

# DAVE

DAC • Preamp • Headphone Amplifier



An introduction into Chord's DAC Technology



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# WHY DAVE?

- DAVE is an acronym of Digital to Analogue Veritas in Extremis
- DAVE's development was centered upon a question: why was Hugo so musical?
- Where was Hugo's sound quality performance coming from in technical terms?
- DAVE has an FPGA ten times the capacity of Hugo
- This gave opportunities to further improve performance:
  - Improved time domain (transient timing accuracy)
  - Improved noise-shaper performance
- DAVE has much more advanced analogue electronics



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# TIME DOMAIN

- The primary purpose of a DAC is to reproduce the un-sampled continuous analogue waveform from sampled digital data
- Conventional DACs do a poor job of reproducing the original continuous analogue signal, with timing errors on transients
  - Increasing tap-length of FIR filters gives better time domain accuracy in terms of timing of transients
    - The ear/brain is extremely sensitive to very small timing errors
      - Timing accuracy upsets the perception of the start and stopping of notes
      - It also degrades the ability to perceive instrument timbre and power
        - It degrades soundstage precision



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# DAVE WTA FILTERING

- DAVE has 164,000-tap WTA filter
- The WTA algorithm was subjectively optimised and improved to suit the longer tap lengths
- WTA filtering is now up to 256 FS – no other DAC has ever FIR filtered at such a high rate
  - DAVE has massively parallel processing with 166 DSP cores
    - Further advanced filtering to 2048 FS
- This means DAVE more accurately retrieves the original continuous analogue un-sampled signal



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# DAVE NOISE-SHAPER

- The noise-shaper takes the high-resolution 2048 FS data and converts to 5 bits
  - It also creates the 20-element Pulse Array outputs, so is the heart of the DAC
    - Initially, Hugo-standard noise-shapers were employed
- But increased FPGA capacity and 20-element operation allows better performance
- Over 3 months of continuous listening tests and redesign pushing to improve sound stage depth perception – I (Rob) would not stop until performance would no longer increase
- Constantly pushing for better sound stage depth-perception led to world's most advanced and complex noise-shaper
- It employs 17<sup>th</sup> order noise-shaping, with a total of 46 integrators; the design of the noise shaper alone would not fit into Hugo's FPGA.



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# ANALOGUE

- 20-element Pulse Array DAC
- Unique 2<sup>nd</sup> order analogue noise-shaper for output stage – this gives ultra-high HF linearity and no increase in distortion with difficult loads
- Still employs single global feedback path with equivalent of simple 2 resistors and two polypropylene capacitors in direct signal path
- Ultra-low-noise sub-milli-ohm power planes for Pulse Array element flip-flops
  - Digital DC servo
- Headphone drive 6V and 0.5A RMS OP capability



