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Telemus, Inc. Deploys a Pentek Talon Recorder in a UAV-based ELINT/ESM System

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Telemus System Overview

Telemus, Inc. has installed a **Pentek Talon RTX Rugged IF Recorder** for operational use onboard an Unmanned Air Vehicle (UAV) as part of their **ALR-510 ELINT/ESM system**. They chose this recorder not only for its wide instantaneous bandwidth and environmental performance, but also for its rugged, compact design.

The end user, a military organization within a NATO country, needed both Electronics Intelligence (ELINT) and Electronic Support Measures (ESM) facilities for radar surveillance in its border regions and selected the ALR-510 ELINT/ESM System from Telemus.

This system harnesses Linear Phase Interferometer Direction Finding (DF) technology and an ESM system based on an Instantaneous Frequency Measurement (IFM) receiver and omni-directional antenna.

The ELINT system incorporates the Pentek Talon RTX series IF Recorder for digitizing and capturing wideband IF analog signals and retrieving them for analysis. The recorder is shown in the ELINT System block in the system diagram of Figure 1.

Talon Recorder used for Continuous Data Capture

The ALR-510 ELINT/ESM system has been deployed by the end user on operational missions to detect, identify, and geolocate radar systems targeting the end user's country border regions. The Pentek IF Recorder was added to the system to meet the end user's requirement for continuous data capture.

Pentek SystemFlow® Software

Telemus took advantage of Pentek's **SystemFlow API** high-level software function calls to control and monitor all operational functions of the IF recorder.

