User's Guide

LNI-2 DC

Better Power

Super Low Noise DC Power Filter & Stabilizer
Galvanic Isolation between Input and Output
Integrated HF / RF Filter
Universal 9 – 18 Volt DC Input
12 Volt 2 A 24 Watts DC Output
Ultra Low Noise µFilter
Sensor Technology
Overload and Overheating Protection
Short Circuit Proof
GND Connection Option
Compact & Portable

Heat Notice

Surface may become hot during operation – ensure sufficient ventilation. Avoid direct sun light and do not place it near other sources of heat, like radiators or stoves. Leave some space between this device and others for ventilation.

Unauthorized servicing/repair voids warranty. Only use accessories specified by the manufacturer.

Read the manual completely. It includes all information necessary to use and operate this device.

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- **General**

1. Introduction

Thank you for your confidence in the RME LNI-2 DC. This worldwide unique tool cleans and decouples your audio device from any power source, no matter how good or bad that one is. It provides a super-clean 12 V DC, highly stabilized and noise free. Despite its astonishingly small size, the LNI-2 DC delivers 24 watts of pristine power to any connected 12 Volt device.

This manual will guide you through the functions, features, and other interesting facts about the LNI-2 DC. Enjoy!

2. Package Contents

- LNI-2 DC
- DC Sensor connection cable with lockable DC plug 2.1x5.5 mm, 1 m
- DC Sensor connection cable with DC plug 2.1x5.5 mm, 1 m
- Manual

3. Proper Use

- Input voltage 9 - 18 Volt DC, center pin +
- Connection of a device that uses 12 Volt and less than 2.0 Amps (< 24 Watts)
- DC output plug: Positive inside, Negative/GND outside

4. Brief Description and Characteristics

- Super Low Noise DC Power Filter & Stabilizer
- Galvanic isolation between input and output
- HF and RF filter on input
- Housing milled from a solid block of aluminum
- Coupling capacity 35 pF
- Output µFilter with µFilter technology
- Sensor compensation technology
- Noise typical < 2 µV
- Overload protection
- Short circuit protection
- Overheating protection
- Status display via 2-color LED
- Low idle power consumption (0.7 Watt)
- GND terminal to ground the DC output to other devices or PE
- Small, compact, portable

5. Connectors – LED

On the **top** of the LNI-2 DC, near the rear output jack, an LED signals normal operation (white) or failure (red). The LED near the input jack confirms input voltage.

On the **back** of the LNI-2 DC you will find a lockable DC input jack, a ground terminal, and the lockable DC output µFilter.

The **ground terminal** has a fixed connection to the housing and the DC output minus (GND). It can be used to connect other grounded devices directly, or to connect the whole system to PE.

The **DC output socket** is lockable, the matching special cable with lockable 4-pin round plug is included. The cable features a widely used 5.5x2.1 mm DC plug, in a lockable and a non-lockable variety.

! *RME devices use the lockable plug, but the socket on the device also fits the non-lockable one. Conversely, however, the lockable plug often makes insufficient contact on devices without such a socket. Therefore, the non-lockable plug should be used there.*

Note: After complete insertion of the lockable plug into the device to be powered, it must be turned 90° for locking. If the connected device fails when the cable is moved, the plug is NOT correctly inserted in the socket!

5.1 Connector Pinouts

DC Special Cable

The special DC cable with sensor leads has the standard 5.5x2.1 mm DC connector on one side, with and without locking plug.

The connection to the LNI-2 DC is made via a Kycon KPP-4P connector, with 4 poles, shell and locking function.

Pinout

Kycon KPP-P4		DC Connector	Function µFilter	Function Linear
Pin	**Cable**	**Pin**		
1	**Red**	**Outer (-)**	**GND**	**GND**
2	**Brown**	**Inner (+)**	**+12 V**	**+12 V**
3	**Green**	**Outer (-)**	**Sense GND**	**GND**
4	**Black**	**Inner (+)**	**Sense +12 V**	**+12 V**
Shell	**Pin 1**		**Plug detection**	**Plug detection**

6. Installation and First Time Operation

- Plug the enclosed DC power cable into the µFilter output. The flat side of the 4-pin round plug is on top.
- Connect the other side of the DC cable to the device to be powered (e.g. ADI-2 DAC).
- Plug a suitable DC power source into the LNI-2 DC input jack.
- The top LEDs should both turn on in white color.

