TECHNICAL OVERVIEW

FieldFox Handheld Analyzers

4/6.5/9/14/18/26.5 GHz

N9913B	N9933B
N9914B	N9934B
N9915B	N9935B
N9916B	N9936B
N9917B	N9937B
N9918B	N9938B

KEYSIGHT TECHNOLOGIES

FieldFox Handheld Analyzers

The Keysight FieldFox handheld analyzers can withstand your toughest working conditions with a ruggedized yet light weight and portable battery powered design for making measurements for RF devices like cables, antennas, filters, amplifiers and signal/spectrum analysis. Create your specialized handheld analyzer solution by selecting FieldFox options and features to address cable and antenna test (CAT) spectrum analysis (SA) or vector network analysis (VNA) real time spectrum analyzer and over the air digital demodulation analysis required for your application. The FieldFox analyzers are always ready to make RF measurements, ensuring every operating mode is flexible enough to meet the needs of novices and experts alike.

This technical overview provides details of the standard FieldFox handheld analyzer features as well as selectable options for addressing your specific application needs.

Why choose FieldFox?

- Ideal 5G deployment and field testing tool with 100 MHz real-time bandwidth and over-the-air (OTA) measurements
- Ability for 5G, satellite and radar operators to make true RF coverage measurements and beamforming verification with phased array antenna support
- Simplified field signal monitoring with wideband capture and recording of fully corrected IQ data
- Highly efficient radar and EW systems diagnostics with spectrum analysis, full 2-port VNA, power meter, pulse and noise figure measurements and results that correlate with high-performance bench top instruments
- Durable handheld analyzers that can withstand your toughest working conditions

Designed for You and the Work You Do Everyday

Carry FieldFox wherever you need to go

- Kit friendly at 7.35 lb. (3.34 kg) for the N991/3xB
- Large buttons are easy to operate, even when wearing gloves
- Field swappable battery lasts up to 4 hours
- Non-slip rubber grip securely fits in your hands and won't slide off the hood of your vehicle
- Vertical "portrait" orientation makes it easy to hold and operate at the same time

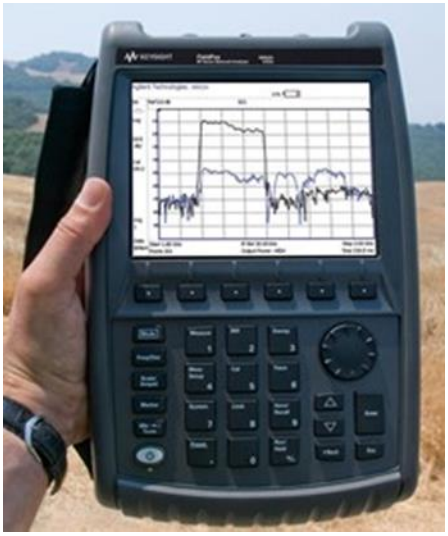
Field-proof usability for better answers in less time

- Bright, low-reflection display and backlit keys enable easy viewing in direct sunlight or darkness
- Intuitively designed user interface for your workflow, enabling measurements in fewer key presses
- One-button measurements simplify complex setups and ensure quick, accurate results with confidence
- Calibration Wizard guides user to ensure simple and accurate calibrations
- Standard three-year warranty ensures field confidence, especially in harsh environments
- 5, 7- and 10-year warranties are also available

Easily operate FieldFox, even when wearing gloves, through the large front panel keys

Designed for your Toughest Working Conditions

- Rugged enough to meet MIL-specs
- Completely sealed instrument enclosure provides measurement stability in harsh environments, -10 to +55 ºC, (14 to 131 ºF)
- Specially designed to protect instrument from damage due to drops, shock or other external impacts
- Water-resistant chassis, keypad and case withstand wide temperature ranges and salty, humid environments
- Meets MIL-PRF-28800F Class 2 requirements
- Type tested and meets MIL-STD-810G, Method 511.5, Procedure I requirements for operation in explosive environments
- Type tested and meets IEC/EN 60529 requirements for ingress protection



Read measurements in direct sunlight with the transflective display

Count on extended instrument reliability with Field Fox's dust-free design: no vents or fans.

RF and Microwave Spectrum Analyzers

"Combination" Analyzers

Base: Spectrum analyzer	Base: Cable and antenna analyzer
100 MHz bandwidth	
Built-in power meter	
Pulse measurements	
Channel scanner	
GPS receiver	
Real-tome spectrum analyzer	
89600 VSA software connection	
Surveyor 4D software connection	
I/Q analyzer	
Noise figure	
Over-the-Air (OTA) LTE FDD and 5G	
Indoor and outdoor mapping	
EMF measurements (general and 5G)	
Full-band tracking generator	Spectrum analyzer
Full-band preamplifier	Vector network analyzer
USB power sensor	TDR cable measurements

Vector network analyzer (VNA)	
Frequency range	300 kHz to 26.6 GHz
System dynamic range	117 dB
Trace noise	0.001 dB
Directivity	39 dB
Output power	9 dBm
Calibrations	CalReady, SOLT, WG, Unknown thru, Response Cal, Ecal

Spectrum analyzer	
Frequency range	5 kHz to 26.5 GHz
Spur-free dynamic range	
Amplitude accuracy	0.2 dB
Phase noise	-117 dBc
DANL (pre on)	163 dBm
CW/tracking generator	30 kHz to 26.5 GHz
Input related spur	-80 dBm
TOI	+13 dBm @ 2.4 GHz

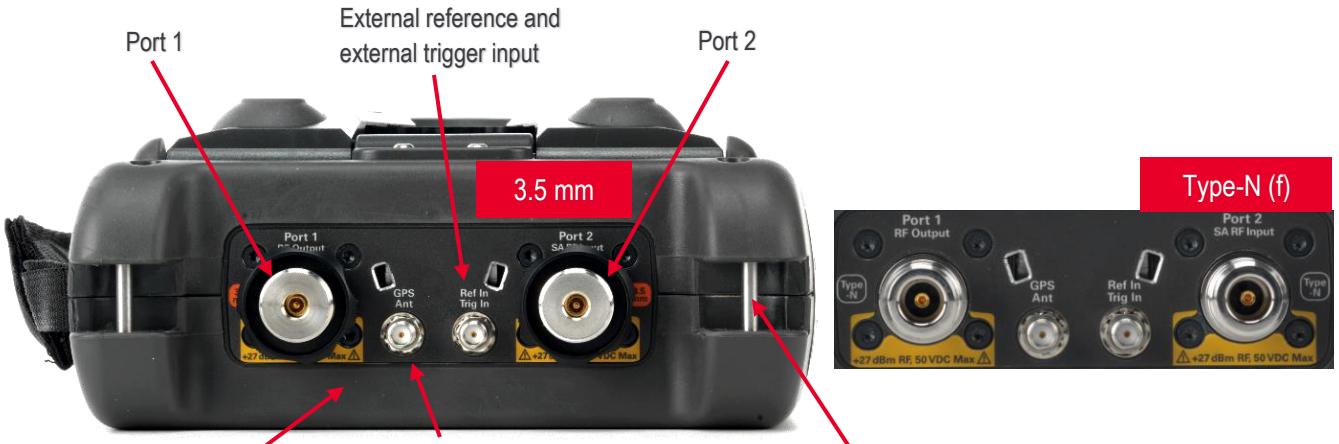
For details of the selectable options and their features of these high-level configurations and more, see the following topics.

