TABOR ELECTRONICS

Radar and EW Primer

How to use the Proteus Software Defined Radar / Threat Transceiver

Scalable Radar / Threat Generation from Simple Waveforms to Complex Multi-emitter Environments

Enabling the Breakthroughs of Tomorrow

TABOR ELECTRONICS

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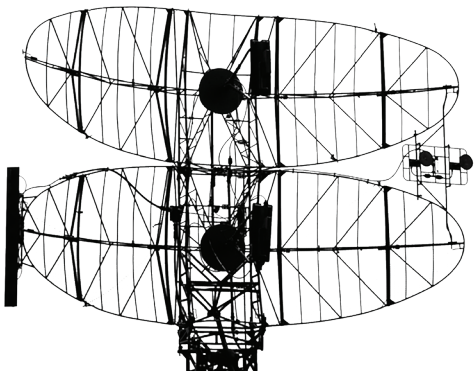
A World Leader in Signal Source Solutions | Advanced Radar, SDR, and EW Testing

Enabling the Breakthroughs of Tomorrow

Adaptability is the key to staying ahead in radar development and electronic warfare (EW). At Tabor Electronics, we engineer scalable, future-proof RF and microwave signal simulation solutions designed to evolve and scale with your design, test, and evaluation needs.

Radar/EW Development, Test and Evaluation

For DRFM development, HIL simulation, or multi-channel radar target simulation, our solutions ensure uncompromised capability.



Our modular product offers high-fidelity signal generation, real-time processing, and precise control over frequency, amplitude, and phase, allowing engineers to simulate complex radar scenarios and ensure robust system validation.

Modular Scalable COTS Architecture

Tabor modules are based on COTS industry standards such as the PXIe modular format and the SCPI programming language. Each module can be configured to have up to four RF/µW differential outputs and two digitizer inputs. Hardware-based user programming is facilitated by the easy-to-use FPGA-based DSP programming system, large waveforms and acquisitions can use its large 16GS onboard memory, and fast data transfer is facilitated through its PCIe interface..

Radar/EW Capabilities

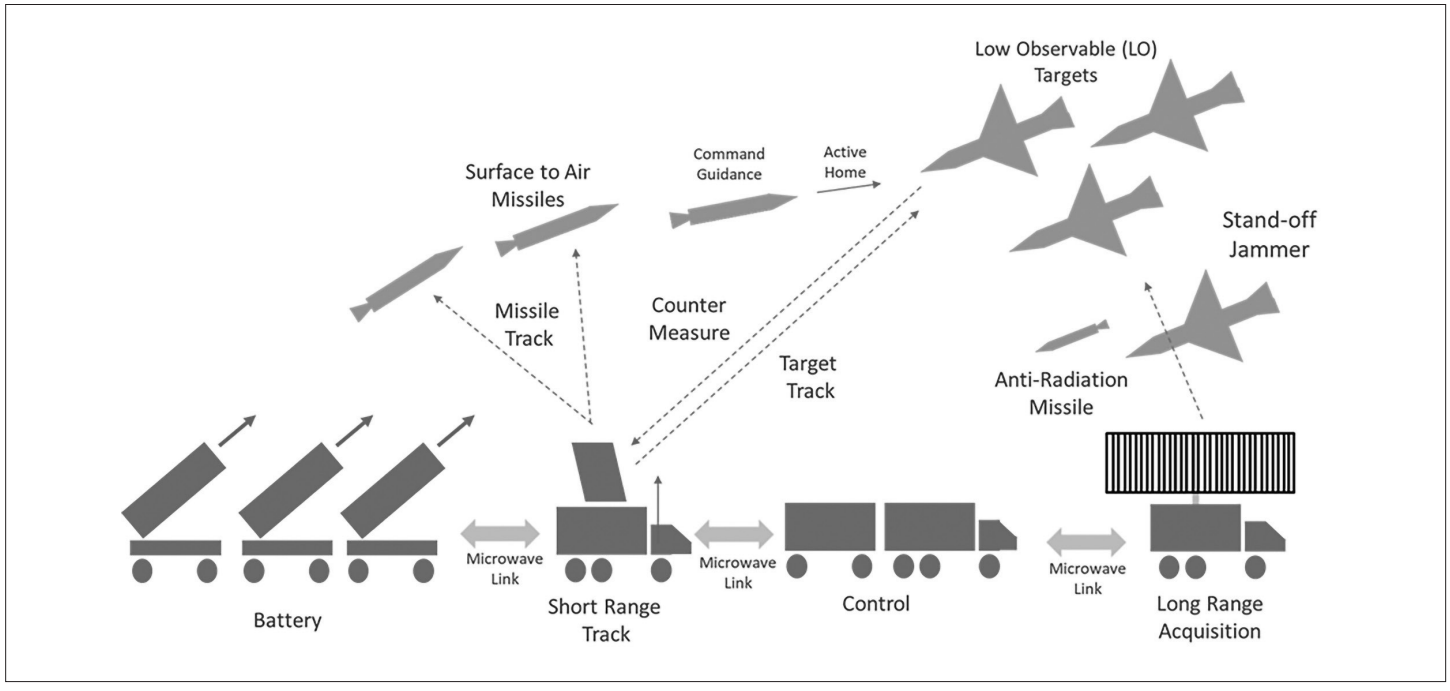
- Multi-channel microwave signal generation – Enables coherent high-fidelity radar threat development
- Waveform scheduling – mulitiple radar modes, and/or Electronic Counter-Measure (ECM) techniques
- Digital RF Memory (DRFM) – Easily emulate movement with real-time transceiver technology creating velocity and distance
- Hardware-in-the-loop (HIL) testing & simulation – Closed loop signal processing for adaptive radar and

