Tubbutec uniPulse

General manual

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Contents

Disclaimer

Tubbutec is not responsible for any damage caused by improper installation of the uniPulse.

1 Introduction

The following manual describes the functionality and specifications of the Tubbutec uniPulse. In the second part, examples are shown for typical drum machine topologies. This information can be applied to almost any drum machine. Installation manuals for specific drum machines can be found here:

https://tubbutec.de/blog/category/uniPulse/

New manuals will be added constantly. You can also help to expand the database of installation manuals and will be rewarded for your help. See

http://tubbutec.de/uniPulse

for details.

2 Hardware

2.1 Overview

The uniPulse hardware consists of a board with the dimensions 40x43mm. It features a 'learn' button and a multi connector to connect a ribbon cable. Midi in is provided via an installed midi socket, or a connector to connect a midi socket via two wires.

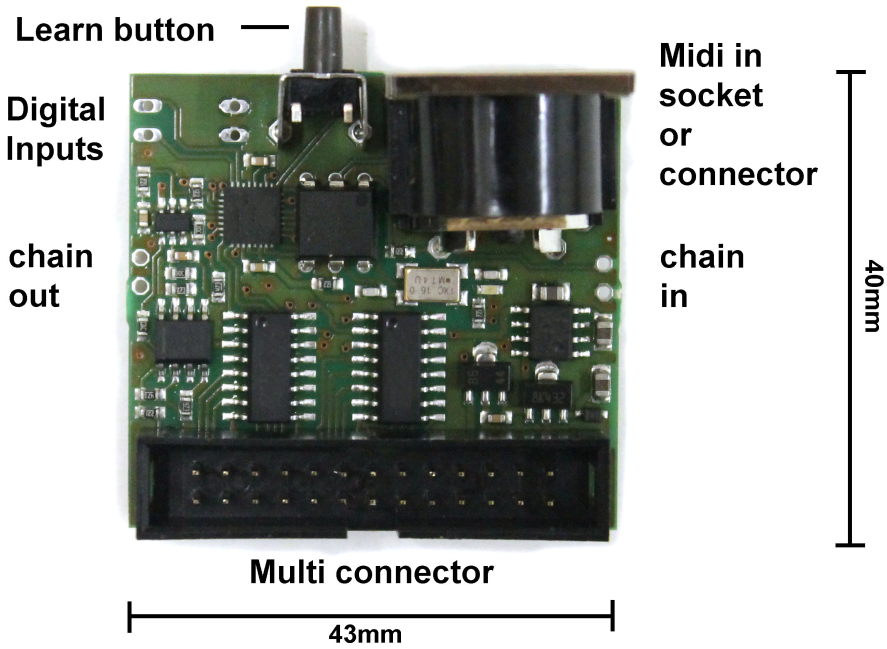


Figure 1: The uniPulse hardware and connectors

The Midi socket version (A) can directly be mounted behind a panel with two screws. Four holes are necessary: one for the learn button, one for the midi socket and two for the screws. The midi connector version

(B) requires three holes to be drilled for the midi socket. See figure 2 for mechanical drawings.

The 'digital inputs', 'chain in', and 'chain out' seen in figure 1 are currently not used and reserved for future updates.

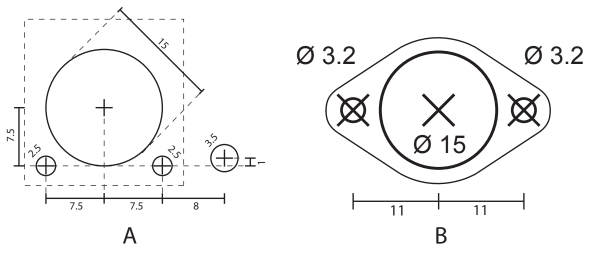


Figure 2: Location of holes for the two configurations

The multi connector houses connections for supply voltage, trigger outputs, digital outputs, CV input and CV output.

Figure 3 shows the connections of the multi connector.

