Kit building instructions for:

QROlle II

Analogue boards A and B

With all SMD components preassembled

Ver 1.5 – 29 Jan 2010

More information at:

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This is how your QROlle II will look like when ready built. Have fun!

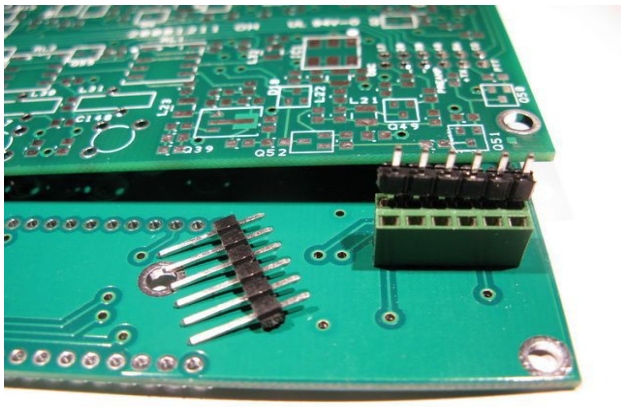
Content:

Preparation

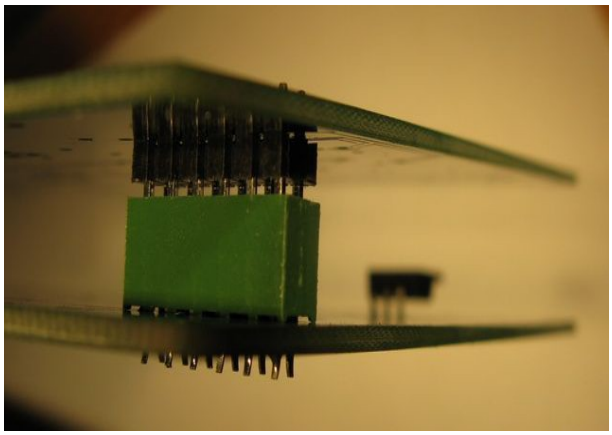
Start by getting acquainted with the boards, A and B. Walk through the construction by comparing the circuit diagram, the block diagram and the boards. Components on board A have postfix A, B board correspondingly postfix B (R12A, R12B etc) on the schematics. All semiconductors, coils and bigger components are labeled with white text on the boards.
The transmitter driver and power stages are mounted on the B board. The power control part and a few lesser function are also situated on B board.
The transceiver's main oscillator is on the Combo (C) board, feeding the A board via the B board. The analog boards are controlled digitally by the Digital (D) board via an IO-controller-chip on the C board and the processor on the D board. The controlling signals have the prefix IO (IOPRE, IOMO etc). For example, if the 40 meter band is selected the IO-signal IO40 is active, i.e. +5 volts. If compression is selected the IOCO is +5 volts. This information is necessary when tracing and measuring the signals on the boards. Check that the boards have all components aligned and soldered. When circuit boards are machine-assembled there MIGHT be a connection with bad soldering or a component that is slightly twisted. Should you find these types of errors resolder the component.

Connecting the A and B boards

Two 2x6 pole connectors make the electrical connection between the A and B boards.



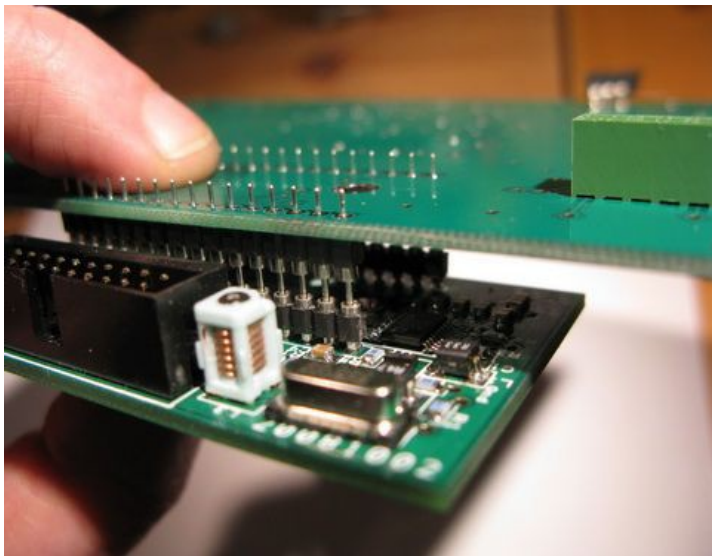
Connectors between A and B board.



The connectors in position.

