BittWare WaveBox-119 RF System ›

The BittWare WaveBox-119 is an AMD Versal™ RF VR1902 or VR1952 chip in a commercial 1U chassis with NEBS Level 2 environmental specifications. It is a cost-optimized platform for commercial satellite base station or naval shipboard applications as well as a development kit for rugged defense applications.

This 1U server implementation of the AMD Versal RF device features direct RF up to 8 GHz (amplified) or 18 GHz. The Versal RF VR1902 chip features 4 GHz of instantaneous bandwidth along with 16x ADCs and DACs. This device offers significantly more FPGA programming resources and digital I/O bandwidth than previous generation cards based on UltraScale+ RFSoC. A single WaveBox-119 provides more resources than multiple typical RFSoC cards, as well as the FPGA card users often deploy alongside, potentially offering better analog performance in a smaller space for less money.

Preliminary product concept image

Preliminary Product Info

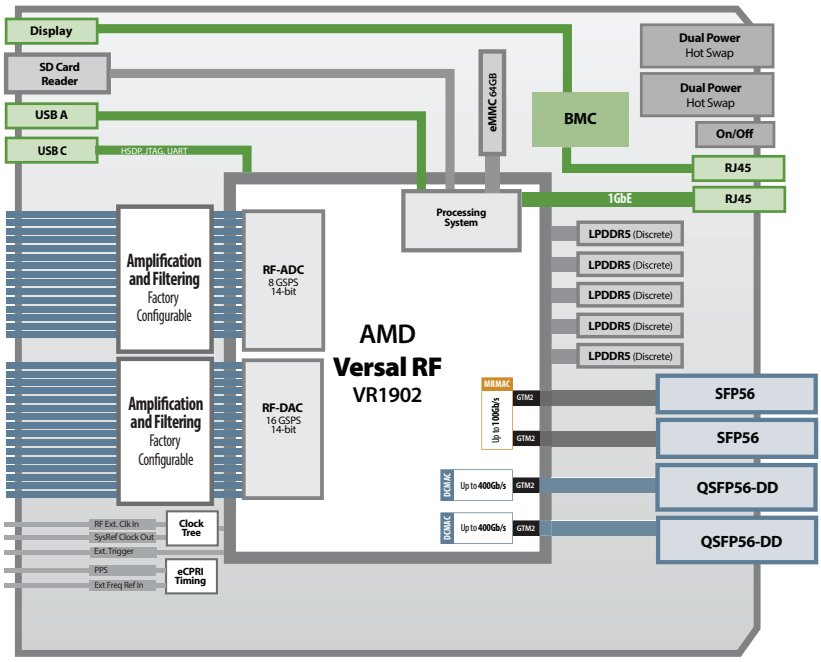
The BittWare WaveBox-119 includes a reference application providing VITA 49.2 over Ethernet (a DIFI subset). Additional data plane protocols are available through our IP Partner eco-system such as Aurora, Ethernet MAC frames, RoCE v1 RDMA, and UDP.

FEATURES AND ADVANTAGES

Integrated amplification and filtering
Higher performance and reduced cost

AMD Versal RF adaptive SoC
Direct RF up to 8 GHz (amplified) or 18 GHz and ARM processing subsystem

16x in/out in 1U Chassis
High-density from a single direct RF chip



Simplified diagram not showing all features under consideration.

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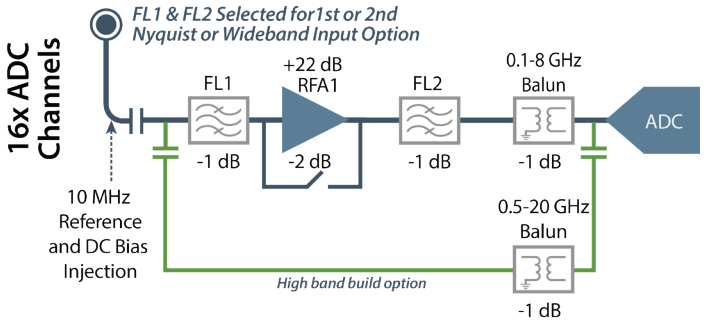
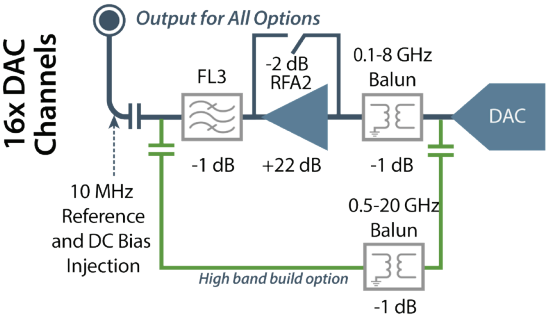
PRODUCT DETAILS

