~~DIS~~ENTANGLER

User Manual
Version 1.1.0

INFRASONIC AUDIO

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OVERVIEW

~~DIS~~ENTANGLER is a 4hp mid-side encoder/decoder and stereo width processor.

At its simplest, ~~DIS~~ENTANGLER is a compact solution for adjusting the width of a stereo signal - from a mono sum up to "double wide" (side content amplified) with the switch set to 2X. This makes it a great companion to WARP CORE or other stereo oscillators as well as a useful end-of chain mix utility for stereo voices, effects chains, and submixes.

Going a level deeper, ~~DIS~~ENTANGLER is also a versatile tool for creative processing of stereo signals or CV. For creative stereo audio processing, the MID and SIDE inputs and outputs allow patching out to other modules to affect either the center or edges of your stereo image with compression, ducking, filtering, or whatever else you can think of. And all the inputs and outputs of ~~DIS~~ENTANGLER are DC-coupled, enabling sum- and difference-based CV manipulation.

- Mid-side processor with controls to attenuate/boost the SIDE decoder input level
- Normalled routing and slider provide easy manual stereo-width adjustment of stereo voices and submixes
- Fully analog design using high quality, low noise audio op amps
- DC-coupled inputs for creative CV processing
- Reverse power protection

QUICKSTART PATCH

Here's the simplest way to use the module:

1. Patch a stereo audio signal into IN L/R
2. Patch out of OUT L/R into a stereo mixer or output module
3. Use the slider and switch to adjust the stereo width of the signal

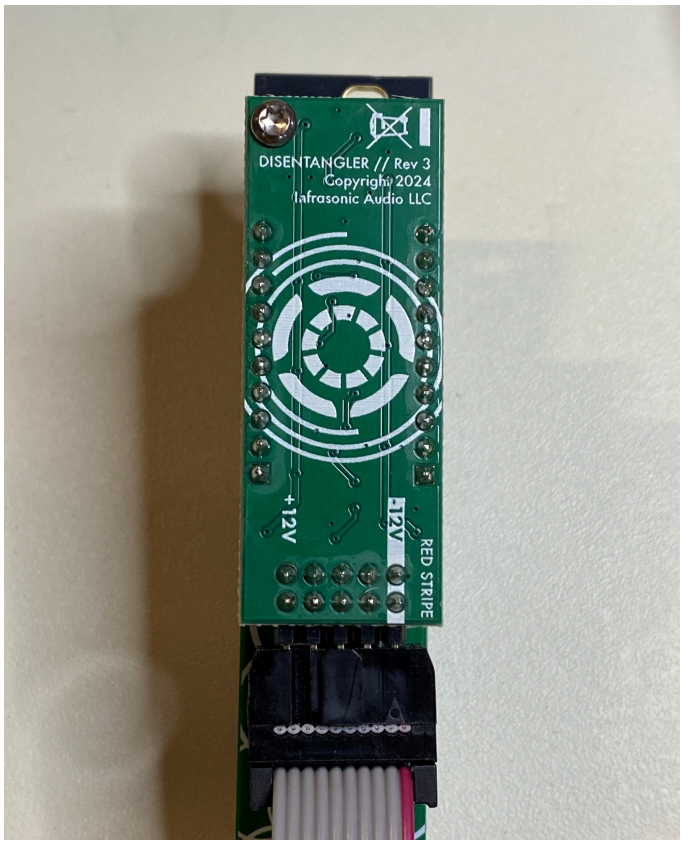
Read on for a lot more information and Patch Ideas

TECHNICAL SPECIFICATIONS

- **Width**: 4hp
- **Depth**: 29mm*
- **Power consumption (peak):**
  - +12V: 18 mA
  - -12V: 19 mA
  - 5V: 0 mA

INSTALLATION

Connect the power ribbon header to DISENTANGLER with the -12V red stripe facing to the **right** side if you are looking at the back of the module, as pictured.

