

Tubbutec SH-1oh1

MIDI RETROFIT AND FEATURE EXTENSION FOR ROLAND SH-101

User Manual v1.1

<http://tubbutec.de>

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1 SH-1oh1

The SH-1oh1 is a MIDI retrofit and feature extension for the Roland SH-101 synthesizer. This manual only describes the features that differ from those of the original SH-101. Great care has been taken to avoid altering the original behavior of the synth while only adding features on top.

2 Accent

While the siblings of the SH-101 – the MC-202 and TB-303 – both have this feature, which is important to many musical styles, it was unfortunately lacking in the SH-101. . . until now!

The SH-1oh1 accent consists of an envelope with a fixed fast attack and a decay adjustable between one millisecond and five seconds. It can be routed to the VCA, filter or both while the amount can be adjusted individually. The accent can be programmed in the sequencer or triggered via MIDI velocity in various ways.

Accents give the SH-101 new possibilities in terms of expression and variation.

See chapters 'Improved sequencer' and 'MIDI' for information on how

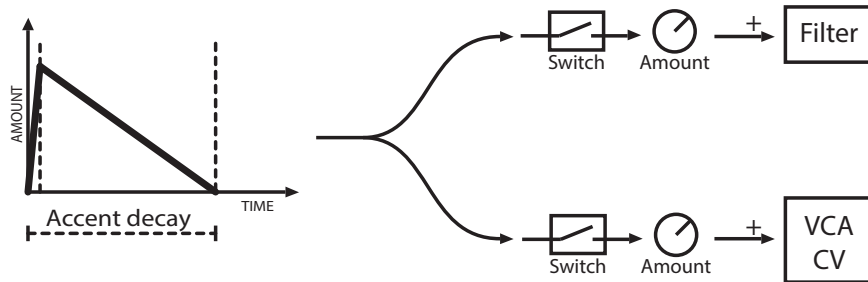


Figure 1: Accent flow chart

to trigger and program the accent.

3 Improved sequencer

3.1 New features

While the original SH-101 sequencer features one sequence with a maximum of 100 steps, the SH-10h1 provides 32 sequences with 120 steps each. Additionally the sequences can be chained to create a song. This can be done live while another song is playing. Each step of a sequence can be either a rest or a note. Additional attributes can be assigned to notes: glide, volume accent and filter accent. These attributes can also be combined.

Despite the vastly improved functionality, a user who has experience with the original SH-101 can still use the sequencer as they did originally.

3.2 Recording a sequence

To record a sequence press the LOAD button. This will select the last sequence used for editing. To select a different sequence for editing, instead of pressing LOAD, press and hold LOAD and use the keyboard to select a sequence. Each of the 32 keyboard keys has a sequence assigned to it. Release the LOAD button to start recording.

You can now enter notes by using the keyboard. Additional attributes can be added to a note by first pressing an assigned button:
press HOLD for a glide, UP for volume accent and U&D for filter accent. The LEDs above the buttons will light up to indicate the attribute's state. Press the same button again to remove the attribute. When you are finished selecting the attributes press a keyboard key to save the next step. You will hear the note including the attributes (except glide). Press KEY TRANSPOSE to enter a rest.
To delete the last step press DOWN. SH-1oh1 now plays the new final note of the sequence.

The sequence is saved in the SH-1oh1 memory and will be available again after power up even without a battery or external power supply.

3.3 Playing a sequence

To play a previously recorded sequence press PLAY.

3.3.1 Playing directions

You can use the UP, U&D and DOWN buttons to change the direction in which the sequence is playing. Press DOWN and U&D simultaneously to play the sequence in a random order.

3.3.2 Shift sequence

While a sequence is playing it can also be triggered manually and shifted forward or backward. This is very useful when syncing the SH-1oh1 to an external clock to adjust the start of a sequence. This function can also be used as a performance tool, by shifting the sequence while it is playing to create variation.

Press KEY TRANSPOSE and hold it. Now press UP to trigger the sequence one step forward, and press DOWN to trigger it one step backward.

