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AC or DC?

MOST SERIOUS HI-FI TURNTABLES ARE BELT-DRIVEN BY SYNCHRONOUS AC MOTORS, SO WHAT SHOULD WE MAKE OF CLAIMS THAT THE LATEST DC MOTORS OFFER SIGNIFICANT ADVANTAGES? MARTIN COLLOMS LOOKS AT THE ENGINEERING ISSUES AND CHECKS OUT THE ORIGIN LIVE CONVERSION KITS.

Although there are a number of exceptions, probably more than 80 per cent of all hi-fi turntables currently being manufactured use inexpensive, fairly high quality synchronous motors. Multi-pole in construction, these operate at quite low rotational speeds from a 50Hz (or 60Hz) mains supply, and are sufficiently accurate, medium to long term, to act as a velocity reference for a turntable platter: they've also been used in clocks for more than a century. Offering high torque, low speed and satisfactorily low noise, these motors have produced numerous excellent turntables. The motor drives the platter via a rubber cord or similar elastic belt, which filters out some of the inherent vibrational noise on the pulley, preventing it from reaching the disc and thence the cartridge.

Whether a turntable is designed around a rigid plinth foundation, or includes a spring-suspended subchassis, some mechanical noise is also inevitably generated in the frame of the motor, some as a result of interference and distortion in the mains supply. Synchronous motors are bi-phase with two fixed windings, and the required 45 degree phase shift may be supplied via a single mains rated capacitor, or via a more sophisticated power supply such as the Linn *Lingo*: by synthesising a pure 50Hz bi-phase signal, the latter aims to provide lower noise, low distortion power to the motor. Adopting an alternative approach, Naim's *Armageddon* 'supply' offers a cleaner, low impedance power by feeding the motor via a massive mains transformer: this filters DC and some other components from the raw mains. Having noted some degree of inherent imbalance between the stator windings of motor samples, some manufacturers provide a match to a given motor, or an adjustment which may be tuned to minimise motor frame noise (Pink Triangle, Roksan, Rega etc).

The whole idea is to keep motor noise out of the drive system, since for a synchronous mains powered motor it comprises wide spectrum mechanical hum (and some electrical induction too). Some high precision, higher torque DC motors are now available and are claimed to be more than quiet enough. On the face of it, their higher shaft rpm would suggest greater noise, and in some cases this is true. If DC motor noise can be reduced to a satisfactory minimum, its non varying direct current supply (eg from an outboard control unit) would usually allow the 240V/50Hz element to be entirely removed from the turntable assembly, with the consequent potential for near zero electrical and mechanical hum induction with vinyl replay.

While the supply to a DC motor can be virtually noiseless, in order to make the shaft rotate, a rotating field must be created to react with the magnetic poles within. Essentially a switch is required which rotates with the shaft rotor and which directs the power to the right windings in sequence which provides rotational power. Usually the switch is realised as wire contact 'brushes' which bear lightly on the rotating surface of the switch contacts. Some electrical and mechanical noise will be present but can be very low with top quality types (far removed form the ozone producing sparking motors familiar from model railways or Scalextric). A few, usually larger models replace the brushes with electronics, hall sensors or photodiodes, but some switch noise will still be present. The finest of these was the Technics *SP10* direct drive motor.

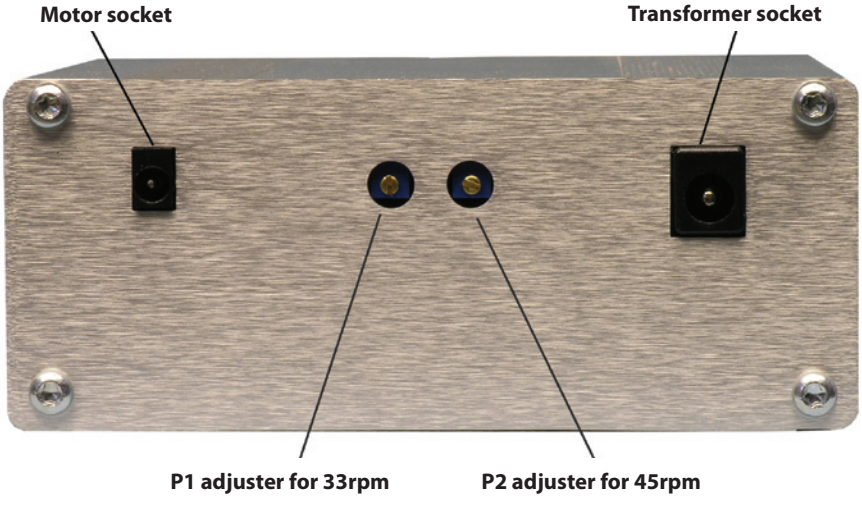
In practice all motors are imperfect: slight rotor imbalances generate vibration; a spinning shaft runs in real world bearings. Also the windings will produce mechanical noise if there is electrical noise on the supply, and in this respect they can behave like a loudspeaker motor. Pole cogging may also be a feature and some designs have overlapping fields to smooth the

flow of power. The success of any attempt to replace an established AC synchronous drive with a DC motor will depend upon the following key issues: low self-noise, low power supply noise, stable speed, sufficient torque, a compatible match to the belt, adjustable belt tension, and a good match to any subchassis dynamics.

