FS-4 Wizard for Drake Synthesizer FS-4

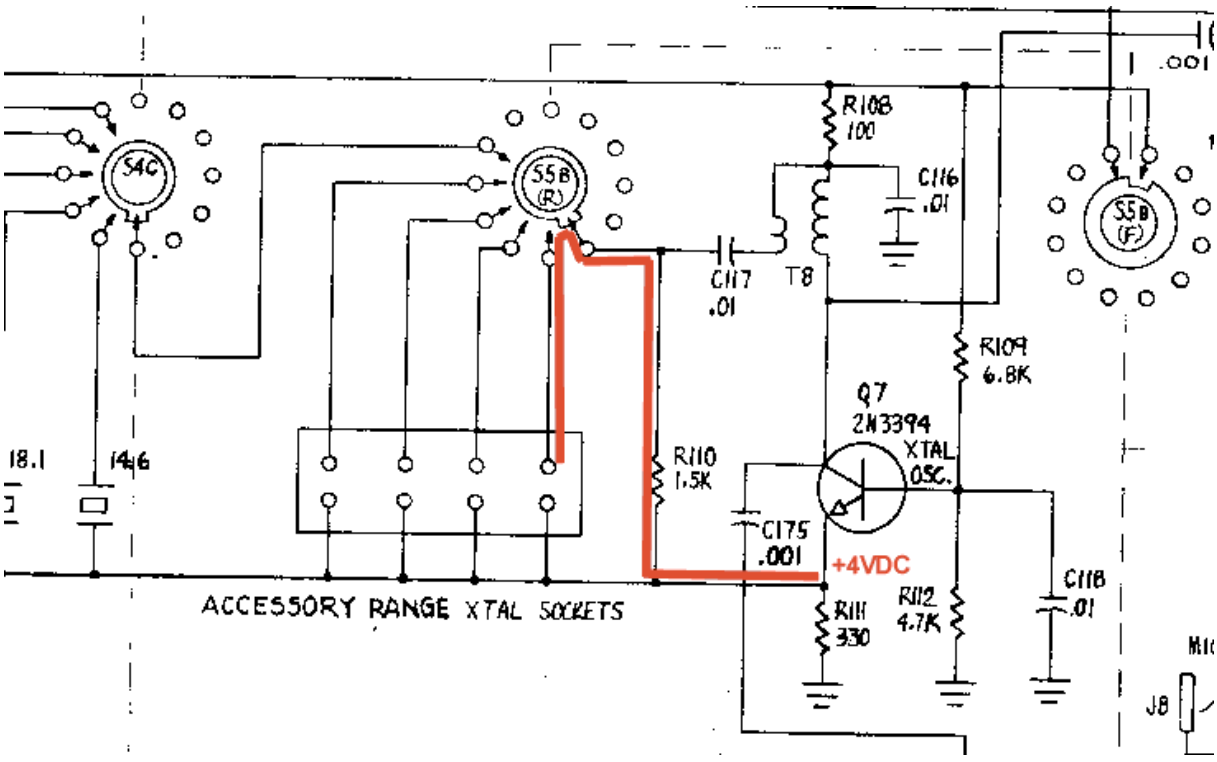
The FS-4 is nice, but has some small disadvantages when operated with a C-line:

1. The FS-4 can be connected only to the R-4 or T-4 but not simultaneously to both.
2. „The FS-4 should be unplugged ... if operation is desired from internal crystal control because the cable capacity can cause oscillations in the receiver or transmitter“ /1/.
3. Furthermore i observed that the level of the FS-4 at higher bands – e.g. beyond 21MHz – is lower than the internal crystal oscillator.

The **FS-4 Wizard**, consisting of
1. FS-4 Adapter
2. Buffer Amplifier
solves these three problems.

Note: *Some older versions of the R-4´s and maybe also of the T-4´s have a different wiring of the XTAL-oscillator. For more details see addendum.*

The Principle:



Picture 1: XTAL-oscillator in the T-4XC (applies also for R-4C)

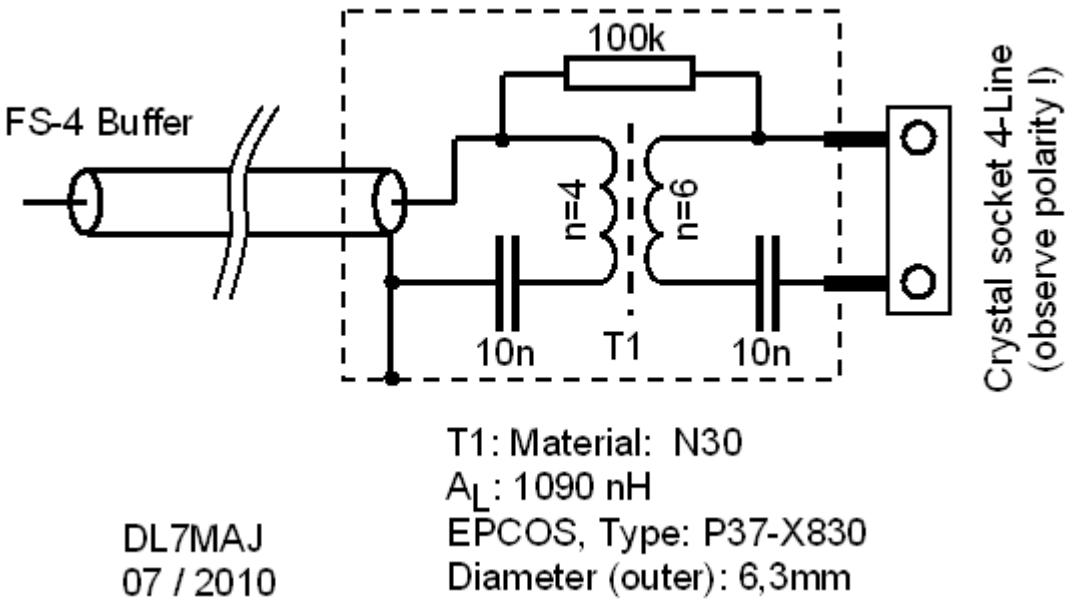
When an accessory crystal is selected, the positve voltage (+4VDC) from the emitter of Q7 is also switched via R110 to this socket (picture 1). This voltage can be used as an „indication“ for the new buffer in the FS-4 to operate when connected to this socket – see red line in pictures 1 and 4 . For the PNP-transistors Q3 and Q4 (emitter at +12VDC) in the new buffer amplifier these +4VDC are effectively a voltage of –8VDC.

Therefore the „polarity“ of the new adapter in the XTAL-socket has to be observed!

The Circuit:

1. The FS-4 Adapter

The FS-4-Adapter isolates the capacity of the coax cable from the crystal socket, so this adapter with the cable may be left plugged in even when the FS-4 is not used!
Additionally it transfers the DC-voltage via the 100kOhm resistor from the emitter of Q7 to the FS-4 Buffer (picture 2). **OBSERVE POLARITY IN THE XTAL-SOCKET!**

