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Analysis of Dirty Adapters and Dirty Connectors on Fiber Optic Transmission

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ABSTRACT

The author conducts research on dirty adapters and dirty connectors in fiber optic transmission to determine the value or attenuation that will be produced due to the influence of dirty adapters and dirty connectors. This study was conducted to evaluate the attenuation value due to dirty adapters and dirty connectors in fiber optic transmission before and after the use of Passive Splitter 1: 16. The method used includes the initial step of calibration between the Optical Power Meter (OPM) and Handheld Light Source (HLS). The HLS was connected to the first Optical Distribution Point (ODP) with a patch cord cable to provide attenuation, and data was taken at the second ODP using the OPM. The power data received on the unproblematic core (gray) without the 1:16 Passive Splitter was 0.65 dB, while with the 1:16 Passive Splitter the attenuation increased to 13.71 dB. The red dirty adapter causes 5.99 dB of attenuation without the Passive Splitter 1:16 and 19.21 dB with the Passive Splitter 1:16. The brown dirty connector exhibits an attenuation of 4.68 dB without the Passive Splitter 1:16 and 19.08 dB with the Passive Splitter 1:16. These findings suggest that the physical condition and cleanliness of the components significantly impact the attenuation in the fiber optic network.

INTRODUCTION

Telecommunication is a long-distance communication process that involves the exchange of various types of information between different locations. Nowadays, telecommunication services are a very important element in everyone's daily life. Innovations in communication technology continue to evolve rapidly, in line with the demands of modern society who want high mobility, service flexibility, ease of use, satisfaction, and efficiency in all aspects. To provide these services, adequate bandwidth and high-speed internet access are required. In an effort to increase the speed of internet access, many copper transmission media are currently switching to optical fiber to meet these demands.

Telecommunications technology is now developing very quickly. The need for high-speed and large-capacity communication has become very important to support the advancement of information technology that continues to grow in the era of modern society (Daniel, Prasetyo, & Widodo, 2021a). Telecommunication systems use various transmission media such as copper cables, wireless, and optical fibers that function as a means to transmit signals (Mardhatillah, Asril, Yustini, & Yulindon, 2022). The use of copper cables as a transmission medium in communication systems no longer meets the needs for long-distance data transmission that requires large capacity and high speed. This limitation causes copper cables to be replaced by optical fibers that have far superior transmission capabilities (Daniel, Prasetyo, & Widodo, 2021b). Fiber optic cables serve as a solution to the transmission media problems encountered in the delivery of telecommunications networks (Minal Zukri & Yolanda, 2022).

The device used is Optical Distribution Point (ODP) as a passive cable termination media, so that it is protected from corrosion and weather (Minal Zukri & Yolanda, 2022.). In fiber optic transmission, there is a power distribution process depending on the output used, the device used in power distribution in fiber optic transmission is a passive splitter which has one input and has different outputs depending on its use. There are various kinds of passive splitters, namely 1: 2, 1: 4, 1: 8, 1: 16, 1: 32 (Minal Zukri & Yolanda, 2022.).

The use of optical fiber as a transmission medium also has several problems that can reduce system performance. One of these problems is the frequent loss of information caused by attenuation losses that occur along the fiber optic cable so that it affects the power from the transmitter to the receiver. Power requirements will be disrupted by the presence of too large attenuation problems on the links of a fiber optic system (Nugroho A K, Wahyu, Kota Malang Jl Tlogowaru No, & Malang, 2019). There are several other problems that often occur in optical fiber, namely the occurrence of dirty adapters and dirty connectors in optical fiber transmission. Where these problems can affect the

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attenuation that will be received by the output.

Based on this research, this fiber optic design aims to provide an understanding of fiber optic splicing techniques, including the negative impacts caused by dirty adapters and connectors, and understand the function of each device in a fiber optic transmission system.

