# History and Present Status of The Decoder Interface


**Joseph B. Glaab**
**General Instrument**



## Abstract:

This paper reviews the decoder interface from its inception as Multiport, through the present development work to satisfy customer desires to use all the features available on their TV or VCR while maintaining all the functions and features available to the Cable Box user. The use and control of the TV/VCR tuner with a decoder interface, the interconnection between units, and the video, audio, and control bus techniques will be discussed. Of special interest is the section describing the control language which enables this system to work.


## History:

Over the years there has been a love-hate relationship with the "Cable Converter". Often the converter overcame consumers' TV reception problems, while other times the converter was the gateway to receiving programming not otherwise available. While providing improved TV performance to the cable subscriber, most times only one channel at a time is presented to the TV for viewing. The desire to remove the converter, and its second remote control, prompted the idea of Multiport. Actually this was not a unique solution because Zenith had the "Redi-Plug" connector on Tvs during the same time frame. Basically it was suggested that the TV and VCR circuitry could be used if some control and descrambling were done external to the TV/VCR. The joint Electronics Industries Association (EIA) and the National Cable Television Association (NCTA) Engineering Committee worked to design an interface between the TV/VCR that the consumer owns, and the Cable Conditional Access device (descrambler) which the Cable supplier owns. The result of this was the first "Multiport", which was described in EIA Interim Specification 15 (IS-15). After some time, and the incorporation of some changes, the IS-15 specification was standardized as EIA-563. Among the changes was the incorporation of a one way command set to the decoder from the TV. This was because addressability was becoming popular and such control was deemed necessary. Prior to that time, scrambling was done on a "Pay" basis, a subscription type service, which required a truck roll for service level change. While a couple of million Televisions were made with Multiport Connectors, there was no way of knowing who had them in a cable system. The other problem was that Tvs from the largest manufacturer of Tvs with multiport did not work well with the most popular scrambling system decoders. General Instrument, and others, made IS-15 multiport descramblers, however, not too many were ever deployed. Few, if any, Tvs or descramblers meeting the full EIA-563 Multiport specification were ever sold.

## IS-105:

The emergence of Picture in Picture (PIP) Tvs obviously created another opportunity to improve the way Tvs and converters communicate. The PIP issue, on top of what the consumer felt were unfair costs for the products and services that they received from being connected to Cable TV, prompted the US Congress to enact the Cable Act of 1992. The law directs the Federal Communications Commission (FCC) to resolve all of these issues. The FCC has requested the Cable and Electronics Industries to present a solution to compatibility concerns and other issues. The FCC declared that, lacking a suitable solution, it will resolve these issues in their own way.

The joint EIA/NCTA has been working on a number of issues with the goal of creating systems which will supply good pictures at a reasonable cost. IS-23 looks to describe all of the factors involved in interfacing a TV, VCR or Converter to the cable system. IS-132 is a successor to IS-6 and attempts to standardize the channel assignments for analog signals to 800 Mhz. IS-105 is the successor to EIA-563, but very different. While the TV/VCR IF and detector still exist, their video output is not presented as an output. Instead, the TV/VCR tuner output at 45 Mhz is split with one path for the signal being the normal TV/VCR IF for detection and display, and the other path is to an "F" connector on the back of the TV/VCR. That signal is terminated in the first of a possible chain of devices using the IF of the TV/VCR. In every decoder box, a sample of the IF at unity gain is passed on to an output terminal for the next device. The interesting point here is that the TV/VCR delayed Automatic Gain Control (AGC) can be multiplexed back up the IF coaxial cable by the device actually using the tuners' IF. If the signal is in the clear, the TV/VCR will do the tuner AGC. Only if the signal is scrambled or uses digital modulation will the decoder need to do tuner AGC. The descrambler, or feature box, will supply baseband video, and audio if necessary, back to the TV/VCR through a multiconductor connector. The connector is the standard for the Audio-Video Bus (AVBus). This is a subset of the CEBus, created by the EIA for control in a whole house environment. The AVBus is targeted at connecting Tvs, VCRs, Disc Players, etc together without having to have a large number of cables running between the units. The minimum configuration of the AVBus for the decoder interface connector is to have pairs of wires, balanced for noise immunity; incorporating a ground reference, a control pair, one video pair, and one audio pair. The full configuration decoder interface adds three video pairs, and three audio pairs. With this many pairs, the video can be composite, or use two pairs for S-VHS connections, and audio can be carried as stereo pairs. The minimum configuration is for the TV/VCR to be "receive only" on the videos and audios, while the decoder will be "send only" on those pairs. In all cases, the control is "bi-directional" with a high degree of contention resolution capability. Multiple decoders for different scrambling systems, or to supply different features, can simultaneously operate to satisfy the consumers needs.

