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Introduction

I started on doing modifications of CB- and HAM-radios since 1980 at the age of 12 years. I mostly wasn't satisfied with the sound of the modulation or reception of my rigs. This is normally founded by restrictions of the local law or by rationalize productions. Only expensive high-class amateur radios have a good sound on their basic state.

Therefore there must be some possibilities for improvements. So I learned the basics of RF electronics on myself and did a lot of modifications until today and I would like to spend my experiences to all other electronic interested people, CB- or HAM-radio stations.

You have to recognize your local laws. Mostly modifications aren't allowed by the local law or by the manufactures. So you do it on your own risk. Also the brand new HAM rigs are mostly build with a lot of teeny-weeny SMD parts. You have to use special equipment and you also must have a great expert knowledge. So some modifications aren't for only hobby electronic technicians.

So this and all of my Modification Sheet are for education purposes only !

Used pix are mostly done with my Fujifilm „FinePix 6800 Zoom“ on resolution „3M/Fine“, but they are reduced on their size due to minimize the total file size of this publication.

Some background informations about the FT-897 mods

FT-897 → FT-857

Both transceivers are based on the same circuit diagrams but they have a different mechanical case. All my electronics modifications can be done on the FT-857 mobile transceiver too. But actually I hadn't the time to compare the numbers/names of the parts between those both TRX. So it could be that some parts have a different number/name on the FT-857 than described here for the FT-897. As many FT-897 just wait for this modification sheet I will check and compare this later and just spend my men-power in finishing this modification sheet first.

AGC

A lot of users have criticised the "too fast SLOW AGC" on SSB mode. For my opinion, that's true too. The circuit is similar to the FT-817 portable TRX on which I recognized the same problem some years before. But the fix is simple and easy by only adding an additional electrolyt capacitor (10µF) parallel to the "SLOW AGC" capacitor C1503 (1µF). As this stock capacitor can be found and handled very easily and without the need to remove any PCB this fix could be done from everyone and it only needs about 15 minutes including opening and closing of the TRX case. After that mod the SSB receiving sound is much, much better – especially on strong signals. And the time constant is still fast enough not to loose weak signals between those "big guns". I don't like those TRX which needs 3 sec. or more to come back.

Oh, I just hear a lot of FT-897 owners breathing a sigh of relief.... Hihi.

Speechprocessor

A story what I better would call "*..the mystery of the FT-897 speechprocessor..*" !! You ask me why !? Cause the stock FT-897 just has a speechprocessor-Button, but no build-in real speechprocessor ! Or let me better say the FT-897 has no build-in circuit which would act like a real speechprocessor.

You're confused ?

Then you react like me as I first read some remarks about that fact on several ham discussion forums – just a long time before I got my own FT-897. Prior to my own buying I had a QSO with a ham from Sweden (SM4YPG, Lars-Gunnar) on 20m and he used a FT-857. As I told him that he sounded distorted and "harsh" we did some on-air tests and comparisons on different menu settings. And the difference between "speechprocessor ON and OFF" wasn't really significant, even not on a speechprocessor level of "100". This was the final proof for me.

A real speechprocessor consists of either an AF compressor, an AF clipper, an AF lowpass filter, ...or the combination of all these parts. The better and what I call "real" speechprocessors would be the RF speechprocessor which clip directly on the RF signal to prevent excessive distortions.

And what on the FT-897 so called speechprocessor, when looking into the schematic !?

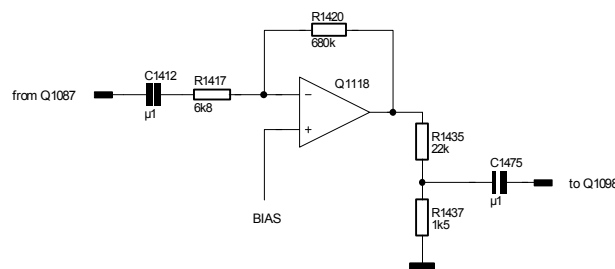
It's only an additional simple AF amplifier (MAIN UNIT, IC Q1118, NUM2902V, pins 8 – 10) with an amplification factor of 100 (R1417/R1420), but the output level is reduced again with a resistor divider (R1435/R1437, 1:15) !!

And what is the effect of this ? You get a real minimum additional amplification when activating this speechprocessor. The real amplification factor is set by the BIAS-line and the menu item no. 074

(Proc. Level). But if the menu level no. 074 is set too high (up to 100) the audio sounded distorted cause the IC is overdriven. But it don't sounds much louder cause the output resistor divider "destroys" this higher AF level.

I think the Yaesu engineers called this a "speechprocessor" cause when an IC audio amplifier is overdriven the signal "clips" as no more amplification is possible. This can be a kind of "processing" but the resulting distortions are ugly and not understandable. The sound is getting more and more "hollow" and the distortions reduce the total readability.

But a real speechprocessor should HELP on weak signal operations, ...and should not additionally DESTROY them. So this "overdrive" way is one of the simplest but most bad possibilities which can be chosen for a speechprocessor.

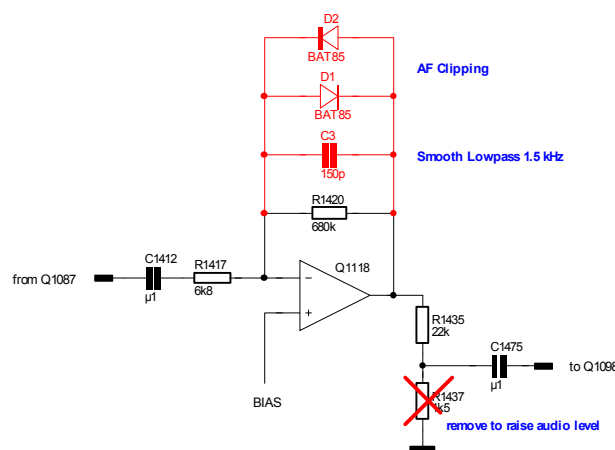


The stock "mystery" speechprocessor

To change this unusable speechprocessor into a good and working speechprocessor the trick is quite simple.

I removed R1437 to get a much higher output level. Now you would hear a difference between speechprocessor ON/OFF and the audio distortions are reduced significant cause you don't need as high menu levels on no. 074 than before. But now we would only have a switchable additional audio amplifier and nothing more. Does this make sense !? No ! So I had to limit the audio level to get a real speechprocessor.

And I did this with two antiparallel lownoise diodes. As clipping on the audio side always produces some distortions and a "high pitched" sound characteristics (like loosing all basses) I added a capacitor to have an audio lowpass filter too.



The modified speechprocessor

So the resulting sound with "speechprocessor ON" is great now ! And it has a real DX punch now !

The stock smooth AF highpass filter, consisting of C1412/R1417, reduces frequencies below 230 Hz and helps a little too. My AF lowpass filter with 1.5 kHz seems to be too low on the first view. But as we have a strong high pitched audio sound while being in the clipping area this reduction is necessary and the resulting sound of this both effects (working in opposite directions) is great as you can hear on my sample wav files I recorded.

I'm using a pair of BAT85 schottky diodes as they only have a forward voltage of 0,3V. So the clipping starts on the quieter voice parts too. But it should be possible to use 1N5711, HP2800-2810 or other lownoise diodes with 0,7V too.

On menu item no. 074 I'm using a Proc. Level of "35" now (with my audio modified MH-36 DTMF handmike) and the difference between ON/OFF is absolutely significant. Of course YOUR final value for no. 074 is depending on YOUR used microphone, its characteristics and its audio level.

The DX can come !....

ALC audio pumping

Another big fault of the 857/897 design is the REV ALC which is documented on several ham radio forums too. The 897 reduces its output power when having a bad SWR. This is a real good and necessary option. But this detector works too fast and the SSB modulation is "clipped" or sometimes "cut" on its peaks. A QSO isn't possible in this state, as many users told.

