LF-MF DDS by RN3AUS
Control program DDS_ctrl.exe
User manual.

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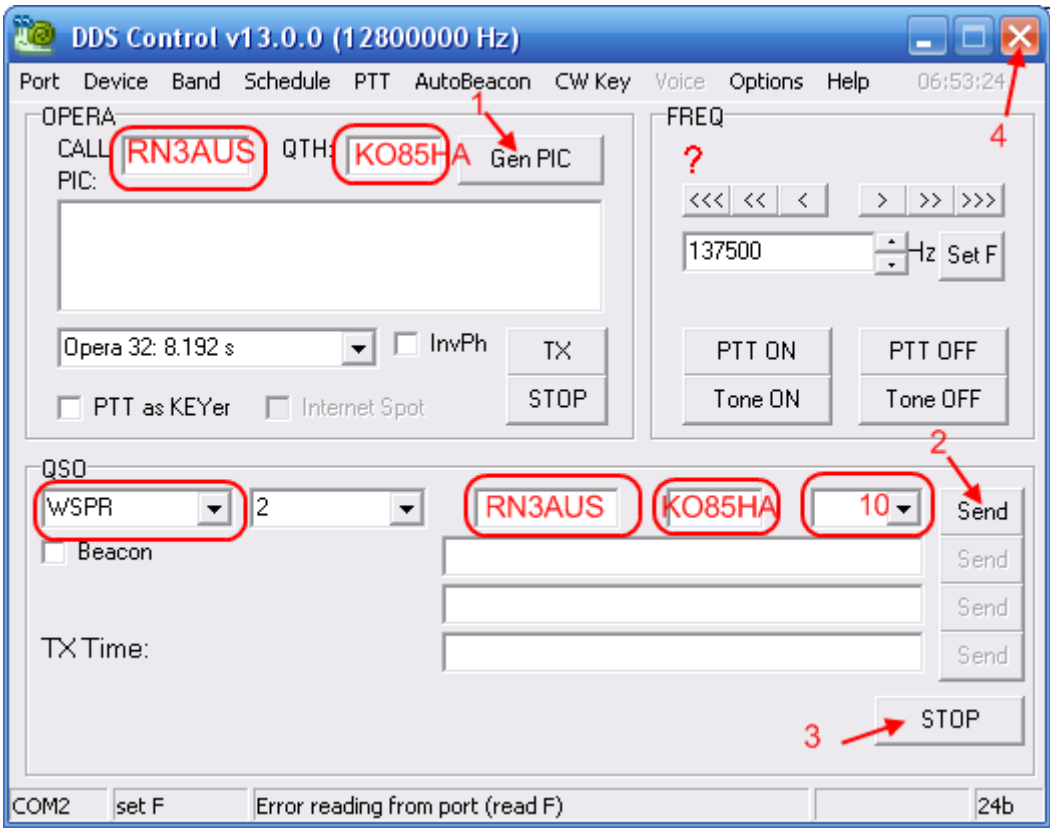
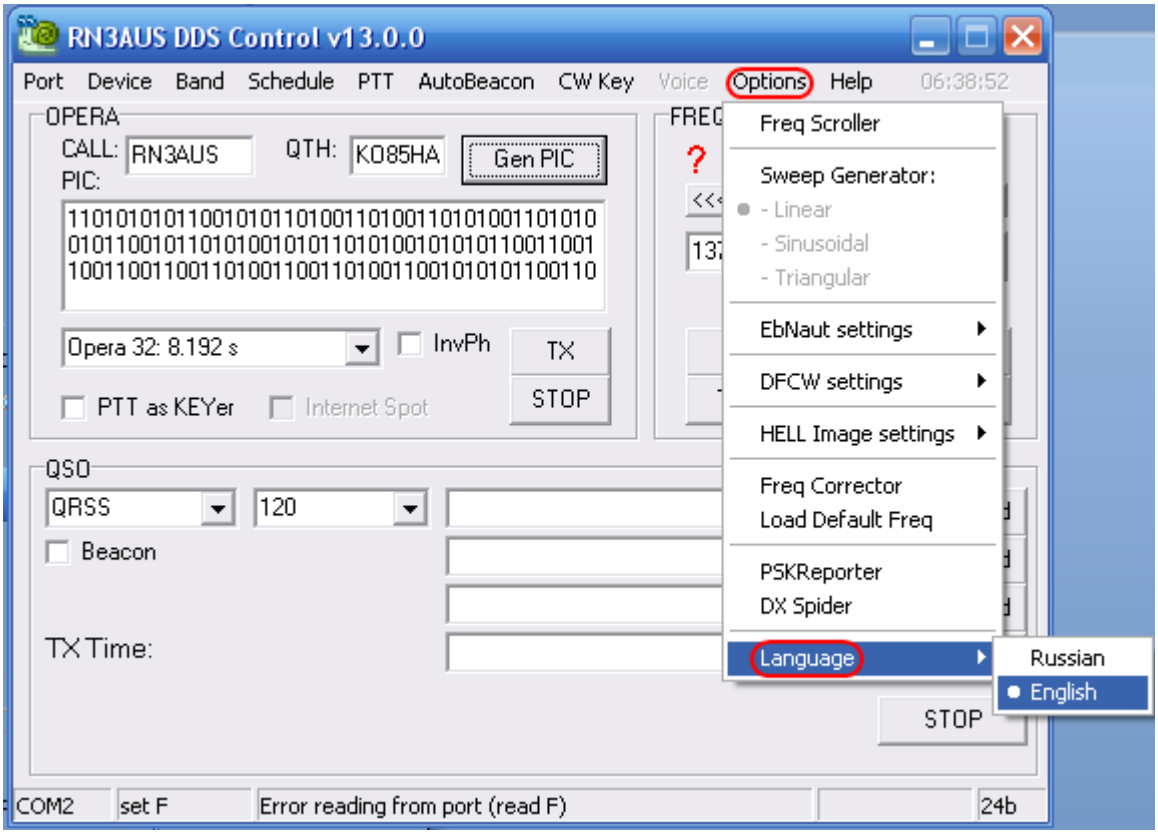
1. Installation of the program and settings

The program doesn't demand installation, just copy it on the hard drive. Start the program. The window with the blank fields will appear. Enter the call sign of CALL and QTH, press the GenPIC button:



In the QSO panel in a drop-down list choose the WSPR mode and fill three opened fields – CALL, QTH and PWR. Press the Send button, then Stop. All this is necessary for formation and record in the INI file of your individual settings.

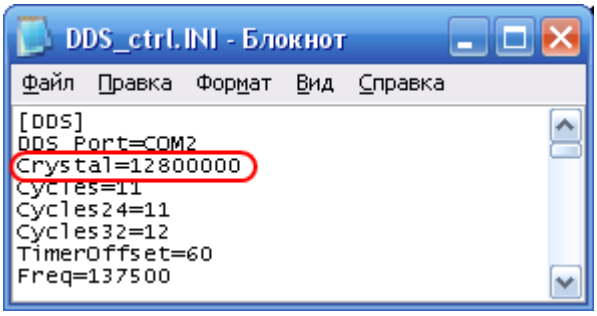
In the menu Options-> Language-> choose a desirable interface language of the program:



Now close the program. All data will remain in the INI file. In the same folder where there is a DDS_Ctrl.exe file, the file of the DDS_Ctrl.INI settings appeared. Open it by means of any text editor, for example "Notebook". Find a line:

[DDS]
Crystal=12800000

also enter exact value of frequency of the basic generator of your synthesizer in Hertz.

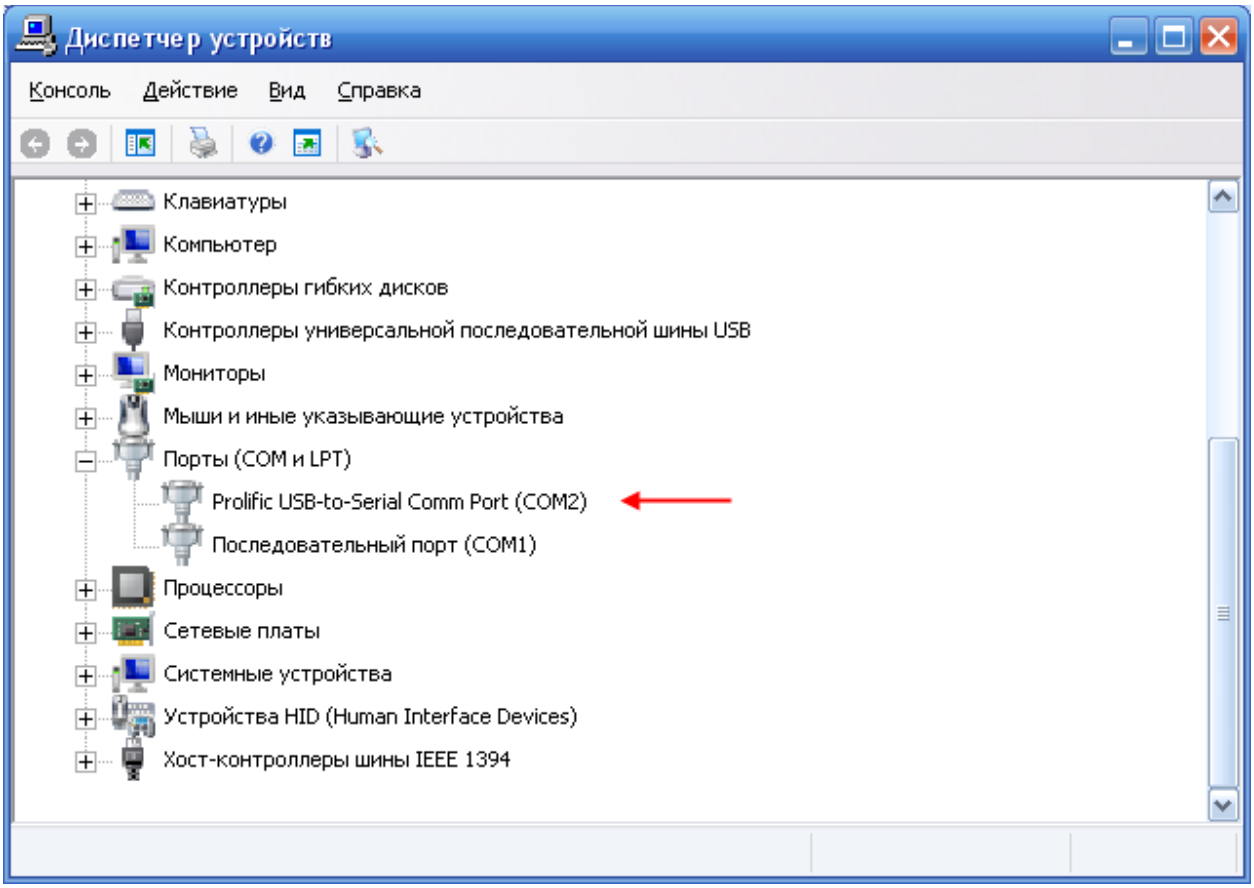


Save changes. Now the program has a necessary minimum of settings, it is possible to connect a synthesizer.

2. Connection of a synthesizer

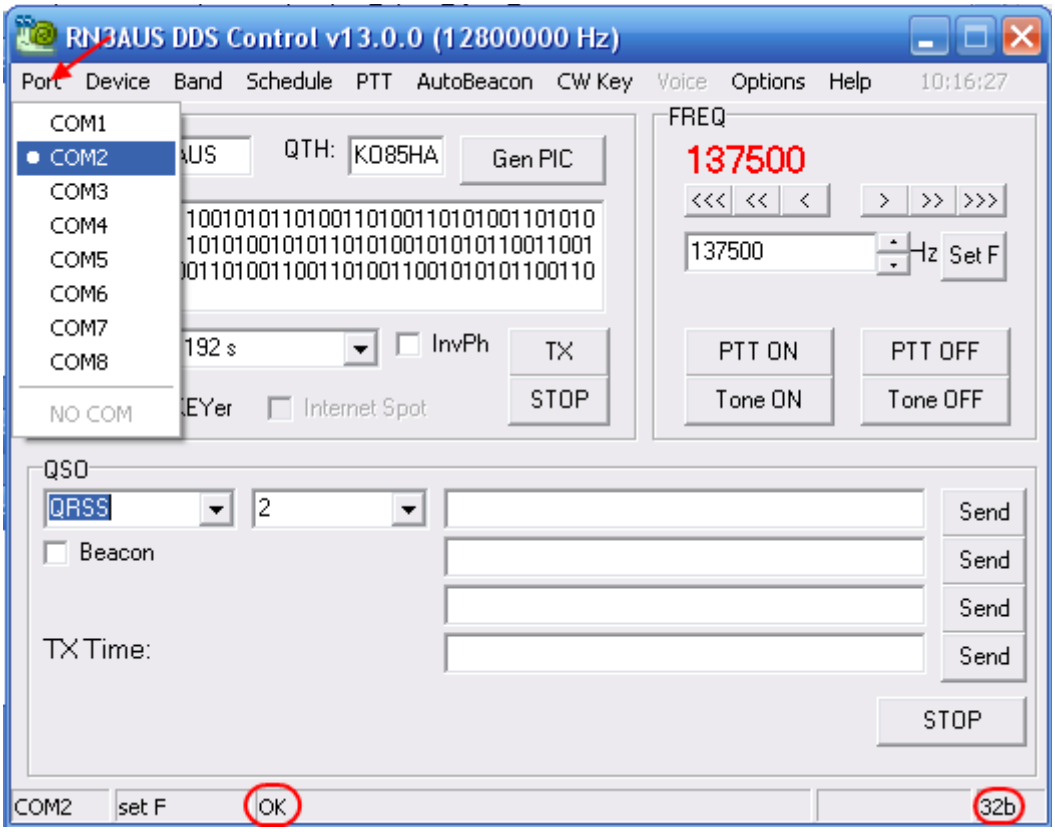
The synthesizer can be connected to the computer or immediately to COM port (if it is), or, what is more often, by means of the USB-to-COM cable adapter. Choose the high-quality adapter! Well Prolific series devices work. Connect the adapter to USB port of the computer. As a rule, the device will be automatically identified by an operating system. Installation of the driver can sometimes be required. In a result in to a system the new COM port has to appear:

The control panel-> the System-> the Inventory-> the Device manager-> COM and LPT Ports

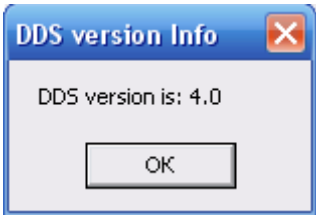


Number of this COM port needs to be remembered. In this example it is COM2.

Having connected a synthesizer to a cable, we include it. We start the DDS_ctrl.exe program. In the Port menu we choose the necessary COM port. In a line of the status the inscription OK has to appear. If the firmware of a synthesizer has the version of v.3 above, the mode 32 bits will join.



To learn the version of an firmware and to request a condition of a synthesizer it is possible in the menu **Help -> DDS version?**

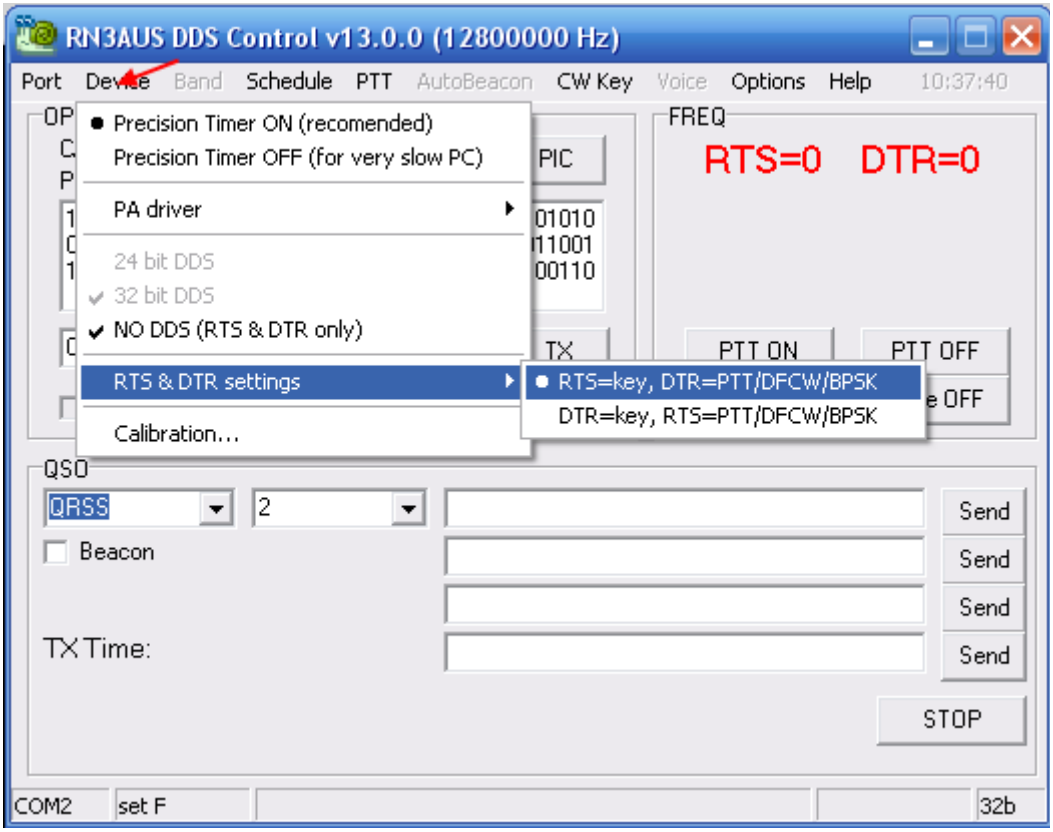


To check whether the synthesizer controlled it is possible by means of buttons **PTT ON/PTT OFF** и **Tone ON/Tone OFF.**

If the synthesizer doesn't controlled, or in the status line the error message appears - perhaps, cases of the computer and a synthesizer aren't grounded and at a control cable there is a stray voltage, breaking its normal work. Connect the case of the computer and a synthesizer to the earth bar. Close the program, switch off a synthesizer, disconnect a cable from the computer. Then connect a cable, turn on a synthesizer and start the program. Usually after these actions everything begins to work normally.

3. **If there is no synthesizer.**

The program can be used also without synthesizer for management of any peripheral equipment by means of signals of DTR and RTS of COM port, similar to that, how to do it in the known program QRS.exe от ON7YD.
For this purpose it is necessary to select item in the menu **Device -> NO DDS (RTS&DTR ONLY)** and to define functions of signals RTS and DTR in the submenu **RTS&DTR settings.**



Without synthesizer the following modes are available: CW, QRSS, OPERA, DFCW, RTTY, PSK, WOLF, EbNaut, VOICE AM/FM/BPSK. Signals of RTS and DTR at the same time have the following appointment (depending on the chosen control):

«Device->RTS&DTR settings->RTS=key,DTR=PTT/DFCW/BPSK»

Режим	RTS	DTR
CW QRSS OPERA VOICE-AM	KEY (manipulation: ON-OFF keying)	PTT (turn transmitter on)
DFCW VOCE-FM	Carrier on-off	Freq shift
PSK WOLF EbNaut VOICE-BPSK	Carrier on-off	Phase inversion control: 1 - inversion 0 - no inversion

«Device->RTS&DTR settings->DTR=key,RTS=PTT/DFCW/BPSK»

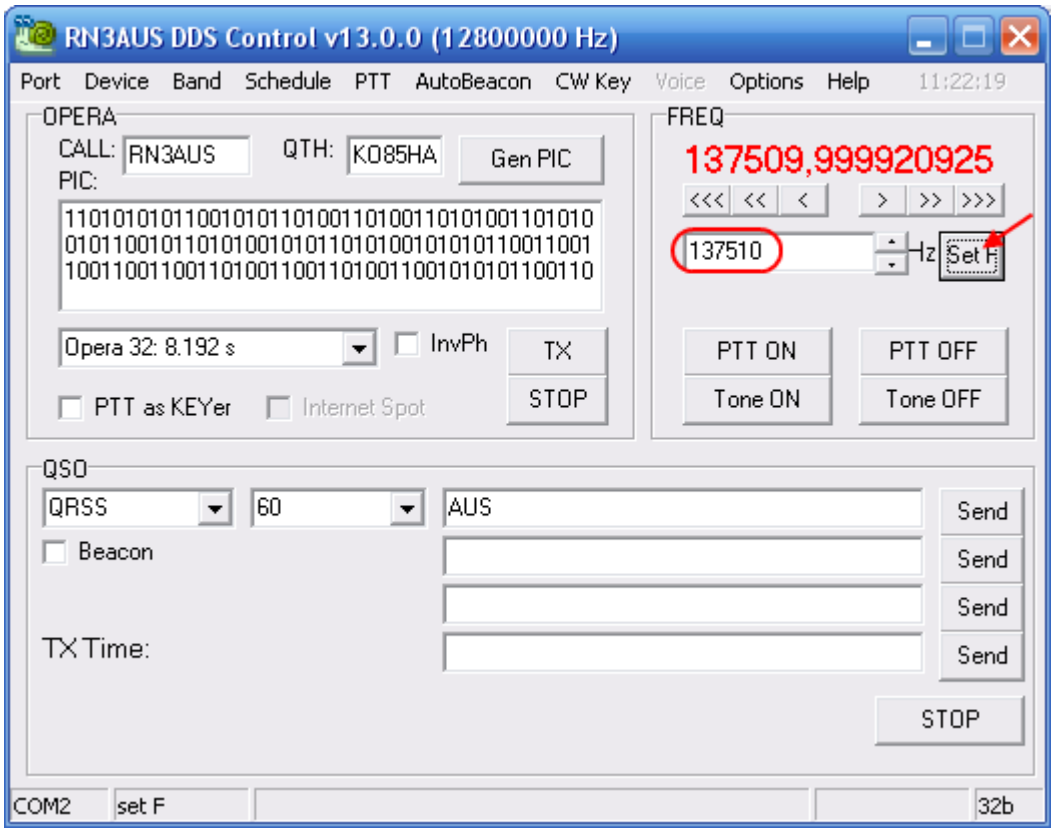
Режим	RTS	DTR
CW QRSS OPERA VOICE-AM	PTT (turn transmitter on)	KEY (manipulation: ON-OFF keying)
DFCW VOCE-FM	Freq shift	Carrier on-off
PSK WOLF EbNaut VOICE-BPSK	Phase inversion control: 1 - inversion 0 – no inversion	Carrier on-off

For the implementation of phase manipulation, you can use, for example, a logical element XOR (exclusive OR).

4. Using of the program

4.1 Frequency setting

Frequency control is carried out in the panel FREQ. The frequency in Hertz is entered in the text field; a decimal point is used to separate the integer and fractional parts. Double clicking on this field clears it. The frequency is written to the synthesizer at the touch of a button **Set F**. In response, the synthesizer returns the actually set frequency, which is always a multiple of the minimum step. This step is equal to Step24= Fcrystal /11/2^24 for 24-bit mode and Step32= Fcrystal /12/2^32 for 32-bit mode. For example, for Fcrystal = 12800000 Hz Step24 = 0.0693581 ... Hz, Step32 = 0.00024835 ... Hz.



