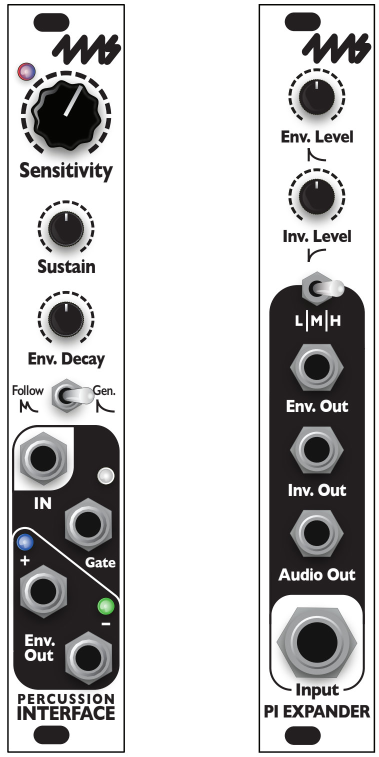
Percussion Interface (PI) & PI Expander
4ms Company
User Manual 1.0 – August 3, 2020



The **Percussion Interface (PI)** and **PI Expander** are a pair of Eurorack modules that generate gates and envelopes from acoustic drums, samplers, drum machines and virtually any audio source. Converting microphone, instrument, line and modular signals into CV and clock/gate signals, the **PI** and **PI Expander** are suited for synchronizing sequencers or other modules to the rhythm of an audio track or live percussion. The modules can simultaneously be used as a pre-amp for microphones or line-level signals, while generating inverted envelopes useful for side-chaining. The **PI** module contains all the core functionality and can be used without the **Expander** to conserve space. The **Expander** requires the main **PI** module and adds three gain stage options, a modular-level audio output jack, a 1/4" (6.35mm) input jack, and envelope attenuation capabilities.

The **PI Expander** connects to the **PI** with an included ribbon cable and does not require a separate power header.
The two modules are only available together as a pair.

Percussion Interface and **PI Expander** features:

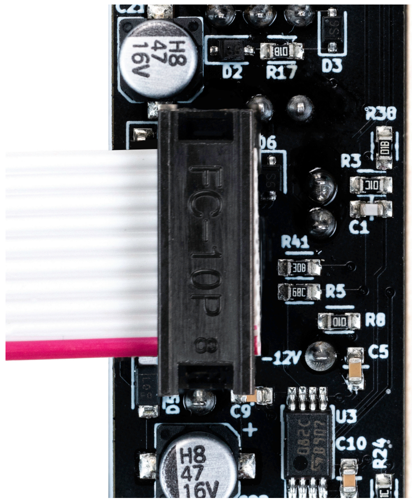
- Sensitivity knob, Low/Medium/High gain switch, and clipping LED
- Sustain control to prevent misfires, increase gate length, and control the envelope
- Envelope decay control
- Non-inverted and inverted envelope outputs, useful for side chaining
- Four envelope outputs: two attenuated with independent attenuators, and two non-attenuated
- Envelope following or generation modes
- Gate output for clocking sequencers or any unit with a clock or trigger input
- Compatibility with drums, samplers, microphones, drum machines, etc.
- 1/4" input jack (6.35mm)

Table of Contents

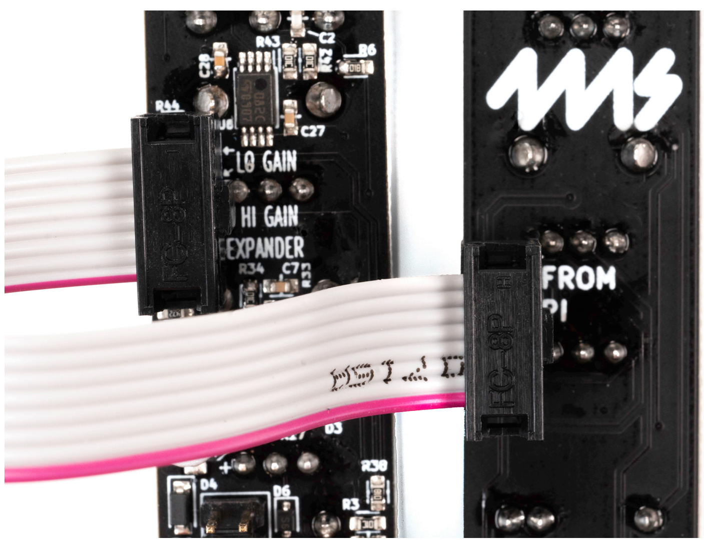
Setting up your Percussion Interface and PI Expander..3
Controls and Jacks: Percussion Interface 4
Controls and Jacks: PI Expander 5
Setting Input Gain...6
Using the PI with Various Sources...7
Envelopes in Gen Mode..8
Envelopes in Follow Mode..9
Velocity Sensing..10
Preventing Misfires and Undesired Gates 12
Calibrating Lockout Time for Gate Out...13
Sidechaining with the PI 14
Electrical and Mechanical Specifications 15
My Patch Notes 16

Setting up your Percussion Interface and PI Expander

1. Power off your Eurorack system.
2. On the back of the **Percussion Interface** you will see two headers: a 10-pin header and an 8-pin header. The 10-pin header connects to a Eurorack power header using the included power cable. Connect the 16-pin end of the power cable to a 16-pin Eurorack power header on your power supply distribution board and the 10-pin end to the **PI** with the red stripe on the power cable oriented towards the bottom of the module.



3. On the back of the **PI Expander** you will see one 8-pin header. Using the provided 8-pin ribbon cable, plug one end of the cable to the **PI Expander** and the other end to the 8-pin header on the back of the **Percussion Interface**. The red stripe on the cable should be orientated towards the bottom of both modules.



4. Using the included screws, securely attach the **Percussion Interface** and **PI Expander** to the rails of your case.
5. Power on your Eurorack system.

