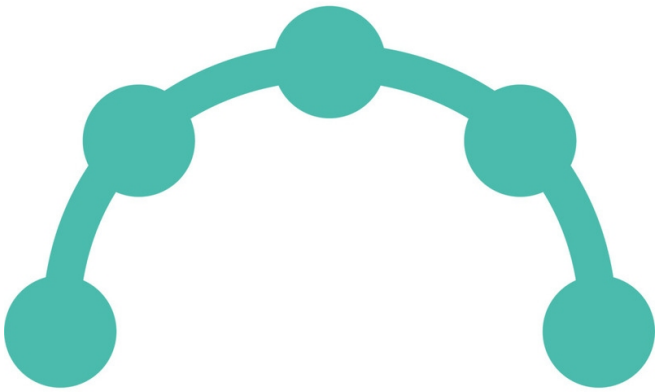


O7A Spatial Audio Plugins

v2.4.0

Table of Contents

1 Introduction

This plugin collection provides experimental decoders to convert O7A 3D audio scenes into audio designed for use with "Spatial Audio" systems like Dolby Atmos or Apple Spatial Audio. A number of Spatial Audio objects in fixed locations are used as virtual speakers. Depending on the plugin, 20, 24, 32 or 64 objects are used and are arranged in a dome configuration. Only the 64 object configuration is supported with AAX.

This library should be considered experimental and may be subject to significant change.

In general we recommend the use of O7A streams primary for research purposes, or in studios with high-end modern hardware. **The CPU load generated by the O7A plugins can be very high and may not be suitable for use on standard studio computer systems.** Third order (O3A) streams are an alternative. These carry enough spatial detail for most practical applications and present a much lighter processing load. Many O3A plugins run roughly four or sixteen times faster than their O7A equivalents.

1.1 Compatibility

O7A streams require audio busses with at least 64 channels, which (at the time of writing) most Digital Audio Workstations (DAWs) cannot handle. Some are limited at 2 channel stereo and many are limited at the 8 channels used for 7.1 surround mixes. **The O7A plugins *will not work correctly* with these DAWs**, which may even crash. In general, Reaper or Pro Tools Ultimate (version 2023.6 or later) are good options.

1.1.1 AAX

Only the 64 channel dome decoder is supported in Pro Tools, and Pro Tools Ultimate version 2023.6 (or later) is required.

1.1.2 VST2

The plugin library works as a "shell" plugin. This means that a number of individual audio plugin effects are provided by a single library file. Some VST2 hosts may have a slightly different way of managing these plugins to ordinary ones. For instance, in Max/MSP the vst~ plugin uses "subname" messages to specify the individual plugin within the library. At the time of writing, VST2 shell plugins are not supported in Nuendo or Cubase.

Most VST2-compatible DAWs (such as Reaper) have a plugin "path", which is a list of directories which will be searched for VST2 plugins. You may need to change this path to point at the location of the plugins, or move the plugins there. By default, these plugins are installed into `/Library/Audio/Plug-Ins/VST` on macOS. Various directories may be used on Windows, but `C:\Program Files\Steinberg\VST2` is not uncommon.

1.1.3 Buffering

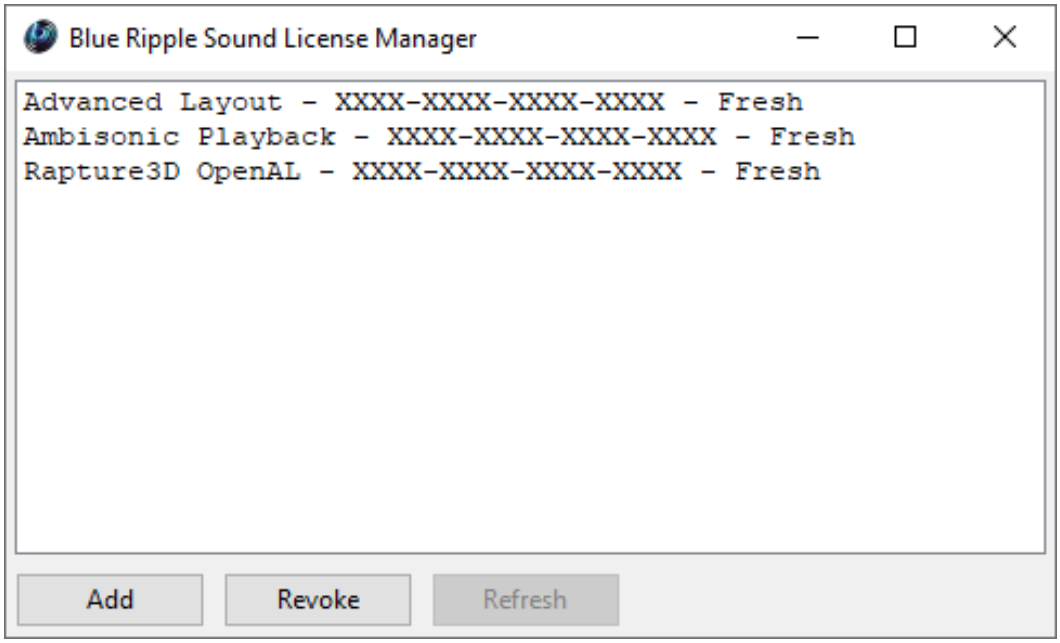
Some of the O7A plugins use internal buffering with a length of 128 samples. For smooth CPU load, you may wish to ensure your DAW buffer size is a multiple of this.