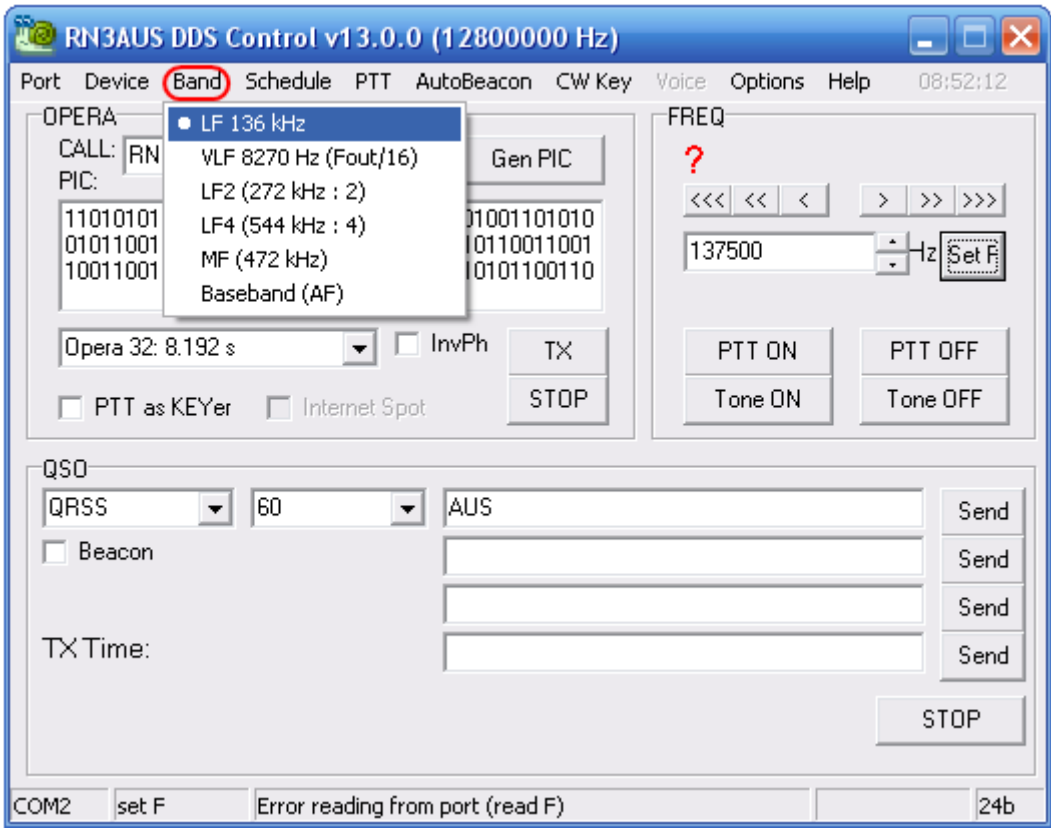
In the very first versions of the synthesizer firmware, only 24 bits of the frequency was implemented; subsequent firmware versions work with 24 and 32 bits. The selection of the bitness of the frequency representation occurs automatically, but it can also be switched manually using the menu **Device -> 24 bit DDS or 32 bit DDS.**

Sometimes, after several automatic switches from 24 to 32 bits and back, there may be a problem with the display of the set

frequency (when something very different from the operating frequency is indicated). This means that the synthesizer is, say, in 32-bit mode, and the DDS_ctrl program perceives the frequency received from it as 24-bit. To restore "sync", select **Device -> 32 bit** и затем нажмите кнопку **SetF**.

Next to the frequency entry field are small buttons for changing the frequency by + - one step and 1 Hz, 10 Hz and 100 Hz.

The frequency generated by the synthesizer depends on the selected range.



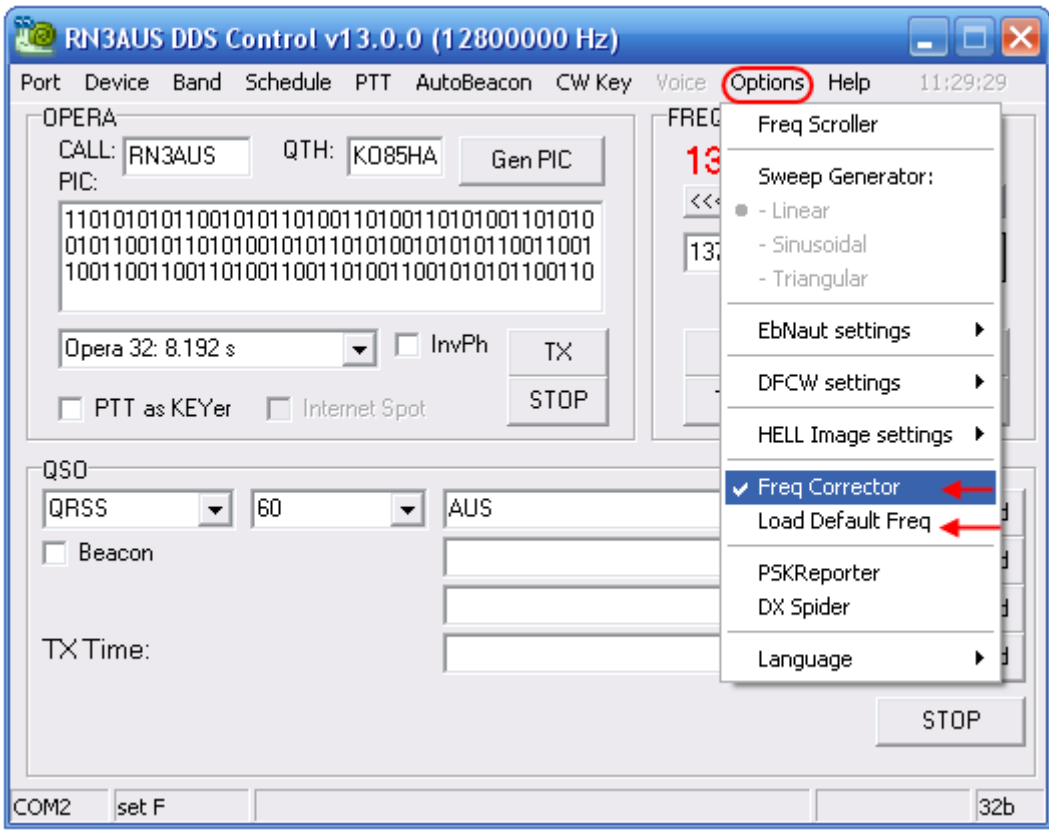
For options LF, MF, Baseband (AF) - the frequency of the synthesizer is equal to that indicated in the FREQ field.

In some cases, the transmitter must be served twice or even four times the frequency, depending on the type of driver. The following options are provided for this:

- LF2 - frequency is formed twice as high as displayed,
- LF4 - the frequency is formed 4 times higher than the displayed one.

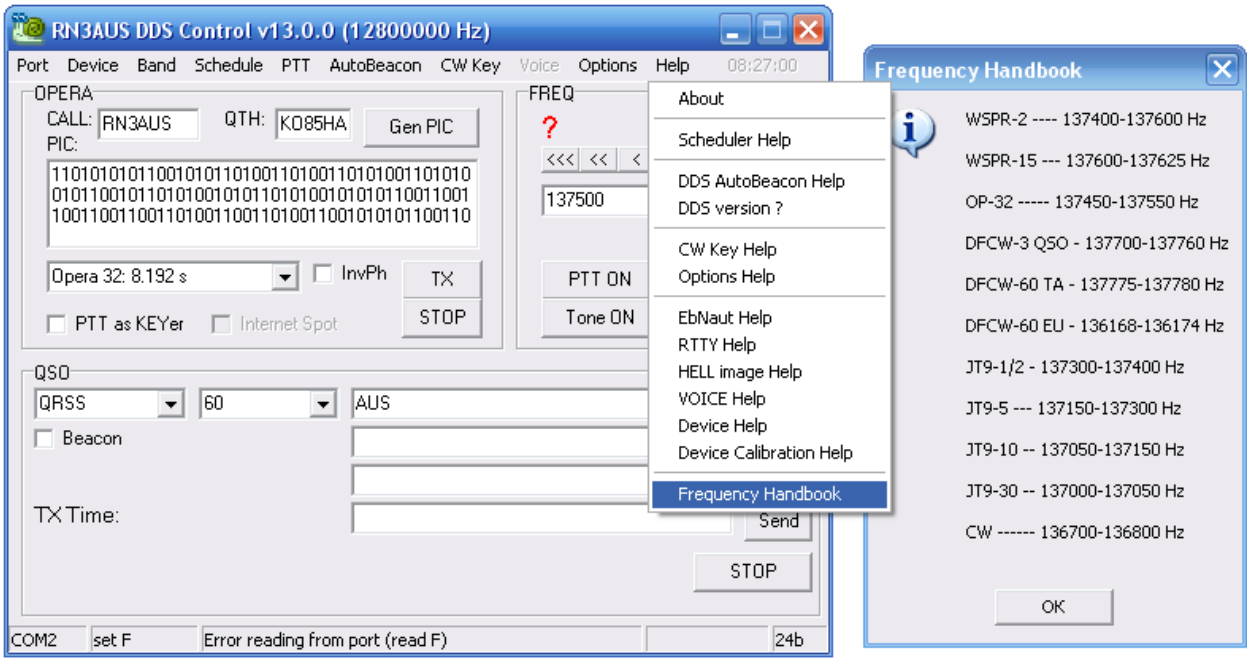
For experiments on VLF, where the requirements for accuracy of frequency setting and its stability are even higher, the menu item VLF is provided. In this case, the frequency is formed 16 times higher than the specified one. Accordingly, the power amplifier must be preceded by a counter-divider by 16.

The program has the ability to validate the entered frequency **Options->Freq Corrector.**



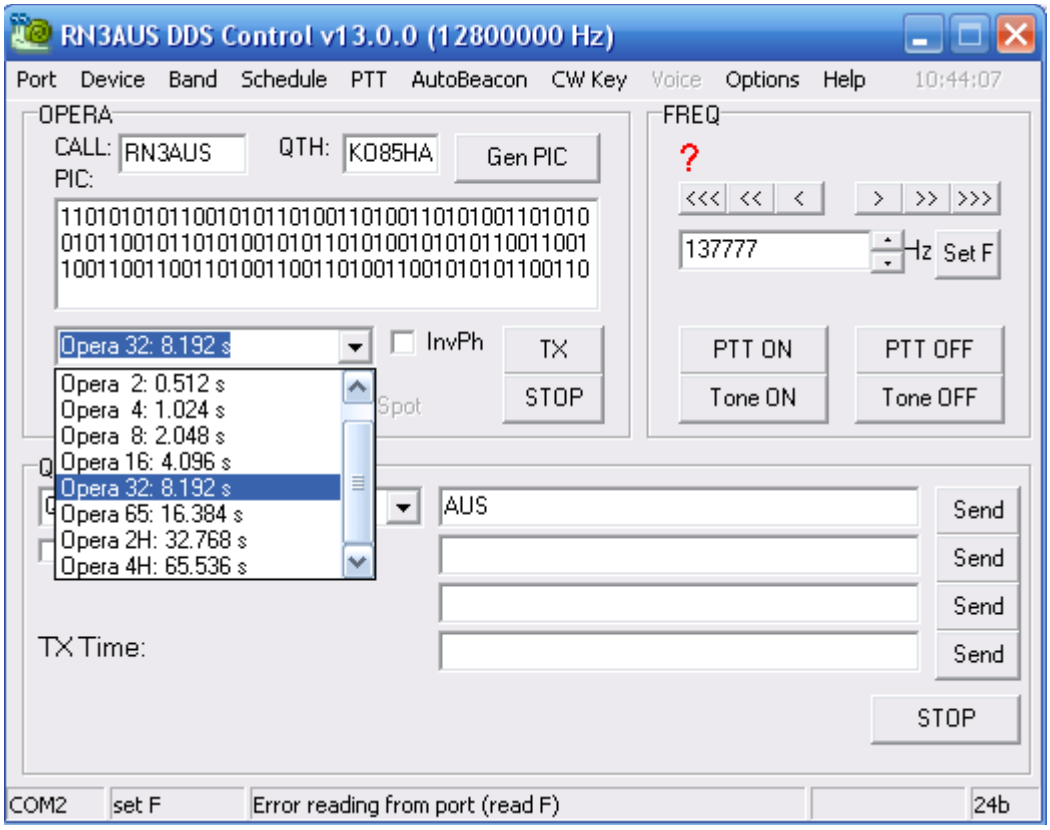
If this option is enabled, each time you start a transmission, the program will compare the set frequency with the boundaries set aside for this mode of operation. So, for example, if the WSPR-2 mode of operation is set, then the frequency should be within 137400-137600 Hz, and for WSPR-15, 137600-137625 Hz. If the input frequency goes beyond these limits, it will be "replaced" by some randomly selected frequency within their limits. If the **Options-> Load Default Freq** option is also enabled, then the default frequency will be automatically set for each operation mode. The values of these frequencies are defined in the INI file in the [DEFAULT_FREQ] section and can be changed if desired.

In the menu **Help-> Frequency Handbook** you can get information about the boundaries of frequencies for different modes of operation.

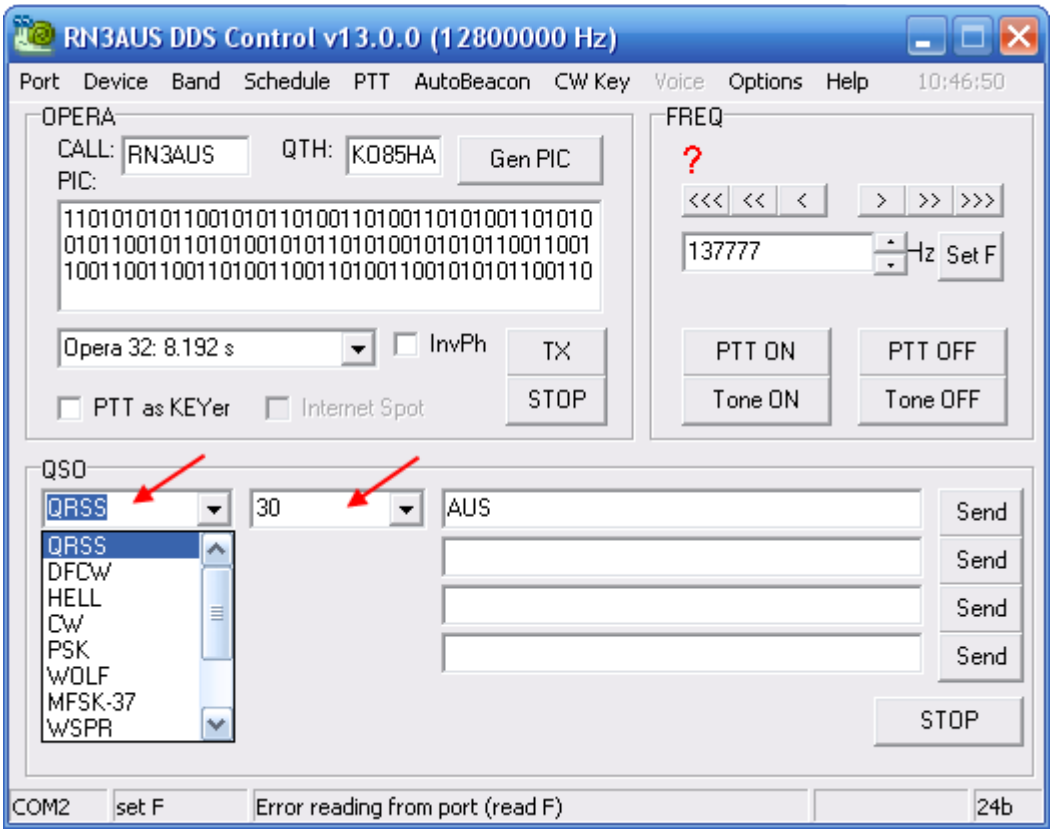


4.2 Selection of mode and duration

For the OPERA mode, selected in a separate panel (as historically), the choice of one of the standard durations is carried out in the drop-down list:



All other modes of operation are on the QSO panel in the drop-down list: QRSS, DFCW, HELL, CW, PSK, WOLF, MFSK-37, WSPR-2 и -15, JT9, VOICE, RTTY, EBNAUT.



Depending on the selected mode, the "content" and the meaning of the elements of the drop-down list for selecting the duration / speed change:

Mode	Duration / speed	Extra options
QRSS DFCW MFSK-37	The duration of the "dot", s	
HELL	The speed of the spectrogram (sec / point) on which HELL will be observed. For example, HELL-60 is conveniently observed on the QRSS-60 Argo spectrogram or SpectrumLab.	A field appears, double clicking on it opens the image file (.BMP) for transfer. Settings in the **Options-> Hell Image settings**.
CW	The speed of transmission in WPM (PARIS system)	**A field appears, pressing the left or right mouse button on it turn on the carrier. You can use the mouse as a telegraph key.** **Settings in the CW Key menu**
PSK	Manipulation speed, baud. When PSK-31 is	The information is preceded by a synchro sequence of 30 "zeros" (alternating 0-180 degrees). Upon

	selected, the manipulation speed is 31.25 baud.	termination - 30 "units" (carrier without manipulation)
WOLF	Manipulation speed, baud	The field for selecting the number of frames (repetitions) of a message in one transmission appears.
WSPR	Duration of transmission, min. Standard values: 2 (WSPR-2) and 16 (WSPR-15) - 8 times longer.	The entry fields for call sign, QTH-locator and power level open. The start of the transmission is tied to the beginning of every 2nd (even) for WSPR-2 or a multiple of 15 minutes (hh: 00: 00, hh: 15: 00, hh: 30: 00, hh: 45: 00) for WSPR -15. Waiting for this moment occurs automatically. In the ini-file there is a section of parameters [WSPR]
JT9	Duration of transmission, min	The moment of the beginning of the transmission is tied (automatically) to the beginning of the minute, multiple of the selected duration.
VOICE	How many times will the transmitted speech be slowed down	A field appears, right-clicking opens the settings menu. Left button – to select wav file for transmission. The set modulation type is displayed next to: FM, AM, BPSK
RTTY	Modulation rate, baud	Frequency spacing [Hz] is set in the ini-file: [RTTY] DF=170
EBNAUT	symbol period, s	Opens the code selection and CRC. The moment of the start of transmission is tied to the beginning of the minute, a multiple of the parameter specified in the menu **Options->EbNaut settings**…

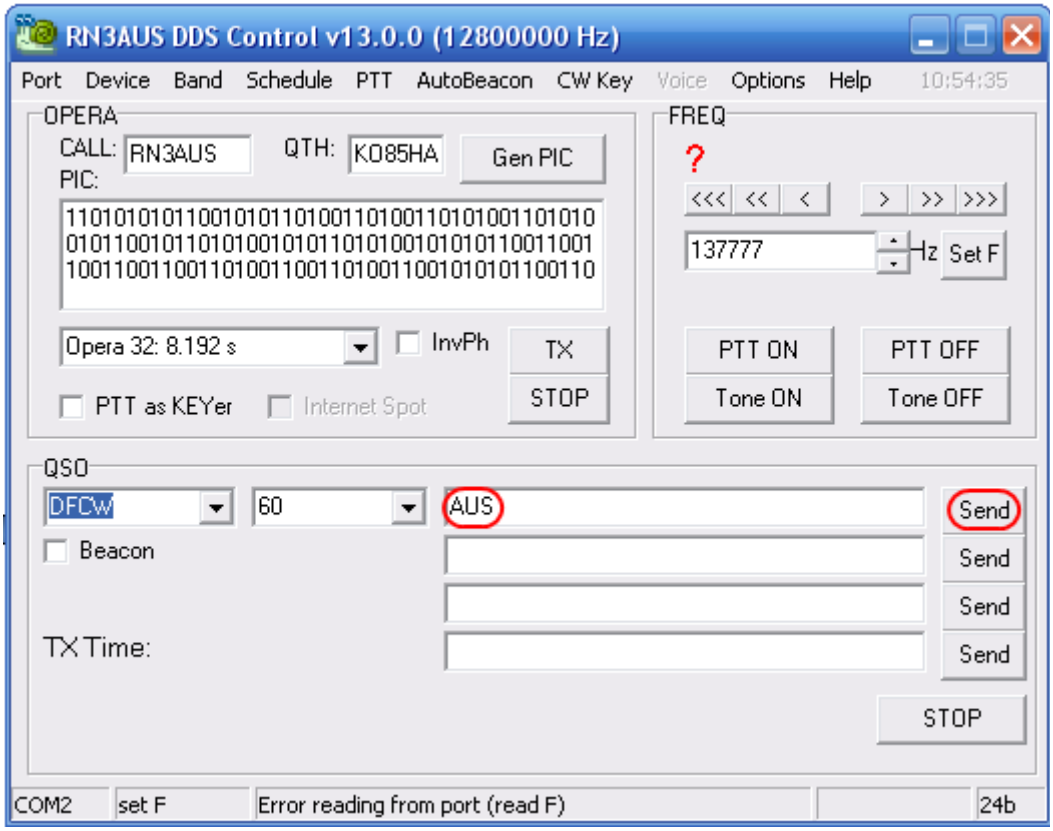
The speed / duration selection field allows not only selecting “predefined” values, but we also can enter values manually.

As already mentioned, if the Options-> Load Defaul Freq option is activated, then when each mode and duration is selected, the corresponding “default frequency” value will automatically be entered in the frequency setting field.

These frequencies are stored in the ini-file and can be changed manually if desired.

4.3 Entering messages

Message text can be entered in the four text fields of the QSO panel. The entered text is stored in the ini-file and, when the program is restarted, is again displayed in the corresponding field.



By clicking the Send button located next to each of the fields, the selected message is transmitted. At the time of transmission, the correction of this message is blocked. All other messages can be edited at this time.

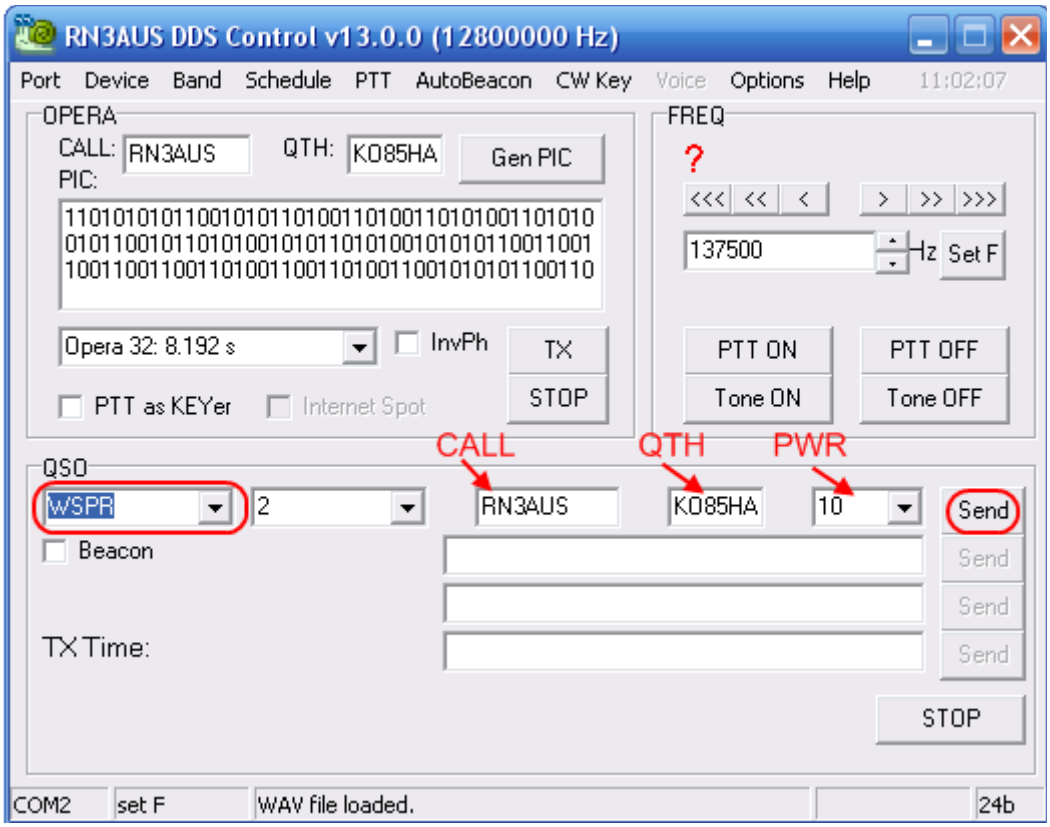
For JT9, the maximum message length is limited to 13 characters.

For WOLF - 15 characters.

4.4 Transmission start

The transmission starts by pressing the TX button in the OPERA panel, or, for all other modes, with one of the **Send** buttons next to the messages.