- Cable and Antenna Analyzer
- RTSA, digital demodulation and noise figure
- Spectrum Analyzer
- Vector Network Analyzer
- USB Power Sensor Support
- Software and System Features

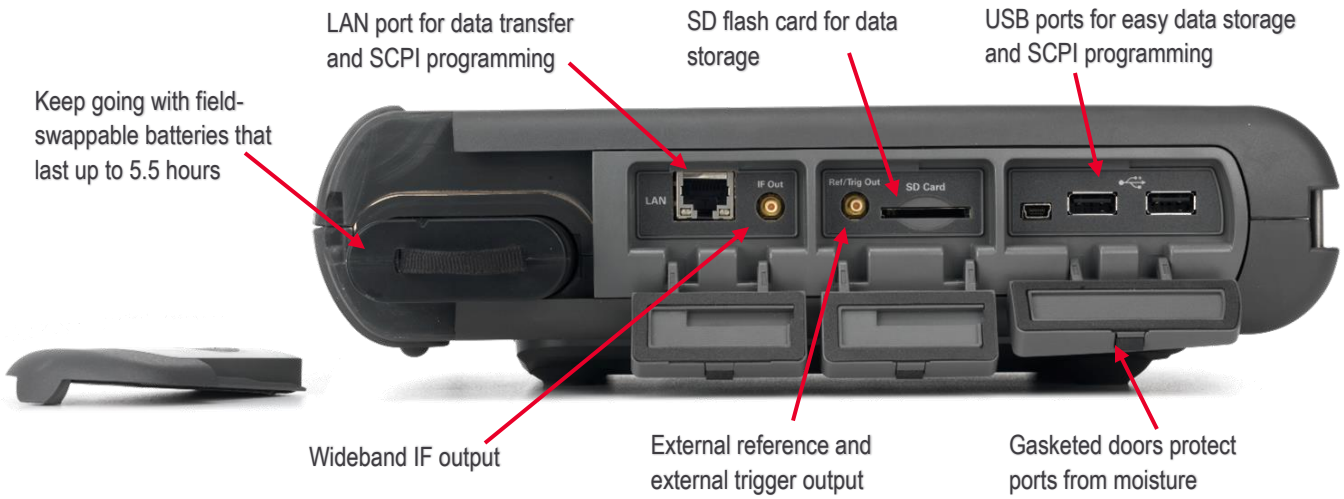
Pick Up FieldFox for its Ergonomics

… and Depend on Its Durability and Convenience

TOP



RIGHT SIDE



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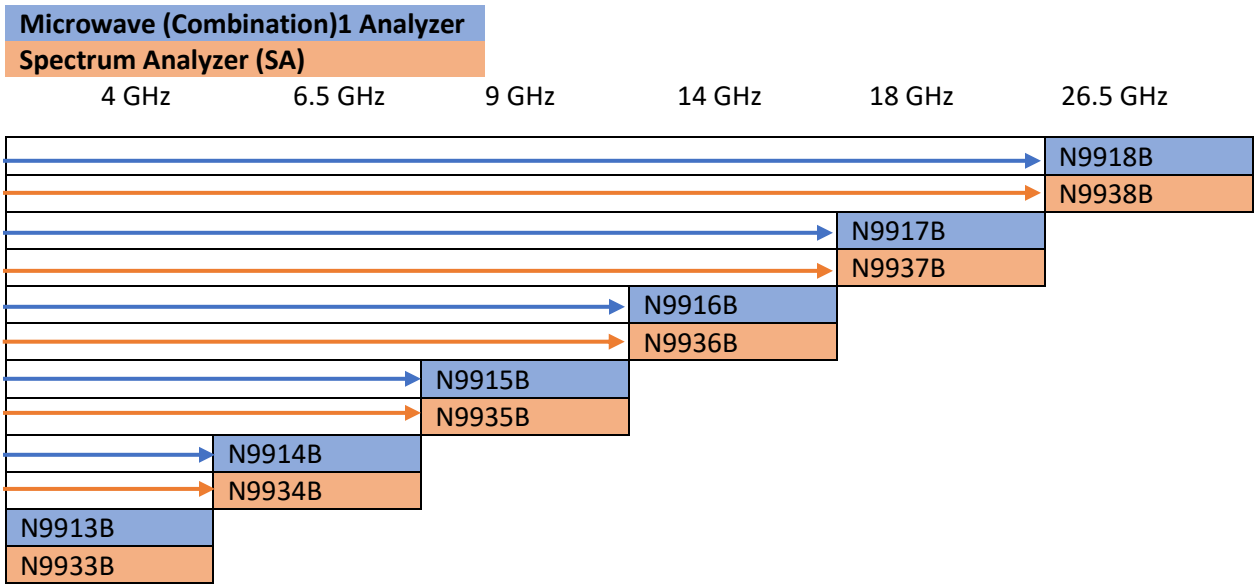
Choose the FieldFox that Meets Your Needs



Notes:

- For more information on N991xA, N992xA, N993xA, N995xA, N996xA RF, microwave and milli-meter wave FieldFox models, see Technical Overview (5992-0772EN), Configuration Guide (5990-9836EN) and Data Sheet (5990-9783EN).

Create the Right Configuration for Your Application

Select the capabilities (FieldFox options) you need today and add more as needs change. Add field-upgradeable features via software license keys. The reference to combination analyzers includes RF and microwave analyzers in this section. See the FieldFox Handheld Analyzer Configuration Guide for complete information on all FieldFox products and accessories http://literature.cdn.keysight.com/litweb/pdf/5992-3701EN.pdf

Option	Description	Combination Analyzers N9913/4/5/6/7/8B	Spectrum Analyzers N9933/4/5/6/7/8B
CAT / vector network analysis			
010	VNA time domain	✓	—
210	VNA transmission/reflection	✓	—
211	VNA full 2-port S-parameters	✓	—
212	1-port mixed-mode S-parameters	✓	—
215	TDR cable measurements	✓	—
305	Cable and antenna analyzer	Base model	—[1]
308	Vector voltmeter	✓	—
320	Reflection meas. (RL, VSWR and scalar meas.)	—[2]	✓
Spectrum analysis			
209	Extended range transmission analysis (ERTA)	✓	✓
220	Tracking generator	—[3]	✓
233	Spectrum analyzer	✓	Base model
235	Pre-amplifier	✓	✓
236	Interference analyzer and spectrogram	✓	✓
238	Spectrum analyzer time gating	✓	✓
312	Channel scanner	✓	✓
350	Real-time spectrum analyzer (RTSA)	✓	✓
351	I/Q analyzer (IQA)	✓	✓
352	Indoor and outdoor mapping	✓	✓
355	Analog demodulation	✓	✓
356	Noise figure (NF)	✓	✓
358	EMF measurements	✓	✓
360	Phased array antenna support	✓	✓
370	Over-the-Air (OTA) LTE FDD	✓	✓
377	Over-the-Air (OTA) 5GTF	✓	✓
378	Over-the-air (OTA) 5G NR	✓	✓
B04	Analysis bandwidth, 40 MHz[4]	✓	✓
B10	Analysis bandwidth, 100 MHz[4]	✓	✓
Power measurements			
208	USB power sensor meas. versus frequency	✓	✓
302	USB power sensor support	✓	✓
310	Built-in power meter	✓	✓
330	Pulse meas. with USB peak power sensor	✓	✓

[1] Option 305 is not available on the N993xB. A subset of CAT measurements, return loss and VSWR, is available as Option 320.
[2] Option 320 is not applicable to N991xB. The reflection measurements of return loss and VSWR are included with every N991xB. So, there is no need for an Option 320 on these analyzers.
[3] On the N991xB analyzers, order Options 233 and 210 to obtain a tracking generator with the spectrum analyzer. There is no Option 220 on the N991xB analyzers. Option 233 provides the spectrum analyzer capability and Option 210 the "tracking" capability.
[4] 10 MHz standard.

