Machine Head Digital Tape Saturation Processor

SPL Machine Head Digital Tape Saturation Processor User Manual

Contents

SPL Machine Head Digital Tape Saturation Processor

Specifications:

- **Product Name:** Machine Head Digital Tape Saturation Processor
- **Versions:** Original version, Ultimate version

- **Control Elements:** Active, Input Gain, Low Freq Adjust [Ultimate], Output Gain, High Tape Speed, Presets, Metering

Product Usage Instructions

Introduction:
The Machine Head is designed to replicate the sonic effects of an analog tape machine in the digital domain. It enhances loudness, energy, tape glue, and warmth in audio recordings.

Control Elements:

- **Active:** Enables or disables the processing effect.
- **Input Gain:** Adjusts the input signal level.
- **Low Freq Adjust [Ultimate]:** Adjusts low-frequency response (available in Ultimate version).
- **Output Gain:** Controls the output signal level.
- **High Tape Speed:** Simulates different tape speeds for varying effects.
- **Presets:** Offers predefined settings for quick application.
- **Metering:** Displays signal levels for monitoring.

History:
The Machine Head algorithm was initially developed in the mid-90s using C++ for the original version. It has been updated over time to support modern systems and higher sampling rates while maintaining its original sound characteristics.

Models version

Original version

Ultimate version

Introduction

- The idea of the Machine Head is to make the sonic effects of an analog tape machine available in the digital world.
- These effects are a higher loudness at the same peak level, more energy as well as “tape glue” and warmth.
- Certain aspects of an analog tape machine are interlinked. For example, the saturation and hysteresis effects are associated with treble loss due to excessive drive levels. In the digital domain, the machine head algorithm allows overdriving independent of the treble response. It is even possible to boost the treble if this is desired in terms of sound.
- In the digital simulation of an analog tape machine, the conditions in the structure and concept of the algorithm that differ from the analog world must be carefully considered – especially in the case of non-linear signal processing.
- The entire signal processing is based on SoundArt’s own developments. Especially the complex filter routines, which do not originate from third-party libraries, were developed in-house with regard to the desired quantization behaviour.

Machine Head plugin in the “Original” version

- The original algorithm was developed in the mid-90s as a plug-in under C++ with floating point calculation. However, two Motorola 56002 fixed-point DSPs were used in the Machine Head hardware at the time. Careful scaling of the algorithm for the fixed-point implementation was necessary to prevent internal clipping.
- At that time, the DSP assembler code was developed by comparing the processing result of the hardware with the processing result of the floating-point reference code, using music as a test signal with properties that ensured the occurrence of all operating states of the algorithm. The correspondence between the two processing results was the quality criterion for the DSP implementation.
- The plug-in based on the floating point reference implementation from the mid-90s now had to be made to run again after 28 years on a Windows 2000 workstation with a Pentium Pro processor.
- CD backups of the source code directories were used to run the reference source code in a current development environment. It was possible to achieve a bit-identical audio result compared to the reference implementation on the Windows 2000 workstation.
- The source code was then adapted to the C++ functions available today, whereby the results of the audio processing were also bit-perfect compared to the reference version at the time.
- The Machine Head hardware only supported sampling rates of 44.1 or 48 kHz. In today’s production environment, support for higher sampling rates is required. Therefore, adjustments had to be made for higher sampling rates without changing the sound of the original filters with all their characteristics. For this purpose, SoundArt 2024 developed a new filter approximation system.
- Thanks to the S/P-DIF standard, it was possible to carry out comparative measurements between the hardware machine head, the floating point reference code and the new plug-in versions.

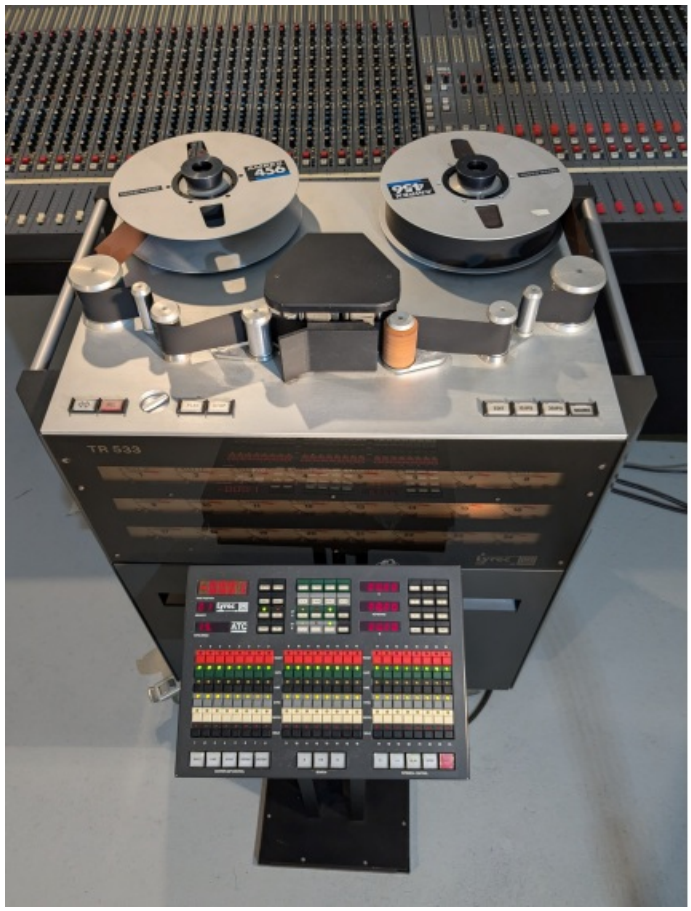
Machine Head plugin in the “Ultimate” version

