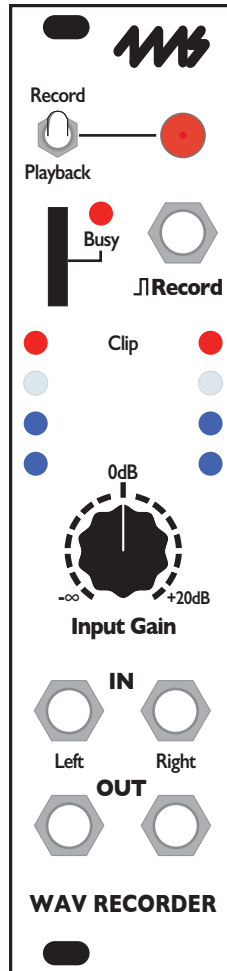


# WAV Recorder

## 4ms Company

User Manual 1.0.1 – June 27, 2018  
for firmware v1.0



The **WAV Recorder** from 4ms Company is a high fidelity, two-channel stereo audio recorder with basic playback features. Accepting a wide range of input signals, from line-level to modular-level, the **WAV Recorder** stores audio onto a microSD card in lossless .wav format up to 96kHz/24-bit. The trigger jack can be used for capturing rhythmic loops or synchronizing multiple **WAV Recorder** modules for multi-track recording. In **Playback** mode, the trigger jack or button plays the most recent recording. A simple file/folder navigation system can be used to browse the folders on the card for playing back .wav files. A **Gain** knob allows for up to +20dB of boost, and an LED Signal Meter indicates clipping and the signal level.

- Records up to 96kHz/24-bit, creating stereo or mono .wav files on the microSD card
- Gain knob and LED level meter make it easy to record a wide range of signal levels
- Plays standard .wav files from the card, without renaming files
- Browse any folder on the card for playback
- Card can be hot-swapped without rebooting module
- Extremely low noise, high-fidelity design
- Includes 16GB microSD card (Class 10), SD adaptor, 10-to-16 pin power cable and M3 screws
- Can be used as a stereo pre-amp (line to modular level), providing up to +20dB of gain

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## Setting up your WAV Recorder

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1. Power your Eurorack modular case off and find 6HP of available space.
2. Connect the free end of the power cable to a 16-pin Eurorack power header on your power supply distribution system, with the red stripe towards to the -12V. The other end of the power cable is a 10-pin connector which should already be connected to the WAV Recorder with the red stripe on the power cable orientated towards the bottom of the module. **Note: The WAV Recorder is reverse-polarity protected, but other modules being incorrectly connected could damage anything on the power bus.**
3. Using the included Knurlie screws, securely fasten the **WAV Recorder** to the rails of your case.
4. Power the system on.
5. Begin with **Tutorial: Basic Recording** on page 4 of this manual.



### Important!

**Never remove the microSD card when the Busy light is on. This could corrupt the files on the card.**

**If you remove the Wav Recorder from your case, always store and transport it in the included anti-static bag.**

## Controls: Button, Knob, Switch and Jacks

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Record



Playback

### Record/Playback switch

The **WAV Recorder** has two main functions: recording and playing .wav files. This switch toggles between these functions.

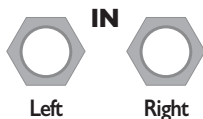
Flip the switch up to enter **Record** mode. Flip the switch down to enter **Playback** mode.



### Button

In **Record** mode, press the button once to start recording a new .wav file onto the card. Press it again to stop recording. The button will turn red while recording.

In **Play** mode, press the button once to play the currently selected .wav file from the card. Press it again to stop playing. The button will turn green while playing.



### Audio IN jacks

Patch the audio signal you want to record into the **IN** jacks. The jacks are normalized so that if you patch a mono signal into the **Left IN** jack and have nothing plugged into the **Right IN** jack, the signal will be routed to both channels. To record a stereo signal, patch into both **Left IN** and **Right IN** jacks. These jacks accept a wide range of signal levels, from line level up to modular level.



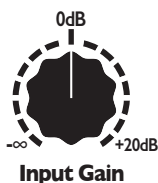
### Audio OUT jacks

The **Audio OUT** jacks can be used for monitoring the signal while recording and for listening to playback of .wav files. The **Left OUT** jack outputs the left channel, and the **Right OUT** jack outputs the right channel. The Signal Meter shows the level of the signal present on these jacks.



### Signal Meter

These eight lights will show the level of the signal being output on the **OUT** jacks. If you are recording, this is equivalent to the signal being recorded. The left column represents the left audio channel, and the right column represents the right audio channel. More lights turned on means there's a louder signal. The top red lights indicate clipping. If the Signal Meter shows that your signal is either too loud (clipping) or too quiet, you can use the the **Gain** knob to adjust the level.



### Gain knob

The volume (level) of the signal being recorded or played can be adjusted using this knob.

Turning the **Gain** knob up will make the output louder, while turning it down will make the signal quieter. When the knob is turned all the way to the left, the signal is muted. When the knob is pointed directly up, the signal is neither boosted nor cut. When the knob is turned all the way up, +20dB of gain is applied (which is enough to boost a line level signal to a modular level signal).



