RIGOL

Application Guide

Introduction to the Density View

Version 1.0

June. 2021

RIGOL TECHNOLOGIES CO., LTD.

Preface

Copyright

Notices

- **RIGOL** products are covered by P.R.C. and foreign patents, issued and pending.
- **RIGOL** reserves the right to modify or change parts of or all the specifications and pricing policies at the company's sole decision.
- Information in this publication replaces all previously released materials.
- Information in this publication is subject to change without notice.
- **RIGOL** shall not be liable for either incidental or consequential losses in connection with the furnishing, use, or performance of this manual, as well as any information contained.
- Any part of this document is forbidden to be copied, photocopied, or rearranged without prior written approval of **RIGOL**.

Product Certification

RIGOL guarantees that this product conforms to the national and industrial standards in China as well as the ISO9001:2015 standard and the ISO14001:2015 standard. Other international standard conformance certifications are in progress.

Contact Us

If you have any problem or requirement when using our products or this manual, please contact **RIGOL**.

E-mail: service@rigol.com
Website: www.rigol.com

This Application Guide

- Briefly introduce the concept of the density view.
- Explain how to find the detailed characteristics of the measured signal.
- Introduce how to find hidden signals.
- Explain how to distinguish co-frequency signals.
- Introduce how to observe the crowded spectrum.
- Summarizes the related RIGOL products.

It will take about 10 minutes to complete the full text reading.

Overview

Due to the fact that radio spectrum resources are limited and non-renewable, and the number of users and radio applications are increasing rapidly, current RF spectrum is becoming more and more crowded and busy. How to make more efficient use of the limited RF spectrum resources is the primary problem faced by current radio practitioners.

At the same time, the difficulty of product design and testing is also intensified. Engineers must not only ensure that their products comply with relevant regulations, but also need to always pay attention to the effects of other RF interference sources on their products. How to capture these occasional RF interference sources and comprehensively understand the signal frequency, power, probability, time and other multi-dimensional information is an important challenge facing RF engineers.

Compared with traditional RF receivers or spectrum analyzers, real-time spectrum analyzers provide many superior functions for radio monitoring and spectrum management applications. Using the real-time analysis characteristics of the real-time spectrum analyzer, the transient, sudden and elusive complex signals can be captured quickly and reliably. However, the light capture is not enough. How to present the details and characteristics of the signal? This requires the use of the *density* in the real-time spectrum analysis mode, which is often referred to as *afterglow display*.

What is the density?

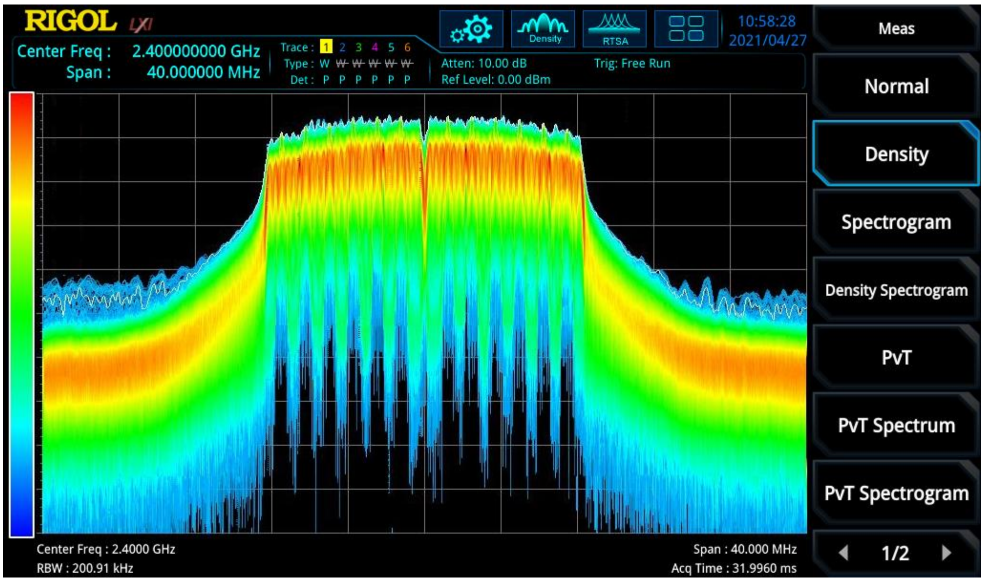

Fig. 1 Density view

The density is defined as the number of times a frequency and amplitude point is hit during an acquisition interval. X-axis represents frequency, Y-axis represents amplitude, Z-axis represents number of hits, and T-axis represents time. This view displays four-dimensional data on a two-dimensional display, using color to represent Z-axis and brightness to represent T-axis.

As shown in Figure 1, the density view will also display a white trace. This trace shows the real time spectrum for the latest acquisition interval. When using positive peak, negative peak or average detectors, the white trace obtains detector data from all data within the acquisition interval. When using the Sample detector, the last FFT was adopted. In order to display the signal status over a longer time range, multiple density view can be displayed on the screen. The latest density view is displayed with the highest brightness. The longer the time from the latest density view, the lower the brightness of the density view. Such display of the brightness is generally called persistence view.

