**Research Paper**

**Engineering**

# Analog Catv Transmission System

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| **KEYWORDS** | |

## CHAPTER 1
### INTRODUCTION

Networks within buildings have become more and more universal over the past years. Phone systems and computer networks more and more use the same infrastructure as defined by international standard IS 11801 or european standard EN 50173-1. Most beneficial for the customer are significantly lower costs than having plenty dedicated networks for each apllication separately. Following this idea next migration step might be the integration of CATV applications and replacement of the coaxial network by a few more twisted pair lines. Thisdocument describes a few basics behind CATV and gives design support for active equipment required.

Bands and frequencies for analogue and digital TV transmission over coaxial networks and terristric antennas are well defined. An overview of bands is given in the table below. Most TV channels in the cable broadcasting network you find as of economical reasons below 470 MHz, terrestrical below 606 MHz.

| Band | Description | Frequency | Application | Media |
|---|---|---|---|---|
| VHF I | VHF Band I | 47-68 MHz | TV | cable & aerial |
| VHF II | VHF Band II | 87.5-108 MHz | Radio (FM) | cable & aerial |
| USB | Midband | 111-125 MHz | Radio (DSR) | cable & aerial |
| USB | Midband | 125-174 MHz | TV | cable & aerial |
| VHF III | VHF Band III | 174-230 MHz | TV | cable & aerial |
| OSB | Superband | 230-300 MHz | TV | cable & aerial |
| ESB | Hyperband | 300-470 MHz | TV / Radio (DAB) | cable & aerial |
| UHF I | UHF Band I | 470-582 MHz | TV / DVB | cable & aerial |
| UHF II | UHF Band II | 582-862 MHz | DVB | cable |

**Table 1:frequency bands for TV transmission**

CATV world is based on 75 Ohms while premise cabling systems are specified for 100 Ohms. To use twisted pair cabling for TV distribution baluns need to be used.

Sending TV devices typically use output signals of 75 dBìV, receiving units require correct signal at 55 dBìV signal strength to show a clear picture. This means the total attenuation of the passive link should not exceed 20 dB. On a purely passive link using 450 MHz bandwith length is restricted to 50 meters for example. Please keep in mind that the TV provider may not deliver full signal strength shortening maximum length under 30 meters. Minimum signal strength provided by the provider should not be lower than 65 dBìV.

To extend the distance in a certain band amplifiers may be used in the TV links to allow higher attenuation of longer distances. The maximum allowed signal strength is 105 dBìV.

Planning and dimensionating the amplifiers it has to be ensured that maximum input signal of the TV does not exceed 75 dBìV and is not less that 52 dBìV. Below of 52 dBìV you may have to few signal noise ratio. Above 75 dBìV the receiving unit (TV) may be overpowered. In both cases you will find a poor picture quality. Double shielded cables in PiMF construction are recommended by AMP Netconnect. The quality of amplifiers is important as well. Noisefloor is raised by 3dB even if you use better ones decreasing signal noise ratio.

## CHAPTER 2
### LITERATURE SURVEY
#### 2.1 CATV:

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.

Catv contrasts with traditional broadcast television(terrestrial television) in which the television signal is transmitted over the air by radio waves and received by a television antenna attached to the television. FM radio programming, high-speed Internet , telephone service, and similar non-television services may also be provided through these cables.

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## 2.3 COMPOSITE SECOND ORDER DISTORTION:

Composite second order is the compilation (or composite) of a number of individual second order distortions. A second order distortion arises from the product of two carriers (signals). When combined, F1 and F2 will produce an F1+F2 product and an F1-F2 product. These products occur in analog cable TV distribution as a result of non linearities in amplifiers and other devices which are handling many channels.

There are two types of Composite Second Order distortion. First one when the two frequency tones are modulated internally and the other is when the two frequency tones are modulated externally.

## 2.4 COMPOSITE TRIPLE BEAT DISTORTION:

Composite triple beat is a combination (composite) of a number of third order distortions that are generated by non linearites within amplifiers and other components in a cable TV network handling many RF signals. It is a form of coherent distortion. These third order distortions are products of three signals (usually carriers) to form beats. As it is a combination of three signals there are many beats that can be formed. F1 +/- F2 +/- F3 or 2F1 +/- F2 or 3F1.

