



## INDIA'S LARGEST MAGAZINE EXCLUSIVELY FOR SATELLITE & CABLE TV

### BUYERS BEWARE ! POINTS TO CONSIDER WHEN BUYING FIBER OPTIC HARDWARE

*The prices of CATV fiber optic transmitters and nodes has fallen drastically over the past 12 months. However, the buyer needs to carefully check what he is buying. We provide you some tips and caution you on pitfalls....*



Less than 5 years ago, Fibre CATV equipment was considered esoteric. A 550 MHz Fibre optic node cost approximately Rs 80,000. Happily, today an 860 MHz optical Fibre node can be procured for as little as Rs 5,500. However as they say "if you pay peanuts you can only attract monkeys" holds true in this case too.

Similarly, today, a 4 dBm Fibre optic transmitter is available for as little as Rs 25,000 from some vendors while other vendors ask for double that for a similar product. Clearly, there is more to the products than just price. This article should help readers make a more informed decision and

spend their money in not buying the cheapest product but one that provides value for money and meets their technical requirement.

#### **BANDWIDTH**

Most networks now recognise the need for an 860 MHz distribution plant to meeting their existing and future needs hence one is advised to only buy 860 MHz equipment. In many cases the price difference between 550 / 750 / 860 equipment is not substantial.

To fully understand the issues involved in selection of FO products, let's take a look into the Block diagram of a Fibre Optic Transmitter & receiver.

#### **FO TRANSMITTER**

The heart of the Fibre Optic transmitter is the Laser Diode module, which also accounts for a lion's share of the price of the FO transmitter.

The block diagram of a fibre optic transmitter is shown in Figure 1.

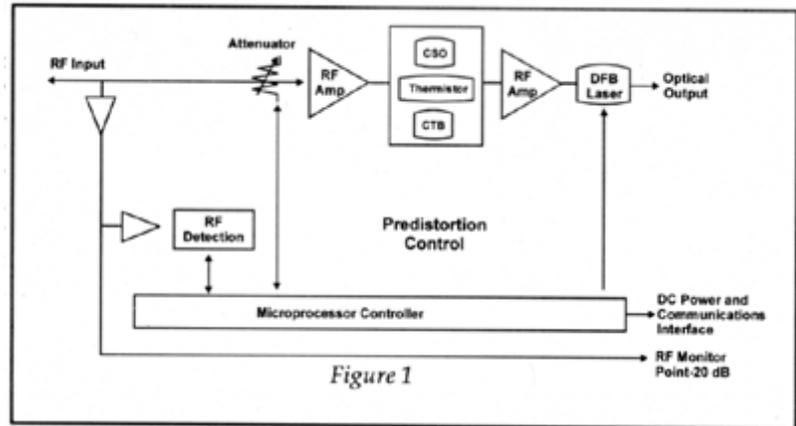
#### **THE LASER MODULE**

The quality and performance characteristics of the Fibre optic transmitter are decided by the laser module. Low cost unbranded laser modules yield low cost Fibre optic transmitters, generally with poor performance.

## OVER DRIVEN LASERS

The cost of the laser module is also closely linked to its power output. An increase in laser power output by 3 dBm substantially increases the cost of the laser module.

The laser output tends to reduce slowly with age hence laser module manufacturers provide a facility to slightly increase the laser output power by increasing the drive current fed to the laser.



However, driving the laser with a current higher than its normal rating, very significantly reduces the life of the laser module. Some low price, low quality fibre optic transmitters enhance their specifications by over driving the laser module. Hence the manufacturer could have bought a 9 dBm laser module. By over driving, it would be used as a 10 dBm or even 10.5 dBm output Fibre optic transmitter. Ofcourse, under these conditions, the laser transmitter is unlikely to operate for more than 3 years, where as a good quality laser module has an anticipated life (Mean Time Before Failure or MTBF) of approximately 10 years.

