neuzeit
INSTRUMENTS

Quasar

Manual

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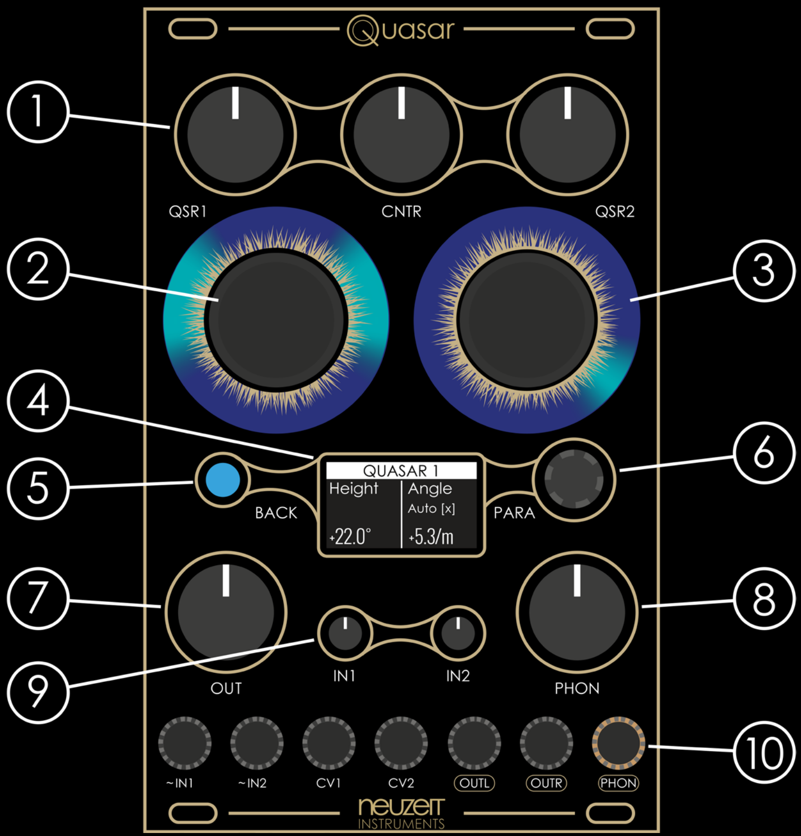
Content

Module overview



A **QUASAR*** describes the combination of:

- position
- room reverb
- internal LFO

The module features two independent Quasars **QSR1** and **QSR2**.
There is also a center position corresponding to the unprocessed signal, abbreviated **CNTR**.

1. Volume knobs for the outputs of Quasar 1, 2 and center position.
2. Aluminium encoders to set parameter values. Pressing while turning changes from coarse to fine values.
3. LED rings to indicate the parameter value, including modulation by internal LFOs and external CV mappings.
4. Display to show menu content and parameters.
5. Menu navigation button, step one level back.
6. Menu navigation encoder, turn to scroll through pages and push to enter submenu.
7. Master volume for audio output OUTL and OUTR.
8. Master volume for headphone output PHON.
9. Input gains of IN1 and IN2.
10. 3,5" jacks for

    - Audio inputs **~IN1** and **~IN2**
    - Control voltage inputs **CV1** and **CV2**, range +-5V
    - Audio output **OUTL** (left) and **OUTR** (right)
    - stereo jack **PHON** for headphones

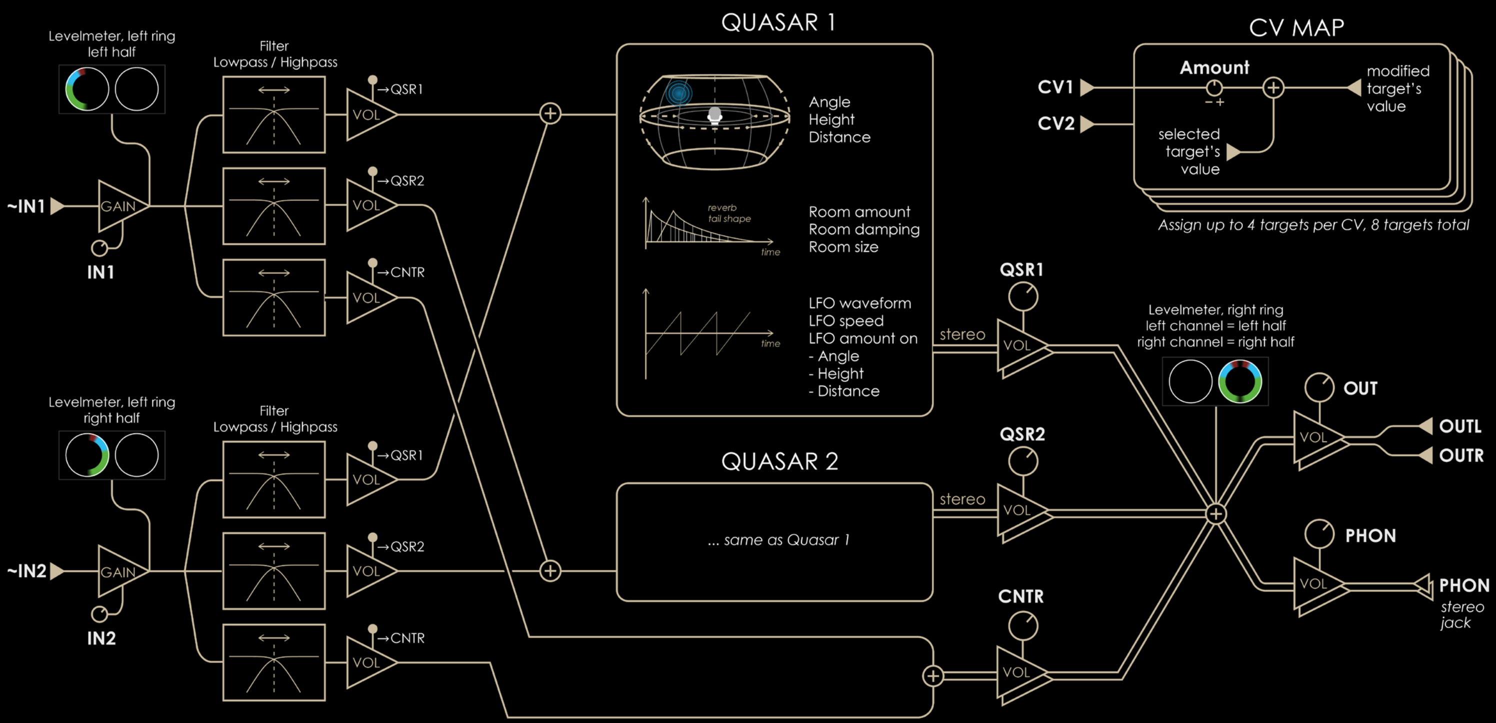
** Actually, a quasar is an extremely luminous active galactic nucleus powered by a supermassive black hole. Quasars are also used for navigation through the cosmos. But most of all, they look really cool.*

Navigate through the menu with the **PARA** encoder and the **BACK** button.
A push on the PARA encoder invokes the selected menu. Turning the PARA encoder scrolls through the pages of the menu. A push on the BACK button exits the menu.
The function of the large aluminium encoders depends on the currently selected menu. Turning the encoders changes the corresponding values.

Note:
Turning an encoder while pressing it changes the selected values in a fine resolution. Turning the encoder without pressing it changes the corresponding value in coarse steps.

Signalflow

The diagram below can also be found on our website in high resolution.



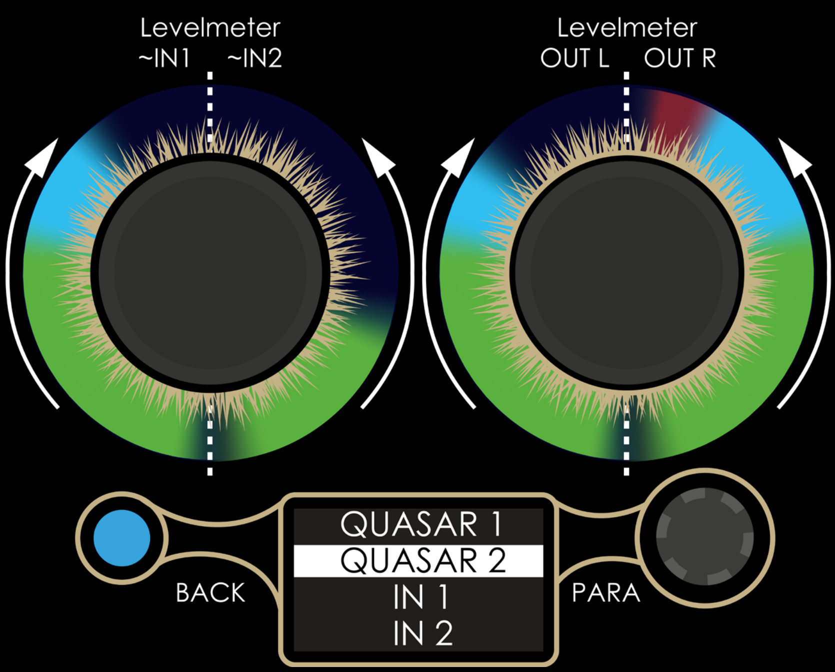
Quasar accepts audio signals via its input sockets ~IN1 and ~IN2. The gain of the respective input is set with potentiometers. The input signals are each distributed to Quasar 1, Quasar 2 and the center position via separate high/low pass filters and internal volume controls. The operation is the same as a matrix mixer.

