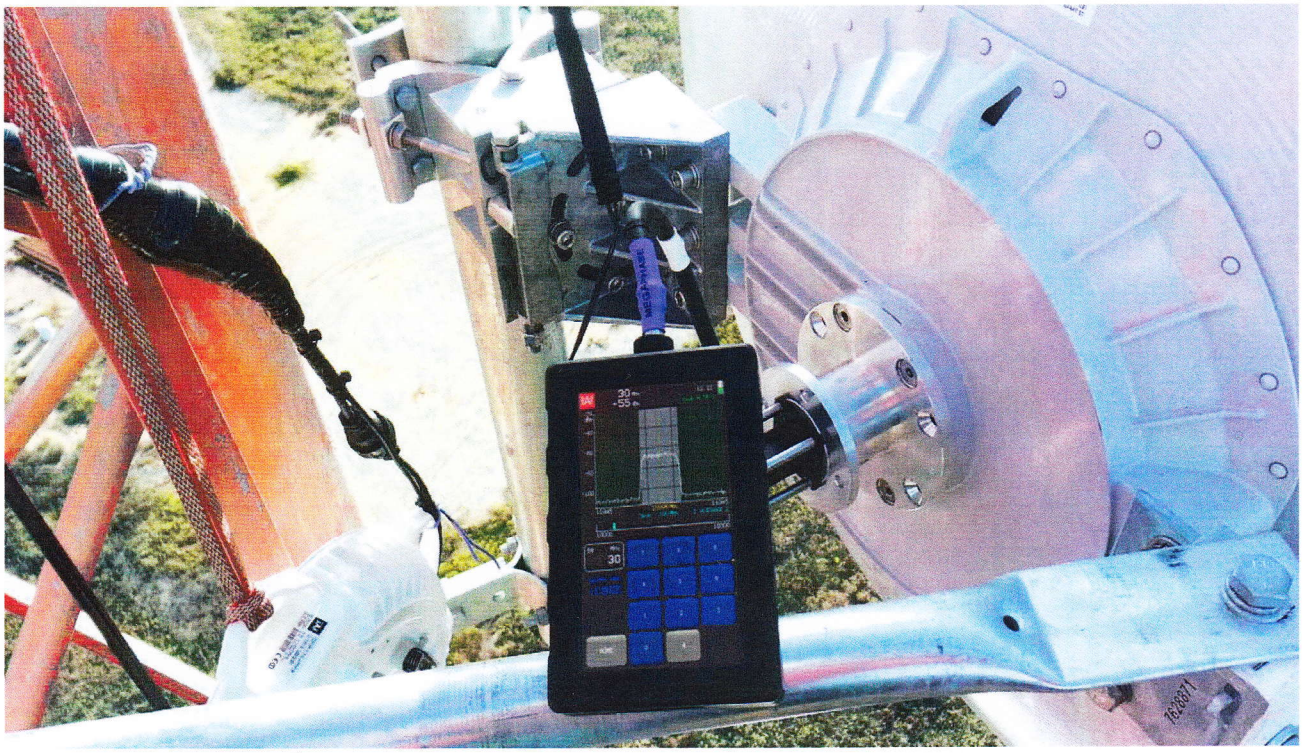


# Microwave Field Work With a Portable Spectrum Analyzer

The ultimate tool for microwave engineers is a compact, portable spectrum analyzer that brings the functionality of a mobile laboratory into the field. Antenna alignment becomes quick and easy.

**By Vents Lacars**



Nearly all activities related to microwave link troubleshooting have involved moving back and forth between miles-long links, climbing towers and using expensive, heavy, inconvenient and complex tools. A cell phone-sized spectrum analyzer represents a productive alternative for determining the causes of problems and for focusing on their resolution. Given how costly an hour of an installer's service is, using a portable spectrum analyzer would prove efficient in saving time and money.

Many current spectrum analyzers can be used for the same application, but they are complex to operate, they usually cost tens of thousands of dollars and, despite being marketed as mobile, they have an impractical form factor. A better alternative is a

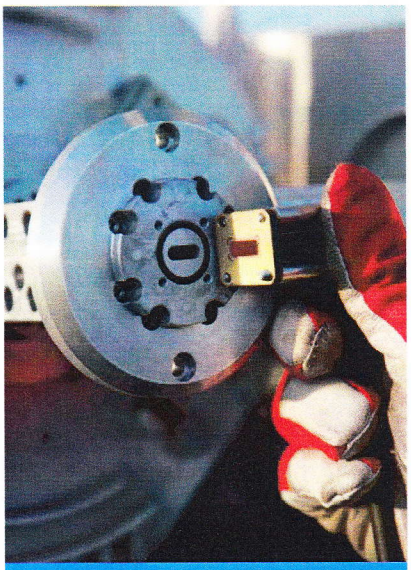


IMAGE 1

IMAGE 2

Image 1. The standard kit includes connectors that are compatible with most antennas.

