LinNWT/WinNWT V4.xx

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Chapter 1

foreword

Bernd Kernbaum's NWT has been around for a number of years. First in the DOS version and later a version that runs on Windows. Bernd developed a new network tester with a more modern DDS, the AD9951, which makes it possible to work up to around 150MHz. This DDS has better technical parameters than its predecessor types, the D/A converter has 14-bit resolution. Based on this, the FUNKAMATEUR developed a kit for a 0.1 Network tester FA-NWT measuring up to 160, MHz was developed.
I have been working with Linux for several years and had started a Linux software to develop. I didn't want to do without the great measurement technology that Bernd developed. Due to a different protocol flow on the serial interface, it was also necessary to redesign the FW in the PIC. Linux programming is based on C++, which was also used for this software. In addition, I used the program library QT3 from Trolltech for programming. In the meantime I have ported the source code to the new QT version QT4.3. From this version there is also an open source version of QT4 under Windows. Only then was it possible to port and compile the programs that were developed under Linux to the Windows interface. This is how a Linux and Windows version of this program was created.

Chapter 2

Notes on installation

2.1 The Software

2.1.1 Installation on Linux

Under Linux you have to compile the program yourself. This is the only way to guarantee that all suitable LIBs are included and the program runs safely. The condition is that the compiler plus compiler environment of Linux are installed. The header files are also used by the system.
From experience it is best to install the "KDevelop" package. With the- All packages for compiling are also installed with this package. The second Step is from Trolltech" download and install the open source package v.4.x ly. Now load the source package from my site www.dl4jal.eu" and pack. Either open with the mc" and copy uncompressed or with the command
dl4jal@funkraum :~> tar -xvf linnwt-3.xx.tar.gz (CR)
unpacking
dl4jal@funkraum :~> cd linnwt (CR)
change to the directory With the
command
dl4jal@funkraum :~> qmake or qmake-qt4 (under UBUNTU) (CR) creates a new Makefile. This is then required for compilation. If that doesn't work, the QT version should be queried first. Many distributions have QT3 set as the default. If the call is faulty, the command is given first

dl4jal@funkraum :~> qmake -v or qmake-qt4 -v (under UBUNTU) (CR) the installed QT version is queried. The version must start with 4.xx. The command
dl4jal@funkraum :~> make (CR)
creates an executable file. Now all we need to do is rename the file and move it to the directory
/usr/local/bin
copy. The rights to access the serial port must also
be set. You can run the program with root privileges to test it." start to see if it works.

2.1.2 Installation on Windows

The programwinnwt setup.exeinstalls all associated files. It is sufficient within a version if only one update is installed. All required DLLs and program parts are installed. From version 3.xx, installation in multiple languages is possible. Therefore, first select the appropriate language. Different languages can also be installed one after the other. Then come the usual questions. There really isn't anything else to explain. The translated texts are in the file with the extension

* . sqm" included. These files are used as an argument when the program is called appended with a space in between. And all relevant

vanten texts in the appropriate language. The setup program takes care of setting up the program icons, depending on the selected language.

Chapter 3

The software „LinNWT / WinNWT"

3.1 The directories and files

In the user's "HOME" directory, there are 2 directories „/hfm9" and „/short-ven" created. in the „/hfm9" are all configuration files from the program. This applies to Linux and also to Windows. On Windows, this ver-directory in„Documents and Settings/USER/hfm9".Important! the configuration and the measuring head files are always stored in the directory HO-„ME/hfm9". It is possible to store the files temporarily somewhere else to save, but the LinNWT/WinNWT always searches for the files on the above mentioned place. The default directory /cu„rves" serves as the directory for the curve files and is created as a standard from version 4.xx. The cure-ven can also be saved in any other directory. The curve directory is saved in the configuration file, so that the directory used last is always the current one.

Here are the file types used by the program:

suffix	description
*.hfc	Configuration file of the program Curve file with data from
*.hfd	channels 1+2 Sensor file with the properties of the sensor
*.hfm	Mathematical correction file with data (frequency-dependent)
*.hfe	SWV calibration file with data (frequency-dependent)
*.hfs	

3.2 The menu commands

3.2.1 File

To press

Printout of the displayed graphic window. The content of the information window is then formatted and also printed. Unfortunately, the information window

not editable. To create a heading is the menu itemLayout- „
enter tag"intended. It is normal if the size of the graphic
automatically adapts the window to the print size when printing. This only happens during the printout.

Print PDF

Printout of the displayed graphic in a PDF file.

Enter layout label

A description of the graphic to be printed is also entered in this menu item. From version 2.03 the label is also saved in the wobble curve data.

End

The program is terminated and closed. All important settings are saved in the configuration file.

3.2.2 Settings

load

With this menu item you can load special settings that were previously saved. From version 1.07 it is also possible to load the corresponding configuration when the program is started. To do this, the file name (without directory) is written as the 1st or 2nd argument after the program name. The extension is always used for the configuration file
* . hfc" is used. The default configuration file has the name " „hfm9.hfc". The default name is also used when the program starts if no other
re file is specified as the 1st or 2nd argument when the program is called.

To back up

All settings mentioned in the previous point can be saved in a file. The file name extension *.hfc is used. When pro-
grammstart, however, the configuration is always searched for in the "hfm9" directory. „

info

Specification of the SW version etc....

firmware version

Querying the firmware in the module in the PIC. A number is displayed> 100. As of SW version 3.xx, the FW is displayed in the program header. A variant number is also specified. The version query is carried out automatically by the program in the background. This variant number was created from the many different HW variants that my program can control. There are now about 9 different ones

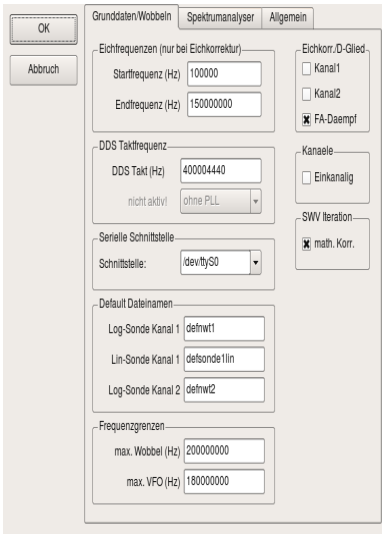

Figure 3.1: View of the menu item “Basic data/wobble”

HW variants, with each variant requiring a different FW to control the various DDS or other HW parts. It was difficult for me to keep track of the various assembler source texts. It was even more difficult to correct all variants when errors were found. That's why I painstakingly merged all variants into one source code. An example: if I set the variant number to 1, settings are made via compilation switches that are used as the compilation result.

did a HEX file for the FA-NWT without PLL 400MHz directly". but this is not relevant for the user. I just wanted to explain why the Variant number was introduced by me.

option

basic data/wobblingA view ofBasic data option"one sees in figure 3.1 on page 10. With this menu item basic settings made. The setting options have become more extensive the. Therefore there are now 3 worksheets. The first sheetbasic ten/wobble"has the following meaning:

Point	value	description
Calibration frequencies at Math. Correction	Longint	beginning+end
DDS clock frequency	Longint	exact clock frequency
PLLmode	unsigned int	The PLL setting in the DDS is not used in the FA-NWT
Serial interface	selection	Windows: Predefined selection
Serial interface	input	Linux: Editable
Log probe channel 1	thong	probe file
Lin probe channel 1	thong	probe file
Log probe channel 2	thong	probe file
max wobble	float	maximum sweep frequency FA-NWT = 200000000 NWT500 = 550000000 NWT7 = 90000000
max VFO	float	maximum VFO frequency Setting see above
calibration corr. channel1	(Yes No)	math Corr. for channel 1 math.
calibration corr. channel2	(Yes No)	Correction for channel2
FA steam	(Yes No)	Activate the attenuator from the FA
single channel	(Yes No)	Work with 2 or 1 measuring heads
SWV iteration math. corr.	(Yes No)	Activate for FA-NWT Smooth SWV curve

From version 1.09 the 2 dots aremaxvfoandmaxwobbleadded. The reason for this extension is the use of this program for different hardware. If the older NWT7 from Bernd Kernbaum is used, the maximum cut-off frequencies can be set differently. There is already hardware that works with the AD9858 and can generate frequencies up to about 560MHz. This hardware can also be adjusted with these 2 settings by increasing the cut-off frequencies accordingly.

spectrum analyzerA view of the Spectrum Analyzer option can be seen in figure 3.2 on page 12.

The second worksheetspectrum analyzer"has the following meaning:

General		
Point	value	description
HW feedback	Yes No	Message from the SAV to the SW the switch position of the HW from the SAV
Automatic step correction	Yes No	with HW feedback the number of steps is increased accordingly depending on the bandwidth set on the SAV

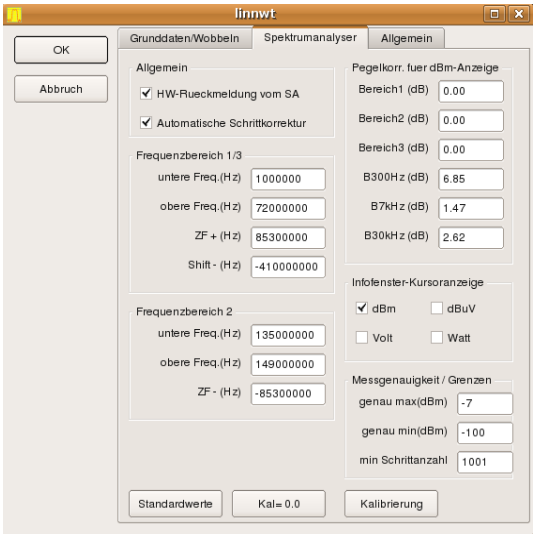

Figure 3.2: View of the Spectrum analyzer„option menu item

Area 1/3	week	
Point	value	description
lower frequency	float	lower frequency limit
upper frequency	float	upper frequency limit
IF	float	intermediate frequency
shift	float	Shifting of the frequency display in the Spek.FRQ-shift operating mode

area 2	2m	
Point	value	description
lower frequency	float	lower frequency limit
upper frequency	float	upper frequency limit
IF	float	intermediate frequency

The first two checkboxes in the picture only become active when the correct firmware is detected in the PIC. The IF must be calibrated according to the deviation of the 2nd oscillator in the SAV. The first step is to calibrate the frequency of the DDS clock. We describe this process in chapter 3.5.1 on page 29. You can then determine the deviation of the SAV and change the ZF accordingly by the deviating amount. Three groups of settings have been added to the right. From SW version 4.04, the level in the display is shown directly indBmdisplayed. A calibration is necessary for this.

level correction for the	dBm	advertisement
Point	value	description
Range1 (dB)	float	Total variance in area 1 Total
Range2 (dB)	float	variance in area 2 Total variance
Range3 (dB)	float	in area 3
		Spec.FRQ-shift
B300Hz (dB)	float	Level deviation BW 300Hz
B7kHz (dB)	float	Level deviation BW 7kHz
B30kHz (dB)	float	Level deviation BW 30kHz

info window	cursor	advertisement
Point	value	description
dBm	Yes No	Display of the cursor value
dBuV	Yes No	Display of the cursor value
volt	Yes No	Display of the cursor value
watt	Yes No	Display of the cursor value

measurement accuracy	limits	
Point	value	description
exactly max (dBm)	integer	graying of the
		inaccurate measuring range
exactly min (dBm)	integer	graying of the
		imprecise measuring range
min number of steps	integer	minimum number of steps
		atAutomatic step correction

There are 3 buttons below. Here is the meaning:

- default valuesreset all settings to reasonable values.
- Cal=0.0set the calibration array to value 0.0.
- calibrationAdditional calibration with the dB deviations of the SAV input low pass in range 1 and the SAV band pass in range 2.

A detailed description of how the spectrum analyzer attachment is calibrated follows later in this document.

