FluidSynth
Adding poly/mono functionality

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Patch 0001
- first writing 10/052015 PatchFluidPolyMono-0001.
- first coding PatchFluidPolyMono-0001 may-june 2016.

Patch 0002
- Correction typos errors 1/07/2016.
- Correction to get uniform compilation on Rpi2. Thanks to Ben Gonzales for reporting and testing on Rpi2.
- Correction in the method to apply the patch. Thanks to R.L Horn.

Patch 0003
21/07/2016:
- Many enhancements functionalities (see 1).
- Tutorials examples with commands files (see 2.1 and 3.1) (The easy way to learn Poly/mono functionalities).
- Thanks to Ben Gonzales for informations about monophonic accoustic instruments and electronic winds instruments behaviors.

20/10/2017 :
- Correction typos errors.
- Adding explanations about Legato playing through InstrumentZone and PresetZone (see 3.6.6).
- Correction API documentation (see 2.6.1, 2.6.4).

28/10/2017 :
- Adding missing explanations about the legato detector (3.4.3).
- Adding example about breathmode (3.4.5).

3/11/2017 :
- Missing complements about using sustain/sostenuto behavior on mono mode (3.1.8).
- Adding appendices for understanding implementations in FS (3.11)

1. Introduction

This document describes Poly/mono functionalities for FluidSynth library.
This patch supersedes previous poly-mono patch.(0001,0002)
New functionalities supported by patch-0003 are marked in **bold.**
For clarity the document is in 3 chapters

Chapter 1
Patch content (see 1.1), describes

- how the patch has be done, and
- how it can be applied to actual sources tree (v 1.1.6 SourceForgeGit).
  fluidsynth-code-git-f52597be038a5a045fc74b6f96d5f9b0bbbbc044.zip

Functionalities are in two chapter.
Chapter 2
It describes Poly/Mono mode

- **Tutorial examples (2.1).** Useful examples to learn what is poly/mono mode.
  The easier way to learn quickly Poly/Mono mode.
  Examples are executable directly on the console using the *source* command.
- This patch handle the MIDI specifications concept of *basic channel* (see 2.2,2.4, 2.5).
- MIDI modes messages in Fluidsynth:Omni On/Off, Poly/Mono (see 2.3).
- New API for channel basic and Poly/Mono mode change(see 2.6).
- New shell commands for basic channel and Poly/Mono mode change(see 2.7).
- Part 1 table that helps to dive into the patch contents for those who want to see the details inside the patched code(see 2.8).This table enumerates the steps in the order of construction of the patch.

Chapter 3
It describes mainly the monophonic behavior(news functionalities are in **Bold**):

- **Tutorial examples (3.1).**
  Useful examples to learn what is mono mode behavior.
  The easier way to learn quickly Mono mode.
  Examples are directly executable on the console using the *source* command.
- Type of MIDI Input controller (monophonic/polyphonic) (3.2, 3.3).
  - MIDI CC messages handled (3.4.8).
  - CC portamento(65d) On/Off (3.4.9).
  - CC legato(68d) On/Off (3.4.10).
  - CC portamento time (msb,lsb) (5, 37d).
  - **CC Portamento Control(84d) supported in Poly and Mono mode** (3.4.11)**.**
  - **CC Global to control all channels at the same time (Mode 3) (OmniOff- Mono)**(3.4.12).
- **Portamento mode (3.8)**
  New API, shell commands to handle portamento mode (3.8.6, 3.8.7, 3.8.8, 3.8.9).

- Use of sustain/sostenuto pedal in monophonic mode (3.4.7).
- Use of CC Breath(3.4.5).
  New API (3.7.1) and shell commands to handle default breath to Attenuation modulator (3.7.3).
  New option **Breath Sync** to trigger noteOn/noteOff with the breath controller (3.7.3)
- Legato mode playing (3.6).
  New legato mode: Retrigger_1 (normal release) (3.6.2)
  New API (3.6.7) and shell commands to handle legato mode (3.6.9).
- The Part 2 table that helps to dive into the patch contents contents for those who want to study the details inside the code (see 3.9, 3.10,3.11).This table enumerates the steps in the order of construction.

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- Appendices for understanding implementations in FS (3.11).

No more limitation (see 3.6.6):
This patch now accept legato passage through multiples Instruments Zones and Preset Zone.This chapter describes the enhancement to suppress the know unacceptable limitations of previous patches.

Things not handled
- Sysex message to handle channel basic (2.1.9)

1.1. Patch archive content

- Documentation: PatchFluidPolyMono-0003.pdf.
- Compete tree of file patched: ./fluid-polymono-0003
- Patch: fluid-polymono-0003.patch
- Soundfont for tutorials examples: Legato_demo.sf2
- Tutorials commands files examples:
  Legato mode: leg_0.txt, leg_1.txt, leg_2.txt , leg_3.txt, leg_4.txt
  Portamento: leg_por_0.txt, leg_por_1.txt, leg_por_2.txt , leg_por_3.txt, leg_por_4.txt

1.1.1. fluid-polymono-0003.patch content

This is the list of the file impacted by this patch

Base directory: fluisynth-1.1.6	**action on this file**
include/fluidsynth/types.h include/fluisynth/synth.h	patch adding poly mono
src/sfloader/fluid_defsfont.h src/sfloader/fluid_defsfont.c src/sfloader/fluid_ramsfont.c	patch adding poly mono
src/synth/fluid_chan.c src/synth/fluid_chan.h	patch adding poly mono
src/synth/fluid_voice.c src/synth/fluid_ voice.h	patch adding poly mono
src/synth/fluid_synth.c src/synth/fluid_synth.h	patch adding poly mono
src/synth/fluid_synth_polymono.c	new file
src/synth/fluid_synth_mono.c	new file
src/midi/fluid_midi.h	bug
src/bindings/fluid_cmd.c src/bindings/fluid_cmd.h	patch adding poly mono
src/rvoice/fluid_rvoice_event.c	patch adding poly mono
src/rvoice/fluid_rvoice.c src/rvoice/fluid_ rvoice.h	patch adding poly mono
src/rvoice/fluid_adsr_env.h	minor bug
src/CMakeLists.txt	file adding (fluid_synth_polymono.c, fluid_synth_mono.c)
src/Makefile.am	file adding (fluid_synth_polymono.c, fluid_synth_mono.c)

1.1.2. How the patch has be done ?

The patch has be done starting from the actual source tree coming from **git source repository (./fluidsynth-1.1.6)**

For convenience the full tree of sources already patched is given in the PatchFluidPolyMono-0003.zip **(./fluid-polymono-0003**). So this tree is directly usable to build on the target platform.

For conveniance a diff is given to get a full insight of the changes
diff -Naur ./fluidsynth-1.1.6 ./fluid-polymono-0003 > fluid-polymono-0003.patch
All changes are listed in chapters 2.8, 3.10.

Now you have 2 methods to build this patch on a target platform:
- The direct method using the provided tree already patched. (1.1.3).
- The indirect method building your own tree to be patched (1.1.4).

1.1.3. How to apply the patch using tree **./fluid-polymono-0003** ?

- Copy the provided directory tree **./fluid-polymono-0003** to the platform
- Then use the usual tools to build from this tree (cmake,make).

1.1.4. How to apply the patch using diff result: **fluid-polymono-0003.patch** ?

- get **./fluidsynth-1.1.6** the base directory source coming from **git source repository**

- Put **fluid-polymono-0003.patch** in **./fluidsynth-1.1.6** directory
- From this directory execute patch command.
  cd fluidsynth-1.1.6
  patch -p2 < fluid-polymono-0003.patch
- Now tree ./fluidsynth-1.1.6 has been patched,you may use the usual tools to build from this tree (cmake,make).

2. Part1: Specifications Omni On/Off, Poly/Mono in FluidSynth

Note this chapter is based on MIDI standard specification knowledge. It doesn't replace the MIDI specification. So report to this document when necessary: MIDI_MMA_Specification.pdf 1.0 version 4.2 1995.

2.1. Part 1: Tutorial examples – understanding poly/mono mode

This chapter describes useful examples to learn and understand what is poly/mono mode
Example files are executable directly on the FluidSynth console application using the ***source*** command.
This files are in ./poly/mono directory) must be used with the soudfount: ***Legato_demo.sf2*** **.**
This is an easy way to learn Poly/mono functionalities quickly.

The first commande to use at the console is:
>help polymono.

>source command-example-file

2.1.1. Getting help

The first commande to use at the console is:
>help polymono.

basicchannels Display the list of basic channels
resetbasicchannels [chan mode val..] Reset the list of basic channels
setbasicchannels chan mode val [chan mode val..] Change or add basic channels
channelsmode [chan1 chan2..] Print channels mode
legatomode [chan1 chan2..] Print channels legato mode
setlegatomode chan mode [chan mode..] Change legato mode
portamentomode [chan1 chan2..] Print channels portamento mode
setportamentomode chan mode [chan mode..] Change portamento mode
breathmode [chan1 chan2..] Print channels breath mode

setbreathmode chan poly(1/0) mono(1/0) breath_sync(1/0) [..] Set breath mode

2.1.2. What are basic channels ?

Basic channels is a MIDI specification. It allows to split the whole set of MIDI channels in independents groups of MIDI channels. Each group can bet set in differents mode (poly, mono, omni on, omnioff). The first MIDI channel of a group is called 'basic channel'.

2.1.3. What are default 'basic channels' in FluidSynth ?

At initialization the default basic channel is defined by settings (see 2.2).

type the command ***basicchannels*** to display actual basic channels.
> **basicchannels**
Basic channel: 0, poly omni on (0), nbr: 16

There are only one group starting at basic channel 0. All MIDI channels (0 to 15) inside this group are able to play in polyphonic.

Note: command file execution :**source poly_mono_0.txt**

2.1.4. How to change the whole set of actual basic channels ?

Assuming you want to set 2 groups of channels
Group 1: first channel 5 in poly mode, only one channel
Group 2: first channel 10 in mono mode , only one channel

Group 1 should have following settings:
- basic channel **5**, mode poly, omni off (mode **2**), number of channel (dont'care because in this mode all channels are used)

Group 2 should have the following settings:
- basic channel **10**, mode mono, omni off, (mode **3**), composed of **one** channel (1).

Use command ***resetbasicchannels***:
>**resetbasicchannels 5 2** 0 **10 3 1**

Use ***basicchannels*** command to verify your settings
> **basicchannels**
Basic channel: 5, poly omni off(2), nbr: 1
Basic channel: 10, mono omni off(3), nbr: 1

Now you see 2 groups.

Note: command file execution :**source poly_mono_1.txt**

2.1.5. How to add a new basic channel among others actual basic channels ?

Perhaps you have already set several groups of basics channels and you want to add a new one without modifying actual groups.
Assuming following actual groups (from the previous example):

- Basic channel: 5, poly omni off(mode 2), nbr: 1
- Basic channel: 10, mono omni off(mode 3), nbr: 1

Now we want to add a 3rd new group:
Group 3 should have the following settings:
- basic channel **13**, mode mono, omni off, (mode **3**) composed of **2** channels.

Use command ***setbasicchannels***:
>**setbasicchannels 13 3 2**

Use ***basicchannels*** command to verify your settings
> **basicchannels**
Basic channel: 5, poly omni off(2), nbr: 1
Basic channel: 10, mono omni off(3), nbr: 1
Basic channel: 13, mono omni off(3), nbr: 2
>

Now you see 3 groups.

Note: command file execution :**source poly_mono_2.txt**

2.1.6. How to change an actual basic channel ?

Perhaps you have already set several groups of basics channels and you want change the settings of one.

Assuming following actual groups:
- Group 1:Basic channel: 5, poly omni off(mode 2), nbr: 1
- Group 2:Basic channel: 10, mono omni off(mode 3), nbr: 1
- Group 3:Basic channel: 13, mono omni off(mode 3), nbr: 2

Now we want to change group 1:
Group 1 should have the following settings:
- basic channel **5**, mode poly, omni on, (mode **0**) composed of **all** channels in this group.

Use command ***setbasicchannels***:
>**setbasicchannels 5 0** 0

Use ***basicchannels*** command to verify your settings
> **basicchannels**
Basic channel: 5, poly omni on (0), nbr: 5
Basic channel: 10, mono omni off(3), nbr: 1
Basic channel: 13, mono omni off(3), nbr: 2
>
Note a
- in omni on mode (mode 0 and 2) , a group is composed of all possible channels from the Basic Channel number of this group to the to the basic channel of the next group minus 1.So the 1st group is composed of 5 channel (Regardless of the 3rd parameter).

Note b: command file execution :**source poly_mono_3.txt**

2.1.7. How to change an existing basic channel and add a new one ?

Note that command **setbasicchannels** allows to add or change groups of basics channels.
Note also that the commands allows this for more than one groups using only one command:

The following command changes Group 1 to the following state:
- Group 1:Basic channel: **5**, poly omni off(mode **2**), nbr: 1

Than add a new group:
- Group :Basic channel: **2**, mono omni on(mode **1**), composed of **all** possible channels in this group (see 2.1.6 Note a)

Use command ***setbasicchannels*** to change a group and add a new one
>**setbasicchannels 5 2** 0 **2 1** 0

Use ***basicchannels*** command to verify your settings
> **basicchannels**
Basic channel: 2, mono omni on (1), nbr: 3
Basic channel: 5, poly omni off(2), nbr: 1
Basic channel: 10, mono omni off(3), nbr: 1
Basic channel: 13, mono omni off(3), nbr: 2
>

Note: command file execution :**source poly_mono_4.txt**

2.1.8. How to know the state of one or more MIDI channels ?

Use the command **channelsmode** [chan1 chan2 ….]
Ig gives details about anay channel settings.

To display the state off alls MIDI channels
> **channelsmode**

Channel	Status	Type	Mode	Nbr of channels
channel: 0	disabled			
channel: 1	disabled			
channel: 2	enabled	basic channel	mono omni on (1)	nbr: 3
channel: 3	enabled	--	mono	--
channel: 4	enabled	--	mono	--
channel: 5	enabled	basic channel	poly omni off(2)	nbr: 1
channel: 6	disabled			
channel: 7	disabled			
channel: 8	disabled			
channel: 9	disabled			
channel: 10	enabled	basic channel,	mono omni off(3)	nbr: 1
channel: 11	disabled			
channel: 12	disabled			
channel: 13	enabled	basic channel	mono omni off(3)	nbr: 2
channel: 14	enabled	--	mono	--
channel: 15	disabled			

>
Note: When disabled a channel ignore MIDI NoteOn, noteOff, and CC.

To display the state of MIDI channels 2,5, 10, 13 only
> **channelsmode 2 5 10 13**

Channel	Status	Type	Mode	Nbr of channels
channel: 2	enabled	basic channel	mono omni on (1)	nbr: 3
channel: 5	enabled	basic channel	poly omni off(2)	nbr: 1
channel: 10	enabled	basic channel	mono omni off(3)	nbr: 1
channel: 13	enabled	basic channel	mono omni off(3)	nbr: 2

>

Note: command file execution :**source poly_mono_5.txt**

2.1.9. Is there a way to set basic channels vial MIDI ?

Sorry, actually in Fluidsynth there no way to set or get basic channels via MIDI cables.

The MIDI specifications propose to use MIDI sysex messages to do that. To implement MIDI sysex messages manufacturers need to grant a unique ID from MMA or JMSC. This is not a free operation.

The only way to intruct a FluidSynth synthesizer is to use the settings() (2.2.2) or API (2.6)

2.1.10. Is there a way to change the mode of an actual basic channel via MIDI ?

Yes, simply by sending MIDI CC poly On, mono On, omni On, Omni Off message on this basic channel. (see 2.3 for details)

2.2. "Basic Channel" in FluidSynth

2.2.1. Poly Mono mode numbering convention in FluidSynth

A fluisynth instance may have more than one Basic Channel.
So FluidSynth can work in more than one mode at the same time(see 2.5).

- Inside API FluidSynth Mode numbers are zero based: 0,1, 2, 3.
- In the MIDI standard, mode number are 1 based (1 to 4) but inside FluidSynth mode number are zero based (0 to 3).

