DK7IH Amateur Radio Website – Ham radio for builders.

Amateur projects for the radio draftsman. QRP, QRO and more radio stuff that YOU can build.

Category: NE612-NE602-SA602-SA612

Shrinking a QRP transceiver to (nearly) the size of a pack of cigarettes

28. JULY 201828. JULY 2018 ~ DK7IH ~ 7 COMMENTS

The challenge started some weeks ago, when John, ZL2TCA, commented to this blog

> you next challange is to build a rig into a cigerette packet size case.

My problem: I don't smoke, have never smoked and probably never will. 😉 But I have a new transceiver for 20 meters, that might come close to the dimensions of a pack of "cancer sticks".

DK7IH pocket sized QRP transceiver 20-4

The transceiver is nearly the same circuit as applied with the "[Micro 20-III (https://radiotransmitter.wordpress.com/2017/10/04/the-micro20-iii-a-simplified-pocket-size-ssb-transceiver-for-14-mhz/)](https://radiotransmitter.wordpress.com/2017/10/04/the-micro20-iii-a-simplified-pocket-size-ssb-transceiver-for-14-mhz/)" but uses a single ended final amplifier instead of a push-pull circuit. I hope to find time the next days to publish an article on this rig featuring full description of the radio. Currently I'm in the IOTA contest and working stations from all over Europe.

73 de Peter

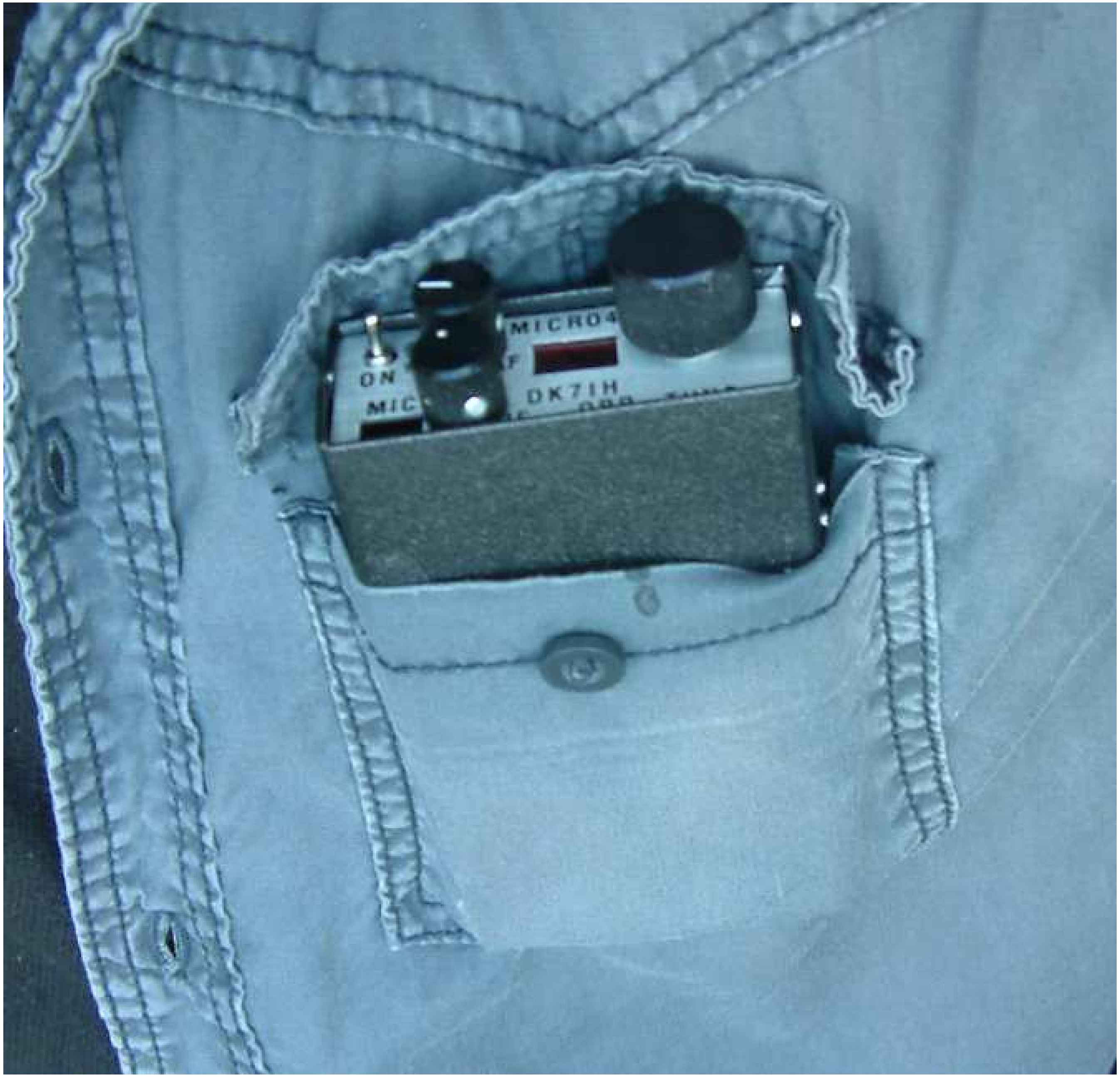
A compact project: The "Micro42" – Another "shirt pocket"

SSB transceiver.

4. JULY 20184. JULY 2018 ~ DK7IH ~ 9 COMMENTS

Having deferred the work on the "micro multibander" for some time I finished another small QRP rig (this one for 7MHz) that is suitable for my summer excursions by bike or hiking the local mountains here in the State of Rhineland-Palatinate or the Black Forest that is not that far away on the other side of the Rhine valley.

Besides, this transceiver to be discussed here is some sort of a "remake" of a 20 meter rig (https://radiotransmitter.wordpress.com/2015/01/24/qrp-transceiver-for-the-20-meter-band-ssb-by-dk7ih-peter-rachow/) I built 3 years before. And this time, the transceiver really fits into a shirt pocket without having to wear "XXXXL"- clothing. ;-):



The Micro42 – A really shirt pocket sized QRP SSB transceiver (this is my work shirt, so don’t mind the stains! 😉)

General circuit description (instead of presenting a block diagram)

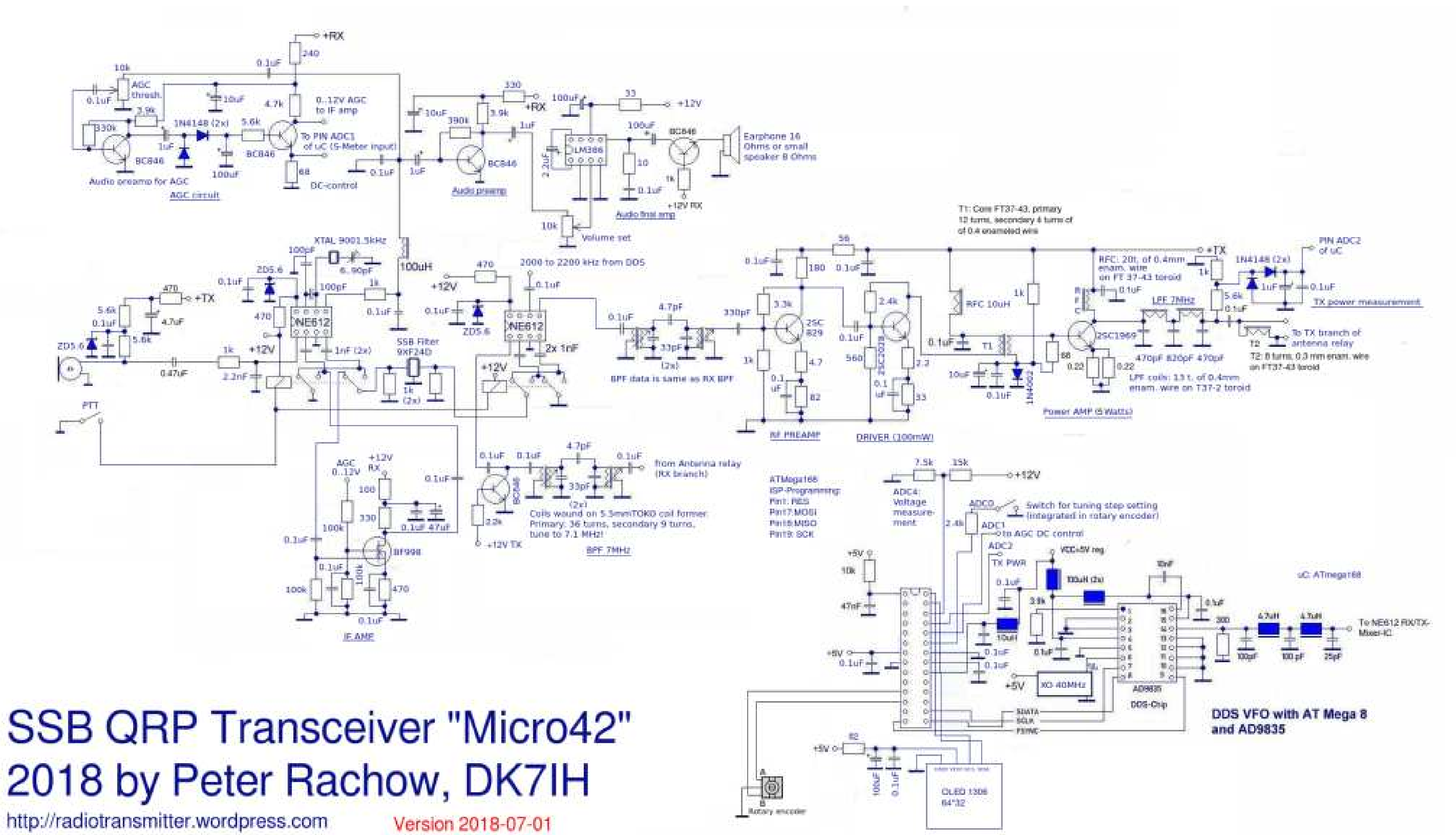
The rig uses two mixers NE602 plus one filter as central elements. The signal way is reversed when switching from receive to trasmit mode. This is done by 2 relays and is a well known technique for simple QRP rigs. You will find lots of equivalent ideas on the internet (Example 1 (https://ot15.pgk.net.pl/99.html), Example 2 (http://www.qrp.cat/ea3ghs/peregrino.html)).

But not to ignore the shortcomings of these designs: They are somehow inferior to my requirements, particularly concercing receiver performance. I prefer to have higher signal gain **and** an AGC circuit. AGC for me is a must. But these designs can be expanded easily, so I added an AGC controlled interfrequency amplifier with dual gate MOSFET BF998 into the receiver's signal path enhancing performance significantly.

Frequency layout

The frequency generation of the superhet transceiver scheme is simple: Again I use one interfrequency (i. e. 9MHz). The VFO is DDS based on AD9835 (https://www.google.de/search?source=hp&ei=bYo8W7HpM4XykgXp1qTADw&q=ad9835&oq=ad9835&gs_l=psy-ab.3..35i39k1j0i30k1l9.325.177593.0.179374.8.7.0.0.0.0.308.873.5j1j0j1.7.0....0...1c.1.64.psy-ab..1.7.867.0..0j0i10k1j0i10i30k1j0i131k1.0.nh5q-iWziII) operating below the desired radio frequency, which means that it is set to the range of about 2 MHz. Due to this low frequency you could replace the DDS by a VFO if you don't like the relatively complex work with the software programming and microcontroller stuff). A 2MHz VFO can also be made very stable, so this is an alternative not to be ignoered.

