

*Jo. Fahl*  
Zähl



# ZÄHL HM1

Manual V 1.3



## HM1 Reference headphones mixing amplifier

Reference Amplifier with unprecedented transparency and precision, attention to detail and massive power performance.

Rich feature set for both high-end enthusiasts and professional users.

- perfect impulse reproduction
- ultra wide frequency response
- extremely low impedance output precisely controls complex loads
- pure analogue design
- consistent dual-mono layout
- logic circuits without clock generators
- straight linear power supply with power transformer in external housing
- no-compromise selection of components
- no-compromise interior and exterior construction

Designed and manufactured in Germany.

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# NOTES, SAFETY INSTRUCTIONS, WARRANTY

1. The equipment must only be used for the purpose described in this manual.
2. Keep the manual for further reference. When passing the equipment on, enclose the manual.
3. Do not operate the equipment at
  - very high air humidity (>85% relative humidity)
  - high ambient temperature (>40°C) or in the vicinity of heat radiating equipment or objects
  - places which are exposed to solar radiation
  - very low temperatures (<5°C)
4. Ensure appropriate air ventilation.
5. Do not store the equipment at temperatures below -20°C or above +50°C.
6. Do never expose the equipment to environmental conditions which can lead to the incidence of condensation water.
7. Do not expose the equipment to mechanical stress or shock.
8. Ensure that liquids cannot get into the equipment.
9. Ensure that foreign objects cannot get into the equipment.
10. Only operate the equipment on a safe, legally approved, mains power supply
11. Only clean the equipment with smooth cleaning tissues and soft detergents.
12. Never open the equipment.
13. In case the equipment has been dropped or there is any external or functional damage, do not continue to operate the equipment. Have the equipment checked at your dealer's workshop or a person who is qualified to do such checks.
14. When shipping, use a package which protects the equipment from environmental impact such as mechanical shock or humidity.
15. Manufacturer's warranty covers the equipment to be free from defects of quality at the time of delivery for a period of 36 month presumed that
  - the equipment was treated properly according to its intended use
  - all information and safety instructions given in this manual have been followed
  - the equipment shows no external damage
  - the equipment is shipped to the manufacturer or to an authorised repair-shop free of charge
  - a proof of purchase is supplied
  - a detailed failure description is supplied

The manufacturer takes over cost of parts and labour incurred by repair. Unless otherwise agreed any other costs including shipping and packaging will be charged.

16. We expressly exclude any liability for incidental or consequential damages which might arise from operating the equipment, including failure of the equipment.
17. All information in this manual has been carefully reviewed. It has been updated at the time of passing for press. Nevertheless we do not take over any liability for sufficiency or errors.
18. EEC Declaration of Conformity: The equipment applies to applicable EMC rules 2014/30/EU

# SCOPE OF DELIVERY

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- HMI Main Unit
- HMPI Mains Adapter
- HMPI Connection Cable
- Mains Cable
- Spare Fuses
- Manual

# SET-UP

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- First read the chapter NOTES, SAFETY INSTRUCTIONS; WARRANTY in this manual.
- Remove the HMI from its packaging: insert your hands into the foam recesses on the front and back of the unit, reach your fingers slightly under the unit and then lift it upwards. Do not lift the unit by the knobs or the connectors.
- Remove the HMPI from the packaging: insert your hands into the foam recesses on the sides of the unit, reach your fingers slightly under the unit and then lift it out upwards. Do not lift the unit by the connectors.
- Remove the HMPI connection cable from the packaging. It is equipped with 12-pin connectors on the ends.
- Plug the end with the female connector into the socket on the rear panel or the HMI.  
Make sure that the locating peg shows upwards.
- Turn the strain relief nut clockwise. Push the connector slightly after a few turns.  
The connector is seated correctly when the rubber seal on the socket is no longer visible.
- Plug the end with the male connector into the socket on the rear panel or the HMPI Mains Adapter.  
Make sure that the locating peg shows upwards.
- Turn the strain relief nut clockwise. Push the connector slightly after a few turns.  
The connector is seated correctly when the rubber seal on the socket is no longer visible.
- Check whether the mains voltage setting on the HMPI Mains Adapter front panel complies to your local mains voltage.  
If not, set the voltage selector to the correct voltage. Use a coin or something similar to operate the mains voltage selector.
- Make sure that the mains switch on the rear panel of the HMPI is in the off position.
- Insert the mains cable.
- Turn the mains switch to the on position.
- On your HMI unit, press the power on/off button, the power button will illuminate.
- After several seconds the operating indicator (logo sign) right to the power button will illuminate.  
Now your HMI is ready for operation.

