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All Buttons In: An Investigation Into The Use Of The 1176 FET Compressor In Popular Music Production

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1. Introduction

The Urei/Universal Audio 1176 is one of the most revered and popular compressors used in music production (Senior 2009). Bill Putnam introduced the design in 1966 and at the time it was the first peak limiter based on all transistor circuit (Universal Audio 2009). Many engineers attribute its famous sound to the FET and fast time constants and despite being through many revisions it is still a studio staple today.

This paper aims to investigate why the 1176 is so widely used in production and will attempt to define its particular sonic signature. Due to the nature of popular music production and its under researched status in academia, information will primarily be gathered from textbooks and interviews given by contemporary music producers. From this information the author will attempt to ascertain how producers use the 1176 and undertake a series of subjective listening tests to verify their views.

2. Hardware Compressor Types And Characteristics

Tube (valve) compressors are more typically know as Vari-Mu. Unlike some designs, which simply have a valve in the circuit, a Vari-Mu compressor uses the valve for gain control. As pointed out by Case (2007) a circuit is sent to a valve by the level detection unit to alter its gain, which results in compression of the audio signal. Vari-Mu compressors do not have a ratio control and increasing amounts of gain reduction are achieved with louder levels (Izhaki 2008). Due to the use of a valve for gain reduction, Vari-Mu compressors are not as fast as the transistor-based units. This can make them a suitable choice for drum busses and full mixes when preservation of transients is desirable. The classic Fairchild 660/670, Altec 436 and modern Manley Variable Mu are all examples of compressors that use valves for gain reduction.

Optical compressors (more commonly known as Opto) use a light and a light sensitive resistor to alter gain (Case 2007). A bulb, illuminated by the level detection circuit, shines on a photo-resistant material to control the amount of gain change. As noted by Izhaki (2008) despite the fact that light is used, Opto compressors are slow to respond to rapidly changing musical dynamics making them a poor choice if quick clamping on transients is required. The classic UA LA-2A and modern Tube Tech CL-1B are examples of popular Opto compressors.

VCA Compressors are arguably the most common design. These compressors use a transistor based voltage-controlled amplifier. When using a VCA in a compressors circuit the control voltage is derived from the input signal and any gain reduction is related to this level. In simple terms, more level, more voltage more gain reduction. VCA compressors are considered to be the most transparent of the hardware-based designs. As Paul White states “In very general terms, a well-designed VCA compressor will provide the most transparent gain reduction, which is ideal for controlling levels without changing the character too much” (White 2003). Examples of VCA compressors include the dbx 160, the SSL console compressors and the Neve

Portico 5043.

FET Compressors use a Field Effect Transistor. Like the VCA, FET compressors can achieve very fast attack and release times. FET compressors also tend to colour the signal somewhat due to the FETs non-linear transfer function (White 2000). The 1176 and the Empirical Labs Distressor are both examples of FET compressors.

2.1 The Design Of The 1176 And FET Compression

As noted in the current Universal Audio 1176 manual, the 1176 was designed by Bill Putnam in 1966 (2009). The manual goes on to claim that the original "was a major breakthrough in limiter technology-the first true peak limiter with all transistor circuitry offering superior performance and a signature sound." Rudolph (2001) states that the original 1176 came into existence after Putman had managed to design a remote controlled amplifier from the then new Field Effects Transistor (FET). He was able to find a way to use a FET as a voltage-controlled variable resistor and it was implemented as the gain-controlling element of the 1176 (Robjohns 2001). The current 1176 manual points out that the FET "acts like a resistor whose resistance is controlled by the voltage applied to its gate. The higher the voltage applied to the gate, the smaller the resistance drain source will be" Universal Audio (2009).

It is also worth noting that the 1176 is a feedback compressor. This type of design sees the control side chain "fed from the output end of the signal path." (Brice 1998) A feed-forward compressor on the other hand has the input to the side chain taken from the input end of the signal path. In the case of the 1176 the audio is sent through the FET and then a side chain signal is sent to the detector unit, which in turn sends the control voltage back into the FET. Consequently the feed-forward design can react a little quicker than the feedback. The Neve Portico 5043 is one of the few compressors that allows the user to switch between feedback and feed-forward signal flow. The manual for the 5043 claims that the feedback setting "produces a sweeter, warmer sound but is not as accurate if you need to protect a transmitter, for example" (Neve 2011). However in real terms any delay introduced by the feed-forward design will be almost imperceptible and the actual gain reduction element will play a much larger part in how fast the compressor can react. It is also worth noting that by virtue of the feedback design some of the audio being compressed will have already attenuated. Could the sweet warm sound be attributed to this behavior?

Due to the FET one major part of the 1176s sound is its ability to very quickly apply gain reduction. The current manual states that attack times are between 200-800 microseconds. Similarly the release times can also be very fast, ranging between 50 milliseconds and 1.1 seconds. As a comparison the Neve Portico 5043's quickest attack and release times are 20ms and 100ms (Neve 2011).

Although the 1176 is often noted as having a fixed threshold, from analysis of a transfer function diagram (shown here in Fig. 1) from an out of print Urei 1176 manual the author noted that the threshold changes depending on the ratio. The current manual confirms this observation, stating, "The 1176 has been designed so that selecting higher ratios also raises the threshold level." Looking at Fig. 1 you can see that the knee also appears to change. At higher ratio/thresholds the knee is harder which is obviously useful for controlling peaks while lower ratio/thresholds have a softer knee for more subtle gain reduction. Shanks clarifies this observation in an edition of the Universal Audio Webzine when he notes that "The 4:1 and 8:1 ratios are commonly used for compression, 12:1 and 20:1 are used for peak limiting" (Shanks 2003).

