User Manual for

# SHUpHLER-III – stereo signal matrix




Version 1.1 (August 2024)

PHÆDRUS
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# Chapter 1 - Introduction

**The Phædrus Audio SHUpHLER-III is a high-quality stereo matrix product.**

# Chapter 2 - Safety

## General

Before using any piece of equipment manufactured by Phædrus Audio, be sure carefully to read the applicable items of these operating instructions and the safety suggestions. Keep them for future reference. Follow the warnings indicated on the unit, as well as in these operating instructions.

THE USER SHOULD NOT ATTEMPT TO SERVICE THE UNIT. ALL SERVICING SHOULD BE REFERRED TO QUALIFIED SERVICE PERSONNEL OR FACTORY ONLY.

Phædrus Audio products should NEVER be connected to the external power supply or in any other way energised when the case is opened and/or the circuit boards are accessible.

## General Safety Instructions

- Do not operate this equipment near any source of water or in excessively moist environments.
- Keep this equipment away from babies, children and pets.
- Do not let objects do not fall, or liquids be spilled, onto the enclosure.
- Situate this equipment away from heat sources or other equipment that produce heat.
- Ensure this equipment has adequate ventilation. Improper ventilation will cause overheating, and can damage the equipment.
- When cleaning this equipment, remove all connections to the unit; including power and gently wipe with a clean lint-free cloth; if necessary, gently moistened with lukewarm or distilled water. Use a dry lint-free cloth to remove any remaining moisture. NEVER use aerosol sprays, solvents, or abrasives on this equipment.
- This equipment should be serviced by qualified service personnel or returned to Phædrus Audio when: an object (or objects) have fallen into the enclosure; or liquid has fallen into, or been spilled into the unit; or the unit has been exposed to rain or high humidity; or the unit does not operate normally or exhibits a marked change in performance; or the unit has been dropped, or the enclosure has been damaged

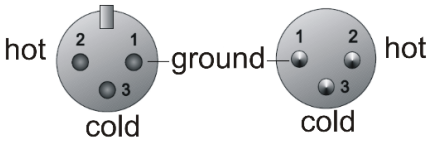
# Chapter 3 – Connecting the equipment

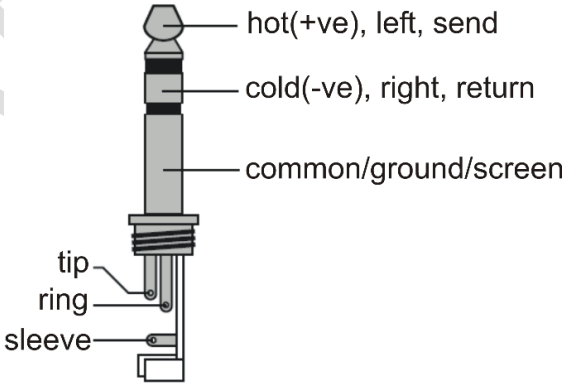
The rear of the panel Phædrus Audio SHUpHLER-III is illustrated here. Connecting the SHUpHLER-III is straightforward.


## Signal connections

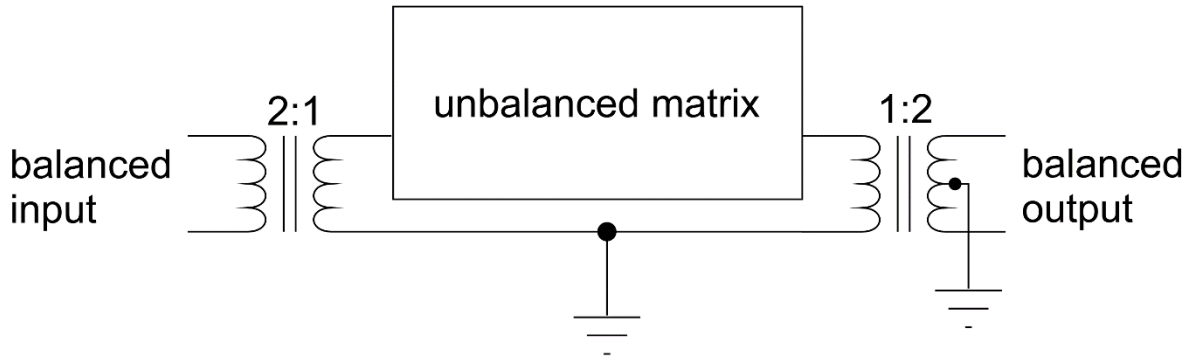
The SHUpHLER-III uses 3-pole, ¼" balanced jack sockets for balanced or unbalanced audio. Be sure to respect the correct channel polarity. The convention used in the Phædrus Audio SHUpHLER-III is the left channel is labelled I and the right II. The following graphic illustrates how balanced signals should be connected.

connections




When using the unit for unbalanced signals. Ideally, use stereo 1/4" jacks, and leave the **ring unconnected**: tip = signal, and the sleeve = earth. But mono jacks will work too.