Quasar 1 and 2 convert their mono input to binaural stereo signals. Both the coordinates from which the sound seems to come, as well as the reverb parameters and the internal LFO modulation are flexibly adjustable.
Likewise, the input signals are mixed to the left and right output channels without binaural signal processing, only high/low pass and volume adjustment. The position perceived here corresponds to the center, the sound seems to come from inside the head.
The volume mix of Quasar 1, Quasar 2 and the center position CNTR is adjusted with the potentiometers on the top of the module. Their sum is routed to the OUTL/R output jacks and the PHON headphone jack, whose volume can also be individually adjusted with the corresponding potentiometers.

In the chapter „*Get the most out of Quasar*“ you will find more advice on how to achieve the best results.

Volume meters

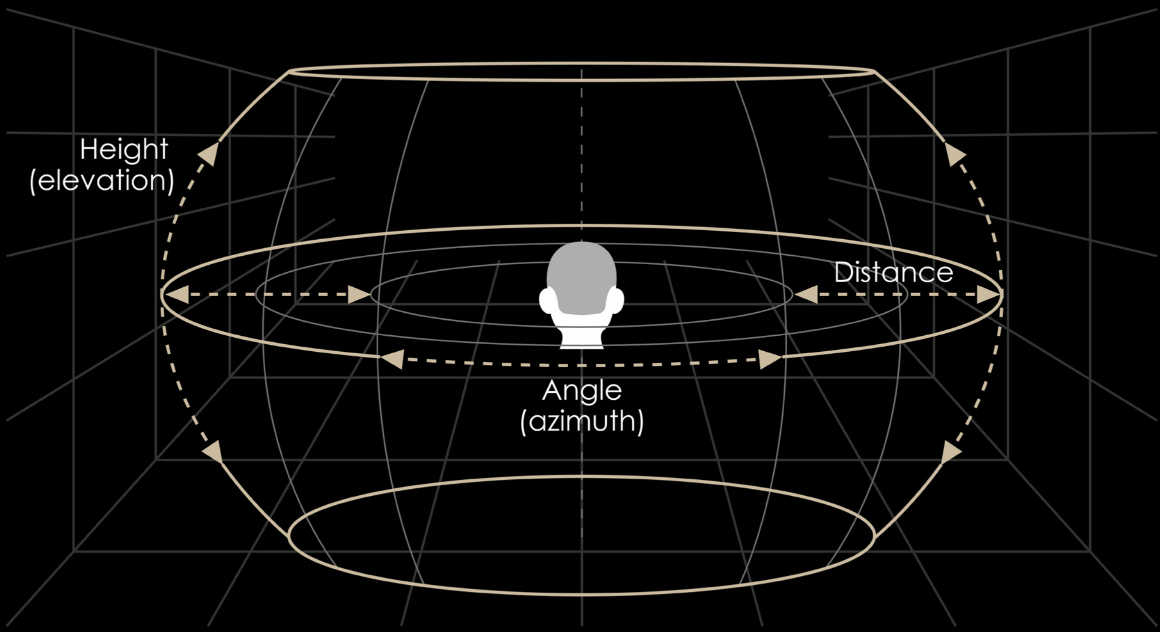
In the main menu, turning the PARA knob selects one of the submenus and pressing PARA calls up the respective submenu.
The LED rings indicate level meters for the audio inputs (left ring, post-gain control) and outputs (right ring, pre-OUT/PHON control).



Try to keep the signal level of input and output always in the blue range. A too low level, which never leaves the green area, might carry more noise than neccessary. Adjust the signal level with the IN1/2 gain knobs accordingly.
Use the volume knobs QSR1, QSR2 and CNTR for the output level. Also internal volume parameters can be used to achieve well balanced output levels.
A too high level for both input or output is indicated by the red area of the level meter and can lead to clipping and a distorted signal.

Coordinate system

Quasar works in polar coordinates. This means that the location of a virtual sound source is specified by the angle in the horizontal plane (azimuth), the angle in the vertical plane (elevation) and the distance to the listener's head. Polar coordinates are an alternative to cartesian coordinates where locations are specified by XYZ axis. The way Quasar's algorithm is built, polar coordinates lead to better sound quality and are also the more natural way to move sound sources around the head.



Menu structure

Quasar's menu structure is flat and easy to understand. Also, every LED ring color combination is unique for each menu, so that display reading reduces to a minimum when you know the module well.

NOTE:
The display always shows the value you set for a parameter. The LED ring shows the same value plus any modulations by the internal LFO or external CVs.
With modulation, the highlighted LEDs are moving while the display shows a constant numeric value.

QUASAR 1/2
- Height | Angle
- Distance | Room reverb amount
- Room damping | Room size
- LFO Waveform | LFO Speed
- LFO Amount Height | LFO Amount Angle
- LFO Amount Distance | Special Actions

IN 1/2
- Filter | Volume
- ... same for destinations QSR1, QSR2, CNTR per input

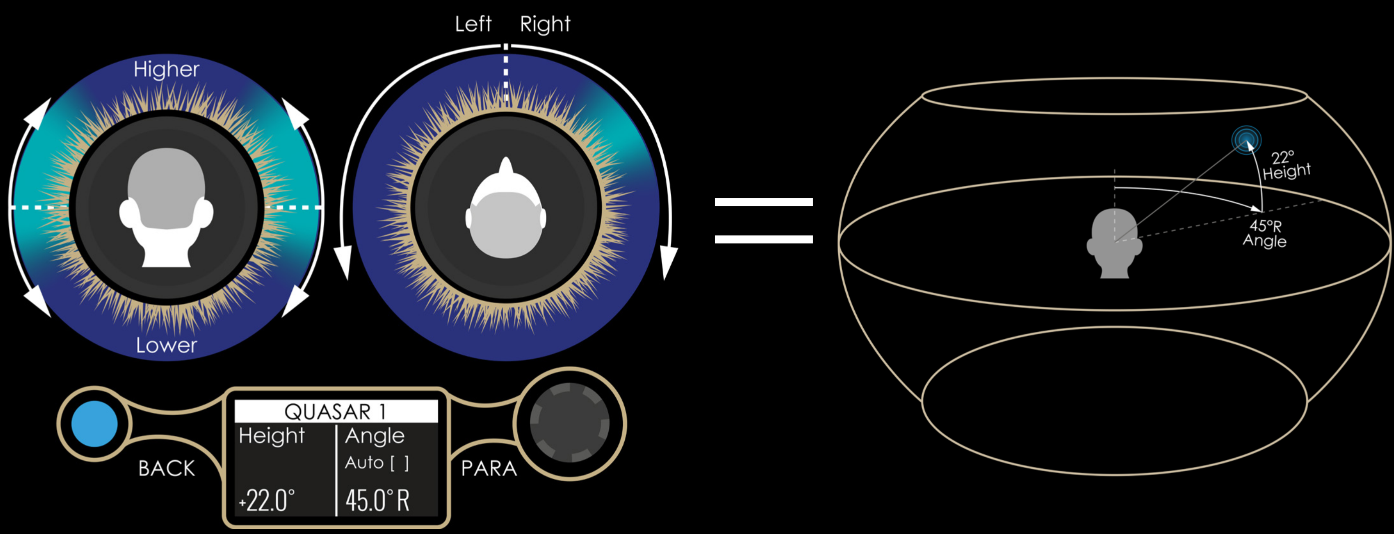
CV 1/2 MAP
- CV Target | CV Amount
- ... same for Target 1-4 per CV

MORE
- Save Preset
- Load Preset
- Bypass
- Ear Type
- Brightness
- Calibrate CVs

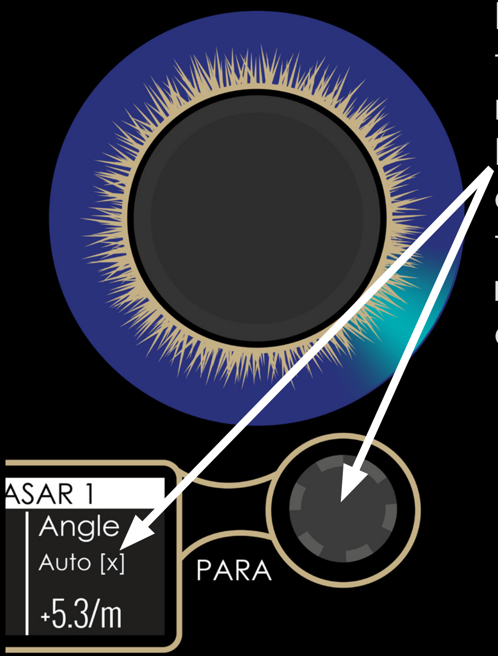
Quasar 1/2 - Height | Angle

The left encoder determines the **Height** of the sound source by changing the elevation in a range from -30.0° to +45.0°. The sound thus appears to come from above or below. The turquoise LEDs visually indicate the elevation. Highlighted LEDs on the upper half indicate a positive value, meaning the tone appears to be coming from above, while highlighted LEDs on the lower path indicate negative values, meaning the tone appears to be coming from below.

