STD
(Salt Transient Digitizer)
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- Hardware (Arttu)
- Firmware (Tero)
- Software (Marko)
Hardware

Table of contents:
- RF-signal route
- Trigger
- Other operations (Sampling etc.)
- Powering the board
RF-signal route

- 2 Channels
- Changing the voltage level in software changes the attenuation on board

Diagram:
- Ch1
  - Attenuator
  - Power Splitter
  - Power Splitter
  - Multiplexer

- Ch2
  - Low frequency
  - High frequency
  - Control signals from CPLD
  - To trigger
Trigger

- DAC sets the values for trigger level and for ROVDD and ROGND
- Changing the time scale in software changes the ROVDD and ROGND values on board

![Diagram showing the trigger system with DAC, Comparator, ROVDD, ROGND, and CPLD connections.]

- Ch1
- Ch2
- Trigger level
  - Ch1
  - Ch2
- DAC
- Comparator
- Comparator
- To CPLD
- ROVDD for LABRADOR
- ROGND for LABRADOR
- Control signals from CPLD
Other operations

- LABRADOR takes care of the sampling and digitizing the incoming signal.
- CPLD’s function is to provide the logic for the board and to control the board when the commands come from the end user.
- USB handles the traffic between the board and the software.
Powering the board

- Board can be powered in two ways: external power supply or USB
- Goal was to be able to power the board via USB, but it’s not possible right now, because it can provide only +4.85V when the actual voltage should be +5.0V
Instead of using the typical schematic design, for creating the architecture and behavior of the firmware, I decided to use the VHDL-code. In my opinion the VHDL-code gives the user more options to implement the design and a better understanding of the design. In this case I did the top level of the design by using the schematic design, because of some troubles I had with the top level by using the VHDL-code, but all other lower level modules are written in VHDL-code.
Instructions

- In order to change the attenuator value, ROVDD and ROGND values, trigger level, trigger type (rising/falling), the sampling frequency and the write pointer delay, we need to send sets of instructions from the software to the CPLD-firmware.

- Whenever the user changes some value in the software a 16- or 32-bit instruction set is sent to the USB. In every instruction set the first three bits tell to the CPLD-firmware the target of the packet, whether its instructions to the DAC, attenuator, etc.
## Instruction codes

<table>
<thead>
<tr>
<th>Targetcode</th>
<th>Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>010</td>
<td>Attenuator</td>
</tr>
<tr>
<td>110</td>
<td>Delay</td>
</tr>
<tr>
<td>101</td>
<td>Trigger</td>
</tr>
<tr>
<td>011</td>
<td>DAC</td>
</tr>
</tbody>
</table>
There are two channels in the board. Labrador SCA-bank holds a total of 8 * 256 = 2048 samples. ADC takes maximum of 128 at a time. So 2048/128=16 conversion cycles are required.

From the ADC we only read out the samples from channel 1 and channel 2.

Each conversion cycle we get a total of 128/8=16 samples. So total of 16*16=256 samples after the whole SCA-bank is digitised.
Data packet creation

Channel 1
Channel 2
3
4
5
6
7
Channel 8

16
Data packet creation

- Each sample is 12-bits wide, but when we send it to the USB, we will send a 16-bit packet, which includes 1 sample, hitbus- and channel identifiers.
- So 16-bits per sample 256 samples = 4096 bits = 512 Bytes.
- So this 512 Bytes will fill the USB-FIFO and the packet can be sent to the end-user.
Problems?

- Macrocells.
- EEPROM.
- And I think the most biggest one, the project didn't work.
Software
Hierarchy

- Application
  - USB Application Interface
  - Device Driver
  - Physical Interface
Driver

- EZ-USB General Purpose Driver
- The application is a user mode application
- The EZ-USB GPD is a kernel mode device driver
Graphical User Interface
Application