-Mount the female connectors on the bottom of the B board, i.e. the soldering will then be done on the component side of the B board. Press the connector against the surface of the board when soldering.
-Mount the male connector parts on the bottom of the A board, i.e. with the soldering on the component side of the B board. Keep the connector part perpendicular and against the board when soldering.
The electrical connection between the Combo and B boards is made of two 16-pin headers, the male part on the B board.
-Cut the 20-pole pin headers so you have two 16 pin headers.
-Press the thinner pins half way into the female part of the connectors mounted on the Combo board.
-Press the thicker pins into the B board component side.

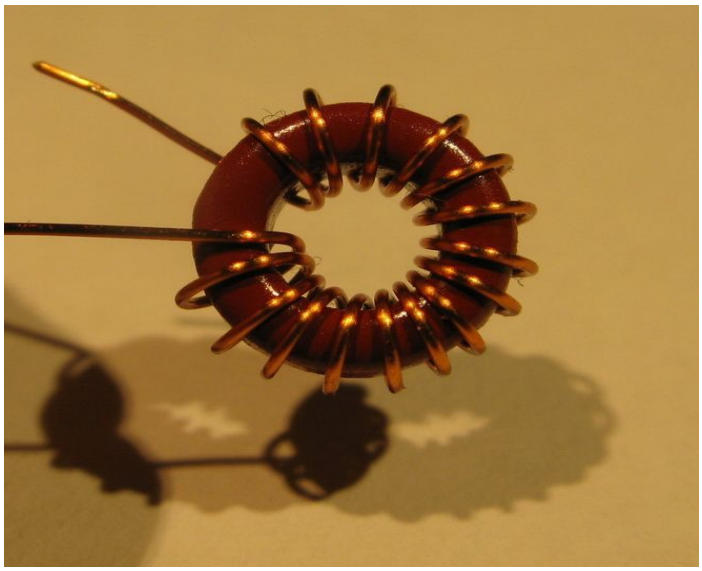
-Solder the outermost pins of the two pin headers on the solder side of B board. Check that all pins are fully pressed into the B board. Check that the pin headers are perpendicular to the B board and adjust if necessary.
-Remove the Combo board. Finish by soldering the rest of the pins.



Soldering of connectors between Combo and B board

Winding the coils and transformers

Wind the coils and transformers according to the table below. Count the number of turns by counting the number of times the wire passes the center of the core. The table also tells you the length of wire you need for a particular coil. The picture to the left shows L13B with 16 turns of wire.



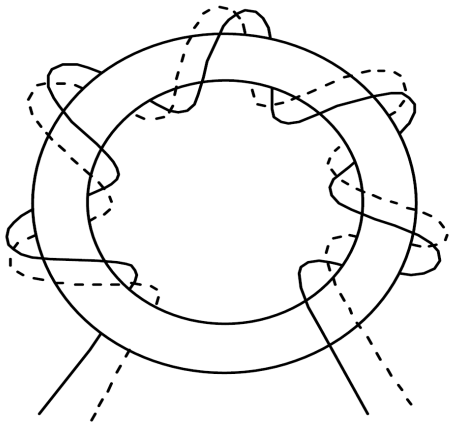
Showing single winding

The direction of the wires into the coils is very important (see image). If the coils are wound incorrectly you are bound to have problems later. Rewind a coil directly if you find you have made an error. Covering the wire ends with tin is most easily done with your soldering iron. Practice with a few wire ends before starting in earnest. Using a lot of tin makes this easier! Tin one end of the wire for a coil and start winding by threading the untinned end into the coil.

The tinning of the wire ends should be all the way to the toroid core on the coils and on the T1B transformer. Use a little less tin on T1A and T2B! The white core is sensitive to heat, so unwind a turn before tinning the wire end. Then wind the unwound wire back!

Start with the coils that have only one winding. Separate the turns to an even distribution around the coil. This will lessen the inductance spread and makes the coils look better! By practicing with the simple coils your work with the transformers will be improved. Soon you will learn how to make a nice looking coil!

Bifilar winding is done with two wires in parallel, see image! Check thoroughly so that the wires do not cross each other and that the turns are evenly distributed! This will improve the function and the appearance of the transformer.



Bifilar winding. Do not cross the wires!

