

# Frequently asked questions about phono cartridges

*or*

***" Everything you always wanted to know  
about phono replay but were afraid to ask... "***

*Version 2A*

*By: A.J. van den Hul, Cartridge designer*

**Dear website visitor,**

Our company is specialized in the construction of new phono cartridges and the repair of any type of Moving Magnet (M.M.) and Moving Coil (M.C.) system.

It is therefore understandable that during the years our customers came up with a lot of questions for example dealing with setup, life-span, refurbishing and upgrades.

To provide extra support service, I thought it would be better to have everything organized on our website so that many more audiophiles can see what we are doing and can read how to deal with common problems like e.g. tuning (or taming) a tone arm equipped with an odd system.

There are many existing questions related to the replay of LPs, so it is not easy to answer whatever comes up.

To make a serious start, I like to begin with the cartridges, continue with tone arms and turntables and last but not least, the LPs.

Many subjects are interrelated, like the relation between cartridges and arms, so use your noodle and work yourself through.

The knowledge presented here is built up from a simple introduction to a what higher level of understanding. You don't need to be the well respected Prof. Einstein to understand all and everything...

Pleasant reading,

A.J. van den Hul

# General information concerning all van den Hul phono cartridges:

## Precision handmade masterpieces:

All van den Hul cartridges are personally hand built and tuned by Dutch Master cartridge designer Aalt Jouk van den Hul. They are packed in attractive boxes, accompanied by Mr. van den Hul's personal signature.

## Special customer demands/specifications:

Thanks to the many variations in materials available, it is always possible to build a phono cartridge to match the personal demands of the customer.

With these personalized cartridges the wooden container mentions the name of the customer it has been specially built for. This option is available for all our cartridges with exception of The DDT - II Special and our MC - xx types.

The customer demands/specifications that can be taken into account when building a personalized van den Hul cartridge for instance are:

The tone-arm used, the pre-amp and load impedance used, a particular brand of records to be played, the type of music generally played (jazz being more dynamic and classical more spacious and detailed) and other personal/sound preferences.

## Retune service after run-in:

With exception of The DDT - II Special and our MC - xx types, each owner can return his new bought cartridge after the first 200 hours playing time. Besides adjustment and fine-tuning, any further complaints are dealt with as well (this provided the cartridge has not undergone any accidents or maltreatment).

Returning the cartridge after its run-in is not a must, but merely an option.

## Warranty:

All new van den Hul cartridges have been fully tested before shipment.

Might problems occur, all van den Hul cartridges carry warranty on material or production defects for a period of one year after purchase date.

Warranty is **ONLY** accepted after **OUR** examination and when the defective cartridge is returned in its original packing **INCLUDING** the stylus protector (the latter applies to all DDT, MC - xx and FROG<sup>®</sup> cartridge types), otherwise warranty claims are **NOT** accepted.

## Cartridge repair service:

Damaged units are repaired with the same hands, eyes and experience used during the original build-up; The quality of repair is therefore very constant.

The repair costs (e.g. in case of an accident) are very low compared to the general charges by other companies (might there be any other repair service available in the world anyhow). Repair is always cheaper than a new cartridge.

You will always get your own original unit returned with its same original sound quality. With a replacement unit you can doubt this for sure...

## Returning cartridges for repair:

1. Defective units should be sent to us through the van den Hul distributor in your country.

2. Defective units must be packed with utmost care:

To avoid damage during transport, the cartridge should be returned in its original packing **INCLUDING** the stylus protector (the latter applies to all DDT, MC - xx and FROG<sup>®</sup> cartridge types).

If the original cartridge packing is missing we advise to use a small and sturdy box and to safely secure the cartridge inside by means of its mounting screws.

Don't add padding or other loose material (like screwdrivers, brushes, other accessories or papers) inside. They are not required in repair and could damage the cartridge during transport.

Also, never use any kind of sticky tape to directly secure the cartridge and/or any broken parts thereof.

Any broken-off cartridge parts are best to be included in a small zip-lock bag safely placed below the original packing's insert tray.

To further minimize damage during transport, surround the container with sufficient padding material. But please don't overdo. Unpacking shouldn't take 5 minutes or more...

### **Cartridge pin colour coding and dimensions:**

All van den Hul cartridges have four color-coded connection pins at the rear. Their colour coding is standard and as follows:

- Red = Right channel plus (R+)
- Green = Right channel minus (R-)
- White = Left channel plus (L+)
- Blue = Left channel minus (L-)

The connection pins at the rear of all van den Hul cartridges are 1.2 mm in diameter.

For connection to the tone arm we have Headshell Connection Wires (The HEADSHELL LINK set) and Cartridge Connecting Clips available in our program.

### **Cartridge headshell mounting information:**

All van den Hul cartridges have two screw mount holes which accept M2.6 size screws (supplied with the cartridge). The center distance between both screw threads is 0.5 inch.

Advice:

- Don't tighten the cartridge mounting screws too firmly. Just fixed is the best in all cases.
- Before tightening apply a very tiny amount of lubrication on the screws' threads (run out can damage your cartridge).
- When missing, always use stainless steel or brass screws (i.e. non-magnetic and non-aluminum screws).

### **Further points of attention:**

Damage due to the following points is frequently seen with cartridges sent in for repair:

- Don't bend or twist the cartridge connection pins and don't solder at them. They may break or loose signal.
- Never use oil containing or oil contaminated cleaning liquids as explained in the following Phono FAQ's points [50](#) and [5](#).

### **More information:**

In our following Phono FAQ, A.J. van den Hul has written down his answers to the questions most commonly asked to him during the years. A very comprehensive "question and answer styled" list which treats phono replay, cartridges, turntables and nearly all matters related is the result. Both the novice and experienced record enthusiast will come across many points of interest here. Well worth browsing through...

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# Phono FAQ:

**1 Q:** Why are there 2 different types of phono cartridges: Moving Magnet (M.M.) and Moving Coil (M.C.) ?

**A:** This has partly to do with the principle of signal generation and partly with the cost of production. Theoretically it does not make a big difference whether you move the magnet and hold the coil or vice versa. The difference in sound by the way is on the plus for the Moving Coil systems, because with the M.C. principle the manner in which the magnetic field variation interacts with the coil is more correct. Also the mechanical stability of the cantilever and stylus is in most cases better. This produces better sonic results. Especially the channel separation is higher with M.C. cartridges. Also the mechanical resonance frequency is higher so intermodulation distortion is lower. There is one disadvantage with M.C. systems: the output is lower, so you need an extra step-up device like a transformer or a typical M.C. amplifier.

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**2 Q:** Which of the 2 phono systems, M.M. or M.C. has a longer expected lifespan ?

**A:** The construction of the M.M. is, related to the lower price, always somewhat more industrial. So expected lifetime is normally shorter. Also by reason of the generally lower reproduction quality, the quality of the stylus is limited. So stylus wear is usually higher. This is in advantage of M.C. systems. The application of aluminum for the cantilever also limits the total lifespan. Despite this, with care a M.M. system can give you years of pleasure. And when you buy one, at the same time already buy your spare replacement stylus unit. You never know what the manufacturer will do in the future.

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**3 Q:** Which of the two, M.M. or M.C., will sound better ?

**A:** In practically all cases, the M.C. sounds better. Especially owing to the construction, the dynamics, the detail and the resolution are better. Also in the field of channel separation the M.C. systems score higher. So a higher delight for the ears.

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**4 Q:** What parts of a M.M. are most critical ?

**A:** Always be careful with the aluminum cantilever. The little aluminum tube with its thin walls is weak and can be destroyed by a light mechanical pulse. Also give the stylus enough attention. Stylus wear happens as a result of the mechanical tracking process. And never solder your tiny tone arm leads to the mounting pins: At the same time you desolder the internally connected coil wires or break the fixing in the rear panel due to exposure to heat. Coil systems of M.M. cartridges are made of copper wire with a diameter of around 20 micron (0.02 mm) or even less. A human hair is about 80 micron. Just to give you an idea.

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**5 Q:** What parts of a M.C. cartridge are most critical ?

**A:** Again the stylus, the cantilever and the suspension. The stylus can have all kind of shapes. The mounting or fixing of the stylus on the cantilever can be damaged by the application of cleaning liquids contaminated with oil (see [50](#)). This softens the epoxy glue so the tip will fall off within 6 - 12 months. Cleaning the cantilever with water can damage the aluminum. It causes corrosion when the pH factor is not around 7 (= neutral). When the cleaning liquid contains oil, the oil will creep along the cantilever and will finally reach the rubber suspension along the coil. This is the beginning of the end of the damping properties of the rubber suspension pad. So NEVER use any oil containing cleaning liquid (see [50](#)). Advice: Use "LAST". When you are an environmental guy don't use "LAST" because it contains Freon as a carrier. Better advice: Go to your beverage shop and buy a bottle of brandy. Brandy contains about 70% pure water and 30% pure alcohol. And don't forget to also clean the cleaning brush itself. And again: Don't solder the arm leads directly to the cartridge's 4 connecting pins. You will damage more than this optional profit can bring you. Don't forget: A clean record always sound better than a dirty one. So keep your records as clean as possible.

---

**6 Q:** What can I do to make my phono cartridge sound even better ?

**A:** Keep everything clean. Especially the 4 color-coded mounting pins on the rear. (Red for right + and green for right -. White for left + and blue for left -). Also the 4 little (generally 1.2 mm diameter) clips connecting your cartridge with the

tone arm leads. Also mind the correct position of the cartridge in the tone arm. That means in the forward - backward position and in the way the cartridge, in front view, is rotated by differences in your fastening of the mounting screws. A good alignment gauge is very helpful here. Just use minimum forces during tightening the 2 or sometimes 4 screws. When you use too much torque power, the result is a damaged cartridge body and headshell. The platform of the headshell must be flat and even. After an explosion of torque power this is seldom the case. A tiny spirit level will help you here. We have them in our product program. And don't use a too high tracking force to track 100 micron or more. There are about 5 records around with such high modulations. Four of them are test records... and they don't make music at all.

---

**7 Q:** How do I position my cartridge in the tone arm ?

**A:** Always use an alignment gauge to assure the correct position. This concerns especially the distance between the vertical rotating point of the tone arm and the stylus (under pressure). There are different alignment systems around: All can be used and some are very good. Working to your advantage in most of all alignments is the following experiment: In play position, your tone arm should not be parallel to your record but at a small angle: around 3 - 5 degrees. This can be achieved by lifting the tone arm at the rear (i.e. the bearing part and not the cartridge mounting part) by 4 - 8 mm. The sonic result is a better spatial reproduction and cleaner high frequencies and it is very easy to do. So why not try?

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**8 Q:** How do I adjust the tracking force ?

**A:** The function of the tracking force is to keep the diamond stylus in the groove during groove modulations. As you can imagine, the stronger the modulations (the louder the music) the more difficult it is to keep the stylus in the groove. So some extra tracking force is required. But where do we stop? There is a limit, otherwise the sonic qualities of the cartridge will fail and/or the suspension will give up. Each manufacturer specifies the tracking force. Mostly this works fine with new cartridges. But during playing (in the course of around 200 hours) the suspension softens so the tracking force can be reduced by around 10% - 15%. This saves the record, makes the lifespan of the diamond tip longer and your music will sound better. The tracking force can be measured by a spring scale running from 0 - 5 gram or an electronic device like the old and good Technics. There are at the moment new versions around. NEVER use a metallic balance because in practically all situations the metal strip will be attracted by the strong magnetic field in and around your cartridge.

---

**9 Q:** How do I adjust the anti-skating force ?

**A:** The anti-skating force is necessary when you use a regular tone arm. So those few and proud owners of a linear tracker can read but don't need to be bothered.

The static anti-skating force is a minor force that pulls the arm to the outer rim of the groove during playing. This to compensate for the moment of force caused by the friction of the stylus in the groove (the force) and the moment arm (the distance between the tip and the vertical bearing).

So, many arms have a little device close to the vertical bearing at their rear to compensate for this moment of force. As you will remember from your great physics lessons, two moments of force compensate each other when their direction is opposite. So playing causes a moment of force in clockwise direction and the compensating correction is automatically counterclockwise. It was a wise decision by the way to compensate. But as usual there are always new problems created when you try to solve old ones.

One is the fact that music never has the same loudness, or stated otherwise, a record never has a constant amplitude or frequency. So a static compensation (the anti-skating force) has to deal with a dynamic problem. It doesn't work well but it works better than no action. It depends on the difference in friction between the tip in a blank groove and the modulated tip how much you have to compensate.

Round, spherical tips have much more friction in the groove (they really don't fit well there) compared to special shapes like our VDH type 1 or VDH type 2. So it depends on the shape of the contact area between the stylus and the groove how much you have to compensate. The higher the frequencies cut in the record groove, also the higher the friction. For conical shapes (somewhat old-fashioned today and only mounted in cheap systems) the anti-skating force setting should be equal to the tracking force. With more groove-shape adapted stylus designs the anti-skating setting can be less. When a cartridge uses the VDH type 1 or VDH type 2 stylus, the anti-skating can be adjusted at 1/3 of the tracking force. This assuming that the scale on the tone arm is correct. Otherwise you have to listen to the sonic results.

When the anti-skating setting is too high, the violins in the left channel on a record with classical music will distort during loud modulations. This is caused by missing contact between the stylus and the left groove wall. And when the anti-skating setting is too low, the violoncellos will distort due to the missing contact between the stylus and the right groove wall.

As you see a long story about a small topic. But it is vital for pleasant listening that the settings are done well.

---

**10 Q:** Are there other alignment methods ?

**A:** Yes. A good way is the use of an oscilloscope and some test records (when you can put your hands on them). Assuming you know how to operate an oscilloscope, connect the oscilloscope to the tape output of your pre-amplifier and observe the shape of the left and right channel's output signals. When the tops of the sine waves are cut or flat, it indicates some serious distortion.

By looking at the screen and listening to the sound you will get an idea of what the relation between the two is.

An oscilloscope is also very useful for phase measurements. When playing a test track with a mono sine wave (left and right channel are in phase) and with the scope triggered on one channel, both traces (left and right channel) should be identical with their sine wave zero crossings at exactly the same time points, else your horizontal tracking angle is not right.

When there is an "add both channels" option on your oscilloscope, the two signals must double in level. When with both channels added there is no signal, just a line, then it is worth to check the so-called polarity of the output of your cartridge and/or have a closer look at the polarity of the wiring.

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**11 Q:** Is there a simple method to change the polarity of a cartridge ?

**A:** Just interchange the two connector clips in one of the two channels. Like changing the green tone arm wire clip to the red marked output pin and the red clip to the green pin of the cartridge. And don't change the other channel, otherwise the total effect is zero again. And don't get sleepless nights if something is not perfect in your sound system.

---

**12 Q:** Can phase problems also be easily detected by simple listening ?

**A:** Of course. You have a phase problem when there for instance hardly is any bass. And when you try to concentrate on sound coming from between the two loudspeakers, there is a funny empty feeling without any serious information about direction and distance. But don't always blame your cartridge (see [107](#)). One of your speakers may also be connected with wrong polarity. And to make it even more complicated: When in one channel both the cartridge as well as the speaker are connected with inverted phase the sonic result is correct again. But only when you play records. Not with radio reception or CD replay.

---

**13 Q:** Are there records that I can use for the adjustment of tracking force and anti-skating ?

**A:** A long time ago, when records were all around, there were also a lot of test records. In the meantime they have disappeared to the barn. So look around to find one on your flea market. Some companies have lately produced records for this purpose. But any good record like older Deccas and EMIs will help you. Just listen and fine-tune both settings. NEVER use an unmodulated record surface to adjust the anti-skating: This is static replay without the normal friction between the groove and the stylus, so don't use this way of setup. The result is always a too low value and your violoncellos will distort again.

Keep in mind that a too high anti-skating force will give asymmetrical tip wear on the outer part of the stylus. I.e. the lifespan of the stylus is shortened by a too high anti-skating setting.

---

**14 Q:** What is wrong when the output signals of my cartridge are not equal in level ?

**A:** There are two possible reasons for level differences.

One is the incorrect position (rotation - in front view) of your cartridge in the tone arm.

The other is a defect in the cartridge itself caused by aging, rotation of the armature or shunt(s) between the turns of one coil.

The first cause (rotation of the cartridge in the tone arm) can be adjusted by yourself by twisting the headshell or repositioning the cartridge by applying thin rings between the cartridge body and the (fixed) headshell. Don't overdo because normally it just concerns a few or less degrees in angle and not more.

---

**15 Q:** Is it worthwhile to spend many hours in fine-tuning a cartridge / player combination ?

**A:** Yes, very worthwhile. Anything that you improve by fine-tuning improves the sound quality and that is a serious part of the hobby. A hobby is something that you do yourself and not something that you can buy. By anything you do yourself, you train your ears to perform better and to enjoy your LP replay even more. So don't give up.

---

**16 Q:** How do I become aware of a worn stylus ?

**A:** As a consequence of the friction between the groove walls and the stylus both wear off. That is a normal process. The record will absorb most of the diamond dust because the groove walls are relatively very soft.

This dust acts as grinding powder for the same stylus again when you play the same record. So after a fine evening with friends, before you turn out the lights, always have a look at your record player. Arm in the rest and not (already) in the run-out groove. Otherwise the next morning you will find your player still playing that last groove. And the tip already really suffered the night before...

Practically, after around 1000 hours of playing a tip needs a serious investigation. With a traditional record side taking about 23 minutes of music, we are talking here about 1300 records played on both sides or 2600 record sides.

When inspecting a stylus it requires a good microscope and trained eyes to see the real spot and the wear there. A lot of styli have been sold by salespeople not knowing where to look at than just their cash registers. But with a bit of listening you can detect a change yourself, especially in the high frequency reproduction. Take your test Decca or EMI again and give it a serious listening. When the higher frequencies are sounding distorted and you find a lot of gray-brownish dust around your stylus then that was your record.

With regular styli, 1000 hours is a time for replacement. With special styli like our VDH type 1 or VDH type 2, you can expect the need for a change after 3000 hours or about 8000 record sides. This due to the fact that the orientation of the diamond crystal is taken such that its hardest zones are just the spots where the stylus contacts the groove. This helps to reduce wear of the stylus and the groove.

---

**17 Q:** The manufacturer of my cartridge gave up production. How can I get a new stylus replacement ?

**A:** Just send your cartridge to our company (through one of our distributors) and we will take care of replacement and other upgrades if you want those.

Don't put your valuable cartridge (with the even more costing) record player on the attic because a minor part of the whole player is out of order.

---

**18 Q:** Can I save my stylus by wet replay ?

**A:** Yes, you can. But keep in mind that from that moment on you must play that record always wet. Whatever you try to overcome this, you have to suffer till you change to CD. The reason is that the diamond powder from that late night a while ago (see [16](#)) and all other dust will dry up on the bottom of the groove after the liquid you used has evaporated. And when you play dry afterwards, the stylus will help you by pushing the debris even more tightly into both groove walls. So once a wet player, always a wet player. Therefore the strong advise is: NEVER start, then you also never have to stop.

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**19 Q:** Where does the stain on my cartridge's front pole come from ?

**A:** You are probably one of the so-called wet players.

Any metal, especially the mu-metal used for front poles gets stained as soon as it is regularly exposed to water. Also extra debris will build up around the coils and the hole in the front pole. After a while this can cause some tracking problems because the free movement of the cantilever will be limited.

---

**20 Q:** Can I improve the sound by so-called "demagnetization" of my phono cartridge ?

**A:** NEVER demagnetize a M.M. cartridge with the replaceable stylus still inserted. It will ruin the mini-magnet at the end of the cantilever in its magnetic power. With the stylus insert removed you can consider it, but first read the rest of this answer:

From a more theoretical point of view, I think it is not wise to demagnetize. It is a short term effect with more negative side effects on the long-term. Your first experience will be very positive as also was mine. But after 2 record sides you have to do this again and it never stops. So you have become a serious victim. And keep in mind: the original cartridge magnet already puts the tiny armature in such a strong magnetic field that its magnetization is unavoidable, so why should you demagnetize? Also, since the magnet never is perfectly at center position but always has some offset, the mu-metal made centre of the coil system always holds residual magnetism and can't become demagnetized. And if this is not enough: The current through the 20 micron thin coil wire is so small that there is no chance to build up any serious magnetic field to cancel the existing residual magnetism. What it only does is breaking down the magnetic domain boundaries in the mu-metal. This improves the magnetic resolution of the music. But after a short while these boundaries will be there again and the number of atoms per magnetic domain has only got bigger. So the magnetic resolution is worsening instead of getting better. So from the point of view: "I bought the thing and now I will use it", you have to use



it. The only advantage is that some crystal boundaries inside the coil wires are welded. But as soon as you move the armature by playing your records that effect is over again. So save the money and buy some good records.

---

**21 Q:** What produces a higher sound quality: a M.C. step-up transformer or an electronic M.C. pre-pre-amplifier ?

**A:** Because of the magnetic effects involved in transformers (i.e. the complex magnetization of a big quantity of mu-metal or transformer iron with a very low current) the first choice is always an electronic input device like a M.C. pre-pre-amplifier. Though in some cases with strong HF interference a transformer can be of help.

But keep in mind that a good transformer also needs a good ground system and a very good protection against magnetic stray fields radiated from your amplifiers. Otherwise the only and exclusive choice is the electronic solution. The last is only correct when the input noise is low enough (with the cartridge connected) to make the music sounding like music and not that all records sound like they have been recorded on a wavy beach.

Compared to a unit with limited frequency range, a unit with a bandwidth fairly exceeding the 20 Hz - 20 kHz range also produces better results within the audio frequency range itself. But for such a specialized unit you also pay more. Try to get a transformer or pre-pre with some options in input impedance. This gives you the possibility to do some experiments and the best will always win.

---

**22 Q:** With the use of another pre-pre-amplifier the sound quality changes. What is happening ?

**A:** You need a pre-pre-amplifier to improve the signal level. Normally a M.M. cartridge produces enough healthy output to supply the M.M. input of your pre-amplifier. The output can be between 2.5 - 6 mV at 5.7 cm/sec cutting speed of the record.

But... what happens when you like your M.C. cartridge more? The regular output of a M.C. cartridge is between 0.1 mV - 0.6 mV. This requires an extra step-up device with a gain of around 26 - 32 dB. There are by the way some M.C. cartridges with enough output to be connected straight away to the M.M. input of your pre-amplifier like our MC - TWO Special.

After this long introduction we now come to the answer:

When a different pre-pre-amplifier (boosting the cartridge's output) presents a different input impedance (loading impedance) to your M.C. cartridge, the sonic properties will also change. When you measure the DC impedance (resistance) of the coil systems there will be a value on your display between 3 and 50 Ohm. Let's say that your cartridge reads 10 Ohm. In the past the optimal loading impedance (usually by a transformer) would also be 10 Ohm. So you had to look around for a transformer with a 10 Ohm impedance primary coil. The secondary coil always had to be 47 kOhm to match the M.M. input impedance of the pre-amplifier. This 47 kOhm is an international standard. Nowadays there is a somewhat less theoretical thinking about load impedance because with modern cartridges the basic resonance frequency of the armature lies fundamentally higher - so there is less need to tame the amplitude at the resonance frequency. The result is that more attention can be paid to the sonic result. This means that when you are a Jazz addict, you simply take a pre-pre-amplifier with around 100 Ohm - 200 Ohm input impedance. This produces an extra accent on the dynamics of the sound. If you rather like classical music or small groups in an acoustical environment, take a higher impedance value: say around 500 Ohm (also see [23](#)).

So playing with the input impedance means also playing with the sound character.

