Laser-Synchronization

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MSK Collaboration Workshop
DESY
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Outline

- Introduction
- Firmware
- Hardware
- Frequency Issues
- Status
Motivation – Lasers at Accelerators

Timing and Synchronization
Laser Synchronization

- PLL-like system
- Reference is optical and/or RF
- Different detection methods for RF vs. Laser Phase

Conventional: Direct Conversion + Mixer

‘New’: Down-Conversion + IQ detection

Future: MZI Setup ("MOPED"?)

Different Readout schemes
Blockdiagram of Signal Processing - Existing FW

DRTM-DWC10
1.3 GHz REF
1.354 GHz RF (laser)
54 MHz IF
54 MHz
81 MHz CLK

SIS8300L
ADC
ADC
PI
Xilinx XC6VLX130T
DAC
PCIe
MGT
DAC
Gen2 CPU
Gen1 CPU

DRTM-PZT4
to laser
Piezo Driver
DAC

DAMC-FMC20.rev2
Xilinx XC6SLX45T
LLL
MGT
SPI
PCIe
II
FMC
FMC
AMC Backplane

Slot N
PI: PI controller
PCIe: Peripheral Component Interconnect express
MGT: Multi-gigabit transceiver
LLL: Low Latency Link
SPI: Serial Peripheral Interface

Slot M

Courtesy of C. Gerth
Future Application Firmware Signal Needs

**To-do:**
- Take newest base FW from Łukasz and combine it with Pawel's Simulink Interface
- Copy Uros' SysGen Model to other channels and provide switching between different inputs
- Debugging of application FW
  - In-loop drifts
  - Error clipping
  - ...
MTCA Setups - Laser Synchronization

New RTM, specially for laser synchronization

New FMC, specially for laser control
- 39 TTL GPIO pins, jumper activation/deactivation
- RS232 interface
- 2x Shutter driver

New FMC for Digital IO to be designed

FMC Multi-Purpose I/O Board.  
DFMC-LASIO

Applications
- Laser and Shutter controls
- Industrial process control
- Manufacturing automation
- Research & development
- Accelerators

Features
- Low-Pin-Count FMC Module (Vita 57.1 compliant)
- Up to 39 general-purpose digital IO pins, Selectable 3.3V or 5V levels
- 40-pin MDR connector with high density and easy ribbon cable connection
- Each pin can have following function: IO, GND or alternate function (selected with 0R resistor)
- Highly Flexible Alternate functions available:
  - 2 pins useable as 8-Bit DAC (0-5V, 50 mA drive)
  - 2 pins useable as 8-Bit ADC
  - 2 pins useable as two independent digitally controlled power supplies (1A, up to 18V)
  - 4 pins useable as standard UART (12V levels)
- Xilinx CPLD can control all IOs and options and can generate real-time patterns
- Adjustable FMC voltage (VadJ): 1.2 to 3.3V
- RoHS compliant

The DFMC-LASIO is a cost-efficient FMC board designed according to ANSI/VITA 57.1. The card can be used in all applications where standard IO channels with 3.3V or 5V levels are required. Additionally, it offers analog functions needed for measurement and control tasks such as two programmable power supplies, two DACs and two ADCs and a true RS232 UART.

All IOs and all functions are routed to a CPLD where special supervision functions can be implemented and where special waveforms can be generated on the analog channels.

One use scenario of the card is the control of a laser system. The IOs are used to communicate with a laser controller. The power source is used to drive a shutter with CPLD-generated pulse shapes. The DAC and ADC are used to drive and monitor the optocouplers in the shutters.

DESY offers the DFMC-LASIO for licensing to industry. DESY can modify this product to meet special customer requirements.
Used/Needed Frequencies

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<td>3000</td>
<td>25</td>
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Aliasing with Phase Shift: $$\phi = 0^\circ$$

- Fundamental of Rep. Rate: 333.1 MHz
- Aliased Frequency: 41.64 MHz
- Sample Points: $$f_{\text{sample}} = 124.91\text{MHz}$$

Phase is fixed: only amplitude readout
Don’t need IQ → Amplitude conversion
At the right phase I or Q are amplitude!
SIS8300L ADC bandwidth

Courtesy of Maciej Grzegrzółka

Need SIS8325L
Board Status

- SIS8300L/SIS8325L
  - Waiting for no-split version (~2 month)
- LASY
  - Under development, for now use DWC (and DS8), how many available?
- FMC20
  - 2x prototype in use, 5x (10x) V2.0 produced
- PZT4
  - 2x prototype in use, 3x (5x) V2.0 produced
- LASIO
  - Under Development
- MD22
  - 10x V2.0 produced, works with FMC20, needs redesign for other carriers
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<th>Tune</th>
<th>Freq</th>
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Synchronization of EOD Laser

[Diagram showing various components and connections related to synchronization of EOD Laser]