

# Millimetre Wave CW Exchanger

(The brief user's guide)

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The Millimetre Wave CW Exchanger program was originally developed for the first EME 47 GHz QSOs, however it can be very useful in other situations when the signal spectrum is widened for reasons of the propagation (aurora, rainscatter) or if there is deep and frequent QSB signal fades (EME libration QSB, troposcatter on SHF etc.). The program uses standard CW code and allows up to a ten times (10 dB) reduction in the threshold of readability for a signal buried in the noise. The program is based on the noncoherent averaging of repeating messages. More technical details about the program can be found in the MWCW Exchanger description document.

## Installation

The installation is very simple. Install the program and start it from the directory of your choice. You should see a screen display similar to that shown in figure 1.

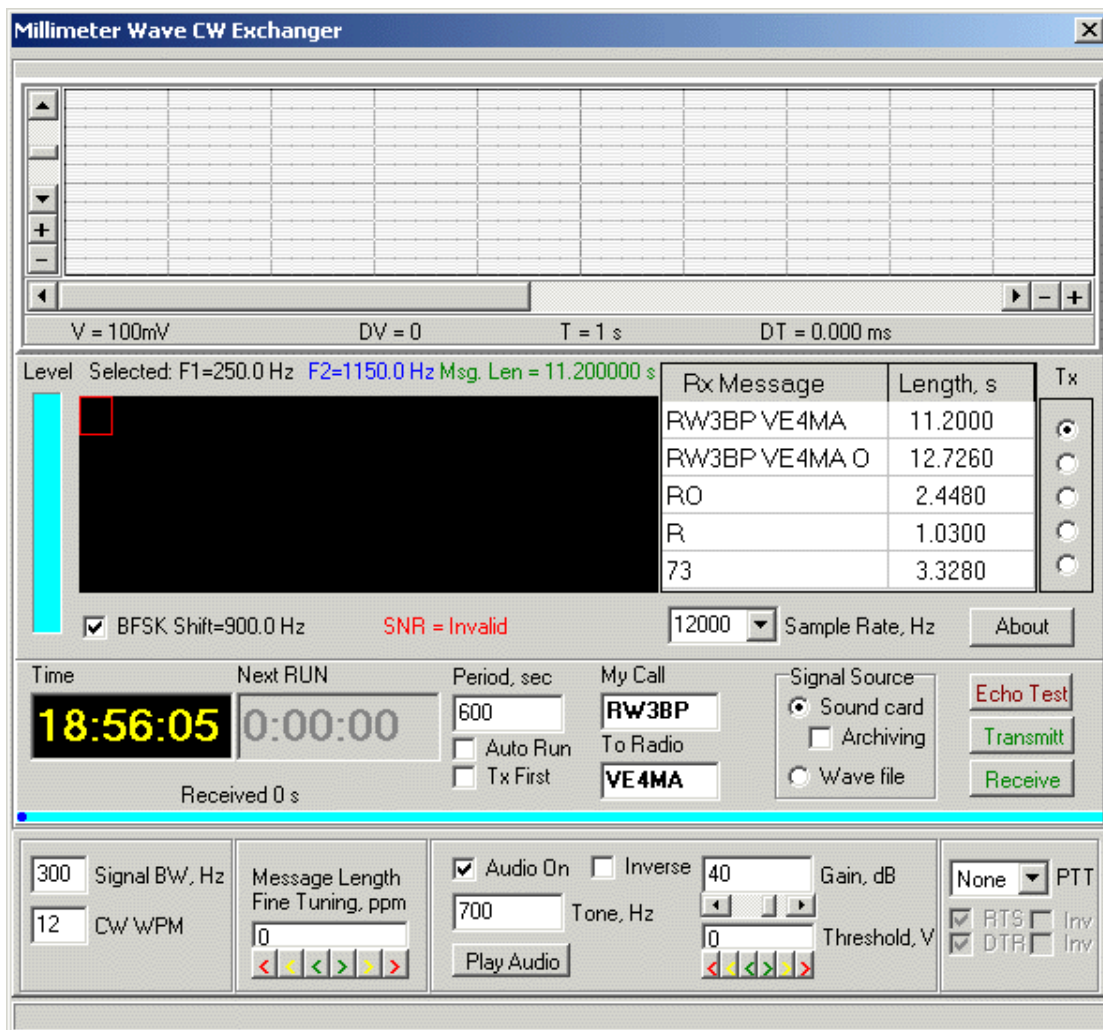


Figure 1 MWCW Exchanger Main Screen

There are three (3) parts to the main screen. The upper part of the screen contains an oscilloscope. It allows viewing of the output signal after processing.

