

Digital mode Comparison

Introduction

The performance of different digital modes can be compared in numerous ways. The comparison most expected by uninformed users is 'sensitivity', i.e. performance in the presence of white noise, which can be measured with reasonable repeatability using an ionospheric simulator.

However, this measurement is generally meaningless as so many other factors come into play when considering HF performance - things like the susceptibility to ionospheric Doppler effects, sensitivity to impulse or burst noise, and sensitivity to multi-path reception, where there can be selective fading and timing differences between paths. However, these can also be measured with a simulator, provided care is taken in choosing appropriate simulations.

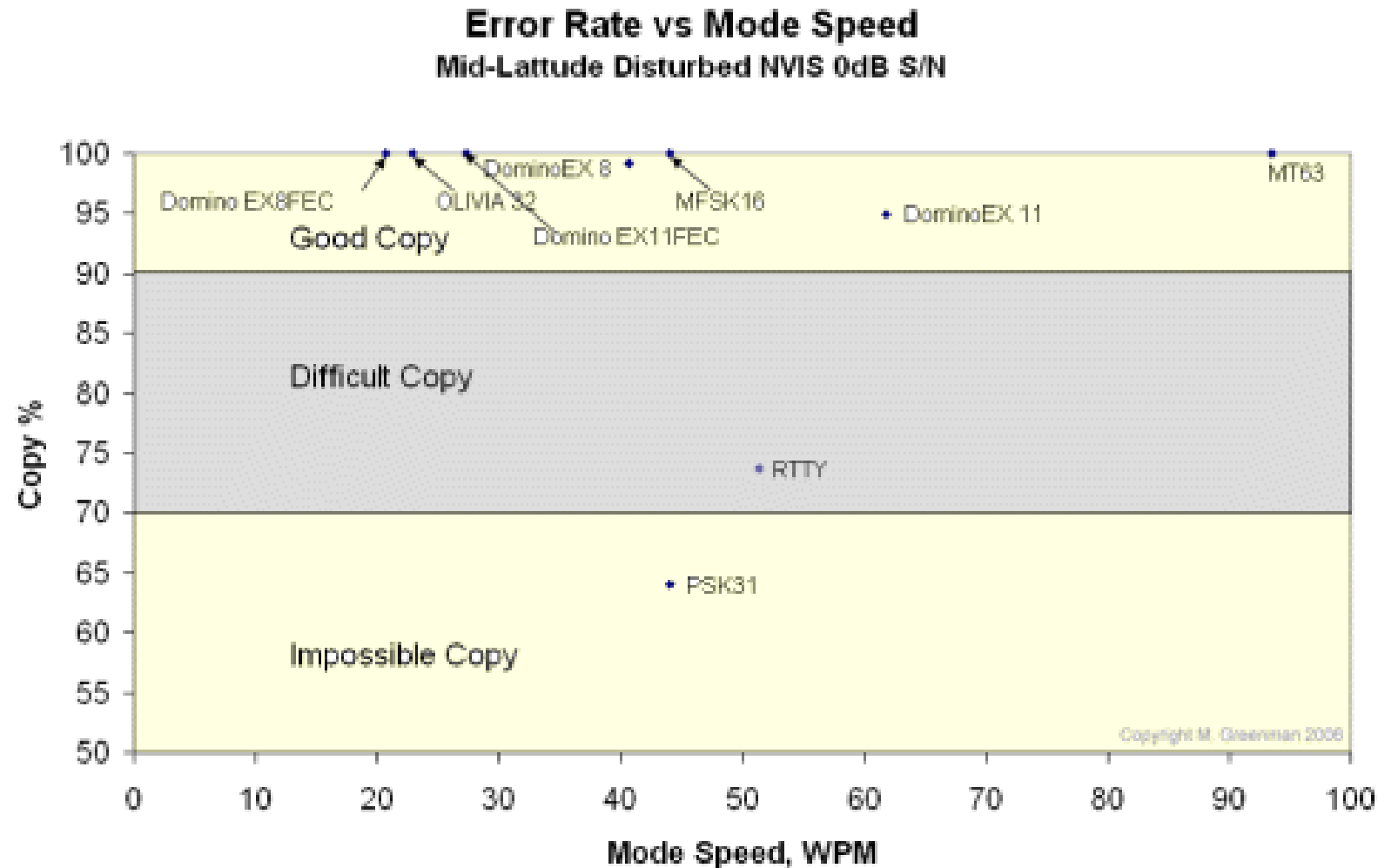
Several other comparisons prove interesting and certainly less controversial, since the performance of each mode can be calculated. The factors which are easily compared are bandwidth, bandwidth efficiency and coding efficiency.

Digital mode Comparison

Propagation Performance

- Rather than providing a series of measurements that would be difficult to understand, the information shown below was condensed from a detailed study made of representative popular modes, using the standard CCIR ionospheric simulation known as 'Mid Latitude Disturbed NVIS'. This is a near approximation of poor multi-path conditions, without static or other interference, but with white noise reducing the signal to 0dB S/N in 2.4kHz bandwidth.
- It should be stressed that simulation results can be highly subjective, and are usually presented as comparative text results for the observer to assess. A method has been evolved which involves counting the number of correctly received complete words and the total number of words, and giving the ratio the value '% Copy'. This technique has proved to be repeatable. From practical experience a QSO is viable if '% Copy' is on average

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From this graph it is clear that under these conditions (typical of 80m at night) PSK31 gives poor results, and RTTY is not much better (remember this is for this specific simulation - for others the results will be different). The error corrected modes all perform well. Not how well DominoEX8 performs - with no error correction! This mode was designed for these conditions.

The horizontal axis of this graph is typing speed, and you can see that MT63 is the clear winner. However, the graph tells only part of the story - MT63 also consumes much more bandwidth than most other modes. Olivia is the same bandwidth as MT63, but look at the low typing speed!

Digital mode Comparison

'Error Rate' as shown in this next graph is simply $100 - \% \text{ Copy}$. Thus an Error Rate below 10% will give comfortable copy during a QSO. The data has been rearranged to show (on the horizontal axis) a measure of how effectively the mode manages its bandwidth. Clearly PSK31 uses the least bandwidth for its typing speed, while Olivia is the least efficient, but at least has a low error rate.

Again, it must be stressed that the measurements are for 'Mid Latitude Disturbed NVIS' and the modes which perform poorly may well perform better under other conditions. Anyone with two computers and a copy of the AE4JY 'Pathsim' simulator can repeat these measurements for any appropriate simulation conditions.

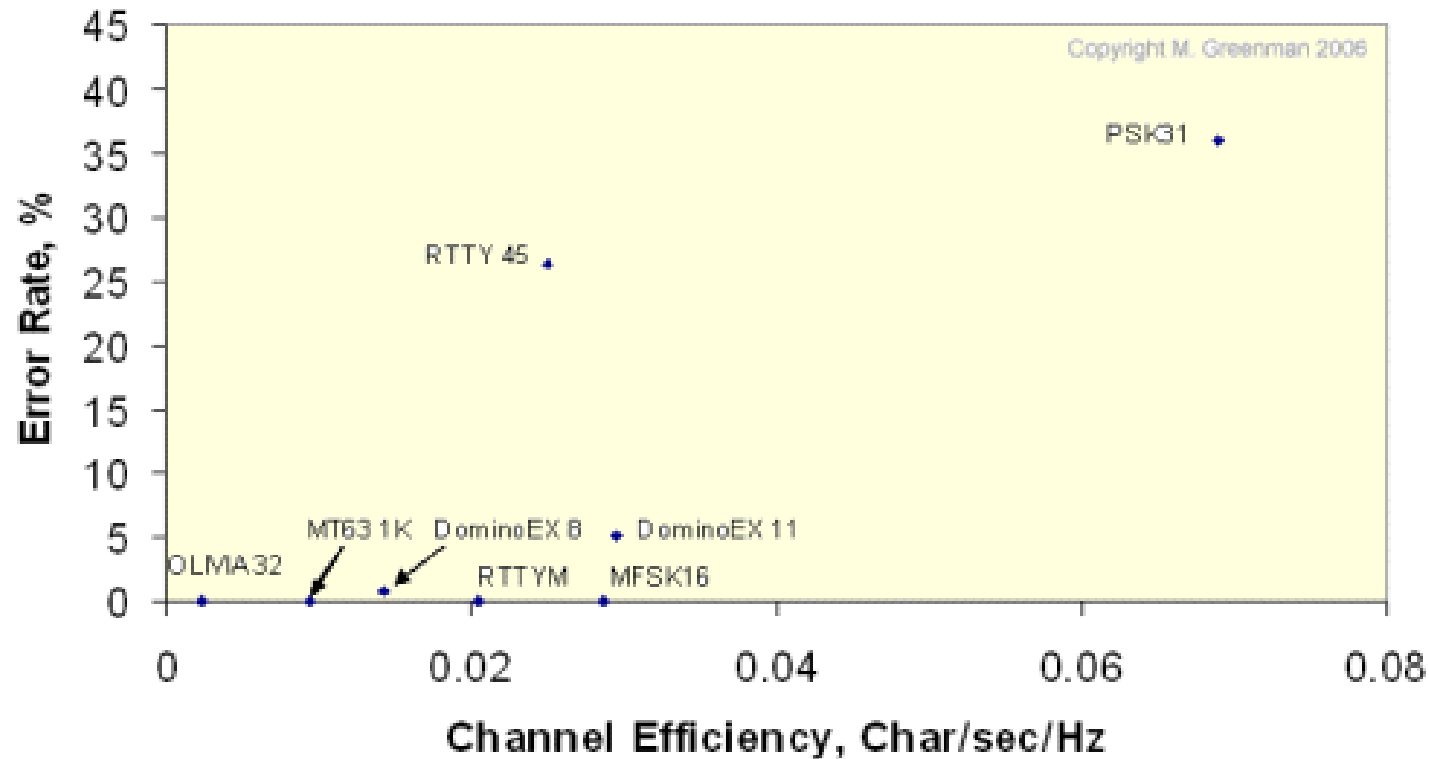
Bandwidth

- There is no controversy, subjectivity or choice of measurement conditions involved in comparison of bandwidths of different modes - it all comes down to mathematics and modulation theory. The 'Necessary Bandwidth' is defined by the CCIR using a set of mode-related formulae.

Digital mode Comparison

Mode Error Rate vs Channel Efficiency,

Mid-Latitude Disturbed NVIS 0dB S/N



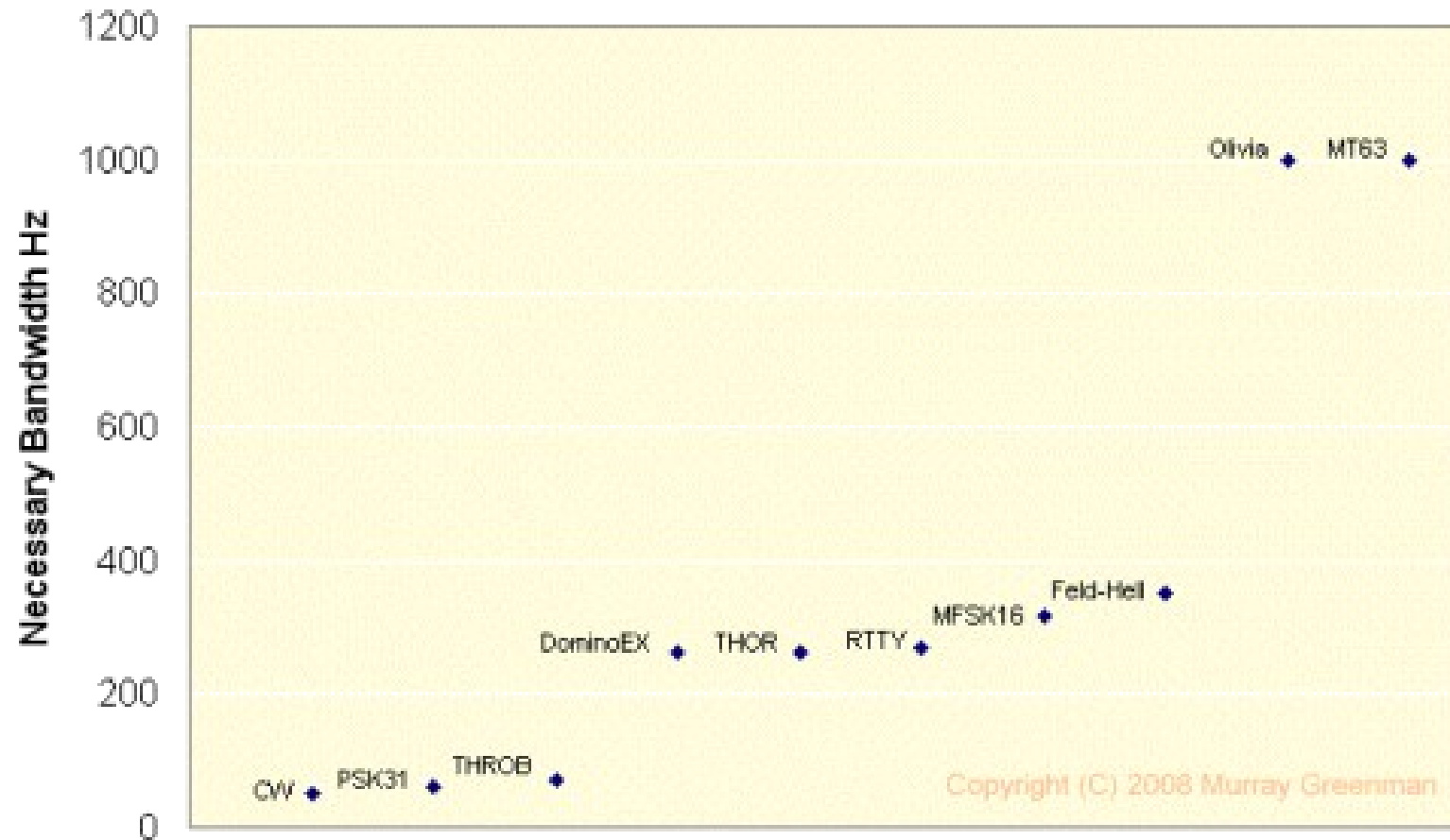
Digital mode Comparison

- Clearly the narrowest bandwidth mode considered here is good old CW - Morse code, with PSK31 a close second. The widest modes are MT63 and Olivia, both at 1kHz. However, this graph doesn't tell us everything, it is purely arranged in order of bandwidth. Let's look at this bandwidth in relation to the typing speed of each mode.

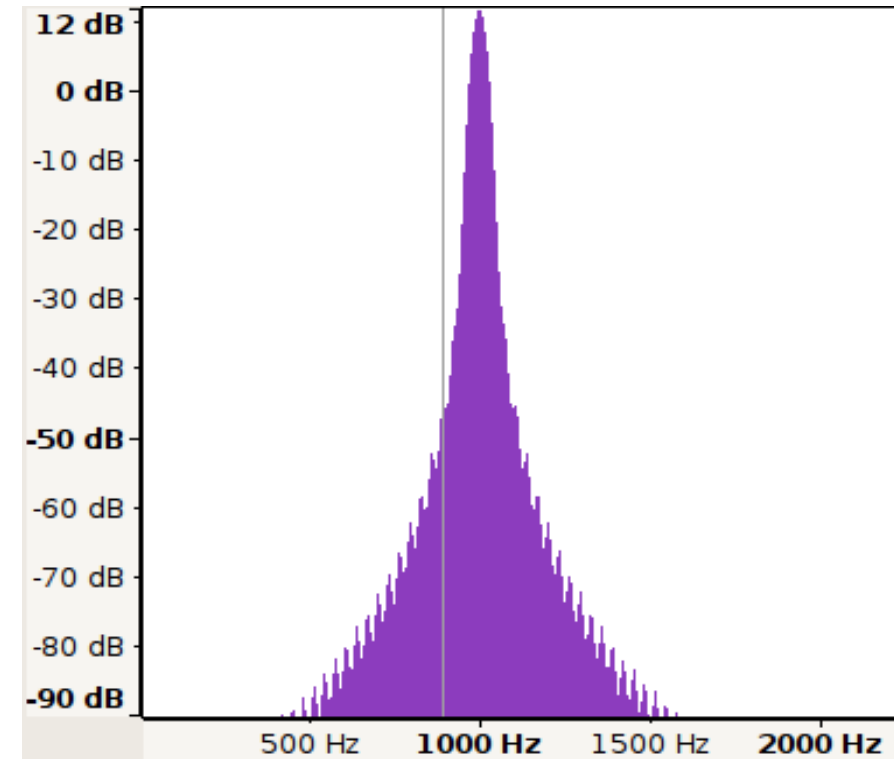
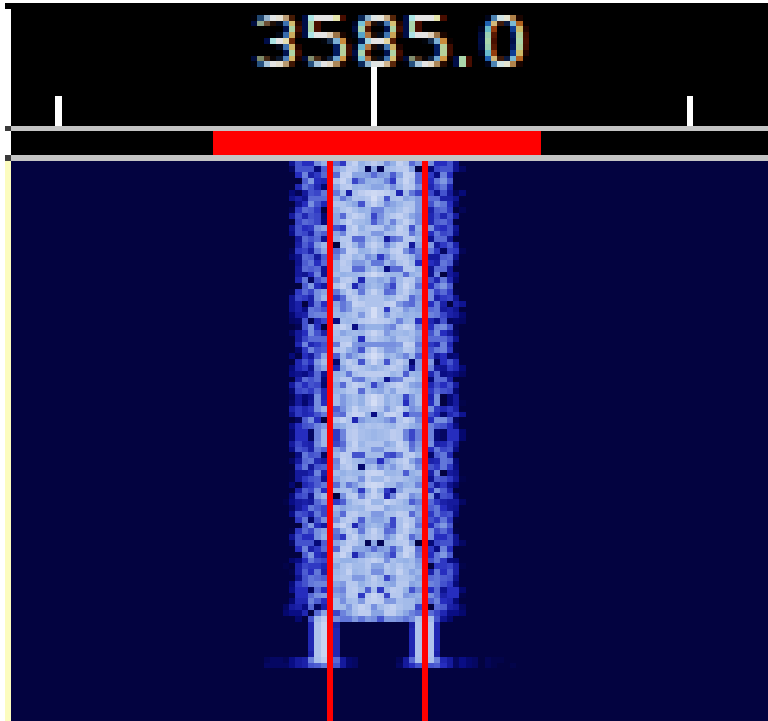
The following pictures and wave files are for 59 out of 104 different digital modes.

Digital mode Comparison

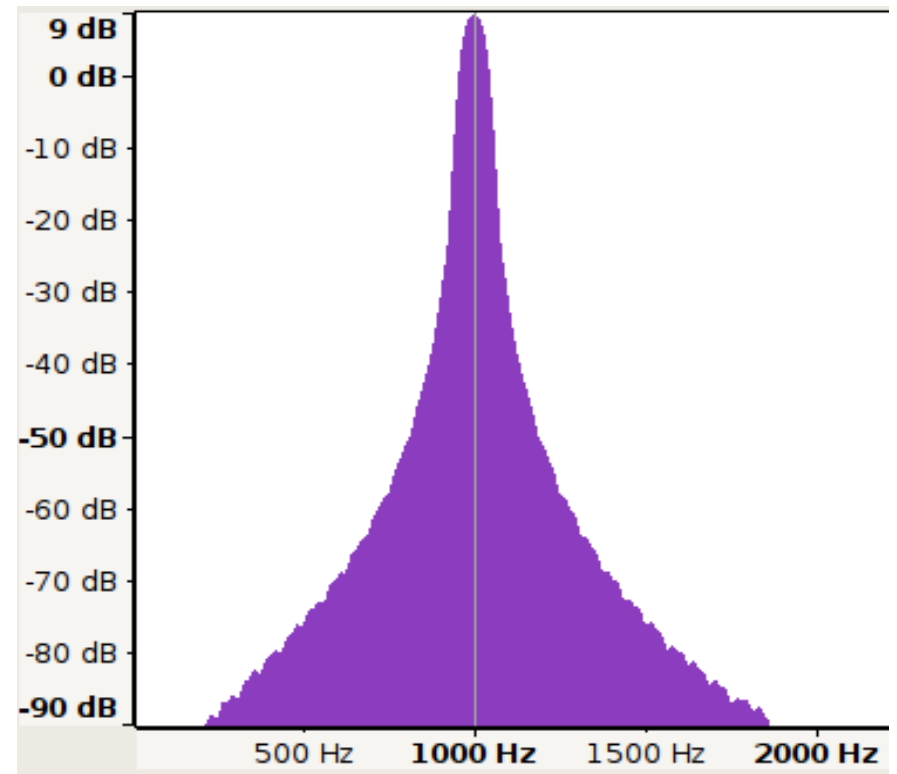
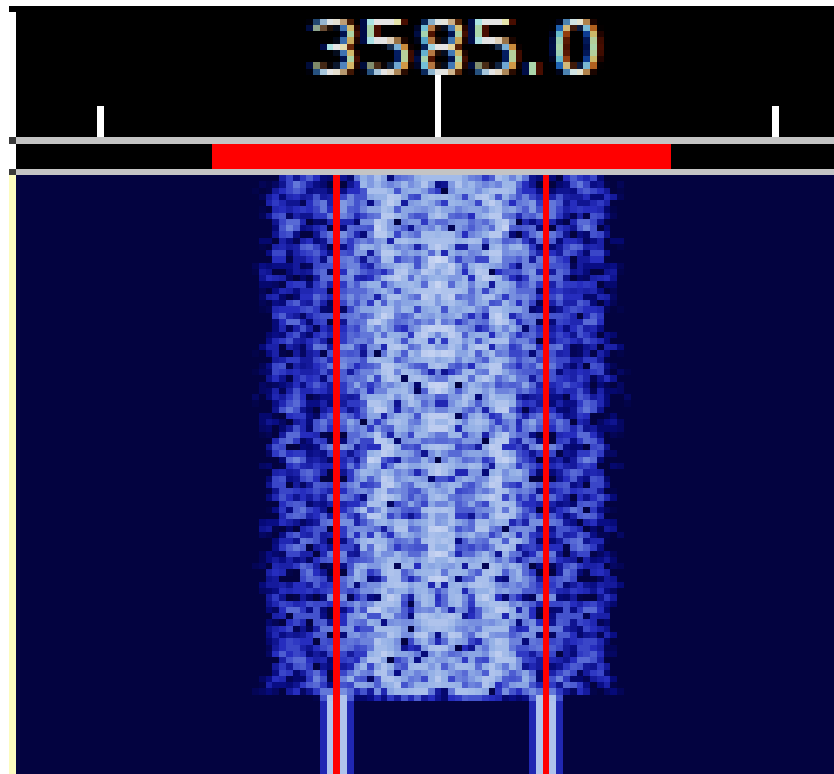
Digital Mode Bandwidth Comparison



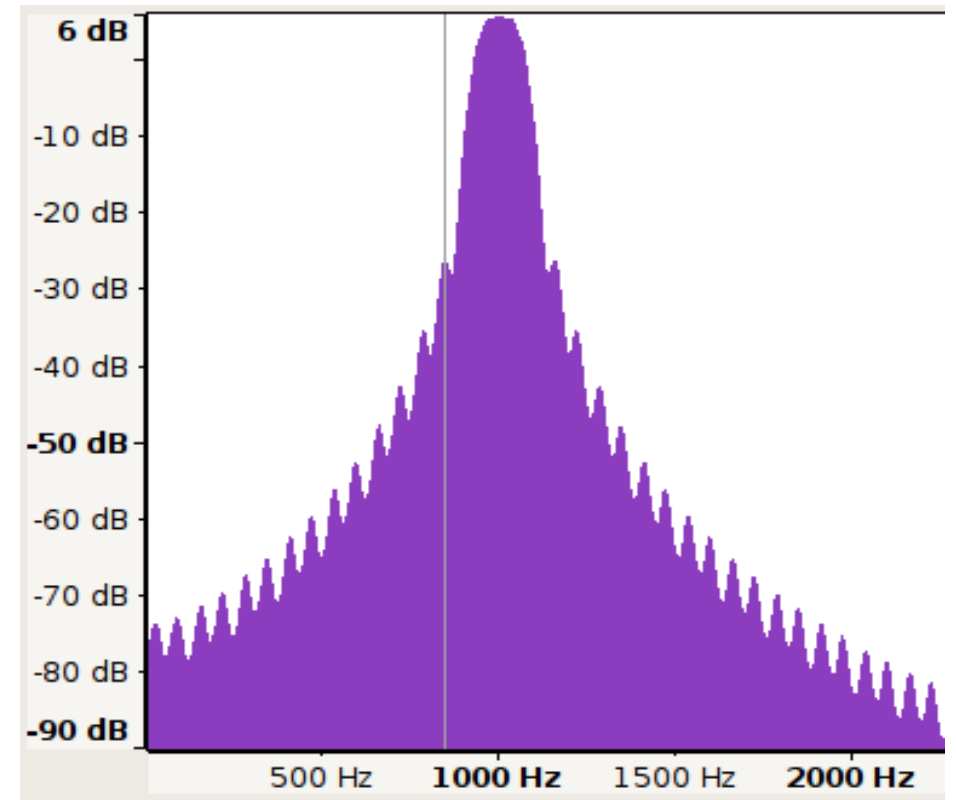
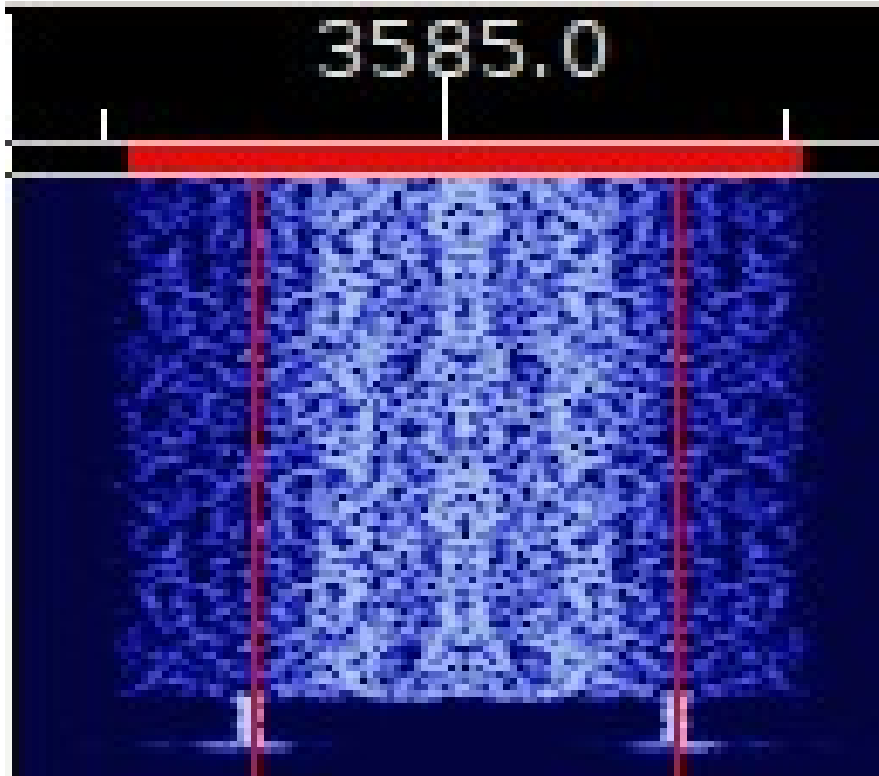
BPSK-31



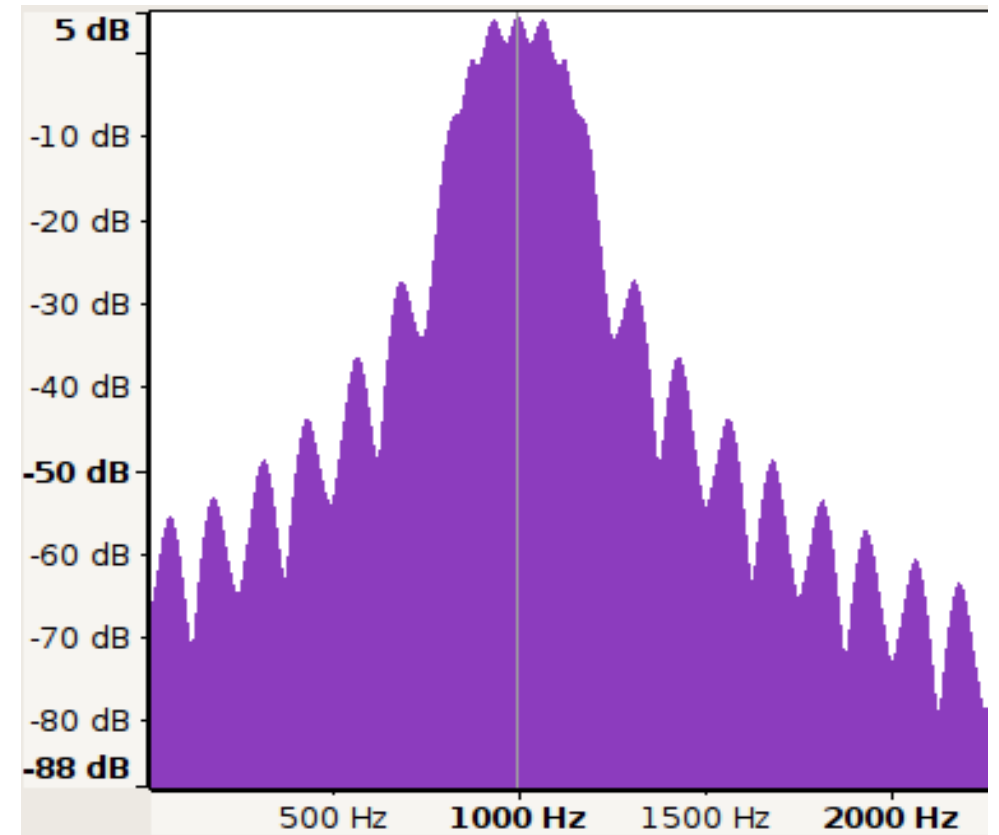
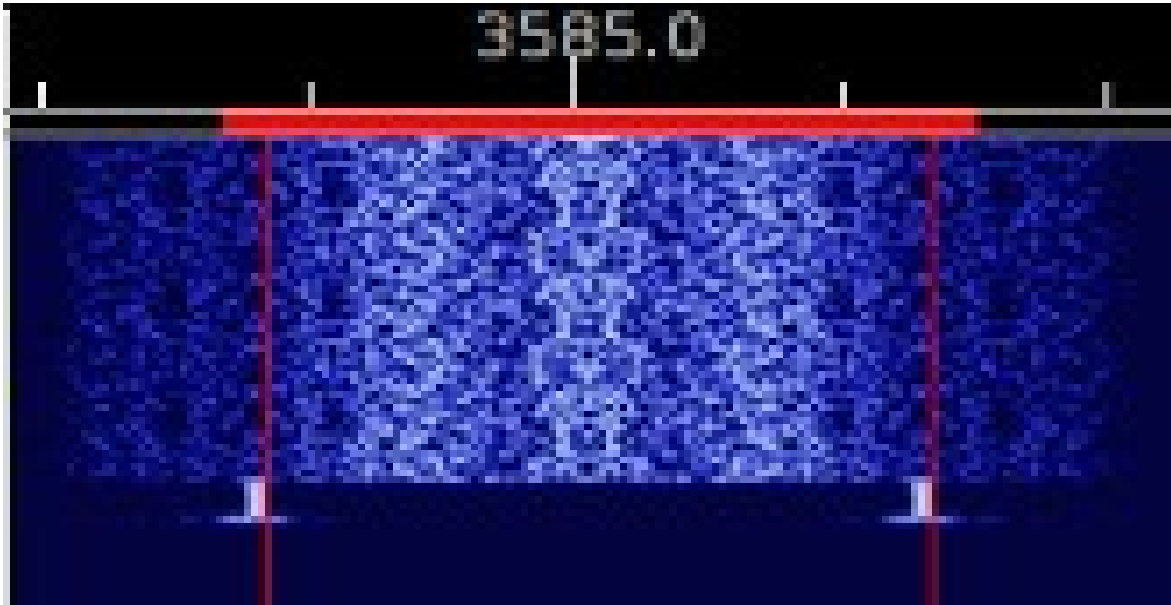
BPSK-63



