

# AudioBus specification

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# AudioBus System

## Introduction

Current audio technology has achieved a certain degree of standardization for equipment interconnection. These are the standard RCA jacks and the electrical specifications that allow you to connect a Yamaha CD player to a Carver Pre-Amp and in turn connect the Carver to their own or another vendor's power amps. This has served the audio community well over the last couple of decades, but today digital audio is beginning to permeate every aspect of audio equipment, with microprocessors being used for many control functions. Yet the standard for component interconnection is still analog, and there are no provisions for inter-component communications except for some single-brand systems.

To alleviate this lack of 'communication' or 'Inter-operability', I have designed a platform that resolves most of the issues regarding feature integration and system expansion, the AudioBus. The genesis of this idea was a common one. Lets say I wanted to be able to enhance or expand my Audio system with a new feature, such as some form of ambience recovery, I would first have to sell my old pre-amp and replace it with a model that had the new feature, and hopefully most of the features of the pre-amp I just replaced. Then there is the issue of control integration, all these different brand components would not talk to each other. We have always had to consider these issues when planning an update to our systems, but there had to be a better solution. And now that digital audio processing, computer controls and display technology are at affordable levels, we can contemplate a system based on these technologies.

## Description of Audio Bus

Purpose: Design an audio signal processing and control system that would accommodate flexible configuring, add-ons, upgrades and future system features. A global extensible user interface that provides a vendor independent means of controlling the overall system, yet maintains sufficient individuality for vendor/feature differentiation.

These goals are met thru the use of a simple, yet powerful concept of a standard communication structure that allows multiple signal data paths, a logical control definition and software defined parameters. The implementation, as I have conceptualized it, starts with the basic hardware platform for the system. This is a module cage that allows for a given number of system modules to be installed. A "Module" is defined as a circuit that accepts an input, processes it in some fashion and generates an output signal. The inputs and outputs can be either from outside the system, or from / to the internal signal bus. These modules interconnect via what is really the heart of the system, the AudioBus. This is a multi line electrical connection that carries musical data signals, system control/data signals and power lines. The signal lines all carry digital signal data only, this system has no internal analog signaling, all analog inputs must be converted to digital before being put on the bus. This bus provides the pathway for signal exchange, but an important ingredient is the means of controlling who exchanges signals with whom. This is accomplished by the interface definitions imposed on all the modules and the fact that a "Master Module" exists. This Master Module is the "Control Panel" equivalent of today's equipment. It provides not only the interface between the user and the system, but also performs all internal signal direction. The functions of the Master module are as follows:

Upon power up, interrogate the bus for presence of other modules, accept answers from lowest ID number first. When a module responds, the data it sends are the resources for the module that tell the Master how to depict, setup and control that particular module.

Once all resources for all modules in the system have been acquired, the main task of the master is to interact with the user. This essentially means performing the commands in the resources, in response to user input. This is accomplished by a touch sensitive screen upon which pictorial representations of controls and data are displayed, and when the user touches the screen region where a picture of a control resides, this control will change based on that motion (either on/off if a button or higher/lower if a slider).

Another important feature of the control module, is that of remembering setups and sequences of commands for later recall. This permits fast and flexible system configuration changes without having to issue long strings (or executing multiple steps) of commands.

All other modules are broken into the following four groups:

- Signal generating modules
- Signal processing modules
- Input processing/interface modules
- Output processing/interface modules

Lets examine types and features of modules from each group, starting with Input modules. These accept audio signals from outside the AudioBus system. These may be analog or digital. If analog, they must be converted to the digital format of the AudioBus, which conforms to the AES/EBU Digital Audio Format. If digital, and not of the correct data format, they must be converted to the internal standard format. The main functions of an input module are routing a given input signal to the audio bus line indicated by the user.

Output modules take the signals off the bus, as indicated by the user, and either convert them to analog, or present them in digital format for use by outside devices such as a DAT. It is in these modules that signal level control is achieved.

