last modified: 22. Mai. 2004

Directory

Jochen Heilemann, DG2IAQ
P.O. Box 1106
D - 75218 Niefern-Öschelbronn Germany

Phone: +49 (0)7233 972 340
Fax: +49 (0)7233 972 341
e-Mail: dg2iaq@web.de

last modified: 22. Mai. 2004

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. Therefor 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.

Jochen Heilemann, DG2IAQ
P.O. Box 1106
D - 75218 Niefern-Öschelbronn Germany

Phone: +49 (0)7233 972 340
Fax: +49 (0)7233 972 341
e-Mail: dg2iaq@web.de

Modifications overview

TX

Mic socket	PIN5 → +8 volts	Using a line from the left pin of Q2 (78L08, max. 100mA) to the un-used 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)	→ bridge R146	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	→ BAT85	Better RF Clipping (This is the RF SpeechClipping diode ! It works together with C74 to ground and limits the IF signal peaks)
C74 (100nF)	→ 470nF	Better RF Clipping, less distortions
D19	→ BAT85	Higher RF average output

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 loosing the DX punch. By im-proving 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	→ 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 ! <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 1N5711 schottkys and the effect had gone. Strong receive without loosing sensitivity and preventation 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

Jochen Heilemann, DG2IAQ
P.O. Box 1106
D - 75218 Niefern-Öschelbronn Germany
Phone: +49 (0)7233 972 340
Fax: +49 (0)7233 972 341
e-Mail: dg2iaq@web.de

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)	→ 0.0047uF	AF lowpass: 160Hz → 3.200Hz !! 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.
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)	→ 100uF/35V	Adding more basses and audio output level

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 (0.1µF)	→ 2.2µF	Adding more basses
C36 (0.1µF)	→ 2.2µF	Adding more basses
Input resistor 100k	→ 33k	Better response of the DSP module. Now it works great on weak signals too. SGC has chosen a 100 kOhms which reduced weak signals too much to get the ADSP2 working properly. It was only useable on strong signals by factory default. It's the input resistor on the EXCITER PCB which is soldered to the ADSP2 green wire (= Input).

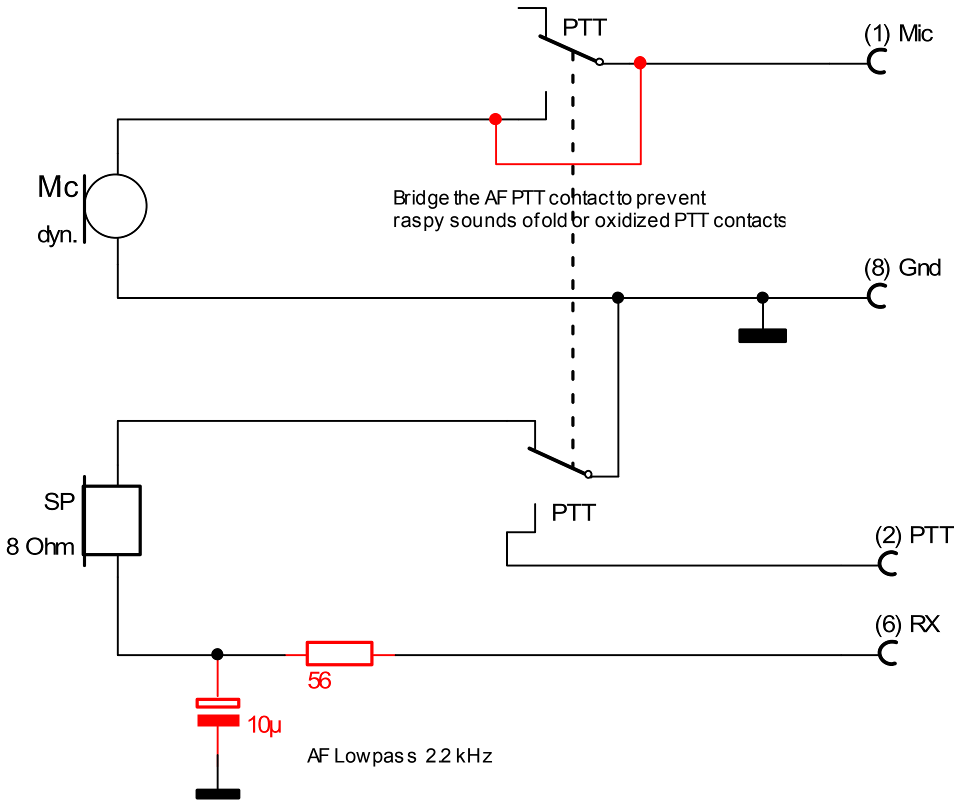
By doing the ADSP2 mods in addition to the RX audio mods above the ADSP2 module gets useful the first time for me. It still sounds a little "robotic" but most of the DSP modules do so. But now the received audio is readable very good even on real weak signals where the original ADSP2 had collapsed.

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.