1.2 Getting Started

This documentation assumes you are familiar with Reaper or a similar DAW, and with the O7A Core library, which provides a number of essential tools for working with O7A streams. If you are not, you may wish to start with the documentation for the O7A Core.

1.3 The License Manager

The Blue Ripple Sound License Manager application can be used to move license keys around between computers.



The application is generally available in the Start Menu on Windows, and in your installation directory, which is typically:

- `C:\Program Files\Blue Ripple Sound\` on Windows, and
- `/Applications/Blue Ripple Sound/` on macOS.

License keys can be removed from a computer using the 'Revoke' button and added with 'Add'. If data is not 'Fresh' this probably indicates a network connectivity issue, in which case the 'Refresh' button may be used. Generally, licenses are refreshed automatically.

1.4 Technical Requirements

1.4.1 Operating System

Supported versions of Microsoft Windows are 10 or 11, 64bit Intel.

Supported versions of Apple macOS are 10.14 to 13.5, 64bit Intel or Apple Silicon.

1.4.2 VST Host

The VST plugins require a VST 2 host with shell plugin support.

These plugins do not work with all VST 2 hosts. One reason for this is that the O7A plugins need large numbers of channels on their input or output busses. Check the individual plugins for the channel counts they need, but all of the O7A plugins need at least 64 channels on each track. Also, at the time of writing VST 2 shell plugins are not supported in Nuendo or Cubase.

1.4.3 AAX Host

The AAX plugins require **Pro Tools Ultimate version 2023.6** or later.

Due to channel and stem restrictions, not all plugins are supported in AAX. Please see the plugin descriptions for details.

1.4.4 PC Hardware

Please check your PC meets the following requirements:

- Intel Core i7 CPU or better, or Apple Silicon.
- 400MB of free disk space.

1.4.5 Permissions

You'll need administrator permissions while installing on Windows. The software probably won't install properly using a "restricted" account.

1.4.6 Internet Connection Required

This software requires an Internet Connection for license activation and verification.

Successful license verification isn't required every time you use the software, but it is needed during installation and needs to succeed once every couple of weeks to keep the license fresh.

The license can be "revoked" to remove it from one machine so it can be moved on to another. You should also do this if you're updating your system in case the machine appears to have changed identity.

1.4.7 No Bitstream Encoding

Please note that these plugins produce audio suitable for use with Spatial Audio systems, but do not perform bitstream or metadata encoding directly.

2 The Domes

These plugins convert O7A 3D audio scenes into audio designed for use with "Spatial Audio" formats like Dolby Atmos or Apple Spatial Audio. A dome of 20, 24, 32 or 64 Spatial Audio objects is used to present the scene. Each of these objects should be placed at a particular fixed location, described below.

2.1 Coordinate Conventions

Tables are provided with the plugin documentation below which give the locations of the objects that make up each dome. The locations are expressed using three different, but equivalent, coordinate conventions. Hopefully one of them will match the system you are using. Please let us know if not.

2.1.1 Spatial Audio Coordinates between -1 and +1

This is a Spatial Audio convention where X is to the right, Y is forwards and Z is upwards. This is used in some Spatial Audio systems such as Logic's 3D object panner.

Please note that this is not the coordinate system generally used in mathematical, ambisonic or acoustic literature (X is forwards, Y is left, Z is up) or gaming (X is right, Y is up, Z is forwards or back).

The coordinates place the objects on the edge of a box-shaped "room", so locations are different distances from the listener. These plugins assume that the downstream Spatial Audio renderers do not modify levels based on these differences in distance, so only the direction is important. If you find Spatial Audio renderers where this is not the case, please let us know.

2.1.2 Spatial Audio Coordinates between -100 and +100

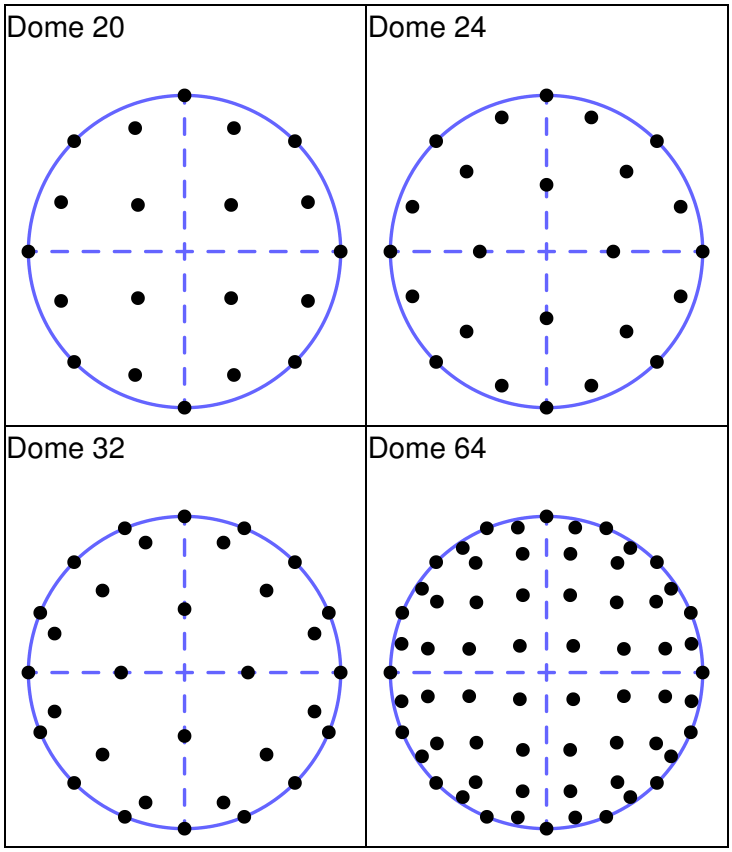
This is a very similar system, but the numbers are scaled by 100. It is used in Pro Tools.