3.4 Continue recording a sequence

If you want to continue recording a sequence, press LOAD while it is playing. The sequence will stop playing and you can add or delete steps.

3.5 Switch sequence

The SH-10h1 features 32 different sequences with 120 steps each. Each of the 32 keyboard keys has a sequence assigned to it.

3.5.1 Select sequence to play

Press and hold PLAY and press one of the keyboard keys to select a sequence.

If the sequencer was inactive it will begin playing the new sequence as soon as you release the PLAY button.

3.5.2 Change playing sequence at the end of the current one

To change a sequence at the end of the one currently playing press and hold PLAY and press the assigned keyboard key for the new sequence. After releasing the PLAY button the current sequence will play until it ends, followed by the new sequence, which will start from the beginning.

3.5.3 Change playing sequence instantly

While the sequencer is playing you can also change the sequence instantly by pressing the corresponding keyboard key. The new sequence will not start from the beginning, but instead will be synced to the playing one. Synchronization is guaranteed as long as the two sequences have lengths which are multiples of each other. For example 8 and 4 or 6 and 12, and so on.

3.6 Record and play a song

You can chain up to 120 sequences to create a song. To record a song press and hold PLAY and press the keyboard keys in the order you want the sequences to be chained in. You can also select a single sequence multiple times. If another song is currently playing, it will continue to play until you release the PLAY button. After this, the currently playing sequence will

play until it ends and the first sequence of the new song begin.

4 Additional filter ADSR envelope

The SH-10h1 features an additional ADSR envelope for the filter.

The envelope parameters - attack, decay, sustain, release and amount - can be controlled via MIDI controller messages. See the MIDI controller chart in the appendix.

The range of these parameters is very wide: from a few milliseconds on the low end up to six seconds on the longest setting. The parameter control law is logarithmic to ensure good control over the whole range.

The envelope does not retrigger if you play legato, in a similar fashion to the 'GATE' setting on the SH-101's envelope selector.

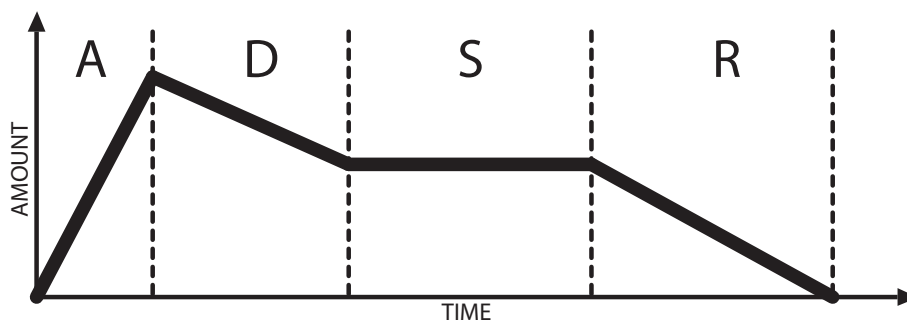


Figure 2: ADSR overview

5 Additional filter LFO

The SH-10h1 features an additional LFO for the filter which outputs a triangular waveform. Its frequency can be adjusted from 0.12 Hz - 8