Jochen Heilemann, DG2IAQ
P.O. Box 1106
D - 75218 Niefern-Öschelbronn Germany
Phone:+49 (0)7233 972 340
Fax: +49 (0)7233 972 341
e-Mail: dg2iaq@web.de

I'm using a CB telephone receiver for outdoor events. To take care of my ears I build in a small attenuator, combined with an AF lowpass on about 2.2 kHz. Now the telephone receiver has an accurate volume compared to the usual volume set of the SG-2020 internal speaker on outdoor usage.

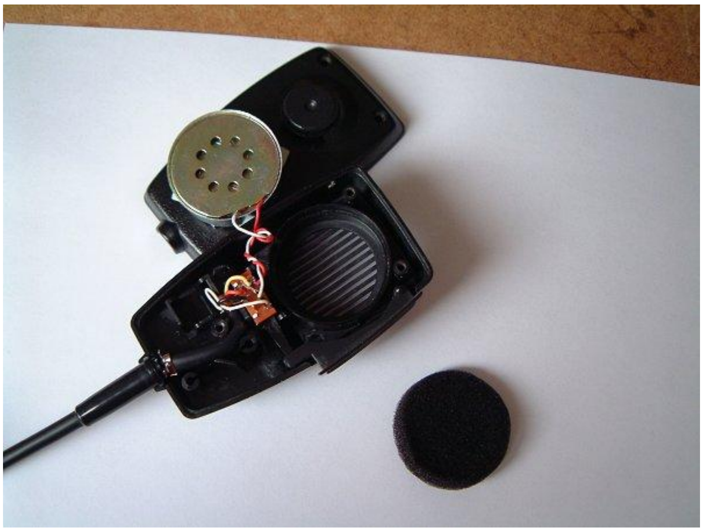


Ready for outdoor usage !!!

Jochen Heilemann, DG2IAQ
P.O. Box 1106
D - 75218 Niefern-Öschelbronn Germany

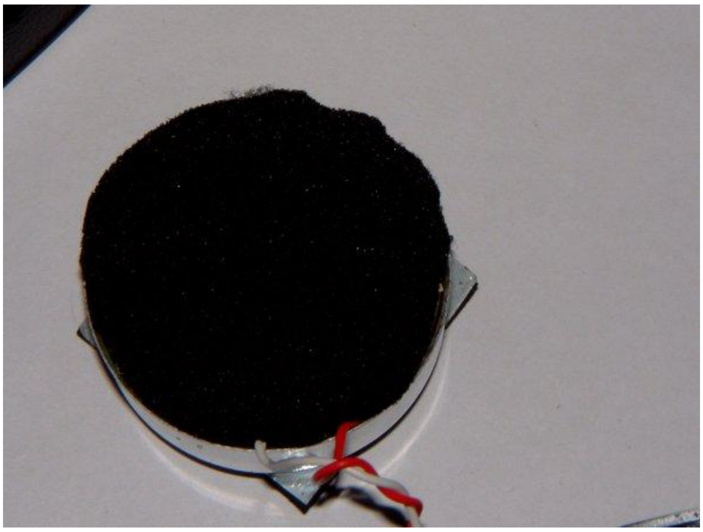
Phone: +49 (0)7233 972 340
Fax: +49 (0)7233 972 341
e-Mail: dg2iaq@web.de

Stock Mike Mod



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

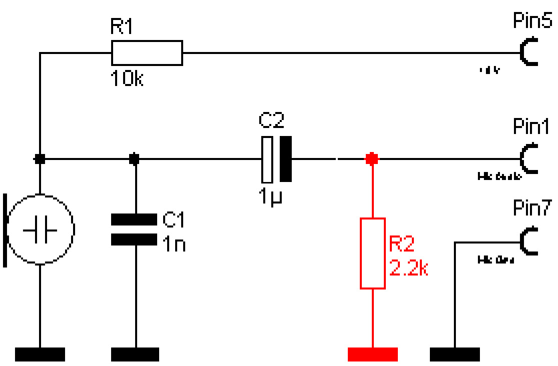
This foam normally should eliminate "pop" effects when talking real close to the front of the mike capsule. But when the foam is too thick the resulting sound through that foam is "twaging". It sounds like talking through the nose.



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.

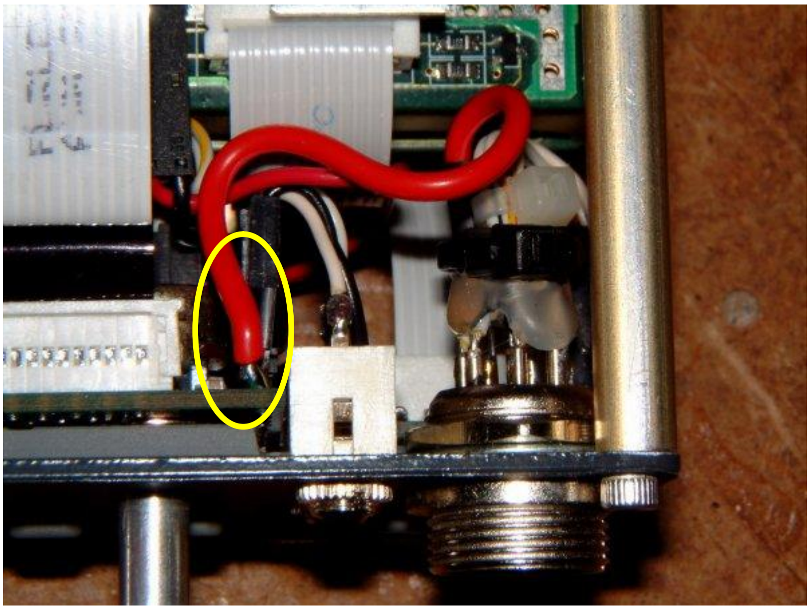
R2 is optional and would reduce the mic level a little bit…
a) to reduce a high background noise, e.g. on fielddays or loud environments
b) not to stress the VOGAD too much cause the electret capsule has enough punch.