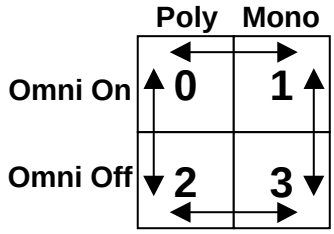


Fig 1. Poly / Mono mode in FluidSynth (Mode number is 0 based).

2.2.2. Basic Channel Settings

- New settings **synth.basic-channel, synth.basic-channel.mode, synth.basic-channel-modeval**. allow to set only one basic channel.
  - setting **synth.basic-channel** (int type) is the basic channel number (defaut: 0).
  - setting **synth.basic-channel-mode** (int type) is the mode of this basic channel group (defaut: 0, i.e Omni On Poly On).
  - setting **synth.basic-channel-modeval** (int type) is the number of MIDI channels (int type) for mode 3 (défaut 0).
- At synthesizer creation time (new_fluid_synth()) the settings have default value (basic channel 0, mode 0,modeval 0).
  So by default this synthesizer is a polyphonic synthesizer on all MIDI channels.
- An application can use the API **fluid_synth_reset_basic_channels()**(2.6.1)**,** **fluid_synth_get_basic_channels()** (2.6.3) to change or read "Basic channels" informations.

2.2.3. Basic channel commands in Shell

- Default commands shell have new commands to set/print "basic channels informations" (see 2.7). So a synthesizer instance can work in "multi mode" (more than one basic channel) (2.5).

2.3. MIDI Modes messages in FluidSynth

2.3.1. Specification MIDI: Omni On/Off and Poly/Mono in FluidSynth

Following MIDI CC are handled :
Omni On, Omni Off, Poly On, Mono On only on Basic channel, otherwise messages are ignored.

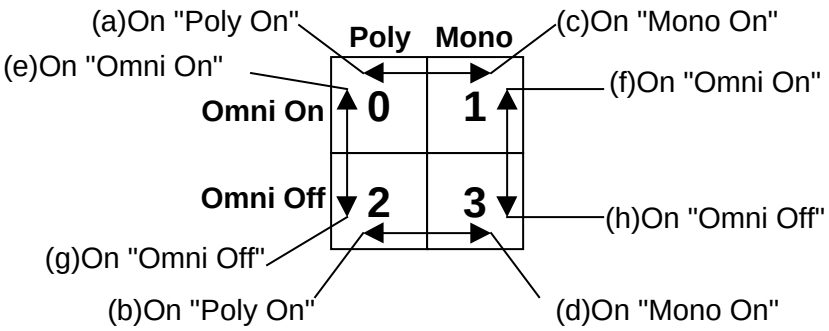


Fig.2: Poly Mono mode change in FluidSynth, usingg MIDI CC messages.

2.4. Receiver with one "Basic Channel"

MIDI standard specify 2 CC messages **Omni On** and **Omni Off** to define if channels listening is global (**Omni On**) or limited to a channels range (**Omni Off**).
Basic Channel are to be set inside the receiver. (by sysex or others methods (see 2.7)).

2.4.1. Listening control: **Omni On**, **Omni Off**

Omni On : CC 125 Data=0
Allows listening on all MIDI channels MIDI (0 to 15).
Data field is 0.

Omni Off: CC 124 Data 0
Allows listening on a range relative to "**Basic Channel**" channel.
Data field is 0.

Remark: This message gives no information about the range(see Mono On 2.4.2).

2.4.2. Mode polyphonic or monophonic: **Poly On**, **Mono On**.

MIDI standard specify 2 others CC messages to set channels in polyphonic or monophonic mode.

Poly On: CC 127 Data=0
Data field is 0.
Set the MIDI channels in polyphonic.

- If Omni is On, all channels (0 to 16) are listened and polyphonic.
- If Omni is Off, as data field is 0, there is only one channel set in polyphonic (i.e "Basic channel"). Others channels aren't listened.

Mono On: CC 127 Data=M
Set the MIDI M channels in monophonic.

- If Omni is On, data field is ignored, all channels (0 à 16) are listened and monophonic.
- If Omni is Off, data field M is the MIDI channels range (relative to "Basic Channel "), listened in monophonic. Others channels aren't listened.
  Value M to 0 means all channels from "Basic Channel" .

Remark: MIDI standard specify to send Poly On, Mono On messages only on "Basic Channel" number in order to be accepted.

MIDI standard allows the following combinations:

- Mode 1: Omni On , Poly On Data=0: All channels are listened in polyphonic.
- Mode 2: Omni On , Mono On Data=0: All channels are listenned in monophonic.
- Mode 3: Omni Off , Poly On Data=0: Basic Channel only is listened in monophonic.

Note: In MIDI standard mode number are 1 based (1 to 4) but inside FluidSynth mode number are zero based (0 to 3).

- Mode 4: Omni Off , Mono On Data=M: Only MIDI channels from "Basic Channel" up to Basic Channel+M-1 are allowed in monophonic.

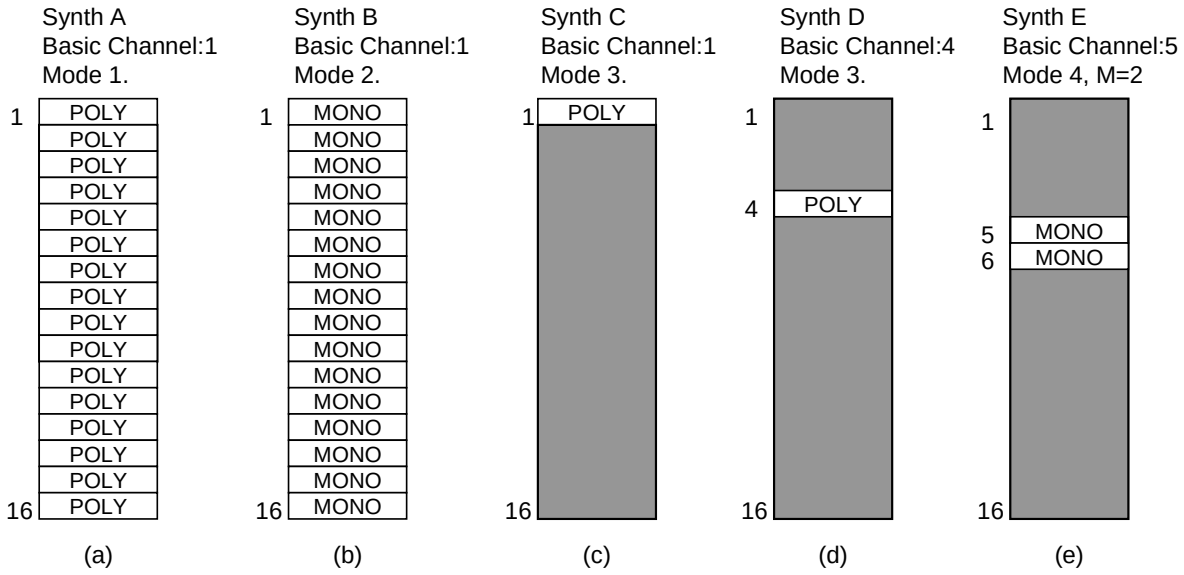


Fig. 1

Notes:

N1: mode **Omni On** (mode 1 and 2) allows to set a receiver listenning all MIDI channels. In this mode we are sure that the synthesizer is listening any MIDI channel.

- Fig 1.a shows a synthesizer A set in mode 1 on "basic channel" 1. All MIDI channels (1 to 16) are listened in polyphonic.
- Fig 1.b show a synthesizer B set in mode 2 on "basic channel 1". All MIDI channels (1 to 16) are listened in monophonic.

N2: mode **Omni Off** (mode 3 and 4) allows somes MIDI channels to be not listened. So we can use more than one receiver (C,D,E) in a manner that a MIDI channel can be listened by only one receiver at a time. To get this result we need to set each receiver on distinct basic channel.

- Fig 1.c shows a synthesizer (C) set in mode 3 on "basic channel" 1. MIDI channel 1 is the only one listened in polyphonic.
- Fig 1.d shows a synthesizer (D) set in mode 3 on "basic channel" 4. MIDI channel 4 is the only one listened in polyphonic.

N3: With **mode 4** it is easy to choose a group of consecutive MIDI channels (M > 1). This mode is suited to strings instruments (guitar, bandjo,..) on which a string can play only one note at a time.
Furthermore, in this mode we can use only one CC to control all the M MIDI channels at the same time .

- Fig 1.e show a synthesizer (E) set in mode 4 , M=2 on basic channel 5. Only MIDI channels 5,6 are listened in monophonic.

N4: Note that with only one "Basic Channel" (Fig 1.a to Fig.1 e,) there are no possibility to have somes channels polyphonics (mode 1,3) and others channels monophonics (mode 2,4) at the same time..

In the MIDI standard, mode number are 1 based (1 to 4) but inside FluidSynth mode number are zero based (0 to 3).

2.5. Receiver with more than one "Basic Channel"

A FluidSynth Synthetiser (MIDI receiver) can have more than one "basic channel" (MIDI specs(1.0 v 4.2 p7)).
Each basic channel can be set in distinct mode. This is called "muti-mode".

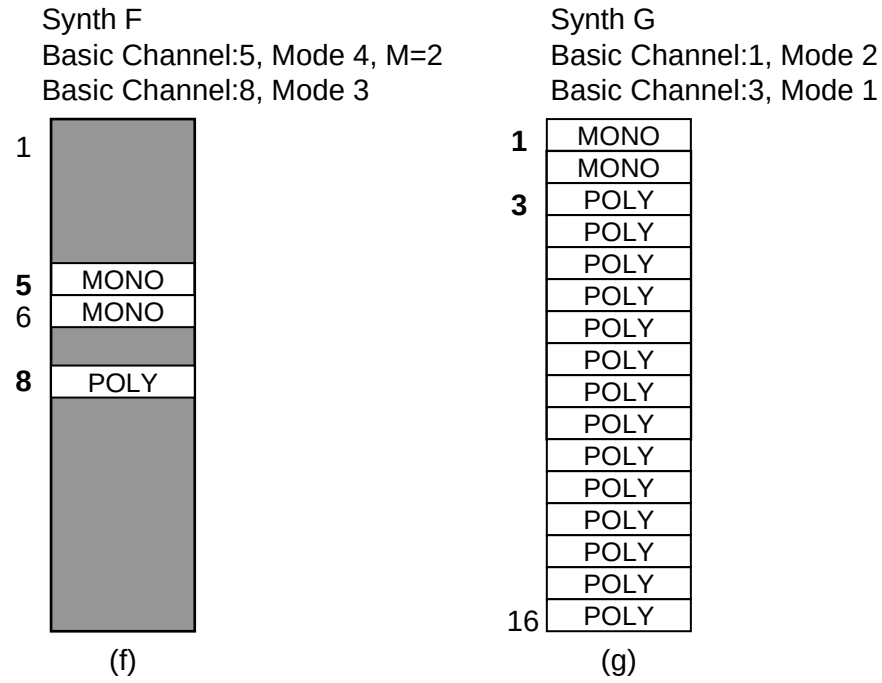


Fig.2

fig 2.f shows a fluidsynth instance (F) with 2 "Basic Channel" in two distinct modes.

- Mode 4 is set on basic channel 5. MIDI channel 5 and 6 are listened in monophonic.
- Mode 3 is set on basic channel 8. MIDI channel 8 is listened in polyphonic.
- Others MIDI channels aren't listened.

2.5.1. Using Omni On (mode 1 and 2) with more than one "Basic Channel"

When a receiver have more than one basic channel (i.e BCx, BCy), a MIDI message Omni On received on Basic Channel (BCx) set the range of MIDI channels from BCx up to BCy-1 enabled .

Fig 2.g shows a fluidsynth instance (G) with 2 Basic channel 1 and 3 both in mode Omni On:

- Mode 2 is set on basic channel 1. MIDI channels 1 and 2 are listenned in monophonic.
- Mode 1 is set on basic channel 3. MIDI channels 3 to 16 are listened in polyphonic.

2.6. Poly/Mono mode API in FluidSynth

The Following API hare added .Thes API are used by the new shell commands (2.7).

2.6.1. Reset basic channels: **fluid_synth_reset_basic_channels(n, BasicChannelsInfos)**

```
FLUIDSYNTH_API
int fluid_synth_reset_basic_channels(fluid_synth_t* synth,
                                     int n,
                                     fluid_basic_channel_infos_t *basicChannelInfos)
```

The function set a new list of basic channel informations in the synthesizer.
This list replace the previous list.

On input

- ***synth*** the synthesizer instance.
- ***n*** number of entries in basicChannelInfos (0 to 256).
- ***basicChannelInfos*** the list of Basic channel infos to set.

If ***n*** is 0 or ***basicChannelInfos*** is NULL, the function set one channel basic at basicchan 0 in Omni On Poly (i.e all the MIDI channels are polyphonic).

Each entry in the table is a fluid_basic_channels_infos_t information
-*basicchan* the Basic Channel number (0 to MIDI channel count-1).
-*mode* the MIDI mode to use for basicchan (0 to 3).
-*val* is the value (for mode 3 only) (0 to MIDI channel count).

On Output
- FLUID_OK on success
- FLUID_FAILED,
  - synth is NULL.
  - n, basicchan or val is outside MIDI channel count.
  - mode is invalid.
  - val has a number of channels overlapping the next basic channel.

Note:This API is the only one to replace all the basic channels in one synthesizer instance.
The default shell has an equivalent command "*resetbasicchannels*" to set one or more basic channels (see 2.7.2).
When more than one basic channels are set, the synthesizer is said to be in multi mode.

2.6.2. Get Basic Channels count: **fluid_synth_count_basic_channels()**

Returns the number of MIDI basic of a synthesizer.

```
FLUIDSYNTH_API  int fluid_synth_count_basic_channels(fluid_synth_t* synth);
```

On input
- ***synth*** the synthesizer instance.

On output: Count of basic channels

This API is a short version of **fluid_synth_get_basic_channels().**

Note: not implemented

2.6.3. Get basic channels: **fluid_synth_get_basic_channels()**

The function gets the list of basic channel informations from the synthesizer.

```
FLUIDSYNTH_API
int fluid_synth_get_basic_channels( fluid_synth_t* synth
                                    fluid_basic_channel_infos_t **basicChannelInfos);
```

On input
- ***synth*** the synthesizer instance
- ***basicChannelInfos***
  If non NULL the function returns a pointer to allocated table of fluid_basic_channels_infos or NULL on allocation error.The caller must free this table when finished with it.

  If NULL the function returns only the count of basic channel.
  Each entry in the table is a fluid_basic_channels_infos_t
  -*basicchan* the Basic Channel number (0 to MIDI channel count-1)
  -*mode* the MIDI mode to use for basicchan (0 to 3)
  -val Number of channels (0 to MIDI channel count).

On Output
- Count of basic channel informations in the returned table or
- FLUID_FAILED
  - synth is NULL.

- allocation error.

Note: The default shell has an equivalent command "*basicchannels*" to display basics channels (see 2.7.1).

2.6.4. Set basic channel: **fluid_synth_set_basic_channel(chan,mode, val)**

FLUIDSYNTH_API
int fluid_synth_set_basic_channel(fluid_synth_t* synth, int basicchan,int mode, int val)

The function changes the mode of an existing basic channel or inserts a new basic channel part.
- If basicchan is already a basic channel, the mode is changed.
- If basicchan is not a basic channel, a new basic channel part is inserted between the previous basic channel and the next basic channel. val value of the previous basic channel will be narrowed if necessary.

On input
- ***synth*** the synthesizer instance.
- ***chan*** MIDI Basic channel number (0 to MIDI channel count - 1).
- ***mode*** the MIDI mode to use for basicchan.
  0:OmniOn_Poly 1:OmniOn_Mono
  2:OmniOff_Poly 3 OmniOff_Mono
- ***val***: Number of monophonic channels (for mode 3 only) (0 to MIDI channel count).

On Output
- FLUID_OK on success
- FLUID_FAIL,
  - synth is NULL.
  - chan or val is outside MIDI channel count.
  - mode is invalid.
  - val has a number of channels overlapping the next basic channel.

