Ultimate - Pixels analogue characterization modes
Strasbourg November 2010

OUTLINE

- **Ultimate / Mimosa 26 ?**
- **Pixel characterization → 8 columns**
  - **Test protocol**
  - **Configuration**
  - **Steering & Readout**
- **Pixels characterization → whole matrix scanning**
  - **Test protocol**
  - **Configuration**
  - **Steering & Readout**
- **Characterization modes → Constraints on DAQ (Board + SW)**

Mimosa 26 ?

- **Matrix of 663 552 pixels :** 1152 columns x 576 lines – 21,560 mm x 13,780 mm – 18,4 µm pitch – 115,2 µs integration time
  - Analogue test modes → Pixels analog characterization
    - Acquire 8 columns over 1152 → 8 analogue outputs
    - Scan the whole matrix (1152 columns) by blocs of 8 columns → 144 blocs
    - During each line (200 ns) read on each output 576 lines x 2 samples (read + calib) → 10 MHz analogue stream

Steering

- **Configuration (operating modes, bias etc …) by JTAG slow control**
- **Main clock 80 MHz**
- **Start & Speak commands**
  - By external HW Start signal → Start Mimosa 26
  - By external HW Speak signal → For DAQ boards synchronization

Readout

- 8 columns → 8 Outputs @ 10 MHz – 576 lines x 2 samples = 1152 samples / output
- Scan matrix → 8 Outputs @ 10 MHz – 144 blocs x 576 lines x 2 samples = 165 888 samples / output

Ultimate Vs Mimosa 26 → Ultimate

Ultimate ?

- **Matrix of 890 880 pixels : 960 columns x 928 lines – 19,872 mm x 19,210 mm – 20,7 µm pitch – 185,6 µs integration time**
  - **Analogue test modes → Pixels analog characterization**
    - **Acquire 8 columns over 960 → 8 analogue outputs**
    - **Scan the whole matrix (960 columns) by blocs of 8 columns → 120 blocs**
    - **During each line (200 ns) read on each output 576 lines x 2 samples (read + calib) → 10 MHz analogue stream**

Steering

- **Configuration (operating modes, bias etc …) by JTAG slow control**
- **Main clock 160 MHz**
- **Start & Speak commands**
  - **By external HW Start signal → Start Ultimate**
  - **By external HW Speak signal → For DAQ boards synchronization**

Readout

- **8 columns → 8 Outputs @ 10 MHz – 928 lines x 2 samples = 1856 samples / output**
- **Scan matrix → 8 Outputs @ 10 MHz – 120 blocs x 928 lines x 2 samples = 222 720 samples / output**

Ultimate Vs Mimosa 26 → Differences

Slow control

- Tests modes controlled in the same way
  - Slow control SW will have the same configuration options
  - Conclusion → We can use Mimosa 26 slow control screen shots to show how to configure Ultimate

Steering & Readout

- The protocol principle is the same but → Differences on columns position & data stream size
  - 8 columns mode
    - Mimosa 26 or 22 – 8 rightmost columns / Ultimate 8 columns in the middle
    - Mimosa 26 – 1152 samples per output / Ultimate 1856 samples per output
  - Matrix scanning mode
    - Mimosa 26 – 165 888 samples per output / Ultimate – 222 720 samples per output
  - Conclusion → We can use Mimosa 26 or 22 signals scop screen shots to show how to control & read Ultimate

Steering & Readout : Signals ?

Steering and Readout protocol : Start and Speak phases

Start and Speak Phases

- Start signal used to synchronize all Ultimates
- Start signal => Starts all clock generation
- Clock (Analog & Digital) starts after Speak pulse
- Speak signal (after Start pulse) => Starts all Sync generation
- Sync (Analog & Digital) occurs at least one frame after Speak

Speak Phase

- Accumulation of N Sync signals after Speak rising edge
- No Sync signal during the frame where Speak occurs

Why Speak signal ?

