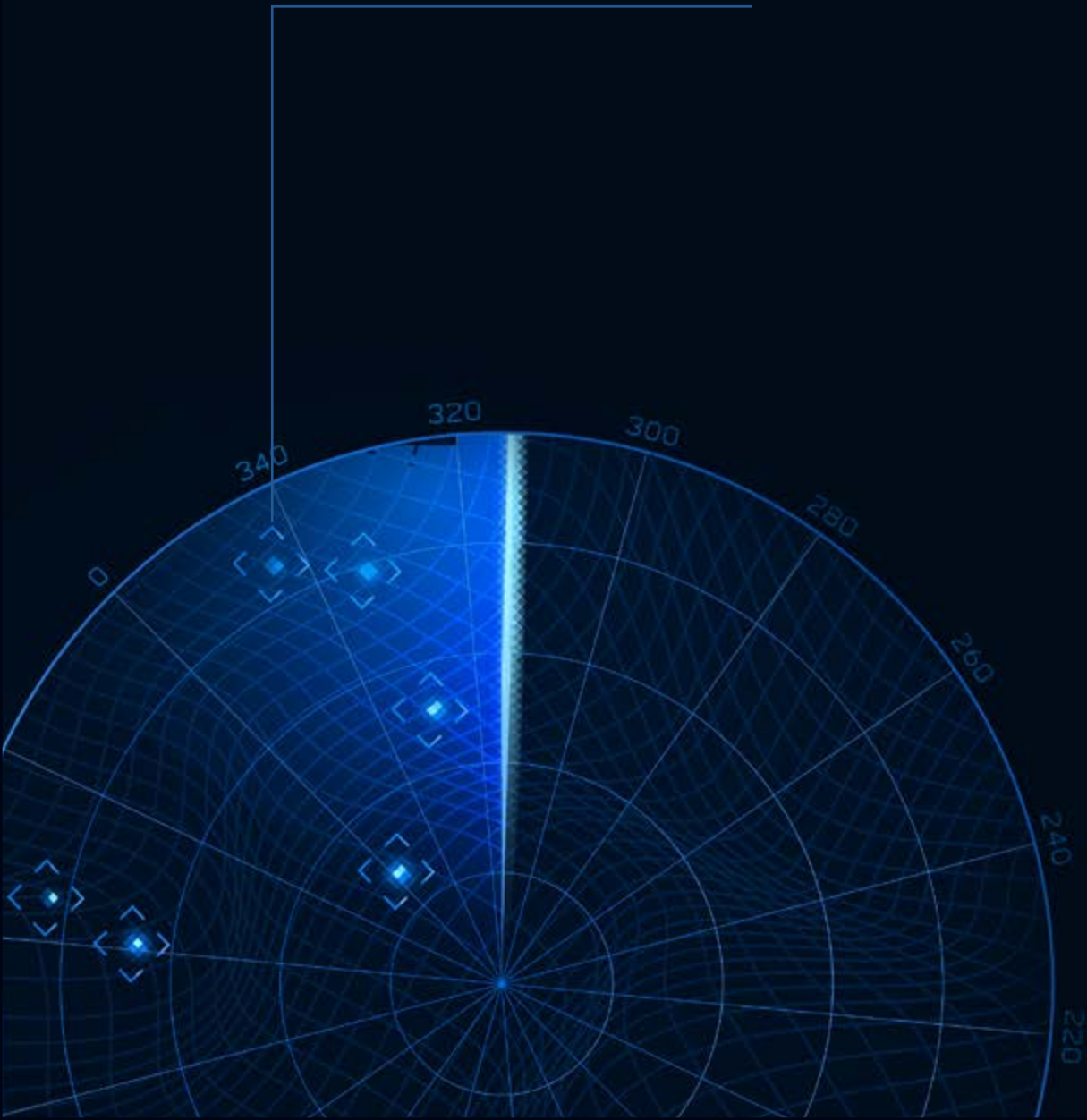


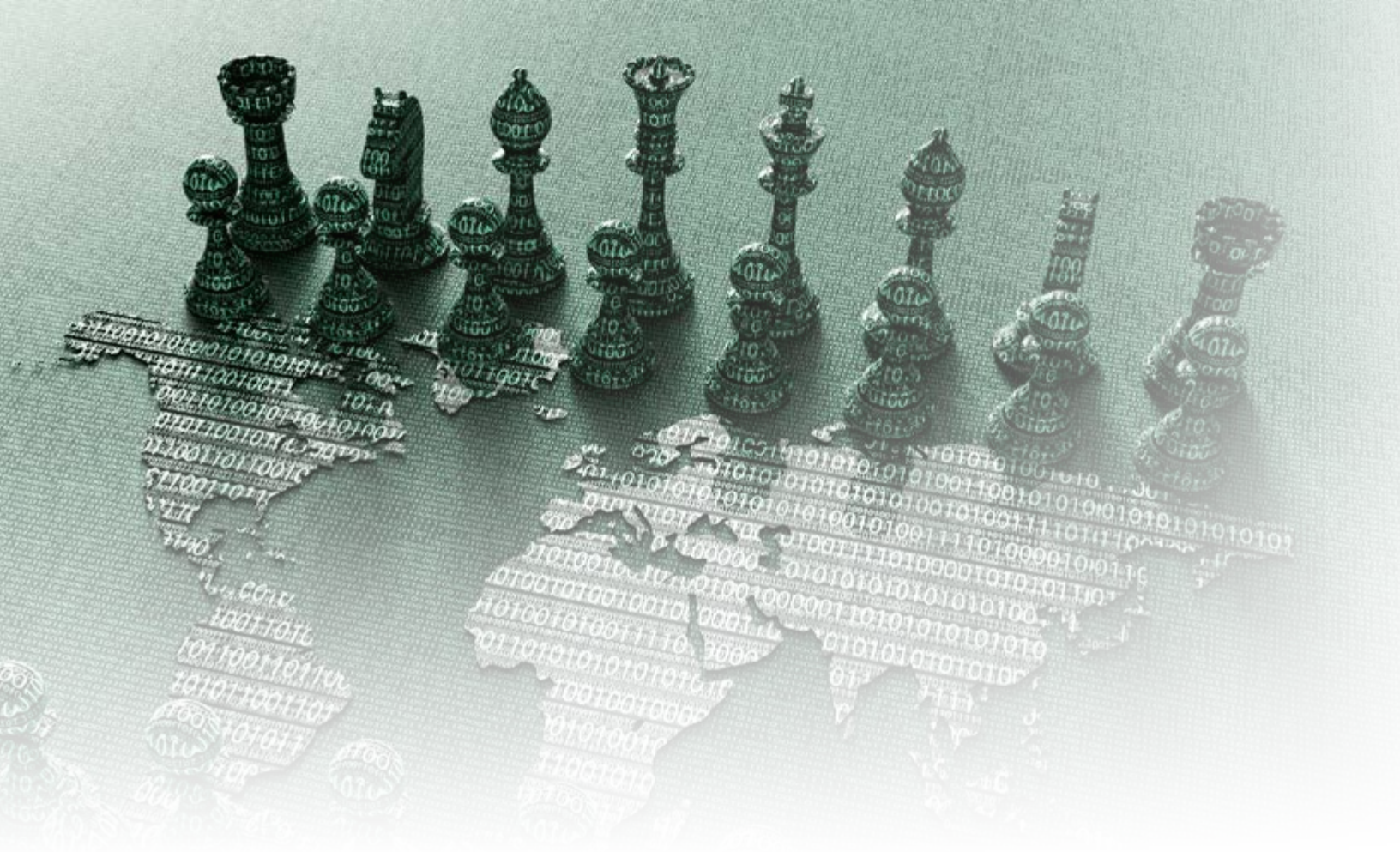
TAKE YOUR LAB TO THE NEXT LEVEL WITH

Keysight Technologies Electronic Warfare Test and Evaluation Solutions

Keysight Technologies

The world's leader in electronic measurement provides complete end-to-end solutions for designing, testing, and verifying Electronic Warfare (EW) System Under Test. We're stepping forward as a commercial collaborator, creating and delivering the rapidly adaptable EW solutions you need to succeed far into the future. We will work with your team to ensure enhanced realism and greater confidence in test and evaluation.





Overview

As the EW threat environment continues to evolve, confidence and reliability in EW system validation and verification is