RECEIVING AUXILIARY SERVICES VIA SATELLITE

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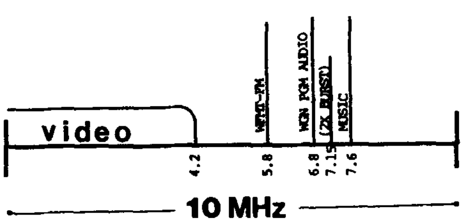
The number and type of services to be offered along with video on satellite transponders will be large and varied. These will provide financial opportunities for carriers and CATV operators. This report deals with methods of transmission, types of services, and receive station capability requirements.

Many services other than television signals are now available on the satellites. All of the non-TV signals which are available now and will be made available in the future are being put there to make money for both the CATV companies and the carriers. In order to avail yourselves of the potential revenues sources which are and will be available, a CATV operator will have to have a satellite station capable of proper reception of this additional information.

First, let's look at a typical baseband spectrum from a satellite transponder to see how these additional services might come to you.

(First Overlay)



BASEBAND OF TRANSPONDER THREE, SATCOM I

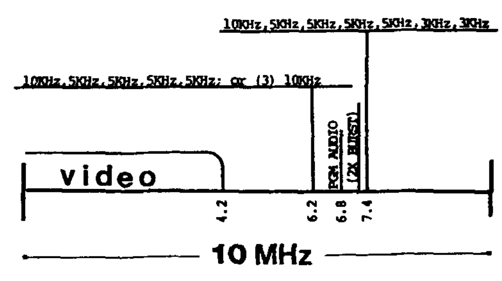
This diagram shows the baseband spectrum of Transponder 3, Satcom I, United Video's WGN signal.

The baseband is 10 MHz wide. Video takes up, for practical purposes, 0-4.2 MHz. The first FM subcarrier is at 5.8 MHz. The space between video and 5.8 MHz is for the skirts of the video low-pass filter in the satellite receiver. This filter requirement will be covered a little later in the presentation. At 5.8 MHz, we have a stereo multiplexed signal. This is WFMT-FM, a radio station in Chicago. Deviation of this FM subcarrier is 300 KHz. It requires 800 KHz spacing to prevent adjacent channel interference. The WGN program audio is at 6.8 MHz. This is the standard slot for program audio on all Satcom I transponders. This FM subcarrier is deviated at 75 KHz. The next thing you see is at 7.15 MHz. This is roughly twice the color subcarrier frequency and is usually avoided because of the possibilities of intermodulation. The last subcarrier is at 7.6 MHz. It is to be used soon for a monaural music service and will be deviated at 75 KHz. Nothing over this subcarrier frequency is used due to the additional technical requirements for receivers and receive system performance.

Remember that these subcarriers above video are FM modulated and are, in turn, used to FM modulate another (main) carrier. Therefore, two processes of demodulation are required. What we have here is known as FM, on FM. This was once described to me as "the carrier goes ape."

The main carrier, approximately 4 GHz, is demodulated by your satellite receiver, and then the output of the composite baseband will be video with FM subcarriers. These must also go through FM demodulation to arrive at baseband information. Most satellite receivers have the 6.8 MHz FM demodulator built in so that baseband audio is available at the output of the receiver along with baseband video.

(Second Overlay)



ANOTHER SCHEME

Another scheme which has been successfully tested is shown here. Again, video takes up 0-4.2 MHz. At 6.2 MHz there is a multiplexed subcarrier capable of one 10KHz and four 5 KHz audio channels or three 10 KHz channels. The 6.8 MHz subcarrier is the standard program audio for the video channel.

7.4 MHz is another multiplexed subcarrier capable of one 10 KHz channel, four 5 KHz channels, and two 3 KHz channels.

For clarification, a 10 KHz channel is the fidelity equivalent of an AM radio station. The 3 KHz channels are the equivalent of standard telephone voice channels. The 5 KHz channels are better than the 3's but not as good as the 10's, and this might be used for such services as background music. These channels are capable of data transmission as well as voice or music. The data may be slow scan video or alphanumeric information. It may also be video-graphic information.

The ways in which this capacity may be used are varied and the transponder operator will select information to be sent in this way in order to maximize his profits and that means he will be providing services that CATV operators can use and sell--either to his subscribers or to another business. This session will not attempt to deal with the specific types of services and the economics involved in each. Rather, we will try to show the volume of traffic capable of being transmitted on the transponder and what you will need to receive all of it.

It should be obvious that proper reception of all of the potential information will require proper receive facilites. In general, you cannot expect the best performance from a receive station with the lowest price.

According to Intelsat, with many years experience in satellite transmission, a G/T of approximately 40 db is desirable. Anything less, according to Intelsat, "remarkably hinders the effective use of a satellite's power." Intelsat satellites have, generally, 10 db less EIRP than our domestic satellites. Therefore, I would recommend a G/T of 30 as a minimum for unhindered performance in a receive station.