One possibility is to check and realign the REV ALC parameters as described in the servicemanual. Normally 100W on HF should be reduced to 50W on a SWR of 3:1.

So some users only raised the digital values of the servicemenu to make the REV ALC acting later. This is done by servicemenu items 053 – 058.

Here's an email from Mike (KM6AB) to me, as an additional statement to this fact:

Von: Mike
Gesendet: Mittwoch, 17. November 2004 16:37
An: Jochen - DG2IAQ
Betreff: Re: FT-897D - Reverse SWR alignment

Hi Jochen,
Hold down the A, B and C menu buttons during power up to get to the alignment menus. The main tuning knob will now change alignment parameters, be careful!
Use the small menu/vfo/ch knob to find the parameter HF1-REV-ALC. This is the set point for SWR foldback on the lower HF bands and the main tuning knob will change the numbers in the upper right corner of the display. Factory settings are usually 40 to 50 and higher setting will make the radio ignore higher reflected power conditions. There is also an HF2 and HF3-REV-ALC for the higher HF bands I moved mine to 75 on all three menus and the radio now behaves fine with an LDG AT-897 autotuner into a G5RV on all bands from 80 through 10m. I would recommend trying the radio into the antenna you have (as long as the match is good) and move the numbers up until the radio stops breaking up on transmit. Do this mod at your own risk, you will be making the radio more susceptible to damage from an antenna mismatch.
I have been very happy with my 897 after two trips back to Yaesu, but this is a very early model. I also replaced the stock mic cartridge with a Heil HC-5 element and it gets great audio comments and has a lot more audio punch, which helps with 20w battery operation.
Good luck,

Mike KM6AB

Menue No.	Description	Remarks	Value	Modified KM6AB	Realigned DG2IAQ
053	HF1-REV-ALC	CW 1.8 MHz	47	75	60
054	HF2-REV-ALC	CW 7 MHz	42	75	55
055	HF3-REV-ALC	CW 21 MHz	48	75	49
056	50M-REV-ALC	CW 50 MHz	48		40
057	VHF-REV-ALC	CW 144 MHz	61		90
058	UHF-REV-ALC	CW 430 MHz	61		115

↑
on a 150 ohms
dummyload (= 3:1)

As Mike told this can solve the problem but can be dangerous too as you don't have this good protection on bad SWR than having before.

So I tried another way and I had lengthen the time constant of the ALC circuit a little bit. This prevents from acting too fast, but still having the "bad SWR" protection as well as you can see on the table above.

The mod is done simply by adding a capacitor parallel to the ALC time delay capacitor C1061.

Exciter Stage Protection

What a surprise !!

The FT-857/897 uses the same critical FETs 2SK2975 for the exciter stage as the FT-817 uses on its PA module !

Have you ever heard of the "BFC", the "FT-817 Blown Finals Club" !? Hihi.
Oh yes, ...I think so...

So as I found out this fact on the FT-897 I decided to make a real necessary modification to prevent a damage of these FETs. Of course on the FT-897 these FETs never see a bad SWR as they work "behind" the PA module, but on the 817 these FETs weren't destroyed only by bad SWR. They were also destroyed by overheat, overvoltage, voltage peaks, ...or combinations of this even when the FT-817 handbook tells about using this TRX on DC power supplies up to 15 volts. A real guarantee to destroy them !

The 2SK2975 have their full RF output still on less than 10 volts ! Each higher DC voltage would produce more heat but you won't get more RF out. On more than 12V you get into the "critical area" where the shown "combinations" above can produce higher RF voltages than the used DC voltage. But I don't want to bore you, you can read the whole stories on huge ham radio forums. Just search for the "BFC" and you will find tons of stuff...

Of course you can de-solder the 2SK2975 and re-solder their follower (Mitsubishi RD07MVS1) which is much more rough and can handle higher voltages. But I will only do that if my 2SK2975 would really die.

The solution is simple here too. Just add a 10V fixed voltage regulator into the +DC line.

Replacing the stock MURATA filter

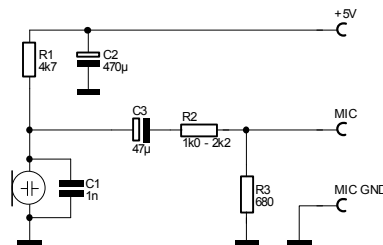
I'm not a CW man (..I never learned it, cause I never liked that mode). But still to have the option to build in a CW filter later I de-soldered the stock MURATA filter and fit in an **INRAD 706F (2.6kHz)**. On the option socket #1 I'm using an **INRAD 720F (2.0kHz)**.

The FT-897 has a great TX-FILTER / RX-FILTER switching method. You can either use the one or the other filter independently targeted for TX and RX.

This makes me able to transmit with a "fixed" 2.6kHz "HIFI sound" and on the RX side I can switch between the 2.6kHz and the 2.0kHz, depending on the crowded bands.

Using an Electret capsule

As the modified FT-897 has a great build-in speechprocessor now, I wasn't forced to use any external one. So the MH-31 stock microphone can easily be modified to get a strong and great audio without any of the "strange" sounds of the dynamic capsules. No additional mic amp, compressor, clipper and so on is needed.



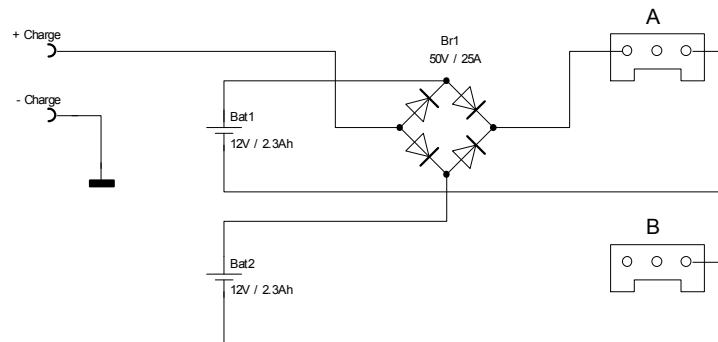
C1 should be an SMD type and should be directly soldered on the backside of the electret capsule. This prevents any RFI.

R2/R3 is a resistor attenuator as electret capsules have much more audio output level than dynamic capsules. Audio distortions and overdrive of the FT-897 mic amp would occur. The value of R2 varies on the used electret capsule, as some has more or less internal audio amplification (5.6mV or 7.9mV output). The resulting level should be some higher than with the dynamic capsule before, but still under the level where the distortions begin to start. A value of 1k5 would give a good "never-to-think-about-any-more" average.

Battery modification from W4CNG

I did the battery modification of W4CNG as described on <http://www.eham.net/articles/4114>.

Battery Modification for the FT-897 from Stephen Reynolds, W4CNG



Service Menu Settings

I collected the factory settings of some FT-857/897 owners and calculated the average values of each setting. This gives a real good information for those users who have mis-aligned their TRX or would like to optimize some values. As YAESU told these values are INDIVIDUAL on each rig as they compensate production stray but as you can see the AVERAGE values work on ALL rigs and you can't damage anything with them.

I read out the FACTORY DEFAULT values for each line too (by pressing the HOME button). But these values give only a good "starting point" for the service technicians but some interact the protections with that (REV ALC, overcurrent,...). **NEVER USE ONLY THESE FACTORY PRE-SETTINGS (HOME button on each item) !!** Of course for this they're NOT calculated into my average results.

Freeband Mod

I'm a friend of enhancing all my rigs into "freeband" rigs (MARS/CAP). That's not cause I want to use them on CB band or on Pirate frequencies, but I always would have the option to use them for emergency purposes. And if you really have emergency circumstances its too late to heat up the soldering iron.... I want to be prepared sooner.

Jumper	DG2IAQ original = "B3"	MARS/ CAP	German version = "B1"
J1007		X	X
J1008	X	X	X
J1009		X	
J1004			
J1005			
J1006	X	X	X
J1001	X		X
J1002			X
J1003			X

Don't forget to do a MASTER RESET after that !!

