THE DESCRAMBLER INTERFACE, A PROGRESS REPORT

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ABSTRACT

The incompatibility between full-feature TV receivers and cable systems with scrambling has been discussed before in this forum, and is well known in the industry. TV receivers that tune the special cable channels are available, but their sophisticated tuning and remote-control features cannot be used in scrambled cable systems providing combined converter-descramblers. Last year, we proposed a standardized decoder interface for TV receivers, that would permit cable operators to supply relatively inexpensive decoder modules to subscribers for use with such receivers. The Electronic Industries Association and the National Cable Television Association have sponsored working groups to define such an interface. Considerations included which types of scrambling can be provided for without compromising cable security or unduly burdening the manufacturing cost of TV receivers. Connections useful for other video accessories as well as descramblers are obviously preferred. The problem is complicated by the numerous scrambling methods in use and being introduced. The progress of the industry working groups will be discussed.

Introduction

The problems of cable-ready TV receivers in scrambled cable systems are well known in the industry. I originally discussed the problem at the Western Cable Show in Anaheim, CA in December 1981, and again at ICCE in June 1982.[1] There, I showed that cable-ready receivers operate well in cable systems secured by the trapping or jamming of pay channels, but have a serious problem in cable systems secured by scrambling. The problem is illustrated in Fig. 1, which shows a typical converter-decoder supplied by the cable operator, used with a TV receiver. While the TV receiver may have remote control, and may have a very sophisticated tuner covering all the required cable channels, these features are wasted when the receiver is in a cable system requiring the converter-decoder to be used ahead of the receiver in order to descramble the premium channels. The duplication of the tuners and remote control equipment adds to the customer's cost, and can only be detrimental to the performance and to the operating convenience of the system. In the earlier work, I proposed the descrambler module that would plug into a standardized descrambler interface connector on the TV receiver. The module would be supplied by the cable operator, and would provide for the descrambling of those programs that the customer has ordered, just as the converter-decoder does now. The module would provide for recognition of program tags, and could be addressable if desired. I proposed the signals shown in Table 1 for use at the interface. This list was by no means intended to be the finished product. Rather, it was a starting point, including all signals thought to be available in TV receivers, that could be useful for interfacing minimum-cost descrambler modules for the various known scrambling systems. It was clear that a recommended standard along these lines would require a concensus among TV manufacturers, cable product manufacturers, and cable-system operators.

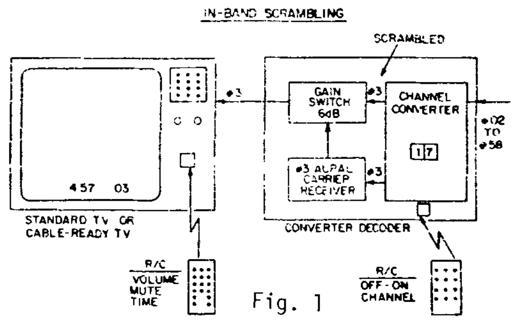

Fig. 1

Industry Activities

1982 has indeed been a year of intense industry activity in solving the compatibility problem. Early in the year, the EIA and the NCTA formed the Joint Commmittee on The Cable Interface, headed by Robert Rast. A working group on cable channel identification, also headed by Rast, succeeded in preparing a cable channel identification plan that will clear up much of the confusion that presently exists in cable-channel numbering. With that work complete, two new working groups have been established, one on The Cable Interface, headed by Walter Ciciora, and the other on Interface Alternatives, which I chair. The EIA receiver committee also has an active working group on The Decoder Interface, headed by James Hettiger. All of these groups are administered by Tom Mock of the EIA. While the job is by no means completed, a great deal of progress has already been made. The cooperation among the three industries involved has been very encouraging.

Table 1

Possible connections at decoder inteface

1. Loopthrough of cable from tuner to IF amplifier.
2. Loopthrough of detected video signal with level and polarity specified.
3. Loopthrough of audio with level specified.
4. 4.5 MHz audio IF signal for data receiver.
5. Wide-band audio ahead of de-emphasis for off-air systems with multiplexed audio.
6. Loopthrough of cable from antenna terminal for out-of-band telemetry channel.
7. Power for decoder module.

General Considerations

Before deciding what signals to include at the interface, it is necessary to settle on which scrambling methods can and should be provided for. The most widely used scrambling methods presently are sync suppression of the pulsed and sine-wave types. However, it is the mood of the cable industry that these systems do not provide adequate security, and that within a few years, more sophisticated scrambling methods will be widely used. This is the same time frame required for a decoder interface, if approved this year, to become widely available. Thus, we have the following reasons for not providing for sync-suppression descrambling at the interface. 1) An interface providing for sync-suppression descrambling would make it too easy for the customer to use home-built or commercial pirate equipment to defeat the system. 2) It is not clear that cable operators will ever buy sync-suppression decoder modules, because in the time frame when the decoder interface becomes available, converters-decoder boxes for sync suppression are likely to be available as surplus, since many systems are expected to convert to more secure methods. There is also the matter 3) of whether the pilot signal required for pulsed sync-suppression descrambling, is really available in TV receivers without costly modification. The pulse amplitude modulation of the aural carrier in such systems has a bandwidth of over 1 MHz, and would be best handled in a TV receiver with a special AM receiver at 41.25 MHz, the sound IF.