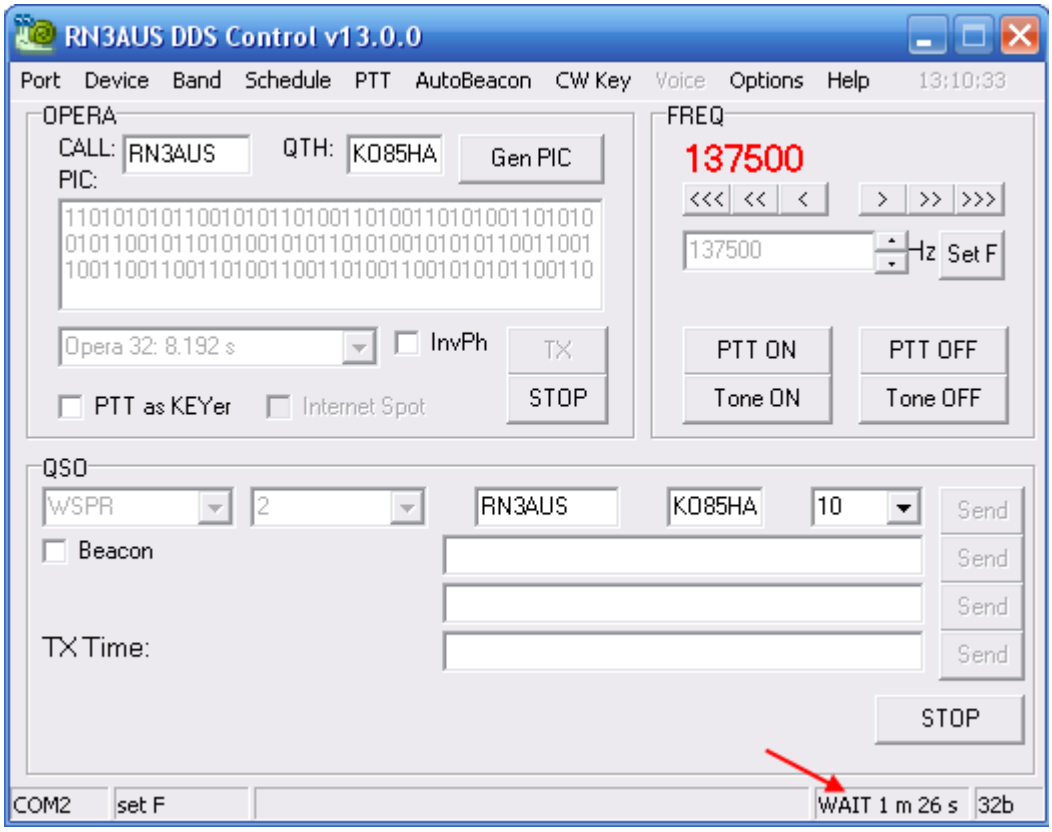
For WSPR, only a single Send button remains active next to the parameters CALL, QTH, PWR.



Some modes of operation are synchronous, that is, the transfer must begin at a specific time. There are several such modes:

Mode	The moment of the start	Where is configured
WSPR-2	00 sec every even minute	
WSPR-15 "WSPR-16"	hh:00:00, hh:15:00, hh:30:00, hh:45:00	
JT9-1	00 sec of every minute	
JT9-2	00 sec every even minute	
JT9-5	00 s minutes multiple of 5	
JT9-10	00 s minutes multiple of 10	
JT9-30	hh:00:00, hh:30:00	
EbNaut	00 sec minutes, a multiple of the parameter in the ini-file [EBNAUT] START_TIME_MULT=5	Menu **Options->EbNaut settings…** **5,10,15,20,30,40,50 мин** (default 5 min)

So, if one of these modes is selected, the Send button can be pressed at any time, the link to the exact time will occur automatically. The timer waits for the desired time:



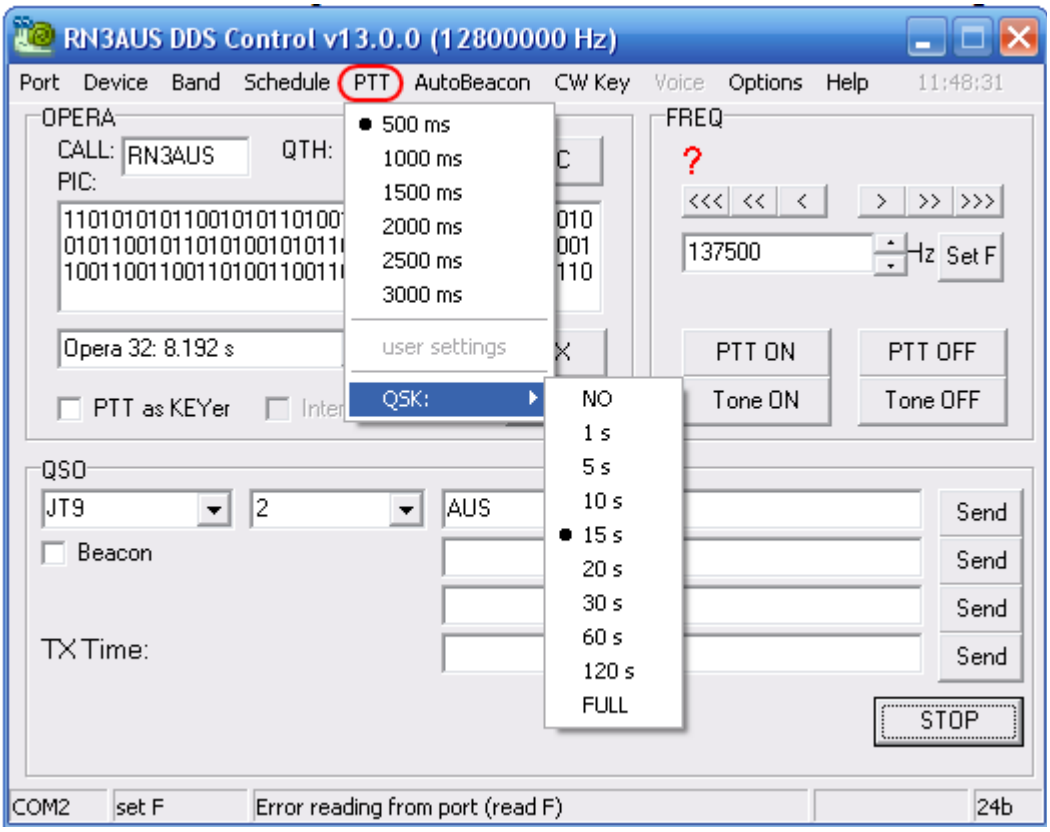
If we are a bit late to click Send, then if no more than 10 seconds have passed since the beginning of the period, the transmission will start with the next parcel, which should have been transmitted at this time. This is done in order not to lose the whole period of transmission with a slight delay to the beginning, which is especially important for QSO in JT9 mode, where you need to have time to type the text of the answer.

As already mentioned, if the O**ptions-> Freq Corrector** option is set, at the moment of the start of the transfer, the set frequency is compared with the boundaries set aside for the selected operation mode. If the frequency is "wrong", then it will be automatically replaced with some random "allowed" value, or, if the **Options-> Load Defaul Freq** option is also enabled, with the "default" frequency. For each of the operating modes and ranges, these frequencies are stored by default in the ini-file and can be changed manually if desired.

4.4.1. How PTT works

Before starting the transmission, you must turn on the transmitter, or apply power to the power amplifier. To do this, use the PTT ON command. This command is given automatically at a certain time before the start of the transfer.

Setup is done in the PTT menu:

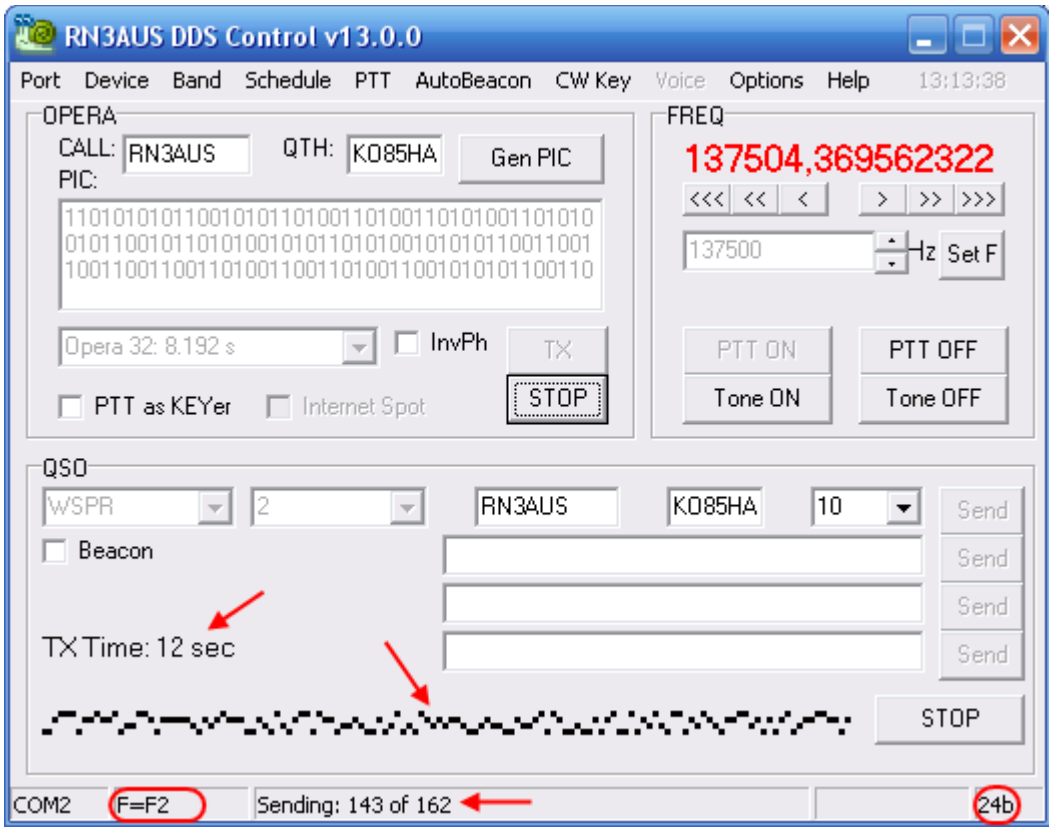


The PTT delay time, that is, the time that must elapse from turning on PTT to the start of information transfer, is specified in milliseconds.

In addition, it is possible to configure the QSK mode, that is, switch to receive in the pauses of its transmission, for example, between QRSS dots. To do this, use the PTT-> QSK submenu ... Here you can specify the length of the pause between characters, for which it is allowed to turn off PTT. For example, if QSK is set to 15s, then when sending a QRSS-60, after each dot transmission PTT will turn off, since the pause between dots is 60 seconds and exceeds the QSK time. If QSK = NO, then PTT will be enabled until the end of the entire message. With QSK = FULL, PTT is turned off at the end of each dot, regardless of the duration of the upcoming pause.

4.5 **Transfmission process**

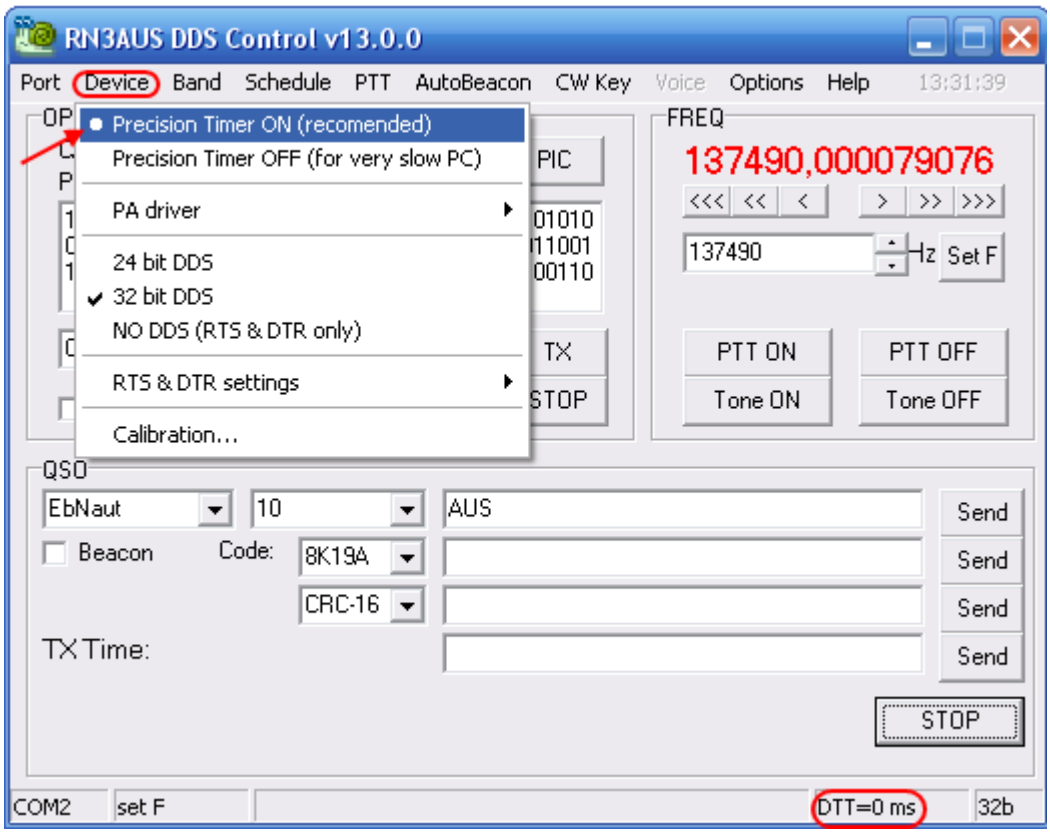
During the transfer, the status bar displays: the last command sent to the synthesizer, the number of the transmitted information packet “Sending: xxx of yyy”, as well as the 24/32 bits mode. The QSO panel shows the remaining time until the end of the transmission “Tx Time”. The graphic line shows the approximate view of the transmitted signal.



Digital modes of operation place fairly high demands on the timing of the generated signal. This means that the duration of the elements of signal and their location on the "time axis" must be maintained as accurately as possible, otherwise the noise immunity of the reception is deteriorated. As you know, the Windows operating system is not designed to control devices in real time. For example, the processing of a system WM_TIMER message may have a jitter of the order of tens of milliseconds, which is comparable to the duration of the PSK-31 element. Without additional measures, the signal is formed with an unequal duration of the parcels. The total duration of the transfer of the entire message will also differ from the regular one, since timing errors may accumulate. This is not critical for

visual QRSS / DFCW and HELL modes, but for WSPR, PSK, EbNaut, RTTY this is already becoming a big problem.

To provide highly accurate making of durations, the DDS_ctrl program uses the so-called high resolution timer, available in WindowsAPI (timeBeginPeriod (1) function). Enabling and disabling this mode is available in the menu **Device->Precision Timer.**



By default, the high-resolution timer is always on. Disabling it may be necessary only for the oldest and slowest computer models that are sorely lacking in performance.

The essence of the method is as follows. To form the sending time, the standard WM_TIMER system timer is used, the duration of which is set less than the required one by 60 ms, but not more than 1/3 of the sending time (everything is calculated automatically). This initial lead time is set in the ini-file TimerOffset = 60, it is selected experimentally and is suitable for all PCs, it is not recommended to change it. Before the transfer begins, the high-resolution timer counter QueryPerformanceCounter is remembered. At the end of each WM_TIMER, the counter is read again, it will be slightly less than the required

value, corresponding to the exact moment of the start of the next parcel. The program temporarily increases its priority to HIGH_PRIORITY_CLASS and, constantly asking for the value of the high-resolution timer counter, is in a loop until the expected value is reached. Now you can send another command to the synthesizer to form a new parcel. Thus, the CPU load on average is small, but for short periods of time it increases due to the polling cycles of the high-resolution timer. For any PC, not older than 10-15 years, this is not a problem. If it is noticeable that the work of the system is jerking, then dying down, then resuming again - it means that performance is still not enough and the precision timer will have to be turned off **Device->Precision Timer OFF.**

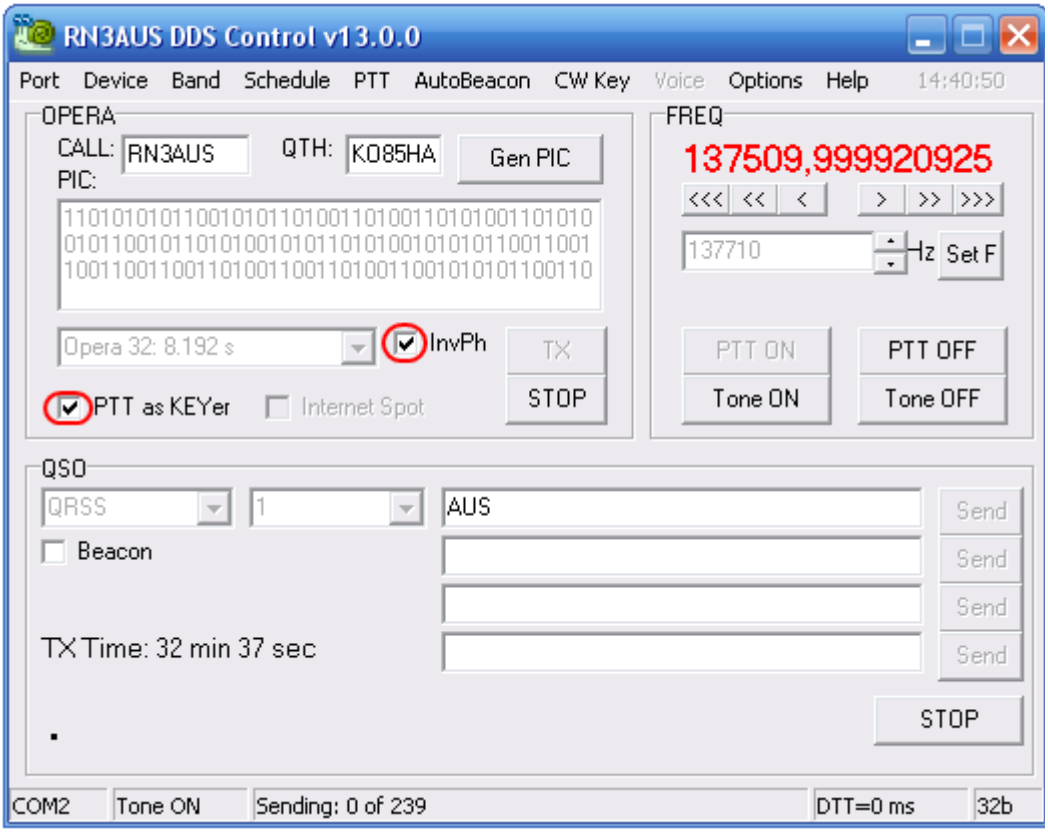
At the end of the transfer, the program checks how much the actual transfer duration differs from the required one. The difference value is displayed in the status bar DTT = XX ms. Usually, if everything works correctly, this difference is zero even for the fastest mode.

Note: in order to avoid unexpected problems with timing, it is better to refrain from using the computer for other resource-intensive purposes for the duration of the transfer in the critical mods to it.

4.6 Features of the transfer process

4.6.1 OPERA

This mode was the first digital mode implemented in this synthesizer, so it was moved to a separate panel, where it remained in the future. A feature of OPERA is the ability to manipulate the transmitter not only in tone as usual, but also alternatively in a PTT signal. To do this, use the “PTT as KEYer” checkbox. Maybe someone this opportunity will be useful.



Another checkbox "**InvPh**" is used to ensure the inversion of the carrier phase at each send relative to the previous one. In theory, this would have to increase the level of carrier sideband information in the spectral representation of the signal, which could improve reception with OPDS by DF6NM correlation detector. It turned out that the improvement, if any, is insignificant. When this checkbox is unchecked, the program ensures the coherence of the signal sendings.

4.6.2 WSPR

The first feature is related to the choice of duration if you wish to work in WSPR-15. You have to choose the value 16 in the drop-down list! What it is? Why it was impossible to write 15? The explanation is simple. Basic mode is WSPR-2. Historically, it was developed first. WSPR-15 is its slowed 8 times version. And what ever prevents to try, for example, an even slower and noise-resistant version, slowed down by 32 times? The DDS_ctrl program allows you to form a WSPR signal with an arbitrary slowdown, not only 8 times, but 16 times, and so on. Therefore, the designation was obtained as a multiplication of the original length of 2 to 8 times, that is, "WSPR-16". I suggest just to accept it. But when you need it, you can work at any other speed that

is a multiple of two. You only need to manually enter this value in the duration field.

The second feature is the use of the so-called fast frequency switching for transmitting WSPR-2 and WSPR-15. A typical frequency switching requires sending a command with a frequency code to the synthesizer, all together 6 bytes, and receiving a response from it, another 6 bytes. It takes not so little time, at least 13 ms. All this time, the signal at the output of the synthesizer will be absent, the transmission is received "ragged". To get rid of this unpleasant effect, a pre-setting of 4-frequency values was used in the synthesizer, which are used to transmit the WSPR codes and then quickly set them up with just one command (1 byte) for each regular dashes. The "gap" between the dashes is less than 1 ms, which is much better. Frequency codes are memorized by the synthesizer in 24-bit mode, therefore, for WSPR transmission, the program switches to 24-bit mode each time and remains in this mode after the transfer is completed.

By default, the fast frequency mode is enabled. However, you can refuse it by changing the parameter in the ini-file:

[WSPR]

FAST=1 - 1-enabled, 0-disabled

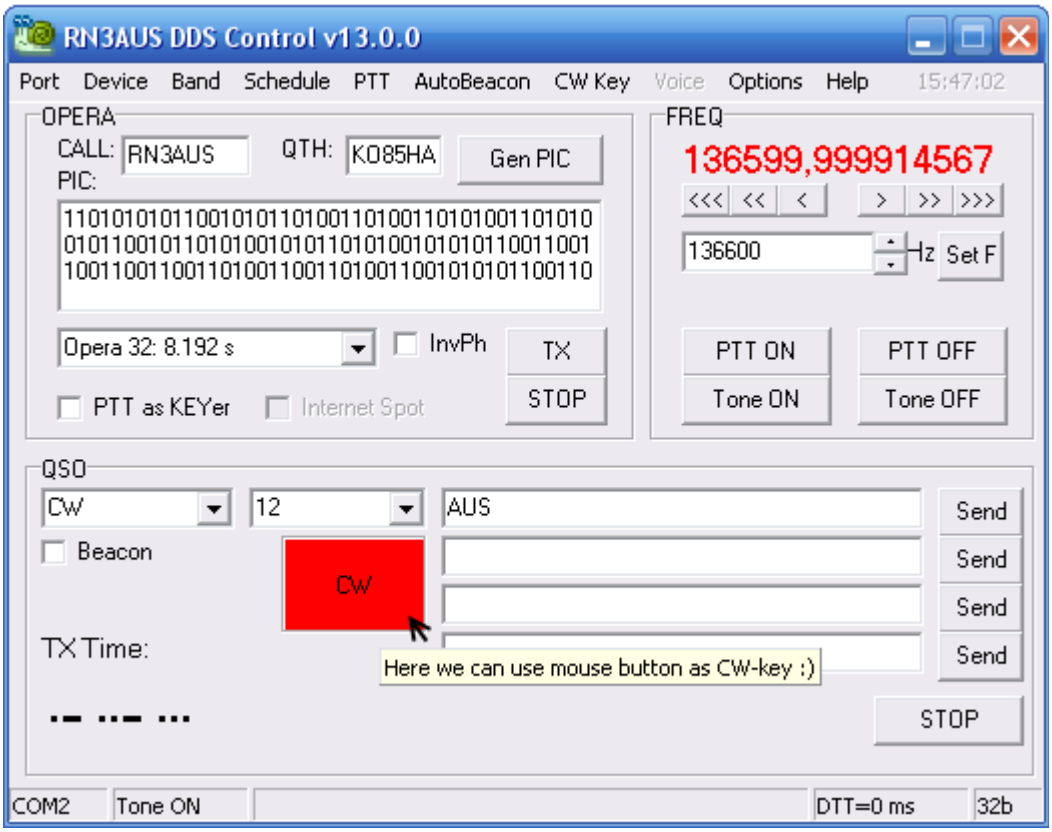
For WSPR longer duration, if such modes will ever be used, a 32-bit frequency is used and the usual, not fast, frequency setting is used. In 24-bit mode, the frequency setting step becomes greater than the separation between the frequency parcels, so you have to increase the bit depth. The synthesizer can only memorize 24-bit frequencies. But in this case, with large durations of parcels, the occurrence of small pauses between them is not so important.

