

Security Level:

Flexible-Rate 50G-PON Supporting 50, 37.5 and 25 Gb/s Data Rates

Huaiyu Zeng, Andy Shen, Xiang Liu and Frank Effenberger
Futurewei Technologies, Huawei R&D USA

www.huawei.com

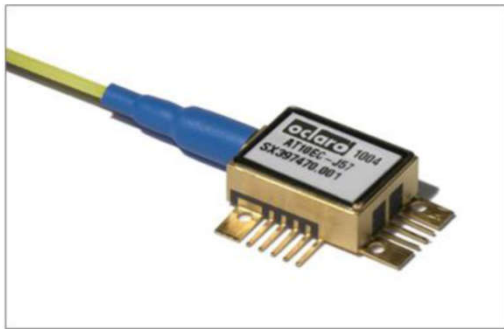
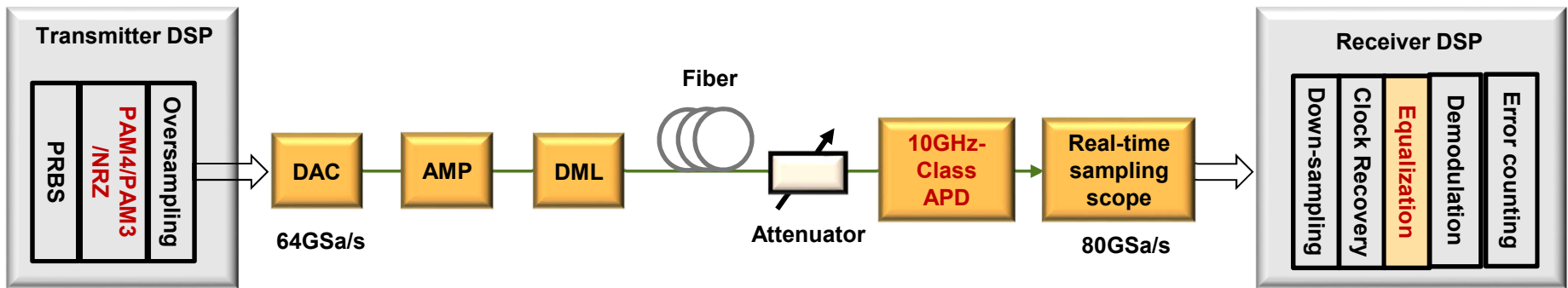
HUAWEI TECHNOLOGIES CO., LTD.



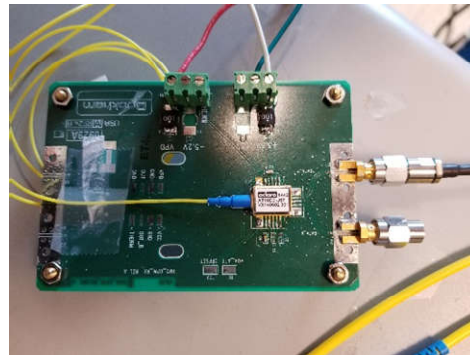
Background

- In the Berlin meeting, the task force called for contributions on 50G PON solutions analysis.
- This contribution shows that with the use of DSP, high-performance 50Gb/s downstream transmission can be supported by using commercially available 10GHz-class APD with PAM4 modulation.
- Better link budgets can be further supported by using PAM3 and NRZ modulations, respectively achieving 37Gb/s and 25Gb/s.

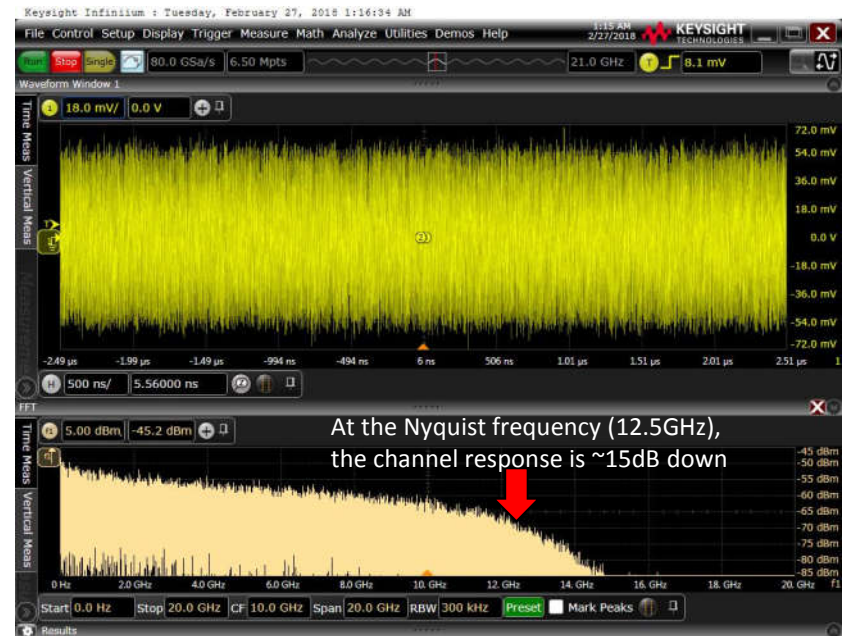
Experimental Setup for DSP-Assisted Transmission with 10GHz-Class APD