### Record Trigger jack

This jack accepts a trigger. In **Record** mode, a trigger signal will toggle recording. In **Play** mode, a trigger will make playback start or re-start. The **Record Trigger** jack allows you to connect and synchronize your **WAV Recorder** with a clock, other **WAV Recorders** or other modules. It also allows you to remotely control recording and playback.



### SD Card slot and Busy Light

The **WAV Recorder** records and plays back from a microSD card inserted into the card slot. Insert the end of the card with the shiny pins facing to the left.

The **Busy** light will turn on whenever the card is being read or written.

**NEVER REMOVE THE SD CARD OR POWER OFF WHEN THE BUSY LIGHT IS ON!** Always wait until the light is off. The light will turn off after you stop recording or playing.

## Tutorial: Basic Recording

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Recording on the **WAV Recorder** is easy!

1. Find something you want to record. It can be audio from your modular, another synth or musical instrument, your phone or computer, or anything that outputs a line-level, headphone-level, or modular-level signal.
2. Patch the audio signal into the **Left IN** jack. If you have a stereo signal, you can patch the right channel into the **Right IN** jack.
3. Patch the **OUT** jacks to something that lets you hear the audio (speakers, amp, or a mixer).
4. The lights on the **Signal Meter** should be responding to the signal you patched in. Turn the **Gain** knob so that some lights turn on, but not so high up that the red lights turn on. You should also hear the audio output change volume as you turn the **Gain** knob.
5. Make sure the switch is flipped to **Record** and press the button. The button will turn red, and the **Busy** light will start to flash.
6. Record as much as you want and then press the button again. Wait for the **Busy** light to turn off.
7. Congratulations! You just made a high-quality recording!

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Tip: Use an adaptor cable to convert to 1/8" (3.5mm) if necessary. You can patch a stereo cable into the **IN** jacks, but the right channel will be ignored.

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The **WAV Recorder** has now created a .wav file on the microSD card. You can listen to your recording by flipping the switch to **Playback** and then pressing the button. The button will turn green and you'll hear your recording. You can press the button again to stop playback.

You also can listen to the recording on your computer. Wait until the **Busy** light has turned off and then pull out the microSD card. Insert it into your computer or card reader and browse the **WAV Recorder** folders for the folder and file with the highest number. See the **Folders and File Organization** section for more details.

## Folders and File Organization

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Every time you power on the **WAV Recorder**, a new session is started. All of the recordings you make in each session are saved in the same session folder. Session folders are named like this:

WAV Recorder - 0001

WAV Recorder - 0002

The most recent session folder will always be the highest numbered folder.

Inside each folder are your recordings, named in numerical order:

001 - recording.wav

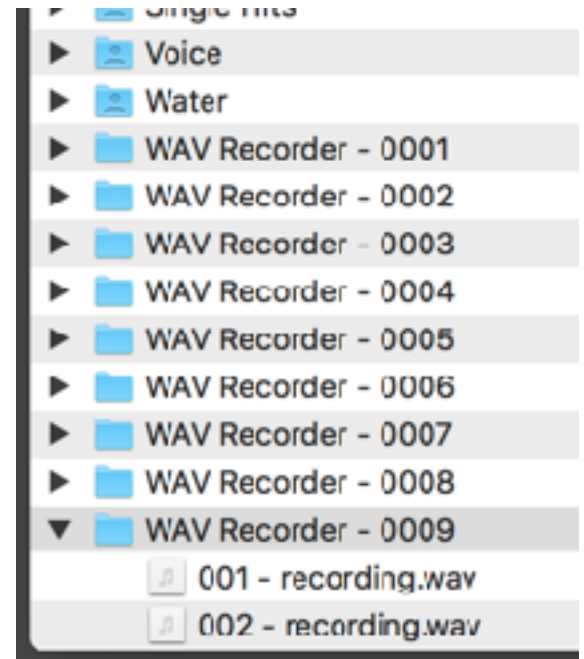
002 - recording.wav

Once it reaches 999 - recording.wav, it'll automatically create a new session folder and start over at 001.

**The most recent recording will always be the highest numbered file in the highest numbered folder.**

If the system gets powered down unexpectedly while recording (and luckily it happens while the **Busy** light is off), you might find your recording in the `_tmp` folder.

*Note: This naming system is what the WAV Recorder uses when you make a new recording. In Playback mode, any file with any name can be accessed. You do not need to rename your files to play them.*



## Playback

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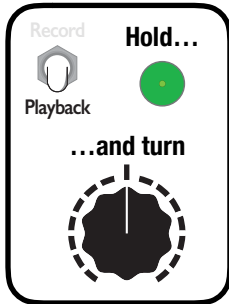
Playing .wav files with the **WAV Recorder** is easy.

Flip the switch to **Playback** and press the button. The most recent recording will play. The button will turn green while a recording is playing. Turn the **Gain** knob to adjust the playback volume. You can press the button again to stop playback, or it will stop by itself when the .wav file has finished playing.

If you haven't recorded anything yet this session, but you've made previous recordings, the the **WAV Recorder** will play the most recent recording it finds (the highest numbered file in the highest numbered session folder on the microSD card). See **Folders and File Organization** for an explanation of the naming system. If no session folders are found, the **WAV Recorder** will pick the first .wav file in the first folder on the microSD Card, alphabetically.

