

User manual for NWT-7-Ex

hardware version 2.3.02

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1. Purpose of the device.

NWT-7-Ex - an advanced NWT-7. Into [NWT-7](#) was added expansion board with a two-line display, the buttons and the encoder, which allows the device to work stand-alone without a computer. The basic pcb NWT-7 device is not necessary to reconstruct.

2. Specifications and description of the device.

2.1 Description

The device works as a standalone:

- signal generator;
- power meter;
- SWR;
- impedance meter..

When connected to a computer, it operates as :

- Sweep Generator;
- Power Meter with logging measurement results;
- Heterodyne based IF shift.

Full customization of the device operating modes can be made via the serial interface command in the absence of the expansion board.

2.2 Specifications

The following characteristics the board NWT-7 and the device as a whole, are generalized characteristics collected from the publications on the Internet and used of the equipment datasheets and are not intended to metrological precision. The instrument parameters are given for said synthesizers and using other may not reflect the specified:

1. VFO generator characteristics of the first DDS channel (AD9851):
 - The frequency range from 50 kHz to 70 MHz with the unevenness of not more than 3dB and from 10kHz to 80MHz when the unevenness of not more than 6db;
 - Step adjustment is 1 Hz;
 - Built-in switchable attenuator from 0 to -50dB to 10dB step;
 - The signal level at the output to 13 dBm;
 - The spectrum up to 70 MHz according to various estimates from Spur value to 40 dB, defined set of DDS and low-pass filter at the output of DDS;
 - The output impedance is 50 ohms.
2. Paramerty oscillator VFO second channel ADF4350:
 - The frequency range of 137.5 MHz to 4.4 GHz;
 - Step adjustment is 1 kHz;
 - The signal level at the output to -1 dBm;
 - The spectrum with the magnitude of Spur to - 20dB;

- The output impedance is 50 ohms.
- 3. SWEEP measurement mode frequency response using WinNWT program:
 - The frequency range from 25 kHz to 90 MHz (70 MHz higher than the signal is bad, but the harmonics up to 90 MHz and has a permit to measure the frequency response) with the unevenness of not more than 4dB (when enabled mat. Correction).
 - The dynamic range from 80 dB to 90 dB (depending on the instrument workmanship, housing and electromagnetic environment around).
 - measuring the unevenness in the range of 0 to -50 dB less than 1.0dB (if the mat. adjustment)
 - measuring the unevenness in the range of 0 to -80dB at most 4 dB (if the mat. adjustment)
- 4. The POWER METER - logarithmic detector::
 - The dynamic range of -75 dBm to + 16dBm;
 - Frequency range up to 400MHz on the datasheet (not tested);
 - Step display values in offline mode 0,1 dB, measuring step limited ADC resolution 0,25 dBm.
 - Input impedance 50Om.
- 5. The POWER METER - Linear detector::
 - The dynamic range of -20 dBm to +10 dBm
 - Frequency range up to 2000MHz on the datasheet (not tested)
 - Input impedance 50Om.
 - Step display values in offline mode 0,1 dB, step limited ADC resolution of 0.06 dB.
- 6. The SWR mode (what happened with my bridge):
 - Frequency range 200 kHz to 70 MHz
 - accuracy +/- 0.2 VSWR up to 2
 - accuracy +/- 0.3 VSWR more than 2
 - SWR meter calibration is performed on 350 points;
- 7. Measurement of impedance:
 - Produced in the frequency range of 200 kHz VSWR bridge - 70 MHz
 - Accuracy depends on the accuracy of measurement of VSWR, because this is purely a mathematical operation on the measured SWR.
- 8. Characteristics of the external detector depends on the connected external detector.

2.3 Device components

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3. Designations of the user manual.

1. If the input command is required several successive pressing device buttons, they are written in the curly quotation marks in this manual. Each button is written by a space. For example «F 0 5» mean for consistent pressing «F» key, then «0» and then «5».
2. Starting with firmware version 3.2.00 introduced the concept CHANNEL (Channel DDS):
 - Channel 1 (system designation CH1), considered the pins of the MC, which is connected by the scheme v1.3 synthesizer AD985x.
 - Channel 2 (system designation CH2), is considered to be additional channel, which is

connected by ADF435x scheme.

