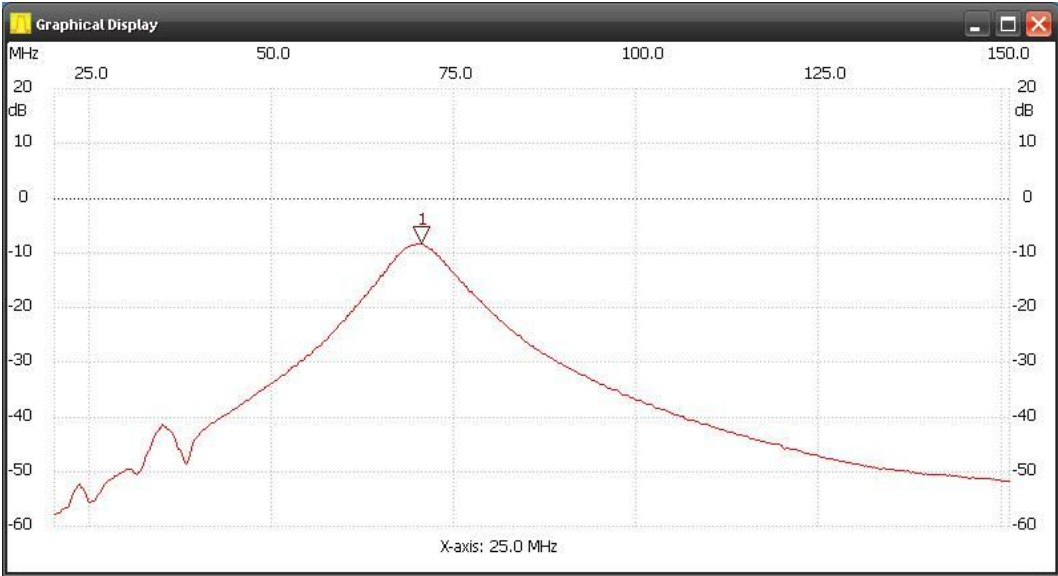


And here's a prototype amplifier before installing:





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



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.

Disclaimer:

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

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## 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

# Modification Yaesu FT-847 for 70MHz

## Part II – practical solution v. 1.0 (Oct 2013)

Greg SP3RNZ sp3rnz@wp.pl  
PA mod idea by Marc PA1O  
TX/RX mod idea by Hellar ES1II/8

This article describing how to do modification of your RIG in practice. Theoretical aspect were described in previous part of the article about modifying Yaesu FT847 RX/TX filters to get all we can have from this nice radio. Because You probably read part first before ( if not – I insist You should!) I will focus on practical aspect of the mod.

The job we need to do is:

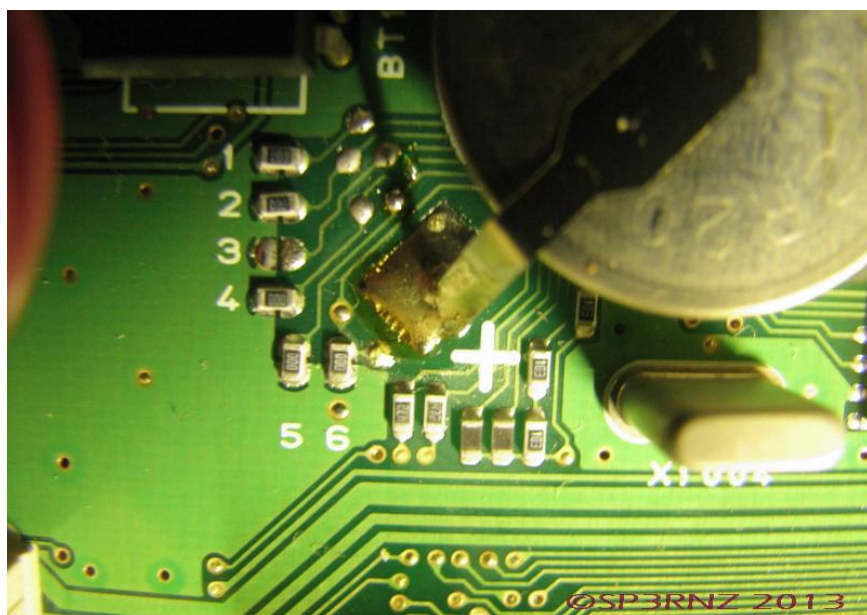
- unlocking the radio, if it's still locked to gain access to 4m,
- remove capacitor in PA module to increase TX efficiency
- replacing existing RX Bandpass filter to modified one with LNA,
- replace existing TX filter chain to sharper one to get clean signal.

Let's get it started ;-)

### 1. Unlocking your FT847 to get 4m ( for those who already have unlocked one, please move to chapter 2).

Assuming we have fresh one locked 847 on the workbench we should start with make it alive on 4m. Job is easy, and should not take long time even if You haven't much electronic experiences.