System features			
030	Remote control capability	✓	✓
307	GPS receiver	✓	✓
309	DC bias variable-voltage source	✓	✓
	SCPI over LAN and USB		
Windows based software			
89601B	89600 VSA software	✓	✓
N6820ES	Surveyor 4D Software	✓	✓

Cable and Antenna Analyzer

Fifty to sixty percent of microwave-link equipment issues are related to cables, antennas and connectors. Degraded feeder lines cause poor coverage, link failures, and reduced sensitivity in the receive path. To maintain the quality of a microwave link, it is critical to keep cable and antenna systems in good working condition. FieldFox is uniquely qualified to provide all the necessary measurements to troubleshoot and maintain these systems.

Insertion loss and cable loss

Insertion loss or cable loss characterizes the loss of a jumper cable, feeder cable, diplexer, or gain of a tower-mounted amplifier (TMA). With FieldFox, you can measure both the 1-port cable loss and 2-port insertion loss. Also, FieldFox's extended range transmission analysis (ERTA) option, is useful for measuring long, lossy in-situ cables.

Return loss/VSWR

Return loss (RL) or VSWR is the single most important parameter used to measure and verify a cable and antenna system. This measurement reflects the power transfer efficiency of a given system.

Distance-to-fault (DTF) and time-domain reflectometry (TDR)

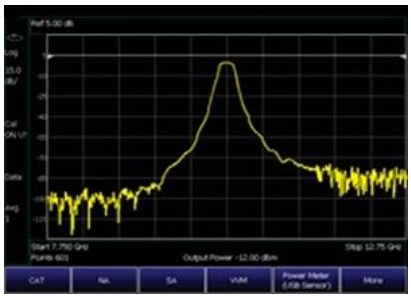
DTF helps you determine the location of discontinuities in feeder lines. TDR helps you determine the nature of the discontinuities, for example, short, open, or water ingress.

With FieldFox, you can make RL and DTF measurements at the same time. This helps you correlate overall system degradation with specific faults in the cable and antenna system. The built-in cable editor lets you edit existing cable types onsite and save them as new cable types with user-defined names.

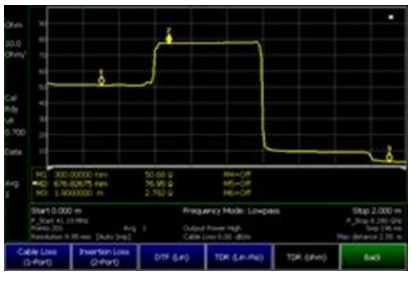
Measure both DTF and TDR in single sweep

FieldFox's TDR complements RL and DTF measurements. TDR measures impedance changes along the cable and helps identify specific faults, RL exposes mismatch issues, and DTF indicates faults and poor connections. FieldFox is the only handheld instrument that can measure both DTF and TDR in a single sweep.

View return loss and DTF simultaneously



Characterize filter insertion loss



Gain insight into faults with TDR measurements

CalReady-calibrated at power on and ready to go

Save time and get right to work with FieldFox's CalReady feature. With CalReady, the analyzer is already calibrated and ready to make measurements such as S11, S22, 1-port cable loss, and DTF/TDR measurements without having to connect and disconnect additional calibration devices.

Broadband calibration

FieldFox allows you to make broadband calibrations, which means the instrument is calibrated over the maximum frequency range. After a broadband calibration, you can change the frequency range or number of points without recalibrating the instrument. The calibration is interpolated, and accuracy is maintained.

User cal kit support

For users who wish to use traditional mechanical calibration kits, FieldFox supports most Keysight/Agilent/HP cal kits and allows you to define your own custom calibration kits.

Fast and accurate calibration with ECal

The FieldFox calibration engine supports Keysight's USB ECal modules. ECal support reduces calibration time and the need to make multiple connections during testing, while also providing for greater consistency between measurements. For FieldFox users, that translates into fewer human errors and increased accuracy.

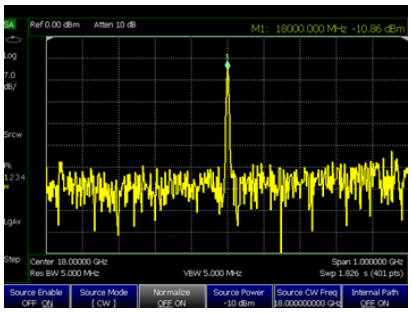
Perform fast and accurate calibrations using ECal

Spectrum Analyzer

In microwave, radar, satellite communications, and commercial microwave backhaul, you may be responsible for hardware installation and maintenance as well as over-the-air signal quality. This could require regular monitoring for unexpected signals and performing signal surveillance.

FieldFox's spectrum analyzer will excel in a dynamic spectral environment. You may face measurement challenges such as the need to detect a low-level signal under strong signal conditions (requiring high dynamic range), or close-in small interference signals (requiring excellent phase noise).

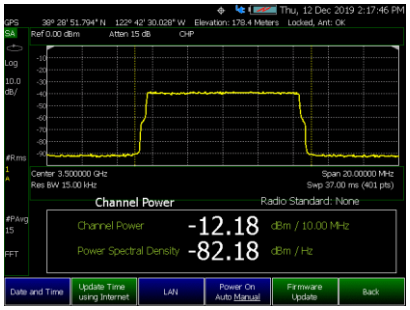
FieldFox's superior dynamic range (TOI +15 dBm), close in phase noise (-117 dBc/Hz at 10 kHz offset), and fast sweep time make these challenging tasks easier. FieldFox's spectrum analyzer also provides a full power measurement suite and complete trace and state control.



Monitor frequency spectra up to 26.5 GHz with FieldFox

Unprecedented amplitude accuracy without instrument warm-up

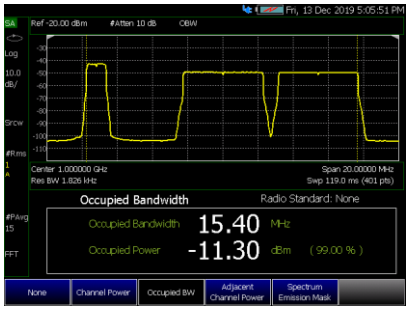
With FieldFox's InstAlign capability, internal amplitude alignments occur automatically as environmental conditions change, without any user intervention. This provides unprecedented amplitude accuracy of ± 0.3 dB for spectrum analysis and power measurements. Better yet, FieldFox provides this accuracy immediately upon instrument turn on - no warm-up required.



Channel power measurement of 5G NR FR1 signal

Channel power measurements

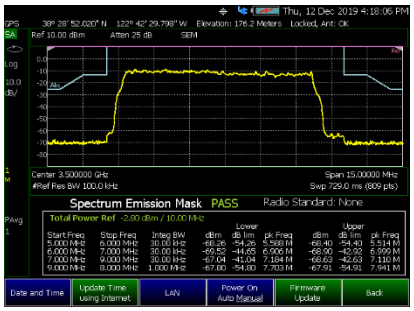
In modern wireless communications, the ability to accurately measure the power of digitally modulated signals enables you to maximize the capacity of a system and improve the quality of communication. For broadband signals, FieldFox offers fast and accurate power measurements that include channel power, occupied bandwidth, adjacent channel power and spectrum emission mask (SEM). When performed manually these measurements can be complicated and time consuming, but the FieldFox power measurement suite makes measurement setup fast and simple.



