



System Documentation

phAMP 2

Phono pre amplifier / 2 channels / MM and MC input scheme /
consumer out +00dBu

phAMP 2 B

Phono pre amplifier / 2 channels / MM and MC input scheme /
symmetrical out +10dBu



The new phono pre-amplifier **phAmp 2** exhibits excellent noise performance due to the application of extremely low noise circuit topologies. One reason for the superb sound quality of the preamplifier might be seen in high accuracy active and passive RIAA (Recording Industries Association of America) equalization with selectable old RIAA or RIAA/IEC (International Electro- Technical Commission) curves.

The amplifier concept employs solid engineering concepts, and dismiss "golden ear" discussions. It includes an input scheme for both moving coil (**MC**) and moving magnet (**MM**) - or variable reluctance - transducer. The overall circuit structure does not incorporate any design compromises and is completely devoid of transient or frequency dependent gain errors.

The wide bandwidth stages minimize the in-band phase shift and provide exceptional phase and frequency response accuracy. This allows the RIAA/IEC filter to render the exact reciprocal of the recorded phase and frequency characteristic. The main focus has been set on the topics of low noise performance, minimal harmonic distortions (THD) and an accurate reproduction of the transducer output signal.

1. Modular Concept:

- **DC supply stabilization** – To guarantee a strict separation of both (left and right) channels, each channel has been build on a separate PCB, with its own power supply stabilization and filter unit. We have favored on-board power supply stabilization since the roll out of the first preamplifier in 1995.
- **MM – Moving Magnet** (or variable reluctance) input amplifier. Based on an instrumentation amplifier scheme and taking full advance of the resulting high common mode rejection. The input configuration is completely symmetrical and allows a wide range of different transducer loading combinations. Due to the widely acceptance of chinch connector the amplifier comes with chinch input terminals at the **MM** input. For other types of input connectors please contact our support directly.
- **MC – Moving Coil** input amplifier. Also based on an instrumentation amplifier scheme and therefore taking full advance of the resulting high common mode rejection. The input configuration is completely symmetrical and guarantees in input loading of exactly 100Ω in parallel with 470p (Note: some transducer need a loading of 10Ω for maximum reproduction accuracy. In these cases please contact our support). Due to the widely acceptance of chinch connector the amplifier comes with chinch input terminals at the **MC** input. For other types of input connectors please contact our support directly.
- **RIAA/IEC filter stage** is build around a conventional **OPA** (**O**perational **A**mplifier) and is an active feedback type filter. The overall gain of the circuit is -2.5 dB at 1 kHz. **RIAA** equalization requires a gain of 19.3 dB at 20Hz , and an attenuation of 19.6 dB at 20kHz. The open-loop gain of the selected **OPA** is more than 120dB at 20Hz and nearly 60dB at 20kHz so there is plenty of loop gain to ensure exceptional RIAA equalization curve tracing.



- **High level amplifier** The amplifier comes either with an unbalanced (consumer) output with a line level of +00dBu or a balanced output signal with a line level of +10dBu. The default option for the high level amplifier is AC coupling. For the “audio purist” the decoupling C can be omitted to gain a direct coupled DC design. Thus resulting in minimized envelope and group delay distortions.

All amplifier feedbacks are direct coupled, and are referenced to circuit ground (GND). Due to the modular concept the amplifier is not specifically targeted for a **MM** or **MC** transducer. Both inputs can be used with the same reproduction quality. There is no cascading of the **MM** and **MC** inputs like in various other system. The **MC** input is not just another amplifier stage it is a complete independent input stage optimized for the **MC** transducer (see also input characterization for both MM and MC inputs).