Note: The ***Percussion Interface*** *is reverse-polarity protected, but incorrectly connecting any module in any system can damage other modules on the power bus.*

Controls and Jacks: Percussion Interface

IN Jack

The **IN** jack accepts a wide range of signals from microphones directed at acoustic sounds such as drums, electronic drum machines, samplers, guitars, synthesizers, line-level equipment, or any other audio source. With the exception of microphones that require power (phantom-powered and electret microphones), any microphone or piezo transducer will work. The **IN** jack is mono, but will work with a stereo or balanced cable.

Sensitivity Knob and Light

The **Sensitivity** knob controls how much the input signal is boosted. At maximum gain settings, the smallest input signal that will trigger a gate output is roughly 5–10mV. The **Sensitivity** range is determined by the position of the **L|M|H** switch on the **PI Expander** (see Setting Input Gain section on page 6 for more details). The light will show blue when a signal is detected and will gradually turn red as the unit begins to clip at the input. Clipping may result in undesired gates or envelopes, also known as misfires. See Preventing Misfires and Undesired Gates on page 12.

Sustain Knob

The **Sustain** knob controls the pulse width of the gate output as well as the sustain time of the envelope while in *Gen.* mode (see Envelopes in Gen Mode on page 8). When the gate output is high no additional triggers will be generated, thus misfires can be reduced. See Preventing Misfires and Undesired Gates on page 12. The minimum pulse width is 5ms, and the maximum is 0.5s.

Envelope Decay Knob

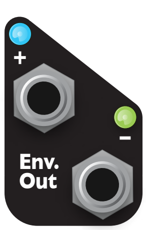
The **Env. Decay** knob sets the decay time of the envelope. The envelope has an exponential curve.

Follow/Gen. Switch

The **Follow/Gen.** switch selects between two envelope modes. In *Gen.* mode, the envelope has a sharp attack, followed by a sustain period and an exponential decay. The attack and sustain period are synchronized with the gate output, that is, the envelope remains high as long as the gate is high. In *Follow* mode, the envelope responds to the peaks and valleys of the input signal and ignores the gate. See Envelopes in Gen. Mode on page 8 and Envelopes in Follow Mode on page 9.

Gate Out Jack and LED Indicator

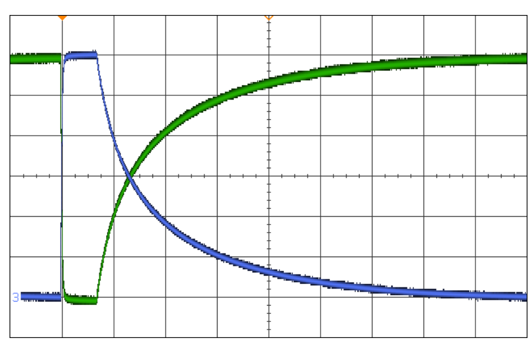
The **Gate** jack outputs a pulse which is generated from the input signal. It can be used to clock sequencers and trigger other modules. When high, the **Gate** jack outputs 8V, indicated by the white light above the jack.



Envelope Output Jacks

The top left jack, marked by the **+** symbol, outputs a 0V to 9V envelope when triggered by the input signal. The blue light above the jack indicates the envelope's level.

The jack at the bottom right, indicated by the **–** symbol, outputs an inverted copy of the envelope. When the envelope is at rest, this jack outputs 9V and the green light above the jack is fully bright. When the envelope is triggered, it falls to a minimum of 0V and the green light will dim. This envelope is useful for side-chaining (see Sidechaining with the PI on page 14).



+ Env (blue) rests at 0V and sustains at +9V.
-Env (green) rests at +9V and sustains at 0V.

Controls and Jacks: PI Expander

Env. Level Knob
The **Env. Level** knob attenuates the signal of the **Env Out** jack on the **PI Expander**. When the knob is turned all the way down, the jack will output 0V (no signal). As the knob is turned up, the signal will increase in amplitude to a maximum of 9V.

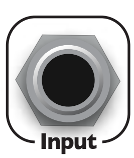
Inv. Level Knob
The **Inv. Level** knob attenuates the inverted envelope signal of the **Inv. Out** jack. When the knob is turned all the way down, the jack will output 0V (no signal). As the knob is turned up, the signal will increase in amplitude to a maximum of 9V. For example, if the knob is at 50%, the **Inv. Out** jack will output a steady 4.5V until an envelope is triggered, at which point it will fall to 0V and then decay back to 4.5V.

Env. Out Jack
The **Env. Out** jack on the **PI Expander** outputs an attenuated envelope signal. This jack functions like the + **Env. Out** jack located on the main **Percussion Interface** module, except that it can be attenuated with the **Env. Level** knob**.**

Inv. Out Jack
The **Inv. Out** jack outputs an attenuated inverted envelope signal. This jack functions like the - **Env. Out** jack located on the **Percussion Interface** module, except that it can be attenuated with the **Inv. Level** knob**.**

Audio Out Jack
The **Audio Out** jack outputs an amplified version of the input signal. It can be used as a pre-amp for microphones or other low-level signals to boost them to modular level. The gain/boost amount is determined by the position of the **Sensitivity Knob** on the **Percussion Interface** and the **L|M|H** switch on the **PI Expander.**

L|M|H Switch
The **L|M|H** Switch selects the gain range of the input signal. The **L** setting corresponds to *low gain,* the **M** to *medium gain,* and the **H** setting to *high gain.* See Setting Input Gain section on page 6 for more information.



1/4" Input Jack (6.35mm)
The **1/4" Input** jack allows for the use of a mono 1/4'' (6.35mm) instrument cable. The **1/4" Input** jack can only be used when the **IN** jack on the main **PI** module is unpatched; patching into the main **IN** jack will disable the **1/4" Input** jack. This jack is mono (TS), so only the left channel of a stereo TRS cable, or the + signal of a balanced cable, will be used.