Now the connected device can also be switched on and should start properly.

7. Using the Ground Terminal

GND terminal: Connects to the ground of the DC output and the unit's housing. This features might come in handy when there is a need to ground a system. Examples:

- Another unit in the audio path is fed from an ungrounded SMPS, and the leakage current becomes audible. Connect the GND terminal to a metal water pipe, heating radiator or any other proper ground.
- A humming or buzzing noise becomes audible for unknown reasons. Solution as before.

8. Hotline – Troubleshooting

The device becomes very warm

- As long as the LED does not indicate an error condition, this is normal. The LNI-2 DC housing serves as heatsink. The higher the current demand of the connected device, the warmer the unit will get.
- Operate the device as a free-standing unit
- Do not operate the unit on top of or below other heat sources. Always place the device next to another device - or further away.
- Do not place on or under a cloth or pillow.

The LED lights up red, the connected device does not get any power.

- The device has overheated. It will work again after cooling down
- The device has been permanently overloaded - too high current demand
- Short circuit at the output - disconnect DC cable, check if LED turns white
- Check the connected power source – working and in spec?
- If the LED remains red even after cooling down and removing the DC cables, the LNI-2 DC might be defective. Please contact your dealer or the RME sales department.

The LNI-2 DC will no longer turn on, the LEDs remain dark.

- Check that the power source works and is connected properly to the LNI-2 DC input jack.

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Technical Reference

9. Technical Specifications

9.1 DC Input

- Input voltage range: 9 – 18 V DC
- Polarity: Center +, Outside -
- Connector: 2.1x5.5mm, lockable or normal
- Power consumption idle: 0.7 Watt
- Power consumption typical, 12V input, 2 A load: 31 Watts

9.2 DC Output µFilter

- Output voltage: 12.0 V
- Continuous output current: 2.0 A
- Continuous output power: 24 Watt
- Maximum output current: 3.0 A
- Noise @ 0 - 3 A, AES17: < 2 µV, < 1 µV A-weighted
- Noise @ 0 - 3 A, 100 kHz bandwidth: <3 µV, < 2 µV A-weighted
- Output impedance including cable: 0.012 Ohm
- Load Regulation (0/1/2 A): 0.20 %
- Overload protection: > 3.0 A
- Overheating protection: > 80 °C (176 °F)
- Undervoltage detection: < 9.0 V
- Short circuit current (LED red): <0.1 A

- Filter (decoupling) efficiency, 10 Hz – 1 kHz: >110 dB
- Filter (decoupling) efficiency, 1 kHz - 200 kHz: >70 dB

9.4 General

- Dimensions (WxHxD): 80 x 30 x 123 mm, 3.15“ x 1.18“ x 4.84“
- Weight: 605 g (1.33 lbs)
- Temperature range: +5 °C up to +40° Celsius (41 °F up to 104 °F)
- Relative humidity: < 75%, not condensing

10. Technical Background

10.1 Differences Linear and Switched Power Supplies (LPS, SMPS)

A **linear power supply** (LPS) consists of a transformer, rectifier and capacitor, as well as a voltage regulator for a constant output voltage. The voltage regulator also significantly reduces the residual ripple voltage after rectification. A large part of the power loss occurs at the voltage regulator, since its input voltage must be significantly higher than the desired output voltage for various reasons - a linear power supply cannot be easily implemented with so-called low drop regulators, because the mains voltage can vary by more than 20%.

Advantages: Very clean output voltage possible. No generation of high frequency switching noise. No issues with leakage current (although the effect also exists with linear power supplies).