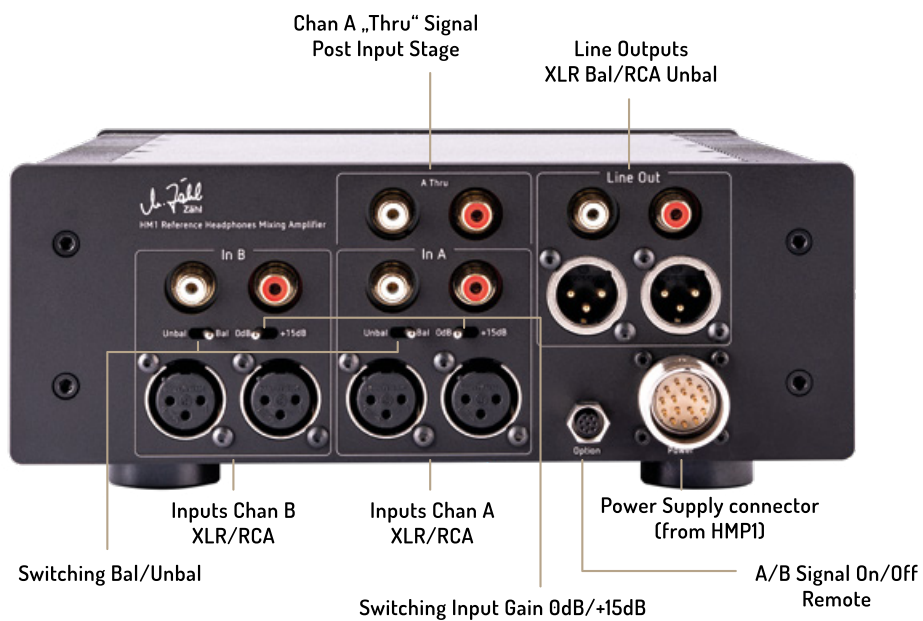
**Note:** On the 2022 and on parts of the 2023 series front and rear panels are black anodized with a special matt finish, the lettering is lasered. Fingernails or other abrasive objects can leave marks on the matt surface. These can be wiped off very easily with microfibre cloth or similar lint-free cloth.

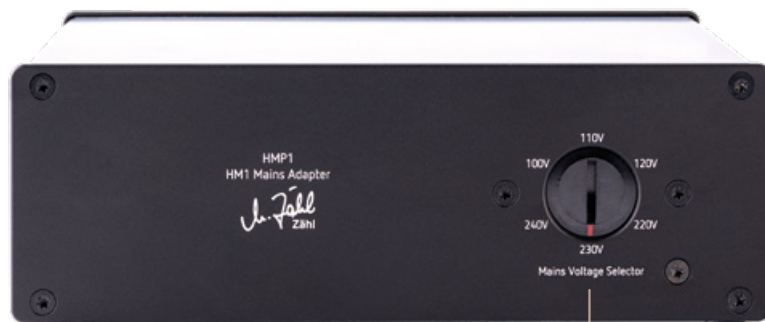
On parts of the 2023 series and on all units produced since 2024 front and rear panels are lacquered and digitally printed. If necessary, they can be cleaned with soft cleaning tissues and soft detergents.

**IMPORTANT!** Always follow this order when connecting, otherwise damage may occur!

1. Install HMPI connection cable
2. Install mains cable
3. Switch on, any order: power switch on HMPI rear panel and power button on HMI front panel.

