

Directory

Introduction.....	2
Modifications overview	3
TX	3
RX	4
ADSP2.....	5
Others.....	6
Details.....	10
Calibration Procedure.....	18
Maximum power diagram	21
Disclaimer • Disclaimer of liability.....	22
Copyright.....	22

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.

Important item on SGC models

As I bought a used and damaged SGC SG-2020 on eBay I had to send it to SGC USA to replace the damaged CPU, to upgrade to the newest release and I wanted to have the ADSP2 upgrade too. As the technicians of SGC saw my modifications they told me that they have the rule only to do repairs, upgrade or alignments on non-modificated rigs otherwise the factory specs wouldn't be accurate. Therefore they first had to remove my mods and set the rig back to original. This service costs about 80 US\$ extra.

So if you have to send your SGC model back to the factory, if you want to upgrade to a new CPU or something like that, you never should do the following mods or you have to pay extra amount and have to do the mods again when the rig is returning from factory.

Please ever think about that item !!!

Otherwise as I got my SGC SG-2020 back from factory, now with the CPU revision 1.12 and the ADSP2 module I unfortunately had to recognize too what other people told in the net several times.

The audio was awfully, the ADSP2 useless cause you only heard the heights, no basses. Only a scratchy receiving sound and the rig was about 200 Hz besides the frequency. As I recognized later they didn't check the PA bias level, cause it was down from the pre-owner. With that nearly-zero bias I had a scratchy SSB modulation too.

Now you know the matter, why I wrote this modification sheet....

I must remark that I really don't want to dis the SGC techs. They gave good tips on the yahoo groups, always monitor them, but sometimes we end-users are on our own. As I read several statements of other SG-2020-owner there should be a better final control for future to prevent those drawbacks.

Modifications overview

TX

Mic socket	PIN5 → +8 volts	Using a line from the left pin of Q2 (78L08, max. 100mA) to the unused PIN5 of the mic socket provides a voltage supply for a optional electret capsule in a handmike
C41 (100nF)	→ 470nF parallel	Adding more basses
R25 (100k)	→ 220k	HEIL HC-4/HC-5: Higher amplification of microphone amplifier (v=10 up to v=22 → R25/R27)
R28 (2.7k)	→ 5.6k	HEIL HC-4/HC-5: Better matching of input impedance.
C43 (220pF)	→ 100pF	By raising up R25 its necessary to reduce C43, otherwise you get a AF lowpass filter of 2.2kHz with the original C43 = 220pF. A muddy modulation sound would occur. A value of 100pF would raise up the AF lowcut to 4.8kHz again. Originally there's no significant AF low-pass, cause the original R25/C43 would have a cutoff frequency of 7.2kHz and the IF SSB filter wouldn't let this wide frequencies through, so the modified 4.8 kHz would be a good choice.
D5 (1N914)	→ BAT85	Higher RF average output
R146 (300)	→ 330 parallel	Better AF throughput, higher RF clipping.
C5 (10µF)	→ 47µF	Adding more basses + a little higher HF output
D14	→ BAT85	Higher RF average output
D12	→ BAT85	Higher RF average output
D13	→ serial of 2x 1N5711	Less RF Clipping (D13 is the RF SpeechClipping diode ! It works together with C74 to ground and limits the IF signal peaks). With that mod only the real peaks are clipped and the audio strength isn't attenuated as much as original. You're near double as loud and the sound has less distortions.
D19	→ BAT85	Higher RF average output
C42 (1nF)	→ 0,47µF	Higher average reading on FWD (LED display shows more than only flicker a few dots).
C43 (1nF)	→ 0,47µF	Higher average reading on REV (to have the same time constant for the "bad SWR" detection)

With these mods you get a more full audio range of your signal and it don't sound tiny or only sharp again. Even a HEIL HC-4 sounds better and more well-balanced without losing the DX punch. By improving the IF clipper you get a real wide input level range without getting significant distortions. Real great to improve the VOGAD additionally ! On the 20 watts level my average output usually was only about 5 – 10 watts on maximum, depending on the used mic capsule. With this mods the sound is much richer and the clipping level is much higher. Now I'm working mostly on an average output of 15 watts at least.

RX

D15	→ BAT85	Lower noise floor + higher amplification for weak signals
D20	→ 1N5711	Lower noise floor
D10/D11	→ 4 x 1N5711 → or remove	Replace both diodes by better and much less noise floor schottkys 1N5711 or HP5082-2800 (any lownoise diodes with 0,7 V forward voltage should work). Don't use the BAT85, they only have 0,3 volts ! <i>For one 1N914 use two 1N5711 in serial !!! This prevents the permanent clipping of the IF stage and result in a clean sound. Then you have to re-align T4 again to maximum audio level.</i> <u>Other users have done this:</u> Like reported in some forums this removes the IF and audio clipping effects on RX. Less distortions on strong signals. You have to re-align T4 for maximum receive level. As I did this I recognized short strong distortions on signals higher than S7 until the AGC reacts ! So I replaced both D10/D11 with a serial of 2 x 1N5711 schottkys for each 1N914 and the effect had gone. Strong receive without loosing sensitivity and prevention of distortions on strong and loud signals. Perfect for me.
C45 (220pF)	→ 1 nF	AF lowpass 15.000 Hz → 3.300 Hz to reduce hiss
C46 (220pF)	→ 1nF	AF lowpass 15.000 Hz → 3.300 Hz to reduce hiss
C17 (0.1uF)	→ 2.2uF	Adding more basses If the ADSP2 module is build in, C17 is removed from factory and the ADSP2 module is fit in instead.
C11 (1µF)	→ 4.7µF parallel	Adding more basses
C12 (10µF)	→ 47µF parallel	Adding more basses
C13 (1µF)	→ 4.7µF parallel	Adding more basses
C14 (0.1uF)	→ 0.01uF	AF lowpass: 160Hz → 1.600Hz !! More clarity and audio level.
C20 (10µF)	→ 47µF parallel	Slowing down the AGC to reduce audio pumping effects on strong signals. This don't change the behaviour on weak signals. This mod is to try out by holding the new capacitor parallel to C20. Some users like the original time constant of the AGC more. Of course on CW the sensitivity is coming up much faster with the original (fast) AGC time constant. The choice is on your side.
C28 (33µF)	→ 220µF	less DC ripple on AF amplifier TDA2003
C35/C36	→ 22µF parallel (from Pin 2 U2A to Pin4 U2C)	Adding more basses on AF bandpass 1.3 – 2.7 kHz (HP1)
C39 (1uF)	→ 10uF	Adding more basses
C31 (10uF)	→ 470uF/25V	Adding more basses and audio output level
C70 (10nF)	→ 470nF parallel	Better sensitivity for the weak signals, much better audio detection of those weak stations.
C69 (100nF)	→ 330nF parallel	To have an nearly symmetrical design I increased the capacitor to ground too (equal to C70). But this is not necessary and I didn't recognize any improvement.