Below this in the middle of the screen is the multichannel signal strength indicator section. It contains an array of 90 large square pixels or “LEDs” with 18 LEDs in a row and 5 LEDs in each column. To the right of the LED array is the message panel, and every line of the LED array corresponds to a message line. Every column corresponds to the energy in a particular input frequency filter “window”.

The lowest section is mainly for the setting of schedule and signal processing parameters.

## Operation & Use

There are three modes of operation within this program. The first mode is the processing of a received signal from a saved wave file. The second mode is the real time processing of a received signal and creation of a corresponding wave file. The third mode is the generating of a one tone or two tone CW signal for transmitting. The second and the third modes can be used the same time (Echo Test mode). This allow to get own echoes from the moon.

## Processing of Wave File

This mode allows the analysis of signals previously saved as a wave file. The wave files can be created from real signal data or generated by the **MWCW Simulator** program. The **MWCW Simulator** program is able to test the decoding system for operation at various levels of signal to noise ratio.

In the **Signal Source** area of the lower window, switch the input from **Sound card** to **Wave file**. The **Transmit** button will disappear, and instead of the **Receive** button there will be a **Load File** button.

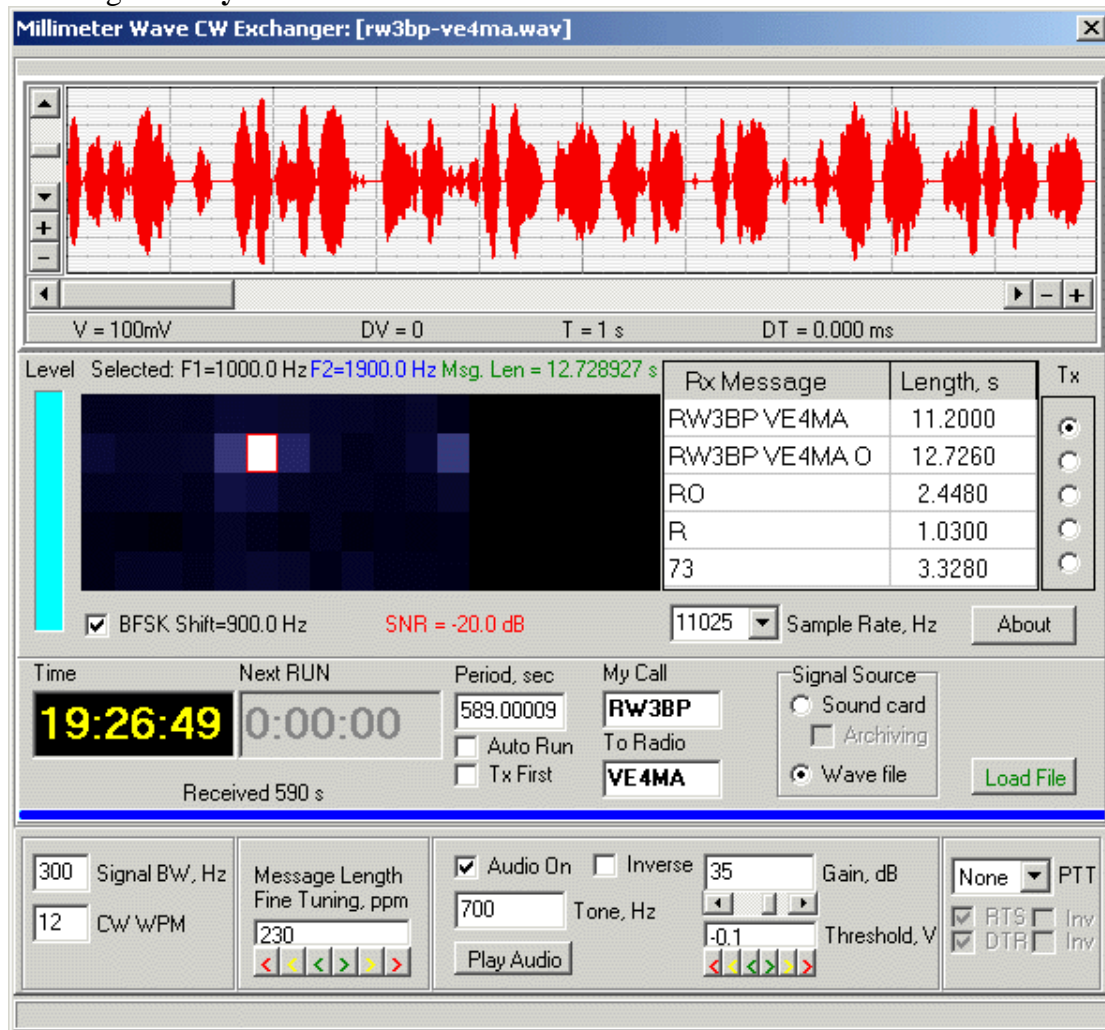
Before processing a file, it is necessary to do the following things:

- Type into **My Call**, the callsign of the first station;
- Type into **To Radio**, the callsign of the second station;
- In the middle window, just below the LED display, select **BFSK** mode if the saved signal is two-tone CW ( normal mode for best weak signal operation);
- Select the proper **Signal BW** (frequency shift generated for BFSK by this program is equal to three x Signal BW);
- Set CW speed (12 WPM on default);
- Set **Audio on** to play the processed signal.

Click **Load File** and choose the file you want. Please see the result of processing a file with the real 47 GHz EME signal from VE4MA (Apr 12, 2005) shown in figure 2.

A bright “LED” indicator will appear in the LED matrix after processing the file. This shows the frequency “channel” (150 Hz wide for the selected 300 Hz signal BW) where a signal has been found. The LED will be brighter for higher signal strength. Click on the brightest LED and the output of the channel will be displayed in the oscilloscope section. The **SNR** (signal/noise ratio) of the signal in this channel is also

displayed (-20 dB in this example). In addition the displayed output can be played by selecting the **Play Audio** button in the lower window.



**Figure 2 Processing of Recorded Signal File**

It may be necessary to tune the message length for best results. The issue is that the real length of the message can differ from the expected value, due to differences in the sample rates of the sound cards used for TX and for RX. Correction of this can be done by using **Message Length Fine Tuning**. For the example the best result (the best indicated SNR) was produced with a +230 ppm correction (1 ppm is one part to 1 million. 1 % = 10000 ppm). Thus the best result has been received at length of repetition 12.728927 s, instead of at the setting of 12.726 s. From experience the range of fine tuning for most sound cards is around +/- 200 to 300 ppm.

The other settings on the display are:

- **Sample Rate** = 11025 Hz. This is determined by the wave file attributes for a saved signal.
- **Period** = 589 s. This is also determined by the wave file attributes.
- **Tone** = 700 Hz. This is the frequency of the tone for playing back of the CW signal. It can be changed to suit the operator's preference.
- **Gain** = 35 dB. This is the amplification of the signal received after averaging, increasing it up to a level suitable for listening.

- **Threshold** = -0.1 V. This is the adjustment for the threshold of the audio modulator. Usually Threshold = 0 but it can be changed to suit the operator's preference for the playback signal.

## Real Time Processing

The processing of real time signals is very similar to the processing of a saved wave file and this section will only indicate the differences. Please see figure 3 below:

- The **Signal Source** selection should be in the **Sound card** position.
- Connect an output of the receiver to an input of the sound card.
- Click the **Receive** button and adjust input level for an indication on the **Level** bar graph of 50...75 %.
- Select **Sample Rate**. For old sound cards use 11025 Hz, but for modern cards use 12000 Hz. Higher rates will work but the file size is very large.
- Select **Period**. This has to be predetermined with the scheduling stations and more averaging time should be used for weaker signals. The weaker the signal, the more averaging time should be used. However the increase in averaging time, leads to a lengthening of QSO duration. For 47 GHz EME it was found that a period of 600 s produced good results, however the frequency must be maintained accurately for the duration of the period and this includes any Doppler frequency correction that might be required.
- To save the received signal, use the **Archiving** button. The program will prompt the entry of a file name, and for each pressing of the **Receive** button a wave file will be created with the given name and the addition of a sequential number.