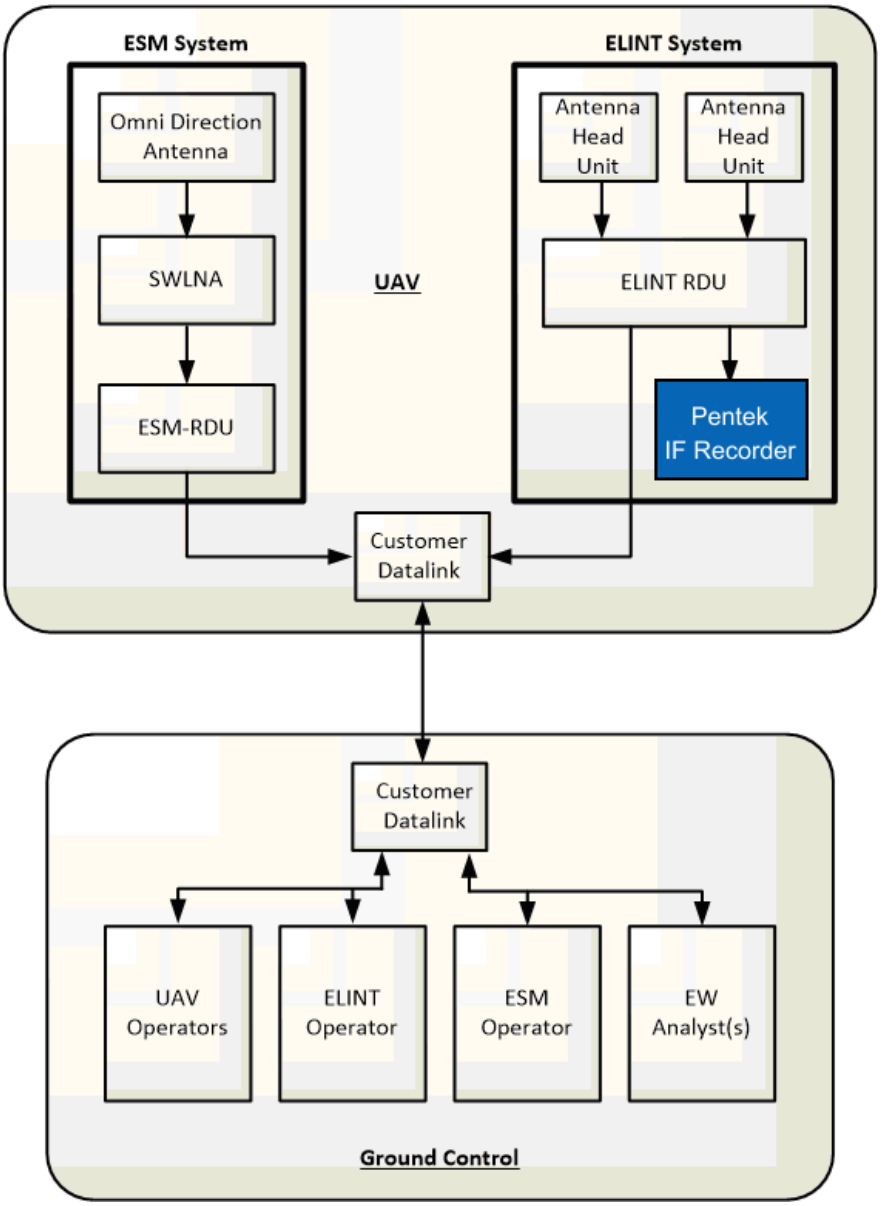


Figure 1. ALR–510 ELINT/ESM with Pentek IF Recorder

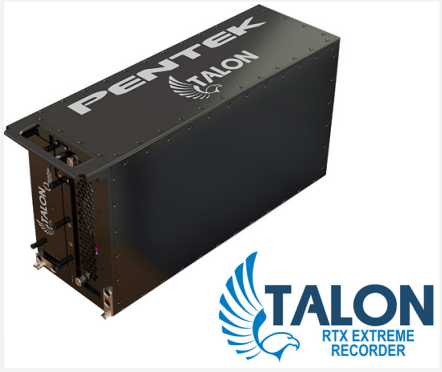
By integrating these API commands within their ELINT system software, Telemus provided a unified user interface that seamlessly coordinates for both ELINT and IF Recorder operations.

Telemus Software

Telemus offers specialized software which also uses the name Talon. **Telemus' Talon Virtual Pulse Analyzer (VPA) software** performs detailed ELINT analysis on the data from either the ALR-510 ELINT/ESM system or from data imported from the Pentek IF Recorder (see **Figure 2**). VPA has an IF Import Wizard designed especially for the detection of radar pulses and generation of Pulse Descriptor Words (PDWs).

Each radar pulse detected gets a PDW associated with it and the wizard can also correlate and save the corresponding digitized samples. This reduces the vast data from the recorder into a consolidated set containing the emitter's interpulse and intrapulse information that the end user then used for more expedient analysis.

Telemus Follow-On ELINT Systems



Pentek's **RTX 2589** represents the latest IF Recorder, upon which future Telemus ELINT UAV systems will be based. **Pentek's Talon RTX Small Form Factor (SFF) recorders** provide the performance of large rackmount recorders in the smallest footprint available in Pentek's Talon product line. Optimized for SWaP (size, weight and power), Talon RTX SFF recorders are packaged in a 1/2 ATR chassis, measuring 7.7" H x 4.9" W x 14.2" D and weighing only 18 pounds.

The **RTX 2589** is based on the Pentek **Model 78841** 3.6 GS/sec 12-bit A/D board, a member of Pentek's Jade® Kintex UltraScale software radio family, capable of digitizing input IF/RF signal frequencies up to 1.8 GHz. The 78841 also operates as a dual-channel 1.8 GS/sec 12-bit A/D to support input signals up to 2.8 GHz.

Integrated digital down converters are tuneable across these frequency ranges to "zoom in" on IF signals, with programmable DDC decimations for usable output bandwidths from 360 MHz down to 6 kHz. Up to 61 TB of removable SSD storage handles real-time streaming data rates up to 4 GB/s to capture 360 MHz bandwidth signals as baseband complex I+Q samples. All data is recorded in NTFS file format for easy retrieval and processing.

Designed for extreme environments, the RTX 2589 uses Pentek's **QuickPac®** removable 8-SSD drive pack, easily swappable in the field. Military-style circular connectors and a 24V DC power supply make it ideal for UAVs, military vehicles, aircraft pods, ship borne installations and outdoor environments.

