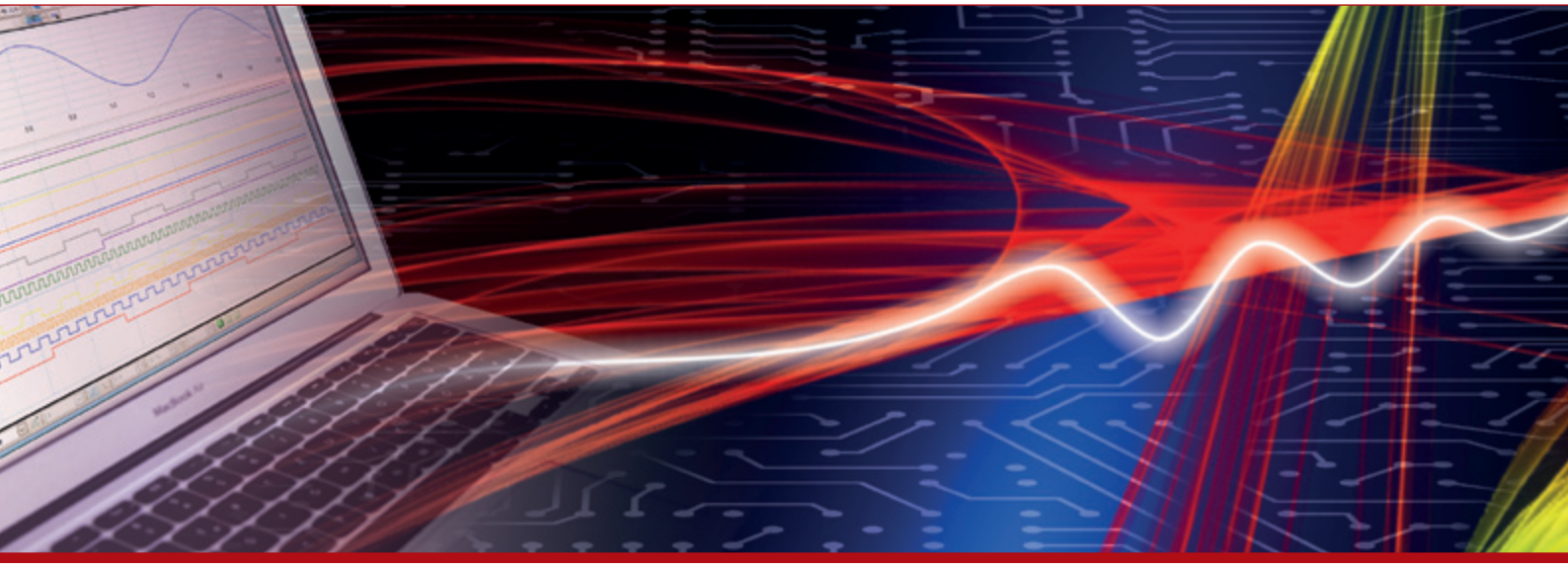
Product Datasheet - Technical Specifications



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FieldFox Handheld Analyzers

4/6.5/9, 10/14/18/26.5/32/44/50/54 GHz

Models

N9912C	N9950B	N9933B/C	N9960B
N9913B/C	N9951B	N9934B/C	N9961B
N9914B/C	N9952B	N9935B/C	N9962B
N9915B/C	N9953B	N9936B	N9963B
N9916B		N9937B	
N9917B		N9938B	
N9918B			

Introduction

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. The newly introduced C-Series analyzer, N9912C in particular, makes the FieldFox a truly software defined instrument.

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

KEYSIGHT

Table of Contents

FieldFox Handheld Analyzers

Why choose FieldFox?

- A truly software-defined analyzer, the newly introduced N9912C RF analyzer in particular, offers the maximum flexibility and the least initial investment to meet rapidly changing market requirements
- Ideal 5G deployment and field-testing tool with 120 MHz real-time bandwidth and over-the-air (OTA) measurements
- Ability for 5G, satellite and radar operators to make true RF coverage measurements, up to 54 GHz and beyond, 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)
- 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

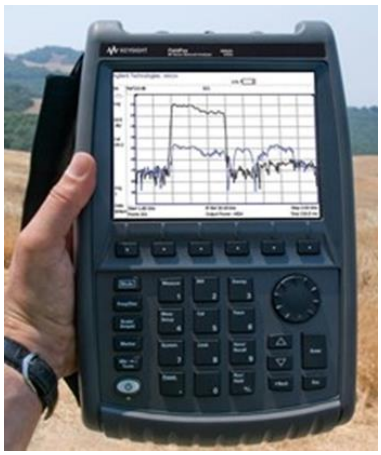
Field-proof usability for better answers in less time

- 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

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

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



Read measurements in direct sunlight with the transflective display

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

"Combination" analyzers Base: Cable and antenna analyzer	RF and microwave signal analyzer Base: Spectrum analyzer

Up to 120 MHz bandwidth
Built-in power meter
Pulse measurements
Channel scanner
GPS receiver
Real-time spectrum analyzer
PathWave 89600 VSA software connection
Keysight Spectrum Management Software connection
Surveyor 4D software connection
IQ analyzer/IQ data streaming
Noise figure
Over-the-Air (OTA) LTE FDD/TDD and 5G
Indoor and outdoor mapping
EMF measurements (general and 5G)
EMI measurements
Directional finding - TDOA

Full-band tracking generator	Spectrum analyzer
Full-band preamplifier	Vector network analyzer
USB power sensor	TDR cable measurements

Vector network analyzer (VNA)		Spectrum analyzer (SA)	
Frequency range	5/30/300 kHz to 54 GHz [1]	Frequency range	3/5 kHz to 54 GHz
System dynamic range	117 dB	Spur-free dynamic range	>104 dB at 2.4 GHz
Trace noise	0.001 dB	Amplitude accuracy	0.2 dB
Directivity	39 dB	Phase noise	-117 dBc/Hz
Output power	9 dBm	DANL (preamp on)	-163 dBm
Calibrations	CalReady, SOLT, WG, Unknown thru, Response Cal, Ecal	CW/tracking generator	5/30/300 kHz to 54 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