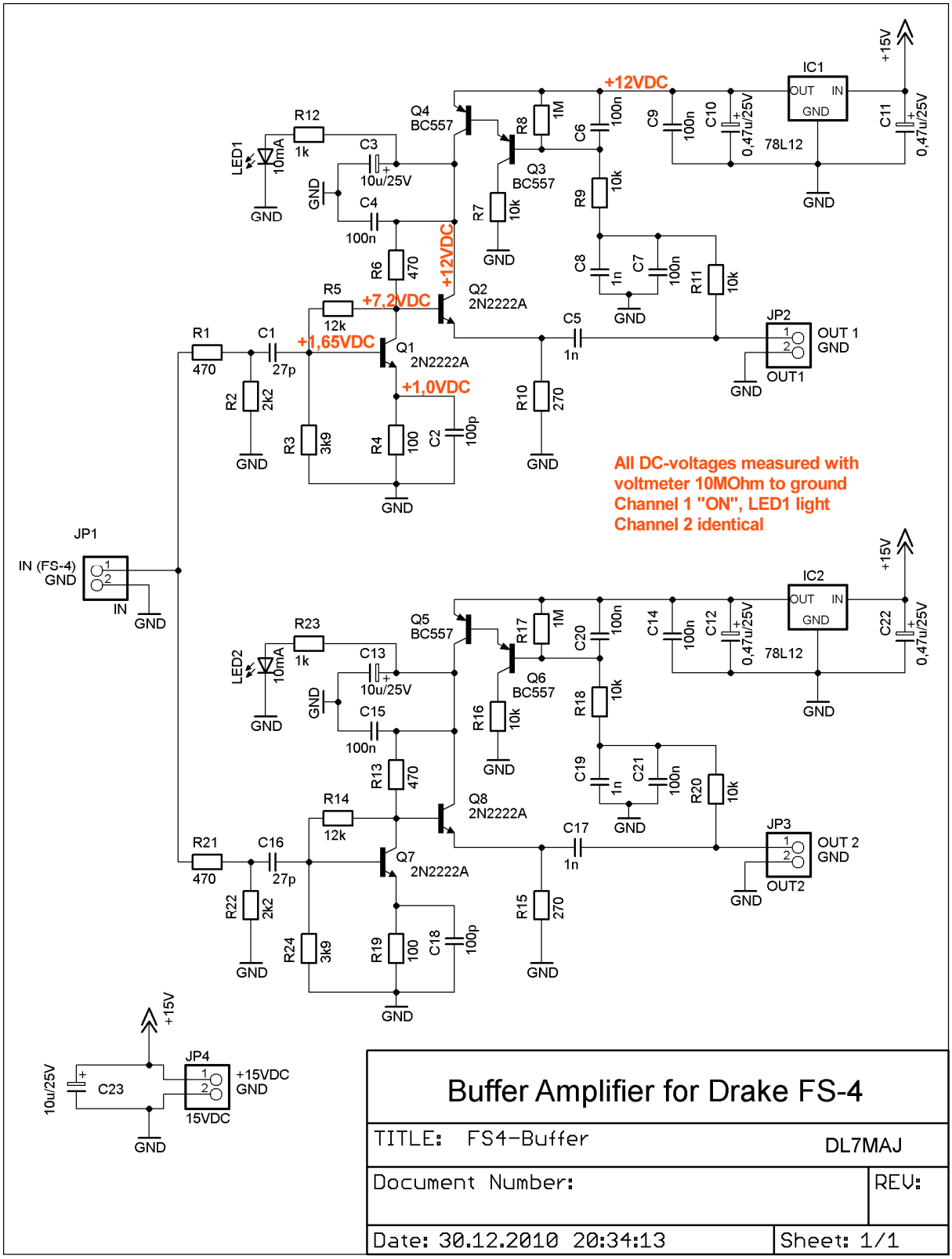


Picture 2: FS-4 Adapter

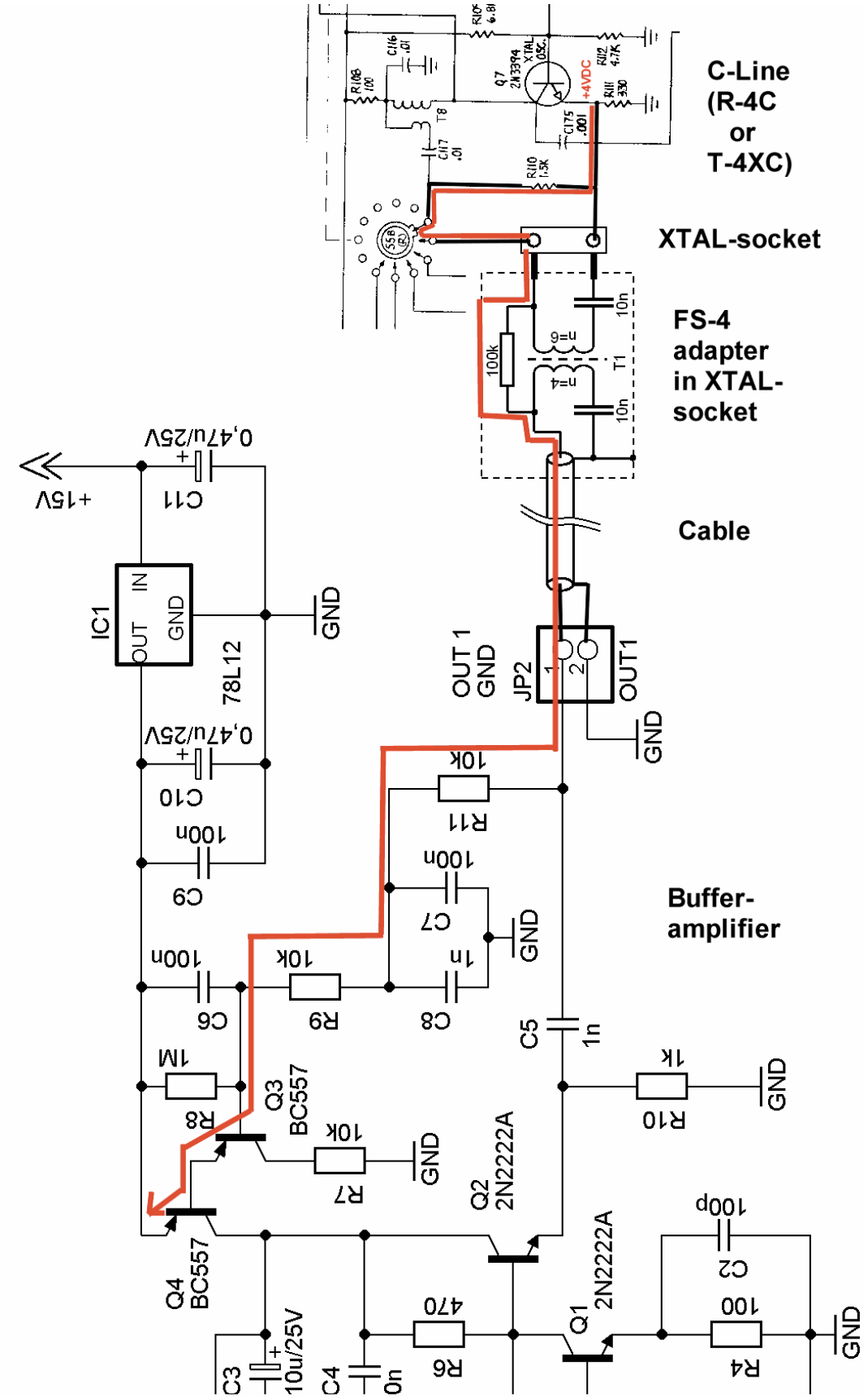
T1 is a step-up transformer to increase the voltage. Both windings are on the opposite side of the core to minimize the capacitive coupling between. Via the resistor (100kOhms) the DC-voltage is fed to the buffer; the two caps (one is SMD) isolate this DC against ground; see also picture 7. I used the case of an old crystal.

