Transceiver SQT

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Credit Line: **QRP Transceivers and PAs from Accessible Parts**

http://www.antentop.org/009/qrp009.htm

Transceiver SQT differs from TST only by TX part, therefore main volume of the article will be devoted to the TX part. **Figure 1** shows the TX part of the SQT. Transceiver provides output RF power not less then 1 Wtts.

Transmitter consists of from a crystal oscillator (made on T1), PUSH- PULL amplifier (made on T2, T3). Transistor T4 provides keying of the Push- Pull amplifier. Crystal oscillator works both, in RX and TX mode. Through a coupling coil RF voltage going to capacitor C6 of RX (see article about TST). From value of R3 depends function of the RX. To much value is going to low sensitivity, too low value is going to bad reception (with spurious channels of reception). As usual, R3 should be near 100 – 1000-Ohms. Coupling coil has ¼ turns from L1. Data for L1C2 are the same like for L1C1 from RX of the TST (see Table 2 for TST article).

You know, that at RX/TX mode in the DC transceiver the generator should have shift 400- 800-Hz. Sometimes, when we down on the key of the SQT transceiver, we get the shift because changing mode of crystal oscillator. If we have not got reliable shift at the case, we may use circuit shown in **Figure 2**. The circuit is switched of instead jumper and turn on to the RF-amplifier. At TX mode a current going through inductor coiled above ferrite that is changed the permeability of the ferrite. So, we will have shift of the frequency at RX/TX. The shift is depend on quantity turns switched instead jumper (1- 5) and value of the resistor R*. It may be near 500- 5000-Ohms. Any ferrite with permeability 400- 2000 should be used in the circuit. For example, it may be ferrite ring with OD 7- 20-millimeter, ferrite road in 3- 8 mm diameter and 10-40 millimeter long. Wire in diameter of 0.1- 0.3-millimeter (38AWG- 28AWG) should be okey for both inductors. First winding (to point “2”) is coiled turn to turn, the second one (to point “1”) by pile-up.

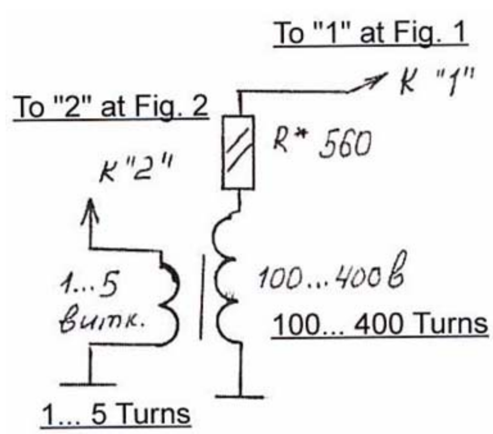


Figure 2 Frequency shift RX/TX circuit

If in serial with frequency- shift inductor an additional inductor plus capacitor is inserted, we will get circuit for frequency shift of the quartz in limit near 10-kHz plus circuit for frequency shift at RX/TX mode.

Figure 3 shows the circuit. **Table 1** shows data for L3, TR1, TR3, C3, L2C9, RFC1, RFC2. **Figure 4** shows design of transformer for frequency – shift circuit (**Figure 2**, **Figure 3**). **Figure 5** shows design L2.

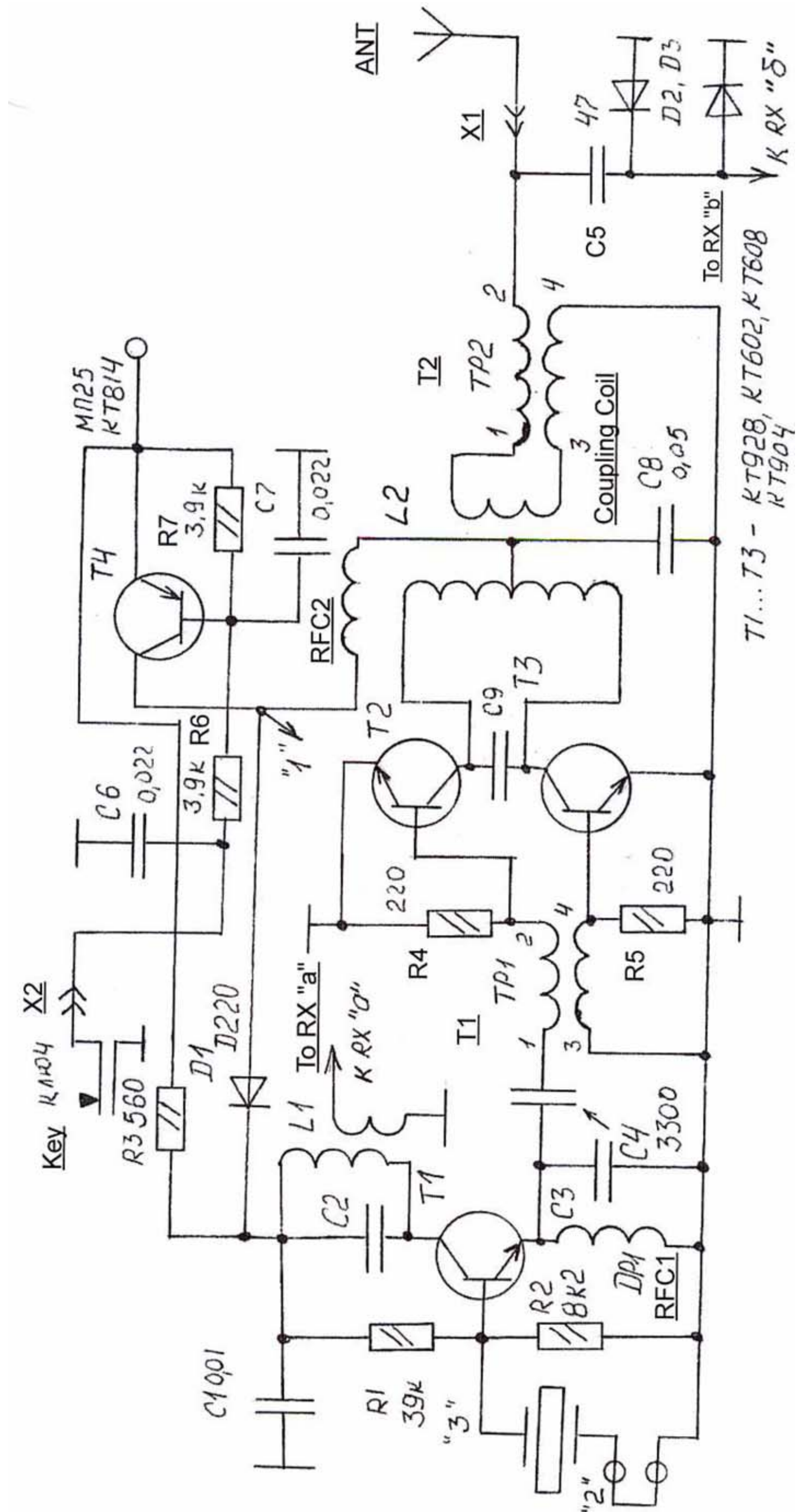


Figure 1 TX part of the SQT.