Due to the fact that the schematic is not very difficult to analyze you are kindly requested to refer to it for further talking:



Schematic – The Micro42 – A really shirt pocket sized QRP SSB transceiver. Click for full size picture (https://radiotransmitter.files.wordpress.com/2018/07/micro42-by-dk7ih_b1.png)

Circuit description

In the center of the schematic you can see the main elements of the circuit: One SSB filter (9MHz), correctly terminated by 2 resistors of 1k each (to ensure proper filter response curve) and two relays with a double set of switches. These relays reverse the way the signal travels through the filter. The advantage of this: You can use the integrated oscillator of the NE612 controlled by a crystal and a tuning capacitor to set the carrier frequency correctly for the lower sideband because the mixer is used as SSB generator and as product detector in common.

A word on chosing the proper relays: An intense examination of the relays' data sheet is essential. I built a prototype of this transceiver on a breadboard prior to soldering the components to a veroboard. I found that some SMD relays have signifikant coupling capacities between the unused relay contacts (in the range of some Picofarads). So stray coupling was a severe problem. Later I used some second-hand Teledyne RF relays (https://de.rs-online.com/web/p/products/0351465/?grossPrice=Y&cm_mmc=DE-PLA-DS3A-_-google-_-PLA_DE_DE_Relais-_-Universalrelais%7CHf-_Und_Rf-Relais-_-PRODUCT+GROUP&matchtype=&gclid=Cj0KCQjwvezZBRDkARIsADKQyPkBFcLzbyDizXNhUe2Q4fbjTRdRHrJgFkWZFPt7659LIrbquFbXni0aAlVREALw_wcB&gclsrc=aw.ds) that I had purchased via ebay two years ago (price originally 50€!) for 1€ each. These relays are absolutely superb!

The receiver

Before we go: In the circuit scheme above I missed out the antenna switch relay because I think every homebrewer knows what to do in this case. 😉 So the receiver's signal path starts with a band filter for 7MHz consisting of to tuned LC circuits. The coupling is relatively loose. As coils I use the well known coil formers in TOKO style (http://www.qsl.net/g4usp/OZL%20Coils/Toko_425_3.jpg) with 5.5mm outside measure.

Coil data for the 7MHz band pass filter (BPF) is 39 turns primary and 9 turns secondary of 0.1 mm enameled wire. The respective capacitor is 33pF. This is a high L to C ratio which gives you excellent LC quality factor. This is mandatory especially when working on the 40 meter band, because of the strong broadcasters starting from 7.200 kHz intermodulation might be a problem when the receiver is connected to a high gain antenna and broadcasters' signals might overload the first mixer (remember that NE612 has a relatively low IM3!). If you still should have problems coping with too strong out-of-band signals you can reduce the coupler from 4.7pF down to 2.7pF.

In practical terms I could not detect any unwanted signal products even when using an antenna with high rf output voltage. One reasons for this is, that there is no rf preamplifier for the receiver. This avoids overloading the first mixer generally.

The NE612 has two mixer inputs and two outputs. This makes it very suitable for this sort of radio. In receive mode pin 2 of the **right** NE612 is used as signal input. VFO signal is fed into pin 6. The resulting mixer products are taken out from pin 4. Next the 9MHz filter follows from right to left.

The 9MHz IF signal then is fed into an IF amplifier. This one is equipped with a dual gate MOSFET (BF998), gain is about 15dB when full AGC voltage is applied wich leads to about 6V by the 1:1 volatge divider in the applied to gate 2 of the MOSFET.

The **left** NE612 is the product detector. I use the internal oscillator with a 9MHz crsytal and a tuning capacitor here. This saves building an extra oscillator and simplifies the rig again.

One AF low pass filter made of 1k resistor, 100uF rf choke and a 0.1 uF capacitor eliminates high frequency remainders generated by the mixing process.

The audio stages are also made simple: One preamplifier (using bipolar transistor in grounded emmitter circuit) and a final stage with LM386 transform the signal to a level that is sufficient to be fed into a small 8 ohm loudspeaker or a set of standrd MP3-player headphones. Because the rig is very small and there was definetely no space for a loudspeaker I use headphones instead.

Keep an eye on the power supply switching of the two audio stages. The problem was to eliminate the switching click and pops to a minimum and to avoid acoustic feedback when unsing a loudspeaker. So the audio preamp is only connected to DC on receive. When switching to transmit the charged capacitors avoid instant cut off supplying some Milliseconds DC to the amp until significantly discharged. The main amplfier on the other hand is connected to permanent DC supply. So it won't pop when switching from tx to rx an vice versa but can cause feedback. To avoid feedback a transistor is used to cut the speaker/earphone from the power amplifier.

AGC

AGC is audio derived. A two stage amplifier provides a DC voltage analog to the audio input sginal strength. First amplifier stage is a common emitter bipolar transistor supplying sufficient audio voltage. This voltage is rectified by a two diode circuit letting only the positive halfways pass. You can use silicon diodes (1N1418) oder Schottky diodes here. An electrolytic capacitor (100uF/6V) provides the time constant respectively DC decay once the signal has disappeared. Output of the DC stage is split. The collector is connected to 12V via a 4.7k resistors causing a voltage drop when the transitor's conductivity increases. The emitter is fed to the ADC of the microcontroller (pin ADC1) causing a proportional voltage to the voltage of the applied audio signal so that on the OLED an S-meter can be displayed.

The transmitter

An electret microphone picks the operator's voice. The signal output level of these microphones is high enough to drive the **left** NE612 (which serves as balanced modulator in this case) directly. Signal input for the mixer should be 200mV RMS according to data sheet. An electret produces about 0.5 to 1 V pp if spoken with a decent voice in the distance of some centimeters. So you have more than enough audio signal power for the modulator.

BTW: Carrier suppression of the modulator is excellent. I achieved 56dB without doing anything else!

The resulting DSB signal then is fed into the SSB filter, the SSB signal subsequently is directly sent into the right NE612. A band pass filter for 7 MHz eliminates the unwanted mixer products. You should have 400 to 500 mV pp of rf signal here when the transmitter input is fully driven. I recommend a two-tone test generator (https://radiotransmitter.wordpress.com/tag/two-tone-test-generator/) to check out the linearity of this and the remaining amplifier stages!

Next parts of the transmitter are a band pass filter (same coils and capacitors like th rx bandpass filter), a preamplifier and a driver. The later should put out about 150 mW into a 50 ohm load. They are made more linear by emitter degeneration (4.7 and 2.2 ohm resistors for predriver and driver) and negative feedback. This helps to ensure that transmitter performance is fine when IMD3 products are concerned even if the main IMD3 problems usually occur in the final stage.

To transfer the rf power into the final stage proper impedance matching is mandatory. Input impedance of the final stage is fairly low (<10ohms), therefore a broadband (down)transformer is used. Data is: Core T37-43, primary 12 turns, secondary 4 turns of 0.4 mm enamled wire.

Last stage is a single ended linear amplifier in AB mode equipped with a 2SC1969 rf power transistor by eleflow.com (http://eleflow.com).

BIAS circuit: The combination of the 1k resistor, a silicon diode (1N4002 or equ.) and a capacitor sets up the correct bias. Bias is fed into the cold end of the input transformer. Quiescant current should be around 40mA. A good thermal contact between the diode and the transistor is recommended. As the transistor gets warmer the diode will increase its conductivity so reducing bias current. This will prevent thermal runaway effectively!

To avoid bulky output transformers the PI-filter (7MHz LPF) is part of the tank circuit of the final amplifier transistor. For this power level this is an acceptable and practical solution because the output impedance of the stage is nearly equivalent to 50 Ohms. A certain mismatch is not a severe problem. DC to the final transistor is applied via an rf choke, for exact data please refer to the schematic!

T2 helps to suppress unwanted signals that I encountered when taking the transmitter from the dummy load test environment to a real antenna. I observed unwanted parasetic oscillation in the range of about 1MHz. T2 has a low reactance for this frequency range thus eliminating the oscillations in a reilable way by short circuiting them towards ground.

Powered with 12.5V DC the transmitter will put out slightly more than 5 watts PEP.

DDS VFO

AD9835 (http://www.analog.com/media/en/technical-documentation/data-sheets/AD9835.pdf) is a simple but well performing 10-bit DDS chip made by Analog Devices (AD). It is controlled via 3 SPI lines transmitting the frequency data. Maximum output frequency is around 16MHz when the chip is clocked with its maximum clock rate of 50 MHz. Oscillator output voltage is some hundred millivolts peak-to-peak, so you can connect the output directly to pin 6 of the NE612 mixer.

Control signals come from an Arduino Pro Mini (https://www.google.de/search?source=hp&ei=i3s8W-j4HsbisAevub6ICQ&q=Arduino+Pro+Mini&oq=Arduino+Pro+Mini&gs_l=psy-ab.3..35i39k1j0l9.689.689.0.1098.2.1.0.0.0.0.216.216.2-1.1.0....0...1c..64.psy-ab..1.1.213.0...0.WHYqG3u8sI8) board. The microcontroller in this module is, if you are an Arduino user, preinstalled with a bootloader program. I overwrote this small portion of code and use the ATMega168, which is the core of the Arduino, in "native" mode. My software is written in C and transferred via "AVR dude" software using the ISP lines MOSI, MISO, SCK and RESET. These lines are not in the schematic, please refor to ATmega168 data sheet (http://ww1.microchip.com/downloads/en/DeviceDoc/Atmel-2545-8-bit-AVR-Microcontroller-ATmega48-88-168_Datasheet.pdf). Alternatively you can use, like shown in the schematic, an ATmega168 controller. So you have to de neccessary wiring on your own.

You will find the source code here (https://radiotransmitter.files.wordpress.com/2018/07/c-sourcecode_mircro42_qrp_ssb_trx_by_dk7ih_2018.odt). I packed it into an Open Document Text File because of problems I encountered when I tried to store the code into this Blogtext. If you need a compiled HEX-file, please feel free to email me!

Display is a very small OLED with 64 by 32 pixels (https://www.google.de/search?q=oled+64x32&spell=1&sa=X&ved=0ahUKEwi22d-v-4TcAhUnsaQKHadDATEQBQglKAA). The OLED is, to my point of view, a little bit noisy. To suppress any rf traveling on VDD line I use an 82 ohm resistor and a set of bypass capacitors of 100uF and 0.1uF capacity closely connected to the OLED VDD pin to GND.

A low pass filter by the output of the DDS ensures spectral purity and avoids clock oscillator feed through. Remember that if you need another output frequency other than 2 MHz you should redesign the low pass filter.

Frequency control

Tuning is done by a rotary encoder connected to PD5 and PD6 of the microcontroller. I use the pull up resistors internal to the microcontroller, so you won't see any other things than the mere encoder.