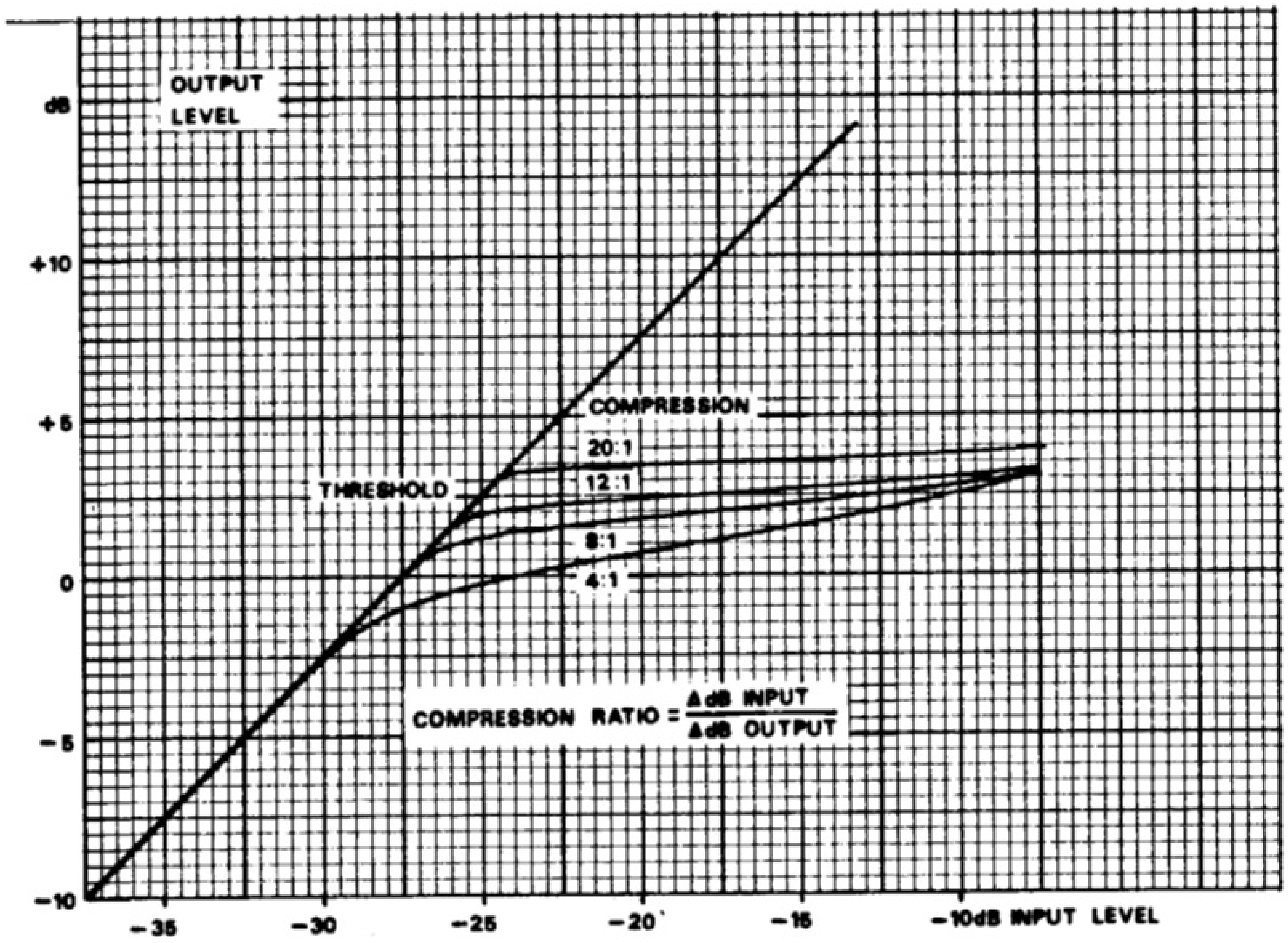

Fig. 1 Urei 1176LN Transfer Characteristics courtesy of Urei 1989

The “program dependent” nature of the 1176 is also worthy of consideration. According to an article in the 2003 edition of the

Universal Audio Webzine entitled "All Buttons Mode" the attack, release and ratio are all source dependent. Shanks points out that:

The 1176 will faithfully compress or limit at the selected ratio for transients, but the ratio will always increase a bit after the transient. To what degree is once again material dependent. This is true for any of the 1176's ratio settings, and is part of the 1176's sound (Shanks 2003).

From this quote it can be deduced that part of the 1176's punchy sound is due to how it compresses the attack portion of the transient lighter than the rest of the volume envelope. This program dependent nature of the device may also be one of the reasons it is often listed by producers and engineers as a compressor that can be used on practically any source with good results-more on this in chapter 3.1

It should be pointed out that the 1176 has been through a series of revisions since it was first designed by Putnam in 1966. The following is a concise list of the versions and how they differ.

- Model A was the first 1176 released in 1967
- Model AB, also released in 1967 was an update that changed resistor values to reduce noise
- Revision B (1968) had some revisions to the preamplifier
- Revision C (1970) was the first of the blackface editions and introduced the 1176LN (low noise) circuit by Brad Plunkett
- Revision D (1973) featured a redesigned PCB (printed circuit board)
- Revisions E-H (1973 onwards) made a number of changes including a different transformer and output amplifier
- Current UA 1176s are claimed to be a faithful reissue of Revision D/E

As with most musical equipment there is much debate between engineers concerning which revision is the best. Without having access to all of the above it is impossible to say and any observations would only ever be subjective at best. Due to financial constraints and availability the current UA reissue is tested in this paper. It would be interesting to compare the results with the same tests through other revisions.

2.2 When To Use Compression?

From analysis of interviews with producers and engineers it quickly becomes apparent that a significant number of them are ardent users of compression. Joe Chiccarelli candidly claims, "Using compression is like this drug that you can't get enough of. You squish things, and it feels great and it sounds exciting" (Owsinski 2006 pg.60). John X simply states, "I use it a lot. Not always in great amounts, but I tend to try to get some handle on peaks" while Ed Seay notes that "To me, the key to compression is that it makes the instrument sound like its being turned up, not being turned down" (Owsinski 2006 pg.59).

Before a discussion regarding how producers and engineers use compression, it is first worth clarifying the more general and obvious reasons for its use. Huber and Runstein (2010) note a variety of technical motives that includes minimizing extreme changes in dynamics that are too great for the music, to reducing obvious changes in source to mic distance during a take. Case (2007) also adds that compression can be used to "improve intelligibility and articulation" while Izahki (2008) lists containing levels, balancing levels and loudening as three core applications.

However, many producers and engineers use compression as a creative tool. Both Case (2007) and Izahki (2008) discuss the use of compression to change the amplitude envelope of a sound. For example, a snare or bass drum transient can be pronounced by using a long attack and a short release to let the initial attack portion of the hit through before the compressor clamps down on the decay. Stavrou points out that if the attack is slow "its as if the sick is much thicker" (Stavrou 2003 pg. 121). The same tactic can be used on bass guitar parts, a slower attack time can let the plectrum attack through uncompressed with the compressor again pulling down the decay of the note therefore changing the envelope. Alternatively fast attack and release times, coupled with a high ratio and low threshold (for maximum gain reduction) can make parts of the sound that were not audible much more apparent. As Case says:

Through fast release compression, the engineer effectively turns up the later parts of the sound, revealing more of the decay of the snare, the expressive breaths between words of the vocal, the ambience of the room between drum hits, the delicate detail of the sax note and so on (Case 2007 pg. 147)

From research it seems engineers often use the 1176 to heavily compress drum busses and room mics, bringing out the ambience between drum hits. As noted by Adam and Ward (2011) this technique is referred to as "All-Buttons-In" or "Nuke Mode." The current Universal Audio manual claims when all the ratio buttons are depressed at once the 1176 has a ratio that "goes to somewhere between 12:1 and 20:1" (Universal Audio 2009). Shanks claims that attack and release times change with there being a "lag time on initial transients" and from his description the compression curve is anything but gentle, he likens it to a "plateau" (Shanks 2003). It can be presumed that in this mode the 1176 turns into something that almost resembles a brick wall limiter that responds uncharacteristically slow to transients.

Distortion artifacts can also be deliberately introduced to the signal by using extremely fast attack and release settings. Izahki (2008) claims that low-frequencies distortion occurs when "the period of low frequencies is long enough for the compressor to act within each cycle rather than on the overall dynamic envelope of the signal." This issue is also discussed by Case (2007) who notes that when attack and release times are faster "than a fraction of the period of the sine wave, the compressor will attenuate during the peak (positive or negative) and uncompress in between the peaks." Obviously this is something to take into consideration, as it could indeed be a problem. However this artefact can and has been used as a creative effect in music production and the ultra fast time constraints of the 1176 should in principle make it a good tool for this job. In a 2003 edition of the Universal Audio Webzine Crane calls this "The 1176 Comp-Distortion Trick" and goes onto describe in detail how it can be used to "give a male or female rock vocal an in-your-face sound that you can't get anywhere else" (Crane 2003). Obviously the later part of his comment is perhaps marketing jargon but the additional harmonics created by this deliberate distortion theoretically could make a vocal appear more up front in a mix.

