Zenko
technologies, inc.

3W-TRX™ and VPON

December 2006

1. Introduction to 3W-TRX™ Device

In single fiber passive optical networks, two different wavelengths are used for down-stream and up-stream to achieve duplex operation of digital communication. In general, wavelengths of 1.55 μm and 1.31 μm are used for down-stream and up-stream, respectively. Recently, there is a new trend that uses the fiber for broadcasting video signal in the down-stream using a third wavelength. We call this scheme "Video PON" or "VPON". In VPON, the digital signals in the down-stream and up-stream are sent by 1.49 μm and 1.31 μm wavelengths, respectively, while the video signal is sent by 1.55 μm wavelength (C-Band) only in the down-stream. The optical power for a video signal at each ONU is much higher than the optical power of a digital signal. A high optical video signal is needed because of the wide video band and the requirement for a high signal-to-noise ratio, S/N ratio in the video signal. For example, in the 155 Mbps BPON, the sensitivity of an ONU receiver is less than –30 dBm, while the optical power of the video signal is often as high as +3 dBm. In order to avoid the interference of the video signal to the digital receiver at the ONU, the high power optical video signal must be blocked from the ONU digital receiver. In the past, opto-electronic (OE) devices have been developed to cope with this situation. Triplexer (trademark of Infineon Technologies) was an example. Figure 1 illustrates the Triplexer module. Triplexer has been widely used. However, it is potentially costly because of the complex manufacturing procedure and isolation between 1.55 and 1.49 um is very difficult because isolation of at least 40 dB is normally requested. In addition, the electrical interference between video signal receiver and digital receiver often degrades the performance of the ONU unit. We believe the biggest draw back of this approach is that the ONU customers do not have choice of service. That is if an OLT line is constructed using ONUs with Triplexers, all the customers must have video receivers whether they want it or not.

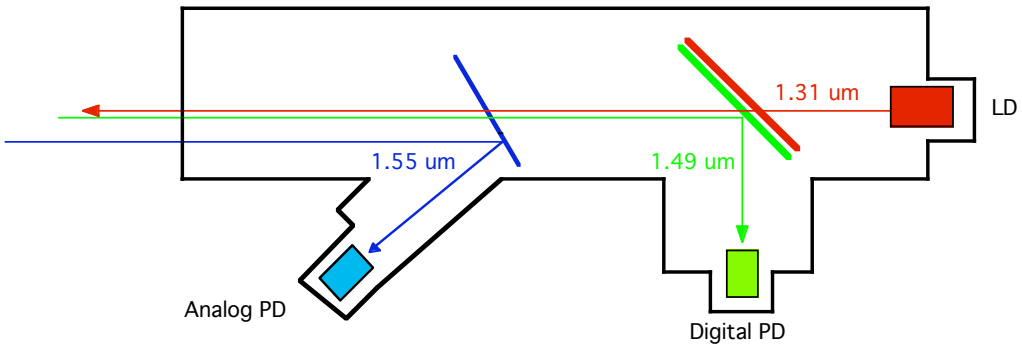


Figure 1: Triplexer™ (Trademark owned by Infineon Technologies)

Zenko Technologies, Inc. has developed a new type of three-wavelength bi-directional optical device, called "3W-TRX™" (read as three-double-u-tracks, patented by Zenko Technologies). This device is potentially low in cost and can eliminate the problems inherited by Triplexer.

2. VPON

Figure 2 illustrates the configuration of the VPON (Video-PON). The VPON is a combination of the standard PON (BPON, GPON, LEPON™, EPON and so forth) and video service such as CATV. In general, the digital signals are transmitted using 1.49 and 1.31 μm wavelengths and the video signal is broadcasted from a video provider in the down stream using 1.55 μm wavelength. There are three types of ONU customers. In one type (Type-A in Figure 2), only digital service is in demand as in regular business offices. In the other type (Type-B in Figure 2), both digital and video services are in demand as in regular households. Some customers may just want only video service (Customer Type-C). Using 3W-TRX, customers can choose kinds of service without additional cost.

