



# **Optisystem based CATV System-Performance Improvement by Using External Light-Injection Technique**

S.Adithyan<sup>1</sup>, S.Srinath<sup>2</sup>

U.G. Student, Department of EEE, C. Abdul Hakeem College of Engineering & Technology, Vellore, Tamilnadu, India<sup>1</sup>

Final Year Student, B.Tech, Department of ECE, Vellore Institute of Technology, Vellore, Tamilnadu, India<sup>2</sup>

**ABSTRACT:** Cable Television (CATV) is designed with erbium-doped amplifier-repeated system that uses an external light – injection technique and a directly modulated wave using amplitude modulation. The external light – injection technique can greatly enhance the frequency response of the laser diode, and hence improve the overall performance of the fibre optical CATV system. It implemented using **Optiwave Optisystem 10.0**.

**KEYWORDS:** External Light-Injection Technique, Semiconductor Lasers, Optical Communication, Directly Modulated Transmitter.

## **I.INTRODUCTION**

CATV is a shared cable system that uses a tree-and-branch topology in which multiple households within a neighborhood share the same cable. Cable television is a system of distributing television programs to subscribers via radio frequency (RF) signals transmitted through coaxial cables or light pulses through fiber-optic cables. The abbreviation CATV is often used for cable television. It originally stood for Community Access Television or Community Antenna Television, from cable television's origins in 1948, in areas where over-the-air reception was limited by distance from transmitters or mountainous terrain, large "community antennas" were constructed, and cable was run from them to individual homes.

## **II.RELATED WORK**

Lu et al [7] developed a CATV system Based on Lower-Frequency Sidemode Injection-Locked Technique with an injection power level of 4.8 dBm.

Wen et al [8] proved that Injection-locking enhances the resonance frequency of the laser and the electrical feedback achieves strong resonance at the base-rate frequency of the injected data streams.

Our paper is based on directly modulated transport system which employs the external light-injection technique. The external light-injection technique greatly enhances the frequency response of the laser diode, and thus improves the overall performance of the fibre optical CATV system. The idea is implemented using Optisystem 10.0 and we analyse how the output power varies with and without the external light-injection technique. Using external light-injection technique we are analysing how the output power varies with 3dBm, 4dBm, 5 dBm and 8 dBm external injected power.

## **III.INTRODUCTION TO THE EXTERNAL-LIGHT INJECTION TECHNIQUE**

The recent changes in telecommunication regulations and changing market forces are making the market for broadband network services to the home an extremely lucrative and competitive area. Out of many competing technologies for such broadband services, major CATV companies are banking heavily on various methods of making the network more

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and more fast and efficient. Most of the interest exists in broadband network services to deliver a variety of products to consumers, such as Internet access, telephony, interactive TV, and video on demand. But due to its cost efficiency, we need to find a better way to do that. When we send any optical signal, we find there is some loss in the transmission and hence there is the loss in data. So to increase the fibre transmission distance, achieve high quality for the given system and increase the performance is the ultimate goal of the fibre optical cable television (CATV) transport systems. However, nonlinear distortions introduced by laser chirp, fibre dispersion effects can degrade the system performance as well as limit the maximum transmission distance. Till now many techniques have been devised to circumvent these problems, but many of them just increase the complexity of the system. In a recent study, external light-injection technique has been employed in a hybrid radio–fibre system to improve the bit-error-rate performance but it has not been employed as a system-performance improvement technique in an analog light wave system. We suggest that the external light injection technique can be used to meet all the goals of CATV system efficiently. The external light-injection technique can greatly enhance the frequency response of the laser diode. It is expected to have good performances in analog fibre optical CATV systems.

## IV. THE CATV NETWORK

A CATV network is made up of three main parts: the trunk, the feeder, and the customer drop. The trunk is usually intended to cover large distances of tens of miles. The feeder portion of the cable is used by the consumers for tapping signal. Its maximum length is only a few miles since energy is tapped off to feed homes (subscribers) which require relatively high power levels. The drop is the flexible cable which goes to the home and it has a maximum length of approximately 600 feet and is made up of lower quality co-axial cable than the feeder or trunk. Older generation CATV systems used co-axial cables in the trunk and feeder portions of the network and therefore experienced many problems related to (a) interference from spurious radiation, (b) distortions introduced by amplifiers and (c) limited bandwidth. Long-distance transmission of fibre AM-VSB 80-channel CATV systems is used widely and is spread throughout the cable industry. Whereas, the maximum transmission distance of such systems is still limited by RF parameters and it is difficult to obtain better CNR performance due to full channel loading. In an optical CATV system, the signal is directly or externally modulated with light wave before it communicates. Directly modulating signal with LD is an economic method whereas the transmission distance and performance are significantly limited by laser chirping issues. In order to provide an economic structure with advanced transmission performance in external modulation system, direct modulation method is often combined with other techniques or components to compose higher performance and lower cost CATV system. By increasing the wavelength numbers, major parts of CSO distortions from each communication band are automatically removed from each communication channel. External light technique in particular have been experimented and proved as efficient method to enhance laser output power and laser resonance frequency.

