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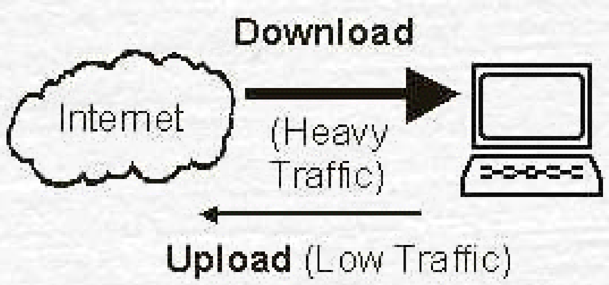
UPGRADING FOR INTERNET DELIVERY

While several CATV networks have started upgrading for Internet delivery, there appears to be a lack of information on the technical requirements that CATV hardware needs to meet, for successful implementation. Often refuge is taken by selecting the most expensive equipment, or those of Imported origin.
This article takes a look at the various parameters that need to be addressed, for proper selection of equipment.

INTRODUCTION

Internet delivery over existing cable networks provides tremendous scope for adding value to the services provided to end customers. While a conventional CATV network provides 36 to 70 channels for a monthly revenue of Rs 80 to Rs 150, adding Internet delivery raises the bar to well over Rs 1000 per subscriber per month. Use of cable modems for Internet delivery on existing CATV networks is not very bandwidth intensive. It utilises a bandwidth of just 6 MHz or one channel in the forward path and only 2 MHz in the Reverse Path. Clearly, Internet delivery provides a huge additional revenue for a very small bandwidth.

PRACTICAL CONCERNS



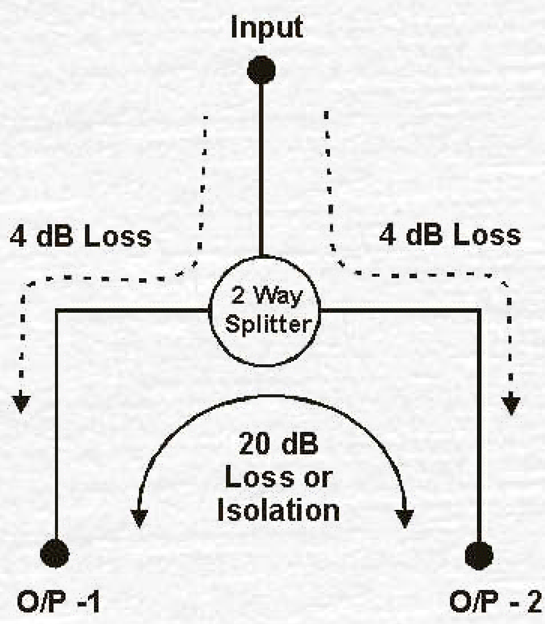
Pioneering CATV networks that first upgraded to cable modem services soon realised that Internet delivery on cable networks was not as quite as easy to implement, as it appeared on paper. The major concern was that of noise. Internet delivery requires a 2 way path to be established from the Headend to the customer. Details of the site requested flow from the Headend to the customer in the forward path. When a customer requests a particular website, he effectively sends a small amount of information containing the website's address to the Headend i.e. along the reverse path. Also, emails are sent by the customer to the Internet i.e. on the reverse path. The data traffic is highly asymmetric i.e. there is much more data flowing in the forward path than in the reverse direction. It is for this reason that 6 MHz is allocated for forward path traffic and just 2 MHz for reverse path traffic.

DIGITAL MODULATION

The forward path utilises Quadrature Amplitude Modulation (QAM) various levels of QAM exist e.g. QAM 16, QAM 32 upto QAM 256 and even higher. The higher levels of modulation compress more data over the same bandwidth. They however require the transmission path to be noise free. Densely modulated signals are very easily corrupted with line noise. Line noise is primarily generated at the lower frequencies of 0 MHz to 30 MHz.

This is the frequency range predominantly used by the reverse path on most of Indian CATV networks. Recognising this problem the world over, Quadrature Phased Shift

Keying (QPSK) modulation is employed in the reverse path. QPSK is an extremely robust modulation technique and delivers very weak video signals from a satellite to the LNB with reasonably good carrier to noise levels. QPSK is however less efficient in transmitting data over a given amount of bandwidth. However, this is not a concern since as we have seen, the reverse path carries a relatively much smaller amount of information.



Most cable networks have faced problems when first installing a cable modem system. Many of these have then assumed that the equipment employed by them is not of adequate quality to deliver Internet data signals without corruption. These networks have often blindly installed the most expensive imported equipment available, which has then enabled proper system functioning.

It is however not important to take on a blind sledge hammer approach. An informed purchase of products could save a huge amount of money as well as tiers in ensuring that the system works as designed. Lets take a closer look at the areas to focus on when selecting CATV equipment for proper Internet delivery.

