



## Speaky 5 Band CW SSB PSK Transceiver

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## Preface to building

Please note a few basic rules, before you begin building. Even the most proficient kit builder makes errors. A few rules and experiences keeps the error count low. You will find lots of good advice in the FI Workbench Manual, contained in the kit. In the Workbench Manual, we describe parts, tell about soldering, help in winding coils on the different coil forms used in RF electronics. As our kits primarily are directed towards beginners, old hands will find lots of known material. But repetition isn't that bad, and even experienced builders will probably find helpful advice. We advice reading through the Workbench Manual, as well as the present manual, before beginning assembly. Reading is very important. The developers have built several kits, the last of which were original kits like the one you have bought. We have tried to avoid any tricky procedures, to simplify the job for the beginner. It will pay off to read the manual before proceeding. Read every section in its full length before soldering!

The manual

**As the Speaky is quite complex, all diagrams and parts lists are put into a separate cover. This is to avoid flipping back and forth in the manual. The Speaky manual is divided in eleven sections. For every section you will find a text part with a check list, and a separate diagram and parts placement diagram. All parts belonging to the relevant section is printed in black. When needed for understanding function, parts from other sections are presented in grey. In the parts placement diagram, all parts to be mounted are in black, and already mounted parts are in grey. In the text, parts are listed in order of mounting. Please use the check boxes. This will in our experience reduce errors to a large degree. New parts are introduced in the text, when used. As the density doesn't allow a placement mask on the pc board, , we have introduced a coordinate grid on the board. The pc board is divided into 56 20 by 20 mm squares. Horizontally marked from A to H, and vertically 1 to 7. Every part is easy to find from this square grid.**

At the end of each text section, you will find a test description. Please don't continue till the assembled kit passes these tests.

And when you don't know what to do?

Please come to me. Easiest via email to [support@qrproject.biz](mailto:support@qrproject.biz) or by phone to +46 30 859 61 323.

To give you an impression of to whom you are speaking, I will present

myself briefly.:

DL2FI, Peter, known as QRPeter. Ham operator since 1964.

I am a passionate home brewer and QRP'er, and have been for years. It is my belief that the great chance for ham radio lies in the rediscovery of home brewing. My motto is: ham radio will be true again, when it is true to its roots. (Der Amateurfunk wird wieder wahr, wenn Amateurfunk wird, wie er war).

Based on this, I founded the DL-QRP-AG in 1997, the german QRP working group. Since then the group has grown to 2300 members, who have developed several designs helping to promote QRP world wide. Since january 2002, I also spend a lot of time on being chairman of the local Berlin chapter of the DARC (German ham radio club), as I rather prefer doing something to just quarrelling. Because of my work, I have been elected to the QRP Hall of Fame.

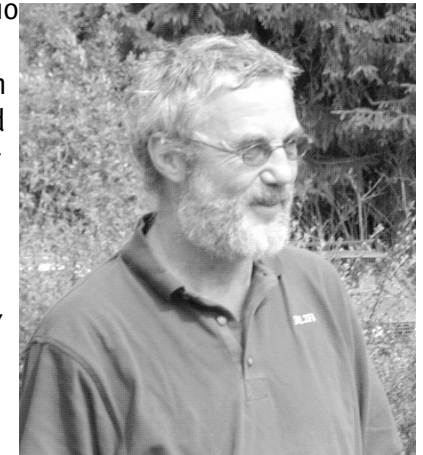
I wish you lots of fun on building the Speaky (Gonzales)

73 de Peter, DL2FI

DK1HE QRP SSB/ CW- Transceiver SPEAKY

### Preface:

Till recently ham operators equalled QRP work to CW. QRP'ers were ridiculed or considered masochist, who made it difficult for their fellow hams with their weak signals. This changed with the marketing of the FT-817 and its rapidly increasing sales. In several QSO's, it was noted, that the FT-817 was only some 2 S degrees below a standard 100 W rig. Previously impossible SSB DX contacts were now possible. [... EMVU .... pleas fix this: Die Scheu vor der Abgabe der EMVU- Selbsterklärung] made for a QRP renaissance. Thanks to the new licensing rules for VHF/UHF licensees, we can expect a further increase in QRP SSB activity. This couldn't be ignored by the DL-QRP- AG developers, and is was decided at the HAM- RADIO 2003 conference, to produce a SSB / CW- Transceiver in kit form for at least two



switchable HF bands. Based on the Black Forest, the Tramp and the Sparrow, it was possible to develop a kit in 4 months, primarily using conventional parts (only some 12 SMD's), for a 5 band SSB/CW transceiver, leaving nothing to want for its price class. Peter, DL2FI, nicknamed it SPEAKY (Gonzales) as complement to the Miss Mosquita. The following data speaks for themselves:

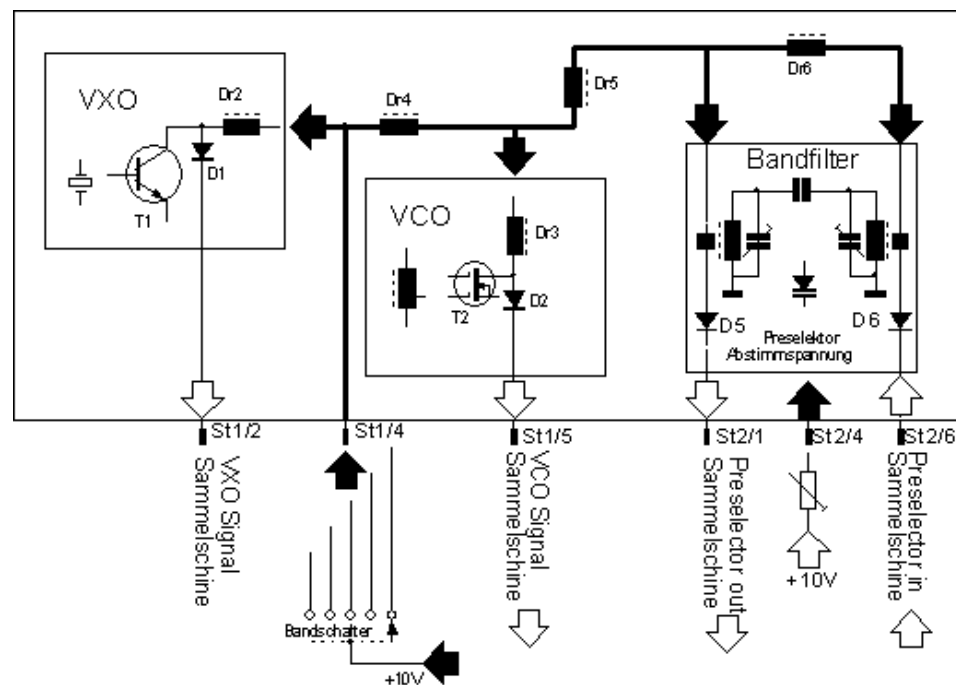
### Speaky technical data:

- From 1 to 5 HF bands switchable from the front of the box.
- Modulation: SSB/ CW/ PSK31 etc.
- Power input: 10W PEP
- DDS/ PLL- frequency control, with programmable frequency steps.(rotary encoder)
- choice of RIT or XIT; integrated keyer
- VFO tuning range 500KHz
- optional digital frequency readout.
- automatic bandwidth selection ( 2,4KHz/ 600Hz) of the 4pole 8MHz-crystal filter
- tunable high Q preselector
- High current RF input circuit with dynamic feed back.
- +7dBm- Schottky- ring mixer ( TUF- 1)
- High current J- FET IF amplifier
- > 90dB IF dynamic range (A244 IC)
- AGC production with peak to peak rectifier.
- AF section with power for loudspeaker
- robust PA with 2 x 2SC1969
- Transmitter output of 10W PEP
- switchable harmonics filter
- integrated speech compressor with a compression of max. 15: 1
- [please change this] Modulationsklirrfaktor of the compressor < 1% !!
- adjustable transmitter power
- CW- VOX with adjustable decay
- 10,8- 15V power supply
- Stable enclosure with prepunche holes
- Digital Frequency readout - measuring LO frequency
- Bargraph S-meter/relative Power Meter

### Description of the individual stages:

#### 1. Band switching:

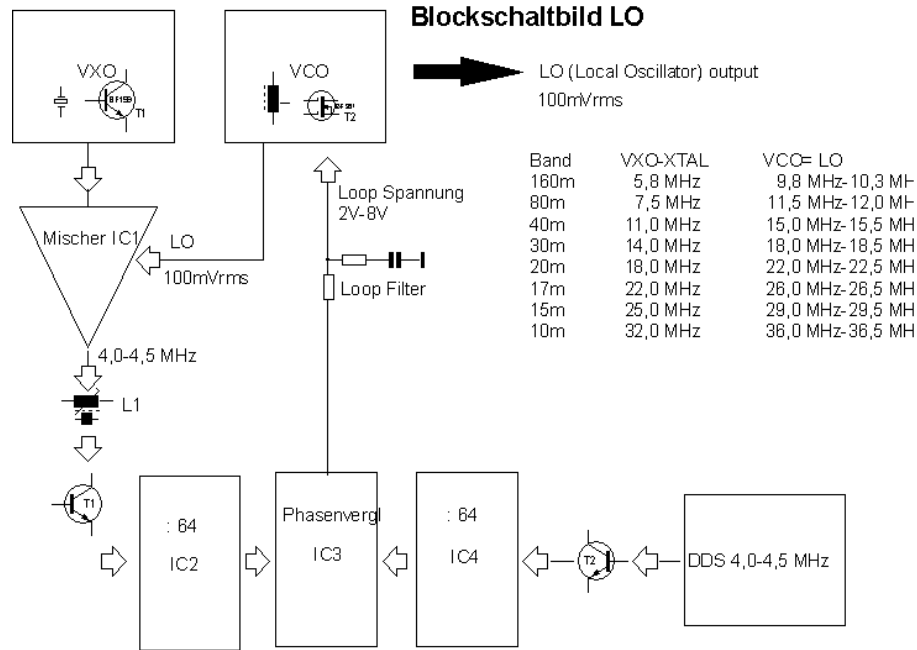
One of the main qualities of the transceiver is the ability to switch up to 5 HF band modules. To conserve space, only electronic switching was considered. All band specific parts are mounted in replaceable band modules. The following sections are switched when changing bands.:



- VCO
- Band set oscillator
- RX/ TX preselector

The inputs and outputs of all band modules are connected via the PIN diodes D1- D2- D5- D6 to a common bus. The 10V switching signal activates the diodes of the corresponding HF module. The chosen module is RF-wise connected to the bus. All other diodes on the inactive modules are blocked and high impedance. The systems impedance of the RF ports is some 50-100 Ohms, so the inactive modules are effectively decoupled.

## 2. Local oscillator signals:



The LO signal needed for transmitting and receiving is created directly on the frequency. Via a PLL the VCO is tied to a 4,0- 4,5MHz DDS- VFO. This approach reduces the need for filtering the harmonic rich DDS output before entering the transmitter/receiver mixer.

The MOSFET (T2) VCO in the band module oscillates on a frequency 8 MHz (the IF frequency) higher than the actual working frequency. The oscillator proper works a Hartley. D4 stabilizes the amplitude. The signal from P1/Dr3 is coupled via D2 to the common VCO bus. Because of the cascode coupling of T2, the VCO is effectively decoupled from the oscillator tuned circuit. The tuning diode D3 is coupled so hard via C20 to the VCO tuned circuit of L1-C9-C11, that it gives the proper tuning steepness. This gives a good side-band noise distance. The band set oscillator of the band module swings with T1 and Q1 4 MHz lower to the band frequency of the VCO. C3-Cr1 avoids 1. harmonic function of the overtone crystals (necessary on 15, 12, 10m). The crystal signal of R4-Dr2 is coupled to the bus via D1. IC1 handles the mixing of the VCO and band set XO frequencies. The mixer output circuit of L1-C5 is tuned to the difference between the two inputs; the fre-

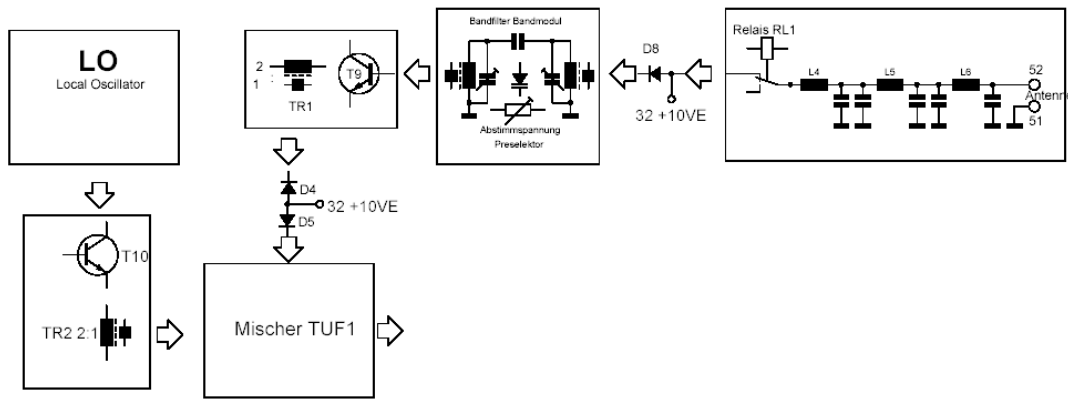
quency range is the range of the DDS- VFOs (4,0- 4,5MHz) . The via L1 inductively coupled amplifier T1 serves to raise the output signal of the mixer to the required input level of the following 64: 1 divider, IC2. At the output of IC2 is some 66 kHz, to feed to the frequency/phase comparator of IC3. The 2. port of IC3 gets another 66 kHz signal from the division of the DDS VFO frequency by 64 in IC4. IC4 will give a tuning voltage, depending on the size and direction of the difference between the output frequency of IC2 and IC4. This voltage is smoothed in the loop filter of R3-R4-C1 and passed to the VCO to give equal phase of the two ~66 kHz signals. If the VFO frequency changes, the VCO follows the change. As both VCO and XO are switched in a band change, it is possible to use the same VFO range for all bands.

## 3. VFO

We use a direct digital synthesis (DDS) VFO. The AD9835 chip is the heart of the circuit. With a 25 MHz clock from IC8 and serial data from the CPU (IC7), the DDS signal is taken from pin 14 of the AD9835 and passed on to the PLL. The low pass filter of L2-L3 dampens the side bands and phase noise typical of the DDS. Tuning of the VFO is done by a rotary encoder, and the frequency step can be chosen with a push button. IC7 also gives the possibility to program a transmission (XIT) or reception (RIT) offset. IC7 gives a CW marking of the mode, using the keyer function of IC7. LED's show the frequency range of the VFO in 100 kHz steps. An optional 7 segment LED display is available. Transmission or reception offsets are signalled on a LED. The VFO has a tuning range of 4,000 to 4,500 MHz (+/- 5 kHz). The stability of the VFO is based on the 25 MHz clock, and thus is the crystal stability needed for PSK31.

## 4. RX input:

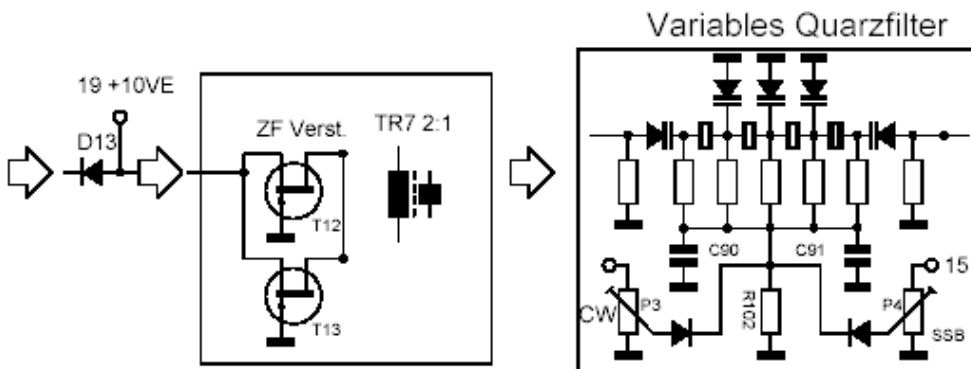
The input signal from the antenna passes through the 33 MHz transmitter low pass filter and goes via relay RL1 to the electronic switch of PIN diode D8. D8 conducts and leads the antenna signal to the band module/preselector bus via C35. This is followed by an undercritical double band filter with a out of band suppression (L2-L3). The antiseriably coupled capacity diodes D7-D8-D9-D10 changes the pass band for the SSB or CW band segment. Due to this good preselector, the RF stage and the input mixer is free of large BC signals. The steep preselector filter also gives a high mirror suppression and a minimum of IF throughput. The output from the preselector is led via



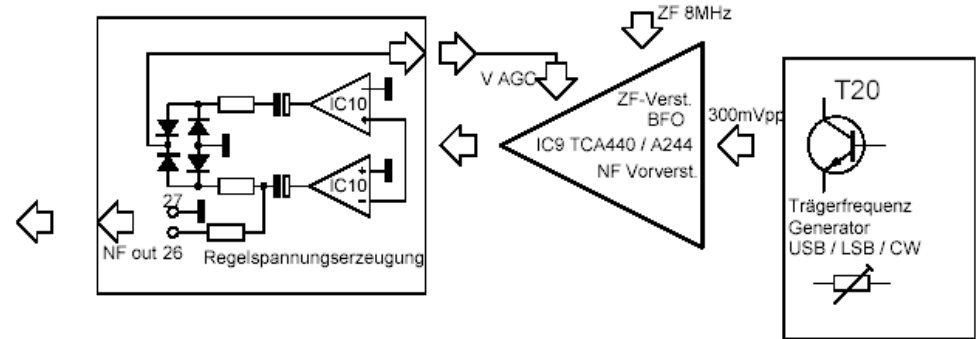
PIN diode D5 to the bus, and from there via C36 on to the RF input stage of T9. The amplifier works with a combined voltage and current feed back, and uses a large signal BK transistor. The working point is at  $I_c = 30 \text{ mA}$  to give good large signal data in conjunction with the feed back mechanism. The broad band transformer Tr1 in the collector circuit adapts the  $\sim 200 \text{ Ohm}$  amplifier output to some  $50 \text{ Ohms}$ . The amplification is at some  $18 \text{ dB}$ . The amplified RF signal is led via the PIN diodes D4-D5 to the RF port of the Schottky ring mixer M1, where it is mixed to an IF of  $8 \text{ MHz}$ . The broad band amplifier of T10 raises the signal level of the LO from the VCO bus to the  $+7 \text{ dBm}$  necessary for M1. Setting jumper J1 to the  $47 \text{ Ohm}$  terminating resistance, you can measure this level, when adjusting it with P1 on the band module.

#### 5. RX IF section:

The  $8 \text{ MHz}$  signal at the IF port of M1 is led on via the conduction PIN



diode D13 and C81 to the input of the gate coupled IF preamplifier. By parallel coupling of JFETs T12-T13 a  $50 \text{ Ohm}$  termination is achieved for M1; the forward steepness of some  $20 \text{ mS}$  gives a stage amplification of some  $15 \text{ dB}$ . The gate coupling gives good large signal characteristics and reduces the risk of intermodulation. The 1:1 transformer Tr7 gives a potential free coupling of the IF signal to the IF filter. We use a 4 pole  $8 \text{ MHz}$  Cohn filter with electronically adjustable filter band width. The usual capacitors are replaced by capacity diodes BB112. The crystals are chosen for less than  $50 \text{ Hz}$  difference around  $8 \text{ MHz}$ . P4 and P3



adjusts the filter width for SSB or CW. At  $4,5 \text{ V}$  on R102 the band width is some  $2,5 \text{ kHz}$ , at  $2 \text{ V}$  the width is some  $500 \text{ Hz}$  ( $100 \text{ pF}/350 \text{ pF}$ ). The filter is terminated at  $330 \text{ Ohm}$  as a compromise for pass band dampening. C93 leads the signal from the filter to the IF IC, IC9. IC9 is a TCA440 (or its replacement A244), having excellent RF data never achieved by any successor.

