

# The Pentek Pipeline

*A quarterly publication for engineering system design and applications.*

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### In This Issue

- The Medical College of Wisconsin has received a grant from the National Institutes of Health to study brain connectivity, the way signals are conveyed between regions of the brain. More in the feature article.



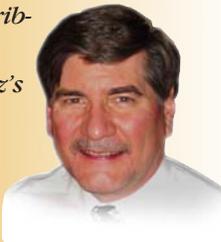
*“Pentek is pleased and honored to have contributed to Dr.*

*Jesmanowicz’s successful research in brain connectivity*

*studies at the*

*Medical College of Wisconsin.”*

*Rodger Hosking, Pentek Vice President and Co-founder*



- **Product Focus:** [starts on page 4](#)

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## Cobalt Board Helps Researchers Improve Brain Connectivity Studies

The Medical College of Wisconsin (MCW) has received a grant from the National Institutes of Health to study brain connectivity, the way signals are conveyed between regions of the brain. With this grant, researchers will develop new technologies in functional connectivity magnetic resonance imaging (fcMRI). Brain connectivity is an emerging field in neuroscience that is expanding rapidly. Brain connectivity is suspected to be a key indicator in some diseases such as schizophrenia, Alzheimer’s, and Parkinson’s.

### Some Definitions

**Magnetic resonance imaging (MRI)** is a medical imaging technique to visualize detailed internal structures. MRI makes use of the property of nuclear magnetic resonance (NMR) to image the nuclei of atoms inside the body. An MRI machine uses a powerful magnetic field to align the magnetization of some atomic nuclei in the body, and RF fields to alter the alignment of this magnetization. This causes the nuclei to produce a rotating magnetic field detectable by the scanner. This information is recorded to create an image of the scanned area of the body. Magnetic field gradients cause nuclei at different locations to rotate at different speeds. By using gradients in different directions, 2D images or 3D volumes can be obtained in any arbitrary orientation.

**Functional magnetic resonance imaging (fMRI)** has been around for about 15 years. It is an MRI procedure that measures brain activity by detecting associated changes in blood flow. This is a specialized brain and body scan used to map activity in the brain of humans or animals by imaging the change in blood flow related to energy used by the brain cells.

In the last ten of those years a revolutionary method has been developing that uses this technology. This method, **functional connectivity (fcMRI)**, has recently gained popularity for its ability to measure how brain regions interact while the subject is at rest. Being able to measure

innate functional brain connectivity allows us to know if a set of regions active during a particular task is connected enough to be considered a network. We could then predict which brain regions are likely to be active together in the future. This could, in turn, motivate us to look deeper at the nature of each brain region and how it contributes to the neuron networks underlying our behavior.

**k-space** in MRI physics is the 2D or 3D Fourier transform of the MR image being measured. Its complex values are sampled during an MR measurement controlled by a pulse sequence, i.e. an accurately timed sequence of RF pulses. In practice, k-space often refers to the temporary image space, usually a matrix, in which data from digitized MR signals are stored during data acquisition. k-space is full at the end of the scan and the data is processed to produce the final image.

Magnetic resonance systems are rated in terms of the maximum magnetic field they can produce in Teslas. **One Tesla (T)** is equal to 10,000 Gauss which is about equal to 20,000 times the Earth’s magnetic field.

A **Voxel** is a volume element that represents a value on a grid in three-dimensional space. This is analogous to a **pixel**, which represents 2D image data in a bitmap. A voxel represents a single sample, or data point, on a regularly-spaced, three-dimensional grid.

### Work at the MCW

The specific purpose of the work at the Medical College of Wisconsin is to reduce the time needed for acquisition of a single volumetric echo-planar imaging (EPI) data set. For whole brain studies, a time set of these data sets is required. The methodology used in fcMRI involves the cross correlation of a seed voxel resting-state time course with other voxel time courses.

In principle, every possible correlation coefficient that can be formed between pairs of voxel time courses can be of interest. Ideally, one would acquire all the time courses simultaneously to ▶

## Cobalt Board Helps Researchers Improve Brain Connectivity Studies

► preserve coherencies of resting-state fluctuations across the entire brain. In actual testing, we can relax this requirement by setting a realistic goal to achieve a whole-brain data set in a time less than 2 seconds.

Data acquisition can be accelerated by the use of partial k-space EPI. This reduces the number of partial k-space lines that must be acquired in a single image. Likewise the echo time (TE) can be shorter, which helps minimize signal dropout. This time can be further reduced by using in-plane sensitivity encoding. These methods cause a degradation in the signal-to-noise ratio, since less time is used to collect the data.

Multislice acquisition of 2D MR images to cover a volume of tissue, such as the brain, usually proceeds one slice at a time. The acquisition time can be reduced by acquiring two or more slices at a time. To achieve this goal, researchers at MCW designed multislice excitation RF pulses with distinct phase tagging of each slice and developed a method to disentangle the overlapping slices in the acquired data. The

acquired signal is increased and SNR is improved when using multislice acquisition.

This work was carried out on a GE Signa EXCITE 3 T MR Scanner using a whole body excitation coil and an axially symmetric 32-channel receive-only coil. The RF pulses were formed by the GE Scanner without the need for any other external equipment.

### Signal Processing

Figure 1 provides an overview of the multislice acceleration method. The path to the image formation is indicated by the green blocks of the flow chart. There are three important events along this path:

- Excitation by a multislice RF pulse
- Phase shift correction
- Unaliasing, or removal of aliasing, through projection

The column of connected blue and orange rectangles on the left concern RF pulse formation: the position and RF phase of each of the N individual slices are determined and the Fourier Transform (FT) is calculated assuming single excitation frequency for the slice group. For reference slices, these pulses are used independently. For

aliased slices, the FT of the composite pulse is calculated by summing the N slice profiles and calculating the FT of the sum.

The most important block is shown in red: short time courses of reference images are obtained for each slice N for each of the n-number RF coil arrays. The first few are discarded and the remaining images are averaged to improve the SNR. Therefore, there are N x n reference images with good SNR available, n for each of the N slices and they are complex-valued images.

