TiTUS
BBD *Delay*

v2.1.0

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Coding by Pitchblende Ltd for Jiggery-Pokery

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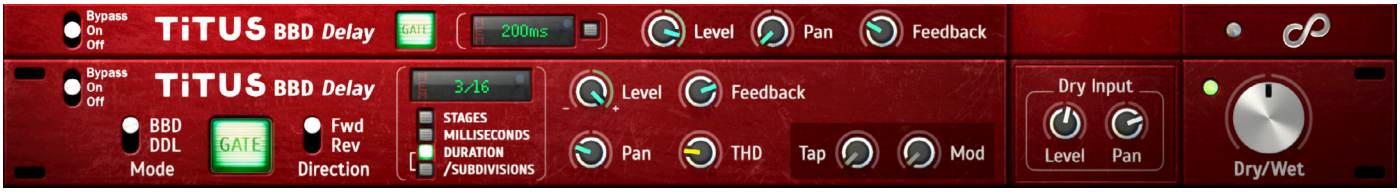
Re Rack Extension

Titus BBD Delay



Titus is a 1U delay, based on the classic Bucket Brigade Delay integrated circuits of the 1970s and 1980s, found in many classic delay pedals.

BBD Delay

A BBD is a type of Integrated Circuit (IC), which is a Sample & Hold device with a fixed number of stages, known as a delay line; an audio input would be held as if it was a bucketful of water being passed along a line of people (hence, "bucket brigade"). For a chip such as the SAD512D, think of it as if there were 512 people in that line. Other BBD ICs had differing lengths, up to 4096 stages.

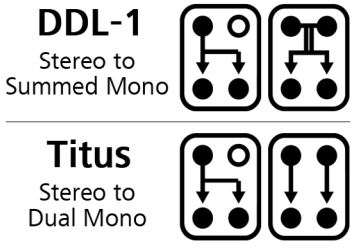
Titus overview

For *Titus* we have taken a single delay channel from *Steerpike* and made it into a compact 1U device. Several useful features from *Steerpike* are carried over.

The delay time can be set by the number of BBD stages (**#**), time (**ms**) or tempo synced to the Reason transport. For the first time in Reason, tempo sync ranges are no longer entirely determined and limited by the designer: you can select any beat division from /2 (minim) to /16 (semiquaver) and all halved and triplet steps up to /256 using the **Duration** control, and any the number of delays to that division using the **Subdivision** control, from 1 to 16. Thus you can create flexible and creative tempo synced delay times such as 3/7, 14/96, 3/2, 5/3, 2/15 as well as the Reason standard 3/16, 1/8 and so on.

The delay line supports up to eight seconds of delay time, regardless of the sample rate or song tempo, and can be set as a reverse delay without feedback.

Titus also has a Tap Out and Tap In audio connection, essentially send and return breakout jacks for feedback loops. The Tap In has its own feedback adjust on the front panel.



Unlike Reason's native DDL-1 delay device, *Titus* can operate both as true mono-to-stereo (by panning a mono signal and delay signal to opposite stereo positions) and as dual mono for handling stereo inputs on two separate delay lines, although note that the same parameters are shared between both left and right channels. Thus *Titus* offers a useful alternative setup to the old Reason half-rack delay, which sums stereo inputs to mono first. For stereo with different parameters for each channel, use two devices in mono as you would with DDL-1.

Controls

Bypass/On/Off Switch

This is an important control! In an emergency, if the delay audio is doing things you would rather it not be doing, set this to **Off** to immediately stop audio output. This will also purge all the delay lines. Setting to Bypass will not clear the delay lines.

Mode

Use this button to switch between **BBD** mode and **DDL** (Digital Delay Line) mode. Unlike *Steerpike*, BBD mode in *Titus* uses a fixed clock rate and fixed frequency anti-aliasing low-pass filter.

