Technical Information and Tips on Torq's Vinyl Control System

by Chad Carrier

When you first experience the thrill of controlling an MP3 file with external vinyl, some of you may feel that it is nothing short of magic. In some ways, this is almost the truth because the system employed in Torq is very complex and subject to numerous variables, all of which can have an impact on its performance. This document will outline, in basic terms, the vinyl tracking system and its workings. Thorough knowledge of this information will help you get better performance from the system and also aid when troubleshooting issues.

Introduction to Vinyl Tracking

Before starting, we must state that tracking vinyl is no small task, especially when the only mechanism available is a standard tonearm equipped with a standard stylus. There are many more mechanisms for reading the rotation of an object that would yield better results but, as DJs, this is what we're forced to use. This creates some unique problems that have been solved by various companies in a number of similarly unique ways, all with varying levels of reliability and accuracy.

We'll start now by explaining what kinds of information we need in order to make an MP3 (or similar digital audio file) playback under the control of vinyl. There are three things the computer needs to know: The *speed* of the record, its *direction* of rotation, and the *position* of the stylus on the record. The speed will tell the computer how fast to play the audio file. The direction will determine if the file is played forwards or backwards. The position will set the playback location within the file. With all three of these parameters being communicated to the computer at a high enough rate, the results are astounding. The audio file will react as if it's pressed directly on the record. So how can a computer determine these three values by dragging a stylus across some wax? The answer is: sound.

How It Works

Each of Torq's Control Vinyl records are imprinted with special audio signals that the computer can listen to in order to determine the speed, direction, and position of playback. In the case of Torq's tracking system, the audio signal is comprised of two parts: the *pilot tone* and the *position stamps.* These two audio signals exist simultaneously on the record, but in different frequency bands so they can be analyzed independently of one another.

Torq uses the pilot tone to determine two of the three values: speed and direction. The pilot tone itself is actually very simple: it is a sine wave at a fixed frequency that plays throughout the entire duration of the record. If you've ever played with a record before, you'll know that changing the speed of the record causes the pitch (key) of the music to change. For example, if you slow a record down, the pitch of the music will drop. Conversely, if you speed up a record, the music will rise in pitch. Torq uses this phenomenon to calculate playback speed by listening to the pitch of the pilot tone. If the pitch drops, that means that the record has been slowed down—Torq then slows down the playback of the audio file by the same amount. If the pitch goes up, that means the record is spinning faster and Torq increases the playback rate of the music. If Torq hears the pilot tone at its original pitch, it means the record is playing at its normal speed (33 1/3 RPM), thus Torq plays the song at its original speed.

By listening to the pitch of the pilot tone, Torq can determine speed. But how does it determine direction? The answer is *stereo phase-shift.* Records are stereo devices and can encode two channels of audio (left and right). The pilot tone is printed onto the record with the left and right channels 90-degrees out-of-phase. When the record plays

forward, the right channel will be 90-degrees ahead of the left channel. When the record plays backwards, the right channel will be 90-degrees behind the left channel. Torq evaluates this phase relationship to determine direction of playback.

The pilot tone mechanism explained above allows the computer to generate a **Velocity** value. The velocity is both speed and direction expressed as one number. When the Velocity is 1.000, the record is spinning forward at normal speed. When the Velocity is -1.000, the record is spinning backwards at normal speed. If the Velocity is 0.500, the record is spinning forward but at half its normal speed. If the Velocity is 0.000, the record is stopped. Torq displays the Velocity value for each Deck in the External Control Preferences.

The last piece of information needed to properly emulate vinyl control is **Position.** While you can do scratching just using the Velocity value, you won't be able to perform needle drops or prevent "sticker drift" without using the Position information. Position is one of the most difficult pieces of the vinyl control puzzle and is also the mechanism that differs most from one vinyl control system to the next. Torq employs a system of *position stamps* in order to determine playback location on a record.

The position stamps are digital numbers encoded as analog audio signals which are placed on the record at regular intervals. In the case of the Torq Control Vinyl, there are about 155 stamps for each revolution of the record. As the stylus passes over a position stamp, Torq can decode it to determine location. Furthermore, the decoding can occur if the record is playing forwards or backwards.

The Position value is not determined only by the position stamps. Instead, Torq uses the position stamps and Velocity together to determine Position. The reason for this is that the position stamps are "coarse". That is, they only occur at periodic intervals across the record instead of being continuous, and there is a certain amount of "empty space" between each stamp. How can Torq determine position if the needle is between two position stamps? The answer is *interpolation.* Torq can track Velocity between two stamps (thanks to the continuous pilot tone). Therefore, if Torq reads a little bit of movement after passing over a position stamp, the actual Position will be a value between that position stamp and the next. This final value is displayed as Position on Torq's External Control Preferences.

So there you have it: a continuous phase-shifted pilot tone for determining Velocity and thousands of tiny position stamps for determining Position. In theory, this all sounds great, doesn't it? In practice, things are a little more difficult. There are a number of factors that fight this system's reliability including stylus quality, cleanliness, audio isolation, ground hums, and wiring.