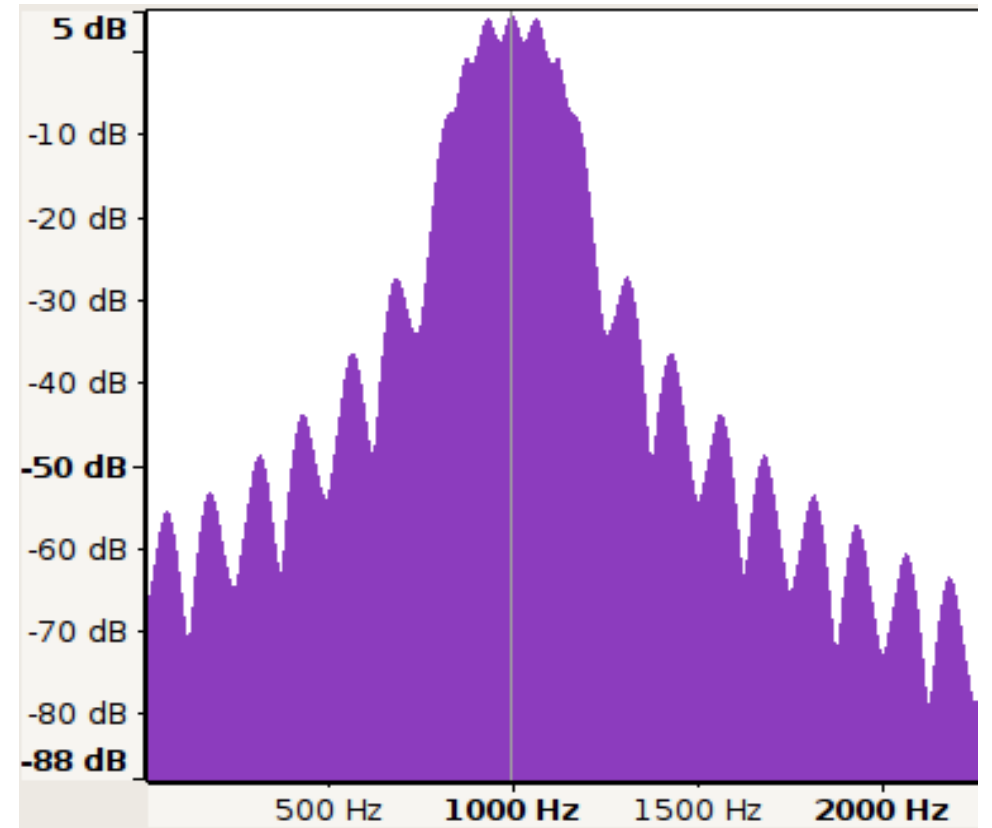
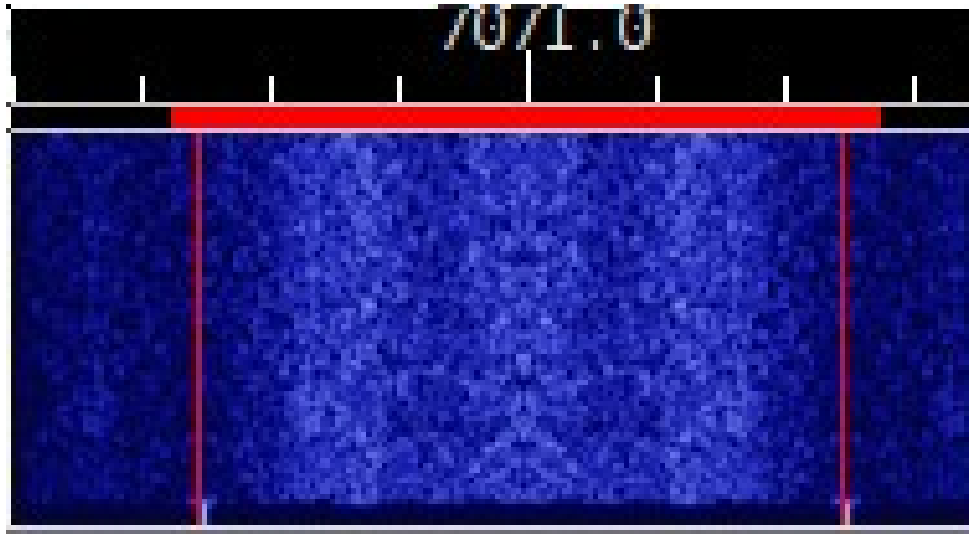
BPSK-125



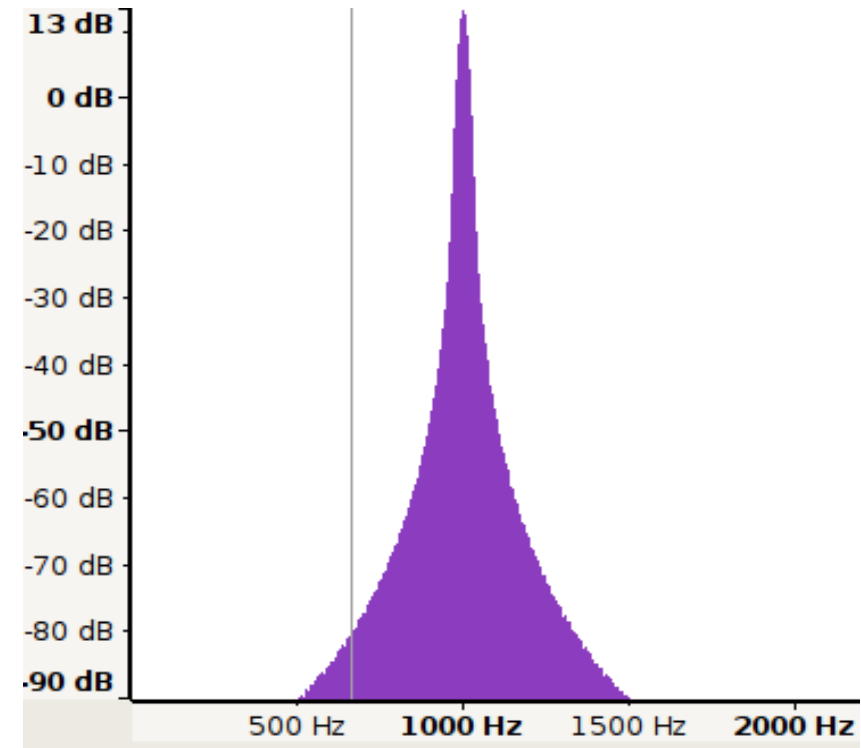
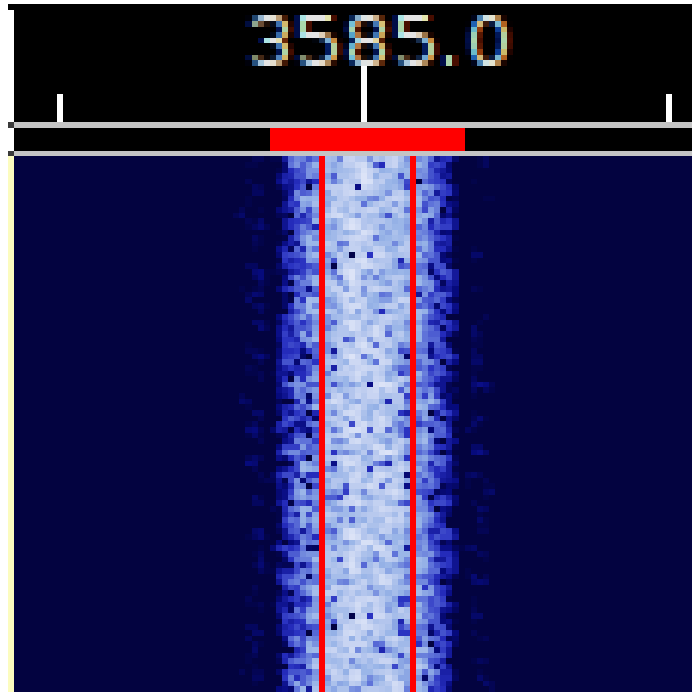
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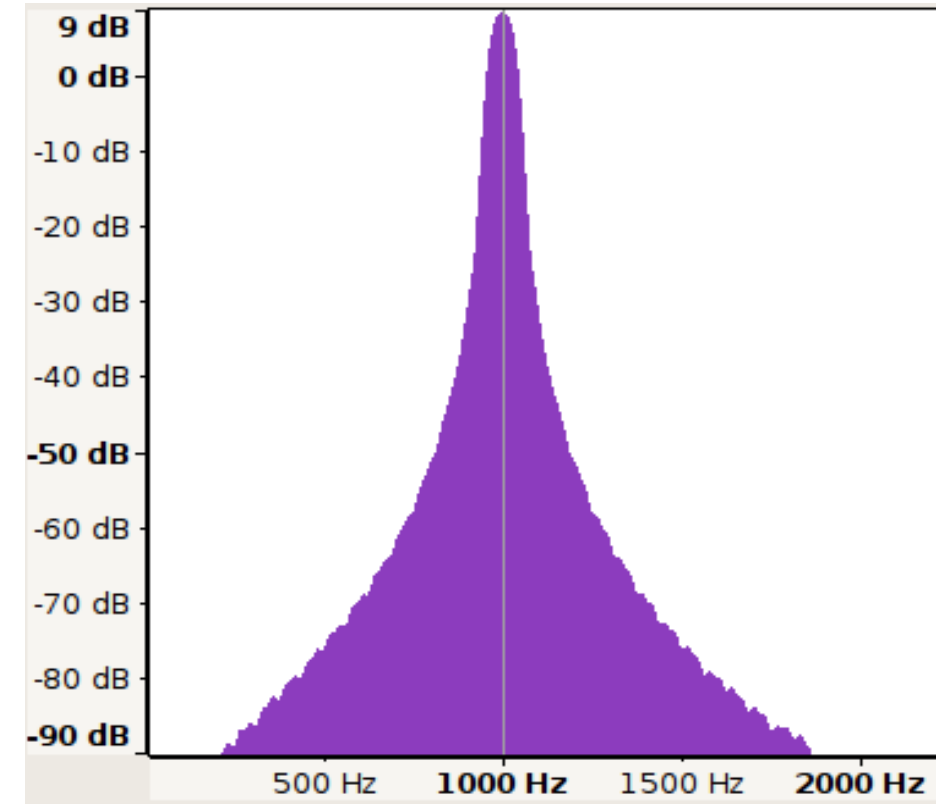
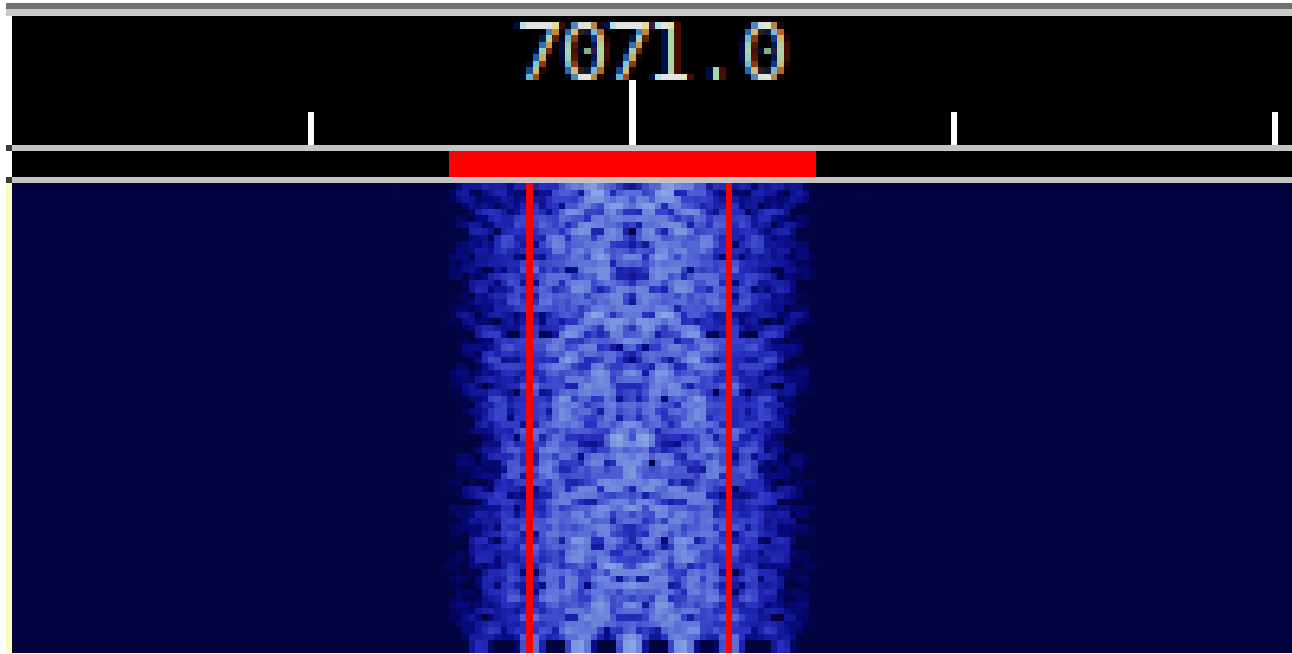
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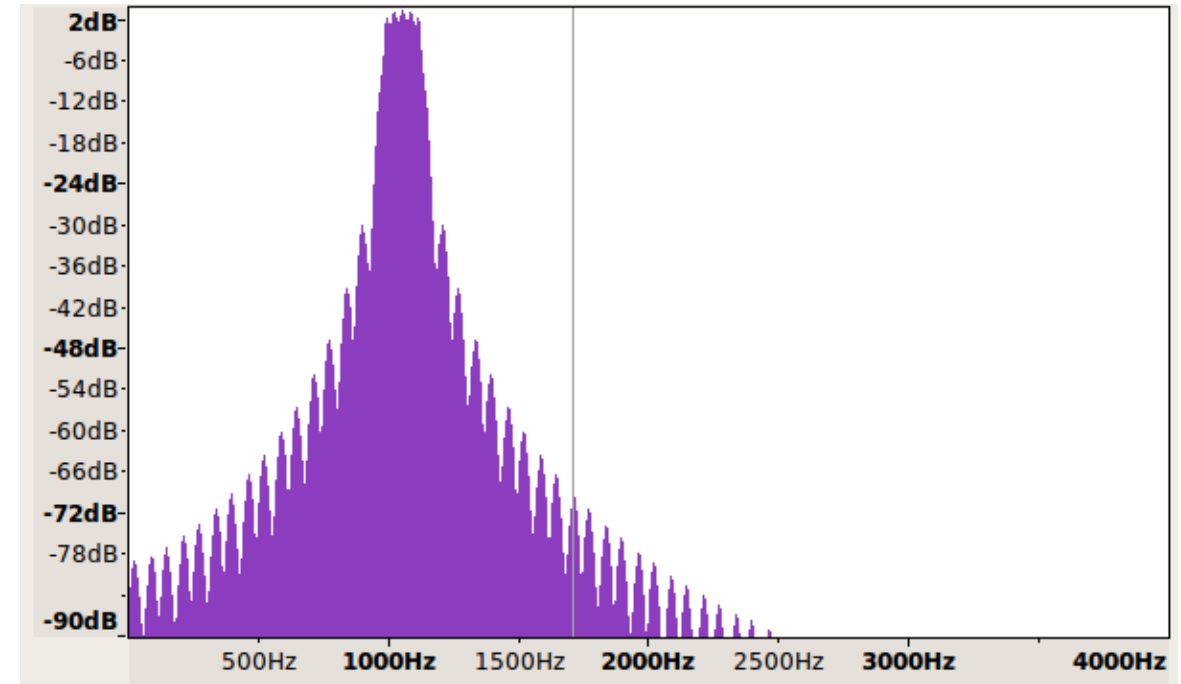
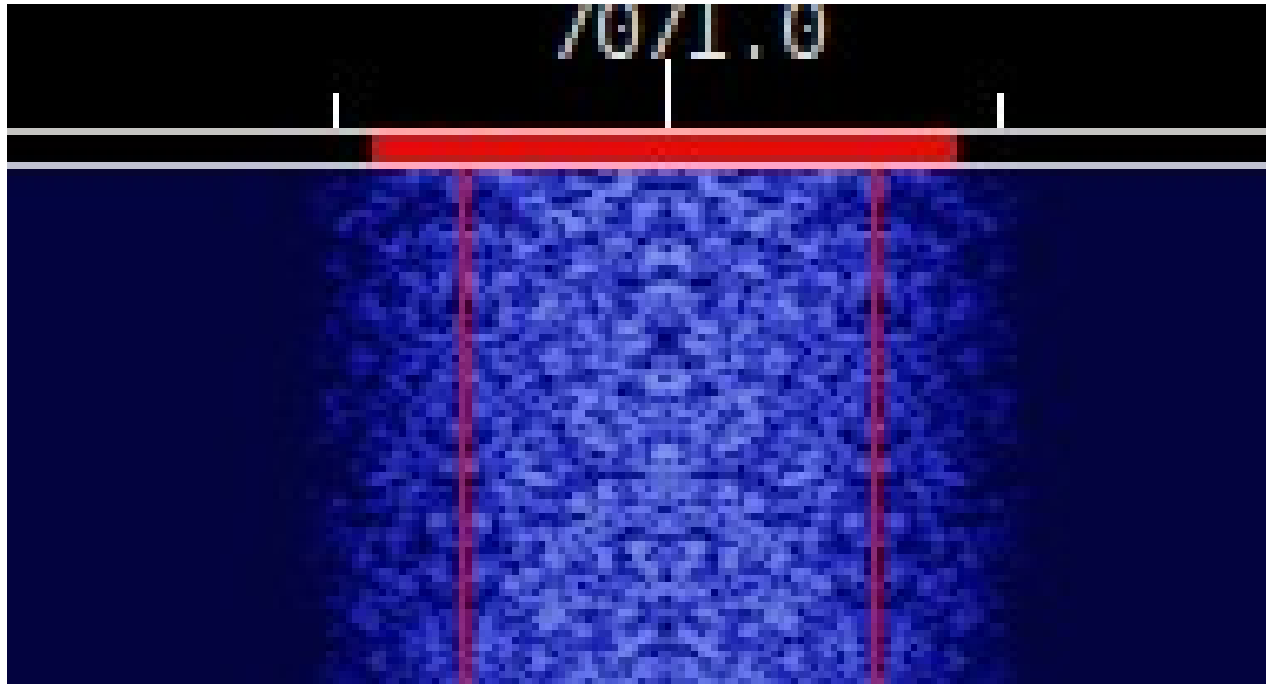
PSK-31