2. The Buffer Amplifier

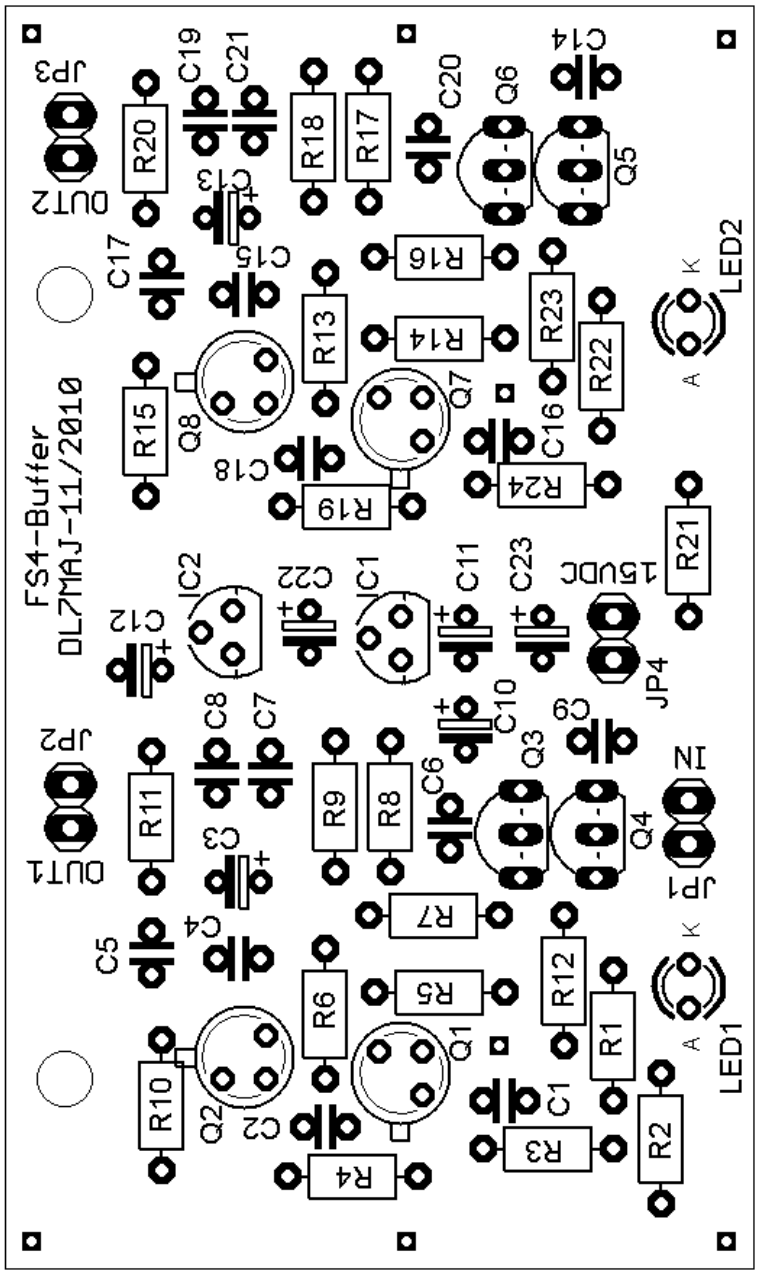
The buffer amplifier (picture 3) has two identical „channels“; the function is described for channel „1“: The signal from the FS-4 (JP1) is separated by R1/R2 and R21/R22 from channel 2 and fed to amplifier Q1. C1 and C2 are dimensioned for more amplification at higher frequencies (see topic 3 above). Q2 is an emitter follower to get an low impedance output at JP2. Q3 and Q4 get conductive when the above mentioned DC-level is fed to the circuit via the FS4-adapter and R9/R11. LED1 indicates the „ON“-status of this output ; the complete DC-path is shown in picture 4. The 15VDC are taken directly from the FS-4 (see pictures 8 and 14) and stabilised by IC1.
Channel 2 (Q5/6/7/8) operates in the same way (picture 3).



Picture 3: Schematic of the buffer amplifier



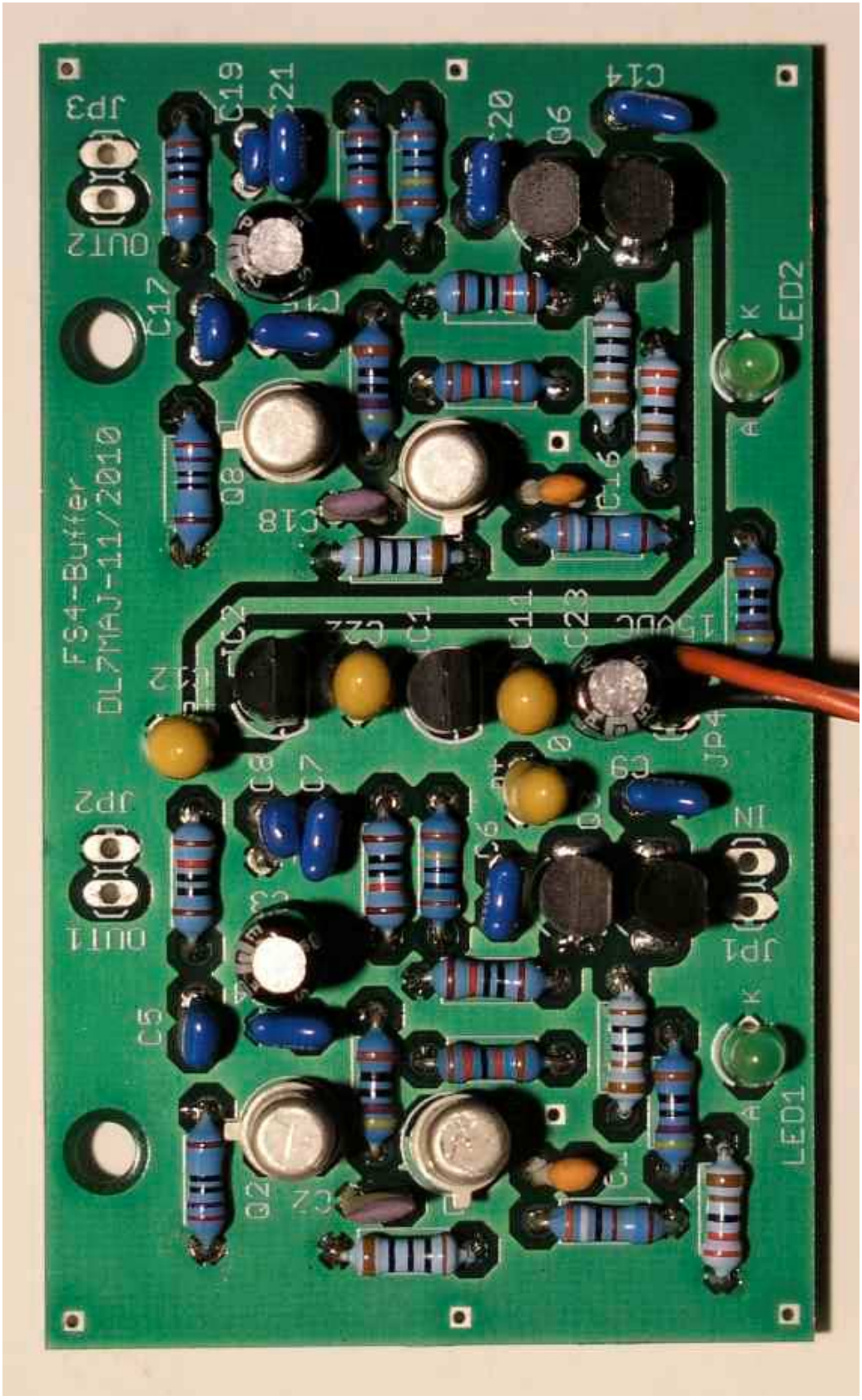
Picture 4: DC-path from the emitter of Q7 (T-4XC) to the buffer amplifier (Q3/Q4)



Picture 5: Layout of the buffer amplifier (74mm x 44mm)

3. Technical Data

Frequency:	11MHz to 41MHz
Gain:	between JP1 and JP2 or JP3 (FS4-adapter connected) At 11MHz: app. 1,0 / at 41MHz: app. 1,2
Supply Voltage	>14VDC
Current consumption:	Both channels „ON“ and both LEDs lighting: 95mA One channel „ON“ and one LED lighting: 50mA Both channels „OFF“ and no LEDs lighting: 5mA
Dimension:	74mm x 44mm



