

Identifying VDSL interference using Lelantos software

The presence of VDSL interference can be proven using a software tool called Lelantos developed by Dr Martin Sach (G8KDF and a member of the RSGB EMCC). Lelantos uses sophisticated digital processing to identify the VDSL Cyclic Extension waveform, a signal unique to VDSL, in order to positively identify whether or not VDSL interference is present in a sample radio spectrum recording.

If you have an SDR receiver and a pc running Windows, then you can use Lelantos.

Lelantos is a stand-alone Windows application which can be downloaded from www.rsgb.org/vdsl-reporting. On the download page are the Lelantos executable file, a detailed Lelantos instruction manual and two example recordings that can be used to test the application once it has been installed. It is strongly recommended that you read this manual before proceeding further.

To use Lelantos, a short recording in standard I/Q format of the HF spectrum, in which VDSL interference is suspected, is uploaded into the Lelantos application. The recording can be made using virtually any SDR receiver. The Lelantos application then searches within this recording for the VDSL Cyclic Extension waveform in order to positively identify whether or not VDSL interference is present. Further details of how Lelantos works can be found in the Instruction Manual and in an article in the November 2018 edition of RadCom, page 28 onwards.

To install and use Lelantos

Download the Lelantos application (the current version is Lelantos119-Setup.exe) and the Instruction Manual (current version Lelantos119 Manual.docx) to a suitable folder on a Windows pc.

Install Lelantos by double-clicking on the application, then click Install on the screen shown in figure 1. During the install process you may need to answer "Yes" to the question "Do you want to install this app from an unknown publisher to make changes to your system?".

By default, Lelantos will install shortcuts to the start menu and on the desktop.



Figure 1. Lelantos Install screen

Making a suitable wav file recording

Before running Lelantos, you need to make a wav file recording using an SDR receiver of the radio spectrum that you believe may contain VDSL interference. Most SDR's can be used to make this type of recording.

The recording must have a minimum bandwidth of 192kHz of spectrum, although much wider bandwidths can be used, at the expense of creating a much larger wav file. In practice most SDRs will allow bandwidth recordings up to many MHz wide. We recommend making a recording of around 2MHz of bandwidth. Higher bandwidths can be used but will create larger files and will not make a significant improvement to the detection of VDSL by the software.

Note that a raw RF recording is needed in standard I/Q format, and that audio recordings cannot be used.

If you want to be able to observe the size of any changes in the background noise around the VDSL guard bands then the recording spectrum should be centred on one of the guard bands e.g. at 3.75MHz, 5.2MHz, 8.5MHz or 12MHz. Alternately, if you suspect you are suffering from VDSL interference on a particular amateur band then you could centre your recording on this particular band. Any amateur band between 160m and 20m could be affected by VDSL interference. Identifying interference in one or more of the amateur bands is important because these are the bands that we can legitimately complain to Ofcom about loss of service.

The recording needs to be only about a half second long, irrespective of the bandwidth. A half second long recording of 2MHz wide spectrum will create a wav file with a size of around 4 Mbyte. Increasing either the length of the recording or the bandwidth recording will lead to significantly larger files.

Example: making the recording using an SDRplay RSP1A receiver with SDR Uno software

As an example, here are the instructions for making the necessary recording using an RSP1A receiver.

Connect the RSP1A receiver to the main station antenna and to your PC, and run the SDR Uno software. Full details of how to do this can be found on the SDRplay website at www.sdrplay.com.

Launch the SDRuno software. On the main console, click "Play!" to start the software running. If you have a RSPduo then set it into single mode by clicking "Single" as shown in figure 2.

