



##TS2019###PP80-FIG8##
##dual#mono## -- Jacques-v-Eijk

Explanation of the power stage circuit

Feedback circuit:

The configuration of the PP80 amplifier consists of an input stage, a phase inverter and a PP power stage.

Only the PP power stage is shown because various feedback methods were explored during the TS-course 2019-2020.

In this amplifier local feedback is applied where the signal voltage variation on the Anodes of the power tubes is fed back to the input of the power stage. Here the signal earth is the 0 reference. There is no OPT in the feedback loop.

The feedback is negative because of the crossing of the split signal to the opposite signal phase input.

Build:

The FETs M1 and M2, the coupling Capacitors and the 3pF Mica capacitors were matched.

The high DC voltage on the Anodes must be isolated from the input. So in each feedback loop, 2 Electrolytic capacitors of 10 μ F/400V in series and each has parallel a 1M Ω resistor applied.

>>This feedback circuit and capacitor cans must be isolated properly and safely from the circuit and chassis because of High Voltage danger! ⚡ !<<

The feedback factor is defined by the value of the feedback resistor (470k Ω) and the 1 k Ω resistor at the input.

An delicate tuning procedure is needed to:

1. With R9 and R10 set the quiescence I_a equally for both power tubes. To be measured on R17 and R18 taps.
!!! Be aware to start with $-V_n$ on Grid terminal.
2. With R8 set $V-D1 = V-D2$
3. With R7 tune for minimum H2 @ 1kHz sine on output
4. With either R9 or R10 tune for minimum H2 @ 40Hz sine on output

Measurements with Waveform generator and Oscilloscope and ARTA

Results:

- Open loop gain, from input to output, unloaded at 4 Ohm tap: $A_{o,U} = 2723 \times = 68,7 \text{ dB}$
- Open loop output impedance at 4 Ohm tap: $Z_{out,o} = 18,4 \text{ Ohm}$
- Open loop gain, from input to output, 4 Ohm loaded at 4 Ohm tap: $A_{o,L} = 53,7 \text{ dB}$
- Closed loop gain, from input to output, unloaded at 4 Ohm tap: $A_{e,U} = 20,82 \times = 26,4 \text{ dB}$
- Closed loop output impedance at 4 Ohm tap: $Z_{out,e} = 0,35 \text{ Ohm}$; Damping-factor $D_4 \approx 12$
- Closed loop gain, from input to output, loaded with 4 Ohm at 4 Ohm tap: $A_{e,L} = 25,7 \text{ dB}$

- Internal Feedback fraction from primary-OPT to input per PP-side: $\beta = 1 / 471 = 2,13 \cdot 10^{-3}$
- OPT turns-ratio: $N_p/N_s = 44,7$; $R_{ip} = 100 \text{ Ohm}$; $R_{is} = 0,16 \text{ Ohm}$
- \rightarrow NFB-Factor = $A_{o,U} - A_{e,U} = 68,7 - 26,4 = 42,3 \text{ dB}$

