

## O-band Optical Amplifiers (PDFA)



### Applications of O-band Optical Amplifiers (PDFA) for 100GBASE-LR4

The 100GBASE-LR4 standard is defined by IEEE as an Ethernet interface for transmitting 100 Gigabit Ethernet (100GbE) frames over 10 km of conventional SMF, and it has been one of the fastest-growing Ethernet interfaces in the 2010s. 100GBASE-LR4 uses four wavelengths in the **O-band** (1260-1360 nm), referred to as either DWDM or LAN-WDM wavelengths, and each of the four wavelength lanes carries 25 Gbps signal to support 100 Gbps (25 Gbps x 4) data rate.

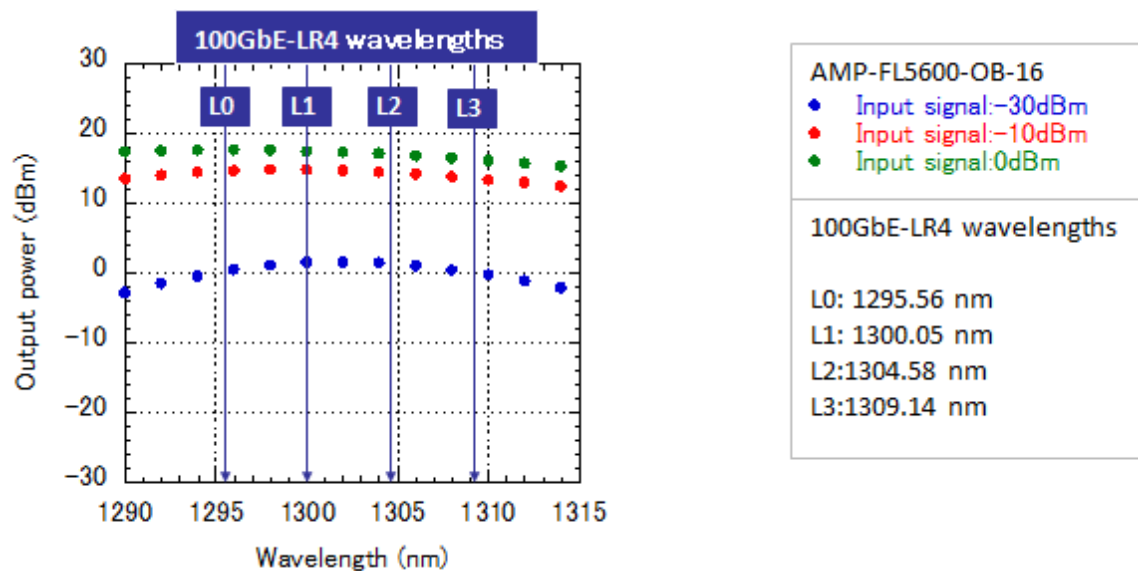
Praseodymium-Doped Fiber Amplifier (PDFA) is known to have its gain in the O-band, and the gain peak matches the 100GBASE-LR4 wavelengths. FiberLabs is the only manufacturer of O-band PDFA, and our PDFA features:

- High output power (up to +20 dBm)
- Large signal gain (> 25 dB available)
- Low noise figure (< 7 dB)
- Low signal distortion (no pattern effects, no cross-gain modulation, negligible polarization-dependent gain)
- Encoding format independent (<100G/100G/200G/400G, NRZ/RZ/PAM4)

These superior optical characteristics are unrivaled by alternative schemes (e.g. Semiconductor Optical Amplifier (SOA) and Raman amplifier), providing a solid and versatile platform for amplifying 100GBASE-LR4 signal. Typical applications of FiberLabs' PDFA for 100GBASE-LR4 are:

- Transceiver test and measurement (CFP, QSFP, etc.)
- Splitting/branching loss compensation inside data centers
- Increasing link budget (reach extension) for inter data center networking

The following is an example, in which FiberLabs' AMP-FL56xx-OB series PDFA is used to increase the link budget of 100GBASE-LR4.



100GbE-LR4 wavelengths and amplification characteristic of O-band optical amplifier AMP-FL5600-OB-16

