Pis'ma v ZhETF, vol. 105, iss. 5, pp. 259 – 260 © 2017 March 10

Performance investigation of suppression of four wave mixing using optical phase conjugation with different modulation format in DWDM soliton communication system

G. Kaur[+1)], *R. S. Kaler*[+], *S. Singh*[*]

[+]*Optical Fiber Communication Research Laboratory (OFCR Lab), ECE Department, Thapar University, Patiala, 147004 Punjab, India*

[*]*Department of Electronics and Communication Engineering, Punjabi University, Patiala, 147004 Punjab, India*

Submitted 13 December 2016
Resubmitted 11 January 2017

DOI: 10.7868/S0370274X17050010

Optical fiber communication system are being extensively used in the world for telecommunication, data rate, and data transmission purpose. The demand for transmission over the global telecommunication network will continue to grow at an exponential rate and only fiber optics will be able to meet the challenge [1–3]. In a dense wavelength division multiplexed (DWDM) transmission system four wave mixing (FWM) is one of the major limiting factors and to suppress this undesirable effect the optical phase conjugation (OPC) is the best alternative [4, 5]. By using OPC which change the phase of the signal in the middle of the link and it cancelled the impairment which occurred in the first part of the transmission link (before conjugation) with impairments that occurred in the second part of the link (after conjugation).

In this paper, the performance of DWDM soliton transmission system for return-to-zero (RZ) and non-return-to-zero (NRZ) modulation formats have been investigated. The main aim of this paper is to estimate and mitigate the four wave mixing power by using in-line optical phase conjugator. In this work 32 channels DWDM soliton system is used. The performance of proposed system is checked with OPC and without OPC. In the simulation setup, 31 spans (3100 km) of proposed combination of DCF and SMF is considered whereas in single span transmission distance is covered 100 km (i.e. DCF = 20 km and SMF 80 km).

The Q-factor is observed as a function of transmission distance for both RZ and NRZ and it is observed that the Q-factor is decreased with respect to transmission distance due to induced non-linearity in the fiber. When the performance of data formats are compared then, as a result, RZ data format provides superior performance with good level of Q-factor. To measure the received power, a power meter is used at the end of proposed link and checked the performance after each span of link. The proposed system provides acceptable level of power after each span. The variation of output power is observed over number of spans for RZ and NRZ data format are 10^{-25}–10^{-55} mW and 10^{-1}–10^{-31} mW, respectively. Bit error rate measurement is also obtained for RZ and NRZ data formats for with OPC and without OPC individually at different launched input power. These results indicated that RZ modulation format with OPC is the best combination among all, it is provides better BER.

To further check the impact of FWM after 3100 km with RZ modulation, we have taken fiber link in two regimes i.e. real and non-real. In real fiber link regime, several effects are considered such as group velocity dispersion, third order dispersion, attenuation, polarization mode dispersion, self phase modulation etc. to check the outcomes of these effects on FWM. We also have compared the FWM induced in real fiber link with the FWM convinced in non-real fiber link regime to check the difference, see Fig. 1. It can be seen that,

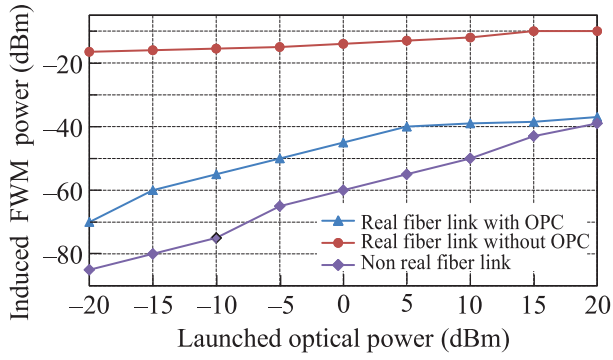

Fig. 1. (Color online) Induced FWM power as a function of launching optical power in RZ formatted DWDM system

[1)]e-mail: gksumman@gmail.com

in the case of non-real fiber, the induced FWM power is below than unacceptable range (> -40 dBm [6, 7]), means FWM suppression is not needed in this case. On the other hand, in the case of real fiber link the FWM power is dominate the performance. From the results, it can be seen that the real fiber link, without OPC, the FWM power is induced as > -22 dBm in all cases of input power. The effect of FWM has been estimated using real fiber link having non-linear and attenuation losses. The FWM power is strongly suppressed by introducing destructive interference between the first and second halves of in-line OPC.

It has been indicated that RZ with OPC yields the better performance with FWM power suppression (more than 20 dBm in certain cases) with reasonable bit error rate and Q-factor.

Full text of the paper is published in JETP Letters journal. DOI: 10.1134/S0021364017050010

1. G. P. Agrawal, *Fiber-Optic Communication Systems*, Third edition, Jhon Willey & Sons (2010).
2. R. J. Essiambre and G. P. Agrawal, J. Opt. Soc. Am. B **14**(2), 323 (1997).
3. A. Selvamani and M. T. Sabapathi, *Suppression of Four Wave Mixing by Optical Phase Conjugation in DWDM Fiber Optic Link*, Intern Conf. on Recent Advancements in Electrical, Electronics and Control Engineering (2011).
4. G. Kaur and M. S. Patterh, Optik **125**, 3781 (2014).
5. G. Kaur and M. S. Patterh, Optik **126**(3), 347 (2015).
6. S. Singh, Optik **125**(21), 6527 (2014).
7. S. Singh and R. S. Kaler, Optik **125**(18), 5357 (2014).