Provisioning for a Cable Modem

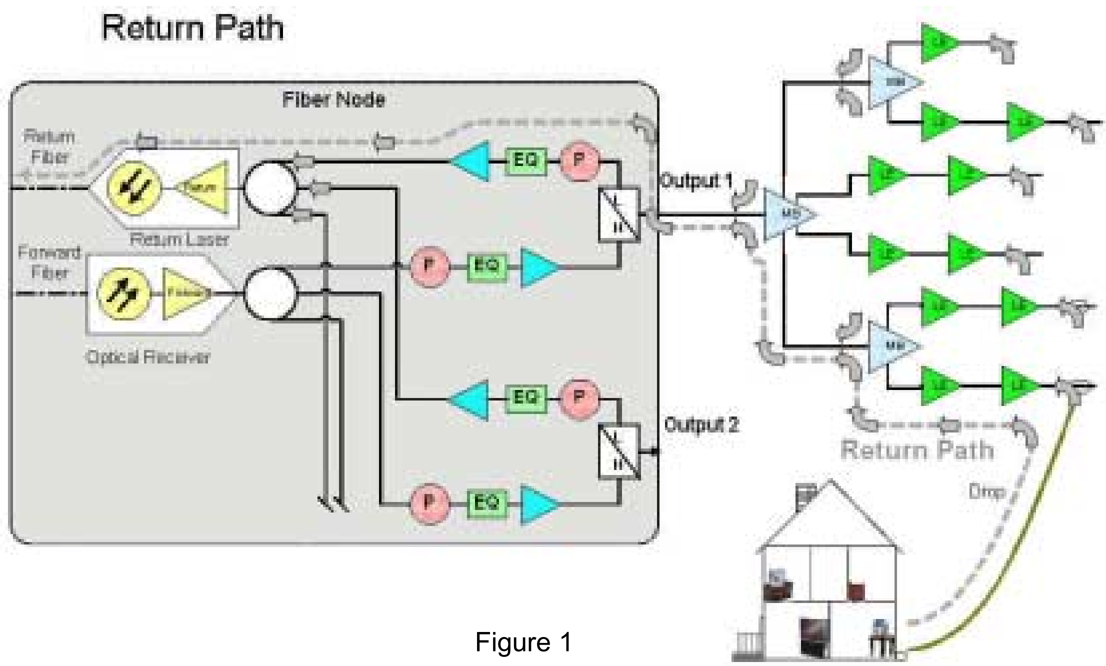


Figure 1

Provisioning the Drop system for Cable Modem Service

The proliferation of cable modems and advanced two way digital video set top boxes has put new demands on the cable system return path. The QPSK and 16 QAM signals used for these applications require that care be taken to ensure reliable trouble free service. The biggest challenge in maintaining a return path is signal ingress. The frequency band used (5 42 MHz) is rife with potential interferers including CB and amateur radio signals, industrial signals and even interference from home appliances.

What particularly makes keeping ingress out of the return path a challenge is the phenomenon of noise funneling. All the return band signals from each subscriber on a CATV node are summed together, first at the Node and again at the hub and or headend. This means that all the noise from as many as 2000 homes is also summed (see figure 1). Many designers split larger node returns, using dual return lasers to limit the effects of the noise and ingress. At the hub/headend, the returns are processed individually to alleviate the summing problem. This significantly increases the cost and complexity of the hub/headend. If this summed noise and ingress becomes significant enough to impair signals on the return path, all the subscribers on the node using the return path will be affected.

As you can see in figure 1 above, the noise and ingress from each sub is summed together in the distribution leg, summed at each branch in the leg at the mini-bridgers and summed again at the node. As an example, if we assume that each distribution leg contributes the same amount of noise and ingress, the C/N or carrier to Interference would degrade by 3 dB each time two legs are summed and by 4.7 dB when three legs are summed and 6 dB when 4 legs are summed. Thus, in our example above, working back from the end of the line, the return C/N would degrade by 3 dB at the last MB, degrade by 6 dB at the four output MB and degrade by 4.7 dB at the 3 way splitter in the node.

Studies indicate that most sources of ingress occur inside the home. It is therefore important that installation personnel use the proper techniques and are properly equipped so that two-way installations minimize pick up of ingress and noise. This will ensure reliable operation, fewer truck roles, lower maintenance costs and higher customer satisfaction.