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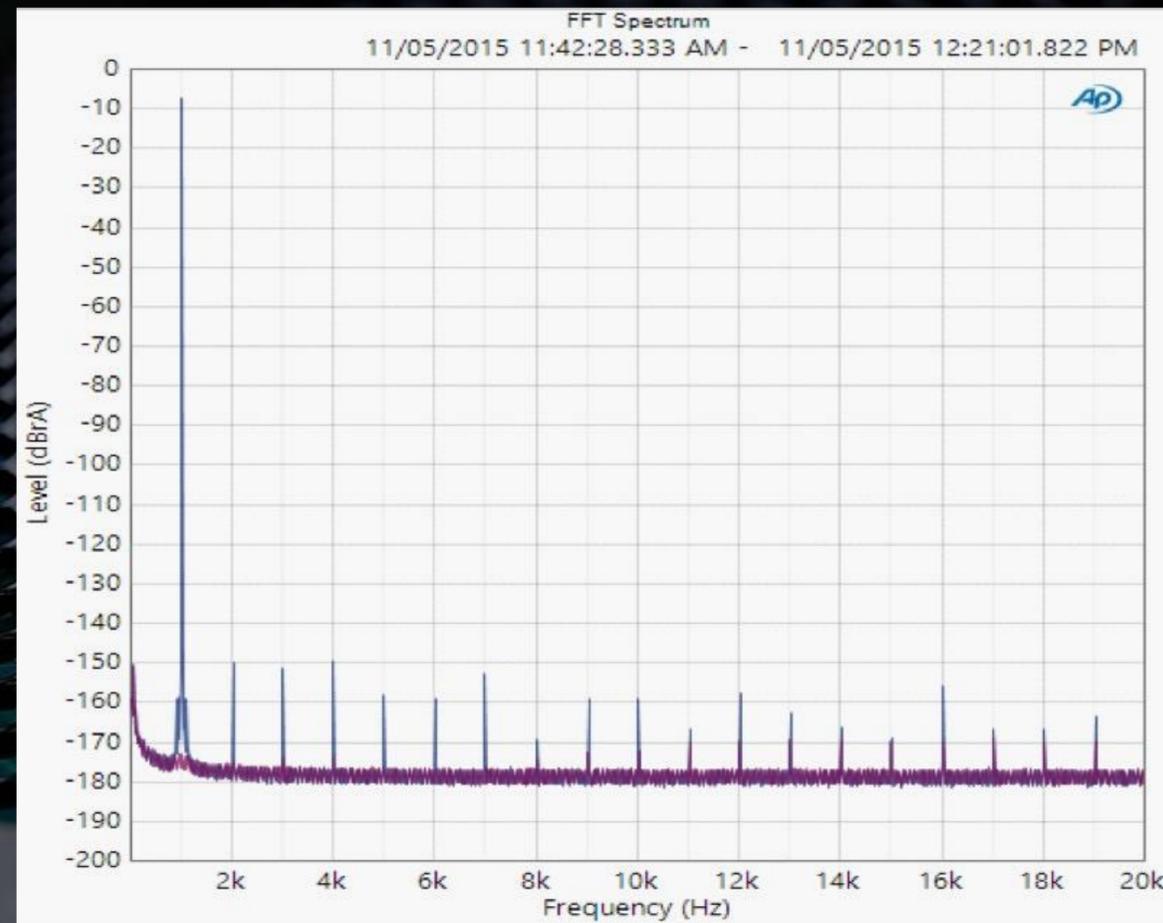
# MEASURED PERFORMANCE

- Maximum output voltage 6V RMS – the reference voltage dBA, measured using APx 555
  - THD and noise at 5V RMS 1kHz -124 dBA A wt
- THD and noise at 2.5V RMS 1kHz - 127 dBA A wt (-124 dBA into 33 ohms)
  - THD 1kHz 2.5V RMS 0.000015%
  - Dynamic Range at -60 dBFS 1kHz -127 dBA A wt
- No measurable noise floor modulation, no anharmonic distortion
- Analogue distortion characteristic – no distortion for small signals