3. What Do Recording Engineers Say About The 1176?

From research carried out on interviews given by well-known producers and engineers the 1176 appeared to perform well under a number of circumstances. However from the authors' observations the most common applications seemed to be on vocals, bass guitars and drum buses/room mics.

Vocals

Whilst discussing the mix of My Chemical Romance's 'Welcome to the Black Parade' Chris Lord-Alge comments that all vocals were treated with a 'Blueface' (Rev A-B) using 4:1 ratio and a quick release. Tom Elmhirst used a Blackface 1176 in conjunction with a Fairchild as part of the vocal chain for Amy Winehouse's 'Rehab.' Elmhirst states in an interview that the 1176 had been "set with a very fast attack and a super-fast release, doing perhaps 10dB of compression" (Tinegan 2007). Mike Shipley when asked what compressors do you like for vocals simply replied "The good old LA-2A and 1176s" (Droney 1999). In another interview printed in the current 1176 manual, Shipley points out that he sets the attack and release depending on the song but adds he uses a faster attack if he wants more "bite" (Universal Audio 2009). An interesting "preset" that appears occasionally in discussions is the "Dr Pepper" setting. Charlie Clouser in an interview for the March 2004 edition of the Universal Audio Webzine states, that the setting has "attack at 10 o'clock, release at 2 o'clock, and 4:1 ratio with tons of input level on the 1176" resulting "in a thickly compressed vocal with tons of texture." He notes the well-known engineer Jim Scott suggested this setting (Vdovin 2004).

Bass

In an article that surveyed a number of engineers and producers the 1176 'topped the polls.' Senior says:

That the Urei 1176 convincingly topped the polls for bass processing in my survey of producers might raise an eyebrow, given what I've said about it thus far. After all, fast compression can introduce serious distortion on slow-moving bass waveforms. However, as long as the time constants are kept away from the fastest settings (in other words, somewhat counter-intuitively, away from the higher-numbered, clockwise end of the control settings on the unit), the circuitry's tonal brightening and subtle FET distortion really help the bass to cut through the mix in a way that other designs can't match. The lowest ratio (4:1) is the most common choice, as evidenced by independent recommendations from Steve Churchyard, Chris Lord-Alge and Ralph Sutton, although Tom Elmhirst likes the result you get when you push in the 4:1 and 8:1 buttons together (Senior 2009).

It is interesting that Senior notes the 1176 seems like an unusual choice given the possibility of low frequencies distortion. However he does point out that using slower release times will resolve this issue.

Owsinski notes that bass tracks with little note definition can be improved by using an 1176 with an 8:1 ratio, a good amount of gain reduction and "attack set to around noon and the release set to around 3 or 4 o'clock" (Owsinski 2006). These settings yield a long attack and a short release, which is presumably to alter the envelope of the note to increase articulation.

Drums

Hugh Padgham states in a 2005 interview that he used a pair of 1176s on two room mics which provided 90% of the drum sound for Phil Collins "In The Air Tonight" (Flans 2005). Adam and Ward (2011) suggest using the 1176 with 'All Buttons In' on drum submixes to add a sense of urgency to the kit. Similarly Jay Newland also likes to build his drum mixes from the sound of an 1176. In a Universal Audio Webzine interview he claims that he will:

Always place one big mike, like a U47 (Neumann) or a ribbon mic such as a Coles or Royer, five or six feet in front of the drum. I try to get the whole drum set to sound good thru that mic and then put it thru an 1176. That's the secret weapon track. The 1176 compresses and makes it sound bigger and more present and a lot more exciting without having to crush it. I just it give a healthy 3-5db compression and turn up the gain a little bit – it sounds great! If I have that mono track, where the whole drum kit sounds balanced, then I can build a decent drum sound with whatever else I have (Vdovin 2003).

It should be noted that the 1176 does seem to be used regularly on spot mics but for the purposes of this paper the author is only concerned with full spectrum drum mixes such as busses or room mics.

3.1 Summarizing The Behavior And Sound

The behavior and sound of the 1176 can be summarized as follows:

- Feedback compressor
- Program dependent time constants
- Program dependent ratio
- Fixed threshold that changes with the ratio setting E.g. Low ratio and low threshold or High ratio and high threshold
- Very fast attack and release times
- Engineers claim it exhibits a thick texture when applied to vocals
- Engineers claim it can help the bass cut through a mix, implying it adds "punch" and definition.
- Under certain conditions it can distort the signal, which can bring it forward in a mix. This would seem to imply presence.

- Engineers claim it can make drums appear more present and exciting when used on drum busses/groups

4. Testing Audio And Objective Tests

When attempting to measure how well a piece of audio equipment performs objective and subjective measures are used. With objective testing the input signal is compared to the output signal by using measurements such as Total Harmonic Distortion (THD) and Signal to Noise Ratio. While these tests have their uses and are certainly suitable for measuring the linearity of an audio system, the results are rarely of any use to the music producer. For example a THD test will use a sinusoid wave but this doesn't come close to representing the complex interaction of harmonic components (timbre) that help the producer distinguish between varieties of audio sources (Fenton et al. 2011).

4.1 Subjective Tests

Subjective tests on the other hand are primarily concerned with listening to the audio and making judgments based on what has been heard. Libshiftz and Vanderkooy (1980) state that not all characteristics of an audio system can be measured in a way, which correlates accurately with what is heard. They also note that the tests must be blind or double blind using A/B switchboxes. Findle (1997) points out that the most important aspect of all is to ensure that the relative levels of any sources are very accurately matched, noting that a difference of 0.1dB can be heard. On the other hand Bob Katz claims that he has "never found any meter to be useful for the practice of matching levels for mastering purposes" and goes on to claim that DAW meters are no substitute for the ear (Katz 2009). Clearly matching levels to within 0.1dB is practically impossible so a range of metering solutions, including Peak/RMS and traditional VU style were used in tests conducted by the author.

While double blind, MUSHRA and ABX testing methods are worth consideration, personal subjective tests and visual analysis of waveforms and spectrograms was undertaken for this paper. In future work the author intends to carry out much more rigorous and robust testing methods-see section 7.0.

4.2 What To Listen For?

When utilizing subjective listening tests the first question must be what exactly are we trying to assess? It has been claimed that audio quality consists of two major attributes: pleasantness and fidelity (Toole 1985). While the author does indeed agree with this, these two attributes alone are much too broad. Zielinksi (2006) goes on to argue that pleasantness pertains to sensory judgments whilst fidelity is related to what he refers to as hedonic judgments. He makes a clear distinction between the two and lists “loudness, pitch, timbre, angle of sound, incidence, sound width, spatial envelopment etc.” as being examples of sensory judgments. On the other hand he notes that hedonic judgments are concerned with what participants of audio tests liked and disliked and extrapolates that expectation bias and bias due to mood can affect results.

Thinking more about sensory judgments Howard and Angus (2006) state that pitch, loudness and timbre are the three most important descriptors of sound used by musicians. Timbre is concerned with the harmonic relationships, phase relationships and the overall volume contour or envelope of the sound. Moylan (2007) suggests that dynamic envelope; spectral content and spectral envelope are all crucial in the perception of timbre. For these reasons timbre was a suitable choice to measure when quantifying the effect the compressor had on perception of “punch”, “texture” and “presence.”

For the audio tests a number of short recordings were used to observe the character of the 1176. Given that the audio sources were all mono and the compressor used was a single channel device, there was no reason to consider how the compressor could affect the perception of the stereo image. It should be noted however that the manipulation of the sense of space when hard compressing mono room mics is something that could be worthy of further study.