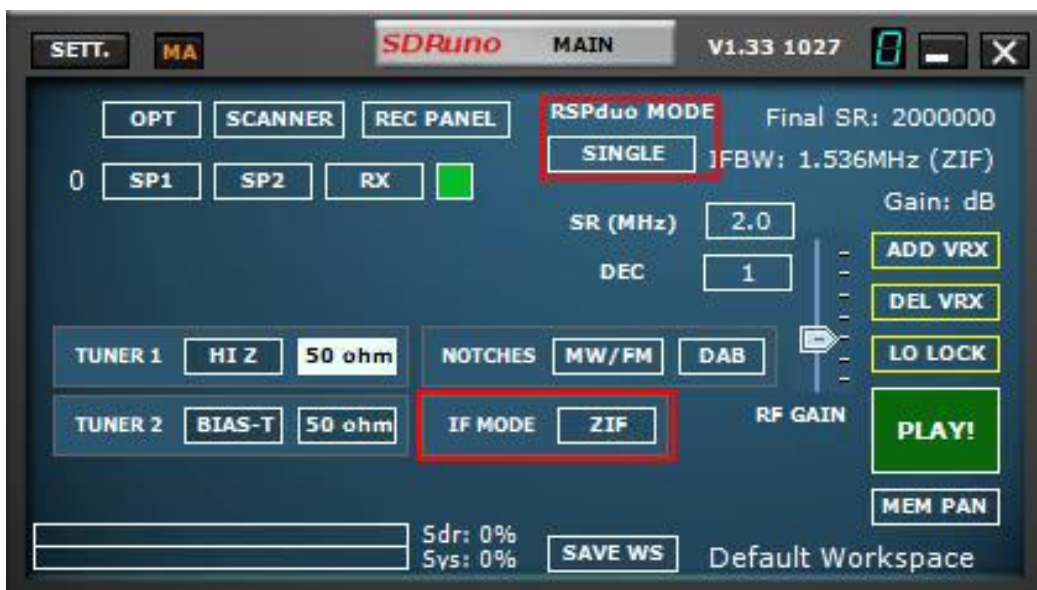


Figure 2. SDRuno Main Console

Then set the IF mode to "ZIF" (Zero Intermediate Frequency) and the display bandwidth (SR MHz) to 2.0 in order to display 2MHz of spectrum. (see figure 3)



Figure 3. Bandwidth setting on SDRuno Main Console

On the RX Control console set the main VFO to your chosen centre frequency e.g. 8.5MHz, as shown in figure 4.



Figure 4. Main VFO setting in the RX Control console

Then back on the main console, adjust the RF Gain control to maximise the receiver signals relative to the background noise as seen on the spectrum display on the main SP console. See figure 5.

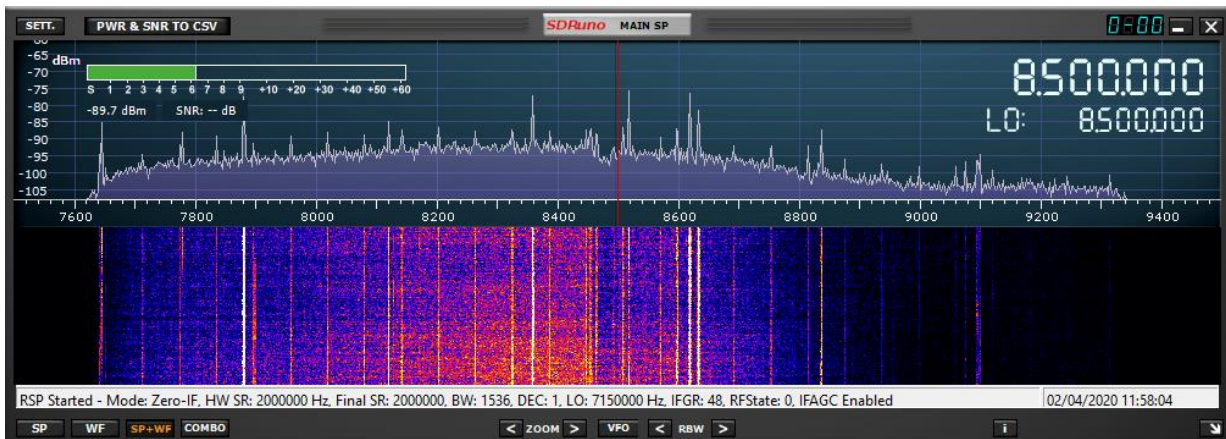


Figure 5. Main SP console showing spectrum and waterfall display

For the purpose of making the recording, you can ignore all the other settings (e.g. mode, noise blanking, squelch, AGC etc.) since these all occur after the raw IQ output.