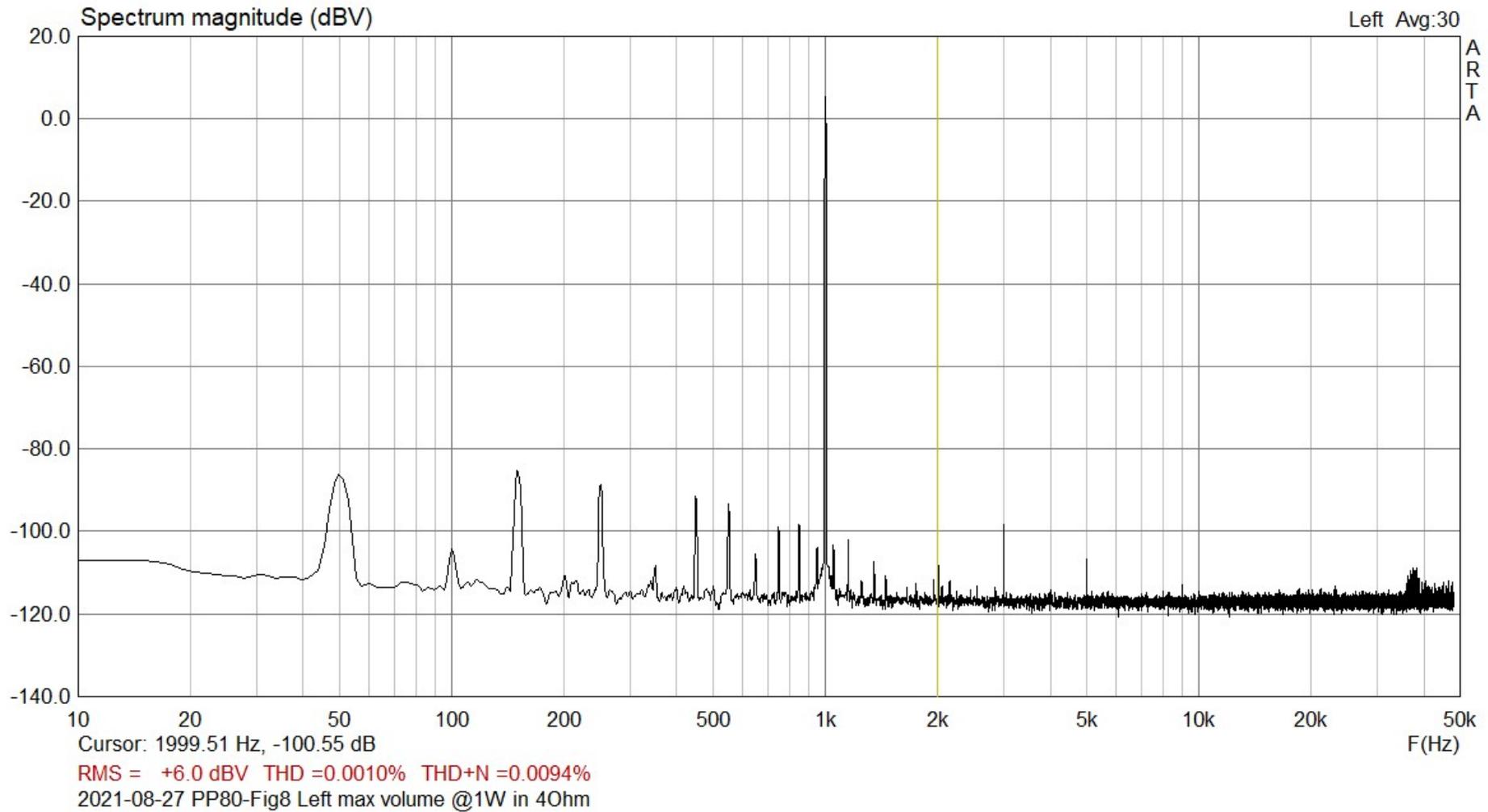
- Output power with NFB: $\approx 100 \text{ Watt}$ in 4Ω (20 V_{rms} in 4 Ohm)