The influence of the load impedance on the differences in sound is caused by the change of the crosstalk levels and the amplitude raise at the resonance frequency. The lower the load impedance, the lower the amplitude raise (actually Q-factor), the higher the current and the more dynamic the sound.

---

**23 Q:** What is the influence of the crosstalk signals on the sonic performance ?

**A:** Crosstalk is the signal that belongs in the right groove and shows up in the left channel and the other way around. So the violins from your classical recording performing on the left side of the soundstage show up (at around -25 dB to -35 dB) in your right channel loudspeaker. That's not nice but it's a fact of life.

The lower the crosstalk figures the cleaner the sound. So -35 dB is better than -25 dB. The crosstalk signals NEVER are pure sine waves but always have a complex signal structure, mainly built of distortion components caused by mechanical shortcomings of the cartridge itself and partly resulting from the recording. (Yes, keep in mind that also recordings are never perfect, just like you and me).

So, mainly depending on the design and the way how the cartridge is made, there is less or more distortion created in the other channel. And this gives the acoustic impression of another loudspeaker standing between your 2 units. This imaginary extra center loudspeaker produces only distortion and (in worst case) a stiff accent on the higher harmonics of the basic musical signal that your are listening to.

So, to keep it simple, with a higher cartridge load impedance (see [22](#)) you run the risk to have some extra distorted or harsh sound between your 2 loudspeakers.

But... with a good cartridge a higher load impedance can also be a good option: The spatial reproduction improves and, when being a lover of Vivaldi and his friends, the church (or at that time the cathedral) will sound even more magnificent. There are audiophiles who load their M.C. cartridge directly with the 47 kOhm of the M.M. input on the pre-amplifier. And why not? Any experiment that you do in live is a part of your learning curve. So give it a serious try. When you like it and the technology is (this time, as an exception) friendly for you, enjoy it.

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**24 Q:** Is there a difference in sound between a low output M.C. cartridge and a high(er) output unit ?

**A:** In principle: no, but in all day life: yes. This has directly to do with the number of coil turns inside the cartridge. The higher the number of turns, the higher also the output. So far, so good. But a higher number of turns also means a rounder rear part of the coil. The actual shape of the coil's metal centre which focuses the magnetic field is always square. This produces a better mechanical damping by the damping rubber(s) and thus a lower crosstalk level in the direction of -35 dB. A coil with more turns is shaped rounder (the impression of the coil in the rubber(s) is also rounder), therefore the damping is also less and the crosstalk gets higher (in the direction of -25 dB). The advantage of a higher number of turns is (yes, there is also an advantage) that you need less pre-pre-amplification or even none when the output is high enough. So some minor shortcomings caused by transformers or pre-pre-amplifiers are also finished. The choice is yours again.

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**25 Q:** Is there a difference in sound between the various metals that are used for winding coils ?

**A:** Yes, there is a clear sonic difference. This is caused by the method of production of the wire and hardly by the material itself. The more precious the metal, the higher the production quality and the better the sound quality. So in the same cartridge a gold wire coil will always sound better compared to a silver coil. But... gold wire is very soft and any mistake in production or cleaning afterwards will sooner or later (but always sooner) lead to a broken lead-out wire. So go away with your high pressure cleaning pump, especially with coils made of gold wire.

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**26 Q:** What produces a better sound quality: an aluminum cantilever, a boron cantilever or one made of sapphire or even diamond ?

**A:** An alternative question is: Which material is stiffer? Aluminum, boron, sapphire or diamond? Yes, in that same order the stiffness is also getting higher. And stiffer means a better mechanical pulse transfer from the stylus to the coil system. So your first choice would be to look straight away for a cartridge with a diamond cantilever. But... (next to the price) there is another property that also counts: the weight. Heavy materials are more difficult to accelerate around. From all possible options the 300 micron diameter boron cantilever is the best. Already relatively very stiff but also very light. And the dynamic rigidity gets better when the total length is kept as short as possible. Actually I am working on a new model with a total boron cantilever length of just 3.5 mm. Still not as short as the famous Dynavector cartridges with diamond cantilevers of 1.7 mm length. But the way the Dynavectors were built is different to the units I intend to produce. I.e. different designs.

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**27 Q:** What is the influence of damping rubbers on the sonic performance ?

**A:** A lot. Therefore special attention must be paid to the mechanical and chemical stability of these vital and minute parts. So please, no oil around! (Also see [50](#)). All types of oil (even silicone oil) attack the damping rubbers. Also avoid crazy temperature changes or mechanical experiments. All adjustments that amount to extra tracking force will pose a problem to the rubber(s).

Rubber(s) means that some cartridges have more than one damping rubber. A central somewhat stiffer type and an outer more flexible one. This has to do with the differences in mechanical damping experienced by the coil's central and outer parts: The amplitude of movement of the central part is less than that of the outer parts. Therefore two rubbers are used for thermal compensation.

In Bangkok on a really warm day, the cartridge must perform just as good as on a cold day in Novosibirsk. This sets technology records and not just analog records.

And don't play wet in Novosibirsk, the stylus gets fixed and frozen at the record before you have finished your vodka...

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**28 Q:** When I changed my cartridge suddenly one channel was gone. What happened ?

**A:** Some cartridge manufacturers have used a type of connecting pins that don't have a proper fixing in the cartridge's rear panel, so these pins can get loose after a while.

When people change cartridges, they tend to rotate the connecting clips (1.2 mm diameter) on those pins. At the other end of each pin is the joint with a coil lead-out wire, normally made by soldering both (the lead-out wire and the pin) together. At the place of this joint the diameter of the lead-out wire is even thinner due to the fact that some copper or silver has dissolved in the solder. So any mechanical movement of the connecting pin automatically causes a problem there. Don't try to solder this tiny lead-out wire back again. In 99% of all efforts that I have seen the owner or his very experienced friend failed. And the disaster afterwards is not always easy to restore.

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**29 Q:** How can it happen that after soldering new connectors to the turntable cables both channels of my M.C. have an open circuit ?

**A:** You must be the person who did not disconnect every possible connection between the turntable and the rest of your hi-fi system and the mains. Both cartridge's coils have been blown by the leakage current of your - not ground connected - soldering device. They acted as fuses. So whatever you do in and around your turntable, always electrically disconnect everything attached.

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**30 Q:** After about 1000 hours playing, one of the channels of my M.C. cartridge gave up. I did not do anything. I even didn't change one of the phono plugs. What happened this time ?

**A:** There are cartridge manufacturers who have one simple idea: "the more the better". I mean sales. Thanks to an exchange program you can turn in your cartridge and receive a new unit with 30% discount. But this wouldn't have been necessary at all if the same manufacturer would have examined the returned cartridges. Why didn't they respond to this typical failure? The simple reason is that the coil lead-out wires are kept too short and are mounted much too tightly (I assume on purpose). This because it never changes over the years. And someone who doesn't want to change a wrong point must have a good reason. What really happens is that when you play records, the whole armature moves. The more so when the records are not even. So the 4 - 6 mm long 20 micron wires have to follow all movements of the armature. At the point of the strongest movements (the point where these wires leave the coil) this causes a serious metal fatigue problem. And sooner or later (often even much sooner) a wire gives up. And the next cartridge in the exchange program has the same problem again. So when you experience this once, change to another brand without an exchange program. They don't need it.

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**31 Q:** Suddenly one of the channels gave up and I didn't solder or change anything and my cartridge is from a company without an exchange program. What happened this time ?

**A:** You may have cleaned your cartridge with a brush or by using a compressed cleaning liquid intended for cleaning slides. Or you picked a hair or four out of the magnetic gap with a pair of tweezers and afterwards they turned out to be all four coil wires.

Anything you do when you clean your cartridge must in the first place save the coils and the coil lead-out wires. Otherwise, afterwards you own a clean cartridge with open channels (also see [5](#), [6](#), [25](#), [49](#) and [50](#)). And be very careful with magnetic stray particles like iron dust or even tiny burrs coming from drilling. These particles always settle at the point with the strongest magnetic field: Just between the armature and the front or rear pole. Now you can wait for the critical moment. As a consequence of all the movements during playing or cleaning, after a while one of these iron parts simply cuts one of the coil wires. Result: another open channel. So stay away from your player after some heavy drilling work at the neighbours. First clean yourself with a magnet.

Since phono cartridges always tend to collect potentially damaging magnetic stray particles over time, another suggestion is to mount a magnet on your record player near to the cartridge's rest position (of course not against it), such that this magnet functions as a magnetic vacuum cleaner - catching magnetic stray particles away instead of having them ending up inside your expensive cartridge.

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**32 Q:** I regularly play one specific record. Sometimes there are no clicks and pops, sometimes there are many. What happened ?

**A:** Your record is made from PVC. This insulating material has the fine property to accumulate and store electrostatic charges of different voltage at different places. When the climate is dry this gets even worse due to the friction between the sleeve and the record when taking the record out. Your record cleaning with a non conducting brush also does a nice job. And even the friction between the stylus and the record helps to build up charge. So, a nice strong electric field of 1000 Volt/mm can easily be achieved. And (when things have been done right) your cartridge has a connection to ground. So, during replay you heard some (or a lot of) mini strokes of lightning.

What can be done about it? Simply mount a sponge somewhere on the platform of the player and keep the thing wet with

demineralized water. The humid air around it will allow the built charges to disappear along the air and the record instead of into your expensive hi-fi set.

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**33 Q:** The sound of my cartridge has changed suddenly. What happened ?

**A:** There are several options:

Someone cleaned the turntable and (without knowing) changed the tracking force and/or the anti-skating adjustment. So re-adjust.

Or someone (not you of course but your overactive cleaning lady) cleaned the turntable and pushed the front side of the cantilever inwards. This causes a severe problem: The steel suspension wire of around 60 micron diameter has got two kinks now and the coil is also off-centre.

Or the damping rubber got a crack as a result of aging and climate conditions.

Or the stylus fell off because you used an oil containing cleaning liquid (see [50](#)) or anyhow performed your cleaning too well.

Or the contact pins at the rear panel of the cartridge are oxidized and the contact resistance has gone up dramatically.

Or a new carpet was brought in and your turntable is not horizontal anymore.

Or the tone arm is blocked in its free movements.

So you have to work out some cure now...

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**34 Q:** The body of my cartridge cracked because I tightened the screws too firmly. Do you have any remarks ?

**A:** To align the cartridge in the headshell, the body must be repaired anyhow. Be very careful. Too many cartridges died after too much of crazy or super glue at once. Afterwards even the coils wouldn't move anymore.

Another body-cracker are the nuts used to fix the cartridge. Most nuts are too big and cause mechanical pressure on the side of the body. Koetsus need special nuts. Otherwise the Onyx turns to gravel. Plastic bodies used in the past by Denon (like their 103 series) need tender treatment. The material is too soft to work on like you do on your weekly fitness training.

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**35 Q:** Are there any treatments that I can apply to improve the sound of my cartridge ?

**A:** Don't put shiny aluminum foil stickers with a hologram on front. It doesn't work and so far also no physics known let it work.

Any cartridge put in a body of metal with "bigger" metal panels can sound cleaner by removing these resonators. Like the black box with aluminum bottom of the EMTs. But it also means that the inner parts of the cartridge will then be in the open air and wires can be damaged. So be very careful. Better is to apply a thin layer of sticky material to reduce the Q-factor of (mechanically dampen) the panel. This material can be on the outside (easy but cosmetically not so nice) or on the inside (risky because you damage more than you expect to save).

The cartridge must always contact the headshell in a secure way to transmit/drain all vibrations. Any layer in between will not make a better sound, except when this layer helps in the transmission of the mechanical movements of the body. And for security reasons always use stainless steel or brass (i.e. non-magnetic) screws to fix everything. Iron parts can easily be attracted by the magnet and damage your cartridge.

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**36 Q:** Recently I bought a very good looking rather long tone arm made in Japan around the '70s. Suddenly the bass response is very different. What happened ?

**A:** It sounds like you bought a 12 inch Fidelity Research arm with probably even silver wiring inside. These arms were made for the, in those days, very famous cartridges of the same company, like the FR-1 and later FR-7.

These cartridges had a stiff suspension and worked with a tracking force of around 2.0 gram or even more. The compliance (flexibility) of the suspension was not very high. But with some extra coupled weight around (your heavy arm) the basic resonance frequency of cartridge and arm would be around 10 Hz.

Your actual cartridge has a much higher compliance and already tracks well at 1.35 - 1.50 gramf. So the heavy arm combined with the softer spring (the suspension's steel wire and rubber together) resonates at a much lower frequency and at a higher amplitude - like 5 Hz. The sonic result is that a lot of extra energy of your power amplifier is used to move your woofer at around 5 Hz and the real bass is gone.

Lesson: Never match what is not made for each other. New arm designs are made for today's cartridges with a dynamic compliance of 10 - 15  $\mu\text{m/mN}$ . The other way around is also a fact of live: For instance your SME Series V will not work so well with the Fidelity Research FR-1 because the compliance of this cartridge is too low here. So the resonance frequency of the cartridge/arm combination (see [Appendix 2](#)) is too high and your bass reproduction is too strong. The whole acts as

a low frequency resonator at around 25 - 30 Hz, so the output at these frequencies is also higher. But even worse is the fact that the tracking ability of your cartridge is gone. This because any resonating cartridge/arm combination already causes a healthy number of microns in excursion at the stylus. So what's left is for your music. And in worst case that is not much.

So, sudden tracking problems are partly caused by uncontrolled low frequency resonances. A way to solve this problem is a reduction of the headshell mass. And also some fluid damping can help, but ONLY when you play flat records. Otherwise the cure causes your cartridge to age faster than you age yourself.

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**37 Q:** Can I expect an improvement in sound when the arm wires are changed ?

**A:** Yes, when you change to better and also more flexible wires. If the new arm wiring is not flexible enough you improve on sound only (by the better wires) and obstruct the movements in and around the bearings. To overcome this, just make a double loop with the 4 wires and bypass the bearings completely. And the new wires don't need to be IN the arm. Just wrap them around the arm and fix them with Scotch tape. When you want to sell the arm it is and looks original when you remove your own modifications. From experience I know that many manufacturers have not put the best stuff inside their tone arms. So there is good room for improvements.

But keep in mind that replacement of wiring is a precise job and not everyone will end up with success. Think about removing parts of the arm with special screwdrivers. Watch out for the adjustments of the bearings! The arm lift and the soldering in the socket are always parts that cause problems. And mind that when stresses are put on a wire it always breaks at the soldering.

Keep a smart eye on the colour coding: Red for right + and Green for right -. White for left + and Blue for left -. Also keep in mind that each (extra) connector in the electrical signal path will change the sound. The less is ALWAYS better. Straight from the cartridge clips (the 1.2 mm type) to your pre or pre-pre-amplifier is the best (see [147](#)). A good tone arm wire and a flexible and balanced cable from your tone arm socket to your pre or pre-pre-amplifier will take away harsh sound and will improve the spatial reproduction of your records. In our product program we have the MCS - 150 M and MSS - 7 for tone arm wiring. Our flexible D - 501 HYBRID (also used by SME for already many years), its silver version the D - 501 SILVER HYBRID and its twin version the D - 502 HYBRID furthermore are the perfect connection between the arm and the outside world.

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**38 Q:** Do I need to connect some capacitors parallel to the M.M. or M.C. input of my amplifier ?

**A:** Fundamentally: No. With modern M.M. cartridges the frequency response is such that the average capacitive load of around 125 pF formed by the tone arm cable and the internal wiring together is just enough to straighten out the frequency response. With M.Ms. the load must be around 47 kOhm.

With M.C. cartridges there is no need for any capacitor parallel to the coils. As far as I know it is only done by EMT which use 0.475 µF. to tame the top end of the frequency response. The normal inductance of the miniature coils in an M.C. is so low that what ever you do within the pF region will never have any sonic effect. Values in the µF region will cause phase shifts at 20 kHz. And that is not what we really want.

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**39 Q:** What is the influence of a cartridge's frequency response on the sonic result ?

**A:** Many cartridges are delivered with a frequency response flatter than an airport runway or the water in a fishbowl without fish. So the suggestion is that all cartridges sound the same. A flat response however does not tell you anything about the phase or time behaviour. It also doesn't tell you anything about harmonic and/or intermodulation distortion. All frequency response measurements are made with equipment where a filter (tracking with a frequency sweep from a test record) takes out ALL harmonics including ALL distortions.

Also resonances are not taken into account well, this because at the speed of the frequency sweep the mechanical system and the tracking filter don't have enough time to respond. So what is left is partly the truth. What is different is NOT on the paper.

So when we look at the papers all cartridges should sound the same. But in practical life the story is different. The other parameters are more difficult to measure so they are left out. And even when two cartridges should sound the same, the tone arms used can make the difference. Also the pre-pre-amplifier or transformer can do an unhealthy job. So take the frequency response for granted; But there is more between the moon and the earth...

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**40 Q:** When I play a record and the volume is down, I hear the music coming straight from the cartridge. Is this good or bad ?

**A:** Anything that moves in air produces sound. Also the tiny cantilever and all directly coupled to it. But... the lower the

level of the directly radiated sound the better. Anything that makes sound has little damping and contributes to colouration and interference. Also sound from the cartridge gets around in the tone arm. And from the tone arm the sound gets in the mounting plate. And each of these parts also has its own resonances. So the extra colouration by transmitted sound is reducing the final sound quality.

What you hear is not always what you get.

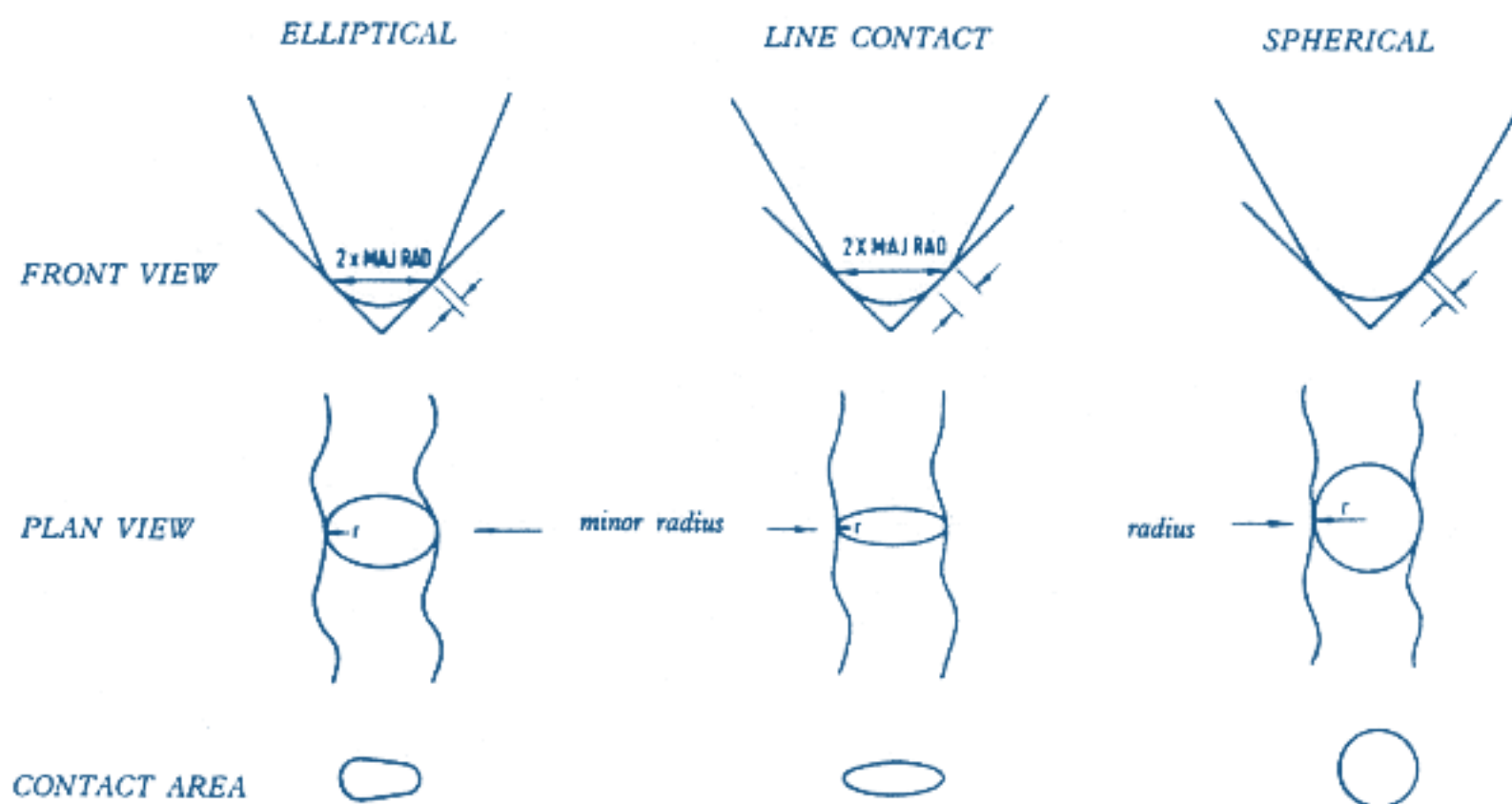
**41 Q:** What is better: A cartridge with a short cantilever or a longer one ?

**A:** Stiff and light is the main law here. From fishing you know that a short rod is stiffer than a longer one. So there is the answer.

A long cantilever acts as a filter for higher frequencies. They are simply absorbed and will not arrive at the other end (the coils). But you will hardly hear this because this also heavier cantilever (longer means also more weight) produces a flamboyant resonance just after 20 kHz. So you will not miss a lot of the high frequencies. Just the music there, that is all.

**42 Q:** What is the relation between the shape of the stylus and the frequency range ?

**A:** The better the shape of the stylus fits the shape of the cutter (that cut the master) the better the final tracking result. The minor radius of the cutter is around 1 - 2 micron. This is the cutting edge. I.e. the curvature that determines the highest frequencies that are still possible to be mechanically cut by this "stylus". So replay with a round or conical stylus with an overall radius of 18 micron compared to the cutting radius of just 1 - 2 micron is not the best option. A conical stylus can only track the outer grooves of a record up to 20 kHz without linear distortion.



*Elliptical (or bi-radial), line-contact and spherical styles: the 'footprint' of contact area (drawn to larger scale) shows the asymmetrical contact area of the elliptical type*

Regarding stylus shape, the smaller the top radius of the tip the better would be your first thought. But... the tip gets also deeper in the groove and a sharp point can touch the bottom without any music but with plenty of noise (thanks to your wet replay). So we must find another solution.

The second thought would be to make the minor radius (horizontally contacting the groove walls) smaller and the major radius (vertically contacting the groove walls) bigger. The answer here was the so-called elliptical stylus. But... as usual,

all inventions also have their drawbacks. The minor radius was not constant so depending on the music level the accuracy was changing. Loud music, more distortion. In the gray past there has been a record company who on purpose cut records with the opposite type of distortion. Dynagroove was the name of the record type. Not a bad idea. But like with many great inventions they disappeared in the dust of history. So there was a problem again.

After several technological steps like the Pramanik and Shibata tips, the Van den Hul type VDH-1 line-contact stylus was made with several advantages compared to other designs in the market. The vertical radius (that makes the vertical fitting in the groove) was maximized to 85 micron: the highest value possible to fit all the variations of cutters around. The minor radius (allowing to track the highest frequencies possible) was brought



back to 2 micron, achieving a stable frequency range of 80 kHz. And this 2 micron was constant (along the stylus edges contacting both groove walls) far beyond the point where no groove could ever touch the stylus anymore. Made in 1976 and still actual. So even 2 Japanese companies, Namiki and Ogura, still make them, thus far without paying any royalty (or as the Japanese say: loyalty). Though in the meantime more than 1.4 million have been legally sold. The story behind this is that you have to manage your own success, even where it only concerns a mere 2 micron. It makes a world of difference. Thanks to this 2 micron you can read this story.