heavily dependent on the modernization and improvements of the test and evaluation process. Complex and diverse threats drive the need for EW systems to be capable of identifying and neutralizing radar threats accurately, and just as importantly, can respond with adaptive and cognitive countermeasures. The challenges of EW test and evaluation are increasing with high-fidelity complex emitters as there is a need to simulate and analyze high-density environments. The battle for dominance in the electromagnetic spectrum domain is a high priority for national defense and is driving the need for significant advancements in EW test and evaluation capabilities, methods, and solutions.

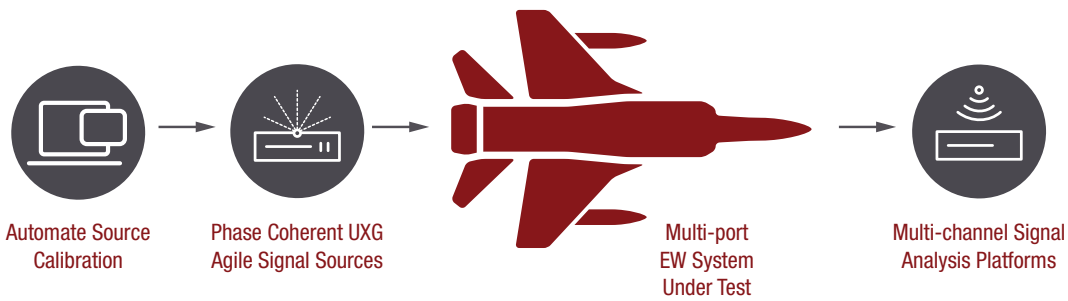
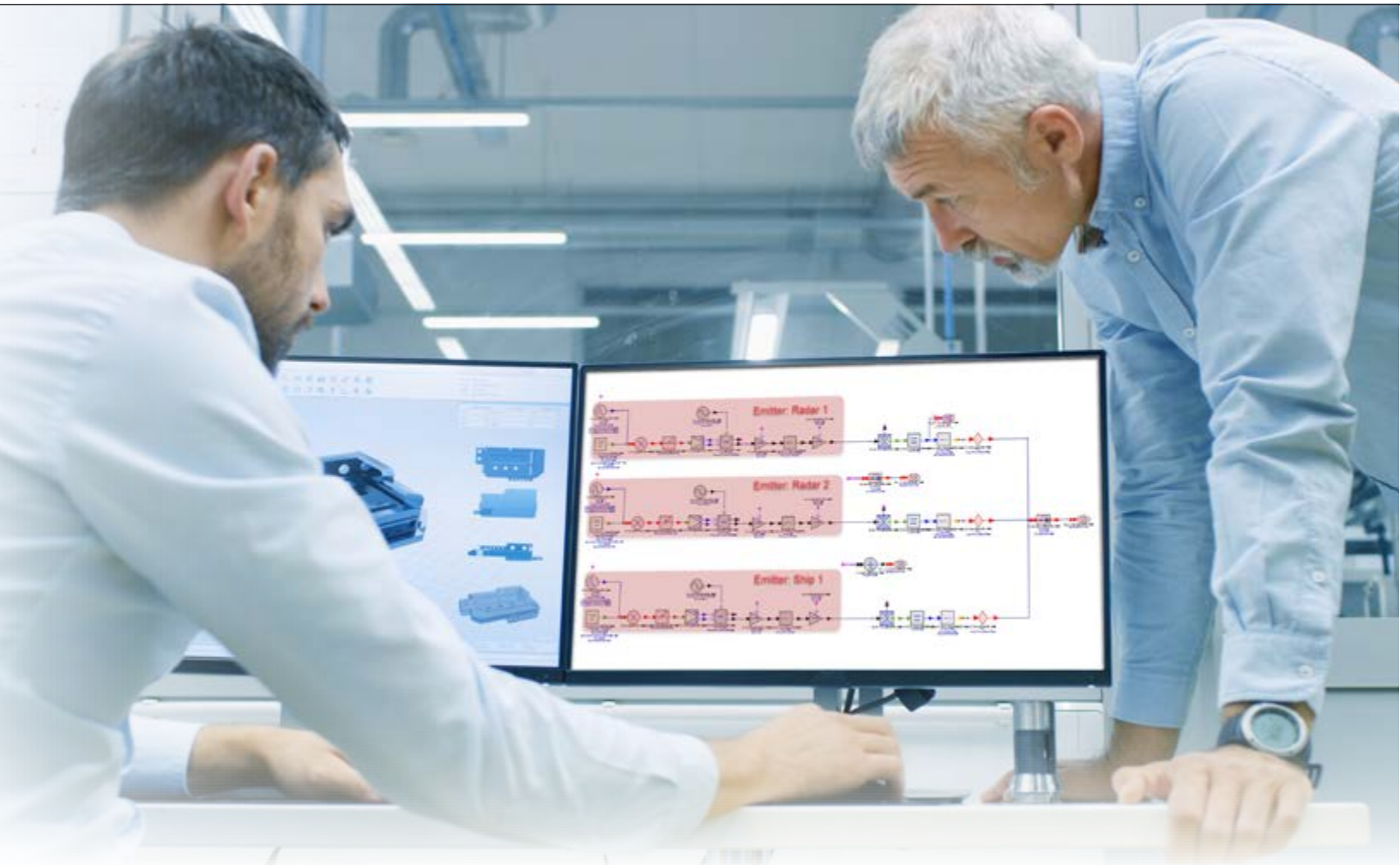


