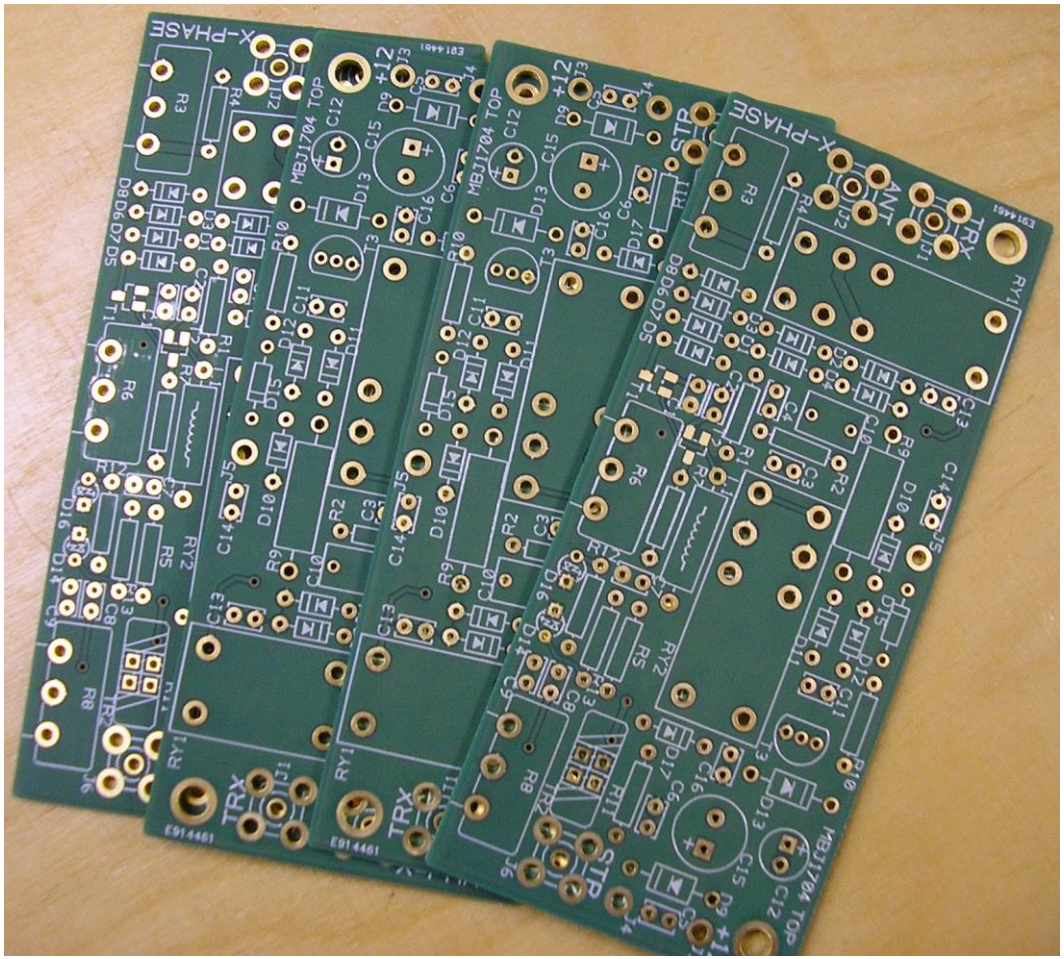
The X-Phase-2 QRM-killer

Picture:
Luit Popken
PA0LPN

Developed originally by G4WMX and GW3DIX, later improved by DK9NL.
Latest improvements by DG0KW (version used by us)

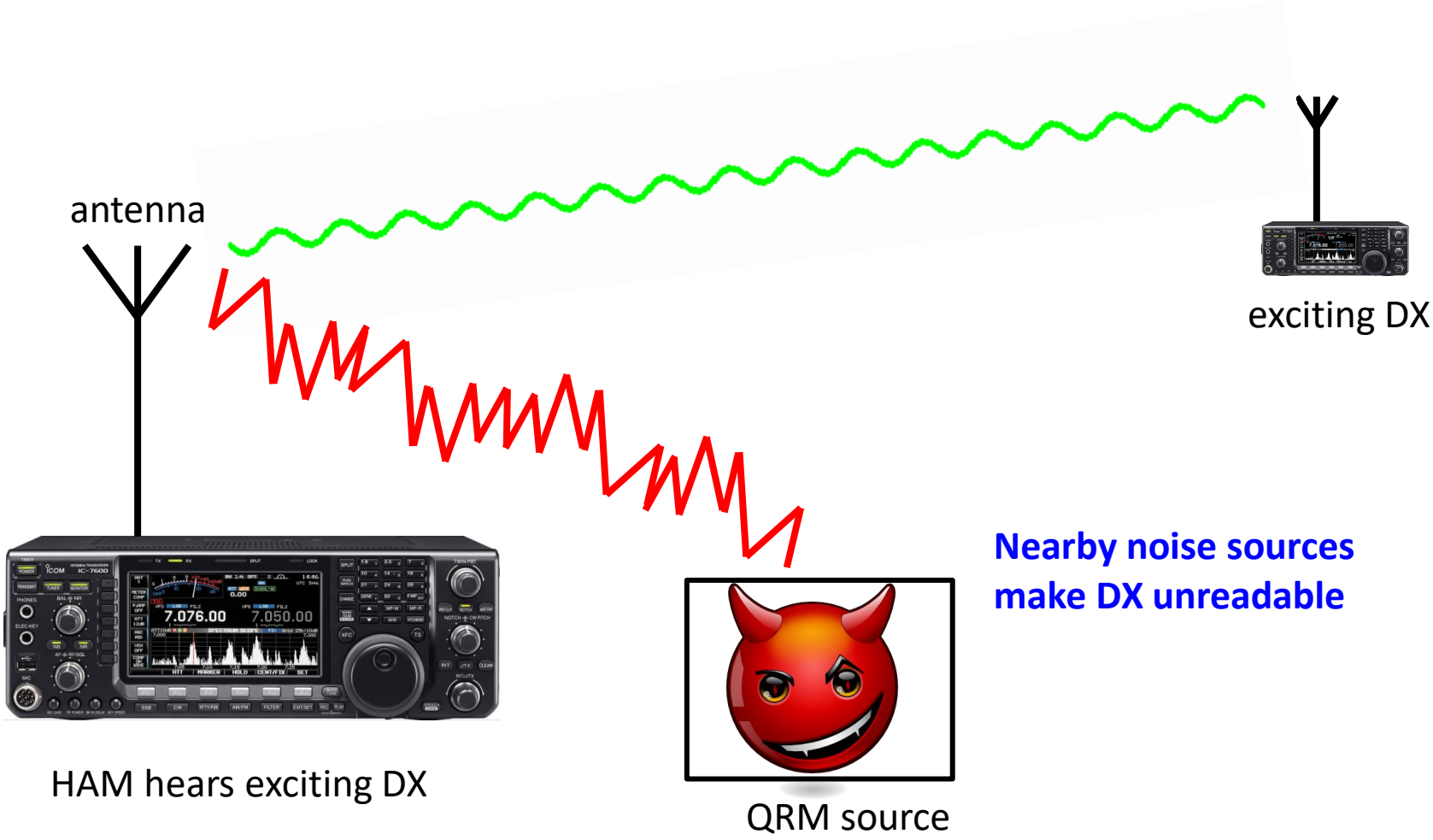
A hobby project of the local VERON and VRZA departments Wageningen/Ede, Netherlands



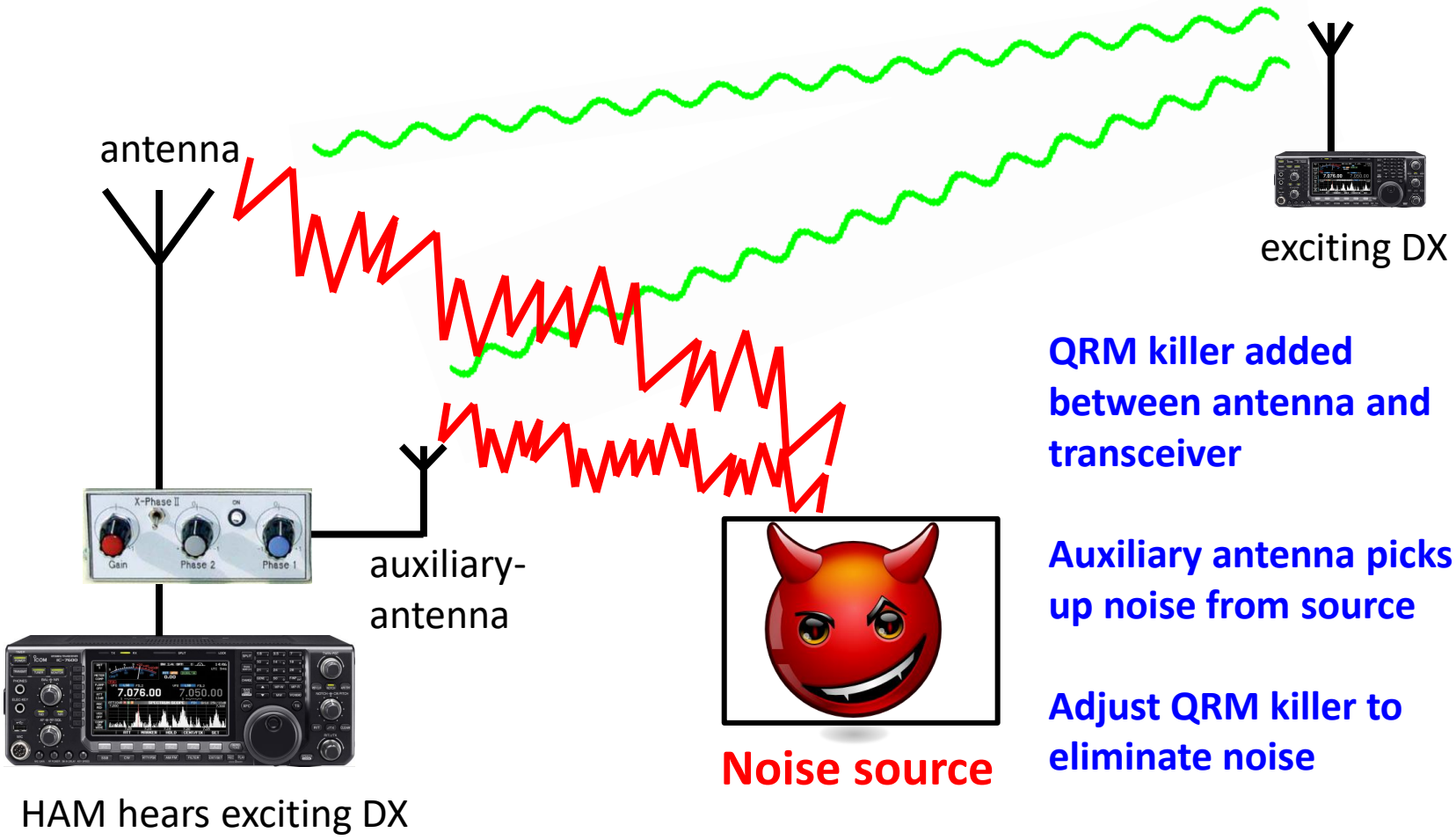
Professionally developed and produced PCB's

Component kits for the PCB's made available

Problem to be solved…….



….. And the solution!



Principle of killing the local QRM

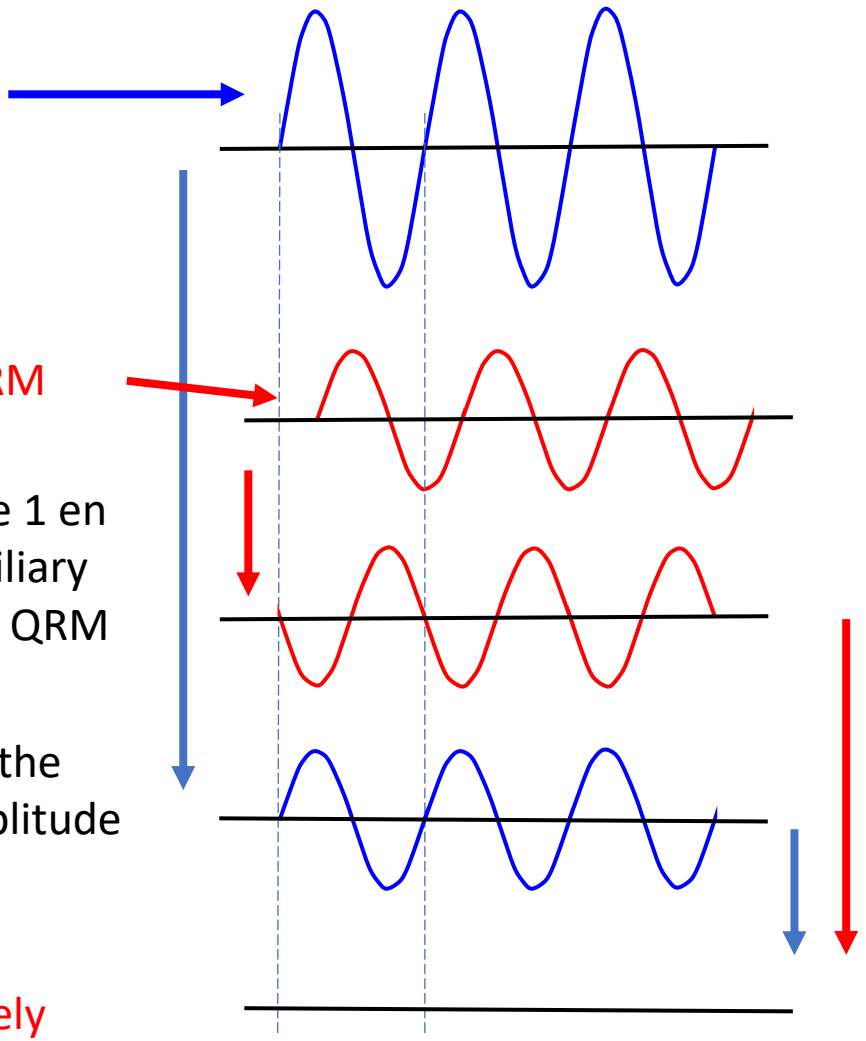
Picked up QRM via main antenna
(desired DX- signal not shown)

Picked up QRM via auxiliary antenna
(amplitude and phase differs from QRM added on main signal)

Use middle and right potmeter (Phase 1 en Phase 2) to shift the phase of the auxiliary QRM 180 degrees with respect to the QRM via the main antenna

Use left potmeter potmeter to make the QRM on the main signal equal in amplitude of the auxiliary signal

Result: QRM disappears almost entirely



Tips and tricks

QRM must come from a local source (within a radius of 100m)

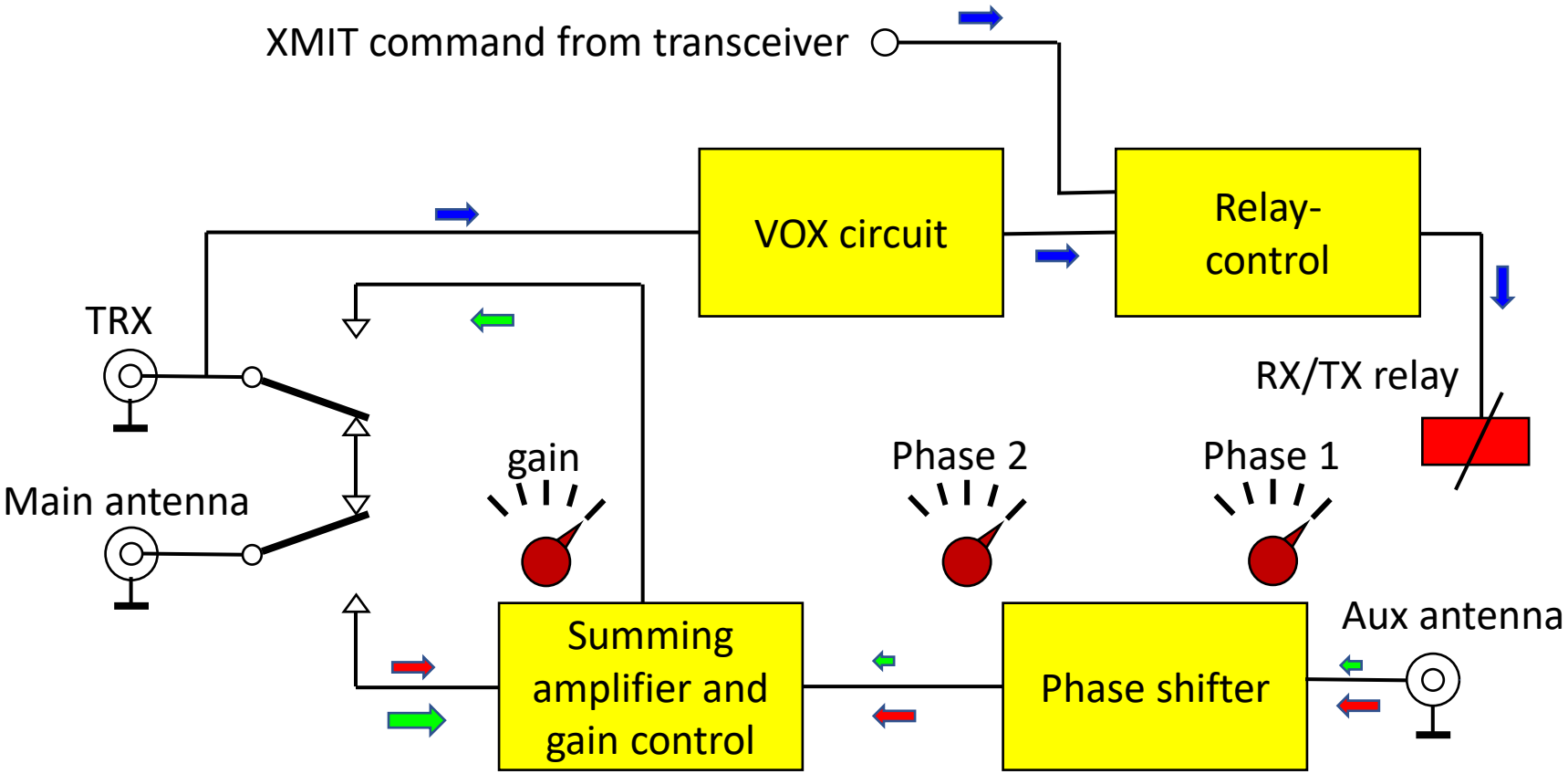
Auxiliary antenna must not be too good. You need a strong QRM signal on it and the desired signal must be relatively weak