The TCA440 was originally developed as an AM receiver, but isn't used as such here. The integrated, regulated input amplifier is used as an  $8 \text{ MHz}$  IF amplifier. The following mixer works as a product detector with an external BFO. The part originally used a regulated  $455 \text{ kHz}$  IF amplifier is used as a regulated AF preamplifier. The AF signal of pin 7 is limited to a band width of  $0\text{-}2800 \text{ Hz}$  by C105. The following high pass filter of C106-R75 dampens signals below  $300 \text{ Hz}$ . This is followed by the AGC amplifier of IC10. This bridge amplifier with an amplification of some  $32 \text{ dB}$  leads the signal on to the symmetrical rectifier D24-D25-D26-D27. The DC voltage at the charge capacitor C103 is proportional to the IF signal and is fed to the regulating input of IC9 (pin 9). The two way rectifier gives a frequency doubling, producing only half the AC swing on C103 compared to the classical ap-

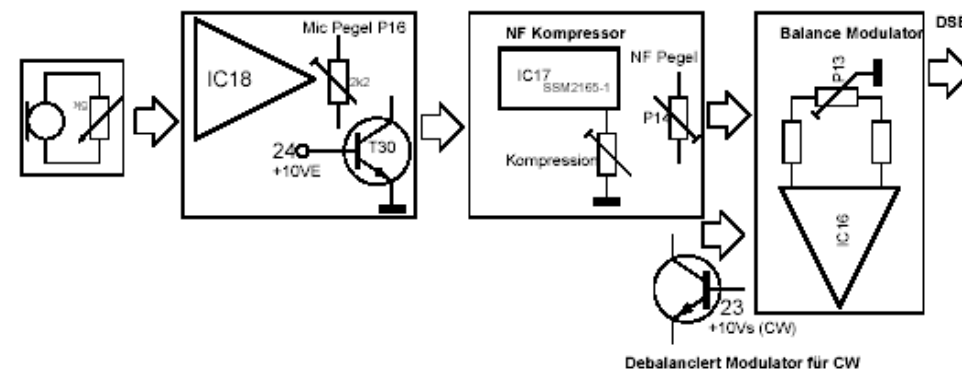
proach. Unpleasant overloading effects from insufficient regulating voltages at low speech frequencies is thus minimized. The decay is regulated by R72. R76-R77 defines the attack. You can attach an optional 100  $\mu$ A instrument at P5 to give a relative field strength indication. The combined IF/AF regulation is more than 90 dB!!! Input signals of S9+60dB are regulated distortion free. After a further 2800 Hz low pass at R78-C110, the signal is fed to an 800 mW AF PA in IC11. T16 blocks the regulating voltage during transmission. T17 blocks the AF amplifier during T/R switching to reduce switching noise.

#### 6. Side band oscillator:

The carrier needed for modulation and demodulation is generated by the capacitive three point circuit (Colpitts) at T20. The produced frequency is determined by the parallel coupled 8 MHz crystals Q6-Q7. The tuning diodes D29-D30 in conjunction with L7 leaves a tuning range of some 6 kHz for the VXO. P7 adjust the RF signal to some 300 mVpp and leads the signal via C97-C137 to the product detector of IC9 and the balanced modulator of IC16. The tuning voltage for D29-D30 comes from potentiometers P8 and P11, switched by the analog switch in IC12. This circuit gives the necessary carrier frequencies for the different modulation types, and for the varying center frequencies, in an easy way.

#### 7. 8MHz SSB generation:

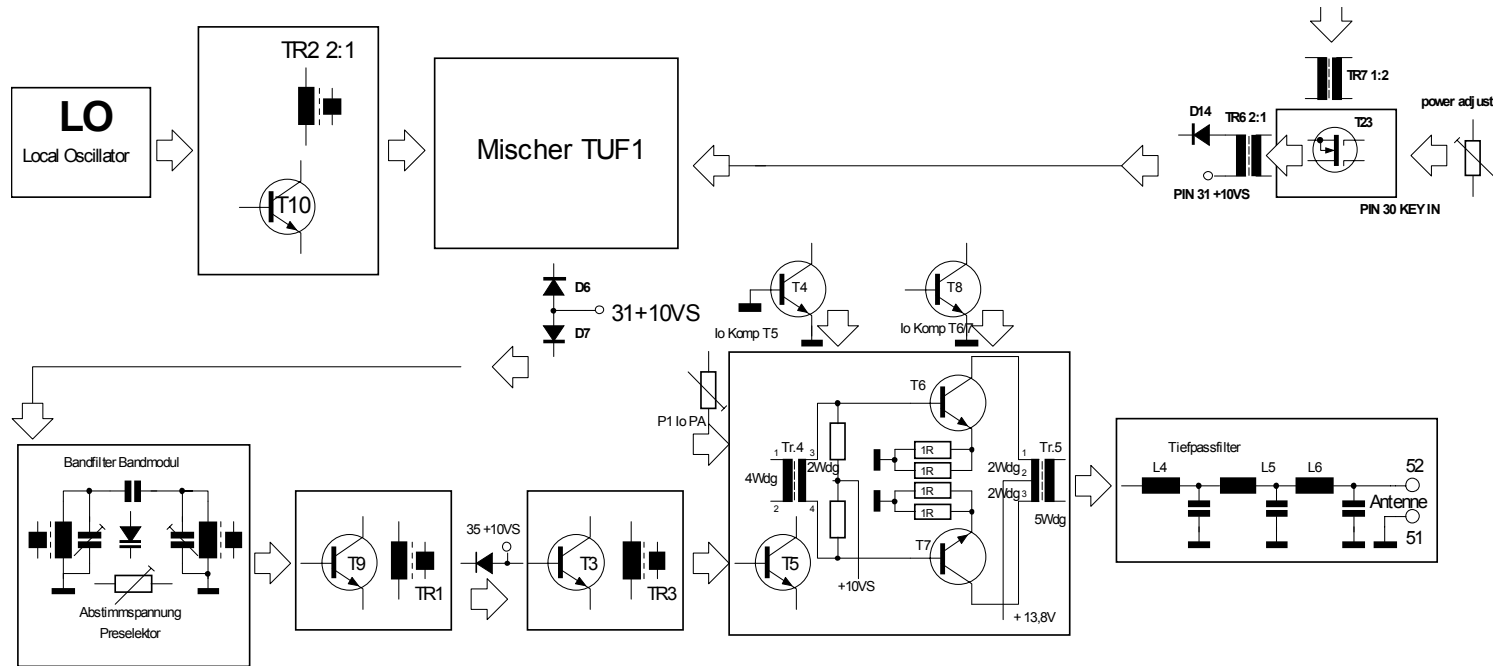
The microphone signal is led via the mic gain potentiometer to the input of the preamplifier IC18. The circuit of C150-Dr12-C149 reduces transmitter RF in the modulation amplifier. The amplification of the stage is set to some 26 dB by R126-R127. C148-C147 cuts speech frequencies below 300 Hz. The level of the amplified microphone signal is adjusted in P16 before going into the dynamic compression IC17. The utilized IC SSM3165 from Analog Devices was made for studio techniques and gives a compression of max. 15:1, that is 15 dB input dynamic range for 1 dB og output dynamic range. The [klirrfaktor - please change!!!] of the output signal is less than 1 %. This compressor will allow the PA to swing to the QRP allowance of 10W PEP. This gives a subjective power level of some 50W uncompressed!! P15 allows individual adjustment of the compression. P14 leads the compressed signal on to the balanced modulator of IC15. C139 gives a further low pass cut off. The modulator uses the universal Gilbert cell NE612. The internal oscillator isn't used. C137 leads the appropriate signal in from T20. P13



adjust the carrier suppression. In CW mode the modulator is debalanced by T29-R116, that is the carrier signal is no longer suppressed, but led on to the modulator output. to avoid swing in problems at the modulator at T/R switching, IC16 is at permanent power. For this reason T30 blocks the modulation path during reception and disallows a DSB signal at open microphone. This guarantees against feed through to the high amplification IF. The 8 MHz DSB signal is led from pin 5 of IC15 to T14. The collector of T14 sees the transformed filter terminating resistance via the 1:1 transformer of Tr8. This gives a stage amplification of 6 dB in conjunction with R66. During reception T15 breaks the emitter circuit of T14, blocking the collector-basis voltage at R65. Pin 12 on the pc board is at ground potential at this moment, also blocking the PIN diode D22. This serves to dampen the residual carrier signal at the input of IC9. During transmission the amplified 8 MHz DSB signal is led the other way through the Cohn filter and shows up as an SSB signal with suppressed carrier at Tr7. The MOSFET T23 gives a voltage amplification of some 6 dB. Choice of side band is by the carrier frequency from T20. C85 couples the SSB signal to the amplifier at T23. A positive voltage at the source of T23 is used to adjust TX power. In CW mode, keying is done by breaking the drain voltage at pin 30. Tr6 transforms the output impedance determined by R98 to the 50 Ohm level. PIN diode D14 leads the 8 MHz signal to the IF port of M1. D13 blocks and T12-T13 are decoupled.

## 8. Transmitter:

The transmission frequency is obtained by mixing the 8 MHz signal with the LO signal. M1 works as a transmitter mixer with changed signal direction.



The signal at the RF port is coupled via PIN diodes D6-D7 and C35 to the input bus of the preselector filter, now working as a transmitter prefilter. The high selectivity of the filter reduces unwanted signals from the mixer. The filtered output signal is led via the output bus over C36 to T9, the transmitter preamplifier. The 18 dB signal at Tr1 is led via PIN diode D3 to the predriver at T3. The stage amplification is chosen to be able to drive the two stage PA fully. Tr3 serves to impedance match T3 to T5. The circuit at T5-T6-T7 is a slightly modified DL-QRP-PA:

The PA quiet current is adjustable by P1, and independent of the board voltage.

The push-pull stage uses robust 2SC1969's with a large collector current reserve, given good intermodulation characteristics.

The ferrite volume of Tr5 is enlarged to reduce distortion due to

saturation

The transmitter is followed by a 3 stage Chebychev low pass filter with a cut off frequency of 33 MHz, to reduce harmonics in the BC/TV bands by more than 60 dB. The in band variation is a maximum of 0,3 dB. The band 80 to

17 meters, this should be followed by the electronically switched output filter, developed for the "Tramp", to reduce emissions in higher ham bands. D11 works as a measuring rectifier for the relative power output meter. To avoid uncontrolled feed back in the transmitter, the decoupling between transmitter output and the T/R switch diode should be at least 70 dB. Experiments with electronic switching showed problems with the high RF voltage (up to 70 Vpp). As the switch carries no RF current (only active during reception), the choice was a small DIL Reed relay, which also allowed shorting the the [Übersprechsignal - please change!!], in a painless way. The

attack time of the relay is only some 0.5 mSec. The life time at some 10 million cycles. Thanks to the low weight of the moveable parts, no clicks are heard.

## 9. CW logic, T/R switching:

Pin 2 of the CPU (IC7) is bidirectional, having the following functions:

During reception pin 2 is kept at high potential by an internal pull up resistor. When the integrated keyer is activated, pin 2 is pulled low in the rhythm of the CW signal. Synchronously pin 15 of IC7 generates a side tone. And further an optional RIT/XIT is activated.

When the internal keyer isn't used, external keying is possible. In this mode pin 53 is grounded via R103-D31 in keying rhythm. In SSB mode the PTT keys the same pins, but T18/T19 quiets the side tone input at IC11.



In CW mode soldering pin 9 is left at +10V, that is pin 10 of IC13 shifts low to high in keying rhythm. R106-C127 rounds the attack and decay soft keying T23 via T25. T26 leads during the high phase of pin 10 (IC13), and charges C128 via R108 with at very low time constant. Below the triggering point of pin 6 of IC14, pin 4 goes high and pin 3 goes high, resulting in blocking T27 and opening T28 (both P channel MOSFETs). The transceiver is switched to transmission. After releasing the key/PTT, this status is kept as long as C128 takes to discharge over the delay potentiometer of P12 and R107 to the triggering point of pin 6 of IC13. Then T28 blocks and T27 opens. The transceiver goes back to reception mode.

During SSB pin 9 is open, that is the gate is blocked and T25-T26 are inactive. Pin 5 at IC14 is now controlled directly by the PTT button. The T/R switch now works without decay control.

#### 10. Stabilization stages:

To make the voltage dependent characteristics of the transceiver independent of the supply voltage, all critical parts are supplied by a stabilized 10 V derived from the low drop regulator IC15. This concept limits the supply voltage for the transceiver to 10,8 to 15 Volts. The 5 Volt regulator at IC5 served to feed IC1-IC6-IC7. D2 reduces the effect loss at IC5. The R11-C12 filter reduces regulation noise at the PLL in conjunction with D1, during the short breaks in the 10 Volt supply during T/R switching (reducing chirp in the first CW character sent). The 6 Volt regulator IC14 feeds IC16-IC17 and T20.

#### 11. Optional circuits:

The JFET source follower T11 serves as a load free decoupling of the LO signal. 100 mVeff is found at soldering pins 16 and 17 for feeding an external frequency display.

one. The standard kit with the bigger enclosure as shown on the manual frontpage will contain an LCD display. This backlight display is counting the LO frequency.

The number of SMT parts had to be increased to abt. 25 to prevent the amplifier stages against Meißner oscillation. All SMT parts are premounted when the kit is shipped.

March 2004, DL2FI

Version: 13. September 2004

Author: Peter Solf DK1HE  
11. 12. 2003

In the mean we designed a 3 digit frequency display for to the Speaky. This should be used if you use the very small tramp enclosure or a similar small

## Building description for the Speaky

Please follow the prescribed building order for all sections. Check each part in the parts list with a pencil, to keep track. To the right of each part in the lists, you will find its coordinates on the pc board. C3 means that the component is at square C3. B/C3 means that the component is located at the border between grid squares B3 and C3.

Start with the voltage regulators.

### Section 1, Voltage regulators

In this first section, the necessary voltages are produced. The Speaky needs +5V, +6V und +10V. In a later section these voltages will be divided in two groups, one for the receiver and one for the transmitter. But here we will only make the raw voltages. The order of building is mainly decided by the height of the components.

First the resistors.



**We recommend measuring the resistors individually. The colour coding is often misinterpreted because of the body colour of the resistors. By experience we now wrong resistor values to be a common source of errors.**

As the Speaky is very small, yet not use SMD parts, most resistors are mounted vertically. To do this one lead must be bent back parallel to the resistor. In the placement diagram, the circle marks the position of the resistor body.

[ ]	R11	39R		B6
[ ]	R112	120R metal foil 1%		E1
[ ]	R113	820R metal foil 1%		E1

Now the diodes. Please check the type with a loupe. D32 is a comparatively large component, D1 and D2 looks alike, but have a printed marking. The cathode is marked by a ring. When diodes are mounted standing up, it is always the cathode lead, that is bent back parallel to the body of the diode. The ring on the placement

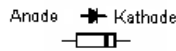
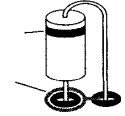


diagram marks the place for the body.

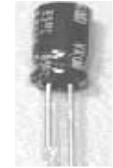
[ ]	D1	1N4148		B6
[ ]	D2	ZPD 2V7 (500mW)		A6
[ ]	D32	1N5822 o.Ä.		F1



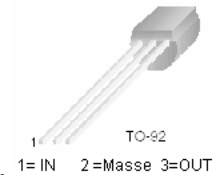
**Please note the polarity of the electrolytic capacitors. The long lead is always the positive lead. Further a minus on the body marks the negative lead.**



[ ]	C20	1µF/63V rad.		A6
[ ]	C21	1µF/63V rad.		A6
[ ]	C129	1µF/63V rad.		B/C 1
[ ]	C130	1µF/63V rad.		C1
[ ]	C131	10µF/35V rad.		D/E 1
[ ]	C132	10µF/35V rad.		D/E 1
[ ]	C133	470µF/25V rad.		E/F 1

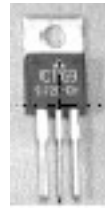


The following parts are the integrated voltage regulators for 5 and 6 Volts in T092 casings. Voltage regulation with these parts look easy but is quite complicated. They contain several dozens of components. They output a constant voltage, as long as the input is at least 1 Volt higher than the output voltage. Please take care to mount the correct regulator in the correct place!! Many small signal transistors and voltage regulators are made in T092 casings. The placement diagram shows most parts from above. Please take care to mount these T092 parts with the round side oriented correctly, as shown in the placement diagram. Mount them close to the pc board, not more than 2-3 mm above the board. This is obtained with a SLIGHT pressure, - no violence! Don't mix up the two regulators. The 8 Volts regulator is marked L08, the 6 Volt one is marked L06.



[ ]	IC5	78L05 T092		A6
[ ]	IC14	78L06 T092		C1

The next part is a higher effect version in a T0220 casing. This is kept at 10 Volts by an external circuit. NOTE: The casing of this regulator is NOT at ground potential, so it must be mounted isolated. The picture shows the T0220 casing. In the placement diagram, the parts is shown from above. The fat, black line shows the metal strip, and show the mounting direction. In the kit you find a heat sink for this part.



[ ] IC15 LT1086CT T0220 E1



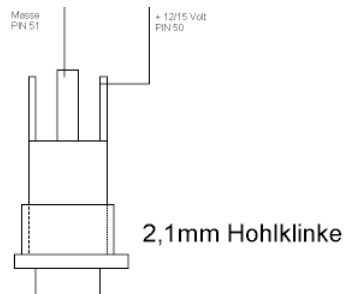
The following fuse holder consists of two parts. To make them fit later on, it makes sense to mount the fuse during soldering.

[ ] SI-1 Fuse holder F1  
 [ ] Fuse 2,5A F1

Finally we mount the soldering pins. Press the short end of the pin through the hole in the pc board with a pair of pliers. No violence, but some pressure is needed. Solder to the down side of the pc board.

[ ] PIN50 + 12V G1  
 [ ] PIN51 Ground G/H1  
 [ ] PIN46 E1  
 [ ] PIN45 E/F1  
 [ ] PIN47 E1  
 [ ] PIN18 C5

To connect the external power, you will need a coaxial power connector and proper wires. In the bag with peripheral parts, you will find the connector. Solder two wires of about 10 cm to the connector. To avoid later damage, it makes sense to use a red wire for the plus, and a black wire for the minus pole.



[ ] Connect pin 47 of the pc board with pin 18 with a short piece of wire and two [Steckhülsen - please change!], to supply the upper part of the board with +10 Volts.

[ ] **Connect pin 45 and 46 with a short piece of wire and two of the plugs provided for the pins. Here you will mount a switch later on.**

### Testing Section 1

#### 1. Visual inspection.

As a first test, inspect every section with a loupe to find shorts. Take this test seriously. Even a master solderer makes shorts with bent leads or small blobs of solder. Or even unsoldered soldering spots! Parts are overlooked more often than you think. Also check the values of all parts: Right part in right place? Electrolytic capacitors correctly polarized? Diodes?

#### 2. Resistance test

Measure the resistance from plus to minus at the pc board (pin 50 and 51). This should be larger than 50 kOhms. Always use the black lead of your ohm-meter connected to ground. Be aware the measurement not to be stable if there are electrolytic caps in the measuring path. The will be loaded causing a wandering resistance value. The resistance test is done to find shorts. Shorts will be shown by the meter by a clear ZERO Ohm resistance.

#### 3. Smoke test

If Speaky passed the resistance test, try applying voltage to the pc board. Put between 10 and 15 Volts between pin 50 (PLUS) and pin 51 (GROUND). Use a laboratory supply with a current limiter, or put a 100 mA fuse in line. It is good sense to use a regulated power supply with a current limiter. Reduce the current limiter to its lowest before connecting!



**Always turn the power supply on before turning on the device under test. ALWAYS! Many power supplies have an initial voltage peak, large enough to kill your apparatus!**

Having connected the Speaky to the power supply, keep an eye on the current level and another eye on the pc board. Smoke is a definite sign of malfunction, as is a current of more than 20 mA.

#### 4. Funktional test:

Measure at test point,  $U_1 = 10V \pm 5\%$

Measure at test point  $U_2 = 6V \pm 5\%$  (Track from c129 field B1 to the left)

Measure at test point  $U_3 = 5V \pm 5\%$  Track from C21 field A6/7 up

When the measurements are OK, remove the power supply and the shorts, and turn to the next section.

## Section 2 T/R Switching

We begin with the trimming potentiometer P12, as mounting this is easier, when no other parts are present. PT6 lying means a 6 mm diameter component. The value is printed sideways on the casing, and often difficult to read. The mounting position is given by the three leads, placed in an equilateral triangle.

