

Analysis of Signal Attenuation in the Indosat Fiber to the Home (FTTH) Network at Three Fat Points and the Role of Closures in Optimizing Optical Signals in Cluster RW07, Dusun I, Madegondo, Sukoharjo Regency, Central Java

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Abstract— The implementation of Fiber to the Home (FTTH) networks is an effective solution for providing high-quality telecommunication services with stable data speeds. This study was conducted on the FTTH network in Cluster RW 07, Dusun 1, Madegondo, Sukoharjo Regency, Central Java, to evaluate its feasibility based on PT. iForte's standards. These standards specify a receiving power range of -10 dBm to -21 dBm and a total attenuation range of 15 dB to 26 dB. The research process involved observation, optical power data collection, data processing, and analysis using the Power Link Budget parameter.

The measurement results showed an improvement in network quality after optimization. The uplink and downlink attenuation at FAT 1, 6, and 11 experienced significant reductions, with the final attenuation values falling within the specified standard limits. For instance, at FAT 11, the downlink attenuation decreased by 1.10 dBm, representing one of the most significant improvements. These findings demonstrate that the FTTH network in the study area meets the feasibility criteria and delivers performance suitable for supporting user needs.

Keywords: FTTH, attenuation, Receiving Power, Power Link Budget, PT. iForte.

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I. INTRODUCTION

At this time people need communication technology in almost all their daily activities. According to (Maria et al, 2022) To increase the speed of high internet access, a transmission medium is needed that can provide this and copper is currently being migrated to fiber optic in order to meet these needs. According to (Zukri et al, 2022) Fiber optic cables are a solution to transmission media in distributing telecommunications networks from various telecommunications network problems. According to (Albar, 2020) The most commonly used fiber optic cable splicing is fusion splicer because it produces less attenuation loss than mechanical methods. According to research (Kartiria 2022) in an effort to overcome the problem of increasing attenuation in both new installation lines and old installations, it is still

necessary to check the fiber optic cable using devices and measuring instruments, because it could be that some time after installation the position of the cable has changed a lot or it could be loose, loss of light energy due to broken cables, inaccurate cable connection, cable bending, less efficient travel paths and other factors that greatly affect the increase in attenuation. Due to a report from the MS team after checking there are several FATs that have a high loss attenuation value. With regard to this, a performance analysis was carried out from the data of 3 FAT points, in this study choosing Cluster RW 07 Dusun 1 Madegondo because the population is quite large and requires a good FTTH network with 3 FAT points that can be sampled and compared to the three points that have decent attenuation values to unfit attenuation, from the closest to the farthest distance from the distribution point and must be followed up to take appropriate steps such as repair and maintenance. It is very necessary to know the performance of an FTTH (Fiber To The Home) network by evaluating and analyzing the calculation of

attenuation on the network path based on attenuation standardization using periodic power link budget calculations to assess network feasibility and be able to make decisions and solutions based on the results of the analysis.

II. RESEARCH AND METHOD

The first step in analyzing FTTH networks is to determine the location to be analyzed. The reason for choosing Cluster Rw 07 Dusun 1 Madegondo is because with the population density that requires a good FTTH network and there are reports from MS regarding high loss attenuation in several FATs, a special analysis is needed to determine the condition of the FTTH network in the area.

A. Research Flow

The first step in analyzing FTTH networks is to determine the location to be analyzed. The reason for choosing Cluster Rw 07 Dusun 1 Madegondo is because with the population density that requires a good FTTH network and there are reports from MS regarding high loss attenuation in several FATs, a special analysis is needed to determine the condition of the FTTH network in the area.