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# FFT 2.5v RMS OUTPUT

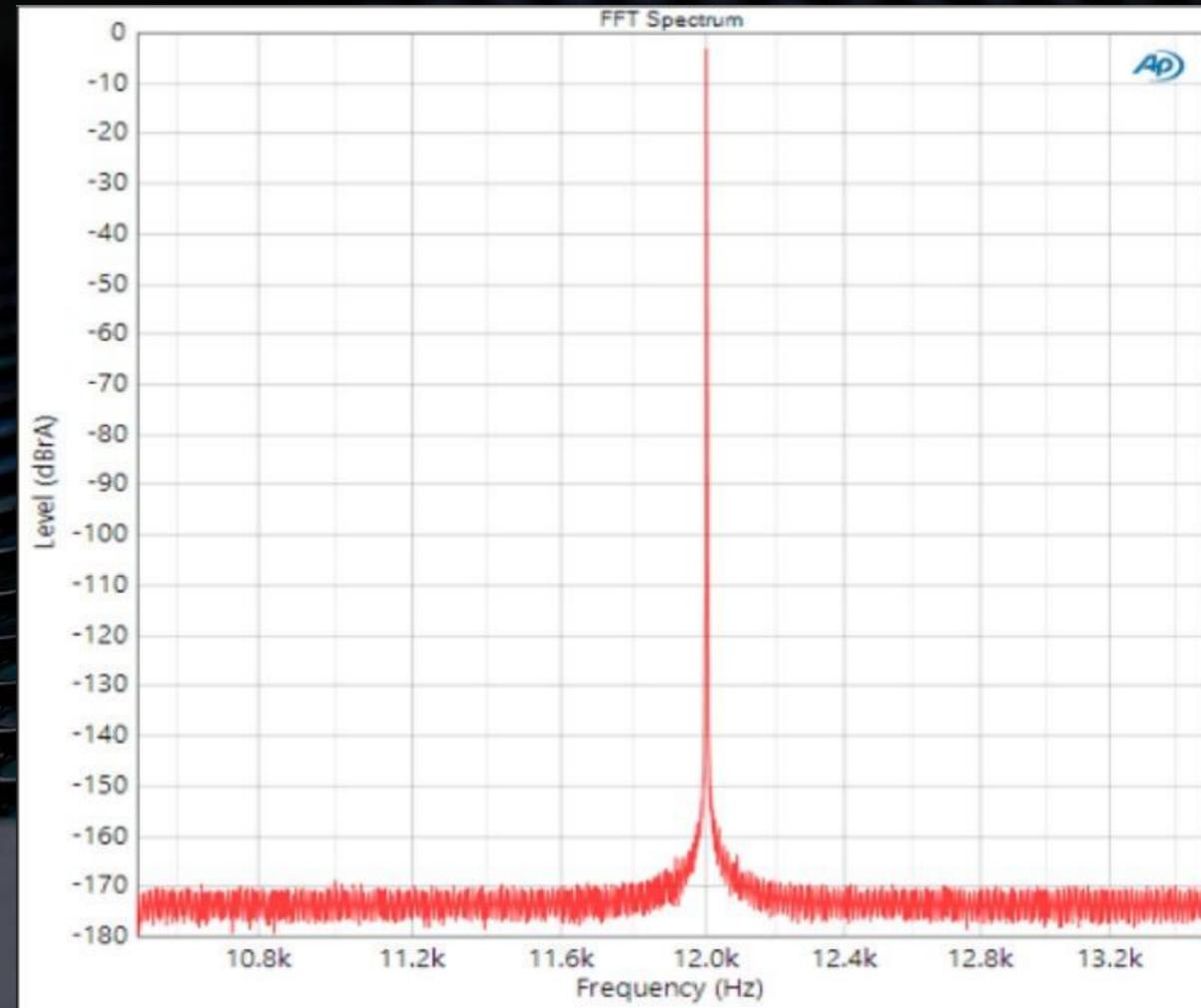


Blue 2.5v RMS, red no signal zero noise floor modulation. Noise floor at -178 dBA, distortion peaks -150 dBA, no anharmonic distortion.