LITERATURE REVIEW

Fiber Optic

Optical fibers are thin wires made of glass or plastic, used to transmit light signals generally from LEDs at high speed. Light remains trapped due to the difference in refractive index between glass and air. This cable consists of three main parts namely :

1. Core
   The core is a key element in fiber optics, serving as a conduit for light waves coming from the source. This component is made of high-quality silicon glass.
2. Cladding
   The cladding serves as a reflection boundary that ensures optical light is reflected back into the core, allowing light to continue traveling to the end. The cladding is made of a glass material with a lower refractive index than the core, which affects the flow of light within the core.
3. Coating
   Coating serves as a protector of the optical fiber, increasing its resistance to external interference. This coating is made of plastic and is also used as a color-coded marker on each fiber tube.

Fiber Optic Cable Type

Fiber optic cable has 2 types, namely :

1. Singlemode
   This singlemode fiber has a core diameter of between 5 to 10 µm, capable of transmitting information with a sharp beam thanks to its high effective frequency. The small core size allows only one mode of light to propagate, so the number of light reflections is reduced and the signal can cover longer distances.
2. Multimode
   These multimode fibers have a core diameter between 50-100 µm larger than the cladding, making them more suitable for short-distance transmission due to high losses and slower speeds. The large core size allows for more light reflection, increasing data capacity, but reducing transmission efficiency

Factors Affecting Attenuation

The attenuation in fiber optic systems that can affect fiber optic transmission performance includes several factors, namely:

1. Dirty adapter
   The attenuation in fiber optic transmission can increase due to dirty adapters. Dirt or dust that interferes with the connection between two optical fibers blocks the path of incoming light. As a result, the signal transmitted through the optical fiber becomes weaker, causing a decrease in network performance and an increase in errors in transmission.
2. Dirty connector
   Dirty connectors can increase attenuation in fiber optic transmission. This occurs due to dirt or dust on the surface of the connector blocking the path of incoming light. As a result, the transmitted signal is weakened, which ultimately impacts the quality of the received signal.

Power Link Budget

The Power Link Budget is a calculation used to determine the maximum allowable receiving power limit on an optical link. This calculation considers the total attenuation caused by cables, connectors, and connections along the fiber optic communication path. The equation for calculating the Power Link Budget can be seen in the following formula.

$$\alpha_{total} = L.\alpha_{serat} + N_c.\alpha_c + N_s.\alpha_s + N_a.\alpha_a + SP \qquad (1)$$

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Description :
L : Length of optical fiber (Km).
a_{tot} : Total Atternuation (dB).
a_{serat} : Attenuation Of Optical Fiber (dB/Km).
a_c : Attenuation Of Connector (dB/buah).
a_s : Attenuation Of Splice (dB).
a_a : Attenuation Of Adapter (dB)
N_a : Number Of Adapters
N_s : Number Of Splice
N_c : Number Of Connectors
a_{sp} : Attenuation Of Splitter (dB).

METHOD

Research Flowchart

In this study, the flow of this research based on the flowchart in Figure 1 includes literature study, preparation of tools, materials, and tool design, tool making and testing, data collection and analysis, and report writing. The following in Fig. 1 is a research flowchart.

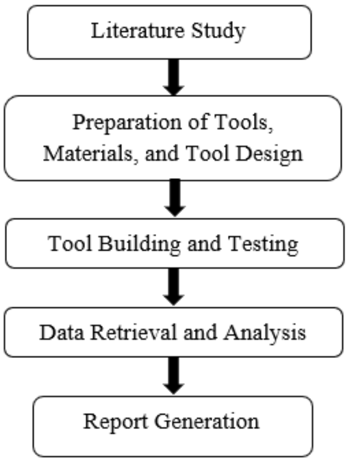
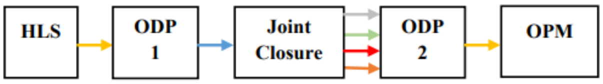


Figure 1. Research Flowchart

Design Block Diagram

In the block diagram below, it can be seen that HLS is used as input which is connected to the first ODP using a patch cord cable to provide attenuation to the ODP. From the first and second ODP, it will go through a joint closure that has been connected according to the problems that occur and the second ODP will take data using OPM which is connected using a patch cord cable. The OPM will show the power received by the second ODP, in the second ODP there are 2 treatments, namely cores that have no problems (gray and green) and cores that have problems (red and brown) with problems, namely dirty adapters and dirty connectors. Then from the second ODP, it will be connected to the input on Passive Splitter 1:16 to provide attenuation on Passive Splitter 1:16 and OPM will be connected to Passive Splitter 1:16 to see the power received after the addition of Passive Splitter 1:16.



