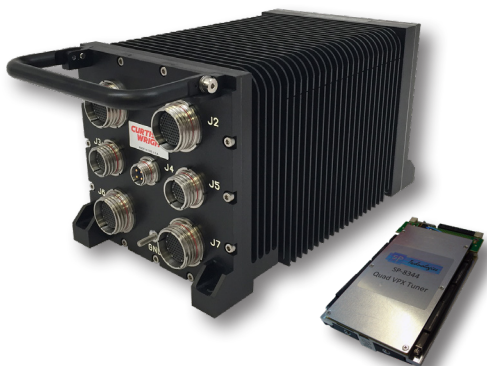


# Electronic Warfare System

## 3U VPX Compact Multi-Channel Tuner System

**CURTISS-  
WRIGHT**

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### Key Features

- SWaP-optimized signal processor
- 4 High-performance tuner channels
  - + 20 MHz to 6 GHz
  - + 40 MHz IF passband
- Intel Xeon D Octal Core DSP
  - + 410 GFLOPs with AVX2
- Xilinx Kintex-7 410T FPGA processor
  - + User Programmable - PCIe/GTP
- High bandwidth I/O options
  - + 1 and 10 Gigabit Ethernet, USB
- MIL-STD-810/MIL-STD-461 qualified

### Applications

- Signal Intelligence
- Electronic Warfare
- Electronic Support

### Products included in the system:

- MPMC-9323 Chassis Enclosure
- SP-8344 Multi-Channel Tuner
- VPX3-482 CHAMP-XD1 DSP
- XF07-523 Xilinx Kintex-7 FPGA
- PSU3-THOR Power Supply
- XMC-651 Ethernet Switch (option)
- XMC-554 SSD Flash Memory (option)

## Overview

Electronic Warfare (EW) platforms face an increasingly difficult task in terms of RF channel density and signal evasiveness. Curtiss-Wright and Silver Palm Technologies have collaborated to develop an open architecture RF signal processing system to address this challenge.

The Curtiss-Wright EW multi-channel tuner system is a ruggedized compact 3U VPX system that combines state-of-the-art multi-channel receivers, Intel® Xeon® D multi-core DSPs, and Xilinx® Kintex®-7 FPGAs. The Silver Palm SP-8344 card provides four high-performance configurable tuner channels. The Intel Xeon D octal-core (12-core optional) CHAMP-XD1 DSP processor card provides the EW signal processing and system control. Signal processing in the system is augmented by the XF07-523 XMC that provides a user programmable Xilinx Kintex-7 FPGA with direct interconnect to the SP-8344 tuner. The EW tuner system supports CentOS 7.2 (contact the factory for other OS options).

The compact EW system is packaged in a 2-slot 3U OpenVPX MPMC-9323 Mission Computing System. The MPMC-9323 enclosure is rugged and designed to minimal size, weight, and power (SWaP). The system includes the PSU3-THOR power supply that provides two XMC sites for adding Gigabit Ethernet ports or terabytes of storage depending on customer application requirements.

The EW system is a rugged compact solution to today's RF challenges. It provides multiple receiver channels and supports from 20 MHz to 6 GHz frequency coverage. The RF tuner provides the necessary bandwidth and dynamic range with low noise, processing, and for EW applications.