CUSB Application Interface

CSTDView

CControlsDlg

CData

device driver
<table>
<thead>
<tr>
<th>CData</th>
</tr>
</thead>
<tbody>
<tr>
<td>CString m_timeDiv float m_Volt1 float m_Volt2</td>
</tr>
<tr>
<td>int m_horPos int m_verPos1 int m_verPos2</td>
</tr>
<tr>
<td>int m_trigPos bool m_ch1 bool m_ch2</td>
</tr>
<tr>
<td>bool m_ok bool m_average bool m_bad</td>
</tr>
<tr>
<td>bool m_chk bool m_stop int m_avg</td>
</tr>
<tr>
<td>int m_fltSource int m_trigSource int m_trigEdge</td>
</tr>
<tr>
<td>float m_trigLev int m_trigPosStor int m_avgSource</td>
</tr>
<tr>
<td>struct m_dacPacket</td>
</tr>
<tr>
<td>float m_amplificationCh1</td>
</tr>
<tr>
<td>float m_amplificationCh2</td>
</tr>
<tr>
<td>unsigned int m_delayArray[4][17]</td>
</tr>
<tr>
<td>int m_attenuatorArray[10]</td>
</tr>
<tr>
<td>float m_amplificationArray[10]</td>
</tr>
<tr>
<td>float m_freqArray[2][24]</td>
</tr>
<tr>
<td>float m_redBg float m_greenBg float m_blueBg</td>
</tr>
<tr>
<td>float m_redCh1 float m_greenCh1 float m_blueCh1</td>
</tr>
<tr>
<td>float m_redCh2 float m_greenCh2 float m_blueCh2</td>
</tr>
<tr>
<td>float m_redGrid float m_greenGrid float m_blueGrid</td>
</tr>
<tr>
<td>float m_redTrig float m_greenTrig float m_blueTrig</td>
</tr>
</tbody>
</table>

unsigned int createDelayPacket(void)
unsigned short createTrigSelectPacket(void)
unsigned int createDACPacket(bool trigger, bool rovdd)
unsigned short createAttenuatorPacket(int ch)
CUSBAplicationInterface

- Get handle to the device driver
- Application submits an I/O control code through the handle

<table>
<thead>
<tr>
<th>CUSBAplicationInterface</th>
</tr>
</thead>
<tbody>
<tr>
<td>int arrayIndex</td>
</tr>
<tr>
<td>int sampleCount</td>
</tr>
<tr>
<td>unsigned long nBytes</td>
</tr>
<tr>
<td>unsigned short firstPart[256]</td>
</tr>
<tr>
<td>unsigned short secondPart[256]</td>
</tr>
</tbody>
</table>

| void createHandles(void) |
| void freeHandles(void)   |
| bool getNewData(bool lowspeed) |
| bool sendData(unsigned int dataPacket) |
| bool sendData(unsigned short dataPacket) |
| int * getSamples(bool lowspeed) |
CControlsDlg

- Contains all the controls
- Sets values to the Cdata member variables
CSTDView

- All the drawings are made in here
- OpenGL program draws the waveforms
- Double buffering
File Format

CSV (Comma Separated Variable)

*Can be opened with a text editor and spreadsheet program*
Questions?
SUOMI - FINLAND
Finland

- Finland (Suomi). Its population is 5.2 million. The capital Helsinki has 560,000 residents.
- Forests cover three quarters of the country's surface area of 338,000 sq. km (slightly smaller than Montana). Other features of Finland's scenery are some 190,000 lakes and approximately as many islands.
- Finland's neighbouring countries are Sweden, Norway, and Russia, which have land borders with Finland, and Estonia across the Gulf of Finland.
History

- 1155 The first missionaries arrive in Finland from Sweden. Finland becomes part of the Swedish realm.
- 1809 Sweden surrenders Finland to Russia. The Czar declares Finland an autonomous Grand Duchy with himself as constitutional monarch represented by a governor general.
- 1917 Finland declares independence from Russia on December 6.
- 1919 The constitution is adopted and Finland becomes a republic with a president as head of state.
- 1939 - 40 The Soviet Union attacks Finland and the Winter War is fought.
History (cont)

- 1941 - 44 Fighting between Finnish and Soviet forces resumes in the Continuation War. Some territory is ceded to the Soviet Union but Finland is never occupied and preserves its independence and sovereignty.

- 1955 Finland joins the United Nations and, in 1956, the Nordic Council.

- 1995 Finland becomes a member of the European Union (EU) and wins its first World championship of ice-hockey.

- 1999 Finland backs European monetary union.