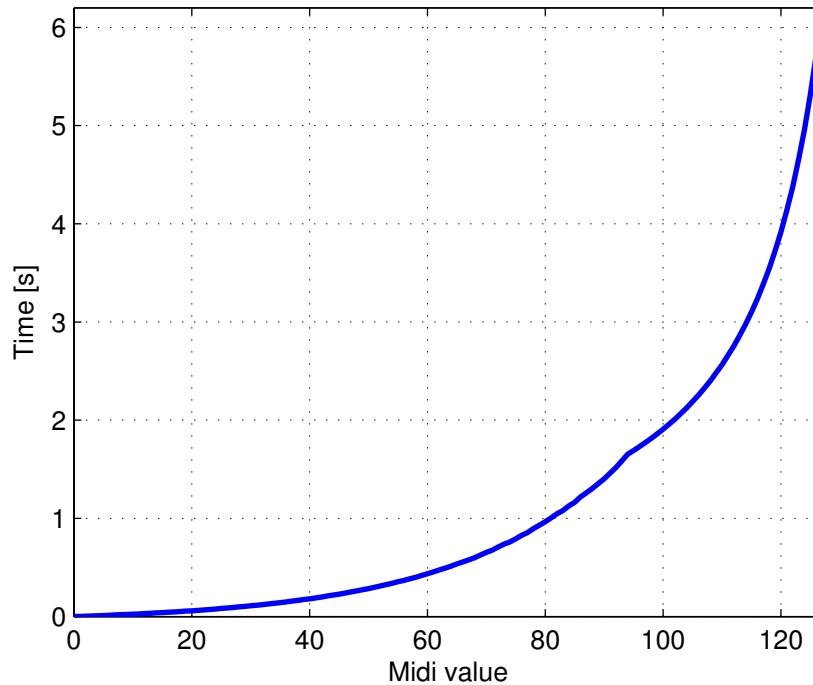


Figure 3: Attack, Decay and Release times and their corresponding MIDI controller values

kHz using a fine and coarse control. High LFO frequencies sound especially interesting with a high resonance setting. The amount can also be adjusted. See the MIDI controller chart for corresponding controller numbers.

6 Arpeggiator, sequencer and random-LFO clocks

The 'RANDOM LFO' mentioned in this paragraph refers to the 'RANDOM' setting in the SH-101's MODULATOR section. In other words, it's one of 4 LFO types in the stock SH-101. It is not to be confused with additional

filter LFO described in chapter 5.

The SH-10h1 sequencer, arpeggiator and ‘RANDOM’ LFO mode (and only the RANDOM mode) can be clocked by multiple sources: the internal LFO or external trigger input, MIDI clock, or MIDI notes.

Additionally, clock dividers are built in for these clock sources. This means that you can, for example, have the ‘RANDOM’ LFO synced to the internal LFO clock, while the arpeggiator is clocked at half its speed, the sequencer is synced to MIDI 16th and the ‘random LFO triggered by an external trigger signal.

There are four clock dividers: ARP / SEQ MIDI clock divider, ARP / SEQ clock divider, RANDOM MIDI clock divider and RANDOM clock divider. These are used depending on which sources are selected.

The figure below shows an overview of the general clock flow.

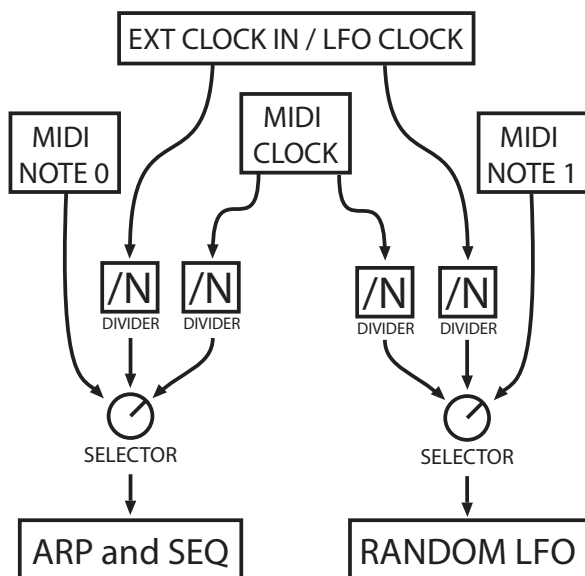


Figure 4: Arpeggiator, sequencer and random-LFO clock flow chart

The clock sources and divider settings can be made using the config menu or via MIDI.

6.1 MIDI clock dividers

The table below shows the possible dividers for the MIDI clock and their MIDI controller values. When changing the divider a special algorithm ensures that the clock stays in sync.