2.1.3 Polar Coordinates

Here, the direction to each object is given using a horizontal azimuth and vertical elevation, in degrees. Azimuth is measured anticlockwise from the front, and elevation is measured upwards from the horizontal plane.

2.2 From Above

As the distance from the listener doesn't matter, the object positions can be drawn on the edge of a sphere. This gives a "dome" view of each of these layouts. From above, these domes appear as follows:



2.3 Decoding Methodology

The decoders in this library are not generated using the same methodology as decoders in the O7A Decoding library, which mostly assume playback will use real speakers in a physical acoustic.

Instead, this library assumes audio will be presented by a Spatial Audio system using virtual rather than real speakers, and signals will be combined by summation in hardware or software rather than acoustically in the air.

Decoders for domes of real speakers can be generated with Rapture3D Advanced.

3 Practical Considerations with Spatial Audio

3.1 Lower Sounds

The dome arrangements used here have channels only on the horizontal or above, because objects may not be placed below the horizontal in many Spatial Audio systems, which have their origin in cinema.

Audio in the lower half of the O7A scene is typically not lost during decoding however. Instead, it is moved up to the horizontal, or made spatially ambiguous if panned more directly downwards.

For some applications, you might want to reflect the lower half of the scene into the upper half with the O7A Fold plugin from the O7A Music plugin library before decoding with these plugins.

Rendering the lower half of the scene is typically supported well in 3D audio rendering systems capable of handling Higher Order Ambisonics directly, such as Rapture3D Universal. In these cases, better imaging can generally be achieved by rendering from ambisonics directly rather than via these domes, which are intended for use with Spatial Audio systems that cannot do this.

3.2 Reverb

These Spatial Audio systems may apply additional reverberation during rendering, on top of what is already present in the mix. Different systems apply this reverberation in different ways, and may or may not allow it to be configured or disabled. It is generally a good idea to monitor for each possible playback method.

3.3 Rendering Quirks

It may be tempting to compensate for a directional inconsistencies in timbre or level produced by a particular renderer. This is not recommended in general, particularly where audio may be played back on different renderers, now or in the future.

Even on the same renderer, if head tracking is used, improvements made for one head orientation may make the mix worse in other head orientations.

3.4 Object Counts and Beds

Currently, Spatial Audio systems typically allow up to 128 channels of audio. However, delivery "profiles" will reduce the number of channels actually delivered to devices for final bed and object playback. For instance, the "MPEG-H 3D Audio Baseline" profile supports up to 24 audio objects to the device. If you have more objects in your mix than the delivery profile can handle, it is likely that the excess will be pre-rendered into a speaker bed (typically 7.1.2) or otherwise be merged together.

We don't particularly recommend use of speaker beds rather than objects for Spatial Audio delivery, not least because the rendering angles can be quite inconsistent. For instance, Front Left and Right are typically rendered on headphones at +/-45 degrees rather than the normal +/-30 degrees recommended on speakers.

3.5 Which Plugin Should I Use?

At the time of writing, there is no immediate easy answer to this. It will depend on the number of objects that the Spatial Audio system will provide to playback devices without folding any of them

into beds or otherwise reducing their spatial separation. You may need to ask your distributors.

If you are targetting more than one delivery system, you can focus on getting your O7A master right, and then provide separate Spatial Audio mixes for each system, using separate decodes.

If it is not clear how your Spatial Audio will be distributed, the 20 channel dome here is hopefully not a bad option. It should allow Spatial Audio to be distributed well using the "MPEG-H 3D Audio Baseline" while still leaving a few channels spare for other needs.

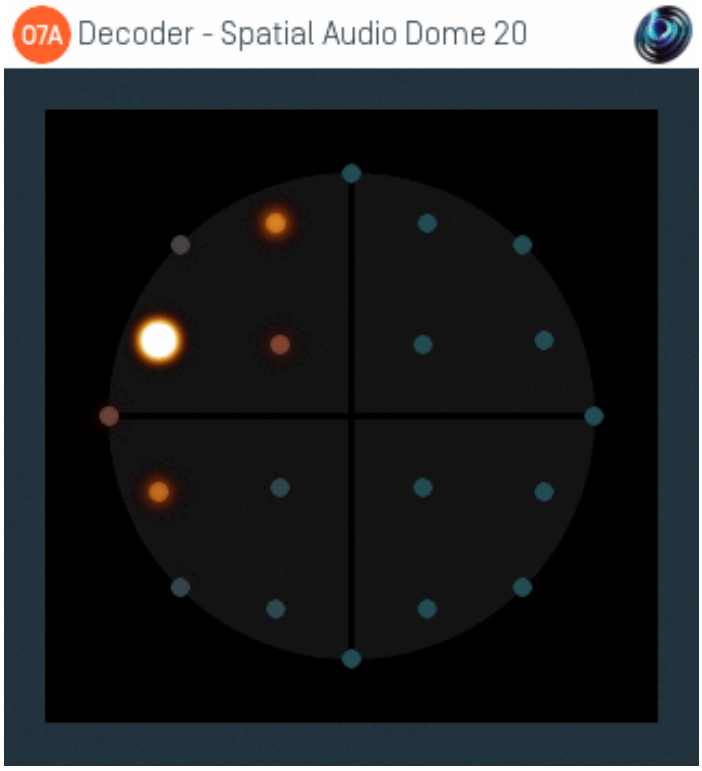
3.6 Getting Good Results

Whichever plugin you use, please be careful to:

- Ensure that all the dome channels are present as objects in the Spatial Audio mix, and that their gains are all equal.
- Ensure that the object locations are exactly as specified. Quite small errors can have a significant effect. You may wish to create template projects so you do not have to enter the numbers too often!
- Check that your distribution profile(s) have sufficient capacity to keep the objects distinct and in the correct locations.
- Check the results carefully on a variety of playback devices or systems before release.