- 2002 Banknotes and coins of the EU's single currency, the euro, enter circulation.
Climate

- The four seasons of the year are clearly distinct from one another. The climate is marked by cold winters and warm summers. The mean annual temperature in the capital, Helsinki, is 5.3 degrees Celsius.

- The highest daytime temperature in southern Finland during the summer occasionally rises to almost 30 degrees. During the winter months, particularly in January and February, temperatures of minus 20 Celsius are not uncommon.

- In the far north, beyond the Arctic Circle, the sun does not set for about 73 days, producing the white nights of summer. In the same region, during the winter period, the sun remains below the horizon for 51 days, creating the polar night known in Finnish as kaamos.
People

- Finland is the sixth largest country in Europe in area, with a low population density of 17 persons per square kilometre.
- Most Finns, some two thirds, now live in urban areas, while one third remain in a rural environment. The capital, Helsinki, and the neighbouring towns, Espoo and Vantaa, form the fast growing Helsinki metropolitan region, which is now home to almost a million Finns.
- Finland has two official languages, Finnish and Swedish, the latter spoken as a mother tongue by about 6% of the people.
Education

- Finnish people have a high standard of education. All children receive compulsory basic education between the ages of 7 and 16. Education beyond the age of 16 is voluntary, taking the form of either a three to four-year course in upper secondary school or 2 to 5 years at a vocational school.

- Finnish higher education consists of two sectors: universities and polytechnics. There are 20 universities and 29 polytechnics in the country. Nearly 60 per cent of the population have completed post-primary education and 13 per cent have a university degree or comparable qualification.
Industry

- Forests are still Finland's most crucial raw material resource, although the engineering and high technology industries, spearheaded by the Nokia corporation, have long been the leading branches of manufacturing.

- The paper industry is one of three major export sectors, the other two being electronics and metal and engineering. Electronics is the most spectacular success story in Finnish exports. Its remarkable growth in the 1990s was mainly based on mobile phones and other telecommunication equipment.
Few words in Finnish...

- We have the same alphabets plus couple of more: Ää, Öö and Åå
- Thank you = Kiitos
- Welcome = Tervetuloa
- Hello, Hi... = Terve, Hei, Moi...
- Hawai’i = Havaiji
- Ice-cream = Jäätelö
- Beer = Kalja
- Can I have one beer, please = Saisinko yhden kaljan, kiitos
- ? = Epäjärjestelmällisyttömyydettömyyksillämmekäänkö
Beware of the ship. Two popular Finnish sports, icefishing and ferry cruising, meet outside Helsinki. Fish are free and ferries are tax-free.
Typical scenery from Finland.
Pictures

Those who do this swear that it is better than sex.
Those who don't will just have to settle with sex.
Quattro stagione
Pictures from Kuopio
Pictures from Kuopio
Picture from Puijo tower
Pesäpallo (baseball)
Misc.
Thoughts about Hawai’i

- People are friendly and aloha spirited.
- Nature is beautiful and sun is shining all the time.
- Surfing is hard, but snorkeling and hiking are very fun activity. Marko and Arttu also tried paddling, but they didn’t have time to practice and compete.
- We don’t like Hawaiian music.
- Surprisingly food might be even more expensive than in Finland. Milk at least is (compared to Finnish milk price 1 cent per liter).
Pictures from Hawai‘i
Pictures from Hawai‘i
Conan’s thoughts

SWEDEN SUCKS!
¡HOT thoughts!

- Climate, HOT.
- Weather, HOT.
- Outside, HOT.
- Inside, HOT (except in IDLab).
- Beach, HOT.
- Girls, HOT.
- Boiling water, HOT.
- STD that has been running for few days, HOT.
- Coffee, HOT.
- Dog, HOT.
Okay, let's get serious!

- The project was harder than we thought before we came here and at some point it looked that we’ll never get it done. As it finally turned out to be true.
- On the other hand it was really instructive, and we think we did okay. Although we are very disappointed that we couldn’t finish the job.
- At some point we would have needed more help. Couple of times we were stuck for some time, because we didn’t know where to seek for help or solution. But life goes on :-D
- Atmosphere in the lab is great and we even managed to get couple of close friends. Cheers Marlon and Bryan!
- Overall this trip has been great and we have a lot of good memories and stories to tell our friends and families back in Finland.
¿Questions?
MAHALO EVERYONE!

APPLAUSE

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