Finally, we arrive at the block labeled, Unalias through Projection. For each aliased voxel, a complex valued number exists from each of the n channels; in addition, the reference images provide unaliased data from the N slices and n channels for that voxel. Singular value decomposition is used to solve the system of linear equations on a voxel-by-voxel basis. Data is combined across channels in this process yielding N unaliased slices.

### The Pentek Connection

When developing the original RF transmit pulse sequence on the GE Scanner, ►

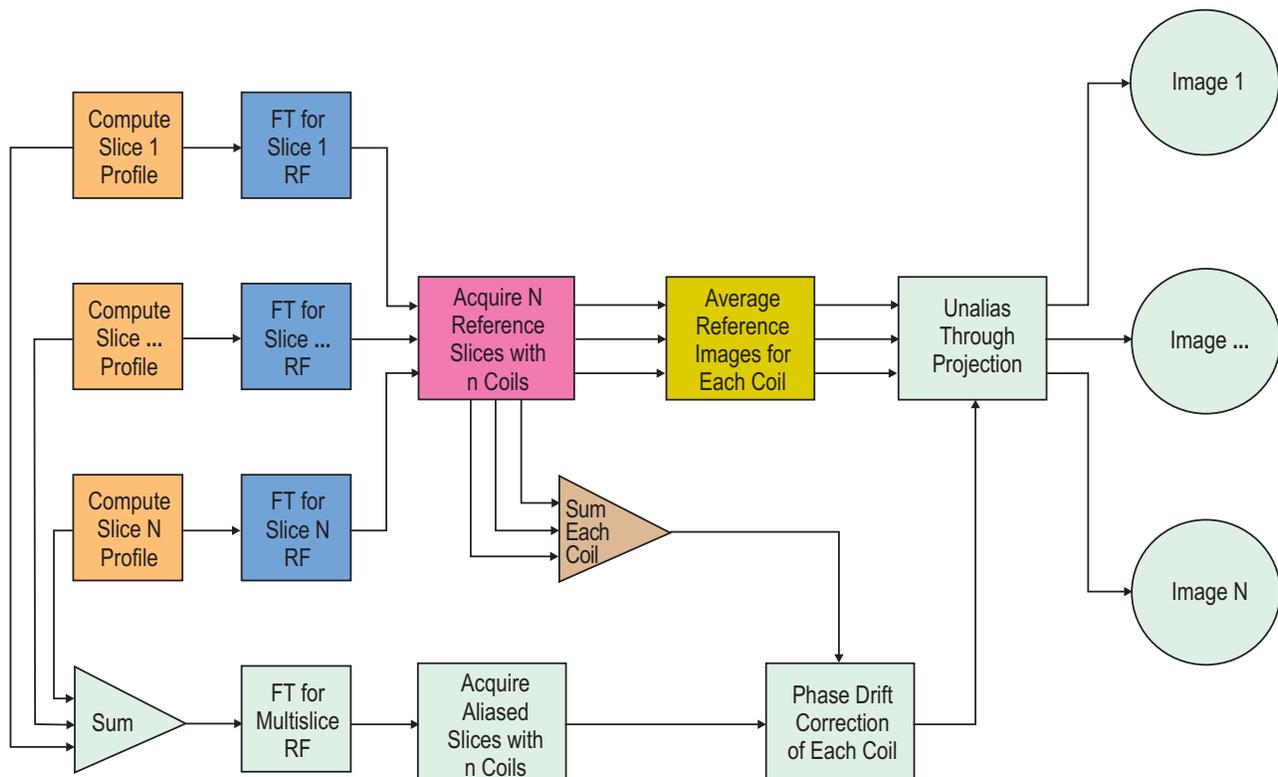


Figure 1. Flow Chart of Data Acquisition and Reconstruction when Using Parallel Slice Excitation with Phase Tagging.

## Cobalt Board Helps Researchers Improve Brain Connectivity Studies

► researchers found spurious frequencies that gave rise to ghost frequencies. Unanticipated excitation signals with amplitudes as large as 40% of the RF pulse amplitude, as seen in Figure 2A, were observed.

The researchers addressed this problem by using a Pentek Cobalt Model 78621 PCI Express board to generate the RF pulses instead of using the internal modulator of the GE Scanner. The RF pulse created by the 78621 has better than two orders of magnitude lower out-of-slice excitation and does not exceed 0.1% of full scale spectral amplitude, as shown in Figure 2B.

The model 78621 dual-channel 800 MHz D/A converter was used in the interpolating mode to create RF pulses with a 2 nsec sampling rate and smooth stair-step-less modulation of the I and Q channels with 16-bit resolution. The center frequency was

created by the numerically controlled oscillator (NCO) of the DAC5688 D/A converter chip. The signal is modulated by custom pulses followed by a continuous signal for acquisition reference.

The modulating I and Q channels are created by harmonic functions with a continuously increasing argument. Tests showed that the phase argument of sine and cosine as large as  $10^{19}$  radians still produces accurate waveforms. With a 2 nsec update time, it is good for over 500 years! This unprecedented accuracy was used to create a reference signal that compensates the phase of off-resonance frequencies used to excite different slices.

The image in Figure 3A was acquired conventionally using the RF pulses created by the GE Scanner. The lack of phase coherence is obvious. The image in Figure 3B

was created by the same sequence except the RF pulses were synthesized by the Pentek 78621 D/A converter. In Figure 3C, standard EPI phase images are shown for comparison. The phase variation across slices is apparent in Figure 3B and is in agreement with Figure 3C. This is not the case for the standard acquisition used to create Figure 3A.

### Acknowledgment

The editor wants to acknowledge the invaluable help provided by Dr. Andre Jesmanowicz, Associate Professor at the Biophysics Research Institute of the Medical College of Wisconsin in writing and illustrating this article.

Dr. Jesmanowicz has authored or coauthored numerous papers and two book chapters. Together with his associates, he also holds a number of patents. When he is not conducting research or writing a paper, he enjoys group skydiving.