General A view of the General option is shown in Figure 3.3 on page 14.
The Third Tab" „General"has the following meaning:

Point	value	description
Color background	dialog	color setting
Color Channel1	dialog	Color setting channel1
Color Channel2	dialog	Color setting channel2
Font size	integer	Font size of the program
focus switching		
button wobble	Yes No	Automatic focus switch to graphics
button once	Yes No	Automatic focus switch to graphics
Stop button	Yes No	Automatic focus switch to graphics

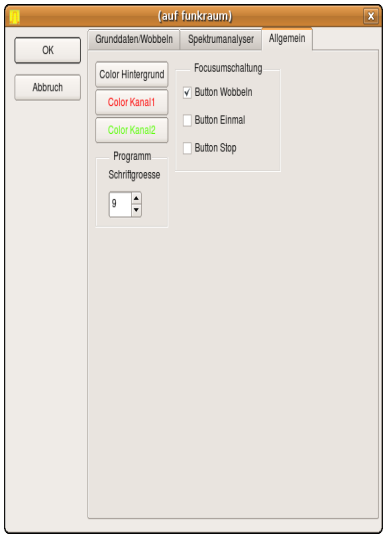

Figure 3.3: View of the General option menu item

Since the graphic representation was separated in an extra window, there are the last 3 checkboxes. Here it is determined whether the graphic window should move to the foreground immediately after pressing the button, which in technical terms means that the focus goes to the graphic window. Everyone can choose their own setting here.

Firmware update (depending on the bootloader)

This paragraph hasonly valid with the appropriate bootloader.A new firmware is loaded into the PIC. The first rule is that communication with the NWT must work. Don't allow yourself any experiments here. The bridge PortB.0 was activated against ground and it happenedPower ON,it is essential to load new firmware. The following happens in the PIC:

PORTB.0 = 5V (normal operation):
After PowerON the bootloader is jumped to. There it is checked whether PORTB.0 has 5V. If YES, a jump is made to the program routines of the NWT and the assembly works as normal.

PORTB.0 = 0V (bootloader active):
After PowerON the bootloader is jumped to. There it is checked whether PORTB.0 has 0V. If YES, the firmware is marked for renewal and it
there is no turning back. The bootloader waits until the new firmware ar„rives".

What needs to be done is explained in dialog windows. But this function is only possible with the bootloader from me or from the FA-NWT.

When renewing the FW in all other hardware, you have to inform yourself in detail beforehand!

3.2.3 Curves

As of version 4.xx, each newly created curve file receives a version stamp so that the software can recognize the format of the measuring probe parameters. If an old version is recognized, the parameters are automatically converted. Whether a curve loaded in the main program has the new version can be seen in the header of the graphic window. There is the loaded file name and at the new file version at the end of the string #V3.05". in the „wobble manager" there is no version identification.

load

A saved curve file can be reloaded into the main program with this menu item. The previous settings in the program will not be overwritten. The properties of the measuring head used are also loaded and from version 2.03 also the layout label. The file extension *.hfd is used. The directory used is saved in the software and offered again automatically (from version 4.xx).

To back up

Swept curve is saved to a file. The properties of the measuring head used are also saved and from version 2.03 this too layout label.The m„athematical calibration correction" is not included saved in the curve file.The same explanation applies here as in Sweep manager” see paragraph 3.4 on page 26. For the curve file, the ” *.hfd" ext„ension is used. The directory used is specified in the configuration saved and offered again automatically (from version 4.xx).

3.2.4 Wobble

wobbling

Wobbling is started. The same function can be used with the button *wo„bbling*" be started. As of software version 3.xx, the "W" key in the gra„phics also turn off the wobbling.

Once

The sweep is run through only once. the button *Once*“ „ works the same. As of software version 3.xx, the "E" button in the graphi„c window releases also the wobbling off.

stop

The sweep is stopped. The full run will continue to the end-guided. There is also a button *stop*“„ From software version 3.xx stops the "S" key i„n the graphics window causes wobbling.

Calibrate channel 1

From version 4.xx it is possible to use the top and bottom dB„line in the value set. This performance feature made a total conversion of the topic in the display is required. I also had to redesign the calibration of the measuring probes mathematically. If an old calibration is recognized, the new software converts the parameters and an additional information window appears. The software version 4.xx is therefore backwards compatible. But no measuring head files created with version 4.xx * . hfm" and curve files" „ * . hfd" in the old software versions be used.

Each probe must be calibrated to achieve accurate measurements. The first query is the type of sensor lin/log. Then an attenuator -6db/-40dB to be looped in. Finally, the VFO output is connected directly to channel 1. From both series of measurements, calculated from the two constants that the RF level„function -> output voltage" of the sensor. This function is always linear" and „ can be described with only 2 states. The result can menu item “Save properties of measuring probe channel 1” can be saved, but the save dialog is offered immediately during calibration. Owners of a connected attenuator do not need to insert any additional attenuators, the software automatically takes care of inserting the attenuator. This applies to the full extent (linear measuring probe needs -6dB element) only with the FA attenuator. So only one connection cable needs to be plugged in between the two coaxial sockets. When determining the second reference line, which should normally be 0dB, a small attenuator can also be looped in. This is intended for measuring probes that measure the level of + 4dBm cannot be tolerated and become inaccurate in this range. But these are special cases, we use the presented 0dB insertion loss. *Mathematical calibration correction when using the log. measuring probe.*

Let's look at our calibration result when we compare„ the output of the connect the oscillator directly to the measurement input. It can be seen that the calibration curve falls after the high frequencies. We are lucky with the FA-NWT, due to the good construction, the 0dB line is inherently very straight. However, if we compensate for the deviation mathematically, we can correct the course of the line. A file is created in which the frequency per frequency deviation in „dB". We can use this to measure our measurement curves compensate file. The measurement accuracy increases over the entire range + /–0.5dB. In order to compensate the entire range, the frequency range to be calibrated is defined in the configuration data and can only be set via the menu item„Attitude; Option"to be changed. In the file with the ending *calibration file name-kx.hfe* the correction values are saved. These The innovation also applies to channel 2. The linear measuring probe is not taken into account. If the calibration correction is activated for a channel, the color changes the labeling of the check button in the color RED„".

There is a problem„ with the mathematical calibration correction, however. As soon as a saved curve file is loaded into the sweep curve manager the "mathematical„ calibration correction" is not included in the curve progression shown. There is therefore a deviation between the provided curve and the curve in the„Manager". That's why I have a warning

note added to the program that allows this calibration correction"
switch off when loading curve files. That's the only way to be error-free
work with, the wobble curve manager. So I suggest on this one
Refrain from correction and prefer once more the special frequency range
to calibrate.

Calibrate channel 2

Here we proceed as with channel 1. However, this only makes sense if an additional measuring probe is also connected.

Selection of measuring probe channel 1

Data from the measuring probe on channel 1 can be loaded with this menu item.
the. The measuring probe file has the file extension *.hfm". From version 4.xx has
the file other parameters. The old parameters are converted automatically
automatically and a message appears on the screen asking you to recalibrate
everything.

Selection of measuring probe channel 2

Data from the measuring probe on channel 2 can be loaded with this menu item.
the. The measuring probe file has the file extension *.hfm". From version 4.xx has
the file other parameters. The old parameters are converted automatically
automatically and a message appears on the screen asking you to recalibrate
everything.

Save properties of measuring probe channel 1

The determined data of the used measuring probe channel 1 are saved with the
menu item. In addition, the data from the calibration is saved in the wattmeter.
Which file is loaded automatically when the program starts,
we put in theOption"fixed. The measuring probe files must always be in the
directory /hfm9" in the HOME" area. From version 4.xx
each newly created measuring probe file receives a version stamp so that the software
ware can recognize the format of the parameters.

Save properties of measuring probe channel 2

The determined data of the used measuring probe channel 2 are saved with the
menu item. In addition, the data from the calibration is saved in the wattmeter.
Which file is loaded automatically when the program starts,
we put in theOption"fixed. The measuring probe files must always be in the
directory /hfm9" in the HOME" area. From version 4.xx
receives a version stamp for each newly created measuring probe file so that the software
ware can recognize the format of the parameters.

Reset cursor

The cursor in the graphic window is deleted.

Set the font in the info window

Setting the font in the information window of the wobble area.

frequency marks

From version 1.08 it is possible to display frequency markers in the wobble window as a frequency orientation. The bands 160m to 2m are predefined and you can also define 3 frequency pairs yourself. all one
Settings are stored in the„ program configuration file.

profiles

The profiles are edited in this menu item. Start frequency, end frequency and steps are saved together under one name. The
default” profile is not displayed. All defined profiles are saved in the ” configuration saved.

Change window width

In version 3.xx it is possible to hide the information window. Since an extra window has now been programmed for the graphic display, it is necessary to reduce the width of the window in order to display the wobble window and the operating window next to each other on PCs with a low resolution. This menu item is provided to enable this. The operating window is set to minimum. With this setting it is even possible to run the program on the eeePC 701.

3.2.5 Measure (Wattmeter)

set font

Font setting in the measurement window.

Calibrate channel 1

Calibrate the probe to dBm. For this we need an exact HF level, which must be known. Since the AD8307 delivers a linear DC voltage depending on the dBm value applied, 2 points are sufficient to determine the data. The known level is set once and an attenuator greater than or equal to -20dBm is required as the second measuring point. The default value corresponds approximately to the actual dBm level of the NWT from the RADIO CAMATOR. The results of calibrating in the wattmeter range are saved in the same probe file as when sweeping. After calibration, the corresponding file is offered for saving. It is advisable to use the file name offered for the first calibration. This one is coming
from the„Option".We have the guarantee that the correct measuring probe data be loaded automatically when the program starts.

Calibrate channel 2

Calibrate the probe to dBm.See channel 1.

Write measured values in table

Current displayed values are written to the table. the button
Measured value acceptance" does the same. "

save table

The table values can be saved in a file. Save"- But- „
sound does the same.

Set damping to default

This point sets the "Damping" box to default. That means everyone will
additional entered values removed from the box. The meaning of this
Box will be described later.

Edit probe 1/2

In this menu item, a table can be edited that describes the dB deviations depending on the frequency. The result is the possibility to activate the correction data described here via a combo box. This makes it possible to increase the measurement results accordingly. The values specified here are also saved in the probe file. A view of the dialog can be seen in figure 3.12 on page 32.

3.2.6 Help

tip

Here you can activate the tip. I have almost all the important controls written a so-called tooltip". „This appears when the
Tip is activated and you hold the mouse pointer for a while on the corresponding the place remains.

3.3 The wobbling worksheet

Here we start with the description of the user interface of the program.
The wobbling worksheet has been completely revised in version 3.xx. Please refer Figure 3.4 on page 20. Not all setting options were possible
bring to this sheet. For this reason, the graphic representation was removed from this sheet and space was made for new functions. The wobble graphic was programmed in an extra window. See Figure 3.5 on page 20. I'll come to that description later. I have grouped all functions in small groups.

3.3.1 Sweep Settings

Beginning, end, measurement points

The start frequency is entered in the "Start" editing window and in the „End" the end frequency. Finally, the number of measuring points is determined. The increment is determined from this information itself. The inscription of