The azimuth **Angle** is set by turning the right encoder. It can be set within a range of 180.0° to the left and right of the listener's head. Here, 0.0° means that the sound is coming directly from the front. In this case, the highlighted LEDs are located at the very top of the ring.



If the marker is turned to the bottom of the ring, the sound comes to the head from behind. If the marker is on the left or right side of the ring, the sound comes from the left or right side, respectively. You can imagine that the LED ring describes the possible path along which the sound source can move when the listener is viewed from above.



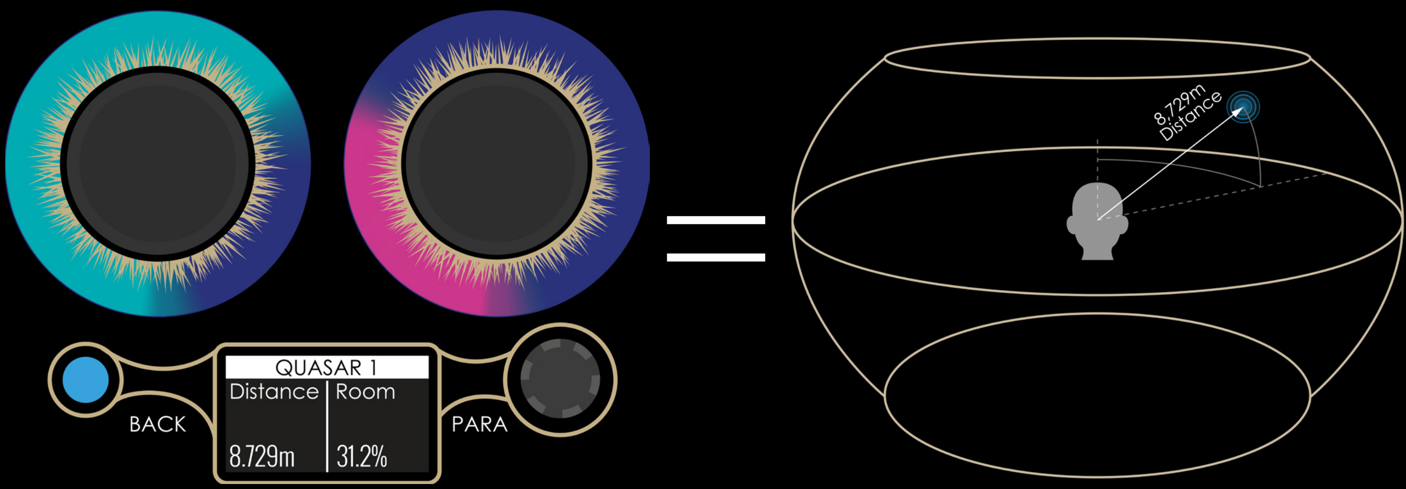
For the azimuth **Angle**, there is also the possibility to activate automatic constant rotation (**Auto** mode).

Push the PARA encoder to switch Auto rotation on or off. Note, that the display now shows the rotation speed in rotations per minute („ /m“). The LED ring still shows the absolute position of the azimuth angle.

NOTE:
Auto rotation changes the actual angle and is not a modulation „on top“. Instead, when de-activating Auto mode again, the actual azimuth angle has changed. Alternatively, an LFO with an amount of +/-100% and Ramp waveform could be used for a constant rotation as well.

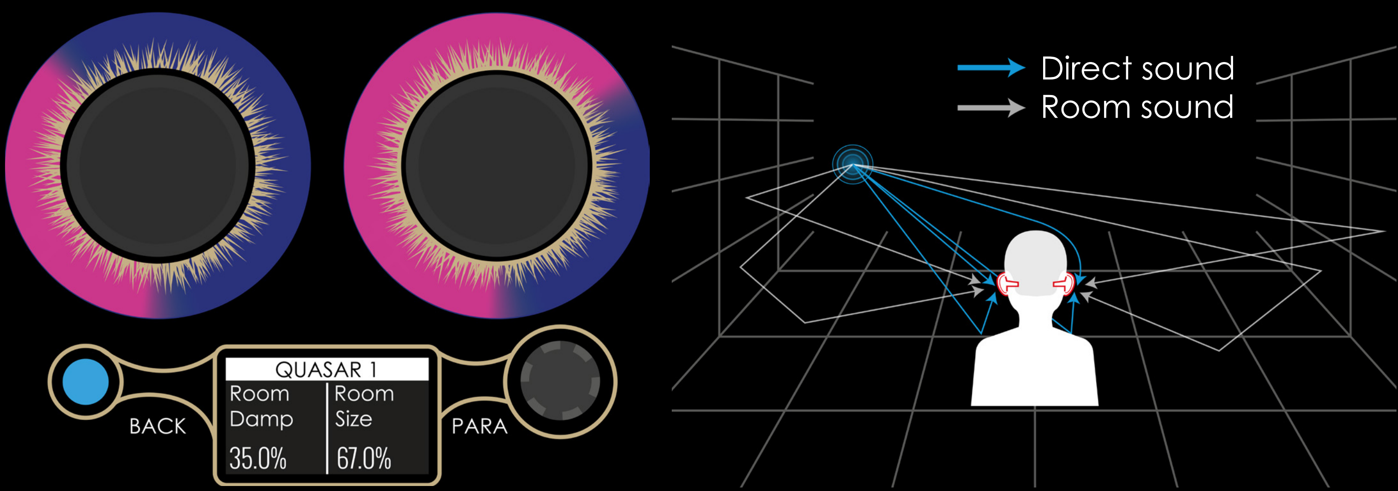
Quasar 1/2 - Distance | Room reverb amount

This menu is used to set the **Distance** of the virtual position of the quasar on the left side and the amount of reverb of the emulated **Room** on the right side. The distance ranges from 20.0 centimeters up to 10.0 meters, while the room amount can be set between 0% and 100%. Room reverberation is an important cue for distance estimation by human hearing. Therefore, distance judgement might improve when applying a little reverb to the signal.



NOTE:
Distance also changes the volume of the audio signal. The closer a sound source is, the louder it is perceived.

Quasar 1/2 - Room damping | Room size

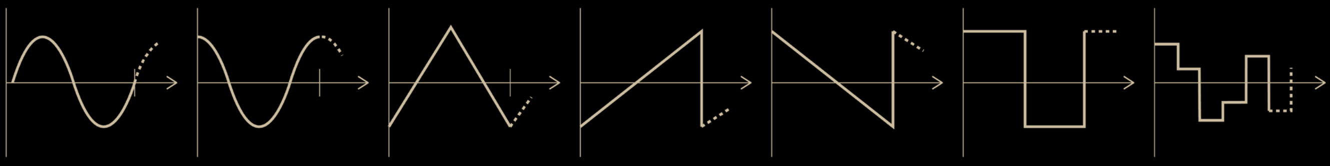


This menu sets two parameters of the reverb: The **Room Damp**ing on the left, which determines the attenuation of high frequencies in the reverb tail, and the **Room Size** on the right, which determines the length of the reverb tail. Both values range from 0% to 100%.

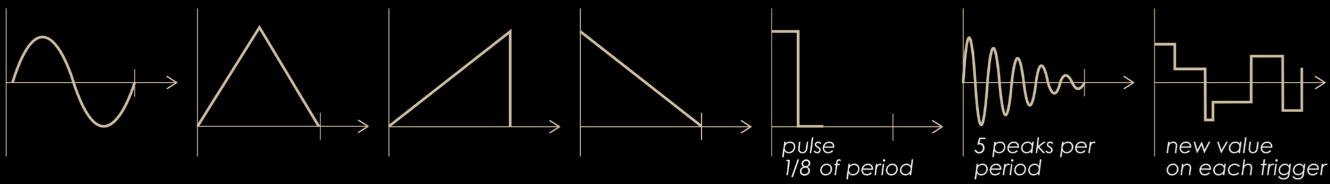
NOTE:
Sound waves travel from their source directly to the body where they are refracted at the torso and auricles. Room reflections arrive at the ears with a slight time delay.

Quasar 1/2 - LFO Waveform | LFO Speed

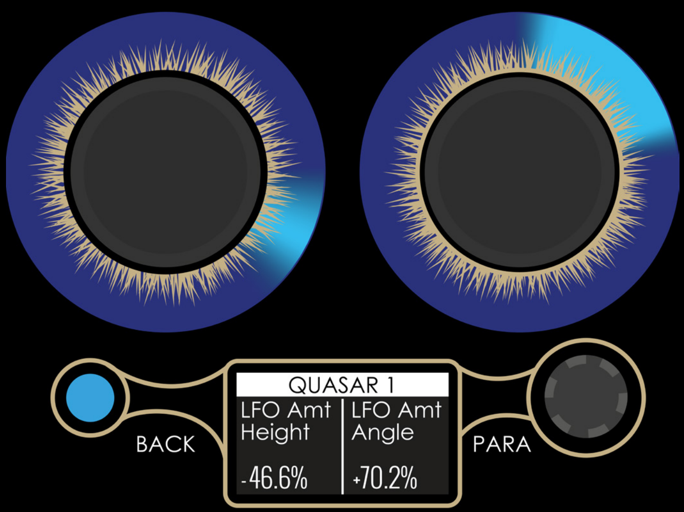
This menu sets an internal LFO which can modulate the Quasar's position co-ordinates Height, Angle and Distance. An overview of all possible waveforms is given below.



