Two Channel, Multi-Band RF Record and Playback

Benefits

- Record RF signals with no acquisition dead time and guaranteed capture of the shortest duration events
- Build an RF Capture library of high fidelity field test reference signals for future regression tests in a laboratory environment
- Interchange a common set of RF Capture libraries across multiple labs and organizations to ensure lab-to-lab test repeatability
- Capture transient field test events for later playback in a controlled lab environment

Features

- Two channel, multi-band RF Recorder and RF Player
- 10MHz – 6.6GHz Tuning Range (Record) Each channel independently tunable
- 50MHz - 6.6GHz Tuning Range (Playback) Each channel independently tunable
- 50MHz Maximum Record Bandwidth
- 100MHz Maximum Playback Bandwidth

Applications

- Simultaneous GPS L1 & L2 Capture/Play/Generation; M-Code compatible
- Capture & examine interactions of signals in two different frequency bands

Instrument Overview

Instrument Function	Two independently tunable channels of RF capture & playback. Tightly synchronized start triggers and sample clocks ensure deterministic timing relationships between channels.
Instrument Architecture	National Instruments Modular RF Instruments in PXI Express Form Factor High Speed Disk Storage Subsystem High Performance Quad-Core Embedded CPU with Windows 10 O.S. All PXI instruments may also be used as general purpose programmable instruments when the Spectrum Defender software is not active.

Signal Acquisition Characteristics

Acquisition Channel	2
Inter-Channel Electrical Relationships	Two Multi-Band, Synchronous Channels with Independent Tuning + Sample Rates Frequency & Phase Locked + Start Triggers Locked Deterministically + Center Frequencies Locked to Common 10MHz Timebase Center frequencies are independently tuned, and therefore not phase coherent. Alternate Spectrum Defender Models will provide fully phase coherent capture & reproduction, but without independently tunable center frequencies.
Signal Capture Type	Downconverted, Contiguous, Baseband IQ Data Stream
Tuning Range	10MHz – 3.3GHz (Standard) 10MHz – 6.6GHz (Option)
Tuning Resolution	1Hz
Signal Capture Bandwidth Minimum/Maximum	100kHz minimum 50MHz maximum
Signal Capture Bandwidth Adjustment Resolution	1Hz , IQ rate automatically adjusts for user selected capture bandwidth, where Sample Rate = Selected BW / 0.8 (e.g. 50MHz RF BW = 62.5MS/s)

Amplitude Range Adjustment Method	Software controlAled electrical & mechanical attenuators operating in one of two modes: + Manual Gain Control + Assisted Gain Control (Set & Hold)
Signal Capture Modes	Fixed Record Duration , Indefinite Record Duration , Fill to Disk Capacity Record Duration
Trigger Sources	Software button-press start , External Pulse (pos or neg edge) , Time-of-day- start, Network packet start

Additional acquisition performance specifications per National Instruments PXIe-5663E Device Specifications document

Signal Storage

High-Speed Non-Volatile Storage Capacity & Type	Qty=1, 24TB RAID, spinning disks (Additional options available)
Duration of Stored Signal(s)	22 hrs at 30MHz/chan signal bandwidth typical for GPS M-code applications See charts below for storage durations at alternate signal bandwidth
High-Speed Non-Volatile Storage Filesystem	Microsoft NTFS (Direct plug-in compatibility with MS Windows)
High-Speed Native Record File Formats	SL Standard 001, Raw Binary Essence
Off-Line Storage Types	Export to external storage devices (e.g. HDD, memory stick) using USB 2.0 or USB 3.0 interface. Export to any network file share, SAN storage, or FTP server using standard Windows networking technologies and tools.
File Formats Exported To Off-Line Storage	SL Standard 001, Raw Binary Essence SL Standard 002, Raw Binary Essence SL Standard 003, National Instruments TDMS