As I got my upgraded SG-2020 (now with ADSP2) I found the audio sound useless in the majority of cases. The sound was real tiny and sharp, no basses and even the stronger stations were real hard to copy by ears in comparison with all my other rigs I owned yet. With my mods the sound gets much richer, the heights are reduced down to the upper level of the human speech on about 3.500 Hz. By slowing down the AGC time delay the pumping effect has gone totally without getting a too high delay. You don't miss weak signals between strong signals. If you mainly use the SG-2020 on digital modes you maybe shouldn't do the C20-AGC-Mod to have the fastest response.

ADSP2

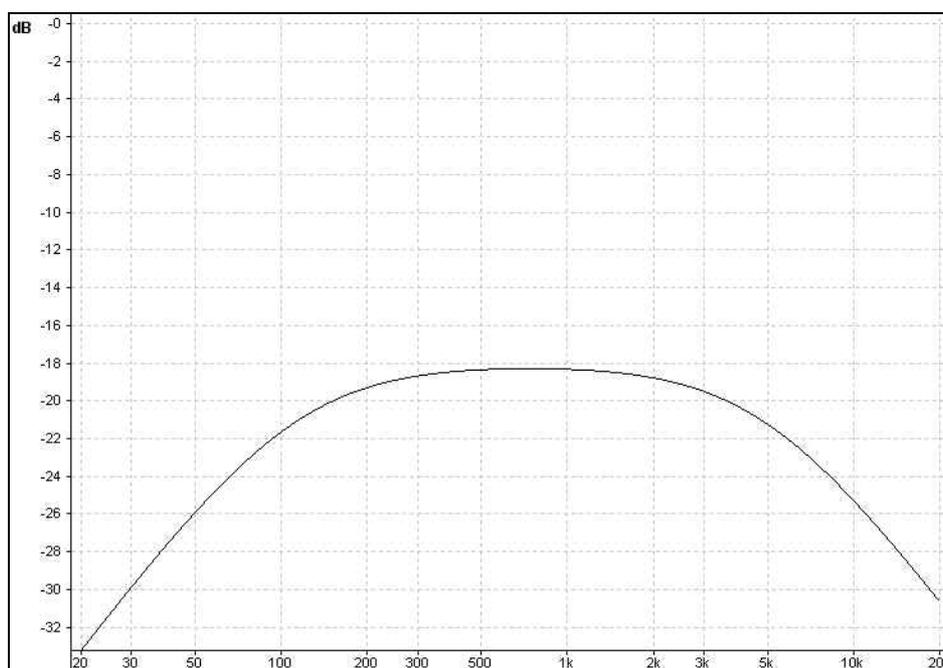
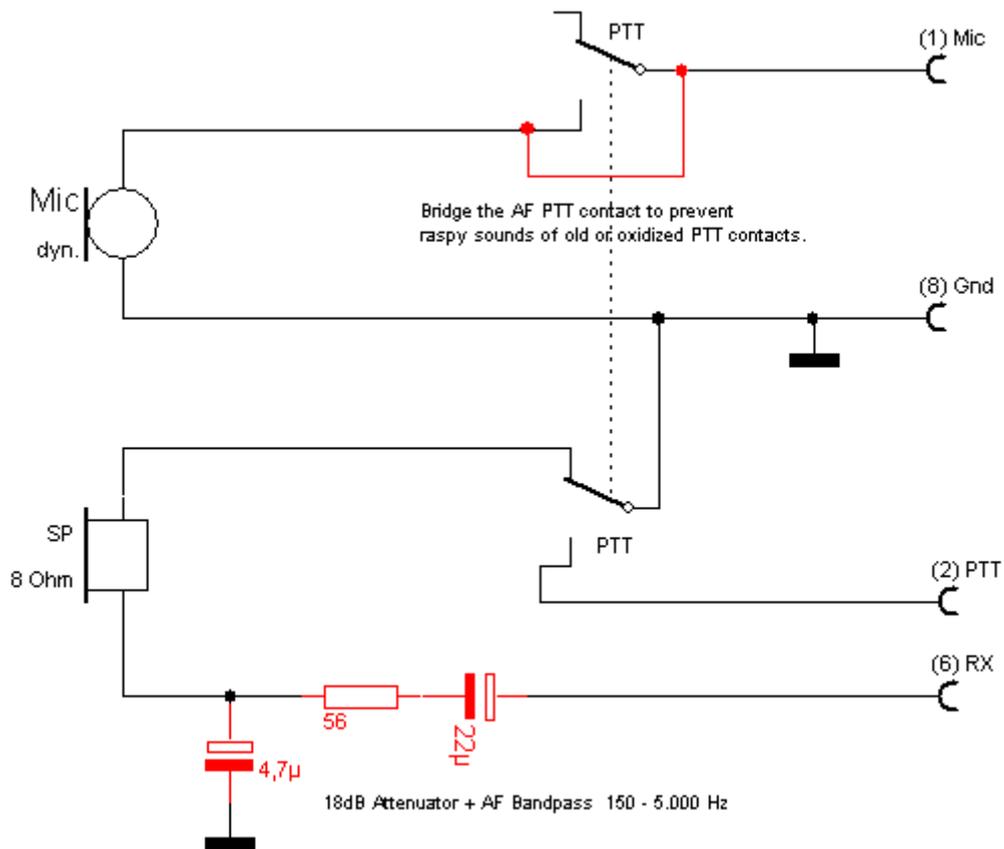
C26 (0.1 μ F)	→ 2.2 μ F	Adding more basses
C36 (0.1 μ F)	→ 2.2 μ F	Adding more basses
Input resistor 100k	Verify value.	Verify that there's a 100k resistor on the INPUT line (green wire) of the ADSP2 module. If the existing resistor has a smaller value audio distortions could be produced by the ADSP2 module cause of a too high audio input signal level. It's the input resistor on the EXCITER PCB which is soldered to the ADSP2 green wire (= Input).

