Spatial single mode laser source interaction with measured pulse based parabolic index multimode fiber

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11 authors, including:

Ahmed Nabih Zaki Rashed
faculty of electronic engineering menoufia university

Hasane Ahammad Shaik
K L University

Malek G. Daher
Islamic University of Gaza

Vishal Sorathiya
Parul Universiy

Ahmed Nabih Zaki Rashed*, S.K. Hasane Ahammad, Malek G. Daher, Vishal Sorathiya, Abrar Siddique, Sayed Asaduzzaman, Hasin Rehana, Nitul Dutta, Shobhit K. Patel, Vincent Omollo Nyangaresi, Rayhan Habib Jibon and Huda Said Abdelhamid

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Abstract: The study clarified spatial single mode laser interaction with measured pulse based parabolic index multimode fiber. Peak power level margin, maximum/minimum signal amplitude margin after parabolic index multimode fiber are measured with core radius of 25 μm, cladding thickness of 10 μm, refractive index peak of 1.4142, length of 300 m, and refractive index step of 1%. Maximum signal power margin against spectral frequency after PIN light detector based parabolic fiber properties is tested under the same operating parameters. The signal power amplitude/power within parabolic index multimode fiber is also measured based on variations of fiber lengths and relative refractive index step. The study implies the multimode graded index fibers with parabolic or near parabolic index profile cores have transmission bandwidths than other multimode fibers.

Keywords: measured pulse; optical time domain; parabolic index multimode fiber; spatial single mode laser.

***Corresponding author: Ahmed Nabih Zaki Rashed**, Electronics and Electrical Communications Engineering Department, Faculty of Electronic Engineering, Menoufia University, Menouf 32951, Egypt, E-mail: ahmed_733@yahoo.com. https://orcid.org/0000-0002-5338-1623
S.K. Hasane Ahammad, Department of ECE, Koneru Lakshmaiah Education Foundation, Vaddeswaram, Andhra Pradesh 522302, India, E-mail: ahammadklu@gmail.com
Malek G. Daher, Physics Department, Islamic University of Gaza, P.O. Box 108, Gaza, Palestine, E-mail: malekjbreel20132017@gmail.com
Vishal Sorathiya, Department of Information and Communication Technology, Marwadi University, Rajkot, India, E-mail: vishal.sorathiya9@gmail.com
Abrar Siddique, Department of Smart Robot Convergence and Application Engineering, Pukyong National University, Busan 48513, Korea; and Department of Electrical and Computer Engineering, University of Waterloo, Waterloo, ON N2L 3G1, Canada, E-mail: abrarkhokhar.iiui@gmail.com
Sayed Asaduzzaman and Hasin Rehana, Department of Computer Science and Engineering, Rangamati Science and Technology University, Rangamati, Bangladesh; and Department of Computer Science and Engineering, Daffodil International University, Dhaka, Bangladesh, E-mail: asadcse.rmstu@gmail.com (S. Asaduzzaman), hasin.cse13@gmail.com (H. Rehana)
Nitul Dutta, Computer Sc and Engg. Dept., SRM University, Guntur, Andhra Pradesh, India, E-mail: nituldutta@gmail.com
Shobhit K. Patel, Computer Sc and Engg. Dept., SRM University, Guntur, Andhra Pradesh, India; and Electronics and Communication Engg. Department, Marwadi University, Rajkot, Gujarat, India, E-mail: shobhitkumar.patel@marwadieducation.edu.in
Vincent Omollo Nyangaresi, Tom Mboya University College, P.O. Box 199-40300, Homabay, Kenya, E-mail: vnyangaresi@tmuc.ac.ke
Rayhan Habib Jibon, Electronics and Communication Engineering Discipline, Khulna University, Khulna 9208, Bangladesh, E-mail: jibon.ece.ku@gmail.com
Huda Said Abdelhamid, Electronics and Electrical Communications Engineering Department, Faculty of Electronic Engineering, Menoufia University, Menouf 32951, Egypt, E-mail: hudasaidabdelhamid@gmail.com

1 Literature review

The optical fiber communications enable telecommunication networks to transport large bandwidth, high data rate speed for long connections distances across countries over the globe [1–12]. In the optical communication system, the optical transmitter converts the electrical input signal that represent the information to be sent, into corresponding optical signal through modulating the output of the optical source using one of two methods [13–18]; by varying the source drive current or by varying the light intensity at the output of the light source [19–29].