LTE-A occupied bandwidth measurement

Spectrum Emission Mask (SEM)

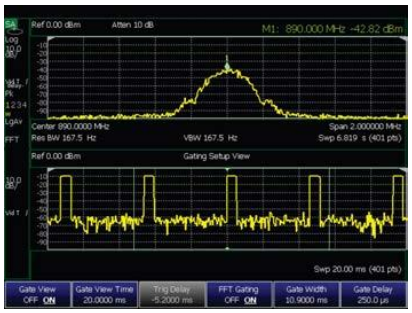
The SEM measurement characterizes transmitting signals where the power from in-band and out-of-band emissions is measured at specified frequency bandwidths and at specific offsets relative to the total carrier power. The SEM measurement is performing a segmented sweep, segmenting a different frequency on the lower level and upper level from a reference center frequency. Each segment may have different frequency span, resolution bandwidth (RBW) and integrated channel bandwidth settings. Supports up to 8 offset segments and pass or fail mask with absolute or relative limit lines.



SEM measurement of 5G NR FR1 signal

Spectrum analyzer time gating

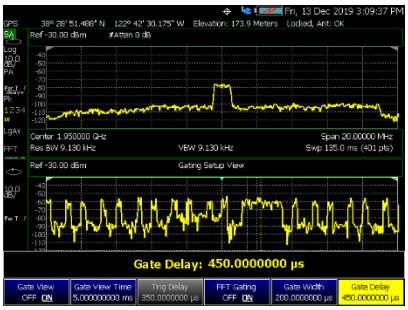
The testing of RF pulses is always challenging because so many instrument settings interact. With Option 238, gated FFT with time gating, FieldFox behaves like a spectrum analyzer and an oscilloscope. This enables you to quickly detect pulses in the time and frequency domains. A gate time of 6 µs to 1.8 s enables simultaneous examination of one or more pulses, or pulse rise and fall times, revealing the effects of spectrum growth due to various pulse shapes. Functions such as video trigger, external trigger and RF burst ensure reliable pulse detection. Automatic trigger-delay and bandwidth settings enhance characterization of RF pulses.



Analyze pulsed RF signals using the time-gating option

Periodic frame trigger synchronized with GPS

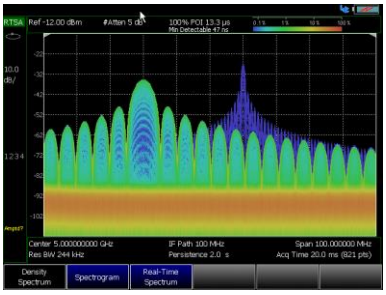
Periodic frame trigger allows for trigger execution at a fixed interval between successive executions. Modern communication systems like 5G use TDD for spectrum access, periodic trigger with time gating can help to differentiate uplink and downlink signals, this is particularly useful to find uplink interference in TDD networks. When the measurement is triggered by a frame boundary, which can be synchronized with GPS, then the data is captured only within the designated boundary.



LTE FDD control channel captured with periodic frame trigger synched to GPS

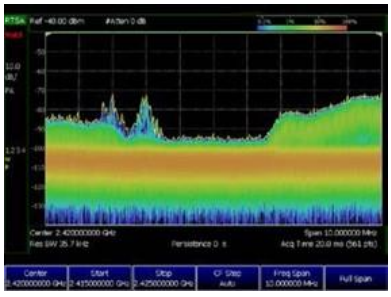
Real-time spectrum analyzer (RTSA)

With the widespread increase of wireless technologies in commercial and military networks, intentional and unintentional interference fills the spectral environment. The interfering signals result in network quality deterioration and communication link breakdowns. Additionally, the prevalent use of digital modulation and burst-transmission methods have made it difficult to reliably detect interference sources. This is where RTSA in FieldFox can help. By combining a fast, overlapping FFT processing technique, gap-free data acquisition, and 100 MHz of real-time bandwidth, FieldFox can detect signals as short as 5.52 µs with 100% POI with full amplitude accuracy. In some applications, detecting signals is the critical factor, independent of amplitude accuracy. In such cases, FieldFox can detect signals as short as 47 ns.



Multi-pulse detection using density display with settable persistence

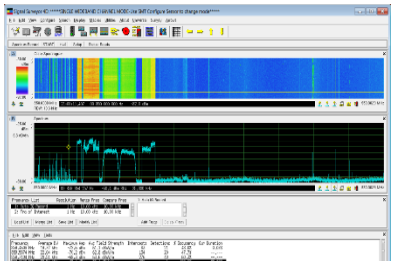
The spectrum density view displays three-dimensional data on a two-dimensional display. It uses color to show the detected number of frequency and amplitude points during a capture interval. This is an excellent way to understand and visualize the spectral occupancy of the frequency band. For example, with RTSA you can detect a low-level signal in the presence of a high-power transmitter using the spectrum density view. Finding an elusive signal can typically take hours or days. With FieldFox's recording and playback, data can be saved for further analysis offline. With RTSA in FieldFox, you can now eliminate the need for a separate, dedicated instrument. When needed, just shift to real-time capabilities in the same unit with one key press.



Identify multiple types of signals in the same band (Bluetooth and WiFi)

N6820ES Surveyor 4D software

Turn FieldFox into a portable, battery operated spectrum monitoring system by adding the N6820ES Surveyor 4D software. This powerful software allows the user to configure up to four high-resolution, flexible spectral displays. These displays can simultaneously show different parts of the spectrum in either a traditional spectrum view or full-color spectrogram. Further, Surveyor 4D includes features to automatically detect signal energies, extract their basic parameters and log the information to a database. With the optional modulation recognition feature, the software turns the FieldFox into a powerful signal classifier with 25 different analog and digital modulation formats that are recognized from a live spectrum or previously recorded IQ times-series data.

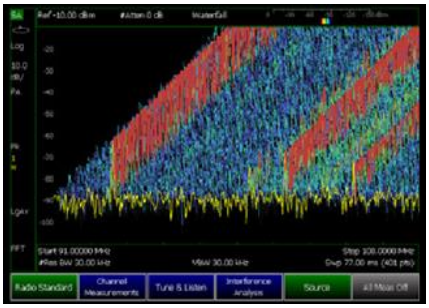


Portable monitoring system covering VLF to 5G millimeter wave bands

Finally, Surveyor 4D provides an alarm function that can trigger actions (recordings, email, etc.) based on simple or complex criteria derived from the extracted signal parametric data. Highly configurable in fully automatic or manual operating modes, Surveyor 4D software dramatically steps up the spectrum monitoring capabilities of the FieldFox.

Interference analyzer

Interference can be internal or external, uplink or downlink, and has a direct impact on the quality of service (QoS) of a communication network. FieldFox's interference analyzer identifies interfering signals quickly. Spectrogram and waterfall displays detect intermittent signals or monitor signals over a period of time. You can record signal traces into internal memory or external flash memory devices and play back the saved traces for offline processing. It has excellent dynamic range.



Waterfall display makes interference hunting easier

Channel scanner

Channel scanner allows users to make multiple channel power measurements simultaneously and verify wireless network coverage, path loss and potential interference issues. It also measures primary carriers and their intermodulated products. Each instrument state can be a custom set of frequencies with each frequency having a unique integrating bandwidth. Users can record and playback the data with data logging. Using time interval logging along with geotagging, you can export files to Google Earth for network coverage analysis.