To make the recording, open the recorder by clicking “Rec Panel” on the Main Console. This will open the Recorder Screen shown in figure 6.



Figure 6. Recorder Console

Right click on the recorder panel and select an appropriate folder where the recording will be saved. Then click record, wait for at least 0.5 seconds then click stop. This will record the file and save it in the chosen folder. During the recording, the recorder panel will display the size of the file being created.

The recording needs to be only about 0.5 seconds long, irrespective of the bandwidth. A half second long recording of 2MHz wide spectrum will create a wav file with a size of around 4 Mbyte. Increasing either the length of the recording or the bandwidth recorded will lead to significantly larger files.

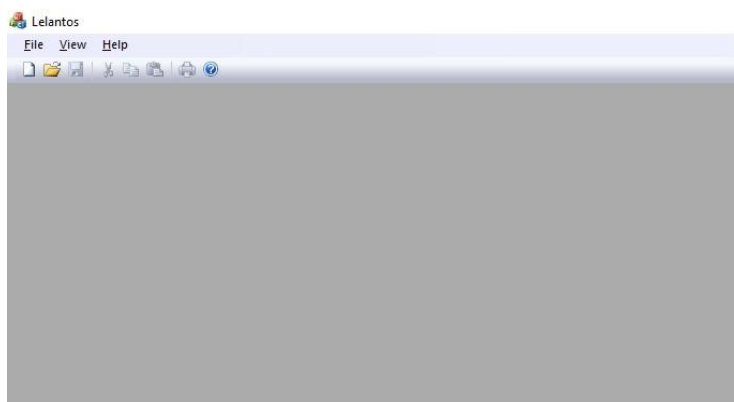
The recorded file has a file name in the format SDRuno_DDDDDDDD_TTTTTTZ_FFFFkHz.wav where DDDDDDDD is the date, TTTTTTZ is the time and FFFF is the centre frequency of the recording. This file is now suitable for use with the Lelantos software. If you intend to share the recorded files with other radio amateurs or the RSGB then it would be helpful if you can also include your callsign within the filename.

A similar process will be required to make the necessary recording with other types of SDR receiver.

Running Lelantos with the recorded spectrum file

Once a recording has been made then open and run Lelantos, for example by clicking on the desktop icon.

When Lelantos launches, it starts with a menu bar and a large blank grey area below as shown in figure 7.



On Lelantos, go to File – Open, then point at the saved spectrum wav file and click “Open”.

After a few seconds of processing time, Lelantos should produce four graphs showing its analysis of the wav file. An example display of the four graphs is shown in figure 8 (here an 8MHz bandwidth has been used).

