OPM
Optical Pulse Machines

White paper: Handling gain saturation in an Erbium-Doped-Fiber-Amplifier by pulse shaping

Abstract

The described experiment used a commercial Erbium-Doped-Fiber-Amplifier (EDFA) that was designed for the fiber communication industry with saturation power of +20dBm (100mW). In our experiment we operated the EDFA in a way that is more typical to industrial fiber-lasers or lasers in LADAR systems.

We tested the response of the EDFA to 100ns long square shaped pulses with frequency of 50KHz. The EDFA output showed – as expected – a severe gain saturation effect. Then we changed the optical pulse shape at the input until the output signal became a square wave. We also showed that the EDFA is capable of providing peak power levels of 5W.

Setup

The experimental setup used OPM's AnyPulse™ (ref. 1) Demonstration Unit (OADU) that is capable of producing arbitrary optical waveforms with time resolution of 2ns. The unit includes a 1550nm DFB laser diode.

The EDFA is 90x70mm module from Red-C , model M7300 (ref. 2). The amplifier's saturation power is +20dBm (100mW) and the gain was set to 20dB (x100).

The output of the EDFA was monitored by a power meter, a high speed optical detector and an oscilloscope.

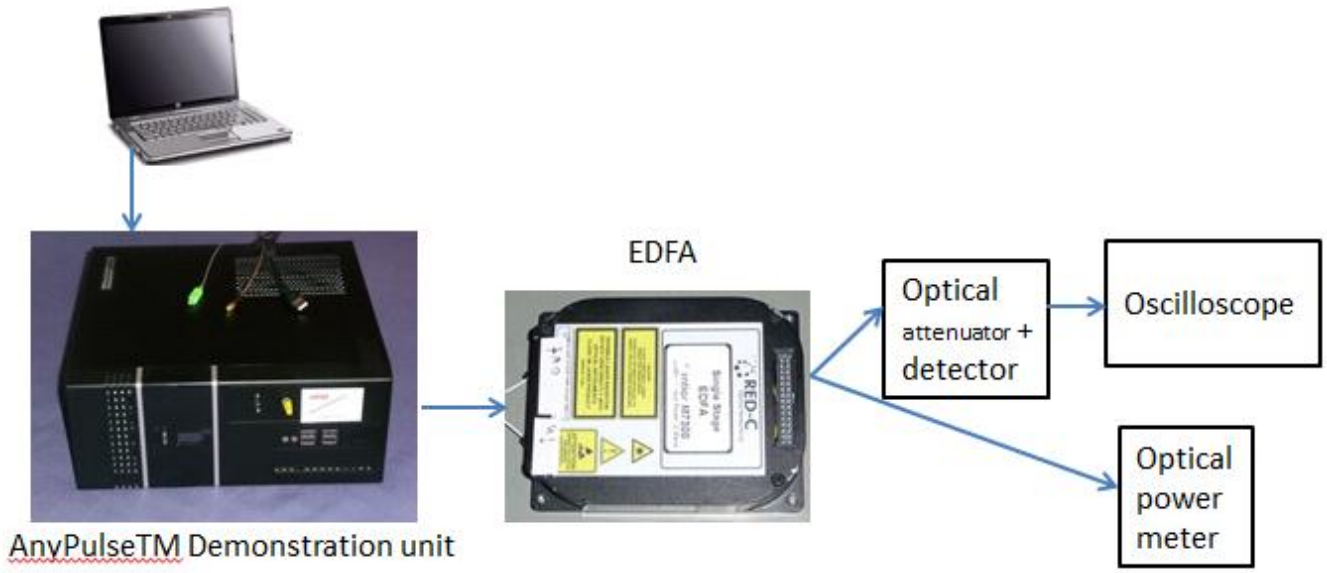

Figure 1 - Test setup

Tests

Test #1 – Square wave input, average power of 100uW.

The OADU was set at first to a square waveform with pulse width of 100ns and frequency of 50KHz.

The average optical output power from the OADU was tested to be 100uW (peak power of 20mW).

The output signal of the EDFA was tested. See figures 2a and 2b for input and output signals. As expected, the output signal shows severe gain saturation with peak power of ~5W at the leading edge of the pulse.

