



TOA Core VST Plugins User Guide

v1.1.7

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1 Introduction

The TOA Core is a set of VST plugins designed for work with [Third Order Ambisonic \(TOA\) streams](#). These streams can be used to create rich 3D mixes that can be played back on a wide variety of sound systems.

There are a number of collections of TOA plugins. This one provides a set of essential tools including panning, rotation, visualisation and basic decoding. Other plugin sets available from [Blue Ripple Sound](#) are:

- TOA Decoding
- TOA Decoding - Rapture3D Advanced
- TOA Manipulators
- TOA Reverb
- TOA Upmixers

1.1 Compatibility

TOA streams require audio busses with at least 16 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 TOA plugins will not work correctly with these DAWs**, which may even crash. However, all is not lost; you may wish to try [Reaper](#), which handles 16 or more channels comfortably on modern hardware. Adobe Premiere is also well worth a look, particularly if you are working with video.

This plugin library works as a VST2 "shell" plugin. This means that a number of individual audio plugin effects are provided by a single library file. Your VST host 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.

Most DAWs have a VST 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 Mac OS X. Various directories may be used on Windows, but C:\Program Files\Common Files\Steinberg\VST2 is not uncommon.

Some of the TOA 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.

2 Getting Started

2.1 Working with TOA

When working with stereo, you normally "pan" a mono sound to stereo and "mix" it onto a stereo bus. With TOA, it's similar but there's an extra "decoding" step:

1. Panning - mono sources are panned to 16-channel TOA. The [TOA Panner](#) plugin can be used for this.
2. Mixing - multiple channels of 16-channel TOA can be mixed together using your DAW's mixing engine. No special plugin is needed here, as long as the DAW can handle 16-channel busses. You end up with a final mix, as a TOA stream.
3. Decoding - during actual playback (and you probably want to listen while you work!) you "decode" the TOA stream for whatever speaker layout you are actually listening with. One of the huge advantages of ambisonic techniques is that your final TOA mix is independent of its final playback environment, so you can switch between stereo speakers, headphones, 5.1, 22.2 or whatever. One of the simplest of these decoders is provided by the basic [TOA Decoder - Stereo](#) plugin.

This is the simplest case. You can also manipulate the TOA streams, for instance to [rotate](#) the soundfield. Plugins that do this have 16-channel TOA as both an input and output. There are some [technical notes on TOA streams](#) at the end of this document.

If you are also working with conventional first order B-Format (also known as "Plain Old Ambisonics" or "POA") you can mix this in too.

2.2 Getting Started with Reaper

This section gives an introduction to using the TOA plugins with [Reaper](#). If you are not using Reaper, you can probably skip this section.

We're also assuming that you know how to use Reaper already. If not, you might like to familiarise yourself with it before proceeding.

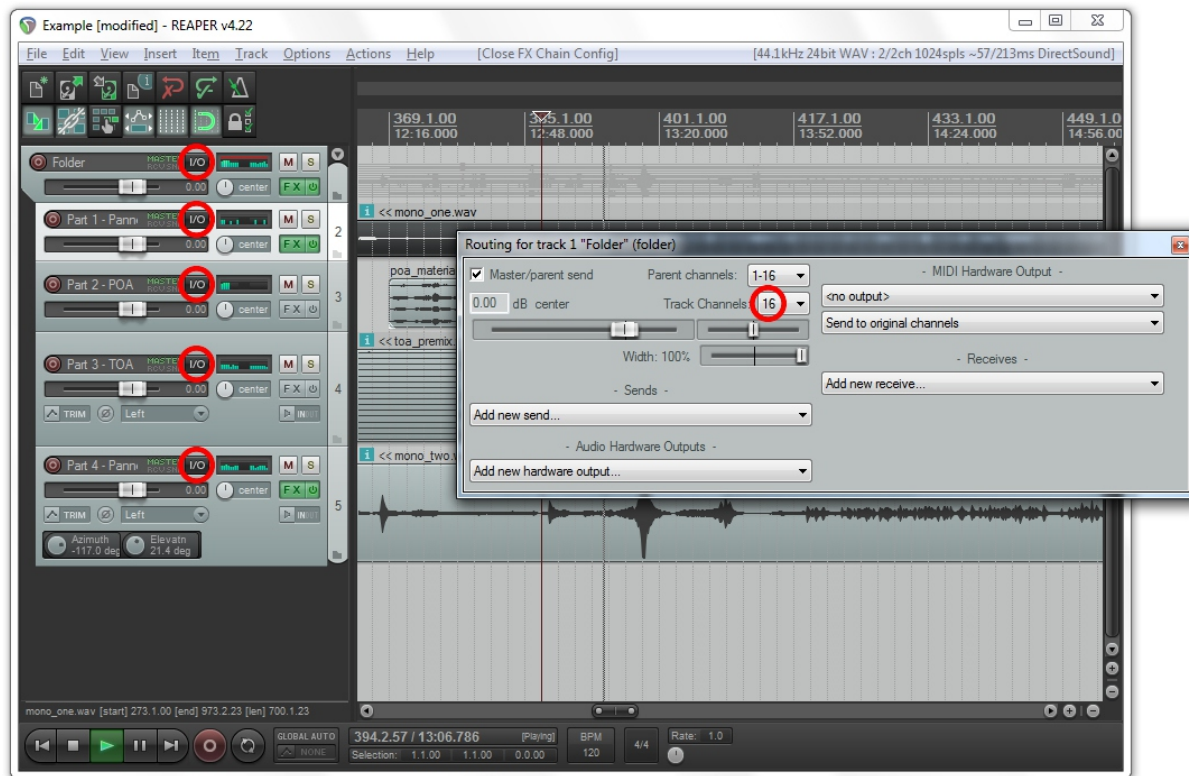
2.2.1 Shell Plugins

The TOA plugin libraries are VST2 "shell" plugins which each provide a number of plugin effects. If you find your list of TOA effects is short, with names like "TOACore", this means that Reaper has not scanned the content of the libraries.

To fix this, go into the Reaper "Options" menu and select "Preferences..." to bring up the preferences screen. Then, under "Plug-ins", find "VST". On the VST tab, please ensure that "Get VST names/types when scanning" is checked, and then click "Clear cache/re-scan".

2.2.2 Basics

In Reaper, whenever you create a track to be used with [TOA streams](#), make sure it has at least 16 channels. A few plugins need even more (e.g. a decoder for Hamasaki 22.2).



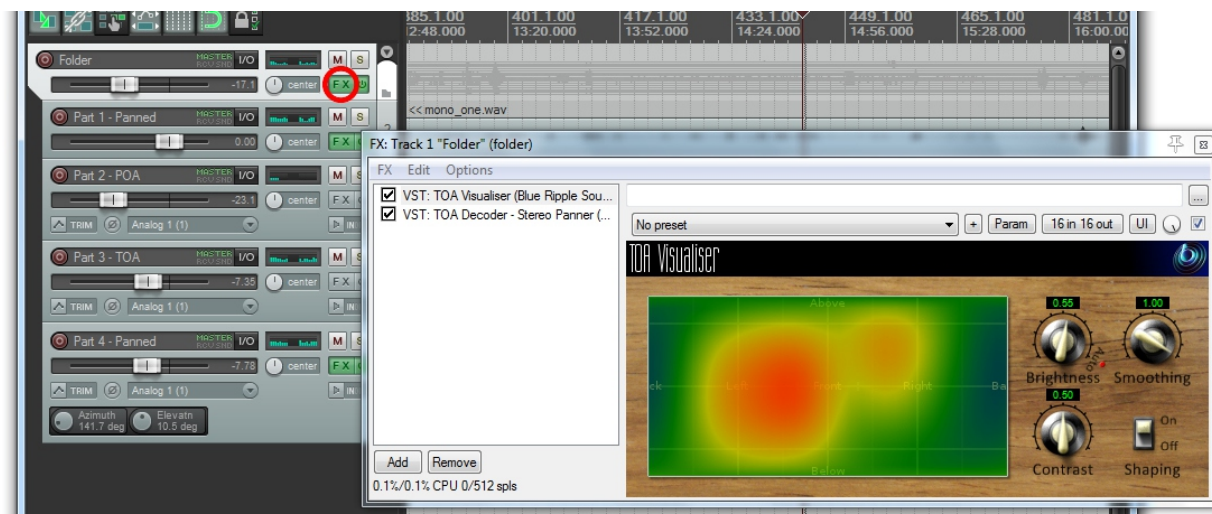
2.2.3 Layout

A practical way we use to set up projects in Reaper is to create one "folder" track which takes TOA in and decodes it, and a number of individual tracks within it which output TOA. This is based on an approach to working with ambisonics in Reaper developed by Bruce Wiggins.

On the folder track, add the following plugins *in this order* to the FX chain:

- [TOA Visualiser](#)
- [TOA Decoder - Stereo](#) (or whichever decoder best suits your speaker rig).

