Hardware and Operating Considerations of The Decoder Interface

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Abstract:

The hardware specification of the Decoder Interface is finished. The control software is almost finished. Products incorporating the Decoder Interface will soon appear on the market. This paper describes the details of what will be in the TV, VCR, and decoder, and how these units will interact to create a consumer friendly system which permits watching one program while recording another, recording successive programs on different channels, and doing this whether the channels are in the clear or scrambled. In addition, none of the features of the TV, such as picture in picture (PIP), are kept from working as originally intended.

Introduction:

The Decoder Interface is being standardized with two degrees of complexity. The Level I, "Cable Ready" standard is intended to satisfy the requirements for basic "Cable Ready" as outlined in the "Cable Television Consumer Protection Act of 1992" which are:

1 - Ability to watch a program on one channel while simultaneously using a VCR to tape another program on a second channel.

2 - Ability to tape two consecutive programs that appear on different channels.

3 - Use of advanced picture generation and display features.

4 - All of the above while realizing "the need for cable operators to protect the integrity of the signals transmitted by the cable operator against theft or to protect such signals against unauthorized reception".

The Level II "Advanced Cable/Media Ready" standard has a less formal set of requirements, but adds remote control pass through from the TV or VCR to a subsequent user as well as adding a variable number of the features from the tool box of AVBus functions. An example of this would be a VCR or TV with video and/or audio outputs via the Decoder Interface connector and cables. The "Cable Ready" version Decoder Interface hardware requirements, as specified in EIA-IS-105.1, sets minimum requirements, while permitting greater functionality. There are some pieces specified to accommodate a full system, while other elements are optional or reserved for the Level II Decoder Interface.

The Bus Cable:

The thirteen twisted pairs of conductors, of which the cable is composed, are not shielded. Connectors on the ends of the cable are a small "D" shaped shell which latches onto the mating connector, and uses

"ribbon" contacts. The maximum length of the cable, or the sum of the pieces which can interconnect up to ten devices, is ten meters. The cable cannot be "star" connected and the pairs specified for video must be terminated at both cable ends. The cable is the same for Level I and Level II systems. Level II is a part of the AVBus system which allocates the thirteen pairs as; 7 video, 4 audio, 1 control, and 1 reference.

Tuner IF Cable:

The key to consumer friendliness is the use of as much of the TV or VCR hardware as possible, while maintaining all of the TV or VCRs' operating features. With this goal, the channel selection is done by the TV or VCR tuner. The tuner output is split electrically so that the TV or VCR can process clear channel video and audio signals, and the clear audio part of a scrambled signal when the video portion is scrambled. The portion of the tuner IF sent to the descrambler is level controlled by the decoder, via the tuner AGC when the decoder is being used. The maximum length of the IF cable is two meters. If two to four decoders share use of a TV or VCR tuner, an "IF Expander", which includes optional decoder powering, is defined.

Cable Ready TV:

As described above, the cable ready TV has a minimum of Tuner IF output, with tuner AGC returned on the cable, and the following decoder interface bus receivers; V1 - Video Input, A1 - Audio Input, Control bus and the Reference pair. The video and audio is delivered to the TV on twisted pairs and is converted from differential to single ended. From this conversion on, the processing is as if the signal arrived to the TV jack panel. Control is the key to this system and the detailed operation will be discussed later.

Cable Ready VCR:

This model follows the Cable Ready TV description above with the exception that the bus receivers are V3 - Video Input, and A3 - Audio Input.

Decoder:

The decoder can be used to supply signals to the TV or VCR by using the Decoder Interface Bus. While the CATV operator supplied descrambler is the decoder most often envisioned, the decoder could just as well supply video and/or audio from another source such as ADSL telephone lines, video with overlays from program guide decoders, etc. The minimum configuration requires outputs to be available on either or both V1, A1-A2, and V3, A3-A4. The decoder requires only bus transmitters. Notice that while TVs and VCRs only have to have a single audio input, Decoders must supply signals on both of the audio pairs, even if the signal is monaural. If audio privacy, or stereo audio privacy is in use in the system, the decoder must have an audio demodulator, and possibly a stereo demodulator.