4.3 Testing Resources

The tests were carried out on a new reissue 1176. Pro Tools and Logic were used as DAWs with a Digidesign 192 I/O used for conversion during recording. All examples were recorded at 24/44.1. The microphone signal path used a Neumann U87 into an API 3124 preamp. All DI signals were sent to the API DI input. Listening tests took place in a moderately treated home studio using a Metric Halo 2882 for playback into a SPL 2Control stereo controller over a pair of Genelec 8040A monitor speakers. A set of Sennheiser HD25s was used in addition to the nearfield monitors. All audio was sent to the hardware 1176 with an average level of around -18dBFS. As can be seen in Fig.2. the levels were monitored using the Sonalksis FreeG plugin (peak and RMS metering) and Klanghelm VUMT (for VU metering calibrated to -18dBFS=0VU) to ensure accurate level matching.

Sonic Visualiser was used for generating visual data.

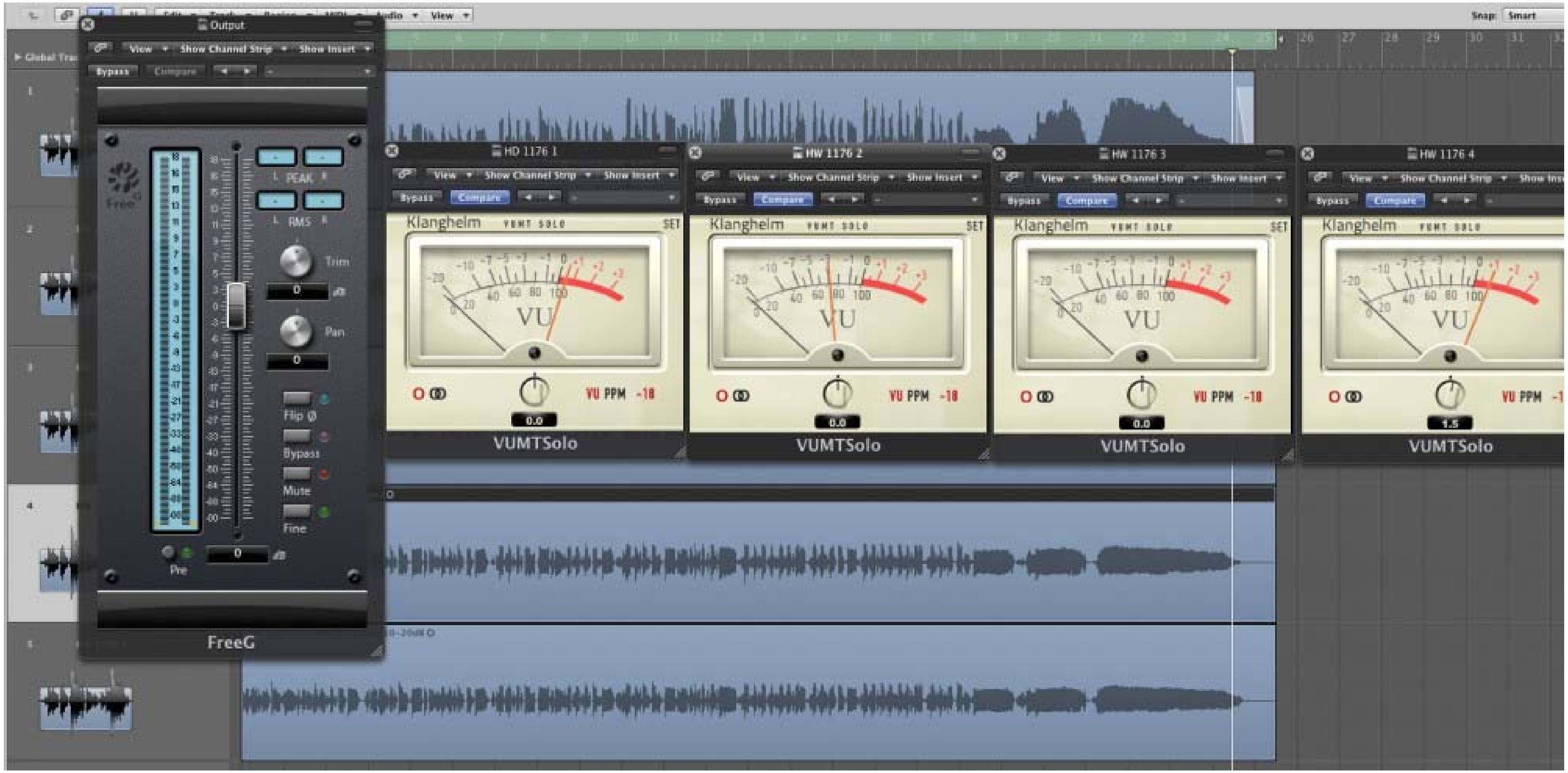

Fig. 2 Metering Plugins

4.4 Testing Sources

- A male vocal extract recorded with a Neumann U87 into an Api 3124 preamp. A/D Conversion was from a Digidesign 192 I/O. The passage crescendos from quiet to loud.

- A single mono room mic of a drum kit recorded with a Neumann U87 into an Api 3124 preamp. A/D Conversion was from a Digidesign 192 I/O
- A bass guitar was DI'd into an Api 3124. A/D Conversion was from a Digidesign 192 I/O. The bass part was deliberately performed with a pick to produce pronounced transients.
- All sources were sent to the hardware 1176 using Logics I/O plugin. A Metric Halo 2882 was used for conversion to and from the compressor.

4.5 Making Observations

All compressed versions of the audio were compared against the uncompressed sources. Both the ITU-R BS.1116 and the BS.1534 use a five-point scale to measure impairment and quality respectively. The author devised a five-point grading scale to record any audible differences.

4.6 The Grading System

Texture was noted as being an attribute of 1176 compression on vocals and a five-point scale to measure texture was used:

5. Very significant addition of texture

4. Significant addition of texture

3. Slight addition of texture

2. Very slight addition of texture

1. No difference

Definition was often noted as being an attribute of 1176 compression on bass and a five-point scale to measure definition was used:

5. Very Significant increase of definition

4. Significant increase of definition

3. Slight increase of definition

2. Very slight increase of definition

1. No difference

Presence was often noted as being an attribute of 1176 compression on drums and a five-point scale to measure presence was used:

5. Very Significant increase of presence

4. Significant increase of presence

3. Slight increase of presence

2. Very slight increase of presence

1. No difference

5. Results Of Testing

The following chapters discuss the observations made during testing.

