Multipurpose Baseband Instrument

using AsAP Digital Signal Processing

Jeremy W. Webb

University of California, Davis
Electrical & Computer Engineering
VLSI Computation Laboratory

October 26\textsuperscript{th}, 2009
Outline

1. Multipurpose Baseband Instrument Highlights
   - Multipurpose Baseband Instrument
   - Multipurpose Baseband Instrument Modes
   - Specifications
   - Measurement Board
   - AsAP DSP Tasks

2. Multipurpose Baseband Instrument IF
   - Multipurpose Baseband IF Block Diagram
   - Signal Analyzer
   - Signal Generator
Multipurpose Baseband Instrument

Multipurpose Baseband Instrument Highlights
The multipurpose baseband instrument supports several different operation modes:

1. Spectrum Analyzer
2. Oscilloscope
3. Arbitrary Waveform Generator
4. Signal Source

The operation mode can be changed on-the-fly.
## Instrument Specifications

<table>
<thead>
<tr>
<th>Specification</th>
<th>RF Input</th>
<th>RF Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency Range</td>
<td>DC to 120 MHz</td>
<td>DC to 120 MHz</td>
</tr>
<tr>
<td>BW</td>
<td>120 MHz</td>
<td>120 MHz</td>
</tr>
<tr>
<td>Sample Rate</td>
<td>500 MS/s</td>
<td>500 MS/s</td>
</tr>
<tr>
<td>Waveform Memory</td>
<td>2 GB</td>
<td>2 GB</td>
</tr>
<tr>
<td>Impedance</td>
<td>50 Ω</td>
<td>50 Ω</td>
</tr>
</tbody>
</table>
Measurement Board Assembly

Figure: Measurement Board Assembly Top.
The Measurement board contains:

- 2 AsAP ICs providing up to 500 GigaOps/sec of signal processing capability.
- 16-bit, 1GS/s Digital-to-Analog Converter.
- 12-bit, 500MS/s Analog-to-Digital Converter.
- Xilinx Virtex-5 SX50T
- QDR-II SRAM, 36Mbit, Burst of 4, 250MHz
- DDR2 SDRAM, 2GB, 250MHz
The Measurement board contains:

- 2 AsAP ICs providing up to 500 GigaOps/sec of signal processing capability.
- 16-bit, 1GS/s Digital-to-Analog Converter.
- 12-bit, 500MS/s Analog-to-Digital Converter.
- Xilinx Virtex-5 SX50T
- QDR-II SRAM, 36Mbit, Burst of 4, 250MHz
- DDR2 SDRAM, 2GB, 250MHz
The Measurement board contains:

- 2 AsAP ICs providing up to 500 GigaOps/sec of signal processing capability.
- 16-bit, 1GS/s Digital-to-Analog Converter.
- 12-bit, 500MS/s Analog-to-Digital Converter.
- Xilinx Virtex-5 SX50T
- QDR-II SRAM, 36Mbit, Burst of 4, 250MHz
- DDR2 SDRAM, 2GB, 250MHz
The Measurement board contains:

- 2 AsAP ICs providing up to 500 GigaOps/sec of signal processing capability.
- 16-bit, 1GS/s Digital-to-Analog Converter.
- 12-bit, 500MS/s Analog-to-Digital Converter.
- Xilinx Virtex-5 SX50T
  - QDR-II SRAM, 36Mbit, Burst of 4, 250MHz
  - DDR2 SDRAM, 2GB, 250MHz
The Measurement board contains:

- 2 AsAP ICs providing up to 500 GigaOps/sec of signal processing capability.
- 16-bit, 1GS/s Digital-to-Analog Converter.
- 12-bit, 500MS/s Analog-to-Digital Converter.
- Xilinx Virtex-5 SX50T
- QDR-II SRAM, 36Mbit, Burst of 4, 250MHz
- DDR2 SDRAM, 2GB, 250MHz
The Measurement board contains:

- 2 AsAP ICs providing up to 500 GigaOps/sec of signal processing capability.
- 16-bit, 1GS/s Digital-to-Analog Converter.
- 12-bit, 500MS/s Analog-to-Digital Converter.
- Xilinx Virtex-5 SX50T
- QDR-II SRAM, 36Mbit, Burst of 4, 250MHz
- DDR2 SDRAM, 2GB, 250MHz
The Measurement board contains:

- 2 AsAP ICs providing up to 500 GigaOps/sec of signal processing capability.
- 16-bit, 1GS/s Digital-to-Analog Converter.
- 12-bit, 500MS/s Analog-to-Digital Converter.
- Xilinx Virtex-5 SX50T
- QDR-II SRAM, 36Mbit, Burst of 4, 250MHz
- DDR2 SDRAM, 2GB, 250MHz
Multipurpose Baseband Instrument Highlights

AsAP DSP Tasks

- 4096-point Fast Fourier Transforms.
- Window Filters: Hanning, Flattop, and Gaussian
- Signal Statistics: Minimum, Maximum, Average, Frequency.
- Magnitude, Phase, Magnitude Squared.
AsAP DSP Tasks

- 4096-point Fast Fourier Transforms.
- Window Filters: Hanning, Flattop, and Gaussian
- Signal Statistics: Minimum, Maximum, Average, Frequency.
- Magnitude, Phase, Magnitude Squared.
AsAP DSP Tasks

- 4096-point Fast Fourier Transforms.
- Window Filters: Hanning, Flattop, and Gaussian
- Signal Statistics: Minimum, Maximum, Average, Frequency.
- Magnitude, Phase, Magnitude Squared.
AsAP DSP Tasks

- 4096-point Fast Fourier Transforms.
- Window Filters: Hanning, Flattop, and Gaussian
- Signal Statistics: Minimum, Maximum, Average, Frequency.
- Magnitude, Phase, Magnitude Squared.
Figure: Instrument IF Block Diagram.

- \( f_s = 500 \text{ MS/s} \), \( \text{BW} = 120 \text{ MHz} \), and \( f_{\text{dsp}} = 250 \text{ MS/s} \).
Anti-Alias Lowpass Filter

Figure: Frequency Response

Figure: Pass-band Response
**Digitized 100MHz Sine Wave**

*Figure: $f_{in}$: 100 MHz - Decimated-by-2.*
Signal Generator

40MHz Sine Wave

Figure: $f_{out}$: 40 MHz