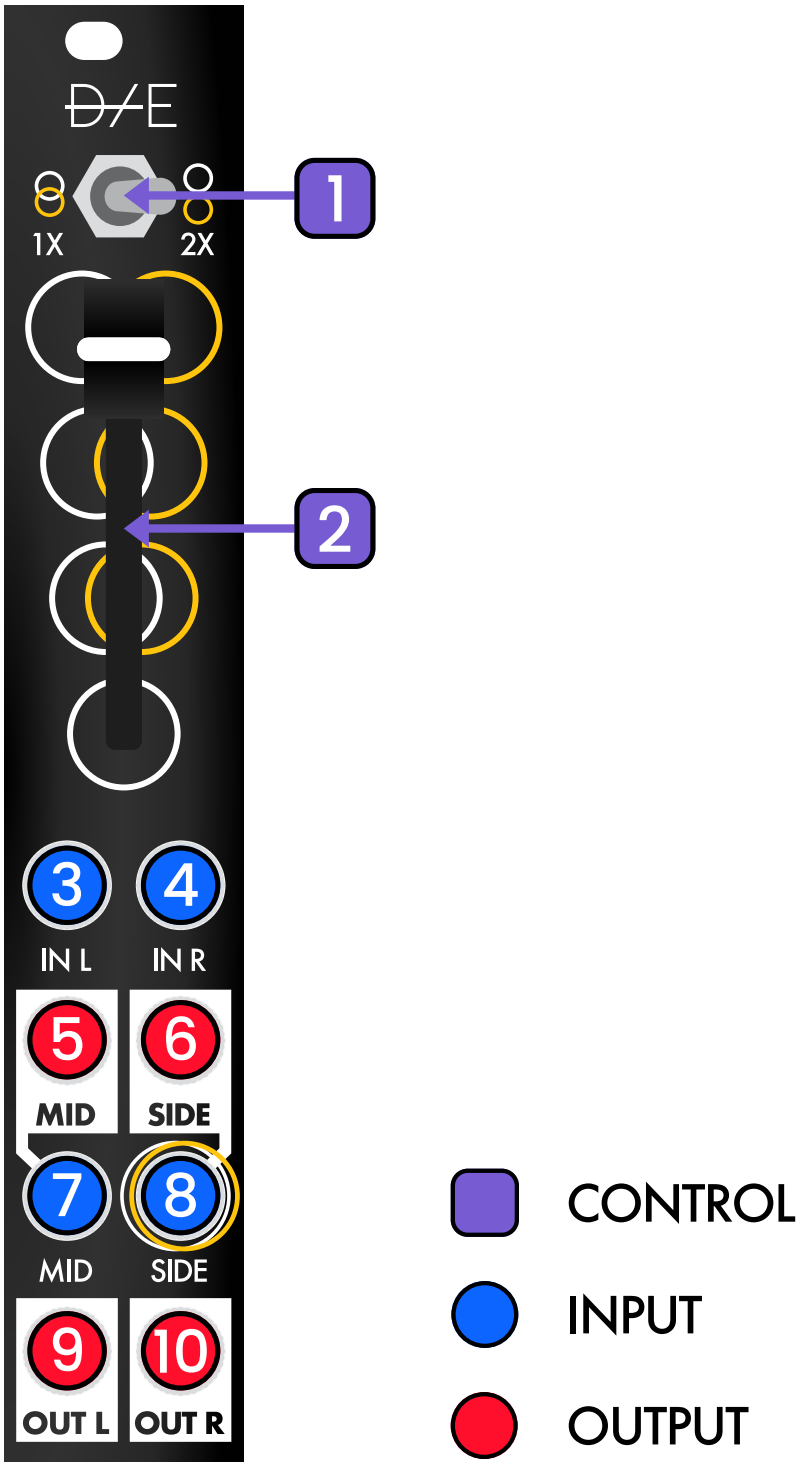


The other end of the cable should be connected to your power bus with the red stripe aligned to the -12V side of the bus connector.

The module is protected against reversed power but always ensure that you are placing the header correctly to prevent any potential issues.

**Note: Serial numbers below 25 (Rev2) have the power header perpendicular to the PCB on the back, and thus are ~38mm deep. The power header orientation is the same on all revisions. Pay attention to the -12V stripe and everything will be fine.*

PANEL LAYOUT



CONTROLS

1 SIDE IN SCALE

Sets the nominal amplification level of the **SIDE IN** signal.