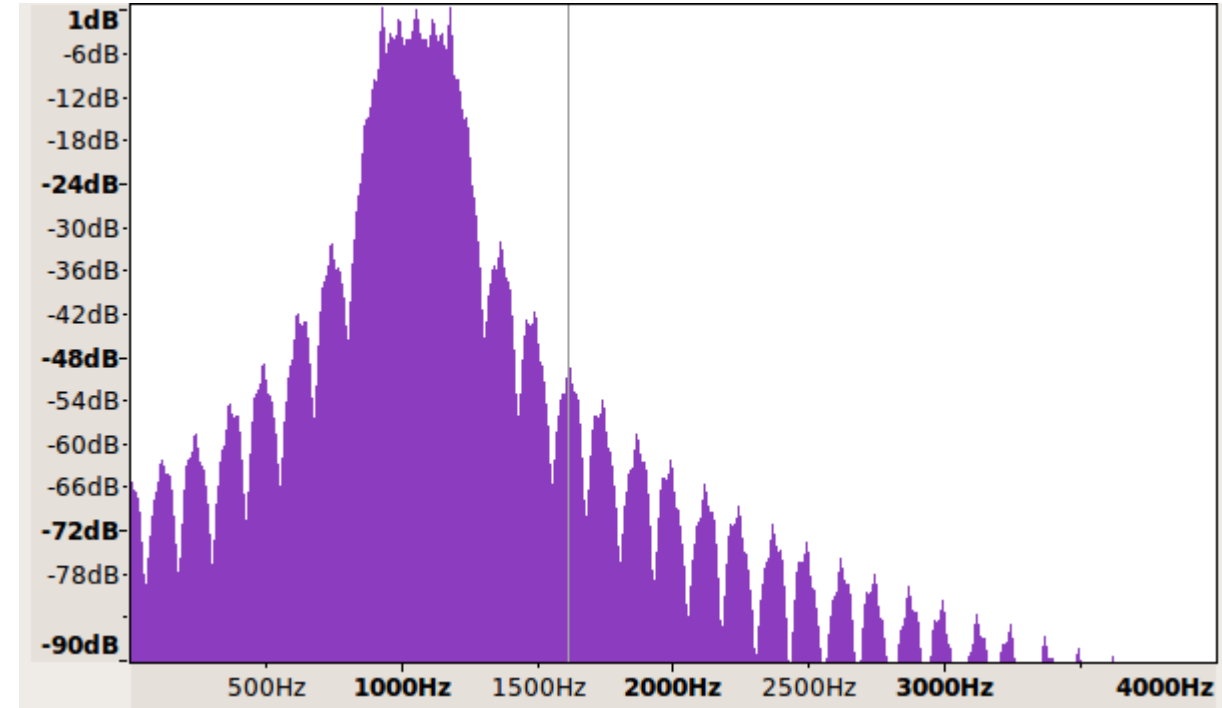
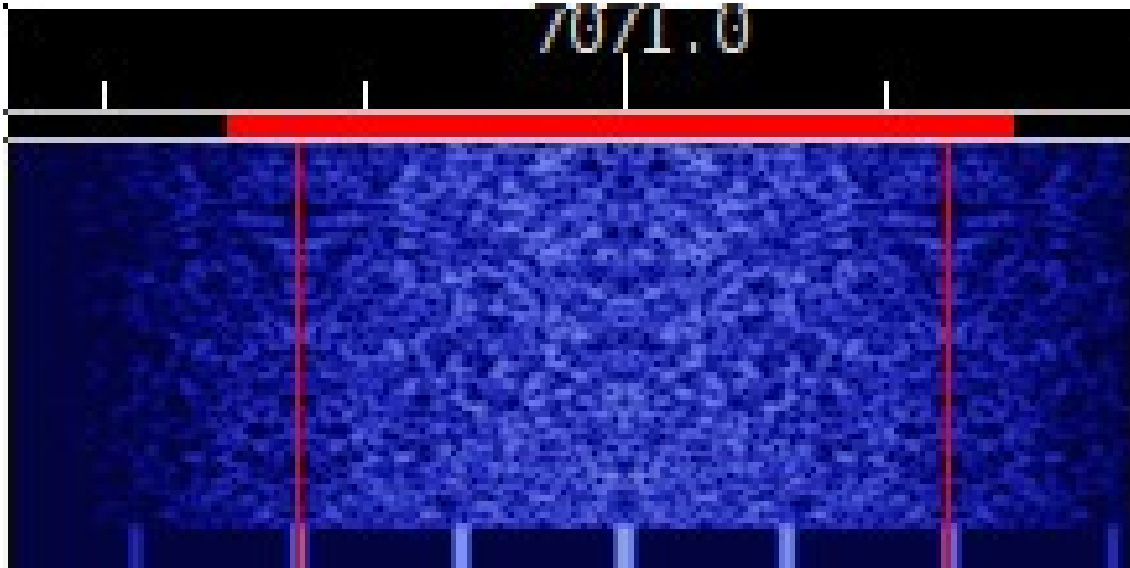
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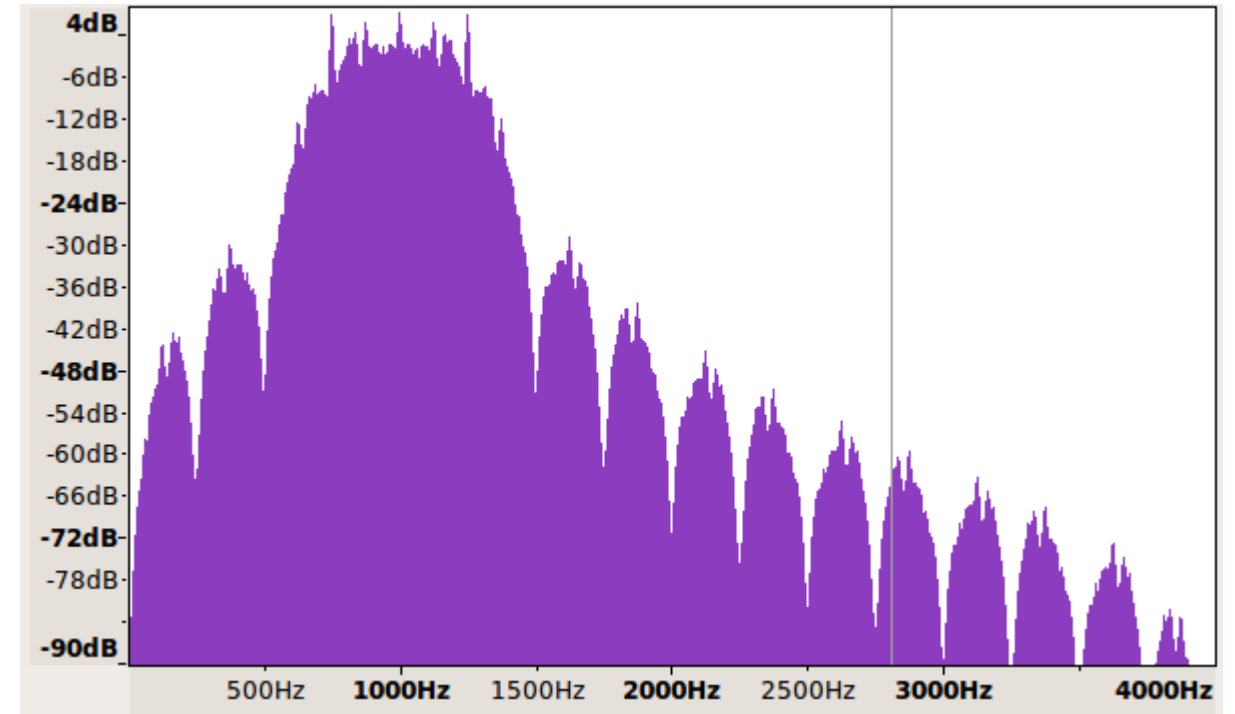
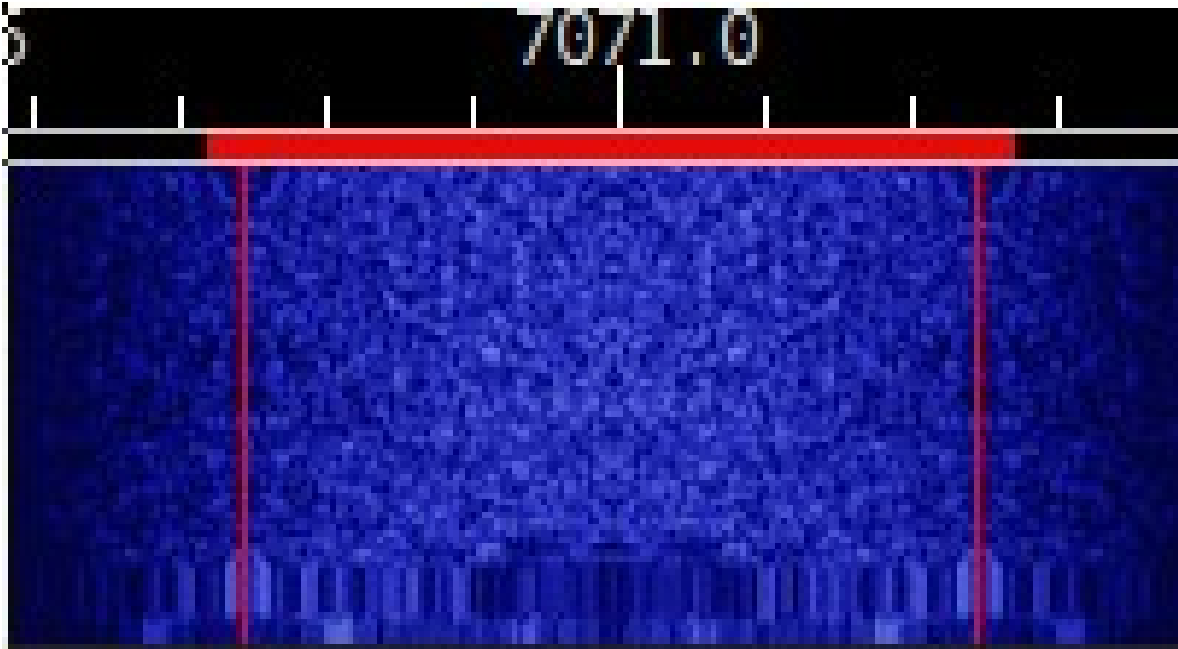
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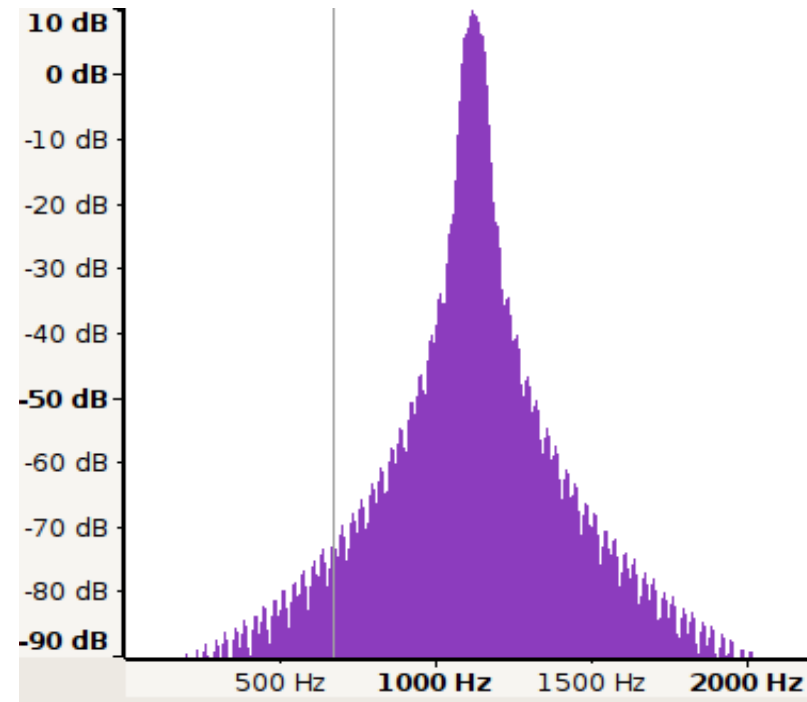
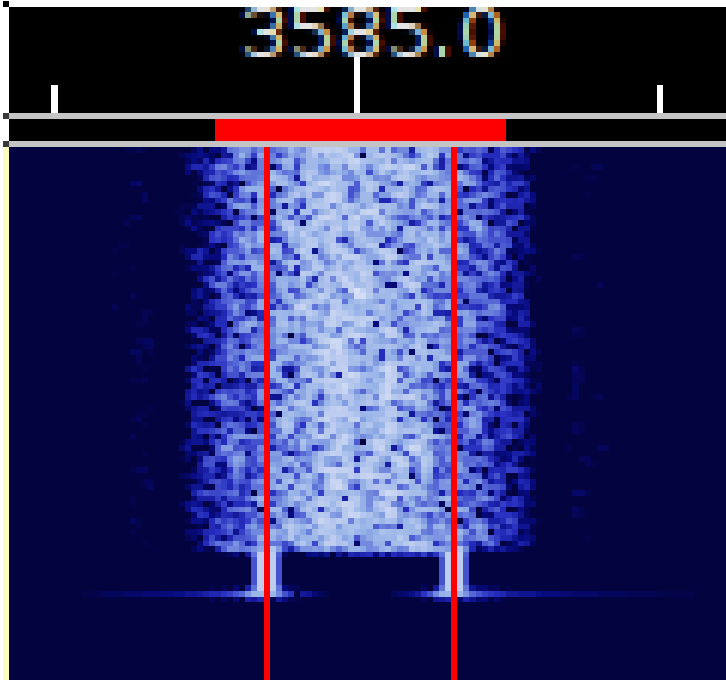
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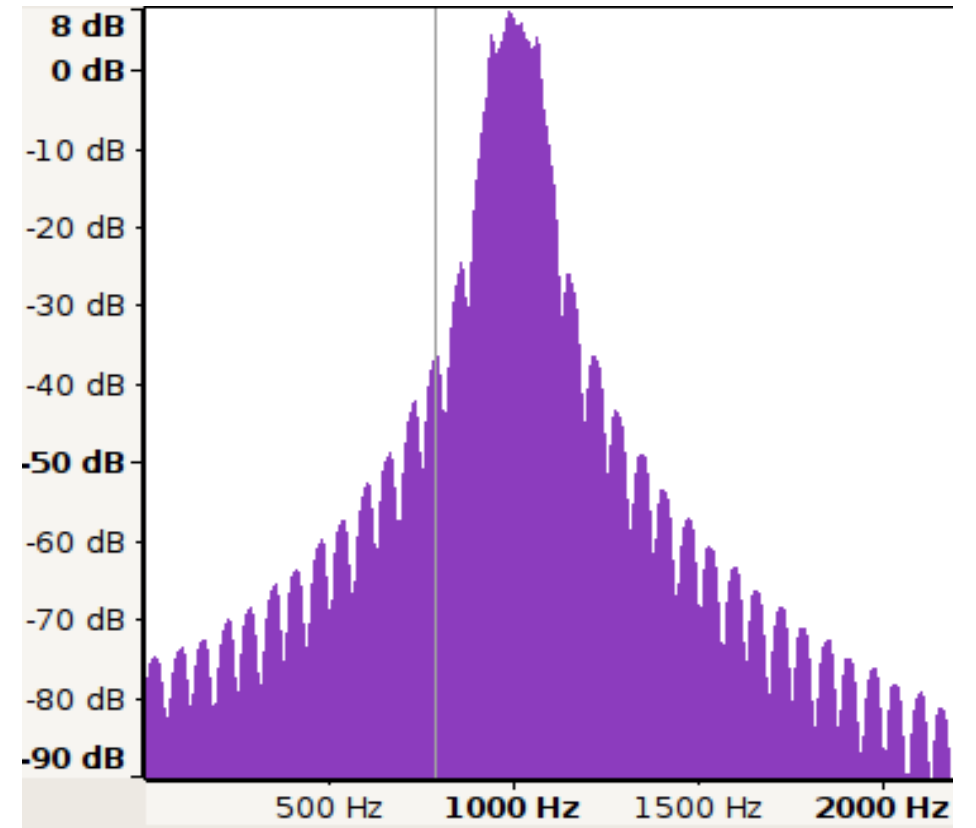
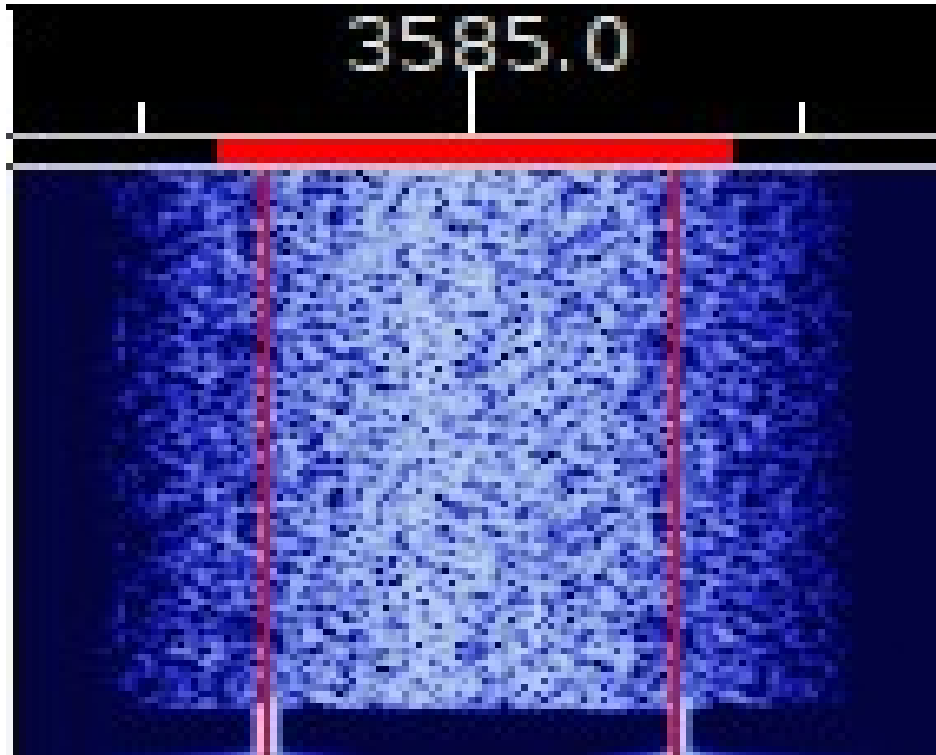
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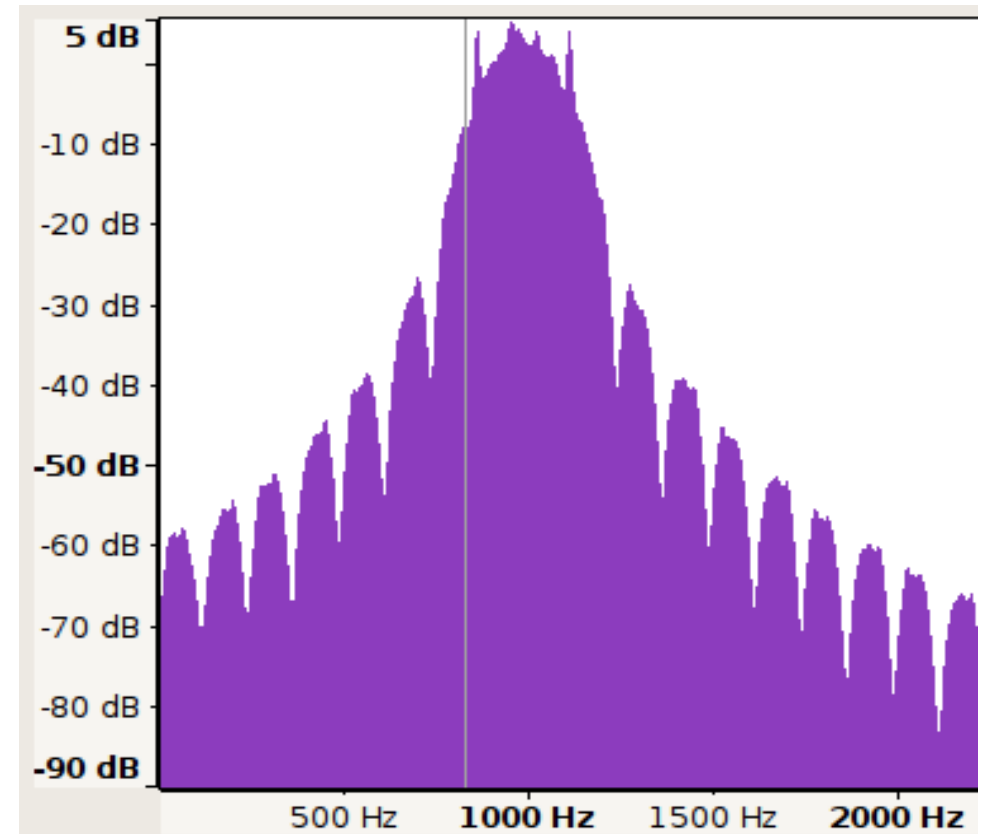
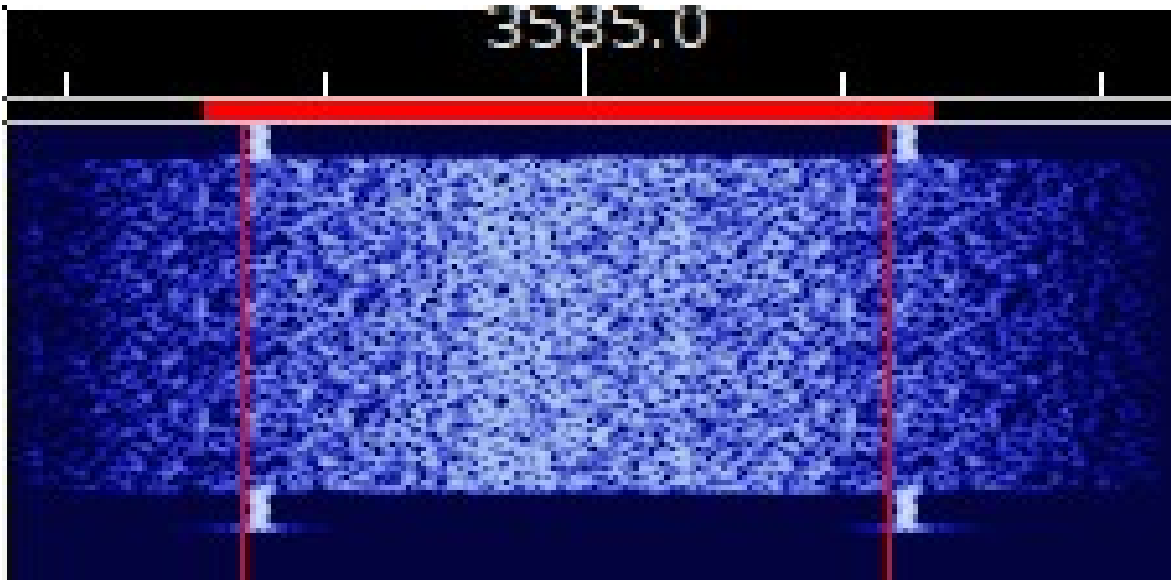
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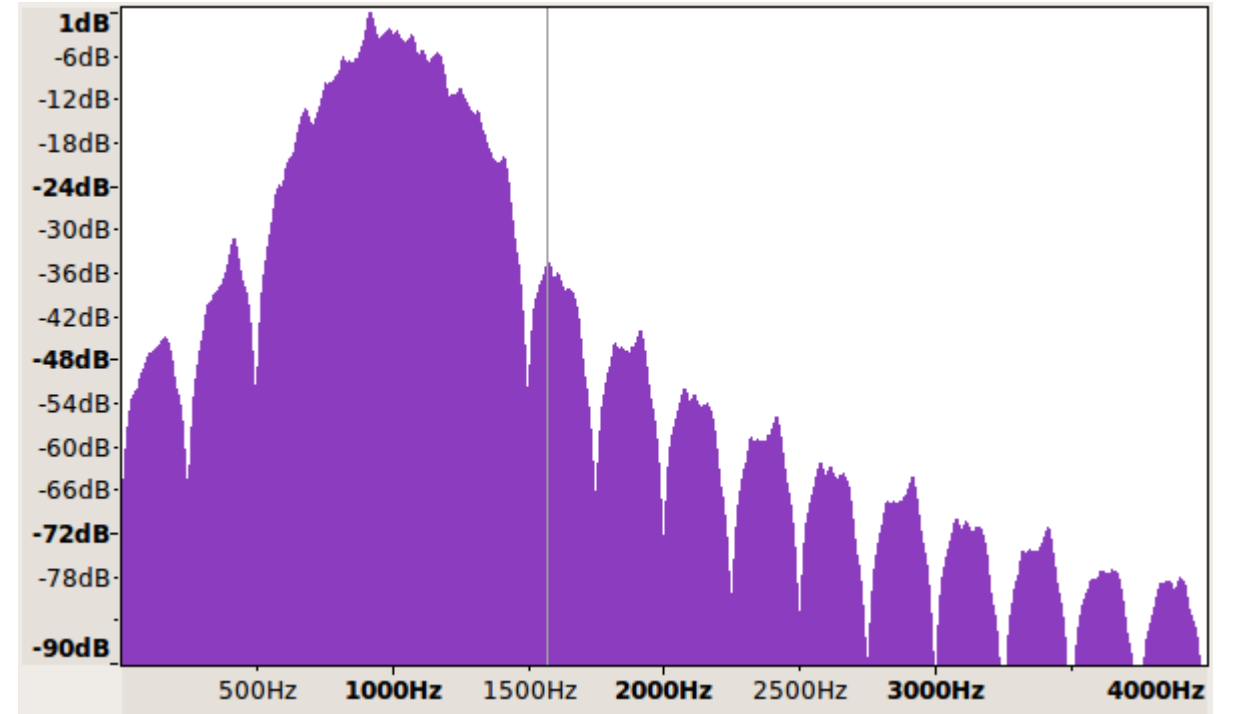
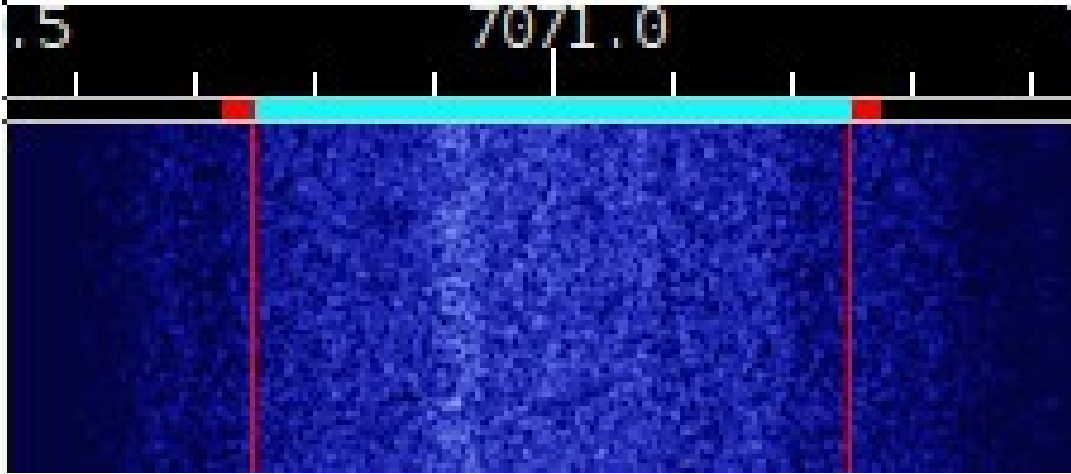
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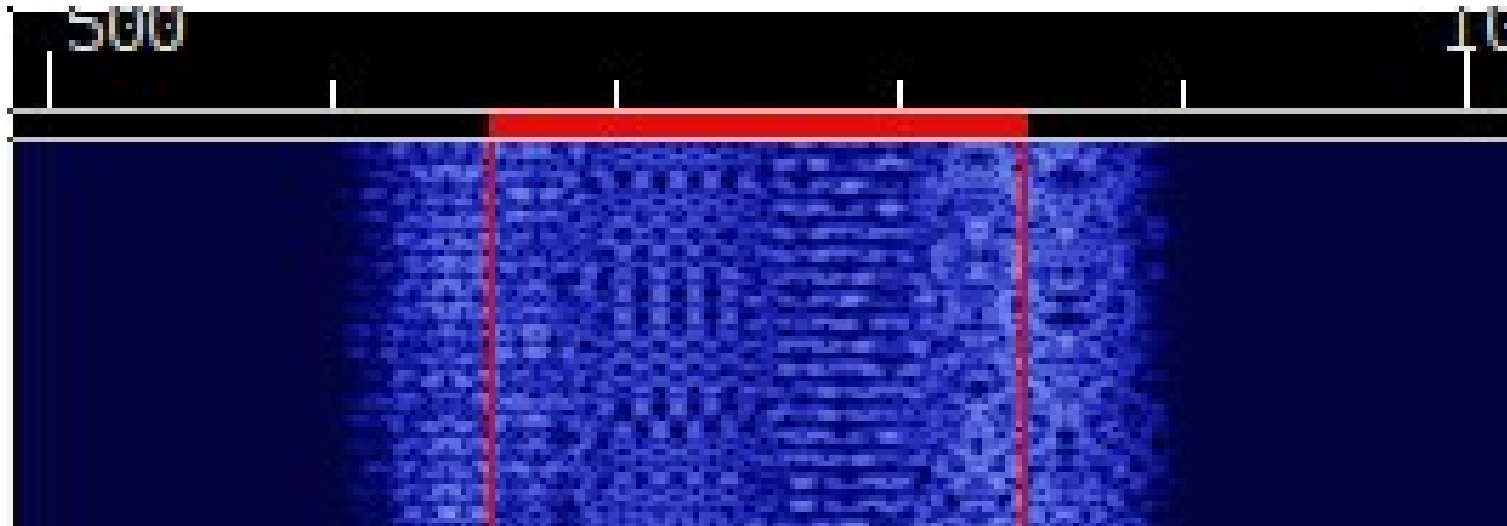
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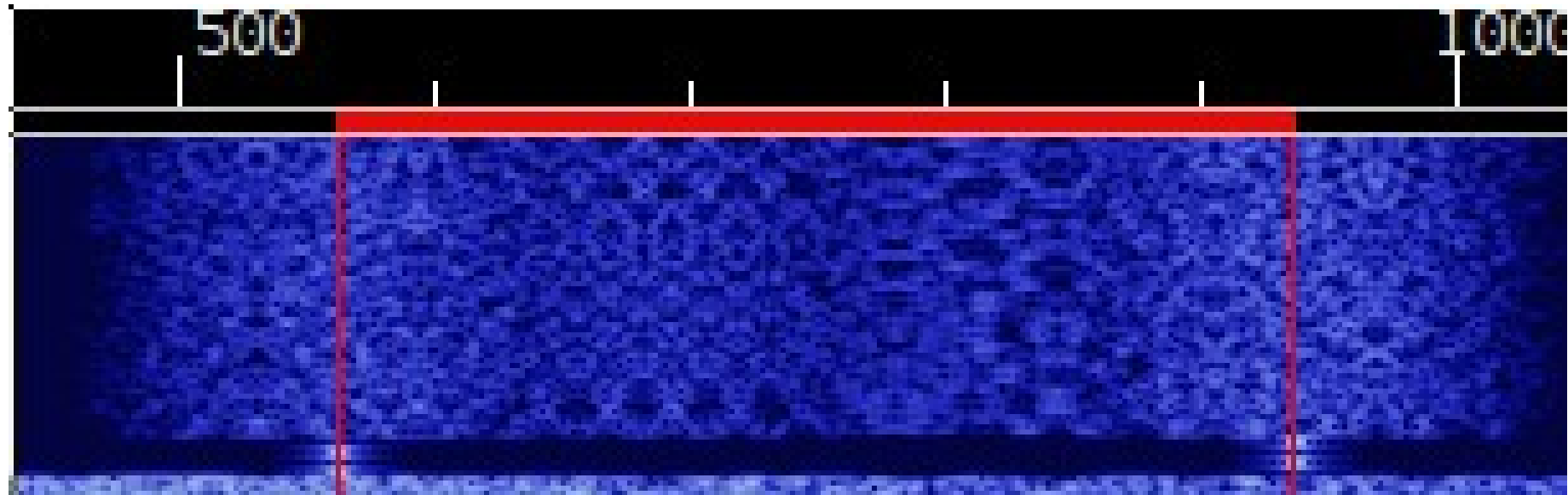
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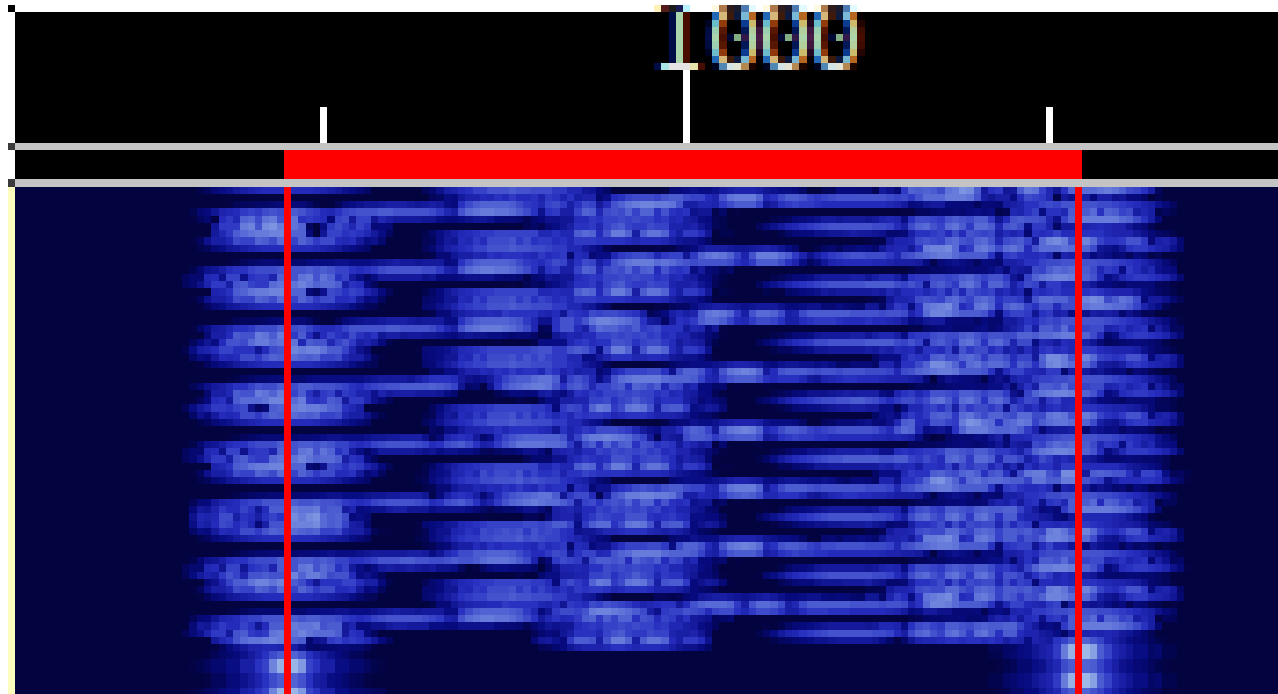
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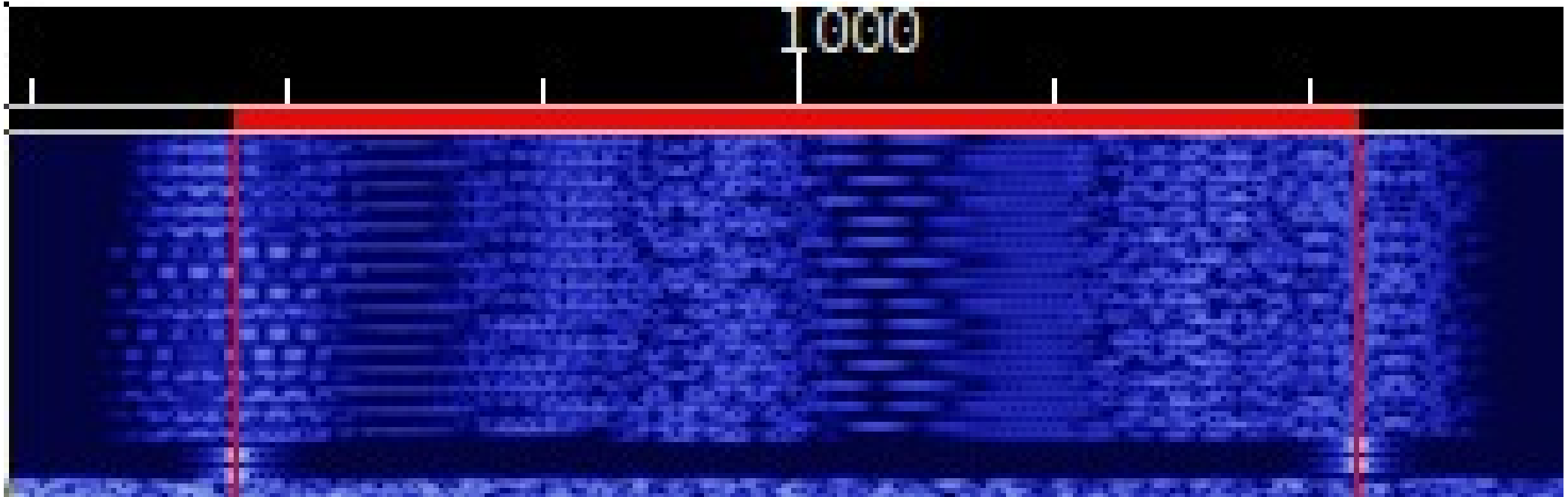
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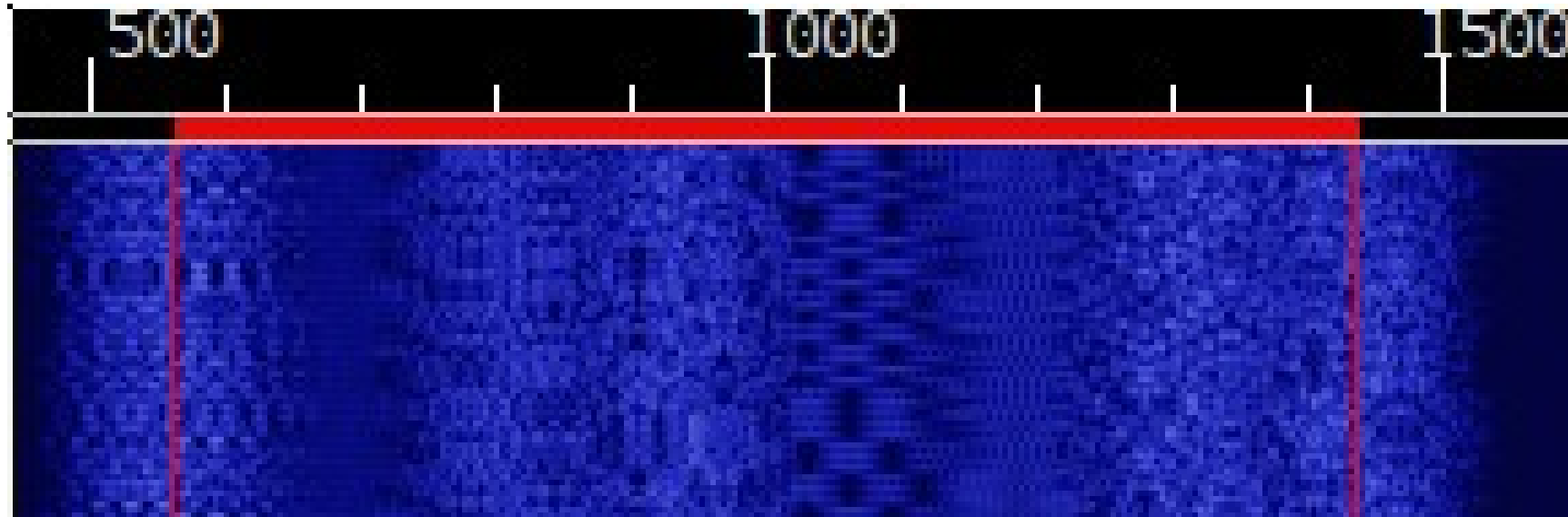
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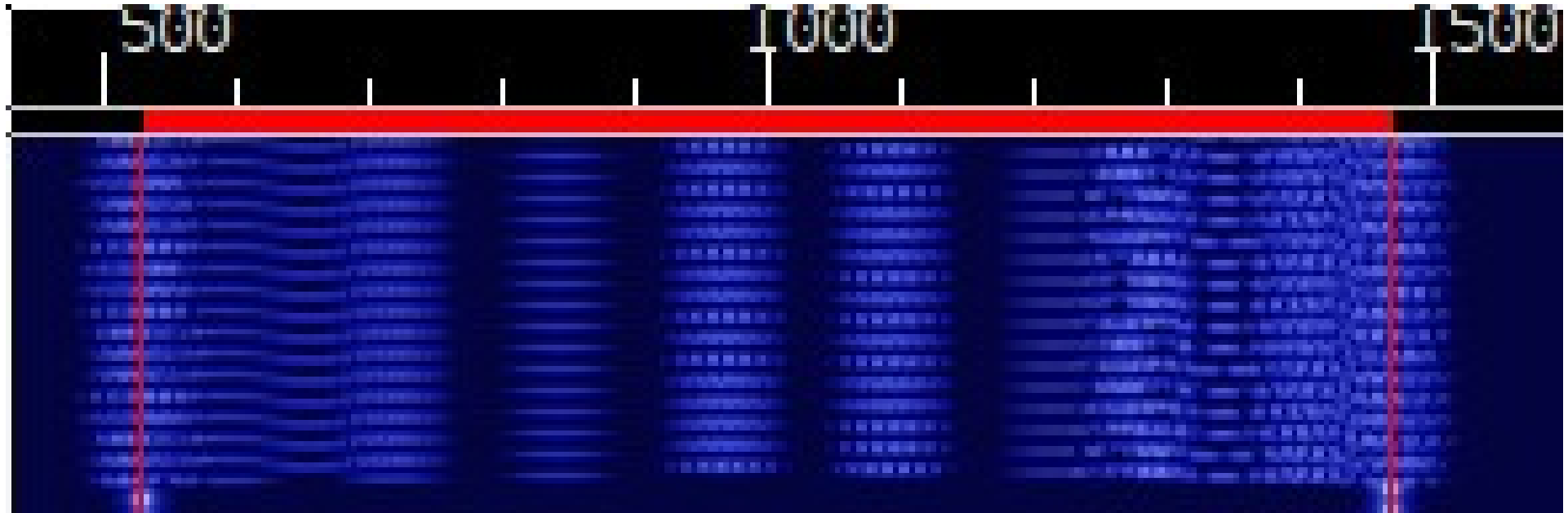
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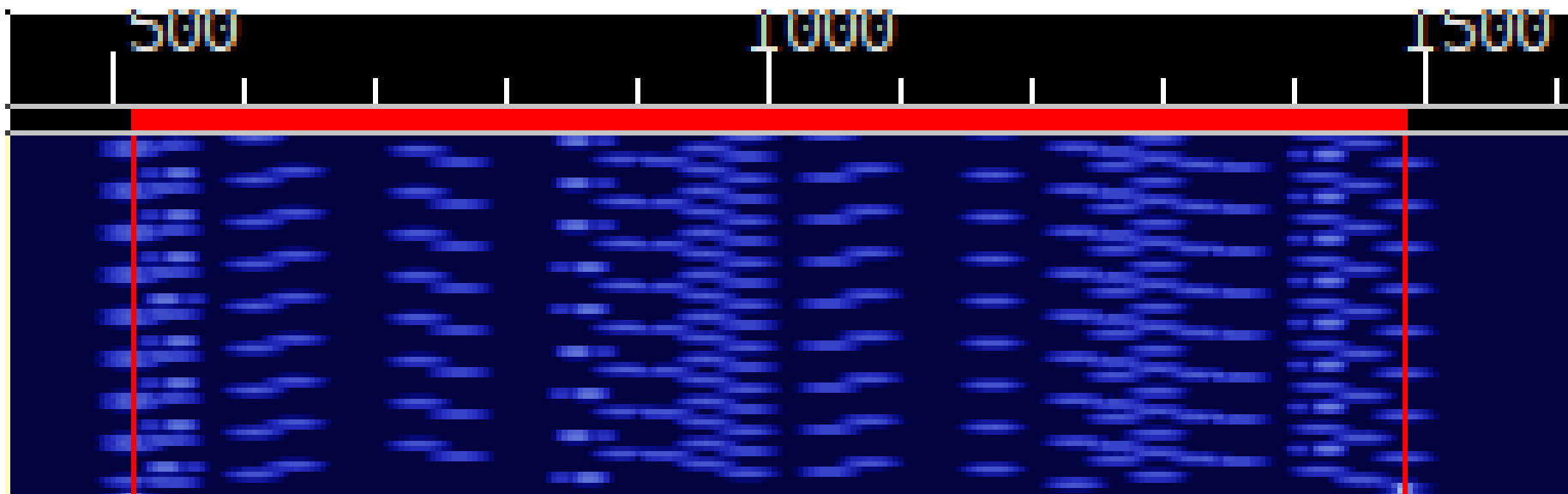
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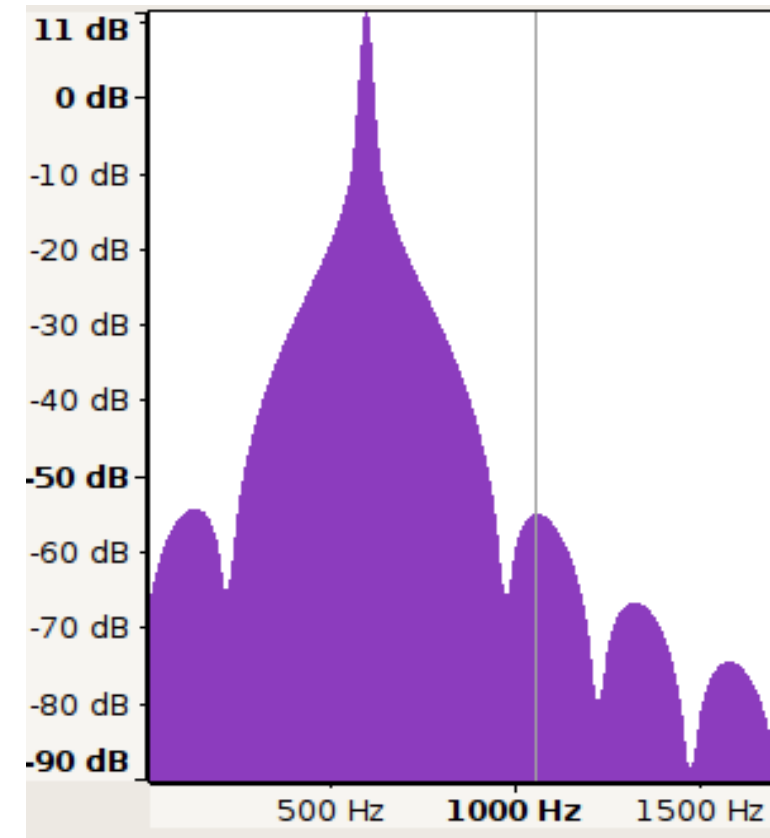
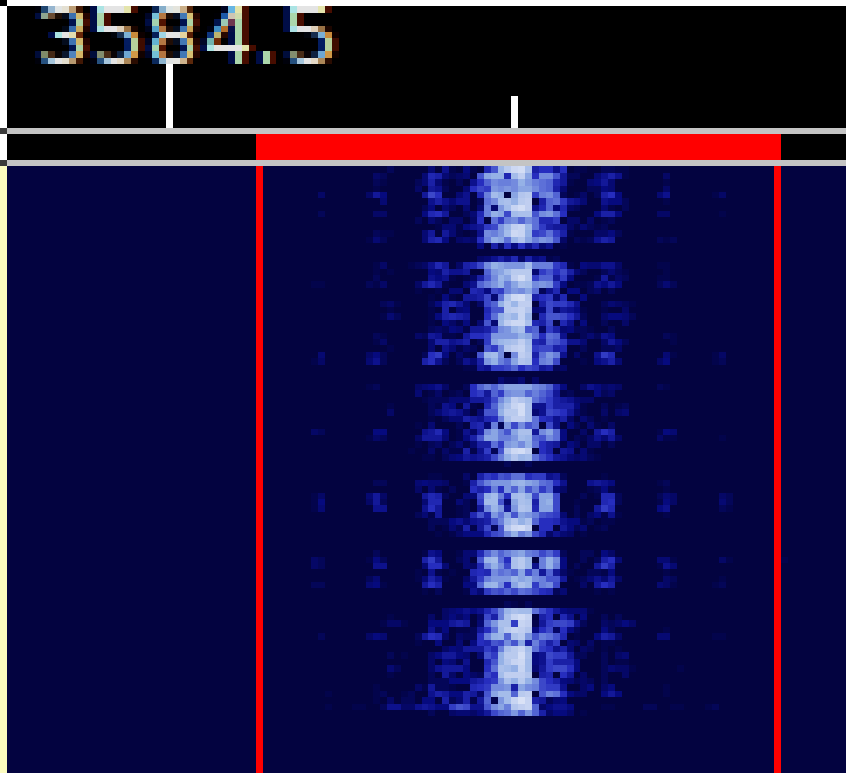
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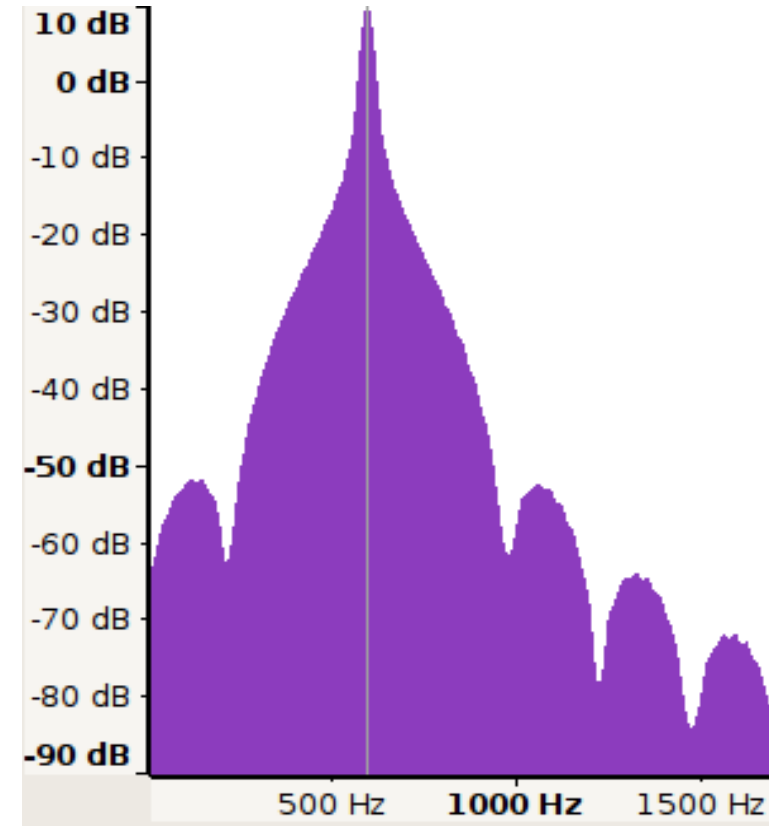
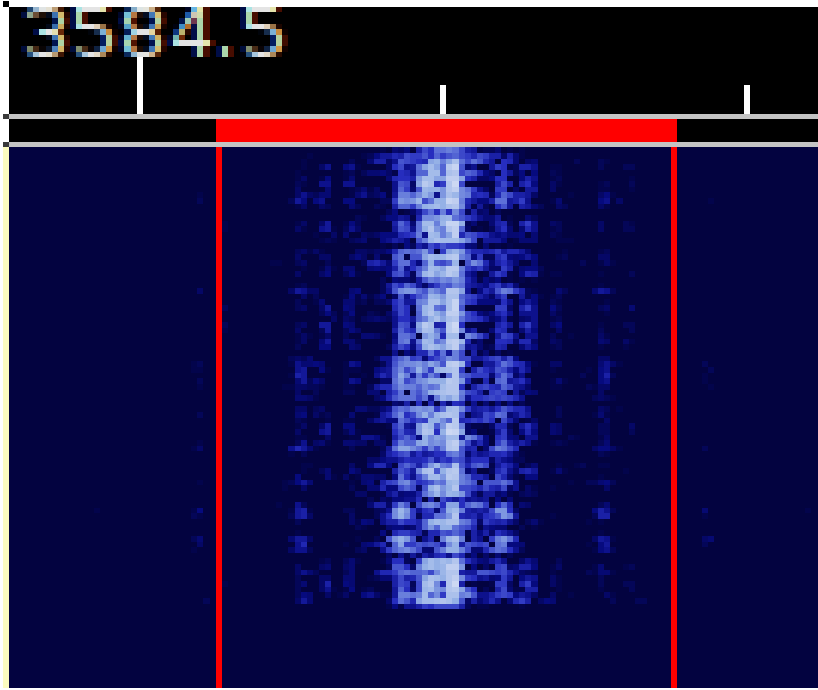
CONTESTIA 32-1000