First unscrew top and bottom cover, and turn the radio upside down. If You have Your radio facing with the main tuning knob facing You, look on the left upper corner. There is Lithium battery, and on the left You will see six solder points marked 1-6 . They could be just shortened by solder, or small SMD 00hm resistors. On the picture You can see factory state unmodified 847.



Regarding our needs and mood we can do the unlocking in two basic but different ways.



- a) No ham band restriction HF 1,8-76MHz, VHF 137-174MHz, UHF 410-470Mhz
- b) Only ham bands HF/VHF/UHF + new one 70Mhz.

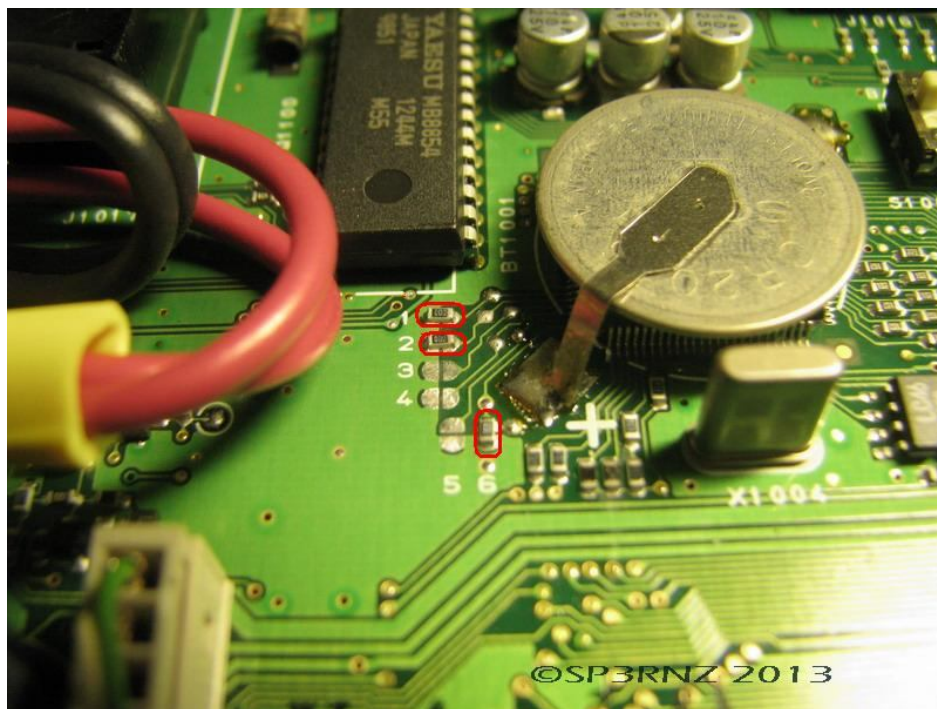
To do version „a” – remove all SMD or solder joints and leave all 1-6 fields open. After that, push FAST and LOCK and turn the radio on. Voila!

To do version „b” – leave (if they are shorted) points 1,2and 6, removing all the rest if any. After that, push FAST and LOCK and turn the radio on. Done.

To remove solder joints it's good to have smart thing called „SolderWick” or You can use small tweezers with low power solder iron. BE sure that You disconnected your solder from mains, before start. As we are working around Memory and uPC is good to Pay attention to ESD.

After all to avoid any supprises clean the soldering place with Isopropyl Alcohol IPA. It will ensure that joints are clean and no any solder dust left on place.

You should end with similar result for version „b” mod.



## **2. Next step will be increasing efficiency of Power Amplifier in our 847 by applying mod described by Marc PA1O in his superb article about Yaesu 847 filters.**

I'm pretty sure few of You experienced already that unlocking gives You advantage to get into 4m band, but big power supply is a must. It's mostly due to design of the filters in PA stage and spurs produced in early stage of TX chain transmitted together with 70Mhz signal. In almost all tested (4 until now) 847 TX current was very high, despite low TX power and reaches even 17A by 10 W of output ( last tested 847 reached 26A by 30W of power – really amazing efficiency ☺)

But better don't try to transmit for longer period, you can get new # and possibly few burned elements... and then some troubles with repairing your 847.

To get the transmitter much more efficiently we must do another mod, described by Marc PA1O – removing one of the capacitor in PA board. This is exactly described in his article about FT847 filters, but will be presented also here more as “how-to” for those who did not read it before.

After removing all screws from upper part of TRX, under the Main Board we will find PA stage board.