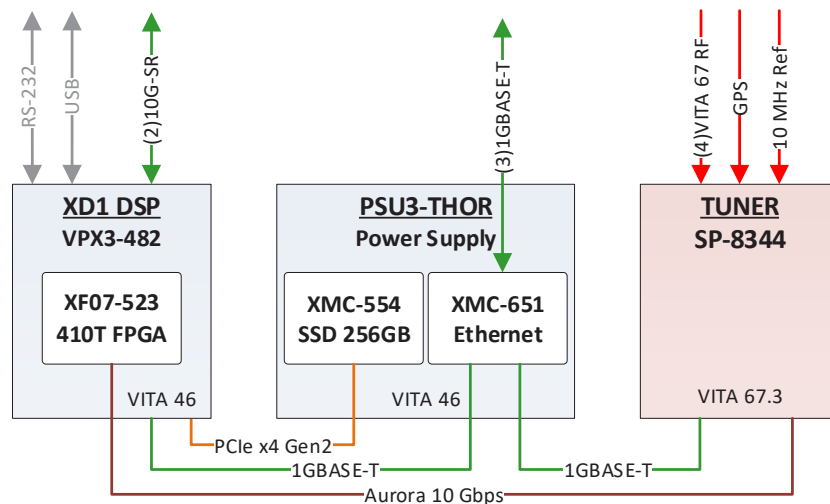


Figure 1: EW Multi-Channel Tuner

## Multi-Channel Tuner Receiver

RF tuners are the backbone of Signal Intelligence (SIGINT), Communications Intelligence (COMINT), and Electronics Intelligence (ELINT) applications. Curtiss-Wright's CHAMP-XD1 Xeon D DSPs and Xilinx FPGA XMCs, coupled with Silver Palm's multi-channel tuner technology, leverage COTS advanced electronics to create a highly capable compact and SWaP-efficient solution to counter emerging battlefield threats of today's EW applications.

The Silver Palm SP-8344 tuner packs four receiver channels with a wide frequency range, low noise, and low latency tuning in a 3U OpenVPX module. The SP-8344 has exceptional RF signal fidelity, low spurious content, high dynamic range, and 40 MHz digitized instantaneous bandwidth per channel to ensure that signals can be detected in dense signal environments and not masked by noise or spurious artifacts. Signal performance features of the SP-8344 are shown below.

### SP-8344 Tuner Features

- Frequency input range: 20 MHz to 6.0 GHz
- RF Input VSWR: 3:1 maximum
- Maximum RF input without damage: +20 dBm
- Noise figure: + 13 dB typical, 15 dB maximum
- Spurious performance
  - + In-band 3rd order intercept point: 0 dBm typical
  - + IF rejection: 70 dB
  - + Image rejection: 70 dB

### SP-8344 Digitizer features

- Maximum bandwidth per tuner: 40 MHz
- Sampling per tuner: 16-bit, 250 Msps
- Wide band IF resampler
  - + Programmable 124 Msps to 200 Ksps range
- Digital NCO per channel
  - + 32-bit phase, 1 Hz resolution
- Automatic tuner gain enable/disable
- Selectable frequency reference:
  - + External or internal 10 MHz reference
- Timing reference: 1 PPS input

The tuner module provides high-resolution ADC sampling, feeding the digitized data to a Xilinx Kintex-7 FPGA. Signal processing on each RF channel input is on-the-fly independently selectable. The tuner has an external reference clock input, and RF data is time-stamped using local or an external 1PPS time input. Configurable digital down conversion, filtering, decimation, and other signal processing are performed in the FPGA to reject interfering signals and provide superior RF performance.

In the EW multi-channel receiver, the digitized processed signal is packetized and output in Aurora protocol over the Xilinx SerDes gigabit transceiver links for each RF channel. The data transfer is received by the FPGA hosted on the CHAMP-XD1 XMC site. Transferred data can be raw wideband bypass data, processed signals, or direct digital synthesizer test data.

The XF07-523 Xilinx Kintex-7 FPGA operates in conjunction with the Intel multi-core DSP to perform mission specific signal processing on the received signals. Data and other information can be transferred between the two over an eight-lane PCIe Gen 3 interface that supports a data bandwidth of 8 GBytes/second.

The CHAMP-XD1 can be augmented with additional terabytes of optional direct access Flash Solid State Drive (SSD), for aid in real-time online analysis of received RF target waveforms for detection and identification or storage for offline post-mission-analysis of received signals. Processed data can be output over its two 10G Ethernet ports that are converted to fiber on the front panel. Analysts can use signal data gathered by the EW multi-channel tuner to assess characteristics and limitations of target waveforms to design EW countermeasures to defeat the threats.

The EW multi-channel receiver is useful for a variety of SIGINT EW applications. The MPMC family and the modularity of the design simplifies scaling systems to higher number of receiver channels and is an advantage over proprietary products. A variety of tuner channel combinations are possible. A 20-channel system in 3U VPX format (MPMC-936x enclosure) could support up to five SP-8344 tuner cards. The FPGAs on the tuner module would perform the front end signal processing, feeding the multiple channels into the XF07-523 FPGA cards to perform back end processing with the CHAMP-XD1 doing the post-processing.