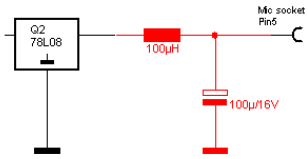
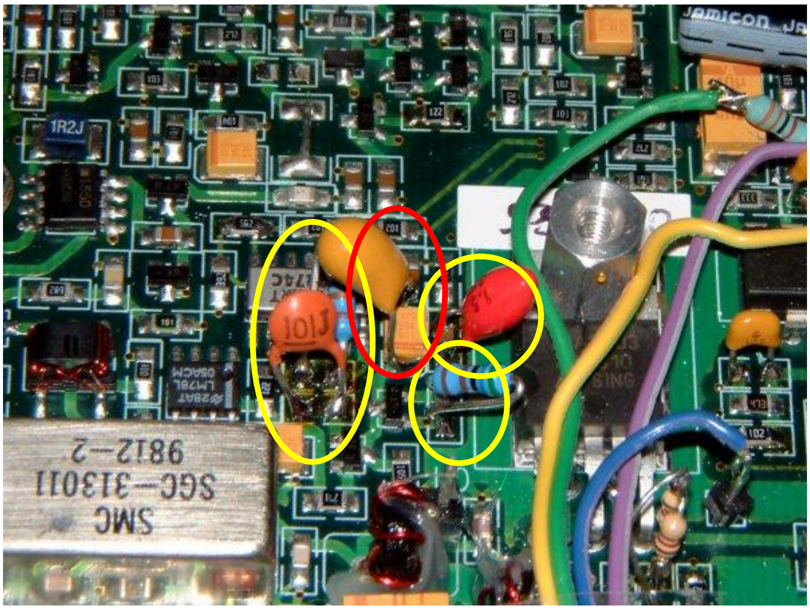
The electret capsule has a HIFI audio range and gives a real full modulation with a much higher audio level. If you like a DX modulation here too, remove R2 and replace C2 by 22nF – 47nF which gives an AF highpass and which reduces frequencies lower than 500 Hz.

Jochen Heilemann, DG2IAQ
P.O. Box 1106
D - 75218 Niefern-Öschelbronn Germany
Phone:+49 (0)7233 972 340
Fax: +49 (0)7233 972 341
e-Mail: dg2iaq@web.de

Details

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

<table>
<tr><th>TX mods</th><th></th></tr>
<tr><td></td><td>TX

Wire to get +8 volts from output 78L08 to PIN 5 of mike socket. I added 100µH and 100µF to prevent RFI.
</td></tr>
<tr><td></td><td>TX

