

A Treatise on Tapes

We know that we have many Diamond Cut users who are restoring tapes. A good number of our customers have cassettes they recorded during the 70s and 80s and our forensics users frequently end up with either cassettes or microcassettes. Diamond Cut is great for cleaning up these recordings, but you should not wait if you have them. Tape does not get better with age. One of these days your old tapes will degrade to the point where they will either break or the coating will flake off. Best to make a high resolution (24 bit 96khz) master now and keep this master.

There are two big issues with consumer analog cassette tape formats. One is the azimuth alignment of your playback head, and second is an audio phenomenon called Wow and Flutter.

By the way, we aren't really going to discuss 8 Track tapes here. If you have some and can play them - just do the best you can. These things have a host of other problems that make them difficult to work with.

Kicking your own Azimuth

The first problem with your cassettes is one of head alignment - the most common type being referred to as Azimuth misalignment. You see, when you write audio to a standard stereo cassette, you are recording two tracks on 40% of the 1/8th inch width of the tape. This 40% of the tape is side one. Another 40% of the tape width is side two. If you music is stereo, you are putting two separate recordings in that tiny 40% space. The remaining 20% is called a Guard Band. Your recorder should not be recording in the guard band.

The tape heads should also be perfectly vertical to the direction of travel of the tape. If your heads are even slightly off in the vertical orientation, you will record magnetic patterns on the tape in a somewhat "tilted" manner - this is an incorrect azimuth setting for your record head. Now when you go back to play the tape, everything will be fine if you play it back on a machine with the same "tilt" to the head.

But most of our 1970s tapes are being played on machines whose playback heads do not match the record heads that we used 30 years ago. We probably don't have the original record machine anymore, and even if we did, it's probably changed its head alignment now so that it no longer matches the tapes.

If you play back your 30-year-old cassettes on a different player and you have an Azimuth misalignment, you'll lose high frequencies. Remember, we want to take off everything that is on the tape, so an Azimuth adjustment is in order.

The easy way to adjust your Azimuth is simply to set your current cassette machine to exactly the same Azimuth error that you had in your recording machine 30 years ago. This sounds hard, but it's not. Just find the Azimuth adjustment screw in the machine.

It'll be near the playback head and it'll likely have a spring beneath the head of the screw. The spring applies pressure so the screw doesn't move all by itself.

Once you find the adjustment screw, mark it so you can return it to its present position. Now put on a pair of headphones and play your tape.

Adjust the screw for maximum high frequencies in the audio. You can do this by listening. You can also use Diamond Cut to do this by playing the tape in Live mode with a high pass filter set near the top of the frequencies on the tape. For music recordings, a setting of about 8khz is pretty good, but you can perhaps go higher. Just look at the playback meters in Diamond Cut and adjust the screw for maximum volume.

That's it. You've now adjusted the playback head on your modern playback deck to the same error that your old record deck had. You're now pulling more information off the tape. This is a good thing!

Don't forget to return the Azimuth screw to its original position when you are done.

The second problem with playing tapes is wow and flutter. This is simply the tendency of the tape to speed up and slow down constantly - usually around 3-6 times per second for Wow and more often for flutter. There are two main reasons for this problem. One is that the motor in your machine is not perfect. Its speed will vary. The second reason for wow and flutter is the combination of the little rubber round part and the metal shaft that the tape is squeezed between when it is playing. The metal shaft is called the Capstan and the rubber wheel is called the Pinch Roller.

If either of these items is not PERFECTLY round, you will cause your tape to speed up and slow down with each revolution. With the Capstan, it'll do it very often and with the Pinch roller it'll do it less often. This is wow and flutter.

You can actually hear WOW and flutter on bad machines - especially in the high frequencies. It'll sound like an annoying tremolo effect.

But the biggest effect is on frequency domain filters such as are using in Diamond Cut. If the continuous noise filter finds a tone of, say, 1191Hz and needs to remove it, the filter will try to do just that. However, due to wow and flutter the actual tone will be changing in pitch all the time as the tape speeds up and slows down. This results in a frequency problem called Sidebands where our main frequency has "ghosts" on each side of it. So our 1191Hz tone is removed only here and there. In order to completely remove it, we have to make the filter remove frequencies above and below our target frequency. This leads to over filtering and artifacts.

To make matters worse, your original tapes you recorded in 1977 already have wow and flutter effects on them that appeared when they were recorded. We can't fix this. BUT, when we play back the tape on a different player, the wow and flutter of that player also interacts with the wow and flutter that occurred when the tape was recorded. The result

is a spectral fog that makes it hard for our filters to find and lock onto offending frequencies.

About the only thing you can do to reduce wow and flutter is to get a newer or better cassette unit or have your unit refurbished at a repair shop. Keeping the Capstan and Pinch Roller is clean is a given, of course. If you are into tapes, this is a good thing to do! It'll make for better restorations and better CDs.

Want an Out of the World Tape Machine?

These problems of Wow and Flutter and Azimuth correction has lead to the creation of some amazing tape machines. Making a tape play at a pretty constant speed might and having the heads in the right spot might sound like a simple engineering problem, but it's not.

Nakamichi made some super nice cassette units in the 1970s and 80s which may still be the best consumer full size cassette units around. These did things like use a computer to find and adjust the right Azimuth for a tape.

In the forensic world, JBR Technologies, makes a super high end cassette and micro cassette unit which are available today. These units use a precision made timing wheel with tiny slits in it to measure speed and continually adjust. These units are totally amazing and certainly the micro cassette unit is the best such unit that has ever been in existence. These are not cheap at about \$4500 for the micro cassette units and \$7900 for the full size unit (which has 9 heads by the way!), but if you are a pro in this area, you should consider them. We are a dealer for these units, so feel free to call us with your questions. Any forensic audio expert or audiophile, who only wants the best, should give us a buzz at 886-260-6376.