

# Chord Mojo 2

Tiny, solidly made, UK-built and now even more capable, is this compact USB DAC/headphone amp from Chord Electronics still the one to beat below £500?

Review: **Ken Kessler Lab: Paul Miller**

**I**ndundated as we are with pocket-money portable headphone amp/DACs, Chord's Mojo 2 asks the question: why drop £449 on a portable headphone DAC? Once you hear it, you'll understand, especially if top-quality sound on the move matters to you. The Mojo 2 is an upgrade on the top-drawer Mojo [HFN Jan '16], the battery-powered, smaller-than-a-deck-of-cards DAC/headphone amp. It arrives with only a £50 price increase that doesn't even correspond to real-world inflation. Even without the Mojo 2 improvements, the original Mojo should retail for £470 in 2022 just for the inflation, so Chord has somehow managed to squeeze in a host of upgrades with but a nominal price hike.

Two visual clues, aside from the engraved '2' on the surface, identify the new version. The most obvious is a fourth control sphere, adding to the bespoke light show which tells you what function or level is being addressed via the new menu system. And you need good eyesight, as some of the colour differences are subtle. If you're colour-blind, forget it.

## OVER THE RAINBOW

While most of these functions are secondary, many will welcome them: access to mute, crossfeed, button-lock and tone control adjustment in addition to battery level and charging status. I almost said 'easy access', but that would be a fib for I found the Mojo 2 especially challenging to navigate. Its 'user interface' is simply very *different*...

The  $\pm 9$ dB four-band tone adjustment, in particular, is accessed and set via no fewer

**RIGHT:** A 40,960 tap version of Robert Watts' WTA filter and DAC (now with quad-band tone control) runs on a powerful Xilinx Artix-7 FPGA. The battery [left] has improved charging management and boasts a 9% uplift in capacity

than 14 permutations of the centre pair of buttons. The menu button, meanwhile, lights up red to indicate the 20Hz (bass) tone shelf is active, yellow for 125Hz (upper bass), green for 3kHz (presence/treble) and blue for 20kHz (high treble). To see the 'shape' of these cut 'n' boost tone controls, turn to PM's Lab Report, p73.

For me the most valuable external change is the addition of a symmetrical, (plus 768kHz/32-bit and DSD256 compatible) USB-C input, bringing the Mojo 2 into line with most current smartphones, MacBooks, etc. However, while the Mojo 2 might be purchased by some users mainly as a top-flight headphone amp, remember that this is an exclusively digital in/analogue out device. So, if you *only* want a portable headphone amp, to improve on your smartphone or tablet's meagre analogue headphone output, there are other solutions available without a DAC section.

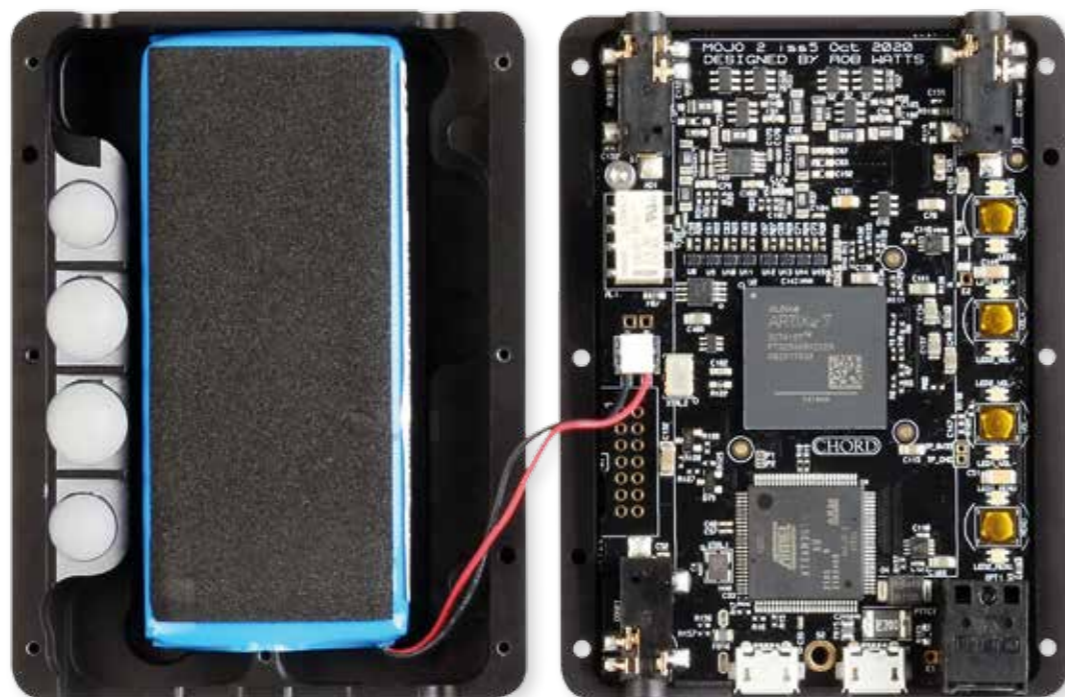
The abundance of digital inputs [pictured, p73] increases the Mojo 2's usability while Chord has also held onto its two 3.5mm headphone sockets, for two listeners, albeit without separate output levels for each. The retention of the original Mojo's Micro-USB port also maintains compatibility with Chord's £495 Poly add-on, which adds wireless connectivity and microSD card storage – although my personal experience of the various interfacing apps between