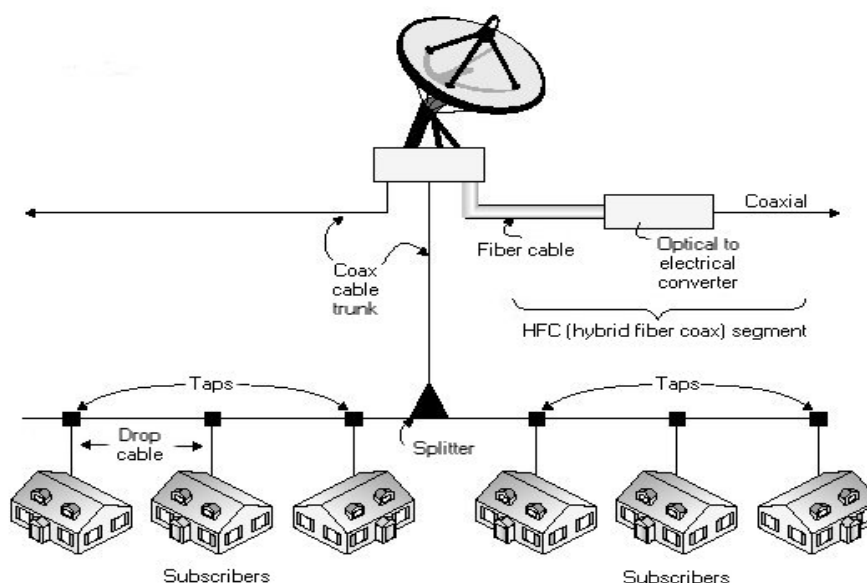


Fig. 1 General Block Diagram of CATV System

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## V. SIMULATION DESIGN

Our proposed directly modulated transport system employs the external light-injection technique. Without external light injection (Fig 3), CH 2-40 (ranging from 55 – 320 MHz) are directly fed into the first Continuous Wave (CW) laser diode and CH 41-78 (325 – 550 MHz) are directly fed into the second one. **The CATV frequency bands are up-converted to the first microwave frequency bands (14.75 – 15.25 GHz) and then fed into the Continuous Wave (CW) laser diodes. The second CATV frequency bands are up-converted to the second microwave frequency bands (18.25 – 18.75 GHz) and then fed into the CW laser diodes. The central wavelengths of the two CW laser diodes are 1550.5nm and 1555.7nm, respectively.** Without external light injection, the relative intensity noise (RIN) of the two CW laser diodes is about -170 dB/Hz. With external light injection, the RIN of the two DFB laser diodes are lower than -170 dB/Hz. Light is injected in the counter propagation direction through an optical isolator and a 3-dB optical coupler. The wavelengths of the injected light are 1550.7nm and 1555.6nm, respectively. In the system the optical power was coupled into the EDFA - I by a 2x1 optical coupler. After a 50 km single-mode fibre (SMF) transmission, the received optical signal was split by a 1x2 optical splitter, went through two separate optical band pass filters in order to select the appropriate wavelength, and detected using two broad-band analog optical receivers. This system can be used to increase the power of the sent signal to a larger extent while maintaining the efficiency at the same time.