You're not stuck with only playing the most recent recording! Use the browsing feature to choose a different file in a different folder. See the next section for details.

## Browsing Files for Playback



When you first flip the switch to **Playback**, the most recent recording in the most recent session folder will be selected as the current playback file. If there are no session folders on the card, then the folders will be scanned alphabetically and the first file in the first folder will be selected.

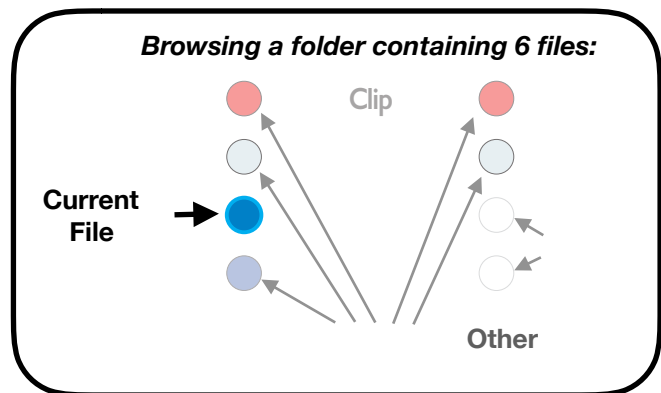
Hold down the button while turning the knob to browse the folder of the currently selected file. As soon as you start turning the knob with the button down, the lights will show you how many files are in the folder. Any light that's turned on represents a file in the folder. For example, if six lights are on, then there are six files in the selected folder. The files are in alphabetical/numerical order.

The light corresponding to the currently selected file will be brighter than the others. As you turn the knob (while still holding the button down), the bright light will move through all the available files. See diagram below.

If you want to hear the new file that you've selected, you can play it like you would play any other file: just tap the button or fire a trigger into the jack. If you're playing a long file, you can continue to browse while the file is playing without interrupting it. As long as you are holding the button down while turning the knob, the playback volume won't change.

### Folders with lots of files

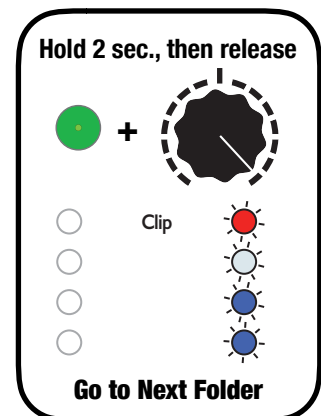
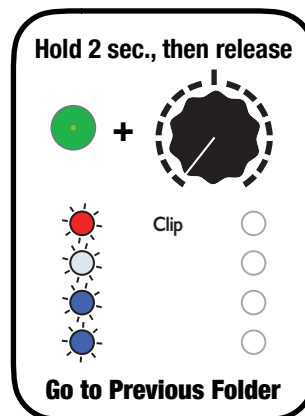
If there are more than eight files in a folder, then the files will be split up into "pages" of eight files each. The first and/or last light will flicker a bit to indicate there's another "page" of files before or after it. The number of flickers indicates the next or previous "page" number (i.e., one flicker means you can access the 1st page by turning past that light, two flickers means the 2nd page is past that light, etc...) Turn the knob to the first or last light, and then keep turning it a little bit more to jump to the next or previous page. The light will jump from the first to last position, or vice-versa, when you change pages.



*Tip:* If you can't quite reach the top or bottom file, just let go of the button, turn the knob to a new position, and then resume the button+knob motion. This will also change the playback volume, so another technique is to turn the knob rapidly to advance by more files.

### Browsing to a new folder

If you want to select a file in a different folder, press and hold the button while turning the knob just like you do for file selection. Turn the knob all the way up (to access the next folder) or all the way down (to access the previous folder), and leave it there for about two seconds (while still holding the button down). The four lights on the left or right column will flash rapidly to tell you that you're about to go to the previous or next folder, respectively. Release the button when you see the flashing, and you will jump to the next or previous folder. The folders are browsed alphabetically/numerically.



If you see the column lights flashing, but don't want to change folders, turn the knob up or down to cancel the action.

## Trigger Jack

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Record

In **Record** mode, the **Record Trigger** jack can be used to synchronize the starting and/or stopping points of a recording: simply patch a trigger or gate into this jack. When a trigger or rising edge of a gate is received, recording will start (if it's not already started) or stop (if it's not already stopped). There are several uses for this:

### Multi-track recording

Using two or more **WAV Recorder** modules, you can patch the same trigger into all of the trigger jacks. Firing a trigger will start recording on all units simultaneously. Since each module is a two-track recorder, the number of tracks you can record will be twice the number of modules: two **WAV Recorders** can function as a four-track recorder, three **WAV Recorders** can function as a six-track recorder, and so on...

Combining the .wav files from the microSD cards on all of your units is easy to do with most audio-editing software packages. For example, the freely-available program Audacity can combine stereo recordings by copy/pasting the individual stereo tracks into one multi-track file.

See the **Example Patch: Multi-track Recording**.