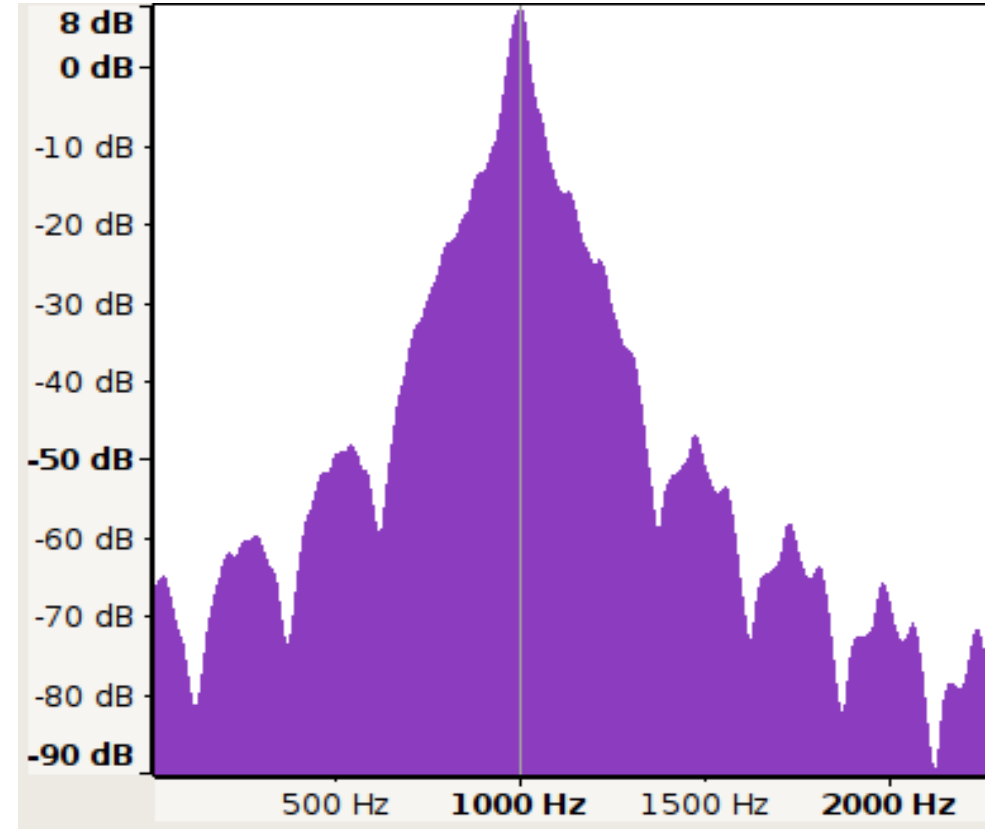
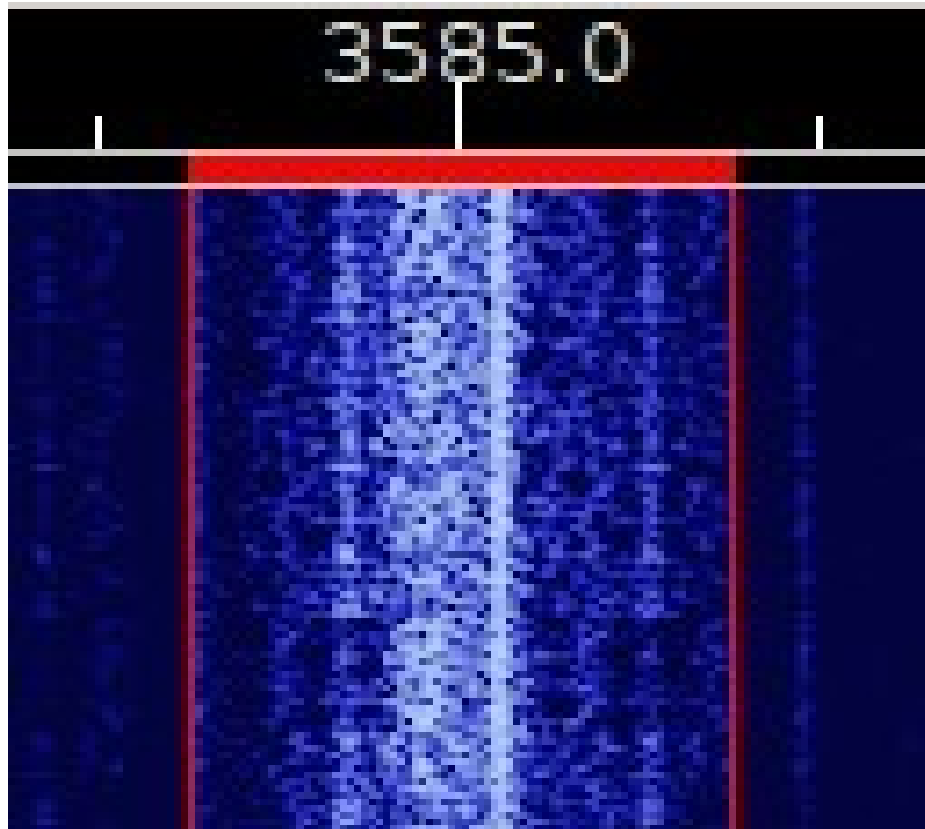
CW-20 WPM



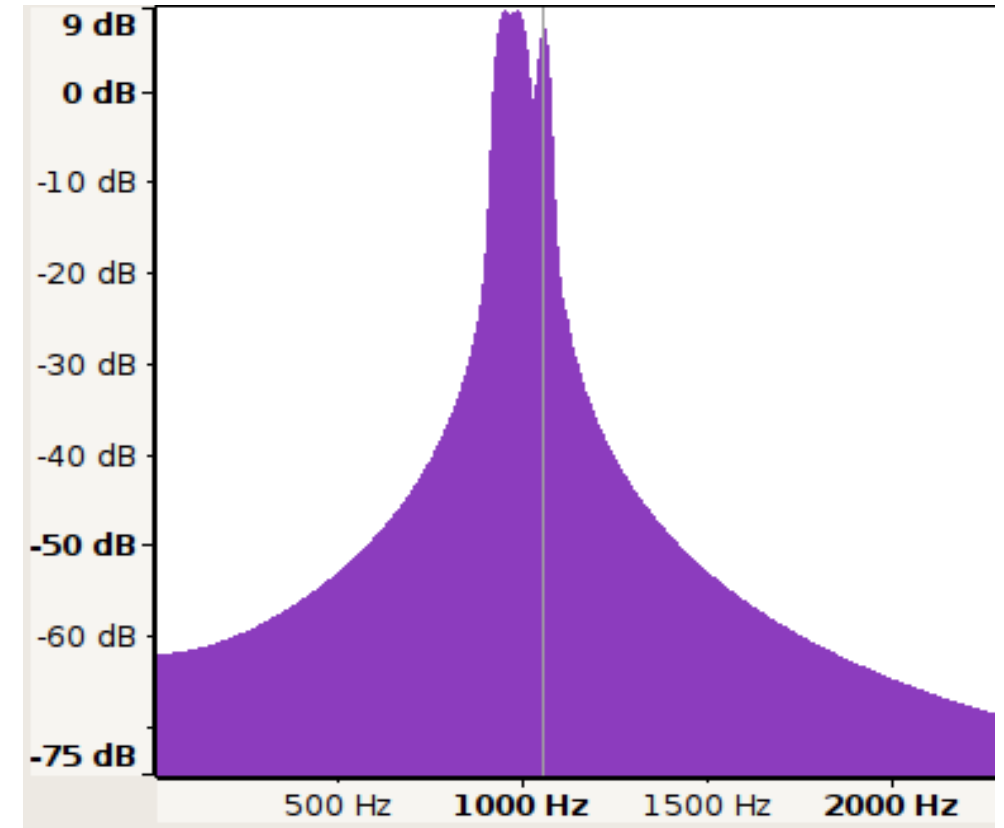
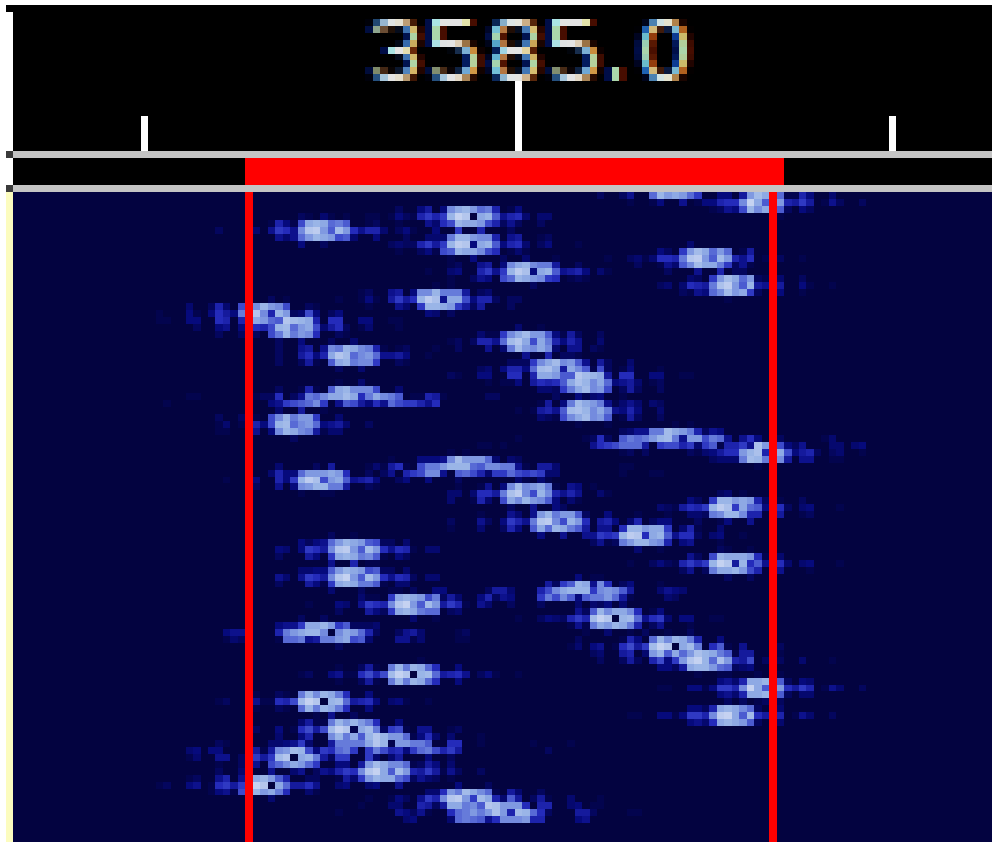
CW - 40 WPM



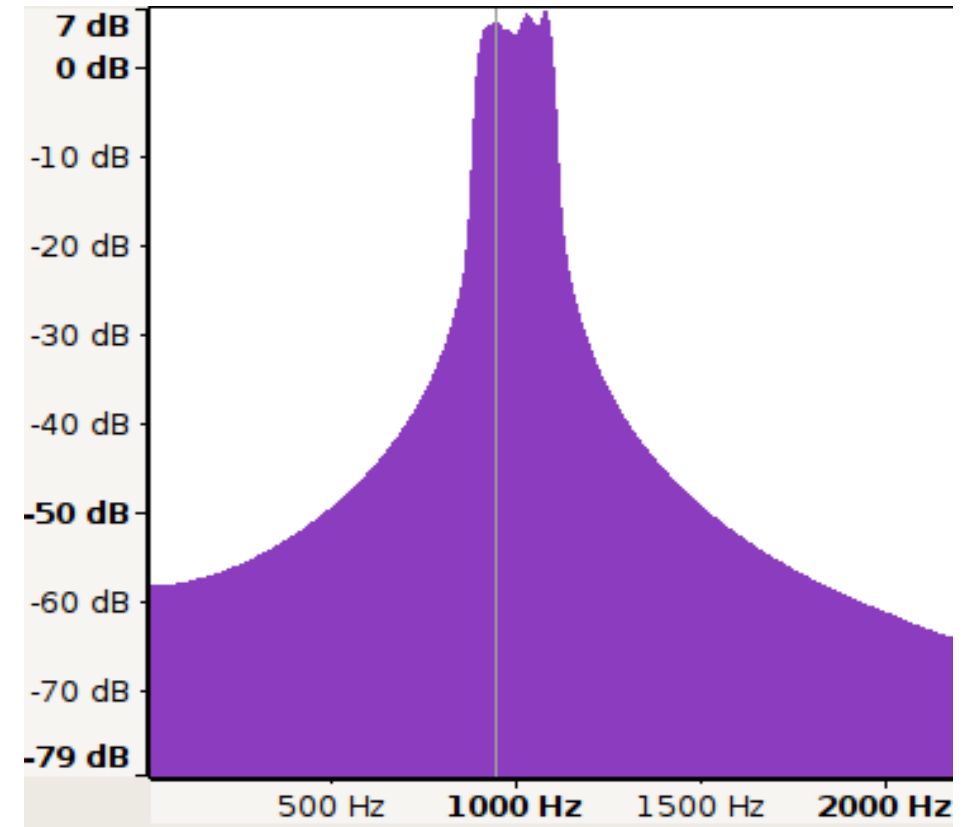
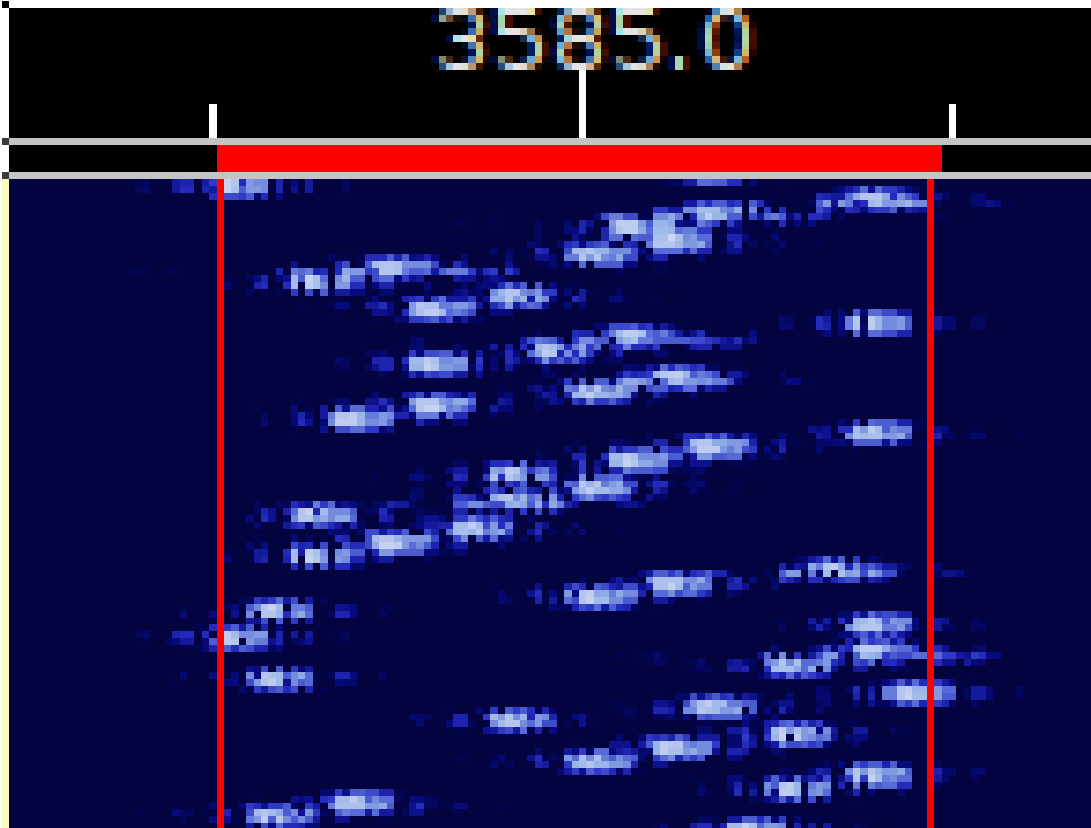
CW-100 WPM



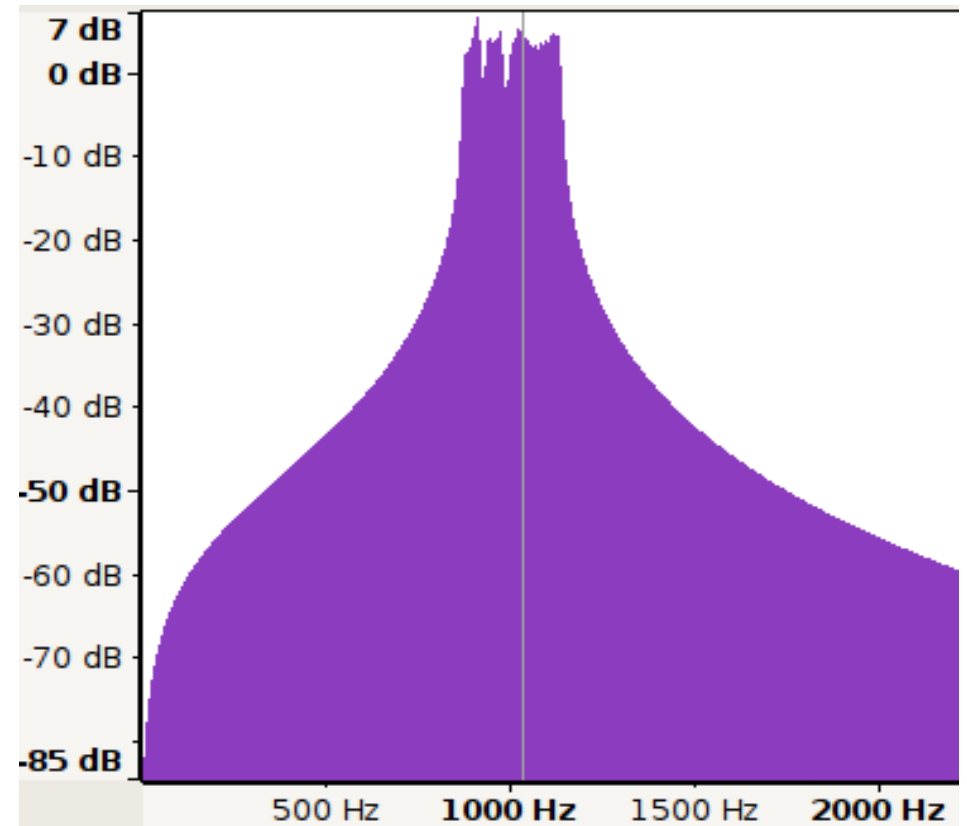
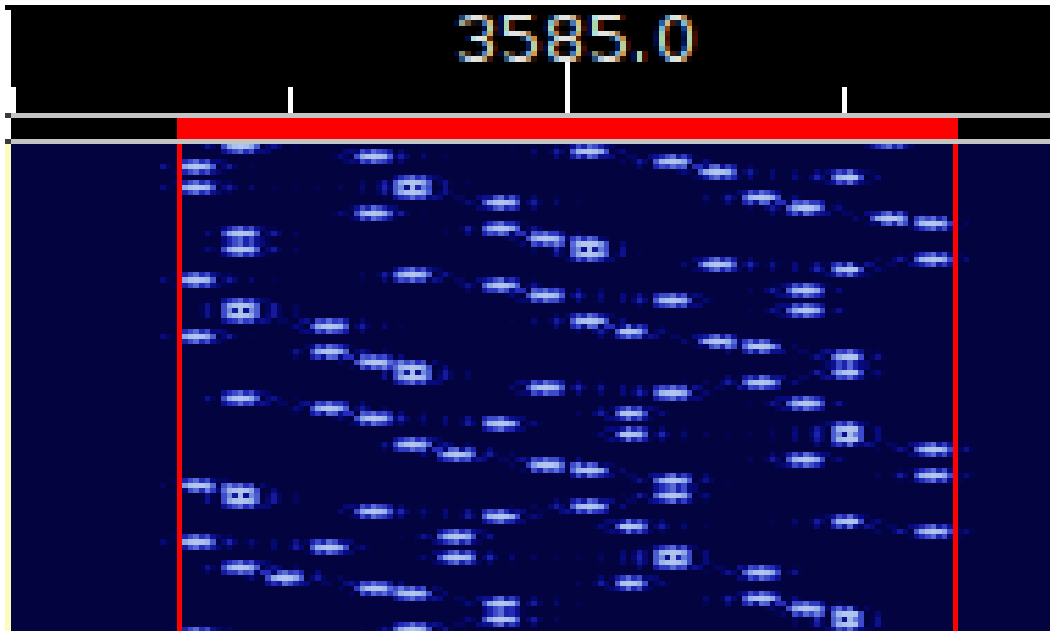
DominoEX-4