Data collection along with field surveys to determine the Housing area to be analyzed. Field survey data in the form of location, device location points. and the number of OLT devices, fiber optic cables, FDTs, FATs, Splitters, obtained from PT. IFORTE. Then perform mathematical calculations to determine the Power link budget parameters. The results of the analysis using measurements and mathematical calculations are then compared with the eligibility standards of PT. IFORTE

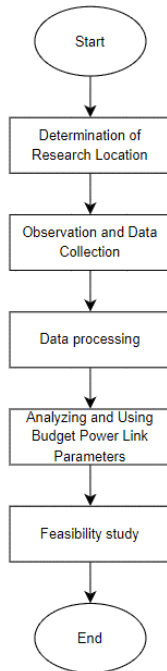


Figure 1 Flowchart of the research

B. TOOLS AND MATERIALS

The equipment used in this study are:

1. Laptop / gadget
2. OPM
3. Patchcord
4. OLT
5. FDT
6. FAT
7. Google Earth Pro software
8. Data collection notebook

III. RESULTS AND DISCUSSION

A. Parameters Power link Budget

1. Calculation from OLT to nearest FAT

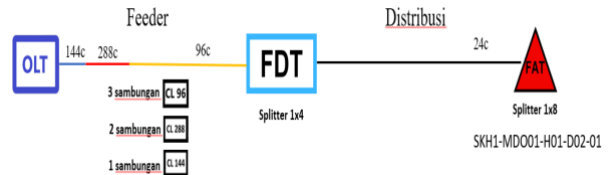


Figure 2 Block diagram of FAT 1

TABLE I
FAT 1 NETWORK PARAMETER DATA

Parameter	Description
Pt	5 dBm
Pr	-21 dBm
αserat (1310)	0,35 dB/km
αserat (1490)	0,28 dB/km
Nc	5 connector
αc	0,25 dB/connector
Ns	10 splice
αs	0,1 dB/splice
αSp 1:4	7,25 dB
αSp 1:8	10,38 dB
Safety Margin	3 dB
Margin Daya	> 0dBm

Here is the calculation of the nearest FAT (FAT 1) with a distance of 12,070 km from OLT to FAT will be shown as follows.

OLT to FAT calculation:

a. Uplink

$$\begin{aligned}
 atot &= L.\alpha_{serat} + N_c.\alpha_c + N_s.\alpha_s + Sp\ 1:4 + Sp\ 1:8 \\
 &= (12,070 \times 0,35) + (5 \times 0,2) + (10 \times 0,15) + \\
 &(7,25) + (10,38) \\
 &= 4,2245 + 1 + 1,5 + 7,25 + 10,38 \\
 &= 24,3545\ dB
 \end{aligned}$$

Power receives

$$\begin{aligned}
 atot &= Ptx + Prx \\
 Prx &= Ptx - atot \\
 Prx &= 5 - 24,3545 \\
 Prx &= -19,35\ dBm
 \end{aligned}$$

b. Downlink

$$atot = L.\alpha_{serat} + N_c.\alpha_c + N_s.\alpha_s + Sp\ 1:4 + Sp\ 1:8$$

$$\begin{aligned}
 &= (12,070 \times 0,28) + (5 \times 0,2) + (10 \times 0,15) + (7,25) + \\
 (10,38) & \\
 &= 3,3796 + 1 + 1,5 + 7,25 + 10,38 \\
 &= 23,5096 \text{ dB}
 \end{aligned}$$

Power receives

$$\begin{aligned}
 atot &= Ptx + Prx \\
 Prx &= Ptx - atot \\
 Prx &= 5 - 23,5096 \\
 Prx &= -18,50 \text{ dBm}
 \end{aligned}$$

Based on the calculation of the uplink and downlink power budget links, the Pr value is less than -21 dBm, namely Pr = -19.35 dBm for downlink and Pr = -18.50 dBm for uplink. At a power margin of more than zero, namely for downlink and for uplink.

2. Calculation from OLT to Central FAT

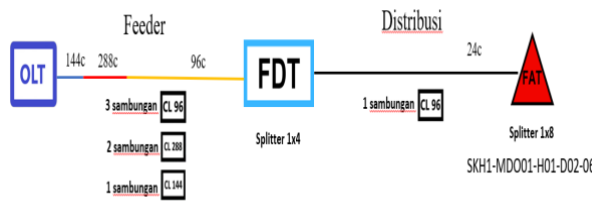


Figure 3 Block diagram of FAT 6

TABLE II
FAT 6 NETWORK PARAMETER DATA

Parameter	Description
Pt	5 dBm
Pr	-21 dBm
aserat (1310)	0,35 dB/km
aserat (1490)	0,28 dB/km
Nc	5 connector
ac	0,25 dB/connector
Ns	11 splice
as	0,1 dB/splice
αSp 1:4	7,25 dB
αSp 1:8	10,38 dB
Safety Margin	3 dB
Margin Daya	> 0 dBm

Here is the calculation of the middle FAT (FAT 6) with a distance of 12,862 km from OLT to FAT will be shown as follows.

