Making Music with *Jamulus* Software

The *Jamulus* software enables several musicians to play together,
in real-time, over the internet, with very low latency.

Hardware Requirements:

- A desktop or laptop computer (Chromebooks not recommended), running either Windows 10, MacOS X El Capitan (v10.11) or higher, or Linux.
- A quality USB microphone or good dynamic or condenser microphone, plugged into an external audio interface that is plugged in via USB to your computer.

  If you aren't using a USB microphone, to avoid latency you are strongly advised to use an audio interface: a box that you can plug your external microphone (or instrument) into, rather than using your computer's built-in sound card. The interface will connect to your PC usually via USB.
- Wired Headphones into your computer or through your USB microphone. (Using external speakers will cause echo or feedback).

  The best 1/8" input to your computer will have three little bands around the male jack. A two-banded jack can cause unstable connection and cut out … really annoying.
- A wired Internet connection (Ethernet connection to a router or a good WiFi Repeater/Booster with Ethernet connection to your computer, as a hardwire option).

  Wi-Fi only connection will cause sound problems. Most broadband connections will be fine. If you have 10Mbits down and 1Mbps up, you're unlikely to run into bandwidth-related issues. This link will explain audio bandwidth parameters:

  https://github.com/corrados/jamulus/wiki/Quality,-delay-and-network-bandwidth

Software Requirements:

- *Jamulus* Software (free download): https://llcon.sourceforge.io
- *Zoom* account (free download): https://zoom.us/download

  Jamulus serves only as an audio platform. It will be necessary for each musician and conductor to attend large *Zoom* meetings in order to "see" each other in rehearsals.

For a list of good/suggested hardware (microphones/audio interfaces), please see Appendix A.

Getting Started

Minimizing "latency" (signal delay) is crucial for playing successfully together. While using *Jamulus*, make sure that nothing else on your machine or your network is competing against it. Don't watch YouTube/Netflix, or have anything else running on the machine that you are using for *Jamulus*. That being said, in order to see each other, you need to run a platform like *Zoom*. Some find it better to run *Zoom* on a separate device and *Jamulus* on the computer, but most computers can run both without any issues.

Make sure your headphones and microphones are plugged in when you open *Jamulus* or you will hear nasty feedback, distortion, echo, or other noises.

STEP 1: Download and Install Jamulus

Installation for Macintosh:

1. Download the latest version of Jamulus: https://llcon.sourceforge.io
2. Extract the downloaded .zip file. Double-click on the .zip file, which will create new folder of same name. The folder contains the license file and a .dmg file containing the application.
3. Double-click the .dmg file to open it. It will unpack and you will see two files (Jamulus client and server).
4. Drag both icons into your Applications folder to install *Jamulus*.

   You will not need the server file unless you would like to play with musicians across the globe. If so, you will join the *Jamulus* server and be able to join rooms with anyone outside of this organization.

   Our organization has a dedicated server IP address (XXX.XXX.XXX.XXX) and you will not need to click on the *Jamulus* server for our rehearsals and performances.
5. Run *Jamulus*. Now you should be able to use *Jamulus* just like any other application.

   If you see a message which tells you that *Jamulus* can't be opened because the developer can't be verified, click on *Jamulus* in the Applications folder, right-click (or control-click), and select "Open" from the top of the menu.

   You will then get a slightly different version of the same message, which allows you to click “Open” and run the software. You will not be shown this warning again - just double-click it to run after that. Only when you download updated versions (and they come out regularly), you will need to do this step.

   You can remove the folder in the Downloads directory containing the .dmg and eject the "Jamulus" drive on your desktop. They are no longer needed.

Installation for Windows

1. Download and run the latest version of *Jamulus*: https://llcon.sourceforge.io

   If you get a warning notice, click on "More info" and "Run anyway" to install *Jamulus*.

2. If you receive the error “No ASIO audio driver found” when opening *Jamulus*:

   a. Download ASIO4ALL (http://www.asio4all.org/)

      - This is an audio driver that allows your computer’s sound card to interact with the speakers. Essentially, it allows Jamulus to receive audio and transmit it.
      - You may need to download ASIO4ALL even if you have an audio driver already, as *Jamulus* only supports certain audio drivers currently.

   b. Close all applications (especially those that could access your soundcard) to minimize conflicts. If the audio doesn’t work right away, make sure that only the correct inputs/outputs in its control panel are switched on.

