

Thermo-iOS is conceived, designed & programmed by Sinan Bökesoy

in VST3/AU programming platform: C++ / JUCE ,

*sonic***LAB**

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www.sonic-lab.com

installation of Thermo iOS

Thermo-iOS comes as a standalone and a AUv3 app for your iPad only, which you can purchase and download on the AppStore.

We recommend at least an A12 processor iPad and the small screen iPad's can be challenging for the usage of the app. (such as the iPad mini)

Thermo uses the resources for best sonic quality. The audio engine calculations are done continuously and even partly if there is no audio output. sonicLAB audio engine design does exclude optimization methods applied to favour the compatibility of old iOS hardware while degrading the audio quality.

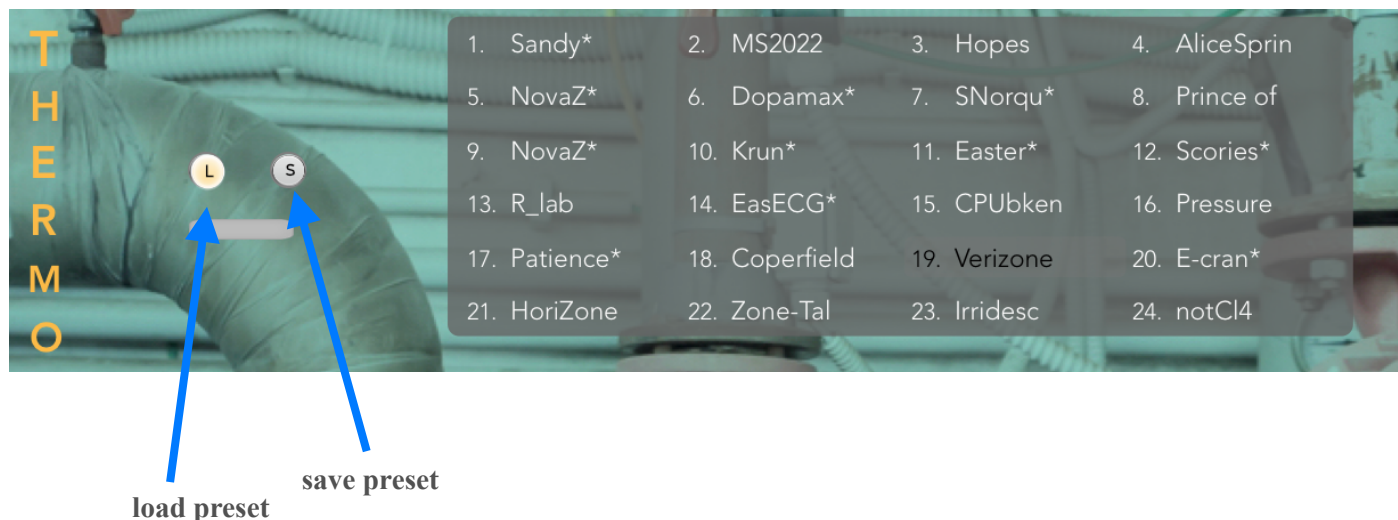
Thermo uses the full screen width of your iPad automatically on the standalone version. The AUv3 version also tries to use the full window width when running on the hosting app.

some important issues :

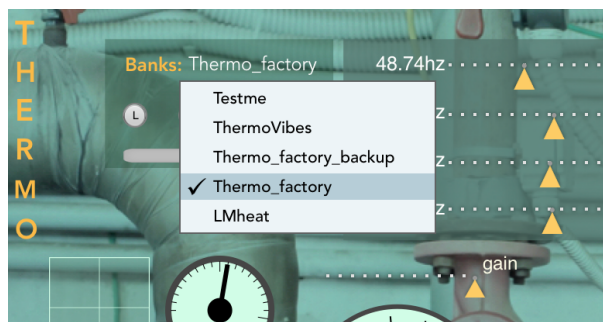
- . Thermo can generate high signal levels and unexpected drifts, it is a self organizing feedback system in constant motion. We strongly suggest you to check keep your signal level safe (audio interface, DAW / plugin output) at an ideal output level.
- The filters might get unstable at certain occasions, but security measures have been taken that this kind of explosions won't get reflected at the app output. Just you need to change/experiment the filter cutoff settings to avoid the present feedback situation.
- . Thermo uses sample rate precision calculation for audio and any control signal. However using a buffer size of 128 or higher will save some CPU without sacrificing the quality.

Presets : Presets are inside each bank of 24 slots. You can load from these slots , save onto them, import and export other banks. **Thermo** comes with preset banks created by **Sinan Bökesoy and Laurent Mialon**.

To load and save presets press the respective button as shown below and the current work bank will open



For both operations, just press on the desired preset slot. When saving on a slot, a confirmation dialogue will open. To select your bank, tap on the dropdown menu next to the “Banks:” and you will see a list of available banks.



Important notes: The default bank when Thermo launches will be the Thermo_factory.xml which sits inside the Thermo PresetBanks directory (explained above).

It is this bank being loaded by default each time you launch the Thermo. (other than that you have saved the last plugin state along with your DAW project) and the first preset will be loaded.

All the preset save operations you do apply on a slot will replace the content of this particular bank slot. So it is a destructive operation. However when you reopen the application, the present changes which you have applied on the working bank remains.

Therefore we suggest that you keep a backup of the factory bank and when finished working on a custom bank with new presets then create a copy of this bank later with a different name. Likewise you can create easily backup copies of your banks in the Thermo work directories.

preset bank handling on Thermo iOS

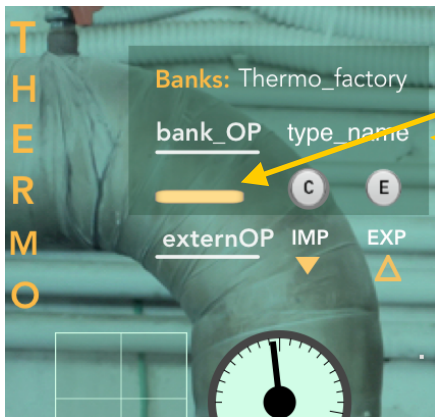
Both the standalone iOS and AUv3 version share the AppSandBox file space where the Thermo files are stored and shared. But it is only the standalone version which is authorized to import/export from outside to the Thermo preset bank folder or vice versa. You can import preset banks to the Thermo/PresetBanks folder or export your custom ones from there to outside.

You cannot directly access inside this folder ! but you can see its content on the preset bank pop-up menu.

You can use a file utility software to access the exported preset banks or bring other ones to your Thermo folder and import them to your PresetBank folder.

You are welcome to check Thermo tutorial videos on our [YouTube channel](#).

Fundamental iOS standalone



You can import external banks into the bank menu only on the standalone iOS version. For this and other features, press on this button first.

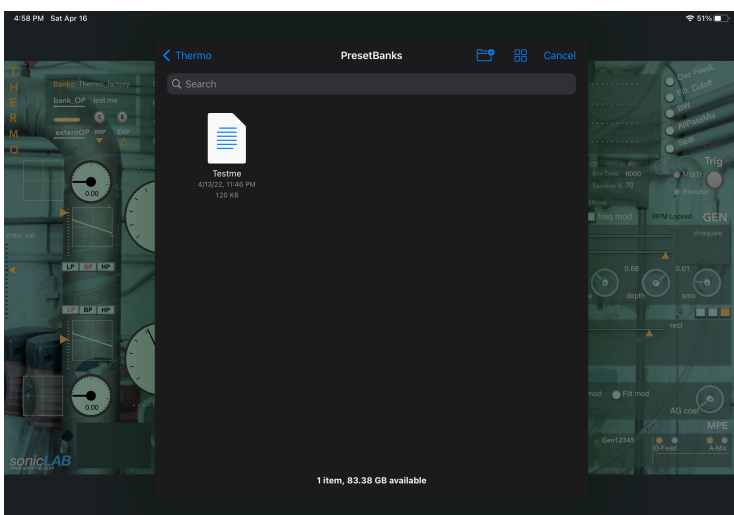
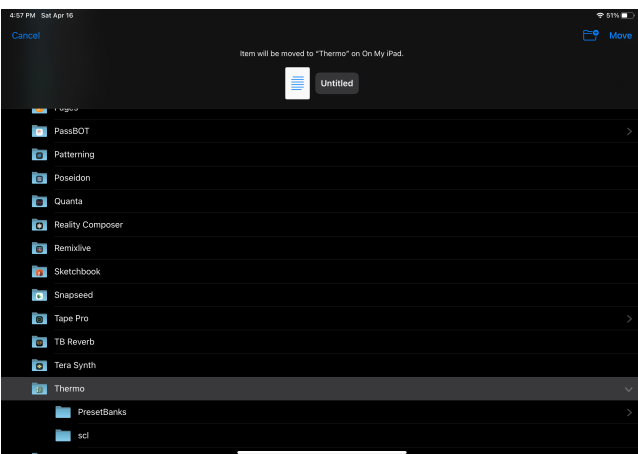
You will see that the layout has changed. Here you can copy the last selected bank with another, or erase it. First type a custom name here for the bank you would like to copy. Then press the “C” button, and the app will ask your confirmation, hence press again on that button to confirm. A copy of the bank with the new name will be created and added to the bank list.