Image 2. Look for possible interference using the Max Hold feature.

Image 3. Verify the polarity of the transmitting radio by just pointing the horn antenna in the direction of the transmitting antenna. Also try a different polarity by rotating the connector by 90 degrees to detect right polarization.

Image 4. Adjust the Antenna using the Spectrum Compact spectrum analyzer for a cross polarization interference cancellation (XPIC) application.

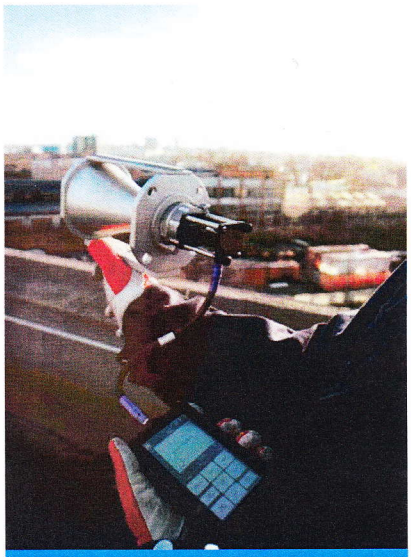


IMAGE 3

IMAGE 4

handheld spectrum analyzer that is only slightly larger than a cellphone in weight and size, yet is as functional as expensive mobile laboratories.

At SAF Tehnika, extensive knowledge of radio-related processes and issues faced by customers provided a good basis for what started out as an effort to provide a local solution. The project morphed in unforeseen ways. The idea to create a handheld spectrum analyzer appeared as a remedy to deal with the realities of some developing markets where regulators have almost no power and users are effectively relying on self-planning and frequency allocation. These users constantly need to monitor the frequency channels that are in use or to be used.

The small spectrum analyzer, Spectrum Compact, efficiently performs radio parameter verification, antenna alignment, interference and multipath detection, TX and RX power measurements and link troubleshooting, and saves the spectrum curves for reports and later analysis. A resistive touch screen allows the engineer to wear gloves to manipulate the device. High sensitivity (–105 dBm) and a low noise floor enable field engineers to detect exceptionally week signals — much better than the spectrum analyzers built into the microwave radio that may have –80 dBm sensitivity.

## Single Tool for Any Situation

A spectrum analyzer is a useful tool during the entire life cycle of a microwave link, from site survey to radio installation, site acceptance and, finally, maintenance and troubleshooting. It performs a multitude of tasks: searching free channels, interference detection, verification of the radio

configuration, antenna adjustment, cross-polarization adjustment and verification, comparative measurements of received signal power, radio operation measurements, inspection of the radio-antenna connection and replacement of already installed antennas.

During the planning stage, it is possible to perform spectrum scans to determine if the chosen frequency and channel are available. This is especially important for license-free frequency bands (17-GHz and 24-GHz bands, depending on the region) and area license frequency bands such as 28 GHz and 38 GHz, the LMDS spectrum.

Until now, the most widely used device for link installation and antenna adjustment has been the multimeter. A multimeter is affordable and allows a relatively simple antenna adjustment. Unfortunately,

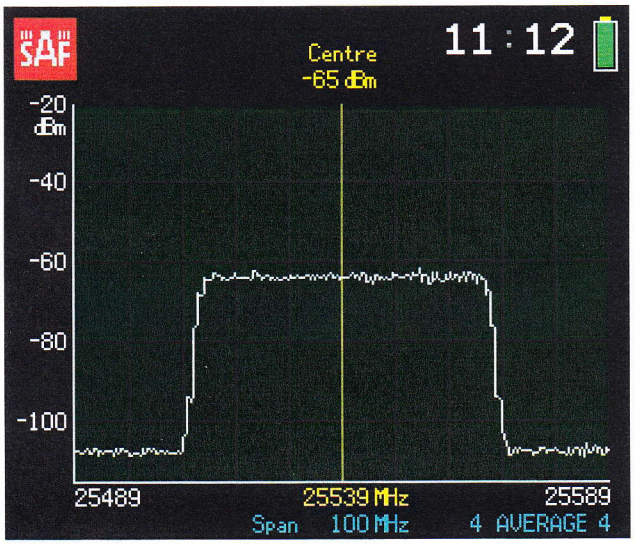



Figure 1. A spectrum scan showing a normal signal. The channel bandwidth is 56MHz; the signal strength in the center is -65 dBm.

