Design Attention System of Single Mode Aerial Fiber Optic Cable Transmission on Connection Loss on Passive Splitter

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ABSTRACT

In this study, a comparison of the attenuation value of single mode aerial cable with pigtail is made. Perform several types of connections using a 4 cm and 6 cm protection sleeve, with one and two connections and use a barrel adapter connector. How does the connection affect the installation of a 1:2 passive splitter device. The measuring instruments used for the measurement process are Optical Power Meter (OPM) and Optical Time Domain Reflectometer (OTDR). The attenuation value of aerial single mode optical cable is smaller than that of pigtail cable. The measurement results using OPM at a wavelength of 1310 nm, connection using a 4 cm protection sleeve, one connection, the attenuation value is 0.18525dB, this value is smaller than the pigtail cable, which is 1.2728 dB. In the installation of a passive splitter, the attenuation value on the aerial cable is smaller, namely 0.2081 dB compared to the pigtail cable, which is 4.3281. The measurement results using the OTDR obtained the connection loss value for the connection type using a 6 cm protection sleeve, one connection is smaller with a value of 0.155 dB, compared to the connection type using an adapter barrel with a value of 12,216 dB.

1. Introduction

The increasing need for data communication, especially fiber optic communication systems, which has recently grown rapidly, has prompted the creation and development of various methods and technologies that can be used to accommodate the large capacity and high speed requirements of the system. Along with the increase and development of using fiber optic cable as a data transmission medium, there is also often a loss of information caused by losses that occur along the fiber optic cable, one of these losses is power loss caused by attenuation along the cable. optical fiber, which results in a change in power from the optical transmitter to reach the optical receiver [1].

The author conducted research using several types of splicing to see the effect of attenuation of each connection. The type of splicing used in this study is a development of previous research, namely Putri Azizah [1] and Tiara Audina in 2020 with the title "Designing the Effect of Passive Splitters in Transmission Attenuation Systems from Connection Loss in Single Mode Optical Cables with Pigtail Types"[2] which in this study the authors changed the transmission medium (cable type) used from the pigtail type single mode optical cable to the aerial type single mode optical cable at a cable length which was originally 10 m, the pigtail type single mode optical cable became a single mode cable type. aerial type with a length of 150 m.

Transmission attenuation on optical cables with the influence of cable connection losses has been studied previously, where from the results of previous studies it can be seen that one sample data shows that attenuation in a 10 meter pigtail type optical cable that is connected there is an increase with the installation of a passive splitter device than optical cable without connection as seen in table 1 and table 2 of the results of previous studies, which in this study used a pigtail type of single mode optical cable [1].

Table 1. Measurement Results Without Connection [2]

λ	Pin (watt)	Pout (dBm)	Pout µW	Pout Watt	Losses / α(dB)
850	0,001	-6,36	230,2	0,0002302	0,63789
1300	0,001	-12,11	61,47	0,00006147	1.21133
1310	0,001	-12,15	61,16	0,00006116	1.21353
1490	0,001	-12,59	55,25	0,00005525	1.25766
1550	0,001	-12,51	55,75	0,00005575	1.25375
1625	0,001	-12,74	53,22	0,00005322	1.27392

Table 2. Results of connection measurements with 6cm sleeve protection one connection

λ	Pout (watt)	Pin (dBm)	Pout µW	Pout Watt	Losses / α (dB)
850	0,001	-27,3	1,98	0,00000198	2,703
1300	0,001	-32,04	0,7184	$7{,}184x10^{-7}$	3,143
1310	0,001	-31,59	0,7055	$7{,}055\ x10^{-7}$	3,151
1490	0,001	-32,78	0,5042	$5{,}042\ x10^{-7}$	3,297
1550	0,001	-33,32	0,4721	$4{,}721\ x10^{-7}$	3,325
1625	0,001	-33,61	0,4373	$4{,}373\ x10^{-7}$	3,359

In tables 1 and 2 you can see as an example at a wavelength of 850 nm the attenuation value by using an optical pigtail type using a connection using a 6cm Sleeve Protection there is an increase from 0.637894681 to 2.70333481, this increase is due to the addition of attenuation of the passive splitter device. , because in this study the author wants to reduce the transmission attenuation value so that the information signal data sent to the receiver is very good by changing the type of optical transmission cable to Single Mode Aerial Type.