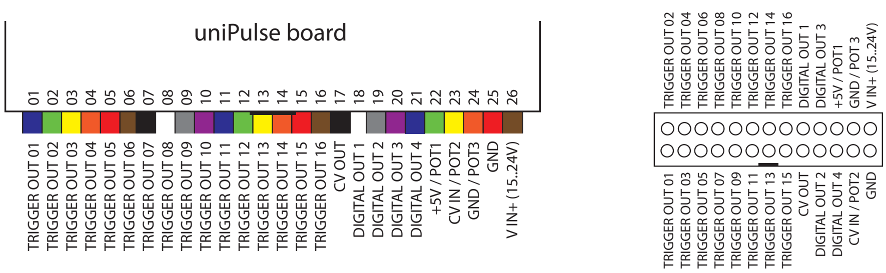


Figure 3: Ribbon cable and multi connector configuration

2.2 Supply voltage

The uniPulse needs a DC supply voltage between 15V and 25V. An -12V supply is generated internally to allow for negative pulses. The supply voltage is connected between 'V IN+' (Pin 26) and 'GND' (Pin 25). The uniPulse draws about 30mA of current. If the supply voltage is connected correctly, the blue indicator on the board lights up. The supply voltage input is polarity protected.

2.3 Trigger outputs

The uniPulse features 16 Trigger outputs. Each of these can output pulses ranging from -12V to +12V. After each pulse, the output returns to a high impedance state. The amplitudes of the pulses are configurable and can also be linked to midi velocity. The pulse length can also be adjusted and linked to midi velocity or the CV input (see below).

Additionally various pulse shapes can be selected for each output: Rectangular, Triangular, Decay, Gaussian and Open Rect. The latter is similar to the rectangular pulse, with the exception, that instead of returning to zero volts, it goes into a high impedance state. This allows it to make use of the characteristics of an existing pulse shaping network, such as an RC network built into the drum machine. The pulse shapes have different sonic characteristics, experimenting which suits best is recommended. The Gaussian pulse for example contains less higher harmonics and can be used to simulate drums hit by a felt headed mallet. Figure 4 illustrates the various pulse shapes.

The trigger outputs can also be used to output clock signals.

Figure 4: Different pulse shapes

2.4 Digital outputs

Four digital outputs are available. They output a digital signal with either 0V or 5V.

The digital outputs can be configured for various purpuses. These are:

- Gate: a gate reacting to midi note on and off commands
- Sync gate: A start/stop signal derived from the midi clock
- Sync clock: A clock signal derived from the midi clock. A divider/multiplier can be configured between 48PPQN and 1PPQN (pulses per quarter note)

For each of these settings the polarity can be configured.

These outputs are current limited to about 20mA, but are not over voltage protected. If you connect them to a voltage higher than 5V or lower than 0V, you need to install an additional 10k-100k resistor in series, or use a buffer. Otherwise the output, or even the whole uniPulse can be destroyed.

2.5 CV-out

The CV-out is able to output a voltage between 0V and 12V. Various functionalities can be assigned to the CV-out:

- Velocity CV: Outputs a voltage proportional to the velocity parameter of a note on command.
- Controller CV: Outputs a voltage proportional to the amount of a midi controller command.
- CV-Gate: Outputs a voltage proportional to the velocity parameter of a note on command, but returns to a resting state if a corresponding note off command is issued.
- Sync gate: Same as for digital outputs, but the voltage is selectable
- Sync clock: Same as for digital outputs, but the voltage is selectable

For each of these settings the maximal voltage and the polarity can be configured.

2.6 CV-in

This analog input can be connected to a potentiometer or a CV input socket. The CV-in can be linked to the length or amplitude of the pulses (see chapter 3, Configuration tool).

In case a socket is connected, a current limiting series resistor is recommended. Figure 5 shows how to connect a potentiometer or a socket. R2 provides over current and over voltage protection for the analog input, while R3 sets the input to a defined voltage when nothing is connected. With the values shown, CV-link is set to the maximum, if nothing is connected.

The input accepts voltages between 0V and 5V, without a current limiting resistor, any voltage above or below this will destroy the input.

