

Keysight Technologies

Gap-free Recording and Analysis of Elusive, Intermittent Signals Made Simple

Application Brief

On an electronic battlefield, the frequency spectrum is crowded, chaotic and complex. The ability to fully understand signal behavior in a real-world environment is crucial as you design and validate the latest radar and electronic warfare (EW) systems.

There are two key measurement challenges. First, highly unpredictable signals of interest are difficult to capture using traditional measurement tools. Fortunately, the latest digitizers and digital interfaces enable creation of RF streaming solutions that can record signals for seconds, minutes, or even days. The resulting mountain of data is the second challenge. An optimized combination of measurement hardware and software makes data reduction and analysis more manageable and accelerates the time-to-answers. A turnkey RF streaming solution from Keysight Technologies, Inc. and X-COM Systems simplifies recording and analysis of elusive and intermittent signals, bringing you closer to the answer.



Unlocking Measurement Insights

Enabling high-performance RF streaming

Gap-free recording of a complex RF environment is a practical way to capture elusive and intermittent signals for further analysis via playback and post-processing. The Keysight N9040B UXA and N9030B PXA signal analyzers enable streaming of I/Q data at up to 255 MHz real-time to the X-COM IQC5255B signal record and playback system (Figure 1).

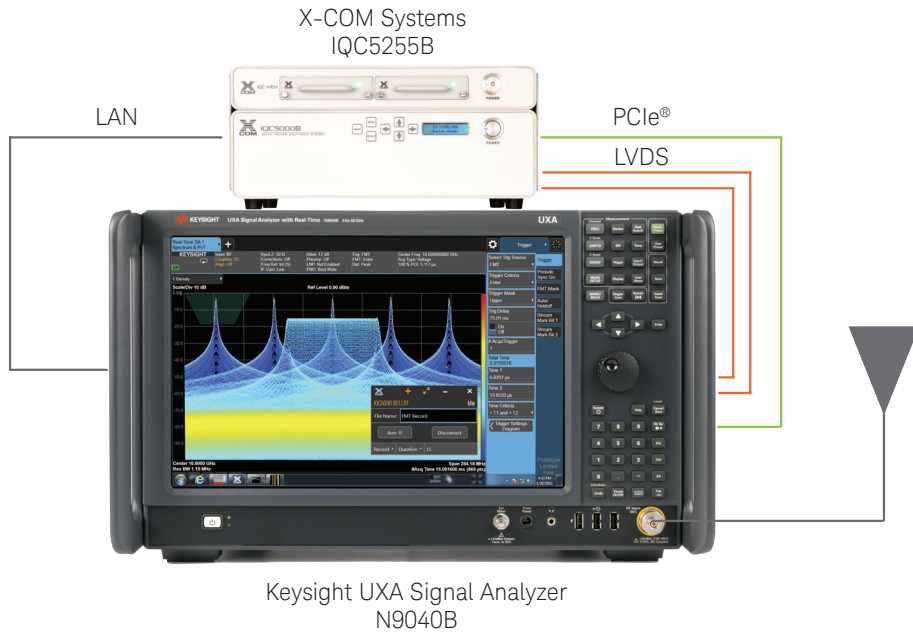


Figure 1. Combining the UXA signal analyzer and IQC5255B recorder with powerful software components creates a comprehensive solution for RF streaming.

With up to 15 TB of memory, the IQC5255B can capture more than three hours of data at full bandwidth¹. Table 1 provides approximate recording times based on the bandwidth setting in the UXA.

Bandwidth	Memory ¹	Approximate Recording Time		
		Seconds	Hours	Days
10 MHz	15 TB	300 k	83.3	3.5
100 MHz	15 TB	30 k	8.3	0.35
255 MHz	15 TB	12.5 k	3.5	0.14

Table 1. Maximum recording time is a function of available memory and analyzer bandwidth setting.

The values in the seconds column are calculated as follows:

$$\text{Maximum time (sec)} = \frac{\text{Memory capacity in bytes}}{(\text{Bandwidth in Hz}) * (\sim 1.25) * (4 \text{ bytes/sample for I/Q data})}$$

The 1.25 value is an approximate span-to-sample rate conversion factor. In practice, it rolls off to about 1.18 with the 255 MHz span.