The formula used to calculate the damping value:

$$\alpha(dB) = \frac{10}{L}\log\left(\frac{Pin}{Pout}\right) \quad (1)$$

Based on the problems above, the author will try to reduce the value of transmission attenuation by changing the type of transmission cable that is used by PT. Telkom, namely the Aerial Type Single Mode optical cable, this attenuation measurement is carried out using several types of connections and an assessment will be carried out in analyzing the effect of changing cable types on the installation of passive splitter devices with several types of connections made on optical cable transmission media.

In this study, the measurement system used is the same as the previous one, namely using an Optical Power Meter (OPM) and Optical Time Domani Reflectometer (OTDR) measuring instrument.

2. Literature Review

Optical fiber is made of a dialectical material consisting of a core material, namely glass and a protective layer, namely plastic. It is in this fiber that the light energy generated by the light source is channeled (transmitted) so that it can be received at the end of the receiving unit.

Based on the structure of the fiber optic cable, the cable installation method is as follows:

2.1. Cable Duct (Duct Cable)

Duct cable or cable duct is all types of cable housing whose construction is specifically designed to be installed below ground level and the installation must be placed in pipes under a resistant surface. Which installation uses a protective duct pipe. This cable is buried in the ground. Installation by means of an open trench (open trench). In Figure 1 the size of the duct cable is different. The difference occurs because it is adjusted to the needs needed.[6]

Figure 1. Duct Cable Form

2.2. Direct Buried Cable

Direct planting cable is a cable whose installation is buried in the ground by the open excavation method and the cable is directly planted in the ground without using a shield (duct).

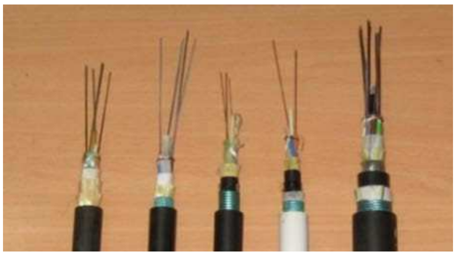

Figure 2. Form of Direct Buried Cable

2.3. Aerial Cable

Aerial cable is a cable whose installation hangs in the air (aerial). This cable installation is hung between the support poles. The difference between aerial cables and other types of cables is that in aerial cables there is a reinforcing wire that serves to hold the data cable from hanging.

Figure 3. Basic Construction of Aerial Cable

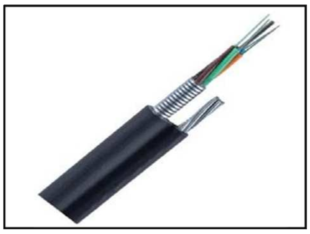

Figure 4. Shape of Aerial Cable

3. Method

3.1. Research Flow

In the design process of this research using an experimental method consisting of a research flow chart which can be shown in Fig. 5 so that a system is formed that becomes a goal, then the work data obtained are analyzed so that a conclusion can be drawn.

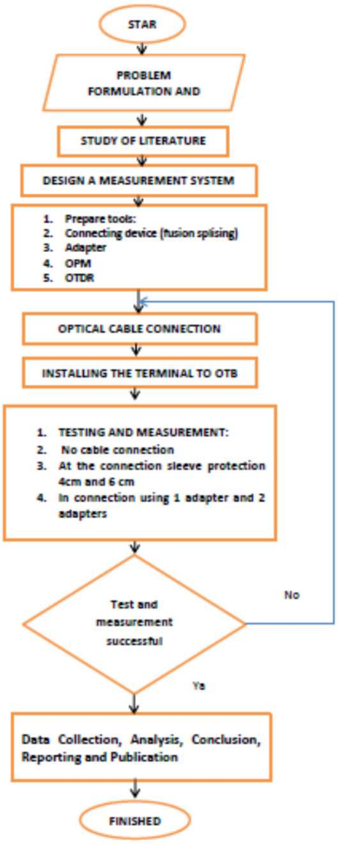

Figure 5. Research Flow

3.2. Study of literature

In this stage, literature discussion activities are carried out from a research, namely Designing Transmission Attenuation Systems in Single Mode Aerial Fiber Optic Cables for Connection Loss in Passive Splitter Devices, where the authors collect data and learn relevant basic theories from various sources such as books, internet, resource persons and research that has been done related to the research that will be carried out by the author.