Operating the QRM killer is easy. You will soon get used to the knob fiddling to eliminate the QRM

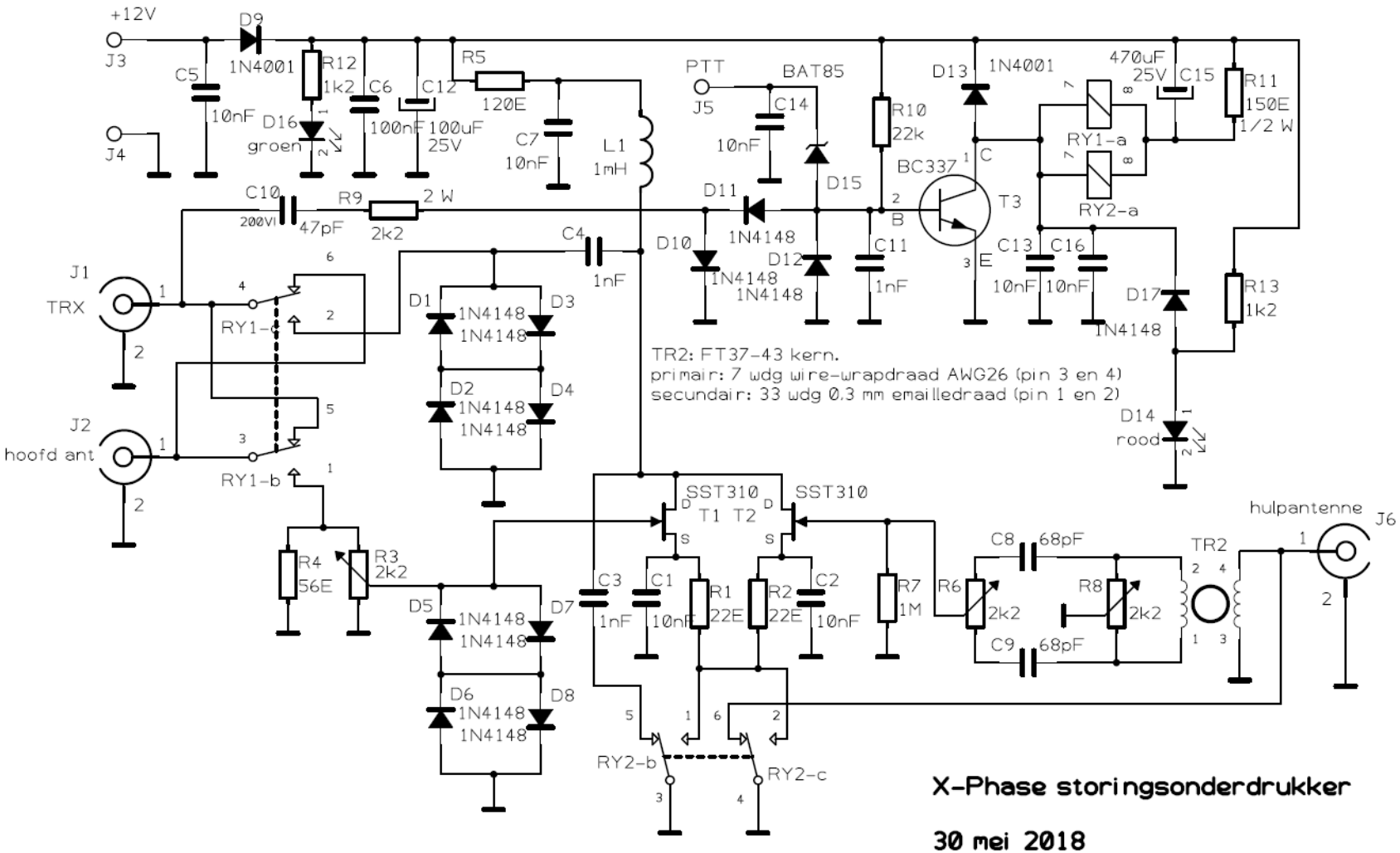
Centre and right potmeter are for phase shifting the auxiliary signal. Left potmeter is for adjusting the amplitude of the main signal

Reduction of the QRM is quite good in most cases.

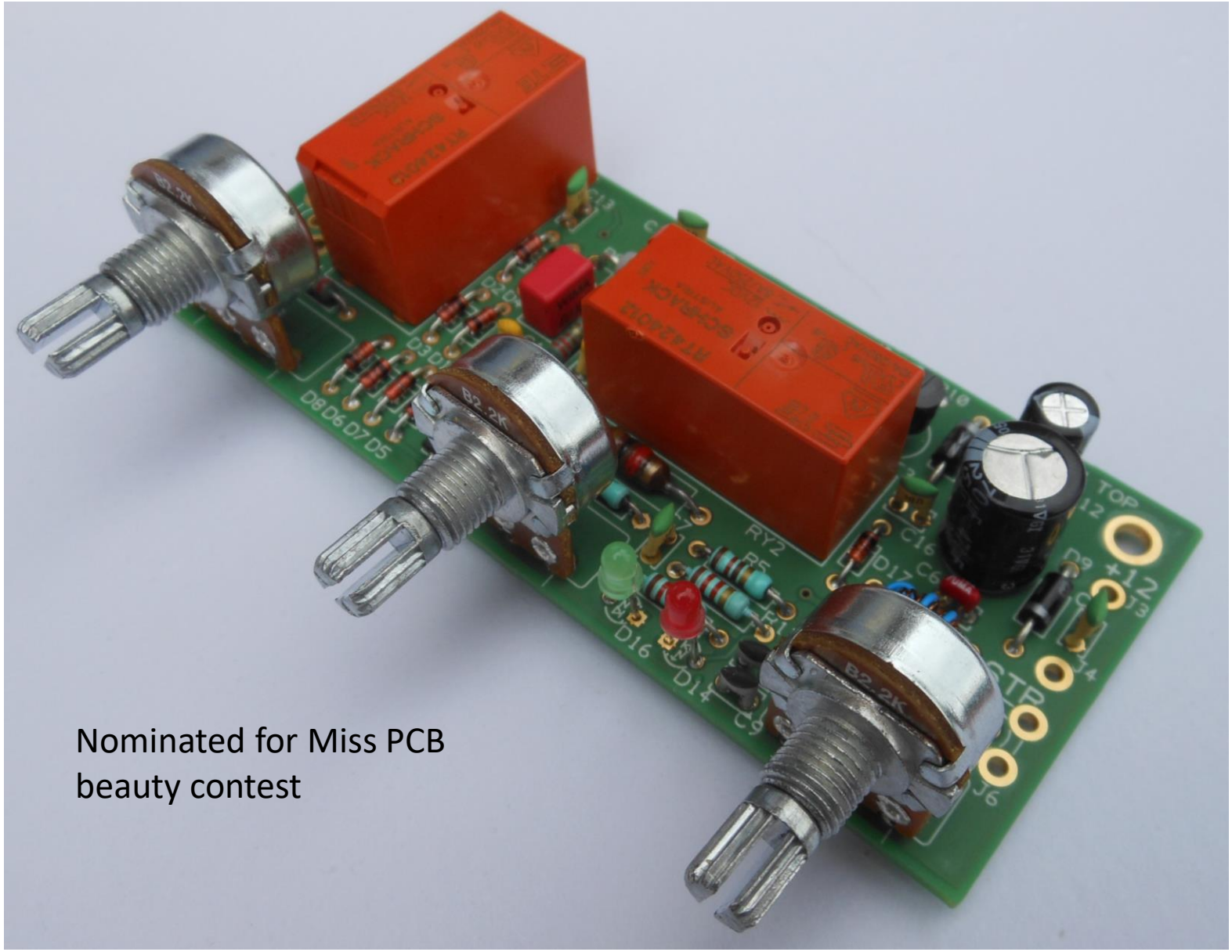
X-Phase block diagram



Schematic diagram



The assembled printed circuit board

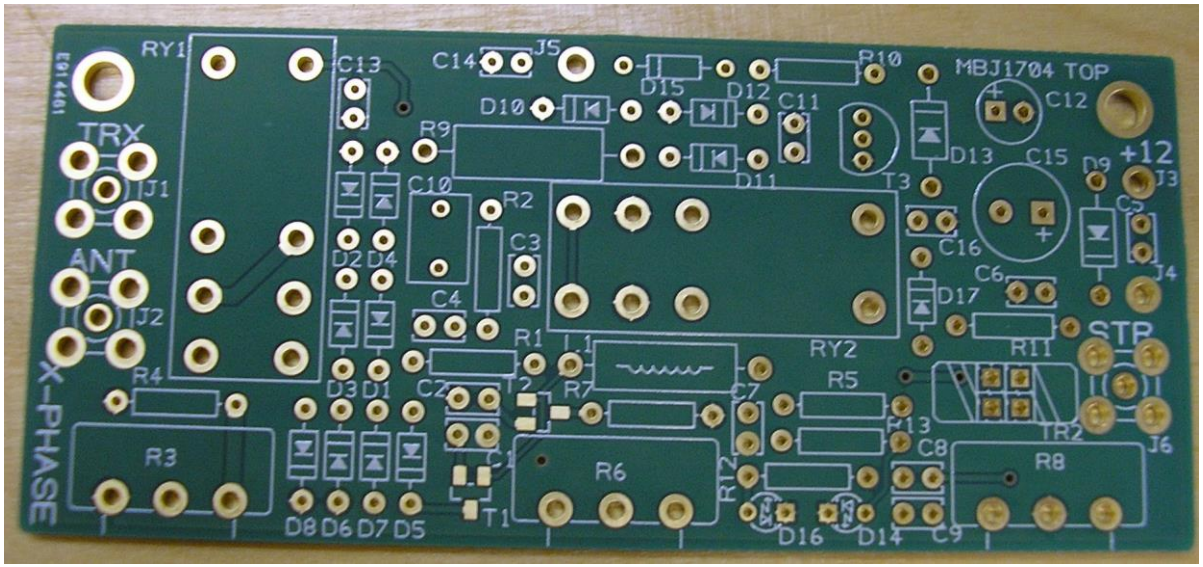


Design aspects

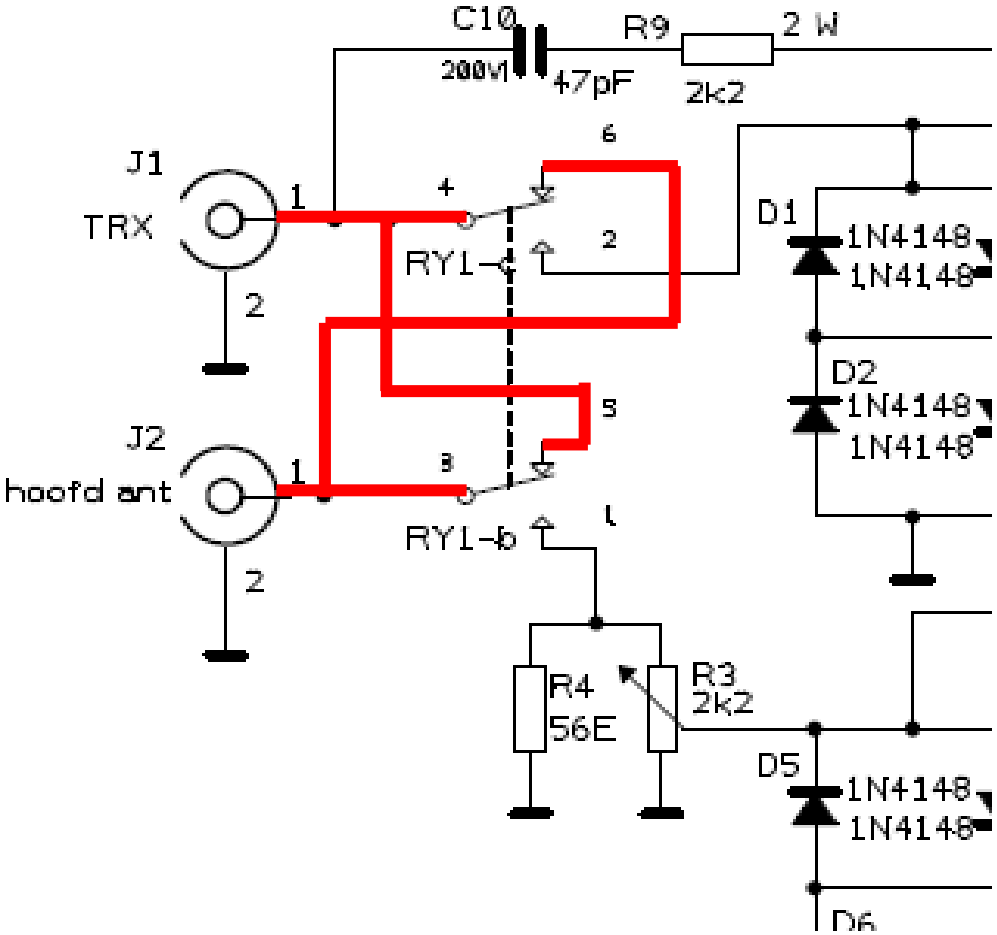
- **Professionally designed and fabricated PCB, double sided, through hole metallized and silk screen**

- **RF connections on board are as short as possible**

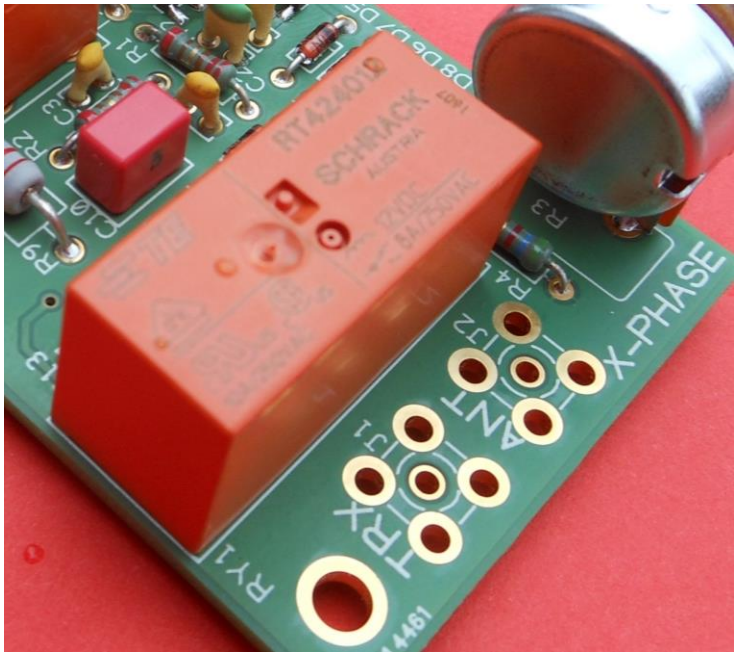
- **PCB top layer is used as ground plane**