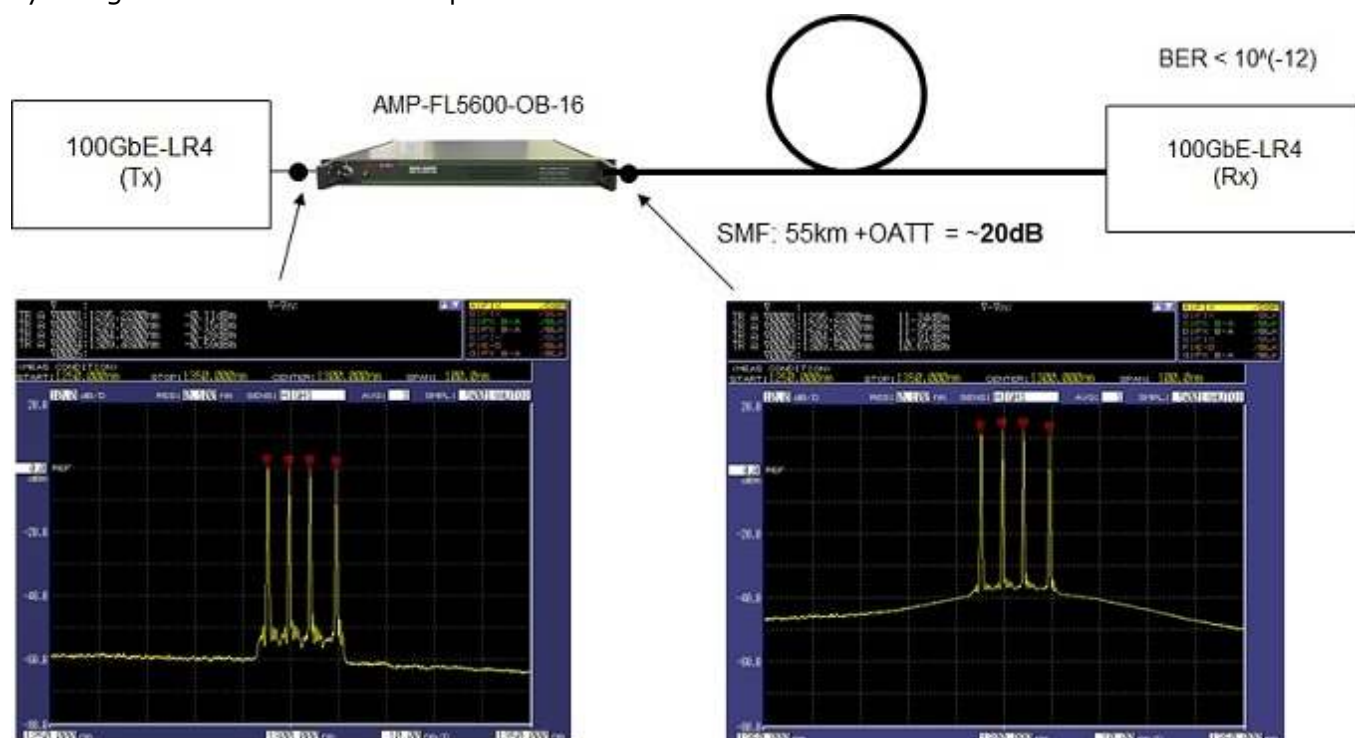
Applicable amplifiers

1U type O-band optical amplifiers  
Module type O-band optical amplifiers  
Bench-top type O-band optical amplifiers

## Examples of amplification

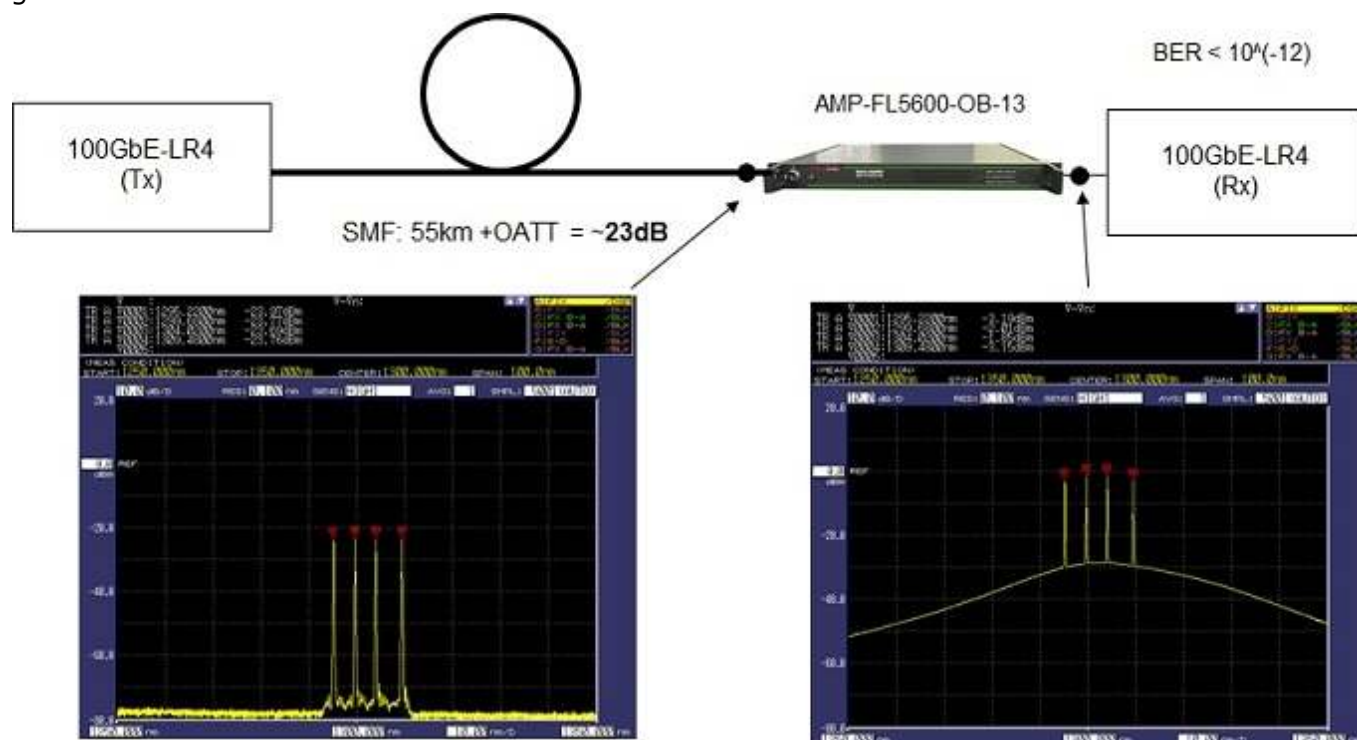
### 20 dB link budget using as a booster amplifier