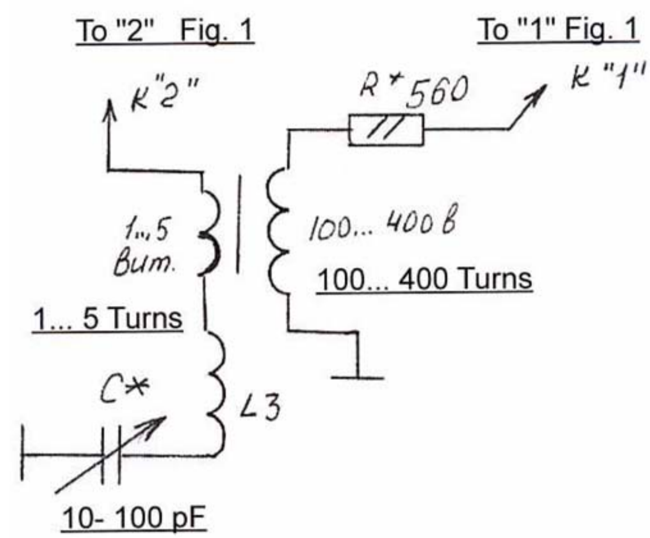


Figure 3 Circuit for shift quartz frequency plus frequency sift RX/TX

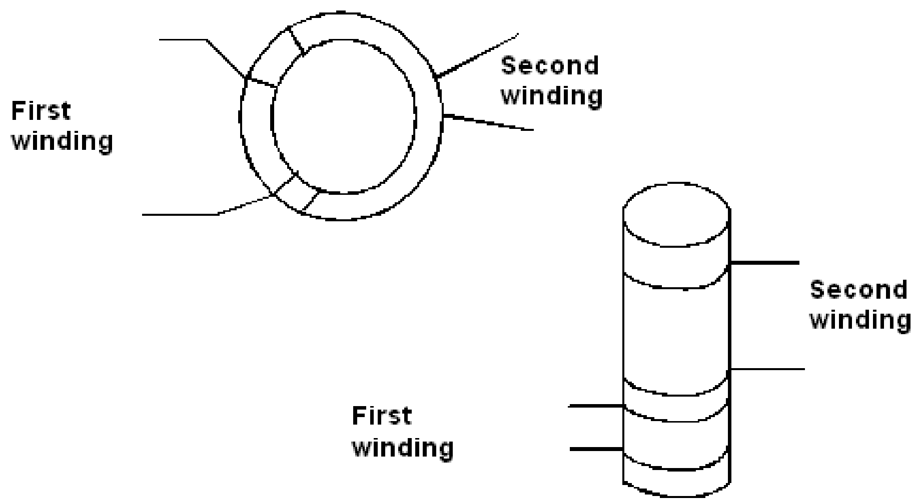


Figure 4 Design of transformer for frequency – shift circuit

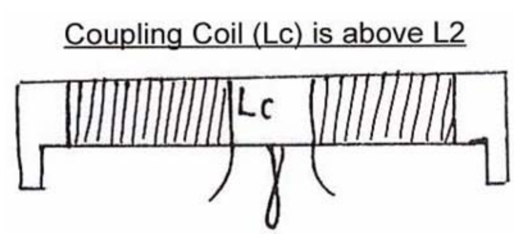


Figure 5 Design L2

Table 1 Data for inductors of the SQT

Band, MHz	1,8	3,5	7	10	14	18	21	24	28	Note
L2	32/120	10/60	3,5/36	2,5/30	1,5/22	0,9/18	0,9/18	0,9/18	0,9/18	*
L3	50/150	30/100	20/80	15/60	12/50	10/46	9/42	9/42	8/40	**
RFC1, RFC2	300	250	200	180	150	150	120	120	100	***
C9, pF	250	200	150	110	91	68	51	30	30	
C3, pF	1000	1000	560	470	470	300	100	56	56	
T1, T2	20	17	14	12	11	10	10	8	8	****

Note

* L2: First column is inductance in microHenry, the numbers of turns. Tap from center of the inductor. Inductor must be made symmetrically. L2 for 160- 80 meters may be wound by wire in diameter 0.1- 0.2 mm (37- 32 AWG), for 40- 30 meters may be wound by wire in 0.25- 0.5 mm (30- 24 AWG), for 20- 10 meters may be wound by wire in diameter 0.5- 0.8 mm (24- 20 AWG). L2 for bands 1.8- 3.5 – MHz is wound on Russian Resistor WS-2, for 7- 28 –MHz is wound on Russian Resistor WS1. Resistance for the resistors should be more than 51-k

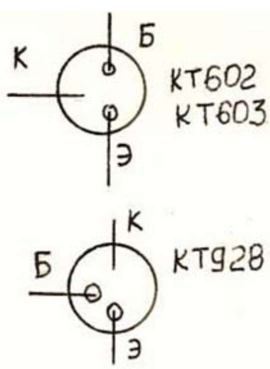
WS-2 (sizes: diameter 9.7-mm, length 49-mm)
WS-1 (sizes: diameter 7.6-mm, length 31-mm)

**L3: First column is inductance in microHenry, the numbers of turns. L3 for 160- 80 meters may be wound by wire in diameter 0.1- 0.2 mm (37- 32 AWG), for 40- 10 meters may be wound by wire in 0.25- 0.5 mm (30- 24 AWG). L3 for bands 1.8- 3.5 – MHz is wound on Russian Resistor MLT-2, for 7- 28 –MHz is wound on Russian Resistor MLT-1. Resistance for the resistors should be more than 27-k

MLT-2 (sizes: diameter 8.6-mm, length 18.5-mm)
MLT-1 (sizes: diameter 6.6-mm, length 13-mm)

***RFC1, RFC2: Coiled by pile- up on Russian Resistor WS- 0.5 by wire in diameter 0.1- 0.2 mm (37- 32 AWG).
WS- 0.5 (sizes: diameter 5.5-mm, length 26-mm)

****T1, T2: Coiled by two twisted wires (1 turn to 1 centimeter) by wire in diameter 0.25- mm (30- AWG). Core – ferrite ring with OD 7… 20-millimeters (not critical), with permeability 100- 1000 (not critical). **Figure 6** shows the design of the transformer.



