



# OPTICAL CARTRIDGE

Its Technology and Advantage P2

Read before you use Optical Cartridge P6

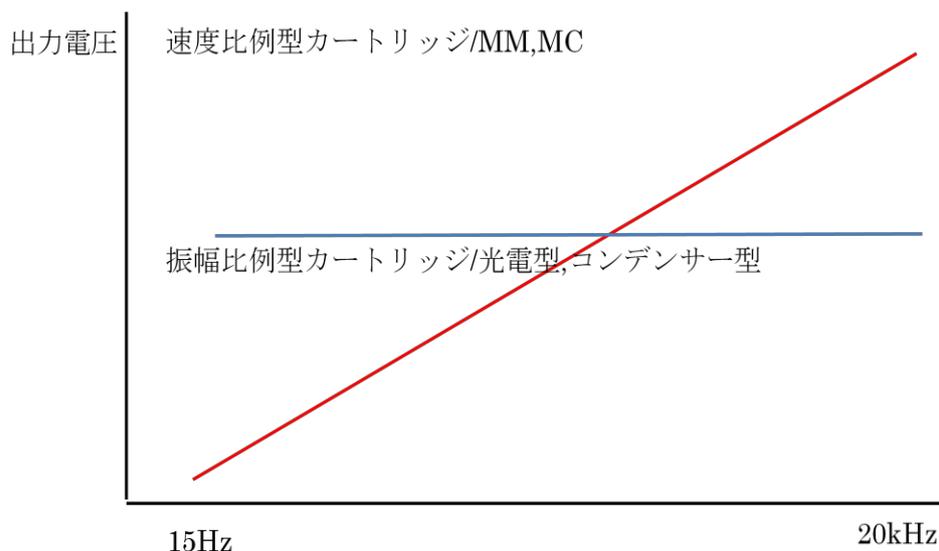
History of Optical Cartridge and

Fundamental advantages from other cartridges P7

Advantages of Optical Cartridge

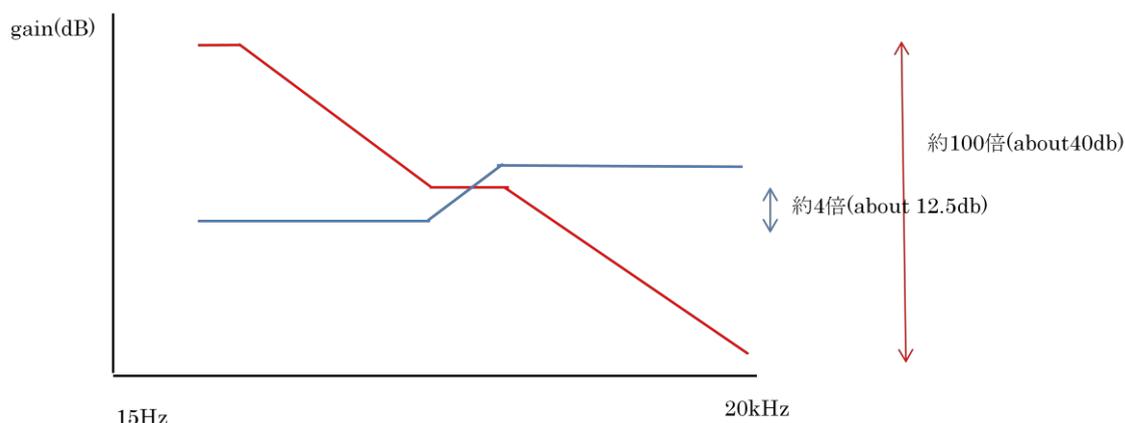
① Flat and simple Equalizing : Pure and original sound reproduction

Unlike MM/MC cartridges (Velocity proportional read out), Optical Cartridge is based on Amplitude proportional signal read out. A simple example below explains this great advantage of optical cartridge.



Unlike MM/MC cartridges (Velocity proportional read out), Optical Cartridge is based on Amplitude proportional signal read out. Suppose you have an analog record containing 15Hz to 20KHz signals with Amplitude of, say 1 unit. Red Line in Figure-1 shows the expected read out signal level from Velocity proportional read out system (MM/MC). Output level goes up as frequency goes up. This is the characteristic behavior of Electro-magnetic induction principle, where Velocity goes up (higher frequency), Electro-induction gets larger. Another words, faster magnet moves, output level gets larger.

