Sudan University of Science and Technology (SUST)

College of Graduate studies

Performance Evaluation of Optical Networks Using Erbium Doped Fiber Amplifier

تقييم أداء شبكات الألياف الضوئيه باستخدام المكبر الضوئي خليط أربيوم

A Thesis Submitted in Partial Fulfillment of the Requirement for the Degree of Master of Science in Electronics Engineering (Communication Engineering)

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صدق الله العظيم

Dedications

This project is dedicated to my parents who have been a constant source of support and encouragement during the challenges of life since day one , I would never forget how they always loved me unconditionally and taught me that even the largest task can be accomplished if it is done one step at a time specialization my mother AMEERA HALAL .

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Abstract

Fiber optic in communications today is one of the most important cables to use for sending and receiving data and is used for protection and safety and also for long distance transmission and high speed .

Some of the factors that limit the use of optical fibers, for example, are the loss problems, the weakness of the data being transmitted within the optical fiber cable. These problems affect the reception of data clearly, which increases the length of the fiber optic cable. There are some ways to compensate for this loss, which occurs in the data when sent in cables, including the use of amplifiers. The use of optical amplifier Erbium dope fiber amplifier between transmitter and receiver is one of the most effective ways to compensate for data loss.

In this research, the optical amplifier was used to solve the problem by placing it in different places and then comparing the data obtained in all cases to know the importance of using optical amplifier .The search also includes the number of optical amplifiers that are determined according to the length of optical fiber cables. The greater the distance, the greater the number of amplifiers used. Therefore, the standard was two cases of transmission at 80 kilometers and 120 kilometers transmission .

Opti System was used to analyze through eye diagram, bit error rate, quality factor, and height eye

The results showed that the optical amplifier (Erbium doped fiber amplifier) showed better results than the transmitter in fiber optic cables without the optical amplifier .

المستخلص

أصبحت الألياف الضوئيه في مجال الأتصالات اليوم من اهم واكثر الكابلات أستخداما لارسال ولاستقبال البيانات لتمتعها بالحمايه والامان وبالأضافه للارسال لمسافات طويله وبسرعه عاليه رغم المميزات الكثيره التي تتمتع بها الالياف الضوئيه الأ ان هنالك بعض العوامل التي تحد من استخدام الألياف الضوئيه منها الفقد الذي يحدث للبيانات اثناء ارسلها داخل كابل الليف الضوئي وتؤثر هذه المشكله في استقبال البيانات بصوره واضحه حيث تذبذ بزياده طول كابل الليف الضوئي ، هناك بعض الوسائل لتعويض هذا الفقد الذي تحدث في البيانات عندما ترسل في كابلات ومنها أستخدام المكبرات ويعتبر استخدام المكبر الضوئي خليط أربيوم بين المرسل والمستقبل من اكثر الطرق الفعاليه في تعويض الفقد في البيانات , وفي هذا البحث تم استخدام المكبر الضوئي لحل المشكله وذلك بوضعه في اماكن مختلفه وهي بوضعه قبل كابل الليف الضوئي ووضعه بعد كابل واخيرا وضعه بين كابل الليف الضوئي ثم المقارنه بين البيانات المستقبله في جميع الحالات لمعرفه تأثير استخدام المكبر الضوئي علي حسب موضعه في الشبكه وايضا شمل البحث عدد المكبرات الضوئيه التي تحدد علي حسب طول كابلات الالياف الضوئيه كلما زادت المسافه زاد عدد المكبرات المستخدمه لذلك كان المعيار في حالتين حاله الارسال في مسافه 80 كلم ثم الارسال في مسافه 120 كلم والمقارنه بين معارين الارسال والاستقبال ، وتم استخدام برنامج **أوبتي سيستم** لتحليل من خلال شكل العين ,اقل معدل للأخطاء , عامل الجوده , وارتفاع العين ، واظهرت النتائج استخدم المكبر الضوئي خليط الأربيوم في الشبكه الضوئيه يعطي نتائج افضل من الارسال في كابلات الالياف الضوئيه بدون استخدامه.

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LIST OF ABBREVIATIONS

APD	Valance Photodiodes Detector
AR	Antireflection
ASE	Amplified Spontaneous Emission
BER	Bit Error Rate
CATV	Cable Television
CDM	Code Division Multiplexer
CW	Continues Laser
EDFA	Erbium Doped Fiber Amplifier
GUI	Graphical User Interface
ILD	Injection Laser Diode
LAN	Local Area Network
LED	Light Emitting Diode
MAN	Metropolitan Area Network
MMF	Multi Mode Fiber
NRZ	Non Return to Zero
OSD	Sample Optical Design
PD	Photo Detector
P_{in}	Power Input
PON	Passive Optical Networks

Pout	Power Output
PRMS	Pseudo Random Binary Sequence
Q-factor	Quality Factor
RZ	Return to Zero
SLAs	Semiconductor Laser Amplifiers
SMF	Single Mode Fiber
SNR	Signal Noise Ratio
SOAs	Semiconductor Optical Amplifiers
TDM	Time Division Multiplexer
WDM	Wavelength Division Multiplex

LIST of Symbols

L	Length
$LOSS_{Actu}$	Actual loss
$LOSS_{accep}$	Acceptable loss
N	Number
G	Gain
P_{in}	Power Input
P_{out}	Power Output
λ	Wavelength
ΔE	The difference in energy levels
h	The Planck's constant.
N	Number of Amplifier
G	Gain
C	Velocity
F_n	Figure noise