

## Universal Frequency Display for QRP equipment

## Frequency Counter based on PIC with minimal-hardware

von Wolfgang "Wolf" Büscher, DL4YHF

Letzte Aktualisierung: 2006-06-03.

The heart of the circuit is an 18 pin PIC 16F628 Microcontroller. With the software of Wolf we get an universal frequency counter.

- \* Frequenz range 1 Hz to 50 MHz (Most kits work up to 60 MHz which is pretty high above the specification of the Processor).
- \* Automatic range switch with different gate timing
- \* programmable offset for superhet receivers (IF shift), either addition or subtraction possible
- \* Preprogrammed Offsets for common IF e.g. 3.999 MHz for "Miss Mosquita" Transceiver
- \* Optional power save mode: power of after 15 s with no variation of the frequency.

The actual firmware can be downloaded from Wolfs homepage. If you want to add something, you may use the assembler file which is also available there. The QRPproject kit contains a preprogrammed PIC

### Description of the Function

After power on the counter shows "8.8.8.8." to test all segments of the Display for a short time.

In the next step the actual measured frequency will be shown.

- \* flashing decima point: = Display in kHz;
- \* steady decimal point = Display in MHz.

The range is automatically switched to give maximum resolution and minimum Gate time:

Range	Display	Gate	decimal point
0 ... 9.999 kHz	X.XXX	1 second	flashing
10 ... 99.99 kHz	XX.XX(X)	0.5 second	flashing
100 ... 999.9 kHz	XXX.X(X)	0.25 second	flashing
1 ... 9.999 MHz	X.XXX(X)	0.25 second	steady
10 ... 50.00 MHz	XX.XX(X)	0.25 second	steady

## Programming mode

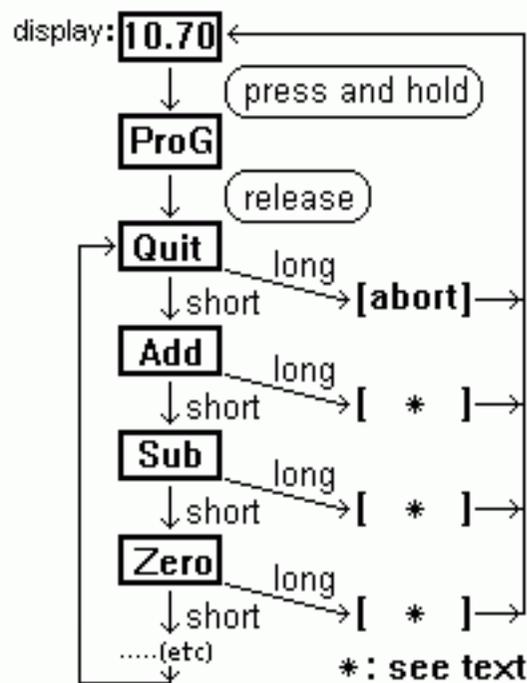
During 'Programming mode' you can programm an frequency offset and the power save mode. To programm the controller you must attach a closing switch to pin 4 of the microprocessor.

### Programming mode flow chart

The program flow chart on the left shows how to enter programming mode, how to select a menu, and how to execute the associated function. To enter programming mode, press and hold the programming key (or connect pin 4 and 5 of the PIC with a small screwdriver), until the PIC shows „ProG“ on the LED display. Then release the „key“. You are now in the first menu of the programming mode.

To select the next menu, press the key for a *short* time (less than a second). To execute the selected function, press the key for a longer time (more than a second). The menu functions are :

- „Quit“ : Aborts programming mode without changing anything.
- „Add“ : Saves the previously measured frequency permanently, so it will be added in future.
- „Sub“ : Saves the previously measured frequency permanently, so it will be subtracted in future.
- „Zero“ : Sets the frequency offset to zero, so the display will show the measured frequency without offset. The previously programmed offset will be lost.
- „Table“: Allows you to select a predefined offset value from a table. The table itself is also located in the PIC's data EEPROM, so you may find different values in it. When skipping through



the table, the frequencies are shown in numeric form, like 455.0 (kHz),

4.1943 (MHz), 4.4336 (MHz), 10.700 (MHz). After selecting an entry (long keypress), you will be taken back to the main menu to select „Add“ or „Subtract“.

