Construction Manual
4m-Linear-Transverter
XV4-15

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Technical data

exciter frequency:	21.0 ... 21.5 MHz
RF frequency:	70.0 .. 70.5 MHz
supply voltage:	11.5 ... 13.8 Volts
current consumption (rec./ transm.)	0.04A / 1.5A

Receiver

noise figure:	<2 dB
gain:	16 dB
image response:	-60dB
input intercept point IP_3:	0dBm

Transmitter

transmission power at 12 V:	3 Watts single tone
input power:	0.1 ... 10 Watt adjustable
spurious transmissions:	-50 dB

Introduction

Building a 4m transverter which converts on the “classical” band like 2m or 10m is not easy. On the 10m band you would need a LO frequency of 42MHz. Unfortunately this gives two higher-order products which fall directly into the wanted band and cannot be filtered.

On 2m it looks similar. Though the higher-order products are a cople of MHz away from the 4m band, the main problem comes from the strong LO frequency itself.

For that reason I choose 21MHz as backend frequency. The closest products are ±7MHz away from 70MHz which is sufficient for an attenuation of 50dB.

Circuit description

Fig 1. shows the circuit diagram. The receiving path leads from the RX/TX relays and the hi-Q input filter L6 to the pre-amplifier T2, which operates in grounded base configuration. In transmit mode the stage is shut down by a bias voltage from D3. On the bandpass filter L3, L4 follows the dual-gate-FET mixers T1. An the drain the IF signal is coupled through another band pass and the RX/TX relays to the output.

In transmit mode the input signal first reaches the load resistors R19 and R21. They are required as the maximum input power for the mixer is only 1mW. The resistors are good for up to 15 Watts in SSB and 8 Watts in FM mode. You can match the output power of your exciter to the transverter with the variable resistor R27. L14, C41 is a notch filter for 70MHz.

Between mixer T9 and driver transistor T7 there is a hi-Q bandpass filter with L12 and L15. T7 provides the PA transistor T8 with a power of 500mW. The output power leads through a 5-pole low pass filter to the RX/TX relays and then to the output connector.

T3 generates the oscillator signal. T4 works as buffer stage. Since the same PCB is used for the 10m and the 2m version there are different components to mount depending on the crystal frequency.

To switch between RX and TX mode you can either put pin 4 to ground (PTT-mode) or use the RF-VOX. RF-VOX means that an input power of at least 50mW will be rectified by D3 and D4 which renders T5 to supply the TX chain. C35 determines the hold time, which is 500ms with the current values.

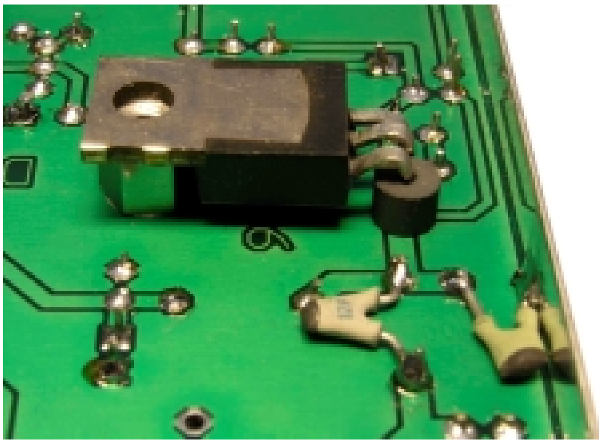
Construction

Fig. 2 shows the place plan, a picture of the read-made PCB shows fig.3. All components fit on a double sided board of 71x109mm size. Nearly all traces are on the solder side, the component side mainly consists of a copper plane.

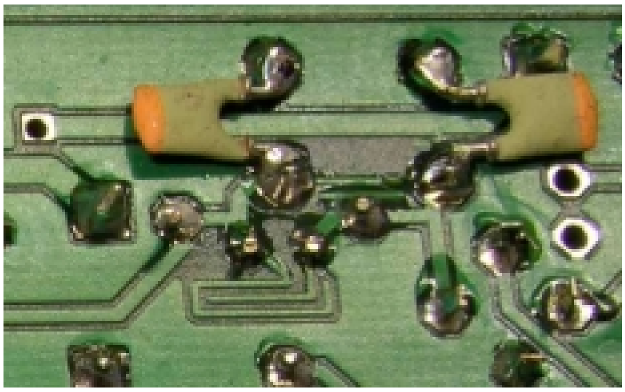
The best idea is to start with the low-profile components like resistors and diodes. Then proceed with the next bigger like capacitors and finally placing inductors and crystal. Each part which is soldered should be checked on the component list. This makes it unlikely to make errors. **The relay K1 must not be mounted before the PCB sits in the housing**. Otherwise you would not reach the soldering pad beneath the BCN connectors.