## SP-8344 Quad Channel VPX Tuner

### SP-8344 Tuner Overview

The Silver Palm SP-8344 is a 3U VPX (VITA 65) tuner. The module accepts up to four antenna inputs delivered to up to four independently configurable tuner channels covering the 20 MHz to 6 GHz frequency range with 40 MHz instantaneous bandwidth. VITA 67.3 coaxial backplane connectors employed for the RF input reduce mean time to repair and simplify integration modularity.

The analog input channels are down converted and filtered prior to ADC conversion. The digital output data is fed into an FPGA for time stamping, user programmable filtering and resampling, and then packetized for digital transport via the Aurora protocol.

The SP-8344 features a programmable fractional resampler with sample data rates from 124 Msps to 200 Ksps in 1 Hz steps. This allows adjustment of processing bandwidth from 40 MHz down to 160 KHz. There is a user programmable 64-tap FIR filter. There is an internal 65-channel GPS receiver with a disciplined 10 MHz oscillator for nanoseconds accurate timing.

An integrated host functions as the module controller. It supplies command, control, and status over a Gigabit Ethernet interface. It can command all tuner channels independently within the module and also supports internal test signal generation.



Figure 2: SP-8344 Receiver Tuner

### Features

- VITA 65 3U VPX quad tuner
- Configurable independent tuning
- 20 MHz to 6 GHz coverage
- Automatic gain control

### Digitizer/IF processor

- Xilinx Kintex-7 410T FPGA
- 40 MHz bandwidth per tuner
- 1 Hz digital NCO tuning
- Wideband programmable resampler
- Internal DDS test signal generator

### Inputs

- 4 VITA 67.3 RF inputs
- 10 MHz external reference
- 1PPS time stamp

### Interfaces

- Gigabit Ethernet command
- 8 VITA 49 digital IF output
- Aurora Fat Pipe

## XF07-523

### XF07-523 FPGA Overview

The Curtiss-Wright [XF07-523](#) high performance user-programmable FPGA XMC combines direct high-speed I/O links and next generation FPGA processing making the XF07-523 ideal for demanding EW applications. The XMC is built around a user programmable Xilinx Kintex-7 410T FPGA coupled to fast LVDS data I/O ports and supported by high speed DDR3 memory directly connected to the FPGA.

The XF07-523 FPGA XMC supports 512 MBytes of DDR3 SDRAM, divided into two memory banks directly connected to the FPGA. Banks are independent to enhance flexibility with read or write bandwidths of up to 2.5 GBytes/sec each.

A four or eight channel PCIe interface is supported using the FPGA's built-in PCIe end-point block. High bandwidth and low latency interfaces can be implemented using the SerDes Gigabit Transceiver data links over the P16 XMC I/O connector.

Curtiss-Wright's FusionXF development kit includes software, HDL, and utilities complete with examples. It includes a C language API, driver framework, and sophisticated DMA support.

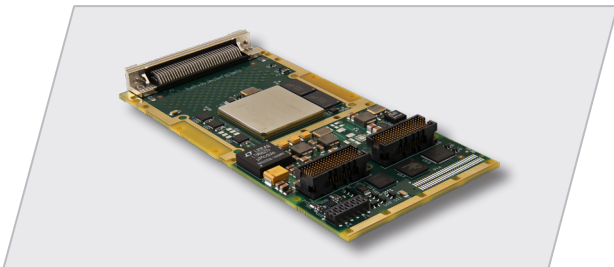


Figure 3: XF07-523 Xilinx Kintex-7 FPGA XMC

### Features

- VITA 42.0 XMC FPGA Processor

### Processor

- Xilinx Kintex-7 410T FPGA
- 406K logic cells, 1540 DSP slices
- 3 Mbytes Block RAM

### Memory

- 2 x 128M x 16-bit DDR3 SDRAM
- To 5.0 GBytes/sec bandwidth
- 1 Gbit configuration Flash

### Interfaces

- x4/x8 PCIe over P15
- 8 x SerDes GTP over P16
- JTAG/ChipScope Pro port

### Software

- FusionXF FPGA development kit

# CHAMP-XD1 DSP Card (VPX3-482)

## CHAMP-XD1 Overview

The CHAMP-XD1 DSP card is designed for [High Performance Embedded Computer \(HPEC\)](#) systems deployment. It has an octal-core (12-core optional) Intel Xeon D processor operating at 1.6 GHz with peak performance of 410 GFLOPs. It comes configured with either 16 or 32 GB ECC DDR4 dual channel memory with >34 GBytes per second total bandwidth. Non-volatile memory includes 16 GB or 32 GB SATA NAND Flash, 16 MB SPI Flash, and 512 NVRAM.