When installing a two way service in the home, the most important thing to realize is that the home also represents the most likely source of ingress. Many cable systems have

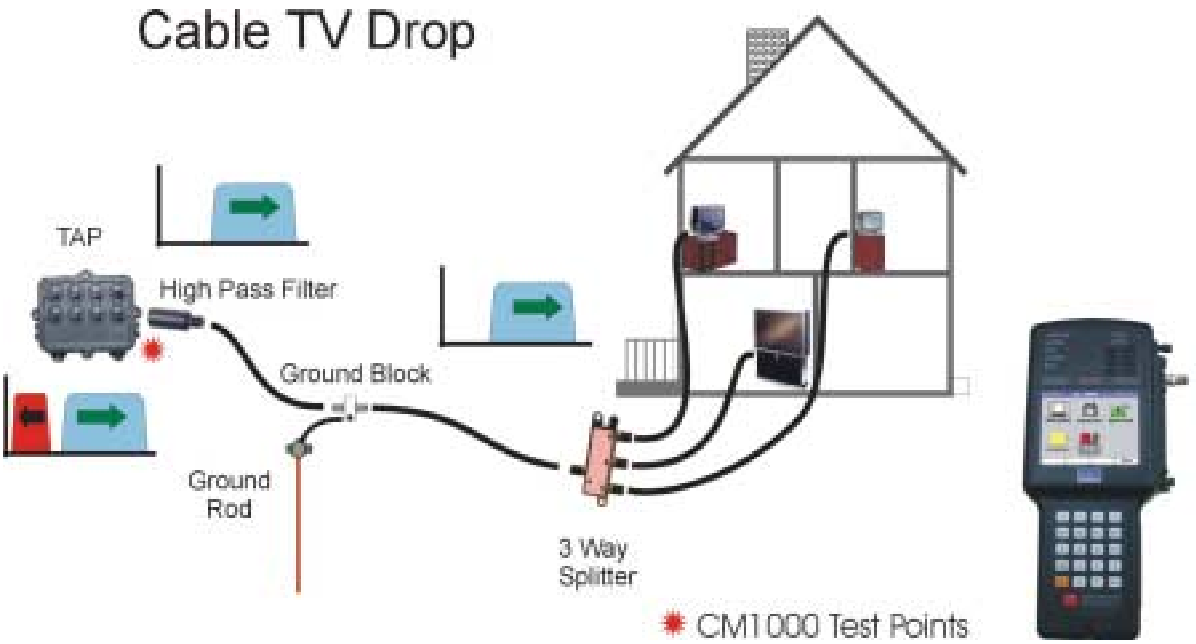


Figure 2

opted to install high-pass or window filters on every home that is not currently using a two way service. If these filters are installed at the tap, the home wiring and the drop cable are effectively removed as a potential source for the ingress. In figure 2 above, you can see that the return spectrum is active on the distribution leg up to the tap, but blocked by the high pass filter at the tap output.

The problem with the high pass filter, however, is that it has to be removed at the time two way service is installed at the home. Simply removing the filter and installing a two way set top box or modem exposes the network to ingress **the potential problem the filter was intended to eliminate in the first place**. At the time the filter is removed, the continued integrity of the return path requires that appropriate installation techniques be used. This application note describes how to perform that installation in a way that maintains the maximum reliability of the network by minimizing the noise and ingress that can be conducted back through the system.

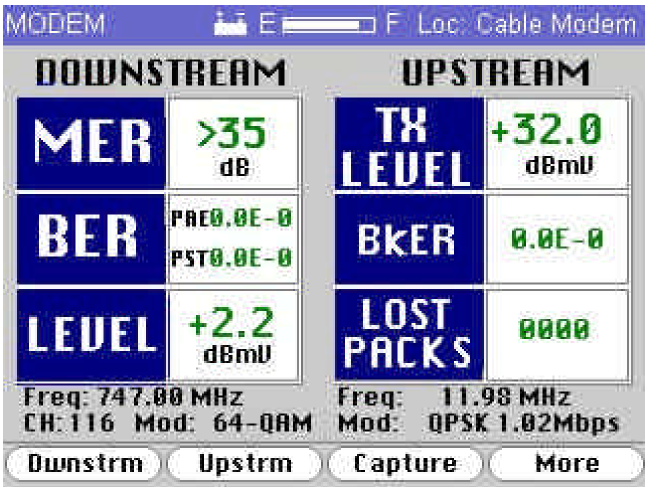
Step 1

Remove the high pass or window filter (if installed) and check the integrity of the upstream and downstream signals at the tap. If the high pass filter was installed at the ground block, the verification can be made at this point.