The AT10EC receiver consists of an APD photodiode, a low-noise AGC preamplifier and a precision NTC thermistor in a hermetic coplanar package with a connectorised single-mode fibre pigtail. The wide linear operating region permits the use of electronic dispersion compensation (EDC) and other impairment mitigation schemes. Differential outputs are provided for improved power supply noise rejection. It has been optimized for use in 10Gb/s metro or long-haul applications, either as a discrete device or within a transponder, using NRZ modulation with or without FEC, at data rates up to 11.3Gb/s.

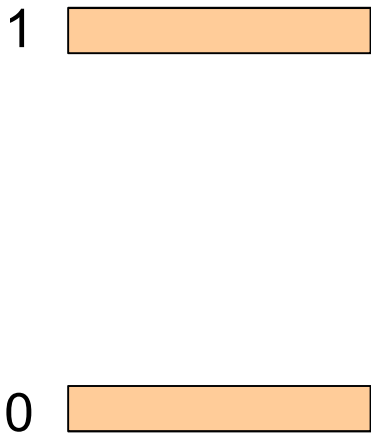


<http://www.oclaro.com/wp-content/uploads/2014/08/AT10EC-Datasheet-D00211-PB-02.pdf>



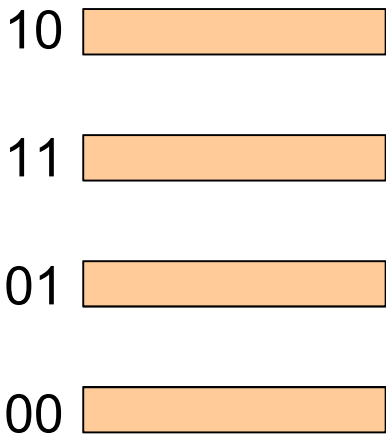