4.6.3 CW

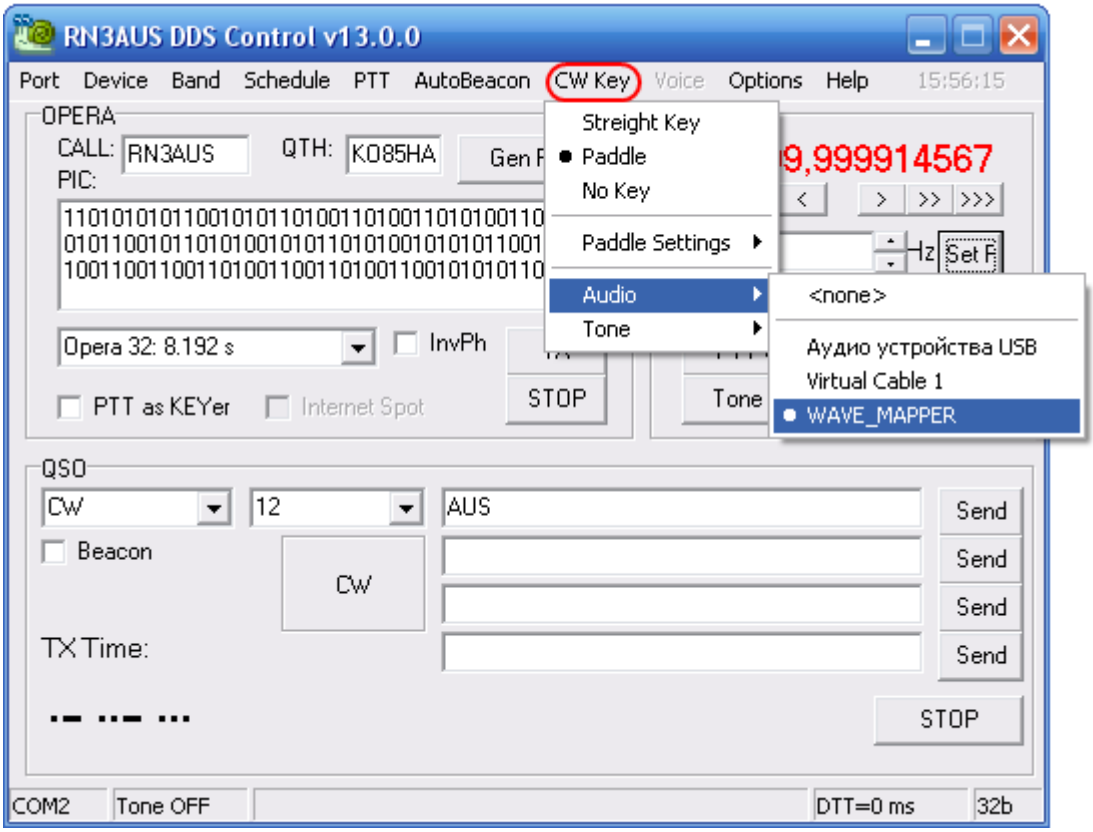
The CW mode involves not only the transmission of your call sign in the beacon mode, but also live communication on the air. It is rather inconvenient to make a CW-QSO when the reporter needs to feverishly type the answer from the

keyboard and then send it with the Send button. The QSO is obtained with pauses, when the correspondent wonders why he is not answered and begins to doubt that you heard him. Here you need a telegraph key.

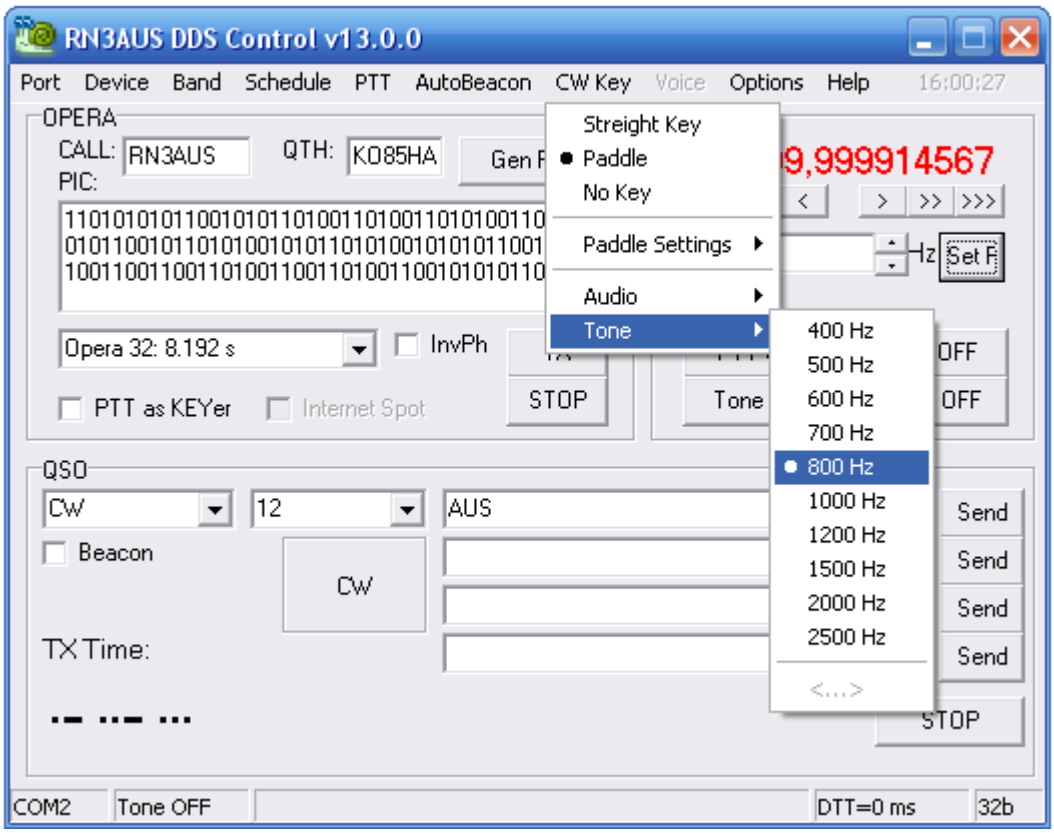
The first possibility is to use a computer mouse as a telegraph key. Hover it over the appeared field with the inscription CW and begin to transmit using the mouse button. Not very convenient, but when there is nothing else, it works.



In the speakers of the computer or headphones connected to the output of the sound card, the self-control signal will sound. In the **CW Key-> Audio** menu, you can select a sound card for self-control, or disable self-control (**<none>**).



In the **CW Key-> Tone** menu, select the self-control tone frequency.

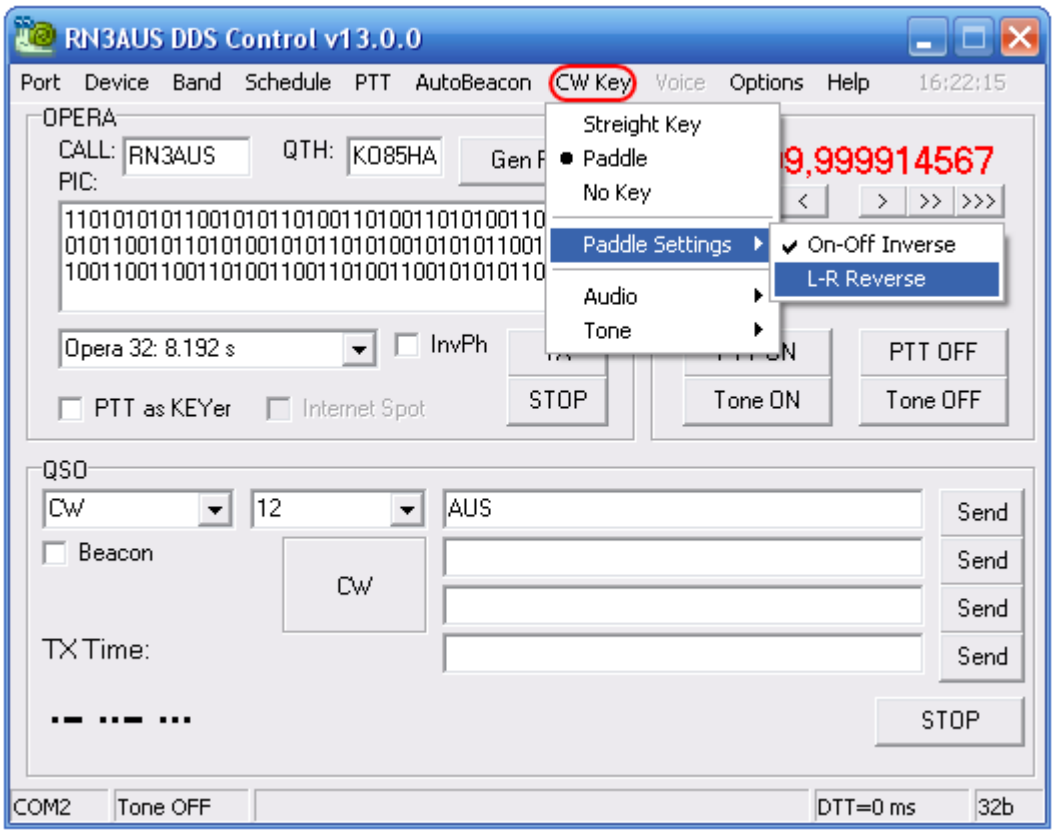


You can also set some other arbitrary value of this frequency using a parameter in the ini-file:

[CW_KEY]

AUDIO_TONE=800 - frequency in Hertz.

Another possibility to connect a telegraph key is through a specially designed connector (see diagram). In fact, the key, whether it is a traditional vertical Streight Key or a horizontal Paddle, is connected to the DSR (pin 6) and RI (pin 9) signals of the computer's COM port. These signals are analyzed by the DDS_ctrl program. When the key is not pressed, both signals are "pulled" by resistors to + 12V. Pressing the key closes them to the ground. The choice of key type is made in the **CW Key** menu: **Streight Key** or **Paddle**. If you select **No Key**, the manipulation on the pins of the COM port is ignored. In the case of a Vertical key, it can use either of the DSR or RI signals, or both. In the case of Paddle, dot contact is connected to DSR, dash - to RI. In the **CW Key-> Paddle Settings** menu, if necessary, you can "swap" the contact of the dash and dots, as well as invert the "press" and "release."



4.6.4 HELL

Undoubtedly, HELL is one of the most "spectacular" modes of operation. The transmitted text is directly and quite nicely read on the spectrogram. Each symbol is “drawn” by a sequence of tonal parcels of different frequencies, at each moment of time only one frequency is radiated.

The outline of each character is set in the ini-file in the section

[HELL FONT]

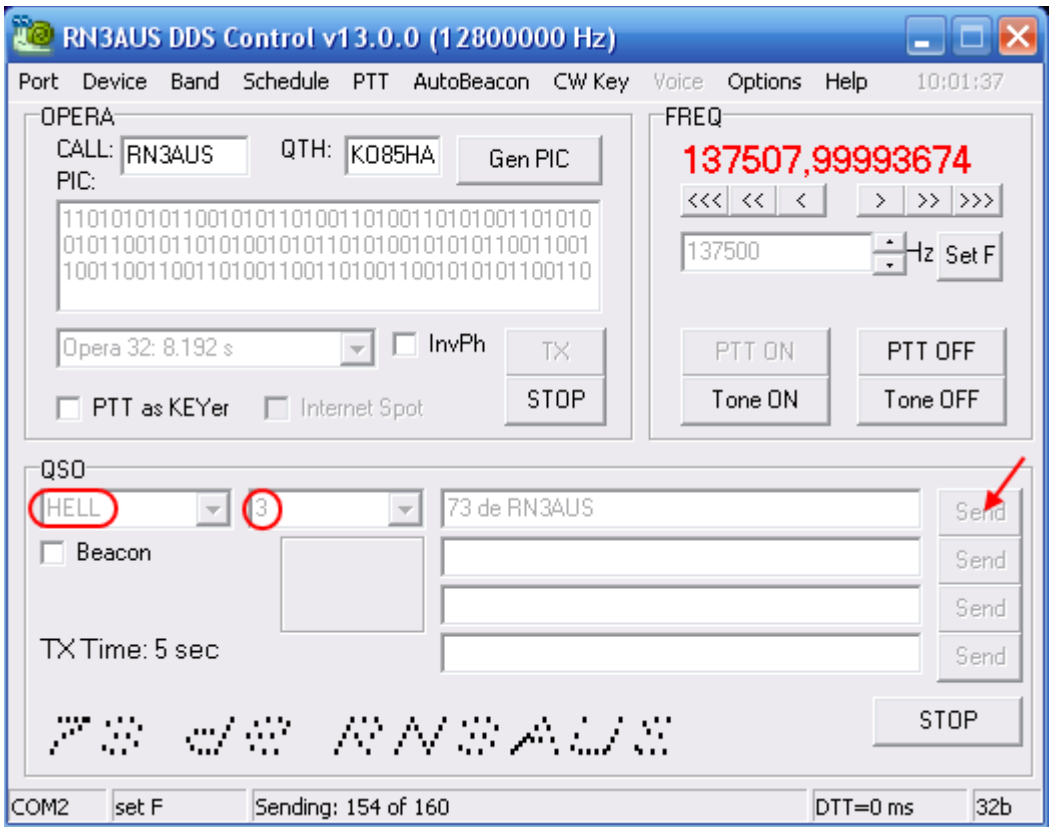
A=123454749741000

The numbers set the pitch of the tone transmitted in this position. The number 0 means that nothing is emitted (tone off). For the symbol "A" we get the following:

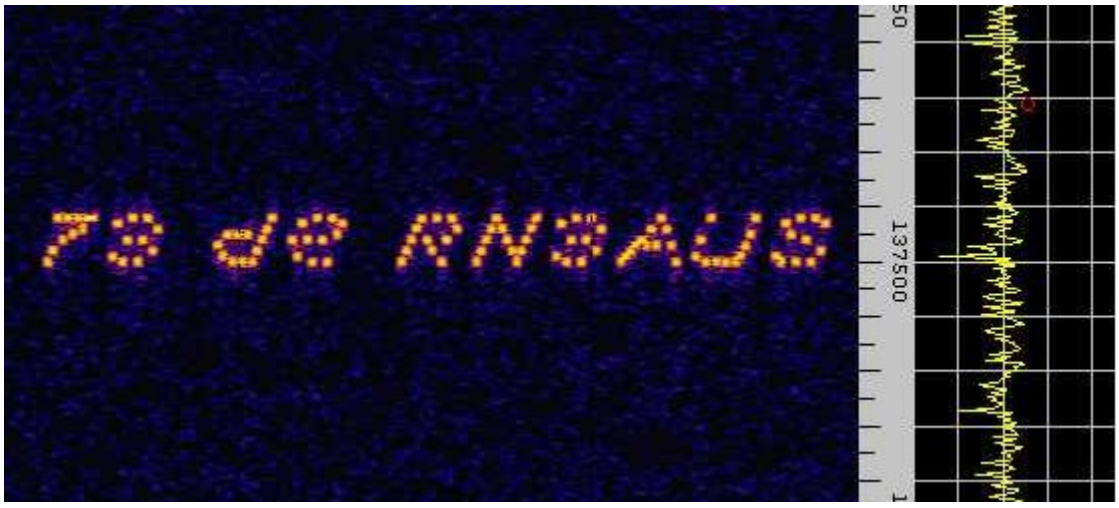
Freq															
9								9							
8															
7							7			7					
6															
5					5										
4				4		4		4			4				
3			3												
2		2													
1	1											1			
0													0	0	0

If you wish, you can independently design your own "font" by making the necessary changes in the ini-file.

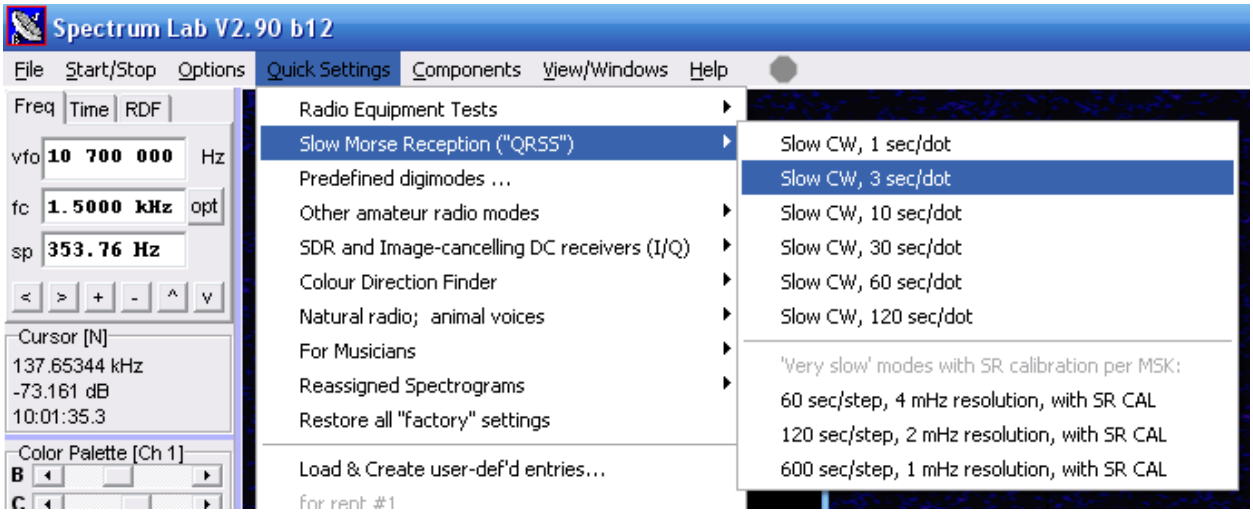
Let's see how the HELL transfer process looks in practice:



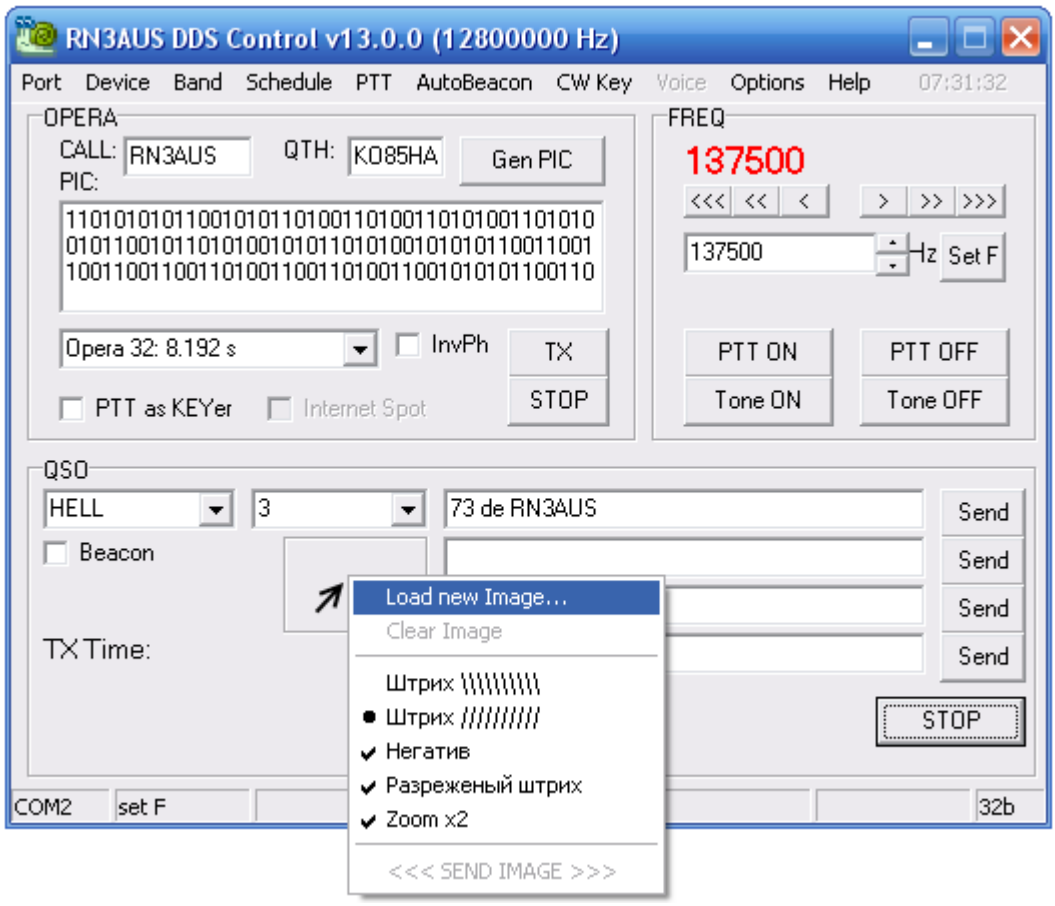
The spectrogram will be received at the receiving side:



SpectrumLab settings were taken as default for QRSS-3 mode:



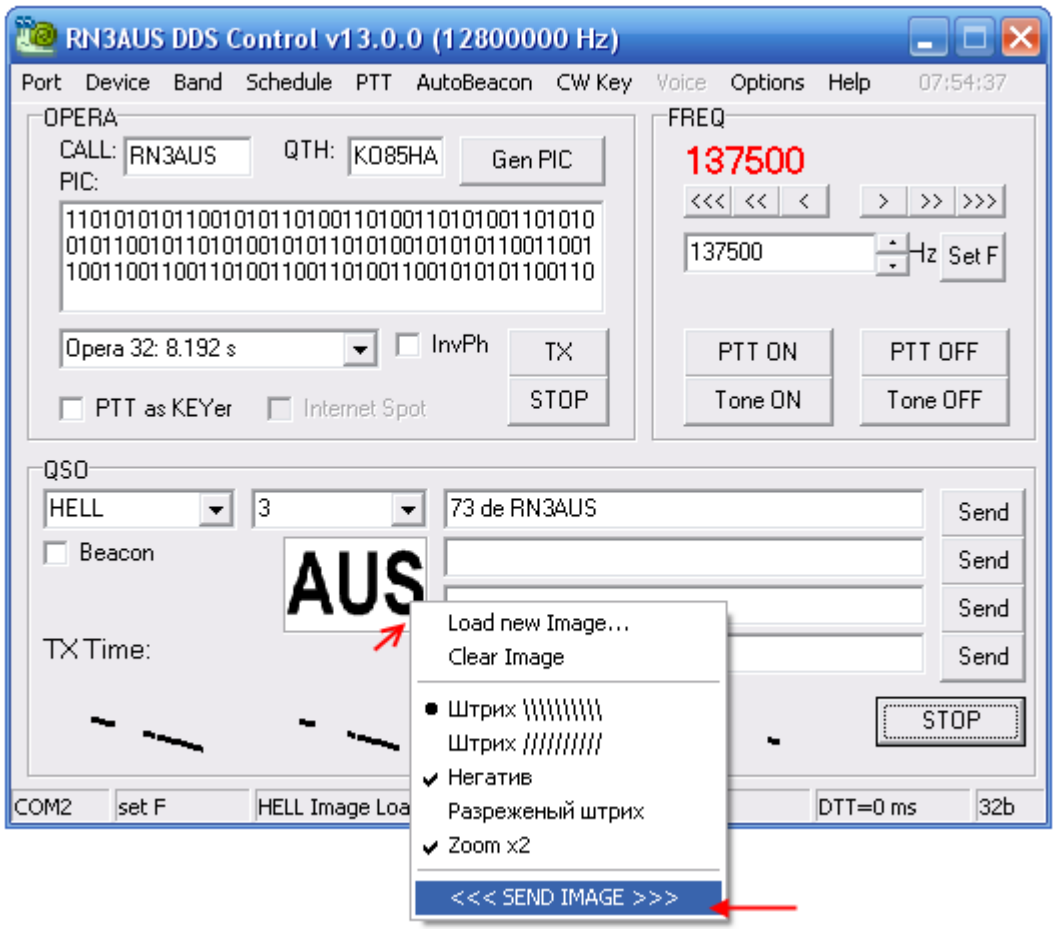
Even more possibilities open up when using HELL to transfer graphic images. First of all, prepare any graphic file with a not very complicated image in BMP format. Hover over a small panel next to the HELL mode selection field.



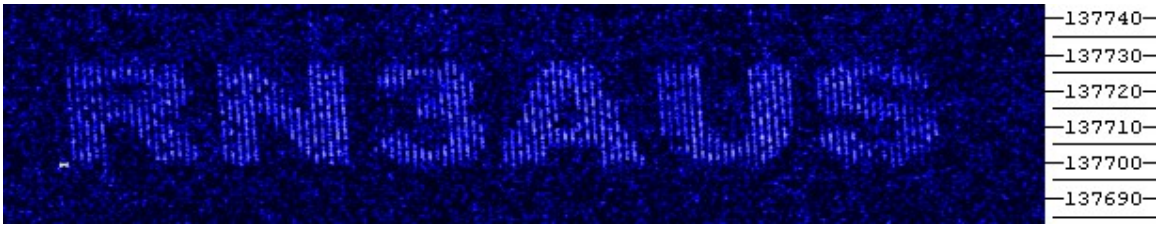
Select **Load new Image ...**, in the dialog box, load the prepared file.

The image will be transmitted using the "hatching" on the spectrogram: the transmission frequency will continuously "slide" from bottom to top (or from top to bottom - as indicated in the **Stroke /////** or **Stroke ** menu). Simultaneously read a raster image. If there is a light tone - the transmission is allowed, if dark - the tone is off. The Negative menu item changes the transmission order — the tone is turned on if the dot is dark and turns off if it is bright. Hatching can be thinned (**Sparse Stroke**) or zoomed (**Zoom x2**). Here you need to try how the resulting spectrogram will look better. All these settings are duplicated in the main menu **Options-> Hell Image Settings ...**

So the image is uploaded, now you can transfer it by selecting the **<<< SEND IMAGE >>>** item in the dropdown menu.



