

# Eight Channel, Phase Coherent RF Player and Arbitrary Waveform Generator

## Benefits

- + Reproduce arbitrary waveforms with unlimited complexity and lengths extending into hours or days
- + Simulate the output from a multi-element phased array receive antenna
- + Playback multi-channel field recordings while preserving inter-channel relationships
- + Regression test RF receive hardware in a realistic spectral environment without the expense and limited repeatability of field tests

## Features

- + Eight Channels of Phase Coherent Arbitrary Waveform Generation
- + 50MHz – 6.6GHz Output Frequency Range
- + 100MHz/CH Maximum Output Bandwidth

## Applications

- + Beamforming Signal Generation
- + MIMO Test & Evaluation
- + Electronic Warfare Research
- + Direction Finding Receiver Test



## Instrument Overview

<b>Instrument Function</b>	Eight channel, phase coherent, frequency agile RF Player and Arbitrary Waveform Generator (AWG)
<b>Instrument Architecture</b>	National Instruments Modular RF Instruments in PXI Express Form Factor High Speed Disk Storage Subsystem High Performance Quad-Core Embedded CPU with Windows 7 O.S.

## Signal Storage

<b>High-Speed Non-Volatile Storage Capacity &amp; Type</b>	Qty = 2, 6TB RAID, spinning disks (additional options available)
<b>Duration of Stored Signal(s)</b>	50 mins at 100MHz/chan signal bandwidth 1 hr 40 min at 50MHz/chan signal bandwidth 3 days, 11 hrs at 1MHz/chan signal bandwidth  <i>See charts below for storage durations at other signal bandwidths</i>
<b>High-Speed Non-Volatile Storage Filesystem</b>	Microsoft NTFS (Direct plug-in compatibility with MS Windows)
<b>High-Speed Native Playback File Format</b>	SL Standard 001, Raw Binary Essence, IQ Time Series SL Standard 002, Raw Binary Essence, IQ Time Series SL Standard 003, National Instruments TDMS, IQ Time Series
<b>Off-Line Storage Types</b>	Import from external storage devices (e.g. HDD, memory stick, DVD-ROM) using USB 2.0 or USB 3.0 interface.  Import from any network file share, SAN storage, or FTP server using standard Windows networking technologies and tools.
<b>File Formats Imported From Off-Line Storage</b>	SL Standard 001, Raw Binary Essence, IQ Time Series  SL Standard 002, Raw Binary Essence, IQ Time Series  SL Standard 003, National Instruments TDMS, IQ Time Series

## Output Signal Characteristics

<b>Signal Output Channels</b>	8
<b>Inter-Channel Electrical Relationships</b>	All Channels Phase Coherent <ul style="list-style-type: none"> <li>+ Center Frequency Locked</li> <li>+ Sample Rate Locked</li> <li>+ Shared Start Trigger</li> </ul> All Channels Deterministically <ul style="list-style-type: none"> <li>+ Calibrated Inter-channel phase relationships are calibrated and deterministic across repeated playback events and system reboots</li> </ul>
<b>Inter-Channel Phase Alignment</b>	Phase alignment at any given center frequency: < +/- 0.5 degree across multiple start triggers < +/- 0.1 degree within a single trigger, and with manual tuning by user
<b>Output Signal Types</b>	Arbitrary Waveform, IQ Stream from High Speed RAID, Arbitrary Waveform, IQ Stream from VSG RAM, Continuous Wave Tone (CW)
<b>Frequency Range</b>	50MHz-6.6GHz
<b>RF Power Range</b>	-152dBm/Hz to +10dBm
<b>RF Power Resolution</b>	0.1dB
<b>Output Signal Bandwidth Minimum/Maximum</b>	100kHz minimum 100MHz maximum
<b>Output Signal Bandwidth Resolution (IQ Stream Type)</b>	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)
<b>Playback Repeat Modes (IQ Stream Type)</b>	Single-Play Continuous Loop Loop Specified Number of Times

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

## SD-BTO-3829 Configuration Matrix

Module	Description	
0101	Spectrum Defender® Reviewer Module	Included
0105	Spectrum Defender Player Module	Included
0104	Spectrum Defender TCP Remote Control	Optional
0401	Primary Storage – 12TB (2x 6TB)	Included
0402	Upgrade Primary Storage to 96TB (4x 24TB)	Optional
0403	Direct Connect Storage to External PC Workstation	Optional
0404	Secondary Storage – 2x 6TB	Optional
1001	One Year Hardware Warranty	Included
1002	Extend Hardware Warranty to Two Years	Optional
1003	Extend Hardware Warranty to Three Years	Optional
88XX	Custom Software Extension	Available – Call Factory
99XX	Custom Hardware Extension	Available – Call Factory

## Output Signal Fidelity

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

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

## Instrument Control Interfaces

<b>Primary User Interface</b>	Microsoft Windows Desktop Application Accessible locally via built-in KVM console or remotely via Windows Remote Desktop Protocol (RDP) over Ethernet
<b>Primary Programming Interface</b>	Native LabVIEW Application Programming Interface (API)
<b>Secondary Programming Interface</b>	ASCII command/response protocol over TCP/IP Interacts with common terminal emulation software or may be automated using any TCP/IP capable programming language
<b>Integrations</b>	System 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.

