Symmetrical Phone Filters for ADSL

Pulse TECH TIP #102

Background

Broadband service providers seeking to simplify the process of ADSL installation will sometimes consider the use of third-order symmetrical (sometimes called "reversible") ADSL phone filters. This type of filter provides the same input characteristics regardless of which port connects to the line and which port connects to the telephone equipment. The perceived benefit of such a filter design is that it can eliminate potential installation errors.

Unfortunately, establishing symmetry as a filter design criterion can result in impaired performance with regard to telephone service quality. The constraint of making both connections electrically similar forces compromises in the design that are in opposition with the impedance requirements of the telephone equipment. In addition, a reversible filter with a plug-to-jack connector configuration increases the potential for crosstalk and audible noise in the telephone. This technical brief discusses some of the issues that should be considered when evaluating the use of symmetrical filters for general deployment.

Return Loss and Sidetones

Maintaining proper impedances in communication circuits is an important factor in phone filter design. The goal is to achieve a measurably high "return loss", which is an inverse expression of the fractional amount of signal reflection caused by an impedance mismatch. When an ADSL or HPN in-line filter is used to suppress phone interference, the difference in impedance presented to the telephone equipment (as compared with the non-loaded phone cable) can be measured in terms of return loss. A decrease in return loss will produce a hybrid imbalance in the telephone that results in increased sidetone.

Sidetone, the sound of the speaker's own voice as heard in the speaker's telephone receiver, affects telephone transmission quality in several ways. Too much sidetone causes the returned speech levels to be too loud. Because an optimum sidetone level helps speakers judge how loudly they are talking, too much sidetone can often cause the speaker to lower his/her voice, which in turn reduces the received levels at the far end of the connection. Excessive sidetone also amplifies the ambient background noise picked up by the local mouthpiece, which can make it harder to hear the person speaking on the far end of the connection.

Symmetrical Filter Design Constraints

One of the challenges in designing DSL phone filters lies in maintaining a steep roll-off within the 10-25kHz range while minimizing the in-series inductance and shunt capacitance. Since symmetrical filters must present the same impedance at both jacks, a third-order design that meets the required frequency response criteria will also possess a very high in-series inductance due to the need to have similar coils on both sides of the filter. This higher inductance reduces the effective Echo Return Loss (ERL) and Singing Return Loss high (SRL-hi) specification parameters.

Return loss is further decreased by the parallel capacitance contributed to the transmission system by the filter, especially when multiple filters are used throughout a household on a single line.

Tests have shown that the increased capacitance realized by having several symmetrical filters in parallel, combined with the high in-series inductance of the symmetrical filter design, can actually cause more energy to be reflected in the SRL-Hi band (2200-2400Hz) than was originally transmitted!

A decrease in return loss produces a corresponding increase in sidetone, which increases the volume of the speaker's voice in the speaker's own telephone receiver. Symmetrical filters, though they can achieve very favorable roll-off characteristics, will therefore sacrifice sidetone due to the requirements of the third-order filter design. A lower return loss can also affect the reliability of phone/fax/modem switches, causing them to become inoperable in some cases.

Excelsus® Second-Order Filter

While no phone filter design is perfect, test results have confirmed that the impedance characteristics of Excelsus Z-BLOCKER® 200-series filters deliver significantly better return loss performance than symmetrical filters,

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Excelsus® Second-Order Filter *(continued)*

especially when multiple filters are used at a single customer premise. This translates into consistently clearer voice communications and more reliable voiceband data transmissions over widely varying installation situations. The wide-band characteristics of Excelsus Z-BLOCKER 200-series filters deliver a superior capability to suppress interference with ADSL modems caused by cordless telephone operation, as compared with other filter designs. They have also been used to improve the operation of voiceband modems in the presence of line noise or impedance problems. The wide-band characteristics of Excelsus Z-BLOCKER 200-series filters deliver a superior capability to suppress interference with ADSL modems caused by cordless telephone operation, as compared with other filter designs. They have also been used to improve the operation of voiceband modems in the presence of line noise or impedance problems.

Convenience Contributes to Crosstalk and HPN Problems

The purpose of the in-line filter is to isolate the high-frequency digital signals from the voiceband telephone equipment. What is largely overlooked is the need to also isolate the flat 4-conductor extension cord that often connects the telephone equipment to the wall jack. While these cords work well with low-frequency voiceband signals, the fact that the conductors are not twisted makes the cords susceptible to crosstalk when they are used to carry high-frequency signals. This crosstalk can then cause audible noise in the telephone equipment. For this reason, Excelsus always recommends that the filter be installed at the wall jack so that the digital signals are blocked from both the extension cord and the telephone equipment. A reversible filter that incorporates a male RJ11 plug on one end and a female RJ11 jack on the other end can be easily installed at either end of the extension cord. This means there is a 50% probability that the customer will plug the filter into the telephone equipment jack instead of the wall jack, which will leave the flat phone cord unfiltered and susceptible to high-frequency crosstalk.

This situation could be corrected by advising the customer to plug the male end of the filter into the wall jack, but this then defeats the benefit of reversibility. Another solution is to replace the flat phone extension cable with twisted-pair cable, which adds to both cost and inconvenience. A home phone-line network (HPN) can also be affected adversely if filters are plugged directly into telephone equipment on the end of a long (14-21 ft) extension cord. Such a wiring situation can create what is known as a "1/4-wave stub", which attenuates the HPN signal causing a reduction in data rate. Again, this occurs because the high-frequency signals are allowed to travel on this "branch" from the main house wiring. The problem can be resolved by relocating the filter to the wall jack end of the extension cord.

Conclusion

Establishing "reversibility" as a primary selection criterion for ADSL phone filters can yield a degradation in telephone performance that is not resolved quite as easily as turning the filter around. Concerns over such issues as poor audio quality and unreliable phone/fax/modem switch operation, plus the increased possibility for installation-related crosstalk, and HPN degradation should be taken into consideration as potential consequences of symmetrical filter deployment. Alternatively, the connection jacks on all Excelsus filters are "user friendly" because they are clearly marked to promote correct installation by the customer.

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