The Next Generation CATV Tester for Ease of Monitoring and Maintenance in Fiber-to-the-Home (FTTH) Network

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Abstract

Fiber-to-the Home (FTTH) network system is a broadband network system which can transmit video, data and voice signals. To ensure good signals condition, a CATV tester device is proposed. The CATV tester device is designed to measure CATV signals passing through the optical network unit (ONU) at users' premises. A single mode optical fiber signal entering the ONU will be obtained by 'tapping' method and the signal will then be fed into the CATV tester device through optical cable connection. A wireless technology is applied through the implementation of audio video transmitter and receiver. Then, this tester will display the received signal on the display panel. Although the signal received is accompanied by undesired signals and noises, it will then indicate that the status of main FTTH drop line, the possible damages and action needed that can be easily determined afterwards. By the application of wireless technology, signal transmitted through the fiber optic cable located underground can be easily detected and determined whether it is functioning or not.

1. Introduction

FTTH network system is the latest broadband network system which capable of transmitting video, data and voice signals to the user at a high speed level. FTTH network uses optical fiber as the medium cable for signals transmission to users. Before optical fiber is implemented into networks, telephony copper cable is used to carry signals generated by telephony devices. This analog signal technology is only capable of sending signals with a small capacity. However, with the implementation of optical fiber, multiple signals can be transmitted in a swift, and at once. This provides the possibility for users to employ the internet and video and other services with more ease and at a faster speed. This is so due to optical fiber's capability of carrying the data signals at a speed exceeding 2.5 Gigabits per seconds compared to the speed of the signals carried through copper cables, which is 1.5 Mbps. Therefore, network using copper as the main cable has restricted uses based on the capacity of signals that can be carried at one time. Besides that, the maximum capacity limit for the cooper based wire is 10 Gbps and fiber is the potential technology to carry this traffic. In laboratory, the speed of transmission has already achieved 10 Gbps.

FTTH system transmits 3 types of signals to users which are voice, data and video. Video service penetrates the FTTH system from television cable central office or via satellite. These signals will then be combined using WDM method and transmitted to users through a single optical fiber. Wavelength for each data and voice signals are 1480 nm and 1550 nm for each video signal. All the combined signals will be transmitted to end users through passive optical splitter with the splitter separation rate varies from 2 up to 32 users. At the user part, there will be an optical-to-electrical converter (OEC) that functions to convert the received optical signals to electrical signals. Subsequently, OEC will differentiate the signals according to users' need [5].

FTTH system has many advantages. The passive optical network that is being deployed enables the users to share the services offered by using the same fiber connection. This FTTH network is also very simple and does not require active components with low operating cost to comply with users' demand. The bandwidth of the network is very important and will be the deciding factor of the capacity that can be carried. The broader the bandwidth, the larger the data can be carried at one time [3]. Figure 1 shows the FTTC (Fiber to the Curb) and FTTH system [6].

CATV technology has been used since a few decades ago and nowadays its usage has escalated into variety of applications. In general, the usage of television cable is to send the television broadcasting signals to the remote areas in which these areas could not receive the broadcast signals through antennas. With the usage of CATV as the television cable, it gives a plus in term of bandwidth. This is because the bandwidth for CATV

television cable is wider and this made it possible for the cable to transmit a number of entertainment channels and video signals to users [4].

There are five main parts of the coaxial cable system which are headed, trunk cable, distribution cable, and trunk drop and equipment terminal. Figure 2 shows the distribution system that uses CATV as cable.