The dual-gate FETs have one long leg which is the drain. This pin is marked with a “D” on the place plan. Some capacitors have their values coded in Picofarads like the resistors in Ohms, starting with two value digits and the number of zeros. 103 e.g. means 10,000pF or 10nF or 330 is 33pF. Unfortunately the printing on the parts sometimes has low contrast so that a magnifier is highly recommended. C4, C8 and C44 are printed capacitors and will not be stuffed. The resistors R7 and R13 can become rather warm and should have an 1mm gap to the PCB. Please notice that C7 (5.6p) and the 10nF capacitors look very similar as do the 1N4148 diodes and D7. Don’t mix them up.

Since the PCB originally was desinged for the 6m Band ther are some components which must be place on the solder side of the board. These are C59 to C62. How to mount the parts show the pictures below.



C61, C52 and T8 with the ferrite bead



C59 and C69

The resistor R35 lies in paralle to the inductor L7. As there is no particular place for it on the board it is mounted on the position of QU2 (which is only needed at the VX6-10 version).

The resistors R19 and R21 can become hot so please mount them so that there is 1mm air between resisitor and board.

The variable inductor L7 consists of 3 turns of 0.3mm enameled copper wire. The 0.1, 0.22 and 0.47µH inductors look like a resistors and are coded with color rings. L8 and L11 are made from 0.5mm enameled copper wire. The inner diameter is 6mm. Wind the wire tight on a 6mm drill. L8 has 6 turns, L11 7 turns. L10 has 8 turns of 0.5mm enameled copper wire and is wound on a torrid core.

You can see the winding schemes on the pictures on the next page. Please notice the the pictures are taken from the 6m version so the number of turns do not correspond with the 4m version.

L7

L11

L10

A little haet sink sticks on T7. Take care that is does not touch other conponents.

The PA transistor T8 will be mounted on the rear side of the PCB (see picture on previous page). First bend the legs 90 degrees in opposite direction to the mounting flange. Mount the short 5mm nut with the 4mm M3 screw to the board. To prevent self-oscillation on GHz frequencies a ferrite bead has to be stuck over the drain pin of the transistor.

Now T8 must placed in the way that the mounting hole sits above the nut. Then solder the part. The long 6mm nut is fixed on the opposite hole of the PCB with the second 4mm screw.

Mount the BNC connectors and the feed-through capacitors before assembling the housing. The nuts of the connectors should be tightened strong. It is difficult to do it later if all is put together. The next step is to solder the walls of the housing. It can be done easily if the parts are put together by sticking it into the cover. Don't forget to solder the pads of the PCB with the sidewalls. The last component to solder is the relay. Finally mount cover and heat sink as shown in fig. 4.

Adjustment

Necessary equipment:

- 70MHz signal source
- 21MHz transceiver
- Power meter (or SWR meter with dummy load)
- Frequency counter 100MHz, 20mV sensitivity
- Volt- and Ampere meter

All the adjustments must be done after the PCB and enclosure are assembled. Please notice that the transmission mode must not be switched on without heat sink. Otherwise the PA transistor can become hot enough to die within a couple of seconds.

Supply

At first apply a supply voltage of 12 Volts to the transverter the current shall be 30...40mA. Connect the PTT pin (P4) to ground. A "click" from the relays shall be heard. Adjust the quiescent current with R31 to 300mA. Return to receive mode.

Oscillator

Connect the frequency counter to the emitter of T8. If you have a sensitive counter you can also use a cable with a coupling loop of a few turn close placed at L7. Turn the core of L7 into the coil until the counter shows a frequency of 49MHz ±1kHz.

Receiver

Connect a signal generator of 70,25MHz and 1mV output to the antenna connector. Connect a receiver tuned to 21,25MHz to the transverter output. Recursively adjust C10, C11, C13, C15 and C16 so that the signal in the shortwave receiver gets to a maximum. If you don’t have an appropriate signal source you can tune to maximum noise level. However this method does not give optimal results.

