Interference and Direction Analyzer IDA 2

Technical Note TN107

Recognizing and separating signals in spectrograms

IDA 2 High-Resolution Spectrogram demonstrated using a practical example

Spectrograms are generated by representing the level values of the measured spectrums by different colors and displaying them line by line. This produces an image that provides frequency and time information simultaneously. Displaying the results becomes difficult at high time resolutions. A measurement over a period of just 10 ms with a resolution of 1 µs would produce 10,000 lines, which would be impossible to show on any display. The measurement data is therefore usually compressed, which produces a clear display but destroys valuable information at the same time – information that is actually needed for detecting sporadic interference signals or other impairments.

The IDA 2 takes a different course with its *I/Q Analyzer* option. It records up to 250,000 data pairs in real time and then generates spectrums, spectrograms or time responses from the data. Because the data set remains unaltered, uncompressed, the parameters for evaluation such as frequency and time resolution can subsequently be chosen at will. For example, in *HiRes Spectrogram Zoom* display mode the signals can be examined in depth, right down to the original resolution.

A practical measurement example was given by taking a section of the mobile communications band at 1800 MHz. Along with an LTE channel with a center frequency of 1870 MHz, two GSM mobile phone BCCHs at 1865 MHz were “on air”. An RF generator was used to generate and emit a variable frequency GSM TCH signal.

The conventional spectrogram: A good overview

A normal spectrogram is a good way to get an overview of what is happening within a frequency band. The example shows a capture of part of the mobile communications downlink band at 1870 MHz. It shows the typical image of an LTE resource block with a transmission bandwidth of 9 MHz (10 MHz nominal channel bandwidth). There are two GSM mobile BCCHs “on air” at 1865 MHz; these Broadcast Control Channels are recognizable by their constant level. There is an unused frequency range between these two services.

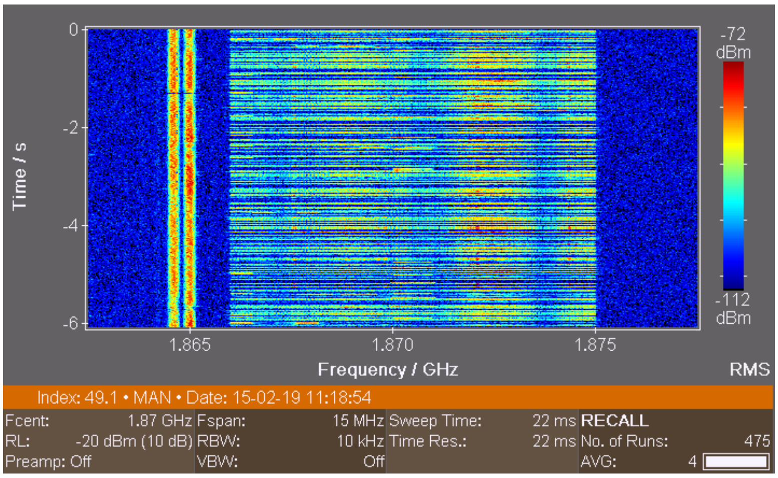

Figure 1: Spectrogram. Bandwidth (Fspan) 15 MHz, frequency resolution (RBW) 10 kHz, time resolution 22 ms.

An artificial signal produced by a generator is now inserted into this unused section of the “live” spectrum. It is modulated to simulate a GSM Traffic Channel, TCH, which has one timeslot occupied constantly. It is easy to see because it is in the unused part of the spectrum (see arrow).