Since the typical video receive-only station is, according to Scientific Atlanta, about 26.8 db, you can see that there is a problem here. The additional 3 db recommended can only be made up, practically, in antenna gain. A 10 meter antenna with 120 degree LNA will move you close to this goal.

To be sure, smaller aperture antennas can be used, but performance of video and the various FM subcarriers will suffer accordingly. This degradation may be something you can live with, or it may not. Whether or not you can live with it will be determined in part by the performance of your cable distribution system. Remember, a 48 db signal to noise at your headend will be degraded further by distribution system noise. You should take this into consideration in your system design.

I would estimate that the additional cost encountered in installing a 10 meter antenna instead of a 5 meter antenna would be about $30,000. But, this will allow you to pursue many new business opportunities which will be afforded by clear reception of this additional information. The additional cost may be recovered very quickly. I recognize that this extra cost may not be practical for small cable systems, but in larger systems, this extra cost should be absorbed very easily. We are talking about a $30,000 additional cost in a multi-million dollar cable television system. It is a small price to pay for the assurance of proper reception. This one piece of equipment, the satellite receive station, is for most systems, the primary source of services that make the system feasible in the first place. You are getting pay television, independent television stations, news services, and in short--everything you do not pick up off air or generate internally. I think that it is the bulk of the key services offered for many systems. Your satellite receive station is not the place to scrimp.

If you already have a station in place let us see what you can do about making it work as good as possible.

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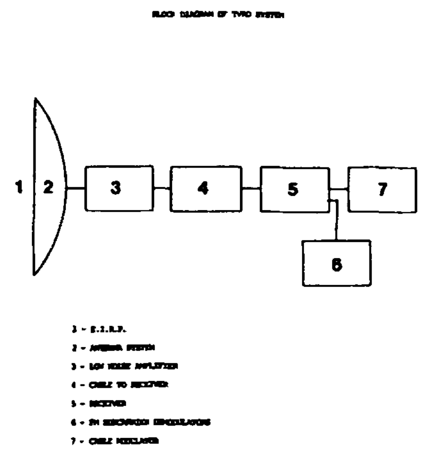

The components to consider in the receive system are:

1. EIRP
2. Antenna
3. Low noise amplifier
4. Coaxial or waveguide run from the low noise amplifier to the receiver
5. Receiver
6. FM subcarrier demodulators
7. Cable modulator

Some considerations on each component are:

(Fourth Overlay)

1. EIRP
   a) Actual levels may vary from published figures. An on-site survey is recommended to assure that the actual number is used in performace summaries for the station. All summaries provided by coordination agencies are published numbers. Variations in this may be caused by a local blockage of the signals, reflected signals, etc.
2. Antenna
   The actual gain published may not be achieved because of:
   a) Poor installation. Surface tolerance and feedhorn alignment are of prime consideration as is alignment with the satellite. The antenna should be carefully assembled. No parts should have to be forced. The installation should be done by an experienced

crew. Alignment to the satellite should be done when the satellite is in the center of its box. This information is available from RCA. Pay particular attention to polarization alignment. If you look at the LNA output on a particular polariztion, you will see carriers spaced 40 MHz apart. Interspersed between these halfway (20 MHz) are the carriers of the transponders from the other polarization. These should be 20 to 30 db down or more from the peaks of the carriers for the polarization you are looking at. If they are not you have a problem with alignment of the feedhorn. Misalignment will result in poor polarization discrimination. You will have noisy pictures due to adjacent channel interference. This looks much like impluse noise. If you see any carriers 10 MHz away then you have terrestrial carrier interference. Terrestrial frequencies plans are offset from satellite frequency plans by 10 MHz.

Make sure that you have a clear path over the horizon at the proper elevation to the satellite.