Pins for Soviet/Russian transistors KT602 and KT928

Coiled by two twisted wires
(one turn per 1 centimeter)
Wire has diameter 0.25-mm (30-AWG)

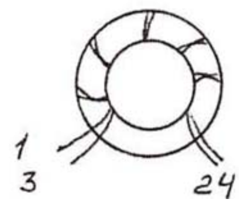


Figure 6 Design of the T1, T2

Part List TX

Resistors:

R1: 39 k/ 0.25 W* (27- 100 k)
R2: 8.2 k/ 0.25 W* (5.1- 10 k)
R3: 560 Ohm/ 0.25 W* (100-Ohms-1k)
R4, R5: 220 Ohm/ 0.25 W* (51- 300-Ohms-1k)
R6, R7: 3.9 k/ 0.25 W* (2.2 - 10 k)

*Recommended
() In brackets- may be used

Capacitors:

C1: 1000- pF 0.1 uF
C2: ***See Table 1 article TST trcv***
C3: ***See Table 1***
C4: 1000- pF 0.1 uF
C5: 47 pF
C6, C7, C8: 0.022- 0.1-uF
C9: ***See Table 1***

Do not down the key too long because VT2, VT3 may be overheated. If quartz is too active, switch in serial with it a resistor in 15-100 Ohm.

The capacity for C3 is given (at **Table 1**) for active quartz. If quartz is low- active the capacity of C3 should be pick- up. As usual it needs a little reduce the capacity compare to **Table 1**.

Caution: Moving frequency for quartz described below suits for OLD QUARTZ made in 30- 60s years of 20 century, which installed in the socket on holders (i.e., has not wires soldered to the quartz plate). Moving frequency by the methods may destroy modern tiny quartz plate. Only experienced ham have to use the Procedure that described below.

Semiconductors

Transistors

VT1: Small power NPN bipolar RF transistor (250-mWtts/250-MHz)
VT2, VT3: Middle power NPN bipolar RF transistor (1-Wtts/250-MHz) *
VT4: Middle power Switch PNP transistor (Ic not less the 0.2-A)

“ Small heater is must or VT2, VT3. It may be a little length of a copper tube that is sitting on the case of the transistors.

Diodes

VD1: Any small power diode 50-mA/50-V
VD2, VD3: Any small power RF diodes

Connectors:

X1: Any RF Connector
X2: 5- PIN Audio Connector

Old Crystal

If you have quartz with frequency a bit high what you need – you may move the frequency a little down. Mark the quartz with smooth pencil, measure the frequency, mark again (if frequency not low enough) or remove line carefully with rubber (if frequency is too low). Depend on quartz you may move the frequency up to 20 kHz down

To move the frequency up follows next steps.

1. To take out quartz from the holder.

2. Remove silver plating (if it is) from the quartz. I did it with fresh solution of iron chloride.

3. Make the holder for quartz shown on **Figure 7**.

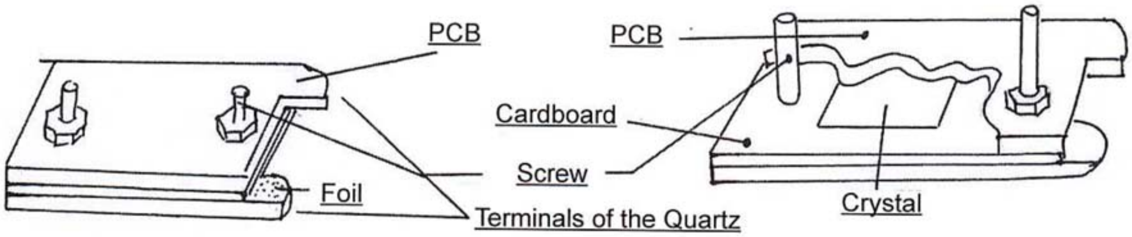


Figure 7 Home made holder for quartz plate

4. Put the quartz plate in to the holder.
5. Measure the frequency of the quartz.
6. If the frequency is lower the needed one, carefully rub the quartz plate on very tiny glass-paper. It is possible to rub quartz with some kind of abrasive paste.
7. Measure the frequency of the quartz.
8. Repeat item 6 if the frequency of the quartz is lower the needed one
9. When the needed frequency is got, put the quartz into holder, make little cavity (with help of a small broach file) on the side of the holder, then put epoxy into the cavity. **Figure 8** shows the closed holder.

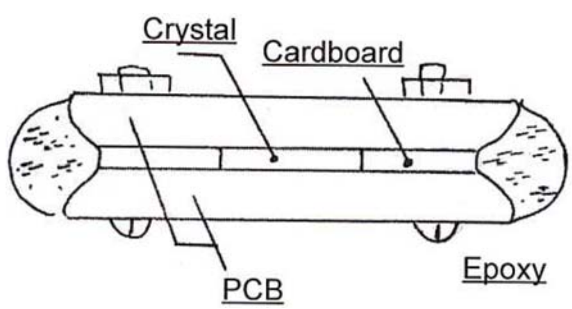


Figure 8 *Closed holder*

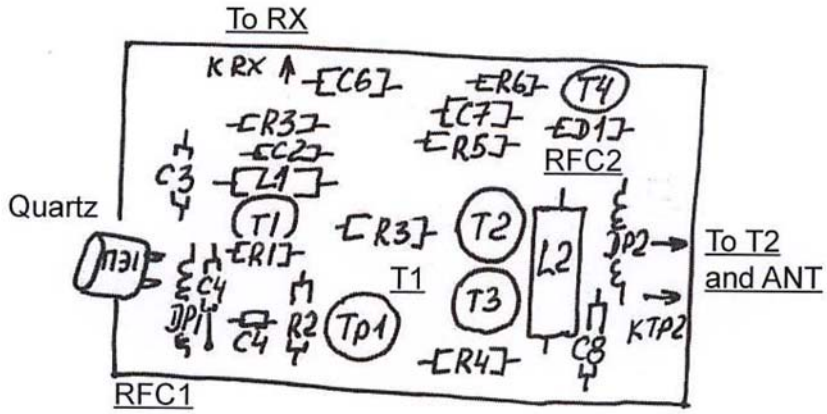
Note: Be careful when work with quartz plate. Quartz plate is fragile, it may be broken at fall down or at too high tightened of the screw in the holder. Quartz may go off generation when the screw in the holder tight too much. Do not worry if the quartz plate is split up on several pieces.