Scan up to 20 channels simultaneously with the channel scanner option

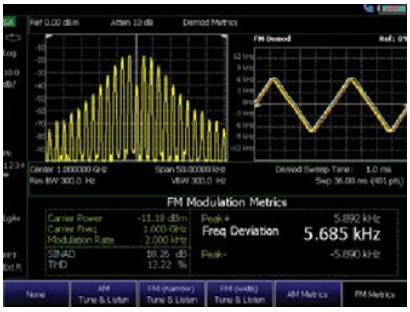
Noise figure (NF)

Internally generated noise can limit communication system capacity. This noise will impact link budget, increase investment on the transmitter design, or will increase antenna cost at the receiver. One of the key performance indicators for a receiver is its sensitivity, which is the ability to reliably discern small signals that are close to the noise floor. The performance of a communication system is also based on signal-to- noise-ratio (SNR). Signal behavior analysis uses a combination of vector network analyzer S-parameter measurements, spectrum analyzer channel power and adjacent channel power measurements. However, additional evaluation of internally generated noise is necessary to have a complete picture of the system performance. To address this need, use noise figure measurements to quantify the degradation in SNR caused by components in the link. The FieldFox noise figure mode uses the industry proven Y-factor technique to accurately verify and characterize the noise figure of devices. FieldFox can also provide real-time feedback on measurement integrity with measurement data that includes built-in uncertainty calculator error bars.

Accurately characterize noise figure of devices

AM/FM analog demodulation

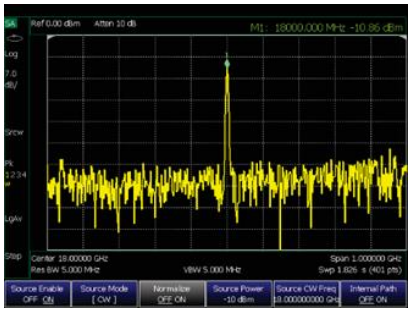
Using FieldFox's analog demodulation, users maintaining AM/FM radio transmitters can demodulate and characterize AM and FM transmitters. They can tune to the signal and listen to the audio tones using FieldFox's built-in speakers or a headphone. They can also measure the RF spectrum, the demodulated waveform and AM/FM metrics such as carrier power, modulation rate, and SINAD.



Characterize AM/FM signals using AM/FM demodulation

IF signal output

FieldFox provides a spectrum analyzer IF output with 10 MHz bandwidth (narrowband path) or an optional 100 MHz bandwidth (wideband path). This enables use as a frequency downconverter and digitize the signal using external test equipment like real time scope, or 89600 VSA software to perform deep signal analysis.



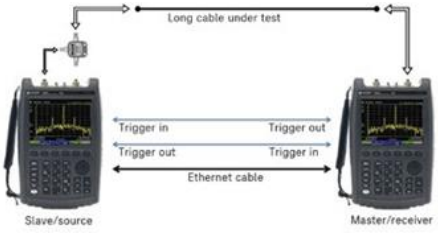
Use the internal microwave signal source for transponder testing

Field strength measurements

To characterize the electric and magnetic fields, you must account for the gain and loss of the antenna and cables. With FieldFox, you can load antenna factors and cable loss data using either the front panel or the complimentary Data Link software.

Independent signal source

FieldFox has a built-in independent signal source, with a frequency range up to 26.5 GHz and high output power over 8 dBm. You can tune the signal source to any frequency, independent of the spectrum analyzer frequency. You can also use the signal source to create a test signal to measure coverage, antenna isolation, antenna direction alignment, shielding effectiveness, and to verify frequency-offset devices.



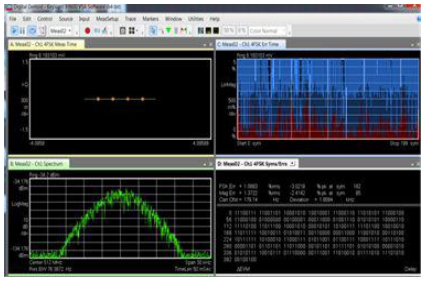
Measure long, lossy cables using ERTA

Extended range transmission analysis (ERTA)

Measuring long in-situ microwave cables such as those on ships is a challenging task and requires instruments with high dynamic range and fast measurement speed. Historically, these measurements used benchtop scalar analyzers, which are cumbersome to operate in the field. Using FieldFox's ERTA, users can measure dynamic ranges of 108 dB (at 6 GHz) or 77 dB (at 26.5 GHz), with a portable analyzer that requires no calibration and no warm-up. ERTA uses two FieldFox, one deployed at each end of the cable. One FieldFox acts as a source, while the other acts as a receiver. Make cable loss measurements, with accuracy of ± 0.7 dB, by taking advantage of Keysight's proprietary InstAlign technique.

Digitally modulated signal quality verification

Modern wireless communication signals include digital modulation to improve system capacity and enhance the ability to counter interference. In order to improve system capacity/spectrum efficiency, there is an increasingly high order of modulation schemes deployed. One of the key challenges to evaluating overall system performance is to correlate RF component performance to signal quality over-the-air.



Public safety transmitting signal quality test – P25 C4FM demodulation with FieldFox

Traditionally we measure the transmitter power, frequency response, operating bandwidth, and 1 dB gain compression to examine the transmit chain of the system. However, for digitally modulated signals, these measurements may not be enough. This is because the current measurements are based on a continuous wave test signal having a peak to average ratio of 0 dB. For digitally modulated signals, this ratio is much higher (could be easily 3 to 10 dB), which means peak power could be much higher than the test signals used to evaluate the above-mentioned metrics.

The peak power can push the amplifier into a nonlinear region and induce degradation of signal modulation quality. Like poor error vector magnitude (EVM), this signal degradation makes it much harder for mobile devices to demodulation transmitted signals. Therefore, we need more information in order to examine the signal quality, demodulating and recovering the digital signal helps to provide insight as to why the system sometimes fails.

Keysight's 89600 VSA software can analyze digitally modulated signals simultaneously in the modulation, time and frequency domains providing useful insight to modulation quality with measurement displays views including spectrum, IQ constellation, EVM, frequency error and many more. The 89600 VSA link provides a powerful combination of hardware and software for design and troubleshooting of devices using signal formats such as APCO-25, TETRA for public safety radio, IEEE 802.11p for wireless vehicular communications, low power wide area networks and other IoT formats, as well as cellular communications including 5G NR, LTE-A, WCDMA, GSM and more.

FieldFox can connect to the 89600 VSA software (Keysight model number 89601B) via Ethernet to a Windows based PC or tablet. In order to connect with the 89600 VSA software, FieldFox requires a spectrum analysis option.

I/Q analyzer

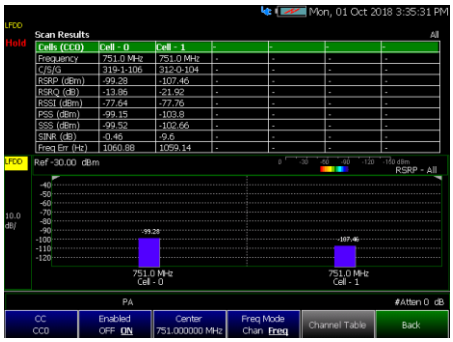
I/Q analyzer mode is the ideal capturing tool to verify final signal chain integration or troubleshoot signal quality degradation due to hardware or software issues. Frequency and time domain measurements provide demodulated I/Q data for analysis with customizable multi-domain display views. I/Q data can also be captured on the instrument and analyzed using 89600 VSA software, MATLAB, Python tool kit and other third-party demodulation software. Additionally, I/Q capture data of an RF signal environment can be re-generated and played back using a vector signal generator. Features such amplitude and IF alignment before capture and single or continuous capture allow for enhanced performance and flexibility.