# LEGEND





Voltage Selector for world wide use



Power Supply Output to HM1

IEC Mains Inlet

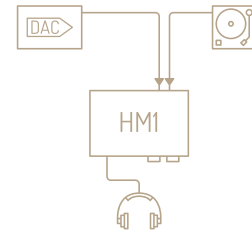
Main Switch

Fuseholder

# APPLICATION EXAMPLES

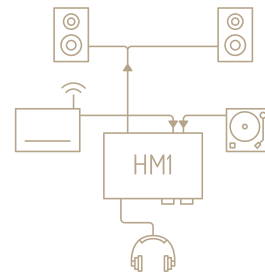
## Conventional

Example for a conventional setup as headphones amplifier:  
Your reference DAC at Input A and an analogue source at Input B



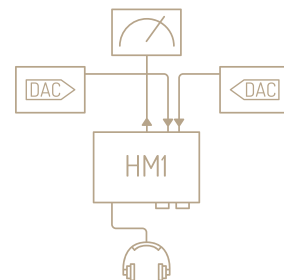
## Preamplifier in minimalist system

Headphones connected to amplifier output, speaker amps or active speakers to the Line Output. Toggle between headphones and speakers. Example of a minimalist setup: Streamer to HM1 Input A, analogue source to Input B, active speakers to Line Out.



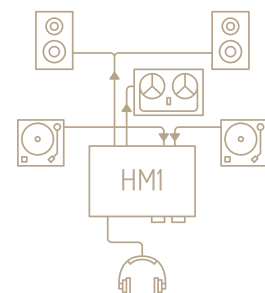
## Precision comparison

Two sources connected to Inputs A and B, precision level meter connected to Line Output. Source levels can be exactly matched using the level meter and the volume controls. Activate the sources alternately by the Chan on/off switches.



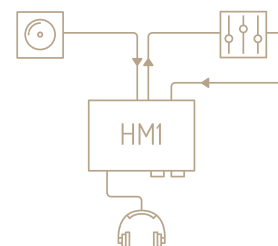
## 2-Channel Mixing Console

As a mixer, the HM1 can merge any two sources at Inputs A and B to create a new music programme - or simply cross-fade from one source to the other.



## Effect/Test

A device is fed from output „A Thru“ and its output is applied to Input B. The ratio between the original and the „looped-in“ signal is set at the A/B volume controls. Or switch between the two.





## SPECIAL FEATURES

### UNIQUE: CLASS A POWER AND A STEP BEYOND

- Class A power amplifier in its purest form
- switchable negative feedback („servo“) while maintaining Class A operation



### CROSS-FADE, COMPARE OR MIX TWO STEREO SOURCES

- Cross-fade or switch between two stereo sources (channel A /channel B)
- perform a precise, critical A/B comparison with independent volume compensation
- create a mix from two audio sources

### SOUND ADJUSTMENT AND STEREO BASE CONTROL

Precise, finely tuned tools for sound adjustment. Stereo base control for adjusting the stereo image (spatiality).



## DETAILS

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### Power Stage

#### Class A - HM1 realisation

The HM1 power stage provides massive power reserves, which is already evident from the fact that it consumes almost 40W in idle mode. The output power is more than sufficient for any application, and in the millisecond range it is increased substantially. The output resistance is remarkably low. The optimum operating point of the power stage was first specified by theory, then by measurements on the sample units and finally fine-tuned during numerous listening tests with experts, especially mastering engineers. The same applies to the selection of components. This meticulous way of design largely compensates for the possible disadvantages of Class A described in the theory paragraph below.

#### Class A & Servo - HM1 realisation

To take Class A one step further, we implement an idea which is as simple as it is ingenious: We take the best of Class A and the best of negative feedback amplifiers and put it together: Class A operation is supplemented by negative feedback ("Servo"). Since there is no crossover distortion, there is nothing for the feedback circuitry to correct. Rather, it only corrects the errors which result from the interaction between the power amplifier and the headphones. The feedback path is designed in such a way that no artefacts are created by the correction. The output resistance drops to a value which is smaller than the sum of headphones cables and connectors. In this way, headphone systems can be controlled precisely. One can say that with the HM1, any headphones sound as they should.