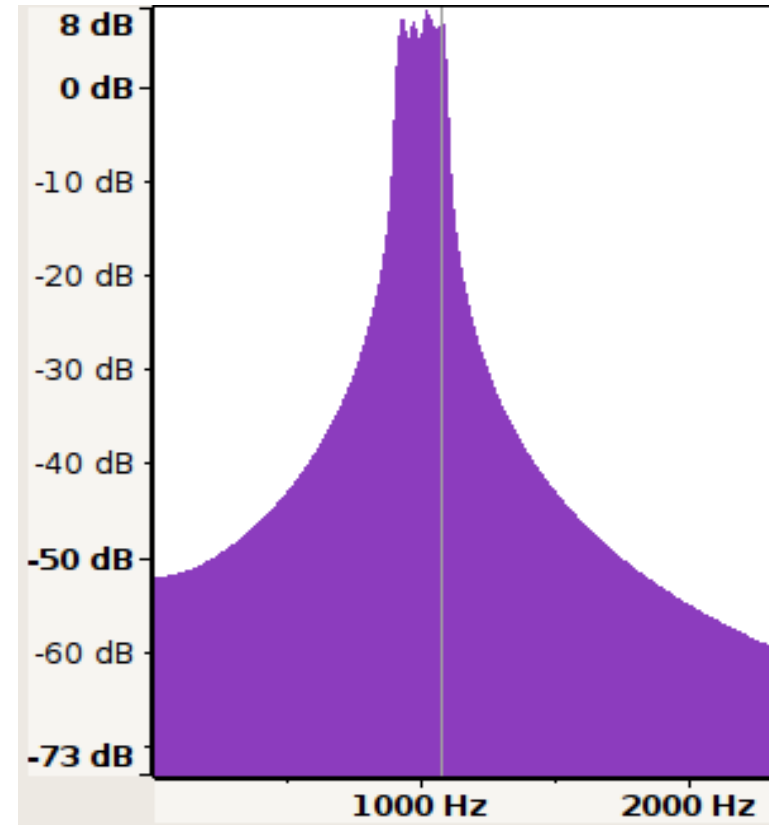
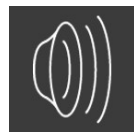
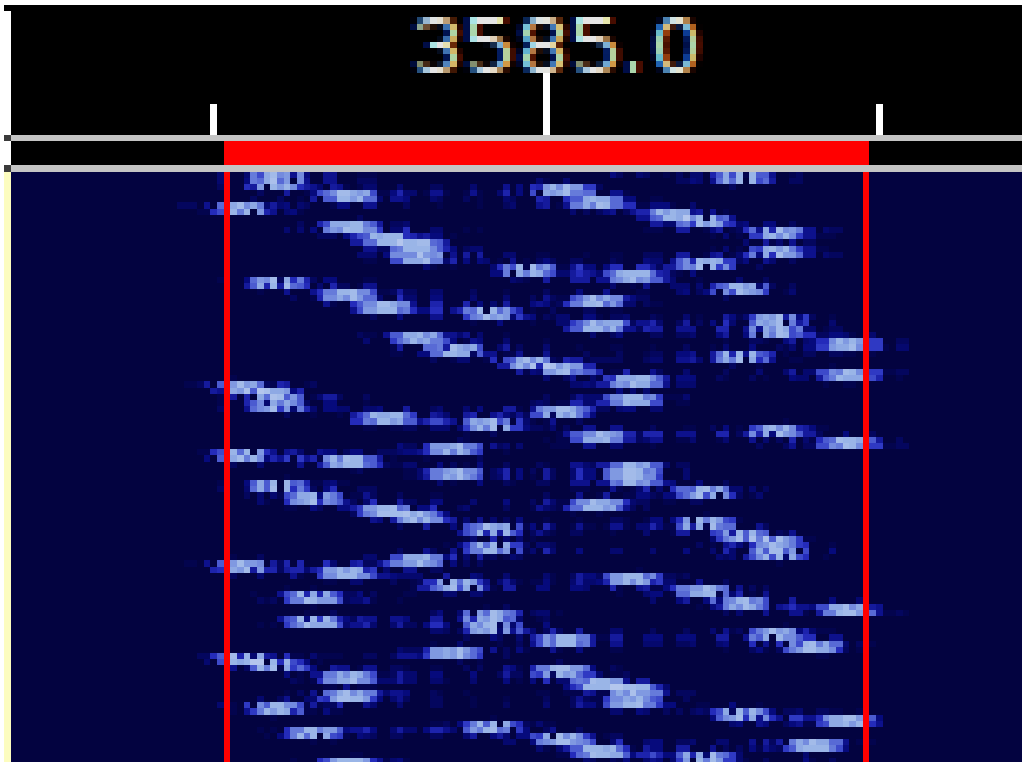
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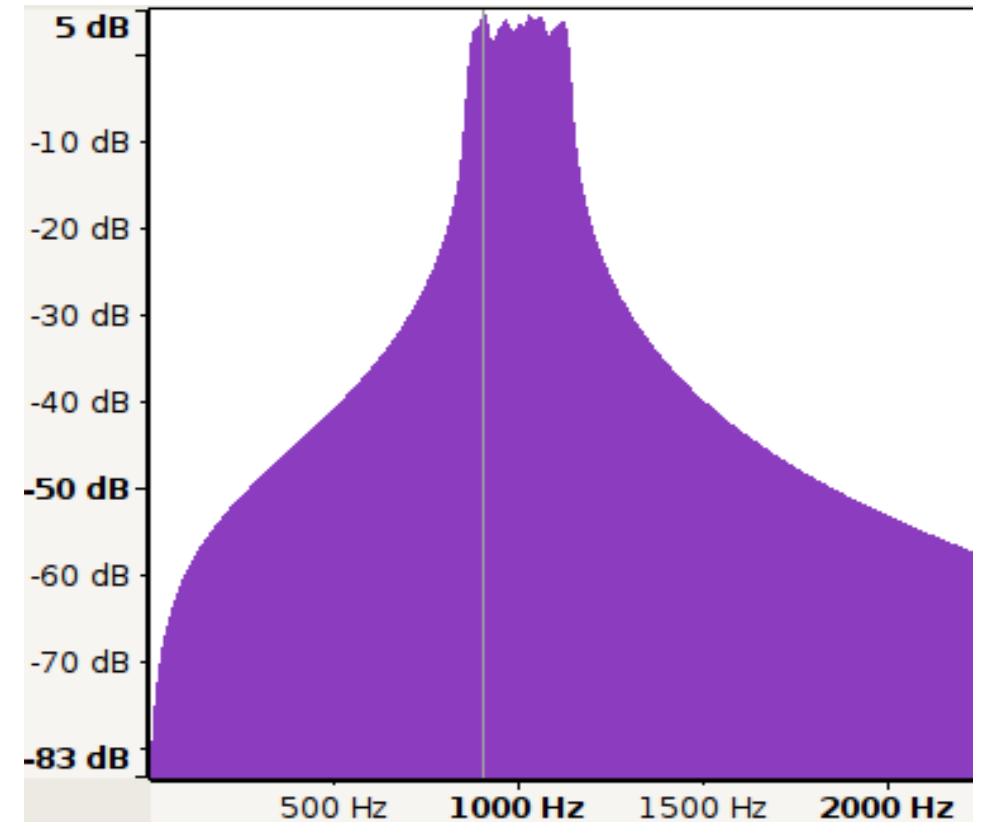
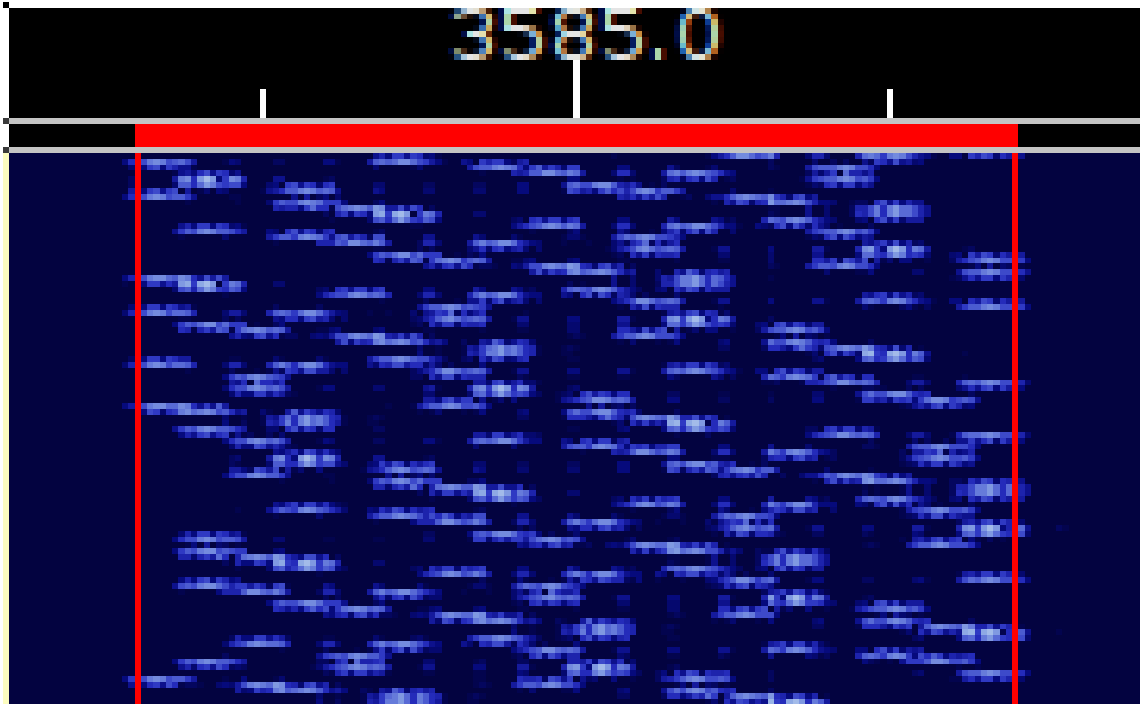
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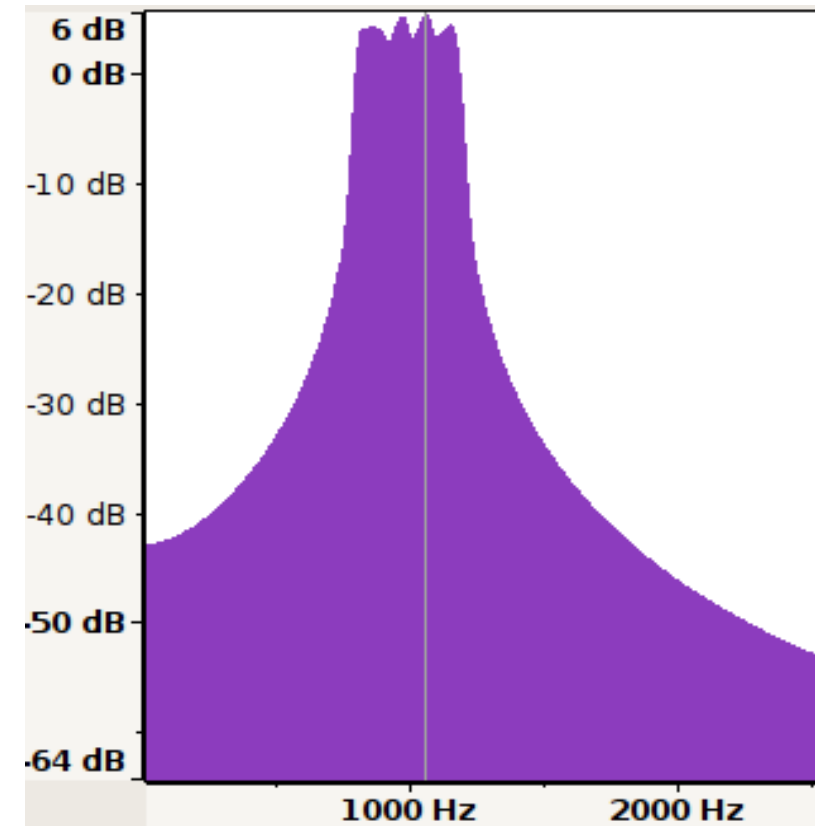
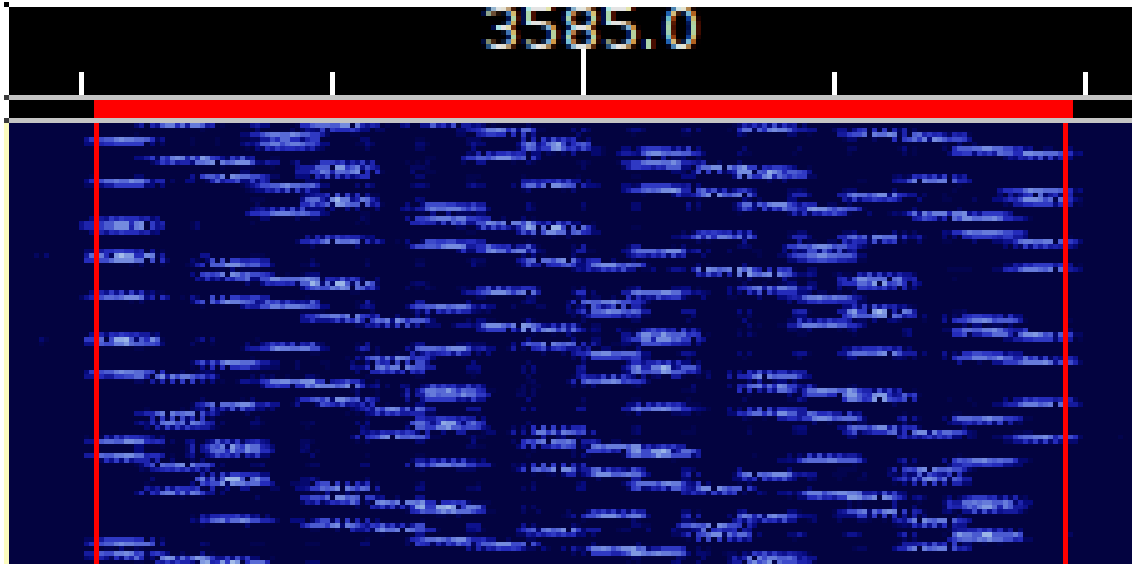
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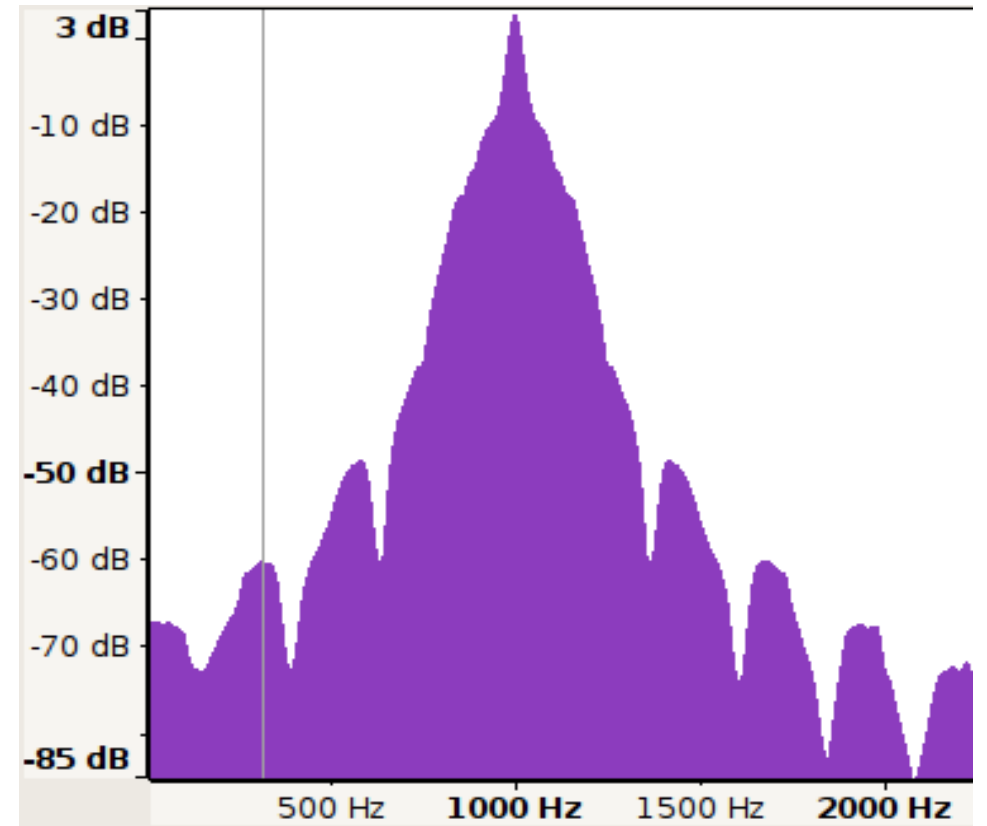
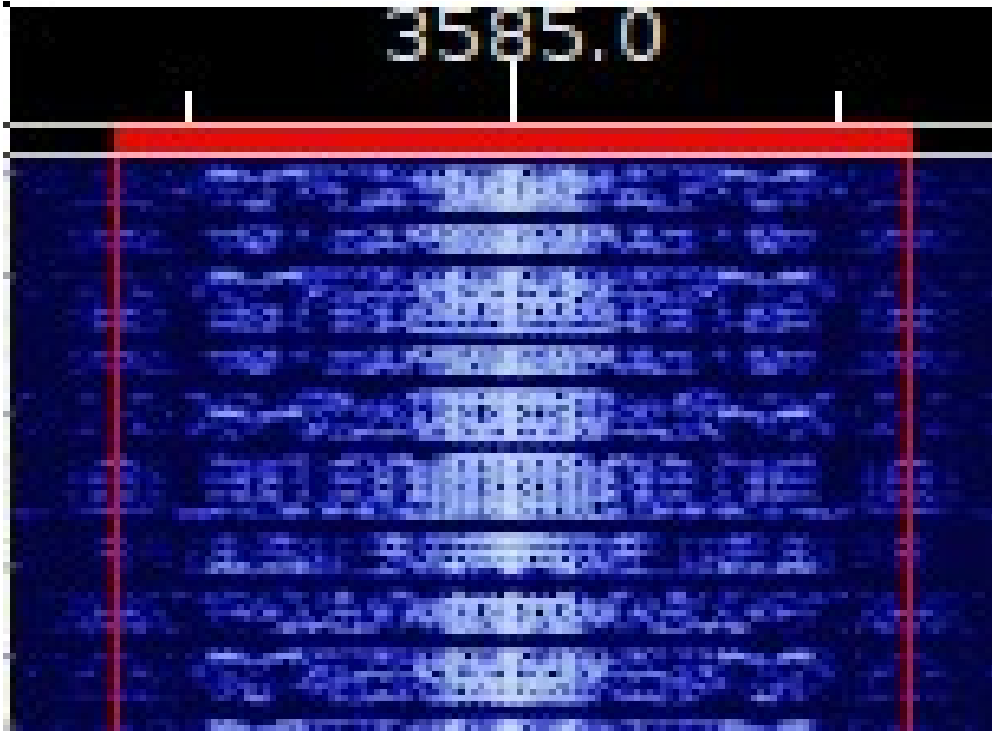
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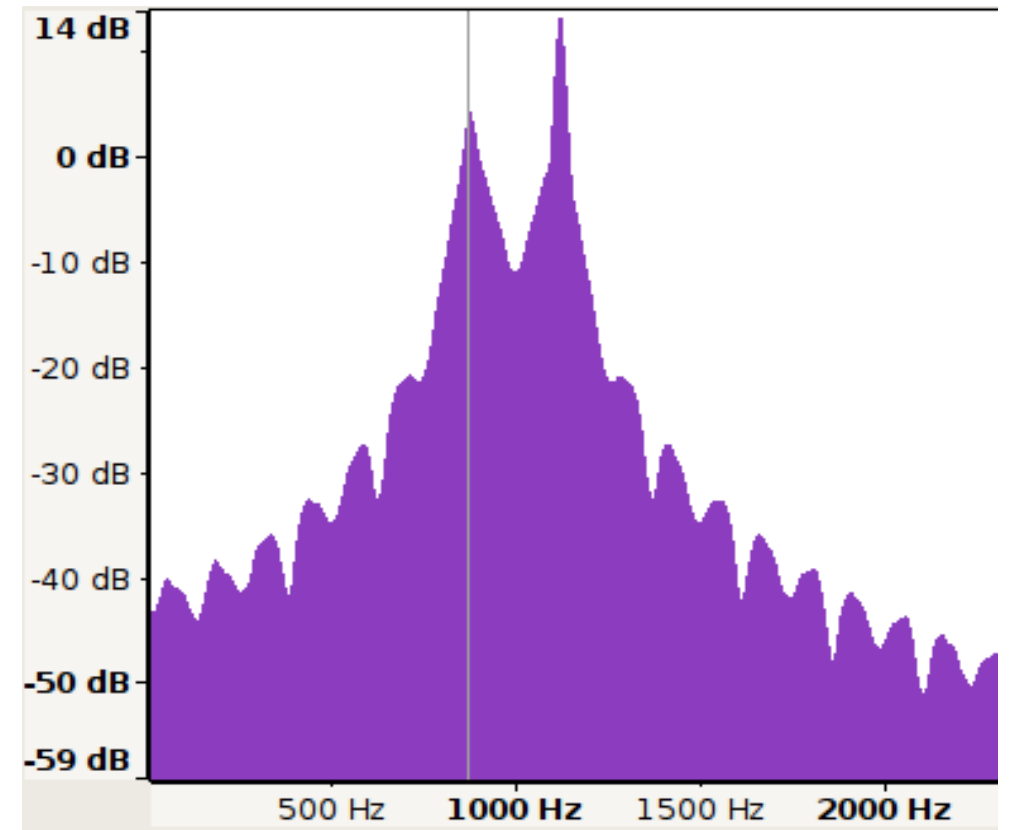
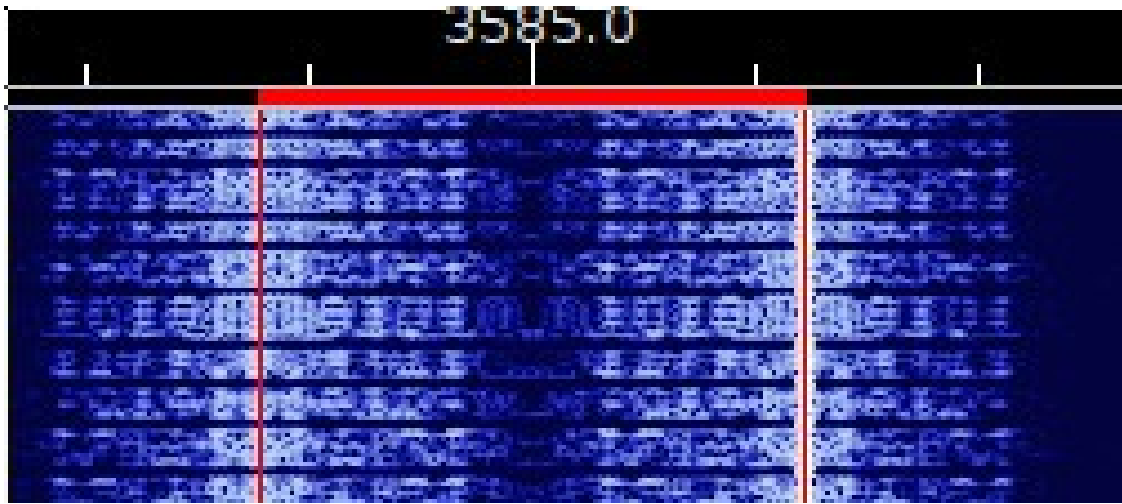
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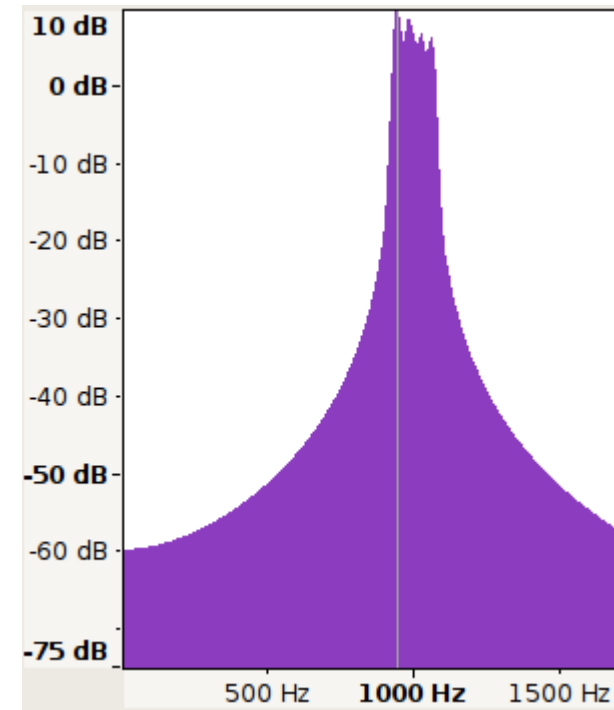
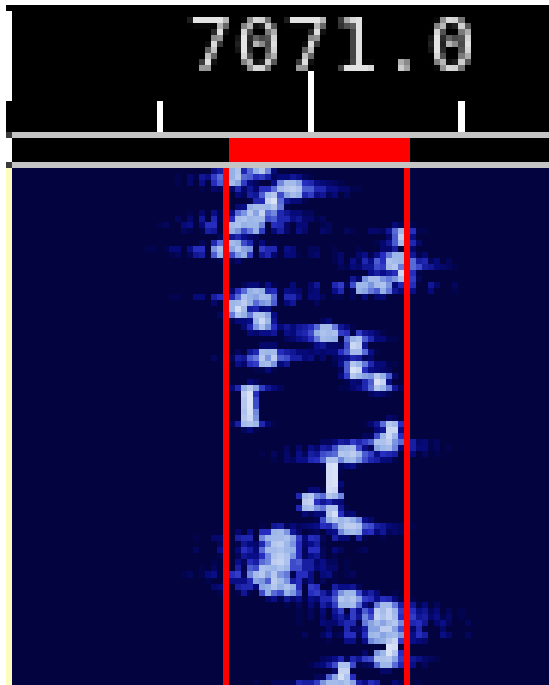
FeldHell



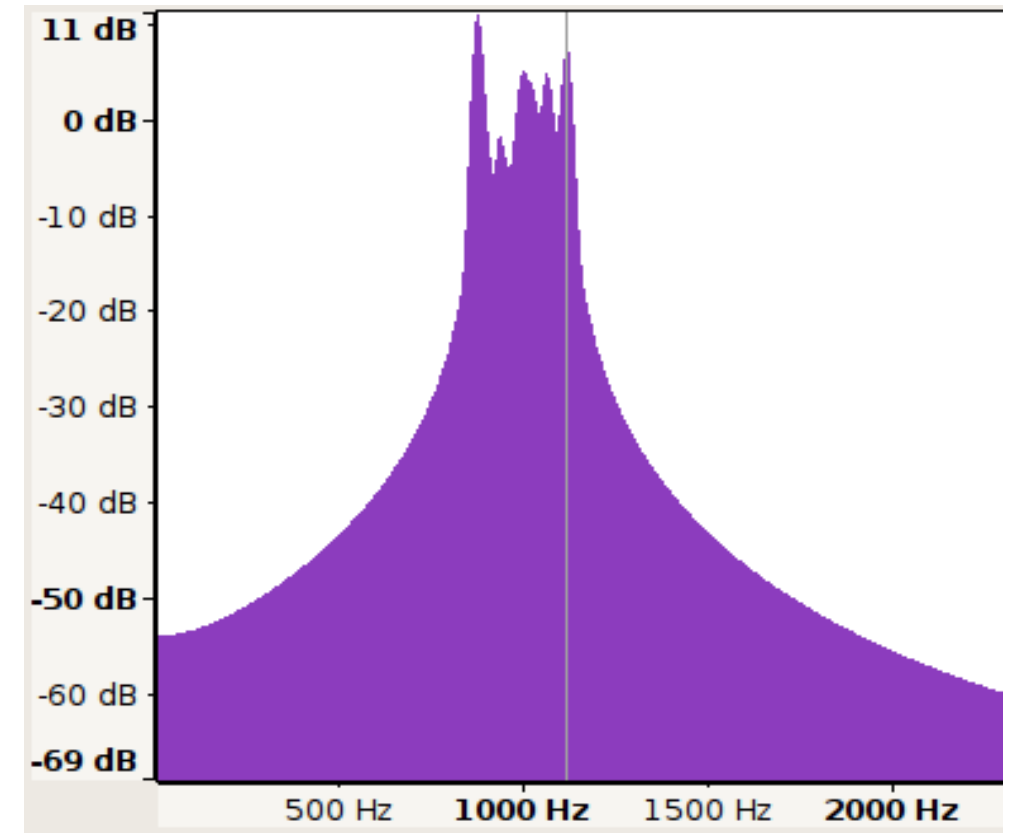
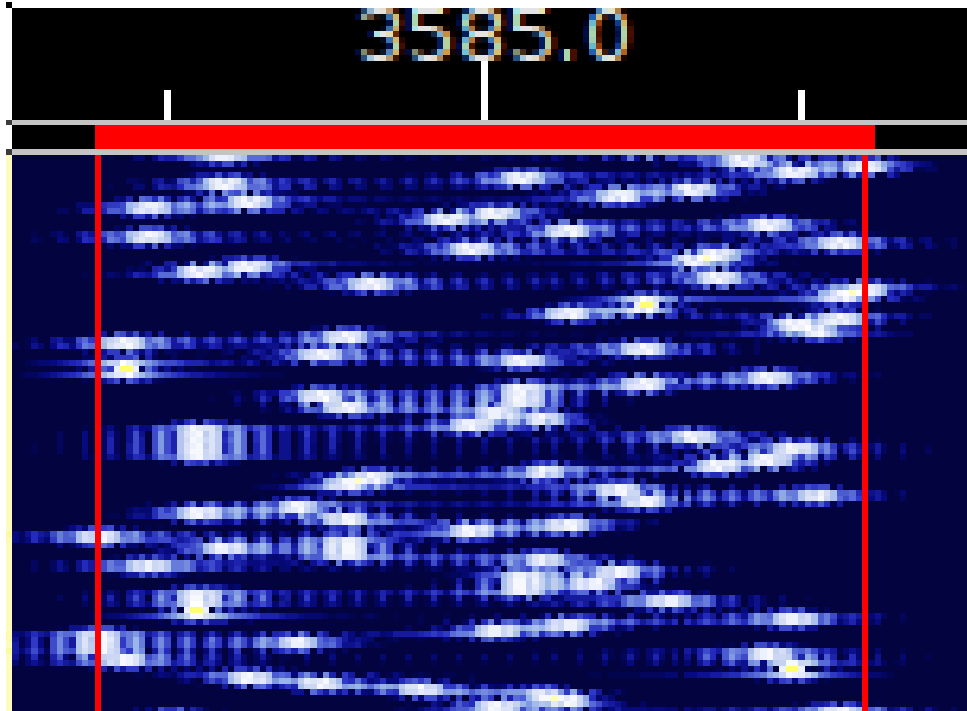
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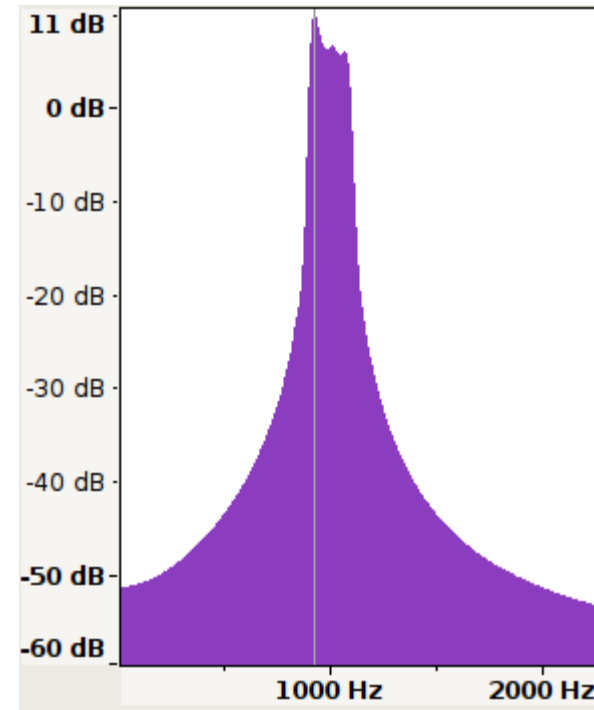
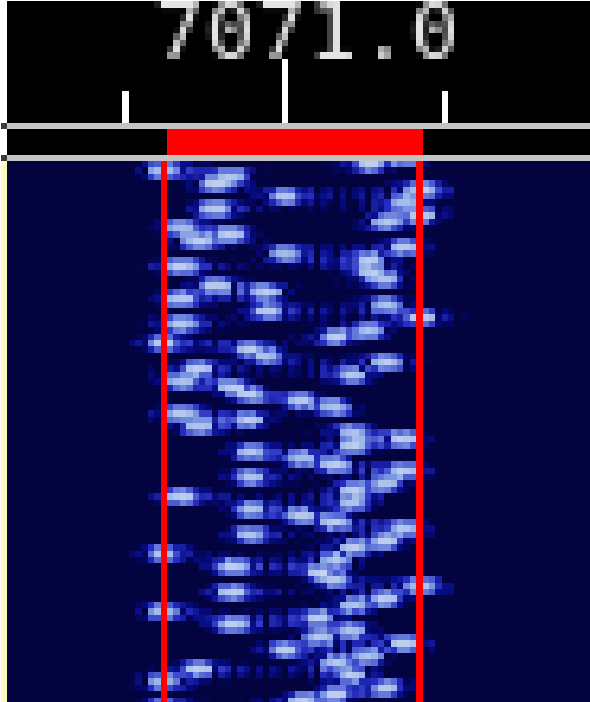
MFSK-4