ADC Front End Options

The Versal RF chip at 8 GSPS offers 4 GHz instantaneous bandwidth at up to 8 GHz (amplified) or 18 GHz. To address aliasing challenges requiring filtering in the path, the WaveBox-119 features on-card filtering and amplification. The standard front end targets 1st Nyquist: 500 MHz to 3.5 GHz on the ADC side, and 500 MHz to 7.5 GHz on the DAC side.

Our implementation allows users to inject power and a 10 MHz reference signal into all ADC and DAC channels. This eliminates external boxes that do the same thing in many configurations.





An option is available for an amplified, 2nd Nyquist configuration on selected ADC channels using different filters. We can also replace the filters with 0.5 dB Thru-Line attenuators if a user prefers to filter before signals reach the WaveBox-119.

Processing signals above 8 GHz is possible, depending on customer interest. This option leverages the green signal path in the diagrams above, using the same high band balun as our VRF-319 3U VPX defense product. Please contact us for details.

Analog Characterization Data

Molex fully tests and documents the analog characteristics of each WaveBox-119 configuration. That data is available for most revisions through our developer website.

System rear view (preliminary product concept image)

Included IP

The BittWare WaveBox-119 servers ship with a reference application that converts between analog data and timestamped, VITA-49.2 packets. It works in both ADC and DAC directions. The application also transfers raw data to and from ARM memory.

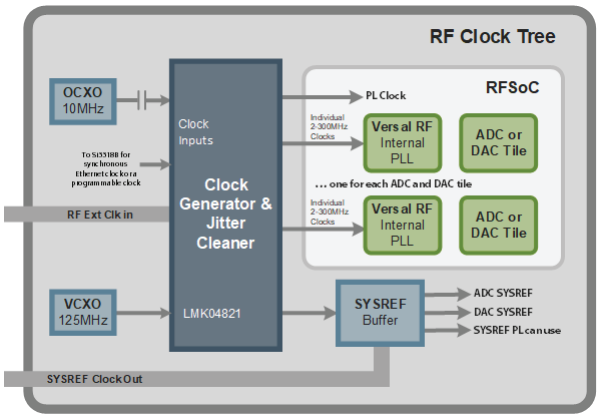
The direct RF chip's ARM Processing System runs Linux and acts as a control plane. More specifically, we have integrated card management functions through customized Linux drivers. Molex has also ported AMD's RF Tool application, a socket library that configures a direct RF chip. Above both Linux and RF Tool, we provide our own RFUtils commands and examples. RFUtils can generate synthetic waveforms as well as load and stream waveforms from files. All of this is fully supported by Molex, and we provide source code.

Molex created a GUI tool called RFX Surfer to help configure and monitor BittWare RFX and WaveBox-119 cards, as well as analyze data. We use RFX Surfer to automate RF performance characterization, including automating external test equipment. It communicates over Ethernet to a socket server running on the ARM PS. WaveBox-119 systems include this utility, with source code.

The WaveBox-119 reference application moves VITA-49 data over Ethernet. The application supports VITA-49 in Ethernet frames and Aurora frames. DIFI uses a specific VITA-49 subset over UDP. We have also demonstrated a variation of our reference application that includes the Atomic Rules UDP Offload Engine.

Clock Tree

TheWaveBox-119 offers a very flexible clock tree. It can accommodate an external reference clock input from Synchronous Ethernet or a clock fed in directly over a coax cable. The default card configuration also has a 10 MHz OCXO and a programmable clock. The PLL uses a reference 125 MHz VCXO which we have replaced with other values for specific customer applications. Some of the WaveBox-119 clock tree flexibility is established through build options when the card is manufactured. We will configure optimized cards for each customer, with a minimum quantity requirement in each order.



Target Environment

The WaveBox-119 provides a next-generation option for users of BittWare RFX-880 products. It offers more I/O capabilities than previous generation products, reducing the need for external digital I/O cards.

The WaveBox-119 box is ideal as a development platform for Versal RF VR1902 chip-down designs, for customers designing Versal RF in ruggedized form factors, or as a deployable solution.