## CHAPTER 3
## THEORY

This project demonstrates using Optisystem in block mode to analyze a analog CATV transmission system. Here we consider distortions such as composite second order, composite triple beat, and intermodulation distortion. In fiber-based analog CATV transmission systems, there is usually one wavelength used for the signal transmission with multiple analog RF channels modulated onto it. While BER is the most common performance metric in a digital transmission system, measurements of distortions are the critical metrics in an analog transmission system. These results can be produced through simulations in OpSim.

## MODEL DESCRIPTION
## 3.1 CASE 1:

Let us first consider a two tone direct modulated analog transmission system shown below
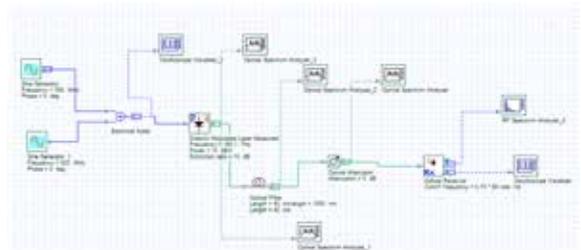


**Fig.1: two tone direct modulated analog transmission system**

In this case, there are two electrical sine-wave frequencies generated and summed. These two frequencies are at 500 MHz and 525 MHz. These are then modulated onto a direct modulated DFB laser at a wavelength of 1550 nm. This is then propagated over 40 km of singlemode optical fiber to a PIN-based optical receiver. The RF spectra can be viewed in the spectrum analyzer to measure the distortions such as composite second order (CSO) distortion, which are due to new frequencies generated at $f1 + f2$ and $f2 - f1$. Figure 1and 2 shows respectively the RF spectra with power at frequencies 25 MHz and1025 MHz as well as the original frequencies of 500 MHz and 525 MHz. Also figure 3 shows are the modulation distortions at and at 1000 MHz and 1050 MHz respectively.
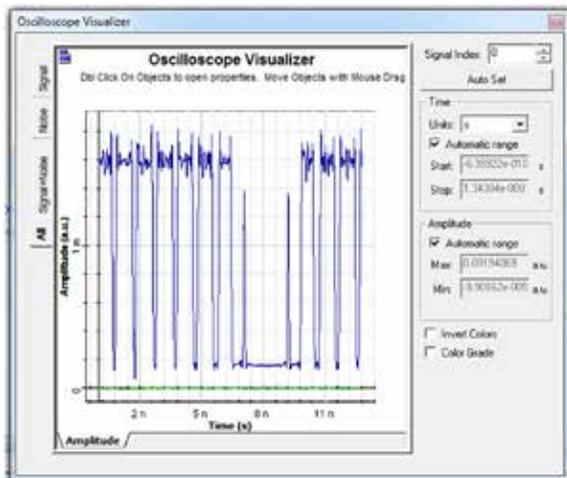


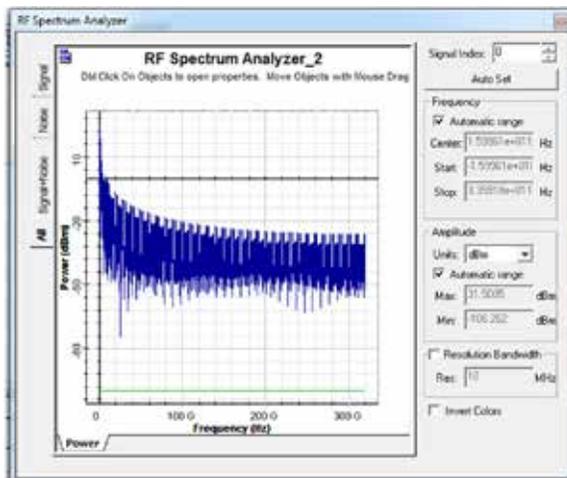**Fig.2.RF Spectra of two tone directly modulated, CSO distortion at 25MHz**



**Fig.3.RF Spectra of two tone directly modulated, CSO distortion at 1025MHz**
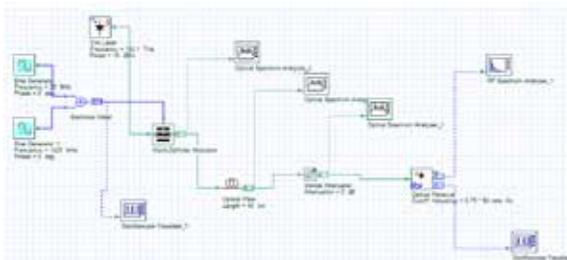
## 3.2 CASE 2:



**Fig.4 a two tone externally modulated analog transmission**

This time, two tones are externally modulated; Figures of 4 and 5 shows respectively the RF spectra with power at frequencies 25 MHz and1025 MHz. Sidebands around in figure 5 shows again the modulation distortions at 1000 MHz and 1050 MHz respectively; the most striking difference between this and the direct modulated example are the additional distortions at a number of additional frequencies.
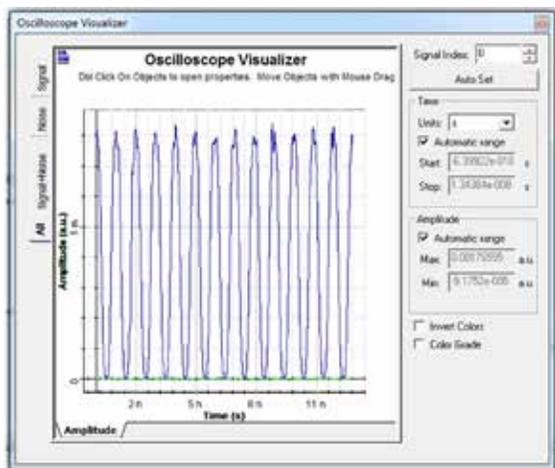
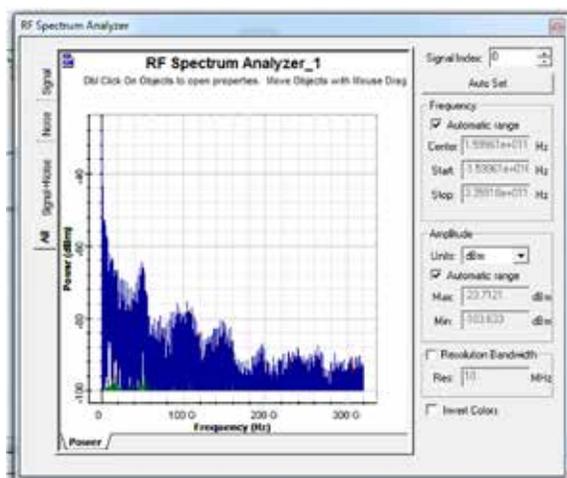**Fig.6.RF Spectra of two tone externally modulated, CSO distortion at 25MHz**



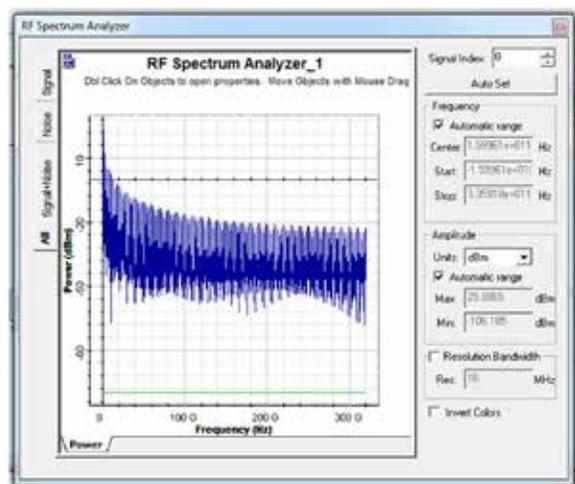**Fig.8.RF Spectra of to three frequencies directly modulated**

### 3.3 CASE 4:
**Let us now consider the fourth case:**



**Fig.10:This case demonstrates a simulation of a 20-channel analog CATV system**

Now considering a 20-channel analog CATV system, starting at 500 MHz with a frequency step of 6 MHz and focusing on the distortions, one can observe the distortions at many frequencies by zooming the RF Spectra