There are also waveforms that only run through a single cycle and must be triggered by one of the control voltages CV1 or CV2 to do so.



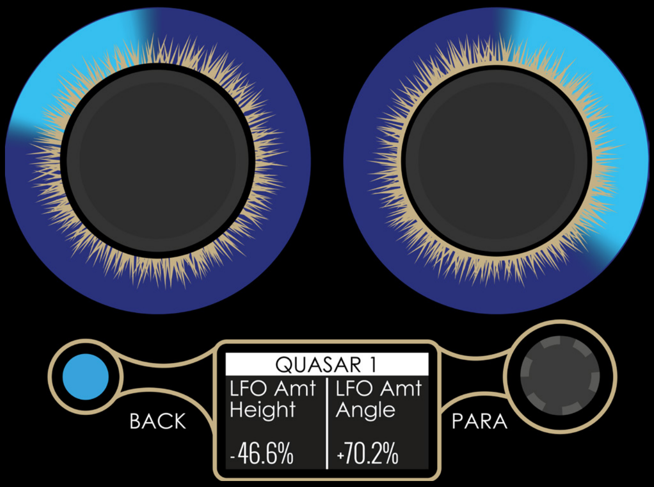
NOTE:
In order to start a single-shot waveform, you also need to set the LFO trigger as one of the CV's targets. This can be done in the menu CV MAP.



In the menu on the right side the **LFO speed** is set. The range can be set between -300.0 and +300.0 revolutions per minute („/m"), which corresponds to a max of +- 5 Hz. Localizing a sound works best with slow position movements, but high LFO values can also lead to interesting effects such as tremolos.

An LFO can be retriggered via external CVs. Therefore, the corresponding CV MAP needs to have the LFO trigger set as a **Target**.

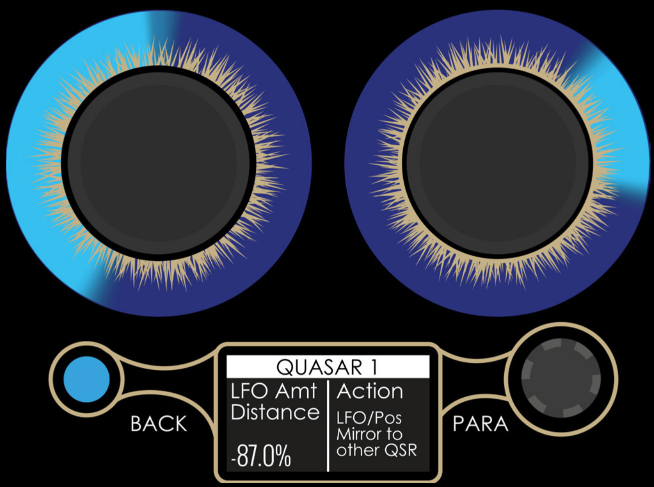
Quasar 1/2 - LFO Amt Height | LFO Amt Angle



In the next menu, the **Amount** of the LFO is set to the **Height** and **Angle** co-ordinates of the quasar.
Positive and negative values can be applied in a range of +-100.0%. The LFO value is added or subtracted to the manually set coordinate value.
The change of the value is displayed on the LED ring of the corresponding „Height | Angle“ menu.

NOTE:
It is possible to modulate the angle (azimuth) with an LFO while the auto-rotation is also activated. This means that the sound source moves in the horizontal plane with the auto-rotation speed, but the LFO additionally changes the movement speed.

Quasar 1/2 - LFO Amt Distance | Actions



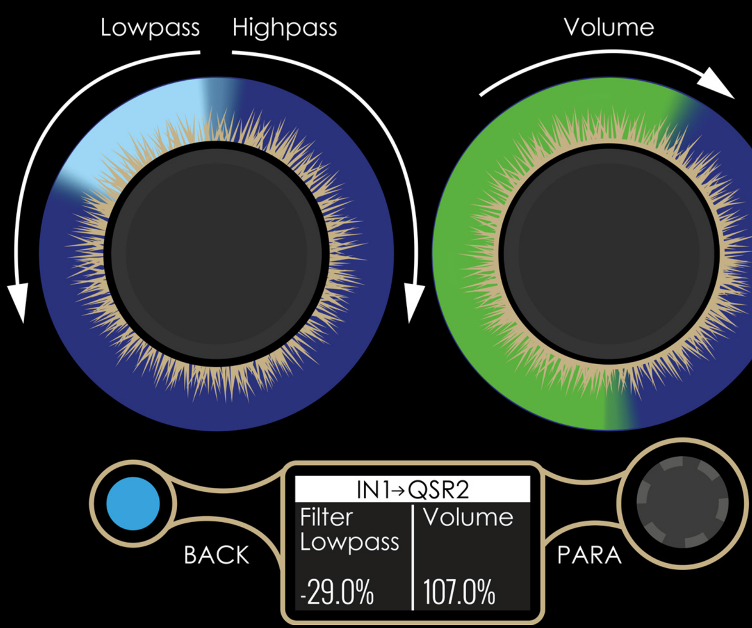
As third coordinate, the **Distance** parameter can be modulated via LFO as well. Also here, the amount is set in a range of +-100.0%.

On the right side, some special **Actions** can be selected with the large aluminium encoder. Push the encoder to execute the Action. The following actions are availble:

LFO Reset	Reset the LFO. Sets speed and amount values to 0.0, waveform to Sine.
LFO Copy to other QSR	Copy LFO parameters (waveform, speed and amount values) to the other Quasar. Either from QSR1 to QSR2 or from QSR2 to QSR1.
LFO/Pos Copy to other QSR	Copy LFO values and coordinate values (Height, Angle, Distance) to the the other Quasar.
LFO/Pos Mirror to other QSR	Same as copy, but the Angle is switched from left to right or from right to left. Also, the polarity of the LFO amount on the Angle is inverted.
All Copy to other QSR	Copies the whole Quasar, including position, LFO and Room parameters.
All Mirror to other QSR	Same as copy, but the Angle is switched from left to right or from right to left. Also, the polarity of the LFO amount on the Angle is inverted.

Input 1/2 - Filter | Volume

The audio inputs can be flexibly routed to the targets Quasar 1 (QSR1), Quasar 2 (QSR2) and center position (CNTR). The **Volume** as well as a preceding lowpass or highpass **Filter** can be set.



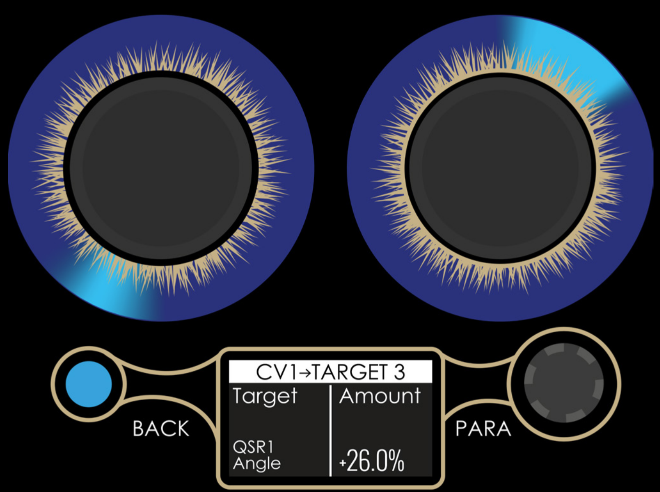
Enter the IN1 or IN2 menu, then turn the PARA encoder to scroll through the available targets:

IN1 → QSR1
IN1 → QSR2
IN1 → CNTR

... or ...

IN2 → QSR1
IN2 → QSR2
IN2 → CNTR

CV1/2 MAP - Target | Amount



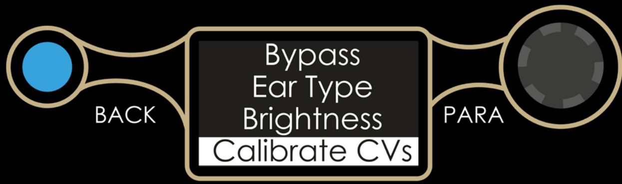
The inputs CV1 and CV2 can be flexibly routed to different destinations. Each CV has four available **Targets**.
Enter the CV1 MAP or CV2 MAP menu, then turn the PARA encoder to scroll through the available targets 1-4.
Turn the left aluminum encoder to select a target, and turn the right encoder to set the value between +-100.0%.
External CV voltages should be within a range of +-5.0 volts.