4. Controls and Interface.

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4.1 Appearance and controls.

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4.2 Purpose of the device control buttons.

Button	General mode	Command mode
F	Entry to command mode	Command cancel
OK		Command enter
+	Attenuator value up (generator level up)	Value Up
-	Attenuator value down (generator level down)	Value Down
GEN	Generator On/Off	
C	Deleting the current symbol in frequency input mode.	Deleting the current symbol in frequency input mod
1 (FQ)	Inputting the number 1 in mode direct frequency input	Mode direct frequency input
2 (SWR)	Inputting the number 2 in mode direct frequency input	Mode SWR meter
3 (IMP)	Inputting the number 3 in mode direct frequency input	Mode impedance meter
4 (PWR)	Inputting the number 4 in mode direct frequency input	Mode power meter
5 (BAND)	Inputting the number 5 in mode direct frequency input	Band PWR change (changing calibration values)
6 (LOG)	Inputting the number 6 in mode direct frequency input	Internal LOG detector
7 (LIN)	Inputting the number 7 in mode direct frequency input	Internal LIN detector
8 (EXT)	Inputting the number 8 in mode direct frequency input	External LOG detector
9 (CH)	Inputting the number 9 in mode direct frequency input	Changing channel of the synthesizer
0 (SETUP)	Inputting the number 0 in mode direct	Enter to setup mode

Button	General mode	Command mode
	frequency input	
>	Moving the cursor to the right to change the frequency step	Moving the cursor to the right to change the frequency step
<	Moving the cursor to the left to change the frequency step	Moving the cursor to the left to change the frequency step

Table 1

4.3 Purpose of the device control buttons in SETUP mode.

Button (command number)	Screen message	Operation description
1	SAVE STATE	Saving device settings for use when the device will be switched on.
	LIGHT ON/OFF	Turn on / off the backlight display with a record of the state of the EEPROM
3	CALIBRATE POWER	Calibration of the power meter. For the current detector with data entry in the current cell BAND.
4	CALIBRATE SWR	Calibration of the SWR measurement mode (this is done for the integrated logarithmic detector).
5	SET ATT INPUT	Setting ATT or gain on the power meter input. Write to the EEPROM.
6	DDS TYPE	Changing DDS type for the current channel.
7	ADF REFIN/CORE	Setting the reference oscillator frequency ADF435h or core clock speed for AD985x
8	Hardware version info	Hardware version info

Table 2

4.4 Basic device management rules.

1. Entry to the command mode by pressing the «F» button.
2. When you enter to the command mode by pressing the «F», you can choose a command one of three ways:
 - Press the command number, see Table 1;
 - Select a command by encoder, consistently turning over command from the list on the screen;

- Select a command by pressing the "+" or "-" (to increase or decrease the number of command).

It is necessary to press the button «OK» to activate selected command. If the command does not require any additional parameters, it is activated immediately. If required, then you get into the value input mode or select the next menu item.

3. All of the commands for DDS, applied for the current channel.

4.5 Displaying information on the display

4.5.1 Basic display mode

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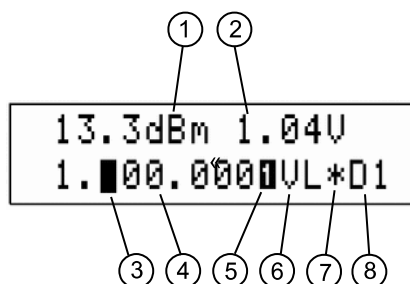


Рис. 1. Информация на дисплее в режиме измерения мощности (PWR).

- 1 — Значение измеренной мощности для текущего детектора в dBm на нагрузке 50 Ом, 2 — Значение измеренного среднеквадратичного напряжения ,
 3 — Курсор, 4 — значение частоты для текущего, активного канала, 5 — Номер текущего, активного канала, 6 — Название ячейки хранения калибровочного значения измерителя мощности, 7 — Символ сигнализирующий о включенном синтезаторе, 8 — Название текущего активного детектора.

4.5.2 Displaying information in different modes.

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5. Getting started.