SD-3836 Configuration Matrix

Module	Description	
0101	Spectrum Defender® Reviewer Module	*Included*
0102	Spectrum Defender Recorder Module	*Included*
0103	Spectrum Defender Surveyor Module	*Optional*
0104	Spectrum Defender TCP Remote Control	*Optional*
0105	Spectrum Defender Player Module	*Included*
0106	Spectrum Defender Time & Navigation Module	*Optional*
0201	10MHz – 3.3GHz Tuning Range (Record) 50MHz – 6.6GHz Tuning Range (Play)	*Standard*
0202	10MHz – 6.6GHz Tuning Range (Record) 50MHz – 6.6GHz Tuning Range (Play)	*Optional*
0301	50MHz/chan Record Bandwidth 100MHz/chan Play Bandwidth	*Included*
0401	24TB Primary Storage	*Included*
0402	Additional 24TB Secondary Storage As Additional 2U Chassis	*Optional*
0403	Additional 24TB Secondary Storage As Individual, Swappable Hard Drives in Shipping Kit (also includes 2 spare drives for maintenance)	*Optional*
0404	Storage Maintenance Kit: Includes 2 spare drives + tools for field replacement in rugged shipping/carrying case	*Optional*
0601	GPS/IRIG-B/IEEE-1588/PPS Receiver	*Optional*
77XX	Custom File Format Import/Export	*Available – Call Factory*
88XX	Custom Software Extension	*Available – Call Factory*
99XX	Custom Hardware Extension	*Available – Call Factory*

Signal Acquisition Fidelity

Digital Sample Resolution	32-bits per IQ sample pair (16-bit I, 16-bit Q)
Modulation Quality (Representative)	57dB MER (64-QAM; 6MHz BW; 825MHz CF) 41dB MER (64-QAM; 50MHz BW; 825MHz CF)
ADC SFDR	-80dBc or -75dBc (dependent on RF Center Freq & IF Center Freq)
Equalization	Real-time, linear equalization (EQ) of full signal acquisition bandwidth for optimized frequency response and group delay +/- 0.15dB amplitude ripple (typ); 25MHz BW; 23 deg C +/- 5C
SSB Phase Noise	-129dBc/Hz @ 10kHz Offset @ 800MHz CF; 23 deg C +/- 5C

Additional acquisition performance specifications per National Instruments PXIe-5663E Device Specifications document

Instrument Control Interfaces

Primary User Interface	Microsoft Windows Desktop Application Accessible via locally attached Keyboard/Video/Mouse or remotely via Windows Remote Desktop Protocol (RDP) over Ethernet
Primary Programming Interface	Native LabVIEW Application Programming Interface (API)
Secondary Programming Interface	ASCII command/response protocol over TCP/IP May be automated using any TCP/IP capable programming language. Also interacts with common terminal emulation software for command line experience .
Integrations	Instrument may be integrated to function seamlessly with other manual and automated laboratory test systems via either the LabVIEW native API or the TCP/IP API.

Output Signal Characteristics

Signal Output Channels	2
Inter-Channel Electrical Relationships	Two Multi-Band, Synchronous Channels with Independent Tuning + Sample Rates Frequency & Phase Locked + Start Triggers Locked Deterministically + Center Frequencies Locked to Common 10MHz Timebase Center frequencies are independently tuned, and therefore not phase coherent. Alternate Spectrum Defender Models will provide fully phase coherent capture & reproduction, but without independently tunable center frequencies.
Output Signal Types	Arbitrary Waveform, IQ Stream from High Speed RAID Arbitrary Waveform, IQ Stream from VSG RAM Continuous Wave Tone (CW)
Frequency Range	50MHz-6.6GHz (Standard) 50MHz-3.3GHz (Option)
RF Power Range	-152dBm/Hz to +10dBm
RF Power Resolution	0.1dB
Output Signal Bandwidth Minimum/Maximum	100kHz minimum 100MHz maximum
Output Signal Bandwidth Resolution (IQ Stream Type)	IQ sample rate (and signal bandwidth) automatically adjust to native rate of IQ waveform with resolution of 1 sample/sec. Usable output bandwidth is nominally 0.8 x IQ Rate (e.g. 125MS/s = 100MHz RF BW)
Playback Repeat Modes (IQ Stream Type)	Single-Play , Continuous Loop, Loop Specified Number of Times
Trigger Sources	Software button-press start , External Pulse (pos or neg edge) , Time-of-day- start, Network packet start

Additional acquisition performance specifications per National Instruments PXIe-5663E Device Specifications document