Transmission will begin, the frequency will change rapidly. On the receiving side you get something like this:

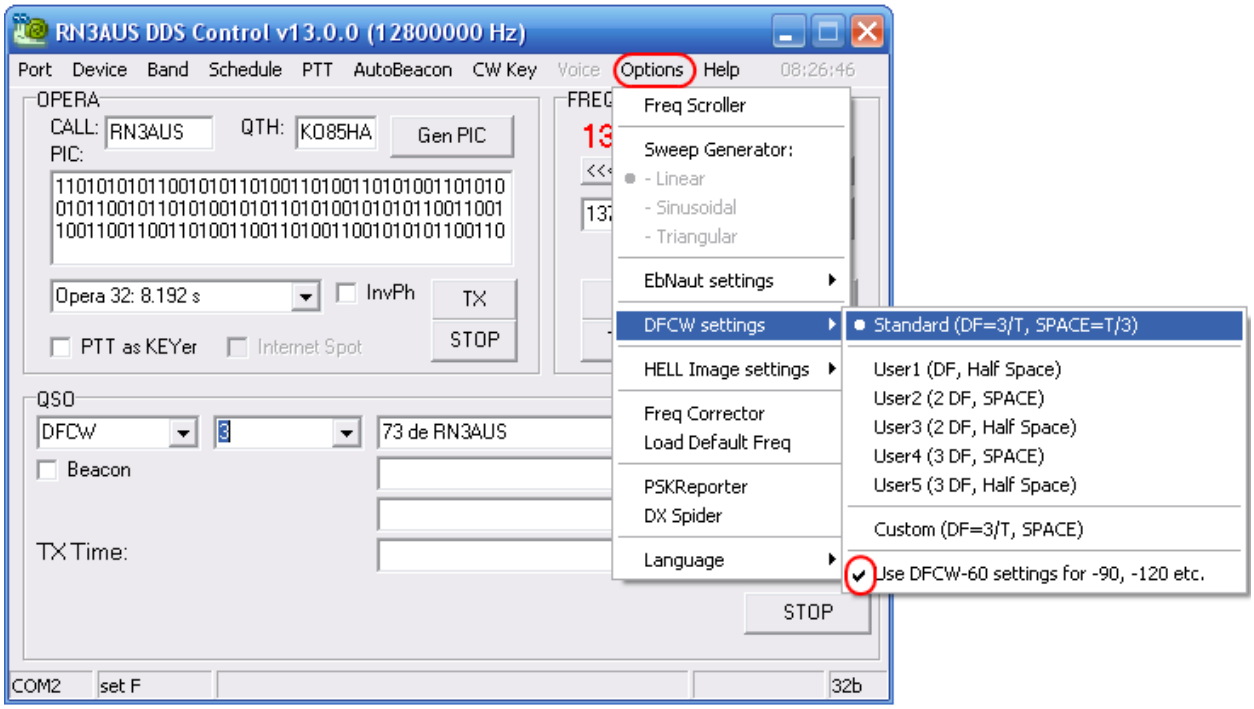


However, the Hell Image mode is not intended for serious work - only for local experiments and entertainment. Punching his ability is small - the signal is too “smeared” over the area of the spectrogram.

4.6.5 DFCW

This is one of the most penetrative and at the same time fast visual modes. Transmission is Morse code. Dashes have the same duration as points, but are transmitted higher in frequency. In order to better read such a signal in the spectrogram, such a frequency shift is chosen so that it equals dF = 3 / dot. For example, for DFCW-3, the sending time is 3 seconds, dF = 3/3 = 1 Hz. For DFCW-60 dF = 3/60 = 0.05 Hz. Between the packages, you also need to have some “gap” so that they do not merge with each other and read each separately. Usually take dT = dot / 3, that is, for DFCW-3 dT = 3/3 = 1 sec, for DFCW-60 dT = 60/3 = 20 sec.

These are “standard” values. Sometimes it may be necessary to establish different ratios so that your signal looks more readable or somehow different from others. All these settings are made in the menu **Options-> DFCW Settings ...**



There are several ready-made sets of such settings, in addition to the standard. In addition, you can prepare your personal settings by changing the parameters in the ini-file (they will be displayed in the **Custom** menu item after launching the program):

```
[DFCW]
USER_SETTINGS=0
DF=3
SPACE=1
```

Pay attention to the checkbox:

«Use DFCW-60 settings for -90, -120 etc»

By default, this checkbox is checked. This means that for longer modes than the usual 60 seconds, the same frequency spacing of the parcels will be used as for 60, and not reduced. The fact is that grabbers usually display a spectrogram in QRSS-60 mode. If we transmit, say, DFCW-120, then the dashes of dots and dashes would turn out not only longer, but also pressed to each other vertically. It turns out some oblate and poorly readable signal. If we increased the duration, and the frequency shift was left unchanged - this signal is read much better.

If the grabber, where we want to break through, works in the mode of 90 sec / dot or 120 sec / dot, then here, on the

contrary, the tick should be removed, otherwise our signal will be too stretched vertically.

As a rule, it is enough to use the standard default settings.

4.6.6 VOICE

This is an experimental mode of transmitting slow speech or music using a non-linear transmitter. Various modulation methods can be used for transmission: frequency (FM), amplitude (AM = CW) and phase BPSK.

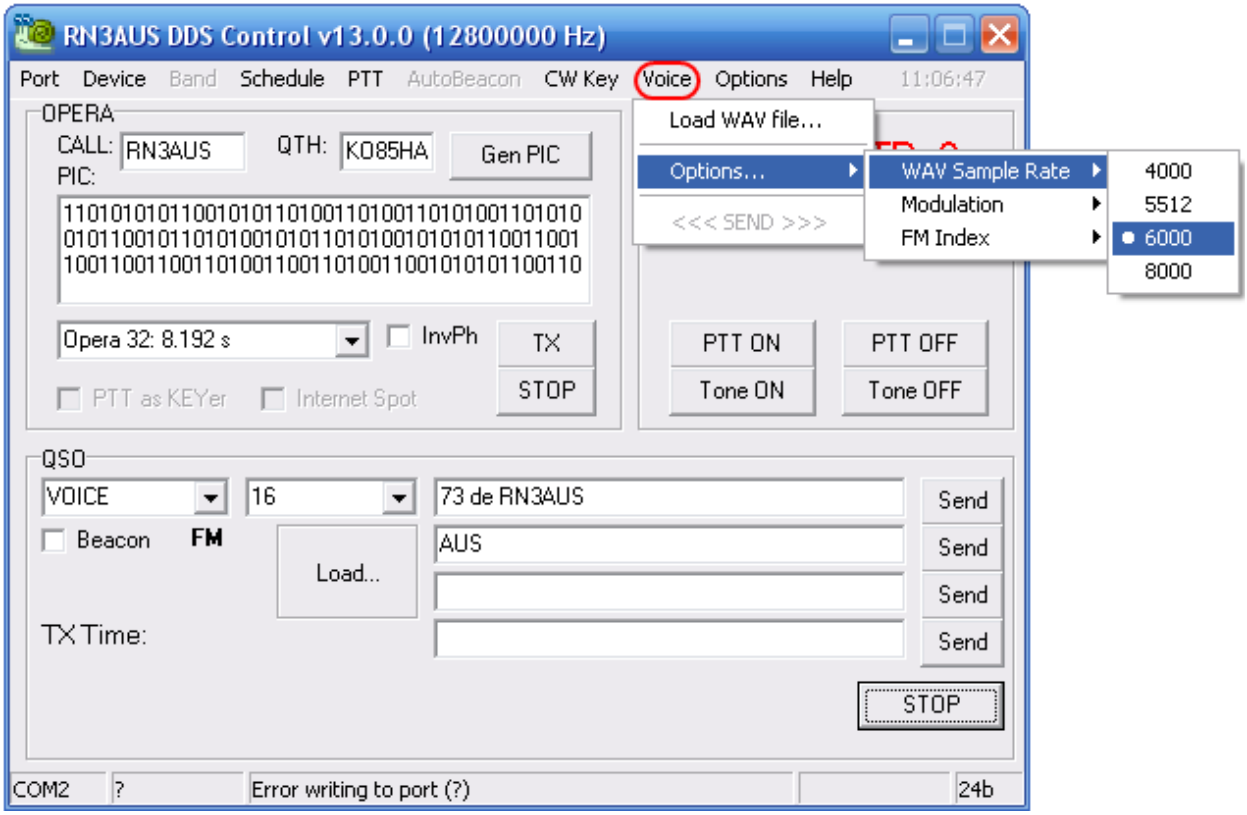
First of all, you need to prepare an audio file with a recording of a short phrase that you would like to transmit. For example, something like: “2200 meters band, this is Romeo Nancy Three Alfa United Sierra. Calling CQ and standing by!” You can record your voice using any suitable program: Sound Recorder Windows, CoolEdit, etc. Choose the lowest sampling rate available - 8000 or (if possible) 6000 Hz. This sampling frequency must be equal to or a multiple of the one specified in the ini-file:

```
[VOICE]
SAMPLE_RATE=6000
MAX_SAMPLES_NUMBER=1000000
```

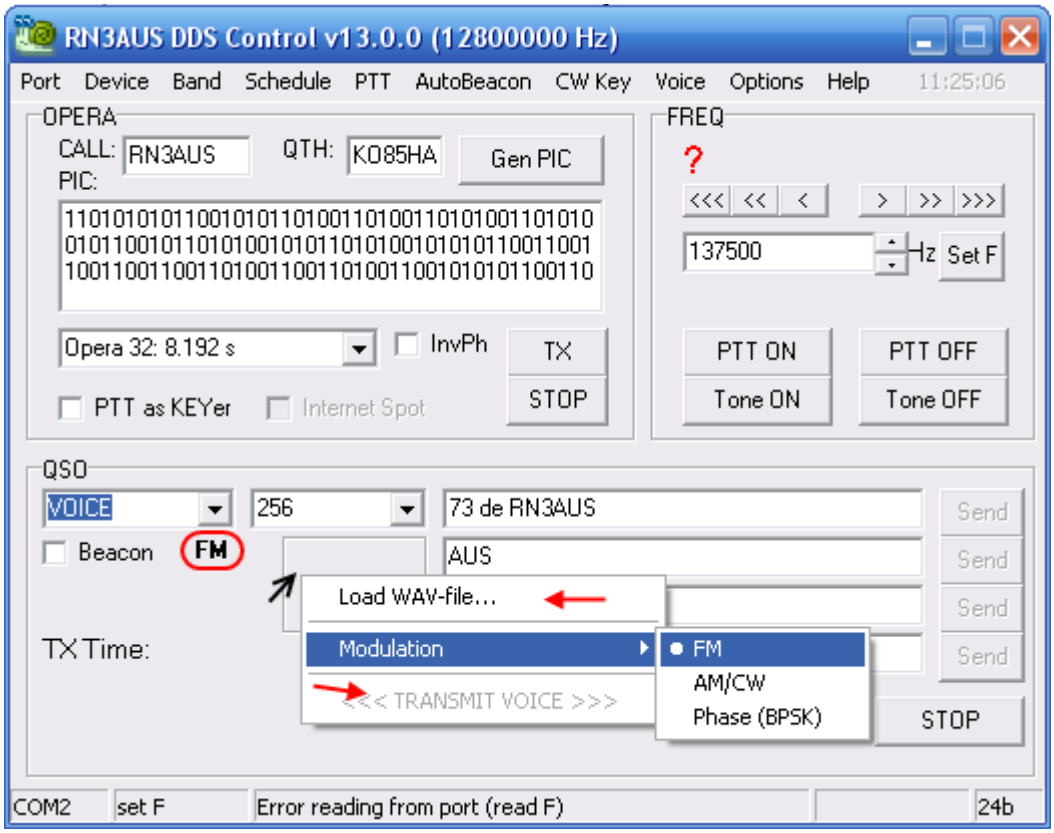
The file length is limited, as you can see, 1,000,000 samples, which is enough for 166 seconds of recording. This is a lot for LF! It is better to limit your speech for 5-10 seconds.

To increase speech intelligibility, you can process the file by raising high frequencies with the help of an equalizer.

Sample Rate can be selected via the menu: **Voice->Options->WAV Sample Rate**



Having set the type of VOICE operation and selecting the required rate of slowing down speech (100 or 128 for local connections and long phrases, and up to 1024 for DX and short phrases), right-click on the panel to bring up the context menu:

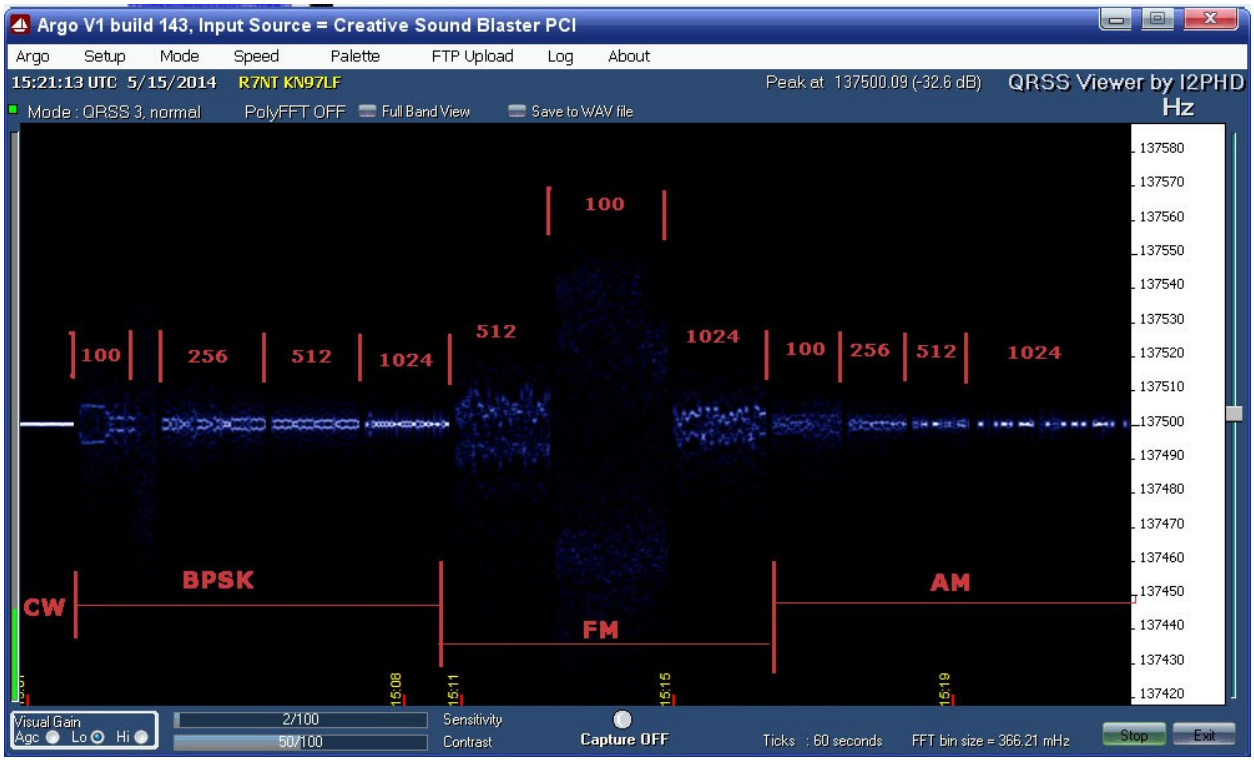


- Load the prepared sound file: **«Load WAV-file…»**
- Select the type of modulation
- Press **<<<TRANSMIT VOICE>>>**

(The same actions are available in the main menu **Voice**).

The transmission begins. If the source file had a duration of, for example, 5 seconds, the transfer will last (as shown in the figure) 5 x 256 = 1280 seconds = 21 minutes 20 seconds. Transferring each sample of the source file will take 256 times longer.

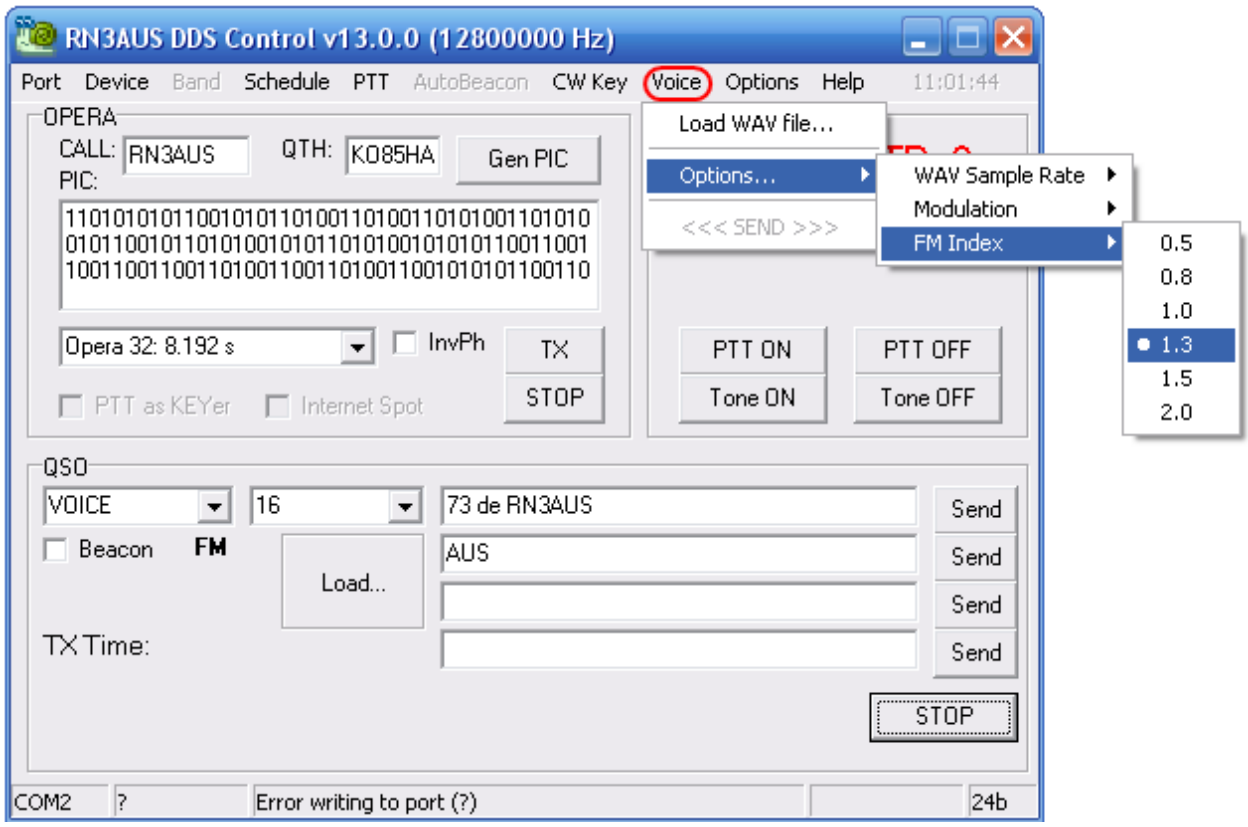
On the receiving side, the spectrogram, depending on the chosen modulation and deceleration rate, will look similar to the one below:



Let us briefly discuss the types of modulation.

a. Frequency modulation FM.

The frequency shift will be proportional to the amplitude of the next transmitted sample. The slower the transmission, the narrower the spectrum. Frequency modulation gives the reception the highest quality sound, but it is the most wide-band and its noise immunity at equal speed is lower than that of other modulation methods. The best ratio of noise immunity and quality gives the frequency modulation index from 1 to 2. The default index is set to 1.3. You can adjust this value in the menu **Voice->Options->FM Index**…

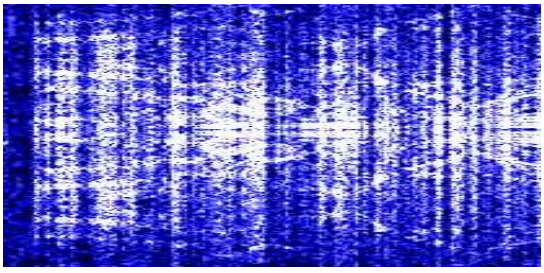


b. Amplitude modulation AM.

This method of transmitting the most simple and sounding on the air is similar to CW. If the amplitude of the transmitted reference is greater than zero, the tone is transmitted, otherwise nothing is transmitted. That is, speech is subjected to binary quantization, but, nevertheless, the method is quite legible.

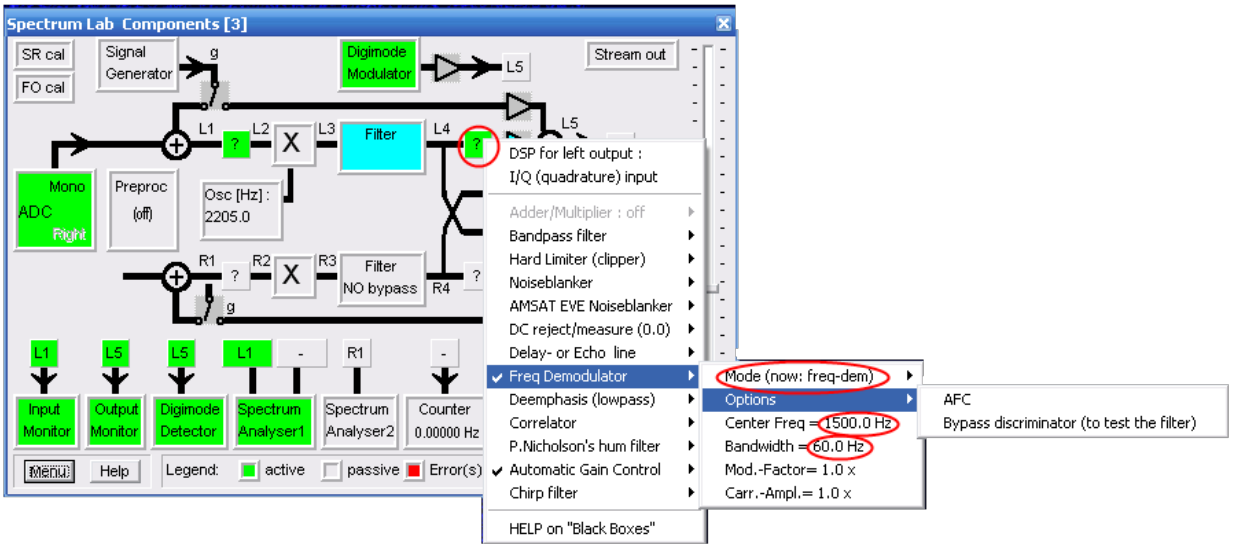
c. Phase modulation BPSK.

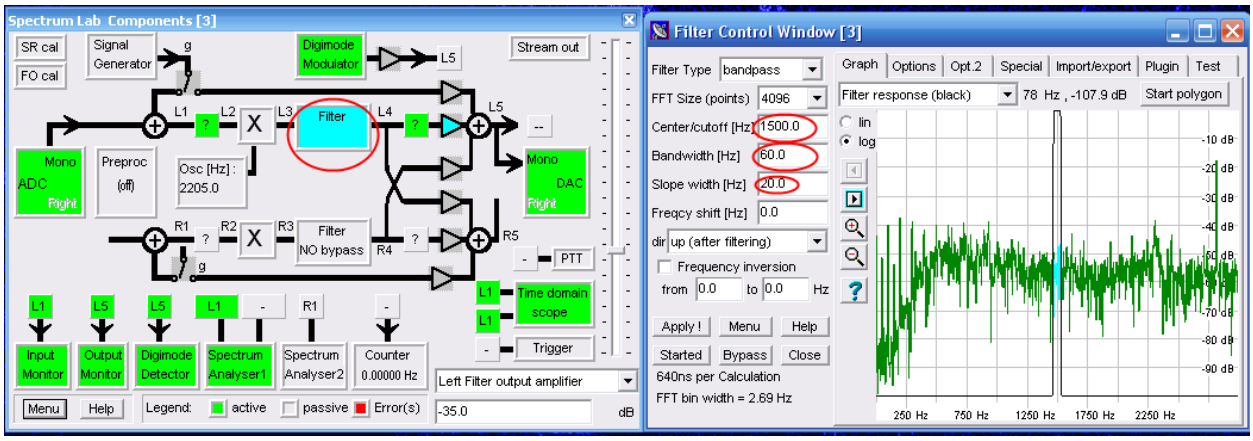
If the signs of the current and previous speech samples are different, then the carrier phase is inverted, otherwise the transmission goes without inversion. Surprisingly, this modulation method provides a rather high-quality speech recovery; moreover, characteristic spectral speech "samples" that are symmetric about the carrier frequency (DSB modulation) appear on the spectrogram.