  EW systems

Test System Requirements - Ability to Emulate an Emitter Set

To understand the requirements for developing a Radar/EW test system, let us examine a simplified air engagement. For an aircraft to complete it's mission it needs to be able to counter its advisaries attempts to defeat it. The aircraft can have stealth capability creating a low observable target to certain frequencies of radar. It can have on-board electronic counter measures utilizing jamming or deception techneques, or it can be supported by a stand-off jammer aircraft that could also be armed with anti-radiation missiles. In order to verify all these systems are functional for a specific threat environment, we need to have the following capability:

- Simultaneous Multiple Emitters
- Frequency Range of Threat/Emitter Set (C-Band, X-Band etc.)
- Bandwidth of Emitters (Hop sequence or LFM Bandwidth)
- Frequency Coherence (pulse to pulse)
- Accurate pulse emulation (rise, fall, peak, droop, etc.)
- Mode evaluation (short pulse, long pulse, LFM, etc.)
- Multi-channel pulse timing alignment and programmability (AOA)

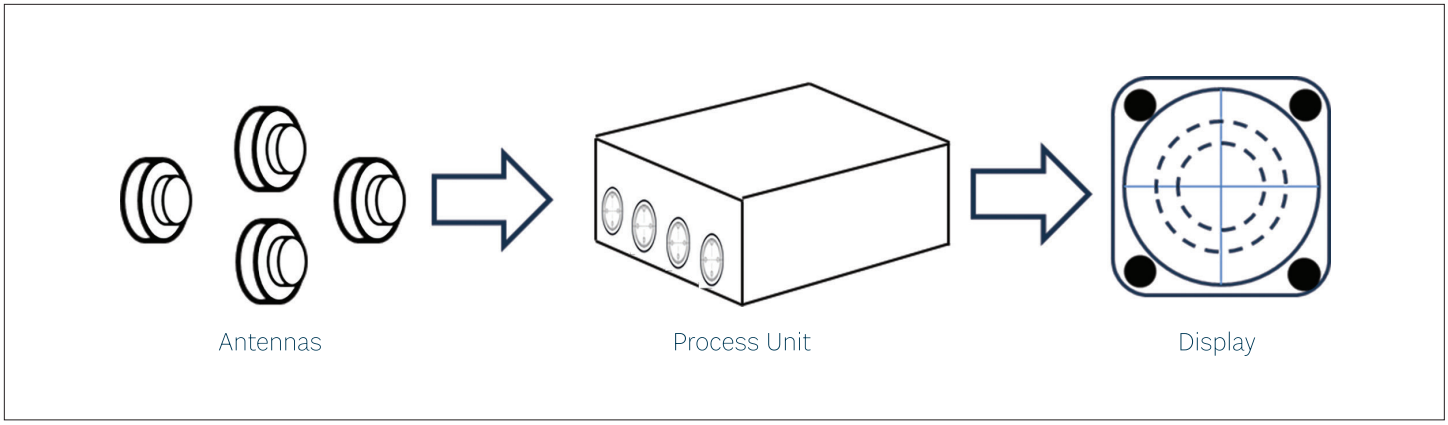


Simplified Air Engagement

This presents the Electronic Warfare Engineer with a number of challenges especially with equipment selection. Many electronic warfare test solutions are expensive and are usually in high demand by many projects and programs. Also, the complexity of a large scale threat emulator means that adding new threats to the system is a time consuming process.