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# JITTER TEST



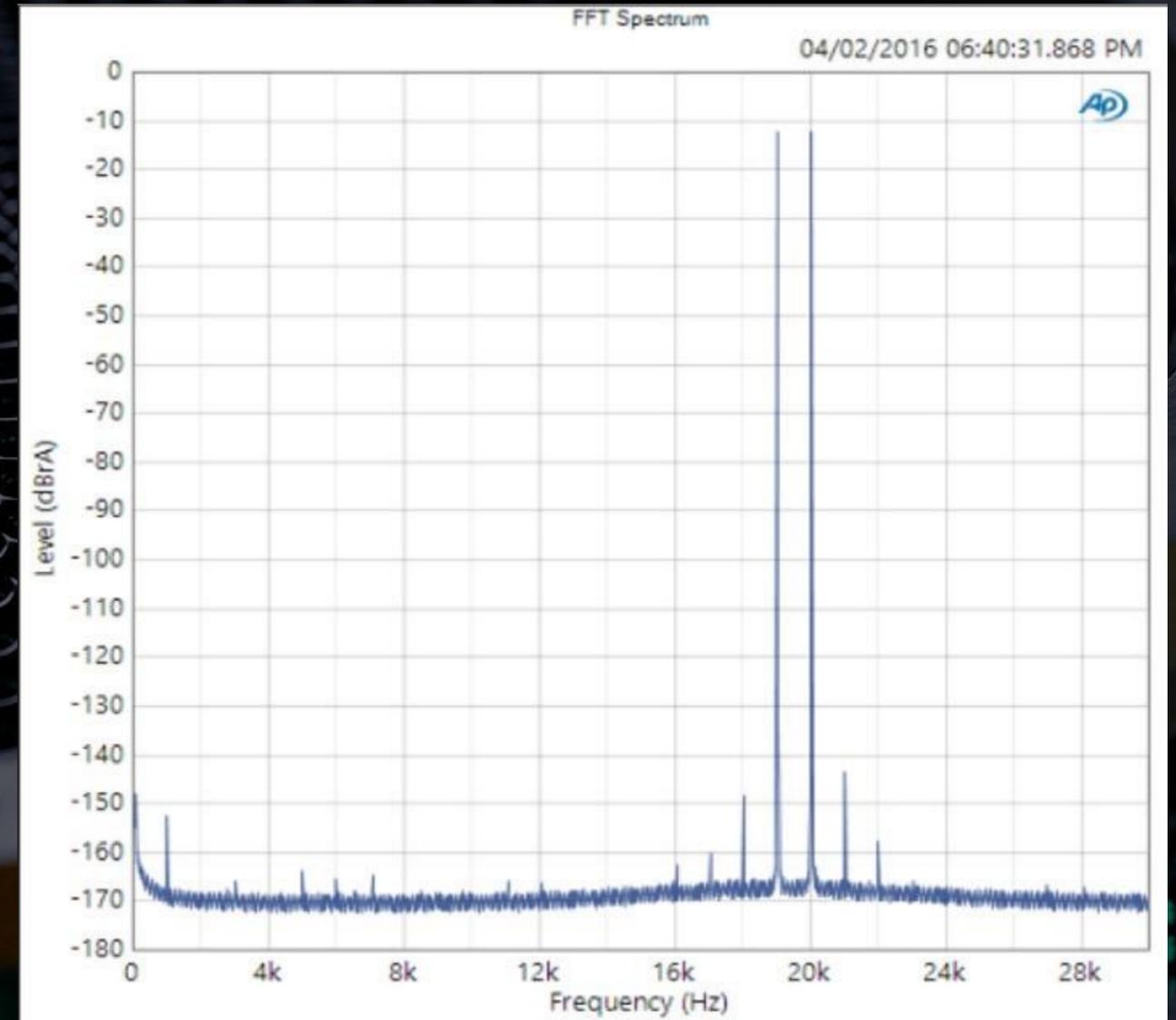
No measurable jitter artefacts



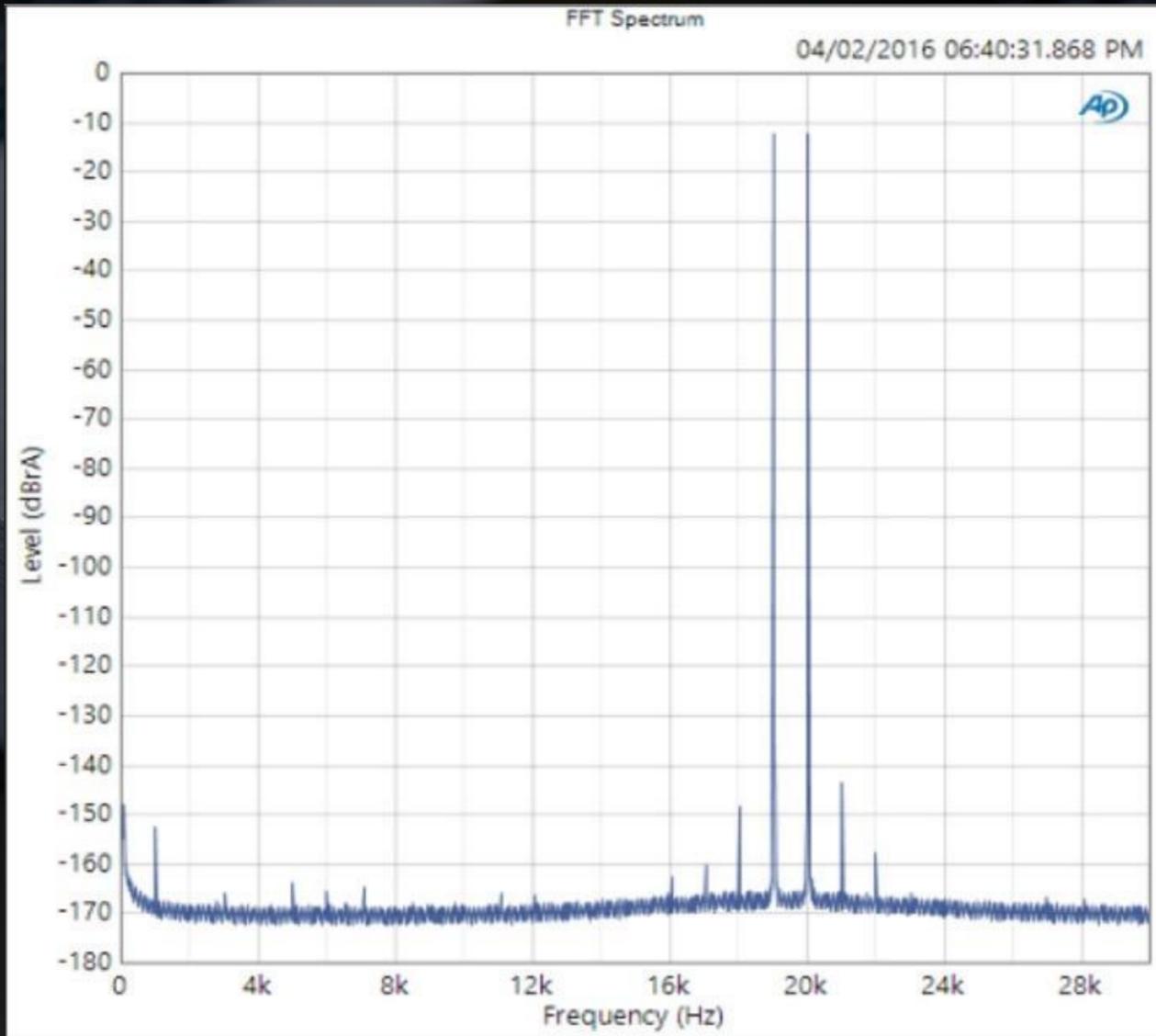
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# TWO TONE 19/20kHz TEST

- 1kHz is extraordinarily low at -152 dB
- I suspect that the APX555 audio analyzer is adding more distortion than DAVE
- Elevated noise floor is the APX555



# 16bit -90.3dB



- 16 bit levels are perfectly reproduced
- Note how similar left/right channels are