4 Spatial Audio Dome Decoders

4.1 O7A Decoder - Spatial Audio Dome 20



4.1.1 Host Support

Host Type	Support
AAX	No
VST2	Yes

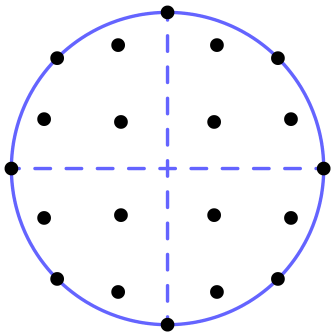
4.1.2 Audio

	Channels	Content
Input	64	O7A
Output	20	Feeds for 20 Spatial Audio Objects

4.1.3 Description

This plugin converts a 3D O7A mix into 20 channels of audio for use in a "Spatial Audio" mix.

4.1.4 Dome 20



This dome arrangement is designed for use with 20 objects. They need to be set to specific fixed locations:

4.1.4.1 Spatial Audio Coordinates between -1 and +1

Object	Left/Right (Sp. Audio X)	Back/Front (Sp. Audio Y)	Elevation (Sp. Audio Z)
1	0.000	+1.000	0.000
2	-0.400	+1.000	0.664
3	+0.400	+1.000	0.664
4	-1.000	+1.000	0.000
5	+1.000	+1.000	0.000
6	-1.000	+0.400	0.664
7	+1.000	+0.400	0.664
8	-0.329	+0.329	1.000
9	+0.329	+0.329	1.000
10	-1.000	0.000	0.000
11	+1.000	0.000	0.000
12	-0.329	-0.329	1.000
13	+0.329	-0.329	1.000
14	-1.000	-0.400	0.664
15	+1.000	-0.400	0.664
16	-1.000	-1.000	0.000
17	+1.000	-1.000	0.000
18	-0.400	-1.000	0.664
19	+0.400	-1.000	0.664
20	0.000	-1.000	0.000

4.1.4.2 Spatial Audio Coordinates between -100 and +100

Object	l/r	f/r	height
1	0	100	0
2	-40	100	66
3	40	100	66
4	-100	100	0
5	100	100	0
6	-100	40	66
7	100	40	66
8	-33	33	100
9	33	33	100

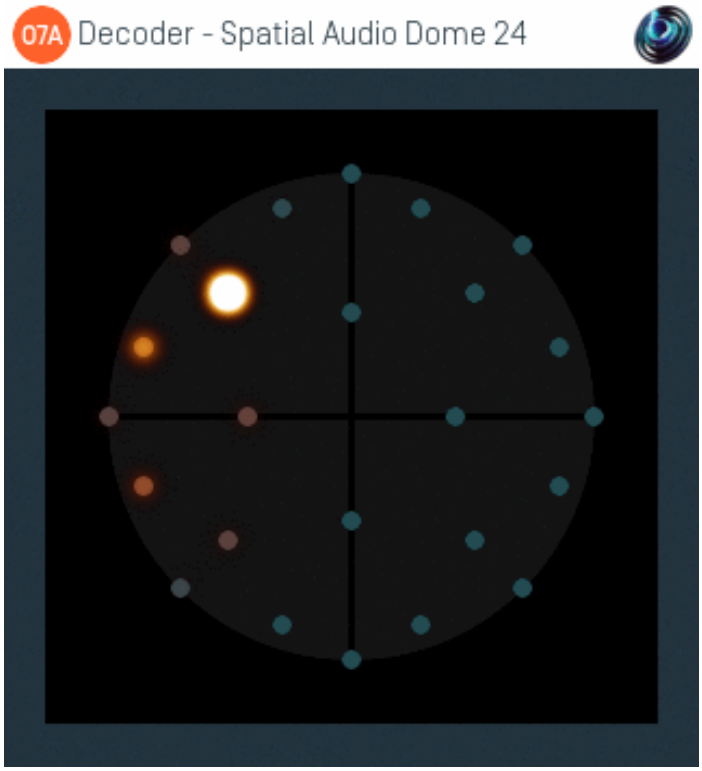
Object	l/r	f/r	height
10	-100	0	0
11	100	0	0
12	-33	-33	100
13	33	-33	100
14	-100	-40	66
15	100	-40	66
16	-100	-100	0
17	100	-100	0
18	-40	-100	66
19	40	-100	66
20	0	-100	0

4.1.4.3 Polar Coordinates

Object	Azimuth	Elevation
1	0.00	0.00
2	21.80	31.65
3	-21.80	31.65
4	45.00	0.00
5	-45.00	0.00
6	68.20	31.65
7	-68.20	31.65
8	45.00	65.05
9	-45.00	65.05
10	90.00	0.00
11	-90.00	0.00
12	135.00	65.05
13	-135.00	65.05
14	111.80	31.65
15	-111.80	31.65
16	135.00	0.00
17	-135.00	0.00
18	158.20	31.65
19	-158.20	31.65
20	180.00	0.00

In the table above, azimuth is measured anticlockwise (left) from the front.

