AMBISONICS

Audio + Design Multi-Speaker Auditorium Decoders

The Audio + Design Auditorium decoders comprise a range of professional multi-loudspeaker Ambisonic decoders for the replay of Ambisonically encoded horizontal surround-sound.

THE AMBI-SERIES DECODERS

All the decoders in the range feature the same common input and are distinguished by the number of line level outputs. Each Auditorium decoder must be connected to the auxiliary output (9-pin D-type) found on the back of all Audio Design Ambisonic Decoders. The four loudspeaker outputs on the Ambisonic decoder should not be used in conjunction with the Auditorium decoder's outputs except in special circumstances (consult Audio Design).

MULTI-WAY AUDITORIUM DECODERS IN-USE

For the Auditorium decoders to function correctly, the loudspeaker aspect ratio control ('layout') must be set to square (i.e 1:1) on the preceding Ambisonic decoder. The feed to the Auditorium decoder is produced after the internal 'Shelf Filters' of the Ambisonic decoder. Each of the output components (termed W'', X'' and Y'') are different from the normal B-format signals W, X and Y. Direct connection of the Auditorium decoder to a B-format source should not be done. When using an Auditorium decoder, the front sector phasiness control ('forward preference') on the Ambisonic decoder is bypassed.

Each Auditorium decoder features a 'Rotated Output' to allow cascading of further decoders. For example, a 5-way Auditorium decoder generates a loudspeaker angular separation of 72°. The Rotated Output from this decoder produces an offset of 36° to feed the input of a second 5-way Auditorium decoder. The overall result is a matrix of 10 loudspeakers each with an angular separation of 36°. By employing the cascading technique, cost effective matrices from 5 to as many loudspeakers as required may be easily realised.

Auxiliary line inputs may be provided for each of the line level outputs. Each input is mixed internally with its respective output to provide for spot effects or cascading with other surround-sound decoders.

Comparisons may still be made with 2-channel (Consumer format) UHJ, 3-channel UHJ and also with the original B-format (studio format) where appropriate. To allow comparison between mono, stereo and surround the primary audio should be routed to an Audio Design UHJ Encoder/Decoder package followed by an n-channel Auditorium decoder. Two primary paths are required. A Direct feed to the Auditorium decoder's auxiliary inputs for Left, Centre (if present) and Right and another feed to the UHJ encoder. Both feeds should not be used at the same time and must be alternately switched using the logic control I/O on the Ambisonic decoder.

Switching between the direct feed and the B-Format/UHJ equivalent will highlight the differences and possibilities of multi-speaker surround sound decoding. No logic or 'steering' control lines are used to position the audio signals on decoding. All positional information is contained within the phase and amplitude relationship of the B'' signal.

The acoustics of a room or auditorium also determine how well stereo or other similarly produced effects are perceived. By using 4 or more loudspeakers greater realism can be achieved by ameliorating room effects.

AMBI-5 AUDITORIUM DECODER

The Ambi-5 produces five loudspeaker feeds arranged as a regular pentagon with loudspeaker spacing of 72°. The rotated output gives a clockwise rotation of 36°. Cascading two Ambi-5's will generate a 10 loudspeaker matrix of 36° angular separation.

AMBI-8 AUDITORIUM DECODER

The Ambi-8 produces eight line level loudspeaker feeds arranged as a regular octagon with loudspeaker spacing of 45°. The rotated output gives a clockwise rotation of 22.5°. Cascading two Ambi-8's will generate a 16 loudspeaker matrix of 22.5° angular separation.

The number of loudspeakers required is determined by many factors. These include amongst others - size and shape of venue and for even distribution, loudspeaker dispersion angles. Not all situations will require 4,5,8,10 or 16 loudspeakers, therefore 'hybrids' are available.

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APPLICATIONS

Movie Theatre Sound Systems

Auditorium decoders may be used to enhance existing cinema playback formats and could become a three dimensional record and replay process. Ideally suited to Imax and Omnimax theatres.

Discotheques

Auditorium decoders permit an even spread of sound energy around the dance floor while still maintaining directional detail.

