

sensitivity, is 21.2 dB for a single ONU in case of employing Reed-Solomon RS(255, 223) forward error correction (FEC). This fits to a TDM-PON with 1:32 split and 25 km reach, as there is still a small power margin of 0.3 dB. Table 1 summarizes the characteristic power levels and loss budget values.

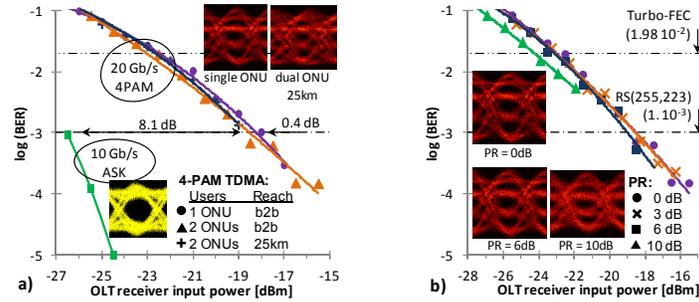


Fig. 5. (a) Comparison between 10 Gb/s NRZ and 20 Gb/s 4-PAM transmission, and (b) BER for 4-PAM at different packet power ratios between loud and soft packets.

The BER for the weak packets in case of different PRs between loud and soft ONU is presented in Fig. 5(b). There is no penalty for a PR up to 6 dB compared with equal-power packets. In case of 10 dB power difference there was a limitation in the power budget; however, the BER did not worsen. Higher loud-soft ratios were not evaluated to avoid overloading the BM-TIA (specified at -5dBm) during the loud bursts. In case that a stronger turbo-FEC is used [10], a loss budget of 27.3 dB is compatible and fits to a scenario with extended 1:64 split in the tree once the high 6.4 dB power margin is eroded for the purpose of split extension. This confirms that 4-PAM is a good candidate for high bit-rate TDM PONs with high dynamic range and high user share.

Table 1. Compatible optical budgets and power margins for a 1:32 split, 25 km reach TDM-PON.

Scenario	10 Gb/s	20 Gb/s			
	NRZ	4-PAM			
ONUs:	single	single	dual	dual	dual
PR [dB]	-	-	0	6	10
P_{Launch} [dBm]	3	3			
$P_{\text{Sens,RX}}$ [dBm]	-26.6	-18.2	-18.5	-19	-24.3*
$LB_{\text{Compatible}}$ [dB]	29.6	21.2	21.5	22	27.3*
LB_{PON} [dB]	20.9				
Power Margin [dB]	8.7	0.3	0.6	1.1	6.4*

*Values are listed for the case of employing turbo-FEC at the OLT receiver.

4. Conclusions

A 20 Gb/s quaternary TDM-PAM access network has been demonstrated as upgrade path for legacy PONs. A loss budget of 27.3 dB can be supported in combination with a high loud-soft power ratio of 10 dB. Chirped, non-linear transmitters and 10 Gb/s burst mode receivers are compatible.

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