The schematic illustrates the gain structure of the unit. Incoming balanced signals are reduced by 6dB to maintain headroom in the unbalanced unit. This gain is made up in the output circuitry which restores the level to that of the input and thereby provides an overall gain of 0dB. If the output is taken unbalanced, the gain of the unit will be -6dB.

## Power Supply

Make sure that the separate power supply is not energised before you connect the multi-way, screw-lock connector from the power supply to the SHUPHLER-III. The screw lock only needs to be taken to just finger tight. Do not overtighten. Finally plug in the power supply to the mains supply. The Phædrus Audio SHUpHLER-III preamplifier is ready to use.

# Chapter 4 – Operation and facilities

Phædrus Audio **SHUpHLER III** incorporates the following features:

- Five *stereo shuffling* circuits for
  - Cosine (figure of eight) microphones & pan-pot stereo
  - Binaural techniques (Blumlein's original "δ" technique)
  - Crossed Cardioids - unique, new circuit
  - Elliptical equaliser
  - Spaced microphones
- Balanced/unbalanced operation
- Clip indication (blue pilot light goes red)
- Flexible, line level connection at semi-pro and pro levels

Despite being discussed since the earliest days of stereophony, there remains much confusion about the term *Stereo Shuffling*. This is not surprising because the term actually refers to two, quite separate and different techniques.

Simply put, the earliest use of the term (coined by no less than Alan Blumlein, the inventor of stereo himself), refers to the processing of near-spaced omni' microphone signals so that they reproduce correctly on loudspeakers. The second *Shuffler* was invented some twenty years later for the processing of crossed, cosine (figure of eight) microphone signals to give better realism.

Why use the same name? Well the later "Shuffler" was invented by the same team who had worked with Blumlein before he was killed in WW2. Perhaps they sought to honour him in adopting the term which derived from him?

In any case, the Phædrus Audio SHUpHLER II incorporates *both type of historical Shuffler*, plus some newer shuffling (or matrix) processes, so that you can experiment and use these amazing techniques on your own recordings.

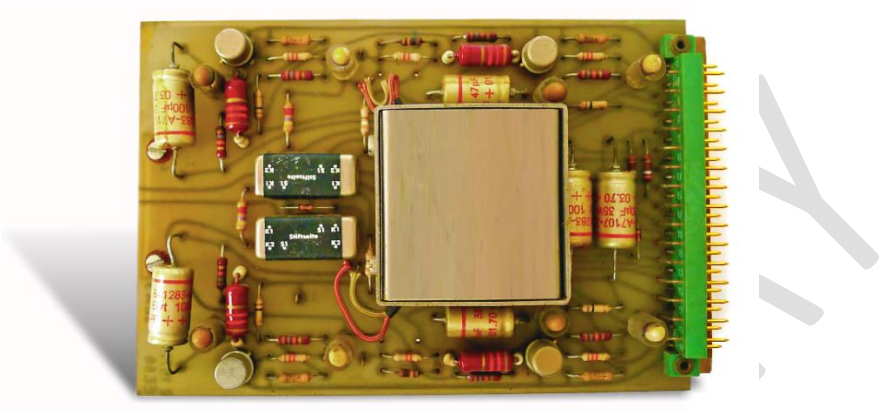
The Phædrus Audio SHUpHLER III is a line-level device which may be used in unbalalnced and balanced circits. The device has a high overload margin (>+18dBu), and low-noise, so that it's equally useable connected at insert-points, across the stereo bus/ stereo signal or used in a balanced or un-balanced send-return loop with a DAW.


The front panel of the SHUpHLER III is simplicity itself. In addition to the "off" position, five selectable shuffling techniques are available, each of which is described below.

## What the *correction* switch does

This is effectively the "OFF" position. In this position, the input signals are left unprocessed and simply pass through the low-distortion, low-noise line amplifiers.

