Integrated Transmitter for 100 Gb/s OOK Connectivity Based on Polymer Photonics and InP-DHBT Electronics


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Presentation Outline

• Intro – Why serial 100Gb/s connectivity

• Technical solutions and our approach

• Transmitter device and experiment at 80-100 Gb/s

• Next step

• Conclusions
Why serial 100G connectivity?

Despite current achievements on 100 GbE interconnection, efforts on higher bandwidth transceivers are ongoing

- A robust solution for 100 Gb/s NRZ-OOK connectivity has the potential to revolutionize datacom applications
  - Robustness
  - Simplicity
  - Energy efficiency
  - Number of components
  - Footprint
  - Cost

- High-speed modulators and the underlying technology for high-speed electronics may:

Define a new base for operating baud-rates

Parallelism
- High-order formats
- Coherence technology

400G and 1T systems
State of the art on 100G optical modulators

Two technologies with proven 100G potential

✓ InP travelling wave EAM (InP-TWEAM)
  • Amplitude modulation only

✓ Mach-Zehnder modulator based on electro-optic polymers operating at 100 Gb/s

M. Chacinski et al, JLT 27, 16, 2009

S. R. Nuccio et al, OFC 2011, JThA30

Single device demonstrations rather than complete transmitter solutions
High speed electronics so far...

InP-DHBT technology has a proven potential for:

- High speed operation
- High breakdown voltage

2:1 MUX and RF-drivers based on InP-DHBT technology and operating at 100 Gb/s have already been demonstrated

However: they have never been integrated with the optical part of 100G transmitter in order to improve performance and reduce cost
Optical sub-assembly

- Mach-Zehnder modulator on EO polymer platform
  - Single mode waveguides
  - $V_{pi} = 3.5 \text{ V}$
  - High EO coefficient of the core material when poled (65 pm/V)

- Hybrid integration of an InP DFB laser at 1550 nm
  - 2 dB loss at the polymer/InP interface
  - $90^\circ$ rotation of the TE laser due to the properties of the MZM
Developing an integrated 100G transmitter

Development of a MUX-DRV circuit using 0.7 μm InP-DHBT technology

- Integration of MUX and RF-driving functionalities in a single circuit
- It receives two 50 Gb/s data signals and a 50 GHz input clock
- 2x2V differential output
- Power consumption equal to 2W
Assembly and packaging

- Alumina stiplines (50 Ohm impedance) at the MUX-DRV input
- Short (<150 µm) wire-bonds at the MUX-DRV output
- Lensed fiber at the optical output (1.5 dB coupling loss)
- 8.5 dB total optical loss
- 0.8 dBm output power at the transmission peak of the MZM
Experimental setup

- Generation of $2^{31}-1$ PRBS data signals at **80 to 100 GB/s**
- 1:2 DEMUX using EAM and 1:4 electrical DEMUX to acquire 8x10Gb/s channels
- BER measurements on all 8x10Gb/s channels
Experimental results

Eye-diagram-based evaluation

80 Gb/s

ER = 14.1 dB

90 Gb/s

ER = 13.6 dB

100 Gb/s

ER = 13.5 dB

Timing-jitter (rms) at all data rates <1 ps
• 80 Gb/s stream was 1:2 demultiplexed using EAM
• Further demultiplexing to 10 Gb/s using electrical DEMUX

✓ Lower power penalty at 80G as well as error-free operation at 100G is expected with shorter optical switching windows
Summary

• Presentation of the first integrated transmitter for NRZ-OOK operation directly at 100 Gb/s.

• The transmitter relies on a EO polymer Mach-Zehnder modulator and the hybrid integration of:
  
  1550 nm DFB laser
  InP-DHBT MUX-DRV electronic circuit.

• Evaluation through eye-diagrams and BER measurements in 80-100 Gb/s reveal high-quality performance.

• Next steps include:

  The use of new MUX-DRV designs
  Complex monolithic and hybrid integration on the EO platform for modules of higher functionality
Thank you for your attention!

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