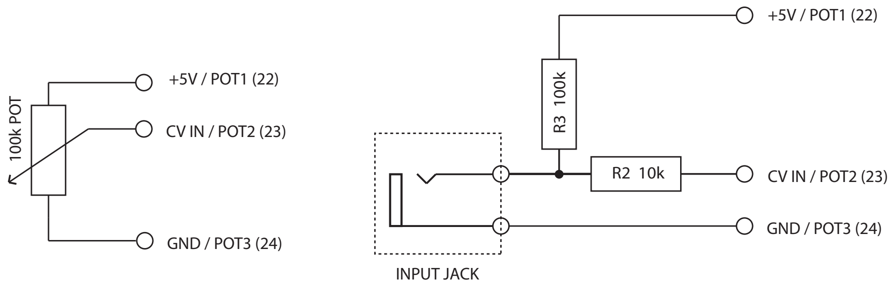


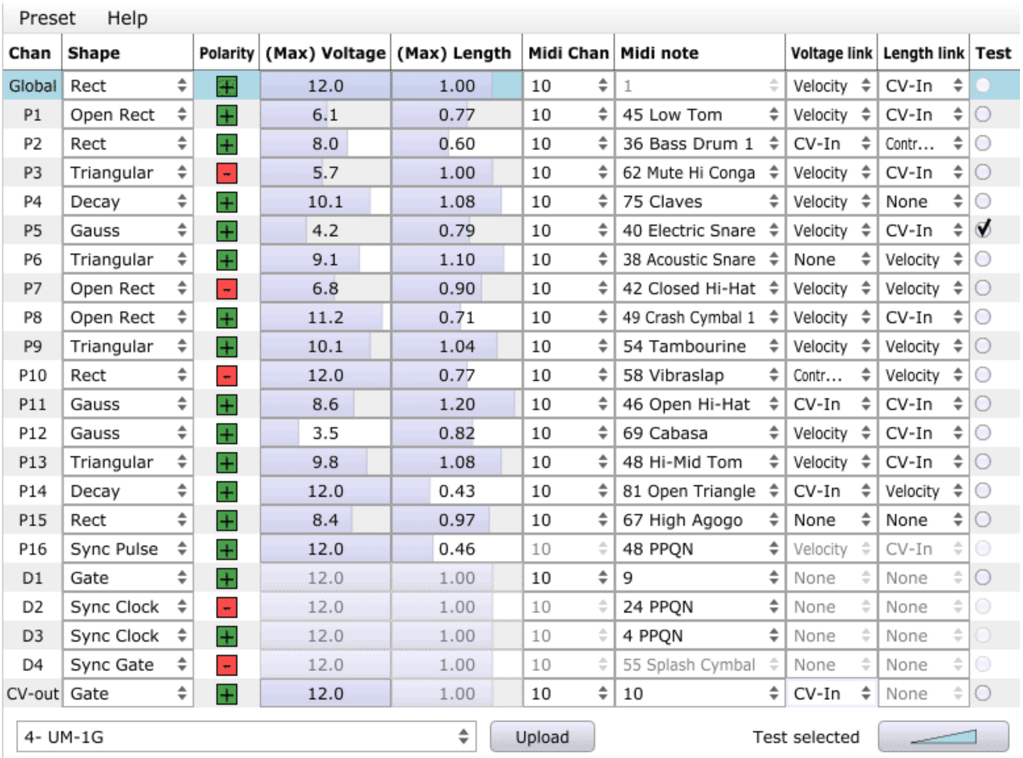
Figure 5: Connecting a potentiometer or socket to CV-in

2.7 Learn button

The learn button can be used to configure the midi channel without using the configuration tool. After pressing it for about 1s, the midi channel of the next note event will be assigned to all outputs. The learn button also serves as a fail save after a failed firmware update. Hold the button during power up of the uniPulse and it will enter the bootloader mode. Make sure the button is installed in a way so it is not touching anything during normal operation. Otherwise the bootloader mode will be entered each time you turn on the device and normal functionality is not provided.

3 Config Tool

Figure 6 shows a screen shot of the uniPulse configuration tool. It is available for Windows and Mac and uses sysex messages to configure the uniPulse hardware.