His research has shown that modern arbitrary waveform generators like the one in the Pentek 78621 Cobalt PCIe board can be used to create consistent fMRI volumetric images. □

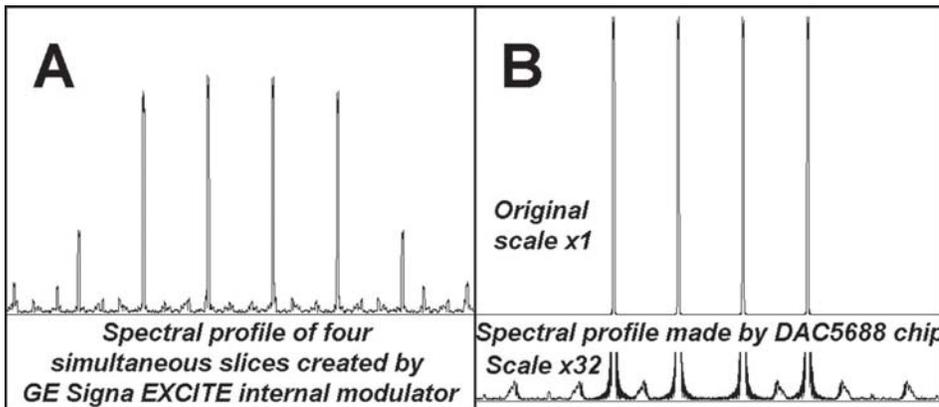


Figure 2. Multislice Spectral Profiles Showing Ghost Slices. (Courtesy Medical College of Wisconsin)

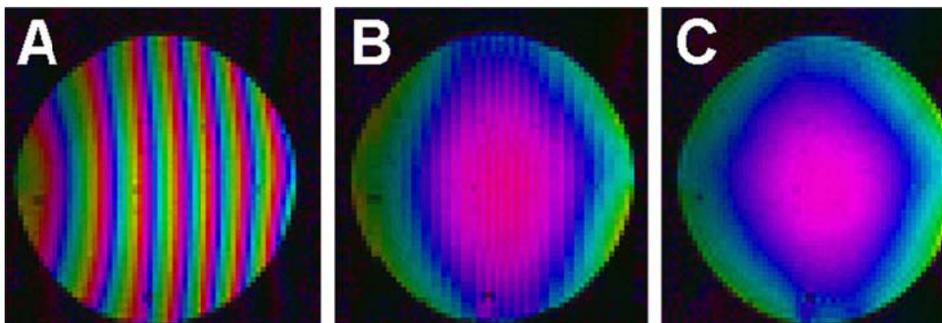


Figure 3. A: EPI Phase Image made from Axial Slices Conventionally. B: Image Obtained with Synthesized RF Pulses. C: Reference Slice Obtained for Comparison with B. (Courtesy Medical College of Wisconsin.)



Dr. Andre Jesmanowicz  
<http://andrix.biophysics.mcw.edu/andre/>

# Product Focus

## Model 71760

### 4-Channel 200 MHz, 16-bit A/D with Virtex-7 FPGA - XMC

#### General Information

Model 71760 is the first member of the Onyx™ family of high performance XMC modules based on the Xilinx Virtex-7 FPGA. A multichannel, high-speed data converter, it is suitable for connection to HF or IF ports of a communications or radar system. Its built-in data capture features offer an ideal turnkey solution as well as a platform for developing and deploying custom FPGA processing IP.

#### The Onyx Architecture

Based on the proven design of the Pentek Cobalt family, Onyx raises the processing performance with the new flagship family of Virtex-7 FPGAs from Xilinx. As the central feature of the board architecture, the FPGA has access to all data and control paths, enabling factory-installed functions including data multiplexing, channel selection, data packing, gating, triggering and memory control. The Onyx Architecture organizes the FPGA as a container for data processing applications where each function exists as an intellectual property (IP) module.

Each member of the Onyx family is delivered with factory-installed applications



Model 71760 is also available in OpenVPX, PCI Express and CompactPCI formats.

#### Features

- Supports Xilinx Virtex-7 VXT FPGAs
- Four 200 MHz 16-bit A/Ds
- 4 GB of DDR3 SDRAM
- Sample clock synchronization to an external system reference
- LVPECL clock/sync bus for multimodule synchronization
- PCI Express (Gen. 1, 2 and 3) interface, up to x8
- Advanced reconfigurability features
- Optional user-configurable serial gigabit interface
- Optional LVDS connections to the Virtex-7 FPGA for custom I/O

ideally matched to the board's analog interfaces. The 71760 factory-installed functions include four A/D acquisition IP modules for simplifying data capture and data transfer.

IP modules for DDR3 SDRAM memories, a controller for all data clocking and synchronization functions, a test signal generator, and a PCIe interface complete the factory-installed functions and enable the 71760 to operate as a complete turnkey solution without the need to develop any FPGA IP.

#### A/D Converter

The front end accepts four full-scale analog HF or IF inputs on front panel SSMC connectors at +8 dBm into 50 ohms with transformer coupling into four Texas Instruments ADS5485 200 MHz, 16-bit A/Ds.

The digital outputs are delivered into the Virtex-7 FPGA for signal processing, data capture or for routing to other module resources.