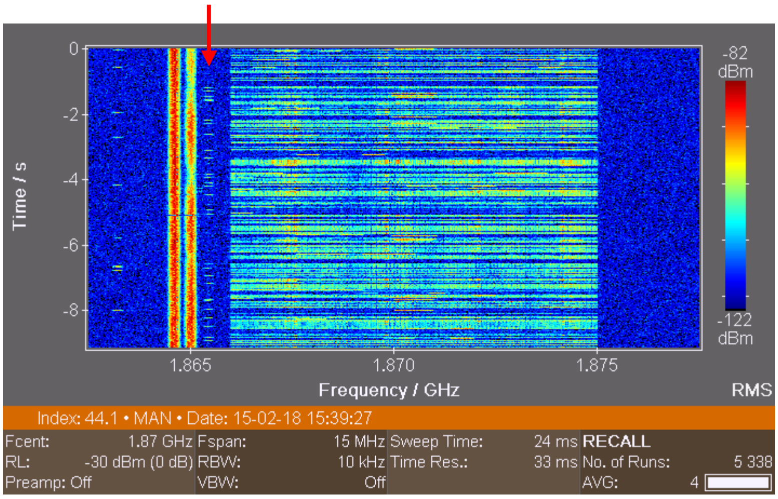

Figure 2: Spectrogram. Bandwidth and frequency resolution as above, time resolution 33 ms.
By chance, a “real” TCH occurred during the measurement (left-hand edge of image).

If the generator frequency is now altered so that the artificial signal moves beneath the LTE-Signal, it can hardly be seen.

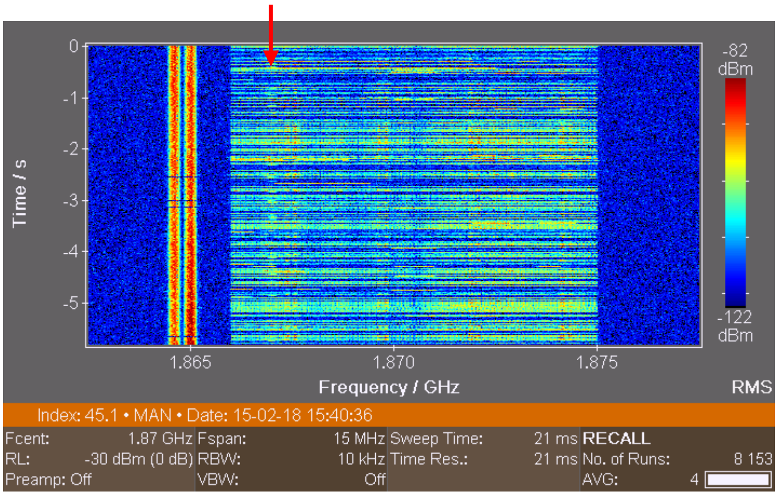

Figure 3: Spectrogram. Bandwidth (Fspan) 15 MHz, frequency resolution (RBW) 10 kHz, time resolution 21 ms.

A conventional spectrogram with a time resolution in the 20 ms range is therefore not much use in this instance.

The High-Resolution Spectrogram: A deeper view

This is where the *IQ Analyzer* mode with its *HiRes Spectrogram* view comes into its own. It provides a time resolution down to 1 µs.

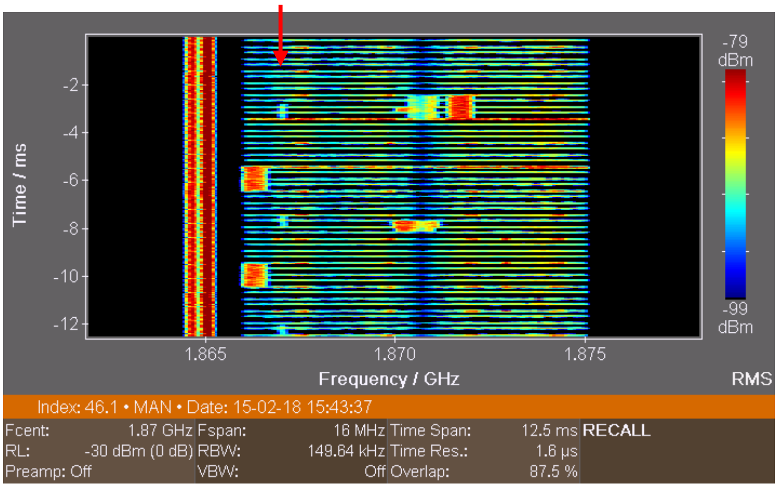

Figure 4: High-Resolution Spectrogram Full. Bandwidth (Fspan) 16 MHz, frequency resolution (RBW) approx. 150 kHz, time resolution 1.6 µs.
The instrument only compresses the data for display to match the screen resolution, but the original data is retained.