You could even combine tracks in a computer-free environment by using a mixer to combine the playback outputs of all the **WAV Recorders** which were used to make the recording. Feed the stereo output of the mixer to an additional **WAV Recorder** and record the mix-down "live".

### Recording timed loops

If you have a rhythmic patch, you can feed a slow clock into the trigger jack to record a "bar" or "measure" of the patch. If you just want to capture just one measure, plug in the trigger while the clock gate is low. When the clock goes high, recording will begin on the start of the measure (assuming your clock is synced to the start of the measure). When the next measure starts, the clock will go high again and cause the recording to stop, create a recording that's exactly one measure long. If you're making variations to the patch as it plays, you can keep recording more measures to capture a variety of loops.

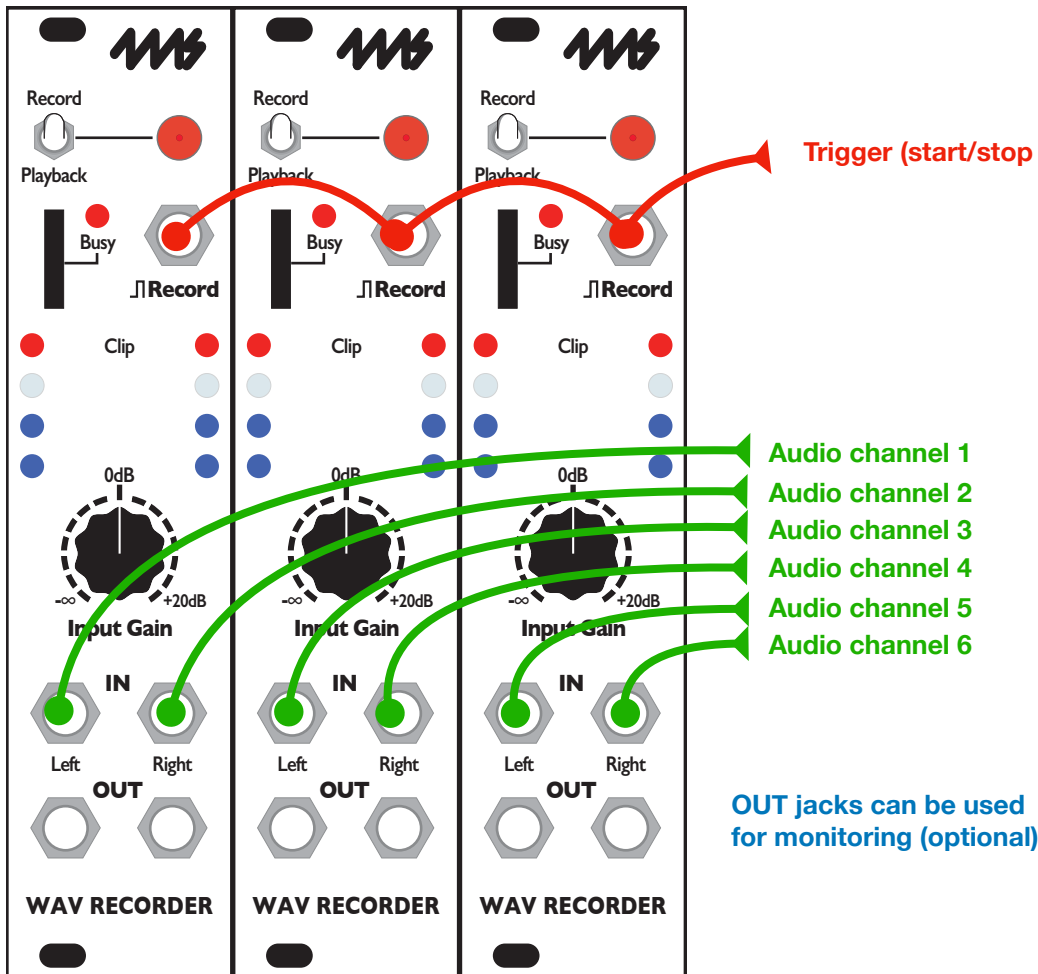
Once the recording is stopped (the button is not lit up), flip the switch down to **Playback**. When the next trigger fires on the next measure, your loop will play in time. This technique allows you to create a new loop while the old one is playing (you'll need to route/split/mix your signals in way that you can independently adjust the level of the **WAV Recorder's** output and your source audio). You can even use the file browsing techniques to go between different variations of the loop you captured (see **Browsing Files for Playback** section).

### Pausing Recording

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If you start recording and then flip the switch to **Playback**, the recording will be paused. The button flashes red to indicate recording is paused. You'll continue to hear the audio pass through, but it won't be recording. To continue recording, flip the switch up to **Record** and then press the button again. It'll turn solid red to show that you've resumed recording.

## Example Patch: Multi-track Recording



### Six-track recording

The diagram above shows how you can use multiple **WAV Recorder** modules to record more than two tracks at a time. A common trigger can start and stop all the recordings at the same time. The trigger can be from a touch pad or any module that generates a manual gate or trigger. Using a passive mult, active mult, or stacking cables, split this trigger signal and run it to all the **Record Trigger** jacks.