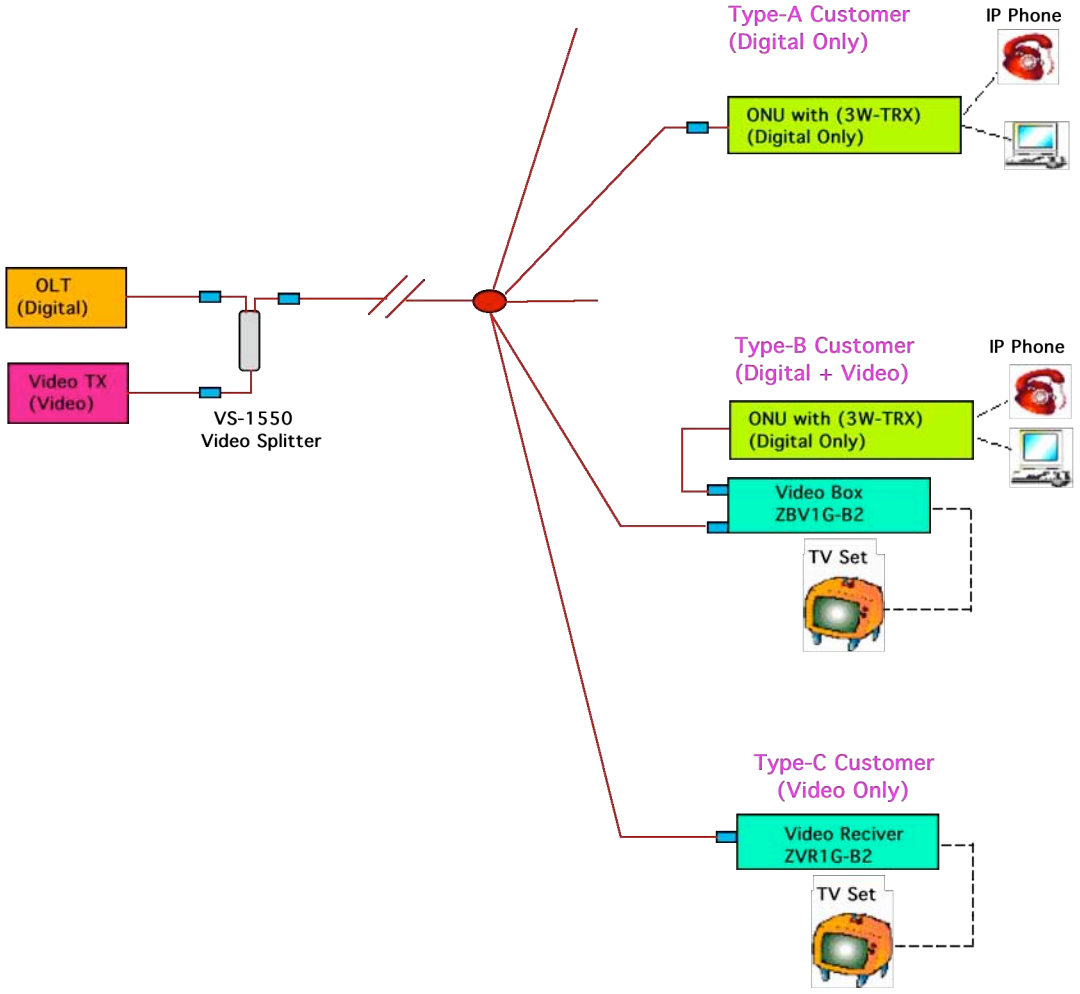


Figure 2: VPON

3. 3W-TRX™ Devices (The 3W-TRX™ device is patented by Zenko Technologies, US patent, 7062171).

The 3W-TRX™ device is patented by Zenko Technologies Inc (US Patent 7062171). and is illustrated in Figure 3(a). The 3W-TRX™ is basically identical with the standard bi-directional module, BiDi™ (Infineon Technologies). In this device, the 1.55 μm high power video optical signal is blocked by a blocking filter (blocker). Figure 3(b) shows the spectral characteristic of the blocker. The fabrication process of the 3W-TRX™ device is similar to that of BiDi and no alignment of 1.55 μm light to the analog photodiode is needed, resulting in the low cost of the device. In addition, many ONUs do not need a video signal, in particular, when the ONUs are used for business office use. In that case, the expense of the video portion (analog PD section of the Triplexer) can be eliminated. If a video signal is required, a simple wavelength-multiplexing device "Video Splitter" is attached in front of the 3W-TRX™device. The video splitter is illustrated in Figure

3(c-1). Figure 3(c-2) shows a photograph of the video splitter, ZVS-1550. Or a video box with a video splitter-analog PD combo, such as ZVB1G-B2 video box by Zenko Technologies. Figure 5(a) illustrates the video-splitter-analog PD combo.