In the example here, the IDA 2 recorded a real time IQ stream of length 12.5 ms and generated spectrums spaced 1.6 µs apart in time. This means that the device has 7805 spectrums stored in memory. In *HiRes Spectrogram Full* display mode, the device compresses these 7805 spectrums so that it can display the entire 12.5 ms length of the signal. Already, the GSM signal under the LTE signal can be seen.

The High-Resolution Spectrogram Zoom: The whole truth

When the view is switched to *HiRes Spectrogram Zoom*, each line of the display represents just one of the 7805 spectrums. As only a small fraction of the 7805 spectrums can be shown on the screen, it is necessary to scroll "through time" (Figure 5). To give an idea of the quantity of information that is present, all 7805 lines have been put together graphically in figure 7 (at the end of this document).

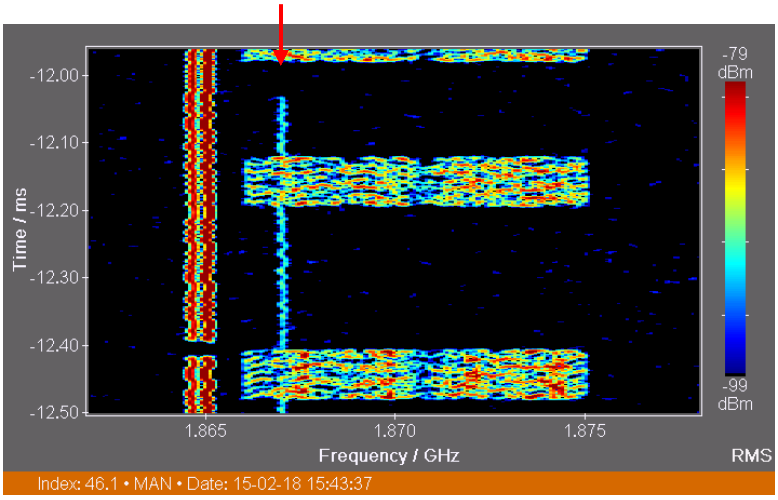

Figure 5: High-Resolution Spectrogram Zoom. This is based on the same data set used for the High-Resolution Spectrogram Full.

Because the data for all the spectrums is retained, each spectrum can be displayed conventionally as amplitude versus frequency, simply by moving the marker to the corresponding line in the spectrogram.

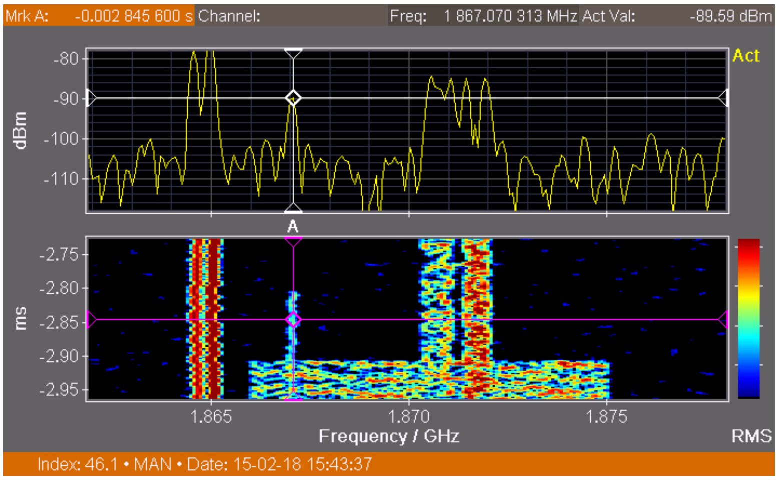

Figure 6: High-Resolution Spectrogram Zoom with mixed display. The marker can be used to scroll through the spectrogram and recall the associated spectrums so that the exact level of the interference at a given time point can be determined.

The artificial signal can be seen clearly at this resolution. Its start and end are not in the time pattern of the LTE signal, so it is classified as interference. If its length is measured using the markers, it has the typical pulse length of a GSM timeslot, which in real life would indicate interference with GSM. The time offset from the two BCCHs shows additionally that the interference cannot be emanating from the same base station.