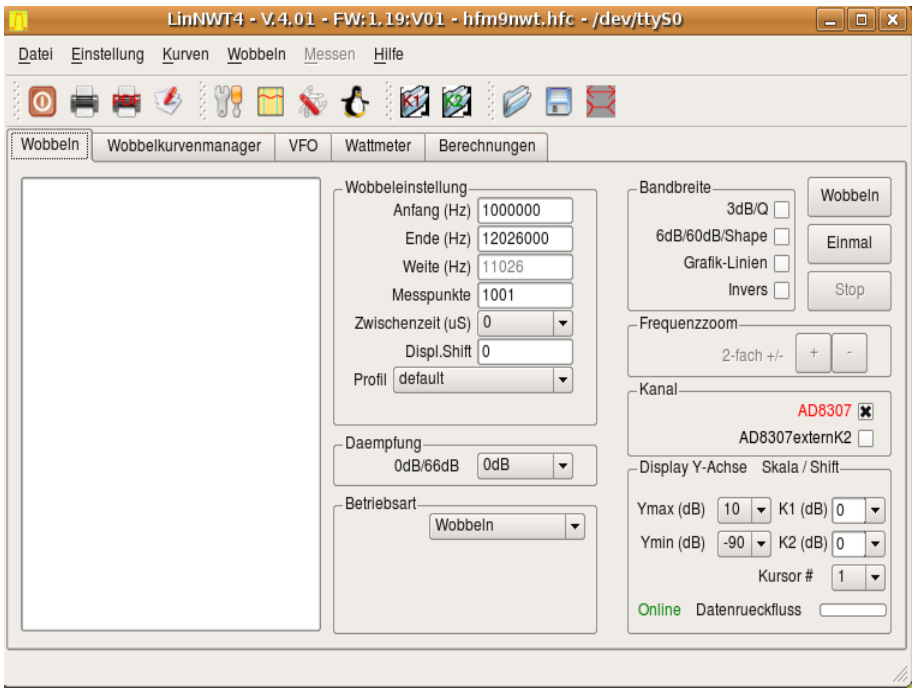

Figure 3.4: View of the wobbling worksheet

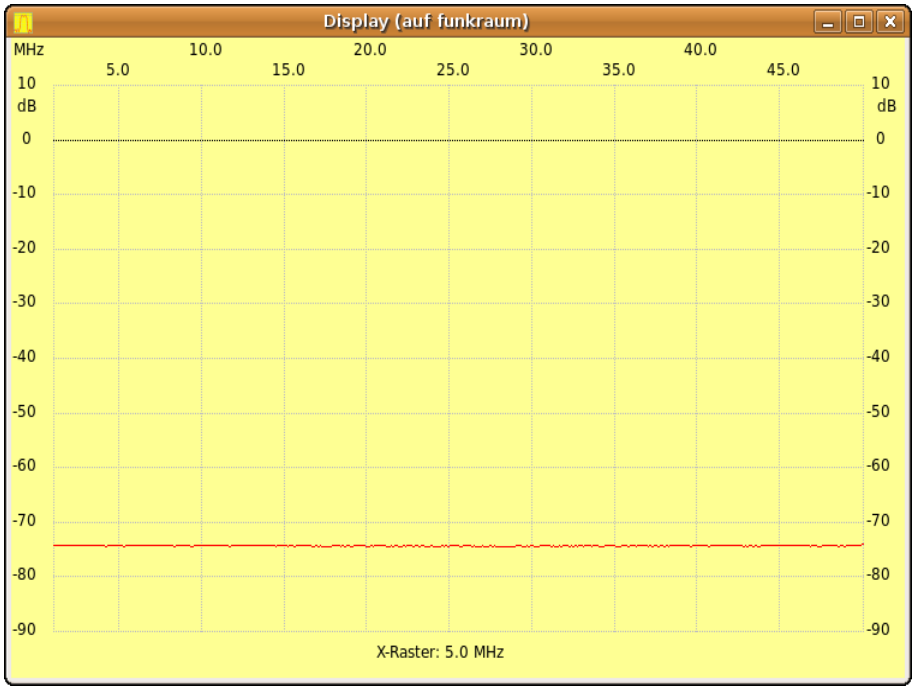

Figure 3.5: View of the extracted graphic

X axis is also done independently from this frequency data. In addition, the distance of the X grid is displayed as a value at the bottom of the wobble window. This should serve for better orientation. The input values can be Hz, kHz or MHz according to the following format: 3m5 3.5m 3.5m = 3500000 Hz.

meanwhile

In version 4.xx and the corresponding FW it is possible to slow down a wobble run. In the NWT, each measuring point needs time for the program processing in the pic. It consists of 1. Calculating and setting the DDS frequency and 2. Measuring channel 1 and channel 2 and transferring to the PC. I have optimized these running times in the PIC in such a way that a faster wobble run is achieved and a filter adjustment is visible almost immediately (setting about 401 measuring points). However, it has been shown that for the display of curves with steep edges and a low level, the time between the measuring points must be longer. That's why I „schenzeit" programmed as a performance feature. That's extra time between the measurements during the sweep. Does the software recognize the correct current firmware in the NWT, the selection of the "meanwhile" becomes active and can to be set. A maximum of 999 uSec can be set. Is the meantime greater than zero, another transmission protocol is used on the RS232 to transmit the meantime to the NWT (therefore the appropriate FW is required in the PIC). The FW 1.18 is currently up-to-date. Increasing the number of steps to a maximum of 9999 sometimes does not bring as good results as increasing the scan time. It's worth experimenting with.

Display Shift

This point has not existed for long. This entry will move the zero line in increments of 10. A small example: The output of the NWT is used to control a transmission output stage. We connect a power termination with a measurement output of -40dB to the output of the transmission amplifier. If the PA has a gain of 15dB, a line would appear at about -25dB and I would have to completely re-calculate. With „Display Shift" and „Shift X-axis" I can interpret the label so change that the „dB values" as „dBm values". I wobbled some self-made amplifiers in this way. my performance termination (200 watts from the FA) works in the entire shortwave range a good SWV. But there are also other uses for displays „Shift" conceivable.

profile

Predefined profiles can be selected in this combo box. Start frequency, end frequency and steps are saved together under this name. There is one for setting up and editing the profiles menu item under „Sweep". The „default" profile is generated automatically and contains the last used frequency data. All defined profiles are saved in the configuration.

3.3.2 Attenuator

0dB/50dB or 0db/66dB

This is the ComboBox for the controllable attenuator. Was a steam max -50dB connected to port B, the relays for the attenuator „ fung" can be controlled by the program. From version 2.xx it is also possible the attenuator can be controlled by the radio amateur. This attenuator has better resolution (2dB per step and a range from -4dB to -66dB). During calibration, both attenuators are automatically switched accordingly, so that only one connection cable needs to be plugged in between the generator and the measuring probe. Switched to the FA link is in the option below„Cal. corr. D link".

3.3.3 Operating mode

For sweep, SWV, SWV „ant and Z-impedance modes, „SA Be rich 1" and SA„ range 2" the frequency settings are noted separately and saved. When switching the operating mode, the old frequency setting is position loaded again. These settings are also written into the configuration and are available again the next time the program is started.

wobbling

This is the operating mode for normal sweeping. The result is shown in the graphics window. In order to obtain accurate results, a calibration must first be carried out. The calibration result is displayed for each probe in saved in a separate file. The entry becom„es the default name used in„ the option. This file with its data is start loaded automatically. But I can also load another file, for example if calibration was carried out separately in special frequency ranges. Switching to the linear measuring probe is also done by reloading a corresponding probe file. The name is now also in the opto- „ on" and becomes the name template when calibrating the linear internal probe used.

SWV

In this operating mode, the SWV can be displayed in the graphic window. A calibration process is also required for an accurate measurement.First must but a calibration was carried out in the wobbling „mode will.This calibration process is the basis of the calibration for the SWV mode. The SWV r„esolution can be set accordingly.

SWV ant

This operating mode also enables the cable losses to be calculated up to the point of the SWV calculation. No calibration is required here.

Z impedance

If a resistance of 50 ohms is connected in series to the measurement object, it is possible to display the real Z value. The trick here is that with 50 ohms to finish, we add another 50 ohms giving a SWV of 2.0. The 2.0 SWV line becomes the 50Ohm line. Unfortunately, only real values can be displayed. No calibration is required here.

spectrum analyzer

From SW version 4.xx it is possible to connect a spectrum analyzer attachment to the FA-NWT. This SAV has 2 measuring ranges, the 1st range is from kHz to 72MHz and the 2nd range is from 135MHz to 149MHz and is suitable for measurements in the 2m band. The HF output of the FA-NWT is used as a VFO for the SAV. The measurement input of the NWT is connected to the measurement output of the SAV. All required information is in the Option", „Spectrum Analyzer"registered. The IF is automatically included " taken into account as soon as this mode of operation is selected, depending on the area, the IF added or subtracted. Will in the„Option"the point „HW feedback report from SA"activated, the corresponding switch position of the SA automatically reported to the SW and displayed. In addition, the SW monitors some wobble settings and reacts accordingly to incorrect values. Through the„HW feedback from SA"the measuring range is switched over tomatic. Was still the„Automatic Step Correction"activated the step size is set according to the bandwidth setting ment on the SAV by increasing the number of steps accordingly. As of SW V4.04, the number of steps is automatically reduced again. the mini most number of steps you can in„min number of steps"set. the „HW feedback from SA"and „Automatic step correction correction"is only activated if the correct FW is recognized in the FA-NWT will.

Spec.FRQ-shift

This additional operating mode is also intended for spectrum analyzers. Additionally the frequency indication in the display increases by an adjustable amount„Opti on", „Spectrum Analyzer", Shift"postponed. But only the ad. sex this operating mode is intended for the use of a frequency converter in front of the SA.

3.3.4 Bandwidth

This area is used to automatically determine different bandwidths from the wobble curve. The check button bandwidth 3dB„Q" is intended and „bandwidth 6/60dB/shape". Activating causes a calculation of the Bandwidths and the output in the information window. In the 3dB range, the exact center frequency written down with. In addition, the quality and if the 60dB sideband attenuation is reached, the shape factor is calculated with net and displayed in the information window. Will the check button„Graphic"activated the bandwidths are displayed in the graphic window by vertical lines.

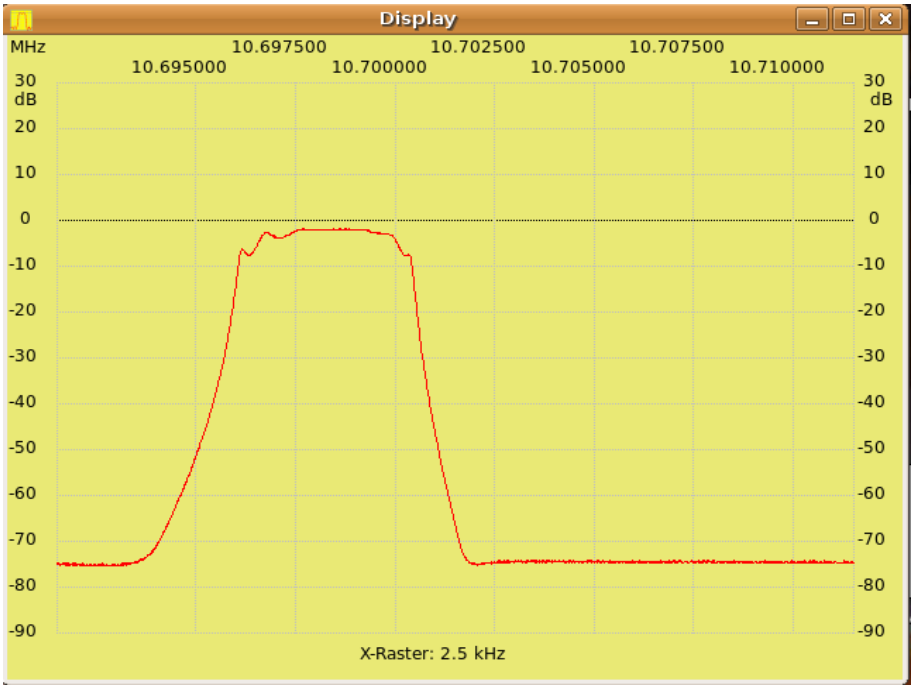

Figure 3.6: Maximum dB view−area

The point „inverse"is used to determine the above values for the inverse resonance curve, but this only applies to the 3dB range.

3.3.5 Frequency zoom

Setting the cursor activates the frequ„ency zoom". I don't have a better name invaded. The purpose is to move from the cursor to the frequency range decrease or increase without making new frequency entries for start and end frequency. After each enlargement or reduction, a sweep is started to make the changed sweep window visible. The center frequency is approximately the cursor. The frequency specifications for the calibration correction in the option are used as the limits of the frequency change. The frequency magnifier can now also be used from the graphics window. See chapter 3.8 on page 33.

3.3.6 channel

Two check buttons follow. They are for the display channel 1 and channel 2. The measurement data of both channels are always transmitted to the PC, only the channel display can be switched on/off. is in option” „ „one-can lig" can only be activated on channel 1⁄be deactivated. an additional The measuring probe is„available from the FUNKAMATEUR. Is themathematical calibration correctionactivated, the label appears in the color RED". „

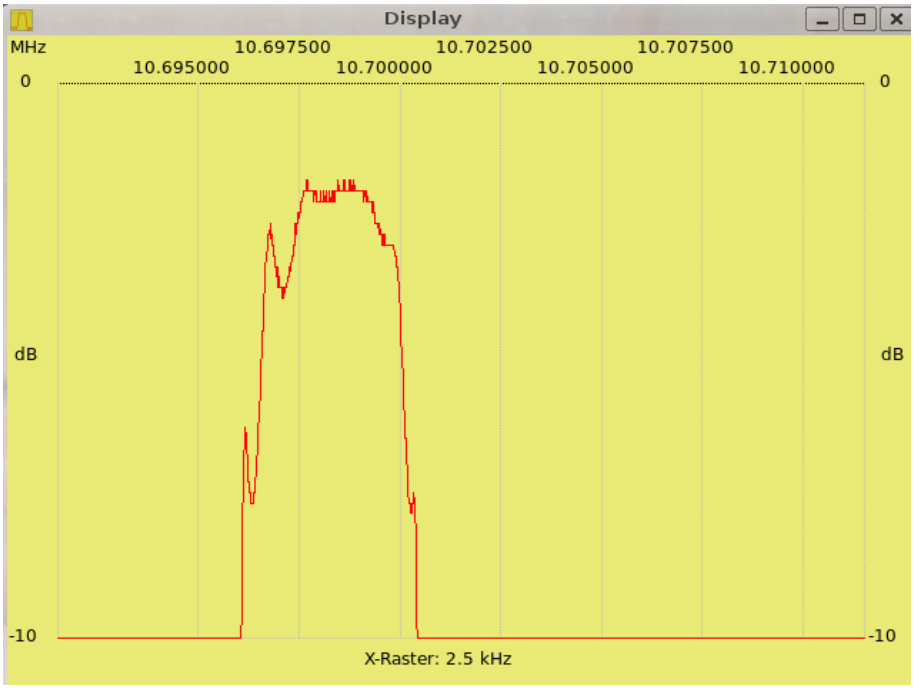

Figure 3.7: View of the same curve in the range 0dB to –10dB

3.3.7 Ymax, Ymin

As of version 4.xx, scaling of the Y range is possible. These 2 setting options are used for this purpose. The upper dB line and the lower dB line are set. In figures 3.6 on page 24 and figure 3.7 on page 25 we see two settings of the Y-dB range.