You can find those information on several other sides on the net too. Please pay attention on the special sort order of the jumpers.



Programming Software

I'm using FTBasicMMO from G4HFQ (www.g4hfg.co.uk). A great, simple and fast software which has me allowed to program my new FT-897 in less than 1 minute (!) by using the exported CSV file of my FT-817. So I was able to take all of my defined memory settings of my FT-817 without the need to re-program any of them. I had all relay frequencies on VHF or UHF and all my HF memories as well.

Now my FT-897 is a super-fast cloned "big brother" of my FT-817. Great !!!

FT-897 won't Power ON

The FT-897 can have three possible error sources when he don't power on immediately. One is documented by YAESU and they sent me their service sheet about that.

1.) R1595 (6.8 ohms SMD)

This fault is documented by YAESU. There's a small 6.8 ohms SMD resistor on the input of a 78L05 fixed voltage regulator. This resistor can fail and a break of the 13.8V DC input line would occur. Simply replace that 6.8 ohms resistor. I would recommend to use a real 1/8W resistor which should be more rough and which can handle higher temperatures under strong consumption. **Never easily bridge that resistor !!** I found out that there will be an ON-flash cause of the fast charging of some bigger electrolytes. **These voltage peaks can destroy a FET !!** This low resistant resistor is needed to have a little power-on delay and a smoother charging of those electrolytes.

2.) **Q1031** (FET 2SJ355 SMD)

This P-Channel MOS FET is in the same "Power-ON State" line as the resistor R1595 above. By pressing the ON/OFF button this FET let the +13.8V through and it feeds two fixed voltage regulators, which "started" the CPU and the rest of the transceiver electronics. Maybe it was a fault from me cause of my bridging of R1595 (see 1.) above). Or my Q1031 would have failed anyway. I don't know but I presumed it were the power-on voltage peaks which destroy this FET. I got a replacement via YAESU UK and the TRX works again. Of course I'm using R1595 now again, hihi...

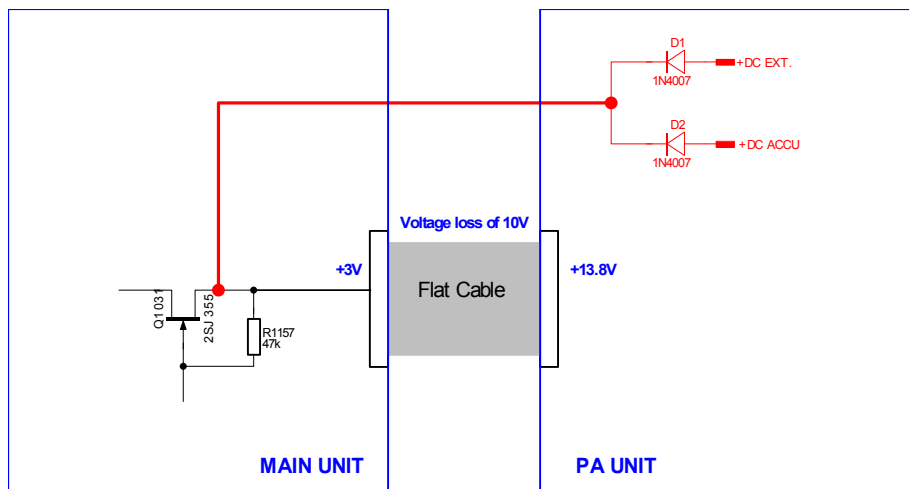
3.) **13VUS line fault**

I had this error too and my FT-897 immediately stopped to power on. After a long time of excessive testing and disassembling I found out that I had a voltage drop of about 10V (!!) on the needed power-on status line. I had the full 13.8V on the PA UNIT, but going on the other side of the flat cable and measuring on the MAIN UNIT I only had 3V (!!). I had an equal fault on the same flat cable on my FT-817 so I expected a bad flat cable, maybe damaged by several turnings of the MAIN UNIT to test my mods. I ordered a new flat cable from YAESU UK and as it arrived – ...no difference !

Finally I found out that there must be some bad soldering on the flat cable sockets or some of the filigree PCB lines were burned.

So soldered a separate cable which is parallel to the +13VUS line and removes this voltage loss. No problems any more !!

As I didn't want to reassemble the PA UNIT too, I decided to use 2 additional diodes to get the DC voltage from the (1) EXT and (2) ACCU connections on the upper side of the PA UNIT.



Modifications overview

TX

1.	C1569 (0.1µF)	2.2µF parallel	More basses Mic Amp
2.	C1555 (1µF)	2.2µF parallel	More basses Mic Amp
3.	R1437 (1k5)	removed	Higher audio output level of SpeechProcessor
4.	R1420 (680k)	adding 2x BAT85 schottky-diodes (anti-parallel) + 150pF parallel	Adding clipping facility to SpeechProcessor. Prevents overdrive and "hollow" audio sound. Adding a smooth 1.5 kHz AF lowpass to reduce clipping distortions.
5.	C1502 (1nF)	560pF	More heights AM/SSB-lowpass filter
6.	C1492 (4.7nF)	22nF parallel	More basses FM-lowpass filter
7.	C1444 (10nF)	removed	More heights FM-lowpass filter
8.	C1051 (1 or 2.2µF)	10µF parallel	Better ALC detection. Longer time delay prevents the "BAD SWR audio fault". For this you don't have to change the "REV ALC"-parameters in the servicemenu.
9.	Exciter 2SK2975 (Q1001/1002)	Adding 10V fix voltage regulator in collector line	Prevents sensitive 2SK2975 FET's (the same as the PA in the FT-817) from overheating and damaging. You get out full RF output by only 10V maximum. They can be damaged by peaks when connected to the DC power supply of more than 12V.
10.	TX Wideband MARS / CAP	Solder only Jumpers J1007, J1008, J1009 and J1006	Get full TX range of 1.8 – 56 MHz 137 – 164 MHz 420 – 470 MHz
11.	BIAS of PreDrivers, Drivers and PA FETs	check and re-align	Get better modulation on SSB. Some BIAS currents from factory are too low (distortions), others too high (overheat).