#### Why Class A and Class A & Servo?

The previous paragraph may lead to the conclusion that the optimum is achieved with Class A & Servo operation. So why do we still have the switching option? Quite simply because we judge our circuits by ear. Our Class A amplifier was developed with the highest musical demands in mind. We experienced that it does not sound the same as the servo version, but it sounds equally outstanding. Depending on headphones, music and personal preference, the user can make his choice. Even we were surprised to find that despite clearly different characteristics and measurement results, the hearing difference is rather subtle.

## A little theory

### Class A

Advantages: no crossover distortion at the output transistors and no artefacts which under certain circumstances can be caused by negative feedback.

Disadvantages: The internal resistance of the output transistors and usually also the emitter or collector resistors are in series with the load. Simplified, one can say that the material properties of the output stage components substantially determine the sound. And since both the resulting internal resistance of the output stage and the resistance of the load, i.e. the headphones, are complex items, the result is also complex: it is quite common that certain combinations of even very high-quality amplifiers and headphones do not produce optimal results. Experienced audiophiles know this experience.

### Class AB with negative feedback

Advantage: Any error at the output caused by the effects described above is "corrected" by a negative feedback circuit. And furthermore, the output resistance of the power amplifier, as long as there is no overload condition, theoretically approaches zero; practically it is in the 2-digit milli-ohm range. The complex internal resistance of a headphone system is almost equalised by the low impedance output. A headphone system is therefore tightly "guided" by the power amplifier.

Disadvantage: The crossover distortion occurs first, then it is corrected. Thus, negative feedback control (at least theoretically) always runs a little behind the action, which can lead to artefacts in the signal. However, modern negative feedback audio power amplifiers are usually not purely Class AB. Very effective techniques are used to keep crossover distortion low without having to use the costly and power-intensive Class A technique. Certain techniques are used in the negative feedback signal, so that the "lagging" of the correction almost no longer plays a role.

## Mixing Stage

### A/B comparison

Concerning the reference quality of the HM1, the idea of using it for critical A/B comparisons is most obvious - be it for evaluating different sources like D/A converters or cartridge systems in the high-end range or comparing different mixes or sound processing options in the professional range.

For this purpose, the HM1 has two inputs with independent level control and on/off buttons. Exact level matching is essential for a critical A/B listening comparison. By the way, the A/B switching can also be operated via a cable remote control, which facilitates a blind comparison (Future function, details will be published when available).

### A/B switching logic

**Toggle:** After power-up, both A and B On/Off switches are in the off state. If you press A or B, the corresponding channel is switched on. If you then press the other button, this channel is switched on while the one that was on before is switched off. So you can toggle between A and B.

**Individual:** Pressing a button repeatedly will switch the respective channel on and off and on and so on.

**Hold:** If you hold down one button while pressing the other, both channels are switched on.

### Cross-fade

The mixing stage can also be used to crossfade two sources. A very musical alternative to the otherwise usual "hard" switching.

### Mixing two sources

And of course this stage is suitable for mixing any two sources. A new programme is created from two music programmes. This new programme can then not only be listened to in the headphones but is also available at the line outputs on the back of the unit, which can be used for connecting active speakers and recording units. This turns the HMI into a 2-channel stereo mixing console with reference quality.

Also important: If only one channel is used, the mixing stage is not superfluous "ballast". An unused channel is switched off directly at the input stage and thus cannot negatively influence the signal integrity. This switch-off is realised via relays and is triggered as soon as a volume control is set to minimum or a channel on/off button is in the off position

### Note

The HMI volume controls are precision audio potentiometers that have an additional taper. When a volume control is set to the full counterclockwise position, this additional taper provides a control voltage to cut off the audio signal at a suitable point in the signal path by relays. This provides far better signal attenuation than would be possible with a potentiometer alone.