Disadvantages: Low efficiency, therefore high power loss and high heat dissipation. High weight due to very large transformer. High risk of magnetic stray field due to large transformer, including the generation of magnetically excited ground loops. Reacts strongly to fluctuations in mains voltage. Comparatively expensive.

A **switched mode power supply** (SMPS) consists of a rectifier and capacitor. The very high DC voltage obtained in this way is chopped at high frequency and fed to a transformer, which provides galvanic isolation and divides the voltage. Additional filtering and stabilization on the output side is also common.

Advantages: Very small and light. Very high efficiency (> 80%), very low heat dissipation. No generation of large and low frequency magnetic fields, thus no magnetic ground loop excitation. Accepts any input voltage between 100 and 240 volts, therefore does not react to fluctuations in mains voltage. Comparatively inexpensive.

Disadvantages: Output voltage does not have low-frequency noise, but often has high-frequency noise due to switching technology. Leakage current of up to 200 µA is typical. In ungrounded systems it causes various effects, from hum-buzzing to mild electric shock (> 90 V AC on housing parts).

Our conclusion
Both systems have their advantages and disadvantages, and both can be significantly improved in detail to eliminate some of the drawbacks. Example:

Linear power supply: Efficient magnetic shielding of the transformer. Use of a quality transformer that does not go into magnetic saturation early, causing generation of an even more interfering stray field. Use of passive pre-filtering (choke) and a floating voltage regulator to reduce power dissipation. Use of a highly efficient switching regulator on the secondary side for minimum power dissipation despite fixed output voltage (this is not comparable to a switching power supply, e.g. there is no comparable leakage current generated).

All this can be found in RME's amazing DPS-2!

Switching power supply: Grounding of the DC side via a high impedance resistor to PE of the primary side eliminates all effects of leakage current. Additional LF and HF filters on the output side reduce noise.

The additional grounding with resistor is a feature of RME's new switching power supplies with IEC socket, which RME successively adds to the devices. Additional filtering is also available with the *LNI-2 DC*, which includes galvanic isolation and the complete µFilter technology. It can be used behind any normal 12 V power supply and dramatically improves DC stability and ripple/noise.

10.2 Galvanic Isolation

Galvanic isolation describes the complete electrical separation of two circuits. For example, the standard transformer provides galvanic isolation between the input (such as 230 V AC) and its output. The output is therefore also electrically isolated from the mains net.

However, due to the capacitive coupling of the primary and secondary windings, there is still a residual coupling. This can be easily measured, it is typically about 1 nF (nanofarad, 10^{-9}), and is mainly noticeable in the higher frequency range.

The galvanic isolation of a DC connection is much more complicated than the example of a simple transformer connected to alternating current. If this is also to be done in excellent quality, it becomes even more complicated. Especially the capacitive coupling makes the difference. In the LNI-2 DC, it is not 1 nF as in the transformer, or 500 pF (picofarad, 10^{-12}) as in typical switching power supplies, but around 35 pF. This presents an effective barrier and perfect separation of input and output voltage on the LNI-2 DC.

10.3 Leakage Current

Leakage current and leakage voltage are terms that only became generally known with the introduction of switching power supplies. Almost all of these include an interference suppression measure in the form of a capacitor connecting the primary and secondary sides. This results in a high-impedance AC voltage at the DC output of typically half the line voltage. High impedance means harmless, since no large current can flow. But current and voltage can easily be measured even with cheap multimeters, and often felt. Be it the famous vibration when stroking the lid of a MacBook, or a tingling sensation on sharp case edges, which already feel like a slight electric shock.

The leakage current can also be clearly audible, as a buzzing noise, depending on the device configuration and where and how the current flows. The main problem here is rather one of the power supply manufacturers, because they have denied a remedy as simple as useful to the audio industry for many years: if a power supply is not operated ungrounded (2-pin mains plug) but grounded (3-pin IEC socket) the leakage current flows off directly at the source. And therefore has no negative effects on the audio equipment anymore, so it remains inaudible. Nevertheless, manufacturers have refused to provide grounded versions of their small wall warts for many years.