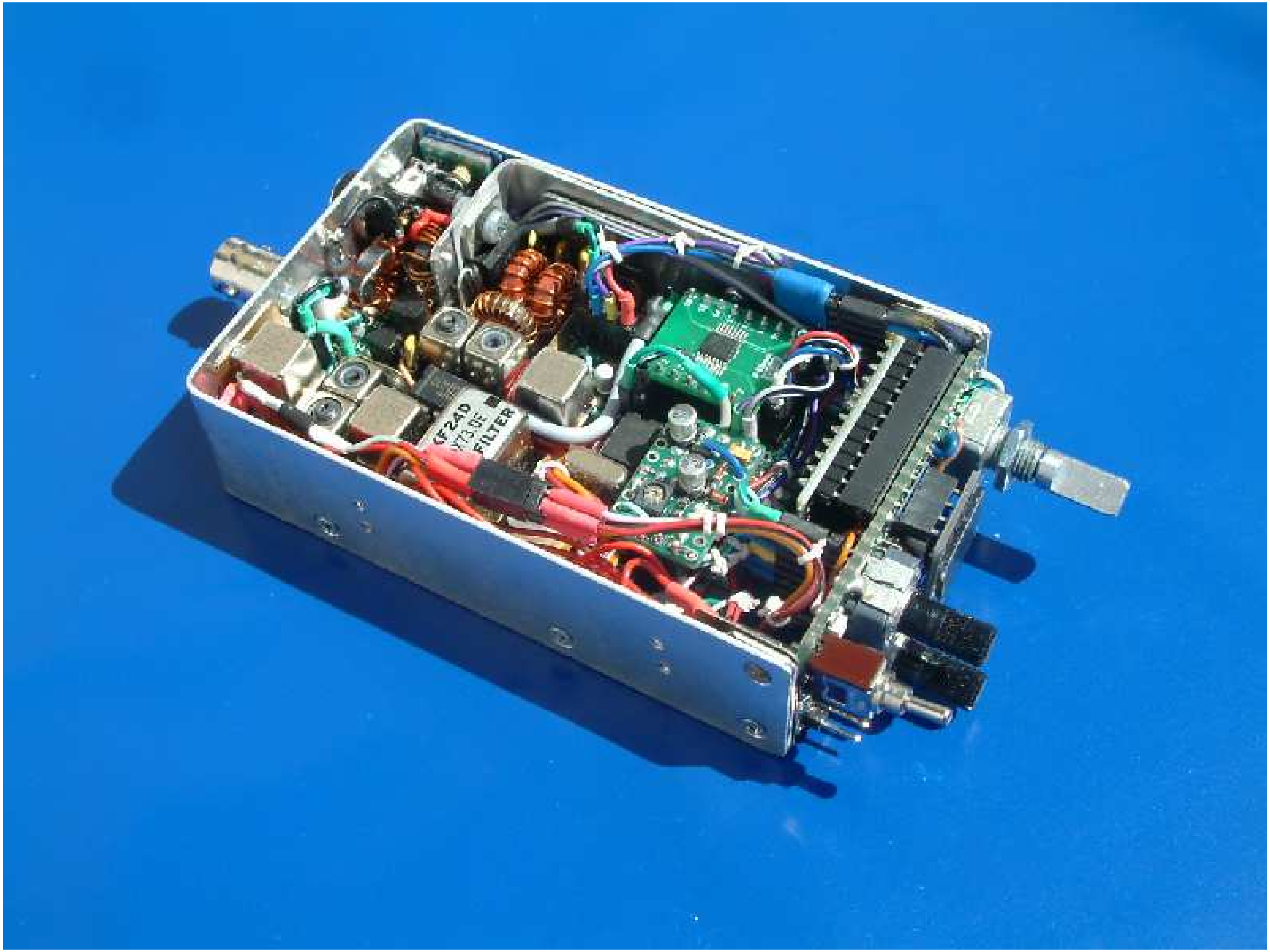
Tunings steps are selected by pushing the encoder knob or another suitable push button. This button is connected to ADC0 in the

ATMega168 via a 3.9k resistor. The resulting ADC voltage might be problem because of a certain variation in the values of the pull up resistors that form the second resistor of the voltage divider. There is an outcommented section in the code that will show you the exact ADC value that has to be typed into the code so that key recognition works exactly.

The button once pushed will increase the tuning step by a certain amount of Hz. Steps are 10, 50, 100 (standard step), 250, 500, 1000 and 5000 Hz in and endlessly revolving chain. The step will be reset to 100Hz (standard tuning step) by leaving the tuning knob idle for 2 seconds. That's all with the controls. Very simple, but sufficient.

Practical aspects

The transceiver is constructed on a double sided veroboard with 6 by 8 centimeters area. Components are through hole and SMD where available. The Arduino is mounted to the front panel (another Veroboard carrying the controls etc.) as well as the OLED is. The veroboard is inserted into an aluminium frame connected to the front panel with 4 lateral M2 screws:



Mounting frame – The Micro42 – A really shirt pocket sized QRP SSB transceiver

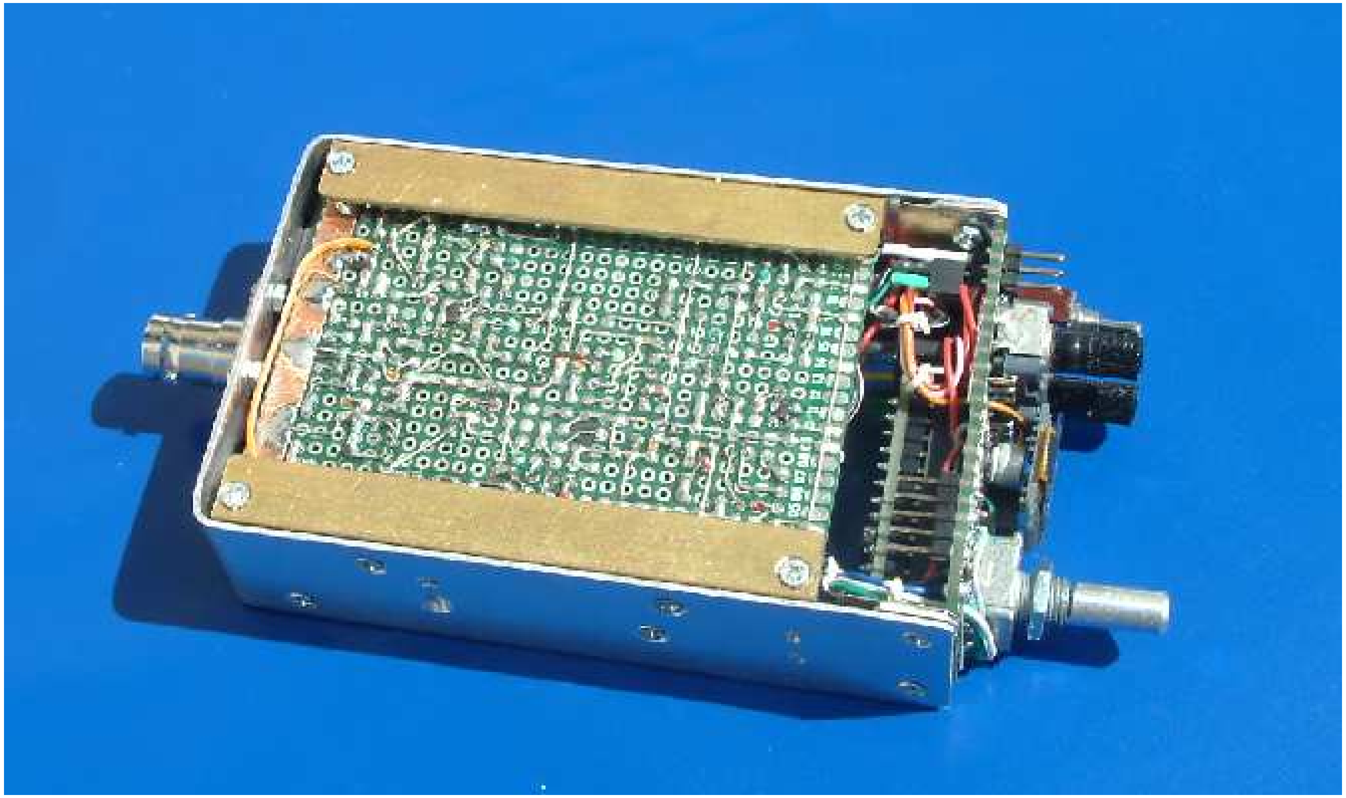
Design hints:

Wiring can be made by using the colored lines stripped from old parallel printer cables. These cables have a diameter of precisely 1mm an fit through the holes of the veroboard excactly.

If you connect any external components that are not on the same veroboard use standard 2.54 mm (0.1″) male and female board connectors! This will make it much easier to dismantle and reassemble the rig in case troubleshooting is neccessary.

Use M2 srews instaed of M3 when building very small rigs like this one!

The reverse side of the main arrangement:



Reverse side of mounting frame – The Micro42 – A really shirt pocket sized QRP SSB transceiver

Two brass made bends (from the local hardware store and each cut to a length of 8 centimeters) hold the PCB inside the mounting frame. A winding has been cut into the brass to fix the bends with screws in M2.

Final assembly

Together with 2 halves of a bent aluminium cabinet covered with “DC-fix” (a German manufacturer of self-adhesive PVC coating) the final rig looks like that:

The Micro42 – A really pocket sized SSB QRP transceiver for 7MHz

(https://radiotransmitter.wordpress.com/2018/07/04/a-compact-project-the-micro42-another-shirt-pocket-ssb-transceiver/micro42-qrp-ssb-7mhz-by-dk7i-finally-assembledh/)

(https://radiotransmitter.wordpress.com/2018/07/04/a-compact-project-the-micro42-another-shirt-pocket-ssb-transceiver/micro42-qrp-ssb-7mhz-by-dk7i-finally-assembled2/)

So, that's the end of the story so far. Now it's time for going outdoor and test the rig in field use. 😉

73 and thanks for watching!

Peter (DK7IH)

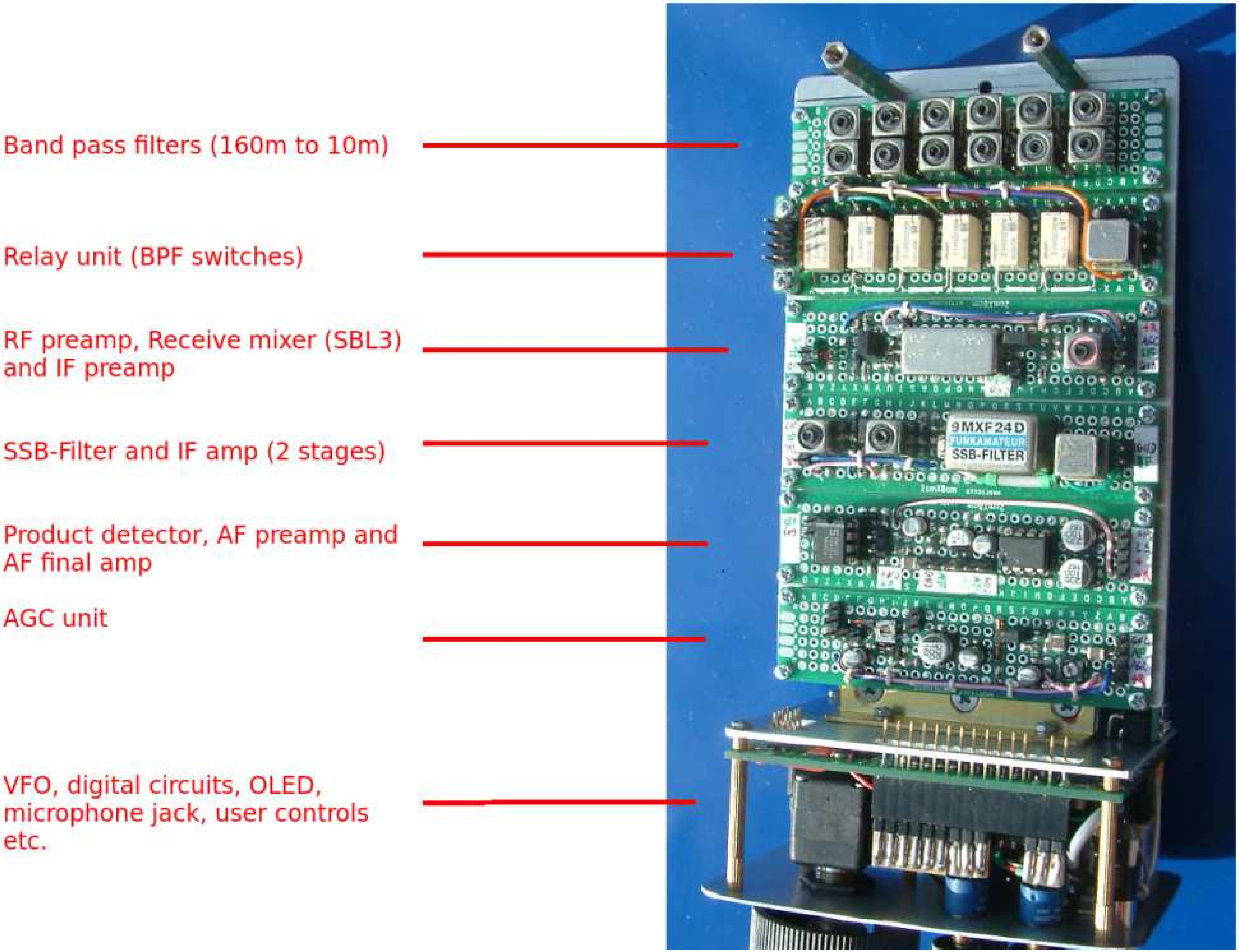
A Micro Multibander – Step by step (Part III): TheReceiver (Overview)