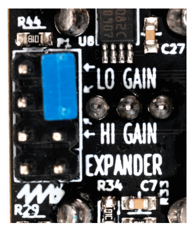
Setting Input Gain

The **Percussion Interface** boosts low level signals in order to generate gates and envelopes at modular level. There are two controls for adjusting gain: the **L|M|H** switch sets the gain range, and the **Sensitivity** pot adjusts within that range.

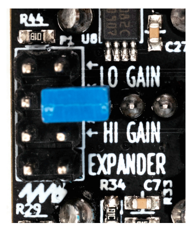
L|M|H switch position		Range	Use Cases
	**L (Low Gain)**	*0–2x gain*	Best for modular level and some professional line level signals
	**M (Medium Gain)**	*0–20x gain*	Best for instrument, line, and some low impedance mic signals
	**H (High Gain)**	*0–500x gain*	Best for high impedance mics, piezo discs (contact mics), and other very low signals

Setting the Gain Without a PI Expander
If you are using the **Percussion Interface** alone (without the **PI Expander**) the gain range can be set using a jumper on the back of the **Percussion Interface**. Note that if the jumper is missing completely, the default setting will be MEDIUM GAIN.

LOW GAIN



MEDIUM GAIN



HIGH GAIN

Using the PI with Various Sources

The **PI** has three gain settings (LOW, MEDIUM, and HIGH) and a **Sensitivity** knob that can be used to generate gates and envelopes from almost any sound source. The best setting for the **L|M|H** switch is usually determined by the type of sound source, and the **Sensitivity** knob is usually adjusted until the desired gate and envelope outputs are achieved. As always, if you're not getting the results you wish, experiment with other settings.

When using the **PI** to sense velocity (that is, in *Follow* mode), the widest range of dynamics can be tracked by setting the gain to the lowest possible setting that still triggers with your softest input signal. For example, hitting a drum very softly, with medium force, and then very hard should ideally produce a small-, medium- and large-amplitude envelope, respectively. If the gain is turned up too high, the medium and hard hits will produce similar envelopes, and thus some dynamic range is lost. However, at higher gain settings, the PI can pick up very subtle variations of soft hits and quiet input signals. See Velocity Sensing on page 10 for more details.

Piezo Discs / Contact Microphones

Piezo discs, often called contact microphones, are useful in isolating a drum from nearby drums or sound sources. If using an acoustic mic generates false triggers from sounds in the vicinity of the drum, a contact mic might be a better approach. The HIGH GAIN setting on the **PI** is typically the most useful for contact mics. If you're experiencing noisy gates, try putting a soft material such as rubber or fabric between the sound source and the contact mic. This may also help protect the piezo disc from being damaged.

High-Impedance Microphones

Inexpensive microphones such as the types found in children's toys and low cost karaoke systems are typically high-impedance. These microphones are rarely used in a professional environment since they are susceptible to external noise and audio degradation. If you find yourself using one of these microphones, keep the cable as short as possible. The HIGH GAIN setting on the **PI** is typically the best setting for high-impedance microphones.

Low-Impedance Microphones

Low-impedance microphones such as professional vocal or drum microphones typically require setting your **PI** to MEDIUM GAIN. In some situations, LOW GAIN and HIGH GAIN settings will perform better, so experiment to find the best setting.

Acoustic drums will often have a long resonance/decay period after being struck. This can cause the **PI** to misfire by producing an unwanted gate. One way to prevent this is to dampen the drum head using dampeners purchased from a music store, or a scrap of fabric taped to the drum head below the microphone. If you want to prevent misfires without dampening your drums, refer to the Preventing Misfires and Undesired Gates section on page 12.

Instrument Pickups

Pickups, such as the kind often found in electric guitars, can produce a wide range of signal levels depending on the characteristics of the device. Setting the **PI** to MEDIUM GAIN is a good place to start with any pickup. Some active pickups may perform better on LOW GAIN, so experiment to find the best setting for your pickups and playing style. Since stringed instruments can be played percussively as well as with continuous notes, adjusting the **Decay** knob and setting the **PI** to *Follow* mode can yield interesting results.

Line Level Equipment (Keyboards, Drum Machines and Samplers)

Many line level instruments have a volume control. When using these types of signals with the **PI**, a good practice is to center the volume control of the line level instrument and adjust the **Sensitivity** knob on the **PI** until it triggers cleanly. Typically the **PI** works best with line level signals when set to either LOW GAIN or MEDIUM GAIN. For more information on how to extract clean gates from drum machines or samplers, refer to the Preventing Misfires and Undesired Gates section on page 12.

Modular Level Equipment

When using a modular level signal, set the **PI** to LOW GAIN. Modular synthesizers typically produce signals which are very high in amplitude. For more detailed information on generating clean pulses using an external sound source, see the Preventing Misfires and Undesired Gates section on page 12.

Envelopes in Gen Mode

When the **PI** is in *Gen.* mode, it will generate a consistent envelope shape each time it's triggered. In this mode, the **Gate** will always fire at the same time as the envelope. When triggered, the envelope will rise quickly with a very fast attack, and then sustain for a period of time set by the **Sustain** knob. The sustain period is the same amount of time as the gate pulse width. After sustaining, the envelope will decay back to 0V at a rate set by the **Decay** knob.

Figures 1 and *2* illustrate this process. The input signal is shown in red, the gate output in orange, and the envelope output in blue.

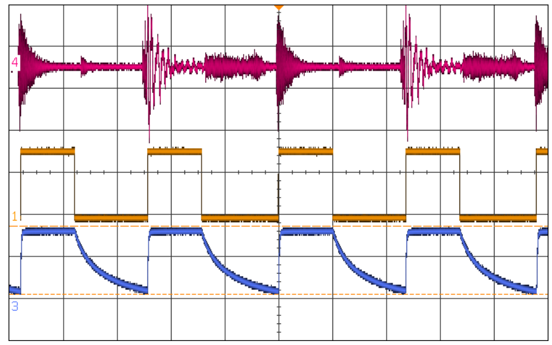


Figure 1

In *Figure 1*, the **Sustain** pot is set to about 50% and the envelope sustains as long as the gate is also high. In *Figure 2*, the **Sustain** pot is turned fully counter-clockwise and both the pulse width of the gate output and the sustain period of the envelope become very short.