Picture 6: PCB

Part	Value	
C1	27p	
C2	100p	
C3	10u/25V	
C4	100n	
C5	1n	
C6	100n	
C7	100n	
C8	1n	
C9	100n	
C10	0,47u/25V	
C11	0,47u/25V	
C12	0,47u/25V	
C13	10u/25V	
C14	100n	
C15	100n	
C16	27p	
C17	1n	
C18	100p	
C19	1n	
C20	100n	
C21	100n	
C22	0,47u/25V	
C23	10u/25V	
IC1	78L12	
IC2	78L12	
LED1	10mA	
LED2	10mA	

LED1 and 2 are only for indication during tests
They can be removed – and also R12 and R23

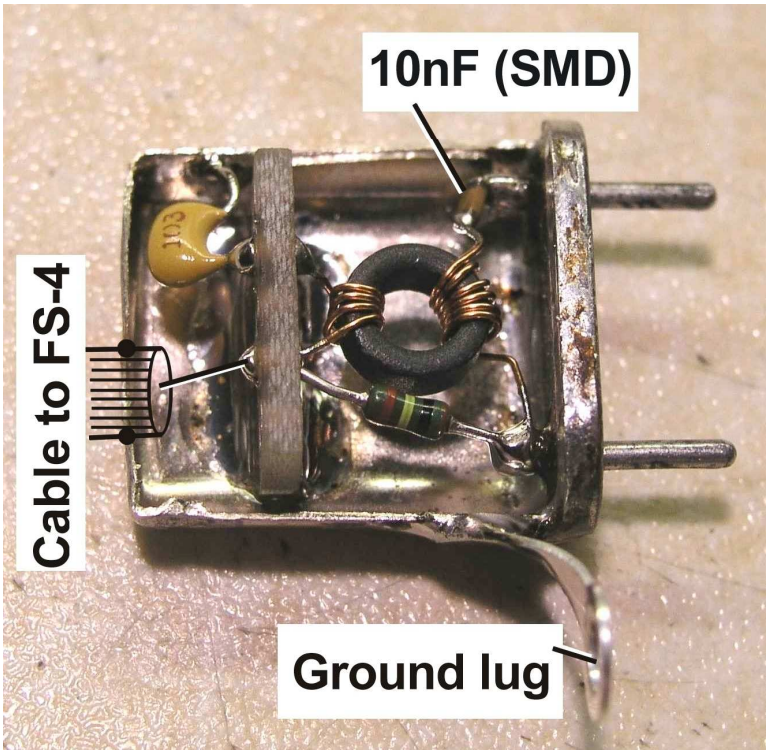
Part	Value	
Q1	2N2222A	
Q2	2N2222A	
Q3	BC557	
Q4	BC557	
Q5	BC557	
Q6	BC557	
Q7	2N2222A	
Q8	2N2222A	
R1	470R	
R2	2k2	
R3	3k9	
R4	100R	
R5	12k	
R6	470R	
R7	10k	
R8	1M	
R9	10k	
R10	270R	
R11	10k	
R12	1k	
R13	470R	
R14	12k	
R15	270R	
R16	10k	
R17	1M	
R18	10k	
R19	100R	
R20	10k	
R21	470R	
R22	2k2	
R23	1k	
R24	3k9	

List 1: Partslist

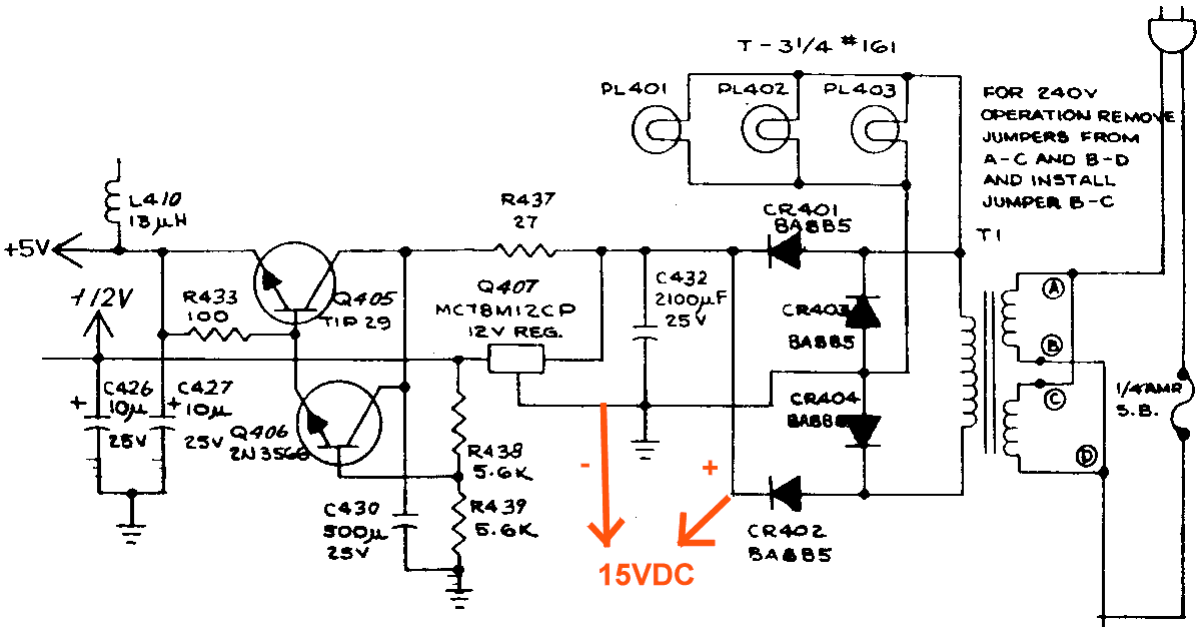
Picture 5,6 and list 1 show the layout and partslist.

Installation and no alignment

The buffer may be installed inside the FS-4 (pictures 14 and 15). Input, output and DC-supply are wired on shortest ways. Only one additional hole has to be drilled on the rear side of the FS-4 (picture 16). No alignment is necessary; also the FS-4 requires no realignment.