## Sound Adjustment

This stage is not designed to massively affect the sound. As a rule, all audio gear connected to the HMI is of extremely high quality, a classic tone control would not be appropriate.

However, it can be advantageous to make fine, precise adjustments in the frequency response domain, depending on the headphones, music programme or even personal preference.

### Low and high frequency adjustment

The low and high frequency adjustment, each in three fixed steps as boost and cut, is primarily designed for musical purposes. We have further developed proven circuits from studio technology to achieve a stage which sets subtle accents rather than changes the sound character. The basis are filters with selected components, of course all circuits are precisely switched by relays.

Professionals use the functionality, for example, to find out whether a mix is balanced in terms of low and high frequencies or can still be optimised.

## Stereo Base control, a little theory

A special feature is the possibility to adjust the stereo width. The perception of spatiality when listening with headphones differs from listening with loudspeakers. Instead of a cross-feed circuit, we use our stereo base width setting. It is based on the mid/side technique which is commonly used in professional studios. It provides additional benefits.

The stereo signal is converted into a mid signal (in simple terms, what L and R have in common) and a side signal (in simple terms, what distinguishes L and R). Summing mid and side signals in a 1:1 ratio will result in the original stereo signal. However, if you change the ratio between mid and side before summing them, you change the stereo base width. In our circuit, we leave the mid signal as it is. We only adjust the level of the side signal. If we lower the level, the stereo image becomes narrower, if we raise the level, the stereo image becomes wider.

### Stereo Base control, what it does

You have direct access to the perception of spatiality. With a music programme which seems too "wide" in the headphones, one will turn the control one or two steps to the left. If you perceive a recording as too "dry" (centred), turn the control one or two steps to the right. The leftmost position is mono. This is the preferred setting for early stereo recordings, when individual instruments have been mixed to the extreme left or right - without spatial reference.

Professional users check the spatiality of their mix with this function and may discover possible problems, especially in the extreme positions.

Also important: With the DIR (Direct) button, this stage can be completely switched out of the signal path. In this way, the purist approach is taken into account.

## Balance

A precision potentiometer with 21 detents is available for balance control. The centre position is perfectly calibrated and haptically clearly defined. In fine increments, left/right volume differences of up to about 2.5 dB - caused by music programme, headphones or individual perception - can be compensated.

## Headphones Outputs / Balanced Connection

XLR 4-pin connector and ¼ inch jack socket are wired in parallel and are intended for alternative use. Theoretically, you could use both at the same time, the power amplifier is strong enough. However, for a reference quality listening experience, we do not recommend such use.

Ideally, the XLR 4-pin is used in conjunction with balanced wired headphones. In this case, the signal currents of the two power amplifiers are not mixed with each other, mutual interference is impossible. The HMI can unfold its full quality (also refer to chapter "Dual Mono Design").

### Dual Mono vs. Balanced amplifier design

With its dual mono design, the HMI features the same advantages as a balanced output stage but avoids the drawbacks.

The drawbacks of a balanced output stage are the significantly increased number of electronic components - a balanced output contains two output stages per channel which work in reverse phase. Two output stages result in doubling the output impedance. More components result in an increased risk of non-linearities.

#### ¼ inch jack compatible

Another advantage of the HMI architecture is that unbalanced headphones with ¼ inch jack plugs can also be operated without any problems.

## Line Outputs

The signal at the line outputs corresponds to the signal in the headphones, except that it does not pass through the headphones amplifier, but through balanced or unbalanced line output stages and is routed to connectors on the rear.

Each output is driven by its own active circuit. So whatever you connect to one output, it has no effect on any other output. The balanced outputs are truly balanced with transformer-like behaviour: hot or cold may be connected to ground without loss of level or quality.

### Connect active speakers, power amps or other gear

Balanced and unbalanced outputs may be used simultaneously to drive power amplifiers, active speakers, level meters or other components. If, for example, the HMI is used for comparing two stereo sources, the result may be recorded using one of the outputs. The same applies when using the HMI as a mixing console.