Transmitter

First you have to disable the ALC circuit by shorting R33 to ground. Connect the transmitter to the 21MHz input and a wattmeter to the output of the transverter. Turn R27 fully counter clockwise. Apply a CW signal on 21.250 MHz with a power of 1Watt. Put the PTT pin to ground. Adjust C49, C51 to maximum output power. Watch the peaks, they are very sharp. The output power shall be around 8 Watts now. You can optimize the output by carefully spreading or squeezing L8 and L11.

Apply the maximum power which the 2m transceiver is intend to give in normal operation. Turn R22 counter clockwise until the output power does not exceed 4 Watts. Then remove the R33 short. The output power shall be around 3 Watts, the current consumption approximately 1.5A.

Component list XV4-15

C1	10n
C2	10n
C3	10n
C4	1p
C5	8p2
C6	10n
C9	5p6
C10	10p
C11	10p
C13	10p
C15	30p
C16	30p
C17	68p
C18	1p
C19	10n
C20	10n
C21	10n
C22	10n
C23	10n
C24	10µ
C25	47µ
C27	33p
C28	100p
C29	33p
C30	10n
C32	2µ2
C33	12p
C34	22p
C35	10n
C36	10n
C37	10µ
C38	10n
C39	10n
C40	10n
C41	10n
C42	10n
C43	10n
C45	4p7
C46	2p2
C47	10n
C48	4p7
C49	10p
C51	10p
C53	10n
C54	10p
C55	10n
C56	10n
C57	10n
C58	47µ
C59	47p
C60	47p
C61	12p
C62	12p
D1	1N4148
D2	1N4148
D3	1N4148
D4	1N4148
D5	1N4148
D6	1N4148
D7	BA479
D8	ZF5.1
IC1	78L08
K1	351
L1	FCX
L2	1µH
L3	0.47µH
L4	0.47µH
L5	1µH
L6	0.47µH
L7	7Wdg.
L9	0.1µH
L10	T37-6, 8Wdg.
L11	5Wdg, 5mmØ
L12	0.47µH
L13	0.47µH
L14	0.47µH
L15	0.47µH
QU1	49MHz
R1	47
R2	47
R3	680k
R4	22k
R5	47
R6	100k
R7	330
R8	10k
R9	560
R10	1k5
R11	3k9
R12	4k7
R13	3k9
R14	1k
R15	10k
R16	330
R17	4k7
R18	47k
R19	100/4W
R20	47
R21	100/4W
R22	1k
R23	2k7
R24	1k
R25	1k
R26	100k
R27	1k
R28	470
R29	47
R30	10k
R31	1k
R32	1k
R33	100
R34	1k
R35	2k7
T1	BF961
T2	BFR91
T3	BF255
T4	BF255
T5	BD140
T6	BC547
T7	2N2222A
T8	RD06HFV1
T9	BF961

