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

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

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^{th} order noise-shaping, with a total of 46 integrators; the design of the noise shaper alone would not fit into Hugo's FPGA.

ANALOGUE

- 20-element Pulse Array DAC
- Unique 2nd 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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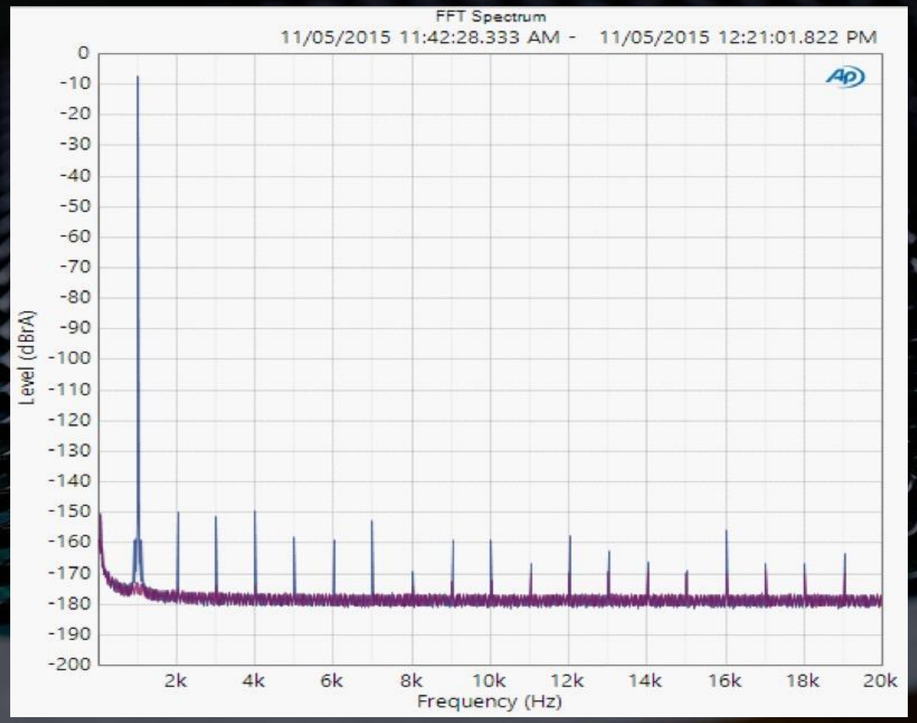
FFT 2.5v RMS OUTPUT



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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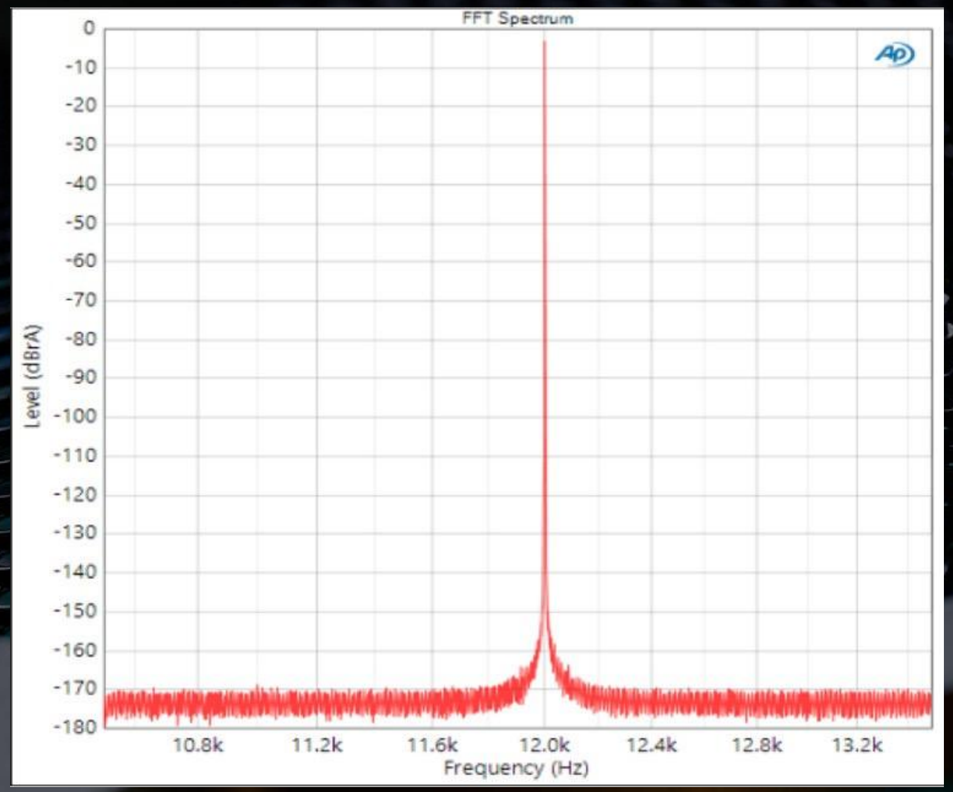
JITTER TEST