Ctrl val	0-7	8-15	16-23	24-31	32-39	40-47	48-55	56-63
Bars	2.5	2	1.5	1	$\frac{3}{4}$	1T	$\frac{1}{2}$	$\frac{3}{8}$
Ctrl val	64-71	72-79	80-87	88-95	96-103	104-111	112-119	120-127
Bars	$\frac{1}{2}T$	$\frac{1}{4}$	$\frac{3}{16}$	$\frac{1}{4}T$	$\frac{1}{8}$	$\frac{1}{8}T$	$\frac{1}{16}$	$\frac{1}{32}$

Table 1: MIDI controller settings for ARP, SEQ and RANDOM MIDI clock divider

6.2 ARP, SEQ and RANDOM clock divider

In addition to the MIDI clock divider there is a second set of dividers used for the internal LFO clock and the EXT CLK input. Using MIDI, the dividers can be adjusted from 1 to 192 with the following mapping: divider = Controller value + 1, with the following exceptions: MIDI value 126 is mapped to 128 and MIDI value 127 to 192. This is to make sure the useful values of 128 and 192 are included.

The divider can also be used to clock the SH-1oh1 to an external DIN-SYNC clock. Divider factors useful for this purpose are included. The table below shows the divider factors selectable via the config menu with a few selected DIN24 values.

Divider	1	2	3	4	5	6	7	8	
DIN24	$\frac{1}{96}$	$\frac{1}{48}$	$\frac{1}{32}$	$\frac{1}{24}$		$\frac{1}{16}$			
Divider	10	12	14	16	24	36	48	96	192
DIN24		$\frac{1}{8}$		$\frac{1}{6}$	$\frac{1}{4}$	$\frac{3}{8}$	$\frac{1}{2}$	1	2

Table 2: Divider factors for clock dividers and their DIN24 meaning

6.3 Sensitivity

When triggering the arpeggiator or sequencer from an external source such as an other sequencer, a modular system or an audio output, double triggerings can occur if the trigger signal is not conditioned properly. A typical example would be triggering the sequencer with the audio out of a drum machine.

On the other hand very fast triggers or clocks are sometimes desirable, a typical example being a DIN-SYNC clock in combination with the SH-1oh1's internal clock divider.

Time in ms	0	6	13	19	26	32	38	45	51	58	64	70	77	83	90	96	102
Frequency in Hz	max	156	78	52	39	31	26	22	20	17	15.6	14.2	13	12	11	10.4	9.8
SYNC24 BPM	max	390	195	130	97	78	65	56	49	43	39	35.5	32.6	30	27.9	26	24.4

Table 3: Possible hold-off times and their corresponding clock frequencies and SYNC24 BPM values

To avoid double triggerings in one scenario but allow fast triggers in another, an additional parameter is introduced: the trigger hold off. After a trigger has occurred, the next is only allowed after a certain amount of time has passed. The hold-off time can be adjusted in the config menu and is by default set to a value of 26ms, allowing the internal LFO to trigger at its maximum speed.

When using a SYNC24 clock with more then 97BPM as external trigger, the hold off time needs to be reduced or turned off completely.

When using an audio signal as a trigger, it is recommended to increase the hold-off time to avoid double triggerings.

7 Improved arpeggiator

The existing arpeggiator has been slightly expanded. It now features a random mode. You can access the random mode by pressing the DOWN and U&D keys simultaneously.

It is now also possible to 'arpeggiate' a single note. This differs from the original SH-101, as here the envelope is retriggered on each arpeggiator event.

8 Extended pitch range

Internally, the SH-101 has two different CVs (control voltages) for pitch. Only one of these is routed to the CV OUT jack - this we will call CV1.

The other one is only available internally: CV2.

Before it is passed to the CV OUT jack and then back in over a switchable connection to the CV IN jack, CV1 passes the portamento circuit where the glide is added. After this both CVs are added and passed to the internal VCO (voltage controlled oscillator).

Natively the SH-101 features a range of only 56 notes: the 32 notes of the keyboard plus 2 octaves via the TRANSPOSE SWITCH. This is done using CV1. The range is then further increased by adding the TRANSPOSE and RANGE data via CV2 which is not available at the CV OUT jack.