Patch your audio signals into the **IN** jacks on the **WAV Recorders**. Check that the switch is set to **Record** on all the modules, and remember to refresh any cards that you've recently inserted. You also may wish to verify the recording rate settings and set all the modules to the same values.

Turn all the **Gain** knobs to the same position unless you have a reason to record some channels louder than others. When you're ready to record, fire the trigger to start recording. When you're done, fire another trigger to stop. Copy the .wav file from each of the microSD cards onto a computer and combine the files into a multi-track file using any audio-editing software.

### High precision phase alignment

For most purposes, the files can be combined simply by snapping the beginnings to the same point. However, if you are doing some specific work that requires the phase differences between tracks to be exact, then you may need to line up the tracks manually. In our tests, a typical difference was between 340uS and 1.7ms (15 to 75 samples at 44.1kHz). This is well under the perceivable latency threshold of human hearing. If your project requires a tighter tolerance than this, we recommend beginning the recording with a "clap" or some signal common to all tracks: this will make it easy to see how far to adjust each track along the time axis.



## Using the WAV Recorder as a Pre-amp

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Since the **WAV Recorder** can provide a wide range of gain or attenuation to stereo signals, it can also be used as pre-amp to interface external equipment with Eurorack modules.

Patch any line-level, headphone-level, or modular-level signal into the **IN** jacks and turn the **Gain** knob until you see some signal but no clipping. The signal on the **OUT** jacks will now be at standard Eurorack audio signal levels and can be patched to any other Eurorack module.

For example, if you wanted to use your Eurorack modular system to process an online live stream from your smart phone, you could patch the phone directly into the **Left IN** jack using a mono or stereo cable. (If you want to get a stereo signal from the smart phone, use a stereo-to-mono adaptor and patch into the **Right IN** jack as well.) Turn the volume up on the smart phone, and turn the **Gain** knob so that you see some blue lights. You can now patch the **OUT** jacks to any other module that works with normal Eurorack audio signals.

*Note: The WAV Recorder does not work with microphones that require voltage from the pre-amp.*

## Busy Light

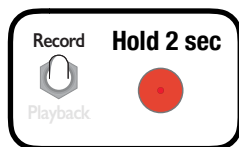
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The microSD card is safe to remove if you stop recording and wait until the **Busy** light turns off. If you're in **Playback** mode and not currently playing anything, it's also safe to remove the card. It's *not* safe to remove it while **Paused** (you'll lose the file you recorded).

You can corrupt the files on your microSD card if you pull it out while the **Busy** light is on. This is similar to unplugging a USB thumb drive or external hard drive from your computer while copying files. You might get lucky and keep your files; but, if the card starts to act weird, do a disk repair or "first aid" using Disk Utility on MacOS or fsck (or something similar) on Linux. After repairing the disk, copy all your files off, format it in ExFAT, and copy your files back on. Always keep backups of important files!

## Checking for Free Space

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You can check the amount of free space on the card by holding the button down for 2 seconds while in **Record** mode. An animation of the lights will display while the card is being scanned. Once the lights stop animating, the number of lights that are off will show how many hours of free space you have available. If there are 8 or more hours of recording time available, all the lights will turn off when the animation stops.

For example, let's say you hold down the button and the animation stops with five lights on and three off (see diagram below):

- |                                  |      |                                  |  |
|----------------------------------|------|----------------------------------|--|
| <input type="radio"/>            | Clip | <input type="radio"/>            | The fact that there are three lights off means that there are three to four hours of |
| <input type="radio"/>            |      | <input type="radio"/>            | recording time available on the card.  |
| <input checked="" type="radio"/> |      | <input checked="" type="radio"/> | Changing recording settings will change the amount of time available. If you went    |
| <input checked="" type="radio"/> |      | <input checked="" type="radio"/> | into System Mode and changed to mono recording, the next time you check for          |
|                                  |      |                                  | free space it will show six lights off (six hours mono = three hours stereo).        |

Checking for free space serves a dual purpose: if you insert a microSD card into the module while it's powered on, the card will need to be mounted before it can be used for recording or playback. Checking for free space will mount the card safely and report the free space available. See **Hot Swapping** (next section).

If the card is ever detected as being full (or having less than 50MB in available storage), all 8 lights will flash brightly twice when you press record. The lights will keep flashing every 5-10 seconds until you flip to **Playback** mode or insert a new card and refresh it.

*Note: The WAV Recorder will always leave about 50MB available for swap space.*

## Hot Swapping the microSD Card

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As long as the **Busy** light is off, it is acceptable to remove the microSD card (and put it into a computer to check the files, etc) without powering down the **WAV Recorder**. You can even re-insert a different card.

When you reinsert the microSD card into the **WAV Recorder** while the module is powered on, you must re-mount it (refresh it) by holding the button down for 2 seconds while in **Record** mode. This will display an animation which shows how much available space is on the card (see **Checking for Free Space** section). After the animation is complete, the card is ready for recording and playback.

If you forget to refresh a newly inserted card and try to start recording or playing immediately, the **WAV Recorder** will attempt to re-mount the card before recording or playing. This can cause a delay and sometimes a “hiccup” in playback or recording.

You do not need to refresh a card if it’s already inserted when you power up the **WAV Recorder**. The module always mounts the current card as part of its normal boot-up sequence.

