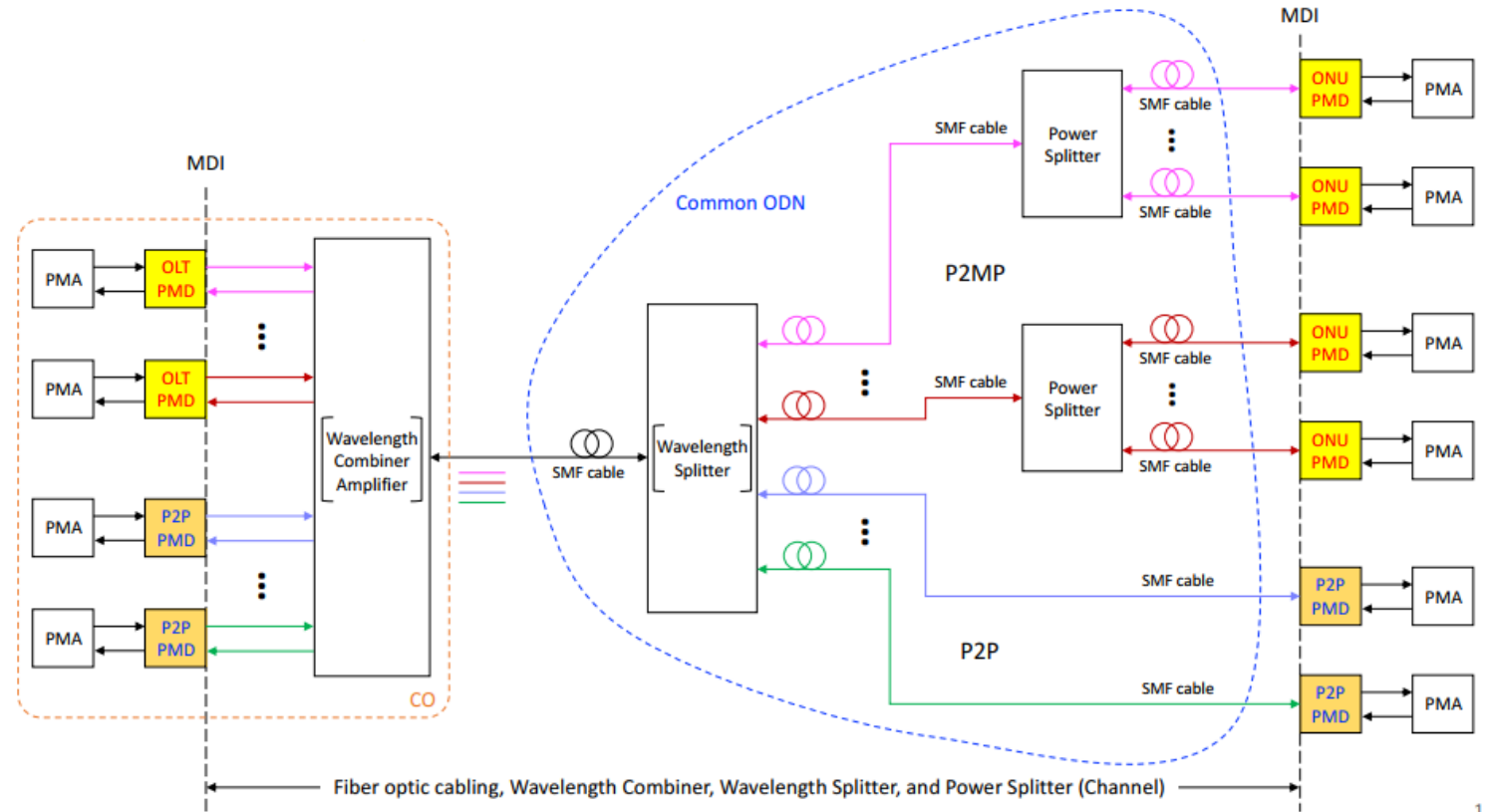


Optical Amplification for a Super-PON System

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Super-PON PMD Requirements

- Preliminary objectives:
 - 50 km reach with a 1:64 splitter
 - 10 Gb/s downstream
 - 2.5 and 10 Gb/s upstream
 - 16 or more channels