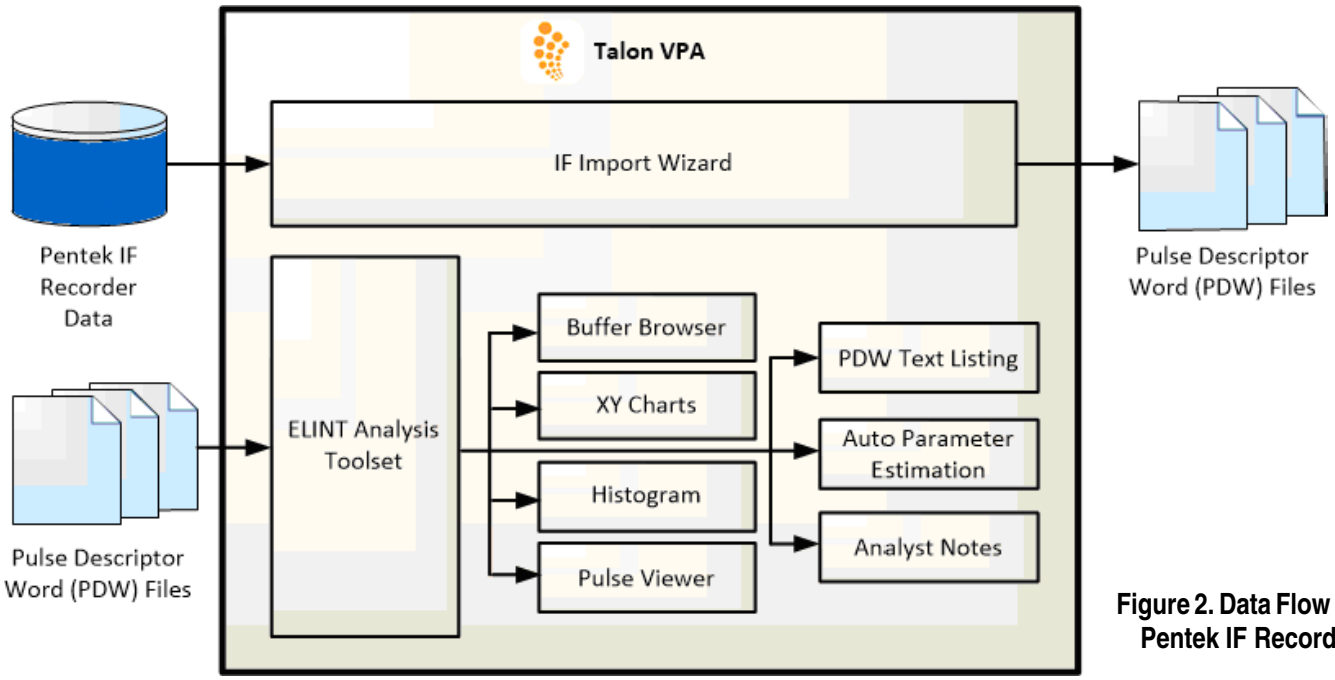


Figure 2. Data Flow with Pentek IF Recorder

Using the Telemus Software

The Telemus Talon VPA software (see Figure 3) is a Windows-based application that is in-service with various Electronic Warfare (EW) organizations around the world. VPA is used for both detailed ELINT analysis and radar threat database creation. The wizard uses a Telemus proprietary Noise Riding Threshold (NRT) design to detect pulses as narrow as 50 nanoseconds. The pulses are grouped into files of up to 500,000 pulses based on Time of Arrival (TOA).

VPA provides the ability to open and view ten PDW Files simultaneously and enables these to be tested against different radar threat libraries. VPA includes the Talon Emitter Library (TEL) Editor so the analyst can generate and maintain threat libraries.

Figure 3. VPA Screenshots

VPA provides the following windows, per PDW file:

- Buffer Browser
- Histogram
- XY Charts
- Auto Parameter Estimator
- PDW Text Listing
- Analyst Notes
- Pulse Viewer

Buffer Browser

The Buffer Browser provides a view of all PDWs in the file, and the ability to zoom into a subset of PDWs and manipulate the data via 'Transforms'. A Transform is a function that allows users to add/subtract/isolate/deinterleave PDWs and to apply successive transforms to shape the PDWs into groups (also known as “Clusters”). The transforms are added to a “Transform Stack” that enables any change to be removed and all other changes reapplied automatically. The analyst can also review how the data looks at each transformation stage.

Histogram & XY Charts

The Histogram and XY Charts enable the PDW data to be viewed per cluster or all together, to understand basic radar parameters such as Frequency, Pulse Width (PW), Pulse Repetition Interval (PRI) and Scan. Multiple Histograms and XY Charts can be opened per PDW file to enable different views. Each cluster of PDWs is displayed in a unique colour, which is replicated on all open windows.

Auto Parameter Estimator

The Auto Parameter Estimator is a tool that performs an estimation of the potential Emitter parameters of the selected cluster. The estimator provides the key radar characteristics and their associated statistics, whose results are compared to the active threat library for emitter identification. The analyst can send the estimation report to a server or save it to file for future reference.

PDW Text Listing

The PDW Text Listing is a tabulated view of the PDW data in the file, alongside the colour coding for easy cross-referencing. Selection of PDWs on any window are highlighted on all windows associated with the PDW file.

Analyst Notes

Analyst Notes lets users add notes and comments to the PDW file, and those entries are time-stamped and saved into the PDW for future reference. This is useful to understand any data manipulation choices that have been applied by the analyst.