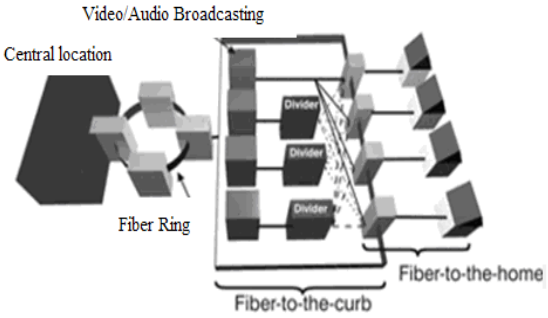

Figure 1. Network system for FTTC and FTTH

The signals carry by the distribution cable will be tapped and sent to users through drop cable. Distribution cable will be interfaced with the amplifier at the main trunk cable. The amplifier at the trunk cable functions to strengthen the signals before it is transmitted to users. The signal transmission system that is able to transmit and maintain the quality of the signals is considered as a good transmission. This is the main objective desired by every transmission system. It can be realized with an optical fiber-based cable system.

First generation CATV tester unit was developed to measure video signals for FTTH system. The tester consists of two parts; portable unit and passive components. These parts are merged together to form a system that was capable of detecting and displaying video image on the portable unit.

CATV tester prototype measures the video signal that is passing through optical network unit (ONU). Signal in the single core optical fiber is obtained through a tapping method and is then connected to the CATV tester unit via an optical wire. If the signal received by CATV tester unit consists of interferences (poor condition) it shows that the main cable line is in distress and needed to be fixed [2]. However, this system is difficult to be implemented in closed areas such as underground connection. Thus, a new method is required to make it possible for the CATV tester unit to measure the video signal without the need of wire connection.

2. Next Generation CATV Tester

Video signal transmission system to users via optical fiber has been proven in providing more benefits compared to video signal transmission via satellite. However, the possibility of impairment occur to the network system is unavoidable. Thus, to verify whether impairment has occurred, a CATV tester unit is developed. This device used a direct connection to the tapped signal. However, this method limited the area of measurement. Therefore, a new method is required to obtain the tapped signal wirelessly, without the presence of wired connection.

A new tester unit is designed by adapting CATV's video signal detection method via wireless that is capable of measuring CATV video signal. Phases involves in the development of second generation CATV tester unit is system theory and design, system development and system evaluation and device's specifications verification. The second generation of CATV Tester is renamed as Wireless CATV Tester Unit (WCTU).

Signal on the main line will be transmitted to ONU before it is distributed to users. Signals sent to ONU are the already combined signals. Hence, it need to be split according to their respective wavelength with 1480nm for data and voice signal and 1550nm for video signal by using passive components. In this passive circuit also, video signal will be split to a 90:10 ratio. 90% of the split signal will be recombined with 1480 nm signal while the other 10% of the split video signal will be sent to optical-to-electrical converter to translate the optical signal into an electrical signal.

In the next stage, CATV electrical signal will be sent to wireless system. Wireless system consists of demodulator, A/V transmitter and receiver, and portable television. A/V transmitter and receiver operate in transmitting and receiving A/V signal through wireless. To make it easier to understand, the configuration of the system is as shown in Figure 2 below.

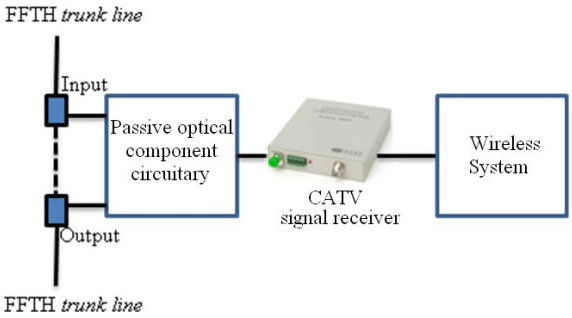

Figure 2. Second generation CATV Tester

This system is made of two parts; transmitter and receiver. Transmitter will transmit 10% of the tapped signal to receiver to be displayed on portable television.

The overall operation of CATV tester unit is as follows. Signal from the trunk line that carries data and video signal will pass through 1480/1550 WDM channel coupler. The signal will then be multiplexed in which the

video signal will pass through 10:90 fused couplers while data signal will go through the next WDM coupler. Data signal will be multiplexed with 90% of video signal obtained from 10:90 fused couplers and resent back to users through trunk line.