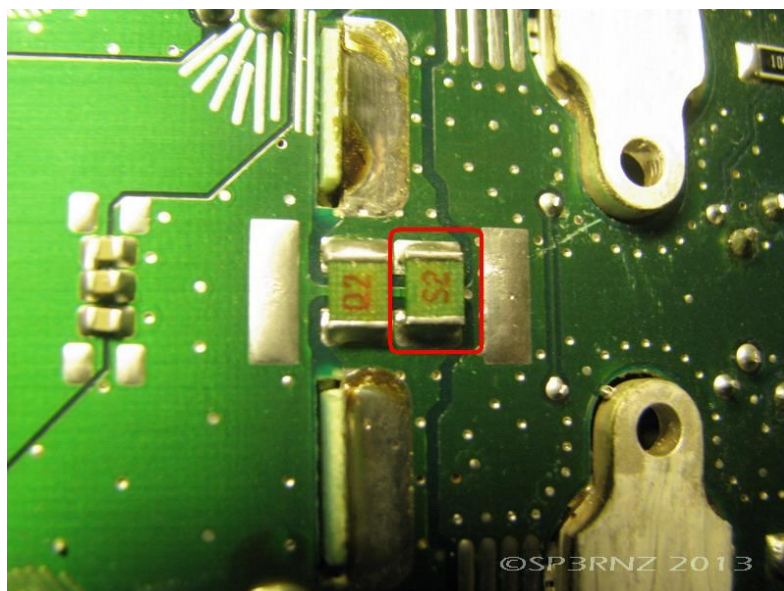


To do the mod we must pull the PCB out of chassis, so let's start with unscrewing all necessary screws, all of them including transistor screws. Then we should disconnect two HF outputs on the rear. Be careful, as these pins need to be bend a bit to suck the solder out.

At this point please look carefully for two small bronze spring soldered to PCB. This is additional ground, and it's nothing exceptional in them, except they are soldered with small amount of tin, and likes to broke from PCB and jump somewhere.

As we don't need them to make short circuit after mounting PCB back– take look on them and make them soldered well.

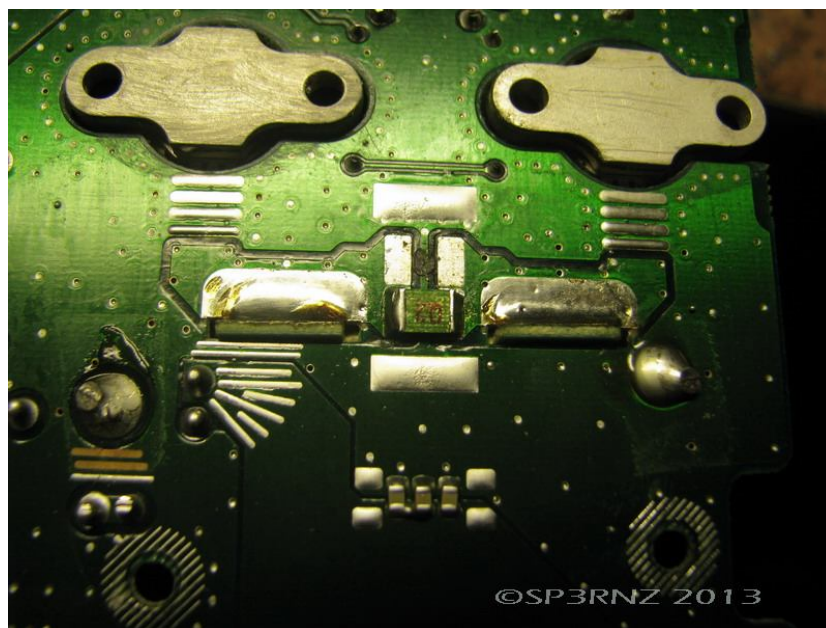
After PCB removal ( no need to disconnect any cables, just gently pull the PCB back and lift it up, and rotate upside down ) we need to locate two capacitors located near PA transistors marked Q2 and S2. We will remove this one marked S2.



Marc PA1O concluded that Yaesu applied strong glue, Yep. ☺ In fact they used very strong one, and this can make capacitor removal bit tricky, as it can't be just warmed and desoldered. The best idea is to suck the tin on each side (i.e using smart thing like "solderWick" tape by Chemtronics) and use small tweezers to catch the capacitor and turn him gently applying some heat together. Warming the capacitor with more heat or bigger soldering iron will not help, as this is silver mica one spreading the heat around on PCB, and will not move as standard SMD device. More heat can only burn the track, and/or PCB itself.

After removing You will probably see that bottom side of cap is still on PCB, but that's is easy to solve. You can remove this with sharp knife. Just apply small drop of IPA alcohol at the place where cap was fitted, letting IPA penetrate under the capacitor foil. Then use solder at the one solder point and try to lift the foil in the middle. It will easy move up then, leaving only small Japanese mega strong glue. (Tested on two different 847).

After cleaning the place You should get something like that:



50% Job is done now. But.