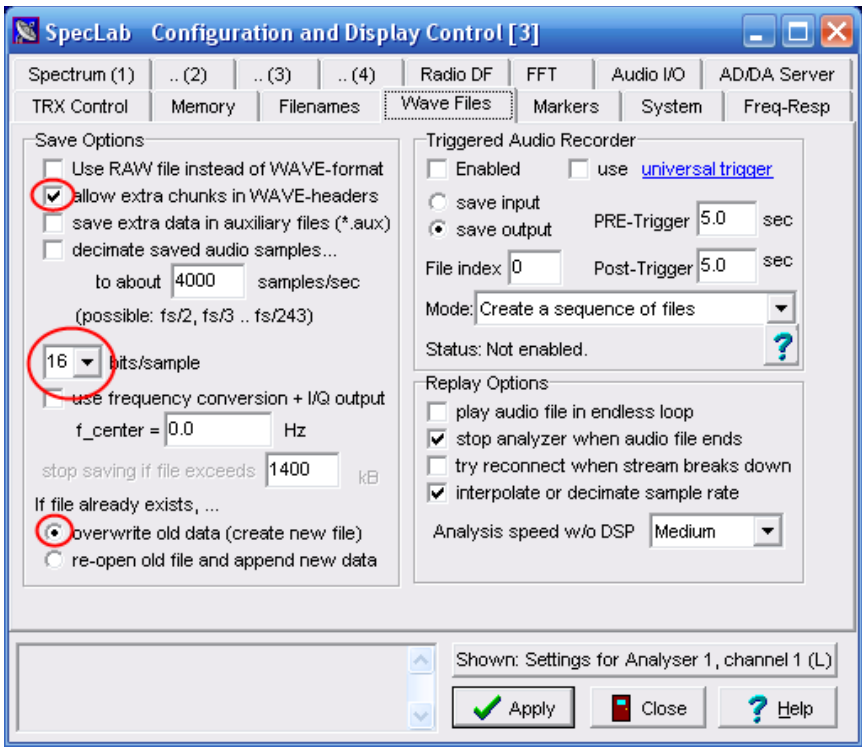


It turns out that the main speech information is contained in the moments of the speech signal passing through zero! This type of modulation turned out to be the most penetrative and noise-resistant.

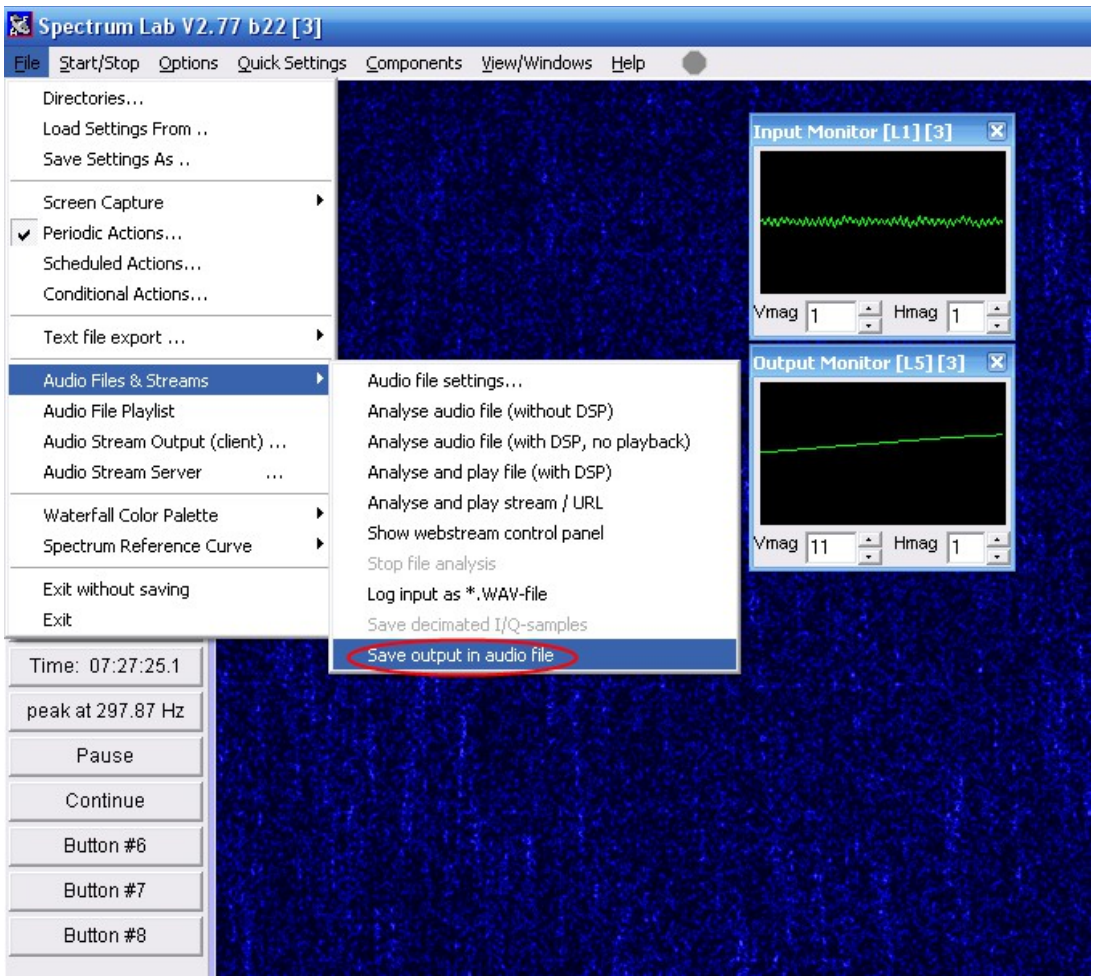
Reception can be conducted using SpectrumLab with some advanced settings. The figures below show the settings for FM reception:







Here it is assumed that the transmission will go at a frequency of 137500 Hz (audio frequency at the output of the receiver is 1500 Hz). We start record:



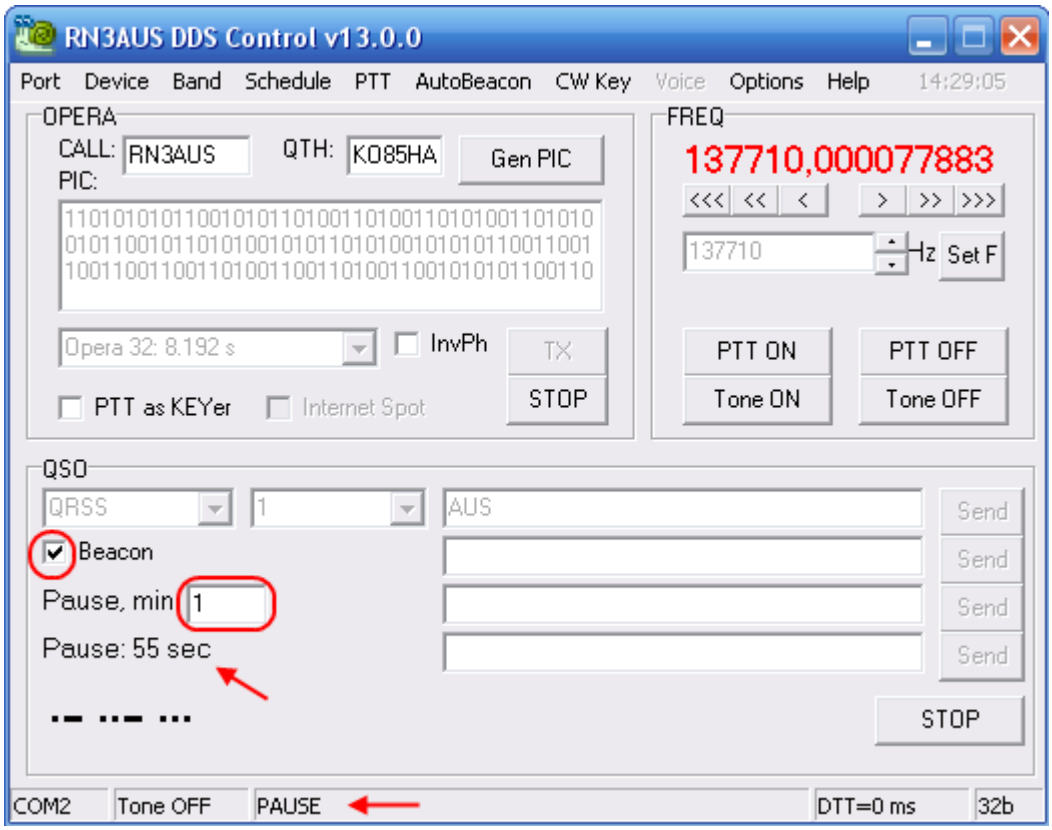
If the exact time of the start of the experiment is unknown, you can leave the record on for the whole night. Having finished the recording, the resulting file can be played, for example, using the Windows Sound Recorder program — any program that has an accelerated playback mode. Accelerate playback as many times as it was set on the transfer. Long hours of night recording will be played within a few minutes, and you will hear the sound of an ultra-narrowband channel (just a few Hertz!) and the live voice of a distant correspondent!

4.7 Stop transmission

The transfer is completed automatically if all information is transmitted. This turns off the carrier and PTT. Forcibly stop the transfer by pressing the STOP button. There are two such buttons - one for OPERA mode, the other for all the others, but they operate in parallel and in the same way, so it’s like one button.

4.8 Beacon

To organize the work of the simplest beacon is the **Beacon** checkbox. A field opens where you can enter the length of the pause in minutes between replays. If Pause = 0, then the repetition will be executed immediately, without a pause.



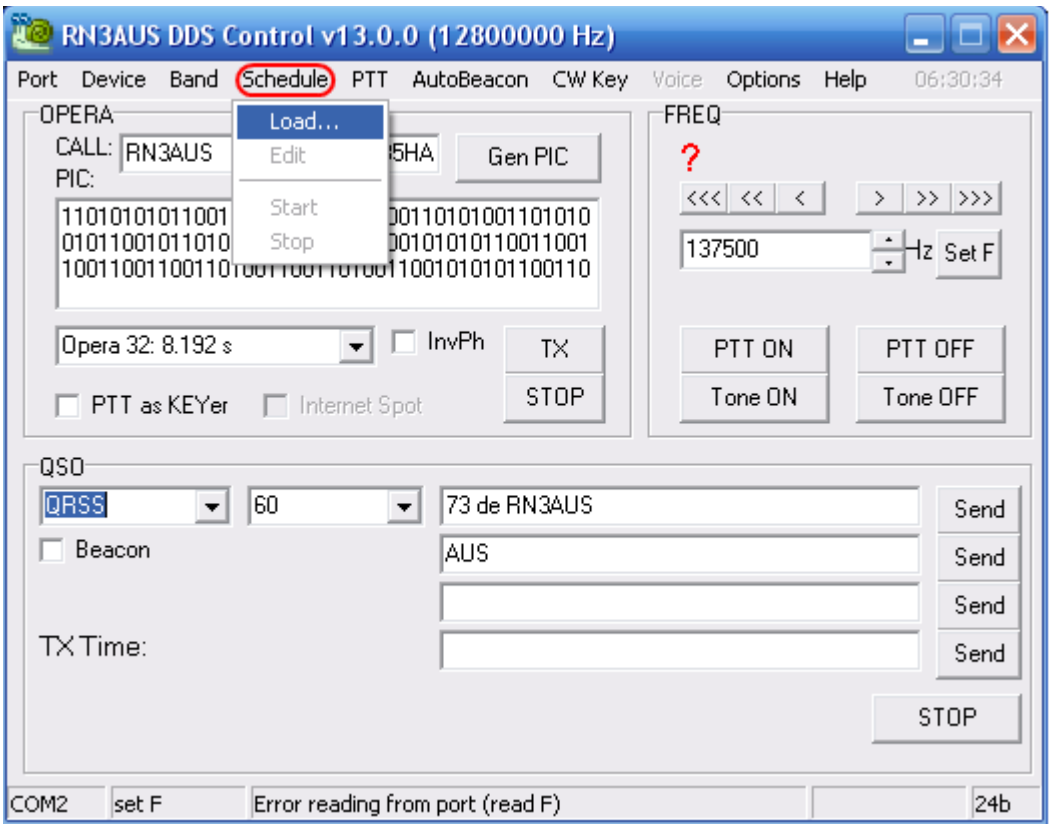
During the pause, the remaining time will be displayed.

You can stop working in the beacon mode by either unchecking the Beacon checkbox, then the next program will end and stop. Or you can press the STOP button, and then both the transmission and the pause for waiting for repetition will stop.

5 Work on schedule

Often there is a need to organize the work of the beacon in several different modes, to tie the beginning of the transfer to a specific point in time, etc. The program has a mechanism for automating such operations, which has quite wide opportunities.

The loading of the schedule (cyclogram) and management of its execution are carried out in the menu **Schedule:**



First of all, you need to prepare a schedule file. This is a text file whose format structure somewhat resembles the organization of various ini-files.

Operations are performed sequentially, each of them must be assigned a number from 1 to 99, written in square brackets. The following are the necessary parameters for the operation.

For example:

```
[1]
MODE=QRSS
DOT=60
MSG=RN3AUS
FREQ=137778
```

The following commands are supported:

Command	Valid values	Action
[N]	N – task number	
MODE	QRSS, DFCW, HELL, CW, PSK, WSPR, JT9, WOLF, MFSK-37, VOICE, EBNAUT, OP-1, OP-2, OP-4, OP-8, OP-16, OP-32, OP-65,	Mode

	OP-4H, RTTY	
	STOP	The end of the cyclogram. Stop execution and exit Schedule mode.
DOT		Duration/speed
FREQ		Frequency in Hz
MSG		Text of message
PAUSE	Pause duration, sec.	Pause
NEXT	N (0…99)	Go to the task number [N]. Serves for organizing cycles.
REPEAT	M – number of loop repeats	Repeat M times. Used in conjunction with NEXT. Nested loops are not supported.
TIME	HH:mm:ss	Run the task at the specified time: 21:15:00 - at this time; HH:15:00 - at 15 minutes 00 seconds of any hour
RUNTIME	SS, sec	Time in seconds allotted for the task. Allows you to limit the transmission time, if by this time not all the parcels are transmitted, the transmission will still stop. So you can "adjust" the duration of the cyclogram to the desired value.
BAND	LF, LF2, LF4, VLF, MF, AF	Band, similar to the **Band** main menu action.
DDS_BIT	32, 24	Set the bit depth of the DDS (see the **Device** menu)
EBNAUT_DT	5, 10, 15, 20, 30, 40, 50	The EBNAUT transmission will start at time hh:mm:00, where the mm minutes are multiples of the EBNAUT_DT value. For example: with EBNAUT_DT = 20, the transfer may begin at 00 min 00 s, 20 min 00 s, and 40 min 00 with each hour.
CODE	2K3A, 2K4A, 2K5A, 2K6A, 2K7A, 2K8A, 2K9A, 2K10A, 2K11A, 2K12A, 2K13A, 2K13B, 2K14A, 2K14B, 2K15A, 2K15B, 2K16A, 2K16B, 2K17A, 2K17B, 2K18A, 2K21A, 2K23A, 3K3A, 3K4A, 3K5A, 3K6A, 3K7A, 3K8A, 3K9A, 3K10A, 3K11A, 3K12A, 3K13A, 3K14A, 4K13A, 4K14A, 4K15A, 4K15B, 4K16A, 4K17A, 4K19A, 4K21A, 4K23A, 4K25A, 8K17A, 8K19A, 8K21A, 8K23A, 8K25A, 16K19A, 16K21A, 16K23A, 16K25A	EBNAUT code
CRC	0…32	CRC EBNAUT
FRAME	1…32	Number of frames (repetitions) WOLF
FILE	Имя файла	File to transmit in HELL (*.bmp)

		or VOICE (*.wav)
MODULATION	FM, AM, CW, BPSK, DSB	Type of modulation for VOICE
INDEX	0.5 – 2.0	VOICE frequency modulation index (default 1.3)

Consider the rules for compiling cyclograms on an example.

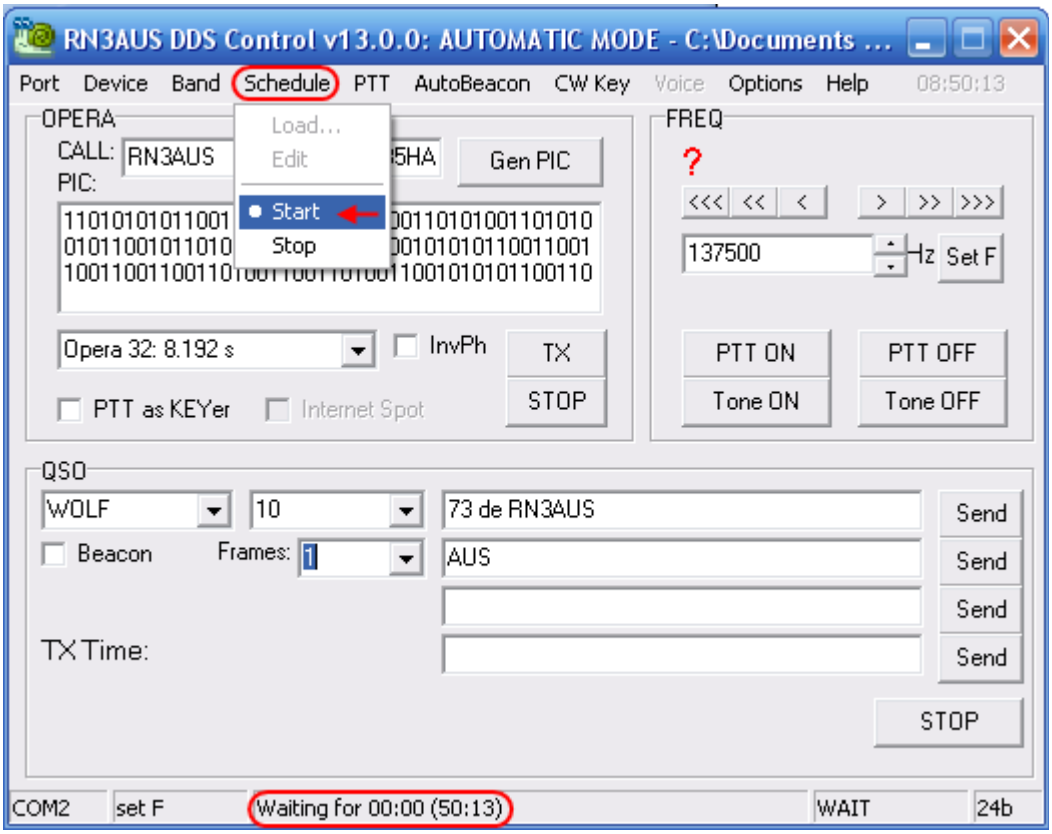
Suppose we want at the beginning of each hour to transmit 2 times WSPR-15, then Opera-32 in such a way as to complete its transfer by the end of the hour. So do 3 times (three hours) and then send your call sign to DFCW-60 three times with a pause between each transmission. After this transfer to stop.

The text of the cyclogram will be as follows:

```
[1]
TIME=hh:00:00
MODE=WSPR
DOT=16          - do you remember? See chapter on WSPR
FREQ=137611

[2]
MODE=WSPR
DOT=16
FREQ=137611

[3]
TIME=hh:30:00
DDS_BIT=32
MODE=OP-32
FREQ=137512
RUNTIME=1798

[4]
NEXT=1
REPEAT=3

[5]
MODE=DFCW
DOT=60
MSG=RN3AUS
DDS_BIT=32
FREQ=137778

[6]
PAUSE=180

[7]
NEXT=5
```

```
REPEAT=3

[8]
MODE=STOP
```

Place the text of this cyclogram in any text file. Load it in the menu **Schedule-> Load...** Then run its execution **Schedule-> Start:**



The execution of the cyclogram will begin with waiting for the beginning of the hour. As soon as hh: 00: 00 comes, the WSPR-15 transmission will begin. Please note that the mode selection and duration fields and the frequency field are automatically filled with the desired values.

WSPR-15 retransmission (task [2]) will begin at hh: 15: 00 and end at hh:29:52. Then the cyclogram will go to task [3] and will wait for hh:30:00. In task [3], there is a command for switching to 32-bit mode (as we remember, WSPR transmission occurs in 24-bit mode). The transmission of Opera-32 will begin and continue for 1798 seconds, that is, until hh:59:58. Then the cyclogram will return to the task [1].

So will repeat three times.

Then the execution of task [5] will begin. At the end of the DFCW, there is a pause of 3 minutes (task [6]) and a three-time repetition of tasks [5] - [6]. The last task [7] MODE = STOP stops the execution of the sequence diagram. If you forget to specify this command, the program will scan the file in order to detect the following tasks up to the number [99] and the execution of the sequence diagram will also stop in a few seconds.

In a sequence diagram, do not use nested loops!

If there are commands to wait for a certain point in time (explicitly TIME = or implicitly when using synchronous modes WSPR, JT9, EBNAUT), then you need to ensure that the previous task is completed no less than 1-2 seconds before point in time.

When loading the cyclograms the correctness of the composed algorithm is not checked. The program simply starts to execute the script, trying to execute those commands that it will meet and “understand”. Wrong commands are ignored.

In fact, the cyclogram is an attempt to automate the actions that have to be done manually when preparing a program in one mode or another: enter the frequency, select the mode and speed, press "Send". The program, reading the values in the text of the cyclogram, simply substitutes them in the appropriate fields. If in the text of the task these or other parameters are not indicated (for example, BAND or FREQ), then they will be taken from the current settings (state) of the program.

During operation of the cyclogram can affect the progress of its implementation. Pressing the **"STOP"** button stops the execution of the current task, immediately proceeds to the next task. You can stop the cyclogram in the **Schedule-> Stop** menu.

6 Autonomous Beacon

It is not always convenient to keep the computer on all night. It is also inconvenient to take it with you on trips. For such cases, the AutoBeacon mode is available, available for synthesizer firmware from version 3. Memory size EEPROM ATTiny2313 is 128 bytes, ATTiny4313 is 256 bytes (firmware version 4 for ATTiny4313 supported by DDS_ctrl v.13).

We will need a cyclogram file compiled according to the same rules as for the “Schedule” mode. However, since the memory of the synthesizer is relatively small, there are certain limitations:

- if WSPR mode is used, it should be **first** in the sequence diagram.
- Modes available: CW, QRSS, DFCW, WSPR, OPERA, RTTY
- Commands: RUNTIME, PAUSE, NEXT.
- Commands REPEAT and TIME not supported.
- bit depth is always 24 bits.
- The length of messages is also limited: they should not consist of more than 255 elements.

For example, a point in QRSS takes 2 elements (a dot and a pause after it), a dash takes 4 elements (three dots and a pause). In DFCW, both a dot and a dash have the same length and each consists of four elements of 2 bits each (sending a length of three elements and a pause of one element). Thus, messages can only be quite short, but more often this is enough.