#### „A Thru“ Output

The "A Thru" signal is tapped from Input channel A, post input amplifier. The switchable 15dB gain stage at Input A affects the "Thru" signal. The Thru output has an unbalanced output stage.

### Setup your own test bench / experimental bench

A signal connected to Input A can thus be routed to another application without loss. Application example: "A Thru" is routed to a sound processing device or effects unit, the output of this unit is fed to Line Input B. The ratio between original and processed signal can be set by the A/B volume controls. Of course, this setup is also excellent for testing any device: Channel A supplies the original, channel B the signal coming from the unit to be tested.

## Output Select

The output select toggle switch - located on the front panel above the XLR headphones output - is very useful if you are using your HMI to drive your headphones as well as to drive a power amp or active speakers at the line outputs. In the upper position only the line outputs are active, in the lower position only the headphones output is active. In the middle position both are active, which makes sense in case you have a recording or metering device (or other) connected to the line outputs.

## Line Inputs

Balanced signals (XLR) or unbalanced signals (RCA) can be connected to Line Input A and Line Input B. XLR and RCA are not meant to be used simultaneously on the same input! The Bal/Unbal switches do not select XLR or Cinch, but set the inputs to balanced (Bal) or unbalanced (Unbal) mode.

Use as a standard:

XLR in Bal Mode: Pin 1 Ground, Pin 2 hot, Pin 3 cold

Cinch in Unbal Mode: Case Ground, Center contact hot

Use in special cases:

XLR Unbal Mode: Pin 1+3 Ground, Pin 2 hot

Cinch bal Mode: Case cold, Center Contact hot (Ground Lift mode)

Each input provides another switch which adds an extra 15dB gain. This ensures that even signals with low levels can be processed without any problems.

## Dual Mono Design

### The idea

The idea behind strictly separating left and right channels is to keep any interference away from the circuits. A term like "crosstalk" does not get to the core of the matter. Music signals usually have left/right references, so that an extremely low crosstalk value - moreover, usually measured with sine waves - does not mean so much. But with music highly energetic signal pulses occur, and then high currents are individually demanded by the output stages. It is extremely important that in these cases there is no coupling via a common power supply or via ground lines carrying signal current. Only this way an amplifier can produce absolutely undistorted output signals.

### Realisation inside the HM1

In the HM1, the power supplies for left and right channels are separate, for preamplifiers and power amplifiers. The mains transformer has independent, potential-separated windings for each channel. Rectification, filtering and voltage regulation for each channel are individual. For logic circuitry and front-panel indicators, there is another winding and separate rectification, filtering and voltage regulation.

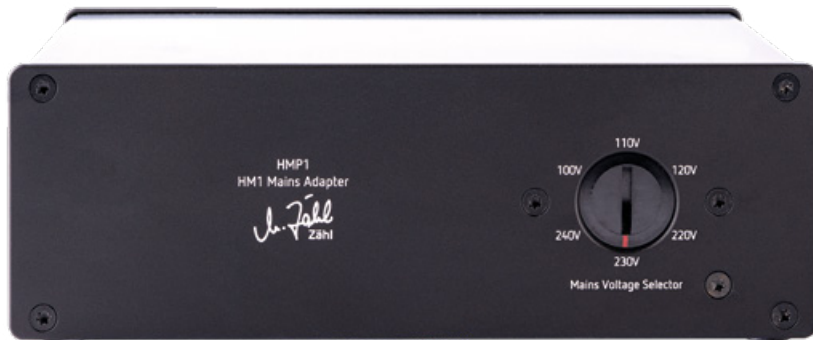
The ground potentials of the two channels are connected to each other at one point only, but this is done purely as potential equalisation; it is impossible for signal currents to be mixed.

### Optimal output connection

If the XLR 4-pin output is used in combination with balanced wired headphones, the dual mono principle is implemented in full consequence.