Remaining 10% of video signal will be fed to CATV tester unit to be measured. 10% of the optical video signal will be converted into analog radio frequency signal by CATV optical receiver. This radio frequency signal will next be translated into A/V signal using demodulator. After the audio/video signal is successfully obtained, the signal will be fed to transmitter for it to transmit the signal to receiver.

As the final step, the received signals obtained by receiver will be displayed on portable television. Similar to first generation, second generation CATV tester unit will determine the state of the signal based on the received channel displayed image.

3. CATV Tester Setup

Testing on the development concept of the second generation tester is carried out. From this testing, it is established that tester unit is capable of measuring video signal by mapping the image and displaying the received image on portable television to verify whether damage in trunk line is present or not. Testing method for CATV tester system is divided into to two stages. The first stage is about the concept verification and the second stage is the development of the CATV.

In the first stage, the testing is carried out using equipments such as video cassette recorder (VCR), A/V trasmitter, A/V receiver, portable television and radio frequency source. Testing in first stage is meant to evaluate the concept of audio/video (A/V) signal wireless transmission using video cassette recorder as radio frequency signal to A/V signal to make it possible for the A/V signal to be transmitted by transmitter and received by receiver.

Next, tests on equipments such as modulator and demodulator were carried out. CATV tester unit is evaluated by using radio frequency signal generated from A/V signal modulation from DVD player to replace the radio frequency signal acquired from cable television, similar to the testing done in early stage.

This RF signal is then fed into the demodulator to get back the A/V signal form before it can be transmitted by transmitter to receiver as video signal input to the display system, the portable television. System module and tests results using modulator and demodulator for CATV tester unit are as shown below in Figure 3.

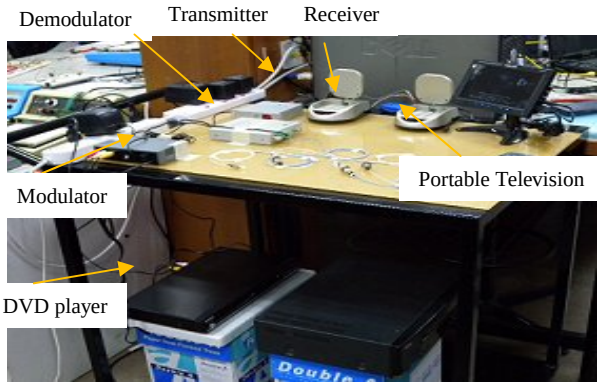

Figure 3. CATV video signal tester system module

In the last stage of testing, CATV tester system will be evaluating an FTTH network. The FTTH network system is as shown in Figure 4.

Figure 4. Testing on FTTH network system

This FTTH network will be tested using components and equipments such as optical fiber (WDM 1480/1550 nm and TWC 1550 nm 10:90), WSG coupler connector, CATV receiver, demodulator, A/V transmitter and portable television.

From the testing carried out, specifications of measurement device can be determined. Second generation CATV tester operates on 12V (d.c) and is capable of measuring CATV video signal with frequency in the range of 40MHz-870MHz.This CATV tester is capable of detection via wireless for a maximum distance of 30 meter. Figure 5 is the display image obtained during the testing by measuring only 10% of the video signal from the original signal transmitted through the network.

Figure 5. Received signal from tester (10% tapping)

4. Conclusion

The system design and development of second generation CATV tester unit via wireless method is developed and applied on the FTTH system network. This is proven during the system evaluation and testing. From the testing, tapped video signal is successfully sent via wireless from transmitter to the receiver to be mapped by portable TV for it to display the signal. Specifications for CATV tester unit have also been determined. The development of CATV tester unit is in correspond of the latest technology development considering the widen usage of optical fiber as transmission medium. With the usage of CATV tester unit, it brings ease in testing and maintenance works of verifying damages reported by users. Therefore, CATV tester unit satisfies the market demands and posses commercial qualities.

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