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EDFA : IDEAL Fibre Optic SOLUTION FOR LMOs

The EDFA Provides The Ideal, Cost Effective Solution For The Last Mile Operator

New technologies often provide unique and even sometimes elegant solutions. However, more often than not, these solutions come with a hefty price tag attached to them. Five years ago, fibre optics was a typical case. It offered distortion free CATV distribution but at a hefty price tag that could not be justified in the Indian context.

However, over the past 2 years, the situation has changed radically. 4 core fibre optic cable today cost less than half the price of quality RG 6 drop cable! Also as seen in the fibre optic survey in our June 2004 issue, an 860 MHz fibre optic node can be obtained at a lower price than an 860 MHz amplifier !

Clearly, fibre optic solutions are now no more expensive, or may be even cheaper than RF coaxial CATV distribution.

UPGRADING

Several Indian CATV networks, particularly those of LMOs have grown on a piece meal basis over the past several years. Often, sections of the LMO's network have utilised poor quality coaxial cables. The quality of workmanship also sometimes leaves a lot to be desired.

In some cases it is possible to "clean up" the signal path by changing connectors as well as tapoffs and splitters and using good workmanship.

However, where poor quality coaxial cable has been deployed, particularly if the cable provides inadequate shielding, the only solution may be to change the entire coaxial cable. This solution is extremely expensive. Infact, a 4 core fibre optic cable cost less than Rs 10 per meter compared to over Rs 50 per meter for quality trunk cable.

FIBRE OPTIC ALTERNATIVE

Fibre optic cable also provides extremely low attenuation. As a result, a fibre optic CATV distribution system does not utilise any amplifiers at regular intervals. This eliminates additional distortion and also makes the system more reliable and immune to power surges and power failures.

Clearly, where the LMO plans a distribution system rebuild, fibre optics provides not only a technically superior but possibly a cheaper solution as well.

DEEP PENETRATION OF FIBRE

Most MSOs in the metro cities currently provide a fibre optic feed to their Last Mile Operators (LMOs).
The LMOs immediately convert the fibre optic signal into an RF signal and then distribute it over an RF plant to their customers. This solution has helped the LMO retain his old RF distribution system. At best, the old RF distribution system has been upgraded in recent years for 750 or 860 MHz bandwidth. However, due to poor quality materials and workmanship, even these wide bandwidth systems are far from ideal.

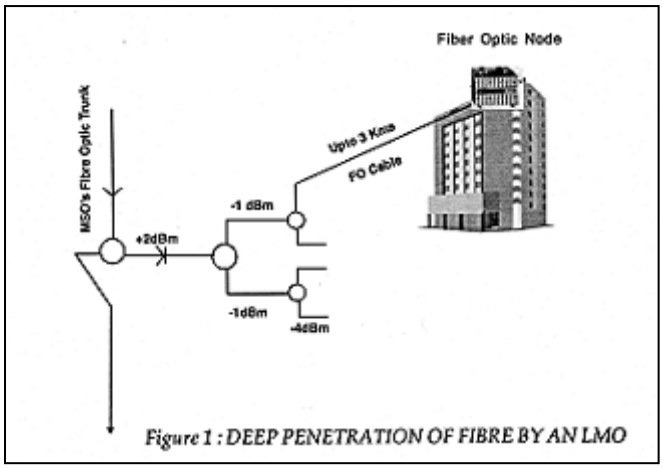

Figure 1 : DEEP PENETRATION OF FIBRE BY AN LMO

Since fibre is immune to picking up external noise during distribution and because it is amplifier free, does add distortion. To fully utilise the benefits of fibre optic technology, it is desirable to take the fibre as deep into the system (i.e. as close to the customers home) as possible.

Given the fact that an 860 MHz fiber optic node is today cheaper than an 860 RF amplifier, there is no cost penalty at all for deploying fibre deep into a system.

FIBRE INPUT LEVELS

The fibre optic feed provided by the MSO is typically at a level of 0 dBm to 2 dBm.

Classic system design dictates that each fibre optic nodes should receive an input of approximately 0 dBm. However, several manufacturers offer low noise FO nodes, which will accept signals as low as -5 dBm. Ofcourse, if fed a signal of -5 dBm, a certain amount of noise will be added when the RF signal is generated. However, if these FO nodes either feed a CATV home directly, (through tapoffs / splitters) or through a maximum of 1 Line Extender Amplifier, the results at the consumers premises will be perfectly acceptable, even for digital STB deployment.

Assuming an input signal from the MSO of + 2 dBm and a worst case input of -5 dBm at a FO node, the LMO has a 7 dB margin for distribution of his signal.

Figure 1 indicates how this 7 dBm could be optimally utilised. An array of 3 fibre optic splitters (each with a 50:50 division ratio) will generate 4 output trunks each with a signal level of -4 dBm. This signal could be transmitted over 3 kilometers of fibre before they need to be terminated into a -5 dBm fibre optic node.

The ideal solution would be to farm out each of the 4 trunks to geographically distinct areas within the network.

Once terminated into an FO node, the signal could be distributed to a cluster of buildings / homes as an 860 MHz RF signal.

MARGINAL DESIGN

Ofcourse the above represents an undesirable marginal design where each node barely receives the minimum required signal. The above solution is probably best for LMOs with a small number of subscribers.

A far superior solution would be to use a single EDFA Amplifier by the LMO.

EDFA SOLUTION

The Erbium Doped Fibre Amplifier (EDFA) is an amplifier that accepts an optical input signal, amplifies it and puts out the amplified optical signal. There is no conversion of the signal into RF or any other electrical signal conversion within the EDFA amplifier.

