Ambisonics and the ATK toolkit for Reaper for multichannel playback.

This page contains links to sources containing information about Ambisonics, the Ambisonics Toolkit, and several tutorials on how to use the plugins in conjunction with soft and hardware.

https://www.youtube.com/embed/51dUnndYwo4?t=6s

Ambisonics

Ambisonics is a full-sphere surround sound technique used for recording, mixing, and reproducing three-dimensional audio. Unlike traditional stereo or surround sound systems, which typically only cover a horizontal plane (like 5.1 or 7.1 setups), ambisonics captures sound from all directions: above, below, and around the listener.

Here’s how it works:

1. **Sound Field Representation:**

- Ambisonics represents a sound field mathematically, using what’s called a "B-format" signal. This is a multi-channel signal that describes the sound from different directions using spherical harmonics. Typically, in the first-order ambisonics (the most basic level), there are four channels:
  - **W (omnidirectional)**: captures sound pressure equally from all directions.
  - **X (front-back)**: represents the front-back axis.
  - **Y (left-right)**: captures the left-right axis.
  - **Z (up-down)**: represents the vertical axis.
- Higher-order ambisonics (HOA) extend this by adding more channels to capture finer directional details.

2. **Recording Ambisonics:**

- Ambisonic microphones (like the Soundfield microphone) capture sound using multiple capsules arranged in a tetrahedral pattern. These recordings are processed into the B-format, which encodes the 3D sound field.

3. **Playback:**

- To reproduce ambisonic audio, the B-format signal is decoded for playback on various speaker setups, or binaurally for headphones. The decoder can adjust the signal based on the listener's position or speaker arrangement to ensure an immersive sound experience.
- In virtual reality (VR) and 360° video, ambisonics is particularly useful because it allows for real-time head-tracking, so the sound perspective changes as you move your head, maintaining spatial accuracy.

4. **Applications:**

- **Virtual Reality (VR)**: Ambisonics is widely used in VR and 360° video to create immersive soundscapes.
- **Game Audio**: It allows sound to move dynamically within 3D game environments.
- **Cinema and Music**: Some modern music and films experiment with ambisonic mixes to provide an enveloping sound experience.

In summary, ambisonics is an advanced sound format that enables full 3D audio immersion by capturing and reproducing sound from all directions, offering a much richer and spatially accurate audio experience compared to traditional surround sound methods.

Hardware setup

A typical ambisonics hardware setup includes:

1. **Ambisonic Microphone**: A microphone with multiple capsules arranged in a tetrahedral or other pattern (e.g., Sennheiser AMBEO, Zoom H3-VR) to capture sound in all directions.
2. **Audio Interface**: A multi-channel interface to record the signals from the microphone capsules, converting them into digital B-format signals.
3. **Computer with DAW**: A digital audio workstation (DAW) with ambisonics plugins (e.g., IEM Plugin Suite, SPARTA) to process, encode, and decode the B-format audio for playback or mixing.
4. **Monitoring System**: For playback, either a multi-speaker setup (for full 3D sound reproduction) or binaural headphones for VR/360 applications.

Speaker setup

Here are a few common multi-speaker configurations used in ambisonics for 3D sound reproduction:

1. **Quadraphonic Setup (4 speakers)**: Four speakers are placed at the corners of a square or rectangle around the listener (two in front, two behind), offering a basic but immersive spatial sound experience, laying the groundwork for more complex surround systems.
2. **Cube Configuration (8 speakers)**: Speakers are placed at the corners of a cube, with four on the ground and four at elevated positions to cover all axes (left-right, front-back, up-down).
3. **Dodecahedron Configuration (12 speakers)**: Speakers arranged in a dodecahedron shape (12 equally spaced vertices) to capture more detailed directional sound.
4. **3D Hemisphere (16+ speakers)**: Speakers are arranged in a half-sphere around the listener (above, in front, behind, and around) for immersive sound, often used in dome environments.
5. **Icosahedron Configuration (20 speakers)**: Evenly spaced speakers form a spherical shape for highly detailed spatial sound representation, often in higher-order ambisonics.
6. **Spherical Array (32+ speakers)**: A full 360° sphere of speakers, providing the most detailed and immersive sound experience for advanced higher-order ambisonics setups.

8 speaker setup configurations:

There are several different **8-speaker setups** used for immersive audio experiences, especially in ambisonics, spatial audio, and surround sound configurations. Here are a few common types:

1. Cube Configuration (3D)

- **Placement**: Speakers are arranged at the eight corners of a cube around the listener. Four are positioned at ground level and four at elevated positions above.
- **Purpose**: Provides full 3D sound coverage, capturing sound from above, below, and around the listener.
- **Application**: Common in ambisonics for full-sphere audio experiences.