DDL is the typical software digital delay. With **DDL** mode you will avoid aliasing entirely. More usefully it will allow you to have longer feedbacks, even infinite feedbacks, without the sound degradation that would occur when using **BBD** mode (or with tape-style delays like The Echo), even with **THD** at minimum: for *Titus* the internal filter is disabled in **DDL** mode, allowing the signal's full frequency range to pass through the delay. This is in contrast to *Steerpike*, where the filter can be manually set as required in either mode. As with **Bypass/On/Off Switch** Off, switching **Mode** will also instantly clear the delay lines.

Gate (Audio to Delay Line In)

This useful oversized button turns the delay line gate off and on. If turned off, no audio enters the delay line, and is only passed to the Dry/Wet mixer in the Dry output. When on, the audio is passed to the delay lines.

What is particularly useful about the **Gate** function is that turning it off doesn't clear the delay line, so it allows you to shut off new audio into the delay line while still allowing the already delayed audio in them to progress and finish playing. With infinite delays—where feedback set to 100%—this is especially important, as you can effectively record the delay like a loop, letting it play indefinitely, while shutting off the delay line input to prevent it swamping the dry signal as you continue playing a unique input over the top with the dry signal.

Try mapping **Gate** to your sustain pedal for delay-sustain.

Delay Mode

Titus features two modes, using the **Direction** switch: Forward delay or Reverse delay. Reverse delay does not use the Feedback. Reverse delays are complex to produce, since of course we cannot predict the future: everything we want to reverse must be in the delay buffer *before* we can reverse it! To get a reverse delay with feedback is even more complex, as it requires two buffers, one for the delay and feedback, and another to reverse it. For example, to reverse delay a one second block of audio with feedback requires up to three seconds of delay: the first to delay and add feedback, and up to two seconds for the reverse (since the reverse recording is free-running, its point of recording the loop may not be where you need it). You also cannot, for most practical scenarios, have the reverse in the same buffer as the feedback or else you will get a forward-reverse-forward-reverse effect.

To use Reverse delay with feedback, is it therefore more logical to use two Titus devices in series, one set to Forward, one set to Reverse, which provides more flexibility by providing different delay lengths via adjusting their delay times separately.

When Reverse delay is enabled the display will feature a blue metronome lamp in the upper right of their **Delay Time** display to help you time triggering and recording of the loop. As you may find you need to predict the future, it is likely there will be scenarios where to get the reverse ending at precisely the correct moment, such as at the end of a bar, you will have to record the trigger and manually move the required clips until the timing is correct. The key to understanding and using reverse delay is to remember that the reverse delay should end at twice the delay time you have set. So for a 1 bar delay the *first* transient of the input signal should arrive at the *end* of the second bar. See page 6 for further guidance.

Delay Time

To set the **Delay Time** drag your mouse up or down on display to increase or decrease the delay time. There are three different ways you can set the delay time, by clicking on the buttons below the display to change the delay time mode.

- **Stages (#):** Use this mode to set the fixed number of stages the BBD uses, from 2 to 16,384. The hold time between each stage is fixed.
- **Time (ms):** This mode allows you to set the delay time in milliseconds (0.01–999ms) or seconds (1.0–8.0s). In **BBD** mode *Titus* converts these to the required number of Stages.
- **Tempo Sync (Duration/Subdivision):** These two controls allow you to independently set duration and subdivision for tempo sync values. In **BBD** mode *Titus* converts these to the required number of Stages. *Titus* will operate in tempo sync mode with either **Duration** or **Subdivision** buttons selected. Default is 3/16. (*Note: There are two tempo sync selector*

buttons to maintain backwards compatibility with Titus version 1; for version 2 either button can be selected—and the folded view will still need to step through "both" to get back to Stages mode—but they show exactly the same display). Use the left side of the display to control the **Duration** value, the right side to adjust the **Subdivision**.