Distributed feedback lasers (DFBs) are candidates for various high speed system applications such as the Gigabit-Ethernet [30–44]. They are cost-effective fabrication with on-chip testability [45–52], and the easy fabrication of two-dimensional arrays [53–65]. Distributed feedback lasers (DFBs) do not need to be cleaved and hence they enable monolithic integration with other optoelectronic devices such as photodetectors, modulators or hetero-bipolar transistors (HBTs) [66–72]. The output beam is circular and of a low divergence [73–78]. This is ideal for optical fiber communication systems, where the effective fiber coupling (>90%) of vertical laser diodes allows relaxed tolerance in alignment [79–89]. Its design allows the chips to be manufactured and tested on a single wafer [90–107].

2 Model setup and discussion of results

Figure 1 show the spatial single mode laser with parabolic index multimode fiber simulation model. Data source generate the stream random sequence of data bits and these are encoded with measured pulse. The encoded signal is then forward to spatial single mode laser with a frequency of 1550 nm, input power of 10 dBm, power ratio array is unity. The light source converts the electrical signal form to light signal form. The light modulated signal through internal modulator inside the light source is directed to parabolic index multimode fiber with a length of 300 m. The dramatic improvement in multimode fiber bandwidth achieved with a parabolic or near parabolic refractive index profile is highlighted by consideration of the reduced delay difference between the fastest and slowest modes for graded index fiber. The light signal which is routed from the optical fiber cable to the erbium doped fiber amplifiers with a length of 5 m in order to be amplified.

The amplified signal is then treated with Bessel light filter with a frequency of 1550 nm and total bandwidth of 10 GHz from any rippled overlapped the original signal. The treated light signal is detected into electrical form through the PIN photo detectors. Optical/radio frequency spectrum analyzers are used to measure the signal amplitude and power levels in both spectral and time domains.

Peak power level margin versus time bit period after parabolic index multimode fiber with core radius of 25 μm, cladding thickness of 10 μm, refractive index peak of 1.4142, length of 300 m, and refractive index step of 1% is shown in Figure 2. The peak signal power reaches a value of 0.031158 W and minimum signal power is −0.00148 W.

Maximum/minimum signal power margin against spectral wavelength after parabolic index multimode fiber with core radius of 25 μm, cladding thickness of 10 μm, refractive index peak of 1.4142, length of 300 m, and refractive index step of 1% is clarified in Figure 3. Where the maximum signal power level achieved a value of 3.875 dBm