Over-the-Air (OTA) Measurements for LTE FDD

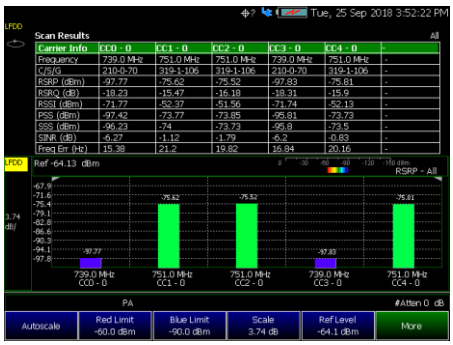
Our wireless networks have become ever-increasingly complex with the roll out of 4G and 5G. One of the key challenges is the question of "what network coverage is", since today's wireless networks are comprised of macrocells, microcells, and picocells, and deployment of these cells occurs in layers. The macrocell provides overall coverage, while the microcell and picocell deliver high data throughputs to end users.

To guarantee smooth handover from various cells and frequencies, it is essential to make sure each cell has enough neighbors to handle various communication scenarios from mobile users, like coverage for voice, text messages and data services.

At any location, a mobile phone sees all types of cells at the same time and must determine which ones are intended for the phone. With the OTA measurement on FieldFox, engineers can scan the area to determine how many type cells are available and which cells are good neighbors.

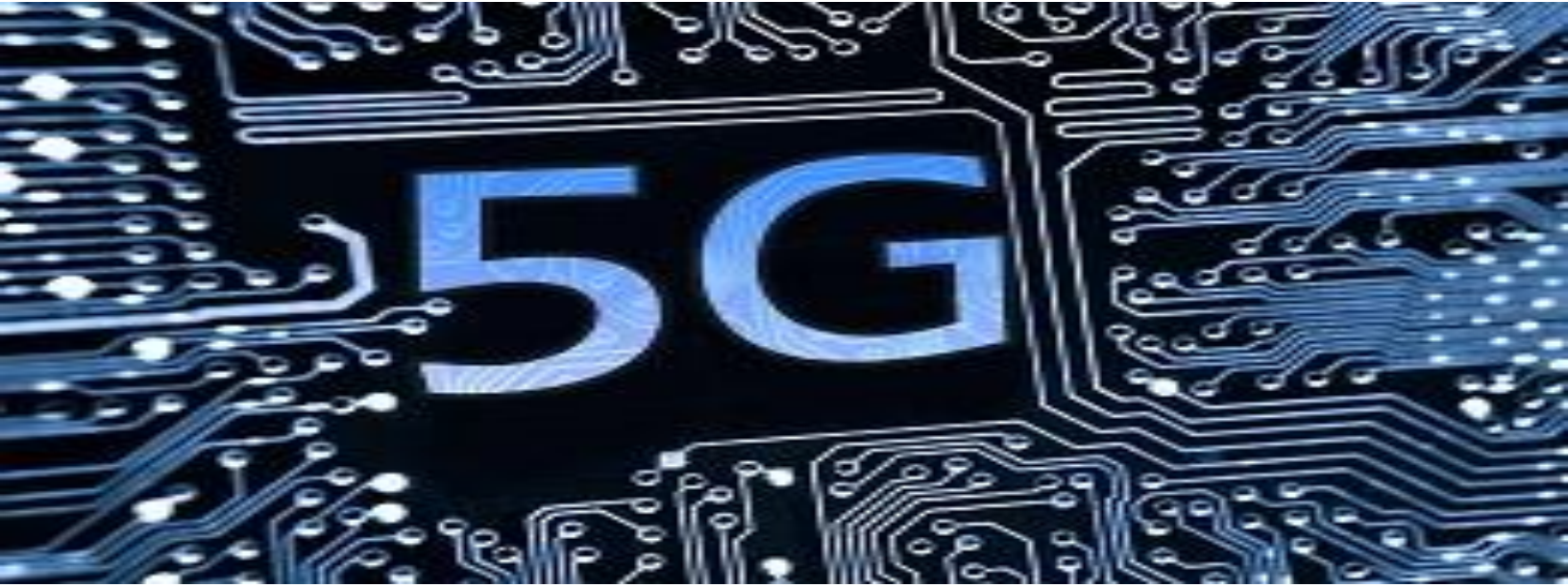


Multicell measurement with cell ID on single carrier frequency



Multiple carrier frequencies measurements with strong cell display

FieldFox LTE FDD OTA demodulation can provide insights to available cells with physical cell ID (PCI) on any given frequency, or the component carrier. This measurement demodulates and decodes all available cells on a single component carrier allowing engineers to see if any additional cells are available to use, thereby addressing the common problem of finding missing neighbors. In addition to single carrier multicell measurements, FieldFox also displays the strongest cell on different component carriers (up to a maximum of 6 cells, if present). This greatly expedites the process to find out which frequencies are the best for any given location and optimizes inter-frequency handover. LTE FDD OTA measures and decodes cell ID, RSRP, RSRQ, RSSI, PSS, SSS, SINR and frequency error.

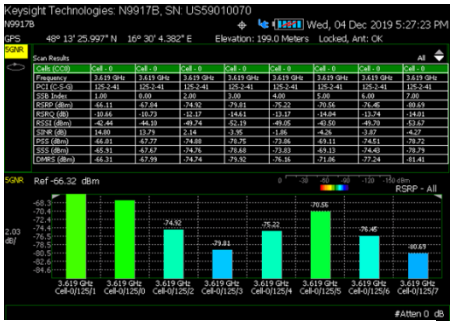


Over-the-Air Measurements for 5G

5G technologies provide dramatic network speed improvement and super-fast connection time. 5G NR is the 3GPP standard for the wireless network running on the sub 6 GHz frequency band (FR1) and the millimeter-wave frequency band (FR2) that offers gigabyte data rates. The key challenges for 5G network deployment are characterizing air interface pathloss and beam coverage. Since 5G network technology uses beamforming and massive MIMO to achieve high data rates, its control channels are on beam steering and are not always on.

When transitioning to 5G, you must verify the quality of their network and beam performance so that users can connect without issue. To do this, you need a solution in your field kit that is capable of reading and displaying important metrics from several base stations in the vicinity. To measure the effective coverage, FieldFox 5G OTA can measure and decode PSS, SSS, beam indexes, cell ID and various signal quality metrics, which are key parameters to verify 5G coverage. This information enables users to identify frequency drifting, isolate power issues, investigate performance problems, and verify Inter- RAT handovers. These measurements are especially imperative in optimizing network coverage for 5G.

Since 5G control channels are not always on and they are using initial access beam sweeping, it can be challenging to determine the location of the 5G signal. Switching into the FieldFox RTSA mode quickly and reliably detects 5G signals, control channels and provides insights to beamforming performance.



5G NR OTA measures control channels and displays cell ID

5GTF OTA supports Verizon's pre-5G networks

Increased Precision is Here with Wider Bandwidth

The world of communications is embracing wireless in an unprecedent way regardless of industry segment. 5G will completely change human-to-human, machine-to-machine and human-to-machine communications and it will make industry 4.0 a reality, commonly referred to as the fourth industrial revolution.