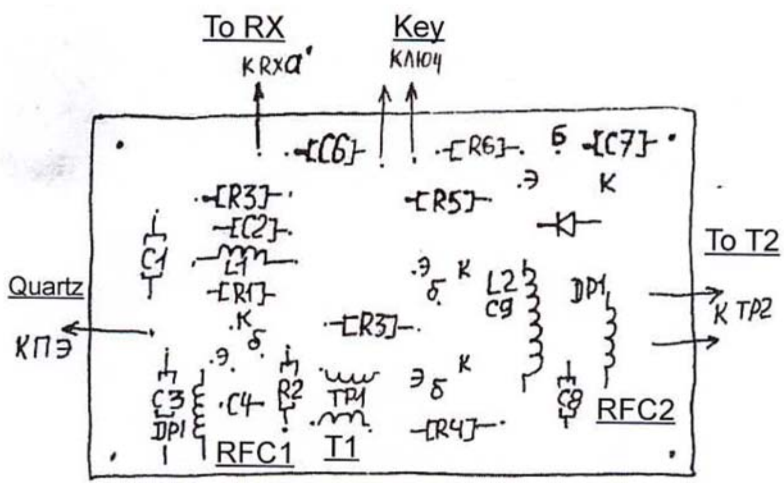
You will be surprised when find off that each pieces of the quartz plate may be used in quartz generator. Having some experience you may cut big quartz plate (I have used for this sharp broach file, good result are obtain with diamond glazier) on to 4-6 and ever 8 working crystals!

Design SQT

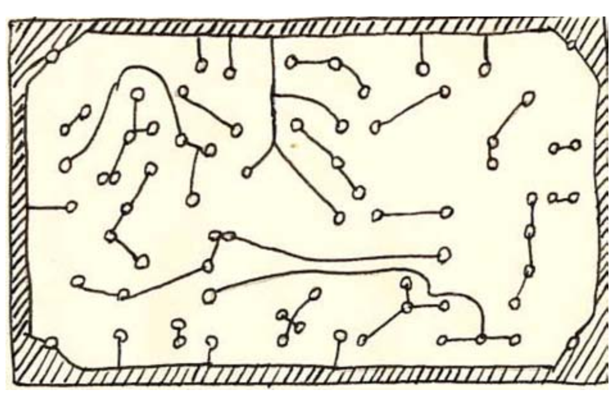
Transceiver made right to the drawing works well and is easy to tuning. **Figure 9 (page 87)** shows the design of the Transceiver SQT. Cabinet made from PCB-stuff.

Figure 10 (page 88- 89) shows the parts of the cabinet with recommended sizes. **Figure 11** shows PCB for TX part of the SQT. Assembly and Tuning SQT is similar to those ones for TST