OLT to FAT calculation:

a. Uplink

$$\begin{aligned}
 atot &= L.aserat + Nc.ac + Ns. as + Sp \\
 &= (12,862 \times 0,35) + (5 \times 0,2) + (11 \times 0,15) + (7,25) + \\
 (10,38) & \\
 &= 4,5017 + 1 + 1,65 + 7,25 + 10,38 \\
 &= 24,7817 \text{ dB}
 \end{aligned}$$

Power receives

$$\begin{aligned}
 atot &= Ptx + Prx \\
 Prx &= Ptx - atot \\
 Prx &= 5 - 24,7817 \\
 Prx &= -19,7817 \text{ dBm}
 \end{aligned}$$

b. Downlink

$$atot = L.aserat + Nc.ac + Ns. as + Sp$$

$$\begin{aligned}
 &= (12,862 \times 0,28) + (5 \times 0,2) + (11 \times 0,15) + (7,25) + \\
 (10,38) & \\
 &= 3,60136 + 1 + 1,65 + 7,25 + 10,38 \\
 &= 23,73 \text{ dB}
 \end{aligned}$$

Power receives

$$\begin{aligned}
 atot &= Ptx + Prx \\
 Prx &= Ptx - atot \\
 Prx &= 5 - 23,73 \\
 Prx &= -18,73 \text{ dBm}
 \end{aligned}$$

Based on the calculation of the uplink and downlink power budget links, the Pr value is less than -21 dBm, namely Pr = -19.78 dBm for downlink and Pr = -18.73 dBm for uplink. At a power margin of more than zero, namely for downlink and for uplink.

3. Calculation from OLT to Farthest FAT

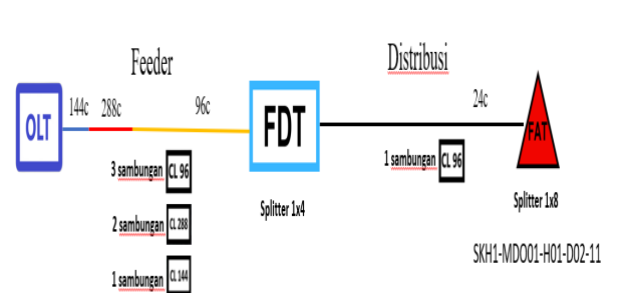


Figure 4 Block diagram of FAT 11

TABLE III
FAT 11 NETWORK PARAMETER DATA

Parameter	Description
Pt	5 dBm
Pr	-21 dBm
aserat (1310)	0,35 dB/km
aserat (1490)	0,28 dB/km
Nc	5 connector
ac	0,25 dB/connector
Ns	11 splice
as	0,1 dB/splice
αSp 1:4	7,25 dB
αSp 1:8	10,38 dB
Safety Margin	3 dB
Margin Daya	> 0 dBm

Here is the calculation of the furthest FAT (FAT 11) with a distance of 13,206 km from OLT to FAT will be shown as follows.

OLT to FAT calculation:

a. Uplink

$$\begin{aligned}
 atot &= L.aserat + Nc.ac + Ns. as + Sp \\
 &= (13,206 \times 0,35) + (5 \times 0,2) + (11 \times 0,15) + \\
 (7,25) + (10,38) & \\
 &= 4,6221 + 1 + 1,65 + 7,25 + 10,38 \\
 &= 24,9021 \text{ dB}
 \end{aligned}$$

Power receives

$$\begin{aligned}
 atot &= Ptx + Prx \\
 Prx &= Ptx - atot \\
 Prx &= 5 - 23,97 \\
 Prx &= -19,9021 \text{ dBm}
 \end{aligned}$$

a. Downlink

$$\begin{aligned} \alpha_{tot} &= L_{aserat} + N_{c.ac} + N_{s. as} + S_p \\ &= (13,206 \times 0,28) + (5 \times 0,2) + (11 \times 0,15) + (7,25) + \\ (10,38) & \\ &= 3,69768 + 1 + 1,65 + 7,25 + 10,38 \\ &= 23,97 \text{ dB} \end{aligned}$$