Challenges of Amplification in Super-PON PMD

- The link loss between CO and ONU can exceed 39dB, which requires high output power booster amplifier
- For upstream, burst-mode support requires **transient insensitive** amplification technology
- Larger link loss and high channel speed **tighten the OSNR requirements**, which result in stricter constraints on noise figure of upstream amplifier

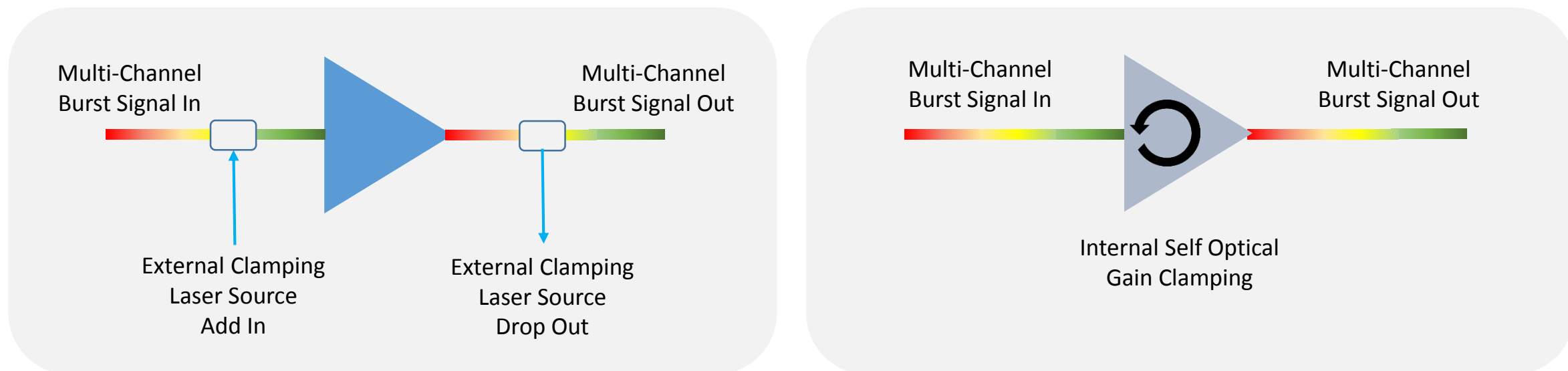
Possible Solution for Upstream Amplifier

| Items | SOA | EDFA |
|--------------------------------|---|---|
| Burst Mode Transient | No significant transient | Conventional design is transient sensitive design |
| Noise Figure | 7.5dB typical | Can be easily limited to below 5.5dB |
| PDG | <1.5dB | <0.3dB |
| Output Power And Gain Control | Typical maximum output power is around 12dBm. It is hard to keep constant gain for wide input dynamic input range and channel loading change. | Easy to reach high output power and AGC control technology is quite mature. |
| XGM (cross gain modulation) | Significant when output power is close to maximum value for multi-wavelength and intensity modulation application | No significant XGM |

Possible Solution for Upstream Amplifier (cont.)

- SOA is not suitable for multi-wavelength and high output power application due to nonlinear effects
- SOA induces penalty due to high NF and PDG
- Conventional EDFA design needs be optimized for burst-mode support

Optimization of Upstream EDFA Design



There are two solutions to optimize a conventional EDFA for burst mode operation:

- Using **external out-of-band laser** source which is much larger than burst signal power in full channel loading. It can reduce the impact on pump adjustment during the burst signal on/off. and improve the overshoot/undershoot of output power further.
- Using **internal self-generated signal to clamp the gain** of the burst signal. It can achieve the same effect as external design.