## BRAND OF LASER MODULE

Your best assurance for a quality Fibre optic transmitter is to have a well reputed laser module manufacturer. Generally, Agere - USA is considered to be the very best. Laser modules from Fujitsu Japan, are also considered good. However, beware of unbranded products from low cost manufacturers.

## PRE DISTORTION CIRCUIT

A Fibre optic CATV transmitter basically converts an RF input signal to an Amplitude Modulated optical signal. This implies that as the instantaneous value of the RF signal increases the laser diode inside the Fibre optic transmitter glows brighter and emits a larger output.



If the light output increases in exact proportion to the RF input, there would be zero distortion. However, in most practical cases, the light output does not exactly follow the RF input. The result is a small amount of distortion.

The Fibre optic transmitter manufacturer can measure and therefore predict and compensate for the optical module's distortion. The circuit that does this is the "Pre-Distortion Circuit".

Earlier generation optical modules needed a pre-distortion circuit to correct their fairly large non-linearity (distortion).

Over the years, optical modules have improved in their characteristics and today, some manufacturers do not find it necessary to incorporate a pre-distortion circuit for optical modules of 4 to 6 mW. Most manufacturers of quality Fibre optic transmitters do incorporate a pre-distortion circuit, particularly for high power Fibre optic transmitters.

Laser transmitters with a pre distortion circuit will almost certainly provide better distortion specifications.

### **MAXIMUM POWER INTO FIBRE**

It is not widely known, but fibre optic cable can only accept a certain amount of optical power. The exact amount of optical power accepted depends to a small extent on various factors such as wavelength, the temperature of the fibre and the mechanical strain on the optical fibre. Also, short lengths of Fibre can accept significantly higher power.

If more power is launched into the cable than what the cable will accept, the excess power is simply reflected back into the transmitter and rejected by the cable.

This is due to Stimulated Brillouin Scattering (SBS). The Power reflected back due to SBS is at a slightly lower wavelength ( typically 0.1nm less, at 1550nm ). This SBS back scattering is a waste and will not reach the other end of the cable. In fibre optic systems where optical power is extremely expensive, it is imperative to ensure that all power launched into a cable is transmitted onwards by the cable.

A few meters of ( non specialised ) Fibre optic cable can accept even 25dBm of optical power. 1Km to 5 Kms of cable may accept upto 17dBm of optical power. However long lengths, such as 10 Kms or more of non specialised cable can accept only 20mW or 13 dBm of optical power, beyond which SBS bounces back additional power.

SBS suppression is therefore a MUST if you plan to feed more than 13 dBm into your fibre.

For most 1310 nm systems this is not a concern since 1310 nm transmitters usually have output powers of 14 dBm or less.

SBS suppression is done at the 1550 nm Transmitter ( Not in an EDFA ! ).

The amount of SBS suppression depends on the capability of the SBS suppression circuit. Current state-of-the-art circuits permit optical powers of 17 dBm to 18dBm to be launched into the fibre.

Hence most systems are designed to limit the optical power launched into long cable lengths to 17 dBm or less.

However, high power 1550 nm EDFA amplifiers can easily put out 22 dBm or even higher optical outputs. In such cases, the EDFA output must be immediately split into 8 or more multiple outputs using splitters. Each of these multiple outputs must be below 13 dbm before it can be optimally launched into a fibre optic cable.

Alternately, the 1550nm Transmitter feeding the EDFA MUST incorporate SBS suppression, to launch higher powers.

### **EXTERNALLY MODULATED LASERS**

For the best performance, Fibre optic systems usually employ transmission at 1550 nm rather than at 1310 nm. The cable losses at 1510 nm are 0.25 dB per km compared to 0.35 dB per Km for 1310 nm.

Also, higher power Fibre optic transmitters are available for use at 1550 nm.

For the highest level of performance, 1550 nm laser transmitters are often externally modulated.

In typical low cost transmitters, the laser is internally modulated, that is the laser's drive current is directly changed in response to the input RF signal level. Hence the laser brightness fluctuates (is modulated by) in accordance with the RF input signal.