[ ]P12 100K PT6 lying A/B5

Now the capacitors. After the electrolytic capacitors comes for the first time a multilayer capacitor. It has a marking of 104, meaning 100 nF.

As examples of this type of marking, we present a few values:

101	100 pF	0,1nF	0,0001uF
102	1000 pF	1,0nF	0,001uF
103	10000 pF	10nF	0,01uF
104	100000pF	100nF	0,1uF
221	220pF	0,22nF	0,00022uF
222	2200pF	2,2nF	0,0022uF
223	22000pF	22nF	0,022uF
224	220000Pf	220nF	0,22uF

Note that the last figure marks the number of zeros. This type of capacitor, type X7R, is often used to bypass RF. Their Q isn't very high, making them unusable for resonant circuits. You will find more on capacitors in the FI Workbench Book.

[ ]C126 100nF 104 A6

Now follows a film capacitor. WIMA film capacitors are nonpolarized, making the mounting direction unimportant. Good practice though is to mount them, so the marking can be read. They are used at AF because of their high Q. RM5 means raster measure 5 mm, most parts of the kit has a raster measure of RM2,5 equalling 2,5 mm.

[ ]C127 0,22μF Film RM 5mm B5/6



Now follows a new component, the tantalum capacitor. These are polarized as electrolytic capacitors. You will usually find their value as text on the drop shaped body, and a small plus sign at one lead.

When no plus is found, the positive terminal is marked by a dash. The longer lead always shows the positive terminal. Tantalum capacitors are often used, when low leak currents are needed at high capacities.

[ ]C128 6,8µF 16V Tantalum pearl B5



Now follows an integrated circuit. **TAKE CARE. The device is static sensitive. Before handling it, you must discharge your hand to ground. The soldering iron MUST be potential free, the best thing is a potential levelled soldering station.**

Due to production circumstances, ICs have their leads spread a little wider than the standard raster. By careful rolling, the leads are brought to their proper position. Pin 1 is marked on the top of the IC, either by a notch or by a dot. The notch is marked in the placement diagram. Mount the IC as shown, and begin by soldering two diagonal leads. Check that the IC is flush to the pc board, and correct it, before soldering the rest of the leads.



[ ]IC13 4093 DIL 14 A/B6

The following transistors are all in T092 casings as the voltage regulators of section 1. Check the marking with a loupe, to avoid mixing them up. The mounting direction is shown in the placement diagram.



**For the MOSFETs remember to discharge your hands before handling them!**

[ ]T24 BS170 MOS take care of statics A6  
 [ ]T26 BS170 MOS take care of statics B5  
 [ ]T25 BC546B B5  
 [ ]T27 BS250 MOS take care of statics E1/2  
 [ ]T28 IRF9520 take care of statics E1

Note the mounting direction with the following diode.

[ ]D31 1N4148 A5

The resistors should pose no problem.

[ ]R104 10K A6  
 [ ]R105 39K B6  
 [ ]R103 220R A5  
 [ ]R107 8,2K A5  
 [ ]R109 33K A/B5  
 [ ]R108 39R B5  
 [ ]R106 22K B5  
 [ ]R110 56K E1/2  
 [ ]R111 56K D/E1

Now follows the pins for connecting the peripheral parts.

[ ]PIN 9 A/B6  
 [ ]PIN10 A5  
 [ ]PIN11 A5  
 [ ]PIN13 B5  
 [ ]PIN39 E2  
 [ ]PIN40 E1  
 [ ]PIN41 E1/2  
 [ ]PIN42 E1/2  
 [ ]PIN53 A/B5

To test this section the connection between pins 47 and 18 of section 1 is needed again. And also pin 9 should be connected to +10 Volts. A short is needed between pin 11 and pin 41, and one from pin 10 to pin 42.

## Test Section 2

1. Visual inspection (see Section 1)
2. Resistance test (see Section 1)

[ ] Apply supply voltage as in Section 1 test. current should be abt 20mA

3. Smoke test (see Section 1)
4. Functional test

When pin 53 is grounded,

pin 13 must measure +10 Volts

Pin 39 should be at +10 Volts, when not keyed,  
and when keyed, at 0 V

Pin 40 should be at 0 Volts , when not keyed,  
and at 10V when keyed.

For a closer look to the function have a look at the logic plan in the schematic part.

### Section 3 DDS VFO

The heart of the DDS VFO is the IC AD9835BRU, which is already mounted on delivery. most other parts are well known. As allways, take care to check the markings to avoid mixing up parts. It is often impossible to read the markings on the small ceramic capacitors. This is unfortunately impossible to change, so they will have to be measured. As most cheap multimeters today measures capacitors to below 1 pF, this should pose no problem. (Multimeters are offered by QRPPProject at 29 Euro).

[ ]C13	1nF	102	C6
[ ]C14	8p2	8p2	C6
[ ]C15	220pF	221, n22	C6
[ ]C16	68pF	68p	C6
[ ]C17	470pF	471, n47	C6/7
[ ]C18	68pF	68p	C7/6
[ ]C19	220pF	221, n22	C7
[X] C22	100nF	SMD 0805	B6
[X] C23	10nF	SMD 0805	C6
[X] C24	10nF	SMD 0805	C7
[ ]C25	22pF	220,22p	B6
[ ]C26	22pF	220,22p	B6
[ ]ST3	3 Pin Connector		A6
[ ]C27	10nF	103	A6
[ ]C28	10nF	103	A6
[ ]C29	470pF	471, n470	A7
[ ]C30	100nF	104	A7
[ ]C33	10nF	103	C7
[ ]C31	10nF	103	B7
[ ]C32	10nF	103	B7
[X] C34	100nF	SMD 0805	B7

Now mount the socket for the processor. Please take care to mount it as shown in the diagram. The notch on the short side should be mounted as in the placement diagram.

[ ]IC7                      socket 20 PIN                      A/B7



**Take care of statics, the Processor is very sensitice against Electro Static Discharge (ESD)**

[ ] IC7 AT90S2313 (programmed) A/B7

The following part is an integrated 25 MHz oscillator. Pin 1 is marked on the part and in the placement diagram.

[ ] IC8 25MHz oscillator C7



**Take care of statics, the next transistor is very sensitive against Electro Static Discharge (ESD)**

[ ] T2 BF199 C6

[X] IC6 AD9835 TSSOP16 B6/7 SMD

[ ] R9 1,5K B6

[ ] R10 100K C6

[ ] R12 270R C7

[X] R13 3,9K SMD 0805 C7

[ ] R14 680R B7

[ ] R15 not used B7

[ ] R16 10K A7

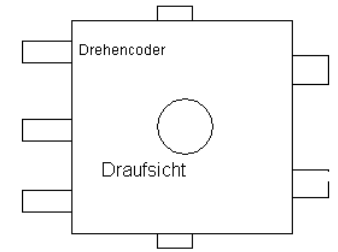
Now follows two SMCC RFCs. They look like fat resistors. Measuring them with an ohmmeter, they are close to 0 Ohm. The colour coding is as with resistors, but due to their light bodies, they are easier to read.



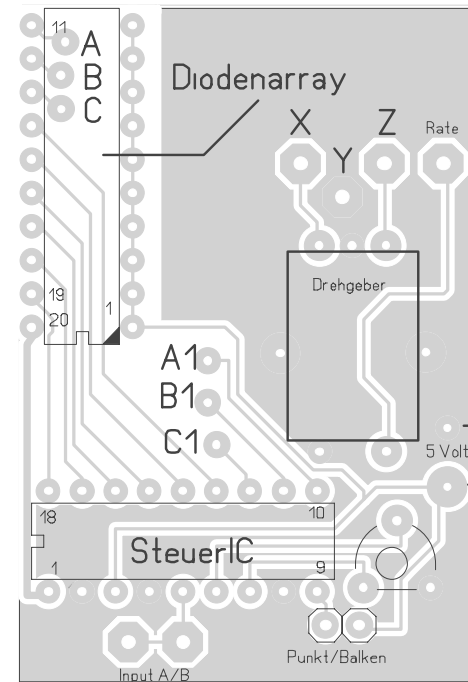
[ ] L2 4,7µH SMCC C6

[ ] L3 4,7µH SMCC C7

[ ] St3 connector A6 St 3 / 3  
 [ ] St4 connector A/B7  
 [ ] PIN7 A/B7 St 3 / 1



To use the section, the rotary encoder should be connected. If you got the kit including the Bargraph.S-Meter, go to step "Building the S-Meter now. The 3-Pin Plug, ready with 3 wires is do make the connection to ST3 on the main board. Twist the 3 wires and solder them directly to the encoder solderlugs as you can see in the drawing right.



**Assembling the S-Meter / Power-meter / Encoder- PCB**

This is a single sided PCB. You need 3 wire bridges to make functional. Solder the 3 wires first. Solder them at the parts placement side of the PCB. Use thin wire to make it possible to place the bargraph flat in the next step.

- [ ] Wire from A to A1
- [ ] Wire from B to B1
- [ ] Wire from C to C1

Next place the bargraph, DO NOT USE a Socket. Be careful to identify PIN 1, compare the chip to the drawing.

- [ ] Solder the bargraph
- [ ] Solder the Encoder

[ ] Solder the control IC (Steuer IC), attention PIN 1!

Attention, the next parts have to be placed and soldered to the solder Side of the PCB

- [ ] Trimpot
- [ ] 2 Pin Jack for jumper
- [ ] Solder PINs

Version: 13. September 2004

Now we mount a crystal in HC18 casing. Mounting crystals, it is necessary to avoid shorts on the pc board from the casing. To avoid this, the crystal is mounted at a short distance from the pc board, or by putting an isolating disc below the crystal. A common way to do it is to place to cut off leads from resistors temporarily under the crystal as placeholders, during soldering. Remember to remove the resistor leads again after soldering!

[ ] Q1 4,096MHz HC18 B6/7

Now prepare the wires for this group. The 3-Pin Plug, ready with 3 wires is do make the connection to ST3 on the main board. Twist the 3 wires and solder one of the SolderPin Plugs to each end. Isolate them partially to prevent against shorts. ST3/1 MUST go to PIN Y. ST3/2 and ST3/2 can be interchanged to change tuning direction of the DDS VFO. The other connections are not used in this section.

### Test Section 3

1. **Visual inspection** (see Section 1)

2. **Resistance test** (see Section 1)

[ ] rotary encoder at St 3

[ ] connect bridge from pin 18 to pin 47 (see Section 1)

[ ] Apply supply voltage as in Section 1 test.

3. **Smoke test** (see section 1)

current abt 50 mA

4. Functional test

Method 1:

After turning on, the DDS VFO should oscillate at 4.030 MHz. This is easy to check with a short wave radio. Make a wire link from isolated wire. The free ends should be twisted. Leave a small sling at the closed side, and connect the free ends to ground and antenna input of the receiver respectively. Put the sling over T2. Turn on power. The receiver should now have a strong 4.030 signal.

Method 2:

Oscilloscope owners could inspect the signal at C13. It should be some 2-3 Vpp.

Method 3:

With an absorption frequency meter (or a grid dip meter in absorption position), you should be able to demonstrate the function of the DDS.

Method 4:

Those who have already built the speaky counter or own another counter

may measure the frequency at C13. The counter should show 4030 +/- 2 kHz. Remove the supply voltage and the bridges, and proceed to the next section.

### Section 4 IF

The following trimming potentiometer was supposed to be standing. In practice, this has shown to be difficult to trim. Instead we mount a PT6 lying. The raster is a little too small for this, so the leads of the trimming potentiometer must be bent carefully. This is a little clumsy to do, but better clumsy now, than when trimming!

[ ] P6      2,5K PT6 lying      E2

IC 11 should be rolled gently, as we did previously.

[ ] IC11    LM386-4 DIL8      E2/3

Now the capacitors

[ ] C111    0,1µF      Film RM 5mm      D3

[ ] C112    2,2nF      222      E2/3

[ ] C113    22nF      223      E2

[X] C114    10µF/6,3V (SMD)      E3/2



**Don't forget to polarize electrolytic capacitors correctly. The long lead is plus.**

[ ] C115    10µF/35V rad.      F2/3

[ ] C116    220µF/16V rad.      F2

[ ] C117    220µF/16V rad.      F2

[X] C118    47nF      SMD 0805      E2

[ ] C125    10nF      103      D2

[ ] R79      22K      E2/3

[ ] R80      1M      D3

[ ] R83      100k      D2



<input type="checkbox"/>	R84	22K	E2
<input type="checkbox"/>	R85	39K	E2
<input checked="" type="checkbox"/>	R86	SMD 0805	
<input type="checkbox"/>	R87	3,3R	F1
<input checked="" type="checkbox"/>	R88	4,7R	SMD 0805 E2

measure the current during this test. Without hum it should be about 60mA. If you touch PIN 33 it may increase to as much as 150 mA.

Connect PIN 7 or PIN 8 of connector 4 to ground. If you tune up Trimpot P6, you will hear the internal CW generator in the headphones.

Diode D28 will be mounted standing up. The cathode will be bent back, the body is placed where the circle on the layout is drawn.

Remove the power supply and the headset and continue with the next building group

<input type="checkbox"/>	D28	1N4148	D3
--------------------------	-----	--------	----



**There is an extreme risk to destroy CMOS Transistors by ESD. Use a potential free Soldering Station, at least discharge yourself by touching a blank, metall ground plane before you handle any electrical part**

<input type="checkbox"/>	T17	BS170 MOS Caution ESD!	D3
<input type="checkbox"/>	T18	BS250 MOS Caution ESD!	E2
<input type="checkbox"/>	T19	BS170 MOS Caution ESD!	E2

<input type="checkbox"/>	PIN33	E3
<input type="checkbox"/>	PIN34	E3
<input type="checkbox"/>	PIN43	E/F 1/2
<input type="checkbox"/>	PIN44	F1/2
<input type="checkbox"/>	PIN 8	D2/3

Test Building Group 4 (BG 4)

**1. Visual inspection** (see Section 1)

**2. Resistance test** (see Section 1)

Connect power supply as described at building Group 1 (BG1)

Connect PIN 7 and PIN 8

Connect headset between PIN 44 and ground

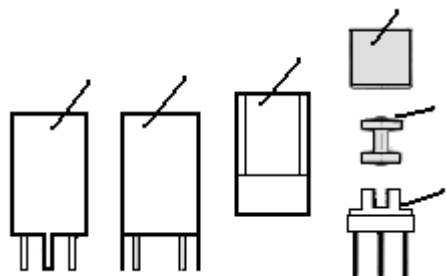
**3. Smoke test** (see section 1)

4. Functional test

Put the finger on PIN 33. You will hear a clear hum in the Phones. You may


## Building Group 5, Carrier Oscillator and Switches

The Neosid coil, used in this group is completely different from the known Neosid cylinder coils. Here we are using a so called BOBIN coil. The kernel is made from ferrite material, which is looking like a reel. The windings on this kernel are not brought on, turn for turn, but simply winded as are. The only importance is the right number of windings.



1=Shield Can 2= Guidance from Plastic 3 Kernel  
4= Coilbody 5= Socket


Take the socket of the Bobin and put a little drop of Super glue between the kernelholders and press carefully the Ferrit bobbin into the holders. Wait until the glue is dry before continuing the work. You are free to solder other parts in the meantime.

 **Caution! IC12 is sensitive against static charging. Discharge yourself before rolling the part.**

[ ] IC12 4066 DIL14 D2

PT6 we already knows. These are the little black trim-potentiometers

[ ] P71K PT6 lying B2

 **Spectrol 75H are precision-trim-potentiometers in a metal case. Caution, first compare the three terminals exactly with the respective holes on the pc board. The trim-potentiometers are gliding very easy into the holes, if they are mounted right. If you need pressure, they are mounted the wrong way!**

[ ] P8 10K Spectrol 75H D2  
[ ] P9 10K Spectrol 75H D1

[ ] P11 10K Spectrol 75H D2  
[ ] P10 10K Spectrol 75H D1  
[ ] D29 BB109G / BB409 or equivalent C1  
[ ] D30 BB109G / BB409 or equivalent C1



**The following transistors are mounted according to the placement diagram. Caution! they are sensitive against static charging. Discharge yourself before rolling the part.**

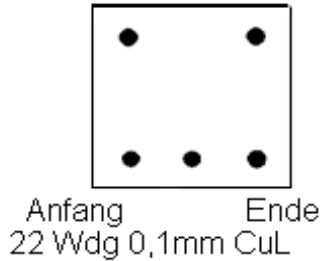
[ ] T20 BF199 B2  
[ ] T21 BS250 MOS beware of static! E2  
[ ] T22 BS250 MOS beware of static! E2

The crystal is mounted with the help of two cut off resistor leads.

[ ] Q6 8,000MHz HC18 B1  
[ ] Q7 8,000MHz HC18 B1  
[ ] R89 47K B2  
[ ] R90 47K B2  
[ ] R91 68k C1  
[ ] R92 39K C/D2  
[ ] R93 39K D2  
[ ] R94 39K D/E2  
[ ] R95 100K D1/2  
[ ] C97 1nF 102 B3  
[ ] C119 22nF 223 A/B2  
[ ] C120 330pF 331 or n33 B2  
[ ] C121 220pF 221 or n22 B2  
[ ] C122 10nF 103 C1/2  
[ ] C123 100nF 104 C2

Now the coil form should be glued properly, and the coil can be wound.

The picture shows the coil from below. Start at pin „anfang“, by twisting the 0.1 mm wire three times around the pin, and then through the notch



onto the body. Put 22 turns on the body, and then again go down through the notch at pin „ende“. Put the turns around the lead. And you're done.

Fix the coil in a vice and solder wire and pins at the same time. This is easy: Touch the wire and solder with the soldering iron at the same time (LITTLE solder!). Don't push too hard. The leads become hot, and the plastic soft! Check for contact with an

Ohmmeter.

All well? Then screw the core into the plastic holder till it is flush with the top. Please take care not to set it askew. Solder the coil onto the pc board, and put on the covering core. Loosely fit the can, but don't solder it yet.

[ ] L7                      Neosid filter 7.1 F10b B1  
22 turns 0.1mm lacquered copper wire (AWG 38).

We only have to put in 3 pins, to finish this section

[ ] pin 28                      C/D2  
[ ] pin 29                      D2  
[ ] pin 38                      E2

## Test Section 5

1. **Visual inspection** (see Section 1)
2. **Resistance test** (see Section 1)

[ ] Apply supply voltage as in Section 1 test.

3. **Smoke test** (see Section 1)  
current about 65 mA

## 4. Functional test

Connect pin 29 to +10V (e.g. pin 18 or pin 47)  
Put trimming potentiometer in centre position.

Put your link wire from Section 3 close to T10 position and tune the receiver to about 8.000 MHz. You should hear the BFO loud and clear. P8 should tune the BFO +/- 1 kHz.

With an oscilloscope, you should be able to see the 8 MHz signal at C97 and adjust it to some 300 mVpp.  
If you have no Scope, you may use the calibrated RF probe available from QRPproject or another type of RF probe.

If everything is OK, proceed to Section 6.

## Section 6 BFO, IF amplifier, AGC

[ ] IC9 Socket 16 PIN A/B3



**If you install the IC now, be very carefully. All IC pins must go straight into the corresponding part of the socket. Dont bent the IC pins. Discharge yourself before you handle the IC.**

[ ] IC9 TCA440/A244 DIL16 A/B3  
 [ ] IC10 TDA7050 DIL8 B/C2  
 [ ] D23 1N4148 B2



**The following germanium diodes have quite sensitive, large glass bodies. The raster on the pc board is too small for them to be mounted horizontally. All 4 diodes should be mounted obliquely.**

[ ] D24 AA143 or the like C2  
 [ ] D25 AA143 or the like C2  
 [ ] D26 AA143 or the like C2  
 [ ] D27 AA143 or the like C2

[ ] T16 BC337-40 B2

[ ] C93 1000pF RM 5mm A3  
 [ ] C94 10nF 103 A3  
 [ ] C95 22nF 223 B3  
 [ ] C96 10nF 103 B3  
 [ ] C98 100µF/16V rad. A4  
 [ ] C99 100nF RM 5mm A3  
 [ ] C100 22nF 223 A4



**Remember to polarize the tantalum capacitors correctly. The long wire is PLUS.**

[ ] C101 10µF/16V Tantalum pearl A/B4  
 [ ] C102 1µF/35V Tantalum pearl B4  
 [ ] C104 10µF/16V Tantalum pearl B4

Mount the electrolytic capacitors correctly. The long lead is PLUS.