4.2 O7A Decoder - Spatial Audio Dome 24



4.2.1 Host Support

Host Type	Support
AAX	No
VST2	Yes

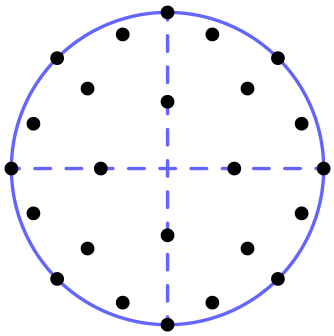
4.2.2 Audio

	Channels	Content
Input	64	O7A
Output	24	Feeds for 24 Spatial Audio Objects

4.2.3 Description

This plugin converts a 3D O7A mix into 24 channels of audio for use in a "Spatial Audio" mix.

4.2.4 Dome 24



This dome arrangement is designed for use with 24 objects. They need to be set to specific fixed locations:

4.2.4.1 Spatial Audio Coordinates between -1 and +1

Object	Left/Right (Sp. Audio X)	Back/Front (Sp. Audio Y)	Elevation (Sp. Audio Z)
1	0.000	+1.000	0.000
2	-0.334	+1.000	0.495
3	+0.334	+1.000	0.495
4	-1.000	+1.000	0.000
5	+1.000	+1.000	0.000
6	-0.743	+0.743	1.000
7	+0.743	+0.743	1.000
8	0.000	+0.473	1.000
9	-1.000	+0.334	0.495
10	+1.000	+0.334	0.495
11	-1.000	0.000	0.000
12	-0.473	0.000	1.000
13	+0.473	0.000	1.000
14	+1.000	0.000	0.000
15	-1.000	-0.334	0.495
16	+1.000	-0.334	0.495
17	0.000	-0.473	1.000
18	-0.743	-0.743	1.000
19	+0.743	-0.743	1.000
20	-1.000	-1.000	0.000
21	+1.000	-1.000	0.000
22	-0.334	-1.000	0.495
23	+0.334	-1.000	0.495
24	0.000	-1.000	0.000

4.2.4.2 Spatial Audio Coordinates between -100 and +100

Object	l/r	f/r	height
1	0	100	0
2	-33	100	49
3	33	100	49
4	-100	100	0
5	100	100	0

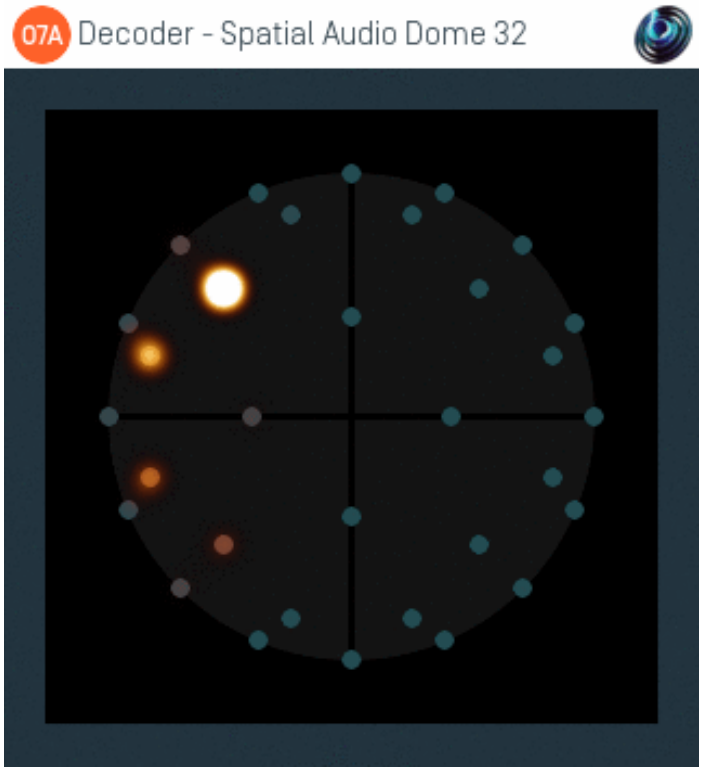
Object	l/r	f/r	height
6	-74	74	100
7	74	74	100
8	0	47	100
9	-100	33	49
10	100	33	49
11	-100	0	0
12	-47	0	100
13	47	0	100
14	100	0	0
15	-100	-33	49
16	100	-33	49
17	0	-47	100
18	-74	-74	100
19	74	-74	100
20	-100	-100	0
21	100	-100	0
22	-33	-100	49
23	33	-100	49
24	0	-100	0

4.2.4.3 Polar Coordinates

Object	Azimuth	Elevation
1	0.00	0.00
2	18.47	25.15
3	-18.47	25.15
4	45.00	0.00
5	-45.00	0.00
6	45.00	43.58
7	-45.00	43.58
8	0.00	64.69
9	71.53	25.15
10	-71.53	25.15
11	90.00	0.00
12	90.00	64.69
13	-90.00	64.69
14	-90.00	0.00
15	108.47	25.15
16	-108.47	25.15
17	180.00	64.69
18	135.00	43.58
19	-135.00	43.58
20	135.00	0.00
21	-135.00	0.00
22	161.53	25.15
23	-161.53	25.15
24	180.00	0.00

In the table above, azimuth is measured anticlockwise (left) from the front.