3. Low noise amplifier
   These are generally reliable as to noise and gain figures. However, they may be adversely affected in these respects by an extremely hostile environment (extreme heat or cold). Remember, the noise figure is specified at ambient temperatures. Check what they are. Perhaps an enclosure for the low noise amplifier would be appropriate.
4. Coaxial cable
   a) N-type connectors with RG214 cable is commonly used to jumper the low noise amplifier to the coaxial cable. This is not an outdoor cable and the connectors, especially, should be protected from intrusion of moisture. Degradation of performance will be severe if even small amounts of moisture are allowed to penetrate the connectors.
   b) The connectors on the heliax should be installed as per manufacturer's specifications. Inproper installation will result in VSWR, causing unwanted and unnecessary losses.
   c) Half-inch cable may be used in installations up to 200 feet. Above this 7/8 inch heliax should be used.
5. Receiver performance
   Critical areas:
   a) Sensitivity. A low noise figure and threshold will be desirable. Manufacturer's specifications vary. Check for the best and test to see if they meet specifications.
   b) Bandwidth of satellite transmission is 36 MHz, of which 34 MHz is considered usuable for practical purposes. Anything less than this is cheating on the bandwidth to improve noise performance. This would be tolerable if the only information on the transponder is video and program audio. If a transponder is fully loaded, bandwidth limiting to achieve lower noise figures actually lowers the carrier to noise of the receiver, causing noisy video to result, as well as non-linear distortions in the demodulation process.
   c) Filtering on the video output to your modulator should be provided. Proper performance demands a 4.25 MHz equalized video low-pass filter. Check with your manufacturer to see what you have. Many are not providing this. If required, these filters may be bought and added externally. The price range is $145-220, depending on where you get them. Improper filtering will cause noisy waveforms, noisy pictures, and perhaps beats in the pictures on the cable systems.
6. FM demods
   These are used to demodulate the FM subcarriers above video which are present at the receiver composite output.
   a) As with basic receivers, sensitivity should be checked.
   b) Bandwidth should be the same as that of the subcarrier being demodulated.
   c) Proper filtering should be provided in the equipment to reject adjacent subcarriers.
7. Modulators are not really part of the receive system but should be considered because that output is the one the television customer sees.
   a) The noise figure should be as specified by the manufacturer.
   b) The modulation linearity should also meet specifications.

Now if you are receiving the signal as well as possible, you will be ready to take on additional services.

United Video added the first stereo signal to satellites on its transponder. This was done not long after Southern Satellite Systems pioneered slow scan video with the introduction of UPI Newstime on Transponder 6.

In our case, we wanted to provide a high quality stereo transmission channel to accomodate the signals of WFMT-FM of Chicago.

We investigated equipment manufactured by several different companies. Our primary considerations in the equipment selection were economics and spectrum usage on the transponder. The first consideration was to keep the cost of customer owned equipment at the receive sites as low as possible. The second consideration was that we wanted to transmit the signal on a single subcarrier over the satellite in order to save room for other new services.

Our previous terrestrial experience with delivering WFMT had proved that any audible degradation of the signal transmitted would be unacceptable to cable company customers purchasing FM service. We chose the Leaming transmission system because it met all of the criteria. This equipment allows high quality transmission on a single subcarrier with low cost upconverters. The system transmits the signal over the satellite in a composite stereo format. This allows accurate reproduction of the WFMT signals without necessitating regeneration of the 19 KHz pilot signal. That factor cuts the cost of the equipment at the receive end virtually in half, when compared with dual subcarrier systems which regenerate the 19 KHz pilot signal. The equipment used at the customer site to demodulate the FM signal from the composite baseband of the satellite receiver is the Leaming FMU-201C. This device employs a technique called deviation enhancement which encreases the frequency deviation of the subcarrier from a standard 75 KHz to 300 KHz. This is coupled with a special filter for removing unwanted intermod products that may occur as a result of non-linearities in transmission and demodulation systems, and a unique pre- and de-emphasis curve which improves signal-to-noise in the upper portion of the baseband.

Actual testing of this system proved that the results were worth the effort. One Sunday night at midnight, WFMT engineers generated test signals in the studio, which were transmitted over the air in Chicago, received by the Leaming downconverter, transmitted through microwave to Lake Geneva, uplinked to Satcom I Transponder 3, received at Tulsa Cable, upconverted by a Leaming FMU-201C, and there were tested for signal-to-noise, frequency response, stereo separation, and distortion. Signal-to-noise on the channel was recorded at 67 db. This is 7 db better than FCC requirements for an over-the-air broadcaster. That proves not only the quality of WFMT's broadcast in Chicago, but also the quality of the transmission system through the microwave and the satellite. Stereo separation was around 35 db. Frequency response was essential flat from 50 Hz to 15 KHz. Distortion was well within FCC limits, ranging across the frequency band from one percent to two percent.

The next item on United Video's agenda will be activation of the 7.6 MHz subcarrier on Transponder 3. This subcarrier will be used to transmit monaural music for use as background on cable TV channels and in stores. The 7.6 MHz subcarrier has already been tested and its performance is satisfactory. This subcarrier will be transmitted with a standard 75 KHz deviation. Its bandwidth will be 5 KHz.

United Video also plans to replace the 6.8 MHz program audio subcarrier on Transponder 3 with a multiplexed 6.8 MHz subcarrier. The 6.8 MHz demodulators built into most satellite receivers will still receive the same monaural audio signal, but those systems wanting to put WGN audio in the FM dial in stereo, will be able to use a Leaming FMU-201C similar to the one used for WFMT for this purpose. United Video will not charge cable systems for this service.

A great deal of additional information may be transmitted on a satellite transponder through the use of vertical interval transmission. It would take another session to discuss that, so I will not cover it here.

In conclusion, I would say that during the next two years, many additional audio and data services will be activated on various transponders carrying video information. The smart cable operator will be the one who will be prepared to receive these serivces and recognize them for the money-making opportunities they are.