5G is not only for commercial communication, it will completely change the military communication paradigm by providing higher capacity, instant sensing capability and hyper fast speeds.

The three main trends happening in RF and microwave communications are:

- Wider bandwidths
- Higher operating frequencies
- Active antenna systems like phased array antennas

The goal of these trends is to increase network speed and latency; nevertheless, these trends impose greater challenges to RF engineers and technicians who design and maintain these networks, including:

- Interference becomes much harder to detect due to short signal durations
- Microwave and millimeter wave signals can be easily blocked, and coverage is limited
- Signal beams from phased array antennas need to be optimized to achieve the intended coverage area vs. creating coverage holes

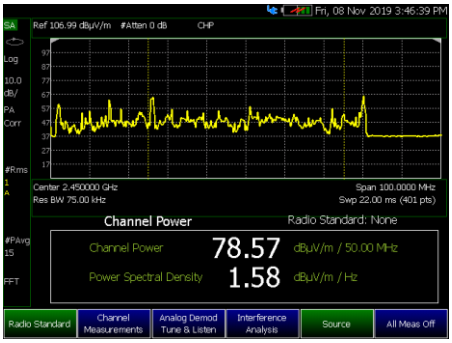
Given the new dynamics of wideband, microwave and millimeter wave communications, Keysight developed the next generation FieldFox Microwave Analyzer with 100 MHz of real-time bandwidth and frequency coverage up to 26.5 GHz. To address the millimeter wave frequency requirements for 5G, satellite and automotive radar industries, FieldFox can easily extend its frequency up to 110 GHz with an add-on downconverter. FieldFox is also the industries most integrated handheld analyzer supporting over 20 key RF and microwave instrument functions including signal analyzer, full 2-port vector network analyzer, real-time spectrum analyzer, over-the-air demodulation, CW signal source, power meter and many more, in an all-in-one field proof package.

EMF Measurements

Radio frequency electromagnetic fields (EMF) are key tests to evaluate total RF exposure in any given area due to deployment of various RF/MW networks, such as mobile phones, base stations, Wi-Fi, smart meters, IoT devices, as well as satellite and radar systems.

Exposure limits for electromagnetic field (EMF) radiation differ by country. Many countries around the world base their regulations on findings from research organizations like the International Commission on Non-Ionizing Radiation Protection (ICNIRP), the Institute of Electrical and Electronics Engineers (IEEE), and the Federal Communication Commission (FCC).

Compliance and verification of exposure levels set by these government and regulatory agencies need to be verified in the field. FieldFox with EMF measurements supports connectivity to AGOS Advanced Technologies Triaxial Isotropic Antenna. The spectrum analyzer and over-the-air (OTA) 5G NR modes support EMF measurements and total field strength is measured across the frequency band of interest.



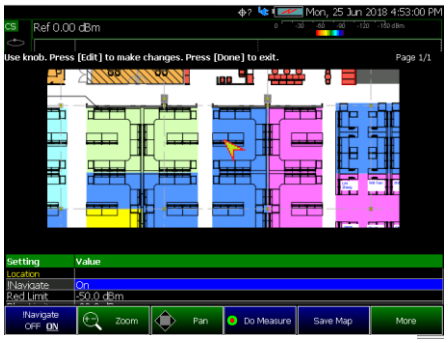
EMF measurement using spectrum analyzer channel power mode

Indoor and outdoor mapping

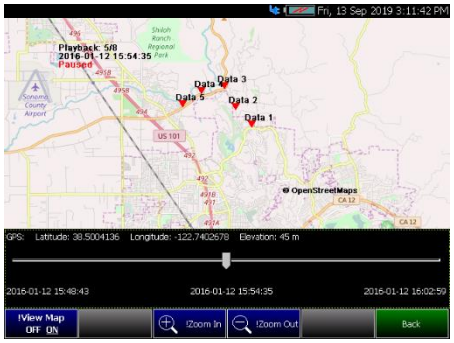
To verify network coverage or identify interference in any area, it is essential to combine receiver measurements with GPS location tags or from indoor markers. FieldFox can import maps from OpenStreetMap (OSM) for data collection and mapping to the FieldFox instrument display. The FieldFox indoor and outdoor mapping feature resides at the System level and can be enabled within the following modes:

Channel Scanner
Phased Array Antenna Support
Over-the-Air (OTA) LTE FDD
Over-the-Air (OTA) 5GTF
Over-the-Air (OTA) 5G NR

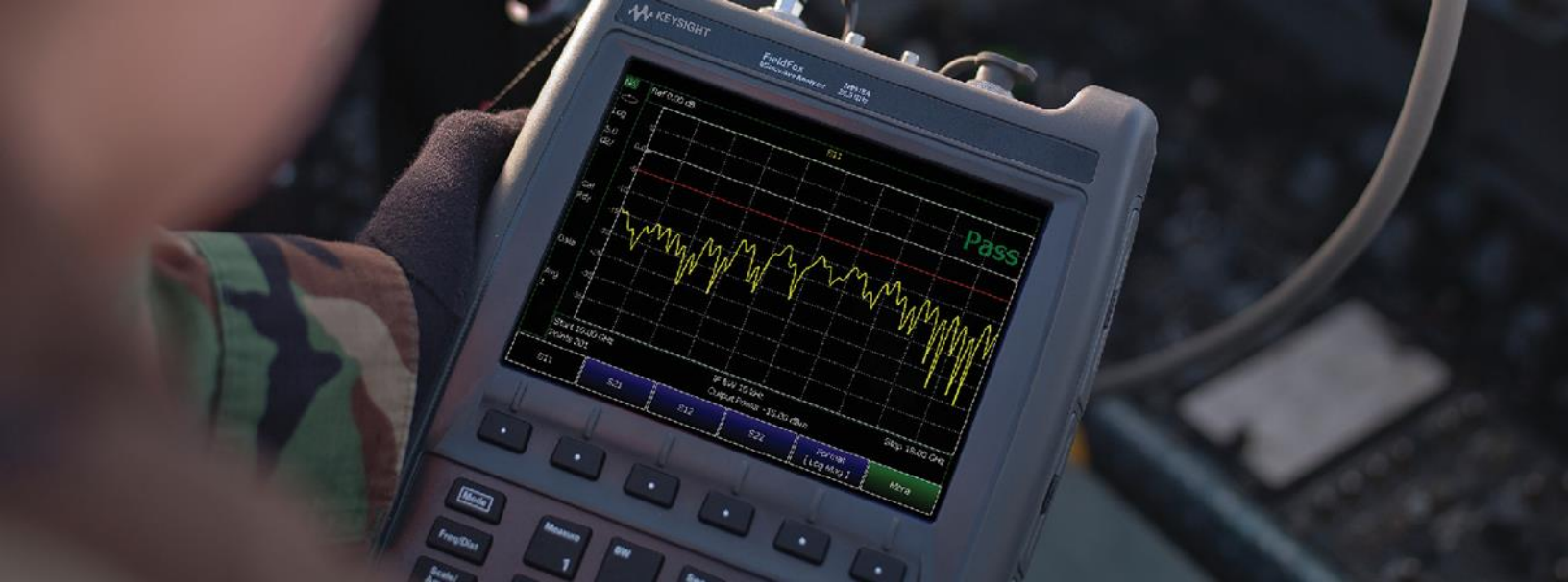
Maps can be saved to the FieldFox internal memory, SD card or USB drive. This can be done via a direct wired LAN connection or OSM maps can be downloaded and saved to FieldFox using the FieldFox Map Support Tool.