At this place, I will propose, that if we already made efforts to remove this PCB, we should do general inspection to avoid surprises when using our TRX in the future. Depending on your TRX age, and intensity of use in the past without the TX mod you will see melted or even partially evaporated solder on SMD capacitors and legs of toroidal coils in filter stage! There's the place where famous L5022 is. More less, I did found these „heat signs” and even partially evaporated tin in two of four modded 847, and these clean ones were not QRV on 4m at all. Answer should be obvious for those who read Marc's articles.

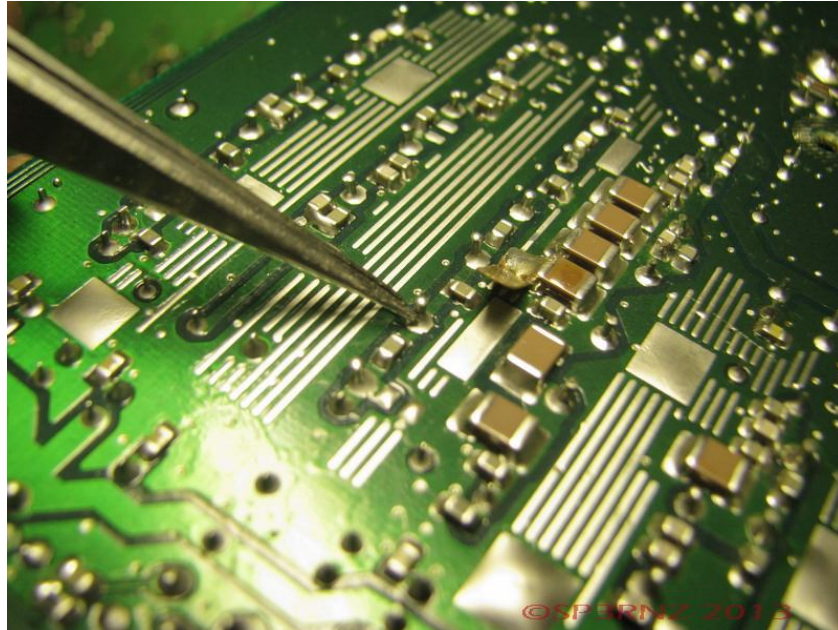
I will not discuss why it was happen, and is this possible or not, or am I right about 45MHz second harmonics is guilty for that.

I just did some test 2 days ago when preparing to mod this TRX. Transmitting 15W for 10minutes on dummy load causes temperature rise of about 10°C at the L5022. Would it be more when longer period of transmission? Possibly. Or better to say: YES. I'm pretty sure. Whatever the cause really is, there's no significant temperature rise after TX filter mod. You can make conclusion yourself.



Anyway if nothing wrong can be seen, just good idea will be to re solder the points, especially the coils legs. Nothing to lose, but (possibly) way to avoid further troubles.

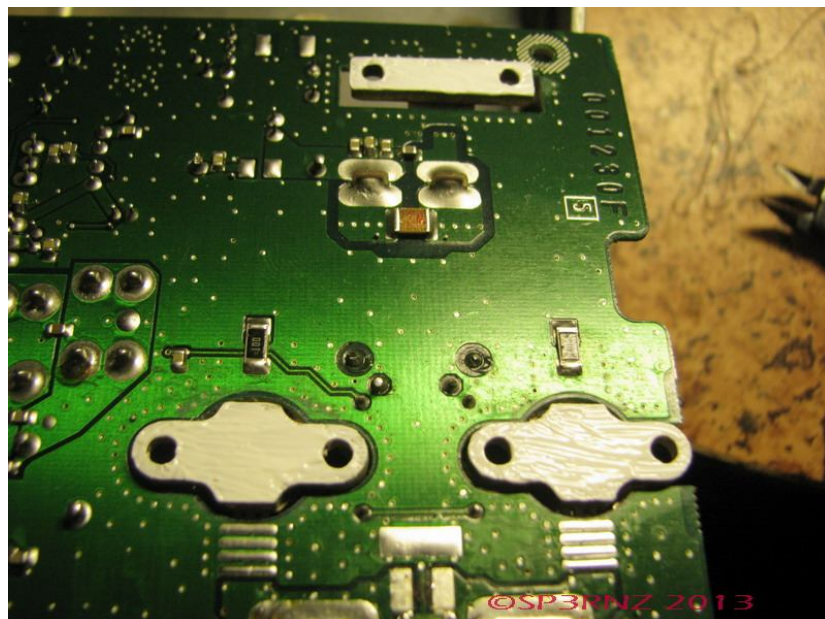
On the next pic You can see the points for examination.



At the end of PA job, another good idea. As observed in all four 847 after some (years) of time beryllium oxide paste used as heat spreader on transistors is getting dry and hard.

**NOTE: I found that in 847 year model 8G there was NO thermal paste AT ALL – hard to say why? Maybe they forgot to apply before inserting the PA into chassis?**

All we need is to clean transistor places and their base, apply small amount of ceramic thermal paste same as used in PC.