If the selected destination is set to QSR1 or QSR2 LFO Trigger, the control voltage is interpreted as a positive gate trigger voltage between 0V and +5V.

NOTE:
When the left encoder is turned all the way to the left, the amount is automatically set to 0.0%. This way an existing mapping can be reset quickly.

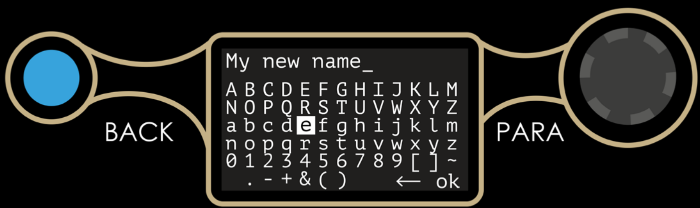
MORE

Quasar offers some additional options that can be accessed by entering the MORE menu page from the main menu.



MORE - Save Preset

All settings can be saved as a preset and recalled later. To do this, select the „Save Preset“ option from the menu. In the next screen, use the PARA rotary encoder to select one of the 128 preset slots from the list. If you select a slot that already contains a saved preset, that preset will be overwritten.



On the next screen, a name for the preset can be entered. Use the right aluminum encoder or the PARA encoder to scroll **horizontally** through the letters.
Use the left aluminum encoder to scroll through the letters **vertically**. Press either one of the aluminum encoders or the PARA encoder to enter a new letter.
The last letter can be deleted by selecting the back arrow from the alphabet. Confirm the entered name by pressing the „ok“ key.

> *NOTE:*
> *Quasar automatically retains the temporary settings between power off and power on.*

MORE - Load Preset

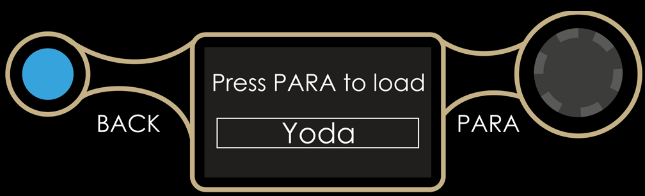
Presets can also be recalled from the list. Navigating to the Load Preset menu, select the desired preset with the PARA encoder and press the encoder again to load it into Quasar.

MORE - Bypass

From time to time it may be useful to listen to Quasar's input signals as an untreated reference. To avoid having to reconnect patch cords externally, Quasar offers a bypass function.
When entering the menu, the inputs IN1 and IN2 are immediately routed to the outputs without sound processing.
Turn the PARA encoder to select whether IN1 and IN2 are routed to both the left and right outputs, or IN1 is routed to the left channel and IN2 to the right channel. The latter option is suitable when a stereo signal is present at the input where IN1 is the left channel and IN2 is the right channel.

MORE - Ear Type

It varies from person to person how precisely sounds processed through Quasar can be located. For spatial hearing, the shape of the torso, head and ears play a crucial role in locating sounds, but these are slightly different for each person.
For this reason, Quasar offers five **Ear Types** from which to choose by turning the PARA encoder: Human, Hobbit, Yoda, Bunny and Elephant*.



Ear types differ in how much the frequency response is altered at different listening positions. Human" has the least influence on the frequency spectrum and „Elephant" the most.

Human **Hobbit** **Yoda** **Bunny** **Elephant**

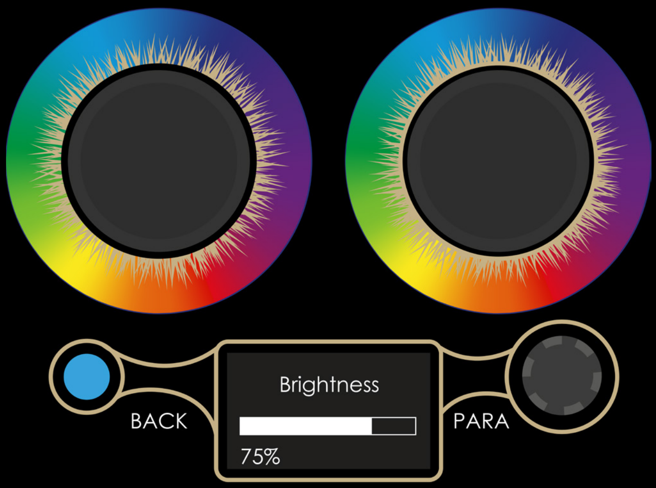
weak effect *strong effect*

It will probably take some time to find the ear type that suits you best. The stronger the selected type is, the more the frequency spectrum is changed. This can also lead to undesirable overemphasis, which is why weaker types may be preferred.
The differences manifest themselves most clearly in accuracy of height perception and front-back distinguishability. Localization ability is generally better when the virtual sound source is on either the left or right side of the head, rather than exactly centered.

More information about localization accuracy can be found later in this manual in chapter "*Get the most out of Quasar*".

** No animals were harmed during the development of Quasar. Quasar may contain traces of hobbit ears.*

MORE - Brightness



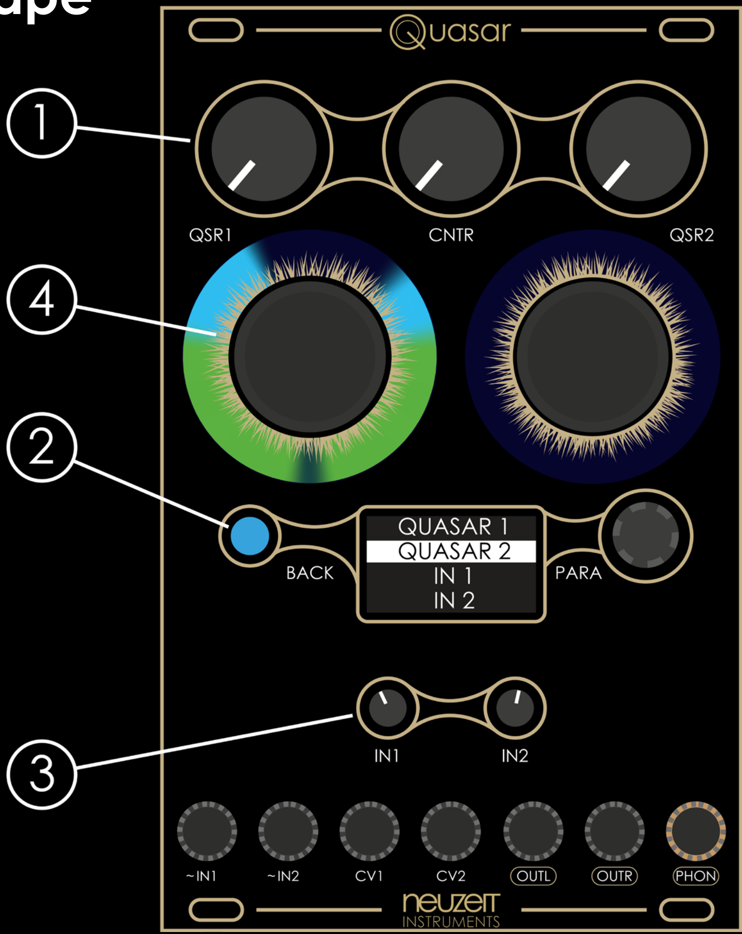
Depending on the environment of your rack, you might want to change the overall brightness of the LED rings.
Use the aluminium knobs or the PARA encoder to change the brightness and confirm by pressing PARA or one of the encoders. Push the BACK button to proceed without changes.
The brightness is stored in the module and is restored the next time the module is switched on.

MORE - CV Calibration

The CV inputs of each Quasar module are pre-calibrated at the factory. Due to differences in power supply or temperature, there may be situations where recalibration is required if you notice CV activity if there is no CV cable plugged into the module. Calibration involves measuring and resetting the default zero level of the CV inputs.
To perform calibration, enter the menu and follow the on-screen instructions (disconnect all cables and press PARA to start calibration). Quasar will output two reference values on the screen after the measurement. Values between +-50.0 are common.

Create a binaural landscape

To get started, it is recommended to first set all volume controls QSR1, QSR2 and CNTR to zero (1). Then push the BACK button until you are in the main menu (2) and adjust the input level knobs IN1 and IN2 (3) so that the level meter is in the blue range (4).
To explore how Quasar 1/2 and the Center Position behave, turn up the volume potentiometers (1) only one at a time. Make specific changes to Quasar 1/2 and the center position in this isolated state. Then decide afterwards in which ratio you want to use the Quasars and the Center Position to each other and set the volume potentiometers (1) accordingly.



All presets explained

Quasar comes with some **Factory Presets**. These are intended to give a basic overview of the module's functions and should also serve as a starting point. To load a preset, navigate to the MORE > Load Preset menu and select the desired preset from the list.

INIT
A good starting point for a new scene.
QSR1 is 45° on the left side, QSR2 is 45° on the right side. LFOs are turned off.
CV1/2 are mapped to the Angle of QSR1 and QSR2.
Both inputs IN1/2 are routed to QSR1, QSR2 and CNTR with 100% volume each.
Filters are turned off.