3.3.8 Shift Y axis

This ComboBox allows to move the curve on the Y-axis. The smallest unit is 1dB. The easiest way to do this is with the mouse wheel, by placing the mouse pointer in the ComboBox and using the mouse wheel to make the settings. The shift range is -10dB to +20dB and should be sufficient for most applications. If the shift value is not equal to 0 changes
the labeling of the Y-axis in the graphics window from the color„black" to the Red color". This serves as a reminder that something has been messed up.

3.3.9 Cursor

From version 2.00 it is possible to set up to 5 cursors. They work independently of each other.

3.3.10 Data Reflow

Here is a progress bar for receiving the sweep measurement data. The return flow of data from the module to the PC is displayed on this progress bar. When working with a large number of steps, this is an additional way to see whether the network tester is still working. Sweep progress is continuously displayed. From version 3.xx it is displayed whether there is a connection via the RS232. From the defined FW version, the variant number is also read out and displayed in the header. This can be seen in figure 3.4 on page 20. The variant number corresponds to the hardware used.

3.3.11 Info text window

On the left is the information window for text output. The maximum and minimum values are determined for each displayed channel. In the info window can via the menuFile"; „Enter layout label"a descriptive be entered in writing. This label may be important for a printout and is written to the curve file from version 2.03. A direct entry in the information window will not be included in the printout! The information for each set cursor also appears here. However, during wobbling, the information from cursors 2 to 5 is hidden. This is done for reasons of speed when text is output. Otherwise the information window will described too quickly with useless text output. The "Stop" button causes that all information appears again.

3.4 The Sweep Curve Manager Worksheet

From version 2.xx there is the wobble curve manager. It is possible to display saved curves and curves that have just been wobbled as vector graphics in the background of the wobble window. The use of the Wobbelma nageres makes it necessary to disable the "mathematical calibration correction" activate. You get this notice when using the software. the Reason is very simple. When saving the curve file, the properties of the currently used measuring head are saved in the file, but not the values of the mathematical calibration correction of the measuring head used. Unfortunately that is not possible. If we load the file into the sweep curve manager, the calibration corrections per frequency are missing and the trace will be like this displayed as if without mathematical calibration correction". been. That's not too bad, but these deviations are visible. Therefore my advice, rather calibrate once more without mathematical ones Calibration correction" and the display is really accurate. In any case, exactly enough for our amateur purposes. It is important to only calibrate in the frequency range that you actually use. This method gives the most accurate results. A view of the worksheet is shown in Figure 3.8 on page 27.

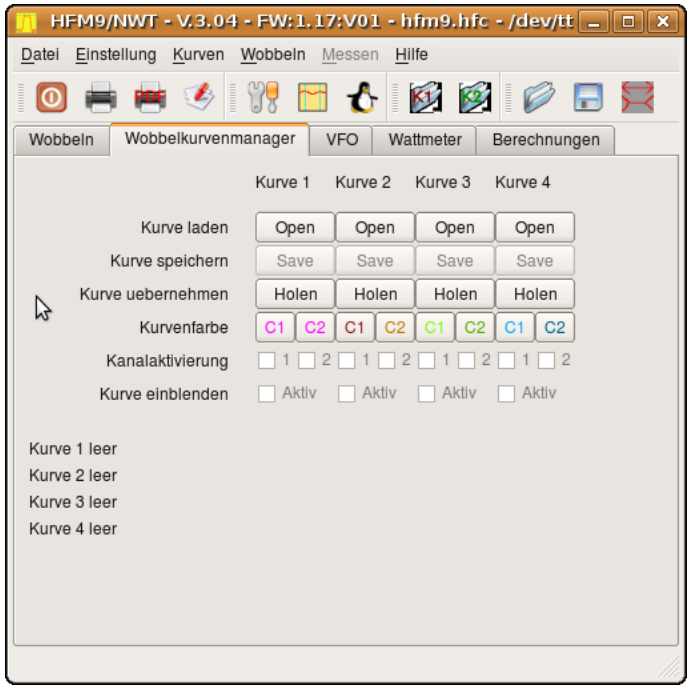

Figure 3.8: Curve manager view

3.4.1 Load curve

With the button "Open" you can open a saved curve in the background load reason. It doesn't matter which resolution, which catch frequency and which end frequency the data was saved. If the curve goes to be displayed, it is also displayed. The curve is presented with the properties of the measuring probe that were also used to record the curve. So we're back to the point that calibration is in the frequency range we're currently usingwithout mathematical calibration correctionis very important for an accurate representation.

3.4.2 Save curve

Dir Punkt Save" is used to subsequently save a curve file, if, for example, you use the "Get" button to move a curve to the background loaded and wobbled happily on. So you can see the curve file save later.

3.4.3 Get curve

The "Get" button fetches the curve data from the main program into the Wobbelmanager without having to save the data first. As above described, the mathematical calibration correction is not taken into account.

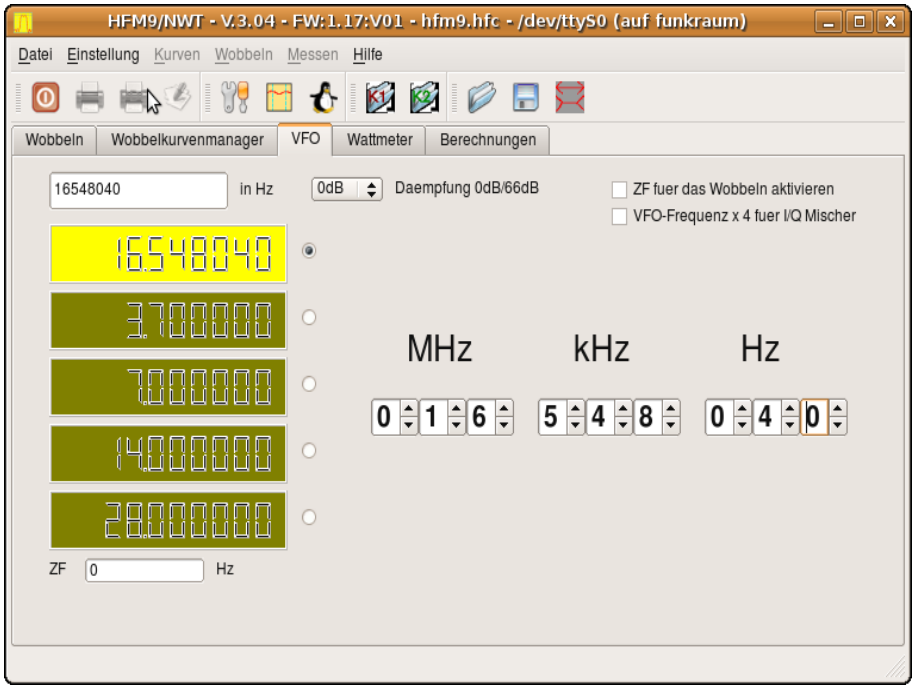

Figure 3.9: View of the VFO worksheet

3.4.4 Curve color

The buttons „C1“ and „C2" are used to set the colors for the lines in the Background. Where C1 is for channel1 and C2 for channel2. The color settings are saved in the file „wkm.cfg".

3.4.5 Channel Activation

As the name suggests, the individual channels are activated here.

3.4.6 Show curves

With this activation you can completely show or hide the data from the background. This is useful when displaying both sweep curves channel 1 + channel 2.

3.4.7 Curve Info

Here you can see information about the curve. When „fetching" only the time is blinded and when „loading" the file with the entire path + layout label.

3.5 The VFO worksheet „

We see a view of this area in Figure 3.9 on page 28.

3.5.1 VFO frequency calibration

The frequency accuracy of the VFO depends on the frequency accuracy of the clock generator in the NWT. I would like to explain this to the FA-NWT. At the FA-NWT the DDS clock frequency is 400MHz. This clock frequency is in the option „Basic Data/Sweep" under DDS „Clock Frequency". We need now an exact reference frequency for calibration. Either a frequency times or it is also possible to compare it with a radio station, for example German Wave" at 6.075 MHz. This transmitter is very frequency accurate. I adjust the VFO also on 6.075MHz and couples the VFO signal very slightly in the HF receiver, so the frequency deviation between the VFO and the AM Carrier of „Deutsche Welle" audible, maybe the AF signal will also help in visualized with an oscilloscope. Now adjust the VFO until exactly zero beat of the two frequencies is reached. The exact clock frequency can be calculated from the set VFO frequency. Assuming the VFO frequency is 6075120 Hz, the new clock frequency to be set is calculated using the formula:

$$\text{new clock frequency} = \frac{6075120}{6075000} * 400000000$$

As a result, in our example, we get 399992099 Hz. This frequency we set in the option" and confirm with „OK". The program calculates net the new DDS status and transmits it to the NWT. Then the new value is saved in the eeprom of the PIC and the NWT performs a „warm begin". After the „warm start" is as default" again 4MHz at the NWT- " output on. Only a new command on the RS232 changed by the program the frequency. So now set the VFO frequency exactly to 6.075 MHz and the zero beat should be reached.

3.5.2 Operating elements worksheet VFO"

The VFO frequency is only correct if the clock frequency has been precisely calibrated beforehand became. In „the VFO" a frequency from 1 Hz to „maxvfo" (in the „Option") MHz can be set. I set the frequency in 3 groups divided to make it clearer. The best way is to use the mouse wheel. Each decimal place can be set individually. The IF can be entered in the IF line. If the VFO should oscillate below the displayed frequency, the sign is entered negatively. From version 1.09 it is possible to use the IF for wobbling. The background is that there are OMs that use the NWT as a VFO for a good HF receiver. The HF receiver is used as a spectrum analyzer by analyzing the IF signal is fed into the measurement input. Better it is the option „settings" for using the spectrum analyzer. In the upper input line, the frequency can be entered directly. The VFO frequency can also be adjusted with the keyboard from version V1.09 (see table).

PLUS	Q	W	E	R	T	Z
	10MHz	1MHz	10kHz	1kHz	10Hz	1Hz
MINUS	A	S	D	f	G	H

The selection of the various attenuators can now also be added

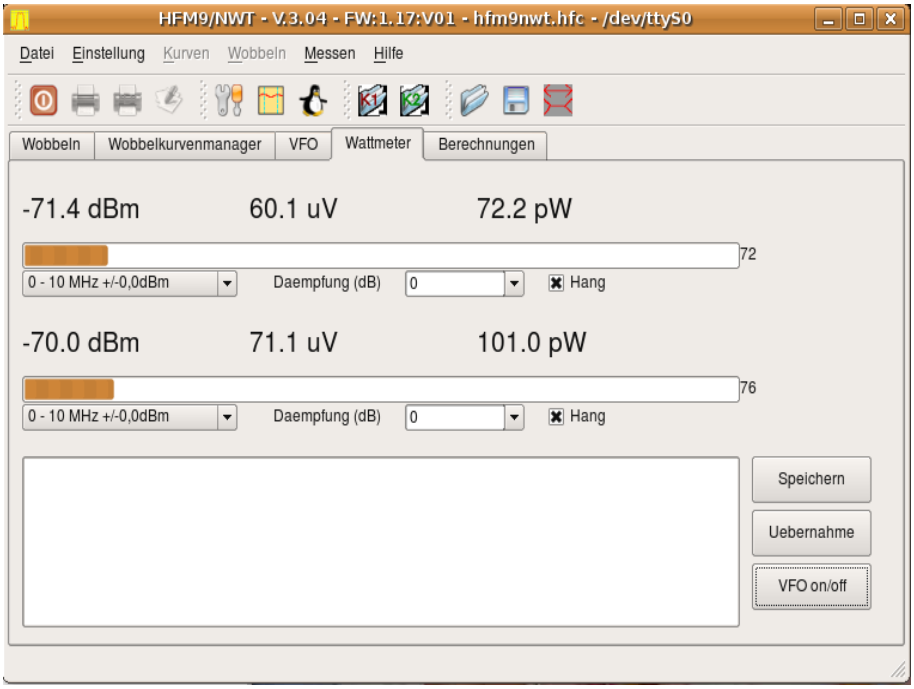

Figure 3.10: Wattmeter worksheet view without VFO

set in this worksheet. The corresponding „
appropriate attenuator switched (0-50dB or 4-66dB from the FA), at point
„FA Steam.".