the two gave me a headache. Then again, I often find myself dreaming about the glory days of installing scanners, modems and printers in Windows 95...

## DSP TO SPARE

Internally, the changes from Mojo to Mojo 2 are extensive, not least being the addition of those lossless DSP tone controls (hence the need for the fourth button), and

'Trust me:  
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the removal of coupling capacitors in the output stage. Processor coding and filtering have been upgraded, the noise shaper has been improved for 'greater depth and detail', while the dynamic range is said to have increased from 122dB to 125dB (like I'd notice...).

The lithium-ion battery has witnessed a 9% uplift in capacity and benefits from swifter, more efficient charging. The loss from heat (the original Mojo could double as a hand-warmer during cold months...) has been reduced by 75% according to Chord and while the Mojo was said to offer eight hours' playing time this has been updated to 'over 8 hours' for the Mojo 2. Before, the amp was fed by the battery but in the Mojo 2, it's fed via regulators, so there's lower PSU noise [see PM's boxout, below, and Lab Report, p73]. Importantly, if the Mojo 2 is left plugged in to a charger, the battery now remains isolated.

## MOJO RISIN'

To pitch this against the original Mojo, I used it with EQ set to flat, and employed the input types common to both. For my final verdict, however, and optimising the conditions, I used the aforementioned USB-C port. Both Mojos were tested with a selection of headphones from Audeze and Master & Dynamic, including the high-end Audeze LCD-5 which need lots of power.

## BATTERY BEEFCAKE

Chord's debut Mojo was the most impressive portable battery-powered USB DAC/headphone amp we'd had on the bench thus far [HFN Jan '16] and, on the basis of power output alone, remains the class leader besting the likes of Astell&Kern's CA1000 [HFN Mar '22]. At full volume, and with a peak level (0dBfs) digital input, the Mojo 2's output is already clipped (+15.5dBV or 5.95V), but backing off reveals a 'clean' voltage output of +13.5dBV (4.7V), realising power output(s) of 37mW/600ohm, 540mW/32ohm and a full 630mW/8ohm [blue, black and red traces, respectively, inset Graph]. Even at substantial outputs, distortion remains very low, increasing from 0.0001-0.002% (unloaded) to 0.0009-0.021% (10mW/32ohm, 20Hz-20kHz) once loaded.

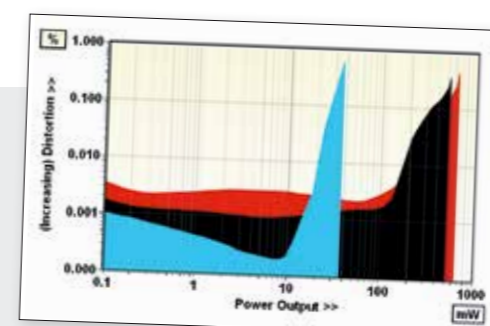
Chord's under-the-bonnet updates all hit the mark. So, the Mojo 2 offers lower noise than the Mojo – the A-wtd S/N is significantly wider than before at a massive 114dB while hiss and hum remains very low at -101dBV to directly benefit very sensitive headphones. The Mojo's output impedance was always low at ~0.75ohm but is a little lower still in the '2 at ~0.5ohm (20Hz-20kHz), resulting in a mere 0.1-0.2dB loss into a standard 32ohm load while further improving its 'resilience of response' into low and variable headphone impedances. Otherwise the frequency response is determined as much by Chord's WTA digital filter and DAC as the incoming sample rate [see Lab Report, p73]. **PM**



**LEFT:** The Mojo 2's durable 'milled from solid' alloy case features multi-colour, illuminated 'ball' controls for power, volume and a new menu/tone function. A rainbow of colours indicates volume level, tone band, battery status and incoming sample rate

Stupid me: I should have expected the Mojo 2 to be at full gain when I first fired it up. Who knew that Johnny Mathis could have the ear-shattering power of Metallica? Wow, can this go loud! Once regaining my senses, I dialled down the level and worked my way through material on a Huawei P30 Pro smartphone and Pioneer XDP-100R DAP [HFN Aug '16].