Pulse Viewer

The Pulse Viewer (Figure 4) supports review the digitized samples associated with a pulse. The aim is to conduct Intentional Modulation On Pulse (IMOP) analysis. The Pulse Viewer provides a pulse-by-pulse or pulse overlay display of the Amplitude, Frequency and Phase modulation within a pulse or group of pulses (known as AMOP, FMOP and PMOP) plus an FFT. A key feature unique to VPA is the ability of the software to automatically determine the IMOP type.

The analyst can save the changes made into the original PDW file or generate a new PDW file containing the data or a subset of the PDWs. This allows saving of emitter details file-by-file without affecting the original PDW file.

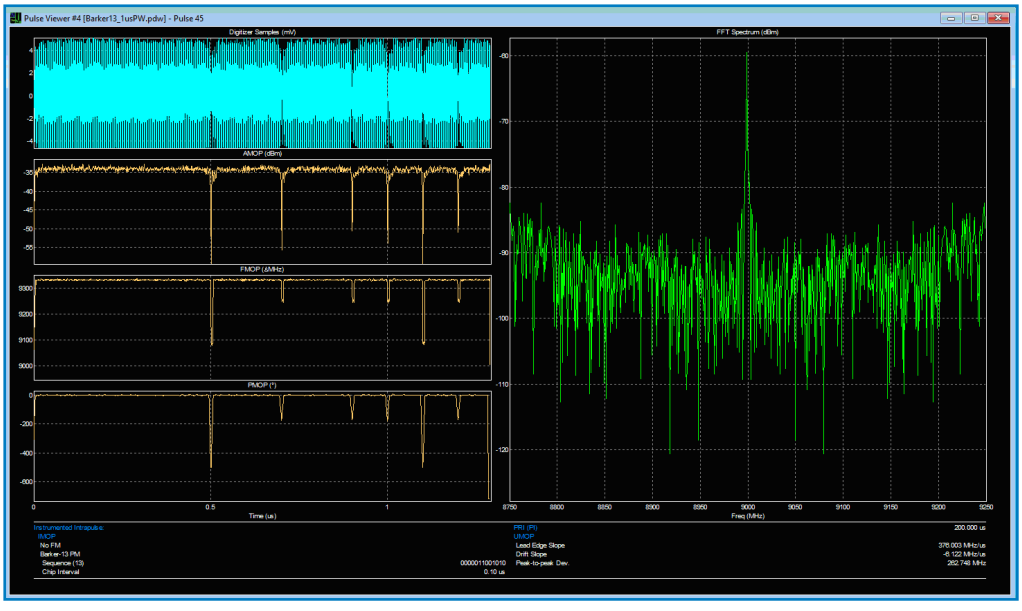


Figure 4. VPA Pulse Viewer

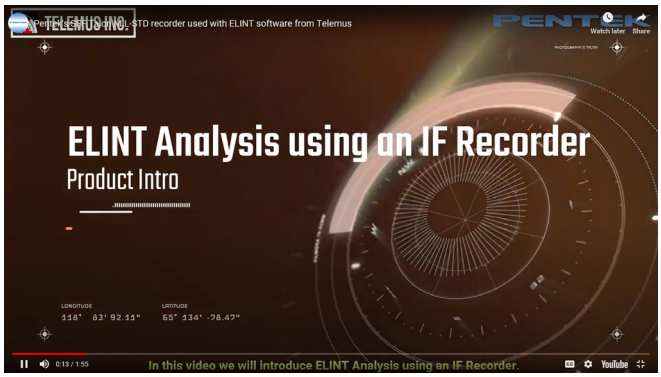
About Telemus

Telemus Inc. is the Canadian EW Company and can trace its roots back to 1984. Telemus has a range of ELINT and Radar Electronic Support (ES) systems and technologies including Phase Interferometer DF, Automatic Polarization Measurement, Single Station and Multi-station Geolocation, and Automatic IMOP recognition algorithms. Telemus has a range of ground and airborne ELINT and ESM systems in operation around the world, providing leading edge surveillance capabilities.

For more information please visit **www.TelemusInc.com** or email Info@TelemusInc.com. □

Pentek's SFF Talon MIL-STD Recorder used with ELINT Software from Telemus

Click the image to view a short product introduction video about the Telemus system described in the feature article.