4.3 O7A Decoder - Spatial Audio Dome 32



4.3.1 Host Support

Host Type	Support
AAX	No
VST2	Yes

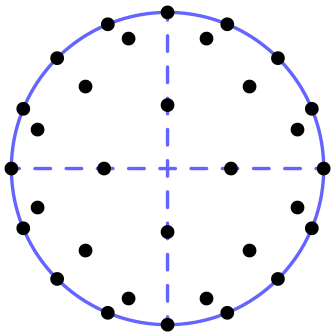
4.3.2 Audio

	Channels	Content
Input	64	O7A
Output	32	Feeds for 32 Spatial Audio Objects

4.3.3 Description

This plugin converts a 3D O7A mix into 32 channels of audio for use in a "Spatial Audio" mix.

4.3.4 Dome 32



This dome arrangement is designed for use with 32 objects. They need to be set to specific fixed locations:

4.3.4.1 Spatial Audio Coordinates between -1 and +1

Object	Left/Right (Sp. Audio X)	Back/Front (Sp. Audio Y)	Elevation (Sp. Audio Z)
1	0.000	+1.000	0.000
2	-0.414	+1.000	0.000
3	+0.414	+1.000	0.000
4	-0.300	+1.000	0.594
5	+0.300	+1.000	0.594
6	-1.000	+1.000	0.000
7	+1.000	+1.000	0.000
8	-0.784	+0.784	1.000
9	+0.784	+0.784	1.000
10	0.000	+0.445	1.000
11	-1.000	+0.414	0.000
12	+1.000	+0.414	0.000
13	-1.000	+0.300	0.594
14	+1.000	+0.300	0.594
15	-1.000	0.000	0.000
16	-0.445	0.000	1.000
17	+0.445	0.000	1.000
18	+1.000	0.000	0.000
19	-1.000	-0.300	0.594
20	+1.000	-0.300	0.594
21	-1.000	-0.414	0.000
22	+1.000	-0.414	0.000
23	0.000	-0.445	1.000
24	-0.784	-0.784	1.000
25	+0.784	-0.784	1.000
26	-1.000	-1.000	0.000
27	+1.000	-1.000	0.000
28	-0.300	-1.000	0.594
29	+0.300	-1.000	0.594
30	-0.414	-1.000	0.000
31	+0.414	-1.000	0.000
32	0.000	-1.000	0.000

4.3.4.2 Spatial Audio Coordinates between -100 and +100

Object	l/r	f/r	height
1	0	100	0
2	-41	100	0
3	41	100	0
4	-30	100	59
5	30	100	59
6	-100	100	0
7	100	100	0
8	-78	78	100
9	78	78	100
10	0	45	100
11	-100	41	0
12	100	41	0
13	-100	30	59
14	100	30	59
15	-100	0	0
16	-45	0	100
17	45	0	100
18	100	0	0
19	-100	-30	59
20	100	-30	59
21	-100	-41	0
22	100	-41	0
23	0	-45	100
24	-78	-78	100
25	78	-78	100
26	-100	-100	0
27	100	-100	0
28	-30	-100	59
29	30	-100	59
30	-41	-100	0
31	41	-100	0
32	0	-100	0

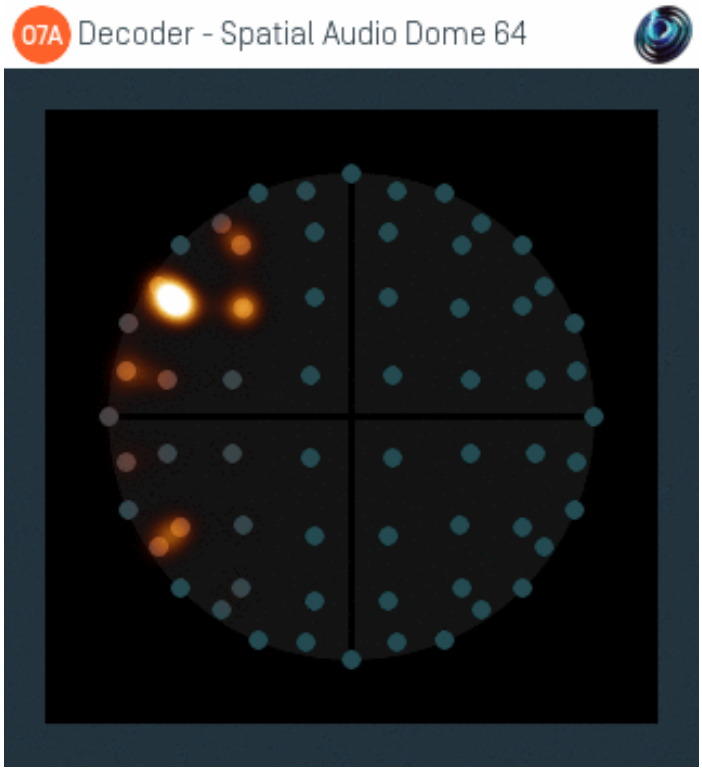
4.3.4.3 Polar Coordinates

Object	Azimuth	Elevation
1	0.00	0.00
2	22.49	0.00
3	-22.49	0.00
4	16.70	29.64
5	-16.70	29.64
6	45.00	0.00
7	-45.00	0.00
8	45.00	42.05
9	-45.00	42.05
10	0.00	66.01
11	67.51	0.00
12	-67.51	0.00

Object	Azimuth	Elevation
13	73.30	29.64
14	-73.30	29.64
15	90.00	0.00
16	90.00	66.01
17	-90.00	66.01
18	-90.00	0.00
19	106.70	29.64
20	-106.70	29.64
21	112.49	0.00
22	-112.49	0.00
23	180.00	66.01
24	135.00	42.05
25	-135.00	42.05
26	135.00	0.00
27	-135.00	0.00
28	163.30	29.64
29	-163.30	29.64
30	157.51	0.00
31	-157.51	0.00
32	180.00	0.00

In the table above, azimuth is measured anticlockwise (left) from the front.

