O-Band Fiber Amplifier

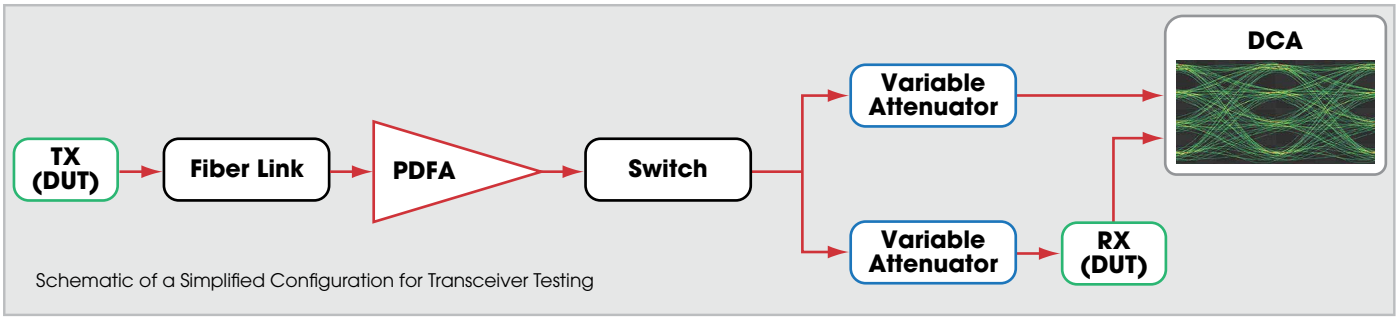
THORLABS
APPLICATION NOTE

OVERVIEW

Thorlabs' Praseodymium-Doped Fiber Amplifier (Item # PDFA100; PDFA) operates across the CWDM channels in the O-band. Based on Thorlabs' proprietary fluoride fiber technology, the PDFA is a compact and reliable solution as a pre-amplifier or booster amplifier in a data communication system. The PDFA offers the same fundamental advantages as erbium-doped fiber amplifiers in telecommunications, enabling distortion-free amplification of optical signals independent of modulation format, data rate, or power level. It is available in two packages: a benchtop platform geared towards laboratory settings, and a compact module for integration into test and measurement environments. Please contact lasersales@thorlabs.com regarding OEM packaging requirements.

PERFORMANCE

The PDFA offers high gain (>25 dB) combined with a low noise figure (<7 dB), making it ideal for amplifying small signal levels as low as -30 dBm. These features enable direct amplification of optical signals without the need for optical-to-electrical conversion. Testing interfaces such as LR4/LR8, 100GE, 200GE, and 400GE can be significantly improved by boosting the signal above the electrical noise floor of digital communication analyzers (DCA). A simplified configuration for transceiver testing is shown below, wherein the PDFA compensates for the losses in the optical system before the signal is analyzed, for standard measurements, such as a Transmitter and Dispersion Eye Closure Penalty Quaternary (TDECQ) in a PAM4 system.

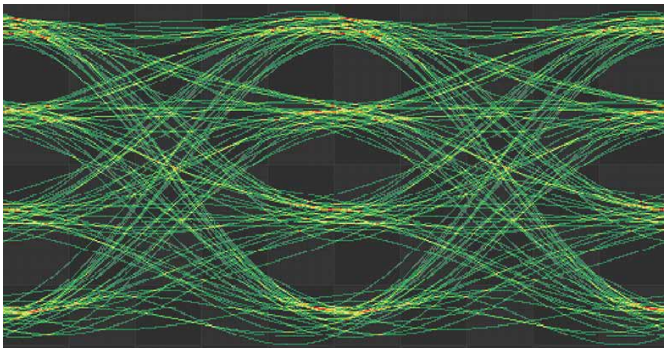


Schematic of a Simplified Configuration for Transceiver Testing

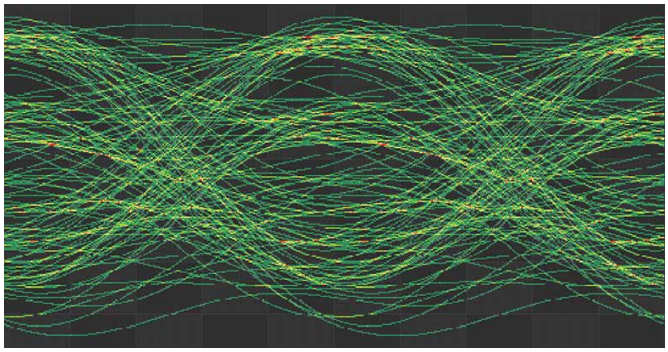
COMPARISON WITH SOA

Another key advantage of the PDFA is its high saturation power of >16 dBm, compared to around 10 dBm for a typical semiconductor optical amplifier (SOA). Combined with the PDFA's slow, millisecond-timescale gain dynamics, this high saturation power eliminates signal distortion effects due to saturation. The faster gain dynamics in the SOA, which occur on picosecond timescales, result in data pattern dependence, which severely distorts optical data signals when the amplifier is driven into saturation. For this reason, the input power into the SOA must be attenuated to avoid the saturation effect. In contrast, the PDFA is immune to the pattern dependence even when the amplifier is driven into saturation. This eliminates the need to control the input power to the PDFA and enables the use of the device as a booster amplifier. In transceiver test and measurement applications, the PDFA enables overload testing of multiple optical receivers or multiple channels in parallel.

The example images below further demonstrate the distinction between PDFA and SOA performance. The two eye diagrams shown below are measured by amplifying a 50 GBaud/s PAM4 signal with a 27-1 pseudo-random bit sequence (PRBS) using either Thorlabs' PDFA100 amplifier or a commercially available SOA. The output power from both amplifiers is set to 10 dBm, and the output signal from each amplifier is attenuated and sent into a high-speed receiver. A comparison of the two diagrams illustrates that the PDFA produces an open eye diagram with minimal distortion, whereas the SOA saturation dynamics cause significant distortion to the corresponding eye diagram. These eye diagrams were measured using Thorlabs' MX65E-1310 65 GHz Linear Reference Transmitter and RXM40AF Ultrafast Receiver.



50 Gbaud/s Eye Diagram for Thorlabs' PDFA100 Fiber Amplifier



50 Gbaud/s Eye Diagram for Commercially Available SOA