Step 2

Use the CM1000 to verify signal integrity at this point.

Note that it is only necessary to verify basic physical layer operation, it is not necessary for the CM1000 to complete the entire Range and Register operation. The user should check the downstream level, MER and the upstream level.



Initial CM1000 Cable Modem Test Display

If solid upstream and downstream signals are not obtained, more detailed analysis of the network will be required. See the CM1000 manual for details on making upstream and downstream cable modem measurements and troubleshooting.

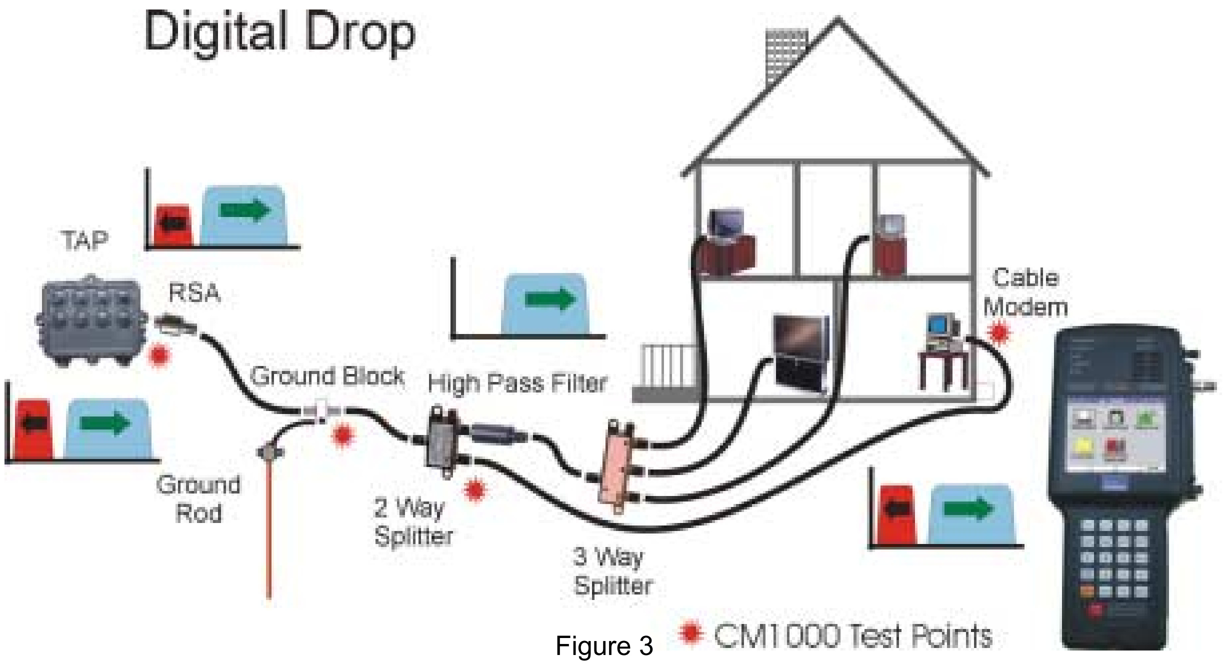


Figure 3

If the return path attenuation from the tap / ground block is known, an RSA (return step attenuator) can be installed at the tap. The value of the return step attenuator should be such that its attenuation, the attenuation back to the headend, plus the estimated attenuation of the splitters and cable inside the home equal approximately 48 dB. More on selecting a step attenuator value at the end of this application note.

Step 3

Once signal integrity to the tap or ground block is established; the coaxial cable for the data service should be run. Ideally, all the cables in the home should be run in a home run configuration. That means that every device in the home has its own cable run back to a central location near the ground block as shown in figure 3 above. All the cables are combined using splitters at this point.

The advantage of the home run configuration is that it provides relatively equal levels to each TV set and allows both forward and return levels for each type of device in the home to be adjusted, if necessary. It also results in a more reliable installation. The most important advantage, however, is that is allows devices that don t require return path operation to be combined in a way so that the high pass filter (perhaps the same one removed at the tap) can be placed to eliminate potential sources of ingress from the Cable TV side of the drop. Note that the return spectrum of the cable modem drop and the network are isolated from the TV drops by the high pass filter as shown in figure 3.