Baseband Descrambling

The baseband video loopout is clearly the most important signal in the interface, and the most attention has been given to the problems in standardizing it. This loopout will provide for black-to-white inversion systems, time permutation systems, and any other baseband scrambling methods developed. It also makes available timing, tag and address information sent in the video signal during the vertical blanking interval. The vast majority of the committee members believe that this loopout should have standard 1-volt video, terminated in 75 ohms, thus maintaining compatibility with other video accessories. A video loopout with non-standard signal level and impedance has also been proposed in an effort to get decoder modules into the field more quickly and at lower manufacturing cost. This method, however, offers these advantages only with TV sets of a particular design. Most participants do not consider it a suitable standard.

A subtle, yet critical issue with the video loopout is the handling of the TV's automatic gain control (AGC). TV receivers, whether or not they employ AGC keying, usually rely upon peak of sync to establish the correct gain in the IF stages and in the tuner. A TV receiver whose AGC system is designed to give the correct amount of tuner and IF gain with standard video, will not operate correctly on sync-suppressed video. The video signal will be amplified too much, and the amount of gain will vary with scene content. To get correct operation with the sync-suppressed signal, it is necessary to do the sensing for AGC after the sync is corrected, hence, after the video loopout if a module is to be used. The AGC sensing could be done within the TV receiver using the signal returned to the TV receiver by the decoder module, as shown in Fig. 2. Buffering and isolation, not shown in the figure, may be needed. An AGC control voltage determined by the returned video signal can be looped back to the IF stages and to the tuner completely within the TV receiver. No separate AGC control voltage needs to be involved at the decoder interface. The decoder module is necessarily in the forward path of the TV receiver's AGC loop, but it has no major effect on the TV receiver's AGC loop characteristics, and the module manufacturer is not taking control of the receiver's AGC loop in the sense for which concern has been expressed by TV manufacturers. The decoder module is necessarily DC coupled, and it will probably require a trim pot for DC offset. A TV receiver built with this interface differs from current TV receivers only in that the standard terminated video loopout is provided, and that the DC sensing is done after the return of the loopout, instead of within the IF chips, as is current practice. This method has the advantage that the decoder module is minimally involved in the receivers AGC loop. A different proposed method would have the AGC sensing done in the decoder module, and a control signal returned to the TV's AGC system through a dedicated interface pin. The AGC issue has not yet been resolved.

The IF Loopout

The IF loopout was originally proposed for RF descrambling, where the pilot information is amplitude modulated on the aural carrier. More recently, it has been proposed for use with a baseband decoder module having its own IF stages

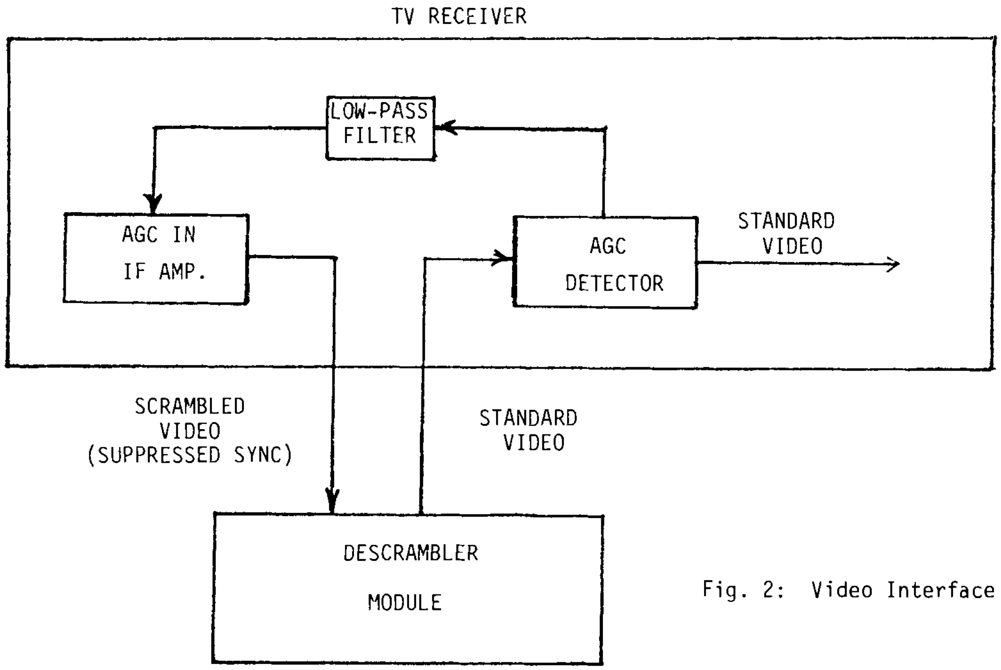

Fig. 2: Video Interface

and video and audio demodulators. This decoder would return baseband video and audio to the TV receiver, using the receiver only for its tuner and monitor functions. An IF loopout of this type has the problem of supplying correct AGC and AFT control signals to the tuner, since the internal IF amplifier will not be operating correctly. The IF loopout does not presently have a consensus going for it.