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**43 Q:** Which are the basic resonances that I have to keep an eye on when it concerns sound quality ?

**A:** The first thought is: Keep resonance frequencies as far apart as you can. Each resonance is always caused by a mechanical spring-mass system: The interaction between a suspension (i.e. a flexibility or elasticity, sometimes more than one) and a mass (or combination of masses).

The lowest resonance frequency is the one originating from the cartridge suspension and the total mass of the cartridge together with the mass of the headshell and the arm (see [Appendix 2](#)). Optimized this is around 9 - 11 Hz. With heavy arms lower than, and with stiffer suspensions higher than 9 - 11 Hz. Above this subsonic frequency there are the typical arm, plinth and mounting board resonances. Each produce their own colouration depending on the Q-factor of the resonator.

The higher the Q-factor (i.e. the less damped), the more dominant the effect and the worse the sound quality. And having two resonators at the same frequency is even worse. So try to keep all resonances spread across the total spectrum, each with the lowest Q-factor as possible (i.e. damped as much as possible).

The highest resonance frequency is the cartridge suspension / cantilever incl. diamond resonance. The higher this frequency the better because that reduces the harshness of the reproduced sound. With a high quality cartridge it lies at about 50 kHz or even higher.

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**44 Q:** Is there a simple method to listen to the resonances in and around a turntable ?

**A:** Yes, just buy a good mechanic's stethoscope with a probe tip on top and pick any spot with this tip. You will hear all the sound running around in your turntable. You can also glue a tiny magnet to a critical spot and hold a MM system (without replacement stylus inserted of course) as close as possible to this magnet. You will hear even more and be surprised.

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**45 Q:** What is the influence of a stiff connection cable on my replay system ?

**A:** From the outside world there is a direct transmission of mechanical movements along the connection cable to the arm mounting board. So, a stiff cable transmits more and a flexible cable (like our D - 501 HYBRID, D - 501 SILVER HYBRID or D - 502 HYBRID) transmits less. Less transmission makes the sound cleaner and the replay quality higher.

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**46 Q:** Do arm bearings have something to do with resonances and their effects ?

**A:** A poor arm bearing (with bearing play) causes a very unpleasant extra resonance in your arm and therefore in the sound reproduction. The effect is non-existent with unipivot arms. For enough stability the unipivot arms are generally also more heavy. This results in a lower fundamental resonance frequency.

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**47 Q:** How can a turntable effectively be decoupled from the rest of the audio system ?

**A:** Any object movement around your turntable also transfers mechanical movements to it. So keep all movements as low as possible or decouple as much as possible. Like putting your turntable on a marble plate supported by springs (e.g. valve springs from a worn-out car motor). Or take a heavy tile supported by soft air cushions. Or a heavy concrete tube (diameter around 60 cm - 100 cm) filled with gravel put on a concrete floor. Anything that is heavy reduces the resonance frequency or (when heavy enough) does relatively not move enough to cause harm.

Keep in mind that cables connected to your turntable also transfer mechanical movements (also see [45](#)).

And very important: Always keep the turntable far away from your loudspeakers. Listening to music means that the loudspeaker cones move and having those vibrations transferred to your turntable is something that you are not looking for.

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**48 Q:** What to do when my turntable hums ?

**A:** There are several possible reasons for experiencing hum:

There is e.g. the possibility of a poor grounding of your tone arm. It means that the ground pin of your 5 pin DIN type tone arm connector (see [82](#)) is not connected to your arm or not connected to the ground of your first amplifier after the arm.

Another option is that one of the other 4 signal leads is not connected to your cartridge (an open circuit at the arm side). Sometimes another cause of hum is the transformer of the power supply of your turntable. When the distance of separation is not big enough, it induces hum in your cartridge or in the first amplifier after the cartridge. Rotating the transformer can be an excellent solution. Even tipping the power supply to one side.

Hum can also be introduced by oxidized contacts in your ground system. So keep the contacts clean (even those of your removable headshell).

An unwanted short circuit between any of the signal leads of your cartridge (Green = R-, Blue = L-, Red = R+ and White = L+) and the arm can cause hum. Without a cartridge in your arm and the preamplifier disconnected there should be no short between any of the 5 lead-out wires.

When the preamplifier has an unbalanced input, the shielding ground wire may be connected only to this first amplifier at one of the two input grounds of this amplifier; Though normally the preamplifier has a special grounding nut for this extra ground wire. Try to connect there first and keep the contacts very clean. In practically all situations a phono preamplifier with balanced inputs (i.e. with XLR connectors) reduces all hum. But they need to be connected in the right way.

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**49 Q:** How do I clean my cartridge ?

**A:** Normally you do not need to clean your cartridge. When you keep your records clean you don't need any stylus cleaning. When records are greasy or covered with dust, you will collect dust. Move a very soft brush along the stylus, always from the rear of the cartridge to the front. When there is sturdy and sticky grease on your stylus, use a very soft brush dipped in alcohol and make the same movements (also see [50](#)). A carbon-hair brush will have the same effect. Don't use knives or screwdrivers. They damage the cantilever caused by uncontrolled movements. (Also see [5](#), [6](#), [25](#), [31](#) and [106](#)).

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**50 Q:** Every once in a while my stylus comes off and I have to have my cartridge repaired again. I don't do anything wrong and the retippings also can't be blamed. Do you have any clue what the cause of this might be ?

**A:** Your bottle of stylus cleaning liquid probably has become contaminated with oil.

Due to the cleaning brush's repeated movements between the stylus, cantilever etc. and the bottle, the cleaning liquid can become contaminated with oil. This because the dirt collected at your stylus often also contains residue from the oil or wax used to release the records during pressing.

Especially old/often used cleaning liquid bottles may have become contaminated and using such liquid will leave an oily residue at the stylus after having evaporated. Such oily residue e.g. may after months cause the stylus to come off by weakening the special glue that fixes it to the cantilever or may creep along the cantilever and finally reach and attack the suspension rubber(s).

To check whether your cleaning liquid is not contaminated by oil and still safe to use, just put a drop on a mirror and let it evaporate. There should remain no residue.

To avoid your cleaning liquid to become contaminated it is good practice to always wipe your cleaning brush dry on a piece of absorbing paper before reinserting it into the bottle.

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**51 Q:** Do cartridges age when they are not used for tracking records ?

**A:** Yes, they do. This is caused by changes in the suspension rubber due to ozone and/or chemicals in the air.

Aged damping rubbers are always either hardened or just the opposite: softened and sticky. When the damping properties are changed, the tracking ability and also the low and high resonance frequency (see [43](#)) will alter. The mechanical properties of a cartridge are very important (it is fundamentally a mechanical device) and they must be kept in close tolerance to the original values.

If you want to store your cartridges for a long period and want to avoid aging of their suspension rubbers you might keep them in the freezer. Keep them separated by some distance to avoid their magnets interacting.

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**52 Q:** Can I still play (very) warped records ?

**A:** As long as the cartridge can track them: yes. But keep in mind that the pressure of the diamond in the LP groove will get higher when your arm moves up and will be reduced when the arm moves down. Both effects should be within the



tracking limitations. And what you also should know is that any warp will put a nice stress on the suspension wire inside your cartridge. Too many warps and there's the risk that your suspension wire (diameter around 60 micron) will break due to metal fatigue. In many cases this is the end of your cartridge, though some units can be repaired as I do regularly.

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**53 Q:** How can warped records be made flat again ?

**A:** The trick is to put them for a longer time between two warm glass plates with some extra weight on the top plate. This forces the warps out again. Some experimentation may be necessary.

In my cases it worked out well after a week at around 40 degrees Celsius (104 °F). But keep very well in mind that any dirt remaining between the glass and the record will get forced into the record surface.

Clean them first with a mixture of triple distilled water and alcohol. Protect the records by putting them between very smooth lint-free paper (e.g. silicone baking paper) and don't make a direct contact between the record and the glass.

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**54 Q:** Are record washing machines of any use ?

**A:** Yes, they are for sure. Especially when you bought your records on a flea market. The cleaning of the records must be done at both sides and also with a CLEAN brush. Cleaning the brush is normally forgotten, so in the end you're transferring the dust from one record to the next. And when dirt and particles are washed into the grooves they are very hard to be removed. This also tells you that wet tracking means wet tracking forever (also see [18](#)). Once the dirt is fixed at the groove walls it will stay there.

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**55 Q:** Can wet played records, played dry again afterwards ?

**A:** Even when they are washed seriously there will always be extra pops and plenty of surface noise. The dirt particles were forced into the groove walls and can hardly be removed by any means. So once wet, always wet.

Keep in mind that aluminum cantilevers don't like to be exposed to water or cleaning liquids for always and ever. They oxidize both internally and at the outside, so they will break. Only beryllium, boron, sapphire and diamond cantilevers can stand this wet experiment.

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**56 Q:** Are there differences between natural and synthetic diamonds ?

**A:** Yes, there are. The natural diamonds have a 8 - 10 times longer stand-time compared to the synthetic models.

The reason is that natural diamond is much harder because of its perfect carbon structure. Synthetic diamond contains a lot of other atoms that weaken the structure of the stylus. The synthetic diamonds are easier to produce and the material is cheaper, so it is clear that the lifespan is also shorter. You may calculate how much money you "save" by buying a cheap replacement stylus for your MM cartridge or a MC cartridge without a natural diamond. Natural diamonds by the way are very transparent and shiny, whereas synthetic diamonds are somewhat yellow to brownish and not shiny.

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**57 Q:** Can a turntable be improved after buying ?

**A:** Of course. The first thing is cleaning. Even the platter bearing must receive this cleaning treatment. Also clean and adjust the tone arm bearings.

After this, check the arm wires and replace them when you doubt the quality (especially when they are hair-thin and insulated with PVC). For this purpose we have the MCS - 150 M and MSS - 7 in our product program. (Also see [37](#)).

Also the signal wiring leading to your phono pre or pre-pre-amplifier must be of extremely good quality. From our program we suggest the 501, 501 SILVER or 502.

Resolder all electrical contacts and listen with a mechanic's stethoscope to the arm board (also see [44](#)). When you hear music coming from it, dampen the arm board with additional sticky damping material. The board should not sound at all. Have the cartridge's stylus checked under a microscope by a skilled person. In case of doubt our company can also do this for you.

Mechanically clean all electrical contacts and afterwards use our contact protection liquid: "The SOLUTION". "The SOLUTION" provides excellent protection and is especially advised in very humid and warm climates.

And don't forget to put new oil in the bearing. For this purpose we also have a superb oil available.

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**58 Q:** Can I build a turntable myself ?

**A:** Any very good mechanical engineer can do it, but it takes 2- 4 years before you are happy with the results. I have seen these experiments with friends around me and often they had to give up because of lack of tools to produce the proper parts. So be warned. But when you have managed, the result will give you a very good feeling. And don't forget, anything you do yourself also produces knowledge which you wouldn't acquire without this learning process.

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**59 Q:** Some cartridge frequency response measurements are made with just noise and others with a frequency sweep. Which method produces the most honest results ?

**A:** The pink noise method produces the most honest result because all frequencies are constantly available during the measurement. Here also harmonic and intermodulation distortion products - caused by internal mechanical shortcomings of the cartridge - add to the response, thus providing more realistic information on performance. With a frequency sweep record a steep bandpass filter runs in track while measuring, so any other than wanted frequency component from the output of the cartridge is filtered out. This method produces the cleanest curves but not the most honest ones. So the question is: do you want to hear or see? Hearing means pink noise measurements and seeing means frequency sweep.

---

**60 Q:** By an accident I broke my cartridge. The cantilever disappeared. What to do ?

**A:** There are 3 options: You might not want to use the cartridge anymore because you are looking for a better one. Or you can return it to the manufacturer (when the company is still in business) and pay 75% of the new value for repair. Or... send it to our company and, if possible, the cartridge is fixed again for a price at around 20% of the new value. In case of a broken cantilever our repair also includes the mounting of a new stylus of the best shape: the VDH type 1. Saves your records and reduces the tracking noise by at least 6 dB. Also the inner-groove distortion will be really reduced.

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**61 Q:** Are there many differences between all the cartridges one can buy ?

**A:** In many cases the differences are very limited.

There are cartridge manufacturers that have not changed the interior over years and only work on the cosmetics. So, what you're paying for is what you see and not what you get. Here I will not mention brands and type numbers, but there are plenty. With an open (non-encased) cartridge what you see is what you really pay for. A closed unit is more safe in practical life but can also hide a surprise.

Any surprise has its own price...

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**62 Q:** What to expect from my warranty claims ?

**A:** An open coil circuit or no cantilever is obviously a warranty but must already be seen by your retailer before proceeding... Also when you're missing a connection pin.

Things are different when you used the cartridge for about half a year and one channel failed after you soldered the connector of the turntable. I got warranty claims even though in this real-world situation the whole coil system was burned away. This was caused by a soldering device with excessive leakage current, so the coils acted as a fuse. Very confusing for the owner by the way...

Another odd warranty claim: After remounting the cartridge the screw holes "disappeared". No threading anymore. This was the result of someone's workouts at the gym...

So think twice before you use all your muscles in fixing the cartridge again. Just use minimum forces during tightening the 2 or sometimes 4 screws.

And don't forget: Aluminum screws bond together with aluminum screw holes when you don't apply a tiny amount of lubrication before mounting them. We advice our "The SOLUTION".

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**63 Q:** Can I personally tweak my cartridge because my grades for physics were always very high ?

**A:** Even with high marks for physics, please only do your modifications on the outside of the cartridge. Stay away from silicone grease and chewing gum. Also gold paint on the outside or even inside will not do a lot. And extra screw holes in the bottom may just end the life of the coils. Also iron powder residues on an applied sticky damping pad can change the magnetic performance and will e.g. reduce the channel separation.

All examples mentioned here are my real findings during the years and caused a lot of cleaning work.

And, please, don't fix a broken cantilever with a drop of crazy or super glue. You'll also stick down the coil and the suspension and with so many other home modified units the cartridge is gone to the not-so-happy hunting grounds. (Also see [90](#)).

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**64 Q:** Can I tune a cartridge ?

**A:** Tuning a cartridge means simply: Change the mass of the cartridge so that mounted in the tone arm it will produce a fundamental resonance frequency of 9 - 11 Hz (see [Appendix 2](#)). The bass is then controlled and not boomy. When you can manage well it may also give you a booming business...

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**65 Q:** How do I adjust a cartridge ?

**A:** Normally, adjustments are made by fine-tuning the overhang and putting the cartridge body in parallel with the record. Overhang jigs and plates are commonly available, so your dealer must have one for sale or for loan. We supply Acrylic overhang adjusters with markers and a mirror coating.

So, by simply moving the cartridge in the slots of your tone arm you can already do a good job.

Please check if the arm support is positioned perpendicular to the player board. Otherwise you have a serious crosstalk problem in replay.

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**66 Q:** I have damaged a screw mounting thread in the cartridge body. What to do ?

**A:** When the screw is made of stainless steel and you admit the damage, please control your applied force next time. Send the cartridge to our representative in your country for repair shipment to our company.

When the screw is made of aluminum you may ask a friend to drill a hole of around 2.0 mm and tap a new thread again with a diameter of 2.6 mm. We can do the same for you.

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**67 Q:** When playing records I constantly hear a clicking sound. What can be done ?

**A:** The clicking is a sign that there is a higher than acceptable low frequency resonance amplitude. So the resonance frequency is under 9 Hz. This clicking originates from the suspension wire (sometimes) and from the coil lead-out wires (in many cases). When the lead-out wires are touching a pole piece or another object within the magnetic stray field, they produce the clicks. Also the mechanical transfer of extra external (not the coil's) motions along the lead-out wires to the coil itself will cause this clicking. So return the cartridge for repair to one of our representatives.

---

**68 Q:** When playing records my needle skips. What's wrong ?

**A:** There are two possible causes:

1. There is no stylus left on the cantilever and the adhesive residue acts as a stylus.
2. The fundamental resonance is too low because of a too heavy arm - cartridge combination;  
Here you either need another cartridge with a lower compliance together with your current arm, or another arm with lower mass in combination with the current cartridge. Both methods are helpful to bring the fundamental resonance frequency again between 9 - 11 Hz (also see [Appendix 2](#)). The lower the resonance frequency the higher the amplitude.

Of course, when the record is very warped, also then the cartridge will hop to the next symphony every turn of the record.

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**69 Q:** I have a unipivot arm from the USA. What sort of cartridge should I buy ?

**A:** A cartridge with a lower compliance to avoid the well known Olympic game: Groove jumping. When you order a cartridge from our company, please tell your dealer that you need a cartridge for this type of arm. It helps to reduce all kinds of problems.

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**70 Q:** When I can not obtain the correct overhang, what to do ?

**A:** Some tone arm manufacturers adjust the overhang by an extra jig. The layout of the jig assumes that the zero distortion points are at 66 mm & 121 mm.

But there is also a unipivot arm manufacturer who has a different approach: The zero distortion point is to his opinion the

best at the inner grooves. This works well with cartridges with a spherical tip. With this approach you have to accept that the distortion at the outer grooves is higher than normal.

With other stylus shapes like the VDH type 1 it is better to have the two nulling points at the above mentioned 66 mm & 121 mm. So the overhang is also different. In case you own the unipivot arm, just use another jig and overhang is correct in combination with a cartridge with e.g. a VDH type 1 stylus.

And don't let getting your overhang right give you a hangover...

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**71 Q:** Is there a basic difference between cartridges with a lower compliance compared to a higher compliant units ?

**A:** Yes, there is. A higher compliant cartridge needs a lower tracking force. Something between 1.0 and 1.5 gramforce. A lower compliant cartridge works well starting from 1.5 till even 3.5 gram. Some rebuilds of original designs need this 3.5 gram; A tracking force that really can damage your grooves, especially where also an original spherical stylus is used. A higher compliant cartridge with a lower mass arm is my advice to keep your records in a good condition, even after many replays.

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**72 Q:** Is the application of oil as a tone arm damper a blessing for the audiophile ?

**A:** Not always, because it somewhat delays the adaptation of the arm to the side movements of the cartridge. So, it puts an extra mechanical load force on the suspension wire and it also modulates the crosstalk of the music based on the same effect. The cantilever must first move out of centre before the arm can follow.

These off centre movements are caused by an off centre position of the "centre" hole of the record. With the oil it takes more force (momentum) before the arm moves, so the off centre movements of the cantilever will be bigger. Especially when the oil's viscosity value is over 500 centistokes.

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**73 Q:** The manufacturer of my cartridge stopped production despite the impressive sticker: "Deutsche Garantie" on the packing. What to do now when my stylus needs replacement ?

**A:** Just return the cartridge to our representative in your country so we can care for a correct repair. Some manufacturers went only for the business but not for the care.

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**74 Q:** When I want to buy a new cartridge, what properties are the most important ones ?

**A:** Just listen for lower distortion and higher resolution.

The lower distortion originates from a better magnetic modulator (like in our The COLIBRI).

The higher resolution comes from e.g. a stiffer and despite that a lower weight cantilever (e.g. boron).

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**75 Q:** What can be done when my cartridge's maximum tracking ability is only 60 micron ?

**A:** When the specifying measurement was made with the well known DHFI record, the real tracking amplitude is around 66 - 70 micron.

In many cases this will do because the peak tracking ability is always 20% higher; Meaning that for a short period the tracking of the extra modulation will not cause distortion. Only when you constantly play a 20% higher amplitude there is tracking distortion.

To improve the tracking anyhow (you will hardly ever need this), increase the tracking force by around 20%. So e.g. instead of 1.5 gramf. you use 1.8 gramf.

Keep in mind that only measurement records have a constant modulation. Music always has a high variation, meaning that the average amplitude is about 40 - 50 micron. When you want to go higher (what you hardly ever need) the mechanical load on the groove is also higher. At most spots of the record you don't need this. The modulation is less. So, the higher tracking force's result is that the record and stylus wear are unnecessarily higher. With a high modulated record (and just for that specific record) you may enlarge the tracking force. Afterwards you need to re-adjust back to 1.5 gramf. again before playing your standard modulated records.

Keep always in mind that in M.C. cartridges the armature must be parallel with the pole pieces to obtain maximum channel separation. With M.M. cartridges the magnet must always be in parallel with the armature's poles for the same reason. In the non parallel situation the channel separation is less and the sound more harsh.

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**76 Q:** Why does a cartridge need around 200 hours of playing before the sound is well ?

**A:** It is the same with cars. The engine also needs to smoothen and run-in. Especially the gearbox. With cartridges especially the suspension rubber needs to settle and that requires some "massage" time. Also the groove produces some extra polishing of the stylus.

It is a habit of cartridge manufacturers to adjust the cartridge for a flat frequency response at delivery. What means that after running-in the frequency response has a lift of about 2 dB at 20 kHz.

In our company it is a good habit to adjust the suspension with a bit extra tension so that after the running-in time the frequency response is just flat. For the rest of the 3500 hours of stylus life this produces the best quality possible.

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**77 Q:** What is the signal to noise ratio with records? The CD manufacturers claim theirs is 96 dB.

**A:** On average with 33 1/3 RPM records we talk about 60 - 65 dB. In rare cases this value is around 70 dB. Keep in mind that the surface noise gets higher by wear after many replays and when the records are not kept clean.

With 45 RPM records the average is about 70 - 73 dB.

The better the vinyl quality (smaller particles) the lower the noise floor and the higher the signal to noise ratio.

Also the quality of the tape the record was cut from is important. It is about the technical edge to achieve 80 dB with tape (happens once in a while) so the record's signal to noise ratio is always lower. When the same tape is used for a CD production, the signal to noise ratio is again 80 dB. With extra noise cancellers the noise floor is lower, but it also reduces the reproduction of the natural space in the music. In combination with a (low noise) pre-amplifier a signal to noise ratio of 66 dB is still a good value. At this 66 dB, the relation between the amplitude of the maximum modulation and the noise is a factor 2000.

Your neighbours make more noise...

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**78 Q:** I am designing a phono input stage and need to be able to determine what the maximum output from any cartridge might be. Typically it appears that the output of a cartridge is quoted for a groove velocity of 5.6 cm/s. What is the maximum groove velocity that is likely to be cut onto a record and can this be used to linearly scale the output at 5.6 cm/s to obtain the maximum output in this case ?

**A:** More accurately spoken the RMS output voltage of a cartridge is quoted for a sinusoidal groove velocity waveform with a RMS value of 5.7 cm/s. (The amplitude of this sinusoidal velocity is exactly 8 cm/s.; a factor of Square\_Root(2).)

The often mentioned reference velocity of the modulation of 5.6 (or even 5) cm/s. seems to be a written simplification/truncation of the actual 5.656854249... (5.7) cm/s RMS.

The output of a magnetic phono cartridge is linearly proportional to its stylus' perpendicular velocity.

For the amplitude of the cartridge's output voltage you have to use the amplitude of the stylus velocity by multiplying the often given RMS value of the velocity by a factor of SQRT(2).

The maximum velocity that is likely to be cut often can be found on test records.

An example is the Shure test record with a 315 Hz sine wave which exhibits a RMS velocity value of 25 cm/s (35 cm/s amplitude).

An amplitude of velocity of 40 cm/s can well be regarded as the absolute maximum that is likely to ever be cut/found on a record.

A cartridge with a specified output of 1.0 mV RMS at 5.7 cm/s RMS therefore can be expected to exhibit a maximum output voltage amplitude of:  $1.0 \text{ mV RMS} * \text{SQRT}(2) * 40/8 = 7.1 \text{ mV}$ .