Use a 2-way (3 dB) splitter to combine the newly installed cable modem line with the rest of the devices in the home. The high pass or window filter can be installed on the opposite leg of the splitter to mitigate any ingress coming from those devices.

Step 4

Test the signal levels using the CM1000 at the location where the cable modem is to be installed. If solid upstream and downstream signals are not obtained, the drop cable, ground block and associated connectors should be tested with a TDR, inspected and replaced as required. If an RSA filter was not installed when tests were performed at the tap or ground block, install one such that the total attenuation from this point back to the headend CMTS is approximately 48 dB. (See using Return Path Attenuators). Verify physical layer operation. If the transmit level displayed on the CM1000 is not 48 dBmV – 3 dB, note the level, subtract this number from 48 and increase or decrease the RSA value by that amount. For example: if the CM1000 measure + 42 dBmV increase the RSA by 6 dB (48 - 42 = 6).

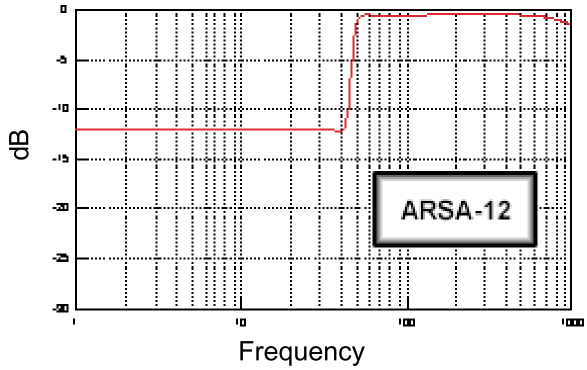
Step 5

Perform the CM1000 Downstream MER, BER, Level FEC, Constellation, Frequency Response and Equalizer detailed tests per the CM1000 manual instructions. If all the measurements are GREEN the installation is within specifications and will operate correctly. Note any RED measurements, these indicate out of specification measurements that may require troubleshooting and correction.

Return Step Attenuators

Return step attenuators (RSAs) provide much of the benefit of installing a high pass filter while retaining the ability for two-way operation. RSAs have minimum attenuation at frequencies used for the downstream (50 ñ 1000 MHz) and fixed attenuation at frequencies used for the upstream (5-42 MHz). RSAs are available in attenuations that range from 3 to 25 dB.

In order to minimize the amount of ingress that arrives back at the hub / headend from a given subscriber, it is desired to have the maximum attenuation in the reverse path. The maximum carrier to ingress ratio will be realized when the signal is near the maximum and the noise and ingress is attenuated as much as possible prior to being summed with the other returns. This is the function of return step attenuators.



Since cable modems are capable of transmitting over a wide dynamic range (+8 to +58 dBmV), adding attenuation in the reverse path causing the modem to transmit at the upper range of its power level minimizes ingress from the home. Assuming the desired power level at the CMTS is 0 dBmV, 48 dB of attenuation in the reverse path is an appropriate target. Still providing ten dB of headroom for plant variations due to changes over time and temperature.

The best performance is achieved when the RSA is installed at the tap output and the high pass filter is installed on the Cable TV output leg of the 2-way splitter as shown in figure 3 on the preceding page. This configuration provides maximum isolation from unwanted signals conducted and radiated into the drop.

If the CM1000 modem is transmitting at a level of +32 dBmV, a 16 dB step attenuator should be added. Any ingress generated on the consumer side of the RSA will also be attenuated by 16 dB, without affecting the downstream NTSC, digital TV or cable modem signals.

The appropriate return attenuation at every cable modem installation will significantly improve the reliability of the return path, resulting in fewer truck roles and increased customer satisfaction.

Window Filters

Window filters provide a similar function in that they limit the bandwidth of the return spectrum to a much narrower band of frequencies than the typical 5 to 42 MHz return band. The filters attenuate the ingress and noise outside of their pass band and thus improve the overall carrier to interference ratio of the return. Some window filters also incorporate loss in the return band similar to the RSAs. In problem areas of high ingress, a combination of High pass filter at the Cable TV splitter and both a window filter and RSA or window filter with return attenuation at the tap would provide the maximum reduction in noise and interference.

RSA picture and graph courtesy of ARCOM Labs

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Sunrise Telecom

Hukk Division
3250-D Peachtree
Corners Circle
Norcross, GA 30092
888-236-8948

www.hukk.com
www.sunrisetelecom.com
Email: support@hukk.com