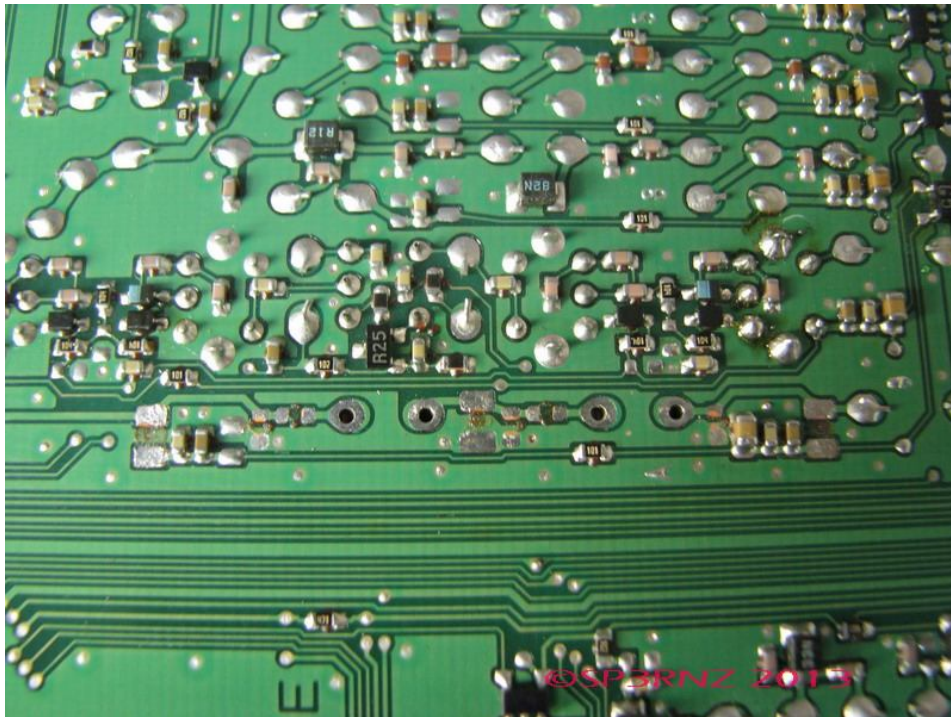




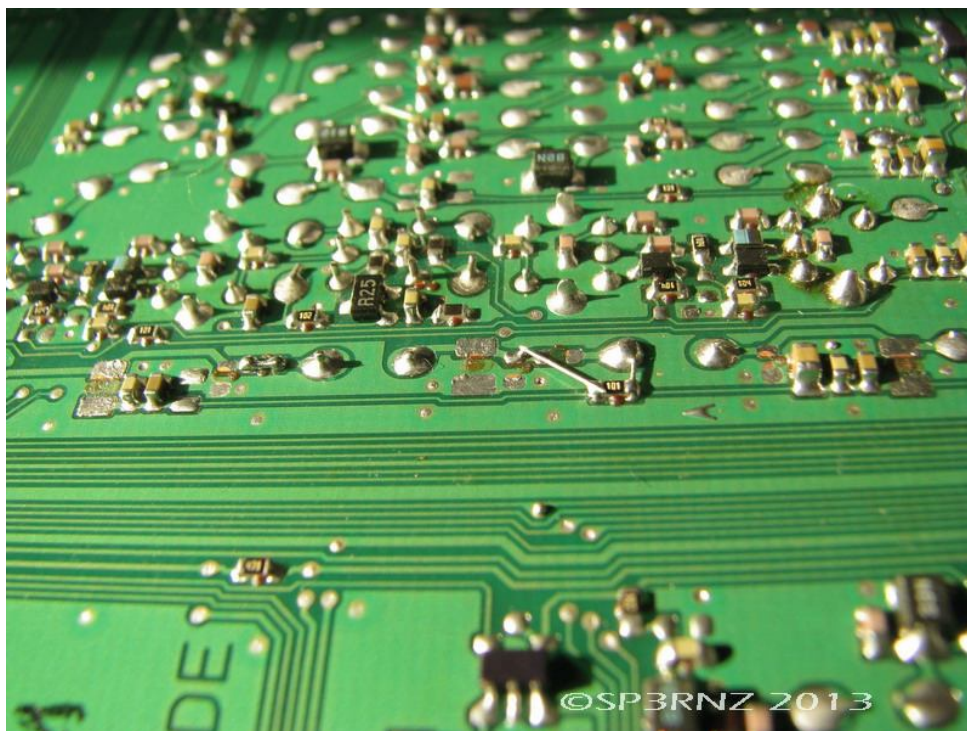




In effect, we will have clean place to mount new filter with LNA.