Preset Help

Chan	Shape	Polarity	(Max) Voltage	(Max) Length	Midi Chan	Midi note	Voltage link	Length link	Test
Global	Rect	+	12.0	1.00	10	1	Velocity	CV-In	
P1	Open Rect	+	6.1	0.77	10	45 Low Tom	Velocity	CV-In	
P2	Rect	+	8.0	0.60	10	36 Bass Drum 1	CV-In	Contr...	
P3	Triangular	-	5.7	1.00	10	62 Mute Hi Conga	Velocity	CV-In	
P4	Decay	+	10.1	1.08	10	75 Claves	Velocity	None	
P5	Gauss	+	4.2	0.79	10	40 Electric Snare	Velocity	CV-In	✓
P6	Triangular	+	9.1	1.10	10	38 Acoustic Snare	None	Velocity	
P7	Open Rect	-	6.8	0.90	10	42 Closed Hi-Hat	Velocity	Velocity	
P8	Open Rect	+	11.2	0.71	10	49 Crash Cymbal 1	Velocity	CV-In	
P9	Triangular	+	10.1	1.04	10	54 Tambourine	Velocity	Velocity	
P10	Rect	-	12.0	0.77	10	58 Vibraslap	Contr...	Velocity	
P11	Gauss	+	8.6	1.20	10	46 Open Hi-Hat	CV-In	CV-In	
P12	Gauss	+	3.5	0.82	10	69 Cabasa	Velocity	CV-In	
P13	Triangular	+	9.8	1.08	10	48 Hi-Mid Tom	Velocity	CV-In	
P14	Decay	+	12.0	0.43	10	81 Open Triangle	CV-In	Velocity	
P15	Rect	+	8.4	0.97	10	67 High Agogo	None	None	
P16	Sync Pulse	+	12.0	0.46	10	48 PPQN	Velocity	CV-In	
D1	Gate	+	12.0	1.00	10	9	None	None	
D2	Sync Clock	-	12.0	1.00	10	24 PPQN	None	None	
D3	Sync Clock	+	12.0	1.00	10	4 PPQN	None	None	
D4	Sync Gate	-	12.0	1.00	10	55 Splash Cymbal	None	None	
CV-out	Gate	+	12.0	1.00	10	10	CV-In	None	

4- UM-1G Upload Test selected

Figure 6: Configuration tool

3.1 Configuration table

Each row of the configuration table shows the configuration of one uniPulse channel. Channel P1 - P16 denote the 16 pulse outputs, D1-D4 are the digital outputs and 'CV-out' the analogue output. The 'Global' channel at the top allows a user to set a parameter (such as the midi channel) globally.

- Shape: Here you can select the pulse shape, output and input configurations.
- Polarity: When the box is set to '+', the polarity of the output is positive, otherwise negative. In case of the trigger outputs this means positive or negative voltage, in case of the digital and CV outputs this switches between active high (checked) and active low(unchecked)
- (Max) voltage: The maximum voltage to be output on this channel.
- (Max) Length: The maximum pulse length adjustable between 0 and 1.27ms.
- Midi chan: The midi channel of the output reacts to.
- Midi note: The midi note of the output reacts to.
- Voltage Link: Select whether the voltage is linked to nothing, midi velocity, CV-input or a midi controller.
- Length Link: Select whether the length is linked to nothing, midi velocity, CV-input or a midi controller.
- Test: select which channel to test via the test button (see below)

3.2 Test Button:

Use this button to upload the current configuration of this particular channel and test it. The button is velocity sensitive: The more you click to the right on the button, the larger the velocity value will be.

Configuration for the selected channel is updated in the UniPulse, but not saved. Powering off the UniPulse will reset it to the last saved configuration. Use 'Upload' to save the configuration.

The correct midi output channel needs to be selected for this to work.

3.3 Midi upload

The configuration is sent to the uniPulse using midi sysex messages. Select a midi output in the drop-down box on the bottom and connect the uniPulse to this midi output. To upload the configuration, press the 'Upload' button.

The blue indicator LED on the uniPulse will blink to indicate an upload in progress.

3.4 Presets

Via 'Load preset', 'Save preset' and 'Save preset as' in the 'Preset' menu, preset configurations can be saved and loaded.

4 Typical applications

4.1 Power supply considerations

Drum machines often supply a DC voltage of 15V to 25V which can be used directly to power the uniPulse. Some drum machines however use a negative supply voltage, such as -15V. Is this case a positive voltage for the uniPulse must be supplied.

Usually the drum machine uses a transformer followed by rectification and filtering to produce a DC voltage. If half-wave rectification is used here, one can use the other half wave to power the uniPulse. An additional diode and electrolyte capacitor is all that is needed in this case. Figure 7 shows how to connect the uniPulse in such a case. The value of the capacitor depends on the supply voltage. Table 1 shows minimum capacitor values depending on the AC supply voltage. Shown are the amplitude of the AC voltage (or (peak-to-peak)/2) and the RMS voltage. A higher capacitor value than the one shown is beneficial.