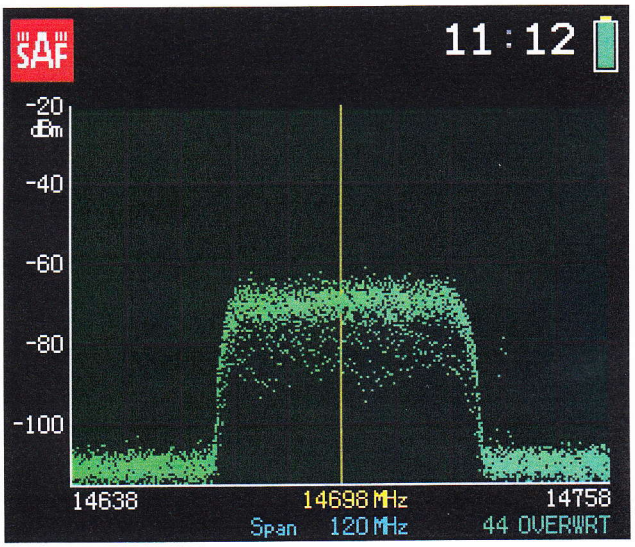
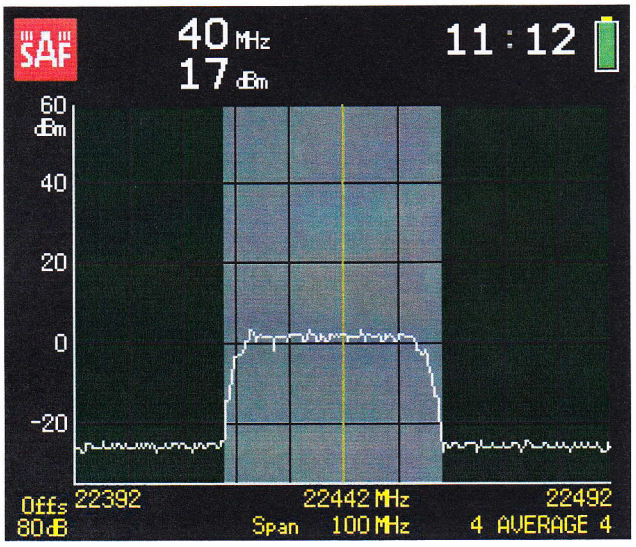



Figure 2. In real-time mode, the compact spectrum analyzer creates layers of scans to reveal multipath interference. This image shows 44 overlaid spectrum scans. The scattered dots indicate that the signal is being influenced by multipath.




.Figure 3. Power-in-band mode allows measuring absolute signal power. The gray area shows the channel bandwidth (40 MHz) with absolute

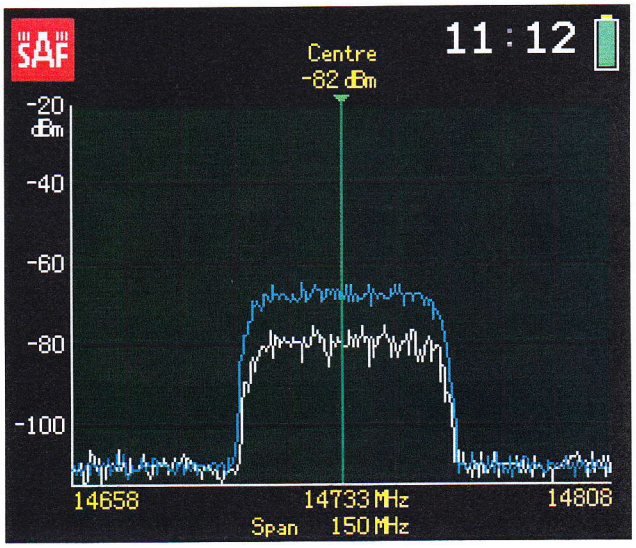



Figure 4. The Max Hold feature fixates the blue line in the received signal peak position so you can adjust the antenna accordingly.

# Spectrum Analzyer Advantage Compared with a Multimeter

Conventional antenna alignment was done by using a multimeter and usually took at least an hour depending on the site topology. The receiving antenna had to be aligned by using a multimeter, which has a few significant drawbacks compared with the antenna alignment using the SAF Tehnika Spectrum Compact spectrum analyzer.

**Multimeter**

• With a multimeter, the installer doesn't see the actual signal and thus is unable to determine its quality.It is impossible to make sure whether the received signal actually comes from your transmitting radio or from other sources.

• Possible multiple interferences cannot be detected.

• A multimeter's nonlinear RSSI scale makes understanding the actual Rx level more difficult.

• With a multimeter, it is possible to miss the signal peak level, thus increasing the risk of aligning the antenna to the side lobe.