Discover the detailed characteristics of the measured signal

The density view is particularly suitable for analyzing signal features that are difficult to detect by traditional methods. By comparing the monochromatic spectrum display of the traditional spectrum analyzer with the density view of the RSA real-time spectrum analyzer, we illustrate the difference between them.

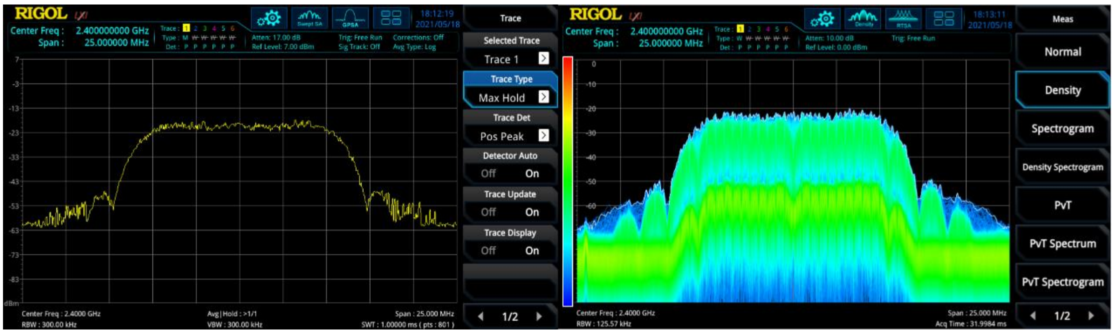

Fig. 2 Normal view(left), Density view(right)

Fig. 2 shows the analysis and display of the same WLAN signal by the traditional sweep monochromatic spectrum and density spectrum. We can clearly observe that the density mode can clearly display the upstream and downstream content of WLAN signal, while the traditional spectrum analyzer can only display the peak amplitude of the signal using a monochromatic trace. This is because the density view uses the color temperature technology, which uses colors to represent the frequency and time of different signals.

- First of all, the number of signal hits is represented by the color depth. Low hits are represented in lighter color, and high hits are represented in darker color.
- Secondly, the time information of the signal is displayed by adjusting the color shade. The newly appeared signal is displayed with the highest brightness. The longer the distance from the current time, the lower the brightness of the signal.

In contrast, because of the principle of "power accumulation", the traditional scanning spectrum analyzers can only display the highest energy signal in the maximum holding trace and cannot distinguish whether there are other signals on the same frequency point or frequency band.

Find hidden signals

Density mode is very effective for detecting instantaneous signals that are hard to find, or for finding time-varying small energy signals that are hidden beneath the spectrum of other signals.

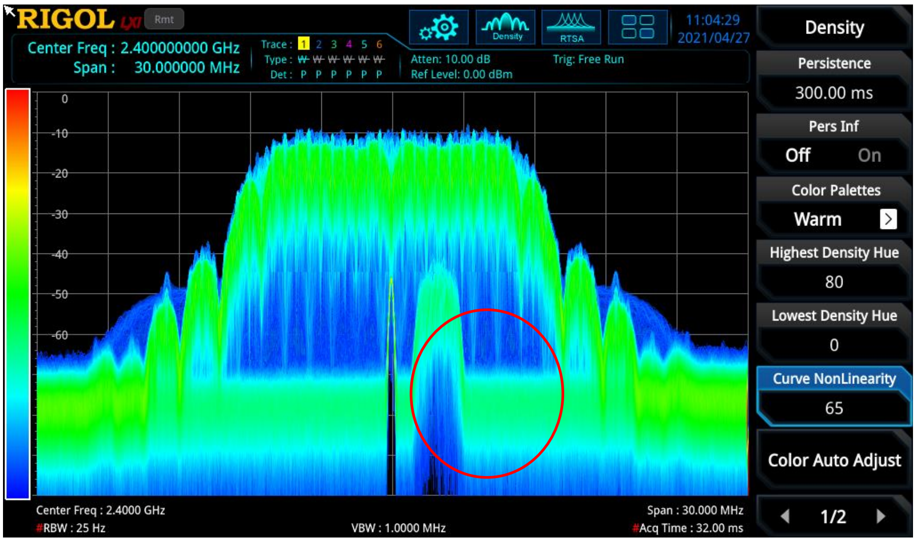

Fig. 3 Hidden signals found in density mode

Usually, the small transient signals hidden beneath larger signals are hard to detect, but they will have a serious impact on the quality and safety of the signal. With the advent of real-time spectrum analyzer, even if the small signal appears irregularly in time and the signal duration is very short, using density view, it can also be displayed on the screen, "leaving a trace", which provides the possibility for further signal analysis and intervention.

Resolve co-frequency signals

When there are multiple signals in a frequency band and overlap each other, traditional analyzers can hardly view these signals separately. The display usually only shows the superposition of the signal energy at each frequency point.