      You may need to experiment a bit to find the right ones since every computer is different.

      Do this while you're connected to a server to hear your instrument or voice to check if everything is correctly setup.

Note: If the you are using an interface from Focusrite, Steinberg or Zoom recorder, you should NOT use the ASIO4ALL. Instead, download the driver from the manufacturer accordingly.

- Zoom recorder: https://zoomcorp.com/en/us/support/, type in the product, then it will take you to the driver option accordingly
- Focusrite: https://customer.focusrite.com/en/support/downloads
- Steinberg: https://www.steinberg.net/en/support/downloads_hardware/yamaha_steinberg_usb_driver.html
- Behringer also has their own driver, but it is terrible, that ASIO4ALL is better.

3. Enable multiple apps use your audio devices

   a. Navigate to Control Panel using the bottom left search bar on your PC.

   b. Click Hardware and Sound, then Click “Sound”

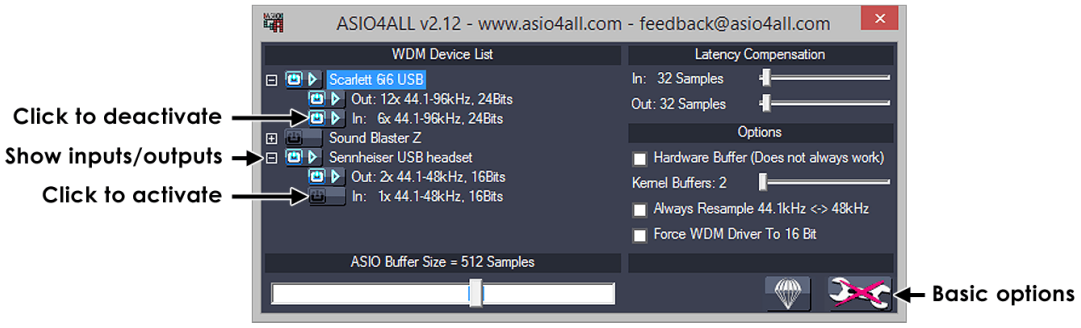
   c. Under Playback, select the audio device you are using to hear other people. Click “Properties.”

   d. Under Advanced, make sure "Allow applications to take exclusive control of this device" is unchecked. Click “Apply,” then OK.

   e. Do this with all audio devices you use for both Zoom and *Jamulus*, under both Playback (from step 4) and Recording.

4. In the bottom right corner of Windows 10 taskbar, you should see a new icon. Click on it

    a. Change settings in ASIO4ALL:



    - At the bottom, slide the ASIO buffer size slider all the way to the left. It should now be at 64 samples.

    b. Deactivate all inputs except the one you are using.

    c. Close the window

    Having trouble with ASIO4All setup?

    Although ASIO4All should work, you might experience problems with its setup.

    If nothing works, first try to restart Jamulus and/or your PC. Afterwards, try to setup the inputs/outputs again. Enabled and accessible inputs/outputs show a lit up on/off button and a play button. If you see a red cross or a yellow symbol, you might need to close other applications like your browser, Zoom, ...

    For more assistance view these two links, to make your experience much better:

    https://www.sweetwater.com/sweetcare/articles/installing-and-using-asio4all-for-windows/

    https://www.image-line.com/fl-studio-learning/fl-studio-online-manual/html/envsettings_asio4all.htm

    Have a look at this video from @trombonepizza which gives more detailed setup information on ASIO4All:
    https://www.youtube.com/watch?v=_GzOsitVgLI&feature=youtu.be

STEP 2: Set up Jamulus

Macintosh:

1. If you are using an interface, plug it into a USB port on your computer.
2. Close all programs and start *Jamulus* software (not the Jamulus server).
3. Plug your microphone and headphones into your computer via USB.
4. Connect to the RHPO *Jamulus* server: (XXX. XXX. XXX.XXX)

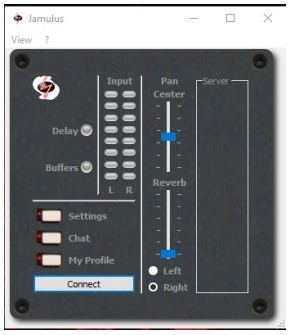
Detailed step-by-step instructions are below for Mac and Windows users … read on!