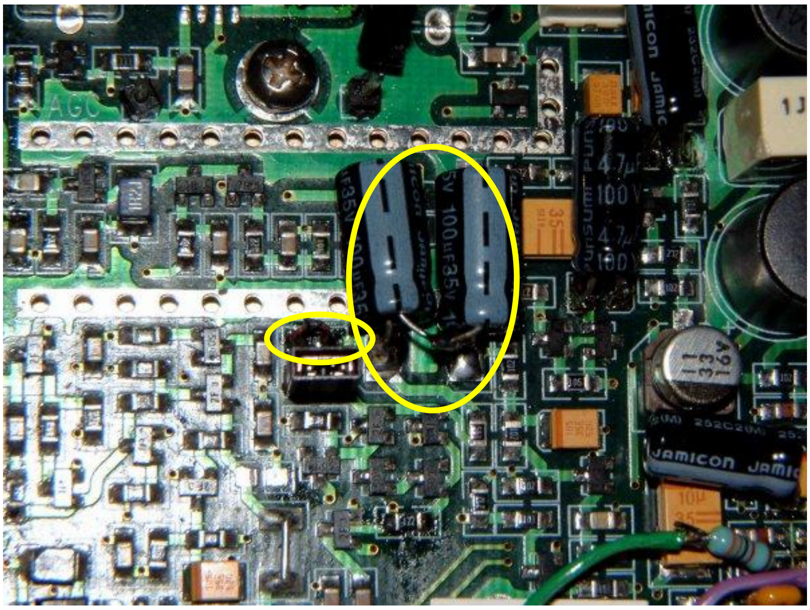
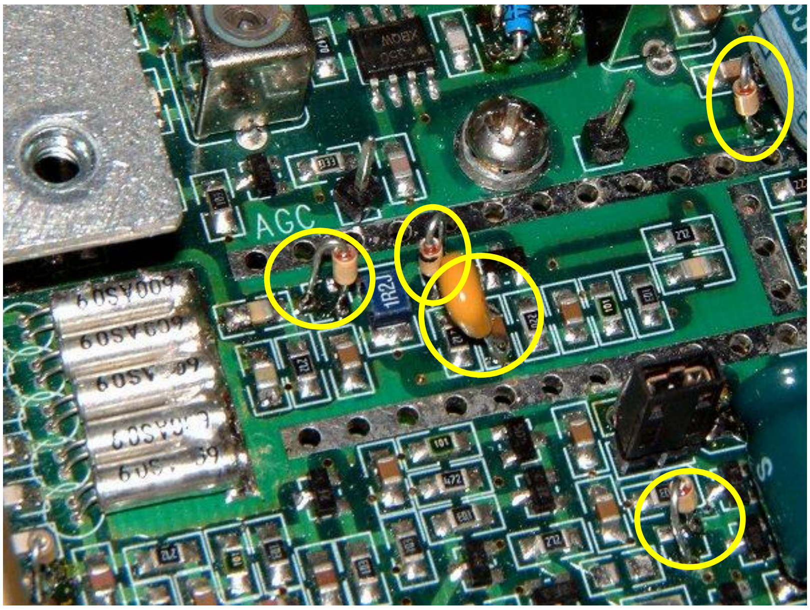
R25
C28
C41
C43

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.

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.</td></tr>
</table>

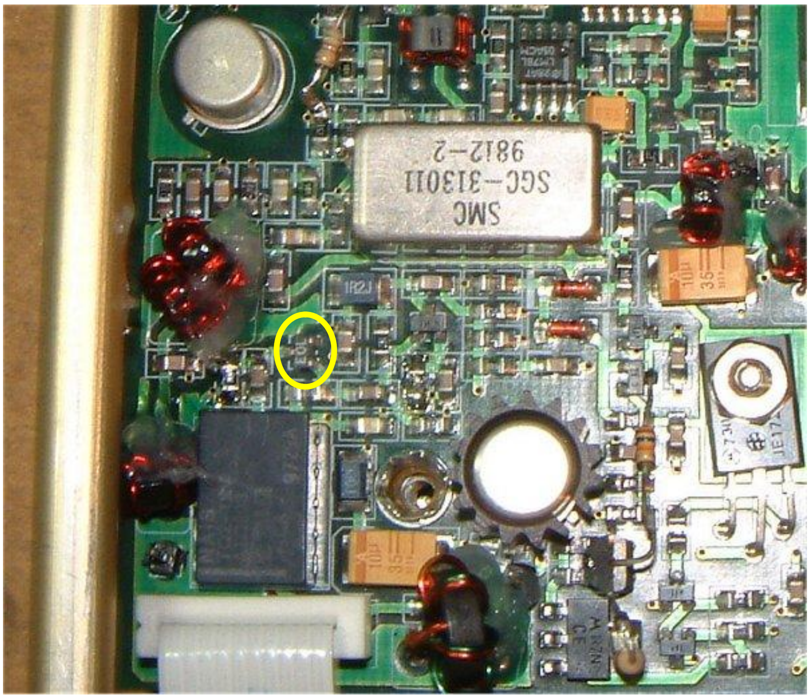
Jochen Heilemann, DG2IAQ
P.O. Box 1106
D - 75218 Niefern-Öschelbronn Germany

Phone: +49 (0)7233 972 340
Fax: +49 (0)7233 972 341
e-Mail: dg2iaq@web.de

	TX Bridge **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.
	TX **C74** **D12** **D13** **D14** **D5**