When switched to 1X, the **SIDE IN** will have a maximum of unity gain (no amplification) when the **SIDE IN ATTENUATOR** slider is all the way up. When patching a stereo signal through the module via the IN L/R and OUT L/R jacks, this setting allows the slider to be used to adjust the perceived stereo width of the signal to be adjusted from its original, full width all the way down to a mono sum.

When switched to 2X, the **SIDE IN** signal will have a maximum of 2x gain applied when the **SIDE IN ATTENUATOR** slider is all the way up, and unity gain when the slider is approximately in the middle. This setting allows the side content of the stereo image to be overemphasized when the slider is all the way up, which can give the illusion of an "extra wide" stereo image.

2 SIDE IN ATTENUATOR

Sets the attenuation/amplification level of the **SIDE IN** signal.

At the top position, the **SIDE IN** signal will have either 1X (unity) or 2X gain applied, depending on the position of the **SIDE IN SCALE** switch. At the bottom position, the **SIDE IN** will be completely silenced, resulting in only the "mid" content being decoded into the **OUT L/R** jacks.

3 4 IN L / IN R

Left and right signal inputs for the mid-side encoder. DC-Coupled.

The IN R *jack is* ***not*** *normalled to the* IN L *jack if nothing is patched into* IN R*. This would result in the* SIDE OUT *signal always being zero. That doesn't mean patching a mono signal into the inputs is completely pointless though...*

5 MID OUT

“Mid” signal encoded by the mid-side encoder from the **IN L** and **IN R** signals.

6 SIDE OUT

“Side” signal encoded by the mid-side encoder from the **IN L** and **IN R** signals.

7 MID IN

“Mid” input signal for the mid-side decoder. DC-Coupled.

Receives signal from **MID OUT** via normalling if nothing is patched into this jack.

8 SIDE IN

“Side” input signal for the mid-side decoder. DC-Coupled.

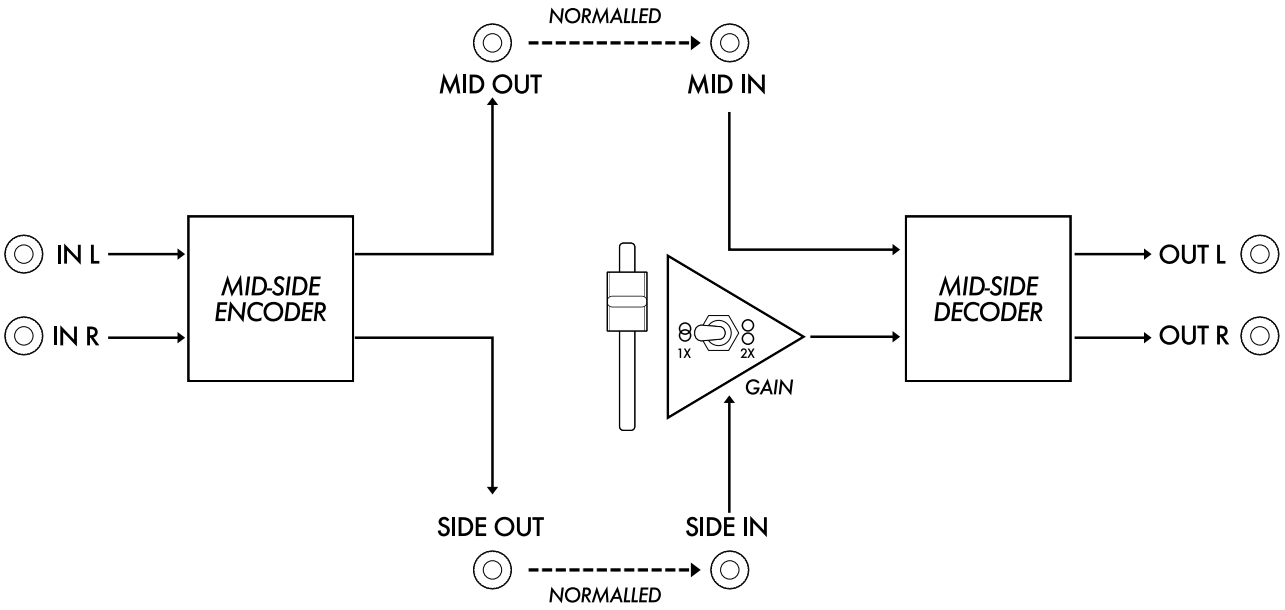
Receives signal from **SIDE OUT** via normalling if nothing is patched into this jack.

