# LINone

## User Manual

MAAT Inc.

MAAT Incorporated

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*Free ones too!*

# Table of Contents

## Installation & Setup

When preparing for installation of MAAT LINone, we recommend that you quit all applications prior to proceeding. Also, after downloading the installer and prior to installation, let any anti–malware measures you may have running scan the installer. Then, temporarily disable all anti–malware measures once scanning is complete.

To install, simply double click on the downloaded Installer for your particular operating system. The installation process will guide you through the install procedure. If you have an older OS version, restarting your host may be required. Don't forget to reënable anti–malware measures or simply restart your host.

### Licensing

MAAT software is licensed through our dongle–free, cloud–based license control framework. If your hosts are net–connected, our licenses "float," making it easy to move from one machine to another. All you have to do is close all MAAT stuff on one machine before you open anything on another. If you're going to use the laptop in an environment where Internet is spotty or non–existent, you can also go offline temporarily for up to 30 days.

To license your MAAT purchase, open yours or instantiate an example in your preferred plug–in host. When licensing, we recommend you open a new session in your DAW just for this purpose.

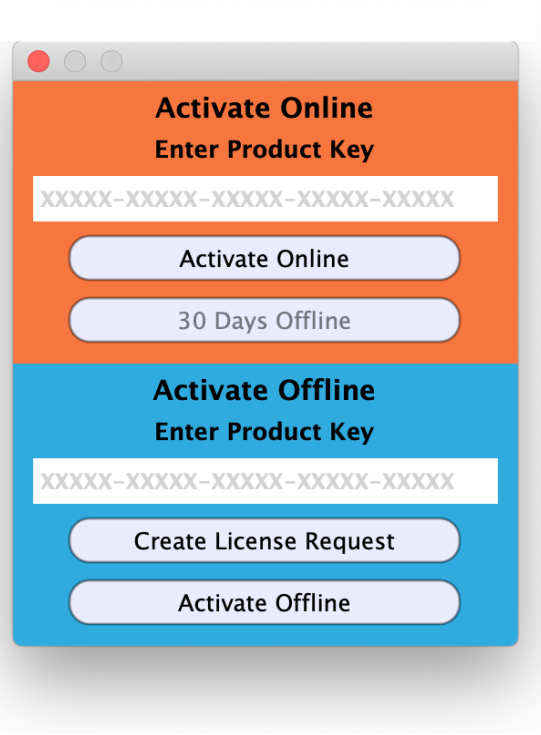


*Figure 1: The initial Activation dialog*

## Online Activation

Once the Activation dialog appears, paste or type in your Product Key supplied at the time of purchase. Then click on Activate/Deactivate Online and follow the prompts.

NOTE: The Online process requires a live internet connection. You must have an active internet connection for activation.

A feature of our cloud–connected system is that, if you close a DAW session that contains MAAT plug instances, then open that session on another host, the license will "follow" you onto the new host as long as you have live Internet.

You can also return or park your license on our licensing server, and pick it up later on another host. Once your product is licensed, click the Activate/Deactivate Online button to deactivate your license, then repeat to reactivate.

## Offline Activation

If, for security reasons you have an offline host computer or you plan on working without a reliable Internet connection, it is best to go with an offline license. There are two offline options, temporary offline and full offline.

### Temporary Offline

If you plan on working without a reliable Internet connection, we designed the temporary offline option just for you. The temporary offline process also requires a live Internet connection, but only during activation.

A temp offline license has two unique features:

- It can remain offline, without an Internet connection, for up to 30 days
- It auto–renews its lease whenever it does make a server connection

So, if your Internet is spotty or unreliable, or you're heading temporarily to a location where an Internet connection isn't available, the temporary offline option let's you work untethered to the 'net for up to a month.

By clicking the "30 Days Offline" button, your online license will become temporarily offline for a maximum of 30 days. If, however, you use the product while connected to the Internet at all during that time, the "lease" duration is automatically reset, extending another 30 days.


*Figure 2: The 30 Days Offline activation option*

Full Offline

This will license your MAAT product without the need to periodically contact our licensing server. If you anticipate working without the Internet for more than a month at a time or, for security purposes, your studio machine is "air gapped" and has no Internet, take a moment to surrender your online license, and replace it with an offline version.

NOTE: A FULL OFFLINE LICENSE DOES NEED TO BE EXPLICITLY RENEWED ONCE A YEAR.

To prepare for offline activation, you will need:

1. Your Product Key!

2. Some method to move your License Confirmation file to the offline host machine.

That latter requirement can be accomplished in any number of ways, but a USB flash drive is often readily available and most convenient. You will also need your Product Key that was supplied to you via e–mail when you purchased your MAAT product.

The offline activation process starts with generating a License Request, with a "maatr" file extension, which is submitted on–line

to our server or via e–mail to MAAT Support <support@maatinc.zohodesk.com>. A License Confirmation file, with a "maatc" extension, will be returned to you, which will activate your product.

To proceed, click on the Activate/Deactivate Offline button, and follow the prompts.

In a year's time, 365 days from the date the maatr file is created, a full offline license must be renewed using the same maatr/maatc method.

## Introduction

Thanks for purchasing MAAT's LINone re-dithering plug–in, and congratulations on committing yourself to maintaining and preserving linearity in music!