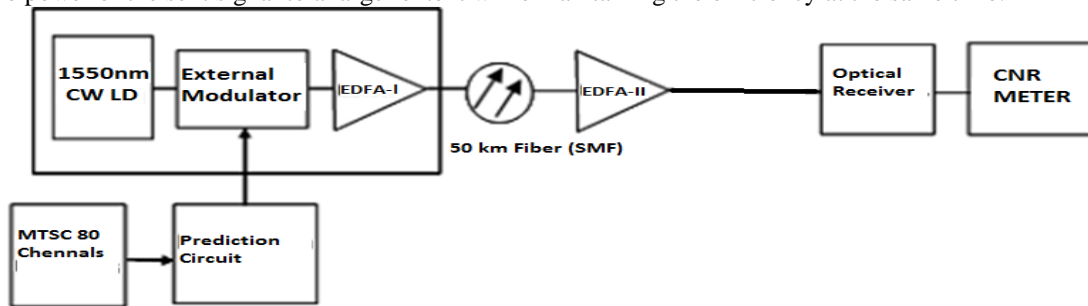


Fig. 2 Normal CATV system without external light-injection technique

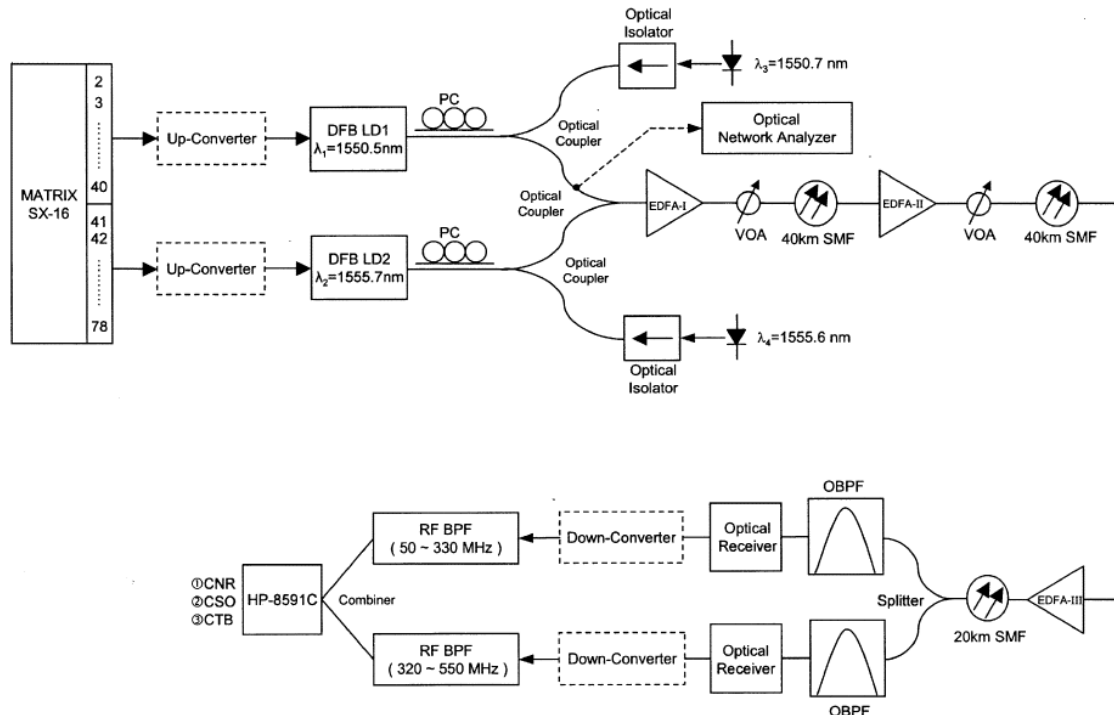


Fig. 3 Directly modulated CATV system employing external light-injection technique

## VI. SIMULATION, RESULT AND DISCUSSION

When the power injected into the laser diode is increased, the power launched into the EDFA-I is also increased. This is due to the fact that the external light injection will reduce the laser diode threshold current and hence increase the optical output power of the laser diode. The higher the input power launched into the EDFA, the better the CNR performance we can obtain in the system.