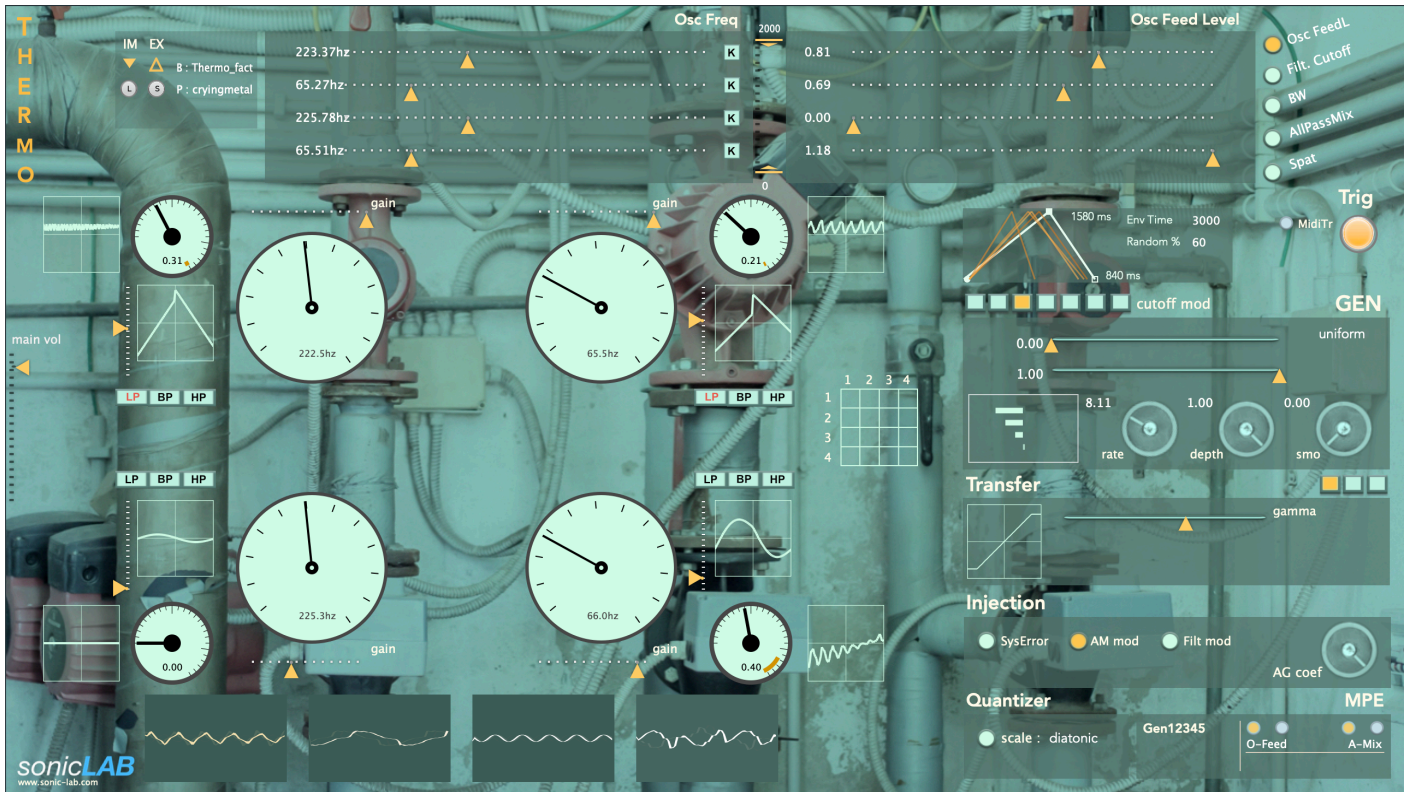
In order to erase a selected bank, press the “E” button, and confirm by pressing on it again.

You can export a selected to your apps document directory to share with the external environment, for example use it on your Thermo desktop plugin version. For this press the “IMP” button, and this window on the left will open.

Select the *Thermo/PresetBanks* directory and then type a name on the field called “Untitled” and then press on **Move**.

Likewise you can import a saved bank, press the “EXP” button and this window will open. Here you see the previously saved banks and when you click on it, the bank will be imported and the bank list will be updated accordingly.





What is Thermo ?

Thank you again for choosing Thermo. It connects science, engineering and sonic art.

Thermo is a unique synthesizer, a hyper oscillator engine inspired by thermodynamic systems. It is an indispensable tool developed and tuned with expertise in experimental electronic music and sound design.

Sound is typically air waves which represent a quantifiable energy form that can be processed, converted and directed. **Thermos** means *heat* and dynamics means *energy* coming originally from Greek language. Energy, heat and light as a waveform do establish this communication in many processes. In thermodynamic systems, heat can be translated to work, can be taken away to control it and put back, and one can generate that heat in many ways. Heat exhibits at the same time a radiation, a wave length of light (for instance stars in the universe radiate the light with corresponding wave lengths in accordance to their radiated heat.)

Thermodynamics is the science that define the laws of how we can convert / obtain the energy in useful and workable manner among these processes and the interrelations in them. Enclosure, containment, systemic equilibrium, preserving different kind of states and moving between them causing actions and reactions. One expects from a thermodynamic system with the continuous transformation of its inner dynamics to maintain its equilibrium state with the action / reaction mechanisms to fulfill its task for what it is designed for.

Perceptually we are very sensitive to such energy forms ; heat, light, sound... We are naive creatures which can only exist inside a specific narrow range of this energy eco-system. Loudspeaker sound is indeed the transformation of electrical signals to moving air particles which establish the sound waves. And these electrical signals we generate in Thermo through its thermodynamic states. A sound wave exhibits a frequency, a quantifiable power related to its amplitude, and also a waveform which affects its power as well (so it is not just the frequency and amplitude.) A classic sound wave oscillator has certain control over these features. Thermo consists of a bank of 4 unique oscillator engines, running in parallel but also feeding their signals each other with a configuration matrix.

This is a system of sonic interaction with an embedded mechanism capable of reacting to its own internal state and introducing perturbations through the user and through its behavior tied up to these reacting states.

At its basic initial parameter state, the transformations inside Thermo (the dynamics of importing and exporting the waveforms from each oscillator and exchanging these waves between oscillators) can be heard as transformations on the waveform. Hence the output of oscillator 2 engine is no more the waveform rendered by its waveform generator but a mixture and transformation of other oscillators as well.

Without any regulations, this feeding energy from one place to another can cause drifts to extreme points (emphasis of certain frequencies , saturation in loudness etc..) at various perceptual levels. Thermo has the capability to react at these states and suppress this intension / rampancy and also transform it by actuating certain DSP chains which would remotely alter the current reached state. This suggests a sonic animation at the hands of a thermodynamic system.

While preserving this continuous sonic animation, we can keep this regulation to achieve for us a “*quasi state*” equilibrium dynamics state. Many sonic structures tend to be perceived quasi static on their macro temporal characteristics even while they are exhibiting rich animations on micro temporal levels. It is exactly the purpose of thermodynamic laws (and also the science of statistics) to render the behavior of complex structures (billions of molecules in irregular motion of a gas inside a chamber) with minimum amount of parameters and let a system to be regulated on macro temporal levels to reach specific conditions and achieve certain tasks.

While not being able to see the molecular motion of gases (depends also which kind) we can perfectly perceive the sound of a waveform, its continuous change in microscopic level in great detail. Likewise the entropy of the Thermo synthesis engine is something to perceive at all times. Thermo is the perfect drone synthesizer which finally does not mean only static / interference of waveforms but also a mass movement of a complex sonic structure within certain controllable margins.

Furthermore, while designing the Thermo synthesis engine, the stochastic GEN modulators (a trademark of sonicLAB) have not been forgotten. So these are also the elements of introducing irregular change to various synthesis parameters. For example changing slowly the frequency of the oscillators around a center value can create great amount of changes on the RMS analysis as also the power of the waveform is changing while creating accidental interferences emphasizing or killing the waveform output of cross feeding oscillators.

While degrees of regulation can be maintained among those changes , Thermo also offers some perturbation options to change its state depending on its internal actions, called “Injections”. These can be applied as user performance gestures and right after, the system tries to reach another level of quasi state. The enjeux between regulations and perturbations is exactly the uniqueness of Thermo taking you to some unheard sonic territories.

Finally, “Self Evolving Sonic Structures” has been the subject of my Ph.D. thesis, so the implementation of these ideas have their foundations back on the research done since then. The information gained about the temporal state of a sound generating system can be used to prepare its future state and even if this particular state would never be reached, the continuous interaction creates these actions, reactions and the sonic animation on which we are particularly interested in.

If you have an interest in further background on this particular subject of systems with self regulated sonic interactions, and perhaps eco-systemic approach in sound synthesis; I suggest you to check Agostino DiScipio’s work , his philosophy and original applications of it.

Dr. Sinan Bökesoy

chapters:

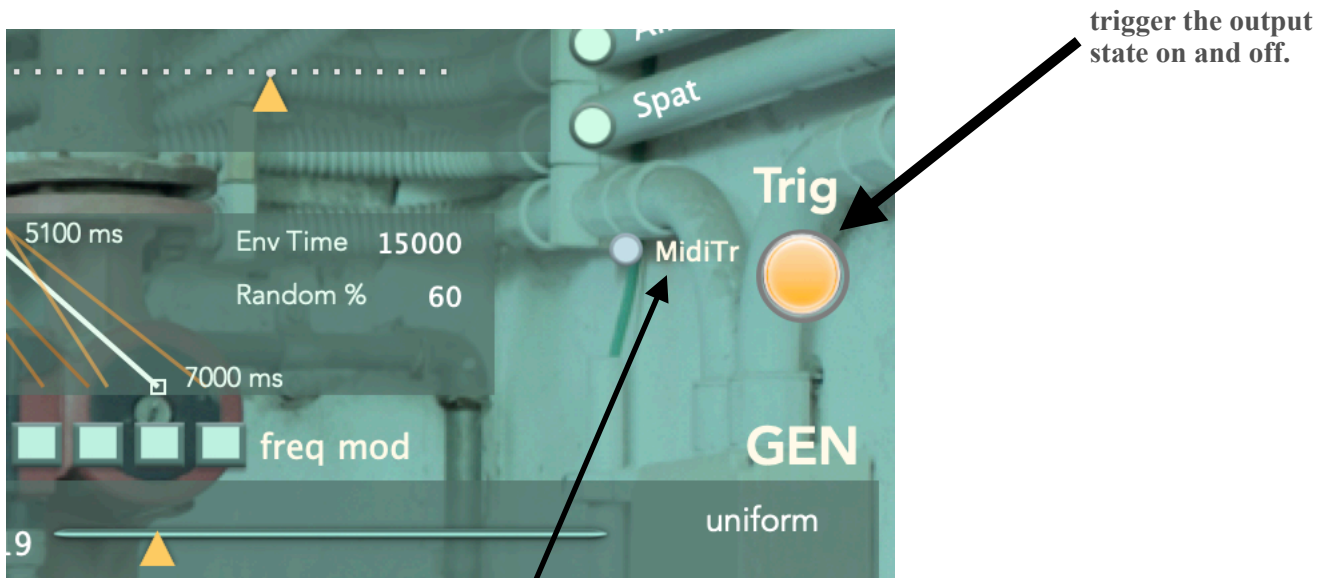
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Integrating and running the Thermo in your workspace

Triggering Thermo :

- When a preset is loaded , Thermo expects a trigger to run the output. It is this button below.