Imported indoor site map PNG file



Outdoor map of OTA LTE synched with GPS



Vector Network Analyzer

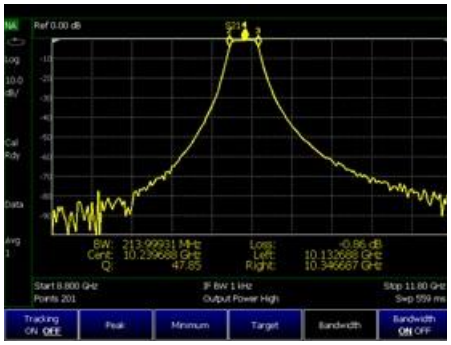
FieldFox includes options for VNA transmission/reflection (T/R) capability for S11 and S21 measurements, or with full 2-port capability for measurements of all four S-parameters and full 2-port calibration.

With a full 2-port network analyzer, you can measure the forward and reverse characteristics of your component without having to disconnect, turn around, and reconnect it to the analyzer. Additionally, the full 2-port calibration gives you the best measurement accuracy possible.

FieldFox's four independent, sensitive receivers provide 117 dB of dynamic range for measurement of high rejection, narrowband devices such as cavity filters. The receivers also enable full 2-port error correction with the unknown thru method, allowing users to measure non-insertable devices accurately and easily.

FieldFox's calibration engine is the same engine that powers the well-respected Keysight ENA and PNA network analyzers. FieldFox leverages Keysight microwave expertise to deliver consistent measurements with Keysight benchtop VNAs.

Simultaneously measure and view all four S-parameters, with a single connection



Use the marker bandwidth/Q factor function to simplify filter testing and tuning

Calibration

FieldFox's guided Cal Wizard takes guessing out of calibration and allows you to easily perform the following calibrations:

- Full 2-port unknown thru
- Full 2-port QSOLT
- OSL, response, enhanced response
- TRL, LRL, offset short

Network analyzer time domain

With the time-domain option, FieldFox computes the inverse Fourier transform of the frequency-domain data to display reflection or transmission coefficients versus time. You can remove unwanted responses such as connector mismatch or cable discontinuities using Time-domain gating and display the results in either time or frequency domain.

Waveguide support

Waveguides better provide transmission links between microwave transmitters and antennas than coax cables due to lower loss. Keysight offers both high-performance and economical waveguide calibration kits. The economical kits are ideal for field maintenance and troubleshooting because they provide good measurement results at a lower cost.

Vector voltmeter

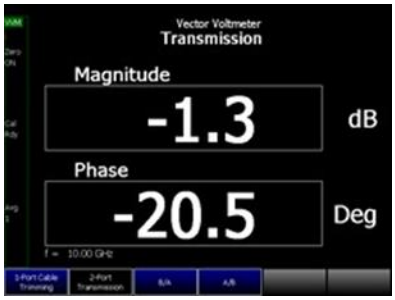
Using FieldFox's vector voltmeter (VVM), you can measure the phase shift and electrical length of a device. You can view results on the large display as far as ten feet or three meters away. VVM also provides ratio measurements of magnitude and phase of two channels, A/B or B/A. You can use this capability to verify the magnitude and phase differences between multiple signal paths such as in an antenna or phased array.

FieldFox offers all the key functionalities of the HP 8508A in a handheld form factor, and without the need for the source, bridge and accessories required with the 8508A.

Mixed-mode S-parameters

With FieldFox, you can measure the common- and differential-mode reflections of a device. Mixed-mode S-parameters are also known as balanced measurements. This measurement requires the full 2-port VNA and 2-port cal functionality.

Easily use waveguides with FieldFox



Simplify cable trimming with the vector voltmeter capability

Characterized common and differential mode reflections with mixed-mode S-parameter measurements

USB power sensor support

FieldFox can connect with Keysight USB power sensors to make RF and microwave power measurements. Using USB peak power sensors, you can measure both the average and the peak power of a modulated signal.

USB power measurements versus frequency

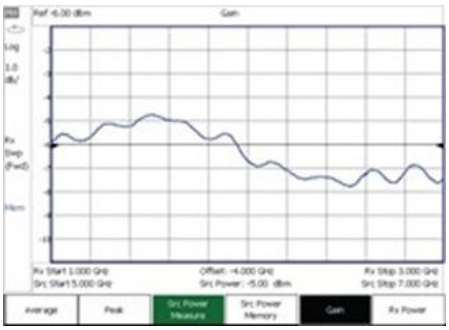
In addition to power measurements at a single CW frequency, you can measure power versus frequency - a swept measurement. FieldFox's source frequency can be set equal to the sensor/receiver frequency, or with an offset. The swept source and receiver frequencies track each other. The offset frequency can be negative, zero, or positive.

This capability is useful for characterization of the scalar transmission response of devices such as mixers and converters. The FieldFox source stimulates the DUT and the measurement receiver is a power sensor.

Pulse measurements

FieldFox's pulse measurement option allows you to efficiently characterize pulsed RF signals such as those used in radar and electronic warfare systems, leveraging the Keysight USB peak power sensors. Measurements include peak power, peak to average ratio, and pulse profile parameters such as rise time, fall time and pulse repetition frequency.

Simplify power measurements with USB power sensors



Characterize mixers with FieldFox and a USB power sensor

Use FieldFox to characterize pulses

Software and System Features

Remote control capability with iPad and iPhone

Engineers and technicians can now remotely monitor and control their FieldFox using their iOS device such as an iPhone, iPad, or iPod Touch. FieldFox's Remote Viewer iOS app emulates the front panel of the unit, letting you simply press any FieldFox key right from your iOS device. The app also allows you to instantly access technical documents such as data sheets.

Control and view your FieldFox via your iPad

FieldFox's Data Link software makes report generation and documentation easier

FieldFox's complimentary Data Link software provides data transfer, data definition and report generation. You can add markers and limit lines to traces, and you can load cable files and antenna factors using Data Link.

Remote control via LAN and FieldFox programming

You can control all FieldFox models using SCPI over LAN and USB.

Built-in variable voltage DC bias

FieldFox has a built-in variable voltage DC bias source. The DC bias source can provide DC power to amplifiers under test and bias tower mounted amplifiers (TMA) when you need to sweep through the TMA to reach the antenna (bias tees available separately).

Obtain geolocation data with the built-in GNSS/GPS capability

Built-in GNSS/GPS

A built-in GNSS/GPS receiver provides geo- location tags to measurements. You can display and save the geo data-time, latitude, longitude, and elevation in data files. In addition to location information, the GPS provides an external reference to improve FieldFox frequency accuracy.

USB keyboard and mouse support

FieldFox supports use of USB keyboards and mice to simplify the input of text such as file names while working in the field.

Simplify text entry with a USB keyboard and mouse

Carry Precision with You

Every piece of gear in your field kit had to prove its worth. Measuring up and earning a spot is the driving idea behind Keysight's FieldFox analyzers. They're equipped to handle routine maintenance, in-depth troubleshooting and anything in between. Better yet, FieldFox delivers precise microwave and millimeter-wave measurements- wherever you need to go. Add FieldFox to your kit and carry precision with you.

Related Literature	Number
FieldFox Handheld Analyzers N991x/3xB, Data Sheet	5992-3702EN
FieldFox Handheld Analyzers N991x/3xB, Configuration Guide	5992-3701EN

Download application notes, watch videos, and learn more: www.keysight.com/find/fieldfox

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