Figure 1. Multi-port EW System Under Test

Many times EW Test and Evaluation (T&E) is performed with large, complex, expensive custom systems not widely available to EW design engineers, leaving room for potential error as they aren't testing under the most realistic situations. To ensure consistency throughout development, testing, and deployment of EW systems, it is critical to identify when or where the error occurred. With Keysight's full range of commercial off-the-shelf (COTS) building blocks test confidently and evaluate starting with digital modeling in research and development all the way through system integration, flight tests, and fully operational systems. Use individual test and measurement blocks or engage with our team to create and deliver exceptional EW Test and Evaluation Solutions.





Reduce Risk with Simulated EW Systems Under Test (SUT)

Modern EW systems are very complex with complicated architectures. Digital modeling prior to hardware implementation of an EW System Under Test (SUT) reduces the risk of development time and high program costs. Keysight's SystemVue Radar Modeling library helps verify and analyze EW system processing, algorithms, and countermeasures by creating digital models of the system and running simulations with environmental effects including, multi-path reflections, interference, jamming, targets, and clutter.

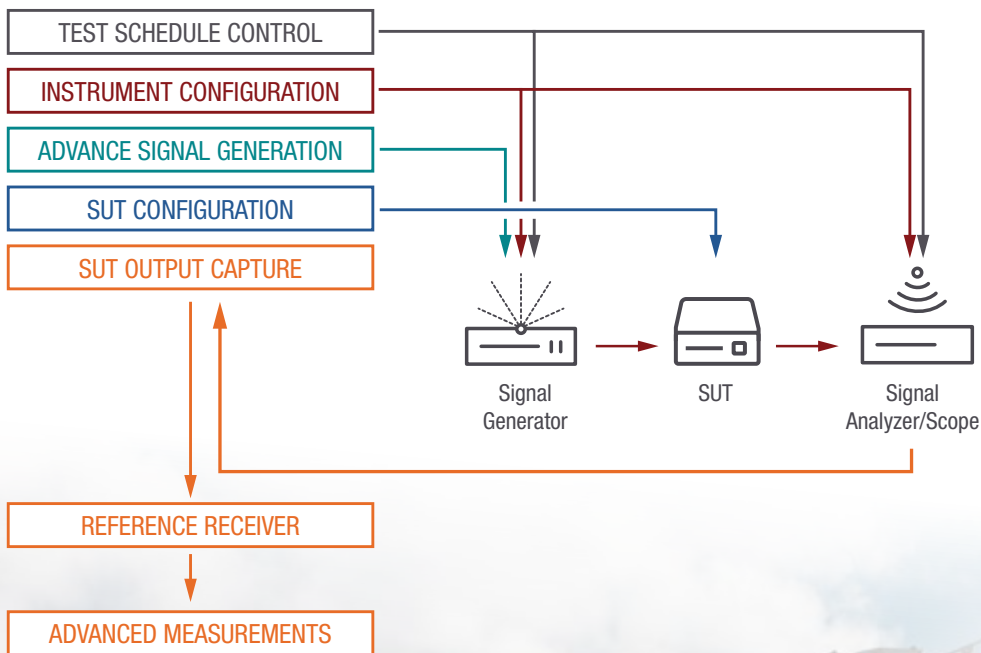
Analyze entire system including dynamic flight path, multi-emitters, jamming, and interferers

Model Environment, RF HW, antenna, and phased array effects

Reduce cost and time of field flight tests through simulation

Keysight's full range of COTS test and measurement equipment offers extensible testing as the system moves from a digital model into hardware prototypes during hardware-in-the-loop (HIL) testing. Choose from a range of arbitrary waveform generators and agile vector signal generators for signal generation and signal analyzers, oscilloscopes and digitizers for signal analysis. Use SystemVue as a platform to control hardware test setup.

SystemVue





System Integration and Verification Lab



Get Closer to Reality

To accurately simulate radar threats and targets, an agile signal generator that can switch frequency and settle amplitude in the hundreds of nanoseconds at different frequencies is necessary. When looking for a solution to simulate your RF environment, make sure the product's internal modulation bandwidth is sufficient to cover your threat frequencies of interest.



Keysight N5194A UXG X-Series Agile Vector Adapter, 50 MHz to 40 GHz



Keysight N5193A UXG Agile Signal Generator, 10 MHz to 40 GHz

The UXG agile signal generator's ability to fast frequency hop with phase continuity and repeatability makes it an ideal source to efficiently simulate complex threat environments across the full 40 GHz range of the signal generator.

- **Multiple pulse-Doppler radars** at different frequencies while maintaining the original phase as the signal generator hops from one emitter frequency to another
- **EW scenarios** with thousands of radar threat-emitters and millions of pulses per second with unique antenna scans
- **IQ custom complex modulation** on pulse with the UXG Vector Adapter including linear and nonlinear frequency modulated chirps over a 40 GHz range (see Figure 4)
- **High pulse density environments** by scaling up in the number of UXGs increases pulse density and allows the ability to perform pulse-on-pulse simulations or do multi-port angle of arrival (AoA) simulations.
- **AoA simulations** with multiple UXGs and staggering identical pulses played out of different ports (different UXGs) in time, phase, amplitude, or all three¹



Figure 4. Two 1.5 GHz wide LFM chirped emitters 7 GHz apart from one UXG source
UXG source

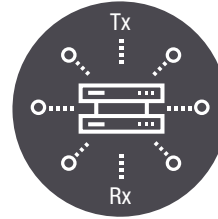
¹ Multi-source calibration (MSC) software is available as part of Keysight's custom threat simulation solutions. For more information, please contact your Keysight sales representative