4.4 O7A Decoder - Spatial Audio Dome 64



4.4.1 Host Support

Host Type	Support
AAX	Yes, output mapped to seventh order ambisonics
VST2	Yes

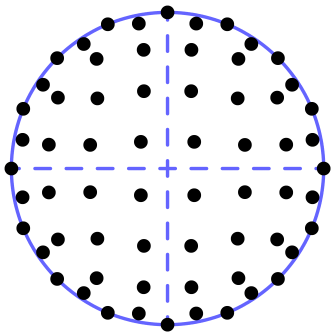
4.4.2 Audio

	Channels	Content
Input	64	O7A
Output	64	Feeds for 64 Spatial Audio Objects (mapped to seventh order ambisonics for AAX)

4.4.3 Description

This plugin converts a 3D O7A mix into 64 channels of audio for use in a "Spatial Audio" mix.

4.4.4 Dome 64



This dome arrangement is designed for use with 64 objects. They need to be set to specific fixed locations:

4.4.4.1 Spatial Audio Coordinates between -1 and +1

Object	Left/Right (Sp. Audio X)	Back/Front (Sp. Audio Y)	Elevation (Sp. Audio Z)
1	0.000	+1.000	0.000
2	-0.198	+1.000	0.349
3	+0.198	+1.000	0.349
4	-0.414	+1.000	0.000
5	+0.414	+1.000	0.000
6	-0.673	+1.000	0.345
7	+0.673	+1.000	0.345
8	-0.201	+1.000	0.831
9	+0.201	+1.000	0.831
10	-1.000	+1.000	0.000
11	+1.000	+1.000	0.000
12	-0.647	+1.000	0.782
13	+0.647	+1.000	0.782
14	-1.000	+0.673	0.345
15	+1.000	+0.673	0.345
16	-0.177	+0.579	1.000
17	+0.177	+0.579	1.000
18	-1.000	+0.647	0.782
19	+1.000	+0.647	0.782
20	-0.582	+0.582	1.000
21	+0.582	+0.582	1.000
22	-1.000	+0.414	0.000
23	+1.000	+0.414	0.000
24	-1.000	+0.198	0.349
25	+1.000	+0.198	0.349
26	-0.176	+0.176	1.000
27	+0.176	+0.176	1.000
28	-1.000	+0.201	0.831
29	+1.000	+0.201	0.831
30	-0.579	+0.177	1.000
31	+0.579	+0.177	1.000
32	-1.000	0.000	0.000
33	+1.000	0.000	0.000

Object	Left/Right (Sp. Audio X)	Back/Front (Sp. Audio Y)	Elevation (Sp. Audio Z)
34	-0.579	-0.177	1.000
35	+0.579	-0.177	1.000
36	-1.000	-0.201	0.831
37	+1.000	-0.201	0.831
38	-0.176	-0.176	1.000
39	+0.176	-0.176	1.000
40	-1.000	-0.198	0.349
41	+1.000	-0.198	0.349
42	-1.000	-0.414	0.000
43	+1.000	-0.414	0.000
44	-0.582	-0.582	1.000
45	+0.582	-0.582	1.000
46	-1.000	-0.647	0.782
47	+1.000	-0.647	0.782
48	-0.177	-0.579	1.000
49	+0.177	-0.579	1.000
50	-1.000	-0.673	0.345
51	+1.000	-0.673	0.345
52	-0.647	-1.000	0.782
53	+0.647	-1.000	0.782
54	-1.000	-1.000	0.000
55	+1.000	-1.000	0.000
56	-0.201	-1.000	0.831
57	+0.201	-1.000	0.831
58	-0.673	-1.000	0.345
59	+0.673	-1.000	0.345
60	-0.414	-1.000	0.000
61	+0.414	-1.000	0.000
62	-0.198	-1.000	0.349
63	+0.198	-1.000	0.349
64	0.000	-1.000	0.000

It is very easy to make a mistake entering coordinates like these. We recommend setting up a template and checking it carefully before using it for any real projects.

4.4.4.2 Spatial Audio Coordinates between -100 and +100

Object	l/r	f/r	height
1	0	100	0
2	-20	100	35
3	20	100	35
4	-41	100	0
5	41	100	0
6	-67	100	35
7	67	100	35
8	-20	100	83
9	20	100	83
10	-100	100	0
11	100	100	0

Object	l/r	f/r	height
12	-65	100	78
13	65	100	78
14	-100	67	35
15	100	67	35
16	-18	58	100
17	18	58	100
18	-100	65	78
19	100	65	78
20	-58	58	100
21	58	58	100
22	-100	41	0
23	100	41	0
24	-100	20	35
25	100	20	35
26	-18	18	100
27	18	18	100
28	-100	20	83
29	100	20	83
30	-58	18	100
31	58	18	100
32	-100	0	0
33	100	0	0
34	-58	-18	100
35	58	-18	100
36	-100	-20	83
37	100	-20	83
38	-18	-18	100
39	18	-18	100
40	-100	-20	35
41	100	-20	35
42	-100	-41	0
43	100	-41	0
44	-58	-58	100
45	58	-58	100
46	-100	-65	78
47	100	-65	78
48	-18	-58	100
49	18	-58	100
50	-100	-67	35
51	100	-67	35
52	-65	-100	78
53	65	-100	78
54	-100	-100	0
55	100	-100	0
56	-20	-100	83
57	20	-100	83
58	-67	-100	35
59	67	-100	35
60	-41	-100	0