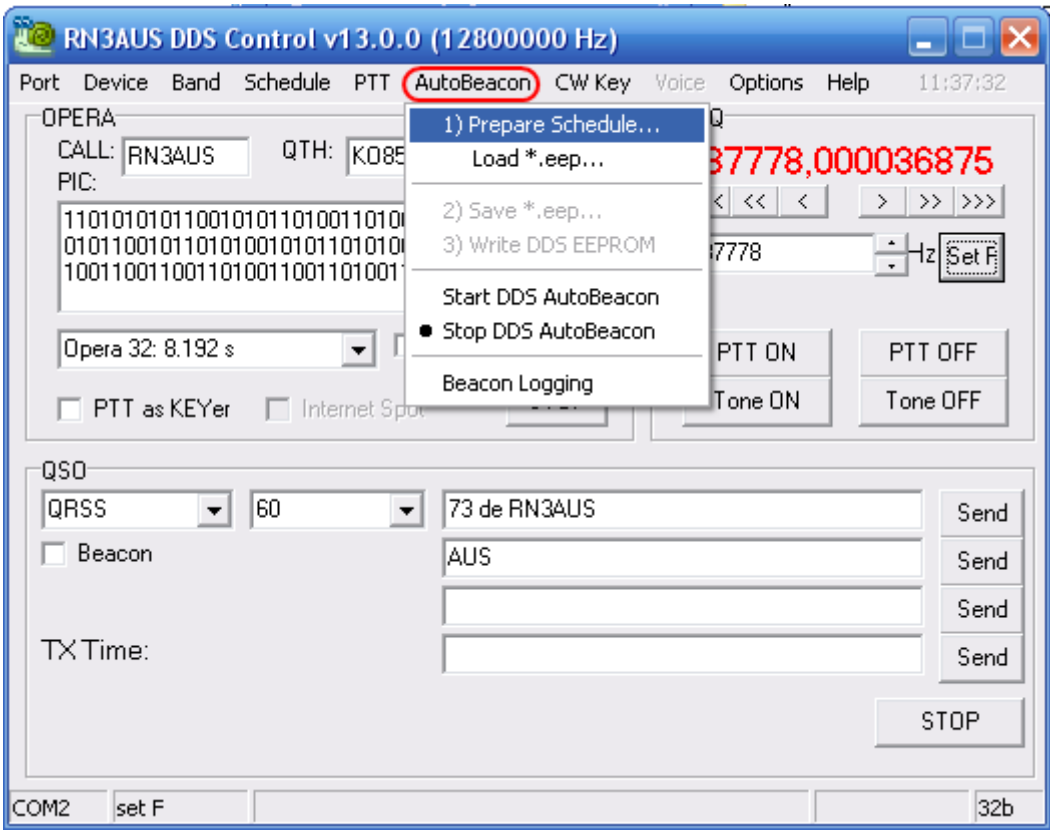
Example of cyclogram:

```
[1]
FREQ=137567
MODE=WSPR
DOT=2

[2]
FREQ=137512
MODE=OP-32

[3]
FREQ=137778
MODE=DFCW
DOT=60
MSG=AUS
```

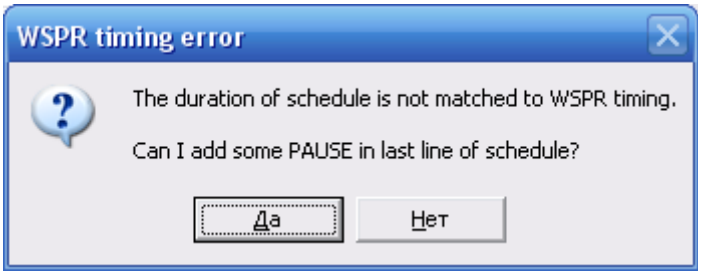
```
[4]
PAUSE=60
NEXT=1
```

Note: in this case, the PAUSE command can stand along with NEXT.

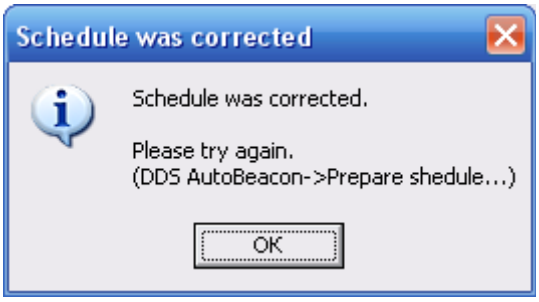
Using the **AutoBeacon->Prepare Schedule...** menu you need to select and load a sequence file:



After the file is loaded, it is processed and data is prepared for writing to the synthesizer's EEPROM. Suppose we load a file with a sequence diagram from the example. The first is the WSPR mode, therefore, the total duration of the entire sequence diagram should be such that upon its completion a new WSPR transmission occurs at the right time. The program keeps track of this. A message will be displayed:



Press YES.



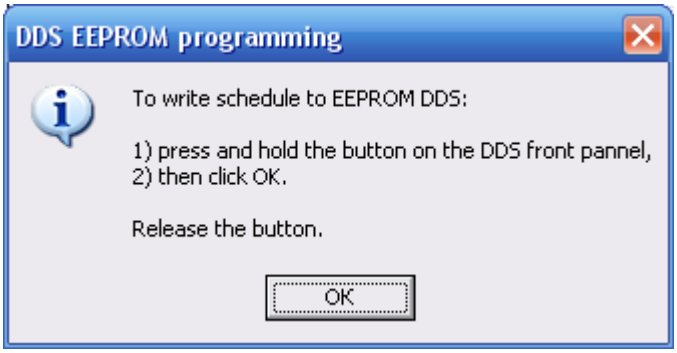
The sequence diagram has been adjusted, now the last task looks like this:

```
[4]
PAUSE=111,52108
NEXT=1
```

Changed the duration of the pause. Load the file again and see in the status bar: “Schedule is ready: 2399,999 s”.
The total duration of the cyclogram was 2400 seconds = 40 minutes.
Since the precision TCXO is usually used for clocking the synthesizer, the accuracy of the cyclogram execution is very high, better than the stability of an ordinary electronic clock.

The finished data for the synthesizer cyclogram can be previously saved to the *.eep file (standard EEPROM data file format for various programmers) using the **AutoBeacon->Save *.eep** menu. Later, you can immediately load and use this finished file **AutoBeacon->Load *.eep** menu.

Next, you need to write the cyclogram directly into the memory of the synthesizer **AutoBeacon->Write DDS EEPROM.** A message will appear:



You must press the control button on the front panel of the synthesizer, and while holding it pressed, click "OK". Recording will start, you can release the synthesizer button.

This is done to protect against accidental damage to information in the EEPROM and to confirm the action by the operator.

You can launch a recorded auto-beacon sequence diagram using the AutoBeacon-> Start DDS AutoBeacon menu. The program will ask the synthesizer about the first mode of the cyclogram and, if it is WSPR, wait for the right moment of time and then give the command to start the transfer.

If the synthesizer is used autonomously without a computer (for which the AutoBeacon mode is intended), then the cyclogram starts as follows:

- turn off the power to the synthesizer
- press and hold the control button and turn on the synthesizer
- release the control button

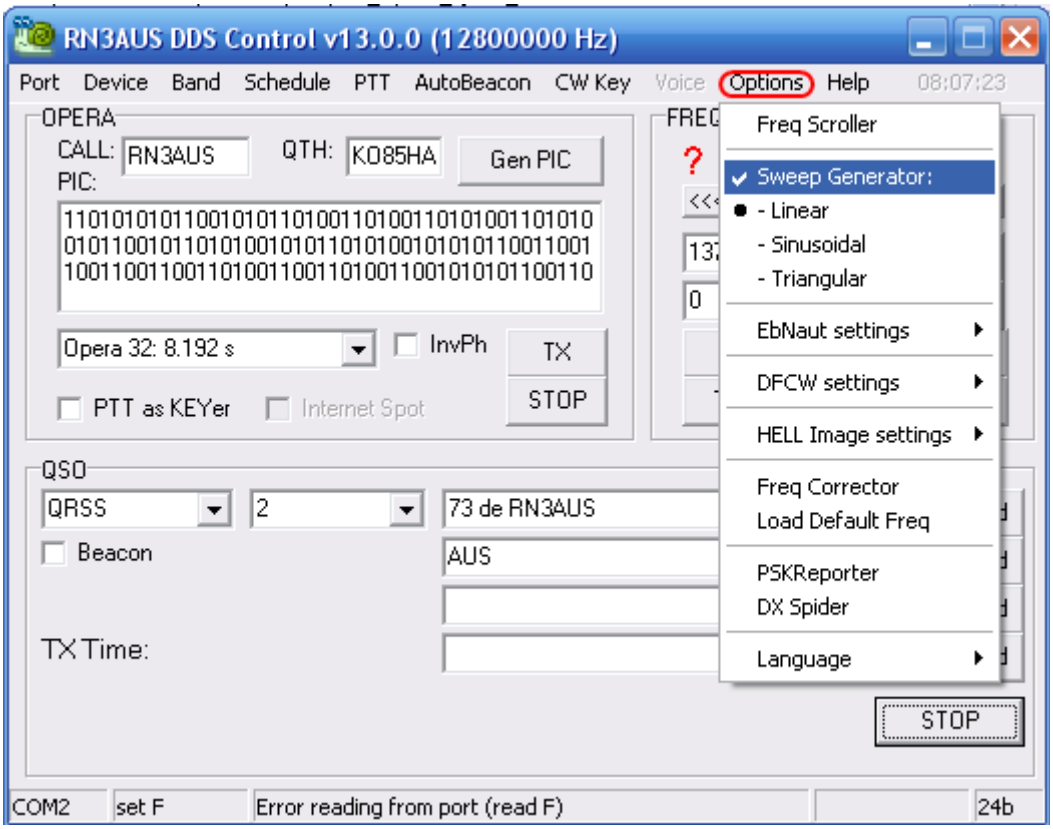
After powering up, the synthesizer controller checks the state of the control button. If it is pressed, the automatic beacon mode is activated; if not, the normal mode is with external control.

When the synthesizer is working in AutoBeacon mode, at any time we can start the performance of the sequence diagram again by pressing the control button. This is useful if the first mode of the cyclogram is WSPR (the synthesizer will not display it in any way, but we ourselves must know which cyclogram was previously recorded in it). So, turning on AutoBeacon, at the right time, looking at the clock (the mobile phone shows the exact time, if it has the synchronization option for network time), you need to briefly press the control button of the synthesizer at 00 sec. The transfer will start again now with reference to time.

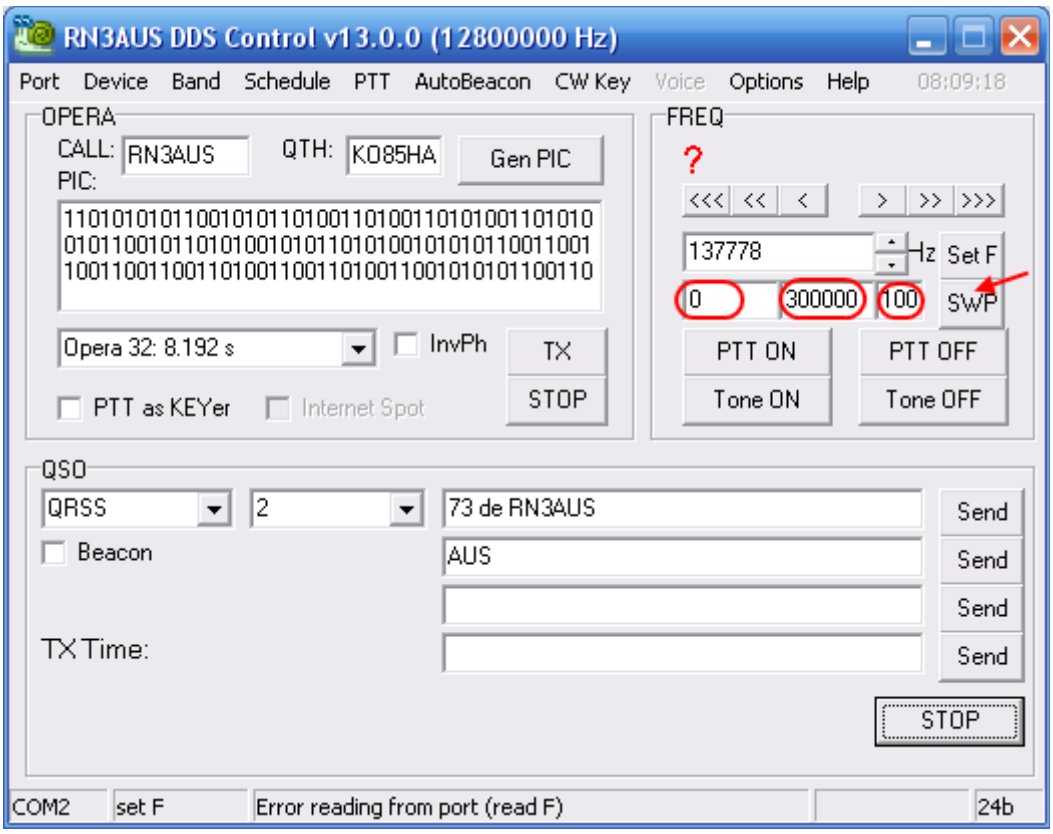
7 Additional features

7.1 Swing frequency generator.

The synthesizer can be used as a sweep frequency generator. For this is the menu **Options->Sweep Generator:**



You can choose a linear, sinusoidal or triangular law of frequency variation. On the FREQ panel, new controls will appear:

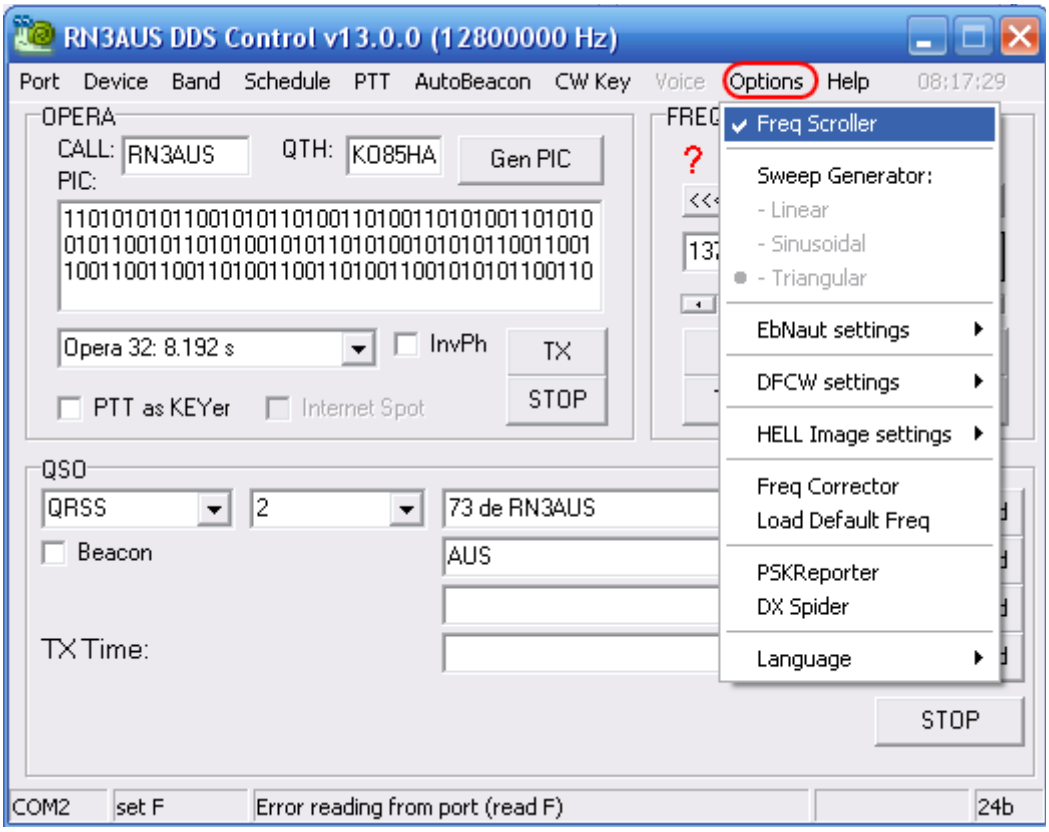


The first field: the lower limit of the frequency change in Hertz.
The second field: the upper limit of the frequency change in Hertz.
Third field: frequency tuning rate Hz / sec.
The SWP button starts / stops operation.

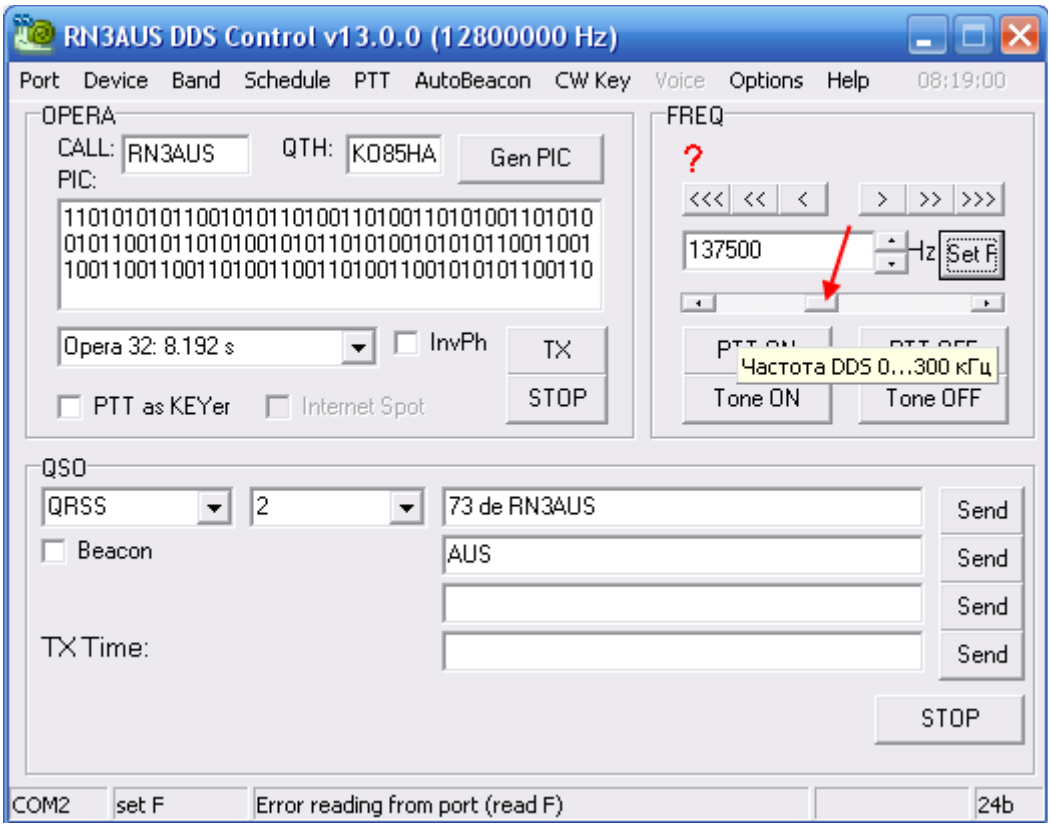
7.2 Frequency scroller

Sometimes for experiments it is convenient to enter the frequency not manually, but in a faster way - using the slider (scroller).

This option provides a menu **Options->Freq Scroller:**



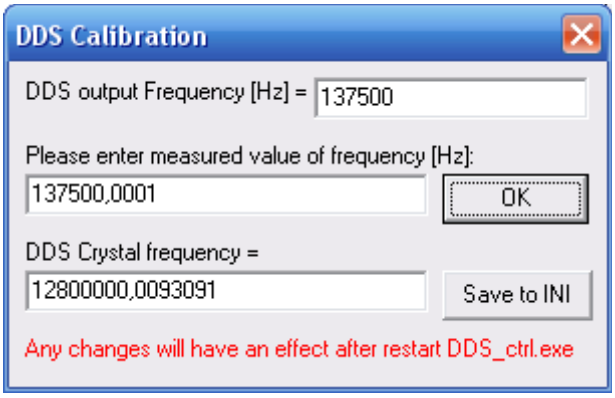
A new control appears on the FREQ panel, with the offset of which you can change the DDS frequency from 0 to 300 kHz. The frequency rating is displayed in the frequency input box.



7.3 Synthesizer calibration

If the frequency of the reference generator of synthesizer differs from the nominal, which happens when using quartz or not very accurate oscillators, then the signal generated by the synthesizer will have a frequency shift. This shift can be measured, for example, by observing your signal on any grabber that displays the frequency accurately. For example, the DF6NM grabber (http://df6nm.de) has excellent frequency accuracy and stability.

The menu **Device->Calibration...** opens a dialog box where you need to specify the frequency for which the synthesizer is tuned, and the frequency measured in one way or another with maximum accuracy.



After pressing **OK**, the program calculates and displays in the lower field the exact frequency of the reference generator of synthesizer. By pressing the **"Save to INI"** button, the calculated frequency will be recorded in the INI file. Changes will take effect after the program is restarted.
At the same time, the **dds_round_freq_list.txt** file will be generated in the working directory. It contains a list of "round" frequencies in the range from 135700 to 137800 Hz, available to the synthesizer with the current settings:

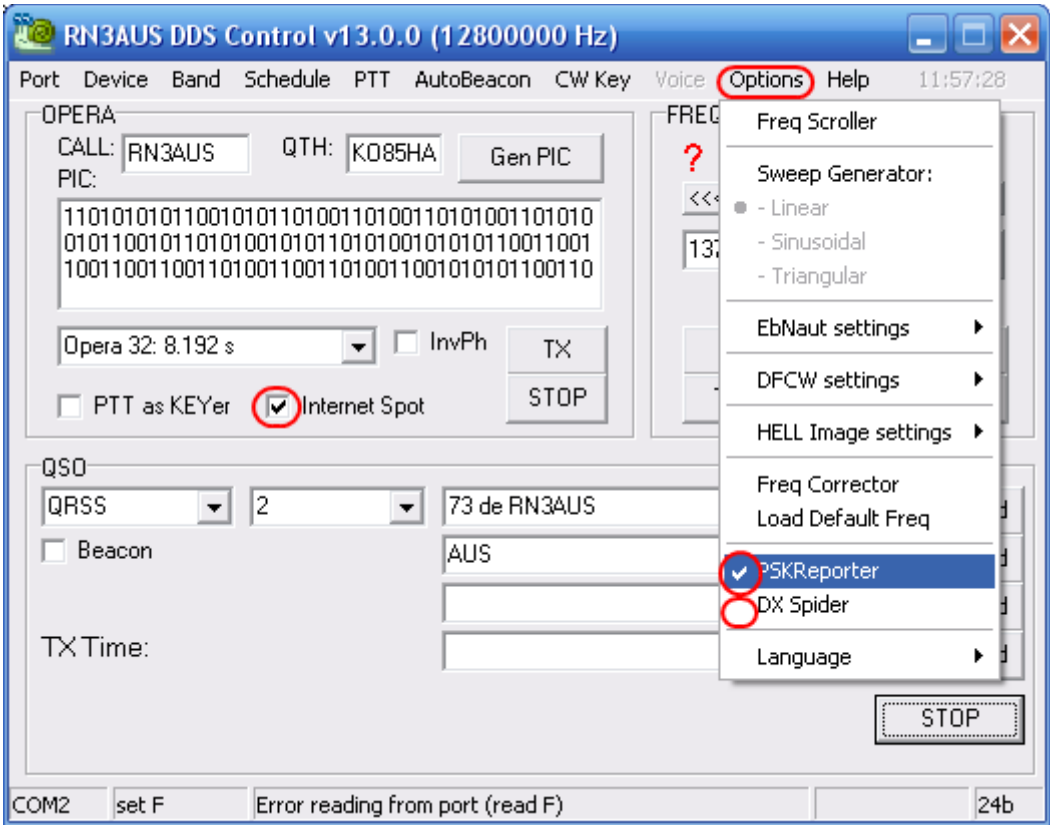
```
LIST of round DDS FREQ in LF range
Crystal=12800000.000000 Hz
24-bit mode

135937.500000 Hz
136718.750000 Hz
137500.000000 Hz
```

Round frequencies are those that are exactly (not worse than 0.000001 Hz) multiples of 0.25 Hz. As you can see, there are

not so many such frequencies in the 24-bit mode. In 32bit mode, the list will be much longer.

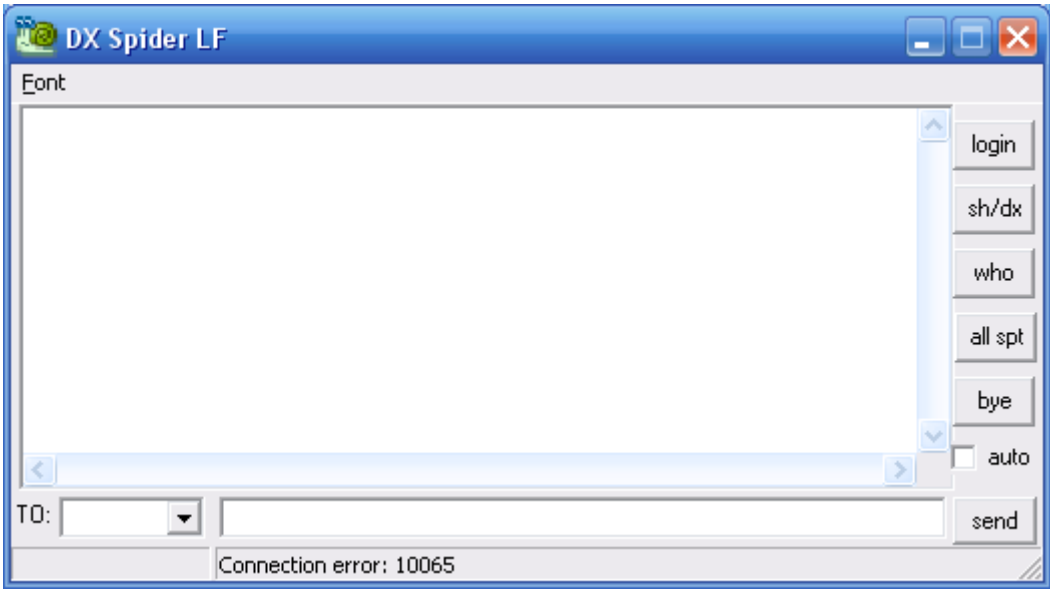
7.4 **Using of PSKReporter and DX Spider.**

You can announce your activity in various modes through the well-known services PSKReporter and / or DX Spider. You can enable this mode in the menu **Options->PSKReporte** and **Options->DX Spider.**



When you enable PSKReporter spots, the **Internet Spot** checkbox is activated in the OPERA field.