Signal generating modules are devices such as a tuner, which after responding to the commands for setup, present a signal on the indicated line of the AudioBus.

Signal processing modules take an input from the AudioBus, perform some form of processing on it (such as equalization), and present the output on a AudioBus line. The variations on type and amount of processing are indicated by the user, as are the input and output lines to be used.

All modules have the following in common:

- No module may output to a signal line that is already being used for output.
- All modules may accept input from any signal line.

Most modules will be based on two important technologies emerging today, DSP chips and low cost processors. This translates into meaning

that most functions will be driven by software algorithms rather than by fixed logic hardware, as in current Hi-Fi equipment.

This software driven system design permits further flexibility in regards to updating the way a given module works, a vendor could ship a diskette with a new version of software to increase the module's features or performance.

Now that the concept of what modules are, and an overview of what they are capable of has been described, lets examine the AudioBus itself in a little more detail. As those of you whom are familiar with computer design know, a bus is nothing more than a group of specifications for an interconnection scheme between two or more circuits that need to exchange information and receive power. There are two main components to a bus specification, one is the electrical and physical specification, how many lines, what voltages are present on each one, the physical type and dimension of the interconnects, and other such hardware specs. The other component is the logical one, this states what format the information to be transmitted will have, timing information, and how the various circuits will interact with each other. On the hardware side I will only touch on the necessary highlights, which are:

- 48 independent audio lines
- A master clock signal
- 3 lines for inter module communication
- DC voltages for all modules : -5 V, +5 V, -12 V, +12 V
- A slot ID indication provided by connector on bus back plane

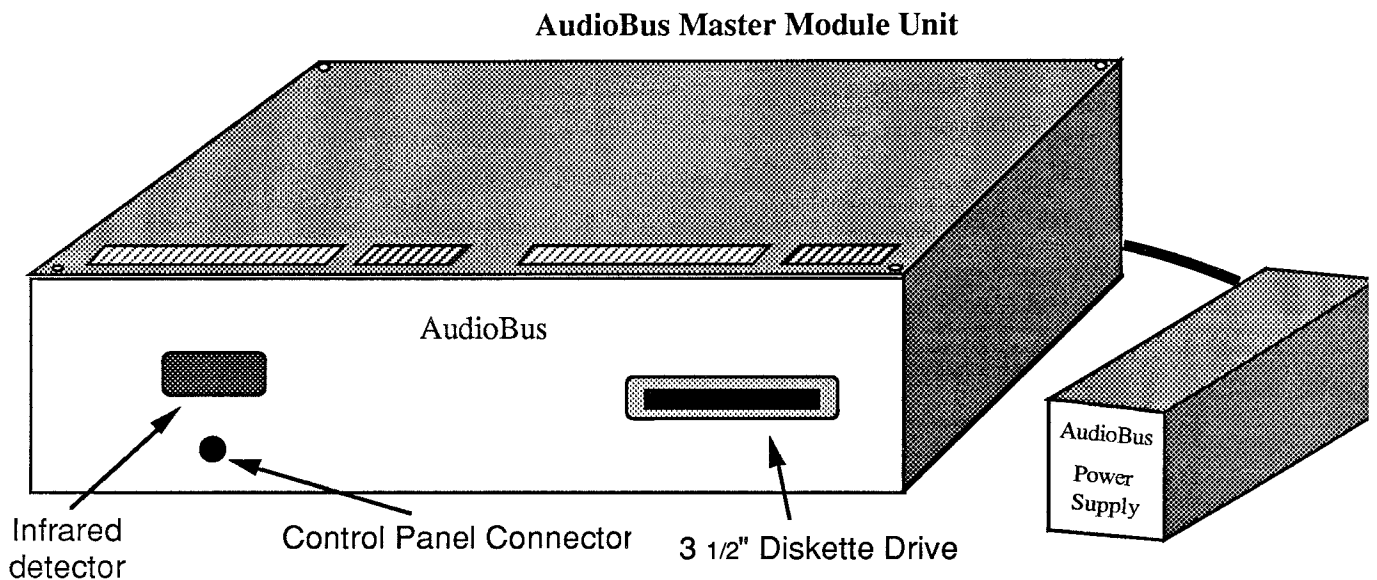
The logical definition highlights are:

- All audio lines are digital audio data transmitted with 16 bit resolution at a 44.1 KHZ sampling rate (AES / EBU Digital Audio format )
- Communication with Master Module (or other cards) accomplished thru three line data communications link. Master module polls individual modules for input.

Following is the AudioBus implementation design I have invented, it involves a modular approach to system integration. It has three basic building blocks:

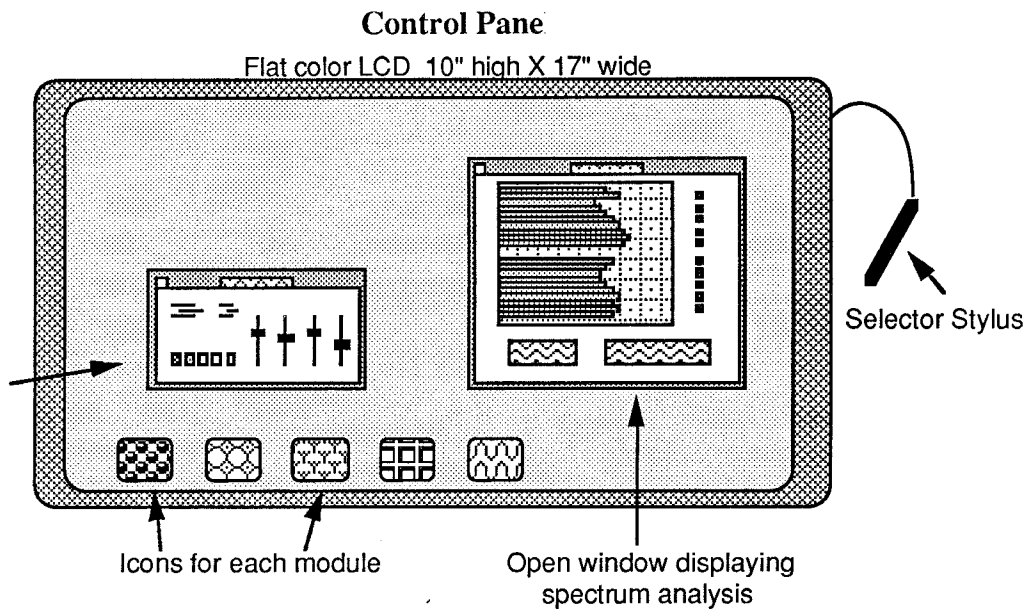
**- The base or control unit module.**

This contains the main control processor and various support pieces such as the diskette drive for loading new software for either the master or any of the other modules. It provides both the connector for the control panel and the infrared detector, for using either the panel or a small hand held remote. It also includes the power supply (external), including battery backup for brownouts or losses of power lasting less than one second. The connectors on the top couple with the connectors on an Expansion Module Unit. The right side connectors are for terminating the bus signals.