Description :
-Yellow : Patch Cord Cable
-Blue : Fiber Optic Cable
-Red : Dirty Adapter
-Cokelat : Dirty Connector

Figure 2. Block diagram of the design without using Passive Splitter 1:16

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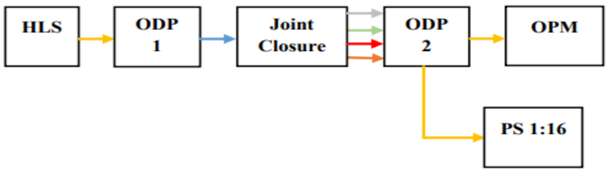

Description :
-Yellow : Patch Cord Cable
-Blue : Fiber Optic Cable
-Red : Dirty Adapter
-Cokelat : Dirty Connector

Figure 3. Block diagram of the design using Passive Splitter 1:16

RESULT

1. HLS and OPM Calibration
   The results of three calibrations between HLS and OPM using a frequency of 1310 nm can be seen in Table 1.

Tabel 1. Kalibrasi HLS dan OPM

Attempt to	λ (nm)	Received power value (dBm)
1	1310	-7.11
2		-7.11
3		-7.15

2. Measurement without using Passive Splitter 1:16
   The measurement results for non-problematic cores and problematic cores can be seen in Tables 2 and 3.

Table 2. Measurements without using Passive Splitter 1:16 cores that are not problematic

Color	P_{Tx}(dBm) (1310nm)	P_{Rx}(dBm) (1310nm)	Attenuation (dB)
Gray	-7.11	-7.76	0.65
Green		-7.86	0.75

Table 3. Measurements without using Passive Splitter 1:16 problematic cores

Color	P_{Tx}(dBm) (1310nm)	P_{Rx}(dBm) (1310nm)	Attenuation (dB)	Information
Red	-7.11	-13.10	5.99	Adaptor kotor
Brown		-13.00	4.68	Konektor kotor

3. Measurements on unproblematic cores and problematic cores using a 1:16 Passive Splitter
   The measurement results of unproblematic cores and problematic cores can be seen in Tables 4 and 5.

Table 4. Measurements on non-problematic cores

Port	P_{Tx}(dBm) (1310nm)	P_{Rx}(dBm) (1310nm)		Attenuation (dB)	
		Abu-abu	Hijau	Abu-abu	Hijau
1	-7.11	-20.82	-21.11	13.71	14
2		-21.11	-21.30	14	14.19
3		-21.20	-21.50	14.09	14.39
4		-20.93	-21.23	13.82	14.12
5		-20.90	-21.18	13.79	14.07
6		-20.95	-21.47	13.84	14.36
7		-20.98	-21.47	-13.87	14.36
8		-20.75	-21.39	13.64	14.28
9		-20.60	-21.01	13.49	13.9
10		-20.81	-20.93	13.7	13.82
11		-20.70	-21.17	13.59	14.06

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12	-20.94	-21.25	13.83	14.14
13	-20.95	-21.27	13.84	14.16
14	-20.76	-21.03	13.65	13.92
15	-21.10	-21.13	13.99	14.02
16	-21.12	-21.39	14.01	14.28