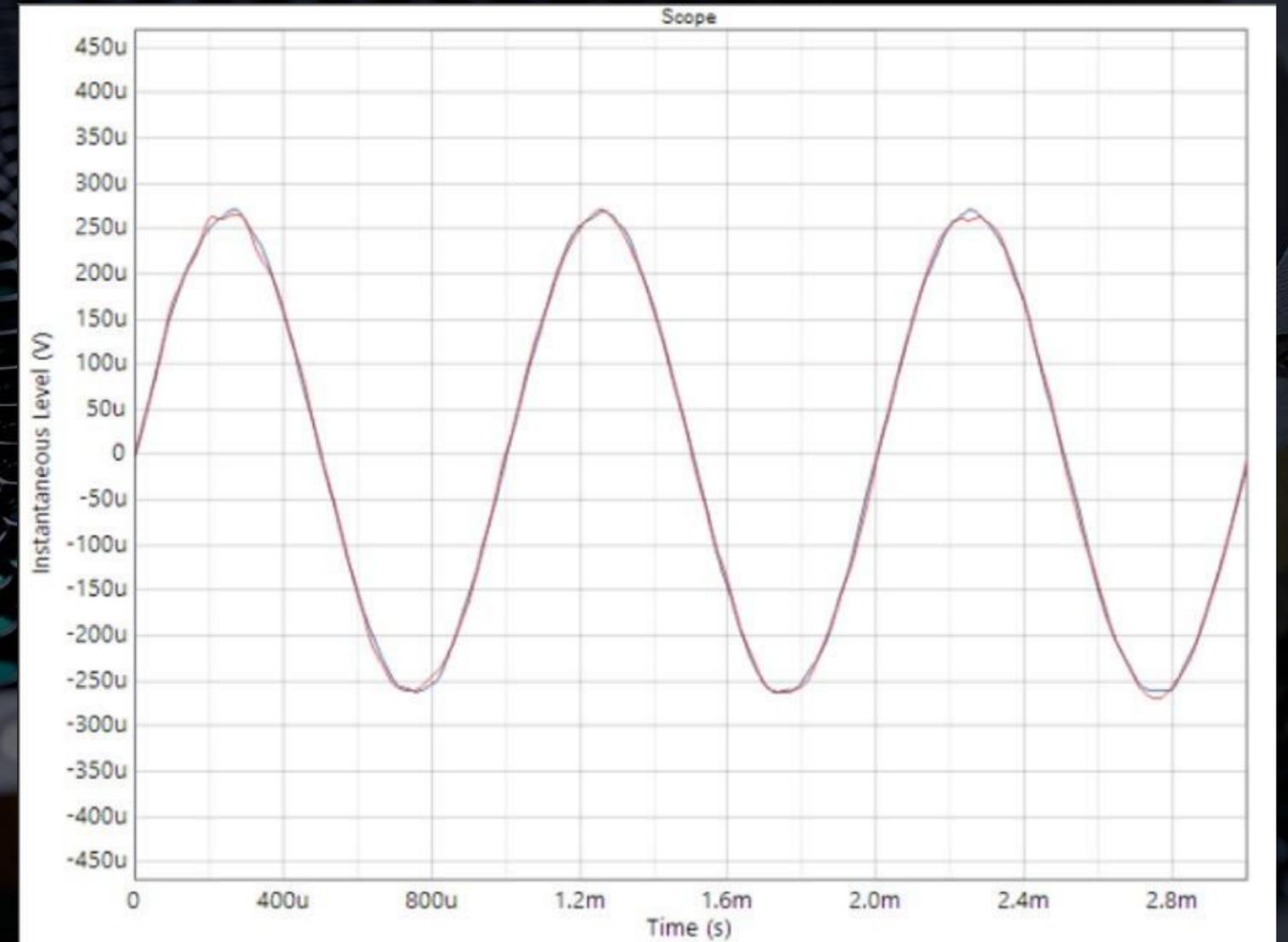


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# 24bit -90.3dB

- No small-signal distortion
- Note how similar left/right channels are

Extremely low noise



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# DAVE: CONCLUSION

1. Most advanced DAC technology in the world!
2. Redefines DAC measured performance
3. In my view, it sets new DAC sound quality and musicality performance



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