Unfortunately, the laser's optical distortion is not constant for all input drive currents and despite the pre-distortion circuit, the laser yields some distortion.

In an externally modulated laser, an optimal, fixed drive current is constantly fed to the laser making it operate in a uniform, virtually distortion free mode. A shutter like device is placed in front of the laser diode, which modulates the final light output passing through the shutter in accordance with the input signal. The shutter could be an optical crystal whose transparency varies with an externally applied electrical signal.

Clearly, due to its increased complexity, an externally modulated laser transmitter is much more expensive than an internally modulated laser. Prices of externally modulated lasers

could be 2 to 3 times that of internally modulated lasers. The distortion improvement ranges from 3 dB to 6 dB.

**Table 1 :**  
**Optical Power In milli-Watts & dBm**

mW	dBm
1 mW	0 dBm
2 mW	3 dBm
4 mW	6 dBm
8 mW	9 dBm
16 mW	12 dBm
32 mW	15 dBm
64 mW	18 dBm
128 mW	21 dBm

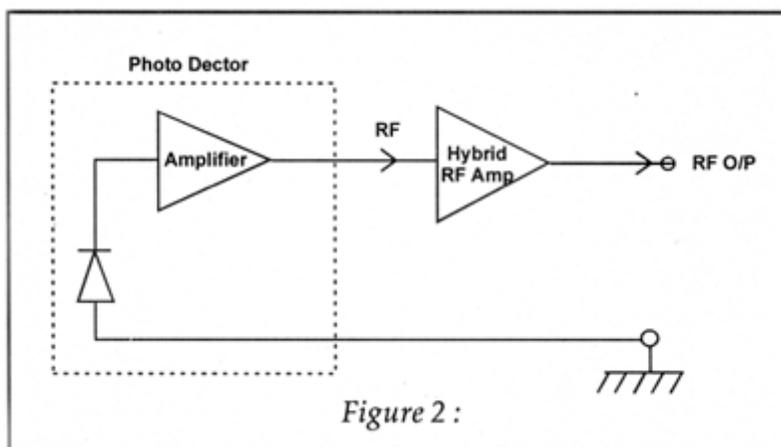
### PRACTICAL IMPLICATIONS OF EXT MOD LASERS

For most modest CATV networks, internally modulated 1550 nm, Fibre optic transmitters are adequate. However, in very large networks that use multiple, cascaded EDFA amplifiers, an externally modulated laser operating at 1550 nm is a must. The signal would rapidly deteriorate and become practically unusable if an internally modulated laser transmitter is used for a cascade of 2 or more EDFA amplifiers.

Do note that EDFA amplifiers operate at 1550 nm. Their counterparts for 1310 nm operation (PDFA Amps) are not commonly available or used.

### SBS SUPPRESSION

SBS limits the optical power that can be launched into a regular quality Fibre, to just 20 mWatts or 13dBm ( Refer to " MAXMIMUM POWER INTO FIBRE " box ). If your system design calls for launching higher power into your cable, you will need to buy a Transmitter with SBS suppression.



monitor and ensure that the maximum power limit is not exceeded, & SBS does not occur, even at sharply tuned frequencies.

SBS compensation is therefore an important feature in Fibre optic transmitters that are to be used with EDFA amplifiers. A regular quality 1550 nm transmitter can be used to usefully launch only

Also, in applications such as Wavelength Division Multiplexing (WDM) and Dense Wavelength Division Multiplexing (DWDM), the Stimulated Brillouin Scattering (SBS) reflected power, (Refer Box "MAXMIMUM POWER INTO FIBRE") which is at a slightly lower wavelength ( typically 0.1nm at 1550nm ), can interfere with some of the carriers in the DWD multiplex. As a result, the lower frequency signals are usually attenuated. To ensure that this does not happen, SBS suppression circuits are employed in the transmitter, which

13dBm of optical power.

However a high quality, externally modulated, SBS compensated transmitter could usefully feed a cascade of 4 or even 5 EDFA amplifiers.