Note: The default shell has an equivalent command "*setbasicchannels*" to set basics channels mode (see 2.7.3).

2.6.5. Get channel mode: **fluid_synth_get_channel_mode(chan, modeInfo)**

FLUIDSYNTH_API
int fluid_synth_get_channel_mode(fluid_synth_t* synth, int chan,
fluid_basic_channel_infos_t *modeInfo)

Returns poly mono mode informations about any MIDI channel.

On input
- ***synth*** the synthesizer instance.
- ***chan*** MIDI Basic channel number (0 to MIDI channel count - 1).
- ***modeInfo***: pointer pointer on a fluid_basic_channels_infos_t information.
  A fluid_basic_channels_infos_t
  -basicchan, chan
  -mode MIDI mode infos of chan:
  - bit 0: **MONO**: 0, Polyphonic; 1, Monophonic.
  - bit 1: **OMNI**: 0, Omni On; 1, Omni Off.
  - bit 2: **BASIC_CHANNEL**: 1, chan is a Basic Channel.
  - bit 3: **ENABLED** 1, chan is listening;
    0, chan ignore voices messages (MIDI note on/of, cc).

  -val Number of channels in the group from basic channel (if bit 2 is set), or 0 if bit 2 is 0.

On Output
- FLUID_OK on success

- FLUID_FAILED
  -synth is NULL.
  -chan is outside MIDI channel count.
  -modeInfos is NULL.

Note: The default shell has an equivalent command "*channelsmode*" to display basics channels mode (see 2.7.4).

2.7. Poly/mono modes commands in FluidSynth

2.7.1. Command to get MIDI basic channels number: **basicchannels**

basicchannels

Print the list of all MIDI basic channels informations
example: Basic channel 3 mode:2 nbr:6, Basic channel 6 mode 3: nbr:3, ..

This command uses API fluid_synth_get_basic_channels() (2.6.3).

2.7.2. Command to replace MIDI basic channels: **resetbasicchannels**

resetbasicchannels [chan1 Mode1 nbr1 chan2 Mode2 nbr2 ….]

Set the list of MIDI basic channels with mode
This list replace any previous basic channels list.

With no parameters the function set one channel basic:
basicchan 0, mode 0 (Omni On Poly) (i.e all the MIDI channels are polyphonic).

This command uses function API fluid_synth_reset_basic_channels() (2.6.1).

2.7.3. command to change/add MIDI basic channels : **setbasicchannels**

setbasicchannels chan1 Mode1 nbr1 [chan2 Mode2 nbr2 ….]

Change or add basic channel 1 [and 2]

-if chan is already a basic channel, its mode is changed.
-If chan is not a basic channel, a new basic channel part is inserted
between the previous basic channel and the next basic channel.
val value of the previous basic channel will be narrowed if necessary.

This command uses API fluid_synth_set_basic_channel() (2.6.4).

2.7.4. Command to read MIDI channels mode: **channelsmode**

channelsmode

Print channel mode off all MIDI channels (Poly/mono, Enabled, Basic Channel)
example

```
channel:  0, disabled
channel:  1, disabled
channel:  2, disabled
channel:  3, disabled
channel:  4, disabled
channel:  5, enabled, basic channel, mono omni off(3), nbr:  2
channel:  6, enabled, --          , mono          , --
channel:  7, disabled
```

channelmode chan1 chan2

Print only channel mode off MIDI channel chan1, chan2

These commands uses API fluid_synth_get_channel_mode() (2.6.5).

2.8. Part 1: implementations steps in Fluidsynth.

2.8.1. Implementation steps: Poly/mono mode API (2.6)

- API fluid_synth_reset_basic_channels()
- API fluid_synth_get_basic_channels()
- fluid_synth_set_basic_channel()
- fluid_synth_get_channel_mode()

to do	comments
	fluid_chan.h
done	Add ***mode,mode_val*** in struct _fluid_channel_t
done	/* acces to channel mode */ /* SetChanMode set the mode for a MIDI basic channel */ #define SetChanMode(chan,mode) \ (chan->mode = (chan->mode & ~MASKMODE) | (mode & MASKMODE)) /* GetChanMode get the mode for a MIDI basic channel */ #define GetChanMode(chan) GetModeMode(chan->mode) /* IsChanMono(chan) return true when channnel is Mono */ #define IsChanMono(chan) (IsModeMono(chan->mode)) /* IsChanPoly(chan) return true when channnel is Poly */ #define IsChanPoly(chan) (!IsChanMono(chan)) /* IsChanOmniOff(chan) return true when channnel is Omni off */ #define IsChanOmniOff(chan) (chan->mode & OMNI) /* IsChanOmniOn(chan) return true when channnel is Omni on */ #define IsChanOmniOn(chan) (!IsChanOmniOff) /* IsChanBasicChannel(chan) return true when channnel is Basic channel */ #define IsChanBasicChannel(chan) IsModeBasicChan(chan->mode) /* IsChanEnabled(chan) return true when channnel is listened */ #define IsChanEnabled chan) IsModeChanEn(chan->mode) /* End of macros interface to poly/mono mode variables */

to do	comments
	fluid_synth.c , fluid_chan.c
done	In fluid_chan.c - fluid_channel_init(fluid_channel_t* chan) ***mode*** and ***mode_val*** initialization.
done	In fluid_synth.c - fluid_synth_settings() settings registering.
done	In fluid_synth.c – new_fluid_synth() Reading default settings (2.2)

to do	comments

	synth.h
done	/* API: Poly mono mode */ */* Macros interface to poly/mono mode variables */* enum PolyMonoMode { OMNION_POLY, /* MIDI mode 0 */ OMNION_MONO, /* MIDI mode 1 */ OMNIOFF_POLY, /* MIDI mode 2 */ OMNIOFF_MONO, /* MIDI mode 3 */ MODE_NBR }; */* bit mode */* #define MONO 0x01 */* b0, 0: poly on , 1: mono on */* #define OMNI 0x02 */* b1, 0: omni on, 1:omni off */* #define MASKMODE (OMNI|MONO) #define BASIC_CHANNEL 0x04 */* b2, 1: channel is basic chanel */* #define ENABLED 0x08 */* b3, 1:channel is listened */* */* access to mode */* #define GetModeMode(mode) (mode & MASKMODE) #define IsModeMono(mode) (mode & MONO) #define IsModeBasicChan(mode) (mode & BASIC_CHANNEL) #define SetModeBasicChan(mode) (mode |= BASIC_CHANNEL) #define ResetModeBasicChan(mode) (mode &= ~ BASIC_CHANNEL) #define IsModeChanEn(mode) (mode & ENABLED) #define SetModeChanEn(mode) (mode |= ENABLED) #define ResetModeChanEn(mode) (mode &= ~ENABLED)
done	struct _fluid_basic_channel_infos_t; typedef struct _fluid_basic_channel_infos_t fluid_basic_channel_infos_t;)
done done done done	function declaration fluid_synth_get_basic_channels() function declaration fluid_synth_reset_basic_channels() function declaration fluid_synth_get_channel_mode() function declaration fluid_synth_set_basic_channel()

to do	**comments**
	fluid_synth.c, **fluid_synth_polymono.c**
done	function **fluid_synth_get_basic_channels()**
done	function **fluid_synth_set_basic_channel_LOCAL()** Using fluid_synth.c - fluid_synth_all_notes_off_LOCAL() that needs to declared non static to get scope in module fluid_synth_mono.c.
done	function **fluid_synth_reset_basic_channels()**
done	function **fluid_synth_get_channel_mode()**
done	function **fluid_synth_set_basic_channel()**

2.8.2. Implementation steps: Poly/mono mode commands (2.7)

to do	**comments**
	fluid_cmd.c

done	add entry in fluid_commands[ ]
	fluid_cmd.h
done	add functions declaration

to do	**comments**
	fluid_synth_polymono.c
done	command **basicchannels ,** fluid_handle_basicchannels()
done	command **resetbasicchannels ,** fluid_handle_resetbasicchannels()
done	command **channelsmode** , fluid_handle_channelsmode()
done	command **setbasicchannels,** fluid_handle_setbasicchannels()

2.8.3. Inplementation steps: MIDI mode messages (2.3)

to do	**comments**
	fluid_synth.c
done	In fluid_synth.c – fluid_synth_cc_LOCAL() uses fluid_synth_mono.c - fluid_synth_set_basic_channel_LOCAL() that needs to be delcared external in fluid_synth.c.
done	test non basic MIDI channel
	initial state: mode:3, nbr:2
done	cc POLY_ON, val:0 --->mode:2,nbr:1
done	cc POLY_OFF, val:0--->mode:3,nbr:16
done	cc POLY_OFF, val:3--->mode:3,nbr:3
done	cc OMNI_ON, val:0 ---->mode:1,nbr:16
done	cc OMNI_OFF, val:0 --->mode:3,nbr:1
	Etat initial: mode:2, nbr:1
done	cc POLY_ON,val:0 ---->mode:2,nbr:1
done	cc POLY_OFF, val:0--->mode:3,nbr:16
done	cc POLY_OFF, val:5--->mode:3,nbr:5
done	cc OMNI_ON, val:0 ---->mode:0,nbr:16
done	cc OMNI_OFF,val:0 --->mode:2,nbr:1
	Etat initial: mode:0, nbr:16
done	cc POLY_ON, val:0 --->mode:0,nbr:16
done	cc POLY_OFF, val:0--->mode:1,nbr:16
done	cc OMNI_ON, val:0 ---->mode:0,nbr:16
done	cc OMNI_OFF,val:0 --->mode:2,nbr:1
	Etat initial: mode:1, nbr:16
done	cc POLY_ON, val:0 --->mode:0,nbr:16
done	cc POLY_OFF, val:0--->mode:1,nbr:16
done	cc OMNI_ON, val:0 ---->mode:1,nbr:16
done	cc OMNI_OFF,val:0 --->mode:3,nbr:1

2.8.4. ignoring MIDI messages on dsabled MIDI channels

to do	**comments**

	fluid_synth.c
	Following API aren't dependant of channel state 'enabled'
	FLUIDSYNTH_API int fluid_synth_sysex(fluid_synth_t *synth, const char *data, int len, char *response, int *response_len, int *handled, int dryrun);
	FLUIDSYNTH_API int fluid_synth_get_channel_info (fluid_synth_t *synth, int chan, fluid_synth_channel_info_t *info);
	enum fluid_midi_channel_type { CHANNEL_TYPE_MELODIC = 0, CHANNEL_TYPE_DRUM = 1 }; int fluid_synth_set_channel_type(fluid_synth_t* synth, int chan, int type);
	Following API are enabled only when channel is enabled
done	FLUIDSYNTH_API int fluid_synth_noteon(fluid_synth_t* synth, int chan, int key, int vel);
done	FLUIDSYNTH_API int fluid_synth_noteoff(fluid_synth_t* synth, int chan, int key);
done	FLUIDSYNTH_API int fluid_synth_cc(fluid_synth_t* synth, int chan, int ctrl, int val);
done	FLUIDSYNTH_API int fluid_synth_get_cc(fluid_synth_t* synth, int chan, int ctrl, int* pval);
done	FLUIDSYNTH_API int fluid_synth_all_notes_off(fluid_synth_t* synth, int chan);
done	FLUIDSYNTH_API int fluid_synth_all_sounds_off(fluid_synth_t* synth, int chan);
done	FLUIDSYNTH_API int fluid_synth_channel_pressure(fluid_synth_t* synth, int chan, int val);
done done	FLUIDSYNTH_API int fluid_synth_pitch_bend(fluid_synth_t* synth, int chan, int val); FLUIDSYNTH_API int fluid_synth_get_pitch_bend(fluid_synth_t* synth, int chan, int* ppitch_bend);
done done	FLUIDSYNTH_API int fluid_synth_pitch_wheel_sens(fluid_synth_t* synth, int chan, int val); FLUIDSYNTH_API int fluid_synth_get_pitch_wheel_sens(fluid_synth_t* synth, int chan, int* pval);
done	FLUIDSYNTH_API int fluid_synth_program_change(fluid_synth_t* synth, int chan, int program);
done	FLUIDSYNTH_API int fluid_synth_bank_select(fluid_synth_t* synth, int chan, unsigned int bank);
done	FLUIDSYNTH_API int fluid_synth_sfont_select(fluid_synth_t* synth, int chan, unsigned int sfont_id);
done	FLUIDSYNTH_API int fluid_synth_unset_program (fluid_synth_t *synth, int chan);
done	FLUIDSYNTH_API int fluid_synth_get_program(fluid_synth_t* synth, int chan, unsigned int* sfont_id, unsigned int* bank_num, unsigned int* preset_num);
done	FLUIDSYNTH_API int fluid_synth_program_select(fluid_synth_t* synth, int chan, unsigned int sfont_id, unsigned int bank_num, unsigned int preset_num);
done	FLUIDSYNTH_API int fluid_synth_program_select_by_sfont_name (fluid_synth_t* synth, int chan, const char *sfont_name, unsigned int bank_num, unsigned int preset_num);
done	FLUIDSYNTH_API int fluid_synth_program_reset(fluid_synth_t* synth); used by fluid_synth_program_change()
done	(fluid_channel_reset()) Add a channel basic set in mode Omni On Poly ignoring settings

2.8.5. MIDI CC MIDI global

to do	comments
	\fluidsynth-1.1.6\src\synth\fluid_chan.h
done	adding macro #define GetChanModeVal(chan) (chan->mode_val)
	\fluidsynth-1.1.6\src\synth\fluid_synth.c
done done	adding in fluid_synth_cc(fluid_synth_t* synth, int chan, int num, int val) test: Ok

3. Part 2:Polyphonic/monophonic behavior inside Fluidsynth

This part describes the behavior of a monophonic instrument (like MIDI Wind Controller) when played by a musician (3.2).
This part describes also the behavior of a polyphonic instrument (like keyboard) when played by a musician (3.3).

The synthesizer (receiver) at the other side needs to behave correctly without knowledge of the MIDI controler (transmitter) connected on its input. This is how FluidSynth behaves.

3.1. Part 2: Tutorial examples- understanding monophonic behavior

This chapter describes useful examples to learn and understand what is poly/mono mode
Example files are executable directely on the console using the *source* command.

>source command-example-file

3.1.1. How to set a MIDI channel in mono mode ?

To be able to play monophonically a MIDI channel must be set in mono mode.
- This can be done by setting basics channels (see 2.1 for détails.)
- This can be done also by using legato pedal On (see 3.1.2).

3.1.2. Why using legato pedal On/Off ?

When a channel is in poly mode, it can be set temporarily in mono mode during performance by deperessing the legato pedal (cc 68d). When legato is On, the channel reacts as if it was set in mono mode.
That means that if the musician is playing legato the channel will react legato (because the channel is in mono state). When the musician release the legato pedal, the channel restore in the state prior legato On.
In others words legato On/Off is useful only when playing on MIDI polyphonic controller.

When playing on MIDI monophonic controller (any electronic wind instrument, or electonic valve instrument), normally this kind of instruments send CC legato On/Off at the appropriate moment.

In summary when a channel receives CC legato On/Off it will be able to reacts monophonically regardless its actual poly/mono mode .
Legato On/Off is a real time performance CC to allowing polyphonic instrument to be played like monophonic instrument.
This doesn't mean that legato On/Off supersede the functionnality offers by 'basic channels' (see 2.2).

When a channel is in mono mode (set by basic channels 2.2), this channel is always able to play legato (if the musician plays legato) regardless of legato pedal state.

See 3.4.10 for détails.

3.1.3. How reacts FluidSynth when the musician plays legato or staccato ?

When a channel is mono or legato is On, the channel reacts to the musician playing.
That means that if the musician is playing staccato the channel will play staccato.
If the musician plays legato , the channel will react legato.

3.1.4. What are legato mode ?

Legato mode are only used when the musician plays legato on a channel that is in mono state (i.e the channel is mono or CC legato is On) (see 3.1.2).

Legato mode define the way the note transition between n1,n2, is articulated on n2On. There are 5 legato modes. When a channel is set in a mode, articulations betwween note transition always make use of this mode.

When the musician play staccato, the notes are articulated normally (as defined by the soundfont preset) regardless of legato mode.