There are also more cleverly designed – and quite expensive - switching power supplies with lower leakage current, mostly for the medical sector. If the leakage current drops from an effective 50 µA to 5 µA, that sounds like a lot. But expressed in dB this is -20 dB. And not enough to make an audible interference signal inaudible. In this case better does not mean good enough, unfortunately.

A less known fact is that linear power supplies also have leakage current which remains unnoticed, because it has no negative effects there for various reasons. One reason is that linear power supplies are usually grounded via the earth contact (which also helps with switching power supplies, see above). Another reason is that the typical capacitance between primary and secondary side mainly stems from the capacitive coupling within the transformer. And this turns out to be lower than the one in typical switching power supplies. The leakage current of a transformer also consists of the original sine wave of the mains voltage, i.e. a comparatively clean 50 Hz, while in a switching power supply numerous harmonics are added due to the regulation function, which makes the leakage current audible in the first place.

! *With its galvanic isolation between input and output, and a coupling capacity of only 35 pF (pico Farad) the LNI-2 DC easily removes any leakage current and its side effects on audio.*

10.4 µFilter

RME's *µFilter* (micron filter) comes with a number of surprising features. First of all, the µFilter is a discrete Ultra Low Noise linear regulator with an extremely low noise output (a few µV, hence the name µFilter). Since it is internally supplied with a constant +13 volts by the galvanic isolator circuit, it has a comparatively low power dissipation to deal with.

To push voltage stabilization to the extreme, the µFilter also features 2-wire sensor technology, directly connected to the 5.5x2.1 mm DC connector of the supplied, special 4-wire cable. This sensor function on ground and positive line guarantees +12.0 V at the end of the cable, both at no load and at 3 A load, and therefore achieves a sensationally low output impedance and low load regulation (in percent - the smaller the value the better). See chapter Technical Specifications.

From soft start to thermal overload and short circuit protection, everything that makes a power supply safe is also found here.

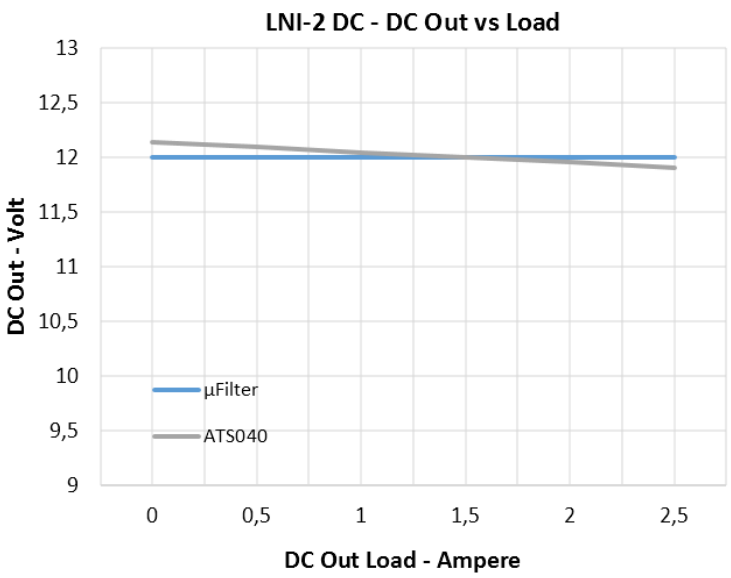
This output works quasi load-independent (see below), always reaching maximum performance. The measured 2 µV correspond to -114 dBV. Thus broadband noise is a whopping 135.6 dB lower than the delivered DC of 12 V.

The µFilter output also shows its output status via an LED on the top: normal operation (white), overload and short circuit state (red).