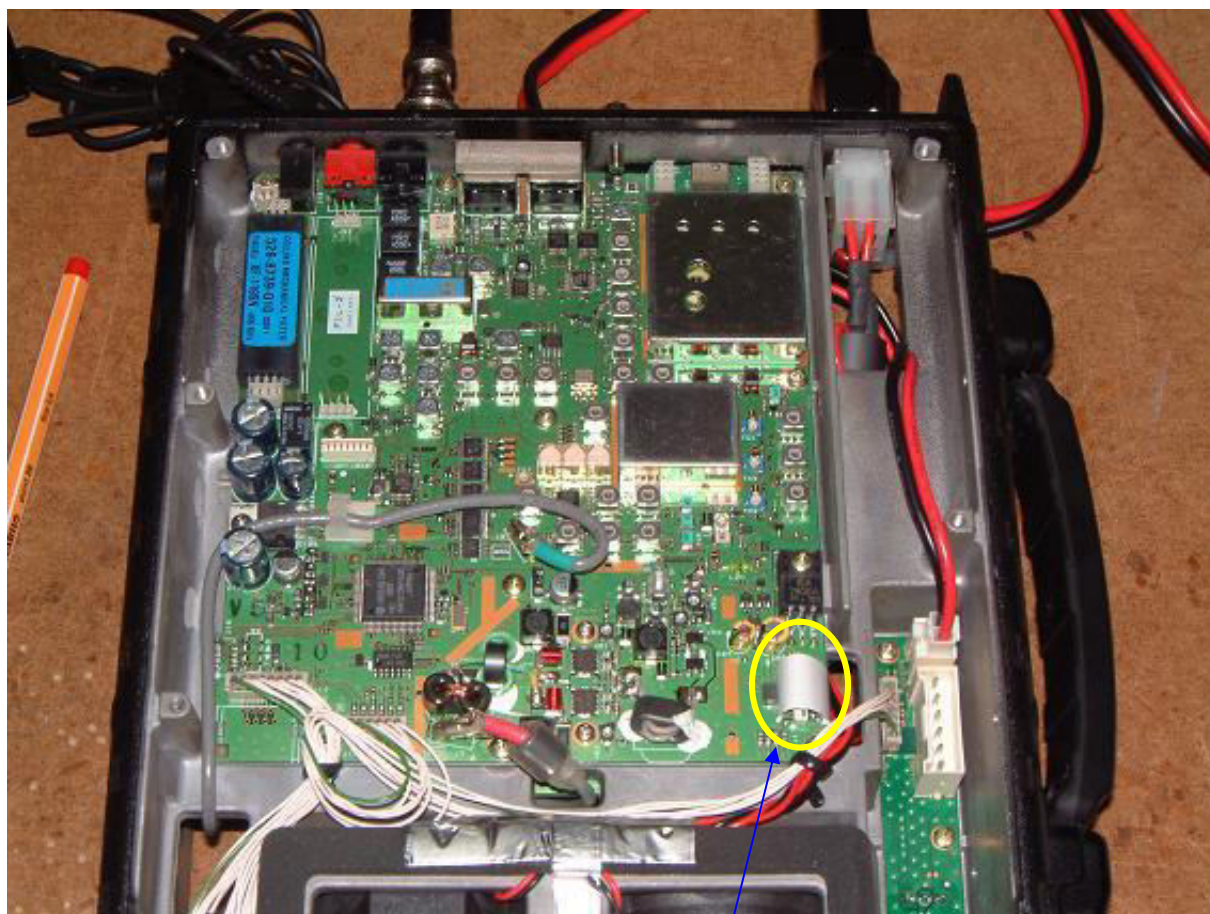
RX

12.	C1503 (1 μ F)	10 μ F parallel	Raise delay time constant of "AGC SLOW" for much better SSB audio on strong stations
13.	C1383 (1.5nF)	1nF	More heights on AF audio lowpass
14.	R1421 (82k or 100k)	470k parallel	Eliminating audio overload of audio IC and eliminate CW crackling noise too YAESU TroubleShooting Note TSN-0405 / 02. June 2004
15.	C1519 (0.1 μ F)	2.2 μ F parallel	HIFI Basses Audio Amp
16.	C1540 (1 μ F)	10 μ F parallel	HIFI Basses Audio Amp
17.	C1542 (47 μ F)	470 μ F / 16V	HIFI Basses Audio Amp
18.	C1550 (470 μ F)	1000 μ F / 16V	HIFI Basses Audio Amp
19.	R1577 (3.9)	bridged	Higher audio level on internal 8 ohms speaker

Miscellaneous

20.	MH-31	Removed 680 ohms resistor Replaced 0.33 μ F by 0.1 μ F	Higher AF output level. Get back HIGH/LOW tones switch without the 680 ohms resistor.
21.	MH-36 DTMF	Replaced 1k8 or 270 by 4k7 Bridged 2k2//0.1 μ (in serial) to electret capsule Removed 0.33 μ F and added a bipolar 47 μ F instead	Much higher AF output level. Adding basses and a natural human voice sound by removing the audio preemphasis. More basses and more natural human voice sound..
22.	Battery modification from Stephen Reynolds (W4CNG)		see http://www.eham.net/articles/4114
23.	MURATA filter 2.4 kHz	Replacing by INRAD 706F and adding a 720F on filter option #1	
24.	13VUS Line Fix	Adding a separate cable to circumvent voltage loss of flat cable	The FT-897 won't power on if there's a voltage drop on the flat cable connections
25.	R1595 (6.8)	Replace	The FT-897 won't power on if R1595 is damaged.

Mods – Summary View

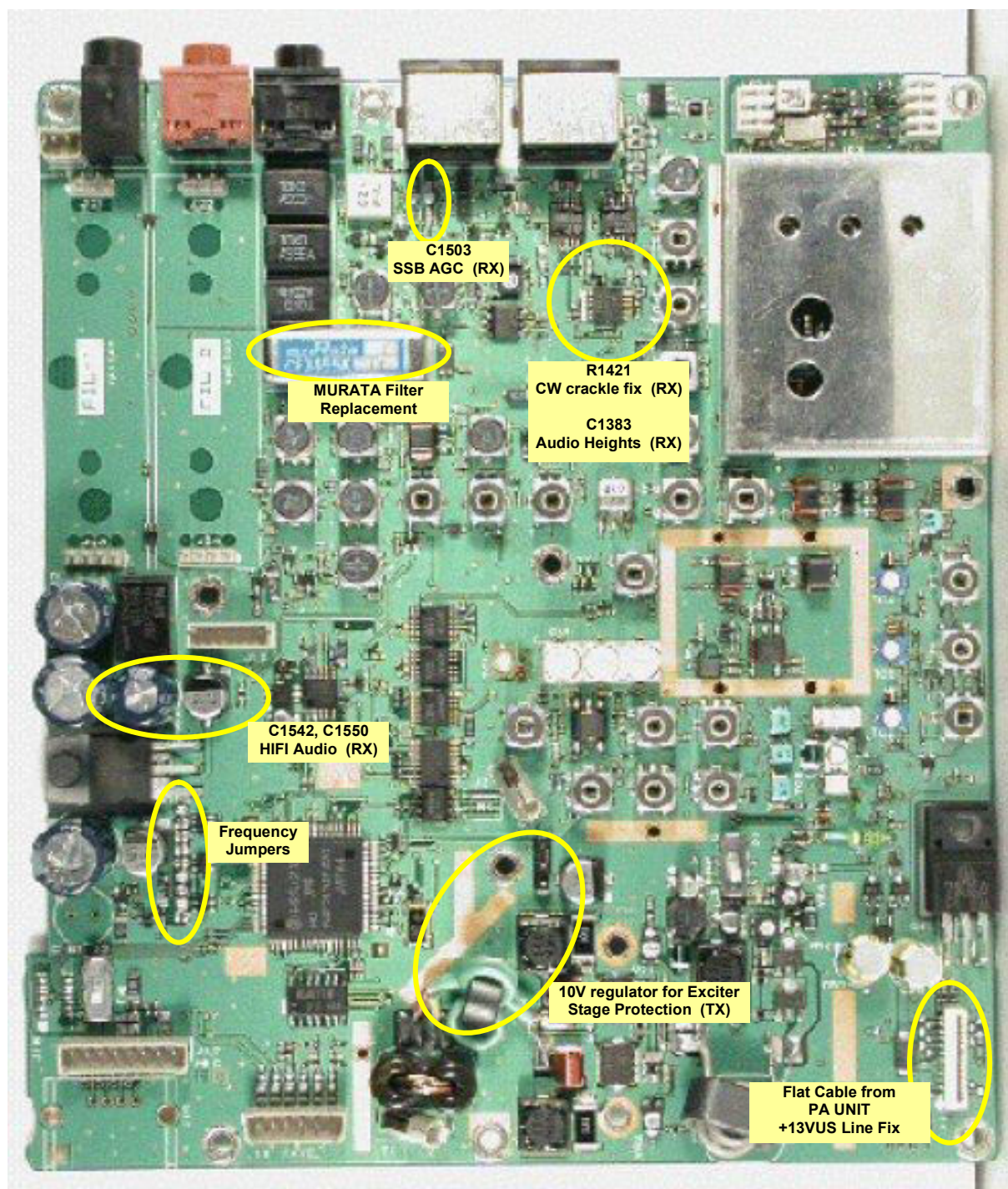


For my mods you only have to disassemble and remove the MAIN UNIT. All other PCB can be left at their place.