Jochen Heilemann, DG2IAQ
P.O. Box 1106
D - 75218 Niefern-Öschelbronn Germany

Phone:+49 (0)7233 972 340
Fax: +49 (0)7233 972 341
e-Mail: dg2iaq@web.de



TX

D19

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

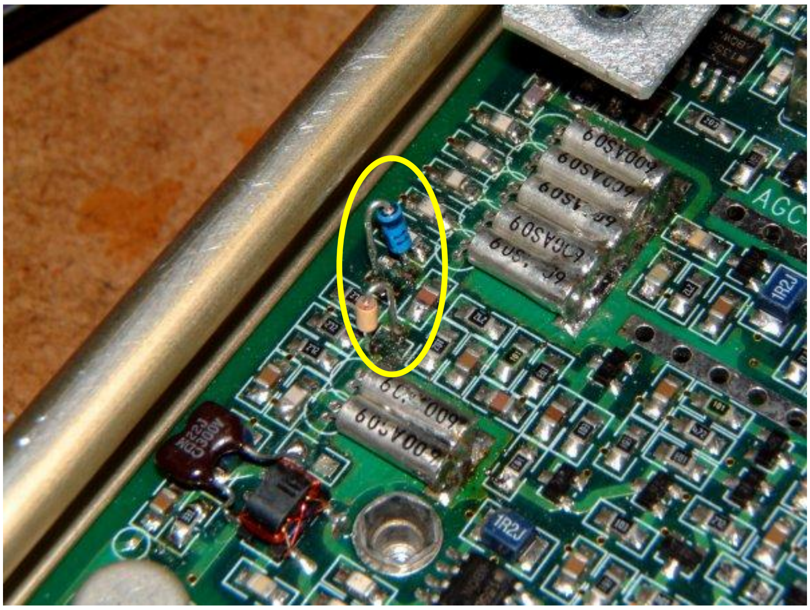
Kathode is left

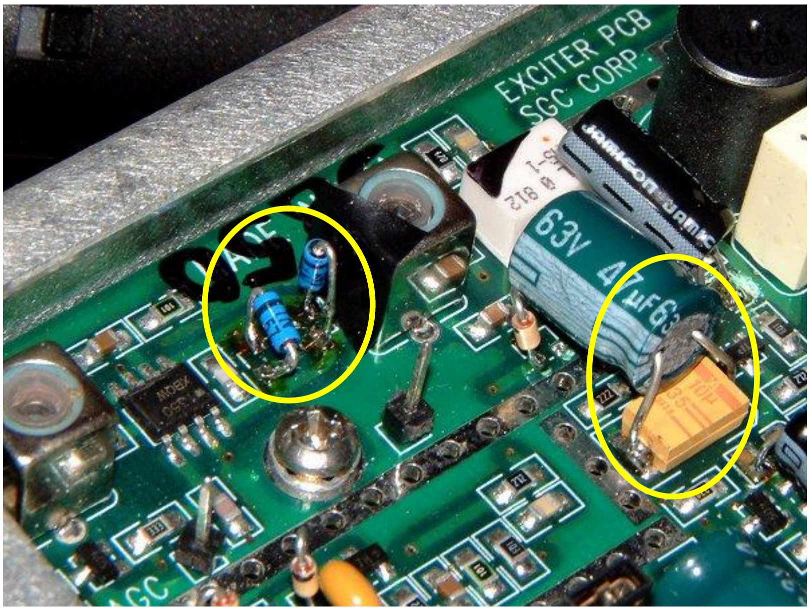
Anode is lower right.

Upper right is unused.

Jochen Heilemann, DG2IAQ
P.O. Box 1106
D - 75218 Niefern-Öschelbronn Germany

Phone: +49 (0)7233 972 340
Fax: +49 (0)7233 972 341
e-Mail: dg2iaq@web.de

<table>
<tr><th>RX mods</th><th></th></tr>
<tr><td>
</td><td>RX

D15 (BAT85, orange one)
D20 (1N5711, blue one)</td></tr>
<tr><td>
</td><td>RX

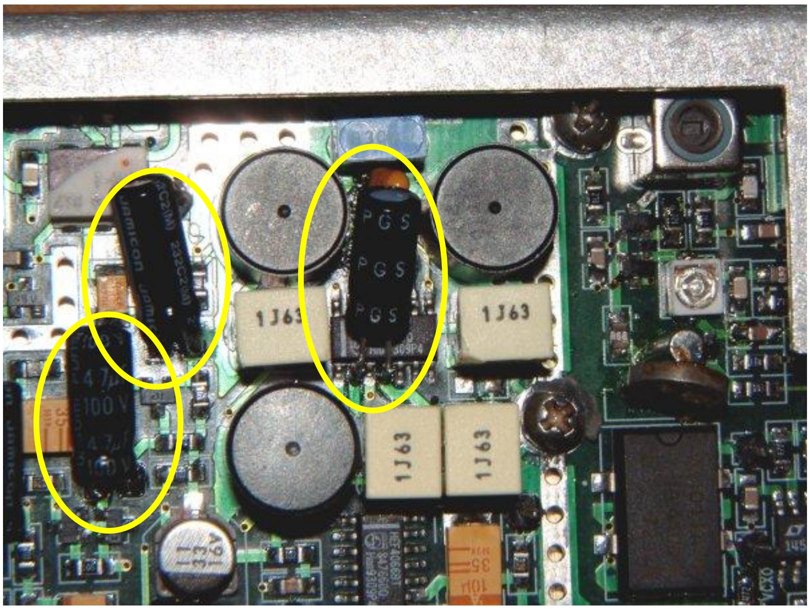
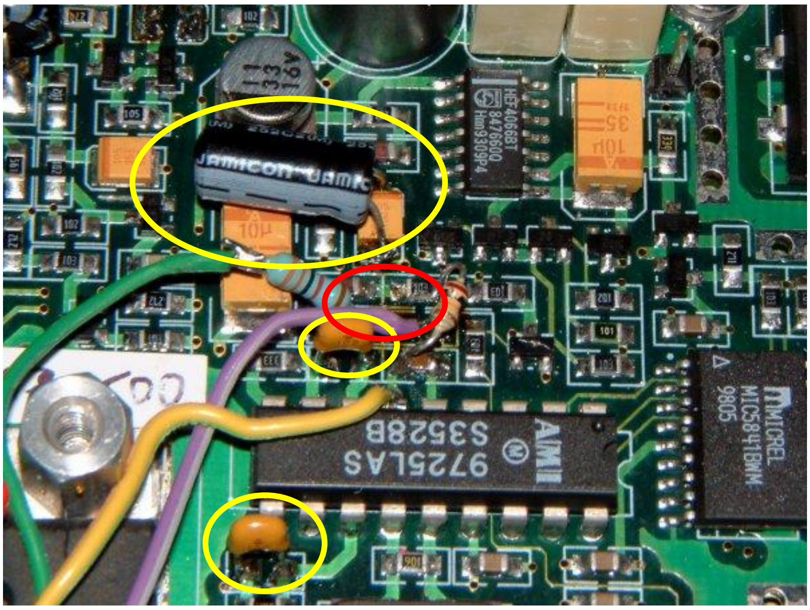
C12
D10
D11

