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Video Signal Identifier for Optical Line Monitoring in FTTH

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Abstract: Fiber network security has become a very essential and important topic for optical network. Fault isolation became an important issue in order to provide an efficient fiber network and provide continuous services to the end user without being interrupted by any failure in fiber line. The aim of this study was to develope a video signal detector in order to determine the presence or loss of optical signal in FTTH. Phase detection method is used detect the existence of video signal. This is faster and more accurate than contrast detection. This device can accept an AC-coupled composite (CVBS), luma (Y), or any other video signal with sync and outputs a logic-level signal. The Video Signal Identifier (VSI) output is low when no sync is detected and high impedance when sync is detected. The device operates from a single +3.3V supply and is capable to detect the video signal in less than 2 sec. Hence, it offers a complete solution to detect the presence or loss of video signal with no external components in the FTTH network.

Key words: Video detection in FTTH, video detector, optical failure tester, optical line monitoring, video monitoring

INTRODUCTION

The introduction of PON-based FTTH allows the network to transport huge amounts of data and provide communication services that play a very important role in many of our daily social and economical activities (Ng *et al*., 2010a). Fiber-to-The-Home (FTTH) network system is used to transmit three types of signal (video, data and voice signals) to users at a high speed level. These signals are combined using WDM method and transmitted through a single optical fiber. Wavelength for each data and voice signals is 1480 and 1550 nm for each video signal. All the combined signals are transmitted to end users through passive optical splitter with the splitter separation rate varies from 2 up to 32 users. At 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 in accordance to user's need. Figure 1 shows the example of FTTH system (Ab-Rahman *et al*., 2009a).

FTTH systems have many attractive features; one of it is the passive network deployed minimizes the network maintenance cost and requirement, as well as eliminating the need for a DC power network. FTTH solutions also provide higher bandwidth than any other broadband solution. Recently, with the rapid development of the Internet and extraordinary increase of bandwidth requirement, more and more Internet business has gradually entered numerous households and then bottlenecks of bandwidth in access networks emerge (Luo *et al*., 2005; Jaehyoung *et al*., 2008; Xiong *et al*., 2007; Asiedu and Feng, 2003). An ideal FTTH system would have the ability to provide all of the services users are currently paying for, such as circuit-switched telephony, high-speed data and broadcast video services. FTTH is all the way to the customer enables network future-proofing, maximizes the symmetrical bandwidth throughput of a carrier's access network, provides for network reliability, reaps significantly reduced operating expenses and affords enhanced revenue opportunities (Kunigonis, 2008).

A Passive Optical Network (PON) is a single, point-to-multipoint optical network that uses inexpensive optical splitters to divide the single fiber into separate strands feeding individual subscribers (Velmurugan, 2009). PONs are called passive because, other than at the CO and subscriber endpoints, there are no active

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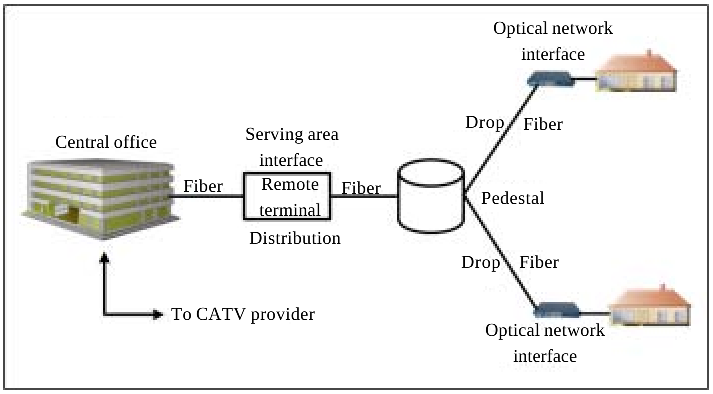

Fig. 1: A typical FTTH network

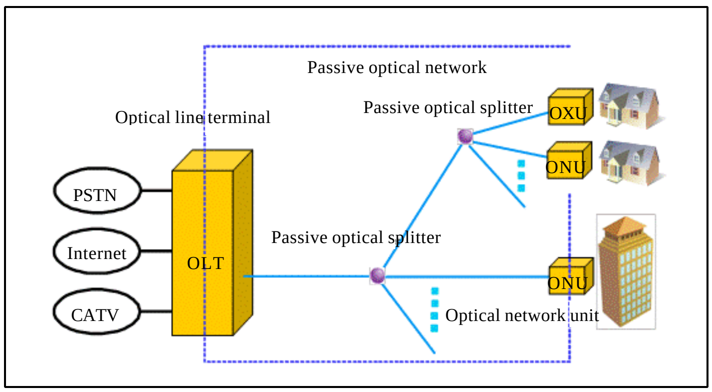

Fig. 2: A typical PON network

electronics within the access network. The ultimate goal of fiber reaching all the way to customer premises to perform FTTH, FTTB, FTTP and FTTC solution is PON (Sarkar, 2007). Figure 2 shows the PON network.