Taking signal analysis farther

You can use the combined strengths of Keysight and X-COM to take signal analysis farther with wider, longer-duration views of elusive and wideband signals:

- Record long and complex pulsed radar environments and system interactions, capturing crucial RF events.
- Push the envelope in next-generation radar and electronic warfare systems.
- Accelerate time-to-insight using high-speed offload and signal analysis tools.
- Use the latest turnkey solution based on the Keysight N9040B UXA signal analyzer and X-COM Systems IQC5255B
- Test radar detection systems with continuous recording playback through Keysight vector signal generators

1. The IQC5255B is available with 2 or 4 TB of internal memory; the optional 15 TB capacity is external memory in the form of a RAID array.

Configuring and recording seamlessly

When the environment contains numerous emitters of varying amplitudes, it can be difficult to find low-level signals in the presence of much larger ones. In the streaming solution, the PXA or UXA provides 78 dBc of spurious free dynamic range (SFDR) across the full 50 GHz frequency range, and this is recorded with the high-resolution 16-bit I and Q capture capability of the X-COM recorder to produce deeper views of signal behavior.

Seamless integration between the analyzer and recorder enables you to configure and initiate recordings directly from the UXA or PXA, streamlining recording control and eliminating the need for an external PC or laptop. An added benefit is the ability to simultaneously view the live spectrum measurements on the analyzer screen while a recording is in progress (Figure 2).

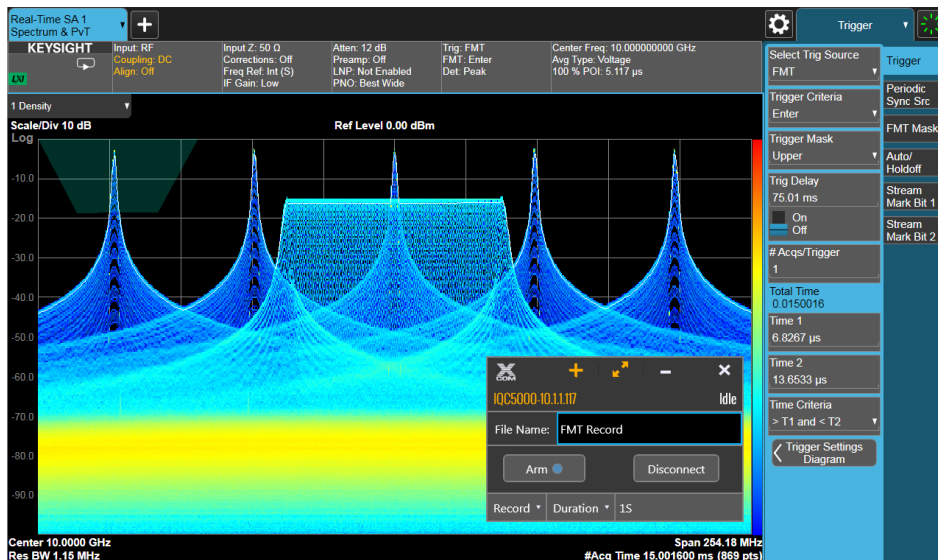


Figure 2: Real-time spectrum analysis (RTSA) mode provides live measurements of elusive signals even while recording is underway.

Extracting useful information from massive data sets

This is a “big data” process. Streaming 100 MHz of I/Q bandwidth with 16-bit samples for just 10 minutes creates a 300 GB file. Today’s RF streaming applications routinely require bandwidths in excess of 200 MHz.

With a modern interface such as PCIe, large files can be offloaded from the IQC5255B’s redundant array of independent drives (RAID) array to the analysis computer (in the UXA) with nearly gigabyte-per-second speeds. Once the data has been captured and stored as I/Q samples on the IQC recorder, it must be analyzed, interpreted and distilled into more compact forms such as mission data file (MDF) entries or pulse descriptor words (PDWs).

Advanced signal processing tools are needed to turn this raw data into useful information and actionable results. For example, the ability to search through large sets of data and isolate specific signal behavior is essential to helping a system engineer or signal analyst determine whether the system performed as expected or if there were any timing anomalies or unexpected RF emitters.

X-COM's Spectro-X software allows you to quickly zoom in on desired recording segments using automated signal- and pulse-search algorithms. It includes functions that range from basic frequency, time or amplitude filtering to highly advanced pulse pruning based on pulse width, pulse repetition interval (PRI), and more. This level of functionality makes it easy to search through vast sets of data and uncover rare events or signals (Figure 3).