Examples
Presets numbers in Legato_demo.sf2:
66 Tenor Sax 56:Trumpet 71:Clarinet
70: Bassoon 73:Flute 74:Alto Recorder Yamaha
The following examples use preset Tenor Sax (66)

legato mode 0: **source leg_0.txt**
legato mode 1: **source leg_1.txt**
legato mode 2: **source leg_2.txt (see remark)**
legato mode 3: **source leg_3.txt (see remark)**
legato mode 4: **source leg_4.txt (see remark)**

Remark:
- Note the difference between mode 0 vs mode 1. Mode 0 is more percussive than mode 1 due to fast release (mode 0) vs normal release (mode 1). This is more obvious using flute.
- Dependant of the switching preset zones, controled both by velocity range and key range , legato mode (2 to 4) can use temporarily the same articulation than legato mode 1. This is audible in the examples above. On noteOn, each time there is a switch ("velocity range" or "key range"), the note restarts the attack. In all exemples velocity is the same for all the notes, so there is no "velocity range" switching".
- If you want to change the preset you can edit the file leg_x.txt and modify the **prog** command.

See 3.6 for détails about legato mode.

3.1.5. What are breath mode ?

Breath mode allows a keybordist to control dynamic using a Breath controller.

This functionnality is useful only in case of no CC Breath modulator inside the Soundfont.
It is a quick way to try the effect of Breath Controller (please see the important note below).

This patch gives FluidSynth the possibility to set a Default *Breath To InitialAttenuation* inside FluidSynth with the help of a shell command.
The command allows to set a cc Breath modulator to replace the default "*velocity to initial Attenuation*" modulator for a channel, independently when played polyphonic or monophonic.

Important:
- Any identical modulators in the Soundfont will supersede the default breath modulators set by breath mode commands.
- After you have done your try , for portability and Soundfonts sharing, it is important to add the necessary modulators in the Soundfonts using the appropriate editor.

Breath mode allows also the musician to synchonize noteOn/noteOff using the breath controller. (see 3.4.4 for détails.)

3.1.6. What is portamento ?

Portamento is a smooth pitch sweep produced on noteOn. The sweep start from a 'from key' note to reach noteOn note smoothly.

Examples
Presets numbers in Legato_demo.sf2:

66 Tenor Sax	56:Trumpet	71:Clarinet
70: Bassoon	73:Flute	74:Alto Recorder Yamaha

The following examples use preset Trumpet(56). Note that accoustic Trumpet doesn't not allow portamento !. So this demo is a bit exotic !

legato mode 0, with portamento: **source leg_port_0.txt**
legato mode 1, with portamento: **source leg_ port_1.txt**
legato mode 2, with portamento: **source leg_ port_2.txt**
legato mode 3, with portamento: **source leg_ port_3.txt**
legato mode 4, with portamento: **source leg_ port_4.txt**

Remark:

- Dependant of the switching preset zones, controled both by "velocity range and key range" , legato mode (2 to 4) can use temporarily the same articulation than legato mode 1. This is audible in the examples above because of the portamento presence. On noteOn, each time there is a switch ("velocity range" or "key range"), the note restarts the attack. In all examples velocity is the same for all the notes, so there is no "velocity range" switching".
- If you want to change the preset you can edit the file leg_x.txt and modify the **prog** command.

See 3.4.9 for détails.

3.1.7. What are portamento mode ?

With portamento mode you choose the situation in wich portamento occurs. This situation (i.e this mode) is set with portamento mode commands (see 3.8 for détails.)

3.1.8. What about sustained note in monophonic mode ?

When in mono mode, note can be sustained (by sustain or sostenuto pedal) as in poly mode.

- While a note is sustained, playing staccato always release previous sustained note and than sustain the new note. The result sounds like legato mode (normal release).
- Playing legato while sustain (or sustenuto) is depressed will sustain only the last note of the legato passage (always releasing any previous existing sustained note before sustaining the last note)

3.2. monophonic MIDI Wind Controller instrument

This chapter describes MIDI Wind Controller behavior supplied by Louis B.

- see starting thread [Fluid-dev] Help about MIDI Wind Controller behavior 30 Apr 2015

With the help of Louis B, it was easy to implement the monophonic behavior in this patch. Thanks to Louis B.

Many thanks to Ben Gonzales also for informations about monophonic accoustic instruments and electronic winds instruments behaviors.

3.2.1. Basic behavior

Starting sending note,dynamic control and ending sending note is done when blowing in breath controller.

- No notes are sended when the musician doesn't blow.
- Playing starts when blowing starts. A MIDI noteOn is sended with a velocity value coming from Breath value. Notes value depends of the depressed key.
  While breath continue, the musician can change key. This is a legato manner playing (see 3.2.3).
  There is a note change on each key change, 2 consecutives MIDI messages are sended(see R1).
  {noteOn n2, noteOff n1}, {noteOn n3, noteOff n2}, (see R2)...
  The noteOn velocity is the current breath value.
  Legato passage can be in ascending {noteOn 2, noteOff n1},{noteOn n3, noteOff n2} or descending {noteOn 2, noteOff n3} order (see R3).
- Playing stops when the musician stops blowing; a MIDI noteOff is sended with the note pitch egal to the previous noeOn .
- Between starting end ending blowing , if the musicien plays and release the same key, only one note is sended (noteOn n, noteOff n). Doing this several times is a staccato playing manner (3.2.2)

Remarks:
R1: noteOff presence is a MIDI standard recommendation that says that a noteOn must be send for each noteOn sended.

We remark that to reproduce a legato passage, typical synthesizer behavior is to use the voices of the previous note.

R2: We note also that during a legato passage, a MIDI noteOn can be sended while the musicien release a key.For example if n1 than n2 key are depressed we ear note n2. Then when n2 is released we ear note n1

R3: We remark also that when receiving noteOff messages a synthesizer needs only care of the last noteOff received and ignore previous one.

3.2.2. Playing staccato

To start and stop a note n1, musician starts and stops blowing.

When musician blows in breath controller, the MIDI Wind Controller sends CC Breath followed by noteOn n1.

- daten1_on: CC breath 2(MSB), data > 0
- daten1_on: CC breath 34(LSB), data >0
- daten1_on: noteOn n1, vel = databreathMSB

When the musician release blowing, the MIDI Wind Controller sends noteOff n1 followed by CC Breath.

- daten1_off: noteOff n1, vel=0
- daten1_off: CC breath 2(MSB),data =0
- daten1_off: CC breath 34(LSB), data= 0

MIDI noteOn,noteOff stream is framed by CC Breath. Velocity of note is typically in MSB value of CC breath.

3.2.3. Playing legato: n1,n2,n1

To get a legato result the musician plays a note n1 by blowing and plays an other key n2 keeping blowing.

Playing note n1

- daten1_on: CC breath 2(MSB), data > 0
- daten1_on: CC breath 34(LSB), data >0
- daten1_on: noteOn n1, vel = databreathMSB

Playing note n2 legato with n1. a noteOn n2 is sended followed by a noteOff n1 (see R3). noteOn n2 is preceded by CC legato On (see R1,R2).

- daten2_on: CC legato On
- daten2_on: noteOn n2, vel = current data breathMSB
- daten2_on: noteOff n1, vel=0

R1: The MIDI Wind Controller detects a legato playing because the musicien continue to blow at n2 key time while n1 was still pressed. This wan't not the case at n1 time.

R2: The MIDI Wind Controller detects the start of a legato passage and sends CC legato On which informs the synthesizer that it needs to interpret n2 legato with the more recent note received (i.e n1). So even if the synthesizer is in polyphonic mode (see 3.5), it can reacts has if it was in monophonic mode (see 3.4.2)..

R3: a noteOff n1 is sended for each noteOn sended (a standard MIDI behavior).
The synthesizer can ignore this message.

The musician continue legato playing, keeping blowing and playing key n3 (legato n2,n3) .

- daten3_on: noteOn n3, vel = current data breathMSB
- daten3_on: noteOff n2, vel=0 (voir R3)

The MIDI Wind Controller detects a running legato n2,n3. So it idoesn't send unnecessary cc legato On. Receiving n3, the synthesizer remember of a running legato state, so it reacts legato n2,n3 (same as R2).
Remark R3 is relevant.

The musician can continue legato playing, keeping blowing and releasing key n3 (legato n3,n2)
Remarks R1,R3 sare still relevant.

- daten3_off: noteOn n2, vel = current data breathMSB
- daten3_off: noteOff n3, vel=0 (see R3)

The MIDI Wind Controller detects a legato playing n3,n2 because at n3 release time, key n2 is still pressed.
The synthetizer reacts the same way.

When the musician release breath a noteOff is sended (R4)

- daten2_off: noteOff n2, vel=0
- daten2_off: CC breath 2(MSB),data =0
- daten2_off: CC breath 34(LSB), data= 0

If the musician restarts blowing , has key n1 and n2 are still pressed ,the MIDI Wind Controller send a noteOn n2 that will be played legato with n1 at musician desire.

- daten2_on: CC breath 2(MSB), data > 0
- daten2_on: CC breath 34(LSB), data >0
- daten2_on: noteOn n2, vel = databreathMSB

The musician can continue legato playing, by breath maintain and releasing key n2

- daten2_off: noteOn n1, vel = current data breathMSB
- daten2_off: noteOff n2, vel=0 (see R3)

When the musicien release breath a noteOff is sended (R4) eventualy followed by legato Off (R5) if legato was running.

- daten1_off: noteOff n1, vel=0
- daten1_off: CC legato off
- daten1_off: CC breath 2(MSB),data =0
- daten1_off: CC breath 34(LSB), data= 0

R4: Synthesizer must play this event, it doesn't ignore it has it does in R3.
The MIDI Wind Controller detects a legato ending because it knows that the played note was the last pressed note.

3.3. Polyphonic controller (Keyboard)

3.3.1. basic behavior

Each key is independant. Notes can be played simultaneously.
A MIDI noteOn is send when the musician press a key and a MIDI noteOff is send when the key is released.

3.3.2. Playing staccato

Musician can play staccato. MIDI stream messages (noteOn/noteOff) are the same that with MIDI Wind Controller.

3.3.3. Playing legato

A polyphonic MIDI controller doen't not detect legato playing. So it it very difficult for a musician (even for a skilled one) to get a legato result when playing legato.
So, a Polyphonic controller doesn't send MIDI legato On/Off automatically (has does MIDI Wind Controller see 3.2).

3.4. Synthesizer monophonic behavior

This chapter describes the synthesizer behavior when it receive MIDI messages on monophonic channel. The synthesizer must behave the same regardless which MIDI controller (monophonic,polyphonic) is connected on its input.

- polyphonic controller (keboard) to monophonic channel (see 3.4.2).
- CC Breath controller to) to monophonic channel (see 3.4.4).
- Monophonic controller (MIDI Wind Controller) to monophonic channel (see 3.4.6) .

3.4.1. Input controller (mono/poly)

The synthesizer must behave the same regardless which MIDI controller (monophonic,polyphonic) connected on its input. This must be true regardless the playing manner (staccato or legato). Chapter 3.4.2 gives the algorithm when polyphonic controller is on input.

3.4.2. polyphonic controller (keyboard) to monophonic channel.

When playing staccato on keyboard, synthesizer behavior is the same regardless the channel mode (Poly/Mono).
When playing legato, it is different. The synthesizer needs to remember of the notes belonging to a legato passage from the 1st note. This memory is necessary detect a legato and to allow reverse order playing legato (see explanations 3.4.3).

3.4.3. Legato playing detector – the monophonic list

The list allows an easy automatic detection of a legato passage when it is played on a MIDI keyboard input device.
It is useful also when the input device is an ewi (electronic wind instrument) or evi (electronic valve instrument) and these instruments ar unable (like many polyphonic MIDI controller) to send MIDI CC legato on/off.

The list remembers the notes in playing order.

- (a) On noteOn n2, if a previous note n1 exists, there is a legato detection with n1 (with or without portamento from n1 to n2).
- (b) On noteOff of the running note n2, if a previous note n1 exists, there is a legato detection from n2 to n1, allowing fast trills playing (with or without portamento from n2 to n1).

The features are:

- 1) It is always possible to play an infinite legato passage in direct order (n1_On,n2_On,n3_On,....).
- 2) Playing legato in the reverse order (n10_Off, n9_Off,,...) results in fast trills playing as the list memorizes 10 most recent notes.
- 3) Playing an infinite lagato passage in ascendant or descendant order, without playing trills is always possible using the usual way like this:
  - First we begin with an ascendant passage: n1On, (n2On,n1Off), (n3On,n2Off) , (n4On,n3Off), then
  - we continue with a descendant passage: (n3On,n4off), (n2On,n3off), (n1On,n2off), n1Off...and so on

Each MIDI channel have a monophonic list.

The following examples shows the purpose of the monophonic list.

Exemple 1 :Imagine a flutist (playing a flute with holes) who wants to play the whole passage in legato playing:

n1,n2,n3,n2,n1

The whole passage is n1,n2,n3 (in direct order) than n2,n1 (in reverse order).

The flutist needs to do:

First playing n1,n2,n3 in direct order:

- Press key n1, No legato detection, n1 is started normally . (1st note the legato passage).
- Press key n2, legato detection (n1,n2) , so n2 is played (using voices of n1).
- Press key n3, legato detection (n2,n3), so n3 is played (using voices of n2).

Then playing n2,n1 in reverse order

- Depress n3, legato detection (n3,n2), so n2 is played (because key n2 was still depressed) (using voices of n3).
- Depress n2, legato detection (n2,n1), so n1 is played (because key n1 was still depressed) (using voices of n2).
- Then depress n1, no legato, n1 is stopped. (end of the legato passage).

Exemple 2: Now imagine the flutist wants to play a trill beetwen n1 and n2
The flutist needs to do:
First playing n1On, n2On than quicklly depress n2, and release more times, this produces a fast trill.

These examples showed :

- how the monophonic list helps to detect a legato between pairs of notes.
- how the legato detector can trigger a note during the reverse ordre using the note value and velocity value memorized by the list at noteOn time.

On noteOn, the note are added in the monophonic list that works as a circular buffer.
On noteOff, any corresponding note are removed from the list. So when playing in the reverse order the musician have the possibility to ignore some notes.
Example
lets n1,n2,n3,n4 to be played legato in the direct order.
Than the musician wants to continue in the reverse order without n2, so simply he needs to release n2 before releasing n3.

With a monophonic list size of 10 notes, we have

- Low memory cost (40 bytes per channel)
- Fast insertion/removing (at noteOn/noteOff)

3.4.4. CC Breath controller to monophonic channel .

The MIDI breath controller on MIDI Wind Controller allows fluid dynamic control beetween notes of a legato passage.
Furthermore starting and stopping notes is triggered via the breath controller.
This possibility allows differents articulations inside a legato passage.

Consequently , it is very important that the synthesizer reacts to CC Breath. (3.4.5).

polyphonic controller (keyboard) on input
When the musicien play on a keyboard, the dynamic is controled only at noteOn time but not between noteOn. So a keyboard suffers of a lack of dynamic control.
The chapter 3.4.5 is a proposal to bring CC breath.

3.4.5. How FluidSynth can play CC Breath controller

It is up to the soudfont preset designer to add CC Breath support. If a CC "Breath to attenuation" modulator is present in the soundfont, Fluidsynth synthesizer will play it. It is the right way as it allows preset sharing.

To get FluidSynth able to play CC Breath, it is necessary that the preset have the following properties:

- 1)Cancel the effect of the default modulator *Velocity To Initial Attenuation*
  This can be done by adding a modulator *Velocity To Initial Attenuation* with amount value to 0.
  This is not mandatory, it just useful for keyboardist who want to control dynamic with only a breath controller (but not with both key velocity + breath controller).
  For MIDI Wind Controller player, as far the MIDI Wind Controller put breath data in velocity data (which is normally the case), step (1) is unnecessary.

- 2) Adding a *CC Breath To Initial Attenuation* modulator with a amount of 960 cB.
  This amount value is dependant of the synthesizer "dynamic range" capability. Actually FluidSynth range is 960 cB as the internal audio engine generates 16 bit samples.