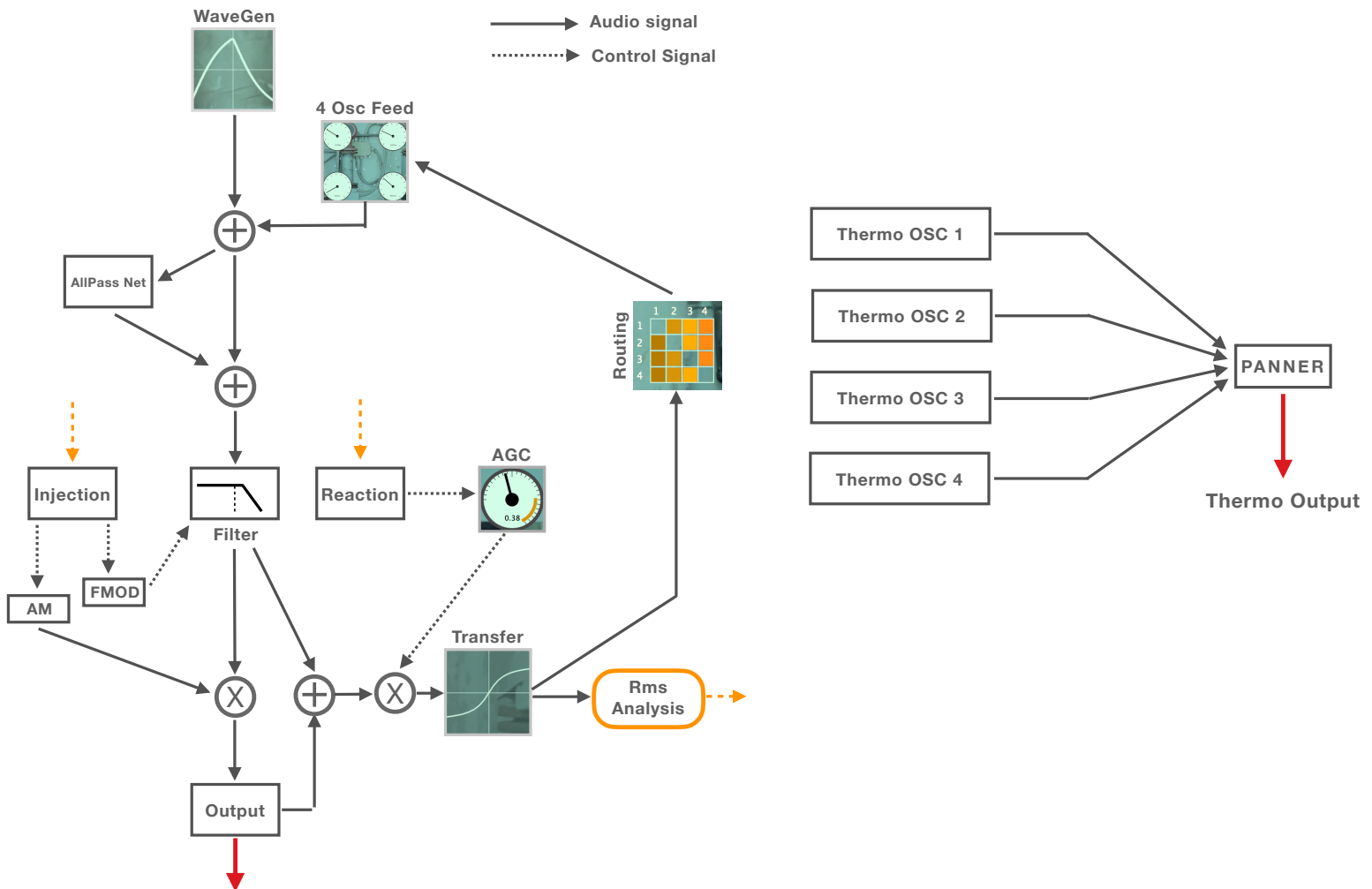


- Furthermore, if the MidiTr button switch is turned on, any key pressed on your midi keyboard (or a note on / note off message sent to Thermo from elsewhere) will turn on/off the Trig button.
- Triggering the Thermo on/off activates the Attack/Release envelope phases automatically. Hence Trig On launches the attack phase of the envelopes and Trig Off launches the release phase of the envelopes.

Important : You can save Trig state along with the preset, so that when recalled it will keep the last state.

Thermo signal flow chart

Below you will find a simplified version of the oscillator engine in Thermo. Some components are discussed in more detail in the further sections of the manual. The chart does not include the modulation sources neither. Note that users with some patching background can try out similar structures in modular programming platforms. Instrument design deals a with a great amount of fine tunings, coefficients, attenuations and love, so for sure everyone's experiment will be sounding different.



The story of the signal begins with a waveform generator (WaveGen) which can calculate (not reading from a table) high precision basic waveforms such as sine, triangle, square and sawtooth. The waveform generator has the following parameters : gain, frequency and morph position (between these 4 basic waveforms) This signal is being summed with the signals of other oscillator outputs directed by the feedback routing matrix, which is configured by the user.

How much signal is being sent to the feedback routing matrix from an oscillator ? This can be adjusted with the **Osc Feed Level slider set** of the Thermo user interface. But also the **AGC** component (Automated Gain Control) has direct action on this signal level to regulate the levels. (see the figure)

The next phase is applying an AllPass filter net to the signal with variable wet/dry level. This is not a reverb but can smooth the harshness of the signal at will. The mix level is the **Allpass Mix slider set** of the Thermo user interface.

As next, you can apply a band-pass, low-pass or high-pass filter of which cutoff is controlled with the **Filter cutoff slider set**.

Now things get more interesting. The filter output will be used for the injection models if they are active, which are basically perturbations that can be injected to the system triggered by the user. The process builds the oscillator output but also part of it will be fed to the right side of the signal chain which at the end feeds the routing matrix. The injection model mechanism will be discussed later in more detail in the manual.

Likewise the filter output goes also through the Transfer component, which handles the saturation of the signal with various settings. However before that, the AGC (Automated Gain Control) takes effect on the gain of the signal compensating the excessive high values shown at the RMS analysis according to its settings.

The signal exiting the Transfer component is also the source of the RMS analysis being used at the Injection and Reaction components. (see the dotted orange arrow lines)

The reaction controls and decides for the AGC actions, using directly the RMS analysis. In a way this is the ear and eye of the system.

Then the signal reaches the routing matrix and as said before the user can use the **Osc Feed Level slider set** of Thermo to adjust the level of each feed signal.

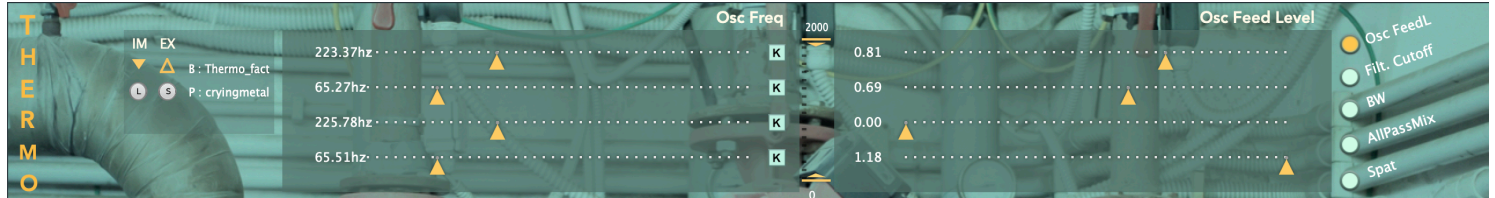
There are 4 Oscillators and each output can be processed with a stereo panner at the last stage. The panner settings can be adjusted with the **Spat slider set** of Thermo.

There are 7 stochastic GENs which can modulate 7 different parameters of each oscillator engine simultaneously.

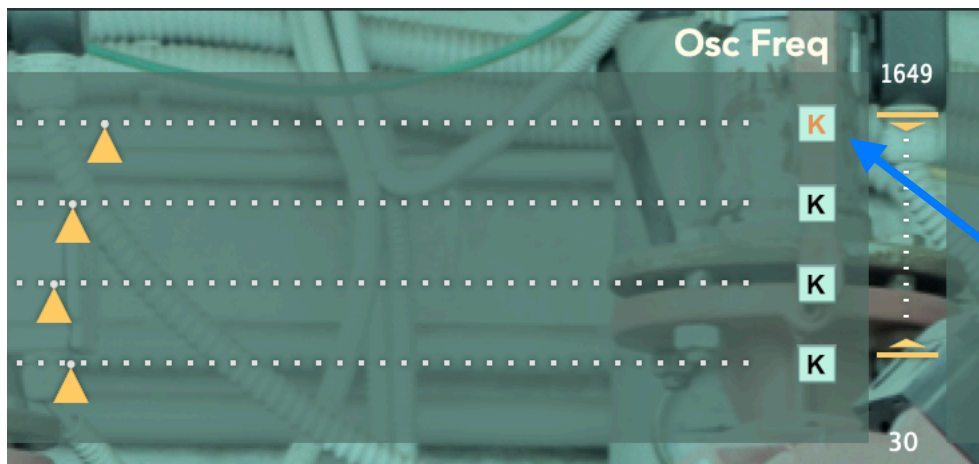
Screen Layout and parts of Thermo

Slider controls :

You can control various parameters of the oscillator and also actions applied to them directly with the sliders arranged on the user interface.



When you look at the upper part of the window, the left section has 4 sliders which are hard wired for the frequency setting of each oscillator.

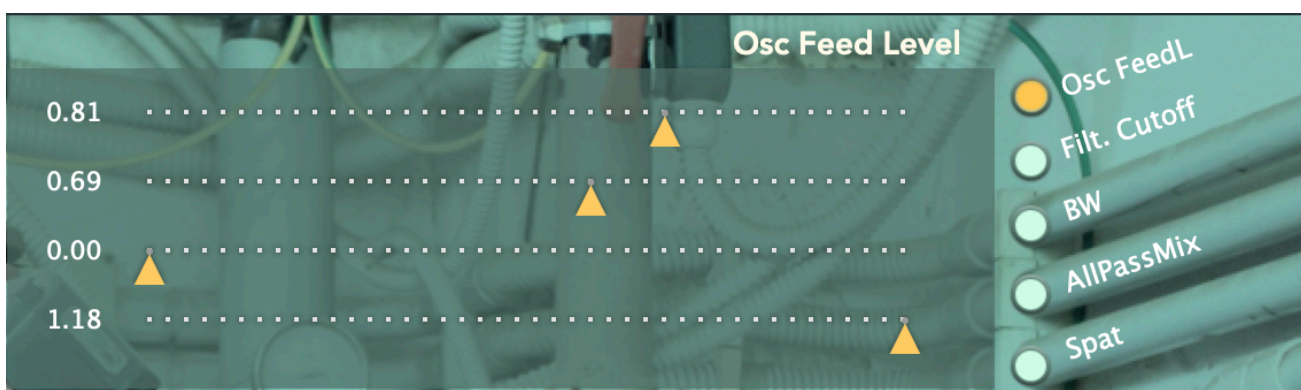


When you click on the “K” buttons, then each oscillator frequency can be assigned with a midi key value pressed on the keyboard.

You can only assign one oscillator frequency with a midi key at the same time.

The midi key should be sent on **midi channel 1** ! (in order not to confuse with MPE layout)

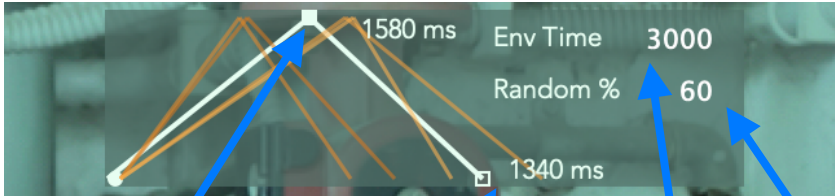
Furthermore, when no "K" button is active, you can still use your midi keyboard to shift all the 4 oscillator frequencies at the same time proportional between the pressed midi key value and the center “C” key (Midi Key 60). Likewise you can choose easily various frequency shifting configurations without destructing the inter relations of your chosen frequency setup; perfect for drone composition !.



