Possibilities and More

Comparing Spectrum Analyzers: GPSA vs RTSA

Application Note

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Date: 05 September 2024

Version: 1.0
Status: Release

Contents

1 Document Control

1.1 Revision History

Revision Number	Date	Name	Notes
1	8/27/24	Hugo Torres	draft
1.0	9/5/24	Torres / Hodges	Release

1.2 Reviewers

Reviewer	Date	Feedback
Eric Hodges	9/3/24	Minor edits

2 Introduction

The spectrum analyzer and the oscilloscope are two of the most used electronic devices for the measurement of electric signals. Whilst oscilloscopes present the final information in the time domain on a screen, spectrum analyzers display the intensity (vertical axis) of electric signal information in the frequency domain (horizontal axis). Currently, it is possible to find oscilloscopes able to handle high-frequency signals in the gigahertz frequency band. However, oscilloscopes have an important limitation: as the frequency increases, the noise floor displayed in the time domain also increases, making it difficult to distinguish low-intensity signals, such as harmonics and spurious signals, from the background noise. Thus, spectrum analyzers represent the best tool when working with high-frequency signals. The most advanced spectrum analyzer can work from some kilohertz to various tens of gigahertz. There are even spectrum analyzers applied to optics for measuring fiber-optic signals.

2.1 Types of Spectrum Analyzers

At present, there are two principal techniques for processing electric signals on spectrum analyzers. They represent the evolution of this instrument. The first type is the swept spectrum analyzer or general-purpose spectrum analyzers (GPSA), which is an analog measurement device and consists basically of filters and a local oscillator that sweeps a range of frequencies, one frequency at a time. This process captures signals in the frequency domain. As available technology has advanced, GPSAs have been enhanced with the use of analog-to-digital integrated circuits, allowing for the storage and processing of signals for mathematical operations and basic functions such as peak detection and measurements. This represents a significant advancement, as signals can now be processed digitally rather than analogically, as was the case with the initial versions of GPSAs, which were heavy and bulky instruments.

One of the most significant limitations of GPSAs is their inability to detect intermittent and fast-changing signals. This phenomenon can be attributed to the fact that signals present within a given frequency range are captured one at a time. The counterpart of GPSAs is the real-time spectrum analyzers (RTSA), which captures information in the time domain. This information is then transformed by advanced data processing algorithms into the frequency domain. In other words, the user can observe all the signals present within the specified frequency range, thereby ensuring that no information is lost.

RTSAs are especially useful to analyze advanced signals, for example, frequency hopping spread spectrum signals in Bluetooth or detect intermittent spurious transient signals. Nevertheless, this technique is not without its disadvantages. For instance, the implementation of windowing filters is necessary, and the frequency range of analysis is relatively narrow.

Owing to this limitation, the technological development focus of RTSAs as advanced tools has been to expand the frequency range of real-time operation. Currently, typical

RTSAs have a dynamic frequency range of a few tens of MHz, enabling them to detect signals in real-time mode. Another capability of RTSAs is their operational flexibility, which allows them to transition to GPSA mode when the user needs to cover a broader range of frequencies that exceeds the functional real-time frequency range. This feature is particularly beneficial in EMI analysis, as it allows users to conduct tests on different frequency segments during the testing process.

3 General Purpose Spectrum Analyzers

Figure 1 illustrates the fundamental general purpose spectrum analyzer (GPSA) diagram. This is the standard design based on a superheterodyne receiver, which is a widely used component in high-frequency receivers. The design employs a sequential approach, with each frequency being processed individually. This is followed using an RF mixer to lower the frequency through the use of a local oscillator (LO). The sweep control module is then synchronized to cover the user's frequency range in discrete frequency steps.