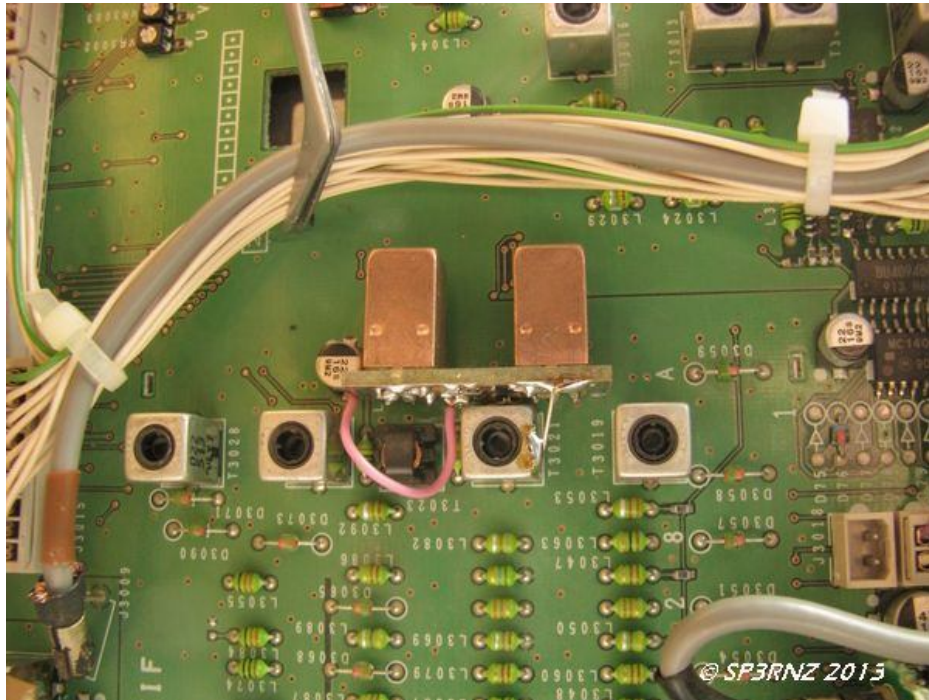
After inserting and soldering filter module we need only to make two wire bridges from diode switch to make it working. It's clearly shown below.



Of course it's good to check with any multi meter if no sudden short circuits accidentally were made.

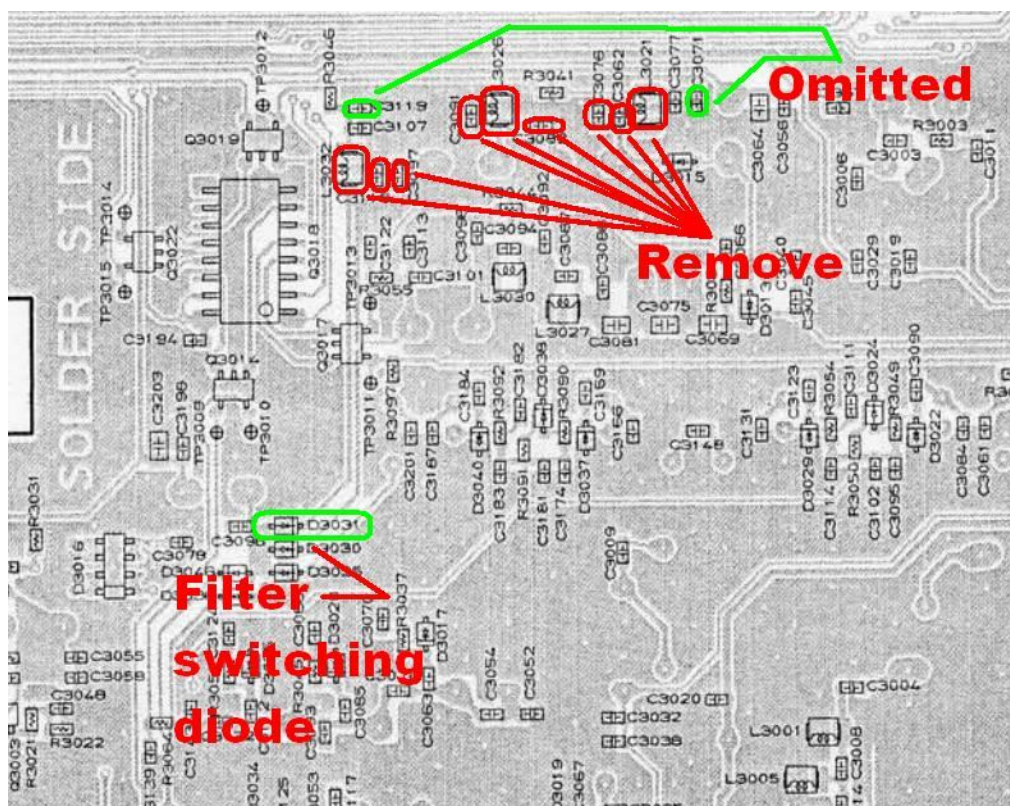
Last thing we need to do is connect +Vcc on filter PCB to nearest SMD 22uF capacitor giving us +8V to feed the LNA on RX.