Gen. mode is useful for isolating a sound source. For example, when using a microphone to sense the sound of a snare drum, other parts of the drum set could be loud enough to trigger the **PI**. In *Gen.* mode, it's easy to adjust **Sensitivity** until unwanted envelopes and gates are no longer generated.

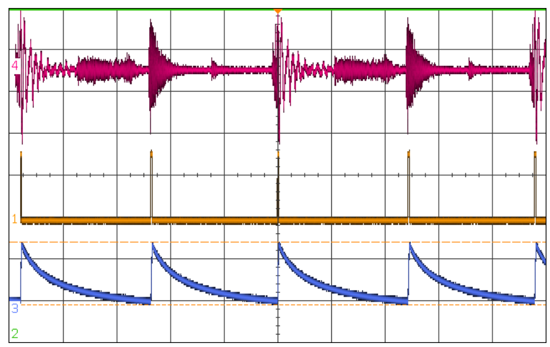


Figure 2

Another use case for *Gen.* mode is to trigger a **PI** with one part of a drum (say, the snare head), but not with another part of the drum (say, the rim). By setting the **L|M|H** switch and **Sensitivity** knob appropriately, and placing the microphone in a location where it picks up the head louder than the rim, you can isolate the two regions. This technique can be extended to use two **PI** modules on a single drum: the rim triggers one **PI**, and the head triggers another **PI**.

If you don't want the **PI** to trigger every time a drum is struck, but only want it fire when the drum is hit with high velocity, the **Sensitivity** knob can be set very low. Gates and envelopes will be generated from loud signals while quiet signals will have no effect on the **PI**. This technique of setting a high threshold is useful if you want to trigger events such as advancing a sequencer, or play periodic sounds (such as a long sample) instead of tracking every drum hit. This technique can also be extended when using multiple **PI** modules: each unit can be set to fire at a different velocity, thus allowing control of complex sounds and events from a single drum.

Envelopes in Follow Mode

Using the **PI** in *Follow* mode allows the envelope to directly follow the amplitude variations of the input signal. The velocity of the input signal can be imparted onto the output envelopes. The envelope shape can be more complex than the sustain-decay envelope of *Gen.* mode. In *Follow* mode, the envelope and **Gate** outputs can fire at different times.

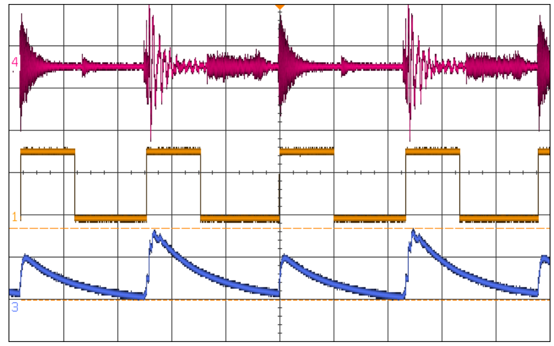


Figure 3

Figures 3 and *4* use a similar input signal as *Figures 1* and *2* in the previous section. Notice that the envelopes (represented by the blue waveform on the bottom) are not uniform. Also notice that the shape of the envelope correlates more strongly to the contours of the input source (represented by red waveform at the top) as opposed to the gate (represented by the orange waveform in the middle). The amplitude of the input source directly influences the envelope's maximum voltage, allowing for more organic envelope shapes and introducing some variability into the CV output.

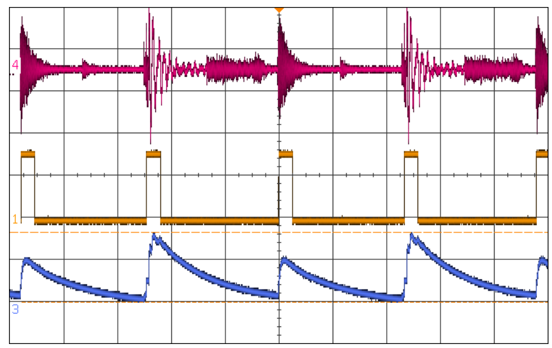


Figure 4

In *Follow* mode the **Decay** knob controls how quickly the envelope decays when the input amplitude falls. The envelope attack is always very rapid. *Figure 5* illustrates the envelope shape when **Decay** is set fully counterclockwise*.* You'll notice the envelope begins to resemble the input source more closely. This can be used as an audio output, as a frequency modulation source, or in other creative ways.

In *Follow* mode, the **PI** envelopes are sensitive to the velocity of the input source and therefore produce a greater variety of envelope shapes. Because envelopes generated in *Follow* mode follow the amplitude of the input signal, louder sounds result in higher voltage envelopes, and quieter sounds result in lower voltage envelopes. *Figure 6* shows two waveforms: the envelope output in blue, and the input signal in red. The **Decay** knob is set very low in this example. The input signal consists of a bass drum hit followed by a high-hat hit. Notice the bass drum hit causes a relatively high voltage envelope, while the high hat produces a lower voltage envelope. See the Velocity Sensing section below for more information.

