RETURN PATH FILTERING AND CONDITIONING

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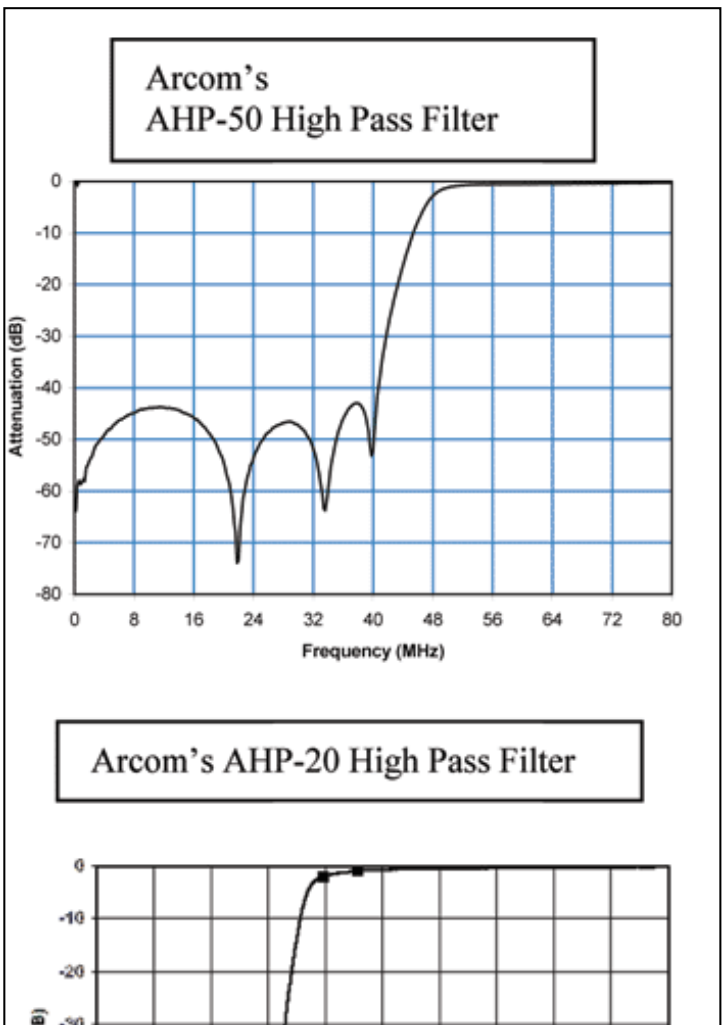
Much has been written on the system design and technology required for transmitting signals upstream from subscribers to the headend. Sometimes overlooked is a small but crucial element in the return system - the filtering method used to limit the potentially damaging effect of ingress from the subscriber's home or surrounding environment. This article will describe and compare the benefits of three distinct return filter types: high pass filters for non-users of interactive services, windowed high-pass filters to pass the set-top box (STB) carrier and other data carriers, and return step attenuators for all universal applications.

HIGH PASS FILTERS (HPF's)

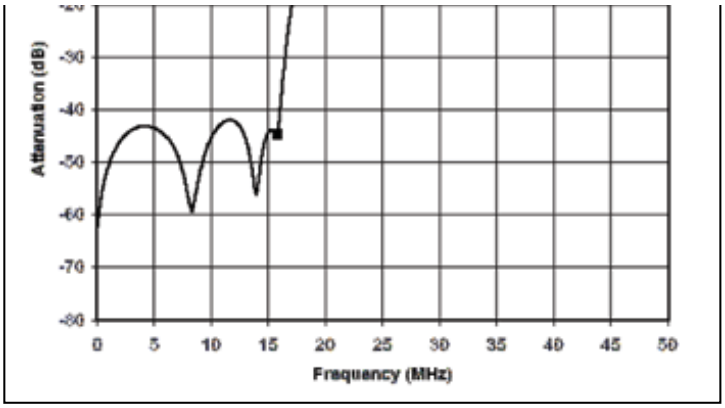
The easiest and most effective method of limiting the amount of noise and ingress that enters a cable network from the subscriber end is to install a high pass filter. With these filters the entire bandwidth below a certain point is attenuated and unusable. All ingress is prevented from entering the return path from the subscriber home.