Accelink Burst-Mode EDFA Performance



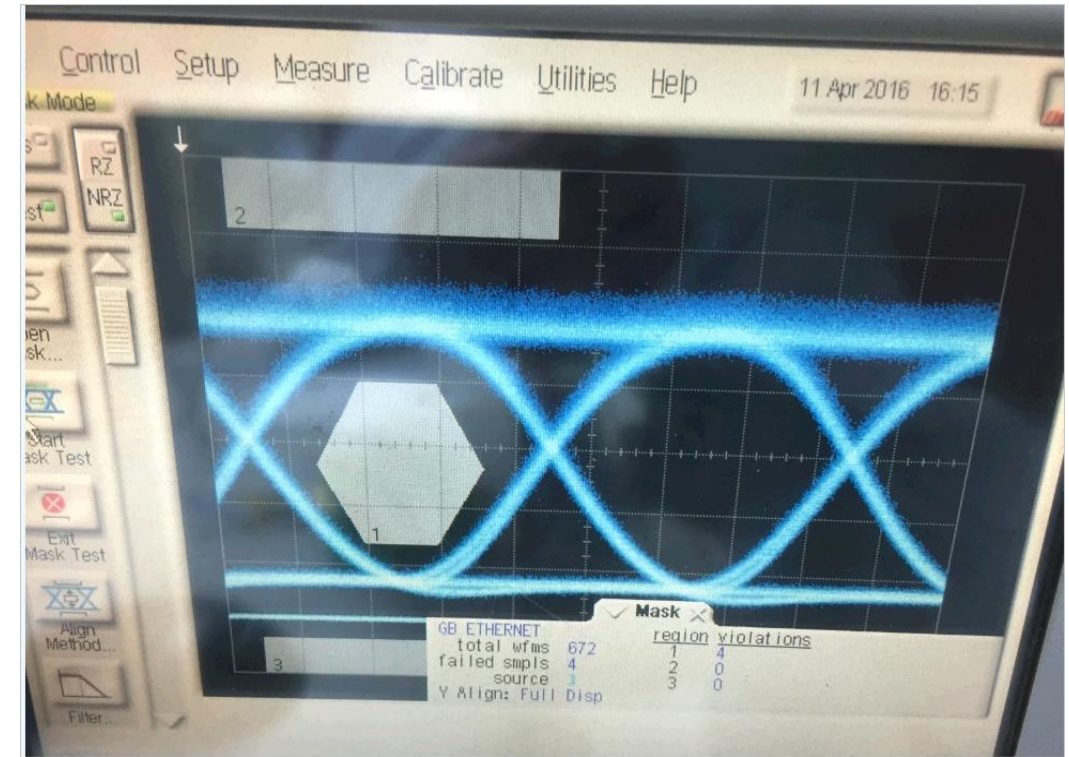
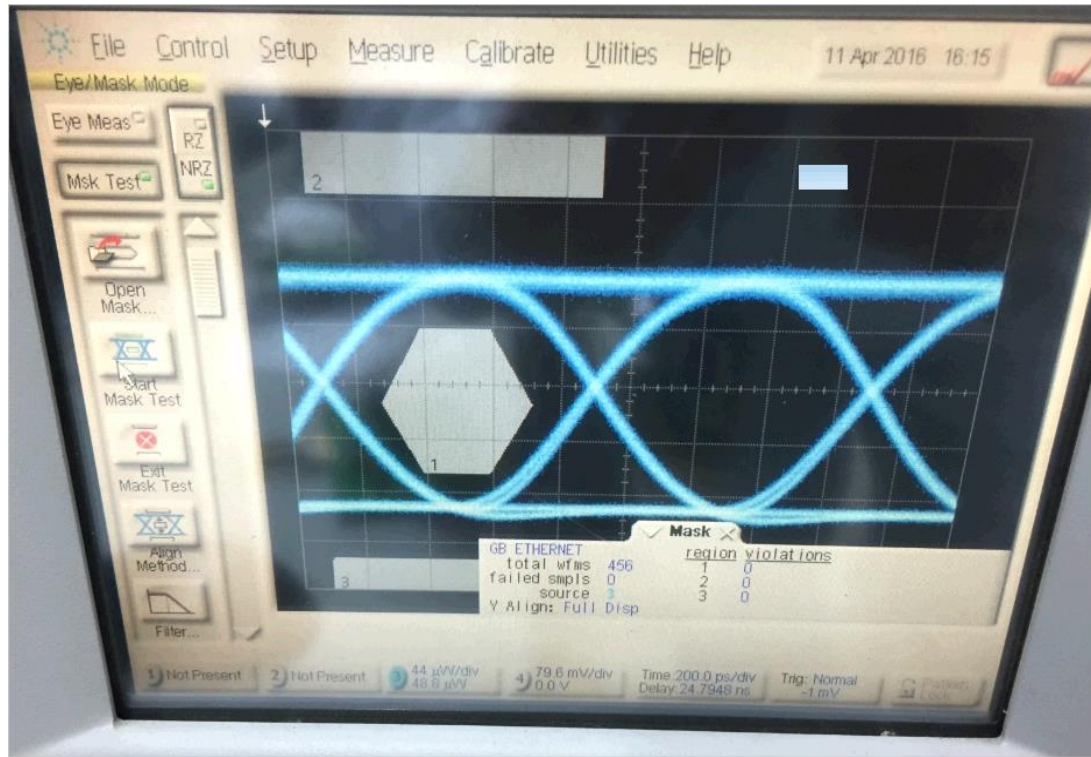
Figure 1-1, 20 channels burst on at same time, -13dBm Per Ch, Monitor one of all channels, Gain excursion:0.5dB