Sources included lossless rips from CDs via assorted programmes, as well as high-res downloads. Among them was the complete Beatles library in the unusual 44.1kHz/24-bit FLAC format from the 2009 remastering [HFN Yearbook '09], supplied in a metal Apple USB stick. It took, oh,



maybe 15 seconds to decide emphatically that the Mojo 2 does *everything* better than the original Mojo.

I don't write that to disturb you, because Chord's mould-breaking Mojo is still better than just about anything out there. Also, I can't see too many people schlepping around one of the larger, heavier, dearer Chord Hugos [HFN Aug '18], even for those who think they want more than a Mojo. Trust me: through the highest-resolution headphones in my arsenal, both Mojos did something wonderful, as Peggy Lee once sang. But the Mojo 2 further opened the sound to a degree I can liken only to going from sealed-back to open-back headphones. And it did this while avoiding the one sacrifice you expect to make with that transition: the loss of bass.

## LOST IN HEAD SPACE

With the opening notes of The Beatles' 'Come Together', I heard deep, extended, solid lower octaves, in a sound space – or should that be a head space? – which seemed to have no boundaries. Remember, all the new menu/tone settings were flat, as pure and unadulterated as I could manage. Unfortunately, I didn't have the same tracks on the same player in two different formats, and Apple has yet to reissue The Beatles' canon at higher resolution, so I turned to other material which I did have in more than one form.

How I ended up with Mink Deville's "A" Train Lady' in both AAC 44.1kHz/16-bit and FLAC at 192kHz/24-bit I'm not sure, but ↪



## USB DAC/HEADPHONE AMP



**ABOVE:** The Micro-USB port is joined by a new USB-C input on the Mojo 2 (up to 768kHz/32-bit and DSD256). Another Micro-USB socket handles battery charging, alongside a 3.5mm S/PDIF coaxial socket with Toslink optical insert. Dual 3.5mm headphone outputs are included on the opposite side of the case

here the Mojo 2 showed its mettle. Listening straight off the Pioneer DAP, it was possible with just a bit of effort to hear the difference between such widely varying encodings. From the Pioneer player's USB output first into the Mojo and then the Mojo 2, I heard progressively better sound in terms of smoothness and air.

To be fair to the Mojo – and don't ditch yours just because the Mojo 2 has arrived – it so improved on the Pioneer DAP's headphone output that this little A/B comparison alone was sufficient to recommend either Chord device. The main areas of improvement were retrieval of fine, low-level detail and dynamic swings, the latter due in no small part to a more powerful headphone amplifier in both Mojos. I must stress, too, that moving from Mojo to Mojo 2 delivered fewer gains that moving to either Mojo from the Pioneer player.

As for the switch from Mojo to Mojo 2, the most readily discernible gain came in the vocal textures, Willy Deville's voice a challenging mix of the gravelly and the nasal. The Mojo 2 was slightly less sibilant and a hint warmer, but almost as startling an improvement, to my ears, was the extension of the soundstage. The presentation really did appear wider, certainly outside of the headphone cups.

### FREAK SHOW

Perhaps it's a little freakish to talk about a perceived soundstage when it's in one's skull. That's why I *only* listen to headphones when I have to, for testing or in transit, because I still find cans unsettling, even 54 years after buying my first proper pair to use when the old man didn't

want to hear me rocking away upstairs. However, and despite my apparent reluctance, I still seem to be donning headphones on a surprisingly frequent basis...

Nevertheless I was also keen to hear the Mojo 2 as just a DAC, with a Toslink connection from a universal player and the analogue out into my regular system. Fed with George Harrison's *All Things Must Pass 50th Anniversary* [Capitol/Dark Horse/Apple 02435 65238], I ran it alongside a couple of highly-regarded DACs which I'm choosing not to embarrass. Chord's Mojo 2 delivered such smooth, silky, open, transparent and *undigital* sound that it's now a reference in my system.