[ ] C103 33µF/16V radial B4  
 [ ] C107 10µF/35V radial B/C2

[ ] C108 10µF/35V radial B2  
 [ ] C109 47µF/35V radial C2

[ ] C105 0,1µF Film RM 5mm B3  
 [ ] C106 0,033µF Film RM 5mm B3  
 [ ] C110 0,1µF Film RM 5mm C1/2

[ ] R70 120R B3

[ ] R71 2,2K A4

[ ] R72 100k B4

[X] R73 27R SMD 1206 B3

[ ] R74 560R B3

[ ] R75 18K B3

[ ] R76 470R C2

[ ] R77 470R C2

[ ] R78 27K C2

[ ] R81 33K B2

[ ] R82 12K B2

[ ] P5 2k5 PT6 lying B3

[ ] PIN20 B4

[ ] PIN25 B2

[ ] PIN26 B1/2

[ ] PIN27 B1

As shown in the wiring plan (see schematic section of the manual) you must solder a 100nf (104) cap and a 1k0 resistor between pin 20 and ground. Solder at the solder side of the PCB. be carefull not to short any other tracks.

[ ] 100n 104

[ ] 1k0

To test this section, we need the link to the AF amplifier. Prepare the volume potentiometer (2k2 log). Logarithmic potentiometers are identified

either by the word log or the letter B (2,2k B or 2k2B). Solder 3 pieces of wire, each 15 cm long onto the potentiometer. To prevent hum, twist the three wires.

## Test Section 6

**1. Visual inspection** (see Section 1)

**2. Widerstandstest** (see Section 1)

[ ] put pin 29 to +10 Volt (see Section 5)

[ ] Bridge pin 47 to pin 18

[ ] Bridge pin 20 to ground

[ ] Connect head phones to pin 44 and ground

[ ] Connect potentiometer arm to pin 33, ends to pins 26 and 34

[ ] Put potentiometer in center position

[ ] Apply power as in Section 1 test.

**3. Smoke test** (see Section 1)

current should be abt 85 mA

## 4. Functional test

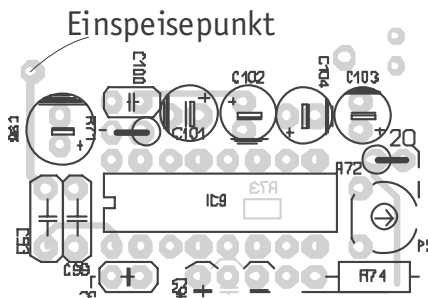
After switching on, a definite noise should be audible in the phones. If the pin 20 to ground bridge is removed, the noise should decrease substantially

(instead of this bridge you can later on install an S meter). Without the bridge or S meter, the A244/TCA3440 doesn't work correctly.

With the bridge in place, touch the point marked input test (Einspeisepunkt) in the drawing with a screw driver. Now you should hear weak BC signals. If you hear some irregular up and down in the hiss, dont take care

this is because the input of the high gain IF amplifier is open in this moment.

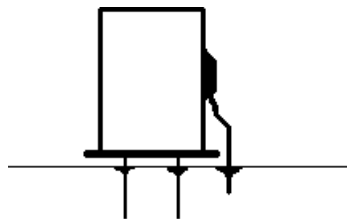
If all tests were successful, remove the bridges and proceed to section 7.



## Section 7 IF amplifier, IF filter

Begin with the crystals. These are not the lowest parts, but in prototyping, we found the ground connection of the crystals difficult, when the other parts were in place. Please again note the minimum distance between the crystals and the pc board (use cut off resistor leads to help!).

<input type="checkbox"/>	Q2	8,000MHz HC18	C4/5
<input type="checkbox"/>	Q3	8,000MHz HC18	B4/5
<input type="checkbox"/>	Q4	8,000MHz HC18	B4/5
<input type="checkbox"/>	Q5	8,000MHz HC18	A4/5



In close proximity to the crystals, you will find ground soldering spots (Q5 left lower, Q4 and Q3 lower, Q2 right lower). Solder cut off resistor leads into these spots, an solder the free ends to the crystal bodies at half height of the narrow side of the respective bodies. Grind the crystals lightly with sanding paper, this eases the soldering.

Crystal ground connections, 4 pcs.



**The following 5 diodes are in T092 casings. They look like transistor, but only have to leads. Mount according to the placement diagram.**

<input type="checkbox"/>	D15	BB112	C4
<input type="checkbox"/>	D16	BB112	B4
<input type="checkbox"/>	D17	BB112	B4
<input type="checkbox"/>	D18	BB112	A/B4
<input type="checkbox"/>	D19	BB112	A4



**BEWARE, the BA479 should not be confused with the 1N4148. Use a magnifier!**

<input type="checkbox"/>	D13	BA479	C/D
<input type="checkbox"/>	D14	BA479	C/D3

<input type="checkbox"/>	D20	1N4148	B5
<input type="checkbox"/>	D21	1N4148	C5
<input type="checkbox"/>	D22	BA479	A4

<input type="checkbox"/>	T12	BF246A	C4
<input type="checkbox"/>	T13	BF246A	C4
<input type="checkbox"/>	T14	BF199	A3
<input type="checkbox"/>	T15	BC546B	A3

<input type="checkbox"/>	R56	1,5K	D3
--------------------------	-----	------	----

The following resistor is in principle an adjustment value. The Intermodulation characteristics of the receiver can be optimized, if this resistor is chosen so that the quiescent current through it is about 10 mA.

<input type="checkbox"/>	R57	220R	will be installed later on
<input type="checkbox"/>	R58	330R	C4
<input type="checkbox"/>	R59	47K	C4/5
<input type="checkbox"/>	R60	47K	B4/5
<input type="checkbox"/>	R61	47K	B4/5
<input type="checkbox"/>	R62	47K	A/B 4/5
<input type="checkbox"/>	R63	47K	A4/5
<input type="checkbox"/>	R64	330R	A4
<input type="checkbox"/>	R65	47K	A3
<input type="checkbox"/>	R66	82R	A3
<input type="checkbox"/>	R67	820R	A3
<input type="checkbox"/>	R68	12K	A/B3
<input type="checkbox"/>	R69	33K	A/B3
<input type="checkbox"/>	R102	68K	B5
<input type="checkbox"/>	C59	47nF	473 D3/4
<input type="checkbox"/>	C81	47nF	473 D3/4
<input type="checkbox"/>	C82	22nF	223 C4
<input type="checkbox"/>	C83	22nF	223 D4
<input type="checkbox"/>	C84	22nF	223 C5
<input type="checkbox"/>	C90	10nF	103 C4/5
<input type="checkbox"/>	C91	10nF	103 A5
<input type="checkbox"/>	C92	22nF	223 A4/5

[ ]	C124	22nF	223	A3
[ ]	Dr10	47μH	SMCC	C3/4
[ ]	Dr11	47μH	SMCC	D4

The Spectrol 75H' s are trimming potentiometers in metal casings.

[ ]	P3	10K Spectrol 75H	B5
[ ]	P4	10K Spectrol 75H	C5

Now we encounter two news parts: transformers on Amidon toroid ferrite cores. As this is an error prone area, we will present a little more text on them.

### Little toroid coil school

As our American QRP friends, we often use high Q toroids from Amidon.

Basically iron carbonyl rings are for narrow band applications and ferrites for broad band applications. On the CD you will find the Mini RK program by Wilfried, DL5SWB. With this small, but helpful program, it is child's play to calculate the necessary turns for a given inductance, or the other way around, the inductance for a known number of turns.

Winding toroids always provokes fear in beginners. Unjust! In you start without prejudice and keep the basic rules in mind, nothing can go wrong.

Important: one wire through the ring is one turn. For practice begin by making Tr7, as we will need this shortly.

Cut off some 25 cm of 0.3 mm lacquered copper wire (AWG 28), and take the core in one hand. Put one end of the wire through the hole. That was the first turn. But STOP!!!

Look at your work, and consider how you put the wire through the ring. There are two possibilities. Either back-to-front, or front-to-back. From an RF point of view, this doesn't matter. but for the later mounting, this is very important, as it decides the placement on the pc board. You should chose the direction that feels best for you.

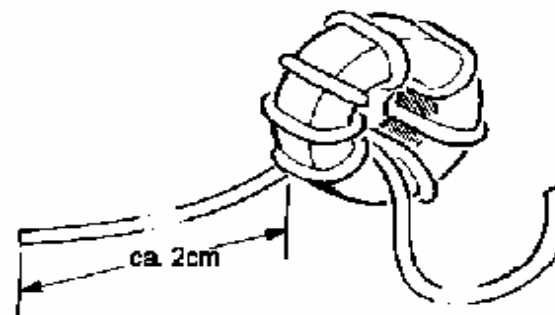
If you started back-to-front, the next turn must be clockwise, to get the right geometry for Tr7. If you start front-to-back, you must wind counter clockwise.

This rule is only for Tr7. Developers have their oddities too. Wayne, the constructor of the K2, always turns opposite to DK1HE. Worse: For DK1HE the optimum layout of the pc board is so important, that he changes the winding geometry for each coil in the Speaky. A quick test winding will always make it possible to see, what the developer meant to be done.

Now put on the necessary number of turns distributed well over the ring. To avoid error, count the turns on the INSIDE of the ring. The coil in the picture has 8 turns. Well distributed means that the turns are spread over some 270 degrees of the ring circumference. That is the optimal range for toroid coils. When you think of this while winding, you will never need to adjust the turns afterward, even though it is possible to some degree. Turns should never cross, but should be single layer for each coil (primary or secondary for transformers).

Take care on winding, to pull the wire snugly on the core. This is no problem on iron carbonyl rings as they are round and smooth. But on ferrites, the sharp edges might damage the isolation on the wire.

Cut the free ends, but not too short, and solder the ends. How this is done is a little under discussion.



The lacquer on the wire used is solderable, this means that it melts at soldering temperature. Up to about 0.8 mm wire the heat capacity of a standard soldering iron suffices for this, even for burning off the lacquer. To do this, touch the wire as close to the core as possible with the soldering iron, and

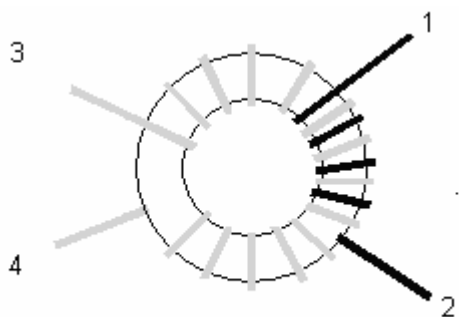
put on liberal amounts of solder. You should get a real drop. After a short while the lacquer should melt, and smoke should rise. Keep your nose away,

as the smoke isn't exactly healthy! When smoke rises, move the solder blob slowly towards the end of the wire, till you have soldered about 1 cm of the wire. If the lacquer won't melt, it helps to add fresh solder. There melted lacquer is shoved away with this method.

When you are done, check that the wire is soldered all the way around. This is very important, as most errors in home brew transceivers are from badly soldered coils made from lacquered copper wire. With thicker wires, you will have to scrape off the lacquer with a knife. Please be careful not to nick the wire, as it will break at the nicks!

Use the same technique on the other end of the wire. This completes the toroid coil.

Often you will need a secondary winding, as in Tr7. This can be symmetrical or unsymmetrical. Symmetrical always means without ground connection. No coil end will reach ground or a bypass capacitor. Such symmetrical coils always have the secondary centred over the primary.



Now, let us focus on an example of a symmetrical winding: The primary should have 14 turns, the secondary 4. To have the secondary symmetrically placed, we have to count on

the INSIDE of the ring.

14 divided by 2 is 7. The middle is at 7 turns. The 4 secondary turns must start at the 5th turn of the primary, and end at the 9th, as shown in the drawing. In another way: The secondary is symmetrical to the center of the primary, before and after it, you will find 5 turns.

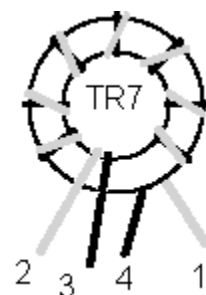
Should calculations ever result in half turns, you ignore the half turn, and accept the slight asymmetry.

With unsymmetrical secondaries, you put the secondary turns between the turns of the primary. You begin in principle at the cold end of the coil.

Which end is cold? Cold in an RF sense, is close to ground. This doesn't necessarily mean galvanically connected to ground. From an RF point of view the connection can be via a capacitor of low reactance. Don't be scared by this!

Another type of transformer is made by twisting two wires and winding bifilar turns. Such transformers are found at Tr7 and Tr8 in Section 7. Bifilar technique gives a transformer of low stray capacitance.

Now for the real thing: Tr7 consists of 2 x 10 turns of 0.3 mm lacquered copper wire on an Amidon FT37-43 core. FT37-43 means ferrite, material 43, 0.37 inch diameter. No colouring, ferrites are carbon coloured.

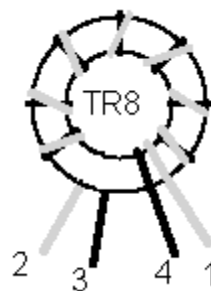


Take two pieces of 25 cm wire of different colours (I call them red and gold), and twist the pieces at about two twists per cm. This isn't critical, but rather use more than less turns per cm. With this „double wire“ put ten turns on the toroid (The drawing only shows 8, not to be too cluttered). Both end now have to be untwisted, and now the coil should look a lot like the drawing on the left (remember the drawing has 8 turns, you should have 10!).

[ ] Tr7

Amidon FT37-43

C4/5



[ ] Tr8

Amidon FT37-43

A4/5

And now we have a case of changing the geometry of the pc board for the coil geometry. The coil 1/2 doesn't mount from lower right to upper left, but instead from lower left to upper right. You have to wind opposite to Tr7! (Only 8 turns shown!).

Not that difficult, eh?



Now the easy part, the pins, and you complete this section.

- [ ] pin 12                      A5
- [ ] pin 14                      B5
- [ ] pin 15                      B5
- [ ] pin 22                      B3
- [ ] pin 19                      C4

### Test Section 7

#### 1. Visual inspection (see Section 1)

#### 2. Resistance test (see Section 1)

Now install R57, you remember, this resistor helps optimizing the intermodulation characteristic. My way to optimize is as follows:

I do not install the resistor directly into its holes, but I install to pieces of wire instead as standoffs. Now I solder a 220R resistor to both of the standoffs. This trick makes it easier to change the value of the resistor if needed. To make it possible to measure the current, we need all power supplies now.

- [ ] pin 29 to +10 Volt (see Section 5)
- [ ] pin 19 to 10V
- [ ] pin 15 to 10 V
- [ ] Bridge pin 47 to pin 18
- [ ] Bridge pin 20 to ground

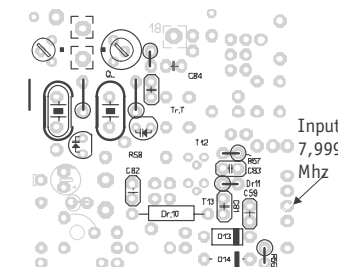
#### 3. Smoke test (see Section 1)

- [ ] Apply power supply as in Section 1
- Total current should be abt 100 mA

No we use Mr. OHMs law to calculate the quiescent current:  
measure the voltage across R 57. If Mr. Ohms law is correct and we get 10 mA, you should see  $U=R \times I = 220R \times 0,01A = 2.2V$ . If you measure much more ore less, the current is not ok and you must change the Resistor (assuming Mr.Ohms Law is ok :-). Try to get the current to 10mA +/- 2mA by changing the resistor.

If this is ok, you can do the functional Test.

### 4. Functional test



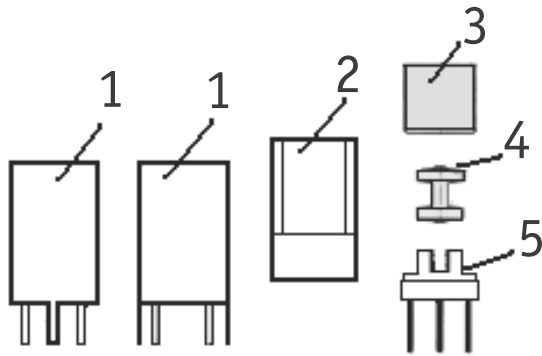
You should hear noise in the head phones. The simple test with the finger on the input, as with the BFO, won't work this time, as the crystal filter only will allow 8 MHz to be received (Actually rather 7.999 MHz, as the centre frequency of the Cohn filter depending on band width is a little lower than the individual crystals).

At this place, we need a signal generator. A simple, but very usefull tool is the little Xtal controlled testoscillator / Xtal Tester you can order from QRPproject. If you have a variable transmitter, you can use that. Connect it to a dummy load at low power, and tune it to 7.999 MHz. A link wire connected to point Input 7.999 MHz should give a beat tone in the head phone, if the transmitter frequency is changed slightly.

Remove all bridges after the test, and proceed to Section 8.

## Section 8 PLL

In this section we will once more use a Neosid Bobin core.



1 = can, 2 = plastic cover 3 = covering core 4 = coil body 5 = socket.

[ ] Grasp the base of the bobin core, put a small drop of super glue between the edges and push the ferrite spool into the base. Let the glue dry before proceeding with the coil. You can mount other parts while waiting.

Mounting the ICs first will help in orientatation for the other parts.



**Be careful with IC2 to IC4, they are static sensitive. Remember to discharge your hands to ground. Use a potential free soldering station.**

The ICs should be rolled gently before mounting.

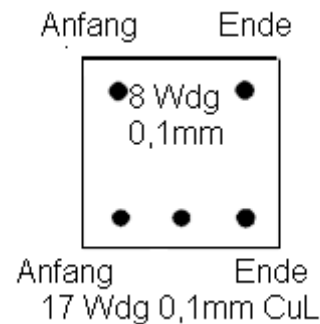
[ ] IC2	4060 DIL16	D/E6
[ ] IC3	4046 DIL16	D/E6
[ ] IC4	4060 DIL16	B/C6
[ ] IC1	NE612 DIL8	D7
[ ] T1	BF199	D7
[ ] R1	1,5K	E7
[ ] R2	1,5K	E7
[ ] R3	47K	E6/7

[ ] R4	4,7K	E6/7
[ ] R6	1,5K	C/D 6/7
[ ] R7	1M	D6/7
[ ] R8	1M	C6
[ ] R5	100K	D7

[ ] C1	0,22µF	Film	E6
[ ] C2	10nF	103	D/E7
[ ] C3	22nF	223	D7
[ ] C4	47nF	473	D7
[ ] C5	220pF	221	D7
[ ] C6	1nF	102	D/E7
[ ] C7	10nF	103	C/D7
[ ] C8	1nF	102	D6/7
[ ] C9	100nF	104	C/D6
[ ] C10	100nF	104	E5/6
[ ] C11	100nF	104	B6
[ ] C12	220µF/16V rad.		B6

Now the coil form should be dry, and you can wind the coil.

The picture on the left shows the base of the coil from below. Begin at pin „anfang“ by winding the 0.1 mm wire around the pin 3 times, continuing up the notch. Now put on 17 turns, and return through the proper notch to pin „ende“. Three turns around the pin, and you're done. For the secondary, with a new piece of wire, go to pin „anfang“, up through the notch, put on 8 turns, return through the proper notch, put 3 turns around pin „ende“, and DONE.



Mount the coil carefully in a vice and solder pins and wires at the same time. This is easy: touch the wire and the solder (LITTLE solder) at the same time. Don't

push too hard: The lead will be hot, and the plastic softens. Test for shorts with an ohm meter.

Everything OK? Then put the ferrite core gently into the plastic body, be

careful not to put it in at a wrong angle. Solder the coil in place and put on the covering core. The can should be mounted loosely, not yet soldered.

[ ] L1 Neosid filter 7.1 F2 C/D7  
(17 turns primary / 8 turns secondary)

Now we will continue with the Band modules slots.

The connector strips should be carefully mounted at a right angle to the pc board. Good practice is to start soldering on lead at the middle of the strip, an check and adjust for proper position, before soldering the rest.