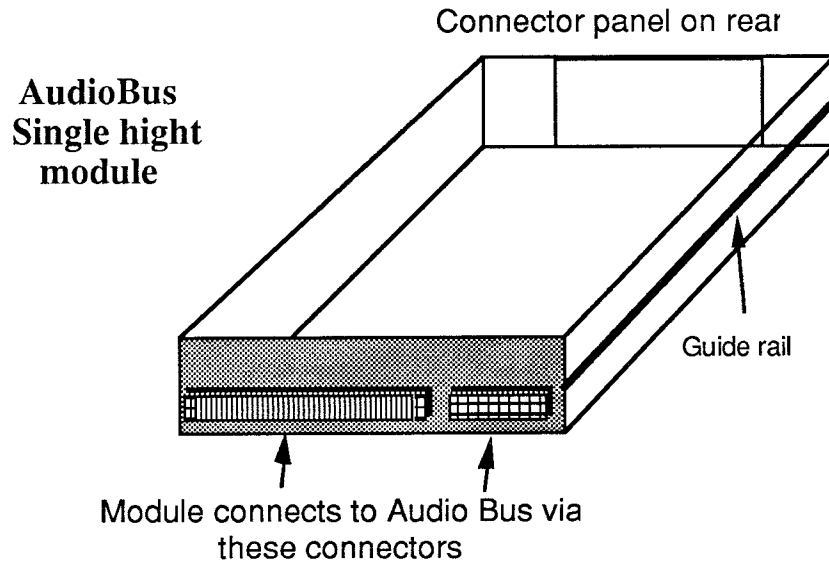
**- The Control Panel.**

The control system used with the AudioBus could be any type of system that provided a display capability of sufficient area and resolution. Along with some form of selection indication, a regular CRT would do, but in this design the ideal controller would be a flat panel that could be placed anywhere the user desires. This flexibility of placement means that we can now control and get feedback out of the system from our listening position. The controller pictured here features a one inch thick flat panel display with an attached selector stylus. This stylus is used to pick which module will be worked with. When the window containing that module's controls pops up, the stylus is used to change the settings. The user interface for interacting with the control module is very much like that of using an Apple Macintosh computer application.



**- The Generic module.**

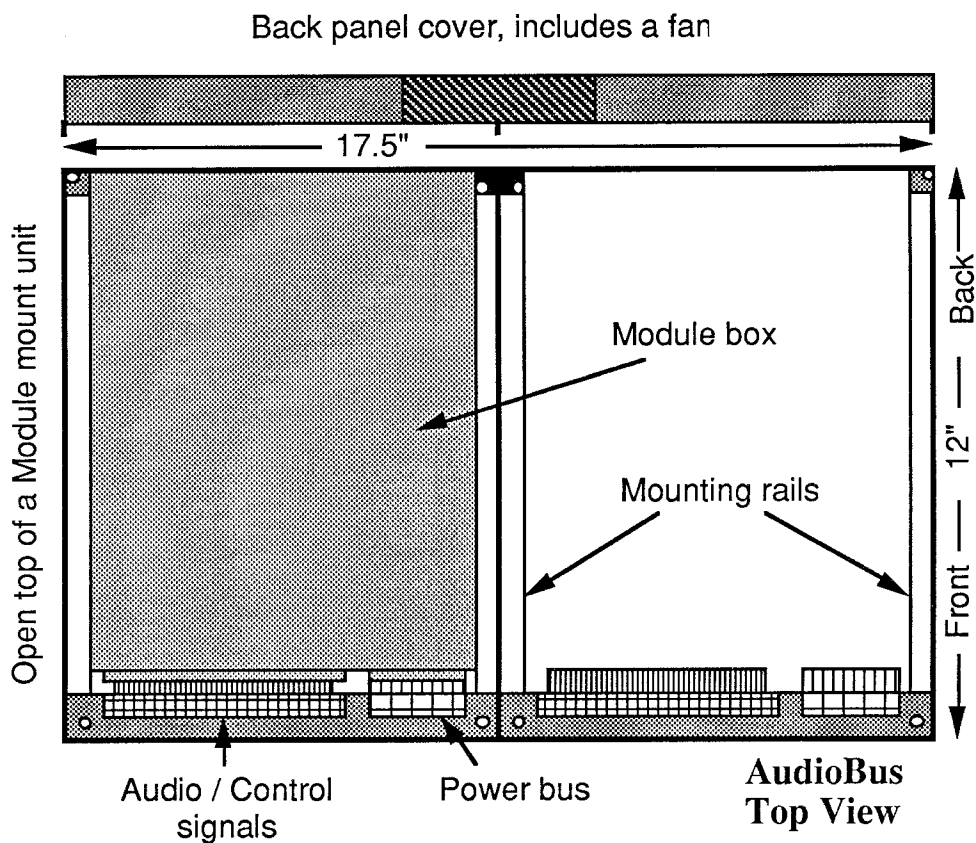
This would be the basic configuration for any input, output or signal processing type module. It is a one unit high module that mounts inside an expansion module mount unit.