19. MAY 2018 ~ DK7IH ~ LEAVE A COMMENT

Work is in progress. The recent weeks I finished all the 6 modules that are going to be the receiver:

- Band pass filter section
- Relay switches for switching the BPFs
- RF preamp, RX mixer and IF preamp
- IF main amp
- Product detector and AF amp section
- AGC unit

Mounted together to an aluminium carrier board it looks like this:


Band pass filters (160m to 10m)
Relay unit (BPF switches)
RF preamp, Receive mixer (SBL3) and IF preamp
SSB-Filter and IF amp (2 stages)
Product detector, AF preamp and AF final amp
AGC unit
VFO, digital circuits, OLED, microphone jack, user controls etc.
9MXF24D
FUNKAMATEUR
SSB-FILTER

On the picture the board is not equipped with the neccessary wiring yet to give the reader more sight on the single circuits. Next I will draw a schematic of each board to point out the used circuitry for those who want to build this or a similar receiver.

First test are promising so far, the receiver is sensitive, has a very low noise figure (due to dual gate MOSFETs in the preamp and the two main IF amp stages) and has shown no problems to cope with high out-of-band broadcaster signals on the 40 meter band which is due to the SBL-3 mixer I have used that has a good IM3 performance..

Thanks for watching an 73 de Peter (DK7IH)

The „Micro20 III" – A Simplified Pocket Size SSB Transceiver for 14 MHz

4. OCTOBER 201710. NOVEMBER 2017 ~ DK7IH ~ 18 COMMENTS

by Peter Rachow (DK7IH)

After having built my first shirt-pocket transceiver (https://radiotransmitter.wordpress.com/2016/12/03/the-micro-qrp-transceiver-a-pocketful-of-radio-in-smt/) about a year ago I occasionally thought of how this or a more or less modified design could be made simpler to save components and therefore limit space as well as reducing the complexity of the whole rig. This was due to the fact that I thought that the ancestor (see link above!) of this project was somehow „overkill" because I used plenty of stages redundantly that could have been used for receive and transmit operation.

Before we go into the details of this new project, let's have a look on the new micro transceiver (here operating portable as EA8/DK7IH/QRP from the island of Fuerteventura):

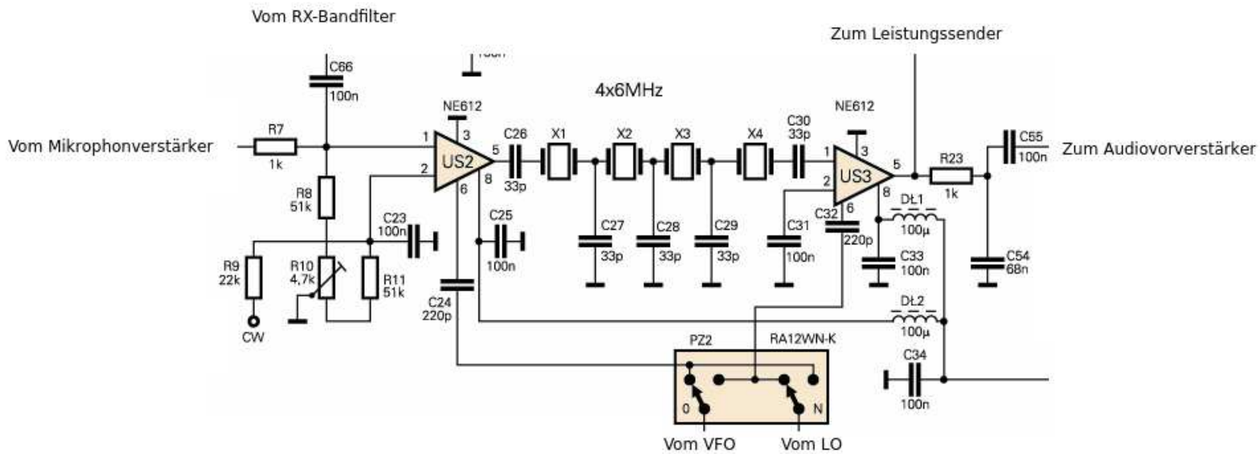
(https://radiotransmitter.files.wordpress.com/2017/10/1_dk7ih_small_qrp_transceiver_2017_14mhz_ssb.png)

The "Micro20 III (by Peter Rachow, DK7IH)

Cabinet size is about 10 by 4 by 5.5 centimeters which equals to a volume of 220 cubic centimeters (cm³).

Making it simpler without detereorating the performance?

Under the aspect of simplifying the circuit I remembered that I had searched for simple designs of transceiver circuits some years ago intensely. After having revisited some of them on the Internet my attention was caught by the „Antek"-Transceiver that has been published by SP5AHT a while ago. This was an ideal basis for my purpose because I intended to build a „2 mixers+1 filter" circuit in order to make at least 2 of the 4 mixers that are necessary for a fully functionally SSB transceiver redundant. The central part of SP5AHT's design matched my requirements in an ideal way:



[(https://radiotransmitter.files.wordpress.com/2017/10/2_dk7ih_small_qrp_transceiver_2017_14mhz_ssb.png)](https://radiotransmitter.files.wordpress.com/2017/10/2_dk7ih_small_qrp_transceiver_2017_14mhz_ssb.png)

"ANTEK" Transceiver by SP5AHT

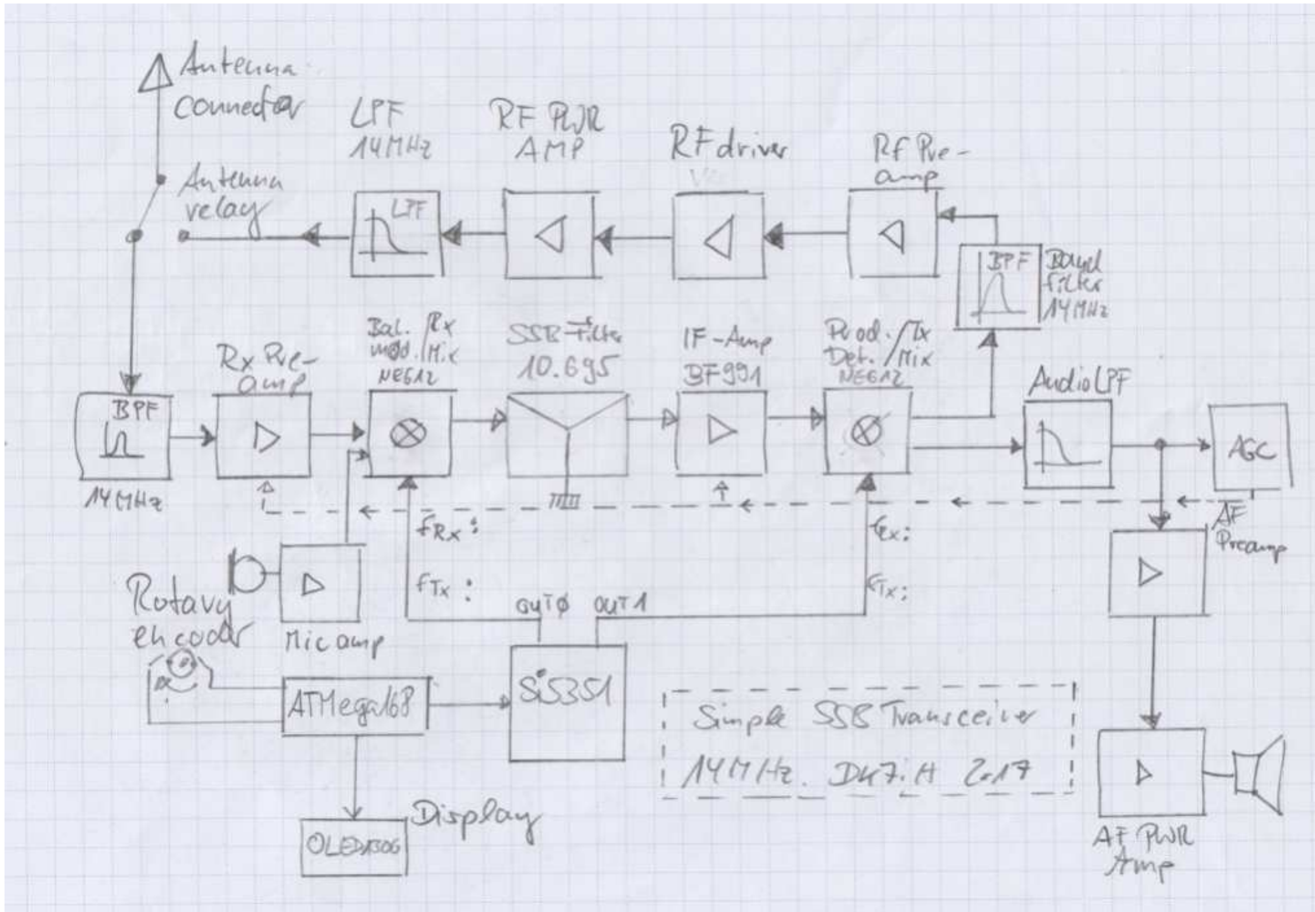
SP5AHT's circuit uses one mixer (US2 in the schematic) to serve as the receive mixer during rx periods and for the balanced modulator when on transmit. Then the resulting signal is fed through the filter and subsequently processed by mixer 2 (US3). This mixer works as the product detector on receive mode and as transmit mixer when you are on the air. The two oscillators (VFO and LO) are fed to the respective mixer depending on the current operation. This is done by a simple relay connected to the PTT. So when changing from receive to transmit the two oscillators are swapped thus changing the complete function of the circuit.

To get rid of the relay and because I wanted to use the Si5351A clock oscillator chip, my idea was making two of the 3 oscillators present in the clock chip act as LO and VFO. By software, when switching from rx to tx, these oscillators' frequencies are simply swapped. The microcontroller driving the Si5351A reads the PTT and when pressed to talk the frequencies present on CLK0 and CLK1 are put out reversely. Thus no hardware switching is required.