The Audio Loopout

Although there is presently very little scrambling of audio for pay-TV, cable operators are in agreement that audio scrambling will be an important part of their security in the years to come. There is a consensus that the decoder module should provide for audio descrambling.

Three types of audio connections have been considered: 1) baseband audio in and out, 2) wideband composite audio in and out, and 3) 4.5 MHz audio. The 4.5 MHz output from the TV receiver was intended for sync-suppression descrambler modules, and has been dropped from consideration. Wideband audio, taken ahead of deemphasis, is desirable as an output from the TV because it makes possible descrambling by the module, of audio, scrambled or encrypted through the use of subcarriers on the audio carrier. Good-quality wide-band audio will be readily available in a few years from TV receivers having multi-channel sound. Wide-band audio, ahead of de-emphasis, is not available in many current receivers. Even if it were made available, the intercarrier conversion, as it is done in current receivers, might impair the quality that signal. Wide-band audio, as an input to tne TV receiver, from the module, is probably not needed, as descrambler modules will probably not return composite stereo to the TV receiver when they can simply return right and left audio channels. Baseband audio inputs to the TV set are needed to return this decoded audio as baseband right and left channels. Right and left audio outputs from the TV set are useful because they permit modules, intended for video-only descrambling, to loop the audio back to the right and left inputs, with no additional switching complications. The decoder interface will probably be a multipin connector with automatic jumper switches for the video and audio loopouts.

Cable Loopthrough

Many addressable cable-systems have their address data on a separate carrier, outside of the TV channels. While the TV receiver cannot be expected to demodulate this data channel, the descrambler module can, if it is provided with a loopthrough of the cable. This cable loopthrough would be in addition to the multi-pin interface connector, where desired,and is shown in Fig. 3.

Power

The interface could be defined to include limited power supplied by the TV receiver to the descrambler module. Modules requiring higher power, or needing their out-of-band address receivers maintained continuously, can, of course, be provided with a separate power cord. Descrambler modules, however, lacking the tuners and IF circuits of baseband converters, will consume far less power than our current converter-descramblers. Inclusion of a power pin in the interface would encourage the development of low-power modules within a few years. A concensus does not presently exist for this feature.

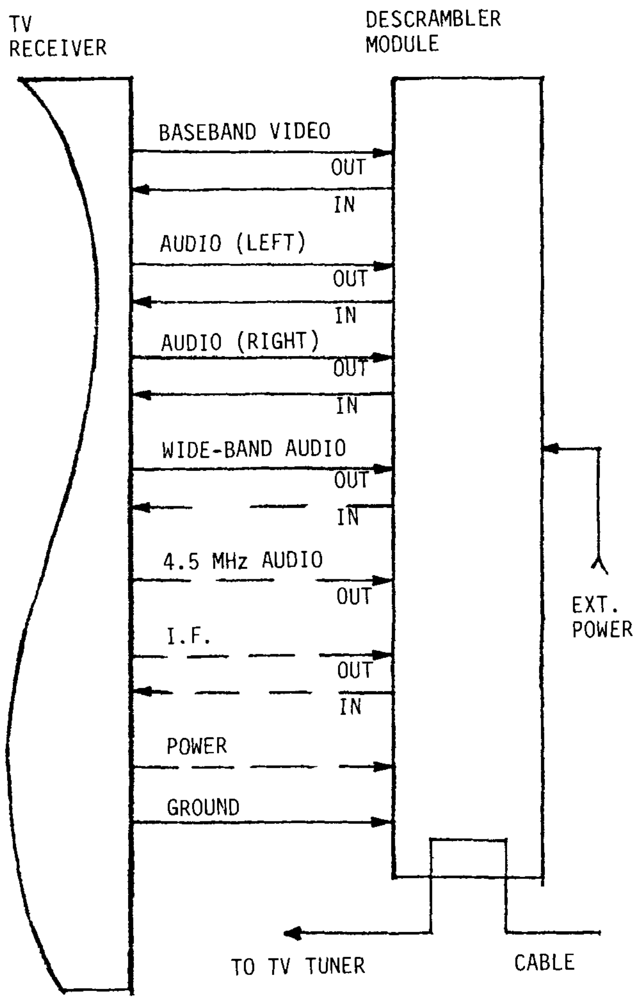

Figure 3: The descrambler module, showing the descrambler interface and other connections.

Conclusion

The problem of compatibility between full-feature TV receivers and cable systems has received considerable attention in the past year. Cable operators have announced a willingness to use the interface when it becomes available. Unsettled questions, of course, remain. Among them is the important question of isolation and safety. While work remains to be done, the progress to date has been very encouraging, and we have reasonable hope of seeing truly cable-compatible TV receivers within a few years.

References

1) E. S. Kohn, "Scrambling and Cable-Ready TV Receivers", IEEE Trans. on Consumer Electronics, CE-28, #3, 220-225, August 1982.