Keep in mind that such Transmitters are VERY expensive, and you should consider an alternate system design, if possible.

### FIBRE OPTIC NODES

The basic block diagram of a fibre optic node is shown in Fig 2. It consist of two sections viz. an optical section and an RF amplifier. The optical section receives the light input from the optical fibre and converts it into an RF signal.

### PINS & HYBRID MODULES

A PIN photo diode is used for the optical to RF conversion. This conversion is crucial and deals with extremely small electrical signals and currents of a few micro-amperes. Any noise generated by the PIN diode or the RF amplifier immediately following the PIN diode will permanently degrade the signal quality. Hence, it is crucial to use a high quality PIN diode. The amplification circuit immediately following the PIN diode must be matched with a PIN diode characteristic and should provide high gain with low noise. The PIN amplifier usually provides a gain of 60-65dB.

For best results, reputed manufacturers such as Philips offer high quality hybrid modules that combine a high quality PIN diode that is closely matched to a low noise electrical amplifier immediately after it.

### CAUTION !

If your fibre optic node uses such as a hybrid module, it provides you a simple assurance of consistantly high quality. To save cost, many fibre optic nodes utilise low cost optical hybrid modules sourced from China, which may offer significantly poorer performance.

There are also a fair number of duplicate / spurious Optical Hybrid modules available in the market. It is interesting to note that a genuine Philips Hybrid module costs approximately Rs 8,500 & a Chinese module about Rs 2,800. Hence if a manufacturer offers a Hybrid module based node, with a "Phillips" hybrid for less than Rs 9,000, view it with suspicion !



### PIN BASED NODES

Some fibre optic nodes prefer to save cost and assemble their own optical detector using a separate PIN diode with their own design of electrical amplifier after it. While in principle, such designs can also achieve good performance, in general, separate PIN diode detectors offer poorer performance than a quality hybrid module. The PIN diode design, however saves costs yielding a much cheaper node.

Incase you do not plan to cascade more than one CATV amplifier after the node, you could get away with the use of a PIN diode based optical node. However you must ensure that the optical input signal is atleast of the level dictated by the node's specification.

Also, if a cheap node that generates noise is used in conjunction with a cheap fibre optic transmitter that puts out a noisy signal you could end up with a fairly shabby signal at the customer end!

### RF AMPLIFIERS

The RF output from the FO hybrid module is usually at approximately 70-75 dBu. Low cost nodes some times directly put out this signal without adding a hybrid RF amplifier module. This substantially brings down the cost of the node but requires you to add an external RF amplifier immediately after the node, unless you can make do with an RF signal of 75 dBu. In a particular application such as where there is not much distribution beyond the node.

However, most quality fibre optic nodes utilise a hybrid RF IC. Ensure that your node preferably

utilise a product from a reputed manufacturer such as Philips or Motorola. This will add to the final price but you can be assured of good picture quality even after a fairly long RF cascade after the node.

It is reported that some low cost, poor performance fibre optic transmitters sourced from china use 550 MHz or 750 MHz refurbished (i.e. second hand!) modules. These refurbished modules have been selected where they do provide some output even for 860 MHz signals but the picture quality for the upper band signals is extremely poor. Hence if your new fibre optic system seems to yield poor performance for channels above 750 MHz, check out the node that you purchased !

### **SUMMARY**

The price of fibre optic equipment available in India has fallen dramatically over the last one year. It is hard to believe, but true that an 860 MHz fibre optic node can be bought for less than the price of a good quality 860 MHz RF amplifier. When you consider the fact that an optical node actually consists of A Fibre Optic Module + A 860 MHz RF amplifier, it is almost a miracle ! Clearly corners have been cut in such a design and the product sold at such absurd prices would have compromised on the quality of electronics used.

Let the Buyer Beware !

It is hoped that this article will help readers make an informed choice when buying fibre optic transmitters and nodes. They don't need to buy the most expensive or the cheapest. The above knowledge should help them determine the right product at the best price for the intended application. ■

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