Pulse Descriptor Word Based Operation

- 1Gb LAN or SSD streaming to > 1Mpps
- 10 GB LAN streaming to > 10Mpps

Applies User RF Corrections to Pulse Descriptor Word Data

- To system under test input port



Reports Pulse Counts

- Received, played, expired, or collided

EW System Under Test

With the different interface options, the UXG is a great replacement for legacy and unreliable RF sources:

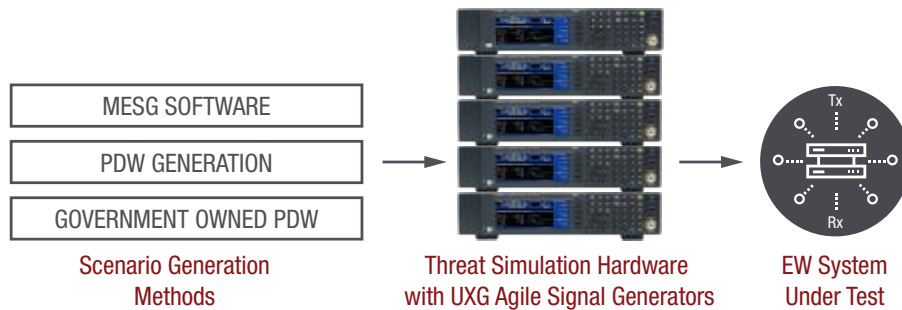
N5193A

- Binary Coded Decimal (BCD) for legacy compatibility
- Low Voltage Differential Signal (LVDS) for lowest latency HITL

N5193A and N5194A Pulse Descriptor Word (PDW) Streaming

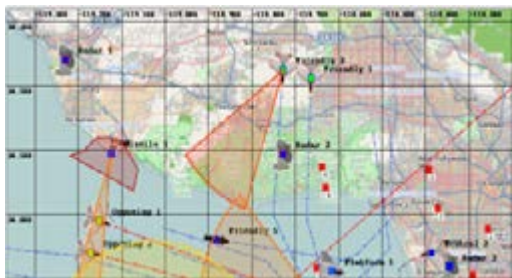
- Solid-state Drive Streaming (512 GB SSD)
- 1Gb LAN Streaming
- 10Gb LAN/Optical (Option CC3 on N5193A)

Spend Less Time Creating Pulse Descriptor Word Simulations and Spend More Time Testing your SUT

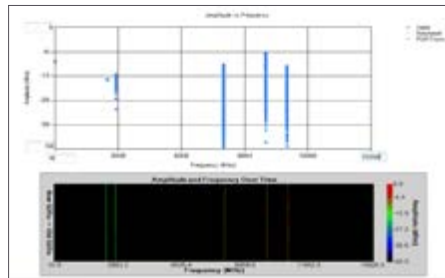


The UXG's flexible architecture and legacy threat library import capability is an ideal replacement for current RF sources or integration into new threat simulators.

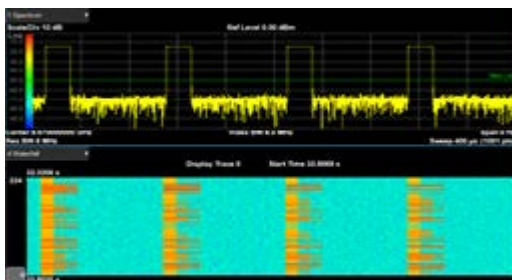
Easily use already created Pulse Descriptor Word (PDW) libraries or create them using a variety of tools including Excel, Matlab, or Keysight's **N7660C Multi-Emitter Scenario Generation software** or **Z9500A Simulation View software**¹.



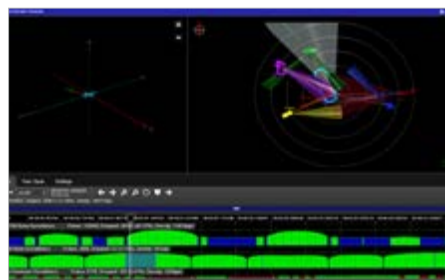
Game board with real-time navigation data input



PDW Reports and SUT monitoring



Automated RF Verification with PDW reports and SUT monitoring



3D Visualization Tools

Figure 5. Create high pulse density environments and view simulation in time domain and compute both AoA and Kinematics.

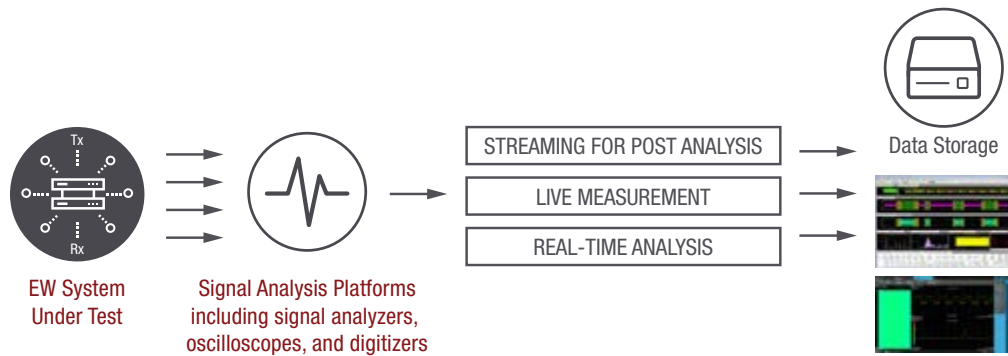
¹ N7660C and Z9500A software are subject to US ITAR export regulations. For more information, contact your Keysight sales representative

Create validated EW scenarios for the UXG agile signal generators with N7660C Multi Emitter Scenario Generation (MESG) for pre-scripted scenarios and Z9500A Simulation View for dynamic real-time scenarios.

Table 1. Compare N7660C and Z9500A capabilities

	N7660C	Z9500A
Automatic AOA and Kinematic calculation	✓	✓
Multi-emitter support	✓	✓
Dropped Pulse Reporting	✓	✓
Legacy Data Translation	✓	✓
Scenario Game Board	✓	✓
Plug-in Open Architecture		✓
War Gaming with DIS protocol		✓
Navigation Data Input		✓
Real-time PDW streaming		✓
Automated RF output Verification		✓

See, Capture, Analyze, and Understand Highly Complex Signal Environments



Analysis and scoring of EW stimulus and electronic attack resources can be a challenge due to wide-bandwidth and complex pulse modulation types in high-density environments. With the diverse portfolio of Keysight's COTS analysis hardware including signal analyzers, oscilloscopes, and digitizers, you can capture and characterize the EW environment up to 110 GHz with wide modulation bandwidths.