Why two *Tempo Sync values?*

Normally in Reason devices you are given a fixed list of tempo synced values by the designer of the device. This list usually has to be fairly short so as not to be overwhelming, but has the disadvantage of providing a limited range of rates, at a limited range of BPMs with which to use them.

In *Titus* the delay itself can be freely set to a massive range of creatively tempo synced delay times by adjusting the **S**ubdivision (the right hand number, the beat division) and the **D**uration (the left hand number, the duration, or number of beats at the set subdivision). While some are settings are going to be the same as others, (e.g. 2/128 is the same as 1/64), you can simply dial in the precise number you want rather than have to work out what is equivalent to what. You can select from 1 to 16 beats over 36 subdivisions: that's 576 possible tempo synced delay lengths, per BBD. For displaying the length we have, for consistency, used US style numeric subdivision values, from /2 (Half Note) to /256 (Two Hundred and Fifty-Sixth Note). The most important ones you may wish to be aware of are /16 (Sixteenth Note/Semiquaver), /12 (Triplet quaver), which is often listed in Reason as 8T, and /24 (Triplet semiquaver), aka /16T.

Steerpike Duration	Steerpike Subdivision	Equivalent to:	
1 to 16	/256		
1 to 16	/192	/128T	
1 to 16	/128		Demisemihemidemisemiquaver
1 to 16	/96	/64T	
1 to 16	/64		
1 to 16	/48	/32T	Thirty-Second Note Triplet
1 to 16	/32		Thirty-Second Note / Demisemiquaver
1 to 16	/24	/16T	Sixteenth Note Triplet
1 to 16	/20		Sixteenth Note Quintuplet
1 to 16	/16		Sixteenth Note / Semiquaver
1 to 16	/15		
1 to 16	/14		
1 to 16	/13		
1 to 16	/12	/8T	Eighth Note Triplet
1 to 16	/11		
1 to 16	/10		
1 to 16	/9		
1 to 16	/8		Eighth Note / Quaver
1 to 16	/7		Quarter Note Septuplet
1 to 16	/6	/4T	Quarter Note Sextuplet
1 to 16	/5		Quarter Note Quintuplet
1 to 16	/4		Quarter Note / Crochet
1 to 16	/3	/2T	Half-note triplet
1 to 16	/2		Half Note / Minim

Naturally /16 is the most useful at typical BPMs, so /16 is the default for the **S**ubdivision value. If requiring just /16 values, you'll only ever need to change the **D**uration figure and do not need to look at the /Subdivision value. At slow BPMs however, you might find it's easier to use /32 or even /64, while at very fast BPMs /8 or /4 become useful.

But we only have a delay buffer of eight seconds! Well actually eight seconds is a *very* long time for a delay. It's likely to be rare you'd need a delay time that long: if you have a *really* long delay time, such as 16/2 and your song is 58 BPM, or perhaps you have set a delay time of 16/4 and a song tempo of 27 BPM, in both cases the required buffer size for that delay to be achievable is too big when in **DDL** mode and will trigger the **MEM** warning lamp to the left of the **Delay Time** display. The delay time will still be limited to eight seconds. If you need that 16/4 delay time at lower than 28 BPM, then you can still use multiple *Titus* devices in series.

Level

Centre is zero output level. Increase the value to the right to set the Wet level into the Dry/Wet mixer. Increase the value to the left for a phase inverted and high pass filtered output.

Pan

For a mono input this sets the stereo position of the delayed output. For a stereo input **Pan** controls the balance between left and right delayed outputs.

Feedback

Use this control to set the number of repeats before the delay subsides. *Titus*'s **Feedback** control provides up to 100% Feedback for infinite delay. In **BBD** mode destructive interference because of sample & hold will still cause the delay to fade, so **DDL** mode will normally be the preferred option when you require a continuous, non-fading repetition that will continue until you clear the delay line, but even then in **DDL** mode for infinite delays you will likely not want to use EQ or LFO modulation.

Feedback is not available in Reverse mode.