Figure 7. Lelantos opening screen

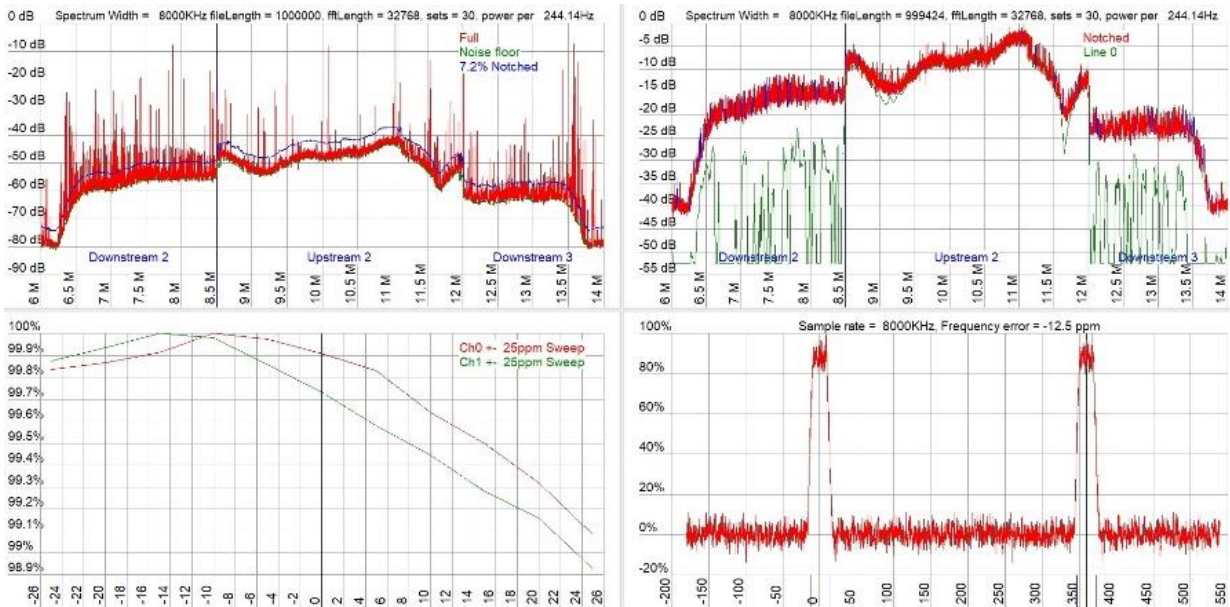


Figure 8. Typical Lelantos screen display

The top 2 graphs show the spectrum from the wav file. In the example in figure 8 the spectrum is centred on 10MHz and the SDR's filtering rolls the spectrum off at each end. The first (top left) graph shows in red the spectrum of the wav file.

There are several upward red spikes on the top left graph which are narrow band signals such as individual radio signals. The top right graph shows the spectrum with these narrow band signals suppressed.

Now look at the bottom right graph on the Lelantos display. If VDSL interference is present it will show the timing of the VDSL Cyclic Extension symbols being detected.

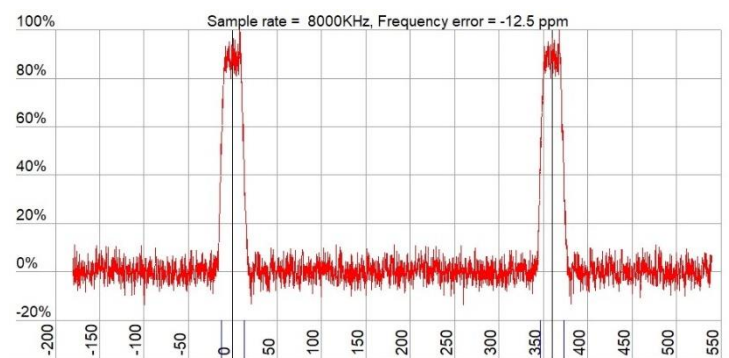


Figure 9. Lower right graph on Lelantos showing detection of VDSL timing signals

Figure 9 shows the lower right graph with Lelantos detecting VDSL timing signals proving the presence of VDSL interference in the spectrum recording. The x axis on this graph is in degrees, with 360 degrees representing one symbol time in the VDSL signal.

If there is no VDSL interference present in the spectrum recording, then the bottom right graph on the Lelantos display will show only random noise, with no discernible symbol pattern, as shown in figure 10.

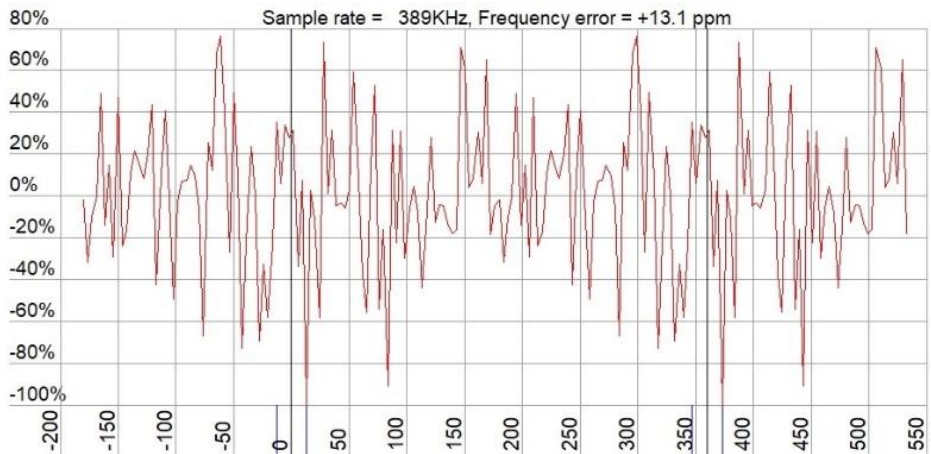


Figure 10. Lower right graph on the Lelantos screen display showing no VDSL interference present in the spectrum recording