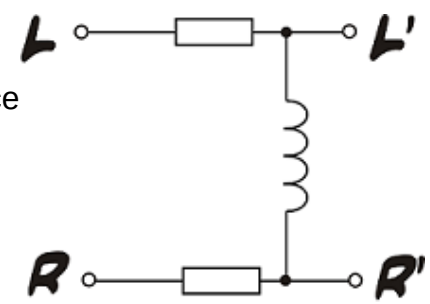
# ΣΔ - Neumann elliptical equaliser



Vertical modulation of the cutting stylus must be limited when cutting records because, if these modulations aren't carefully restricted, at the peaks of the wave the cutter chisel either digs so deep that it scrapes the aluminium substrate of the lacquer master disc or it produces a groove so shallow that the stylus slides out on playback. Out-of-phase information, or excessive L-R information is especially problematic when cutting a record because it causes these vertical movements of the cutter.

Mindful of the above, recording engineers are all taught not to plague their recordings with excessive energy in the channel-difference signal (bass and bass-drum are usually panned to the centre and so on). But large amounts of low frequency channel-difference energy can arise due to operational oversights. For example, spaced microphones can respond to very low-frequency air-conditioning or traffic noise and, by dint of their physical spacing, result in excessive channel difference information. The recording engineer, listening on small loudspeakers, may be completely unaware of the effect until the horror is unleased on the disc mastering team.

To contend with problems such as these, lathe electronics include a piece of equipment dedicated to eliminating vertical modulation below a certain frequency known as the **elliptical equaliser**.




This special equaliser (in the case of Neumann' lathes, the EE66 or EE70) is a relatively simple device, at the heart of which are just three impedances. The reactance of the cross-feed inductor (visible within its mu-metal can in the image of the EE70 above) is substantial at high-frequencies which ensures good channel separation. But, as the reactance of the inductor falls with reducing frequency, the channels separation is

reduced until – at a theoretical zero-frequency, when the reactance of the inductor is zero – the resulting L' and R' signals are identical and no channel-difference information exits at all.

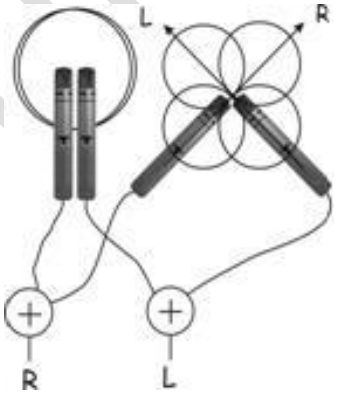
The elliptical equaliser in the Phædrus Audio SHUpHLER may be used in several ways. Clearly, it may be used as Neumann intended; to reduce problematical signals for a project destined for vinyl release. But, it may also be used to concentrate bass and bass-drum signals within the mix, and it works very well as a headphone shuffler - making mixes easier to judge on headphones. Or make listening simply more enjoyable on headphones.

**Elliptical equaliser as a headphone shuffler**

Recordings with instruments panned full left or full right produce a particularly odd sensation when reproduced with headphones. Early Beatles recordings are famous for this early stereo technique, as are many Blue Note jazz recordings. These recordings offer a very striking demonstration of the great advantage of elliptical shuffling technique for headphone listening.

The shuffling technique selected here is an entirely new technique and is intended to compensate for various shortcomings in crossed-cardioid recordings which are usually accused of lacking "spaciousness".

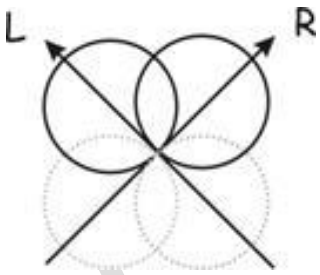
The directional response of a cardioid microphone is equivalent to the combination of a cosine (figure-of-eight) and omni-directional response. (In fact, the earliest cardioid microphones were made in this way). So, the signals from a crossed-pair of cardioid microphones are mathematically equivalent to those produced by a crossed pair of eights, mixed equally with a mono signal.




It's not surprising this technique is often accused of lacking "spaciousness".

The truth is, the only reason the crossed-cardioid technique gives reasonable results is due to the HF "beaming" of the microphones which cause high-frequency channel differences to predominate over the mono signal at higher frequencies.

