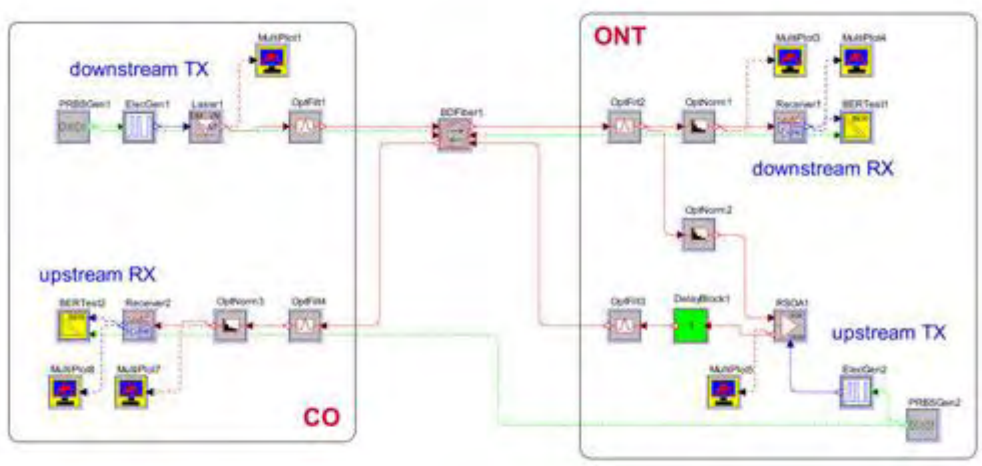
Bidirectional Modeling of RSOA-based PONs

Tool Used: OptSim

This example shows RSOA-based bidirectional PON modeling in OptSim. Within the global fiber-optic infrastructure, passive optical networks (PONs) play an important role in fiber-to-the-home (FTTH) and fiber-to-the-premises (FTTP) solutions. In a typical PON, a central office (CO) distributes data over passive optical fiber to various optical network terminations (ONTs), which in turn send data back upstream to the CO. Researchers have proposed a number of low-cost solutions for the ONT upstream transmitters, including the use of reflective SOAs (RSOAs) to remodulate the downstream signal in order to produce the new upstream signal. With its new comprehensive model for SOAs, OptSim - RSoft's industry-leading fiber-optic systems simulator - is ideal for modeling these types of PONs.

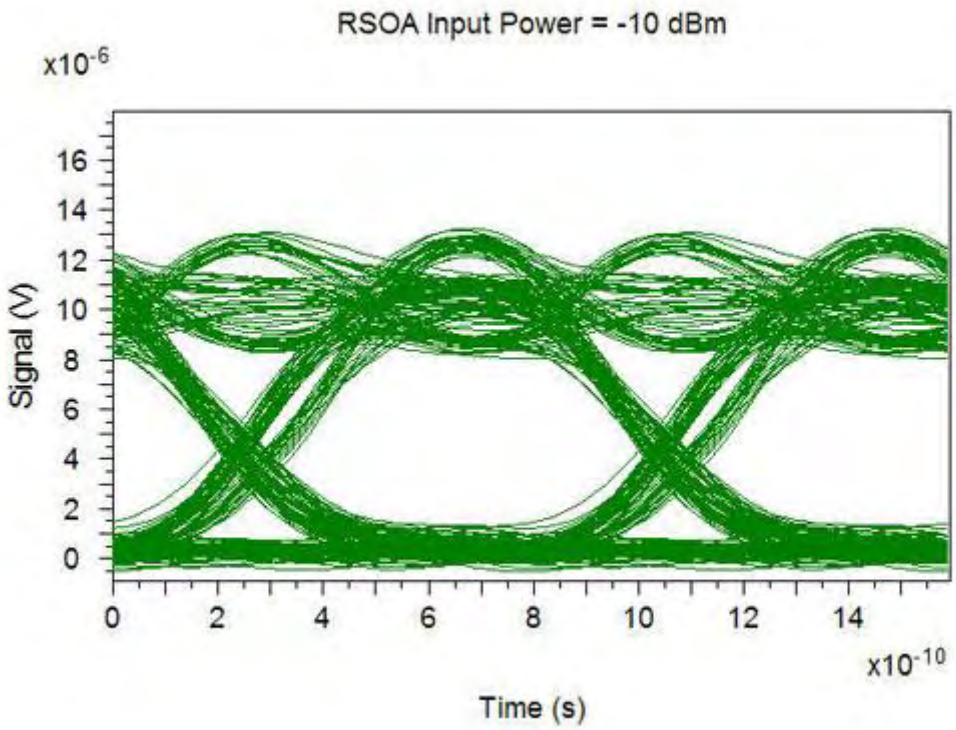
The figure below illustrates an OptSim schematic for simulating the simultaneous upstream and downstream transmission of a single optical channel over a PON:

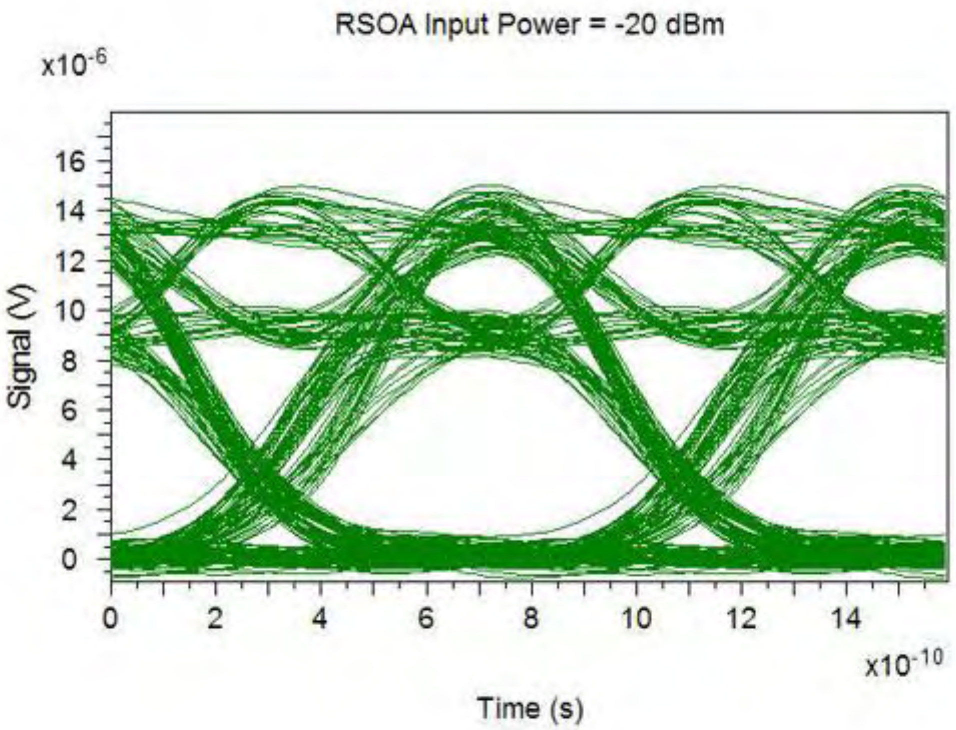


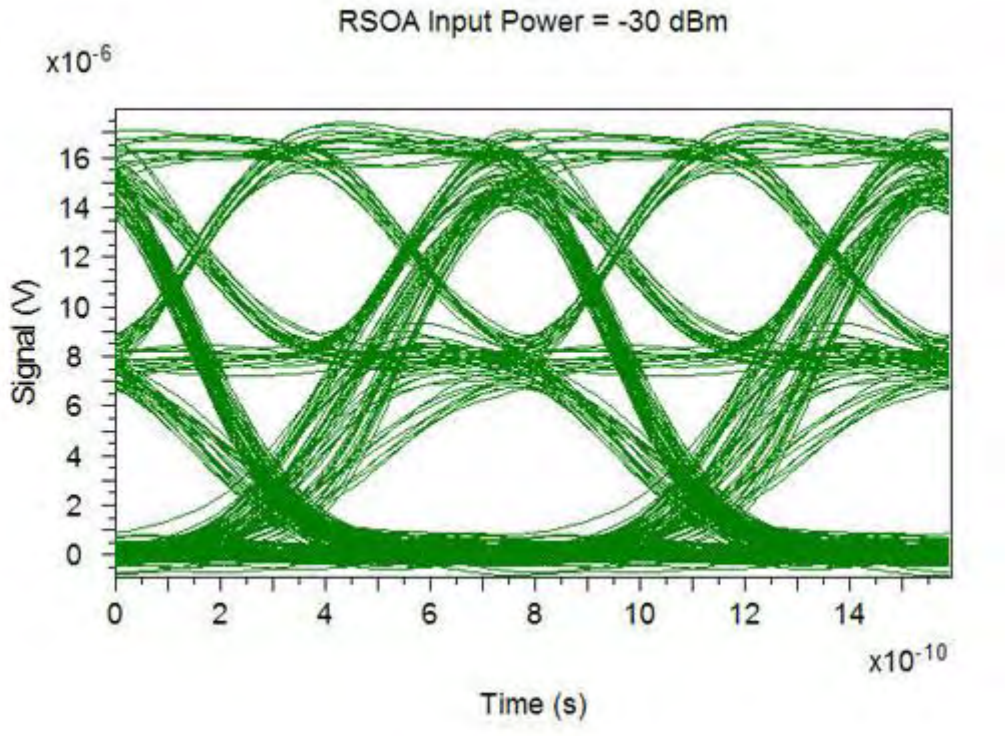
This design is a simplified representation of a PON with a CO and ONT connected via 20 km of optical fiber. Optical filters model the filtering effects of AWGs in an actual PON network. In the CO, a downstream transmitter generates a 1550-nm 2.5-Gbps NRZ signal. The ONT routes the downstream signal to both a receiver and an RSOA-based upstream transmitter. A 1.25-Gbps NRZ signal modulates the RSOA, effectively overwriting the downstream signal. The transmitter then sends this new upstream signal back over the same 20 km of fiber, after which the CO routes it to a receiver. OptSim simulates the entire bidirectional design in two passes, first taking into account the downstream transmission in the fiber, and then simultaneously accounting for both the upstream and downstream signals.

The effectiveness of this design depends on the ability of the RSOA to remodulate the received downstream signal with the new upstream signal. Towards this end, the high-pass filtering effect of the RSOA, which becomes more pronounced at higher input powers, helps to suppress the downstream signal. As the power of the optical signal at the RSOA input is increased, the RSOA does a better job of eliminating any modulation on this input and superimposing the modulation of the RSOA control current.

Figures below depict the eye diagram of the received signal in the upstream RX for each of the three RSOA input powers under consideration:


RSOA Input Power = -10 dBm
x10-6
Signal (V)
16
14
12
10
8
6
4
2
0
0
2
4
6
8
10
12
14
x10-10
Time (s)


RSOA Input Power = -20 dBm
x10-6
Signal (V)
16
14
12
10
8
6
4
2
0
0
2
4
6
8
10
12
14
x10-10
Time (s)



As can be seen, as the RSOA input power increases and the device becomes saturated, the downstream signal is increasingly suppressed, which corresponds directly to the improved BER values.

The extinction ratio of the downstream signal also plays an important role in determining the effectiveness of the RSOA remodulation. The greater this extinction ratio, the harder it is for the RSOA to overwrite the downstream signal.