SELECTION OF CABLE

Noise is always the greatest concern during Internet delivery and therefore every care must be taken to minimise the ingress of noise onto a CATV network. The distribution cable runs for several kilometers and is easily the most susceptible element for the entry of noise into the cable network.

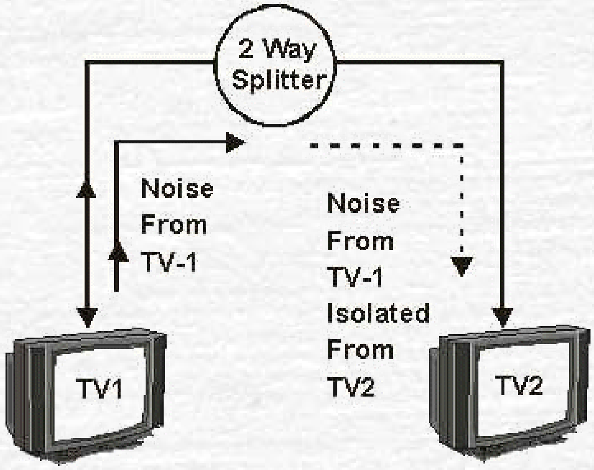
SHIELDING

Good shielding prevents external noise from plunging into the signals on the coaxial cable. It therefore logically implies that the cable must have both a metallic foil as well as closely spaced braiding (Heavy Braiding). These 2 elements will provide excellent isolation from noise.

JOINTS

Great care must be taken to ensure that any joints in the cable are done using proper connectors. The shielding must make good contact with the connector body to ensure proper electrical connectivity.

CONNECTORS



Connectors are often the most neglected part in a CATV network. It is estimated that connectors contribute less than 2% of the cost of a network but are responsible for more than 70% of the problems! Clearly it makes tremendous sense to invest in high quality connectors and ensure that the connectors are perfectly installed, making good contact with both the center conductor and the outer shield. Coring and Crimping tools must be used wherever required.

A connector not crimped properly will not provide a proper electrical shield. As a result it forms a weak spot in the distribution network from where noise can plunge into the system.

SPLITTERS & TAPOFFS

SHIELDING

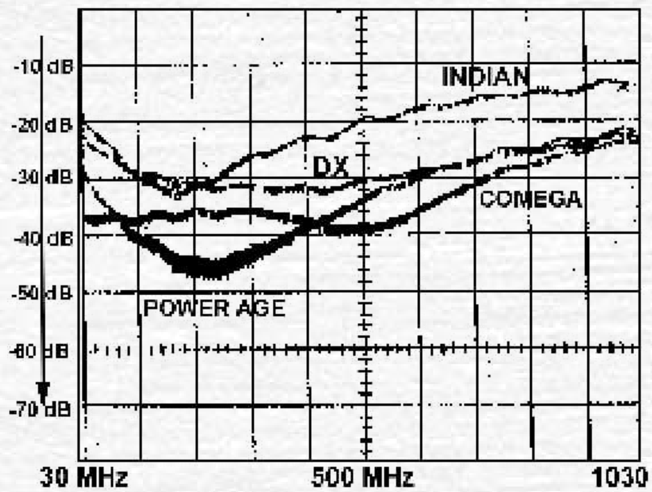
Splitters & Tapoffs are used to distribute the signal along the network. The body of the Tapoffs and Splitters must be made of a tightly fitted metal case. The metal case provides an electrical shield around the internal components of the Passive. This specification is also referred to as shielding efficiency. While a low quality metallic housing could provide shielding efficiencies of approximately 24 dB, this is clearly inadequate. Keep in mind that a network could actually have several thousand passives each of which could provide a weak spot from where noise can enter the network. Tapoffs & Splitters specifically optimise for Internet delivery offer shielding efficiencies as high as 100 dB.

ISOLATION

Isolation is the property of a Tapoff or Splitter where signals from one output are prevented from leaking into another output. As an example, in a 2 way Splitter any noise generated from the antenna socket of one customer's TV set should not leak into another customer's signal path at the second output.Similarly in a Tapoff, any noise from a customer's TV set located on the branch or Tapoff should not leak into the main line. Both these cases are illustrated in Figure 1.

Isolation is a very important design parameter for passives used on a Broadband enabled CATV network.

Figure 2 shows actual measurements conducted on various 2 way Splitters available in the market. The low quality 2 way Splitter typically provides an isolation of 12 to 18 dB. The isolation is fairly good mid band but drops significantly at the frequency extremes. Most important, the isolation falls significantly at the reverse path frequency where noise is anyway a problem. If the reverse path isolation is just 12 dB, it indicates that such passives will reduce injected noise by only 12 dB. Considering that a cable network could easily have 5,000 subscribers each with their own levels of noise generated. This generated noise is attempted to be injected back into the cable network from all these 5,000 subscribers! Clearly a 12 dB isolation is far too poor.