Table 5. Measurements on problematic cores

Port	**P_{Tx}(dBm) (1310nm)**	P_{Rx}(dBm) (1310nm)		**Attenuation (dB)**	
		Merah	Coklat	Merah	Coklat
1	-7.11	-26.32	-26.19	19.21	19.08
2		-26.48	-26.31	19.37	19.2
3		-26.58	-26.37	19.47	19.26
4		-26.45	-26.18	19.34	19.07
5		-26.42	-26.28	19.31	19.17
6		-26.58	-26.10	19.47	18.99
7		-26.55	-26.28	19.44	19.17
8		-26.23	-26.00	19.12	18.89
9		-26.12	-25.90	19.01	18.79
10		-26.34	-26.03	19.23	18.92
11		-26.20	-26.29	19.09	19.18
12		-26.55	-26.32	19.44	19.21
13		-26.47	-26.21	19.36	19.1
14		-26.23	-25.92	19.12	18.81
15		-26.45	-26.27	19.34	19.16
16		-26.47	-26.31	19.36	19.2

DISCUSSION

The measurements in this study were carried out using HLS as input with a wavelength of 1310 nm. The Optical Power Meter (OPM) acts as the main measuring device to ensure data accuracy. After a series of tests and calibrations, a final power value of -7.11 dBm was obtained, reflecting the accuracy of the measurement process.

Measurement without using Passive Splitter 1:16

To determine the quality of the attenuation obtained, a power link budget calculation is performed. This calculation is important because it provides an overview of the comparison between the received and transmitted signal strengths, taking into account all the gains and losses that occur during signal travel. Through this calculation, it can be ensured that the level of attenuation is still within acceptable limits and in accordance with applicable standards.

$$\alpha_{total} = (L.\alpha_{serat}) + (N_c.\alpha_c) + (N_s.\alpha_s) + (N_a.\alpha_{a)} + Sp\ 1:16$$
$$= (0{,}01\ km.\ 0{,}35\ dB/km) + (6.0{,}25\ dB) + (3.0{,}1\ dB) + (3.0{,}5\ dB)$$
$$= (0{,}035\ dB + 1{,}5\ dB + 0{,}3\ dB + 1{,}5\ dB$$
$$\alpha_{total} = 3{,}335\ dB$$

Based on the power link budget calculation the resulting total attenuation is 3.335 dB, which is the maximum limit in development. The measured attenuation value in gray without problems is 0.65 dB, indicating that the total attenuation is lower than the power link budget value which means that the manufacturing process is going well and produces satisfactory transmission quality. However, in the red color with dirty adapter conditions the attenuation value reaches 5.99 dB while in the brown color with dirty connector conditions the attenuation value reaches 4.68 dB. This condition shows that the total attenuation in both colors is higher than the power link budget value, which indicates that the manufacturing process is not running optimally and the transmission quality is poor. This shows that dirty adapters and dirty connectors affect the attenuation of the optical fiber.

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Measurements on non-problematic cores and problematic cores using a 1:16 Passive Splitter

To assess the quality of the attenuation values that have been taken, a power link budget calculation is performed using PS 1:16. This calculation is important because it provides an overview of the comparison between the received and transmitted signal strengths. Through the power link budget analysis, it can be ensured that the attenuation that occurs is within acceptable limits and in accordance with applicable standards.

$\alpha_{total} = (L.\alpha_{serat}) + (N_c.\alpha_c) + (N_s.\alpha_s) + (N_a.\alpha_{a)} + Sp\ 1{:}16$
= (0,01 km. 0,35 dB/km) + (6.0,25 dB) + (3.0,1 dB) + (3.0,5 dB) + 14,10 dB
= (0,035 dB + 1,5 dB + 0,3 dB + 1,5 dB + 14,10 dB
α_{total} = 17,435 dB

Based on the results of the power link budget calculation above, the total attenuation value is 17.435 dB. Which means the maximum limit of the total attenuation value when building is 17,435 dB.