When activating DX Spider, a new window will open:



In this window, if you managed to connect to the cluster, the current spots of the LW range will be displayed. You can send your own messages. In the Font menu you can customize the desired font, its size and color.

All settings required for PSKReporter and DX Spider to work are in the INI file.

During the transfer of modes, especially critical to timing (WOLF, EbNaut), network communication with PSKReporter and DX Spider is forcibly turned off, since network components can in some cases introduce undesirable delays in the work of the program.

8 INI-file DDS_ctrl.ini

Those fields that should not be changed are marked with color.

```
[DDS]
DDS_Port=COM2      - COM-port
Crystal=12800000   - frequency of reference generator of DDS
Cycles=11
Cycles24=11
Cycles32=12
TimerOffset=60
Freq=137500        - frequencie
Mode=PSK           - mode
Dot=1              - dot duration
MSG1=AUS           - message 1
MSG2=              - message 2
MSG3=              - message 3
MSG4=              - message 4
BAND=LF            - band (LF,LF2,LF4,MF,AF,VLF)
PTT_DELAY=500      - PTT delay [ms]
                     (PTT will turn on 500 ms before
                     transmission)
PTT_QSK=15         - turn off PTT if the pause is more than 15
                        seconds
FREQ_CORRECTOR=0   - use FREQ_CORRECTOR (1-yes, 0-no)
USE_RTSDTR=1       - use the mode "NO DDS" (1-yes, 0-no)
RTS_IS_KEY=1
LANGUAGE=ENG       - Interface language (ENG, RUS)
B_PAUSE=0          - pause between repetitions of the beacon,
                        min

[POWER_AMPLIFIER]
PA_x2_d2=0         - type of power amplifier driver (0-normal,
              1-with doubling / frequency division). Only work
              with phase manipulation is different. Normal
              driver - the phase is inverted abruptly, otherwise
              - quasi-smoothly.

[DFCW]
USER_SETTINGS=0    - use non-standard settings (1-yes, 0-no)
DF=3
SPACE=1
USE_DF60=1         - use DFCW-60 frequency spacing for longer
                   modes (1-yes, 0-no)

[OPERA]
```

```
CALLSIGN=RN3AUS  - callsign
PIC=1101010101100101011010011010011010100110101001011001011010
1001010110101001010101100110011001100110011010011001101001100 1
0101011001101010101001100110100110010110100101101010101001100 1
1010101001011010010110100101100101010101100110101010100110 1
USE_PTT_AS_KEYER=0 - use PTT for manipulation (1-yes, 0-no)
PHASE_INVERSION=0  - invert the carrier phase after each dash
                (1-yes, 0-no)
[WSPR]
QTHLOC=KO85HA
PWRLEVEL=10
PAUSE=2000
FAST=1           -  use  fast  frequency  switching  in  the
synthesizer (1-yes, 0-no). It is recommended to use.
WSPRTONES=       - reserved

[HELL FONT]      - characters in HELL mode
A=123454749741000
B=135791591573000
C=427191919198000
D=426161613579000
E=52851951968000
F=135795959599000
G=528191949418000
H=1357950513579000
I=31619112000
J=3219191939579000
K=135795361789000
L=12315171912000
M=135797535797531000
N=1357975313579000
O=316181929497000
P=13579494957000
Q=36181919392471000
R=135795391597000
S=21861951938000
T=9195890909000
U=2519101012469000
V=996310135799000
W=975313575313579000
X=19284653719000
Y=1916243579000
Z=12919495169189000
0=427181929497000
1=1121376789000
2=173919581000
3=2815915937000
```

```
4=57950513579000
5=157951951939000
6=3618691969148000
7=1395969799000
8=241751951937000
9=1752939486000
-=5050505000
+=0525456585000
,=001200
.=001000
/=123456789000
\=987654321000
'=8900
"=8908900
(=5281900
)=9182500
>=192836400
<=56381900
:=003700
_=00000000
?=081495700
!=0145678900
*=01593753715900
Б=135791969249000
Г=13579090909000
Д=1224692929521000
Ж=193713583719000
И=2519101013579000
Л=11246890909741000
П=1357909091959000
Ф=574914794957000
Ц=352920235291000
Ш=13519135713579000
Щ=2462923572246291000
Ъ=1497915153000
Ы=13579151530135790000
Ь=1357915153000
Э=159159159258000
Ю=13579525719296000
Я=17394941479000
@=3161869249597000

[HELL]
CHIRP_DIRECTION=1     - direction of hatching of images during
       their transfer in the HELL mode (0 - from bottom to
       top, 1 - from top to bottom)
```

```
CONTRAST_INVERSE=1     - transfer the image in the negative (1-
       yes,  0-no).  On  the  spectrogram  the  negative  looks
       better.
ZOOM=0
NAKLON=1

[CW_KEY]
AUDIO_TONE=800
AUDIO_DEVICE=-1

[DEFAULT_FREQ]         -  default  operating  frequencies  for
                  different modes and bands
LOAD=0                      - set these frequencies (1-yes, 0-no)
CW=136600
QRSS-3=137710
QRSS-60=137777
DFCW-3=137710
DFCW-60=137777
HELL-3=137710
HELL-60=137777
OP-8=137650
OP-32=137510
WOLF=137500
PSK=137500
JT9-2=137500
JT9-5=137500
JT9-10=137140
JT9-30=137040
WSPR-2=137500
WSPR-15=137615
MFSK=137500
VOICE=137500
RTTY=137500
EBNAUT=137490

[DEFAULT_FREQ_MF]
CW=472400
QRSS-3=476150
QRSS-60=476150
DFCW-3=476150
DFCW-60=476150
HELL-3=476150
HELL-60=476150
OP-8=478510
OP-32=478510
WOLF=475500
PSK=475500
```

```
JT9-2=475700
JT9-5=475700
JT9-10=475700
JT9-30=475700
WSPR-2=475700
WSPR-15=475815
MFSK=475500
VOICE=475500
RTTY=475500
EBNAUT=475500

[DEFAULT_FREQ_AF]
CW=600
QRSS-3=1710
QRSS-60=1777
DFCW-3=1710
DFCW-60=1777
HELL-3=1710
HELL-60=1777
OP-8=1650
OP-32=1510
WOLF=1500
PSK=1500
JT9-2=1500
JT9-5=1500
JT9-10=1140
JT9-30=1040
WSPR-2=1500
WSPR-15=1615
MFSK=1500
VOICE=1500
RTTY=1500
EBNAUT=1490

[VOICE]
DF=30
SAMPLE_RATE=6000
MAX_SAMPLES_NUMBER=1000000
MODULATION=FM
SSB_NF=1
PWM_N=1

[PSKREPORTER]
ENABLE=0
HOSTNAME=report.pskreporter.info
PORT=4739
```

```
[DXSPIDER]
ENABLE=0
HOST=
ADDRESS=93.88.130.90   - DX Cluster IP Address
PORT=8000              - cluster port
LOGIN=RN3AUS-1         - my login
MYCALL=RN3AUS          - my callsign for the cluster
NAME=Alex              - my name for the cluster
QTH=nr Moscow          - description of my location
QRA=KO85HA             - locator
FILTER=acc/spot on vlf
SHDX_COMMAND=sh/dx 10 on vlf
REFRESH_TIME=60
FONT_NAME=Lucida Console
FONT_SIZE=8
FONT_COLOR=8388608
FORM_HEIGHT=292
FORM_WIDTH=523

[RTTY]
DF=170                 - frequency shift for RTTY

[EBNAUT]
START_TIME_MULT=5      - EbNaut transmission will begin with
                 the beginning of the minute multiple of this
                 multiplier.
```

9 DDS control protocol

The synthesizer microcontroller is controlled via the COM port, the speed is 9600, the data width is 8 bits, the parity is not used, the stop bit is one, and there is no flow control. The following commands are supported:

Command	ASCII	Operation	DDS response
+	0x2b	increase the freq by 1 step	F<F4><F3><F2><F1><0x0a>
u	0x75	increase the freq by 10 steps	F<F4><F3><F2><F1><0x0a>
U	0x55	increase the freq by 100 steps	F<F4><F3><F2><F1><0x0a>
-	0x2d	reduce freq by 1 step	F<F4><F3><F2><F1><0x0a>
d	0x64	reduce frequency by 10 steps	F<F4><F3><F2><F1><0x0a>
D	0x44	reduce frequency by 100 steps	F<F4><F3><F2><F1><0x0a>
T	0x54	enable PTT (TX)	F<F4><F3><F2><F1><0x0a>
R	0x52	disable PTT (RX)	F<F4><F3><F2><F1><0x0a>
s<F4><F3><F2><F1>	0x73 (first symbol)	Set frequency, <F4><F3><F2><F1> - code of frequency, 4 bytes. The first byte, denoted as <F4>: - 24-bit mode: empty, the microcontroller ignores it; - 32 bit mode: low byte of frequency. The remaining three bytes are in order from higher to lower. The total command length is 5 bytes.	F<F4><F3><F2><F1><0x0a>
?	0x3f	Frequency request	F<F4><F3><F2><F1><0x0a>
3	0x33	Enable 24 bit mode	F<F4><F3><F2><F1><0x0a>
4	0x34	Enable 32 bit mode	F<F4><F3><F2><F1><0x0a>
G	0x47	Launch Autonomous Beacon Transmission	B<mode><F3><F2><F1><T2><T1><T0><N><F4> 10bytes <mode>: W – wspr Q – qrss D – dfcw O – opera B – bpsk N – pause <F…> - freq <T> - duration <N> - number of elements
H	0x48	Stop the transfer of autonomous beacon	B<0x00><F3><F2><F1><T2><T1><T0><N><F4> 10bytes
&	0x26	Starting EEPROM Recording	&
/	0x2f	Write another byte EEPROM	W – writed ! – not enough memory
#	0x23	End of EEPROM recording	#
L<F02><F01><F00><F12><F11><F10><F22><F21><F20><F32><F31><F30>	0x4C (first)	Record 4 frequencies F0, F1, F2, F3 for their "fast" switching	F<F4><F3><F2><F1><0x0a>
0xf0	0xf0	Switch to F0	
0xf1	0xf1	Switch to F1	
0xf2	0xf2	Switch to F2	
0xf3	0xf3	Switch to F3	
1	0x31	Enable tone	
0	0x30	Disable tone	
p<x4><x3><x2><x1>	0x70	Set phase shift,	

	(first)	<x4><x3><x2><x1> - phase code, 4 bytes. This value will be added to the phase accumulator by the “phase inversion” command. <x4> is empty, ignored, <x3> low, <x1> high. Only 5 bytes.	
P	0x50	Invert phase. The value set by the "set phase shift" command will be added to the phase accumulator.	

The last eight commands are maximally optimized for real-time operation, therefore, in response to them, the microcontroller does not send anything through the COM port. All other commands (unless otherwise indicated), including those unrecognized by the controller, return a response containing the code of the set frequency, in the form F <F4> <F3> <F2> <F1> <0x0a>, a total of 6 bytes, the first character ASCII 0x46.

The F4 byte in the synthesizer responses always contains the following information:

Bit number							
7	6	5	4	3	2	1	0
Firnware version			24/32 bit	Record EEPROM	Beacon On/off	Tone On/off	PTT On/off
1	0	0	1	0	0	0	0

The last row of the table shows an example:

- firmware version: 4
- 32 bit mode is enabled
- EEPROM programming is not performed
- autonomous beacon mode disabled
- tone (output) is off
- PTT is off

Note: as you can see, in 32-bit mode, only 3 high bytes of frequency are transmitted from the synthesizer, the low byte is not transmitted, that is, the frequency is not fully reported to the control program. It is assumed that the control program "remembers" this byte. In 24-bit mode, the frequency is fully reported.

The calculation of the frequency code is made by the formula:

- 24 bit mode: Code=F/Step, Step= Fcrystal /11/2^24.
- 32 bit mode: Code=F/Step, Step= Fcrystal /12/2^32.

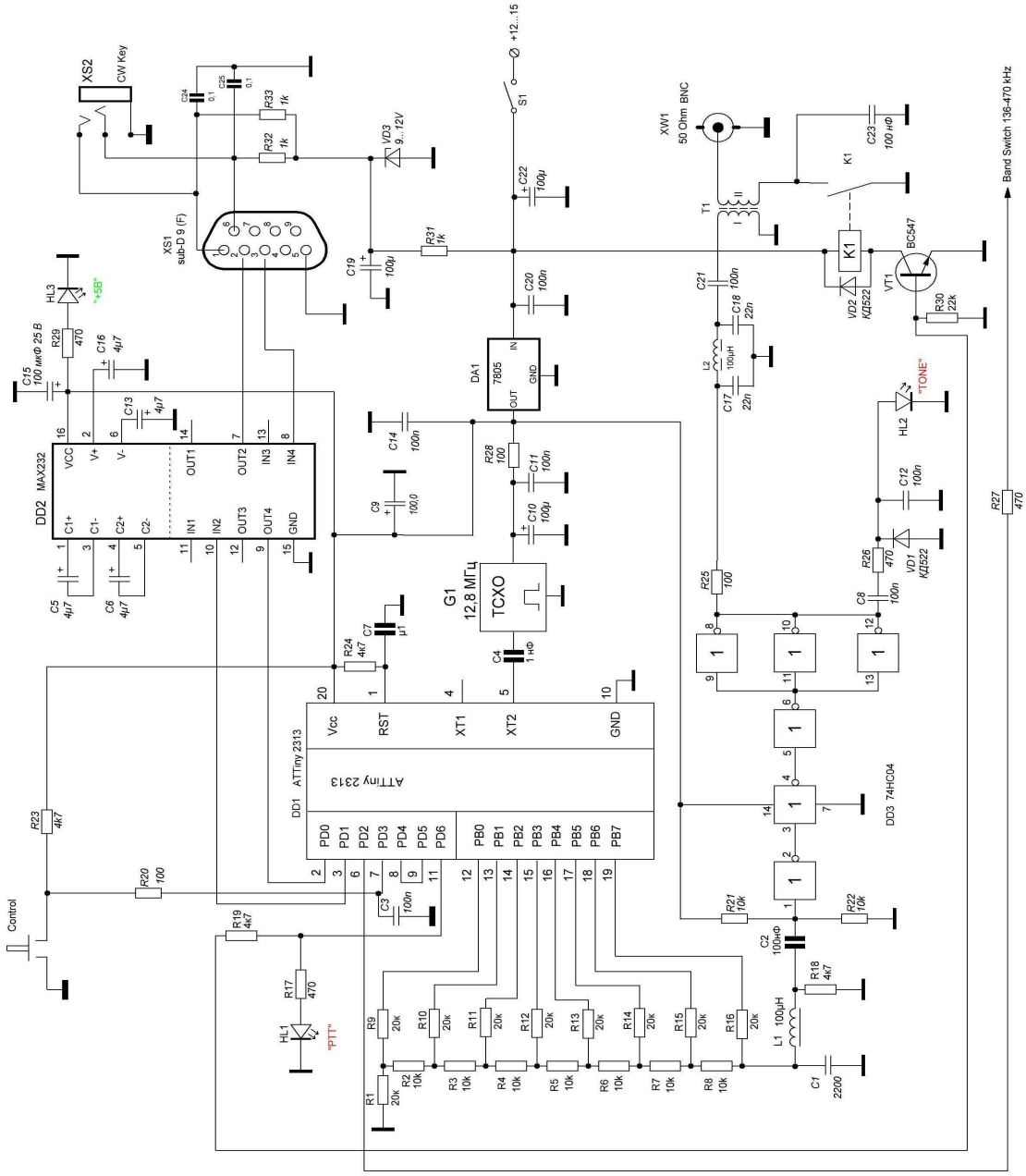
Reverse calculation of the set frequency by its code: F=Code*Step.

The processing of the phase inversion command takes 22 machine cycles, which corresponds to the formation time of 2 samples of the output signal (in 24-bit mode). The code for the required 180 degree phase shift (BPSK) depends on the frequency and is calculated by the formulas: N = Fcrystal / F / 11 (number of samples per signal period), taking into account the interrupt processing time (2 signal samples) shift by half period will take Nph = N / 2 + 2 samples, therefore, the phase code will be PH_Code = Nph * Code, where Code is the code of the set frequency.

Note: for the 32bit mode, N = Fcrystal / F / 12 and Nph = N / 2 + 22/12.

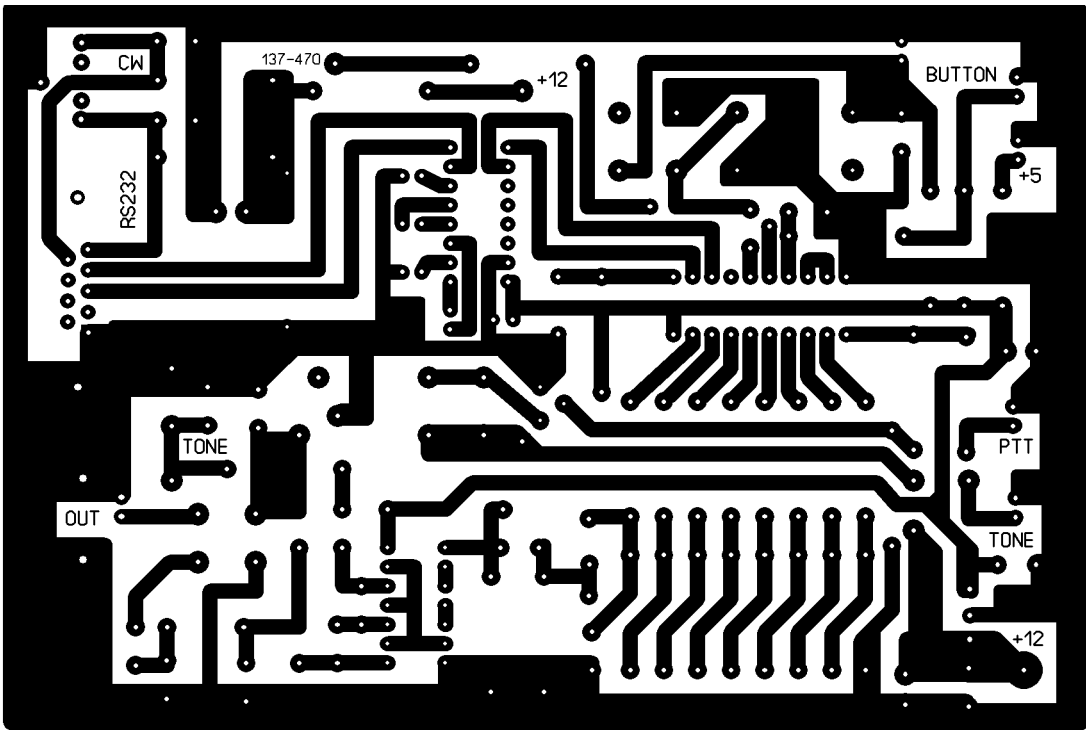
10 DDS

For completeness, here is one of the synthesizer circuit. DD1 – ATTini2313 or ATTiny4313.

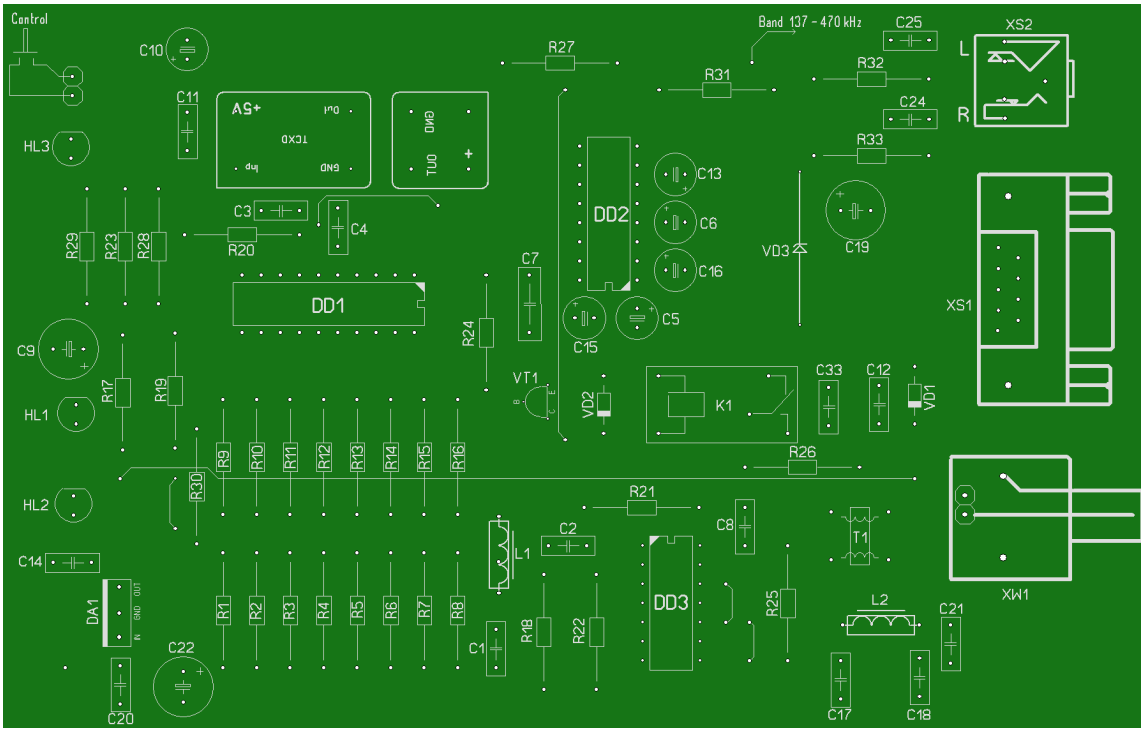


Note: the “Band Switch 136-470 kHz” signal is generated automatically and has the value “logical 0” at the output frequency <200 kHz and “logical 1” otherwise.

The PCB version with simplified installation is 95 x 145 mm. View from the printed conductors:



Placement of parts:



On the author's website http://rn3aus.narod.ru/dds_tx/index.html there are other design options for the synthesizer that are smaller.

The functions of the control button.

The synthesizer has only two controls: the power on switch and the multifunction button.

The button operates on the falling edge, that is, at the moment of its release.

Button functions:

- a short press switches on the tone - the synthesizer starts to generate the frequency. The default frequency is 137500 Hz.
- a second short press turns the tone off
- long press (the button should be held down for about 2 seconds) enables PTT. The state of tone (on or off) is not affected.
- A second long press turns PTT off.
- If the control button is held down when the power is turned on, the synthesizer enters the automatic beacon mode, starting the transmission in accordance with the cyclogram recorded in the EEPROM. If the EEPROM is empty, the synthesizer turns off automatic beacon mode.
- If the synthesizer operates in the automatic beacon mode, then a short press on the button forces the transmission of the sequence diagram to begin again. Thus, it is possible to “tie” the beginning of the sequence diagram to the exact time.
- Long press in automatic beacon mode enables / disables PTT
- You can complete the transmission of the cyclogram by turning off the power to the synthesizer.

If the synthesizer operates normally, then if there are no control commands for more than ~ 20 minutes, the PTT signal will be turned off. This is necessary to protect the transmitter in case of possible control computer hanging. The emission of a tone continues without time limit.

11 Conclusion

The DDS synthesizer project was launched in 2011 based on the development of the EW6GB. Gradually, the control program, and then the firmware synthesizer improved. New modes and ideas appeared and were being implemented, so over the years, the “weekend project” has become a multifunctional software and hardware complex, the source texts have a volume of more than 10,000 lines. Of course, in programs and hardware, not everything is implemented perfectly. Something is already outdated, but continues to be maintained for compatibility with the oldest of the first DDS firmware. This product has been distributed to different parts of the country in a dozen instances, so the DDS_ctrl program of any version supports all previous versions of synthesizers by the backward compatibility rule.

Make yourself such DDS, and you will have a simple, convenient and versatile tool for working on the air and not only!

With questions, wishes and suggestions you can contact the author directly: rn3aus@mail.ru

Successes on LF and 73!

PS: I apologize for the not-so-good quality of the translation into English. I used Google translator :)