The right side exhibits another 5 sliders which you can use to set the **Osc Feedback Level**, **Filter Cutoff**, **BP filter bandwidth**, **All Pass Filters net mix level** and the **Spat stereo positioning** for each oscillator.

Just click on the buttons positioned vertically at the far right to choose which set you would like control.

AR Envelope section :



When Thermo is triggered on or off , it will also trigger the attack and release phases of the Envelopes assigned to the oscillators.

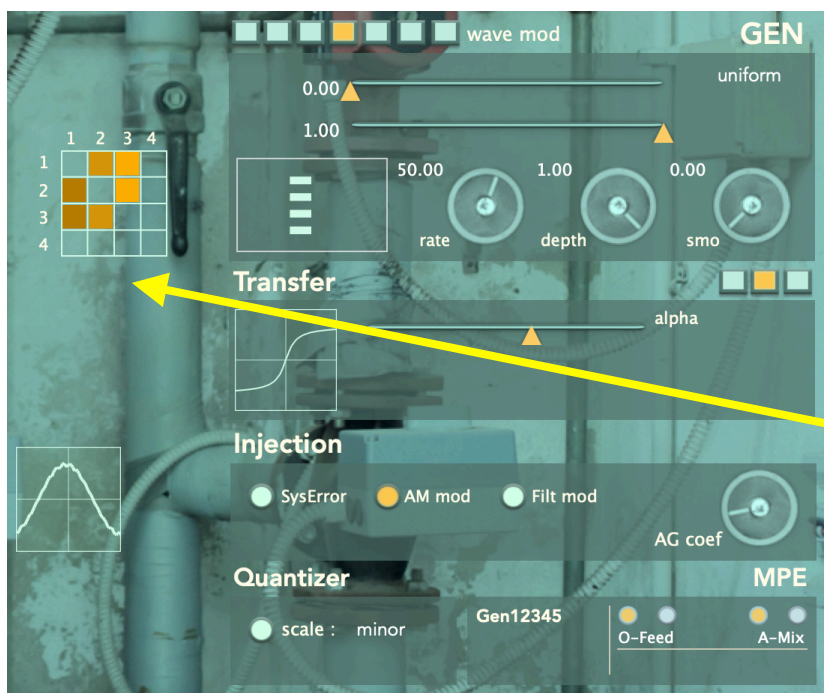
The main settings for the AR Envelope are the **EnvTime** , **Randomness degree**, and the value of **attack duration** and the **release duration**.

You can type in the EnvTime and the Randomness degree on their relevant fields and set the attack duration and the release duration by dragging the envelope corners.

The maximum duration of **attack time** + **release time** can be the amount set on the **Envtime**.

Just like on sonicLAB PaSSBot and Fundamental, there is a randomness which can be applied to each envelope attack and duration of each oscillator. The orange envelope shapes represent the real calculated and assigned values to each oscillator envelopes regarding all these settings.

The envelopes multiply directly the value of the waveform gain of each oscillator.



On the section shown at the left we see the following departments of Thermo|:

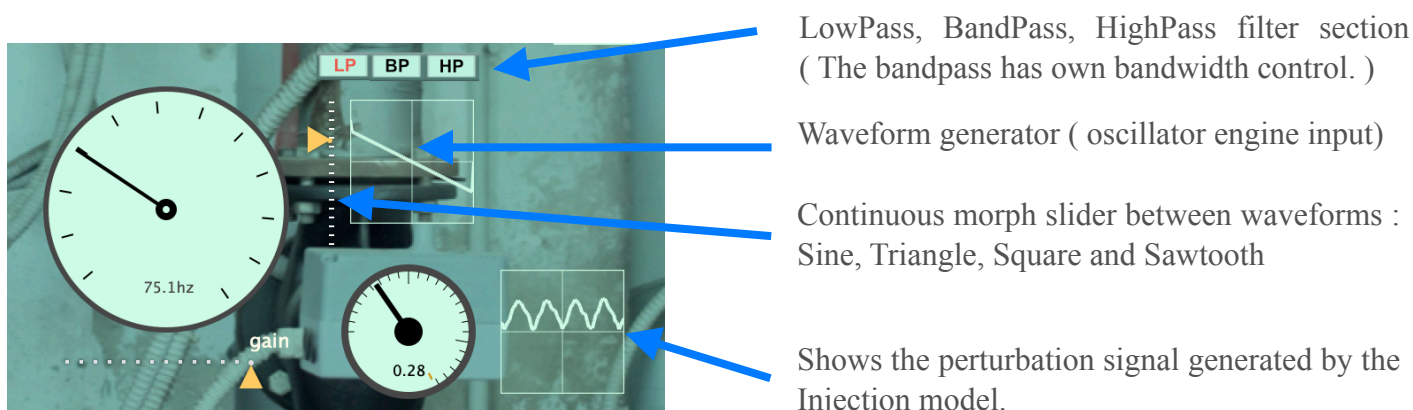
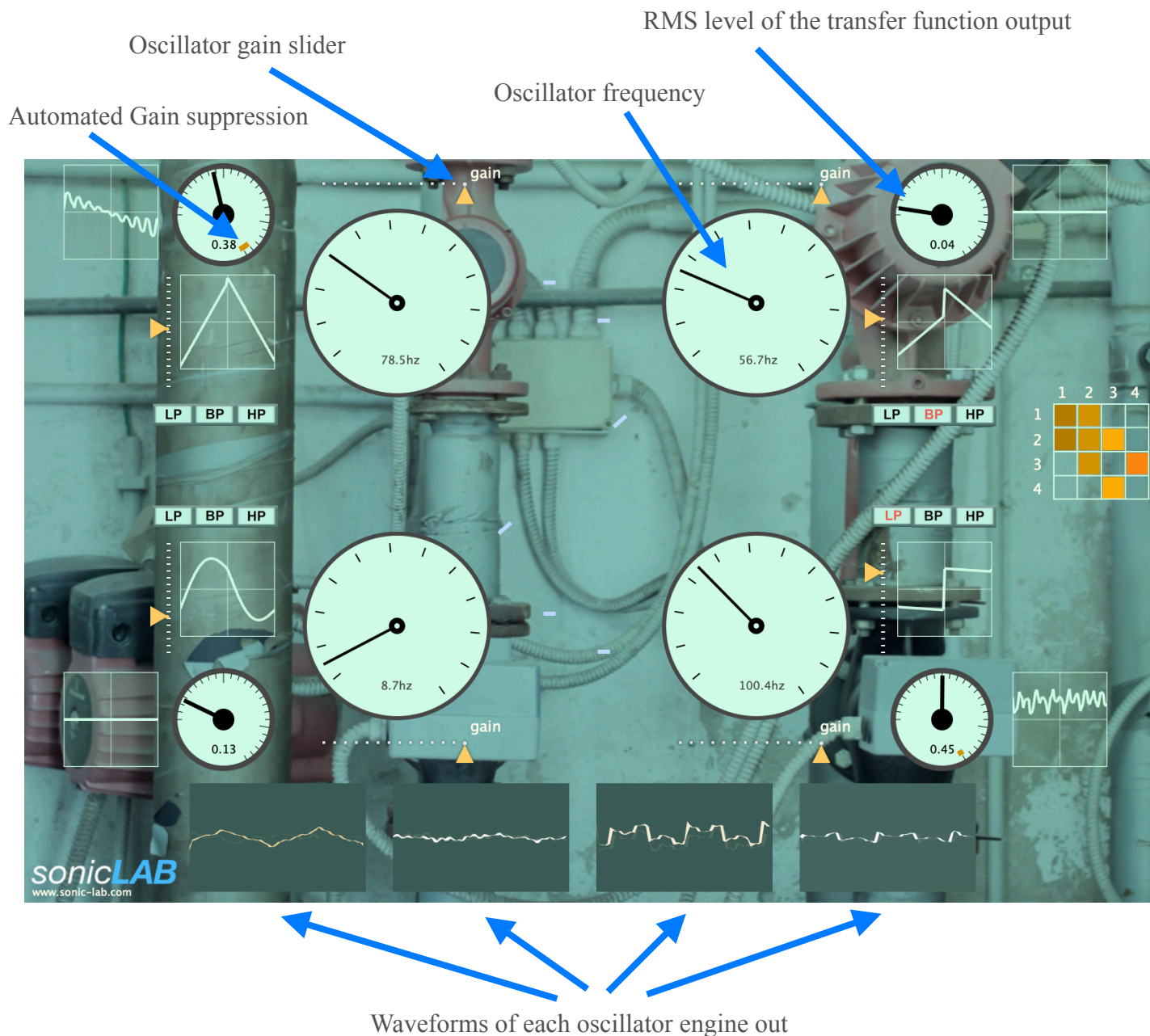
GEN modulation, **Transfer section**, **Injection section**, **Scale Quantizer** and the **MPE settings** section.

These sections have their own pages on the manual.

This signal routing will be shown clearly on the interface with moving arrows between oscillators.

The main engine and its components

This part of the screen exhibits the dynamic content of the Thermo and also offers some control directly to the oscillator.

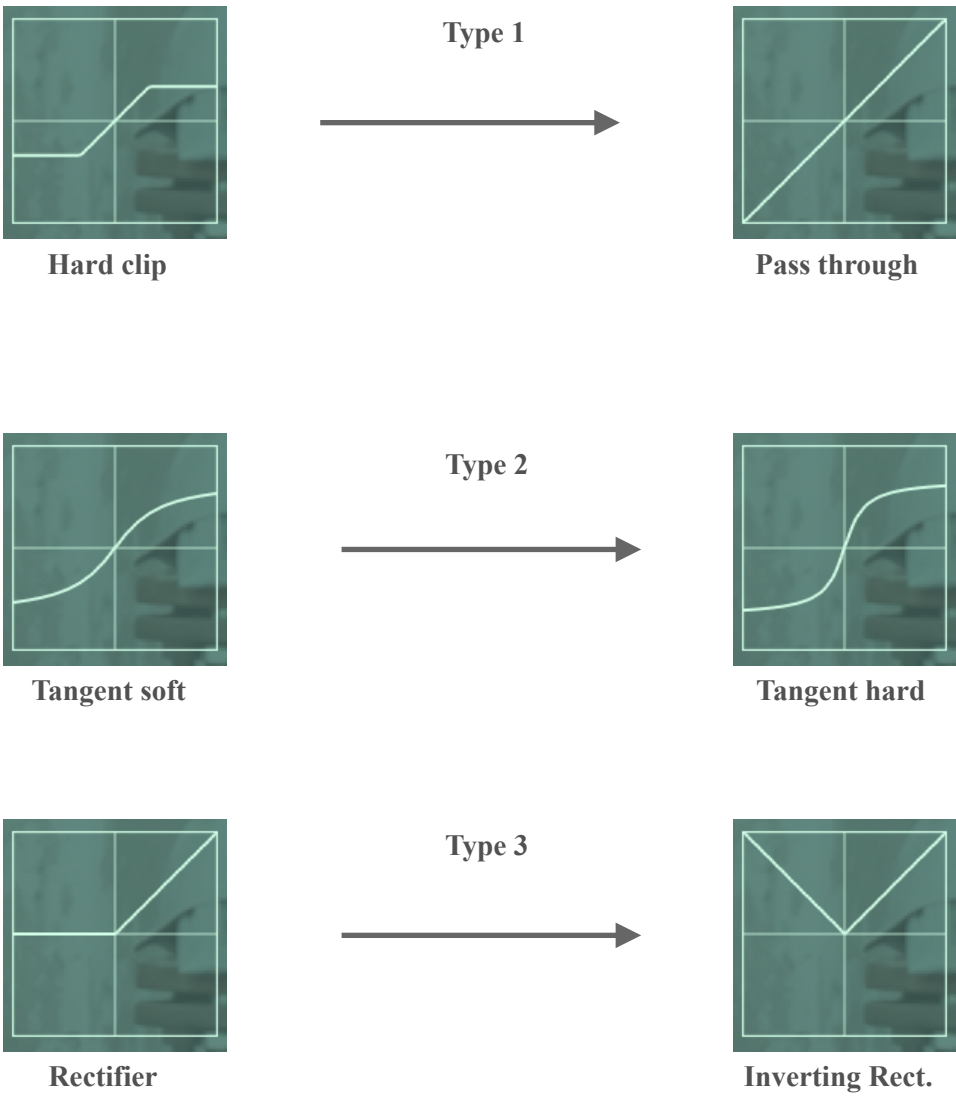


Transfer section :

