Latest MTCA High-Performance Digitizer Technology

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MTCA Digitizer Roadmap

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<th>Channels</th>
<th>GSPS</th>
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**ADQ7 – Digital Baseline Stabilizer IP “DBS”**

**Interleaving correction**
- High frequency input signal
- Interleaved ADCs for high sample rate
- Typical distorted time-interleaved signal
- DBS corrects for base-line differences
- Signal restored by DBS

**Baseline stabilizer**
- Baseline fluctuation (for example due to temperature)
- DBS corrects for base-line variations
- Signal restored by DBS
Each application requires a unique pulse analysis. The FPGA is thus open for custom designs. TSPD’s design service is available to support the implementation work.
ADQ7-FWATD Advanced time domain firmware

ADQ7

ADC
10 GSPS
14 bits
3 GHz BW

FPGA Kintex Ultrascale: FWATD

- DBS (Digital Baseline Stabilizer)
- User controlled FIR filter 32 taps
- Sample skip (1, 2, 4 … )
- Threshold
- Condition
- Filter
- Waveform Accumulator (1)
- Flow control
- MTCA / PCIe / USB3.0 / 10GbE

PC

- Waveform accumulator (2)
- Flow control
ADQ7-FWSDR Software defined radio firmware

- Two analog RF channels
- Streaming of 4 separate digital RF channels
- Sustained streaming to disk > 5 GBytes/s
- ADX interleaving technology
ADQ14 - Success Story – W7-X

- Wendelstein 7-X stellarator at Max-Planck IPP
- Thomson scattering for plasma temperature measurement
- ADQ14DC-4C-MTCA
  - 14 bits vertical resolution, 4 channels @ 1 GSPS
  - 70 Boards, 280 channels, synchronized sampling
- Comment from the customer[1]:

  “The combination of 14 bits dynamic range and 1 GS/s sampling rate is taking the performance of digitizer for TS system to an unprecedented performance level. The ADC boards are also equipped with Kintex-7 FPGAs for real-time signal processing.”

ADQ7- Series Digitizers

ADQ7DC

- 14 bits vertical resolution
- DC-coupled version for pulse data
  - 1 / 2 channel @ 10 / 5 GSPS
  - 2.5 GHz bandwidth (3 GHz with equalizer)
  - DBS IP for baseline stabilization
- 4 Gbyte onboard DRAM
- Open Xilinx Ultrascale FPGA XCKU085
- High-precision trigger (25 ps)
- Flexible clocking capabilities
- Multi-channel synchronization support
- Multiple form factors incl. MTCA.4
- 6.8 Gbyte/s peak data transfer (PCIe gen3x8)

- SDK supporting multiple environments
- Windows and Linux support
- Firmware options for pulse detection, advanced time-domain and software defined radio
- FPGA firmware development kit optional
- 3-year warranty
ADQ7DC - Bandwidth (1 channel 10 GSPS)

-3 dB

Linear frequency

Log frequency

1 MHz 1 GHz 2 GHz 3 GHz
Preview: ADQ7- Series Digitizers (cont’d)

ADQ7RF (Preliminary)

- 12 bits vertical resolution
- AC-coupled version for RF capture
  - 2 channels @ 5 GSPS
  - Target >4 GHz bandwidth
  - DBS IP for baseline stabilization
- 4 Gbyte onboard DRAM
- Open Xilinx Ultrascale FPGA XCKU085
- High-precision trigger (25 ps)
- Flexible clocking capabilities
- Multi-channel synchronization support
- PCIe and PXIe form factors (MTCA tbd)
- 6.8 Gbyte/s peak data transfer (PCIe gen3x8)
- SDK supporting multiple environments
- Windows and Linux support
- Firmware option software defined radio
- FPGA firmware development kit optional
- 3-year warranty
Preview: ADQ8-8 for multi-channel applications

Key specifications

- 10-bit vertical resolution (8-bit option)
- 8 channels with 1 GSPS / channel
- DC - 250 MHz
- DRAM: 1 Gbyte
- Standard: 1-slot
- Open FPGA architecture
- Superior timing engine
  - 52ns re-arm time
  - 25ps Trigger time-resolution
  - Internal clock reference: 10 MHz +/- 3 ppm
  - Triggered streaming
  - Time-stamp information

Options

- Variable-gain
- 1 MOhm
- Pulse detection firmware
- Streaming to PC + GPU
- FPGA development kit
Upcoming Product Features

White Rabbit

- Ethernet-based time distribution network
- Sub-nanosecond accuracy and picoseconds precision of synchronization for large distributed systems

Supported features (ADQ7)
- Clock reference distribution
- Time stamp distribution

EPICS

- Experimental Physics and Industrial Control System – standardized control interface
- Abstracts away device specific protocols
- Supports initially EPICS CODAC Installation
- In collaboration with Cosylab
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