Insufficient torque, whether due to poor belt tension or inadequate power, may be audible as dynamic wow, but the low frequency speed variation termed 'wow' may be so deep, or low pitched, that the usual expected 'wobble ' in pitch is not identifiable; rather it may be perceived as a more subtle and unsettling change in musical timing. This undermines confidence and can insidiously dilute the drive and pace of the replay of a well recorded rhythm band. For me at least, some earlier generation DC motor upgrades failed on this score. Technically this resulted from minute but aurally significant changes in load on the motor due to variable stylus drag (frictional contact which is partly dependant on the loudness and complexity of the music). Sufficient torque means that the speed changes resulting from stylus drag dynamics are rapidly absorbed, hopefully before the ear can notice, so that the drive and rhythm of the track is unimpaired.

The Origin Live DC conversion kits

Origin Live is one of the chief protagonists of using DC rather than AC motors for turntables. Besides its own extensive ranges of turntables and tonearms, the company promotes and supplies conversion kits to change existing AC-synchronous driven turntable over to DC motor drive. There are four grades of these kits:



all are based on the *DC200* motor, but this can be used with either the *Advanced* or *Ultra* speed controllers, and with either the *Standard* or *Upgrade* power supplies. Approximate prices run from £470 for the *DC200* motor with *Advanced* control unit and basic supply; add £160 for the upgrade transformer (well worthwhile), and a further £230 for the *Ultra* controller upgrade, and the most costly package totals £860. All four options were assessed on a Linn *Sondek LP12* that is normally used with a Naim *Armageddon* power supply feeding its AC-synchronous motor.

At the recent Heathrow Show, Origin Live's Mark Baker had explained his thesis that an ideal drive would generate no resonance oscillation between the elastic belt and the platter inertia. It should provide steady, very low vibration power, with low associated Q (to reduce subchassis flutter), and deliver a quieter more stable stylus groove interface. In addition it should remove electrical hum from the turntable assembly, and provide an easy 33/45 speed change. The *DC200* motor comes already fitted to a stainless steel mounting plate, and is designed to work with the existing belt. Plugs and sockets are also fitted so trial, installation and changeover is easy enough.

Sound Quality

Prior to getting the belt tension right, I found that although I could get true speed, the drive also suffered from the dreaded dynamic wow. Once I had satisfactorily set a standard belt tension, all was well. I tried every combination of supply and controller, four in all, all with a *DC200* motor which had been run in before serious listening.

I was not convinced by the lowest cost combination of *Standard* supply and *Advanced* controller, as the clarity did not seem better than the well set up synchronous Linn, and in some respects might have been worse. The *Upgrade* power unit helped substantially, showing real promise, and then the change to the *Ultra* speed controller answered any remaining questions I might have had.

With this top 'upgrade' package installed, the DC-driven *LP12* delivered notably silent and essentially hum free backgrounds (excluding any residual contribution from my partnering amplification). I noticed more

extended low frequency decay reverberation, a subjectively more extended bass, with plainly lower coloration in mid and bass. In addition there was less grain and increased depth in treble range.

Focus was improved with the front stage images more clearly differentiated from the main group. Further listening revealed better tune playing in the bass, a more upbeat tempo, and improved dynamics in both micro dynamic subtlety and the range from soft to loud. The soundstage was larger, more spacious, and vocal articulation was clearer. While not chalk and cheese, I suspect habituated *LP12* users would certainly appreciate and value the difference.