Transfer is basically a table applied on the input signal for pass through, soft saturation , hard saturation , diode like inverter tasks. This type of mapping will apply non-linear transformation to the input signal and therefore add harmonic content which is not existing in the original signal. (a type of distortion)

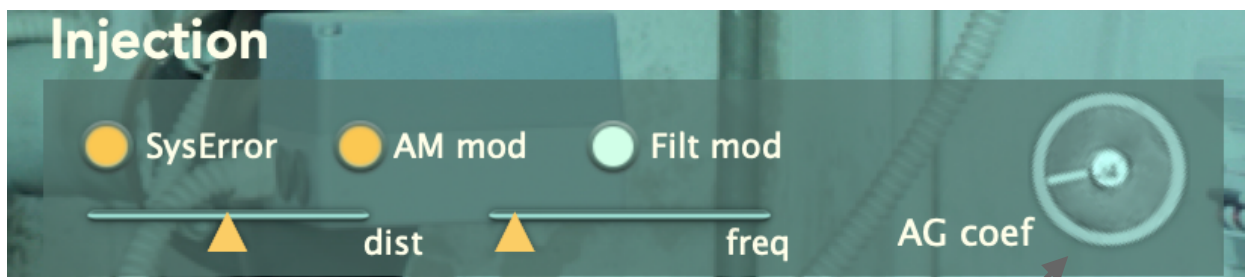
Another way of saying it could be that it is a type of regulator of signal boundaries, deciding at which boundaries the signal should exist.

There are 3 types of tables for this mapping, and a slider serves the degrees or table morph between two extreme states. Below you can see the 3 types of maps and their extreme settings.

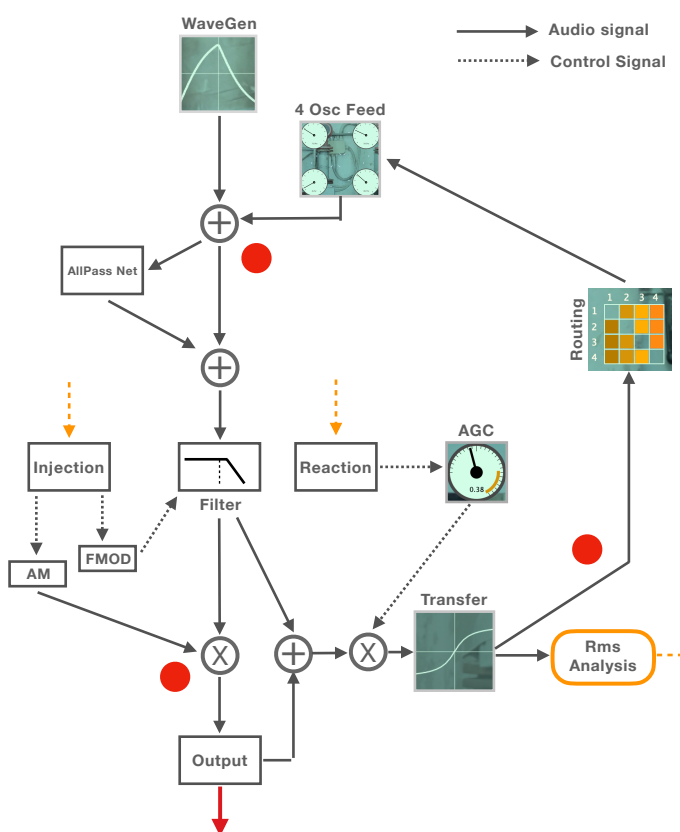


Injection section :

The injection section is basically injecting some perturbations to the existing system dynamics. It reads certain state parameters of the system and releases its actions by using these states. There are 3 different injection types and they can be selected and applied together as well.



SysError:



Thermo realizes an RMS (Root Mean Square) analysis of the signal at the output of the Transfer component. The analysis shows the continuous power change in the signal and will be used on the Injection and Reaction components.

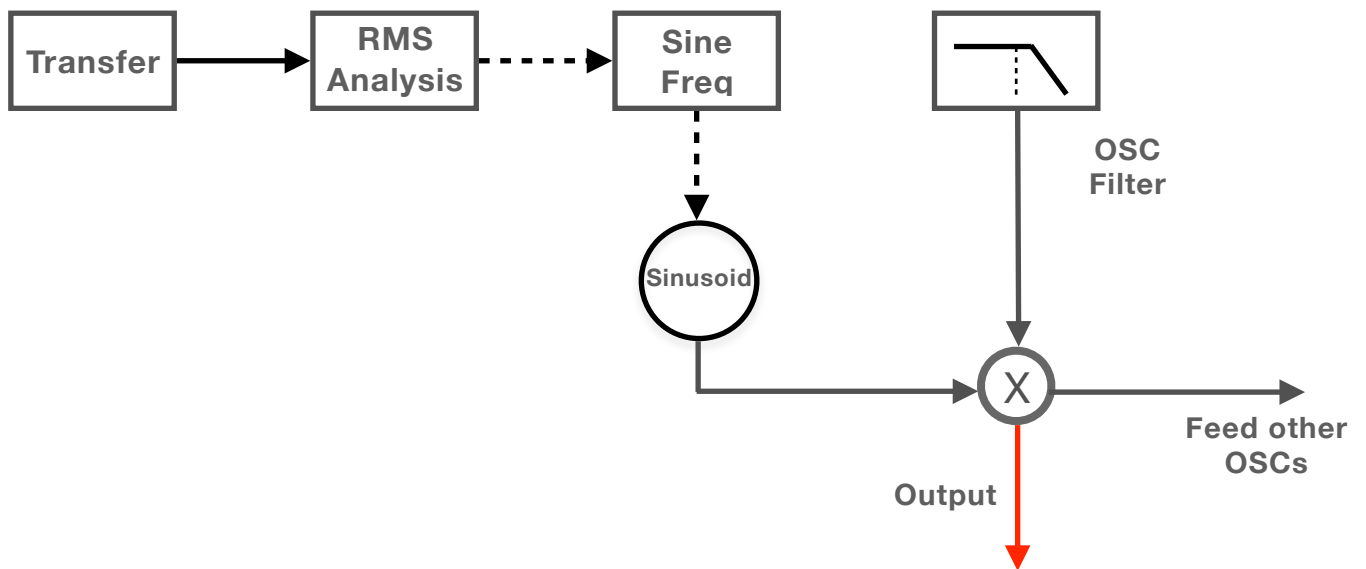
For instance the **AG coef** control is a value which multiplies the gain suppression of the Automated Gain Control component. This component reduces the signal level at the input of the Transfer component according to the reaction calculated with the RMS analysis. So if you want to increase this reaction just increase the AG coef value.

This “**SysError**” injection cuts the signal at 3 different nodes on the signal flow of the oscillator engine. And these cuts on each node happen statistically controlled with a dedicated binomial distribution reminiscent of a light bulb turning on and off randomly. The frequency and the distribution parameter of the SysError has its slider controls.

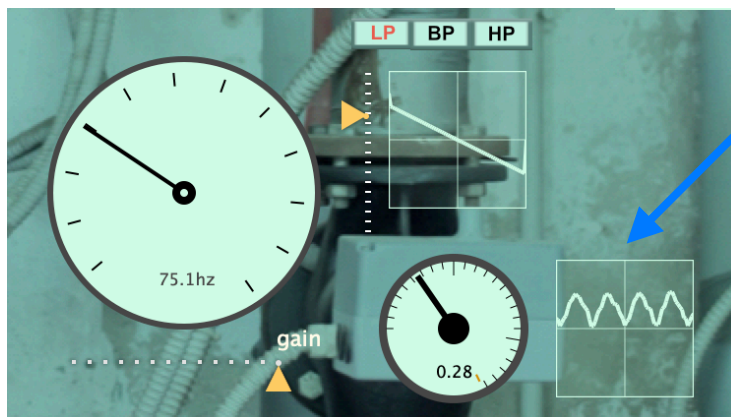
The particular nodes interrupted with this SysError has been shown with red circles on the diagram at the left. Also the Thermo UI has some visual effects presenting these actions.

AM mod :

This injection mode uses the RMS analysis applied on the signal output of the transfer section. The value of the rms value is being mapped to the frequency of a sine wave oscillator which will be used as a ring modulator on the signal of the filters section output. Here is a brief diagram of this signal flow.



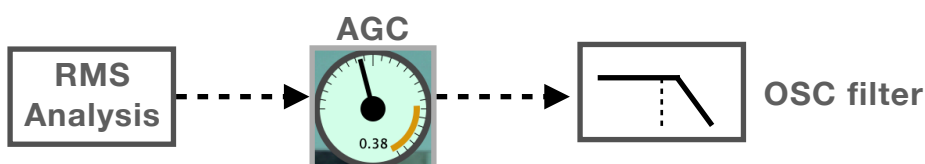
The dry filter output and the ring modulated filter output balance will be set relating to the Rms analysis value. Then this dry and wet sum will be sent as the oscillator output, but also an attenuated version will be fed to other oscillators according to the routing matrix settings.



This window shows the sine wave being used for the ring modulation effect of which frequency is a mapped result of the RMS analysis. The higher the RMS value, the higher the frequency and the depth of the ring modulation.

Filter mod :

The filter cutoff modulation is related to the AGC (Automated Gain Control) value which tries to compensate the rises in the RMS level of the oscillator filter output signal. The higher the value, the lower the filter cutoff frequency; since AGC is a negative value.