3.6 The Wattmeter Worksheet

A view of the worksheet is shown in Figure 3.10 on page 30. The
Wattmeter" shows when using logarithmic sensors the displayed "
level in dBm", „ „volts" and „watts". volts" and watts",
calculated from the dBm values and displayed in the appropriate unit of measurement. the
calculated values for „olts" and „watts" appear a bit rough, that's because of the
resolution of the AD converter of 10 bits and the measured value is logarithmic
mixed If the voltage is calculated from dBm values, there are also large
jumps in the measurement range. That's why I used the trick of forming an
average value from several measurements. In addition, a rising value is
displayed immediately and a falling measured value is displayed with a delay,
similar to a hang control with the AGC of an RX. With the check box
Hang" you can deactivate the hanging function. Every 100 ms "
the mean value is formed from the measured values obtained. default setting
is an interval of 20mseconds between each measurement. This means that a
measurement consists of 5 partial measurements.
On the right above each of the two measurement channels are 2 combo
boxes for the correct display correction when using pre-attenuation elements

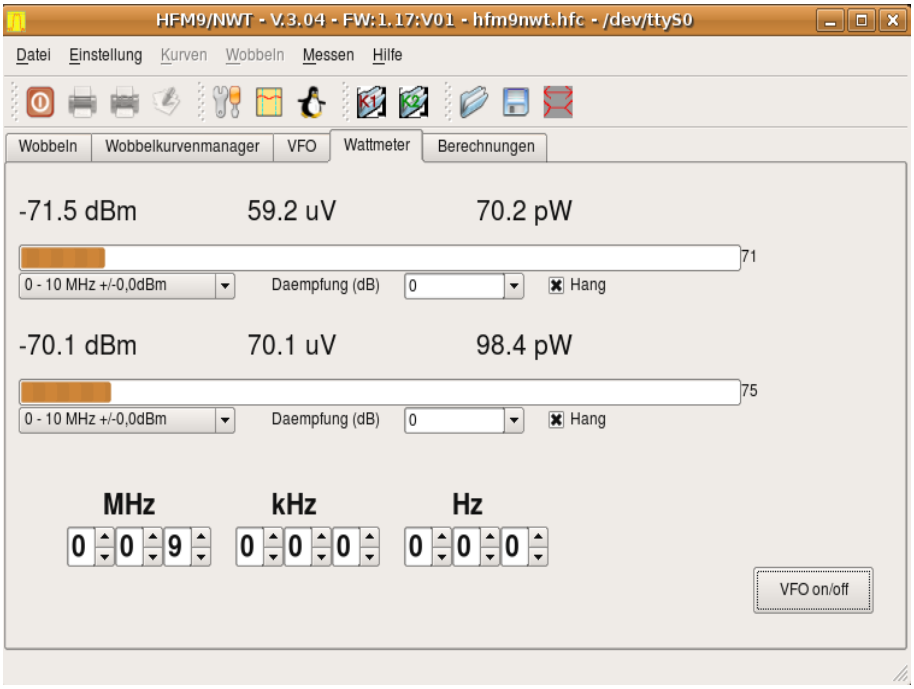

Figure 3.11: Wattmeter worksheet view with VFO

(performance measurement). On the left below the display bar is the combo box for the frequency correction of the dBm measurement values. This was necessary to compensate for the dB drop after high frequencies. This is especially when Use of the AD8307" necessary. These settings can be used from version 2.03 can also be edited by yourself. Editability is necessary for use from other ICs in the measuring heads. The Edit menu item is used for editing animal probe 1 / probe 2". A view of the dialog can be seen in the figure 3.12 on page 32.

The displayed values of the two transferred to the channels in the table. In this text window you can edit immediately will. For example, you can enter a short description of the measuring point wear. This is included in the text file, which can be saved with the "Save" button. can be saved. In addition, from version 3.xx there is a button for switching to an additional VFO was added. This VFO is useful for adjustment work, for example: on bandpasses. The switched-on state and the set values are saved in the configuration file.

3.7 The Calculations Worksheet

A view of the worksheet is shown in Figure 3.13 on page 32.

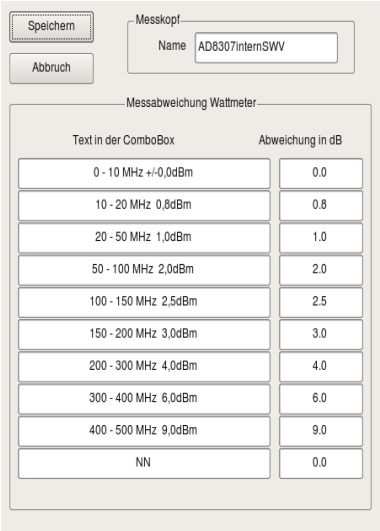

Figure 3.12: View of the dialog for editing the dBm deviation

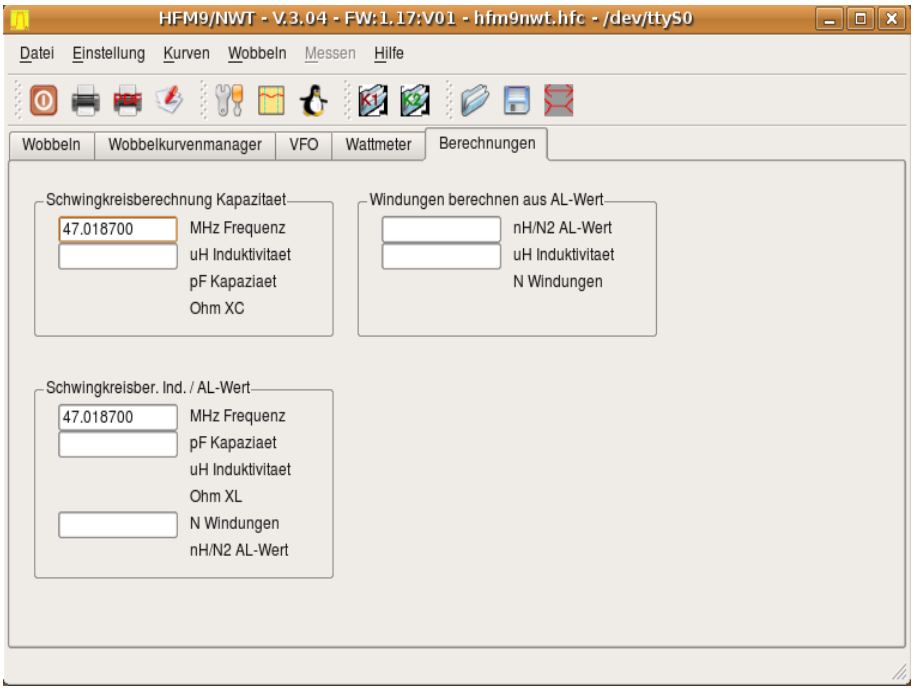

Figure 3.13: Calculation worksheet view

3.7.1 Resonant Circuit Calculation Capacity

For entering the frequency, there is the option of assigning the value directly from the graphic window (right mouse button, menu) or simply entering the value by hand. Both are possible. The inductance used and the frequency must be known.

3.7.2 Resonant circuit calculation ind. AL value

For the frequency input there is the possibility to assign the value directly from the graphic window or you simply enter the value by hand. Both are possible. In addition, the AL value can be calculated. I only need to specify the number of turns of the test circuit. The AL value is calculated automatically and also transferred to the next group field. Here, the capacity and the frequency must be known. If the number of turns is also specified, the AL value is automatically calculated as well.

3.7.3 Calculate turns from AL value

Either the AL value has already been transferred from the resonant circuit calculation or you simply enter the number yourself. The number of turns is calculated.

3.8 The extra window for the graphics

In version 3.xx, even more control elements had to be added to the worksheet „Wobbe accommodated. That was no longer possible. That's why I have it graphic display of the wobble curve programmed in an extra window. After initial difficulties with the new operation, it was the right one Decision. In the„Option"in the TAB „General"can be determined on which button the focus automatically switches to the graphic window target. Another simplification is the reduction of the width of the main window ters with the menu item„obble, change window width"or the speaking icon button in the icon bar (far right). In addition, it is possible to control some functions in the graphics window with the keyboard. Here is a list of the possibilities.

button	function
return	set the cursor
Space	Sweep once with the cursor set, the cursor point becomes the frequency center in the sweep window and then the middle of the window cursor to the middle
up	and magnifying plus once wobbling cursor to the middle
Down	and magnifying minus once wobbling cursor 5 pixels to
Left	the left
Right	Cursor 5 pixels to the right
1	Switch to cursor 1 with return set the cursor Switch to
2	cursor 2 with return set the cursor Switch to cursor 3
3	with return set the cursor Switch to cursor 4 with
4	return set the cursor Switch to cursor 5 with return set
5	the cursor delete all cursors
0	
E	Once (like button)
W	wobble (like button)
S	stop (like button)

3.8.1 Mouse function left „button" in the wobble graphic

After the wobble curve has been displayed, a curve analysis can be performed with the mouse be performed. Simply click the left mouse button on the corresponding one click position. The „data is displayed in the info window.

3.8.2 Mouse function right „button" in the wobble graphic

A small „additional menu is displayed with the right mouse button. I can either accept the frequency values as the start or end frequency or also delete the cursor.
Another additional item in the menu is to calculate the exact cable length based on the resonant frequency of the cable. The description appears in a dialog box. A menu item follows with which the electrical data of the cable can be calculated from the cable length. The last menu item is the transfer of the frequency to the calculation worksheet.

3.8.3 Resizing of the wobble window

The size of the wobble window can be changed arbitrarily. The minimum is fixed so that a meaningful representation is still possible. The maximum is determined by the screen resolution. When printing, the wobble window is briefly reduced to a defined size. This is necessary for the correct representation in the printout. After printing, the previous window size is set again. The size of the cursor triangle is also changed when the size of the sweep window is changed.

3.9 The calibration

In order for the HW to become an accurate measuring device, it needs to be calibrated. The correct description is provided in the following chapters. The correct order of calibration also plays an important role. The following order is recommended.

1. Calibrating the exact frequency of the DDS output. This depends on the exact DDS clock.
2. accurate 0dB line in the modewobbling.This depends on the HW of the NWT kit (frequency response of the generator output and the HF sensitivity of the measuring head input)
3. The calibration of the HW of the SWV measuring head in theSWV mode.
4. Calibration the accurate dBm display in the modespectrum analyzer.This calibration is divided into two areas. The first area describes the calibration for beginners and is purely independent of the frequency used. The second area is intended for the expert. In the expert section, the frequency-dependent deviations of the input low-pass filter in area 1 and the input band-pass filter in area 2 are included in the calibration. With this we reach the accuracy limits of the HW of the SA attachment, which are quite considerable for this device.