· „PSave“ / „NoPSV“: turns the power-saving on/off. In power-saving mode, the display is turned off after 15 seconds of no „significant“ change in frequency, and on again as soon as the frequency changes by more than a few dozen Hertz (in the 3..4 MHz measuring range)

### **Addieren oder Subtrahieren von Frequenzen**

If the counter is used in a superhet receiver (or transmitter) you must add or subtract the IF frequency (depending on up or down conversion. In the programming (Setup) Section you can choose a common IF frequency or if your IF cannot be found in the table you can program any IF.

The following example shows how to program a transceiver like our Miss Mosquita with 4MHz IF Quartzfilter (Oscillator of TX at 3,999 MHz)

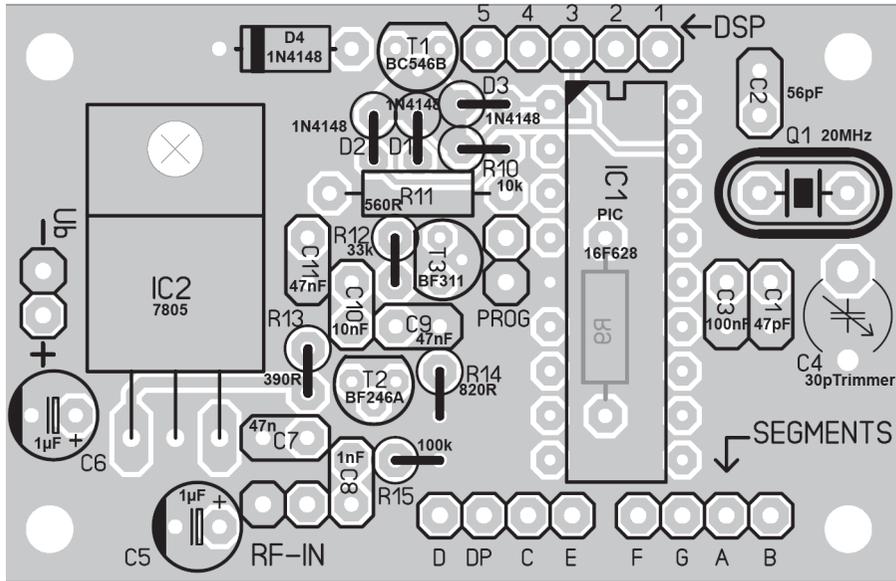
1. counter power on
2. close programming- switch shortly until display shows "PROG"
3. Release the switch
4. Close and open the switch until you see "TABLE" in the display
5. Close and open the switch until you see "TABLE" flashing, release the switch. You are now in a sub menu which shows all preprogrammed offsets.
6. Close and open the switch until the wanted IF (3.999) is shown in the display.
7. Close switch until "3.999" is flashing, release the switch
8. Now you should see "Add" in the display. If not close and release switch until you see "Add"
9. Close switch until you see "Add" flashing, release switch

Ready. The IF of 3.999 MHz has been written to the EEPROM now, it will be added to the actually measured VFO frequency.

Little bit more tricky is the calculation for the 10MHz and above. Because we have only 5 digits it makes sense not to show the 10 and 1 MHz digits. If we use a negative offset, the display will only show the 1 MHz digit but the 100Hz digit can still be seen. Example for a 30 Meter Transceiver with VCXO:

RX Frequency = Oscillatorfrequency - IF = 14,314 - 4,194 = 10120  
If you want not to see the 10 MHz use 14,194 instead of 4,194. The 10120 will be shown as 1120.0

## Assembling



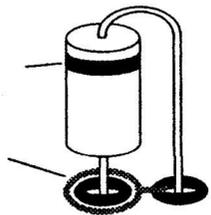
Use the PCB as shown in the picture to get some orientation. Don't install the connectors now, this will be done later on.

