CRFS

RFeye Nexus

Wideband Receiver and Detector modules for SIGINT applications

RFeye®

Key features

- ✓ PCIe control/data interface via VPX, cable connection or custom backplane
- ✓ Ethernet option using Linux controller card
- ✓ DF and geolocation capable
- ✓ Optional IP67 housing

Receiver

- ✓ High performance superheterodyne receiver
- ✓ 6 GHz and 18 GHz versions
- ✓ 100 MHz instantaneous bandwidth
- ✓ Sweeps at up to 150 GHz/s at 2 kHz resolution bandwidth

Detector

- ✓ 18 GHz instantaneous bandwidth
- ✓ Class-leading sensitivity
- ✓ Can be paired with Receiver

Introduction

High performance wideband Receiver and Detector modules for system integrators or standalone operation.

RFeye Nexus is the new range of premium wideband Receiver and Detector modules from CRFS. These have been developed for the most demanding SIGINT/ELINT applications and offer class-leading signal interception capability and analytics. The modules are available in a number of configurations with different backplane options, allowing them to be installed in any suitable enclosure and easily connected to power, network, trigger and reference sources. The Nexus range is designed for integration into broader sensor arrays or for direct deployment as nodes in a distributed sensor network. Using the optional Linux module, the Nexus receiver can also be deployed remotely in standalone missions.

Nexus Receiver

The superheterodyne Nexus Receiver provides 100 MHz instantaneous bandwidth from 100 kHz to 18 GHz. The excellent noise figure and low spurious levels enable the receiver to distinguish very low power signals from the noise floor. It sweeps at up to 150 GHz/s (at 2 kHz resolution bandwidth) and has class leading phase noise characteristics normally associated with laboratory-based equipment.

The Receiver is fully PCIe capable for high speed IQ data streaming and can be directly connected to and controlled by a PC via a VPX backplane or PCIe cable connector (optical or cable). PCIe is the highest performance peer to peer networking architecture. Alternatively, the receiver can be paired with a Linux controller card for fully standalone remote Ethernet operation.

Multiple RF input ports allow comparison of signals from different antennas and support for direction finding. Timing and synchronization features allow correlation of data between multiple modules for accurate geolocation of target signals using Time Difference of Arrival (TDOA) or Power on Arrival (POA) techniques.

Nexus Detector

The Nexus Detector provides 18 GHz of instantaneous bandwidth with class-leading detector sensitivity. The Detector samples detected signal power and outputs all detected power, frequency and pulse signatures over PCIe.

The Detector can be deployed standalone or paired with a Receiver to offer "detect and tune to target" capability that allows analysis of frequency characteristics and pulse signatures at the highest receive sensitivity and phase noise quality.

The Nexus Detector can be integrated with sensor arrays to enable geolocation techniques of AOA, POA and TDOA.

Robust IP67 housing for harsh environments

The engineered high performance aluminum casing is designed to house the Nexus Receiver and/or Detector with a custom PCIe Edge backplane. The system is modular and can contain a single Receiver or Detector, a Receiver and Detector or two independently tuneable Receivers. In addition, the enclosure has space for the Linux controller card for standalone Ethernet operation. A range of front panels and heat sinks are available for different configurations. IP67 protection and cable strain relief are achieved through the use of the fully sealed nose piece that has a built in Gore-tex® breather for pressure equalization.

Distributed Ethernet and Optical PCIe networking

The PCIe standard used for the RFeye Nexus range enables a new approach to wide area peer-to-peer networks for distributed signal intelligence systems. This provides exceptional performance over switched optical fibre PCIe networks for high speed data transfer, signalling and synchronization. The Nexus nodes can also be networked over Ethernet using an onboard Linux controller card.

Optical PCIe allows full rate IQ data streaming from the network of distributed Nexus nodes back to a centralized processor or parallel processors. The advantage over Ethernet is that all data can be captured and can be transferred over much greater distances at much greater data rates. Centralized processing also allows powerful real-time analytics including geolocation of target transmitters using multiple nodes.