Add Custom IP to RF/IF Signal Recorders' FPGAs with Pentek's ArchiTek FPGA Development Suite

"If you design or develop systems for signal-intelligence (SIGINT), communications-intelligence (COMINT), or electronic-intelligence (ELINT) applications, there have likely been times when you needed to insert some custom IP blocks into an COTS RF/IF signal recording system's processing chain. But doing so typically carries the risk of breaking either the existing IP residing on the system's FPGA or the corresponding recording software. If you need threshold detection, spectral filtering, digital down-conversion, signal classification, demodulation, or other DSP techniques,ArchiTek makes adding those sorts of functions a breeze." – David Maliniak, Senior Editor, Microwaves & RF

Click **here** to view the **ArchiTek datasheet.**

Development Tactics and Considerations for Small Form Factor RF Signal Recorders

Signals intelligence (SIGINT) – the ability to gather intelligence by intercepting signals – has perhaps never been more essential within military operations due to today's highly sophisticated, often encrypted communications. The key to SIGINT systems are spectrum recording systems, which are often suitcase-sized, but continually trend into smaller form factors.

This eBook describes the engineering considerations and design techniques used to develop small form factor rugged recorders that can handle the extremely high data rates associated with very wide bandwidth RF signal recording. Click here to download this resource.

TALON FAQs

How do I select the correct Talon RF/IF signal recorder?

There are two major characteristics that differentiate one Talon RF/IF signal recorder from another: the **form factor** (see next question) and the **maximum sample rate of the A/D converter.**

The maximum sample rate of the A/D converter is listed in the main description of every Talon RF/IF signal recorder. For example, the Model 2746 - 200 MS/s RF/IF Rugged Rackmount Recorder provides A/Ds with a maximum sample rate of 200 MHz. This sample rate dictates the maximum bandwidth signal that this recorder can accurately sample and record.

In the case of a 200 MHz A/D, we know that the maximum signal bandwidth that can be captured is 0.8 x fs/2, assuming a user-supplied 80% anti-aliasing filter. This means that this A/D is capable of capturing signals that are 80 MHz wide. A 3.6 GHz A/D product is capable of capturing signals that are 1440 MHz wide, also assuming an 80% anti-aliasing filter.

RTV Recording Systems are an excellent value for under $20,000

RTS Recording Systems are designed for commercial applications

RTR Portable Recording Systems are designed for harsh environments

What is the difference between the RTV, RTS, RTR and RTX series of recorders?

The **RTV series** is the value series of Talon recorders. These are the least expensive Talon recorders and are intended for laboratory use (benign environments.) They are limited in storage and streaming data rates to disk and have very few options available. In addition to their low cost, they also have the advantage of shipping from stock, unlike the other series that typically have lead times from six to eight weeks or longer. These recorders come in a rackmountable PC server chassis.

The **RTS series** is the commercial series of Talon recorders. These are intended for benign environments, have great flexibility in channel count and are capable of holding large volumes of data storage. These systems use HDDs (hard disk drives) for data storage and are limited in their sustained data rate to disk. These recorders come in a rackmountable PC server chassis.

The **RTR series** is the rugged series of Talon recorders. RTR recorders come in both a portable (briefcase style) and rackmountable PC server chassis form factor. Both use SSDs (solid state drives) to help the systems tolerate shock and vibration. They also include enhanced cooling to allow them to operate in higher temperature environments (up to 55 deg C.) The RTR series recorders provide the highest streaming data rates to disk of all of the Talon series.

The **RTX series** is the extreme rugged series of Talon recorders. RTX recorders are flight-certified, capable of handling high levels of shock and vibration as well as high-altitude use. RTX series chassis use Pentek's QuickPac drive packaging technology so users can quickly remove and replace volumes of data storage from the Talon recorder. This is especially useful during flight missions where aircraft time is expensive.

The RTX series focuses on SWaP and is available in a 1/2 ATR style chassis. This conduction-cooled chassis is extremely rugged and can operate in the harshest environments. This chassis uses QuickPacs to provide up to 60 TB of storage in a very small package. For **more Talon FAQs**, click **here**. □

RTR Rackmount Recording Systems are designed for harsh environments

RTR SFF Recording Systems are designed for harsh environments

RTX SFF Portable Recording Systems are designed for extreme environments

Pentek Accelerates Real-Time Recording with New Talon Recorder for Quartz RFSoC

- Records full 100 GbE bandwidth, supporting up to four independent UDP streams
- Fifty percent faster recording rates than previous generation Talon recorders
- Front-panel removable NVMe storage up to 122 TB
- SystemFlow® software GUI with Signal Viewer analysis tool
- Optimized for Pentek Quartz RFSoC products