We built LINone to be used during post–production, when redithering is most needed. This is especially true during the mastering stage, where it is quite common to play back a digital stream and send that to one or more analog devices. Once the signal passes through the analog equipment, it is re–digitized and further processed in the digital domain. These steps require re-dithering and we provide quite a bit of control over that process so the engineer can either use the optimal dither for your release format, or a custom setting for a subjective "sound."

Today, all audio workstations allow high quality production processes: recording, mixing and mastering, normally with at least 24–bit final output quality. However, with the exception of iTunes and a few other services, lossless distribution and storage format is often the 16–bit linear PCM format widely used for CD production and lower quality lossless streaming. If optimally achieved, 16 bits are sufficient to deliver an excellent quality end product, far better than any lossy coding format.

## Quick Start

We know, reading is old school and such an easy tool to use as LINone would seem to be self evident, wouldn't you think? However, before you begin your explorations with this tool, we want to make a few things clear so you will get the best use out of your "LIN" purchase. Thanks for struggling through this part!

## Dithering Basics

Before we dive into details, here are a few very important concepts to remember:

- Dither prepares the finished audio for down–stream processing by the consumer
- When in doubt, TPDF is the universal default choice
- DACs usually do not dither

We will elaborate more shortly but, but basicallyTriangular Probability Density Function or TPDF dither will function properly in all delivery

and playback scenarios. TPDF dither is an unweighted, theoretically ideal dither that is the most basic of the many choices available.

To produce 16–bit formatted files, high resolution source audio files, minimally 32–bit floating point or 24–bit fixed, have to be reduced to a 16–bit word length. After this operation however, referred to as "re–quantization," a whole range of problems arise:

- the information beyond the 16th bit is lost — fine, low-amplitude audio detail beyond a 16–bit quantizing level disappears
- the noise floor increases to a 16–bit quantizing level
- for large amplitude signals, harmonic and intermodulation distortions appears
- for small signals, nonlinear distortions rise dramatically — small signals are precisely where modern analog devices are generally linear
- for small signals, stereo image instability appears
- at normal levels, unnatural falling off of reverberation occurs — smoothly fading into the noise floor becomes impossible

Especially for low level signals, the quantization errors correlated with and modulated by the original signal can be quite noticeable. Re–dithering technology helps to decorrelate the quantization error and consequently convert these discrete, unpleasant distortions into white spectrum noise. Proper re–dithering reduces or eliminates many of the problems listed above.

The decorrelation process is performed by adding a random signal to the high resolution audio signal prior to the re–quantization process. This random signal is called dither. Dither performs linearization of the nonlinear characteristic of the quantizer.

Re-quantized and dithered content sounds more pleasant, one can say "more analog." The price of this improvement is a noticeably higher background noise level. However, it is white in character and constant in level. Especially at low signal amplitudes, where the error is correlated to input signal, quantization noise sounds subjectively much more unpleasant than the even higher amplitude uncorrelated white noise produced by proper dithering.

The remarkable effect of a properly implemented dither algorithm is that a 16–bit signal can clearly reproduce tones at -110dB. After re–quantization without dither, there is simply no output for input signals below -96dBFS. All low amplitude detail is lost.

Note that DACs or Digital–to–Analog Converters usually do not re-dither. So, for DACs with digital volume controls, the audio quality will not be optimal when the volume control is set to anything other than unity gain.

### Why Shape?

However, with only dithering, we still have no influence on the level and audibility of the quantization noise. Therefore, in addition to dithering, we use noise shaping algorithms. Noise shaping modifies the whole distortion spectrum: re–quantization plus dither noise. The noise power in the system cannot be removed but it can be distributed so the noise after shaping is significantly less audible. It is even possible to partially achieve an SNR or signal–to–noise ration below the original quantization noise floor. It is important to mention that the input signal is transmitted transparently through properly implemented dithering and noise shaping processes up to the re–quantization point.

In general, it is possible to use noise shaping without dither but a significant correlation between successive rounding error samples occurs; distortion and signal–dependent noise modulation. Therefore, we recommend always using noise shapers with proper triangular dither.

### Shaping The Noise

Because the ear's sensitivity to low amplitude broadband noise is not uniform with frequency, we use noise "weighting" curves. Weighting, as mentioned above, redistributes the power spectrum of the noise. Dithered re-quantizing noise shapers approximate the inverse low amplitude noise audibility curve (in the old days, audibility curves were referred to as "Fletcher–Munson curves") allowing one to achieve the least audible noise penalty. Again, this leads to the counterintuitive conclusion that psychoacoustically optimized noise shapers allow for 19–bit audio performance from a 16–bit standard media delivery format. Signals with amplitudes as low as -120dB can be clearly detected.