First, AMP-FL5600-OB-16 is used as a booster amplifier. The four wavelength signals from a 100GBASE-LR4 CFP were directly connected to the amplifier and are amplified by greater than 10 dB per lane. Gain variation between lanes is less than 1 dB. A link budget of 20dB was confirmed by using 55 km of SMF and an optical attenuator.



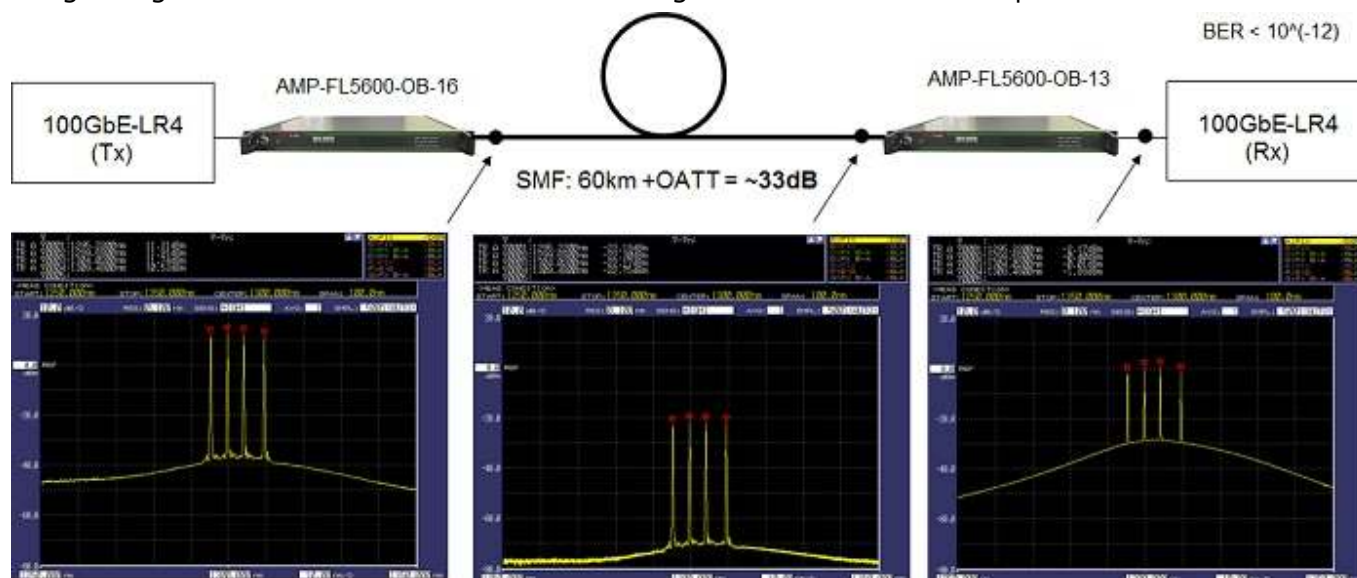
## 20 dB link budget using as a pre-amplifier

In the second scheme, a pre-amplifier configuration is used. The four wavelength signals are simultaneously amplified by AMP-FL5600-OB-13 to be within the range of receiver sensitivity after being attenuated by 23dB/lane using 55 km of SMF and an optical attenuator. A link budget of greater than 20 dB is attained.



## 30 dB link budget using as both a booster amplifier and a pre-amplifier

Finally, AMP-FL5600-OB amplifiers are used as both a booster amplifier and a pre-amplifier. A link budget of greater than 30 dB was confirmed using 60 km of SMF and an optical attenuator.



## Further reach extensions using as inline amplifiers

It should be noted that SMF transmission is not limited to 60 km, but larger link budgets and further reach extensions are possible by using inline amplifiers in addition to booster amplifiers and pre-amplifiers.