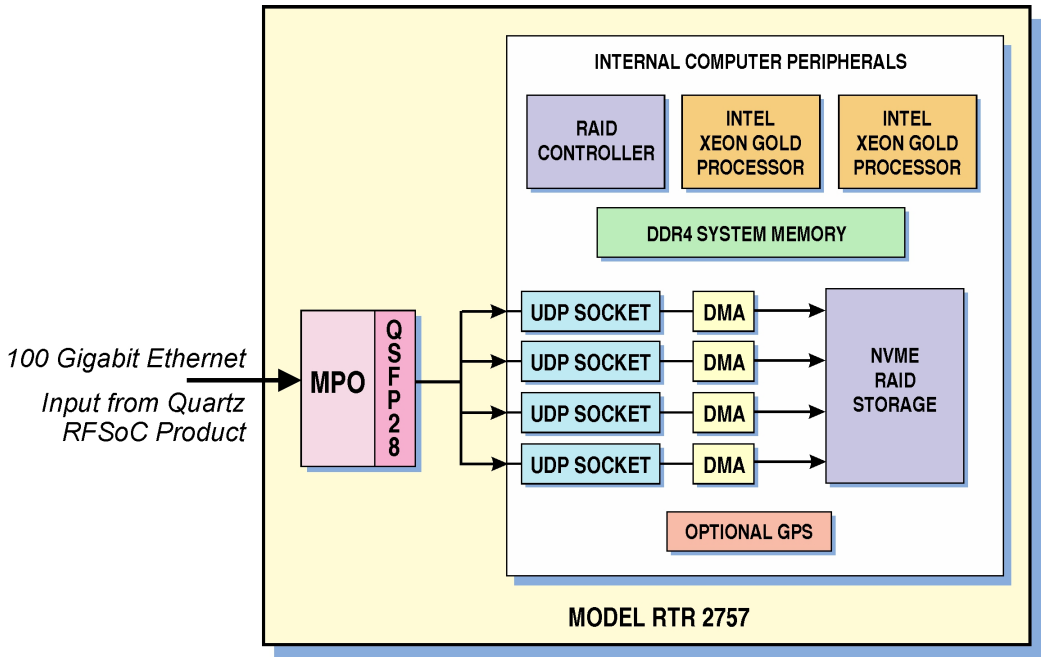
Pentek recently introduced a new addition to the Talon® series of recorders: the **Model RTR 2757** 4U 19-inch rackmount recorder. This new recorder complements **Pentek's Quartz RFSoC products** that stream digitized wide bandwidth signals across 100 Gigabit Ethernet. The RTR 2757 captures these streams in real time at rates as high as 12.5 Gigabytes per second.

"The Quartz RFSoC has gained tremendous popularity with our customers. However, its multi-channel wideband A/D converters produce data at a rate that pushes the limits of data recorders," stated Chris Tojeira, product director of Pentek's Recording Systems. **"We leveraged the performance enhancements of today's storage technology and updated our design architecture to handle these challenging requirements,"** he continued.

The RTR 2757 was designed with performance and rugged environments in mind. It includes up to 122 TB of NVMe (Non-Volatile Memory Express) storage, using high-performance NVME U.2 drives in a RAID0 configuration to provide extremely high-speed real-time recording. Drives are front-panel removable via eight individual drive trays. The independent operating system drive is also removable via the front panel. This architecture improves the recording speed by fifty percent over previous generations of Talon recorders.

The industrial grade 4U rackmount chassis of the RTR 2757 houses a dual Intel Xeon® server-class motherboard. It is optimized for cooling and ruggedized to operate in challenging environments. A single QSFP28 optical port supports up to four independent UDP streams for a combined real-time recording rate up to 12.5 GB/s (100 Gigabits/s).

This allows users to stream data from four of the RFSoC's A/D channels over 100 Gigabit Ethernet and capture them as independent files on the recorder. The recorder captures only the Ethernet payload, providing data files similar to other Talon recorders and compatibility with the SystemFlow signal analysis tools.



Model RTR 2757 Block Diagram

Ease of Operation

All Talon recorders are built on a Microsoft Windows® platform and include Pentek's SystemFlow software, featuring a GUI (graphical user interface), the **Signal Viewer**, and **API** (Application Programming Interface). The GUI provides intuitive controls for out-of-the-box turn-key operation using point-and-click configuration management. Configurations are easily stored and recalled for single-click setup.

The Signal Viewer provides a virtual oscilloscope and spectrum analyzer to monitor signals before, during and after data collection. The C-callable API allows users to integrate the recorder control into larger application systems. Enhancements to the GUI allow more efficient configuration of the recording channels.

