VIVE 3DSP Audio SDK Guide (Unity Plugin)

Release version: 1.3.12

Table of Contents

System Requirements

- Unity version 2017 or higher
- Windows® 7 SP1, Windows® 8 or later, Windows® 10
- Android 8.1 or later
- Intel® Core™ i5-4590 or AMD FX™ 8350 equivalent or better
- NVIDIA® GeForce® GTX 1060 or AMD™ Radeon™ RX 480, equivalent or better graphics card

Why is 3D Audio Needed in VR?

For many VR applications, there may be awesome visuals in the scene, but it will be less immersive without accompanying audio. Therefore, the 3D audio experience is crucial to increase true immersion and sense of presence in VR environments.

There are a lot of factors related to audio experiences in VR applications, such as sound Localization, Room Reverberation, Distance, Spatialization, etc.

Localization

Localization is the inherent ability of human beings to figure out where a sound is coming from based on human auditory system. By understanding the human auditory system, real-world spatialized sound can be simulated in a VR environment.

Here, the factors are listed as:

- **Lateral**
  - **Interaural time difference**

    The direction of a sound source can be determined by the time difference that a sound arrives to our ears, i.e. a sound wave is transmitted to the right ear before the left ear, and so the listener can be aware that the sound wave comes from the right-hand side.
  - **Interaural level difference**

    There is also the sound level difference between both ears of the listener during sound propagation, i.e. the sound wave reaches the right ear before the left ear, the sound energy decays while sound is transmitting.
- **Elevation and Front/Back**

  In order to distinguish the direction of the sound which has the same arrival time and level, direction selective cues (pinna, head, shoulder, and torso) are used as the main reliable features. These cues are used to help determine where the sound comes from. Moreover, people can also cock their head up or turn their heads left or right to determine the direction of the sound source more precisely.

- **Pinna**

  When the sound arrives at the head, it will then be collected and filtered by the outer ears. These filters provide the feeling to the brain to determine where the sound is coming from.

- **Head/Shoulder/Torso**

  A sound wave is partially blocked or absorbed by the body of a listener during sound propagation. That means there is an inference of the body on sound feeling.

Room Reverberation

If the user is inside the room, the walls and objects in that room will reflect or scatter the sound waves. The sound waves will bounce again and again, and form a particular audio perceptual experience in that room. It not only builds a realistic feeling of the room, but also improves the accuracy of the directional perception.

Distance

The distance between a sound source and a listener is also an important factor on spatial audio application. There are some ways to describe the sound level decay that corresponds to the sound transmitting distance.

- **Loudness**

  Louder sounds are usually closer while quieter sounds are usually farther. In some cases, it is hard to judge the distance by the loudness if people are not familiar with the sound. The relative loudness is also considered. When a sound wave approaches, it sounds louder and vice versa.

- **Initial time delay**

  This is the time difference between the arrival of the direct sound and the first significant reflection, reflected from the surface of the room. When somebody is talking to a listener in a room, the listener will hear the direct voice right away then the reflected voice a bit later. If the person is standing farther away, the listener will probably hear the voice and reflections almost at the same time.

- **Mix of direct and indirect sounds**

  The human auditory system unconsciously mixes direct and indirect sounds. When the direct sound is perceived louder than the indirect sound, the sound is emitted near to the listener, otherwise the sound is far away from the listener.
- **Interaural level difference**

  When there is an obvious difference of loudness between the two ears of an audience, the sound is most likely to be close to the audience. When the loudness difference between the two ears of the audience is negligible, the sound is probably far away.

Spatialization

Spatialization is an audio effect that makes listeners feel immersed in a virtual 3D environment. Spatialization is a key factor for an immersive VR experience. A lot of features are accomplished to simulate the real spatial feeling in 3DSP Audio SDK, such as:

- Head-related transfer functions (HRTF) recording and improvement
- Higher Order Ambisonic simulation of sound direction
- Room audio simulation
- Adding background noise floor
- Real-world acoustic properties of distance
- Sound occlusion simulation
- Hi-Res audio support

and many other features

VIVE 3DSP Audio SDK

VIVE 3DSP Audio SDK is an audio solution for simulating realistic sounds in the virtual world. The SDK could be used to create engaging and immersive spatial audio for VR apps or experiences. A host of features are designed for developers.

Some of the unique features of VIVE 3DSP Audio SDK:

- **Higher Order Ambisonics (HOA)**

  Highly optimized 3rd order HOA is implemented with very low computing power.
- **Head-Related Transfer Function (HRTF)**

  The precise HRTF is modelled in this SDK for every 5 degree angles.
- **Room Audio**

  The reflection and reverberation of a real space are simulated in the room audio model.
- **Hi-Res Audio Settings**

  The quality is kept when Hi-Res audio is processed with VIVE 3DSP Audio Features.
- **Sound Decay Model**

  The different models are adopted to create the different sound decay phenomena.
- **Geometric Occlusion**

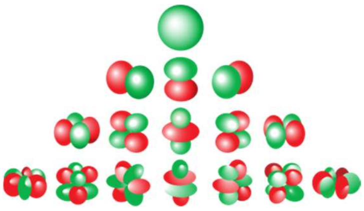
  The super-efficient occlusion model works well without any Unity collider. Moreover, the virtual sound wave could be partially occluded according to the obstacle geometry.
- **Ambisonic Decoder**

  The AmbiX file is supported in the SDK.

VIVE 3DSP Audio SDK is hardware-independent, high-quality, user-friendly, and powerful. Outstanding sound experiences can be provided especially for VIVE devices.

Higher Order Ambisonics (HOA)

Ambisonics is the technology that uses a full-sphere surround sound technique to simulate spatial sound. Spherical harmonics is presented as the sound pressure changes around the listener.



The order of the spherical harmonics is also called the order of Ambisonics. The order of Ambisonics has a big influence on the realistic depiction of the direction of sound. Therefore, 3rd order Ambisonics is used in the spatial audio model as it generates the better directivity of a spatial sound.

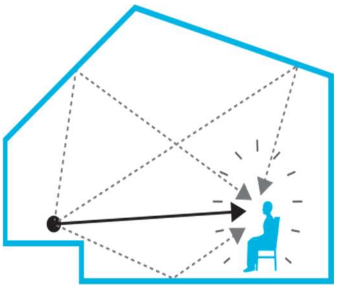
When the higher order is used, higher computing power is required for the Ambisonic process. However, as a patent-pending technique is used on the VIVE 3DSP Ambisonic process, it just requires a low computing power similar to the 1st order Ambisonic.

Head-Related Transfer Function (HRTF)

The head-related transfer function represents the spatial sound model. There are many factors that could change the audio experience coming from an audio source travelling to the human ears, and it is too complicated to simulate the phenomena by dedicated functions. Therefore, a database has been created where all acoustic responses have been modelled. The audio response can be demonstrated by using the recorded data from this database.

In the VIVE 3DSP Audio SDK, there is an HRTF database that was measured with fine directional segments, both horizontally and vertically. This means that thousands of HRTF directions have been measured. For HRTF directions that have not been measured, these could also be generated by the measured directions nearest to it, with the quality benefitting from the fine measurement of the HRTF database. The quality degradation caused by the environment, the measuring equipment, and other factors that affect HRTF have also been improved in our database.

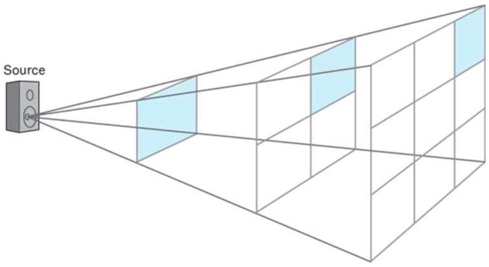
Room Audio



Room Audio is the technology that simulates the sound feelings in a room such as the early reflection, late reverberation, ambient sound, and others. The material (e.g. wood, concrete, glass, etc.) of the walls in a room affects the sound reflections in the early stage of the traveling sound. After that, the sound encounters more reflections and mixes with the background sound and finally turns into late reverberation. Furthermore, binaural acoustics should be simulated especially when a human is located at the corner of the room. Moreover, there should be a lot of low-level sound like the sound from a refrigerator or an air conditioner, therefore the phenomena is also presented in Room Audio technology.

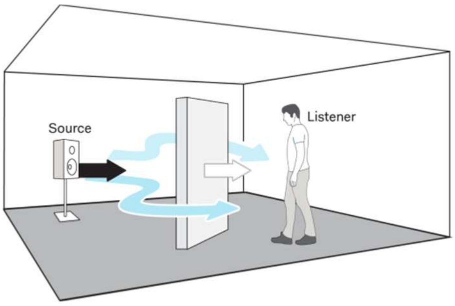
Note: Room audio only works when the audio source and listener are in the same room.

Sound Decay Model



During the sound wave propagation, the sound energy changes according to the distance. The inverse square law is a conventional method for this scenario to determine the change in the sound levels. However, the capability of the sound decay varies depending on the frequency. Point source, line source and linear curve attenuation models are provided.

Occlusion



The occlusion effect is adopted to simulate a phenomena when a sound wave encounters an obstacle. The resulting sound is produced depending on the properties of the obstacles, like the material and thickness.

In some cases, the obstacle asymmetrically occludes the sound transmission between a sound source and a human head. For more realistic experiences, binaural occlusion is considered in VIVE 3DSP Audio SDK to produce different sound feelings for both ears.

In this SDK, a high-precision analytical geometry technique is present in occlusion effect. The occluded-sound effect can be presented according to some geometric factors of the obstacles, such as positions, rotations, sizes, and shapes. It also performs efficiently without using any amount of physics engine of other platforms like Unity or Unreal Engine.

Ambisonic Decoder

Audio recordings for 360/180 and VR videos are now mostly achieved by sound field microphones in the 4-channel B-format. Here, these channels are not translated to a fixed representation of sound. Instead, the Ambisonic decoder can interpret and reshape the sound recordings such that it can dynamically render a stereo audio according to a listener’s rotation.