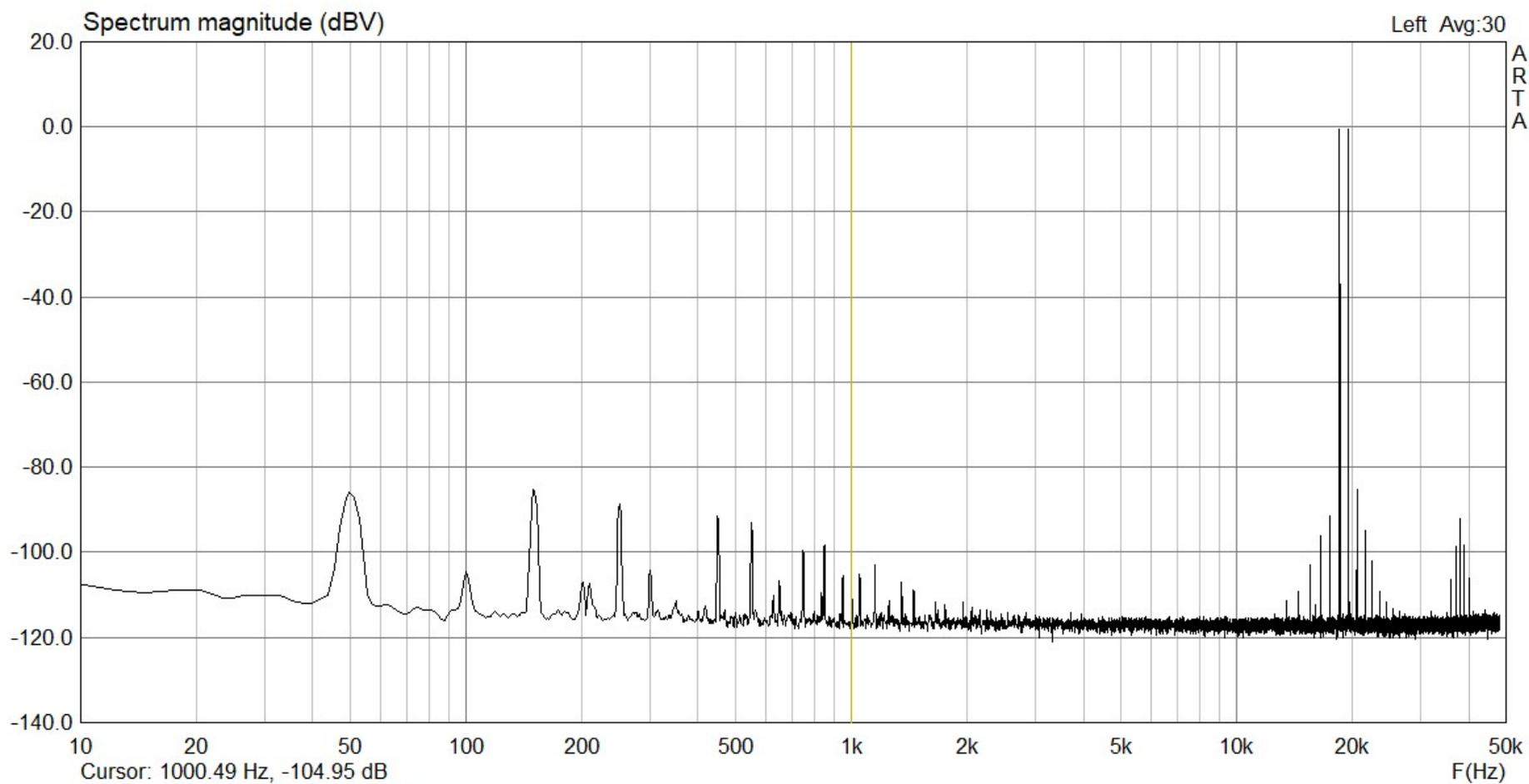
- -3dB limits with NFB:
 - 3dB_{low}: $< 3\text{Hz}$
 - 3dB_{high}: $\approx 72\text{kHz}$

- THD with NFB @ 1 W, 1 kHz, in 4 Ohm = 0,001 %
- THD with NFB @ 100 W , 1 kHz, in 4 Ohm = 0,2 %

Measurements with ARTA, STEPS and LIMP

All measurements at 1W in 4Ω, max volume, unless stated otherwise.