Downsides? The Mojo 2 begs for a tiny touchscreen, as does the Poly, to make it usable for those of us who cannot tell the difference between, say, Pantone 290CS and 291CS colours regardless of ambient lighting. But, ergonomics aside, as both a DAC and a headphone amp, the Mojo 2 is amazing. ☺

### HI-FI NEWS VERDICT

For one who adores dual-purpose items which do more than they need to, the Mojo 2 is a little miracle. You want to know how it serves as a portable DAC and headphone amp: I cannot name a better one. The real surprise, though, is using it in a home sound system. This isn't just a great mobile DAC/amp, it's a red-hot (metaphorically) bargain DAC for *any* use. I absolutely love it, despite the sadistic ergonomics.

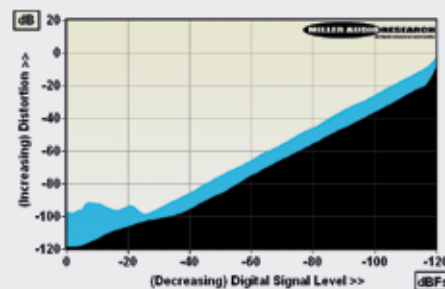
Sound Quality: 90%



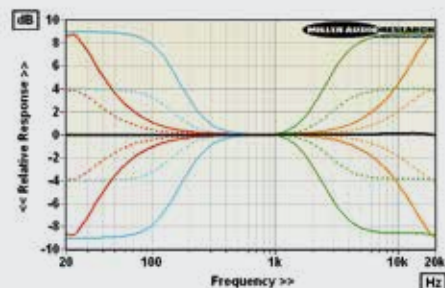
## CHORD MOJO 2

Designed by Robert Watts, the Mojo 2's 16x upsampling, 40,960-tap interpolation filter runs with an eight-element version of his proprietary Pulse Array DAC [pic, p70]. There is only one principal digital filter on offer here (unlike the five or six fast/slow roll-off, linear/minimum phase types sent to baffle many enthusiasts and add to my workload on the lab bench – see p66). Thus there is only one 'response' for the Mojo 2, reaching out to within  $\pm 0.1$ dB from 20Hz-20kHz with CD/48kHz media and rolling away to  $-3$ dB/35kHz with any input at or above a 96kHz sample rate. Naim Audio offers a similar response shaping via its streaming platform [HFN Aug '21] although its combined brickwall IIR filter and two series-connected 3rd-order analogue filters is very different to Chord's WTA technology. For commercial reasons, the time domain behaviour of Watts' filter remains a closely-guarded secret and any 'probing' with a standard  $\sin/x$  impulse reveals a suspiciously idealised pulse [HFN Sep '18, for examples]!

While the exact WTA coefficients are left to musing and mystery there's no concealing the exceptionally 'clean' outcome. Maximum output, prior to clipping, is 4.7V with distortion a very low 0.00013-0.00075% at 0dBfs [note the very linear increase in THD at 1kHz with reducing digital level, Graph 1]. The A-wtd S/N is a wide 114dB, channel balance good to 0.01dB and separation  $>80$ dB from 20Hz-20kHz. Correlated jitter is also fabulously low at  $\sim 10$ -12psec (all sample rates) while phase noise is almost entirely absent [see p57, when used with Melco's N10/2]. The effect of the four 'tone bands' falls within the solid traces on Graph 2 which show the maximum  $\pm 9$ dB contouring at each frequency (20Hz, 125Hz, 3kHz and 20kHz). The dashed traces show the effect at the  $\pm 4$ dB setting. PM



**ABOVE:** Distortion vs. 24-bit digital level over a 120dB dynamic range at 1kHz (black) and 20kHz (blue)



**ABOVE:** Tone responses at mid ( $\pm 4$ dB, dashed), max ( $\pm 9$ dB, solid traces) and 'off' (black). Freqs are 20Hz (red), 125Hz (cyan), 3kHz (green), and 20kHz (orange)

### HI-FI NEWS SPECIFICATIONS

Maximum output level / Impedance	4.68Vrms / 0.44-0.90ohm
A-wtd S/N ratio (re. 0dBfs)	114.1dB
Distortion (1kHz, 0dBfs/-30dBfs)	0.00013% / 0.00075%
Distortion & Noise (20kHz, 0dBfs/-30dBfs)	0.0018% / 0.0020%
Freq. resp. (20Hz-20kHz/45kHz)	+0.1 to $-0.06$ dB / $-7.1$ dB
Digital jitter (48kHz / 96kHz)	10psec / 12psec
Resolution (re. $-100$ dBfs / $-110$ dBfs)	$\pm 0.2$ dB / $\pm 0.7$ dB
Power consumption (charging)	2W
Dimensions (WHD) / Weight	83x23x62mm / 185g