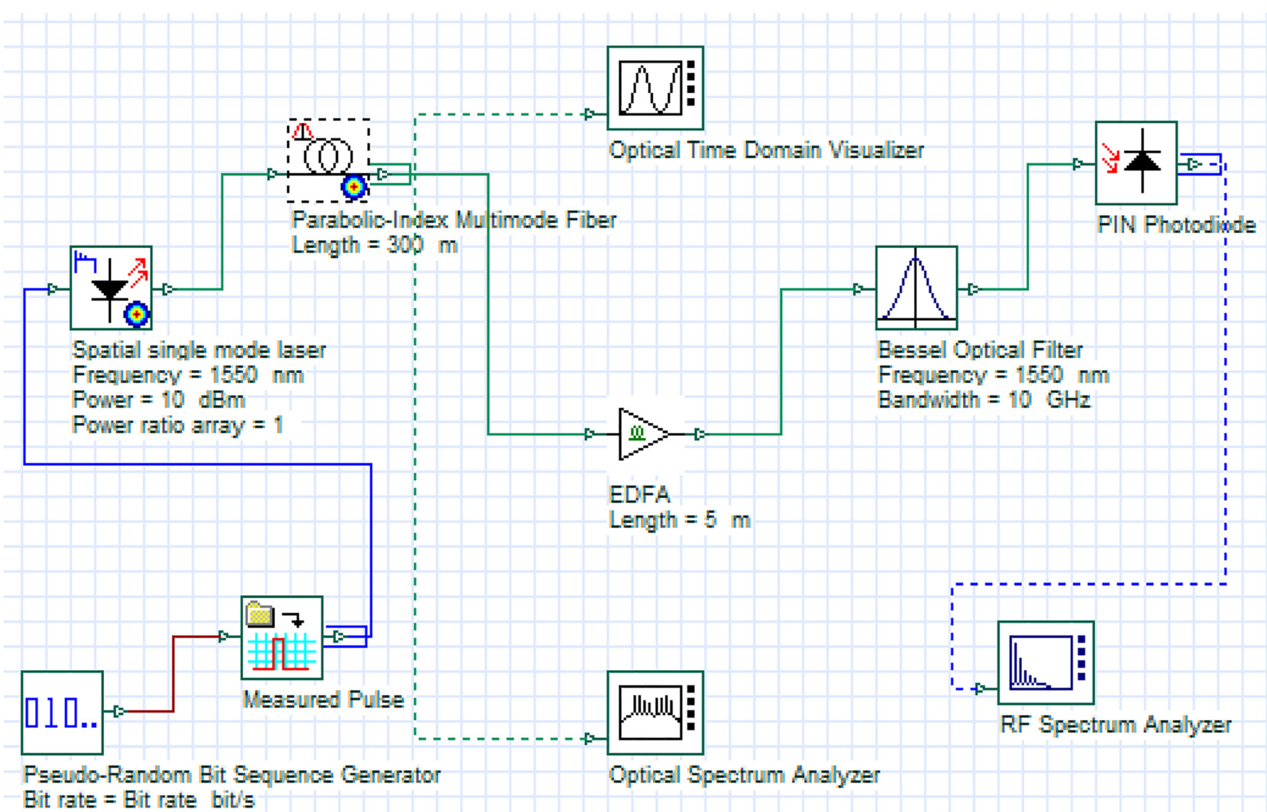

Figure 1: Spatial single mode laser with parabolic index multimode fiber simulation model.

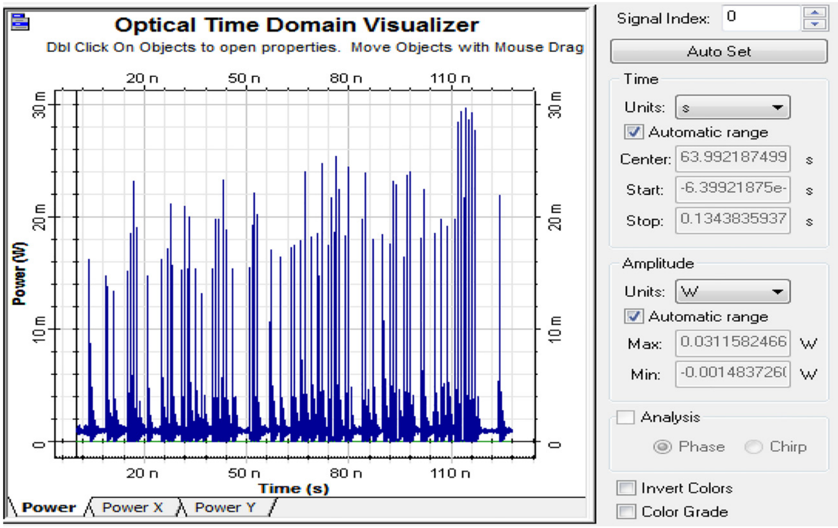

Figure 2: Peak power level margin versus time bit period after parabolic index multimode fiber with core radius of 25 μm, cladding thickness of 10 μm, refractive index peak of 1.4142, length of 300 m, and refractive index step of 1%.