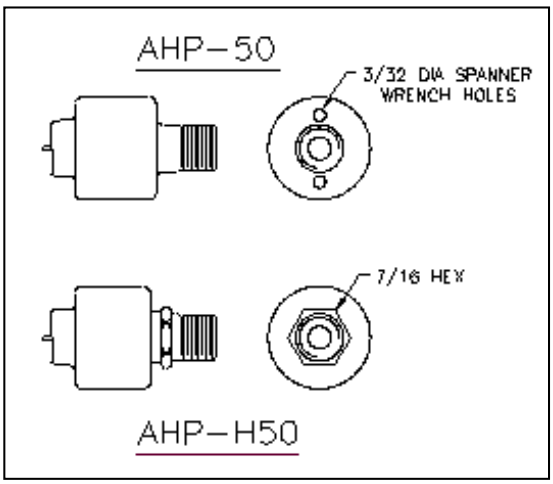
Because most ingress occurs below 20 MHz, some operators have chosen to install 20 MHz filters at all locations and not use the return spectrum below 20 MHz. The bandwidth between 20 MHz and 50 MHz may then be used for the return portion of two-way services. This approach is not completely effective for a number of reasons. There is the probability that harmonics occurring below 20 MHz may propagate to higher frequencies resulting in ingress on the interactive services if they are installed above 20 MHz. Further, this approach does nothing to offset the probability of ingress occurring between 20 and 50 MHz. It is, however, an economical approach.

Others have chosen to install 35 MHz, 47MHz, or 50MHz filters at all locations and remove them when a customer subscribes to a service such as telephony, high speed data, or impulse PPV. In many countries the cable operator will extend the return path to higher frequencies to optimize the bandwidth for more two-way services even at the expense of entertainment channels.

In these cases 70 MHz or even 85 MHz



HPF's may be installed. When the HPF's are removed, window filters or return step attenuators would have to be installed because the interactive services would now be unprotected against ingress.
High pass filters are now available in the super miniature 100% SMD (surface mount) design which uses the new 360° "gripper" collet mechanism for better control of the connection. Beware that poor control of the connector pin can cause the pin to act as an antenna.



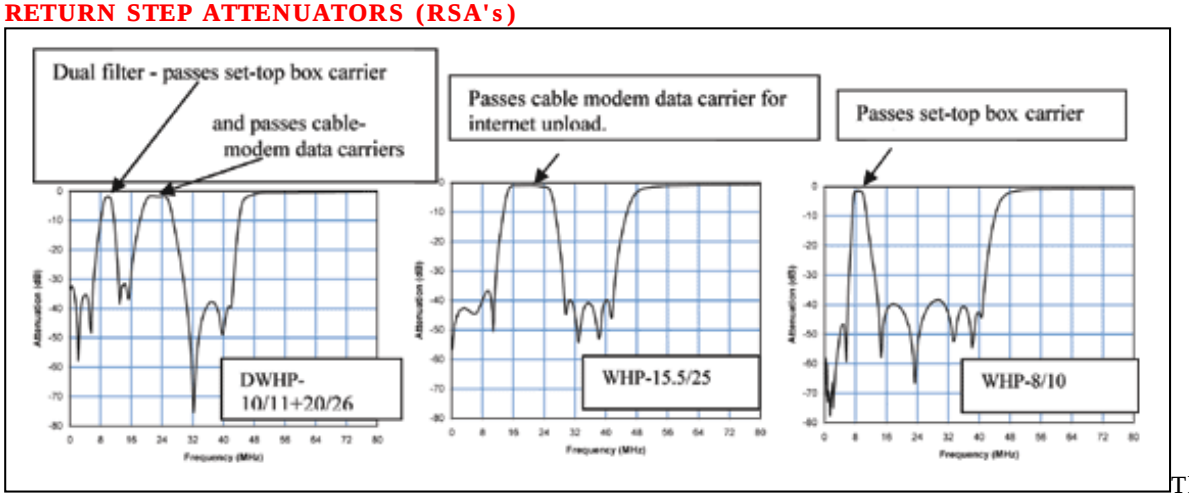
An example of this ingress-antenna effect is the floating or swivel-type connector. When it is difficult to guarantee a secure mating, the stinger-pin can act like an antenna, attracting rather than controlling ingress, thereby defeating the purpose of the high pass filter. HPF's are also available with a 7/16" hex connector for standard wrenches as an alternative to the current holes which require a specially designed tool.

WINDOW FILTERS

Window filters have proven to be an extremely popular method of suppressing noise in the return band when some two-way services are offered. The window filter will allow return transmission from the home back through the filter for two-way services only but will clear out all other frequencies. Window filters can be installed at homes with impulse PPV, set-top boxes, cable modems, and cable telephony; provided the window is at the appropriate frequency.