The total attenuation value for the gray core is as follows :
$\alpha_{total} = P_{in} - P_{out}$
= -7.11 – (-20.82)
= 13.71 dB

The total attenuation value for red cores or dirty adapters as follows :
$\alpha_{total} = P_{in} - P_{out}$
= -7.11 – (-26.32)
= 19.21 dB

The total attenuation values for brown cores or dirty connectors are as follows :
$\alpha_{total} = P_{in} - P_{out}$
= -7.11 – (-26.19)
= 19.08 dB

The power link budget calculation shows that the resulting total attenuation is 17.435 dB, which is the maximum limit for manufacturing standardization. In gray, which is functioning properly, the measured attenuation value is 13.71 dB, indicating that the total manufacturing attenuation is lower than the power link budget value. This means that the manufacturing process went well and resulted in satisfactory transmission quality. On the other hand, the attenuation value on the red cores affected by dirty adapters reached 19.21 dB, while on the brown cores with dirty connectors the value was 19.08 dB. This shows that the total attenuation in both colors is higher than the power link budget value, indicating that the manufacturing process is not optimal and the transmission quality is degraded. Therefore, dirty adapters and connectors contribute to the increase in fiber optic attenuation when using the 1:16 Passive Splitter.

CONCLUSION

This study aims to measure and analyze the impact of dirty adapters and dirty connectors on fiber optic cable connections. Based on the results of research and analysis, the following conclusions can be drawn:

1. The attenuation on the unproblematic core (gray) without using the 1:16 Passive Splitter is 0.65 dB with a power link budget calculation of 3.335 dB. In contrast, the problematic core (red) has an attenuation of 5.99 dB, and the other problematic core (brown) 4.68 dB with the same power link budget calculation of 3.335 dB which indicates poor transmission. This proves that problematic cores increase attenuation in fiber optic transmission.
2. The attenuation on the unproblematic core (gray) using Passive Splitter 1:16 is 13.71 dB, with a power link budget calculation of 17.435 dB. Meanwhile, the problematic core (red) has an attenuation of 19.21 dB and the other problematic core (brown) of 19.08 dB, with the same power link budget calculation of 17.435 dB. This shows that the manufacturing process is not optimal and the transmission quality is poor. This proves that problematic cores with a 1:16 Passive Splitter can increase the attenuation value in fiber optic transmission.

REFERENCES

Ardina, E. N., Dr. Supari, & Cahyono, T. D. (2023). Implementasi Fiber Optik di Ranah Industri dan Penyambungan Fiber Optik Menggunakan Splicer di SMK Telkom Tunas Harapan. Abdimas, 2(2), 9–15. Retrieved from http://www.itbsemarang.ac.id/sijies/index.php/abdimas

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Asril, A. A., Septima, U., Dewi, R., Maria, P., & Herda, D. L. (2023). Fiber Optical Network Damage Detection Passive Splitter 1:8 in ODC uses IOT Technology as a means of Real Time Reporting. Brilliance: Research of Artificial Intelligence, 3(2), 122–133. https://doi.org/10.47709/brilliance.v3i2.2966

Chen, L., Su, Q., Liu, S., & Li, L. (2021). Infiltrated hollow core fiber interferometer for high sensitive temperature and refractive index sensing. Optik, 243. https://doi.org/10.1016/j.ijleo.2021.167336

Daniel, S., Prasetyo, J., & Widodo, S. (2021a). Rancang Bangun Alat Trainer Jaringan Kabel Serat Optik Untuk Kompetensi Teknisi Instalasi Fiber Optik Dan Praktikum Fiber Optik. Integrated Lab Journal, 09(02), 63–79.

Daniel, S., Prasetyo, J., & Widodo, S. (2021b). Rancang Bangun Alat Trainer Jaringan Kabel Serat Optik Untuk Kompetensi Teknisi Instalasi Fiber Optik Dan Praktikum Fiber Optik. Integrated Lab Journal, 09(02).