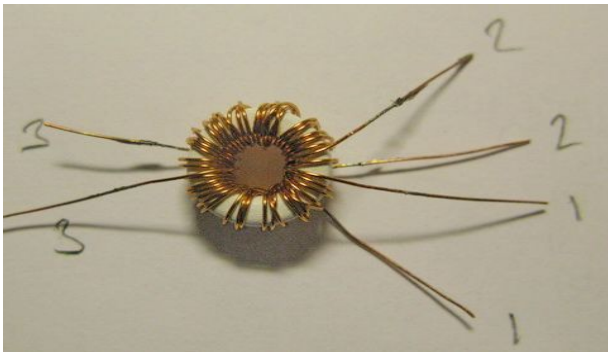
The graphic to the right illustrates how a bifilar winding is done. Take a close look and you will not fail.

Pay close attention on how you are to put windings in serial for correct functionality.

When connecting these windings in serial (like in T1A secondary) your are to put the right hand side solid line wire to the left hand side dotted line wire.

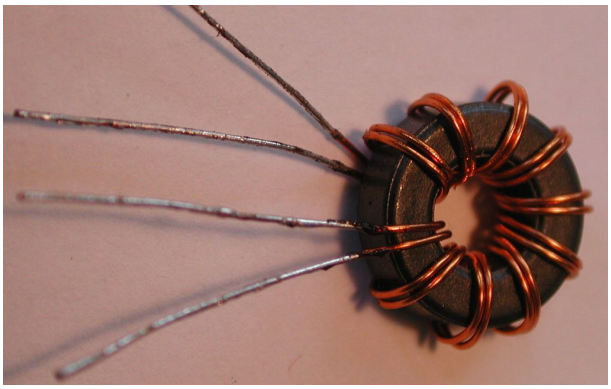
Lets have a look at the transformers in detail:

T1A - First step in winding: Do the bifilar secondary winding

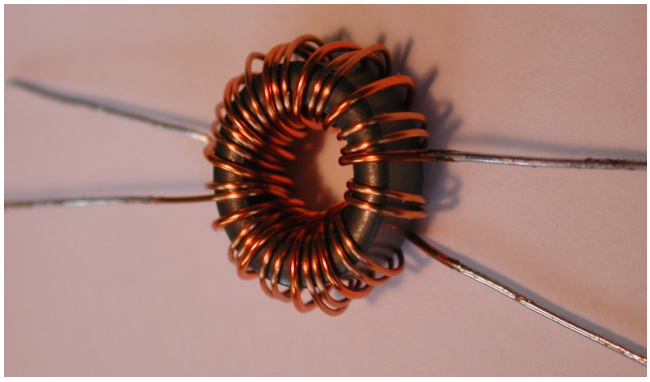


T1A ready - Now with the primary on top. 4C65 TN10/6/4 core used.

T1A transformer is wound in two steps. The secondary winding consisting of 2x15 turns is wound bifilarily, see the left image. In between the secondary windings you wind the primary winding 15 turns such that the wires never cross each other. The wire ends of the primary winding must point to the opposite side compared with the secondary wire ends. See the right image.



T1B: This one is easier. Have a good look at the picture above. Keep the wires in parallel all the way



T2B: First you should put the 10 turns evenly on the core with thicker wire (0.6mm). When done put the 20turns on top starting on the opposite side.

The T2B transformer is wound starting with the primary side, 10 turns with the thick wire. Distribute the turns evenly around the coil. Secondary winding is wound in between the primary winding, such that the wires never cross. So to wind the secondary winding you have to rotate the toroid twice, starting and ending at opposite sides of the primary winding start and end. See image!

Turn page for the winding details:

Name board A	Turns	Toroid type	Wire diameter and length
L24A-L25A	16	4C65 TN10/6/4	0,4 mm, 30cm
L26A-L29A	28	T37-2	0,4 mm, 39cm
L30A-L31A	24	T37-2	0,4 mm, 33cm
T1A	Pri 15 Sek 2x15bi	4C65 TN 10/6/4	0,3 mm, (1 + 2) x 32cm
Name board B	**Turns**	**Toroid type**	**Wire diameter and length**
L7B-L8B	22	4C65 TN 10/6/4	0,4 mm, 42cm
L9B	14	T37-2	0,4 mm, 20cm
L10B	26	T37-2	0,4 mm, 34cm
L11B	21	T37-2	0,4 mm, 30cm
L12B	19	T37-2	0,4 mm, 26cm
L13B	16	T37-2	0,4 mm, 23cm
T1B	Bifilar 2x10	FT-37-43 Black small toroid	0,3 mm, 2 x 16cm
T2B	Primary 10, secondary 20	FT-50A-43 Black big toroid	0,6 mm, 25cm 0,4 mm, 45cm

*) Note that the wire lenght given in the table is the length cut of for the work, to have good working headroom.

Image 1: Aren't they beautiful?