On the other hand, Blue line in Figure-1 shows the expected read out signal level from Amplitude proportional read out system. Output signal level does not depend on Frequency, but depends purely on the recorded signal amplitude. Therefore, the expected output signal level is 1 unit all the way from 15Hz to 20KHz (Flat) (Note: Flat output level does not mean no equalizing is needed)

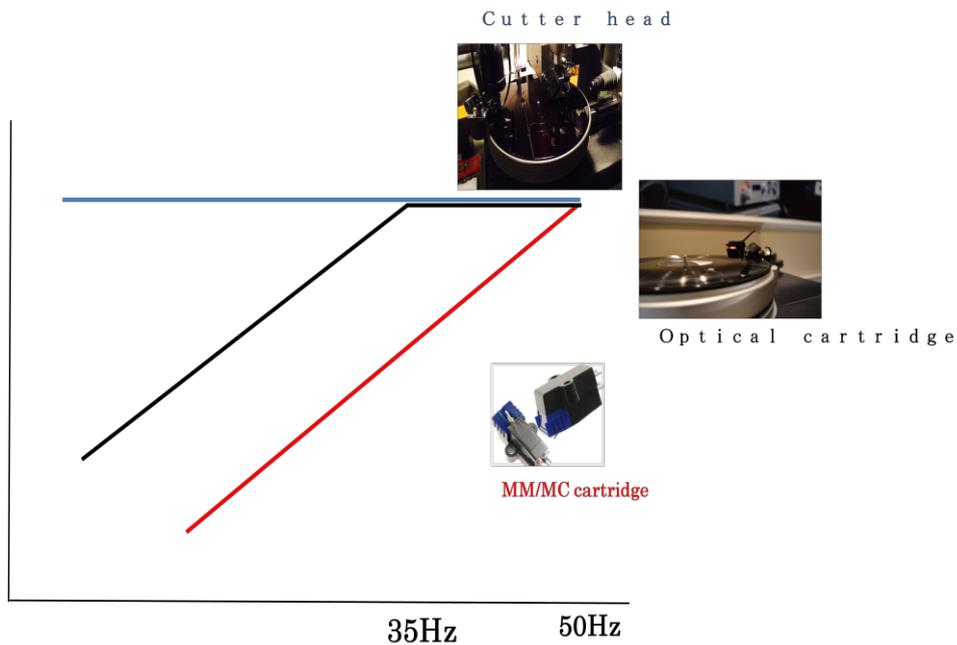


Because of the difference in read out principle between velocity proportional method and Amplitude proportional method, Equalizing process of output signals are very different between the two.

Figure-2 shows the typical Equalizing levels of Velocity proportional method (Red Line) and Amplitude proportional method (Blue Line).

In Velocity proportional method, lower frequency section must be amplified and higher frequency section must be de-amplified. This is unavoidable as long as Electro-magnetic induction is used. As the result, the level difference becomes about 100 times (40 dB) between Lower frequency section and higher frequency section. In Amplitude proportional method, however, the level difference is about only 4 times (12.5dB).

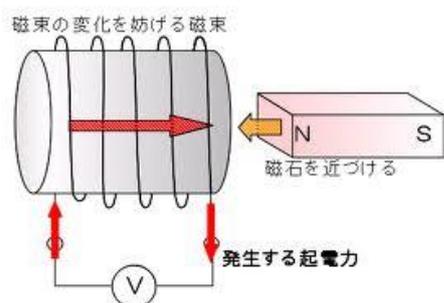
Therefore Amplitude proportional method requires much less signal treatment on output signals, and this is a great advantage for pure and natural sound reproduction of the analog records.



### Very Low Frequency response

And some people mentioned that optical cartridge low frequency sound is very unique. Because theoretically our cartridge (Amplitude proportional method) can detect very low frequency until 1Hz. But MM/MC cartridge output decline 6db/oct, because their output is dependent on a speed. So we follow the cutter head response until 35Hz and then filtering 6db/oct (to avoid tone arm resonance). These 15Hz zone MM/MC cartridge and optical cartridge low frequency output is 6db difference.