Datta, A., & Saha, A. (2020). Realization of a highly sensitive multimode interference effect-based fiber-optic temperature sensor by radiating with a Vortex beam. Optik, 218. https://doi.org/10.1016/j.ijleo.2020.165006

Han, Y., Gong, L., Meng, F., Chen, H., Wang, Y., Li, Z., … Wang, W. (2021). Highly sensitive temperature sensor based on surface plasmon resonance in a liquid-filled hollow-core negative-curvature fiber. Optik, 241. https://doi.org/10.1016/j.ijleo.2021.166970

Juwari, J., Jayadi, P., & Sussolaikah, K. (2022). Analisis Redaman Kabel Fiber Optic Patchcord Single Core. JURIKOM (Jurnal Riset Komputer), 9(2), 202. https://doi.org/10.30865/jurikom.v9i2.3950

Liu, M., & Fu, W. (2020). Multi-core fiber based coherent transceiver utilizing self-homodyne detection and ICA based channel equalization for optical intra-datacenter interconnects. Optik, 205. https://doi.org/10.1016/j.ijleo.2020.164215

Liu, Y., & Song, H. (2021). Theoretical analysis on polarization characteristics of spun birefringent optical fiber based on an analytical Jones matrix model. Optik, 228. https://doi.org/10.1016/j.ijleo.2020.166179

Mardhatillah, K., Asril, A. A., Yustini, & Yulindon. (2022). Analisa Rugi-Rugi Sambungan Kabel Drop Core Terhadap Performansi Jaringan Optik Di Gedung G Lantai 3 Politeknik Negeri Padang. Jurnal Fokus Elektroda, 7(3), 172–177.

Maria, P., Adila Asril, A., Wiharti, W., & Prayama, D. (2022). Fiber to The Home (FTTH) Network Design in Analyzing Macro Bending Problems in The Home Cable Installation Segment. International Journal of Advanced Science Computing and Engineering (Vol. 4).

Nugroho A K, H. R., Wahyu, N. K., Kota Malang Jl Tlogowaru No, P., & Malang, K. (2019). Analisis Redaman Pada Sistem Fiber Optic Akibat Adanya Penambahan ST-Adapter The Analysis Of Attenuation In Fiber Optic System Due To Embedded ST-Adapter.

Rahmania. (2019). Analisis Power Budget Jaringan Komunikasi Serat Optik Di PT.Telkom Akses Makassar. Vertex Elektro, 01(02), 52.

Rahmatulloh, M. A., Hanto, D., Yantidewi, M., Rianaris, A., & Firdaus, R. A. (2023). Analisis Redaman Fiber Optik dengan Menggunakan Pemodelan Software Optisystem. Jurnal Kolaboratif Sains, 6(7), 630–639. Retrieved from https://jurnal.unismuhpalu.ac.id/index.php/JKS

Tian, P., Bi, W., Wang, X., Jin, W., Zhang, B., Fu, X., & Fu, G. (2021). Dual-core mode converter with long period fiber grating. Optik, 231. https://doi.org/10.1016/j.ijleo.2021.166461

Wu, Y., Liu, B., Nan, T., Wu, J., Mao, Y., Ren, J., … Zhang, Y. (2021). Fiber optic hybrid structure based on an air bubble and thin taper for measurement of refractive index, temperature, and transverse load. Optik, 241. https://doi.org/10.1016/j.ijleo.2021.166962

Yuseliani, R. D., Asril, A. A., Maria, P., & Yulindon. (2022). Penambahan Optical Distribution Point (ODP) Menggunakan Metode Branching Dalam Perancangan Jaringan Fiber To The Home (FTTH) Di Gedung G Lantai 3 Politeknik Negeri Padang. Jurnal Ilmiah Poli Rekayasa, 17(2), 58–63.

Zhu, F., Zhang, Y., Qu, Y., Su, H., Zhao, L., & Guo, Y. (2020). Fiber-optic hybrid structure sensor for simultaneous measurement of transverse load and temperature. Optik, 208. https://doi.org/10.1016/j.ijleo.2019.164078

Zukri, I. M., Yolanda, A., Yustini, & Yulindon. (2022). Analisis Pengaruh Penggunaan Passive Splitter Pada Optical Distribution Point (ODP) Terhadap Kinerja Jaringan Di Rumah Pelanggan. Jurnal Ilmiah Poli Rekayasa, 18(1), 32–37.