#### Memory Resources

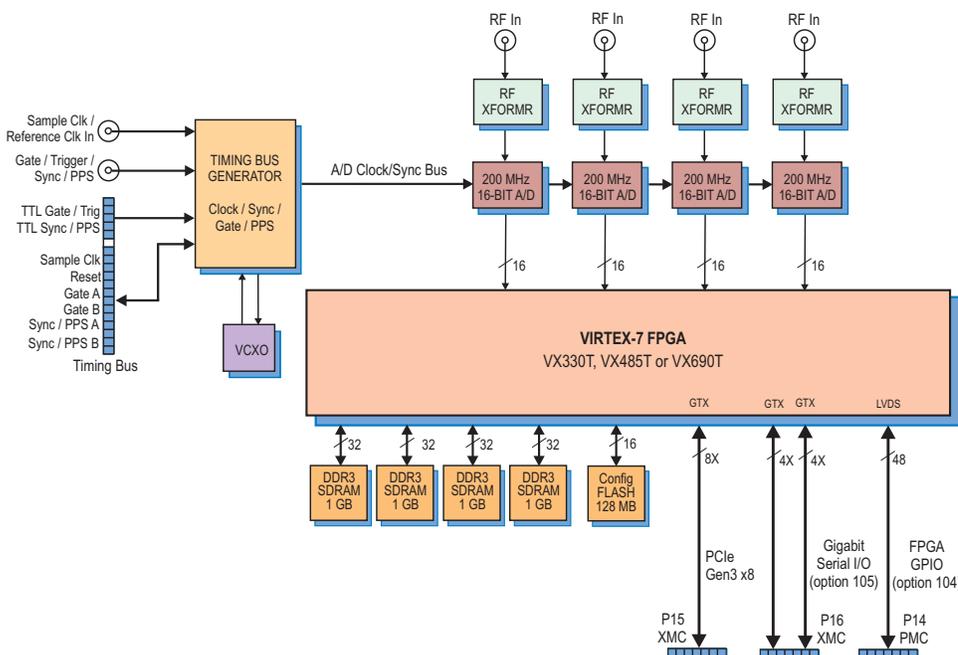
The 71760 architecture supports four independent DDR3 SDRAM memory banks. Each bank is 1 GB deep and is an integral part of the module's DMA capabilities, providing FIFO memory space for creating DMA packets. Built-in memory functions include multichannel A/D data capture, tagging and streaming.

#### XMC Interface

The Model 71760 includes an industry-standard interface fully compliant with PCI Express Gen. 1, 2 and 3 bus specifications. Supporting PCIe links up to x8, the interface includes multiple DMA controllers for efficient transfers to and from the module.

For more information and a price quotation on the Model 71760, go to:

[pentek.com/go/pipe71760](http://pentek.com/go/pipe71760)



# Product Focus

## Model 78670

### 4-Channel 1.25 GHz D/A with DUC and Virtex-6 FPGA - x8 PCIe

#### General Information

Model 78670 is a member of the Cobalt® family of high performance PCIe boards based on the Xilinx Virtex-6 FPGA. This 4-channel, high-speed data converter is suitable for connection to transmit HF or IF ports of a communications or radar system. Its built-in data playback features offer an ideal turnkey solution for demanding transmit applications.

It includes four D/As, four digital upconverters and four banks of memory. In addition to supporting PCI Express Gen. 2 as a native interface, the Model 78670 includes general-purpose and gigabit serial connectors for application-specific I/O.

#### The Cobalt Architecture

The Pentek Cobalt Architecture features a Virtex-6 FPGA. All of the board's data and control paths are accessible by the FPGA, enabling factory-installed functions including data multiplexing, channel selection, data packing, gating, triggering and memory control. The Cobalt Architecture organizes the FPGA as a container for data processing

#### Features

- Four 1.25 GHz 16-bit D/As
- Four digital upconverters
- Programmable output levels
- 250 MHz max. output bandwidth
- 2 GB of DDR3 SDRAM
- Supports Xilinx Virtex-6 LXT and SXT FPGAs
- Dual- $\mu$ Sync clock/sync bus for multiboard synchronization
- PCI Express (Gen. 1 & 2) up to x8
- Clock/sync bus for multiboard synchronization
- Optional user-configurable gigabit serial interface
- Optional LVDS connections to the Virtex-6 FPGA for custom I/O



Model 78670 is also available in XMC, OpenVPX and CompactPCI formats.

applications where each function exists as an intellectual property (IP) module.

Each member of the Cobalt family is delivered with factory-installed applications ideally matched to the board's analog interfaces. The 78670 factory-installed functions include four D/A waveform playback IP modules, to support waveform generation through the D/A converters. IP modules for DDR3 SDRAM memories, a controller for all data

clocking and synchronization functions, a test signal generator, and a PCIe interface complete the factory-installed functions and enable the 78670 to operate as a complete turnkey solution, without the need to develop any FPGA IP.

#### Digital Upconverter and D/A

Two Texas Instruments DAC3484s provide four DUC (digital upconverter) and D/A channels. Each channel accepts a baseband real or complex data stream from the FPGA and provides that input to the upconvert, interpolate and D/A stage.

When operating as a DUC, it interpolates and translates real or complex baseband input signals to a user selectable IF center frequency. It delivers real or quadrature (I+Q) analog outputs to a 16-bit D/A converter.

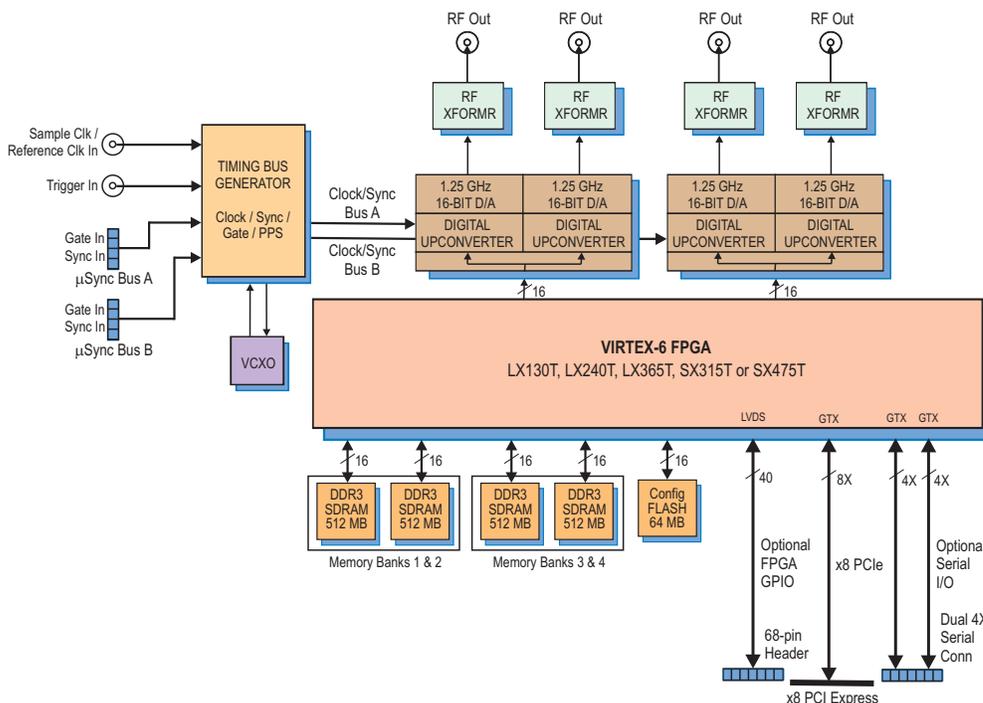
If translation is disabled, each D/A acts as an interpolating 16-bit D/A with output sampling rates up to 1.25 GHz. In both modes, the D/A provides interpolation factors of 2x, 4x, 8x and 16x.