[ ] Connector strip 5A E7  
 [ ] Connector strip 5B E5  
 [ ] Connector strip 4A E7  
 [ ] Connector strip 4B E5  
 [ ] Connector strip 3A F7  
 [ ] Connector strip 3B F5  
 [ ] Connector strip 2A G7  
 [ ] Connector strip 2B G5  
 [ ] Connector strip 1A H7  
 [ ] Connector strip 1B H5

Now the corresponding pins for the band switching:

[ ] pin 5 E7  
 [ ] pin 4 E7  
 [ ] pin 3 F7  
 [ ] pin 2 G7  
 [ ] pin 1 H7

Now for the only fixed bridge on the pc board. This should be made from isolated wire in square E4/E5, and soldered in.

This section cannot be tested yet, as the band set oscillator and the VCO of the band modules are needed. Put the main pc board aside, and finish one band module. We recommend the 40 meter module.

If the bandmodule PCB still has pieces of PCB material left and right, cut of

this parts by breaking them along the lines.

### Band module 40 Meter

[ ] P1 250R Piher PT6 lying  
 [ ] C1 220pF  
 [ ] C2 150pF  
 [ ] C3 left out  
 [ ] C5 22nF 223  
 [ ] C6 10nF 103  
 [ ] C7 22nF 223  
 [ ] C8 22nF 223  
 [ ] C9 47pF 473  
 [ ] C10 220pF n22 or 221  
 [ ] C12 10nF 103  
 [ ] C15 10nF 103  
 [ ] C16 10pF 10p  
 [ ] C17 10pF 10p  
 [ ] C18 22nF 223  
 [ ] C19 22nF 223  
 [ ] C20 27pF 27p  
 [ ] C21 10nF 103

[ ] R1 68K  
 [ ] R2 27K  
 [ ] R3 1K  
 [ ] R4 10R  
 [ ] R5 56K  
 [ ] R6 68R

The next resistor has to be adjusted. Criteria is the oscillation of the VCO. R7 should be as small as possible but if it is too small, the VCO oscillation will become instable. Start with an 1k in this position. If the VCO does not start oscillation during test, try 2k7 or 3k3. Both values are added to the kit's bandmodule pack.

[ ] R7 1K or 2k7 or 3k3, see text  
 [ ] R8 150K  
 [ ] R9 100K  
 [ ] R10 68K

- [ ] R11            68K
- [X] Dr1            left out
- [ ] Dr2            22 $\mu$ H SMCC
- [ ] Dr3            22 $\mu$ H SMCC
- [ ] Dr4            22 $\mu$ H SMCC
- [ ] Dr5            22 $\mu$ H SMCC
- [ ] Dr6            22 $\mu$ H SMCC



**The following transistors may easily be damaged by ESD. Don't forget to discharge yourself, use a potential free soldering station.**

- [ ] T1            BF199

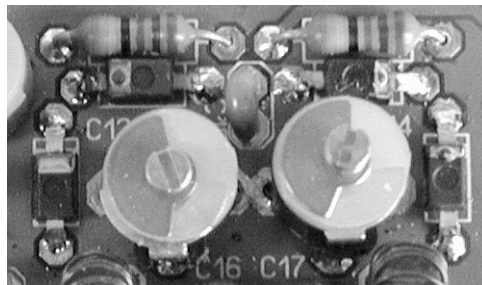
The following BF981 transistor has 4 terminals. One of the leads is definitely longer than the rest. This should be put into the hole marked with a dot on the pc board. **The leads are bent carefully a little away from the printed side, taken extreme care of static precautions!** When the transistor is in place, the marking should be readable.

- [ ] T2            BF981

**BEWARE: Risk of mixing up BA479 / 1N4148. Use a magnifier!!!**

- [ ] D1            BA479
- [ ] D2            BA479
- [ ] D5            BA479
- [ ] D6            BA479
- [ ] D4            1N4148
- [ ] Q1            Bandsetting Quarz

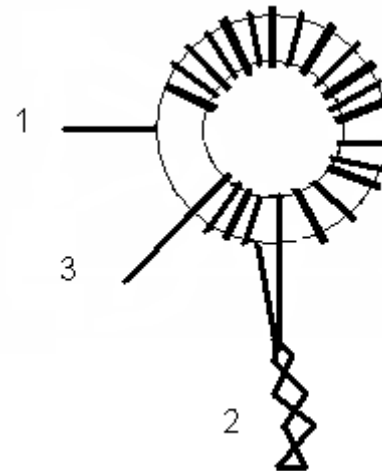
(11 MHz for the 40m Module)  
The varactor diodes following next can have different housings depending on what we get from our supplier. The standard look like the normal 1N4148 have seen a lot of. The other form is rectangular with very short leads. The cathode side is



marked with a band or a dot. The short leads are just long enough to contact the corresponding holes in the PCB, but long enough to go through the holes. Because our PCBs are throughplated that does not make any problem. Just solder the Diodes to the upper side of the hole. The picture shows this special type of diode.

- [ ] D3            BB109G/BB409 or the like
- [ ] D7            BB109G /BB409 or the like
- [ ] D8            BB109G /BB409 or the like
- [ ] D9            BB109G /BB409 or the like
- [ ] D10           BB109G /BB409 or the like

We have done toroids before. On the band module we use iron carbonyl rings, which are colour coded by type. L1 is wound on a 0.37 inch type 6 ring, which is yellow. (T37-6)



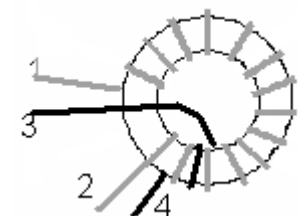
As already tried on the transformers, we will begin by noting the winding geometry. The primary of L1 has the cold end lower left (seen from the upper side of the pc board) at point 3, and ends at the upper right at point 1.

Use 0.3 mm lacquered copper wire (AWG 28) and begin at the cold end. Twist an end after 4 turns (counted on the inner side), to form the tap. Wind a further 19 turns (giving a total of 23 turns with a tap at turn 4 from the cold end).

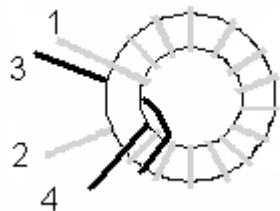
Mount it according to the placement diagram.

- [ ] L1            Amidon T37-6

Both band filter coils have a secondary. This



isn't difficult either. This time it isn't done with a tap, but with a proper secondary. Begin with the primary, 26 turns of 0.3 mm lacquered copper wire (AWG 28). Now put on the secondary as shown in the drawing. The secondary is ended at point 3.



L2 Amidon T37-2

L3 is identical to L2, apart from being a mirror image, to avoid long pc board lines. That is: same number of turns, but winding the other way round.

L3 Amidon T37-2



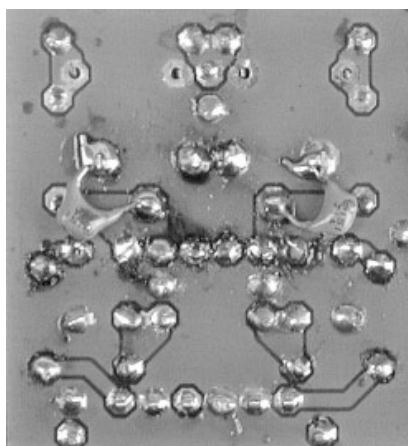
**Now mount the trimming capacitors. BEWARE: Do not to confuse C11 with the others.**

C4 2,5-60pF Film trimmer 7mm Diameter (black)

C11 2,0-45pF Film trimmer 7mm Diameter (violet)

C13 2,5-60pF Film trimmer 7mm Diameter (black)

C14 2,5-60pF Film trimmer 7mm Diameter (black)



Now something unusual, but not special: 2 capacitors are to be mounted on the solder side of the board.

C22 150pF on solder side 150p/n15

C23 150pF on solder side 150p/n15

Now we just have to put in the two connectors to finish the band module. Mount them and put all trimmers in centre position.

Connector strip A

Connector strip B

Trimmers in centre position

## Test Section 8

**1. Visual inspection** (see Section 1)

**2. Resistortest** (see Section 1)

Put a Bridge between pin 47 and pin 18

Put a band module activation PIN to +10C

Insert the bandmodule into the activated slug



The activation pins vor each band module are on the main board.

Which one you use is on yours, the bandmodules are all in parallel but only one is actually activated by its corresponding activation pin.

Connect rotary encoder to DDS

Apply power as in Section 1 test.

**3. Smoke test** (see Section 1)

## 4. Functional test

The complete PLL should work now. Test the band set oscillator (VX0) first. With a link wire and a short wave receiver, the oscillator should be loud at 11 MHz.

Hook up a digital volt meter to the connection between R3 and R4 (main board E7). If the voltage is close to 0 or 8 Volts, the PLL isn't working yet. Turn trimmer C11 very slowly. At some position of the trimmer the PLL will lock, and the voltage can be adjusted by the trimmer between 2 and 6 Volts. Adjust the trimmer to an occurrence of 2 Volts. If you hold the link wire near transistor T2, you should hear a strong signal on the SW-Receiver at 15.030 MHz, +/- 2 kHz. If you are using the Speakys frequency counter it displays 15,030 MHz, too. If you own an oscilloscope, you can see the VCO signal at IC1 pin 6. With trimmer P1 set it to some 250 mVpp. If you use an RF probe, set it to 100 mVeff. With the calibrated probe of QRPproject you have to adjust a value, which you can take from the SW-Calibration-Curve for a nominal value of 250 mVss.

L1 is so broad banded, that it doesn't demand tuning. But set it to a maximum signal at IC2 pin 11, anyhow.

That's that. The PLL works. Remove the bridges and go on to section 9.

## Section 9 RX/TX Mixer, Low pass filter



**The following transistors may easy be damaged by ESD. Dont forget to discharge yourself, use a potential free soldering station.**

The three leads of the BFR96 should be bent carefully down, the writing should be readable, when the transistor is in place.

<input type="checkbox"/>	T9	BFR96(S)	E4
<input type="checkbox"/>	T10	BFR96(S)	D5
<input type="checkbox"/>	T11	BF244A	C/D5



For the mixer TUF 1 you have to be careful about short to the pc board as with crystals. Mount it with the help of two pieces of cut off resistor leads as help, and remember to remove them after soldering! Remember to mount the mixer in proper direction. Seeing it from below, note that the leads aren't centred. At the component side, you can see how to orient it. (Shown as the mixer as a transparent object in the drawing).

<input type="checkbox"/>	M1	Mixer TUF1	D3/4
--------------------------	----	------------	------



**Now a few diodes, check their value with a loupe, not to mix them up.**

<input type="checkbox"/>	D4	BA479	E/F3
<input type="checkbox"/>	D5	BA479	E3
<input type="checkbox"/>	D6	BA479	D3/4
<input type="checkbox"/>	D7	BA479	D4
<input type="checkbox"/>	D8	BA479	D/E4

Now the other type

<input type="checkbox"/>	D9	1N4148	F2/3
<input type="checkbox"/>	D10	1N4148	F2/3

<input type="checkbox"/>	D11	1N4148	F2
<input type="checkbox"/>	D12	1N4148	F2

SMCC RFCs are well known by now

<input type="checkbox"/>	Dr1	10µH	SMCC	F3
<input type="checkbox"/>	Dr2	47µH	SMCC	E3
<input type="checkbox"/>	Dr3	47µH	SMCC	D/E 3/4
<input type="checkbox"/>	Dr4	47µH	SMCC	E3/4
<input type="checkbox"/>	Dr5	10µH	SMCC	C/D 4/5
<input type="checkbox"/>	Dr9	10µH	SMCC	F3

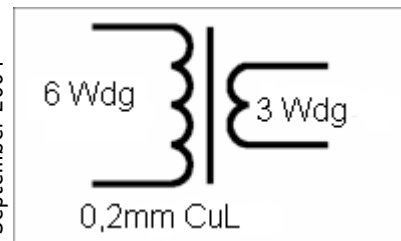
and now a lot of caps.

<input type="checkbox"/>	C35	47nF	473	E4
<input type="checkbox"/>	C36	47nF	473	E4
<input type="checkbox"/>	C37	100nF	104	E3/4
<input type="checkbox"/>	C38	47nF	473	E4
<input type="checkbox"/>	C39	47nF	473	E3/4
<input type="checkbox"/>	C40	47nF	473	F2/3
<input type="checkbox"/>	C41	47nF	473	F3/4
<input type="checkbox"/>	C42	47nF	473	E3
<input type="checkbox"/>	C43	47nF	473	D3
<input type="checkbox"/>	C44	47nF	473	D3
<input type="checkbox"/>	C45	47nF	473	E3
<input type="checkbox"/>	C46	47nF	473	D4
<input type="checkbox"/>	C47	100nF	104	D5
<input type="checkbox"/>	C48	47nF	473	D5
<input type="checkbox"/>	C49	47nF	473	D/E5
<input type="checkbox"/>	C50	15pF	15p	D5
<input type="checkbox"/>	C51	47nF	473	C5
<input type="checkbox"/>	C52	10nF	103	C5
<input type="checkbox"/>	C73	150pF	151;n15	G2
<input type="checkbox"/>	C74	120pF	121;n12	G1/2
<input type="checkbox"/>	C75	120pF	121;n12	G1
<input type="checkbox"/>	C76	120pF	121;n12	G1
<input type="checkbox"/>	C77	120pF	121;n12	G1
<input type="checkbox"/>	C78	150pF	151;n15	H1

[ ] C79	47nF	473	G2
[ ] C80	47nF	473	F2
[ ] R17	1,5K		E5
[ ] R18	1,5K		E5
[ ] R19	1,5K		D/E5
[ x] R20	2k7	0805 SMD	E4
[ x] R21	1k2	0805 SMD	E4
[ X] R22	10R	0805 SMD	E3
[ x] R23	39R	0805 SMD	E3/4
[ ] R24	1,5K		F3
[ ] R25	1,5K		D3
[ ] R26	47R		D4
[ ] R27	2k7R		D5
[ ] R28	1k2		D5
[ ] R29	1K		D5
[ X] R30	10R	0805 SMD	D5
[ ] R31	39R		D5
[ ] R32	100K		D5
[ ] R33	1K		C5
[ ] R52	1,2K		FG/2
[ ] R53	330R		FG/2
[ ] R54	depending on instrument		F2 ( wire bridge is bargraph)
[ x] R55	1K	0805 SMD	E4
[ ] P2	10K Piher PT6 lying		F2

### Winding instructions Transformer TR1

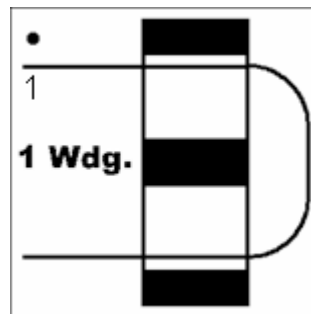
Now, after a pause, follows a new part.



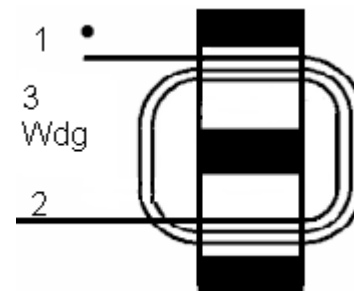
The transformer Tr1 is wound on a double hole („pig nose“) core.

Put the pig nose core in front of you, so that the holes pass from left

to right. Tr1 has a primary of 4 turns, and a secondary of 2 turns, to transform downwards. Like



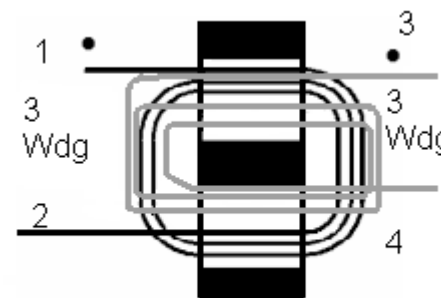
the other diagrams for transformers, this drawing also contains a dot. This is always the beginning of the winding (for coils too). Cut a 15 cm piece of



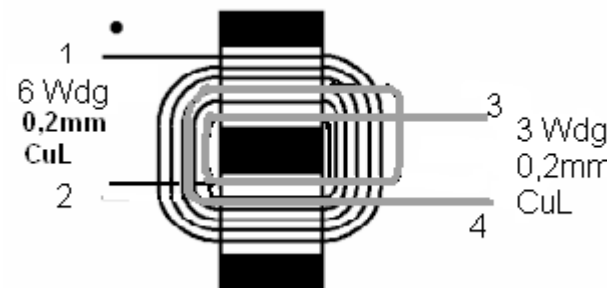
0.2 mm wire (AWG 32), and feed it through the pig nose, as shown in the diagram. One turn is done by going through one hole and back through the other. Make three turns: Through the upper hole going right (leave and end of some 2 cm outside). Back through the lower hole. One turn done.

Now go on: through the upper hole, back through the lower. End of turn two. Don't scratch the wire on the edge of the core! The lacquer is easily damaged.

Go on with turn 2 and the primary is done. This completes the primary, and leaves us to do the secondary. To easy mounting, our developer has laid out Tr1 so that the secondary leaves the core opposite to the primary.



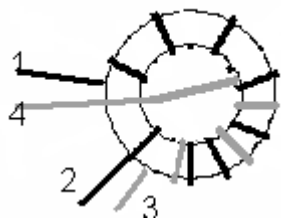
Take a 10 cm piece of 0.2 mm wire (AWG 32) and feed it carefully from right to left through the upper hole and back from left to right through the lower hole. End of the first secondary winding. Two more and we are finished!



Now the transformer can be mounted. The secondary goes to 3 and 4, the primary to point 1 and 2, as shown in the layout.

[ ] Tr1 QRP double hole core F3/4

Now follows another transformer, this time on an FT37-43 core. The primary has 8 turns, the secondary 4. Mounting according to the layout drawing.



Tr2 Amidon FT37-43 8 turns/4 turns D4/5

The three coils for the low pass filter is without any frills.

Just put the proper number of turns on Amidon iron carbonyl rings, type 6, yellow. Use 0.5 mm lacquered copper wire (AWG 24). Note the geometry!

L4 Amidon T37-6 G2  
10 turns 0.5 mm lacquered copper wire (AWG 26),  
270 degrees covered

L5 Amidon T37-6 G1  
11 turns 0.5mm lacquered copper wire (AWG 26),  
270 degrees covered

L6 Amidon T37-6 G/H1  
10 turns 0.5mm lacquered copper wire (AWG 24),  
270 degrees covered

J1 Connector J1 D4  
 pin 6 F5  
 pin 16 C5  
 pin 17 C5  
 pin 31 G/H 0/1  
 pin 32 D/E3  
 pin 36 F3  
 pin 37 F2  
 pin 52 G/H 0/1

RL1 DIL Reed relay 12V 1x Changer F/G 2/3  
 J1 3 pin Connector D4

## Test Section 9

**1. Visual inspection** (see Section 1)

**2. Resistance test** (see Section 1)

Bridge pin 47 to pin 18  
 Connect rotary encoder to the DDS  
 Put pin 29 to +10 Volt (see section 1)  
 Put pin 19 to +10V  
 Put pin 15 to +10 V  
 Put Pin 32 to +10V  
 Put pin 36 to +10V  
 Bandmodul selection pin to +10V  
 insert Bandmodule into the corresponding slot  
 Bridge pin 20 to ground  
 Centre trimmer potentiometer P4  
 Connect head phones to pin 44 and ground  
 Connect volume potentiometer arm to pin 33, ends to pins 26 and 34  
 Turn volume potentiometer to centre position  
 Connect BNC connector to pin 52 and 53  
 Connect pin 6 to preselector potentiometer arm.  
 Connect preselektor potentiometer to +10V and via 1k8 to ground as shown in the wiring diagram.  
 Centre preselector potentiometer  
 Put jumper on J1 2/3 (to give the Ringmixer 50 Ohm)

**3. Smoke test** (see section 1)

Apply power as in section 1 test.  
current about 210 mA

**4. Functional test**

Adjust P1 on the band module for 500 mVeff or 1,5 Vpp at J1/1. If you cannot measure, just peak the voltage with a diode probe.

Move jumper to J1 2/3



Generate a strong signal at 7.030 MHz You may use any RF Generator or the little Xtal Generator from QRPproject. It is also possible to use a station transmitter with a DummyLoad (Attention, do not connect the Transmitter directly to the BNC connector, this will damage your Speaky!) Adjust frequency. Trim C16/C17 to maximum with the weakest possible transmitter signal. Now you should be able to hear ham operators in the 40 meter band if you attach an antenna. Be aware, that the Xtal filter is not yet adjusted. May be it is very small in the moment so you can hear CW stations but not SSB. To decode SSB Stations you must adjust the filter section as described later in this manual.