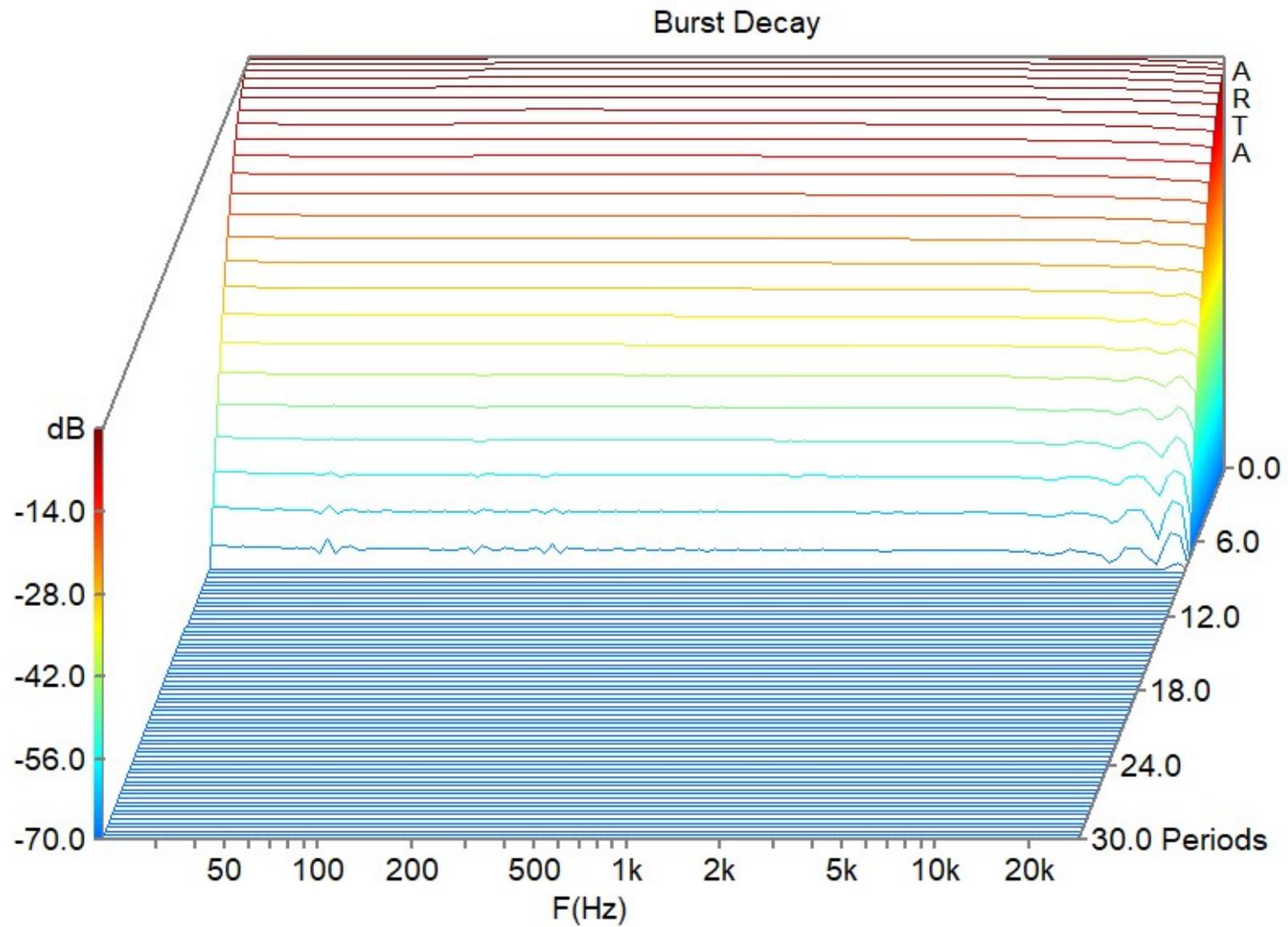




Left Avg:30

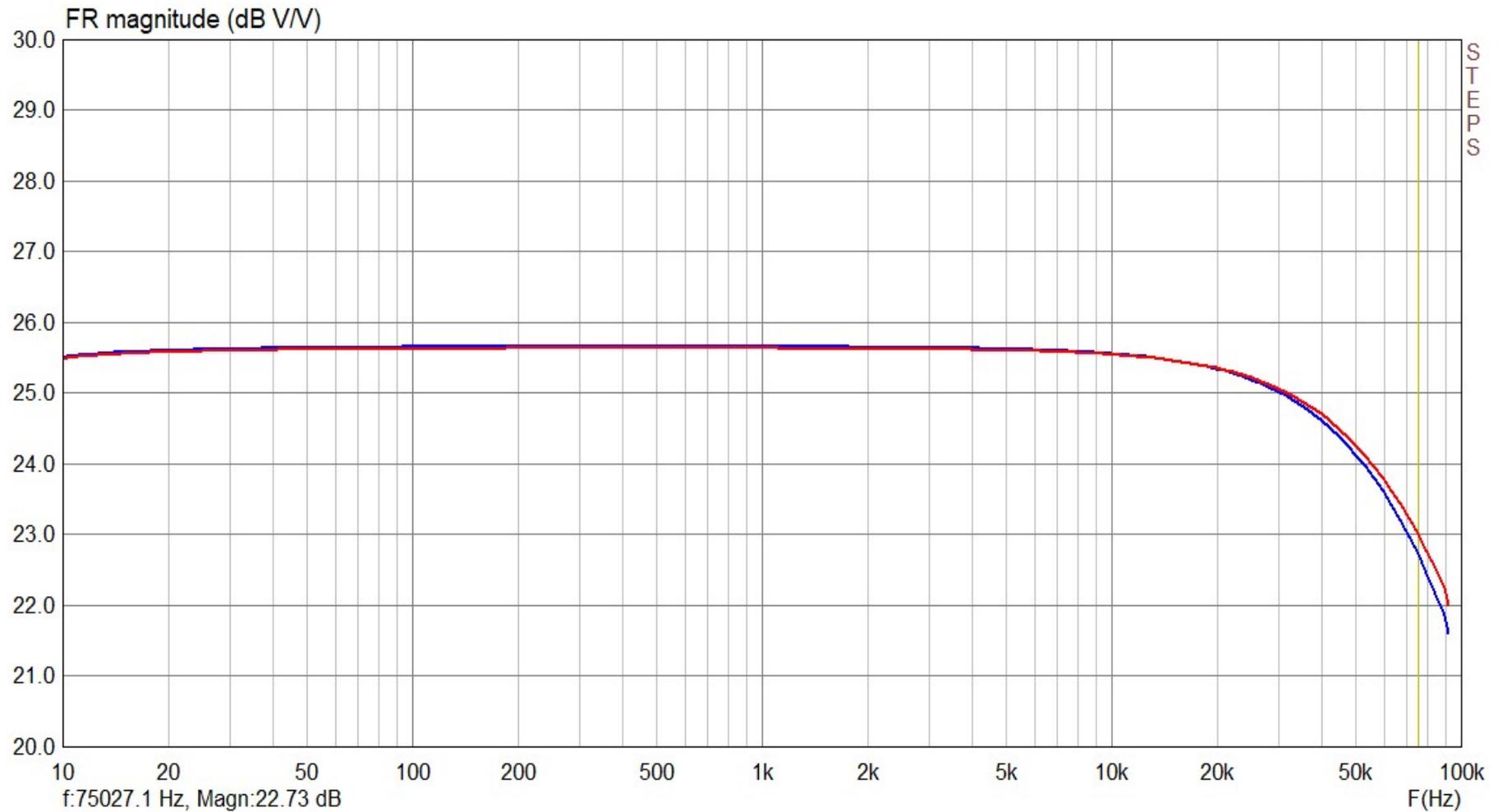
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Cursor: 1000.49 Hz, -104.95 dB
RMS = +2.9 dBV IMD =0.0054%
2021-08-27 PP80-Fig8 Left max volume @1W in 40hm