By doing the ADSP2 mods in addition to the RX audio mods above the ADSP2 module gets useful the first time for me. It still sounds a little "robotic" but most of the DSP modules do so. But now the received audio is readable very good even on real weak signals where the original ADSP2 had collapsed.

Others

Black foam in front of stock mike capsule	Replace by a piece of covering of hifi speakers	Gives a more natural sound. No "wanging" modulation any more.
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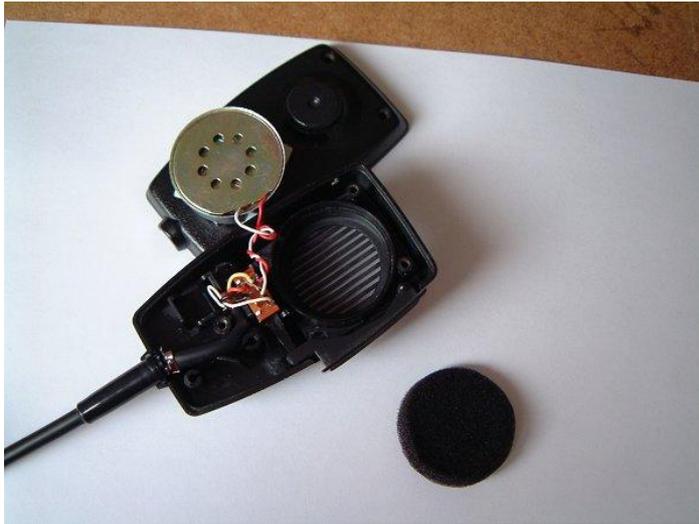
I'm using a CB telephone receiver for outdoor events. To take care of my ears I build in a small 18 dB attenuator, combined with an AF bandpass (150 – 5.000 Hz). Now the telephone receiver has an accurate volume compared to the usual volume set of the SG-2020 internal speaker on outdoor usage.





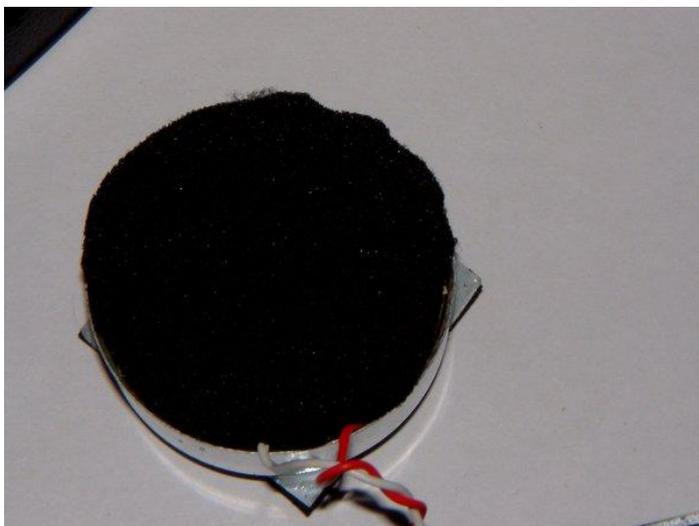
Ready for fieldday or outdoor usage !!!

Stock Mike Mod



I opened the stock mike and removed the thick black foam in front of the capsule.

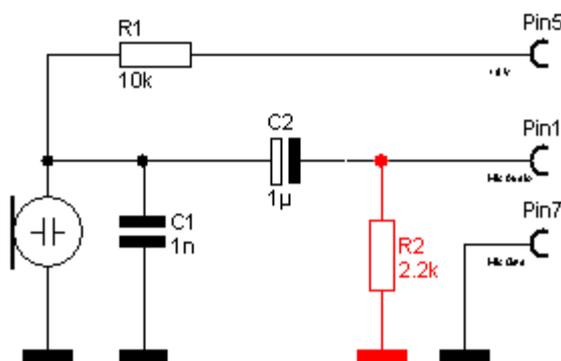
This foam normally should eliminate "pop" effects when talking real close to the front of the mike capsule. But when the foam is too thick the resulting sound through that foam is "twaging". It sounds like talking through the nose.



Without the foam you could produce pop sounds on talking close to the mikes front.

Therefore I had to find an alternative.

I found it by using a piece of cloth which is normally used in HIFI speaker boxes. This cloth lets through all the human speech frequencies without influence them.



Or you can replace the dynamic capsule by a much better electret capsule when you do my "PIN5"-mod too to get the power supply of 8 volts on the mic socket.

R2 is optional and would reduce the mic level a little bit...

- a) to reduce a high background noise, e.g. on fielddays or loud environments
- b) not to stress the VOGAD too much cause the electret capsule has enough punch.