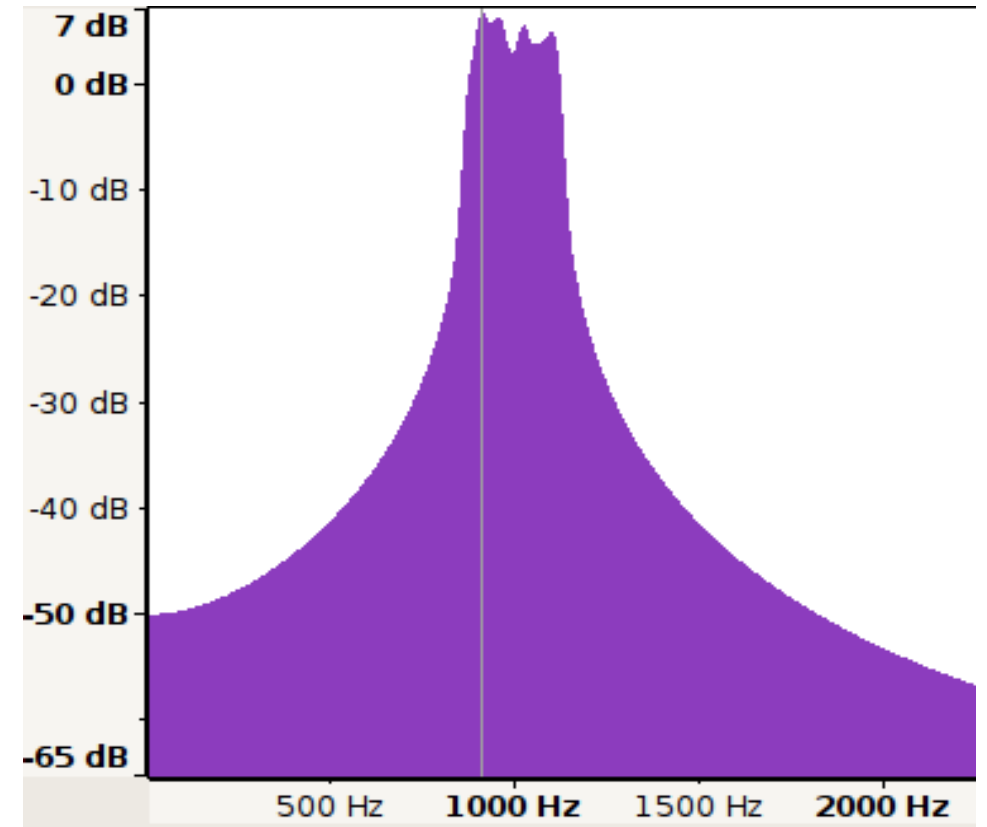
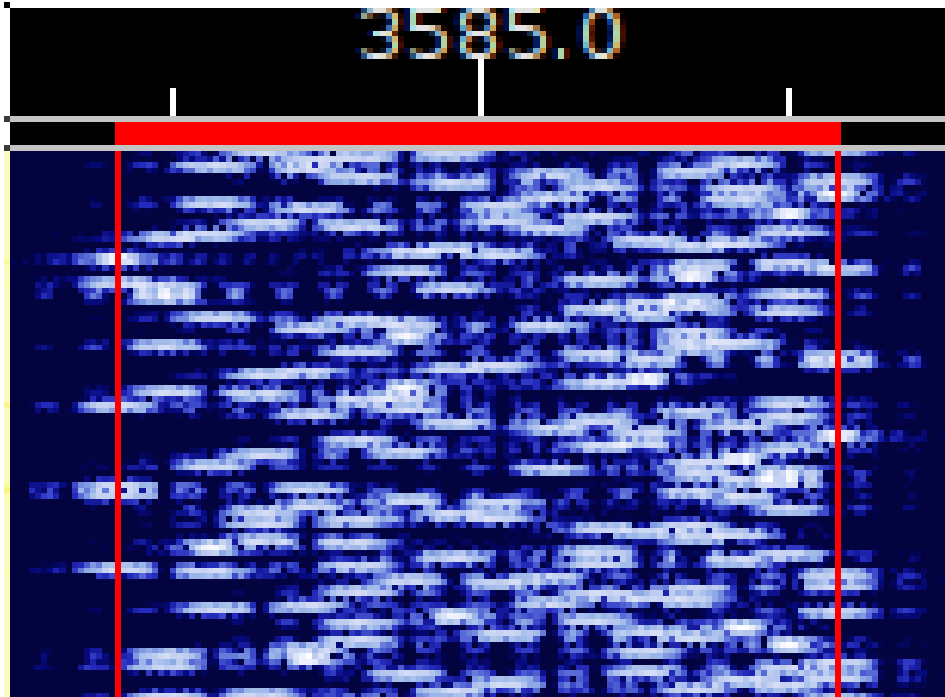
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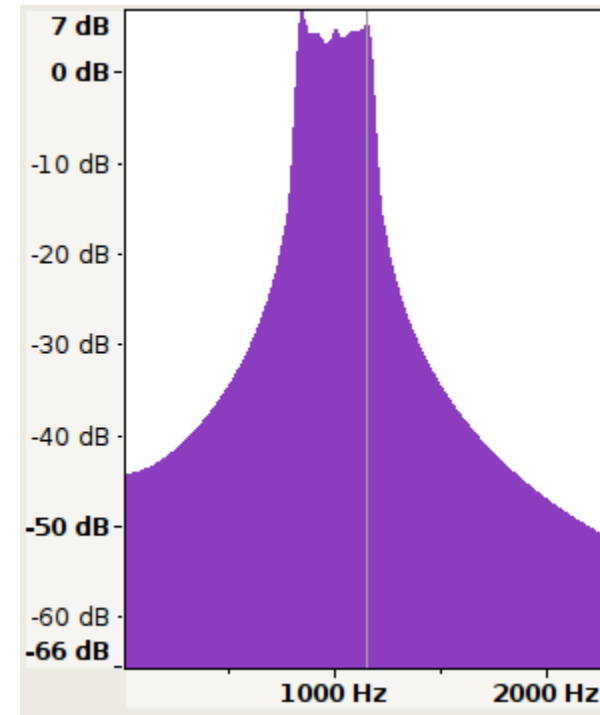
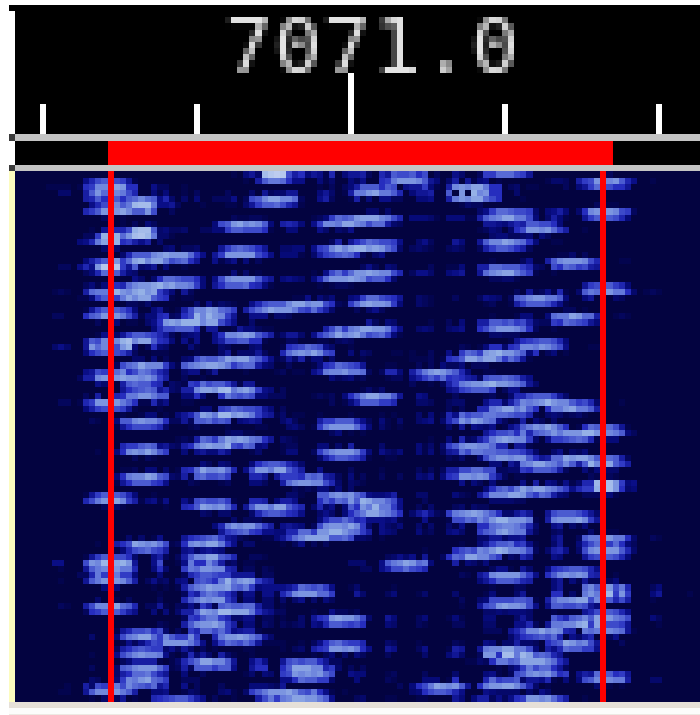
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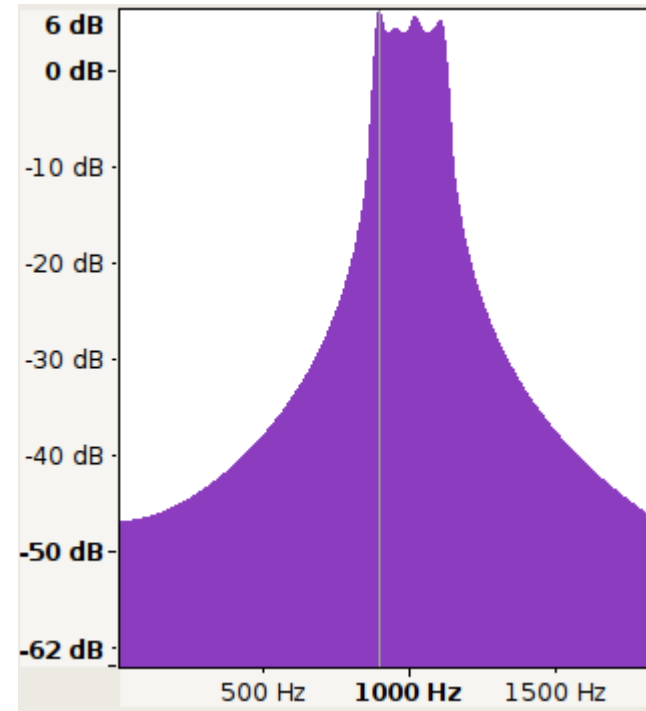
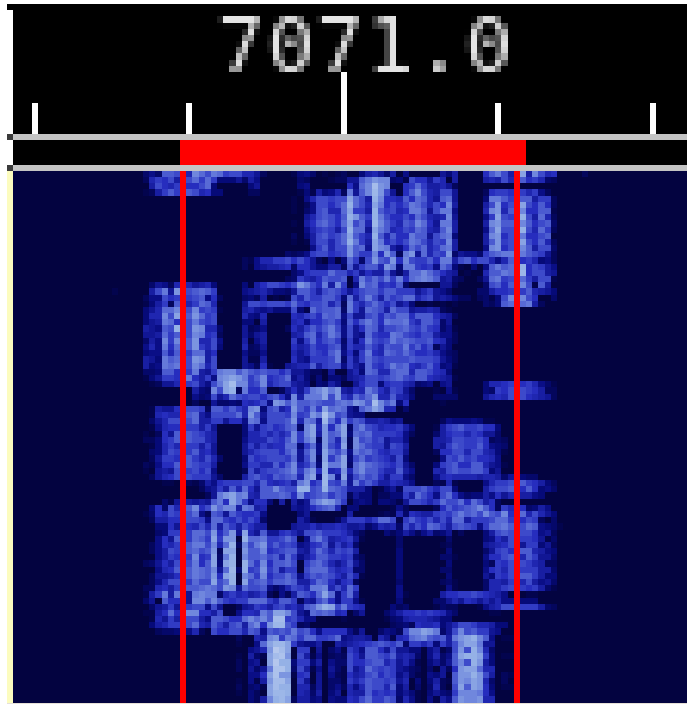
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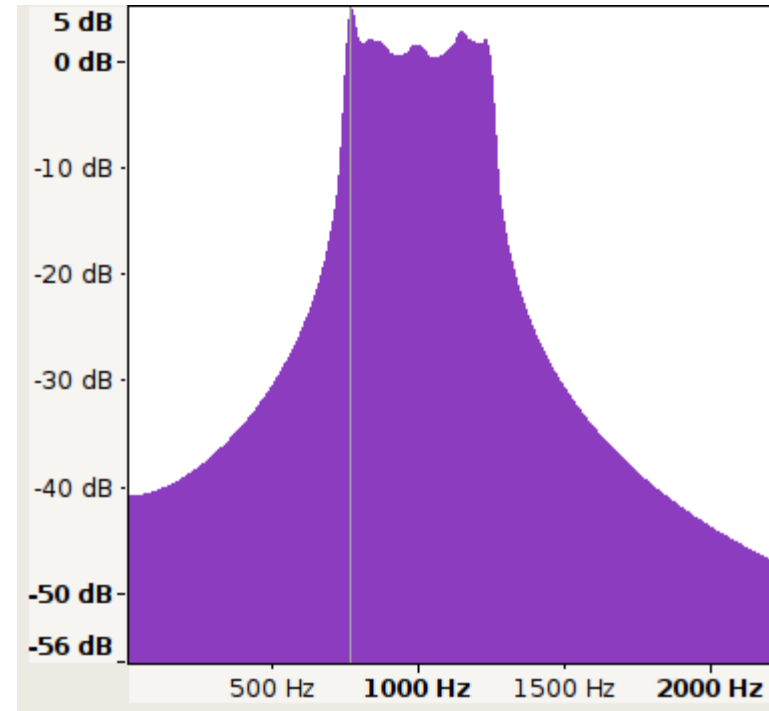
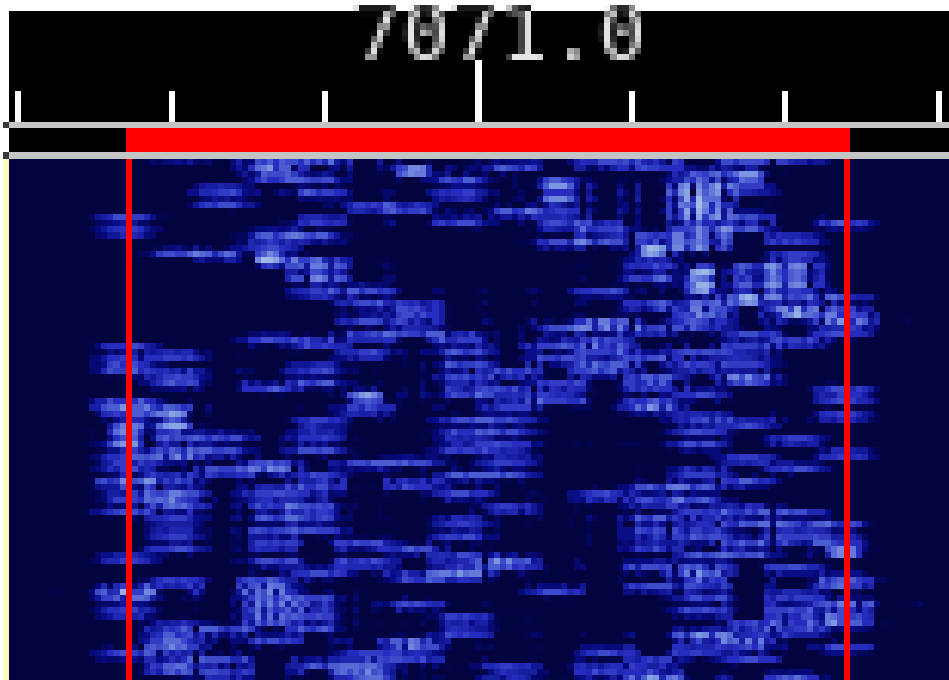
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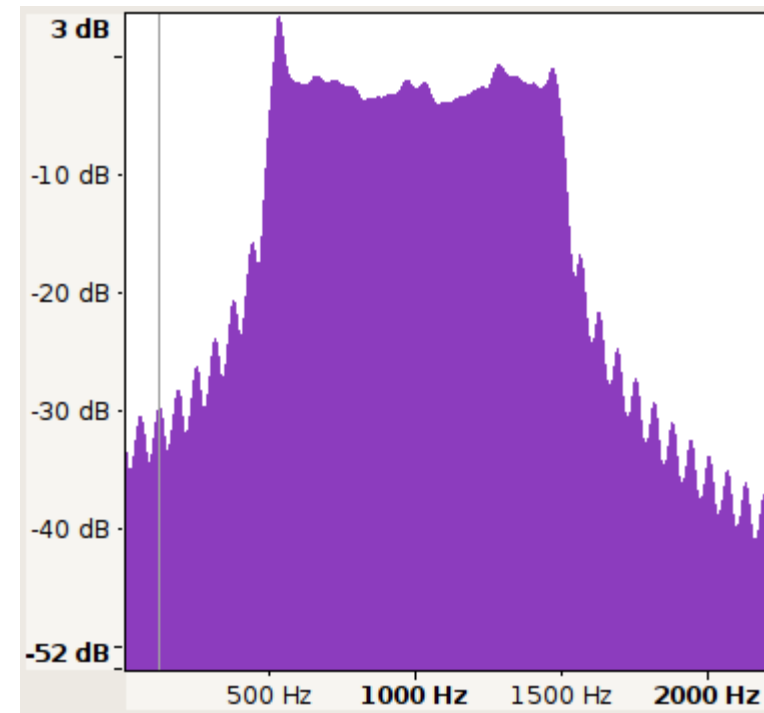
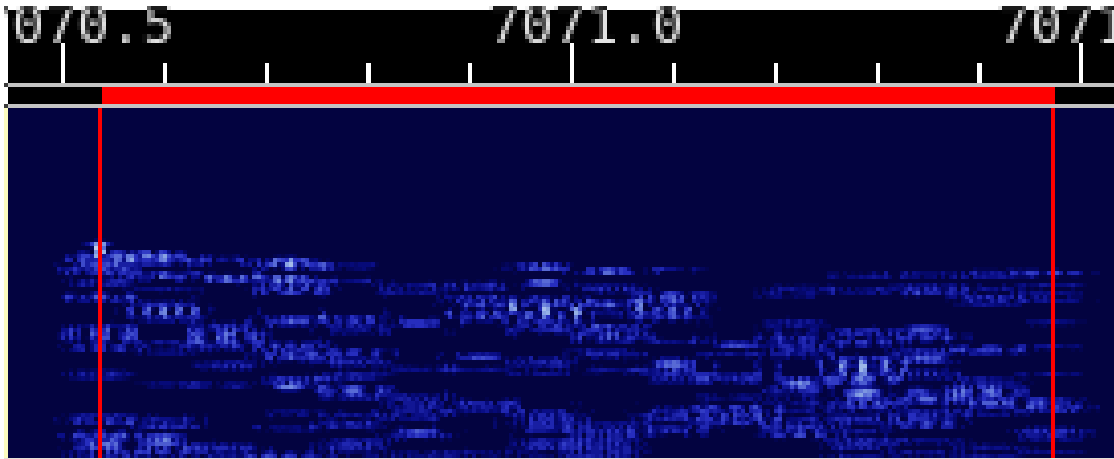
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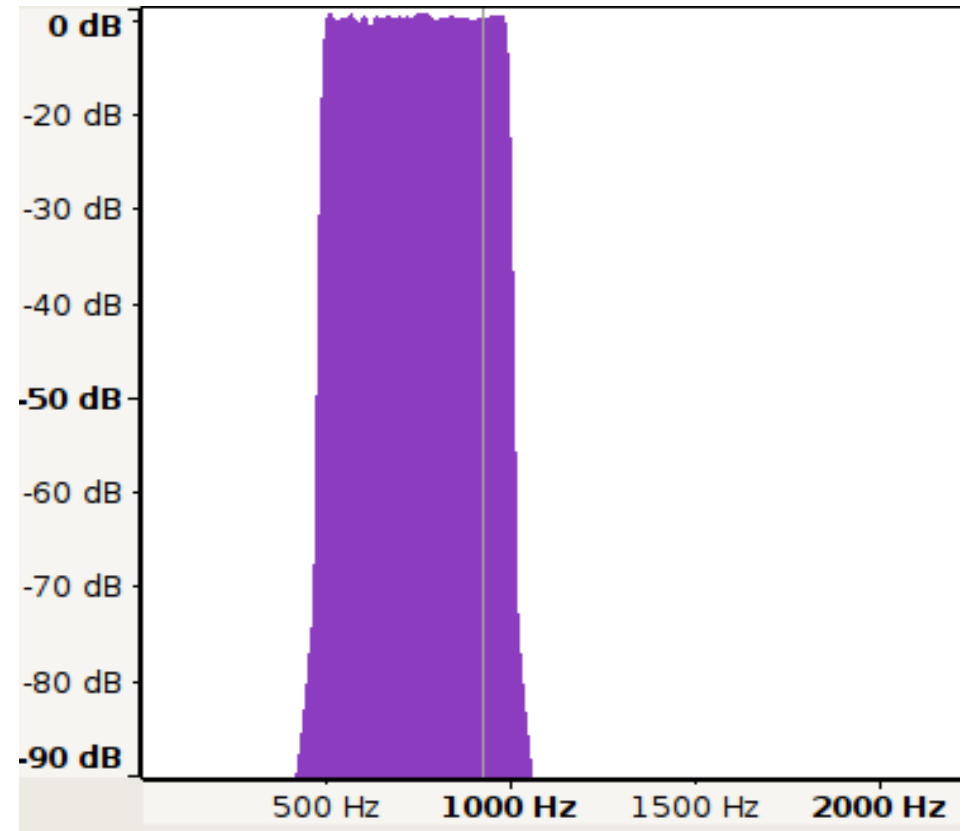
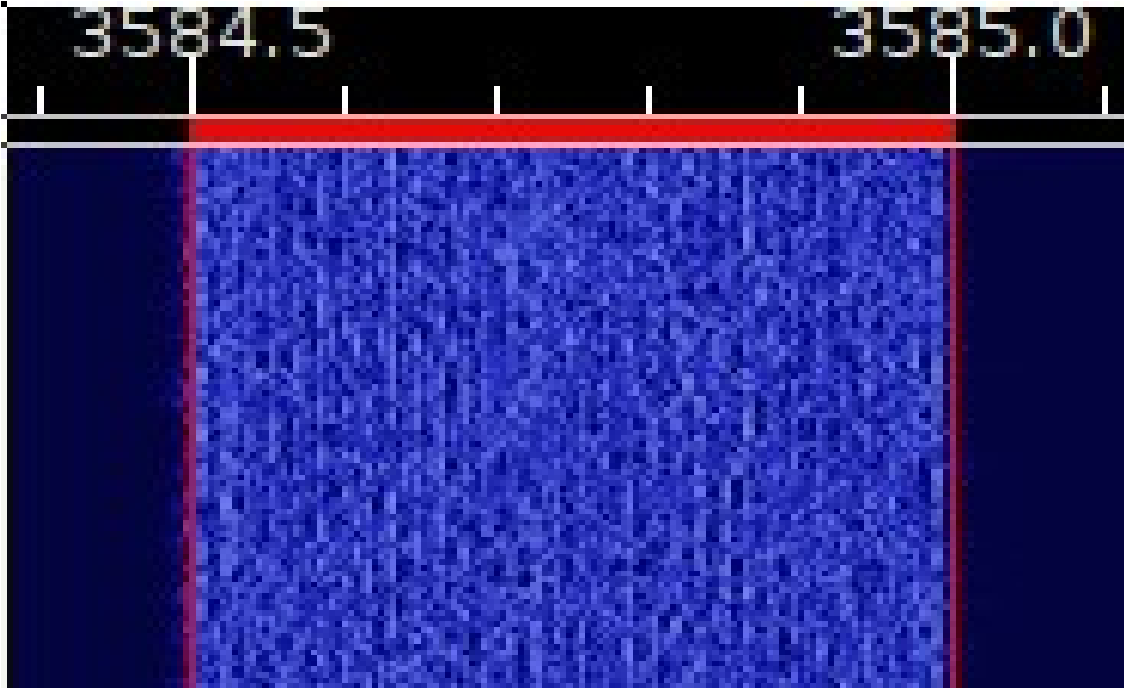
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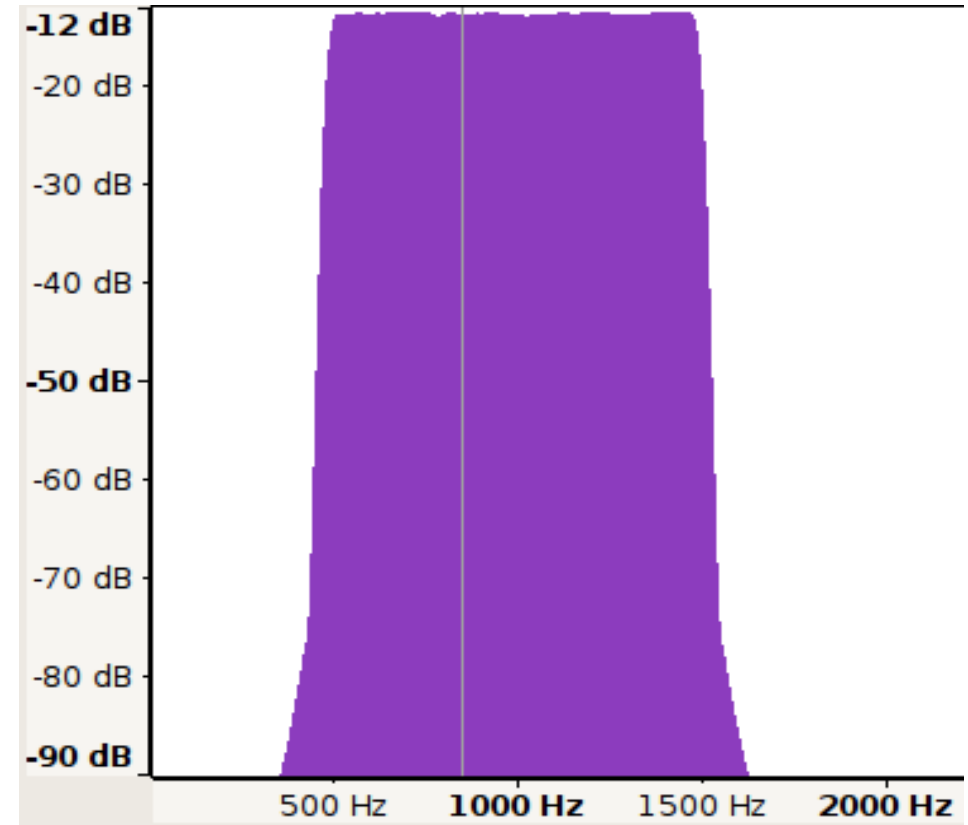
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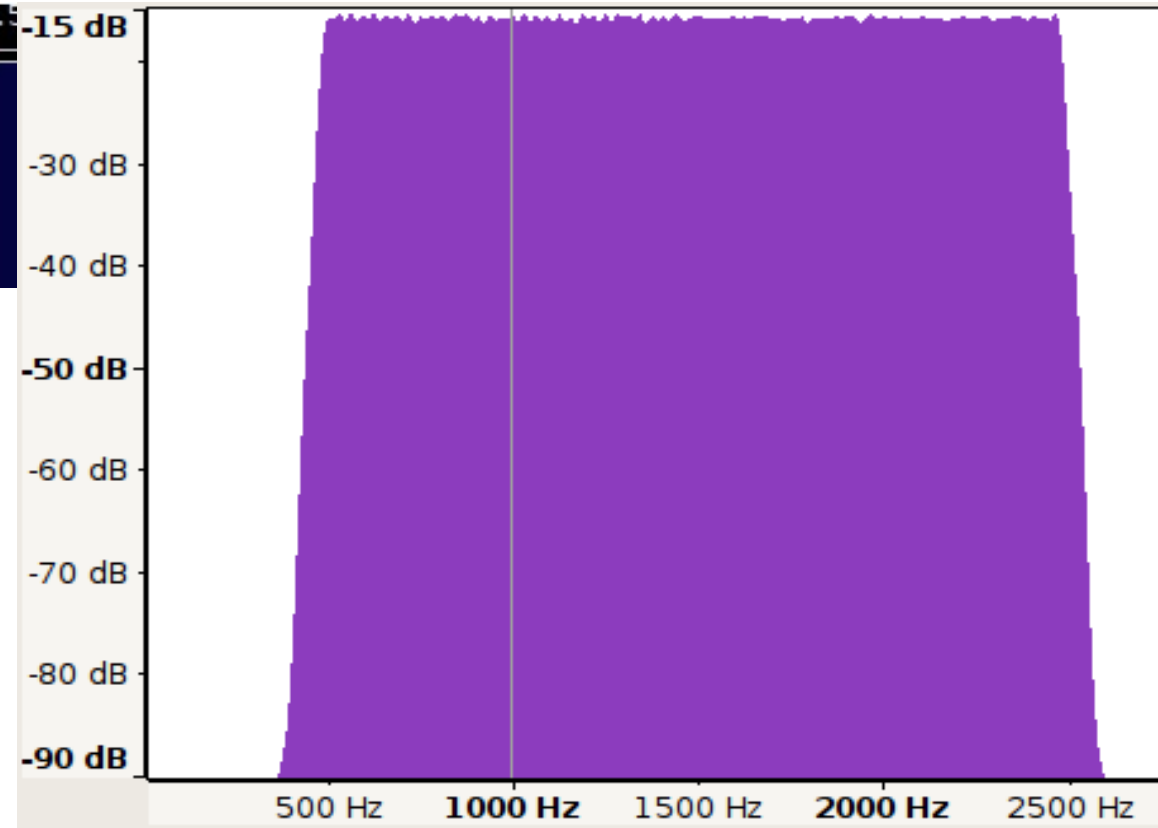
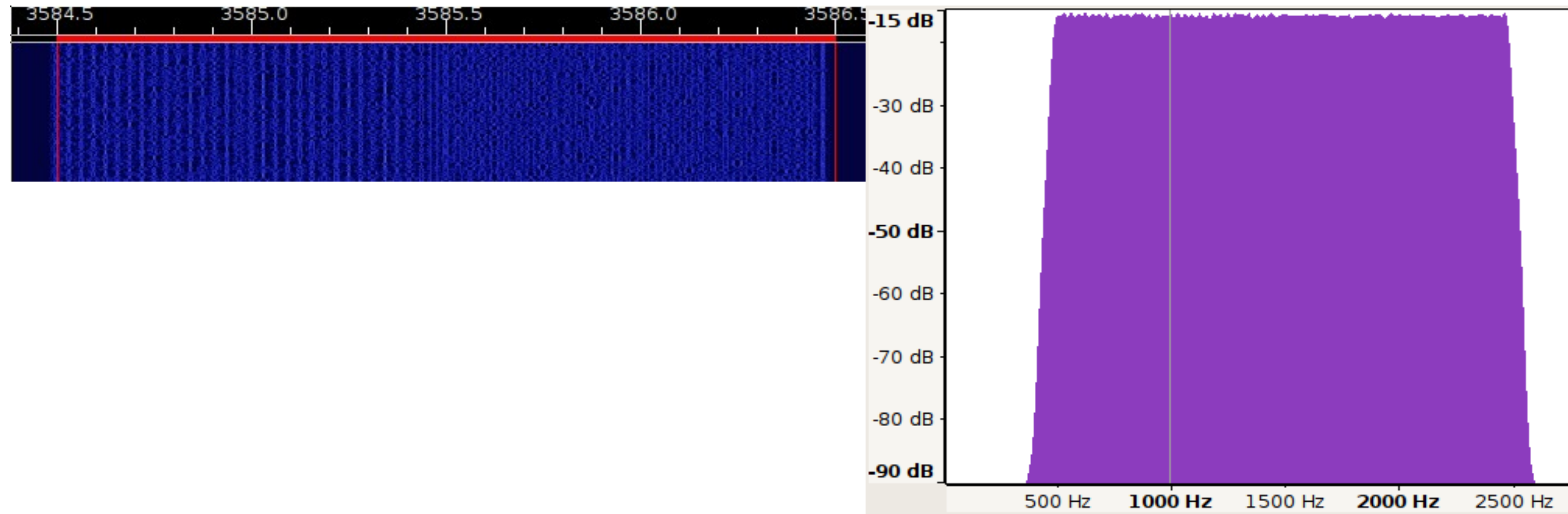
MT63-500