[1] Under VNA, 300 kHz starting frequency is for N995xB; under SA, tracking generator starting frequency of 300 kHz is for N995xB or N996xB. All C models SA starts at 3kHz, VNA and tracking generator starts 5kHz

Pick up FieldFox for its ergonomics

Portrait design and large buttons for easy operation – even with gloves on

Convenient side strap makes it easy to hold and carry

Anti-glare 6.5-inch LCD display with LED backlight

Task-driven keys are grouped to easily perform field measurements

Backlit keypad

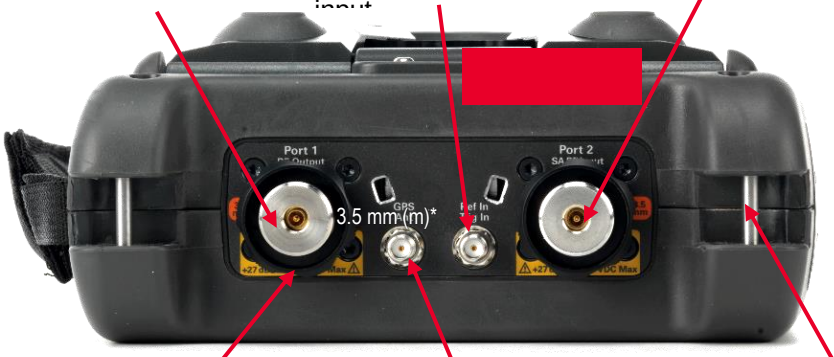
Dedicated marker keys for quick marker function access

11.5 inch
(292 mm)

7.4 inch
(188 mm)

…and depend on its durability and convenience

For N991xB/C, N993xB/C,
and N9938B without Option 100



Port 1

External reference and external trigger input

Port 2

Connector bay protects RF connectors

Get precise location using the built-in GPS receiver

Quick connect shoulder strap clips

For N9950/51/52/60/61/62B.
N9953/63B (54 GHz) are with 1.85 mm (m)

* For N9918B, and N9938B (with Option 100) only

Right side

Keep going with field-swappable batteries that last up to 4.5 hours

LAN port for data transfer and SCPI programming

SD flash card for data storage

USB ports for easy data storage and SCPI programming

Wideband IF output

External reference and external trigger output

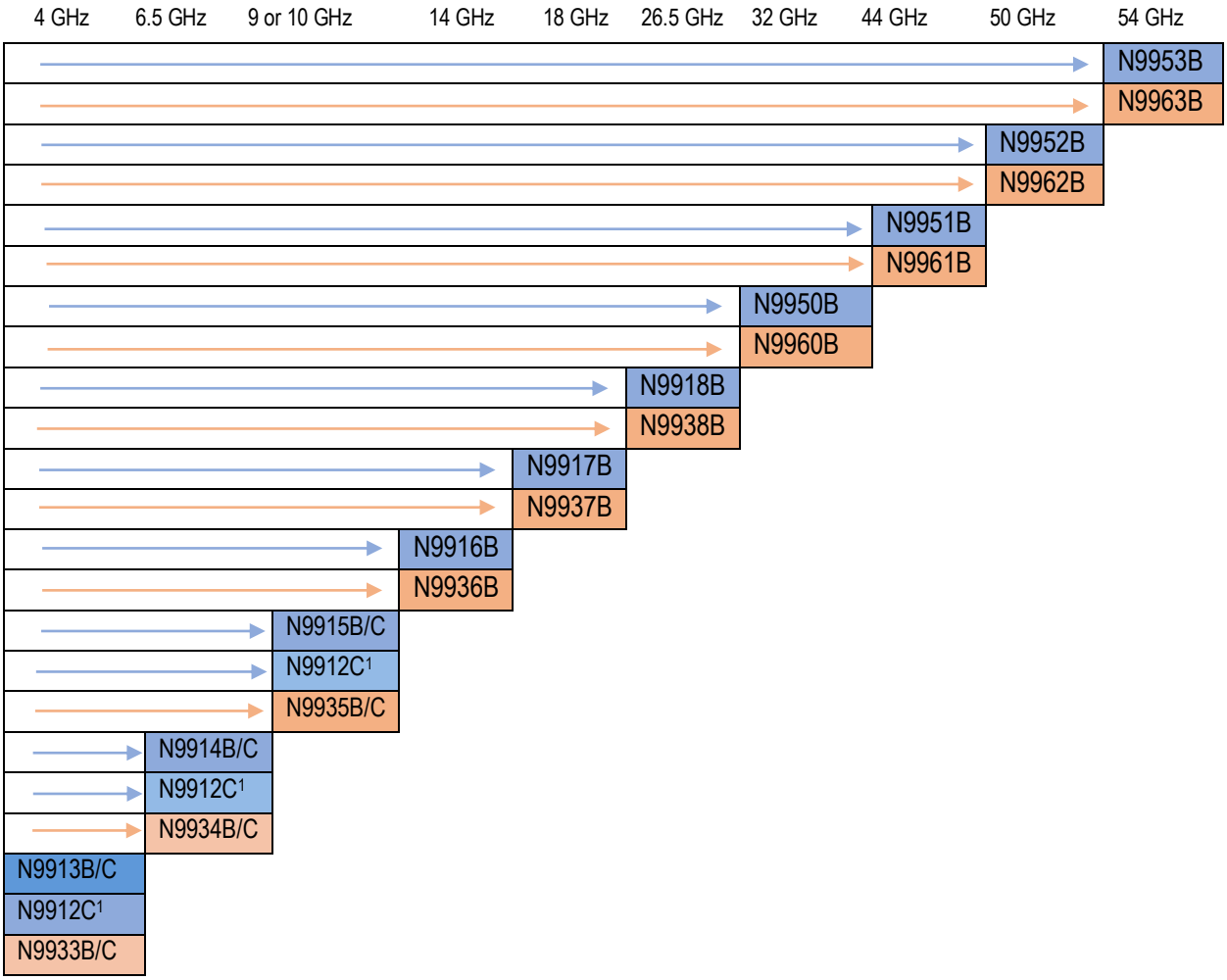
Gasketed doors protect ports from moisture

Left side

Built-in DC supply for powering external bias-tees, probes, and active devices

Choose the FieldFox that Meets Your Needs

Microwave (Combination) analyzer
Signal analyzer (SA)



[1] The maximum frequency of N9912C can be configured to 4, 6.5 or 10 GHz.