When using the jack output, the ground wires of both channels are connected in the jack socket and the jack plug of the headphones. The use of headphones with jack plugs therefore is not that ideal. In the HM1, however, an optimised ground routing ensures that the disadvantageous effects are as low as possible.

(also refer to chapter: Headphones Outputs / Balanced Connection)



## Power Supply

Mains voltage and mains transformer are always potential sources of interference - consequently, we have outsourced them to the HMP1 mains adapter.

The mains adapter also contains a standby power supply unit which delivers a stabilised low voltage. This voltage is applied to the Power switch on the front panel of the HM1 and serves to switch on the actual mains transformer via a relay.

### Worldwide operation

The standby power supply has a wide-range input, is a purely linear design.

The mains input is equipped with one of the best interference filters available and can be set for operation on the following voltages: 100V-110V-120V-220V-230V-240V.

For each selected voltage a tolerance range of +/-10% is acceptable.

The mains switch on the back of the HMP1 can be used to completely de-energise the unit.

### Variable cable length

The connecting cable between the mains adapter and the main unit carries potential-separated low voltages only. Standard length is 0,65m. Shorter and longer versions are available. Custom length upon request.



# TECHNICAL DATA

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## Headphones Output

Class A	Impedance 0,8Ω	max. level +23dBu
Class A & Servo	Impedance 0,045Ω	max. level +23dBu

unbalanced / dual mono design

## Output Power per Side

RMS	4W@30Ω / 7W@15Ω
Peak	7,6W@30Ω / 11W@15Ω / 12W@10Ω (18W for 1,5ms)

## Headphones Output THD (Total Harmonic Distortion)

Class A	0,07%
Class A & Servo	0,0005%

(typ. @ +20dBu/7,75Veff / 30Ω load / 2W RMS)

## Frequency Response

10Hz ... 30kHz	-/+0,05dB
1Hz ... 500kHz	better than -3dB @ +6dBu output level

## Line I/Os

Inputs	Impedance 20KΩ	max. level +23dBu
Outputs	Impedance 47Ω	max. level +23dBu

balanced I/Os: transformer-like behaviour: hot or cold may be connected to ground without loss

## Gain

Line/Line 0dB, additional 15dB switchable on rear panel

Line/Headphones 6dB, additional 15dB switchable on rear panel

## Noise

XLR/RCA Output	-102dBu
Headphones Output	-97dBu

20Hz ... 20kHz flat RMS / A or B active

## Power Supply

Mains Voltage	AC 50-60Hz, 100V, 110V, 120V, 220V, 230V, 240V resp. +/-10%
Power Consumption	typ. 40W
Mains Fuses	5x20 mm, rating 1,6A time-lag (2x)

## Measures & Weights

HMI	WxHxD approx. 225 x 90 x 300mm, approx. 5kg
HMP1 (Mains Adapter)	WxHxD approx. 170 x 60 x 185mm, approx. 1,5kg

# TROUBLESHOOTING

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## Checking mains fuses

In case your HMI does not show any function although it is correctly connected and switched on, you may check the mains fuses on the Mains Adapter HMP1.

- Unplug the power cable.
- Find the fuse holder drawer on the mains input assembly, between mains input connector and mains switch.
- Use your thumbnails or a small flat-blade screwdriver to unlock the latches at the top and bottom of the fuse drawer. The drawer will pop out slightly.
- Take the fuse drawer out completely. It contains two identical fuses, size 5x20 mm, rating 1,6A time-lag.
- If a fuse is blown, always replace it with an identical type.
- Even if only one is blown, always replace both.
- Put the fuse drawer back in place.
- Repower your unit.
- If it still does not work properly, contact us or your local dealer in order to get it serviced.

## Checking connectors

If brief interruptions or other unexplained faults occur during operation of the HMI, this could be due to the plugs of the connecting cable between the HMI and HMP1 not being plugged in all the way. (also refer to "Set-up" on page 5)

Push the connectors and then try to turn the strain relief nuts further clockwise. Repeat this.  
The connectors are seated correctly when the rubber seal on the sockets are no longer visible.

# CONTACT

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