Rest of A board components

-Start by soldering the coils to their assigned places. The coil core with its winding must be mounted tightly to the board. Check that the placement of coils is correct.
-Solder T1A tightly to the board. The wire connection of the T1A is important. Measure with an ohmmeter which wires is connected. The bifilary winding must be connected so the 15 turns of the second wire are connected so that they are wound in the same direction as the first 15 turns. Even if you measure the windings it may be wrong so check carefully that the windings are serial! Another way to describe this step is to start the first part of the winding into the toroid in one direction. The start of the second part of the winding enters the toroid IN THE SAME DIRECTION AS THE FIRST PART! The start of the second winding, connected with the end of the first part, will form a center tap. The effect will be the same as if you wind 30 turns, making a center tap after 15 turns. Look at image 5. The dotted left wire must go to one of the center points in the layout, the right fully drawn line to the other center point pad.
-Solder the rest of the components; check that the electrolytic capacitors are correctly polarized!
-Cut off excessive wires on the board bottom side.

Rest of B board components

-Start by soldering the coils to their assigned places. The toroid with its winding must be mounted tightly to the board. Check that the placement of coils is correct.
-Solder T1B tightly to the board. The bifilarly winding must be connected so that the turns of the second wire are connected serially to the first turns so that they are wound in the same direction as the first turns.
-Solder T2B tightly to the board. The thick 10 turns wire is connected to the power transistor side, the thin 20 turn winding is connected to the harmonics filter and antenna output.
-Solder the rest of the components except the voltage regulator 7809, the RF power transistor IRF510 and the four diodes D10B-D13B (1N4148).
-Check that the electrolytic capacitors are correctly polarized before soldering them!
-Bend the pins of the 7809 and IRF510 perpendicular to the body as shown in the image. These two components are mounted on the bottom side of the B board, fastened to the aluminum sheet with M3-screw. This will help to cool the bodies. IRF510 must also have insulation between the sheet metal and the body, as the metallic part of the body is +13.5 volts! The insulation is made up of two parts, a thin insulating washer and an insulating bushing.

Image 2: Where to bend the pins

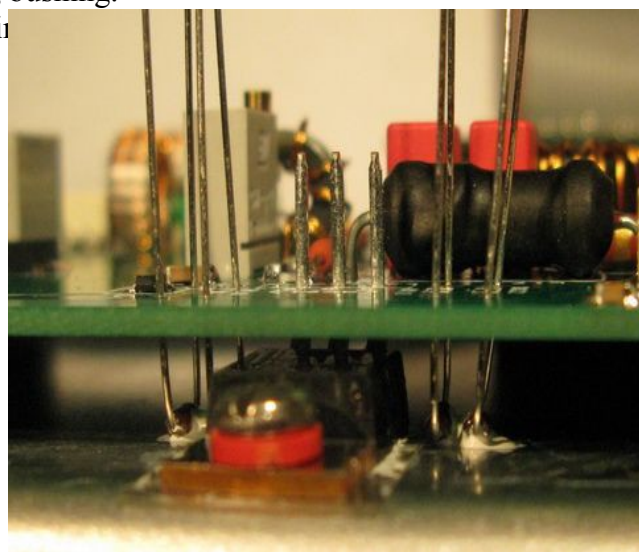
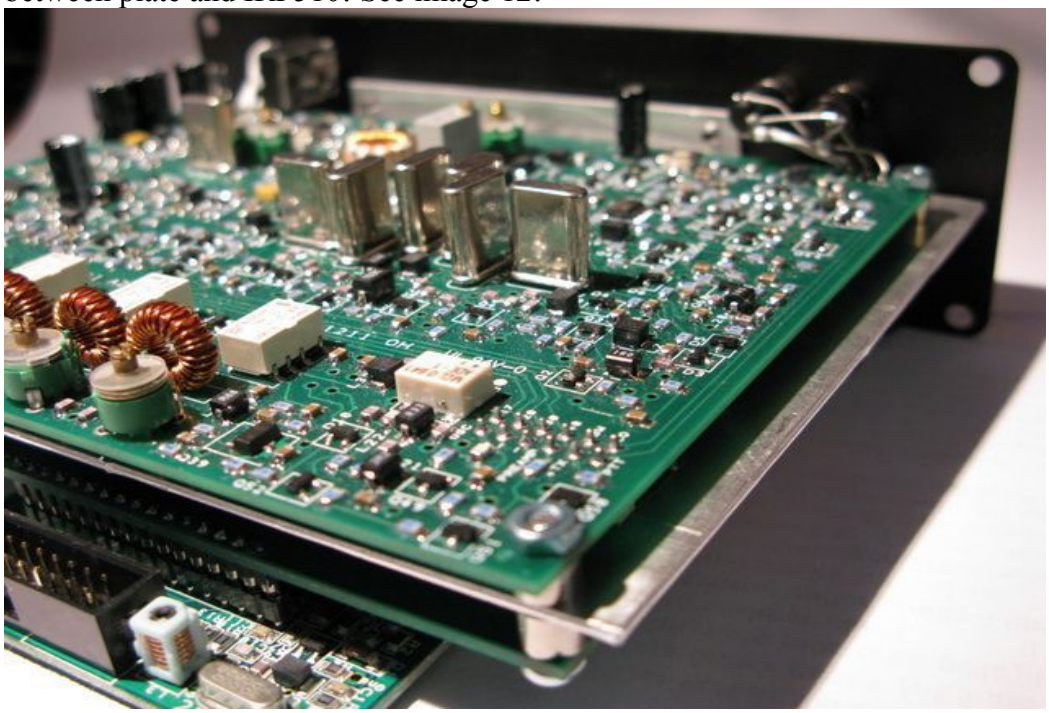