B. Positions of parts



A. Layout

Figure 11 PCB for TX part of the SQT
Different views

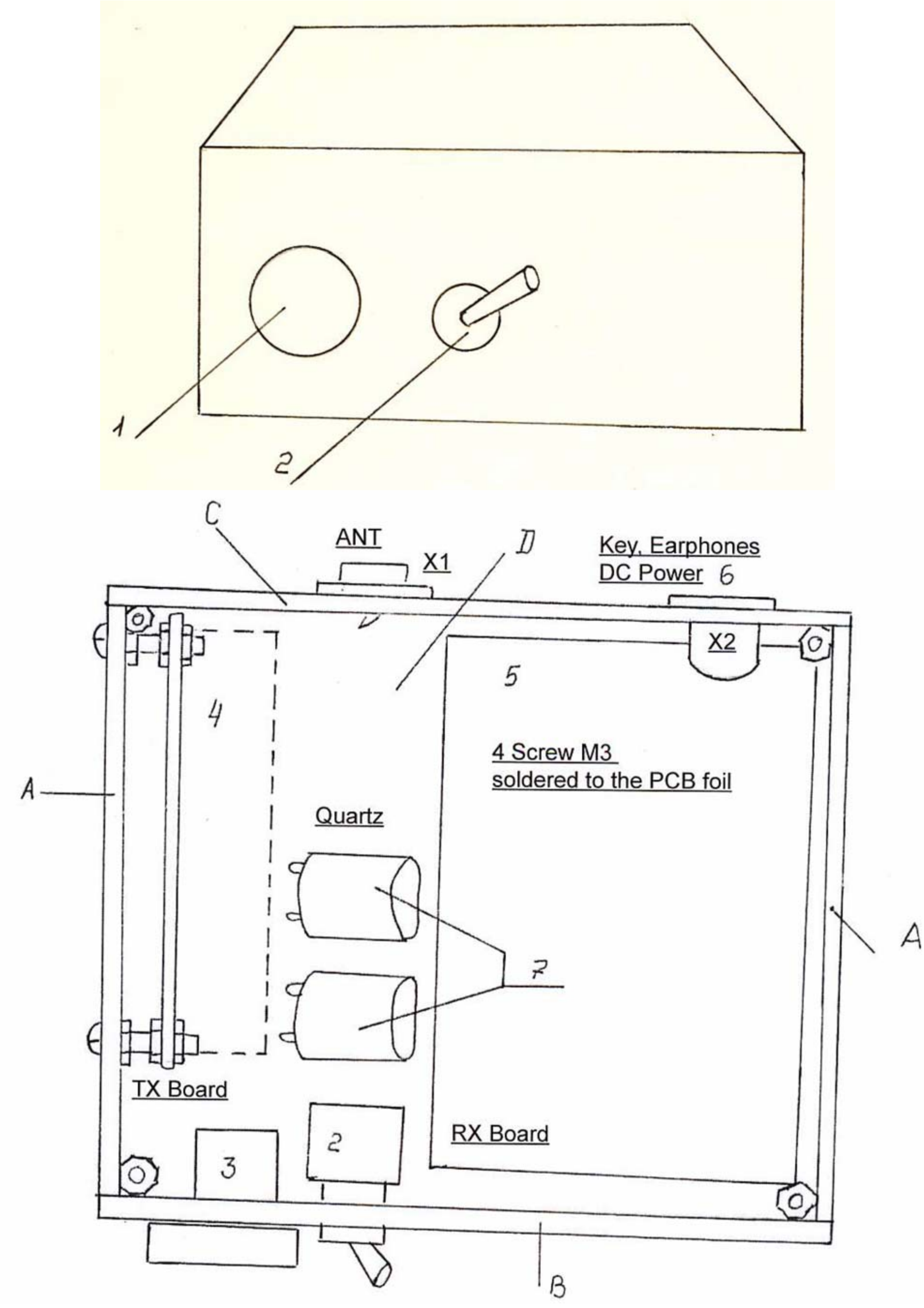
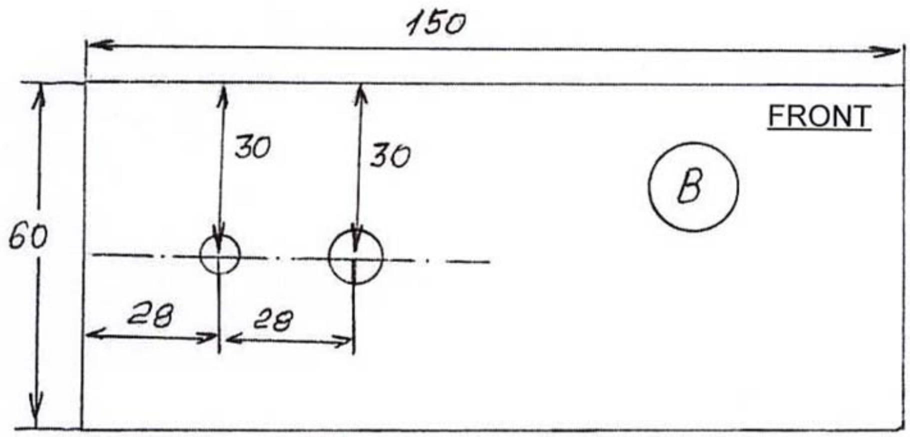
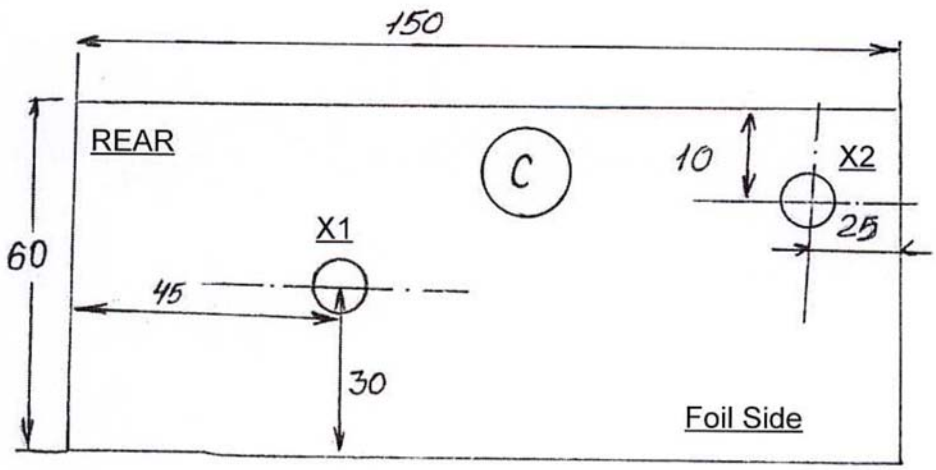