• Multimeter measurements are limited to the maximum capacity of the radio receivers's Rx scale sensitivity, thus making it impossible to spot weaker signals. For example, the maximum signal level the radio can indicate is -90 dBm, while the spectrum analyzer can spot signals at levels as low as -105 dBm.

• On towers located near powerful transmitters, multimeter readings can be influenced by unwanted electromagnetic fields.

• Conventional antenna alignment methods do not allow saving spectrum scans for future reference and future troubleshooting.

**Spectrum Analzyer**

• When using the spectrum analyzer, you can align the antenna in less than 10 minutes.

• Program the frequency at which your radio is transmitting.

• Adjust the span of resolution.

• Verify the polarity of the transmitting radio by just pointing the waveguide adapter in the direction of the transmitting antenna. Also try a different polarity by rotating the connector by 90 degrees to detect right polarization. With the spectrum analyzer sensitivity of -105 dBm, even if the link is tens of miles away, you will still be able to pick up signal with this method.

• Attach the spectrum analyzer to the antenna. Go to Trace mode and enable the Max Hold feature, which adds a blue line to the graph. It will indicate and fixate the strongest signal the spectrum analyzer has seen along the configured span.

• Next, loosen the antenna for horizontal adjustment. As you slowly move the antenna, the spectrum curve on the screen is sweeping in real time. You can actually see the signal reaching the main lobe. All you need to do is to tighten the antenna in a position where the spectrum analyzer has fixated the signal maximum, and then make the vertical adjustment.

• Perform the same steps during the vertical alignment and you will quickly find the main lobe and adjust the antenna into a position where it receives the strongest signal, meaning you have successfully aligned it to the maximum possible precision.

• Hit the Save button, which will save the screen for further analysis. And that is all you have to do. Alignment is finished in just a few minutes.





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it has shortcomings: There are situations in which it is difficult to adjust an antenna and locate the incoming radio signal peak while using a multimeter because of the poor reciever sensitivity of the microwave radio. The process tends to be time-consuming, the multimeter's readings could be affected by unwanted electromagnetic fields, and the conversion of volts to dBm requires using conversion tables provided by manufacturers. Less-experienced engineers could accidentaly adjust the antenna to the sidelobe. In contrast, a spectum analyzer makes it easy to adjust the antenna with maximum precision in less than 10 minutes.

Connected with the antenna and with the initial adjustments made, a spectrum analyzer visualizes the changes in the detected signal amplitude or strength. It finds the point where the received signal is strongest and adjusts the antenna accordingly, avoiding the sidelobe. During the antenna installation process, it is also possible to use the spectrum analyzer as a power and bandwidth meter. The analyzer can be attached to almost any manufacturer's antenna using standard flange waveguide adapters.

A multimeter is a fine tool for antenna installation and adjustment, but troubleshooting usually turns out to be a guessing game because there is no universal system for determining the possible causes for the encountered problems, to say nothing of situations in which an engineer has to climb a tower only to verify that the radio is functioning at all.

Checking whether the radio is turned on and operating, determining the transmitter's bandwidth and frequency, and scanning for interference can now be done from ground level with the spectrum analyzer. It also aids in inspecting radio-antenna connections. This advanced functionality is a significant time-saver because it allows the user to quickly narrow down the range of possible problems and their causes.

For site maintenance purposes,

the analyzer user can save spectrum scans, which could then later be compared with current measurements in order to detect possible changes in radio performance. This is already a common practice of several large telecommunication companies.When saving a spectrum scan, the device also makes a time stamp and allows saving the coordinates using a GPS logger. By using the spectrum analyzer's PC application, the gathered data later can be viewed in Google Maps.

Most national regulators use expensive and bulky equipment, including mobile laboratories and portable spectrum analyzers costing hundreds of thousands of dollars. However, their daily tasks of determining the presence of interferences and their causes, tracking license-free frequency and channel usage, as well as determining frequencies and bandwidths of installed radios could be efficiently performed with a spectrum analyzer in hand.

## The Future Is Near

Good ideas can easily be ruined by poor execution; many ideas do not even see the light of day because of doubts and insecurities. But fortune favors the bold. Apple completely changed the cell phone market in 2007, proving with the iPhone that the future belongs to touchscreen technology. Similarly, spectrum analyzers will soon become affordable and indispensible tools, popular among engineers and installers. There will always be situations in which people opt for different methods and tools based on different considerations. A test equipment manufacturer's task then is to bring these situations to a minimum and create products that people would increasingly choose to use for the widest range of applications.

## About the Author:

*Vents Lacars is vice president at SAF Tehnika. The company manufactures a spectrum analyzer, called the Spectrum Compact, described in the article. Visit saftehnika.com.*







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