The CHAMP-XD1 features cutting edge bandwidth that includes two 10GBASE-KR or two 1GBASE-KX interfaces, as well as a single 1000BASE-T port, and PCIe Gen3 data plane interfaces. Its core function FPGA provides the serial UARTs, discrete interfaces, reset control, watchdog timer, and six general-purpose timers with better than one microsecond resolution.

### Processor

- Intel Xeon D Octal Core with AVX2
- 410/576 GFLOPs (8/12-cores)

### Memory

- 16 to 32 GB DDR4 @ 34 GB/sec
- 16 to 32 GB NAND FLASH

### Interfaces

- 1 x VITA 46.9 XMC site
- x8 PCIe Gen3 to XMC
- 2 x x4 lane PCIe Gen3 fabric
- 2 x 10GBASE-KR or 1GBASE-KX
- 1 x 1GBASE-T Ethernet
- 2 x EIA-232, 2 x EIA-422/485 serial
- 1 x SATA 3.0, 3 x USB 3.0/2.0
- 4 x GPIO discretes

### Software

- CentOS
- TrustedCOTS
- OpenHPEC Accelerator Suite

It is supported by a suite of firmware, Operating Systems (OS), communication APIs, and signal processing libraries including the OpenHPEC Accelerator Suite. Curtiss-Wright's OpenHPEC integrates proven supercomputer industry tools in a development suite to simplify application deployment.

The module's XMC mezzanine site is designed for up to 25 watts of thermal dissipation. A block diagram of the CHAMP-XD1 is shown below.