Theatres & Concert Halls

Auditorium decoders may be used for special effect, act as public address and relieve "Hot Spot" acoustical problems.

Planetariums

Auditorium decoders can regenerate a three-dimensional soundstage to match the visual presentation.

Audio/Visual & Trade Launches

Auditorium decoders offer greater freedom to the creative producer with wider audience coverage.

Consult Audio Design for further details on the Ambisonic Mastering Package, Auditorium decoders and various installation options.

AUDIO DESIGN

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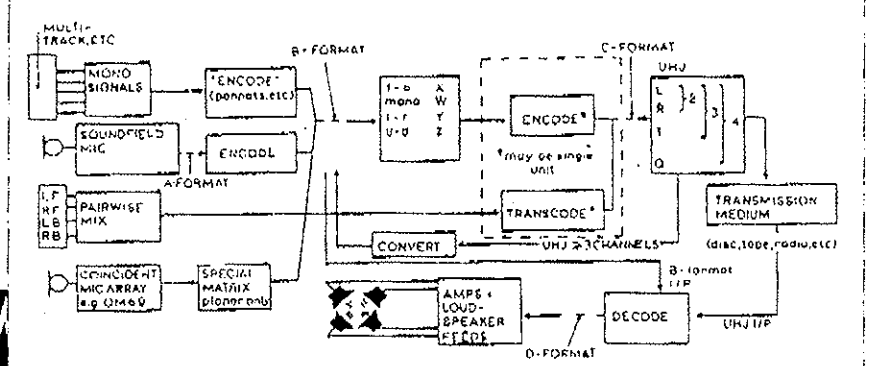
The Ambisonic Mastering Package

It was soon clear that only having a microphone capable of producing the encoded signal, very much restricted the system's production possibilities. Audio Design were commissioned to produce professional encoding and decoding equipment for multitrack use.

Audio Design Pan-Rotate System
The Pan-Rotate system is reasonably self explanatory. Eight mono inputs each have a 360 degree pan-pot on the front panel. →

The Ambisonic signal path and conversion possibilities



Ambisonics

Ambisonic Surround Sound was developed in the mid-seventies under the auspices of the (then) government backed, National Research and Development Corporation.

It has a comprehensive hierarchy of professional and consummer encoding and decoding formats.

The consumer formats were developed in conjunction with the BBC and the IBA and are known as UHJ surround encoded signals and can exist as 4, 3 (2.5) and 2 channel formats – all downwards compatible to stereo and mono.

It is important to understand that the number of channels is not connected to the number of speakers used for reproducing surround sound.

In Ambisonics, a mimimum of four speakers are used, with a three or two channel encoded signal source. For larger commercial presentations special decoders are available that provide many more discrete speaker feeds.
The professional format is known as B-format. It can exist in a 4 channel form (periphonic, having height information), or 3-channel (horizontal surround).
The B-format is the studio working standard and will be Transcoded into UHJ onto a distribution master, prior to transmission or release in a consumer format. B-format can also be used for commercial presentations where sufficient tracks are available and stereo compatability is not an issue.

The microphone used for recording in B-format is the AMS-Calrec Surround Sound microphone, containing four capsules. The capsule feeds are known as A-format and from these are derived four audio components:

X = front-back gradient (figure of 8);
W = pressure (omni component);
Y = left right side facing gradient;
Z = up-down gradient (vertical height component).

Having created a B-format master, it is theoretically possible to transcode this into other surround formats. It is highly likely that B-format will become the studio mastering form for all surround sound work

Ambisonic Decoding

Audio Design Reference Decoder

The Decoder manufactured by Audio Design is used as the reference decoder by the Ambisonic patent holders Nimbus Records Ltd. It is made using very close tolerance selected components to ensure the very highest standards of decoded reproduction when mastering Ambisonic encoded programme material.

Front panel mode switches allow comparison of UHJ 2-channel decoding, 3-channel decoding and also comparison with the original B-format mastering format. Switching the decoder out of circuit restores undecoded stereo to the front speakers to enable compatibility to be checked.