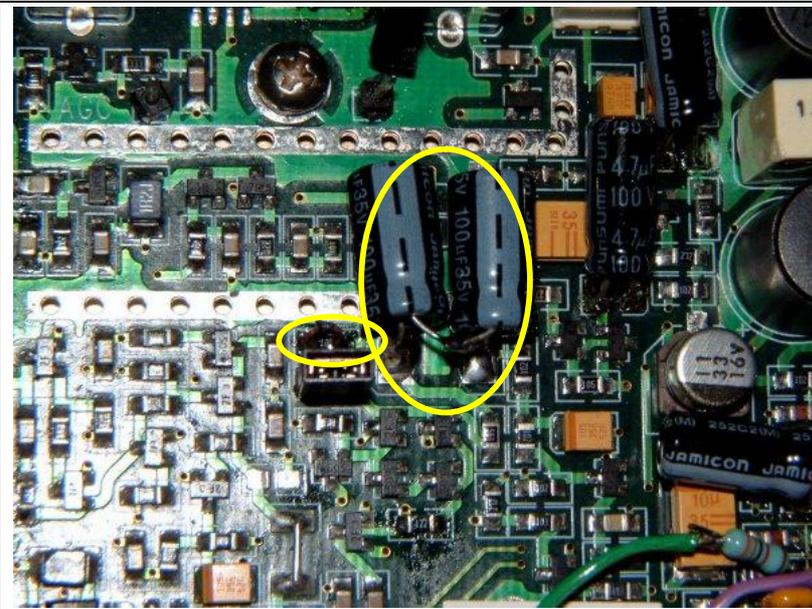
The electret capsule has a HIFI audio range and gives a real full modulation with a much

higher audio level. If you like a DX modulation here too, remove R2 and replace C2 by 22nF – 47nF which gives an AF highpass and which reduces frequencies lower than 500 Hz.

Details

All parts should be located and verified by the SGC user manual which contains the circuit diagrams and PCBs too.

TX mods	
	<p>TX</p> <p>Wire to get +8 volts from output 78L08 to PIN 5 of mike socket. I added 100μH and 100μF to prevent RFI.</p>
	<p>TX</p> <p>R25 C28 C41 C43</p> <p>As you can see I first tried a 4,7μF (yellow tantalum) parallel to C23 too to slow down the VOGAD AGC time delay. This could give some improvements on high level mikes but it's not necessary on my used mikes so I removed that parallel cap.</p> <p>The red one was a 1.5μF parallel to C41 to get more basses on the modulation. Actually I'm using a non-polarised 470nF Sibatitt type which should be enough for most cases.</p>

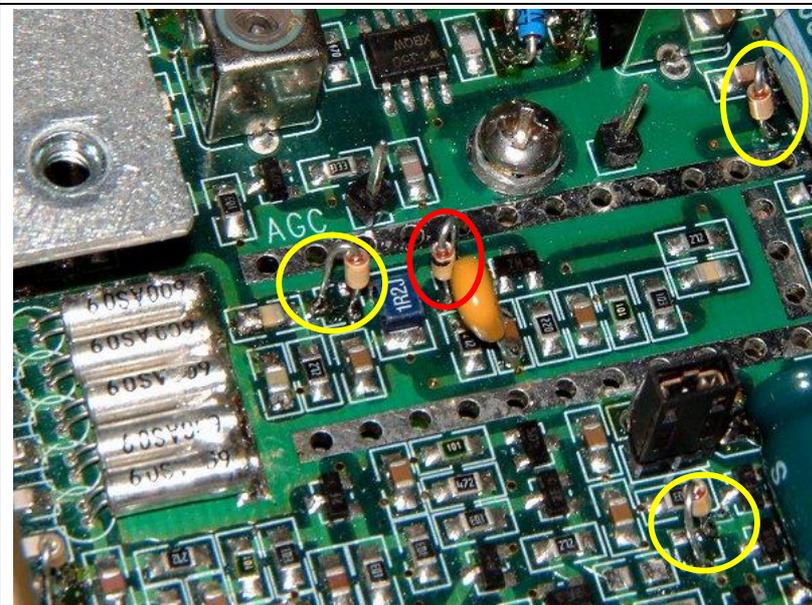


TX

Solder a 330 ohms parallel to **R146**

C5

As you can see on the right side I tried to enlarge C5 by using a serial of two electrolytes of 100µF (to get a non-polarised capacitor of 47µF in summary). Actually I'm using only one 47µF as replacement. Pluspole to left side, minuspole to right side.



TX

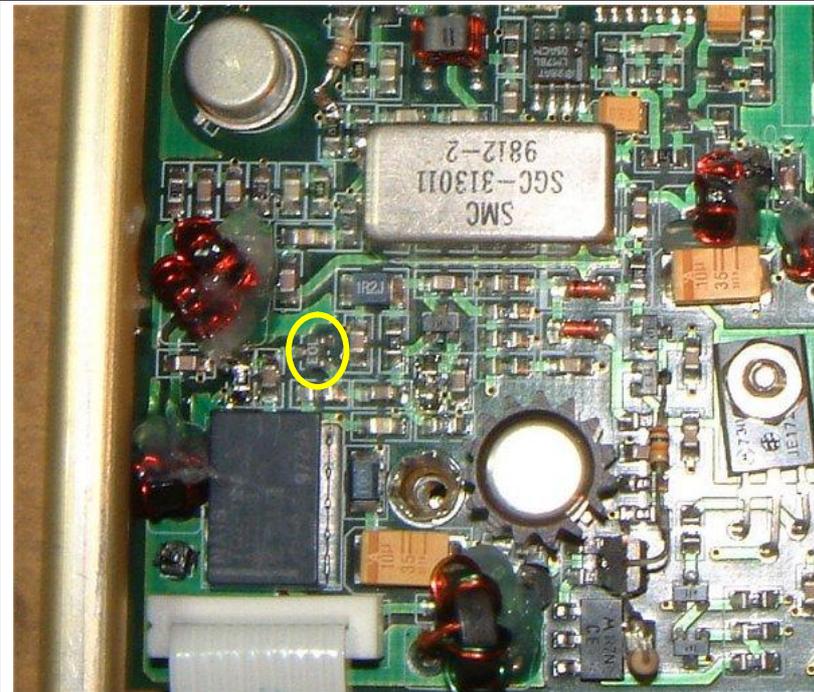
D12

D13

D14

D5

As you can see in the middle I was using **ONE BAT85** replacement diode for D13 (RF clipping TX) first. **But actually I'm using a serial of 2x 1N5711 diodes instead !!!** This gives near double audio volume on your modulator and much less audio distortions. Only the real peaks are clipped now. And I removed the previous tried parallel capacitor over C74 which you can see here too. So let C74 be on its original state.