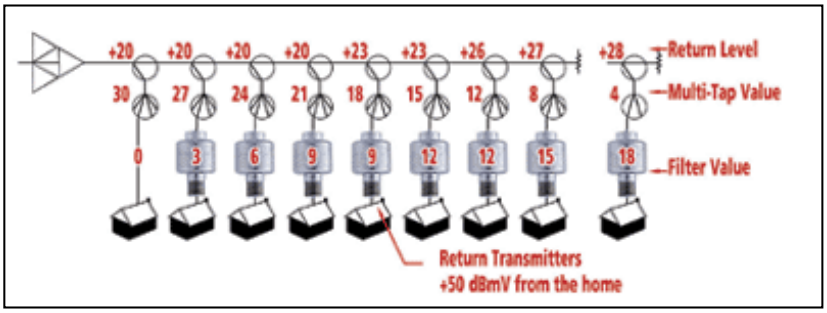
The plots below show Arcom window filters blocking ingress while passing data carriers only. There is an alternative to the window filter - the attenuated window filter. The attenuated window filter has the benefit of adding flat loss to the return passband frequencies. By adding flat loss, the signal from home devices can be made approximately the same when it reaches the tap at a uniform high level; ingress goes down and isolation is increased between all subscribers and the network.

RETURN STEP ATTENUATORS (RSA's)

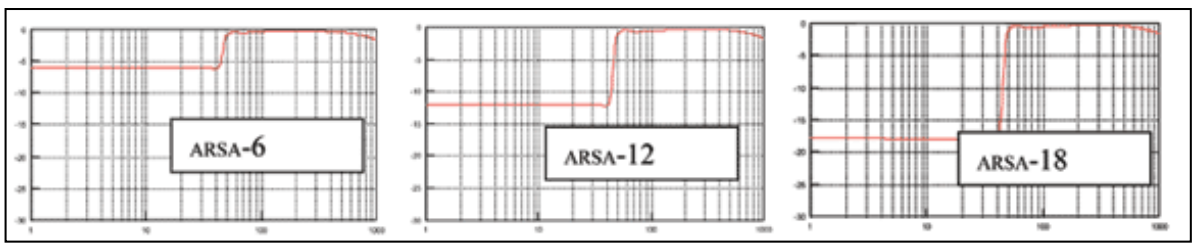


The Return Step Attenuator (RSA) provides advantages found in no other type of return band filters. By introducing selective attenuation in the return band in fixed increments of 3, 4, or 5 dB, the RSA allows the system operator to engineer the HFC network for optimized two way communications. It is the only solution for ingress and noise that is based on an engineering approach - as opposed to the somewhat fragmented method of using high pass or window filters. Besides this advantage of controlling ingress, the return step attenuator has the significant feature

of forcing the cable modems to transmit at higher levels.



There is a correlation between the tap value and the susceptibility of a subscriber location introducing noise and ingress to the network. The smaller value tap will inherently allow more noise and ingress into the network. By installing a high value RSA on the low value tap, that tap at return band frequencies can now behave and offer the same isolation as a high value tap. In addition to the noise and ingress benefits, the RSA will also result in a tightening of spread of signal levels going into the first active - thereby minimizing issues relating to overload and laser clipping. The return step attenuator will also improve tap to tap isolation.



CATV operators have two choices in selecting RSA values: the 'calculated' method, or, the 'approximated' method. Exact values of return Step Attenuators are calculated from a design perspective after carefully balancing the return path, taking into account desired signal level at the node, the number and values of directional couplers, home splitters, transmit levels of home terminal devices, etc. Approximate step values are chosen for different taps as shown below.

With a return network designed using return step attenuators, many of the difficulties encountered in using other filtering strategies disappear. When compared to a window filter strategy, the RSA ensures flexibility by not locking into one specific frequency for a return carrier. From the perspective of frequency usage, the operator does not need to be concerned with switching modem, addressable converter, or digital converter vendors in the future - and the possibility of scrapping any window filter investment. When compared to a high pass filter approach, the RSA will allow the possibility of a retail distribution business model for the modem because a truck roll will not be needed to remove the high-pass filter. The RSA is the only filter to provide for interoperable issues with respect to future conditions and planned expansion without ever having to switch-out a filter. Once installed, it never needs to be removed. The plots below show Arcom return step attenuators with three different levels of attenuation, 6, 12, and 18 dB. Arcom has two patents on the RSA - #5,999,796 & #5,745,838.

ARCOM also provides pay-TV traps and filters. Arcom's sister-company MDI provides analog baseband addressable converters.
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