n.b.= do not mount

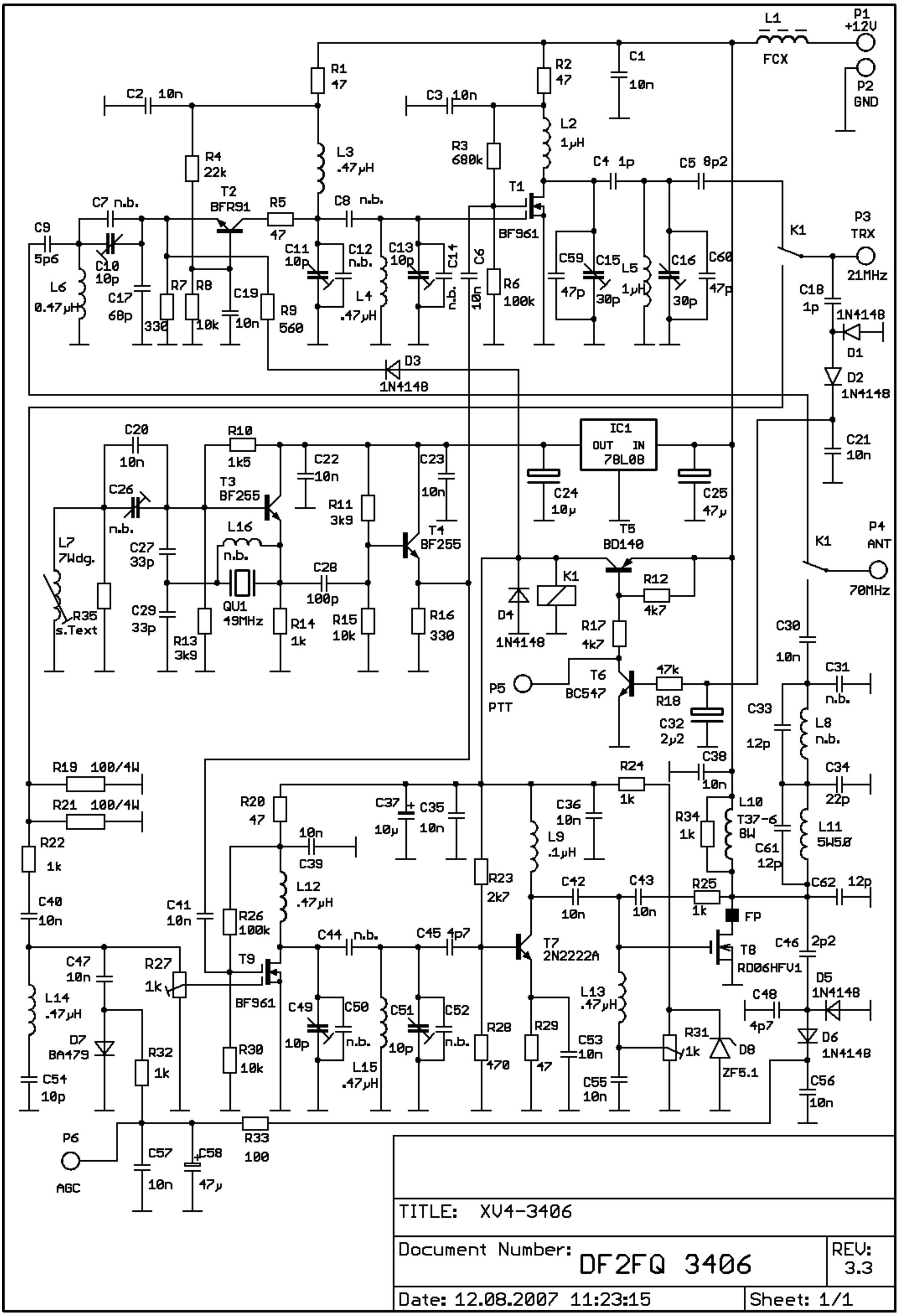


Figure 1, circuit diagram