Solder Resistor R9 first. You see R9 mirrored inside the outline for the microprocessor IC1 that means it must be mounted at the bottom side (solder side of the PCB).

[ ] R9 10k Mount at bottom side, solder at part side. cut the remaining pins short above the solder joint.

Now mount other parts to the part side and solder at the bottom side. Start in the lower left corner. Try to solder each part as low as possible above the PCB. If they are mounted on long legs you will get run into trouble when mounting the Display board.

[ ] D4 1N1448 The diode has a band at the cathode side. Orientation of the band on the PCB as shown in the drawing



[ ] D2 1N1448 -upright If a Diode is mounted upright, there is a circle as an outline on the PCB. Mount the diode with its body inside the circle, the band (cathode) at the upper side (see picture left!)

[ ] D1 1N1448 upright as D2

[ ] D3 1N4148 upright as D2/D3  
 [ ] R10 10k, upright  
 [ ] R11 560R  
 [ ] C11 47 nF (473)  
 [ ] C10 10 nF (103)  
 [ ] R12 33k  
 [ ] C9 47nF (473)  
 [ ] R13 390R  
 [ ] R14 820R  
 [ ] C7 47nF  
 [ ] C6 1uF Elko, ATTENTION, polarized. Long leg = PLUS  
 [ ] C5 1uF Elko, ATTENTION, polarized. Long leg = PLUS  
 [ ] C8 1nF (102)  
 [ ] R15 100k  
 [ ] C2 56pF

[ ] Q1 20 MHz Quartz. Mount the Quartz with a abt 1mm distance between its body and the PCB to avoid a short by solder under it.

[ ] C3 100nF (104)

[ ] C1 47pF (47p, 47j)

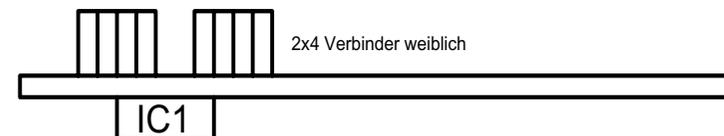
[ ] C4 Foil Trimmcapacitor 30pF

Now the socket for the PIC Take care to mount it exactly as shown in the picture. The GAP at one of the small sides must look to the upper edge of the PCB. They will connect the display PCB to the counter PCB. Best way to mount and solder them is to assemble both PCBs complete with the connectors

[ ] Socket IC1

The following female connectors are mounted on the solder side of the PCB Best way to do is to mount the complete assembly first without soldering. Check if all connectors are absolutely perpendicular. If so, solder them Use the female connectors for the counter PCB and the male connectors for the Display PCB Solder one PIN, check again and if it looks good, solder all

Schnittzeichnung, Bauteile nach unten, von der Breitseite gesehen



remaining PINs.

Solder at the parts side of counter PCB:

- Connector 5,4,3,2,1 (female)
- Connector D,DP,C,E (female)
- Connector F,G,A,B (female)

Now the other connectors to the outer world. They are mounted on the parts side and soldered on the solder side.

- Wire plus/minus (red/black) as connections to power (+6V bis +12V) at „Ub“
- Koaxcable or a pair of twisted wire at „RF-in“ (later connection to VFO, Local Oszillator)
- Programm Switch at „PROG“

Remaining parts are Semiconductors. Some of them, especially the PIC are ESD sensitive. Discharge yourself by tapping your hand to a blank ground plate or better, use ur ESD safety equipment.

- T1 BC546B
- T2 BF2546A
- T3 BF311

- IC2 = 7805 (T0220 housing).

Now put the PIC into the socket. Attention: the Gap or Pin 1 marker must look to the upper edge of the PCB / gap in the socket.