2. Power supply and stabilization:

All following measurement at $T_A = 25^\circ\text{C}$, $V_S = \pm 18V_{DC}$, unless otherwise noted (Absolute maximum ratings $V_S = \pm 25V_{DC}$)

Onboard power supply stabilization	U_{OUT} [V]	I_{LOAD}^1 [mA]	$V_{S-TOLERANCE}$
($V_S = \pm 15V_{DC}$, $T_A = 25^\circ\text{C}$)	$\pm 15,0 \pm 0,04$	37,0 \pm 2	< 0,29%

3. MM input:

MM phono transducer cartridges have to be terminated with the proper **resistance** and **capacitance** combination. Check your cartridge vendors specification for further details. In order to provide these combinations four DIP switches have been integrated onboard the MM section for input loading adjustment. Multiple different loading combinations can be selected via these switches (refer to the manual for further information):

$$R_{IN} = 47k / 68k,$$

$$C_{IN} = 50p, 100p, 200p \text{ (and every parallel combination).}$$

¹ Each amplifier channel, Supply current varies less than 1mA for negative and positive supply rails.



MM input section ($V_S = \pm 15V_{DC}$, $T_A = 25^\circ C$)	U_{IN} [dBu]	U_{IN} [mV]	Type
Nominal input level	-48dBu	3,084	balanced
Common mode rejection (20Hz ... 20kHz)	>50dB		

MM input section ($V_S = \pm 15V_{DC}$, $T_A = 25^\circ C$)	Selectable	
Resistive loading	47k Ω / 68k Ω	
Capacitive loading	50pF ... 350pF	In 50pF steps

4. MC input:

MC phono transducer cartridges have to be terminated typically with a 100 Ω resistance and 500pF capacitance combination. If your cartridge is designed for a different loading scheme please contact our support directly.

MC input section ($V_S = \pm 15V_{DC}$, $T_A = 25^\circ C$)	U_{IN} [dBu]	U_{IN} [μV]	Type
Nominal input level	-64dBu	489	balanced
Common mode rejection (20Hz ... 20kHz)	>50dB		

MM input section ($V_S = \pm 15V_{DC}$, $T_A = 25^\circ C$)	Non Selectable
Resistive loading	100 Ω
Capacitive loading	500pF

5. RIAA equalization filter

Three filters make up the RIAA reproduction curve. The time constants are: 75 μs (2.122 kHz - pole), 318 μs (500 Hz - zero), 3180 μs (50Hz - pole). A fourth time constant is defined by the RIAA/IEC curve at 7960 μs (20Hz - pole). It provides a -3dB attenuation at 20Hz and a rolling off at -6dB/octave below. The



IEC filter was introduced to minimize warp and infrasonic signal interference while maintaining a flat frequency response down to 40Hz. Check table 1. for RIAA/IEC specification and measurement data.

Freq [kHz]	Gain/IEC [dB]	RIAA/IEC	Diff [dB]	Freq [kHz]	Gain/IEC [dB]	RIAA/IEC	Diff [dB]
0,0063	9,23	9,4	0,17	0,4000	3,78	3,8	0,02
0,0080	11,03	11,2	0,17	0,5000	2,65	2,6	-0,05
0,0100	12,60	12,8	0,20	0,6300	1,09	0,8	-0,29
0,0125	14,03	14,1	0,07	1,0000	0,00	0	0,00
0,0160	15,35	15,4	0,05	1,2500	-0,73	-0,8	-0,07
0,0200	16,20	16,3	0,10	1,6000	-1,62	-1,6	0,02
0,0250	16,76	16,8	0,04	2,0000	-2,57	-2,6	-0,03
0,0315	16,96	17	0,04	2,5000	-3,66	-3,7	-0,04
0,0400	16,79	16,8	0,01	3,1500	-5,01	-5	0,01
0,0500	16,28	16,3	0,02	4,0000	-6,55	-6,6	-0,05
0,0630	15,43	15,4	-0,03	5,0000	-8,16	-8,2	-0,04
0,0800	14,23	14,2	-0,03	6,3000	-9,90	-10	-0,10
0,1000	12,91	12,9	-0,01	8,0000	-11,85	-11,9	-0,05
0,1250	11,44	11,5	0,06	10,0000	-13,70	-13,7	0,00
0,1600	9,73	9,7	-0,03	12,5000	-15,57	-15,6	-0,03
0,2000	8,19	8,2	0,01	16,0000	-17,65	-17,7	-0,05
0,3150	5,17	5,2	0,03	20,0000	-19,54	-19,6	-0,06