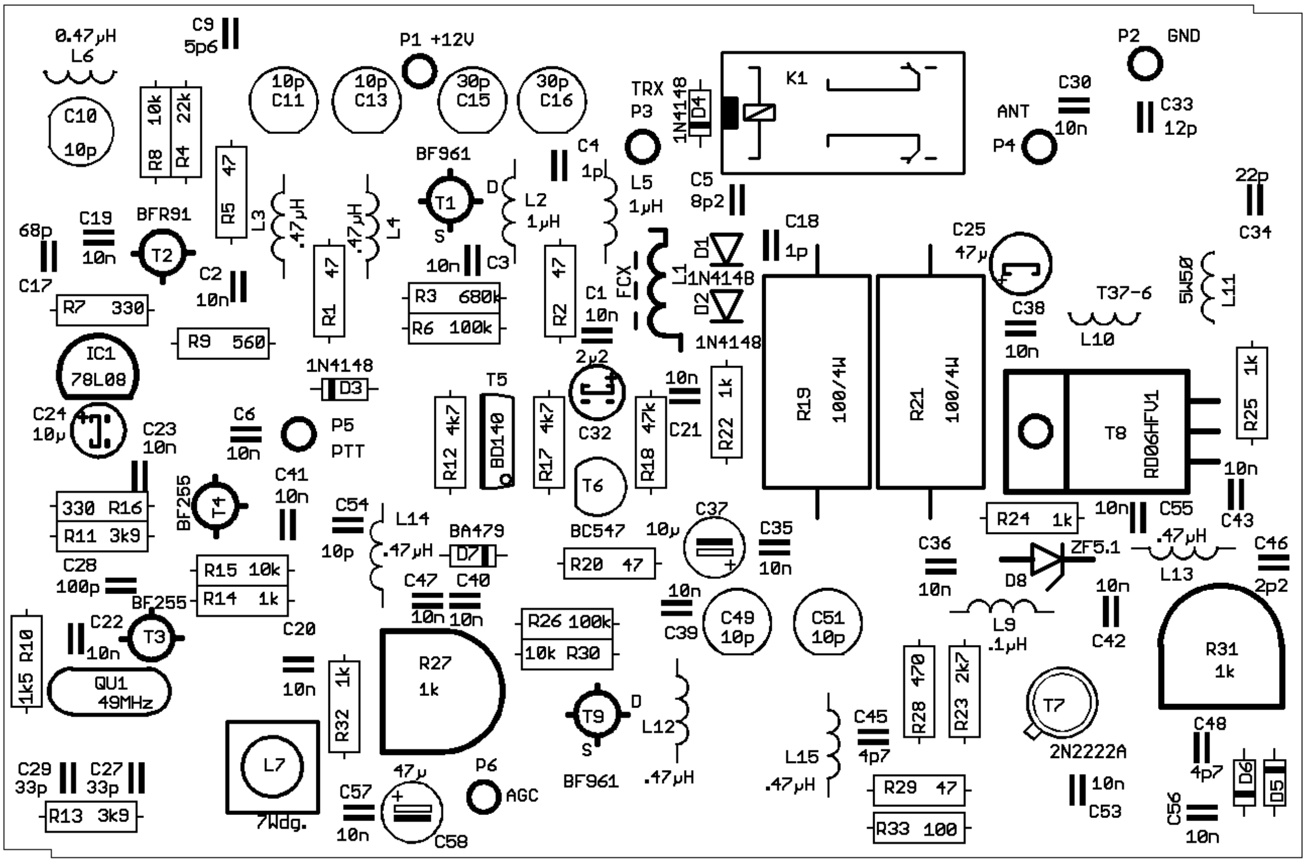


Figure 2, Place plan (unmounted components are not shown)