The PON technology is an attractive solution for next-generation broadband access network that deliver converged data, video and voice over a single optical access system. Multiple services can easily be provided to the end users through PON technology. Due to simple, cost-effective and scalable features, service providers can deploy the access network infrastructure, such as FTTH or FTTC, through the use of PONs without impairing their competitive positions (Hwang *et al*., 2009).

A typical PON system comprises of Optical Line Terminal (OLT), Optical Network Unit (ONU) and Passive Optical Splitter (POS) (Zhou *et al*., 2011). The OLT is placed in the central equipment room and the ONU is placed near or integrated in the client equipment. The POS connects OLT and ONU, functioning to distribute the downlink data and aggregate the uplink data. In PON, the single-core optical fiber is used to transmit uplink and downlink wavelengths. The uplink wavelength is 1310 nm and the downlink wavelength is 1490 nm. A 1550 nm wavelength can be added to the downlink to transfer analog TV signals.

System development: Signal from the Central Office (CO) will be transmitted to ONU before it is distributed to the clients. Signals that are sent to the Optical Network Unit (ONU) are the already combined signals (data, audio and video). Therefore, it need to be splitted according to their respective wavelength where 1480 nm for data and voice and 1550 nm for video signal. The passive circuit is used to split between the data signal and video signal. The video signal is then separated in accordance to 90:10 ratios where 10% of the signal will be used as the input and receiver will convert this optical signal to electrical signal. Then, this input will use as the input signal testing to the VSI device to detect the video signal. The other 90% will be recombined with the other

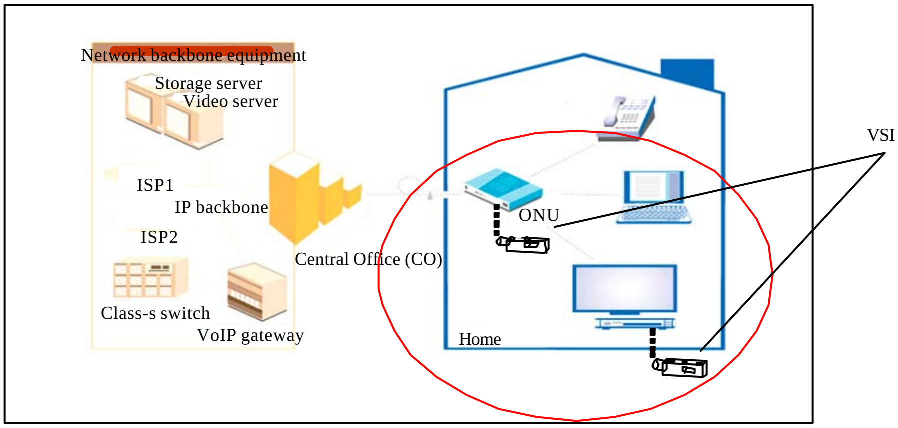

Fig. 3: Device application used at ONU and video system at home

signal and be fed back to the main line to the clients (Ab-Rahman and Jumari, 2009).

Video Signal Identifier (VSI) will be operated by converting the video signal to 1-bit signal and then displaying the 1-bit signal in the form of turning ON the LED indicator as final output. An additional component is used to ensure the functionality of this system such as voltage regulator.

Applications of VSI: The application of this device is useful in a monitoring system in FTTH. The suitable place to apply this device is at the Optical Network Unit (ONU) and also video system at home. Figure 3 shows the propose place to use this device. Among advantages using this devices are simple, the architecture is not complex and does not contain sensitive equipment, does not need to tune to search for the video signal, cost-effective and high survivability.

Comparison between Video Signal Identifier (VSI) and optical tap coupler device: Comparison between VSI and Optical Tap Coupler device (United States Patent 5657155) (Cheng, 1997) has been made. Based from this patent, the proposed solution to this kind of tap device is broadband therefore all the wavelength (frequency) will be tapped out when passing through. Instead for the VSI device, only 10% from the main line will be tap to be fed to the VSI. The other 90% is fed back to the main line, thus, it does not interfere the signal transmit to the user.