The typical output voltage for MM (Moving Magnet) phono cartridges ranges between 2.5 and 10.0 mV RMS at 5.7 cm/s RMS.

The typical output voltage for MC (Moving Coil) phono cartridges ranges between 0.20 and 4.0 mV RMS at 5.7 cm/s RMS.

The absolute maximum output voltage amplitude that is ever to be expected from a magnetic phono cartridge (provided no strong groove damage is present, nor is the cartridge dragged across or dropped onto the record) therefore is:  $10.0 \text{ mV RMS} * \text{SQRT}(2) * 40/8 = 70.7 \text{ mV}$ .

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**79 Q:** What sounds better: analog or digital sound ?

**A:** The answer is not so simple. After the recording, for sure the analog sound. After the production of the record, in many cases also. But records have their limitations as a linear storage medium. You probably already have read about this before. The digital recorded sound (44.1kHz/16-bit sampling) has a lower resolution compared to analog. Also due to the extra filtering involved there is instrument defocusing and filter ringing. This causes a typical digital sound in such a way that a lot of CD users don't hear these defects and some get upset. So the last group sticks with analog and despite the pops, clicks and higher noise floor, they are happy with their aging LPs. Especially where the performers are well-known and were never released on CD.

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**80 Q:** Is it possible to use a 33 1/3 RPM stylus for tracking 78 RPM records ?

**A:** Yes, in several cases I did this myself with very good results. The 78 RPM record must have a clean groove bottom without a too round bottom edge. Otherwise the stylus runs on the bottom of the groove and you'll hear a lot of noise and distortion between the music. Especially the later 78 RPMs made with good cutters behave very well. On Hi-fi News & Record Review shows in the U.K. I have given demonstrations with The BLACK BEAUTY playing 78s. But in all other situations you need styli with a radius between 75 and 90 micron. In English publications you can read values in mil. One mil is 25.4 micron. So 88.90 micron is just 3.50 mil.

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**81 Q:** What is RIAA equalisation ?

**A:** The RIAA recording and replay equalisation characteristics are curve wise are each other's mirrors. During the cutting of the record at 20 Hz the bass reduction is 20 dB and during replay there is the same 20 dB boost at 20 Hz. And at the other end of the frequency range (20 kHz) during the cutting of the lacquer (first record to be cut) the boost is 20 dB and during replay the attenuation at 20 kHz is 20 dB again. The only honest cut and replayed frequency is 1 kHz.

These cutting and replay curves are there for several reasons:

First to unify the signal processing of all records worldwide.

Second to save place on the records in case of heavy bass excursions.

And third to reduce the surface noise in the high frequency range.

All together not a bad idea of the RIAA (Recording Industry Association of America).

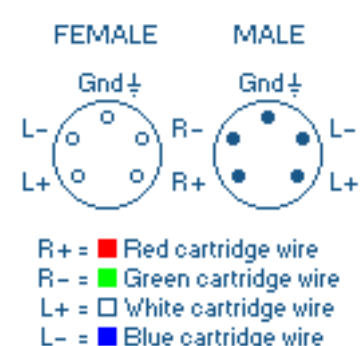
More detailed information about the RIAA replay equalisation characteristics can be found in [Appendix 1](#).

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**82 Q:** My tone arm has a normalized DIN 5-pin connector. How are the connections organized ?

**A:** When you look at the male DIN connector with the 5 pins facing you and the arc of the 5 pins upwards, the centre pin is the ground connection of the tone arm. This pin can also be used for connecting (grounding) the platter support and the housing of the motor. But for quality reasons it is better to disconnect the last two options. So just the tone arm itself and nothing else.

Tone Arm Connector  
front / contact side view:



Then there are the 2 pins on the left side of the centre pin and the two pins on the right side:

Regarding the two pins on the left side, the one closest to the centre pin is the ground of the right channel of your cartridge (so green on your cartridge output pin). The last pin on the left side is the signal pin of the right channel (so red on your cartridge output pin).

When we go to the two pins on the right side of the DIN connector, the pin next to the centre pin on the right side is the ground connection of the left channel (so blue on your cartridge). And the last pin on the right side is the wire signal connection of the left channel of your cartridge (so the white output pin on your cartridge).

The layout of your tone arm connector has a standard 270° pin configuration.

Keep especially these contacts as clean as possible.

Also the contacts of the tone arm connection cable and the DIN 5-pin female tone arm connector must be kept very clean.

Saves you the buying of an extra expensive cartridge because the sound is not as good anymore as you got used to.

To keep all contacts clean use our "The SOLUTION".

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**83 Q:** During playing, I hear all kind of static discharges. What can be done to eliminate this effect ?

**A:** The main reason for static discharges is that static charging takes place first. So avoid the static charging by enlarging the humidity in your listening room. This can be achieved by extra plants and an air cleaner filled with water. In severe cases you can breathe out over the record. Spitting of course is not the right solution... And what always works is a wet sponge close to your turntable and preferable under the cover (when there is one). Use only distilled water.

Also record sleeves can do a good job. When the discharges are strong, first move your record into a paper sleeve to discharge. All plastic coated sleeves build up a static charge. The paper, when it is somewhat humid (by air humidity), is slightly conductive so the static charge will disappear.

An older method is to use a brush with squirrel hair and static control fiber or a conductive carbon fiber brush. This helps to discharge and at the same time also acts as a dust collector. The brush must be connected to the ground of the turntable otherwise the static charges will not completely disappear.

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**84 Q:** How to clean my flea market LPs ?

**A:** First try to get new record sleeves. Otherwise you wash your records and afterwards make them dirty again.

A good method is the following: Go to your drug store (not to your drug dealer) and buy 1 liter of triple distilled water and a pair of cotton gloves. If you can manage also get 250 cc of denaturalized alcohol there (ethanol with some methanol added). The ethanol is the drinking stuff and the methanol is for cleaning or barbecue. Mix 1 liter of the triple distilled water with 250 cc of the denaturalized alcohol. Then add just 1 drop of a high quality liquid cleaning soap (like Dreft). Make this mix in a round and minimally 32 cm wide and 30 - 40 cm deep polyethylene container.

Put only ONE record at a time in your mix and rotate the record while you wash the surface intensely with your gloves.

After washing, dry the records with a sheet of kitchen roll paper. Use a type which has no fibers coming off.

Don't use the same sheet again and again. Just for one side of the record and then take another one. Or just make or buy yourself a nice and usually noisy record cleaning machine. There are several brads around who made one. Also don't forget to regularly clean the record washing machine's cleaning brush (also see [54](#)), otherwise the whole process will just end up in dirt being replaced by other dirt...

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**85 Q:** Is there any maintenance necessary on my player's record mat ?

**A:** Just keep the thing clean, clean and clean. Otherwise it acts as a dust collector (minuscule particles floating in the air will be attracted by the static charge) and your records will be more dirty after playing.

The mat must always be very flat. The mat must support the record over the whole surface and not have any open spaces (produces open air resonators).

A conductive mat is always better compared to a non-conductive type. The conductive component discharges your records during playing. You, the music and the record discharged: both treatments take about 20 minutes...

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**86 Q:** Does the belt of my belt driven turntable need extra maintenance ?

**A:** Yes, keep the belt very clean and never touch it with your fingers. Fingers are always somewhat greasy and this is absorbed by the belt. So, the belt starts to absorb other materials and will change its properties over time. A belt must be perfect: no warps, twirls or thinner spots. Also no joints or repairs. During playing the belt may not vibrate at any spot. Also regular revolving on its axis is a sign of an unstable transport system. Have a careful look at the belt and find the possible irregularities. When you have a perfect belt drive turntable you are a happy person.

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**87 Q:** A longer time ago there was a lot of hype about optical tracking. Where can I get such a player ?

**A:** I noticed the same hype but the equipment shown on that specific C.E.S. show was not ready for production. After a lot of investment there is now a working series but the price is such that I think it is not worth the investment. Better to spend the money on records.

---

**88 Q:** What does Dynagroove stand for ?

**A:** Dynagroove was a cutting method where the distortion to be expected (when the tracking of the record was done with a spherical stylus) was already compensated for in the groove (also see [42](#)). So a kind of trousers with adhesive plasters at the inside around your knees. I case you might fall down... With better styli, the effect became something on its own and was not necessary anymore.

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**89 Q:** I broke my cartridge body by twisting the mounting screws too firmly. How to repair ?

**A:** Over powering does not improve the sound quality; The transmission of minor cartridge body resonances to the tone arm are even getting better.

So tight is tight. Don't overdo. The body itself can be fixed with super glue. When this does not work, just return the cartridge to the manufacturer for replacement.

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**90 Q:** At the bottom of my Danish cartridge there is a heavy brass screw. I tried to modify my cartridge by rotating this screw. Now the connector block fell out. What to do ?

**A:** NEVER do this again. You know now the effect. The best solution is to return the cartridge to the Danish manufacturer and write a nice letter about all your ideas about modifications. Maybe they just need a person like you to improve their

designs...

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**91 Q:** When I buy a new cartridge, what should I look for ?

**A:** A cartridge partly is a matter of personal taste. Like a watch or shoes. Somewhat emotional. But in case you need some support, here are some hints:

First decide whether you want a Moving Magnet (M.M.) or a Moving Coil (M.C.) cartridge.

Moving magnet cartridges:

M.M.s have a higher output (between 3.0 - 7.0 mV) and can be connected to the M.M. input of your phono amplifier. With a regular gain of 46 - 52 dB there is enough output to get to your power amplifier. This about the output.

The load impedance should always be 47 kOhm and the parallel capacitance should not be higher than 200 pF. Lower is better. Keep in mind that the connection cables have already their own capacitance. So a cable with e.g. 150 pF connected to your phono amplifier with an input capacitance of e.g. 200 pF produces a total capacitance of 150 pF + 200 pF = 350 pF. This is simply too much. The result is a nice roll-off of the response between 8 kHz and 20 kHz.

Their price is pleasant, though regarding their sound M.M. cartridges are not very dynamic and are limited in spatial reproduction. The stylus quality is usually also limited and the stylus replacements are for sale produced by other companies. It means that everything is a bit less, and all together it makes music but not at top level.

Moving coil cartridges:

The M.C. cartridge is generally spoken more dynamic and from the design point of view has better options in the reproduction of space and timing. But... the output is between 0.20 mV & 2.0 mV. General speaking, most designs are not healthier than 0.4 mV - 0.6 mV. So you need an extra 20 dB - 26 dB gain. This extra gain can be achieved by transformer or electronic device. To stay away from magnetic problems I normally always use electronic devices, this despite the fact that there are a few very good (but also very expensive) transformers. The magnetic problems originate from magnetic noise (Barkhausen noise) caused by the magnetisation of the transformer core by the low current produced by the M.C. cartridge.

Sonically spoken a M.C. cartridge has the better options compared to the M.M. designs. Especially channel separation can be a 10 dB or more higher and the frequency response is by principle more extended. I have made measurements with M.C. cartridges where the response was flat till 50 kHz and the total response ran up to 80 kHz within -6 dB. This is possible because of the very low coil inductance. With M.M. units on the other hand, this coil inductance is around 600 mH - 1 H and is one of the limitations of the design. You need a lot of thin wire turns to get some output and each turn adds to the final value of the inductance. So the less turns, the lower the inductance and the higher the feasible frequency response. Also from that point of view the M.C. is a better design.

With special designs like from Dynavector in Japan and also from our company like e.g. The COLIBRI, the total length of the cantilever can be kept very short. So the total mechanical resonance frequency is high to very high.

This also helps to improve the quality of the reproduction (replay) of the highest frequencies on the record. A longer cantilever like 6 - 8 mm is not an advantage in the replay, especially not when this cantilever is made from aluminum; Too weak and too soft to reproduce the highest frequencies.

Each cartridge has a mechanical transfer of vibrations from the moving parts (the magnet in the M.M. design or the coil in the M.C. design) to the rest of the cartridge and after that the arm. The lower the level of this energy transfer the better. It keeps the arm and the arm board more quiet. So with a mechanic's stethoscope with a probe tip on top, you can evaluate this signal transfer yourself (also see [44](#)). The lower the better. A nice opportunity to study damping and change parts to improve your player.

Especially the resolution of the M.C. cartridge is high. For a big part this also depends on the stylus shape. The closest to the original cutter is the VDH type 1 stylus. There is a stylus design closer to the cutter but it fits only well with records where the angle between the two groove walls is exactly the same (and that is not always the case). And after 200 hours of playing the final shape is equal to the VDH type 1 stylus again.

The better the stylus shape the better the start of the cartridge. Afterwards a loss of resolution can never be improved, even not with very expensive cables or equalizers. Definition is phase and very low level information. The rounder a tip shape, the sooner phase and low level information is lost and the lower the sonic quality.

After the tip comes the cantilever. The shorter and stiffer, the better. Short is something up to 3.0 mm. Stiff means boron, sapphire or diamond. And the lower the specific weight of the cantilever material the better again. Having the best mix of all these properties is boron. Hard to get nowadays because the best diameter is not for sale anymore. So, to be save for the future, don't break them too often and especially never yours.

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**92 Q:** By origin I'm an Eskimo and was born in an iglo, I now live in Djakarta under a coconut tree and sell original icebear (polar bear) lumpias. The sound of my cartridge has changed a lot. How can this happen ?

**A:** A cartridge is built with its specifications like e.g. tracking ability and frequency response for a certain temperature and humidity range. Normal are 18 - 24 degrees Celsius (64 - 75 °F) and 40% - 70% relative humidity. Now in Djakarta the



temperature is around 34 - 38 degrees (°C) (and with political uprisings even above the 40s). So the shore hardness of your suspension rubber for sure is reduced (for both M.M. and M.C. cartridges) and therefore the high resonance frequency of your cartridge is also reduced. The sound will be sharper or even peaky. And because of the softer suspension rubber your tracking improved and your clearance is less.

Tracking is the amplitude you play without distortion at a specified tracking force. Clearance is the distance between the cartridge and the record surface during playing.

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**93 Q:** I am used to play wet because I got all my records from my father who also played wet. But every time the so-called "suspension wire" of my cartridge breaks. I am very angry at the manufacturer because the exchange price is very high. I consider to buy a bagpipe now. Do you have any remarks ?

**A:** You must be Scotlad from Scotland I assume. The reason that the suspension wire regularly breaks has to do with the fact that tracking wet also moistens the iron inside the (M.C.) cartridge. And after many times it simply breaks because the wire has got rusted right up to its core.

So, to start with, use less liquid.

Second: Find a liquid with more distilled alcohol (must not be big a problem for you).

Third: Try to play new records without a "shower".

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**94 Q:** I experience a bad tracking ability with my Onyx M.C. cartridge. What to do ?

**A:** Onyx stone is heavy stuff so the suspension has to be very stiff to keep the fundamental resonance frequency between 9 - 11 Hz (also see [Appendix 2](#)). This automatically results in a poor tracking ability (around 50 micron with 2.0 gram tracking force). Of course you can track with 2.75 gramforce and will reach the 70 - 80 micron, but... the record will not reveal the highest quality anymore. With records you have to keep in mind: The less tracking force the better.

So the solution is to find a low mass arm and in the meantime send your cartridge to one of our representatives for rework of the suspension and other specialities.

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**95 Q:** Is a brush made of squirrel hair a good device to clean a record ?

**A:** Yes, but the brush only removes dust. Not many or even no particles out of the groove itself because the hair is very soft. So the gain in quality is limited. Don't forget also to clean the brush itself every now and then. And don't blow on the brush in the direction of your record player because the dust you remove then will arrive on your next (static) record to be played.

Carbon fiber record brushes are better. They remove dust, particles and static charge.

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**96 Q:** A friend told me that changing the arm wires produced a much better sound quality. But I think: "Wire is wire". Do you have any remarks ?

**A:** You can also think: soup is soup. But as you know, this conclusion is drawn too fast. Especially when the tone arm wire is made from copper and already old (5 years or more) it might happen that the PVC insulation has done some bad work on your thin lead-outs. So a replacement is an option, but somewhat risky. When a wire breaks somewhere between the headshell connector and the arm-base you are in trouble.

Much better is not to replace the wires, but to make 4 new ones and twist them around the arm. Fix them with Scotch tape and make a cosmetically nice arc when passing the bearing. Because the wires are very close to the ground connected arm, there is no hum pick up. Twist one set of two wires belonging to one channel (e.g. the right channel's: red for right + and green for right -) clockwise and the other two (e.g. the left channel's: white for left + and blue for left -) counterclockwise; This to avoid making a big bundle of wires. Connect the other end at the tone arm connector or make a separate box with the phono connections inside. This is a nice piece of work and it gives the hobby a spark again. (By the way: this of course also works with MM cartridges).

For tone arm wiring we have the MCS - 150 M and MSS - 7 in our product program.

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**97 Q:** What to do with my records that are overgrown with mold ?

**A:** Take distilled water and add some liquid bleach (sodium hypochlorite solution normally used for toilet cleaning). Use a soapy bleach type (one without crystals drying up at the top of the bottle). Let the record stay in this liquid for around 15 minutes to kill off and loosen the mold. Keep in mind that the liquid bleach can change the colour of the record label (so you may not want to wet the label and treat each record side separately).

Avoid transfer of spores: I.e. don't mix anything (including your fingers) touching the old records (to be cleaned) with anything touching the clean ones, otherwise you can't stop the disease.

Afterwards wash the record with triple distilled water (to be used only one time so that no salt residue will remain). Put the cleaned and dried records back again in a new and fresh inner sleeve. Using the old ones will create the same problem again.

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**98 Q:** Do I store my records horizontally or vertically ?

**A:** Always vertically with no extra things placed on top of them. Otherwise your records will be warped after many years of having been being piled together on the warm attic.

Also don't stack them too tightly; There must be some air between the outer sleeves. And don't force too many records in a container. Under pressure, the edges of this plastic material will bend sideways and your records will be warped again.

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**99 Q:** On my flea market I sometimes find records with a special sign on them: "CD-4" or "SQ". Are these records better or worse compared to the ones without these markers ?

**A:** Usually they are better because the music had to be better compared to regular to convince the buyer that there was a future for multi-channel (here 4 channel, i.e. quadraphonic) recordings. Both different recording methods require special demodulators. The CD-4 records even had 4 discrete channels recorded in the two groove walls. (With SQ the rear speakers were receiving the same information as the front just 3 dB down).

The cartridge had to be of a superior high frequency quality (preferably flat up to 50 kHz or higher). Both systems were introduced around the '70s to appetize the interest in LP. Both systems disappeared, also because not many listeners were happy with the recording technology.

You never sit in a jazz formation with another instrument coming from each speaker. Also the family (basis for our existence and permitting our hi-fi hobby in the living room) was not happy with two extra loudspeakers. And they had to be somewhat bigger to enjoy the full potential of Mahler's 9th or 10th.

And don't forget the 1812 overture on 4 channels. It seems that the number of divorces in the early '70s was unexpectedly higher than average...

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**100 Q:** Does effective arm mass also include the weight of the headshell and cartridge ?

**A:** When you like to make all calculations correctly: Yes. Even the screws and the connection wires to the cartridge count here. (Also see [Appendix 2](#)).

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**101 Q:** How do I listen to LPs ?

**A:** That is a matter of ear training. Take a record you respect for its quality, and when possible one with one or more voices. First listen for about 10 minutes to the spatial reproduction only. Forget the rest. Then play the same part again and listen especially to detail and resolution. Try again and concentrate on the acoustics. Try to imagine what type of hall or room is used. Are there bricks or is there wood? Is there a natural acoustic environment or an artificial one with a digital delay? How is the voice recorded: With sharp "s's" and "t's" or natural?

By performing all these listening experiments you train your listening ability, and with the next record you'll be aware of more effects than ever before. The best is to regularly visit live performances. Violins are sometimes really harsh and trumpets are screaming. And voices are very different to what you hear at home. Don't change your audio components every time because they don't sound as you believe they should sound. Wash out your ears before concerts and train your ears every day on e.g. the street, when walking in the forest, in a departure hall of an airport or in a big swimming pool. Reality is the best hi-fi you can get. It helps for sure and you save your money.

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**102 Q:** What is the price for a second hand record and what to look for ?

**A:** This is a very difficult question. The reason is that no record is the same in music, titles, recording technology, pressing quality or actual condition: clean, or dirty and with scratches. But look especially for a good analog recorded Decca, EMI, Deutsche Grammophon, Harmonia Mundi or Eterna. There is not so much risk. And don't forget to also study the music your like: what composers do I like, which period in music has my preference, who performs well, what recording technology is used, who was the recording engineer, where was the recording made? Those are very vital questions before you can come to some helpful conclusions.

And when all parameters are fine it will cost you extra money. But don't look exclusively for the best. There are only a

few. And that's also reflected in the price. Rare RCAs, Mercurys, L'Oiseau Lires and Deccas among others have their price.

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**103 Q:** I have a record that I like very much, but there is always distortion in the final part when the music plays loud. What is the cause of this ?

**A:** There are several options to investigate seriously. Ever thought about the high output of the cartridge or MC amplifier causing the input of the next amplifier to become overloaded? This regularly happens. Or the distortion is in the groove itself so you can never get away from it. Or the arm needs a damper to reduce the (say) 30 micron resonance amplitude at e.g. 10 Hz.

When the music is recorded with, say, an amplitude of 70 micron (already high) and your arm resonates with an amplitude of 30 micron, you are able to track just a nice 40 micron. (This because a cantilever can at its maximum linearly track around 70 micron amplitude, of which, in this case, 30 micron is arm resonance, leaving only 40 micron for the music). And that is not enough to replay the recorded 70 micron without distortion.

Or the anti-skating setting is too low for 70 micron, though works well with an amplitude of 60 micron.

Or to save the record you reduced the tracking force. But sometimes you need more.

Or there is extra friction in the arm at the last part of the record. Together with the 70 micron it gets too much.

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**104 Q:** What wears faster at a M.C. cartridge, the stylus, the coil wires or the suspension rubber ?

**A:** Mostly the stylus. A regular stylus needs replacement each 1500 hours. The VDH type 1 can go till 3500 hours.

When the rubber is of an average quality it loses its damping factor and gets sticky. (So stay away from doing modifications yourself). It is normal that the damping rubber changes in its hardness. So tracking is getting less (with natural rubbers in the cartridge) or tracking is getting better with artificial rubbers. But in that case the sound will have an extra accent on the top end.

There are cartridge designs where the coil lead-out wires are a standard in trouble. This is the case when these 4 wires are too tightly stretched and don't have enough space to move; This especially when you regularly play warped records where each turn of the turntable causes a serious massage of the coil system. Trying to solder them together does not work well because there is already not enough length without being broken. And they always break at the coil end, never at the adhesive and rarely at the cartridge connection pins (unless those are not properly fixed, see [28](#)).

The solution is to at the same time make all four coil lead-out wires somewhat longer with a wire of the same quality and diameter (i.e. stiffness). Otherwise you will experience the same disaster another 3 times.

But fundamentally this is a production mistake and the manufacturer must be blamed for it and not you.

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**105 Q:** A friend told me to use some lead between the cartridge body and the headshell. He said this should dampen better. Do you have any remarks ?

**A:** Don't always believe what friends tell you. The extra lead (with for certain a weight of 6 - 7 gram) adds mass to the tone arm and thus for sure reduces the resonance frequency and enlarges the resonance excursions of the arm. So your tracking will be reduced and the bass response is also in trouble. This especially when your hi-fi set is DC-coupled, because the extra amplitude of the bass response will also move your woofer cone. So there is more intermodulation and your power amplifier must deliver more power at frequencies around 6 - 8 Hz. No music at all there, only trouble: tracking problems and extra distortion. So a fine adjusted arm - cartridge combination doesn't need extra damping. And don't forget to tell your friend that there hardly is damping when the cartridge is fixed to the arm with 2 or 3 screws. The screws transfer all the movements despite the lead.