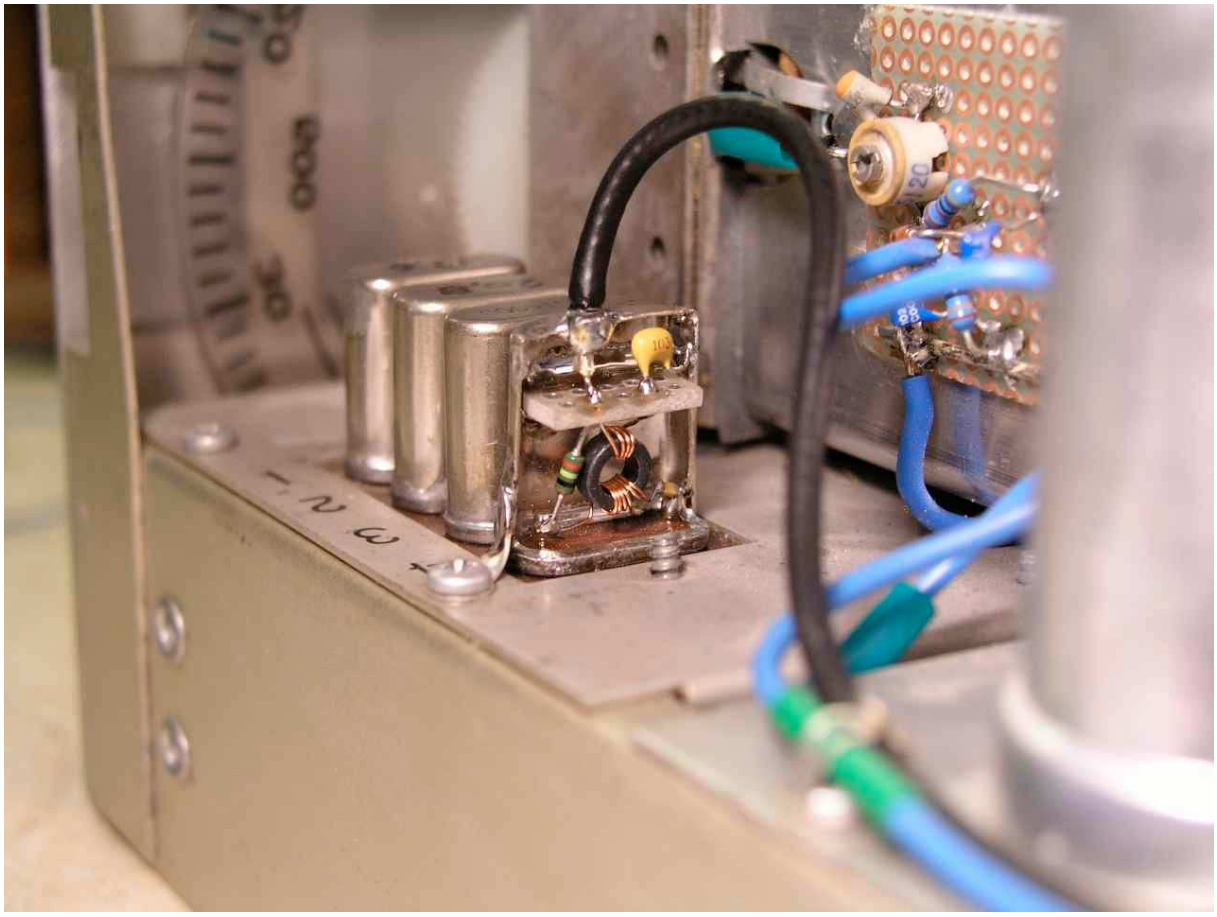


Picture 7: FS-4 Adapter

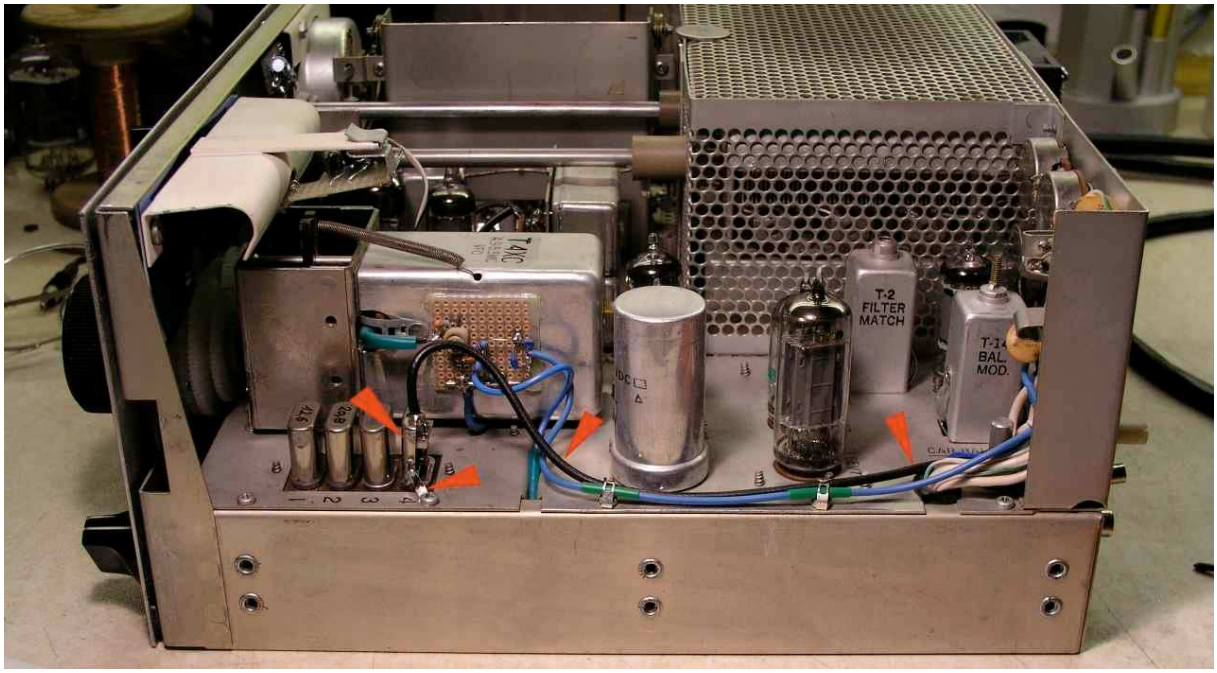


Picture 8: Supply for the buffer

The buffer´s supply is connected to the unstabilised 15VDC in the FS-4 (pictures 8 and 14). Two small holes are drilled into the FS-4´s pcb to connect the supply (picture 14, red and black wire).