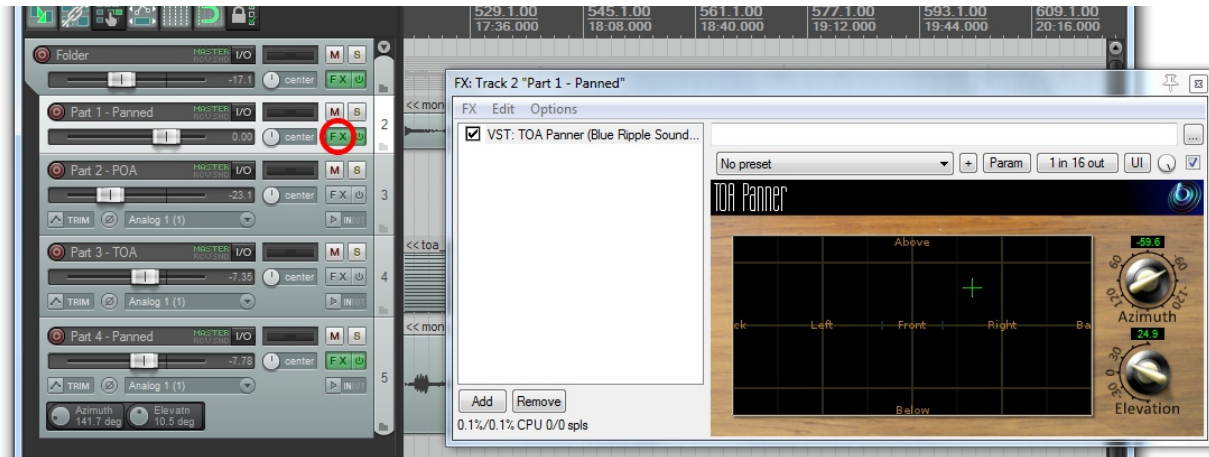
This means that after all the audio from the individual parts has been mixed together it will be visualised in 3D and then converted to stereo for monitoring.



On tracks for mono parts that are to be panned, add the following:

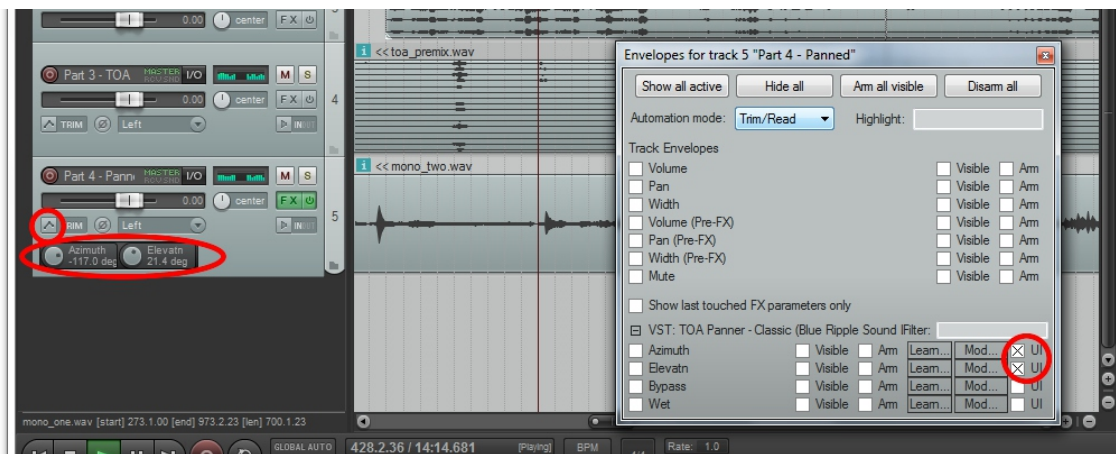
- A [TOA Panner](#) plugin.

Do *NOT* use the built-in Reaper stereo panner with TOA!



It is also possible to add azimuth and elevation controls to Reaper on these channels.

To do this, add the panner as above and then use the "Trim" button and cross the "UI" boxes for the azimuth and elevation controls.

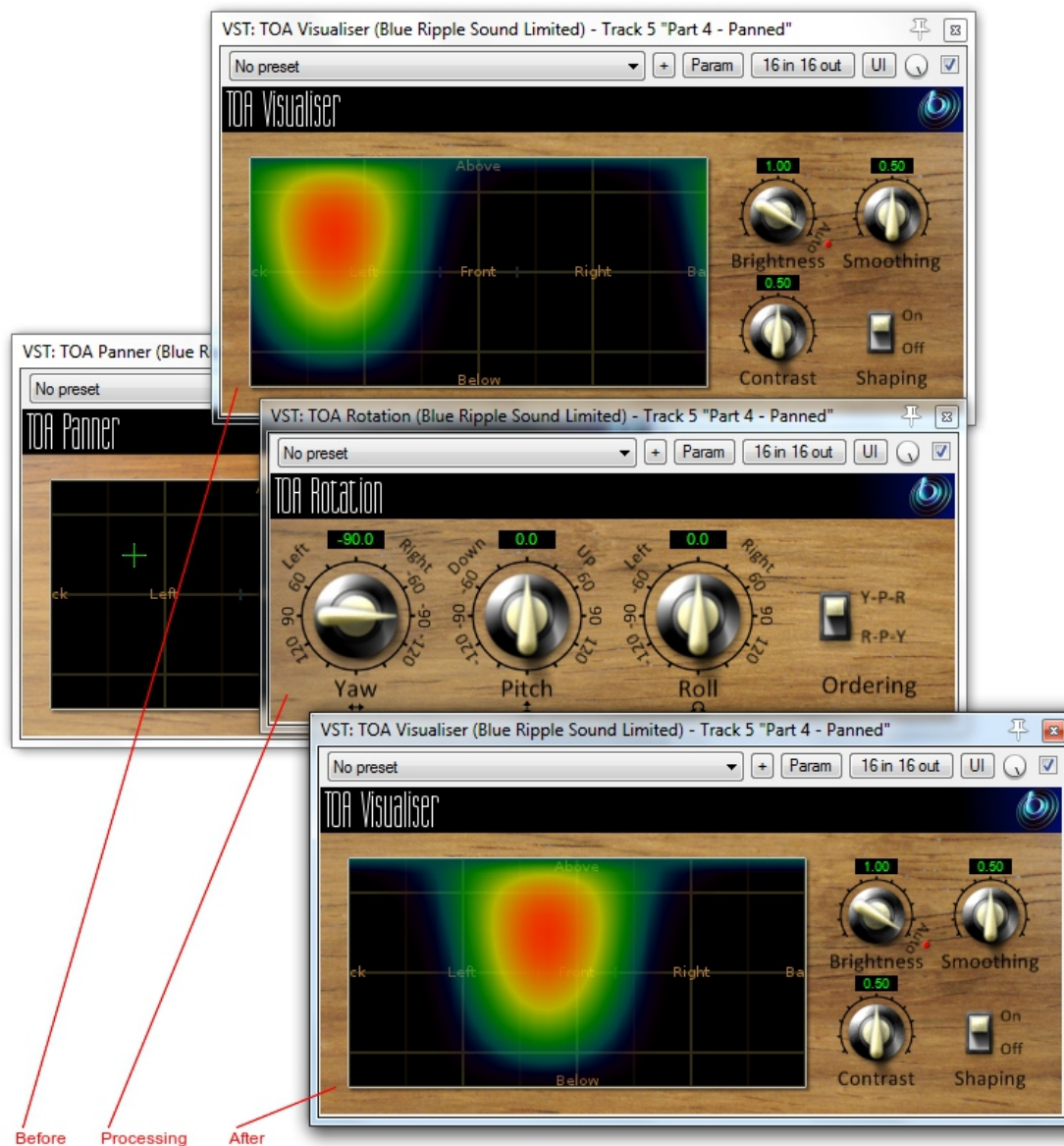


Parts that are already first order ambisonic B-Format can typically be injected directly without issue, though sometimes a little processing can help (e.g. the TOA First Order Injector plugin from the TOA Upmixers set). Of course, other TOA material can be injected directly.

2.2.4 Processing TOA streams

Other plugins (for instance the [rotation](#) plugin) manipulate the TOA stream. Obviously, the stream needs to be in TOA format (for instance by panning) before such processing can be used.

Applying processing to the TOA stream can be confusing at first. We suggest you spend a few minutes getting familiar with the [TOA Visualiser](#) plugin and put visualisers before and after your processing. You can then see what's going on, which can be really helpful!



Some plugins have TOA as an input but output something else. In these cases, make sure you only chain together processors in a combination that make sense. For instance, the [TOA Beamer](#) plugin produces mono which you might want to run through a mono distortion plugin before panning it back into TOA using the [TOA Panner](#).

2.2.5 Sends

Effect sends can be used in the normal way. Just be careful about which busses are expecting mono or TOA as input and output, and be sure to check your channel counts!

2.2.6 Mastering

2.2.6.1 Keep Your TOA Master Mix

Keep your Reaper project files and inputs if you like, keep your favourite stereo and 5.1 downmixes etc. But whatever you do, *keep a copy of the 16-channel TOA mix*. This may not make a difference to you now, but when someone asks you for a 22.2 (or other) downmix in a few years time, you won't need to fake height information from the 5.1 mix, or go searching for a missing file needed by the original Reaper project. Instead, you'll be able to produce the downmix from the ambisonic B-Format (i.e. TOA) master using whatever tools are in vogue then.

In Reaper, probably the easiest way to grab the TOA mix is to switch off your decoder (in your folder track if you've followed the advice above) and then use the "Render..." menu item. You'll probably need to set the Channels to "16" by typing the number in, and use the "Stems (selected tracks)" option rather than what Reaper considers the master mix, in which case you'll also need to have selected your folder track. If you want to check the output, you can always load it into a new Reaper session and run it through your favourite decoder, or use [Blue Ripple Sound's Rapture3D Player](#) if you have it.