The SH-10h1 increased the number of notes available to 74.

MIDI control is available in the full 64-note range of CV1. It starts at C2 instead of F2 and ends with D#7 instead of C7. It is then further increased up to C9 by using CV2. However keep in mind that portamento is not working properly in this range and the control voltage output by CV OUT may distort. It is therefore recommended to use SH-10h1 in the range delimited by C2 and D#7.

9 MIDI

9.1 MIDI in

Depending on the MIDI setting (located in the config menu), the SH-10h1 receives MIDI input on a single channel (1 - 16) or on all channels (omni). It reacts to MIDI notes 24 - 96

9.2 MIDI out

The SH-10h1 has two separate MIDI out modes and sends both on two different MIDI channels simultaneously. You can configure the channel numbers in the config menu or turn the channels off altogether.

The range of MIDI notes sent is 24 - 96.

9.2.1 MIDI out as played

On the as-played channel only the key presses on the SH-101's keyboard are sent. If you record this channel and send its output back to the SH-10h1, the synth will sound exactly the same as when you played it.

This is useful for using SH-10h1 as a MIDI keyboard. In this mode, HOLD pedal events will be sent as sustain MIDI messages.

9.2.2 MIDI out as sounds

On the as-sounds channel instead of the key presses and releases, MIDI is sent the way it actually sounds. In this mode the SH-10h1 will output the arpeggiator, sequencer and normal play mode including retrigger information. Sustain events will not be sent as MIDI messages but rather simulated with note on and off events.

Portamento / glide will be sent as the new note turning on before the old one turns off. Most synths understand this as a glide command.

9.3 MIDI Controller

Most of the SH-10h1 parameters can be controlled via MIDI controller messages. The table below shows the parameters and their MIDI controller numbers. These need to be sent on the correct MIDI in channel.

Note: controller numbers in the chart are in the range of 0-127. If your MIDI controller displays controller numbers as 1-128, you must add 1 to the numbers below.

Controller number	Usage	Range
16	Filter cutoff	0-127
17	ARP/SEQ MIDI divider	0-127 *see table 1
18	ARP/SEQ clock divider	0-127
19	S/H LFO MIDI divider	0-127 *see table 1
20	S/H LFO clock divider	0-127
21	ARP/SEQ clock source	0-127
22	S/H clock source	0-127
23	Triangular LFO frequency coarse	0-127
24	Triangular LFO frequency fine	0-127
25	Triangular LFO amount	0-127
26	Filter ADSR attack	0-127
27	Filter ADSR decay	0-127
28	Filter ADSR sustain	0-127
29	Filter ADSR release	0-127
30	Filter ADSR amount	0-127
31	Accent decay	0-127
32	Accent volume amount	0-127
33	Accent filter amount	0-127
34	Velocity mapping	See chart below
120	All sound off	-
123	All notes off	-

Velocity mapping

Value	0..13	14..27	28..41	42..55	56..69	70..83	84..97	98..111	112..127
Mapping	None	Cutoff	Vol Acc Amt	F Acc Amt	Acc SW	ATT	DEC	SUS	REL

Table 4: MIDI in controller numbers chart

9.4 Saving MIDI parameters

Normally values you have changed using MIDI are not saved and will be lost after a power down. You can however save them manually. To do this, enter the config menu (see config menu chapter), go to the U&D page and press one of the unused buttons. All parameters except ADSR and LFO will be saved.

9.5 Velocity mapping

The velocity information of a MIDI note on event can be mapped to a variety of targets in the SH-10h1. The mapping can be configured in the config menu or by using MIDI controller number 34. For details, see the MIDI controller chart above or in the appendix. By default, velocity mapping is set to 'Accent switch'

9.5.1 None

MIDI velocity is not mapped to any parameter.

9.5.2 Cutoff

MIDI velocity is mapped to filter cutoff. The velocity value is added to the existing cutoff value.