Comparison between Video Signal Identifier (VSI) and in-service line monitoring system in PONs using 1650 nm brillouin OTDR and fibers with individually assigned BFSs: This research introduces an in-service line monitoring technique (Ab-Rahman *et al*., 2009b) that can locate a fault in branched optical fibers in Passive Optical Networks (PONs) from a central office. This technique can upgrade the conventional optical fiber line testing and monitoring system. The technique using OTDR for monitoring by diverting the OTDR signal, respectively to the line connected to the ONU (Ng *et al*., 2010b). The proposed solution is installed before the optical splitter. Instead, the VSI device is applied after the optical splitter and directly connected to the Optical Network Unit (ONU). Hence, it operates without the assistance of OTDR.

Experimental setup and result: Testing on this module concept is carried out. From the experiment, it is established that the VSI device is capable of identifying the video signal by mapping the signal and display the signal in the form of turning ON the LED output to verify whether damage in line is present or not. Figure 4 shows the overall components for VSI device which consists of MAX7461 module and voltage regulator of 9 V as power supply.

The experiment is conduct using the signal from the DVD player as an input for video signal. The input from the DVD player is fed to the input of the VSI and the output to display the presence of the signal is using LED indicator. First test was carried out, 9 V was supplied to the system but no video input was given to the system from DVD player. As a result, only LED indicator for power supply is turn ON while LED indicator for video signal detection is still turn OFF which indicates that there are no signal presence as shown in Fig. 5. If it is applied in the FTTH system, it can be conclude that there is damage in this trunk line.

For the second test, 9 V was supplied to the system and this time video input is given to the VSI. From Fig. 6,

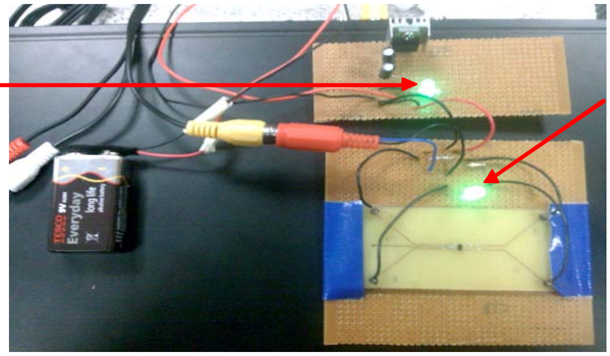

Fig. 4: Overall components of VSI device

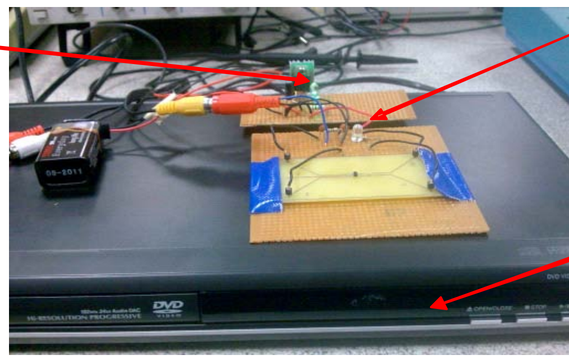

Fig. 5: First test

Fig. 6: Second test

it shows that LED indicator for power supply is turn ON and LED indicator to detect the video signal was also turn ON. It shows that this device is capable to identify and detect the presence of video signal and it can be conclude that this signal or line is in good condition.

Video signal output of VSI: Figure 7a shows the output of optical video detector in which no video signal is received by video receiver. In this condition, optical video detector outputs 0 volt (logic 0). Figure 7b shows the output of optical detector where there is video signal in optical network. In this condition, optical video detector outputs 3.3 volt (logic 1). Figure 7c shows a transient response of video signal into a logic signal.