25Gbaud PAM4, PAM3 and NRZ Modulation

25Gbaud NRZ:
25 Gb/s



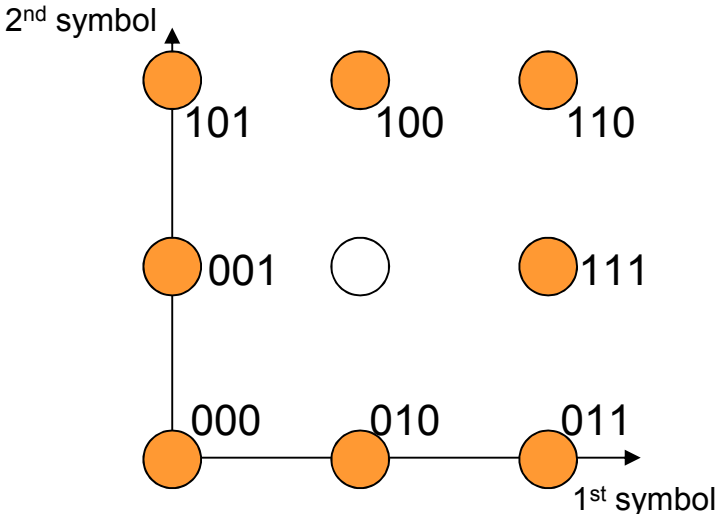
1 bit per symbol

25Gbaud PAM4:
50 Gb/s



2 bits per symbol;
Gray-coded

25Gbaud PAM3:
37.5 Gb/s



3 bits to 2 symbols,
1.5 bits per symbol;
Gray-coded*

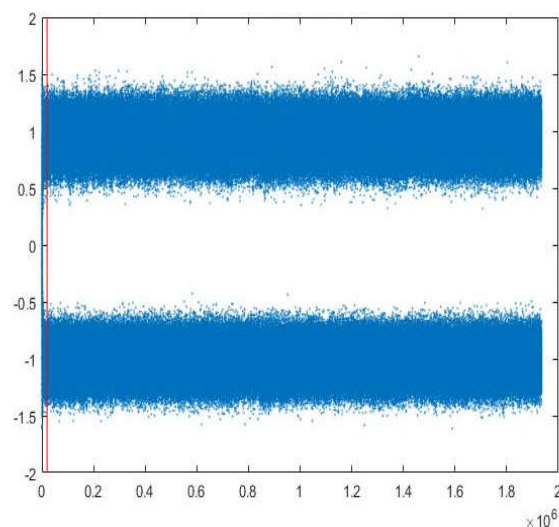
*: For example, see “A Baseline Proposal for 1000BASE-T1 Mapping and FEC” (by BZ Shen of Broadcom), IEEE 802.3bp Task Force’s meeting in July, 2014 http://www.ieee802.org/3/bp/public/jul14/shen_3bp_01_0714.pdf

25Gbaud PAM4, PAM3 and NRZ

-Experimentally recovered symbols at -20dBm received optical power (ROP)

25Gbaud NRZ:

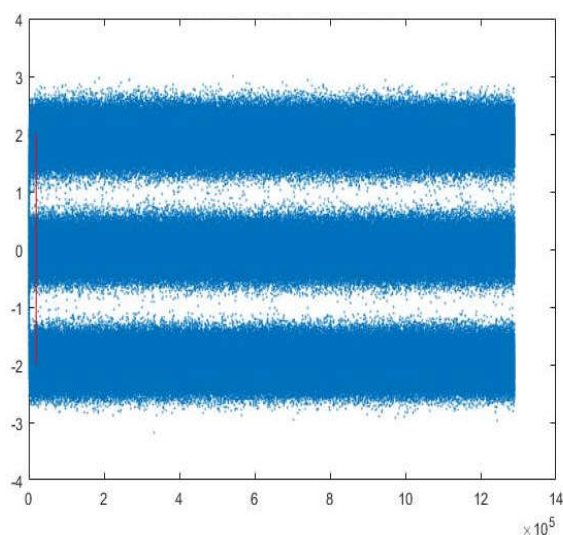
25 Gb/s



BER=0

25Gbaud PAM3:

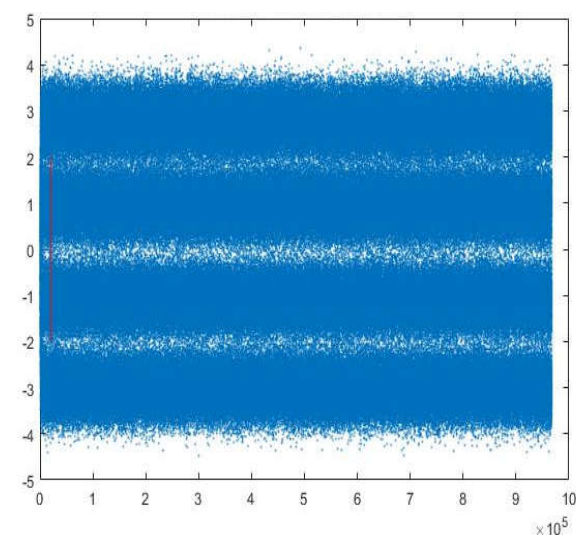
37.5 Gb/s



BER~3E-5

25Gbaud PAM4:

50 Gb/s

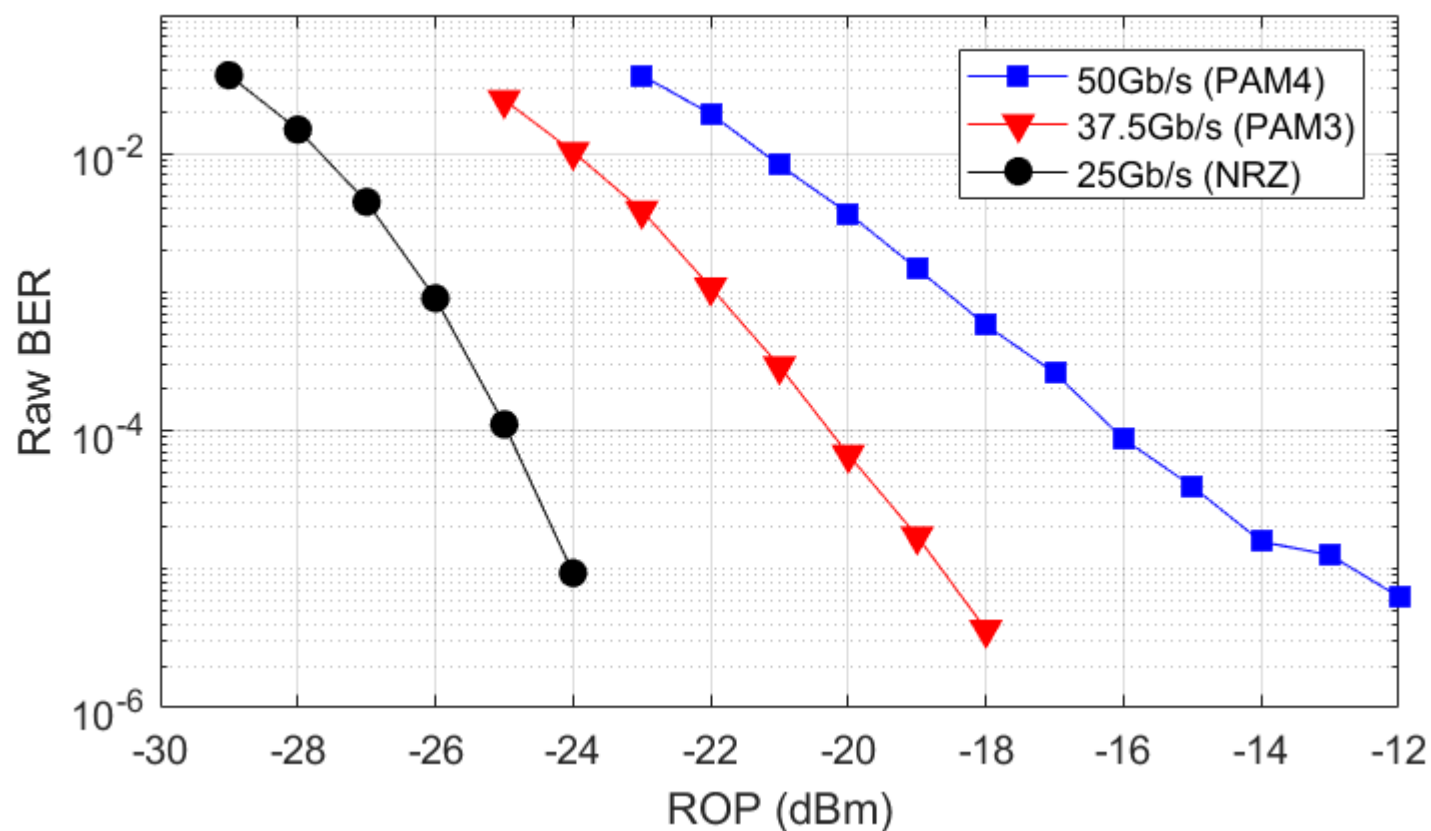


BER~3E-3

With the same hardware and modulation baud, different modulation formats may be used for different link budget requirements.

25Gbaud PAM4, PAM3 and NRZ

-Experimentally recovered symbols at -21dBm received optical power (ROP)



At the LDPC FEC threshold of $1E-2$ (laubach_3ca_1a_1117), the measured receiver sensitivities are -27.6, -24 and -21.2 dBm, for 25Gb/s NRZ, 37.5Gb/s PAM3 and 50Gb/s PAM4, respectively.

Flexible-rate PON power budget analysis

Modulation Format	Receiver solution	Transmitter power	Receiver sensitivity, @BER 1E-2	Power budget*	Margin for 29-dB link budget*
50 Gb/s PAM4	10GHz-class APD with DSP	+8 dBm	-21.2 dBm	29.2 dB	0.2 dB
37.5 Gb/s PAM3	10GHz-class APD with DSP	+8 dBm	-24 dBm	32 dB	3dB
25 Gb/s NRZ	10GHz-class APD with DSP	+8 dBm	-27.6 dBm	35.6 dB	6.6 dB

*: Fiber chromatic dispersion induced transmission penalty depends on the downstream wavelength (to be selected) and the transmitter chirp, and will be evaluated after the downstream wavelength is decided.

Summary

- With the use of digital signal processing (DSP) at the receiver, commercially available 10GHz-class APD can be used to support 50Gb/s downstream transmission with 29.2 dB link budget, assuming the use of the recently accepted LDPC design (laubach_3ca_1a_1117).
- The use of DSP allows one to flexibly change the modulation format to PAM3 and NRZ, respectively achieving 32 dB and 35.6 dB link budgets at 37.5 Gb/s and 25 Gb/s.
- Fiber chromatic dispersion induced penalty will be further studied when the downstream wavelength is decided by our group.
- The combined use of DSP and flexible-rate modulation allows us to meet different link budget requirements in a software-defined way and thus extend the application space of single-wavelength 50Gb/s PON.

Thank you

www.huawei.com