3.3. Design

In this stage, the activity carried out by the author is to create an internal design for measuring optical cable transmission attenuation as shown in Figure 6 below:

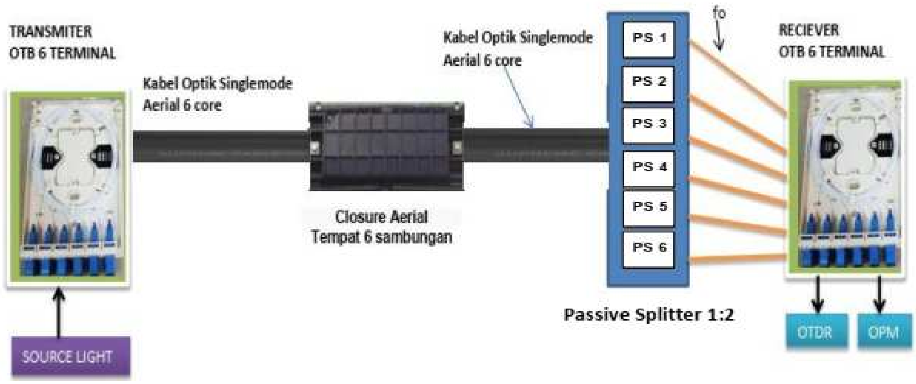

Figure 6. Design of transmission attenuation measurement of Single Mode Aerial Fiber Optic Cable using a passive splitter

3.4. Testing and Measurement

At this stage, the authors carry out the testing and attenuation measurements for each cable connection that is carried out according to the design.

3.5. Analysis, Drawing Conclusions, and Making Reports

This is the final stage in the research process, that is, after all the test data has been collected, the writer will analyze the data, then draw conclusions as the material for the report.

3.6. Research Materials and Tools

In this research, several components are needed to be able to support the tool's work system, namely Single Mode optical cable type Aerial 100 m, 95% Alcohol, Majun Fabric, Protection Sleeve, Tissues, adapter, OTB, Fusion splicer, Passive Splitter, OPM, OTDR, screwdriver, cutting pliers, tube cutter.

4. Results

4.1. Measurement Results Using the OPM Measuring Tool

In this measurement process will be observed the power generated by the input source (source light) sent to the receiver (Receiver) of 10 mW. The results of the measurement of the connection power of the 100 m Aerial type Single Mode optical cable with the cable wavelength used 1310 nm using an Optical Power Meter (OPM) tool. The following are the results of power measurements with an Optical Power Meter (OPM) measuring instrument on a 150 m Aerial Single Mode optical cable with a cable wavelength of 1310 nm:

Table 3. Single Mode Aerial 150 m optical cable

Splicing Type	Pin (watt)	Losses /α(dB) without Passive Splitter	Losses /α(dB) with Passive Splitter
1	0,001	0,16402	0,2198
2	0,001	0,18525	0,2081
3	0,001	0,23018	0,2685

4	0,001	0,19116	0,2155
5	0,001	0,24146	0,2600
6	0,001	0,21834	0,2269

Note Splicing Type:

1. Measurement Results Without Connection with Passive Splitter
2. Measurement Results of the 4 cm Sleeve Protection Connection, one connection with a Passive Splitter.
3. Measurement Results of the 4 cm Sleeve Protection Connection, two connections with a Passive Splitter.
4. Measurement Result of 6 cm Sleeve Protection Connection one connection with Passive Splitter.
5. Measurement Result of 6 cm Sleeve Protection Connection, two connections with Passive Splitter.
6. Measurement results using Barrel Adapter with Passive Splitter.

In table 4 below are the results of previous research measurements that have been made using a 10 meters Pigtail single mode cable.

Table 4. Single Mode Pigtail 10 m optical cable [5]

Splicing Type	Pin (watt)	Losses /α(dB) without Passive Splitter	Losses /α(dB) with Passive Splitter
1	0,001	1,2135	3,1515
2	0,001	1,2728	4,3281
3	0,001	1,9503	5,8471
4	0,001	1,2330	1,8941
5	0,001	1,2552	4,2681
6	0,001	1,2954	4,8141

The next step is to calculate the attenuation value on aerial cables using the attenuation formula. For the calculation of the attenuation value at a wavelength of 1310 nm with a passive splitter, one example is in one connection:

Damping with Connection using Protection Sleeve 4 cm one connection

Given: Pin = 1 mW ; Pout = 0.7536µW ; L = 150 m

Asked: ?