Create the right configuration for your application

- Select the capabilities (FieldFox options) you need today and add field-upgradeable features via software license keys as needs change. In this section, combination analyzers include RF and microwave analyzers. See the FieldFox Handheld Analyzer Configuration Guide FieldFox product and accessories.

Option	Description	Combination analyzers N9913/4/5/6/7/8B N9950/51/52/53B N9913/14/15C	Spectrum analyzers N9933/4/5/6/7/8B N9960/61/62/63B N9933/34/35C
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	✓	—
	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	✓	✓
353	IQ streaming	✓	✓
355	Analog demodulation	✓	✓
356	Noise figure (NF)	✓	✓
358	Electromagnetic field (EMF) measurements	✓	✓
360	Phased array antenna support	✓	✓
361	Eelectromagnetic interference (EMI) measurements	✓	✓
370	Over-the-Air (OTA) LTE FDD	✓	✓
371	Over-the-Air (OTA) LTE TDD	✓	✓
378	Over-the-air (OTA) 5G NR	✓	✓
390	Directional finding – TDOA node support [4]	✓	✓
B04	Analysis bandwidth, 40 MHz [5]	✓	✓
B10	Analysis bandwidth, 120 MHz [5]	✓	✓

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	✓	✓
System features			
030	Remote control capability	✓	✓
307	GPS receiver	✓	✓
309	DC bias variable-voltage source	✓	✓
Windows based software			
89601B	PathWave 89600 VSA software	✓	✓
N6820ES	Surveyor 4D Software	✓	✓
S9910A	Keysight signal management software	✓	✓
S9911A	Directional finding - TDOA	✓	✓

1 Cable and antenna test (CAT) is not available on the N993x/6xB. A subset of CAT measurements, return loss and VSWR, is available as Option 320.
2 Option 320 is not applicable to N991x/5xB. The N991xB/5xB includes reflection measurements of return loss and VSWR. There is no need for an Option 320 on the N991xB/5xB analyzers. option 320 is not available on C models.
3 On the N991x/5xB analyzers, order Options 233 and 210 to obtain a tracking generator with the spectrum analyzer. There is no Option 220 on the N991x/5xB analyzers. Option 233 provides the spectrum analyzer capability and Option 210 the "tracking" capability.
4 Currently, only available on N99xxBU/CU upgrades. Requires PC software KSMS S9910A and S9911A to work.
5 10 MHz is standard.

Option	Description		Combination analyzers N9912C
Instrument options			
N9912C	FieldFox RF analyzer (Base unit) [1]		Must pick one from instrument options
CA4	Cable and antenna analyzer 4 GHz		
CA6	Cable and antenna analyzer 6.5 GHz		Frequency can be upgraded via N9912CU
CAX	Cable and antenna analyzer 10 GHz		Frequency can be upgraded via N9912CU
NA4	Vector network analyzer 4 GHz		Full 2 port VNA
NA6	Vector network analyzer 6.5 GHz		Frequency can be upgraded via N9912CU
NAX	Vector network analyzer 10 GHz		Frequency can be upgraded via N9912CU
SA4	Spectrum analyzer 4 GHz		
SA6	Spectrum analyzer 6.5 GHz		Frequency can be upgraded via N9912CU
SAX	Spectrum analyzer 10 GHz		Frequency can be upgraded via N9912CU
Measurement options			
010	VNA time domain		Require NA option
030	Remote control capability		
208	USB power sensor meas. versus frequency		Require option 302
215	TDR cable measurements		Require CAT option
220	Tracking generator		Require SA option
235	Pre-amplifier		Require SA option
236	Interference analyzer and spectrogram		Require SA option
238	Spectrum analyzer time gating		Require SA option
302	USB power sensor support		Require power sensor
307	GPS receiver		
308	Vector voltmeter		Require NA option
309	DC bias variable-voltage source		
310	Built-in power meter		Require SA option
312	Channel scanner		Require SA option
330	Pulse meas. with USB peak power sensor		Require option 302, peak power sensor
350	Real-time spectrum analyzer (RTSA)		Require SA option, B04 for 40MHz
352	Indoor and outdoor mapping		Require opt 312 or 370, 371, 378
355	Analog demodulation		Require SA option
358	EMF measurements		Require SA option
361	EMI measurements		Require SA option
370	Over-the-air (OTA) LTE FDD		Require SA option
371	Over-the-air (OTA) LTE TDD		Require SA option
378	Over-the-air (OTA) 5G NR		Require SA option and B04
B04	Analysis bandwidth, 40 MHz		Require SA option

1 N9912C main chassis must have at least one option from instrument groups, for example if one from NA group and one from SA group, like N9912C opt NA6, SAX - 6.5 GHz VNA and 10 GHz SA. Don't pick 2 options from the same group.

Cable and antenna analyzer (CAT)

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 microwave link quality, 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)

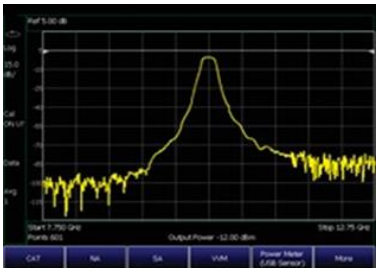
DTF helps you determine the location and nature of discontinuities in feeder lines. For example, short, open, or water ingress.

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.

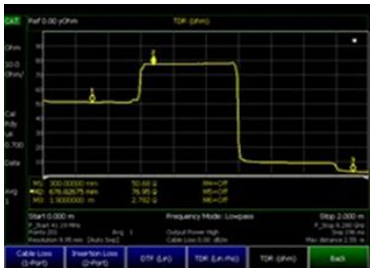
Measure both DTF and TDR in single sweep

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 measuremen

CalReady-calibrated at power on and ready to go

Save time and get right to work with FieldFox's CalReady feature. With CalReady, theanalyzer 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.