## Control Bus:

The control bus is probably the most complex of all the operations in the decoder interface. The data lines are normally relaxed, and everyone listens for an assertion by someone else. If there is no activity, and a device desires an operation, that device can take over using the data lines. At the same time that someone is using the control line they must also listen, in case a second user started at the same moment generating a contention. If that does occur, both users will stop, each will wait a different length of time and try again. Since the times to wait are different, the contention should be resolved.

## Control Bus Data Format:

The unasserted state is the normal off state. A "one" bit is 100 Microseconds ($\mu$sec) long while a "zero" bit is 200 $\mu$sec long. At the ending of a sequence, such as a recipient address, or a source address, an "End of Field" (EOF) bit lasting 300 $\mu$sec is sent. The end of a whole sequence is confirmed by sending an "End Of Packet" (EOP), data bit 400 $\mu$sec long. The data bits have only a time relationship, in that the very first bit goes assertive, whether it is a one or zero, and the second bit goes non-assertive etc. If the last bit in a packet is asserted, then the 400 $\mu$sec EOP would be non-asserted, and in reality a non-bit. The device sending the packet would normally wait for an acknowledge packet before starting a next packet. In most cases, the bus activity will not be so high that the next user would not wait to see if this was indeed the end of the packet.

## Data Packet Structure:

The data protocol is described in EIA IS-60 (the CEBus standard). There are two types of data frames likely to be on the Bus. The first is the Normal frame, which is used to send an original message, and the second is an Acknowledge frame, which is used to confirm receipt of a valid Normal frame. Before describing these frames in detail, it is worth mentioning that there are some commands which are "broadcast", in that there is no target address send and no Acknowledge is expected. These commands include, channel change and power on/off change. There may be more of this type of command included in the future, primarily used to shorten the time to send a command. In the Normal and Acknowledge frames, some of the fields are mandatory and some are optional. All fields must be accounted for however, so empty fields are identified by sending only an EOF bit. The PRE (preamble) field is defined as 8 random bits. The Control field is 8 Bits defined as X0000101. The X bit is a sequence number bit which toggles for each new message. The next field is for the DA (Destination Address). If sent as a null field, the packet is defined as broadcast to all devices on the bus. Address fields can be up to 16 bits long. The recommended practice is to try to keep the addresses to below 15. The DHC (Destination House Code) can be up to 16 bits long used to define the specific bus that is active. In a non-interconnected system, that can be a null field sent as an EOF bit. The next field is the mandatory SA (Source Address). This is followed by the SHC (Source House Code) field, which can be another null field, sending only EOF. Following all of the previous is the actual Information Field. This can be a field up to 32 bytes (8 bits of data per byte). The Information Field of a Normal Frame contains the Network and Application Layer headers preceding the Command to be executed. The actual command information is detailed in IS-105.2. The control possibilities are almost unlimited in that if the need arises for new commands, they can be added by mutual consent of the EIA and NCTA, and the specification revised accordingly. The final field in the sequence is the FCS (Frame Check Sum) which is actually the two's complement of the sum of all the fields on a byte by byte basis. The preamble is excluded in the calculation as are mathematical carries. The beauty of this scheme is that a register is cleared at the receiver during the reception of the preamble. After that, all the fields are added to the register on a byte by byte basis, including the FCS, which will result in the register being zero if no errors are detected. As was related earlier, an Acknowledge frame will be sent by the receiving device. The decoder can start to execute the received instruction at the same time that it is sending the Acknowledge Packet.

With the packet overhead and optimal short addresses, a Normal Packet can be as short as 8,800 μsec or 8.8 Milliseconds (ms). If the message is long, and addresses high etc, the packet may be as long as 26.9 ms. The Acknowledge Packet can be as short as 8.1 ms and as long as about 16 ms. This time has to be added to the time to transmit an IR command, which is typically 50 to 100 ms.

Upon the receipt of a typical channel change request, originated by the IR controller, a channel change command would be broadcast on the control bus. If the decoder recognized from its IF input that the channel was scrambled, a packet would be sent reporting that status. If the program could be descrambled, and if the decoder was not presently supplying video (and/or audio) through the decoder interface connector, the appropriate configuration would be requested by the decoder. The TV would respond, and a descrambled picture would appear on the TV. The IR transmit/receive time, which is not controlled, is added to the approximate 40 ms time that the Packets take going back and forth to establish the path. The time for the descrambler to recognize and authorize the channel might be another 16 ms. All of these times are based on smart assignment of addresses, and in that context, a reasonably short time elapses between the consumer request and the desired result.

## Conclusions:

This paper has presented the parts of a rather complex system. The complexity of the system should be weighed against the flexibility which it imparts. For example, the TV could tune to a scrambled channel, which the descrambler would process and present in a viewable form to the AVBus. That picture could be received and overlaid with data from another decoder box, before being presented to the TV for viewing. The time for packets to traverse the system is variable, and for the most part should be tolerable. The system is designed for setting up system configurations and not for playing interactive games. For fast reaction results, either IR Passthrough or a separate IR receiver may be necessary.