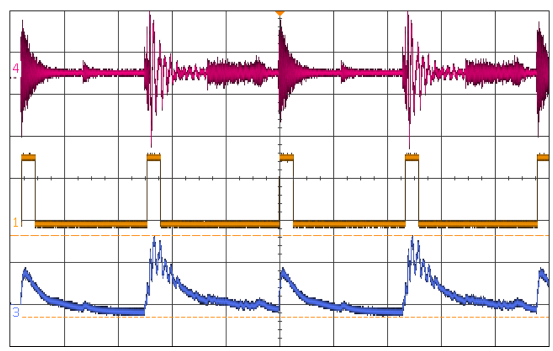


Figure 5

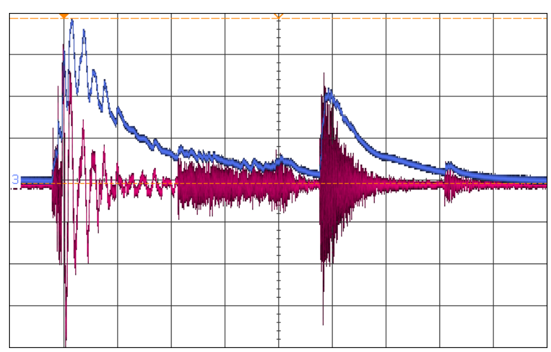


Figure 6

Velocity Sensing

The envelope outputs of the **PI** can respond to the velocity of the input signal. Velocity is a term usually used for percussive sounds when referencing how hard an instrument is hit (harder means more velocity, and softer means less). When using non-percussive audio sources such as vocals, keyboards, etc, you can think of velocity as a combination of the loudness of the notes (or perhaps the "attack" of the notes). When using sound sources that don't produce distinct notes, you can think of velocity as a measurement of how loud the signal gets whenever there's a transition from quiet to loud.

When sensing velocity, the **PI** must be in *Follow* mode. The **Env. Out** and **Inv. Out** jacks will produce envelopes with an amplitude that depends on the velocity of the input signal. Harder hits will produce envelopes with higher peak voltages, and softer hits will produce lower voltages.

The following discussion provides an example of one way to setup a **PI** for velocity sensing, using an acoustic drum and a microphone as the input source. These concepts can be applied to most other audio sources.

Setting the Velocity Response

While velocity-sensitive envelopes are generated whenever the **PI** is in *Follow* mode, setting **Sensitivity** properly is important so that the entire range of velocity (very soft to very hard) produces a wide range of envelopes. If **Sensitivity** is set too high, then medium and hard hits will not be distinguished. On the other hand, if the knob is set too low, very soft hits will barely be detected.
A good rule-of-thumb is that if the gate output is firing only at your hardest hits (and not at medium or soft hits), then the **Env. Out** jacks will be outputting velocity-sensitivity envelopes with plenty of headroom and enough gain to respond to the dynamic range of a normal playing style.

A basic procedure for finding a good velocity-sensitivity range is as follows:

1. Flip the switch to *Follow.*
2. Turn **Sensitivity** all the way up.
3. While hitting the drum with maximum velocity, turn **Sensitivity** down until the gate no longer triggers.
4. Nudge **Sensitivity** up until the **PI** gate begins to fire again.

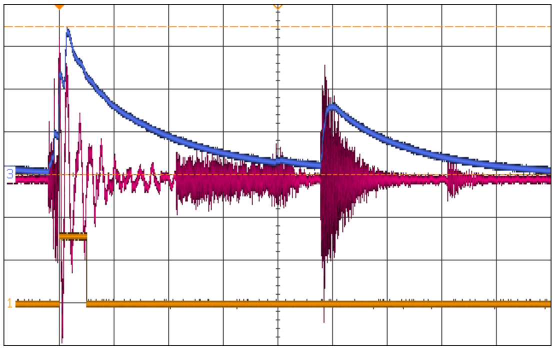


Figure 7

At this setting, the **Env. Out** and **Inv. Out** jacks will dynamically respond to the velocity of the input signal: soft hits will produce low-voltage envelopes, and hard hits will produce higher voltage envelopes. This outcome is shown in *Figure 7.* The red signal is the input, the blue line is the **Env. Out** signal, and the orange pulse is the **Gate** output.

If you find that the envelope output level is too high, use the **Level** knobs and attenuated envelope output jacks on the **PI Expander**. While the **Sensitivity** knob can also be used to attenuate the output level, adjusting it changes the velocity sensitivity range as well as the threshold at which the **Gate** output fires. The **Level** knobs, on the other hand, only controls the output level on the **PI Expander** and should be the preferred method for attenuating envelopes.

Troubleshooting and Suggested Applications

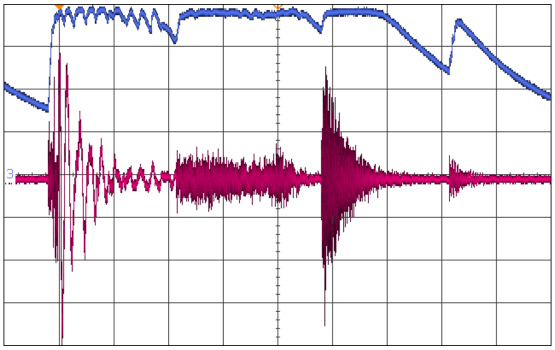


Figure 8

If the **Sensitivity** knob (or **L|M|H** gain range switch) is set too high, the input signal will clip internally, indicated by the input light flashing pink or red. This causes the **PI** to output an envelope around the maximum voltage regardless of the input velocity, illustrated in *Figure 8*. Though this may be desired in some applications, it restricts the dynamic range of the envelope output. Turning down the **Sensitivity** or flipping the **L|M|H** switch to a lower gain setting will solve this issue.

Another issue to consider is the **Decay** setting. If the **Decay** knob is set too high, the envelope will fall so slowly that it'll never reach a low value before it's triggered again. See *Figure 9* for an example.

When adjusting the **PI**, consider what type of microphone or sensor is being used, how it is mounted, and what sort of object it's sensing. For example, piezo discs and contact mics output a wide range of signal levels depending on how firmly they're attached to the object being struck. A metal piezo disc directly attached to a metal object will produce will likely output maximum voltage regardless of the velocity at which the object is being struck. To mitigate this effect, you can place some rubber or soft material between the contact mic and the object. This will improve the dynamic range of the sensor. On the other hand, a contact mic loosely set onto a soft object may result in very little signal when the object is struct. Attaching it more firmly or to a more firm section of the object can help in this situation.

