WHITE PAPER

# Four Measurements You Can Perform on the Go

## RTSA, Noise Figure, CAT, and OTA Portable Measurements

## Introduction

An engineer working in the field conducts routine maintenance on and troubleshoots deployed radio-frequency (RF), microwave, and millimeter-wave systems. On any given day, you may need to measure a variety of devices or signals — cables, antennas, over-the-air signals, or intermittent spurious signals — to ensure robust signal quality and uninterrupted service.

Successfully performing these functions requires a basic understanding of measurements and a portable, easy-to-use handheld instrument. This white paper outlines four common measurements you can perform in the field: real-time spectrum analysis (RTSA), noise figure, over-the-air (OTA) testing, and cable and antenna test (CAT).

KEYSIGHT TECHNOLOGIES

# 1. Real-Time Spectrum Analysis

## What is RTSA?

RTSA processes signal samples gap-free and generates measurements, such as scalar, power, or magnitude, that correspond to traditional spectrum analysis measurements.

## RTSA measurements on the go

Signal interference over wireless networks is on the rise, resulting in poor signal quality that leads to dropped calls or choppy audio. It has a profound impact on wireless devices and communications, ranging from car radios to mission-critical applications such as public safety.

Traditional spectrum analysis techniques contain dead time wherein the analyzer processes the data for display. Intermittent interference signals may occur during such dead time. Additionally, in a highly dynamic signal environment, wider or longer-duration signals mask weak signals and cause interference. Gapless RTSA, on the other hand, detects and reveals these transient, overlapping signals so that you can visualize the interferer.

Co-channel interference detection and troubleshooting is the most challenging task in a communications network, because interferers can hide under the serving frequency. Typically, a user has to turn off the carrier transmitter to find any other signals that appear in the same frequency channel before eliminating or reducing their impact. Turning off the carrier signal tends to be intrusive and can disrupt normal communication services. Furthermore, under many circumstances, turning off serving transmitters is not a viable solution, depending on the nature of the services, such as base station testing. Fortunately, RTSA profiles over-the-air characteristics, detecting hidden interferers under the serving carrier.

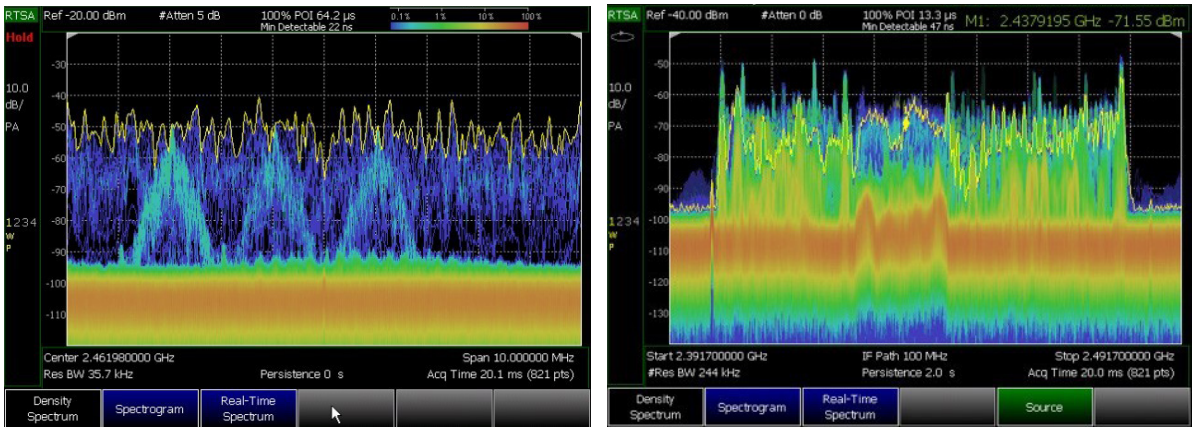
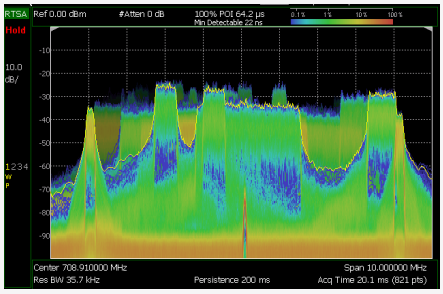
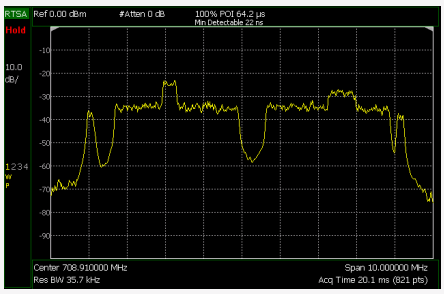