## The Interface

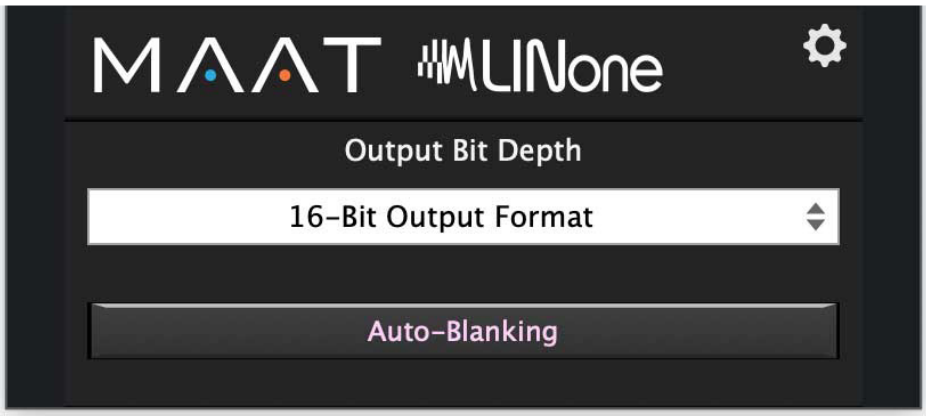


*Figure 3: LINone's user interface*

The straightforward user interface contains a series of menus and parameter controls. All of LINone's functionality is wrapped in a visually unobtrusive user interface. The plug–in is also very "light weight," demanding a minimum of CPU resources so it won't slow down your host.

We've worked hard to make this an exceptionally useful and usable tool and we hope you'll dig it.

## Dither Details

In the digital audio world, dither is noise added to reduce distortion. What? Adding noise to decrease distortion?! Yup, let's dig in some more…

Dither is an interesting and fundamental aspect of digital audio. Although not usually thought of as "DSP," re-dithering is definitely signal processing and so should be part of the overarching DSP umbrella. Back in the Distant Past, re-dithering was an integral part of our original digital telephone system, and much of the pioneering research on the subject was performed at Bell Labs.

According to information theory, you should add a pinch of noise to your digital audio every time you change it. Why is that? Well, take a look again at figure 3 below; that blocky looking mess that used to be a smooth and continuous low amplitude sine wave.

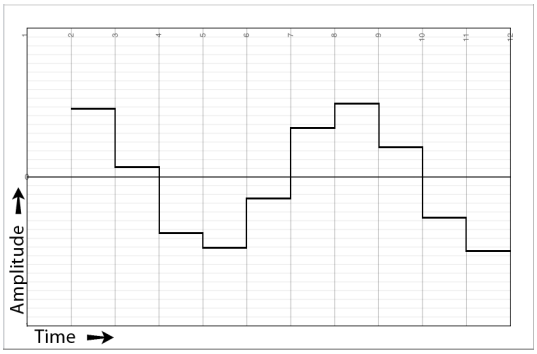


*Figure 4: A digitized sine wave*

Because a digitizer can only choose one discreet sample value during each sample (time) period, not half of one and half of another, adding a touch of noise helps to nudge the system to land on the statistically "right" choice. Injecting a hint of noise "linearizes" a digital conversion, reducing distortion. A properly designed digital system needs to add noise, called re-dithering, every time you change the gain (multiplication), or mix signals together (addition). That includes EQ, effects and pretty much anything else we typically do to our client's music!

The ideal amount of dither noise is about half of the step size of the digitizer, though it differs depending on the type of noise being used. In the case of good ol' linear PCM on which most all of our music is based, is 0.5 times 6dB or 3dB is correct for rectangular dither (RPDF). For triangular PDF, the ideal is about 4.7dB. Either way, half a bit is a very small amount of additional noise.

Without proper re-dithering, the distortion that results from any add or multiply is "correlated." This means it bears an audible relationship or subjective connection to the signal, the music. Trouble is, it's distortion,

so it's a nasty sounding parody of the music and is usually considered to be quite unpleasant to listen to. When properly re-dithered, the signal is linearized, resulting in the ability to hear clean music within the noise floor at less than one bit of amplitude. In other words, that LSB, or Least Significant Bit, now can contain meaningful music "under" the noise.

There are several common types of dither, with the simplest being broadband noise, known as rectangular probability density function (RPDF) dither. Mathematically, this RPDF dither has uniform or equal probability of including any frequency within the audio band from 20 to 20 kHz. So, it has equal power at all frequencies and sounds "white." Because of its power distribution, it is quite audible, even at low amplitude and so should be used with caution. More common is triangular PDF or TPDF, which has less low frequencies and more high frequency energy. Because our hearing is less acute at higher frequencies, TPDF dither is generally less audible than RPDF dither.

As mentioned earlier, dither can linearize a digital audio system, significantly reducing distortion for low amplitude signals, and increasing the signal resolution well below the quantizer step size. Dither does add some additional noise. However, even if the wideband noise has about the same total power as the signal, the high Q filtering action of the basilar membrane allows our ear to clearly resolve sine waves well below, "buried" in the noise.

## Shaped Dither

Back to shaped dither…A fairly modern invention is "shaped" dither. Shaping refers to the power spectrum of the dither signal, which is tailored or shaped for even less audibility. Noise shaping is a technology which reduces the audibility of noise resulting from dithering and re-quantizing. Noise shaping is accomplished not with equalization, but by processing the signal created by comparing the high resolution input and re–quantized output.

Our hearing mechanism is optimized for the frequencies around which the human voice is centered so, higher frequency sounds are less audible than lower frequencies. The more you shape the dither noise, shoving the dither energy toward higher and higher frequencies, the less audible it becomes…sort of. When used in larger than normal quantities, as with several generations of processing, or when set to extreme shaping, the dither signal itself becomes obnoxious, and is a bit like the sound of nails on a blackboard.

