Republic of Iraq-Baghdad
Ministry of Higher Education and Scientific Research
University of Technology
Laser and Optoelectronics Engineering Department

Performance Analysis of Hybrid Optical Communication System Utilizing Wide Band Hybrid Fiber Amplifier

A Thesis
Submitted to the Department of
Laser and Optoelectronics Engineering/University of Technology in Partial Fulfillment of the Requirements for the Degree of Master Science in Laser Engineering

By
Abdulrahman Ameen Abdulrahman Almukhtar
(B.Sc. 2017)

Supervised by

Assistant Professor
Dr. Abdulla Khudiar Abass

Assistant Professor
Dr. Mudhafer Hussein Ali

2022 **1443**

ABSTRACT

The last forty years, fiber optic communication had changed the communication face and transformed it from traditional communication to optical communication, although, the free space optical communication system is an important replacement or complementary system to fiber-optic communication in the cases of tough geographical terrain, like mountains, other special situations. So the in these situations the installation of optical fibers will be expensive, impractical, or inconceivable to be installed, and The fiber optic link downfalls due to the natural catastrophes or thru wars bombing, and the last mile of the wave division multiplexing communication-link which consumes a massive circulation problem. Free space optical communication system also has their disadvantages, thus the integration system between FOC and FSOC is produced to create a hybrid optical communication HOC system, which has been of great interest in the past 10 years.

In addition, the Erbium Doped Fiber Amplifier EDFA is a fiber amplifier typically work at C-band region, which is the most used band. This band is fully utilized and the need to increase communication bandwidth is persisting, thus the hybrid fiber optic amplifier HFOA is introduced to increase the communication bandwidth. The HFOA was proposed to cover a wide band communication system (C and L-band) via combined the EDFA with Raman fiber amplifier (RFA) in serial or parallel configurations.

In this work, a HOC system with HFOA is investigated and demonstrated utilizing Opti-System software and based on the research conducted, no system in the same configuration proposed in this thesis has been found.

This work includes three main contributions namely: 1) performance analysis of HFOA on FSOC system. In this analysis, the communication distance reached at clear weather more than 10 km, at haze weather 7 km, at rain weather 4 km, and at fog weather 3km, 2) Effect of fiber-telescope coupling losses TL on wideband wavelength division multiplexing in free space optical communications under four different weather conditions, namely; clear, hazy, rain, and fog. According to the results, the maximum Telescope-coupling loss TL is 23 dB and 29 dB for single and dual FSOC, respectively, at the clear weather condition and for 1 km communication distance. This means that the dual-channel system could afford higher losses than the single system by approximately 26.1 %. Furthermore, this ratio is approximately the same for the other weather conditions, 28.6 %, 31.6 %, and 40 % for the hazy, rain, and fog, respectively, 3) Optimization and performance analysis of HFOA on HOC system, the HFOA was optimized and the HOC system communication distance reached 8 km for all of the 32 channel bidirectional which is 100% data rate enhancement from the previous work.