VIVE 3DSP Audio SDK Unity Plugin

Import Latest Package into New Project

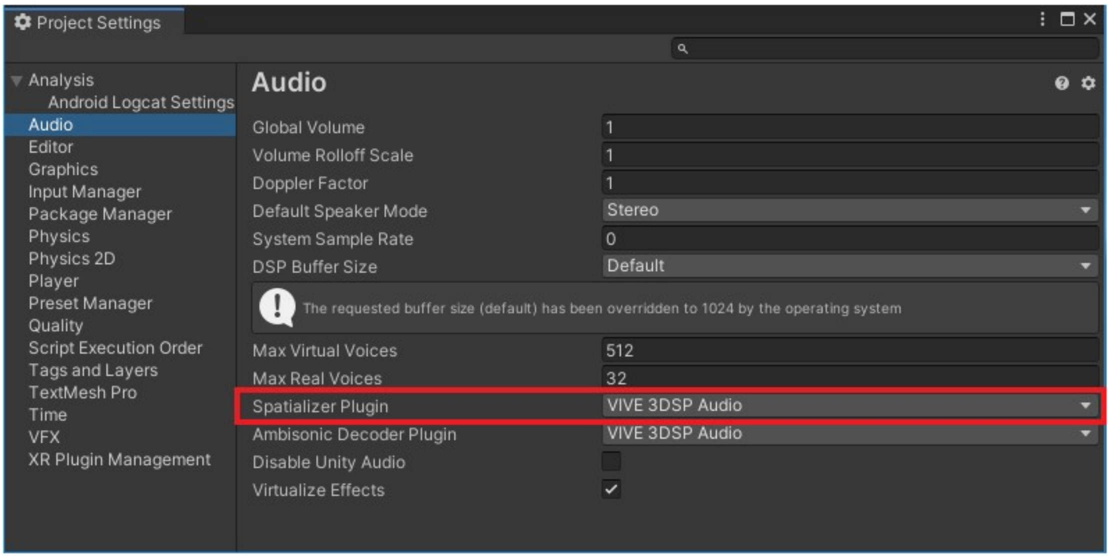
1. Download the latest version of VIVE 3DSP Audio Plugin in website.
2. Create a new 3D project in Unity.
3. Click **Assets > Import Package > Custom Package**.
4. Select the latest version of **Vive3DSP .unitypackage** file and click **Import**.

Upgrade to Latest Package

1. Close Unity project, if open.
2. In the Unity project, go to the **Assets** folder and delete the **Vive3DSP** folder.
3. Open the project and import the latest version of VIVE 3DSP Audio Plugin (follow step 3 and 4 from the Import Latest Package into New Project section).

Set Spatializer Plugin

Select **VIVE 3DSP Audio** in **Spatializer Plugin**.



Audio

Global Volume	1
Volume Rolloff Scale	1
Doppler Factor	1
Default Speaker Mode	Stereo
System Sample Rate	0
DSP Buffer Size	Default

The requested buffer size (default) has been overridden to 1024 by the operating system

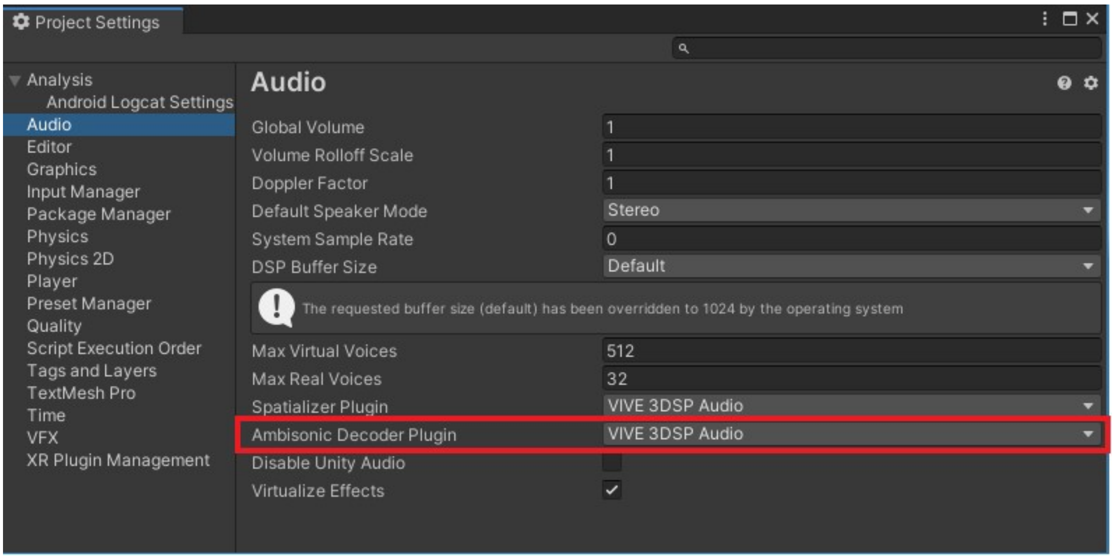
Max Virtual Voices	512
Max Real Voices	32
Spatializer Plugin	VIVE 3DSP Audio
Ambisonic Decoder Plugin	VIVE 3DSP Audio
Disable Unity Audio	□
Virtualize Effects	☑

1. Click **Edit > Project Settings > Audio**.
2. Select **VIVE 3DSP Audio** in **Spatializer Plugin**.

Note: VIVE 3DSP supports 3rd order Ambisonics for spatializer.

Set Ambisonic Decoder Plugin

Select V**IVE 3DSP Audio** in **Ambisonic Decoder Plugin**.



Audio

Global Volume: 1
Volume Rolloff Scale: 1
Doppler Factor: 1
Default Speaker Mode: Stereo
System Sample Rate: 0
DSP Buffer Size: Default

The requested buffer size (default) has been overridden to 1024 by the operating system

Max Virtual Voices: 512
Max Real Voices: 32
Spatializer Plugin: VIVE 3DSP Audio
Ambisonic Decoder Plugin: VIVE 3DSP Audio
Disable Unity Audio: □
Virtualize Effects: ☑

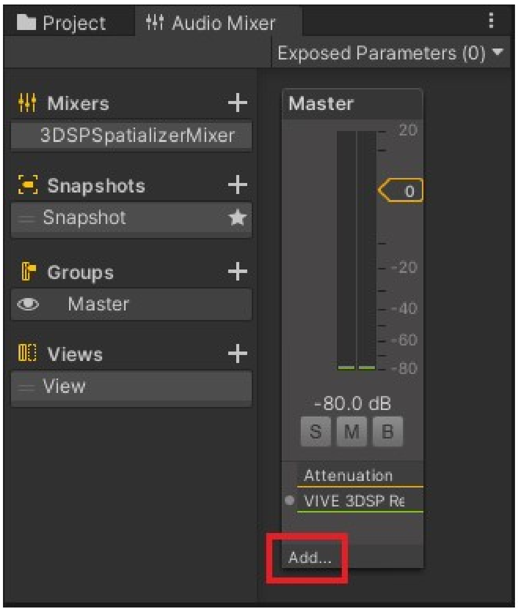
1. Click **Edit > Project Settings > Audio**.
2. Select V**IVE 3DSP Audio in Ambisonic Decoder Plugin**.

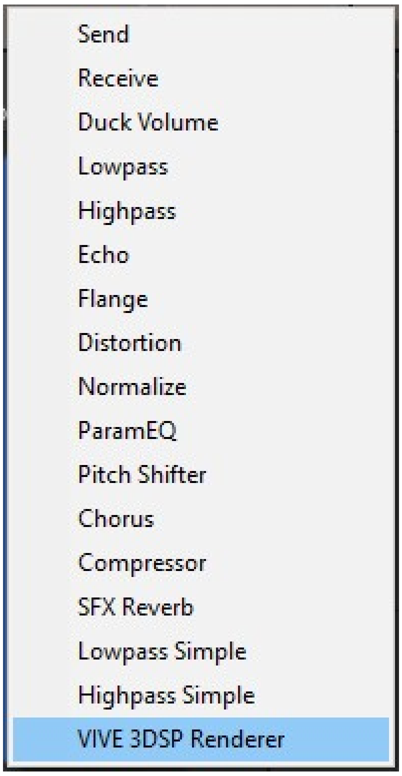
Note: VIVE 3DSP supports up to 3rd order Ambisonics for decoder.

Audio Mixer Settings

Add an audio mixer

1. Click **Window > Audio > Audio Mixer**.
2. Click **+** to add a new audio mixer.
3. In the **Audio Mixer** tab, click **Add**, and then select **VIVE 3DSP Renderer**.

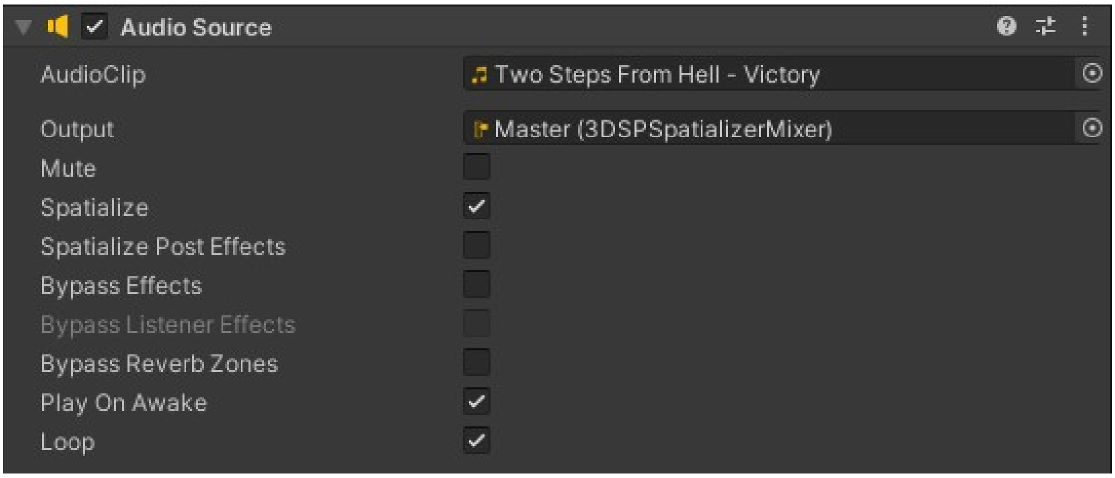




Audio Source Settings

Set an object as the audio source

1. Do any of the following:
   a. Attach the VIVE 3DSP Audio Source component to a Unity audio source object. Click **Add Component > VIVE > 3DSP_AudioSource.**
   b. Attach the VIVE 3DSP Audio Source component to an object that contains a Unity Audio Source component.
2. Add an **Audio Clip** to the Unity Audio Source.
3. Set the audio mixer that includes **VIVE 3DSP Renderer** as the Unity Audio Source output.