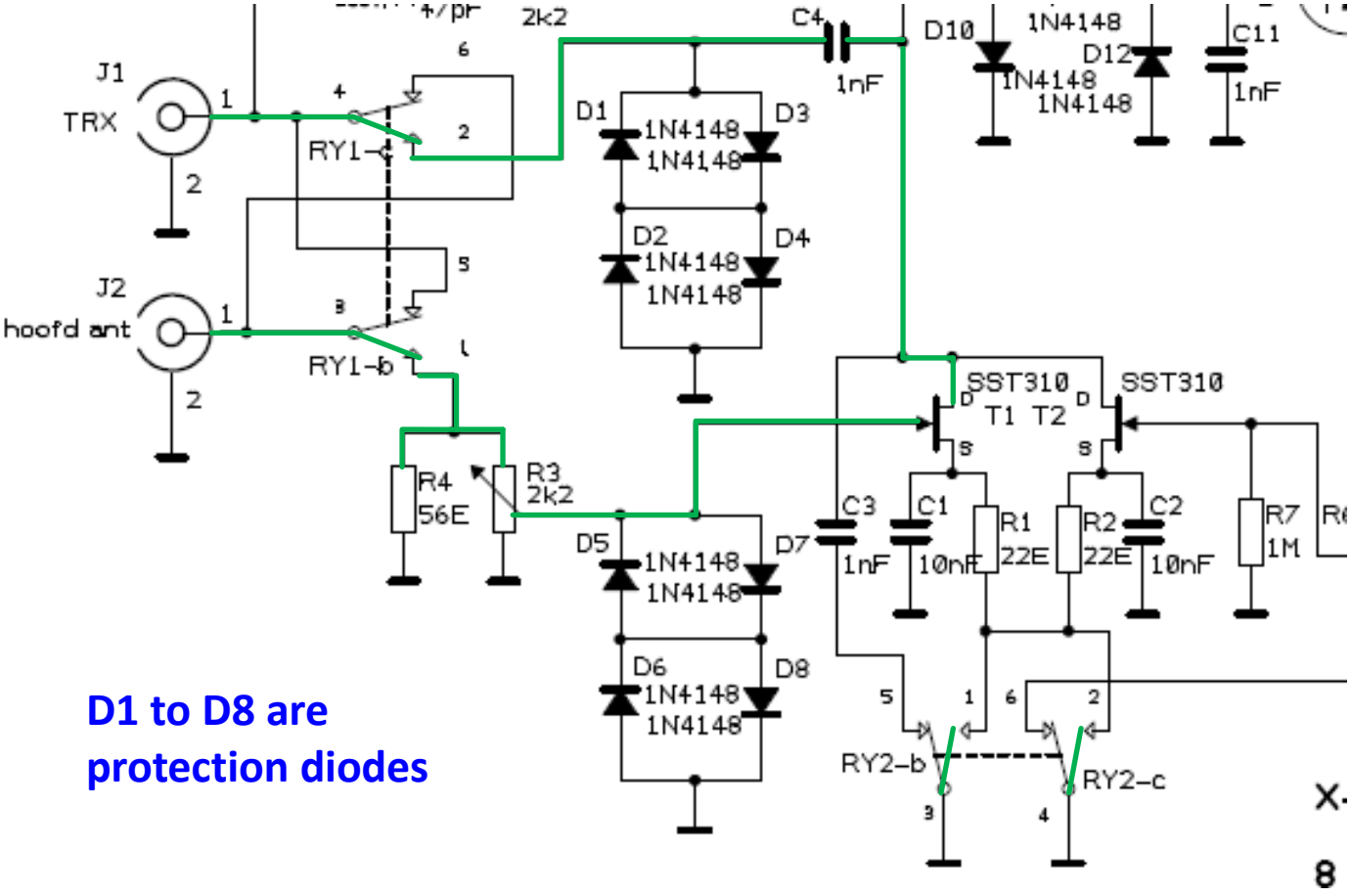
Signal path during transmission



n/c contacts of RY1 are wired in parallel to keep the signal path at a low impedance (**the 100W Xmitter output will flow through it!**)



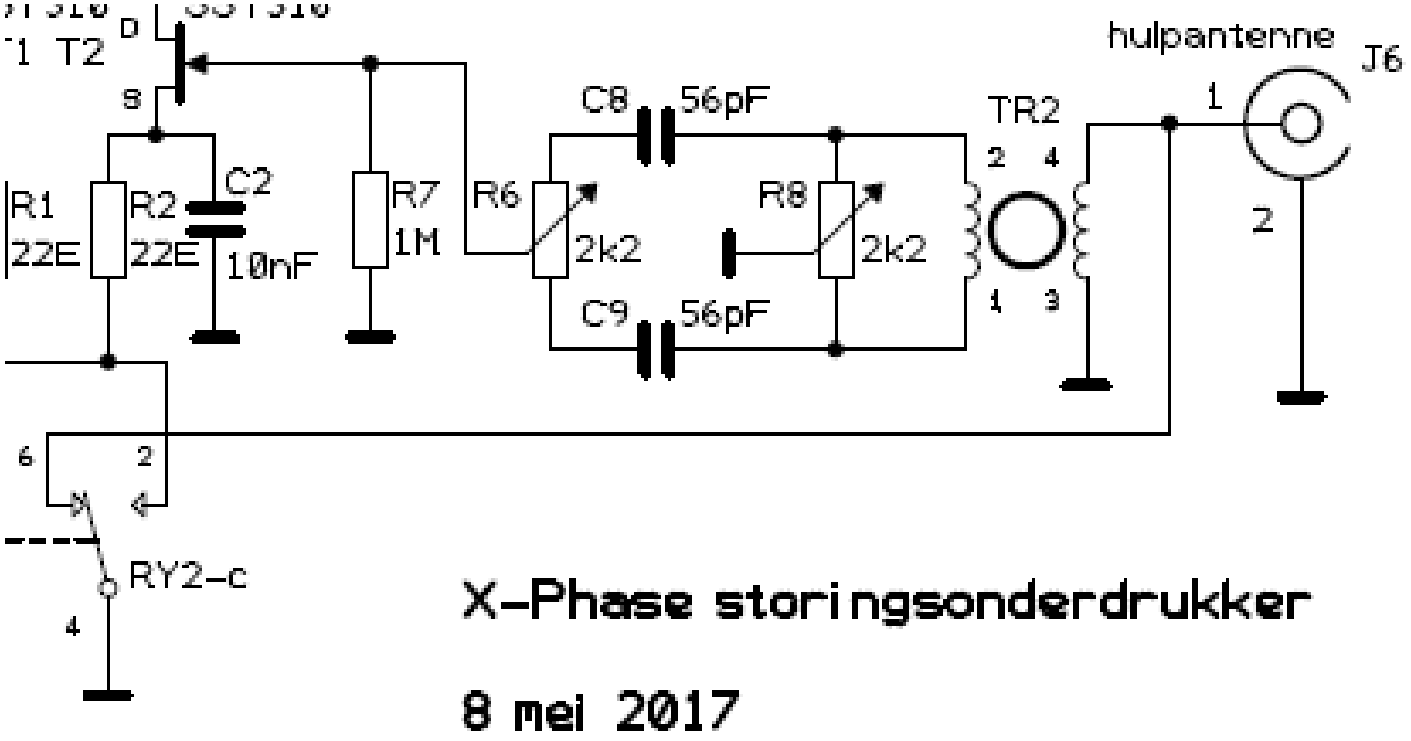
Signal path during receiving



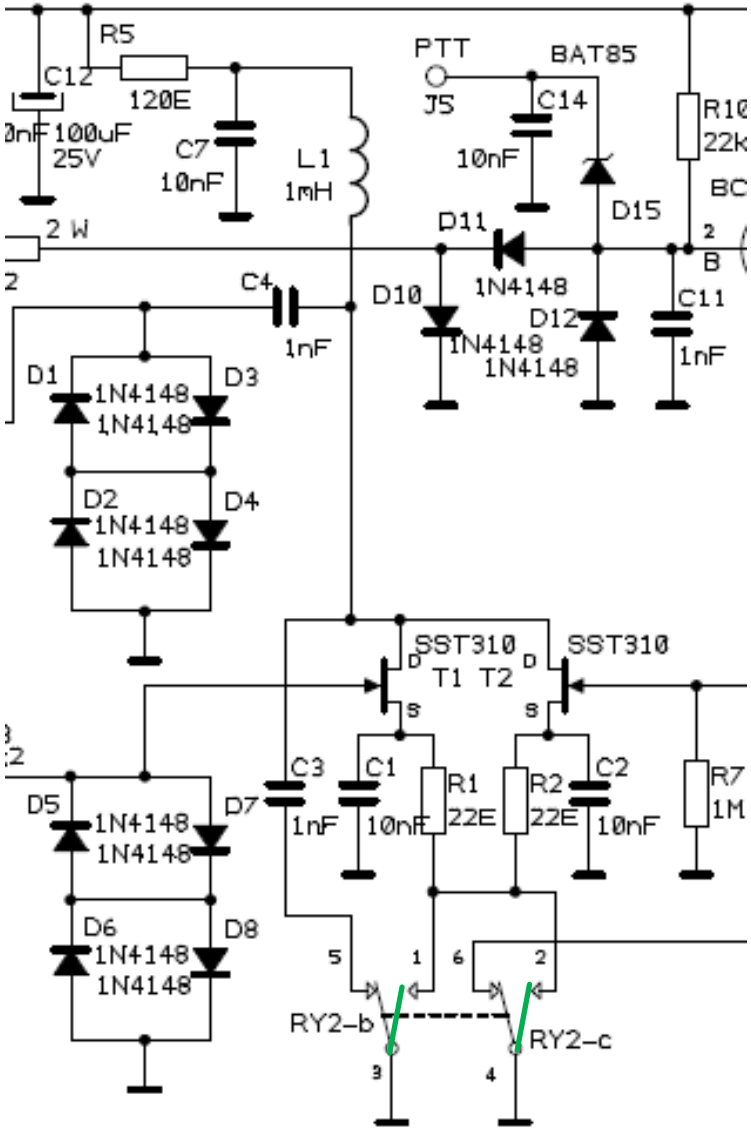
D1 to D8 are protection diodes

Phase shifting circuit details

The phase of the auxiliary signal can be shifted over a wide rang by adjusting potmeters R6 and R8. Note that both potmeters also have an influence on the amplitude of the AUX-QRM signal.



Summing amplifier

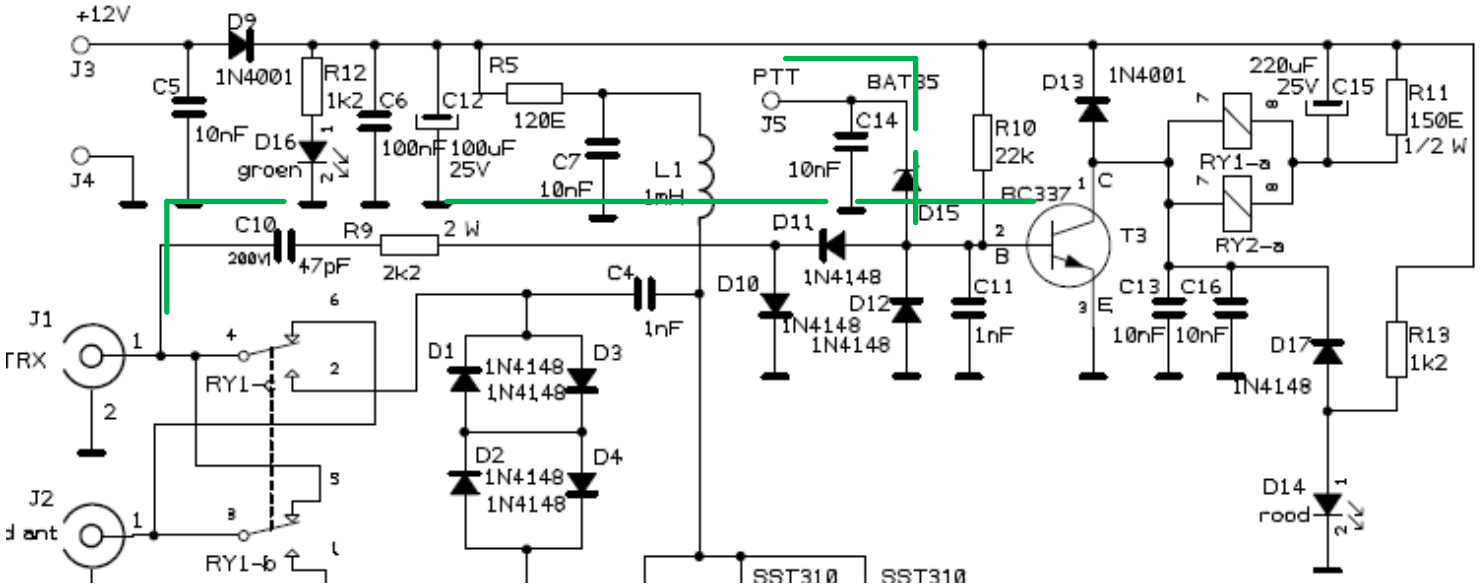


Signals from the main antenna enter the amplifier via the gate of T1. The auxiliary signal enters the summing amplifier via the gate of T2. Both signals are added at the coupled drains of T1 and T2. If the QRM component on both signals are equal in amplitude and differ 180 degrees in phase, both QRM signals cancel each other. The “cleaned up” signal from the main antenna is fed to the transceiver via C4.

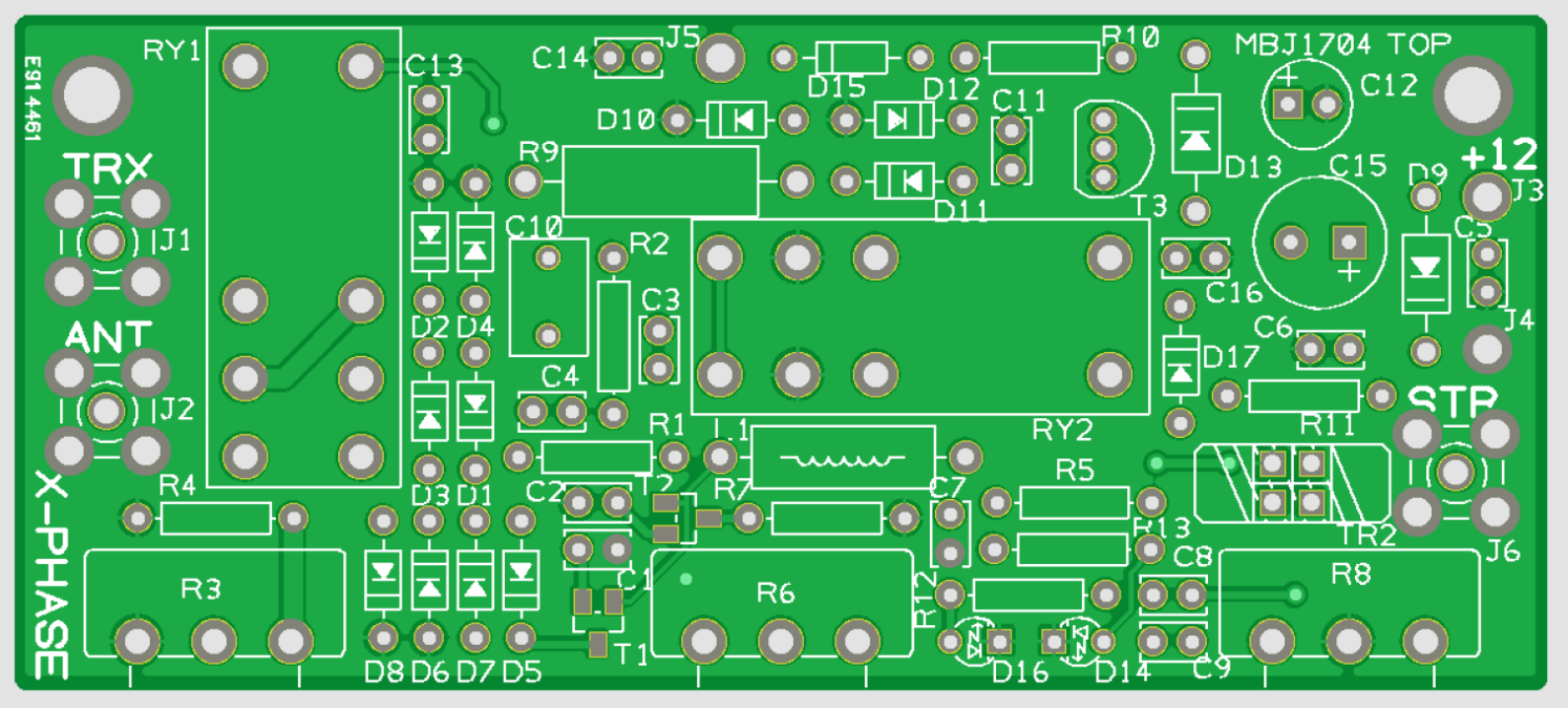
VOX – and TX/RX switching

Note that the relays are NOT activated during transmission. They will be activated during reception. This is a safety precaution. If you forget to switch on the power of the X-Phase, the transmitter power cannot destroy the circuitry but flows directly to the antenna.