One way to improve the situation is to set the microphones at a greater angle than 90 degrees, or separate them slightly, so as to add a time-delay "helper" cue, as is done in the ORTF and NOS arrangements. But, it is also possible to correct for the effect of the unwanted, omni-response electrically; and that is what is done in the SHUpHLER when the switch is in the ♥ position.




One special advantage of the electronic process is that the correction results in a suppressed rear-lobe. Because this looks like half of an eight response (see diagram), we term this technique, *Phædrus crossed-fours*™.

# FRANCI

Read Hugh Robjohns explanation of the problems with intensity-coded (pan-pot) stereo from the Sound on Sound review of the Phædrus Audio SHUpHLER at https://www.soundonsound.com/reviews/phaedrus-audio-shuphler

When the British team developed the Stereosonic, two-channel, stereo recording system after the war which killed its inventor Alan Blumlein, they incorporated special circuitry which corrects for known problems with a standard stereo signal.
In naming this special circuit, its inventors (H. A. M. CLARK, G. F. DUTTON and P. B. VANDERLYN) honoured their old boss (Blumlein) in borrowing the term he had coined for an earlier stereo processor and called it the *Shuffler*. Unfortunately, this borrowing of the earlier term has led to much confusion about stereo "shuffling" over the years because a "stereo Shuffler" is actually two, quite different inventions which share a common name!

For a full description of their work, Clark (et al.)'s paper is available here.

In effect what Clark, Dutton and Vanderlyn found was that, a standard, panned stereo signal (or that derived from crossed-mic's) has the drawback that, for a given position away from centre, or of the pan-pot away from the centre, the high-frequency components of a signal actually appear further from the centre in the reproduced "stereo-image" than do the lower frequency components. This is directly reproduced from their 1958 JAES paper.

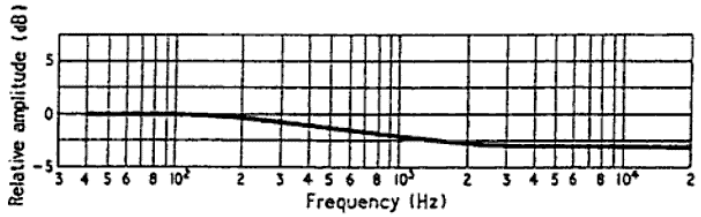
Subjective tests were made with a number of observers using two loudspeakers supplied with known relative voltages from a source of recorded music. First a filter was inserted passing all frequencies up to 700 c/s from a variety of sources of sound including male and female speech, solo, orchestral and brass-band music. The experiment was repeated using all frequencies above 600 c/s. Quite definite location within about $\pm 2°$ was obtained in each case, but whereas at low frequencies the angle was in agreement with that predicted from eqns. (1) and (2) for a given loudspeaker ratio, that obtained at high frequencies was greater. The relationship obtained is in agreement with that published by other workers who rely primarily on intensity differences.[15] By introducing a factor of approximately 0·7 into the ratio $(L - R)/(L + R)$ above 700 c/s, the results for high and low frequencies can be brought into line, except for extreme positions of the source.

The circuit to introduce the 0.7 loss-factor in the ratio (R - L)/(R + L) above 700Hz is the circuit Clark and his team called the *Shuffler*. To avoid confusion, we suggest that Clark's circuit be termed the *Stereosonic Shuffler*, reserving *Shuffler* for Blumlein's original circuit.

The result of not utilising this Stereosonic Shuffler, on a real music signal is a "smeared" stereo image in which the high and low frequencies are not "mapped" on top of one another. The image below is an attempt to give a visual analogy for this effect in which the acoustic effect is analogous to chromatic aberration in a lens, in which the high frequency blue light is refracted differently to the low-frequency red light.

The solution to this was to incorporate sum and difference circuits into the stereo bus of the mixers (derived in a series of transformers) and introduce HF loss into the difference circuits so that, when matrixed back to left and right signals, the required correction had been made.

This method however has the disadvantage that the HF-loss filter-circuits require phase-correction to be applied and moreover require that the sum circuit be delayed. The result, together with the matrixing transformers, is a very expensive assembly, illustrated below.