If all is ok, proceed to section 10.

## Section 10 SSB Generator and SSB amplifier

<input type="checkbox"/>	P13	22K Piher PT6 lying	A1/2
<input type="checkbox"/>	P14	50k Piher PT6 lying	A1
<input type="checkbox"/>	P15	220K Piher PT6 lying	B1
<input type="checkbox"/>	P16	2,2K Piher PT6 lying	B1
<input checked="" type="checkbox"/>	IC17	SSM2165-1 S08	A1



**The following IC may easy be damaged by ESD. Dont forget to discharge yourself, use a potential free soldering station.**

Roll the ICs before mounting! Remember static precautions!

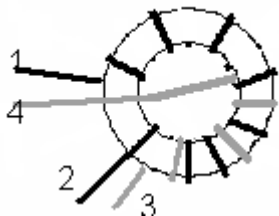
<input type="checkbox"/>	IC16	NE612 DIL8	A2/3
<input type="checkbox"/>	IC18	TL071 DIL8	C/D1



**The following transistors may easy be damaged by ESD. Dont forget to discharge yourself, use a potential free soldering station.**

<input type="checkbox"/>	T23	BF910 MOS beware of static!	C3
<input type="checkbox"/>	T30	BC337-40	B1
<input type="checkbox"/>	C85	100pF 101	C4
<input type="checkbox"/>	C86	22nF 223	C3
<input type="checkbox"/>	C87	22nF 223	C3
<input type="checkbox"/>	C88	22nF 202	D3
<input type="checkbox"/>	C89	10nF 103	C3
<input type="checkbox"/>	C134	47nF 473	A2/3
<input type="checkbox"/>	C135	10nF 103	A2
<input type="checkbox"/>	C137	1000pF 103	A2/3
<input type="checkbox"/>	C138	10nF 103	A2
<input type="checkbox"/>	C139	0,033µF Film RM 5mm	A2
<input type="checkbox"/>	C149	1nF 103	D1
<input type="checkbox"/>	C150	1nF 103	D1
<input type="checkbox"/>	C136	10µF/16V Tantalum pearl	A2
<input type="checkbox"/>	C140	100µF/16V radial	A/B1
<input type="checkbox"/>	C142	1µF/63V radial	A1
<input type="checkbox"/>	C143	22µF/16V radial	A1

[ ] C145	1µF/63V	radial	C1
[ ] C146	100µF/16V	radial	C/D1
[ ] C141	0,1µF	film RM 5mm	A1
[ ] C144	0,1µF	film RM 5mm	A0/1
[ ] C147	0,22µF	film RM 5mm	C0/1
[ ] C148	0,01µF	film RM 5mm	D1
[ ] R96	100K		C3
[ ] R97	150K		C3
[ ] R98	220R		C/D3
[ ] R99	27R		C3
[ ] R100	56R		C3
[ ] R101	100K		C4
[ ] R114	100K	metal film 1%	A2
[ ] R115	100K	metal film 1%	A2
[ ] R116	27K		A2
[ ] R117	33K		A2
[ ] R118	12K		A2
[ ] R119	120R		B1
[ ] R120	12K		B1
[ ] R121	33K		B1
[ ] R122	2k2		B/C1
[ ] R123	390R		C1
[ ] R124	100K		D1
[ ] R125	100K		D1
[ ] R126	2,7K		C1
[ ] R127	56k		C1
[ ] Dr12	100µH	SMCC	D0/1



The transformer TR6 is identical to the transformer TR2 from building group 8. 8 turns primary and 4 turns secondary, 0.3mm CuL (AWG 28).

[ ] Tr6	Amidon	FT37-43
		C/D3

[ ] PIN 21	C3
[ ] PIN 23	A1/2
[ ] PIN 24	B1
[ ] PIN 30	D3
[ ] PIN 48	D1
[ ] PIN 49	D0/1

## Test Section 10

**1. Visual inspection** (see Section 1)

**2. Resistance test** (see Section 1)

**3. Smoke test** (see section 1)

[ ] Apply power as in section 1 test.  
current about 240 mA

## 4. Functional test

During the following test remove all bandmodules from their slots.

Add all Voltages to your speaky

[ ] Connect pin 53 to ground (That is the PTT pin)

Use a scope or the RF probe to measure the 8MHz RF Voltage at Pin 4/5 of IC16 and use P13 to adjust to the lowest possible value.

Solder a 1k Resistor between pin48 and pin 49 at the bottom of the PCB. Connect a source of an 1kHz (abt) tone (Soundcard, Tone generator, Multi-meter with Tone source) to pin 48 (gnd) and pin 49 (hot). Measure the AF Voltage between R122 and C145. Adjust the source to have abt 200mVrms at this point.

Adjust P16 to get abt 50mV rms at its middle contact

Adjust P15 fully clockwise

Adjust P14 to get abt 600mVpp at IC16 pin 4/5. This is our DSB (double Sideband Signal). The remaining parts of the signal generation will be adjusted later.

## Section 11, Transmitter driver and PA

[ ] P1 100R 0,5W Cermet lying RM 5x10mm F/G3



**The following transistors may easy be damaged by ESD. Dont forget to discharge yourself, use a potential free soldering station.**

Bend leads of BRF96 away from the marking text.

[ ] T3	BFR96(S)		G4
[ ] C53	47nF	473	G4
[ ] C54	100nF	104	G4
[ ] C56	47nF	473	H4
[ ] C57	47nF	473	G4
[ ] C58	47nF	473	H4
[ ] C60	2,2nF	222	H3
[ ] C61	47nF	473	F4
[ ] C62	47nF	473	F3
[ ] C63	47nF	473	G3
[ ] C65	47nF	473	H1
[ ] C66	100nF	104	H3
[ ] C68	100nF	104	H2/3
[ ] C69	100nF	104	H2
[ ] C72	47nF	473	F1
[ ] C64	0,47µF	Film RM 5mm	G3
[ ] C55	0,1µF	Film RM 5mm	G3
[ ] C70	1µF	Film RM 5mm	H2
[ ] C67	47µF/16V	radial	G3
[ ] C71	100µF/25V	radial	H1
[ ] D3	BA479		F4
[ ] Dr6	47µH	SMCC	F3/4
[ ] Dr7	10µH	SMCC	G3
[ ] R34	1K		F4
[ ] R35	2k7		G4
[ ] R36	1k2		G4
[ x ] R37	10R	SMD	G4

[ ] R38	39R		G4
[ ] R39	68R		H4
[ ] R40	820R	(adjust for Iquiesc. T5~ 100mA)	H4
[ x ] R41	4,7R	SMD	H4
[ x ] R42	4,7R	SMD	H3
[ x ] R43	1R	SMD	H3
[ ] R44	270R	1 Watt Metal film	G4
[ ] R45	5,6R		H1/2
[ ] R46	10R		G/H3
[ ] R47	10R		H3
[ X ] R48	1R	SMD 1206	H2
[ X ] R49	1R	SMD 1206	H2
[ X ] R50	1R	SMD 1206	H2
[ X ] R51	1R	SMD 1206	H2



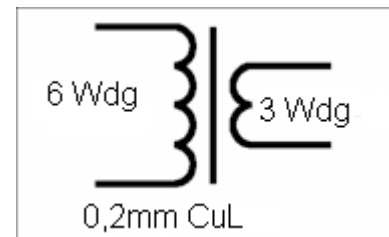
**Mount the T0220 transistors, so they are flush with the pc board edge. Later they will be mounted on the back of the box.**

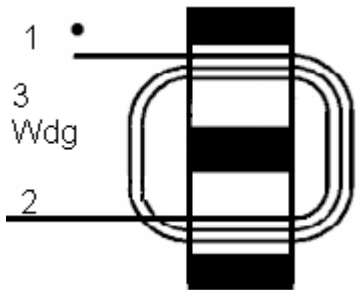
[ ] T4	BD242/ BD244	H4
[ ] T5	2SC1970 Mitsubishi!!	H3/4
[ ] T6	2SC1969 Mitsubishi!!	H2
[ ] T7	2SC1969 Mitsubishi!!	H3
[ ] T8	BD242/ BD244	H1/2

We continue with the broad band transformers Tr3 and Tr4. They are identical. These transformers are wound on pig nose cores.

Building instruction Tr3:

Put the pig nose in front of you, pointing the holes from left to right, an mark the left side with a drop of colour (Nail lacquer is good, felt tipped pens works badly). The marking is important to avoid mixing up primary and secondary. Tr3 contains a primary of 6 turns and a secondary of 3 turns. As in most other transformer diagrams, one winding is marked with a dot. This is always the beginning of the winding.





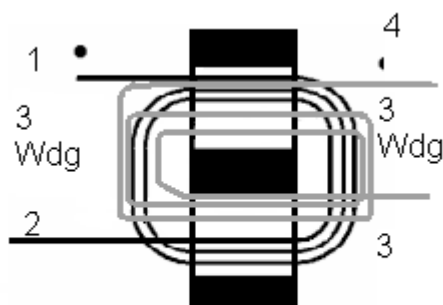
Cut a 15 cm piece of 0.2 mm wire (AWG 32) and feed it through the pig nose as shown in the drawing.

One turn is completed from one pass through each hole.

Put on three turns: left to right through the upper hole, then back right to left through the lower. Once more. Done. Leave 2 cm wire

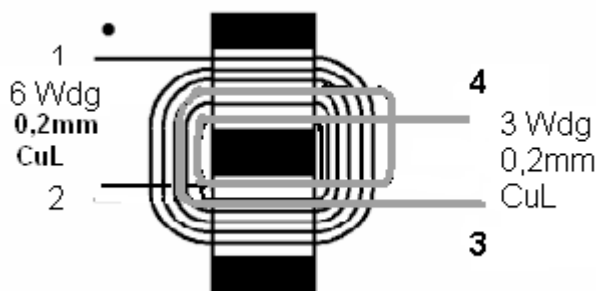
at the beginning of the wire. Don't pull too hard on the wire, not to damage the lacquer.

If you have done right till now, two wire ends are hanging out of the left side of the core, on top a short, at the bottom a longer.



(I hope you don't get mad at my being so detailed, describing twice and thrice. The transformers count for quite a number of mistakes!) Now repeat to put on more turns.

Now do the same from the other side for the secondary, with a 10 cm piece of wire, leaving 3 turns primary and three turns secondary.



Now take the first wire again and put on another three turns for a total of 6 on the primary. That is 6 turns on the left and 3 on the right. This way the secondary is symmetrical.

Now mount the transformer, respecting its orientation by looking at the

number at the leads in the drawings. Solder the ends before mounting, to remove the lacquer.

It is easier if the wires are long enough for them to be held firmly to the pc board during soldering.

[ ] Tr3 QRP double hole core G/H4

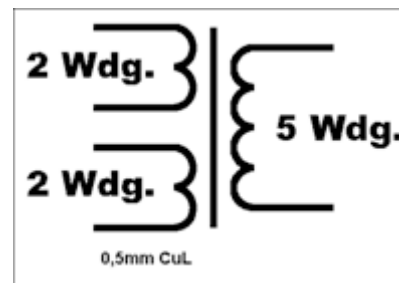


**Repeat this for transformer Tr4, but remember that Tr4 has a primary of 4 turns and a secondary of 2 turns.**

[ ] Tr4 QRP double hole core H3

### Winding Instruction TR5

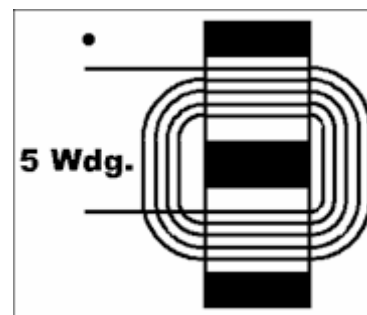
Now Tr5. This isn't much more difficult, but the 0.5 mm wire (AWG 24) is stiffer. The holes in the BD202-43 pig nose core are bigger, though.



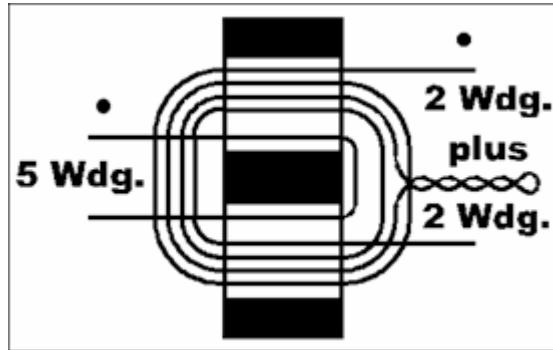
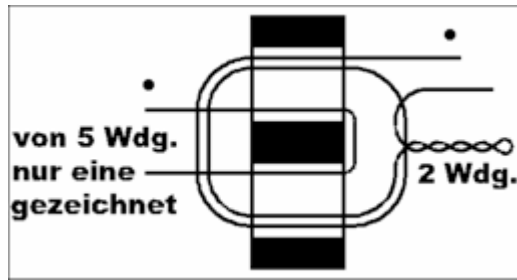
Please be careful not to scrape the lacquer on the wire on the core!!! Tr5 has a primary of 2 x 2 turns and a secondary of 5 turns.

Cut a 25 cm piece of the 0.5 mm lacquered copper wire (AWG 24). Begin upper left and

put on 5 turns. This means from left to right upper, then right to left lower equals one turn. Repeat this for every turn till you have 5. The winding is done. Naturally you have to space the turns less than in the drawing! Be careful not to damage the lacquer on the wire.



Now follows the first part of the primary. Take a 15 cm piece of wire and begin opposite to the secondary, going right to left at the top, continuing left to right at the bottom. One turn. Now repeat this. Now the trick: twist a 30 mm loop back to the pig nose. This should look as in the drawing. Now continue with the free end right to left on top, left to right at the bottom. For two full turns.



Now the transformer should look like the following drawing. To the left two wire ends, to the right three, counting the twisted part as one wire

Solder all 5 ends and mount the transformer. Every wire end should be in its proper place for the pc board.

switches and the pc board. Mount the pc board BELOW the frame, to leave enough room for the peripheral parts.

[ ] Tr5 double hole core BN43-202 G/H 2/3

That's that! Now follows the rest of the transmitter output parts

[ ] pin 35 F3

Now the RFC for the PA power supply. Wind 10 turns of 0.5 mm lacquered copper wire well distributed over an Amidon FT50-43. Take note of the necessary geometry.

[ ] Dr8 Amidon FT50-43 F/G1

Version: 13. September 2004 That should be all. The rest is just trimming. Instead of another section test, I recommend that the pc board is mounted into the box, and all peripheral parts are wired and soldered. The open construction of the box leaves access to both sides of the pc board. I found a test without box, and with live wires too risky.

If you follow our advice, then continue preparing the front and back of the box as you want them or according to our template. Mount potentiometers,

## Pin placement Speaky, placement diagram

PIN 1	BM1	H7
PIN 2	BM2	G7
PIN 3	BM3	F7
PIN 4	BM4	E7
PIN 5	BM5	E7
PIN 6	VPreSel	F5
PIN 7		A/B7
PIN 8		D2/3
PIN 9	+10V_CW	A/B6
PIN 10	to PIN 42	A5
PIN 11	to PIN 41	A5
PIN 12	+10VS	A5
PIN 13	SoftKeyOut	B5
PIN 14		B5
PIN 15		B5
PIN 16	Counter	C5
PIN 17	Counter	C5
PIN 18	+10V	C5
PIN 19		B3
PIN 20		B4
PIN 21		C3
PIN 22	+10VS	B3
PIN 23	to T22	A1/2
PIN 24	+10VE	B1/2
PIN 25	see Wiring Diagramm	B2
PIN 26	AF Pot	B1/2
pin 27	AF Pot gnd	B1
pin 28	LSB	C/D2
pin 29	USB	D2
pin 30	SSB/CW	D3
pin 31	+10VS	D3
pin 32	+10VE	D/E3
pin 33		E3
pin 34		E3
pin 35	+10VS	F3
pin 36	+10V	F3
pin 37	POut Anz.	F2

pin 38		E2
pin 39	+10VE	E2
pin 40	+10VS	E1
pin 41	Ue_	E1/2
pin 42	Us_	E1/2
pin 43	E/F 1/2	
pin 44	F1/2	
pin 45	PWR ON	E/F1
pin 46	PWR ON	E1
pin 47	+10V	E1
pin 48	GND	D1
pin 49	NF Pot	D0/1
pin 50	+DC Input	G1
pin 51	GND	G/H1
pin 52	ANT	G/H 0/1
pin 53	ExtKey/PTT	A/B5

## Trimmer Potentiometers, placement diagram

P1	F/G3	Quiet current PA
P2	F2	Output indicator
P3	B5	Band width CW filter
P4	C5	Band width SSB filter
P5	B3	S Meter indicator
P6	D/E 2	Side tone level
P7	A/B 2	Level of BFO/carrier oscillator
P8	D2	BFO USB
P9	D1	BFO LSB
P10	D1	BFO CW receiver
P11	D2	BFO CW transmitter
P12	A5	CW decay
P13	A2	Carrier suppression
P14	A1	AF level SSB TX
P15	A/B 1	SSB compression level
P16	B1	Mic level

## Adjustments

Adjusting the SSB/CW-Stage requires a constant 8 MHz carrier. Therefore the following adjustments are done in position CW.

Adjusting the carrier frequency for USB/LSB at SSB-filter bandwidth  
Speaky in position CW

1. Using P3, adjust a tension of 4.50 V measured at R102 (results in a filter bandwidth of 2.4 kHz)
2. Remove the band module and key the transmitter
3. Connect a 10:1 Scope probe or a RF-Probe to R58 on the crystal filter output (Use slow time deflection)
4. Vary the BFO frequency turning P11 slowly. You will see a RF band on which amplitude one can see very good the filter edges and the long drawing roof of the filter shape.
5. Notice the maximum RF-Voltage of the filter shape roof. [      ]
6. Turn P11 left until at R58 will occur a RF-Voltage of one fifth of the maximum value noticed in step 5 (corresponds to 15 dB under the filter shape roof) .
7. Measure the DC on the output of IC12 (e. g. Pin 10) using a digital Voltmeter and notice the value. Value A: [      ]
8. Turn P11 to the right away over the maximum filter roof until a RF-Voltage of one fifth of the maximum value is reached again.
9. Measure the DC on the output of IC12 using a digital Voltmeter and notice the value. Value B: [      ]
13. Should it be impossible to adjust the BFO to the higher frequency filter edge, turn the core of L7 higher or try a 22  $\mu$ H coil in parallel to L7 (Repeat steps 5 – 6 and 7 – 8).

The lower voltage on the output of IC12 corresponds to the LSB carrier frequency, the higher one to the USB carrier frequency.

Adjusting the BFO frequency for CW Rx/Tx at CW-filter bandwidth

1. Using P3, adjust a voltage of 2.00 V measured at R102 (results in a filter bandwidth of 500 Hz)
2. Vary the BFO frequency while turning P11 slowly. You will see at the RF-Voltage on R58 the much smaller filter shape.
3. Determine the middle of the filter shape exactly and notice the voltage occurring at the output of IC12. Value C: [      ]
4. Stop keying the transmitter and insert the band module again.
5. Adjust the voltage on the output of IC12 with P10 to exactly that value you noticed in step 3.
6. Feed the Rx-input with a crystal stable signal and tune the DDS exactly to ZERO-Beat.
7. Turn P10 as far to the right, that you can hear a pleasant pitch of 400 to 1000 Hz. This tone should meet your favourite audio frequency for receiving CW. To beginners it is recommended to adjust to 650 Hz. The pitch may be simply controlled by connecting the phone output to the input of a PC-soundcard and examine the signal by an analyser program, like GRAM.
8. Switch SPEAKY to SSB
9. Adjust a voltage of 4.50 Volts at R102, using P4
10. Switch to LSB and adjust P9 until at IC12 an output voltage of the value A occurs, which you noticed above.
11. Switch to USB and adjust P8 until at IC12 an output voltage of the value B occurs, which you noticed above.

Now the adjustments of the SSB stage are finished.