2.2.6.2 Other Mixes

If you want to produce a number of different format outputs from your TOA master (stereo, headphones, 5.1 etc.) you could use a number of projects that use the TOA master file. An arguably simpler option is to place a number of decoders on your decoding/folder track and only switch on the one you want for the particular rendering. You'll need to check the channel counts as was needed for the TOA output above.

2.2.7 .AMB Files

If you have .AMB files which you want to use with Reaper, there are a few things to bear in mind. Specifically:

- At the time of writing, Reaper cannot read .AMB files, so you'll need to convert them. These files are actually .WAV files in disguise, so you can rename them and load them into some other audio packages and then resave them.
- .AMB files can contain "mixed-order" Ambisonics, although this is rather unusual. To be safe, check the channel count. If it is 3, 4, 9 or 16 then all is well already. If it isn't, you'll need to map the channels in the file to the correct subset of the 16 channels used by TOA, for example by using the Reaper routing grid.

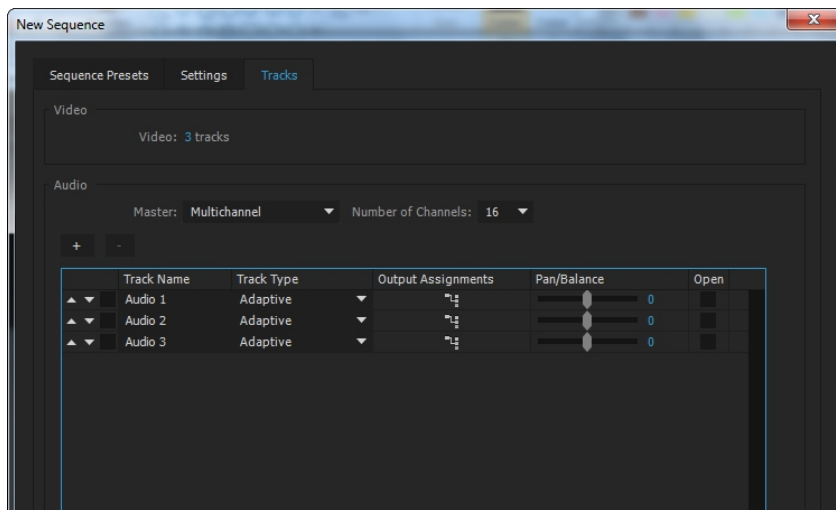
2.3 Getting Started with Adobe Premiere CC 2015

In Premiere, as with Reaper, the key to getting things working is to make sure your audio tracks have 16 channels (or more if you are using plugins that need them).

2.3.1 Sequence Settings

In particular, when creating a New Sequence, go to the "Tracks" tab and make the following changes:

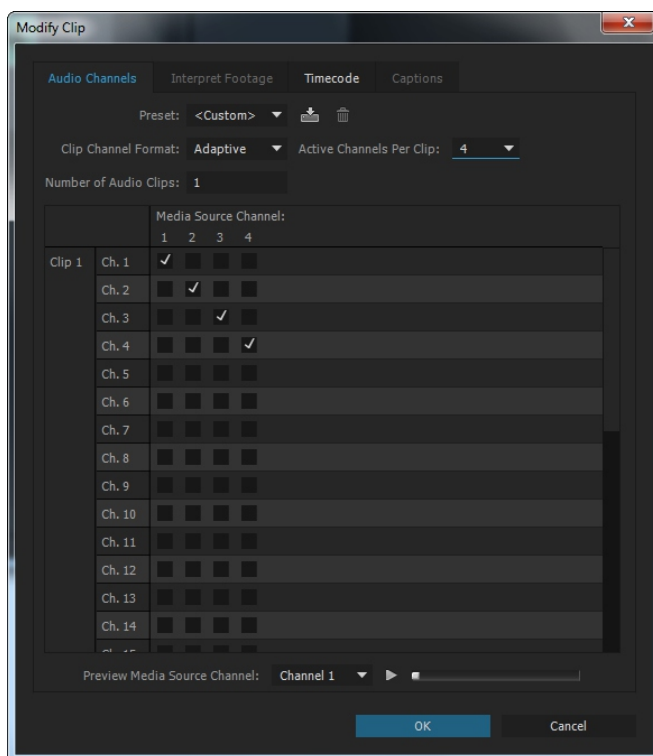
1. The "Master" Track should be set to "Multichannel".
2. The "Number of Channels" should be set to "16", or as many as you need.
3. Each audio "Track Type" that is going to carry TOA audio (or suchlike) should be set to "Adaptive" or "Adaptive Submix".



2.3.2 Importing Audio

When importing audio with a lot of channels, Premiere may place each channel of the audio onto a different track. If this happens, find the clip, right click and select "Modify" and then "Audio Channels..." and do the following before trying again:

1. Set the "Clip Channel Format" to "Adaptive".
2. Check the "Active Channels Per Clip" matches the audio (for instance, 4 for first order ambisonics or 16 for third order ambisonics).
3. Set the "Number of Audio Clips" to 1.

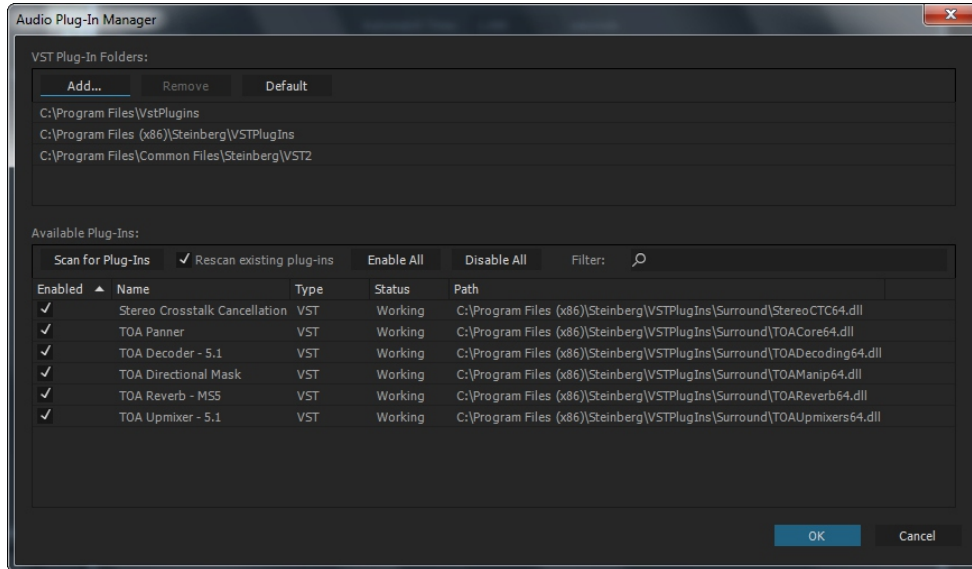


You can also make this the default behaviour by going into Premiere's "Preferences...", finding the "Audio" section and setting the "Multichannel Mono Mono" item to "Adaptive".

2.3.3 Managing Plugins in Premiere

Like other VST hosts, Premiere looks in certain directories for plugins. Under "Preferences...", find the "Audio" section and click on the "Audio Plug-In Manager..." button.

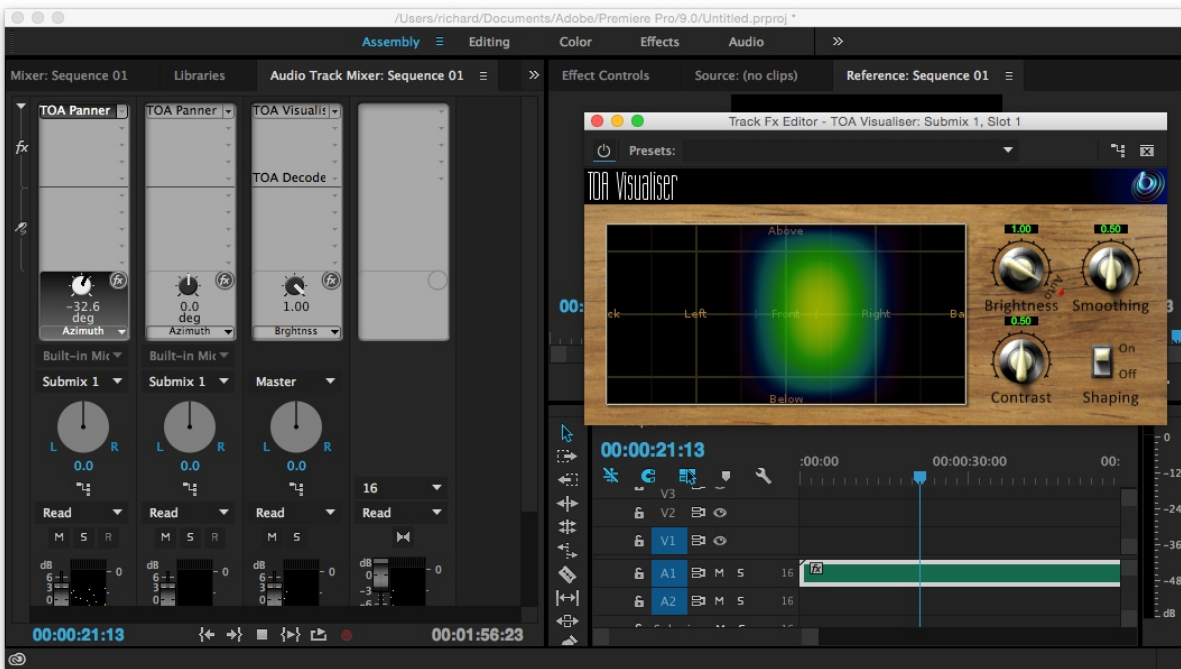
The Audio Plug-In Manager screen should show a list of "VST Plug-In Folders". Ensure this list includes all relevant directories and scan for plugins as necessary.