Noise shapers can modify the distortion spectrum after re–quantization in a way such that the signal–to–noise ratio can be improved over the theoretical quantization noise floor. The noise floor can be optimized to allow for the least possible audible noise penalty in a system. To quote a 1992 AES paper by Robert A. Wannamaker, the "…object (of shaped dither) is to minimize the total perceived output noise power. For this purpose, a new perceptual frequency-weighting function is introduced which provides closer matching to the ear's measured sensitivity at high

frequencies…" Noise shaping shifts the noise energy from high audibility regions where the ear sensitivity is highest to areas with lower sensitivity.

There are a variety of different shapes, from simple to very sophisticated, all based on psychoacoustics. LINone employs 1st order noise shaping. This dither is mathematically ideal as dithering but is more audible than fancier, higher order shaped dithers. An advanced, ninth order noise shaper can reduce the perceived output noise power by about 17 decibels. With some noise shaping schemes, performance equivalent to 19 bits of precision are possible within a 16–bit delivery format.

Since shaped dither moves the subjective dither noise away from our most sensitive hearing region, you can used shaped dither during post–production to best perceive the subtleties of the music.

Some examples of shaped dither brands are Apogee's UV22HR, iZotope's MBIT+, the Power Consortium's POW-r, and Sony's SBM II, (Super Bit Mapping v2). The above mentioned branded redithering schemes also require a license, increasing cost. We have evaluated and improved on those legacy methods for LINpro and LINSurround, from which LINone is derived.

## Limitations

When processing is performed in a DAW, dithering should be applied *at the very end of the deliver chain*. In actuality, this is re–dithering since the ADC or analog–to–digital converter self–dithers the signal during initial digitization.

Notice I said "at the very end…" This is important in that dither should only be re–applied when the content is moved out of your DAW, either by an AES/EBU or other streaming spigot, or as a file or set of stems.

In the 1990s, manufacturers began developing re-dithering schemes that provided the linearization without the audible addition of noise. The first of the resulting products was Apogee's original UV-22, mentioned above, an effective if brute force approach. A handful of better performing and better sounding spectrally shaped re-dithering products followed from several manufacturers.

Unlike the early days of digital audio, many, if not most consumers now listen to music through a largely digital signal chain. The DAC may be in their phone, embedded in their headphone cable or inside the "smart speaker" on the kitchen table. As legendary mastering engineer Bob Olhsson mentioned when asked about his re-dithering choices, "In most cases, people are never going to hear (my product) without some kind of downstream digital processing." Theses days, only audiophiles have integrated amps or stand–alone preamps with analog gain staging. Re-dithering with anything other than TPDF does not "translate" well in our modern, all–digital world.

With that fact in mind, one can also think of dither as just another effect, a "color" paintbrush in the DSP toolbox. No re-dithering at all produces a crunchy aspect that one well known mastering engineer employs as part of his signature sound.

Our point is: rely more on your ears than your eyes. Take some time to compare the dither from LINone to the dither choices available in your DAW, and learn what they do to a piece of reference music played through a reference system. It's easy to do…set up a project just for training your ears, and add several tracks of different genres. In your DAW's Master section, reduce the gain of your clips by 48dB. Then, insert LINone and, downstream from that, insert or dial up gain make-up of +48dB. All that will allow you to better hear the result of your LINone manipulations…

Once you're familiar with the setup and the character of the dither generator, try a much larger gain reduction so you are "down in the mud," where dither really counts. Be careful as this requires a huge amount of postdithering makeup gain.

## In Use

### Optimized Choices

The two controls consist of output bit depth and Auto–blanking, which mutes the dither output when the signal is null data or "digital black." LINone's psychoacoustic noise shaper has been precisely optimized for the 16 bit/44.1 kHz PCM format, also known as "Red Book". It profits from inherently lower quantization noise in the audible frequency range, and are also applicable for 48 kHz deliverables. The beauty of 1st order noise shaping is that it work perfectly with any sample rate and any playback chain, analog or digital. That's true even for deliverables at 88.2 kHz and higher sample rates.

#### Output Bit Depth

For your deliverable word length, 16 or 24 bits are available. As mentioned above, 16 is perfect for CD delivery, while 24 bit works for pretty much all other scenarios.

#### Auto–Blanking

The blanking option, enabled by default, automatically mutes the dither generator after a preset 11 milliseconds of silence. This prevents you from injecting noise into what would otherwise be "digital black" or null data.

### Delivering From Floats To 24 Bit Fixed

What settings are best when delivering from single or double precision floats to 24 bit fixed? Noise shaping typically is used to perceptually "push" the noise floor below what/where it would be with dither alone. As mentioned previously, noise shaping with dither at the 16th bit can move the effective floor lower, over the entire audio passband, by up to ~3 bits. So what does that do for you if you're dithering at the 24th bit?

24 bits encodes 144 dB of dynamic range, which is well beyond either audibility or reproducibility on normal playback gear at normal playback volumes.

With HRA releases, if the data is just truncated at 24 bits rather than properly dithered to 24 bits, correlated noise will result. Vicki R. Melchior, current chair of the AES High Resolution Audio Technical Committee, states that there is "…studio evidence that the truncation noise can become audible because it will be correlated to the signal. It's very hard to show with listening tests, but multiple mastering engineers have heard it." Melchior recommends rounding to 24 bits, adding HP-TPD dither at the 24 bit but not bothering with noise shaping. Since 1st order shaping is your only choice in LINone, just go with the flow!