Sensitivity level of VSI: Two analysis data has been conducted to measure the sensitivity level of the VSI device. The desired output is the maximum and the

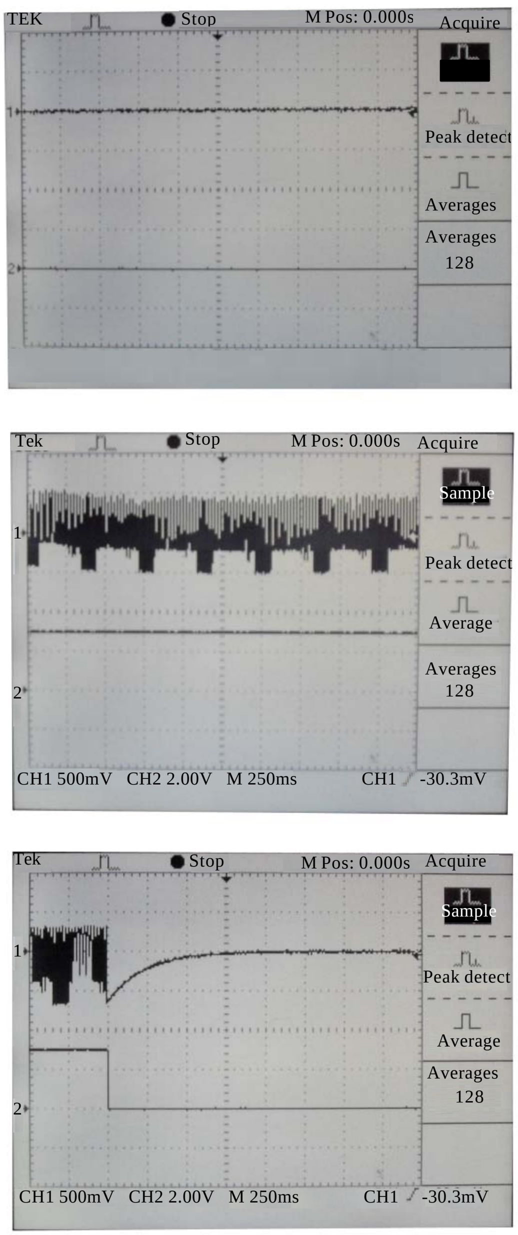

Fig. 7: (a) Video detector detects no video signal, (b) video detector detects a video signal and (c) transient response of video detector

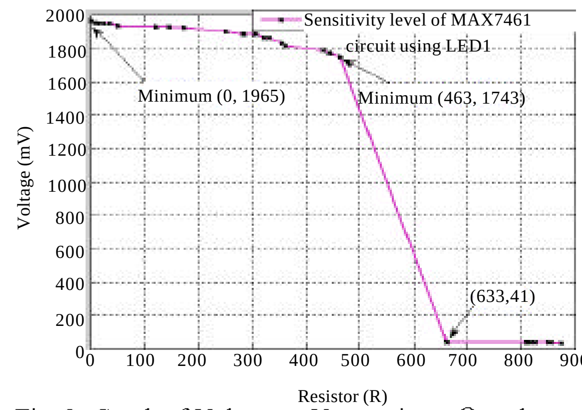

Fig. 8: Graph of Voltage, mV vs resistor, Ω to determine the sensitivity of the MAXIM circuit using LED 1

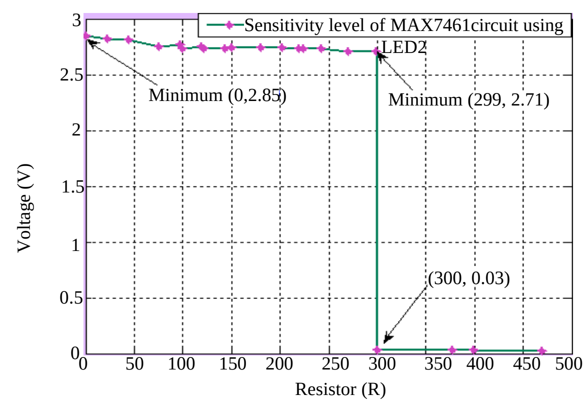

Fig. 9: Graph of Voltage, mV vs resistor, Ω to determine the sensitivity of the MAXIM circuit using LED 2

minimum value of the voltage that can be sustained by this module. Figure 8 and 9 show the graph of Voltage, mV versus Resistor, Ω for 2 types of LED which are LED1 and LED2. Two different types of LED are used to see if there is a different in the value of voltage.

From Fig. 8, the maximum voltage output when no resistance presence (normal condition) is around 1965 mV and the LED is ON which indicates the signal is received. While the minimum value is when the value of the resistor is 663 Ω and the output voltage is 41 mV. When the value is 41 mV, the LED is OFF which indicates the device cannot mapped the video signal. Hence, we can conclude that at 41 mV is the minimum value for the sensitivity level of this module to be able to detect the signal.

