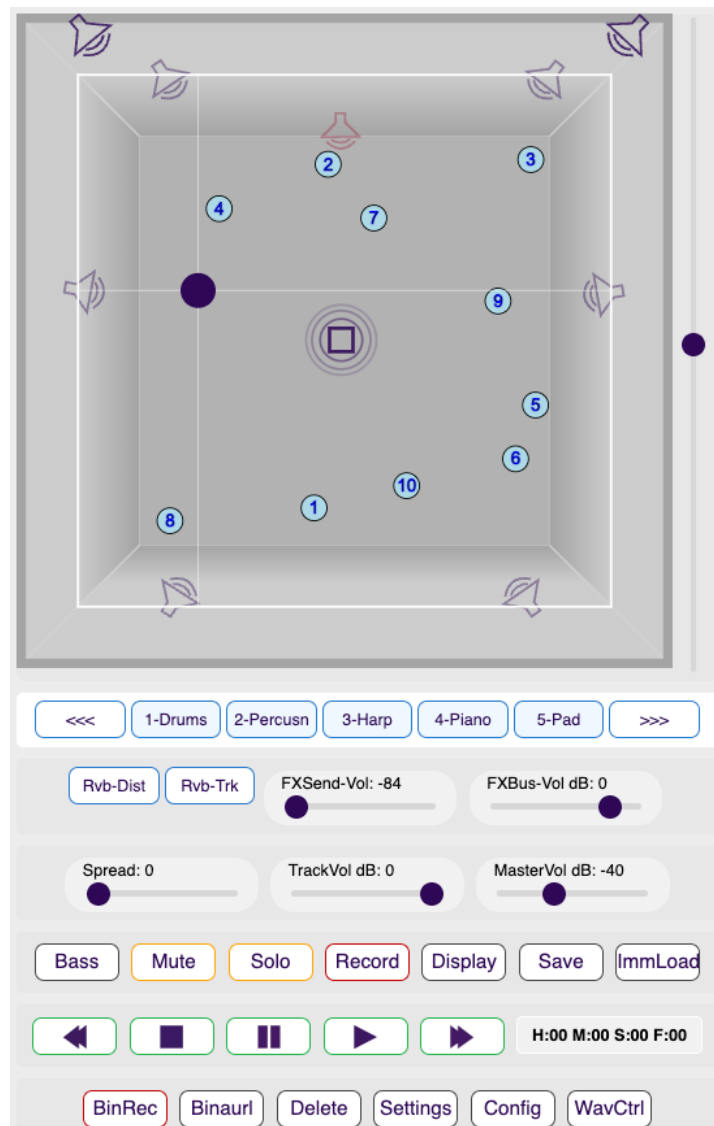


# IMMERGO-MOTU

- AN IMMERSIVE AUDIO SYSTEM FOR MOTU DEVICES

## User Manual (Mac/PC)



## Revision history

Revision	Description	Date
V1.0	First version ported from ImmerGo-Install	5 July 2020
V1.1	Accommodate low height display	8 July 2020
V1.2	Unmute mixer ins and aux ins at startup	9 July 2020
V1.3	Transmit track volume after 1dB change	16 July 2020
V1.4	Enable bass playback	17 July 2020
V1.5	Save analog/USB input allocation in config file	2 August 2020
V1.6	Add main L/R for 2 x extra speakers	6 August 2020
V1.7	Exit alert for clients when server down	16 August 2020
V1.8	Enable Mic and guitar inputs	1 September 2020
V1.9	Ensure even number of mixer ins	6 September 2020
V1.11	Enable reverb for outside sources	10 August 2021
V1.11.1	Enable granularity control	5 February 2022
V1.11.2	Enable Reverb bus spatialisation	28 September 2022
V1.12.0	Incorporate additional immersive renderers	20 March 2023
V1.12.1	Enable bass track selection and track linking	15 August 2023
V1.12.2	Allow sparse configurations for vector rendering	15 February 2024
V2.0.0	Added binaural spatialisation	12 December 2024

## Support:

If you have any queries regarding the use of the ImmerGo system, contact Support at:

[support@immersivedsp.com](mailto:support@immersivedsp.com)

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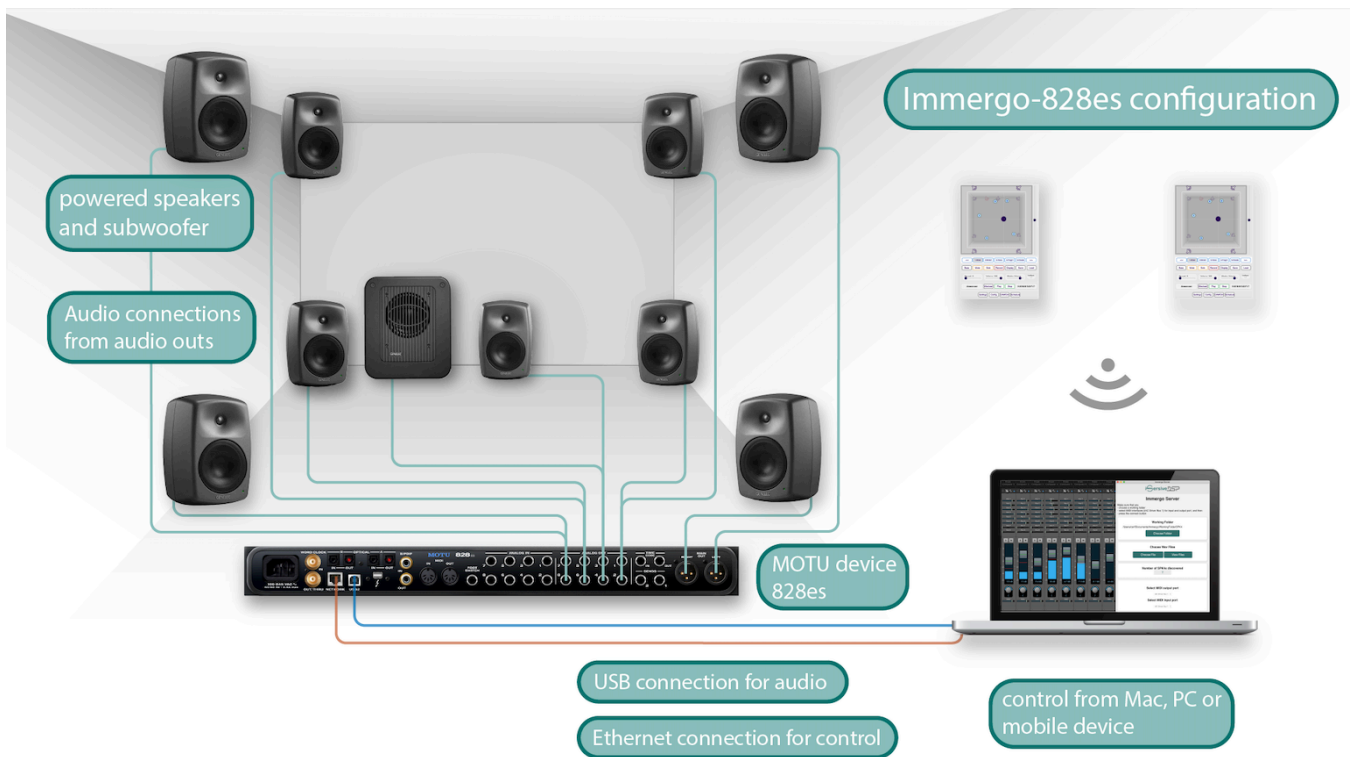
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# 1 WELCOME TO IMMERGO!

This manual will describe how to configure and use the ImmerGo-MOTU system. Before engaging with this topic, it is useful to have a broad understanding of the operation of the ImmerGo-MOTU system. We shall look first at the components of an ImmerGo-MOTU system, and then provide a conceptual understanding of how they interact with each other. With these concepts in place your task of configuration and immersive sound creation will be a lot easier.

## 1.1 IMMERGO-MOTU SYSTEM COMPONENTS:

Given below is a diagram of the hardware components of an example ImmerGo-MOTU system, in this case using the 828es device:



1. You should use an Ethernet cable to connect from the Ethernet port of your MOTU device to an Ethernet port on your computer (shown above), or to an Ethernet port on your wifi router.
2. To spatialize USB inputs from the computer, you should use a USB/Thunderbolt cable to connect from a USB/Thunderbolt port on your computer (Mac or PC), to the USB/Thunderbolt port on your MOTU device. Note – you can also spatialize analog and ADAT inputs.
3. You should connect audio cables from the audio and main outs on your MOTU device (analog outs and main outs) to powered speakers (including subwoofer(s)) or to the inputs of a multichannel amplifier. Note, you should connect at least 4 speakers. Also you can connect one or more subwoofers to any of the outputs.

ImmerGo is a client-server system, where the server can be a Windows or macOS laptop or desktop, and the client can either run on the server machine or a remote device that communicates wirelessly. The remote device can be a mobile device such as a tablet or smart phone (Android or iOS), or a further laptop/desktop. The client is typically run by clicking the 'Client' button on the server computer, but can also be run by typing in a URL into a browser, or running an app from Playstore (Android) or the App Store of an iOS device.

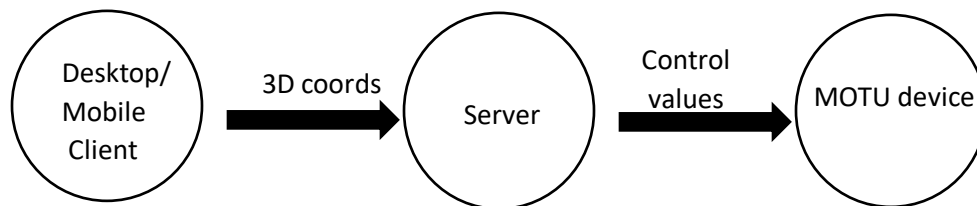
As a user, you will be controlling the localization of sound sources from the desktop or from a mobile device such as a tablet or smart phone. Multiple users can control the localization of multiple sound sources at the same time. These can be computer-based sound sources or analog inputs. The computer sound sources are typically wav files associated with audio tracks in a Digital Audio Workstation (DAW) or multichannel wav files that can be loaded. The DAW will be installed on the server machine, which can be an Apple or Windows computer. Also on the server will be the ImmerGoServer software, which you will need to install.

## 1.2 HOW DO THE COMPONENTS INTERACT?

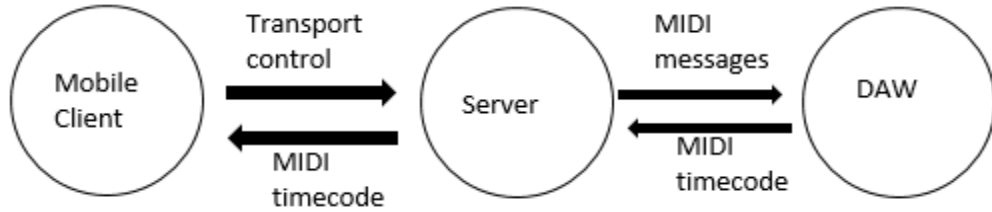
An ImmerGo user with a mobile device can do the following:

1. Choose to select sound sources from mic, analog, or ADAT inputs, or from a DAW or multichannel wav file via USB
2. Select audio channels or a reverb bus and control their localization
3. Control the transport of a DAW
4. Record and playback localization moves
5. Schedule multichannel wav files to be played in sequence with their localizations

When a user controls localization of sound sources, the 3D sound source positions get sent over a wireless network to the server. Using these 3D sound source positions, and the positions of the speakers, the server determines what control values to send over the same wireless network to the MOTU device. The MOTU device is connected to the server or to the wireless network via an Ethernet wired connection, as shown in the configuration diagram.