1. To get started, you must specify the type of DDS, which are connected to channels 1 and 2 or disable unused.
2. Specify a reference frequency for the synthesizer AF435x and core operating frequency synthesizer for the AD985x.
3. Calibrate Power meter.
4. Calibrate SWR meter

5.1 Selecting the type of DDS.

1. Selecting the type of synthesizer is always performed for the current channel
2. Selecting the type of synth made by command «F 0 6».
3. Channel 1 may specify one of the 5 types of synthesizers:
 - 0 – "OFF"
 - 1 – "AD9850"
 - 2 - "AD9851x1" - multiplication RefIn x 1
 - 3 - "AD9851x6" - multiplication RefIn x 6
 - 4 – "ADF4350"
 - 5 – "ADF4351"
1. For channel 2 may indicate one of 2 types of synthesizers:
 - 0 – "OFF"
 - 1 – "ADF4350"
 - 2 – "ADF4351"

5.2 Adjustment the REFIN / CORE CLOCK frequency.

1. To enter the command mode you have to press the «F 0 7».
2. For ADF435x is specified a reference frequency of synthesizer, for synth AD985x is specified a core clock after multiplying the reference clock frequency of DDS, the multiplication factor is determined by the type of DDS circuit and its connections.
3. After entering this value is automatically calculated by the constant value for the DDS, which is based on the frequency setting. Note that when working with WinNWT, a command that comes when you change the settings in WinNWT can change a constant and, in general, they should be the same.
4. This frequency value is essentially determines the value of the output frequency synthesizer.

5.3 Calibrating the Power Meter.

1. Calibration Power Meter is performed for the currently selected storage cell of calibration value. The cell (VL, LF and etc) is selected by the command BAND (see. Section 6.4) and is switched for the current detector. 6 cells exist for each detector. For all detectors is $3 * 6 = 18$ cells.
2. Procedure for calibration for internal Log detector:
 1. Turn on DDS channel 1, if necessary, by command «F 9».
 2. Select the storage cell, setting the BAND (see. Section 6.4), the command «F 5».
 3. Select the internal LOG detector using command «F 6».

4. Connect the output of the internal DDS or external generator to the input of (Log detector) through the triple splitter.
 5. To the triple splitter connect the reference power meter or oscilloscope;
 6. Set the frequency at which you want to calibrate and enable DDS by press button «GEN» or external generator.
 7. Enter to the calibration mode, the command «F 0 3».
 8. In the top line you will see the measured value of the power that you need to adjust the buttons "+" / "-" (roughly) and encoder (for sure). The value of the power measured by the logarithmic detector can not be set to an accuracy of 0.1 dB, because this limitation bit ADC. At the end should match the values on the reference instrument and calibratable detector with reasonable accuracy. «OK» should press when finished.
 9. After clicking «OK» on the screen will be prompted to install an external attenuator to - 40 dB. A output DDS channel 1 will switch attenuators - 40 dB. Accordingly, if the detector is calibrated by the built-in DDS, you need only to confirm that the attenuators incorporated by pressing «OK» button.
 10. At one second will display the inscription «COMPLETE», a calibration value will be stored in the EEPROM.
3. Next, you can repeat the power meter calibration to other frequencies by selecting another cell to store through BAND command or other detector.

5.4 Calibration Mode SWR.

1. Calibrate SWR mode can only be performed after calibrating the built-in logarithmic detector storage cell «LF», because from this storage cell is taken the slope of the transfer characteristic of the current detector.
2. Procedure for calibration:
 1. Connect between the integrated logarithmic detector and output channel synthesizer 1 bridge to measure the SWR. Input for measurement are not connected (open).
 2. Turn on DDS channel 1, if necessary, by command «F 9».
 3. Select the «F 6» built-logarithmic detector.
 4. Select SWR calibration command by pressing «F 0 4». The display will read the proposal to connect the bridge and leave the measurement port open, click «OK».
 5. On the inscription «CALIBRATING» will be displayed, and after 1 second inscription «COMPLETE» will be displayed.

5.5 Calibration mode IMP (measurement of impedance)..

3. Additional calibration this mode is not required, the calibration values are taken from the SWR calibration mode.

6. Operation with the device

6.1 Selecting the current channel DDS.

1. Change the current channel to the connected synthesizer produced by the command
2. «F 9».
3. The number of the current, the active channel is displayed on the screen in the form of inverse numbers 1 or 2 after the frequency value.
4. If for the current channel is not set type of DDS, the inscription «DDS OFF» will be displayed instead of the frequency.