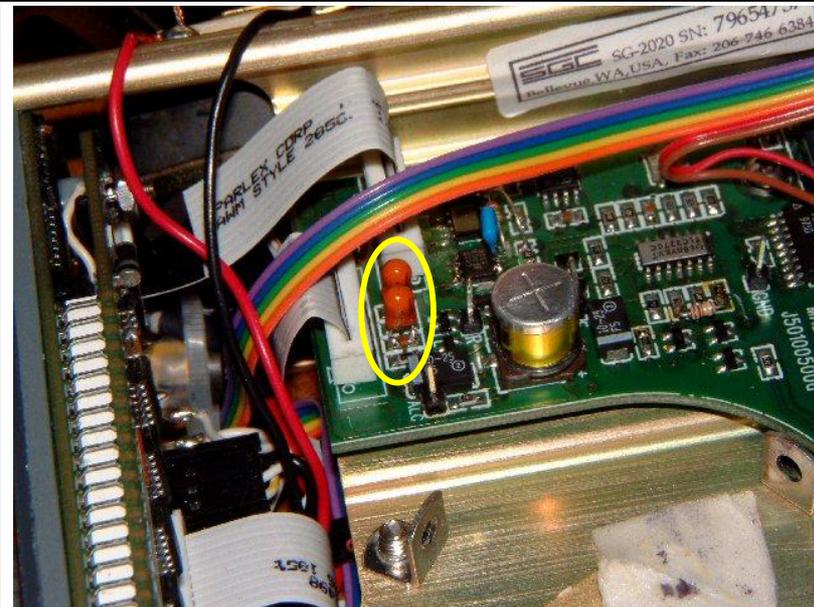


TX

D19

Unfortunately I didn't take a photo of the replaced D19. But here you can see where the original diode is located.

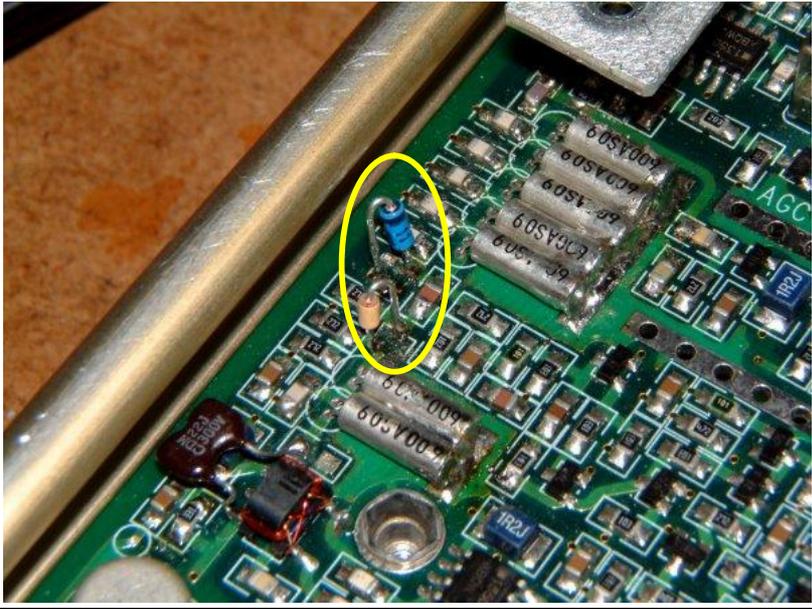
Cathode is left
Anode is lower right.
Upper right is unused.



TX

C42
C43

Adding 0,47µF tantalum parallel to get a better average readout on the LED wattmeter.

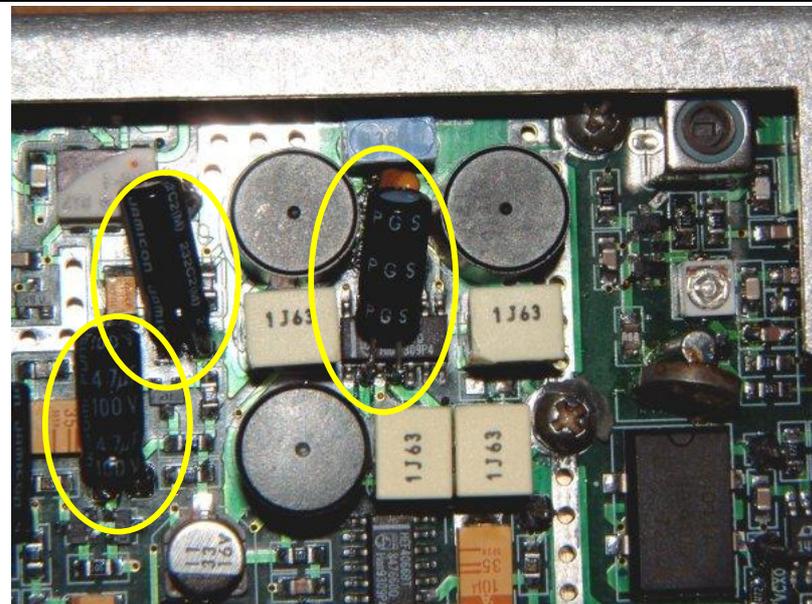
RX mods	
	<p>RX</p> <p>D15 (BAT85, orange one) D20 (1N5711, blue one)</p>
	<p>RX</p> <p>C12 D10 D11</p> <p>Some users told to remove D10 + D11 to stop RX distortions. But then the signal goes non-limiting straight into the SSB detector U12 and this produces distortions until the AGC is starting to react.</p> <p>So actually I replaced both SMD diodes by a serial of each 2 x 1N5711 lownoise schottky diodes. This gives a great audio with less noisefloor on RX and prevents distortions of strong and loud stations by limiting the audio level (like a clipper does).</p> <p>On this picture you see my first trial with only replacing them by 2 x 1N5711 types. Actually I'm using a serial of 2 x 1N5711 for each 1N914 original.</p>
	<p>Don't use BAT85 !!! They only have 0,3 V and would reduce the RX signal, but the distortions too, hihi.</p>