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SYSTEM SPECIFICATIONS

Versal RF
- AMD Versal RF
  - VR1902 (8 GSPS) or VR1952 (32 GSPS)
  - Core speed grade -2

Processing Subsystem (PS)
- Application Processing Unit Dual-core Arm Cortex-A72 MPCore
- Real-Time Processing Unit Dual-core Arm Cortex-R5F MPCore

Analog
- 16x 8 GSPS 14-bit ADCs
  - **Standard ADC config** is 500 Mhz to 3.5 Ghz with bandpass filters and +22 dB of gain
  - **Wideband build option** provides -3 dB gain from 10 MHz to 8 GHz (default)*
  - Max input power +15 dBm
- 16x 16 GSPS 14-bit DACs
  - The standard DAC config is 500 Mhz to 7.5 Ghz with bandpass filters and +22 dB of gain at max output power of +15 dBm.
  - Range of +15 to +10 dBm (this level is a function of frequency)
  - Constrained by a 7.5 GHz LPF in 1st Nyquist zone (FL3)
- **High-band build option** provides 20 GHz balun and no amplification
- Programmable clocks
- External reference and triggers
- Can inject a 10 MHz reference and power into all ADC and DAC channels
  - Reference clock frequency locked but not phase aligned (i.e. at reference frequency of 10 Mhz, the phase shift between each adjacent port will be approximately 0.1 degrees)
- Can inject a DC bias into all ADC and DAC channels at up 12 volts and 500mA each
- All ADC and DAC channels are equal in both phase and amplitude, within a modest tolerance

On-board flash
- PS connects to a pair of 2Gb QSPI parts configured in “Dual Parallel” mode. The PS boots from the QSPI to configure itself, then pulls the logic bitstream from the QSPI and configures the PL
- 64GB eMMC for ARM disk

External memory
- 5x banks of LPDDR5
  - Each bank 32Gb in density (2chx16) @ 8533 Mb/s; total memory bandwidth 170.7GB/s
  - Each bank can be individually assigned between PS and PL

Front I/O Ports
- 4x ganged 8-wide, smooth bore SMPM connectors for 16x ADCs and 16x DACs
  - Molex pigtails with SMA breakouts available
- 5x SMB for clocks and triggers
- USB-C for programming
- USB-A for the ARM PS

Rear I/O Ports
- 2x QSFP56-DD cages connected to 2x 600G Ethernet MACs (DCMAC); each supports 4x 100GbE, 2x 200GbE or 1x 400GbE
- 2x SFP56 cages sharing 1x 100G Ethernet MAC (MRMAC); each cage can support 50/25/10GbE
- RJ-45 for the BMC
- RJ-45 for the ARM PS
- On/off switch

Electrical
- 2x hot-swappable power supplies
- Power dissipation is application dependent

Import/Export
- Exports of this system from the US will require a license for some countries

Form factor
- 1U chassis
- NEBS Level 2 compliant (not formally certified)

DEVELOPMENT TOOLS

Firmware development
Molex provides interface software support for an example bitstream that fully configures the Versal RF chip using a scripting language running on the Versal RF ARM. AMD Vivado development tools are fully supported for development of custom designs.

Software development
- **Embedded Linux image**:
  - Customized using the AMD EDF build flow
  - Runs on the ARM PS
- **Application software:** can be compiled on the ARM PS or cross-compiled on a Linux host
- **BittWare RFUtils:**
  - Added into the embedded Linux image
  - Runs on the ARM PS
- **BittWare RF Surfer host software:**
  - Runs on Windows and Linux systems
  - Communicates with the card over Ethernet to the WaveBox-119
- **System controller:**
  - Communicates over Ethernet and via front panel interface
  - Underlying software is included to allow cusomization

** The Versal RF chip supports much higher frequencies. The WaveBox-119 Wideband is constrained by the balun and connector system. Higher band support is possible in special orders.*

VR1952 Option

You can order WaveBox-119 with a VR1952 chip instead of the VR1902. This increases the ADC sampling rate to 32 GSPS for 16 GHz of instantaneous bandwidth. It also reduces the ADC channel count from 16 to 8. This option is only available with the “High Band” analog configuration (no filtering, amplification, or injection of DC bias and reference).

AMD Embedded Partner Network PLATINUM

To learn more, visit **bittware-molex.com**

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