No measurable jitter artefacts

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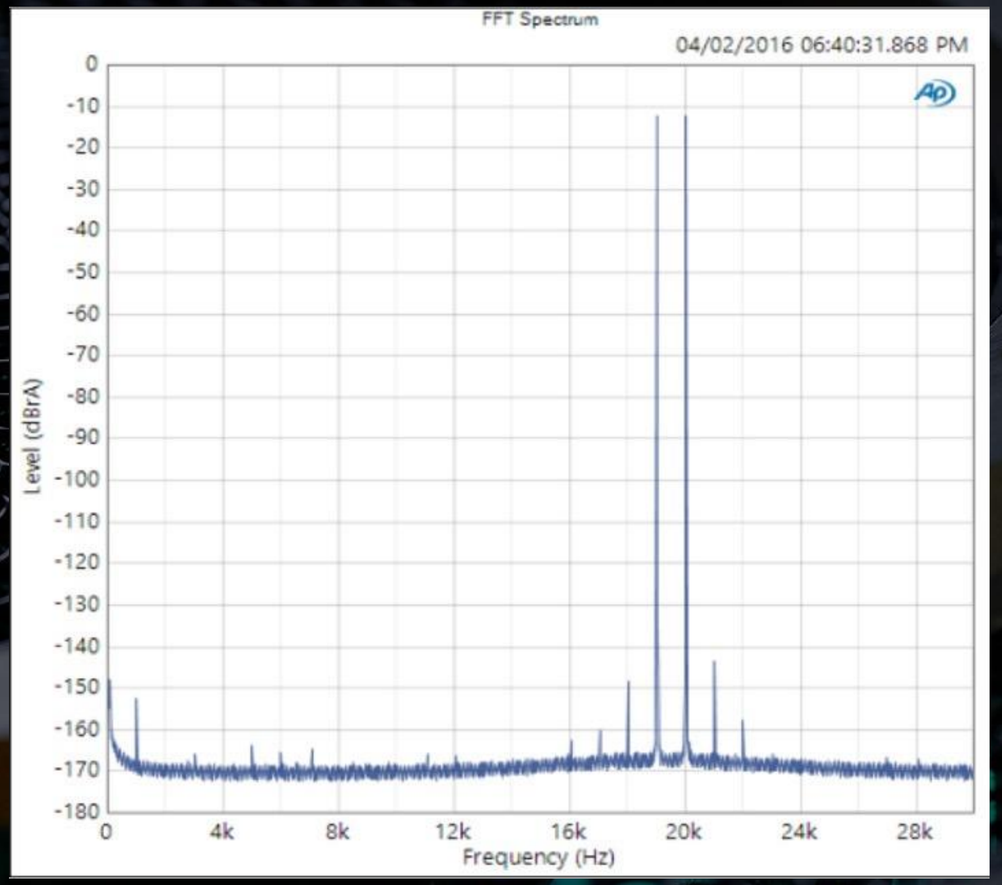
TWO TONE 19/20kHZ TEST

- 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



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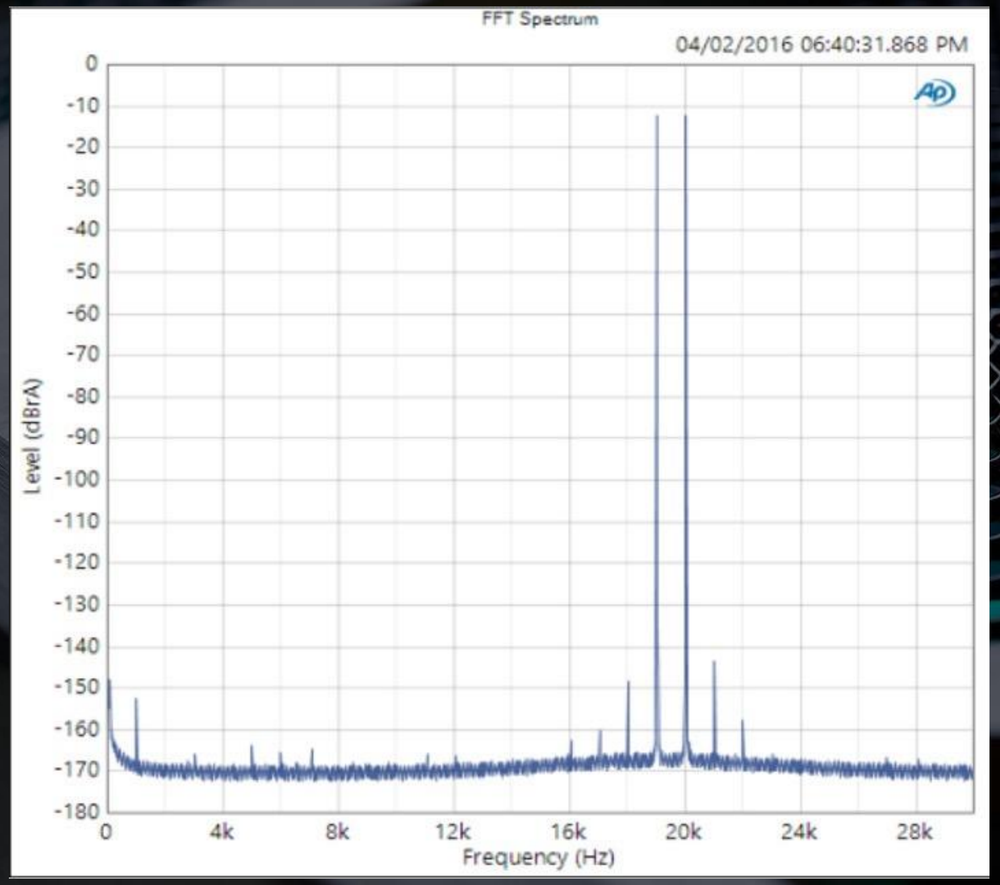
16bit -90.3dB