In addition the audio amps in the end of the receiver chain are powered off. Instead of this the rf power amp of the transmitter section is connected to +12V DC as well as the microphone amp. The antenna relay disconnects the receiver front end from the antenna line and connects the antenna to the LPF that is installed after the rf power transformer of the rf power amp final stage.

By this the whole transceiver is constructed much simpler and lots of circuitry has been removed from the rig.

The block diagram



(https://radiotransmitter.files.wordpress.com/2017/10/3_dk7ih_small_qrp_transceiver_2017_14mhz_ssb.png)

Micro20-III SSB QRP transceiver by DK7IH – Block diagram

Circuit explanation: During receive periods the signal is fed into the antenna jack whose line is switched by the antenna relay and fed to the first band pass filter for 14MHz when listening to the band. Afterwards it is amplified by a dual-gate MOSFET transistor that is connected to the AGC line that reduces gain when strong signals are detected. The next stage is mixer 1 where a VFO signal of about 24 MHz comes from CLK0 of the Si5351A module.

The result of this mixing process is the IF of about 9 or 10.7 MHz or whatever frequency you are about to use depending on the filter you have installed. This signal is amplified by another dual-gate MOSFET. On receive mode this stage is also under AGC control. When transmitting it is powered to full gain of about 18dB applying +12V via a 2:1 voltage divider consisting of 2 resistors with 82k each.

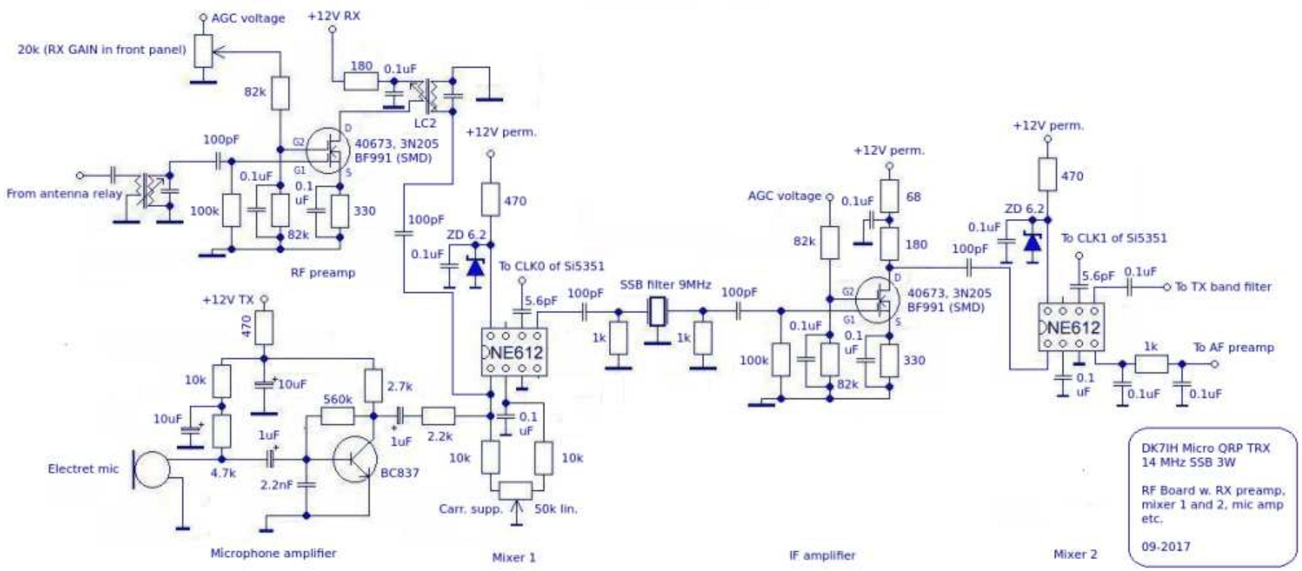
Next step is mixer 2 where the IF signal is mixed with a 9 resp. 10.7 MHz LO signal (receive mode serving a product detector) or with the VFO signal in mixer 2 serving as tx mixer.

On receive two audio stages (a preamp with LPF in advance and a power amp) amplify the audio signal to a level that can be fed into an 8 Ohm loudspeaker.

On transmit a BPF eliminates the unwanted mixing products and a three stage rf power amplifier lifts the signal to a power level of 3 watts peak power.

The Main RF Section

This central section of the rig consists of the two mixers mentioned before, a commercially made (in my case) 10.695 MHz filter stripped from an old CB radio, some amplifier stages and so on. The circuit is the following one:



(https://radiotransmitter.files.wordpress.com/2017/10
/4_dk7ih_small_qrp_transceiver_2017_14mhz_ssb_main_rf_board.png)

The “Micro20-III” SSB QRP transceiver by DK7IH – Main RF board

Starting from left side top there is the first receiver amplifier stage using a dual-gate MOSFET. The use of a MOSFET transistor ensures that the noise figure and sensitivity of the whole receive improve very much. The stage is comnnected to the AGC chain. The dc voltage applied by the AGC section varies in the range from 0 to 6 V DC. In addition it can be set by hand by turning a front panel mounted potentiometer that alters the DC voltage in the range from 0 volts to max. volts from the ADC section.

The input is a single tuned circuit using 4 (antenna side) by 16 turns (MOSFET gate side) on a TOKO 5,5 mm coil former. Parallel capacity is 47 pF. In drain line of the transistor the same filter is used coupling the signal to the first mixer (NE612). Note that the second filter is reversed (secondary in drain line) to avoid self-oscillation of the preamp stage.

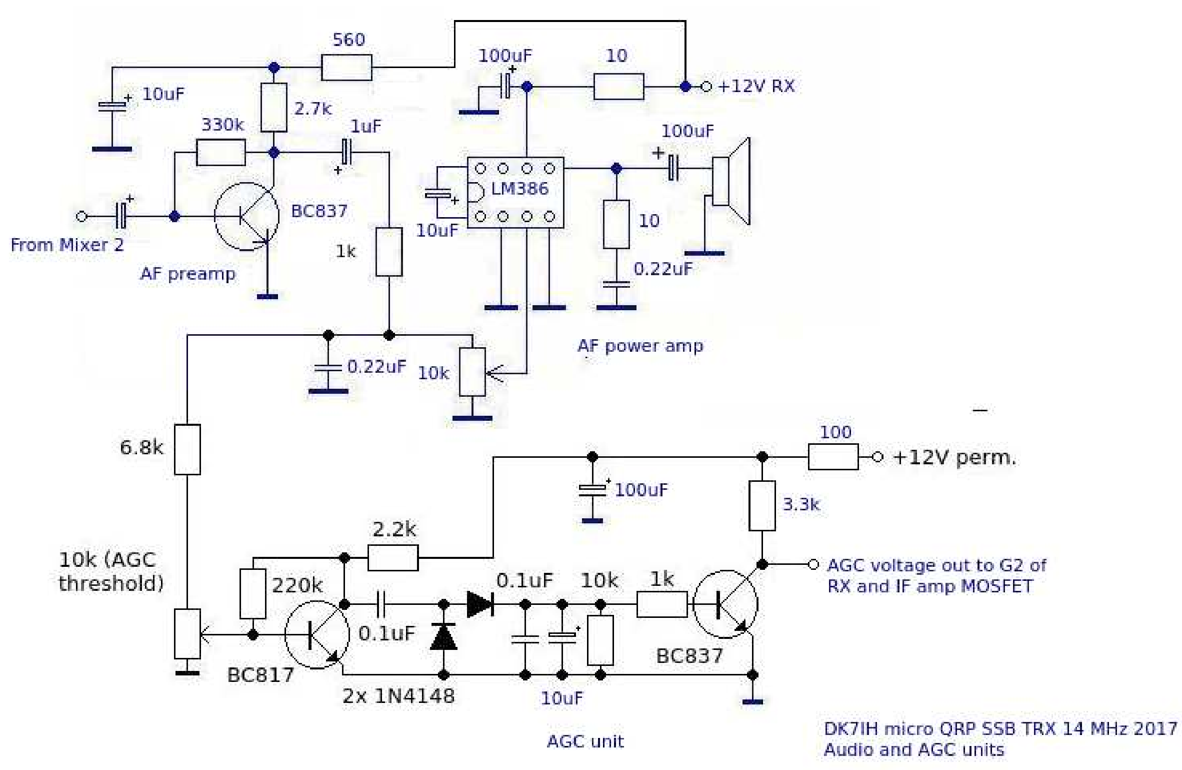
This mixer’s signal is fed with 2 different input signals (antenna or microphone) and with 2 different oscillator frequencies: about 24 MHz on receive mode or 10.695 +/- 1.5 kHz depending on sideband used when on transmit. The resulting interfrequency signal is fed into an SSB filter which is terminated by 2 resistors of 1k each side to ensure proper impedance matching.

Next stage is the interfrequency amplifier which is the same circuit like the receiver’s preamplifier. This one is also connected to the AGC’s

DC line. On transmit mode with no AF signal on the AGC present this stage runs on full gain.

The chain is completed by the second mixer serving as product detector on receive and as tx mixer when going “on the air”.

The audio and AGC section



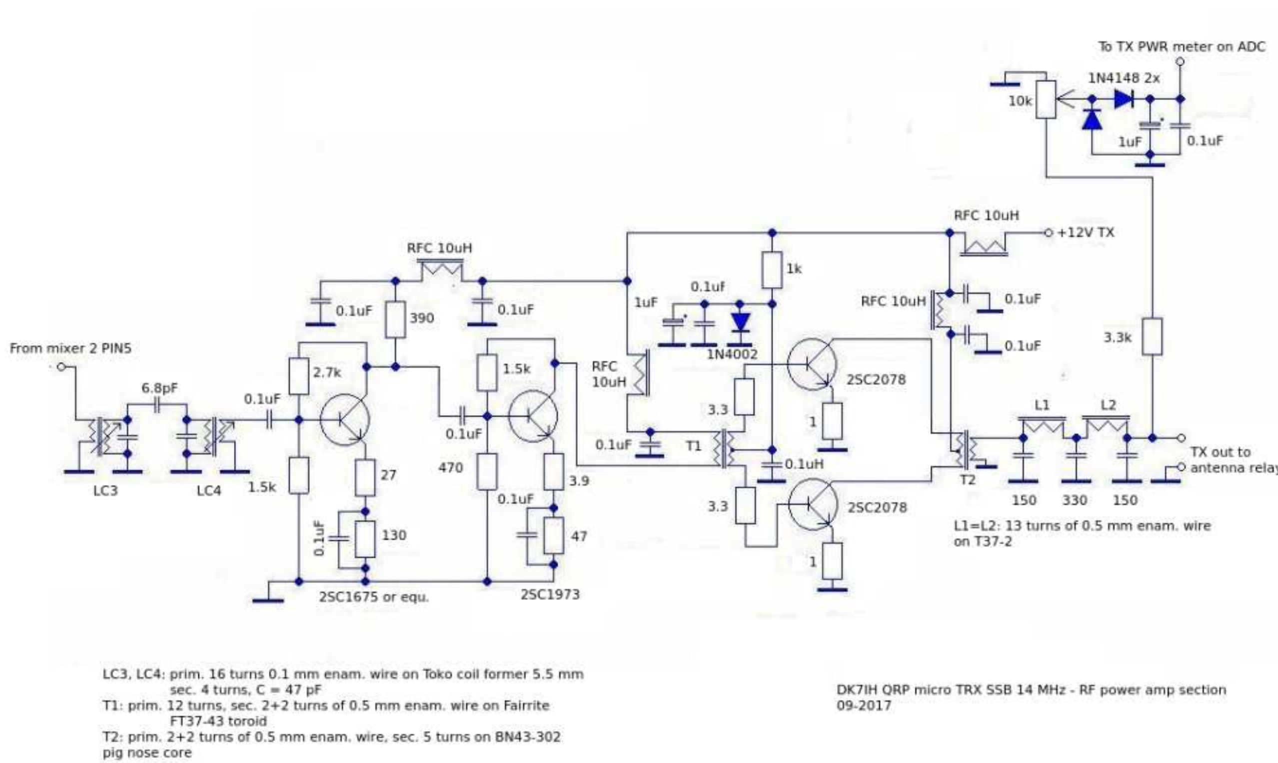
(https://radiotransmitter.files.wordpress.com/2017/10/5_dk7ih_small_qrp_transceiver_2017_14mhz_ssb_audio_amp_agc.png)

The “Micro20-III” – A small 20 meter QRP SSB transceiver by DK7IH – Audio amp and AGC

This section also is no “rocket science”. A simple preamplifier using a bipolar transistor (BC846) in common emitter mode, a low pass filter (R=1k and C=0.22uF) and an LM 386 amplify the resulting af sig to an adequate volume to listen to the sound even in an environment that is not 100% noise free.

