External digital VFO for the Drake receiver R7

Introduction

The Drake receiver R7 is not completely prepared for operation with an external VFO, even the adapter Type 1544 requires some modifications in the R7. Connection of an external VFO is provided via the ACC-jack, but the internal PTO in the R7 cannot be switched off - which is necessary for operation with the external VFO - without these modifications.

Modifications inside the R7

The installation of a new jack for the external VFO is a practicable solution, because the 1544 and it´s associated mods isn´t easier at all. Following steps are necessary (picture 1):

1. Installation of a jack, e.g. DIN-jack 5-pole or more (5 pins are needed – see picture 2)
2. Connection of the Ext.-VFO-Input from the ACC-plug to pin 5
3. Connection of +10T from the ACC-plug to pin 3
4. Cut wire at VFO/Fixed switch and delete wire +13,8VDC
5. Connect wire +13,8VDC to pin 1
6. Connect wire from VFO/Fixed-switch to pin 4

<u>Note</u>

If no external VFO is used, a short-circuit plug is needed to connect pins 1 and 4 in the new jack to feed the VFO/Fixed-switch with +13,8VDC for proper operation of the internal PTO and AUX-7 (picture 3).

After above mods the R7 should operate as before when using a short-circuit-plug in the jack.

Check it before proceeding!
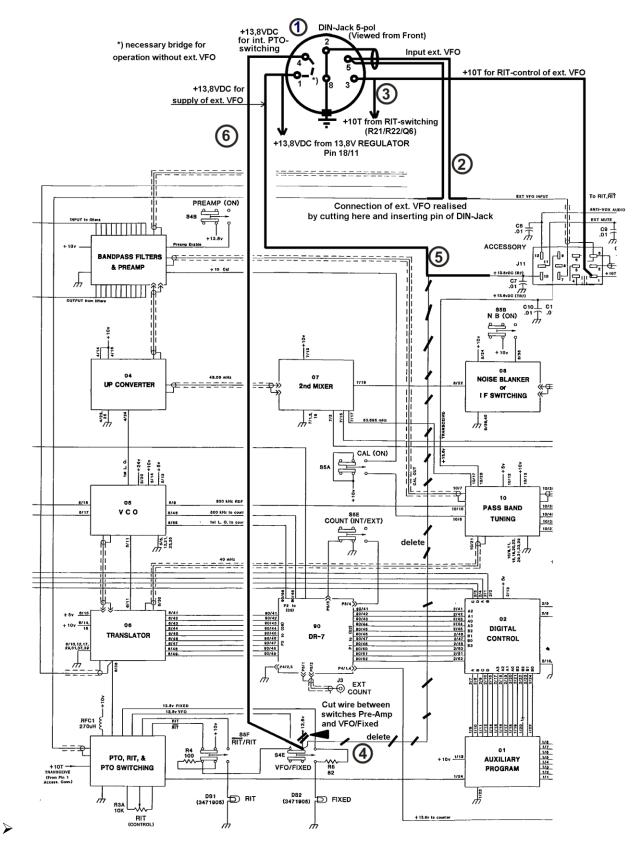
Design of the external digital VFO

My choice was/is the "PA0KLT Low Noise VFO Synthesized Kit", based on the SI570CAC (Kit "A" with CMOS), which is available at SDR-Kits /1/. This kit can be parameterized with:

- Offset (needed for replacing PTO/VFO)
- RIT and Clear
- VFO A/B and memory A/B
- Selectable tuning speed
- Others…

Be sure to get the <u>Firmware Version 4.21</u> for proper operation of RIT:
➢ <u>Version 4.21</u> disables ONLY the RIT but not the offset in TX-mode (we need the offset here also in TX-Mode)
➢ Version 4.20 disables RIT and offset in TX-mode, which is not applicable for here.
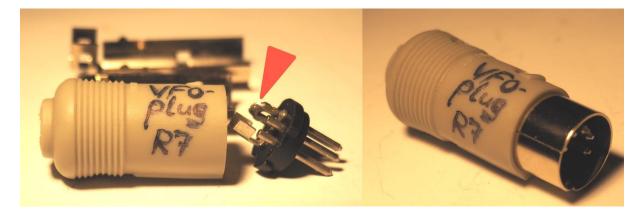
<u>So ask for Firmware-Version 4.21 or equivalent !</u>