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**106 Q:** The gaps between the coils and the two poles of my M.C. cartridge are very dirty. How to clean, because the coils are more or less fixed and can't move very well anymore.

**A:** First find the reason why there is so much dirt. Try to stop the source so that after cleaning it does not happen again. Sometimes it is the (oily) cleaning liquid itself that collects and holds the dirt. The cleaning liquid may have become contaminated (see [50](#)) because you think that you have to clean everything again after each playing session. Don't do this. When there is nothing to clean then don't use any liquid. Try to clean dry instead of with something out of a bottle. The origin of the dirt can also be rust stain. It is collected by the strong magnetic flux in the gap (see [31](#)). So get another strong magnet and mount that one nearby your cartridge with the arm in its rest position (see [31](#)). It will collect all metal parts you brought home after your work. The source for this magnet can be an old tweeter.

But the question is still there: How to clean?

Leave this to an expert because the difference between the coil lead-out wires and the dirt is so little that the risk is high to remove the dirt including the 4 coil wires. So return your cartridge to one of our representing companies.

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**107 Q:** It sounds like my cartridge's two channels are out of phase. How do I get them back in phase ?

**A:** Just interchange the two colour coded clips at the output pins of one channel and connect again. So, the red clip goes on the green pin and the green clip on the red pin. And don't think about the problem anymore. (Also see [11](#)).

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**108 Q:** Do I need to change the adjustments after a change from an aluminum cantilever to a boron cantilever ?

**A:** In principle you don't have to change anything. Overhang may be readjusted because disassembling a cartridge always has the risk of creating a different overhang. But when changing to boron the sound quality will improve a lot, and this concerns especially M.M. cartridges.

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**109 Q:** Can any cartridge (M.M. or M.C.) be combined with any arm ?

**A:** When the mounting is concerned the answer must be yes. But when it concerns fine-tuning of the fundamental resonance at around 9 - 11 Hz (see [Appendix 2](#)) it will make a big difference. So it is really a matter of calculations and/or experience to find out or know what works well and which combination doesn't.

Older salespeople experienced in analog can tell you tear-jerking stories. So go and see them. Like Allen Yee in The Ocean Centre #318 in Hong Kong.

Overhang, arm mass related to the cartridge suspension and the own resonances of the arm are parameters to be kept in mind.

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**110 Q:** Every time when I play at louder levels there is a continuous rumble coming from my loudspeakers. How can this happen ?

**A:** Simple: Your turntable is too close to the loudspeaker so the bass driver excursions will induce record vibrations, and these movements are picked up by your cartridge and transferred to the bass driver again. That is the feedback circle. To break this circle, enlarge the distance between the two components as much as you can and the problem should be eliminated. Keep in mind that any record will always pick up some of the movements of your bass driver. So some instability in the low end originates from this source. A record clamp or vacuum playing ;-) will help for sure.

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**111 Q:** Are there any good overhang adjustment tools around ?

**A:** Yes, there are tools around from the past but also currently produced ones, like the SME overhang protractor. You do not need to buy a SME arm to get one. There are (were) plenty around.

Also the German Schön protractor is a very fine overhang adjustment tool that gives you a lot of information.

SpJ produces a simple metal plate with 2 different adjustments related to the calculations of E.G. Löfgren and H.G. Baerwald (\*).

Some arm manufacturers provide an extra piece of plastic that acts as an overhang adjustment, but I would like to go for the more serious approach.

\*: References:

- E.G. Löfgren: Über die nichtlineare Verzerrung bei der Wiedergabe von Schallplatten infolge Winkelabweichungen des Abtastorgans: Akustische Zeitschrift, Nov. 1938, p 350.  
This article is available on the internet at: <http://www.helices.org/auDio/turnTable/>
  - H.G. Baerwald: Analytic treatment of tracking error and notes on optimal pickup design: Journal of the Society of Motion Picture Engineers, 1941, p 591.  
This article is available on the internet at: <http://www.helices.org/auDio/turnTable/>
  - Of further interest:  
An interesting overview article (in German) titled "Tonarmgeometrie" also containing further literature references and links appeared in issue 2/2001 of the German Analogue Audio Association's "Analog Aktuell" magazine:  
This article is available on the internet at: [http://www.aanalog.de/aaktuell/aa2\\_2001/dateien/lpaa2\\_01.pdf](http://www.aanalog.de/aaktuell/aa2_2001/dateien/lpaa2_01.pdf)
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**112 Q:** Arm manufacturers always advice to keep the arm parallel to the record during playing. Is this right ?

**A:** To my experience it's not right. What I learned was that in the playing position the arm must always be somewhat higher at its rear end (the counterweight end). A 9 to 9.5 inch arm around 7 - 9 mm higher. This improves the resolution a lot. Works with any arm and any cartridge. What you have to keep in mind is that each record is different. So fine-tuning the spatial resolution is slightly different per record. This can be fine-tuned by changing the distance between the arm bearing and the mounting board.

One millimetre up or down can be enough. But the average of 7 - 9 mm up works always in your advantage.

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**113 Q:** Which stylus shape sounds the best ?

**A:** The stylus with the smallest front to back contact area with the groove produces the highest resolution in tracking and the lowest frequency intermodulation. And at the same time this stylus must also have the longest possible contact line (with the groove walls) in vertical direction. So, a spherical stylus with at its front and rear some diamond removed and called "elliptical" is a sales trick and is not more or less than a "spherical" stylus. The so-called Shibata stylus is half a spherical stylus (front part) and half another shape not being able to properly track the CD-4 (quadraphonic record) frequencies. A better design was the Pramanik used by Bang & Olufsen. But this good stylus did not get enough attention. And still going strong is the VDH type 1 stylus with a very short front to rear contact area with the groove (2 - 3 micron radius) and a large contact line in vertical direction (85 micron radius). After the sales of around 1.4 million VDH type 1 styli over the years it is still available.

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**114 Q:** One of the connecting pins of my expensive cartridge rotates but the channel is still working. What to do ?

**A:** Just fix it with a very little quantity of crazy or super glue (or as we name it: one second glue). Don't add the adhesive by putting the 6 gram adhesive container against the rear of the cartridge, but bend a very small circle of mounting wire and dip this in the adhesive. Next bring this small quantity to the pin and the contact block it fits in. By doing so you can control the applied quantity of adhesive much better than the "enough is not enough" method.

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**115 Q:** My cartridge collects a lot of dust after playing one record side. What's happening ?

**A:** There really can be a lot of dust on your record before playing. So clean the record surface.

When you play again and a lot of dust is collected by your cartridge again, then it is time to scratch behind your ears. The reason of this second quantity is record surface material removed during playing. So the cartridge generates surface powder (vinyl powder). Your dear stylus acts as a cutter and after several plays the noise level will come up and there will be audible distortion. So it's better to stop immediately and find the reason of all this.

One reason can be a worn stylus. A worn stylus acts as a cutter again, especially for high frequencies. So have the stylus replaced. This can be done by our company when you hand the cartridge to one of our representatives.

What also can be a serious reason is that the stylus is in a mechanical oscillating mode caused by a suspension with a too high Q-factor. Happened once with a famous English cartridge where the suspension wire was made from a fiber.

Or, when looking at the front of the cartridge, the stylus is not vertically enough positioned in the groove. We have a small spirit level in our product program to compare the horizontal position of the cartridge as seen from front (azimuth) to the record surface.

And don't forget: After playing always put the record back in its sleeve. Otherwise you also collect micro dust that will disappear in the groove itself and next time will be squeezed into the groove wall by the long contact line stylus.

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**116 Q:** I suddenly have a very funny sound with a lot of hum and hardly any channel separation. It happened after a lightning struck our house. What to do ?

**A:** You have to measure if there is an electrical connection between the two channels of your cartridge (colour coding: see [48](#)). When this is the case, your coil system is lost and needs a replacement. With a regular cartridge you can hand it over to one of our representatives for a rebuild. It's by the way not cheap but you can play again. A new cartridge costs more.

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**117 Q:** To improve the sound quality of my cartridge, I have soldered the headshell wires directly to the contact pins of my cartridge. Now I lost one channel and my dealer thinks that this is a typical example of warranty. What to do ?

**A:** Your soldering caused melting solder inside the cartridge body and you lost one connection. This is no warranty but stupid. So return the cartridge to one of our representing firms and we can resolder the coil wire again. Don't try to this

yourself because coil wires are really thin and hard to solder. They just dissolve in your solder without notice.

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**118 Q:** Every year one channel (always the same) gives up. Is this a mistake made by me or is this warranty ?

**A:** It is for certain warranty. The reason is that the coil lead-out wires are too short. So during playing they bend too much and metal fatigue is the result. When every year you also have to pay a lot of extra money to have the cartridge replaced, forget the brand and look for another.

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**119 Q:** How good can the spatial reproduction of a cartridge be ?

**A:** The spatial reproduction can never be better as was cut on the record. With some electronic help you can enlarge the space but the result is also that the phase characteristics of the reproduction deteriorate. So in listening you'll be somewhat handicapped.

The total output of a cartridge on one channel (and also the other) is the sum of the main signal and the crosstalk coming from the other channel. Usually the crosstalk is around - 30 dB. But at higher frequencies this crosstalk level gets higher, so the influence is also bigger. With a channel separation at 20 kHz of say 20 dB the result is that already 10% of the total output is crosstalk signal.

The crosstalk signal practically always is not a sine wave but a peaky and distorted signal. This causes a harshness in the main signal of this channel because the total output is the original signal and the crosstalk together. So a higher channel separation at high frequencies contributes dramatically to clean sound. This leads to a higher resolution in replay.

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**120 Q:** How can the resolution of a cartridge be optimized ?

**A:** First start with a good stylus. What is not collected at the pure front end can never be restored afterwards. Then think about a very stiff and - despite that - light cantilever. Solid boron will do here. Also keep in mind that a short cantilever has a higher flexural rigidity compared to a long cantilever. So 3.0 mm is short and 7 mm is really long.

After the cantilever comes the coil (MC) or the magnet (MM). Moving Magnets by nature have a lower resolution caused by the compensation of the roll-off after 8 kHz. But all other good mechanical properties mentioned above are still very important.

With the Moving Coil cartridges, the adjustment of the magnetic flux in the gap also counts for high resolution. Especially when there is a rear pole and a front pole on either side of the coil. You can think about two different modulators acting not equal. So The COLIBRI from our program has no front pole anymore. A listening experience of the first order.

The coil wire counts for resolution. A worse wire creates harshness and a good wire hardly. So the manufacturer has a great responsibility in the selection of the coil wire type. Copper, silver and gold are by nature better wire materials in that same order. It is the method of production of the wire that in the end counts for the resolution.

Very important is also tracking force. You can not expect a high resolution from a cartridge tracking at 2.75 - 3.0 gram. The fine groove modulations are just removed during playing, even where the cartridge is an exact copy of a cartridge built many years ago.

In the meantime we have learned something and that also counts. Life is not always sentimental.

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**121 Q:** My cartridge dropped on the record. What to do ?

**A:** When there is still a cantilever with a tip on the end, just continue to play. The only disadvantage can be a minor extra indentation in the record reminding you every time you play this record about what happened.

When the tip is missing and/or there is no cantilever, return the cartridge to one of our representatives for repair.

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**122 Q:** Is a sapphire cantilever better compared to one made of boron ?

**A:** The specific weight of sapphire is higher, so the mass influence of this cantilever on the response is also bigger. Also the material is stronger, so in case of an accident you may have damaged more than you did expect. So, personally I do not mount or use any sapphire.

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**123 Q:** Does a cantilever repair have influence on the reproduction quality of the cartridge ?

**A:** When the repair is a replacement from e.g. aluminum to boron, yes; Then there is a strong improvement in reproduction quality. Especially because the specific weight of boron is less, so the influence on the frequency response

starts at a higher frequency. The pulse response gets better and also the resolution. So worth to think it over.

**124 Q:** Is there any advantage in having more than 2 mounting screw holes in a cartridge body ?

**A:** Not always; Until you damage one of them and you are happy that there are another 2 left. Some manufacturers use three holes to create a better fixing to the tone arm. Though sometimes it is rather to be somewhat different.

**125 Q:** My contact pins are made of a silver coated material. They are soon black again after cleaning. What to do ?

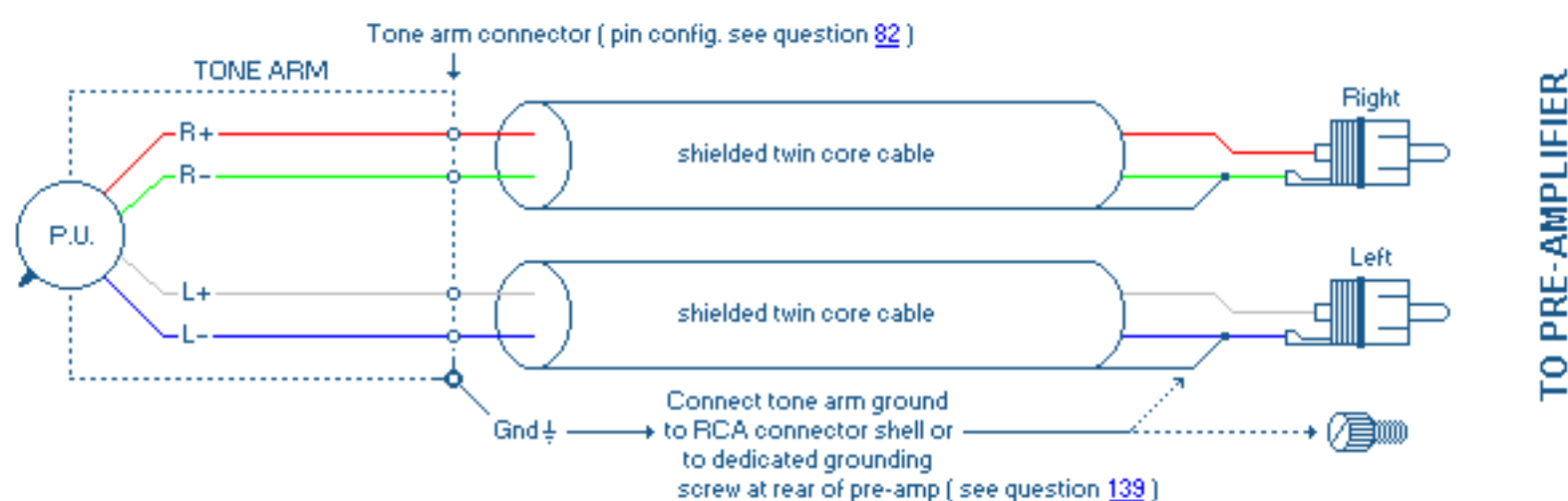
**A:** Especially in tropical countries the silver turns black very fast.

Also when you live close to a highway the exhausts of low level petrol do their work, even on your hi-fi set. Among other corrosive gases they contain sulfur oxides which make silver turn black with a thin layer of semi-conductive silver sulfide. After cleaning your contacts we advise to apply our "The SOLUTION" contact protection fluid, designed to solve your problems. Don't clean too roughly or too often, otherwise there are no pins left anymore...

**126 Q:** When I switch on the light of my listening room I hear crackling sounds coming from my loudspeakers. What to do ?

**A:** These sounds originate from sparks somewhere in of your electrical system. E.g. a sparking starter somewhere in your fluorescent lamps.

The result of these sparks is HF transmission to your phono cables and/or M.C. input. In a sensitive wide band audio system, the shield of your coaxial connection cables between the turntable and the M.C. input acts as an antenna. Mounting separate ferrite rings or clips (RF suppression hinged ferrite clamp cores) around the existing two cables will work in many cases, but a much better method is replacing both coaxial cables by two balanced ones (e.g. our D - 501 HYBRID, D - 501 SILVER HYBRID or twin version D - 502 HYBRID).



The shielding of the cables is connected to ground only at the M.M. or M.C. input side. The two internal conductors of each D - 501 (it is a balanced cable) are respectively connected to the right + (red), right - (green), left + (white) and left - (blue) signal leads of the cartridge along the internal tone arm connections. The cables' internal signal ground (cartridge: green and blue) lines are connected to the cable screen (grounded) only at the RCA connector end of your single-ended M.M. - or M.C. - input. At the record player side, the tone arm ground (top center pin of your tone arm connector) is best to be run as a separate line (wrapped around your phono cable), likewise to be connected to the cable screen (ground) only at the connector end of your M.M. - or M.C. - input. (In case of our D - 502 HYBRID cable: use the yellow wire which runs in center of this figure of eight cable). Using a separate line for your tone arm ground instead of using the cable shield for this connection is by far the best noise free solution (star ground).

When there is still noise at switching on the lights, there are three other options:

1. Connect a high quality 470 - 1000 pF (polystyrene or polypropylene) capacitor parallel across the input connector of your M.C. input (not with M.M. inputs, see [38](#)).
2. Experiment with the ground lead coming from the input connector internally in your M.C. stage.
3. Go fully balanced (i.e. balanced M.C. pre-amplifier) with the cable screen kept totally separately from both audio signal carrying internal lines. Costs more but produces the finest results.

By the way: M.M. stages are not very susceptible to HF interference.

**127 Q:** How do I find out whether my stylus is worn ?

**A:** There is a combination of effects: Playing very clean records will anyhow produce dust particles on your stylus, cantilever and the bottom of the cartridge.

Cleaning will not help, each record produces the same result. Also the sound is different. There is a growing distortion when you listen to voices and strings; Especially at the inner grooves. And the highest frequencies are not clear and transparent anymore; You really start to miss them.

And, with a good microscope, you will see shiny circular shaped (with a spherical stylus) or elliptical shaped (with an elliptical stylus) light reflecting spots on the contact areas where the stylus touches the groove.

A synthetic diamond stands around 600 - 1000 hours. A natural diamond (the centre part of an octahedron) can stand 2500 - 3500 hours.

The diamonds used by our company are always of the long standing type.

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**128 Q:** What is the difference between a straight and a S-shaped tone arm ?

**A:** There are more differences than you think! Most important is that the horizontal bearing is parallel to the connection line between the two cartridge mounting screws. When this is not the case, then your tone arm describes a part of a circle when you lift the arm. So adjusting the arm gets somewhat more difficult because in front view the cartridge must be parallel to the record at playing position. Not having the two lines in parallel (meeting each other) makes the adjustment more difficult.

Most arms are not S-shaped but do have an angle between the straight part and the headshell. The horizontal bearing (allowing the vertical movements) is in most cases perpendicular to the arm.

Adjusting the cartridge position at playing position produces the same effect: The vertical movement produces a circle segment again as described above. So this arm must also be perfectly horizontal at the playing position. Having the bearing under an angle to the arm (and parallel to the connection line between the two cartridge mounting screws) does not produce this effect and is therefore better.

The material length of S-shaped arms is longer than the distance between the pivot (when the horizontal and vertical bearing have a common point) and the stylus. A longer arm describes a smaller circle segment in the horizontal plane. For this reason that is better because the rotation of the stylus in the groove is less. But there's also a disadvantage: more moving mass (higher inertia) and less stiff.

For the same reason a shorter arm is stiffer and has a lower inertia. But the horizontal circle segment is bigger: During the course of playing an LP the stylus rotates more in the groove (i.e. undergoes a higher rotation around its own vertical axis). This causes a bigger difference in time (phase) between the left and right channel. The longer the arm, the less this difference. This, because the arc the arm with the cartridge describes along the record surface comes closer to a straight line.

So what you learn from this is that a linear tracking arm is a perfect solution for all problems. But those arms cost more and are mechanically critical in adjustments. Also the movement support usually comes from an electrical motor. The tuning of the tangential movement of the arm really needs a very precise sensor. Those arm types are mostly made in Europe. In the USA the unipivot is more popular.

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**129 Q:** What type of tone arm cable do I need to connect the output from a tone arm to my M.C. input ?

**A:** Use a very well screened and also very flexible balanced cable.

High flexibility is desirable to dampen the mechanical transmission of vibrations along the cable from outside the turntable to the arm support and the cartridge. Otherwise the mechanical noise will interfere with record replay. A good shielding is today a must to avoid picking up electromagnetic and radio frequency interference.

Our flexible D - 501 HYBRID, its silver version the D - 501 SILVER HYBRID and its twin version the D - 502 HYBRID are especially made for this purpose.

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**130 Q:** I have a serious hum problem when I play records! What to do ?

**A:** In many cases the hum is changing when you rotate the record player or when you move the arm. This indicates that there's a transformer with a magnetic stray field around. So enlarge the distance between the power supply of the turntable and the turntable itself. When nothing changes, it can be the AC motor of the turntable that causes the problem. With presently made turntables this problem should be under control.

Another source of hum can be the power transformer of a nearby amplifier. So a change of distance or repositioning of the turntable in vertical placement will be of big help. When you still suffer, there can be a hum loop caused by a ground problem. The cable shielding ground and the signal ground of your phono input stage are not the same (see [48](#)). An always working solution is to disconnect the ground lead of the tone arm from the grounding screw at the rear of the pre-amplifier and move its clip between the cable insulation and the connector at one of the inputs. Listen if there is an improvement when you use the connector of the right or the left channel.

Another possibility is that the ground of the arm at the tone arm connector is disconnected. And also check your input connectors. Maybe the shielding of the cable is not connected well (also see [126](#)).

When there is still hum, take your turntable to a friend's system and listen there.



No hum: it is your electronics.

Hum: it is your turntable. Measure all 5 tone arm leads with an Ohm meter to find out whether there is a short circuit between them (see [48](#)).

Still hum: It is a short between the cartridge's two coils or a short between one coil and the metal body of the cartridge.

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**131 Q:** It sounds like I am missing a lot at the top end of the frequency range. What can be done ?

**A:** Let us start with the stylus. All phono cartridges are mechanical devices with a very hard, special shaped diamond to trace the mechanical grooves. But however hard the diamond, it also wears. Especially at the areas in contact with the groove. This means that the resolution at the highest frequencies will reduce. These frequencies have the shortest wavelength in the groove. So a worn stylus reduces the ability to track high frequencies. Beside this loss of top end, there will be also audible distortion because the stylus doesn't fit well in the groove anymore.

But... there are more possible reasons:

Cleaning your system with a cleaning liquid that has become contaminated with oil (see [50](#)) will change the damping properties of the damping rubber around the cantilever (M.M. system) or behind the coils (M.C. system). With a softer damping rubber the natural resonance frequency is decreased. So there now is more or less a natural roll-off at the top end.

What always causes a change in the response is a mismatch in the load impedance (also see [22](#)). A higher load impedance provides less electrical damping to the source (your cartridge). So increasing the load impedance also helps to improve the top end. Lowering the load impedance tames the top end, but keep in mind that your cartridge is not a kind of tone control to adjust e.g. a too efficient tweeter or to compensate oxidized and green (and therefore aggressive sounding) loudspeaker cables.

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**132 Q:** I have a Japanese cartridge with a very short cantilever. And from my very old aunt I got a lot of LPs with Scottish ballads all about alcohol and being drunk. She had a great interest in this subject. Sadly enough all records are warped. How to play them ?

**A:** Use a very light tone arm to start with. The Black Widow was a famous sample of this kind.

Lift the arm support as much as you can out of the arm board so the distance between the bearing and the arm board is enlarged.

When this is not enough, try to flatten the records; Clean them first with a mixture of triple distilled water and alcohol. Afterwards put them between two heavy glass plates and leave them there for 14 days. In a warmer environment the effect will be better.