Figure 1-2, 19 channel burst on, total 20 channels Monitor the stable channel

Accelink burst mode EDFA can suppress the gain excursion below than 0.6dB typically even all 20 channels burst on at same time. And the cross talk is also very small in the worst case for the other 19 channels burst on at same time.

Accelink Burst-Mode EDFA Performance (cont.)



The burst-mode EDFA induces a little distortion of eye diagram, but the penalty is very small

L-Band EDFA for Downstream

L-Band EDFA of downstream for super-PON system need support very high output power (typically more than 24dBm).

With lower pump efficiency comparing to C-band application, output power become most challenging part for downstream L-band EDFA.

And the nonlinear effect also need to be taken into consideration.

Accelink L-band EDFA can provide mature solution for all above issues. It features:

- Output power up to 26dBm
- Superior pump efficiency
- Excellent noise figure
- Suppress nonlinear effect in high power applications
- Optional Eco-friendly design supporting ultra low power consumption

| PARAMETER | SPECIFICATION | | | UNITS | NOTE |
|-------------------------------|---------------|------|------|-------|--|
| | MIN. | TYP. | MAX. | | |
| Operation wavelength | 1570 | | 1612 | nm | |
| Output power | 6 | | 26 | dBm | |
| Gain | 17 | | 29 | dB | |
| Input power of full channels | -3 | | 9 | dBm | |
| Input power of single channel | -23 | | -11 | dBm | |
| Gain Slope Tuning range | -2 | | 1 | dB | |
| Gain Ripple | | | 1.5 | dB | (full case temperature range -5~70°C and whole gain tilt -2~1dB) |
| Noise Figure | | | 9 | dB | @gain=17dB, gain slope=1dB |
| | | | 7 | dB | @gain=20dB, gain slope=1dB |
| | | | 6 | dB | @gain≥23dB, gain slope=1dB |