5.1 Vocal Tests

Audio examples of the tests are available for the reader to listen to. The files are named as follows:

1. 1176 Vocal Test Source
2. 1176 Vocal Test Ex1
3. 1176 Vocal Test Ex2
4. 1176 Vocal Test Ex3
5. 1176 Vocal Test Ex4

The 1176 was tested on vocals using settings based on research from chapter 3.1:

Example	Ratio	Attack	Release	Gain Reduction
1	4:1	7	7	7-10dB
2	4:1	6	6	7-10dB
3	4:1	3	5	7-10dB

Note that a setting of 7 represents the fastest attack and release times. The control for attack and release works counter clockwise

1. As can be seen from comparing the first two waveforms in Fig.3 (top is the original and second is the first compressed example) the levels are much more constrained. Sonically the quiet parts at the start of the phrase are very intimate and up-front. As a result of the restricted dynamics the vocal is much more rounded and has a thicker texture. The fast attack time clamps on the transient portion of the phrases very quickly and this is particularly obvious at 18 seconds (when the performer noticeably increases the dynamics) and also at 22 seconds on the word “negativity.” Perhaps the best demonstration of the additional texture is at 37 seconds. Again the time constants clamp down quickly on the phrase and the result is a dynamically restricted yet sonorous texture. The additional texture becomes gradually more apparent over

the duration of the passage. Rating=3

2. The second example sounds practically identical to the first. It appears that the slightly slower attack and release times made no difference. A quick inspection of the waveform after the listening tests confirmed what the author was hearing. Rating=3
3. The third example made use of the Dr Pepper setting and again is very similar to the previous two examples. The most obvious differences are how it clamps down on the sibilance; this can be heard on “said” at 12 seconds and more obviously at 15 seconds. The breath of air at 17 seconds is slightly less pronounced but apart from the reduced sibilance and breathing there is remarkably little difference. Looking at Fig. 3 the fourth waveform (this example) is slightly more dynamic than the previous two. This is obviously due to the slower attack times. However given the speed of the time constants this hasn’t translated into an audible difference. Rating=3
4. As to be expected with high amount of gain reduction (due to “tons of input level” advised by Charlie Clouser) the passage has a much more restricted dynamic range. This can be clearly observed in the fifth waveform in Fig. 3. All of the examples (including the uncompressed) had RMS levels of -19dBFS and a VU reading wavering between -7 to -3 during the first 5 seconds but this example is undoubtedly perceived to be louder. The air frequencies of the vocal recording are much more apparent now and this can be clearly seen in Fig. 4. During the louder sections the compressor clamps and restricts the levels quickly, in a musical yet aggressive way that is very much inline with the sound of a rock vocal. Rating=5

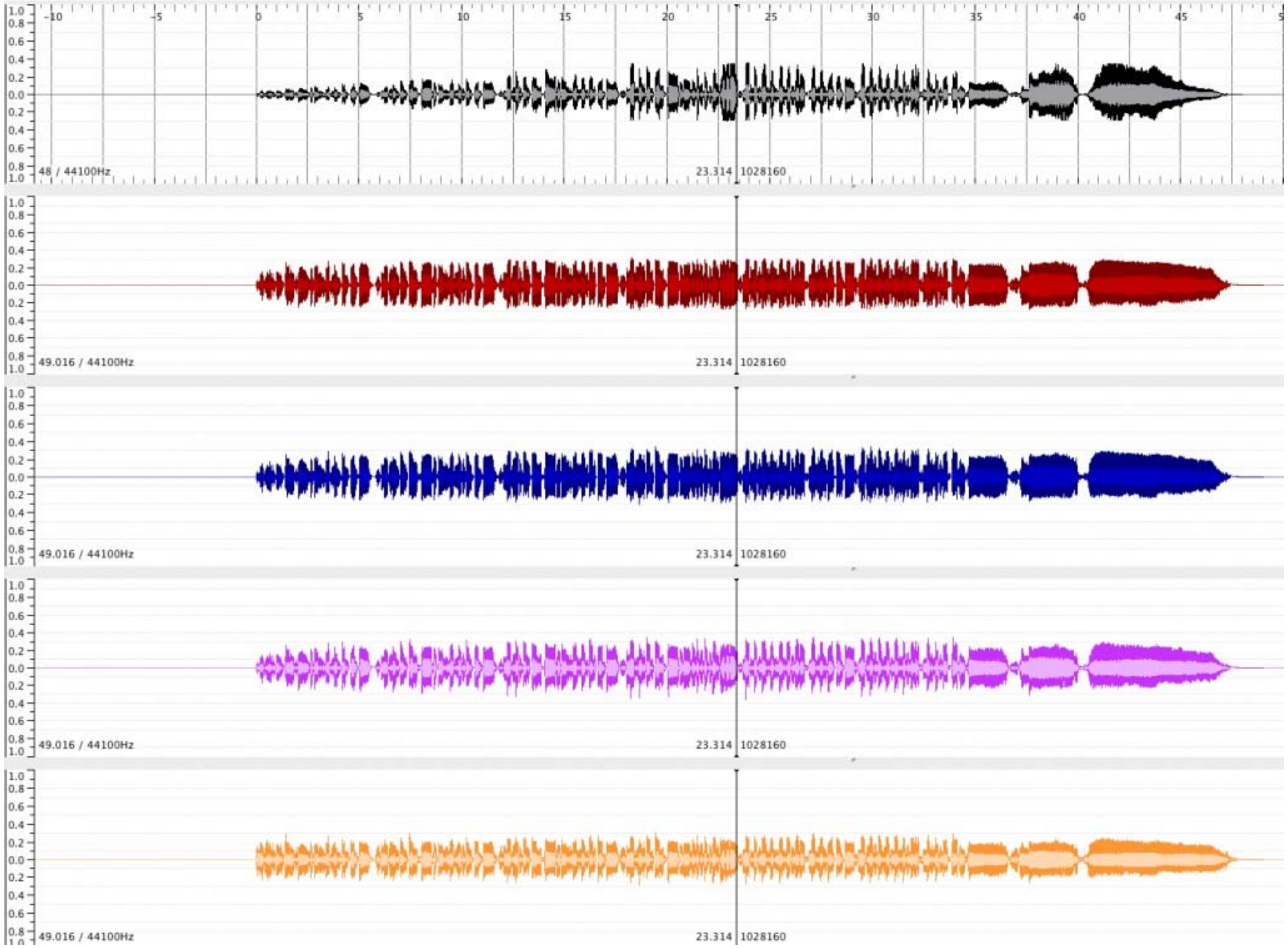

Fig. 3 Waveform overview of the test files-Top to bottom is the original (black) then compressed examples 1-4 (red-orange)