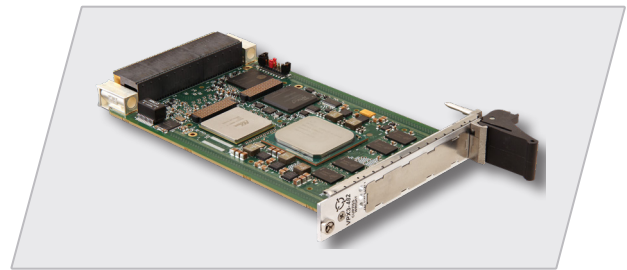


Figure 4: CHAMP-XD1 Digital Signal Processor

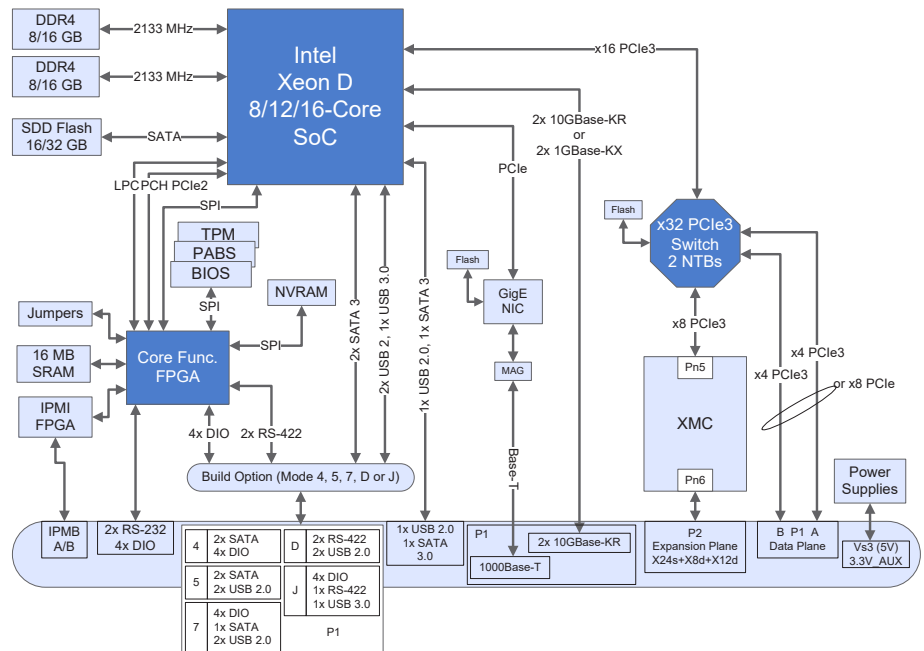


Figure 5: CHAMP-XD1 Digital Signal Processor

## MPMC-9323 3U VPX Rugged Enclosure

### MPMC-9323 Overview

The [MPMC-9323 Multi-Platform Modular Computer \(MPMC\)](#) is designed to meet the harsh environments of military computing applications including temperature extremes, altitude, voltage spikes, shock, vibration, and more. It has two 3U VPX slots and three XMC sites including the two on the power supply.

The enclosure design incorporates several unique features optimized to allow two high performance, high power modules to run at full performance. The chassis structure is a lightweight composite material reducing weight versus a standard metal chassis. The DSP and tuner modules have integrated aluminium heat frames and are located so that the chassis wall provides the cooling path with the power supply between them. Card spacing has been increased to ensure the heat from one slot does not affect the adjacent slot.

The MPMC-9323 has been designed to meet or surpass MIL-STD-810 Qualifications for Military Equipment and DO-160E Environmental Conditions for Airborne Equipment. Circuit cards installed in the sealed chassis are completely isolated from external environmental conditions such as humidity, dust and sand. Proper bonding design and the use of isolation materials such as EMI gaskets are used to ensure EMI / EMC compatibility to MIL-STD-461E. See the environmental and EMI qualifications tables for qualification test details.



Figure 6: MPMC-9323 2-slot 3U VPX System

### MPMC-9323 Features

- 2-slots 3U VPX, 3 XMC sites
- SWaP
  - + Size (L x W x H): 10.5 x 5.9 x 7.7"
  - + Weight: 18 lbs.
  - + Power: Up to 200 watts
- Mechanical
  - + Integrated handle
  - + 4 point or integrated bracket mounting
- Power
  - + To 200 watts 28V input
  - + MIL-STD-704E, MIL-STD-1275D
- Interfaces
  - + Front panel I/O
  - + Mighty Mouse Series 80 connectors
- Environmental / Electromagnetic
  - + MIL-STD-810F / DO-160E Environmental
  - + MIL-STD-461E Electromagnetic Compatibility

## PSU3-THOR Power Supply

The [PSU3-THOR Power Supply](#) is designed by Curtiss-Wright to provide 28V power ranging from 250 to 500 watts, additional XMC sites, and flexible PCIe switching to 3U VPX systems. Architected to integrate with Curtiss-Wright mezzanine cards and MPMC enclosures, this fully ruggedized carrier card expands system functionality for a diverse set of applications that include I/O, communications, storage, and processing capabilities as well as acting as a switch for transfer of data between up to four backplane PCIe ports. Safety features include transient protection, current limiting, and reverse polarity protection. There is also an option that incorporates a 50 millisecond hold-up for temporary power interrupts up to 280 watts.

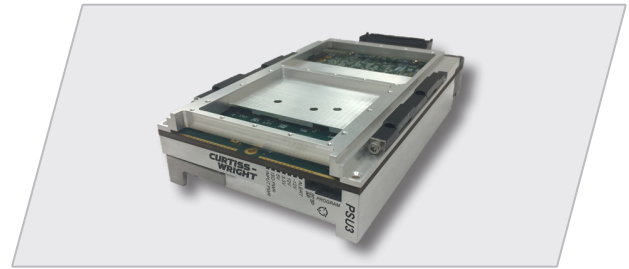


Figure 7: PSU3-THOR Power Supply

## XMC-651 Ethernet Switch - Optional

The [XMC-651 Ethernet Switch](#) is a zero-slot Gigabit Ethernet switching solution designed to support in-chassis networks with managed Layer-2 switching capabilities. It provides 802.3 compliant Gigabit wire-speed non-blocking IPv4/v6 Ethernet switching with VLANs, multicast, link aggregation, port mirroring, and jumbo packets. It supports a variety of port combinations of 5/7/8/12-ports of 10/100/1000BASE-T (with auto negotiation and auto-MDI/MDIX crossover support) or 1000BASE-X (SerDes). The module powers into an operational state with no software required, only power and I/O from the host.