The Radar Warning Receiver

The Radar Warning Receiver (RWR) is the workhorse of any electronic defense system. A typical RWR consists of four antennas, a processing unit, and a cockpit display. The antennas are usually on the wings tips and the fore and the aft of the aircraft, shipborne systems will have the antennas simularly distributed. Each antenna receives the threat signal at a slightly different time in order to determine the Angle of Arrival (AOA). The processing unit contains the signatures of the perceived threats that may be encountered on the mission. This allows the pilot to understand the type of threat and its location in order to determine the appropriate counter measure.



A Representative Radar Warning Receiver

Types of RWR Tests

There are typically three types of tests to perform when verifying the functionality of RWR:

Ability to recognize a single threat signal – this is the simplest test and requires a single signal generator to verify that the RWR can recognize a specific threat.

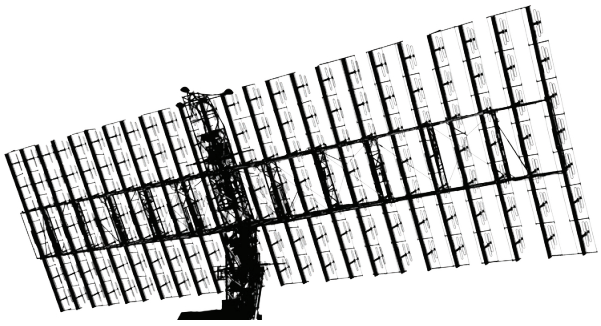
Ability to determine the angle of arrival – this requires four or more signal generator channels with each channel having a specific time off-set to test the ability of the RWR direction detection.

Ability to function in a complex electromagnetic environment – this tests the RWR ability to perform the above two functions when in a simulated real-world environment.

Test Methodology

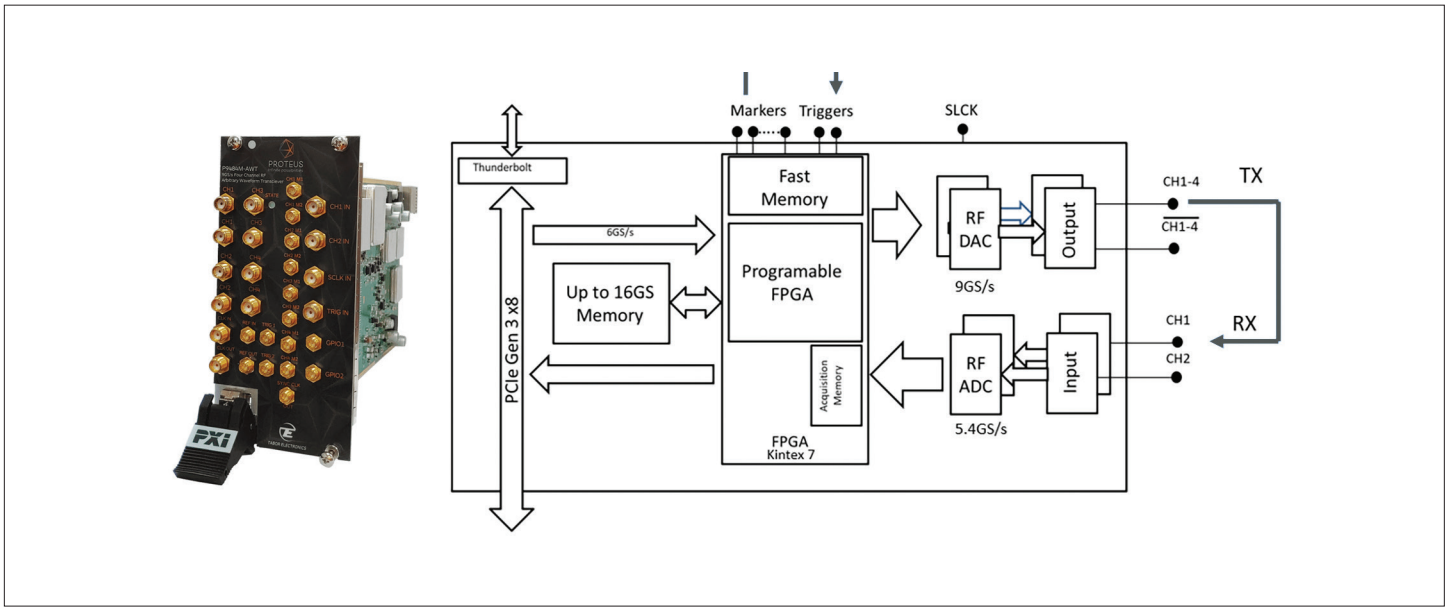
An EW test system can very in scale and cost.