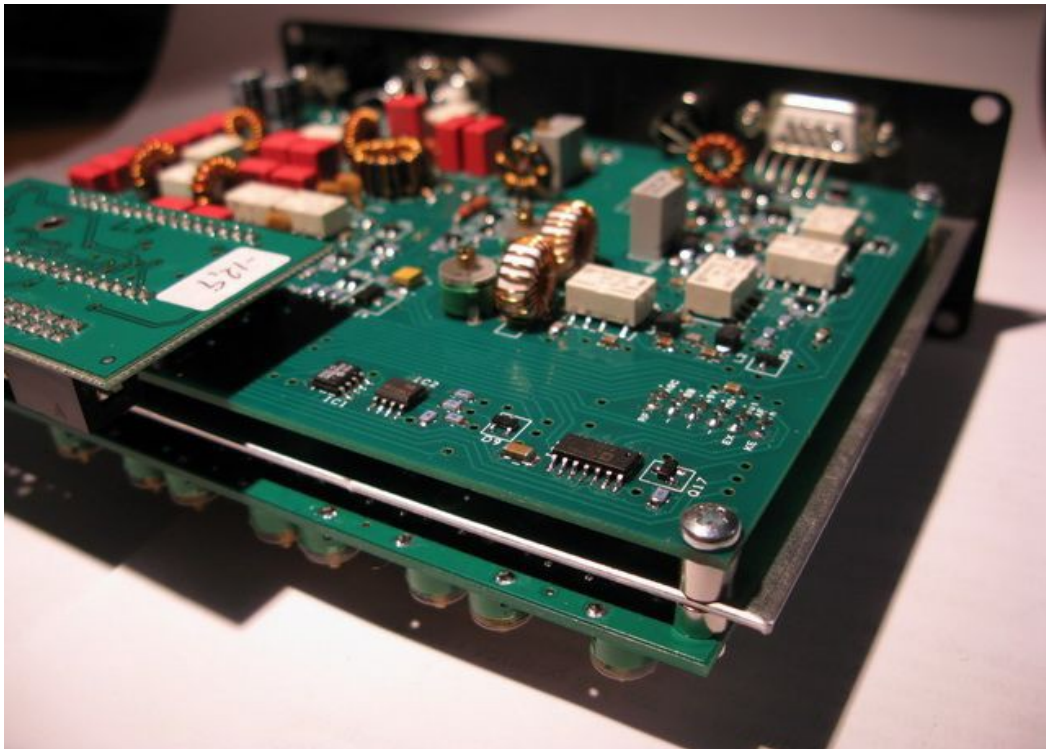
Image 3: Diodes and IRF510 ready to solder.

-Assemble the B board temporarily onto the aluminum plate with M3 screws, nut and 5 mm distance (not the 4 mm distance!). Compare the image showing the placed diodes and TO220 components with your own. Move the diodes so they are perpendicular to the plate, so that only the glass body in contact with the plate! Solder all the component connections.
-Cut excessive (> 1 mm) length of wires.

Assemble the A and B boards

-Press the A and B boards on either side of the aluminum plate.
-Fasten the boards with the long M3 screws and 4 distance spacers of 5 mm between B board and plate, 4 distance spacers of 4 mm between A board and plate. See image of assembly!
-Fasten the 7809 and the IRF510 as well, remember insulating washer and an insulating bushing between plate and IRF510! See image 12!





Both A and B and Combo boards correctly assembled.