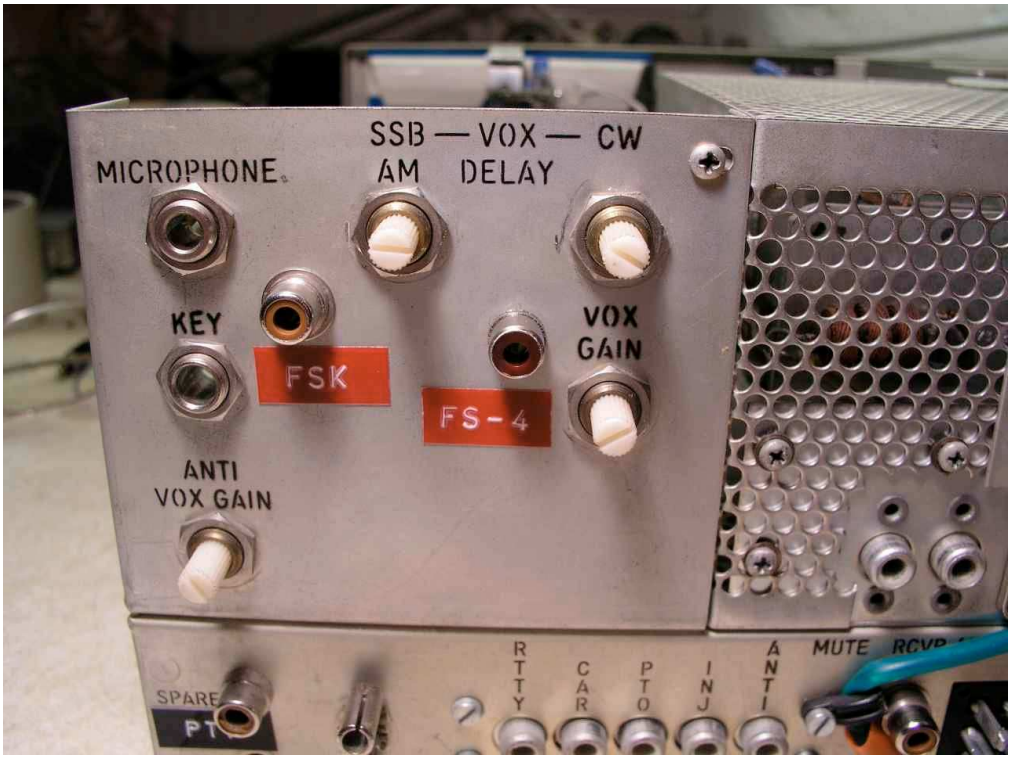


Picture 9: FS-4 Adapter in the T-4XC



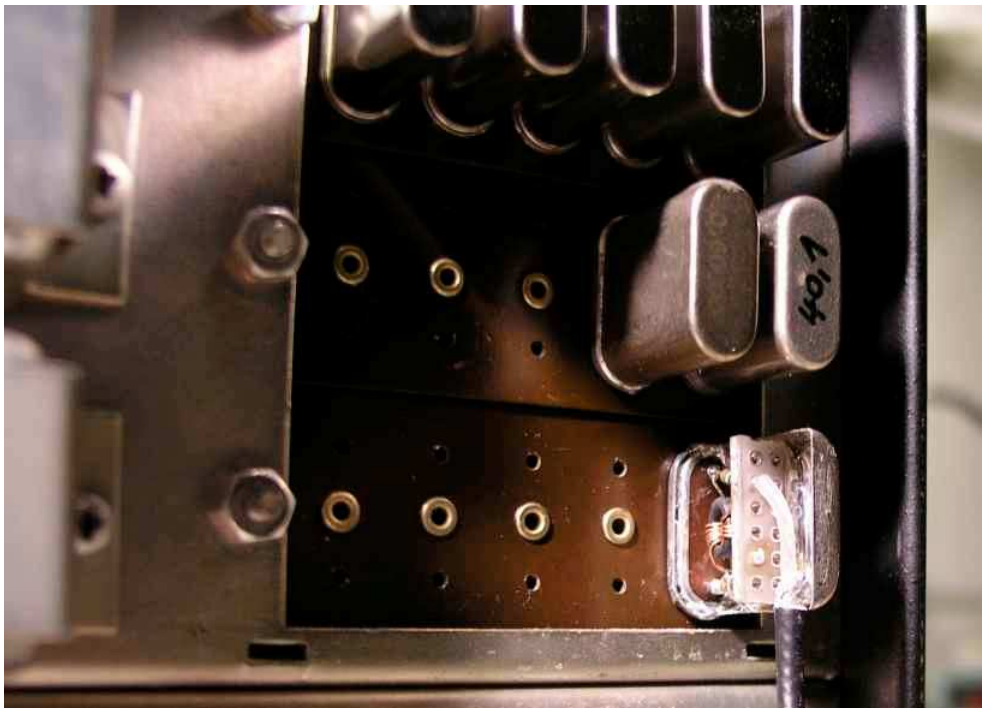
Picture 10: FS-4 Adapter and cabling in the T-4XC

Pictures 9 and 10 show the adapter in the T-4XC at XTAL-position 4 and the cabling.
Picture 11 shows the connection at the rear side of the T-4XC.

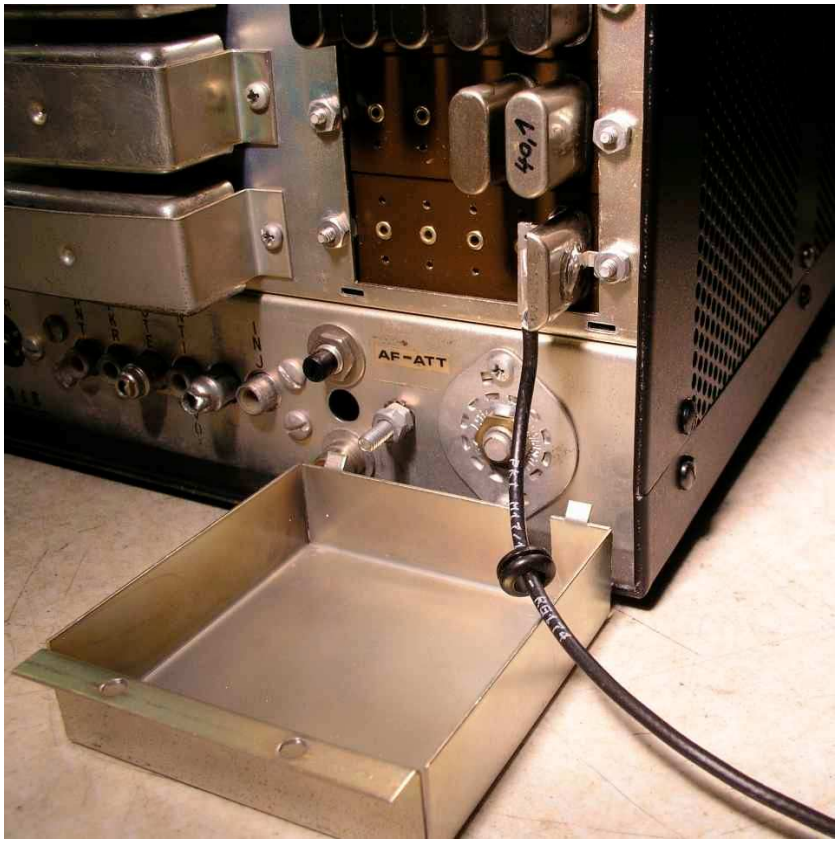


Picture 11: FS-4 connection at the rear side of T-4XC

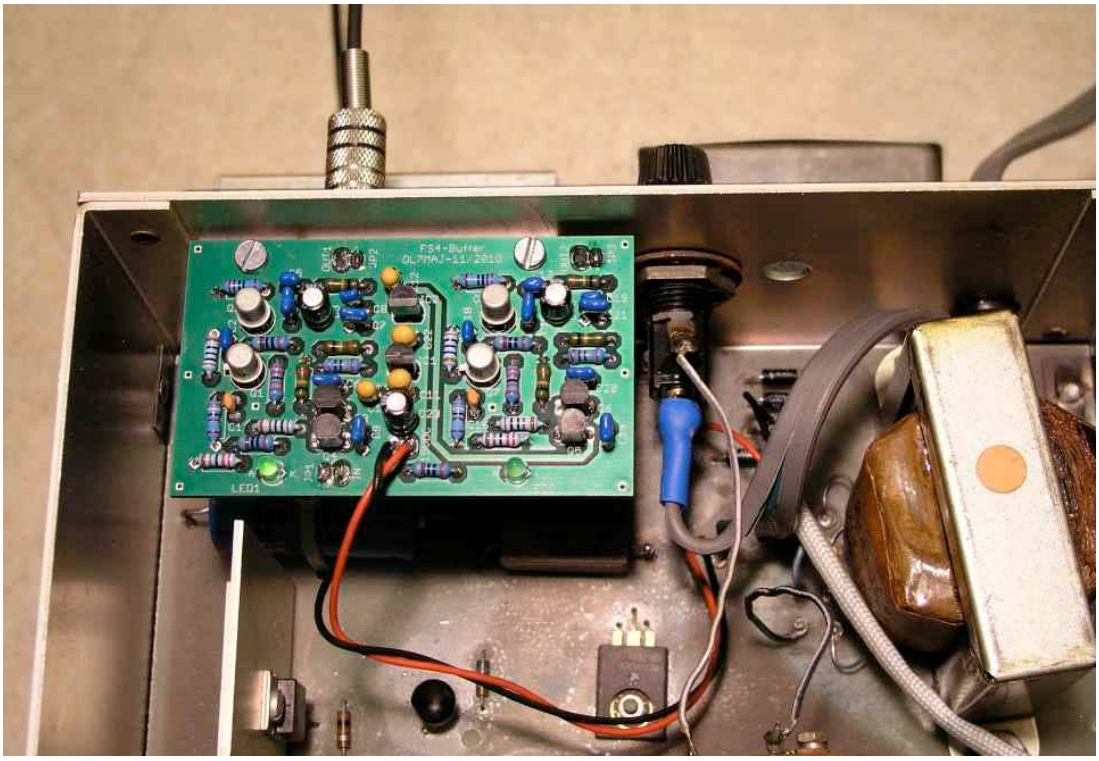
Picture 12 and 13 show the other adapter at the R-4C in XTAL-position 15.