Windows:

1. If you are using an audio interface, plug it into a USB port on your computer. *In the future, always use the same USB port for the audio device.*
    a. If not already done: download and install the free ASIO sound driver (ASIO4All).
2. Close all programs and start *Jamulus* software (not the Jamulus server).
3. Plug your microphone and headphones.
4. Connect to the RHPO Jamulus server IP address: *XXX*. *XXX*. *XXX*. *XXX*

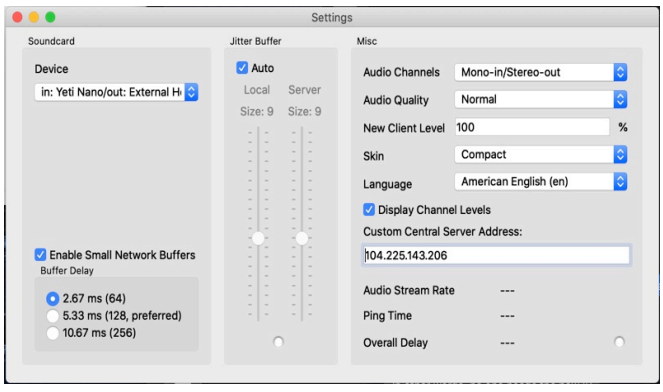
Detailed step-by-step instructions are below for Mac and Windows users … read on!

Launch *Jamulus*

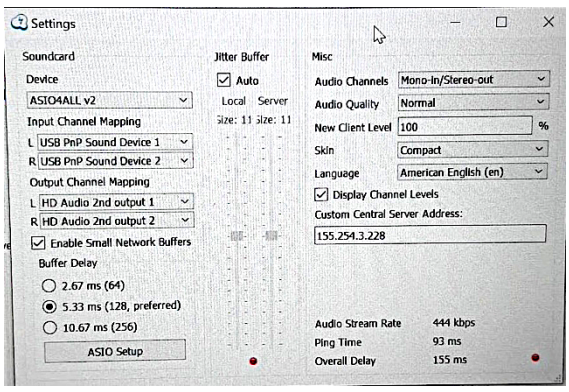


Click the 'Settings' button. This will launch a new window:

For Macintosh:



For Windows:



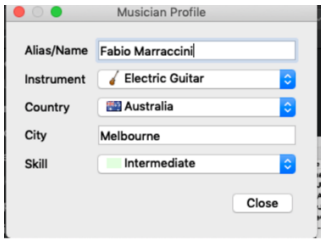
1. Configure the "Device" (input/output or soundcard on the computer). Select the device that the computer is using and choose the correct input and output mappings. This tells *Jamulus* where to find audio (input: mic/instrument) and where to send the sound so it can be heard (output). For Macintosh, you simply need to set the type of USB microphone you are using, unless you are running your mic through an external audio interface.

2. Click (√) Enable Small Network Buffers
3. Select Buffer size (5.33 is preferred, but 2.67 or 10.67 might be better, depending on your connection speed)
4. Click (√) “Auto” Jitter Buffer
5. Audio Channels: Mono-In/Stereo-Out
6. Sound: Normal (The higher the audio quality, the higher your audio stream's data rate. Make sure your upload rate does not exceed the available upload speed of your internet connection).
7. New Client Level: 50%
8. Skin: Change this to “Compact” (this will allow you to see everybody’s input signal)
9. Click (√) “Display Channel Levels
10. Type in the Custom Central Server Address (XXX.XXX.X.XXX)

    * If this changes, the new address will be provided.
11. Current connection status parameter: The Ping Time is the time required for the audio stream to travel from the client to the server and back again. This delay is introduced by the network and should about 20-30ms. If this delay is higher than about 50ms, your distance to the server is too large or your internet connection is not sufficient.
12. Close the settings window

