

# UTILIZATION OF PRE-EDFA IN IMPROVING CATV SIGNALS IN P2P FTTH; A MALAYSIAN SCENARIO

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## ABSTRACT

*This paper describes Malaysia's recent approach in fiber-to-the-home (FTTH) network through the utilization of pre-erbium doped fiber amplifier (pre-EDFA) in improving Community Antenna Television (CATV) signals in point-to-point (P2P) topology. The optical network unit (ONU) input power and the CATV output quality is observed on a television (TV) unit display each time the EDFA current setting is changed, for before and after a second EDFA is installed between transmitter and ONU (pre-EDFA) for a Malaysian scenario. Before pre-EDFA is installed, the dynamic range is not obtained since the saturation point is not clear, and thus could not be pointed yet. The findings after the pre-EDFA is installed is that, the dynamic range is found to be equals to -17.85 dBm ~ 3.03 dBm for fiber spool used length at 15.225 km. The dynamic range is selected based on the ONU input power when the CATV signal's output is good and clear. The result shows that pre-EDFA improved the CATV signals displayed for a Malaysian scenario.*

**KEYWORDS:** CATV signals, FTTH, Pre-EDFA, P2P, Malaysia.

## 1.0 INTRODUCTION

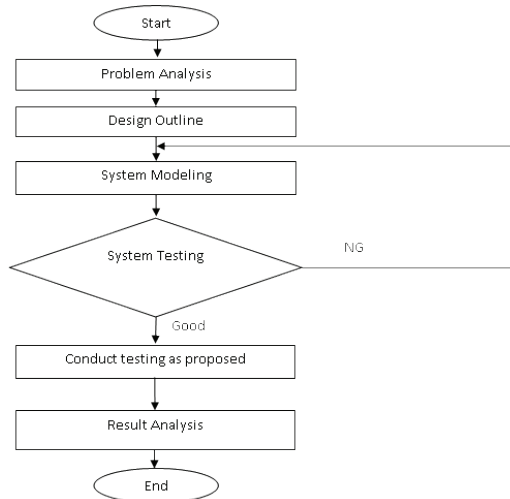
In this paper, we present our recent findings in improving signals of Community Antenna Television (CATV) in point-to-point (P2P) topology of fiber-to-the-home (FTTH) network through the utilization of pre-erbium doped fiber amplifier (pre-EDFA), in Malaysian scenario. Basically in video broadcasting, end users mainly concern about the quality of video they are watching. FTTH network offers unlimited bandwidth, and thus greater service prospects compares to copper and wireless media (Frigo *et al.*, 2004). Thus, the utilization of FTTH network in CATV system ensures a higher quality video and services, and thus would satisfy the customer demand (Mohammad Syuhaimi Ab-Rahman *et al.*, 2009). As in Malaysia,

industry players are struggling hard and competing among them to satisfy the customer's requirement, and to be the top player in this field (Park *et. al.*, 2004).

Our recent study focusing on the improvement of received CATV signals, as one of ways to satisfy the user's demand for a Malaysian scenario. We concentrated on the utilization of pre-EDFA to enhance the CATV signals quality in terms of FTTH-P2P topology. The purpose is to observe whether there are any difference of the signals quality before and after the pre-EDFA is installed in this topology, and whether there is signal improvement after the pre-EDFA is utilized.

## **2.0 METHODOLOGY**

Our approach is feeding a CATV input onto fiber optic link in FTTH-P2P network. Figure 1 as shown below shows the overall research procedures for this study, whereas Figure 2 characterizes the interconnection of associated CATV FTTH-P2P system before a pre-EDFA is installed. Basic components required in this network are video signal source from DVD players, modulator, combiner, CATV Radio Frequency (RF) amplifier, transmitter, EDFA, optical line terminal (OLT), optical fiber cable spool, optical network unit (ONU) and CATV output (TV). Subsequently, Figure 3 shows the interconnection of associated CATV FTTH-P2P system after the utilization of pre-EDFA. Assembly work is performed to connect all the devices required for the network after calibration is done and confirmed that all these devices are functioning properly and well-configured.