The RF power module

This is a circuit I have built several times and it's capable of delivering up to 5 watts of rf power. In this transmitter I'm not driving it beyond 3 watts which is suffice to establish connections on the 20 meter band worldwide a well performing antenna provided.



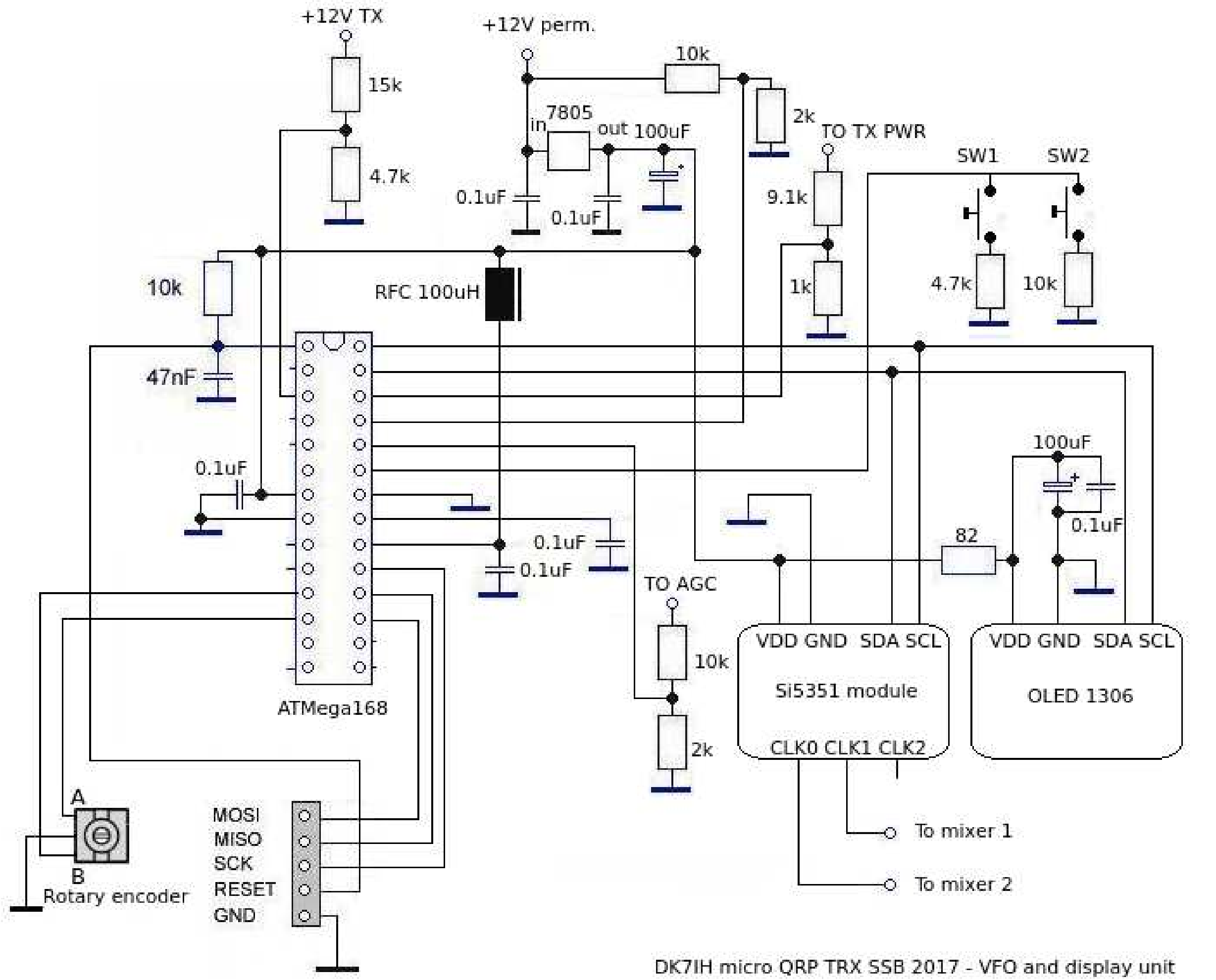
(https://radiotransmitter.files.wordpress.com/2017/10/6_dk7ih_small_qrp_transceiver_2017_14mhz_ssb_rf_power_amp.png)

The "Micro20-III" – A small 20 meter QRP SSB transceiver by DK7IH – RF Power Amp

Emitter degeneration and negative feedback are present in **preamp** and **driver stage** to ensure maximum linearity. Both stages are operated in class A mode. The final stage works as a push-pull stage using class AB. Push-pull mode eliminates even order harmonics by circuit feature. A heatsink is mandatory for the final stage (the mounting frame in my case) and at least recommended for the driver. The values for the broadband transformers are stated in the schematic above.

The VFO module

This one is equipped with the clock oscillator chip Si5351A by Silicon Labs (https://www.silabs.com/documents/public/data-sheets/Si5351-B.pdf). I use it mounted to the well known Adafruit breakout board that can handle 5 volts even if the chip is designed for 3.3V. So, this board is compatible to standard microcontrollers like the ATmega168 that is applied in my transceiver. The display is the 1306 chipset based OLED that is also designed for 5 volts supply voltage. Both, the Si5351 and the OLED are designed for I²C-interface which is called "Two Wire Interface" (TWI) in Atmel's language. The major advantage this interface has got is that only 2 control lines are required, one of them clock (SCL) and the other data line (SDA) to transfer data to the respective units. Basically you need two pull up resistors to tie these lines to +5VDD but I use the internal pull-up resistors in the Atmega168's ports that do the job well.



(https://radiotransmitter.files.wordpress.com/2017/10/7_dk7ih_small_qrp_transceiver_2017_14mhz_ssb_vfo_oled_uc.png)

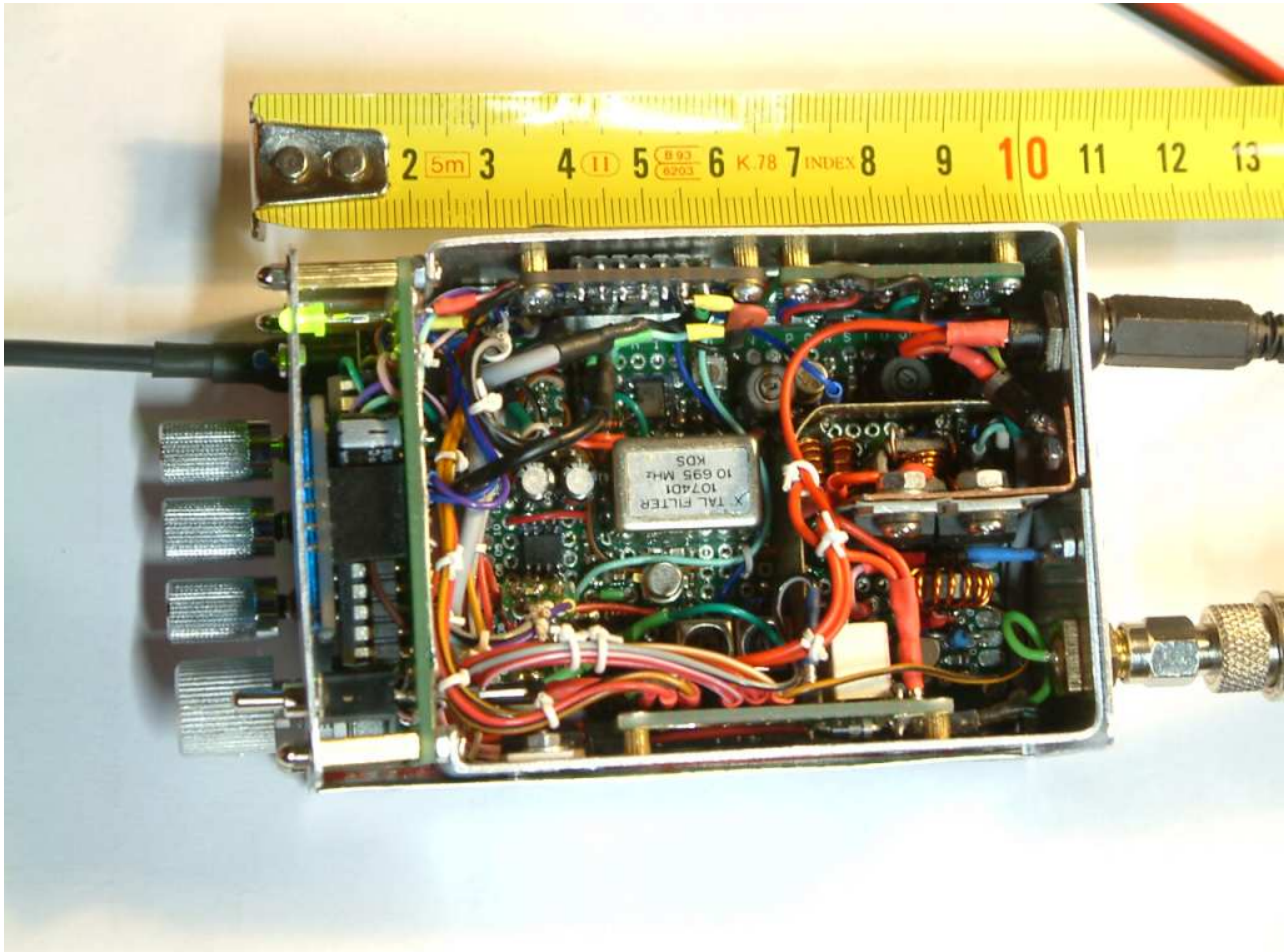
The “Micro20-III” – A small 20 meter QRP SSB transceiver by DK7IH – VFO with Si5351, ATmega168 and OLED 1306

Problem to be mentioned: When testing the early version of the receiver I found the OLED to be very noisy. After a brief research I realized that the signals that were audible in the receiver traveled on the VDD line. Thus I inserted an 82R series resistor and a set of blocking capacitors in the place which made the noise fully disappear.

Practical setup

The main board of the transceiver is made of a 5 by 7 cm breadboard with double-sided soldering pads each connected by a small tubing electrically connecting the both sides of the pad . This is a big advantage when you solder SMD components because you can setup the circuit on both sides of the board and save a lot of space. NExt is that it is nearly impossible to dissolder the pads even if you are resoldering the spots many times. The reason: The soldering pads are rivets anchored on both sides of the carrier of the board.