The best is to set this 2 modulators in the Local Zone (Intrument Zone).
A preset define a sound, so it is logical that those modulators are set in the SoundFont.

However, this patch gives FluidSynth the possibility to set a Default *Breath To InitialAttenuation* inside FluidSynth with the help of a shell command.
This is useful in this cases:

- there is no CC Breath modulator inside the Soundfont or
- the keyboardist want to control dynamic with only a breath controller (but not with both key velocity + breath controller).

The following command allows to set a cc Breath modulator to replace the default "*velocity to initial Attenuation*" modulator for a channel, independently when played polyphonic or monophonic (see fig).

setbreathmode chan 1 | 0 1| 0

Examples

- No default CC Breatth To InitlAttenuation for MIDI Channel 2
  setbreathmode 2 0 0

- MIDI channel 2: Breath modulator for poly mode only.
  setbreathmode 2 1 0

- MIDI channel 2: Breath modulator for mono mode only.
  setbreathmode 2 0 1

- MIDI channel 2: Breath modulator for both mono and poly mode.

setbreathmode 2 1 1

```
# Choosing MIDI channel 2 in Poly mode (for example Poly Omni Off: 2)
setbasicchannels 2 2 0
#  Choosing BreathToAtt on MIDI Channel 2 when it will be in Mono state
# (The 3rd parameter must be set to 1).
SetBreathMode 2 0 1
```

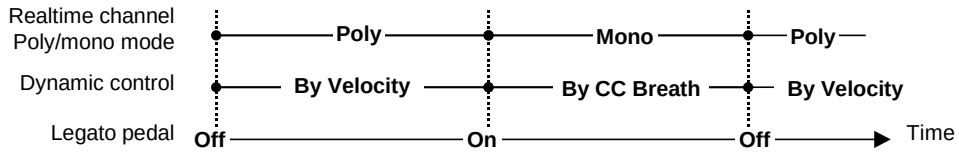


Fig:Realtime source control of dynamic (velocity or CC breath) on a polyphonic MIDI channel.
•When legato pedal is Off, dynamic is controlled by velocity (coming from the keyboard).
•When legato pedal is On, dynamic is controlled by the breath (coming from CC Breath controller).

Triggering notes with the breath controller

This patch brings also a new option called "Breath noteOn/noteOff". This option is the 4th parameter of setbreathmode command

It allows the breath controller (MSB) to trigger noteoff/noteon on the running note. If you are a wind player and you want to play on a keyboard, you would appreciate similar behaviors than playing on electronic wind instruments. So this option is only efficient if the MIDI input device is a keyboard. If the MIDI input device is an electronic wind instrument, this option does nothing as this intrument naturally sends noteOn and noteOff when the player starts and stop blowing.
Example on MIDI channel 4

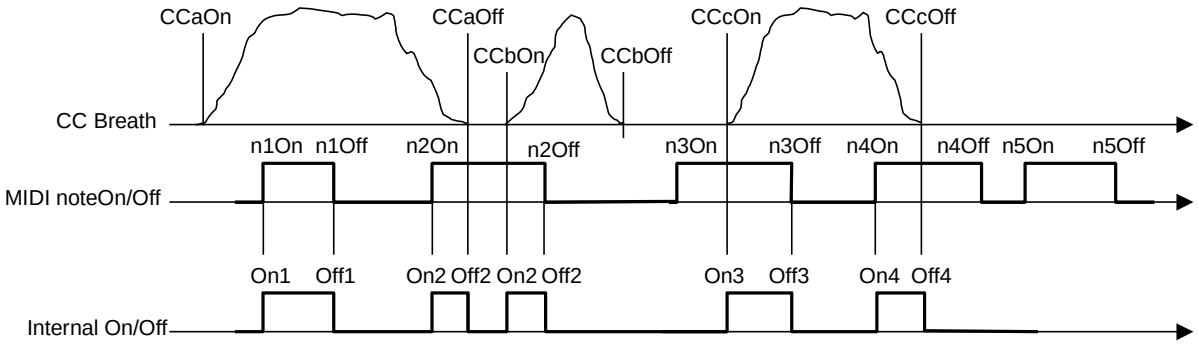
```
setbreathmode 4  0  1  1
```

Parameter 3 is 1 to enable " Breath modulator " for mono mode
Parameter 4 is 1 to enable "breath noteOn/Off" for mono mode only

Summary

- "Breath sync noteOn/noteOff" option works only for mono mode (or poly mode with legato On).
- parameter 3 is not mandatory but is is a natural choice for a musician playing wind instrument.

- Breath sync is useful only for MIDI keyboard on input.
  - Playing on the keyboard will triggers noteOn/noteOff only if the player blow.
  - Starting /stopping blowing will triggers noteOn/noteOff only if the player hold a key.
  - During blowing, the musician can plays legato or not with the keyboard.
  - In others words this option allows to play staccato only using a Breath controller.



The figure illustrate the "Breath sync noteOn/noteOff" option behavior.

3.4.6. Monophonic controller (MIDI Wind Controller) to monophonic channel.

We remark that the behavior of the algorithm that allows a channel to react monophonically (when played by a polyphonic controller (keyboard) (see 3.4.2) works also when the input controller is monophonic (MIDI Wind Controller). FluidSynth reacts the same way regardless the type of MIDI controller connected to its input.

3.4.7. Using Sustain / Sostenuto in monophonic mode

A note on a monophonic channel be hold by Sustain or Sostenuto, the same way as for a polyphonic channel.

Note: On noteOn n1 if a previous monophonic note *np* is held by Sustain (or Sostenuto) this note *np* is released.

3.4.8. Useful MIDI CC in monophonic mode

Controller	number		Value	Monophonic/Polyphonic mode
Portamento time MSB	5d	05h	0 -127	Mono/Poly (see Portamento On/Off) and Portamento Control.
Portamento time LSB	37d	25h	0 -127	Mono/Poly (see Portamento On/Off) and Portamento Control
Portamento off/on	65d	41h	<= 63, >=64	Mono / Poly
Legato off/on	68d	44h	<= 63, >=64	Mono/Poly
Portamento control	84d	54h	0 -127	Poly/Mono
Hold 2	69d	45h		

Hold 2 allows to freeze current ADSR generator value (page 69 MIDI specifications).

This patch supports CC in bold only.

3.4.9. Portamento On/On

When pedal is On, pitch sweep is enabled in both poly or mono mode.
the speed of sweep is instructed by Portamento time (MSB,LSB) in ms. If portamento time is 0 the sweep is not perceptible.
See 3.8 for details.

3.4.10. Legato On/On

If a channel is set in poly mode, it can't play monophonically. In this situation the musician can turn this channel in monophonic state by depressing legato pedal. During the time the pedal is hold, this channel behaves monophonically as if it was set in mono mode.
That means that the channel is able to play legato if the musician plays legato.
A musician plays a legato passage n1,n2 when he plays n2 without releasing n1.

Remarks:

- In Fluidsynth, on a poly channel , if note n1 is keeped depressed, then legato pedal is depressed, when n2 is played On, a legato passage begins with note n1. This way, if the MIDI input device is a keyboard, the synthesizer behaves the same that if the input device was an electronic wind controller intrument. Wind players using a keyboard would appreciate identic behavior.
- When a channel is set in mono mode (by basic channels commands(2.2), or CC poly/mono (2.3)) , it ignores legato pedaling. This channel is able to play legato if the musician plays legato.

3.4.11. CC Portamento Control (PTC)

CC portamento control is a MIDI specification.
When CC portamento is received, the next note is played portamento regardless of Portamento pedal. The portamento fromkey note is given by the value of this CC. In FluidSynth this behavior works in Mono or Poly mode.

In both mode, when the value of the CC coincide with a possible running note (legato in mono and poly). The note (tokey) is played using the voices of the running note.
In Poly this produce a localized legato mono transition in the context of polyphonic playing.
For exemple while the musician hold C major chord (C,E,G) if CC PTC with value G is received, when the musician play A note, the G voices of the chord are stolen to play a portamento from G to A.
When portamento sweep is finished the chord is C E A.

If the value of PTC doesn't coincide with a running note, with the same chord example (C,E,G), no chord voices are stolen. When portamento sweep is finished the chord is C E G A.

3.4.12. CC Global to control all channels at the same time (Mode 3) (OmniOff- Mono).

CC global is a MIDI specification.
If a there is a basic channel in mode 3, it is possible to send only one CC for all MIDI Channel that belong to this group. The CC is called a global CC. To be accepted as global, the CC must be send on a global channel one below the basic channel and that grobal channel must not belong to another group otherwise the CC is considered as a normal CC (sends only to one channel).

In Fluidsynth It is always possible to have more than one basic channel with the use of CC global in perspective (see 2.5).

3.5. Polyphonic Channel behavior

When playing on a polyphonic channel, the musician can use the legato pedal to enter the channel in monophonic mode.

3.6. Legato modes

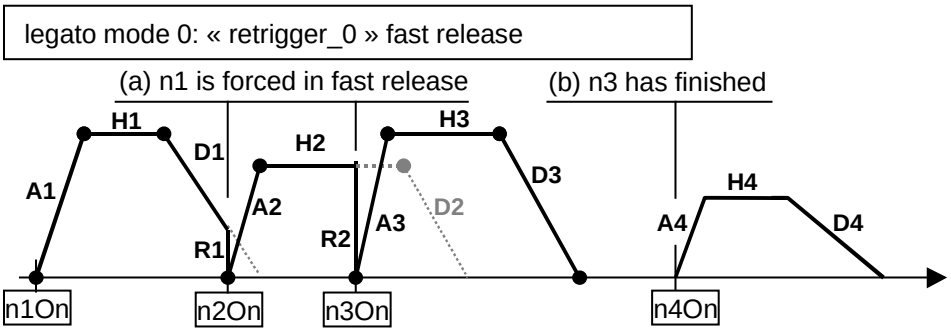
This chapter describes legato modes. Legato modes instructs a channel on how to articulate the notes of a legato passage. This triggering mode are interresting with a keyboard on input witch have velocity or a preset with true adsr volume articulations (i.e with attack decay and sustain not at the same level). These modes have little or no effect on "flat" adsr enveloppe.

These modes articulate the notes follwing the 1st note differently.
For example: let n1,n2,n3,n4,.....
n1 is the 1st note of a legato passage. It is played normally.
n2,n3,n4 are articulated differently than n1. ***Legato mode*** instructs the type of articulation used.

There are 5 modes numbered 0 to 4. The more numbered have the more legato articulation contribution. Mode 0 have the less legato articulation contribution (it sound more percussive on attack).

The legato mode can be set by API (3.6.7) or commands (3.6.9).

3.6.1. Mode 0: "retrigger_0" (fast release)

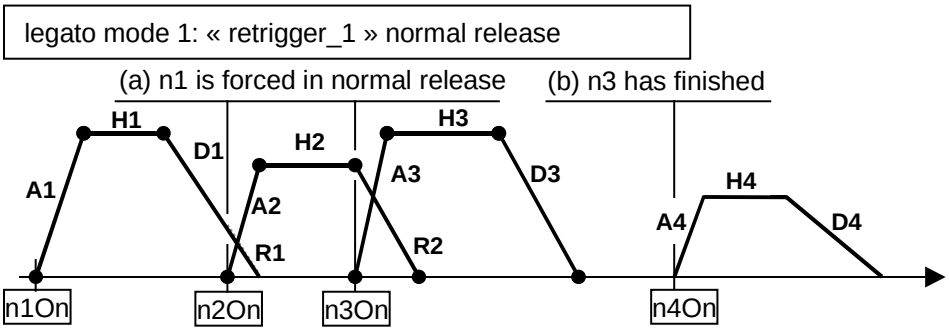


With Mode 0, on noteOn n2,n3....The previous note is released quickly and the new note is started normally.

- The musician gives velocity/breath on each note (n1,n2,n3).
- This mode is called "retrigger" because volume adsr are restarted from 0. This is why the legato perception is diminished.

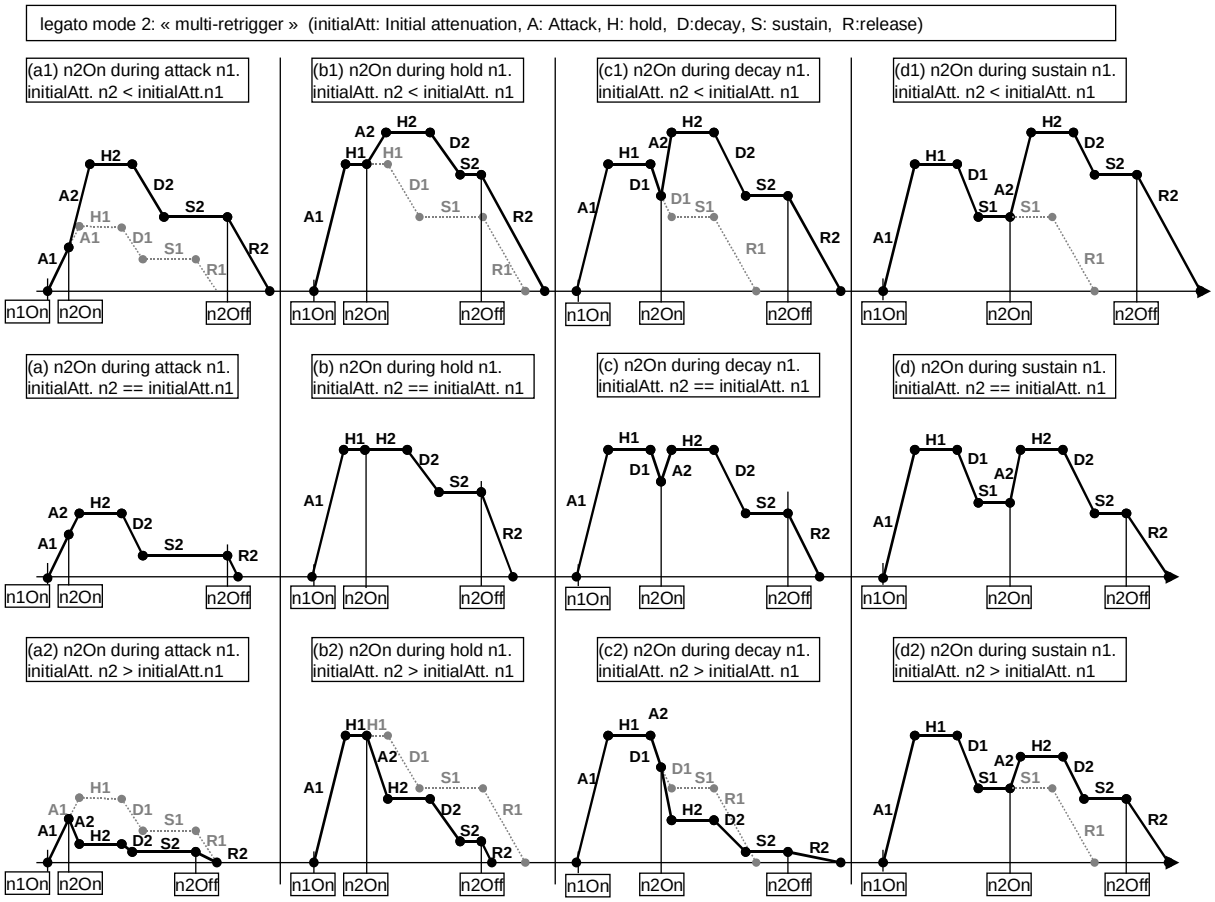
  Remark: for example,this mode is adequat for playing a lot of trills.
  If the musician don't want playing trill he just needs to release previous note before releasing current note .

3.6.2. Mode 1: "retrigger_1" (normal release)



This mode est similar to previous mode 0, but previous note are not released quickly. They release normally as release time is not changed. If relase is not too fast there is a cross fading between release of previous note and attack of the current note. This "cross fadind" offers a more legato perception than mode 0.