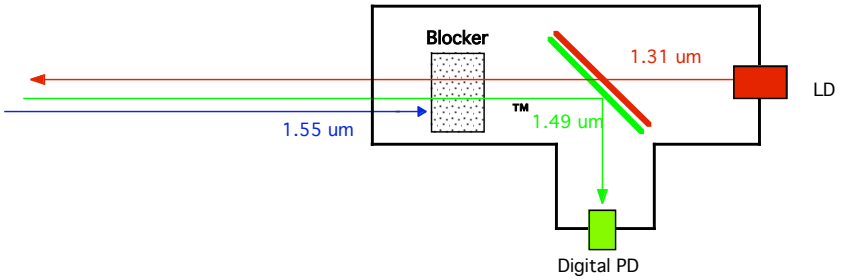


Figure 3(a): 3W-TRX™ Device

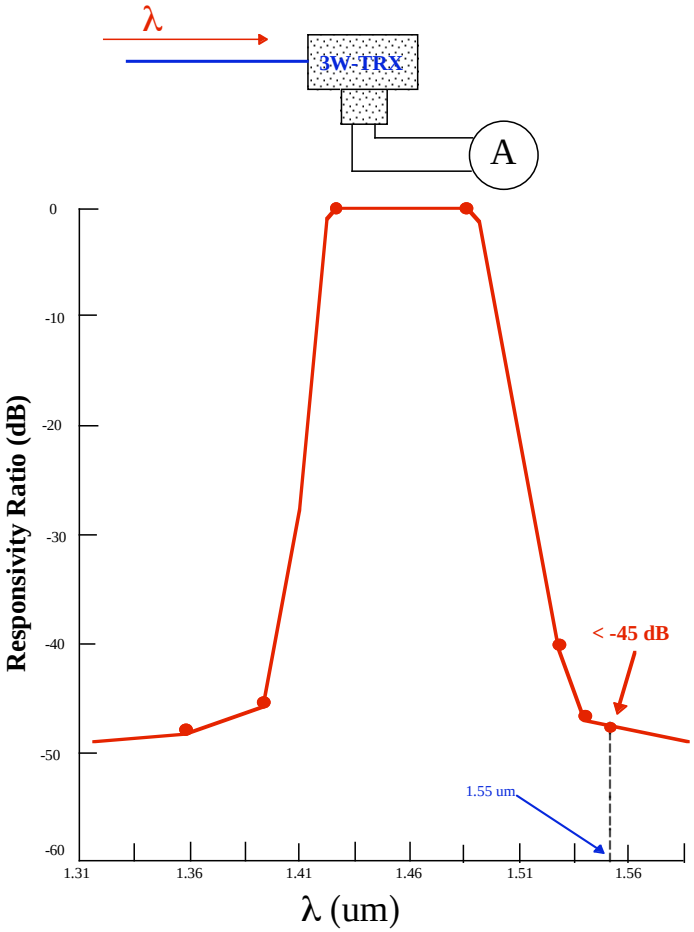


Figure 3(b): Wavelength Dependence of 3W-TRX™ RX Responsivity.

When video signal is not needed as in TypeA, the ONU transceiver is directly connected to the fiber, where the ONU transceiver must be equipped with a 3W-TRX™device. Figure 4(a) illustrates the TypeA ONU where no video signal is needed.

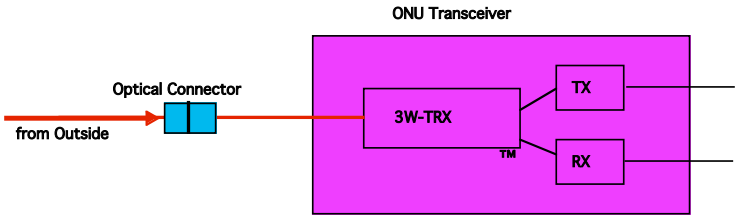


Figure 4(a): TypeA ONU (Digital Only)

When a video service is in demand, a video box ZVB-870 by Zenko Technologies Inc., for example, is simply attached as shown in Figure 4(b).