THD [Total Harmonic Distortion]

Harmonic distortion is introduced by BBD circuits. The more stages in the BBD the more distortion is introduced. The **THD** knob controls the Total Harmonic Distortion produced. Typically you might expect approximately 1% of THD per 1,024 stages. In *Steerpike* you can drive the THD from zero right up to 36% independently of the number of stages, although that 36% figure is fairly arbitrary: it's based on a sine wave of 80Hz at a particular input level, so the *actual* THD amount, as you would therefore expect, will not necessarily reflect what is set by this control.

The effect of this control will be most obvious on signals with less harmonics to begin with.

Tap

This control adjusts the feedback level of the **Tap In** audio jack. **WARNING: There is a serious risk of a loud feedback loops with high Feedback and Tap In levels. Use Tap with caution: reduce levels first and increase gradually!**

Mod

Adjusts the depth/amount of delay time modulation from the Mod CV Input. For best results leave the rear Mod CV Trim Knob at maximum and only use the front panel **Mod** control.

Dry Level

Adjust the level of the Dry signal into the Dry/Wet mixer.

Dry Pan

An incredibly useful feature, this allows you to set the pan position of the Dry signal. Reason's SSL Mixer does not handle insert delays particularly well, as if you have, for example, a delay on the left channel and want the dry on the right, it can't actually be done adequately via the Main Mixer at all. Pan the Main Mixer channel right and you lose the delayed left signal. So traditionally one has typically needed to add insert delays using the extra hassle of setting up a Line Mixer or ReMix and bypass the Main Mixer panner entirely to allow for both wet and dry to be panned differently.

If the input is mono this control will pan the dry signal left or right. If the input is stereo the control adjusts the balance between left and right. For true stereo-to-stereo, use two instances of Titus in mono, one for each channel.

Dry/Wet

Predictably, this knob controls the amount of Dry and Delayed signal in the output.

Back panel connections

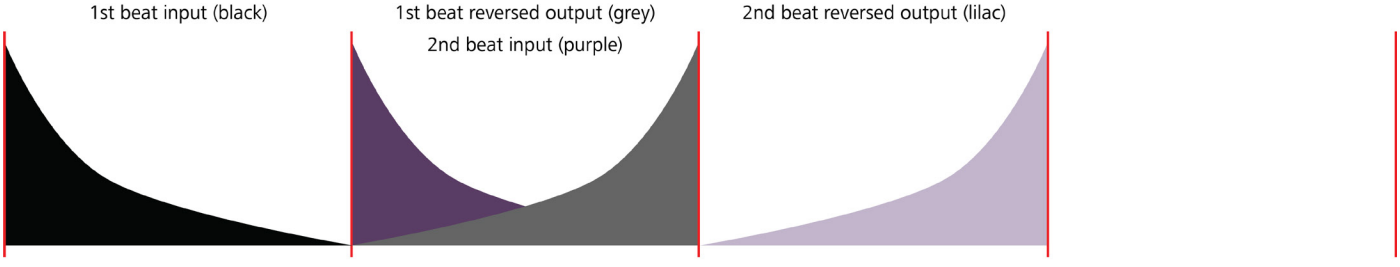
On the back are CV inputs for the Gate, which acts as an input gate, and useful set of additional CV modulation jacks. “Delay” and “Mod LFO” both modulate the delay time, but in different ways. Use “Mod LFO” for more subtle modulation, such as a vibrato or tape wobble effect, and use “Delay” for more dramatic pitch changes.

Tap audio inputs and outputs are available in mono, or dual mono where stereo or dual mono inputs are connected to the main audio in jacks.