Audio Source

AudioClip: Two Steps From Hell - Victory

Output: Master (3DSPSpatializerMixer)

Mute □

Spatialize ☑

Spatialize Post Effects □

Bypass Effects □

Bypass Listener Effects □

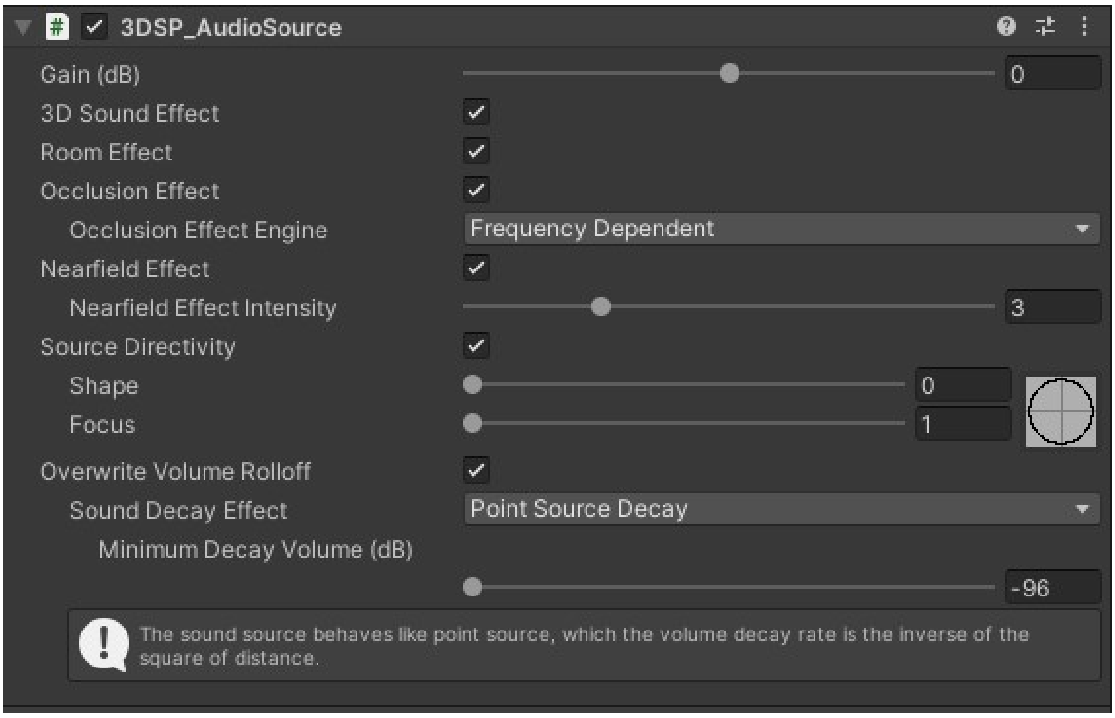
Bypass Reverb Zones □

Play On Awake ☑

Loop ☑

Note: Don’t select **Bypass Effects** and **Bypass Listener Effects** in the Unity Audio Source.

There are a lot of Unity default features in the Audio Source object. The VIVE 3DSP Audio Source component offers more features for the spatializer effect.



3DSP_AudioSource

Gain (dB): 0

3D Sound Effect ☑

Room Effect ☑

Occlusion Effect ☑

Occlusion Effect Engine: Frequency Dependent

Nearfield Effect ☑

Nearfield Effect Intensity: 3

Source Directivity ☑

Shape: 0

Focus: 1

Overwrite Volume Rolloff ☑

Sound Decay Effect: Point Source Decay

Minimum Decay Volume (dB): -96

The sound source behaves like point source, which the volume decay rate is the inverse of the square of distance.

- **Gain (dB)**: This option sets the audio clip volume level (in dB).
- **3D Sound Effect**: This option turns on or off the 3D Sound effect, which includes the directional sound feeling and sound decay properties.

- **Room Effect**: The option turns on or off the room audio application.
- **Occlusion Effect:** This option turns on or off the sound occlusion application.
- **Occlusion Effect Engine**: There are two types of occlusion engines that can be selected:
  a. **Frequency Dependent**: The different material corresponds to the different sound frequency responses during sound transmission. The sound decay caused by objects is different based on frequencies. The real-world material response is modelled in this application.
  b. **Frequency Free**: The sound decay influence of an obstacle is simulated by the volume decay only and the computing cost is minimal.
- **Nearfield Effect:** This option turns on or off the nearfield effect—which performs the sound response—when the sound source is near the listener. The nearfield effect is only active when the distance between the source and listener is **less than one meter**.

  Nearfield Effect Intensity: This option represents the strength of the nearfield effect. The higher the value, the stronger the nearfield effect will be.

  Note: DRC is enabled by default to help prevent audio signal clipping.
- **Source Directivity:** This option turns on or off the source directivity effect which simulates the sound direction and response when the pattern changes.
  a. **Shape**: This option presents the shape of the source directivity pattern.
  b. **Focus**: This option presents the sharpness of the source directivity pattern.
- **Overwrite Volume Rolloff**: If this feature is selected, the Unity built-in volume roll off effect will be disabled, and the VIVE 3DSP Sound Decay Effect will be used instead. Several types of **Sound Decay Effect** can be selected:
  a. **Point Source Decay**: This is the sound decay effect that is based on inverse-square law. It behaves as the point source where the sound energy decreased ratio is based on the propagation area (the square of the propagation distance).
  b. **Line Source Decay**: This is the sound decay effect that is based on

inverse law. It behaves as the line source where the sound energy decreased ratio is based on the propagation distance.

c. **Linear Decay**: It is the customized sound decay effect. The volume decay is linearly proportional to the distance between the source and listener. These parameters can be adjusted:
    - **Minimum Distance (M)**: When the distance is lower than the minimum distance, the volume decay rate is 1.0.
    - **Maximum Distance (M)**: The volume decay rate will be the **Minimum Decay Volume (dB)** if the distance is longer than the **Maximum Distance**.

d. **No Decay**: No sound decay effect will be applied in this audio source.

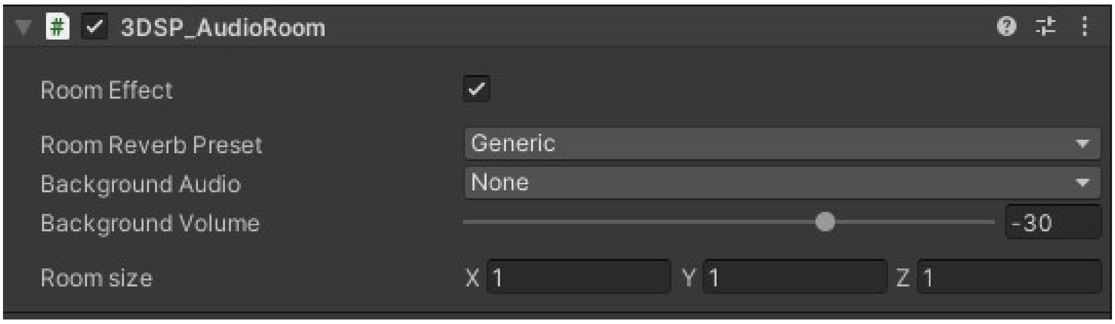
Notes:

- When **Overwrite Volume Roll-off** is selected, the default Unity distance curve will be set to a constant, 1.0.
- **Minimum Decay Volume (dB)** can be set in this application.

Audio Room Settings

In VIVE 3DSP Audio Room, the reverberations can be represented via specific room sound effects. All audio sources inside a VIVE 3DSP Audio Room object are affected by the room properties such as size, materials, etc.

Specifically, several often-used room presets are provided in VIVE 3DSP Audio Room. Moreover, if **User Define** is selected, a list of materials and sound properties can be customized for the walls. This component can be selected via **Add Component > VIVE > 3DSP_AudioRoom.**



☑ 3DSP_AudioRoom

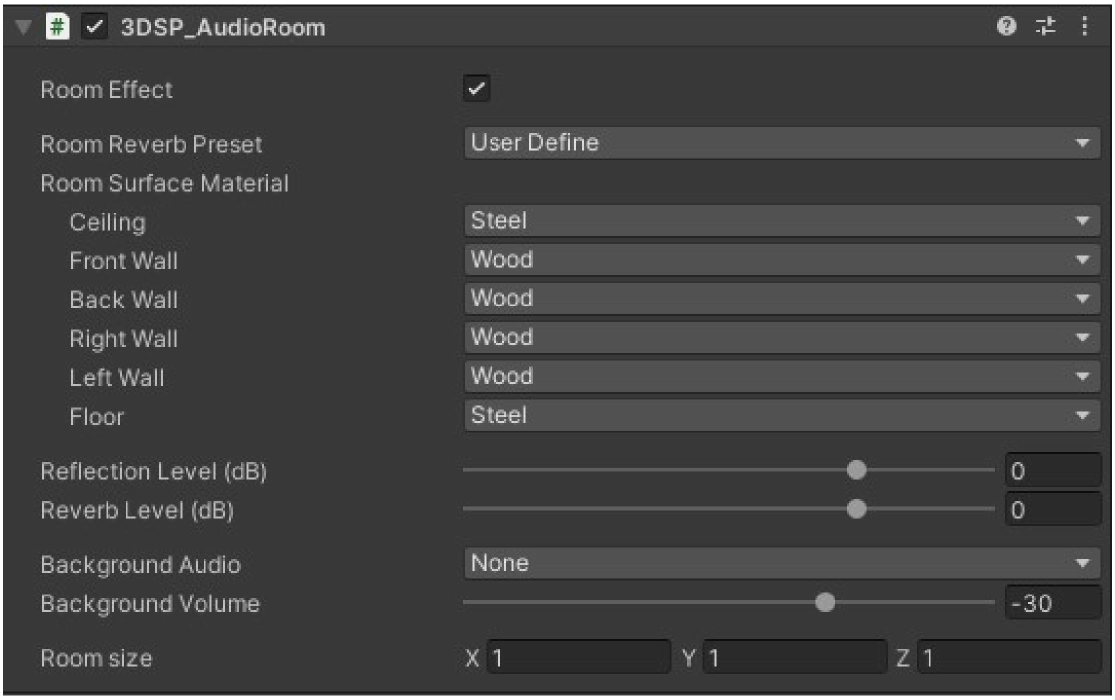
Room Effect ☑

Room Reverb Preset: Generic

Background Audio: None

Background Volume: -30

Room size: X 1 Y 1 Z 1



☑ 3DSP_AudioRoom

Room Effect ☑

Room Reverb Preset: User Define

Room Surface Material

- Ceiling: Steel
- Front Wall: Wood
- Back Wall: Wood
- Right Wall: Wood
- Left Wall: Wood
- Floor: Steel