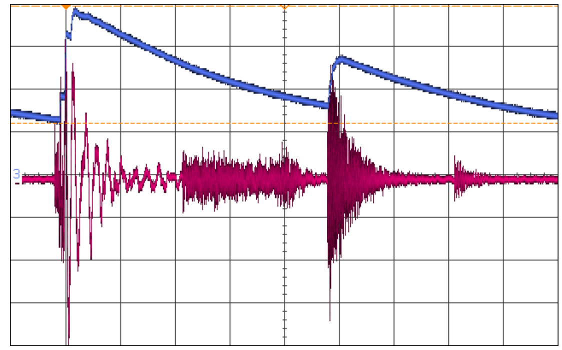


Figure 9

Using a standard drum mic attached to a drum is a good way of introducing dynamics to your setup. Drum mics are durable and typically easy to attach. Clipping a microphone to the rim of a drum will enable you to use the rim as a trigger source more accurately, while picking up less of the signal coming from the drum head.

If you have two **PI** modules, an interesting application includes using two microphones on the same drum, with each mic running into a separate **PI** module. For example, you could place one contact mic on the rim and send it to one **PI**, then place another contact mic on the drum head and send it to a second **PI**. This will allow you to use a single object as two separate voltage / gate sources.

Preventing Misfires and Undesired Gates

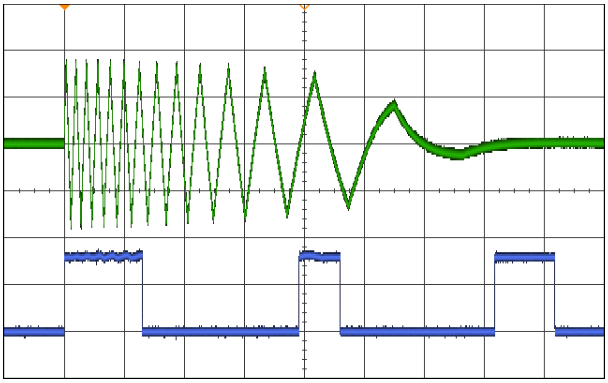


Figure 10

When using the **PI** to generate gates from drum machines with long decays or drums with lots of resonance, you may experience "misfires", or undesired gates. This can usually be fixed by adjusting the **PI**'s **Sensitivity** and **Sustain** knobs.

For this example, the input signal will be a techno track that has a bass drum with about 150ms of decay. Our goal is to have the **PI** generate a pulse whenever the bass drum fires. In *Figure 10*, the green waveform on top is the input signal, and the blue waveform on the bottom is the **Gate** output of the **PI**. We see that three gate pulses are generated when the drum fires, which tells us the **Sensitivity** is set too high and the **Sustain** is set too low. The second pulse is being generated by the decay of the input source which the **PI** mistakenly interprets as a second "hit". The third pulse is being generated because the gain setting is so high that the slightest change in voltage is interpreted as another "hit" by the **PI**.

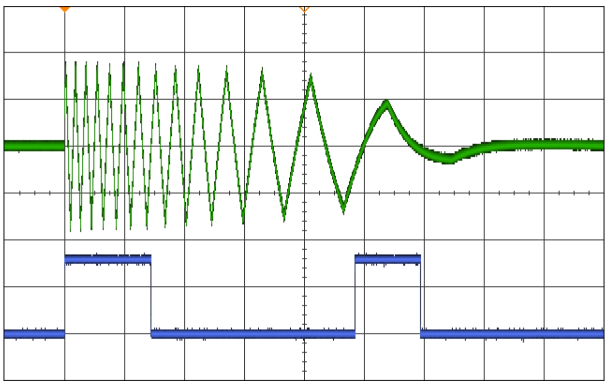


Figure 11

Setting the Correct Gain

In *Figure 11* we've reduced the gain by flipping the **L|M|H** switch to L, removing one of the misfires. In order to get rid of the second misfire, we need to adjust the **Sensitivity** or **Sustain**.

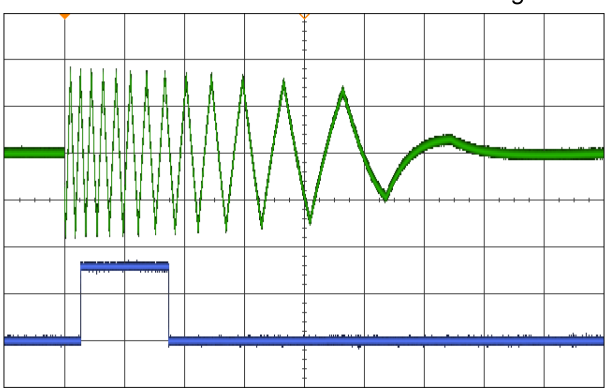


Figure 12

Adjusting Sensitivity

In *Figure 12*, we've turned the **Sensitivity** knob down until only one pulse is generated. This technique works best when using samplers, drum machines or any source with repetitive sounds and consistent amplitudes.

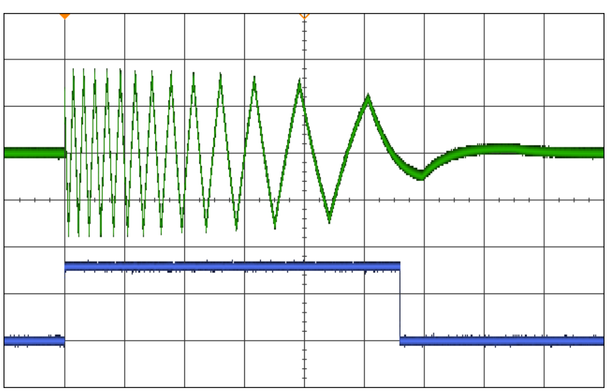


Figure 13

Adjusting Sustain

With input sources of variable or inconsistent amplitude, such as an acoustic drum or a live recording, turning **Sensitivity** down might result in missed triggers (producing less pulses than desired). In these situations, a better technique is to adjust **Sustain**.