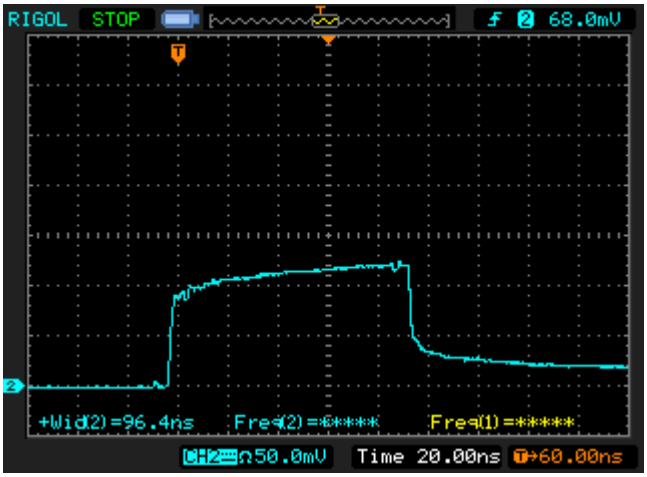

Figure 2a

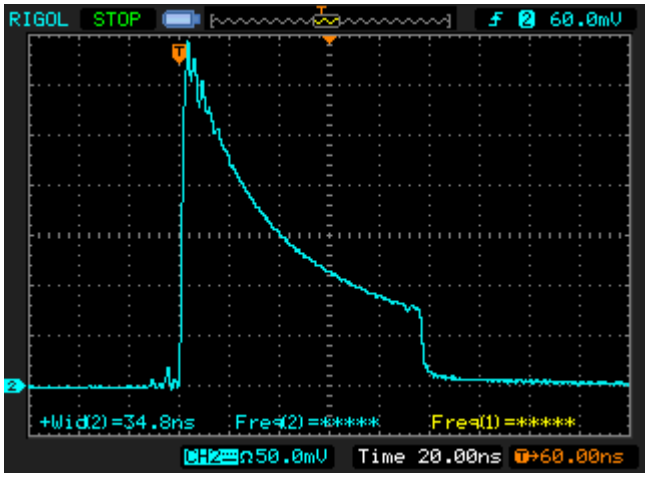

Figure 2b

Test #2 – shaped wave input.

The OADU was set to produce a step waveform followed by a ramp with pulse width of 100ns and frequency of 50KHz.

The output signal of the EDFA was tested. See figures 3a and 3b for input and output signals. The output signal's shape is close to a square wave. The average output power was tested to be 10mW and the pulse peak power 2W. The ASE level was immeasurable.

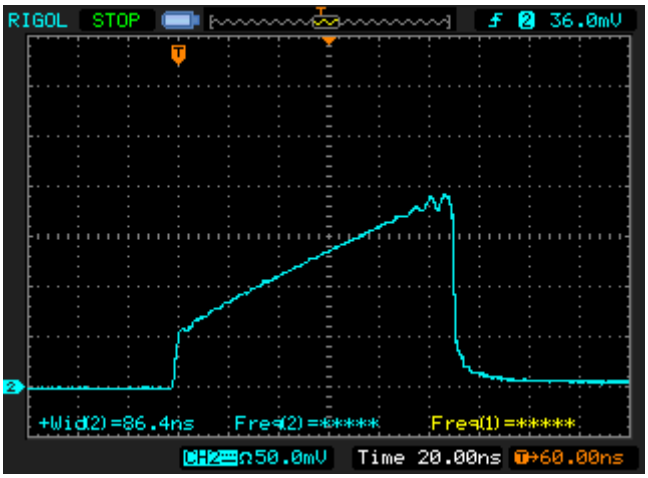

Figure 3a

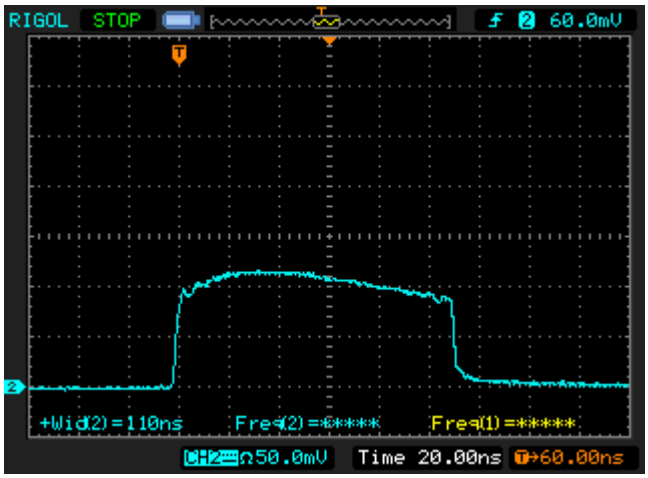

Figure 3b

Test #3 - Square wave input, average power of 33uW

The OADU was set to a square waveform with pulse width of 100ns and frequency of 50KHz.

The average optical output power from the OADU was reduced 33uW.

The output signal of the EDFA was tested. See figures 4 for the output signal. The gain saturation is not as severe as in the first test but the output signal is much lower.

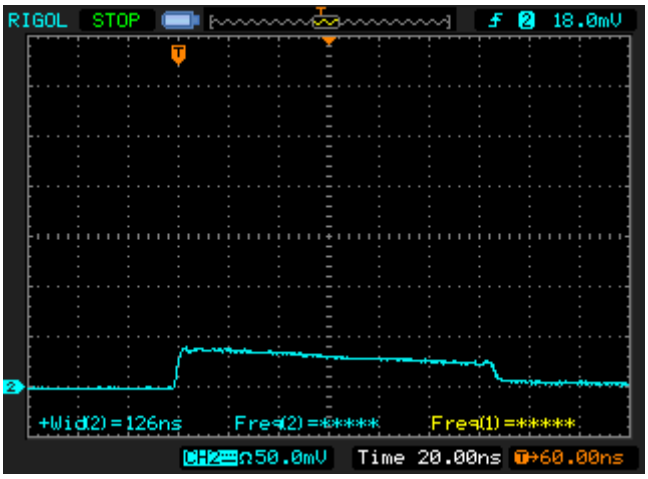

Figure 4

Conclusions

1. We have demonstrated that by using the AnyPulse™ technology even a severely distorted output signal of an EDFA can be fixed to get a rectangular shaped waveform.
2. We have demonstrated generation of optical peak power of 2W at pulse width of 100ns using a commercial EDFA that was designed for telecom applications.

References

1. http://www.opticalpulsemachines.com/

2. http://www.red-c.com/_Uploads/dbsAttachedFiles/70x90ApproachtoEDFADesign.pdf