Table.1 RIAA /IEC measurement (column 1, black), reference values (column 2, blue) and error (column 3, blue)

According to Tab. 1 RIAA/IEC equalization curve matching is well under **0.1dB** guaranteeing an excellent reproduction quality.

6. High level amplifier

The high level amplifier provides a 12.8 dB gain and an additional adjustable 8.9 dB ... 11.4 dB gain stage. For the **phAMP 2** the stage feeds the unbalanced consumer output jack with a nominal +00dBu level. For option **phAMP 2 B** the stage feeds the balanced output terminal (Neutrik XLR3 connector) with a nominal level of +10dBu (output impedance is 75Ω and will drive 600Ω loads to a maximum clipping point level of 28dBm).

Output section - consumer ($V_S = \pm 15V_{DC}$, $T_A = 25^\circ C$)	U_{OUT} [dBu]	U_{OUT} [V]	Type
Nominal output level	00dBu	0,775	unbalanced
Maximum output level	24dBu	12,3	unbalanced
Gain control range (relative to nominal output)	-1,1dB	+1,4dB	

Output impedance	47Ω (typ.)
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Noise floor ($R_{SRC} = 1 \Omega$, referenced to nominal out, no Bandwidth limitation, $R_{LOAD} = 600 \Omega$)	-78dBu	96μV
Noise floor ($R_{SRC} = 1 \Omega$, referenced to nominal out, Bandwidth = 5 ... 20kHz, $R_{LOAD} = 600 \Omega$)	-103dBu	5,8μV

For the AC coupled design output offset is typically well below $4mV_{DC}$. In case of direct coupling the DC offset varies depending on the source resistance of your phono cartridge. For a typical cartridge with a source resistance $R_S < 1k\Omega$ the DC offset is below $150mV_{DC}$.

DC output offset ($R_{SRC} = 600 \Omega$)		+/- 4mV (typ.)	+/- 250mV (max.)
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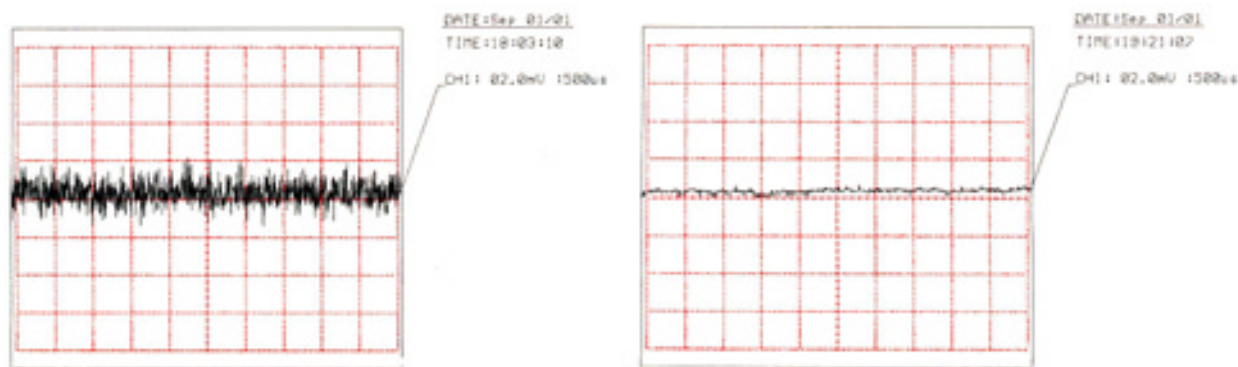


Fig.1 Noise floor with 1Ω source resistance at MM input. *left*: No Bandwidth limitation, *right*: Bandwidth limitation to 30kHz upper frequency limit

7. Harmonic distortions – THD+N figures:

Figure 2 shows the fundamental with a frequency of 1kHz and the residual, mainly constituted out of the first harmonic. Therefore THD is mostly due to the first harmonic (double the frequency of the fundamental or 2kHz). In addition, distortion remains relatively flat throughout the wide output voltage swing range, providing increased headroom.

