REPORT ON THE COAXIAL PORTION OF THE EIA HOMEBUS STANDARD EFFORT

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ABSTRACT

The Electronics Industry Association (EIA) has been working towards the development of a consumer electronics bus (CEBus) standard for several years. During the past year, significant forward progress has been made in a number of bus related areas, and among these is the coaxial portion of the Wired Bus (WIbus), more commonly referred to as the CXbus. This paper reports on the status of this bus topology proposal by presenting results taken on a system model, and also explains some of the thought processes that have been used to arrive at the currently proposed system topology. A possible realization of CATV interconnection is also detailed.

DISCLAIMER

The information contained in this paper is based on work in progress towards an EIA standard. It represents the consensus opinion of the members of the Wired Bus subcommittee and may not fully represent the final version of the standard. The author is not an official spokesman for the EIA.

INTRODUCTION

Consumer electronics manufacturers have shown consumers the advent of a number of sophisticated products (primarily audio and video) over the past several years. These products have produced an increased awareness of the need for the integration of similar type devices into a coordinated system. Manufacturers have attempted to provide interconnection compatibility within their own product lines and have been successful to a certain extent. When manufacturer lines are crossed however, it becomes obvious that the interaction issues are far from resolved. The VCR/CATV dilemma is but one example of this growing problem familiar to the CATV operator. The EIA Homebus standard will provide industry wide "rules of the game" that will sort out how these interrelationships between devices are established. Products that meet these rules will bear the Homebus logo and will be designed for easy "plug and play" compatibility. The standard will apply to all segments of consumer products, but for the CATV operator the integration of the home entertainment center will be the predominant issue. The author hopes that the information in this paper will provide the CATV system operator with the ability to understand the direction of the standard development, and to begin considering the future implications that this standard contains. The intent is not to consider the relative merits of the practical uses of the Homebus standard, but to share technical information on what the author believes will closely represent the CXbus standard.

LOGICAL DEVELOPMENT OF TOPOLOGY

The current topology was arrived at through a series of conceptual iterations which included star, multilevel star, tree and branch and the proposed resemblance of tapped trunk. In addition, it was known that video transport would be required for what was to be called In Home Generated Video (IHGV). The IHGV was to be in a controlled portion of the spectrum. A source would not be allowed to transmit signal unless permission was obtained to do so via the control channel link. This IHGV was to be provided from sources within the home, such as a video camera or VCR, and distributed to receive points in the home for a variety of uses. The actual frequency allocation of this IHGV was a greatly debated issue and was a driving force in determining the level of complexity of the upstream cable. There were a number of system related factors that were considered important to the successful development of the CXbus standard. The main ones were:

Minimum system requirement
Ease of system extension
Cost complexity tradeoffs
User friendliness (plug and play capability)

In addition there were many topological issues related to system performance such as:

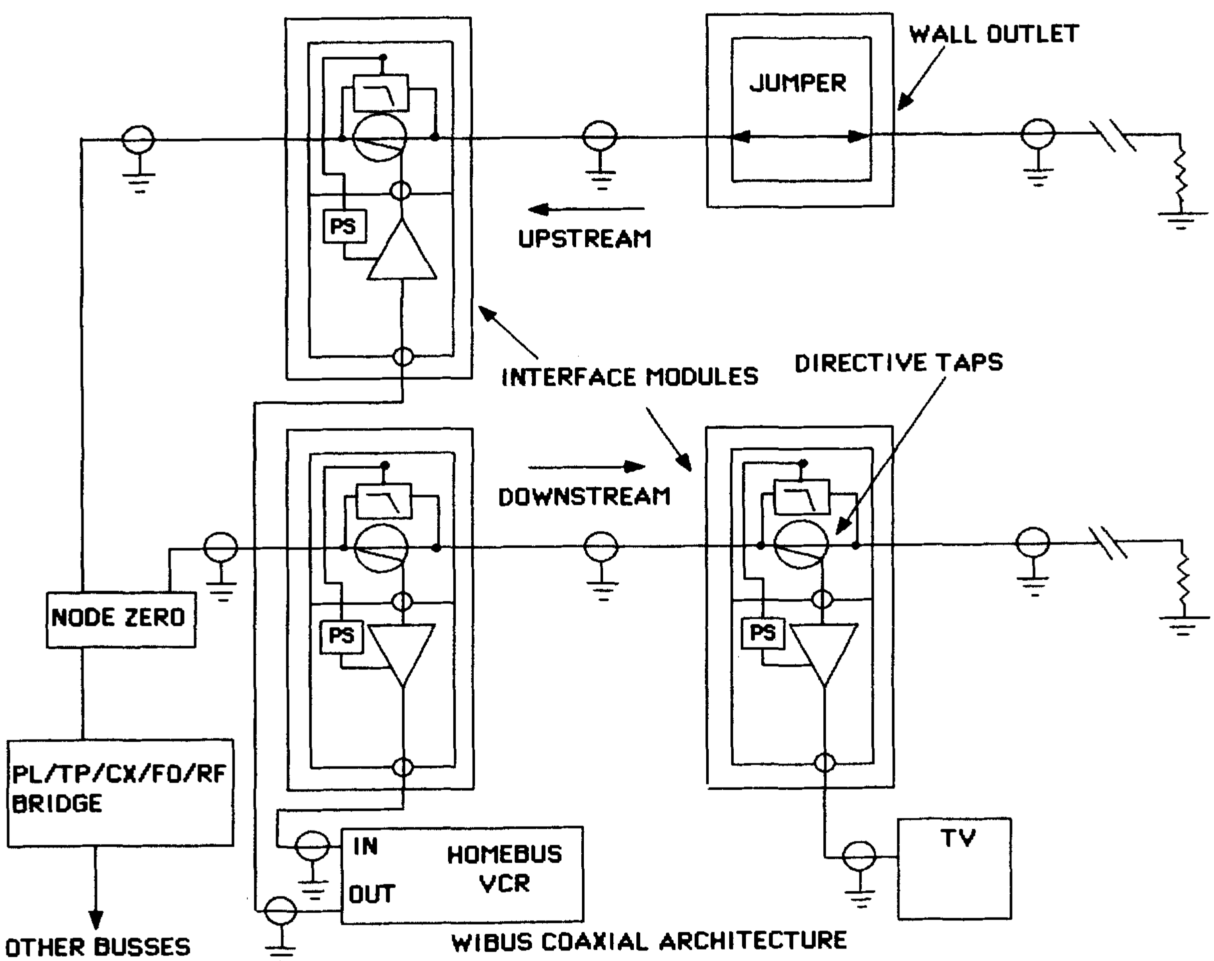
Cable footage efficiency
Practical system length
Technical performance
Powering
Required number of outlets

Through the dedicated efforts of the committee members, these and other issues were traded off against each other and the system described herein evolved.

GENERAL SYSTEM DESCRIPTION

Physical Media

The proposed topology (Figure 1) is dual cable with one cable used for downstream and the other used for upstream transmission. The separate cables exclude the need for a conventional two way distribution system, reducing the complexity of system implementation since diplex filters and two way gain capability are not required. The recognized tradeoff for this was the addition of more cable footage to the system, but the consensus was that this tradeoff was a reasonable one. The CXbus itself is capable of standing alone as an independent WIbus system. The minimum system can consist of a single outlet, with the appropriate interface module and the Node Zero realization. The system will have a defined