Set up Your Profile

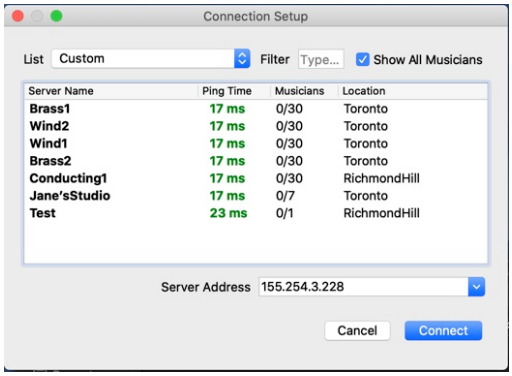
From the View menu, select “My Profile...” to set your Alias/Name which is displayed below your fader in the server audio mixer board. If an instrument and/or country is set, icons for these selections will also be shown below your fader. The skill setting changes the background colour of the fader tag and the city entry shows up in the tool tip of the fader tag.



Type Your Name, Select Your Instrument (and fill in the rest, if you like), for us to be able to easily set up the mixer into groups or sections for the entire ensemble.

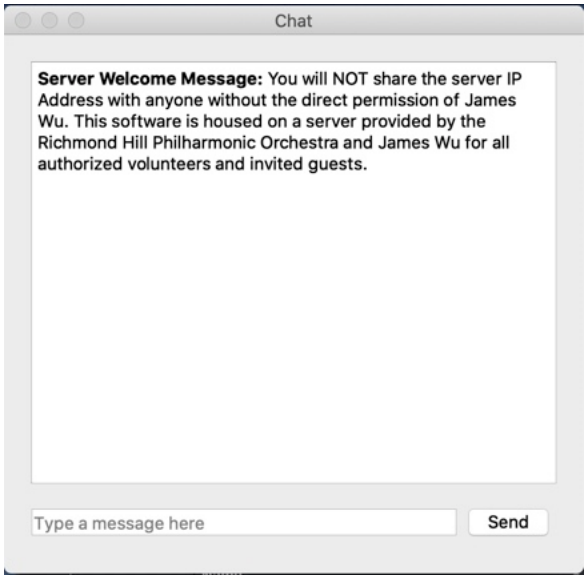
Connect to a room

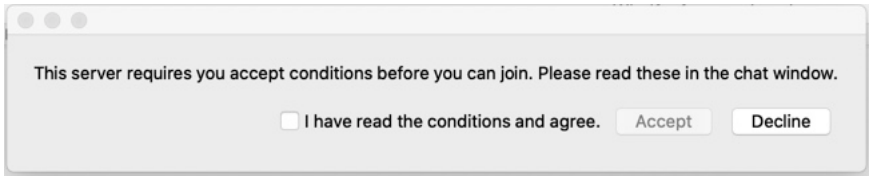
Click on the “Connect” button to view available servers/rooms.



Click “Custom” and choose the room you want to join (Server Name) from the drop down menu and click on “Connect.”

You will then see two windows pop up. One is a “Chat” platform that also includes our Server Welcome Message and terms of agreement. The other is a small window that asks you to check that you have read the conditions and agree.





Check the box “I have read the conditions …” and “Accept.”

Now you are in! You will see a mixer, with “Input,” “Pan Center,” and “Reverb” (your sound), and Pan, Fader, Mute and Solo buttons for each person in the room.

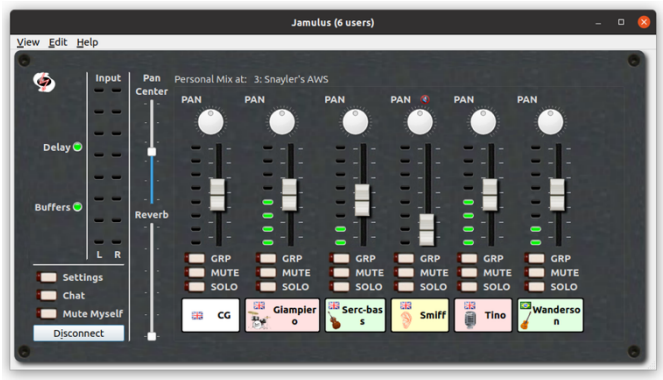
The Faders allow the volume of others in the room to be adjusted. Mute will turn that person’s sound off in your mix. Solo function allows you to hear only select people.