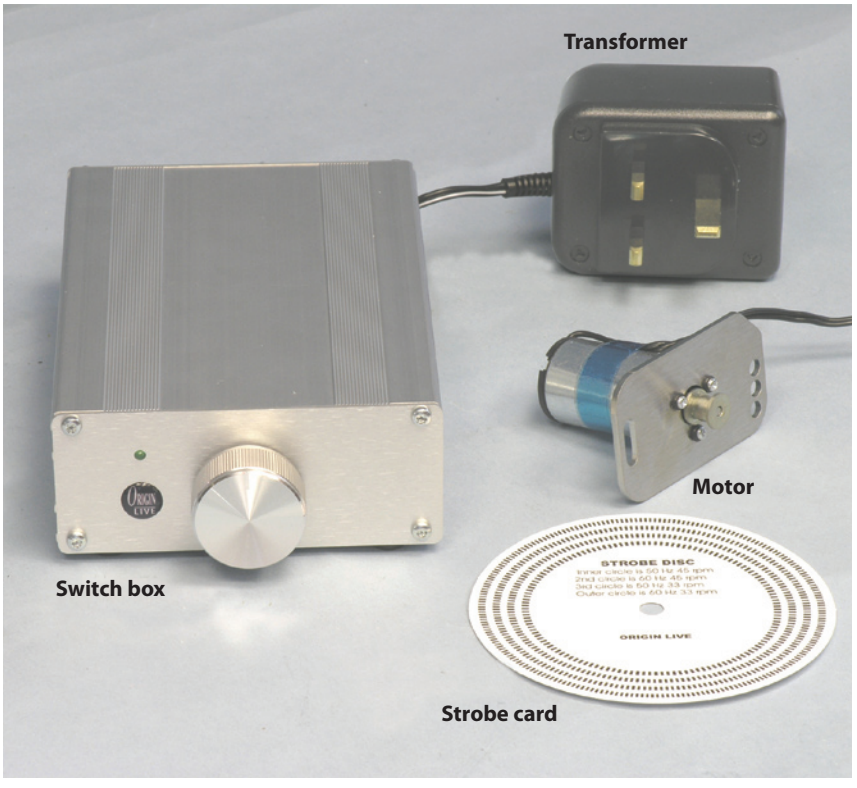
I fine-tuned belt tension and the tautness of the (single) bracket fixing to the motor, balancing the belt tension and zero dynamic wow issues against still lower, vanishingly quiet background noise levels. With belt over-tension the sub-chassis dynamics become slightly more bouncy, adding a faint defocusing 'shimmer' to the soundstage focus.

A Tale of Two Controllers

Once fully installed with the larger power supply I auditioned the two control units, *Ultra* (blue LED) and *Advanced* (green LED). *Advanced* had performed well for a couple of weeks and we were well accustomed to it, including using it for the main cartridge listening tests. Then we tried sequential A/B comparisons of *Ultra* versus *Advanced*.

There was no argument concerning the high quality of the *Advanced*, but *Ultra* was clearly superior, and in an unexpected way. It improved the treble; not that there was much grain anyway, but high frequencies now sounded more explicit, yet also purer, and somehow more 'liquid'. *Ultra* sounded significantly faster, more upbeat, and better focused, both musically and in terms of the soundstage. Yet a check on the strobe suggested that it was actually set to rotate the platter at a fractionally slower speed than *Advanced*, so this was all to do with the music replay. With that improved presentation came deeper silences, greater ambience recovery and more expressive dynamics.

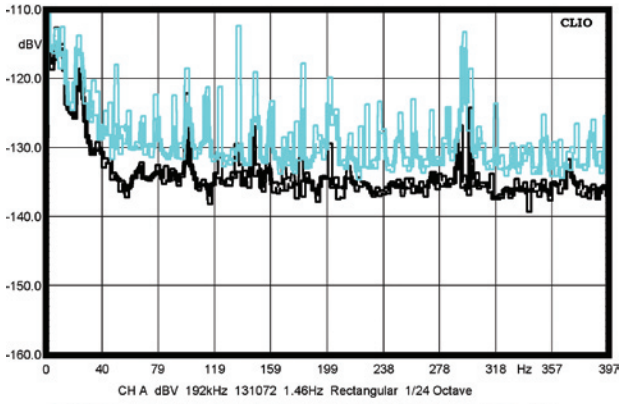
I cannot imagine a much more convincing expression of the manufacturer's art. It's as if the tiny residual variations from the *Advanced* supply and its available power/torque made the stylus-groove contact less stable, fed a little more noise to the platter and plinth, impairing dynamic range, and ever so slightly disturbing the cartridge tracing. It's still worth the money though!



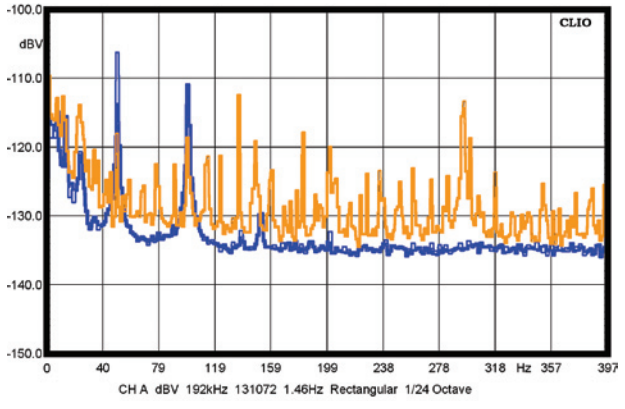
Lab Tests

With both *Advanced* and *Ultra* controllers, the claims for speed accuracy, stability and torque were met. Initial tests (with the belt too slack) got up to speed, but clearly demonstrated dynamic wow. With the motor bracket swung out slightly as directed, there was now even sufficient torque to drive a record cleaner.