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

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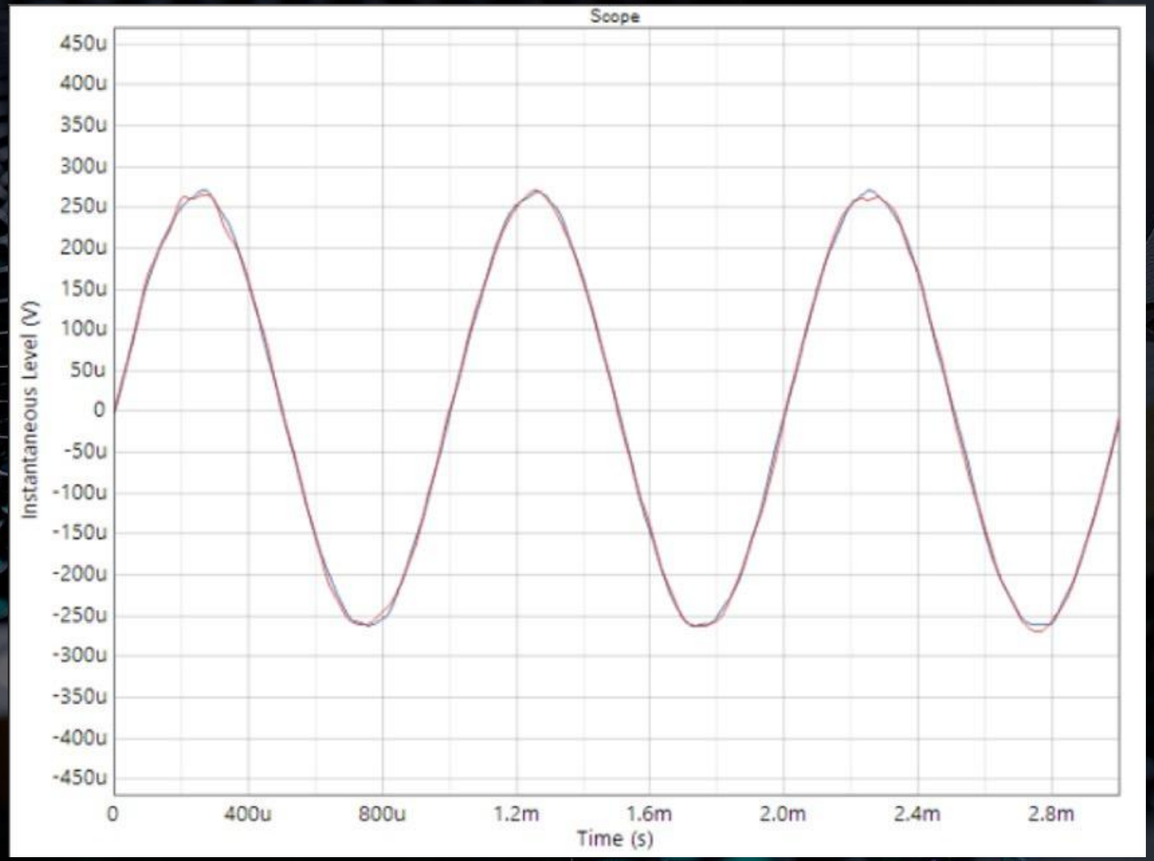
24bit -90.3dB

- 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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