The signal coming into this jack is attenuated or amplified according to the positions of the **SIDE IN SCALE** and **SIDE IN ATTENUATOR** controls.

9 10 OUT L / OUT R

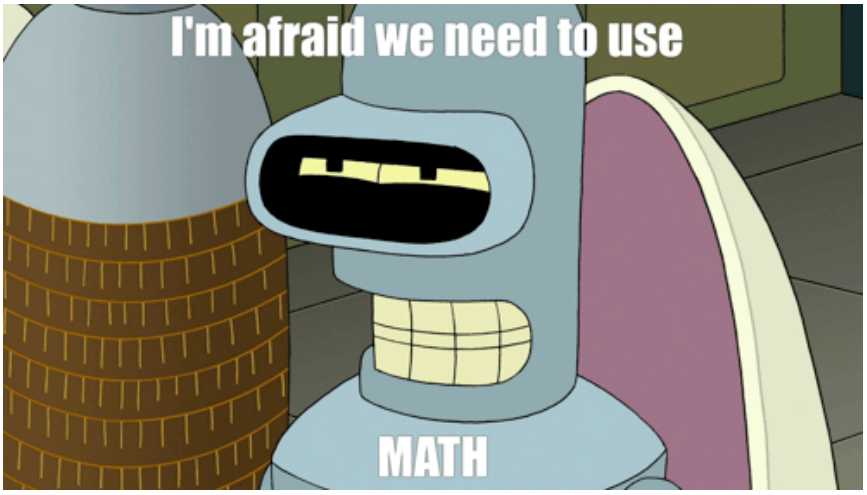
Left and right signal outputs decoded by the mid-side decoder from the **MID IN** and scaled **SIDE IN** signals.

THEORY OF OPERATION



~~DIS~~ENTANGLER is a mid-side encoder and decoder, with the MID and SIDE decoder inputs normalled to the MID and SIDE encoder outputs and additional manual controls to scale the SIDE input level. As a result, it can easily be used to adjust the perceived width of a stereo signal.

How, exactly? Good question.



MID-SIDE ENCODER

First, the “encoder” section takes the signals coming into the **IN L** and **IN R** jacks and “encodes” them into separate mid and side signals on the **MID OUT** and **SIDE OUT** jacks according to the following formulas:

MID OUT = (IN L + IN R) / 2
SIDE OUT = (IN L - IN R) / 2

This produces an “average” of the input signals at **MID OUT**, and a “difference” of the input signals divided by two at **SIDE OUT**, which for audio signals is equivalent to mid-side decoding, creating a “mid” signal analogous to the center of the stereo image and a “side” signal analogous to the “edges” of the stereo image (i.e. the difference of the two channels, divided by two).

From here, the **MID OUT** and **SIDE OUT** signals can optionally be patched out to other modules for additional processing before (optionally) being brought back into the **MID IN** and **SIDE IN** jacks for decoding, or left unpatched.

MID-SIDE DECODER

The “decoder” section (the lower 4 jacks) takes the signals from the **MID IN** and **SIDE IN** jacks – which if unpatched are normalled to the **MID OUT** and **SIDE OUT** jacks above them, respectively – and “decodes” these signals back into stereo left and right signals at **OUT L** and **OUT R** according to the following formulas:

OUT L = MID IN + SIDE IN * SIDE LEVEL
OUT R = MID IN - SIDE IN * SIDE LEVEL

Where SIDE LEVEL is a value from 0 - 2 set by the **SIDE IN SCALE** switch and **SIDE IN ATTENUATOR** slider.