Picture 1: Mods inside the R7
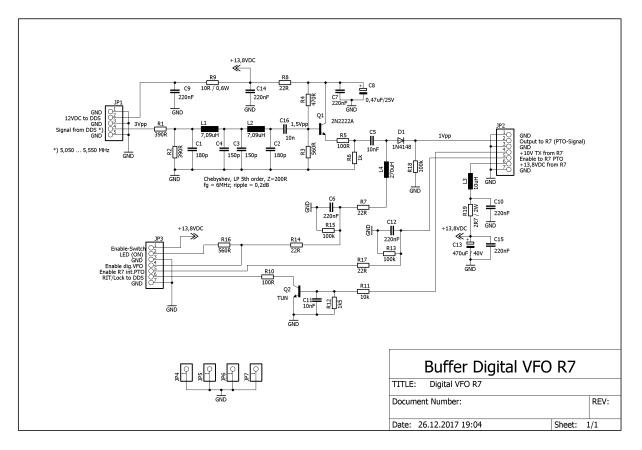
Picture 2: New DIN-jack

Picture 3: Short-circuit-plug

The output of the SDR-kit is very far away from a sinusoidal shape, it supplies app. 3Vpp rectangular (CMOS-output). For switching and other functions a separate buffer is required (picture 4 and 5) and we need a lowpass-filter. This filter is a Tschebyscheff-Lowpass, designed with SVC Filter Designer 2.12 /2/ (picture 6). In- and output are set to 200 Ohms impedance (not 50 Ohms as usual), which considers the output of the SDR-kit (R1//R2) and the input of Q1 (R3//R4//Q1-Emitterfollower).
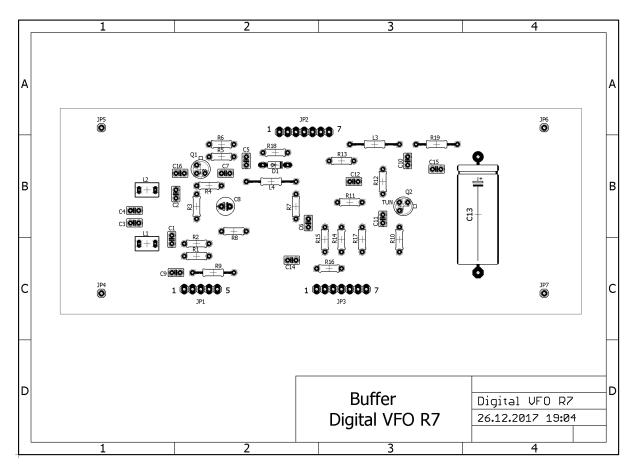
L1 and L2 are 7 turns on a binocular core with Al=140 (picture 7, left side).
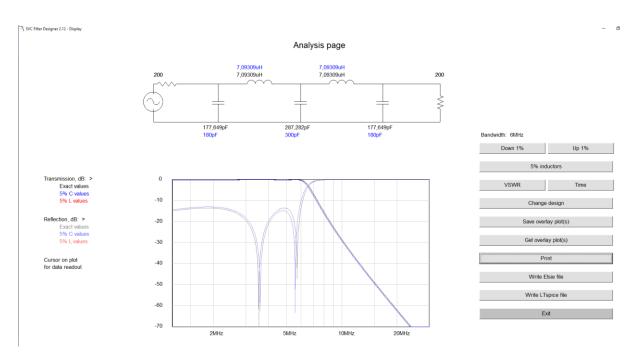
Other functions of the buffer are:

- Power supply 13,8VDC from R7 for the SDR-kit (JP1) and buffer Q1
- Decoupling of all DC-lines
- Enabling of buffer output via D1 and pin 2 of JP2 or
- Enabling internal PTO of R7 via pin 5 of JP2
- Disabling of RIT by +10V TX via pin 4 of JP2, Q2 and pin 6 of JP3
- Mode switch via pins 1, 4 and 5 of JP3
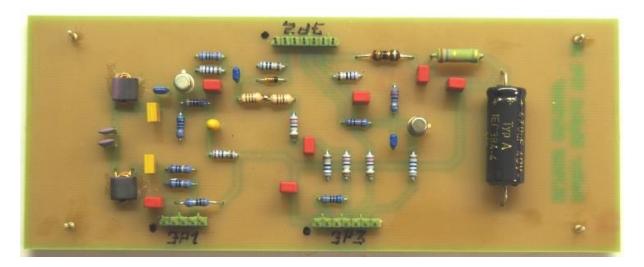- LED for operation pins 2 and 3 JP3

Picture 4: Buffer schematic

Picture 5: Buffer Board

Picture 6: Filter design Tschebyscheff - Lowpass 6MHz (L1, L2, C1…C4)
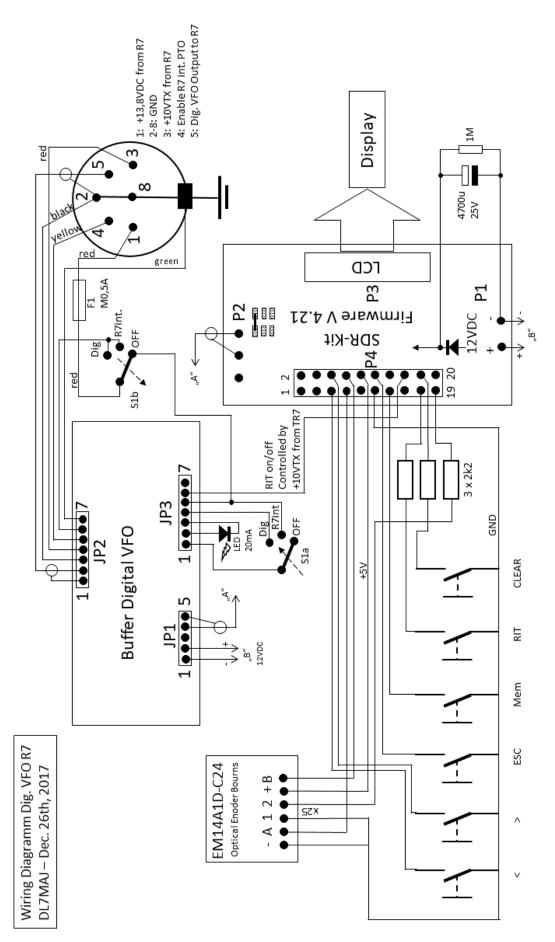

Picture 7: Buffer Board

Part		Value	Details	
C1		180p		
C2		180p		
C3		150p		
C4		150p		
C5		10nF		
C6		220nF		

C7	220nF		
C8	0,47uF/25V		
C9	220nF		
C10	220nF		
C11	10nF		
C12	220nF		
C13	470uF / 40V		
C14	220nF		
C15	220nF		
C16	10n		
D1	1N4148		
JP1	PINHD-1X5		
JP2	PINHD-1X7		
JP3	PINHD-1X7		
JP4	PINHD-1X1		
JP5	PINHD-1X1		
JP6	PINHD-1X1		
JP7	PINHD-1X1		
L1	7,09uH	Al=140, n=7	
L2	7,09uH	Al=140, n=7	
L3	10uH		
L4	270uH		
Q1	2N2222A		
Q2	TUN	BC107	
R1	390R		
R2	390R		
R3	560R		
R4	470R		
R5	100R		
R6	1k		
R7	22R		
R8	22R		
R9	10R / 0,6W		
R10	100R		
R11	10k		
R12	1k5		
R13	100k		
R14	22R		
R15	100k		
R16	560R		
R17	22R		
R18	100k		
R19	2R7 / 2W		

Partlist Buffer

Picture 8: Wiring of Digital VFO

The complete wiring of the digital VFO can be seen on picture 8.