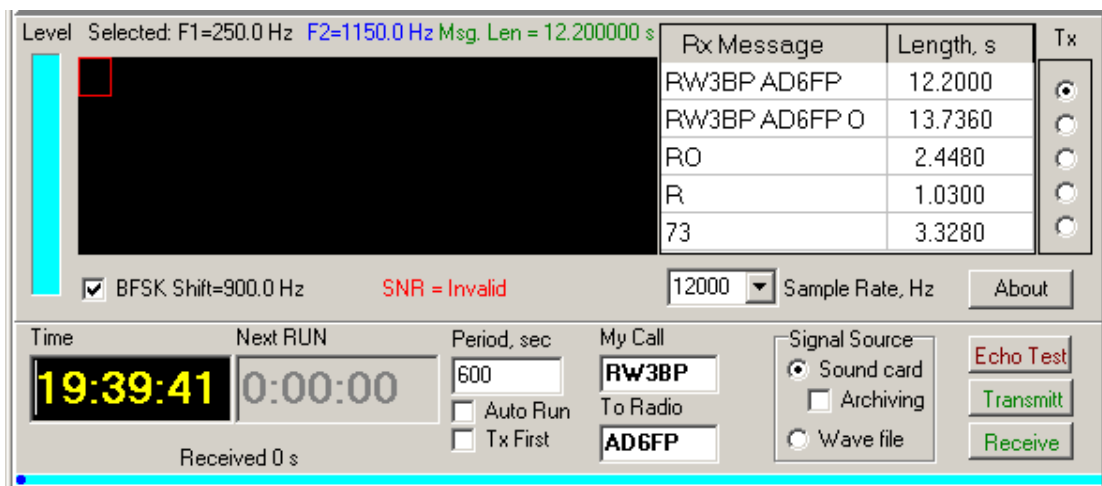


Figure 3

It is possible to fine tune the length of the message, select the message channel and optimize the result during the period of saving of the input signal. However it is better to wait until the second half of processing period, when the averaged signal is better defined.

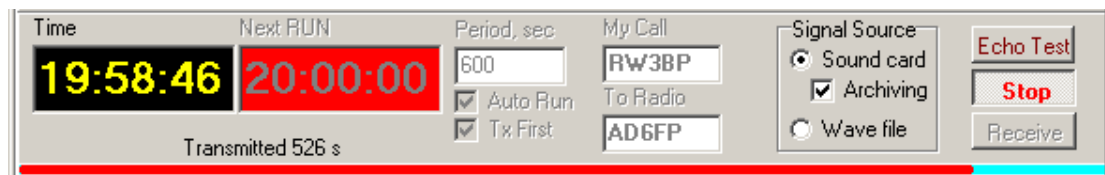
## Transmitting

In the **Transmit** mode the program generates a repeating message in usual one tone CW or two-tone CW formats. For normal CW a tone of 1000 Hz is used, and for two-

tone CW (**BFSK**) a tone of 1000 Hz corresponds to the key down, and 1000 Hz + 3 x **Signal BW** corresponds to key up. Program is generate PTT via the COM port for controlling T/R switching.

Referring to figure 3, select the appropriate message for next transmit period, and select the corresponding **Tx** button. Transmitting starts right after pressing the **Transmit** button and will last according to the selected period duration.

The program allows automated **Transmit/Receive** sequencing as shown in figure 4. To select this mode, double click on **Next Run** and enter the scheduled start time. Then select **Tx First** if appropriate and select **Auto Run**. Transmitting will start at the entered time and will repeat according to the entered **Period**.



**Figure 4**

For very weak signals it is better to have separate computers to get separate sound cards for Tx and Rx, as this will allow use of the Tx period for the analysis of the signal received in the previous sequence.

## **Echo Test**

For this mode it is better to use PTT controlling via COM port. Push **Echo Test** button. The program start generating a repeating message and processing of received signal the same time. T and R periods are the same length a bit more then delay of echo from the moon (about 2.8 s). In this mode you can use any message typed into **My Call** box. It can be more on less then 2.8 s. It must be no noise from receiver in T period.

## **Use on Lower Bands**

On the lower bands where signal distortion is less, it is possible to reduce bandwidth of the input filters. This gives additional improvement and allows CW QSOs at -25 to -26 dB input SNR. The bandwidth however is limited by CW speed. For 12 WPM limit is 10 Hz but it is better to use 15...20 Hz. It is possible to use slow CW speed 1 WPM or less. In this case bandwidth can be done 1 Hz. It allows to read call signs at -33 dB input SNR. To do it more comfortable to read QRS CW program normalize processed signal to 12 WPM speed. QRS can be used with wide BW too. It is not improve SNR but reduce requirement to sound card sample rate accuracy.

This program was designed for signal situations where random QSOs are impossible, but there are ways to use the program for random QSOs, and these methods can be explored further if there is any interest in using this program.

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