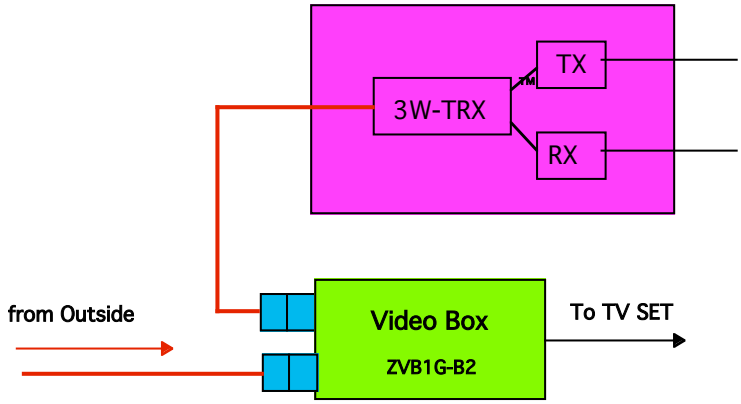


Figure 4 (b): TypeB ONU (Digital + Video)

If a customer wishes only video service, the video receiver is simply attached as shown in Figure 4(c). Video receiver ZVR1G-B2 contains 1.55 μm optical pass filter, which blocks all incoming optical digital signal (1.49 and 1.31 μm).

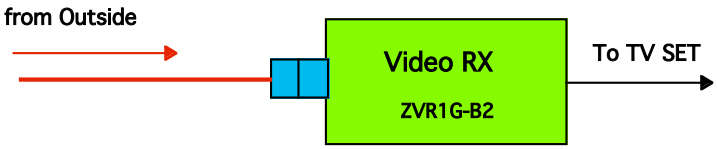


Figure 4 (c): TypeC ONU (Video Only)

The customers can choose TypeA, TypeB or TypeC without restriction.

4. Requirement for OLT and ONU Transceiver Modules

In VPON applications, the OLT must have 1.49 μm transmitter as in LT-74E73E-KC and the ONU transceiver must be equipped with 3W-TRX as in HNU-73E74B-PB-3W.

5. VPON Supporting Products.

Fig. 5 illustrates an example of video overlay in G-PON system. The same configuration can be used in any optical access system.

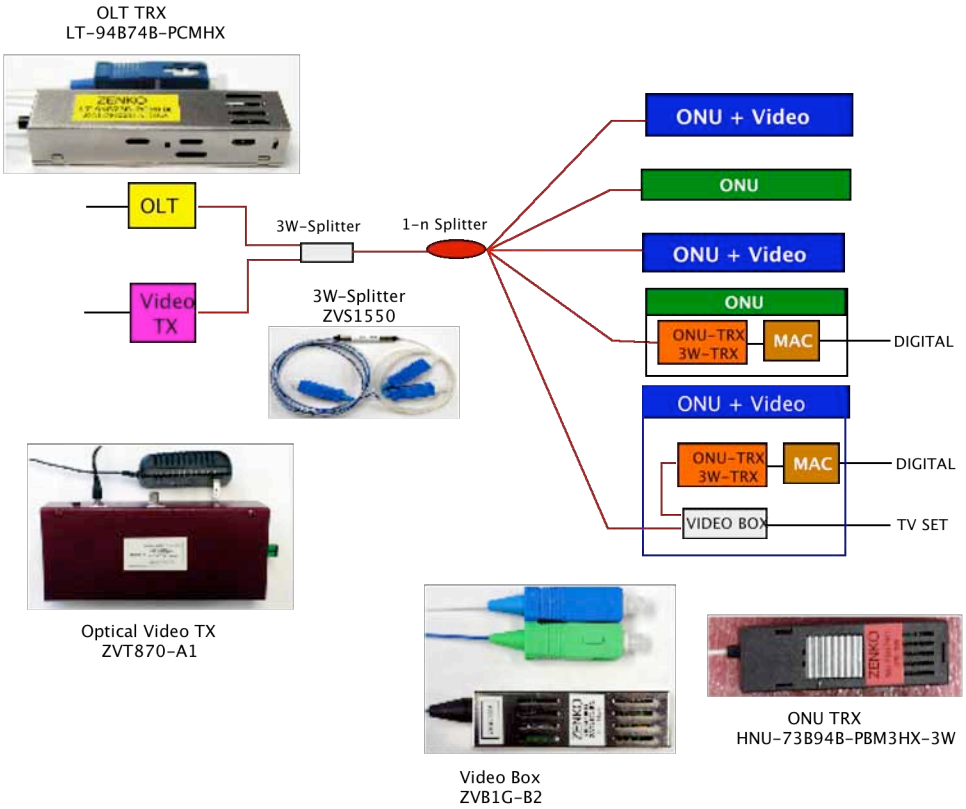
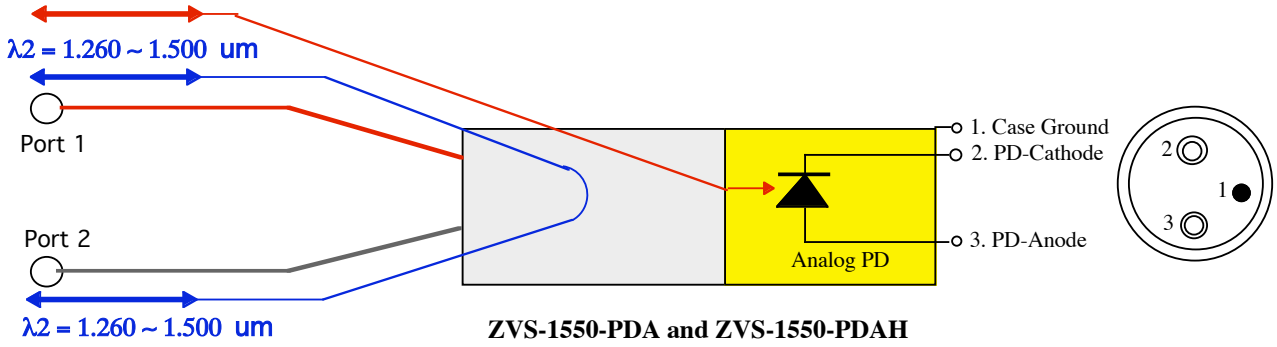