When a user controls the transport of the server-based DAW, transport control commands are sent over a wireless network to the server. The server then sends MIDI commands to the DAW to control its transport. MIDI timecode messages are sent from the DAW to the server for the time stamping of localization changes. They are also sent to the client for display.



When a user chooses a wav file to be the source of sound, then time code messages are generated internally on the server.

### 1.3 WHICH OF THE MOTU CONTROLS DOES IMMERGO MODIFY?

At configuration time, ImmerGo connects user selected mic, analog, ADAT and USB ins to the mixer in channels. It connects aux buses to the analog and main outs.

ImmerGo controls the spatialization of mixer input channels (mic, analog, ADAT or USB) by changing the volume levels of the aux bus sends on the various mixer channels. It implements a master volume change by changing the aux bus fader levels. It does not change the settings on the mixer channels. This means that if you have set up MOTU mixer channels to play DAW multitracks, for example, your mixer channel settings will not be modified by ImmerGo. Shown below are 8 mixer channels with varying levels for the aux bus sends.



As described in section 6.5, when a source moves beyond the speaker boundaries, reverb can be added. In this case, the source will be sent to the reverb bus at a level commensurate with its distance beyond the boundary, and the reverb bus output will be mixed in to the aux outs. The reverb bus itself can also be spatialised.

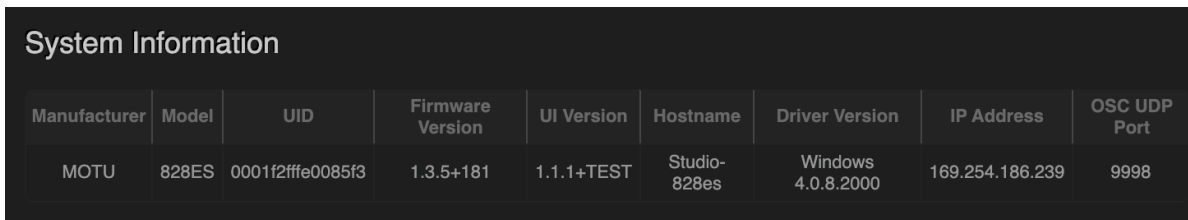
## 2 PREPARATION BEFORE INSTALLING SERVER

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As shown in the ImmerGo-MOTU configuration diagram above, the ImmerGo server controls the MOTU device via the direct Ethernet connection or the wireless network provided by the wireless router. The wireless network is further used by remote ImmerGo clients to communicate with the ImmerGo server. Make sure that you don't have a Firewall preventing communication with the MOTU device.

### 2.1 NETWORK CONNECTION

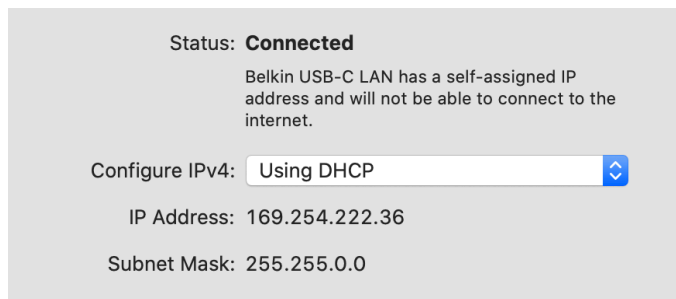
Regardless of the configuration you adopt for your MOTU device, your MOTU device will acquire an IP address, which will be visible in the 'Device' section of the MOTU Pro Audio control app. Scroll to the bottom of the Device section, and you should see something similar to the following:



Manufacturer	Model	UID	Firmware Version	UI Version	Hostname	Driver Version	IP Address	OSC UDP Port
MOTU	828ES	0001f2fffe0085f3	1.3.5+181	1.1.1+TEST	Studio-828es	Windows 4.0.8.2000	169.254.186.239	9998

You can also check your connection to the MOTU router via your computer's settings. On Apple computers go to:

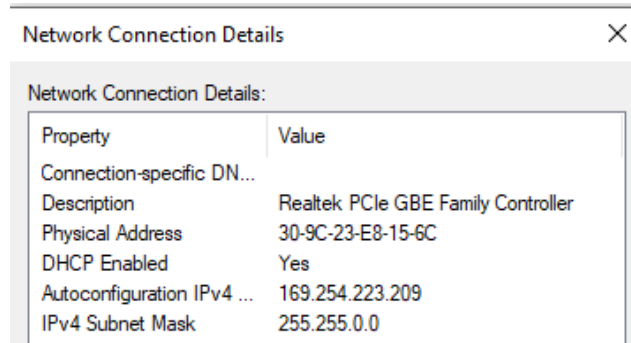
System Preferences -> Network. For a direct Ethernet connection from MOTU to computer, you should see something similar to the following:



On a Windows computer go to:

Control Panel -> Network and Internet -> Network and Sharing Centre

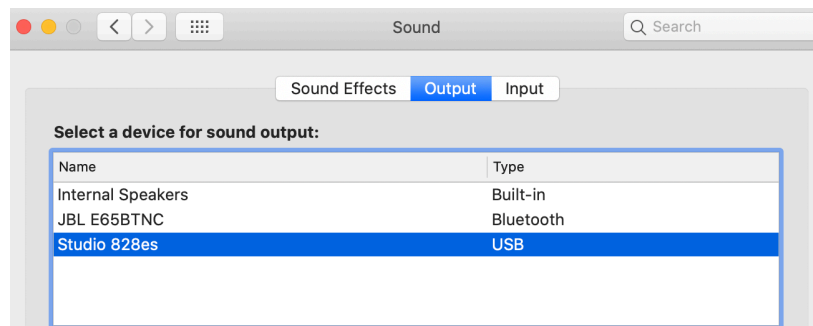
Here you will see all your network connections. Select the connection to your MOTU and click on 'Details'. For a direct Ethernet connection from MOTU to computer, you should see something similar to the following:



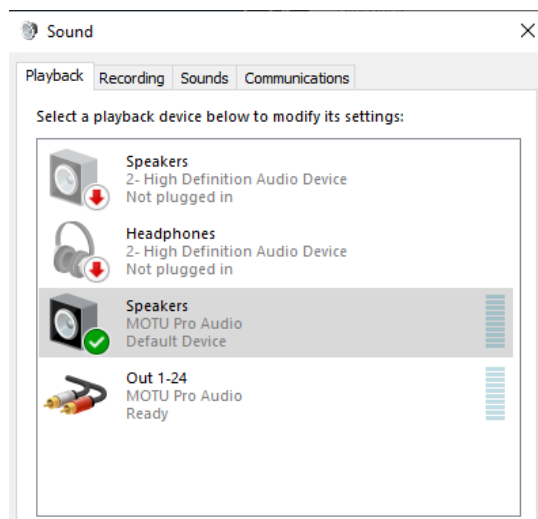
## 2.2 SOUND DEVICE PREFERENCES

Go to the ‘Sound’ system preferences/options on your computer and ensure that the MOTU device you are wanting to work with, is chosen as the device for sound output.

Given below is an example of such a selection on an Apple computer.



Here is an example for Windows:

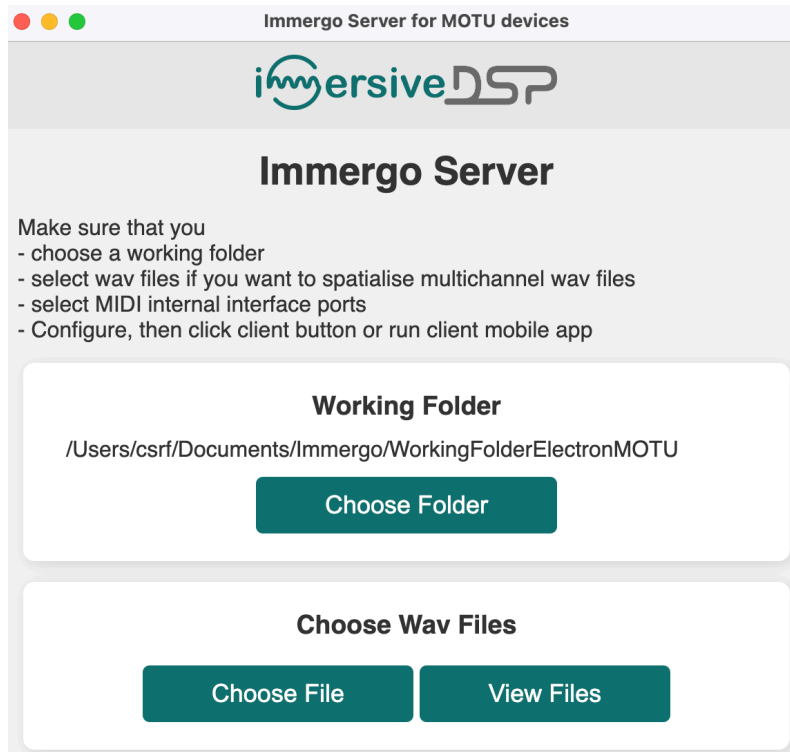




### 3 INSTALLATION OF THE SERVER

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Ensure that your configuration is correctly wired (see diagram in section 1), and that the MOTU device you are planning to use is switched on. You should have downloaded an installation package file *ImmerGo-MOTU-vx.y.z-arm64.dmg* if you are using an Apple Mx computer, *ImmerGo-MOTU-vx.y.z-MacOSx.pkg* if you are using an Apple Intel computer and *ImmerGo-MOTU-vx.y.z-Setup.exe* if you are using a Windows machine. Double click on the file and you will be guided through the steps necessary to install the software. Run the application. The ImmerGo server window will appear, the first half of which is shown below:



Note: - before the appearance of the server, you might be asked whether it is OK for BinauralSpace or ImmerGo to have network access. It is fine to respond with OK. These are two ImmerGo components that need to interact with each other over an internal network.