If we assume **MID IN** = **MID OUT** and **SIDE IN** = **SIDE OUT** as per the jack normalling, and that SIDE LEVEL = 1 (**SIDE IN SCALE** is set to 1X and the **SIDE IN ATTENUATOR** slider is all the way up) and we expand these formulas, we get:

OUTL = MID IN + SIDE IN * 1
= ((IN L + IN R) / 2) + ((IN L - IN R) / 2)
= (IN L / 2) + (IN L / 2) + (IN R / 2) - (IN R / 2)
= IN L

OUTR = MID IN - SIDE IN * 1
= ((IN L + IN R) / 2) - ((IN L - IN R) / 2)
= (IN L / 2) - (IN L / 2) + (IN R / 2) + (IN R / 2)
= IN R

Thus, if only IN **L/R** and **OUT L/R** are patched - the signals flow through the mid-side encoder and back into the mid-side decoder to the output jacks, with no modification.

In this configuration, the encode/decode process is essentially "lossless" – the interesting stuff doesn't happen until we start modifying the mid-side signals before decoding.

SIDE IN ATTENUATION / WIDTH ADJUST

Changing the "width" of a stereo signal using mid-side processing is achieved by manipulating the relative level of the mid and side components of the signal before decoding. To put it simply, reducing the level of the SIDE signal relative to MID will make the stereo signal sound more "narrow" and increasing it will make it sound "wider".

To facilitate this, ~~DIS~~**ENTANGLER** features manual control over the **SIDE IN** signal level, including the option to boost the **SIDE IN** signal with up to 2X gain.

If the side signal is fully attenuated (**SIDE IN ATTENUATOR** all the way down), the expansion becomes:

OUTL = MID IN + (SIDE IN * 0)
= MID IN
= (IN L + IN R) / 2

OUTR = MID IN - (SIDE IN * 0)
= MID IN
= (IN L + IN R) / 2

And thus both signals of the stereo output are equal to the averaged sum of the stereo input signals - resulting in a complete lack of stereo width.

At other points along the length of the **SIDE IN ATTENUATOR** slider, the perceived stereo width is "in between" zero and the original stereo width, since the SIDE signal becomes attenuated/deemphasized in the decoder.

With **SIDE IN SCALE** set to 2X, the SIDE signal can be amplified to a relative level greater than the MID level, which creates a decoded stereo output that can be perceived as having an "extra wide" stereo image. In practice, this results in the left output signal getting a bit of phase-inverted right input signal, and vice-versa.

Expansion of the decoder formulas for arbitrary SIDE scaling factors is left as a super fun exercise for the reader which I'm sure everyone will do immediately.

EXTERNAL PATCHING

Aside from the “default” method of using the module to adjust the stereo width of an audio signal, mid-side encoding and decoding (and the scaling controls) can be used for all sorts of other creative patching, since the mid-side outputs can be patched out to other modules for processing and brought back into the mid-side inputs to be decoded.

Or you can try patching externally-generated signals directly into **MID IN** and **SIDE IN** to “decode” them into stereo left/right, and completely skip the encoder section (or use it for something else).

Applying filtering, dynamic compression, or other effects to either the mid or side component of a stereo signal can yield some really interesting and head-spinning results. There are just a few things to make note of in these experiments:

- Any shift to the overall amplitude of the MID or SIDE signals as a result of external operations will change the character of the perceived stereo image. Try playing with the level of the the MID and SIDE signals to dial it in
    - *The switch + slider can help for SIDE, but level must be adjusted externally for MID if you’re patching external signals back into* **MID IN** *or* **SIDE IN**
- Any external coloration/effecting of the SIDE signal which causes harmonic or phase shifts relative to the MID signal will sound *super cool* when decoded back to stereo, but will completely disappear if your final mix is summed to mono for playback. This is because of the nature of the mid-side decoding process; these colorations/phase changes will be 180 degrees out of phase on the resulting **OUT L** and **OUT R** signals
    - *Example: an often-recommended mid-side patch idea is to patch a mono signal through a multiple, into* **MID IN** *and also into a mono reverb, and then patch the full-wet reverb output back into* **SIDE IN***, and monitor* **OUT L/R** *in order to create a pseudo-stereo result from a mono effect processor.*
      In this type of patch, the wet reverb signal ends up 180 degrees out of phase in the decoded **OUT L/R** *signals, and summing the resulting stereo signals to a mono mix later will completely mask the reverb due to phase cancellation!*

