PAN

Opto-Electronics Review

journal homepage: https://journals.pan.pl/opelre

1.28 Tbps DWDM optical network design using a dispersion compensating distributed Raman amplifier over S-band

Baseerat Gul*, Faroze Ahmad

Department of Electronics and Communication Engineering, Islamic University of Science and Technology, Kashmir, India

Article info

Article history:
Received 31 Jan. 2023
Received in revised form 11 Apr. 2023
Accepted 11 Apr. 2023
Available on-line 13 Jun. 2023

Keywords:
Dense wavelength division multiplexing;
conventional single mode fibre;
optical signal to noise ratio;
stimulated Raman scattering;
S-band;
dispersion compensating fibre.

Abstract

A 100 km long dense wavelength division multiplexed optical network design with a capacity of 1.28 Tbps is proposed in this paper. The novelty of this work is the use of a dispersion compensating fibre as a Raman amplifier in the S-band for a high-capacity dense wavelength division multiplexing network. The transmission is accomplished auspiciously in the wavelength range from 196 THz to 202. 35THz. The coupling of a Raman amplifier made the realisation of the S-band possible in the network, as the erbium-doped fibre amplifier is competent for amplification in C- and L-bands only. Further, a pump coupler is used for multiple pumping to enlarge the gain spectrum for a high-capacity optical network. The performance analysis of the network is carried out systematically in terms of bit error rate (BER), eye diagram, Q-factor, and optical signal to noise ratio (OSNR). The results demonstrate that the proposed set-up shows adequately low BER, sufficient Q-factor values, wide eye-opening, and commendable OSNR for all receiving channels.

1. Introduction

Dense wavelength division multiplexing (DWDM) is currently the most effective technique for increasing the capacity of optical transmission systems. The DWDM technique multiplexes multiple signals through a single fibre, making a high-capacity system possible by multiplying the bandwidth of a single optical fibre channel [1]. There are three substantial limitations to optical fibre: attenuation, dispersion, and non-linear effects [2]. While the attenuation issue can be resolved by adopting a suitable amplifier like an erbium-doped fibre amplifier (EDFA), Raman amplifier, etc., the dispersion issue is the prime limiting factor in optical communication [1, 3]. It becomes elevated in the DWDM technique by introducing cross-talk between consecutive channels [4]. For dispersion compensation, dispersion compensating fibre (DCF) is one of the efficient techniques, offering uniform dispersion compensation to multiple spectral components and upgradability to already installed links [5, 6]. However, in addition to dispersion compensation, data communication development demands throughput increment in DWDM networks [7], for which multiple bands use or band swapping becomes an admirable approach.

The low loss window comprises S-, C-, and L-bands. Although the attenuation in all these bands is almost equivalent, C- and L-bands are the most often used bands as the EDFA is competent for amplification in these bands only [7]. Most optical systems use EDFA for amplification purposes, which can use only half of the low-loss window and hence limit the number of channels that can propagate through the optical transmission system simultaneously [8]. However, Raman amplifiers exhibit a broad gain spectrum and work well in the S-band, which resolves the issue of limited transmission capacity by using S-band. Using S-band in an optical network increases the throughput gains by 65% [9]. Also, the chromatic dispersion in S-band is smaller compared to C- and L-bands.

The current work investigates the performance of a DCF as a Raman amplifier for a high-capacity DWDM optical network. Multiple pump lasers coupling is used to instigate the stimulated Raman scattering (SRS) process in DCF. The DCF used simultaneously employs dispersion compensation and amplification for the signal propagating down the link. Thus, instead of adding further losses, DCF itself acts as an amplifier. S-band is launched in the channel

*Corresponding author at: baseerat.gul@islamicuniversity.edu.in

https://doi.org/10.24425/opelre.2023.146104
1896-3757/ Association of Polish Electrical Engineers (SEP) and Polish Academy of Sciences (PAS). Published by PAS