New Results on
VDC-D2 and DORIC-D2

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Outline

- Introduction
- Results on VDC-D2
- Results on DORIC-D2
- Plans
Introduction

- VCSEL Driver Chip (VDC):
  - convert LVDS signal into single-ended signal appropriate to drive VCSEL
- Digital Opto-Receiver Integrated Circuit (DORIC):
  - decode clock and command signals from PIN diode
Opto-electronics Team

- Ohio State University:

- Siegen University:
  - Michael Kraemer, Joachim Hausmann, Martin Holder, Michal Ziolkowski
Bright/Dim Currents of VDC-D2

- two dice have dim currents < 1 mA
Duty Cycle vs VCSEL Current

- deviate significantly from 50% duty cycle for low VCSEL current
Duty Cycle vs I_set Current

- deviate significantly from 50% duty cycle for low I_set current
- can reduce deviation significantly with tune-pad connected
Improvement in VDC-I

- ideal design: dim current depends on tune-pad but not $I_{\text{set}}$
- VDC-D2: dim current depends on $I_{\text{set}}$ due to imperfect matching of currents in two transistors
  - submit two versions of VDC-I:
    - DMILL version and a version with bright current controlled by $I_{\text{set}}$ added to dim current controlled by tune-pad
VCSEL Current vs Tune-pad Current

- amplitude of VCSEL current remains constant as tune-pad current is increased from 0 to 1 mA
VCSEL Current vs I_set

- dim current remains constant as I_set is increased from 0 to 2 mA
DORIC-D2 with LVDS Reset at VDD (Default)

Decoded clock

Decoded data

Input data
DORIC-D2 with LVDS Reset Grounded

- Decoded clock
- Decoded data
- Input data
BER/Crosstalk Measurement with DORIC and VDC

- SCALER
- Xilinx XC4005SE
- 40 MHz Asynchronous
- CMOS $\rightarrow$ LVDS
- CMOS $\rightarrow$ LVDS
- LVDS $\rightarrow$ CMOS
- DORIC
- VDC
- VDC
- VDC $\rightarrow$ VCSEL
- VCSEL
- PIN
- CLOCK
- fiber optic link
- Opto-package

Data

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ATLAS Pixel Week
DORIC-D2 has significantly more cross talk than DORIC-4A
placing DORIC-D2 in close proximity to PIN yields similar BER
Investigation of Cross-talk

- observe spikes at edge-detector and pre-amp spy points
- pulsing test spy circuit induces a signal at LVDS outputs
- floating and grounding guard-ring has no effect on pre-amp
- back side silicon is highly resistive: ~ 1 MΩ
  - reduce to ~ 100 KΩ when scratched
- currently investigating possibility of grinding and metalizing back side of bare dice
Pre-amp Offset

- 600 mV different at pre-amp +/- spy point outputs
- pre-amp has low gain for small signal and output distorted
- pre-amp offset estimates to be a few mV
- has designed a dc feedback circuit for DORIC-I
  - simulation shows that it will fix offset problem
  - need to include stray capacitance of traces in simulation to verify that circuit will not oscillate
Pre-amp with Feedback
Pre-amp with Feedback
Simulation of DORIC-D2 Pre-amp

- no output signal for small input signal if there is an offset
Simulation of DORIC-I Pre-amp

- produce output signal similar to an pre-amp with no offset

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- current consumption consistent with expectations
- 7-channel opto-board:
  - ✤ 1.0 W @ 10 mA VCSEL current
  - ✤ 1.4 W @ 20 mA VCSEL current
Plans

- VDC-D2 and DORIC-D2 work but with some deficiencies
  - VDC-D2: some have low dim currents
  - DORIC-D2:
    - some pre-amps have small offset
    - cross-talks inside die
- will emphasize irradiation of DORIC-D2 in April
  - a new rad-hard bias circuit without requiring a reset is needed for any DMILL submission