Unprecedented amplitude accuracy without 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 ±0.2 dB for spectrum analysis and power measurements. Better yet, FieldFox provides this accuracy immediately upon instrument turn on - no warm-up required.

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.

Monitor
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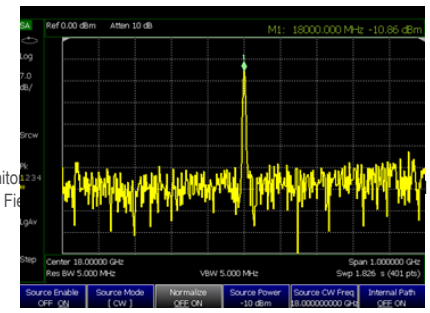
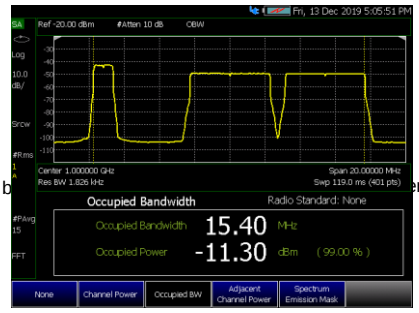
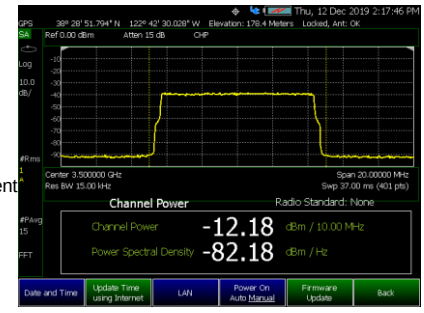






Spectrum emission mask (SEM)

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.

Spectrum analyzer time gating

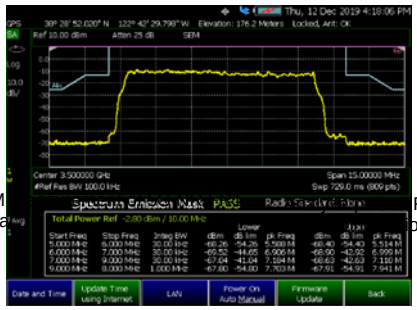
The testing of RF pulses is always challenging because so many instrument settings interact. With Option 238, gated FFT with time gating, FieldFox behaves like a spectrum analyzer and an oscilloscope. This enables you to quickly detect pulses in the time and frequency domains.

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.

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.

SEM signa



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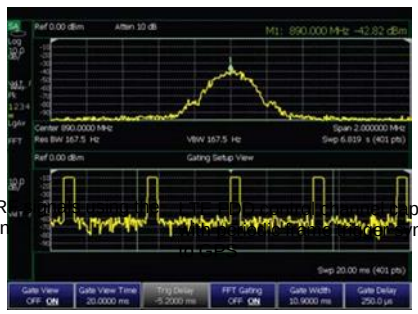
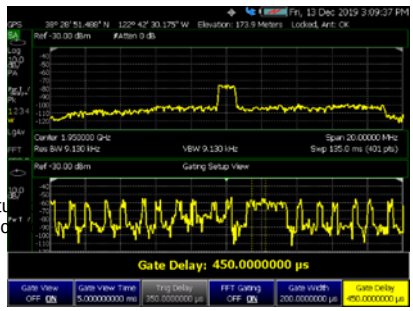




Real-time spectrum analyzer (RTSA)

With the widespread increase of wireless technologies in commercial and military networks, various types of interference fill the spectral environment. The interfering signals result in network quality deterioration and communication link breakdowns. Additionally, use of digital modulation and burst-transmission methods have made it difficult to reliably detect interference sources. RTSA in FieldFox helps by combining a fast, overlapping FFT processing technique, gap-free data acquisition, and 120 MHz of real-time bandwidth to detect signals as short as 5.52 µs with 100% POI and full amplitude accuracy. Detecting signals, independent of amplitude accuracy, can be a critical factor. In such cases, FieldFox can detect signals as short as 47 ns.

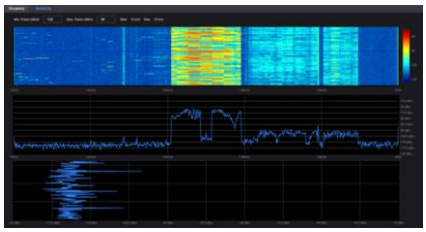
The spectrum density view displays three-dimensional data on a two-dimensional display using color to show the detected number of frequency and amplitude points during a capture interval for a clear view of the frequency band's spectral occupancy. For example, with RTSA you can detect a low-level signal in the presence of a high-power transmitter using the spectrum density view. Find an elusive signal quickly using FieldFox's recording and playback to analyze saved data offline. With RTSA in FieldFox, you can shift to real-time capabilities with one key press.

Keysight spectrum management software (KSMS)

Keysight Spectrum Management Software (KSMS) is a comprehensive software tool kit to modernize how frequency regulators, public and private network operators manage its frequency resource, detect, locate and mitigate interference issues, provide full stack spectrum optimization from RF to over-the-air analog and digital demodulation.

KSMS works with Keysight FieldFox RF and MW analyzers with an operating frequency from DC to 54GHz. FieldFox can be networked and mobile in a vehicle. Users can quickly setup ad hoc or mobile signal monitoring network to monitor RF spectrum activities, report frequency allocation and usage, detect any interference and locate its whereabouts using Time of Difference of Arrival (TDoA) and Received Signal Strength (RSS) techniques. FieldFox RTSA with a handheld directional antenna can find source of interference at last mile.