In Figure 4, at the frequency band of 2.4GHz, there are WLAN signals, Bluetooth transmission signals and multiple signals with low repetition rates and wide frequency bands covering the whole frequency band. With traditional monochromatic sweep spectrum, when there are many different signals in the same frequency band, it is difficult to see which signals exist, or even to distinguish different signals at all. Using density view, the whole problem can be easily solved.

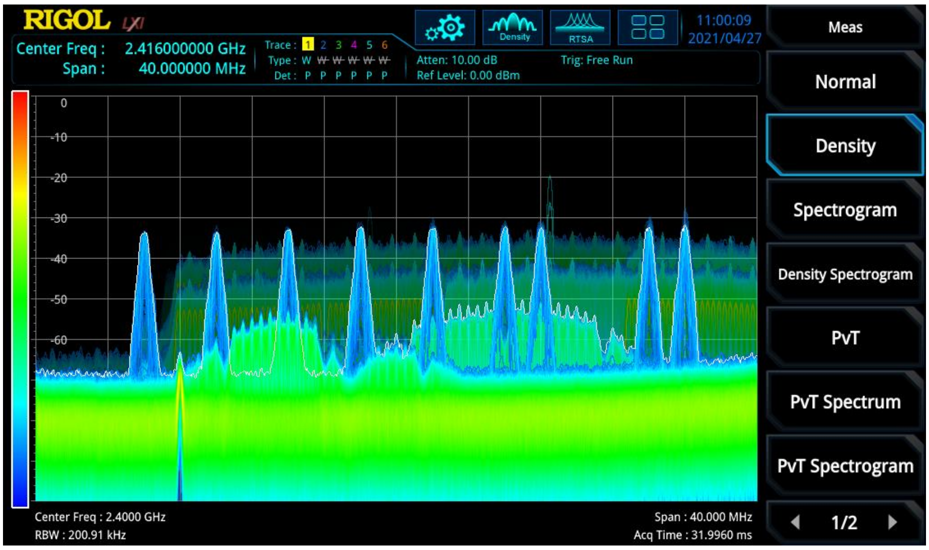

Fig. 4 Resolve co-frequency signals in the density view

When two time-varying signals overlap, the density view can simply display different signals. In the figure above, we can easily distinguish multiple overlapping signals on the same channel. The color of the signal tells us the frequency of each signal, and the brightness of the signal tells us the time information of each signal.

In addition, we can easily analyze that noise-like wideband signals with low occurrence interfere with all other signals, and it is easy to see on the display which signals are stronger and which are weaker than the interference signals.

Observe the crowded spectrum

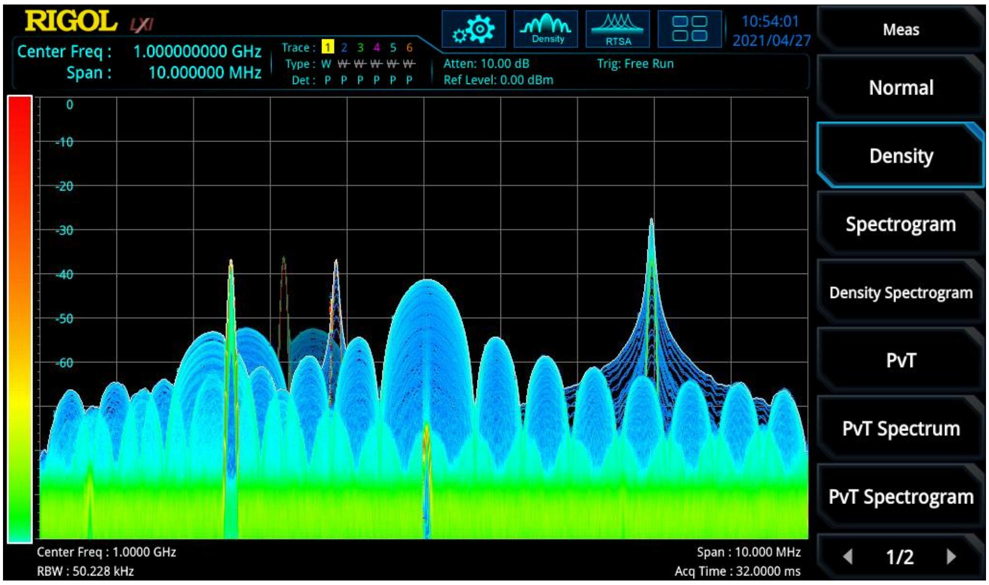

Fig. 5 Observe the crowded spectrum in the density view

Fig. 5 is an example of time-sharing displays of some dynamically changing signals, transient abrupt signals, and multiple signals within the same frequency range. Without effectively viewing all of these signals, we may not know whether they are working efficiently performing time-sharing or whether they are causing serious interference with each other.

The density view can not only help us to see the time-varying RF signals that could not be displayed separately or even at all, but also can accurately analyze the specific information contained in the signal. Even when signals are completely overlapped, the density view can still distinguish and reveal the properties of multiple time-varying signals, and clearly know its amplitude and frequency. This is impossible in the traditional monochrome display.

Conclusion

The density view demonstrated above is just a small feature of the RIGOL RSA series real-time spectrum analyzer. Let's explore more gameplay of the real-time spectrum analyzer!