Note that the Premiere list of "Available Plug-Ins" only shows one plugin from each of the plugin libraries, but they all should be available for use.

2.3.4 Using Plugins

Plugins can be added to tracks and submixes in the Audio Track Mixer. Press the triangle at the top left if the effects are not shown, and use the dropdown next to each effect slot to select effects. Double-click on an effect to bring up its user interface.



Do *NOT* use the built-in Premiere stereo panner with TOA!

If you are working with mono material that you wish to pan into the overall mix, add the following effect (or something similar) to each track:

- A [TOA Panner](#) plugin.

You can then add the following plugins (in order), or put them onto a submix track to which you can send all audio to be visualised and decoded in one place:

- [TOA Visualiser](#)
- [TOA Decoder - Stereo](#) (or whichever decoder best suits your speaker rig).

Depending on the output format you want to included in the final project export, you might wish to switch between various Decoder plugins, for instance to produce stereo or 5.1, or even to output the TOA itself directly. This can be done with the plugin "Bypass" check box.

2.3.5 Exporting

When exporting, check the "Audio" tab in the "Export Settings". Note that different "Formats" have different audio capabilities, and you should set the output audio channel configuration to match the output format you have set up with the plugins.

If you wish to include TOA directly in the export, the QuickTime format is an option.

2.3.6 Limitations

- Plugin presets are not available.

3 TOA Core Plugins

The TOA Core plugin is a VST2 "shell" plugin library which provides a number of plugin effects. These are:

- TOA Beamer
- TOA Decoder - Stereo
- TOA Decoder - Mono
- TOA Decoder - 5.1 Basic
- TOA Gain
- TOA Look
- TOA Meter
- TOA Meter - Signal
- TOA Panner
- TOA Panner - Classic
- TOA Panner - Hemisphere
- TOA Panner - Two Channel
- TOA Panner - Eight Channel
- TOA Rotation
- TOA Virtual Microphone
- TOA Visualiser
- TOA Visualiser - Hemisphere

3.1 TOA Beamer



Audio:

	Channels	Content
Input	16	TOA
Output	1	Mono

Controls:

- [Azimuth](#)
- [Elevation](#)
- [Sharpness](#)

3.1.1 What does this do?

The TOA Beamer extracts sound in a particular "beam" direction from a 3D TOA mix. You can think of this as a narrow directional microphone response, recording in a particular direction in the soundfield.

The beam direction can be set using the azimuth and elevation controls, or the control surface, where the direction is indicated by the green crosshairs. If you look carefully at the figure you'll see there is some faint text to help you find left, right, above etc. However, if this still doesn't make any sense, you might want to see our page on the [TOA Visualiser](#) which lays out its viewing region in the same way.

The algorithm used is a "passive" one and should not colour the frequency content of the sound significantly.

If you are interested in producing virtual microphone responses from a TOA mix, you may also wish to read about the [TOA Virtual Microphone](#).

3.1.2 Controls

3.1.2.1 Azimuth and Elevation

Azimuth is the horizontal angle of the direction to be extracted, between -180 to +180 degrees, measured anticlockwise (left) from the front. Elevation is a vertical angle between -90 and +90 degrees, measured with positive upwards and 0 on the horizontal.

For instance, the direction for azimuth +90 and elevation +45 can be found by turning 90 degrees to the left and then looking up by 45 degrees. It may help to experiment with the [TOA Panner](#) to get used to this way of doing things.

3.1.2.2 Sharpness

The sharpness control determines how directional the beam response is. A value of zero reduces the response to an omnidirectional one like that of the [mono decoder](#). A value of one is the usual case, and gives the sharpest response.

3.2 TOA Decoder - Stereo



Audio:

	Channels	Content
Input	16	TOA
Output	2	Stereo

Controls:

- [Decoder Method](#)

3.2.1 What does this do?

This plugin takes a third order ambisonics (TOA) mix and decodes it as a simple, robust stereo mix.

3.2.2 Controls

3.2.2.1 Decoder Method

Two decoder methods are supported, "Panner" and "Basic Head".

Method	Description
Panner	<p>This method produces a simple stereo mix, largely as if the sounds within the mix had been panned conventionally. This can work well on speakers or headphones.</p> <p>Sounds from the front and back are folded down on the stereo image using different angle conventions. Specifically, sounds panned from -30 to +30 degrees at the front will pass across the stereo image, as will sounds panned from -110 to +110 degrees at the back. Sounds above or below are fed to both speakers.</p>
Basic Head	<p>This method produces a stereo mix using a very crude model of a human head. When listened to on headphones, this imitates typical left and right ear levels that would occur naturally, albeit not in a frequency-dependent way. This can work well on speakers or headphones.</p> <p>The data for this method is based on the Amber HRTF headphones decoder available in the Blue Ripple Sound TOA Decoding library, but massively simplified so that the output is not frequency-dependent. This reduces the strength of 3D cues on headphones, but means that the frequency content is changed less when played on stereo speakers.</p> <p>Unlike most other TOA decoders, this decoder presents sounds from different directions at different levels. For instance, sounds to the front are louder than those behind.</p>

As an alternative to this plugin, you can use the [TOA Virtual Microphone](#) to produce a stereo mix using a virtual stereo microphone.

3.2.3 Technical Notes

The Blue Ripple Sound Amber HRTF uses data from the IRCAM LISTEN HRTF data set, available at <http://recherche.ircam.fr/equipes/salles/listen/index.html>. It has been processed and simplified heavily.

3.3 TOA Decoder - Mono



Audio:

	Channels	Content
Input	16	TOA
Output	1	Mono

3.3.1 What does this do?

This plugin takes a third order ambisonics (TOA) mix and reduces it to mono by discarding everything but its omnidirectional ("W") component.

This type of mix is particularly suitable for level analysis, including loudness monitoring.

If you wish to extract a response from the soundfield in a particular direction, you might also want to try the [TOA Virtual Microphone](#) or [TOA Beamer](#) plugins.

3.4 TOA Decoder - 5.1 Basic



Audio:

	Channels	Content
Input	16	TOA
Output	6	5.1 Surround

3.4.1 What does this do?

This plugin takes a third order ambisonics (TOA) mix and decodes it as a 5.1 surround mix.

A resilient decoding is used suitable for small or large venues. ITU speaker angles are assumed.

3.4.2 Channels

The channel ordering for the 5.1 surround mix is assumed to be:

1. Front Left
2. Front Right
3. Front Centre
4. LFE (not used)
5. Side Left
6. Side Right

The low frequency effect channel (the ".1" of the 5.1 format) is *not* used. Sounds above or below are fed to all speakers (except the LFE).

3.5 TOA Gain



Audio:

	Channels	Content
Input	16	TOA
Output	16	TOA

Controls:

- [Gain](#)

3.5.1 What does this do?

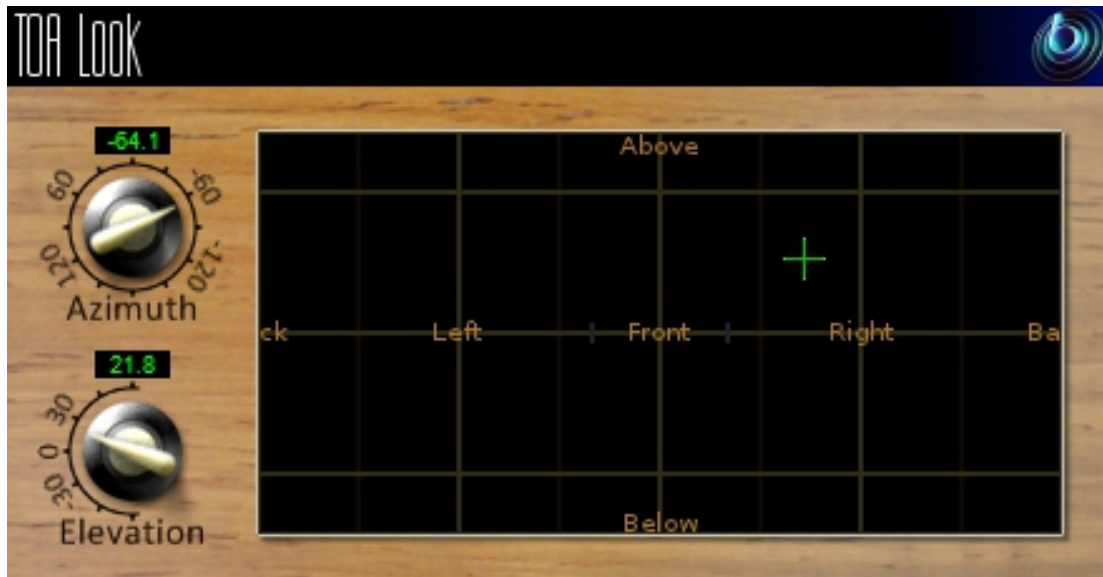
This trivial plugin applies a gain to the TOA stream. All channels of the stream are affected equally.