Spectrum monitoring



cross domain spectrum display

TDoA by three FieldFox

Interference analyzer

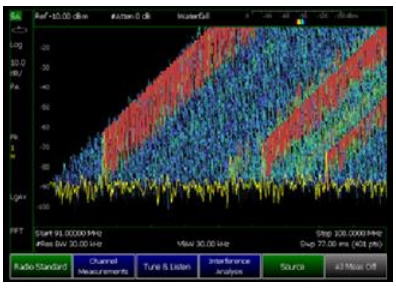
Interference can be internal or external, uplink or downlink, and has a direct impact on the quality of service (QoS) of a communication network. FieldFox's interference analyzer has an excellent dynamic range and identifies interfering signals quickly. Spectrogram and waterfall display detect intermittent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

Channel scanner

Make multiple channel power measurements simultaneously and verify wireless network coverage, path loss and potential interference issues with the channel scanner. Also, measure primary carriers and their inter-modulated products. Configure instrument states with a custom set of frequencies, each with a unique integrating bandwidth. Use data logging to record and playback the data. Use time interval logging along with geotagging to export files to Google Earth for network coverage analysis.

Noise figure (NF)

Internally generated noise can limit communication system capacity and impact link budget, increase investment on the transmitter design, or will increase receiver antenna. A key receiver performance indicator is sensitivity, the ability to reliably discern small signals that are close to the noise floor. A communication system performance 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 for a complete system performance overview. To address this need, use noise figure measurements to quantify the SNR degradation caused by components in the link. The FieldFox noise figure mode uses the industry proven Y-factor technique to accurately verify and characterize device noise figures and can also provide real-time measurement integrity feedback on measurement data that includes built-in uncertainty calculator error bars.



Waterfall display makes interference hunting easier

Scan up to 20 channels simultaneously with the channel scanner option

Accurately characterize noise figure of devices

AM/FM analog demodulation

Use FieldFox's analog demodulation to characterize AM/FM radio transmitters, or tune to a signal and listen to the audio tones with the built-in speakers or a headphone. Measure an RF spectrum, demodulated waveform, or AM/FM metrics such as carrier power, AM depth, FM deviation, modulation rate, and SINAD.

IF signal output

FieldFox provides a spectrum analyzer IF output with 10 MHz bandwidth (narrowband path) or an optional 120 MHz bandwidth (wideband path) to use as a frequency downconverter to digitize a signal using external test equipment like a real time scope, or PathWave VSA (formerly 89600 VSA) software to perform deep signal analysis.

Field strength measurements

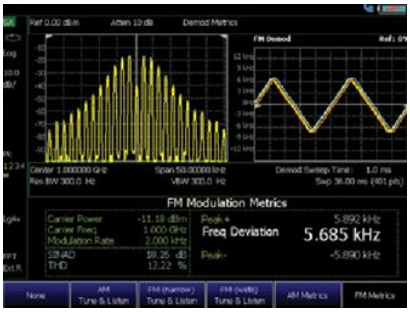
To characterize the electric and magnetic fields, you must account for the gain and loss of the antenna and cables. Load antenna factors and cable loss data via the FieldFox front panel or using the complimentary Data Link software.

Independent signal source

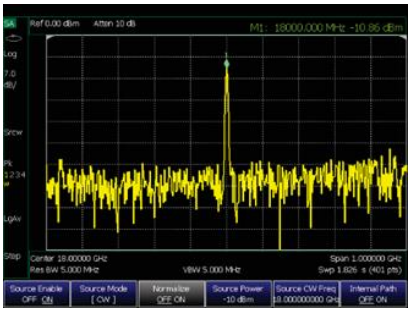
FieldFox has a built-in independent signal source, with a frequency range up to 54 GHz and high output power over 8 dBm. You can tune the signal source to any frequency, independent of the spectrum analyzer frequency. Use the signal source to create a test signal to measure coverage, antenna isolation, antenna direction alignment, shielding effectiveness, and to verify frequency-offset devices.

Extended range transmission analysis (ERTA)

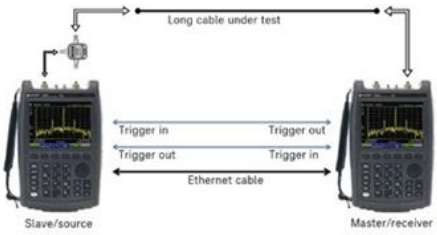
Measuring long in-situ microwave cables such as those on ships is a challenge and requires instruments with high dynamic range and fast measurement speed. Historically, these measurements used benchtop scalar analyzers, which are cumbersome to operate in the field. FieldFox's ERTA can measure dynamic 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.



Characterize AM/FM signals using AM/FM demodulation



Use the internal microwave signal source for transponder testing



Measure long, lossy cables using ERTA set up

Digitally modulated signal quality verification

Modern wireless communication signals include digital modulation to improve system capacity, maximize spectrum efficiency, and counter interference. A key challenge to evaluate overall system performance is to correlate RF component performance to signal quality over-the-air.

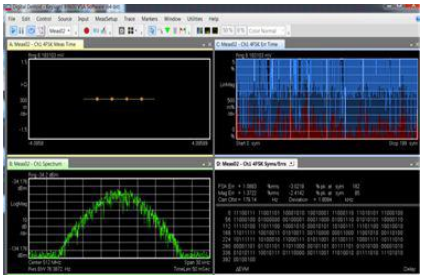
Keysight's PathWave 89600 VSA software can analyze digitally modulated signals simultaneously in the modulation, time and frequency domains providing useful insight to modulation quality with measurement displays views including spectrum, IQ constellation, EVM, frequency error and many more. The 89600 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, and more.

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

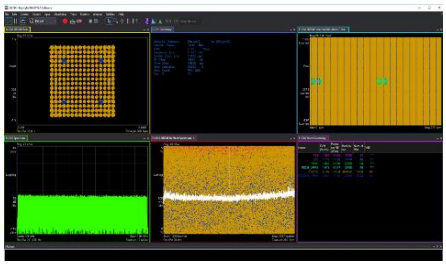
I/Q analyzer

The I/Q analyzer mode helps to verify final signal chain integration or troubleshoot signal quality degradation. Frequency and time domain measurements provide demodulated I/Q data for analysis with customizable multi-domain displays. Captured I/Q data is analyzed using 89600 VSA software, MATLAB, Python tool kit and other third-party demodulation software. I/Q captured data of an RF signal environment can also 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.