### Preferences

The gear icon in the upper right corner opens the Info pane. That pane contains credits, an Activate/Deactivate License button, and a button to open this user manual.

## Specifications

### System Requirements

- macOS: 10.9 and newer, 64 bit only
- Windows: 7 and newer, 32 & 64 bit
- 4GB RAM minimum

### Supported formats

- 44.1 to 384 kHz sample rate
- AAX, AU, VST 2, VST 3

## Updates

Please always use the latest version of the software! You can find your current version on the Info Tab of the back panel. You can download the latest version simply by visiting:

http://maat.digital/support/#installers

For optimal security and stability, you should always stay up to date with Operating System revisions, and we keep up with compatibility changes to our products. We also continue to optimize for reduced CPU load, and this very user manual gets its own improvements.

To stay up to date with the latest version and product releases, please subscribe to our occasional newsletter. You'll find a opt–in form on our Contact page, or sign up for a copy of our free and very handy 2BusControl plug–in which will also subscribe you. Don't worry, we know you are busy so we only send out an average of 10 or 12 mailings a year.

## Support

For product support, please visit:

https://www.maat.digital/support

## License Central

License Central, located in MAAT's Shared directory, is a free utility that validates, repairs and logs your MAAT licenses. It also displays what MAAT products you have installed and assists in downloading both updates and demos.

License Central lists all of our products, and shows you:

- If a product is installed and what licenses you have [CLOUD, SUBSCRIPTION, TRIAL, OFFLINE and TEMP OFFLINE]
- What versions are installed, and version installers are available for download

It also provides:

- A one–click download of an update or a demo
- A button to activate or deactivate any of your licenses
- A copyable list of all your Product Keys
- One–click generation of the MAAT diagnostic report

*It also fixes license issues automagically.*

### In Use

When you launch License Central, it scans your host computer and then attempts to match up each product found with a Product Key on our license server. That scanning happens in real time, and the process is shown as a progress bar. When quitting, this process happens in reverse.

Once all the licenses are validated, a list on the left displays all MAAT products, including License Central. Products that are not installed are grayed out, and installed products are displayed in high contrast. To the right of each product entry is a check mark, which indicated that the product is licensed.

Selecting a product entry displays information about the installed version and if an update is available for download.

### Controls

There are two persistent buttons along the top. At upper left is Check for Updates, which refreshes the list of installed products, and pings our server again for currently available versions to download. It also recreates your Product Key list.

At upper right, the Activate/Deactivate button brings up the familiar blue and orange MAAT license window, allowing you to deactivate or return your license to the Cloud, and to switch to a 30 day temporary

offline license. If you have requested a 365 day full offline license, use the Create License Request function in the MAAT license window, and have received your ".maatc" confirmation file, you can also take your license offline. Finally, you can also paste in a Product Key to activate a new license.

NOTE: Switching to 30 day temp offline requires that your license be already activated. 365 day full offline licenses require a license confirmation file as supplied by MAAT's support department.

If any product is out of date, a third Download Update button will appear when that product is selected. This button is an express method for updating you MAAT products.

At bottom left of the License Central window is an Auto–Refresh check box, which is selected by default. Deselecting that will prevent License Central from frequently scanning your host for changes including new installs. It starts a scan every 3 seconds, waiting for completion of that scan, then begins a new 3 second countdown before starting the next scan. If you find that License Central is interrupting you workflow while scanning, then disable Auto–Refresh.

## Preferences

In License Central, the Preferences' gear icon brings up the Preferences window with four tabs.

### Paths

For those who set up alternate directories for the management of their plug–ins in a DAW, two alternate plug–in paths can be defined. These directories will be also included when License Central searches.

### Keys

This tab lists all of your Product Keys that are known to our license server. Please take a moment to copy all of your Product Keys, paste them into a text or word processor file, and print out a hard copy. Your Product Keys are your proof of purchase and, without them, your purchase will not work and we cannot provide product support.

### Troubleshooting

The Troubleshooting tab has one button, which generates a Diagnostics Report. This report, automatically written to the Desktop, gathers useful, non–personal information about your machine's state that our support team can use to diagnose any problems.

### Info

As with all our products, the Info tab lists credits, copyright information, and the version number you are running.

## Share The Love

Would you like to help us in our quest for better sound quality? Help support MAAT by sharing the love…Like us on Facebook!

https://www.facebook.com/maatdigital/

and Twitter too:

https://twitter.com/maat_digital

Please tell your friends and colleagues about us. We really appreciate it, and thank you for supporting better quality audio.

## Support

For product support, please visit:

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https://www.facebook.com/maatdigital/

and Twitter:

https://twitter.com/maat_digital

and tell your friends about us!

## Credits

Product Concept, Design & Management:

OMas

Programming:

Adam, Agent of Shield & Nils “You da Man” Petersson

Thanks Dr. Christoph Musialik for his contributions in shaping the underlying engine on which LINone is based. Thanks also to all the scientists who, 30 years ago, performed the fundamental research work that led to the development of all the sophisticated dither and noise shaping theories on which later investigators built, including ours. In turn, these pioneers paved a path to much better audio quality at shorter word lengths: Gerzon, Craven, Lipshitz, Vanderkooy, Wannamaker, and many others who have continued their investigations into this topic.