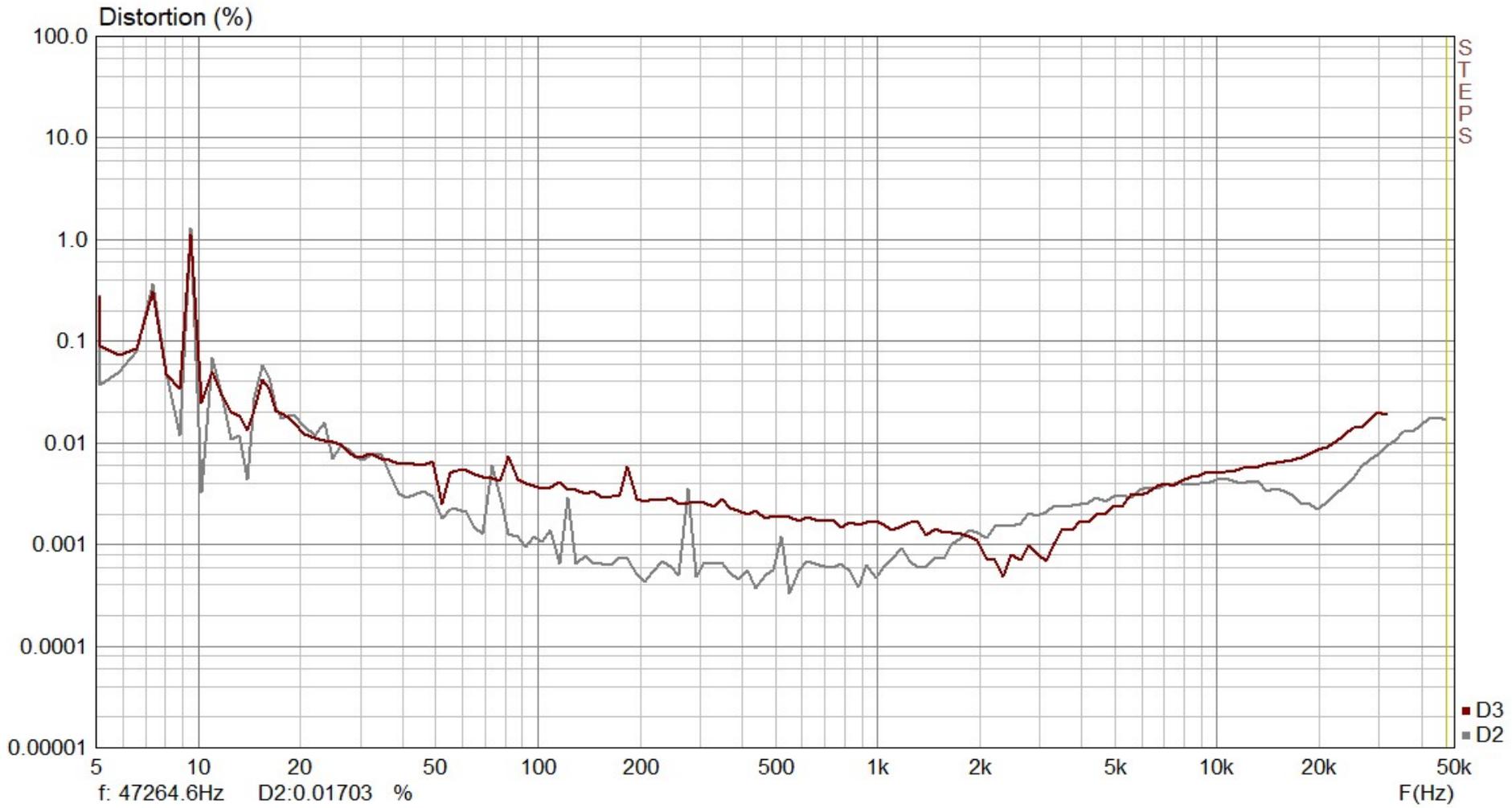
2021-08-27 PP80-Fig8 Left max volume @1W in 40hm