Finally, all of the inputs on ~~DIS~~ENTANGLER are DC-coupled as well, meaning you can use those super fun math formulas above to do manipulations of CV signals too, which doesn't intuitively fit within the concept of "stereo image" but nonetheless can yield some fun results.

Read on for a few patch ideas to get you started!

PATCH IDEAS

STEREO WIDTH ADJUSTMENT

Simply patch a stereo signal into **IN L / R** and out of **OUT L/R** and you can use the slider and switch to adjust the width of the stereo image.

To add CV control, patch **SIDE OUT** through a VCA and back into **SIDE IN**, then add modulation to the VCA level to control the width. Use the slider and switch to scale the effect.

MID-IMAGE COMPRESSION/SIDECHAINING

Let's say you want to tame the classic kick sidechain compression pumping effect so that the ducking applies to the center of the stereo mix to make room for the kick, but doesn't duck the sides and leaves space for any stereo effects or panned content on a stereo voice or submix.

~~DIS~~ENTANGLER makes this easy:

After patching your stereo chain into **IN L/R** and out of **OUT L/R**, patch the **MID OUT** signal through a VCA and back into **MID IN**. Turn up the bias on the VCA so it's normally "open" at unity gain. Use an inverted (negative) envelope synced to the kick to "duck" the MID signal going through the VCA when the kick hits, and adjust the CV amplitude to taste.

This will cause only the center of the stereo image to duck with the kick, nudging the center part of the signal out of the way to make room for the kick but leaving the sides untouched.

SIDE-IMAGE FILTERING

We all love filters, but so many of them are mono! Make a pseudo-stereo, out-of-phase filter effect out of a mono filter by patching a stereo voice or submix into **IN L/R**, then patch **SIDE OUT** into a filter and back into **SIDE IN**. Add resonance and modulation to taste and listen to the **OUT L/R** outputs for a head-spinning out-of-phase filter effect.

You can also keep your low-end centered in a stereo voice or submix by using this technique to apply a non-resonant highpass filter to the SIDE channel.

Also try patching out to two different filters and then back in: one for MID and one on SIDE.

MONO SIGNAL PANNER

Short on panning controls for a mono voice? No problem, as long as you have a spare attenuverter / polarizing VCA around!

Patch your mono signal into **IN R** (yes, the RIGHT input), then patch **SIDE OUT** through an attenuverter or signal polarizer (e.g. Mutable Blinds) and back into **SIDE IN**. Listen to the stereo out of **OUT L/R**.

As you adjust the attenuverter, the mono signal will pan across the stereo field.

Attenuverter Fully Negative = Signal panned hard left
Attenuverter Zero / Muted = Signal centered
Attenuverter Fully Positive = Signal panned hard right

CV MATH / CV MACRO CONTROLLER

You can use ~~DIS~~ENTANGLER to create mathematically related CV signals from one or more LFO or other modulation source. For example, patch two CV sources into **IN L** and **IN R**, respectively. **MID OUT** and **SIDE OUT** can now be used as mathematically related CV signals:

MID OUT = voltage average of two CVs (voltage sum / 2)
SIDE OUT = voltage difference of two CVs divided by 2

With this patch you can also use **OUT L** and **OUT R** as “crossfaded” outputs for the CV signals, with the fader controlling the amount of crossfading as a sort of “macro control”. With the fader all the way up and the switch set to 1X, the CV produced by each output will be equal to the CV going into the corresponding input. As the fader goes down, the outputs will converge towards the voltage average of the two CV signals.

User Manual Changelog

Version	Date	Description
1.0.0	2024-10-01	Initial Release
1.1.0	2024-11-02	Update module specifications for Rev3

For troubleshooting and support, please contact support@infrasonicaudio.com