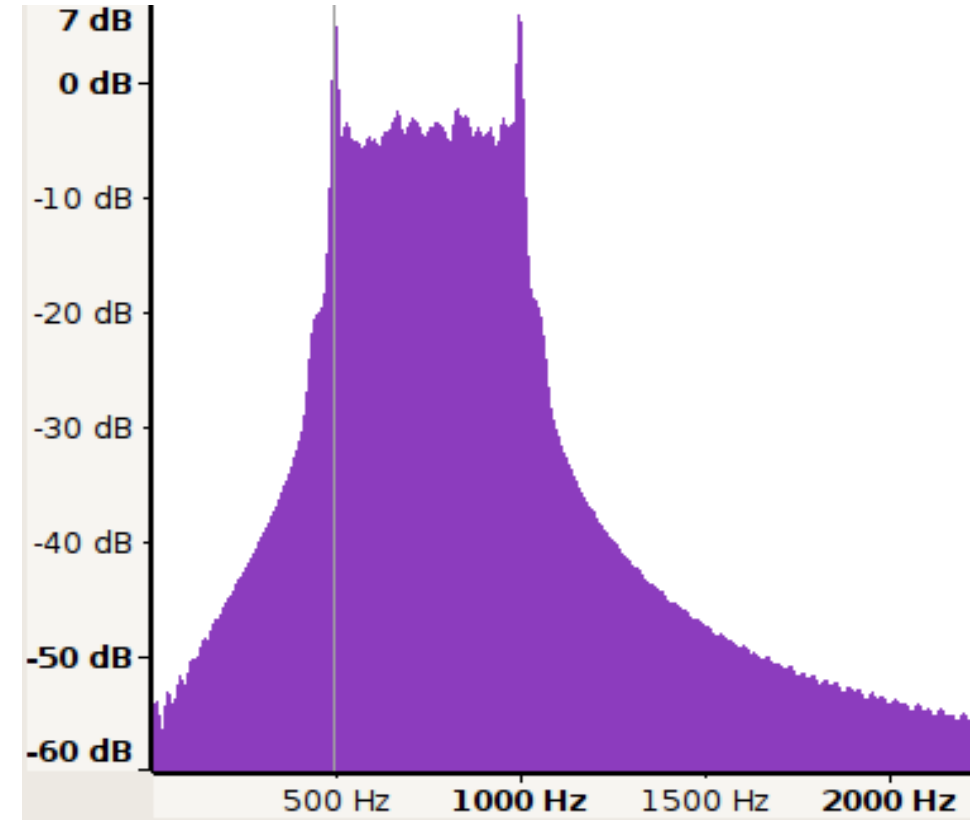
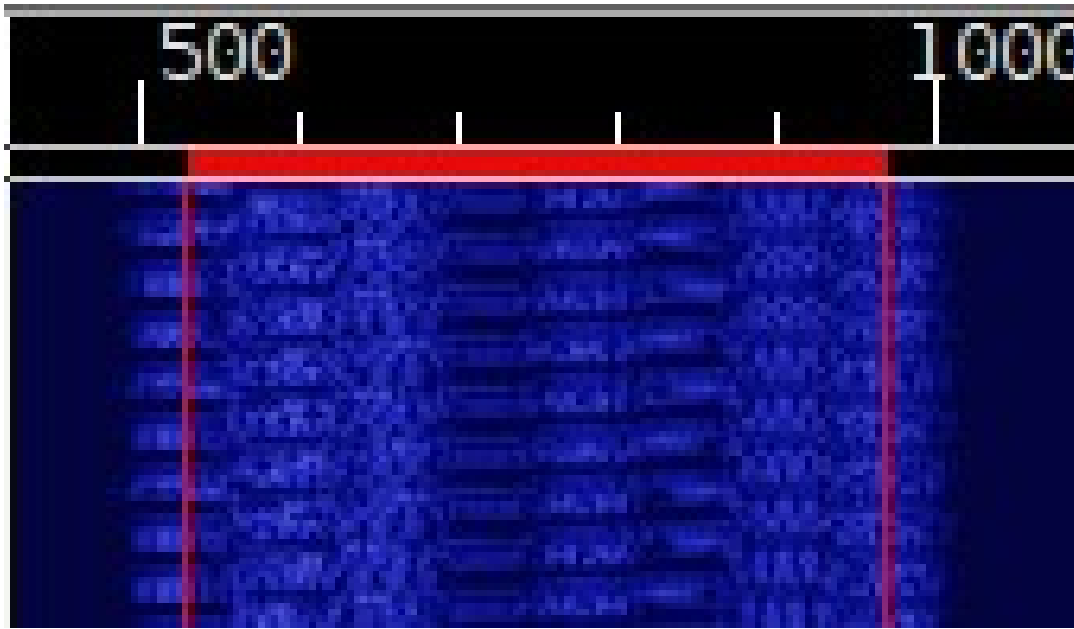
MT63-1000



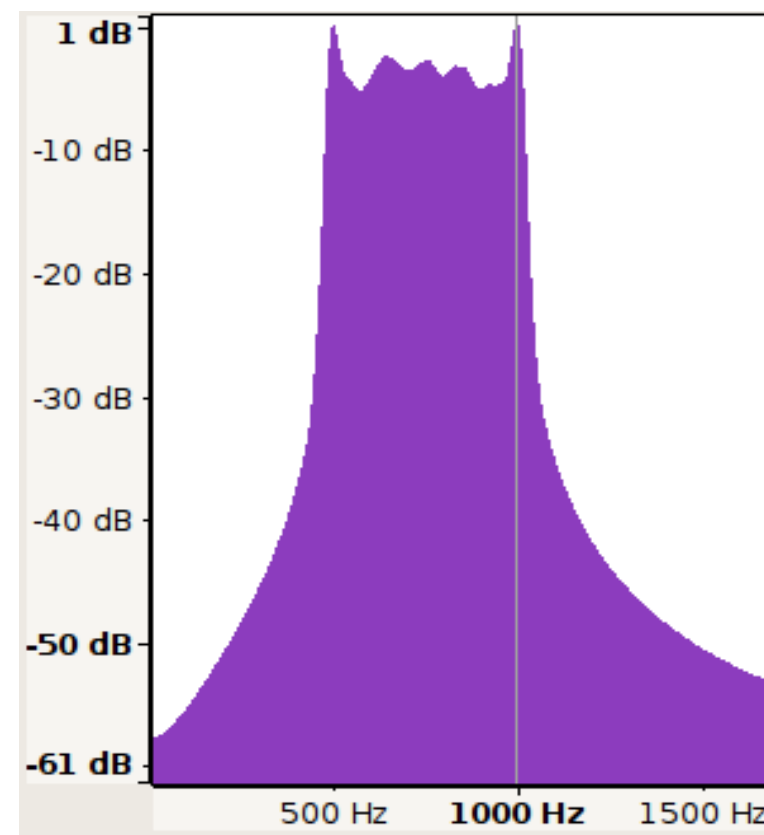
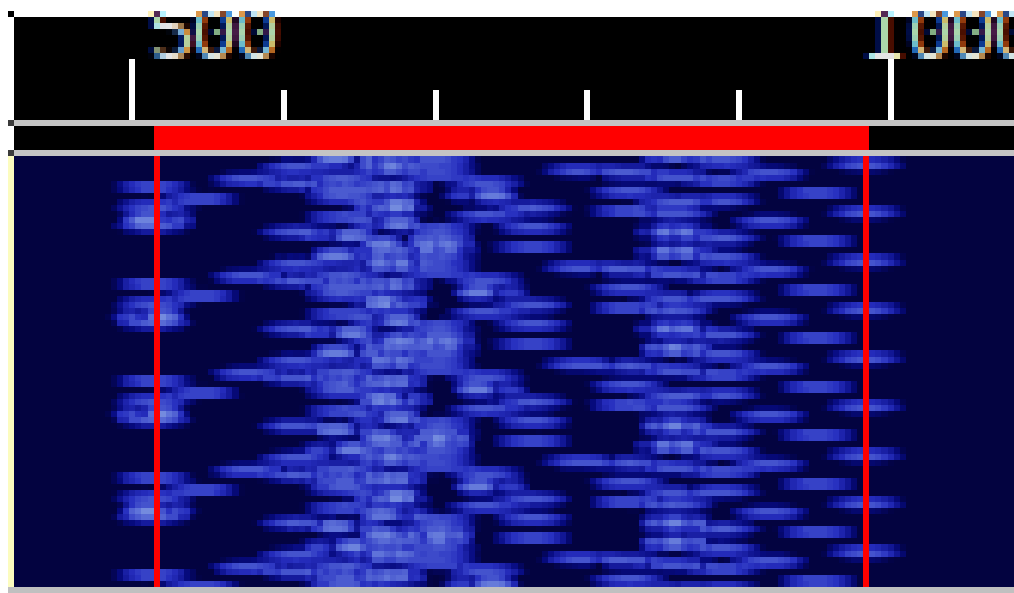
MT63-2000



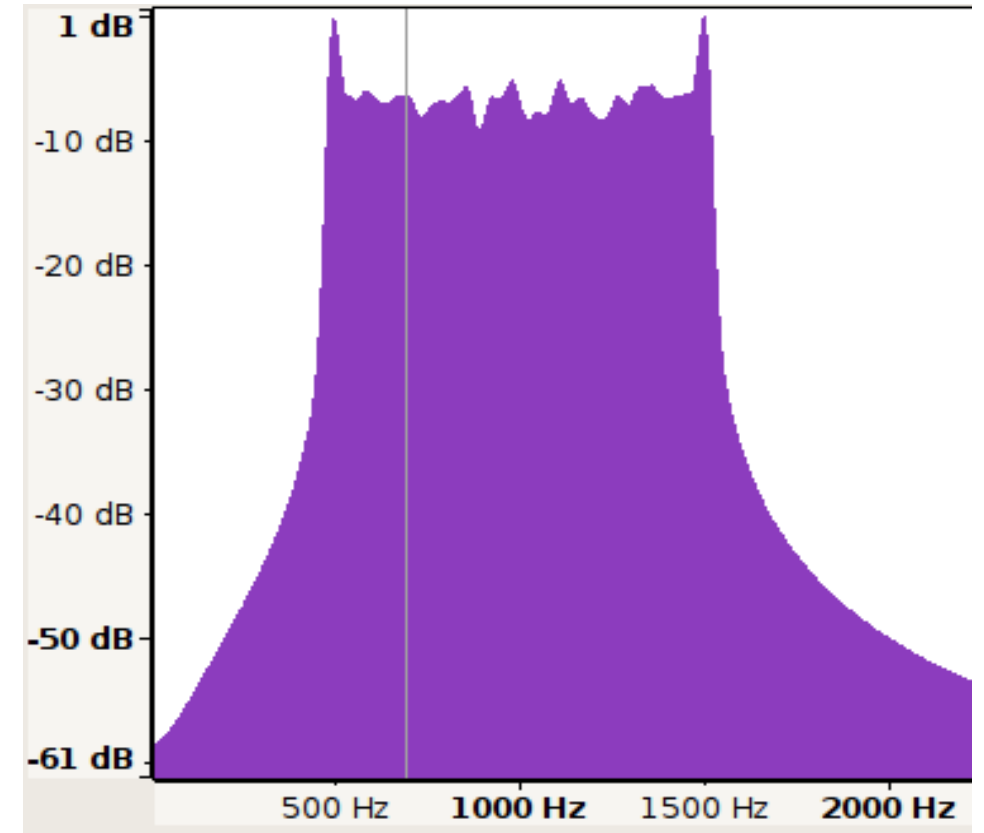
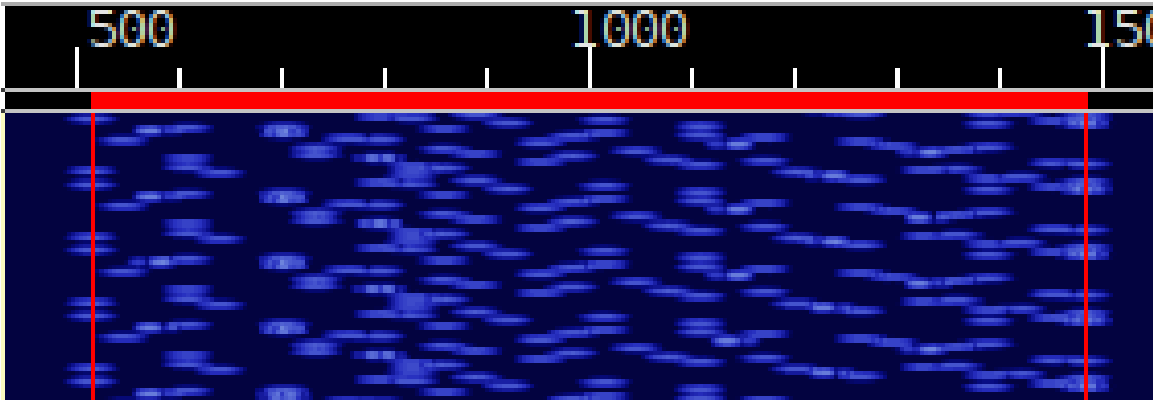
Olivia 8-500



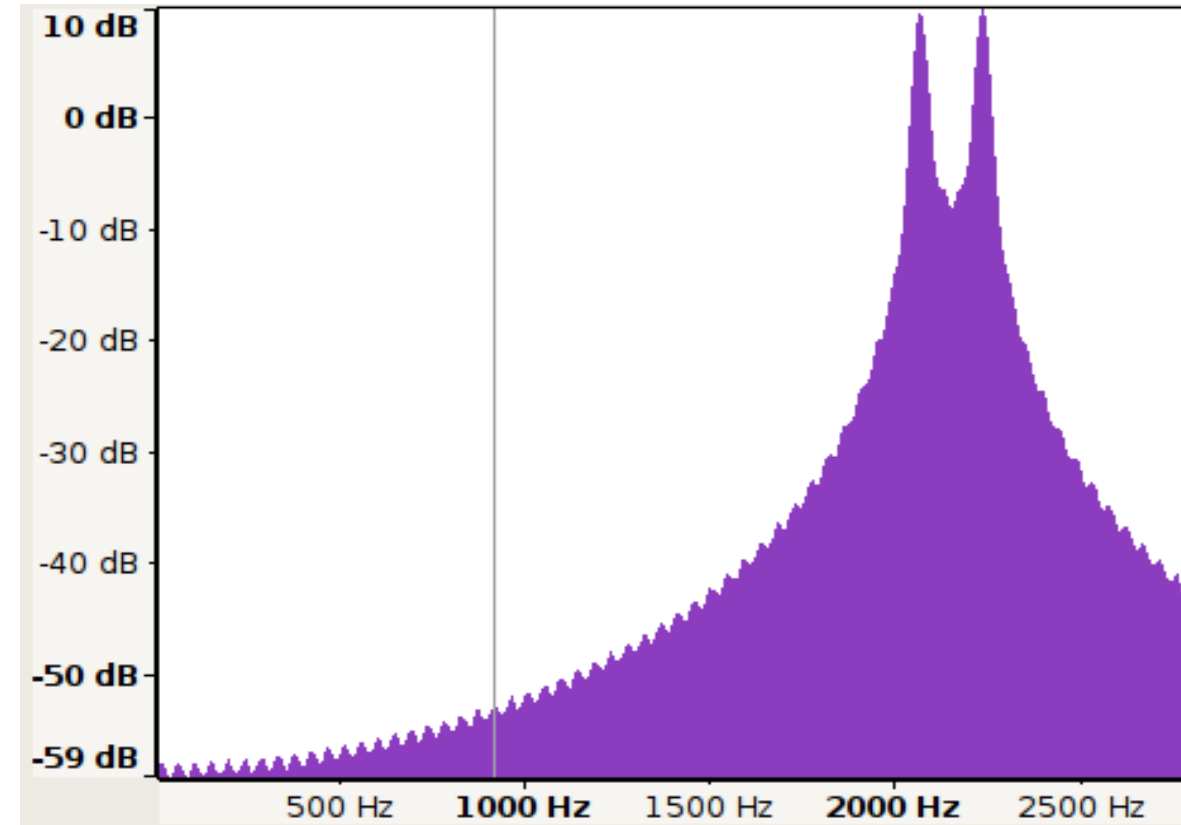
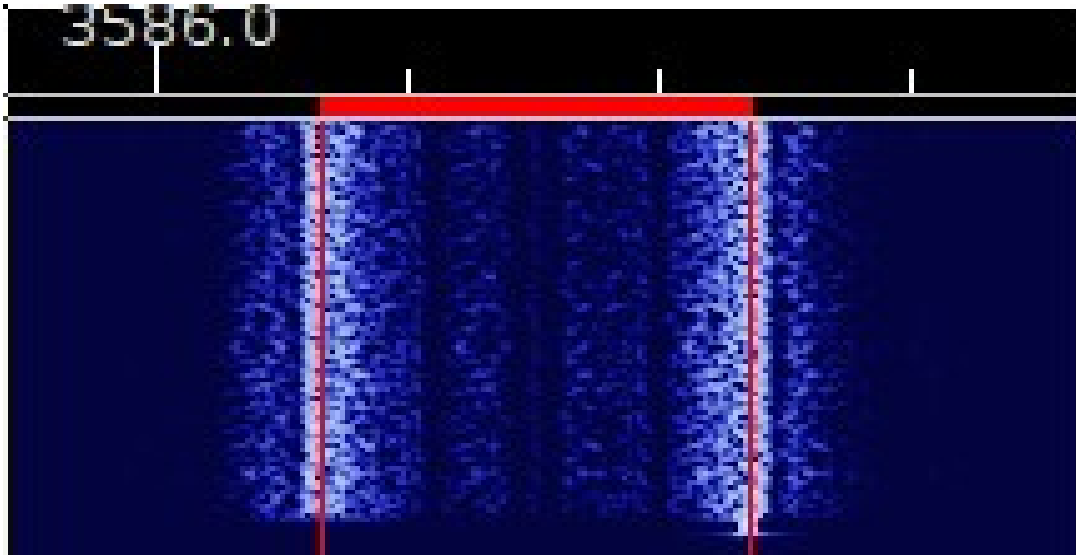
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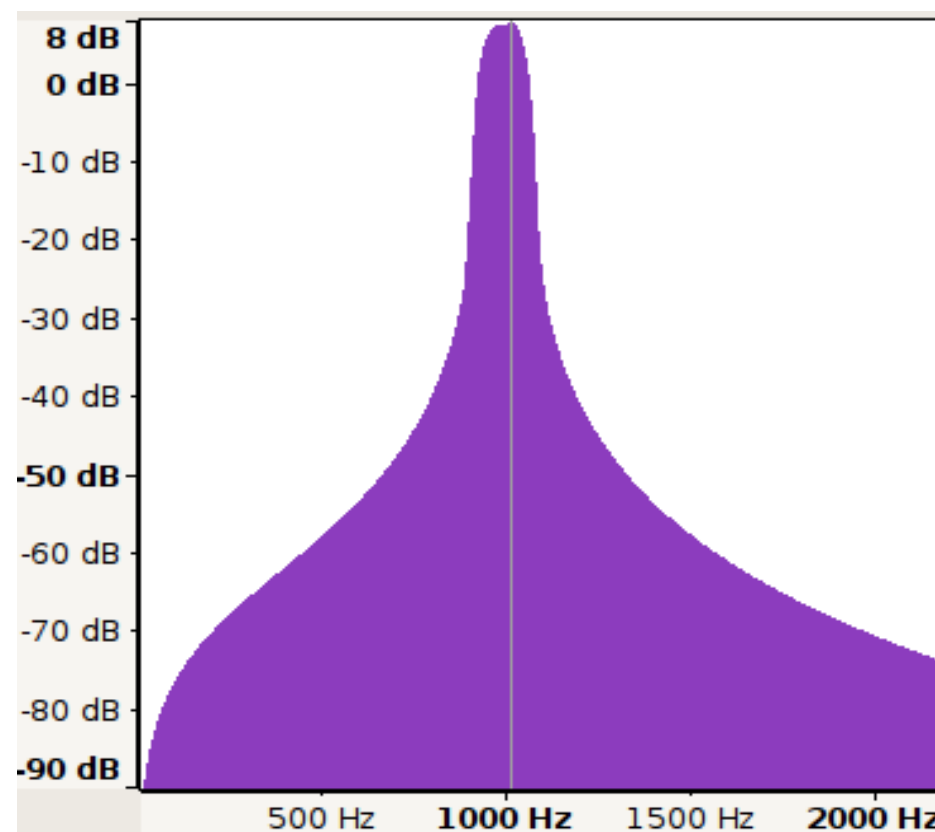
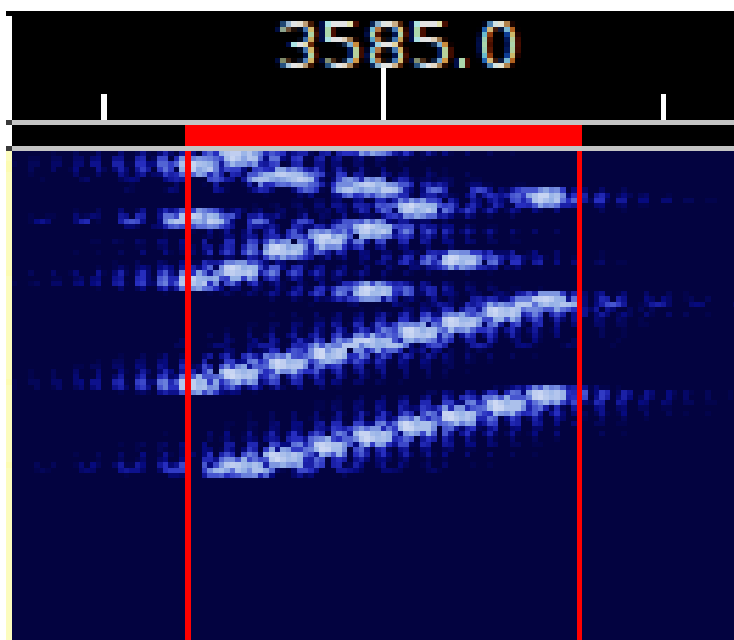
Olivia 32-1000



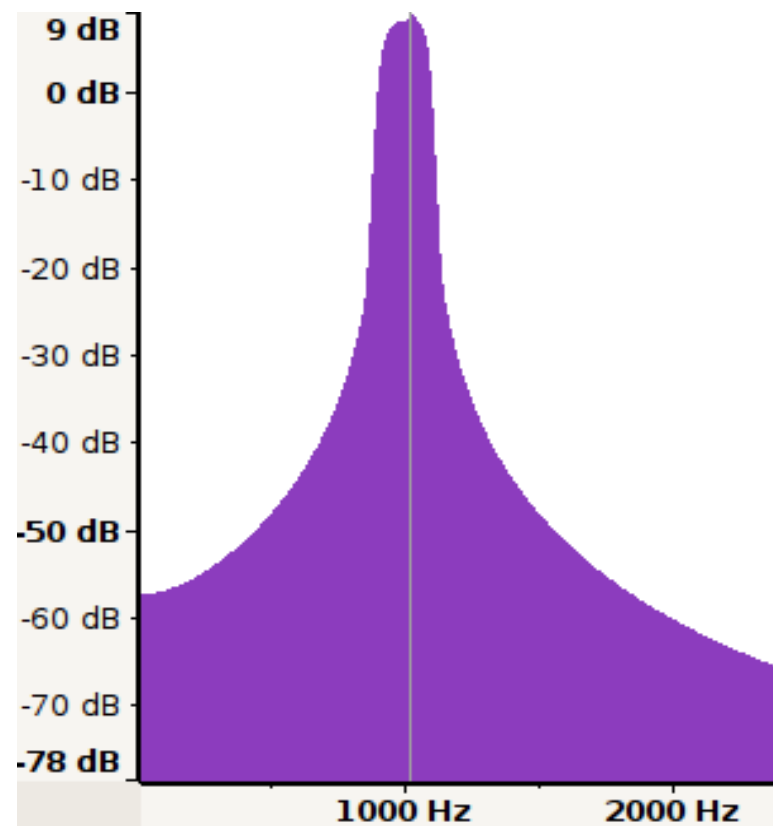
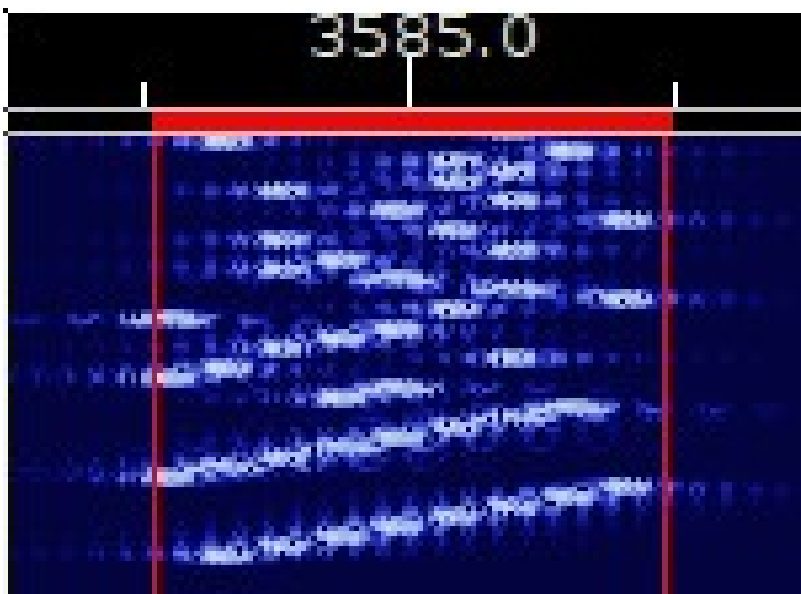
RTTY 45WPM



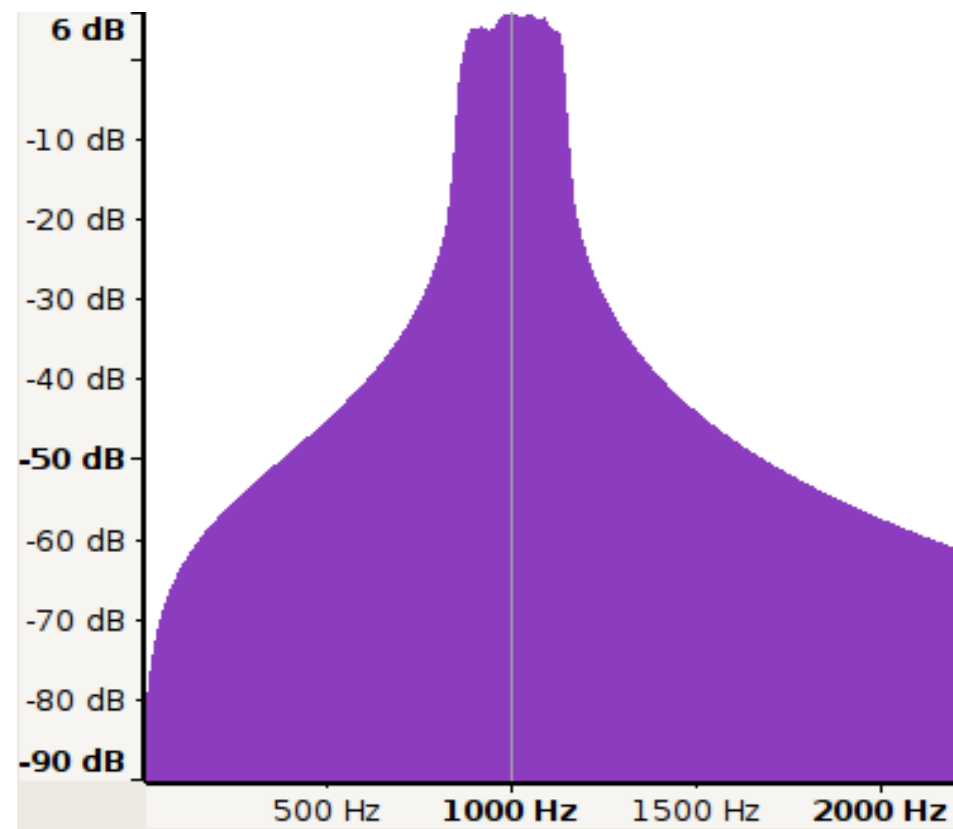
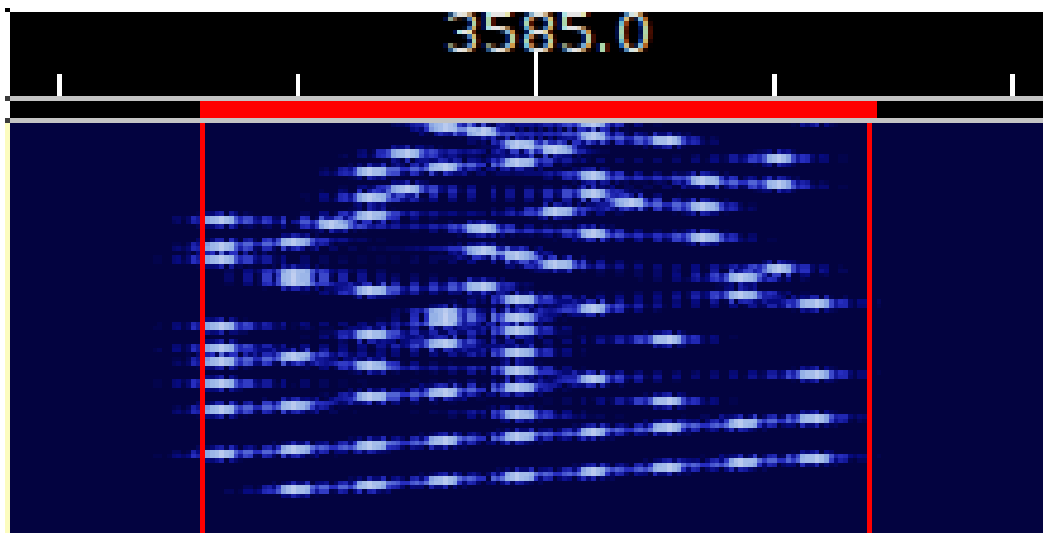
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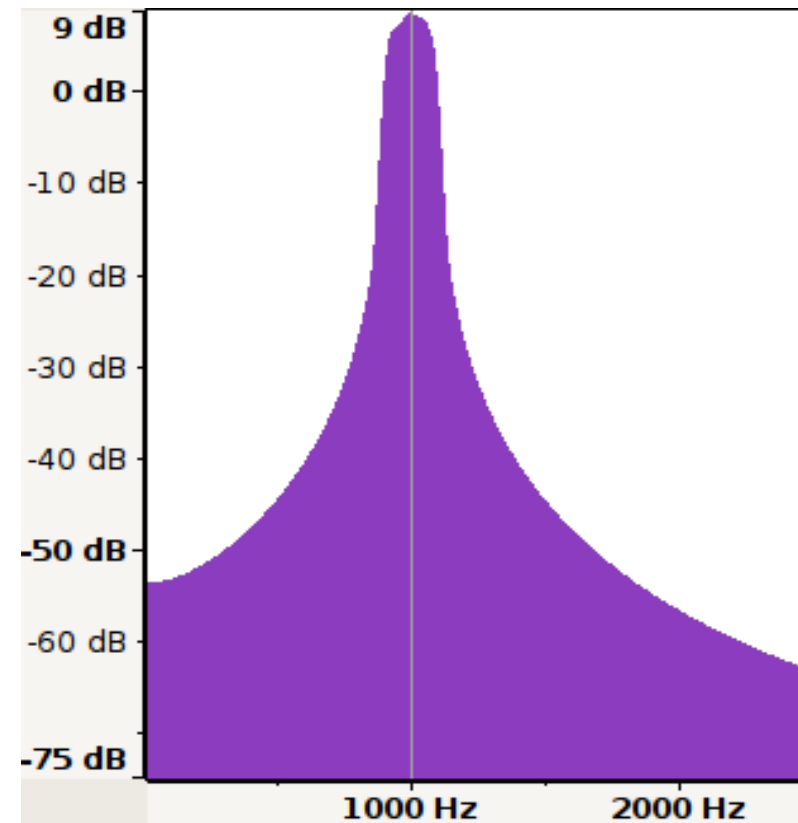
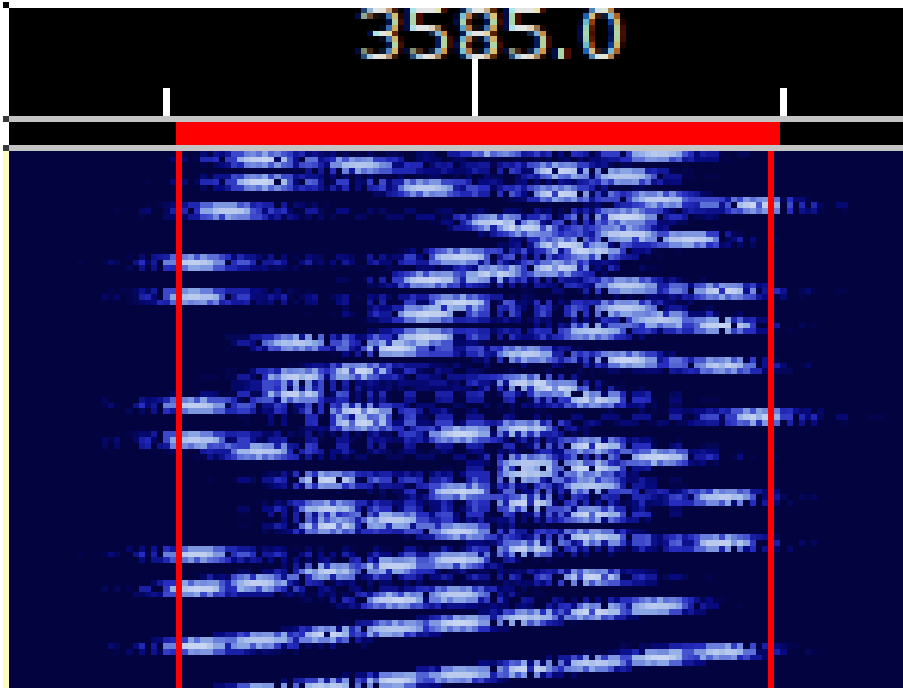
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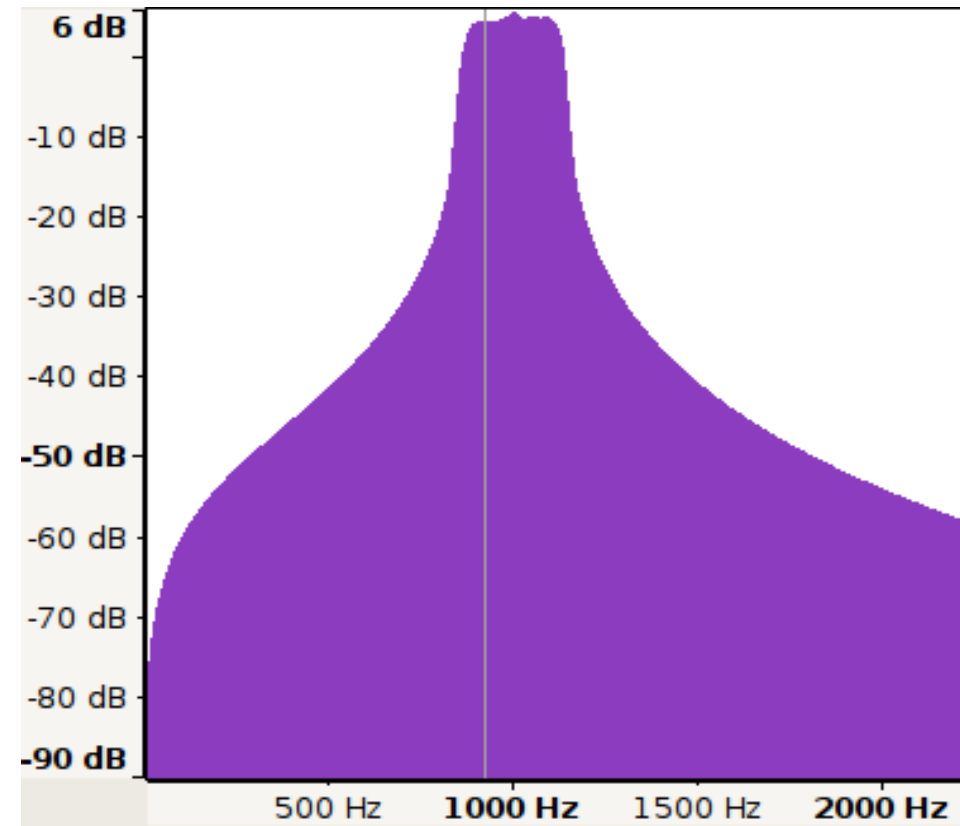
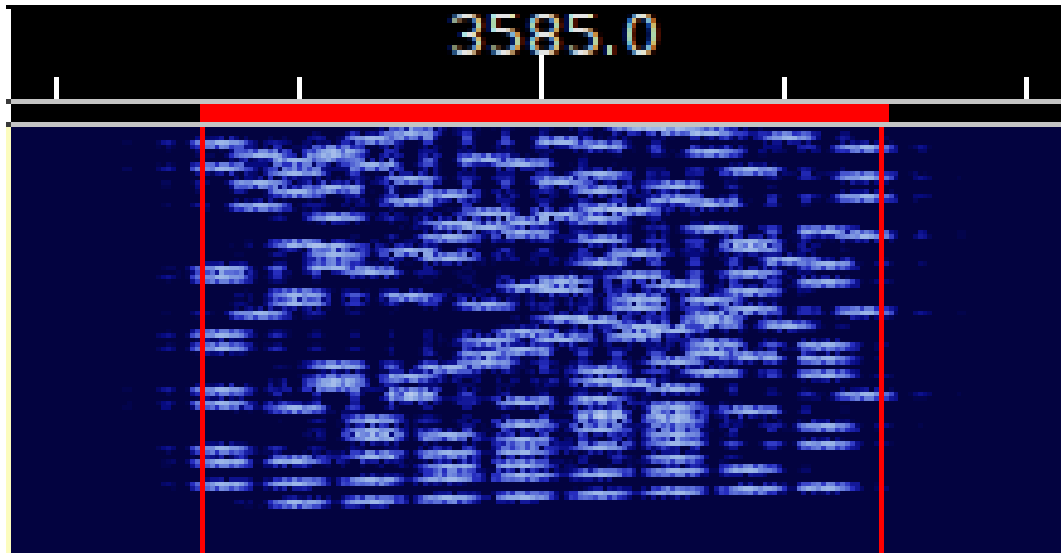
Thor 8