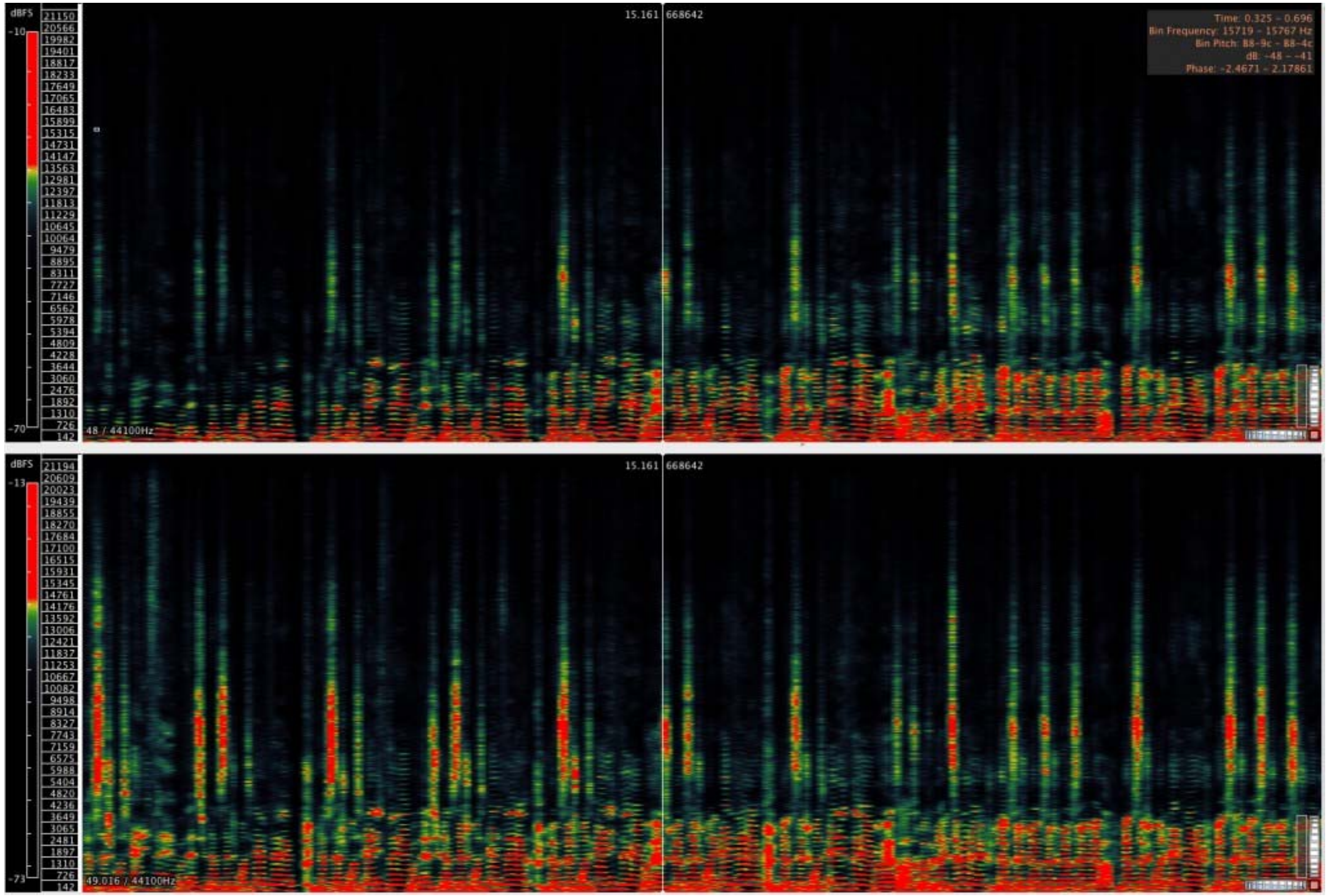

Fig. 4 Top spectrogram is the original; bottom spectrogram is the fourth compressed example. Note the difference in frequency content in the higher end of the spectrum.

Bass Tests

Audio examples of the tests are available for the reader to listen to. The files are named as follows:

1. 1176 Bass Test Source
2. 1176 Bass Test Ex1
3. 1176 Bass Test Ex2
4. 1176 Bass Test Ex3

The 1176 was tested on bass using settings based on the research from chapter 3.1:

Example	Attack	Release	Ratio	Gain Reduction
1	4	4	4:1	3-5dB
2	4	4	8:1	7-10dB
3	7	7	8:1	7-10dB

1. The bass part in this example is more consistent than the uncompressed original and this is particularly audible between 4-8 seconds. In terms of additional punch there is a slight difference which again becomes much more apparent in the higher notes between 4-8 seconds and especially in the skipped octaves figure. However the difference between this example and the source is fairly minimal. It's worth noting that the source is fairly consistently played to start with. Rating=2
2. As to be expected with the additional gain reduction and higher ratio the overall dynamic of the part is more regimented. What is interesting though is that there is now a change to the transients. The passage between 4-8 seconds showcases the additional attack. The notes during the octave skips are punchier with much more definition. These spikey transients are visually noticeable in Fig. 5. The author believes this may be attributed to how the ratio responds to transient material as noted by Shanks on page 9 of this paper. Rating=3
3. The third example deliberately used the fastest attack and release times to assess whether there was any low frequency distortion. The result is both audibly obvious and visually clear from observing the bottom end in Fig. 6. What is interesting however is despite the very fast time constants; the bass part still has a lot of punch with a significant amount of transient attack preserved. However, this not obvious from looking at Fig. 5.

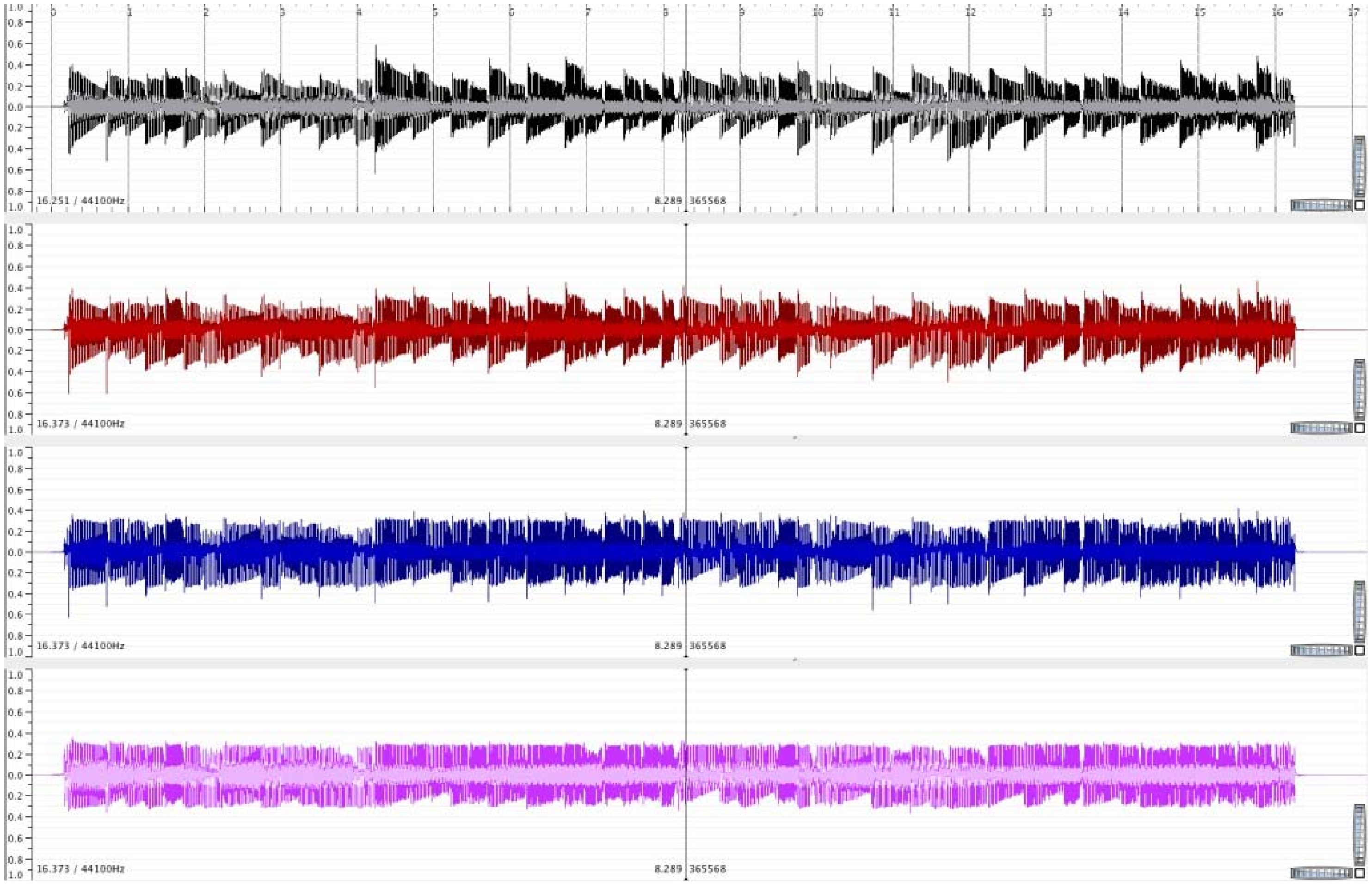

Fig. 5 Waveform overview of the test files-Top to bottom is the original (black) then compressed examples 1-3 (red-pink)