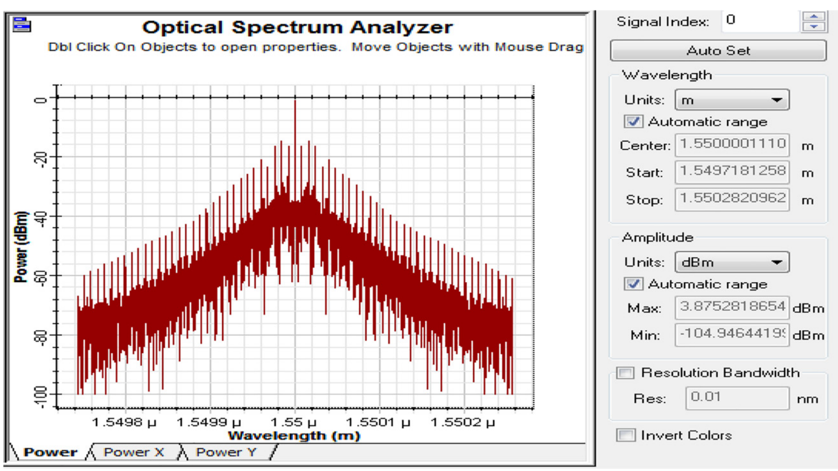

Figure 3: Maximum/minimum signal power margin against spectral wavelength after parabolic index multimode fiber with core radius of 25 μm, cladding thickness of 10 μm, refractive index peak of 1.4142, length of 300 m, and refractive index step of 1%.

and minimum signal power level achieved a value of −104.946 dBm.

The maximum signal power margin against spectral frequency after PIN light detector based parabolic fiber properties with core radius of 25 μm, cladding thickness of 10 μm, refractive index peak of 1.4142, length of 300 m, and refractive index step of 1% is clarified in Figure 4. Where the maximum signal power level is 4.144 dBm and minimum signal power level is −104.959 dBm in this case. Figure 5 clarify the peak signal power variations with fiber length after parabolic index multimode fiber with core radius of 25 μm, cladding thickness of 10 μm, refractive index peak of 1.4142, and various refractive index step ratios. It is observed that the negative effects of increasing fiber length on peak signal power level with various relative refractive index step ratios. The peak signal power value is optimized with a value of Δn is 0.01 with a fiber length value is 100 m.

Signal Bandwidth variations with fiber length after parabolic index multimode fiber with core radius of 25 μm, cladding thickness of 10 μm, refractive index peak of 1.4142, and various refractive index step ratios is shown in Figure 6. It is theoretically found that the dramatic effects of increasing fiber length on signal bandwidth with various relative refractive index step ratios. The signal bandwidth value is optimized with a value of Δn is 0.01 with a fiber length value is 100 m to reach to approximation value of 280 GHz.

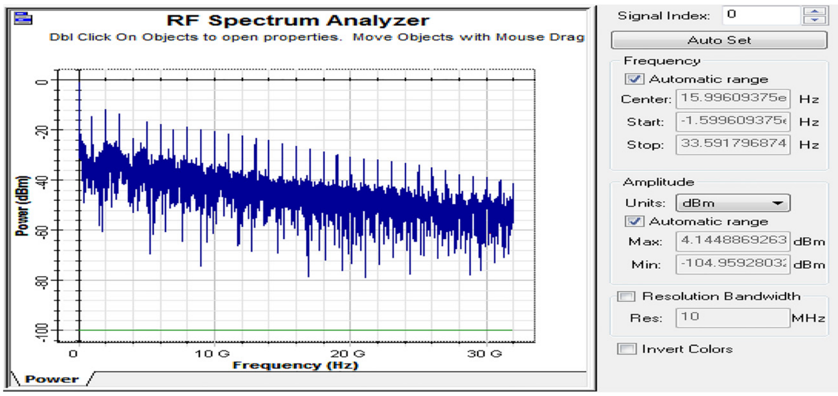

Figure 4: Maximum signal power margin against spectral frequency after PIN light detector based parabolic fiber properties with core radius of 25 μm, cladding thickness of 10 μm, refractive index peak of 1.4142, length of 300 m, and refractive index step of 1%.