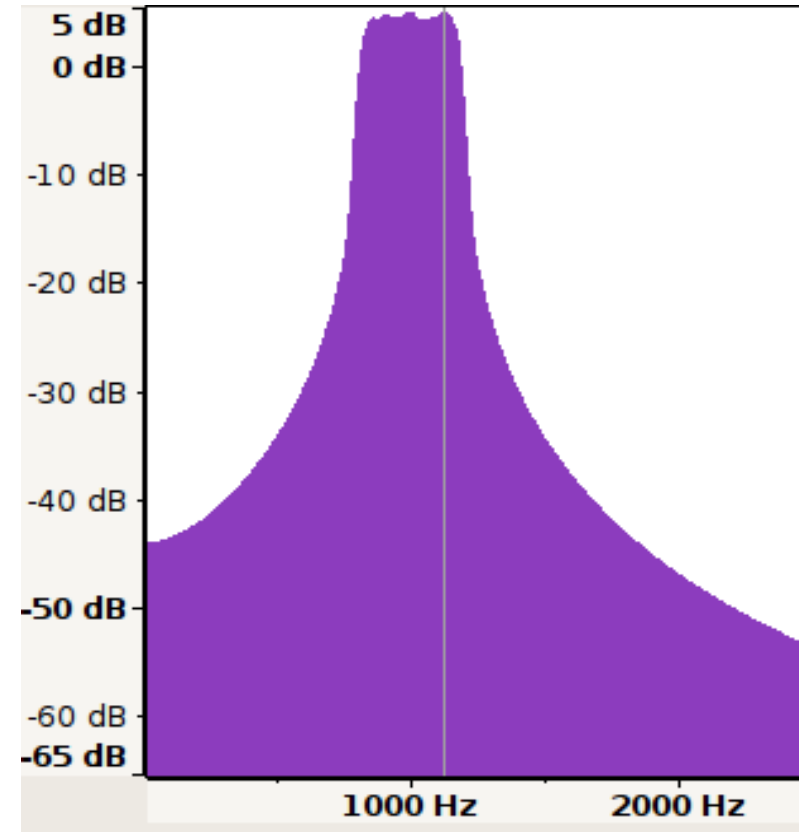
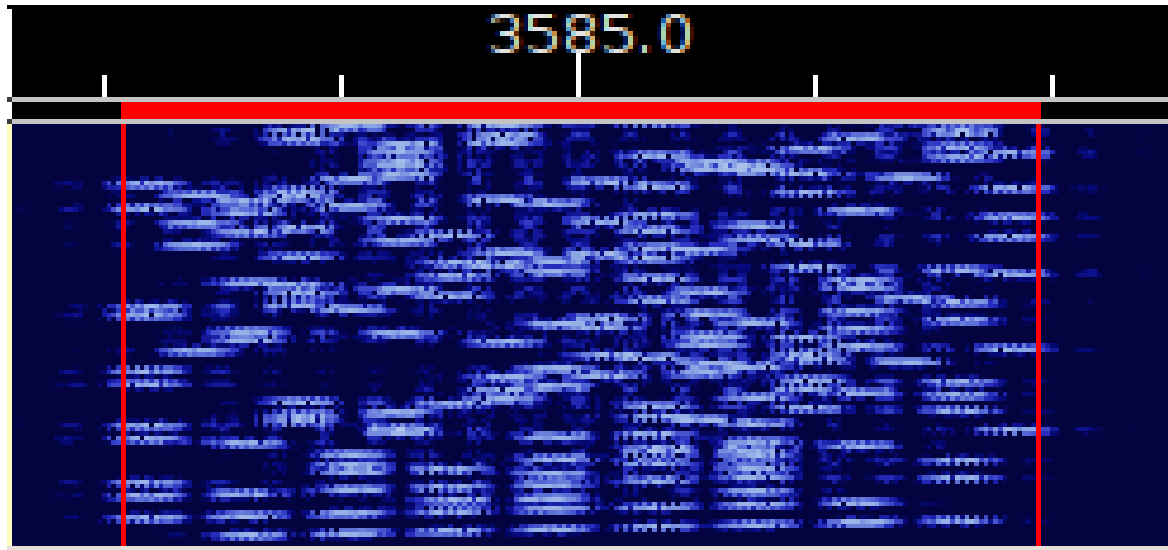
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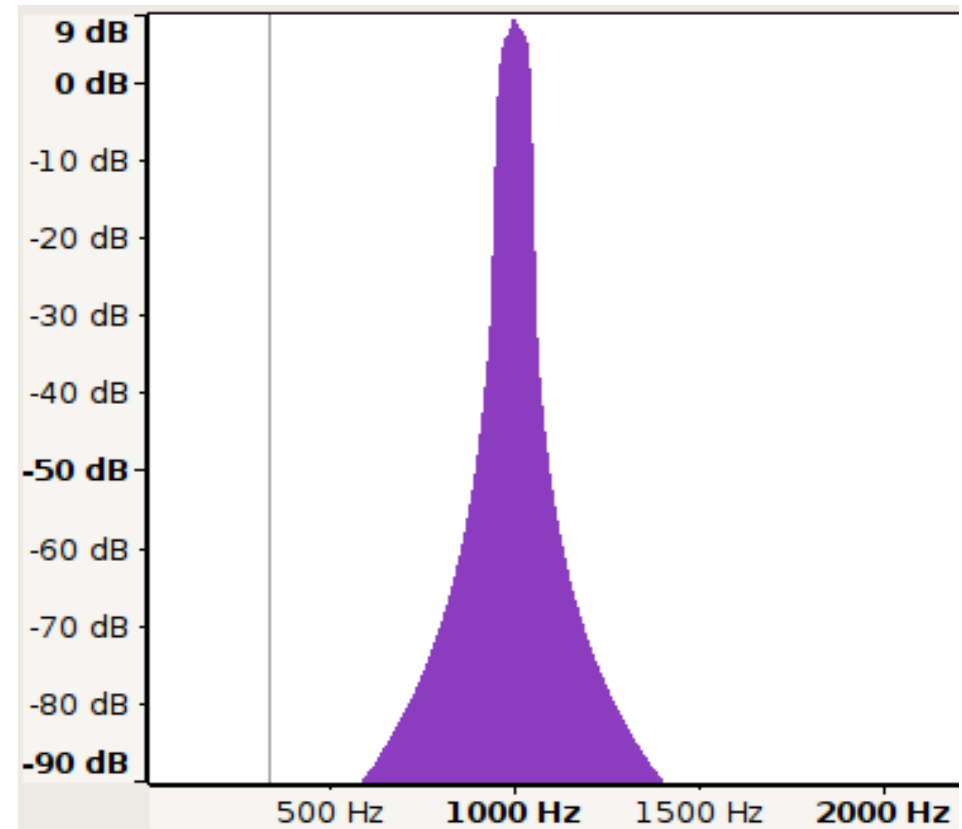
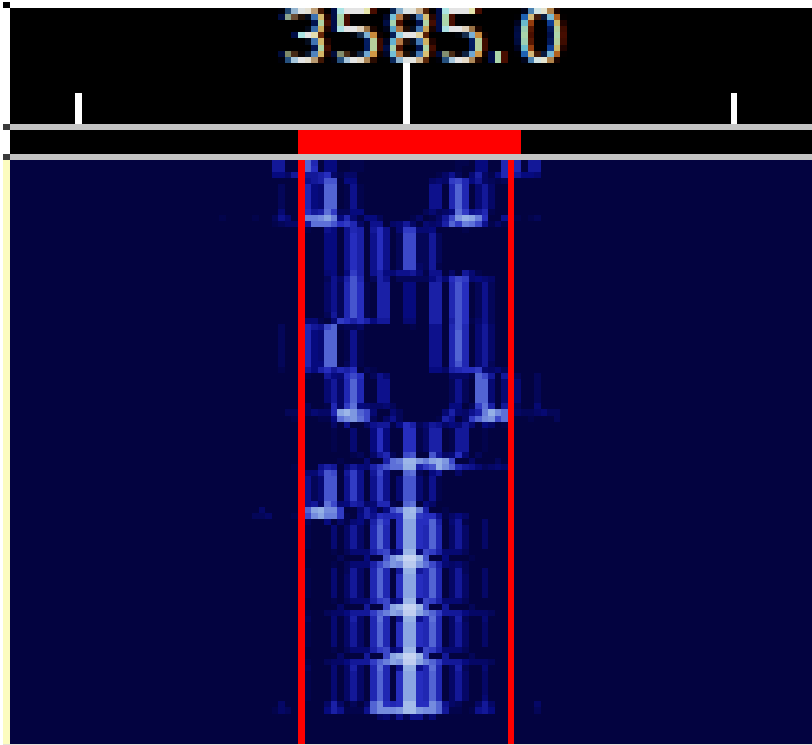
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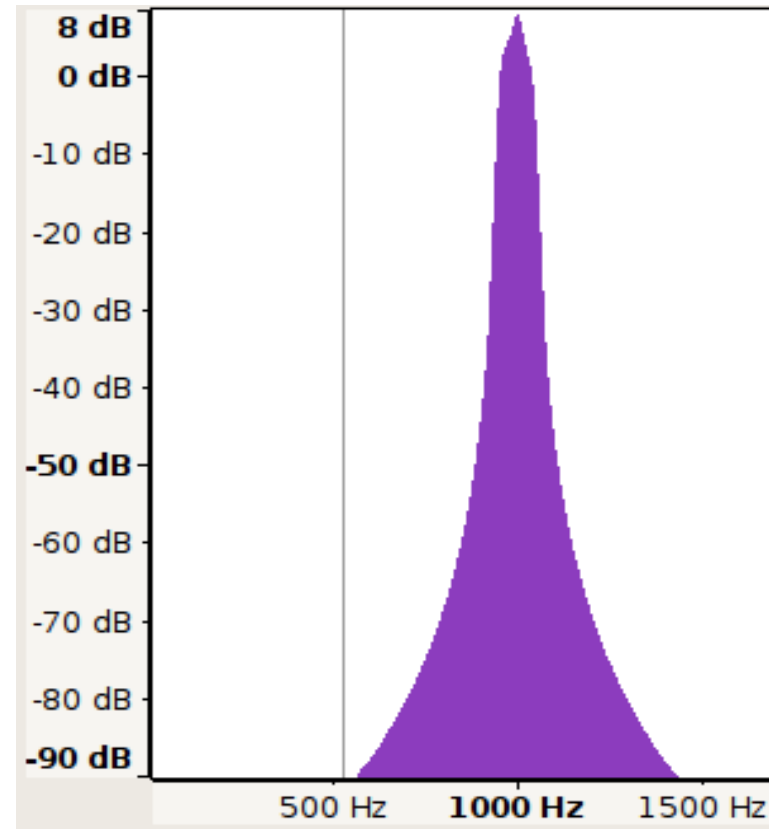
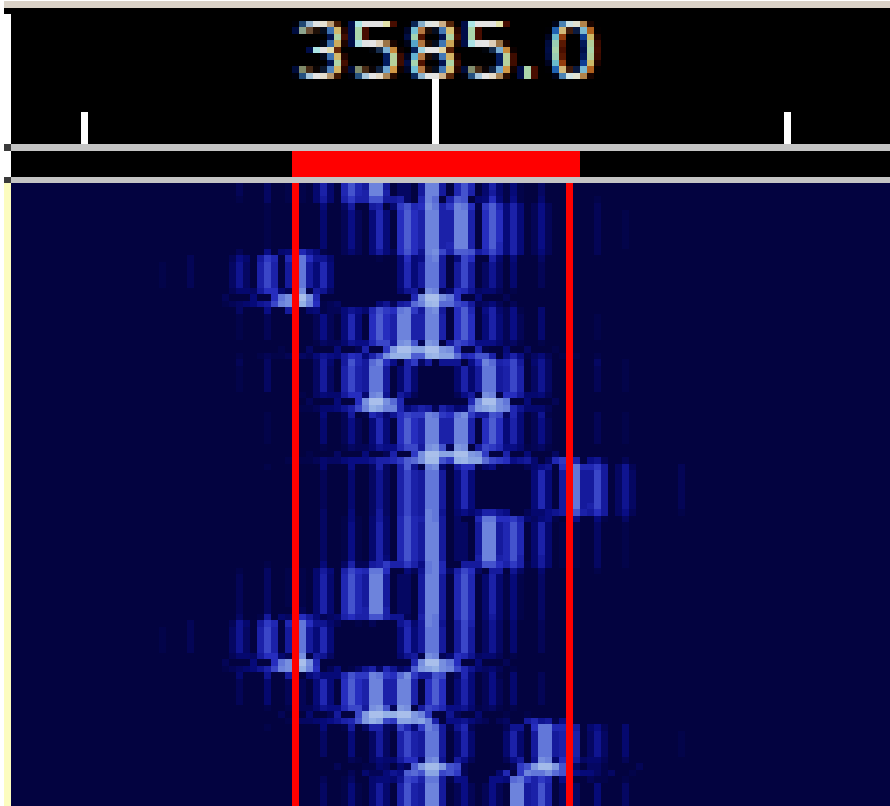
Thor 22



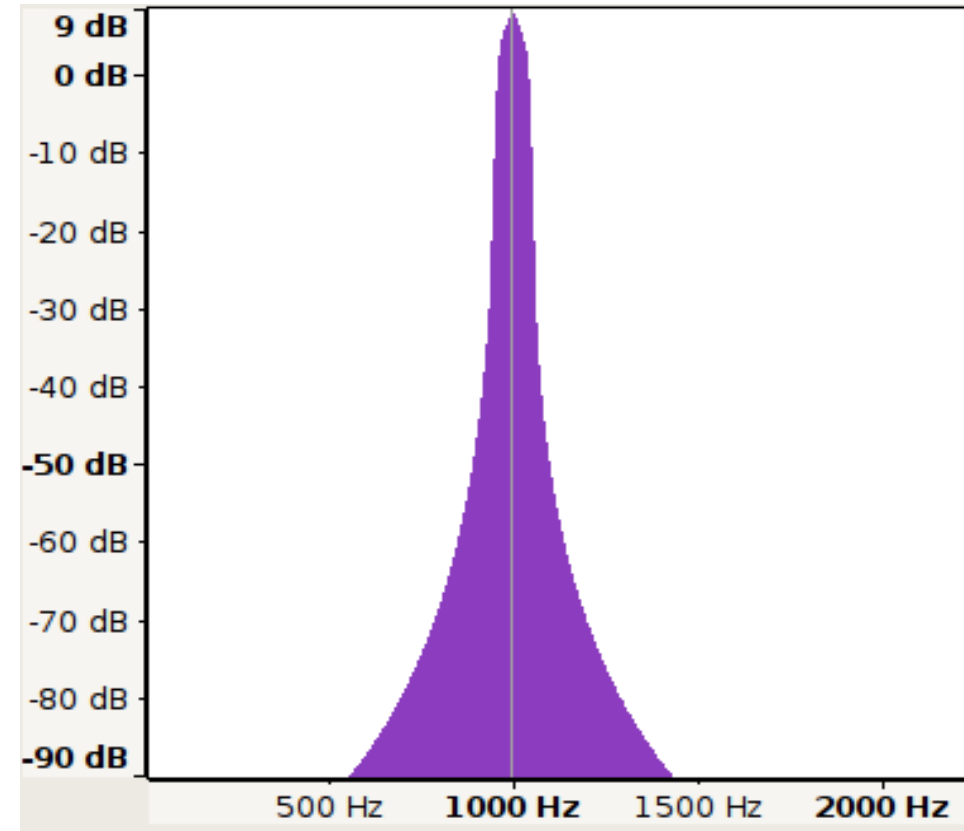
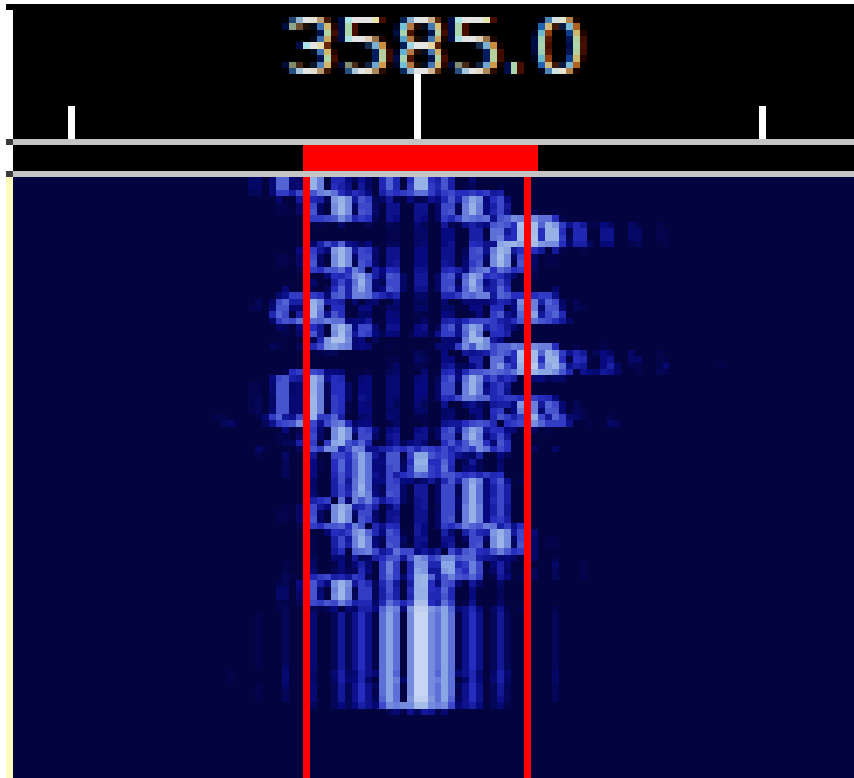
Throb 1



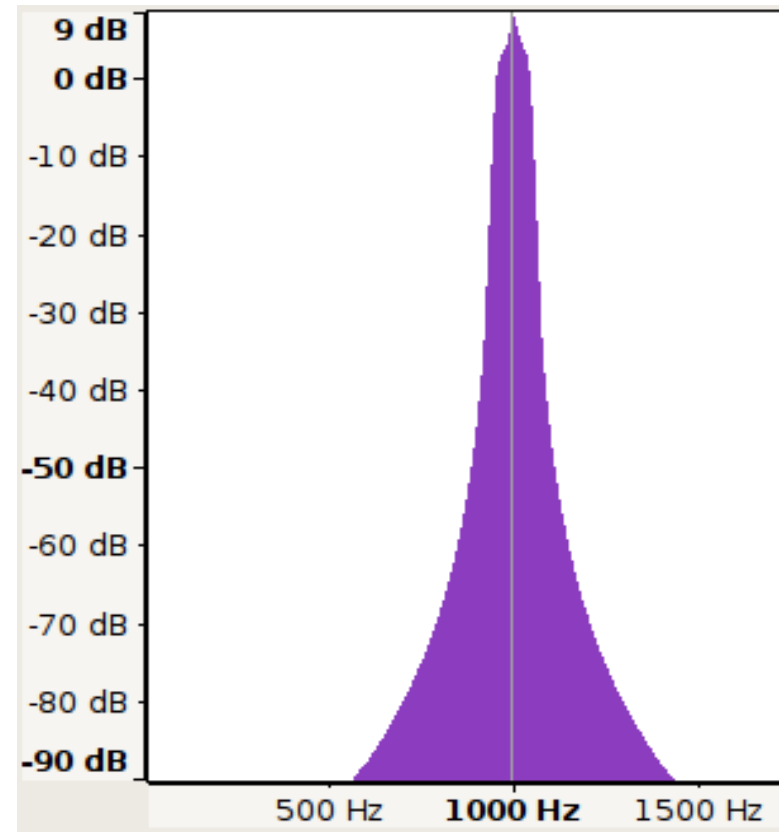
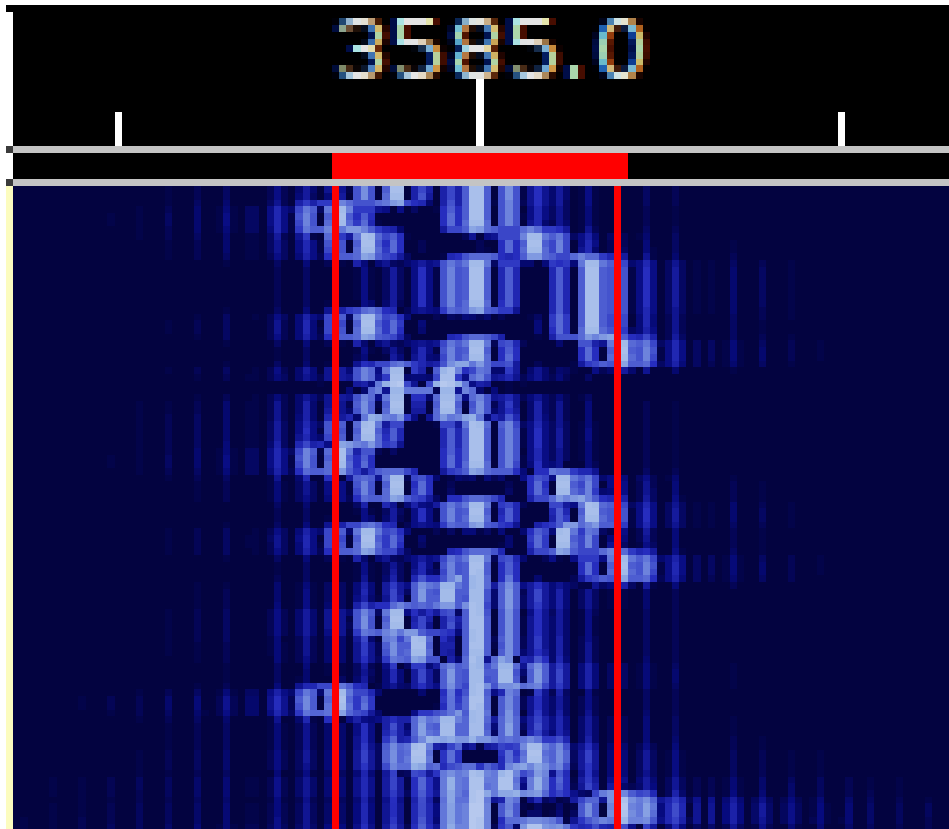
Throb 1X



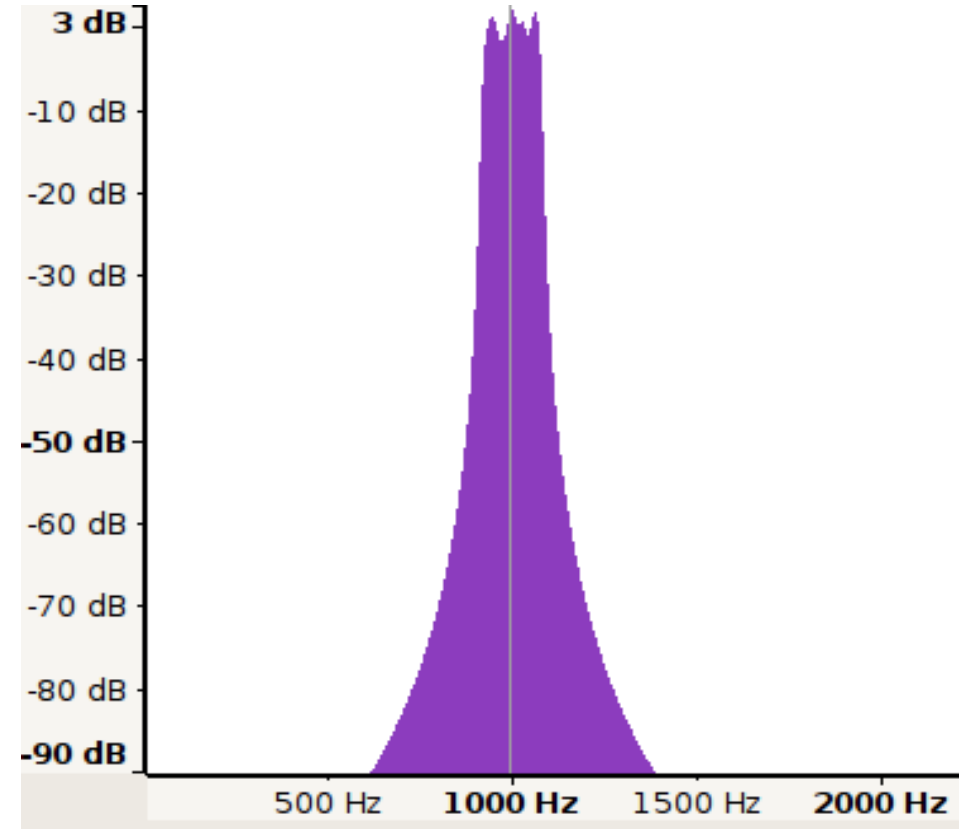
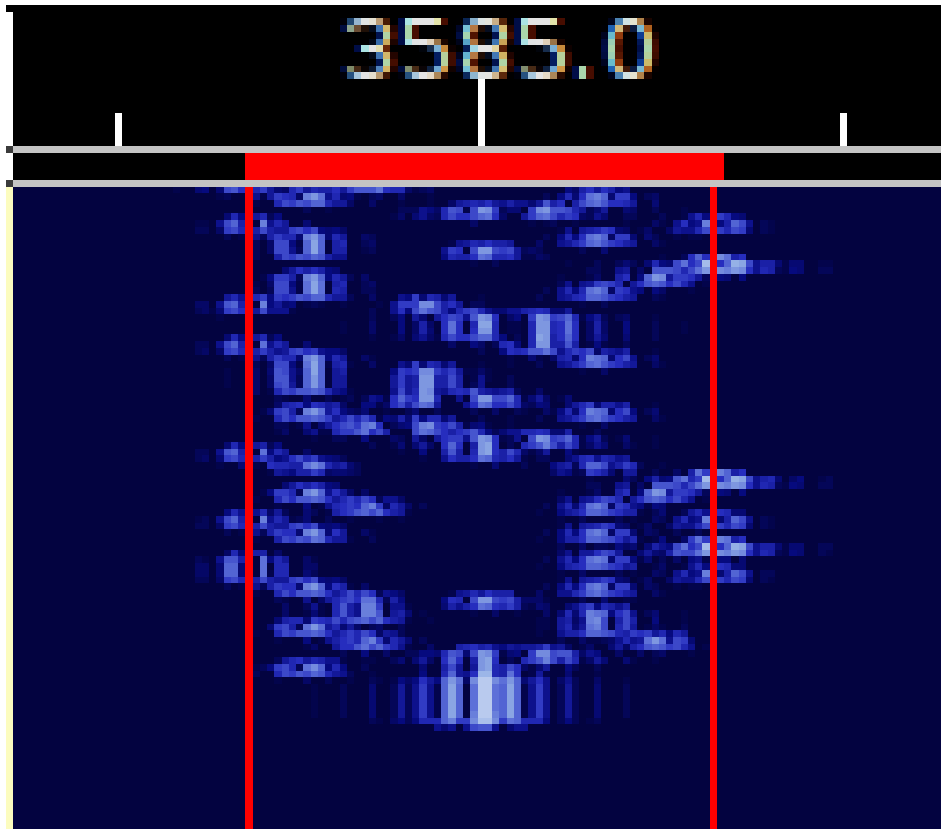
Throb 2



Throb 2X



THROB 4



Throb 4X