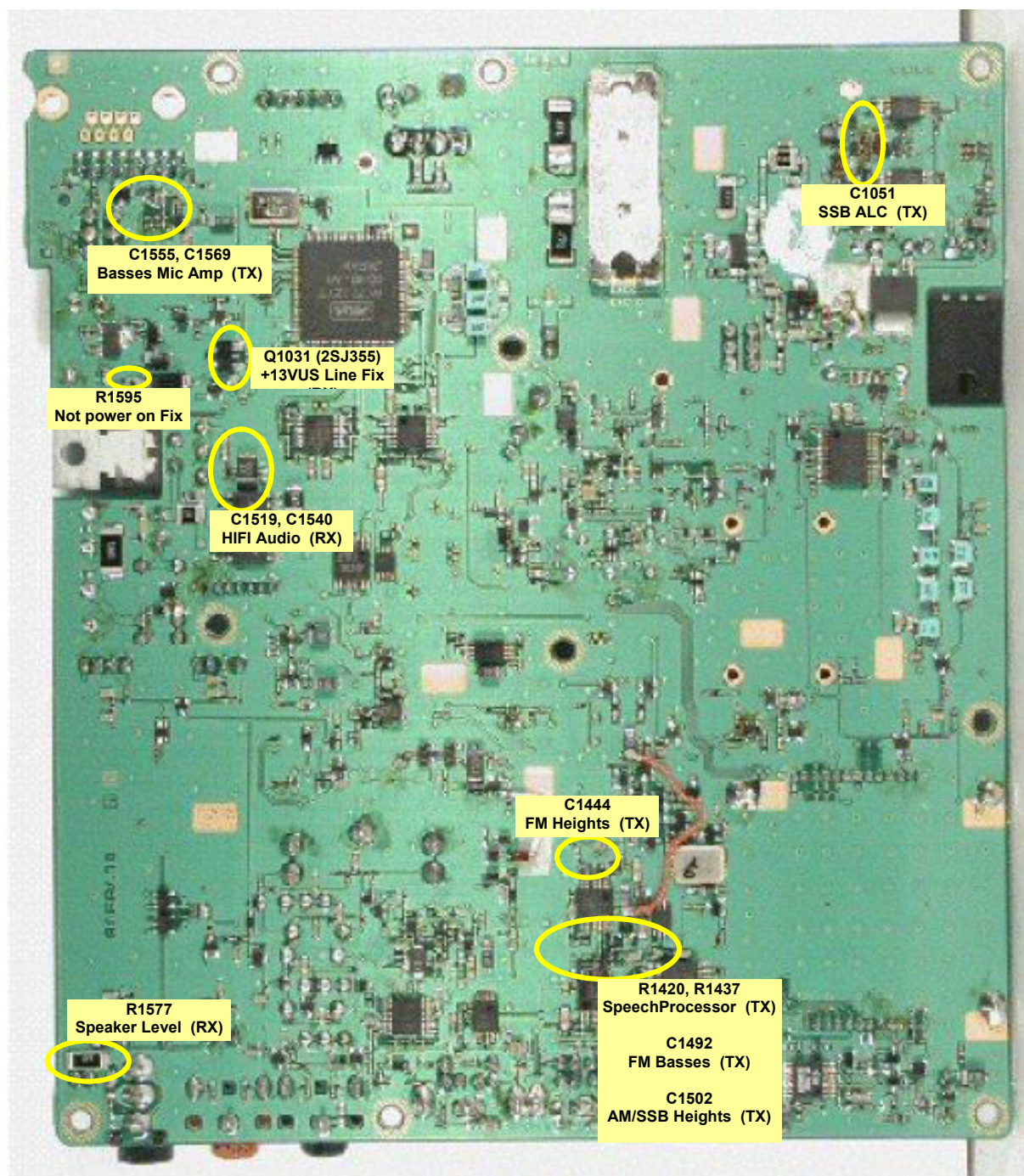
Remove all screws from the MAIN UNIT PCB. All cables can be connected and don't have to be removed too.

For the down side of the PCB you can remove the PCB from case and turn it toward to you. **Please take care not to damage the flat cable on the right side !**