#### 3.1 WORKING FOLDER:

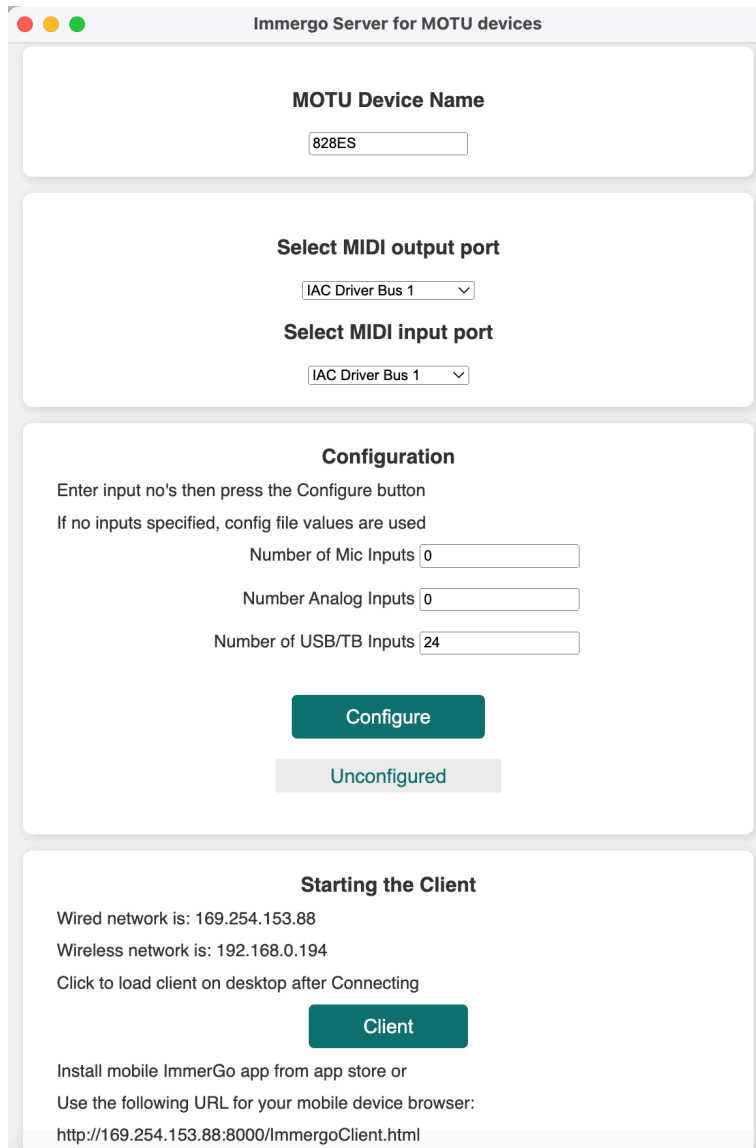
The 'Working Folder' should be a folder that you create and where your localization (.imm) files, multi-channel wav files (.wav), scheduler files (.sch) and your speaker configuration file (speakerconfig.xml) will be stored. You should create a working folder (giving it a name of your choice), and browse to that folder.

### 3.2 CHOOSE AND VIEW WAV FILES:

This option allows you to select multichannel wav files that will be stored on the server and that will be accessible on the clients for playback and localization control. You can load the wav files from any folder where you might have placed them. You can also view the files that are currently stored.

### 3.3 MOTU NAME:

Typically, you will only have one MOTU interface, whose given name will be displayed. The second half of the ImmerGo server interface is shown below:



The screenshot shows a web interface titled "Immergo Server for MOTU devices". It is divided into several sections:

- MOTU Device Name:** A text input field containing "828ES".
- Select MIDI output port:** A dropdown menu showing "IAC Driver Bus 1".
- Select MIDI input port:** A dropdown menu showing "IAC Driver Bus 1".
- Configuration:** A section with instructions: "Enter input no's then press the Configure button" and "If no inputs specified, config file values are used". It contains three input fields: "Number of Mic Inputs" (0), "Number Analog Inputs" (0), and "Number of USB/TB Inputs" (24). Below these are two buttons: a green "Configure" button and a grey "Unconfigured" button.
- Starting the Client:** A section with network information: "Wired network is: 169.254.153.88" and "Wireless network is: 192.168.0.194". It includes the text "Click to load client on desktop after Connecting" and a green "Client" button. Below this, it says "Install mobile ImmerGo app from app store or Use the following URL for your mobile device browser:" followed by the URL "http://169.254.153.88:8000/ImmergoClient.html".

The name of the MOTU device is displayed.

### 3.4 MIDI PORT SELECTION

As indicated in section 1, the ImmerGo server communicates with the DAW in order to control its transport. It also receives MIDI Time Code from the DAW, which it uses to time stamp the 3D coordinates it receives from the mobile client(s). This communication must be done via a software MIDI link within the workstation.

On an Apple workstation this link is provided via the IAC driver bus. Both the input and output ports should be set to the IAC driver bus, except if you are using the Digital Performer DAW (see section 4.3).

On a Windows workstation you will need to install a virtual MIDI driver in order to create this MIDI link. There are a number of free MIDI virtual drivers. One possibility is LoopBe1, which you can download from:

<https://www.nerds.de/en/loopbe1.html>

Your MIDI input and output ports should then appear as follows:

**Select MIDI output port**

LoopBe Internal MIDI 1 ▼

**Select MIDI input port**

LoopBe Internal MIDI 0 ▼

The DAW must be set up to receive messages on the same MIDI link as used by the server (internal driver). This will allow it to respond to particular MIDI transport control messages, and to transmit appropriate MIDI Time Code messages. Note: if you are using LoopBe, make sure that the MIDI port monitor is not muted.

### 3.5 CONFIGURATION

Your last interaction with the server is to configure the MOTU device so that it can have the internal connections and states set up to enable localization requests from the ImmerGo server.

The ImmerGo server enables the localization of mic, analog, ADAT and USB inputs from the computer. You can enter the number of mic, analog, ADAT and USB inputs you want to use. These will be viewed as input tracks when you use the client for localization. If you indicate numbers that are beyond the available inputs, or don't enter inputs, the server will revert to the maximum available. The numbers you enter will be stored in the speaker configuration file.

Example: If you would like to have 10 tracks from the computer with recorded spatializations, as well as two mics and a keyboard that can be spatialized in real time, you could have the following allocation:

Number of Mic Inputs: 2

Number of Analog Inputs: 1

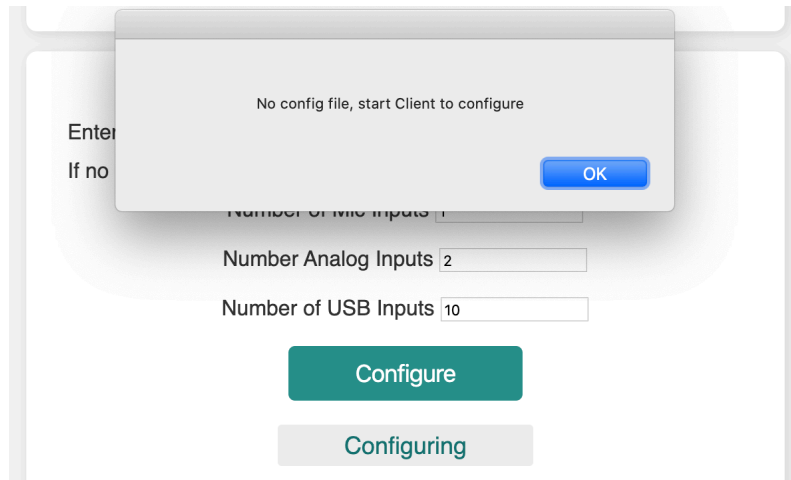
Number of USB Inputs: 10

The process of configuration by the ImmerGo server involves:

1. Setting the number of inputs.

2. Ensuring that the appropriate connections are made from mic/analog/ADAT/USB ins to mixer ins, and from aux ins to analog outs.

This process will be performed when the Configure button is clicked. When you first start the server, there will probably not be a speaker configuration file in the working folder. In this case, you will get the following message:



You will then need to click the client button or run the client from a mobile device. On doing this, you will be presented with a configuration screen. The configuration process is described in section 5 below.

If there is a configuration file in your working folder, and the configuration file incorporates a MOTU device model name that matches your MOTU device, then the previously assigned mic, analog, ADAT and USB inputs will be read from this file.

### 3.6 STARTING THE CLIENT

There are three ways in which you can access an ImmerGo-StudioLive client:

1. Click the Client button towards the bottom of the server user interface – this will cause the client interface to run on your workstation.
2. Type the given URL into a browser (shown on the server user interface), either on a desktop or mobile device. Note that using this approach on a mobile device will not give you access to the tilt capability for height change (see section 6)
3. Run the ImmerGo client app on a mobile device. The app can be installed via the Apple app store or via the Google Play store. In this case, you will be able to use the tilt capability to specify the height of the sound source by tilting the mobile device.

## 4 DIGITAL AUDIO WORKSTATION CONFIGURATION

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As indicated in section 1, your source of audio channels to be spatialised can either be mic/analog/ADAT inputs, a DAW or a multichannel wav file. Regardless of the DAW that you are using, you should ensure that you select the MOTU interface as your audio device. The number of DAW tracks that you can spatialise will depend on the number of USB inputs that you specified in the configuration section of the server.

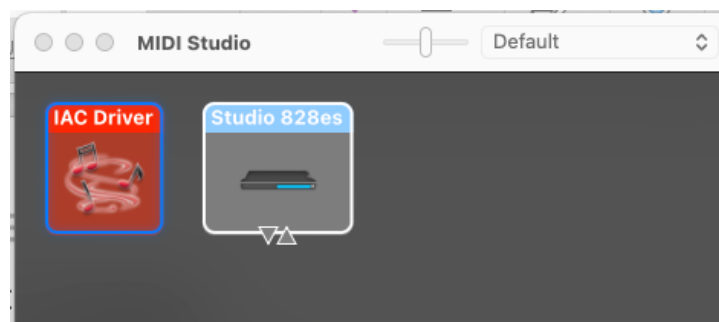
### 4.1 MIDI COMMUNICATION BETWEEN IMMERGO SERVER AND DAW

The ImmerGo server communicates with the DAW in order to control its transport. It also receives MIDI Time Code from the DAW, which it uses to time stamp 3D coordinates it receives from the workstation/mobile client(s), and which it also forwards to the workstation/mobile client(s) for display purposes. To enable this, the DAW must be set up to receive messages on the same MIDI link as used by the server (internal driver), to respond to particular MIDI transport control messages, and to transmit appropriate MIDI Time Code messages.

Note – if you only want to use ImmerGo to spatialise multichannel wav files, you would not need to configure ImmerGo for MIDI communication.

#### 4.1.1 MIDI internal driver

On an Apple workstation: You should run ‘Audio MIDI Setup’ then select ‘Show MIDI Studio’ from the Window menu. You should see the screen below:



Double click the IAC driver icon and check the ‘Device is online’ box. Select the ‘Bus 1’ port and click ‘Apply’. The DAW should be set up such that it reads MIDI from IAC BUS driver 1 and transmits MIDI on IAC BUS driver 1.

On a Windows workstation: If you have a virtual MIDI driver such as the LoopBe driver installed, then it will be available for selection. The DAW should be set up such that it reads MIDI from a LoopBe driver internal port and transmits MIDI on a LoopBe driver internal port.

#### 4.1.2 MIDI and transport control

The DAW on the server needs to be configured in such a way that it will receive MIDI transport commands and respond appropriately. Here are the MIDI messages and the transport controls that they are associated with:

<i>Transport control</i>	<i>MIDI Message - hexadecimal followed by ( CC decimal)</i>
Play	B0 75 7F (CC 117)
Stop	B0 74 7F (CC 116)
Pause	B0 70 7F (CC 112)
Fast Forward	B0 73 7F (CC 115)
Rewind	B0 72 7F (CC 114)

### 4.1.3 MIDI Time Code

The DAW needs to be configured such that it generates MIDI Time Code. By default the frame rate for the timecode is 30 frames/second.