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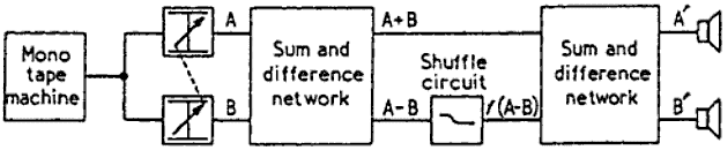


This expense, as well as irresolvable problems of slight audio colouration due to inaccuracies in the phase-correction circuits (note the hand-written "almost" and "substantially" in the text above.), led this vital circuit to be ignored in later stereo equipment. Uncorrected stereo was reckoned to be "good enough".

It's important to point out what this actually means: that *all stereo recordings are "broken" and have been since Electronic and Musical Industries' management sanctioned throwing the last of their tube mixers on the dumpster.* (Yes, they really did that!).

The SHUpHLER incorporates a modern (yet still completely passive) implementation of the *Stereosonic* Shuffler in which the uneven frequency-response and group-delay problems of the original implementation have been entirely resolved. This is the technique developed in the 1990s called FRANCINSTIEN. Audio demonstrations of the Stereosonic Shuffler are available here

## Blumlein δ - binaural to loudspeaker conversion

The greater part of Alan Blumlein's (1933) patent is concerned with a binaural stereophonic microphone arrangement in which,

> *"two pressure microphones a1 and a2 [are] mounted [20 cm apart] on opposite sides of a block of wood or baffle b which serves to provide the high frequency intensity differences at the microphones in the same way as the human head operates upon the ears".*

Blumlein noted that, when listened to with headphones, the direct output from the microphones produced an excellent stereo effect but, when replayed through loudspeakers, the stereo effect was very disappointing.

The transformation Blumlein required was the translation of low-frequency, inter-microphone phase differences into inter-channel intensity differences. To do this, he invented an ingenious circuit which he called the *Shuffler*. (His was the original use of the term.) A modern implementation of Blumlein's circuit is implemented within the SHUpHLER. The full technique is explained here.

The advantages to the recording engineer of this technique are legion. Omnis are usually considered to sound slightly more "open" and "uncoloured" than their cardioid brothers; even as mono microphones. This is due to the acoustical devices which cardioid mic's employ to deaden the sound in the rear lobe of the directional response. Most agree that the stereo recordings with the best stereo "image" are derived from crossed cardioids or cosine (figure-of-eight) microphones. But many engineers are prepared to sacrifice stereo image just to be able to use the more natural sounding omni's.

Using "Blumlein delta" (Blumlein δ) technique, this compromise is no longer necessary: omni's may be employed to capture pin-point sharp stereo images. The microphones should be placed about 22cm apart (not widely spaced as in conventional technique). Various baffles may be inserted between the microphones to good effect too, so this technique suits various binaural and quasi-binaural microphone arrangements like the Jecklin's OSS disc, Faulkner's "Phased-array", the various spherical microphone baffles and the in-ear microphones available on the market. (In fact Blumlein saw the δ technique as a binaural to loudspeaker-stereo conversion process: which is what it is!)

An example of the process is given here as a FLAC file. Once again, The first part of the musical extract is the signal direct from near-spaced omni microphones and the reprise is treated with the Blumlein δ process. Beware.. FLAC is great but the file sizes are appreciable! An alternative 192kbps mp3 file is here.

The technique of near spaced microphones may even be extended to use near-spaced cardioids which enables very nice recordings to be made which suppress rear pick-up. In fact, even hyper-cardioids and gun microphones may be employed which permit good, full-width stereo recordings to be made of relatively distant events - something which no other technique can achieve. This has obvious applications to TV, film and live theatre and music.

# BoF

BoF stands for Bride of FRANCINSTIEN which is very new shuffling technique. The BoF technique is a development of the original FRANCINSTIEN circuit which was launched during the 1990s.

Phædrus Audio recommend that you experiment with both the BoF matrix and the original Stereosonic matrix for processing panned-stereo recordings and for processing stereo signals derived from crossed microphones. We conjecture that, because all, practical microphones tend to "beam" and become more directional with frequency, recordings made in this way have an even greater frequency-dependant smearing effect compared with those derived entirely from pan-pots. Because the Stereosonic matrix position introduces a greater degree of HF narrowing than does the newer BoF matrix, it may better compensate for HF beaming effects in crossed microphone recordings. However, as with all things in the art/science of recording, it's unwise to be pedantic: experimentation is the name of the game!

An example of the BoF Shuffler process is given here as a FLAC file. The first part of the musical extract is the signal direct from the mixer and the reprise is treated with

the *Bride of FRANCINSTIEN* Shuffler process. An alternative 192kbps mp3 file is here.