### Adjustments of the Band Modules

The different band modules will be now adjusted, as described for the 40 m band module. For each module the LO has to be adjusted first. Therefore the VCO has to be adjusted in a way, that at the starting frequency of the DDS the VCO trimmer is set to get 1.5 Volts at the loop filter. With the trimming potentiometer a RF-Level of 100 mV rms at the bus line is adjusted. At the jumper for the ring mixer it should be 7 dBm (jumper at 50 Ohm position) which equals 1.4 Volts peak to peak.

The bandpass filters of each module will be adjusted as follows: Adjust to the middle of each band and set the preselektor trimmer to its middle position. While in mode CW and Tx key pressed, adjust both of the band pass trimmers until a definite and single transmitting power maximum occurs. Tuning should be done at as low transmitting power as possible.

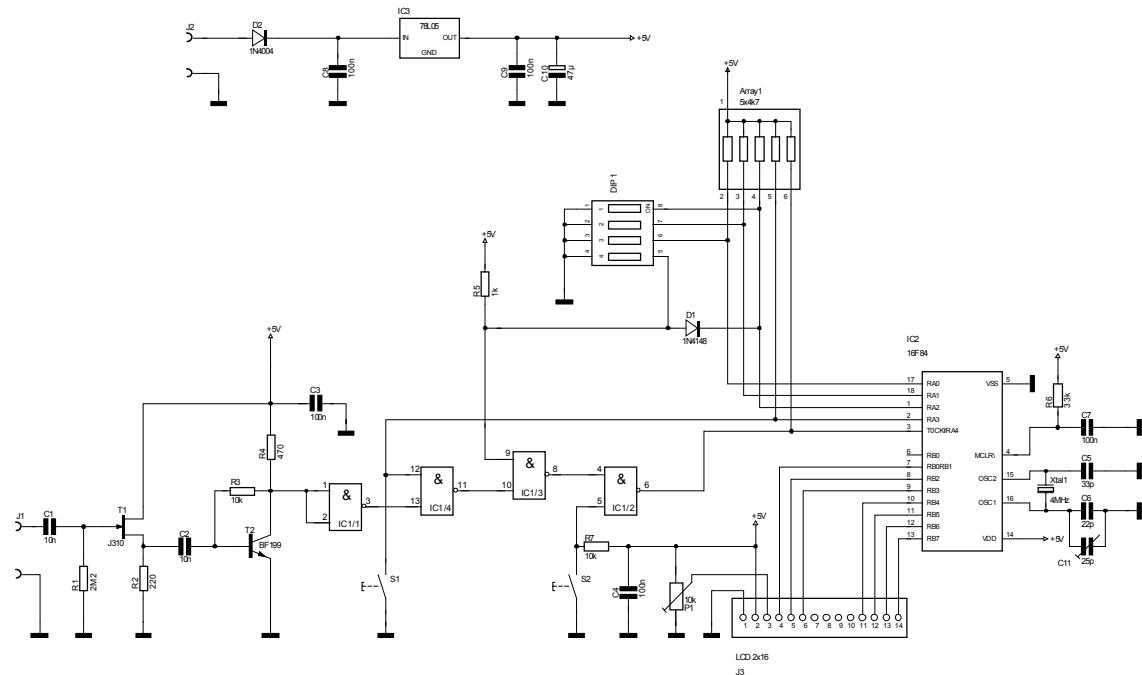
## Building the Frequency Counter

### Introduction

Frequency counters using PIC are already known a long time in different forms. Thereby the basic features like frequency range, resolving and sensitivity are always identical. We were looking for a multiple usable counter which could be used as a single device, but also as a module for a multi-functional set. Finally we found a module which came near to our imaginations.

The counter was developed by Ron Taylor, G4GX0, based on publications of other OM's. These therefore founded the basics of the present product. Ron describes the circuit in the internet (<http://www.g4gx0.cwc.net/>) from where also may be downloaded the software.

We thank Ron Taylor, G4GX0, who developed the counter for us in the present form, Dr. Peter Halicky, who contributed essential basics and ideas for the Software, Ed Skelton, EI8GQ, who contributed ideas for the hardware



Zähler DL-QRP-AG Vers. 18.12.02 Zchnng Jürgen, DL1JGS



and controls and the NJQRP Club, contributing big ideas for the software too.

Our kit contains the complete hardware including a programmed microprocessor, naturally always with the up to date software version. In addition we are offering an up to date service, with which processors with the actual software are available, even if a kit was already build up earlier.

### Description and Technical Data

The frequency counter distinguishes from other projects of this kind in two points: first it is able to show the measured result on a LCD-Display and second there can be given a shift by the user, which may be added or subtracted. These adjustments are done using a four pole DIP-Switch and two micro keys which influence the software of the microprocessor and allow changes at any time. Therefore the application area covers a simple counter for measuring and adjustments to frequency displays for RF-Oscillators until displaying the working frequency of transceivers whereby the IF doesn't matter.

All tests yet brought a maximum measuring frequency of > 40 MHz. For higher frequencies in short will be available a preselektor group.

### Technical Data

Working Voltage: 8 ... 15 Volts  
 Current: < 30 mA at  $U_b = 12 V$   
 Input Voltage: min: 30 mV  
 max: 2 Volts  
 Frequency range: > 35 MHz  
 Display: 2 x 16 characters LCD with backlight

### Operation of the Counter

The counter allows two modes:

- Counting
- Programming a frequency shift

Counting mode

In counting mode is made a difference between direct counting and counting with frequency shift. Switching between these modes is possible

without a reset of the counter. By that it is possible to change the display between direct frequency and frequency shift using an optional switch or relay. An example for such an application would be a superhet receiver in combination with a straight circuit receiver.

The frequency shift can be added or subtracted. The following table 1 shows the possible adjustments of the DIL-Switch for counter mode.

DIP	ON	OFF	Function
1	Shift	Count	Mode switch
2	Frequency	Sum/Diff	+/- sel. when shift is active
3	Direct	Shift	Shift active or inactive
4	Shift	Count	Mode switch

### Programming a Frequency Shift

To program a frequency shift DIP-Switches 1 – 3 are used to address and program every of the 8 positions of the Display. DIP-Switch 4 is used to enter the programming mode itself.

The following steps are necessary to program any shift:

1. Switch off the counter
2. All DIP-Switches to ON
3. Press and hold both the Up- and Down keys
4. Switch on the counter and release the Up-/Down keys
5. After one second „Offset Prog“ on the display occurs

Now the counter is in programming mode and while pressing the Up-/Down keys the last position of the Display can be programmed. All other positions will be selected by switching the DIP-Switch first. For that the following table 2 may be helpful:

DIP	10 MHz	1 MHz	100 kHz	10 kHz	1 kHz	100 Hz	10 Hz
1	OFF	OFF	OFF	ON	ON	ON	ON
2	OFF	ON	ON	OFF	OFF	ON	ON
3	ON	OFF	ON	OFF	ON	OFF	ON
4	ON	ON	ON	ON	ON	ON	ON

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Please note, that increasing to > 9 and decreasing to < 0 will produce an overflow.

If the wanted programming is done, store the value by pressing both Up-/Down keys at the same time for short. This way the shift stays stored even if the device is switched off. The storage may be overwritten by a new programming at any time.

Now, the shift is programmed and the processor changes to programming a multiplier. Speaky doesn't need this. So we let it at a value of 1 and go ahead storing it.

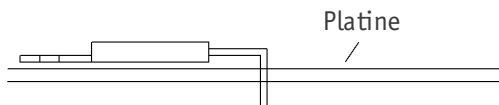
To store the multiplier press both Up-/Down keys at the same time for a short. To confirm the successful storing on the display occurs „saved“.

Now, switch off the counter and set the DIP-Switches 3 and 4 to OFF. After that the counter may be switched on again and a mode can be selected using the settings of Table 1.

### Building up the Counter

<input type="checkbox"/> C1103 10n	<input type="checkbox"/> C2103 10n
<input type="checkbox"/> C3104 100n	<input type="checkbox"/> C7104 100n
<input type="checkbox"/> C8104 100n	<input type="checkbox"/> C9104 100n
<input type="checkbox"/> C4104 100n	<input type="checkbox"/> C5 33p
<input type="checkbox"/> C6 22p	<input type="checkbox"/> C10 47µ rad
<input type="checkbox"/> C11 Folia trimmer green	
<input type="checkbox"/> R1 2M2	<input type="checkbox"/> R2 220R
<input type="checkbox"/> R3 10k	<input type="checkbox"/> R7 10k
<input type="checkbox"/> R4 470R	<input type="checkbox"/> R5 1k
<input type="checkbox"/> R6 33k	<input type="checkbox"/> T1 J310
<input type="checkbox"/> T2 BF199	

At the power regulator chip IC3 the terminals must turned backward by 90°. Backward means away from the labelled side.

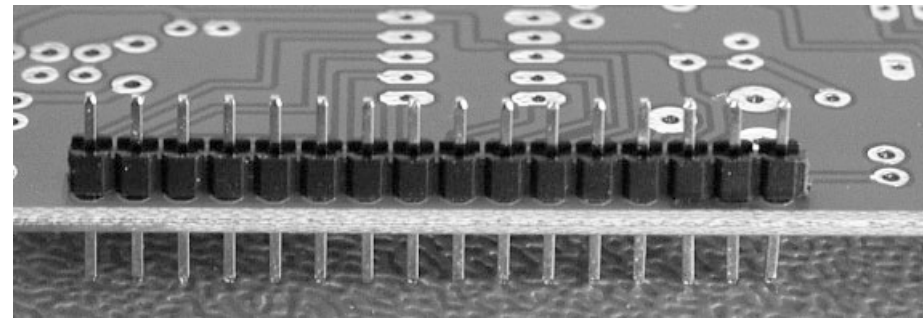


- IC3 7805
- Socket IC2 16F84A
- D2 1N4146
- Resistor-Array 1 5x4k7 CAUTION PIN 1 must point to the PCB edge!
- DIP-Switch 1 4 position (ON shows to the middle of the PCB)
- Crystal 4 MHz
- Socket IC1 74HC00
- D1 N4148
- P1 1 x 10k (Piher PT10)

The pins of the following keys are arranged in rectangle form instead in square. Keep attention to place them on the PCB in the right way.

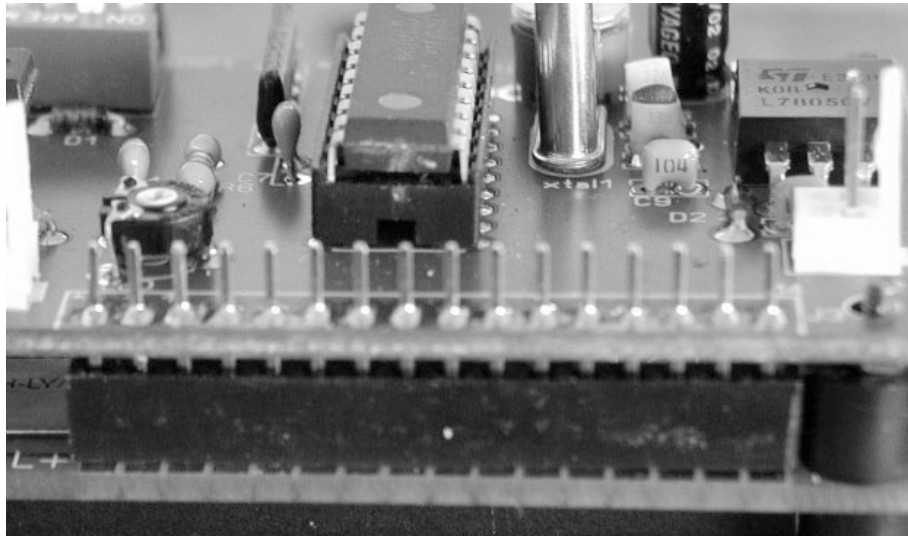
- S1 Key (working contact)
- S2 Key (working contact)
- J1 Plug 2 positions
- J2 Plug 2 positions
- J3 Plug 2 positions

The following PCB connector must be adjusted carefully. The long pins are put through the PCB from the soldering side and soldered on the component side. It is very important, that the Plug is soldered exactly at a 90° angle. This can be made easily if one pin is soldered first and during that



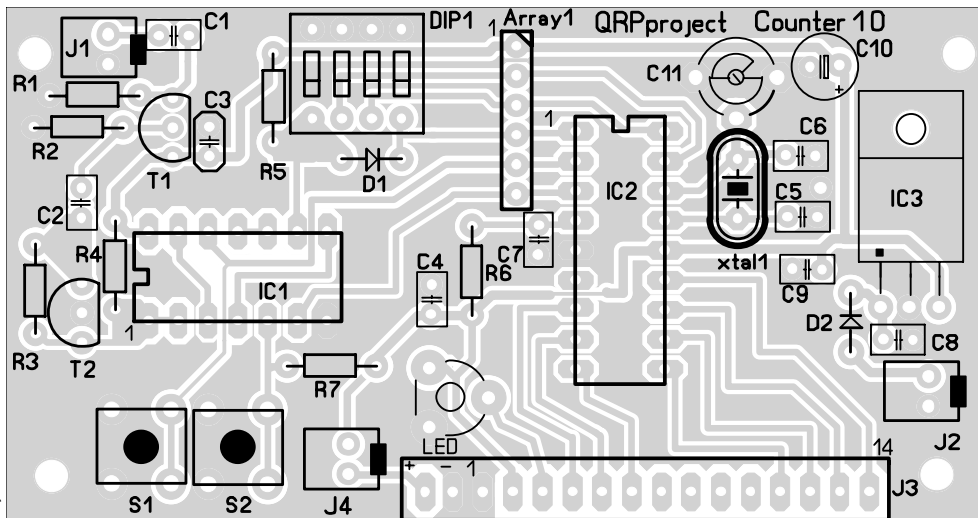
the plug is aligned exactly. Then the soldering of the other pins may follow.

Building in that connector is a little tricky to reach the right distance. Press the connector pins through the holes until the plastic body touches the PCB. Now all pins will be soldered one by one. After all pins are soldered tie the plastic body away from the pins as long as the are still warm. This is easy if you use a little screwdriver as a lever.



[ ] J14 PCB connector 16 pins

On the backside of the display the 16 pin connector will be soldered as shown on the drawing.



Terminator J2 will be connected to +12 Volts and ground, coming from the basic unit. J4 is connected to the display backlight switch and J1 is the RF input-termination.

If +12 Volts are connected, first contrast of the display should be adjusted using the trimming potentiometer that way, that the characters are readable pretty good.

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Display and counter may now be plugged together and tightened with screws and distance bolts to one unit.

## Parts list for SPEAKY 80 m Band Module

T1 BF199  
T2 BF981

D1 BA479  
D2 BA479  
D3 BB109G o.ä.  
D4 1N4148  
D5 BA479  
D6 BA479  
D7 BB112  
D8 BB112  
D9 BB112  
D10 BB112

R1 68K  
R2 27K  
R3 1K  
R4 10R  
R5 56K  
R6 68R  
R7 1kK  
R8 150K  
R9 100K  
R10 68K  
R11 68K

P1 250R Piher

C1 220pF  
C2 150pF  
C3 obsolete  
C4 2,5-60pF Folio trimmer (black)  
C5 22nF  
C6 10nF  
C7 22nF  
C8 22nF

44

C9 68pF  
C10 330pF  
C11 2,0-45pF Folio trimmer (violet)  
C12 10nF  
C13 2,5-60pF Folio trimmer (black)  
C14 2,5-60pF Folio trimmer (black)  
C15 22nF  
C16 12pF  
C17 12pF  
C18 47nF  
C19 47nF  
C20 56pF  
C21 22nF  
C22 270pF on PC board soldering side  
C23 270pF on PC board soldering side

L1 Amidon T37-6 22 turns 0,3 CuL (AWG 28) tap at 5th turn from cold end  
L2 Amidon T37-2 36 turns 0,3 CuL (AWG 28) Lk=3 turns on cold end  
L3 Amidon T37-2 36 turns 0,3 CuL (AWG 28) Lk=3 turns on cold end

Dr1 obsolete  
Dr2 22μH SMCC  
Dr3 22μH SMCC  
Dr4 22μH SMCC  
Dr5 47μH SMCC  
Dr6 47μH SMCC

Q1 7,50MHz, HC18

ST1 6-pin header, right angle, PC mount  
ST2 6-pin header, right angle, PC mount

## Parts list for SPEAKY 40 m Band Module

T1	BF199
T2	BF981
D1	BA479
D2	BA479
D3	BB109G or equivalent
D4	1N4148
D5	BA479
D6	BA479
D7	BB109G or equivalent
D8	BB109G or equivalent
D9	BB109G or equivalent
D10	BB109G or equivalent

R1	68K
R2	27K
R3	1K
R4	10R
R5	56K
R6	68R
R7	1k
R8	150K
R9	100K
R10	68K
R11	68K

P1 250R Piher PT6 right angle

C9	47pF
C10	220pF
C11	2,0-45pF Folio trimmer 7mm (violet)
C12	10nF
C13	2,5-60pF Folio trimmer 7mm (black)
C14	2,5-60pF Folio trimmer 7mm (black)
C15	10nF
C16	10pF
C17	10pF
C18	22nF
C19	22nF
C20	27pF
C21	10nF
C22	150pF on PC board soldering side
C23	150pF on PC board soldering side

L1	Amidon T37-6 19 turns 0,3 CuL (AWG 28) tap at 4th turn from cold end
L2	Amidon T37-2 24 turns 0,3 CuL (AWG 28) Lk=2 turns at cold end
L3	Amidon T37-2 24 turns 0,3 CuL (AWG 28) Lk=2 turns at cold end

Dr1	obsolete
Dr2	22μH SMCC
Dr3	22μH SMCC
Dr4	22μH SMCC
Dr5	22μH SMCC
Dr6	22μH SMCC

Q1 11MHz HC18 32pF

ST1	6-pin Header, right angle, PC mount, RM 2,54mm
ST2	6-pin Header, right angle, PC mount, RM 2,54mm

## Parts list for SPEAKY 20 m Band Module

Version: 13. September 2004

C1	220pF
C2	150pF
C3	obsolete
C4	2,5-60pF Folio trimmer 7mm (black)
C5	22nF
C6	10nF
C7	22nF
C8	22nF

T1	BF199	C11	2,0-35pF Folio trimmer 7mm (brown)
T2	BF981	C12	10nF
D1	BA479	C13	2,0-45pF Folio trimmer 7mm (violet)
D2	BA479	C14	2,0-45pF Folio trimmer 7mm (violet)
D3	BB109G or equivalent	C15	10nF
D4	1N4148	C16	3,3pF
D5	BA479	C17	3,3pF
D6	BA479	C18	10nF
D7	BB109G or equivalent	C19	10nF
D8	BB109G or equivalent	C20	27pF
D9	BB109G or equivalent	C21	10nF
D10	BB109G or equivalent	C22	56pF on PC board soldering side
R1	68K	C23	56pF on PC board soldering side
R2	27K	L1	Amidon T37-6 15 turns 0,3 CuL (AWG 28) tap at 4th turn from cold end
R3	1K	L2	Amidon T37-6 20 turns 0,3 CuL (AWG 28) Lk=2 turns on cold end
R4	10R	L3	Amidon T37-6 20 turns 0,3 CuL (AWG 28) Lk=2 turns on cold end
R5	56K	Dr1	obsolete
R6	68R	Dr2	10μH SMCC
R7	1k	Dr3	10μH SMCC
R8	150K	Dr4	10μH SMCC
R9	100K	Dr5	10μH SMCC
R10	68K	Dr6	10μH SMCC
R11	68K	Q1	18MHz HC18 32pF
P1	250R Piher PT6 right angle	ST1	6-pin Header, right angle, PC mount, RM 2,54mm
C1	220pF	ST2	6-pin Header, right angle, PC mount, RM 2,54mm
C2	150pF		
C3	obsolete		
C4	2,5-60pF Folio trimmer 7mm (black)		
C5	10nF		
C6	10nF		
C7	10nF		
C8	10nF		
C9	33pF		
C10	220pF		

## Parts list for SPEAKY 15 m Band Module

T1	BF199
T2	BF981
D1	BA479
D2	BA479
D3	BB109G or equivalent
D4	1N4148
D5	BA479
D6	BA479
D7	BB109G or equivalent
D8	BB109G or equivalent
D9	BB109G or equivalent
D10	BB109G or equivalent