Figure 9 Transceiver SQT





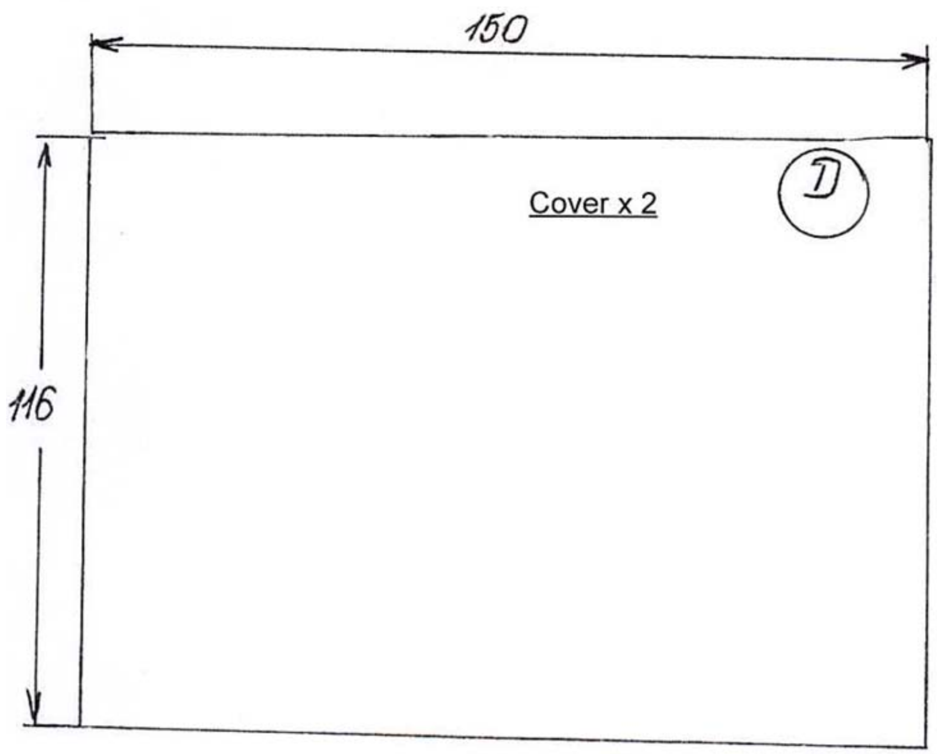


Figure 10 Parts of the cabinet

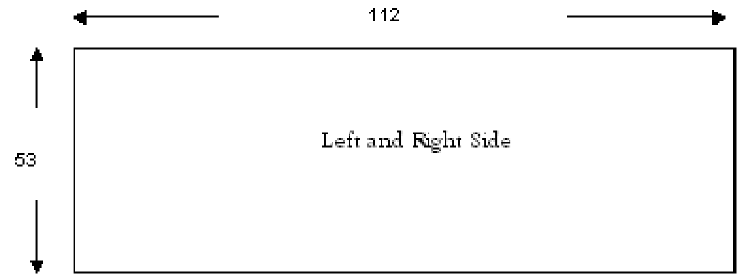


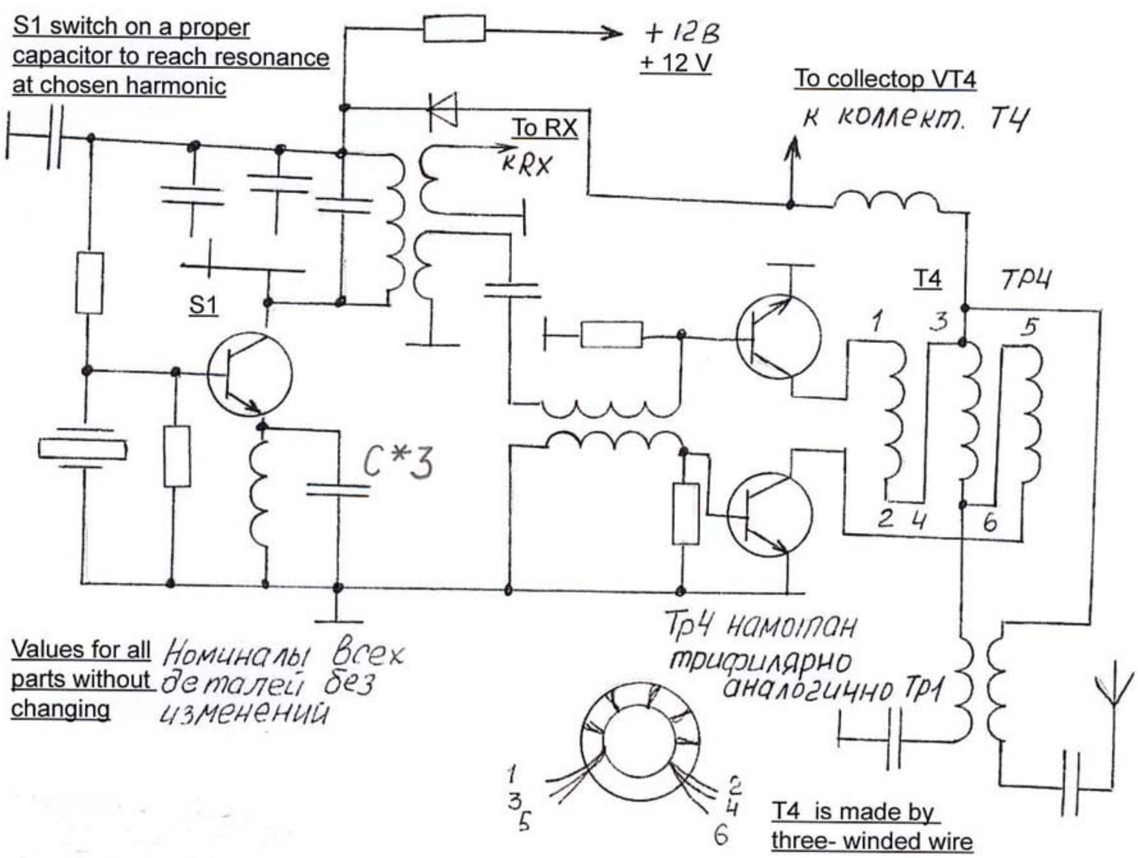
Figure 10 Parts of the cabinet

To **Figure 9**:

1. Knob for frequency shift
2. Toggle - switch for a choice of quartz
3. Capacitor C1 from **Figure 3**
4. PCB TX
5. PCB RX
6. X2 from **Figure 1**
7. Two switched quartzes.

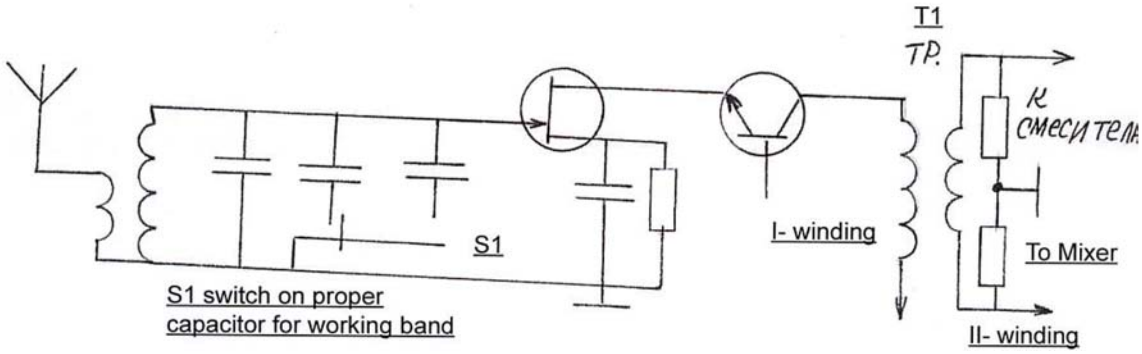
Two/Three Bands SQT

If a crystal used at SQT transmitter is enough active, it is possible to build the SQT for two and ever for three radio- amateurs bands. **Figure 12** shows corrections needed to make work the SQT at 2 or 3 Bands.



A. TX - part

Figure 12 Two/Three Bands SQT



B. RX - part

Figure 12 Two/Three Bands SQT

Corrections at TX board:

L1C1 is tuned to higher frequency. C3 is chosen for stable oscillation of the crystal at main, second and (if it is possible) third harmonic. Switch S1 takes capacitor for tuning L1C1 to resonance. Coupling coil to PA has the same numbers of turns as coupling coil to RX. Transformers T1 and T2 have turns for middle or high band of the multi-band TST. For example, for SQT working on 40-20-15 meter, there are used T1 and T2 for 20 meters. For SQT working on 40-20 meter, there are used T1 and T2 for 20 meters.

Broadband transformer T4 (instead resonance tank L2C9) is installed at the PA. T4 has numbers of turns and coiled wire equal to T1/T2 of the TST. However, the transformer made by three- winded wire, 1 turn per 1 centimeter. PCB for the version is without changing, the new parts are installed by common sense.

Some quartz may not work well at second harmonic but work well at third. RF power at multi- range variant on the high harmonics as usual less in 2- 5 times compare to one- band transceiver. RF power at main harmonic may be less in two times compare to one- band transceiver.