More information on beaming in cosine microphones is given here.

**The table below gives our recommendations for the various SHUpHLER matrices which may be applied in various recording situations.**

**Type of SHUFFLER**

| Mic' arrangement | Elliptical | ♥ | FRANCI | Blumlein δ | BoF | OFF |
|---|---|---|---|---|---|---|
| Crossed cardioids | Good results | Ideal*: Crossed-fours™ | Good results | Not suitable | Good results | No processing |
| Crossed cosines | Good results | Possible; widens image | Ideal* | Not suitable | Good results | No processing |
| Pan-pot | Good results | Possible; widens image | Good results | Not suitable | Ideal* | No processing |
| Near spaced omnis | Good results | Possible; narrow image | Worth a try! | Ideal* | Worth a try! | No processing |
| Near spaced cardioids | Good results | Possible; narrow image | Worth a try! | Ideal* | Worth a try! | No processing |
| Near spaced hypercardioids | Good results | Possible; narrow image | Worth a try! | Ideal* | Worth a try! | No processing |
| Binaural microphones | Good results | Possible; narrow image | Worth a try! | Ideal* | Worth a try! | No processing |
| Phased array cosines (Faulkner) | Good results | Possible; narrow image | Good results | Ideal* | Good results | No processing |
| Wide spaced omnis | Good results | Not suitable | Good results | Not suitable | Good results | No processing |
| NOS | Good results | Worth a try! | Good results | Good results possible | Good results | No processing |
| ORTF | Good results | Worth a try! | Good results | Good results possible | Good results | No processing |
| Decca Tree | Good results | Not suitable | Good results | Not suitable | Good results | No processing |

*The term "Ideal" refers only to a theoretical ideal: artistic judgments may differ.

## RESOLVE PSU


The SHUpHLER-III is supplied with an all-region, universal plugtop power supply. Its performance is very good. A-weighted equivalent input noise is below -100dBu using this unit.

However, for the very best performance, we suggest the Phædrus RESOLVE PSU. This reduces equivalent input noise to -108dBu. This increases the dynamic range of

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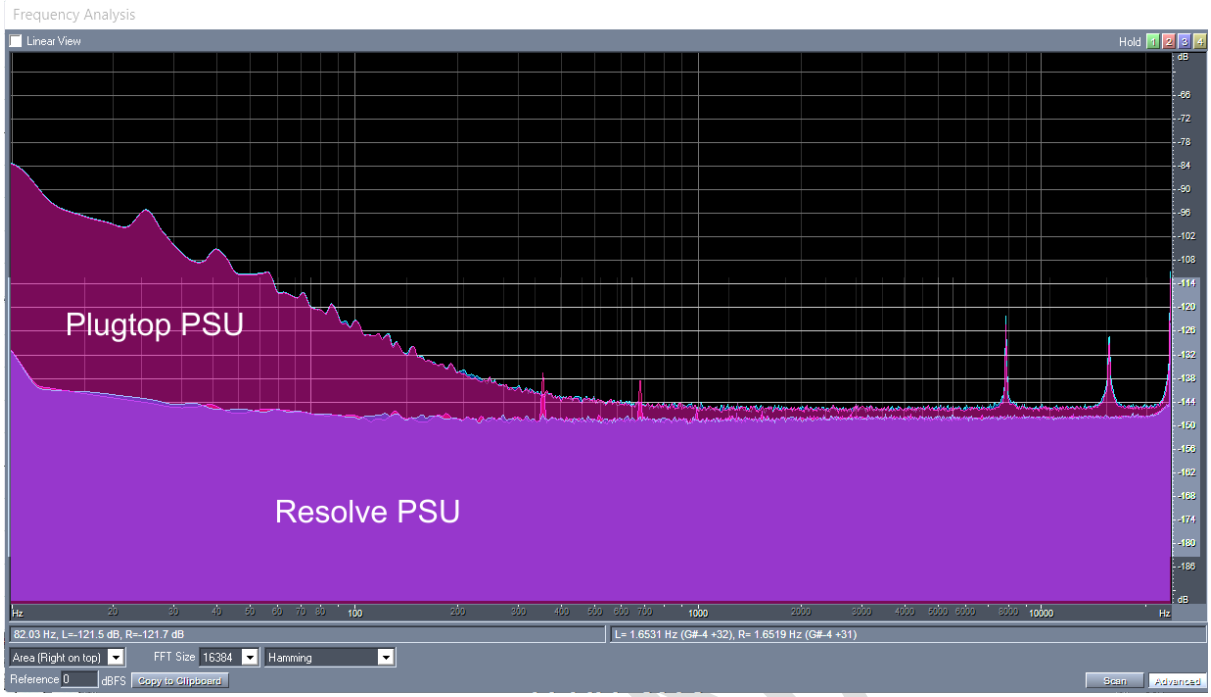
the unit to 126dB. A plot of the noise spectrum (unweighted) of the plugtop PSU and the RESOLVE PSU is given.




