An Analog HDTV Interface for Cable Set Top Boxes

By David Broberg, © February 19, 2001

Can a unidirectional analog component interface adequately serve as a primary connection between an advanced set-top-box and a DTV display?

In August of 1998, CEA (then CEMA) passed a family of standards known as EIA/CEA-770.x that describe a three-wire component analog interface based on Y-Pb-Pr signals. These standards were recently updated to 770.1-B; 770.2-B and 770.3-B and are being considered for international acceptance by the ITU.

In the scope statement of EIA/CEA-770.3-B it says the intended use of this standard should be:

> "For interconnection between HDTV Digital Cable TV set top boxes (STBs)… and compatible television receivers or monitors."

CableLabs, through the OpenCable project, will be evaluating the suitability of this interface for possible inclusion in OpenCable Host Core Requirements Specifications.

To understand the applicability of this interface to the task, we must first examine three basic assumptions of the standard (770.3-B): (1) All programs will be 16x9 aspect ratio; (2) All colorimetry will be compliant with ITU-R BT.709-2; (3) Copy protection can be added at a later time.

Next, to evaluate the suitability of the interface we have to summarize the basic requirements for such an interface and determine how closely the assumptions match. For such an interface to provide an effective solution for HDTV Digital Cable TV STBs, it must easily support all the programming and services available through that terminal. This may seem obvious, but let's examine how this holds up against the standard's assumptions going in.

The HD-STB will be expected to tune to all programs which are authorized to the subscriber, whether HDTV, SDTV or analog. If 770.3-B is selected, then a compliant display can be built which supports only one of the two image sizes (1920x1080 or 1280x720 pixels) This requires that the STB must be able to support both output formats and include all necessary format conversion circuitry to allow any incoming signal to be sent out at the rate needed to support the selected display device.

This action gets complicated when you begin to consider how the aspect ratio conversions will occur with each channel change. Virtually all of the SDTV programs will be 4:3, with a few possibly letterboxed, while most of the HD programs will likely be 16x9. The STB designer must decide how to process the 4:3 source material. The likely choice is to default to a mode that adds side-panels to the 4:3 image. Of course other expansion modes could be added to the box to allow some additional user control.

Another expectation on the box will be the function of colorimetry conversion. Since virtually all standard definition digital TV programming on cable will be available with colorimetry defined by SMPTE-170M and the stated requirement of the standard to support only ITU-R BT.709-2 colorimetry, it will be necessary (or at least desirable) to perform a real-time

color matrix conversion on SDTV programming. While the ATSC standard (A/53) now requires the colorimetry to be identified in the sequence display extension when it does not conform to ITU-R BT.709-2, no such identifiers are commonly used on digital cable signals. This means that the STB must make an assumption about SDTV programming and always convert, considering that it can not rely upon the identifier in the sequence display extension. In the case where the SDTV content was produced in HD, with ITU-R BT.709-2 colorimetry and downconverted by the programmer for the SDTV service, the assumption will be proven false and an erroneous matrix conversion applied. Looking into the future, this situation is likely to become more common.

The authors of the EIA/CEA-770.3-B standard seemed to have recognized this dilemma, and added the following note: "Under some circumstances the colorimetry of the source video may not be ITU-R BT.709-2." The question for STB designers is what assumption do you make about the source colorimetry of SDTV programs? Perhaps the safest choice is to provide a default setting that can later be changed by the user or the cable operator.

Finally we have to examine the consequence of the assumption that copy protection can be added at a later time. Recently CableLabs made the POD-Host-Interface-License-Agreement (PHILA) public in response to a request by the FCC. This license agreement includes certain copy protection provision requested by the Motion Picture Asssociation of America (MPAA) and supported by cable operators in order to assure the widest availability of high quality programming. One such provision addresses the implications of analog HD output interfaces. That provision requires HD-STBs with unprotected analog outputs to be capable of resolution reduction on the analog outputs for certain high-definition source material.

This down-res'ing functionality is required only when a suitable copy protection scheme has not been included on the interface. Since EIA/CEA-770.3-B still doesn't include such a copy protection scheme, the down-res'ing support would be required. What does this mean to the signal on a practical level? We must first realize that support of the EIA/CEA-770.3-B standard only allows for two image sizes (with 4 scanning rates) all of which are considered HDTV. Therefore, it is not possible to simply do a format conversion of the affected HD source material to SDTV rates and couple these across the same interface. Rather, we must maintain the monitors selected scanning rates, by doing the resolution reduction by some process of pixel averaging, while maintaining the chosen scanning rate.

In conclusion, we have evaluated the impact of using the EIA/CEA-770.3-B component interface standard for high-definition digital set top boxes and determined that with some complex format conversion, colorimetry reprocessing and available resolution reduction, the interface can satisfy the basic requirements for a advanced HDTV digital cable box. The standard could be further improved with the addition of a copy protection scheme which would eliminate the need for any resolution reduction.