The components that aren’t available in SMT are standard through-hole but there are only a few like the SSB filter or some old 40673s I used instead of e. g. BF991. Coils for low power are wound on TOKO 5.5 mm coil formers. Power rf transformers are connected to soldering nails in the board. The inside view plus a centimeter scale:



(https://radiotransmitter.files.wordpress.com/2017/10/8_dk7ih_small_qrp_transceiver_2017_14mhz_ssb_inside.png)

The “Micro20-III” – A small 20 meter QRP SSB transceiver by DK7IH – Inside view from top

On the left you can see the front panel with the controls, behind the panel the OLED and then the main rf board. The Si5351 is mounted vertically on top left from the AGC board. Underneath there is the receiver’s front end (hidden by the red power supply cable). On the right I sited the power transmitter, at the bottom there is the relay for tx/rx switching. All is built into a 9 * 5.5 * 4 cm Aluminum frame.

Being “on air” with the rig

Operating is really fun with this micro transceiver. Since the finishing of the transceiver 4 weeks ago I was on air daily. Here are some regions of the world I could establish successful contacts with. Antenna is a Delta Loop fed in on upper corner about 12 meters above ground.

(https://radiotransmitter.files.wordpress.com/2017/10/9_dk7ih_small_qrp_transceiver_2017_14mhz_ssb_worked_regions.png)

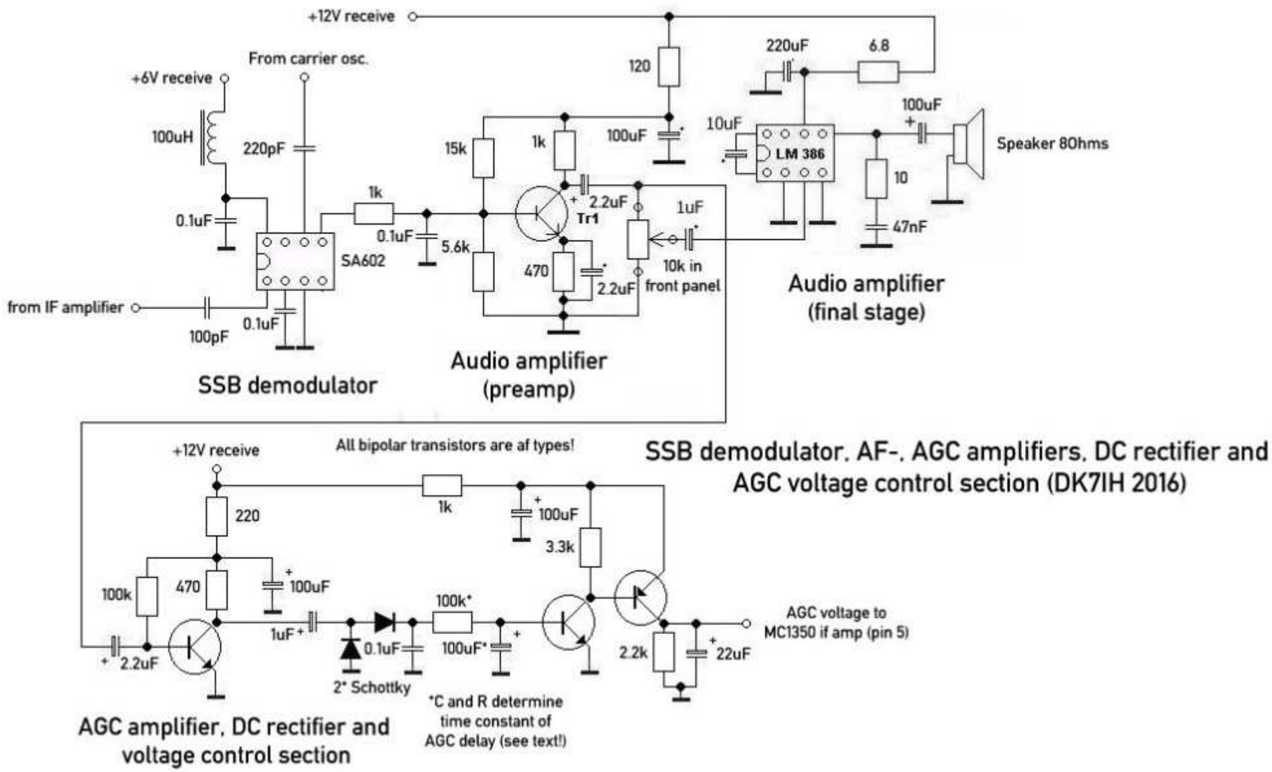
Plans for the future

Several options may be my next project: First I got plans are to expand this rig to a multibander (due to Si5351's capabilites of generating max. 160MHz signals), build a PA of about 30 watts max. power (with 2 transistors 2SC1969 in push-pull mode) or to rebuild the transceiver for 17 meter band and hoping that conditions will be better the next couple of years. Let's see what the real deal will be! 😉

73 de Peter (DK7IH)

A very compact SSB transceiver for 40 Meters with 50 watts of output power (Product detector, AF, AGC)

28. AUGUST 2016 ~ DK7IH ~ 12 COMMENTS
The demodulator section of the transceiver's receiver starts with the product detector, which is made of another SA602. To get more audio volume a preamplifier has been added before the LM386 follows.



(https://radiotransmitter.files.wordpress.com/2016/08/prod-det-af-agc-40-meter-trx-50-watts-ssb.jpg)

Homemade SSB amateur radio transceiver 40 meters (SSB demodulator, AF, AGC section)

The AGC section hast got 2 crucial components: One resistor (this case 100k) and an electrolytic capacitor (in this case 100uF): They determine the time ramp for the AGC regulation curve. This means they define the response and decay time for the AGC and thus should be made easily changable for example by putting them into socket strips.

Hint: In certain cases it can be useful to add a potentiometer to give you control on the audio input of the AGC preamplifier.

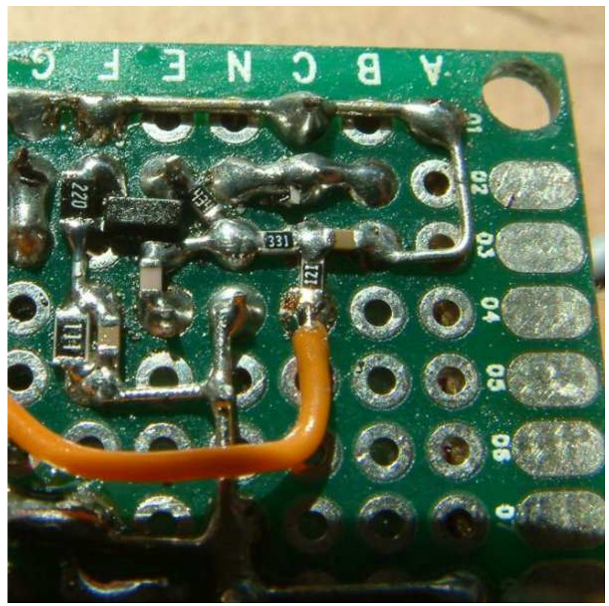
Thanks for watching!

73 de Peter

A very compact SSB transceiver for 40 Meters with 50 watts of output power (IF amplifier)

25. AUGUST 201626. AUGUST 2016 ~ DK7IH ~ 5 COMMENTS

The if amplifier has been slightly revised. I added a preamplifier after the 1st mixer to enhance overall gain. Due to the fact that the veroboard is crowded with the components that had already been installed, the preamplifier has been worked out in SMD technology using the reminaing space on the reverse side of the board underneath the SSB filter were still some room has been available:

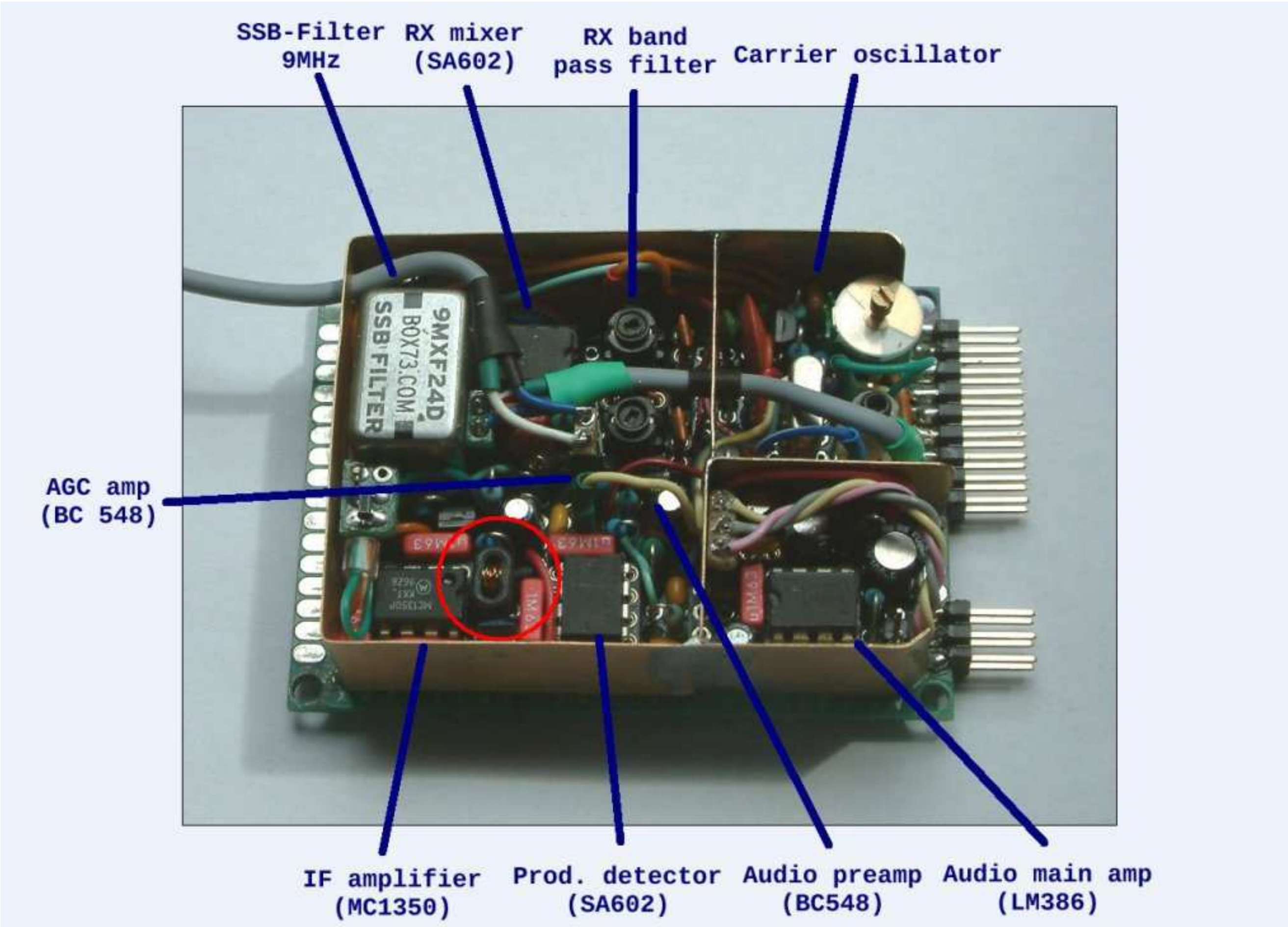


(https://radiotransmitter.files.wordpress.com/2016/08/if-preamplifier-in-smd-technology.jpg)

IF peamplifier in SMD technology

This new part of the circuit is not marked in the block diagram I’ve posted some days ago. As main amplifier of this stage, MC 1350 is used.