- Generic RF Signal Generator and/or wide-band Arbitrary Waveform Generator that generates a static threat
- Small system that emulates the threat with vehicular movement
- Multi-emitter large scale threat emulation system



Software Defined Radios for EW Testing

Software-defined radio (SDR) is a radio system that uses software to process signals instead of hardware. SDRs are used in many fields, including mobile communications, military projects, and research and development. The Tabor Arbitrary Waveform Transceiver is a type of software define radio that is based on the concept of a system in a module. The core elements of the module are RF Digital to Analog and Analog to Digital Converters, user programable FPGA, large memory, and high speed data bus technology.



RF Tranceiver System in a Module

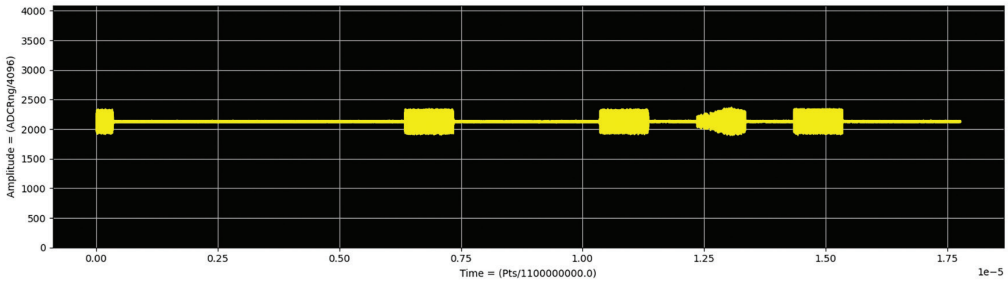
The Proteus System is a modular platform, consisting of 4 Channel direct to RF modules, that are phase coherent and have deterministic timing behavior. Transmitters can be scaled to hundreds of channels if required. The architecture provides wide bandwidth high resolutions waveforms, and an easy to program Test & Measurement style language (SCPI), allowing for fast creation of sequenced waveforms enabling fast and easy creation of complex emerging threat scenarios.

4 Direct to RF Synchronous Outputs, 2 RF Digitizers

Scalable to 1000's of Synchonous Channels

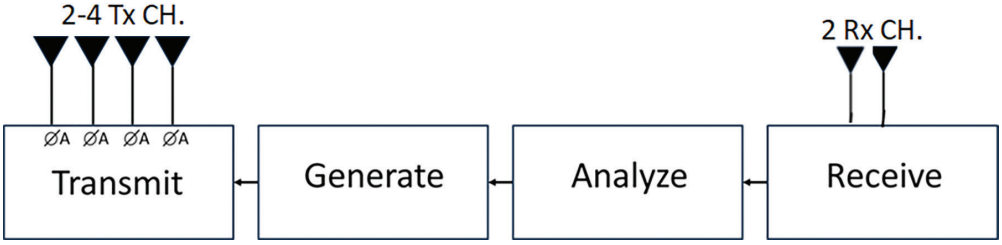
Operational Modes

Simplified static threat generation – the complimentary Wave Design Studio package enables easy generation of radar signals, radar modes, and waveform scheduling. The software makes it easy to define carrier frequency, pulse characteristics, and modulation on pulse if required. Multiples of waveforms can be deterministically scheduled within the instruments FPGA using the software's waveform task system.



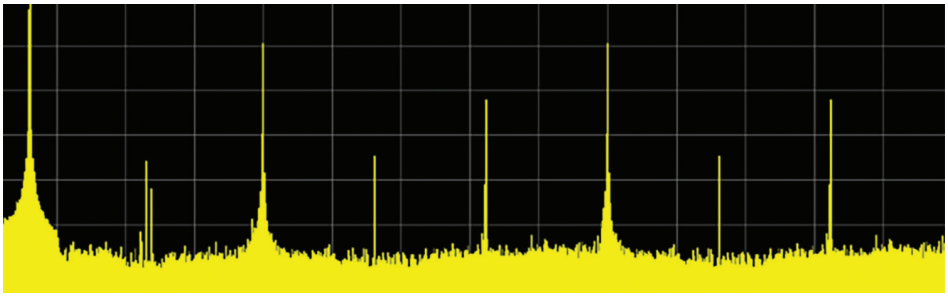
Decreasing PRI and LFM

Digital RF Memory Mode – the transceiver receives the signal, digitizes it, then adds delay and doppler. converts it back to analog and retransmits. The architecture of the system allows a single channel RF capture and real-time signal modification and re-transmission on four channels independently. Allowing you to easily verify threat type and angle of arrival.