Ethernet-based networks are simpler and use distributed rather than centralized processing, avoiding the need for bespoke optical cable runs. It also means that Nexus can be deployed in fully standalone applications using the onboard Linux system and/or integrated into existing Ethernet IP-based networks.

RFeye Nexus modules

Instantaneous bandwidth	Receiver 100 MHz	Detector 18 GHz
VPX connector, rack mountable	 NXR-VPX0001 (6 GHz) NXR-VPX0002 (18 GHz)	 NXD-VPX0001
PCIe cable connector (copper or optical)	 NXR-PCI0001 (6 GHz) NXR-PCI0002 (18 GHz)	 NXD-PCI0001
PCIe backplane (custom PCIe Edge)	 NXR-EDG0001 (6 GHz) NXR-EDG0002 (18 GHz)	 NXD-EDG0001

Configuration examples

NXR-EDG0002 Receiver module with Linux controller card within RFeye Nexus enclosure and connected via CRFS custom PCIe Edge backplane (rear)

NXR-EDG0002 Receiver module and Linux controller card collocated within assembled RFeye Nexus enclosure

RFeye Nexus enclosure fitted with external heatsink and IP67 environmental protection cover ('nose') for rugged deployment

Two Receiver modules with Linux controller card for Ethernet and SyncLinc, within RFeye Nexus enclosure with external heatsink

Rack-mountable 3U format Receiver and Detector modules with VPX backplane connectivity for hardware system integration into SIGINT or similar systems

NXR-PCI0001 Receiver module with PCIe cable for data interface and external control. Custom integrator fitment provides extensive external port connectivity

Networking architecture 1

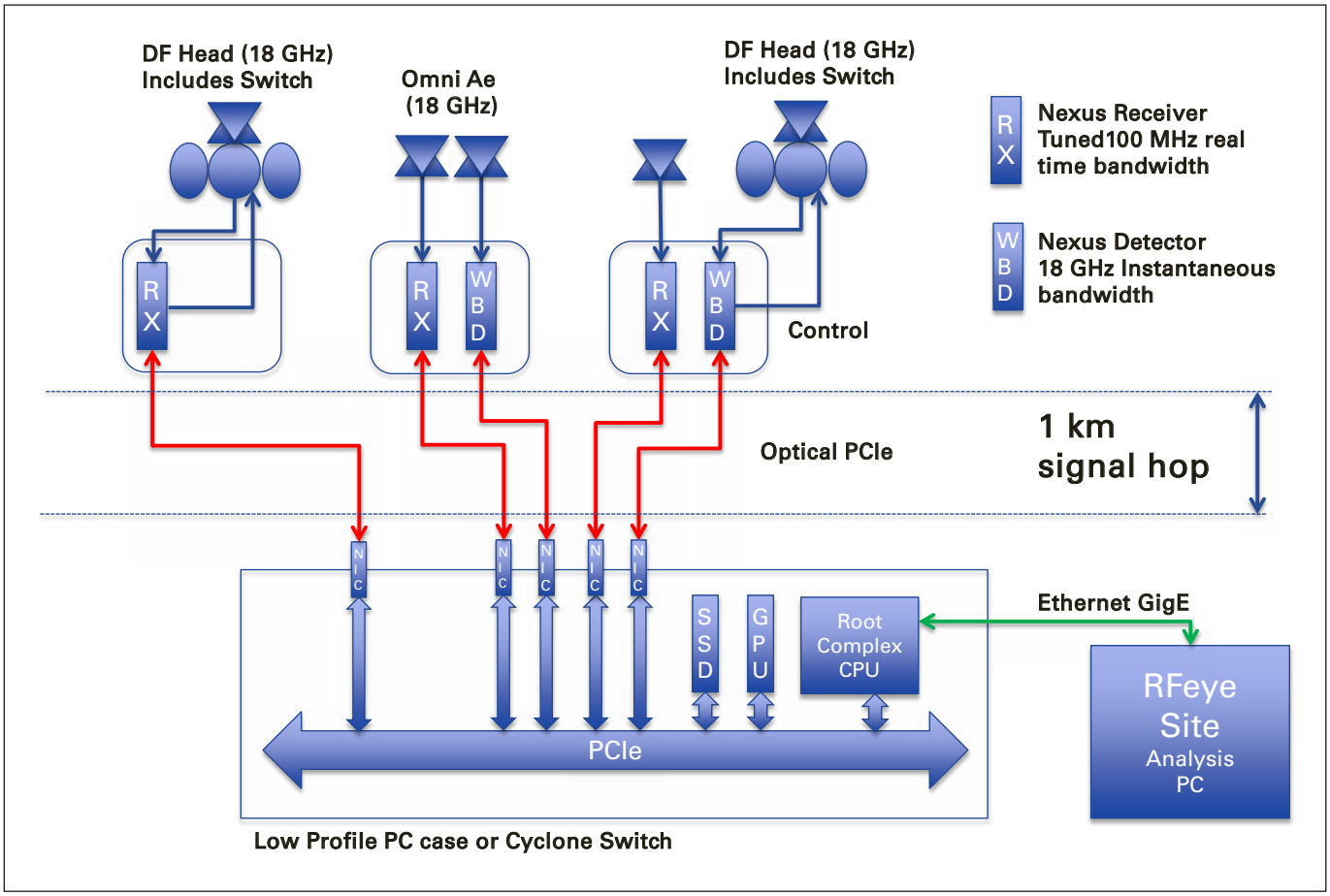
Optical PCIe - 5 Gbit/s links with central processing