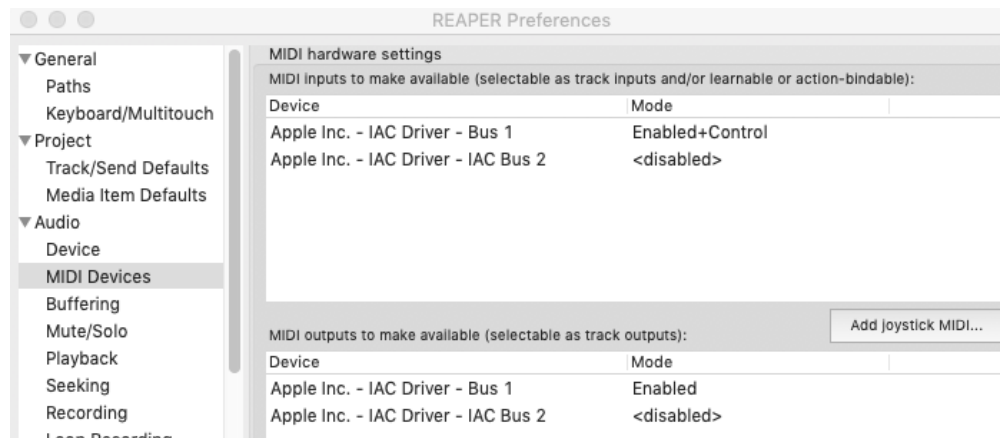
## 4.2 MIDI CONFIGURATION WHEN USING THE REAPER DAW:

To Set up MIDI correctly in Reaper, from the Menu bar:

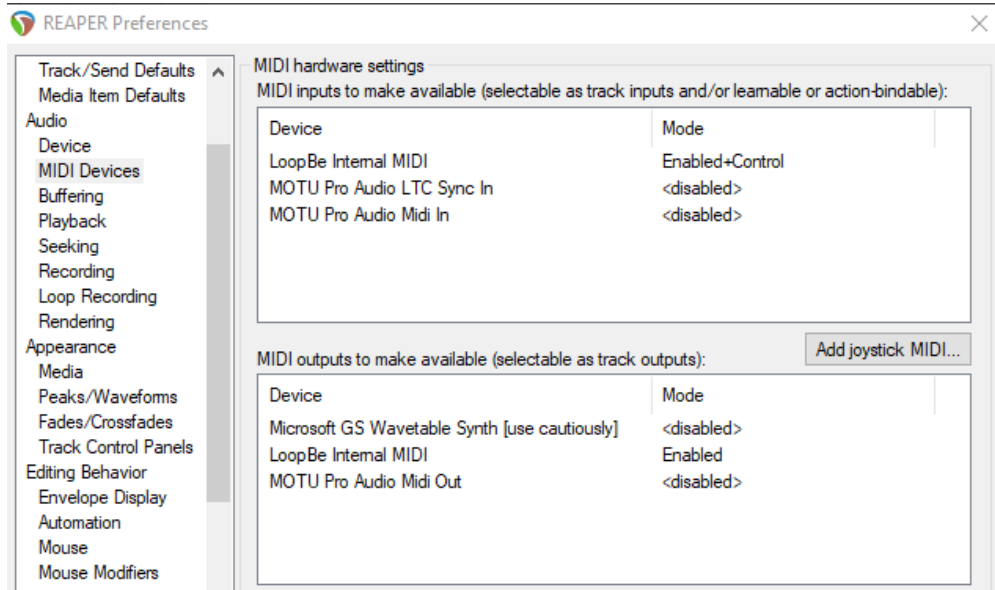
Select Reaper -> Preferences -> from the Audio drop down, select MIDI devices.

On an Apple workstation:

Enable IAC Driver – Bus 1 as the MIDI input and MIDI output driver as shown below. Ensure that the mode is ‘enabled+control’. This will allow for DAW transport control from the client



On a Windows workstation, if you have installed the LoopBe internal driver, enable it as your input and output port. Ensure that the mode is ‘enabled+control’. This will allow for DAW transport control from the client.:



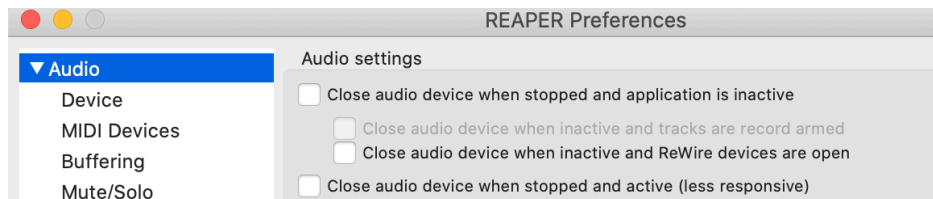
You will have received a zip file called *ReaperFiles*. When you unzip this, you will find :

1. *SkalandunasDistr.zip* – this contains a multitrack Reaper project with a MIDI Time Code generator in the first track. (Acknowledgements to Mike Skalandunas for this multitrack).
2. *Transport.ReaperKeyMap* – this is a file that should be imported into your Reaper project. It contains the MIDI transport control commands. This importing can be done in the following way:

Go to: Actions -> Show Action List -> click import/export button -> select Import -> browse to the file *Transport.ReaperKeyMap* and click Open. This will enable the appropriate MIDI transport commands to be received by Reaper for control of the DAW. However, you will need to create a MIDI Time Code track for the transmission of MIDI Time Code. Refer to the Reaper user guide for this. If you use the *Skalandunas project*, then this is already created for you, and you could use this project as a template for others.

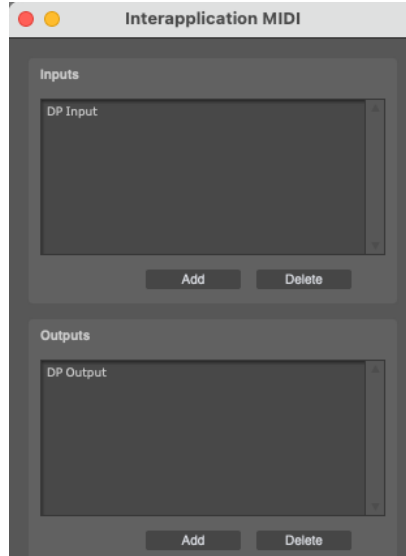
#### 4.2.1 Keeping Reaper active

Note – Reaper will not respond to internal MIDI messages if it is inactive. Reaper can become inactive when ImmerGo has the focus. Ensure that the following Audio settings boxes are not ticked.

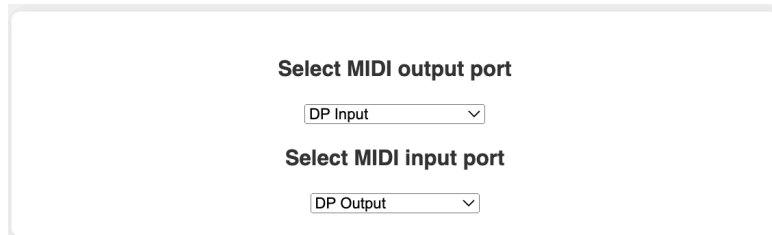


### 4.3 MIDI CONFIGURATION WHEN USING THE DIGITAL PERFORMER DAW:

In order to set up MIDI communication between ImmerGo and Digital Performer, you will first need to go to Setup -> Interapplication MIDI... You will then need to add the DP Input and DP Output MIDI ports:



Start up ImmerGo, and in the ImmerGo server configuration window make the following MIDI selections:



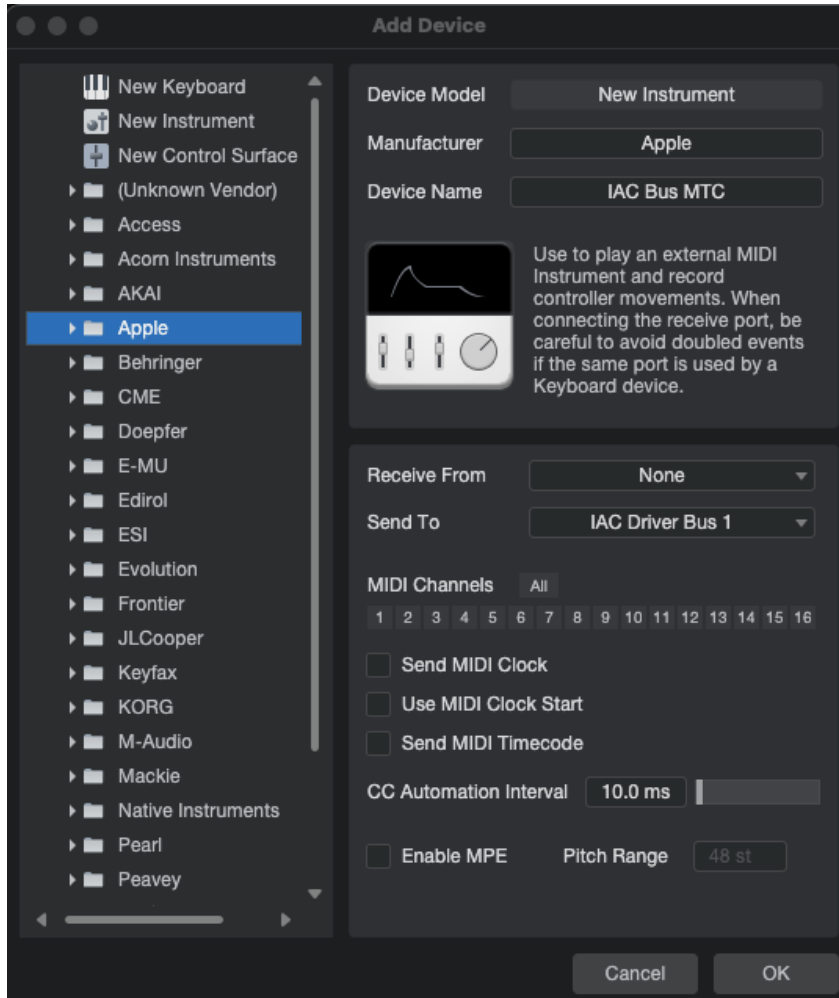
After this, you should go to the Digital Performer Setup menu tab again – Setup -> Commands. Ensure that Transport master is enabled, then scroll down to the ‘Transport’ section. Select ‘Play’ and click the ‘MIDI EVENT’ entry. In the ImmerGo client, click the Play icon. You should see a representation of the appropriate MIDI control message in the MIDI EVENT entry. Now follow this same procedure for ‘Stop’, ‘Rewind’, ‘Fast Forward’. You should have the following entries:

Play	⏮	▲#117   127	any
Record	Ⓜ		
Stop	⏹	▲#116   127	any
Rewind	⏮	▲#114   127	any
Pause On/Off	⏸		
Slow Forward	⏩		
Fast Forward	⏭	▲#115   127	any