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.
So actually I replaced both SMD diodes by 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).

Don't use BAT85 !!! They only have 0,3 V and would reduce the RX signal, but the distortions too, hihi.</td></tr>
</table>

Jochen Heilemann, DG2IAQ
P.O. Box 1106
D - 75218 Niefern-Öschelbronn Germany

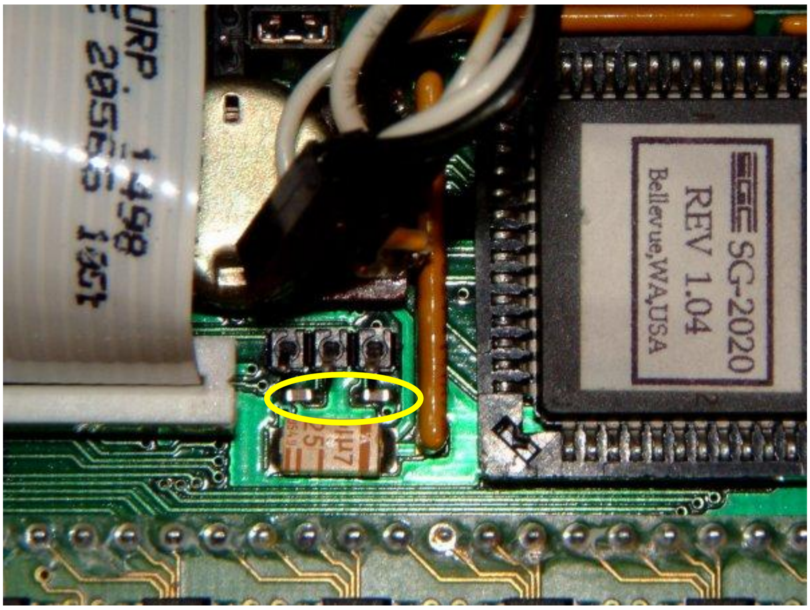
Phone: +49 (0)7233 972 340
Fax: +49 (0)7233 972 341
e-Mail: dg2iaq@web.de

	RX **C11** **C13** **10µF** 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".