# Appendix One — More Dither Discussions

## What Is Dither?

In brief, dither is a small amount of "noise", typically 3dB, that will "linearise" or avoid as much distortion as possible when reducing the word length of a signal. Dither is fundamental to all quantized systems when converting from quantized digital to non–quantized analog, which is continuous. Look carefully at tonal or density gradations in a printed picture in a magazine, and you'll see the dither hiding there.

## How Does It Reduce Distortion?

Dither reduces "quantization error" distortion by randomly giving the signal an amplitude nudge, up and down by one half of one bit or step, which forces the signal, on average, to "land" on the correct value.

Another way to think of that is a box of granola, with big chunks, little chunks and individual oat flakes, all in some random heap. If you shake the box and slowly lessen that shaking until you stop (injecting random energy). then the individual flakes end up on the bottom and the largest chucks end up on top, with the entire contents sorted by size — or amplitude if it were audio. Since granola boxes are shaken in transport, that's why you always find the biggest chunk are on top and the dust on the bottom when you open a fresh box.

## Would I Derive Any Benefit?

Some DAWS alone do a mathematically correct job of dithering within their abilities. That said though, does your DAW provide only basic noise shaping? If so, then there is a distinct advantage to LINpro. If your DAW does not provide noise shaped dither, then LINone would have that advantage. LINpro has far more choices beyond basic dither, so you can produce results that have lower perceived noise. Notice "perceived." That's what our LINpro engine is all about. Old skool dither goes some of the way toward reducing perceived dither noise, but we have tapped modern psychoacoustic research to best shape the dither noise for least audibility.

## Different Dither For Each Song?

Yes, you can also leverage dither as an effect. Our original redithering plug–in performed basic yeoman's dither duties, but it also offered many dither–as–effect choices for those who wanted to purposefully distort their low amplitude bits.

So, if improper dither = distortion, then some material might benefit from distortion. As a mastering engineer, that's your call. Heck, some people actually LIKE truncation distortion! To the trained ear, it provides an audible veil of crunchy distortion and artificial top end to music while, to the untrained ear used to the distortion produced by digital files played back through most consumer playback systems, which are digital; it may sound "normal" as that is what they are used to. As you may know, changing the gain post–dither in the digital domain results

in noise and/or distortion. Also, most consumers are listening to digital playback with some amount of gain reduction or negative gain dialed in so their ears don't get destroyed. In that scenario, most all consumer systems do NOT dither after negative gain.

## Mastering A 44.1 Master

For best fidelity, SRC (sample rate convert) to 88.2 or 2 x 44.1, not 96k which is not an integer multiple and much more difficult to calculate correctly. Then, set the SRC target to double floats or 64 bit. Those are actually two separate choices for best fidelity:

- Always SRC up or down using integer multiples [44.1 —> 88.2 while 48 —> 96] if you can
- Always use double precision [64 bits for floating point, 48 bits for fixed point] if possible prior to mixing and/or mastering

Basically, always dither on export, whether mixing to a final master, or bouncing or when printing to disk as is the case with stems. ALWAYS dither, as you never know when you or someone else will be reusing that asset you are making in some new situation 10 years from now. So, make it the best it can be for the future.

If you need a 44.1 or 48k child from an HRA master, then dither as the very last step.

## Ear Training

It might be time to "train your ears,' if possible, to actually understand this part of music/audio production. Dither is subtle but important.

Listen to your own experiments, starting with 60dB of gain makeup as mentioned earlier in this user manual. Then, gradually decreasing the makeup gain until you can hear the differences with only 24 dB of gain makeup. 4 bits is not a lot of gain change in a typical playback environment, so you'll be able to discern what happens when a consumer "damages" your content.

## Appendix Two — The Curves

These illustrations are not MATLAB simulations, they are actual plots generated by LINone's optimized dither engine. Notice that, in all but the first graph, the -100dBFS input signal or excitation (the vertical spike at 997) is preserved even though the word length has been reduced to 16 bits.

A 16–bit word can only encode or store 96dB of dynamic range. As mentioned earlier, any information quieter than -96dBFS *should be lost* when reducing the word length to 16. The first plot, an empty one, shows that all information residing in the 17th through 24th bit in a 24–bit word is gone *without proper dithering*. For all other illustrations in this appendix, the input signal is preserved.