These will not change what others hear, but gives you control of what you want to hear.

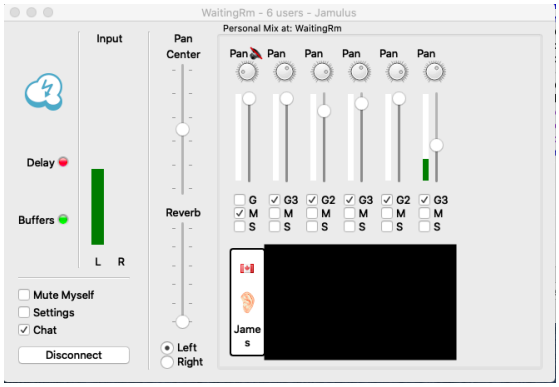
The pan function allows you to move the sound to your left or right ear, allowing for a real or stereo/surround sound experience. Everyone's sound in the centre of your mix will feel and sound like arrows shooting at your forehead.

Each element of these settings are explained in detail in the following pages.

Fancy View



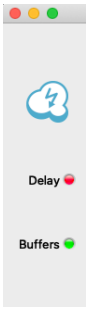
Compact view



Set your sound:

The first group of settings are for <u>your</u> sound set up:

Status LEDs



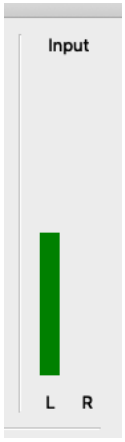
Delay Status LED shows the current audio delay status:

- **Green** – The delay is perfect for playing with others
- **Yellow** – A little delay, but not too bad
- **Red** – The delay is too much and will disturb everyone

Buffers shows the current audio/streaming status. If the light is Red, the audio stream is interrupted. This is caused by one of the following problems:

- The network jitter buffer is not large enough for the current network/audio interface jitter.
- The sound card's buffer delay (buffer size) is too small (see Settings window).
- The upload or download stream rate is too high for your internet bandwidth.
- The CPU of the client or server is at 100%.

Input level

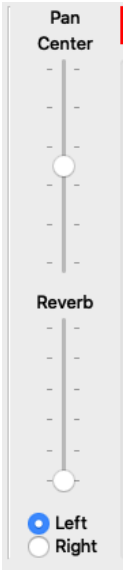


This shows the level of the two stereo channels for your audio input. Green is good, yellow, once in a while is fine, always yellow or red is bad and will cause “clipping” that distorts the audio signal. (the LEDs will indicate clipping when it occurs).

Mute Myself button

Cuts your audio stream to the server so that you will be able to hear yourself and see your own input levels, but other musicians will not. Be aware that other musicians will not know if you have muted yourself.

Local audio pan/balance control & Reverb effect

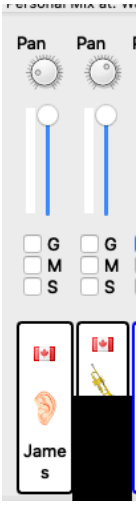


Controls the relative levels of the left and right local audio channels. For a mono signal it acts as a pan between the two channels. For example, if a microphone is connected to the right input channel and an instrument is connected to the left input channel which is much louder than the microphone, move the audio fader in a direction where the label above the fader shows L - x, where x is the current attenuation indicator.

Reverb can be applied to one local mono audio channel or to both channels in stereo mode. The mono channel selection and the reverberation level can be modified. For example, if a microphone signal is fed in to the right audio channel of the sound card and a reverb effect needs to be applied, set the channel selector to the right and move the fader upwards until the desired reverb level is reached. Be careful to not add too much, or it will create a sound that has too much “echo” for others. Most members of large ensembles prefer reverb to be at a low level.

The next settings are for how you hear <u>all</u> participants:

Server audio mixer



In the audio mixer frame, a fader is shown for each connected client at the server (including yourself). The faders allow you to adjust the level of what you hear without affecting what others hear. The VU meter shows the input level at the server - that is, the sound being sent.

If you have set your Audio Channel to Stereo or Stereo Out in your Settings, you will also see a pan control.

If you see a "mute" icon above a channel, it means that musicians cannot hear you. Either they have muted you, soloed one or more channels not including yours, or have set your fader in their mix to zero.