ARTA-STEPS results valid for both channels.

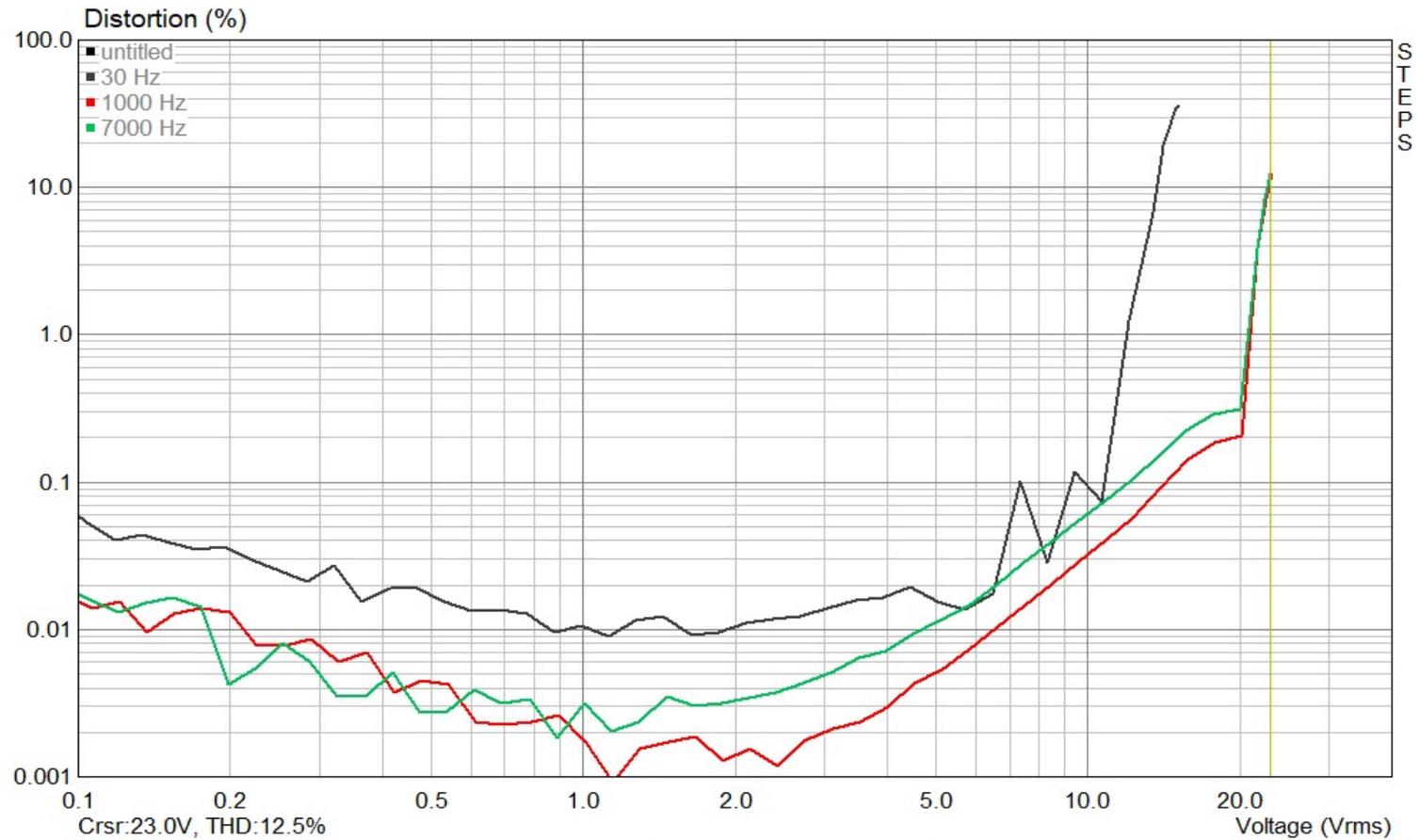


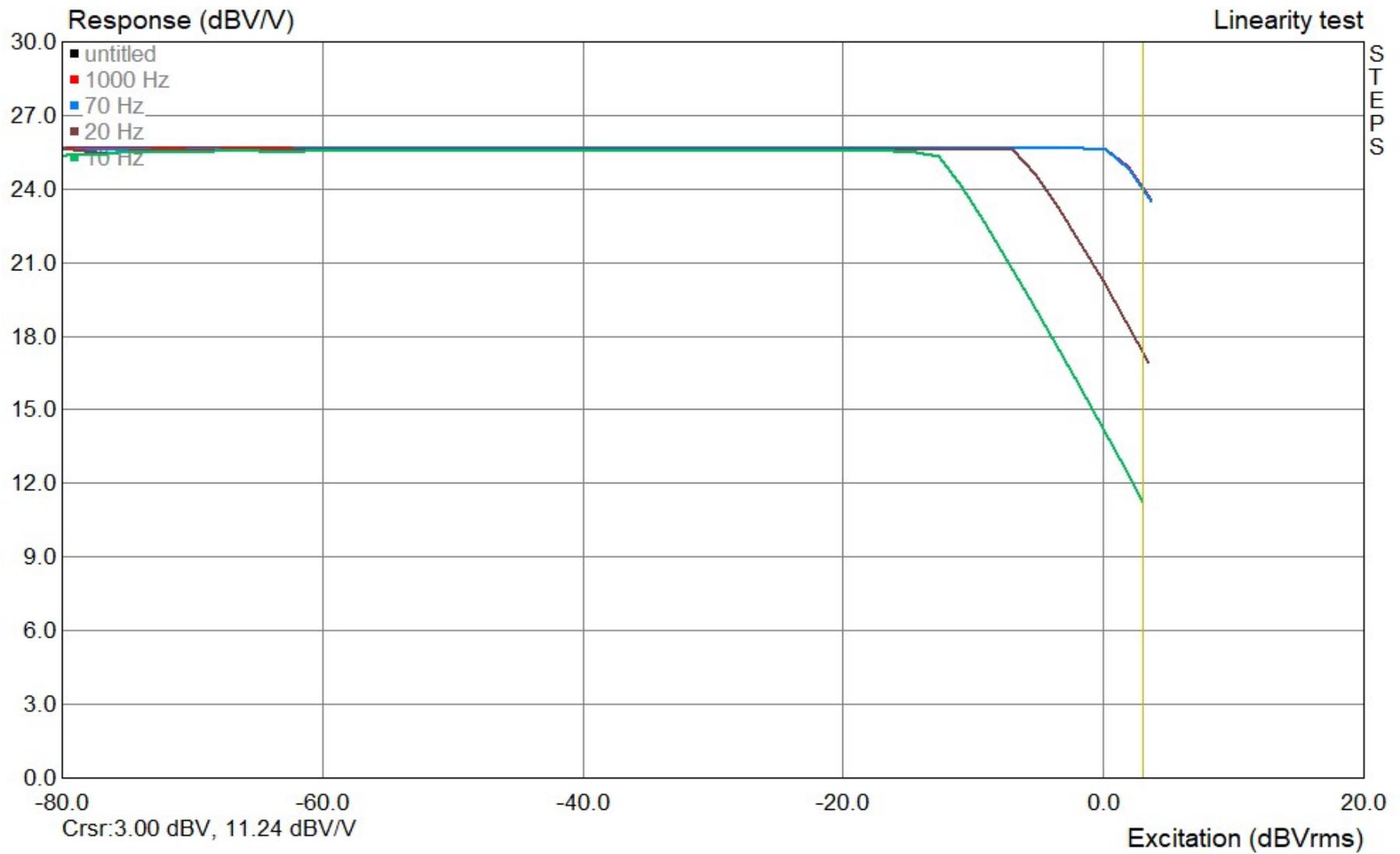
2021-08-27 PP80-Fig8 Right = Red / Left = Blue @1W in 40hm