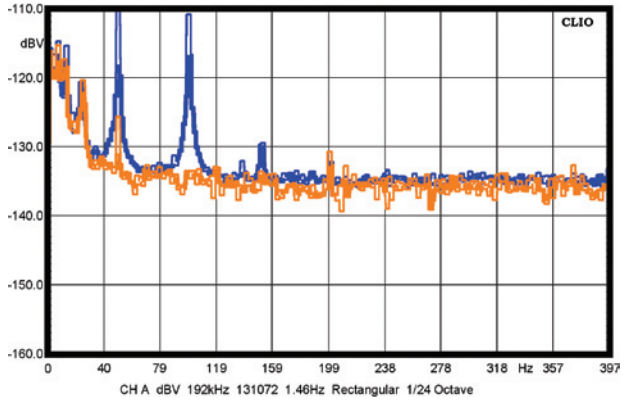
Traditional turntable test parameters – rumble, wow and flutter and speed accuracy – are generally pretty good, except for the cheapest designs, so the unusual and specific requirement to assess low noise motor required a more direct approach. Using a spectrum analyser in averaging mode, the motor noise levels were assessed at the stylus tip, both for the main support/plinth and for the record surface. It proved possible to establish that, in respect of the rotational inertia of the platter viewed as a flywheel, the belt's elasticity and self damping filtered out a high proportion of the higher frequency motor noise, as it is designed to do. Some filtering may be achieved by intentionally fitting the motor frame to the plinth via a lossy mounting: in some less costly Rega models, for example, the motor is suspended on elastic cords. However, higher wow and flutter may result, and Linn's approach calls for a relatively rigid



Graph 1, Origin Live: Motor noise at platter via stylus tip, for *Advanced* motor control: *Standard* plug-top supply (blue) versus *Upgrade* power unit (black). Clearly the power units have a very significant influence.



Graph 2, Origin Live noise levels: lowest cost *(Standard/ Advanced)* option (orange) vs *Armageddon*/Linn *LP12* synchronous (blue). Note the former's reduced hum components but broader noise spectrum



Graph 3, Origin Live top price option: best *Upgrade* supply, best *Ultra* speed controller (orange) vs *Armageddon*/Lin *LP12* synchronous (blue). Note improvement in noise levels throughout, with very low hum products present.

mounting. Origin Live uses a firmly resilient interface of neoprene rings and cork pads.

With the synchronous motor providing the reference point, measuring the four versions of Origin Live power block and speed control showed significant and successive reductions in noise; happily, the 'best quality' and most costly combination also delivered the best results. While the graphs show a trace of electromagnetic hum in the cartridge signal, the broad span of mains frequency and motor related vibrations seen with the standard synchronous motor trace was largely banished.

Specifically, Graph 1 compares the mechanical noise generated via the low cost *Standard* and the *Upgrade* mains power supplies, both using the *Advanced* speed control. The supples have quite an influence, and suggest that the cheaper 'plug top' *Standard* version should be avoided for a high quality system. In Graph 2 the lowest cost Origin Live option (*Standard/ Advanced*) is compared with the Armageddon-driven Linn synchronous motor. In the Origin Live solution, the 50Hz supply components are clearly much reduced, but broader band noise also results. In Graph 3 the *Upgrade* supply operates alongside the *Ultra* controller, and the massive reduction in noise at the stylus is clear enough, correlating closely with the listening tests.

Conclusions

While I cannot recommend the *Standard* power supply with the *LP12*, but the *Advanced* controller sounds fine with the *DC200* motor and *Upgrade* power block. This combination delivered quality as claimed, with fine speed stability, high torque and no audible dynamic wow. Assuming these latter factors are under control, the advantages of lower noise, and particularly frequency related vibration, become apparent. The benefit was clear, since the mid-bass 'bloom' of the *LP12* seemed largely removed, leaving a sound more like master-tape in its clarity, with even tune playing at low frequencies, and significantly improved bass dynamics. With this came greater overall clarity which also seemed to improve image focus and depth. A further and worthwhile gain in quality came with the *Ultra* speed controller, bringing welcome extra treble clarity and improved focus. While Origin Live's internal workmanship and build quality could be higher, and the collection of components would benefit from better naming and labelling, this enthusiast's upgrade path provides a real performance improvement, and may be firmly recommended.