RX

C69
C70

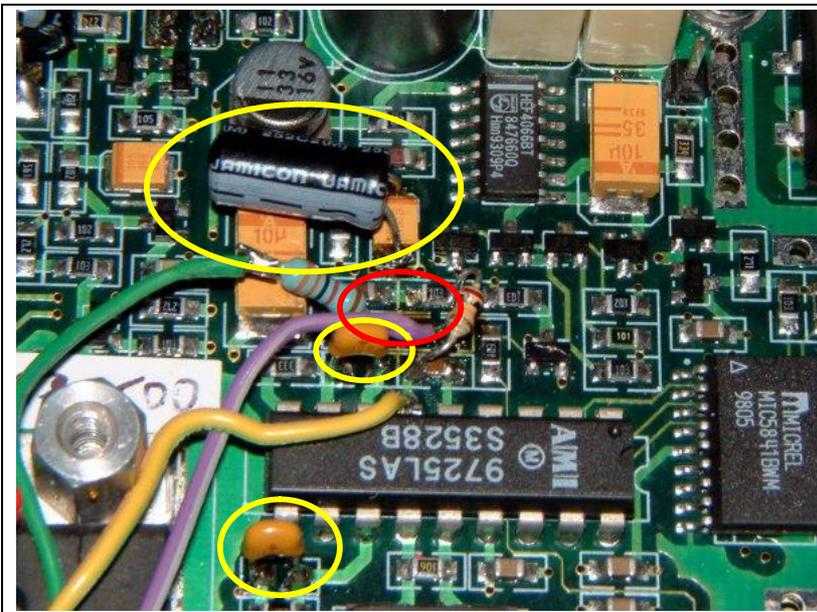
Adding 470nF and 330nF parallel to the original SMD capacitors.



RX

C11
C13

22 μ F bridges C35/C36 (from PIN2 to PIN4 on IC U2)



RX

- C39 (10µF)
- C45 (1nF)
- C46 (1nF)

Input resistor for ADSP2 (green wire)

C17 would be here if not using a ADSP2 module. You should parallel it with 2.2µF to get more basses.

By having an ADSP2 module C17 is removed by factory and the ADSP2 module is soldered in that "hole".

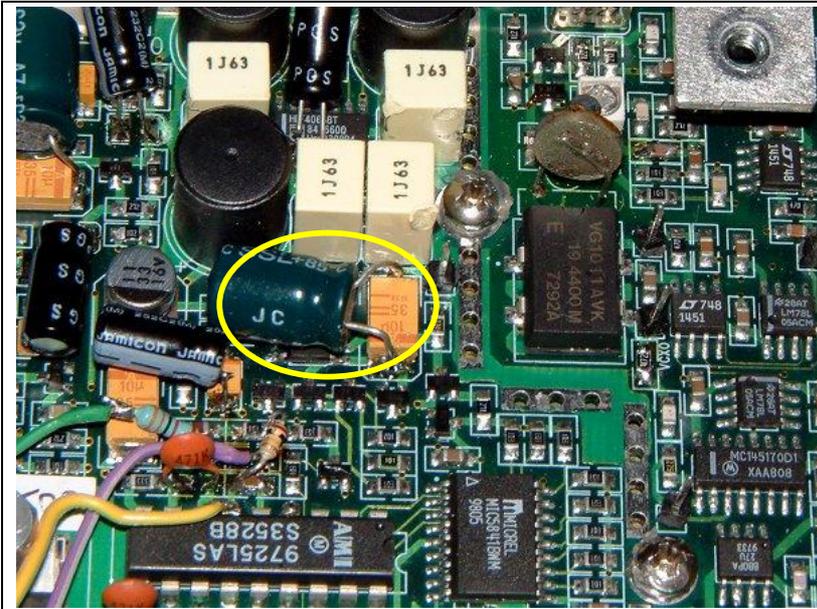
Verify that the resistor in front of the green wire has 100k and not less !



RX

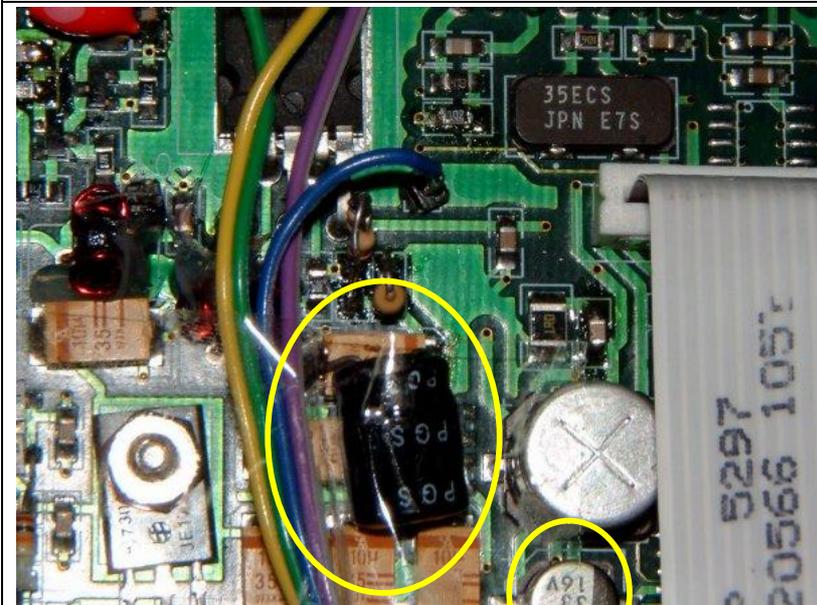
- C14
- C16

Cause of the limited space I removed both capacitors and soldered the replacement ceramic capacitors directly on the three pins of the volume pot.