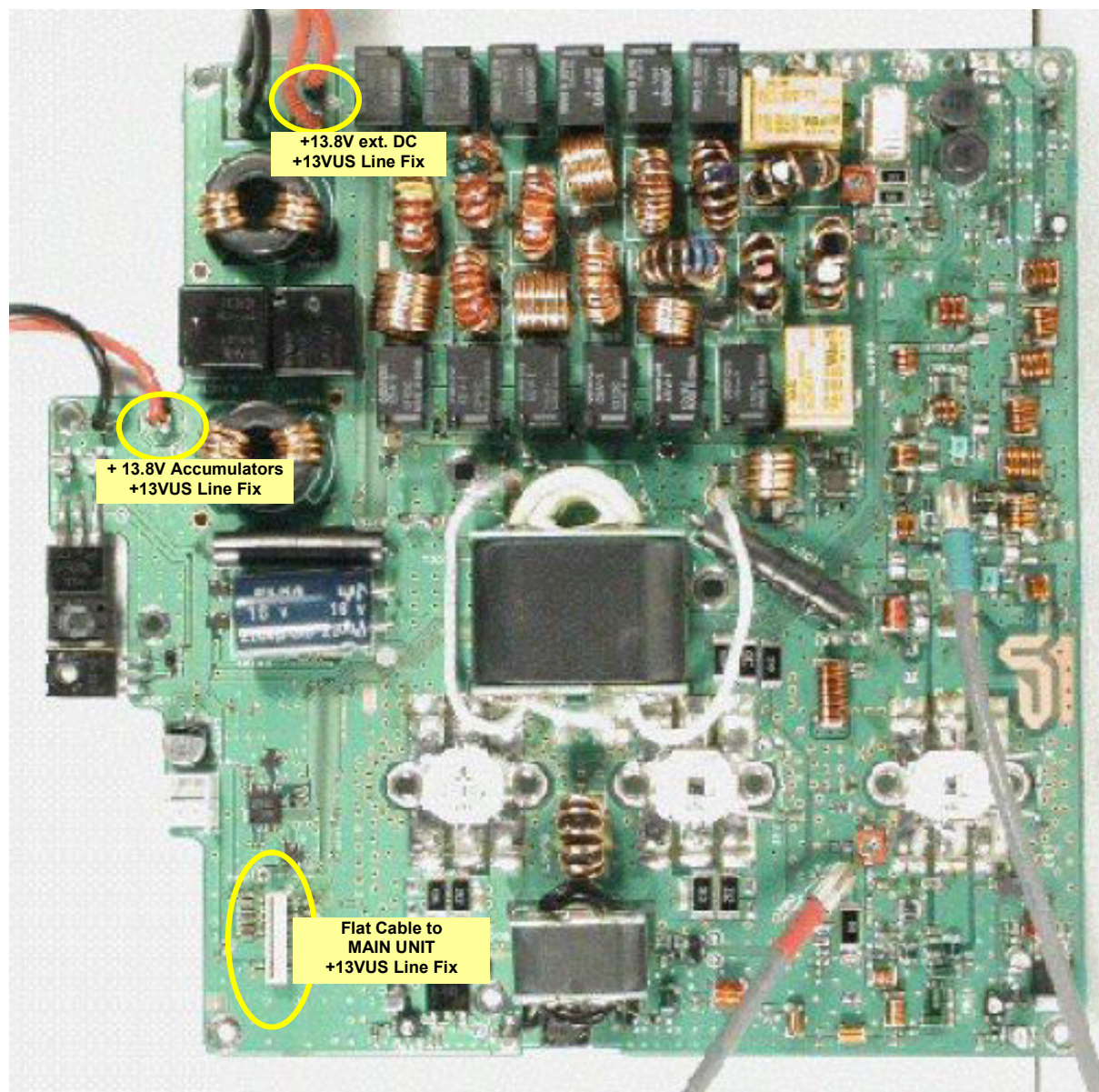
MAIN UNIT – Upper Side



MAIN UNIT – Lower Side

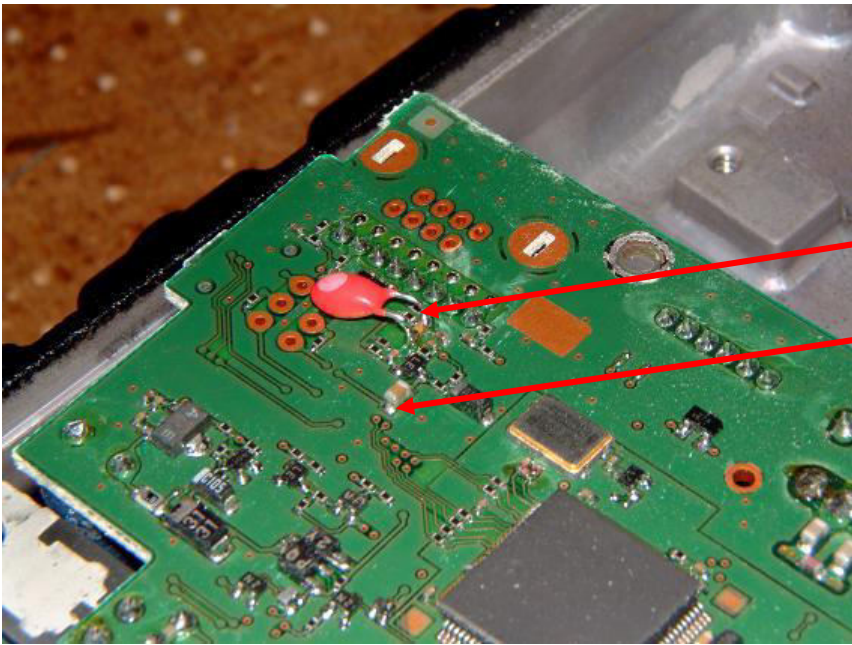
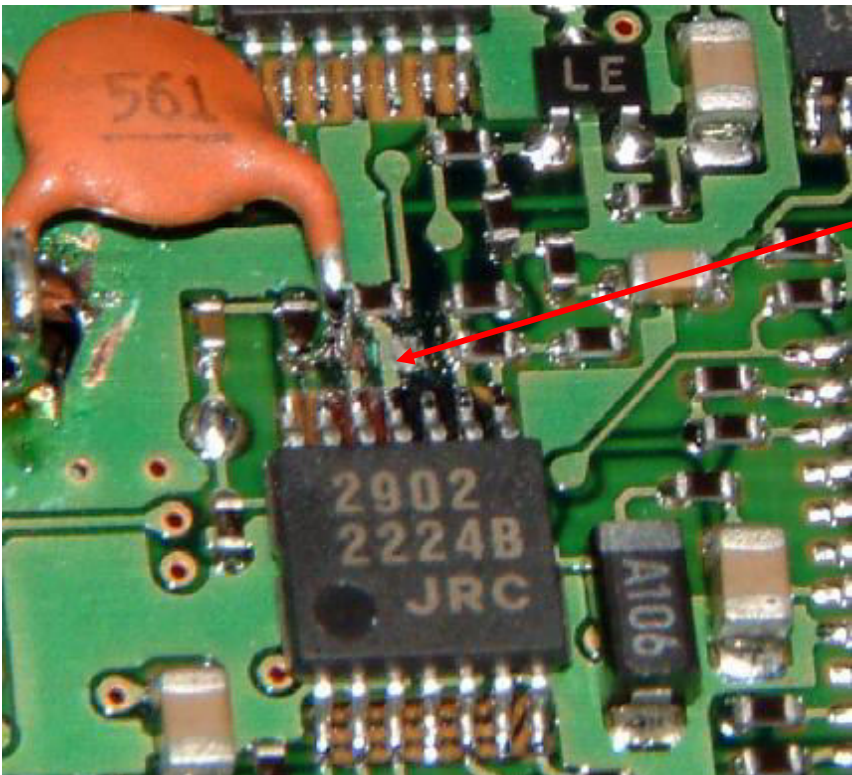


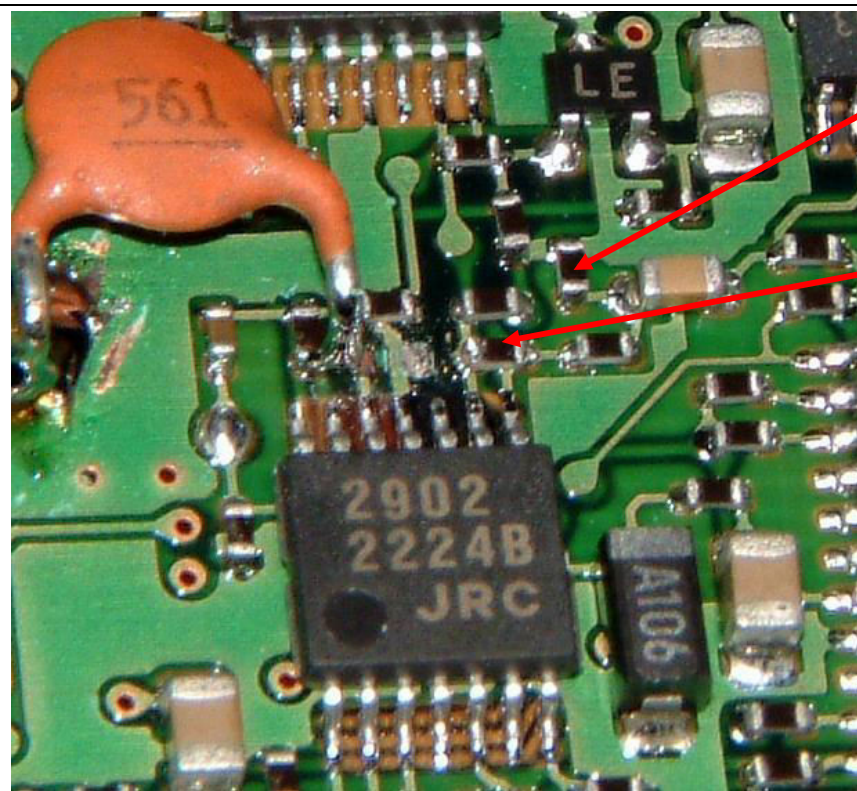
PA UNIT – Upper Side



Mods – Detail View

Some picture were taken during the mods test period – so it can happen that you don't see the final soldering on all of these pictures. But it suffers to show you the correct area on the PCBs.

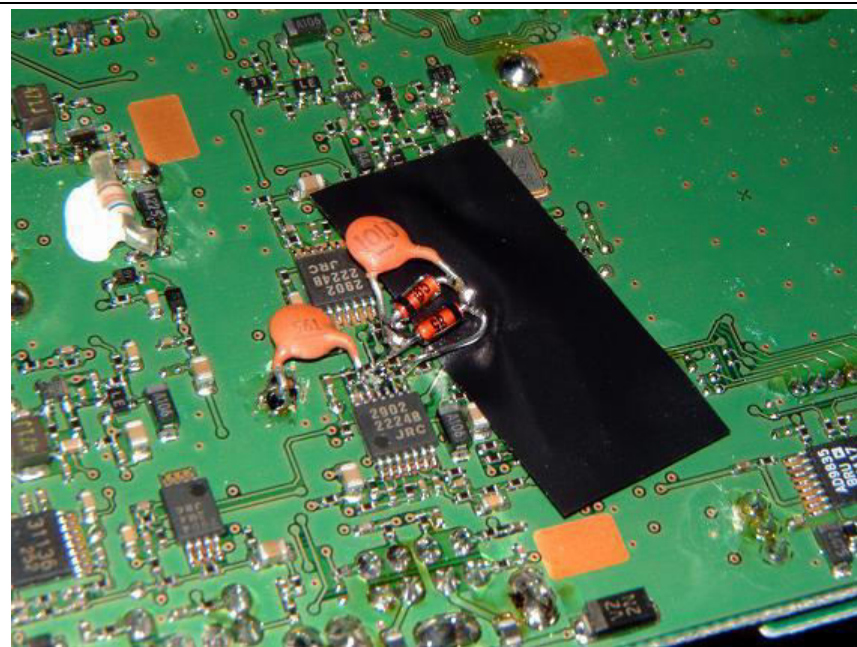
	<p>C1569 (Basses Mic Amp TX)</p> <p>C1555 (Basses Mic Amp TX)</p> <p>Pluspoles of the tanta- lums each toward the middle SMD transistor.</p>
	<p>C1502 (AM/SSB Heights TX)</p> <p>The original SMD capaci- tor was removed here and I'm using the ceramic capacitor above instead.</p>