Shared Decoder:

The Decoder Interface specification defines a shared decoder. This decoder has the ability to accept input selectively from two IF Tuners, and to supply an output to either of the tuners' host TV or VCR. This will permit either watching or recording one scrambled signal while recording or watching either the same signal, or a clear signal. This decoder will possibly be a popular version since this is very close to the single converter useage today. The control of this unit has a special control interest because of the necessity of establishing which decoder IF Tuner port is connected to which Tuner.

Two Decoders - Two tuners:

When two identical signal type decoders are connected to two tuners, each operates as if the system is not interconnected. When the decoders are different, analog vs. digital for instance, a cross connection methodology must be developed. The situation could be that the TV viewer wants the digital program, while it is desired to record the descrambled analog signal. The reverse situation could be desired for the next program session. This cross connection requires an IF switch which cascades decoders, or terminates (Power blocked) the unused IF tuner port if only one decoder is connected. In a similar manner, the decoders used in this configuration must also have audio demodulators, including stereo demultiplexing, if audio and/or stereo audio privacy is in use. Of course, if the decoder is digital, audio reconstruction is always necessary.

IF Switch:

The IF switch will probably be built into the decoder, although that is not mandatory. The switch must maintain DC continuity to the IF paths since the tuner AGC passes that way. Seventy five Ohm impedance and greater that 60 dB of isolation between ports must be maintained which should not be too difficult at the 41-47 MHz IF operating frequency.

Control:

The control follows the CEBus model of pulse width modulation. A "one" is 100 microsecond (μsec) long, a "zero" is 200 μsec, "end of field" 300 μsec, and "end of packet" 400 μsec. The control system is "not asserted" or esentially open circuit when idle. If a unit desires to send, it can do so if the bus is idle. Bits are alternately asserted and not-asserted. Since the system is short and the bits are long there is no possibility of "flying bits", (bits sent and in transit which are not yet received by a unit desiring to send). If the second sender, sends its' first bit , a collision occurs. Both senders detect the collision, stop sending for random lengths of time, and statistically, on a subsequent transmission the second unit detects that transmission and refrains from sending. In a short system such as the Decoder Interface, two units could possibly start sending simultaneously. Since both monitor the line continuously, the first unit to send a "non-assertive" bit while a second unit is still asserted will recognize the collision, and stop sending. In this way, the first unit does not even see the contention and continues its' sending. The control drivers and receivers are relatively simple and are specified as "fail safe" non-assertive even when the unit is unpowered.

Protocol:

The protocol follows the CAL-60 format, which is very extensive. Since the Level II Decoder Interface is AVBus compatible, the packets include addressing to units and network extensions to zones, called house codes. This permits operation of multiple systems in an area when some of the control system are bridged onto a common transport medium such as the power lines. The network interface has been implemented in relatively simple microprocessors. They receive the packets from the control data receiver, establish network and address compatibility and pass the message content on to the device controller. In a similar manner, a unit can send data to a target address, packaged up and transmitted along with an error detection checksum by the data link microprocessor.

Network Architecture:

Establishing what devices are available, device compatibility, and device interconnections are the subject of this section. Assuming that the components are TV, VCR, and decoder(s), the consumer connects the units together with appropriate coaxial cables for IF connections, and AVBus Cable for the Video, Audio, and Control. Upon completion of the connections, the units are plugged into the AC Power. When this occurs, probably at a somewhat staggered rate because all the plugs will not be inserted simultaneously, all of these otherwise intelligent units must evaluate their environment. The individual units know their own capability, and are able to query other devices as to their capability. The first step in such an operation is to acquire addresses, equivalent to names, so that targeted questions and answers can follow. Generally low number addresses are desired so as to minimize the number of bits necessary to be sent to complete an addressing sequence. The zone or house address must be established for all devices. On a Level I network, and probably most other networks intially, the home will be #1. Devices then "hail" for addresses. Certain preference addresses are recommended in the standard, however the general rule is to select an address and "hail" to see if anyone already has that address. Since only one unit can access the control bus at a time, if no response contesting that address is forthcoming, that is the unit address. The analogy could be likened to a group of people in a dark room, with some of those people roped together in pairs. Everyone can listen, however only one at a time can talk. The challenge is to sort out the configuration. After everyone knows the name of everyone else, it becomes necessary to establish device types such as TV, VCR, and Decoder. In the case of decoders, the IF interconnection must be established. A shared decoder must have two addresses, one for each IF tuner.