2. Octagonal Setup (2D)

- **Placement**: Speakers are placed in a circle around the listener, at equal angular distances (every 45°), forming an octagon.
- **Purpose**: Primarily used for 2D spatial sound with good horizontal imaging but no vertical depth.
- **Application**: Useful for ambisonic sound in settings where horizontal localization is the focus, such as concert halls or theaters.

3. 7.1 Surround Sound Configuration

- **Placement**: Six speakers around the listener in a horizontal plane (left, right, center, left surround, right surround, rear center) with a subwoofer for low-frequency effects (LFE).
- **Purpose**: Widely used in home theaters and cinemas for a high-quality surround sound experience.
- **Application**: Cinema, home entertainment, and gaming.

4. Double Quadraphonic Setup (Vertical and Horizontal Planes)

- **Placement**: Four speakers at ear level in a traditional quadraphonic square around the listener, with four more speakers above in a mirrored square formation.
- **Purpose**: Adds vertical sound information while keeping horizontal spatial accuracy.
- **Application**: Often used in ambisonics and 3D audio production for more immersive sound.

5. **Dual Layer Circle (Upper and Lower Rings)**

- **Placement**: Four speakers in a horizontal circle at ear level and four additional speakers in an elevated horizontal circle above the listener.
- **Purpose**: Creates a "dual ring" spatial arrangement for both horizontal and some vertical coverage.
- **Application**: Common in dome environments, VR, or immersive installations.

6. **Surround Sound with Height Speakers (5.1 + Height)**

- **Placement**: A standard 5.1 surround system (left, right, center, rear left, rear right, and subwoofer) with two additional height speakers positioned above the listener.
- **Purpose**: Adds vertical audio dimension to traditional surround sound, giving a 3D feel.
- **Application**: Used in home theaters with formats like Dolby Atmos or DTS.

7. **Horizontal Circle (Octagonal Layout)**

- **Placement**: The 8 speakers are evenly distributed in a 360° horizontal circle around the listener. Each speaker is positioned at equal angular intervals (every 45°) around the listener at ear level.
  - Front (0°)
  - Front-right (45°)
  - Right (90°)
  - Back-right (135°)
  - Back (180°)
  - Back-left (225°)
  - Left (270°)
  - Front-left (315°)
- **Purpose**: This setup provides full 360° horizontal sound imaging, allowing sound to move smoothly and precisely around the listener on a single plane, especially in cases where vertical sound (up/down) isn’t a priority. If vertical immersion is required, the setup can be enhanced with additional speakers above or below the listener, turning it into a more complex 3D configuration.
- **Application**: Often used in ambisonics and 360° audio experiences, like virtual reality (VR), concerts, or sound installations, where immersive horizontal sound movement is key.

Ambisonic toolkit

Via the following link you can find the download for the ATK toolkit for Reaper, and tutorials. There is a short explanation

Introduction

The Ambisonic Toolkit Workflow

ATK separates the task of production work with Ambisonics into three distinct elements.

alt text

The Ambisonic Toolkit paradigmatic workflow.

Author
: Capture or synthesise an Ambisonic soundfield.

Image
: Spatially filter an Ambisonic soundfield.

Monitor
: Playback or render an Ambisonic soundfield.

In its most simple form, Ambisonics can be regarded as splitting the panning law into two separate parts: encoding (Authoring) and decoding (Monitoring), where final panning (decoding) is deferred to an actual loudspeaker array at the time of audition. The ATK considers the Imaging (transforming) of a soundfield to be a critical step; this is where the artist shapes and processes the soundfield in a coherent way which isn't easily available via the other models for working with spatial sound.

Many publicly distributed implementations of Ambisonics provide only encoding and decoding. While giving flexibility regarding final playback, failing to include transformers misses out the concept of imaging and fails to capitalise on the advantages of the sound-field sound-image paradigm intrinsic to Ambisonics.

What's the difference?

The real power in working with Ambisonic over other multichannel surround sound techniques is that rather than being restricted to a sound-scene based paradigm (where the artist is presented

with tools designed to build up a ‘sound scene’) Ambisonics supports a soundfield-kernel model. Here we construct a soundfield in the abstract, and can then shape it as desired. The result may be shaped into a ‘sound scene’, or perceived this way – but a soundfield-kernel approach gives much greater flexibility, and directly supports the realisation of more abstract outcomes. We regard this model as idiomatic for Ambisonics.

Along with powerful soundfield transforms – the spatial filtering tools enabling soundfield-kernel reshaping – the ATK provides a comprehensive set of Ambisonic encoders (including pseudo-inverse) and decoders (5.1, binaural, UHJ, full-3D) allowing users to thoroughly leverage the power of the Ambisonic technique.

https://www.youtube.com/embed/fc5IXiR4KiQ?t=1189s

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