**Figure 1. A Wi-Fi signal captured by a FieldFox handheld analyzer with 10 MHz bandwidth on the left and 100 MHz bandwidth on the right. With 100 MHz bandwidth, you can visualize the whole band in one display.**

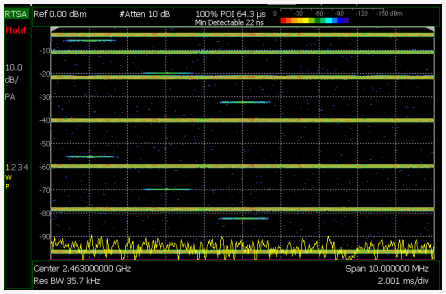
FieldFox handheld analyzers with RTSA capture quickly changing digital and pulsed signals as narrow as 5.52 µs with a 100% probability of intercept and full amplitude accuracy. With up to 100 MHz bandwidth, FieldFox's RTSA mode can verify 5G and other wideband signal types. Use RTSA to verify signal integrity or identify unwanted signals that are undetectable with traditional spectrum analyzers.



Density: histogram display



Spectrum: trace display



Spectrogram: spectrum over time display

**Figure 2. FieldFox displays RTSA in three settings: density, spectrum, and spectrogram.**

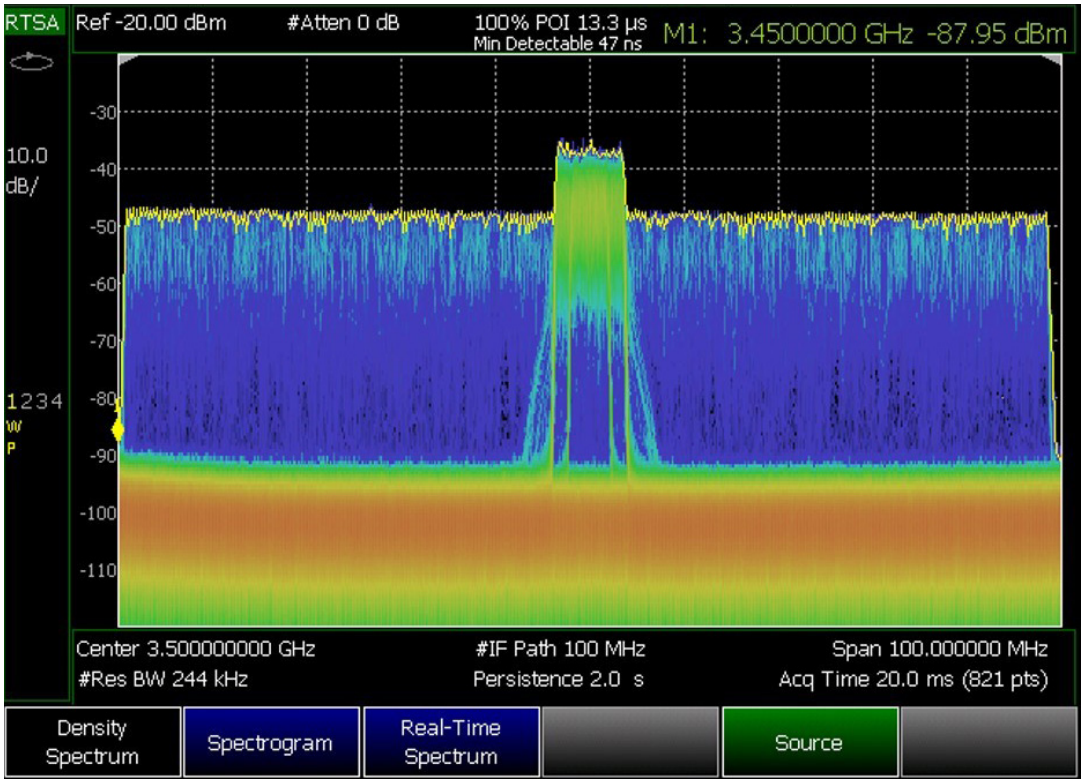



**Figure 3. FieldFox's 100 MHz real-time bandwidth identifies a 5G NR signal.**

To gain a deeper understanding of RTSA, check out the application note Overcoming RF & MW Interference Challenges in the Field Using Real-Time Spectrum Analysis.