When **Sustain** is turned up, the gate length will extend, as seen in Figure 13. No additional gates will fire as long as the gate is high. By setting **Sustain** high enough that the gate is high for the entire bass drum decay period, misfires will be prevented. The gate length can be varied between 6ms and 560ms.

Properly adjusting **Sustain** reduces the likelihood that changing **Sensitivity** will cause a misfire, allowing the **PI** to work better with live drums, mic sources and sounds with long decays. Keep in mind that if **Sustain** is set too high, a rapid sequence of drum hits will miss pulses, since the **PI** won't re-trigger as long as the **Gate** is high.

An advanced technique for preventing misfires is discussed in the next section.

Calibrating Lockout Time for Gate Out

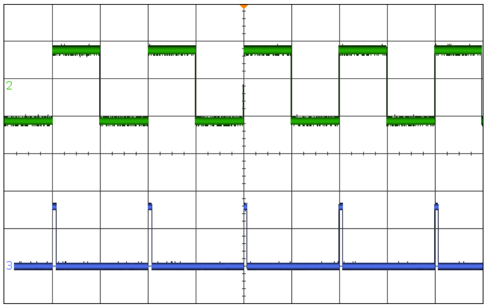
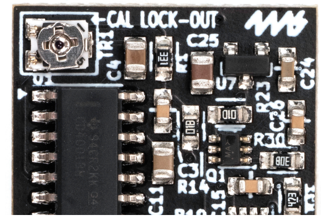


Figure 14



On the back of the **PI**, there is a trim pot labelled CAL LOCK-OUT. This trim pot controls how quickly the **PI** is able to re-trigger. It has been calibrated to a period of 100ms, which is equivalent to 10Hz, ten drum hits per second, or 600BPM. This is known as the “lock-out period”.

The trim pot is small and delicate, so adjust it gently using the proper sized screwdriver (2.0mm flat-head or #00 Phillips screwdriver).

Figure 14 shows a 10Hz square wave in green being sent to the input of the **PI**, and the **Gate** output of the **PI** in blue. The **Sustain** knob is set to minimum. Notice both signals are at the same frequency of 10Hz.

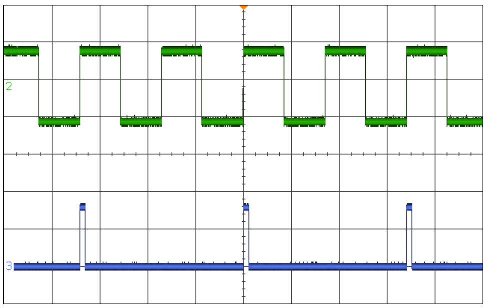


Figure 15

In *Figure 15* the frequency of the green square wave has increased to around 12Hz. The **PI Gate** output in blue is now half the frequency of the input. This happens because the **PI** has been calibrated to ignore frequencies higher than 10Hz in order to prevent misfires and undesired hits. The **PI** is still synchronized with the input signal, but it is outputting half the tempo.

Depending on your preference, the lock-out period can be adjusted. For example, if you find the **PI** is not responding to very rapid drum hits, you can turn the CAL LOCK-OUT trim pot counter-clockwise a small amount. This will allow the **PI** to respond to faster drum hits. Keep in mind that this adjustment will also increase the potential for extra undesired triggers on the gate output.
On the other hand, if you typically use an input signal with long decays or less frequent hits, you can turn the trim pot clockwise to increase the lock-out period and prevent undesired gates. This is similar to adjusting the **Sustain** knob in order to clean up drums with a long decay, but the trim pot doesn’t change the pulse width of the **Gate** output. Setting the lock-out period with the trim pot is useful in *Gen***.** mode, as it enables you to adjust the **Sustain** pot freely to control the envelope shape, without worrying about undesired triggers.

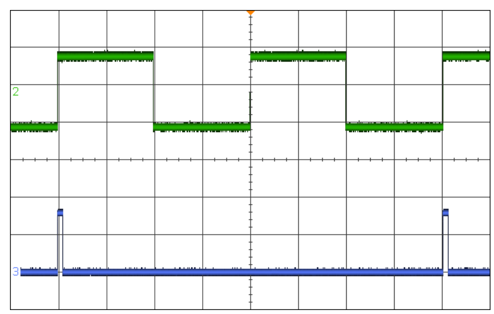


Figure 16

The following procedure explains how to set a precise lock-out period. You’ll need a frequency counter, oscilloscope, or some way to detect frequency or fast BPMs. We’ll use five hits per second, or 5Hz as our desired lock-out frequency.

1. Tune a square wave or clock signal to the desired frequency and patch it into the **PI**’s input jack. In *Figure 16* the input signal is a 5Hz square wave in green.
2. Turn **Sustain** down fully, and adjust **Sensitivity** so that the PI is firing pulses out the **Gate** jack.
3. Adjust the CAL LOCK-OUT trim pot until the **PI** gate output is half the frequency of the input (2.5Hz). In *Figure 16,* the blue signal is the **Gate** output.
4. Slowly turn the trim pot counter-clockwise until the frequencies match, as shown in *Figure 17*.