Reflection Level (dB): 0

Reverb Level (dB): 0

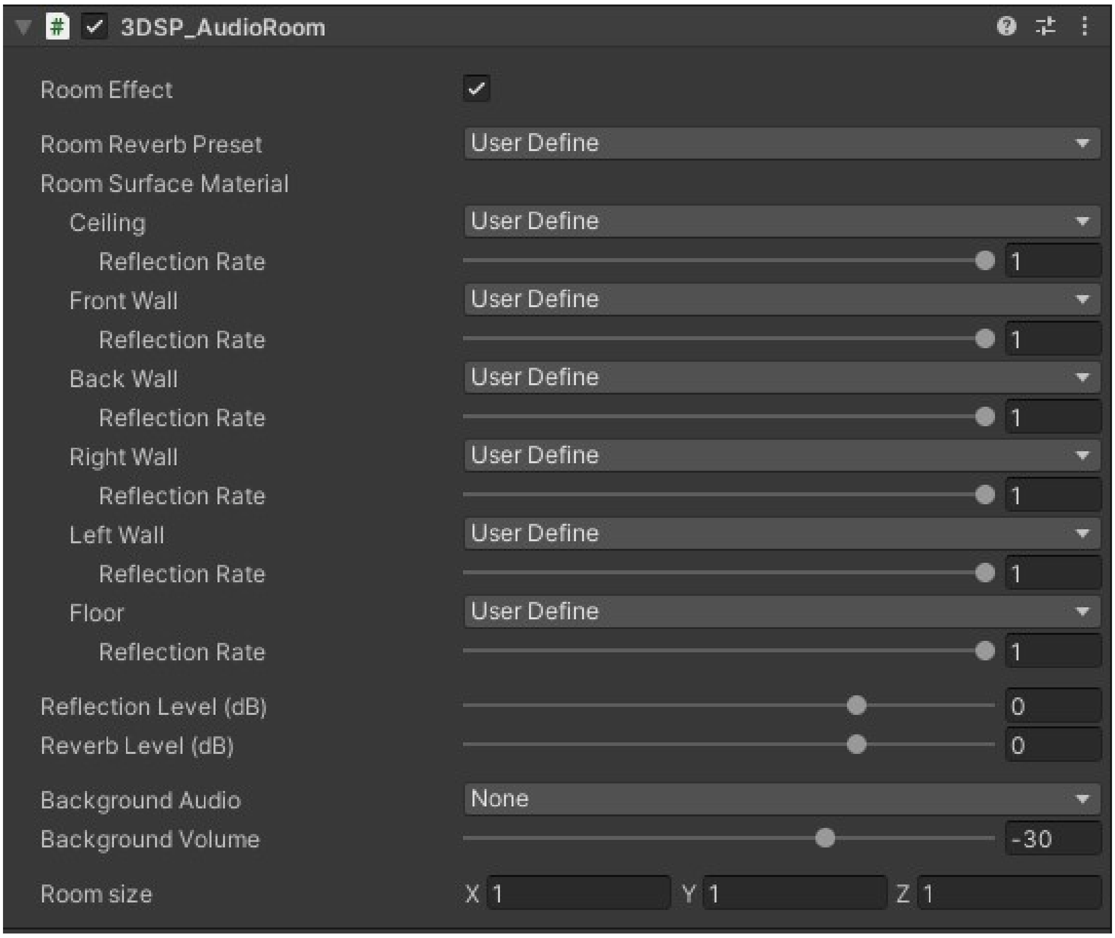
Background Audio: None

Background Volume: -30

Room size: X 1 Y 1 Z 1

- **Room Effect**: This option can be turned on to apply the room reverberation effect.
- **Room Surface Material**: This option shows the material of the walls. It will

change the ingredients of the reflected sound. There are pre-defined material presets for each wall. A customized material can be chosen via **User Define**, and the parameter of the sound reflection ability of the wall can be set via **Reflection Rate**.



3DSP_AudioRoom

Room Effect ☑

Room Reverb Preset: User Define

Room Surface Material

Ceiling: User Define

Reflection Rate: 1

Front Wall: User Define

Reflection Rate: 1

Back Wall: User Define

Reflection Rate: 1

Right Wall: User Define

Reflection Rate: 1

Left Wall: User Define

Reflection Rate: 1

Floor: User Define

Reflection Rate: 1

Reflection Level (dB): 0

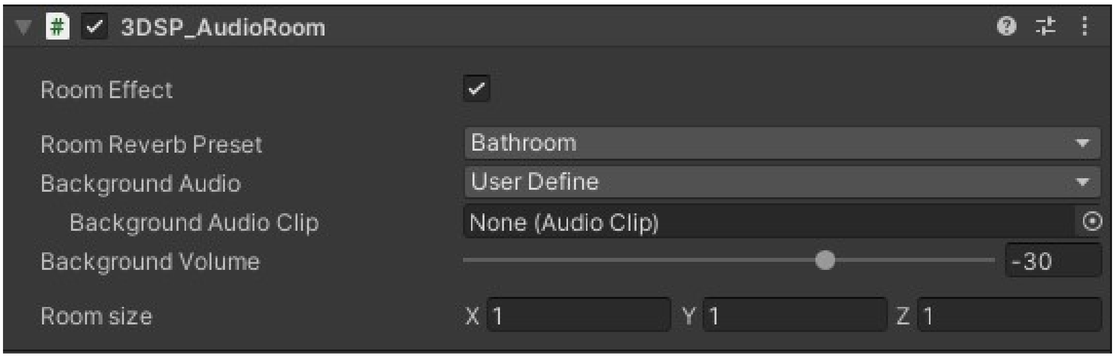
Reverb Level (dB): 0

Background Audio: None

Background Volume: -30

Room size: X 1 Y 1 Z 1

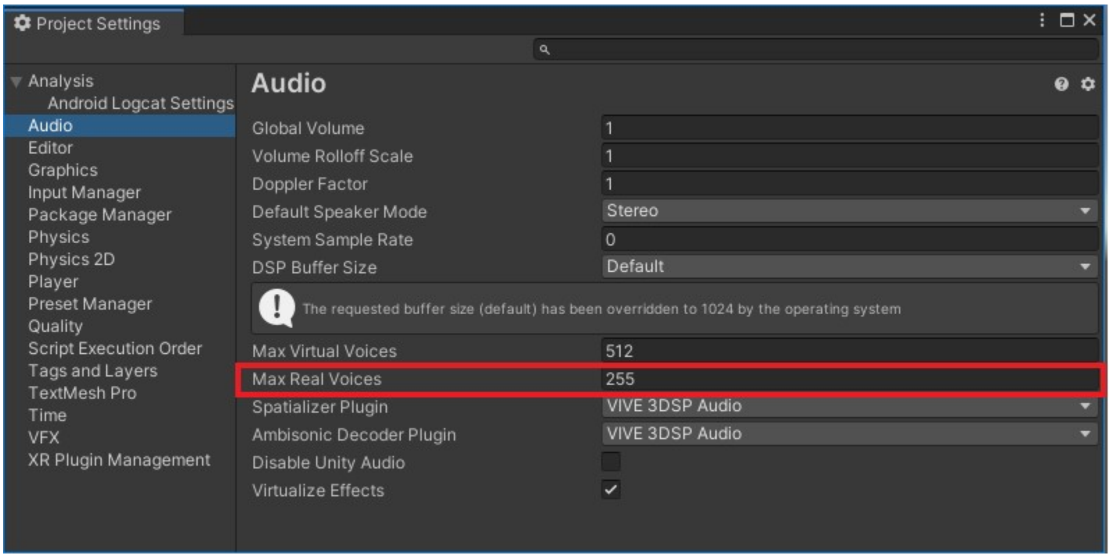
- **Reflection Level**: This option sets the strength of the early reflections, it ranges from -30 dB to 10 dB.
- **Reverb Level**: This option sets the strength of the late reverberations, it ranges from -30 dB to 10 dB.
- **Background Audio**: The background audio presents the sound effect of the ambient sounds in the environment. There are several default types in the background audio option. The preferred audio file can be chosen in **User Define**.



☑ 3DSP_AudioRoom

Room Effect	☑
Room Reverb Preset	Bathroom
Background Audio	User Define
Background Audio Clip	None (Audio Clip)
Background Volume	-30
Room size	X 1 Y 1 Z 1

Note: The background audio is counted as one audio source in Unity. The limitation of the quantity of audio sources in Unity is adjustable in AudioManager settings. The maximum is 255 (setting in **Max Real Voices**).