3.5.2 Controls

3.5.2.1 Gain

The gain to apply, in decibels, between -30dB and +30dB.

3.6 TOA Look



Audio:

	Channels	Content
Input	16	TOA
Output	16	TOA

Controls:

- [Azimuth](#)
- [Elevation](#)

3.6.1 What does this do?

This plugin changes where "front" is in the 3D audio scene, as if the listener had turned their head to look (and listen) in another direction.

The "look" direction is chosen using the dials or control surface, in the normal way (for instance, see the [TOA Panner](#)). Sounds that were in this direction will be to the front after processing.

This is essentially an simplified (and inverted) version of the [TOA Rotation](#) plugin. The "roll" and "ordering" controls are not provided. Instead, we just assume that the listener turns their head and pitches it backwards or forwards. Rolling to the sides is not supported (use the rotation plugin if you need this).

3.6.2 Controls

3.6.2.1 Azimuth and Elevation

Azimuth is the horizontal angle of the "look" direction, between -180 to +180 degrees, measured anticlockwise (left) from the front. Elevation is a vertical angle between -90 and +90 degrees, measured with positive upwards and 0 on the horizontal.

3.7 TOA Meter



Audio:

	Channels	Content
Input	16	TOA
Output	16	TOA

3.7.1 What does this do?

This plugin measures the sound level in a TOA stream. A breakdown by ambisonic order is provided, along with a history graph and the current overall level. Audio is passed through unchanged.

3.7.2 Meters

From left to right, the following displays are shown:

1. Bar meter showing the current and recent peak level in order 0 (TOA channel 1 only).
2. Bar meter showing the current and recent peak level in order 1 (TOA channels 2 to 4).
3. Bar meter showing the current and recent peak level in order 2 (TOA channels 5 to 9).
4. Bar meter showing the current and recent peak level in order 3 (TOA channels 10 to 16).
5. History min/max graph of overall level (all 16 TOA channels).
6. Bar meter showing the overall current and peak level (all 16 TOA channels).

Each bar meter shows the current RMS level in green, averaged using a 400ms rectangular window and translated to a decibel scale, along with a recent peak calculation using a 2s memory. The history graph shows the last three minutes of the overall level, displaying the range from minimum to maximum for each second.

The meters are all normalised so that a 0dBFS peak sine wave panned in any direction will produce a -3.01dB output. There is no sensitivity to frequency or direction. If you are interested in measuring loudness, you may wish to consider the "TOA Meter - Karma" plugin from the [Blue Ripple Sound](#) TOA Decoding library, which will produce comparable numbers when set to use LUFS units, subject to directional weighting.

For material that has been assembled by simple panning, the five bar meters should be roughly in line with each other.

3.8 TOA Meter - Signal



Audio:

	Channels	Content
Input	16	TOA
Output	16	TOA

3.8.1 What does this do?

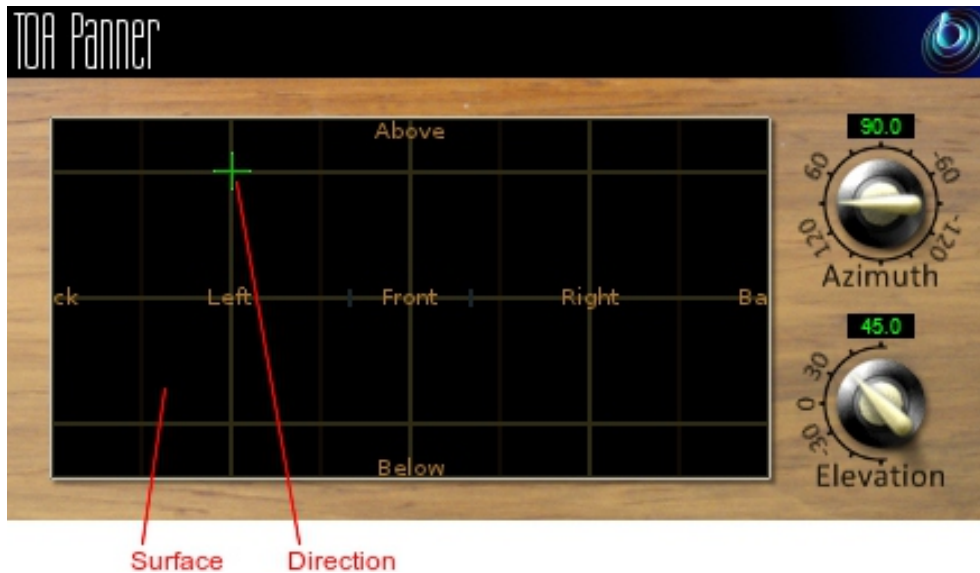
This extremely simple plugin measures the signal peak in each of the 16 channels of a [TOA stream](#) to indicate if a signal is present. It is intended for basic diagnostics (e.g. "are all my channels getting through?") and not for serious signal analysis. Audio is passed through unchanged.

3.8.2 Meters

Sixteen lights are shown, for each of the sixteen channels in TOA. Lights switch on with a yellow colour in the presence of very low signal levels (-100dB and above) and switch to red at high levels (0dB and above). Note that these signal levels are simple peak levels, *not* "True Peak".

Note that plain old "first order" ambisonic B-Format only uses the first four channels (W, X, Y and Z) of TOA, in which case only the first four lights will be on. Normal TOA streams should switch on all sixteen lights; if they don't there's probably something wrong! A common error is to forget to set a track's channel count to sixteen or more.

3.9 TOA Panner



Audio:

	Channels	Content
Input	1	Mono
Output	16	TOA

Controls:

- Azimuth
- Elevation

3.9.1 What does this do?

This TOA panner takes a mono sound and places it in a particular direction in a 3D TOA mix.

There are various versions of this panner plugin, but this is our favourite. This version uses more screen real estate than the ["classic" version](#) but is typically easier to use, particularly if you're just starting out with this way of doing things. That said, some people prefer the ["hemisphere" version](#).

As well as the azimuth and elevation dials that the classic version also has, there's a control surface which can be used to visualise the current direction. The current direction (indicated by the green crosshairs) can also be changed by clicking with the mouse. If you look carefully at the figure you'll see there is some faint text to help you find left, right, above etc. However, if this still doesn't make any sense, you might want to see our page on the [TOA Visualiser](#) which lays out its viewing region in the same way.

3.9.2 Controls

3.9.2.1 Azimuth and Elevation

Azimuth is the horizontal angle of the direction the source will be panned to, between -180 to +180 degrees, measured anticlockwise (left) from the front. Elevation is a vertical angle between -90 and +90 degrees, measured

with positive upwards and 0 on the horizontal.

For instance, the direction for azimuth +90 and elevation +45 can be found by turning 90 degrees to the left and then looking up by 45 degrees. It may help to experiment with the control surface to get used to this way of doing things.

3.10 TOA Panner - Classic



Audio:

	Channels	Content
Input	1	Mono
Output	16	TOA

Controls:

- [Azimuth](#)
- [Elevation](#)

3.10.1 What does this do?

This TOA panner takes a mono sound and places it in a particular direction in a 3D TOA mix.

There are various versions of this panner plugin and this is the most "raw" version. Only the "classic" azimuth/elevation controls are provided, largely to save screen real estate. These are great if you're used to them; if you're not, you might want to try the [standard version](#).

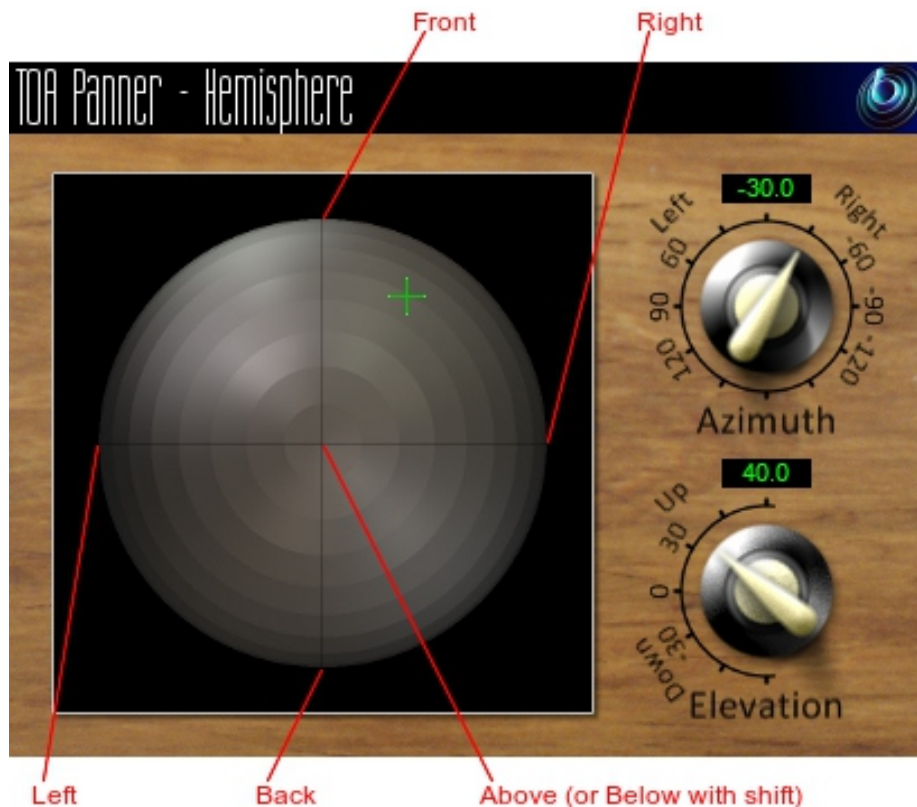
3.10.2 Controls

3.10.2.1 Azimuth and Elevation

Azimuth is the horizontal angle of the direction the source will be panned to, between -180 to +180 degrees, measured anticlockwise (left) from the front. Elevation is a vertical angle between -90 and +90 degrees, measured with positive upwards and 0 on the horizontal.