Fig. 5 (A): V-PON Infrastructure with devices supplied by Zenko Technologies, Inc.

5-(A) ZVS1550-PDA.

ZVS1550-PDA is a combination of analog PD and three wavelength WDM splitter. This is a vital device for a video box to be described, later.



ZVS-1550-PDA and ZVS-1550-PDAH

Figure 5-(a) Illustration of ZVS-1550-PDA

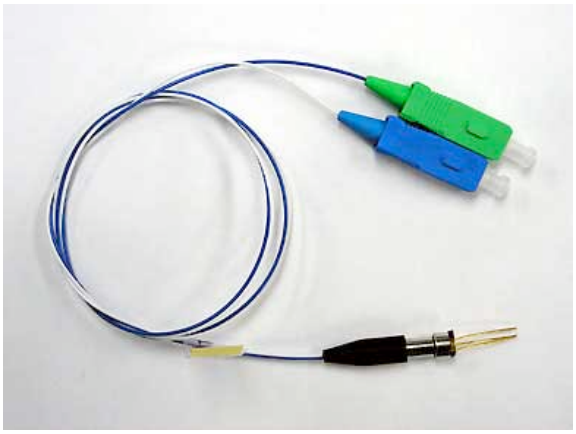


Figure 5(B) Photograph of ZVS-1550-PDA and ZVS-1550-PDAH

Table 1 shows the optical characteristics of ZVS-1550-PDA. In general, the coupling of 1.55 um optical signal to the analog PD is > 85 %.

Table 1: Important Optical Parameters of ZVS1550-PDA.

	Insertion Loss 1.31 and 1.49 um Port 1 ←→ Port 2	Insertion Loss 1.55 um Port 1 ←→ Port 3	Isolation of Port 3 from λ2 (1.31 & 1.49 um)	Isolation of Port 2 from λ1 (1.55um)	Directivity of λ2 (1.31 & 1.49 um)	Return Loss, @ Ports 1 & 2 @ λ1 (1.31 & 1.49um)
ZVS1550-PDA	< 0.6 dB	< 1.0 dB	> 30 dB	> 13 dB	> 50 dB	> 45 dB
ZVS1550-PDAH	< 0.6 dB	< 1.0 dB	> 65 dB	> 13 dB	> 50 dB	> 45 dB

5-(C) ZVB1G-B2 Video Box:

ZVB1G-B2 Video Box is designed to readily extract video signal from the existing ONU in any optical access. The bandwidth is wide enough to accept VHF, UHF and BS in form of NTSC, PAL, digital and FM. It is compact enough to be installed inside of an ONU box. The size is identical with that of a standard SFF package.