## LED Signal Meter and Clipping

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The LED Signal Meter shows the output signal level:

●	Clip	<b>bright</b> →	-0.4dBFS (20Vpp): The red LEDs turn bright solid (clipping)
		<b>dim</b> →	-2.6dBFS (16Vpp): The red LEDs turn on dimly
●		→	-8dBFS (8.5Vpp): The white LEDs turn on
●		→	-12dBFS (5Vpp): The upper blue LEDs turn on
●		→	-21dBFS (1.75Vpp): The lower blue LEDs turn on

The Signal Meter shows the actual signal present on the output jacks-whether you are recording or playing. By adjusting the **Gain** knob while watching the Signal Meter, you can set your level appropriately and avoid clipping.

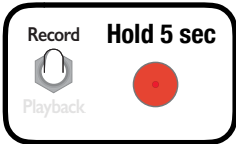
## Recording For Long Periods

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The maximum size of any .wav file is about 4GB. Depending on the recording rate, this could mean anywhere from 2 to 13 hours. The **WAV Recorder** can continue recording beyond this limit by splitting ultra-long recording sessions into a series of files. Once a file becomes about 4GB large, the **WAV Recorder** will close the file and keep recording into a new file. In this way, you can fill your entire card with recordings if you leave the module recording without interruption. The **Wav Recorder** can even record for days or weeks (depending on the size of you card and the sample rate you select in System Mode). The included card is 16GB and will record for about 27 hours before stopping at the default recording rate (44.1kHz, 16-bit, stereo).

**We highly recommend using a faster card for any long recording (see Recording Rates section).**

## System Mode

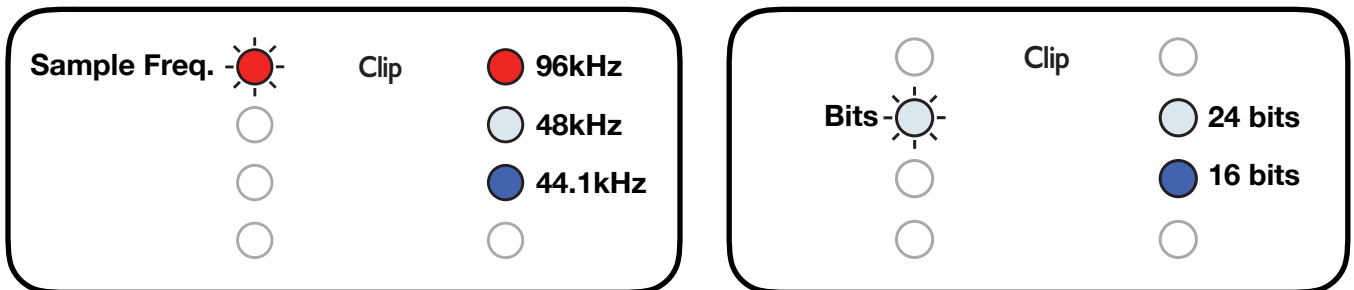


You can change the recording sample rate, bit depth, and number of channels in System Mode.

To enter System Mode, first make sure that the switch is flipped up to **Record**, and that the **WAV Recorder** isn't recording or paused. Then, hold the button down for 5 seconds. As you wait, the lights will show you the free space available (see

**Checking for Free Space**); keep holding the button down. After about 5 seconds, the button will turn blue and you can release it. You are now in System Mode.

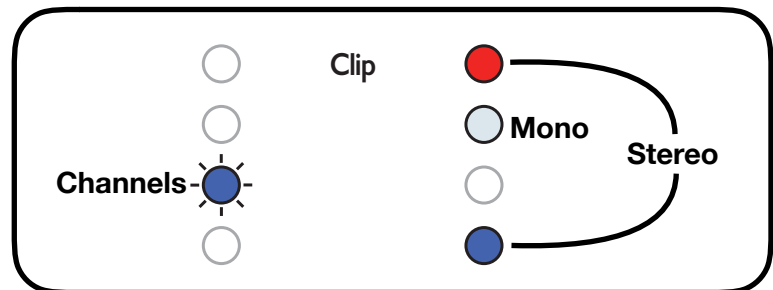
The left column of lights indicates which parameter you are editing, and the right column indicates the value of that parameter.



Tap to select parameter



Turn to set value



To select the parameter you wish to edit, tap the button. The light on the left column will cycle through the three options.

To change the value of the parameter you've selected on the left side, turn the **Gain** knob. The LEDs in the right column will change when you turn fully to the left (0%), fully to the right (100%) and/or to the center (50%). The lights on the right column will tell you the value of the parameter you selected as follows:

A red light in the left column indicates the Sample Frequency menu; its options, listed in the right column, are 96kHz (red), 48kHz (white), or 44.1kHz (blue).

A white light in the right column indicates the Bits menu; its options, listed in the right column, are 24 bits (white) or 16 bits (blue).

A blue light in the left column indicates the Channels menu; its options, listed in the right column are: stereo (red and blue), mono (white).