If the drum machine uses full wave rectification to generate its negative power supply, and there is no positive voltage available, one needs an additional transformer or switched power supply for the uniPulse. Typically a transformer with full wave rectification and filtering would be used. Table 1 shows the minimum recommended value for the capacitor in this case.

When using a switched-mode power supply, no additional filtering or parts are needed.

AC amplitude in V	RMS voltage	C1, half wave rectification in μF	C , full wave rectification in μF
16	11,3	1000	–
18	12,7	220	220
20	14,1	100	47
22	15,6	68	47
24	17	68	22

Table 1: Minimum capacitor value depending on AC supply voltage

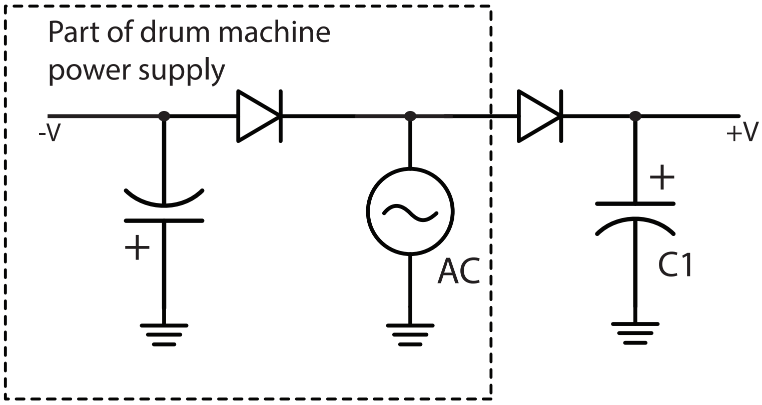


Figure 7: Generating positive voltage via half wave rectification

4.2 Trigger points

4.2.1 Analog drum machines

In vintage analogue drum machines, the audio output is sometimes muted, when the device is not started. One way to circumvent this, is to press start without having a pattern selection switch pressed.

Drums

Vintage analog drum machines usually create their drum sound by a common principle: A pulse is send into a resonant filter to create a decaying waveform. In some cases multiple filters are used for one instrument, in other cases additional noise is mixed with the signal.

As shown in block diagram ?, the pulse usually enters a conditioning circuit CC and from there passes into the bandpass B, which in turn outputs the decaying waveform.

Different implementations for the bandpass are common. The first machines implement it by using an LC network with high Q. To achieve this, rather large inductors are needed (B1). Smaller inductors can be used when using an active element, such as a transistor (B2). By using an active filter topology such as a bridged-T, or a modified phase shift oscillator, the inductance can be neglected. Here an active element can be a single transistor (B3) or an opamp (B4).

The waveform created is not a decaying sine, but contains higher harmonics as well. This is partly due to the limited (not infinite) Q-factor of the bandpass. Especially in cases B1-B3 however non-liniarities in the circuit create additional harmonics. In case B1 this is due to saturation in the coils, in B2, B3 (and B4) this is due to non-linear behavior of the active element. Both effects create an audible dependency between pulse shape and sound. A pulse richer in harmonics will create a drum sound richer in harmonics and vice versa. For this very reason the uniPulse can create different pulse shapes and lengths. The shape and length should be selected based on experimentation.

Since the output waveform is the impulse response, its amplitude is proportional to the pulse's amplitude. This means velocity control can be implemented via the pulse amplitude.

The pulse conditioning circuit CC differs from machine to machine, but is in almost every case contains a diode which you can use to determine the pulse polarity. If the diode is missing and no schematic available, measuring is often the fastest way to determine the polarity.

Hihats, Cymbals, Snare

Hihats, cymbals, and the noise part of the snare are usually created by turning a pulse into a decay envelope, which controls the amplitude of a noise source by means of a VCA. The VCA is often not more than a single transistor, as linearity is of little importance here. The polarity of the pulse is usually the same as for the drums. Often velocity control can be implemented by varying the pulse amplitude. In some cases however, the pulse is conditioned using active elements and the amplitude of the waveform does not react very well to changes in pulse amplitude. In these cases combinations of length and amplitude modulations proved to be successful.

Maracas, Guiro, ...