With option 353 (IQ streaming), FieldFox enables IQ data streaming in VITA 49 format with GPS precision time stamping. This capability provides gapless IQ data to external application software to perform spectrum monitoring, demodulation, and decoding. The streamed data can be saved on a PC hard drive.



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



FieldFox connects to the PathWave 89600 VSA SW via LAN for 5G NR demodulation analysis

IQ data captured in FieldFox I/Q analyzer mode

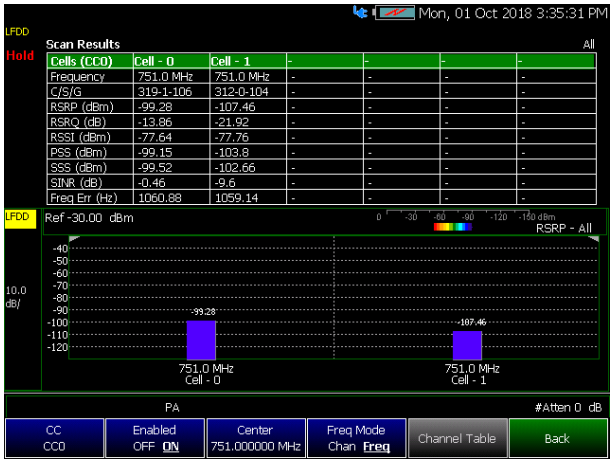
Over-the-Air (OTA) measurements for LTE FDD or TDD

Wireless networks have become more complex with the roll out of 4G and 5G. A key question is “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.

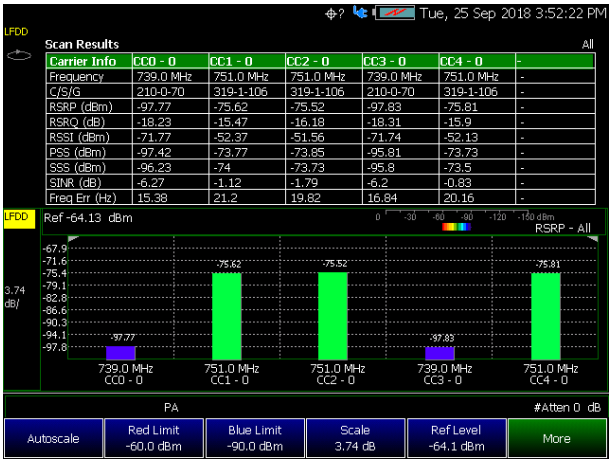
To guarantee smooth handover from various cells and frequencies, it is essential to make sure each cell has enough neighbors to handle various communication scenarios from mobile users, like coverage for voice, text messages and data services.

At any location, a mobile phone sees all types of cells at the same time and must determine the ones intended for that 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.

FieldFox LTE FDD OTA or LTE TDD 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 or LTE TDD OTA measures and decodes cell ID, RSRP, RSRQ, RSSI, PSS, SSS, SINR and frequency error.



Multicell measurement with cell ID on single carrier frequency



Multiple carrier frequencies measurement with strong cell display

Over-the-Air (OTA) measurements for 5G

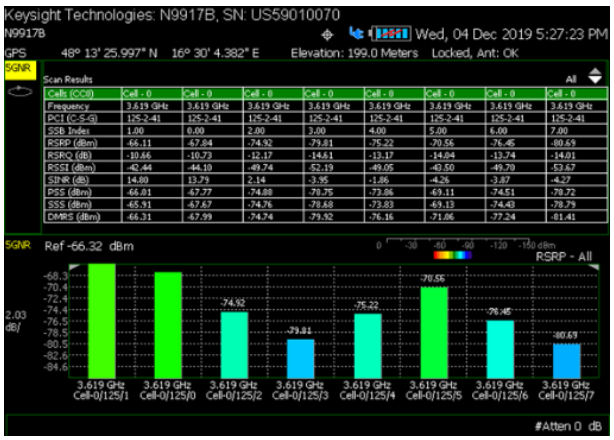
5G technologies provide dramatic network speed improvement and super-fast connection time. 5G NR is the 3GPP standard for the wireless network running on the sub 6 GHz frequency band (FR1) and the millimeter-wave frequency band (FR2) that offers gigabyte data rates. The key challenges for 5G network 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.

The most recent enhancements on the FiedFox OTA 5G NR application enable the constellation diagrams of EVM, to help users accurately and intuitively quantifying the modulations in the 5G NR signal of interests.

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 has two modes of implementation, non-standalone (NSA) and standalone (SA). NSA requires LTE as an anchor to provide a control plane. This improves 5G network reliability because widely deployed LTE has better coverage. For quick 5G coverage deployments, 5G implements dynamic spectrum sharing (DSS) that allows 5G to run on existing 4G LTE physical channels without disrupting LTE operation. However, operators must ensure 5G coverage on the same channel is similar, to and minimize efficiency impact due to higher overhead RRM activities.



5G NR OTA measures control channels and displays cell ID

5G DSS on LTE channel
Top: 5G NR channel scan with cell ID
Bottom: LTE channel scan with cell ID

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.