Using the **Mute Button** prevents the indicated channel being heard in your local mix. Be aware that when you mute a musician, they will see a "muted" icon above your fader to indicate that you cannot hear them. Note also that you will continue to see their VU meters moving if sound from the muted musician is reaching the server. Your fader position for them is also unaffected.

The **Solo button** allows you to hear one or more musicians on their own. Those not soloed will be muted. Note also that those musicians who are not soloed will see a "muted" icon above your fader. Channels are listed left to right in the order that clients connect until they leave, at which point their "slot" is filled by the next new arrival. You can change the sort order using the Edit option in the application menu.

You can group faders together using the **GRP** toggle. Moving the fader of any member of the group will move the other faders in that group by the same amount.

If the server operator has enabled recording, you will see a message above the mixer showing that you are being recorded.

Jamulus will remember your settings and you likely only need to do this once. Adjustments might be needed and you might need to do a quick mix of the group each time, but you don't need to go through all of this every time.

SOUNDING GOOD and HEARING THE BEST VERSION OF THE ENSEMBLE

Microphone Placement:

If you play an instrument where the sound comes from the bell (e.g. brass), or stringed instruments, you should have your microphone set about 3 feet away from you and about 2-3 feet above where the sound comes from. So, violins should be 2-3 feet away and above your bridge. Brass instruments don't play into the mic, but use the 2-3 rule. Woodwinds should place your microphone 1 foot in front of where you would play "G" 2nd line on the staff. Singers place your microphone about 1 foot away from your mouth.

The rest of the process is for you to fine tune your microphone placement, to get the best sound possible. You might need to move your mic around, get a little closer, get a little further, raise the microphone a little higher or lower from your sound source, to get the best sound. Mark you spot, so you can return to the same set up every time.

Set your microphone level so that it is always green at fortissimo dynamic, right before it shows yellow. If you need a little more volume, it will be in the yellow zone, but that's ok. RED is BAD.

Setting the Mix on Jamulus:

Each participant needs to mix everyone for their own aural perspective to be able to hear the best version of the "ensemble." Without using the "Pan" function to mix the ensemble, everyone will be heard like shooting arrows into your forehead.

Imagine where you hear your section and the instruments in the vicinity of your section and seat. Think about a clock. The pan function can be divided like a clock. If you imagine that you are sitting at 6:00, you'll want to mix people that sit to your left, toward the left and vice versa. If you sit at the end of a row (audience side), imagine your chair is turned into the ensemble, so you can get a 180˚ pan and hear those across the ensemble (past the conductor), with stereo sound in your headphones. This should replicate the in-person rehearsal room.

The other option is to set the panning, from the conductor or audience perspective, so you can pan instrument groups where they sit (from the audience perspective) and set your pan in the centre. You will hear yourself in the centre of the ensemble, but have a good perspective of the whole ensemble.

Jamulus will remember your settings, so it should only need to be done once. After you and everyone else mixes/adjusts their own mixing board, you can save your overall mix by going to “File” (top of the window), and click “Save Mixer Channels Setup.” Next time you rehearse, you can go to “File” and click “Load Mixer Channels Setup,” and Jamulus will load what you saved.

Here are some specially designed videos that can help get you started and understand how to navigate *Jamulus*:

https://www.youtube.com/playlist?list=PLWKkfa4PvoTx-e3FkCacB22E6zzfcuACp

APPENDIX A

GOOD MICROPHONES & AUDIO INTERFACES:

Sound Devices:

USB Microphones

- Blue Yeti microphone.
    - Works well on Mac (there is a checkbox to turn off local monitoring).
    - Works OK on Windows with ASIO4all but with a bit more latency than on Mac. You can turn off the local monitoring if you go deep into the settings.
- Shure X2u XLR to USB audio interface with headphone jack, converting an XLR mic into a USB mic. Set PC/Mic mix dial to 100% PC and listen to the output on headphones.

