White Paper

The C Wave patent: making digital audio better for human health and the listening experience

By Mark Levinson, founder, Daniel Hertz

Measurements and audio

Audio performance is defined in part by measurements such as frequency response, THD (Total Harmonic Distortion), and signal to noise ratio. Even though many music lovers know that there is a big difference between pure analog audio and PCM digital audio, no one until now has been able to measure why, in spite of all the advanced audio measuring equipment available.

DH C Wave patent shows why. It's not an audio problem. It's the difference between the way the human brain responds to the continuous waveform of pure analog vs the non-continuous waveform of PCM digital audio. Tests with advanced computer-based health diagnostic equipment consistently and repeatably detect negative effects of PCM processed audio on human physiology. These tests show that C Wave not only eliminates these negative effects, but makes listening to PCM processed recordings of music beneficial for human health.

What do the measurements mean? The measurements show a virtually instantaneous stress response in the brain when listening to PCM digital audio. What's the problem with a stress response? Stress stops emotion and lowers the immune system, both of which are serious problems.

What is C Wave?

C Wave stands for Continuous Wave. C Wave is a finely tuned reverb algorithm that fills in the spaces of the non-continuous PCM digital audio sampled waveform using original music information. With C Wave, the human brain responds like to a continuous waveform. C Wave is subtle and inaudible to many people. It changes the way you feel, not just what you hear.

Since PCM digital audio was introduced in the 1970's, listeners have complained that the sound was "cold", "electronic", not warm like pure analog, or "analytical". With pure analog, music lovers say they can get lost in the music, but it's not the same with PCM digital audio because stress stops emotion. Another effect of stress is that it lowers the immune system which is what keeps us healthy, and causes deterioration of human response. Lowering the immune system is not desirable.

What does the C Wave patent mean? It means because virtually all audio today is PCM digital, there is an opportunity to improve all audio – music, film sound, mobile phone sound, internet, musical instrument amplifier sound, live performance sound, and so forth. While the only C Wave enabled device right now is the DH Maria amplifier, the technology can by implemented by the Daniel Hertz Mighty Cat chip which has the internal architecture to run C Wave; by software; and by porting.

Objective versus subjective

Objective testing is essential to understanding the problems and solving them, and is the basis of the C Wave patent. But subjective responses are equally as important. Mark Levinson asked some

top mastering engineers to collaborate on fine tuning the C Wave on a subjective basis. Quotes from engineers Tim Gennert, CA USA, and Bert van der Wolf are included at the end of this paper.

History of audio testing and the development of C Wave

Audio tests were developed as part of the industrial revolution in which electricity was a key element. Tesla combined frequency (cycles per second), voltage and current (Amperes) to create electricity as found today in buildings in all countries around the world. Every electrical fuse has a specification like 220V/50Hz/2A. This term contains the names of three pioneers in electrical science – Volt, Hertz, and Ampere – which is why the term is spelled with a capital letter.

When people began making loudspeakers and amplifiers, there was a need to define performance. The frequency response test was developed to measure the ability of a speaker or amplifier to reproduce sound in relation to human hearing. It was determined that the lowest frequency a human could hear was 20Hz, and the highest was 20kHz. Frequency response in the audio band was developed to measure the accuracy of a speaker or amplifier in decibels. In the old days of audio, response from 20Hz to 20kHz within +/- 3dB was considered flat. Today's best audio laboratory measurement systems can measure 0.1dB increments.

When two pieces of audio equipment with similar frequency response sounded different, one from the other, additional measurements were developed including harmonic distortion, total harmonic distortion (THD), intermodulation distortion (IM), and so forth.

When Sony introduced PCM digital audio in the 1970's, their claim was that it was perfect. People sold or gave away substantial record collections, and studios threw out original analog master tapes by the box. Nonetheless, many music lovers had their doubts and preferred the sound of pure analog LP's. The LP, which was pronounced "dead" in the 1980's, is now back, and many music lovers either prefer to listen to pure analog LP's or refuse to listen to anything else. But no one could say or measure why this was.

In the 1974, when I made the world's first high end audio component, the LNP-2 Preamplifier, one of my customers was a medical doctor, psychiatrist and therapist who developed extremely profound music therapy. One day he called me and asked if I could visit him. He showed me an LP and said he had used it for many years in his therapy with positive results, but when he bought a new copy, it produced reverse results and was hurtful to people. We found that the only difference was it was "digitally mastered." The same effect was produced by DAT, CD, and every PCM digital audio format in the years that followed. That produced the awareness that the digital audio problem was physiological in nature.

Eventually, I found out about Avatar, an advanced computer-based health diagnostic software that makes predictive measurements based on Electro-Acupuncture Voltage testing. Avatar correlates with blood tests, MRI's and other standard tests. Avatar is silent, non-invasive, and produces consistent, repeatable measurements and computer printouts. We found that Avatar was able to accurately and consistently detect the presence of PCM processing in a recording 100% of the time. It also confirmed that with C Wave processing, the negative effects of PCM were eliminated. In fact, test subjects tested better listening to C Wave processed music than to no music at all.

To sum up, listening to PCM digital audio made test subjects measure worse than listening to no music at all; but C Wave processed music made them measure better than with no music at all, and enormously better than with normal PCM digital music.

Other tests included subjective tests, where people were asked to listen to normal PCM recordings, and to the same recordings with C Wave processing. Over a course of 10 years, virtually everyone preferred C Wave processed recordings. Daniel Hertz began selling Master Class software (for Mac) in 2014 which includes A+ and EQ. A+ is a consumer version of C Wave that is designed to enhance many recordings along with subtle EQ to improve the tonal balance and make it more natural. No one returned Master Class and users reported great satisfaction with the resuls, even with only A+ and no EQ applied.