Power receives

$$\begin{aligned} \alpha_{tot} &= P_{tx} + P_{rx} \\ P_{rx} &= P_{tx} - \alpha_{tot} \\ P_{rx} &= 5 - 23,97 \\ P_{rx} &= -18,87 \text{ dBm} \end{aligned}$$

Based on the calculation of the uplink and downlink power budget links, the Pr value is less than -21 dBm, namely Pr = -19.90 dBm for downlink and Pr = -18.87 dBm for uplink. At a power margin of more than zero, namely for downlink and for uplink.

B. FAT Damping Measurement Results Before Closure Optimization on Distribution Paths

1. Nearest FAT (FAT 1)

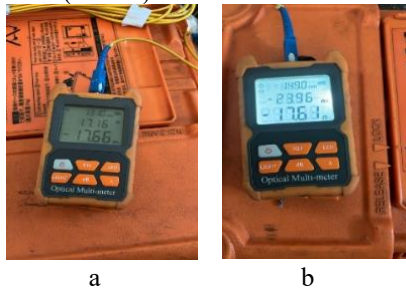


Figure 5 a. FAT 1 uplink attenuation, b. FAT 1 downlink attenuation

The following is the uplink and downlink attenuation in the field on FAT 1 which is the closest FAT with an uplink value = -17.66 dBm and downlink = -17.61 dBm.

2. Middle FAT (FAT 6)

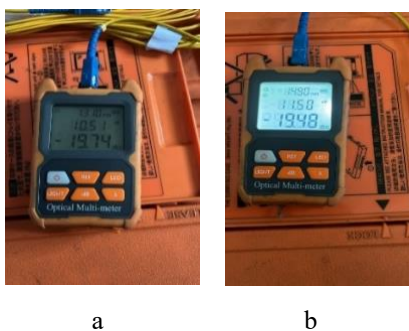


Figure 6 a. FAT 6 uplink attenuation, b. FAT 6 downlink attenuation

Figure 6 shows the results of uplink and downlink attenuation in the field on FAT 6 with an uplink value = -19.74 dBm and downlink = -19.48 dBm.

3. FAT Farthest (FAT 11)



Figure 7 a. FAT 11 uplink attenuation, b. FAT 11 downlink attenuation

Figure 7 above is the result of uplink and downlink attenuation in the field at the furthest FAT which is FAT 11 with an uplink value = -20.15 dBm and downlink = -19.91 dBm.

C. Optimizing Closure in Distribution Channels

Closure optimization is essential to ensure that the quality of the connection is maintained and signal attenuation can be minimized. The first stage is to physically inspect the closure to ensure there is no damage, such as leaks in the sealant, worn gaskets, or pulled cables. This inspection also includes the internal condition of the closure to ensure that the cable connection is properly maintained.

The second stage is to carefully open the closure to repair any detected problematic connections. The re-splicing process is carried out on connections with high attenuation using a splicing machine to produce a precision connection with lower attenuation. Each repaired connection must be re-protected with a splice protector to withstand mechanical stress and environmental disturbances. In addition, the cables inside the closure must be neatly re-arranged to avoid sharp bends that can increase attenuation.

The third step is to clean the optical connectors in the closure using special tools to ensure there is no dust or dirt that can affect signal quality. After all repair processes are complete, the closure is closed again by ensuring all sealants and gaskets are properly installed to maintain water and dust resistance.

D. FAT Damping Measurement Results After Closure Optimization On Distribution Path

1. Nearest FAT (FAT 1)

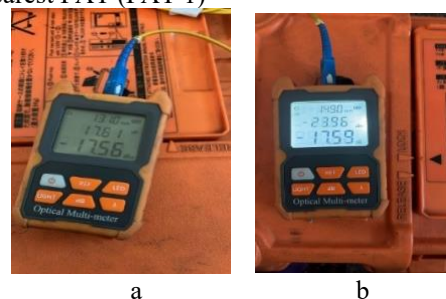


Figure 8 a. FAT 1 uplink attenuation, b. FAT 1 downlink attenuation

In Figure 8 above, the uplink and downlink attenuation in the field on FAT 6 with an uplink value = -17.56 dBm and downlink = -17.59 dBm.