6.2 Setting the DDS frequency generation.

1. There are two ways to specify the frequency:
 1. Direct input frequency numbers in the basic device operation. At the same time checked the correctness of the boundary frequency for the current channel;
 2. Enter the frequency by the command «F 1». In this case the boundary conditions is checked by pressing «OK» button. This allows you to directly enter the desired value of frequency numbers starting from zero.
2. For all input modes frequency:
 1. Digit buttons are using "0" - "9" buttons «>», «<», «+», «-», «C».
 2. The encoder works to change the value at the current cursor decade.
 3. Flashing cursor indicates the place of the beginning of the input value of frequency numbers. Also, the cursor indicates the digit to be changed by the rotation of the encoder or by pressing "+" button, "-".
 4. You can change a digit decade, by buttons ">" or "<".
3. If the generator is turned on, when you enter the direct input, the new value immediately applied to the current channel. Also, the frequency will be immediately changed by the rotation of the encoder and use the "+" button, "-".
4. For synthesizers AD985x setting and displaying the frequency is in Hz. For synthesizers ADF435x setting and displaying the frequency is in kHz in steps of 1 kHz.

6.3 Enable / Disable DDS.

1. Power on / off DDS produced by «GEN» button.
2. If the DDS is enabled, an asterisk displays after the active channel symbol.
3. The generator does not turn on if you do not set up a DDS on a current channel that you want to activate.
4. In the case unless the DDS type on the current active channel, the screen when you try to establish the frequency will be displayed inscription «DDS OFF».
5. If there is no REFIN frequency synthesizer for ADF435x or CORE CLOCK for AD985x,

the DDS also turns on. No further warnings appear.

6.4 Command BAND.

2. Command «F 5».
3. This command is used to select the cell for a storage power meter calibration values. You can save notes with storage cells (range), and frequencies on the case. Frequency ranges and storage location are selected independently. The following frequency values for the cells are for example. When calibration is important to realize that the detector has a measurement range of more than DDS range and high frequencies, respectively, for the calibration can be carried out only with an external oscillator and external attenuators.
4. Detector ranges (the name of the storage cells) as an example for the AD8310:
 - VL - very low (50 кГц — 500 кГц)
 - LF – low frequency (500 кГц — 5 МГц)
 - MF – medium frequency (5 МГц — 30 МГц)
 - HF- high frequency (30МГц — 100 МГц)
 - VH – very high frequency (100 МГц — 300 МГц)
 - UH – ultra high frequency (300 МГц — 400 МГц)

VL, LF and etc are used only for power meter mode as into WinNWT. Ranges are not used for swr mode. You can write on paper(box) any ranges for storage cells (VL, LF...) of power meter.

VL, LF and etc is only name of storage cell !!!

6.5 Measurement of SWR (SWR).

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6.6 Measuring the IMP (impedance).

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7. Work in conjunction with WinNWT program

1. After starting WinNWT program, you need to install the correct serial number in the program settings (standard operation).
2. WinNWT program not produces switching NWT-7-Ex unit channels and is only connected with the current channel. Channel c connected synthesizer must be installed on the device manually before start the program WinNWT by «F 9» command.
3. After starting the program and successfully connect to the device, in the top line of the program should display the firmware version on DL4JAL classification device (HW: 119). The LCD screen of the device at the same time will display "PC CONNECTED". That means the device management WinNWT passed to the program and the device will not execute commands from the keyboard.