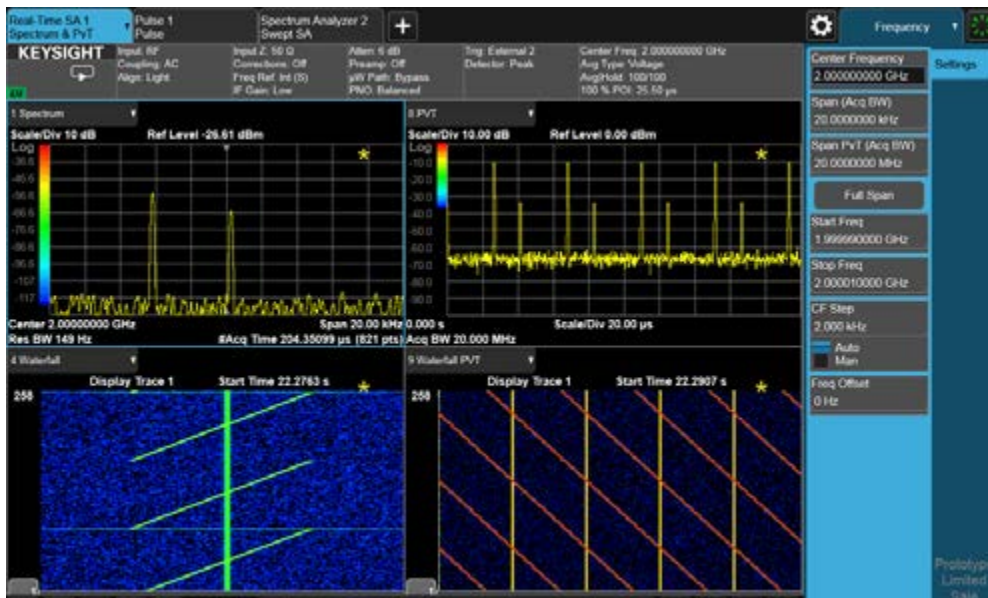


Figure 6. Dual domain analysis to verify Doppler shifts and pulse PRI



Figure 7. Raster scan shows radar modes and patterns

Keysight N9067EM0E and 89601B pulse analysis software capabilities:

- **Differentiate threats** with pulse-scoring filters based on characteristics such as pulse width, PRI, and modulation type (including linear and non-linear modulation)
- **Capture long scenarios** with efficient memory usage
- **Correlations and sidelobe measurements**
- **Dual domain analysis** with narrow bandwidth for frequency domain analysis and wider bandwidth for time domain analysis
- **Pulse Similarity Scores** comparing sequential pulses assist with radar output waveform validation¹
- **Pulse Train Searches** ensure that radar mode changes happen as expected¹

¹ Features included only with the Keysight 89601B

Record, Score, and Analyze Outputs of Electronic Attack Systems

The Radar Recorder can record and analyze pulsed signals in real time, making it the ideal multi-channel system to witness and verify the output of electronic attack systems. Using real-time measurement and PDW scoring, Keysight's Radar Recorder quickly verifies measured pulses. It increases confidence in testing while significantly improving recorder scalability, capability, and support.

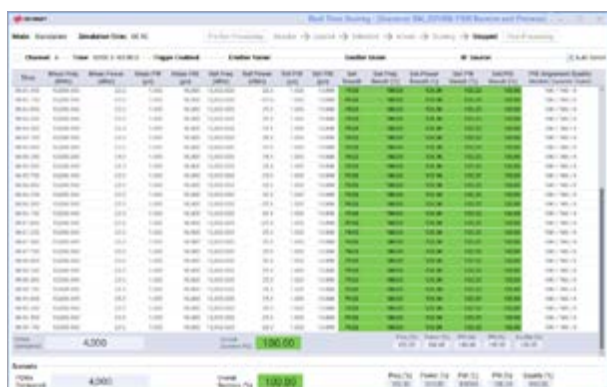


Figure 8. Color-coded scoring results and pulse interval attributes after pulse data collection



Figure 9. PDW browser containing a histogram of all pulses, a short power pulse, and a table of easily filterable pulse attributes

Key benefits of Keysight's Z2099B family:

- **The wideband, multi-channel design** allows simultaneous 2-channel recording for analysis on both inputs and outputs.
- **Real-time measurement and PDW scoring** increase confidence in testing and introduce rapid verification of measured pulses.
- **Easily view and analyze** large amounts of PDW data via the sophisticated analysis software.
- **Staggered channel capture** allows for simultaneous recording and data offloading and analysis.
- **The range of the system family** from small and transportable to fill systems allows the Radar Recorder to scale easily.



Accelerate your EW SUT Evaluation

The Keysight UXR oscilloscope is a multichannel instrument that when combined with the power of Pathwave 89600C Vector Signal Analysis Software (VSA), allows engineers and technicians to use this oscilloscope as a multichannel, phase coherent EW analysis solution for the most demanding EW applications.

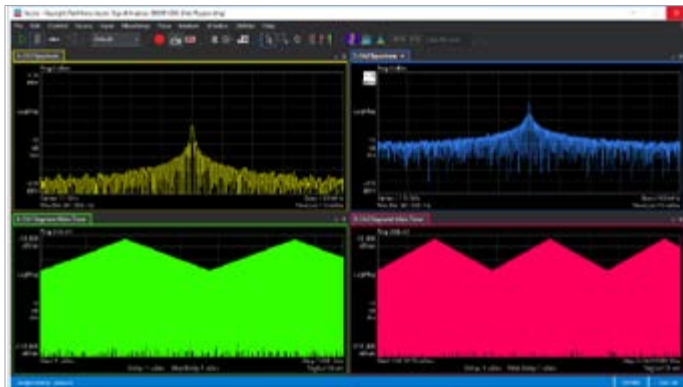


Figure 10. Multichannel, Emitter Scan Pattern Analysis using Variable Length Segmented Capture