# Appendix 1 - Specifications

## SHUpHLER-III Stereo Matrix

**Size:** 112 × 50 × 225 mm (W-H-L)
**Power Supply:** Low-noise +12V DC input on screw locking connector
**Power:** Compatible with European Eco-Consumption directives*
**Inputs:** Balanced or unbalanced on 3-pole, ¼" jack. Tip is "hot". (Unbalanced: tip = signal, ring and body = earth)
**Gain:** 0dB non-inverting, in balanced or -6dB in unbalanced operation
**Frequency response:** 5Hz to 50kHz (-1dB) in bypass mode
**Distortion:** Better than 0.005% THD on 1kHz at 0dBu input
**Equivalent input noise:** -102dBu (supplied plugtop PSU, A weighted)
**Equivalent input noise:** -108dBu (**RESOLVE PSU**, A weighted)
**Max input:** Greater than 18dBu balanced†: +12dBu unbalanced
**Max output:** Greater than 18dBu balanced†: +12dBu unbalanced
**Headroom indicator:** Operation LED (normally blue) flashes red at level -1dB from headroom limit

* The unit is intended to remain energised all the time and still conforms with the European Union's Ecodesign Directive (Directive 2009/125/EC).
† Operation according to EBU R64-1992: PPM4 = 0dBu = -18dBFS

***Phædrus Audio reserves the right to alter specifications without notice.***

# Appendix 2 - Warranty and service

## Service

If you experience a problem with a Phædrus Audio product, contact support@phaedrus-audio.com. We will diagnose the problem remotely and advise you of the warranty status. If a repair or replacement is required, we will issue a Return Merchandise Authorization (RMA) number and tell you where to send the unit to be repaired. You MUST have an RMA number before you return the equipment to Phædrus Audio's support service. Phædrus Audio will not accept responsibility for loss or damage in shipping or for equipment returned without valid paperwork and/or a valid RMA number. Remember, warranty is void if product serial numbers have been removed or altered, or if the product has been damaged by abuse, accident or unauthorized modification and/or repair (see Phædrus Audio Limited Warranty for details). There are no user serviceable parts inside.

PLEASE RETAIN YOUR SALES RECEIPT. IT IS YOUR PROOF OF PURCHASE COVERING YOUR LIMITED WARRANTY. LIMITED WARRANTY IS VOID WITHOUT SUCH PROOF OF PURCHASE.

## Phædrus Audio's Limited Warranty

***Warranty service conditions are subject to change without notice. For the latest warranty terms and conditions and additional information regarding Phædrus Audio limited warranty, please see complete details online at www.phaedrus-audio.com.***

# Appendix 3 - Declaration of Conformity

The Manufacturer of the Products covered by this Declaration is

**Phædrus Audio**
**Newtown House**
**38 Newtown Road**
**Liphook**
**Hampshire**
**GU30 7DX**

The directives covered by this declaration are:

**2014/30/EU Electromagnetic Compatibility directive**
**2014/35/EU Low Voltage Equipment directive**
**UK Statutory Instrument 2012 No. 3032 The Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Regulations 2012**

The products covered by this declaration are:
**SHUpHLER-III stereo matrix**

The basis on which conformity is being declared: The manufacturer hereby declares that the products identified above comply with the protection requirements of the EMC directive and with the principal elements of the safety objectives of the Low Voltage Equipment directive, and that the following standards have been applied:

IEC INTERNATIONAL STANDARD 60065: 2005. - Audio, video and similar electronic apparatus – Safety requirements

The technical documentation required to demonstrate that the products meet the requirements of the Low Voltage Equipment directive has been compiled and is available for inspection by the relevant enforcement authorities. The CE mark was first applied in 2020.

Signed:

Richard Brice, Technical Director Date: June 2023