Protect the records by very smooth lint-free paper (e.g. silicone baking paper) and don't make a direct contact between the record and the glass. You will be delighted.

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**133 Q:** Is it possible to upgrade a GRASSHOPPER III to a GRASSHOPPER IV ?

**A:** In our company everything is possible, but to break a GRASSHOPPER III down in parts and pieces and to start from scratch again is too much work.

So my advice is: Sell the GRASSHOPPER III to a friend and buy a GRASSHOPPER IV. And when you don't have a friend, start to make one immediately now.

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**134 Q:** After examination of my cartridge under the microscope I saw that the suspension wire was rusted. What can be done ?

**A:** Rust or stain is the result of chemical activity at the steel-made suspension wire. It starts by high humidity and (usually) higher environmental temperatures. In addition, corrosive chemicals in the air due to near by traffic or sea will also help very well.

So keep the cartridge dry. Any water or damp air (tropical humidity) acts as a carrier for chemicals. When you are a professional wet player, stop today or reduce the quantity of water splashing all over the record dramatically. Your cartridge is not a high powered racing boat.

Once a suspension wire is stained, it is very difficult to stop.

Oil (even silicone oil) will not help because the damping rubber will absorb this and will change its damping properties. So this is a clear "don't do".

What may help is a return of the cartridge to the manufacturer, or when this company does not exist anymore return your cartridge to one of our company representing firms.

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**135 Q:** My suspension wire is broken. What to do now ?

**A:** Return the cartridge to the manufacturer who will throw it away, or return the cartridge to one of our representatives so I can try to repair it.

This repair is rather difficult and may, despite your faith in our company, not be possible. Meaning that the whole coil system needs to be replaced. If however this is possible, the success rate is more than 90%.

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**136 Q:** From my grandfather I got a cleaning brush mounted on an old tone arm. It runs from its own pivot opposite of my tone arm. Can I use this brush and should I play wet ?

**A:** This device for sure helps to keep your record clean as long as you keep the brush very clean; Otherwise there is just replacement of dust by other dust.

Clean the brush wet but don't play wet, otherwise you start to play wet for ever (see [18](#)). When that is what you want and already do, you can continue. Play wet but not "splash wet".

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**137 Q:** I live in Singapore and all parts of my turntable are stained. How to solve this problem ?

**A:** Buy a stainless turntable and sell your turntable (not to a friend).

Another method is to clean the whole turntable by putting every part in Coca Cola (which contains a mild acid) for 24 hours. Afterwards rinse in distilled water and remove carefully what is left (of the stain of course).

Then take all parts individually and polish where possible with silver or copper polish. And on the end give all parts a thin coating of beeswax. Diluted beeswax is available in the polish used for antique wood. Don't use silicone oil because this runs everywhere where you don't want it to be.

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**138 Q:** Is there a quality difference between a high output M.C. and the same cartridge in a low output version like your "The FROG" ?

**A:** The lower output version has a better channel separation and a smoother top end (highest part of the frequency range). But beside the disadvantage of having less of those, with a high output cartridge you save a M.C. stage which also costs money and can reduce the quality. This quality reduction can be worse compared to the little quality loss involved in having the high output cartridge version. It depends in the end on the total quality of the extra M.C. amplifier required. So the choice is yours.

Keep in mind that the high output version must minimally provide 2.5 mV at 5.7 cm/s to match the sensitivity of your M. M. input.

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**139 Q:** How do I make the ground connections in my turntable ?

**A:** First keep the ground of your audio signal circuit (the signal ground of both cartridge cables) completely separate from the other ground cables. The only place where the grounds may meet is at the (unbalanced) input of your M.M. or M.C. amplifier. Even then there can be some problems with hum or noise. (Also see [48](#), [126](#) and [130](#)).

Your tone arm must have a connection to ground along the center pin of its 5 pin tone arm connector (see [82](#)). When this is not the case, ground your arm with a separate insulated wire by connecting this wire to a fixing screw somewhere at your arm pillar/support, but indeed being in direct electrical contact with the arm itself. When you cannot but do this directly to the arm itself, use a very flexible wire like our SCS - 28 M.

Make another ground connection from the metal of the turntable and connect this separate lead-out at the same point as used for your arm ground (i.e. at your M.M. or M.C. amplifier). This is a so-called "star" ground.

When there (still) is some hum, do some experiments with the point of grounding at the rear side of your amplifier. Even putting both ground leads under the shell of one of your phono input connectors may produce a surprising result.

Most amplifiers employ various electrical grounds: The mains power ground, the cabinet ground, the amplifier (signal) ground, the input ground and the internal power supply ground. When the manufacturer has made one or more mistakes in the correct connection of any of these electrical grounds, there is for sure hum on a lower level (small mistake) or a higher level (big mistake). Keep in mind that the manufacturer is also a human being.

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**140 Q:** Why are the dynamics of a 45 RPM record so high ?

**A:** The cutting speed (Amplitude x Frequency) can be much higher because there is more radial space on the record. The

distances between the grooves are bigger, so the amplitude can be larger at the same frequency. So, as a result, the dynamics are higher. It also requires a cartridge with better tracking properties. This is in many cases a M.M. cartridge and not a M.C. unit.

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**141 Q:** What sounds better: LP or CD ?

**A:** "Sounds better" must be explained first. A good sound system has a great bass extension, a liquid midrange and a sweet high end. There must be a very good control of the sound and plenty of space. High channel separation also above 20 kHz and very low higher-order harmonic distortion. Especially the soundstage must be focused and as deep as possible. The noise floor must be as low as possible and there may be no loss of definition and detail at the lowest signal levels.

As you see this is already an impressive list of properties.

And still there are audible differences between the LP and the CD.

This has to do with the conversion method. Especially at frequencies above 5 kHz the LP has a finer detail and higher resolution. The CD replaces the original signal by a calculated and numerically truncated version. But there is more.

At the introduction of the CD many recording engineers went real multitrack. So plenty of microphones were used. And the sonic result? Plenty of close microphone sound and phase defects. So the ambiance was lost and replaced by digital acoustics. For the fast consumer an improvement but for the real hi-fi lover a big loss. So back to the recordings made around 1960 - 1970 without any digital tricks.

I am not saying here that the LP always is a better medium. The recording engineers around the sixties were also human beings with their specific style. But the medium in itself produced a 'closer to reality' result.

At the moment of this writing (2001) we are waiting for the breakthrough of the Super Audio CD (SACD). Sonic an improvement compared to the regular CD thanks to much less filtering. This results therefore in a higher output of modulator signals above 20 kHz. Not all amplifiers can handle this, not to speak about the regular tweeters. So be warned for the future...

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**142 Q:** An analog friend of mine has a very dynamic phono cartridge compared to my unit. What can I do to improve the dynamics of my cartridge ?

**A:** A dynamic cartridge has one specific property: The magnetic modulation curve is very steep. Yours isn't. This can be because the total flux in the magnetic gap is low or there is too much magnetic stray field in the unit. This is mostly the case with M.M. cartridges.

You can not do anything to improve the dynamics because this is a design property which you are not responsible for. Only for the buying. So sell it again and get the same (usually more expensive) cartridge as your friend has.

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**143 Q:** There are plenty of cartridges with copper used as coil wire, some with silver wire coils and very few with gold wire. Is there a difference in sound between these different wires and when your answer is yes, why? They are all good electrical conductors.

**A:** You are right, they are all good conductors but... It is not only the conductivity but also the purity of these wires, or to be more specific: how chemically clean these wires are and will stay during all your many listening hours. Also the way of manufacturing of the wire will influence the final result. Twin tone (intermodulation distortion) tests with evaluation of the interference results at very low signal levels showed that "well treated" wires produce lower levels of interference compared to conductors made in the regular way. So it pays off in sound when the conductor is chemically more stable (and well protected) and is carefully manufactured. Because gold costs much more than regular or very special copper, the production is also done with much greater care. So the final result after many years of use in your cartridge remains superior to any other conductor material.

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**144 Q:** Is a cartridge with a low weight body always better than a heavy one ?

**A:** As long as the low weight cartridge's body is rigid and stiff it is o.k. It also requires a stiff and especially low weight arm.

For whatever reason, don't use a heavy arm, even not with a heavy cartridge. The extra mechanical load on the grooves of a not flat record will for sure change the fine top end in the recording. A light system (cartridge & arm) works at its best with flat records. And keep in mind that the specific dynamic compliance of the cartridge together with the total moving mass (arm, headshell & cartridge) must produce a low frequency resonance between 9 - 11 Hz (see [Appendix 2](#)). Otherwise you have exchanged one problem for another.

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**145 Q:** I am an American and I always like to modify. This time I did my tone arm: a SME V.

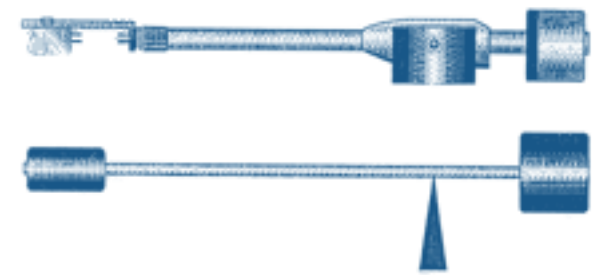
I think that I found the perfect solution: I filled this tone arm with sand. What can I do more to improve my result? I am expecting a fast answer because I hate to wait.

**A:** Take as fast as you can all the sand out of your SME series V and respect the quality of the designer and manufacturer. Modifying is a habit in the USA, but it is not always the correct way to get the best result. A heavy arm puts a lot of mechanical load on the suspension wire of your cartridge. So the lifespan will be shorter than expected. What means that you may claim warranty. But the reason of the defect is your own work on your arm and not the result of a poorly made cartridge. You will also reduce the resonance frequency of the arm-cartridge combination. So your loudspeakers will make strong excursions without making music and your amplifiers have to deliver a lot of extra (bass) current which influences the total music reproduction. So return your sand to the place where you got it from.

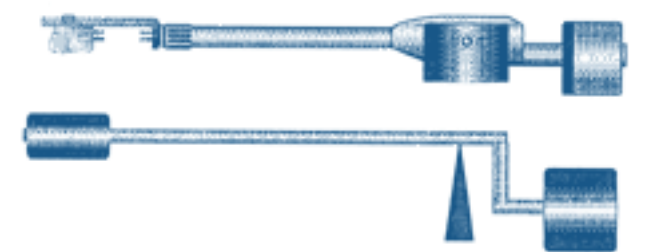
**146 Q:** There are two types of tone arms. The one with the centre of inertia at arm level and the type with the lowered centre of inertia. Can you tell me more about that ?

**A:** The lower centre of inertia has been especially designed concerning so-called unipivot arms. This, to lower the resonance frequency of the arm rotations. This had to be done because there is freedom of movement in all directions around the pivot. The lowered centre of inertia is lowering the wiggling frequency and this helps to improve the tracking and the sound reproduction. The non unipivot arms don't need this specific design criterion because they never tend to resonate on a low frequency around their bearing point; There are enough bearings to avoid this unwanted movement. You can recognize the lowered centre of inertia by looking at the position of the counterweight compared to the top of the unipivot. The bigger this distance, the lower the vertical resonance frequency.

**Centre of inertia at arm level:**



**Lowered centre of inertia:**



**147 Q:** My cartridge has all kinds of connectors between its pins and the final connectors plugging in my amplifier. Do all these connectors help to maintain the sound quality ?

**A:** No they don't. So the best solution is to rewire the whole system from the cartridge clips to the connectors fitting in your amplifier with only one single lead per connection (so in total four). But please note: This and the description below only applies when your phono pre-amplifier has balanced inputs!

(When your phono pre-amplifier has single-ended inputs, extra shielding of the signal lines and grounding of the tone arm is required. For details please see [126](#)).

Direct wiring to balanced inputs:

The only soldering points are at the 1.2 mm clips at the beginning and the XLR type plugs at the end. It takes some hobby time to do this, but for reasons of sound quality it works very well. When you remove the internal wires of your arm, first check if they are fixed somewhere. If this is the case, just wind the new wires all four around your arm and use them as they are. Forget the replacement of the four internal wires. Also get around the bearing externally by a nice double loop, and after fixing the four wires get straight to the XLR type connectors at the other end. (Also see [37](#)). Twist the red & green leads together, do the same with the white & blue leads and keep both pairs close together to reduce noise interference. Also keep the wiring away from transformers and mains cabling. When you are still able to hear Radio Vatican or the BBC World Service, this experiment must be refined by adding two small capacitors, each soldered in parallel to an input of your phono amplifier. For M.M. cartridges there is no risk to hear The Voice of America at all (no capacitors required!) and for M.C. cartridges 470 pF capacitors will do well without any sonic risk. (Also see [126](#)).

Our MCS - 150 M and MSS - 7 tone arm wires are excellently suited for direct wiring use.

**148 Q:** Can I use contact oil to improve the sound quality ?

**A:** Yes, you even must use contact oil to maintain the integrity of all your mechanical electrical connections. But don't splash too much around with it on a cartridge because the suspension rubber is very sensitive to oil contamination and will absorb any oil (usually sooner than later). So a minimal quantity at the connector pins of the cartridge already works. Contact oil is not conductive (contrary to what some people think) but coats contact surfaces with a thin, non toxic, non oxidant and non migrating layer to avoid oxidation of the parts exposed to air and to reduce subtraction and insertion wear on the connector's precious metals.

Our "The SOLUTION" is especially designed for this purpose.

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**149 Q:** It is a habit for some cartridge manufacturers to coat the internal components of a cartridge with gold. Do those cartridges sound better ?

**A:** The gold coating provides more attractive cosmetics and protects against the development of rust stains. For economical reasons the thickness of the coating however is so thin that eddy current damping is hardly possible. Coating all internal components with gold does not cost a lot but improves the economical efficiency of the manufacturer.

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**150 Q:** A friend of me has a German made cartridge with a very long cantilever. He claims that the sound quality is superior to my cartridge with a very short cantilever because the manufacturer gave this information to him personally on the latest hi-fi show in Frankfurt. Is my friend right with this personal statement ?

**A:** A long cantilever helps in the tracking because the angle variation is less. So this is the positive message. The negative message is that the high resonance frequency (normally around 30 kHz or higher) is reduced as a result of the enlarged mass or inertia. With a short cantilever there are risks of tracking problems, but the resonance frequency is much higher so colouration by extra output at 20 kHz is not there. Also, a shorter cantilever is stiffer compared to the longer type when the diameter is kept the same. So the pulse response is more dynamic and hardly has any ringing.

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**151 Q:** Can crosstalk also be caused by magnetic effects ?

**A:** Yes it can. Practically all phono cartridges (M.M. & M.C.) employ a single magnet, therefore any magnetic "load" variation on the magnet caused by music modulation in one channel will cause the magnet's flux to change by a small amount. This flux change automatically also produces electrical output in the other channel (crosstalk). In the ideal situation the magnet's flux would remain constant, like in analogy the power supply voltage of a stereo amplifier would. Cartridges with 2 independent magnets (analogy: separate power supplies) will do better from this point of view. Audio Technica produced some many years ago.

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**152 Q:** What is the purpose of the RIAA equalisation curves ?

**A:** There are several good reasons to work with the record cutting and replay equalisation curves which have been established by the Recording Industry Association of America. Both curves are based on the same time constants but are each others inverse.

One of the ideas behind the RIAA curves is that cutting bass frequencies (e.g. 20 Hz) on a lacquer will take a lot of space (the amplitude is very high). So a level reduction of 20 dB (i.e. a reduction by a factor of 10) should be of big help there. But to maintain an original sound impression, upon replay the original level should again be restored. So where during the cutting a signal attenuation of 20 dB at 20 Hz is applied (on purpose), during replay a signal gain of 20 dB at 20 Hz is employed. The latter is implemented by the RIAA reproduction/correction filter inside your phono amplifier. This, by the way, applies to both M.M. and M.C. cartridges as an iron law. The special phono amplifier for this correction is also called the phono correction amplifier.

The disadvantage is that your turntable should not produce any mechanical rumble around 20 Hz, because this non musical signal (picked up by your phono cartridge) also receives the same 20 dB boost at 20 Hz.

Remark: In 1976 the IEC introduced the RIAA/IEC Reproduction Curve intended to reduce subsonic frequencies (rumble) upon replay (see [Appendix 1](#)).

At 20 kHz it is just the opposite situation: During the cutting of the record, the cutting amplitude is boosted by 20 dB. Also the top-end noise in the recording receives this lift of 20 dB (a level increase by a factor of 10 compared to the 1 kHz gain reference level). During replay over your phono correction amplifier the opposite is applied: At 20 kHz the signal is attenuated by 20 dB compared to the standard gain at 1 kHz. So what we got extra during the cutting is lost again in replay after correction.

This also has a positive effect: All the surface noise from your records (especially around 20 kHz) is also reduced by a factor of 10, and that really helps to make the replay more pleasant.

The RIAA filter time constants are 75, 318 and 3180 microseconds (see [Appendix 1](#)).

The RIAA curves are accepted as a world standard, but many years ago there were many different recording and replay curves. Each respected company had their own. So a lot of extra confusion. That became history after the introduction of the RIAA equalisation curves.

There are more advantages: The tracking ability of a cartridge at 20 Hz would be out of any range on records cut without RIAA equalisation. And with RIAA equalisation the electrical effect of the mechanical resonance frequency of the cartridge

around 20 kHz is also reduced by a factor of 10.

The latter by the way does not mean that the cantilever resonance is damped by 20 dB. The mechanical movements at the system's resonances will stay the same. Only the electrical output of the cartridge is corrected.

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**153 Q:** A while ago I bought a lot of used records (mainly recordings about drunk Irish musicians). The old lady who owned them could tell me how many times she played each of them. That is something I don't understand. How does this work ?

**A:** The answer is very simple: Every time you put a record on your turntable, there is always the search for the centre hole. This search produces some hardly visible traces on the label facing the platter. So by watching the label carefully, you know how many times the other side of the record has been played. A so-called "new record" with some of these traces will show you that the record is not as fresh as the owner wants you to believe.

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**154 Q:** Does the type of bearing and the oil I use make an audible difference ?

**A:** Yes they certainly do. As you will know, the revolution speed of a platter is relatively low (100 revolutions in 3 minutes). So any effect will be at the bottom end of the frequency range. And with the extra gain of 20 dB thanks to the RIAA reproduction curve's correction (see [Appendix 1](#)), the real influence is even 10 times stronger. So the spindle bearing and the oil in the bearing is very important. The slightest free space in the bearing and the uneven surface will produce extra mechanical noise. Along the spindle and the record on the platter, your cartridge will pick this up and the rumble comes with an extra 20 dB boost out of your speakers.

The best oil I know is the version doped with zirconium oxide marbles of 1 micron diameter. This oil is very expensive but produces the best audible quality. (This oil works for all non air-cushioned metal-to-metal turntable bearings and is available from us). The marbles act as an extra rotating separation between the spindle and the bearing bus. And there are so many that there is no direct mechanical contact any more. The friction between the two surfaces is reduced to the surface friction of the oil only.

It is very important that the bearing's friction is stable and temperature independent.

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**155 Q:** What sounds better: a belt driven turntable or a silk string driven one ?

**A:** From the pure listening experience point of view, the silk string driven type. The silk drive string is made by many turns of silk cord around the motor pulley and the platter or platter table. Make a simple knot because any unevenness will cause a mechanical pulse with audible effects.

The belt driven type has one advantage: The seize is less humidity dependent but the internal friction is higher again and not overall constant. Also the rubber belt is more temperature dependent in its flexibility. So overall, just replace your rubber belt with a silk string made of many turns and only one simple knot.

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**156 Q:** Is there any sonic advantage in using a separate motor compared to the turntable with the "on-board" motor ?

**A:** Any turntable with a separate motor ("a non on-board") motor is always in a better sonic position: There's no direct coupling of the motor's mechanical noise to the platter along the otherwise common frame. With a separate motor the mechanically and magnetically induced hum influences are also less due to the bigger distance between the motor and the cartridge: the sound is always cleaner and therefore better.

The same story also applies to direct drive systems; Direct drive turntables also have their motor on board.

So a separate motor at some distance and even with an extra flywheel in between is always a better solution. And a silk string belt helps again to improve the reproduction quality. Keep in mind that the most simple knot is the best (see [155](#)).

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**157 Q:** I bought a used cartridge from my dealer who thinks that selling CDs will improve his business. The cantilever is not exactly in the centre of the body (looked from front). Does this affect the reproduction quality ?

**A:** As long as the cantilever is parallel to the body, the exact centre position is not so important. Many cartridges have this effect because the magnet is not always centrally positioned.

Especially regarding M.C. cartridges it is important that the cantilever is in the middle of the front pole's hole in the horizontal direction and at 1/4 of the hole's height in vertical direction.

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**158 Q:** Is there any possibility to induce mechanical damping by means of reducing the cartridge's electrical load

impedance ?

**A:** No, there is no feedback from electrical properties to mechanical properties. Only from mechanical to electrical. When you want to tune your cartridge mechanically it needs some mechanical work. This can be done by our company with the intermediate help of one of our representatives.

---

**159 Q:** What is the advantage of mechanical arm damping ?

**A:** As you will know, there is a cartridge/tone arm resonance frequency around 8 - 12 Hz (see [43](#) and [Appendix 2](#)). In cases where the amplitude is too high (a too high mechanical Q-factor), it causes problems with the tracking of the grooves of the record. What is left as possible tracking ability is getting too low (see [103](#)). Also with the RIAA reproduction curve (see [Appendix 1](#)), where at 20 Hz there is a bass boost of 20 dB, your amplifier and loudspeakers are running into problems.

So some treatment needs to be applied. An oil damped arm is an option.

The viscosity of the damping oil is a part of the story, also the quantity. The higher the viscosity figure in centistokes, the stronger the damping effect.

Also the paddle surface makes a difference. The bigger the surface, the stronger the damping.

But... keep in mind that any off-centre record also causes a serious problem in combination with your oil damper. The small cantilever has to pull the whole paddle through the damping oil because of the eccentric grooves: two times every revolution. This will cause serious damage to the suspension of your cartridge after a while...

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**160 Q:** Can I play my old 78s with a VDH type 1 or VDH type 2 stylus ?

**A:** Based on my own experience, the VDH type 2 stylus works well in many cases. And you are lucky when the VDH type 1 works even better. Playing 78s with a VDH stylus especially works well in cases where a steel stylus has really damaged the original groove. The original traces of the steel stylus mostly are located somewhat higher up in the groove. The VDH stylus shape bridges these traces and for the largest part touches the undamaged groove walls. So with the VDH type 1 or VDH type 2 in many cases you track a clean and virgin groove again.

Be aware of the fact that the bottom of the groove can be full with dirt and metal powder. So clean first and as good as you can (see [84](#)). This will improve the final result.

In worst case the bottom of the groove is not V-shaped with an angle of around 90 degrees but rounded. In that case there is the risk of so-called bottoming: The stylus runs over the bottom of the groove and that's not what you really like to listen to. Don't be afraid that this experiment would damage the shape of your stylus too soon.

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**161 Q:** My Irish grandfather told me that passive RIAA sounds better than active RIAA. What is the background of this statement ?

**A:** Active RIAA equalisation means that the related filter forms a part of the feedback circuit in your phono correction amplifier. The feedback type of RIAA correction filter by nature is prone to induce Transient Intermodulation Distortion (TIM) and changes the sound for (experienced) listeners. The active RIAA equalisation circuit is relative simple and is also cheap.