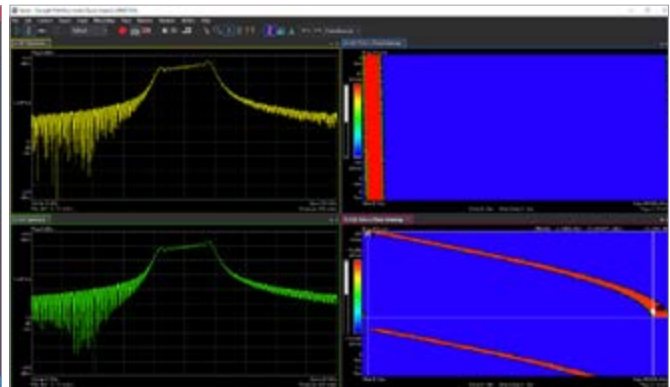


Figure 11. Multichannel Range Gate Pull Off Measurement

Key capabilities of Keysight's UXR Oscilloscope:

- **Detect rising and falling edges** of pulses and signals of interest with Variable Length Segmented Capture
- **Capture signals** across 4 channels simultaneously and with independent bandwidths on each channel
- **Easily extract PDW** files for use with Keysight UXG's
- **Quicker validation** of changing pulse widths, PRIs, and technique development with fast and slow time plots
- **Automatically extract PRI's** from signals for detailed characteristics and statistical analysis
- **Reduce the effective data rate** of measurements with the multichannel digital downconverter



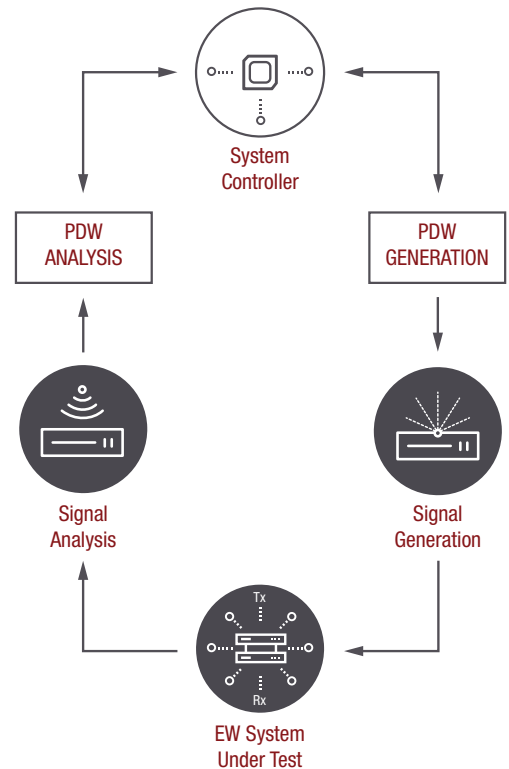
Installed System Test Facility



COTS EW Signal Generation and Analysis Building Blocks

Keysight provides commercially-available building blocks to create EW threat simulation and analysis systems. This includes solutions with:

- **N5193A/94A Agile Signal Generators** for multi-channel and multi-port threat simulations
- **Arbitrary waveform generators** for threat simulation for baseband or wideband verification
- **Oscilloscopes, signal analyzers, and digitizers** for wideband signal analysis
- **Flexible FPGA tools** and storage and streaming options for closed-loop simulations



Flexible EW Threat Simulation and Analysis Solutions

Keysight has a long history in measurement and calibration science. Work with our team of experts to configure and design a scalable and flexible EW test system. Our solutions include full system integration and automated multi-source and system-level calibration.

Create high-density, AoA simulations with flexible multi-port configurations

- **Ensure coherency across** multiple sources with calibration of amplitude, phase, and time
- **Threat simulators** compatible with MESH software or other dynamic PDW-based scenario generation systems

Capture the signal environment using multi-channel, wide-bandwidth streaming recording of RF and processed signals

- **Uses an integrated combination of hardware,** firmware, and software that performs signal selection, downconversion, digitization, signal processing, and data storage
- **Apply post-capture analysis software** to RF test and signal-processed recordings

EW Systems are flexible and scalable based on program or test requirements.