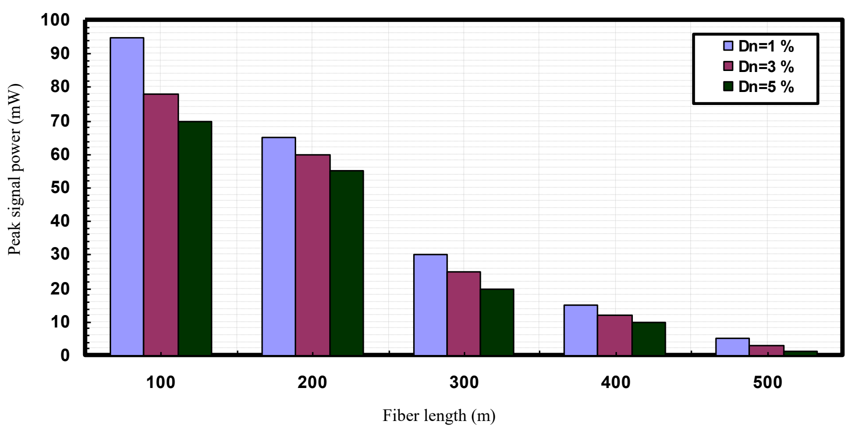

Figure 5: Peak signal power variations with fiber length after parabolic index multimode fiber with core radius of 25 μm, cladding thickness of 10 μm, refractive index peak of 1.4142, and various refractive index step ratios.

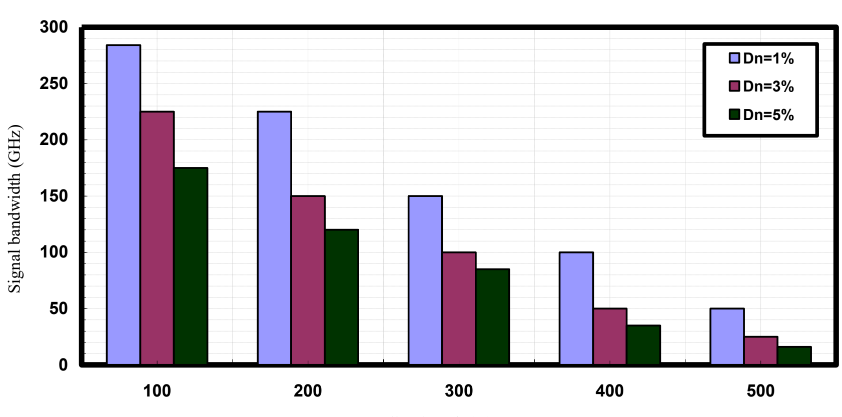

Figure 6: Signal bandwidth variations with fiber length after parabolic index multimode fiber with core radius of 25 μm, cladding thickness of 10 μm, refractive index peak of 1.4142, and various refractive index step ratios.

3 Conclusions

In a summary, spatial single mode laser interaction with measured pulse based parabolic index multimode fiber is stimulated. Peak power level margin, maximum/minimum signal amplitude margin after parabolic index multimode fiber are measured with core radius of 25 μm, cladding thickness of 10 μm, refractive index peak of 1.4142, and refractive index step of 1%. The optimum signal power level and optimum signal bandwidth is achieved with a fiber length of 100 m and relative refractive index step with a value of 1%. The optimum signal bandwidth is 280 GHz and the optimum signal peak power level is 95 mW within multimode parabolic index fiber.

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