RX

C20



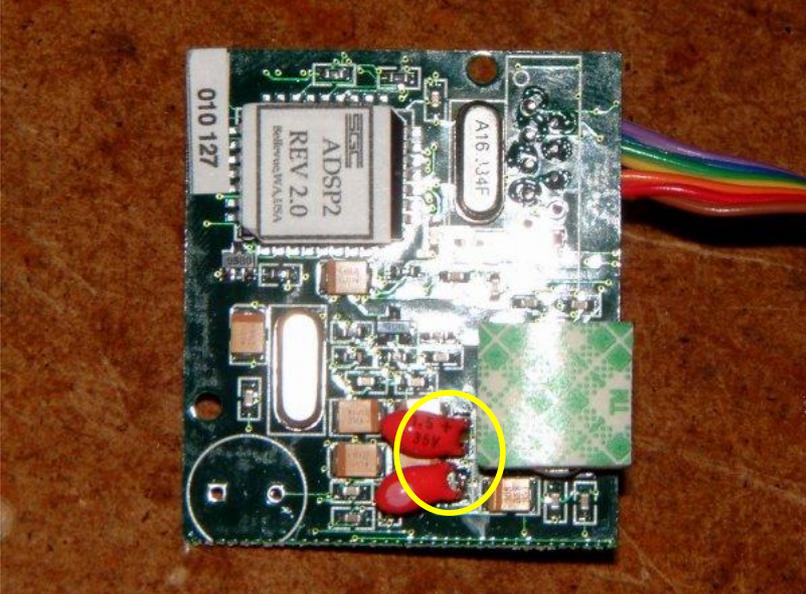
RX

C31 (470µF)

C28 (220µF)

A must-have !!!

On this picture the parallel 220µF for C28 is not soldered in yet, so don't be surprised about that.

ADSP2 mods	
	ADSP2 C26 C36

Calibration Procedure

Some users told that their SG-2020 is misaligned, some even from the factory. Others told their SG-2020 needs to use the PBT to get into the crystal filter passband correctly and to get a readable receiving sound.

As the SGC factory don't like to do the alignment procedure on your own cause of the cover of warranty, my alignment sheet is only for those people who accept that item or for educational purposes only.

You loose your warranty !!!

But this item is OK for me as I can understand the rules of SGC. If I would be a manufacturer I would do that too to prevent warranty problems.

On the other hand shipping from Germany to USA and back is a real, real expensive thing. So my alignment is for that users too who NEVER would send their rig back to SGC/USA cause of the costs of that procedure.

Referring to the document "SG-2020 Transceiver Test/Calibration Procedure" you can download from the SGC homepage (www.sgcworld.com). Also take care of the information of Terry Dettmann, a SGC tech:

The important thing to understand about SG-2020 calibration is that it is dependent on a series of measurements which are reduced through our database into the calibrations used with the rig. The downloadable calibration procedure refers to this test, but doesn't include how to do it for the very good reason that there is only one copy of our database and it cannot be duplicated. A variety of causes can cause a shift in the calibration, any of which requires that we rerun the complete calibration procedure so that the unit is within specification. Attempts to recalibrate in the field may leave your rig worse rather than better off.

*Terry
WX7S*

So have a look on the manual above and referring to **item 5.0 "Radio Calibration"**.

The alignment could not only be done by adjusting the trim capacitor C146 but you have to do the correct alignment of the electronic offset frequencies as well.

With my alignment and my audio mods you get a real useful and well sounding rig. The frequency drift is not as minimal as on some other rigs with a TXCO of course, but if the alignment was done correctly the drift is about only 50 - 100 Hz on maximum. So your partner stations shouldn't need the RIT to copy you but maybe to get your audio to 100% human.

The DG2IAQ calibration

So try this alternate way I did on mine SG-2020. Remember to warm up the rig for **at least 15 minutes**, until the thermistor has heated up, otherwise the 60 MHz xtal wouldn't be on its final working frequency:

1. Alignment like described on items 5.1 – 5.8
2. I connected my frequency counter which has a build-in signal level meter to TP6 (BFO).
3. Instead of item 5.8.2 – 5.8,3 adjust **C146** to get the maximum readout on the signal level meter
4. Adjust **T6** to get the maximum readout on the signal level meter
5. On item 5.8.4 I had those changes to do:

Step	Testpoints	Remark	Factory values	My new values	
1)	TP5	LO USB Reference	0.933 (61.656,304 kHz)	0.921 (61.656,268 kHz)	VCXO reference frequencies like described in the SGC sheet. USB = 61.656,269 kHz LSB = 61.666,294 kHz CW = 61.663,157 kHz
2)		LO LSB Reference	3.808 (61.666,344 kHz)	3.794 (61.666,292 kHz).	
3)		LO CW Reference	2.952 (61.663,184 kHz)	2.944 (61.663,156 kHz)	
5)	TP6	BFO USB RX	3.137 (60.001,396 kHz)	3.254 (60.00 1,500 kHz)	USB → + 1.5 kHz LSB → - 1.5 kHz CW → + 700 Hz Shift from crystal frequency 60.000,000 kHz
6)		BFO LSB RX	0.692 (59.998,156 kHz)	0.810 (59.99 8,500 kHz)	
7)		BFO CW TX (!)	2.449 (60.000,756 kHz)	(60.000, 700 kHz)	
8)	TP5	LO USB TX	6.392 (61.851,624 kHz)	6.379 (61. 851,500 kHz)	USB → + 1.5 kHz LSB → - 1.5 kHz CW → + 700 Hz Shift from test frequency of 1.850 MHz
9)		LO LSB TX	6.058 (61.848,420 kHz)	6.066 (61. 848,500 kHz)	
A)		LO CW RX (!)	6.325 (61.850,972 kHz)	6.302 (61. 850,700 kHz)	

And by doing a back-calculation you can see how much the difference between the factory alignment to my final and correct alignment was.