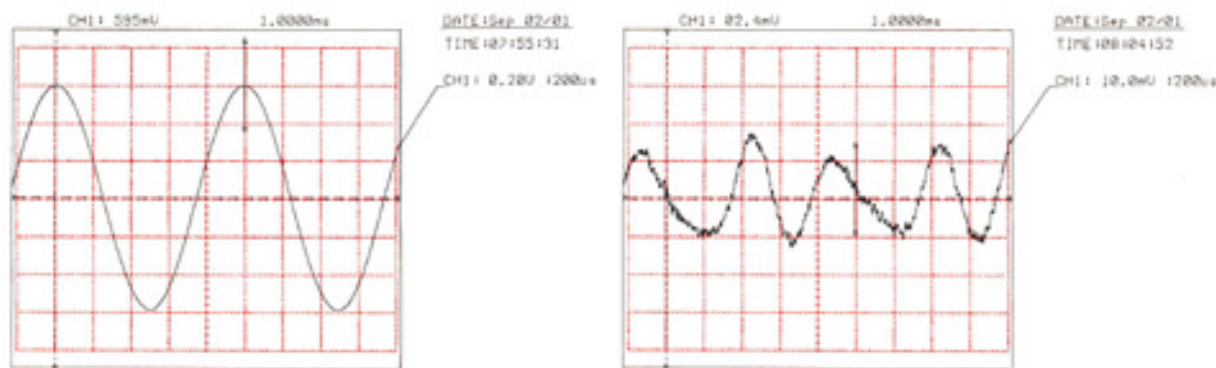


Fig.2 Sine wave with 1kHz (fundamental) and residual amplified by 100

Headroom is expressed as a ratio which compares the maximum allowable output voltage level to a standard output level (e.g. nominal 1mW at 600Ω or 0.7746V_{RMS}) with the condition of nearly unaltered THD figures. Table 2 and Fig. 3 give the numerical data for the THD+N figure. THD is typically **0,007%** with a headroom of about 20dB (referenced to a nominal level of 00dBu).

Frequency [Hz]	THD + N [%]
10,0	0,0071
20,0	0,0071
40,0	0,0071
100,0	0,0074
160,0	0,0074
200,0	0,0074
400,0	0,0073
630,0	0,0073
1.000,0	0,0076
1.600,0	0,0091
4.000,0	0,0148
6.300,0	0,0183
10.000,0	0,0285
16.000,0	0,0404
20.000,0	0,0546