The data format used for storage follows the NTFS standard, allowing users to remove drives from the instrument and read the data using standard Windows-based systems, eliminating the need for file format conversion.

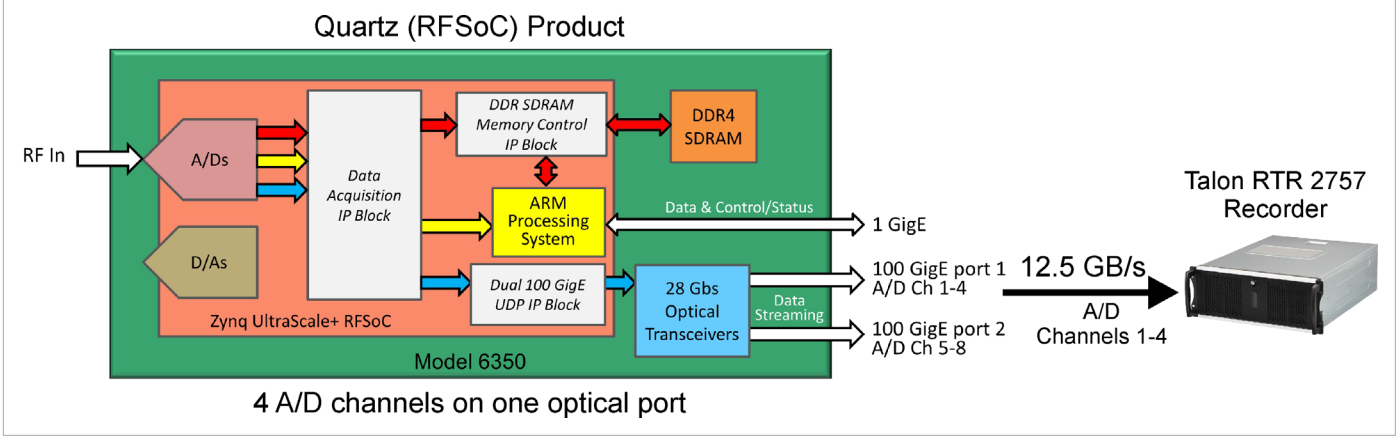
Pricing and Availability

For more information about the **Talon RTR 2757**, click here.

For more information about Pentek's **Talon** recording systems, click here.

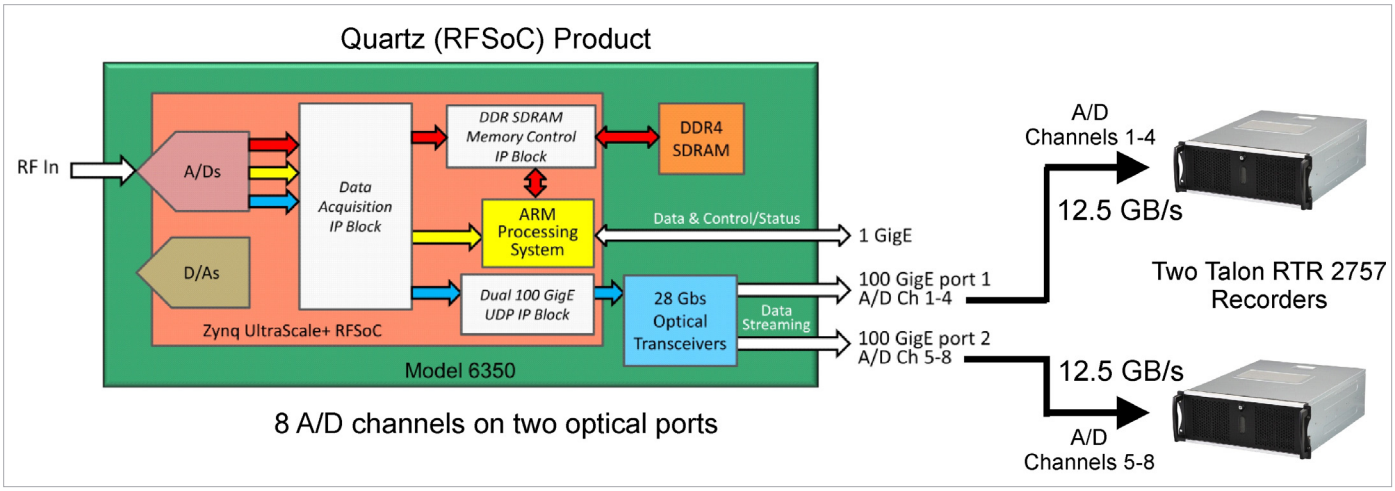
You also can email us at sales@pentek.com, contact your local representative, or contact Pentek directly [+1 (201) 818-5900]. □

Capturing Data from Quartz (RFSoC) Products



4 A/D channels on one optical port

- One 100 Gigabit Ethernet port has a maximum 12.5 GB/s streaming rate.
- One Model 2757 can capture real-time UDP streams at 12.5 GB/s using one QSFP28 optical port.