Wreckin' the Records

As explained above, Torq is paying meticulous attention to the audio signals being received from the turntable. A slight variation in pitch represents a change in the speed of the record. The difference between left and right channels helps determine direction and position. If any of these systems are compromised, the tracking system will start to degrade (or completely fail). Sometimes these issues are hard to track down because, during normal usage of Control Vinyl, you're not listening to the sounds from the vinyl—you're listening to the output of the computer. There could be all sorts of noise being picked up by the turntable that doesn't make it to the speakers. The tips below should help you identify the source of such problems as well as identify solutions.

Dust and Dirt

Dust and dirt is the number one cause of vinyl tracking failure. The main reason for this is that the digital DJ uses the same records over and over again throughout the entire performance. This differs from traditional DJing where the record is changed for every

song. While a traditional DJ might play 50 records one time each during his set, a digital DJ will play the same control record 50 times. Since the same records stay on the turntables for the entire set, this greatly increases the record's exposure to dirt, dust, and other nasty elements which will quickly build up over time. Even worse, since the same records are used for each performance, many DJs never remove their vinyl from the turntables, leaving them out to collect dust all day and night. That dust and dirt will collect within the grooves of the record compromising the control signals. Dust and dirt will also collect on the stylus itself, usually looking like a grey ball of dust on the end of the needle. This ball will limit the movement of the stylus which, in turn, distorts the control signals.

The obvious solution to this problem is to remain diligent with your cleaning efforts. Clean the records and styli at the beginning of your set and continue to do so throughout the duration. This is extremely important in club environments where dust from smoke machines, cigarettes, dusty ventilation systems, and more can collect extremely fast. This is compounded by the fact that sweat and oils from the DJ's fingers help glue the dust and dirt to the surface of the vinyl. Get into a routine of checking for dust every 5-10 songs. Using products like Discwasher and Gruv Glide will help keep the surface of the vinyl nice and clean.

Cue Burn

The second most common reason for tracking failure is cue burn. Cue burn occurs on all records and is caused by repeatedly dragging the stylus over the same surface of the record over and over again. As the DJ works the record back and forth getting ready to drop it into the mix, the friction built up between the vinyl and stylus increases and turns into heat. This heat, along with the abrasive nature of dragging a sharp point across vinyl, starts to physically distort and destroy the grooves on the record. Once they're destroyed, Torq will no longer be able to track accurately over that section of the record.

There are a number of techniques you can use to help limit cue burn on the control records. The first is tracking force of the stylus. Many DJs will put a lot of weight on their styli, either by adjusting the counterweight on the tonearm or by placing additional weight on the headshell, to help keep the needle from skipping across the record during vigorous scratching. While this may help prevent skipping in some cases, the extra weight makes the stylus dig into the vinyl with even greater force, thus increasing friction and heat, which leads to cue burn. It is recommended that you do not set the weight of the needle any higher than recommended by the stylus manufacturer. Setting the proper weight will increase the life of the vinyl.

Another technique that can be used by digital DJs is Relative tracking mode in the software. When using Relative mode, Torq ignores the position of the needle on the record. When you load up a new track onto a Deck, you can place the needle anywhere on the record and the music will start from the beginning once you start the record. By putting the needle in a different place, it keeps you from burning the same area of the record over and over again, thus extending life.

Lastly, in Torq 1.5, there is a new Lead-In preference that offsets the start of the music relative to the start of the control vinyl. If you've burned the beginning of the vinyl, increment the Lead-In by one. This will add a rotation to the record before music starts. Once the new area is burned, increment the Lead-In again. Each increment will make the music start further into the record.

Ground Hum

One factor that can inhibit the functionality of the vinyl tracking is a *ground loop*. A ground loop manifests itself as a low hum or buzz in the audio system, a noise that never stops no matter if the record is playing or not. As explained earlier, Torq listens to the pitch of the pilot tone to determine speed and direction. Torq can become confused if there is a ground hum mixed in with the pilot signal. Torq might "lock" to the ground hum

instead of the pilot tone causing the playback speed to be incorrect. It could also contaminate the position stamps making them impossible to read (position stamps are scattered throughout the audio spectrum). If you listen to the record directly (such as by clicking the Line In button in Torq), you should be able to hear if a ground loop is present. If so, you'll need to change the wiring of your system, possibly plugging the turntable(s) into different power outlets or by changing the location of the turntables. Once the ground hum is gone, tracking will be improved.

Stereo Separation
The vinyl tracking system relies on two channels of audio signals (left and right) played back from the control vinyl. Torq will judge the phase-offset and other aspects of the signals to determine direction and position. If the left and right channels are not separate when they enter the computer, Torq will not be able to perform any phase-offset calculations and the system will fail. There are two main causes of poor stereo separation: wiring and stylus. The first problem will occur if there is a short or other problem with the wiring/connections of the turntable to the computer. If there is a short in the turntable that causes left and right channels to mix together (even partially), Torq won't work properly. Similarly, if the stylus/cartridge is worn to the point where signals on the left are bleeding through into the right (or vice versa), the vinyl control system will also fail. This problem can be difficult to diagnose—a turntable test record is recommended. The test record will play sounds isolated to one channel or the other. If you hear the sound out of both channels when it should be out of only one, then you've got a stereo separation problem. Try a new stylus/cartridge. If that doesn't fix the problem, have the turntable checked by a professional.