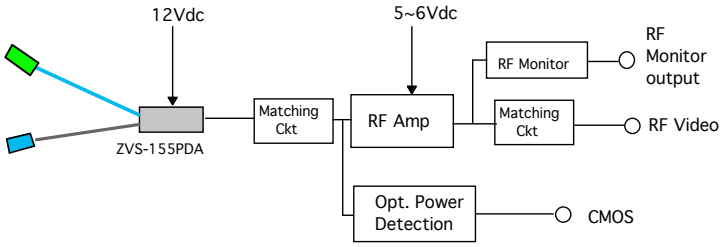


Figure 5 (C): Block Diagram of Video Box, ZVB1G-B2

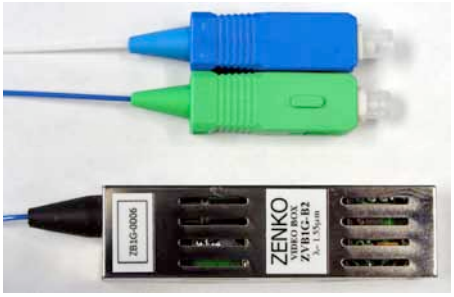


Figure 5 (D): Photograph of Video Box, ZVB1G-B2

Table 2 shows the electrical properties of the video box, ZVB1G-B2

Table 2: Electrical Characteristic of ZVB1G-B2

ELECTRICAL AND OPTICAL CHARACTERISTICS (T_C = 25°C, V_R = 12V)						
Symbol	**PARAMETER**	**Test Conditions**	**Min.**	**Typ.**	**Max.**	**Unit**
	RF Input/Output frequency		**40**		**> 1500**	**MHz**
	Optical Reception (Note)	**AGC**	**-12**		**+3**	**dBm**
	Opt. Signal Detection		**-10**			**dBm**
CSO	**Composite Second Order**				**-55**	**dBc**
CTB	**Composite Third Beat**				**-60**	**dBc**
CNR	**Carrier Noise Ratio**		**48**			**dB**
BR	**Back Reflection at PD**	**1550 nm**			**-40**	**dB**
	Fiber Length		**50**		**150**	**cm**

Note: AGC provides constant rf output level for incoming optical power between -9 and 3 dBm.

5-(D) ZVR1G-B2 Video receiver

All electrical properties of ZVR1G-B2 are identical with those of ZVB1G-B2 except in following features: This device is equipped with a PD with 1.55 μm pass/1.31 and 1.49 μm reject filter instead of ZVS1550-PDA.

Figure 5 (E): Photograph of Video Box, ZVR1G-B2

5-(E) ZVS1550-B

This is a compact and low cost 3 wavelength (1.31, 1.49 and 1.55 um) WDM splitter. This is good enough for mixing Video signal and digital signal at the site of OLT.

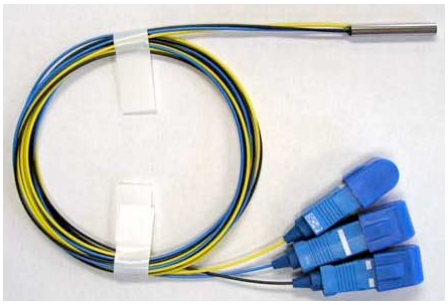


Figure 5 (F): Photograph of ZVS1550-B WDM Splitter.

5-(F) Optical Video Transmitter.

ZVT870:

This is a compact and low-cost optical video transmitter with a 1.55 **µm** forced air cooled DFB LD. The modulation frequency is 40 MHz to 1 GHz. The optical power is 3 dBm. It requires 5V single power supply. The typical application is the simple video transmission test.

Figure 5 (G): Photograph of ZVT870 Optical Video Transmitter.

ZVT870-A1:

This is a high linearity optical video transmitter with a 1.55 **µm** TEC cooled DFB LD. The modulation frequency is 40 MHz to 2.5 GHz. The optical power is 10 dBm. It requires 24 V single power supply. This can be used for all V-PON applications.

Figure 5 (H): Photograph of ZVT870-A1 Optical Video Transmitter.