#### 4. Transmitter part mod.

Just below filter we Just modified we can see TX filter part. If Any trouble finding it, please refer to PA1O article. This should look somehow similar.

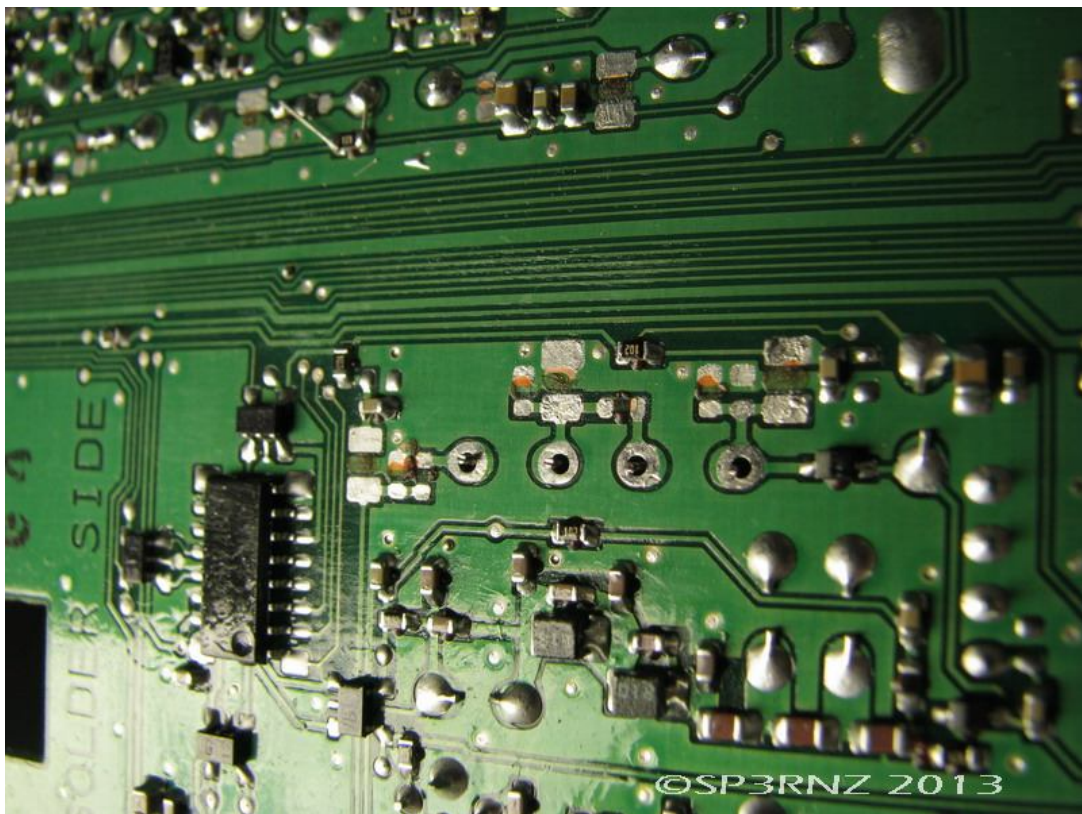


Green SMD were omitted by Yaesu, those are the caps marked with an asterisk on schematic diagram.