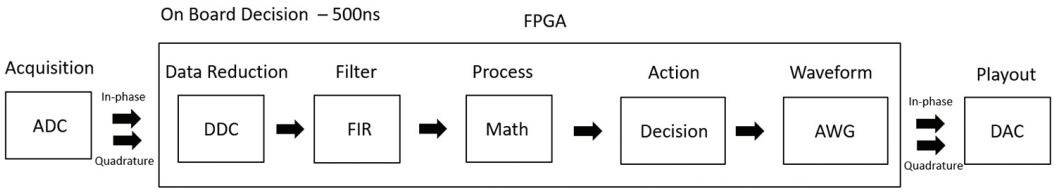
DRFM Mode

Data Streaming Mode – for complex electromagnetic environments, waveforms can be calculated on the fly using GPU's or by streaming directly from a RAID array. The instrumentation uses a high-speed Gen 3 x8 PCIe interface, allowing magnitude or IQ data transfer. With a built-in Digital IQ modulator, frequency conversion to the band of interest is easily performed.



Complex EM Environment

Digital Down Conversion and Signal Processing – The receiver has up to ten digital down conversion channels implemented within the system's FPGA. Using the instruments, simplified SCPI programming language, a receiver can be configured to process the incoming signal. Based on the characteristics of the received signal, it can retransmit different waveform sets depending on what action needs to happen on the transmit, vs. the received signal.



Digital down conversion and signal processing chain

Arbitrary Waveform Transceivers

Proteus Series

Proteus provides both state of the art Arbitrary Waveform Generation and optional Arbitrary Waveform Transceiver capability. The system integrates the ability to transmit, receive and perform user-programmable FPGA based digital signal processing and decision making all in a single instrument. Proteus provides key capability for closed loop transceiver applications in aerospace, defense, telecommunications, automotive and physics applications.

Module Platform

Utilizing state of the art RF DAC and ADC technology, phase coherent channel density (up to 32 channels per 19" 3U 19" chassis) and high- speed data transfer, the Proteus RF PXIe Series can be used to create complex RF environments in real-time..

MODEL	P1282M | P1284M	P2582M | P2584M	P9082M
Channels	2 | 4	2 | 4	2
Modes	Standard, Arbitrary, Task		
Max. Sample Clock Rate	1.25GS/s	2.5GS/s	9GS/s
Memory Size	1G/2G/4G	2G/4G/8G	2G/4G/8G
Vertical Resolution	16 bits	16 bits	Up to 16 bits
Output Type	DC	DC | Direct (AC)	
bandwidth	625MHz	1.25GHz | 2.5GHz	4.5GHz | 9GHz
Max Amplitude (into 50Ω)	1.2Vp-p	1.2Vp-p | 600mVp-p	
Transition Time (20/80 typ.)	<150ps	<100ps | <40ps	
Run Modes	Continuous, Trigger, Gate		
Remote Programming	Full IVI (C++, CVI, LabView), Python & MATLAB drivers and Wave Design Studio		
Connectivity	PXIe Gen3 x8 Lanes		

Desktop Platform

The Desktop Platform provides up to 12 channels of capability, but without a touch screen, saving both space and cost. This compact platform has both an internal computer and remote control via an external PC. Connectivity to the instrument is provided by 3 x USB HOST and 1 x 10Gbit LAN as standard. Thunderbolt 3, GPIB, or 2 x 10Gbit Optical are available as options.