Project Settings

- Analysis
  - Android Logcat Settings
- Audio
- Editor
- Graphics
- Input Manager
- Package Manager
- Physics
- Physics 2D
- Player
- Preset Manager
- Quality
- Script Execution Order
- Tags and Layers
- TextMesh Pro
- Time
- VFX
- XR Plugin Management

Audio

Global Volume	1
Volume Rolloff Scale	1
Doppler Factor	1
Default Speaker Mode	Stereo
System Sample Rate	0
DSP Buffer Size	Default

The requested buffer size (default) has been overridden to 1024 by the operating system

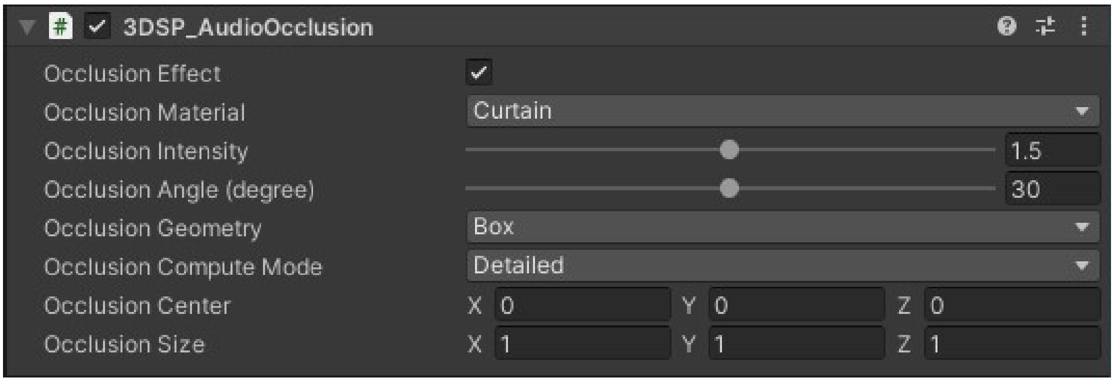
Max Virtual Voices	512
Max Real Voices	255
Spatializer Plugin	VIVE 3DSP Audio
Ambisonic Decoder Plugin	VIVE 3DSP Audio
Disable Unity Audio	□
Virtualize Effects	☑

- **Background Volume**: This option sets the strength of the Background Audio, it ranges from -40 dB to 96 dB.
- **Room Size**: This option means the dimension of the room in meters. The factor, **Scale** in “Transform” of the attached object, is considered here.

Audio Occlusion Settings

To have the occlusion effect, it is necessary to set the environment in both the VIVE 3DSP Audio Source and VIVE 3DSP Audio Listener. In audio source objects, the VIVE 3DSP Audio Occlusion component needs to be added to establish the sound occlusion effects.

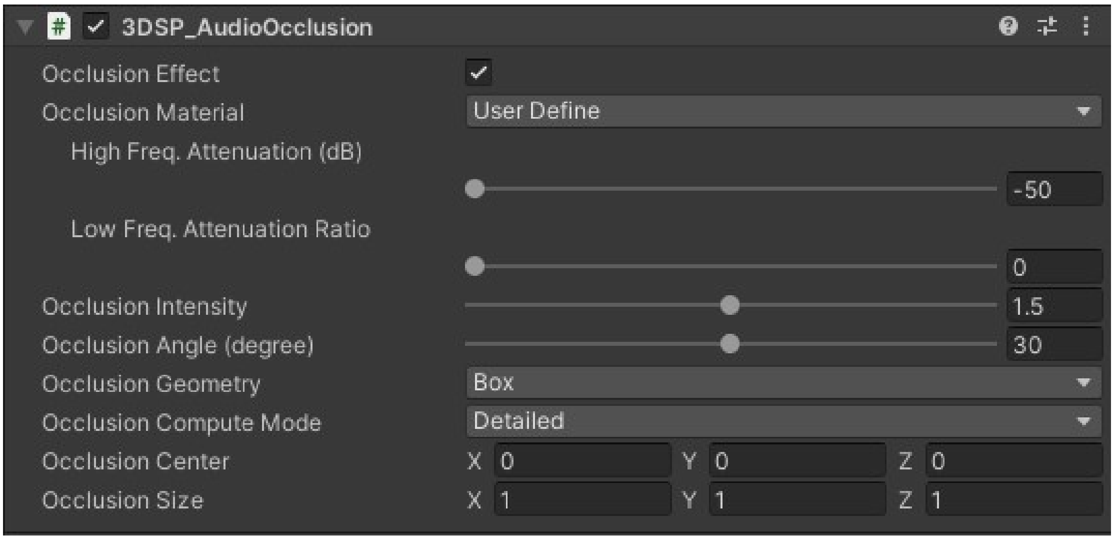
The VIVE 3DSP Occlusion component should be attached along with the object to enable the occlusion effect. This component can be selected via **Add Component > VIVE > 3DSP_AudioOcclusion.**



3DSP_AudioOcclusion

Occlusion Effect	☑
Occlusion Material	Curtain
Occlusion Intensity	1.5
Occlusion Angle (degree)	30
Occlusion Geometry	Box
Occlusion Compute Mode	Detailed
Occlusion Center	X 0 Y 0 Z 0
Occlusion Size	X 1 Y 1 Z 1

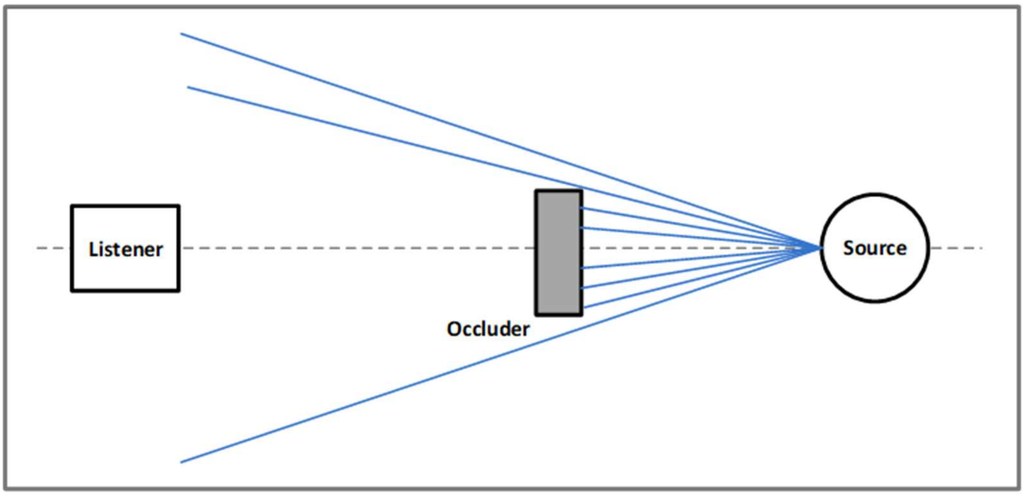
- **Occlusion Effect**: This option turns on or off the occlusion effect on the attached object.
- **Occlusion Material**: The material of an occluder can be changed here. There are some material presets in VIVE 3DSP. A customized material can be created via **User Define** by setting the **High Freq. Attenuation (dB)** and **Low Freq. Attenuation Ratio**.



3DSP_AudioOcclusion

Occlusion Effect	✓
Occlusion Material	User Define
High Freq. Attenuation (dB)	-50
Low Freq. Attenuation Ratio	0
Occlusion Intensity	1.5
Occlusion Angle (degree)	30
Occlusion Geometry	Box
Occlusion Compute Mode	Detailed
Occlusion Center	X 0 Y 0 Z 0
Occlusion Size	X 1 Y 1 Z 1

- **Occlusion Intensity**: This option presents the strength of the occlusion effect. The higher the value, the more occlusion effect is applied.
- **Occlusion Angle**: This option presents the cover range of the occlusion effect. The higher the value, the more occlusion cover range is applied.
- **Occlusion Geometry**: The different shapes of the occlusion object can be set here. For calculating the occlusion effect, the geometrical information of the occluder is necessary. The values for Occlusion Center, Size, and Radius need to be entered.
- **Occlusion Compute Mode**: This is designed specifically for box-type geometric occlusion. It offers an option to select different computing modes to balance the coverage resolution and computation load.



a. **Very Light**: In this mode, it requires the least amount of calculation for geometric occlusion. There is only one ray emitted from the source to the listener, then evaluates whether the ray collided with the occlusion object or not.

b. **Simple**: There are 6 different rays emitted from the source to the listener in this mode. The occlusion ratio is evaluated by the number of rays that collide with the occlusion object.

c. **Normal**: There are 11 different rays emitted from the source to the listener in this mode. The occlusion ratio is evaluated by the number of rays that collide with the occlusion object.

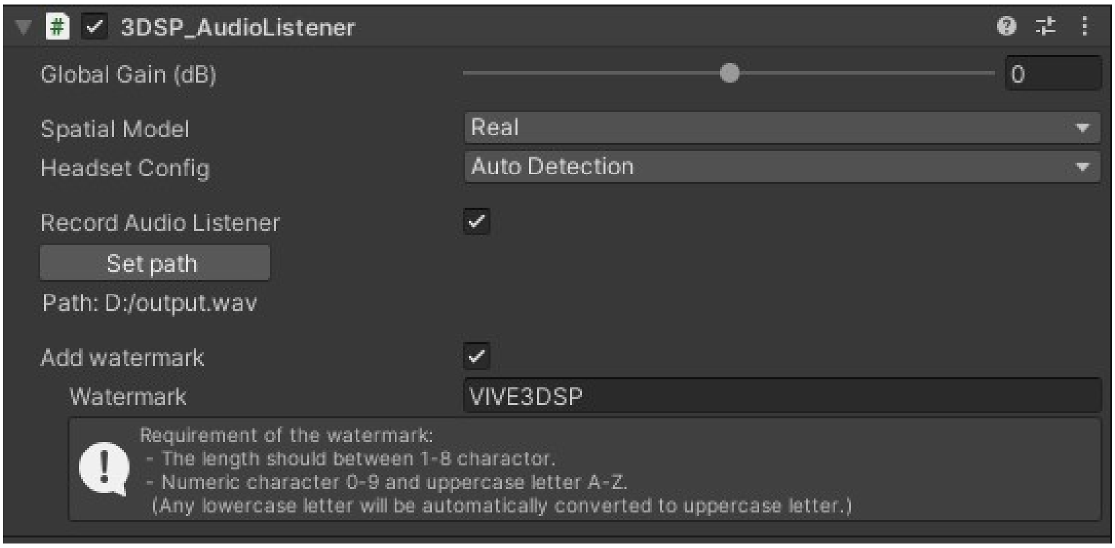
d. **Detailed**: This is the most accurate mode for occlusion coverage calculation. It also takes subtle movements of the occlusion object into consideration when determining the extent of occlusion.