- PIC 16F628

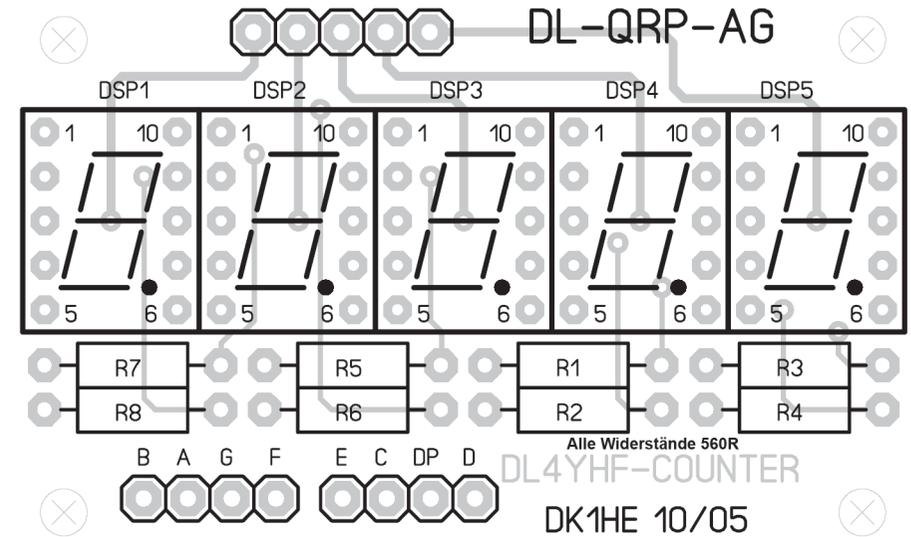
OK, the counter is ready, now do the Display unit.

This are only a few parts. Mount all parts on the parts side, that's the side where you find the designers call sign DL4YHF in the lower right corner.

Start with the resistors:

- R1 560R
- R2 560R
- R3 560R
- R4 560R
- R5 560R
- R6 560R
- R7 560R
- R8 560R

Now the 5 Seven Segment Display Chips. Please install them upright with



the decimal point at the right place. Look at the Picture above to see how they must be installed. Press each Display firmly against the PCB and solder 1 pin at a corner first. Check if it is really sitting flat on the PCB and solder a pin diagonal opposite. Check again if the display is flat on the PCB. If not, reheat and press the display down to the PCB. If it is ok, solder all remaining PINs. Same procedure for all 5 Displays.

- DSP1
- DSP2
- DSP3
- DSP4
- DSP5

Now the connectors, they are mounted on the solder side and soldered at the Parts side. Of course you must use the male connectors at the display PCB. Again assemble the complete unit before soldering. If the PCBs are exactly on eabove the other, solder the PINs carefully without touching the Displays with the hot iron.

- Verbinder 5 pin (männlich)
- Verbinder 4 pin (männlich)
- Verbinder 4 PIN (männlich)

If you now connect Power to the red(black UB line and any signal between 1 and 50 MHz to the RF line (coax or twisted pair of wire) you should see

measured frequency now.

If you use a Receiver / Transceiver as signal source, you will see the local Oscillator frequency. To see the TX/RX frequency you must add or subtract the IF frequency as described in the programming section of this manual.

#### Partlist

D1 1N4148  
D2 1N4148  
D3 1N4148  
D4 1N4148

R1 560R  
R2 560R  
R3 560R  
R4 560R  
R5 560R  
R6 560R  
R7 560R  
R8 560R  
R9 10k  
R10 10k  
R11 560R  
R12 33k  
R13 390R  
R14 820R  
R15 100k

C1 47pF (47p, 47j)  
C2 56pF  
C3 100nF (104)  
C4 Foiltrimmcapacitor 30pF red 2 pin spacing 5mm  
C5 1uF Eléctrolytic cap  
C6 1uF Electrolytic cap  
C7 47nF  
C8 1nF (102)  
C9 47nF (473)  
C10 10 nF (103)  
C11 47 nF (473)

Q1 20 MHz Quartz  
T1 BC546B  
T2 BF2546A  
T3 BF311  
IC1 PIC 16F628 -20P programmed (Attention, extrem ESD sensitive)  
IC2 7805 TO220 Housing  
Socket 18 pin for IC1 (PIC)  
7 Segment Display (5)  
Connector 13 PIN (female)  
Connector 13 PIN (male)  
pushbutton switch

# DL4YHF-Counter