# 2. Noise Figure

## What is noise figure?

Noise figure measures the degradation of the signal-to-noise ratio as a signal passes through an active or passive device. Noise figure uniquely characterizes entire systems in addition to their components, including preamplifiers, mixers, and intermediate frequency amplifiers. By controlling the noise figure and gain of the components, the designer controls the noise figure of the overall system. Once you identify or know the noise figure, you can easily estimate system sensitivity from the system's bandwidth.

## Noise figure measurements on the go

One key performance indicator for a receiver is its sensitivity — the ability to reliably discern small signals close to the noise floor. A communication system's performance relies on its signal-to-noise ratio. Lower noise figure values typically mean better device performance. Internally generated noise, however, can hinder a device's performance. Internally generated noise reduces the link budget, increases investment by the transmitter, and increases the antenna cost at the receiver. To get a complete picture of system performance, you need an additional evaluation of internally generated noise. Decreasing receiver noise is the most cost-effective way to optimize communication systems without reducing quality.

Combining noise figure measurements with FieldFox's two-port vector network analyzer, spectrum analyzer, and power sensor capabilities enables you to completely characterize amplifiers and converters in the field. FieldFox analyzers make noise figure measurements in the field simple with touch-of-a-button measurements. This feature includes the most common method of measuring system noise — the "Y-factor" method. This technique allows you to measure system components such as amplifiers, downconverters, and upconverters. You can easily view the change in uncertainty in real time with the built-in uncertainty calculator, which displays vertical bars over the trace data. Being able to make these measurements quickly to characterize noise figure is important to optimize designs in the most cost-effective manner.

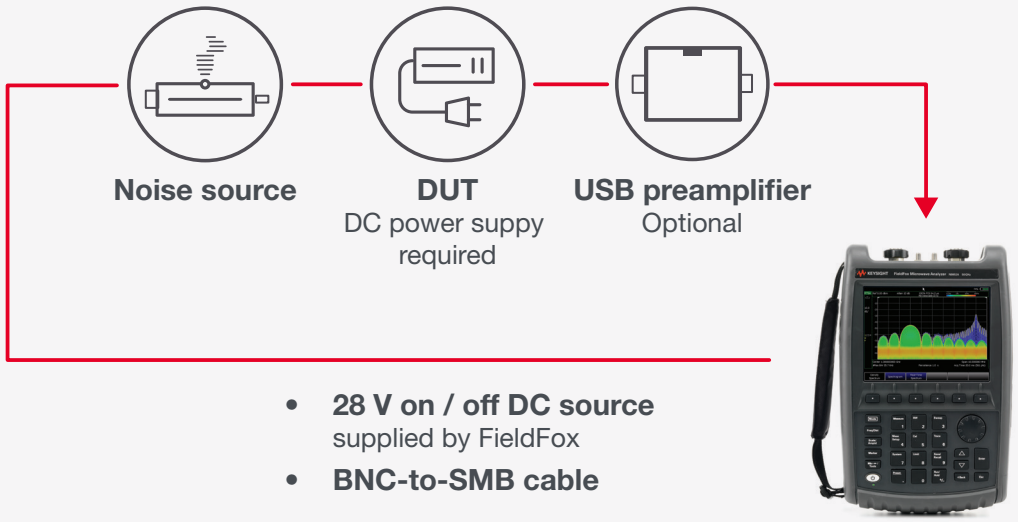



**Figure 4. Noise measurement with the FieldFox handheld analyzer.**

# 3. Cable and Antenna Test

## What is CAT?

Faulty cables, connectors, and antennas cause many cellular base station problems. The failure of these components in cellular systems causes several issues, including poor coverage and unnecessary handovers. Cable and antenna measurements verify and troubleshoot RF / microwave transmission systems and antennas. These measurements occur along the coaxial cable that connects a transmitter to its antenna, or between an antenna and its receiver. CAT identifies the location of poor performance in adapters and damaged antennas, as well as breaks or bends in cable lines.