- When the original algorithm was implemented in 1996/1997, there were limitations in terms of computing power. This has changed. SoundArt has therefore decided to use its current knowledge and the improved code components to create an ultimate version of the Machine Head.
- With today’s computing power, the filter banks could be improved and the positive characteristics of the tape machine could be imitated more precisely. This has further refined the sound.

- The new function in the “Ultimate” version is the Low Frequency Adjust. This parameter is used when calibrating tape machines to equalize the frequency response by compensating for the increase in low frequencies caused by head mirror resonances depending on the selected tape speed.
- The “Ultimate” version allows independent adjustment of the low-frequency response from an ideally calibrated compensation with Low Frequency Adjust to 0.0 through to over- or under-compensation, which may well be justified from a sonic or artistic point of view.
- While the “Original” version only offers integer steps for setting the High Frequency Adjust from -6dB to 6dB, the “Ultimate” version has a 10-fold finer parameter resolution.
- In addition, the resolution of the drive parameter has been doubled compared to the “original” version.
- The optimizations to the algorithm in the “Ultimate” version improve the sonic result in terms of openness, clarity and spatiality.

History

- The creative nucleus of the project was the Jam Productions recording studio, which Kai Lukas has been running as a sound engineer since the 1990s. The sonic advantages of the 24-track 2-inch Lyrec TR-533 tape machine awakened in Kai the vision and desire to make this sound available in the digital world.
- At that time there was nothing comparable, so Kai Lukas teamed up with Frank Hartmann and they started from scratch. First of all, intensive measurements of the Lyrec were carried out with many trials and even more listening tests until a model of the algorithm finally emerged.



- The development was carried out by Kai, a graduate engineer in communications engineering specializing in digital audio signal processing, and Frank, a graduate engineer in communications engineering specializing in digital audio and video signal processing and chip design. The two joined forces and founded the engineering

office SoundArt.

- The source code of the Machine Head audio algorithms and the concept of the tape simulation are the exclusive property of SoundArt.

Control Elements

1. **Active**
    - The ACTIVE switch engages the Machine Head and the processing becomes audible. The illuminated LED indicates that the processing has been activated.
    - If deactivated the unit is in bypass but the metering will continue showing the values of the activated state.
2. **Input Gain**
    - INPUT GAIN adjusts the input level of the incoming audio. Adjustable values range from -12.0 dB to +12.0 dB in 0.1 dB steps.
    - The value is shown in the display (7) and the INPUT PPM meters display the actual input level after the INPUT GAIN control.
    - In practice you will start with the INPUT GAIN set to 0 dB. For most applications this is the appropriate setting. If your source material is of ver y low level or not normalized yet, you can use the INPUT GAIN control to drive the source material near full scale.
    - If you are processing full scale material it may be necessary to reduce the input signal by one or two dBs to create new headroom for the processing. Reduce the INPUT GAIN with the proviso of the INPUT CLIP LEDs (8).
3. **Drive [Original] – Drive Level [Ultimate]**
    - The DRIVE control is the most important parameter of the MACHINE HEAD. You set the recording level above the normal working level of the analogue tape machine. The adjustable values range from -7 to +14 in 0.2 dB steps (Original version) respectively 0.1 dB steps (Ultimate version) and will be shown in the display (7).
    - The DRIVE and the INPUT GAIN are effectively the same parameters. The default settings are 0.0 for both. Internally though INPUT GAIN will then be -7 dB and the DRIVE 7 dB. This is done to free headroom when processing full scale audio and at the same time to drive the tape machine at a level where the

beloved effects begin to come into place.

- The corresponding recording level is displayed in the DRIVE LEVEL LED bars (8). The higher the DRIVE the more intense the saturation of the tape. While increasing the DRIVE the output level may increase too. Compensate for this by reducing the OUTPUT GAIN (5) and monitor the OUTPUT LEVEL meters. The perceived loudness will increase more dramatic than the PPM.