For additional confirmation of the presence of VDSL interference, look at the top left graph on the Lelantos screen showing the radio spectrum. With VDSL interference present, it should be possible to see one or more of the VDSL guard bands. The positioning of these guard bands on the graph will depend upon the bandwidth that you record. If you can't see any guard bands then this indicates that either VDSL interference is not present, or that it is below the background noise level. Nevertheless, Lelantos may still show the presence of VDSL interference in the bottom right graph.

If Lelantos detects interference from more than one VDSL system within the spectrum recording, (for example from VDSL systems serving neighbouring houses) then the graph at the bottom right

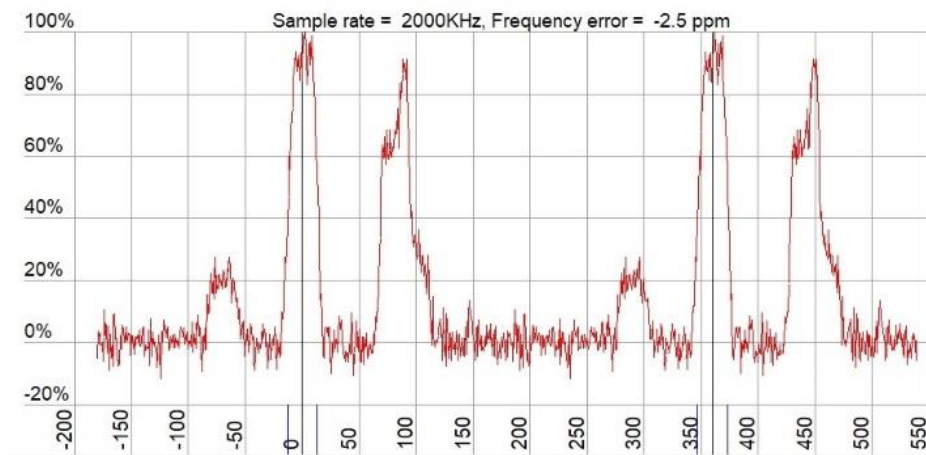


Figure 11. Lower right graph on the Lelantos screen display showing the presence of at least 3 individual VDSL systems within a single recording

will show timing peaks for each system. Figure 11 shows Lelantos detecting at least 3 separate VDSL systems from within a single spectrum recording. Notice that the timing signals for the individual VDSL systems typically occur at different points in the overall frame, determined by the

moment each VDSL system was started up. Once started, because the network uses timing signals derived from a caesium standard, then the phase relationship between individual systems should remain constant over a very long period of time.

Please see the Lelantos Instruction Manual for additional details about the meaning and interpretation of all the graphs displayed by the software.

Using Lelantos to estimate the level of VDSL interference

Lelantos can also be used to estimate the size of the step in the background noise level around the VDSL guard bands.

To do this make a 2MHz wide spectrum recording centred around one of the guard bands (e.g. at 3.75MHz, 5.2MHz, 8.5MHz or 12MHz)

Feed this recording into Lelantos as described above.

View the top right graph displayed by Lelantos.

Expand this graph either by using pan and zoom, or by right clicking and then selecting “View params” (i.e. View parameters) to open the box shown in figure 12.

Make sure that the “Spectrum Centre MHz” setting is set to the centre of the guard band that you wish to examine.

Set the “Spectrum Width kHz” setting to 200 and click OK.

This will expand the graph to show the spectrum around the guard band. Figure 13 shows an example of a recording centred around the 12MHz VDSL guard band.