Jochen Heilemann, DG2IAQ
P.O. Box 1106
D - 75218 Niefern-Öschelbronn Germany

Phone: +49 (0)7233 972 340
Fax: +49 (0)7233 972 341
e-Mail: dg2iaq@web.de

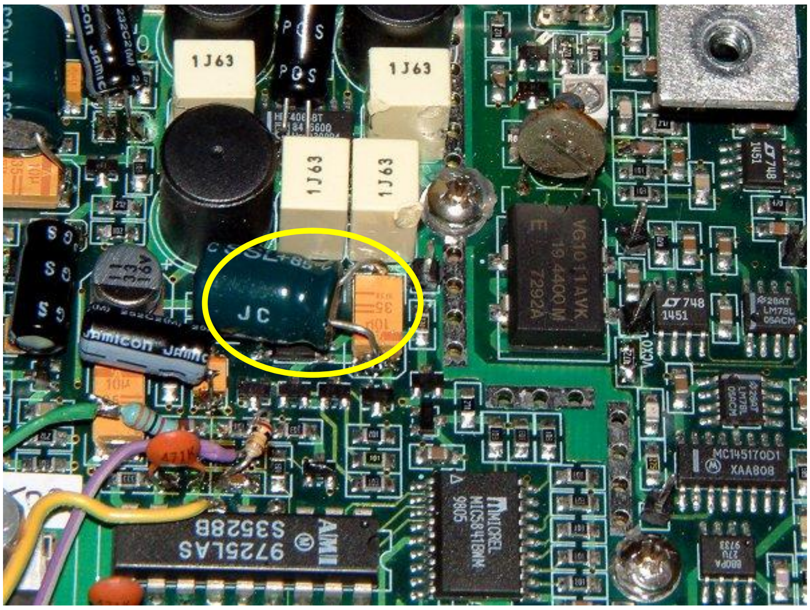
last modified: 22. Mai. 2004



RX

C14
C16

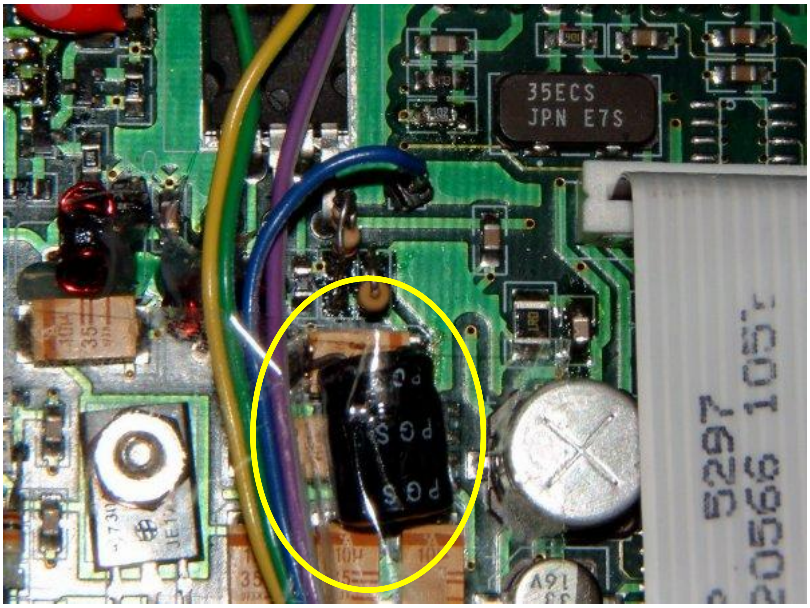
Cause of the limited space I removed both capacitors and soldered the replacement ceramic capacitors directly on the three pins of the volume pot.



RX

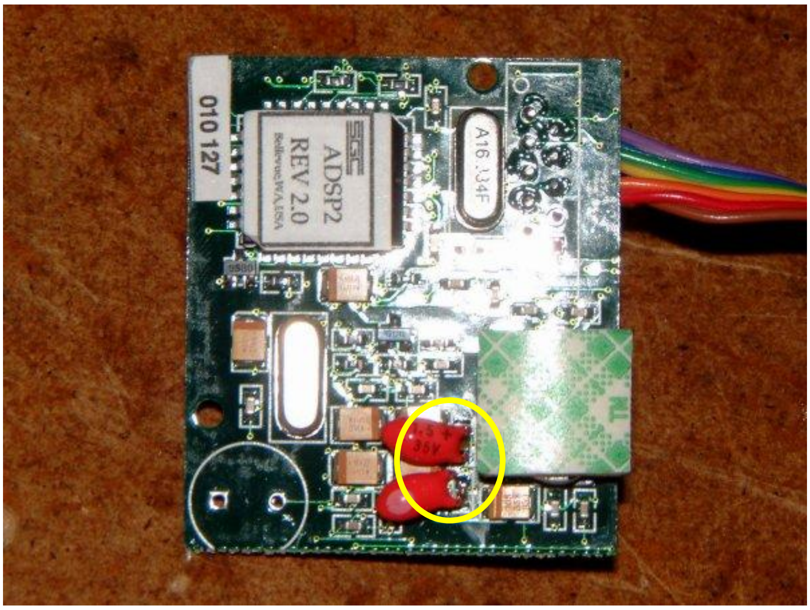
C20

Jochen Heilemann, DG2IAQ
P.O. Box 1106
D - 75218 Niefern-Öschelbronn Germany
Phone:+49 (0)7233 972 340
Fax: +49 (0)7233 972 341
e-Mail: dg2iaq@web.de

	RX **C31 (100µF)** A must-have !!!

Jochen Heilemann, DG2IAQ
P.O. Box 1106
D - 75218 Niefern-Öschelbronn Germany

Phone: +49 (0)7233 972 340
Fax: +49 (0)7233 972 341
e-Mail: dg2iaq@web.de

ADSP2 mods	
 	ADSP2 **C26** **C36**

Jochen Heilemann, DG2IAQ
P.O. Box 1106
D - 75218 Niefern-Öschelbronn Germany

Phone: +49 (0)7233 972 340
Fax: +49 (0)7233 972 341
e-Mail: dg2iaq@web.de

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 main trick is to understand that the variable capacitor C146 is not only for the alignment to the correct frequency for USB/LSB/CW by simply turning it until you receive an accurate station clearly.

C146 has the main effect to be in the passband of the 60 MHz crystal filter or not !!! The frequency shift of USB, LSB and CW to the 60 Mhz crystal frequency generator is only done by the alignment steps 1 – A of the alignment item 5.8, and N O T only by adjusting C146. So if C146 is misaligned before, you never get back in the passband only by adjusting the electronic shift of step 1 –A !!

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 30 - 50 Hz on maximum. So your partner stations shouldn't need the RIT to hear you.