Corrections at RX board:

L1C1 is tuned to higher frequency. Switch S1 takes capacitor for tuning L1C1 to resonance. RF amplifier has broad-band output. Transformer T1 has the same numbers of turn in the first winding as transformer T1 in multi- band SQT. The second winding has in twice less turn compare to the first winding. Core for T1 (used in multi- band RX) is the same as for T1 used in SQT. PCB for the version is without changing, the new parts are installed by common sense.

Figure 13 shows design of the multi-band SQT. The design differs from one- band SQT only by new- installed miniature switch (item 8).

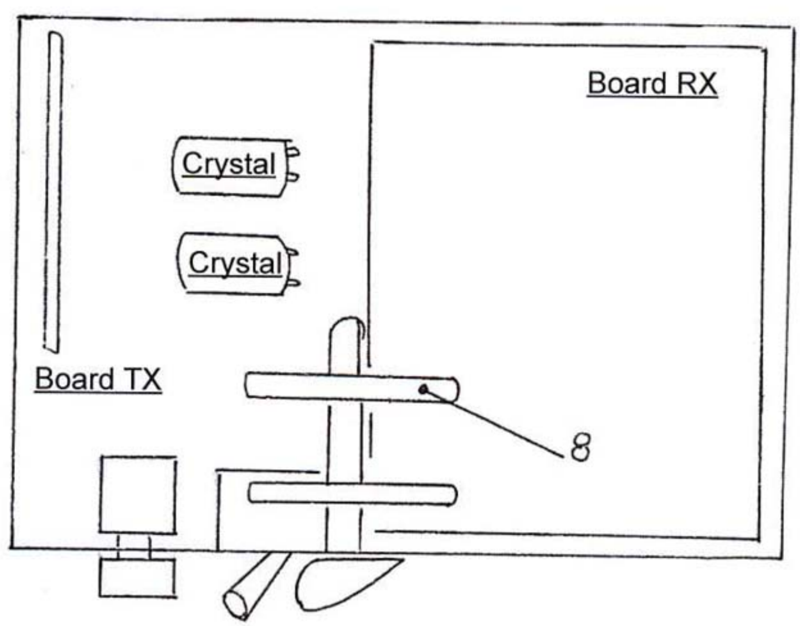


Figure 13 Design of the multi-band SQT

Two Bands SQT with PA for second harmonic

It is necessary to notice that tuning the two/three bands SQT (described above) is not a piece of pie. An oscilloscope plus experience are required for this deal. However, if you have a ready one band SQT, you may turn it to the two bands SQT described below. **Figure 14** (**page 92**) shows schematic for two bands SQT.

Figure 14 Schematic for two bands SQT.

It is wise to build 7/14-MHz SQT. So, there are described such SQT. You may design you own SQT for another bands using the description.

7/14 –MHz SQT consists of (see Figure 14):

1. TX for 7- MHz that was described above (**SQT**).
2. Doubler 7/14-MHz. The doubler is made on T5, VD1, VD2. Transformer T5 is similar to T4 (Figure 12). VD1, VD2- any high speed diodes that can stand 50-mA/50-V. Resonator tank L1C1is tuned to 14-MHz, data for the circuit may be taken from one- band SQT. Coupling coils for RX and TX are contained ¼ numbers of turn from main coil L1.

The coils may be placed close to the “cold end” of the L1. Tap from L1 may be taken from 1/5-1/3 turns from the “cold end.”
Serial tanks L2C2 (tuned to 14-MHz) and L3C3 (tuned to 7-MHz) may considerable to clean output signal on 14-MHz. However, the circuits should be used only if you can see the shape of the signal at input/output item 3. Inappropriate tuning of the two circuit may make worse the shape of the output signal at 14-MHz. Data for the circuit may be taken from one band SQT.

Value of the resistors R*1 and R*2 should be pick up at real design of the transceiver. R*1 is influenced on to RX- sensitivity and noise level, R*2 is influenced on to power at TX mode. The adjusting are depended so you mat need to try different nominal for both resistors several times. However the tuning is not hard to do.

3. PA for 14-MHz. It is board for 14-MHz without a crystal. Signal from the 7/14-MHz doubler goes to the transistor VT1 base.

RX for the transceiver is to similar of 7/14-MHz RX from previous paragraph (**Two/Three Bands SQT**).

Figure 15 shows view of the two bands SQT.

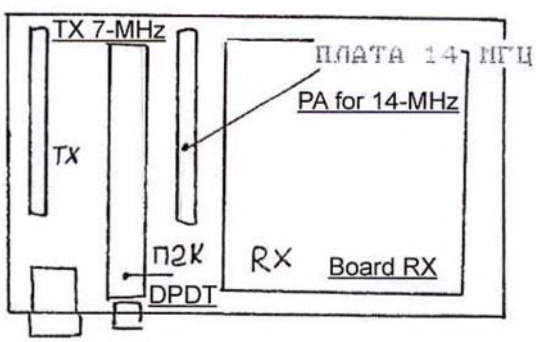


Figure 15 View of the two bands SQT.

All parts of the two bands SQT is switched by a 3-block DPDT. If you have not so long 3-block- DPDT you may make it by itself. Homebrew DPDT is shown on **Figure 16**. The DPDT is made from of three separately DPDT.

These ones are soldered on to PCB. It takes some experience (but not so much) to do the thing. First DPDT has lock. Last two are unlocked. It is possible to use unlocked switch or remove from lockable DPDT a fixating clamp.