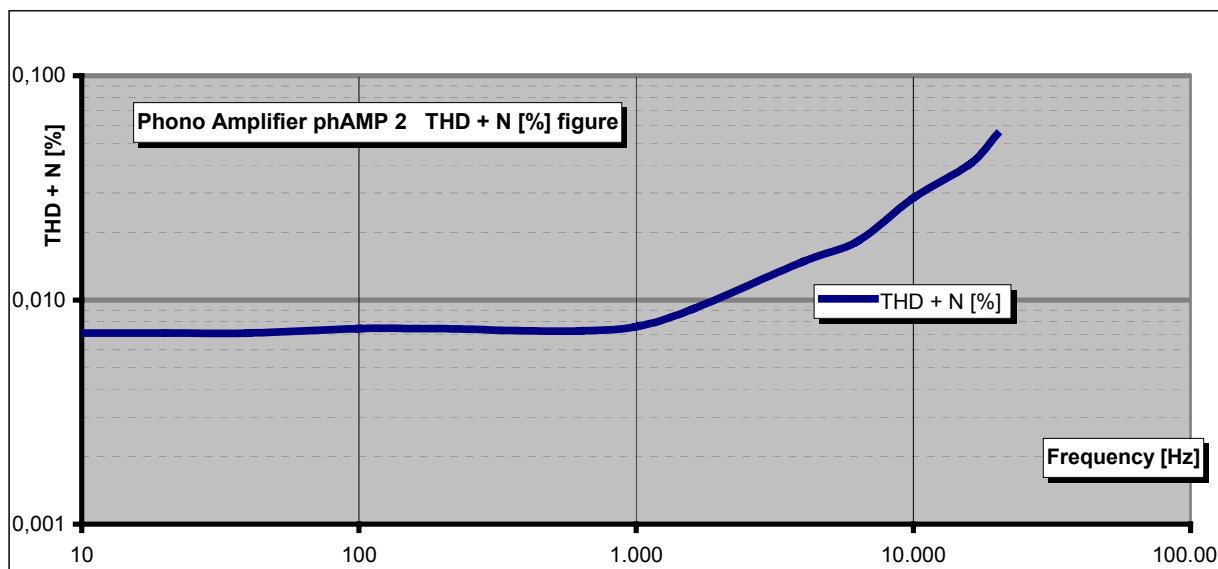


Table2 (left) and Fig.3 (right) - Total harmonic distortions THD + Noise N with 600Ω source resistance at MM input.

8. Transducer cartridge loading and Noise considerations:

For a phono transducer cartridge to deliver the performance as intended, it had to be loaded properly. Selecting the proper resistance and capacitance is essential. The **MM** input circuit has adjustable resistance and capacitance transducer loading. Most transducer currently available (there are not much left) accommodate with a resistive loading of either 47k or 68k and a capacitive loading of a few pF (mostly depending on the input wiring). The capacitance is selectable up to 400pF in 50pF steps.

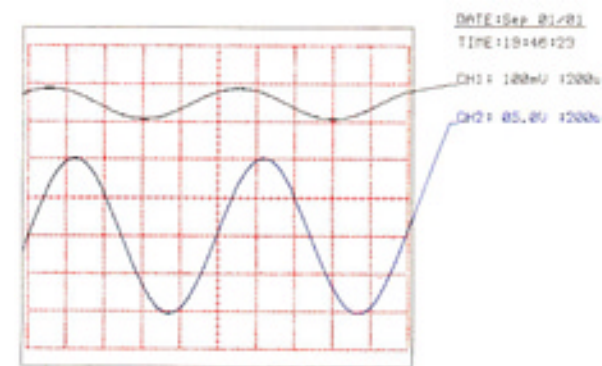
9. Testing and calibration

Every amplifier is tested throughout a burn in period of 2 hours and straight afterwards calibrated to a nominal output level of 00dBu (consumer) or +10dBu (balanced). In case of re-calibration needs used the following parameters (channel mismatch typically < **0.1dB**):

Input voltage at MM terminal ($R_{SOURCE} = 600\Omega$, $R_{LOAD} = 10k\Omega$)	U_{IN} [mV]	U_{OUT} [V]
Sine wave at 1kHz	-28dBu / 30,84mV	+20dBu / 7,746V

Fig. 4 shows in- and output waveforms for recalibration. Set the input voltage to **30,84mV_{EFF}** (channel 1) at the **MM** input terminals. Adjust the output voltage at the high level output to **7,746V_{EFF}** (channel 2). Check for a minimum channel matching of **0,1dB** or greater.

All measurements had been performed with one of the following instruments: Gould DSO 1604, HP oscilloscope HP54602B, HP multimeter HP34401A or a Fluke graphical multimeter 867B, HAMEG triple power supply HM 8040.



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