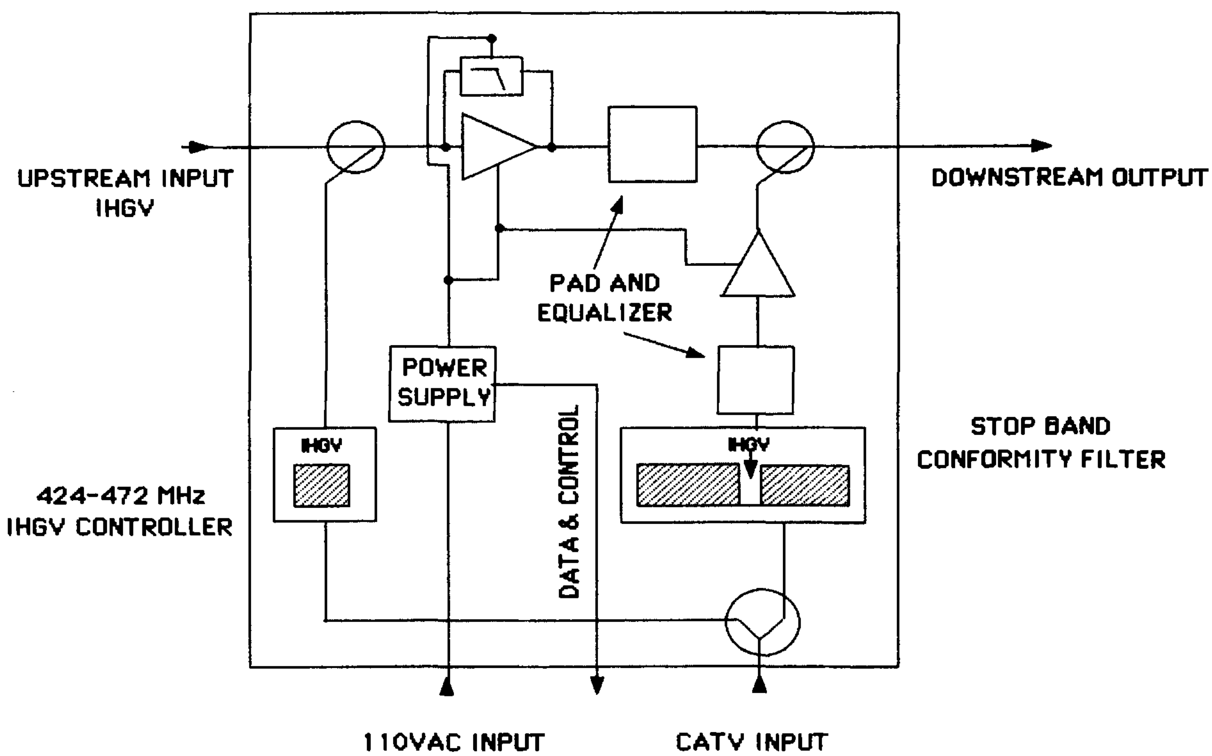


WIBUS COAXIAL ARCHITECTURE
Figure 1

operation to 550MHz with less stringent definition to 806 MHz, this upper portion of the spectrum used primarily to accommodate carrying off air UHF TV signals. The downstream and upstream cables will have the same technical definition, but will of course have different directions of signal flow. Connection to the RF portion of the spectrum of either cable is done through a low loss directional tap which is contained in the interface module. Amplification is also provided for acceptable signal level output or injection depending on which cable is being accessed. In conjunction with this RF coupling, an additional path is provided for low frequency (<1MHz) signal passing and for AC or DC powering as applicable. This low frequency path will be used for control and data applications and will be directly linkable to other bus structures. The Node Zero realization that might be applicable for a minimum system which has been interfaced to an existing CATV system is shown in Figure 2.

Frequency Allocation

As previously discussed, the frequency of operation for this system is from 0 Hz to 806 MHz. Within this wide range of operation there are a number of frequency allocation bands available for use. Figure 3 details the current frequency allocation proposal for the CXbus. Current thinking has the IHGV located in the 424 to 472 MHz range for NTSC type signals and another band from approximately 10 to 54 MHz for other wideband applications. This higher IHGV frequency allocation has some implications for CATV systems that are 450 MHz in bandwidth or higher and will be connected to a CEbus system. The IHGV portion of the spectrum will have to be "unallocated" from the CATV input since this is a reserved and controlled frequency segment. A stop band conformity filter would perform that function. In addition, an IHGV controller would provide access to those CATV channels that reside in the IHGV



NODE ZERO IMPLEMENTATION
Figure 2

spectrum. Figure 2 shows the implementation implication caused by this IHGV allocation.