Arrange for alignment and checkup

Before the A and B boards are adjusted and before power is connected the items below must be checked.
-Remember to disconnect the power EACH TIME you attempt to solder on any of the boards.
-The power transistor gate voltage must be adjusted to ground level. Measure the resistance between gate of Q16B and ground. Turn the trim potentiometer R25B to the lowest resistance, which will be approx 330 ohms. You will get lower ohm values at each end of the potentiometer setting so check that you set the pot to the LOWEST value.
-The driver transistor gate voltage must also be adjusted to ground level. Measure the resistance between gate of Q3B and ground. Turn the trim potentiometer R21B to the lowest resistance, which will be approx 0 ohms. See note above about potentiometer end values above!
-Short circuit the power switch connections temporarily.
-Attach cables for the power connector at the connection pads marked + 13.5V –. Do not attach the power supply yet! Attach the power connector to the cables. Check carefully the polarity of the voltage connected into the board. The best solution for checking and running the QROlle is a current-limited power supply. For the first tests a maximum current setting of 400 mA is sufficient. If the power supply has no current-limiting, attach a fuse in series with the power connector!
-Attach the power switch in between the PTT switch pad and ground temporarily. You will find the connection pad for the PTT switch close to the microphone input on the A board. Start with the switch in open position.
-Short circuit the choke L6B (at the Q3B gate) with a short wire temporarily. This will stop the RF-signal to the driver transistor.

Check of the voltage stabilizer 7809

-Apply 13.5 volts to the power connector. Measure between ground and the pads marked +9v. The

voltage should be approximately +9 volts (+- 5%)

Checking the RX/TX switching

-Measure the voltage at pad marked +RX. Close to C62A is a good place. Must be close to +9 volts.
-Measure the voltage at pad marked +TX. Close to C34B is a good place. Must be close to 0 volts.
-Activate the temporary PTT switch. +RX must now be 0 volt and +TX close to +9 volts.
-Deactivate the PTT switch.

Checking the Mode control voltage

-Measure voltage at +CW pad, close to C76A. Must be approx +9 V volt.
-Measure voltage at +SSB pad, close to C75A. Must be approx 0 volts.
-Attach temporarily a wire from +9v to the pad marked IOMO. This is easiest done at the 2x6 pole connector at the A board.
-Now the voltage at +CW must be 0 volts and +SSB +9 volt.
-Remove the temporarily attached wire.

Checking of the AF unit

-Attach the loudspeaker temporarily to the pads “phone” and ground on the A board.
IMPORTANT – Check one extra time that the connection between +9 Volt and IOMO is removed.
-Attach the Combo card (with the assembled front panel connected) to the B board. The Combo card will remain connected during rest of the testing/measuring.
-When applying power the display should show which software version is loaded, after a few seconds the main and secondary frequencies shown. See the user guide! Noise may be heard from the speaker depending on the volume setting.
-Check the function of the volume control. See the user guide!
-Set CW mode on the front panel.
-Activate the temporary PTT switch.
-Find the transistor Q27A. Connect the collector (CW MONITOR on the circuit diagram) to ground. A 700 Hz tone will be heard from the loudspeaker. After this check, remove the collector-to-ground connection. Deactivate the PTT switch.

Adjustment of the BFO

You need a good frequency counter or a well-calibrated receiver, capable of receiving 5 MHz, to properly adjust the BFO (Beat Frequency Oscillator).
-Connect the frequency counter between the C72A and C73A (IF CARRIER on the circuit diagram). If the signal is not strong enough for the counter you may attach the counter to the primary winding of T1A (the collector of Q31A). In this case the PTT-switch must be activated. If you use a receiver to adjust BFO, attach a short wire as an antenna. The receiver must be in USB or LSB mode. Look for the 5 MHz signal from the BFO. At zero frequency tuning, the BFO and the receiver's frequency are the same.
-Set mode to USB (IOSB 0 volts) on the front control.
-Trim C179A until you reach 5.0012 MHz.
-Set mode to LSB (IOSB +5 volts) on the front control.
-Trim C178A until you reach 4.9987 MHz.
-Repeat the above 4 steps until the values are correct.

Checking the RF IF unit

-Set the front controls to Wide bandwidth (IOBW +5 volt), preamp off (IOPREAMP 0 volt) and mode CW or LSB.
-Measure the voltage drop over following resistors (voltages are approximate):

R60A 0.13 V
R52A 0.05 V
R78A 0.49 V
R36A 0.64 V without input signal
R32A 1.23 V
R42A 0.32 V
R87A 0.086 V

-Measure the AGC-voltage without signal. This voltage is found on one of the 2x6 pole connectors. Before all is adjusted the voltage normally is about 9 volts. Later on it will be be about +6.7 volts.
-Use your fingertip and touch the transistor Q1A. At least in the evenings a few short wave transmitters can be heard.
Check the AGC delay. Check that the AGC voltage slowly increases when you remove your fingertip quickly!
-If you set a narrow filter (IOBW 0 volt) the sound from the loudspeaker will change its bandwidth.