3.6.3. Mode 2: "multi-retrigger"

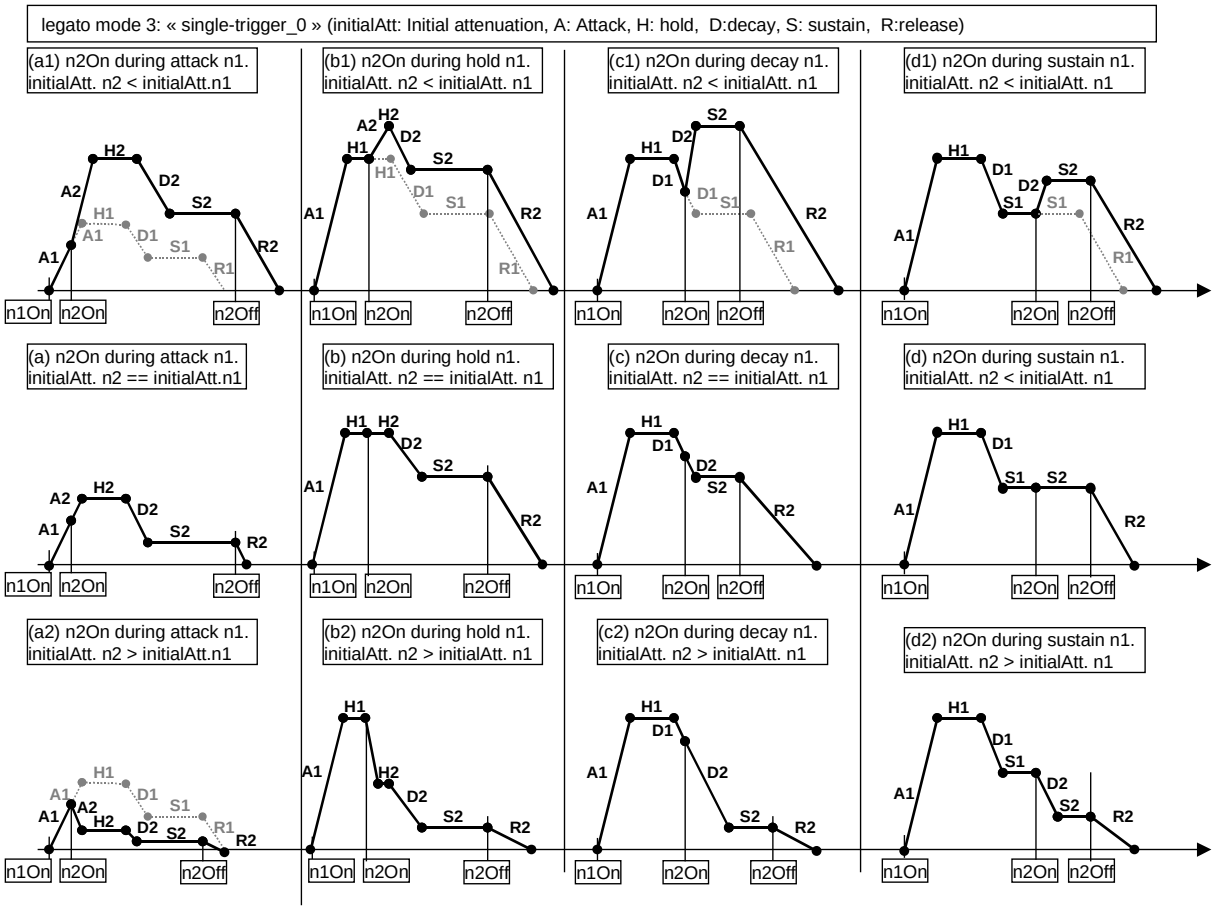


With Mode 1, on noteOn n2,n3,... adsr are forced in attack section but keeping current envelope value.

- The attack section is reshaped by current velocity.
- The musician gives velocity/breath on each note (n1,n2,n3).
- This mode is called multi-retrigger because adsr generators can retriggered during attack section (i.e retrigered more than one time for example if the attack isn' to fast and the following notes (n2,n3) come sooner after n1.

Depending on the envelope shape, this mode is more legato than mode 0.

3.6.4. Mode 3: "single-trigger_0"



With Mode 2, on noteOn n2,n3,... adsr stay in the current section keeping the current envelope value.

- The current section is re-shaped by the current dynamic.
- The musician gives velocity/breath on each notes (n1,n2,n3).
- This mode is called single-trigger because the envelopes are triggered one time (on n1On only). If the enveloppe has a sustain level (i.e above 0), this mode have more legato effect than mode 1.

3.6.5. Mode 4: "single-trigger_1"

- (Mode 3) This is the normal mode. This mode is similar to mode 2 ,but the adsr envelope are not shaped. As this mode don't modify adsr, it can be choosen by MIDI Wind Controller player for example.
  The musician gives velocity/breath on each note (n1,n2,n3).

3.6.6. Legato playing through InstrumentZone and PresetZone in SoundFont

This patch now accept legato passage through multiples Instruments Zones and Preset Zone.This chapter describes the enhancement to suppress the know (and unacceptable) limitations of previous patches.

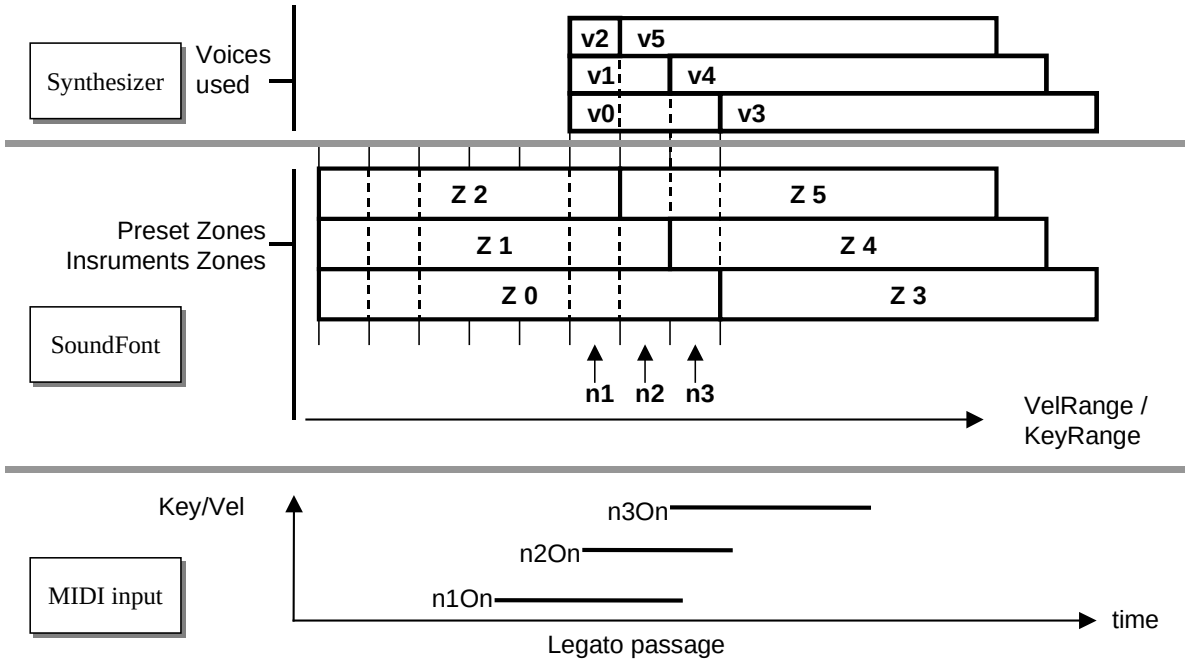


Fig.1: legato passage and zones switching.

Soundfont preset are often designed with multiple key ranges and velocity ranges at Instrument Level. That means that when playing a monophonic passage of notes n1,n2,n3 in a legato manner. n1 been the first:

1) following notes n2, n3 each make use of n1 voices, if n2 or n3 are still in the KeyRange, VelRange of InstrumentZone or PresetZone (IZ,PZ) of the n1 running voices.
2) If n2,n3 are outside VelRange and KeyRange of some running voices, those voices are forced in release section.
3) Next, new eligible voices for n2,n3 need to be allocated.

So, on noteOn, the legato logic must do two things:

- the legato job (step 1 above)and also
- it must respect the keyRange or velRange switching as instructed by the SoundFont designer (steps 2 and 3 above).
  If a zone switching occurs it can compromise the legato job but this is necessary to respect the Soundfont designer decision. Previous patch ignored the zone switching, making use of a previous even the voice pitch gets out the keyRange of the zone. This produced a sound very unatural and unacceptable.

Exemple:
Let n1,vel1 (note and velocity) with layered zones Z0,Z1,Z2 .each represented by their respective VelRange,KeyRange (instructed by PresetZone/InstrumentZone).See Fig.1

- At n1On, voices v0,v1,v2 are allocated and started for note n1.
- At n2On , assuming that a legato passage as been detected, the following occurs:
  1) n2,vel2 is found in the VelRange,KeyRange of Z0, so voice v0 is used (without allocation) to play n2.
  2) n2 is found in the VelRange,KeyRange of zone Z1.This the same situation as (1) so voice v1 is used (without allocation) to play n2 .
  3) n2 is found outside the VelRange,KeyRange of Z2.Voice v2 can't be used to play n2, so voice v2 is forced in release section (see note 2 below).
  4) Now all the previous voices of n1 have been explored. However, it is possible that n2,vel2 will be able to enters in the Velrange,KeyRange of a new Preset Zones or Instrument Zones (Z5).(see note 1) In this case new voices (v5) need to be allocated to play this new Preset Zones or Instrument

Zones (Z5).

This allocation is done using fluid_defpreset_noteon(). During this new allocation, the Instrument Zones corresponding to the already running voices v0,v1 (revived at step 1 and 2) must be ignored. So, steps 1 and 2 need to mark the corresponding Instrument Zone (Z0,Z1) to be ignored during step 3.

Note 1: This situation occurs when Instruments Zones of each layer overlaps partially (i.e the beginning/ending of one zone doesn't coincide with the beginning/ending of others zones) as show in figure 1.

Note 2:
As some voices are necessarily forced in release section, the passage loses its legato caracter at the Instrument Zone transition time.

- The legato mode is retrograded to a "fast release" for legato mode 0 and a "normal release" for legato mode above 0.
- this can be more compensed also at soundfont design level when a Preset Zone have more than one Instruments Zones that overlapps partially as this kind of soundfont design enhance the blending of voices and legato rendering (see Note 1) .

3.6.7. API set legato mode: **fluid_synth_set_legato_mode(chan,mode)**

FLUIDSYNTH_API
int fluid_synth_set_legato_mode(fluid_synth_t* synth, int chan, int legatomode)

The API function set the legato mode of a MIDI channel.

On input

- ***synth*** the synth instance.
- ***chan*** MIDI channel number (0 to MIDI channel count - 1) .
- ***legatomode***
  0: RETRIGGER_0 (fast release) 1: RETRIGGER_1 (normal release)
  2: MULTI_RETRIGGER 3: SINGLE_TRIGGER_0 4 : SINGLE_TRIGGER_1

On Output

- FLUID_OK if success
- FLUID_FAIL,
  - synth is NULL.
  - chan is outside MIDI channel count.
  - legatomode is invalid.

Note: The default shell has an equivalent command "**setlegatomode**" to set legato mode (see 3.6.9).

3.6.8. API get legato mode : **fluid_synth_get_legato_mode(chan,mode)**

FLUIDSYNTH_API
int fluid_synth_get_legato_model(fluid_synth_t* synth, int chan, int *legatomode)

The API function get the legato mode from a MIDI channel.

On input

- ***synth*** the synth instance
- ***chan*** MIDI channel number (0 to MIDI channel count - 1)
- ***legatomode*** pointer to returned mode.
  0: RETRIGGER_0 (fast release) 1: RETRIGGER_1 (normal release)
  2: MULTI_RETRIGGER 3: SINGLE_TRIGGER_0 4 : SINGLE_TRIGGER_1

On Output
- FLUID_OK if success
- FLUID_FAIL,
  - synth is NULL.
  - chan is outside MIDI channel count.
  - legato is NULL.

Note: The default shell has an equivalent command "**getlegatomode**" to display legato mode (see 3.6.10).

3.6.9. command to set legato mode:**setlegatomode**

setlegatomode chan1 Mode1 [chan2 Mode2 ….]

This command uses API fluid_synth_set_legato_mode() (3.6.7).

3.6.10. command to print legato mode:**legatomode**

legatomode

Print legato mode of all MIDI channels
example

channel: 0, (2)single-trigger_0
channel: 1, (1)multi-retrigger
channel: 2, (0)retrigger_0
channel: 3, (3)single-trigger_1

legatomode chan1 chan2

Print only legato mode of MIDI channel chan1, chan2

This command uses API fluid_synth_get_legato_mode() (3.6.8).

3.7. Breath mode

This chapter gives details about the presentation given in chapter 3.4.4

3.7.1. API get defaulth breath mode : **fluid_synth_set_breath_mode(chan, breathmode)**

FLUIDSYNTH_API
int fluid_synth_set_breath_mode(fluid_synth_t* synth, int chan, int breathmode)

The API function sets the breath mode of a MIDI channel.

On input
- ***synth*** the synth instance.
- ***chan*** MIDI channel number (0 to MIDI channel count - 1).
- ***breathmode bits***
  BREATH_POLY default breath modulator poly On/Off
  BREATH_MONO default breath modulator mono On/Off
  BREATH_SYNC breath noteOn/noteOff triggering On/Off

On Output
- FLUID_OK if success
- FLUID_FAIL,
  - synth is NULL.
  - chan is outside MIDI channel count.

Note: The default shell has an equivalent command "**setbreathmode**" to set breath mode (see 3.7.3).

3.7.2. API get breath mode : **fluid_synth_get_ breath_mode(chan,breathmode)**

FLUIDSYNTH_API
int fluid_synth_get_ breath_mode(fluid_synth_t* synth, int chan, int *breathmode)

The API function gets the breath mode option of a MIDI channel.

On input
- ***synth*** the synth instance.
- ***chan*** MIDI channel number (0 to MIDI channel count - 1)
- ***breathmode*** pointer to returned breath mode bits.
  BREATH_POLY default breath modulator poly On/Off
  BREATH_MONO default breath modulator mono On/Off
  BREATH_SYNC breath noteOn/noteOff triggering On/Off

On Output
- FLUID_OK if success
- FLUID_FAIL,
  - synth is NULL.
  - chan is outside MIDI channel count.
  - breathmode is NULL.

Note: The default shell has an equivalent command "**breathmode**" to display breath mode(see 3.7.4).

3.7.3. command to set breath mode:**setbreathmode**

setbreathmode chan1 poly_breath_mod(1/0) mono_breath_mod(1/0) mono_breath_sync(1/0) [..]

Changes breath options for channels chan1 and [chan2...]

Parameter 1 is the channel number (i.e 4)
Parameter 2 is the " Breath modulator " enable/disable for poly mode (i.e disabled)
Parameter 3 is the " Breath modulator " enabe/disable for mono mode (i.e enabled)
Parameter 4 is "breath sync noteOn/Off" enable/disable for mono mode only (i.e enabled)
See presentation in chapter 3.4.4, 3.4.5

This command uses function API fluid_synth_set_default_mode() (3.7.1).

3.7.4. command to print breath mode:**breathmode**

breathmode
Print breath mode of all MIDI channels (poly on/off, mono on/off
example

```
Channel    , poly breath , mono breath , breath sync
channel:  0, off         , off         , off
channel:  1, off         , off         , off
channel:  2, off         , off         , off
.....
```

breathmode chan1 chan2
Print only breath options of MIDI channel chan1, chan2

This command uses API fluid_synth_get_breath_mode() (3.7.2).

3.8. Portamento mode

Portamento can used on both mode Mono and Poly.
Portamento is enabled between notes from n1 to n2 when Portamento is On.
When portamento is Off portamento sweep is disabled.

3.8.1. Portamento **legato only** in mono mode

Portamento On/Off can be used in mono mode when playing legato.
For example: On two consecutives legato passages n1_1,n1_2,n1_3,.... n2_1,n2_2,n2_3

- If portamento is On only during the first passage (n1_1,n1_2,n1_3), there is a portamento from n1_1 to n1_2 and from n1_2 to n1_3. There is no portamento during the second passage.