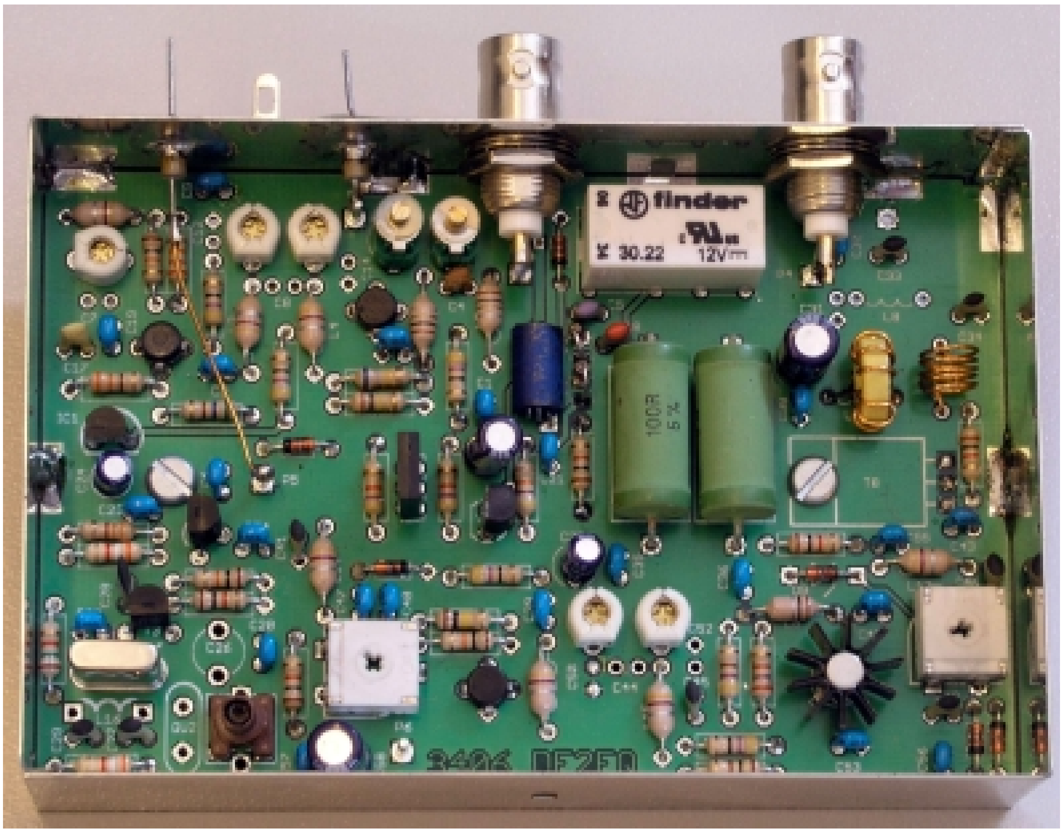


Figure 3, picture of the ready made transverter

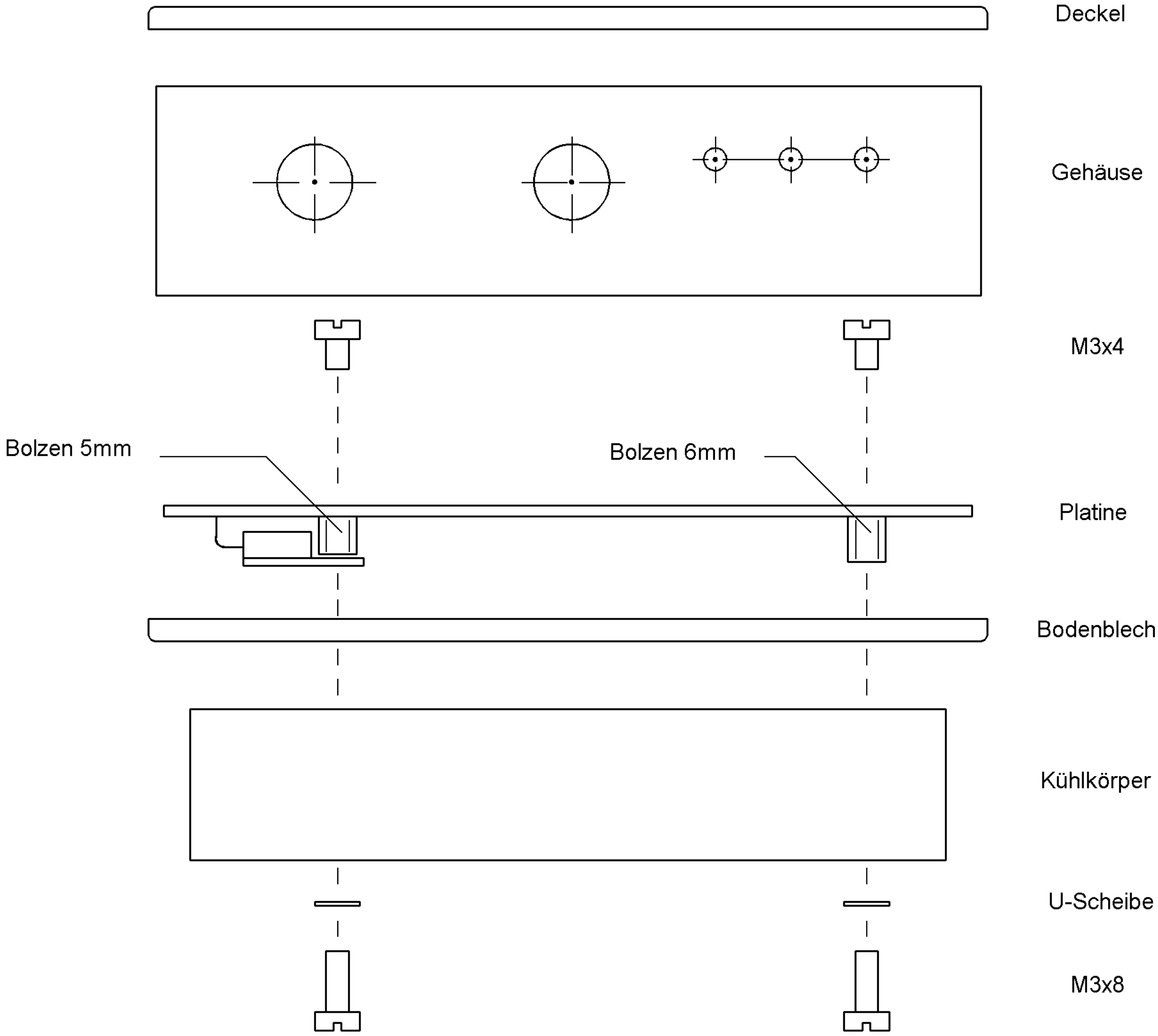


Figure 4, mounting scheme

Final remarks

This circuit design may be used by everybody for private purposes. Each commercial usage, also from parts of the design requires a permission from the author. The author rejects any liabilities for damages which result from construction or use of the device.

Appropriate construction considered the design is compliant to all requirements of the new European standard for amateur radio equipment ETS 300-684 as well as to the EMC standard EN 55022.

For questions and further information the author is available in packet radio or by e-mail under df2fq@amsat.org.