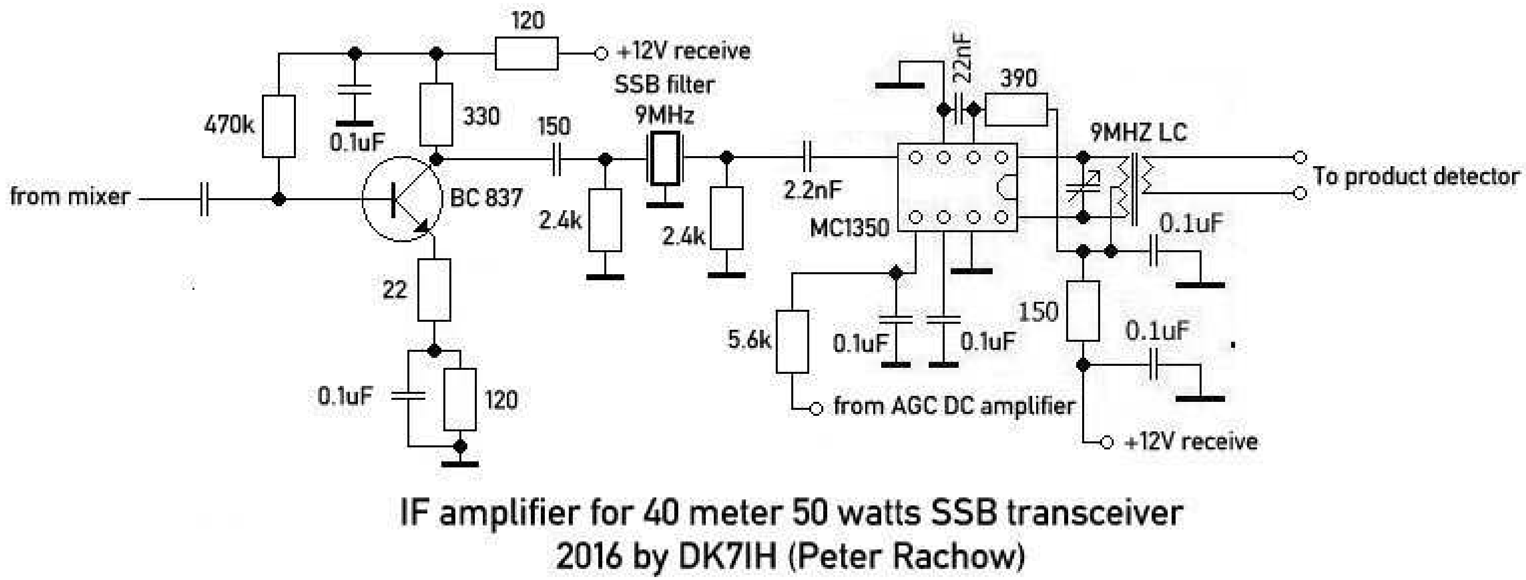
Due to space saving reasons the tuned circuit to terminate the if amplifier IC has been made of a very smmall pig-nose core:



(https://radiotransmitter.files.wordpress.com/2016/08/if-amplifier-detail.jpg)

IF amplifier detail

The parallel capacitor has been experimentally optimized by putting various capacitors into a 2 pin part of a socket strip (http://media.digikey.com/photos/Mill-Max%20Mfg%20Photos/310-43-118-41-001000.JPG) and keeping the best valued. The MC1350 is gained controlled by an AGC amplifier and DC rectifier section to be described later. Please notice the correct termination of the SSB filter with 2 resistors 2.4 kOhms each.



Homemade SSB amateur radio transceiver 40 meters (IF amplifier) Homemade SSB amateur radio transceiver 40 meters (IF amplifier with bipolar transistor and MC1350)

Thanks for watching! Vy 73 de Peter (DK7IH)

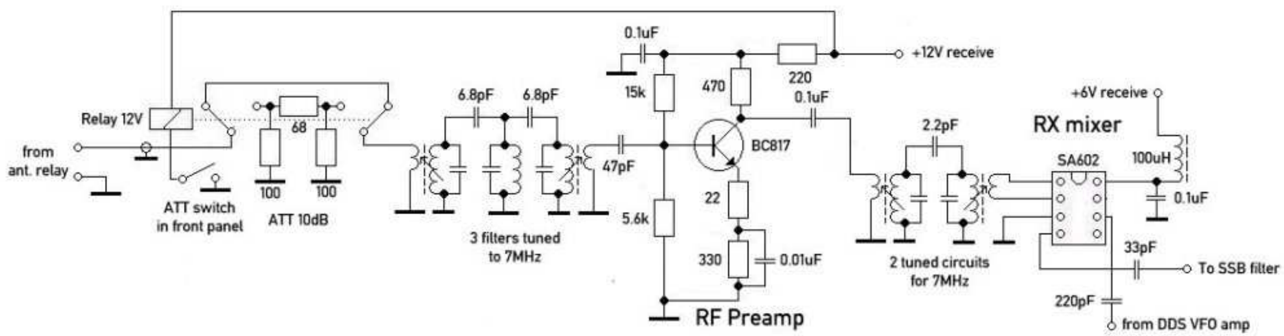
A very compact SSB transceiver for 40 Meters with 50 watts of output power (Receiver front end and 1st mixer)

23. AUGUST 201623. AUGUST 2016 ~ DK7IH ~ 5 COMMENTS

For my compact 40 metres transceiver there was not plenty of space for complicated circuits. So I had to find a simple but effective solution for the singe stages. Everybody knows that the first stage in the receiver's front with the 1st mixer, which is a crucial one, determins the overall performance of the whole receiver to a wide extent. So, which mixer should I use?

Among the "standard" mixers available on the market there is one, that uses only a few external components as a mixer stage that, aside from mixing two signal, delivers a recognizable amount of gain (around 18 dBs): The well-known NE612 (http://www.nxp.com/documents/data_sheet/SA602A.pdf) (aka "SA602" and other derivates).

But there is one problem: The NE602 has been developed for VHF communications where excessive signal strenghtes are not the primarly issue. On 40 metres the situation is different. Very much different. OK, even if strong in-band signals are present they won't push the NE602 to its limits as I could find out, the problem are the extremely strong signals from broadcasters at 7.200 khz and above.The NE602 reacts with lots of spurious signals if input levels are too high. Thus, developing a front end, that is able to cope with extremely loud signals only some Kilohertz away fron the operating frequency was a challenge. Intense filtering was the key to success. Here is my solution:



Receiver front end for 40 Meters/7MHz transceiver
by DK7IH (Peter Rachow) 2016

(https://radiotransmitter.files.wordpress.com/2016/08/rx-front-end-40-meter-trx-50-watts-ssb.jpg)

Homemade SSB amateur radio transceiver for40 meters (Receiver's front end)

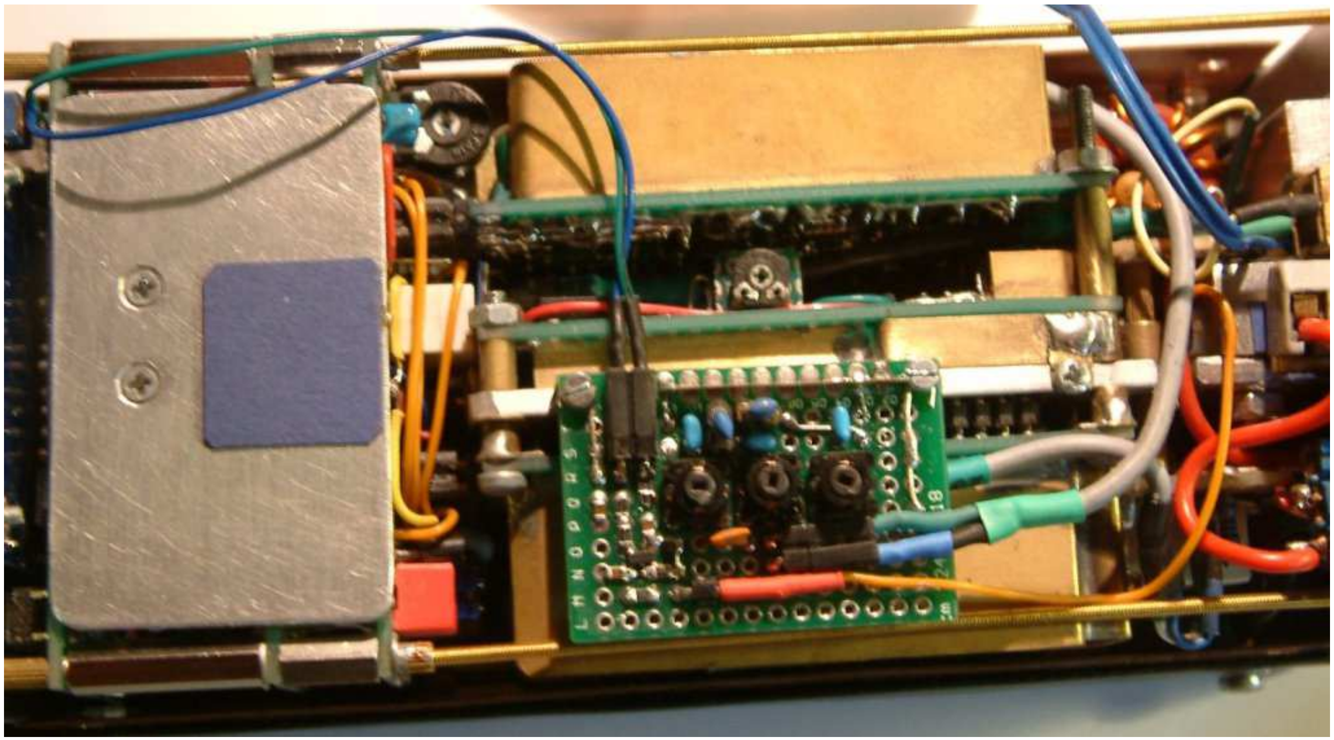
For extreme receiving situations with excessive out-of-band signals there is a 10dB attenuator switchable from the front panel. As I found out this is only required if you use an antenna that delivers high rf voltages in the evening from broadcast stations transmitting above 7.200 kHz (like my Deltaloop does). With my vertical antenna using the attenuator on the other hand is obsolete.

After the attenuator you can see a three-pole filter made of tuned circuits with a center frequency of about 7.100 kHz. The trick is the loose coupling between the single tuned circuits. This makes the filter extremely sharp but costs you some gain. To compensate the loss, the following stage equipped with an NPN-transistor is used. Noise figure enhancement is not the problem on 40 meters, so I did not use a FET.

A bipolar transistor fills the needs.

After that another 2 tuned circuits, also extremely loosely coupled, follow. Next is the well-known SA602 mixer IC powered with the input signal from the 7MHz filtes and the DDS VFO.The input to PIN 1 and 2 of the mixer IC is symmetical which is preferably to the single ended unbalanced method seen in many other circuits.

The practical solution of the RF preamp is a flat package mounted to the side of the transceiver's mainframe:



(https://radiotransmitter.files.wordpress.com/2016/08/rx-front-end-1st-amp-for-40-meter-trx-50-watts-ssb.jpg)

RF Preamp with 3-pole-filter for 7MHz receiver using SMD technologoy for the amplifier

You can see the antenna input from the right, an on/off switch from top (not in schematic) and the output to the 1st mixer also on the right (connected to the reverse side of the PCB).

Thanks for watching es vy 73 de Peter (DK7IH)