Jochen Heilemann, DG2IAQ
P.O. Box 1106
D - 75218 Niefern-Öschelbronn Germany
Phone:+49 (0)7233 972 340
Fax: +49 (0)7233 972 341
e-Mail: dg2iaq@web.de

last modified: 22. Mai. 2004

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, otherwise the 60 MHz xtal isn't still working on its final 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. If necessary reduce RF GAIN to hear only some background noise. Switch permanently between USB and LSB and re-adjust C146 until you get nearly the same audio sound. Now it seems to be in the middle of the 60 MHz passband, both for USB and LSB.
6. On item 5.8.4 I had those changes to do:

Step	Testpoints	Remark	Factory values	My new values	
1)	TP5	LO USB	**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	**3.808** (61.666,344 kHz)	**3.794** (61.666,292 kHz).	
3)		LO CW	**2.952** (61.663,184 kHz)	**2.944** (61.663,156 kHz)	
5)	TP6	BFO USB	**3.137** (60.001,396 kHz)	**3.254** (60.001,500 kHz)	USB → + 1.5 kHz LSB → - 1.5 kHz CW → + 700 Hz Shift from crystal frequency 60.000,000 kHz
6)		BFO LSB	**0.692** (59.998,156 kHz)	**0.810** (59.998,500 kHz	
7)		BFO CW	**2.449** (60.000,756 kHz)	(60.000,700 kHz)	
8)	TP5	LO USB	**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	**6.058** (61.848,420 kHz)	**6.066** (61.848,500 kHz)	
A)		LO CW	**6.325** (61.850,972 kHz)	**6.302** (61.850,700 kHz)	

I didn't verified that but when I'm correct "LO" must be for RX and "BFO" must be for TX frequency accuracy.

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

7. 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. If you have a minimal failure drift on your frequency readout you could optimize that up to 100% accuracy by doing the "Calibrate Frequency Display (CMD + XCVE), handbook p. 23 (9.8)" on final.

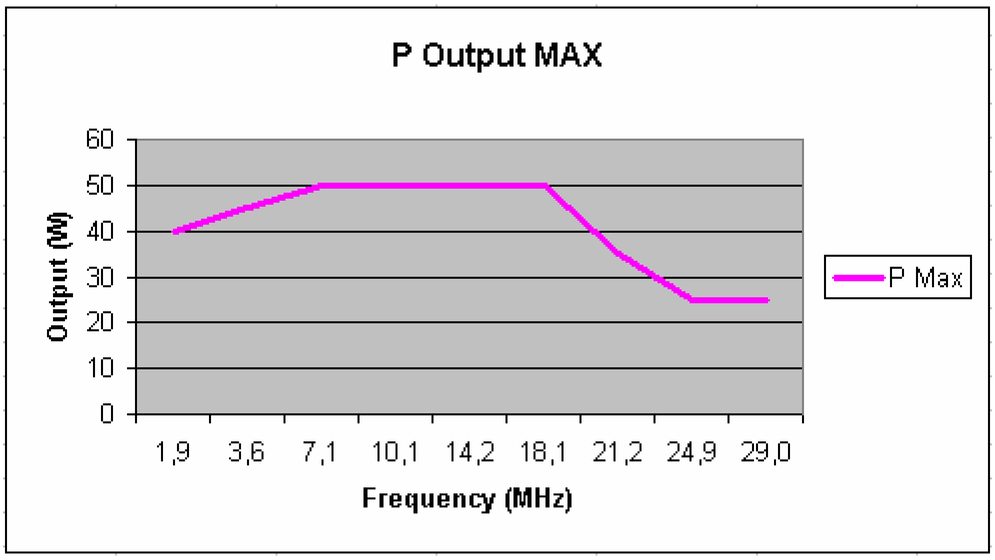
Jochen Heilemann, DG2IAQ
P.O. Box 1106
D - 75218 Niefern-Öschelbronn Germany

Phone: +49 (0)7233 972 340
Fax: +49 (0)7233 972 341
e-Mail: dg2iaq@web.de

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.

Jochen Heilemann, DG2IAQ
P.O. Box 1106
D - 75218 Niefern-Öschelbronn Germany
Phone:+49 (0)7233 972 340
Fax: +49 (0)7233 972 341
e-Mail: dg2iaq@web.de

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!

Although the greatest care has been taken while compiling these documents, we cannot guarantee that the instructions will work on every radio presented.

Copyright

The author intended not to use any copyrighted material for the publication or, if not possible, to indicate the copyright of the respective object. The copyright for any material created by the author is reserved. Any duplication or use of objects such as diagrams, sounds or texts in other electronic or printed publications is not permitted without the author's agreement.

Some circuit details are password-protected because of legal reasons. Please contact me via e-mail.

If your company would like to provide technical information to be featured on these pages please contact me at: dg2iaq@web.de

Jochen Heilemann, DG2IAQ
P.O. Box 1106
D - 75218 Niefern-Öschelbronn Germany

Phone: +49 (0)7233 972 340
Fax: +49 (0)7233 972 341
e-Mail: dg2iaq@web.de