3.9.1 The calibration of the DDS clock

This calibration was already described in paragraph 3.5.1 on page 29 and repeated again. The frequency accuracy of the VFO depends on the frequency accuracy of the clock generator in the NWT. I would like to explain this to the FA-NWT. With the FA-NWT, the DDS clock frequency is 400MHz. These Clock frequency is in the „ option, basic data/sweep" under „DDS clock frequency frequency". We now need an exact reference frequency to librate. Either a frequency standard or the comparison can also be used a radio station, e.g. Deutsche Welle" on 6.075 MHz. This transmitter is very frequency accurate. I also set the VFO to 6.075MHz and couples that VFO signal very easily in the HF receiver, so the frequency deviation between the VFO and the AM carrier of Deutsche Welle" audible, it may also help to make the NF signal visible in an oscilloscope. Now adjust the VFO until exactly zero beat of the two frequencies is reached. The exact clock frequency can be calculated from the set VFO frequency. Assuming the VFO frequency is 6075120 Hz, the new clock frequency to be set is calculated using the formula:

$$\text{new clock frequency} = \frac{6075120}{6075120} * 400000000$$

As a result, in our example, we get 399992099 Hz. This frequency we set in the opti on" and confirm with „OK". The program calculates net the new DDS constant and transmits it to the NWT. Then the

new value is saved in the eeprom of the PIC and the NWT performs a „warm begin". After the w„arm start" is as default" again 4MHz at the NWT- ” output on. Only a new command on the RS232 changed by the program the frequency. So now set the VFO frequency exactly to 6.075 MHz and the zero beat should be reached.

3.9.2 The calibration of the sweep range

This calibration was already described in paragraph 3.2.4 on page 16 and repeated again. Each probe must be calibrated to achieve accurate measurements. The first query is the type of sensor lin/log. Then an attenuator -6db/-40dB to be looped in. Finally, the VFO output is connected directly to channel 1. From all
two series of measurements, two constants are calculated that define the function HF„ level− >Output voltage” of the sensor. this function
is always li„near" and can therefore be described with only 2 constants.
the. The result can be saved in the menu item "Properties measuring probe channel 1".
chern” can be saved, but the save dialog is offered immediately during calibration. Owners of a connected attenuator do not need to insert any additional attenuators, the software automatically takes care of inserting the attenuator. This applies to the full extent (linear measuring probe needs -6dB element) only with the FA attenuator. So only one connection cable needs to be plugged in between the two coaxial sockets. When determining the second reference line, which should normally be 0dB, a small attenuator can also be looped in. This is intended for measuring probes that cannot tolerate the level of +4dBm and become inaccurate in this range. But these are special cases, we use the presented 0dB insertion loss.

Mathematical calibration correction when using the log. measuring probe.

Let's look at our calibration result when we comp„are the output of the
connect the oscillator directly to the measurement input. It can be seen that the calibration curve falls after the high frequencies. We are lucky with the FA-NWT, due to the good construction, the 0dB line is inherently very straight. However, if we compensate for the deviation mathematically, we can correct the course of the line. A file is created in which the frequency per frequency
deviation in „dB". We can use this to measure our measurement curves compensate file. The measurement accuracy increases over the entire range + /–0.5dB. In order to compensate the entire range, the frequency range to be calibrated is defined in the configuration data and can only be set via the menu itemA„ttitude; Option"to be changed. In the file with the ending*calibration file name-kx.hfe*the correction values are saved. These
The innovation also applies to channel 2. The linear measuring probe is not taken into account. If the calibration correction is activated for a channel, the color changes the labeling of the check button in the color RED„".
There is a proble„m with the mathematical calibration correction, however. As soon as a saved curve file is loaded into the sweep curve manager
the "mathematic„al calibration correction" is not included in the curve progression shown. There is therefore a deviation between the
provided curve and the curve in the„Manager". That's why I have a warning note added to the program that allows this calibration cor„rection"

switch off when loading curve files. That's the only way to be error-free work with„the wobble curve manager. So I suggest on this one Refrain from correction and prefer once more the special frequency range to calibrate.

3.9.3 The calibration of the spectrum analyzer attachment

The calibration of the SAV is divided into three areas

1. Calibrate the exact frequency by adjusting the intermediate frequency of the SAV.
2. Alignment of the displayed levels at the different adjusted bandwidths.
3. Setting the dBm level in range 1 and range 2.
4. Inclusion of the frequency-dependent transmission curve of the input filter of the SAV-HW. These curves look different for each SAV. It is necessary to compensate for this.

The frequency calibration

In the SAV we feed a generator level with a known frequency into the input. We set the SAV to 300Hz and check the frequency on the display. We can correct the displayed line by changing the IF in the corresponding area 1 or 2 pointsAttitude; Option; Frequency-area 1/2; IF"

The basic calibration of the dBm display

This calibration is divided into 2 areas. First we adjust the levels of the different bandwidths. To do this, however, you must first try to adjust the levels in the HW of the SAV exactly according to the assembly instructions. Only when this is no longer possible is the remaining level difference adjusted in the SW. To do this, we apply a level that we know to the input of the SAV and note the levels shown on the display for the various bandwidths. ten. We can now use correction values insetting „ lung; Option; level correction for dBm display; B300/B7kHz/B30kHz". After the correction, we check the ad and, if necessary, make corrections to the deviations again. If an alignment is successful, we can get the overall level by entries inAttitude; Option; pe gel correct. for dBm display; Area 1 / Area 2"still correct. This is possible separately for areas 1 and 2. Area 3 is for the operating mode sec.FRQ-shiftthought and is additionally added to area 1 or 2.

The advanced calibration of the dBm display

If the basic calibration is successful, we can increase the display accuracy. To do this, the transmission curves of the 2 input ranges of the SAV must be recorded. It is important when recording the wobble curve that the

mathematical calibration correctionis activated. So first again in the wobble area with the activated onemathematical calibration correction calibrate. Then we determine the transmission curve of area 1 and area 1 by plugging in the calibration measuring cable as described in the construction folder. Rich 2nd setting when sweeping: Intermediate time to 9990„and measuring points 9999". Each determined curve is saved in a curve file and the " File names noted. Now we put the jumpers back in the SAV so that the SAV is operational again. We use these curve files for calibration ren. To this we go inAttit„ude; Option; spectrum analyzer"and press the buttonCalibr„ate".It will ask for the curve file. We activate the curve file for area 1 first. The starting frequency and end frequency is taken from the option and confirmed. By reading in the curve file and themathematical calibration correctionAn SAV calibration array is filled with data, which compensates for the dBm display as a function of frequency. After exiting the option we see our calibration result at the SAV baseline. This now has the mirror image of the recorded wobble curve. For area 2, the correction can now also be made with the 2nd curve file. The mirror-inverted course of the wobble curve in the base line must now also be visible here. As a final level correction tur becomes the overall lev„elAttitude; Option; level correction for dBm Advertisement; Area 1 / Area 2"still readjusted. The frequency dependent ones Calibration correction level values are stored in the sav.„cal file. Now we are done with the calibration and can use the SAV for our measurements use sung. An image of the baseline in region 1 of my SAV is shown in Figure 3.14 on page 39. The spikes in the baseline originate at 30kHz bandwidth and are DDS spikes and mixed products in the SAV. These can only be eliminated with a great deal of effort. Another SAV trace with a bandwidth of 300Hz can be seen in figure 4.2 on page 44.

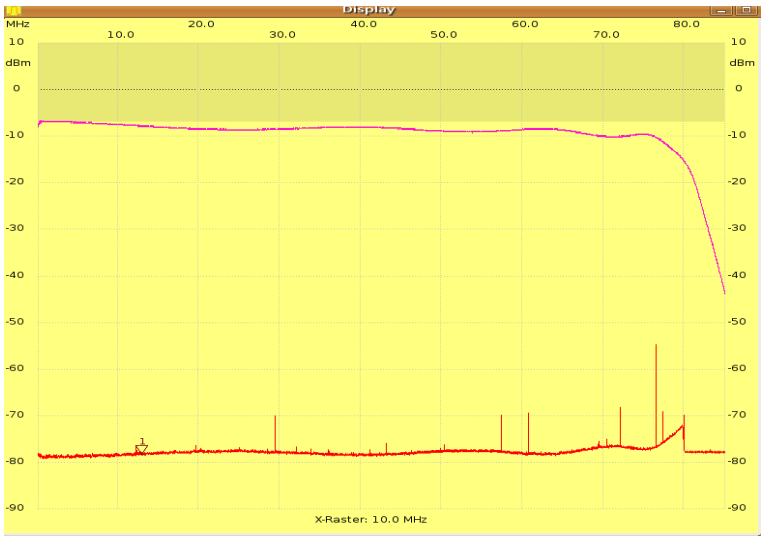

Figure 3.14: View of baseline with mirror image wobble curve in background

Chapter 4

The NWT hardware

4.1 The firmware in general

4.1.1 NWT7 / FA–NWT/ HFM9 / NWT500

For the data exchange I use a different protocol than Bernd. It was therefore necessary to rewrite the firmware in the PIC 16F876/873. If the PIC contains software with a bootloader from the FA or from me, the software can be updated via the serial interface. However, this only works if the appropriate bootloader is present in the PIC. DL1ALT uses one
different bootloader using different strings" for control. Therefore
it is necessary to inform oneself accordingly before obtaining the firmware
renewed and„nothing works anymore". A brief outline of how the FW is imported follows in another section. Further information can be found in Chapter 3.2.2 found on page 14.

4.1.2 RADIO AMATEUR NWT

The FA-NWT has been supplied with the appropriate firmware since 2006. one
Firmware updates are not normally required for the FA-NWT! Egg-
ne exception are a number of extensions and additional modules from
of the magazine FUNKAMATEUR". Usually a
Matching PIC included. However, further information can also be found here
You also in chapter 3.2.2 on page 14.

4.2 FA-NWT

4.2.1 Firmware

The current firmware at this point in time is version 1.18. Renewal of the firmware can be read in chapter 3.2.2.

Firmware variant 1

This firmware is for the FA-NWT with direct generation of the 400MHz clock frequency. No PLL is activated in the firmware in the IC AD9951 and it

the cleanest output signal is to be expected at the AD9951 output. This variant is also used in the latest HW version of the FA-NWT.

Firmware variant 2

This firmware is for the FA-NWT with 20MHz clock frequency. In the firmware, the PLL in the IC AD9951 is initialized with a factor of 20, which also results in a clock frequency of 400 MHz. However, the output signal is not as clean due to the PLL. This variant is used in the older HW versions of the FA-NWT.

4.2.2 The pinout of the PIC 16F876

Below is a table of pinouts:

port pin	IC PIN	direction	function
A-0	2	entry	AN0 A/D converter for lin. probe 1 internal
A-1	3	entry	AN1 A/D converter for log. Probe 1 internal
A-2	4	entry	AN2 A/D converter for status SAV
A-3	5	entry	AN3 A/D converter free
A-4	6	entry	free
A-5	7	entry	AN4 A/D converter for probe 2 external
B-0	21	An exit	Query FW update in the bootloader
B-1	22	exit	Activation of attenuator Activation
B-2	23	exit	of attenuator Activation of
B-3	24	exit	attenuator Activation of attenuator
B-4	25	exit	Activation of attenuator Activation
B-5	26	exit	of attenuator Activation of
B-6	27	exit	attenuator
B-7	28	exit	
C-0	11	exit	Data DDS
C-1	12	exit	free
C-2	13	exit	FQUD DDS
C-3	14	exit	clock DDS
C-4	15	exit	RS232 RTS for bootloader
C-5	16	entry	RS232 CTS for bootloader
C-6	17	exit	RS232 TX
C-7	18	entry	RS232 RX

4.2.3 Connection of a 2nd sensor

Measured values from 2 measuring channels are always read into the software, even if the 2nd channel is not used. If the 2nd analog measurement input is also connected to an AD3807, we can display a 2nd curve at the same time. So there are 2 measurement inputs on the PIC. Pin7 AN4 is used on the PIC for the 2nd measurement input. Using 2 measuring heads has the advantage that 2 curves are displayed simultaneously (in sweep mode). For example, I have always observed the band filters and the SWV at the antenna input on my K2 at the same time during the adjustment. This made the adjustment an optimal
le thing. An additional sensor is included with, the FUNKAMATEUR as a kit

available. If you omit the input resistance, it is possible to design the measuring input of the probe with a slightly higher resistance. It becomes possible to measure directly in active circuits (within certain limits). In my measurements on homemade receivers, the change in impedance was minimal (RX train is almost always in 50 ohm technology).

4.2.4 Connection of attenuator 10 - 50 dB

Connecting the attenuator of DK3WX depends on the FW in the PIC.

FW to 1.09 for FA-NWT and HFM9: PIN B3 =
10 dB attenuator PIN B4 = 20 dB attenuator
PIN B5 = 20 dB attenuator

FW from 1.10 for FA-NWT and HFM9 with adjustment for the FA attenuator:

PIN B1 = 10 dB attenuator PIN B2
= 20 dB attenuator PIN B3 = 20
dB attenuator

4.2.5 Connection of the attenuator from the RADIO CAMERA 4 - 66 dB

The attenuator works only from firmware 1.10 and software 2.03. The advantage of this attenuator is the fine gradation of 2dB. Furthermore, it is fairly linear up to 500MHz.