Poor Frequency Response
Torq's position stamps are scattered throughout the audio frequency spectrum. Some digits will be in the low (bass) frequencies while others will be in the high (treble) frequencies. In order for Torq to read all the digits in a position stamp, you will need a stylus/cartridge that outputs this wide spectrum of audio frequencies. If you have a worn-out needle, the high-frequency signals might not be reproduced properly, thus making it difficult for Torq to read the position stamps. If you find that scratching works but needle drops don't, you may have a worn needle.

Audio Isolation
As with the ground loop issue above, any other audio signals infecting the vinyl control signals will cause problems. This can happen if the turntable is not physically isolated from the room. A great example of this is when a turntable is set up close to a subwoofer. The vibrations of the subwoofer will travel through the floor, up the stand that is holding the turntable, through the base of the turntable up to the platter, then into the needle. These bass frequencies can confuse Torq, causing Torq to "lock" to the erroneous bass instead of the proper pilot tone. When this happens, you'll frequently hear playback problems when the bass is heavy (this might sound like a fast "warbling" of pitch coinciding with the bass). Phonographs are very delicate devices and care needs to be taken to ensure no unnecessary noise is making its way into the control signals.

Wiring
Torq is listening to phase-relationships in the left and right channels of the control signals. If you have the turntable hooked up backwards (such that the left channel plays into the computer's right channel), the vinyl control system won't work properly. The most obvious consequence of wiring backwards is that the music will play backwards while the record is spinning forwards. If this happens, swap your left and right connections.

Signal Levels
Earlier, we discussed the phenomenon where slowing down playback of a record causes the pitch to drop. In addition to this, slowing the record will also cause the overall volume to drop. The slower the record, the quieter the signals. If you are using Torq in a noisy environment or with a needle that has very low output, Torq may loose the ability to hear

the control signals when the record is moved slowly. Try using a stylus/cartridge with very high signal output. Otherwise, you will have to lower the Power Threshold in Torq's External Control Preferences. If you lower the value too much, the music will never stop moving even if you stop the control vinyl (it will move just a little as Torq responds to almost any sound that is picked up by the turntable). If the value is set too high, Torq will stop playback before the turntable has come to a complete stop.

Pitch Phenomenon
We mentioned earlier that Torq determines playback rate by listening to the pitch of the pilot tone. When the record slows, the pitch of the pilot tone drops. Well, it turns out that the pitch of the position stamps is also affected: they drop when the record slows down and they rise when the record speeds up. This poses two problems:

When the record is moved slower, the pilot tone and position stamps will occupy an area at the low end of the frequency spectrum…a portion which is usually infected by some amount of ground hum or other mechanical noise. This makes tracking become more difficult as the record slows. Often, as a consequence, you'll find that you can still scratch at slow speeds but you will not be able to perform needle drops.

Conversely, when the record is moved very quickly, this forces the pilot tone and the position stamps to rise in pitch…possibly beyond the range where the stylus can reproduce them properly. If this occurs, the signals heard by Torq could be distorted and tracking will not perform correctly.

As a result, the pilot tone and position stamps are placed within a narrow frequency band, thus allowing these signals to be read as best as possible when the record is moving slow or fast. This is also the reason for ensuring that there are no ground hums, mechanical noise, or bass being picked up by the turntable as these frequencies will mask the control signals at low velocities.

Best Practices

Aside from the troubleshooting tips above, there are a few other things you can adopt as common practice to make sure your DJ sets go off without a hitch:

Always Carry Extra Control Vinyl
DJs typically take more music to a gig than they would ever play—they do this so that they are prepared for any eventuality that could arise. That same logic suggests that you should take multiple copies of control vinyl with you to the gig so you are similarly prepared for any event that could damage the records. It's wise to start the gig with at least two copies of the control vinyl per turntable.

Use Both Sides of the Control Vinyl
While the control signals are technically different on the two sides of the Control Vinyl, Torq will treat them the same. Therefore, try to use both sides of the record to help distribute wear by flipping them over every other song.

Keep Your Hands Clean
As mentioned earlier, the sweat and oils on your fingers will attract dust and dirt to the record's surface. This isn't as noticeable a problem when changing records every song like a traditional DJ, but when using the same records over and over again all night, the problem pronounces itself much more quickly. This is aggravated even more if you're continually drinking from dirty bar glasses and bottles or snacking on foods. A clean towel and wet wipes are good to use regularly so you're not inadvertently transferring junk to your records.

Our Lady Pinky

The Vinyl and CD Control System used in Torq is developed by Baby Talk FX, LLC and is covered by US Patent 7,273,980. Baby Talk FX, LLC has been bringing you digital vinyl realness since 2003 and would like to remind you that "It may not be the real thing, but at least you're playing with vinyl." Enjoy!