Checking the XTAL filter unit

-Measure the voltage over the resistors:

R199A approximately 0.74 V with PTT-switch to on position.
R3A approximately 0.55 V with PTT-switch to off position.

Alingement of band filters

At this stage of the work the trimming will be only preliminary. The best trimming of the filters will be done using the transmitter, as explained below.
-Set the PTT switch to off position.
-Connect an antenna or signal generator to the antenna input pad.
-Maximize stable signals using the trim capacitors in the band filters. This is easier if you attach a voltmeter at the AGC output and trim for a dip in the voltage.

For the 80 meter band trim C1B and C2B. You must trim each trimmer more than once, alternating between them to cover the whole band.

For 40 meter band use C141A and C142A.
For 30 meter band use C143A and C144A.
For 20 meter band use C145A and C146A.
For 17 meter band use C147A and C148A.

-The receiver is now correctly trimmed.. The frequency displays can still show an incorrect frequency. This is adjusted via software in the menu of the program. The S-meter display is adjusted in a similar manner.
-Measure the following voltage drops over the resistors:

R214A approx 0.14 volts with preamp selected (IOPREAMP +5volt)
R216A approx 5.6 volts

Checking the microphone amplifier/compressor

-Set control to mode LSB or USB.
-Start with compressor off, i.e. no C on the display (IOCO 0 volt)

-Measure (voltages approximate)

Emitter of Q40A 0.34 volt
Emitter of Q41A 1.1 volt
Emitter of Q43A 5.3 volt
Voltage drop over resistor R148A:
Compressor off 0.93 volt
Compressor on 0.99 volt

If you have a tone generator and an oscilloscope you can perform additional checks.
-Connect the tone generator to the microphone input DYN on the A board. Use 1 to 2 kHz frequency. Measure (with the oscilloscope) at the point between C99A and R147A.
-Set trim potentiometer R152A in halfway position. Compressor to off (no C on display).
-Start with 1 mV amplitude and increase the signal. When you reach approx 1 Vpp the ALC system activates. This can be verified by measuring on the Q44A emitter and is easily seen on the oscilloscope.
-Adjust the signal from the tone generator until output voltage of amplifier is 0.5 Vpp. Now lower the input signal 10 dB. The output voltage will now decrease to approx 0.16 Vpp.
-Set the compressor to on (C on display). Adjust the tone generator voltage until the output voltage of the amplifier is 0.5Vpp. Decrease the input voltage 10dB. The output voltage will now decrease to approximately 0.35 Vpp.

Alignement of DSB/CW generator

Trimming will be easier if you use an oscilloscope or RF-meter. If this is not possible you can listen to the signal with an external amateur band receiver (NOT 5MHz!). In this case you can measure the signal level on the S-meter of this external receiver.
-No connection to the microphone input! Important!
-Set trim potentiometer R129A to middle position. Turning the potentiometer 20 turns in one direction, then 10 turns in the other direction, can do this. Ohmic measurement is not possible, the coil has very low ohmic value!
-Set LSB mode.
-Activate the PTT switch.
-If you have an oscilloscope, check the carrier signal on the primary side of T1A (collector Q31A). The expected value is approximately 1.4 volts.
-Connect the oscilloscope or RF-meter to a point between C96A and R138A.
-Minimize the output signal with the trim capacitor C180A. A distinct dip should occur!
-Minimize the same output signal, now with trim potentiometer R129A.
-Repeat the above two steps until the signal cannot be minimized further. The final trimming to dampening the carrier is best done using an external amateur band receiver.
-Connect a suitable microphone to the microphone input. Connect a dynamic microphone to DYN input, an electrets microphone to input marked EL.
-Listen to the signal on the amateur band of interest with an external receiver set in LSB mode when you whistle into the microphone.
-Adjust R152A while talking into the microphone so that only a few peaks reaches the ALC-threshold (measure on the Q44A emitter).
-Evaluate the quality in the LSB and USB modes.
-Listen also with the compressor mode..
Check the CW function:
-Set CW mode.
-Activate PTT switch.
-Keying is done by grounding the collector of Q27A (:or you may select “straight key” mode in the menu and ground one of the bug inputs on the B board). A 700 Hz monitoring tone will be heard.