For instance, the direction for azimuth +90 and elevation +45 can be found by turning 90 degrees to the left and then looking up by 45 degrees. It may help to experiment with the [normal version](#) to get used to this way of doing things.

3.11 TOA Panner - Hemisphere



Audio:

	Channels	Content
Input	1	Mono
Output	16	TOA

Controls:

- [Azimuth](#)
- [Elevation](#)

3.11.1 What does this do?

This TOA panner takes a mono sound and places it in a particular direction in a 3D TOA mix.

There are various versions of this panner plugin. This version provides a control surface that maps directly onto the upper hemisphere of possible sound directions. You can click on the control surface to move the sound, and holding some keys down changes how the sound is moved:

- Use the "shift" key to select the lower hemisphere (so sounds are below rather than above).
- Use the "alt" key to lock the elevation (so sounds move in a horizontal circle).

A [hemisphere visualiser](#) is available for use with this plugin. We also recommend the [standard panner](#), which has a control surface using the same rectangular layout as the standard [TOA Visualiser](#). Alternatively, the "classic"

panner does not offer a control surface at all.

3.11.2 Controls

3.11.2.1 Azimuth and Elevation

Azimuth is the horizontal angle of the direction the source will be panned to, between -180 to +180 degrees, measured anticlockwise (left) from the front. Elevation is a vertical angle between -90 and +90 degrees, measured with positive upwards and 0 on the horizontal.

For instance, the direction for azimuth +90 and elevation +45 can be found by turning 90 degrees to the left and then looking up by 45 degrees. It may help to experiment with the control surface to get used to this way of doing things.

3.12 TOA Panner - Two Channel



Audio:

	Channels	Content
Input	2	Two Channels
Output	16	TOA

Controls:

- Azimuth 1
- Elevation 1
- Mouse Mode
- Azimuth 2
- Elevation 2

3.12.1 What does this do?

This TOA panner takes two mono sound sources and places them in particular directions in a 3D TOA mix.

It can also be used as a simple way to upmix stereo to TOA. However, we don't particularly recommend you do this except for fairly narrow angles because a large "hole" can appear between the two sources. For a more thorough handling of material that was originally panned to stereo you wish to look at Blue Ripple Sound's "TOA Upmixer - Stereo" plugin.

There are azimuth and elevation dials for each of the two sources. Each pair works the same way as the controls in the [mono version](#). There's a control surface which can be used to visualise the current directions for the two

sources, indicated by the green and red crosshairs. These can be changed by clicking with the mouse, using the left mouse button for the first source and the right mouse button for the second. If you have a strange computer which doesn't have a right mouse button, you can hold down the 'Alt' key and use the left button instead. You can also move both sources around together using the 'Shift' key.

If pressing keys on the keyboard is too difficult, there are [mouse mode buttons](#) on screen which can be used instead.

Mouse Mode	Key(s) Held	Function
Norm		Normal operation. Left click to move the first source, right click to move the second source.
Alt	Alt	Flips the source moved when the control surface is clicked, so a left click moves the second source rather than the first (and vice versa). Typically used to select the second source on a mouse with only one button.
Both	Shift	Changes the control surface so that movements of the mouse shift both sources.
Opp	Alt & Shift	Changes the control surface so that movements of the mouse shift both sources, but the sources move in opposite directions.

If you look carefully at the figure you'll see there is some faint text to help you find left, right, above etc. However, if this still doesn't make any sense, you might want to see our page on the [TOA Visualiser](#) which lays out its viewing region in the same way.

3.12.2 Controls

3.12.2.1 Azimuth 1, Elevation 1, Azimuth 2 and Elevation 2

Azimuth is the horizontal angle of the direction the source will be panned to, between -180 to +180 degrees, measured anticlockwise (left) from the front. Elevation is a vertical angle between -90 and +90 degrees, measured with positive upwards and 0 on the horizontal.

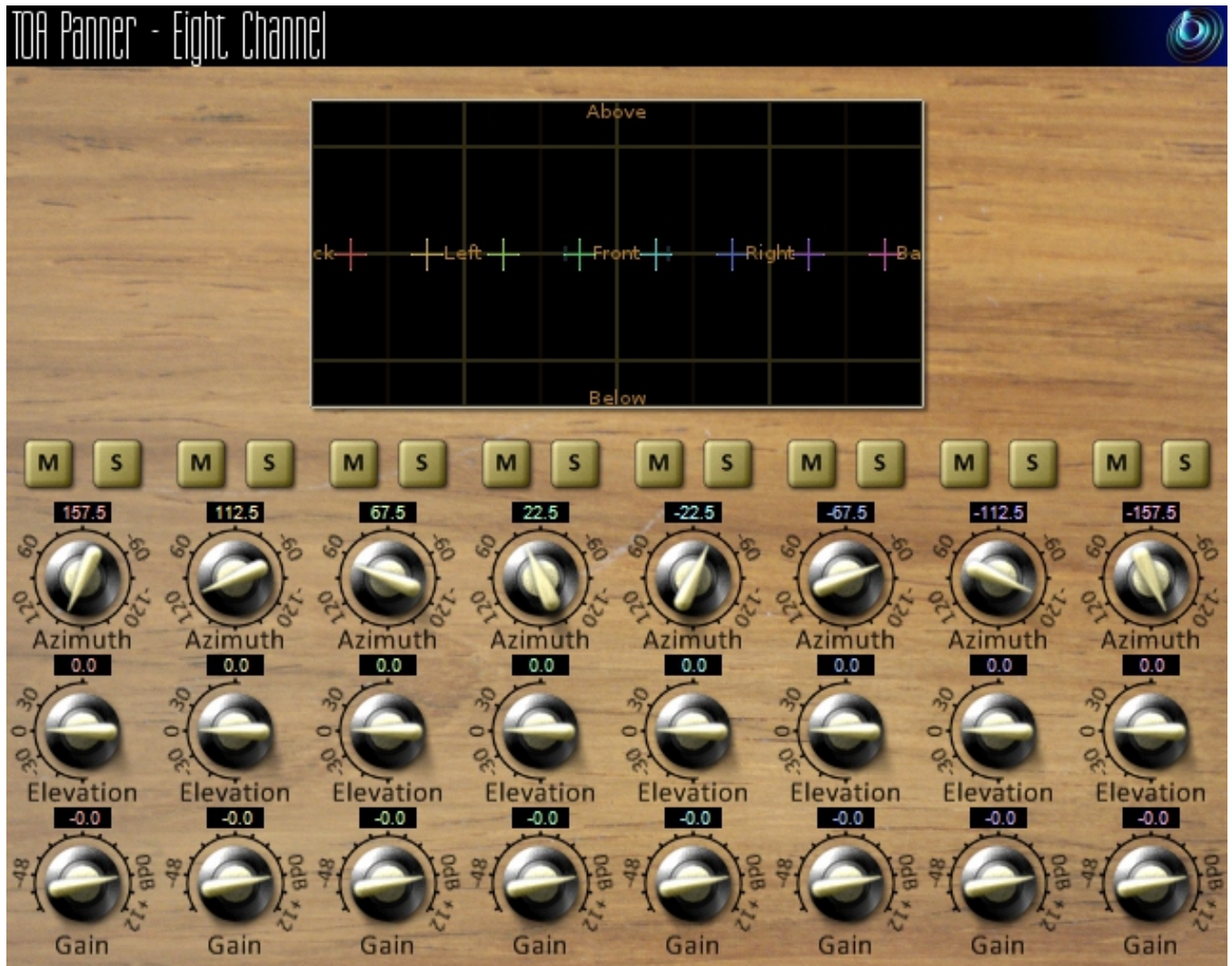
For instance, the direction for azimuth +90 and elevation +45 can be found by turning 90 degrees to the left and then looking up by 45 degrees. It may help to experiment with the control surface to get used to this way of doing things.

Azimuth 1 and Elevation 1 control the location used to pan the first source (which is shown in green on the control surface). Azimuth 2 and Elevation 2 control the location used to pan the first source (which is shown in red).

3.12.2.2 Mouse Mode

The mouse mode buttons in the middle at the bottom of the screen determine the mouse mode used when the control surface is clicked. They are an alternative to use of the Alt and Shift keys. See the [table above](#) for details on how these options affect operation.