*Note: The System Mode feature only changes what happens when you record, not when you play. Playback always happens at the file's native sample rate and bit depth.*

## Recording Rates and Selecting microSD Cards

The microSD card included with the **WAV Recorder** is a Class 10 card and is sufficient for recording at many high-fidelity rates. With the included Class 10 card, we recommend 44.1kHz/16-bit/stereo, 48kHz/24-bit/mono, or 96kHz/16-bit/mono. The default factory setting is 44.1kHz/16-bit/stereo.

To achieve faster rates such as 96kHz/24bit, or 48kHz/24bit/stereo, a high-speed UHS Speed Class 3 (U3) card is required. Specifically, our tests found one card to be of sufficient speed to record at the fastest rates of the WAV Recorder:

- Samsung MicroSDXC EVO Plus (64GB) MB-MC64GA

We found another card which performed well, but had a very occasional glitch at 96kHz/24bit/stereo:

- SanDisk Extreme PLUS microSDHC (32GB) SDSQXBG-032G-GN6MA

At time of printing, the cost of either of these cards is typically around \$20-\$30, and they're available on Amazon or any number of electronics retailers. Beware of cheap look-alikes, and only purchase from a reputable seller. Avoid cards with a price under USD 20, they are likely to be fakes.

The following table reports our findings:

Freq.	Bits	Stereo/Mono	Included card (Class 10)	Recommended card (Samsung EVO Plus)
44.1kHz	16 bit	Mono	✓	✓
		Stereo	✓	✓
	24 bit	Mono	✓	✓
		Stereo	✓*	✓
48kHz	16 bit	Mono	✓	✓
		Stereo	✓	✓
	24 bit	Mono	✓	✓
		Stereo	✓/X**	✓
96kHz	16 bit	Mono	✓	✓
		Stereo	X	✓
	24 bit	Mono	✓/X**	✓
		Stereo	X	✓

\*At 44.1kHz/24bit/Stereo on the included Class 10 card, a 1 hour recording has a 4% chance of dropping samples. Using a faster card is recommended.

\*\*At 48kHz/24bit/Stereo or 96kHz/24bit/Mono on the included Class 10 card, a 1 hour recording has a 25% chance of dropping samples. Using a faster card is recommended.

While dropping samples is typically not acceptable, we allow the **WAV Recorder** to attempt to record beyond the limits of the card you choose for several reasons:

- Short samples have almost no chance of containing glitches. Thus, capturing percussive or brief samples at high rates is OK, even with slower cards.

- For some field recordings and other purposes where the recording will be heavily edited, dropped samples may be acceptable.
- When recording repetitive sounds where it's easy to record a sound multiple times in one take, having one bad section may not be a problem.

If none of these circumstances apply, use a faster card, record at a slower rate, or record in mono. For most audio recording purposes, 44.1kHz or 48kHz is excellent quality. If the recording level is sufficiently high, a bit depth of 16-bits will be of high fidelity. If you only require mono samples, we recommend changing to mono recording mode, and you will be able to record at a higher rate if you wish.

### **Dropped Sample Log**

The **WAV Recorder** will allow you to record at any sample rate using any card, but if you surpass the limits of your card, there is a chance the recording will have some dropped samples. The longer the recording time, the greater the chance this will happen. You may find that making short recordings (under a few minutes) works perfectly for you at any rate. However, you run the risk of dropping samples in the recording or creating an artifact in the playback of the .wav file. Depending on your purposes, this might be unacceptable. The solution is to use a faster card (see list of recommended cards above).

If any samples are dropped during recording, the **WAV Recorder** will create a text file and log the exact time position of the dropped samples. The name of the log file will be the same as the name of the recording, with ".txt" on the end. If you find such a file on your microSD card, open it up and read the time position of the glitches. Play the .wav file at those times to determine if the glitch needs to be cleaned up, or if it isn't a problem. This is just a band-aid (in case you accidentally record at a higher rate than your card can allow, and there's no chance of a re-take). To avoid the possibility of dropped samples when recording at any rate, either use a fast microSD card or keep your settings at a lower rate.

### **Checking the Firmware Version**

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When you power on the module, the LED Signal Meter will briefly show the firmware version number. The button will be magenta (pink) while the version is being shown.

The left column of lights indicates the major version number (e.g 1.x, 2.x, etc..). The right column indicates the minor version number (e.g. 1.0, 1.1, 1.2, etc..). The bottom light represents "1", and the top light represents "4". A "0" is represented by no lights on that side.

For version 1.0 (this version), the bottom left blue light will be on, and the other seven lights will be off.

### **Updating Firmware (Audio Bootloader)**

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You can update the firmware by playing an special audio file into the **Record** jack. When new firmware versions are released, the firmware audio files can be downloaded at <http://4mscompany.com/wavrec.php>. Check/Follow/Like the 4ms Twitter, Facebook, or Instagram social media feeds to be notified of firmware upgrade availability, or email us via our website.

1. Unplug all cables and power off the module.
2. Connect a computer or smart phone audio output to the **Left IN** jack. Remove your phone case, it may be preventing the cable from fully plugging in.
3. Connect the **Left OUT** jack to an amp/speakers so you can listen. Turn the amp/speaker volume down — this is going to be LOUD!
4. **Set the computer/phone's volume to 100%** and the audio player software to 100% volume. Turn off all audio and vibrate notifications. Close any applications that make notification sounds.
5. Hold down the button while powering up the **WAV Recorder**. The button should start flashing green. Release the button.