10.5 Influence of load on DC output voltage

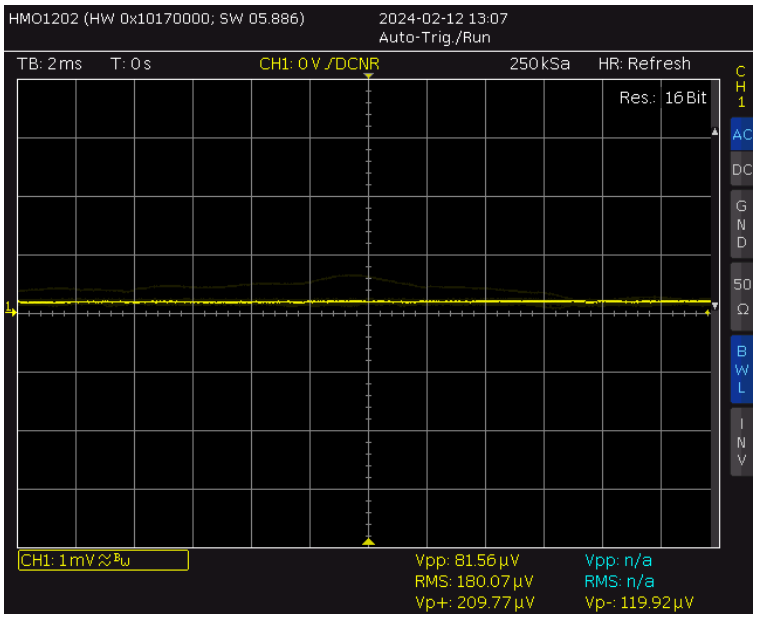
A detailed analysis of the available output voltage and current is provided in the following diagram, which shows the output voltage with increasing load. The output µFilter stays at exactly 12.0 Volt, no matter what load is present.

For comparison the diagram also shows the 40 Watt switching power supply included with the ADI-2/4 Pro. The drop of the output voltage under load here is due to the resistance of the DC cable, which – unlike the one supplied with the LNI-2 DC - is not sensor-corrected.