Object	l/r	f/r	height
61	41	-100	0
62	-20	-100	35
63	20	-100	35
64	0	-100	0

4.4.4.3 Polar Coordinates

Object	Azimuth	Elevation
1	0.00	0.00
2	11.20	18.90
3	-11.20	18.90
4	22.49	0.00
5	-22.49	0.00
6	33.94	15.97
7	-33.94	15.97
8	11.37	39.17
9	-11.37	39.17
10	45.00	0.00
11	-45.00	0.00
12	32.90	33.29
13	-32.90	33.29
14	56.06	15.97
15	-56.06	15.97
16	17.00	58.81
17	-17.00	58.81
18	57.10	33.29
19	-57.10	33.29
20	45.00	50.54
21	-45.00	50.54
22	67.51	0.00
23	-67.51	0.00
24	78.80	18.90
25	-78.80	18.90
26	45.00	76.02
27	-45.00	76.02
28	78.63	39.17
29	-78.63	39.17
30	73.00	58.81
31	-73.00	58.81
32	90.00	0.00
33	-90.00	0.00
34	107.00	58.81
35	-107.00	58.81
36	101.37	39.17
37	-101.37	39.17
38	135.00	76.02
39	-135.00	76.02
40	101.20	18.90
41	-101.20	18.90

Object	Azimuth	Elevation
42	112.49	0.00
43	-112.49	0.00
44	135.00	50.54
45	-135.00	50.54
46	122.90	33.29
47	-122.90	33.29
48	163.00	58.81
49	-163.00	58.81
50	123.94	15.97
51	-123.94	15.97
52	147.10	33.29
53	-147.10	33.29
54	135.00	0.00
55	-135.00	0.00
56	168.63	39.17
57	-168.63	39.17
58	146.06	15.97
59	-146.06	15.97
60	157.51	0.00
61	-157.51	0.00
62	168.80	18.90
63	-168.80	18.90
64	180.00	0.00

In the table above, azimuth is measured anticlockwise (left) from the front.

5 Appendix: O7A Streams

5.1 What is an O7A Stream?

A seventh order ambisonic (O7A) stream is made up of 64 individual channels of audio which together represent a 3D soundfield. Into this "audio scene" can be placed individual sound sources, reverberation and complex spatial textures.

These 64 channels can be quite confusing to understand conceptually. For instance, they do not relate to particular speaker directions, or to individual sound sources in the soundfield. You do *not* need to understand them to use them! But, it doesn't hurt to know the basics.

Each channel adds spatial detail to a sound scene. With just the first channel, you have a basically omnidirectional (mono) sound image. The second channel adds some basic detail left/right, the third up/down and the fourth front/back; these four channels make up first order ambisonics. The first and second channels together provide essentially the spatial detail available with the Mid/Side (M/S) stereo recording technique, which captures a sound image with left/right width. But with the further two channels the detail is available in all directions, not just left/right.

That covers the first 4 channels. The other 60 add further detail to make the image sharper. If you are interested in what exactly is in these channels (which is not so easy to describe) you may want to read up on Higher Order Ambisonics (HOA) and the mathematics of the Spherical Wave Equation and Spherical Harmonics. But you should *not* need to read up to *use* the techniques described here. If you want to make sense of what is going on spatially in an O7A stream, we find that it is normally best to use an O7A Visualiser or O7A Flare plugin.

5.2 What processing can I apply to an O7A stream?

As well as processing designed specifically for O7A streams, it is possible to mix streams together in the expected way. It is also possible to run conventional mono DSP algorithms on them directly by applying the algorithm to all 64 channels individually, subject to some rules. Failing to follow these rules is likely to shred the spatial imaging, so be careful! Specifically:

- If you process an O7A stream with a conventional mono DSP algorithm you *must apply the same processing to all 64 channels identically*.
- Only *linear* processing can be used (e.g. not distortion or compression). Also, be aware that time-variant processing can cause issues.

If you are working in Reaper, current versions do not make it particularly easy to set up this sort of processing, but it is possible if you are prepared to use some advanced features and do some rather tedious set-up. For instance, you can save an "FX Chain" in which a number of equalization plugins are "routed" correctly and in which controls are linked by "parameter modulation" so that one set of controls operates the others. Once the FX Chain is saved, you can load it into other projects.

5.3 Encoding

There are a number of ways in which the channels can be defined in HOA. To a large extent it does not matter which is chosen, as long as *everything uses the same convention*. This is critical and horrible things will happen to the spatial image if this is not the case. However, if you follow the convention, or convert explicitly where you need to, you will be able to pass audio around between different software packages.

These plugins use the "SN3D" ambisonic convention. As is usually the case, we order the channels using "ACN" ordering.

This encoding is used in the "AmbiX" file format and YouTube. It is supported directly by Rapture3D Universal.

5.4 How does O7A SN3D relate to FuMa and Classic Ambisonics?

The ambisonic format used (SN3D) is not directly compatible with classic 1970s four channel "WXYZ" B-Format, or the extension (FuMa) which was used by versions of these plugins prior to version 2.0.

However, conversion is straightforward. The O7A Core pack includes plugins to do this: O7A Decoder - FuMa and O7A Injector - FuMa.