#### PCI Express Interface

The Model 78670 includes an industry-standard interface fully compliant with PCI Express Gen. 1 & 2 bus specifications.

For more information and a price quotation on the Model 78670, go to:

[pentek.com/go/pipe78670](http://pentek.com/go/pipe78670)



# Product Focus

## Model RTS 2715

## 2-Channel 10 Gigabit Ethernet Rack-mount Recorder

### Features

- Records 10 Gigabit Ethernet streams
- 1 or 2 channels
- TCP and UDP protocols
- Copper or optical 10 GbE interfaces
- Aggregate recording rates to 2 GB/sec
- 4U or 5U 19 inch industrial rack-mount PC server chassis
- Windows® 7 Professional workstation with a high-performance Intel® Core™ i7
- Up to 20 terabytes of storage to NTFS RAID disk array
- RAID levels of 0 , 1 , 5 , 6 , 10 and 50
- SystemFlow® GUI virtual instrumentation panel for fast, intuitive operation
- C-callable API for integration of recorder into application
- File headers include time stamping and recording parameters
- Optional GPS time and position stamping



### General Information

The Talon™ RTS 2715 is a complete turn-key recording system for storing one or two 10 gigabit Ethernet (10 GbE) streams. It is ideal for capturing any type of streaming sources including live transfers from sensors or data from other computers and supports both TCP and UDP protocols.

Using highly-optimized disk storage technology, the system achieves aggregate recording rates up to 2 GB/sec.

Two rear panel SFP+ LC connectors for 850 nm multi-mode or single-mode fibre cables, or CX4 connectors for copper twinax cables accommodate all popular 10 GbE interfaces.

Optional GPS time and position stamping accurately identifies each record in the file header.

### SystemFlow Software

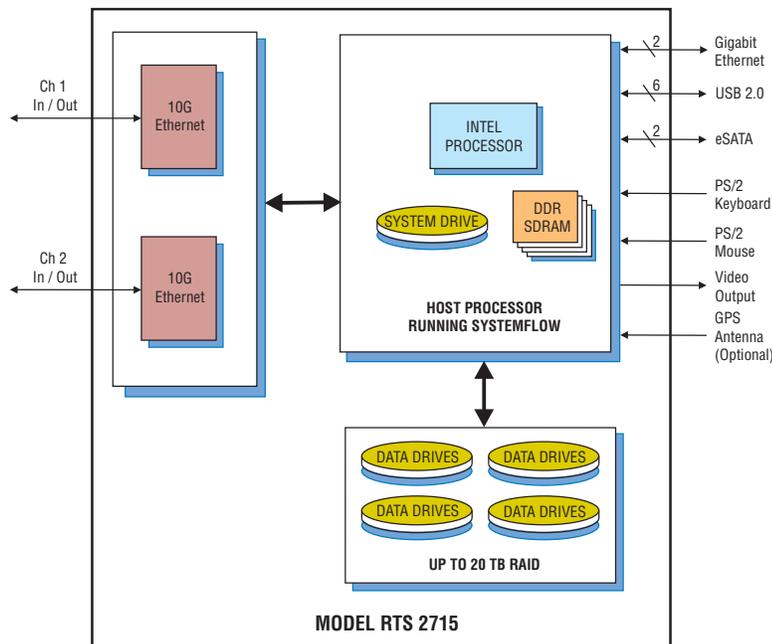
The RTS 2715 includes the SystemFlow Recording Software. SystemFlow features a Windows-based GUI that provides a simple and intuitive means to configure and control the system. Custom configurations can be

stored as profiles and later loaded as needed, allowing the user to select preconfigured settings with a single click.

Built on a server-class Windows 7 Professional workstation, the RTS 2715 allows the user to install post-processing and analysis tools to operate on the recorded data.

The RTS 2715 records data to the native NTFS file system, providing immediate access to the recorded data.

Data can be off-loaded via two gigabit Ethernet ports or six USB 2.0 ports. Additionally, data can be copied to optical disk, using the 8X double layer DVD±R/RW drive.



### Flexible Architecture

The RTS 2715 is configured in a 4U or 5U 19" rack-mountable chassis, with hot-swap data drives, front panel USB ports and I/O connectors on the rear panel.

Systems are scalable to accommodate multiple chassis to increase channel counts and aggregate data rates.

All recorder chassis are connected via Ethernet and can be controlled from a single GUI either locally or from a remote PC.

Multiple RAID levels, including 0, 1, 5, 6, 10 and 50, provide a choice for the required level of redundancy. Up to 24 hot-swappable SATA drives are optionally available, allowing up to 20 terabytes of real-time data storage space in a single chassis.

For more information and a price quotation on the Model RTS 2715, go to:

[pentek.com/go/pipe2715](http://pentek.com/go/pipe2715) □

# Product Focus

## Model RTR 2726

### General Information

The Talon™ RTR 2726 is a turnkey, multi-band recording and playback system that allows the user to record and reproduce high-bandwidth signals with a lightweight, portable and rugged package. The RTR 2726 provides sustained recording rates of up to 1600 MB/sec in a four-channel system and is ideal for the user who requires both portability and solid performance in a compact recording system.