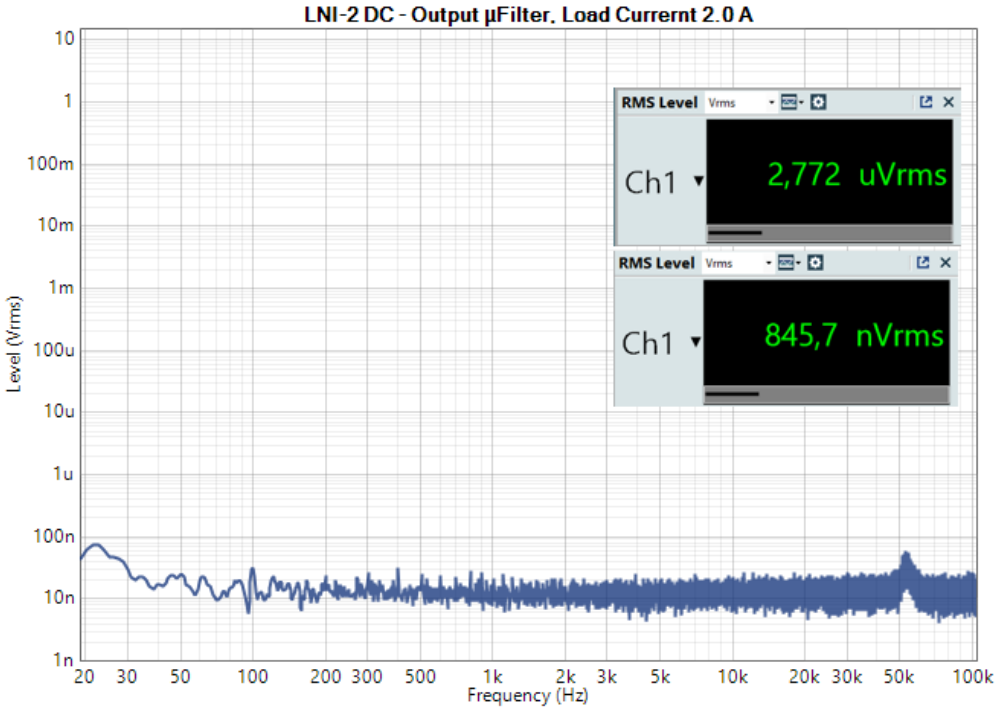
10.6 Measurements

Oscilloscope at the DC output µFilter, output current 2 Amps / 24 Watt

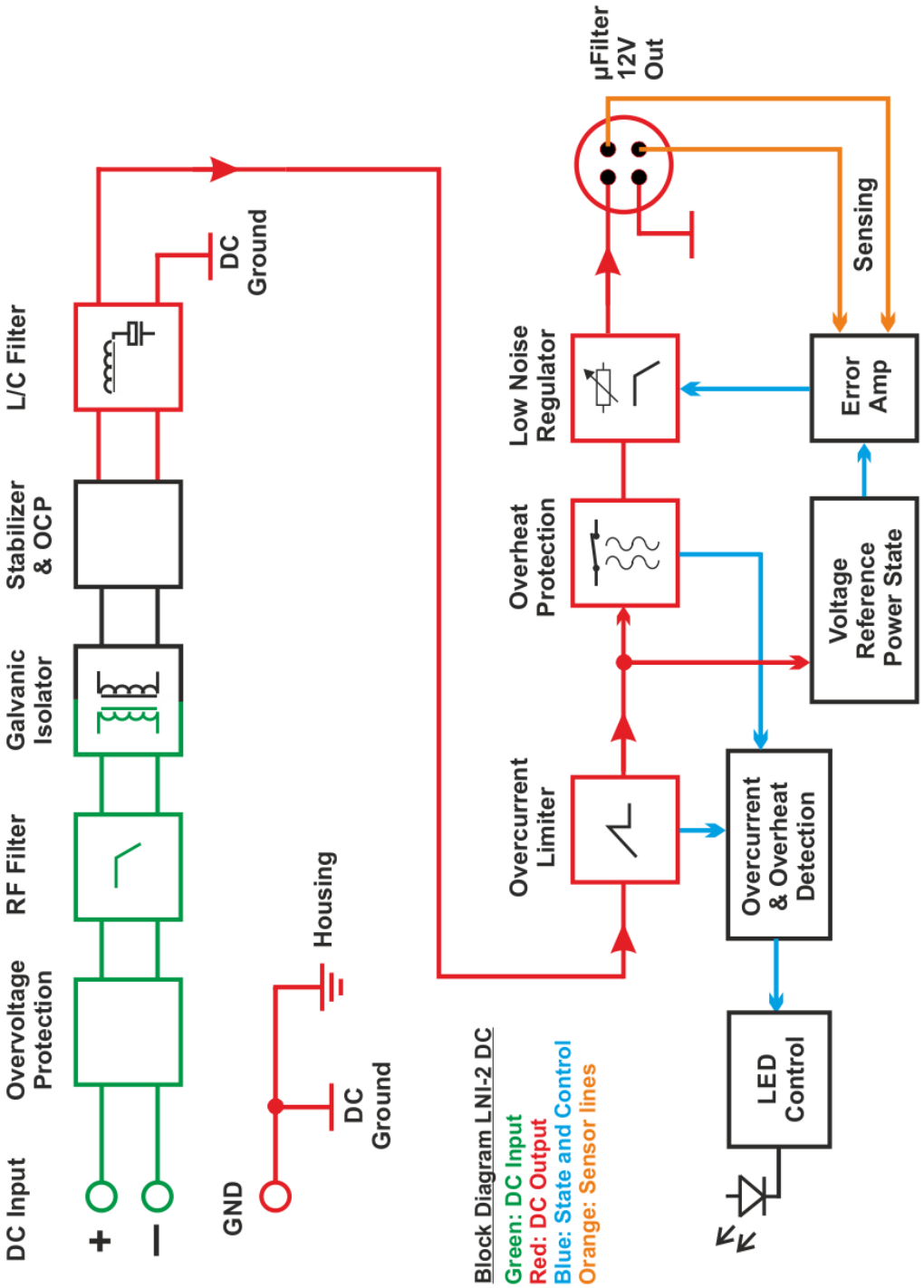


The screenshot of the oscilloscope shows – nothing. Reason: Measuring a clean power supply as the LNI-2 DC with an oscilloscope is useless, because it cannot resolve and display the small noise of only a few µV (microvolt). Therefore the following measurement was made with a measurement system that can perform analysis down to 1 µV (millionth of a volt), a thousand times higher resolution.