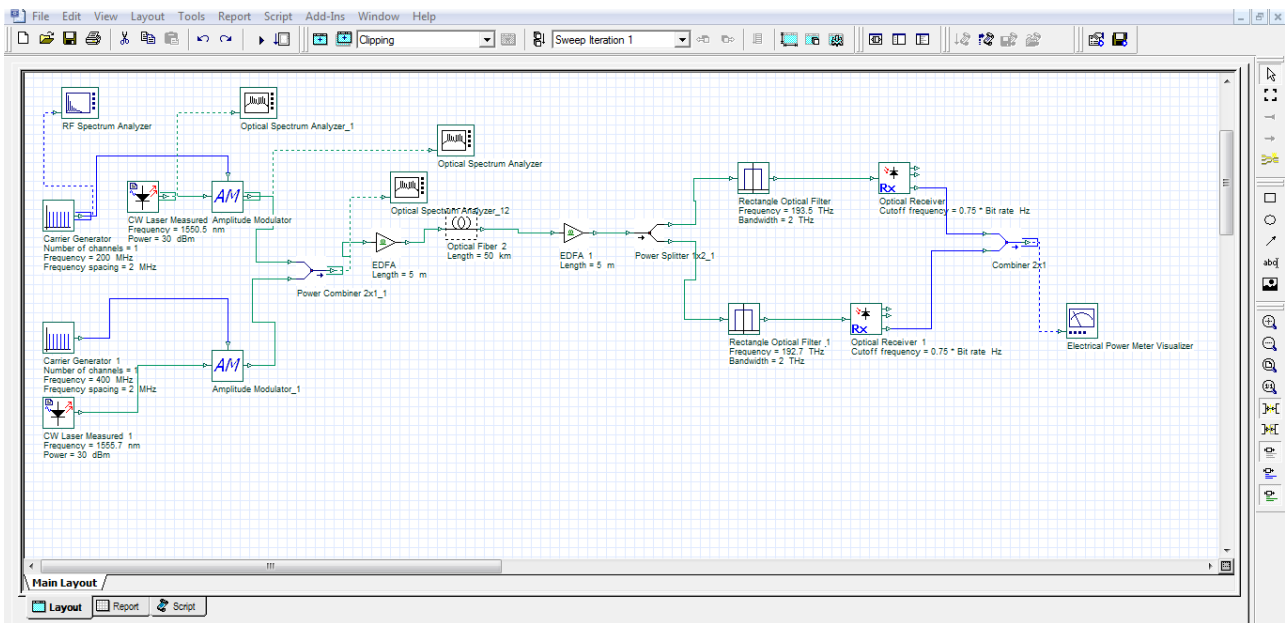


Fig. 4 CATV system without external light-injection technique simulated using Optisystem 10.0

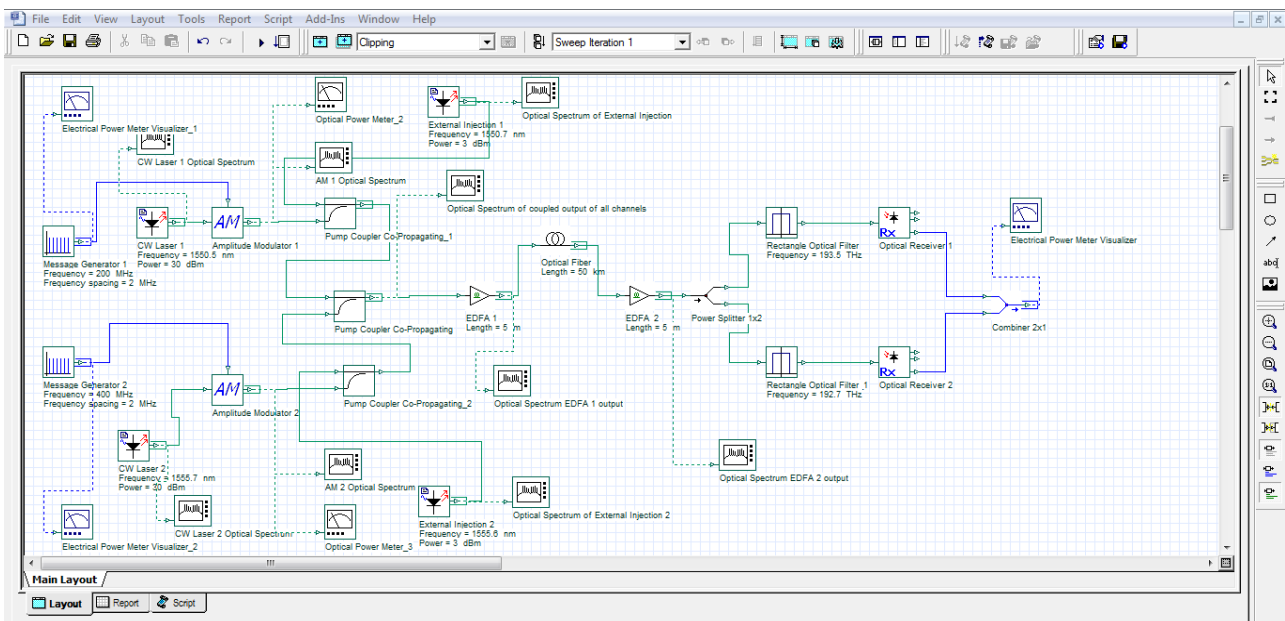


Fig. 5 CATV system employing external light-injection technique simulated using Optisystem 10.0

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INPUT POWER (dBm)	INJECTED POWER (dBm)	OUTPUT POWER (dBm)
30	None	2.34
30	3	4.45
30	4	5.21
30	5	6.53
30	8	8.34

Table. 1 Output to Injected Power Variation

In the normal case (without light injection) by using the 30dBm source light the electrical power output of the system is 2.34dBm . By using the 3dBm, 4dBm, 5 dBm and 8 dBm external light injection technique the electrical power output is 4.45dBm, 5.21dBm, 6.53 dBm and 8.34 dBm respectively.