Audio interfaces

- Ammoon AGM02 and AGM04 USB mixer: relatively inexpensive 4 channel USB mixers, both tested on MacOS Catalina, the AGM02 tested on Windows 10. On Windows 10, with ASIO4ALL, the AGM02 can be used as an input, and the onboard audio as the output. There is no way to monitor only the USB return signal on the AGM02. (USB Audio)

  Note: The Ammoon AGM04 appears to be a re-branded ART USBMix4.
- ART USB Mix4 (USB audio interface + 4 channel mixer).
- Audient EVO 4, driver download and install (USB Audio)
- Behringer UCA222 & UCA202 U-Control (USB audio)

  Note: Works best on Mac and Linux. On Windows, ASIO4ALLdriver works OK but not great. There is also the native driver which Behringer withdrew support for a while ago, and therefore removed from their download section.
- Behringer UGC102 (USB interface for guitar/bass)

  Note: On Mac, appears as "USB Audio Codec" - when selected for input and output in Jamulus, the UGC102 headphone jack is the output (and cannot be used for input).
- Behringer UMC202HD, UMC204HD, and UMC404HD interfaces, Windows 7 to 10 ASIO Driver (USB Audio)
- Behringer X32 digital mixer with X-USB 32-in/32out (USB audio)
- Behringer XENYX 302USB (USB audio) Behringer ASIO Driver
- Behringer XENYX Q502USB (USB audio) Behringer ASIO Driver
- Behringer XENYX Q802USB (USB audio) Behringer ASIO Driver. This Behringer ASIO Driver does not appear to be very good. Audio latency with this 'unsupported' driver seems poor - not better than ASIO4all. It's good device for Mac and Linux, but perhaps not for Windows. More testing is required.
- Behringer XR18/XR16/XR12 digital mixers (USB Audio)

- Edirol FA-66 (Firewire) - good on Mac, Linux, and Windows ASIO driver
- Focusrite Clarett 4Pre interface (Thunderbolt 2)
- Focusrite Scarlett interfaces (USB Audio)

  Note: if you have issues with the buffer size going to 136, download the updated driver version 4.64.15.598 from http://beta.focusrite.com/
- HiFiBerry DAC +ADC (HAT). Virtually no jitters and the good latency (20 millseconds). No headphone amplifier, so you'll need one of those. I used a Rolls MX122 mini mixer. Tested using Raspberry Pi 4 running Raspberry Pi OS Buster, kernel version 4.19.
- iConnectivity AUDIO4+ interface (USB)
- Lexicon Omega (USB audio)

  Note: Works best on Mac and Linux. There is a driver for Windows but this does not allow to use 64 samples buffer size and adds some latency compared to, e.g., the Mac driver.
- Line 6 Helix Stomp, read Remote Jamming with Helix and Jamulus for setup on a Mac. (USB Audio)
- MOTU Ultralite (2010 firewire model mk1/mk2), 2015 MacBook Pro, OS X El Capitan 10.11.6, Apple Thunderbolt/Firewire adapter.
- Native Instruments Komplete Audio 2, Tested on Win10 with 64 sample buffer and am getting great sound and total latency around 15ms over the ping time. (USB Audio)
- Resident Audio T4 (Thunderbolt 2)
- Soundblaster live with kX ASIO driver
- Soundblaster Audigy 4
- Steinberg UR22C (USB3, USBC 32bits 192khz). Works directly on a Mac with a beautiful sound even with un-balanced jack. Works on a Raspberry PI4 provided jackd version used is the one from /usr/bin (Tweaking raspijamulus.sh). Not tested on PC.
- Steinberg UR22 MKII. Sounds great, can achieve 32 frame buffer and works on Windows and Linux. Not tested on Mac.
- Tascam DR-07X stereo recorder with USB audio into computer, headphones in line-out of the recorder. It can also be used with an external mic in the line-in (might need to use a pre-amp). Windows 10.
- Tascam DR-40X stereo recorder as above. Set "Monitor" to "PC/Mac". Ubuntu 18.04.
- Universal Audio Arrow (Thunderbolt 3). Achieved lowest-ever latency with this device.
- Yamaha AG03 (USB audio)
- Zoom H4 (regular USB) - Works also Mac, PC and Raspberry Pi4
- Zoom TAC-2 (Thunderbolt 2)

Known Not to work with Jamulus

- Zoom B3 bass amp-modeling pedal. Does not support 48000 Hz. (USB Audio)