THE REAL WORLD OF TWO-WAY

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Most of you here today will be building and operating two-way cable systems very soon, if you are not already doing so. There is a great deal of information available on two-way systems in general as well as on specific applications as proposed by various vendors. However, in the experience of TeleCable, building and operating two-way is not quite as simple as most of what you hear and read might lead you to believe. So, today I would like to talk very briefly about what we have learned in building and operating a two-way system.

TeleCable installed a two-way system utilizing EIE two-way amplifiers and an interactive system conceived, designed and built by Vicom Manufacturing Company of Dexter, Michigan. This equipment provides us the flexibility and capability of testing and evaluating almost every conceivable type of two-way service.

While there are many considerations in providing such services as shopping at home and education to home-bound students, due to time limitations, I will only talk about interference and maintenance considerations.

Most of you have probably heard at least a rumor that two-way systems have experienced some interference. Well, it's not a rumor. It's a very real problem that must be dealt with. Most two-way gear has been designed to utilize the 5-35 MHz frequency band. Unfortunately, this band is also utilized by many kinds of over the air services. These include amateur radio, commercial short-wave radio, WWV broadcasts, teletype transmission, citizens band services, as well as business radio services.

All of these signals, which are of both local and distant origin, to some degree do get into cable systems that have been built using present day construction practices. There are many variables that determine how objectionable these interfering signals will be in your particular situation. However, I suspect that for most cable operators, it will be necessary to take additional steps to prevent these signals from getting into the cable system. It is convenient to classify the actual means by which these interfering signals are introduced into the CATV system into three general categories. These are (1), the TV receiver, (2) the drop cable, and (3), the cable system itself. So let's consider these in that order.

All of you are quite familiar with ghosts caused by the direct pick-up of the off-air TV signal. The TV receiver is also a very good receiver for signals in the 5-35 MHz band. Signals as high as 0 dbmv in this band have been measured at the TV set antenna terminals and sometimes as high as +10 or +20. One might hope that the amplitude and phase of these signals as picked up by each TV set would be sufficiently random that they wouldn't add. Unfortunately, this doesn't seem to be true. What this means of course is that the TV set must be isolated from the cable system in the 5-35 MHz band. The easiest way of doing this right now seems to be with a filter that only passes frequencies above 50 MHz.

The next item to be considered briefly is the drop cable. Our experience at TeleCable has indicated that the ordinary braided shield drop cable acts as an excellent receiving antenna in the 5-35 MHz band. In the experience of TeleCable, there seemed to be two types which had the best isolation. One had an 8-10 mil thick aluminum wrap. The other cable had a 1 mil aluminum foil on each side of a mylar or polypropylene base, braid and then foil again. Both types of cables have their respective disadvantages so that actually, TeleCable does not use either one of these cables right now. A good compromise solution for us seems to be a cable that has a 1 mil aluminum foil on each side of a mylar or polypropylene base with a 40-60% braid over this. However, since there are many variables involved that haven't been mentioned, I would recommend that you make your own tests before committing yourself to any one type of drop cable. Once you have selected a cable you must decide on the type of fitting to be used and whether it should go over or under the Al wrap. This is rather critical since as much as 20 db reduction in signal pick-up has been observed after replacing improperly installed connectors. And no matter what type of cable you select, you will find that the isolation is not necessarily uniform from reel to reel of cable or even throughout a particular reel of cable. It appears at this time that you will have to measure the pick-up in your drop cable after installation and replace the fittings or cable as appropriate. Again, since I cannot cover all the possibilities, I recommend that you evaluate these factors with respect to your own particular situation.

In the cable system itself, our experience to date indicates that if amplifiers, taps, splitters and the like meet RF radiation requirements, they will also provide adequate RF susceptibility performance in the 5-35 MHz band. The major problem seems to be in what I call the cable-connector-housing interface. There are as many theories about this as there are cable operators and equipment manufacturers. It seems that what works in one area or for one cable operator does not do as well elsewhere. Therefore, I can only highlight briefly some of the considerations that we have found to be critical and indicate what has worked for us.

One of the decisions that you must make is between a connector that is designed to be tightened until it reaches the end of its thread range, or bottoms out, and a connector that has a much greater thread range which requires a torque wrench or similar device to properly tighten it. If one considers only the manufacturers specifications on the connector and the cable, one would probably prefer the connector which bottoms out since this greatly simplifies installation. However, at least one major connector supplier maintains that they received so many complaints concerning their connectors which were designed to be tightened until they bottomed out not making good connections, that they started providing connectors with a greater thread range. Testing by TeleCable has confirmed that indeed something does go awry somewhere between the manufacturers specifications and the cable and connector that is actually installed in your system.

There are a number of possible explanations. As you all know, cable is subject to out-of-roundness which will not necessarily be corrected by tightening of the connectors. Cable is also subject to temperature effects and cold flow. With respect to temperature effects, it has generally been assumed up until now that the radial or axial expansion and contraction of cable is negligible. However, tests performed by TeleCable indicate that this radial expansion or contraction may be quite significant. And lastly, but perhaps most importantly, the installation process itself is a possible culprit.