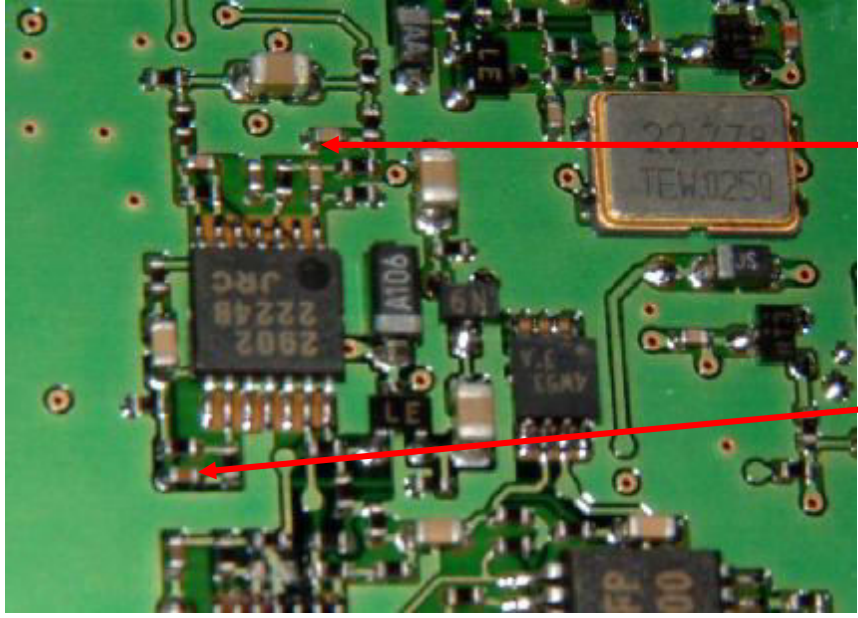
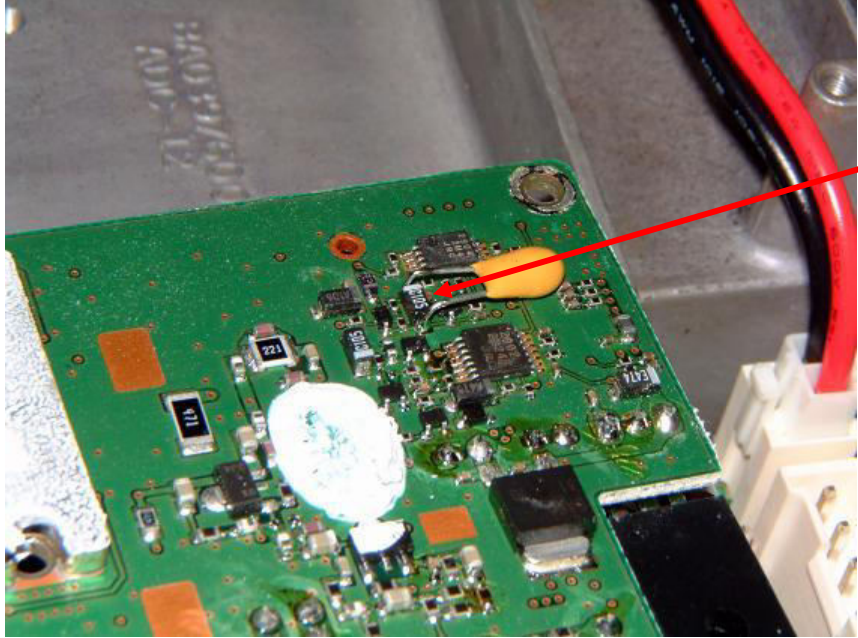
Remove R1437
(SpeechProcessor TX)

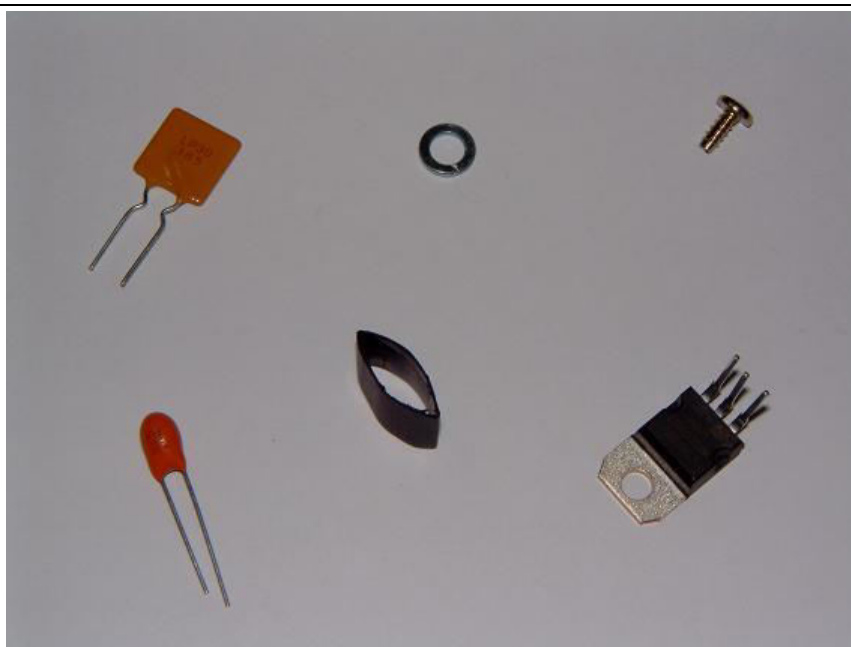
R1420
(SpeechProcessor TX)

The Clipper diodes and
the lowpass capacitor are
soldered on the connec-
tions of R1420

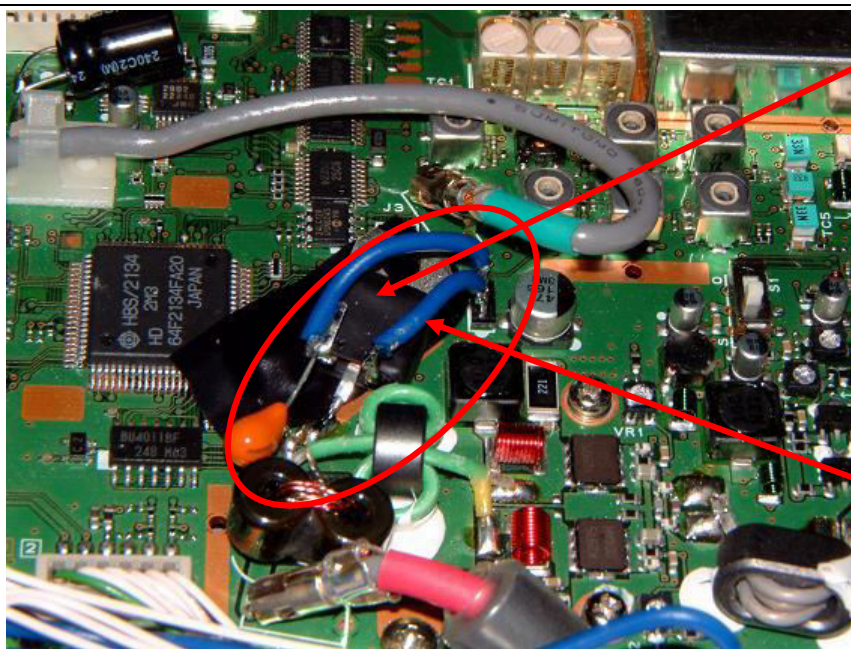


So the final SpeechProc-
essor looks like this. The
100pF were replaced by
150pF after taking that
picture.