## CAT measurements on the go

Harsh weather conditions frequently cause maintenance issues and failures in exposed cable system transmission lines. Sheltered cable installations also subject components to heat, stress, and oils that leak into the system. Additionally, cable faults commonly occur at interfaces between cables and connects where soldered joints and crimps in the cable weaken and break.

Transmission lines are often long, and sometimes kinks or cuts form in a line, making end-to-end cable measurements nearly impossible. Here are two cable troubleshooting techniques to try:

- Distance to fault (DTF) reports the location of each cable fault.
- Time-domain reflectometry characterizes the type of fault, such as a bend in the cable, or cut.
  - A bend in the cable appears capacitive.
  - A nick in the cable appears inductive.

FieldFox can perform DTF and TDR measurements in one sweep so that results show simultaneously, saving you time in the field.

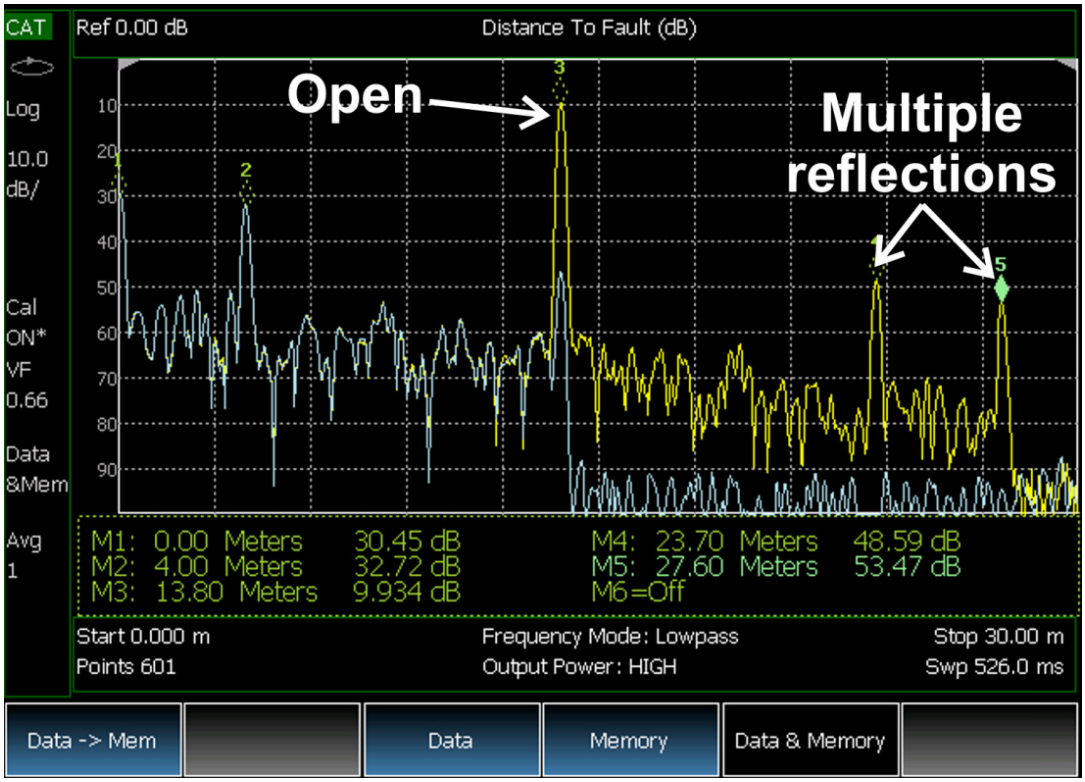



**Figure 5. A DTF measurement made using a FieldFox handheld analyzer. The yellow trace shows a cable with an open end, and the blue trace, stored to memory, shows the same cable terminated in a 50 Ω load.**

FieldFox quickly and accurately characterizes an entire cable transmission system, as well as the individual components in the system. With DTF and TDR measurement capabilities available at the touch of a button, you can quickly pinpoint the location and type of damage in the cable line. You may also verify the performance of a single antenna at the installation site with its signal reflection, return loss, and voltage standing wave ratio functions. When there are multiple antennas at one site, FieldFox also verifies the antenna-to-antenna isolation, whether the antennas are associated with the same system or different systems.

For more information on CAT testing, check out Techniques for Precise Cable and Antenna Measurements in the Field.