4. After the end of the program WinNWT it must be closed and press any button on the keypad. Control will pass to the device with the device initialization values saved at power.
5. If you enter the Setup program when connected to DDS Channel 1, then you must ensure that you have the same frequency of the DDS core installed in the standalone mode of the device and operation via the WinNWT program since when you save the settings in the device WinNWT program writes the new value of the current channel DDS constants in the device EEPROM.
6. WinNWT program does not change the frequency REFIN / DDS CORE, but it changes the value of the constant DDS, which is calculated based on the frequency entered in the settings window. Therefore, if the DDS frequency is set via the device interface and through WinNWT do not match, then you will visually see the different frequencies in the respective interfaces, but DDS constant will be calculated based on the last entered value of the reference frequency. The current value of the constant and the other channel settings are available for command «i» of section 8 (serial commands)
7. REFIN frequency for the DDS ADF435x introduced only via the device interface command «F 0 7». Constant DDS is not used, so the core frequency set for ADF435x when working through WinNWT does not matter.
8. For proper channel working with synthesizer on ADF435x, it is necessary to deliver the program settings WinNWT frequency multiplier equal to «x10». The frequency of the graphs will be displayed correctly to 9,9 GHz and input frequencies in the interface WinNWT it can be entered in Hertz and up to 9,9GHz (Step ADF4350 synthesizer tuning 1 kHz, so set a value less than this value do nothing).
9. In WinNWT program can use an external detector for measuring SWR, which are not implemented in a standalone device mode.
10. When working with the unit in two-channel mode (if you have two synthesizers) is convenient to use the two configured device profiles for WinNWT program. Profiles are stored under different names, and then used as a parameter when starting WinNWT program.
11. Example WinNWT row start with a specific profile:
 - Profile for AD9851 - "C: \ WinNWT5 \ winnwt5.exe" app_ru.qm ad9851.hfc
 - Profile for ADF4350 - "C: \ WinNWT5 \ winnwt5.exe" app_ru.qm ad4350.hfc
12. Creating a profile:
 - Turn on the desired channel on device «F 9»
 - Adjust if necessary synthesizer type and core speed or frequency reference for the current, active synthesizer.
 - Run WinNWT.
 - Make the settings for the selected channel, and synthesizer. Make sure it is working properly.
 - Select the menu in the "Settings / Save Configuration", enter the name of the configuration (profile), as described in the preceding paragraph and save. The name of the configuration that would best match the name of your synthesizer, for a better

understanding of what is happening. Do not forget to attribute extension ".hfc".

- Create a shortcut to start the program, start with a string as described above.
- Repeat this procedure to another instrument or synthesizer.

8. Serial commands of USART.

Described in a separate attached document «Commands SERIAL NWT-EX v2.3.00.pdf»

9. References and links

1. Дополнительные материалы по прибору и его конструкции, а также информация по настройке, находятся в прилагаемом архиве и на сайте в ветке [NWT-7-Ex](#).
2. [DL1ALT](#), автор первоначальной версии прошивки NWT-7 и программы для PC.
3. [DL4JAL](#), автор текущей версии прошивки NWT-7 и программы WinNWT4. На сайте есть все прошивки и программа PC для всех версий NWT.
4. http://www.g-qrp-dl.de/Projekte/NWT_Text/nwt_text.html
5. Примеры измерений от DL1ALT http://www.g-qrp-dl.de/Projekte/NWT_Text/NWT_Fotos_DK3WX/nwt9mhznwt_fotos_dk3wx.html
6. [Описание программы на немецком](#) WinNWT.
7. Перевод на русский части [описания программы](#) WinNWT.
8. Недавно (06.08.2014) автор опубликовал свое описание WinNWT на английском языке датированное 2009 годом. http://www.dl4jal.eu/LinNWT_doc_en.pdf
9. Материалы журналов [со статьями использования NWT](#), есть схемы согласования фильтров.
10. Материалы журналов [продолжение](#).
11. Измерение [длины кабеля и укорочения](#).
12. [Сортировка кварцев](#), последовательный и параллельный резонансы. Но лучше использовать Измеритель КСВ
13. [Истоковый повторитель](#) Автор [leokri](#)
14. [Внешний выносной высокоомный детектор](#). Автор [leokri](#)
15. [Вариант платы на DIP](#) плата и схема не моего варианта, подробнее читайте по ссылке.
16. [Команды последовательного интерфейса NWT](#), перевод UB3TAF. На данный момент есть еще описание в оригинале, см. п.8.
17. Форумы на CQHAM.RU по обсуждению данной конструкции [Ветка 1](#), [Ветка 2](#)
18. [Мои внешние детекторы](#).
19. Похожие Платы NWT-7 можно купить вот тут [UR4QBP](#), схема немного другая, но будет работать.
20. Программа WinNWT5 <http://www.asobol.ru/software/winnwt5>

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 Nizhny Novgorod, Russia,
<http://www.asobol.ru/moi-konstrukcii/nwt-7-ex>
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