Slow Walk
Quasars 1 and 2 slowly move around the head in opposite directions using the Auto rotation of the Angle parameter. A slow sinewave LFO slightly modulates the Height parameter.
Both inputs IN1/2 are routed to QSR1, QSR2 and CNTR with 100% volume each.
Filters are turned off by default, but modulated by CV2. CV1 changes the rotation speed of both QSR1 and QSR2.

Wiggle on Trig
Quasars 1 and 2 are set to static positions at 90° left and right of the head. The LFOs are each set to the waveform „Spiral CV Trigger Single“. This means that the LFO only runs through one cycle of the waveform and must be triggered by CV to do so. Therefore, CV1 is mapped to trigger the LFO of QSR1, CV2 is mapped to trigger the LFO of QSR2.
The LFO affects all three coordinates Height, Angle and Distance. The Spiral waveform causes the sound source to bounce around its default position as if suspended on springs.
Both inputs IN1/2 are routed to QSR1, QSR2 and CNTR with 100% volume each. Filters are turned off.

FlyBy on Trig
As with the Wiggle on Trig preset, also here the LFOs are set to a „CV Trigger Single“ waveform, in this case with triangular shape. Quasars 1 and 2 are set to default positions with Angle 0° directly in front of the listener and are located rather further away. The output level of the quasar is therefore rather low in this starting position. When trigger signals are applied to CV1 or CV2, the LFO of QSR 1 or QSR2 is started and the sound sources move from far away close to the left or right side of the head respectively. Likewise they move away again and return to the starting position.
Both inputs IN1/2 are routed to QSR1, QSR2 and CNTR with 100% volume each. Filters are turned off.

Random on Trig
In this preset the LFO waveform of QSR1 and QSR2 is set to „Random CV Trigger Single“. This means that every time a trigger signal is applied to the CV input, the positions of QSR1 and QSR2 change randomly. In this preset, CV1 triggers both LFOs of QSR1 and QSR2 at the same time (CV MAP).
Also worth noting in this preset is that QSR1 is always in front of the listener and QSR2 is always behind the listener. This is achieved by setting the angle of QSR1 to 0.0° and that of QSR2 to 180.0°. However, the LFO Amount on the Angle parameter is only set to 50% for both QSR1 and QSR2, which corresponds to a maximum swing of +-90.0° around the initial position.
CV2 is mapped to the volume parameters. Without CV2, IN1 is routed to QSR1 and IN2 to QSR2. As the voltage at CV2 rises from 0.0V to 5.0V the volume routing changes, so that at 5.0V IN1 goes to QSR2 and IN2 to QSR1. That way, a fade between both positions is realized.
IN1 and IN2 are also routed to the CNTR position, but here a lowpass filter is applied, so that only the bass frequencies get there.
This preset becomes especially interesting if the sound you feed into the Quasar is also caused by a trigger in your modular rack. If the same trigger is also used for CV1/2, each time the input sound sounds, its position will also change.

Inside Leslie
This preset is aimed more for sound design than for constructing a real 3D environment. It creates a tremolo effect and can be used as a starting point for versatile stereo widening.
QSR1 and QSR2 rotate around the listener‘s head at the same high speed of 400.0 rpm. This corresponds to the maximum speed of a Leslie speaker in tremolo position. QSR2 is initially 120.0° out of phase with QSR1. The rotation is not done by the Auto parameter but by the LFO with ramp waveform and a mapping amount of 100% to the Angle parameter. This allows the phase offset to be set via the Angle parameter.
CV1 is inversely routed to the LFO speed of QSR1 and QSR2 and thus to the rotation speed. The higher the voltage at CV1 the slower the rotation. CV1 is also routed to the Angle parameter of QSR1 to add some more liveliness to the mapping.
CV2 is routed to a variety of parameters like room reverb, distance and height of QSR1 and QSR2. The purpose here is also tonal variation.
Both inputs are routed to QSR1, QSR2 and CNTR. Experiment with filters and volume settings depending on the input signal to get interesting results. Also the Room parameters of each Quasar add a lot of character to the sound.

Tremolo Walk
This preset is also a tremolo effect. It has QSR1 and QSR2 moving in opposite directions around the head at slow speed. The Auto function of the Angle parameter is used for this purpose. However, this constant rotation is modulated with a very fast movement via sine LFO. The LFO influences all three coordinate parameters. Especially the application to Distance causes volume changes that are perceived as tremolo.
For versatility, IN1 is routed with different filter settings to the destinations QSR1, QSR2 and CNTR. IN2 is output to the three destinations without filters.
CV1 is mapped to the rotation speed of QSR1 and QSR2. CV2 adds reverb to the signal and changes the room parameters.

Travel Wiggle
In this preset, two sounds move around the head one after the other.
QSR1 and QSR2 move around the head in slow tempo with the same constant speed. At the same time, the two positions are provided with different amounts of room reverb.
IN1 is routed to QSR1 and IN2 to QSR2. Both inputs are also routed to CNTR, but this is preceded by a low-pass filter, so that only the basses enter the CNTR position.
The LFO is set to the „Spiral CV Trigger Single“ waveform and influences the position parameters to varying degrees. To trigger the LFO of QSR1 and QSR2 a trigger signal at CV1 is required (as set in the CV MAP menu). This allows a trigger to cause a momentary deviation from the otherwise steady orbit.
CV2 instead affects the Angle parameter of QSR1, while QSR1 is in Auto Rota-

tion mode. Although the Angle parameter is not accessible for the user when Auto roation is enabled, it is still available as a target of the CV mapping. Byapplying a control voltage to CV2, the phase offset of the rotating Angle of QSR1 and QSR2 is changed while they both keep the same auto rotation speed.

Speaker Sim (m)
This preset is intended as a starting point to emulate a 2.1 speaker setup. QSR1 is positioned on one side of the head and QSR2 on the other side at a distance of about one meter. They correspond to the left and right speakers in a classic recording studio. The center position CNTR is used as the central subwoofer emulation.
CV mapping and LFOs are initially disabled in this static scenario.
IN1 and IN2 are assumed to be mono signals in the „(m)“ version of the preset. Both IN1 and IN2 are routed to all three destinations QSR1, QSR2 and CNTR. Thanks to an upstream low-pass filter, only the low frequencies are routed to the center position, while the signal before QSR1 and QSR2 each passes through a slight high-pass filter. This is to emulate different frequency responses of two stereo satellite speakers and a subwoofer in the center.
Depending on the input signal, this static scenario can now be changed as needed. Experiment with slightly adding reverb to QSR1 and QSR2. Change the positions of the speakers and try to get a more distinct stereo impression by slightly adding LFO modulation on Height and Angle.
This is where the QSR Action menu should become helpful. Use the „Mirror“ functions to make changes in QSR1, for example, and copy them mirrored at the center axis of the body (sagittal plane) to QSR2.
For a wider stereo image, it is recommended to set slightly different parameters in QSR1 and QSR2. This facilitates a wider stereo impression for the hearing.

Speaker Sim (s)
The same as above, with the only difference that IN1 and IN2 are assumed to be left and right channels of an already existing stereo signal. For this purpose IN1 is routed to QSR1 only and IN2 to QSR2. Also, both inputs are sent to the center position with a low-pass filter.

Get the most out of Quasar

Improve the localization by considiring the following guidelines.

- Moving sound sources make it easier for the brain to locate them. A sound source that moves only slightly on the spot is also easier to locate. Use the integrated **LFOs** or external **CVs** to add slight movements.

- Height perception works best on the left or right side of the head. Use an **Angle** in a range of 25° to 155° left or right and then change the **Height** for best results.

- Use the **Room** reverb of the Quasar primarily to specifically support distance perception. To do this, check how the localization is without reverb and then mix in more and more reverb in small steps. A signal without reverb can be located better in terms of angle and height, but distance estimation can be improved by adding some room reverb.

- Avoid positions that are exactly in front or behind. These are naturally difficult for us humans to distinguish. There is even a scientific term for this common kind of misinterpretation: Front-Back confusion.

- As a rule of thumb, the more likely a sound would also occur in nature, the better our hearing is able to locate this sound. Static oscillator waveforms are not particularly suitable for localization, but all kinds of noisy sounds or anything commonly familiar such as human voices are good candidates.