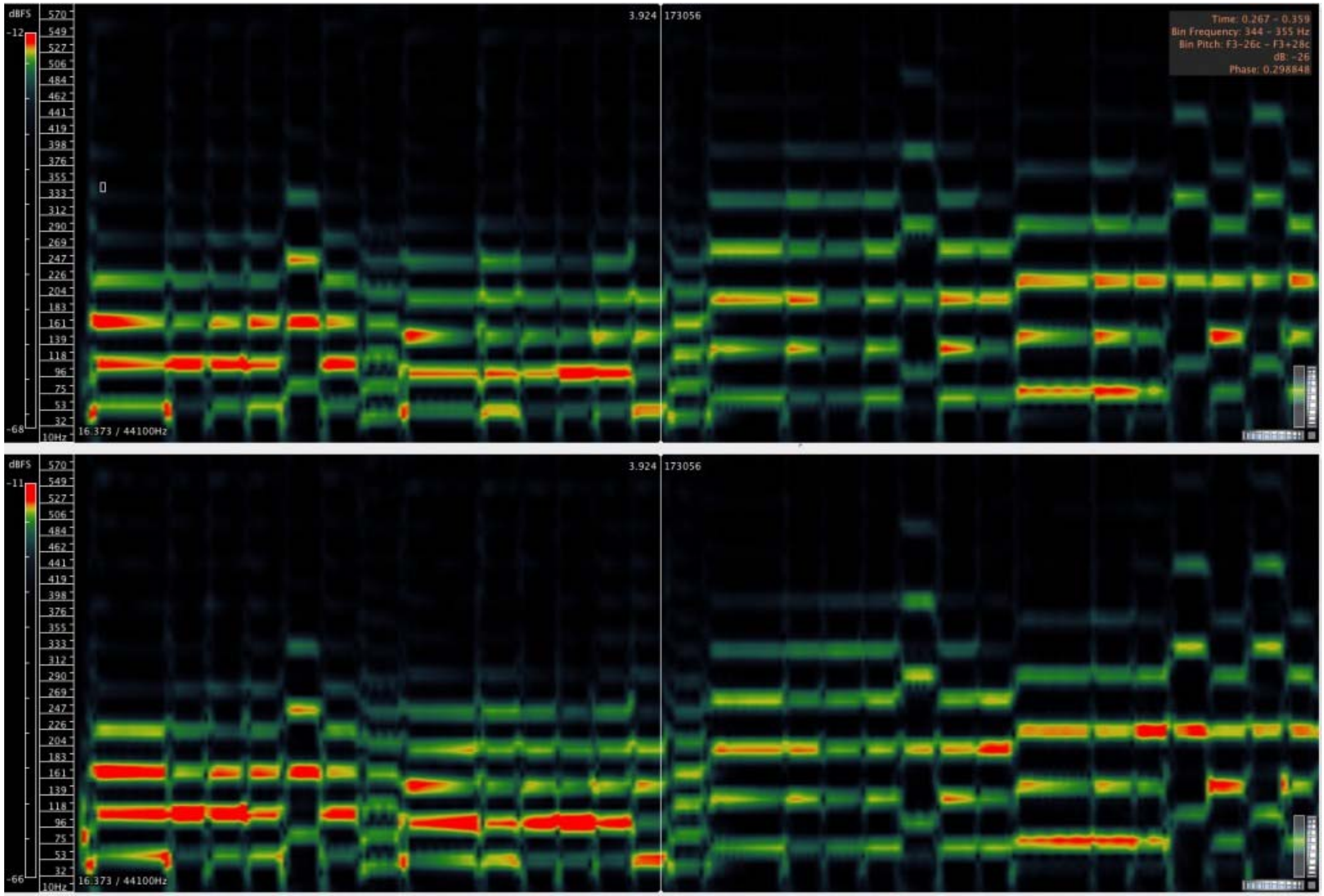

Fig. 6 Top spectrogram is example 1 and the bottom is example 3. Note the differences in the lower end frequencies 50-250 Hz

5.3 Drum Tests

Audio examples of the tests are available for the reader to listen to. The files are named as follows:

1. 1176 Drums Test Source

2. 1176 Drums Test Ex1
3. 1176 Drums Test Ex2
4. 1176 Drums Test Ex3
5. 1176 Drums Test Ex4
6. 1176 Drums Test Ex5

Tests on a mono room mic were carried out to ascertain how the different ratio settings change the behavior of the 1176. The attack and release times were set to exaggerate the transient portion on the snare and bass drum hits using a long attack and short release. This type of setting was in accordance with the author's findings in chapter 2.4.

Example	Attack	Release	Ratio	Gain Reduction
1	3	6	4:1	3-10dB
2	3	6	8:1	3-10dB
3	3	6	12:1	3-10dB
4	3	6	20:1	3-10dB
5	3	6	All Buttons In	3-10dB

1. With these settings the pronounced transient portion of the kick and snare is very noticeable and the decay of the drums significantly more audible. The ambience from the room is much more apparent and this together with the altered transients and decay makes for a considerably more present drum track. Rating=5
2. The author struggles to hear a difference. The similarity can be observed in Fig. 7 by comparing the second and third waveforms.
3. The author struggles to hear a difference. With a variable threshold compressor this is to be expected when moving to such a high a ratio but strange for the 1176 given the threshold and the knee should be changing with each new ratio setting (see Fig.1)
4. As above
5. A significant change here. The transients are still very pronounced with the occasional hit overshooting. This tally's with

Shanks claims in chapter 2.4. Care had to be taken here as despite a low RMS level the occasional transient was close to 0dBFS. The occasional extreme transients can be both heard and seen in Fig. 7. The texture is significantly thicker and it sounds almost as if there is some low frequency distortion from the bass drum hits. From observing Fig.8 it is visibly clear there has been changes to the lower end. Rating=3