# 4. Over-the-Air Testing

## What is OTA?

Wireless networks continue to grow increasingly complex, especially with pioneering technologies such as 5G. Because today's wireless networks consist of layers of macrocells, microcells, and picocells, network coverage is a significant challenge. With users shifting between LTE and 5G, operators face difficulties in defining and troubleshooting wireless coverage. OTA measurements assess the level of cell coverage needed to ensure continuous connectivity in various mobile communication scenarios, including voice, text messages, and data services.

## OTA measurements on the go

Over-the-air antenna testing in the field is the best way to verify that each cell has sufficient neighbors for successful handovers. With OTA measurements, you can scan an area to determine how many cells are available, identify which cells are good neighbors, and troubleshoot handover problems, such as missing neighbors.

FieldFox's OTA application enables OTA LTE and OTA 5G New Radio demodulation to give you insights on cell coverage. This information includes physical cell ID and control channel (often referred to as component carrier) measures on any given frequency for all available cells. OTA measurements also help you address the common problem of identifying missing neighbors. FieldFox OTA provides a useful capability — it displays the strongest cell on different component carriers. This capability expedites the process of selecting the best frequencies for any given location to optimize inter-frequency handover. FieldFox can display cell measurements in table, bar graph, and strip chart formats, as shown in Figure 6.

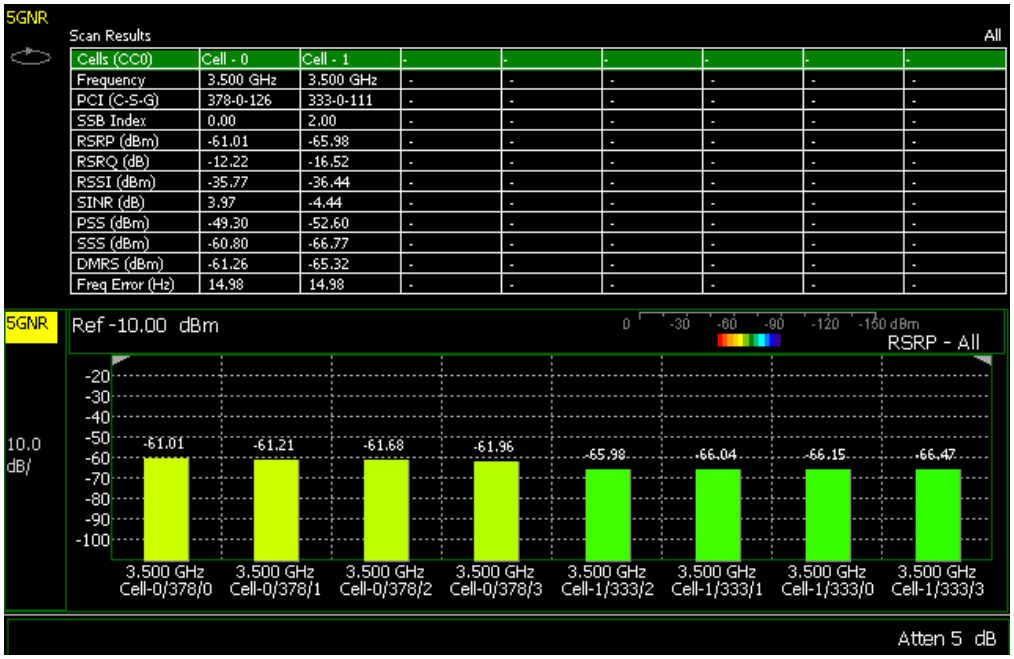



**Figure 6. You can view coverage in table, bar chart, strip chart, or spectrum formats and view up to eight detectable neighbors.**

For more information on 5G over-the-air measurements, check out the application note 5G Over-the-Air Performance Measurement and Evaluation Using FieldFox Handheld Analyzers.

## Conclusion

Installing and maintaining cellular networks, satellite ground stations, radio networks, and other communications systems often requires in-field verification and adjustment of components, such as filters, duplexers, or antennas. Keysight designed FieldFox to perform the measurements that field engineers need so that you never have to sacrifice instrument capability for portability.

With FieldFox's more than twenty measurement applications, you can work with a single user interface that provides customizable parameters for quick measurements that match benchtop precision. Keysight also offers you the convenience and flexibility to upgrade your handheld analyzer with user-installable license keys. When you need additional measurement capabilities added to your unit, there is no need to send the FieldFox back to Keysight for upgrades. To find out more about FieldFox, visit www.keysight.com/find/fieldfox.

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