- **Occlusion Center**: This option means the center coordinates relative to the attached object.
- **Occlusion size**: This option means the dimension of the occluded region in meters. The factor, **Scale** in “Transform” of the attached object, is considered here.

Note: The Occlusion component has its own collider calculator. The Unity collider component does not need to be added.

Audio Listener Settings

The VIVE 3DSP Audio Listener component should be attached along with the Unity Audio Listener to enable some 3D sound effects. This component can be selected via **Add Component > VIVE > 3DSP_AudioListener.**



☑ 3DSP_AudioListener

Global Gain (dB) 0

Spatial Model: Real

Headset Config: Auto Detection

Record Audio Listener ☑

Set path

Path: D:/output.wav

Add watermark ☑

Watermark: VIVE3DSP

Requirement of the watermark:
- The length should between 1-8 charactor.
- Numeric character 0-9 and uppercase letter A-Z.
(Any lowercase letter will be automatically converted to uppercase letter.)

- **Global Gain**: This option sets the overall volume changes of the audio output from VIVE 3DSP Audio Listener. It ranges from **-24 dB** to **24 dB**.
- **Spatial Model:** This option controls the spatializer model.
  a. **Real:** This options performs the sound response that is measured at the different direction from the real world.
  b. **Lossless:** This options performs the sound response that represents the characters of the spatializer without any distortion.
- **Headset Config:** The option controls the targeted headset model. For the best audio experience, sound optimization has been done for most headset models.
  a. **Generic**: Select this option if using non-VIVE VR devices and headphones.
  b. **Auto Detection:** Audio response is optimized for VIVE VR devices. When enabled, the system will automatically detect the type of VIVE device and provide the optimized audio experience for that device. The feature supports the following VIVE devices: VIVE Pro, VIVE Pro 2, VIVE Focus 3, and VIVE XR Elite.
- **Record Audio Listener:** This option is selected to record what the listener is hearing in the scene and exports it as an audio file. **Set path** is applied to set the file location. If the **Record Audio Listener** option is turned off during Play Mode or the Play Mode is stopped, an audio file will be exported in the WAV audio format.
- **Add watermark:** This option lets you add a watermark in the audio system of the application for intellectual property rights and for identification

purposes. You can find the watermark decoder in the VIVE 3DSP SDK package. For more details, refer to **Decoding watermarks**.

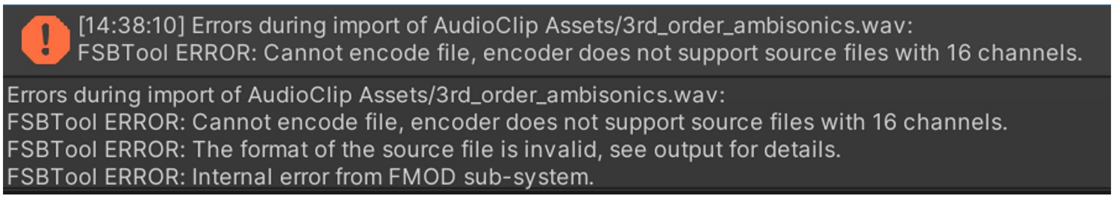
Watermark: The watermark must be **eight** characters or less, and can only contain **numbers** (0–9) and **UPPERCASE** letters (A–Z). (Any lowercase letter will be automatically converted to uppercase letter.)

Audio Ambisonics Settings

1. Put the AmbiX format audio file into your Unity Assets folder.

Note: The Ambisonic file should be **ACN/SN3D** format, and the channel count should be **4**, **9** or **16**.

Note: Currently, Unity only supports Ambisonic files in 1st order. However, in **3DSP**, the application with up to **16 channels is still available**. Therefore, if the following error message is encountered, please safely ignore it as the Ambisonics decode feature will still function correctly.



```
[14:38:10] Errors during import of AudioClip Assets/3rd_order_ambisonics.wav:
FSBTool ERROR: Cannot encode file, encoder does not support source files with 16 channels.

Errors during import of AudioClip Assets/3rd_order_ambisonics.wav:
FSBTool ERROR: Cannot encode file, encoder does not support source files with 16 channels.
FSBTool ERROR: The format of the source file is invalid, see output for details.
FSBTool ERROR: Internal error from FMOD sub-system.
```

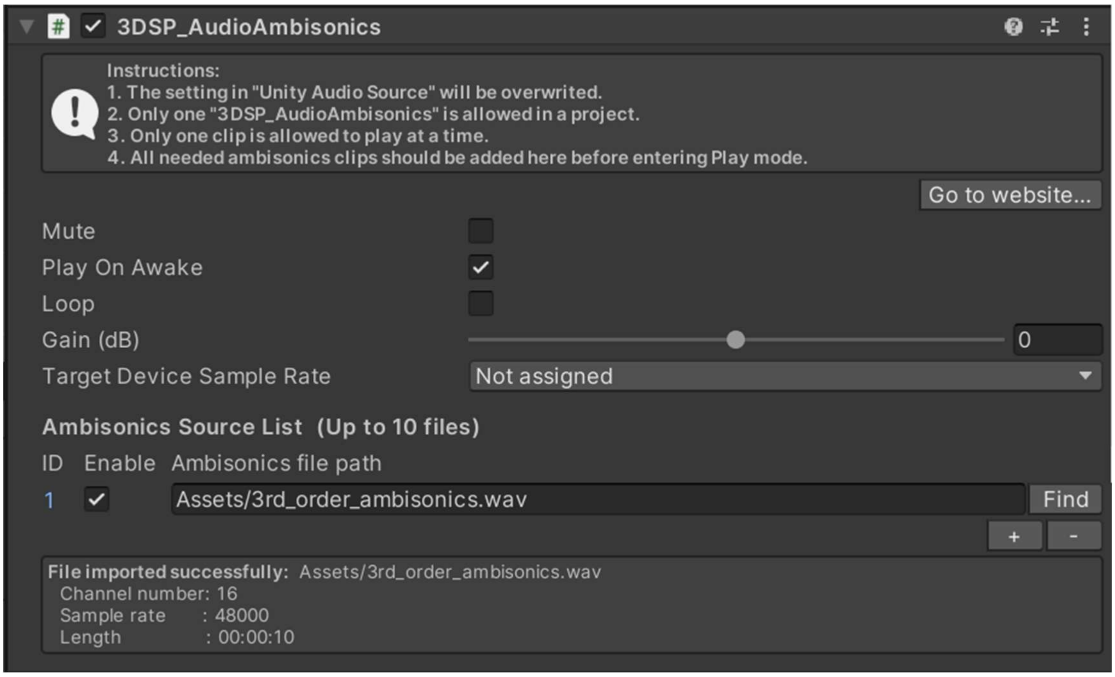
2. Do any of the following:
   a. Attach the VIVE 3DSP Audio Ambisonics component to a Unity audio source object. Click **Add Component > VIVE > 3DSP_AudioAmbisonics**.
   b. Attach the VIVE 3DSP Audio Ambisonics component to an object that contains a Unity Audio Source component.

Note: Only **one 3DSP_AudioAmbisonics component is allowed** in a Unity project.

3. Add Ambisonics audio files to **Ambisonics Source List** by clicking on the **Find** button and selecting an Ambisonics file.

Note: To **add multiple Ambisonics files**, click the "**+**" button. To **remove the last Ambisonics file**, click the "**-**" button.

More features for Ambisonic decoder are offered in **VIVE 3DSP Audio Ambisonics** component. When the 3DSP Audio Ambisonics component is added, the **Unity audio source** component will become **not editable**. Some settings will be managed by the VIVE 3DSP Audio Ambisonics, and these settings will **overwrite** those on the Unity audio source component.



☑ 3DSP_AudioAmbisonics

Instructions:
1. The setting in "Unity Audio Source" will be overwrited.
2. Only one "3DSP_AudioAmbisonics" is allowed in a project.
3. Only one clip is allowed to play at a time.
4. All needed ambisonics clips should be added here before entering Play mode.

Mute □
Play On Awake ☑
Loop □
Gain (dB) 0
Target Device Sample Rate Not assigned

Ambisonics Source List (Up to 10 files)

ID	Enable	Ambisonics file path
1	☑	Assets/3rd_order_ambisonics.wav

File imported successfully: Assets/3rd_order_ambisonics.wav
Channel number: 16
Sample rate : 48000
Length : 00:00:10

- **Mute**: To mute / unmute the audio source. This option overwrites the **Mute** on Unity audio source.
- **Play On Awake**: If set to true, the audio source will automatically start playing on awake. This option overwrites the **Play On Awake** on Unity audio source.
- **Loop**: Checks if the audio clip is looping. This option overwrites the **Loop** on Unity audio source.
- **Gain (dB)**: This option sets the Ambisonics clip volume level (in dB).
- **Target Device Sample Rate**: To set the target device sample rate, specify the device sample rate if known. Select **Not Assigned** if unknown.

Note: If **Not Assigned** is selected, the audio clips will be encoded at all supported sample rates: **44.1k**, **48k**, **96k**, and **192k** Hz. This may result in a larger APK size. The encoded audio clips are located in the directory: **Assets\StreamingAssets\Vive3DSP**.

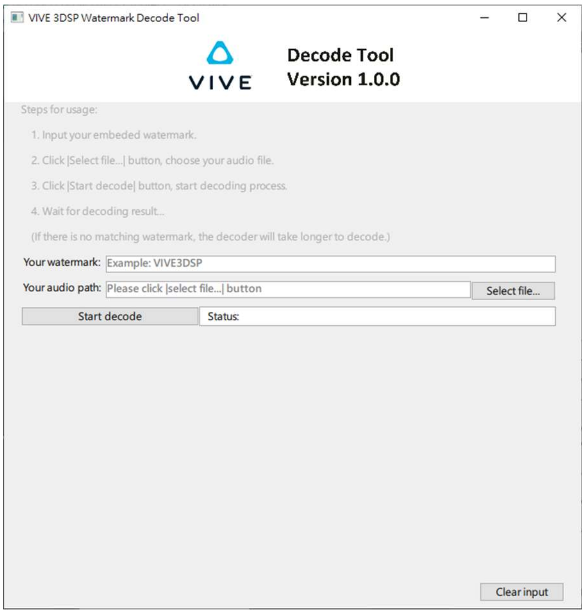
- **Ambisonics Source List**: To add Ambisonics audio clips here, use the "**+**" and "**-**" buttons to increase or decrease the number of clips as needed.