**Fig.7.RF Spectra of two tone directly modulated; CSO distortion at 1025MHz, IMD at 1000MHz &1050MHz**
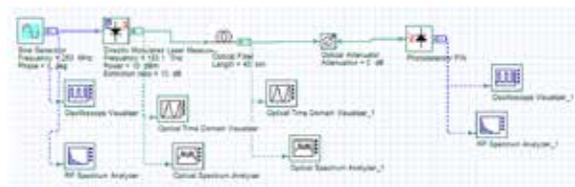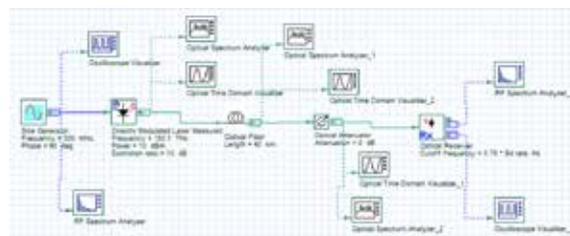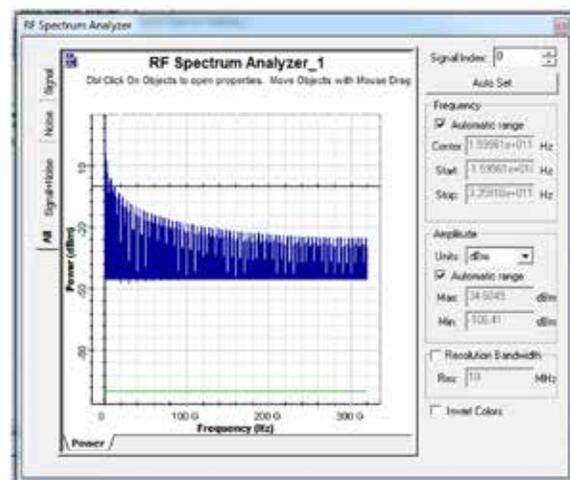
### 3.3 CASE 3:



**Fig.8: a three tone externally modulated analog transmission**

This case is a frequency combination of threefrequencies at 62.5 MHz, 125 MHz, and 187.5 MHz. These three frequencies are then modulatedtogether onto a DFB laser with wavelength 1550 nm and propagated over 40 km of standard singlemode fiber (SMF-28) to a PIN-basedreceiver. The RF spectrum at the receiver can be viewed to analyze the composite second order, composite triple beat, and other distortions in thesystem. As shown in Figure 6, the CSO = -36 dBc (at f = f1 + f2 = 250 MHz and f = f2 + f3 = 312.5 MHz), and the CTB = - 41 dBc (at f = f1 + f2 + f3=375 MHz)



**Fig.10.RF Spectra of to 20 channel directly modulated**

**CHAPTER 4**

## SIMULATION
## 4.1 COMPOSITE SECOND ORDER DIRECT LY MODULATED:
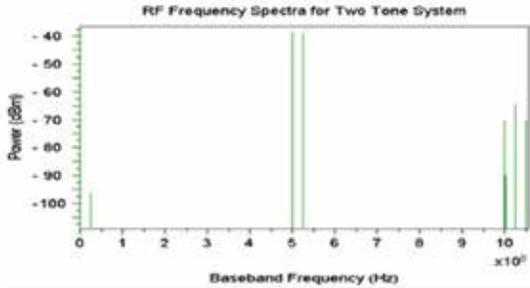For the first case,



**Fig12:output of a two tone modulated analog transmission system**

In this example, there are two electrical sine-wave frequencies generated and summed. These two frequencies are at 500 MHz and 525 MHz. These are then modulated onto a direct modulated DFB laser at a wavelength of 1550 nm. This is then propagated over 40 km of singlemode optical fiber to a PIN-based optical receiver. The RF spectra can be viewed in the spectrum analyzer to measure the distortions such as composite second order (CSO) distortion, which are due to new frequencies generated at f1 + f2 and f2 - f1. Figure below shows the RF spectra with power at frequencies 1025 MHz and 25 MHz as well as the original frequencies of 500 MHz and 525 MHz. Also shown are the modulation distortions at 2*f1 and 2*f2 at 1000 MHz and 1050 MHz respectively.

## 4.2COMPOSITE SECOND ORDER EXTERNAL LY MODULATED:
For the second case,

The RF spectra can be viewed in the spectrum analyzer to measure the distortions such as composite second order (CSO) distortion, which are due to new frequencies generated at f1 + f2 and f2 - f1. Figure below shows the RF spectra with power at frequencies 1025 MHz and 25 MHz as well as the original frequencies of 500 MHzand 525 MHz. Also shown are the modulation distortions at 2*f1 and 2*f2 at 1000 MHz and 1050 MHz respectively. The most striking difference between this and the direct modulated example are the additional distortions at a number of additional frequencies.
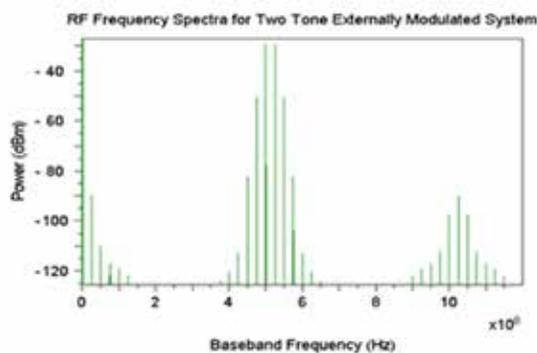