6. Begin playing the file. Immediately you should see the button flash white, and the other lights flash a lot. You should be hearing the sounds very loudly out the **Left OUT** jack.
7. If the sound stops before the file is done playing, there was an error. The button will flash red.
  - a. Stop the file and rewind to the beginning.
  - b. Check all cables are plugged in tightly.
  - c. Tap the button. It should turn green again.
  - d. Play the file again from the beginning.
8. If the file loads successfully, the **WAV Recorder** will display a chase sequence on the LEDs and the button will alternate green and blue. Press the button to start using the new firmware.

Tip: some audio interfaces play a pop when they first start playing a file. If this happens, the button light will turn red as soon as you start playing. One way to overcome this is to hit the button light immediately after pressing play on the computer, but before the noise starts playing (there's a 2 second lead time of silence). Or, an easier way to get around this is to use a different device (smart phones seem to work better than computers for the purpose of updating our firmware).

Tip: Do not play from software like Ableton. We have seen that some software will alter the playback, which is not desirable here. Play from simple, basic software such as VLC, QuickTime, Windows Media Player, or Chrome. Turn off any EQ or "Bass Boost" settings.

The open-source licensed source files (in C, for compiling with gcc-arm) can be found at <https://github.com/4ms/> (note: as of printing of this manual, this is not yet posted).

## microSD Card

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We include a Class 10 card with the **WAV Recorder**, which is sufficient for recording at 44.1kHz. If you need to record at a higher rate, use a faster card. See **Recording Rates** section for recommended cards.

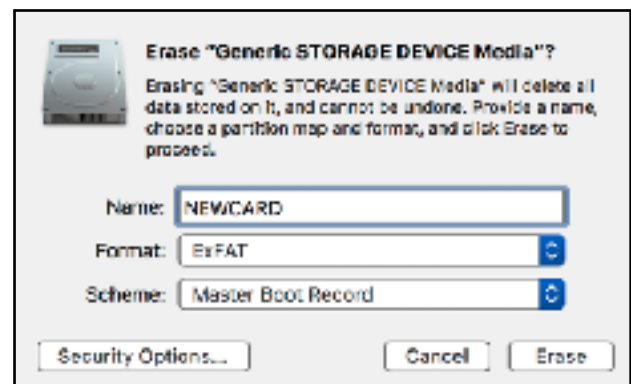
### Never remove the microSD card while the Busy light is on!

It's OK to remove it if the **Busy** light is off. After inserting a card while the module is powered up, flip to **Record** mode and hold the button down for 2 seconds to refresh the card. This will mount the card and display the available free space on the card.

### How to format a new microSD Card

Format new cards as ExFAT (preferred) or FAT32 (acceptable). See screenshot (right) for how to set MacOS standard "Disk Utility" program.

We recommend formatting a cards from time to time to defragment. A freshly formatted card will perform better than a card that had its files deleted. Formatting de-fragments a card, while dragging files to the trash can does not.



## Future Integration with 4ms Listen modules

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There's a header on the back to connect to the **4ms Listen** headphone/line mixer modules. This will allow you to record directly off the output mixer without any patch cables. See the **Listen** user manuals.

*\*Note: at time of printing, the Listen modules are not yet released. See the Listen manuals for connection details when those modules are released.*

## Electrical and Mechanical Specifications

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- 6HP Eurorack format module
- 0.98" (25mm) maximum depth
- 10-pin Eurorack power header
- Power consumption (maximums):
  - +12V @ 112mA
  - -12V @ 12mA
  - +5V rail not used
- Audio **OUT** jacks
  - Frequency Response:
    - File:Out = +/-0.1dB max deviation at 20Hz - 20kHz
  - 21V peak-to-peak = full scale
  - Up to +20dB digital gain can be applied while playing using Gain knob
- Audio **IN** jacks
  - Signal-to-Noise Ratio (SNR)
    - *Measurements taken from recordings made in a typical Eurorack case, powered by a 4ms Row Power 40 module:*
    - -91.7dB @ 16-bit, 44.1kHz
    - -88.9dB @ 24-bit, 96kHz
  - Frequency Response:
    - Out:In = max +/-0.1dB from 20Hz to 15kHz. -0.5dB at 20kHz
  - 20V peak-to-peak maximum before clipping
  - Up to +20dB digital gain can be applied while recording or monitoring using **Gain** knob
- **Record**  $\square$  jack
  - Incoming trigger starts/stops recording, or starts/re-starts playback
  - Trigger voltage must be > 1.6V, rising edge is detected
- microSD card slot accessible from front panel
  - Class 10 card included (16GB)

## Jumpers

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The PCB has one jumper labeled "JUMP", which fits on a 2-pin header located at the bottom right of the PCB.

The jumper must be installed to enable the normalization of the **Left IN** jack to the **Right IN** jack. If this jumper is missing, patching a signal into the **Left IN** with nothing plugged into the **Right IN** jack will record silence on the right channel.

The jumper should only be removed if you are connecting the **WAV Recorder** to a 4ms Company Listen module. See the Listen manual for connection details.