When the Daniel Hertz Maria production started in 2023, we got similar reports from those who purchased one, using a variety of source units and speakers. We saw only positive responses with no negatives.

It's important to understand that human ears can only hear analog information. We cannot hear PCM digital audio, only PCM processed audio, in the analog domain. Avatar testing consistently and repeatably identifies if a recording has been PCM processed. For example, an LP which has been PCM processed can be identified as such. The same for a DSD recording. C Wave eliminates the effects of PCM digital audio processing although we only hear analog audio.

Note: pure DSD tends to test like pure analog. However, as there are almost no DSD workstations, what's marketed as DSD is usually PCM processed audio converted to DSD, and has the same problems as all PCM processed audio.

The US Patent Office approved accepted our C Wave patent based on objective measurements. But the reason for the acceptance of C Wave is simple – it helps people enjoy listening to music more. This confirms what my mentor Dick Burwen taught me: audio is 50% science and 50% ear. You need both. Dick, now 96, is the man who inspired C Wave processing, and has been my mentor since I was a 26 year old jazz musician who could barely change a battery.

Dick, one of the 4 founders of Analog Devices semiconductor company, is the designer of the original LNP-2 Preamplifier circuitry, the Cello Audio Palette block diagram, as well as the inspiration for C Wave and all of my work in audio. From him comes the foundation of solid engineering and good measurements, as well as the human ear.

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Quotes:

Tim Gennert (mastering engineer and record producer, CA USA)

Tim compared a C Wave processed MP3 version of a recording he made, with the original 24/176kHz version as part of his help with the C Wave fine tuning process. Tim knows the recording very well as he is the composer (the piece is called Mass Effect):

““Wow, very nice. It puts back detail without any harshness. I compared it to the high res (24/176kHz) version and not quite as much detail, but nearly so. Now how do you manage that with an MP3? I am impressed. This is a good sample piece since there is a lot of fine detail. I am looking forward to hearing the samples you sent. I will do so in the next day or so. One of my theories is that space in the sound is one of the things that signals the brain that the sound is authentic and thus creates a more connected listening experience. Your process is creating more space so I can hear how it does as you say. This is something I am always striving to accomplish in every step. Great work!”

Bert van der Wolf (Turtle Records, Holland), recording engineer, record producer, and industry authority in high resolution digital recording:

Hello Mark,

Thanks for sending me the “processed” 96/24 files of my TSoT production.

Firstly I’d like to explain my procedure and end with questions.

1. My 30+ years of experience with testing digital audio innovations and permutations, due to my consulting jobs for dCS(UK), have urged me to be rather careful in what, when and how I listen to the different propositions.

The ear/brain and overall perception seems to be easily fooled by several psychoacoustic aspects, which are in itself dependent on fright-flight phenomena, and can trigger premature conclusions that do not hold up over time.

This is why I always try to setup a situation where there is a high probability to surprise myself, or by accident discover things that do actually matter. So I decided to listen to your files completely out of the blue with no comparison to anything other than my memory from countless shows and demonstrations where I used these tracks on different speaker systems. I did a roadshow for dCS actually during their anniversary celebrations and discovered many new aspects in my recordings that indeed surprised me and this gradually developed into a learning experience which told me that no truth exists. The whim of the day and even the company of individuals can shift awareness and perception. It is the interface that creates the reality of the moment and what works now can turn into a problem any moment under different circumstances. In spite of this, I do feel confident that I know my work and can quite thoroughly determine, with any given interface, if what I tried to bring across with my recording technique comes back to live in the playback to a certain degree.

2. So, I dragged the files in the time-line of my Merging Technologies workstation in the studio, playing it through my state of the art monitoring, properly clocked and with superb DAC technology and what I found is that **I really enjoyed what I heard/perceived!** This was beside any mental involvement other than “feeling”. I felt like listening more/longer and even wondered wether it actually sounded this good before… You might say, there you go, prove off your point, but I did not even think about that conclusion for a bit, as I knew that it had been a while that I heard the tracks and to be honest, this was the first time in 96/24. I only know them from the original (352,8kS/s-24bit). Out of pure nostalgia I certainly enjoyed listening to this encounter with my past!

3. I left it like that and pondered about the thoughts I had over it for a few days.

This morning I was at Harry's and we discussed what we experience with the files that you processed, both for him and for me. He as well likes it, as does Michael, his companion at Rhapsody.

We do wonder what is going on however as there is an aspect to it that seems hard to describe consistently.

4. Today I decided to listen to my work as I did send it to you. 96/24 FLACs, so as if "the original". This again struck me as rather enjoyable, but as the sun set is always less exciting the 2nd day of holiday, it struck me as a bit less attractive compared to your version. It was hard to describe, but it seemed as if I was back at "home", watching the sun-set on the best high resolution screen one possibly could imagine, but not for real. All is there, but something seems less engaging. What could it be?

5. Now, the curious technician in me took the pragmatic approach and let loose all the tools in the professional studio on board to compare the tracks. Going back and forth gives the simple effect of a "transportation" of the mind to "another" place. As if my whole studio is picked up from where it is and put down in a slightly larger space around it. Funny enough an effect that manifests on all the (very) different tracks in the set. As if the acoustics in my studio were enhanced slightly and less neutral, the way I know it. A kind of a "room-correction"…In a sense less boring, probably as I know it so well that it is less exciting every day I encounter it (I am only human)…

There is an added sensation of depth and reverb that I would associate with an added IR of a specific kind. As if the door to the kitchen is opened and the reflection of the music traveling back and forth to it mixes with the frontal presentation, making it slightly more smooth and spacious.