Picture 9: Internal View

The case is a Bopla type Alubos 1680-0200, Picture 9 shows all boards:
- Left: Rear side with DIN-jack and fuse holder
- Middle-Left: Buffer board
- Middle-Right SDR-Kit with "big" C *)
- Right: Front panel with Display and controls

*) On the board of the SDR-Kit, a "big" C is connected (4700uF/25V). It has the task to buffer the supply of the digital part, when switching the mode with S1(b) from R7int. to Dig. and back again. This switch is interrupting the DC for a short time and therefore loss of setting of the VFO is possible – this C prevents this!

Three modes are available by S1:

- OFF: The digital VFO is completely off and the R7 is controlled by its internal PTO
- R7: The R7 is controlled by its internal PTO. The digital VFO operates and can be set independently
- Dig: The R7 is controlled by the digital VFO, the LED lights. The R7 internal PTO can be tuned independently

Note:
- When the R7 is connected to a TR7, the RCT mode of the TR7 means, that the TX-frequency of the TR7 is remotely controlled by the R7. Depending upon the Mode-switch of the digital VFO, the R7 is controlled for RX and RCT either internally by its own PTO or the digital VFO. A split operation is NOT possible!
- RIT of R7 is either controlled internally for the PTO or externally for the digital VFO depending upon mode switch.

All other functions of the digital VFO are described in the manual of the SDR-Kit /3/:
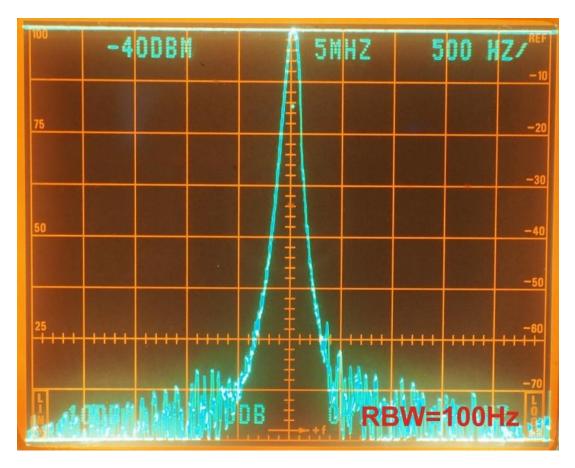
- Switching VFO A & B and Memory A & B
- Memory settings and memory
- RIT and Clear
- Tuning speed < & >
- Tuning speed x1 / x25 by pushing optical encoder knob
- Parameterization, Offset, max. and min. frequency

Some technical data

Consumption:	150mA at 13,8VDC
VFO Output:	1Vpp @ 470 Ohm load (7-Line requirement)
Frequency:	5,050 … 5,550 MHz (7-Line range)
Dimension:	220 x 170 x 90mm (Bopla type Alubos 1680-0200)

Spectral purity, phase noise

Measurement was made with a Tek 492. Channel "A" was an original 7-line PTO and channel "B" the new digital VFO. With attenuators (1dB-steps) their amplitudes were set equal and saved, so their spectra can be compared directly on the screen (picture 10).

Picture 10: Spectra of 7-line PTO and digital VFO

Even with lowest span (500Hz/div) and best resolution (100Hz) there are NO differences in the spectra. Both spectra coincidence and yes – there are two spectra in picture 10!
This method is not a precise phase noise measurement, which requires a bandwidth of 1Hz, but I´m sure, that the overall phase noise in the R7 is not affected by the new digital VFO.

Impressions

Picture 11: Digital VFO

Picture 12: Boot sequence

Picture 13: Dig. VFO A controls R7

Picture 14: Memory B channel 8 controls R7

Note: The display in the digital VFO shows only the hundreds of kHz, but not the band information (No MHz)! The actual operating frequency is displayed only in the R7.

Picture 15: Dig. VFO B operates but doesn´t control the R7

Picture 16: Rear view

/1/   http://www.sdr-kits.net/
/2/   ARRL 2015 Handbook / Companion software / Tonne Software / SVC-Filter Design
/3/   Manual of SDR-Kit

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