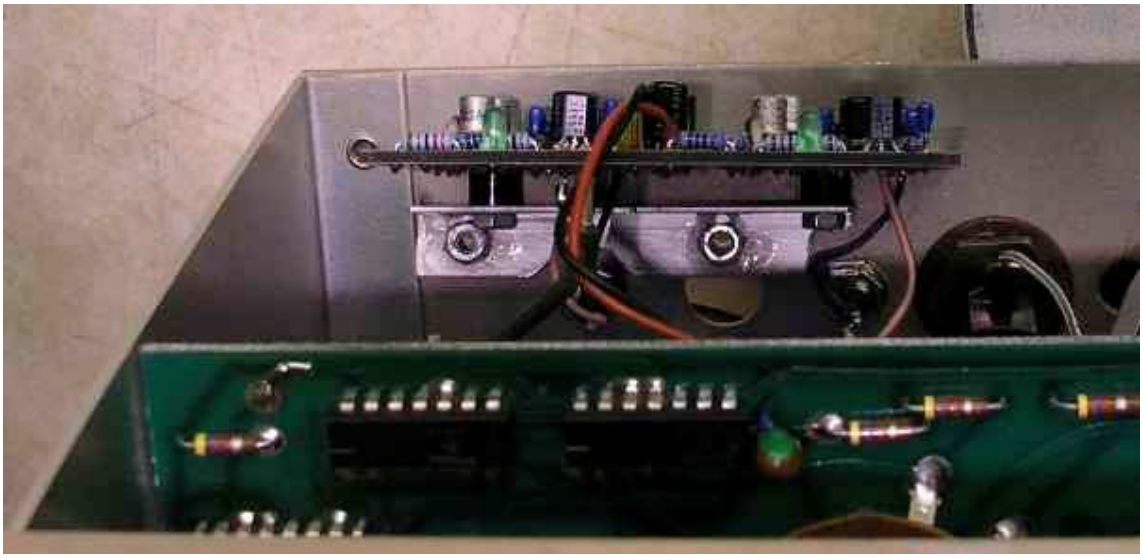
Picture 12: FS-4 Adapter at the R-4C



Picture 13: Rubber-feedthrough and cutout at the XTAL-cover



Picture 14: The buffer in the FS-4; output 1 is active – see LED1



Picture 15: Installation of the buffer in the FS-4

The buffer is installed with a small aluminum-profile, the two nuts are fixed with glue - see picture 15.

Picture 16: Rear side of the FS-4, R-4C and T-4XC with cabling

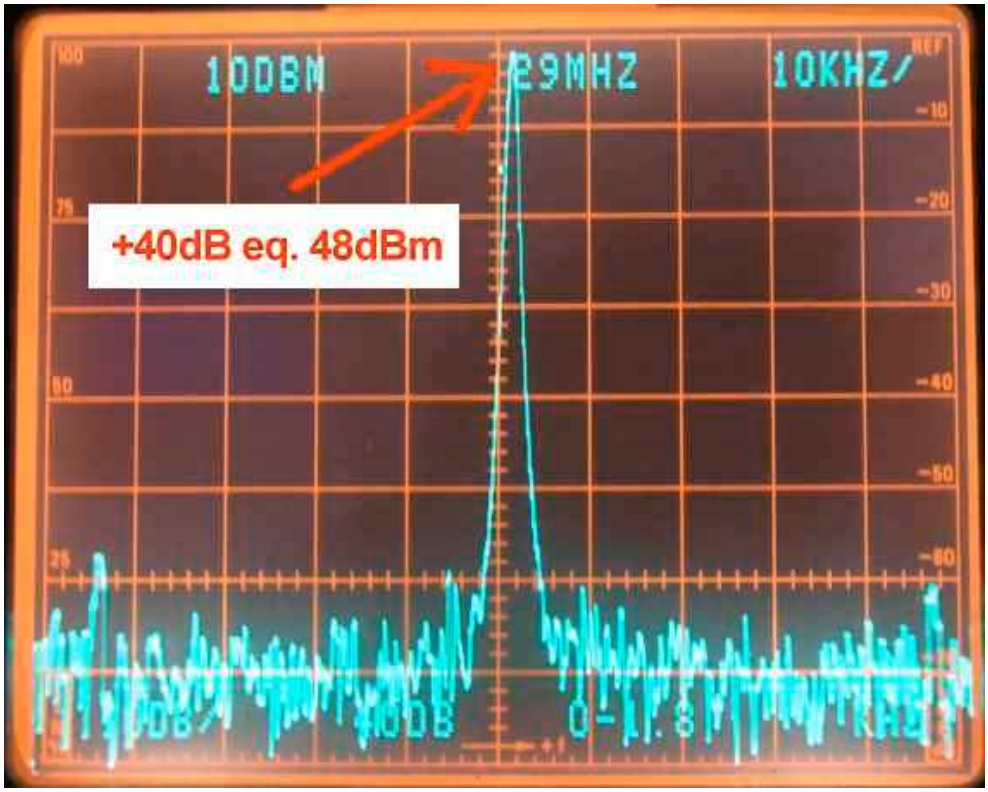
HF-Isolation

When the buffer is automatically switched off, it´s output should be „zero“.
In reality there is a small capacitive coupling through the buffer and the adapter, so the output is not absolutely zero. I measured a damping of >55 dB with my T-4XC at 10m (29,000MHz).
Method:

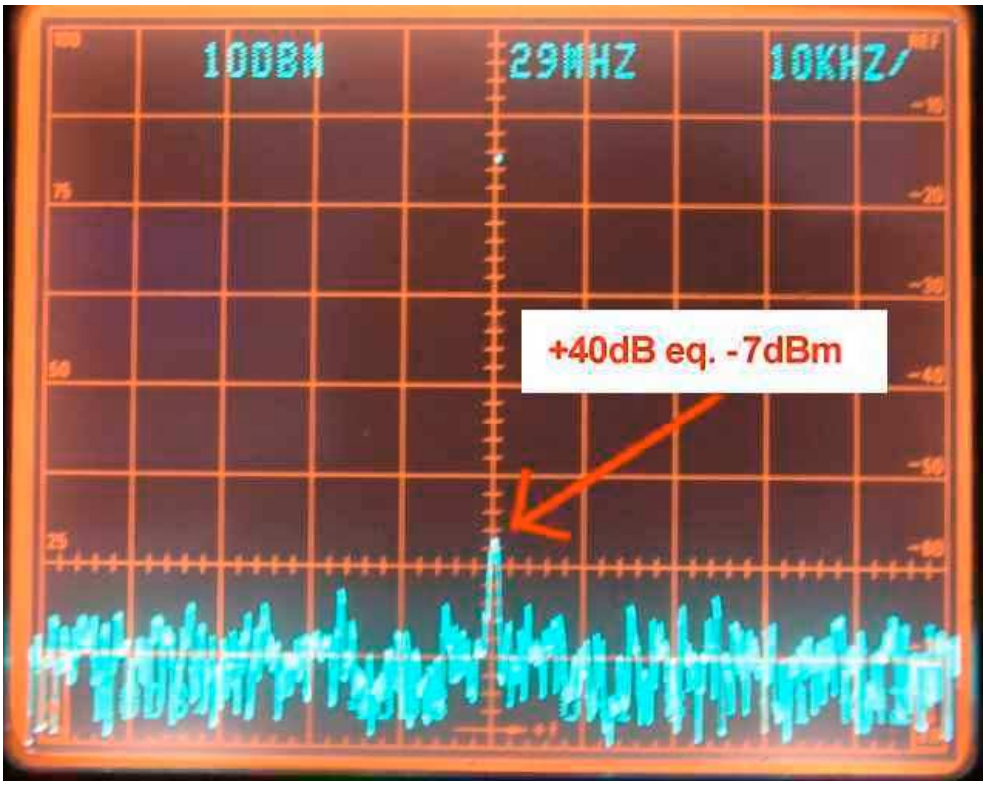
1. 100% output with FS-4 operative, i.e. 48dBm (picture 17).
2. Then selecting an empty XTAL-socket in the T-4XC, so that the output should be „zero“. No change in the T-4XC-settings! The capacitive coupling caused –7dBm output.