9.5.3 Volume accent amount

MIDI velocity is mapped to volume accent amount. If this is activated, the accent is triggered each time a note-on event is received, and the accent volume amount is defined by velocity. The filter accent will keep the value last set.

9.5.4 Filter accent amount

MIDI velocity is mapped to filter accent amount. If this is activated, the accent is triggered each time a note-on event is received and the accent filter amount is defined by velocity. The volume accent will keep the value last set.

9.5.5 Accent switch

The velocity value controls the triggering of filter and volume accent while their amounts remain unchanged. Mapping is as follows:

Velocity value	0-31	32-62	63-93	94-127
Triggered accent	None	Volume	Filter	Volume & filter

Table 5: Accent-switch mapping

9.5.6 Attack, decay, sustain or release

The velocity controls one of the four parameters of the additional filter ADSR while the other parameters remain unchanged.

9.6 MIDI merger

The SH-1oh1 includes a MIDI merger sometimes referred to as 'MIDI soft-through'. When activated all incoming MIDI data is merged with the data generated by the SH-1oh1 and passed to the MIDI output.

The merger consists of two modules. One passes MIDI data such as note on and off, controller data, pitch bend and aftertouch messages. The other passes real-time MIDI information such as MIDI clock, start and stop. Both modules can be activated independently from each other in the config menu. It is recommended to only turn on the merger if the functionality is truly needed as more MIDI data also might mean larger latencies due to the limitations of the MIDI protocol.

The MIDI clock module is optimized to handle clock data with a very low latency and minimum jitter of only 0.35 ± 0.0025 ms. Given the fact that the length of one MIDI byte is around 0.3ms this is very close to the theoretical minimum.

By default the MIDI merger is turned off.

9.7 Control SH-101 buttons

With this setting activated in the config menu, it is possible to send and receive additional button presses as MIDI notes. Buttons such as LOAD or DOWN can be controlled using the lowest MIDI octave and the SH-1oh1 also sends these events on the as-played channel.

By default sending and receiving button presses over MIDI is deactivated.

MIDI note	Associated button / event (if activated)
0 / C0	ARP / SEQ clock event (if MIDI note is selected as clock source)
1 / C#0	RANDOM clock event (if MIDI note is selected as clock source)
2 / D0	TRANSCOPE switch
3 / D#0	TRANSCOPE switch
4 / E0	
5 / F0	LOAD
6 / F#0	PLAY
7 / G0	DOWN
8 / G#0	U & D
9 / A0	UP
10 / A#0	HOLD
11 / B0	EXT HOLD
12 / C1	KEY TRANSCOPE

10 Config menu

The SH-10h1's internal config menu can be used to set many parameters using the keyboard. The only exception are the settings of the triangular LFO and the additional filter ADSR.

10.1 Enter and exit the config menu

To enter the config menu, press and hold KEY TRANSCOPE and press HOLD. The KEY TRANSCOPE and HOLD LEDs will start blinking to indicate that the config menu is activated.

To exit the config menu press either HOLD or KEY TRANSCOPE.

It is recommended to make sure that no MIDI note information is sent on the SH-10h1's MIDI in channel when entering the config menu.

10.2 Using the config menu

The config menu is divided into two pages: the UP page and the U&D page. By pressing the UP and U&D buttons you can switch between these two

pages. Upon entering the config menu, the last page used will be active.

10.2.1 UP page

On the UP page, the lower 17 keys of the keyboard are used to select a parameter's value, and the rest are used to choose the parameter itself. To set the value for a parameter, first press the key associated with the parameter (such as 'MIDI-in channel') and then press one of the value keys to set its value (6, for example).

In this way, MIDI channels, clock dividers, accent parameters and external trigger sensitivity , can be set.

10.2.2 U&D page

On the U&D page further parameters can be controlled. Here MIDI velocity mapping, arpeggiator/sequencer clock source, random clock source and MIDI merger settings can be controlled.

It is also possible to reset the firmware and all its settings to the default values by pressing 'factory reset'.