R1	68K
R2	27K
R3	1K
R4	10R
R5	56K
R6	68R
R7	1K
R8	150K
R9	100K
R10	68K
R11	68K

P1 250R Piher PT6 right angle

C1	150pF
C2	100pF
C3	2,2nF
C4	2,5-60pF Folio trimmer 7mm Diameter (black)
C5	10nF
C6	10nF
C7	10nF
C8	10nF

C9	27pF
C10	150pF
C11	1,8-30pF Folio trimmer 7mm Diameter (red)
C12	10nF
C13	2,0-35pF Folio trimmer 7mm Diameter (brown)
C14	2,0-35pF Folio trimmer 7mm Diameter (brown)
C15	10nF
C16	2,7pF
C17	2,7pF
C18	10nF
C19	10nF
C20	27pF
C21	10nF
C22	39pF on PC board on soldering side
C23	39pF on PC board on soldering side

L1	Amidon T37-6 12 turns 0,3 CuL (AWG 28) tap at 3rd turn from cold end
L2	Amidon T37-6 15 turns 0,3 CuL (AWG 28) Lk=2 turns at cold end
L3	Amidon T37-6 15 turns 0,3 CuL (AWG 28) Lk=2 turns at cold end

Dr1	2,2μH SMCC
Dr2	10μH SMCC
Dr3	10μH SMCC
Dr4	10μH SMCC
Dr5	10μH SMCC
Dr6	10μH SMCC

Q1 25MHz HC18, 3rd overtone

ST1	6-pin Header, right angle, PC mount, RM 2,54mm
ST2	6-pin Header, right angle, PC mount, RM 2,54mm

## Parts list for SPEAKY 10 m Band Module

T1 BF199  
T2 BF981

D1 BA479  
D2 BA479  
D3 BB109G or equivalent  
D4 1N4148  
D5 BA479  
D6 BA479  
D7 BB109G or equivalent  
D8 BB109G or equivalent  
D9 BB109G or equivalent  
D10 BB109G or equivalent

R1 68K  
R2 27K  
R3 1K  
R4 10R  
R5 56K  
R6 68R  
R7 1k  
R8 150K  
R9 100K  
R10 68K  
R11 68K

P1 250R Piher PT6 right angle

C1 120pF  
C2 100pF  
C3 2,2nF  
C4 2,5-60pF Folio trimmer 7mm Diameter (black)  
C5 10nF  
C6 10nF  
C7 10nF  
C8 10nF

48

C9 15pF  
C10 100pF  
C11 1,8-30pF Folio trimmer 7mm (red)  
C12 10nF  
C13 1,8-30pF Folio trimmer 7mm (red)  
C14 1,8-30pF Folio trimmer 7mm (red)  
C15 10nF  
C16 2,2pF  
C17 2,2pF  
C18 10nF  
C19 10nF  
C20 22pF  
C21 10nF  
C22 33pF on PC board soldering side  
C23 33pF on PC board soldering side

L1 Amidon T37-6 11 turns 0,3 CuL (AWG 28) tap at 3rd turn from cold end  
L2 Amidon T37-6 12 turns 0,3 CuL (AWG 28) Lk=2 turns at cold end  
L3 Amidon T37-6 12 turns 0,3 CuL (AWG 28) Lk=2 turns at cold end

Dr1 2,2μH SMCC  
Dr2 10μH SMCC  
Dr3 10μH SMCC  
Dr4 10μH SMCC  
Dr5 10μH SMCC  
Dr6 10μH SMCC

Q1 32MHz, HC18, 3rd overtone

ST1 6-pin Header, right angle, PC mount, RM 2,54mm  
ST2 6-pin Header, right angle, PC mount, RM 2,54mm



## The Low Pass Filters

The low pass filter was developed especially for the „Tramp-8“ and the „Black Forest Transceiver“ of the DL-QRP-AG and is consequently used for the SPEAKY too. The parts for the low pass filters are selected for an output power up to 15 Watts.

The group contains 3 low pass filters and the switching logic for 8 bands:

Low pass 1	for 80 m band
Low pass 2	for 40 and 30 m bands
Low pass 3	for 20 and 17 m bands

For the 15, 12 and 10 m bands the signals passes though the group, as above of 21 MHz the cascaded 36 MHz filter on the basic board is already active.

All switching is done bei SIL-Relays making sure that the brilliant strong-signal capability of the device does not degrades.

The early ideas where to use SMT capacitors but some values where not available for sufficient high voltages. Therefore they were substituted by ceramic- or multilayer capacitors of high quality with a 1/10" raster and are soldered on the PC board directly.

### Parts List

Part	Value	Material
C1	1000pF	NPO (102)
C10	270pF	COG 1206
C11	120pF	COG 1206
C12	270pF	COG 1206
C13	270pF	COG 1206
C14	120pF	COG 1206
C15	22nF	0805
C16	22nF	0805
C17	22nF	0805
C18	22nF	0805

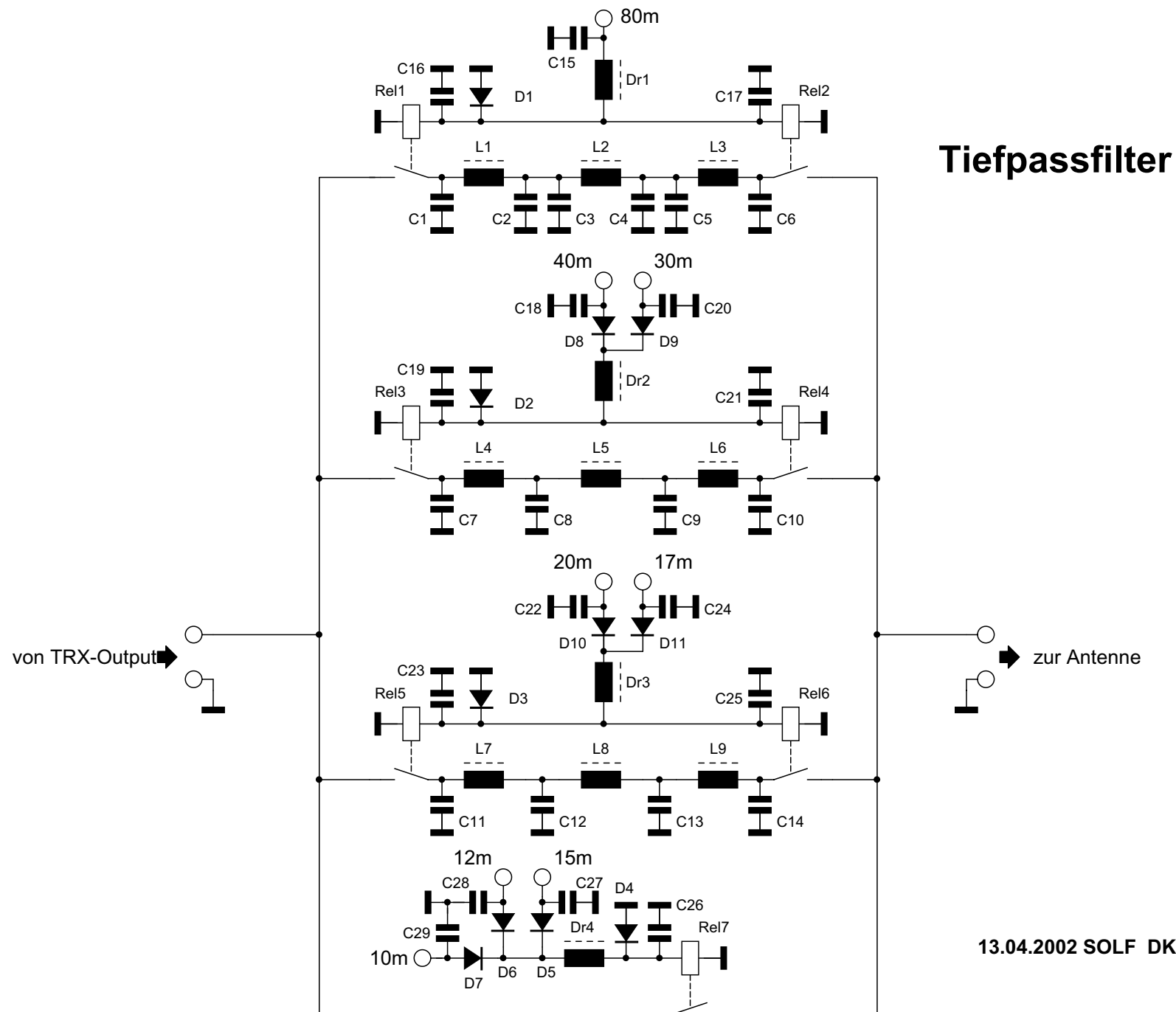
C19	22nF	0805
C2	1000pF	NPO (102)
C20	22nF	0805
C21	22nF	0805
C22	22nF	0805
C23	22nF	0805
C24	22nF	0805
C25	22nF	0805
C26	22nF	0805
C27	22nF	0805
C28	22nF	0805
C29	22nF	0805
C3	680pF	NPO (n68)
C4	1000pF	NPO (102)
C5	680pF	NPO (n68)
C6	1000pF	NPO (102)
C7	270pF	COG 1206
C8	560pF	COG 1206
C9	560pF	COG 1206

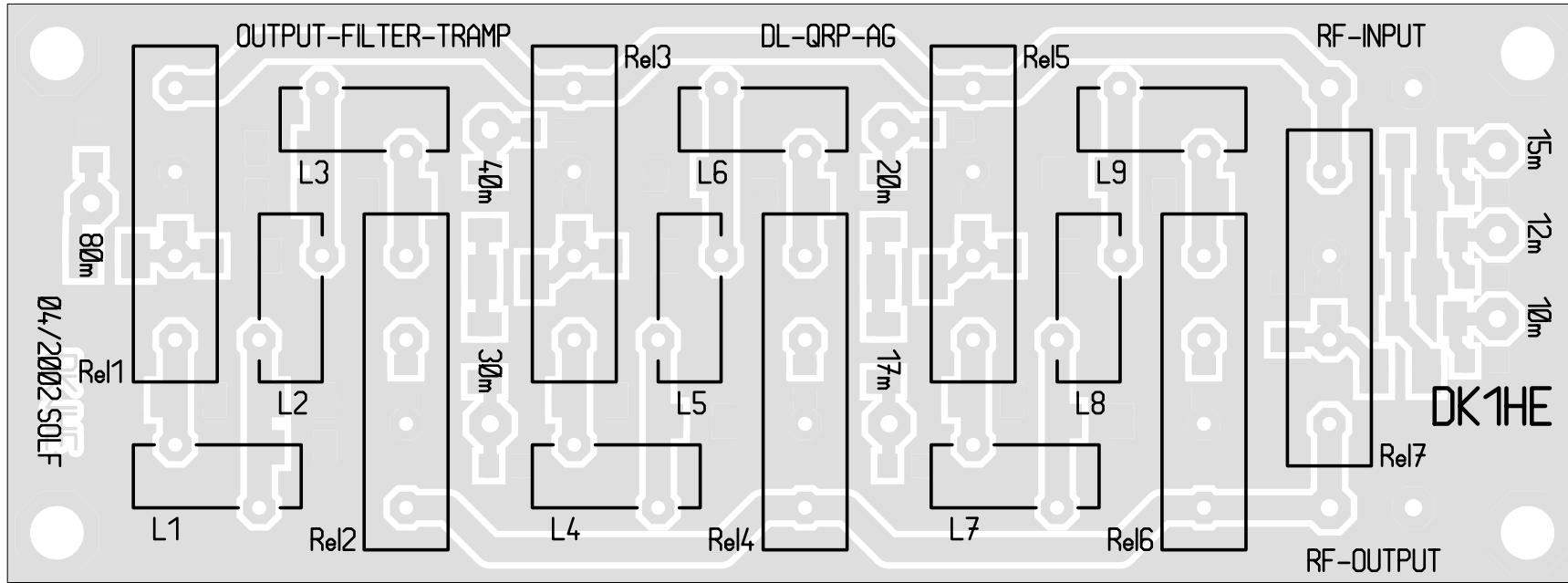
Rel1-7                   MEDER Typ SIL12-1A72-71L

D1-D11               LL4148                   SOD80

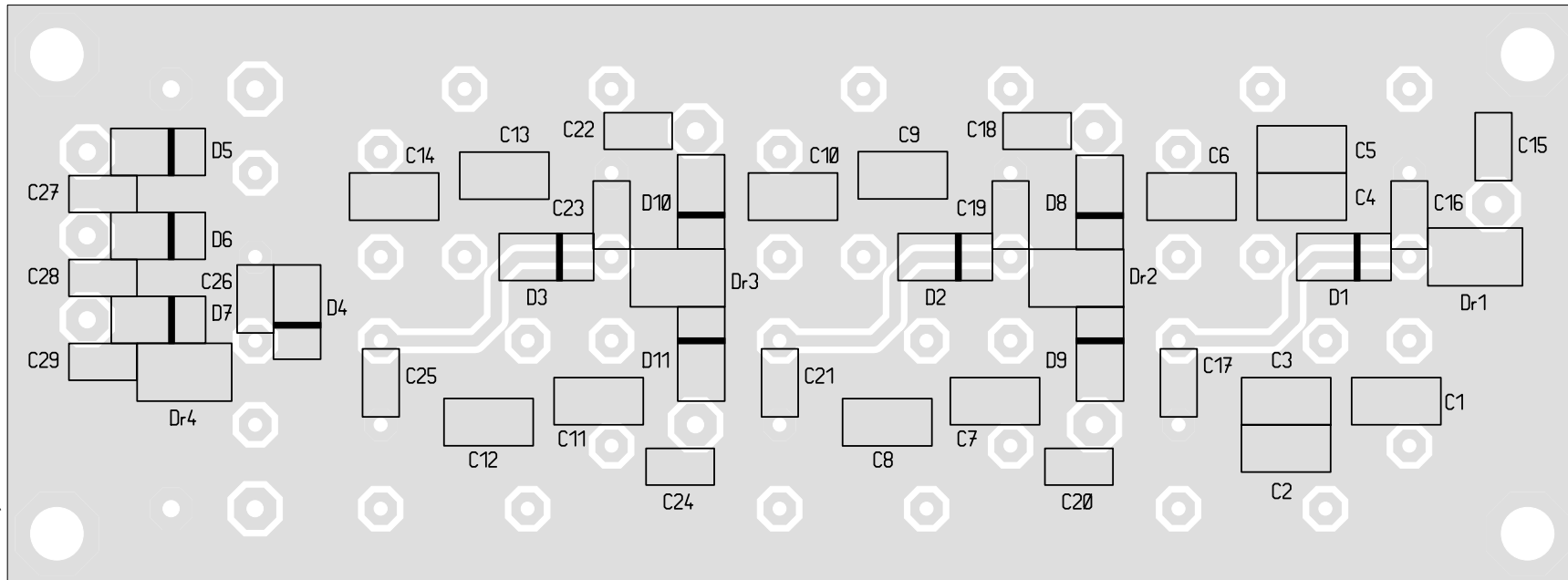
Dr1	47µH	1210
Dr2	22µH	1210
Dr3	10µH	1210
Dr4	10µH	1210

L1=L3	30 turns 0,3 CuL (AWG 28) on AMIDON T37-6
L2	31 turns 0,3 CuL (AWG 28) on AMIDON T37-6
L4=L6	19 turns 0,3 CuL (AWG 28) on AMIDON T37-6
L5	20 turns 0,3 CuL (AWG 28) on AMIDON T37-6
L7=L9	15 turns 0,3 CuL (AWG 28) on AMIDON T37-6
L8	16 turns 0,3 CuL (AWG 28) on AMIDON T37-6



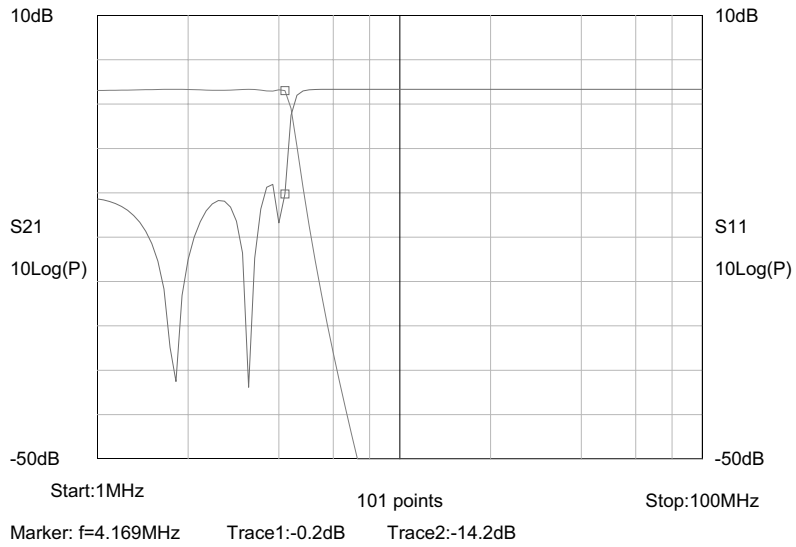


upper side

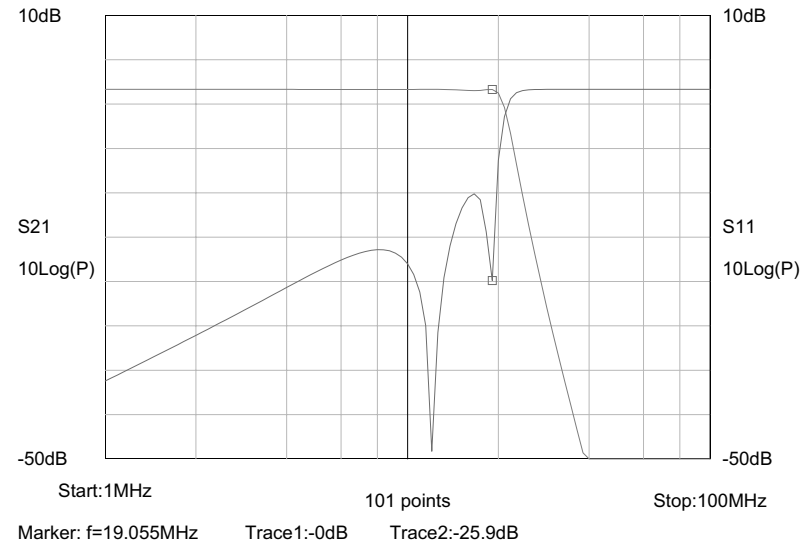


lower side

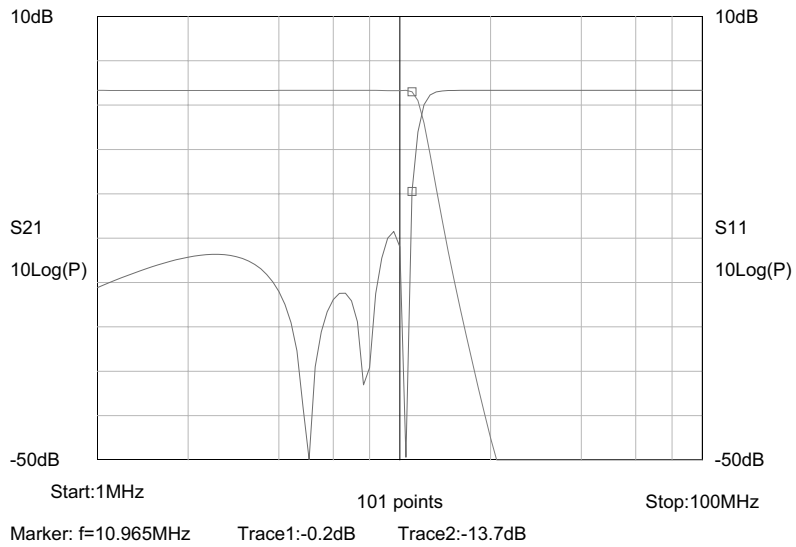
RFSim99 - D:\Eigene Dateien\PM\_Manuals\SPEAKY\TPF80m.cct



RFSim99 - D:\Eigene Dateien\PM\_Manuals\SPEAKY\TPF17m.cct



RFSim99 - D:\Eigene Dateien\PM\_Manuals\SPEAKY\TPF30m.cct



RFSim99 - D:\Eigene Dateien\PM\_Manuals\SPEAKY\SpeakyBilder\TPFMainboard.cct