The RTR 2726 is supplied in a small footprint portable package measuring only 16.9" W x 9.5" D x 13.4" H and weighing just 30 pounds. With measurements similar to a small briefcase, this portable workstation includes an Intel® Core™ i7 processor a high-resolution 17" LCD monitor, and a high-performance SATA RAID controller.

At the heart of the RTR 2726 are Pentek Cobalt® Series Virtex-6 software radio boards featuring A/D and D/A converters, DDCs, DUCs, and complementary FPGA IP cores. This architecture allows the system engineer to take full advantage of the latest technology in a turnkey system.

Optional GPS time and position stamping allows the user to record this critical signal information.

## 4-Channel RF/IF 200 MS/sec Rugged Portable Recorder

### Features

- Portable system measuring 16.9" W x 9.5" D x 13.4" H
- Lightweight: approximately 30 pounds
- Shock- and vibration-resistant SSDs (Solid State Drives) perform well in vehicles, ships and aircraft
- Recording & playback of IF signals up to 700 MHz
- Signal bandwidths to 80 MHz
- 200 MHz 16-bit A/Ds
- 800 MHz 16-bit D/As
- SFDR > 80 dBFS
- Real-time sustained recording rates up to 1600 MB/sec
- Up to of 4 TB storage with hot-swappable SSD drives
- NTFS file format
- SystemFlow® GUI with Signal Viewer analysis tool
- Optional GPS time and position stamping
- Complete high-performance Windows® workstation



### SystemFlow Software

Included in this system is the Pentek SystemFlow recording software. SystemFlow features a Windows-based GUI that provides a simple means to configure and control the system.

Custom configurations can be stored as profiles and later loaded when needed, allowing the user to select preconfigured settings with a single click.

SystemFlow also includes signal viewing and analysis tools, that allow the user to monitor the signal prior to, during, and after a recording session. These tools include a virtual oscilloscope and a virtual spectrum analyzer.

Built on a Windows® 7 Professional workstation, the RTR 2726 allows the user to install post processing and analysis tools to operate on the recorded data. The RTR 2726 records data to the native NTFS file system, providing immediate access to the recorded data.

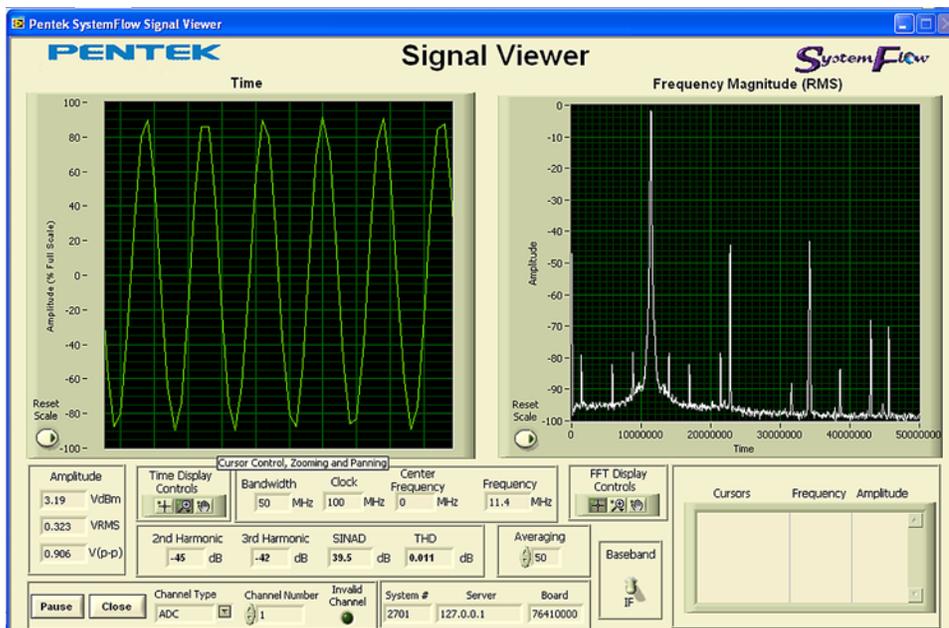
Data can be off-loaded through two 1 Gb Ethernet ports, eight USB 2.0 ports or two eSATA ports. Additionally, data can be copied to optical disk, using the 8X double layer DVD±R/RW drive.

### Rugged Architecture

Because SSDs operate reliably under conditions of vibration and shock, the RTR 2726 performs well in ground, shipborne and airborne environments. The eight hot-swappable SSD's provide a storage capacity of up to 4 TB. The drives can be easily removed or exchanged during or after a mission to retrieve recorded data.

For more information and a price quotation on the Model RTR 2726, go to:

[pentek.com/go/pipe2726](http://pentek.com/go/pipe2726)



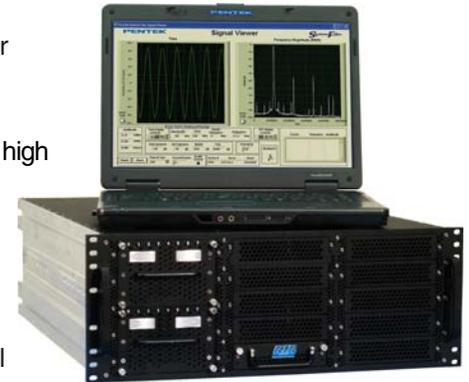
# Product Focus

## Model RTR 2746

### 8-Channel RF/IF 200 MS/sec Rugged Rack-mount Recorder

#### Features

- 4U 19 inch rugged rack-mount PC server chassis
- Designed to MIL-STD-810F
- Windows® 7 Professional workstation with high performance Intel® Xeon® processor
- 200 MHz max. 16-bit A/D sampling for recording, 0 to 8 channels
- 1.25 GHz max. 16-bit D/A sampling for playback, 0 to 8 channels
- 80 MHz max. record and playback signal bandwidths
- Capable of record/playback of IF frequencies to 700 MHz
- Real-time sustained recording rates of up to 1600 MB/sec in 4-channel configuration
- Removable SSD drives
- Up to 24 terabytes of storage to NTFS RAID disk array
- RAID levels of 0 , 1 , 5 , 6 , 10 and 50
- SystemFlow® GUI with signal viewer analysis tool



#### General Information

The Talon™ RTR 2746 is a turnkey, multi-band record and playback system that is built to operate under harsh conditions. Designed to withstand high vibration and operating temperatures, the RTR 2746 is intended for military, airborne and UAV applications requiring a rugged system. With scalable A/Ds, D/As and SSD storage, the RTR 2746 can be configured to stream data to and from disk at rates as high as 1600 MB/sec.