3.13 TOA Panner - Eight Channel



Audio:

	Channels	Content
Input	8	Eight Channels
Output	16	TOA

Controls:

- Azimuth 1-8
- Elevation 1-8
- Gain 1-8
- Mute 1-8
- Solo 1-8

3.13.1 What does this do?

This TOA panner takes eight mono sound sources and places them in particular directions in a 3D TOA mix.

There are azimuth and elevation dials for each of the sources. Each pair works the same way as the controls in the [mono version](#).

There's a control surface which can be used to visualise the current directions for the sources, indicated by coloured crosshairs. These can be changed by dragging with the mouse. If you look carefully at the figure you'll see there is some faint text to help you find left, right, above etc. However, if this still doesn't make any sense, you might want to see our page on the [TOA Visualiser](#) which lays out its viewing region in the same way.

3.13.1.1 Reaper Note

If you are using this panner with Reaper, it is fairly easy to set up the mono source inputs as subtracks of the track on which the panner is set.

On the I/O panel for each subtrack, set the "Parent Channels" to send to the relevant pair of inputs in this plugin, and then pan hard left or right depending on whether this should be an odd or even input. Set this panner plugin as the first effect on the parent track and check the routing using the 'solo' button for the source.

3.13.2 Controls

3.13.2.1 Azimuth 1-8 and Elevation 1-8

Azimuth is the horizontal angle of the direction the source will be panned to, between -180 to +180 degrees, measured anticlockwise (left) from the front. Elevation is a vertical angle between -90 and +90 degrees, measured with positive upwards and 0 on the horizontal.

For instance, the direction for azimuth +90 and elevation +45 can be found by turning 90 degrees to the left and then looking up by 45 degrees. It may help to experiment with the control surface to get used to this way of doing things.

Azimuth and Elevation can also be changed by dragging the relevant source on the control surface.

3.13.2.2 Gain 1-8

Each panned source has its own gain control.

3.13.2.3 Mute 1-8 and Solo 1-8

Each panned source has its own mute and solo switch. These have the usual meanings. Solo overrides mute.

3.14 TOA Rotation



Audio:

	Channels	Content
Input	16	TOA
Output	16	TOA

Controls:

- [Yaw](#)
- [Pitch](#)
- [Roll](#)
- [Ordering](#)

3.14.1 What does this do?

This plugin rotates the entire TOA soundfield around the centre of the room.

Any rotation around the centre is possible and is built up using yaw, pitch and roll rotations. You can think of the rotations as being applied in order.

We *strongly recommend* that you use the [TOA Visualiser](#) when working with this plugin, particularly if you are going to use more than one of the dials at once. Otherwise, this plugin can be very confusing!

If you are using this plugin to simulate changes to the listener's orientation, you might also want to consider the [TOA Look](#) plugin, which is simpler to use but does not include a "roll" control.

3.14.2 Controls

3.14.2.1 Yaw, Pitch and Roll

These controls use angles between -180 and +180 degrees which can each be thought of as controlling individual rotations around three fixed axes. The overall rotation is a combination of the three.

Rotation	Axis	Description of Positive Movement
Yaw	Z	The soundfield is <i>rotated</i> left around the middle of the room. For instance, a sound that starts at the front moves left, a sound that starts at the left moves backwards and a sound directly above does not move.
Pitch	Y	The soundfield is <i>tumbled</i> backwards. For instance, a sound that starts at the front moves upwards, a sound that starts at the left does not move and a sound directly above moves backwards.
Roll	X	The soundfield is <i>tilted</i> clockwise. For instance, a sound that starts at the front does not move, a sound that starts at the left moves upwards and a sound directly above moves right.

This plugin can be used to simulate changes in the listener's orientation. If you are doing this, you will probably want to change the sign of the angles involved. For instance, turning the listener's head to the right means that the listener hears sound move to the left.

3.14.2.2 Ordering

This control determines the order in which the yaw, pitch and roll rotations are applied to make up a single rotation. The default is Y-P-R (i.e. yaw, pitch and then roll) but this can be switched to R-P-Y (i.e. roll, pitch and then yaw).

When simulating changes in the listener's orientation, we generally recommend the Y-P-R ordering. Then, the three dials can be thought of as turning the listener's head horizontally, then pitching it forwards or backwards, and finally rolling it from side to side.

3.15 TOA Virtual Microphone



Audio:

	Channels	Content
Input	16	TOA
Output	2	Stereo

Controls:

- [Stereo Width](#)
- [Response](#)

3.15.1 What does this do?

The TOA Virtual Microphone extracts a stereo image from a 3D TOA mix using a front-facing "virtual" stereo microphone placed at the centre of the sound field. The angle between the two capsules of this virtual microphone can be varied, along with their directional response. Available directional responses include omni, cardioid and figure-of-eight. This makes it possible to synthesise the results of various conventional coincident stereo recording techniques such as Blumlein X-Y and M/S.

This plugin does not allow you to point the front of the virtual microphone in other directions. If the front is not where you want, remember that you can rotate the soundfield using the [TOA Rotation](#) plugin before using this one.

This plugin actually only needs first order ambisonic information (from the W, X and Y channels).

If you are interested in extracting sounds in particular directions from a TOA mix, you may also be interested in the sharper response of the [TOA Beamer](#) plugin.

3.15.2 Controls

3.15.2.1 Stereo Width

This is the angle between the two virtual microphones, between 0 and 180 degrees. For instance, 90 degrees should be used for Blumlein X-Y.

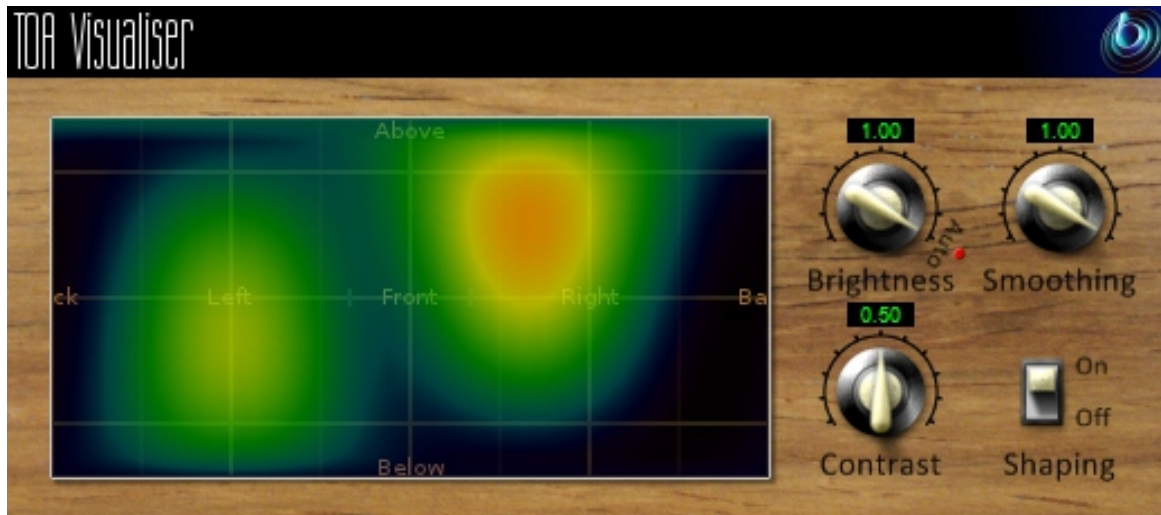
3.15.2.2 Response

The response control determines the directional response of the two microphone capsules. Some useful values are:

Response Value	Name
0.00	Omnidirectional
0.25	Subcardioid
0.50	Cardioid
0.75	Hypercardioid
1.00	Figure-of-Eight

For instance, 1.00 (figure-of-eight) should be used for Blumlein X-Y.

3.16 TOA Visualiser



Audio:

	Channels	Content
Input	16	TOA
Output	16	TOA

Controls:

- [Brightness](#)
- [Smoothing](#)
- [Contrast](#)
- [Shaping](#)

3.16.1 What does this do?

This plugin produces a view of a TOA stream which can help understanding what's happening in it. Audio is passed through unmodified, so the plugin can be inserted in the middle of a TOA effects chain.

The stream is shown using a rectangular screen region. This rectangular region shows an equal-area cylindrical projection of the directional components of the TOA soundfield interpreted over a sphere.

Or, to put it another way, it lights up in different places depending on where a sound comes from. Some of those places are labelled in faint text in the image. The view is like a map of the world, where sounds above are at the "north pole" and are shown across the top of the view and sounds below are at the "south pole" at the bottom. Sounds rotating around at head height move around the equator, so they move along the view half way down, wrapping around between the left and right edges as they pass behind.

A good way to try this out is to chain the [TOA Panner](#) immediately before this plugin as this uses the same directional approach. Then set up a decoder after this suitable for use with your speakers or headphones. Then you can play around with different sound directions and hear *and see* the results.

3.16.2 Controls

3.16.2.1 Brightness

This controls the brightness of the image. If the screen is black when sounds are playing, you may wish to turn this up. If it's red, turn it down.

Alternatively, you can set the dial to "Auto", in which case the plugin will try to ride the brightness control to keep the visualisation useful.

3.16.2.2 Smoothing

The image generated is smoothed over time. Use more smoothing for a more stable, slower moving image. Use less for a more responsive one.