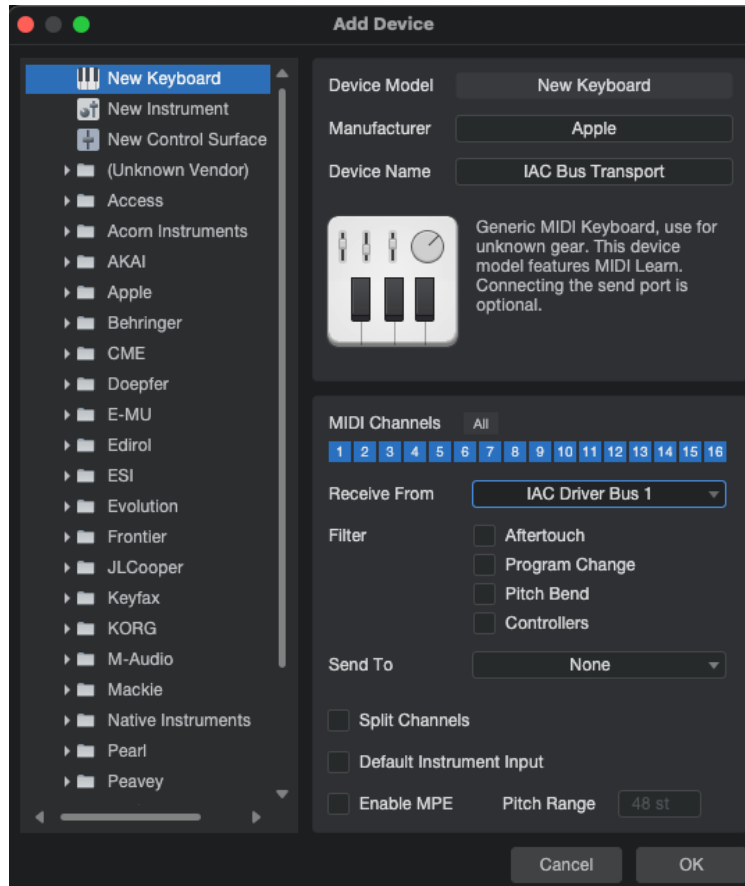


#### 4.4 MIDI CONFIGURATION WHEN USING THE STUDIO ONE DAW:

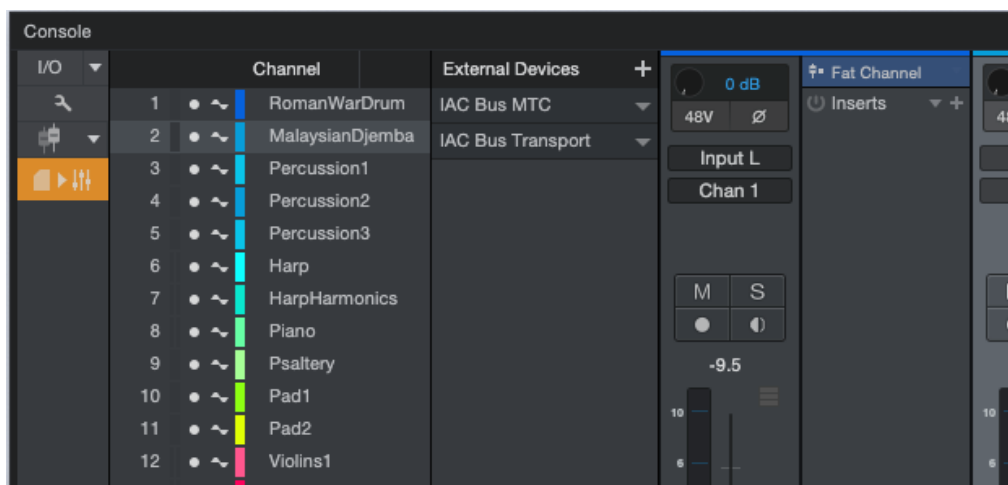
To set up MIDI correctly in Studio One, got to 'Preferences' from the Studio One menu tab, then select 'External Devices'. Now select the 'Add' button at the bottom left of the Window. To send MIDI Time Code (MTC) to ImmerGo, you should create a new Instrument that will send MTC to the IAC bus driver, and hence to ImmerGo. The setup should look something like the following:



To receive MIDI transport commands from ImmerGo, you should add a new Keyboard device that will receive Transport commands from the IAC bus driver. The setup should look something like the following:

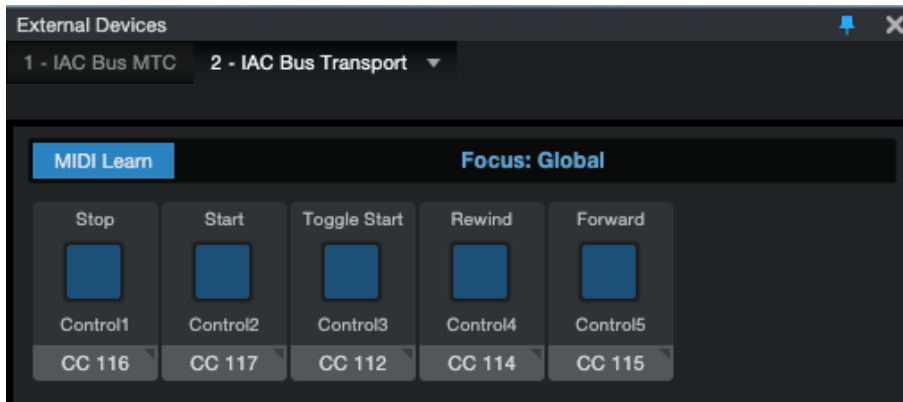


Having set up the Keyboard, you need to assign MIDI transport controls coming from ImmerGo to the transport controls in Studio One. To do this, select the 'View' menu tab, then 'choose 'Console', or select the 'Mix' tab at the bottom right of the Browse view. In the Console view, click on 'External Devices' then double click the Keyboard device that you are using to receive MTC.



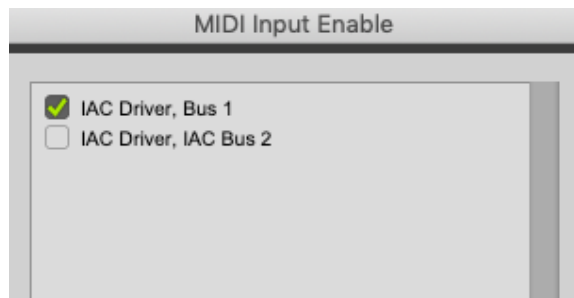
Click on the pin in the upper right of the External Devices window to keep it open. Associating a MIDI transport control with a Studio One transport is then a 3 stage process:

1. Click on 'MIDI Learn'
2. Click on the ImmerGo transport control, for example 'FFwrd'. This will cause a Knob control to appear together with an indication of the MIDI command ID. Double click on the control to select 'Button (press/release)'
3. Double click on the new button control and select 'assign command'. You should make the following assignments (all Transport commands in Studio One):
  - a. Rewind in ImmerGo – assign Rewind
  - b. Stop in ImmerGo – assign Stop
  - c. Pause in ImmerGo – assign Toggle Start
  - d. Play in ImmerGo – assign Start
  - e. FFwrd in ImmerGo – assign Forward



## 4.5 MIDI CONFIGURATION WHEN USING THE PROTOOLS DAW

To set up MIDI correctly, select Setup -> MIDI -> MIDI Input Devices. You should see the following:

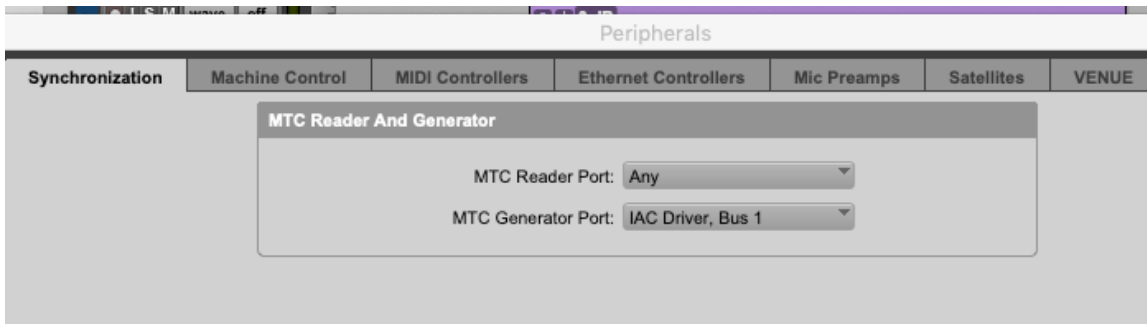


In order for ProTools to receive MIDI transport commands from ImmerGo, you need to choose:

Setup -> Peripherals -> MIDI Controllers, upon which you will see the following table:

Peripherals						
Synchronization	Machine Control	MIDI Controllers	Ethernet Controllers	Mic Preamps	Satellites	VENUE
		Type	Receive From	Send To	# Ch's	
#1		M-AudioKeyboard	IAC Driver, Bus 1	IACDriver.IACBus2	8	
#2		none	none	none		
#3		none	none	none		
#4		none	none	none		

Ensure that you set up the table accordingly. ProTools needs to be configured to transmit MIDI Time Code messages to the ImmerGo server to synchronize playback of localization moves with the audio. To enable this, you should select: Setup -> Peripherals -> Synchronization, upon which you should set the MTC Generator port as shown below:



Make sure that the GEN MTC button in the Transport window is selected. The time code frame rate can be set up via: Setup -> Session, and selecting the frame rate within the session window.

## 5 SPEAKER CONFIGURATION

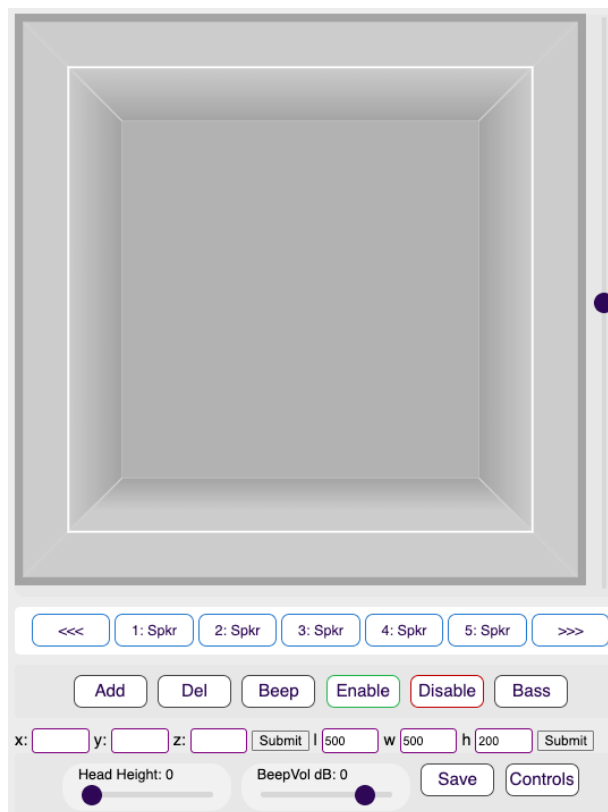
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ImmerGo needs to know the positions of the speakers in your room in order to correctly localize the audio tracks that you select and move. When localizing sounds, ImmerGo refers to a file named *speakerconfig.xml* that resides in your working folder. This section describes a graphical configuration capability within ImmerGo that allows you to place the speakers within a graphic representation of your room. After positioning your speakers, you can save the configuration and this will cause ImmerGo to create the *speakerconfig.xml* file in your working folder. As in the case of localization of sound sources, you can perform graphical speaker configuration within a client that resides on the server or on a remote mobile device.

### 5.1 STARTING THE CONFIGURATION

When you start the ImmerGo server for the first time, you will probably not have a speaker configuration file in the working folder. In this case, the server will indicate that you need to start a client to configure your speakers.

Similarly, when you start up a client, you will be told that there is no speaker configuration file, and asked to continue with the configuration process. On continuing with the configuration process, you will be presented with a representation of a room, and a series of configuration control buttons, as shown below.