VOX: the transmitter is rectified by D10 and D11. The generated negative voltage shuts down T3 which in turn switches off the relays. De VOX is only meant as a safety precaution in case the TX/RX control signal coming from the transceiver fails. This control signal enters the circuit via J5 and pulls J5 to ground during transmission.

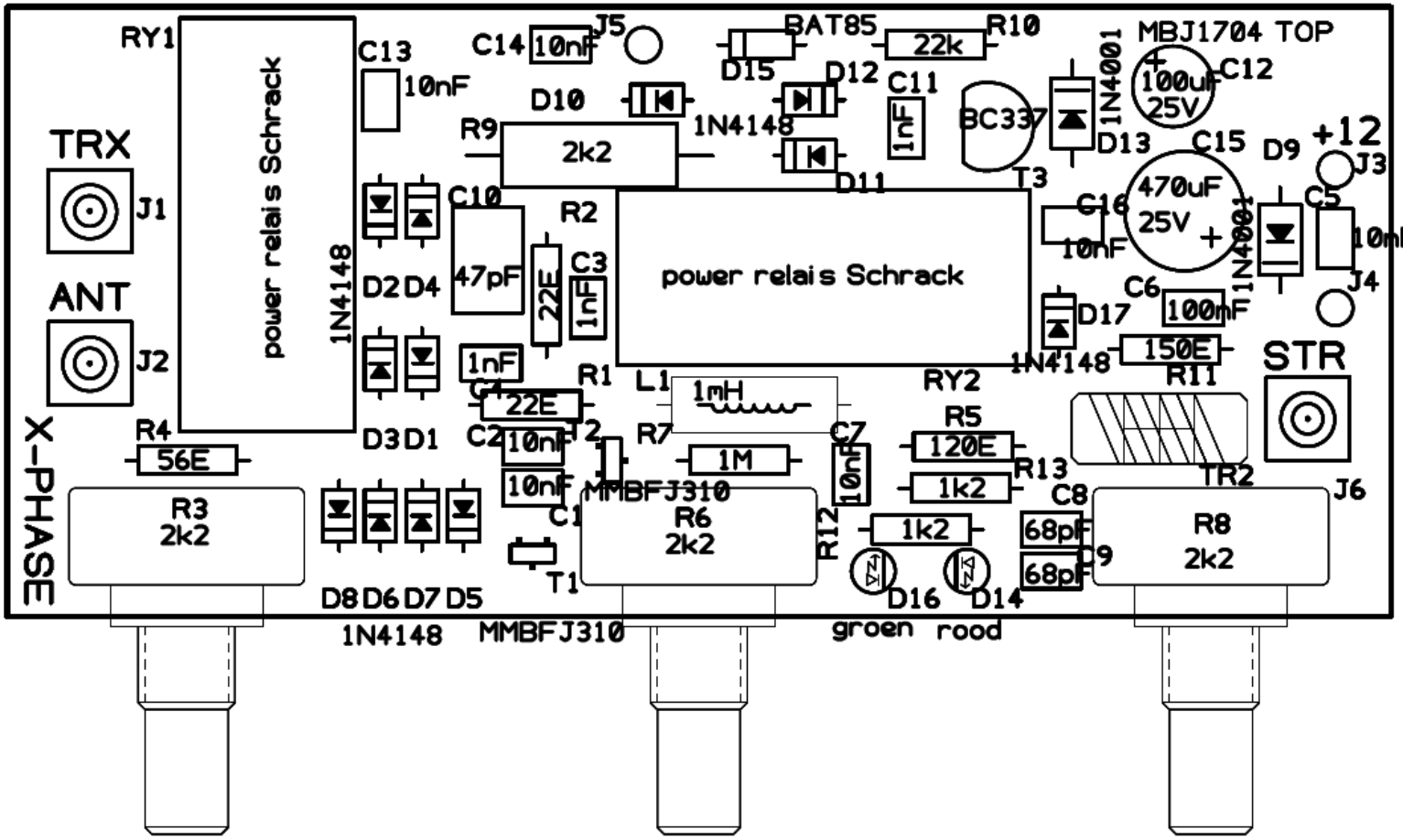


Assembly of the PCB is easy



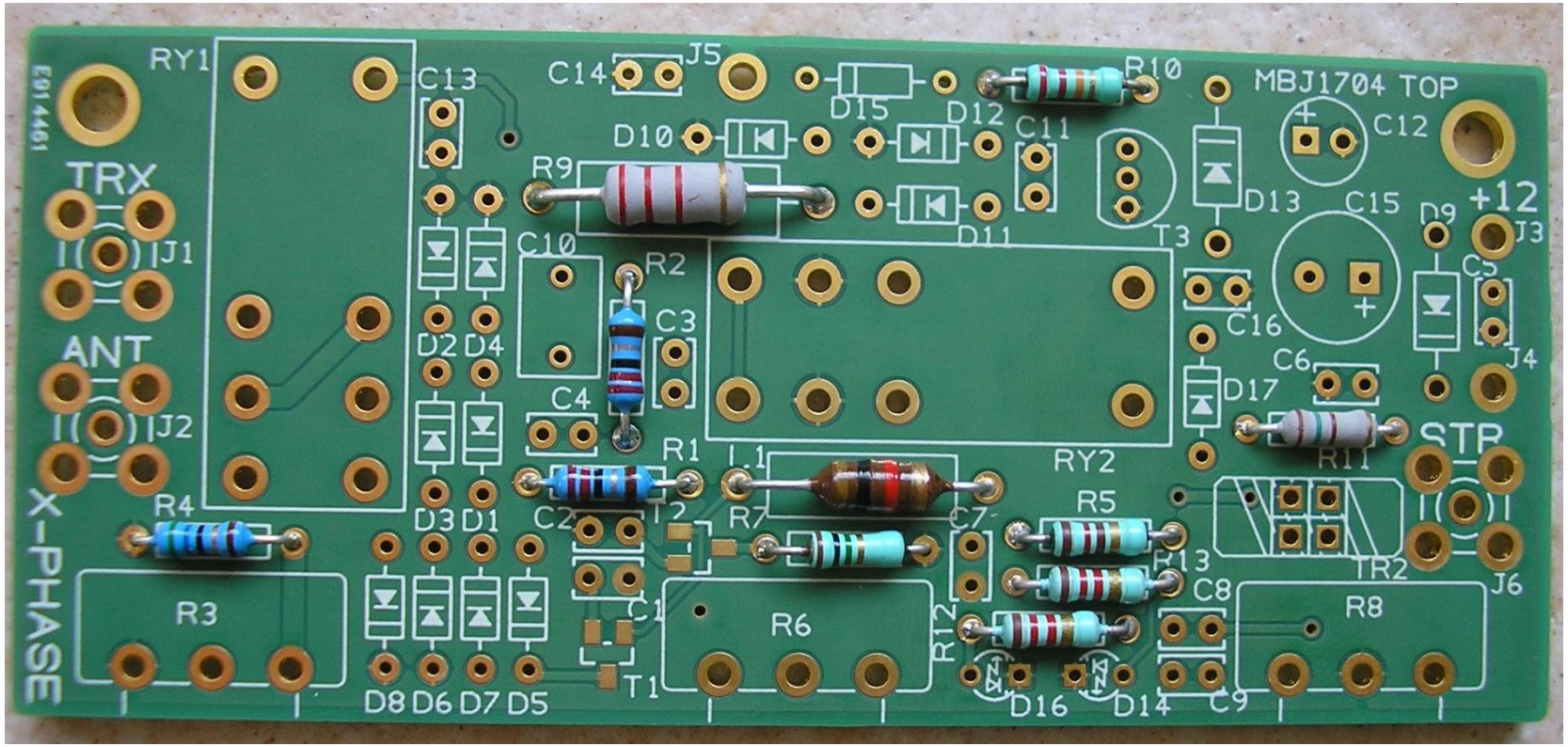
Please watch carefully the polarity of diodes and electrolytic capacitors

Component placement



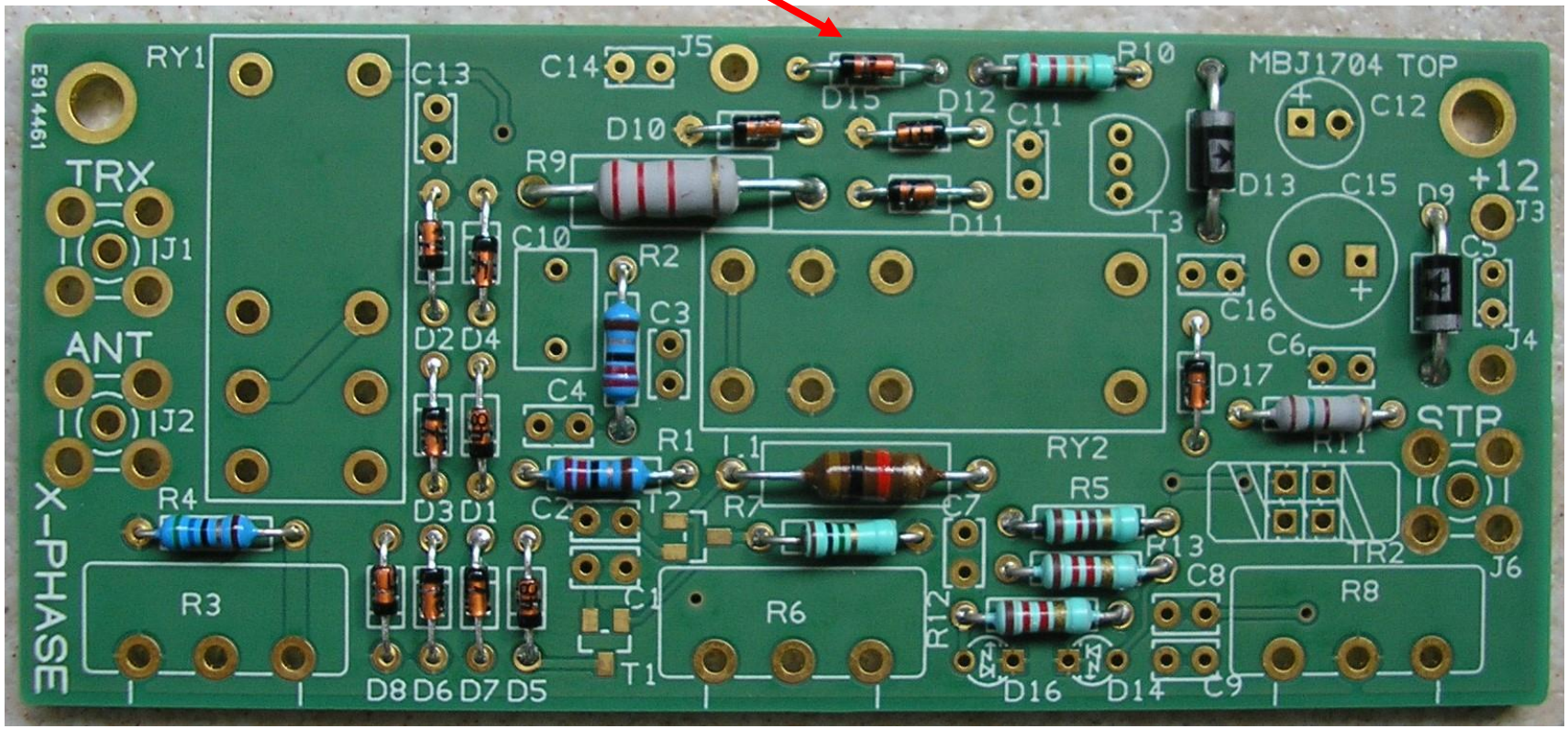
X-Phase 30 mei 2018

Step 1: resistor placement



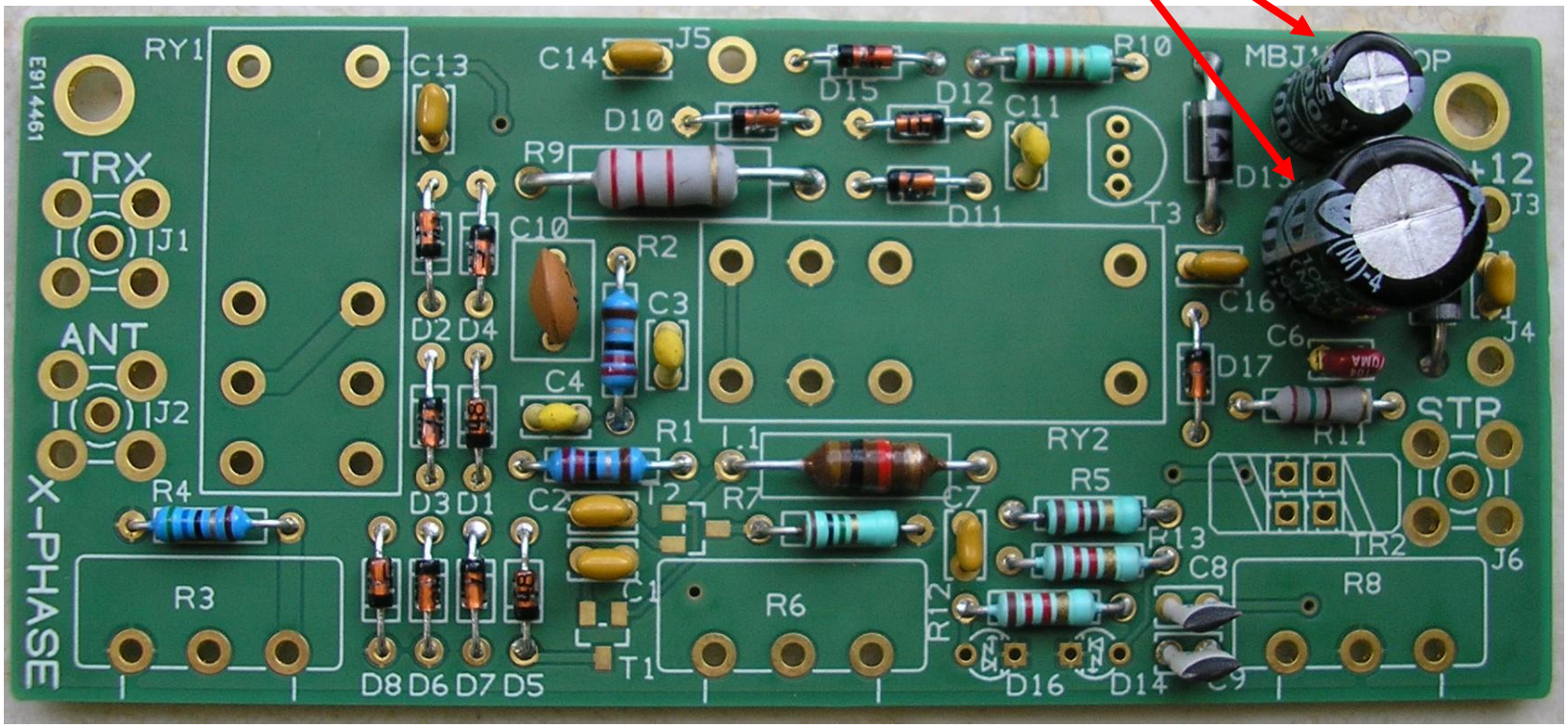
Step 2: diode placement

DO mind the diode polarity!
DO mind D15! This is a Schottky diode (BAT85)
and looks deceptively the same as the 1N4148!



Step 3: capacitor placement

Mind the polarity of (C12 and C15).