The passive RIAA equalisation circuit is built in-line as a series chain of filter sections between the input circuit and the line amplifier. The total signal gain is the same, but the effect on the replay sound quality is less because there is no TIM anymore. Also the sound is evaluated as being "faster".

Phono amplifiers with passive RIAA circuits do cost somewhat more because there are more components involved. They also cost more because they sound better - whatever the reason must be to charge more for better sound.

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**162 Q:** An old broadcast technician told me that I had to reverse the connections at my cartridge in one channel and also at the loudspeaker in the same channel. So e.g. in the left channel both the cartridge and the loudspeaker. He told that the sound should be better after both reversals have been implemented. How is this possible ?

**A:** The answer is very simple. Thanks to all kinds of signal leakage (crosstalk) inside your stereo amplifier, there are other sounds coming from your loudspeakers than you would expect considering the quality of your signal source (e.g. your cartridge).

By inverting the input to e.g. the left channel a kind of balancing effect inside the stereo amplifier is brought about; Both the two leaking (cross-talking) signals (from left towards right out of phase and from right towards left in phase) cancel out internally.

To correct the phase again you also need to reverse your left loudspeaker's connections, otherwise the final result will be

an out-of-phase sound from the left channel. (For some listeners this does not make any difference because their whole they are already listening out-of-phase...)

When you switch back to your CD player (just to compare with how good your analog system plays) don't forget to reverse your left loudspeaker's polarity again, otherwise the CD sound is out-of-phase or "OOP".

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**163 Q:** I have the obscure feeling that my record player's platter is out of balance. How can I test this ?

**A:** A very simple but not perfect test is to put your player in a non horizontal (i.e. tilted) position and draw a vertical line on the rim of the platter with a felt tip pen. Surround the platter's rim by a paper sheet circle (tape together some pieces of paper) and tape that to the player. Now repeat the following process a number of times:

1. Start the player and stop it after a while.
2. Then copy the position of the platter rim's vertical line to the paper circle where the platter has stopped rotating.
3. Then turn the platter 180 degrees by hand.
4. Go to 1

The result must be an even distribution of marker spots on the paper, thus indicating no preference for the platter to halt with its heavier side down. When not, you were right. So take a drill and take away a minor quantity of material from the platter's heavier side (\*) or (safer) is to adhere some chewing gum or an equivalent sticky material to the opposite side. To verify, perform the above test procedure again.

\*: Please note that when the platter is out of balance, the platter's heavy side of course never is where you marked its rim preceding the above test. The platter's heavy side is down if you rotate the platter such that its rim's vertical line is at the centre of the group of marked spots on the paper.

A simpler test method is to place the platter (with a fixed spindle) with its spindle on two really horizontally positioned rails. The platter should remain at in rest in any rotated position. If it rotates to a heavy side down position it's out of balance and you can add or remove material until you are satisfied.

Keep in mind that there is not always a problem with the platter but rather with the molded rubber mat...

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**164 Q:** With some records the rumble level is dramatically higher compared to other records. How can this happen because the turntable is always the same ?

**A:** Dear friend, your records are all different. Thanks to uneven stampers with a non-even rear surface this record manufacturing defect is passed on to you; This because the result of the pressing of the record is also uneven. This is especially the case with older records originating from the fifties and early sixties. The replay quality at that time was so limited that manufacturers didn't care so much about the other side of the stamper. But suddenly someone got awake and the rear side of all stampers was treated to take out the main reason for rumble: The uneven rear side of the stamper.

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**165 Q:** Do magnetic mounting screws have any effect on the replay quality ?

**A:** With a cartridge which has a delicate magnetic layout it for certain has an effect. The extra magnetic load on the cartridge will change the magnetic field modulator internally. To avoid any risk, it is better to use non-magnetic mounting screws (i.e. stainless steel or brass). Stay clear of aluminum screws to avoid a cold welding effect (also see [62](#) and [169](#)).

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**166 Q:** My dealer tries to sell me small stickers. They must be fixed on the cartridge body to "improve" the replay quality. Is he right ?

**A:** In a way he could be. It is not so much the magic effect of the sticker shape or material, but more the damping effect on the mechanical resonating body of your cartridge. In Germany, cartridges are even sometimes called "Tondose". So the Germans know by experience that a cartridge body makes its own "Ton" or sound. The right damper at the right spot will do some good work (also see [35](#)). But don't believe (at least not without serious explanation) the interaction of some magic material placed at an even more magic spot on your cartridge body.

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**167 Q:** I have several Japanese made cartridges and all have an extremely flat frequency response: a patent with all Japanese cartridges. But they all sound different. How is this possible ?

**A:** A flat frequency response is only a part of the story. Does this tell you anything about "speed", "attack" or "impulse



response" or even inform you about something like "tracking" or "crosstalk" and the distortion related to the "channel separation"? Nothing at all. So having a flat frequency response is knowing just one property and the rest is still guesswork. Not to talk about the cartridge body resonances and the relation between arm and cartridge (see [43](#)). And what is the influence of the room temperature on your cartridge's frequency response? (See [92](#)).

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**168 Q:** My boss gave me a ceramic headshell in a very expensive looking packing at the celebration of 25 years of hard labour in his factory. What can I expect from this gadget in my hi-fi system ?

**A:** Not very much, because ceramic headshells are always very heavy and impose a strong mechanical load on your cartridge.

So I am afraid that your boss gave you something he had as a leftover and didn't want to use anymore (probably had the same dramatic effect on his cartridge) and you got it. So smile and don't use it. This to avoid very low resonance frequency problems in your own hi-fi system. You can expect a basic resonance frequency of around 3 - 5 Hz. And that then really is a problem.

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**169 Q:** I have several cartridges with an aluminum body. My dealer told me that I should not use any aluminum screws to fix one of these cartridges in a headshell. But I am also told not to use any screws that can be magnetized. Why and what to do now ?

**A:** Aluminum screws have the unpleasant property to build up a so-called "cold weld". A cold weld is a mechanical connection between two metal parts based on molecular interaction. So-called surface bonding. When this happens your mounting screws are fixed for ever. The screw head may break off when you try to rotate the screw and that is the end of the story. So always use stainless steel or brass screws (i.e. non-magnetic screws).

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**170 Q:** I have several cartridges from a famous cartridge manufacturer. I bought them over a period of 12 years and they all have different type numbers. But, to my biggest surprise: They all sound the same. How is this possible ?

**A:** There are two possibilities:

1. Some cartridge manufacturers don't want to spend money on research & development. The only thing they do is change the cosmetics and the print of the type number. So every time you have bought the same motor in a different body.
  2. You have never upgraded your hi-fi system. So whatever the input quality, there is no improvement possible. The best you can do is to change speakers. Borrow some speakers you like from a friend. Speakers are very important for a good sound quality. Also your tone arm and phono stage are critical.
- 

**171 Q:** Do I need to change the oil in the bearing of my turntable ?

**A:** Each bearing wears in a way. So a change of oil after a good cleaning of all mechanical parts involved is an option. In my own turntable I change the bearing oil every 2 years.

Lately I use an oil doped with ceramic (zirconium oxide) marbles (1 micron diameter each). This means that there are always very small marbles between the rotating and stationary metal parts. So no metal-to-metal contact anymore. And that is what we need after all.

(This oil works for all non air-cushioned metal-to-metal turntable bearings and if requested is available from us).

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**172 Q:** Why do cartridges with a high channel separation (more than 35 dB at 1 kHz) also create a great spatial impression ?

**A:** Because high channel separation is the same as very low crosstalk. And that means that the level of the signals which leak from the right channel into the left channel and the other way around is very low. Especially when both the left-to-right and right-to-left crosstalk levels are the same (e.g. both at -35 dB at 1 kHz).

The content of the crosstalk signals is not music, but in many cases is distortion of an unpleasant order. This means that with high crosstalk levels there is a mix between e.g. the right channel's original signal (the violoncellos in an orchestra) and plenty of distortion from the left channel (the violins in an orchestra). Thanks to this extra distortion, the result is that the cellos sound harsh to very harsh and that the lower level spatial information is lost.

So: a high channel separation automatically produces a spacious and clean reproduction. Assuming that the rest of your

hi-fi system is able to do the same. Also amplifiers have crosstalk and the acoustics of your listening room greatly reduce the good channel separation of your cartridge. Only the pure, first information directly reaching your ears from the loudspeakers (direct sound) is of interest. The waves that secondly reach your ears are from the first acoustic reflections in your room and deteriorate the time information. And correct timing is correct space.

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**173 Q:** I live in Indonesia and I am used to play my records wet. Every time I have a problem with my cartridge; The cantilever falls off even though I am sure that the baby did not touch my turntable. How is this possible ?

**A:** Indonesia is a warm and humid country so the chemical activities in and around your cantilever are high. As long as you use cartridges with an aluminum cantilever the result is a fast corrosive decay of the cantilever tube wall. So there are two solutions:

1. Stop playing wet.
  2. Buy a cartridge with a boron cantilever. Or have your aluminum cantilever replaced by a boron one, as our company regularly does as a modification. Boron is a 100% inert material and it also produces a better pulse response.
- 

**174 Q:** I have a Swedish air bearing arm. That arm was for sale a while ago. And my cartridge is a Koetsu Onyx. To my biggest surprise the combination is not what I did expect. What to do ?

**A:** The air bearing arm you bought has a very different vertical damping compared to the horizontal damping. The vertical movement is easy and the horizontal is relatively difficult. This relates to the air bearing principle. So the vertical resonance amplitude is also different to the horizontal value. The vertical amplitude is for sure higher and reduces the ability to track the recorded music.

Also the rumble of some records triggers extra instability. And... the Koetsu Onyx has a stiff suspension (low compliance) and is heavy.

So, due to the weight of the cartridge, the cartridge/arm resonance frequency is too low, although the resonance is somewhat reduced in amplitude thanks to the stiff suspension. The best solution is to keep the arm and use a higher flexibility suspension (higher compliance) cartridge. And the other way around is also an option: Change the arm for a type with equal damping in the horizontal and vertical direction.

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**175 Q:** Together with my English made arm I unpacked two different counterweights. Why do manufacturers do this because I need only one ?

**A:** But you do not know which one. Normally, with the same cartridge, the best is to have the heavy weight positioned as close as you can to the bearing of your arm. This produces a lower moment of inertia compared to the use of the lighter counterweight placed more to the rear of the arm. The balance of the arm in both cases is correct but the moment of inertia (i.e. the rotational effective mass) with the lower weight version is higher. And that's what your cartridge doesn't like. It puts extra stress on the cartridge suspension, especially when you play non-centric or warped records.

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**176 Q:** At a hi-fi show in Frankfurt I saw someone demonstrating a record player's quality by knocking the side of the platter with a hammer. I was struck dumb with astonishment and surprise when I saw this. What do you think about such a disaster ?

**A:** I do the same at the Frankfurt show. The better the mechanical stability of the platter and the bearing, the less pulses are being able to be transmitted by the metal support of all parts and the better your turntable is. The more you hear from an external pulse, the lower also the internal damping of all parts involved. Likewise, with higher levels of internal mechano-acoustical energy generated by your cartridge/arm combination, the more coloration you can expect. An external pulse by e.g. a hammer being a rough substitute for the same effect. (A more cautious alternative is to listen to the resonances in and around a turntable by using a mechanic's stethoscope (see [44](#)).

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**177 Q:** I am a ballet dancer and I think that putting my turntable on spikes is the best. Do you have any comments on that ?

**A:** It is hopeful that you think like a ballet dancer.

About the spikes: Each object has its own modes of acoustical resonance, and due to the related standing waves the object's surface therefore has outspoken points where the amplitude and energy of vibration is maximum (antinodes) and

other points where the amplitude and energy of vibration is minimum (nodes). These spots are just there due to the mechanical layout of the turntable. Each turntable has its own specific spots (antinodes) with outspoken resonance frequencies and specific amplitudes. A part of the resonance energy at these spots comes from the record you track; Generated at the stylus-record interface and passed along the cartridge and arm, this acoustical energy runs around through the whole construction. And, as said, some spots are "hotter" than others.

Now about the spikes again. By placing spikes just under those energy spots, the vibration energy will "leak away" along the spikes and the damaging effect, i.e. the acoustical coloration, will be less: The replay quality is cleaner, your music will sound more natural.

But... where to put the spikes and how many?

With an engineering stethoscope, you can detect the critical spots (see [44](#)), otherwise by trial and error. And 3 - 4 spikes will do.

The supporting plate under the spikes must be a multilayer construction made of different materials having different speeds of sound propagation. This construction is able to absorb all (or at any rate a lot) of the acoustical energy running around in your turntable.

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**178 Q:** What tone arm material and/or construction is the best ?

**A:** After the cartridge, the arm is the next important item on a turntable. It is therefore important what material(s) and construction are applied. Any arm transmits the mechano-acoustical energy of the cartridge and is also a mechanical resonator itself. Both effects are unpleasant because both change the replay quality in their own specific way. So a tapered arm is a solution because this arm is mechanically less resonant compared to a straight tube. The material of the arm is also important: An arm made of just aluminum is more resonant compared to a multilayer or multi-material construction.

A resonant arm can be tamed by internal polyurethane foam. Do this only after you changed the internal wiring (see [37](#) and [96](#)) and not before...

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**179 Q:** When I play music, I also hear some sound coming directly from the record. Is this normal ?

**A:** When you drive a car, it makes noise. The car vibrates and all panels produce sound. Panel damping by means of a thick, sticky and flexible coating reduces the noise. But the road which you drive on also makes noise because mechanical energy is also transferred from your tires to the road. With a contact microphone connected to the asphalt you can also hear your car tires passing the microphone. The same goes for cartridges and records. The audio modulated record groove moves the stylus, the cantilever and the coil (in case we use an M.C. Cartridge). But where there's action there's also reaction: The groove is also being moved, this in the opposite direction compared to the stylus. So both parts make music. And the record is a rather big surface, so a small amplitude of movement still makes audible music.

Both moving parts are acoustical energy sources and, without measures taken, their vibrations can run around through the whole turntable, which mechanical parts' resonance modes can induce coloration. A separate arm board with arm is in general a better solution to separate both energy sources. A record clamp, or even better a vacuum system, helps to reduce the "record-music".

Also a brass ring over the rim of the record as is made by the German company "Acapella" is a good solution. It holds the record flat on the platter. Also fine for warped records.

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**180 Q:** What problems do I face when I want to build my own turntable ?

**A:** That's hard to predict because I have no idea about your sources. What you have to keep in mind is that the bearing is really important. And the second problem is the motor.

A good friend of me made his own turntable and the project already has taken 5 years. I assume that you buy your tone arm, otherwise the arm bearing is the next problem. Start with the bare turntable and for the time being use an arm you bought. After you are happy with the table, you still can think about your own arm.

The bearing can be the "regular" type or even an air bearing type. Also magnets will do fine.

So don't just take the regular route and try to find a different solution. That makes the design more interesting and the learning more pleasant. Keep especially in mind that acoustical energy runs everywhere and needs to be reduced in an early stage (please refer to the items in the subject index mentioned under "Turntables: Resonances: ..."). Especially acoustical energy that runs from arm to spindle is critical. And keep in mind that the motor ALWAYS must be decoupled from the rest (see [156](#)). A separate motor with a flywheel in between is a good start.

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**181 Q:** I made my own turntable with a rim driven Plexiglas platter. After a year the platter has a slight "eccentric" shape. What to do ?

**A:** It is common that Plexiglas “sets” itself after a while. Plexiglas “works”. So it’s better to have a rim driven metal sub-platter with smaller diameter. The 300 mm record platter on top and the turntable is fine. But in your case this is still a problem, so replace the Plexiglas by e.g. a brass platter with the same dimensions. The moment of inertia (i.e. the rotational effective mass) is higher and the replay therefore is more stable.

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**182 Q:** Over the years the VTA has changed from 15 degrees along 20 degrees to 22 degrees or even higher. What happened ?

**A:** The Vertical Tracking Angle (VTA) is the angle between the horizontal record and the connection line between the top of the stylus in the groove and the suspension point inside the cartridge at the other end of the cantilever.

When the groove in the lacquer has been cut at e.g. 15 degrees, it is necessary to also track at the same value: 15 degrees. Otherwise upon replay the shape of an at 15 degrees recorded (cut) sine wave as seen on an oscilloscope undergoes a forward or backward tilt and this generates extra harmonic distortion (also see [205](#)). But... you never read the correct VCA (Vertical Cutting Angle) on any record. So in many cases it’s pure guesswork.

Typical 15 degrees cartridges are e.g. the EMT series with all a “15” in the type number and the famous V15 series of Shure.

Later the 20 degrees units came out like the Dynavectors and the Ortofon 20 series. The advantages of a 20 degrees cartridge are the shorter cantilever and the bigger clearance between the cartridge and the record.

Having a shorter cantilever automatically means having a higher mechanical resonance frequency and a better pulse response. Also the crosstalk’s frequency response is more flat up to 20 kHz.

But the question is always: Is this a 15 degrees or a 20 degrees VCA record I’m having here?

Till around 1963 all records were 15 degrees VCA types. After 1970 practically all records were cut at 20 degrees and some Japanese record manufacturers even went up to 22 degrees or higher.

The advice is therefore to adjust the height of your tone arm and to listen for the most spacious reproduction possible (also see [112](#)). That is the criterion to which you have to tune.

What happens is that you listen to the most critical parameter by changing the VTA, this by changing the height of your tone arm support. It would be nice when you could restore your arm’s height to the same position when you play the same record again. Many tone arm manufacturers don’t care about this, but fortunately the English manufacturer SME is well known for their interest in VTA and arm adjustments.

When you have no idea how to manage this subject, always lift the arm somewhat at the rear. By doing so you already enlarge the VTA a little. In many cases this works fine and the sonic result is always better.

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**183 Q:** I have a cartridge with 4 screw holes. Why should I use all 4 to fix the cartridge in the headshell ?

**A:** Four screws act as 4 spikes so the cartridge body’s mechano-acoustical vibration energy is better transferred to the headshell. Don’t tighten them too strong: Just fixed is in all cases the best; Otherwise the thread is forced away and there is no fixing possible anymore. A cartridge is not a car.

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**184 Q:** I have a test record and in the explanation I read that when I track a specific section with my cartridge, I should see square waves on my scope. I can’t believe this because I don’t see how a cartridge can track square waves. I think that the stylus will flip away immediately and that my cantilever will twist double. Why did the manufacturer of this CBS test record make this serious mistake ?

**A:** Oops! Ten times my o my in one question.

Dear analog and American fellow. The story is somewhat different to what it looks like on first sight. A magnetic phono cartridge always produces an output signal which is linearly proportional to the modulation speed (the stylus’ perpendicular velocity), this in value and in direction; When the modulation speed is constant, the output voltage automatically is also constant.

When we look at the expected output, a square wave, it means that there are only two signal levels and (theoretically) nothing in between: the stable top level and the stable bottom level connected by vertical lines. So on the record we have to do with variations in direction but no variation in speed. The only shape that fits this description is a constant triangle. And that is a curve which your stylus can track without “flipping away on the double”, or what our Indian analog friends call “the douben”.

In practical life there are some minor problems involved; Like e.g. the oscillation at the resonance frequency of the suspension of the cutter. The cutter has to round sharp corners on the top and bottom edges of the triangle wave on the lacquer.

A sudden change of direction (at constant speed) creates a mechanical oscillation at the resonance frequency. This sine wave modulates the triangle. The result is not a sharp triangle but a somewhat unstable triangle look-a-like. When monitoring the output of your cartridge with an oscilloscope you’ll then see a sine-wave modulated square wave. I wish

you success with your scope observations.

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**185 Q:** I am the proud owner of a very expensive handmade tone arm. But all cartridges I own have a serious problem: Their mounting hole distance is always too big for my tone arm. I have written earnest warning letters to cartridge manufacturers and all tell me that their half-inch hole distance is correct. How to solve this problem ?

**A:** It is for sure your arm with a hole distance of around 1 mm less than the advised 12.7 mm. So all bolts get nuts when you mount a cartridge. Or what's even worse: you damage the mounting holes of your cartridges. To solve the problem don't drill into your cartridge, but make a sideward slot of the two holes in your arm and be a happy record player.

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**186 Q:** I bought my tone arm many years ago. In the meantime I can feel some space in the bearings by minimally rotating the arm. How can I reduce this bearing play ?

**A:** You can do two things:

1. Find the adjustment screws. Take away the sealing compound and tighten the two vertical and horizontal adjustment screws to a point where the arm still can move freely but without bearing play.  
When this is too much work or you are afraid to damage something, there is another less effective solution:
  2. Take some stiff bearing grease normally used for cars or even better: military tanks of the heaviest type and put this in the vertical and horizontal arm bearings. The minor negative effect of this solution is that the arm gets a natural damping you may not like so much. But it works too. Don't put bird sand in the arm. This won't change the play in the arm bearings.
- 

**187 Q:** Over the years I have collected around 5000 LPs of which I only listen to, maybe, about 200. What to do? Collect more or stop now ?

**A:** As long as you can buy records don't stop, because there are always records better than the ones you like among those 200.

Consider seriously to sell a 1500 from your total collection and use the money it brings you to buy again and select again what you really like. In the end you may have about a 500 or more and those will be your friends for ever. Good records will maintain their value. So when it is not for the playing, it is for the investment. But don't stop. Otherwise it is something like saying goodbye to (y)our hobby.

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**188 Q:** I got an arm from a good friend but the counterweight was missing. So I looked around and found one from another arm where the arm was missing. I have a problem now: The centre hole of the counterweight is somewhat too big for my arm. It fits but there is some free space between the arm-end and the centre hole. Does this free space affect the sound quality ?

**A:** Yes it does because the weight acts as a free mechanical resonator and will produce sound at its own resonance frequency. This sound will modulate the tracking of the cartridge and will produce "arm coloration". A counterweight must be fixed very well on the arm's end and must be as close as possible to the bearings to reduce the arm's moment of inertia (see [175](#)). So put some white Teflon tape around the arm's end to fill the free space.

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**189 Q:** I am the proud owner of a famous Scottish made turntable with a Scottish made tone arm on a Scottish made arm board. What can I do to upgrade my replay system ?

**A:** First a minor correction: Your turntable comes from Scotland and your arm from Japan. The arm is put on the arm board in Scotland.

Now the upgrades: I am sure that a change of the stiff arm cable can produce a cheap but good upgrade. A more flexible cable prevents mechanical coupling between the arm board and the rest of the system. When it could be a balanced cable with the shielding connected only at the phono pre-amplifier side, you will really make a big step forwards in quality (see [45](#) and [126](#)).

Another modification is to put damping material (see [197](#)) at the bottom of the arm board. The arm-board is suspended from the main construction to dampen "around going" energy: a good idea in itself. The extra damping at the bottom reduces the arm board resonances. The same material can be used on the inside of the platter. This also helps to clean

the sound.

All mentioned actions require a readjustment of the balance of the arm board and turntable suspension, because extra material enlarges the weight of the parts concerned. The readjustments serve to keep all parts in horizontal position. What always helps is to separate the turntable from its environment by putting the turntable on a thick marble plate, some valve springs underneath and then on another marble plate (also see [47](#)).

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**190 Q:** The sensitivity of my phono amplifier is not high enough to support my 70 microVolt output cartridge. Can I modify my cartridge to produce a higher output ?

**A:** No you can not, because the manufacturer already has used a very strong magnet to produce this 70 microVolt anyhow. The only solutions are to buy a step-up transformer from the same manufacturer to get more "steam" or to change your phono amplifier for another design with more gain (also see [21](#)).

The 70 microVolt comes from a cartridge with a mu-metal free armature with also a very limited number of coil turns. The idea behind mu-metal free armature material is that the modulation is not influenced by magnetic saturation and/or magnetic modulation defects. A vision which I share. But keep in mind that what you gain with the mu-metal free armature will be lost in the mu-metal core of the transformer.