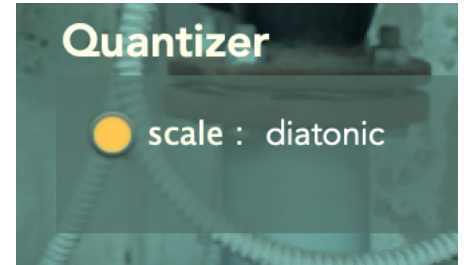
All these operations come back to themselves in some form of systemic change , because these changes are part of a feedback system on the macro level.

Quantizer section :

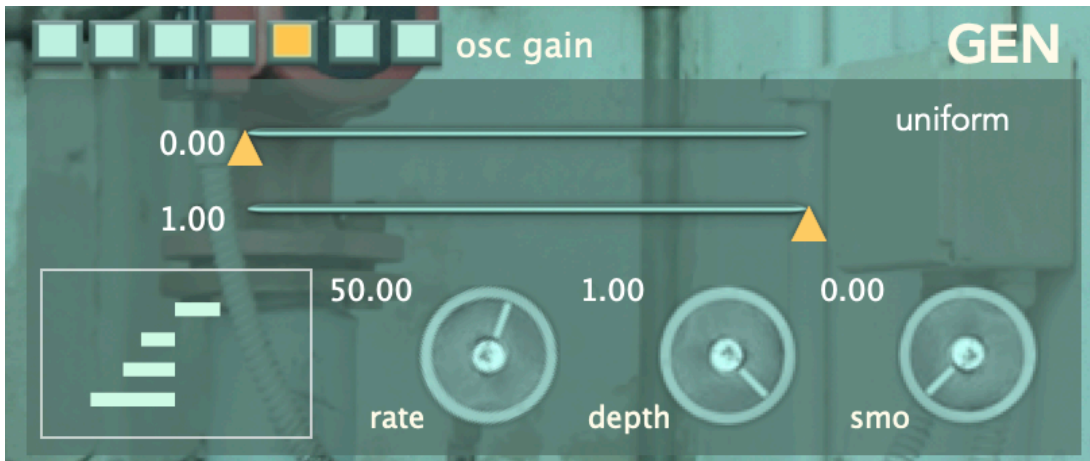
Scala format tuning scales can be imported to Thermo and applied as oscillator pitch quantizers. There are already some example useful scales coming within the Thermo. The existing scala files are located at sonicLAB/Thermo/scl/ directory , and you can put new ones there and the list will update accordingly.

In order to make the tuning scale active, turn it on. Also you need to choose a scale. A pop-up menu will let you choose from the existing scales of Thermo. When you save a preset, these settings will be saved along with.

The reference frequency of the scale is by default 440hz,



Thermo GEN modulation generators



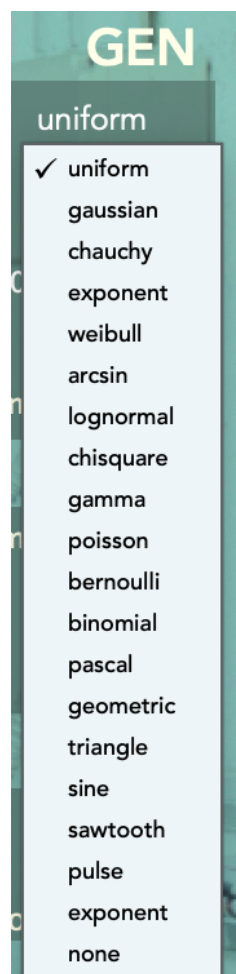
Thermo incorporates 7 continuous modulation generators for each voice with rich stochastic function possibilities called as **GEN**. Their destination is labeled next to the switch area and updated whenever you switch to any GEN. These are hard wired and each Thermo oscillator has its own unique set of stochastic 7 GEN's but the oscillators share the same GEN control parameter values.

Each GEN offers modulation sources with continuous probabilistic distributions, discrete probabilistic distributions and continuous standard waveform functions as listed below. *

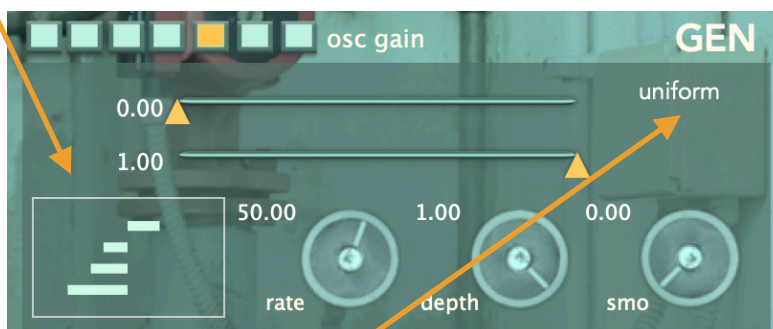
uniform
gaussian
chauchy
exponential
weibull
arcsine
lognormal
chisquare
gamma

poisson
bernoulli
binomial
pascal
geometric

triangle
sine
sawtooth
pulse
exponent



The GEN of oscillator activity can be looked at this dynamic bar display.



For each distribution function selection, the relevant parameter sliders will show up. Some of the functions have one parameter, some two parameters, and some none. Experiment with them !



Each GEN generator has **rate**, **mod depth**, and **smoothing** rotary sliders. The **rate** slider defines the speed of the generator, the **depth** slider defines the mod depth of the generator and the **smoothing** slider sets the degree of softening the rapid changes of the generator function. When the **BPM Lock** mode is on, the **rate** slider shows the speed as note duration values.

*You can turn on / off the **BPM Lock** mode by pressing on the text field.*

The non-stochastic waveform modulation of GEN's are pretty much like a usual LFO. Once again there are $4 * 7 = 28$ independent audio precision GEN's running at all times on Thermo.

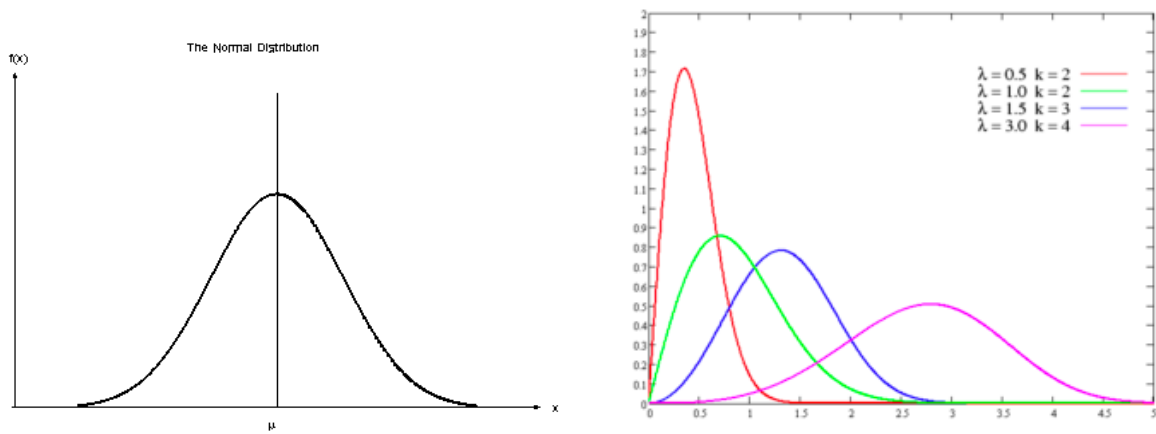
What is a stochastic function / probabilistic distribution ?

Stochastic processes are widely used as mathematical models of systems and phenomena that appear to vary in a random manner. It is a field of statistics, and the term random **function** is also used to refer to a **stochastic** or random process, because a **stochastic** process can also be interpreted as a random element in a **function** space. A type of random function can be modeled with a probability distribution function showing distinctive behavior when distributing the values as its output.

If you flip a coin, both sides have the same probability of showing up, so this can be modeled with a uniform random distribution. For example, if we have a light bulb which goes on and off randomly due to a cable connection failure / electric spark, this is not a uniform random distribution but can be modeled with a poisson distribution. The movement of a mass of molecules in gaseous spaces can be modeled with brownian motion (a random walk).

Most of the stochastic functions have parameters, a value of certain range to change the behavior of the stochastic function. The reason that the **Thermo** offers many types of stochastic functions is to present you different types of 'distribution shapes', which give a distinctive character to the process being used for.

Below, you can see the gaussian / normal distribution and the Weibull distribution shapes (which varies according to its parameters). As you can see, with the normal distribution of events, an x event has a higher possibility to happen towards the centers of the bell shaped curve.



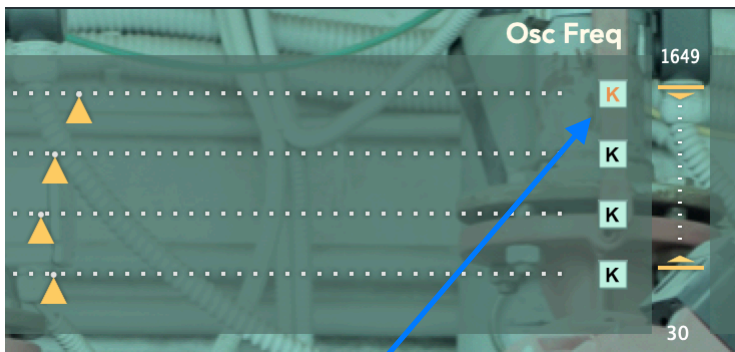
Music is a distribution of events in organized manner and stochastic functions let us control the randomness between order and total disorder. This has been applied heavily in 20th century contemporary music and computer music by the composer Iannis Xenakis *.

sonicLAB products offer similar mechanisms and inspiration in form of modern tools to todays composer / sound designers. We can assign these distribution characteristics to various musical parameters and sound synthesis parameters at various levels. The GEN modulation sources are themselves LFO's which modulate various parameters of the Thermo LFO with a rich palette of stochastic distributions.

Performing the Thermo

Thermo accepts **midi controller messages, midi note on/off messages and MPE messages** to fulfill certain tasks, and applying realtime modulation performance.

Receiving Midi Note On / Off messages



As discussed before you can use single midi key notes sent on midi channel 1 to assign this key value as oscillator frequency.

Click the “K” button of the corresponding oscillator you would like to target, and press a midi key.

When no “K” buttons are selected, pressing a midi key shifts all oscillator frequencies relative to the Midi key value 60 (center C note). The frequency ratios between oscillators are kept.

Again remind that, you have to send the midi note events on **channel 1**.

Receiving Midi Controller messages

Thermo interprets the following midi controller messages:

Midi PitchBend : The value of the pitchbend applies a freq shift to all oscillators while keeping their freq ratio between them in place.

Midi Controller 1 : The value of this CC message defines the glide time of the pitch bend / portamento.

Midi Controller 64 : This acts like a switch controlling the Trig button of Thermo.