Output µFilter, output current 2.0 Amps / 24 Watt
Measured values rms unweighted and A-weighted, Bandwidth 100 kHz



11. Block Diagram LNI-2 DC



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Miscellaneous

12. Accesories

Part Number	Description
DClock1	4-pin DC cable with lockable connector, length 1 m
DCunlock1	4-pin DC cable with non-lockable connector, length 1 m
NT-RME-2	Robust and light-weight switching power supply, 100 V-240 V AC, 12 V 2 A Available with lockable and normal DC connector.

13. Warranty

Each individual LNI-2 DC undergoes comprehensive quality control and a complete test before shipping. The usage of high grade components should guarantee a long and trouble-free operation of the unit.

If you suspect that your product is faulty, please contact your local retailer. Do not open the device by yourself as it may get damaged. It has been sealed with tamper-evident material, and your warranty is void if those seals have been damaged.

Audio AG grants a limited manufacturer warranty of 6 months from the day of invoice showing the date of sale. The length of the warranty period is different per country. Please contact your local distributor for extended warranty information and service. Note that each country may have regional specific warranty implications.

In any case warranty does not cover damage caused by improper installation or maltreatment - replacement or repair in such cases can only be carried out at the owner's expense.

No warranty service is provided when the product is not returned to the local distributor in the region where the product had been originally shipped.

Audio AG does not accept claims for damages of any kind, especially consequential damage. Liability is limited to the value of the LNI-2 DC. The general terms of business drawn up by Audio AG apply at all times.

14. Appendix

RME news, driver updates and further product information are available on RME's website:

https://www.rme-audio.com

Worldwide distribution: Audio AG, Am Pfanderling 60, D-85778 Haimhausen, Tel.: (49) 08133 / 918170

Support via e-mail: support@rme-audio.com

List of international supporters: https://www.rme-audio.de/support.html

RME user forum: https://forum.rme-audio.de

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15. Declaration of Conformity

CE

This device has been tested and found to comply with the limits of the European Council Directive on the approximation of the laws of the member states relating to electromagnetic compatibility according to RL2014/30/EU, and European Low Voltage Directive RL2014/35/EU.

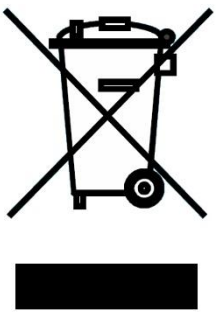
Proper Use

The LNI-2 DC is designed to power devices such as preamps, DACs, and AD/DA converters that operate at typically 12 volts and require less than 2.0 amps of current (< 24 watts), and whose DC jack inner terminal is positive. Operation with differently specified devices may lead to a defect of the LNI-2 DC or the connected devices.

RoHS

This product has been soldered lead-free and fulfils the requirements of the RoHS directive RL2011/65/EU.

Note on Disposal



According to the guide line RL2012/19EU (WEEE – Directive on Waste Electrical and Electronic Equipment), valid for all european countries, this product has to be recycled at the end of its lifetime.

In case a disposal of electronic waste is not possible, the recycling can also be done by Audio AG.

For this the device has to be sent **free to the door** to:

Audio AG
Am Pfanderling 60
D-85778 Haimhausen
Germany

Shipments not prepaid will be rejected and returned on the original sender's costs.

FCC

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) This device must accept any interference received, including interference that may cause undesired operation.

> Warning: Changes or modifications to this unit not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Responsible Party in USA:
Synthax United States, 6600 NW 16th Street, Suite 10, Ft Lauderdale, FL 33313
T.:754.206.4220

Trade Name: RME, Model Number: LNI-2 DC

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.

- Increase the separation between the equipment and receiver.

- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.

- Consult the dealer or an experienced radio/TV technician for help.