	<p>C1444 (FM Heights TX)</p> <p>C1492 (FM Basses TX)</p>
	<p>C1051 (SSB ALC TX)</p>



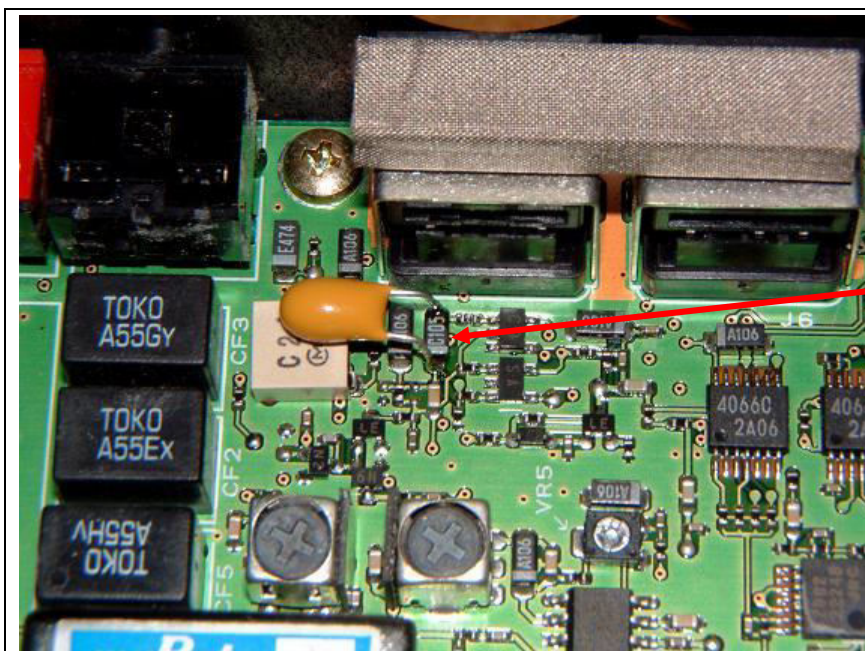
Needed parts for 10V
Exciter Stage Protection.



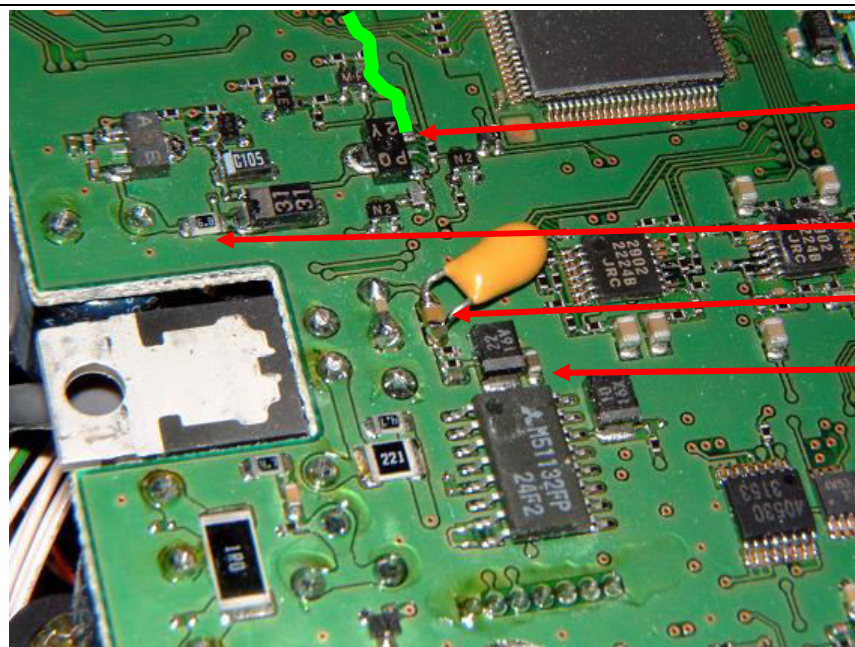
10V fixed regulator for
Exciter Stage Protection

You can solder that in a "flying way". I soldered the middle PIN (ground) to the PCB ground which gives enough mechanical stability. By removing the BIAS jumper you have the needed both connections for +13.8V DC and the power supply line toward the Exciter Stage.

The 1.85A self-resetting fuse was placed instead of this cable later.



C1503
(AGC time constant RX)

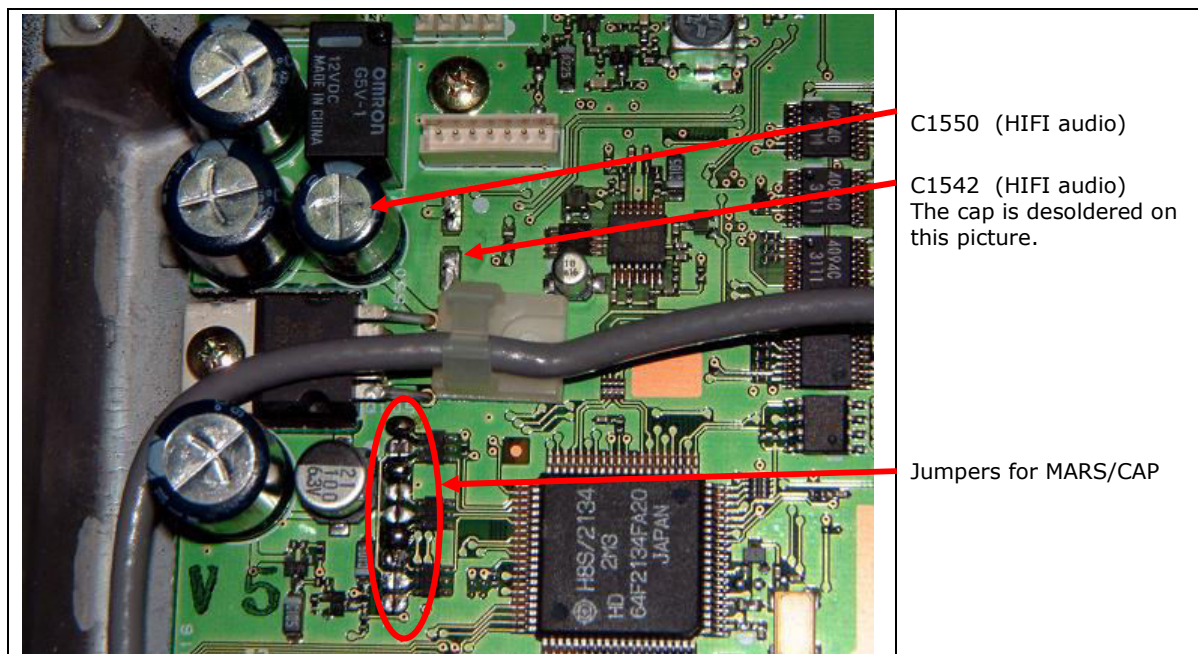


Q1031
Upper pin for 13VUS
bridging cable (shown
green)

R1595 (power on fault)

C1540 (HIFI audio RX)

C1519 (HIFI audio RX)



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This modifications mostly need to be done by a electronic specialist who had enough practise and who has knowledge in SMD soldering. **You do the modifications on your own risk !**

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