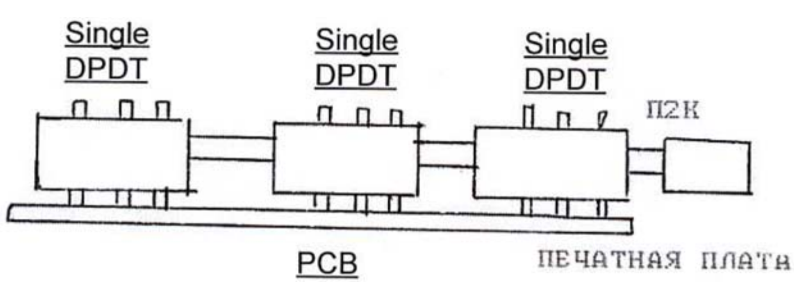


Figure 16 Home made 5- block DPDT

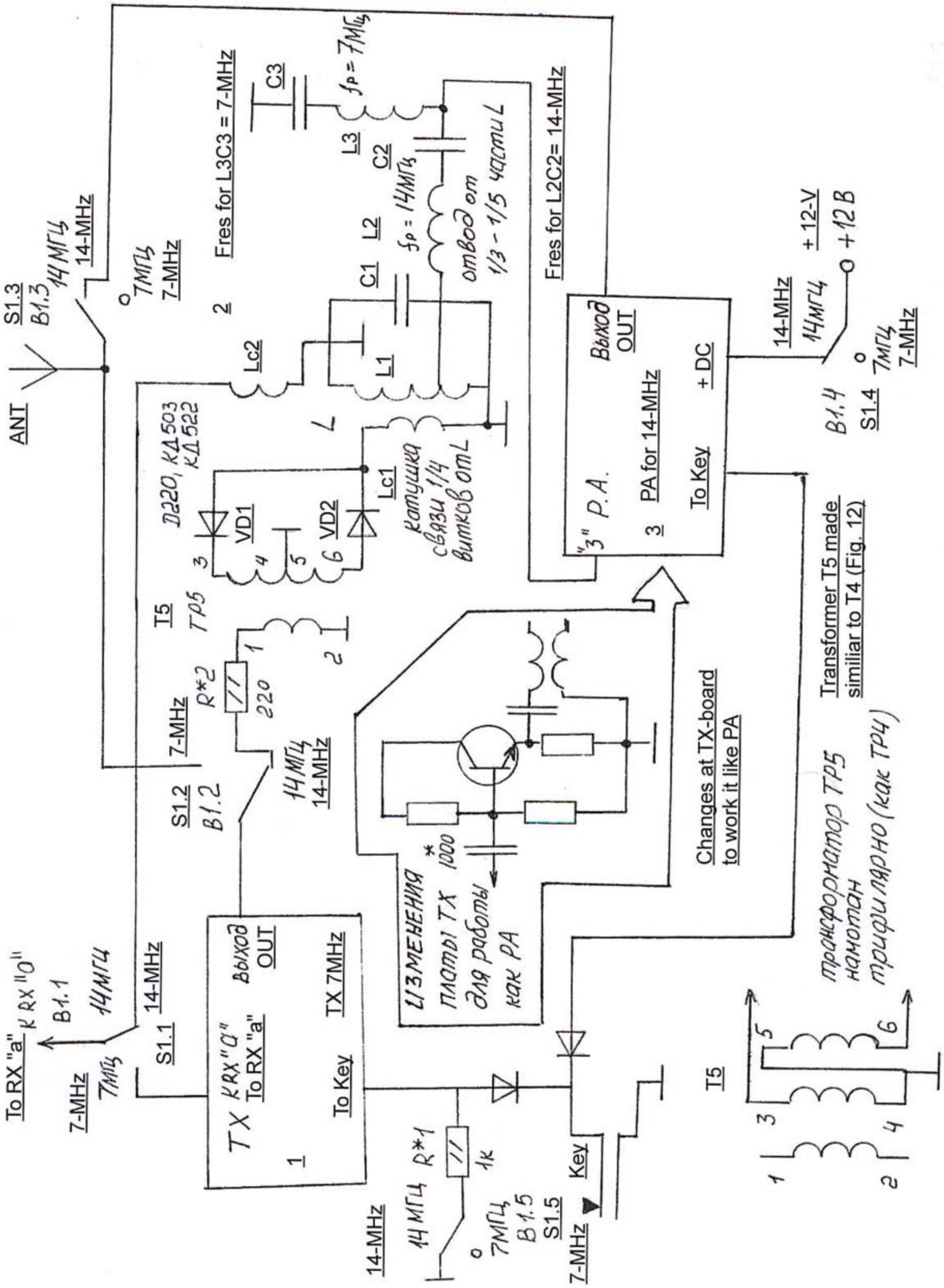


Figure 14 Schematic for two bands SQT.

Commutation of the parts

Switch S1.1:

Position 7-MHz: RF frequency (7-MHz clock) from TX-board 7-MHz goes to the mixer of the receiver board.
Position 14-MHz: RF frequency (7-MHz clock) from doubler 7/14-MHz goes to the mixer of the receiver board.

Switch S1.2

Position 7-MHz: RF power from TX-board 7-MHz goes to antenna.
Position 14-MHz: RF power from TX-board 7-MHz goes to the doubler 7/14-MHz. R*2 is influenced on to power at TX mode

Switch S1.3

Position 7-MHz: Antenna is turned off from PA-board 14-MHz.
Position 14-MHz: RF power from PA-board 14-MHz goes to antenna.

Switch S1.4

Position 7-MHz: DC power turn off from PA-board 14-MHz
Position 14-MHz: DC power turn on to PA-board 14-MHz

Switch S1.5:

Position 7-MHz: Resistor R*1 is turned off.
Position 14-MHz: Resistor R*1 is turned on so it allows TX board 7-MHz to be switch on at working two band SQT at 14-MHz. R*1 is limited the power of the TX board 7-MHz. R*1 is influenced on to RX-sensitivity and noise level

Switch S1.6 (Not shown at the **Figure 12**):

Position 7-MHz: Additional capacitor is switched on at input filter at RX- board (**Figure 14**).
Position 14-MHz: Opened Switch.

Figure 17 shows the position of the switches at DPDT.

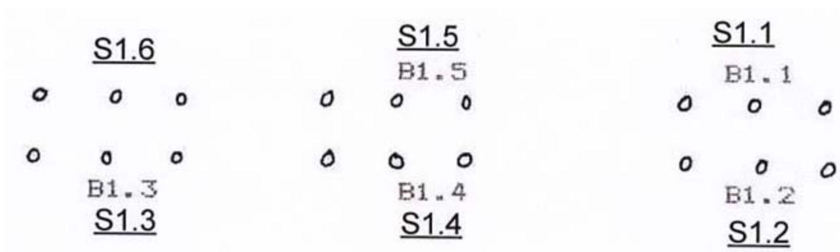


Figure 17 Position of the switches at DPDT

The two bands transceiver is easy tuned and adjusted. Sometimes especially for two band transceiver 3,5/7-MHz and 7/14-MHz output power 1-Watts may be reached without on VT1 on the board "PA." However, it needs to pick up the R*1 and R*2 thoroughly. Broadband PA on 10 watts may be used with the transceiver. So you get compact radio that well work at field and home. Several such transceivers were used at my radio station UA3ZNW at the already late 90s.

At the article were used pictures from the Book:

QRP Transceivers and PAs from Accessible Parts

Some pictures is not in scale compare to original book.

English commentaries were included. <u>The commentaries are underlined.</u>

73/72! I.G.

BEWARE!