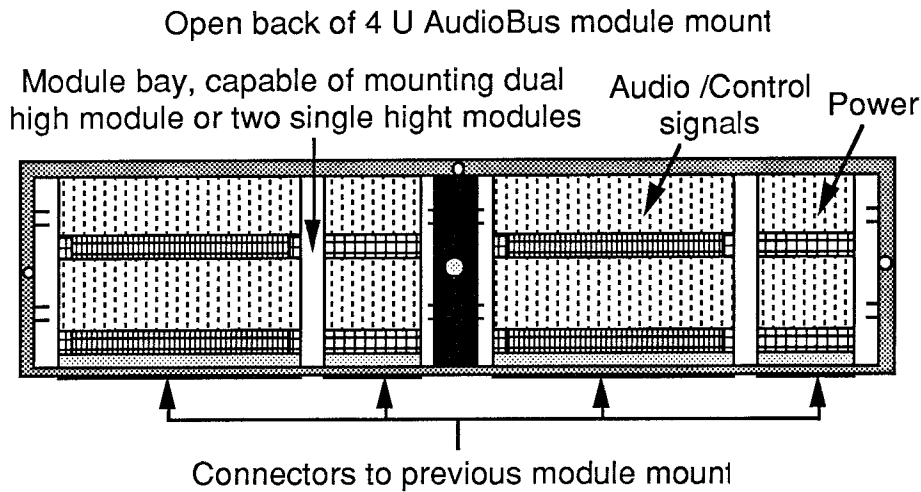
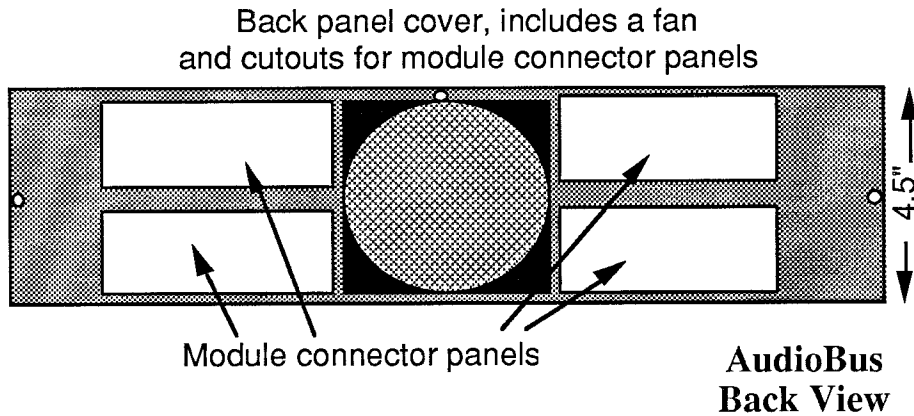
**- The Expansion module mount unit.**

This provides room to mount up to four single high modules. It connects to the control module via its bus extension connectors on the bottom, and provides another set of extension connectors on top, for either the terminating top or another expansion module. Therefore allowing multiple module mounting units to be cascaded together.