SYSTEM TEST BED

Cable Interconnection

The reported system test bed consists of a 20 outlet system with a total cable footage of 312 feet. This system was constructed using RG-59 drop cable with a nominal loss characteristic of 8.35dB/100 ft at 550MHz. The cable length between each outlet and the total footage is shown in Table 1.

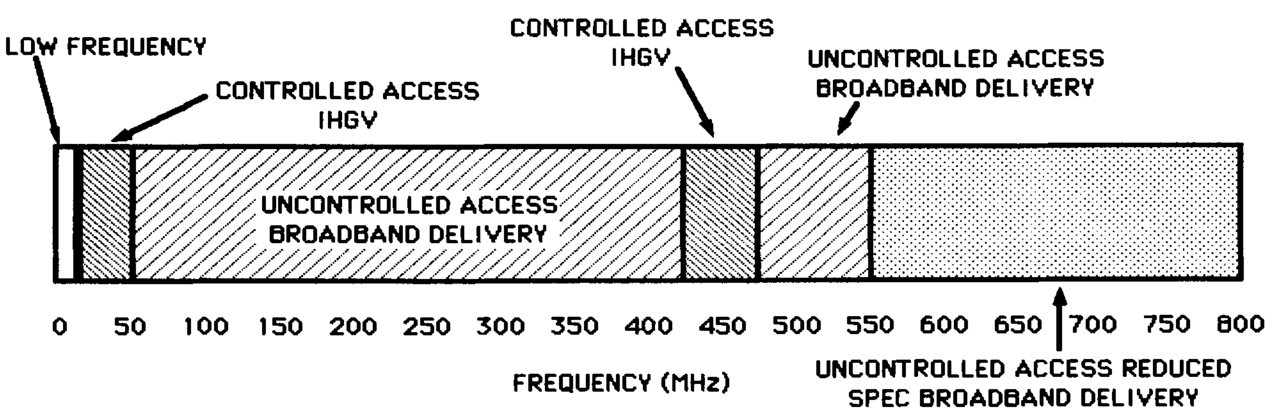
Outlet Number	Additional Footage	Total Footage
1	0	0
2	14	14
3	03	17
4	10	27
5	27	54
6	02	56
7	38	94
8	02	96
9	12	108
10	12	120
11	15	135
12	24	159
13	14	173
14	31	204
15	02	206
16	23	229
17	32	261
18	12	273
19	07	280
20	32	312

Table 1

These cable lengths were arrived at from an actual floor plan of a sample house which put one outlet on practically every interior wall. This particular house contains approximately 3000 $feet^2$ of living area and is in no way intended to represent a "standard" or "average" house. This does not limit the usefulness of the model however, because the dimensional relationships between interior walls is relatively constant over the vast majority of American homes.

Outlet and Module Interconnection

The outlets themselves into which the interface modules connect were constructed out of FR4 PCB and had provisions for two interface module connections, one for the downstream and one for the upstream cable. The outlets were sized to fit within a standard 110VAC electrical outlet box. Connection to the outlet PCB was made with conventional "F" connectors. Connections to the interface module were made with the custom coaxial connector used in the SA 6501/6502 distribution amplifier for diplex filter connection. This connector was used strictly for the sake of convenience. Five functional interface modules were built and used in the testing. These were four port devices with provisions for a main system input and output, a directively tapped (-17dB) RF output and a nondirective low frequency tap. Figure 1 shows an additional gain stage used in the interface module, but in this particular test system the gain stage was not an integral part of the module so that various types of gain stages could be evaluated at a later time. Plug-in jumpers were used in outlets that did not contain an interface module.