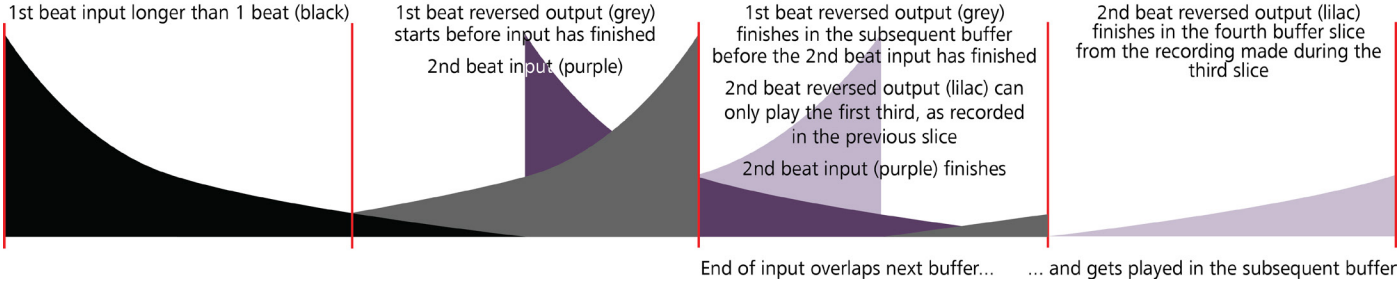
Visualising reverse delay slices

The key to understanding and using reverse delay is to remember that the reverse delay should end at twice the delay time you have set. So for a 1 bar delay the first transient of the input signal should arrive at the end of the second bar. As suggested earlier, especially when requiring “one-shot” reverse, think of reverse delay as the length of a record loop: 1/4 delay = 1/4 record time. This recording length needs to be at least as long as the input:

Snare drum sample that is exactly 1/4 (2/8) in length at 120bpm
Reverse delay set to 1/4



Snare drum sample that is exactly 1/4D (3/8) in length at 120bpm
Reverse delay still set to 1/4



The graphic shows how setting a reverse time of 1/4 creates recording "slices" of 1/4, that are replayed consecutively while recording a new slice in another buffer. The entire slice is reversed, so something at the beginning of the record buffer will be played at the end of the playback buffer.

The first example works as the length of the snare is equal to or less than the recording time of the slice. In the second example, to play the reverse correctly you should increase the delay time to 3/8, to ensure the entire drum hit is still recorded in the same slice, otherwise the end of it will be in the subsequent slice, and the start of the reverse might be truncated. This is still a useful effect in its own right, but be aware of the pitfalls!

Remote Mapping

```
/Remote Map template for        Effects             Jiggery-Pokery Sound: Titus BBD Delay Line
Scope   Jiggery Pokery    com.jiggerypokery.Titus
//      Control Surface Item        KeyRemotable Item       Scale     Mode
//Map   _control_           Delay Mode
//Map   _control_           Delay Line Gate
//Map   _control_           DDL Type

//Map   _control_           Delay Time Mode
//Map   _control_           Stages
//Map   _control_           Time
//Map   _control_           Sync Duration
//Map   _control_           Sync Subdivision
//Map   _control_           Level
//Map   _control_           Pan
//Map   _control_           Feedback
//Map   _control_           THD
//Map   _control_           Tap Level In
//Map   _control_           Modulation Depth

//Map   _control_           Dry/Wet
//Map   _control_           Dry Signal Level
//Map   _control_           Dry Signal Pan
```

Version history

2.1.0

- **Delay time selector displays updated to use custom displays; tempo sync mode can now display both duration and subdivision on the same screen for improved usability**

2.0.0

- **Beautiful new design by esselfortium**
- **Bug fixes**

1.0.0

- **Initial release**

Special thanks to the Steerpike *testing and patch crew: Dogboy1973, JesseRyckman, 0zone0, meowsqueak, alteree, kylelee, NaviRetlav, xcountrycoach.*

Titus BBD Delay was designed and assembled by Jiggery-Pokery Sound, of London, England; DSP coding by Pitchblende Ltd, of Middle Earth.

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- **Titus BBD Delay Line** - A lightweight 1U delay device featuring a single Steerpike delay line, with reverse

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