2. Middle FAT (FAT 6)

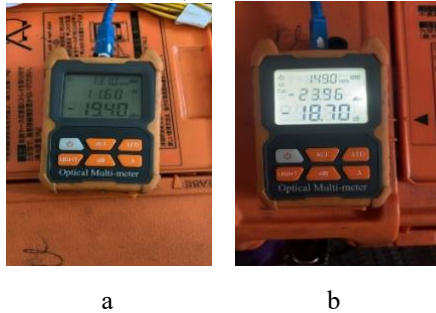


Figure 9 a. FAT 6 uplink attenuation, b. FAT 6 downlink attenuation

Figure 9 shows the results of uplink and downlink attenuation in the field on FAT 6 with uplink values = -19.40 dBm and downlink = -18.70 dBm.

3. FAT Farthest (FAT 11)

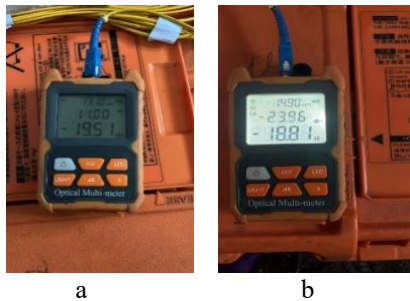


Figure 10 a. FAT 6 uplink attenuation, b. FAT 6 downlink attenuation

Figure 10 shows the results of uplink and downlink attenuation in the field on FAT 11 with uplink values = -19.51 dBm and downlink = -18.81 dBm.

TABLE IV
COMPARISON OF FAT DAMPING MEASUREMENT AND CALCULATION VALUES

FAT	Calculation (dBm)		Measurement Before Optimization (dBm)		Measurement After Optimization (dBm)	
	Uplink	Downlink	Uplink	Downlink	Uplink	Downlink
1	-19,35	-18,50	-17.66	-17.61	-17.56	-17.59
6	-19,78	-18,73	-19.74	-19.48	-19.40	-18.70
11	-19,90	-18,87	-20.15	-19.91	-19.51	-18.81

Table 3 shows a comparison of the calculated attenuation values with the measurement results before and after optimization on three FATs (Fiber Access Terminals). The parameters compared include uplink and downlink. The attenuation values in the table are evaluated against the PT IFORTE standard, which sets a maximum attenuation tolerance limit of -21 dBm to ensure the quality of the FTTH (Fiber to the Home) network.

Based on PT. IFORTE standards, which set a maximum attenuation of -21 dBm, all measurement results before and after optimization are still within reasonable limits. This attenuation value ensures that the FTTH system on the three FATs is able to provide performance that meets the technical specifications for transmitting high-quality data.

From the analysis results, it can be concluded that the attenuation value after optimizing the closure on the three FATs has met the standard. This shows that the implementation and management of the FTTH network at this location has been carried out well and can provide reliable communication services to users.

IV. CONCLUSION

Based on the results of the comparison of calculation values, measurements before optimization, and measurements after optimization, it shows a significant decrease in power receives after optimization. In FAT 1, the power receives uplink decreased by 0.10 dBm, and the power receives downlink decreased by 0.02 dBm. In FAT 6, the power receives uplink decreased by 0.34 dBm, while the power receives downlink decreased by 0.78 dBm. In FAT 11, the power receives uplink decreased by 0.64 dBm, and the power receives downlink decreased by 1.10 dBm. These results indicate that optimization has succeeded in improving the quality of the FTTH network by reducing attenuation, so that the network meets the eligibility standards of PT. iForte. Factors that affect signal attenuation in the FTTH network in the RW 07 Dusun 1 Madegondo cluster include cable length, connection, and the addition of closures to the distribution line. The closure optimization that was carried out has proven effective in increasing signal efficiency and reducing attenuation in the FAT. This process can include resetting devices, maintaining connections, or reconnecting at the closure point on the distribution line to support better signal distribution.

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