- If portamento is On during both passages, there is a portamento during both passage, but the first note of each passage (n1_1 and n2_1) are without portamento without the need to release the Portamento pedal to get this result.

3.8.2. Portamento modes **staccato only** or **each note** in mono mode

Portamento is possible when playing staccato n1 and n2. The portamento from n1 to n2 occurs even if n1 is released.

- In mode **each note** portamento occurs on each note following the first note played (staccato or legato).
- In mode **staccato only** portamento occurs only on note played staccato.

3.8.3. Portamento **legato only** in poly mode

The behavior is the same as in mono mode, but notes are always played in polyphonic (except when a CC PTC has been received. In this case a portamento with legato mono effect is produced (see 3.4.11))

3.8.4. Portamento **staccato** in poly mode:

Same as mono (see 3.8.2)

3.8.5. Portamento time: **CC MSB(5d) and LSB(37d)**

PortamentoTime is instructed by CC Portamento time MSB(5d) and LSB(37d)
PortamentoTime (ms) = 128 x MSB + LSB

MSB,MSB value are 0 to 127 each.
Maximum time: 128 x 127 + 127 = 16,383 second

The resolution of CC 5 is 128 ms
CC 5: 1, time = 128 ms
CC 5: 2, time = 256 ms
CC 5: 3, time = 384 ms
CC 5: 4, time = 512 ms

To get smaller time (< 128 ms) we need to set CC 5 at 0 (which is the default value at fluidsynth initialization), and use only CC 37d

Notes

- To enable portamento CC Portamento 65d must be on
- If portamento time is 0 the pitch sweep is not perceptible.(At fluidsynth initialization: portamento time is 0).
- If pitch bend is send, it is actually understood by FluidSynth as pitch bend (i.e adding pitch shift .This a default behavior). That means, that Pitch bend can be used during a portamento effect.

3.8.6. API set portamento mode: **fluid_synth_set_portamento_mode(chan,mode)**

FLUIDSYNTH_API

int fluid_synth_set_portamento_mode(fluid_synth_t* synth, int chan, int portamentomode)

The API function sets the portamento mode to a MIDI channel.

On input
- ***synth*** the synth instance.
- ***chan*** MIDI channel number (0 to MIDI channel count - 1).
- ***portamentomode*** portamento mode
  0: EACH_NOTE 1: LEGATO_ONLY
  2: STACCATO_ONLY

On Output
- FLUID_OK if success
- FLUID_FAIL,
  - synth is NULL.
  - chan is outside MIDI channel count.
  - portamentomode is invalid.

Note: The default shell has an equivalent command "**setportamentomode**" to set portamento mode (see 3.8.8).

3.8.7. API get portamento mode : **fluid_synth_get_portamento_mode(chan,mode)**

FLUIDSYNTH_API
int fluid_synth_get_portamento_model(fluid_synth_t* synth, int chan, int *portamentomode)

The API function gets the portamento mode of a MIDI channel.

On input
- ***synth*** the synth instance
- ***chan*** MIDI channel number (0 to MIDI channel count - 1)
- ***portamentomode*** pointer to returned mode.
  0: EACH_NOTE 1: LEGATO_ONLY
  2: STACCATO_ONLY

On Output
- FLUID_OK if success
- FLUID_FAIL,
  - synth is NULL.
  - chan is outside MIDI channel count.
  - portamentomode is NULL.

Note: The default shell has an equivalent command "**portamentomode**" to display portamento mode (see 3.8.9).

3.8.8. command to set portamento mode:**setportamentomode**

setportamentomode chan1 Mode1 [chan2 Mode2 ….]

This command uses API fluid_synth_set_portamento_mode() (3.8.6).

3.8.9. command to print portamento mode:**portamentomode**

portamentomode

Print portamento mode of all MIDI channels
example

channel: 0, 0-each note
channel: 1, 1-legato only

channel: 2, 2-staccato-only
---
channel: 15, 0-each note

portamentomode chan1 chan2
Print only legato mode of MIDI channel chan1, chan2

This command uses API fluid_synth_get_portamento_mode() (3.8.7).

3.9. monophonic mode implementation in FluidSynth

3.9.1. ignore MIDI message on MIDI channel disabled

API List

FLUIDSYNTH_API int fluid_synth_noteon(fluid_synth_t* synth, int chan, int key, int vel);
FLUIDSYNTH_API int fluid_synth_noteoff(fluid_synth_t* synth, int chan, int key);
FLUIDSYNTH_API int fluid_synth_cc(fluid_synth_t* synth, int chan, int ctrl, int val);
FLUIDSYNTH_API int fluid_synth_get_cc(fluid_synth_t* synth, int chan, int ctrl, int* pval);
~~FLUIDSYNTH_API int fluid_synth_sysex(fluid_synth_t *synth, const char *data, int len, char *response, int *response_len, int *handled, int dryrun);~~
FLUIDSYNTH_API int fluid_synth_pitch_bend(fluid_synth_t* synth, int chan, int val);
FLUIDSYNTH_API int fluid_synth_get_pitch_bend(fluid_synth_t* synth, int chan, int* ppitch_bend);
FLUIDSYNTH_API int fluid_synth_pitch_wheel_sens(fluid_synth_t* synth, int chan, int val);
FLUIDSYNTH_API int fluid_synth_get_pitch_wheel_sens(fluid_synth_t* synth, int chan, int* pval);
FLUIDSYNTH_API int fluid_synth_program_change(fluid_synth_t* synth, int chan, int program);
FLUIDSYNTH_API int fluid_synth_channel_pressure(fluid_synth_t* synth, int chan, int val);

FLUIDSYNTH_API int fluid_synth_bank_select(fluid_synth_t* synth, int chan, unsigned int bank);
handled by fluid_channel_set_sfont_bank_prog()

FLUIDSYNTH_API int fluid_synth_sfont_select(fluid_synth_t* synth, int chan, unsigned int sfont_id);
handled by fluid_channel_set_sfont_bank_prog()

FLUIDSYNTH_API int fluid_synth_program_select(fluid_synth_t* synth, int chan, unsigned int sfont_id,
unsigned int bank_num, unsigned int preset_num);

FLUIDSYNTH_API int fluid_synth_program_select_by_sfont_name (fluid_synth_t* synth, int chan,
const char *sfont_name, unsigned int bank_num,
unsigned int preset_num);

FLUIDSYNTH_API int fluid_synth_get_program(fluid_synth_t* synth, int chan, unsigned int* sfont_id,
unsigned int* bank_num, unsigned int* preset_num);

FLUIDSYNTH_API int fluid_synth_unset_program (fluid_synth_t *synth, int chan);

FLUIDSYNTH_API int fluid_synth_get_channel_info (fluid_synth_t *synth, int chan,
fluid_synth_channel_info_t *info);

FLUIDSYNTH_API int fluid_synth_program_reset(fluid_synth_t* synth);

FLUIDSYNTH_API int fluid_synth_system_reset(fluid_synth_t* synth);

FLUIDSYNTH_API int fluid_synth_all_notes_off(fluid_synth_t* synth, int chan);
FLUIDSYNTH_API int fluid_synth_all_sounds_off(fluid_synth_t* synth, int chan);

```
enum fluid_midi_channel_type
{
  CHANNEL_TYPE_MELODIC = 0,
  CHANNEL_TYPE_DRUM = 1
};

int fluid_synth_set_channel_type(fluid_synth_t* synth, int chan, int type);
```

see steps 2.8.4

3.9.2. Insertion point of Poly/mono mode on noteOn et note Off

see fluid_synth_noteon_LOCAL(),fluid_synth_noteoff_LOCAL()

3.9.3. fluid_synth_noteon_LOCAL()

In fluid_chan.h

```
#define fluid_channel_legato(_c)          ((_c)->cc[LEGATO_SWITCH] >= 64)
#define IsChanPlayingMono (_c)  (IsChanMono(_c) || fluid_channel_legato(_c))
```

On noteOn

```
if(IsChanPlayingMono(channel)) /* channel is mono or legato On) */
{ /* monophonic playing */
        fluid_synth_noteon_mono_LOCAL(); /* see fluid_synth_mono.c */
}
else /* channel is Poly with legato off */
{ /* polyphonic playing */
        /* Set the note at first position in monophonic list */
        fluid_channel_set_onenote_monolist();

}
```

see steps 3.10.1

3.9.4. fluid_synth_noteoff_LOCAL()

```
if(IsChanPlayingMono(channel)) /* channel is mono or legato On) */
{ /* monophonic playing */
        fluid_synth_noteoff_mono_LOCAL(); /* see fluid_synth_mono.c */
}
else /* channel is Poly with legato off */
{ /* polyphonic playing */
        /* remove the note from the monophonic list */

}
```

see steps 3.10.1

3.9.5. Using fluidsynth router to simulate a legato pedal by Sustain pedal

In the case of only a sustain pedal is available, you don't need to buy a legato pedal to try legato effect. You can instruct FluidSynth MIDI router to transform a MIDI sustain event to a MIDI legato event.
Using fluidsynth console application, you need to enter following commands in the shell to instruct the router.

Remove current rules (to remove cc sustain events):
router_clear
Set the rule to transform CC sustain(64d) to CC legato(68d)

router_begin **cc**
router_par1 64 64 0 68
router_end
Set the rules to pass through other messages types (note, prog, pbend, cpress, kpress)
router_begin note
router_end
router_begin prog
router_end
router_begin pbend
router_end
router_begin cpress
router_end
router_begin kpress
router_end

3.9.6. monophonic algorithm implementation

Monophonic algorithm (see steps 3.10.3).
Playing staccato noteOn: **fluid_synth_noteon_mono()** (see steps 3.10.4).
Playing noteOff poly ou mono: **fluid_synth_noteoff_polymono()**(see steps 3.10.5).
Playing legato: **fluid_synth_noteon_mono_legato()** (see steps 3.10.6).
Playing noteon legato: **fluid_synth_noteon_mono_legato_retrigger()**(see steps).
Playing noteon legato: **fluid_synth_noteon_mono_legato_multi_retrigger()** (see steps).
Playing noteon legato: **fluid_synth_noteon_mono_legato_single_trigger()** (see steps 3.10.7).

3.10. Part 2: Implementations steps in FS.

3.10.1. integration of Polyphonic/monophonic on noteOn and note Off

to do	**comments**
	fluid_chan.h
done	macros #define fluid_channel_legato(_c) ((_c)->cc[LEGATO_SWITCH] >= 64) ##define IsChanPlayingMono(chan) (IsChanMono(chan) || fluid_channel_legato(chan))

to do	**comments**
	fluid_synth.c.
done	add in fluid_synth_noteon_LOCAL() (3.9.3)
done	add in fluid_synth_noteoff_LOCAL() (3.9.4)
done	declaration extern fluid_synth_noteon_mono_LOCAL(),fluid_synth_noteoff_mono_LOCAL()

to do	**comments**
	new file: fluid_synth_mono.c
done	add fluid_synth_noteon_mono_LOCAL(),fluid_synth_noteoff_mono_LOCAL()
done	Test canal 1 mono, on noteOn/noteOff
done	Test canal 0 poly legato off on noteOn/noteOf
done	Test canal 0 poly , legato on, with legato pedal (3.9.5)

3.10.2. Adding monophonic list

to do	comments
	fluid_chan.h
done	In fluid_chan.h, add monophonic list #define maxNotes 10 /* Size of the monophonic list */ struct mononote { unsigned char prev; /* previous note */ unsigned char next; /* next note */ unsigned char note; /* note */ unsigned char vel; /* velocity */ } in _fluid_channel_t, add struct mononote monolist[maxNotes]; /* monophonic list */ unsigned char iFirst; /* First note index */ unsigned char iLast; /* most recent note index since the most recent add */ unsigned char PrevNote; /**< previous note of the most recent add */ unsigned char nNotes; /* actual number of notes in the list **/ #define LEGATO_PLAYING 0x80 /* b7, 1: means legato playing , 0: means staccato playing */ #define IsChanLegato(chan) (chan->mode & LEGATO_PLAYING) #define SetChanLegato(chan) (chan->mode |= LEGATO_PLAYING) #define ResetChanLegato(chan) (chan->mode &= ~ LEGATO_PLAYING

to do	comments
	fluid_chan.c
done	In fluid_chan.c – fluid_channel_init() add list initialization (see **Erreur! Source du renvoi introuvable.**)

to do	comments
	fluid_synth_mono.c
done done done	Add functions fluid_channel_add_monolist(), called in fluid_synth_noteon_mono_LOCAL(), test. fluid_channel_search_monolist(), called in fluid_synth_noteoff_mono_LOCAL(), test. fluid_channel_ remove_monolist(), called in fluid_synth_noteoff_mono_LOCAL(), test.
done	void fluid_channel_keep_lastnote_monolist(fluid_channel_t* chan)
done	void fluid_channel_set_onenote_monolist(fluid_channel_t* chan)
done	void fluid_channel_clear_monolist(fluid_channel_t* chan)

to do	comments
	fluid_synth.c
done done	In fluid_synth_cc_LOCAL() , on legato off call fluid_channel_keep_lastnote_monolist(). Test legato On, noteOn, legato Off.
done	In fluid_synth_noteon_LOCAL(), in poly mode, call fluid_channel_set_onenote_monolist(), test.
done	In fluid_synth_noteoff_LOCAL(),in poly mode, call fluid_channel_clear_monolist(), test.

3.10.3. Monophonic algorithm

to do	comments
	fluid_synth_mono.c
	Add algorithm in fluid_synth_noteon_mono_LOCAL(),fluid_synth_noteoff_mono_LOCAL(). Test: on canal 0 polyphonic:
done	// Test1 polyphonic
done	// Test2 monophonique staccato
done	// Test3 monophonique legato
done	// Test4 monophonique legato, legato Off, with one note in the list
done	// Test5 note polyphonique legato with one note monophonic

3.10.4. staccato noteOn: **fluid_synth_noteon_mono()**

to do	comments
	fluid_chan.h, fluid_chan.c
done	In fluid_chan.h, add **key_sustained** in _fluid_channel_t.
done	In fluid_chan.c - fluid_channel_init, initialization key_sustained to – 1;

to do	comments
	fluid_synth_mono.c
done	In **fluid_synth_mono.c,** add function **fluid_synth_noteon_mono()** , call in fluid_synth_noteon_mono_LOCAL().
done	In **fluid_synth.c,** fluid_synth_release_voice_on_same_note_LOCAL() is used by mono algorithm. It need to be public in fluid_synt.c and extern in **fluid_synth_mono.c.**
done	In fluid_synth-fluid_synth_release_voice_on_same_note_LOCAL().to optmize, the function return immediatly when there are no sustained notes.
done	Test 2 (see 3.10.3) to check **fluid_synth_noteon_mono()** is called

3.10.5. noteOff poly or mono: **fluid_synth_noteoff_monopoly ()**

to do	comments
ok	**fluid_voice.h, fluid_voice.c**
done	function fluid_voice_noteoff() is called for poly and mono. It is changed to return True when the note is sustained.

to do	comments
ok	**fluid_synth_mono.c**
done	Add function **fluid_synth_noteoff_monopoly(),** call in fluid_synth_noteoff_mono_LOCAL(). Test 2 (3.10.3)
done	Test 2 (3.10.3) check **fluid_synth_noteoff_monopoly()** is called.

to do	comments
ok	**fluid_synth.c**
done	Update key_sustained, in fluid_synth_damp_voices_by_sustain_LOCAL(), and in

	fluid_synth_damp_voices_by_sostenuto_LOCAL
done	Test6, note monophonic staccato sustained by sustain
done	call **fluid_synth_noteoff_monopoly()** in fluid_synth_noteoff_LOCAL() to optimize