IF Interconnections:

After addresses are established, the decoder(s) must decide which tuner they are connected to. The algorithm to resolve interconnections is left to the decoder designer. One method would assume an interconnect and for instance re-tune the TV or VCR and see if the video changes. An alternate would be to control the AGC to reduce the signal level, and see if the signal level changed. With an IF Expander box present, there could be multiple decoders connected to a tuner IF. Not all decoders need to control the tuner AGC, so interconnect analysis may vary with decoder.

Hail for A/V lines:

When the units are initializing, it is necessary to evaluate video and audio line availabliity. Some minimum configuration availability is mandated, as previously discussed. In a simple situation, V1 would be allocated for decoder to TV interconnect, while V3 would be allocated for decoder to VCR. If the decoder was digital, or analog with audio privacy, then A1-A2 for the TV and A3-A4 for the VCR would be allocated. If the TV was monaural, the decoder would plan to feed both A1-A2 with the composite audio, while if the TV was Stereo capable, the decoder would stand ready to feed stereo if available. While the exact algorithms are not in place, a decoder would not actually acquire and enable the video and/or audio lines until the first time that they are required. The recommended practice for either holding onto the lines, or releasing them back to TV set operation, for instance when channel surfing, has not been established. It might be expected that the methodology of converter operation might be emulated. For instance tuning to an

authorized scrambled channel would cause the descrambler to acquire the necessary A/V lines, while tuning to a "not-authorized" scrambled channel might cause the descrambler to retune the TV tuner, unlocked from display so the TV still shows the selected channel, to a barker channel. Optionally the descrambler might acquire A/V lines and put up a "Barker" graphics or just a blue screen. The system has great flexibility!

Problems to be Solved:

One problem occurs when a shared decoder is already switched to a scrambled IF and the second tuner lands on a scrambled channel. The decoder is not available. The general prioritization would be that a VCR has a higher priority, however the TV viewer of a scrambled channel should probably be given an option when the pre-programmed VCR requests the descrambler switch over to the VCR IF. Then too, how does the VCR know that the channel is scrambled and authorized if no IF is available to analyze?

Another problem for the designer will be how to utilize the functions and features available in the hardware at hand. For instance, does a descrambler have to assume that an IF expander box is present, or can an assumption be made that the IF port is its' alone? By listening to other decoders who think that they are connected to the same host IF tuner, a deduction of multiple decoders can be made. Does the decoder firmware have to accommodate this from the start?

Some of the advanced thinking is that with a full AVBus system, it will be possible for a TV receiver to output a composite video signal, which a decoder separates into "Y,U,V,". These components then go to a processing decoder which overlays video information and passes the processed "Y,U,V," back to the TV for display.

Summary:

While some of the potential hardware and operations of the Decoder Interface have been discussed here, the number of actual combinations of this powerful network structure have hardly been scratched. The first Decoder Interface equipped TVs and VCRs should appear on the market shortly, and decoders of the descrambler variety will work together to make the TV appear to have descrambling capability. The purchasers of these new systems should be pleased with the progress that the Cable and Consumer Industries are making in working together.

References:

EIA-IS-105.1 Draft Decoder Interface Standard
Revision: 6.1 September 8, 1996

EIA-IS-105.2 Draft Decoder Interface Control Standard
Revision: 2.1 September 5, 1996

Cable World special reprint of "Cable Television Consumer Protection and Competition Act of 1992", Page 12A, October 12, 1992
Reference "The Communications Act of 1934, amended "Sec.624A Consumer Electronics Equipment Compatibility"

Joseph B. Glaab, "History and Present Status of The Decoder Interface: 1995 NCTA Technical Papers, Pages 346-349