## 5.2 CONSTRUCTING A CONFIGURATION

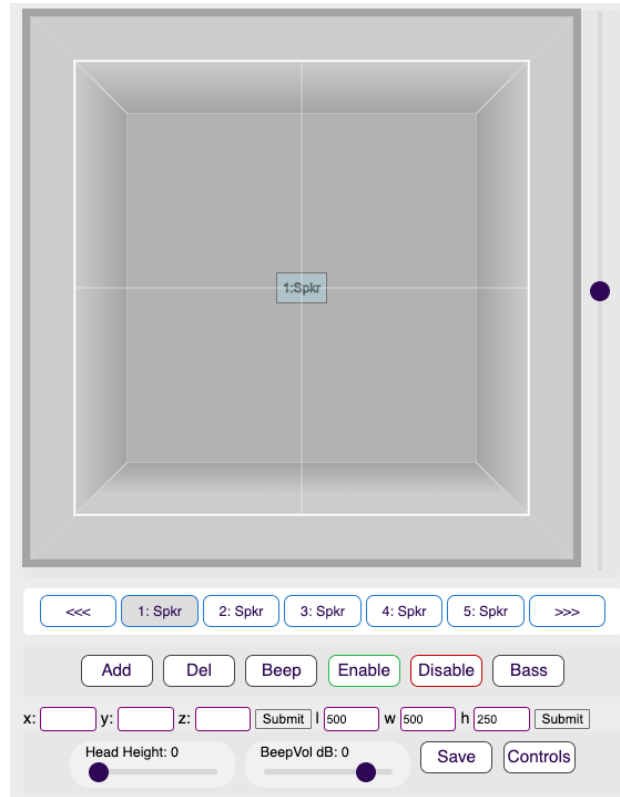
Before you start adding speakers to your configuration, you should first:

- Measure the dimensions of your room (or space):
  - Length – the distance from the front of the room to the back of the room.
  - Width - the distance from the left side to the right side of the room.
  - Height – the distance from the bottom of the room to the top of the room, where the center of the bottom-most speaker marks the bottom of the room, and the center of the top-most speaker marks the top of the room.
- You can then either:
  - Enter the dimensions of the room (cms) – type in the length (l), the width (w) and height (h), then click 'submit' or type <enter> after your last entry. This will give an accurate representation of your room. However, you will lose screen space for performing spatialisation panning.
  - Enter the dimensions of a square that encapsulates all the speakers. This will maximize screen space for spatialisation. It is important that the relative positions of the speakers are accurate.

The top row of buttons corresponds to all the possible speakers in your configuration. The number of speaker buttons corresponds to the number of possible analog outs on your device (this is dependent on the number of aux buses in your device). ImmerGo uses sound (a short 'Beep') to help you associate a speaker button with a particular speaker in your actual configuration.

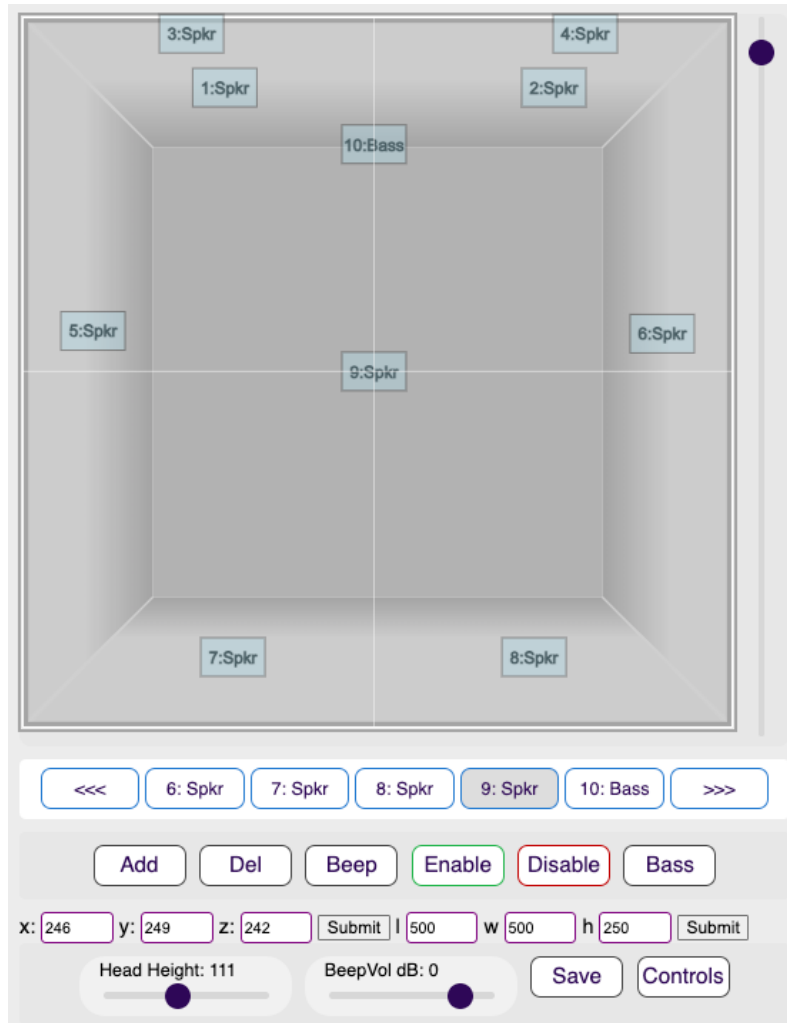
To add a speaker to your configuration, you should do the following:

1. Select a speaker button – it will highlight as the selected speaker.
2. Click the 'Beep' button – if you hear a speaker beep, you know that the speaker is indeed part of your configuration, and you can locate it. If none of the speaker buttons respond to a 'Beep' request upon selection, then there could be a problem with your MOTU configuration or with the setting of your default sound device. Go back to section 2, and check that you have fulfilled the requirements. In particular check that your default sound device is the MOTU device. If it is not, you will need to restart ImmerGo.
3. You can adjust the volume of the 'Beep' with the Beep Volume slider.
4. Select the 'Add' button – this will cause the speaker to appear in the middle of the room, as shown below.



5. Drag the speaker to a position that represents its actual position in the room. You can use the slider to adjust the speaker height (the white rectangle indicates the height of the speaker). If you are using a mobile device, you can select the up/down check box and adjust the height of the speaker by tilting the mobile device.
6. As you re-position the speaker, the x, y and z coordinate values (in cms) will change. The coordinates are relative to the bottom left front of the room.
7. If you select a speaker, click 'Beep', and there is no sound, it could be that there is not an actual speaker associated with that speaker button. In this case, you could select the 'disable' button. This will give the selected speaker button a purple outline, and it will afterwards not be selectable. Selecting the 'Enable' button' will re-enable all disabled speaker buttons.
8. Bass speakers – you can add one or more bass speakers to your configuration by doing the following:
  - a. Select a speaker
  - b. Select the 'Bass' button – the 'Spkr' text on the button will be replaced by 'Bass'.
  - c. Beep the speaker to determine its location
  - d. Move the bass speaker to its allocated location in the room
 Note that if a speaker is designated as a bass speaker, ImmerGo will direct all non-muted tracks to that speaker.
9. Head height adjust the headheight of the listener so that it accurately reflects the listening position relative to the speaker positions.

Following this configuration process, you may have a room configuration that appears as shown below:



To save this configuration, select the 'Save' button. This will save your configuration in the *speakerconfig.xml* file in your working folder. You can now immediately start localization control by selecting the 'Controls', button. The ImmerGo client interface might appear as follows:





As you can see, the speaker positions in the localization page correspond to the positions that you set up in the configuration page.

You can view the contents of the *speakerconfig.xml*, and indeed you can edit the coordinates that are within the file or even create a whole new set of coordinates. Remember that the units are centimeters, and the 3D coordinates are measured relative to the bottom front left of the room.

Given below is a listing for the *speakerconfig.xml* that corresponds to the above configuration.

```

<config>
  <room roomWidth="500" roomLength="500" roomHeight="250"/>
  <mixer name="828ES">
    <speaker number="0" xpos="80" ypos="0" zpos="111" type="normal" used="true"/>
    <speaker number="1" xpos="446" ypos="0" zpos="111" type="normal" used="true"/>
    <speaker number="2" xpos="43" ypos="0" zpos="211" type="normal" used="true"/>
    <speaker number="3" xpos="481" ypos="0" zpos="211" type="normal" used="true"/>
    <speaker number="4" xpos="0" ypos="204" zpos="111" type="normal" used="true"/>
    <speaker number="5" xpos="500" ypos="207" zpos="111" type="normal" used="true"/>
    <speaker number="6" xpos="89" ypos="500" zpos="111" type="normal" used="true"/>
    <speaker number="7" xpos="424" ypos="500" zpos="111" type="normal" used="true"/>
    <speaker number="8" xpos="246" ypos="249" zpos="242" type="normal" used="true"/>
    <speaker number="9" xpos="246" ypos="0" zpos="6" type="bass" used="true"/>
    <speaker number="10" xpos="250" ypos="250" zpos="125" type="normal" used="false"/>
    <speaker number="11" xpos="250" ypos="250" zpos="125" type="normal" used="false"/>
    <speaker number="12" xpos="250" ypos="250" zpos="125" type="normal" used="false"/>
    <speaker number="13" xpos="250" ypos="250" zpos="125" type="normal" used="false"/>
  </mixer>
  <head xpos="257" ypos="184" zpos="111"/>
  <routing micNo="0" analogNo="0" USBNo="32"/>
</config>

```

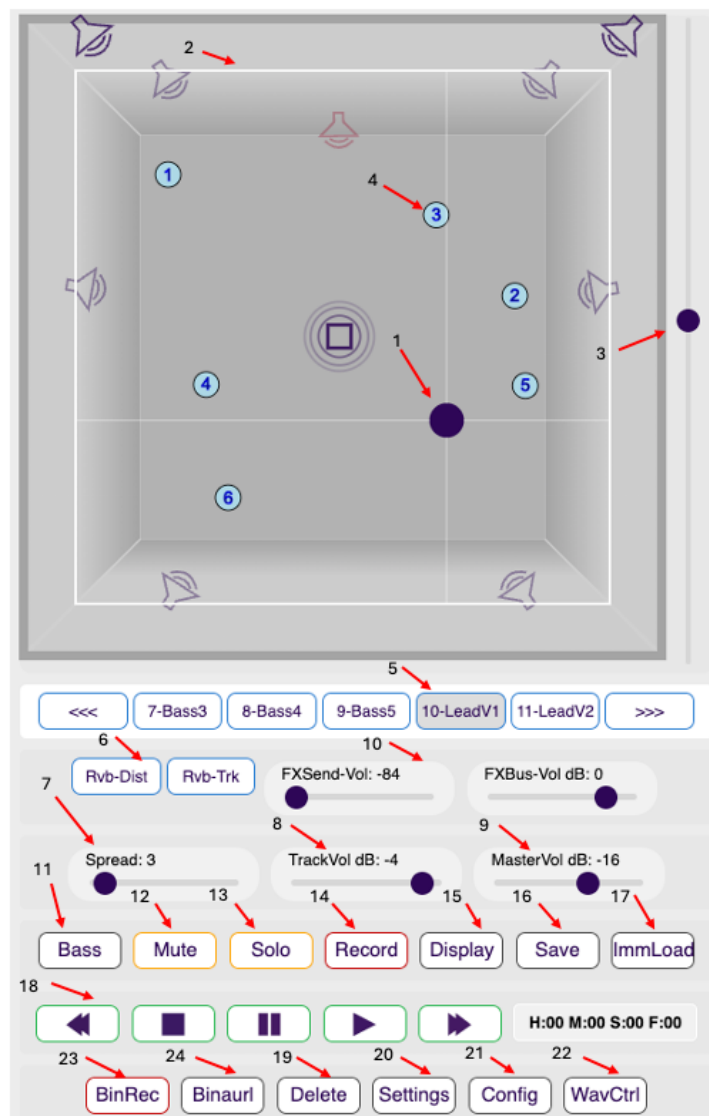
The 'mixer' entity refers to an entity to which speakers are attached. In the case of the above configuration, it is a MOTU 828ES device. Each 'speaker' entity, associated with the MOTU device, has a speaker number, x, y, and z centimeter coordinate values, a type which could be 'normal' or 'bass', and an indication of whether the speaker is used or not. The 'used' attribute takes account of a situation where not all of the MOTU device outputs are connected to speakers. The 'head' entity provides the coordinates of the listener's head position.