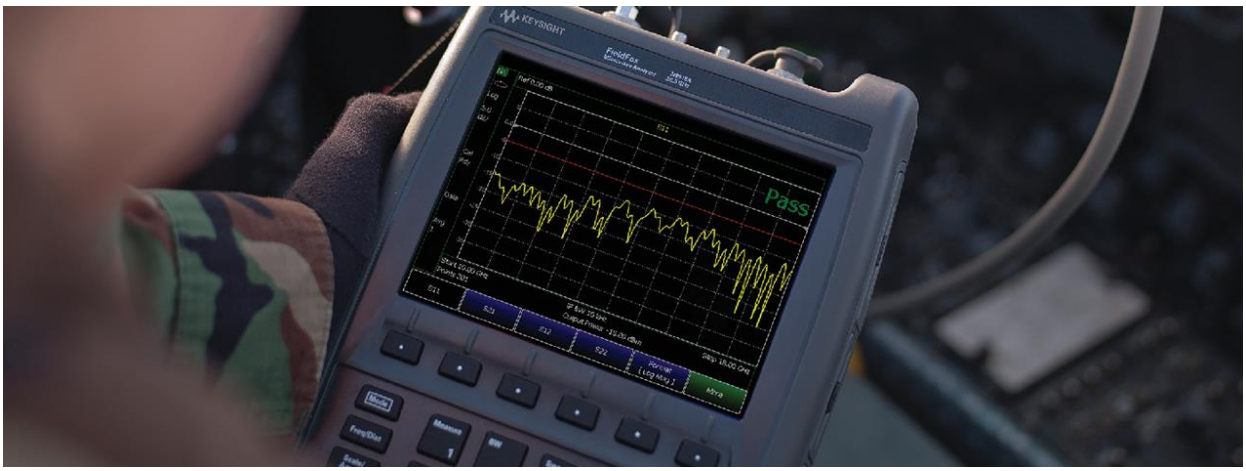
The three main trends happening in RF and microwave communications are:

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

The goal of these trends is to increase network speed and to minimize 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 120 MHz of real-time bandwidth and frequency coverage up to 54 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.



Electromagnetic field (EMF) measurements

Radio frequency electromagnetic fields (EMF) tests 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.

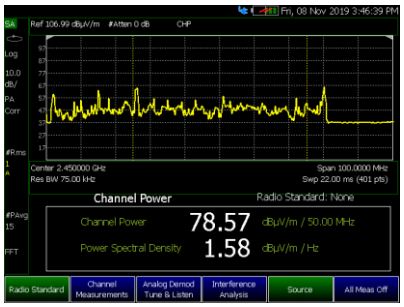
Exposure limits for electromagnetic field (EMF) radiation differ by country. Many countries base their regulations on findings from research organizations like the International Commission on Non-Ionizing Radiation Protection (ICNIRP), the Institute of Electrical and Electronics Engineers (IEEE), and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

Field verification is required for compliance to exposure levels set by these government and regulatory agencies. FieldFox with EMF measurements supports connectivity to AGOS Advanced Technologies Triaxial Isotropic Antenna (or Keysight 85572A-006). The spectrum analyzer and over-the-air (OTA) 5G NR modes support EMF measurements that measure the total field strength across the frequency band of interest.

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 imports and displays maps from OpenStreetMap (OSM) for data collection and mapping. The FieldFox system level indoor and outdoor mapping feature can be enabled within the following modes: (1) Channel Scanner, (2) Phased Array Antenna Support, (3) Over-the-Air (OTA) LTE FDD or TDD, (4) Over-the-Air (OTA) 5G TF, and (5) Over-the-Air (OTA) 5G NR.

Save maps to the FieldFox internal memory, SD card or USB drive. Use the FieldFox Map Support Tool download OSM maps or use a direct wired LAN connection.



EMF measurement using spectrum analyzer channel power mode

Imported indoor site map PNG file

Outdoor map of OTA LTE synched with GPS

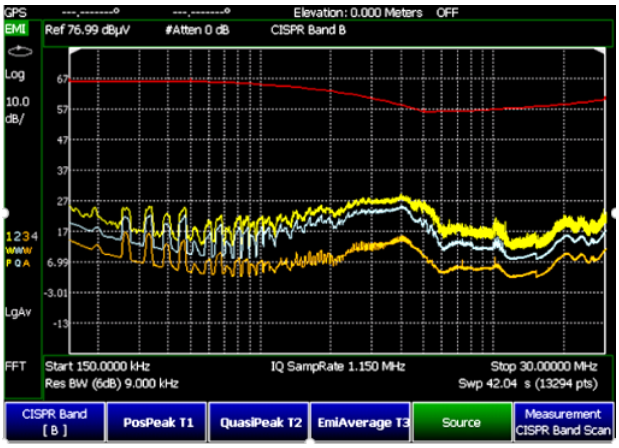
Electromagnetic interference (EMI) measurements

Base stations and mobile devices generate unwanted signals that create noise and interference. One of the key challenges in the wireless industry is to minimize this noise and interference with EMI testing.

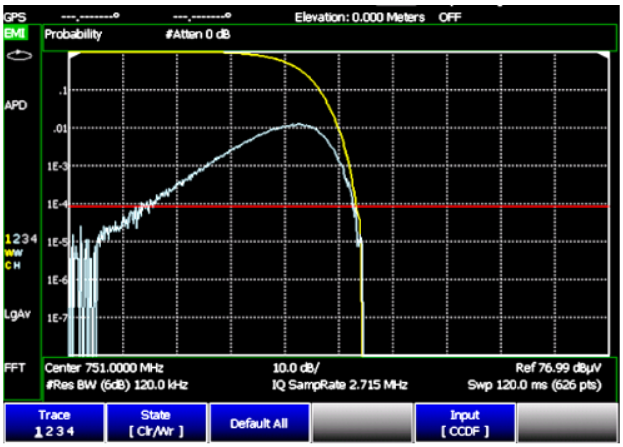
EMI diagnostic and performance verification are common tests for the lab, the manufacturing floor, field equipment, and regulatory inspections. EMI measurements help to:

- Evaluate pre-compliance limits before formal compliance tests
- Identify issues like noise floor rise and interference generated by other equipment
- Perform equipment or network regulatory audits against various limits, such as CISPR 16-1-1.
- Troubleshoot circuit boards
- Test potential system level performance impact due to EMI degradation

Keysight's FieldFox handheld analyzer provides a comprehensive solution to measure EMI, Amplitude Probability Distribution (APD), FFT spectrum analysis, and real-time spectrum analysis with density and spectrogram displays. It also performs vector network analysis for full 2 port S-parameter measurements. It is an ideal tool to address all EMI troubleshooting issues.



EMI measurements with built-in CISPR compliant detectors, RBW's and band presets in addition to a logarithmic scan and user-defined limit lines provide an ideal pre-compliance EMI testing tool regardless of being in the field or in a lab.