Note: In both pictures, the reference line (top) has +10dBm; the power attenuator had 40dB.

In practice, this would only be a problem when operating with XTAL-control in the same band as the FS-4 operates – but this operation makes no sense.
In split operation, all selective circuits within the C-Line prevent any unwanted output or spurii.
The only exception may be split operation within the 10m-Band. In this case, the FS-4 should control the TX.



Picture 17: T-4XC output with FS-4 ON, tuned at 29,000MHz



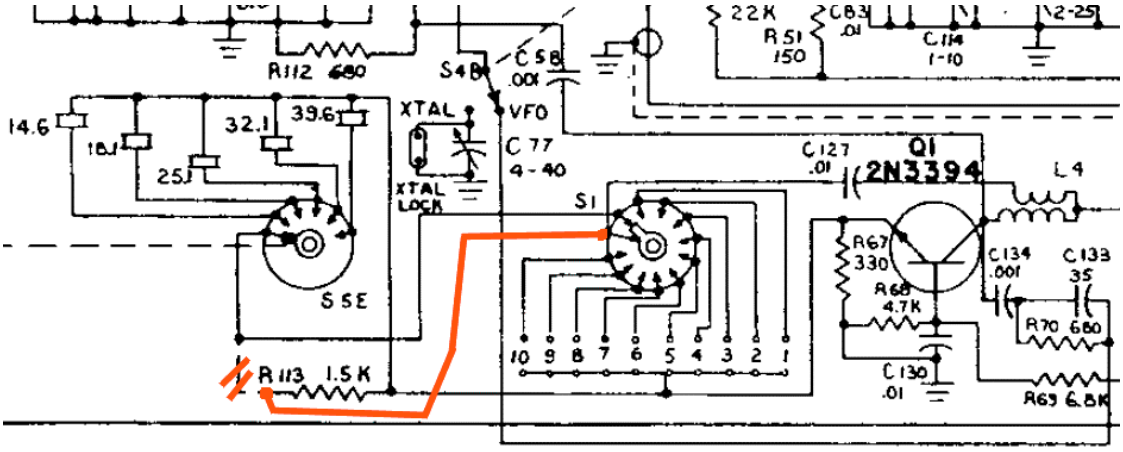
Picture 18: T-4XC output with FS-4 ON, but other XTAL selected

Use of two buffers

If you have more than two 4-Line rigs (congrats!!), you can use a second buffer connected in parallel to the first buffer; so you have totally four outputs. The input impedance of the buffer amplifier is high enough not to overload the output of the FS-4.
This configuration should be made outside the FS-4 due to the small space inside the FS-4.

Addendum

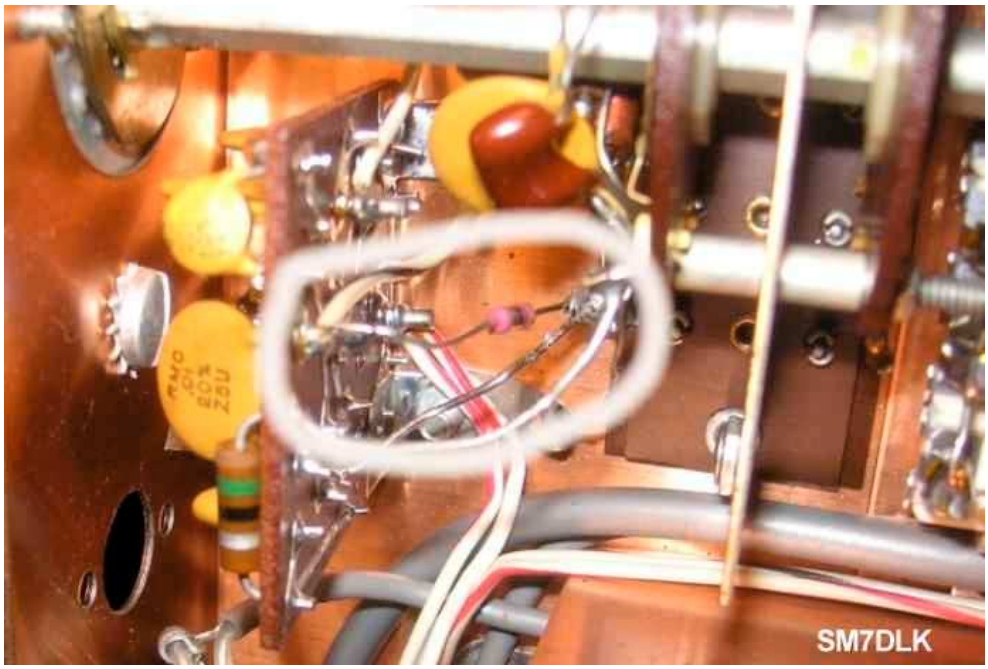
Göran, SM7DLK reported a problem with his R-4B and his solution (picture 18).



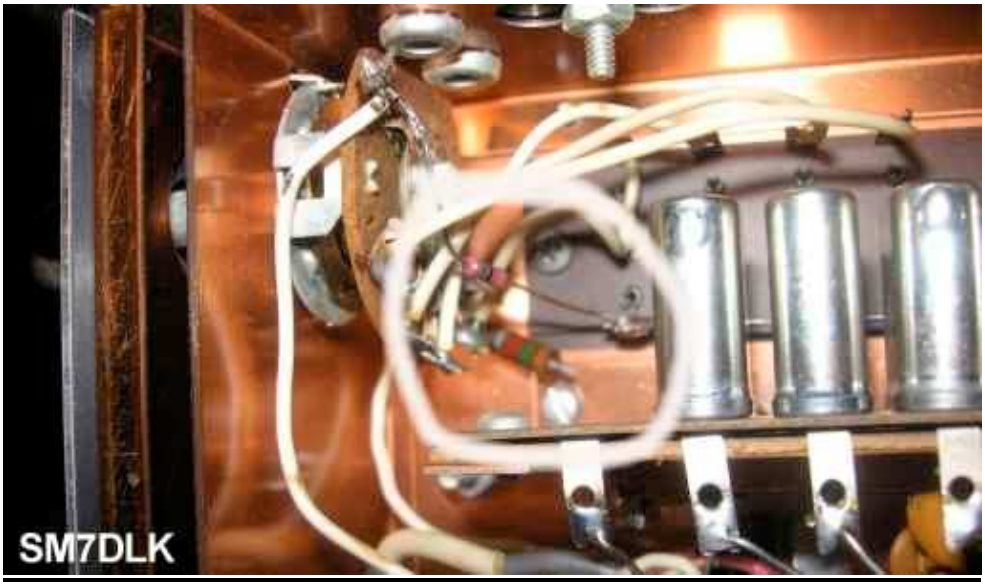
Picture 18: XTAL-Oscillator in the R-4B

The resistor R113 (1k5) is not wired to S1 but to S5E. Therefore this resistor is active only in the NORM-operation of the crystals. When operating the accessory crystals – or the FS-4- this resistor is not active and therefore it can´t activate the buffer amplifier in the FS-4 wizard as described in picture 4 (R110). Göran proposes to cut one side of R113 from S5E and add a new resistor to S1 (wiper) as shown in picture 18 to 21 – mni tnx!

Picture 19: R-4B, cut resistor



Picture 20: R-4B, new resistor



Picture 21: T-4XB, cut resistor

Note:
I don´t know, which rigs from the 4-Line have a need for this modification. When the buffer amplifier is not switched on/off as expected, a check of the wiring is proposed.

/1/ Instruction Manual Drake Model FS-4

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