The RTR 2746 uses Pentek's high-powered Virtex-6-based Cobalt® boards, that provide flexibility in channel count with optional digital downconversion capabilities. Optional 16-bit, 800 MHz D/A converters with digital upconversion allow real-time reproduction of recorded signals.

#### SystemFlow Software

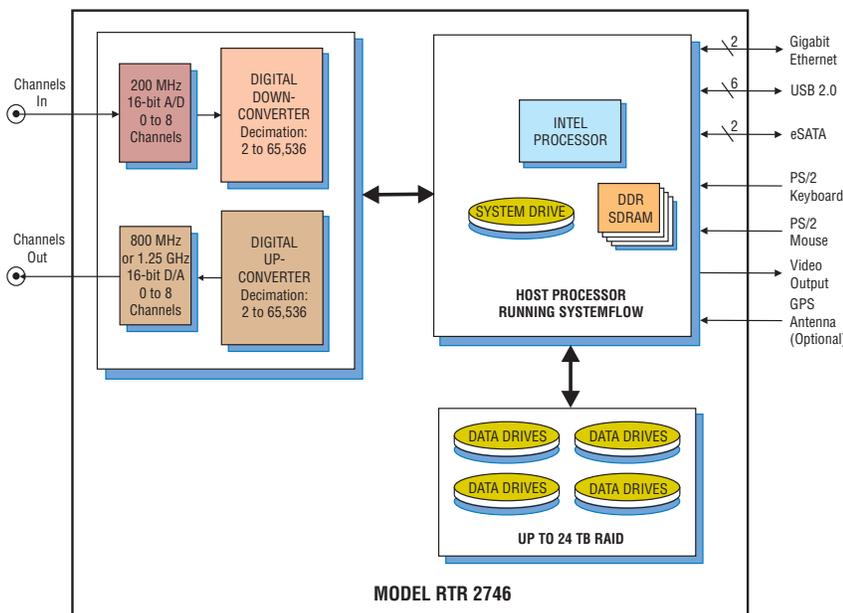
The RTR 2746 includes the SystemFlow Recording Software. SystemFlow features a Windows-based GUI that provides a simple means to configure and control the system. Custom configurations can be stored as profiles and later loaded when needed, allowing the user to select preconfigured settings with a single click.

SystemFlow also includes signal viewing and analysis tools, that allow the user to monitor the signal prior to, during, and after a recording session. These tools include a virtual oscilloscope and a virtual spectrum analyzer.

Built on a Windows 7 Professional workstation, the RTR 2746 allows the user to install post processing and analysis tools to operate on the recorded data. The RTR 2746

records data to the native NTFS file system, providing immediate access to the recorded data. The recorder can be configured with up to six data drive packs, each containing up to eight SSDs.

This feature allows for instant removal of acquired data by simply removing the drive packs for remote copying and analysis. For installations that demand a minimum of downtime, new drive packs can be immediately swapped for the removed ones.



#### Designed for Harsh Environments

The RTR 2746 is delivered in a 4U 19" rugged rack-mountable chassis. Designed to MIL-STD-810F, it is built to survive shock and vibration. Stress to the motherboard and CPU heatsink is mitigated by multiple attachment points to stabilize the PCB. All fasteners and connectors are retained with locking mechanisms and shock-isolated drive bays.

High-speed, high-volume, thermally-controlled fans offer maximum airflow and are designed for long life. Additionally, extended temperature operation is possible with an optional high-temperature CPU.

For more information and a price quotation on the Model RTR 2746, go to:

[pentek.com/go/pipe2746](http://pentek.com/go/pipe2746) □

# Product Focus

## Model RTR 2755

## 2-Channel 10 Gigabit Ethernet Rugged Rack-mount Recorder

### General Information

The Talon™ RTR 2755 is a complete turn-key recording system for storing one or two 10 gigabit Ethernet (10 GbE) streams. It is ideal for capturing any type of streaming sources including live transfers from sensors or data from other computers and supports both TCP and UDP protocols.

Using highly-optimized disk storage technology, the system guarantees loss-free performance at aggregate recording rates up to 2 GB/sec.

Two rear panel SFP+ LC connectors for 850 nm multi-mode or single-mode fibre cables, or CX4 connectors for copper twinax cables accommodate all popular 10 GbE interfaces.

Optional GPS time and position stamping accurately identifies each record in the file header.

### SystemFlow Software

The RTR 2755 includes the SystemFlow Recording Software. SystemFlow features a Windows-based GUI that provides a simple and intuitive means to configure and control the system.

### Features

- Records 10 Gigabit Ethernet streams
- 1 or 2 channels
- TCP and UDP protocols
- Copper or optical 10 GbE interfaces
- Aggregate recording rates to 2 GB/sec
- Removable SSD drives
- 4U short 19 inch rugged rack-mount PC server chassis
- Windows® 7 Professional workstation with a high performance Intel® Core™ i7 processor
- Up to 12 terabytes of storage to NTFS RAID solid state disk array
- RAID levels of 0 , 1 , 5 , 6 , 10 and 50
- SystemFlow® GUI virtual instrumentation panel for fast, intuitive operation
- C-callable API for integration of recorder into applications
- File headers include time stamping and recording parameters
- Optional GPS time and position stamping



Custom configurations can be stored as profiles and later loaded as needed, allowing the user to select preconfigured settings with a single click.

Built on a server-class Windows 7 Professional workstation, the RTR 2755 allows the user to install post-processing and analysis tools to operate on the recorded data.

The RTR 2755 records data to the native NTFS file system, providing immediate access to the recorded data.