6. Switch between USB/LSB several times and adjust **C146** for the same audio range sound (= "symmetrical sound")
7. Now you maybe have a frequency offset between the true frequency and your display readout frequency. For example you have to go to readout 14.342,0 to get the proper RX sound but the received station is in fact on 14.340,0 kHz.

Turn to a station with a known and accurate frequency (maybe check with a second receiver). As the example above you're now on readout 14.342,0 for a station which is true on 14.340,0.

Press **CMD + XCVE** (3 LED's are going on). Now you're in "Calibrate Frequency Display" mode as described in handbook p. 23 (chapter 9.8)

Change **VFO** to the correct frequency readout. (= 14.340,0)

Press **MEM** to store that offset.

8. Go on with items 5.9 of the SGC sheet.

Now the TX and RX frequency should be accurate for USB/LSB and CW with no drift between TX and RX.

As I noted from another SG-2020 rig and its alignment there could be a strong production stray of the accuracy of the 60 MHz IF crystal filters.

This makes it impossible to show a "plug-and-play" solution here. So the alignment above is a good choice to keep a misaligned rig back into a range where it works, even if it's not already on frequency after that as you don't have any informations about Y O U R individual stray shift.

So the final test is done by a second and accurate reference TRX. Check the frequency accuracy on some QSO's on-air.

- If maybe your USB TX is 100 Hz to low in your reference TRX receiver you have to re-align the frequency on **8)** for that 100 Hz higher too. Step through the other test points with only MEM and without doing any changes on the digital values.
- If maybe you LSB RX is 100 Hz to low on a test listening from the transmitter of your reference TRX you have to re-align the frequency of **6)** for that 100 Hz down too. Step through the other test points with only MEM and without doing any changes on the digital values.

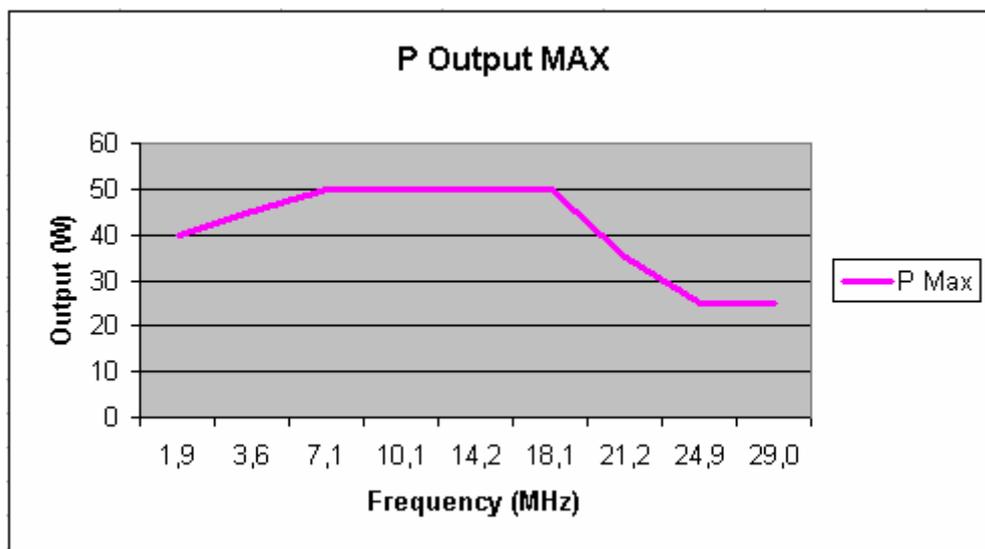
After doing those individual shifts you have to verify that again and check if you had done the frequency step into the right or wrong direction.

I still have re-aligned two SG-2020 here in Germany and now thy're nearly about 10 Hz away from the frequency on maximum on USB, LSB and CW. A real great result as before they were more than 250 Hz away and had an additional shift between TX and RX !

Maximum power diagram

Changing output to "P M" (P max) via CMD + NB.

As you can see in the diagram below I could get about 50 watts out of my SG-2020 between 7 Mhz and 18 Mhz. On the highest frequency it would be about 25 watts.



The PA transistors 2SC1969 are rated on 18 watts each.

So on these maximum regions above they can't work linear as necessary for SSB any more. For this I don't go higher than 20 watts on operating on the air. My memory channels are stored with 20 watts too, like the factory default.

On mine SG-2020 the PA bias was misaligned by the pre-owner and the SGC tech didn't check that too as they upgraded my rig to a new CPU + ADSP2. So I got a real splatter modulation first and I thought the rig wasn't aligned correct but I never would think about the bias first. The bias adjustment on R7 was on the left corner (8 o'clock), so on its minimum and my PA transistors didn't seem to have any bias when monitoring the TX signal audio.

As described in the handbook I get the needed 7mV checkpoint voltage when R7 is in the middle (12 o'clock) !!

To get a more "warm" and perfect modulation I raised up the alignment of R7 a little bit more and now R7 is on about 2 o'clock on mine SG-2020 which has a great modulation audio result. No excessive warm-up of the PA transistors, so don't worry about that.

Disclaimer • Disclaimer of liability

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 !**

Radio modifications shown here are provided for properly licensed operators only! The user is solely responsible for making sure that any modifications made to the radio unit must meet all Federal and State Regulations or the Country of use! Liability of damages to any equipment is the sole responsibility of the user! Downloading , viewing, or using any information provided on these pages automatically accepts the user to the terms of this agreement! Modifications are provided for information purposes only!

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