FW from 1.10 for FA-NWT and HFM9: PIN B1 =
2 dB Electronic Attenuator PIN B2 = 4 dB
Electronic Attenuator PIN B3 = 8 dB Electronic
Attenuator
PIN B4 = 4 dB basic attenuation Electronic attenuator PIN B5 =
16 dB resistance element
PIN B6 = 32 dB resistor element

4.2.6 Spectrum analyzer attachment connection - FA

The use of the spectrum analyzer attachment is already in SW version 3.xx programmed by the magazine FUNKAMATEUR". is rounded off
the operation of the SAV in the current version 4.xx. The SAV has 2 switches. Once the range switching with 2 positions of the measurement frequency ranges and then a switch for the bandwidth (30kHz, 7kHz, 300Hz). With the appropriate FW in the pic, the switching states of the SAV are transmitted to the SW and

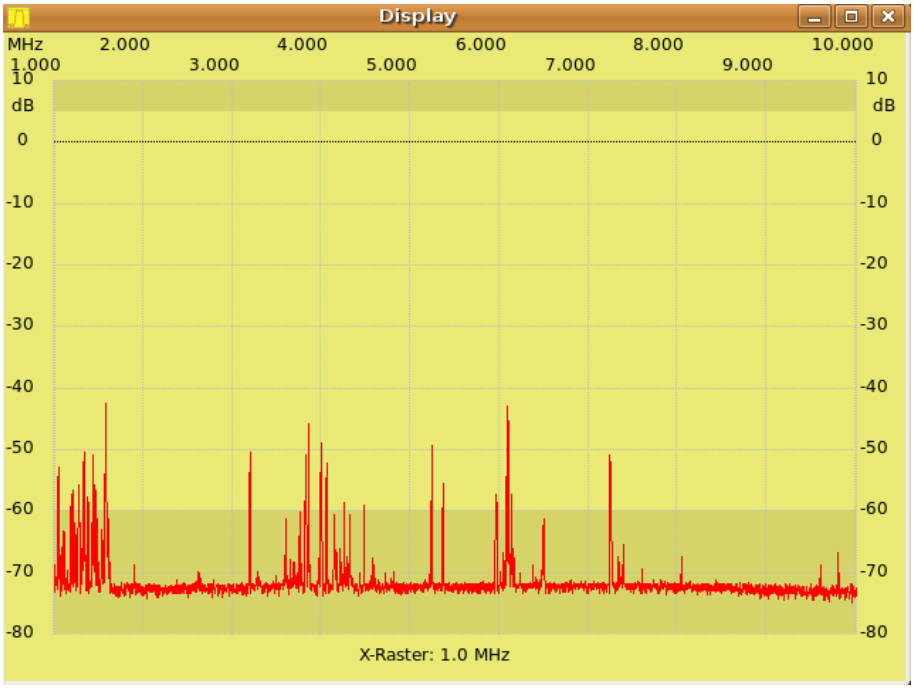

Figure 4.1: View of the Spectrum Analyzer operating mode with connected a SA resolution

shown there. This makes it possible to automatically switch over the frequency ranges to be measured and also to react to some operating errors. An example would be a bandwidth setting that is too narrow on the SAV with a large increment in the NWT. Corresponding instructions for installing the return channel are included with the SAV. For users of the NWT500, the feedback is also included in the FW. However, there is also the possibility of switching the scan areas of the SAV directly with the software. The disadvantage is However, the SW does not know" which switch position the SAV has. the imprecise display area of the SAV is grayed out in the display.
A view of a scan with the connected SAV can be seen in figure 4.1 on page 43. My dipole 2x26m is connected. You can clearly see the medium wave radio stations and also some HF radio stations.

4.3 HFM9

4.3.1 Firmware

The current firmware at this point in time is version 1.18. Renewal of the firmware can be read in chapter 3.2.2. Variants 1 to 3 can be used in the HFM9.

Figure 4.2: SAV view. My PA in the PicAStar, two-tone control 500Hz distance, almost full scale.

Firmware variant 1

This firmware is for the HFM9 with direct generation of the 400MHz clock frequency. No PLL is activated in the firmware in the AD9951 IC and the cleanest output signal can be expected at the AD9951 output.

Firmware variant 2

This firmware is for the HFM9 with 20MHz clock frequency. In the firmware, the PLL in the IC AD9951 is initialized with a factor of 20, which also results in a clock frequency of 400 MHz. However, the output signal is not as clean due to the PLL. If the HFM9 is not used as a VFO for an RX, the purity of the HF signal is completely sufficient.

Firmware variant 3

This firmware is not used in the FA-NWT.The firmware can flexibly set the PLL divider in the AD9951. The command for this comes from the software and all divider factors that are permissible for the AD9951 are possible. This setting item is located in the setup and is „default" blocks. First an entry with a Unix editor in the „configuration file". the setting is free. The following line is in the add: „configuration file"

pllmodeenable=1

With this entry, the ComboBox" in the „Setup" can be operated. This one position option is favorable for the use of other oscillators for the Clock generation of the AD9951. An example would be a cmoscillator 80MHz or 100MHz. To get to 400MHz internal clock, set we read in the „setup" „5x" or „4x" on.

4.3.2 The pinout of the PIC 16F876

The pin assignment is the same as for the FA-NWT see chapter 4.2.2 on page 41.

4.3.3 Connection of a 2nd sensor

The same applies here as in chapter 4.2.3 on page 41.

4.3.4 Connection of attenuator 10 - 50 dB

The same applies here as in chapter 4.2.4 on page 42.

4.3.5 Connection of the attenuator from the RADIO CAMERA 4 - 66 dB

The same applies here as in chapter 4.2.5 on page 42.

4.3.6 Spectrum analyzer attachment connection - FA

The same applies here as in chapter 4.2.6 on page 42. It is possible to work with the feedback of the status of the SAV.

4.4 NWT7

My SW can also be used for the NWT7 with the AD9851. In the firmware I have replaced all routines for driving the AD9951 with routines for driving the AD9851. I have also adjusted the baud rate to my SW, but the pic clock can also be increased to 20MHz. Corresponding variants of the FW are available. See the following chapter 4.4.1.

4.4.1 Firmware variants and pinout 16F876

The firmware for this hardware is available in variants 4 to 7. Variants 4 and 6 work with the PIC clock of 10MHz. Variants 5 and 7 are designed for a PIC clock of 20MHz. The advantage is faster wobbling. The sweep speed reaches the same speed as the FA-NWT. Below is a table of pinouts:

port pin	IC PIN	direction	function
			Variant 4 and 5
A-0	2	entry	AN0 A/D converter for log. Probe 1 internal
A-1	3	entry	AN1 A/D converter for lin. probe 1 internal
			Variant 6 and 7
A-0	2	entry	AN0 A/D converter for lin. probe 1 internal
A-1	3	entry	AN1 A/D converter for log. Probe 1 internal
A-2	4	exit	Attenuator relay -20dB AN3 A/D
A-3	5	entry	converter for probe 2 external
A-4	6	exit	Attenuator relay -10dB
A-5	7	exit	Attenuator relay -20dB
B-0	21	An exit	Query FW update in the bootloader
C-0	11	exit	Data DDS
C-1	12	exit	Reset DDS
C-2	13	exit	FQUD DDS
C-3	14	exit	clock DDS
C-4	15	exit	RS232 RTS for bootloader
C-5	16	entry	RS232 CTS for bootloader
C-6	17	exit	RS232 TX
C-7	18	entry	RS232 RX

4.4.2 Connection of a 2nd sensor

The connection point of the 2nd sensor is in the table in chapter 4.4.1 on page 46. The same applies here as was written in chapter 4.2.3 on page 41.

4.4.3 Connection of attenuator 10 - 50 dB

The connection points for the relay control of the attenuator can be seen in the table in chapter 4.4.1 on page 46.

4.4.4 Spectrum analyzer attachment connection - FA

Unfortunately it is not possible to connect this attachment to the NWT7 because the maximum output frequency of the NWT7 is not sufficient.

4.5NWT500

Helmut DL1ALT has developed an NWT500 that enables sweeping up to the 500MHz range. This NWT uses the AD9858 DDS IC. A different control in the firmware is therefore required. In addition, the firmware has the task of controlling a PLL-IC with which the clock frequency of 1200 MHz is generated for the DDS.

4.5.1 Firmware variants and pinout 16F876

The firmware for this hardware is available in variants 10, 11 and 12. Variant 10 has 12.8 MHz as the reference frequency for clock generation. Variant 11 also has a control pin for a relay. This relay is activated in SWV operating modes (see PIN table). Below is a table of pinouts:

port pin	IC PIN	direction	function
			Variant 6 and 7
A-0	2	entry	AN0 A/D converter for lin. probe 1 internal
A-1	3	entry	AN1 A/D converter for log. Probe 1 internal
A-2	4	entry	AN2 feedback SAV status
A-3	5	entry	AN3 free
A-4	6	entry	free
A-5	7	entry	AN4 A/D converter for probe 2 external
B-0	21	entry	Query FW update in the bootloader
B-0	21	exit	Control LMX enable
B-1	22	exit	Control LMX data
B-2	23	exit	Controlling LMX clock
B-3	24	exit	Control of attenuator -10dB Control
B-4	25	exit	of attenuator -20dB Control of
B-5	26	exit	attenuator -20dB
			only variant 11
B-6	27	exit	Control SWR relay
B-7	28	exit	free
C-0	11	exit	Data DDS
C-1	12	exit	Reset DDS
C-2	13	exit	FQUD DDS
C-3	14	exit	clock DDS
C-4	15	exit	RS232 RTS for bootloader
C-5	16	entry	RS232 CTS for bootloader
C-6	17	exit	RS232 TX
C-7	18	entry	RS232 RX

4.5.2 Connection of a 2nd sensor

The connection point of the 2nd sensor is in the table in chapter 4.5.1 on page 47. The same applies here as was written in chapter 4.2.3 on page 41.

4.5.3 Connection of attenuator 10 - 50 dB

The connection points for the relay control of the attenuator can be seen in the table in chapter 4.5.1 on page 47.

4.5.4 Spectrum analyzer attachment connection - FA

The same applies here as in chapter 4.2.6 on page 42. It is possible to work with the feedback of the status of the SAV.

Chapter 5

various

5.1 Program call with arguments in the command line

5.1.1 Program start with different configuration

From version 1.07 it is possible to specify the configuration file as an argument after the program name. Without an indication after the program name me as the default configuration" is the file „hfm9.hfc" is loaded. Would you like but immediately start the program with a different configuration, the The name of the configuration file is written after the program name. Consequently Is it possible to create several icons on the „desktop, each with a different one configuration settings. However, these configuration files must be in the HO MEREDIRECTORY/hfm9. This procedure is recommended if several network analyzers are available (e.g. 1x FA-NWT, 1x HFM9, the NWT7 with the AD9851 and the NWT500 from DL1ALT). So you can create an extra configuration for each HW. The file names of the default probe files should also be reassigned. When the configuration is loaded, the appropriate probe files are also loaded at the same time. It is also possible to operate several NWTs with one PC on different serial interfaces.

5.1.2 Program start with another language

Thanks to some OMs (Laszlo Rusvai DL2JTE, HA7MAC and G0UEN) the most important texts in the program have been translated into Hungarian and English. This translation file can also be appended as an argument when the program is called. As soon as the program recognizes a valid file, the corresponding language appears. I have already incorporated the language selection in the Windows setup. But under Linux you have to work as described above. See chapter 2.1.1 on page 6.

5.2 Description of all parameters in the configuration file

Description.