Data can be off-loaded via two gigabit Ethernet ports or six USB 2.0 ports. Additionally, data can be copied to optical disk, using the 8X double layer DVD±R/RW drive.

### Rugged and Flexible Architecture

Because SSDs operate reliably under conditions of vibration and shock, the RTR 2755 performs well in ground, shipborne and airborne environments. The 24 hot-swappable SSD's provide storage capacity of up to 12 TB. The drives can be easily removed or exchanged during or after a mission to retrieve recorded data.

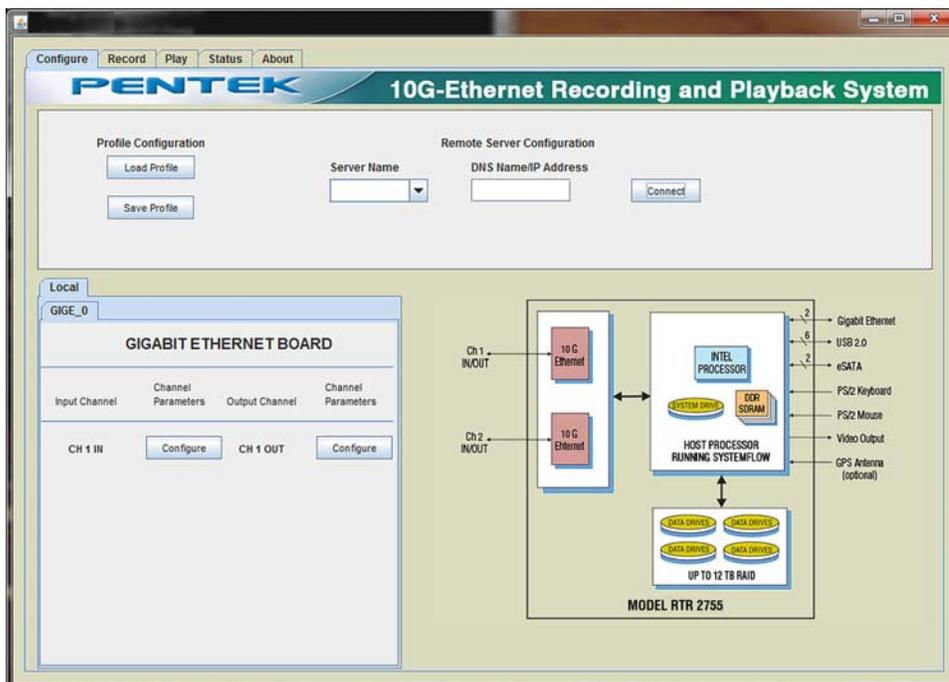
The RTR 2755 is configured in a 4U 19" rack-mountable chassis, with hot-swappable data drives, front panel USB ports and I/O connectors on the rear panel.

Systems are scalable to accommodate multiple chassis to increase channel counts and aggregate data rates.

All recorder chassis are connected via Ethernet and can be controlled from a single GUI either locally or from a remote PC.

For more information and a price quotation on the Model RTR 2755, go to:

[pentek.com/go/pipe2755](http://pentek.com/go/pipe2755) □





## Last Call for Bundle Offer! - Save \$2,000 - Expires March 31!



### Cobalt Bundle Includes:

- Cobalt Virtex-6 boards are available in XMC, PCI Express, OpenVPX and cPCI formats
- ReadyFlow® board support libraries for Windows, Linux or VxWorks
- Time and frequency domain signal analyzer utility
- Command-line interface
- Operating manuals and full documentation
- Complete cable kit
- Lifetime product support
- Online technical resources with automatic alerts for updates and new releases

### It's Up to You!

#### Simply Choose:

- Any Cobalt Virtex-6 product
- Form factor: XMC, or PCIe, or OpenVPX or cPCI or rugged
- Board support package OS: Windows, Linux, or VxWorks



### Cobalt Product Features:

- A/D sampling rates from 10 MHz to 3.6 GHz
- D/A sampling rates from 10 MHz to 1.25 GHz
- Multiboard synchronization
- ReadyFlow board support libraries
- GateFlow® FPGA Design Kit and installed IP cores
- Complete solutions for wireless communications, radar, SIGINT, and beamforming

### Cobalt Virtex-6 FPGA Boards:

- [Model 71630 - XMC](#)  
1 GHz A/D and 1 GHz D/A
- [Model 53650 - OpenVPX](#)  
2-Channel 500 MHz A/D, DUC, and 2-Channel 800 MHz D/A
- [Model 78620 - PCIe](#)  
3-Channel 200 MHz A/D, DUC, and 2-Channel 800 MHz D/A
- [Model 71621 - XMC](#)  
3-Channel 200 MHz A/D, DDC, DUC, and 2-Channel 800 MHz D/A
- [Model 78660 - PCIe](#)  
4-Channel 200 MHz 16-bit A/D
- [Model 53661 - OpenVPX](#)  
4-Channel 200 MHz 16-bit A/D and four DDCs with beamforming IP
- [Model 78662 - PCIe](#)  
4-Channel 200 MHz 16-bit A/D and 32 DDC channels
- [Model 74690 - 6U cPCI](#)  
Two L-Band (925–2175 MHz) Tuners with Four 200 MHz A/Ds

For a list of all Cobalt products [Click Here](#)

## Video Spotlight



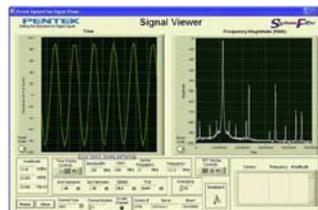
View **Talon RTR 2746 Rugged**  
200 MHz High-Speed  
Real-Time  
Recording and Playback System



## Video Spotlight



View **SystemFlow Software** for  
Talon Recorders



Topics include: API, GUI, Signal Viewer,  
Signal Analyzer, Function Libraries &  
the NTFS file management system

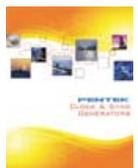
## Segment Catalogs



Analog &  
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Processors



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Generators



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Software &  
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Talon  
High-Speed  
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