RFeye Nexus can use optical fiber links across several kilometres to route data and signalling to switches to create a distributed network of receivers. These networks use the peer-to-peer PCIe protocol to achieve 5 Gbits/s data links that are switched through high performance PCIe switches. These switches are optimized for low latency and data packets are routed directly across the switch fabric, rather than being buffered and forwarded over a host server.

The key advantages are i) high bandwidth for backhaul of data into storage or into high-speed server systems; ii) low latency for signalling and receiver synchronization. This means that the Nexus Receivers and Detectors can capture, analyze and transfer huge quantities of data in real-time, as well as support advanced techniques for geolocation of target transmitters.

The diagram below shows a typical system with multiple Nexus Receivers and Detectors connected to a centralised PCIe switch. This switch also routes to high speed memory storage and parallel GPU processing engines. The root complex control processor manages the data transfers by setting up the switch fabric to route data in real-time either direct to memory or via the GPU and then into memory. RFeye Site analysis software can request processed or raw data from the PCIe subsystem or log and display alarms from the real-time processing of time and spectral data.

Typical applications include ship and UAV SIGINT systems, in-place spectrum monitoring for sensitive buildings and installations, as well as ultra-high speed spectrum data storage and analysis systems. The combination of Nexus Detectors and Receivers allows the system to detect and determine the frequency band of high speed radar type signals. The more sensitive Receiver can then be tuned onto that band increasing the detection range of the interference or threat signal.