Based on Fig. 9, when using the different type of LED, the maximum output of voltage that can be produced is 2.85 V which is in a normal condition where no resistance is present. And the LED is turn ON which indicates the signal is received. While the minimum value is around 2.71 V when amount of 299 Ω of resistance is apply to the device. After that, increasing the value of resistance will result in sudden drop of voltage which is around 0.03V and at this value, the LED is OFF which show that the video signal cannot be received.

CONCLUSION

In summary, the Video Signal Identifier (VSI) device is able to function expectedly and is proven during the system evaluation and testing. The sensitivity level of this module as part of characterization analysis has also been specified. With this device, it brings ease in testing and maintenance works of verifying damages reported by users. The development of this module is in correspond of the latest technology development considering the widen usage of optical fiber as transmission medium for television broadcasting. Therefore, VSI device satisfies the market demands and posses commercial qualities.

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REFERENCES

Ab-Rahman, M.S., B.C. Ng and R. Ismail, 2009a. Passive optical signal tapping device. J. Applied Sci., 9: 3731-3738.

Ab-Rahman, M.S., S.C. Rosli, F. Jaafar, Z. Zakaria and K. Jumari, 2009b. CATV Tester unit for fiber-to-the-home. Proceedings of the International Conference on Space Science and Communication, Oct. 26-27, Negeri Sembilan, Angkasa UK., Malaysia, pp: 119-122.

Ab-Rahman, M.S.S. and K. Jumari, 2009. Multi access detection system for line monitoring in fiber to the home (FTTH). Proceeding of the 2009 International Conference on Space Science and Communication, Oct. 26-27, Negeri Sembilan, Malaysia, pp: 123-125.

Asiedu, B.K. and L.S. Feng, 2003. Information and Communication Technologies (ICT), internet as a tool in the developing world, challenges and the way forward. Inform. Technol. J., 2: 201-212.

Cheng, Y., 1997. Optical tap coupler device. United States Patent 5657155. http://www.freepatentsonline.com/5657155.html.

Hwang, I.S., Z.D. Shyu and L.Y. Ke, 2009. A novel fault-tolerant multi-EPON system with sharing protection through bridge ONUs. Photonic Network Commun., 18: 24-38.

Jaehyoung, P., Y.K. Geun, J.P. Hyung and H.K. Jin, 2008. FTTH deployment status and strategy in Korea: GW-PON based FTTH field trial and reach extension strategy of FTTH in Korea. Proceedings of the IEEE Globecom, Global Telecommunications Conference, Nov. 30-Dec. 4, New Orleans, Lo., pp: 1-3.

Kunigonis, M., 2008. FTTH explained: Delivering efficient customer bandwidth and enhanced services. Corning Cable Systems. http://www.i-policy.org/2008/01/tutorial-ftth-e.html

Luo, R., T.G. Ning, T.J. Li, L.B. Cai, F. Qiu, S.S. Jian and J.J. Xu, 2005. FTTH-A promising broadband technology. IEEE Int. Conf. Circuits Syst., 1: 609-612.

Ng, B., M.S. Ab-Rahman, A. Premadi and K. Jumari, 2010a. Optical power budget and cost analysis in PON-based *I*-FTTH. Res. J. Inform. Technol., 2: 127-138.

Ng, B.C., M.S. Ab-Rahman, A. Premadi and K. Jumari, 2010b. Optical fault monitoring method in 8-branched PON-based *I*-FTTH. Res. J. Inform. Technol., 2: 215-227.

Sarkar, S., 2007. Hybrid Wireless-Optical Broadband-Access Network (WOBAN): A review of relevant challenges. J. Lightwave Technol., 25: 3329-3340.

Velmurugan, B., 2009. How to achieve multi-dwelling unit access to passive optical networks. EE Times Design. http://www.eetimes.com/design/communications-design/4027677/How-to-achieve-multi-dwelling-unit-access-to-passive-optical-networks

Xiong, N., B.X. Xu, Z.W. Zeng, S.E. Chen and W.P. Liu, 2007. Design of access network system based on 10G EPON. Proceedings of the IEEE International Conference on Acoustics, Speech and Signal Processing, April 15-20, Honolulu, HI., pp: I-1205-I-1208.

Zhou, X.L., F.X. Yu, Y.C. Wen and Z.M. Lu, 2011. A novel protection architecture scheme for EPON. Inform. Technol. J., 10: 591-596.