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**191 Q:** By accident I broke one of the coil wires of the open cartridge of my brother who is actually abroad to marry a lady from the Philippines. I tried to solder this thin wire, but now I can't see anything which can be soldered anymore. And the cartridge also hums at the same channel. What to do in this depressing situation because my brother will kill me when he finds out.

**A:** You shouldn't have touched your brothers cartridge and should have shared the wedding in Manila. By trying to solder the 20 micron wire, it dissolved in the solder and disappeared. So there's nothing left to be connected. And where now one end is open, this channel hums because you killed the ground end of the coil. Send this cartridge as fast as you can to one of our representatives and I will repair it before your brother returns from his honeymoon. Promise me that next time he marries you'll stay away from his turntable.

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**192 Q:** I am planning to buy a new turntable. Which platter bearing is the best ?

**A:** For platter bearings there are several solutions:

1. The traditional metal-to-metal type with a very thin layer of oil as separation in between. For many brands this is it. Some brands are specialized in long shaft, others in a short shaft types. An advantage is mechanical stability. A disadvantage is the risk of transfer of vibrational energy from the arm back to the platter again. Vibrational energy is not stopped at the bearing's metal-to-metal boundary; It can pass and thus can be a serious cause of coloration.
  2. The same mechanical solution but with floating air between the two metal parts. A good idea because there is enough mechanical stability and beside that, at the air boundary there is a good damping of vibrational energy running between the platter and the rest of the turntable.
  3. The magnetic floating system. Mechanically more unstable but it has a great advantage: no direct coupled vibrational energy going around.
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**193 Q:** My German grand-uncle from Bavaria died and I got his turntable from his Irish widow. The parallel tracking tone arm is running on two rails with four very small bearings. Is this arm stable enough to work together with my Fidelity Research FR-1 Cartridge ?

**A:** This arm model is made with a main interest in very low friction at tracking records. So all moving parts are very light. There is, I assume, a vertical damping fluid well, but none for horizontal movements. Otherwise the horizontal movement of the arm wouldn't be free enough. So horizontal movements caused by the low frequency resonance of the arm with cartridge are not damped enough to prevent interference with the music modulations. In other words: The horizontal Q-factor is clearly bigger and therefore more critical compared to the vertical Q-factor.

And keep in mind that the FR-1 has a low compliance. In combination with a very light arm, the resonance frequency (see [Appendix 2](#)) will clearly be above 9 - 10 Hz. So some dominant bass will be the sonic result.

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**194 Q:** My four headshell wires are clamped in the eight connecting clips. I see that the internal silver conductor has turned dark after a year of use. Can I improve the quality of these connections ?

**A:** The fact that after one year the internal conductor got black means that you have unexpected sources of sulphur around.

The connection will improve by applying solder to the clamping sites. Solder each connector for a very short time with a limited quantity of solder, otherwise the insulation will melt away and your clips will be full of solder and won't fit anymore. Solder with the clips free; I.e. not attached to the connection pins of a cartridge, otherwise there's the risk that the cartridge's internal soldering points between its coil wires and its connection pins will melt and lose connection. In that case you have fixed one connection and lost the other in the same action.

---

**195 Q:** Why do M.C. cartridges from the same series sound different ?

**A:** This is caused by differences in tension of the suspension wire and differences in the suspension rubbers. Especially the suspension rubbers are critical. This has to do with the fact that there are not many suspension rubber manufacturers left. So cartridge manufacturers have to accept what is actually available.

Knowing this, a long time ago our company bought a serious stock of all kinds of damping rubbers. So replacement or original use is never a problem.

Another reason for differences in sound is the adjustment of the armature in the magnetic gap to evenly balance the crosstalk levels. This makes a big difference between the good sounding or harsh sounding of a cartridge, even of the same series.

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**196 Q:** What sounds better: a record mat made of felt or one made of rubber ?

**A:** Based on experience, the rubber mat sounds better because the contact between the record and the rubber is more intense. Vibrational energy is more easily transferred to the rubber.

With the felt, the contact is less tight and provides opportunities for local resonances and therefore colorations.

Keep in mind that the rubber mat must be clean and even (also see [85](#)) and must be in dense contact with the platter.

You can improve this contact by fixing the mat to the platter with bicycle tire repair (rubber) adhesive. Do this very careful and precisely, otherwise the result will be worse than the original situation.

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**197 Q:** My platter is ringing when I remove it for cleaning. What is the best method to dampen my platter ?

**A:** Run to the car DIY shop and buy some damping material which is normally used in cars to silence vibrating panels (mostly used for cheap French cars). Fix this underneath the platter and the problem is solved. And don't forget the inside rim.

When some damping material is left, think about application to other parts of the turntable, like the arm board (also see [189](#)), plinth and bottom plate. And when the whole turntable is decorated, use the rest for your car.

All mentioned actions require a readjustment of the balance of the arm board and turntable suspension, because extra material enlarges the weight of the parts concerned. The readjustments serve to keep all parts in horizontal position.

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**198 Q:** I have the feeling that my spindle is too wide because many records clamp firmly when I put them on the player and when I (try to) remove them. How to manage this problem ?

**A:** There are three options:

1. Reduce the diameter of the spindle by visiting a machine shop with enough experience, time and patience to clear the job.
  2. When there is no machine shop around, use sandpaper fixed to a piece of wood and let the turntable run for some hours.
  3. The problem can also be "smoothened" by regularly applying a thin layer of our "The SOLUTION" to the spindle. "The SOLUTION" is a contact protection and lubrication liquid from our accessories program.
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**199 Q:** Why do jazz records cost more compared to classical albums ?

**A:** In the past, records with classical music were very popular so many have been produced. Zoot Sims or Gerry Mulligan

were not regarded as top performers in their art so the quantity of records with their music is limited. The result: their art is a collectors item. Not many records are around so the price is higher.

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**200 Q:** Why do older LPs out of the sixties sound so good that even a Super Audio CD is not a good equivalent ?

**A:** In the sixties, all recording technology was pure analog. No black boxes with magic effects in between like phasers or digital delays.

The recording quality was purely based on the experience of the recording engineer. He had to work (hard) with his ears. And despite the fact that the replay quality was limited, with many recordings the sonic result was of a very high standard. The feedback between replay and recording was limited thanks to the lower quality of cartridges, electronics and especially the loudspeakers if no Quad electrostatic speakers were used in the control room. With the fabulous good Quad electrostatics, the final quality evaluation was much better. But not all recording engineers liked the Quads. It was also a good habit to use a limited number of microphones. The advantage was that, even with lower quality microphones compared to today, the final result was better. Especially the spatial result was better thanks to the natural acoustics. Today the digital delay box is very popular but progressively helps to kill natural acoustics.

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**201 Q:** Playing my LPs, I see my woofers constantly moving in and out with a big amplitude. How to extend the life span of my woofers because I think that sooner or later the cones will fly straight through my listening room ?

**A:** There are several reasons for this effect:

1. The bottom end of the frequency range of your phono amplifier is not limited to say 10 Hz, but runs deeper to e.g. 1 Hz or less. So here an internal modification is necessary to produce a stop at around 15 Hz. There is no music around 15 Hz and an extended frequency response only produces problems for the rest of the equipment. Here a subsonic/rumble filter is the correct message for your technician.
2. Your phono amplifier does not produce this 2 - 5 Hz by itself, but gets the signal from your cartridge/arm combination. So the first question here is: Is the cartridge/arm resonance frequency too low? Normally the value is around 10 Hz (see [Appendix 2](#)). When the cartridge has a too high compliance and/or the arm is too heavy (effective mass around 20 grams and more) then the resonance frequency drops from around 10 Hz (which is standard) to 5 Hz or less (also see [36](#)). So remove weight from your arm by e.g. taking a lower weight headshell or by removing weight as much as you can. You can also ask your friend if you can try his cartridge in your arm to see if the same happens again. Assuming that your friend has a different brand of cartridge.
3. What also helps to produce an unhealthy subsonic output is the uneven surface of your records. With uneven and/or unpolished stampers (see [164](#)), the vinyl pressing result is also uneven. When you still like to listen to such records, use your pre-amplifier's subsonic/rumble filter.
4. This effect can sometimes also be caused by a mechanical problem with the turntable itself. E.g. a belt driven platter with a sticky rim, or a damaged bearing, or an object under the platter making regular contact with other rotating parts.
5. Acoustic feedback (see [110](#)).

General and positive conclusion: Your electronics' low end frequency range anyhow is very good with enough extra power to kill the replay (again) of Bach's Toccata & Fugue...

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**202 Q:** When I switch on my phono amplifier, my power amplifier automatically switches off. And they are also of different brands. What's going wrong ?

**A:** Your last remark is not the clue of this sad story.

First switch on your phono amplifier and then some seconds later your power amplifier. Problem solved. And always leave your phono amplifier on. Problem solved for ever.

When you don't want your phono amplifier to be kept switched on all the time, set the volume control of your pre-amplifier to zero before you switch the phono amplifier on or off.

The reason for this shut down effect is that your power amplifier is DC surge protected. Any DC on its input is a trigger to give up. Here the DC surge comes from your phono amplifier which somewhere has a big capacitor (generally in its output circuitry) which is charged at the switch-on moment. The current this takes, and the DC that produces across the input resistance of the next stage - together with enough amplification in between - is enough to trigger your power amplifier's DC protection.

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**203 Q:** I got a big stock of LPs from my father who was a fanatic record collector when he was young. When I play



them, the sound comes only out of the centre between the 2 loudspeakers. They don't seem to play well. What great acoustic mystery is going on here ?

**A:** Both your loudspeakers play back the same signal, so there is no difference in frequency, amplitude or time delay. The result is that the sound comes from a virtual source between your loudspeakers. This effect happens only when you play MONO records.

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**204 Q:** How do you fix a diamond on the cantilever in the retipping service of your company ?

**A:** A diamond tip is always fixed on a cantilever, and the type and/or material of the cantilever is crucial in this process. So the first check is: Is there still a cantilever and what is the quality. Most cantilevers are made of aluminum. This metal has a low specific weight (helpful) but is chemically not stable (not helpful). Especially a thin walled tubular aluminum cantilever loses its strength over several years by external chemical activity and by metal fatigue as a consequence of all the records you played. In many cases the cantilever must be replaced. For this job our company uses solid boron with a diameter of around 280 micron.

And now your question:

At the end of the 5.5 - 6.5 mm long solid boron cantilever is a very small plane. On this plane (the extra grinding job is already done) there is enough surface to make a bond with the stylus (VDH type 1). A special made bonding glue is used for this purpose.

Alignment of the tip on the boron is always a crucial factor for the final sonic result. So great care is given to this part of the job. But it is also possible to cut a slot in the end of the boron cantilever and fix the nude diamond bar in this slot. Again with some extra glue because boron for sure is not a flexible material with a firm grip on the polished diamond. By experience I prefer the bonding because slotted boron is extremely brittle and snaps off very easily at any unwanted accident.

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**205 Q:** When I connect my phono amplifier to my oscilloscope and play my test records, I never see a sine wave at frequencies above 5 kHz. I always see distortion and the sine wave is tilted backwards or forwards. Despite these effects, I still like to listen to my records which I got from my Irish grandmother who loved her home-made brew. Can you tell me what causes this visible distortion ?

**A:** Your sine wave is not free from distortion due to several effects:

Like, e.g. the difference between the vertical cutting angle at which the test record was cut and the vertical tracking angle at which you play. As a result of this difference in angle, the sine wave's shape as seen on an oscilloscope undergoes a slight and quite difficult discernible forward or backward tilt (also see [182](#)).

Another portion is harmonic distortion created by your stylus mainly due to tracking problems; I.e. the stylus' movement differs from the groove's movement. This distortion is superimposed on your sine wave and changes the curve form. Also the crosstalk signal from the other channel helps to change the curve of the sine wave. And the reflected energy from your resonating arm also helps to change the wave shape. Also, even the RIAA circuit in your phono amplifier can be a part of this story. And last but not least also the cutter: If its suspension did have its own resonance frequency, this signal is also superimposed on the test record's 5 kHz signal which you try to track clean and pure...

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# Appendix 1: The RIAA Reproduction Curve:

Filter Time Constants:  $t_1 = 75 \mu\text{S}$

$t_2 = 318 \mu\text{S}$

$t_3 = 3180 \mu\text{S}$

## Additional filter time constants:

In 1976 the IEC introduced an additional time constant intended to reduce subsonic frequencies (rumble) upon replay. The corresponding frequency response is known as the RIAA/IEC Reproduction Curve.

IEC additional filter time constant:  $t_{iec} = 7950 \mu\text{S}$

Normally the RIAA cutting curve (the inverse of the reproduction curve) would increasingly boost frequencies above 20 kHz without a theoretical limit. (At 200 kHz, for instance, the signal would be boosted about 100 times).

To avoid record cutting problems at ultrasonic frequencies, the manufacturer Neumann introduced an extra high frequency time constant in their cutting amplifiers which stops this boost above 50 kHz.

Neumann additional filter time constant:  $t_{neu} = 3.18 \mu\text{S}$

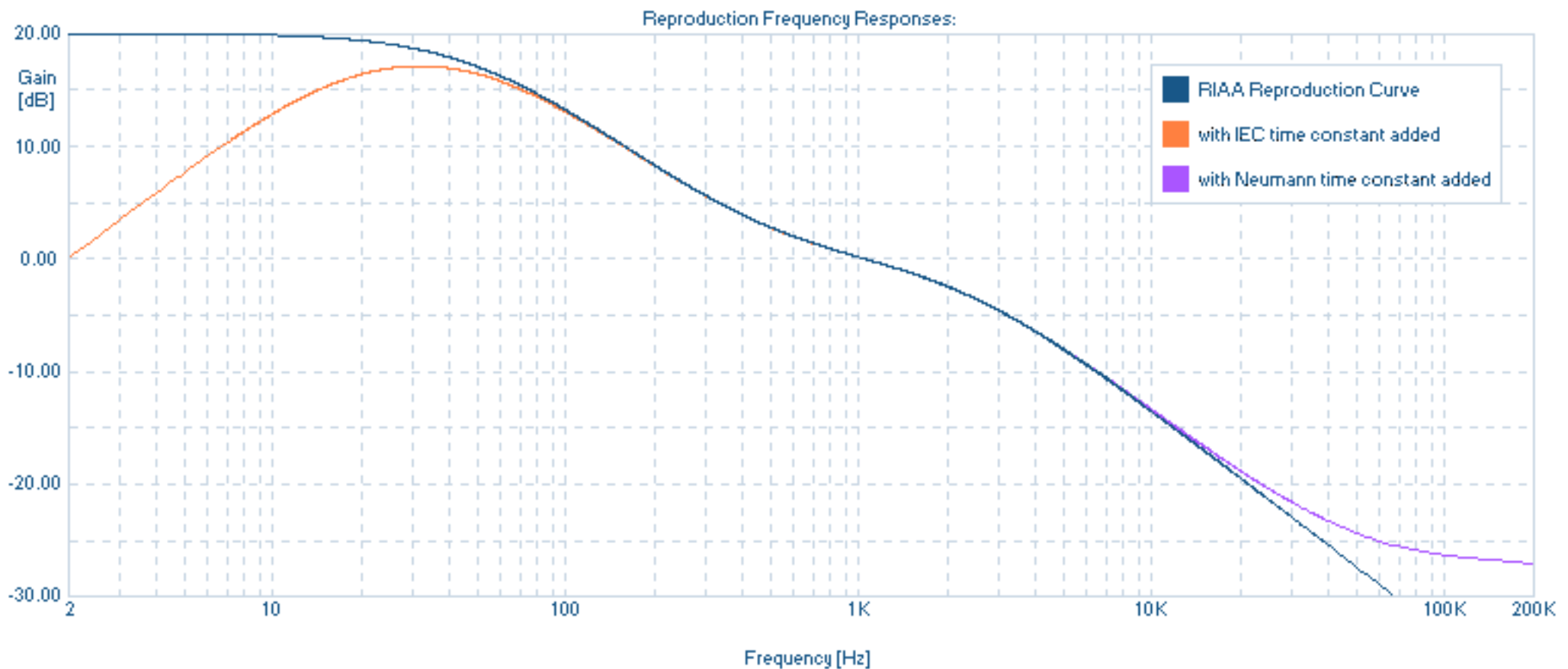
Although the original RIAA curve is still the most widely used, some advanced phono pre-amplifier designs take these additional time constants into account and offer the option to activate either or both of them. (I.e. additional time constants of  $3.18 \mu\text{S}$  and/or  $7950 \mu\text{S}$  are selectable).

## Reproduction Frequency Responses [in dB]:

### Formula:

$$FR_{\text{replay}}(f) := 10 \cdot \log \left[ \underbrace{\frac{1}{1 + (2 \cdot \pi \cdot f \cdot \tau_1)^2} \cdot \frac{1 + (2 \cdot \pi \cdot f \cdot \tau_2)^2}{(2 \cdot \pi \cdot f \cdot \tau_2)^2} \cdot \frac{(2 \cdot \pi \cdot f \cdot \tau_3)^2}{1 + (2 \cdot \pi \cdot f \cdot \tau_3)^2}}_{\text{Standard RIAA reproduction curve}} \right] + 10 \cdot \log \left[ \underbrace{\frac{(2 \cdot \pi \cdot f \cdot \tau_{iec})^2}{1 + (2 \cdot \pi \cdot f \cdot \tau_{iec})^2}}_{\text{Additional section for IEC time constant}} \right] + 10 \cdot \log \left[ \underbrace{1 + (2 \cdot \pi \cdot f \cdot \tau_{neu})^2}_{\text{Additional section for Neumann time constant}} \right]$$

### Graphs:



**Table:**

Freq. [Hz]	RIAA [dB]	IEC [dB]	RIAA+Neu [dB]	IEC+Neu [dB]
5	19.957	7.645	19.957	7.645
10	19.832	12.835	19.832	12.835
20	19.363	16.349	19.363	16.349
50	17.035	16.389	17.035	16.389
100	13.177	13.007	13.177	13.007
200	8.308	8.265	8.309	8.265
500	2.737	2.730	2.737	2.730
1000	0.089	0.087	0.091	0.089
2000	-2.500	-2.500	-2.493	-2.493
5000	-8.121	-8.121	-8.078	-8.078
10000	-13.645	-13.645	-13.475	-13.475
20000	-19.531	-19.531	-18.888	-18.888
50000	-27.452	-27.452	-24.446	-24.446

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## Appendix 2: The Optimal Cartridge/Arm System Resonance Frequency:

In matching a cartridge to a tone arm (or vice versa), it is desirable to achieve a cartridge/arm system resonance frequency between 8 and 12 Hz.

If the system resonance frequency is too low, it can be excited by record warps. If it is too high, it may become excited by low frequencies in the record groove. Either of these conditions will cause distortion and possibly mistracking.

It is therefore necessary to select a cartridge with the proper mass and compliance matching your arm (or to select an arm with the proper effective mass matching your cartridge) to maintain a cartridge/arm system resonance frequency within the range of 8 to 12 Hz; 10 Hz being optimal.

**Formula:** The expected system resonance frequency can be calculated by using the following formula:

$$F_{\text{resonance}} := \frac{1000}{2 \cdot \pi \cdot \sqrt{C \cdot M_{\text{tot}}}}$$

Where:  $F_{\text{resonance}}$  = Cartridge/arm system resonance frequency in Hertz

$\pi$  = 3.14159265359...

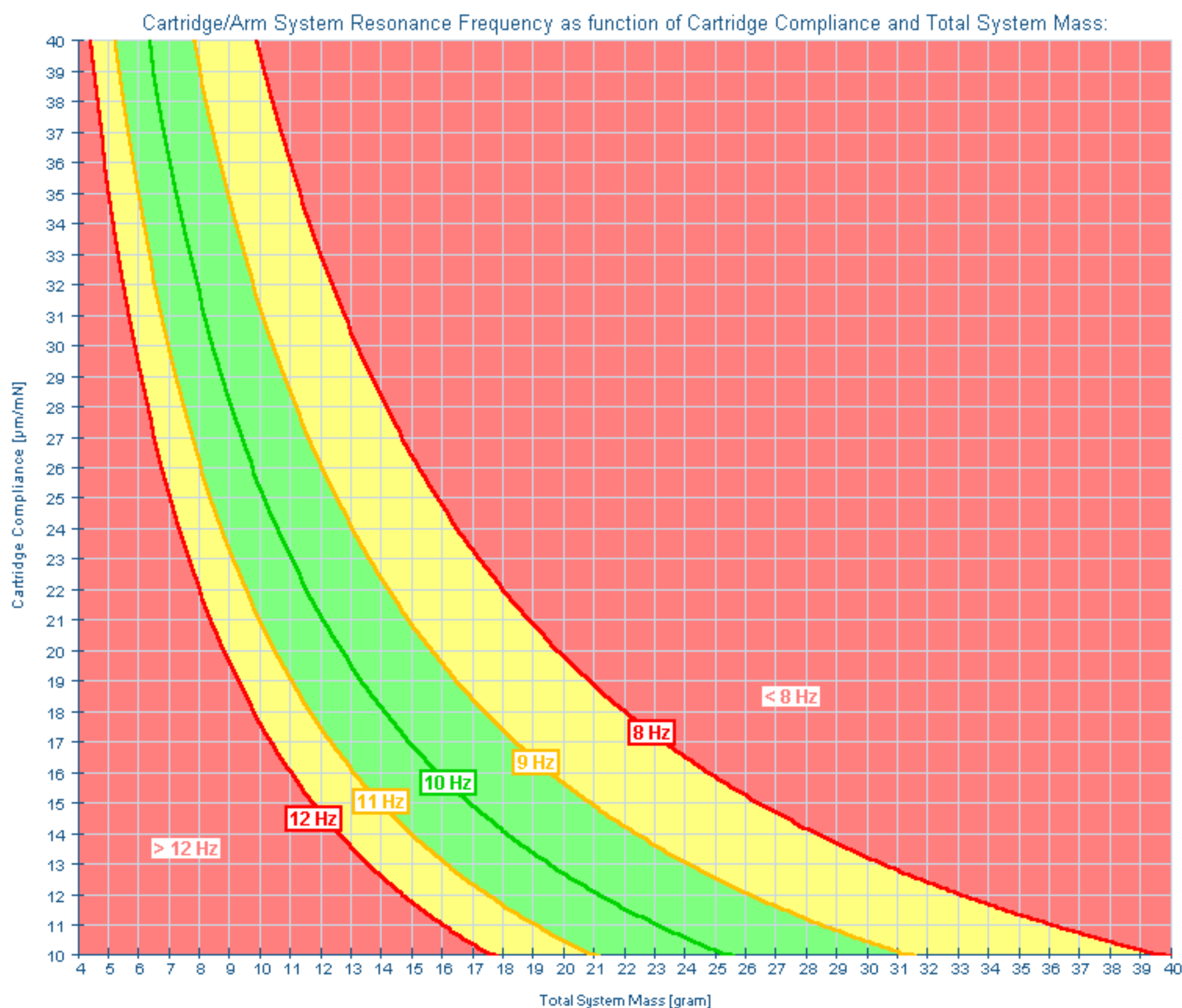
$C$  = Cartridge compliance in micrometer per milliNewton

$M_{\text{tot}}$  = Total system mass =  $M_c + M_h + M_a$  where:  $M_c$  = Mass of cartridge in gram

$M_h$  = Mass of headshell and screws in gram

$M_a$  = Effective mass of tone arm in gram

**Graph:** The following graph provides a practical overview:



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