Open Air Range Testing

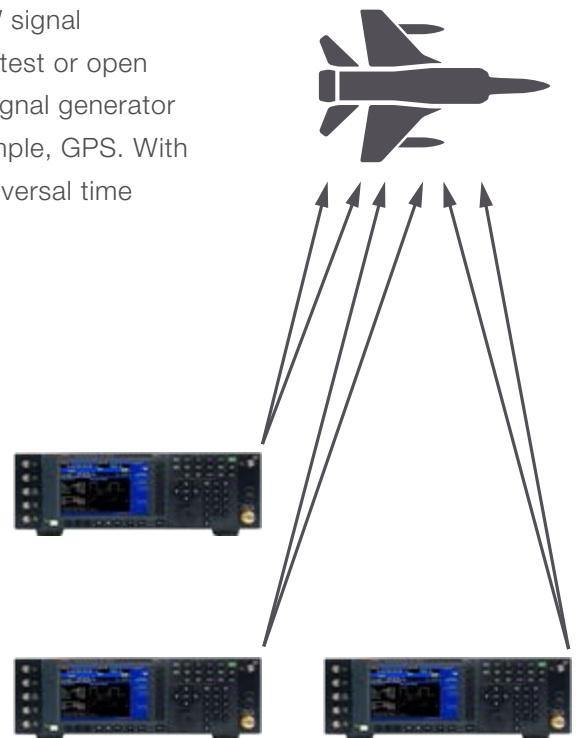


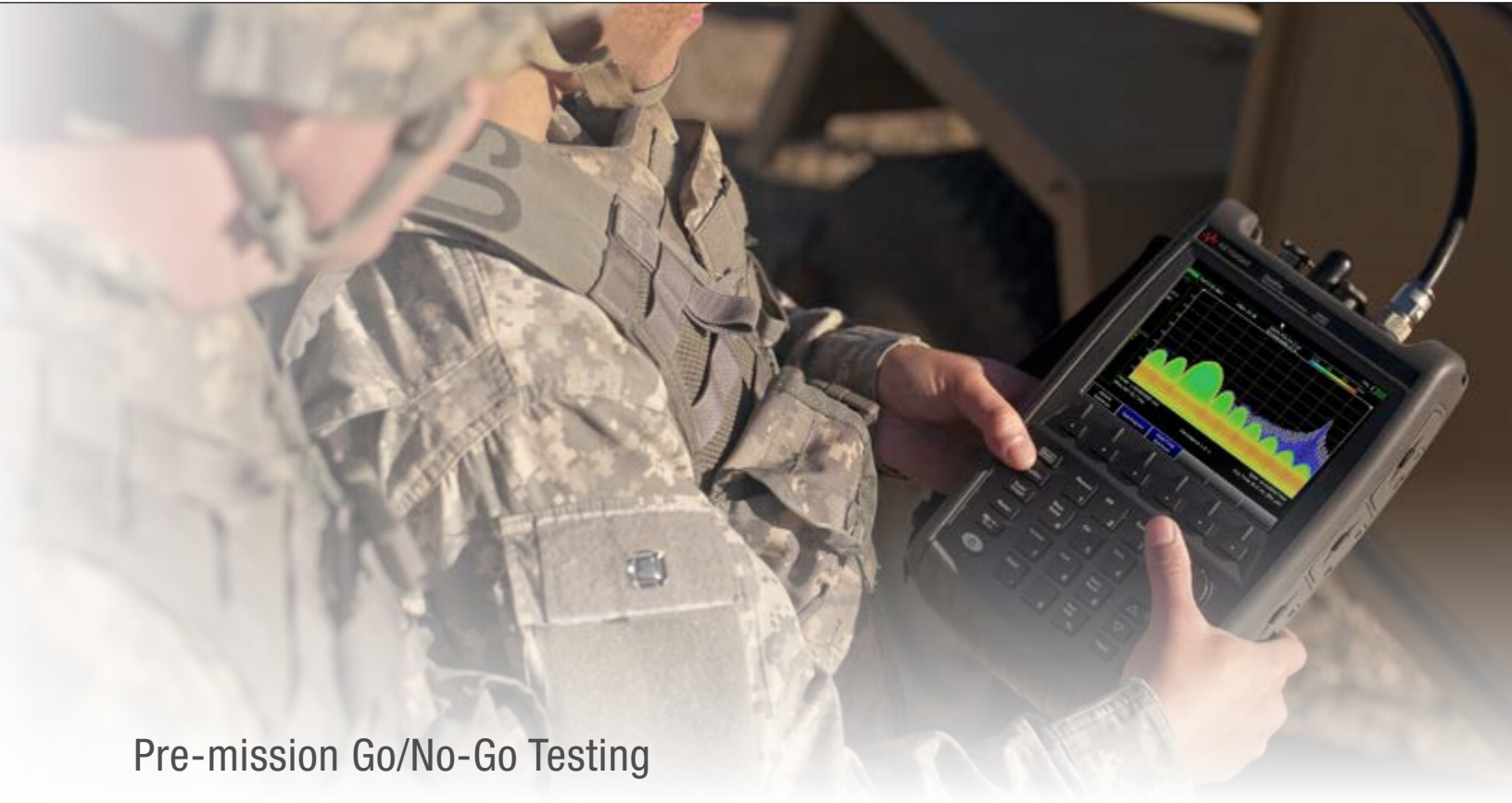
Real-time Sequenced PDW Files

Many times real-time sequenced streaming is necessary for EW signal generation. An example where this is useful during over-the-air test or open range test to simulate multiple ground-based radar. The UXG signal generator synchronizes to any time module that can output PPS, for example, GPS. With multiple boxes synchronized, they are triggered at the same universal time clock.

Enables the operator to:

- **Control several UXG stacks** located over a significant distance from one central location
- **Use the same PDW library** and threat simulation files from early prototype and system integration testing to verify in-flight/operation receiver & processor effectiveness and stability and
- **Play the same files and simulations** at the corresponding UTC across different labs or locations





Pre-mission Go/No-Go Testing

Once a system is deployed into the field—there may be a need to perform pre-mission tests to verify operational readiness.

Keysight's FieldFox handheld microwave analyzers offer benchtop performance out in the field across multiple terrains and extreme environments including clean room to desert, sea, tropics, and arctic. Have absolute confidence for mission-critical measurements including:

- **Receiver Test**
 - Noise figure
 - Functional test with CW source
- **Emitter Verification**
 - Verify signal output & characteristics with a power meter, spectrum analyzer, and Real-time spectrum analyzer to 50 GHz
 - Pulse profiling up to 40 GHz with USB peak power sensor
- **Op check entire RF chain or individual components, radiated or closed loop**
 - Antennas, cables, converters, amplifiers
 - Distance-to-fault, and Time domain reflectometry (TDR)
- **Op Check GPS:** Evaluate carrier-to-noise density (C/N) and distribution amplifiers