Midi Controller 26, 27, 28 , 29 : These messages are translated as switches which control MPE destinations (will be discussed below)

Receiving MPE messages

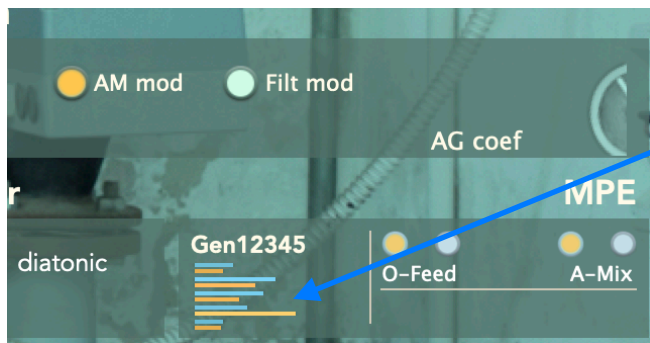
MPE is indeed a multichannel extended configuration built up with existing MIDI messages. Ideally performed with an MPE controller, still you can configure your work platform to configure these messages and send to Thermo for realtime performance.

Below is the list of MPE message and actions which you can use within Thermo :

There are two groups of MPE Keys as defined below :

First group : G2, A2, B2, C3, D3 addressing the Thermo **GEN** modulators 1 2 3 4 and 5.

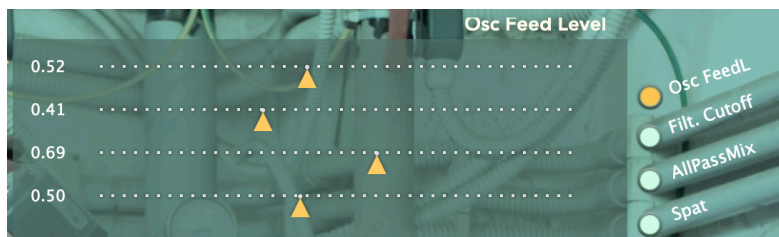
While performing on these keys, the Y axis (Midi **CC74**) will control the GEN modulation depth value of the related GEN, and the pressure (Midi Aftertouch) will control the GEN rate value of the related GEN modulator.



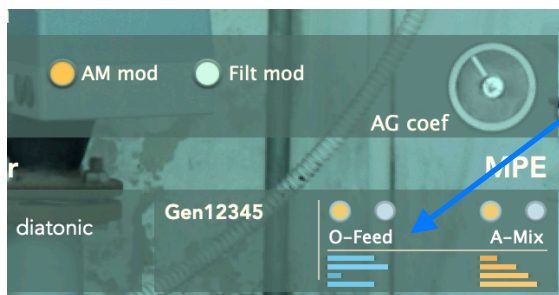
These MPE messages can be seen at the left part of the MPE section on Thermo interface.

The blue lines indicate the MPE Y axis values and the yellow lines indicate the MPE pressure values of the pressed keys.

Second group : E4, F4, G4, A4 addressing the Thermo sliders for assigning direct values to Oscillator Feed Level, Filter Cutoff Freq, Oscillator Waveform Morph and AllPass net mix values.



For this to work, you have to choose the destination group to be modulated on the right side panel of the MPE section. Let's give the example case below;



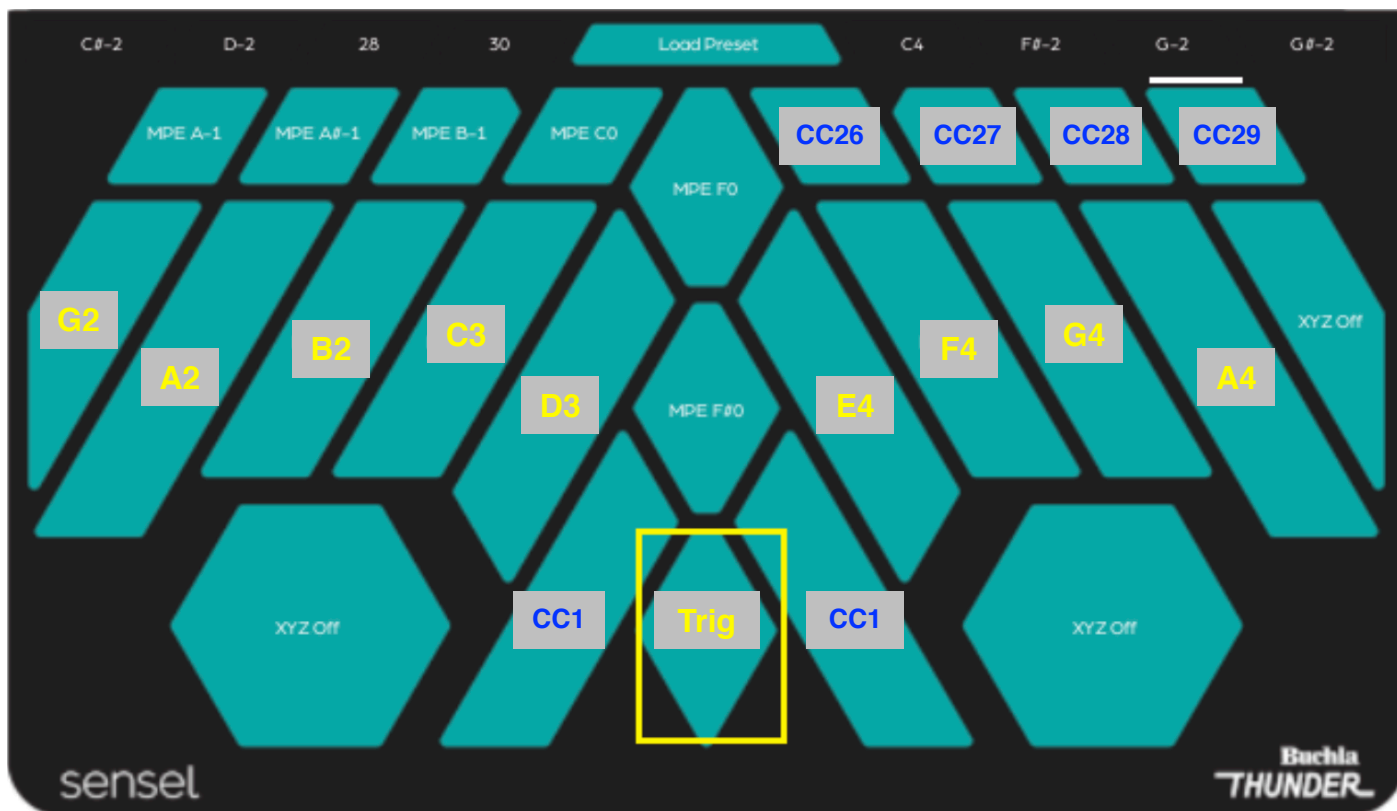
This MPE key group (**e4,f4,g4,a4**) is assigned to send the Y axis (**CC 74**) controller messages to control each oscillators O-Feedback level value. Again the blue lines indicate the Y-axis messages.

The same group controls as well the A-mix destination (AllPass net mix) but with the MPE pressure messages as indicated with the yellow lines.

By selecting the destination for the MPE key and using both the Y axis and MPE pressure continuous controllers, you can send a significant amount of performance data to Thermo, and become a part of its sonic interaction. The destinations you can quickly select also by sending Midi **CC26, CC27, CC28** and **CC29** messages.

Just like for the sonicLAB Fundamental, we have created a ready to use map for Sensel Morph Thunder Overlay to communicate directly with Thermo.

The map file can be downloaded [here](#). Please import it the Sensel Morph and select/load preset 9.



Basically you can use any other MPE controller given that you respect the CC and MPE note numbers to control Thermo.

To remind you again, the MPE midi note events are serving to address specific GEN modulators and slider sets on Thermo control space. They are not for frequency assignment. For this purpose you can still use your MPE midi keyboard but should send these midi note messages on channel 1.

Other CC messages

When using Thermo on a DAW, you can assign custom CC to the parameters of Thermo. However the ones mentioned above are coded direct. So please choose other CC numbers to control the parameters you wish.

High precision Midi control on Thermo with Rotary encoders

Thermo incorporates special handling of encoder style Rotary Midi CC knobs, and therefore it can map the incremental motion of this type of knob to high resolution oscillator frequency and gain values.

A Rotary encoder is an electro-mechanical device that converts the angular position or motion of its shaft to analog or digital output signals. Rotary encoders are used in a wide range of applications that require monitoring or control of industrial systems including robotics, computer input devices (mouse / trackball), many types of rotating platforms such as wind turbines etc.

There are two main types of rotary encoder: absolute and incremental. The output of an absolute encoder indicates the current shaft position, making it an angle transducer. For instance it gives an absolute value based on its angular position. (a value of CC 0-127 for example in MIDI case.)

The output of an incremental encoder provides information about the motion of the shaft, which typically is processed elsewhere into information such as position, speed and distance. Therefore it produces a certain value immediately when moved clockwise or anti-clockwise by stepwise interpretation of the movement.

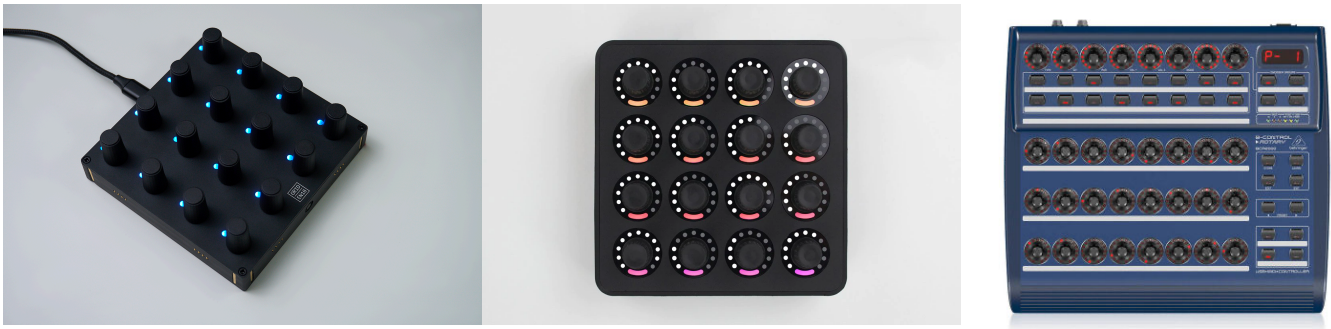
Rotary encoder equipped MIDI controllers exist since a while on the market. For example, DAW controllers and desktop digital mixing consoles have incorporated this type of encoders well for modulating parameters such as track level, panning etc. The photo on the right shows a Mackie DAW controller with 32 Rotary Encoders, and each knob has a led display around it showing the absolute value of its dedicated parameter destination.

The advantage of these endless rotary knobs is that they act relative to the current state (or last recalled preset) of the parameter which they do control. The motion of the knob creates a relative value based on the stepwise incremental / decremental motion of the knob and this adds up to the last recalled state of the parameter.

This is a convenient non-destructive editing method, which is not possible with an absolute standard 0-127 Midi CC controller.



Today, on the market one can find several rotary encoder style midi controller units not just dedicated as DAW controller but for general purpose usage. To name a few the Intech EN16, Midi Fighter Twister, Behringer BCR2000 etc.