Note: The Ambisonics Source List can only be edited in **Edit Mode**.

- **Enable**: Checks to set the enabled clip ID. The following function is also used to change the ID: **Vive3DSPAudioAmbisonics.SetSrcId(int id)**.

Decoding watermarks

The **VIVE 3DSP Watermark Decode Tool (appWmDecToolAPP.exe)** lets you check if there is a watermark in the audio file of the application. You'll need to prepare the audio file of the application first to be able to decode the watermark.



Steps for usage:

1. Input your embeded watermark.
2. Click |Select file...| button, choose your audio file.
3. Click |Start decode| button, start decoding process.
4. Wait for decoding result...

(If there is no matching watermark, the decoder will take longer to decode.)

Your watermark: Example: VIVE3DSP

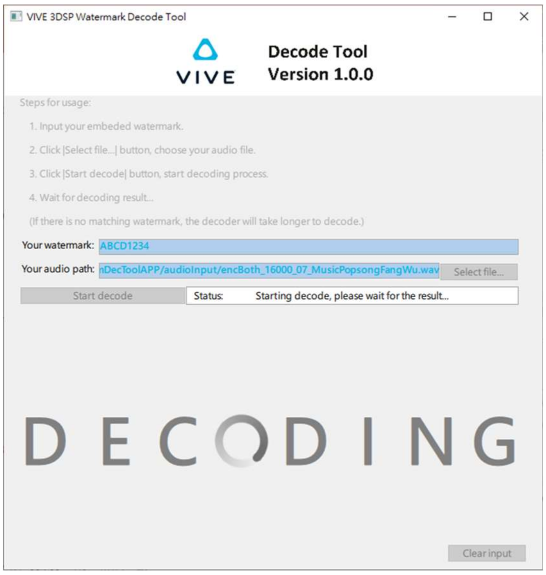
Your audio path: Please click |select file...| button

Status:

Decode the watermark

1. In **Your watermark**, enter the watermark that you used for the audio of the application.

2. In **Your audio path**, select the audio file of application.
3. Click **Start decode**. The status of the decoding process will then be shown on the window. The decoding process may take several minutes.



Steps for usage:

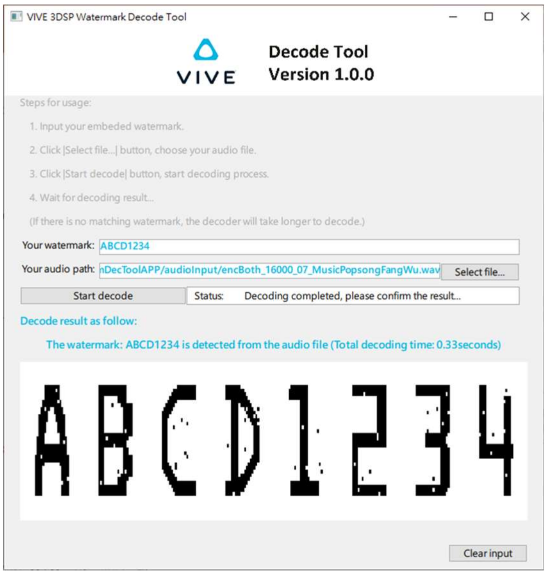
1. Input your embeded watermark.
2. Click |Select file...| button, choose your audio file.
3. Click |Start decode| button, start decoding process.
4. Wait for decoding result...

(If there is no matching watermark, the decoder will take longer to decode.)

Your watermark: ABCD1234

Your audio path: nDecToolAPP/audioInput/encBoth_16000_07_MusicPopsongFangWu.wav

Status: Starting decode, please wait for the result...



Steps for usage:

1. Input your embeded watermark.
2. Click |Select file...| button, choose your audio file.
3. Click |Start decode| button, start decoding process.
4. Wait for decoding result...

(If there is no matching watermark, the decoder will take longer to decode.)

Your watermark: ABCD1234

Your audio path: nDecToolAPP/audioInput/encBoth_16000_07_MusicPopsongFangWu.wav

Status: Decoding completed, please confirm the result...

Decode result as follow:

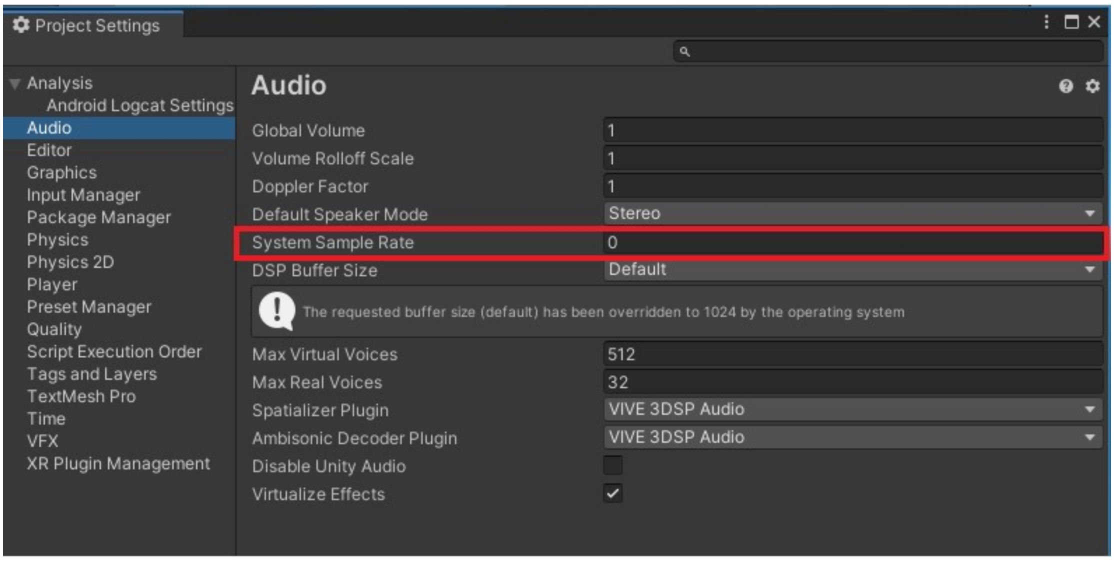
The watermark: ABCD1234 is detected from the audio file (Total decoding time: 0.33seconds)

If the watermark entered is found in the audio file, it will be displayed on the window.

Hi-Res Audio Settings

VIVE 3DSP supports Hi-Res audio file for the audio source. This feature can be set by:

1. Set **System Sample Rate** to **96000** (maximum sample rate of Unity) by clicking **Edit > Project Settings > Audio**.



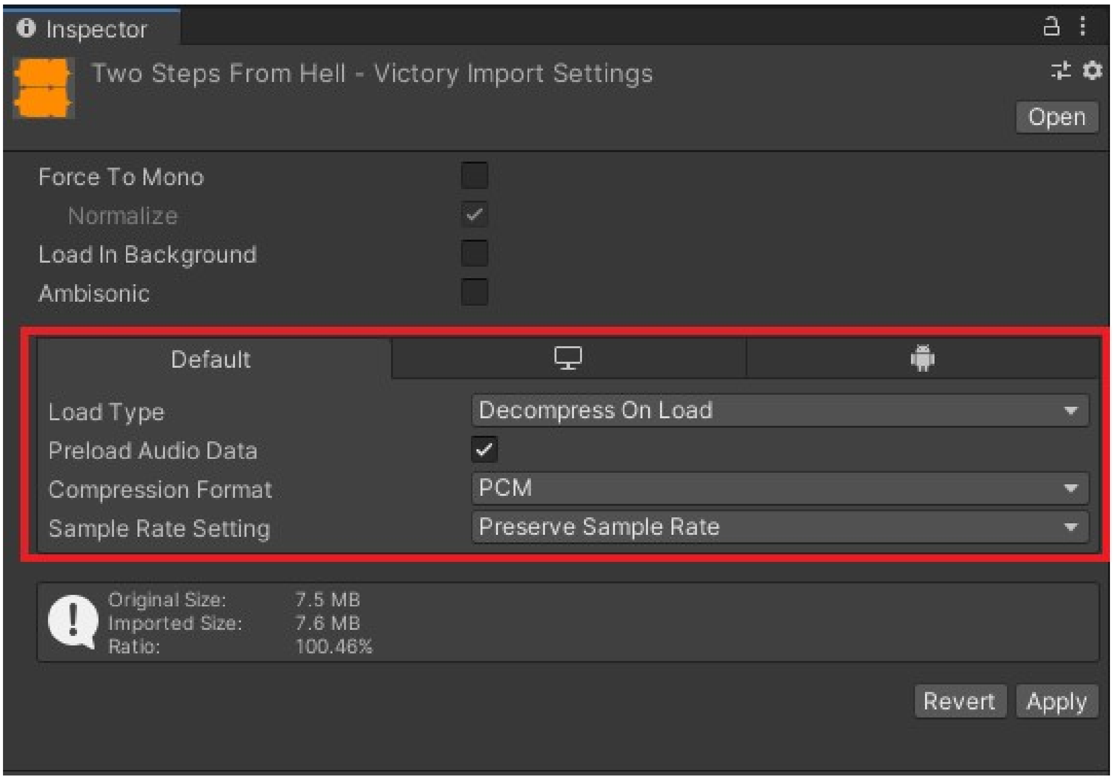
Audio

Global Volume	1
Volume Rolloff Scale	1
Doppler Factor	1
Default Speaker Mode	Stereo
System Sample Rate	0
DSP Buffer Size	Default

The requested buffer size (default) has been overridden to 1024 by the operating system

Max Virtual Voices	512
Max Real Voices	32
Spatializer Plugin	VIVE 3DSP Audio
Ambisonic Decoder Plugin	VIVE 3DSP Audio
Disable Unity Audio	□
Virtualize Effects	☑