Answer:

$$\alpha(dB) = \frac{10}{L}\log\left(\frac{Pin}{Pout}\right)$$

$$\alpha = \frac{10}{150}\log\left(\frac{1mW}{0{,}7536\ \mu W}\right)$$

$$\alpha = \frac{10}{150}\log\left(\frac{1x10^{-3}\ W}{0{,}7536x10^{-6}W}\right)$$

$$\alpha = 0{,}20819$$

4.2. Loss Measurement Results with OTDR

Measurements were carried out using an Optical Time Domain Reflectometer (OTDR) on a 150m single mode aerial fiber optic cable. In this discussion, measurements of several connections will be made as follows:

1. No Connection

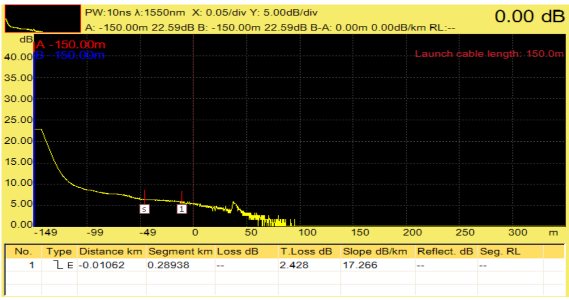

Figure 7. OTDR Test Without Connection

2. Connection Sleeve Protection 4 cm one connection

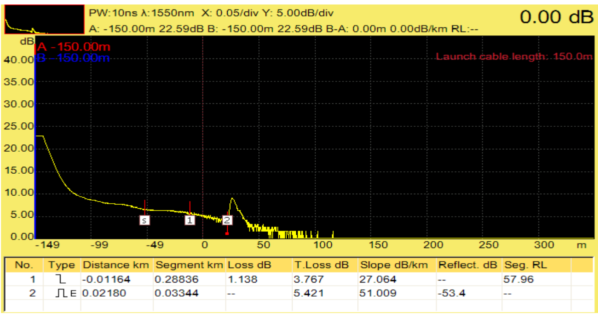

Figure 8. Testing of OTDR with Sleeve Protection 4 cm one connection

3. Connection Sleeve Protection 4 cm two joints.

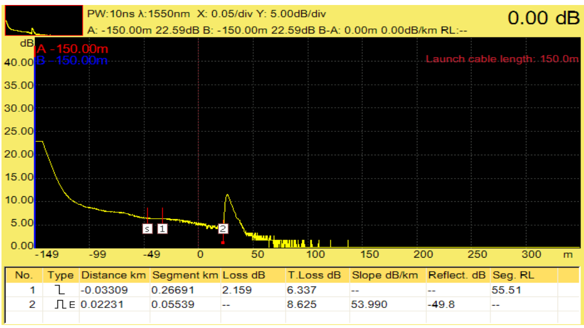

Figure 9. Testing OTDR with Sleeve Protection 4 cm two joints

4. Connection Sleeve Protection 6 cm one connection

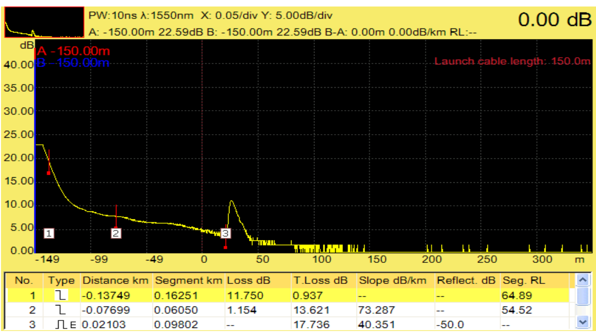

Figure 10. OTDR Test with 6 cm Sleeve Protection one connection

5. Connection Sleeve Protection 6 cm two joints

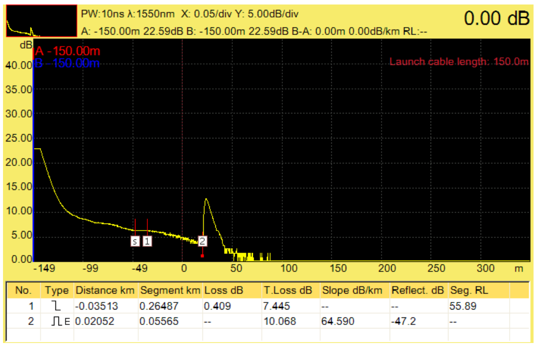

Figure 11. Testing OTDR with Sleeve Protection 6 cm two

6. Connection using Adapter Barrel

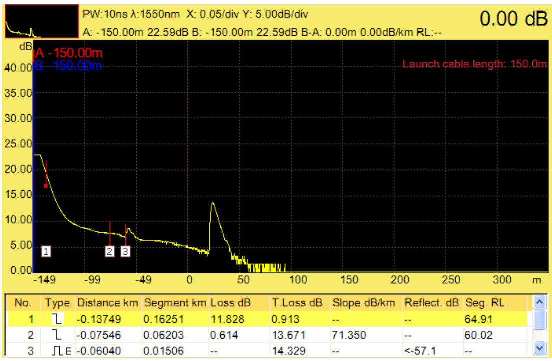

Figure 12. Testing OTDR using Adapter Barrel

4.3. Discussion

The first measurement is carried out with an OPM measuring instrument, the Optical Power Meter is a power measurement tool in a fiber optic communication system, the power level can be displayed in units of W or decibels. In this study, OTB Tx (Transmitter) A will input the input power of the light source of 1 mW and see the output power received using an OPM measuring instrument on OTB Rx B.