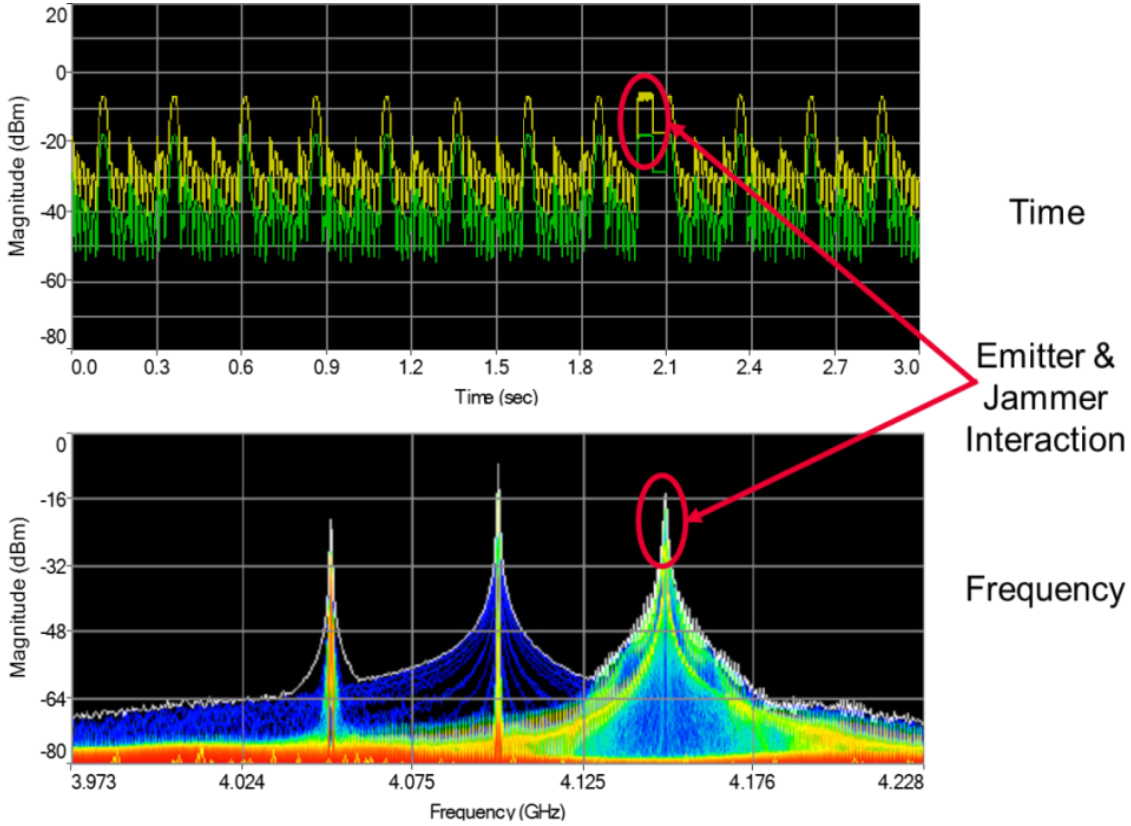


Figure 3. Whether viewed in the time (top) or frequency domain (bottom), Spectro-X software helps detect short-lived signal behaviors as in this interaction between an interceptor radar and a jamming response. Note the relatively short duration of the interaction compared to the other scanning radars in the background.

Once a signal or event of interest has been located in Spectro-X, you can quickly export it to Keysight’s 89600 VSA software for deeper analysis. You simply snip out a section of the recording by drawing a rectangle around the emitters of interest. With the optional pulse-analysis capabilities of the 89600 VSA software (Option BHQ), you can tabulate pulse parameters, measure modulation quality, compute PDWs and evaluate timing relationships (Figure 4). Features such as frequency-mask and time-qualified triggers can pinpoint issues down to a single pulse within thousands, and automatic detection of modulation per pulse enables faster, easier analysis of pulse characteristics. Extensive, flexible displays and markers allow you to view virtually every facet of the signal, giving valuable insight into signal behavior.

Conclusion

The X-Series signal analyzers are the benchmark for accessible performance that puts you closer to the answer by easily linking cause and effect. Across the full spectrum—from CXA to UXA – you’ll find the tools you need to design, test and deliver your next breakthrough.

With the real-time streaming option on the UXA and PXA signal analyzers (Option RTS) combined with the X-COM Systems IQC5255B, you can now capture and record I/Q signatures of complex pulsed radar signal environments, enabling signal characterization and system verification. This comprehensive solution also includes scenario emulation through the ability to play recordings through a vector signal generator.

With seamless integration and accessible usability, the streaming solution from Keysight and X-COM can help you push the envelope in next-generation radar and electronic warfare systems.