2. Modify the audio clip format by changing **Compression Format** to PCM in the **Inspector window**.

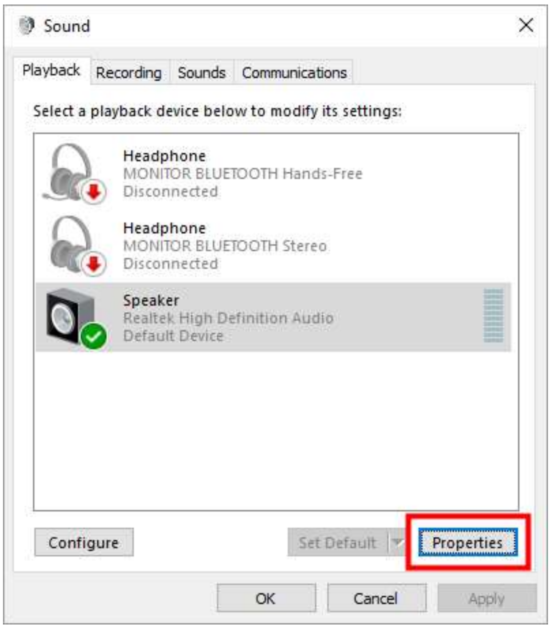


Two Steps From Hell - Victory Import Settings

Force To Mono	□
Normalize	☑
Load In Background	□
Ambisonic	□
Load Type	Decompress On Load
Preload Audio Data	☑
Compression Format	PCM
Sample Rate Setting	Preserve Sample Rate

Original Size:	7.5 MB
Imported Size:	7.6 MB
Ratio:	100.46%

3. Modify the operating system’s audio settings. Change the sample rate to **96000 Hz** in the system sound advanced settings**.**



Sound

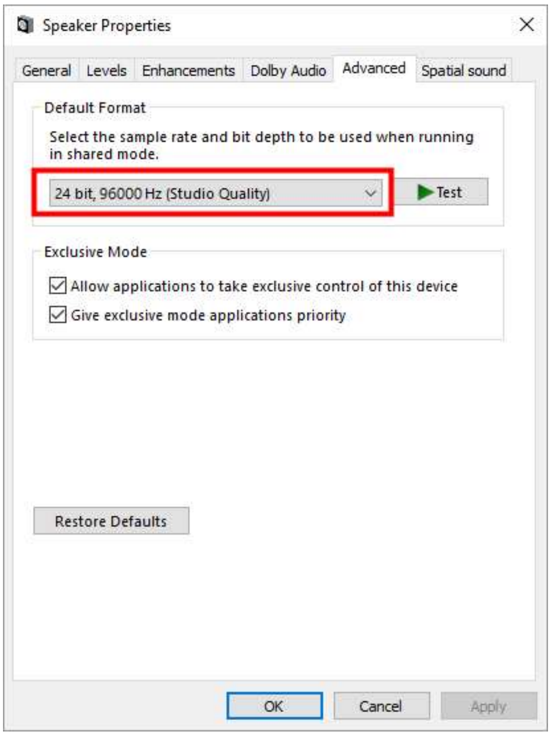
Playback | Recording | Sounds | Communications

Select a playback device below to modify its settings:

Headphone
MONITOR BLUETOOTH Hands-Free
Disconnected

Headphone
MONITOR BLUETOOTH Stereo
Disconnected

Speaker
Realtek High Definition Audio
Default Device



Speaker Properties

General | Levels | Enhancements | Dolby Audio | Advanced | Spatial sound

Default Format

Select the sample rate and bit depth to be used when running in shared mode.

24 bit, 96000 Hz (Studio Quality)

Exclusive Mode

☑ Allow applications to take exclusive control of this device

☑ Give exclusive mode applications priority

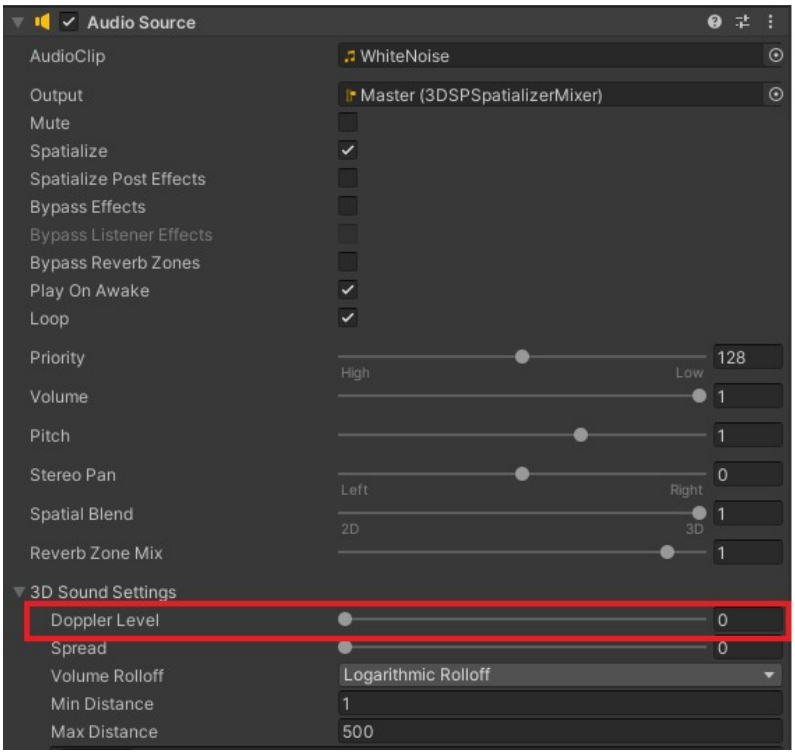
Troubleshooting

- **Memory consumption keeps increasing in Unity Editor**

There is an issue in Unity editor in the Unity version 2018 series. If the game object with a Unity **Audio Source** in a scene has been chosen, and the scene has been shown in the Unity Editor, the memory usage of Unity will sometimes keep increasing. This happens because if the sphere object is shown in the Unity scene, it keeps generating dummy meshes. This issue can be fixed by restarting Unity to delete the dummy meshes. Unity will crash or audio clippings will likely occur if the memory usage is too high.

- **Unity Built-in Doppler Effect might cause audio distortion**

Unity provides Doppler Effect and this can be found in the audio source object. However, the audio stream might be distorted by this built-in effect if the audio source object is moving very fast. For example, a quarter of the speed of sound, the audio stream could occasionally be rugged, therefore audio clipping occurs.



☑ Audio Source
AudioClip: WhiteNoise
Output: Master (3DSPSpatializerMixer)
Mute ☐
Spatialize ☑
Spatialize Post Effects ☐
Bypass Effects ☐
Bypass Listener Effects ☐
Bypass Reverb Zones ☐
Play On Awake ☑
Loop ☑
Priority: 128 (High – Low)
Volume: 1
Pitch: 1
Stereo Pan: 0 (Left – Right)
Spatial Blend: 1 (2D – 3D)
Reverb Zone Mix: 1
3D Sound Settings
Doppler Level: 0
Spread: 0
Volume Rolloff: Logarithmic Rolloff
Min Distance: 1
Max Distance: 500

Appendix

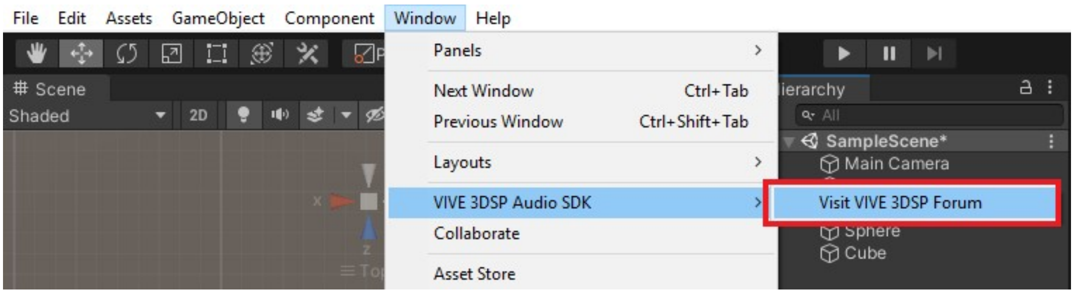
Material preset list

Number	Material
1	Concrete
2	Porous Concrete
3	Marble
4	Brick
5	Glass
6	Wood
7	Gypsum
8	Curtain
9	Plywood
10	Steel
11	Stone Wall
12	Plaster Absorber_Concrete
13	Plaster Absorber_Brick
14	Plaster Absorber_Wood
15	Plaster Absorber_Gypsum
16	Timberboard_Concrete
17	Timberboard_Brick
18	Timberboard_Wood
19	Timberboard_Gypsum
20	Ceramic Tile_Concrete
21	Ceramic Tile_Brick
22	Ceramic Tile_Wood
23	Ceramic Tile_Gypsum
24	Corkboard_Concrete
25	Corkboard_Brick
26	Corkboard_Wood
27	Corkboard_Gypsum
28	Soft Curtain_Concrete
29	Soft Curtain_Brick
30	Soft Curtain_Wood

31	Soft Curtain_Gypsum
32	Curtain_Concrete
33	Curtain_Brick
34	Curtain_Wood
35	Curtain_Gypsum
36	Cotton_Concrete
37	Cotton_Brick
38	Cotton_Wood
39	Cotton_Gypsum
40	Plaster_Concrete
41	Plaster_Brick
42	Plaster_Wood
43	Plaster_Gypsum
44	Plywood_Concrete
45	Plywood_Brick
46	Plywood_Wood
47	Plywood_Gypsum
48	Glazed Tile_Concrete
49	Glazed Tile_Brick
50	Glazed Tile_Wood
51	Glazed Tile_Gypsum

VIVE 3DSP Audio SDK Forum Shortcut

If you have suggestions or questions, you can go to the VIVE Audio SDK forum. It can be accessed by clicking **Window > VIVE 3DSP Audio SDK > Visit VIVE 3DSP Forum**.


File
Edit
Assets
GameObject
Component
Window
Help
Scene
Shaded
2D
Panels
Next Window Ctrl+Tab
Previous Window Ctrl+Shift+Tab
Layouts
VIVE 3DSP Audio SDK
Collaborate
Asset Store
ierarchy
All
SampleScene*
Main Camera
Visit VIVE 3DSP Forum
Sphere
Cube