Key optical Specs of 26dBm VGA

Summary

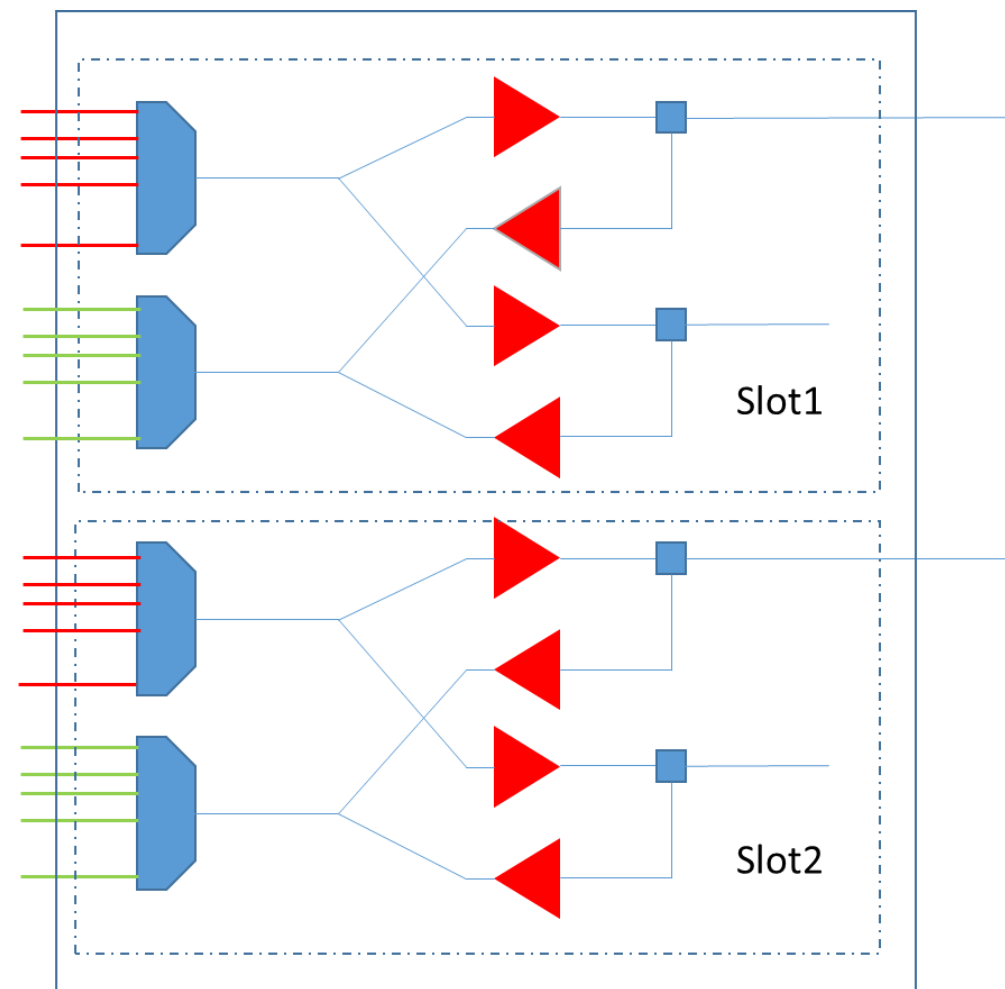
- EDFAs appear to be a viable solution for the Super-PON amplification challenges
 - They have low noise figure
 - Needed for upstream amplification (OSNR limited)
 - They can support burst-mode operations
 - Through self-clamping gain
- As a consequence, Super-PON should operate in C and L-bands

Super-PON PMD: Redundant EDFAs

Optical configuration:

- Supports up to built-in **8 fixed gain Amplifiers**, specification can be customized
- Special gain-clamping amplifier to support burst mode signal
- Built-in **Mux/Demux** (Up to 40channels for each direction)
- Built-in OSC insertion/extraction TFF
- Built-in bandmux for **upgrade band**

Optical Configuration



Thanks!

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