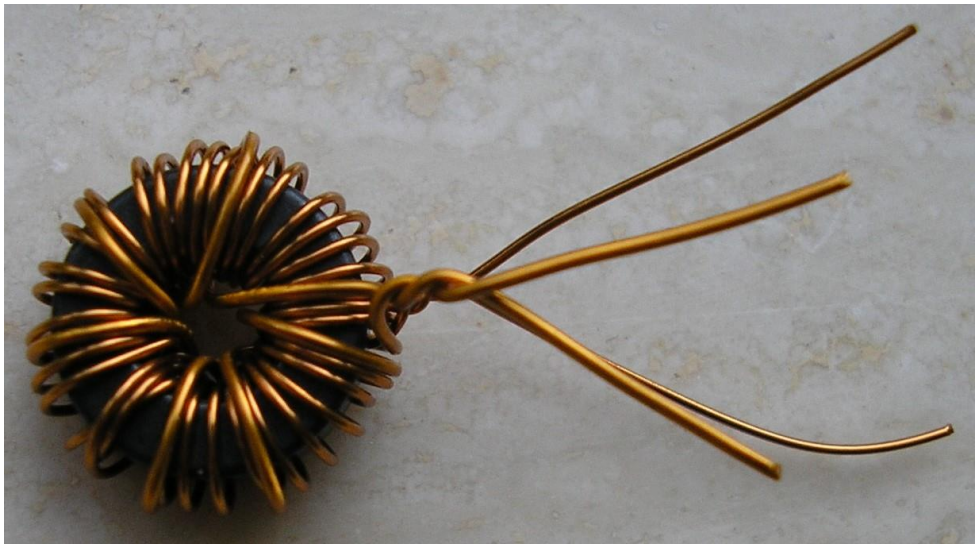


Coil winding

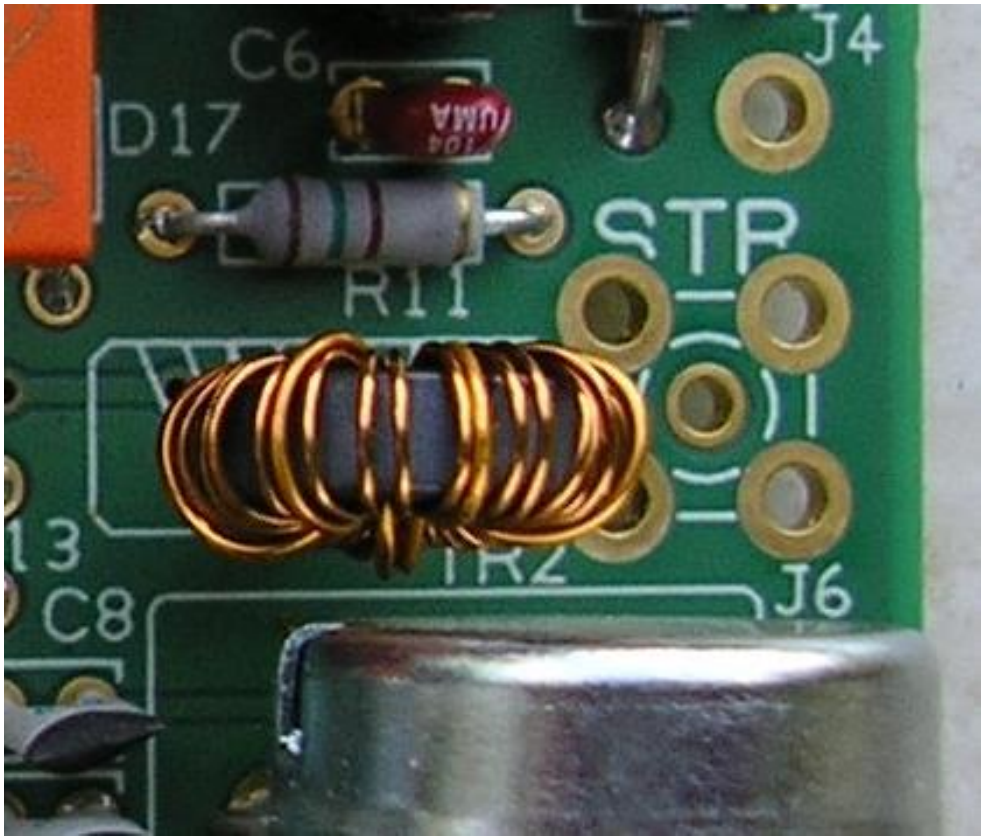
Start with the secondary winding (33 wdg, 0.3 mm dia)

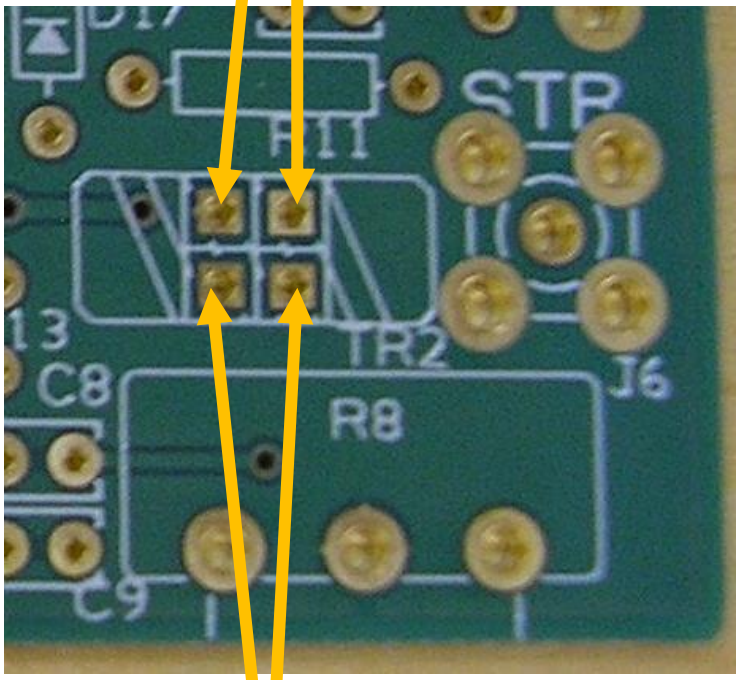
On top of that the 7 windings of 0.4 mm dia wire

Make sure that you connect the transformer in the proper way (see next slide)



Placement of the transformer





WARNING!

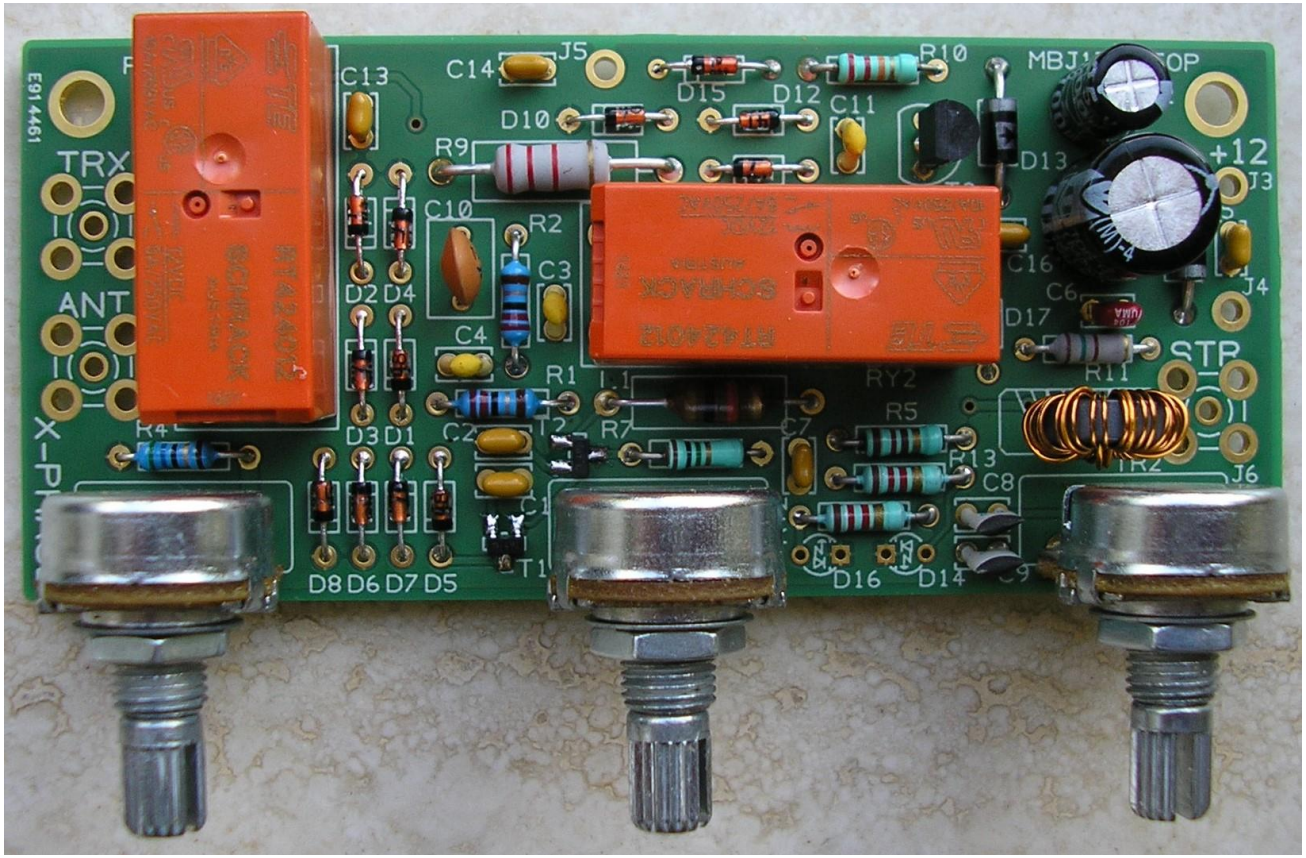
Be careful with the relays!

Under all circumstances, avoid to get near to the relay housings with a hot soldering iron.

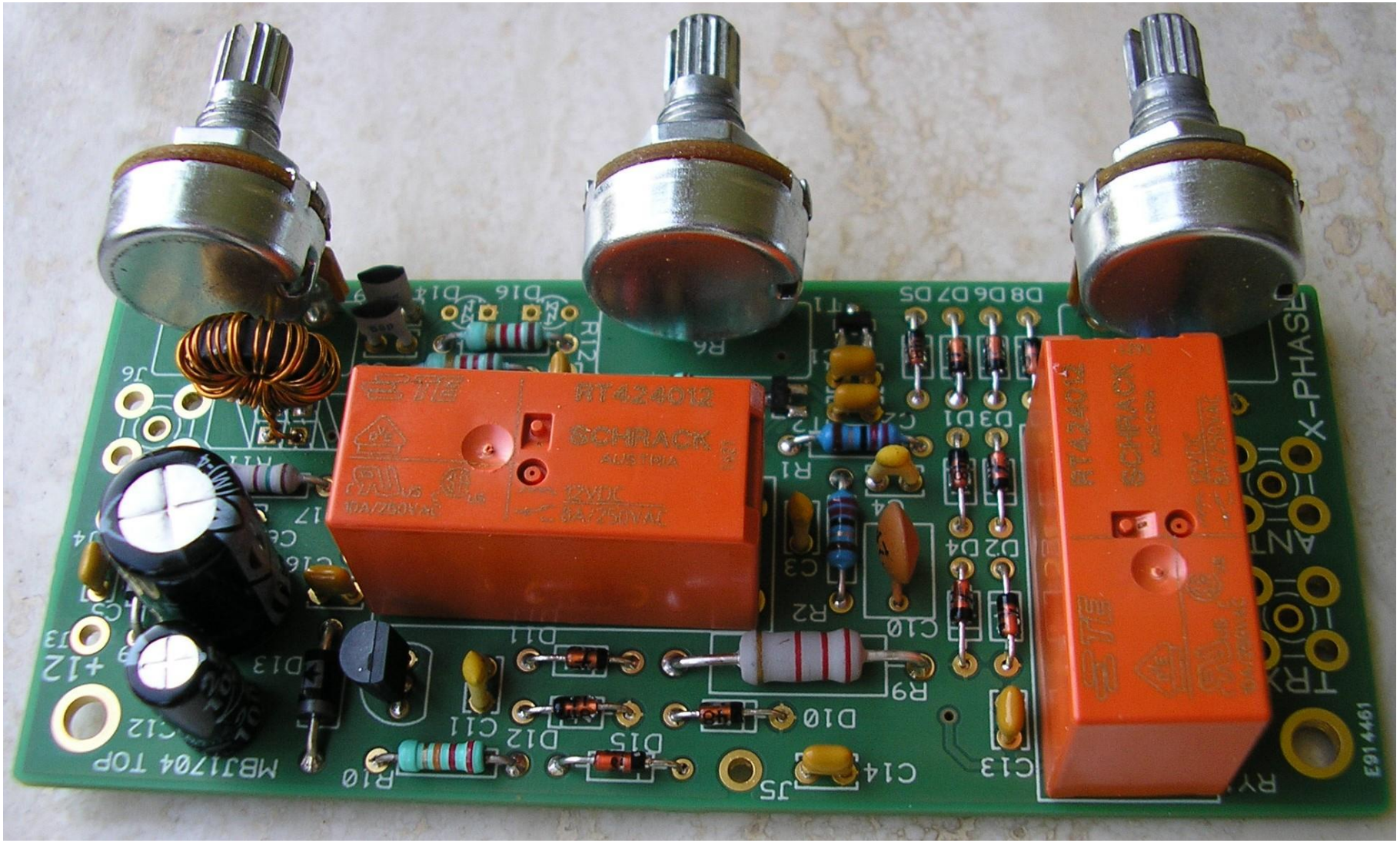
We have had a few cases where the relay housing was touched with a hot soldering iron. In that case, the molten plastic blocks the underneath relay contacts.

Stap 4: assembly of all other components

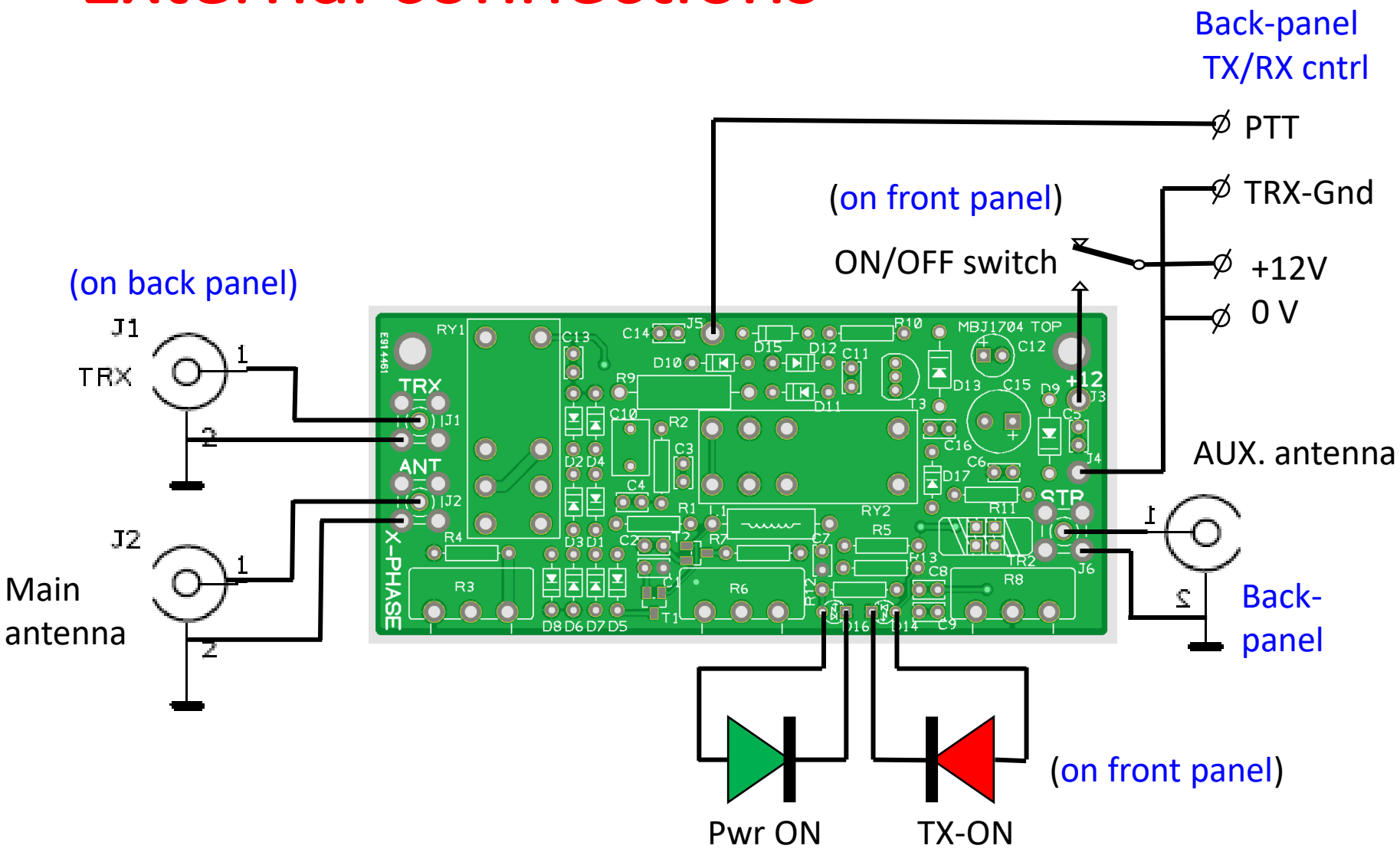
First, solder the two SMD FET's before placing the taller components.



The final result, a real beauty!