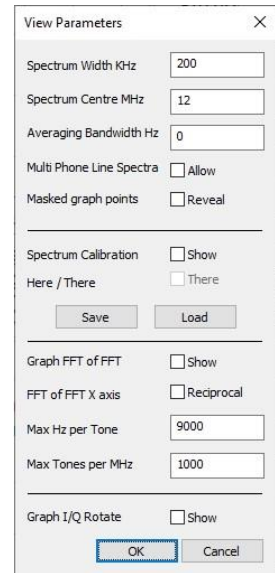


Figure 12. “View params” box

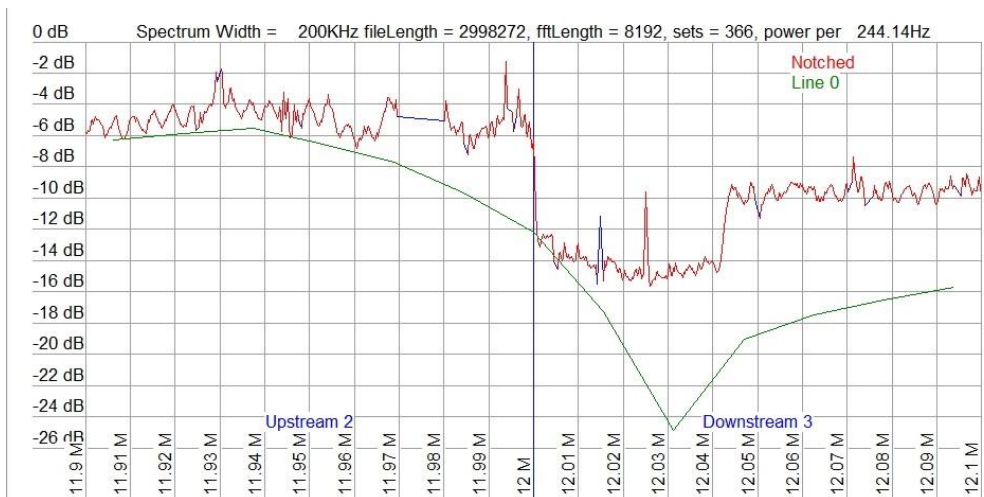


Figure 13. Expanded Lelantos spectrum display showing the 12MHz VDSL guard band

In the example in figure 13, it can be seen that the VDSL interference from the upstream band (in this example this is below the guard band) is about 9dB above the background noise level in the guard band, while the interference in the downstream band (above the guard band in this example) is about 5dB above the background noise level in the guard band.

For reference, the positioning of the upstream and downstream bands relative to the guard bands is shown in figure 14.

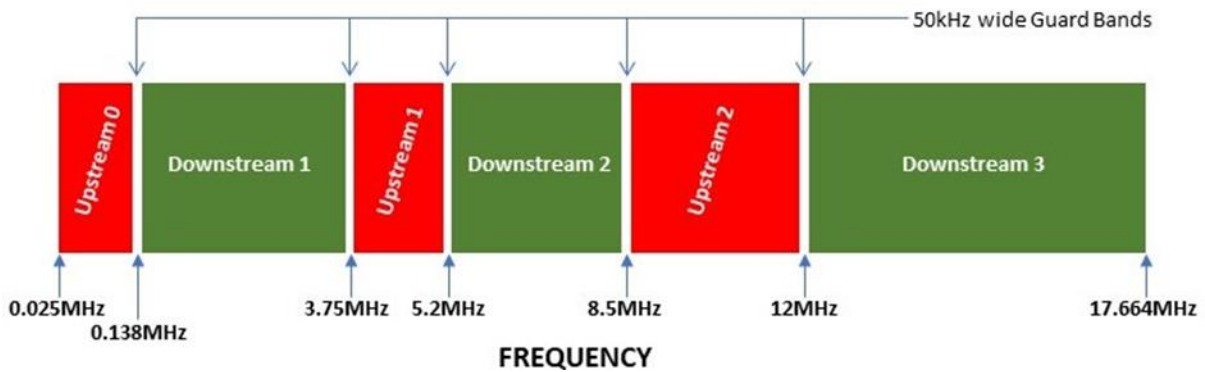


Figure 14. VDSL spectrum showing the position of the upstream and downstream guard bands

Further information on Lelantos

For further information about Lelantos and how to use the software, including details of many additional features not described above, please see the Instruction Manual that is included on the download page.

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