Figure 8: XMC-651 Ethernet Switch (option)

## XMC-554 SSD Memory – Optional

The [XMC-554 SSD Memory](#) is a reliable and power-efficient NAND flash solid-state drive (SSD) solution for data and video storage. The XMC-554 features two independent drives with up to two terabytes of total storage capacity, Error Correcting Code (ECC), wear level and bad block management, and a PCIe Gen2 interconnect. Storage can be either SLC or MLC. Sequential read and write bandwidth to a single drive is 500 and 400 Mbytes/second respectively. It can support AES-256 encryption and ATA Secure Erase features to protect sensitive data.

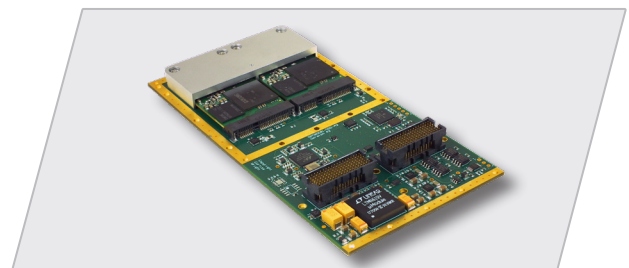


Figure 9: XMC-554 SSD Memory (option)

TABLE 1		System interfaces
	I/O	COUNT
SP-8344 Tuner	RF receiver channels	4
	Reference clock input	1
	1 PPS input	1
VPX3-482 DSP	10GBase-SR Ethernet	2
	USB 2.0	3
	SATA 3.0	1
	Serial EIA-232	2
	Serial EIA-422	2
	Discrete I/O	4
XMC-651 Switch	10/100/1000Base-T Ethernet	3

## Environmental Qualifications

TABLE 2		EMI Qualification Tests
TEST		MIL-SPEC
Bonding test		< 2.5 milliohms
Emissions	Conducted	Power leads, 10 KHz to 10 MHz › MIL-STD-461E, CE102 › Figure CE102-1
	Radiated	Electric field, 2 MHz to 18 GHz › MIL-STD-461E, RE102 › Figure RE102-3 limits Antenna spurious and harmonic outputs 100 KHz to 40 GHz › MIL-STD-461E, RE103
Susceptibility	Conducted	Power leads 800 Hz to 150 KHz › MIL-STD-461E, CS101 › Figure CS101-1 limits
		Bulk cable injection 10 KHz to 200 MHz › MIL-STD-461E, CS114 › Figure CS114-1 5 limits
		Bulk cable injection Impulse excitation › MIL-STD-461E, CS115 › Figure CS115-1
		Damped sinusoidal transients, cables and power leads, 10 KHz to 100 MHz › MIL-STD-461E, CS116 › IMAX=5A
	Radiated	Electric Field 30 MHz to 18 GHz › MIL-STD-461E, RS103

TABLE 3		ENV Qualification Tests
TEST		MIL-SPEC
Temperature Operating	High	MIL-STD-810F Method 501.4, Procedure II
	Low	MIL-STD-810F, Method 502.4, Procedure II
Humidity		MIL-STD-810F, Method 507.4
Altitude		MIL-STD-810F, Method 500.4, Procedure II
Explosive atmosphere		MIL-STD-810F, Method 511.4
Fluid contamination		MIL-STD-810F, Method 504, occasional contamination
Vibration	Performance	MIL-STD-810F, Simultaneous sine and random 30 minutes
	Endurance	MIL-STD-810F 1 hour per axis
Shock		MIL-STD-810F, Operational, Procedure I, 20 g, 11ms, 18 shocks
Acceleration		› + Z: 5.6 g      › - Z: 3.6 g › + X: 3.2 g      › - X: 3.0 g › +/-Y: 2.0 g

## Ordering information

Contact your local sales representative for additional information.