MODEL	P1282D|P1284D|P1288D|P12812D	P2582D|P2584D|P2588D|P25812D	P9082D|P9084D|P9086D
Channels	2 | 4 | 8 | 12	2 | 4 | 8 | 12	2 | 4 | 6
Modes	Standard, Arbitrary, Task		
Max. Sample Clock Rate	1.25GS/s	2.5GS/s	9GS/s
Memory Size	1G/2G/4G	2G/4G/8G	2G/4G/8G
Vertical Resolution	16 bits	16 bits	Up to 16 bits
Output Type	DC	DC | Direct (AC)	DC | Direct (AC)
Bandwidth	625MHz	1.25GHz | 2.5GHz	4.5GHz | 7GHz
Max Amplitude (into 50Ω)	1.2Vp-p	1.2Vp-p | 600mVp-p	1.2Vp-p | 600mVp-p
Transition Time (20/80 typ.)	<150ps	<100ps | <40ps	<100ps | <40ps
Run Modes	Continuous, Trigger, Gate	Continuous, Trigger, Gate	Continuous, Trigger, Gate
Storage	Removable SSD		
Remote Programming	Full IVI (C++, CVI, LabView), Python & MATLAB drivers and Wave Design Studio		
Connectivity	3 x USB HOST, 1 x 10Gbit LAN Std., Thunderbolt 3, GIPB, 2 x 10Gbit Optical Options		

Benchtop Platform

The benchtop platform has all the same capability as the modular system, i.e., transmit, receive and user programmable FPGA, but adds a 9" touch screen and an on-board PC creating a fully standalone system. With a maximum channel count of 12 AWT's it is a compact, self-contained unit, providing waveform creation and sequence programming on the bench.

MODEL	P1282B|P1284B|P1288B|P12812B	P2582B|P2584B|P2588B|P25812B	P9082B|P9084B|P9086B
Channels	2 | 4 | 8 | 12	2 | 4 | 8 | 12	2 | 4 | 6
Modes	Standard, Arbitrary, Task		
Max. Sample Clock Rate	1.25GS/s	2.5GS/s	9GS/s
Memory Size	1G/2G/4G	2G/4G/8G	2G/4G/8G
Vertical Resolution	16 bits	16 bits	Up to 16 bits
Output Type	DC	DC | Direct (AC)	DC | Direct (AC)
Bandwidth	625MHz	1.25GHz | 2.5GHz	4.5GHz | 7GHz
Max Amplitude (into 50Ω)	1.2Vp-p	1.2Vp-p | 600mVp-p	1.2Vp-p | 600mVp-p
Transition Time (20/80 typ.)	<150ps	<100ps | <40ps	<100ps | <40ps
Run Modes	Continuous, Trigger, Gate	Continuous, Trigger, Gate	Continuous, Trigger, Gate
Display	9" Touch Color LCD Display		
Storage	Removable SSD		
Remote Programming	Full IVI (C++, CVI, LabView), Python & MATLAB drivers and Wave Design Studio		
Connectivity	3 x USB HOST, 1 x 10Gbit LAN Std., Thunderbolt 3, GIPB, 2 x 10Gbit Optical Options		

Waveform Creation Software

Wave Design Studio

Wave Design Studio is the latest in instrument control and signal creation software. The intuitive graphical interface facilitates a quick and efficient working process. In addition to the standard waveform creation capability, WDS has a number of optional add-ons for RF, microwave, radar and general purpose applications.

WAVE DESIGN STUDIO

Key features

- PC based software for instrument control and signal creation
- Dedicated add-ons for radar applications, signal correction, digital modulation
- Easy to use waveform creation tools for generating chirps, pulses and modulation
- Powerful and intuitive graphical user interface, including preview of the generated scenario and simultaneous multi-channel and marker view.
- Automatic detection of all connected instruments
- Offline mode for creating waveform, scenarios and setups without a connected instrument.
- Log file and SCPI command editor for code debugging.

PXIe Chassis with Embedded Controllers

The PXIe Chassis allows you to purchase any Proteus PXIe module or amplifier and later add more channels or upgrade to higher sample rates. The system includes an embedded PC with an internal SSD drive, HDMI connection, and USB interfaces for a mouse and keyboard, as well as control using USB-C and 1000BASE-T LAN.

MODEL	PXE6410	PXE21100
Slots	6 slots	21 slots
Bus Configuration	Gen 3, x4 Lanes	Gen 4, x8 Lanes
Embedded Controller		
CPU	Intel D1508 2 Cores Std. / D1548 8 Cores Opt.	Intel i5-13500E Std. / Intel i9-13900E Opt,
Memory	16G Std. / 64G Opt.	16G Std. / 128G Opt.
Storage	120GB Std. / 1T Opt.	
Ports	3xUSB A (Host), 1xUSB C (Device), LAN	4xUSB A (Host), LAN
Build-in Graphics	HDMI	Display Port
Operating System	Windows 10 IoT Std.	

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