② No Magnetic friction on moving parts in the cartridge



In a moving magnet cartridge, the stylus cantilever carries a tiny permanent magnet, which is positioned between two sets of fixed coils (in a stereophonic cartridge), forming a tiny electromagnetic generator. As the magnet vibrates in response to the stylus following the record groove, it induces a tiny current in the coils. The MC design is again a tiny electromagnetic generator, but (unlike an MM design) with the magnet and coils reversed: the coils are attached to the stylus, and move within the field of a permanent magnet. The coils are tiny and made from very fine wire. (Wikipedia)

In both cases, Faraday's law of induction governs the fundamental design of the cartridges. At the same time, both designs cannot eliminate frictional force governed by Lenz's law. This is an intrinsic force that MM/MC cartridges must deal with no matter how you design the cartridge.

In Audio terms, Lenz' law states that Stylus vibration receives a frictional force by its fundamental design, meaning Stylus vibration is never reproduced by MM/MC cartridge systems.

③ Very light and solid moving parts



The above photograph is coils used in a typical MC cartridge. This vibrates more than 20000 cycles in a second. It is natural to think that lighter weight is better for the faster motion. Optical cartridge has the same cantilever as MM/MC. However, it has no coils nor magnets. It has only a tiny slit plate of 50  $\mu\text{m}$  in thickness. Lighter moving parts for better frequency response. This is another advantage of Optical cartridge.

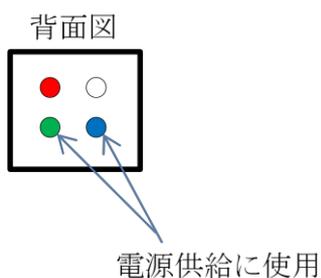
## Important notice on Optical Cartridge

### ① Need Optical Cartridge Equalizer

Optical Cartridge requires its own equalizer. First, Optical Cartridge works with LED light source. LED power is supplied by the equalizer. Secondly, Optical cartridge is based on the amplitude proportional read out. Therefore, it differs from Velocity proportional read out equalizer.



② Optical Cartridge may not work with Arm that uses a common ground line as described below.



Ground line of L-channel and R-channel are used to supply voltage to the cartridge. Therefore, it does not work with any arms that have one common ground line for L-channel and R-channel.

### ③ On the low frequency signal outputs

Optical Cartridge can play back very low frequency signals, thanks to the amplitude proportional signal read out. DS-Audio D-001 is designed to play back the musical signals as they are recorded on the analog disc with most minimum equalization.

This optical cartridge is designed to provide all the information of the analog disc to its user. That extends to the lowest possible frequency area, not speaking of higher frequency areas. However, it is so accurate that it reads out low frequency information caused by the bending of a record disc in some cases. This results a large movement of Woofer on your speaker unit. Often times, it moves at 1Hz up to few Hz. If any of users feel uncomfortable with this woofer motion, please use Subsonic outputs, where Cut off frequency of 15Hz and down is provided.

## State-of-art technology advancement in the New Optical Cartridge



Optical Cartridge is not a new concept. Some of you experienced the first generation optical cartridge 40 years ago. Let us explain DS-Audio D-001 advance technology to sweet away various concerns existed at the time.

### ① Heat-up problem

Even though the first optical cartridge was highly evaluated by its natural sound reproduction, it had an issue of heating up problem due to the white lamp used as the light source. Stronger the light was, higher the S/N ratio was gained. Therefore, after some hours of playing, the cartridge became heated up and 80 °C to 90 °C was measured at the cantilever. Some critics expressed the concerns of heating of a record disc itself by this heat. Today, we know this is not the case. Rather, this heat created a serious problem of softening of the pivot rubber holding the cantilever. Indeed this was the case, and sound quality changed from when it was at the beginning of play back to when it was some time later. The light source used in DS-Audio D-001 is a carefully selected LED device. We are all familiar with LED lights today. It does not heat up like an old light bulb. DS-Audio assures you that there is no heat up issue in this new optical cartridge today.

### ② S/N Ratio

Classical optical cartridge required a strong light beam. This was because stringer the light was, higher the signal level gained, resulting better S/N ratio. However, the signal detection device (Photo-electro detector) is wave length dependant. Generally speaking, Photo-detectors react better at certain wave length, and poor reaction at other wave length. Therefore, a strong white light incidents on the photo detector, only very little of it is actually converted to electro signal.

State-of-art technology is to match up the incident light with the wavelength efficiency of the photo-electro detector. By doing so, highly efficient photo-electro conversion is created. Furthermore, Digital Stream Corporation has over 25 years of experience and milestones in the most advanced laser optical designs. Well proven and highly advanced optical design is in it. It is no need to mention that there are countless know-hows and technologies behind this natural and superb sound of this cartridge.