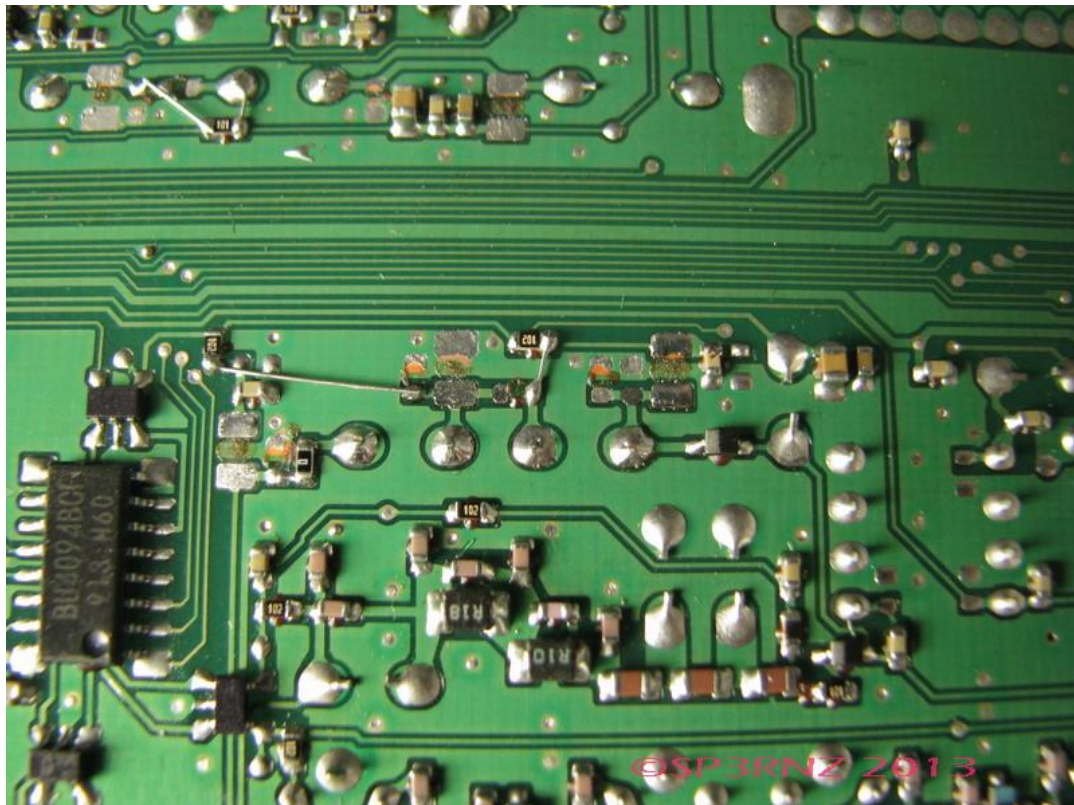
Red ones – we will remove to get place for our mod.



After some cleaning, PCB will look like this. ( damned Japanese glue ☺ )

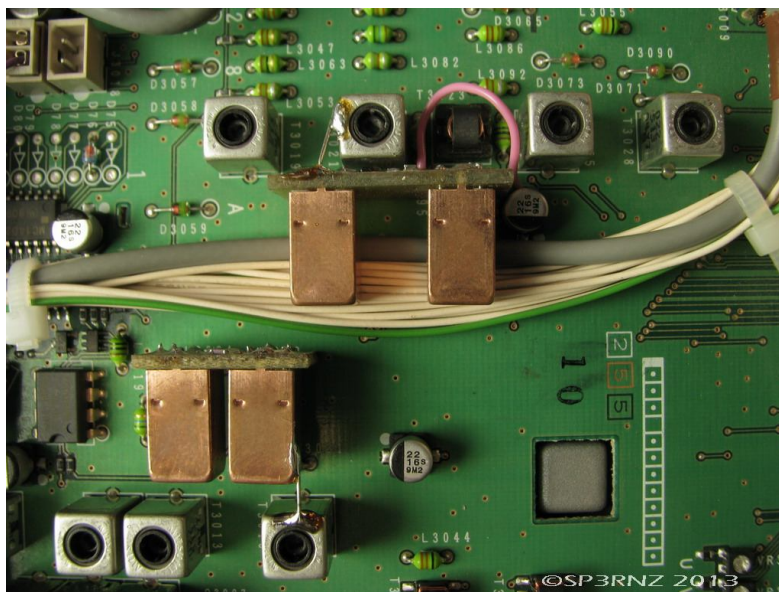


Next step after inserting and soldering the filter is to make two bridges similar as in RX chain:





Assuming you did also small ground connection to near filter shield to make filter module straight and to ground it - this is the end of mod. So we ended up with filter board looking like below.



You can mount the PCB in the chassis, connect all remaining cables and connectors and be happy with your FT847.

Please be careful when You cover the upper shield with speaker. Sometimes You will need to turn the speaker around to move audio soldering points to another position avoid short circuit with filter board.

There's not much place to do anything, and we just added two small but PCB. If the speaker will be too close with filter PCB you can bend the RX PCB toward front of the radio. It will increase the space between the speaker and filter PCB and it will fit OK.

Note : Although I am sure that this mod is repeatable, and anyone can get similar parameters, final result depends on fact if there was any attempt to modify RX gain. It will be good to get into service menu of the RIG and check RX-CHAIN parameter and correct the gain if needed. Standard Hex note for RX-CHAIN parameter is Something like 3E for model 9I and 4E for earlier 8G. The lower Hex, the lower gain.

*Disclaimer: This article is written for information purposes only.*

*Although all described mods were carefully tested myself on my own radio, back and forth in the period of last year of my activity on 4m, I shall not be judged responsible for any damages/failures of your transceiver, if something will go wrong. All mod's you just doing on your own responsibility.*

If You are not sure You can do it yourself, better ask a friend. Or if You want to push more life in your 847 and you don't know how, write me. We are living on the same planet ☺

Sincerely thanks for Marc PA1O, for his super job, and Hellar ES1II with Arvo ES1CW for many hints about 847 mods and Jacek SP3LYU for loan me his FT847 to do .

Best DX DX, 73

Greg SP3RNZ

Oct.2013