Networking architecture 2

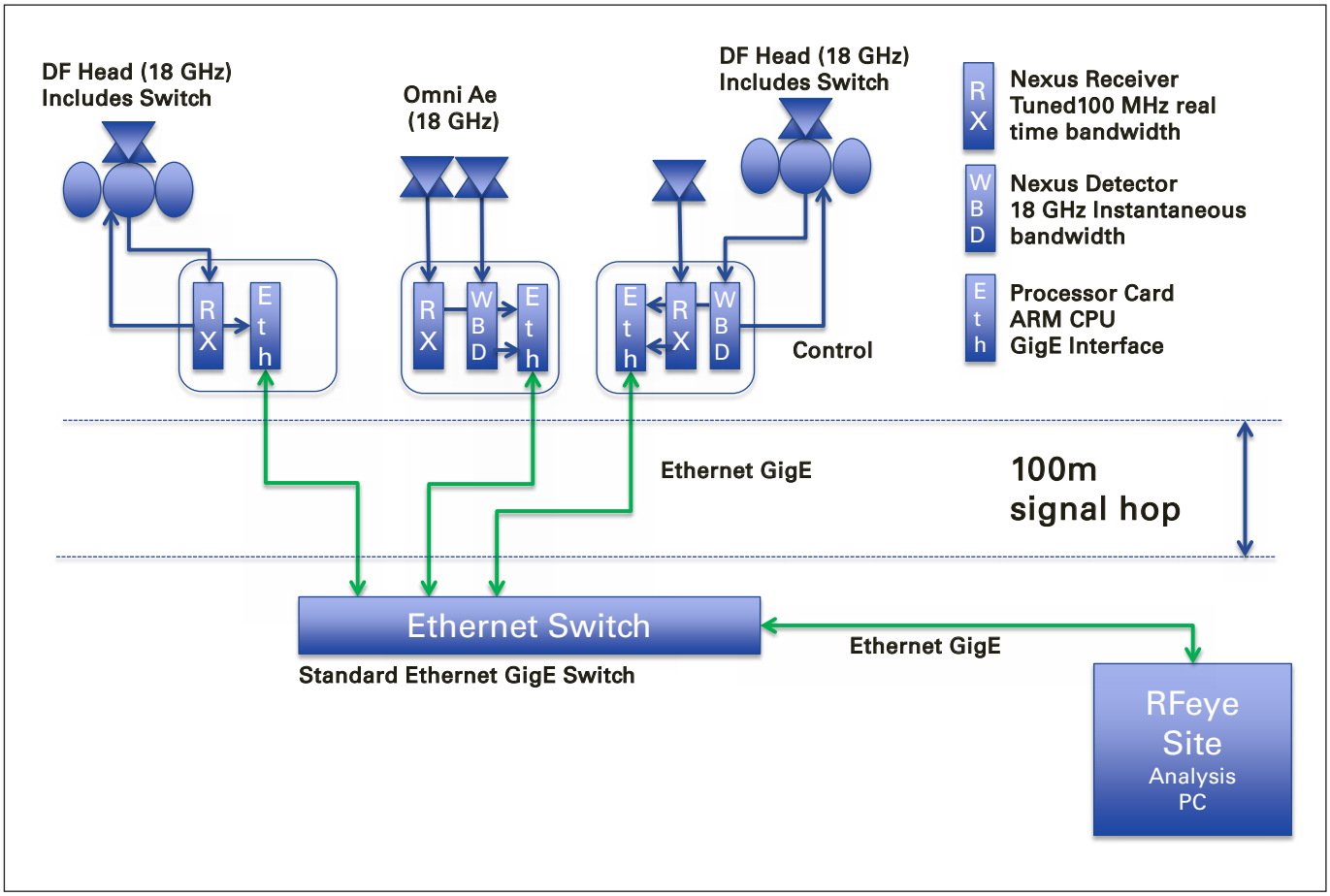
Ethernet - 500 Mbit/s links with distributed processing

RFeye Nexus nodes can also be networked over Ethernet using the matched Linux Gigabit Ethernet controller card. This allows the Receiver to be deployed in distributed sensor applications where the network fabric is more traditional Ethernet IP-based with no guaranteed Quality of Service. This will impact on the overall data offload speed from the Receiver or Detector and, typically, a dedicated Ethernet network will provide data transfer speed over 100 metres of CAT5 cable up to 500 Mbits/s.

Processing of the data can be completed on board the distributed nodes and/or data can be streamed from the node to a centralized PC or processor system. Note that the data rate for a GigE Ethernet network is typically an order of magnitude lower than for an optical PCIe network.

RFeye Nexus has a full software development kit allowing applications to be written that run on the Receiver or Detector. This enables the efficient offload of pre-processed data from the node and/or permits the system to be used in fully standalone applications.