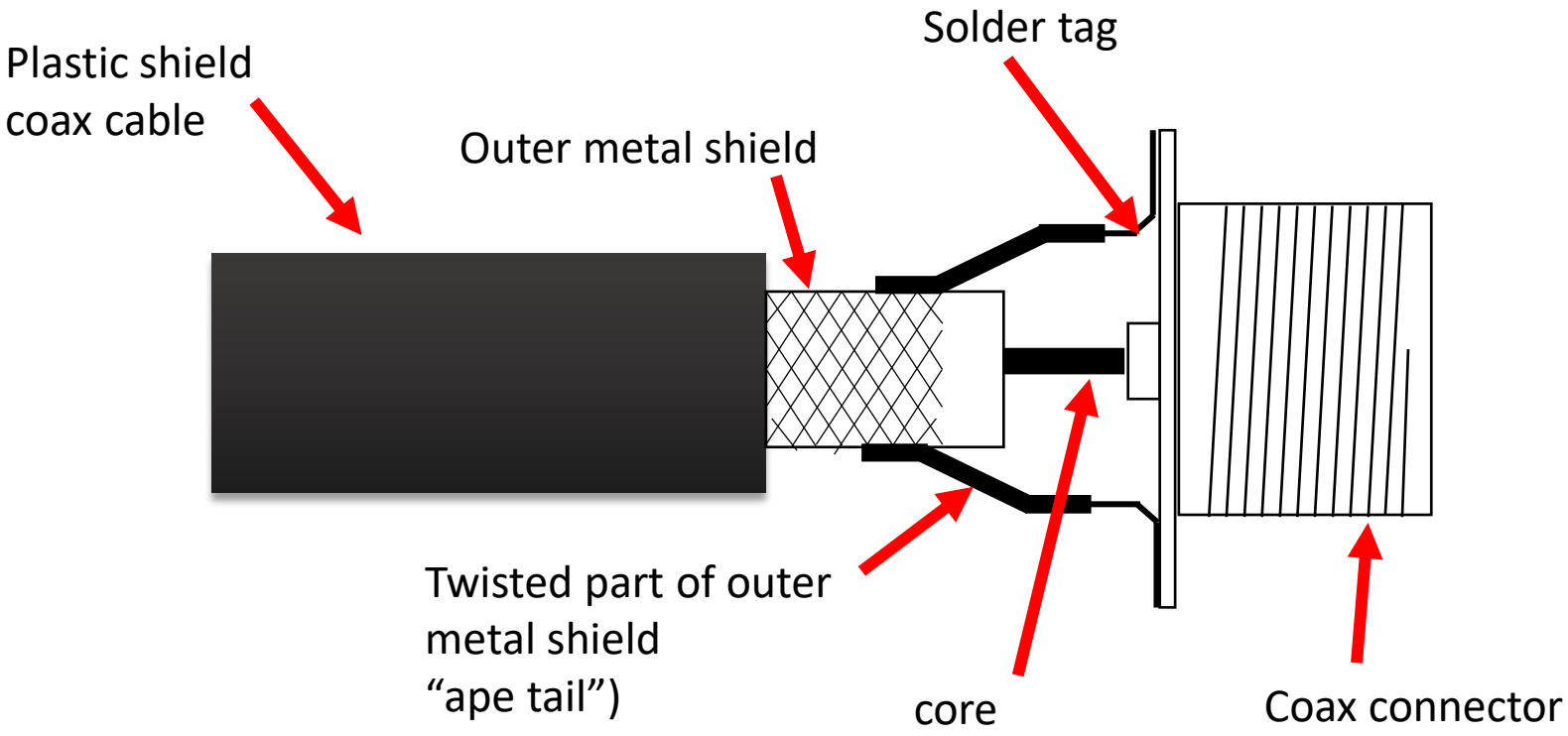


External connections

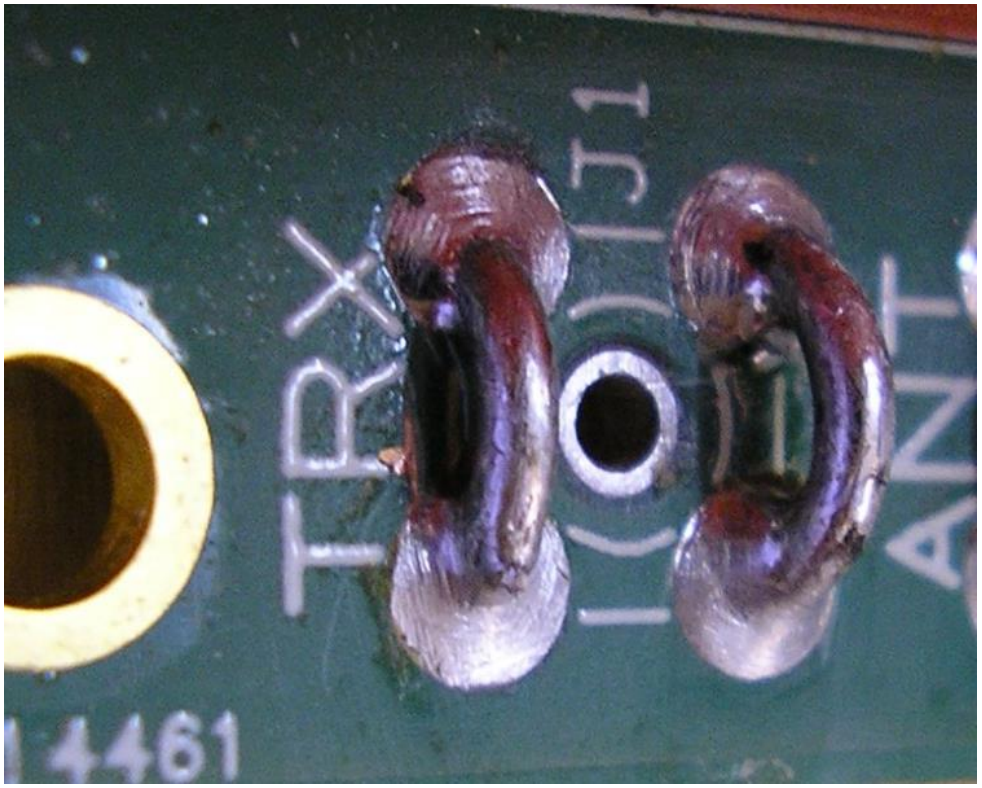


Co-axial antenna connections

Keep connections as short as possible.
Use 2 or more “ape tails” for Ground connections

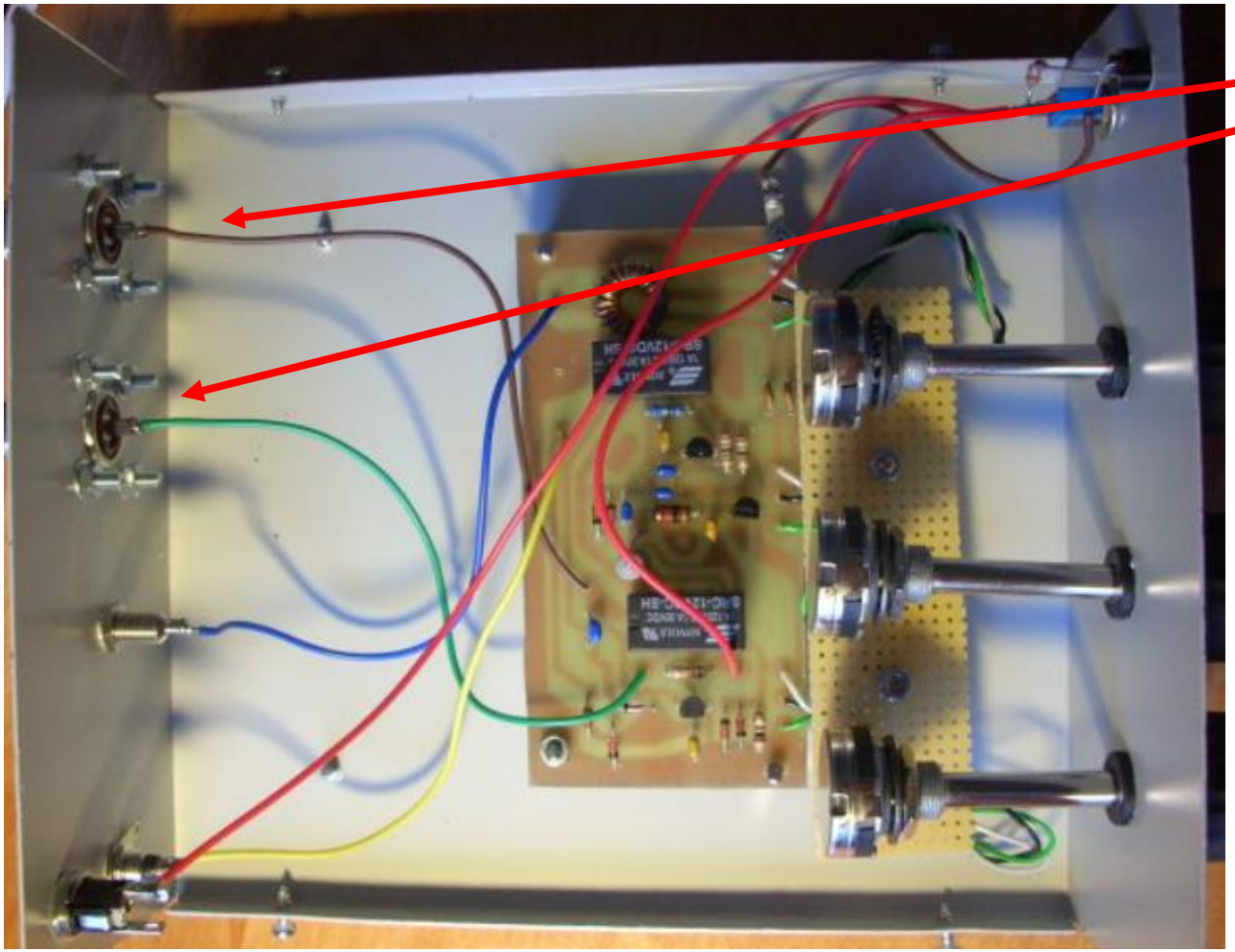


Connecting the coax cable to the PCB



U-bend short lengths of thin wire and solder them in the Ground pads.Now it is easy to solder the “ape tails” to the PCB. You can use thin RG174/U cable. It can handle over 400W of RF power!

DON'T do it this way!!!



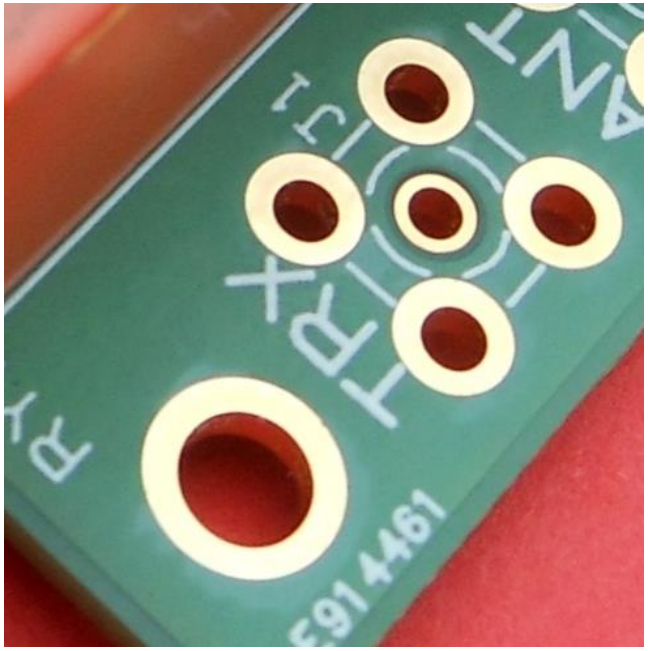
This way of connecting the main antenna and transceiver are BREATH TAKING!

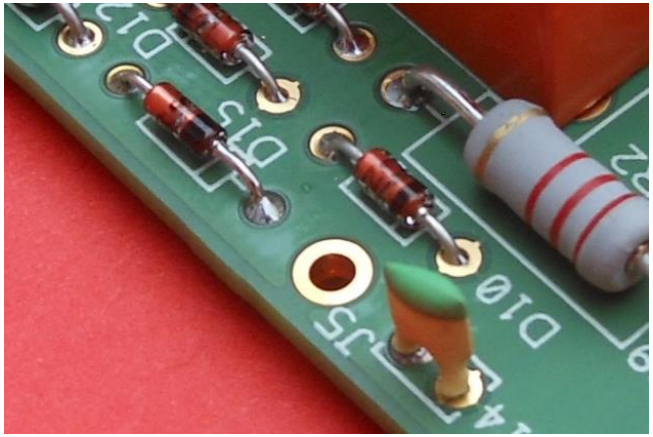
The single wires form a large self-inductance because the return signal must find it's way through the cabinet wall. ALWAYS use coaxial cable with GROUND connections at both ends!

Tips:

Soldering a plated through hole PCB: put your soldering iron on the pad and component wire for 3 seconds, apply enough solder and wait another 3 seconds. In this way the heat gets through the hole and wire and the and allow the solder to flow through the hole.

Removing a component: DON't be rough by putting a screwdriver under the component and forcing the component out while heating the solder. Instead: cut the component wires on both sides, heat up the solder of each pad and remove the end of each wire carefully with a tweezer. Use solder sucking wick to clean up the hole.





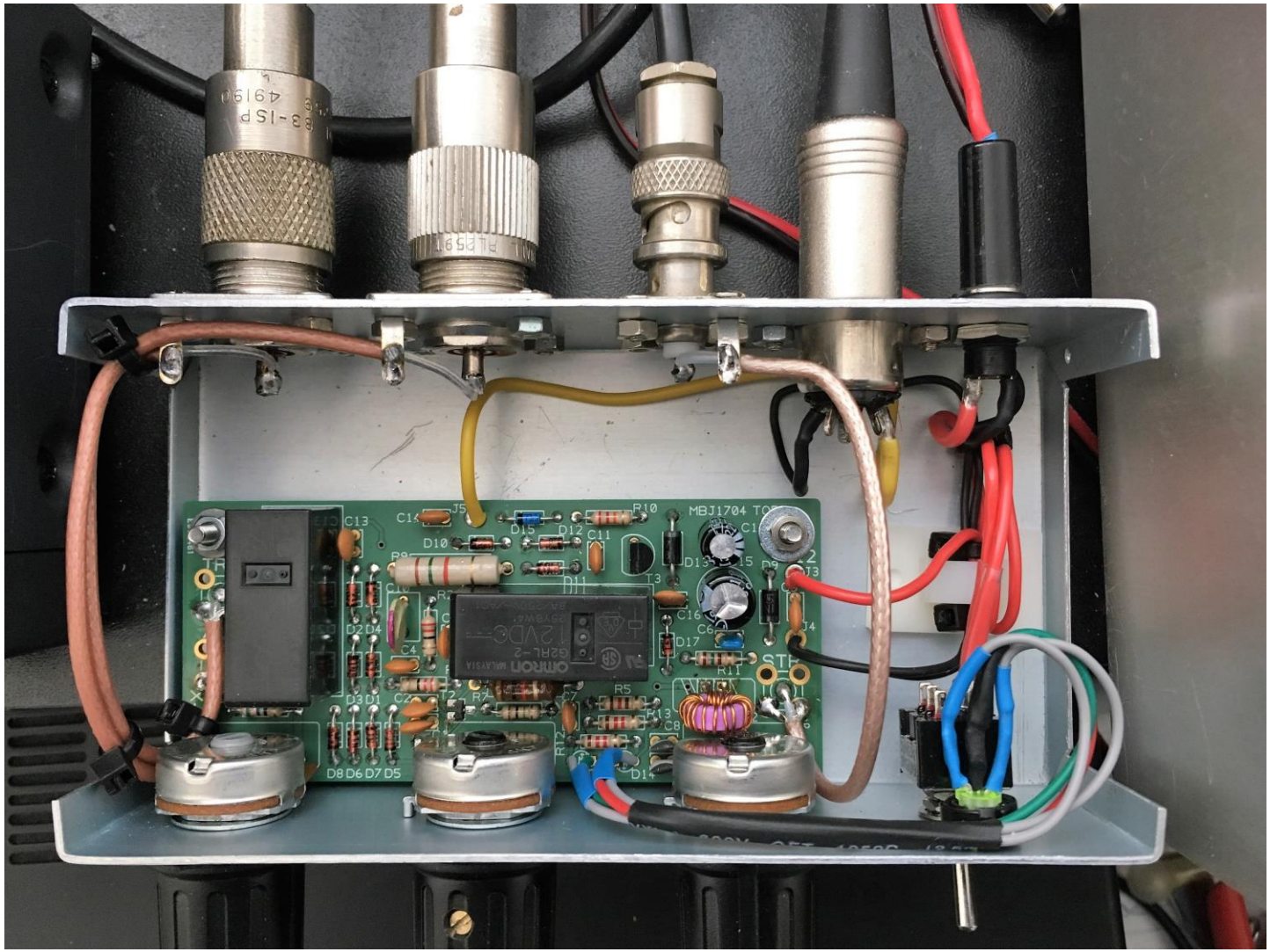
More tips:

Maximum allowable transmitter power: **the X-Phase can be used with output powers up to 200 W. But if you use a linear amplifier, connect the X-Phase between the transceiver and the INPUT of the linear.**

VOX circuit: **resistor R9 is chosen to let de VOX circuit work from 40 Watt transmitter power or more. If you want to let the VOX operate at lower power levels, just lower the value of R9. But ONLY if you don't use higher power levels**

Interchanging the + and - 12V connections **is not harmful. A series diode protects the circuit against reverse polarisation**

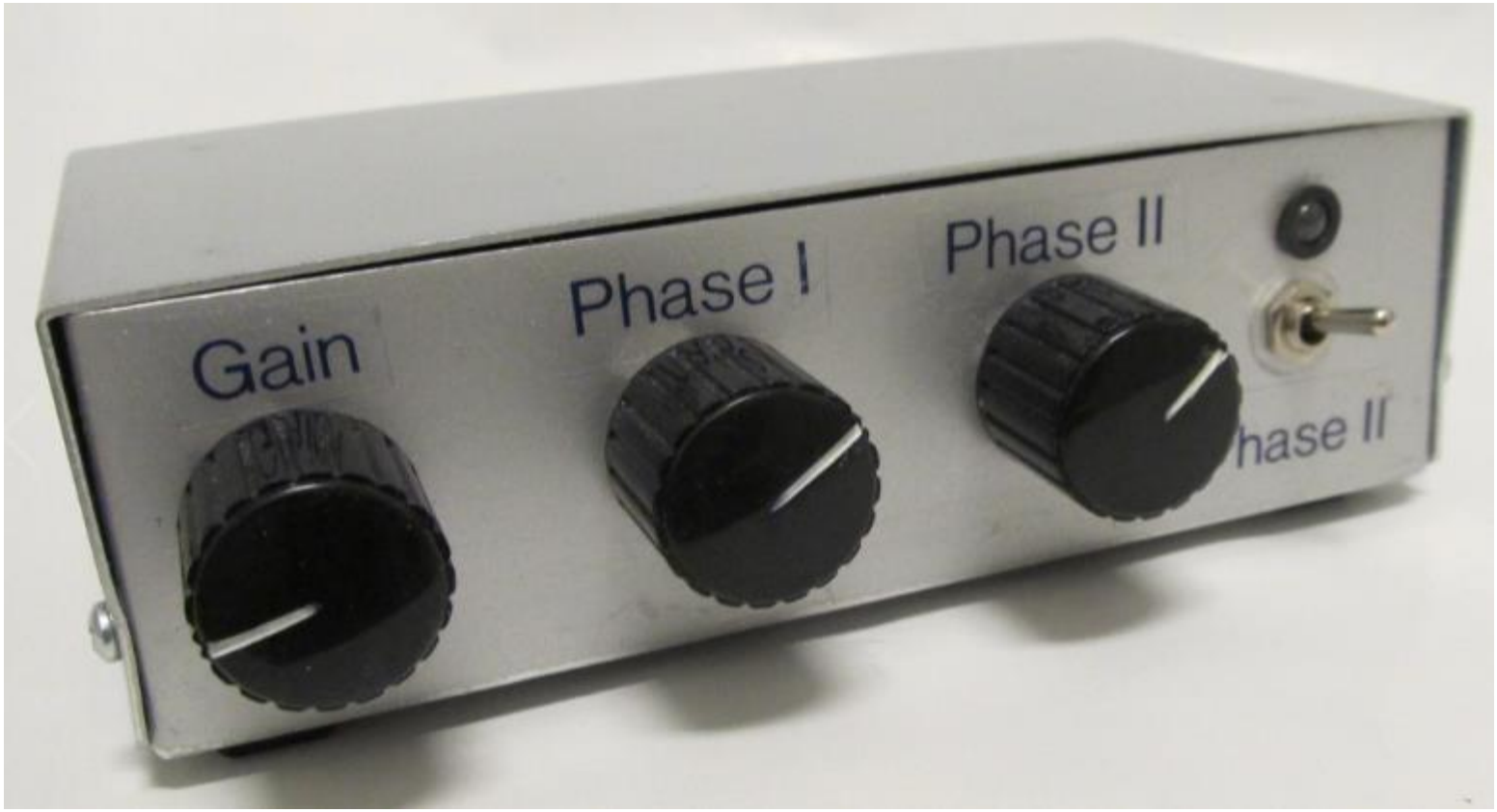
Boxing the PCB



picture:
Luit Popken
PA0LPN

Two bolts and spacers support the PCB at the back side

The finished X-Phase



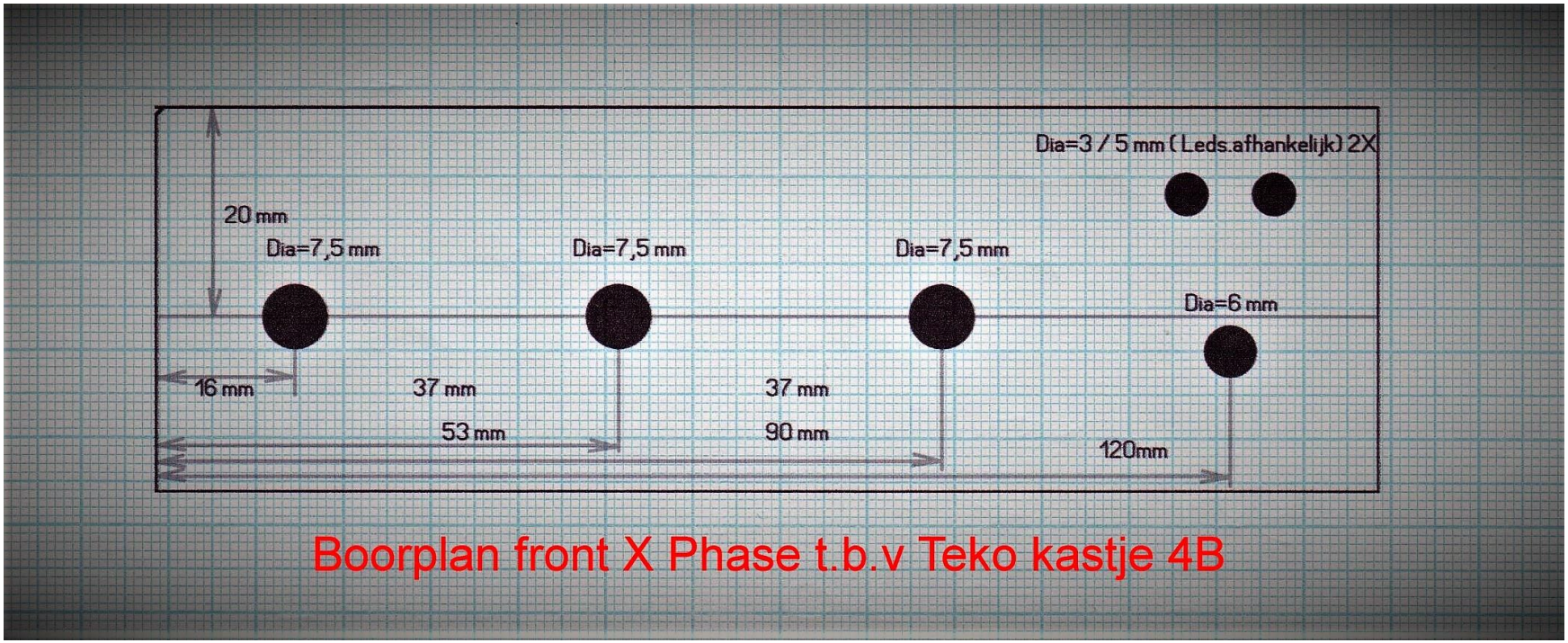
picture: Luit Popken PA0LPN

And the good looking backside

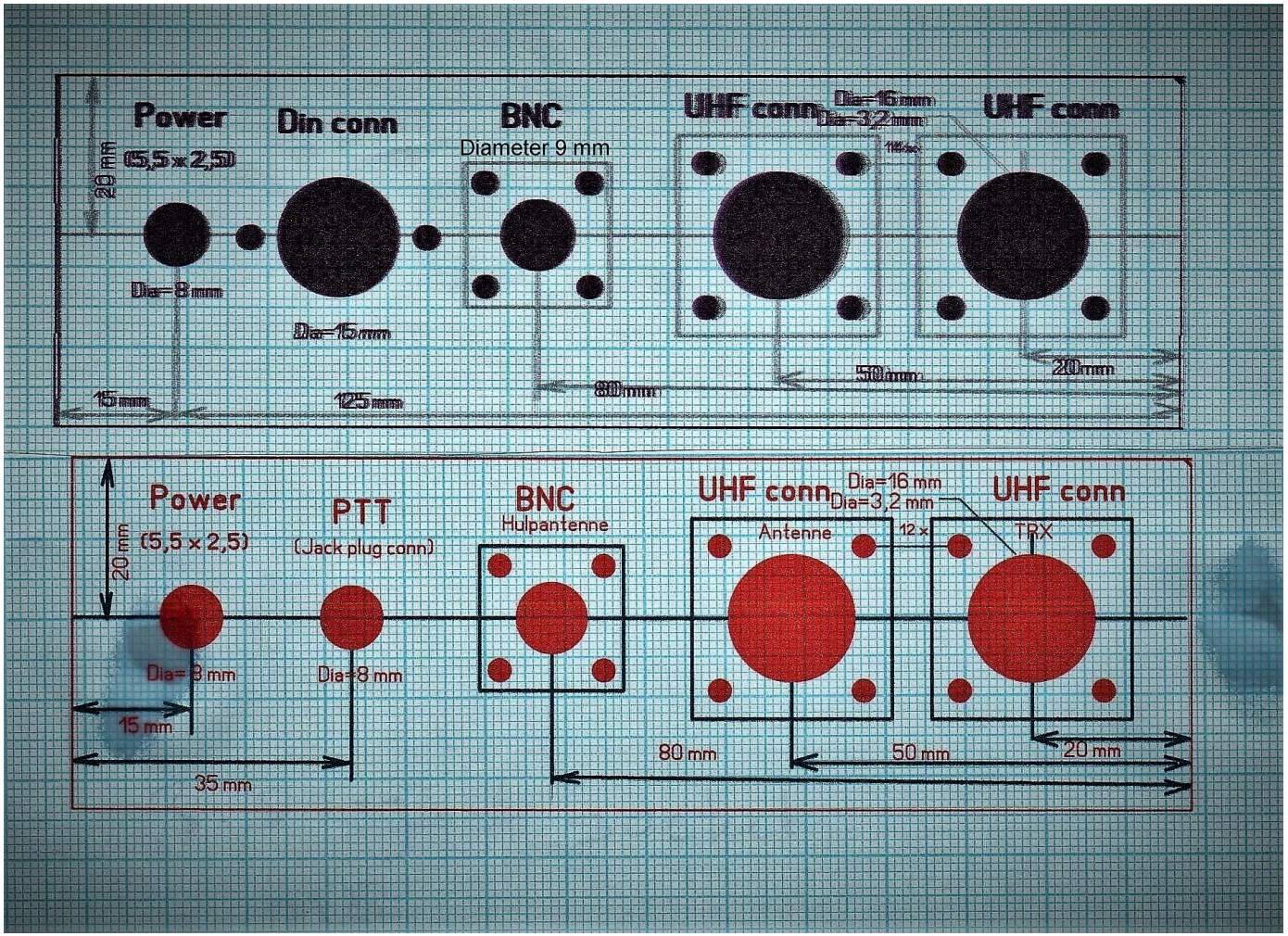
picture: Luit Popken PA0LPN

Drilling diagram of the front side

drilling plan: Luit Popken, PA0LPN

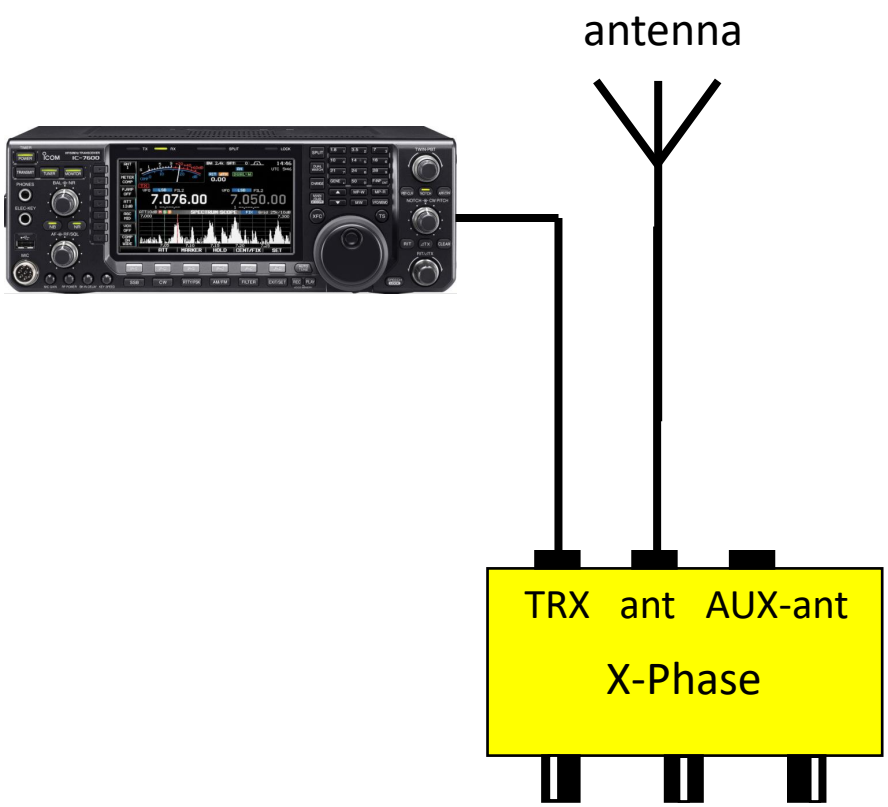


Backside drilling plan



Drilling plan: Luit Popken, PA0LPN

Test 1: (is there a connection between antenna and transceiver via the X-Phase?)



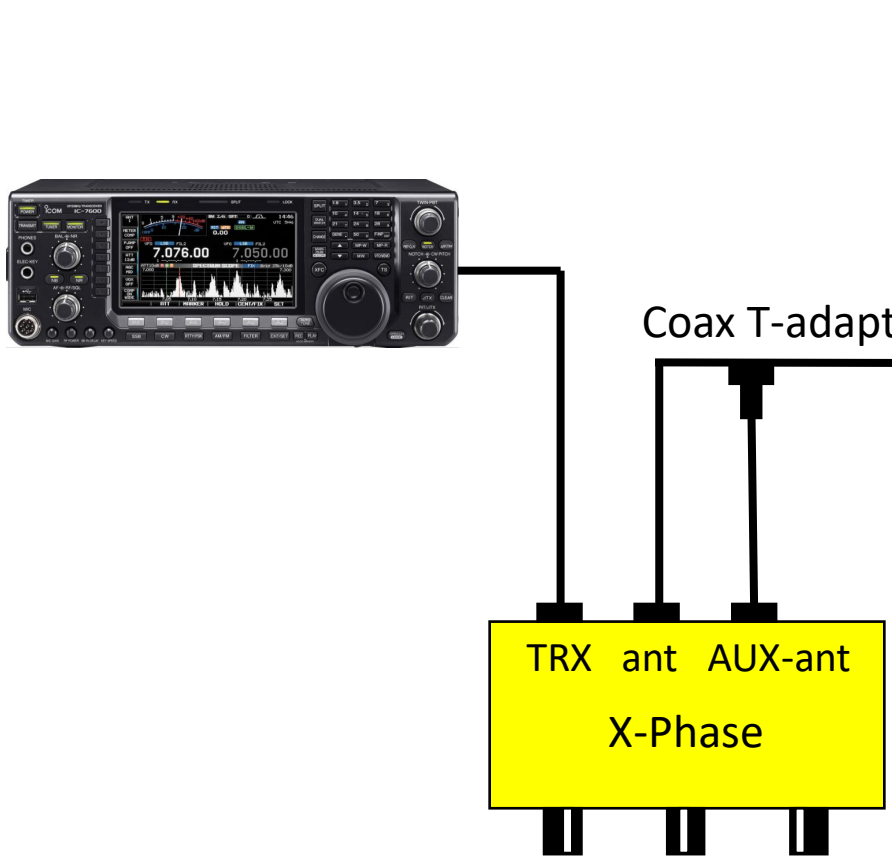
Connect the transceiver on the X-Phase
Adjust the transceiver output power to LOW (as a precaution)

Connect the antenna to the X-Phase
Connect a 12V power supply to the X-Phase

Turn the GAIN potmeter fully clockwise
Check if you hear the normal radio traffic. You can attenuate the reception by the left potmeter

If this all is OK, the summing amplifier is working correctly

Test 2: is the X-Phase working correctly?