'Pitch bend calibration' is not needed by the user and only needs to be performed once after installing the kit.

Controller number	Usage	Range
16	Filter cutoff	0-127
17	ARP/SEQ MIDI divider	0-127 *see
18	ARP/SEQ clock divider	0-127
19	S/H LFO MIDI divider	0-127 *see
20	S/H LFO clock divider	0-127
21	ARP/SEQ clock source	0-127
22	S/H clock source	0-127
23	Triangular LFO frequency coarse	0-127
24	TriangularLFO frequency fine	0-127
25	Triangular LFO amount	0-127
26	Filter ADSR attack	0-127
27	Filter ADSR decay	0-127
28	Filter ADSR sustain	0-127
29	Filter ADSR release	0-127
30	Filter ADSR amount	0-127
31	Accent decay	0-127
32	Accent volume amount	0-127
33	Accent filter amount	0-127
34	Velocity mapping	see chart below
120	All sound off	-
123	All notes off	-

Velocity mapping:

Value	0..13	14..27	28..41	42..55	56..69	70..83	84..97	98..111	112..127
Mapping	None	Cutoff	Vol Acc Amt	F Acc Amt	Acc SW	ATT	DEC	SUS	REL

Midi divider mapping:

Ctrl Val	0-7	8-14	15-22	23-29	30-37	38-44	45-52	53-59	
Bars	2.5	2	1.5	1	$\frac{3}{4}$	1T	$\frac{1}{2}$	$\frac{3}{8}$	
Ctrl Val	50-67	68-74	75-82	83-89	90-97	98-104	105-112	113-119	120-127
Bars	$\frac{1}{2}$ T	$\frac{1}{4}$	$\frac{3}{16}$	$\frac{1}{4}$ T	$\frac{1}{8}$	$\frac{3}{32}$	$\frac{1}{8}$ T	$\frac{1}{16}$	$\frac{1}{32}$

Table 6: MIDI in controller numbers chart

11.2 Latency

The following latencies were measured: (1ms = 1000 μ s)

MIDI to gate delay: 500 μ s

MIDI to gate jitter: 500 μ s

Note: both are due to limitations of the SH-101 hardware

MIDI merger data delay: $100\mu\text{s}$ (end of received MIDI message to start of sent one)

MIDI merger data jitter: $500\mu\text{s}$

MIDI merger clock delay: $300\mu\text{s} + 50\mu\text{s}$ (start of received MIDI clock to start of sent one)

MIDI merger clock jitter: $< 5\mu\text{s}$

Note: The length of a MIDI byte is about $300\mu\text{s}$. It is therefore impossible to achieve a delay below that number.

Note: The clock has been successfully tested at up to 999bpm.

11.3 Thanks

go to

Florian Anwander
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for writing this manual

Alexandra Cielas

for everything else

SEQUENCER

Enter new sequence:	LOAD	
Add step:		
Add rest:	KEY TRANPOSE	
Glide to next step:	HOLD	
Add Volume-Accent to next step:	UP	
Add Filter-Accent to next step:	U & D	
Delete last step:	DOWN	
Play sequence:	PLAY	
Continue edit playing sequence:	LOAD	
Select different sequence to edit:	LOAD	+ 
Change playing sequence immediately:		
Change playing sequence at the end:	PLAY	+ 
Enter new song:	PLAY	+  +  + ...
While playing:		
Forward one step:	KEY TRANPOSE	+ UP
Backward one step:	KEY TRANPOSE	+ DOWN
Direction Forward (default):	UP	
Direction Backward:	DOWN	
Forward / Backward	U & D	
Ping-Pong:	UP	+ DOWN
Random:	DOWN	+ U & D

ARPEGGIATOR

	UP	
Upwards:	DOWN	
Downwards:	U & D	
Up / down:	DOWN	+ U & D
Random:		

CONFIG MENU

	KEY TRANPOSE	+ HOLD
Enter config menu:	KEY TRANPOSE	+ HOLD

Figure 6: SH-1oh1 cheat sheet