While most good quality locally manufactured passives provide an isolation of 18 dB to 20 dB upto 1 GHz, even this level of performance is inadequate for large networks. It was interesting to measure that Comega passives offered an isolation of upto 60 dB at high frequencies. By any standards, this is exceptional performance.

Measured Isolation

VSWR

The Voltage Standing Wave Ratio is an indication of how closely the input and output impedance are matched to 75 Ohms, the ideal impedance. A VSWR = 1 indicates a perfect 75 Ohm impedance. For VSWRs different from 1, some of the signal arriving at the port will bounce back into the system rather than be transmitted smoothly ahead. Clearly, if the signal is successively bounced back from each of the several hundred of Tapoffs & Splitters in the signal path, it will lead to the digital data being corrupted due to signals bouncing back and forth in the network.

AMPLIFIERS

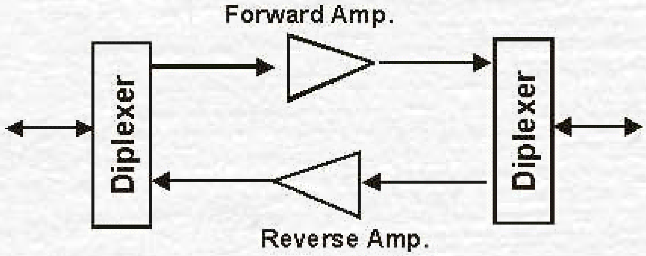
All amplifiers in the signal path from the Headend to the Broadband customer must be bi-directional i.e. they must amplify as well as transmit signals in both directions.

REVERSE AMPLIFIER GAIN

The reverse path signals are typically have a maximum frequency of 50 MHz. Hence the cable losses for these signals is less than 30% of the cable loss at 550 MHz. This has lead network owners to believe that only one reverse path amplifier is required at an interval of 3 forward path amplifiers. Further, a gain of 10 to 15 dB is thought to be adequate. These assumptions are true only along the main trunk where the distribution loss is primarily due to cable losses. However once distribution to customers commences, the Tapoffs and Splitters contribute a significant portion of the total signal loss. The distribution loss on Tapoffs and Splitters is essentially the same at all frequencies. Therefore reverse path amplifiers used in distribution need to have substantial gain even at 50 MHz, to compensate for the loss in the passives.

REVERSE PATH FREQUENCIES

Conventionally, when Cable TV networks began operations in India, networks were designed so that the lowest frequencies were utilised as far as possible for the forward path. Band I was a prime asset since cable losses were low and channels transmitted in Band I enjoyed good picture quality even if customers were located far away from the cable Headend. Due to this the reverse path was earmarked only 5 to 30 MHz. Infact, in these legacy networks, the reverse path was rarely used.



30/42/50 MHz Reverse Path

The few networks that utilised the reverse paths did so for relay of one channel. These users soon realised that the frequency band below 20 MHz was almost unusable due to the high amount of noise. This concern remains even today.

WIDER REVERSE PATH

Today's networks therefore have started widening the frequency span allocated for the reverse path. Currently manufacturers of bi-directional CATV amplifiers offer customers the option for Diplexers, which split the forward and reverse path in different rations. Popular splits currently offered are:

- 30 / 40 MHz. Split
- 42 / 51 MHz. Split
- 50 / 70 MHz. Split

The 42 / 51 split is actually the American, NTSC standard and hardware such as Diplexers for these frequencies are widely available. This split removes the possibility of running Channel 2 (48.25 MHz) in the forward path but currently most networks have more than adequate forward path bandwidth.

The use of upto 42 MHz in the reverse path implies that the cable modem service will have a much better chance of getting a noise free reverse path bandwidth of 2 MHz that it requires, between the 20 MHz and 40 MHz reverse path frequency band.

UNIFORM FREQUENCY RESPONSE

While a uniform and flat frequency response is desirable for Analog TV signal transmissions on a cable network, this factor becomes critical when delivering Internet services through the reverse path. Internet delivery requires that the system be set up for a unity gain signal loop from the control room to the customer and back to the control room. (Details of this will be provided in a separate article that we plan to carry shortly). This unity gain would be very difficult if not impossible to set up if all amplifiers in the loop do not have a uniform frequency response.Poor quality cable which yields notches in its UPGRADING FOR INTERNET DELIVERY

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CONCLUSION

Internet delivery through CATV networks is not a black art. It however requires a good understanding of the requirements for uncorrupted transmission of digital signals. The CATV system has to be carefully set up and good passive distribution equipment such as Tapoffs and Splitters with high reverse path isolation are essential. CATV cable with a high shielding efficiency is also essential. Most cable networks have also realised that re-designating the reverse path frequencies to extend upto 50 MHz provides the much required noise free reverse path bandwidth for Internet delivery.