Surname	function
serial interface	serial interface under Windows COM1 to COM256
start of edit	Contents of the frequency entry Start
end of editing	Contents of the frequency entry End
edit steps	Contents of the input for the number of steps
editdisplay	Shifting of the 0dB line in 10dB steps Yes/No
graphic focus wobble	whether the focus should switch Yes/No
graphic focus once	whether the focus should switch Yes/No
graphic focus stop	whether the focus should switch
profilenameXX	Data for a profile entry Data for a profile
start of profileXX	entry Data for a profile entry Data for a
profiledXX	profile entry Font size in program Sweep
profile stepsXX	settings flag Sweep settings flag Sweep
program font size	settings flag Spectrum analyzer area 1 flag
mwbeginning	Spectrum analyzer area 1 flag Spectrum
mwende	analyzer area 1 flag Spectrum analyzer area
mwsteps	2 flag Spectrum analyzer flag area 2
msa1start	Spectrum analyzer flag area 2 Spectrum
msa1end	analyzer setting in option Spectrum
msa1steps	analyzer setting in option Spectrum
msa2start	analyzer setting in option Spectrum
msa2end	analyzer setting in option Spectrum
msa2steps	analyzer setting in option Spectrum
sa1beginning	analyzer setting in option
end of sa1	
sa2beginning	
sa2ende	
sazf1	
sazf2	

Surname	function
sastatus	Yes/No spectrum analyzer HW status
step corr	message in the option Yes/No spectrum analyzer automatic step correction in the option
measurement label font	Font of the wattmeter display Calibration
initial calibration frequency	start frequency in the Calibration end
final calibration frequency	frequency option in the Calibration steps
calibration steps	option
measuring time	Wattmeter Interval of measurements in mseconds
measurevfoactive	Yes/No whether VFO is active in the wattmeter
measuringvfo	Frequency of the VFO in the wattmeter Exact
DDSclock	clock frequency of the DDS in the NWT
PLLMode	Number of the PLL setting if pllmodeenable is active
pllmodeenable	Yes/No PLL setting in option is activated Yes/No Attenuator from
faeichlink	the FA Font size of the wattmeter
measuring label font size	display Font in the info text
info font	
infofontsize	Font size in the info text
editzf	ZF in the VFO
name probe1	Default name of probe 1 in option
name probe2	Default name of probe 2 in option Yes/
single channel	No active if only one probe is connected
calibrated1	yes/no math Calibration correction yes/no
calibrated2	math. Calibration correction yes/no math.
SWRIteration	Curve smoothing at SWV Yes/No for
SWR relay	special NWT500 with probe switching for SWV Inverse
bandwidth inverse	3dB bandwidth determination color for
colorXr,colorXg,colorXb,colorXa	channel 1 and 2
colorhr,colorhg,colorhb,colorha	color for the background maximum
maxwobbel	frequency for the sweep maximum
maxvfo	frequency for the VFO display channel
k1checked	1
k2checked	Channel 2 display
powerkXX	Additional entries of the attenuation in the wattmeter
a160m - a2m, au1 - au3 b160m - b2m, bu1 - bu3 160m - 2m, additional1 - additional3 operating mode	05-09 vertical blue frequency markings vertical blue frequency markers Yes/No frequency markers Flag for the operating mode
ydbmax	Flag for max dB in the display
ydbmin	Flag for min dB in the display

Chapter 6

The protocol on the serial interface

In order to maximize the speed of the wobble, I programmed the following sequence. Each command in the direction of NWT-Pic is introduced with a small letter. The length of the data telegram results from the letters.

Important !!! The byte is added to each „8F hex" command.

Based on this byte, the firmware branches into my implemented routines and Bernd Kernbaum's software can still be used. All-
However, the module must be„restarted with "Power ON" if the SW is changed. Since the RAM area of the PIC is used twice, one Re-initialization of the firmware required (by "Power ON").

The following commands are implemented:

6.1 Commands up to PIC-FW version 1.13

The PIC FW is downward compatible. Here is the description of the commands.

6.1.1 w“ Sweeping with the AD8361 10 bit from A/D ” Converter, data length 22 bytes.

w	bytes 1
starting frequency	Bytes 2 - 10
increment	Bytes 11 - 18
number	Bytes 19 - 22

A small example:

Data on the PIC:w 001000000 00007000 2000

Initial frequency:	1,000,000Hz
Increment:	7,000Hz
Number of measuring points:	2,000

Data from the PIC:8000 bytes are given as a response to the PC. There are 2 bytes as a return value per measuring point and channel. 2000 measuring points times 2 channels results in 8000 bytes of data, which the module sends to the PC.

6.1.2 x “Sweep with the AD8307 10 bit from A/D” Converter, data length 22 bytes.

x	bytes 1
starting frequency	Bytes 2 - 10
increment	Bytes 11 - 18
number	Bytes 19 - 22

A small example:

Data on the PIC:x 002000000 00014000 2000

Initial frequency:	2,000,000Hz
Increment:	14,000Hz
Number of measuring points:	2,000

Data from the PIC:8000 bytes are given as a response to the PC. There are 2 bytes as a return value per measuring point and channel. 2000 measuring points times 2 channels results in 8000 bytes of data, which the module sends to the PC.

6.1.3 f“ Set VFO, data length 10 bytes. No by-” return.

an example:

f 007030000 the VFO is set to 7.03MHz.

6.1.4 m" Call up measured value, data length 1 byte. return” give 4 bytes.

This command is used to query the measurement channels. 2 bytes are returned to the PC per channel. They contain the 10-bit A/D converter results of the

measurement channels.

6.1.5 e" Calibration, data length 13 bytes, no byte return" be.

This command can be used to precisely adjust the clock frequency.
become men. The e” is followed by 10 characters. 2 Char result in a HEX number. All Letters must be capitalized except for the commanda!!!.as last
th byte comes the setting of the PLL in the DDS. The multiplier of the PLL and the steepness of the current source in the control loop are nested in the byte. For these settings you have to look closely at the data sheet of the AD9951. The PLL byte is only loaded in the PIC with PowerON from firmware version 104, but it must be sent in the data telegram of the command, otherwise the calibration will not work. As of FW version 1.14, the PLL byte is only taken into account in FW variant 3.
eg:

e	0ABCC7711800	corresponds to a clock frequency of exactly 400.000000 MHz
e	0ABCC6BCF300	corresponds to a clock frequency of exactly 400.000400 MHz

This constant is calculated using the formula:

$$constant = \frac{2^{64}}{clock\ frequency}$$

or

$$constant = \frac{2^{32}}{clock\ frequency} * 2^{32}$$

The 2nd formula can be mastered a little better. But you don't need to worry about this formula, the calculation is done by the PC
program if the menu item "Option" is used.

6.1.6 v“ Firmware version query, data length 1 byte, ” Returns 1 byte.

This command reads out the number of the firmware currently being used in the PIC. It starts with the number 100. That meansVersion 1.00.

6.1.7 r" Switching the attenuators, data length 2" bytes, return 0 bytes.

This command switches the outputs for the various attenuators. As of FW version 1.10, the attenuator is also controlled by the FUNKAMATEUR. The following circuits apply:

FW to 1.09 for FA-NWT and HFM9: PIN B3 =
10 dB attenuator PIN B4 = 20 dB attenuator
PIN B5 = 20 dB attenuator

FW from 1.10 for FA-NWT and HFM9: PIN
B1 = 10 dB attenuator PIN B2 = 20 dB
attenuator PIN B3 = 20 dB attenuator

FW from 1.10 for FA-NWT and HFM9 for the FA attenuator: PIN B1 = 2 dB
Electronic Attenuator PIN B2 = 4 dB Electronic Attenuator PIN B3 = 8 dB
Electronic Attenuator

PIN B4 = 4 dB basic attenuation Electronic attenuator PIN B5 =
16 dB resistance element
PIN B6 = 32 dB resistor element

FW for NWT7:
PIC PIN 6 = 10 dB attenuator PIC
PIN 7 = 20 dB attenuator PIC PIN 4 =
20 dB attenuator

Note the data byte from FW version 1.10. It is not converted from char to byte, but is immediately evaluated as a hexadecimal byte. If 0x07 is sent, BITs B1,B2,B3 are set.

B1=2_0
B2 = 2_1
B3 = 2_2
B4=2_3
B5 = 2_4
B6 = 2_5

6.2 Additional commands from PIC-FW version 1.14

The PIC-FW is still backward compatible. From FW version 1.14, all different HW configurations are operated with the same FW version. The difference caused by the different DDS types and HW variants used is marked with a variant number. Here is a list of the different variant numbers and the assignment to the hardware used:

FW variant and assignment to HW:

- 1 = FA-NWT without PLL 400MHz is fed in directly
- 2 = FA-NWT with PLL x20 with 20MHz clock

- 3 = HFM9 with adjustable PLL
- 4 = old NWT7 with PIC clock 10MHz and AD9851, AD8307 at AN0, AD8361 at AN1, channel2 at AN3
- 5 = old NWT7 with PIC clock 20MHz and AD9851, AD8307 on AN0, AD8361 on AN1, channel 2 on AN3
- 6 = old NWT7 with PIC clock 10MHz and AD9851, AD8307 on AN1, AD8361 on AN0, channel 2 on AN3
- 7 = old NWT7 with PIC clock 20MHz and AD9851, AD8307 on AN1, AD8361 on AN0, channel 2 on AN3
- 10 = NWT500 with LMX2330 and 12.8MHz reference frequency, AD9858 1200MHz, PIC clock 20MHz
- 11 = NWT500 with LMX2330 and 12.8MHz reference frequency, AD9858 1200MHz, PIC clock 20MHz, SWV relay switching at PORTB6
- 12 = NWT500 with LMX2330 and 10MHz reference frequency, AD9858 1200MHz, PIC clock 20MHz

If the version greater than 1.13 is detected during the automatic version query, the variant number is then queried and this is then included in the header of the main window. From version 1.14 there are even more commands which we will describe now.

6.2.1 a“ Sweeping with the AD8307 10 bit from A/D ” Converter, data length 25 bytes.

This command is similar to the x command. Here, however, an additional time is given in µseconds for the time between each measurement. This allows even very critical curves to be wobbled.

a	bytes 1
starting frequency	Bytes 2 - 10
increment	Bytes 11 - 18
number	Bytes 19 - 22
scan time	Bytes 23 - 25

A small example:

Data on the PIC:a 002000000 00014000 2000 100

Initial frequency:	2,000,000Hz
Increment:	14,000Hz
Number of measuring points:	2,000
Intermediate time per measurement:	100 in µsec

Data from the PIC:8000 bytes are given as a response to the PC. There are 2 bytes as a return value per measuring point and channel. 2000 measuring points times 2 channels results in 8000 bytes of data, which the module sends to the PC.

6.2.2 b“ Sweeping with the AD8361 10 bit from A/D ” Converter, data length 25 bytes.

This command is similar to the w command. Here, however, an additional time is given in µseconds for the time between each measurement. This allows even very critical curves to be wobbled.

b	bytes 1
starting frequency	Bytes 2 - 10
increment	Bytes 11 - 18
number	Bytes 19 - 22
scan time	Bytes 23 - 25

A small example:

Data on the PIC:b 002000000 00014000 2000 100

Initial frequency:	2,000,000Hz
Increment:	14,000Hz
Number of measuring points:	2,000
Intermediate time per measurement:	100 in µsec

Data from the PIC:8000 bytes are given as a response to the PC. There are 2 bytes as a return value per measuring point and channel. 2000 measuring points times 2 channels results in 8000 bytes of data, which the module sends to the PC.

6.2.3 o" Switching the SWV relay in the NWT500 (special ” execution), data length 1 byte, return 0 bytes.

This command switches a relay in the NWT500 special. This NWT is an extra version with a relay which switches on the SWV measuring head grinds. With 0," it is switched off and with "1" it is switched off again. In front-suspension is the FW variant 11 in the PIC.

6.2.4 s" Status query of the NWT, data length 1 byte," Returns 4 bytes.

With this command, 4 bytes are expected as return:

- 1st byte contains the variant number
- 2nd byte contains the setting of the attenuator. With this feedback, the attenuator is set in the SW as it was switched in the NWT. This is required if the SW was terminated and restarted without the NWT HW being restarted.

- Byte 3 + 4 are the result of an A/D converter query on AN2 PIN4 on the PIC. Byte 3 is LOW and byte 4 is HIGH of the measurement result. With this measured value, the switch position on the spectrum analyzer attachment is reported back from the FA to the SW. In the FW variant 4 to 7 delivers the command in bytes 3+4 has the value 0„.

Chapter 7

final word

7.0.5 Closing Word for Version 2.xx

I think we have now reached a good conclusion and thank you for the useful work on this project. I am now turning to other things in our beautiful hobby. Error corrections are of course still being carried out.

7.0.6 Closing Remarks

As you can see, there is no real end to software development. Furthermore, the development of the SW gives me a lot of pleasure and I would like to take the opportunity to thank all users of the SW for the suggestions. As far as my time allows, new ideas will continue to flow into the SW. You can find out the latest on my website
„http://www.dl4jal.eu”.

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