The relation between monitoring level and received signal can be adjusted with trim potentiometer R102A.

Alignement of TX power amplifier

-Connect a 50 ohm dummy load to the antenna input.
-Set to CW mode. NO short circuit of Q27A collector to ground, bug inputs not connected.
-Activate PTT switch.
-Start with measuring voltage drop over these resistors:

R9B	approx 6.0 volts
R13B	approx 0.062 volts
R22B	approx 3.5 volts
R26B	approx 3.4 volts

-Measure the total current used by the transceiver.
-If you are using current-limiting, increase the max current setting to 1 A.
-Turn the trim potentiometer R21B to a position where the current consumption increases with 50 mA. Many turns will be required until the current suddenly increases! Do this SLOWLY!
-Turn the trim potentiometer R25B to a position where the current consumption increases with 150 mA from the value reached after trimming R21B. Many turns will be required until the current suddenly increases! Do this SLOWLY!
-If you are using current-limiting, increase the setting to 4 Amps.
-Remove the short circuit across the L6B you put in earlier.
-Ground the Q27A collector. Expect RF power over the dummy load. The current from the power supply will increase considerably. -Check that the RF output power control on the front (RF pwr) is functioning.
Now it is finally time to trim the band pass filters. Set the max RF power output to a couple of watts.
-Maximize the output power by adjusting the trim capacitors for the following bands:

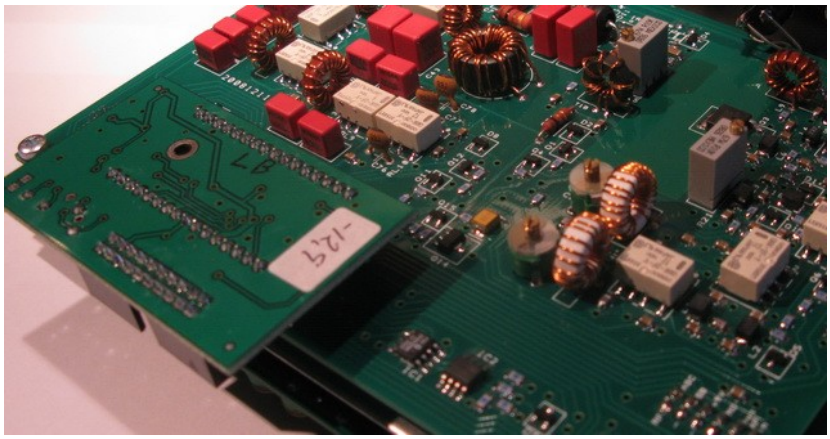
For 40 meter band use C141A and C142A.
For 30 meter band use C143A and C144A.
For 17 meter band use C147A and C148A.

-Trimming of 80 meter band is done by alternating between C1B and C2B until the output is high and approximately even at 3.530 MHz, 3.650 MHz and 3.770 MHz. .
Trimming of the 20 meter band is done so that it is possible to use the transverter.
-Connect an oscilloscope or RF-meter to point IF at the transverter connection. If you do not have access to an oscilloscope or RF-meter, it is possible to use an external receiver and maximize the S-meter indication.
-Set transverter mode with the band switch.
-Turn the RF power to maximum position.
-Trim C145A and C146A, setting the frequencies TA 100.00 (14.100 MHz), TA 500.00 (14.500 MHz) and TA 900.00 (14.900 MHz) respective. Localize a trim capacitor position where the output signal is high and even between the frequencies.
-Set 20 meter band and check that you have RF power over the dummy antenna as well.
-Check the max power output for all bands, normally around 10 Watts, a bit higher on lower bands and a bit lower on the higher bands.

Calibration of displayed frequency

The nominal DDS-reference frequency is 100MHz. The DDS-reference oscillator (5-th overtone) is adjusted for best ref-oscillator power. That will not necessarily result in a exact 100MHz output as it is individual X-tal dependent.

The C-boards (with DDS + DDS-ref circuits) are marked with the difference from 100MHz on a white sticker. In the QROlle software the DDS-reference frequency is adjustable.



Actual DDS-ref = (100MHz + Value on white sticker)

Example:
The C-board is marked -12.9kHz. This say that the reference oscillator frequency is: 100MHz-12.9kHz=99.987100MHz. (Positive numbers are written without + sign.)

Press MENU-button and select the option for setting the DDS-reference frequency. Set the value (As in the example 99.987100) and it's done.

If the BFO-frequencies are adjusted correct, the frequency shown on the LCD will be correct.