The system has a normal output of four loudspeaker feeds for conventional four speaker, close quarter monitoring. However an auxilary ouptut provides feeds and DC to the commercial multi-speaker decoders of the Ambi-5 and Ambi-8 range.

The standard decoder has an aspect ratio control for varying the arrangement of the four speaker array, from square to elongated 2:1 or 1:2 aspect.

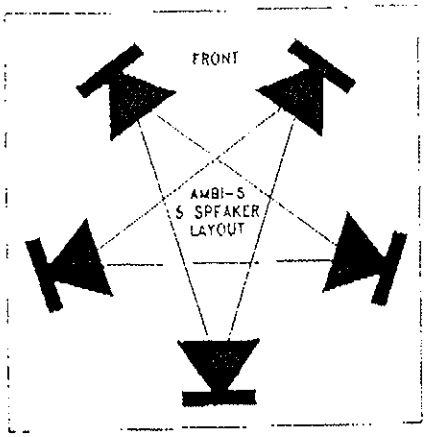
When the unit is powered down, the bypass mode is automatically entered, thus leaving normal stereo monitoring undisturbed in the control room.

Multi-Speaker Auditorium Decoders for

- **Theatres and Concert Halls**
- **Planetaria and Discotheques**
- **Movie Theatres**
- **Commercial Audio/Visual Launches**

When more than four speakers are used, they can be decoded using the Ambi-range of ancillary decoder modules. They are connected to the 9-pin auxiliary output of the Reference Decoder. In this mode the four speaker outputs of the standard decoder should not be used in the large array (though they could be fed elsewhere to a monitoring control room).

Each Auditorium Ambi- decoder module has a cascaded rotated output which allows a further module of the same type to be added.



The Ambi-5 Decoder: The Ambi-5 set in five pointed star array, was very successfully used by the Cure on their USA tour, using five massive sound reinforcement arrays. This layout has the advantage of offering a natural stereo pair to the front of the system. The decoder generates five balanced line level feeds with a loudspeaker angle separation of 72 degrees. Its rotated output produces an offset of 36 degrees. Cascading two Ambi-5s will create a 10-speaker matrix at 36 degree intervals.

The Ambi-8 Decoder: This produces eight balanced line loudspeaker feeds arranged in a regular octagon with speaker spacing of 45 degrees.

For optimum results, speakers must be setup equidistant on the circumference of a circle; or the feeds so delayed so as to allow for variations out of a true circle. It is important that speakers should be of the same type and ideally be of dual concentric construction, especially if fairly close to the audience.

In a large environment it has been found that speakers should be placed around ten feet high on the sides, so as to be above the heads of listeners closest to them. It is possible to crossover to bass bins, say below 100Hz, using the W omni-directional signal as the feed for this purpose.

The Programmable Ambisonic Decoder

The Programmable Decoder was designed by Dave Malham of the University of York's Music Technology Group. It is the first of a new generation of fully programmable speaker decoders for Ambisonic and other psychoacoustically correct multi-speaker stereo and surround sound systems.

The basic unit accepts a three, or four channel B-format signal and under computer control, routes a calculated combination of signals to each of eight pairs of speakers. The unit is fully expandable, in steps of eight speakers, upto a maximum of 64 pairs.
The loudspeakers can be arranged to give horizontal surround sound only (using a three channel B-format input); or with a suitably disposed array, will give full 3-D surround sound periphonic reproduction (with height information) from the fourth B-format channel.
Any array meeting the basic criterea for good Ambisonic reproduction can be handled, giving much greater freedom in speaker positioning than current decoders.

Since the coefficients are set in software, not hardware, future developments in decoder theory will be much more easily implemented than with previous generations of systems. The control elements are digitally implemented, but the signal paths are fully analogue so that the frequency response and dynamic range of the original signal is fully maintained. The coefficients are set to an accuracy of one part in 256 with the actual calculations being carried to a far higher accuracy.

The software runs on either an Atari ST or an IBM compatible PC machine and control is via an RS232 serial link. Coefficients can be stored in internal battery backed RAM so the computer can be disconnected once optimum settings are determined. Further software developments will allow modifications of the basic decoder equations so that anomalies caused by room acoustics can be accommodated.