PROPOSED FREQUENCY ALLOCATION
Figure 3

The purpose of the system model was to determine the limitations of the proposed topology and to collect data on the actual performance of such a system. In addition, the model will be used to formulate and answer questions regarding complete system integration.

System Data

After construction, the 20 outlet system was swept with jumpers only to determine the losses associated with the cable and the outlet PCBs alone. This information is presented in Figure 4 as a function of four frequencies and represents the minimum system loss possible due to cable and jumpered outlets alone. The five available interface modules were added to the system and the same measurements made. These results are shown in Figure 5. The incremental loss for a single added interface module is shown in Figure 6. Figure 7 details the system loss for a given cable footage with only jumpers and outlet PCBs installed.

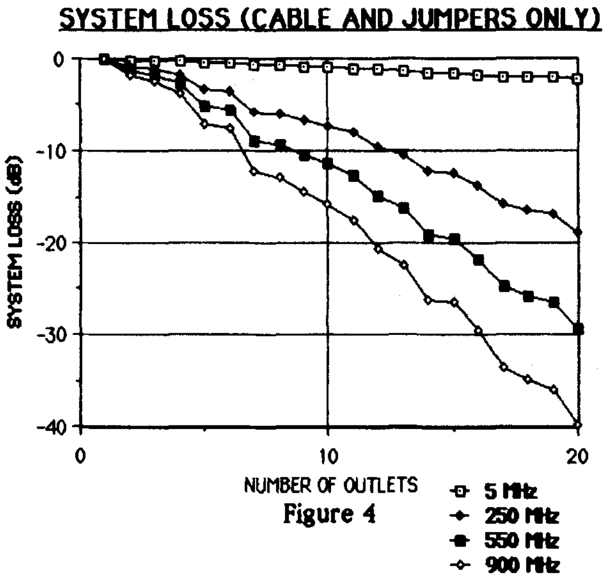


Figure 4

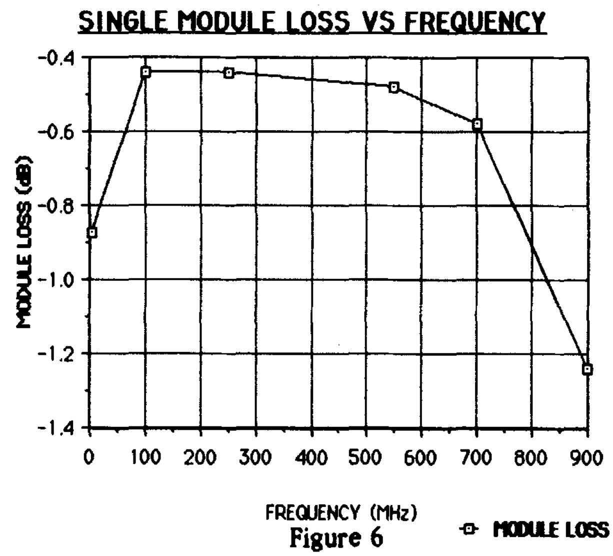


Figure 6

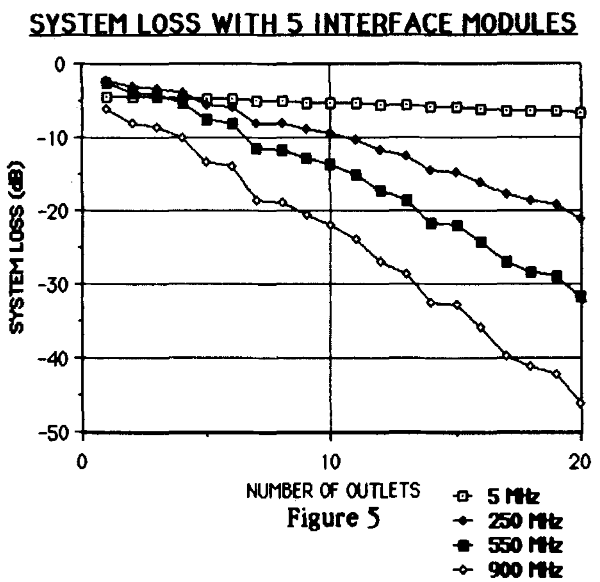


Figure 5

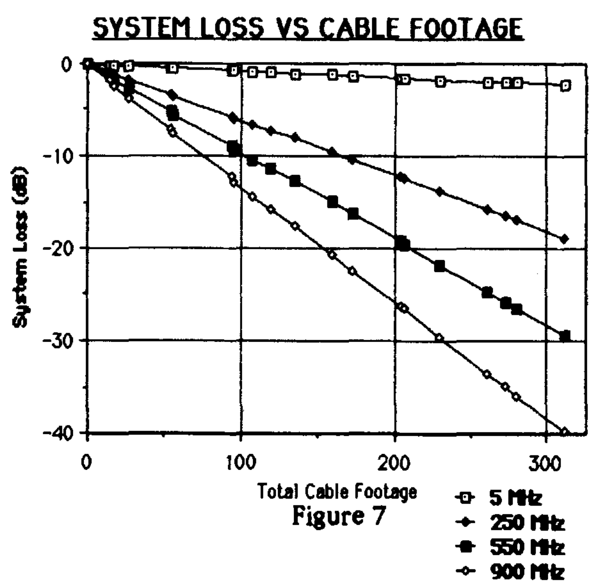


Figure 7

SYSTEM LIMITATIONS BASED ON DATA

General

As stated earlier, the intent of this system analysis was to establish more concrete guidelines for the final implementation of the CXbus structure. The perspective that one has towards the real use of this system is a great determinant in establishing the technical parameters for the operation of the system. When the CXbus structure is examined as a totally closed system, the normal specifications that the CATV industry puts on video distribution systems should not be difficult to meet because there will generally be only two amplifiers in cascade in conjunction with a manageable system loss. When the practical reality of the situation is considered however, it becomes extremely difficult to imagine this system not being connected to a CATV system in the majority of cases, and it will certainly be connected to an off air antenna in the remaining ones.

System Length

The driving issue that determines the system length is the maximum signal level that will be possible to put on this system. Based on Carrier to Noise calculations, it appears that the minimum system level should be in the range of +10 dBmV in order for the interface module to have satisfactory noise performance. This is based primarily on the noise figure of monolithic devices available for the interface module amplifier. It therefore follows that the loss allowable by the system will be:

$$X \text{ dBmV} - 10 \text{ dBmV} = Y \text{ dB}$$

where X is the maximum system level and Y is the allowable loss before an extension (line extension) of the system occurs. If one assumes that Y will be on the order of 15 dB, a general guideline for the system might be an eight outlet system with 135 feet of cable capable of having five interface modules active at a given time. This was calculated using Figure 6 to determine the loss due to the five interface modules and using Figure 7 to calculate the loss due to the cable footage and outlet PCBs. The combinations of system realizations is large once the available loss is known and one of the major challenges of the final system implementation will be to provide an acceptable means of signal level management throughout all of the possible combinations. This maximum system level issue is being addressed from a regulatory standpoint at this time.

CONCLUSIONS

The data presented represents the status of the CXbus system topology. There are a great deal of issues yet to be addressed and these will be resolved as further work is done on the standard. Some of these issues will be generated by committee input and some will come about as a result of more in depth evaluations on the system topology as it further evolves and begins to more completely unveil the related intrabus connection issues. Work to date has focussed on the broader issues relating to the system concept. Now begins the task of complete technical definition.

With regards to CATV systems in particular, this system concept moves more towards an off premise implementation of cable systems. The implications that the emerging Homebus standard has for this industry will become more apparent as other portions of the standard are firmed up, however now is the time to begin consideration and comment on the possible effects of the topology presented herein.

ACKNOWLEDGEMENT

The author would like to thank the members of the EIA Homebus committee for their inputs. A special thanks goes to Mr. Charles Bedgood of Scientific-Atlanta who designed, constructed and evaluated the system model.