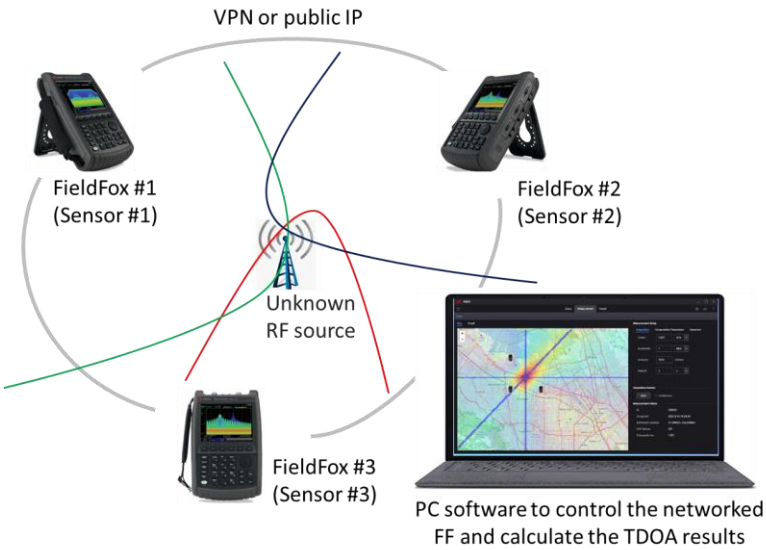


A Complementary Cumulative Distribution Function (CCDF) curve under APD and within EMI measurements reveals the statistical behavior of interference signals

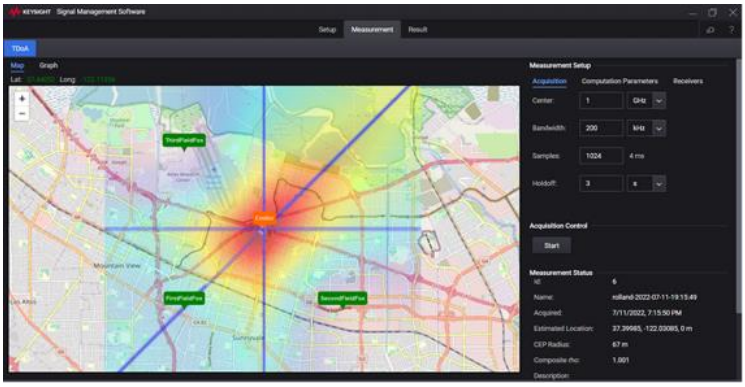
Geo-positioning and directional finding made easy

RF signals, both wanted and unwanted, crowd the modern world. Because of this, finding the geo-location of the signal source or interference of interest is an integral part of signal/spectrum management. Several directional finding techniques are commonly adopted to locate the signal source. Among them, Time Difference of Arrival (TDOA) is a well-established technique providing accurate results with as little as ten meters of uncertainty.

FieldFox, known as the industry's most integrated handheld signal analyzer, finds itself the best fit for the applications of directional finding. TDOA measurements require three or four FieldFox analyzers distributed at separate geographic locations and connected with a data network via VPN or public IP address. These FieldFox analyzers act as RF receivers/sensors and accurately synchronize in time with GPS signals. Each analyzer detects the modulated wideband IQ signals from the unknown signal source and sends the information to a networked computer installed with Keysight Spectrum Management Software (KSMS). The KSMS's TDOA algorithm calculates the set of hyperbolic curves and finds the intersection of these curves, determining the location of the unknown signal source.



TDOA solution using the networked FieldFox analyzers and PC software KSMS



TDOA PC software KSMS calculates the intersection of the hyperbolas and determines the geo-location of the

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.

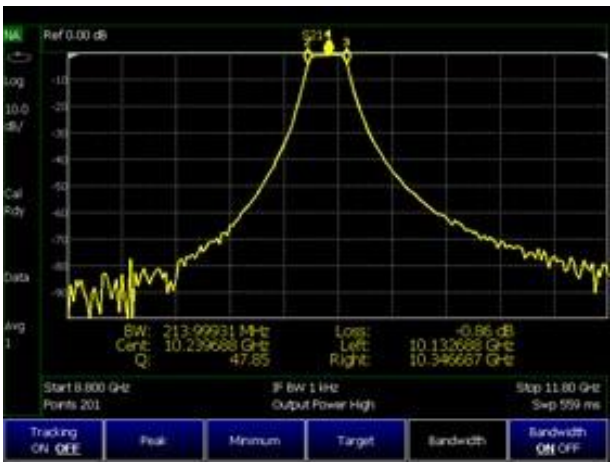
FieldFox's calibration engine is the same engine that powers the well-respected Keysight ENA and PNA network analyzers. FieldFox leverages Keysight microwave expertise to deliver consistent measurements with Keysight benchtop VNAs.

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

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

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 standalone vector voltmeter 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

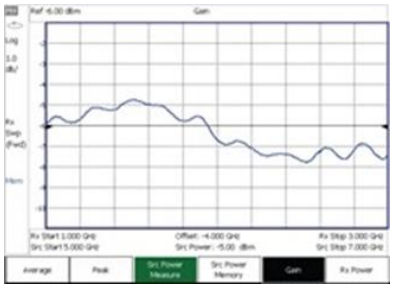
SEM measurement of 5G NR FR1 signal in addition to power measurements at a single CW frequency, you can measure power versus frequency - a swept measurement. FieldFox's source frequency can be set equal to the sensor/receiver frequency, or with an offset. The swept source and receiver frequencies track 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 iOS or Android mobile devices

Engineers and technicians can now remotely monitor and control their FieldFox using their iOS- or Android-based mobile devices. FieldFox's Remote Viewer iOS/Android app emulates the front panel of the unit, letting you simply press any FieldFox key and turn the knob right from your iOS/Android device. The app also allows you to instantly access technical documents such as data sheets.

FieldFox's Data Link software

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).

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

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

Control and view your FieldFox via your iPad

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/3x/5x/6xB, Data Sheet	5992-3702EN
FieldFox Handheld Analyzers N991x/3x/5x/6xB,C, Configuration Guide	5992-3701EN

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