In the following analysis, the researcher will compare the results of research that have been made previously using the single mode Pigtail 10 m type as shown in the measurement results in table 4. with the results of the research that the author developed by replacing the type of optical cable used with the type of single mode Aerial optical cable with cable length.150 m wavelength aerial cable according to the standard wavelength used is 1310 nm, the measurement results are shown in table 3

From the measurement results between tables 3 and 4, it can be seen that the attenuation value using single mode Aerial cable is much smaller than that of single mode Pigtail cable. In connection using a 4 cm protection sleeve, one connection obtained an attenuation value of 0.1852 dB, this value is smaller than the pigtail cable, which is 1.2728 dB. In this type of connection using a 4 cm protection sleeve, one connection with the installation of a passive splitter, the attenuation value on the aerial cable is smaller, namely 0.20819 dB compared to the pigtail cable, which is 4.3281, the difference in the attenuation value is quite large, which is 4.11 dB. This also applies to other types of splicing, because the more splicing is done, the attenuation value will also increase. Where the difference in the attenuation value is quite large, this is because usually single mode pigtail optical cables are never used for transmitting information signals over long distances, usually Pigtail optical cables are used for Patch Cord cables to connect between devices or to telecommunication connections, for transmission using cables. long-distance optics PT Telkom uses a single-mode Aerial cable because it has a much smaller transmission attenuation value like the results of the measurements researchers did.

The second measurement is using an OTDR measuring instrument, OTDR is a measuring instrument used to get a visual picture of the fiber optic attenuation along the link displayed on a screen with distance depicted on the 'X' axis and power on the 'Y' axis. The purpose of the measurement using OTDR is to measure attenuation, measure splice loss, measure loss between two points, measure cable distance and localize interference.

For the attenuation value with the connection type of one and two connections using a protection sleeve of 4 cm and 6 cm, the loss value of the connection with a protection sleeve of 6 cm is smaller, namely 0.155 dB and 0.409 dB can be seen in Figure 10 and in Figure 11, compared to the protection sleeve 4 cm, namely 0.319 dB and 0.414 dB can be seen in Figure 8 and Figure 9.

The attenuation value of the connection is due to the length of the protection sleeve used is very decisive and also the connection process using a splicer. The connection attenuation value is much higher with the type of connection using an adaper barrel with a connection loss of 12,216 dB and a total loss of 14.329 dB this is because the process of installing the adapter barrel and installing the SC connector is done manually which causes the attenuation value of the connection to be larger, but the value of the connection attenuation is higher. the total attenuation loss in the adaper barrel is still below the ITU standard from PT Telkom, the maximum attenuation is still allowed for fiber optic transmission below 28 dB. From the results of measurements with this OTDR will also affect the value of the total attenuation in one fiber optic cable transmission link.

5. Conclusion

The second measurement is using an OTDR measuring instrument, OTDR is a measuring instrument used to get a visual picture of the fiber optic attenuation along the link displayed on a screen with distance depicted on the 'X' axis and power on the 'Y' axis. The purpose of the measurement using OTDR is to measure attenuation, measure splice loss, measure loss between two points, measure cable distance and localize interference. For the attenuation value with the connection type of one and two connections using a protection sleeve of 4 cm and 6 cm, the loss value of the connection with a protection sleeve of 6 cm is smaller, namely 0.155 dB and 0.409 dB can be seen in Figure 10 and in Figure 11, compared to the protection sleeve 4 cm, namely 0.319 dB and 0.414 dB can be seen in Figure 8 and Figure 9.The attenuation value of the connection is due to the length of the protection sleeve used is very decisive and also the connection process using a splicer. The connection attenuation value is much higher with the type of connection using an adapter barrel with a connection loss of 12.216 dB and a total loss of 14,329 dB this is because the process of installing the adapter barrel and installing the SC connector is done manually which causes the attenuation value of the connection to be larger, but the value of the connection attenuation is higher. the total attenuation loss in the adapter barrel is still below the ITU standard from PT Telkom, the maximum attenuation is still allowed for fiber optic transmission below 28 dB. From the results of measurements with this OTDR will also affect the value of the total attenuation in one fiber optic cable transmission link.

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