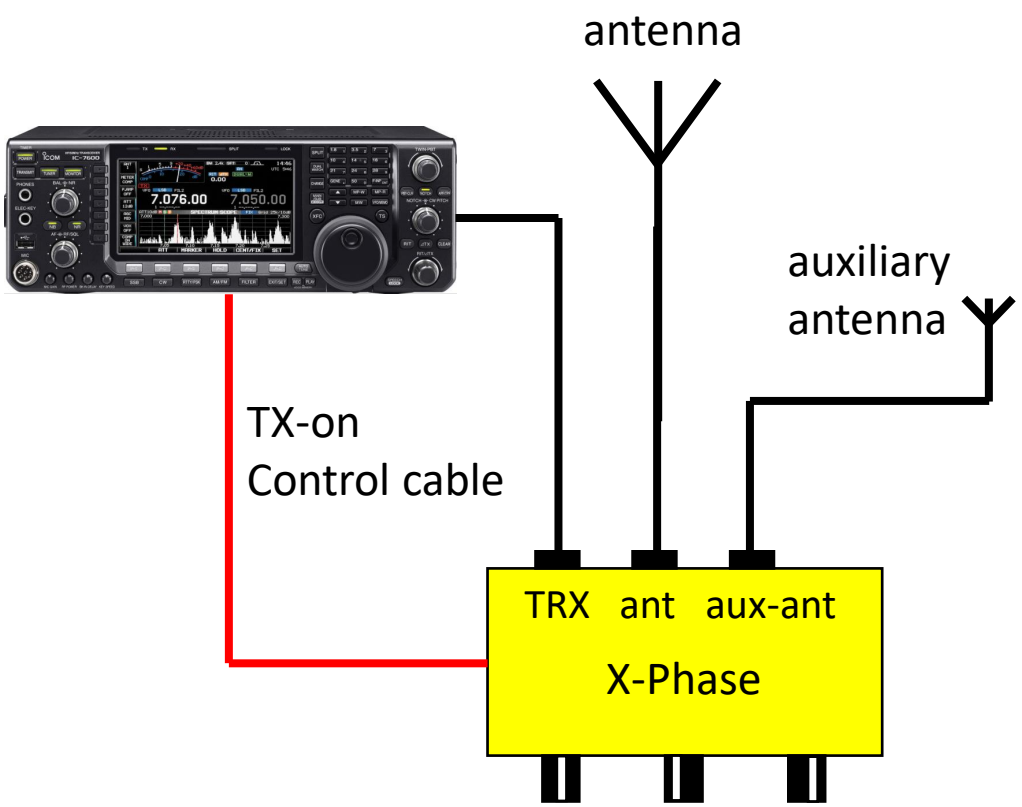
- **Connect the main antenna to BOTH the main antenna input and the Auxiliary antenna input via a coaxial T-adaptor.**
- **Switch on the power supply**
- **Try to minimize the incoming signals by adjusting the three potmeters**
- **If everything is OK, all signals will almost disappear**

Setting up a station with the X-Phase

Most transceivers have an accessory socket on the backside of the set. One of the pins carry the TX-on command signal. Mostly, this pin is connected to ground by the transceiver during transmission. Prepare a connection cable between transceiver and X-Phase to bring the TX-on command to the X-Phase (connect TRX-ground to X-Phase ground and the TX-on pin of the transceiver to J5 of the X-Phase)

TIP: when this cable is ready, connect the X-Phase to the transceiver but DO NOT connect the antenna to the transceiver via the X-Phase. Use a dummy load or connect the antenna directly to the transceiver. Press the transmit key and look if the red LED on the X-Phase illuminates. If this is OK, the moment has come to connect the X-phase between the antenna and the transceiver (see next slide) and start working with it.

Definitive connections



Complete hook-up of the X-Phase in the station

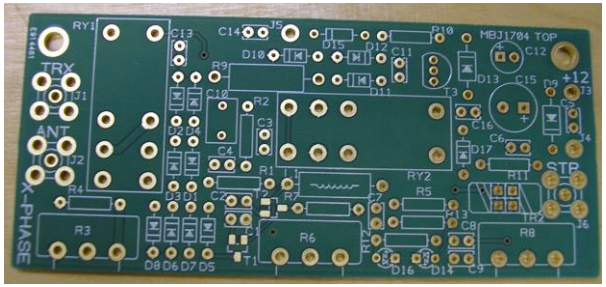
Minimize the QRM with the three potmeters. Try to keep the GAIN potmeter as much as clockwise (first minimize the QRM with the two PHASE potmeters).

How to connect the X-phase when using a linear amplifier

NEVER put the X-Phase between the Linear output and the antenna!!!

Kits can be made available

PCB only: 9 Euro



Complete kit with PCB and all components for assembling the PCB including the 3 potmeters: 30 Euro

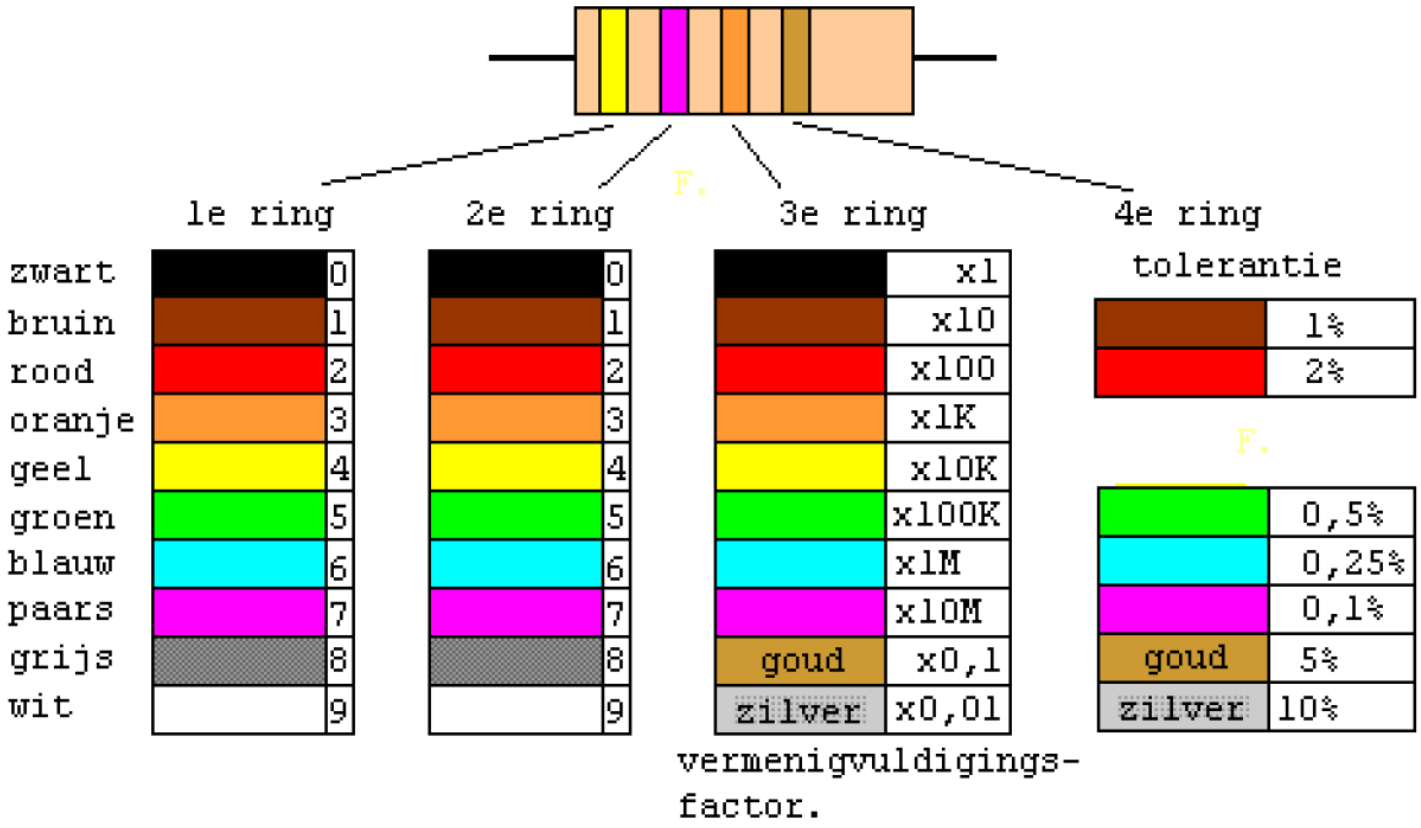
If SMD soldering of the two FET's is a problem: we can do this in advance for you without charge

Detailed assembly and test instructions are available on our website: A43.VERON.NL

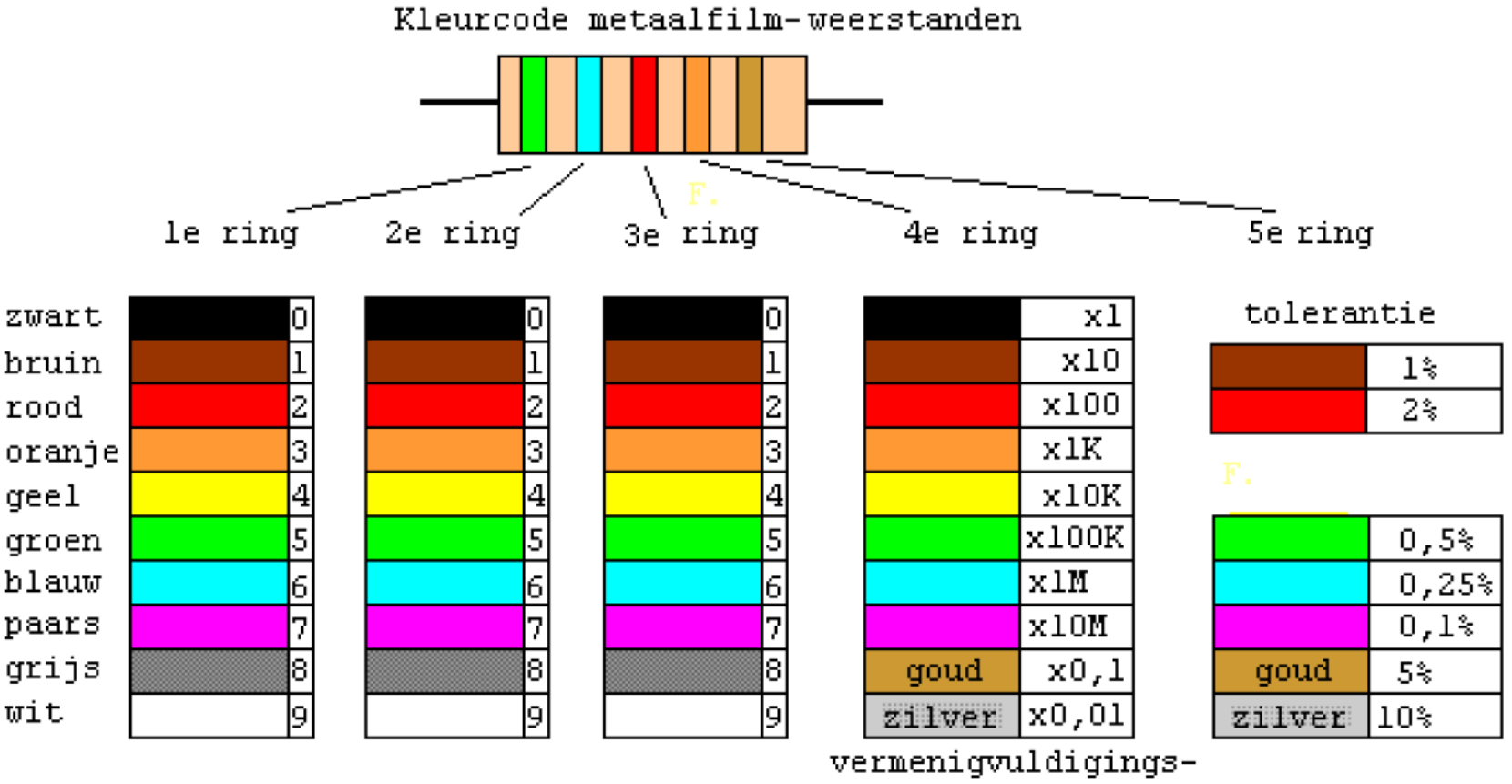
Bill of materials

aantal	waarde	benaming	steek		aantal	waarde	benaming	steek	
2	22E	WEERSTAND	10mm		1	1mH	RF SMOORSPOEL	16 mm	
1	56E	WEERSTAND	10mm		1	FT50-43	ringkerntrafo 2 wdg		
1	120E	WEERSTAND	10mm						
1	150E/0,5W	WEERSTAND	10mm		12	1N4148	diode	7,5 mm	
2	1k2	WEERSTAND	10mm		2	1N4001	power diode	10 mm	
1	2k2/2W	WEERSTAND	18 mm		1	BAT85	BAT85/Schottky	DO-35	
3	2k2	potmeter	2 x 5 mm		1	rood	LED 3mm	2,5 mm	
1	22k	WEERSTAND	10mm		1	groen	LED 3mm	2,5 mm	
1	1M	WEERSTAND	10mm		1	BC337	NPN transistor	TO92	
					2	MMBFJ310	J-FET	SOT23T	
1	47pF/1000V	CONDENSATOR	5 mm		2		DIP power relais 2 x om	Farnell	1629053
2	68pF	CONDENSATOR	2,5 mm						
3	1nF	CONDENSATOR	2,5 mm						
7	10nF	CONDENSATOR	2,5 mm						
1	100nF	CONDENSATOR	2,5 mm						
1	100uF/25V	ELCO-TM	2,5 mm						
1	470uF/25V	ELCO-TM	3,5 mm						

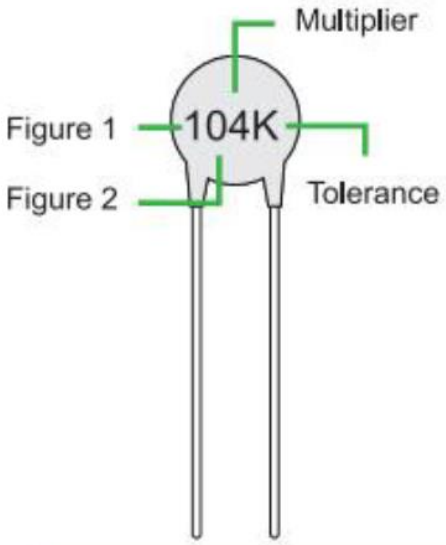
Resistor colour codes (4 rings)



Resistor colour codes (5 rings)



Capacitor value coding

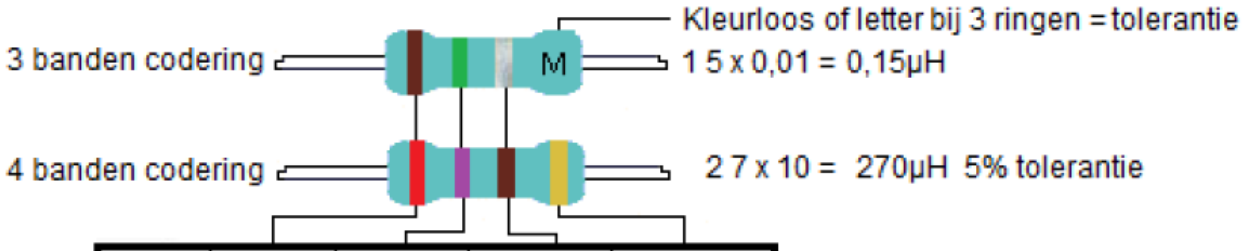


Ceramic Capacitor

VALUE (F1 & 2)	MULTIPLIER	LETTER	TOLERANCE
0	1	B	± 0.1pF
1	10	C	± 0.25pF
2	10^2	D	± 0.5pF
3	10^3	F	± 1%
4	10^4	G	± 2%
5	10^5	H	± 3%
6	N/A	J	± 5%
7	N/A	K	± 10%
8	0.01	M	± 20%
9	0.1	Z	± 80%/-20%

Inductance colour codes

Value in micro-Henry



kleur	1e cijfer	2e cijfer	x (µH)	tolerantie
zwart	0	0	1	
bruin	1	1	10	1% (F)
rood	2	2	100	2% (G)
oranje	3	3	1000	-
geel	4	4	10000	-
groen	5	5	-	0,5% (D)
blauw	6	6	-	-
violet	7	7	-	-
grijs	8	8	-	-
wit	9	9	-	-
GEEN	-	-	-	20% (M)
zilver	-	-	0.01	10% (K)
goud	-	-	0.1	5% (J)