**Fig 13:output of a two tone externally modulated analog transmission syatem**

## 4.3 COMPOSITE TRIPLE BEAT:
Here, the three frequencies are then modulated together onto a DFB laser with wavelength 1550 nm and propagated over 40 km of standard singlemode fiber (SMF-28) to a PIN-based receiver. The RF spectrum at the receiver can be viewed to analyze the composite second order, composite triple beat, and other distortions in the system as shown below:
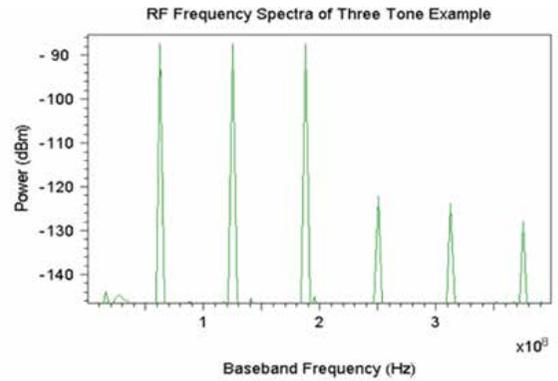


**Fig14: output ofa three tone modulated analog transmission system**

## 4.4 20 CHANNEL:
This case demonstrates a simulation of a 20-channel analog CATV system. In this example as in the above, we focus our attention on the distortions. In the figure below, we see the modulated frequencies for the twenty channels minus the dropped channel, and the distortions present at that frequency.
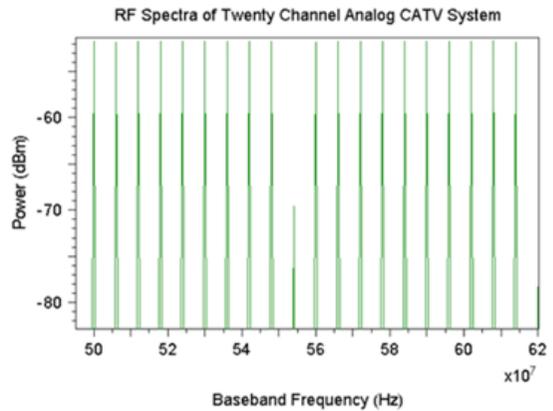


**Fig14: output ofa twenty tone modulated analog transmission system**

## CHAPTER 5
## CONCLUSIONS
## 5.1 COMPOSITE SECOND ORDER DISTORTION:
**DIRECTLY MODULATED:**
In this type two frequencies are directly modulated and the graph shows the distortion that occurs during the transmission of signal. The distortion can be found due to the new frequencies created by the addition and the subtraction i.e f1+f2 and f1-f2.

**EXTERNALLY MODULATED:**
In this type two frequencies are externally modulated and the graph shows the distortion that occurs during the transmission of signal. The distortion can be found due to the new frequencies created by the addition and the subtraction i.e f1+f2 and f1-f2. The difference between the directly modulated and the externally modulated is that in externally modulated the distortion increases when more number of frequencies are added.

## 5.2 COMPOSITE TRIPLE BEAT DISTORTION:
Composite triple beat is a combination (composite) of a number of third order distortions that are generated by non linearites within amplifiers and other components in a cable TV network handling many RF signals. It is a form of coherent distortion. These third order distortions are products of three signals (usually carriers) to form beats. As it is a combination of three signals there are many beats that can be formed. F1

+/- F2 +/- F3 or 2F1 +/- F2 or 3F1.

**5.3 20 Channel Transmission:**
When 20 frequencies are modulated and transmitted the distortion found is great. These distortions can be viewed by zooming in to the frequency at which you wish to analyze the distortion.

Intermodulation Distortion in fiber optic based CATV multi-channel system is recognized by second and third harmonics sidebands of power spectra. Increasing channel numbers, the number of sidebands and thus IMD will increase. This is because of configuration specifications of laser which signal of data is modulated on, optical fiber nonlinearity and external modulator instability in order to sensitivity to laser beam and modulation voltage in the case of utilizing external modulator. This phenomenon is inevitable in optical fiber based analog CATV systems; however distortion is much less than coaxial cable based CATV systems. In order to decrease IMD in optical fiber based CATV systems, optical attenuator seems to be effective

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