8 A/D channels on two optical ports

- Two 100 Gigabit Ethernet ports have a maximum 25 GB/s streaming rate.
- Two Model 2757 recorders can capture real-time UDP streams at 25 GB/s using two QSFP28 optical ports.

Pentek's New Quartz RFSoC PCIe Board is Ideal for Wireless Applications

Pentek has recently added a new model to their Quartz® **RFSoC** Architecture family: **Model 7050**, an eight-channel A/D and D/A converter, PCIe double-wide board based on the Xilinx Zynq® UltraScale+ RFSoC. Model 7050 brings RFSoC performance to PC platforms with a complete system on a board.

The Zynq UltraScale+ RFSoC from Xilinx is the industry's only single-chip, adaptable radio platform, making it very popular for 5G and LTE wireless, SIGINT and COMINT, EW countermeasures, radar on a chip, test and measurement, satellite communications, and LiDAR applications.

"The PCIe form factor makes it easy to develop or deploy in a standard desktop PC," said Bob Sgandurra, Director of Product Management of Pentek. He added, **"The Pentek software developed on the PCIe board can be moved seamlessly to other form factor platforms, including VPX and custom SFF (Small Form Factor). Pentek's extensive support and world-class FPGA technology clearly separate this from other PCIe solutions."**

The Xilinx Zynq UltraScale+ RFSoC Processor integrates eight RF-class A/D and D/A converters into the Zynq FPGA fabric and quad ARM Cortex-A53 and dual ARM Cortex-R5 processors, creating a multichannel data conversion and processing solution on a single chip. Complementing the RFSoC's on-chip resources, the Quartz board architecture adds:

- 16 GBytes of DDR4 SDRAM
- Sophisticated clocking for single-board and multi-board synchronization
- High-signal-integrity connectors for RF inputs and outputs
- x8 PCIe Gen 3 interface
- An optional 8-lane, 28 Gb/sec optical interface with industry-standard MPO connectors for supporting gigabit serial protocols
- 12 LVDS general-purpose I/O pairs for specialized interfaces
- On-board GPS receiver
- Unique QuartzXM eXpress Module enables migration to custom form factors
- Speeds development and deployment for QuartzXM eXpress Module designs
- Factory-installed application IP

The Model 7050 design places the RFSoC as the cornerstone of the architecture. All control and data paths are accessible by the RFSoC's programmable logic and processing system. A full suite of Pentek-developed IP and software functions utilize this architecture to provide data capture, waveform generation, timing and interface solutions for a wide range of application requirements.

Navigator Design Suite

The Model 7050 is pre-loaded with a suite of Pentek IP modules to provide data capture and processing solutions for many common applications. For applications that require specialized functions, users can install their own custom IP for data processing.

The Pentek **Navigator FPGA Design Kits (FDK)** includes the board's entire FPGA design as a block diagram that can be edited in Xilinx's Vivado® IP Integrator. In addition to the IP Integrator block diagrams, all source code and complete IP core documentation is included. Developers can integrate their own IP along with the Pentek factory-installed functions or use the

Navigator kit to completely replace the Pentek IP with their own.

The **Navigator Board Support Package (BSP)**, the companion product to the Navigator FDK, provides a complete C-callable library for control of the 7050's hardware and IP. The Navigator FDK and BSP libraries mirror each other where each IP function is controlled by a matching software function, simplifying the job of keeping IP and software development synchronized.

The Navigator BSP includes support for Xilinx's PetaLinux running on the ARM Cortex-A53 processors. When running under PetaLinux, the Navigator BSP libraries enable complete control of the 7050 either from applications running locally or on the ARMs, or using the Navigator API to control and command from remote system computers.

SPARK Development System

The PCIe **SPARK**® development systems are ready for immediate operation with software and hardware installed. In many applications, the SPARK development PC can become the final deployed application platform.

Pricing and Availability

For more information about **Model 7050**, click here. You also can email us at sales@pentek.com, contact your local representative, or contact Pentek directly [+1 (201) 818-5900]. □

Strategies for Deploying Xilix's RFSoC

This paper provides a look at how RFSoC compares to the current trends in A/D and D/A converters and the strategies for getting the most performance out of this new family of FPGAs.

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