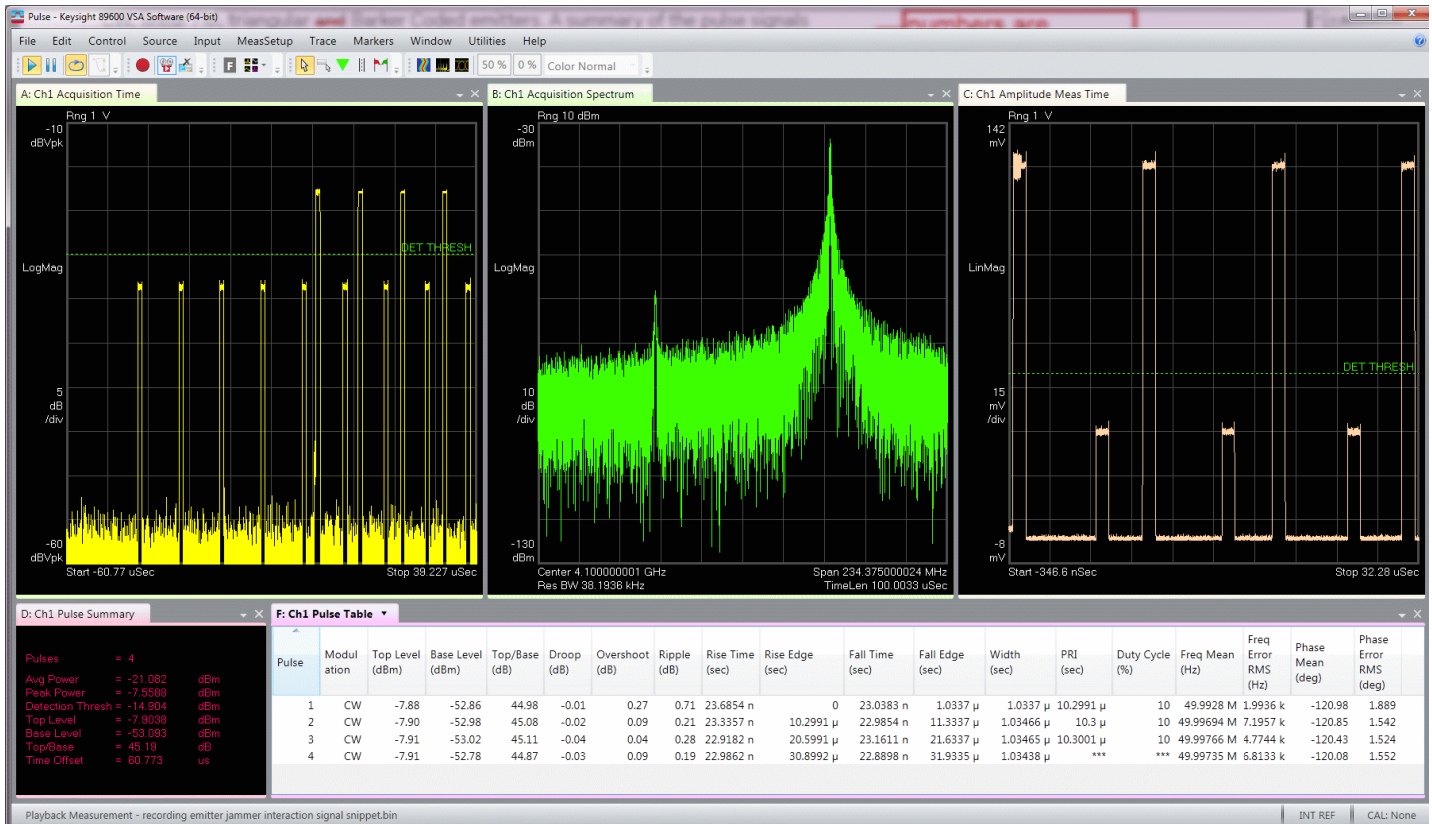
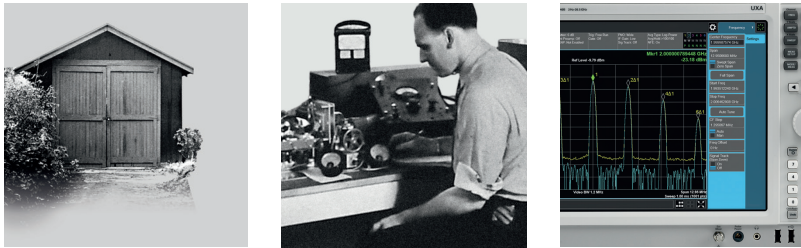


Figure 4. In-depth pulse analysis with the 89600 VSA software (Option BHQ) is simplified through automatic synchronization to pulsed signals and auto-detection of modulation on a pulse.

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