## Physical, Environmental, Power

Form Factor	Roll around instrumentation rack 55" H x 22" W x 33" D (including wheels)
Intended Operating Environment	Office/Lab Environment
Weight	400 lbs. (estimated) Actual weight shall be stated at time of delivery
Power Source	110VAC/60Hz nominal
Power Consumption	With all channels streaming at full bandwidth: 1100 Watts (9.2 amps @ 120VAC)

## Software Functionality

### Spectrum Defender® Reviewer Module Software Features

#### Waveform File Spectrum Analyzer

Select a waveform file and preview 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. Preview 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.

#### Import Waveform Files

Import files from external storage or network sources for subsequent high-speed playback and waveform streaming.

#### 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.

### 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.

#### Sequenced Playback

Build a playback sequence consisting of multiple waveforms from the storage subsystem. Initiate autonomous playback of this sequence for unattended testing or repetition of a standard regression test suite.

### Spectrum Defender Player Module Software Features

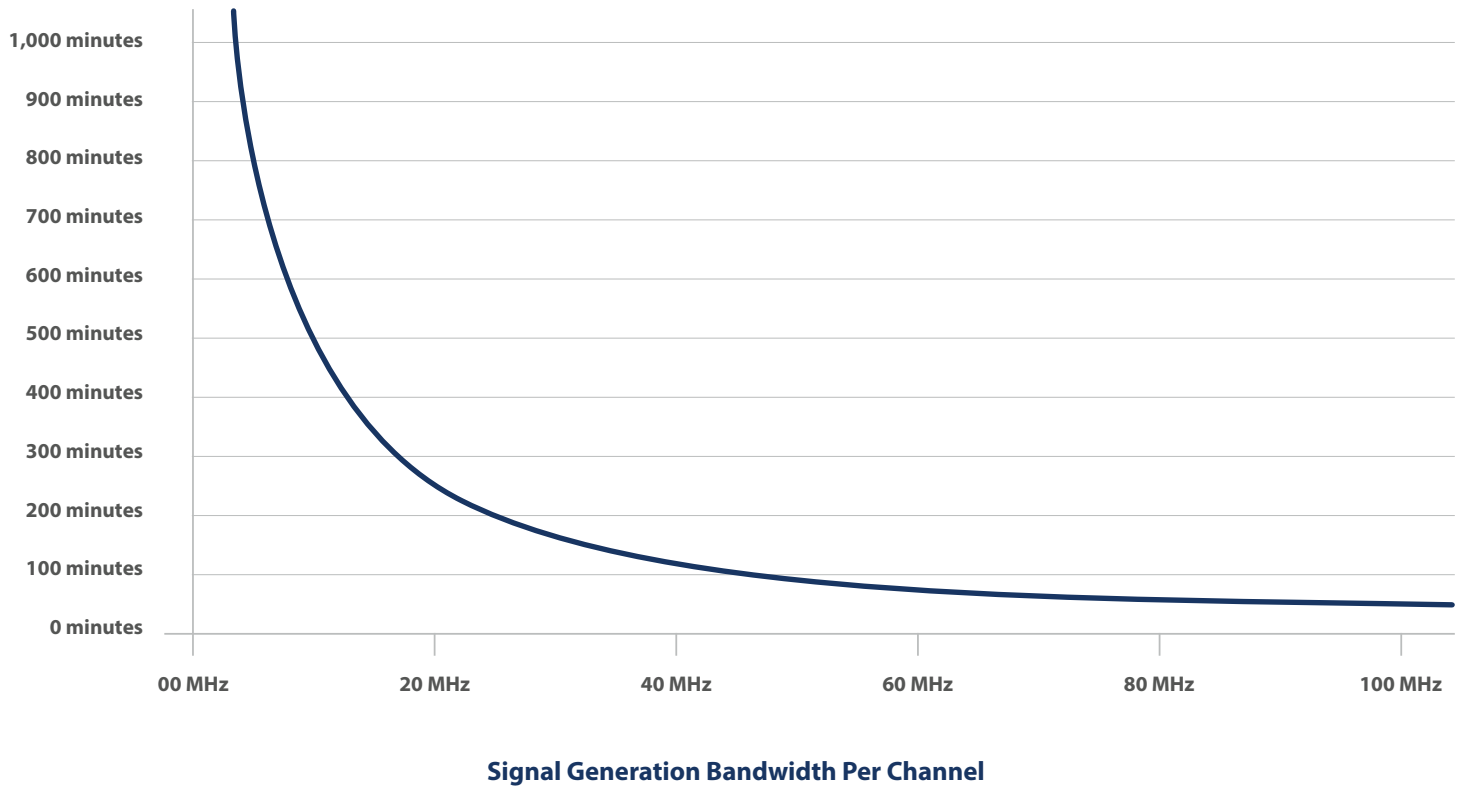
#### TCP/IP Remote Control

Remotely initiate and stop waveform playback, output frequency settings, and output power settings over a TCP/IP network connection.

ASCII text command interface over TCP sockets.

Programmer's Guide documentation included

## Max Duration of Stored Signals as a Function of Signal Bandwidth (Standard Storage Configuration: Option 401)



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