4. **HF-Adjust [Original] – High Freq Adjust [Ultimate]**
    - The HF-ADJUST/HIGH FREQ ADJUST controls the amount of high frequency damping or boosting.
    - The control range of the Original version is -6 (max damping) to 6 (max boost) in 1 dB steps. The Ultimate version has 0.1 increments ranging also from -6.0 to 6.0.
    - The higher you saturate a real tape the more high frequency damping will take place. With the MACHINE HEAD you can set the amount of damping independent of the DRIVE LEVEL. You can either use a strong damping effect with low
    - saturation or the other way around. This freedom is not offered by a real tape machine.
      On the other hand you can boost high frequencies which simulates overemphasized harmonics e. g. due to improper calibration of the tape machine or differences in tape quality.
5. **Low Freq Adjust [Ultimate]**
    - The Ultimate version features an additional control called LOW FREQ ADJUST. It controls the amount of low frequency damping or boosting.
    - The control ranges from -6.0 (max damping) to 6.0 (max boost) in 0.1 dB steps.
    - This parameter is used when calibrating tape machines to equalize the frequency response by compensating for the increase in low frequencies caused by head mirror resonances depending on the selected tape speed.
    - For sonic or artistic reasons the low-frequency response may be varied from an ideally calibrated compensation with LOW FREQ ADJUST set to 0.0 through to over- or under-compensation resulting in low frequency boosting or damping.c
6. **Output Gain**
    - OUTPUT GAIN is variable between -12 dB and +12 dB in 0.1 dB steps and the value is shown in the display (7) as well as in the OUTPUT PPM meter (8).
    - In practice you will start with the OUTPUT GAIN set to 0 dB. In case you have used high DRIVE values you will use the OUTPUT GAIN to compensate for the level increase.
    - You can also use the OUTPUT GAIN control to compensate for the loudness difference between unprocessed and processed signal to judge upon the sonic effect alone.
    - Also, if you have chosen a positive setting on the HF and/or LF filters, it may become necessary to reduce the OUTPUT GAIN slightly to prevent clipping. Watch the CLIP LEDs!
    - You can set positive OUTPUT GAINs, when there is still headroom left after processing. Always check this on the loudest part of the audio file being processed and watch the CLIP-LEDs.
7. **High Tape Speed**
    - With the HIGH TAPE SPEED switch you change the speed of the virtual tape machine from standard tape speed (15 ips – inch per second) to high tape speed (30 ips).
    - When HIGH TAPE SPEED is activated the algorithm simulates the pre-emphasis for high speed recording. The upper mid and high frequencies as well as the harmonic content gain finer resolution and more detail.
    - Note that the 40 Hz to 70 Hz bass reduction induced when recording to analog tape at 30 ips is not reproduced!

8. **Presets**
    - The MACHINE HEAD can store four presets on the front panel. They should be used for fast comparisons.
    - First you select a PRESET A / B / C / D and then you create the settings. The PRESET will always store the latest settings.
    - You can also copy a presets by holding down the CMD key on a MAC or the CTRL key on a PC and click on the PRESET where you wish to store the copy.
    - For more permanent saving of presets you should use the Presets menu in the menu bar.
    - Note that the Original and the Ultimate version share the four presets. This is cool, because you can make a presets and switch to the other version to immediately hear the difference with identical settings.
    - The LOW FREQUENCY ADJUST however can not be replicated in the Original version and will therefore be ignored. If the Ultimate version uses uneven DRIVE values like 4.3 it will be 4.2 in the Original version. Similarly the 1/10th values of the HIGH FREQ ADJUST will be ignored in the Original version.
9. **Metering**
    - The metering consists of six LED chains with ten LEDs each. All LED chains feature a peak hold that keeps the highest PPM value displayed for about one second.
    - The INPUT and OUTPUT PPM meters have yellow LEDs showing PPM values between -40 dB (SIGNAL) and 0 dB. The top LEDs are red indicating clipping with a three second hold period.
    - The DRIVE LEVEL LED chains feature red LEDs with a one second peak hold showing levels between -10 dB and 21 dB.

Digital Tape Saturation Processor
Version 1.0

- **Concept:** Kai Lukas, Frank Hartmann, Hermann Gier
- **Audio Algorithmus:** SoundArt Kai Lukas & Frank Hartmann
- **Plugin Development**: Gary Grudzek
- **Product Management:** Christoph Tkosz, Hermann Gier
- **UI Design:** Goran Lizdek, Hermann Gier

FAQ

Q: Can the Machine Head plugin be used on Mac operating systems?
A: Yes, the Machine Head plugin is compatible with both Windows and Mac operating systems.

Q: Are there any specific system requirements for using the Machine Head plugin?
A: The Machine Head plugin requires a compatible DAW (Digital Audio Workstation) and supports various sampling rates for optimal performance.

Documents / Resources

	**SPL Machine Head Digital Tape Saturation Processor** [pdf] User Manual Machine Head Digital Tape Saturation Processor, Head Digital Tape Saturation Processor, Digital Tape Saturation Processor, Saturation Processor, Processor

References

- **User Manual**