Here is the Top inside view of an Expansion module mount unit:



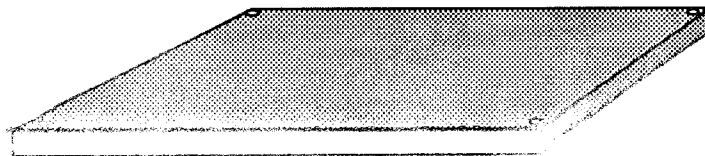
Here is the back inside view of an Expansion module mount unit:



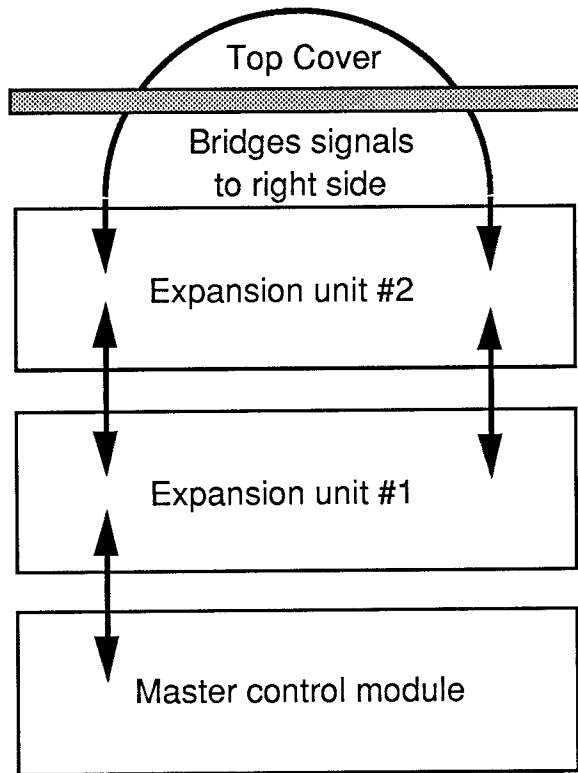
**- Top connector.**

This final piece of the module system provides the means by which the module mounting units and the control module are all held together. It also provides another very crucial service, it bridges the audio, control and power lines from the left side of the units over to right hand side. Since the Audio Bus has a linear bus topology, it does not care where in the chain a particular module is.

**AudioBus Top Cove**



Here is how the various modules and the top piece fit together:



The overall benefits from a system such as this, is first a means of integrating feature modules from various manufacturers with a common interface and control structure. Second, that of providing easy enhancement and upgrade paths. All of this is best demonstrated by depicting several configuration scenarios.

### **Basic System**

Starting with a four module AudioBus mounting cabinet and power supply, we include a Master Module with a CRT interface and small hand held remote control. Next, we add a Multi-Input Module, this allows the system to accept signals from four analog stereo sources and one digital source. Then, to complete a real basic set-up, we add an output module. This particular one would have two stereo analog outputs. This would equate to a basic pre amp system available today, with signal selection and volume, balance adjustments on the outgoing signal.

### **Basic enhanced**

By adding a tone manipulation module, such as a multiband parametric equalizer, we can further control the outgoing sound. It should be pointed

out that the output of the equalizer module may be routed to one or both of the stereo lines of the output module, thus allowing things like recording an equalized signal while listening to same.

### **"Receiver" system**

Again, by adding a tuner module, we convert the system into something akin to today's most popular audio component. But unlike today's receivers, we can move into the areas described below without having to worry about a host of problems and limitations.

### **Advanced systems**

In an advanced application, we could add features such as digital delay processors, Bass expanders, surround sound decoders. These just plug in and are now part of the system, requiring only that the user indicate where in the signal path to insert it, or on which AudioBus signal line to present its output.

### **Integrated systems**

Unlike current integrated systems, what this involves is a piece of audio generating gear, such as a CD player, whose mechanical components remain in an outside housing. But whose control and signal processing components are configured into an AudioBus module. This permits the user to control all features of the device utilizing the same controller as for the rest of the system. This could apply to things such as VideoDisk players, Digital Audio Tape decks, Stereo TV sound decoders and even to things which do not generate sound. This last one would be something like a light display controller that works off the AudioBus internal signals to create interesting light patterns that truly follow the music.

One could also envision the use of an AudioBus as the backbone of an complete home control system, where the control of lights, sound distribution and video routing was all controlled from the flat display panel controller of the AudioBus.