- DAQ development easier (Multiple boards synchronization)
  - Our DAQ can't store consecutives events without dead time
- Can be let at 1 if / while DAQ has no dead time (double buffer)

Pixels test 8 columns mode : Configuration

- Ultimate test mode is selected via JTAG SW
- There are a lot of parameters …
  - Trivial ones like "Pixel scan " Disable (8 columns) / Enable (scan whole matrix)
  - Non trivial ones like Ultimate outputs configuration …
- But we provide configuration files
  - All parameters are well configured for the test
  - You specify the file, load it and write parameters to Ultimate

- How to check analog signal sampling ?
  - Calib and read signals can be emulated if " Discri mode " = Test
  - Can help to setup DAQ before data taking
    - Calib = VTest 2
    - Read = VTest 2 + VTest 1

Pixels test 8 columns mode : Steering & Readout 1/2

- Specific output pads not the same as for normal readout
  - CLK_A, SYNC_A, Analog Out 0, Out 1 ... Out 7
- Start pulse → Start Ultimate (do one time at beginning)
- Speak pulse → Start SYNC_A (do before each event)
- CLK_A = CLK source / 16 = 10 MHz - Sync on first
- SYNC_A on last line (Mimosa 26 = 575 / Ultimate = 927)
- Data provided on CLK_A rising edge
- Read 8 columns in // over 8 outputs
  - 2 samples (read + calib) per line
  - Mimosa 26 = 1152 samples / Ultimate = 1856 samples
  - Line readout = 200 ns → 10 MHz data stream (Mimosa 26 & Ultimate)
  - Readout time per event = Chip frame time
    - Mimosa 26 → 576 lines x 200 ns = 115,2 µs
    - Ultimate → 928 lines x 200 ns = 185,6 µs

Pixels test 8 columns mode : Steering & Readout 2/2

Analog synchronization (578 lines)

- SYNC_A signal : occurs on last line : 577 – One line length
- MK_TEST_A occurs on line 576 (Configured by JTAG)
- Analog clock : Read and Calib phases
- Analog signal
  - Pixels level on line 0-575
  - On markers lines (576-577) : Read = IVTest2 + IVTest1 - Calib = IVTest2

Control

Row Marker A	576	576
Row Marker D	576	576
Matrix Row Num -1	577	577

IVTST1	255
IVTST2	0

Markers lines finding by moving IVTest2

- On top scop plot IVTest2 = 0 udac
- Now IVTest2 = 255 udac => Analog level changes on lines 576-577

IVTST1	255
IVTST2	255

Pixels test matrix scan mode : Configuration

- **Ultimate test mode is selected via JTAG SW**
- **There are a lot of parameters …**
  - **Trivial ones like "Pixel scan " Disable (8 columns) / Enable (scan whole matrix)**
  - **Non trivial ones like Ultimate outputs configuration …**
- **But we provide configuration files**
  - **All parameters are well configured for the test**
  - **You specify the file, load it and write parameters to Ultimate**

- **How to check analog signal sampling ?**
  - **Calib and read signals can be emulated if " Discri mode " = Test**
  - **Can help to setup DAQ before data taking**
    - **Calib = VTest 2**
    - **Read = VTest 2 + VTest 1**

Pixels test matrix scan mode : Steering & Readout 1/2

- **Specific output pads not the same as for normal readout**
  - **CLK_A, SYNC_A, Analog Out 0, Out 1 ... Out 7**
- **Start pulse → Start Ultimate (do one time at beginning)**
- **Speak pulse → Start SYNC_A (do before each event)**
  - **→ One event = a scan of whole matrix by blocs of 8 columns**
- **CLK_A = CLK source / 16 = 10 MHz**
- **SYNC_A on last line (Mimosa 26 = 575 / Ultimate = 927)**
- **Data provided on CLK_A rising edge**
- **Read 8 columns in // over 8 outputs x N blocs**
  - **2 samples (read + calib) per line**
  - **Mimosa 26 = 165 888 samples / Ultimate = 222 720 samples**
  - **Line readout = 200 ns → 10 MHz data stream (Mimosa 26 & Ultimate)**
  - **Readout time per event = Chip frame time x N blocs**
    - **Mimosa 26 → 576 lines x 200 ns x 144 = ~ 16,6 ms**
    - **Ultimate → 928 lines x 200 ns x 120 = ~ 22,3 ms**

Pixels test matrix scan mode : Steering & Readout 2/2

Readout chronogram
➔ To be done !

Characterization modes → Constraints on DAQ

Mode 8 fixed columns

- Acquire 8 links @ 10 MHz – 12 bits ADC (ENOB 11 bits)
- Store 1856 samples / link – Acquisition time ~ 185,6 µs
- Ultimate provides successive events without dead time
  - But DAQ doesn't need to acquire events without dead time
  - Can use Speak signal to acquire " event by event "

Mode matrix scanning

- Acquire 8 links @ 10 MHz – 12 bits ADC (ENOB 11 bits)
- Store 222 720 samples / link – Acquisition time ~ 22,3 ms
- Ultimate provides successive events without dead time
  - But DAQ doesn't need to acquire events without dead time
  - Can use Speak signal to acquire " event by event "