EDFA amplifiers operate at 1550 nm. While PDFA amplifiers are available for 1310 nm operation, they are not freely available and do not provide the same price to performance benefits of an EDFA

amplifier. However, shifting to a 1550 nm fibre optic distribution system is practically transparent to cost implications. The fibre optic nodes available operate equally well at both 1310 and 1550 nm. The fibre optic cable has a loss of 0.35 dB per kilometer @ 1310 nm and an even lower loss of 0.25 dB per kilometer @ 1550 nm. Fibre optic splitters operate equally well at both wavelengths. Clearly, the LMO can comfortably engineer his entire fiber optic distribution system for 1550 nm operation.

Figure 2 shows a block diagram for an LMO's FO distribution system, utilising an EDFA amplifier.

An EDFA amplifier is connected directly to the fibre optic feed of 0 dBm, received from the MSO.

EDFA amplifiers are available with different output capacities. Figure 2 assumes the use of an EDFA amplifier with an output of 18 dBm. If this EDFA output is fed into the distribution network of Figure 1, the LMO will generate 4 fibre optic trunks each with a comfortably large output of 12 dBm.

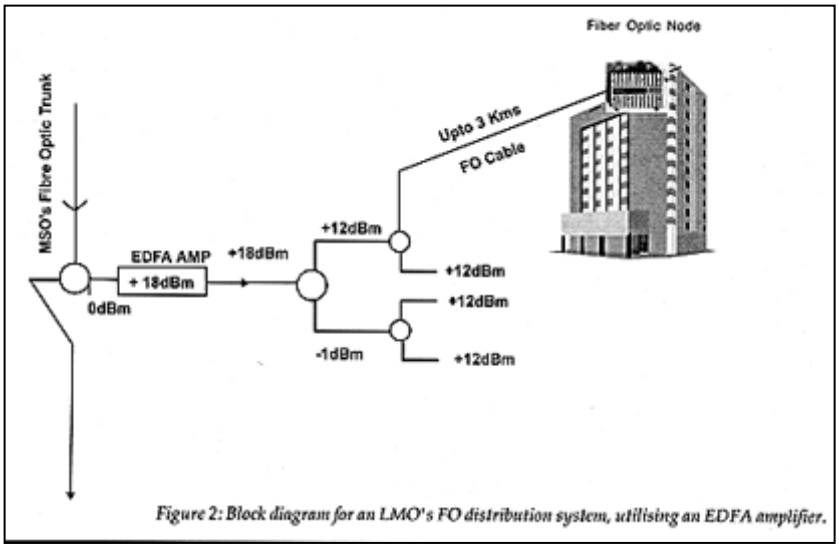

Figure 2: Block diagram for an LMO's FO distribution system, utilising an EDFA amplifier.

Even if 8 fibre optic trunks are generated, with the use of additional splitters as indicated in Figure 2, each of the 8 fibre optic trunks will have an output of 9 dBm.

Such large optical signals will comfortably enable an LMO to deploy fibre practically to a cluster of buildings. Each building cluster can then be serviced by an RF signal directly distributed from a fibre optic node that provides an 860 MHz RF output at 100 dBU.

In some metros, such as Mumbai, with large clusters of multi storeyed buildings, it may be necessary to service some of the customers after adding one additional distribution amplifier some distance away from the fibre optic node.

However careful design can ensure that an LMO that utilises and EDFA amplifier can service each of his CATV consumers either directly from a FO node or with the maximum use of one cascaded amplifier.

Such a signal would provide almost zero distortion at the LMO's distribution plant and little addition of external noise from signal plunging into the distribution network. The EDFA amplifier itself does generate some noise but at a level, which is perfectly acceptable, even when a large number of digital STBs are simultaneously deployed on the network.

COSTS

An EDFA amplifier currently cost approximately Rs 3.5 lakhs however the benefits that it yields is tremendous. Besides eliminating all RF distribution amplifiers, it also provides almost zero distortion, little noise and a zero slope ! These virtues along with the fact that fibre optic cable is significantly cheaper than coaxial cable should make an EDFA based distribution plan, even for the LMO, a very attractive option.

CAUTION

It would be appropriate to highlight a few points that need to be addressed when deploying a fibre optic solution.

◆ A little known fact that needs to be highlighted - you cannot launch more than 13 dBm into a long length of fibre.

◆ SBS compensation can hike the maximum power launched, to 17 dBm.

◆ SBS compensation can only be incorporated by the MSO in his 1550 nm fibre optic transmitter at the Headend. If your MSO does not incorporate SBS compensation, you will have to restrict the optical power launched into long cable lengths to 13 dBm or less. (for a detailed explanation on SBS compensation, please refer to the "Points to Consider when buying Fibre Optic Hardware" article in our June 2003 issue).

◆ Your MSO must provide you a 1550 nm fibre optic feed if you plan to deploy an EDFA. A PDFA (not easily available) will have to be utilised if you are stuck with a 1310 nm feed from your MSO.

PRACTICAL ?

This article puts forward a relatively radical suggestion that recommends the use of state-of-the-art EDFA amplifiers for the "humble" LMO.

A closer look at the solution however indicates that it will provide a completely reliable CATV distribution plan that can sustain any dense deployment of digital STBs cable modems and even Reverse path authorised digital STBs, thus making the system future proof.

The icing on the cake is that the EDFA based fibre optic rebuild may not cost any more than a conventional RF coaxial distribution system. ■