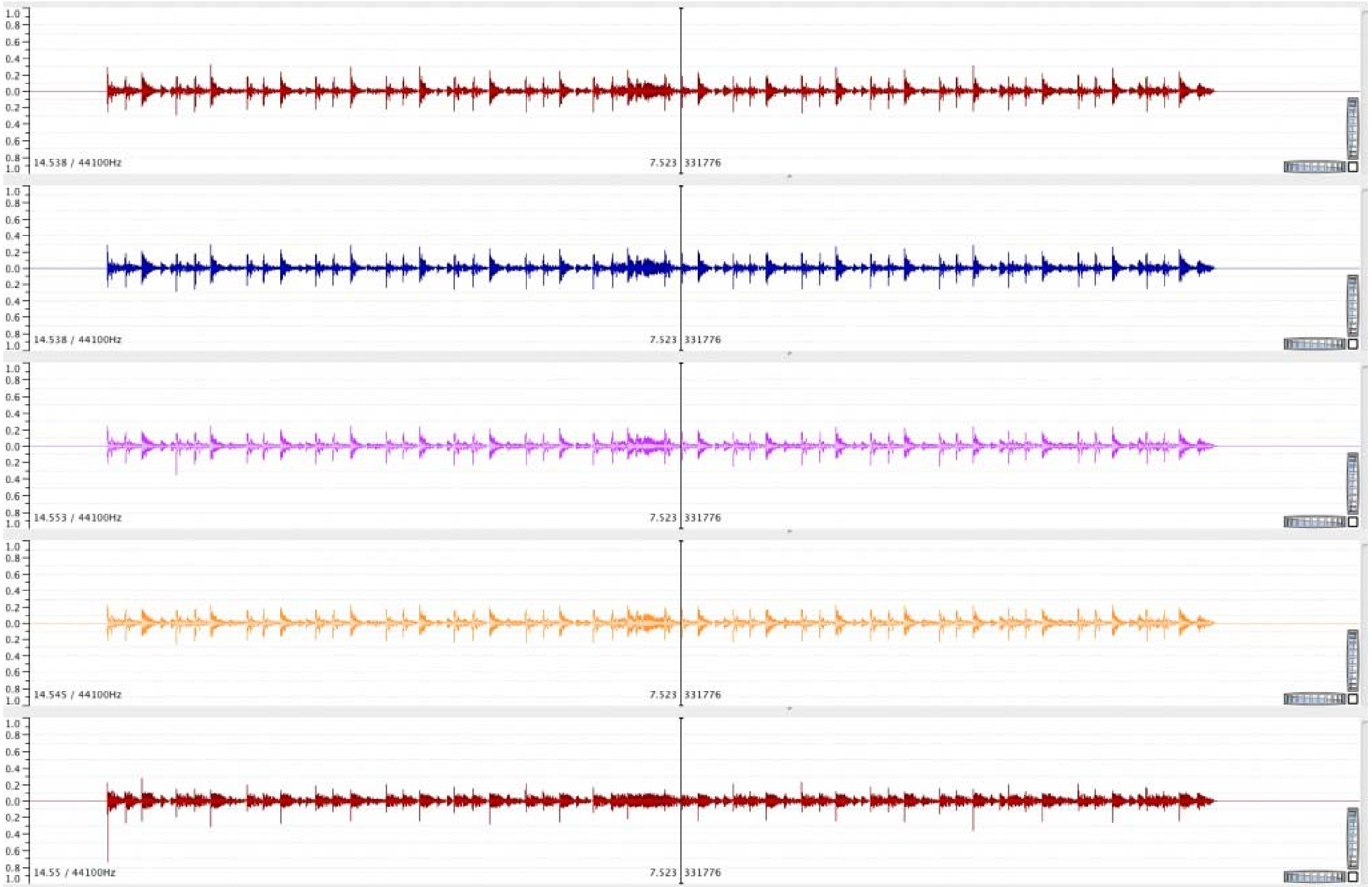

Fig. 7 Top to bottom Example 1- 5

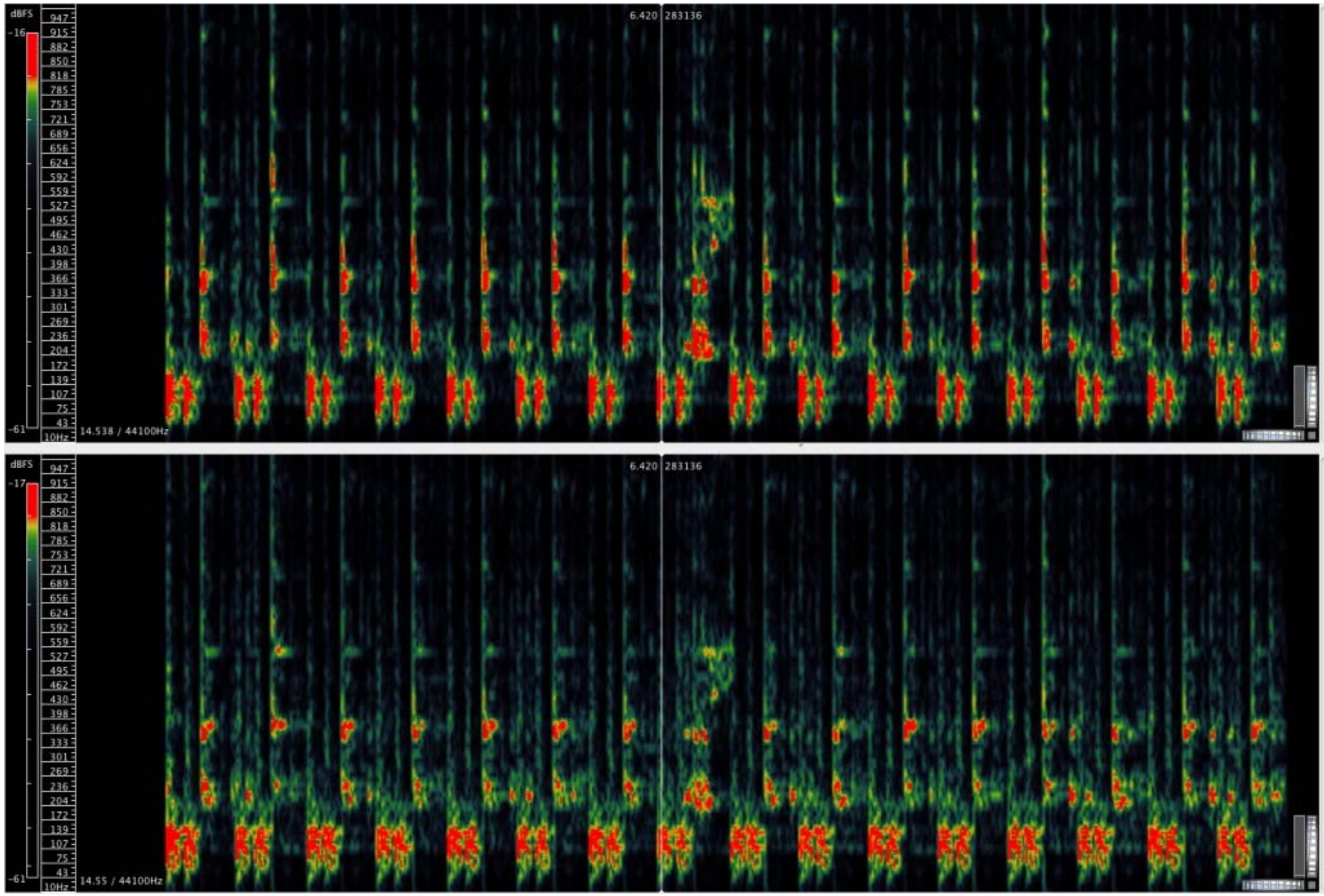

Fig. 8 Top 4:1 and bottom all buttons in. Note the change to the bass drums hits at the bottom of the spectrogram.

6. Conclusions

The popularity of the 1176 compressor is a result of its unique sonic character that can be attributed to the following:

- Its use of a FET for gain reduction
- Program dependent time constants
- Program dependent ratio, which becomes particularly interesting when using the all-buttons-in mode.
- Fixed threshold that changes with the ratio setting
- Very fast attack and release times
- Its ability to distort bass in a sonically pleasing manner when using fast attack and release times
- Its aggressive character when heavily compressing vocals
- Its ability to radically change the envelope of percussive hits
- The distortion and transient punch it adds to drum audio when used in all buttons mode.

7. Areas For Further Research

This is part of a much wider study being undertaken by the author. Further research will include:

- Tests using sinewaves and noise.
- Resynthesizing the audio using FFT and sine wave generator for more control over harmonic relationships of the sound sources
- Testing using a wider range of source material including electronic drums, loops, a variety of vocal performances and electronic synth bass
- Listening tests using the ABX method
- A wider range of listening tests, making use of a MUSHRA type scale carried out on students, engineers and producers
- Listening tests with the processed audio in the context of a mix

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