USB Oscilloscope Integrated with Circuit Simulator Software

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Project Overview / Goals

- Implement cost-effective USB Oscilloscope
- Create duality between hardware & circuit simulator software
- Everything in real-time
Achieved thus far

- Utilized on-chip ADC and DACs
- USB Generic HID Connectivity (Driver-less)
- Real-time oscilloscope display in circuit simulator
- Preliminary triggering system
Circuit Schematics
Hardware Specs

- 12-Bit Res. (1mV ~ 10mV) Sampling Accuracy
- Adjustable Front-end gain and offset
- Over-voltage protection (resistive divider)
- ~30-40mA Current Consumption from USB port
- Designed in DipTrace
- Fabricated by Bay Area Circuits
Hardware Costs

Price for components for one board, excluding tuning trimmers ~$33
$30 for two far-too-large boards.

### Current Board Cost

<table>
<thead>
<tr>
<th>Parts</th>
<th>Cost</th>
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</thead>
<tbody>
<tr>
<td>Front-end Analog parts</td>
<td>$14.11</td>
</tr>
<tr>
<td>Digital Interface parts</td>
<td>$10.47</td>
</tr>
<tr>
<td>Power Management parts</td>
<td>$8.30</td>
</tr>
<tr>
<td>Board Fabrication</td>
<td>$15.00</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$47.88</strong></td>
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</tbody>
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### Estimate Bulk production

<p>| | |</p>
<table>
<thead>
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<tbody>
<tr>
<td>Parts</td>
<td>$20</td>
</tr>
<tr>
<td>Board</td>
<td>$5</td>
</tr>
<tr>
<td>Assembly</td>
<td>$5</td>
</tr>
<tr>
<td><strong>Total Board Cost</strong></td>
<td><strong>$30</strong></td>
</tr>
</tbody>
</table>
Bare PCB
Fabricated PCB
Firmware Specs

- Built in Atmel Studio, written mostly in C, some critical functions written in Assembler.
- UI Generated from Atmel’s Software Framework (ASF)
- Programmed through PDI(2W) using AVR Dragon
START

MAINTAIN S/H VALUES
~500Hz

SEND USB DATA PACKET

Gather Timing/Sampled Data

STORE 128 ADC SAMPLES

USB INTERRUPT FROM PC

WAIT FOR TRIG
Software Specs

- Quite Universal Circuit Simulator (QUCS)
- Written in C++ (Qt Libraries)
- Built with CMAKE/MinGW Toolchain
- USB interface Libraries
- Real-time data injection/plotting
Software Structure
Demo
Issues encountered

- Malfunctioning Voltage Regulator
- Broken Trace
- Trigger stability
Last popular innovation was the digital oscilloscope
Prevalence of PCs and technology increasing Y-O-Y
PC scopes exist, but are unpopular and expensive
Importance cont.

- Integration with circuit simulators yet to be done
- Create all-in-one platform
- Intuitive interface in single window
- Perfect low-cost tool for the increasing numbers of engineering students and electronics hobbyists
Looking Forward

Possible Additions:
- Input resistance 1Meg
- Current sensing and function generator
- Res/Cap/Ind measurement
- Adjustable trigger
- Integration with different simulators
QUESTIONS?
-Thank You-