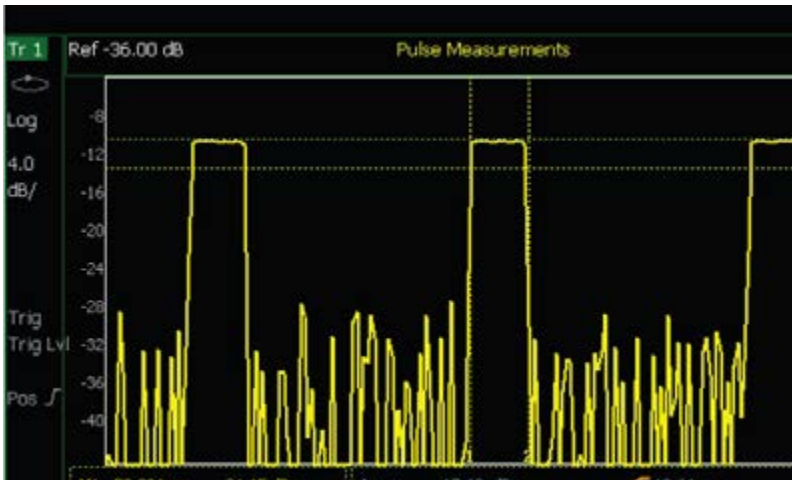


Figure 10. Create pulse measurements on the flightline with Fieldfox

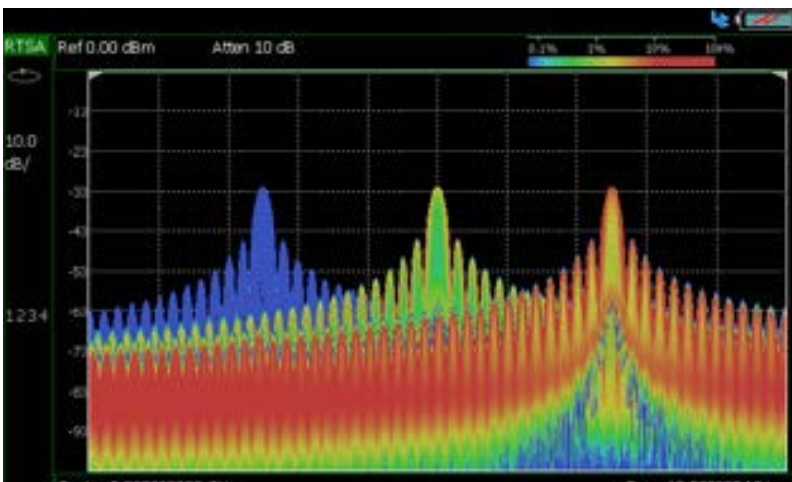


Figure 11. Capture every signal with real-time spectrum analysis

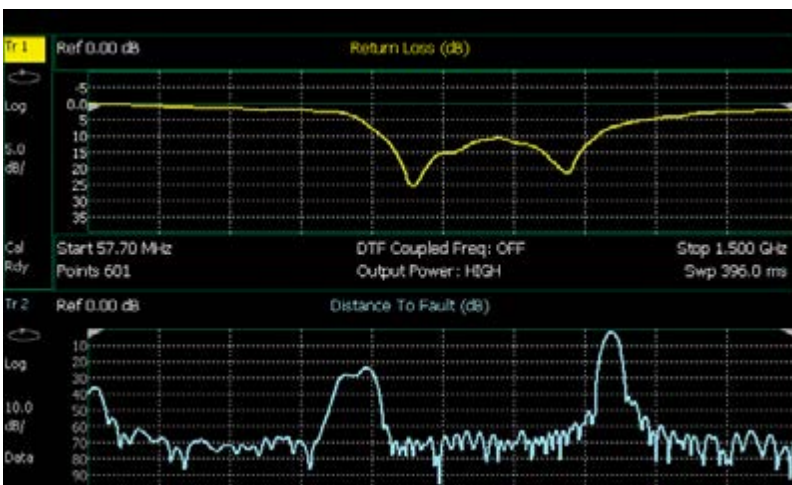


Figure 12. Perform system op-checks with the Fieldfox powerful cable and antenna test application



KeysightCare Services Can Help You Adopt Leading-Edge Test Solutions and Ensure Long-Term Program Support

KeysightCare Solution Services offer a broad portfolio of services and support to assist engineers working on electronic warfare (EW) programs. We understand that engineers count on high fidelity, realistic EW simulations, while ensuring test lab readiness to meet schedule requirements. Time spent managing the support of the individual elements of a complex, custom system puts tight schedules at risk. The emergence of new and unique threats drives a need for constant modernization and test system scalability.

KeysightCare Solution Services guarantee:

- **Committed access to experts** with a dedicated connection between Keysight's solutions support engineers and your teams. Access our technical knowledge center for 24/7 self-help, including frequently asked questions and how-to guides.
- **Proactive notifications** to ensure your software test and design tools are current and include the latest standards. Receive priority access, with a committed timeframe, to application experts who are familiar with Keysight software and hardware.
- **Committed turnaround times** for repair and calibration. Keysight restores your instrument to like-new condition, every time. Our trained technicians have access to factory diagnostic procedures, verification software, test fixtures, firmware upgrades, and service notes. These services minimize solution failure and extend useful solution life.

Services Description

KeysightCare Threat Simulation Solution Services R1130S-0Y3-ITR ¹	
Technical Support (Application and Solution-specific for both Hardware and Software)	
Self-service web portal & knowledge center	Available 24/7
Technical support response time	2 business days
Customized startup training ²	Self-directed startup materials and instructor led training, remote or face-to-face
Software configuration support ³	•
Solution Hardware Support	
Repair service turnaround time	15 business days, system component level ⁴
Calibration service	Keysight Calibration + Measurement Uncertainties + Guard Banding
Calibration turnaround time	10 business days, system instrument level ⁵
Application of service notes ⁶	Mandatory notes only
Optional Services ²	
Exclusive loaners	Leveraged for minimizing downtime during repair and calibration events
Customized onboarding training	Self-directed and instructor led training, remote or face-to-face
Onsite premium technical AE support	Dedicated application engineers will help to answer your toughest questions
Long-term instrument-based support ⁷	10+ Years

For more information about Keysight Services, visit us at:

- [Keysight Repair Services](#)
- [Keysight Calibration Services](#)
- [Exclusive Loaner Services](#)
- [Keysight Instrument Lifecycle Solutions](#)

To learn more about KeysightCare, visit us at www.keysightcare.com

1. The service includes KeysightCare Solution Support for 3 years. All system components will be serviced at a Keysight Customer Service Center with Return-to-Keysight (RTK) coverage. 1-2-, and 5-Year KeysightCare Solution support is also available upon request.
2. Available for additional purchase.
3. KeysightCare Software Agreement required for software support including software updates and notifications.
4. All components covered. Non-Keysight system and custom components may have a longer turnaround time.
5. The N5193B and N5194B UXG's must be scheduled in small batches for calibration in order to ensure committed turnaround times are met. Contact Keysight to schedule the services.
6. Keysight performs application of service notes during scheduled service events.
7. Contact Keysight with any specific requests for long-term support.

Additional Literature

Signal Studio for Multi-emitter Scenario Generation, 5992-0405EN

Z9500A Technical Overview Brochure, 5992-4339EN

N5193A UXG Agile Signal Generator Data Sheet, 5992-0092EN

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89600 VSA Software for Pulse Analysis, Technical Overview, 5992-0320EN

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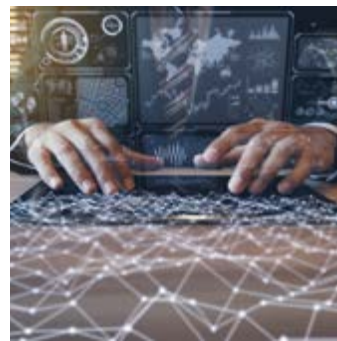
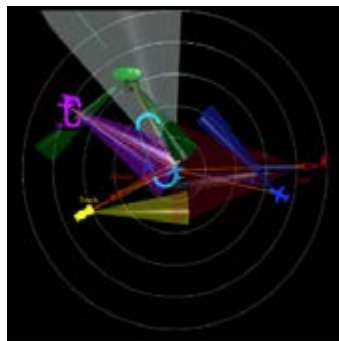


Additional Information

With our full range of test and evaluation solutions, feel confident throughout the entire lifecycle of your EW system under test. To learn more about Keysight's EW solutions and services visit www.keysight.com/find/ew

Your Partner for Electronic Warfare Solutions

Our unique combination of hardware, software services, and people can help you reach your next breakthrough. Our EW solutions have kept pace with the industry and continue to push the boundaries of technical limitations. We are unlocking the future of technology to secure the world.



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