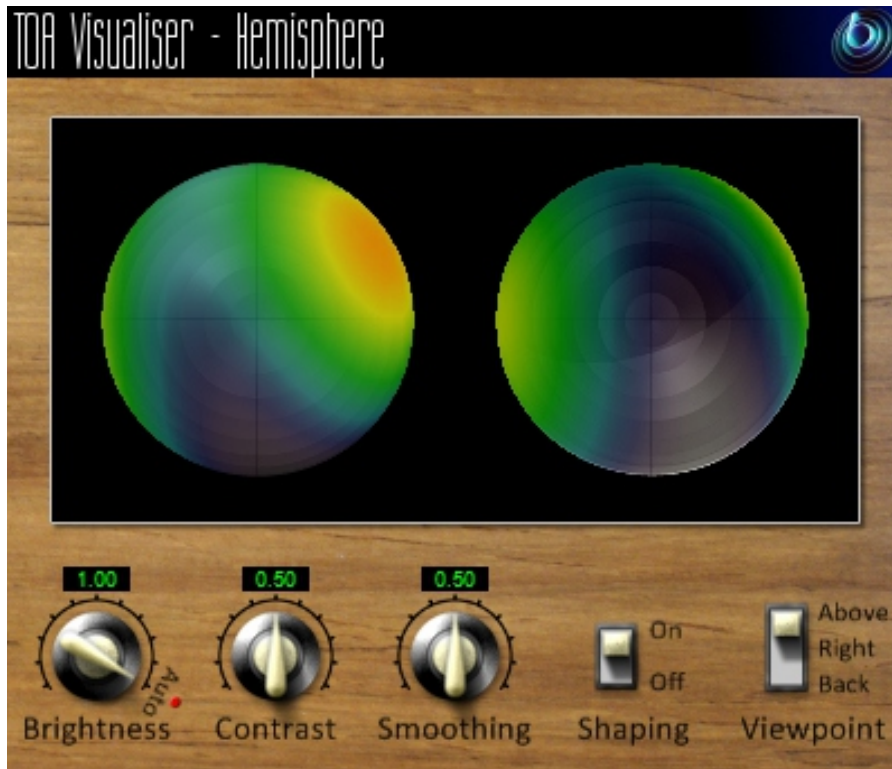
3.16.2.3 Contrast

This controls the contrast of the image. Higher values produce a sharper image but map a smaller dynamic range onto the screen.

3.16.2.4 Shaping

Shaping should normally be left on as it produces a more straightforward view. If this is turned off, the image will typically be sharper, but ripples will be visible in directions away from original sound directions.

3.17 TOA Visualiser - Hemisphere



Audio:

	Channels	Content
Input	16	TOA
Output	16	TOA

Controls:

- [Brightness](#)
- [Smoothing](#)
- [Contrast](#)
- [Shaping](#)
- [Viewpoint](#)

3.17.1 What does this do?

This plugin produces a view of a TOA stream which can help understanding what's happening in it. Audio is passed through unmodified, so the plugin can be inserted in the middle of a TOA effects chain.

The stream is shown using a two circular regions each showing a projection of a half of the directional components of the TOA soundfield interpreted over a sphere.

Or, to put it another way, it lights up in different places depending on where a sound comes from.

By default, the left sphere shows the upper hemisphere of the soundfield and the right sphere shows the lower

hemisphere, as if both were viewed from above. The image is orientated so that sounds at the front appear at the top of both images. However, the [viewpoint](#) can be changed.

A good way to try this out is to chain the [TOA Panner - Hemisphere](#) plugin immediately before this one as this uses the same directional approach (as long as the [viewpoint](#) is set to "Above"). Then set up a decoder after this suitable for use with your speakers or headphones. Then you can play around with different sound directions and hear *and see* the results.

We don't particularly recommend this visualisation. Generally, we suggest you use the standard [TOA Visualiser](#) instead.

3.17.2 Controls

3.17.2.1 Brightness

This controls the brightness of the image. If the screen is black when sounds are playing, you may wish to turn this up. If it's red, turn it down.

Alternatively, you can set the dial to "Auto", in which case the plugin will try to ride the brightness control to keep the visualisation useful.

3.17.2.2 Smoothing

The image generated is smoothed over time. Use more smoothing for a more stable, slower moving image. Use less for a more responsive one.

3.17.2.3 Contrast

This controls the contrast of the image. Higher values produce a sharper image but map a smaller dynamic range onto the screen.

3.17.2.4 Shaping

Shaping should normally be left on as it produces a more straightforward view. If this is turned off, the image will typically be sharper, but ripples will be visible in directions away from original sound directions.

3.17.2.5 Viewpoint

By default, the visualisation shows the upper hemisphere on the left and the lower hemisphere on the right, both viewed as the viewpoint was from **above**.

Alternatively, the viewpoint can be changed to view from the **right** or from **behind**. In both cases sounds above appear at the top of the image.

4 Technical Notes

4.1 What is a TOA Stream?

A Third Order Ambisonic (TOA) stream is made up of 16 individual channels of audio which together represent a 3D sound field. Into this "audio scene" can be placed individual sound sources, reverberation and complex spatial textures.

These 16 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 sound field. You don't need to understand them to use them though, but it is rather interesting. We think.

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 front/back, the third left/right and the fourth up/down. In fact the first and third channels together essentially provide 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 extra two channels the detail is available in all directions, not just left/right.

That covers the first 4 channels. The other 12 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). But you should *not* need to read up to *use* the techniques described here. If you want to make sense of what's going on spatially in a TOA stream, we find that it's normally best to use the [TOA Visualiser](#) plugin.

4.2 What processing can I apply to a TOA stream?

As well as processing designed specifically for TOA streams, it is possible to mix them together in the expected way. It is also possible to run conventional mono DSP algorithms on them directly by applying the algorithm to all 16 channels, subject to some rules. Failing to follow these rules is likely to shred the spatial imaging, so be careful! Specifically:

- If you process a TOA stream with a conventional mono DSP algorithm you *must apply the same processing to all 16 channels equally*.
- Only *linear* processing can be used (e.g. not distortion or compression). Also, be aware that time-variant processing can cause some 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 eight stereo EQ 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.

4.3 How does TOA relate to conventional ambisonic B-Format?

The first four channels of the sixteen of TOA B-Format are backwards-compatible with conventional first order Gerzon B-Format, for instance recorded by an ambisonic B-Format microphone (and sometimes known as "Plain Old Ambisonics" or "POA").

This means that:

- You can mix a TOA stream down to conventional B-Format by simply taking the first four channels and ignoring the rest.
- You can mix conventional B-Format into the TOA stream, although it will not be as detailed spatially as material mixed directly in TOA and it may need slight treatment.

TOA actually uses a standard Higher Order Ambisonic encoding (see below).

4.4 Why Third Order?

These plugins are based on Higher Order Ambisonic (HOA) techniques, which in principle can run at any "order" of spatial detail. We could have made all these plugins work at different orders; once you've got as far as making the maths and DSP work at third order (16 channels) it isn't hard to extend to (for instance) fifth order (36 channels). But we decided to use third order as it provides a good balance between spatial detail, current practice and CPU load. And sticking to just one type of B-Format avoids all sorts of "wiring" headaches.

4.5 Encoding

There are a number of ways in which the channels could have been defined. To a large extent it doesn't 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 isn't 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.

The convention we've used is called "Furse-Malham" or "FuMa" (and sometimes "FMH") which is supported by a number of existing software packages. It was originally developed by Dave Malham with a little help from Richard Furse. This uses a different channel ordering and gain levels to other approaches such as "N3D".

For the avoidance of ambiguity, here, in order, are the 16 gains used in the [TOA Panner](#) when synthesising a planewave sound source from a direction described by azimuth A and elevation E, where the azimuth is measured anticlockwise (left) from the front and elevation is measured with 0 on the horizontal and +90deg above.

Label	Azimuth/Elevation Representation
W	$\sqrt{1/2}$
X	$\cos(A) \cos(E)$
Y	$\sin(A) \cos(E)$
Z	$\sin(E)$
R	$(1/2) (3\sin(E) \sin(E) - 1)$
S	$\cos(A) \sin(2E)$
T	$\sin(A) \sin(2E)$
U	$\cos(2A) \cos(E) \cos(E)$
V	$\sin(2A) \cos(E) \cos(E)$
K	$(1/2) \sin(E) (5\sin(E) \sin(E) - 3)$
L	$\sqrt{135/256} \cos(A) \cos(E) (5\sin(E) \sin(E) - 1)$
M	$\sqrt{135/256} \sin(A) \cos(E) (5\sin(E) \sin(E) - 1)$
N	$\sqrt{27/4} \cos(2A) \sin(E) \cos(E) \cos(E)$
O	$\sqrt{27/4} \sin(2A) \sin(E) \cos(E) \cos(E)$
P	$\cos(3A) \cos(E) \cos(E) \cos(E)$
Q	$\sin(3A) \cos(E) \cos(E) \cos(E)$

4.6 Converting TOA streams to AMB files

As TOA streams are actually third order FuMa, they can be packed into ".amb" files, for instance for use with Blue Ripple Sound's ["Rapture3D Player"](#).

The player will also play ".wav" files containing 16-channel TOA correctly if they are opened directly in the player (we guessed you probably don't want to associate ".wav" files with it). There are tools to convert ".wav" files to ".amb", for instance the "fmh2amb" program which ships with some Blue Ripple Sound software.