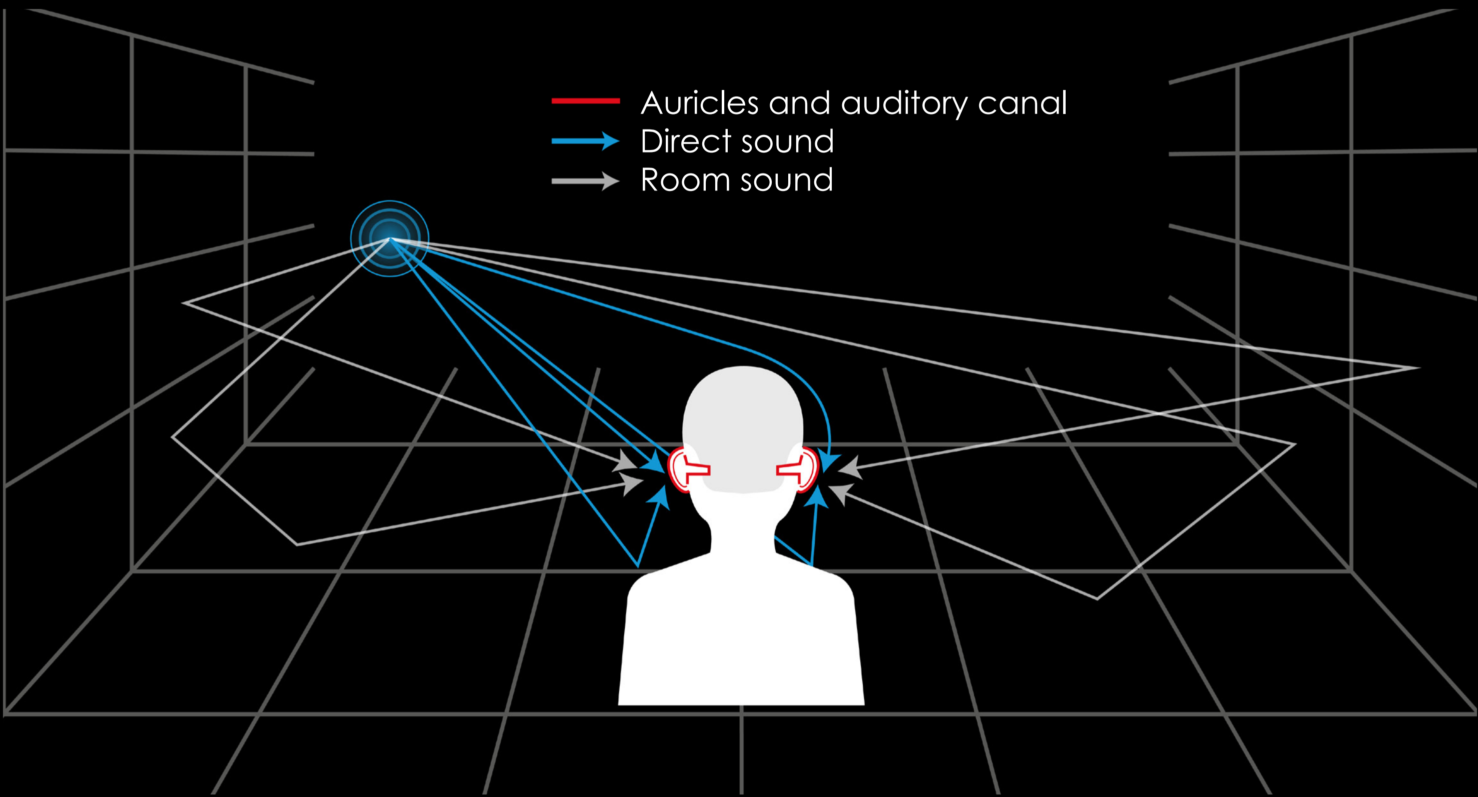
- Signals with a rich frequency spectrum and a short attack or at least some loudness variation are easier to locate. For example, the crackling of wood.

- As a starting point, only use a single sound for example on ~IN1 that you route to only one Quasar, for example QSR1. Make sure that only the QSR1 volume knob is turned up while the CNTR and QSR2 volume knobs are set to zero. With this minimum setting, the localization of the sound is the easiest. Sending the same sound also to the other Quasar or the center position might add some confusion in terms of localization as you introduce other sound sources which makes the virtual scenario more complex. Try to keep it simple at first until you know what you are doing and do it by intention.

- Use the **Filters** to create a frequency crossover. Add a lowpass to the center position and a highpass to the Quasar 1/2. This keeps the bass nicely in the center while only mid and high frequencies travel around your head. This preserves the mono compatiblity of your music and avoids phasing effects when summing up the stereo output to a mono signal on portable speakers or club sound systems.

More background, please!

Spatial hearing is an ability made possible by the placement of our two ears on the sides of our head. The illustration below shows the impact of direct and room sound on our body. Their effects are described in the following, so this illustration may be helpful for a general understanding.
In a scenario without space, only the blue lines in the above drawing come into play. When we are in a reverberant environment, sound waves reflected from the walls also reach our ears. These are represented by the gray lines.



Spatial hearing is one of the most important senses we humans possess. Besides the eyes, it is also hearing that has enabled us as a species to survive in the wilderness. Whereas with our eyes we can only recognize the space that is directly in front of us, our hearing enables us to perceive our environment even around us or behind a visual cover.

Accordingly, spatial hearing has always been essential for survival for humans and many other species. Our anatomy is such that especially sounds that are outside our field of vision can be perceived well. It is equally important for survival to be able to locate moving sound sources quickly. This can be, for example, an approaching enemy or the scurrying prey.

It is not without reason that our hearing has a weakness in distinguishing between front and back. If a sound comes directly from the front, our field of vision is also already directed there. Presumably, we also already see the origin of the sound with our eyes and can make it out perfectly through our spatial vision. If an optical detection is not possible for us, the sound source is possibly behind us. By turning our head, we are able to convert the localization from a front-back problem to a much simpler left-right localization.

For height perception, the change in the frequency spectrum due to refraction at the torso, head and auricle is especially crucial. Therefore, sounds from the side are easier to distinguish in height because the sound waves are refracted in a more complex way than when they hit the body from the front or back. However, our hearing is only capable of locating height really well when a sound source is slightly moving or if we turn our head. We do not know how a sound sounds in the unaltered original and therefore have no absolute comparison of the frequency spectrum. We can only determine how much the frequency spectrum changes when the sound source moves relative to the head, and guess our height estimation from that change.

Similarly, we actually rely on a reference sound source for distance perception as well. In fact, here our brain relies primarily on the familiarity of a sound such as human voices, rustling in the bushes, approaching footsteps, distant birdcalls, etc. For this we have already gained enough experience to be able to estimate the distance of known sounds well on the basis of the total volume. The volume comparison with the otherwise prevailing sounds is also an important parameter to be able to determine the distance of a sound source. If a sound source is far away (>15m), the sound energy of the high frequencies is also reduced. However, the familiarity of the sound is also decisive here, in order to know what the sound is like at a shorter distance.

For very close sounds, the difference in loudness between the left and right ear is an important parameter. Although close sounds sound louder overall, the difference in loudness between the left and right ear is greater at shorter distances than at more distant sound sources.

A final indication for distance estimation is the comparison with the prevailing room reverberation. We are not always in an appreciably sound-reflecting environment, but in such a case we already have a good idea of what the acoustics around us are like through visual perception and our life experience. If a sound source is far away, direct sound and the sound waves reflected from the room arrive at us more or less simultaneously. If a sound source is very close to our ear, the direct sound is perceived much earlier and, above all, louder than the room reverberation.

Another acoustic source of information can be room-dependent sound reflections. For this, however, it is almost essential to also perceive the surrounding room with the other sensory organs and to derive from this an acoustic sound expectation of the room that can serve as a reference. Only when we know where walls and objects are located can we estimate how a sound is likely to sound that is, for example, close to the floor or behind an object.

We can break down all of the above to a series of auditory cues that our brain evaluates:

- Time-of-flight differences between left and right ears
- Differences in loudness between the left and right ear
- Decreases and increases in the frequency spectrum
- Loudness ratio of direct sound to room reverberation
- Overall loudness
- Changes of the above mentioned cues with moving sources

The more clearly these cues are found, the more clearly our hearing can determine the local origin of a sound source. However, as all humans have slightly different body shapes, our brains are specifically trained for our very own ears only. This is why Quasar offers several **Ear Types** to choose from, aiming to provide good localization for everybody while still using a generic algorithm.

As a conclusion to this chapter, let's take a brief look at other solutions for spatial hearing that evolution has found. For example flight animals such as horses have a slightly different approach. Their eyes are located on the side of the head, which is why they don't have direct forward vision. To compensate for this, they have the ability to orient their auricles in different directions in order to be able to hear specifically in different directions. Likewise, the refraction of the sound waves at the torso and the circumnavigation of the head is omitted because the ears are placed on top of the head. Refraction, however, provides us humans with important information. Horses can therefore also compensate for this with rotatable auricles.

Always a good listener: Horse.

What Quasar is

Quasar is a binaural audio mixer that lets you experience three-dimensional listening on headphones.
You will be able to let sounds travel anywhere around your head, be it front, back, top, bottom, left, right, far away or very close. By processing external CVs and featuring a variety of internal modulation, dynamically moving sound sources can be programmed. There are also possibilities to change sound positions randomly or do some one-shot travelling by CV triggers. Also, sounds can be distributed not only to one position but also to a second position and to a center position. Sounds can also be filtered before they are distributed, so that e.g. your bass frequencies stay nicely the same on the left and right output while higher frequency content moves around.