In some cases instruments such as Guiro or maracas need a constant voltage signal instead of a pulse. The signal might be used to turn on a multivibrator, or to create an envelope with long attack and decay. In such cases the CV-output of the uniPulse can be utilized. Its 'gate' mode can be used to turn the instrument on and off. In most cases it is even possible to achieve velocity sensitivity by using the 'CV-gate' mode.

4.2.2 E-Drums

E-Drums can be directly interfaced via their trigger inputs. usually velocity sensitivity is possible by varying the pulse amplitude. If you decide to install the uniPulse inside the device, be aware, that sometimes the trigger inputs of the e-drum are muted, if nothing is plugged in. In such a case we recommend to plug in dummy plugs, such as adapters or connectors without an attached wire.

4.3 Clock sync

The uniPulse offers clock and start/stop signals which are controlled by the midi clock. This allows to control the internal sequencer of drum machines.

4.3.1 Drum machines with DIN-SYNC

Drum machines with an existing DIN-SYNC connector can be interfaced directly with the uniPulse. Configure one digital output to be 'sync gate' and connect it to the DIN-SYNC 'start' signal. Configure an other digital output as 'sync-clock' and connect it to the 'clock' signal. You may have to adjust the clock divider and the polarity according to the DIN-SYNC standard used in your device. Usually the polarity is positive for both, clock and gate.

Optionally you might install a switch to switch between an external DIN-SYNC signal and the one generated in the uniPulse.

4.3.2 Vintage analog

Clock

Vintage analog drum machines are usually clocked via a discrete implemented multivibrator, or an other kind of tunable oscillator. The clock signal is then fed into a number of flip flop stages to create the control signals for the pattern generator. It is often straight forward to install a toggle switch on the input of the first flip-flop stage, so the user can select between internal and midi clock.

Start/Stop

The start/stop signal is usually provided by a switch. When stopped, it inhibits the tempo oscillator and resets the flip-flops.

If the drum machine uses a positive supply voltage, one can interface the start/stop signal in the way shown in figure 8 on the left. R1 is tyically in the range 10k - 100k.

If the drum machines uses a negative power supply, it might be necessary to build a level shifter as shown in figure 8 on the right.

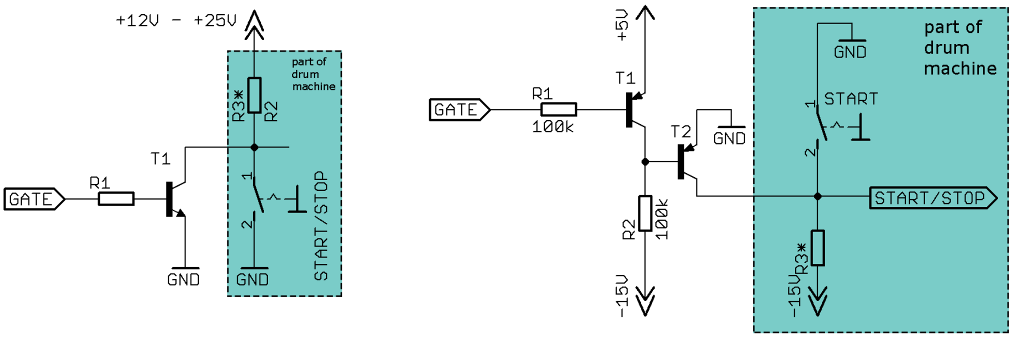


Figure 8: Start/Stop signal, positive supply voltage (left) and negative supply voltage (right)

5 Appendix

5.1 Working principle and pulse lengths

uniTrigger creates its triggers via a process called time multiplexing. This means there can only be one trigger at a time. What sounds bad at first becomes much more harmless if you realize that MIDI operates on the same principle. It is a serial protocol and only one event can be transferred at a time. A complete midi 'note on' message consisting of three bytes is about 1ms long. With running status (which is rarely used) it shortens to two bytes, or 0.66ms. After the message is received, the interface outputs the pulse while receiving the next message simultaneously. The conclusion is: As long as the pulse length is shorter or equal to 1ms, there is no additional delay. Only if you set the pulse length to a value greater than 1ms, an additional delay is introduced. At the maximum setting of 1.27ms, it is 0.27ms.

5.2 Latency

UniPulse has a very low delay of just 0.13ms between a received midi note on command and the begin of a pulse.

The clock output has a latency of 0.2ms. Jitter is 20µs relative to the midi clock jitter.