Apparently, as a result of some of these problems, many connector suppliers now offer stainless steel sleeves as an option. While the sleeves themselves are not expensive, they can significantly increase your installation costs due to the additional time required to insert them. Another option being offered by some connector suppliers is a conductive "O" ring. Hopefully, this would insure a low RF impedance through the connector. This "O" ring is

relatively expensive but there would be no additional installation costs. However, it seems possible that the apparent cable O. D. variations we have been speaking of up to now could also reduce the effectiveness of these devices. Other alternatives that might not be so dependent on cable O.D., would be a conductive lubricant or a conductive water-proofing compound or some type of ferrite ring designed to absorb energy in the 5-35 MHz frequency band.

Actually, while TeleCable continues to test these options for effectiveness, we have not yet found it necessary to use any of them. At this time, we have found that the following will provide us with a tight system. (1) A careful, conservative matching of connector and cable specifications, (2) extra time and effort during installation and (3) extra attention to overall quality control.

The other area that I wanted to touch on briefly today is maintenance. Two-way in a cable system is not a little extra that can be handled in the spare time of your regular cable technicians. You should think of the reverse system as a second cable system which must be staffed accordingly. In addition to the cable system, you will usually have some type of terminal equipment at the subscribers which you will either have to maintain or arrange for a service contract with the firm that supplied it. In addition to this, there will be some kind of central control and processing equipment. Quite often, this involves a very sophisticated computer. Again, you will either have to train additional technicians to take care of this equipment or arrange for some kind of service contract with the company that supplied you with this equipment. Also computers seem to insist on being told what to do. Most of you who are familiar with computers will agree that you quickly find changes that you want to make once you get into operation. You will want to add or delete subscribers or add or delete information that you provide or have it provided in a different form or expand its capabilities. This means changes in what is known as the software. Now software can be much more expensive than hardware initially. But more importantly, changes to software can be very expensive and time consuming. If you have a large operation, then

you will want to provide your own progamming capability. If you only have a small operation, be sure to ask who is going to make these changes, how much it will cost and how much time it will take.

Maintenance of the reverse cable itself can present some rather interesting problems. At first you will probably not have signals on the whole system all the time as you do in the case of the forward system. In all likelihood, you will have fairly long sections that do not have any kind of reverse system subscribers. What this means of course is that you can't just pick up a FSM and go make a quick check on the operation of your reverse system. Even where you do have subscribers whose terminals are being sampled every 30 seconds or so, as in most 2-way systems, you might still have a problem. Let's say you are trying to find out how many people are watching channel 2. How do you know the difference between no response because (1), someone not watching channel 2, (2) the TV set and/or terminal equipment is off, or (3) because there has been a failure in the reverse cable system.

Many of you may have to obtain test equipment that you haven't needed up to now. Some of it, such as spectrum analyzers,are quite expensive. Also if you do not want to go into subscribers homes to send signals back for reverse system testing you may want to provide some type of van with appropriate test equipment and power. The type of testing and maintenance schedule that you set up will probably depend in part on whether or not you can correct the failure in the reverse system without interfering with or otherwise affecting your subscribers that are on the forward system. This is something you should look at carefully before committing yourself to a particular type of system.

Actually, I suspect that you will find your greatest problem in the maintenance of the reverse system is in the control of interference. To locate the source of interference could be quite a problem if you have two or three hundred miles of system in operation. Thus, it is highly desirable that your system be segmented in some way, much as most suppliers suggest that you do for control of noise or noise build-up. Thus, in a hub system, you could quickly isolate the source of interference to a particular spoke of your hub. However, this can still leave quite a significant amount of system in which to locate the source of the interfering signals. Even in one particular spoke of a hub, there can be

many, many connectors, drop cables, and TV sets to check. One way to locate the source of interfering signals is to disable sections of the reverse system. Since most of the systems we are talking about do involve some kind of computer, it seems that the ideal long range solution is to build some means into the amplifiers to turn them on and off remotely with the computer. In the meantime, you will probably want to disable the reverse amplifiers manually. Actually, if possible, you will probably find it very desirable to keep most of the reverse system disabled when you are not using it. This will greatly simplify the task of finding the cable section that is causing the interference. There is another benefit to this too. Keeping local radio services such as hams out of the cable system can be a major task. Thus, it would simplify your operations if the area that the ham is in is disabled in the reverse direction when you are not using it. Of course, if you are providing a relatively limited bandwidth service such as digital only, you might think that all you would have to do is select a frequency that isn't in the ham band and you wouldn't have any trouble. That may or may not be true. It is possible for ham signals to get into amplifiers and generate many beats. Although there is not time to go into it today, required signal levels have not received sufficient attention with respect to operation of the reverse system. But that must be the subject of another talk at another time.

Today, I have highlighted briefly two particular areas that you should consider in building and operating a two-way system. If you are to use the 5-35 MHz band, special measures must be taken to prevent the introduction of undesired signals into the cable system. Maintenance of the reverse system requires a full staff, possibly some specially trained technicians, and some careful planning ahead before you build the system. There are many other considerations which we have not been able to go into; one which I mentioned very briefly at the end was levels. Two-way is not just a nice little extra that you get practically for free. It is a complete system in itself with its own special problems which require a system engineering approach.

I hope I have not discouraged you about two-way. We at TeleCable are still very enthusiastic about it and are proceeding with further experiments and testing. Recently, we have successfully used our two-way system to

enable the local schools to cablecast a mock Republican and Democratic National convention and election. Very soon nurses in local nursing homes will have complete two-way video, audio and digital communication capability with doctors in a local hospital. Two-way works. It is just that two-way must be given the same careful attention and thought as your forward system is presently given.