Listening to music on headphones usually brings one big challenge for mixing engineers: The sound seems to come from inside the head.
This effect can be by intention to get a very direct sound experience (a lot of modern music is produced that way), but it can also be challenging to address if you want to give the listener a more „spacey“ listening experience, at least for certain sound elements. Usually, sound engineers use reverberation and panning as classic tools to address this issue. Sometimes also stereo widening effects are used, which introduce around 20 milliseconds of time delay between the right and the left ear.
Anyways, these techniques do not make use of the fact that nature already gave us a really good apparatus for sound localization. Our body‘s anatomy breaks the soundwaves before they reach our eardrums. These impacts on the signal are exactly what our brain uses for sound localization.

This is exactly where Quasar comes in. It lets you define virtual positions relative to your head from which sounds are coming and mimicks the effects which body and surrounding room have on the soundwaves. Therefore, your brain will be able to locate the sounds again, especially when listening through headphones.

What Quasar is not

Quasar is not very useful for anything else than headphone listening. It is meant for musicians who are listening to their music on headphones or who are producing music that needs to be exported as an audio file - which also may be heard via headphones. Quasar is probably also not useful for live performances, unless the audience wears headphones. You get the point...

Quasar is a contraty concept to any multi-speaker solution like quadrophony, 5.1, 7.1 or Dolby Atmos. All of the above try to make a more realistic 3D listening experience in a certain room by putting many speakers in that room. The more speakers you have, the more possibilities there are for letting a sound come from a particular speaker position and thereby create a spatial listening experience. The downside of all these attempts is:
You need to be inside that multi-speaker room.

So, there is an obvious reason why 3D localization on headphones is a well-suited solution for a 3D listening experience that many people can enjoy:

You rarely have access to a multi-speaker room,
but pretty much everybody has headphones.

Anyways, sounds that were processed through Quasar are still very playable through regular speaker systems and also on mono sound systems. Actually, Quasar‘s mono compatibility is way better than other stereo widening „tricks“ such as the Haas-effect and other tools that mainly rely on introducing time delay differences in the range of 10-20 Milliseconds between the right and the left channel. The impact Quasar has on the audio signal is quite subtile in terms of signal processing, only our brain reacts disproportionately strongly to the effect Quasar creates. This is what we call psychoacustics, or in other words: The brain creates something that is bigger than its ingredients.

Performing a firmware update

Quasar is a digital module, which means that new functions may be available in the future, which can be loaded onto the module through a firmware update. The „brain“ of the Quasar is a separate microcontroller board, called „Teensy“, which is placed inside the module. The Teensy has a USB port that must be used to connect the Quasar to a computer for a firmware update.

You will need:
- A micro USB cable
- A computer (Windows, Mac or Linux)
- A toothpick, Q-tip, or other small stick, preferably made of a non-conductive material such as plastic or wood

Step 1

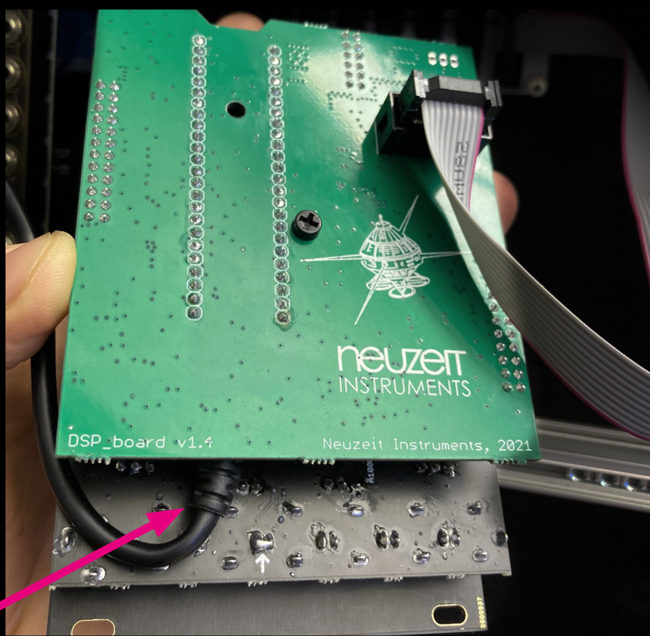
Download the latest Quasar firmware file (.ehex) from the link on our website: www.neuzeit-instruments.com/quasar

Step 2

Download the Teensy Loader application for your computer‘s operating system (Windows, Mac or Linux): https://www.pjrc.com/teensy/loader.html
Install and open the application.

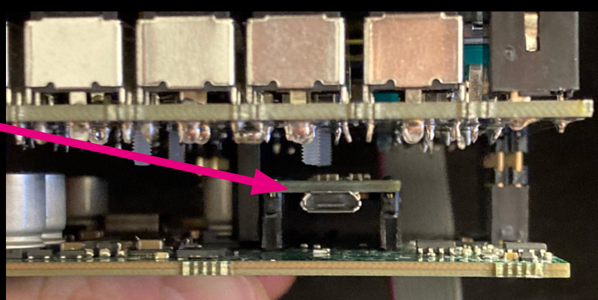
Step 3

Turn off your rack, but leave the Quasar connected to the power bus. Unscrew the Quasar from your rack and hold it in one hand so you can reach its backside while it is still connected to the power bus board.



Step 4

Plug the micro USB cable into the Teensy board in the Quasar. Then place the Quasar back on the rails of your rack with the cable sticking out the side of the Quasar.
The Micro-USB jack is accessible as shown in the picture.



Step 5

Turn on your rack. Check the version number of the current firmware on the Quasar‘s display loading screen.

Step 6

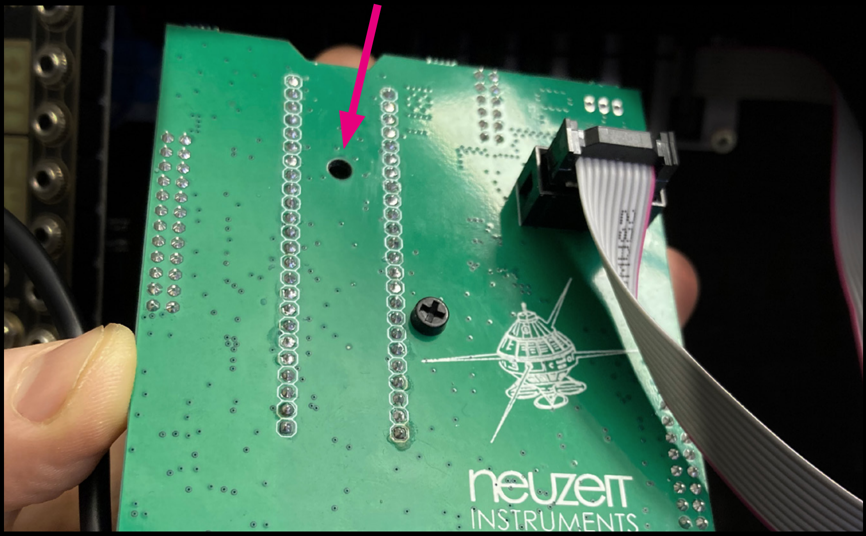
Drag and drop the previously downloaded Quasar firmware file onto the surface of the Teensy Loader application. Alternatively, use the „open HEX file" button.

Step 7

In the Teensy Loader application, enable the „Auto" button. This will allow the application to automatically detect all Teensy boards connected via USB when the upload button on the Teensy board is pressed.

Step 8

Now take the Quasar back out of the rack with one hand, take the toothpick in the other hand and press the button on the Teensy board that is accessible through the small hole on the back of the Quasar.
The Teensy loader application should automatically detect the Teensy and



upload the new firmware. This should only take a few seconds. You can see a progress bar on the application screen.

Step 9

Turn off your rack and disconnect the USB cable from the Quasar.

> *NOTE:*
> Quasar might not function as expected with the new firmware until you turn it off and on again.

Step 10

Screw Quasar back into your rack and turn the rack back on.
The Quasar loading screen will display the new firmware version.

Firmware update troubleshooting

Problem: Quasar‘s Teensy board is not recognized by the Teensy Loader application.

Possible solution: Some USB cables are not able to transmit data if they only contain the wires for charging voltage, but not for data transfer. Use the USB cable shipped with Quasar or another Micro USB cable that is capable of data transmission.

Restore and share presets

Quasar stores data such as user presets on an internal Micro SD card. Normally, there is no reason to ever unplug the SD card from the module, but in case you want to restore factory presets or transfer your own presets to another Quasar, you need to do this with help of a computer.

Insert the SD-card into your computer. You might want to use the Micro-SD adaptor that ships with Quasar. On the SD-card there is a folder named PRESETS. This folder contains all the presets as separate files that you can see in Quasar‘s list view when loading or saving a preset. The filename (e.g. PRST_042.QSR) corresponds to the number of the preset in the list index, in this case list entry nr 42. Renaming the number will change the list index of the preset. Copy any preset file to another Quasar‘s SD-card to share them across modules.

To restore factory presets, we recommend to
1) <u>Rename</u> the folder PRESETS to PRESETS_OLD
2) <u>Copy</u> the folder FACTORY and rename it to PRESETS.
3) Do not simply unplug the SD-card from your computer.
   Instead, <u>eject it properly</u> from your operating system in software first.

If anything goes wrong, please send an email to
contact@neuzeit-instruments.com
and we will provide you with further guidance.

Quasar Manual
Document version 1.0