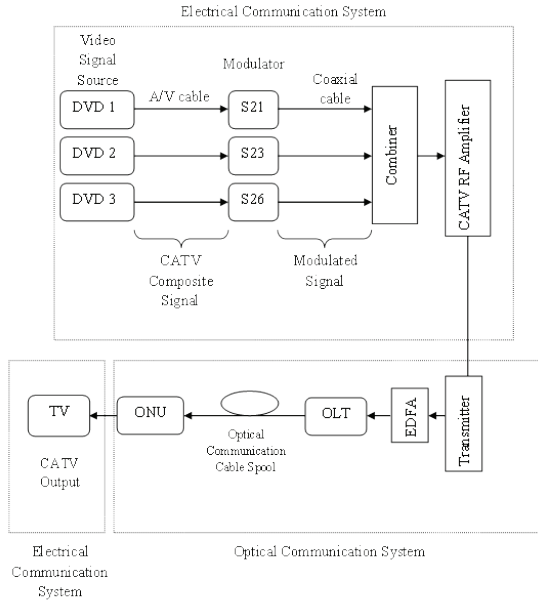


**Figure 1** Overall study procedures

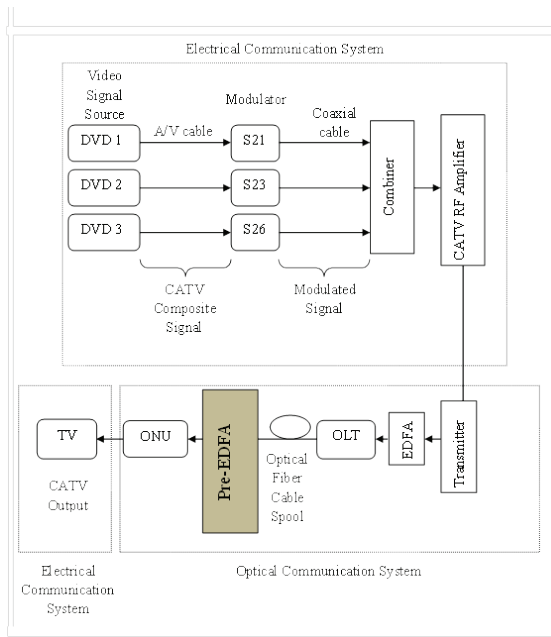
Three DVD players functioned as an input to the system in order to generate video and audio signals. These DVD players are connected to each respective RF modulators using audio/video cable. From here, the DVD players sent a video and audio signal to its respective RF modulator for modulation process. All those modulators are subsequently connected to a combiner using coaxial cables. Here, the signal outputs from RF modulators are combined into the combiner device in order to produce a baseband signal. Frequency Division Multiplexing (FDM) technique is used for these signals combination. From this combiner, the connection went to a CATV RF amplifier, which is then connected to a transmitter, also using coaxial cables. The CATV composite signal is then the input to the optical system.

Afterward, the transmitter is connected to an EDFA using fiber patch cord. Then, the EDFA is also connected by fiber patch cord to an OLT. The transmitter responsible to execute electro-optic signal conversion, while EDFA acts to boost the optical signal power from the transmitter before signal is transmitted to OLT. The video signal is then transmitted by OLT optically for some distance using optical fiber cable spool before it is connected to an ONU which functions as an optical receiver. The optical fiber cable spool is used to provide the transmission line for the optical signal from OLT to ONU. From the ONU, it is then connected to a TV unit operating as the video display output using a coaxial cable. At the ONU, optical signal power is detected and converted to the time varying CATV composite signal. The TV unit is used to perform further electrical

demodulation. Finally, all of the video and audio signals from the DVD players can be viewed in different channel upon tuning on the display of TV unit.



**Figure 2** Interconnection of CATV FTTH-P2P System (Without Pre-EDFA)



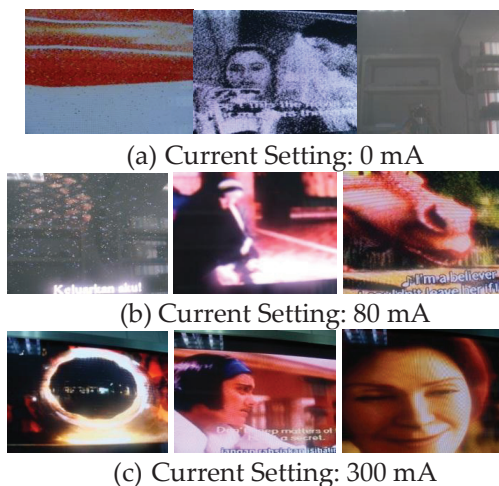
**Figure 3** Interconnection of CATV FTTH-P2P System (With Pre-EDFA)

### 3.0 RESULT AND DISCUSSION

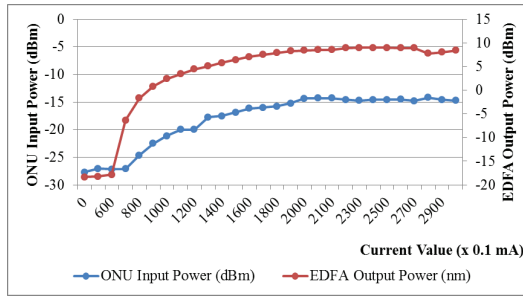
Firstly, the ONU input power and the CATV output quality is observed on a TV unit display each time the EDFA current setting is changed, before pre-EDFA is used. The CATV signal quality is observed on a TV unit display each time the EDFA current setting is changed. The ONU input power is also measured at each setting using an optical spectrum analyzer (OSA). The representative of CATV signal obtained is shown in Figure 4 while the ONU input power result is plotted in Figure 5.