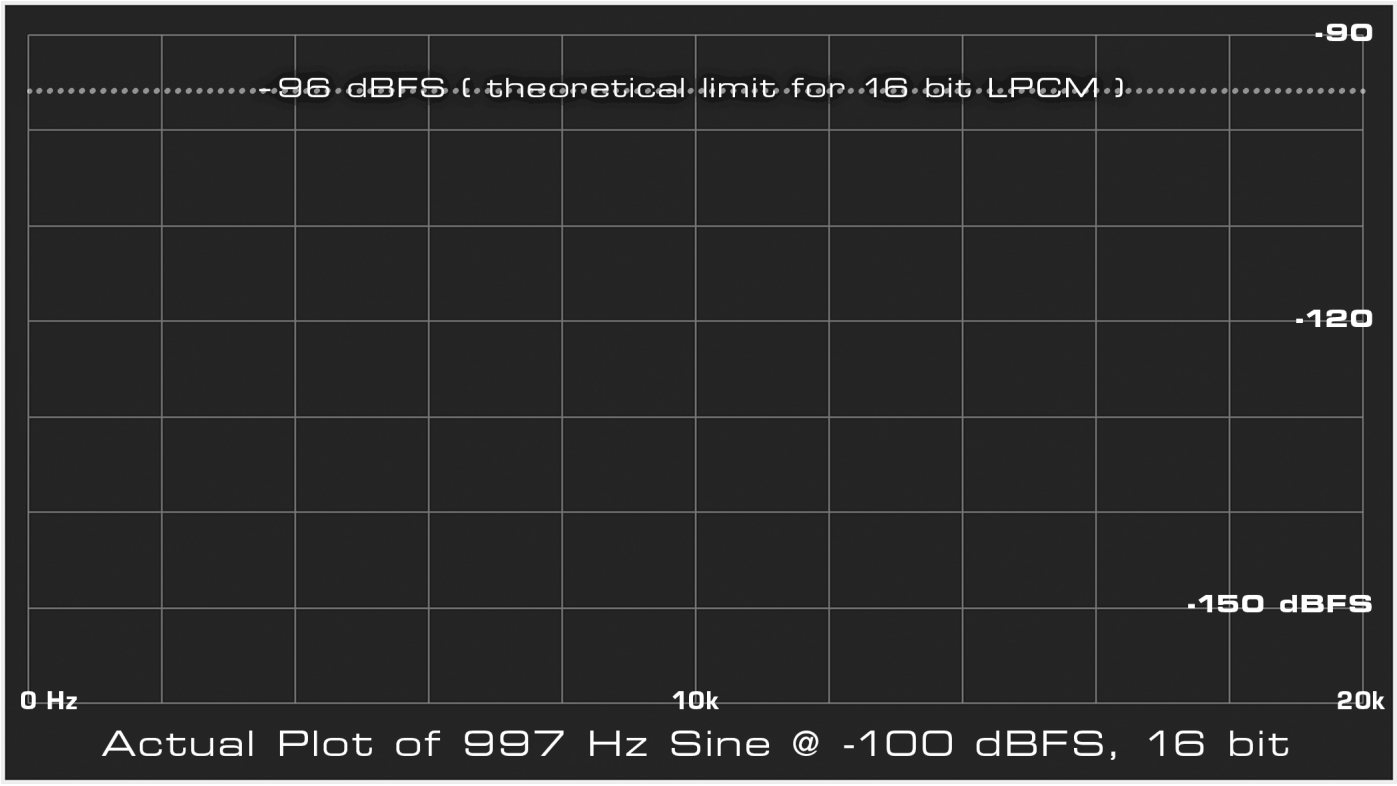


*Figure A1 — No dither, no noise shaping = no low level information preserved*

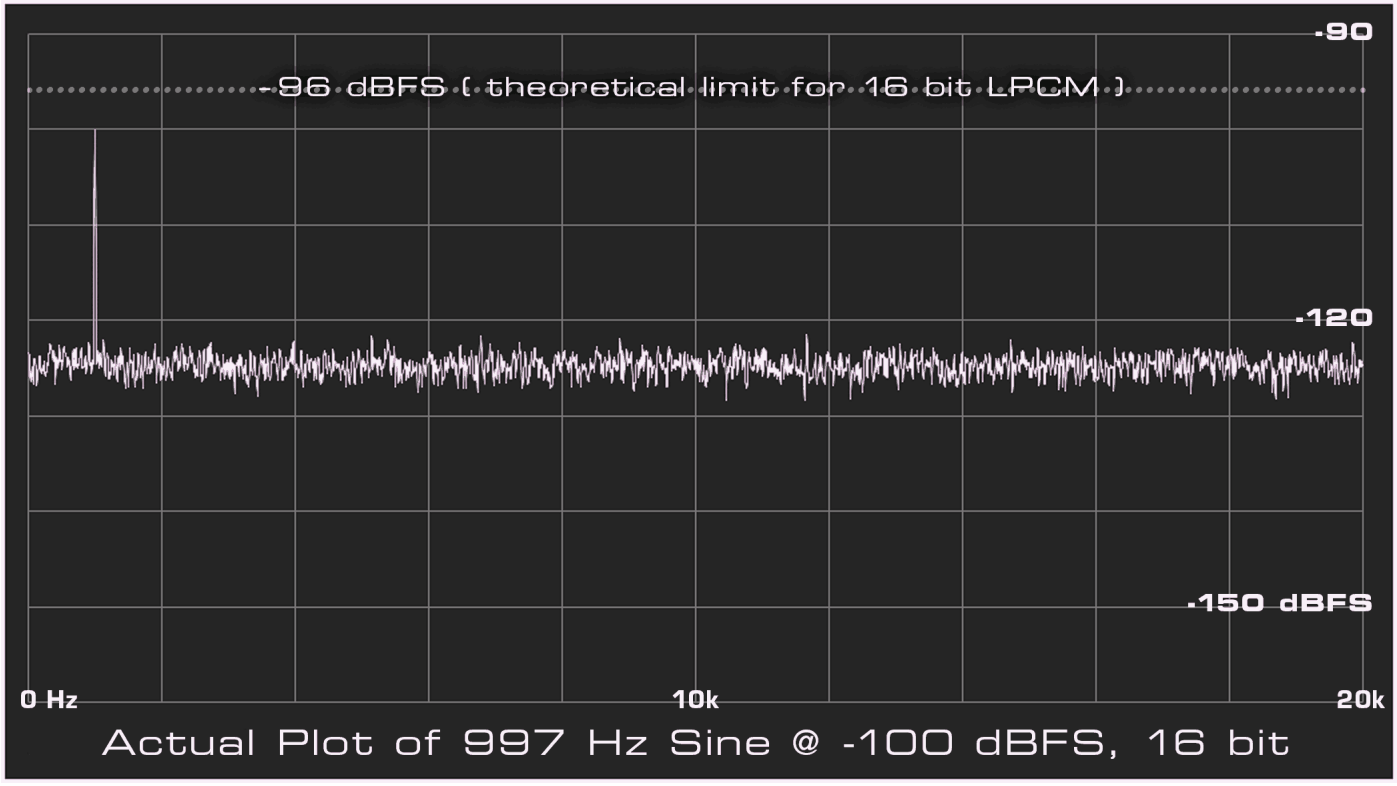


*Figure A2 — Triangular dither, no noise shaping*

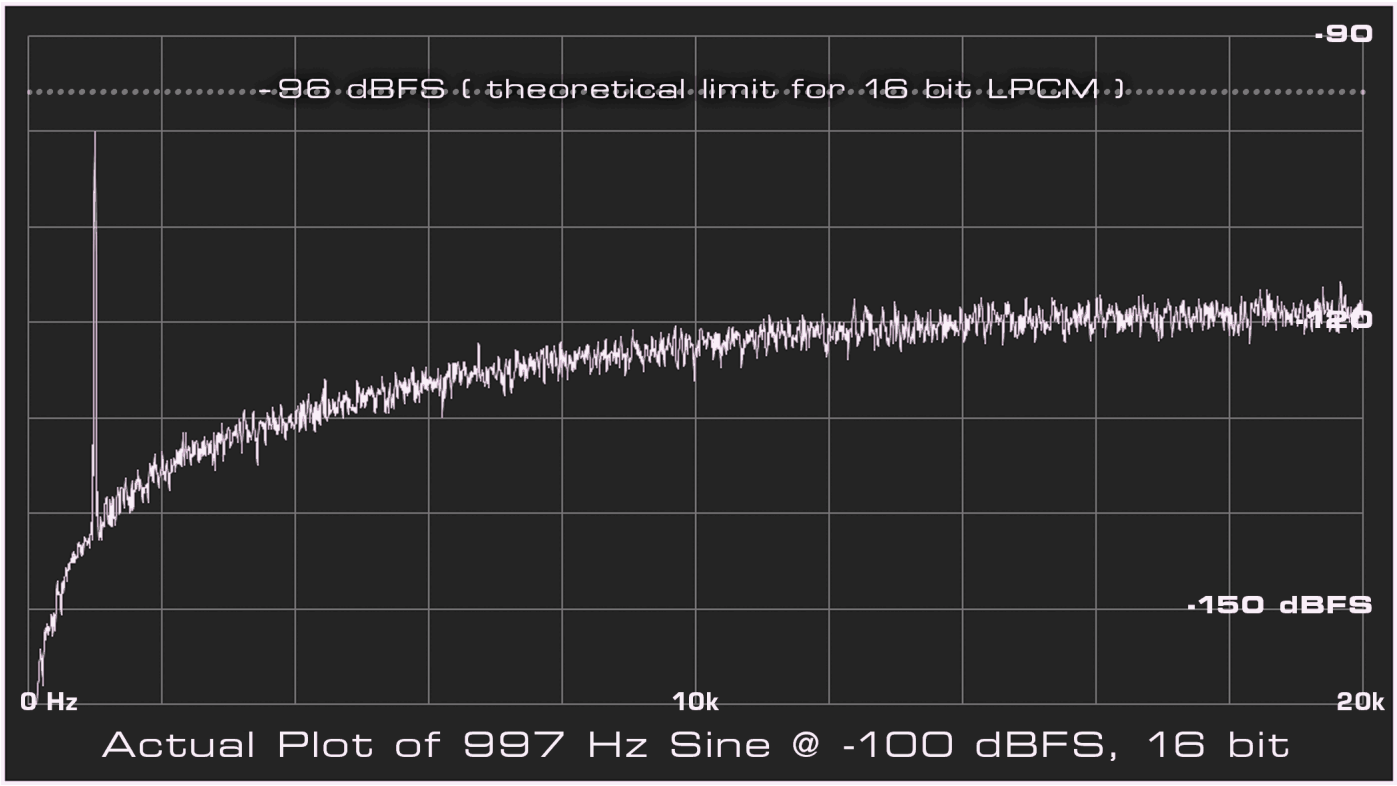


*Figure A3 — Triangular dither, NS1*

# About This Manual

This manual was written in Adobe InDesign 16.4, and is set in Robert Slimbach's Minion Pro and Myriad Pro. The cover page is set in Aldo Novarese's modernist geometric Eurostyle. O.A. Masciarotte supplied the book *To Serve & Groove*, from which some material was adapted for this LINone user manual.



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