Several questions about the problem of “signals beneath signals” are thus answered here at a glance. This is possible because the *High-Resolution Spectrogram* has more than 10,000 times higher resolution than the conventional spectrogram: 1.6 µs compared with about 20 ms. The 12.5 ms long time window shown here with its 7805 spectrums would actually be compressed down and represented by just one line in a conventional spectrogram. No wonder, then, that no comparable detail can be seen.

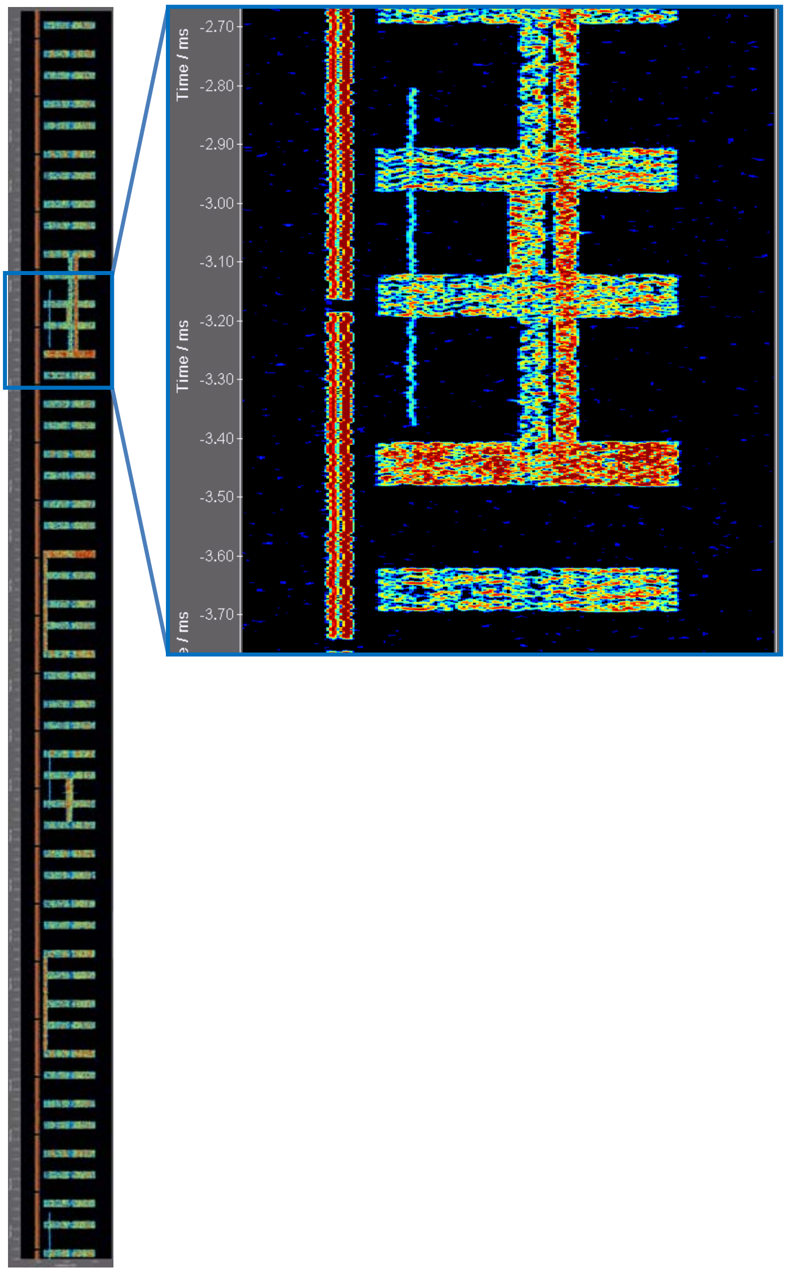

Figure 7: Representation of the resolution in the High-Resolution Spectrogram.
Shown left: all 7805 lines of the spectrogram assembled together graphically.
Shown right: an enlarged section corresponding to two to three screens when scrolling through the High-Resolution Spectrogram Zoom.

Further Technical Notes

TN101: Capturing IQ data with
NRA and IDA

TN103: The signal beneath the signal:
IDA 2 makes payload and interference signals clear

TN106: IDA 2: Receiver or Spectrum Analyzer?
Receiver and Spectrum Analyzer!

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