The diagram below shows how the RFeye Site analysis software can connect to the Receivers and Detectors directly over Ethernet. This software can be used to connect to multiple Receiver and Detector nodes simultaneously. Multiple users can simultaneously connect with the nodes and run multiple missions.



Technical specifications

Receiver

Frequency	
Range	100 kHz to 6 GHz or 100 kHz to 18 GHz
Internal Frequency Reference	
Initial accuracy (pre-calibration)	better than ±1.5 ppm at 20°C
Stability (pre-calibration)	better than ±2.5 ppm at 20°C
Ageing (pre-calibration)	better than ±1.0 ppm per year
External Frequency Reference	
Selection	Internal or external frequency reference selectable under program control
External Reference Input	10 MHz or 100 MHz ±1 kHz
Sweep and Triggering	
Sweep speed	150 GHz/second at 2 kHz resolution bandwidth
Sweep mode	Fully programmable: free run, continuous, single, timed
Trigger on event	Fully programmable: user-definable masks, user-definable action when mask exceeded
Signal Analysis	
Instantaneous bandwidth	100 MHz maximum
Tuning resolution	1 Hz
Sensitivity (equivalent noise figures at maximum sensitivity)	
≤ 12 GHz	9 dB typical
> 12 GHz	11 dB typical
Phase Noise	
Receiver input range: ≤ 1 GHz	≤ -125 dBc/Hz @ 20 kHz offset
Receiver input range: > 1 GHz	≤ -115 dBc/Hz @ 20 kHz offset
Local Oscillator Re-radiation	
Oscillator re-radiation	≤ -90 dBm typical
3rd Order Intercept Point	
TOI / IIP3 (with AGC in operation)	≤ 1 GHz 20 dBm > 1 GHz to ≤ 6 GHz 15 dBm > 6 GHz to ≤ 18 GHz 20 dBm
Sampling	
Sampling resolution	16 bits per channel (I&Q)
Sampling rate	250 Msps (125 Msps I/Q)

Detector

Frequency	
Range	1 GHz to 18 GHz
Internal Frequency Reference	
Initial accuracy (pre-calibration)	better than ±2 ppm at 20°C
Stability (pre-calibration)	better than ±1 ppm at 20°C
Ageing (pre-calibration)	better than ±2 ppm per year
External Frequency Reference	
Selection	Internal, GPS or external frequency reference selectable under program control
External Reference Input	10 MHz ±1 kHz
Amplitude	
Maximum input level	≥ 1 GHz to ≤ 6 GHz : +30 dBm > 6 GHz to ≤ 18 GHz : +33 dBm
Operational input range	≥ 1 GHz to ≤ 6 GHz : -65 dBm to -15 dBm > 6 GHz to ≤ 18 GHz : -65 dBm to -15 dBm
Level measurement accuracy over input measurement range	± 2.5 dB
Noise figure	≥ 1 GHz to ≤ 6 GHz : 5 dB (Typical) > 6 GHz to ≤ 18 GHz : 8 dB (Typical)
RF Input	
Input ports	Port 1: ≥ 1 GHz to ≤ 6 GHz Port 2: > 6 GHz to ≤ 18 GHz
RF input return loss / VSWR	10 dB min / < 2:1 max. (1 GHz - 18 GHz)
Input port isolation	≥ 30dB
Sampling	
Sampling resolution	10 bits
Sampling rate per channel	40 MS/s
Power Supply	
Power input	10-48V DC (Direct or via Ethernet)
Power consumption	25W typical
Interfaces	
RF input	Bulkhead SMA female (2 off), 50 Ohm nominal
External reference input	10 MHz via Firewire expansion port
Reference output	10 MHz via Firewire expansion port

For more information

To find out more or discuss your specific application, please e-mail us at enquiries@crfs.com or call +44 (0) 1223 815 615. You can also find useful resources on our website at www.crfs.com.

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