From 10Hz to 72kHz: 0dB to -3dB



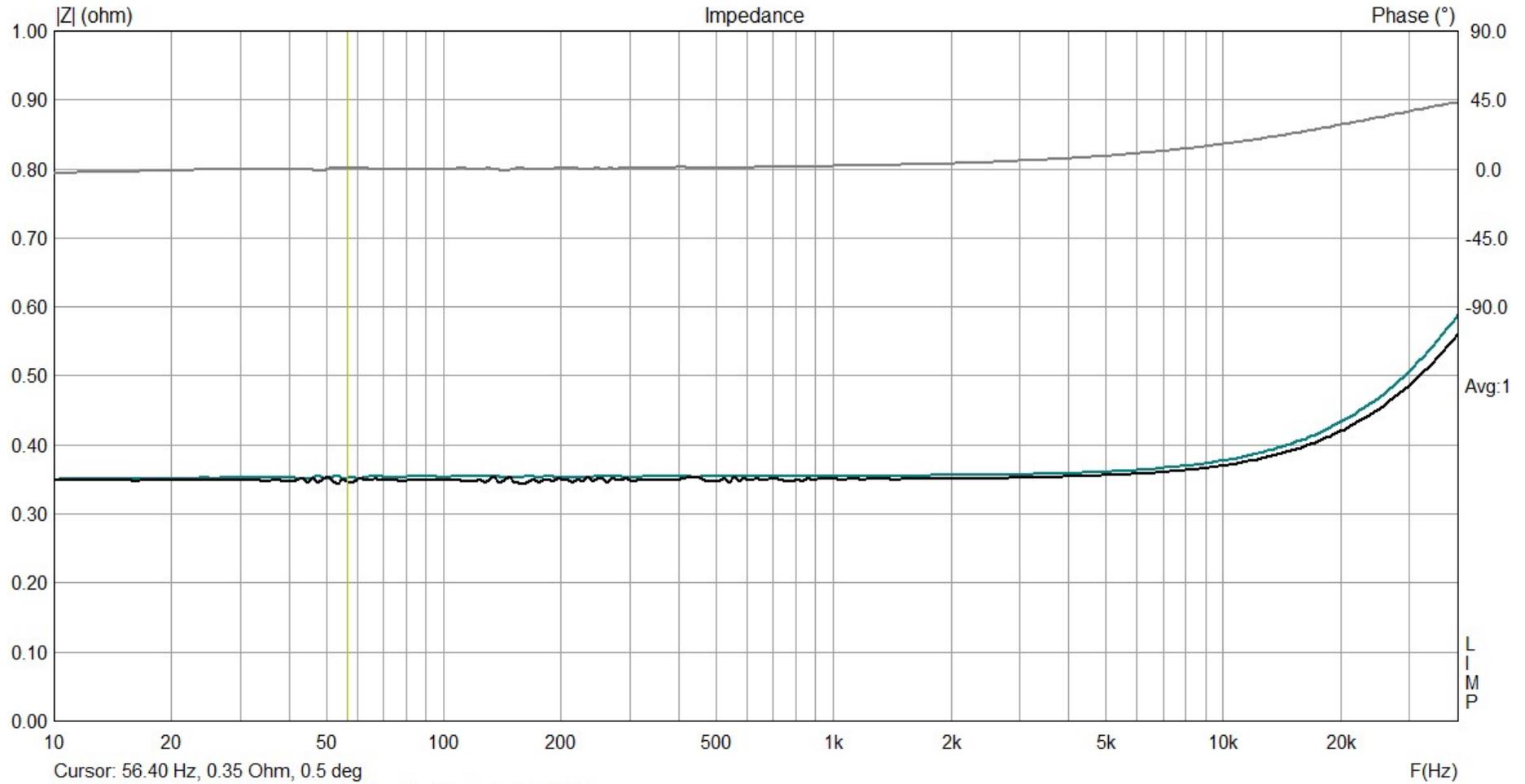
2021-08-27 PP80-Fig8 Both channels @1W in 40hm / D2,3 at or below 0,01% / D4,5,6 at or below 0,001%





LIMP for Z_{out}

Input closed, small difference between Right and Left.



Cursor: 56.40 Hz, 0.35 Ohm, 0.5 deg

2021-08-27 PP80-Fig8 Zout on 4Ohm tap / Left=Black, Right=Blue