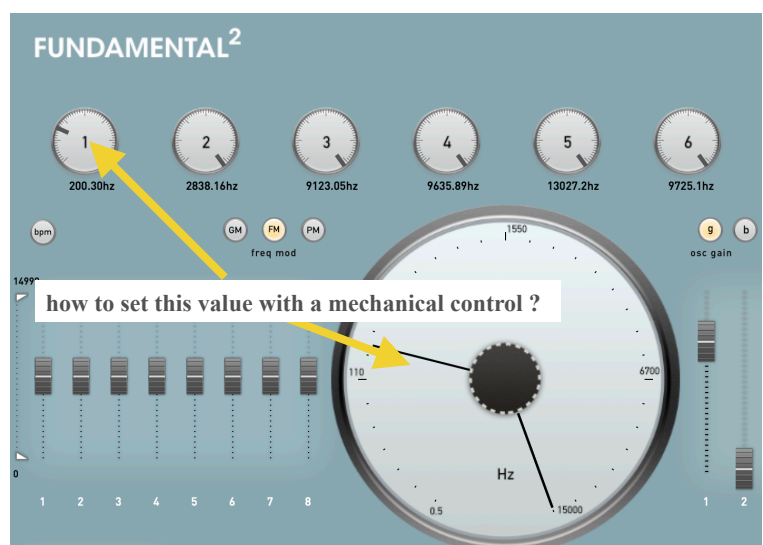
* We are not affiliated business-wise with any Midi Controller device producer. There are different units in price / quality on the market.

Why choose a Rotary Encoder control for Thermo ?

Thermo is a self organizing generative synthesizer of which sound parameters are very sensitive to changes.

The sonic quality of the oscillator varies according its frequency and also the gain, feedback and other settings.

On its user interface one can set the parameters with relevant sliders or assign a midi controller on the DAW to control this parameter.



Standard Midi continuous controller data ranges between 0-127 integer values (7bit resolution) There is no way to address the frequency value range of the Thermo oscillator (1hz - 15000hz) with this range of modulation data.

Standard Midi controller access is destructive. Imagine a Thermo preset; all the frequency and gain settings of each oscillators matters to achieve its beautiful interference between sine waves and the emergent sonic quality of the generative engine. But when you touch a midi controller, its current absolute value will jump the current setting on the Thermo oscillator, which is not what we ideally prefer.

It is not feasible the invent a custom communication method and build a dedicated hardware for this, and yet we need to still use Midi and existing hardware to achieve this.

What did sonicLAB achieve ?

- Therefore sonicLAB has decided to create a high resolution frequency mapper which utilizes the data coming from on an incremental endless Rotary encoder knob. And we succeeded reaching the entire frequency range of the Thermo oscillators with one knob motion and with a **1hz** resolution. !
- There remained another problem, since each product on the market can send different Midi CC messages based on the direction of the knob motion. For example one product sends Midi CC 64 when the knob is being turned clockwise on each step, and Midi CC63 when anti-clockwise. Another product sends Midi CC127 and Midi CC0 for the same motion directions.
- What sonicLAB has achieved is a behavior agnostic to these values, which adapts itself with a simple twist. You just need to move the knob shortly in both directions and that's all, the message of the knob is captured.

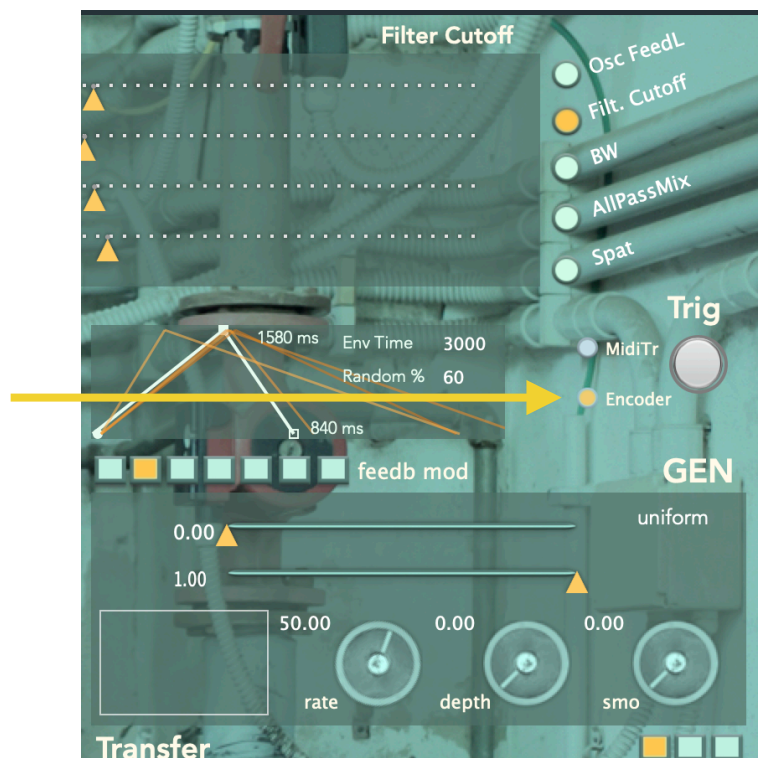
implementation on the Thermo synthesizer

You have purchased a rotary encoder Midi controller and connected it to your computer.

Be sure that Thermo receives it either from the DAW channel or your controller is selected as the input device on the standalone Thermo.

click on the **Encoder** button so that Thermo can receive the Rotary Encoder messages and interpret them.

You can control the frequency, the gain, feedback and filter cutoff values of each of the 4 self organizing oscillators on Thermo with a Rotary encoder.



The relevant CC numbers to control these parameters are hard coded. And here is the list:

Midi CC 32-35 corresponds to Osc1-4 frequency parameter.

Midi CC 36-39 corresponds to Osc1-4 gain parameter.

Midi CC 40-43 corresponds to Osc1-4 feedback parameter.

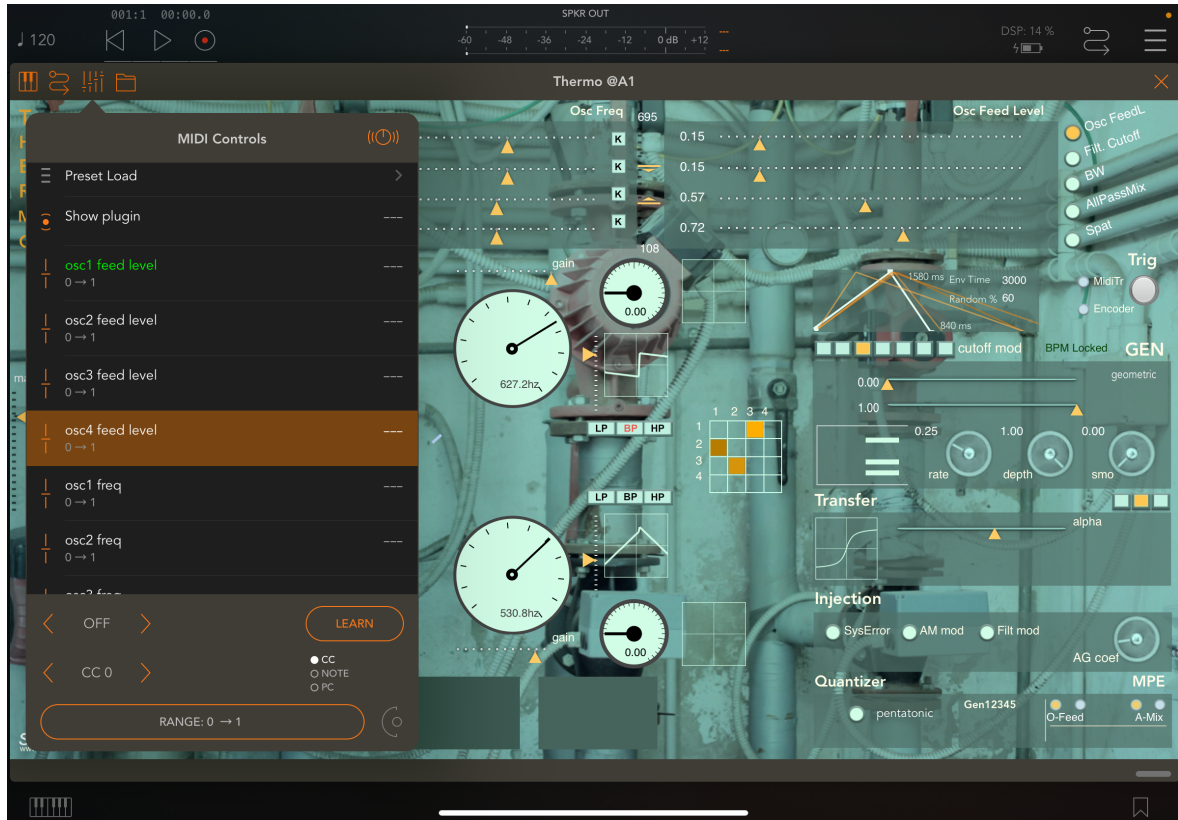
Midi CC 44-47 corresponds to Osc1-4 filter cutoff parameter.

Remarks on the use of Rotary Encoder control on Thermo

- Each step (incremental or decremental) of a Rotary Encoder movement will achieve a **1hz** relative change on the Oscillator frequency / filter cutoff and an amount of **0.01** change on its gain / feedback level. This kind of frequency resolution is never achievable with a standard CC0-127 control.
- We advice to avoid rapid jumps on the Rotary Encoder movement. This implementation is meant to focus on fine movements and fine adjustments of the destination parameter. sonicLAB has implemented adaptive **motion -> freq scale mapping** and higher rotation speeds also maps to faster step intervals in an intelligent way. However the Rotary knobs mechanically won't comply to same results when rotated fast. This depends on the hardware quality and there is not much to do on the software side to fill these gaps.
- A useful analogy would be the use of mechanical mouse / trackballs during 90's (before touch pads) where one could not precisely know the advance of the mouse pointer when moved fast. Slow movements were always more predictable. Therefore when you rotate the Rotary knobs fast, the jump on the destination value will vary.
- sonicLAB implementation aims to adapt to any Rotary encoder whatever CC value it sends for its incremental and decremental change. However there is the logical restriction that the CC value of an incremental change (a clockwise rotation step) has to be higher then the value sent when there is a decremental change (a anti-clockwise rotation step) . When this condition is fulfilled, any Rotary Encoder will work within our implementation.
- First test the standalone version of Thermo with your Rotary encoder controller. When confirming that it works, you can test it in your DAW. Every DAW has different midi port input / output handlings , and we cannot know and test each DAW. This is why that it is important your test first outside a DAW with the standalone version.
- First time you touch a Rotary encoder knob to control a parameter on Thermo, apply a little twist back and forth on the knob so that the CC values for the incremental and decremental motion becomes evident to the software.

Automation in DAW with Thermo

DAW's deliver automation editing for plugin parameters on each track. And it is possible to automate each parameter of the Thermo. Below is a sample screenshot of Thermo on AUM.



It is also possible to assign a MIDI controller to every available parameter to extend your live interaction possibilities. This is only possible