## 6 THE CLIENT

You can control ImmerGo from the client interface on your workstation, or you can run the ImmerGo client on your mobile device. You can access the ImmerGo client on an Android device via the Play Store and also on an iOS device via the Apple store. Alternatively, the server page provides you with a URL that you can type into your mobile device browser. This will be something like the following:

'http://192.168.0.104:8000/ImmerGoClient.html'

but will vary depending on the IP address of your server. The server user interface indicates your particular URL. Regardless of how you load the client, you should be presented with a graphical user interface. Given below is a graphical user interface with annotations:



*A guide to the ImmerGo client user interface:*

This interface will vary, depending on the configuration of speakers in your SpeakerConfig.xml file.

The top half of the user interface is a representation of the room (space) that contains your speakers. The view is from the top of the room. The bottom half of the user interface comprises a number of buttons, sliders and checkboxes that all enable control over the recording and play back of multitrack immersive sound.

This short guide will describe each of the labelled items in the representation of the user interface shown above.

1. The representation of the virtual source that a user can move in the horizontal plane. The sound that will be localized derives from the currently selected track.
2. This white rectangle indicates the vertical position of the virtual source. If the Up/Down check box is ticked (see Settings page), then the rectangle will move as the mobile device is tilted up and down.
3. This slider responds to mobile device orientation, in particular up/down tilts. If ImmerGo is run on a desk top or laptop, then this right vertical slider can also be used to control the vertical position of the virtual sound source, and thus the position of the white rectangle.
4. Small blue circles represent the positions of the sound sources (sound from the various audio inputs). When sound sources are localized and then played back, these circles will move in accordance with the recorded positions. In order to display, select the track, then click the Display button.
5. The sound input selection buttons. They allow you to select a particular input that will be moved within your 3D space. The USB input would be derived from a multichannel wav file or DAW. The '<<<' and '>>>' buttons allow you to display further inputs, either higher or lower numbered.
6. Reverb – Rvb-Dist and Rvb-Trk. Rvb-Dst is a toggle button. When 'on' it will be green and any track source that moves beyond the speakers will have reverb added to it, to provide a sense of distance. Rvb-Trk, when selected, will cause the reverb bus to be spatialised in the same manner that any selected track is spatialised. Spatialisation will be effected by varying reverb bus to aux bus send levels.
7. Spread – this slider controls how 'wide' the sound source seems.
8. TrackVol – allows for the control of the volume of the selected input.
9. MasterVol – This slider will control the volume of outputs to all speakers (via the aux faders).
10. FXSend-Vol and FXBus-Vol sliders – FXSend-Vol controls the level of the selected track sent to the reverb bus. FXBus-Vol controls the reverb bus volume.
11. Bass - This button is relevant if you have one or more sub-woofers in your speaker configuration. Then if this button is selected, the BassVol control slider will control the volume of the sub-woofers. Selected tracks can be routed to sub-woofers – see the Settings page.

12. Mute – allows you to mute the selected input. To un-mute a muted input, select the input and tap the Mute button.
13. Solo – allows you to Solo the selected input. To un-solo a solo'ed input, select the input and tap the Solo button.
14. Record – in order to record your localization moves, you should:
  - a. Select an input
  - b. Tap the Record button
  - c. Tap the Play button
  - d. Move the virtual source circle and/or the white rectangle
  - e. Tap Stop when complete
15. Display - if you select an input and tap this button, then a small track circle will indicate the location of the virtual source for that input when your stored localizations are played back. You can display more than one virtual source.
16. Save – saves any spatialisations that you have recorded. You will be requested to provide a file name. Your spatialisations will be saved as a .imm file.
17. ImmLoad – loads a spatialisation file that you have saved. You will be asked for a file name.
18. DAW transport control buttons – Rewind, Stop, Pause, Play, FastForward and a time code display. These buttons allow you to control the transport of the server side DAW from the client, whether desktop or mobile. The timecode display will change while your DAW/wav file soundtrack plays.
19. Delete – this allows you to delete the spatialisation of the currently selected track.
20. Settings – This button is used to take you to a 'Settings' screen where you can modify various ImmerGo settings. These are described in section 6.1.
21. Config – On clicking, will take you to the speaker configuration window, where you will be able to reconfigure your speaker configuration, as long as there are no other clients currently active.
22. WavCtrl – This will take you to the multichannel wav player window, where you can load a multichannel wav file, then select channels and localize them, much as you do in the DAWCtrl window. Refer to section 6.2.
23. BinRec – When clicked, this button will enable the recording of a binaural spatialization. The recording will appear as a wav file within the "binauralFiles" folder of the working folder. The name should be provided within the Settings page. See section 6.7 for further details.
24. Binaural – when clicked this will enable binaural playback to the headphones connected to your computer. See section 6.7 for further details.

## 6.1 SETTINGS

There are currently six possible setting categories –

- 'Names',
- 'Bass Trks'
- 'Link Tracks'
- 'Rendering Algorithms'
- Up/Down
- Binaural

You can return to the localization control screen by clicking the 'Controls' button.

### 6.1.1 Names

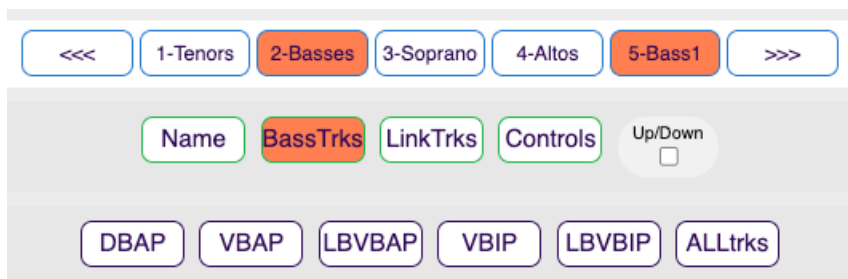
When you first load the ImmerGo client, the input buttons are labelled according to the inputs that you have requested in the server. For example, they might be - Analg1, Analg2, ...,USB1, USB2, etc. The input naming capability allows you to provide meaningful names for each of the inputs. This makes it easier to choose a particular input for localization. You can change a name simply by right clicking a track in the main screen and entering the name in the pop up edit box.

Otherwise, you can select the 'Settings' button and then enter a name as follows:

1. Select an input to re-name
2. Select the 'Name' button
3. Type in the new name of the input

### 6.1.2 Bass Tracks

You can select which of the tracks you would like to be sent to the bass speakers. Select the 'Bass Trks' button, then select each of the tracks that will be sent to the bass speakers. In the screenshot below, the Bases (track 2) and Bass1 (Track 5) are set to be sent to the bass speakers.



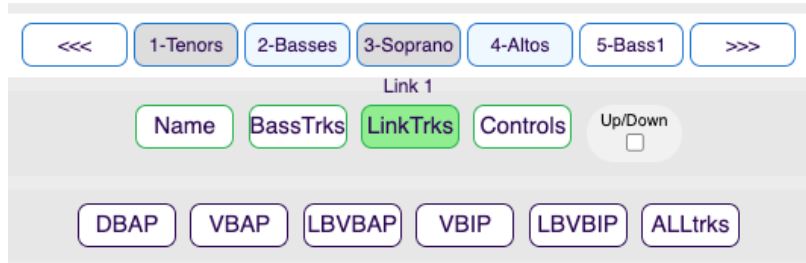
### 6.1.3 Link Tracks

It is possible to link two tracks so that, for example, stereo channels can be spatialized together. To do this:

1. Select a track, for example 3-Soprano.
2. Click the 'LinkTrks' button.
3. Select the track that you want to link to Soprano, for example 1-Tenors.

4. A link indicator will appear below the linked track, indicating the track it is linked to.

When you return to the main Controls page, you can select a track that has a linked track, for example Soprano, and when you spatialize it, the sources for both tracks (Tenors and Sopranos) will be spatialized together.

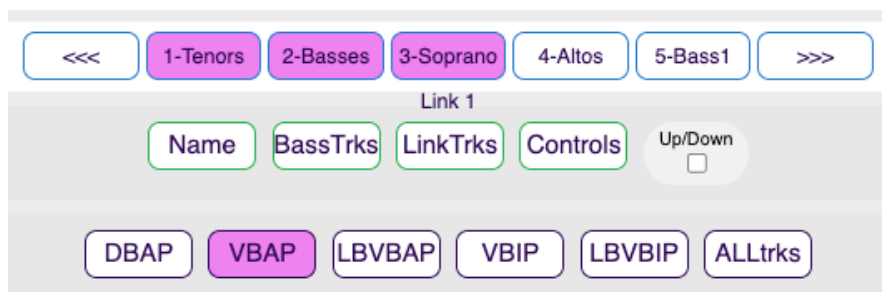


### 6.1.4 Rendering Algorithms

When a user selects and moves a track on a client, or when recorded movements are played back by the server, the 3D coordinates that are generated need to be converted to appropriate mix levels for the speakers within a speaker configuration. This conversion is performed by a rendering algorithm. ImmerGo provides a choice of rendering algorithms on the settings page:

- DBAP – Distance Based Amplitude Panning
- VBAP - Vector Base Amplitude panning
- VBIP - Vector Base Intensity Panning
- LBVBAP - Layer Based Vector Base Amplitude Panning
- LBVBIP - Layer Based Vector Base Intensity Panning

In the Settings screenshot below, the VBAP rendering algorithm has been chosen, and the two tracks that use that algorithm are shown in purple. To set any track(s) to an algorithm, select the required algorithm, and then select the tracks that should use it. If you want to set all tracks to use a particular algorithm, select the algorithm, and then click the ‘ALLtrks’ button.



**Note:**

When you record spatialisations on audio tracks and play them back, then on each quarter frame your computer will ‘render’ the spatialisations. The rendering involves calculations to determine the appropriate mix level to send to your audio mixer for each speaker. In the same quarter frame, the mix levels will be sent to your audio device. If there are many spatialisations for many tracks, this could lead to spatialisations that lag. ImmerGo

automatically adjusts for this by momentarily raising the dB level that determines spatialisation changes, hence reducing the mix level changes for a short period of time.

### 6.1.5 Up/Down

This is a check box for mobile devices. When checked, you can use the mobile device to control the 3<sup>rd</sup> dimension i.e. the height of the virtual source that you are controlling. When you select a track and tilt the mobile device up and down, the track sound position will move up and down. The rectangle in the room display will also move up and down as a visual confirmation. When controlling spatialisation with a mobile device, you can touch move for 2-dimensional spatialisation and at the same time tilt for the 3<sup>rd</sup> dimension.

### 6.1.6 Binaural

In this section of the Settings display, you can alter the width of the listener’s head, and also enter the name of the binaural spatialisation file that you record binaural audio to.