A plot of ‘Injected Power’ vs ‘Output Power’ is shown below. This plot concludes that as injected power through the external light injection technique is increased then the output power also increases.

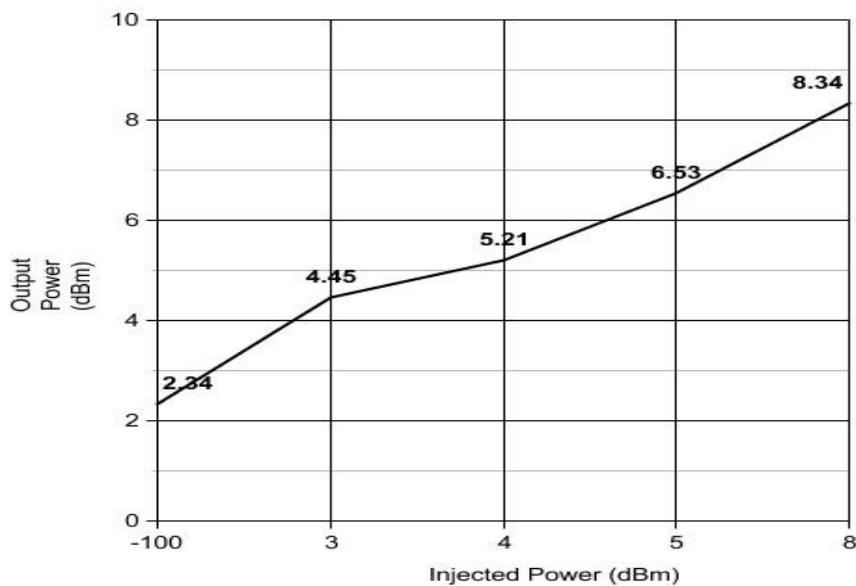


Fig. 5 Graphical Variation of Output to Injected Power

The output power as seen through a ‘Electrical Power Meter Visualizer’ for a CATV system without external light injection is shown below.



Fig. 6 Electrical Power Output (Without Injection)

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The output power as seen through a ‘Electrical Power Meter Visualizer’ for a CATV system employing external light injection (3dBm injection) is shown below.



Fig. 7 Electrical Power Output (With 3dBm Injection)

The output power as seen through a ‘Electrical Power Meter Visualizer’ for a CATV system employing external light injection (4dBm injection) is shown below.



Fig. 8 Electrical Power Output (With 4dBm Injection)

The output power as seen through a ‘Electrical Power Meter Visualizer’ for a CATV system employing external light injection (5dBm injection) is shown below.

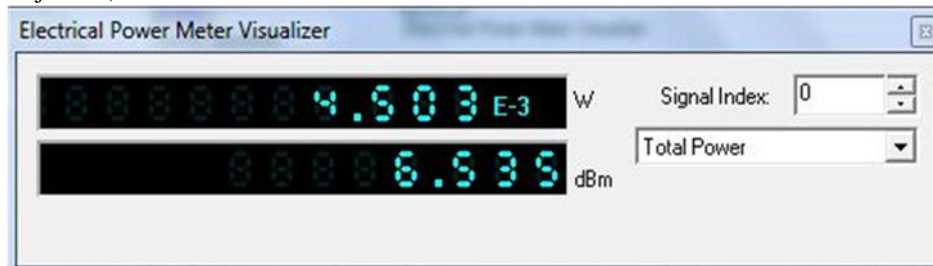


Fig. 9 Electrical Power Output (With 5dBm Injection)

The output power as seen through a ‘Electrical Power Meter Visualizer’ for a CATV system employing external light injection (8dBm injection) is shown below.



Fig. 10 Electrical Power Output (With 8dBm Injection)



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## VII.CONCLUSION

We propose and demonstrate a directly modulated AM- CATV EDFA-repeated system that uses the external light-injection technique to improve the systems' performance. The external light-injection technique greatly enhances the frequency response of the laser diode, and thus improves the overall performance of the fibre optical CATV system. The efficiency of the CATV system can be further increased by feeding the customers using the optical fibre i.e. fibre to home in place of coaxial cable. This can increase the efficiency by 10 times as compared to normal co-axial cable.

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## BIOGRAPHY



**S.SRINATH** is currently studying final year ( 8<sup>th</sup> Semester), B.Tech, ECE, School of Electronics Engineering in VIT University, Vellore, India.