At the target pump drive current of 0 mA, the CATV output image is not good as there is much noised interrupting transmitted signal from the transmitter. Only starting from current value of 80 mA, the CATV output image is started to become clear but still with a small dot in the channel 1 as the ONU input power at this point is just at the power sensitivity level. Then, beyond the current value of 80 mA, the CATV output image obtained is a good, clear picture until the value of 300 mA.

From the result obtained for CATV output image (without pre-EDFA), we could not clearly see yet whether the image already started to look bright; which means already achieved saturation level or not because there is no much changes in the quality of the CATV output image from the current value of 80 mA until the maximum value. The value of ONU input power is not achieved the saturation level yet in this testing as the ONU input power is still increasing until the setting is set at maximum setting value.



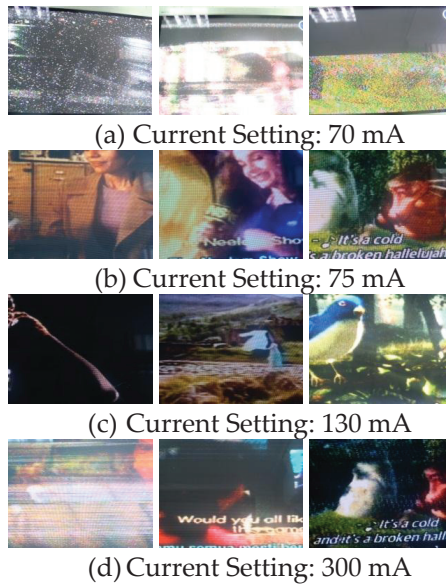
**Figure 4** CATV signal quality at each setting  
(Without Pre-EDFA)



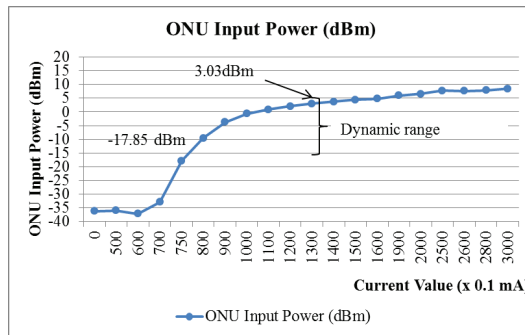
**Figure 5** ONU input power at each setting (Without Pre-EDFA)

Before pre-EDFA is installed, the only installed EDFA is before OLT unit. With this location, when the optical signal is detected by OLT, the optical signal power will be divided by 24 due to the OLT used in the connection has 24 outputs, before the optical signal with the divided power is transferred to ONU unit. Thus, even though the EDFA used in the connection could generate high output power, the function was wasted because the power is then divided to 24 divisions before transferred to ONU unit. That is why we observed only a small increase in ONU input power even the EDFA output power is increased significantly.

To compare the CATV signals quality, pre-EDFA is then installed to observe the difference. The purpose is to get a better CATV signals quality since high power should be obtained as this time the power will not be divided. This is due to the pre-EDFA is connected between the OLT unit and the ONU unit. The representative of CATV signal obtained is shown in Figure 6 while the ONU input power result is plotted in Figure 7.



**Figure 6** CATV signal quality at each setting (With Pre-EDFA)



**Figure 7** ONU input power at each setting (With Pre-EDFA)

Starting at value of 70 mA, the ONU started to receive CATV signal. This means that at this point, it already achieved ONU's power sensitivity level. Then, when the setting value is gradually increased, the CATV output image obtained is getting better. Then, at current value of 75 mA, a good, clear CATV signals are obtained. The ONU input power at this point was -17.85 dBm. This power value shows a great gain from the value obtained at the current value of 70 mA. As the current is increased, the associated CATV signals quality at each setting are also showed as a good, clear signal until the current value is equals to 130 mA; where the ONU input power is 3.03 dBm.

Afterwards, as the current setting is steadily increased from this point until the maximum setting value, we could observed from the CATV signal that its quality is worsen as the image gets brighter and brighter and looks like the image is shining. This is because of too much power amplification, over than the optimal power required. The point where the CATV signal started to seem too bright; or shining is at current value of 130 mA. This means that the ONU input power obtained is already saturated. The ONU data input at this point was 3.03 dBm. As the setting gradually approached maximum setting value, the CATV signal quality get worsen, as too much power amplification is imposed which then decreased the CATV output signal quality.

From this testing, it is concluded that the dynamic range of this model is -17.85 dBm ~ 3.03 dBm, at fiber spool length of 15.225 km. This dynamic range is taken from where the CATV output signal started to have a good, clear image and until just before the CATV signal started to seem shining due to already achieved power saturation level.

#### **4.0 CONCLUSION**

The result shows that as studied for a Malaysian scenario, the pre-EDFA installation enhanced the CATV signals quality displayed.

#### **5.0 ACKNOWLEDGEMENT**

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