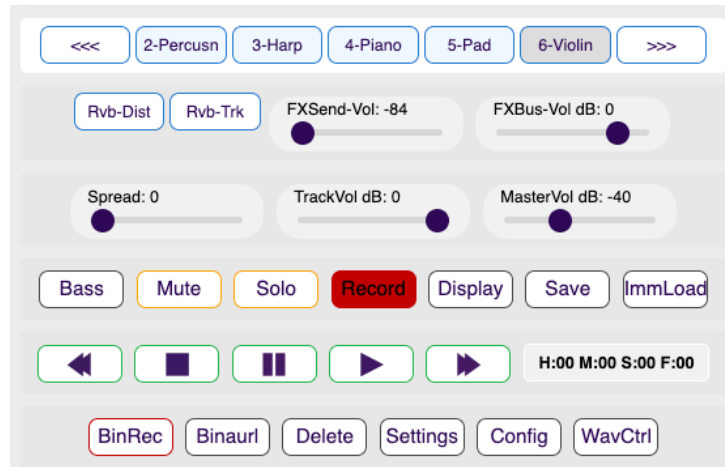
The average head width in adults is approximately **14–16 centimeters** for males and **13–15 centimeters** for females. The head width will be used to determine the audio delay and volume attenuation from one ear to the next. You could experiment with different values by moving the slider and clicking the ‘Set Width’ button. Before recording binaural audio, you should type a name in the edit box and click ‘Submit’.

## 6.2 CREATING A NEW DAW MULTITRACK LOCALIZATION FILE

If you have started the ImmerGo server, and have not loaded a localization file, then you can start recording new position changes for each of the DAW tracks. First, you must start a DAW such as Reaper, and ensure that the DAW is properly configured. Refer to the DAW configuration section 4. Now to record source position changes for a single track you should:

1. Select a track by tapping an input button (USB1 ...USBn, unless you have named the inputs)
2. Tap the ‘Play’ button and listen to the track’s movement as you move the virtual source circle and tilt/swivel your mobile device. This should give you a sense of the nature of the source position changes that you would like to make during the playback of the multitrack soundtrack.
3. You should see the timecode display change as the soundtrack plays. If you would like to hear only the track whose positions you are recording, then ‘Solo’ the input by tapping the ‘Solo’ button.
4. Now tap the ‘Record’ button and then the ‘Play’ button. As you move the virtual sound source circle and/or change the orientation, the server will record the 3D position of the chosen track’s sound, as well as the current time.





5. Tap the 'Stop' button when you have finished localizing the track.
6. You can now localize a different track. To do this, first select the new track and if you want to only hear this track while you localize, then tap the Solo button. If you want to hear the previously recorded track as well as the new one, then select the previously recorded track and tap the Mute button to unmute the track.
7. While localizing a new track, you can visualize the movements of other tracks, by using the ImmerGo 'Display' feature. Select the input you want to visualize, and tap the Display button.
8. At any point, you can save your localization recording to disk. Tap the 'Save' button and type in the name of your file in the dialog box that pops up. Your file will be saved, with the '.imm' extension, in your working folder.

**Note:** It is possible to record over any localization for any track at any point in the multitrack recording. You could for example:

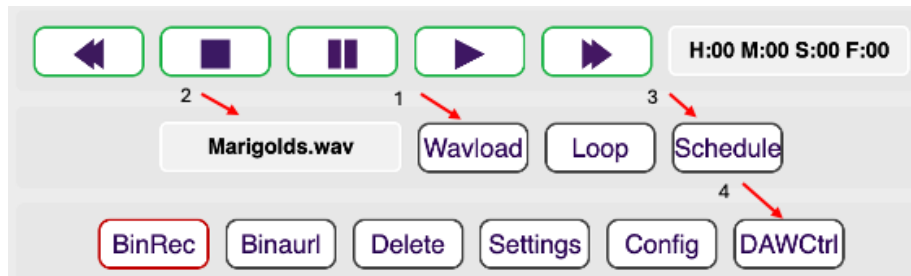
- a. Pause playback at a point where you would like to change the localization for a track. Then you can select the input, tap record, tap play and proceed to change the localization.
- b. While you are playing a multitrack with its localizations, you could select an input, tap record and proceed to change the localization.

For both the above cases, tap Stop to end the localization change.

Note: If at any point you are not able to control the transport of your DAW from your client device, make sure that the MOTU interface is selected in your DAW. It may be necessary to re-select even if the interface was previously selected. In Reaper this is done by selecting Options -> Preferences -> Device.

### 6.3 MULTI-CHANNEL WAV FILE LOCALIZATION

ImmerGo allows you to load multichannel wav files and to localize the channels of these wav files. You would first need to load your multichannel wav files from the ImmerGo server, as described in section 3.2. Then, on the client (mobile or workstation), you select the WavCtrl button. This will take you to the multichannel wav player window as shown below.



The controls are very similar to those for DAW control, with a few exceptions:

1. The Wavload button allows you to load a wav file for localization.
2. There is an indication of the current wav file
3. The Scheduler button, when clicked displays the Scheduler page
4. The DAWCtrl button will enable control over a DAW.

When using this wav playback capability, be sure that your default sound output device is the MOTU device. See section 2.2.

### 6.4 THE SCHEDULER

ImmerGo has a Scheduler capability that allows a user to specify a sequence of multichannel wav files to be played back. It can be accessed by clicking the 'Scheduler' button of the wav control page. The first Scheduler page is shown below:

### Scheduler Table

- click Add button to add Wav file entry

Wav File	Imm File	Loop Count	Playing
<div style="display: flex; justify-content: space-between; align-items: center;"> <span>Add</span> <span>Clear</span> <span>Play</span> <span>Stop</span> <span>LoopOn</span> <span>H:00 M:00 S:14 F:03</span> </div> <div style="display: flex; justify-content: center; margin-top: 10px;"> <span>No File</span> <span>Save</span> <span>Load</span> <span>WavCtrl</span> </div> <div style="text-align: center; margin-top: 10px;"> <p>Master Volume</p> </div>			

By clicking the 'Add' button, you add a new scheduled entry row to the Scheduler table. A Scheduler table with row entries is shown below:

### Scheduler Table

- click Add button to add Wav file entry

Wav File	Imm File	Loop Count	Playing
AmazonMultiChan.wav	Amazon2.imm	1	<input checked="" type="radio"/>
Electronica.wav	electronica.imm	1	<input type="radio"/>
Ambience.wav	ambience.imm	1	<input type="radio"/>
MixTracks1.wav	mixtracks.imm	1	<input type="radio"/>

Add
Clear
Play
Stop
LoopOn
H:00 M:00 S:13 F:01

Amsterdam.sch
Save
Load
WavCtrl

Master Volume

Within the row, there are two drop-down lists that allow you to select:

1. The wav file to be played
2. The imm (localization) file that will localize the multiple channels of the wav file

Furthermore, there is:

3. An edit box that allows for the entry of a loop count, i.e. the number of times the wav file should be played.
4. A radio button indicates which row entry should be scheduled first.

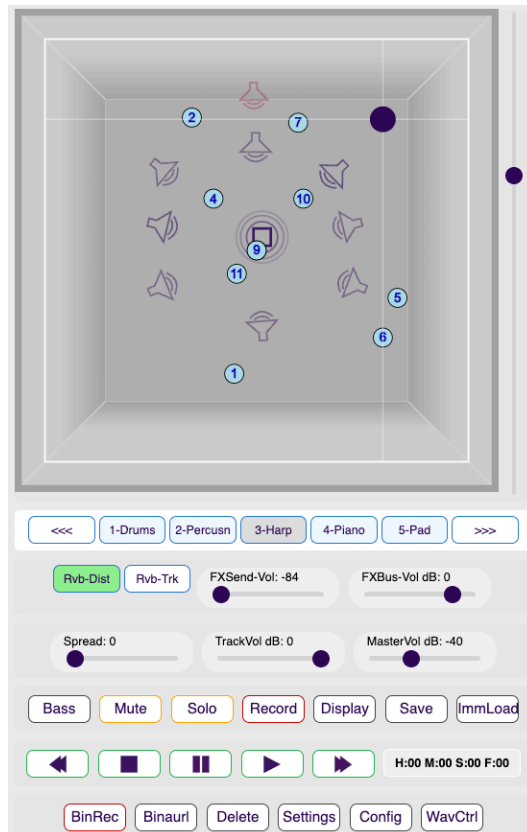
A 'Clear' button causes the whole table to be cleared. A 'Play' button starts playback of the schedule, and a 'Stop' button stops it. A 'LoopOn' button causes the entire schedule to be played over and over again until the button is pressed again, or the 'Stop' button is pressed.

A schedule can be saved by clicking the 'Save' button and typing a name for the schedule. A schedule can be accessed by clicking the 'Load' button and selecting from a list of schedule names.

## 6.5 REVERB TO ENHANCE DISTANCE PERCEPTION

In the second row of buttons there is a 'Rvb-Dist' button. If this button is clicked, it will turn green indicating that ImmerGo will add reverb to sources that are moved beyond the speaker bounds. The further the movement beyond speaker bounds, the more reverb will be added. This capability enhances the sense of distance for the extended sound source. The reverb button is a toggle button, so reverb can be switched on and off. The reverb capability does require additional real time processing. The relative volume and position of reverb can be altered by selecting the Rvb-Trk button, moving the FXBus-Vol slider, and moving the bus position as for a track.

As an example, shown below is a configuration with Rvb-Dist set to 'On', and the Harp sound source beyond the speaker bounds. Reverb will be added to the Harp sound, and its direct amplitude will be reduced.



## 6.6 REVERB SPATIALIZATION

The MOTU reverb bus can be spatialised by selecting the 'Rvb-Trk' button. Shown below is the ImmerGo client where Rvb-Trk has been selected and spatialised to be close to speaker 1. Also shown is MOTU control panel, where it can be seen that the Aux 1 send slider is positioned high.

To adjust the contribution of a track to the Reverb bus, select the track and then adjust the 'FXSend-Vol' slider. The amplitude of the Reverb Bus can be changed via the 'FXBusVol' slider.



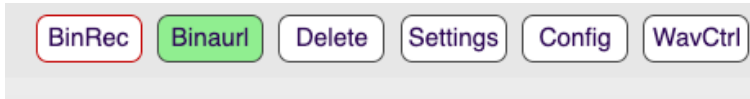
## 6.7 BINAURAL PLAYBACK AND RECORDING

ImmerGo has a binaural playback and recording capability. This allows you to hear spatialized sound over headphones. To enable this, ImmerGo reads the output from the aux buses that would typically go to speakers, and processes the audio within an  $N \times 2$  matrix.  $N$  is the number of speakers, and is the input to the matrix, while the 2 represents the stereo output to your headphones.

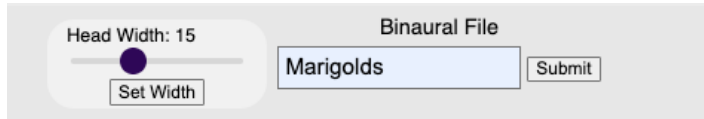
At the bottom of the ImmerGo client control page, you will find the two binaural buttons:



To play binaural, you should select the “Binaural” button. Playback will be to whatever you have set your system settings to, for example headphones. To stop binaural playback, click the Binaural button again.

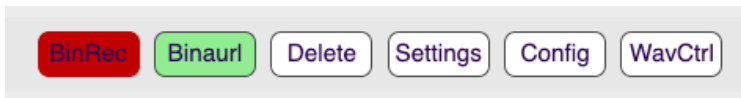


You can adjust head width by going to “Settings”. At the bottom of the Settings page you will see the following:



To set the head width, you should move the slider to reflect your head width (typically around 15 cms) and then select “Set Width”. Increasing the head width will increase the delay of sound to the far ear as well as reducing gain.

To record binaural, you should type in the name of a file and click “Submit”. Then after returning to the main screen controls, select “Binaural” and then select “BinRec”.



When you want to stop recording, select “BinRec” again, and your recorded wav file will be in the “binauralFiles” folder of your working folder.