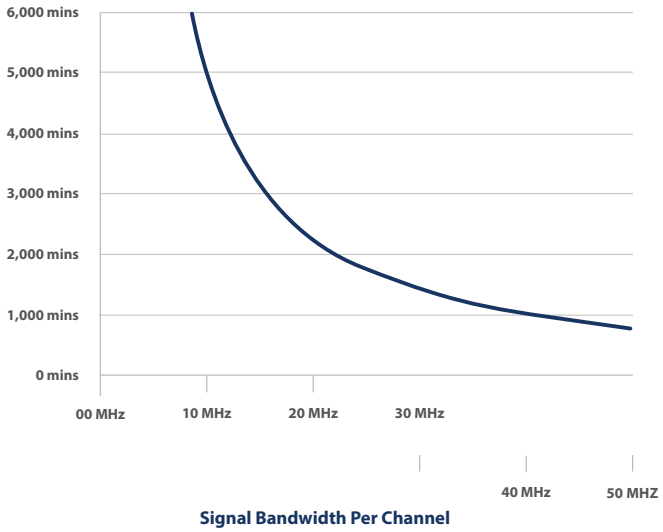
Output Signal Fidelity

Digital Sample Resolution	32-bits per IQ sample pair (16-bit I, 16-bit Q)
Modulation Quality (Representative)	44dB MER (64-QAM; 6MHz; 825MHz) 34dB MER (64-QAM; 50MHz; 825MHz)
Equalization	Real-time, linear equalization (EQ) of full signal generation bandwidth for optimized frequency response and group delay
Phase Linearity	+/- 3.0deg for +/-40MHz from 400MHz-6.6GHz center frequency
Spectral Purity (Phase Noise)	< -105dBc/Hz @ 10kHz offset; 1GHz center frequency

Additional output signal performance specifications per National Instruments PXIe-5673E Specifications, RF Vector Signal Generator document

Waveform Storage Duration

2 Channels, 24TB RAID



Signal Bandwidth Per Channel

Software Functionality

Spectrum Defender® Reviewer Module Software Features

Waveform File Spectrum Analyzer

Select a waveform file and review it on-screen in a Spectrum Analyzer style user interface. Apply averaging, peak-detection and resolution bandwidth adjustments on a previously recorded/imported waveform.

Freeze-Frame, Slow-Motion, High-Speed Waveform File View Modes

Freeze and manually step through the selected waveform file in time. Review the waveform file on-screen in either slow motion, normal speed or high-speed. Quickly scan through long signal waveforms, or perform a slow-motion deep dive observation of short duration signal events.

Trim and Export Waveform Files

Trim a long duration waveform into shorter component parts. Export either the trimmed waveform(s) or the entire original waveform. Convert waveform to alternate file formats on export.

Import Waveform Files

Import files from external storage or network sources for subsequent analysis.

Spectrum Defender Recorder Module Software Features

Contiguous RF Signal Recording

Capture RF signals with high fidelity and outstanding accuracy. Save downconverted IQ baseband data stream to storage subsystem with no dropped samples or acquisition dead time.

Long Duration Recording

Flawlessly capture and record RF signals for minutes, hours or days. Record duration is limited only by size of attached RAID storage system.

Preview Signals Prior to Record

Use an on-screen spectrum analyzer style display to search for RF signals of interest and optimize amplitude, center frequency, and bandwidth settings prior to recording. Apply averaging & peak detection processing in the frequency domain. Adjust resolution bandwidth settings & display averaging to pull signals out of the noise floor.

Spectrum Defender Player Module Software Features

Continuous Waveform Streaming

Stream (playback) IQ waveforms from storage subsystem to RF output connector with no dropped samples or "dead time".

Unlimited Duration

Streaming waveform playback may continue indefinitely, without interruption when operating in continuous loop mode. Streaming waveform playback continues without interruption for the entire duration of the stored waveform when operating in single-play mode.

Center Frequency Tracking

Manually select a specific RF output center frequency or configure the system to automatically track the original center frequency used during recording/import.

RF Power Level Tracking

Manually select a specific RF output power level or configure the system to automatically reproduce the waveform at the same RF power level as the original recording/import.

Spectrum Defender TCP Module Software Features

TCP/IP Remote Control

Remotely initiate and stop recording, set center frequency, amplitude, and record BW settings over a TCP/IP network connection. ASCII text command interface over TCP sockets. Programmer's Guide documentation included

Signal Acquisition Fidelity

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ADC SFDR	-80dBc or -75dBc (dependent on RF Center Freq & IF Center Freq)
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SSB Phase Noise	-129dBc/Hz @ 10kHz Offset @ 800MHz CF; 23 deg C +/- 5C

Additional acquisition performance specifications per National Instruments PXIe-5663E Device Specifications document

Spectrum Defender is a product of the United States of America.

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