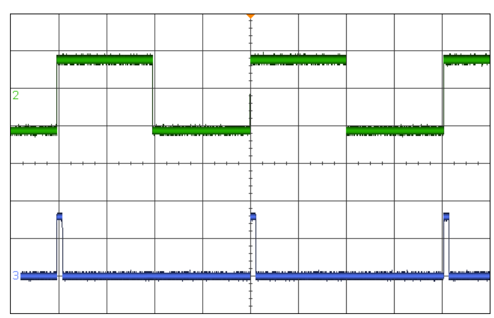


Figure 17

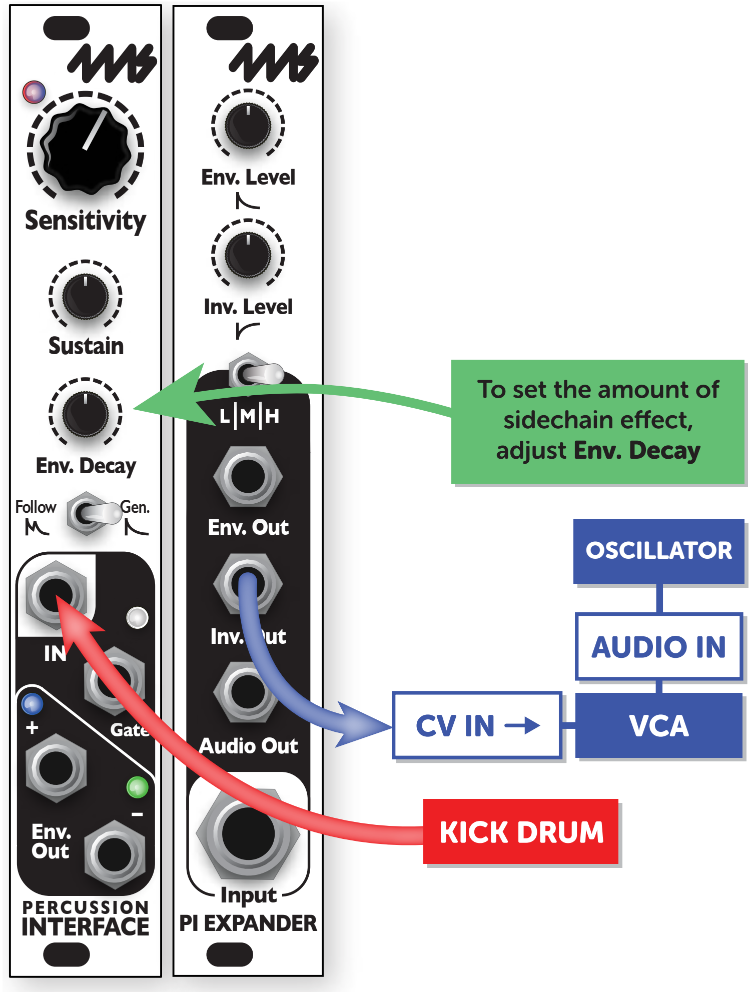
At this point, the lock-out period will be 5Hz and no frequencies faster than this will generate pulses. You can test to make sure this was done correctly by increasing the frequency of the input signal and verifying that the **PI**’s output frequency jumps down to half the input frequency.

Sidechaining with the PI

The **PI** can be used for sidechaining and ducking effects. Sidechaining is a technique where one audio signal triggers an effect on another audio signal. Ducking is a commonly used form of sidechaining where the kick drum of an audio track will cause the other instruments to suddenly decrease in loudness, or "duck".

The following is a basic procedure for creating a ducking effect:

1. Run an audio source such as an oscillator or a musical track into the audio input of a VCA.
2. Patch the **Inv. Out** from the **PI Expander** to the CV input of the VCA.
3. Patch the kick drum signal into the **IN** on the **PI** or the Input on the **PI Expander**.
4. Flip the switch to *Gen.* mode.
5. Adjust **Sensitivity** and the **L|M|H** switch so that the white **Gate** light fires every time the kick drum is hit. Adjust **Sustain** as low as possible without causing mis-fires.
6. Listen to the audio being "ducked" as you adjust **Inv. Level** and **Env. Decay** to set the amount of effect and "recovery" speed.



When triggered, the **Inv. Out** signal will jump low, causing the VCA to drop the volume of the audio. As the inverted envelope decays, it rises back to its resting voltage, and the audio source increases in volume.

The **Inv. Level** knob controls the amount of decrease in the audio signal's amplitude. Turning this knob down might require you to turn the VCA's offset or gain control up to compensate.

The **Env. Decay** knob controls the "recovery" time (the time it takes for the audio signal to return to normal after a kick drum).

The **Sustain** knob can also help craft the sound by adding a delay after the kick drum and before the envelope begins to rise back up to maximum voltage.

Electrical and Mechanical Specifications

- **Percussion Interface**
  - 4HP Eurorack format module
  - 0.98” (25mm) maximum depth (includes power cable)
  - 10-pin Eurorack power header
- **PI Expander**
  - 4HP Eurorack format module
  - 1.13” (28.7mm) maximum depth (includes expander cable)
  - 8-pin cable connects to **PI**
- **Power consumption**
  - Maximum with PI Expander:
    - +12V: 104mA
    - -12V: 65mA
  - Maximum without PI Expander:
    - +12V: 69mA
    - -12V: 56mA
- **Audio IN jacks** (1/8” [3.5mm] on **PI** main module, and 1/4” [6.35mm] on **PI Expander**)
  - 100k input impedance, AC-coupled
- **Audio Out jack**
  - Voltage range: -10.4V to +10.8V, DC-coupled
  - 1k output impedance
- **Gain characteristics**
  - Gain range: < -100dB to +54dB (500x)
  - Clip light turns blue when signal (post-gain) exceeds 2.5Vpp
  - Gate is triggered when signal (post-gain) exceeds 6.3Vpp
  - Clip light flashes red when signal clips on Audio Out jack (exceeds +10.8V)
- **Gate Out jack**
  - 1k output impedance
  - +8V gate/trigger signal
  - 6ms – 0.5s pulse width
- **+ Env Out jack** (jack on PI main module)
  - 1k output impedance
  - +9V peak (sustain), -60mV resting (off)
  - 15ms attack time
  - 70ms – 6s exponential decay time (1% of peak voltage)
- **– Env Out jack** (jack on PI main module)
  - 1k output impedance
  - +9V resting (off), -150mV peak (sustain)
  - 15ms attack time
  - 70ms – 6s exponential decay time (1% of peak voltage)
- **Env. Out jack** (attenuated jack on PI Expander)
  - 1k to 26k variable output impedance
  - +9V maximum
  - -60mV minimum
- **Inv. Out jack** (attenuated jack on PI Expander)
  - 1k to 26k variable output impedance
  - +9V maximum
  - -150mV minimum

My Patch Notes