3.10.6. noteon mono legato: **fluid_synth_noteon_mono_legato ()**

to do	**comments**
ok	**fluid_synth_mono.c**
done	add function **fluid_synth_noteon_mono_legato()** and call in fluid_synth_noteon_mono_LOCAL(),fluid_synth_noteoff_mono_LOCAL()
done	Test

to do	**comments**
	fluid_rvoice.h, fluid_rvoice.c **fluid_rvoice_event.c**
done	add variable prev_attenuation in fluid_rvoice.h - _fluid_rvoice_dsp_t declaration fluid_rvoice_multi_retrigger_attack() in fluid_rvoice.h
done	add in fluid_rvoice.c - fluid_rvoice_set_attenuation()
done	add function fluid_rvoice_multi_retrigger_attack (fluid_rvoice_t* voice) in fluid_rvoice.c
done	add in fluid_rvoice_event_dispatch() EVENTFUNC_0(fluid_rvoice_multi_retrigger_attack, fluid_rvoice_t*);

to do	**comments**
	fluid_voice.h, fluid_voice.c
done	add in fluid_voice.c - fluid_update_multi_retrigger_attack()
done	Declaration in fluid_voice.h - fluid_update_multi_retrigger_attack ()

	Mode 1:"muilti-retrigger" , next
to do	**comments**
	fluid_synth_mono.c
done	call fluid_update_multi_retrigger_attack () in fluid_synth_mono.c - fluid_synth_noteon_mono_legato_multi_retrigger()

3.10.7. noteon mono legato: **fluid_synth_noteon_mono_legato (single_trigger())**

Mode 2: single-trigge_0", Mode 3: single-trigge_1",

done	correction dans fluid_adsr_env.h - fluid_adsr_env_calc()
done	Minor bug: • section count duration (env->count) was 1 less expected. • Whith this patch, section count duration is the right count.

done	add function: **fluid_rvoice_single_trigger** in fluid_rvoice.c.

done	Declaration in fluid_rvoice.h.
done	add EVENTFUNC_R1(fluid_rvoice_single_trigger, fluid_rvoice_t*) in fluid_rvoice_event.c
done done	add fluid_update_single_trigger() in fluid_voice.c Declaration in fluid_voice.h.
done	call fluid_update_single_trigger() in fluid_synth_mono.c
done done done	enhancement fluid_rvoice_single_trigger() add variable dsp.prev_eff_attenuation in fluid_rvoice.h Initialization to –1 in fluid_rvoice.c - fluid_rvoice_reset()

3.10.8. Portamento

to do	**comments**
	fluid_rvoice.h, fluid_rvoice.c, fluid_voice.h , fluid_voice.c **fluid_rvoice_event.c**
done	Add variable dsp.pitchoffset , dsp.pitchinc in fluid_rvoice.h - _fluid_rvoice_dsp_t declaration void fluid_rvoice_set_portamento() in fluid_rvoice.h
done	init variables dsp.pitchoffset , dsp.pitchinc in fluid_rvoice.c- fluid_rvoice_reset()
done	add function fluid_rvoice_set_portamento () in fluid_rvoice.c
done	adding in fluid_rvoice_event_dispatch() EVENTFUNC_IR(fluid_rvoice_set_portamento, fluid_rvoice_t*);
done done	add function fluid_voice_update_portamento() in fluid_voice.c declaration in fluid_voice.h
done	add portamento in dsp
done done	add function **fluid_voice_calculate_pitch()** in fluid_voice.c. add **fluid_voice_calculate_pitch()** in fluid_voice_calculate_gen_pitch().
done	Test 10: portamento

to do	**comments**
	fluid_chan.h
done done	Add macros #define fluid_channel_portamentotime(_c) #define fluid_channel_portamento()
done	add function fluid_voice_portamento() in fluid_synth_mono.c
done	Integration in fluid_synth_noteon_mono_legato (multi_retrigger)

Portamento for mode 0 retrigger
for mode 1,2,3 (when previous note is finished)

to do	**comments**
	fluid_synth.h, fluid_synth.c **fluid_voice.c**
done	add fromkey_portamento in fluid_synth.h - struct _fluid_synth_t
done	initialization _ –1 in fluid_synth - new_fluid_synth()
done	add start portamento in fluid_voice.c - fluid_voice_calculate_runtime_synthesis_parameters()
done	triggering in fluid_synth_noteon_mono_legato (retrigger)
done	triggering , • in fluid_synth_noteon_mono_legato (multi_retrigger) • fluid_synth_noteon_mono_legato (single_trigger0) • fluid_synth_noteon_mono_legato (single_trigger1) when previous note is finished.

3.10.9. implementation API legato mode

see 3.6.8

to do	comments
	fluid_chan.h
done	Add ***legatomode*** in struct _fluid_channel_t
done	/* acces to channel legato mode */ /* SetChanLegatoMode set the legato mode for a MIDI channel */ #define SetChanLegato(chan,mode) \ (chan->legatomode = mode) /* GetChanLegatoMode get the legato mode for a MIDI channel */ #define GetChanLegatoMode(chan) (chan->legatomode) /* End of macros interface to legato mode variables */

to do	comments
	fluid_chan.c
done	in fluid_chan.c - fluid_channel_init(fluid_channel_t* chan) initialization legato mode.

to do	comments
	synth.h
done	/* API: mono legato mode */ /* Macros interface to mono legato mode variable */ /* n1,n2,n3,.... is a legato passage. n1 is the first note, and n2,n3,n4 are played legato with previous note. n2,n3,..make use of previous voices if any */ enum LegatoMode { };
done done	int fluid_synth_set_legato_model(fluid_synth_t* synth, int chan, int legatomode) int fluid_synth_get_legato_model(fluid_synth_t* synth, int chan, int *legatomode)

to do	comments
	fluid_synth_polymono.c
done	function **fluid_synth_set_legato_mode()** (3.6.7). Test Ok
done	function **fluid_synth_get_legato_mode()** (3.6.8). Test Ok

3.10.10. Implementation commands legato mode

see presentation 3.6.9

to do	comments
	fluid_cmd.c
done	add entry in fluid_commands
	fluid_cmd.h

done	add functions declaration

to do	**comments**
	fluid_synth_polymono.c
done	**legatomode** test Ok
done	**setlegatomode** chan1 Mode1 [chan2 Mode2 ….] test Ok

3.10.11. implementation API: mode Default Breath controller

to do	**comments**
	synth.h
	fluid_chan.h
done	In fluid_chan.h */* Macros interface to breath mode variables */* #define MASK_BREATH_MODE (BREATH_POLY|BREATH_MONO) */* access to default breath infos */* */* SetBreathInfos set the Default breath infos for a MIDI channel */* #define SetBreathInfos(chan,BreathInfos) \ (chan->mode = (chan->mode & ~ MASK_BREATH_MODE) | (BreathInfos & MASK_BREATH_MODE)) #define GetBreathInfos(chan) (chan->mode & MASK_BREATH_MODE) */* GetChanLegatoMode get the legato mode for a MIDI channel */* #define GetChanLegatoMode(chan) (chan->legatomode) */* End of macros interface to legato mode variables */*

done	in synth.h /* Interface to default breath state */
	/* bits basic channel infos */
	#define BREATH_POLY 0x10 /* b4, 1: default breath poly On */
	#define BREATH_MONO 0x20 /* b5, 1: default breath mono On */
	/* access to Breath mode bits */
	#define IsPolyDefaultBreath(breath) (breath & BREATH_POLY)
	#define SetPolyDefaultBreath(breath) (breath |= BREATH_POLY)
	#define ResetPolyDefaultBreath(breath) (breath &= ~ BREATH_POLY)
	#define IsMonoDefaultBreath(breath) (breath & BREATH_MONO)
	#define SetMonoDefaultBreath(breath) (breath |= BREATH_MONO)
	#define ResetMonoDefaultBreath(breath) (breath &= ~ BREATH_MONO)
	FLUIDSYNTH_API int fluid_synth_set_breath_mode(fluid_synth_t* synth,
	int chan, int breathmode);

	FLUIDSYNTH_API int fluid_synth_get_breath_mode(fluid_synth_t* synth, int chan, int *breathmode);

3.10.12. implementation: Commands Breath mode

to do	comments
	fluid_cmd.c
done	add entry in fluid_commands **breathmode**, **setbreathmode**
	fluid_cmd.h
done	add functions declaration: fluid_handle_setbreathmode(),fluid_handle_setbreathmode()

to do	comments
	fluid_synth_polymono.c
done	**breathmode** test Ok
done	**setbreathmode** chan1 poly_breath(1/0) mono_breath(1/0) [….] test Ok

3.10.13. implementation: mode Default Breath controller

see presentation in 3.4.5

in fluid_synth_alloc_voice()

```
if (!mono && DefaultBreathPoly) || (mono && DefaultBreathMono))
{
        add default modulator: CC Breath To Initial Attenuation.
}
else
{
        add default modulator: Velocity To Initial Attenuation (voir R1).
}
```

	fluid_synth.c
done	Add modulator modulateur fluid_mod_t ***default_breath2att_mod***
done	Initialization of ***default_breath2att_mod*** in fluid_synth_init().
done	add in fluid_synth_alloc_voice()

3.10.14. sleep command

to do	comments
	src/bindings/fluid_cmd.c **src/ bindings/fluid_cmd.h**
done	In **src/bindings/fluid_cmd.c** add /* Sleep command, useful to insert a delay between commands */ { "sleep", "general", (fluid_cmd_func_t) fluid_handle_sleep, NULL, "sleep duration sleep duration(in ms)" },
done	**src/bindings/fluid_cmd.h,** add declaration. int fluid_handle_sleep(fluid_cmd_handler_t* handler, int ac, char** av, fluid_ostream_t out);

done	**src/bindings/fluid_cmd.c,** add function fluid_handle_sleep(). int fluid_handle_sleep(fluid_cmd_handler_t* handler, int ac, char** av, fluid_ostream_t out);

3.10.15. implementation: legato trough more zones IZ and PZ

to do	comments
	src/sfloader/fluid_defsfont.h **src/sfloader/fluid_defsfont.c**
done	b0) In fluid_defsfont.h- _**fluid_inst_zone_t**, add field **unsigned char flags** add **#define IGNORE_IZ 0x01** **#define IsIgnoreInstZone (iz) (iz->flags & IGNORE_IZ)** **#define SetIgnoreInstZone (iz) (iz->flags | = IGNORE_IZ)** **#define ResetIgnoreInstZone (iz) (iz->flags &= ~IGNORE_IZ)**
done	in **fluid_defsfont.c**, new_fluid_inst_zone() **zone->flags = 0;**
done	b1) in **fluid_inst_import_sfont()**, add parameter ***fluid_preset_zone_t* zonePZ.***
done	b2)In **fluid_preset_zone_import_sfont()** pass parameter ***fluid_preset_zone_t* zonePZ*** to fluid_inst_import_sfont().
done	b3) In **fluid_inst_zone_import_sfont()**, add parameter ***fluid_preset_zone_t* zonePZ.***
done	b4) In **fluid_inst_import_sfont()**, pass ***zonePZ*** to fluid_inst_zone_import_sfont().
done	b5) In **fluid_inst_zone_import_sfont().** for (count = 0, r = sfzone->gen; r != NULL; count++) { sfgen = (SFGen *) r->data; switch (sfgen->id) { case GEN_KEYRANGE: zone->keylo = (int) sfgen->amount.range.lo; zone->keyhi = (int) sfgen->amount.range.hi; break; case GEN_VELRANGE: zone->vello = (int) sfgen->amount.range.lo; zone->velhi = (int) sfgen->amount.range.hi; break; default: /* FIXME: some generators have an unsigned word amount value but i don't know which ones */ zone->gen[sfgen->id].val = (fluid_real_t) sfgen->amount.sword; zone->gen[sfgen->id].flags = GEN_SET; break; } r = fluid_list_next(r); } ***/* adjust IZ keyrange to integrate PZ keyrange */*** **if (zonePZ->keylo > zone->keylo) zone->keylo = zonePZ->keylo;** **if (zonePZ->keyhi < zone->keyhi) zone->keyhi = zonePZ->keyhi;** ***/* adjust IZ velrange to integrate PZ velrange */*** **if (zonePZ->vello > zone->vello) zone->vello = zonePZ->vello;** **if (zonePZ->velhi < zone->velhi) zone->velhi = zonePZ->velhi;**
done	Test that code is neutral
	src/sfloader/fluid_defsfont.h

	include/fluidsynth/types.h **include/fluidsynth/synth.h,** **src/synth/fluid_synth.c,** **src/sfloader/fluid_defsfont.c,** **src/sfloader/fluid_ramsfont.c,** **src/synth/fluid_voice.c,** **src/synth/fluid_voice.h**
done	In **src/sfloader/fluid_defsfont.h** – move * FORWARD DECLARATIONS */ typedef struct _fluid_defsfont_t fluid_defsfont_t; typedef struct _fluid_defpreset_t fluid_defpreset_t; typedef struct _fluid_preset_zone_t fluid_preset_zone_t; typedef struct _fluid_inst_t fluid_inst_t; **//typedef struct _fluid_inst_zone_t fluid_inst_zone_t;** in **include/fluidsynth/types.h** typedef struct _fluid_preset_t fluid_preset_t; /**< SoundFont preset */ **typedef struct _fluid_inst_zone_t fluid_inst_zone_t;** /**< Soundfont Instrument Zone */ typedef struct _fluid_sample_t fluid_sample_t; /**< SoundFont sample ***/*** This is necessary to expose fluid_inst_zone_t at API level**, as** fluid_synth_alloc_voice() is a function API.
done	In **include/fluidsynth/synth.h** fluid_synth_alloc_voice(), change parameter ***fluid_sample_t* sample*** by ***fluid_inst_zone_t* inst_zone*** //FLUIDSYNTH_API fluid_voice_t* fluid_synth_alloc_voice(fluid_synth_t* synth, // **fluid_sample_t* sample**, int channum, int key, int vel); FLUIDSYNTH_API fluid_voice_t* fluid_synth_alloc_voice(fluid_synth_t* synth, **fluid_inst_zone_t* inst_zone**, int channum, int key, int vel);
done	In **src/synth/fluid_synth.c** In fluid_synth_alloc_voice(), change parameter ***fluid_sample_t* sample*** to ***fluid_inst_zone_t* inst_zone***
done	In **src/sfloader/fluid_defsfont.c** b7)fluid_defpreset_noteon() passe ***fluid_inst_zone_t inst_zone*** to **fluid_synth_alloc_voice()** // voice = fluid_synth_alloc_voice(synth, **sample**, chan, key, vel); voice = fluid_synth_alloc_voice(synth, **inst_zone**, chan, key, vel);
done	In **src/sfloader/fluid_ramsfont.c** b8) fluid_rampreset_noteon() pass ***fluid_inst_zone_t inst_zone*** to **fluid_synth_alloc_voice()** // voice = fluid_synth_alloc_voice(synth, **sample**, chan, key, vel); voice = fluid_synth_alloc_voice(synth, **inst_zone**, chan, key, vel);
done	In **src/synth/fluid_voice.c** b9) In fluid_voice_init(), change parameter ***fluid_sample_t* sample*** by ***fluid_inst_zone_t *inst_zone*** //fluid_voice_init(fluid_voice_t* voice, **fluid_sample_t* sample**, fluid_voice_init(fluid_voice_t* voice, **fluid_inst_zone_t *inst_zone**,
done	In **src/synth/fluid_voice.h** b10) in fluid_voice_t add field ***fluid_inst_zone_t* inst_zone***
done	In **src/synth/fluid_voice.c** Add #include "fluid_defsfont.h"
done	In **src/synth/fluid_voice.c** In fluid_voice_init(), add **fluid_sample_t* sample = fluid_inst_zone_get_sample(inst_zone)**

	voice->inst_zone = inst_zone;
done	In **src/synth/fluid_synth.c** b12) In **fluid_synth_alloc_voice()** pass **inst_zone** to fluid_voice_init() // if (fluid_voice_init (voice, **sample**, channel, key, vel, if (fluid_voice_init (voice, **inst_zone**, channel, key, vel,
done	b13) Test

to do	**comments**
	src/sfloader/fluid_ramsfont.c **src/sfloader/fluid_defsfont.c**
	In fluid_defsfont.c- fluid_defpreset_noteon() and fluid_ramsfont.c-fluid_rampreset_noteon() ***/* Check if this IZ must be forgotten */*** **ignoreIZ = IsIgnoreInstZone(inst_zone); /* forget is the request to forget this IZ** **ResetIgnoreInsZone(inst_zone); /* Reset the request inside IZ */** /* check if the **note doesn't be forgotten and** falls into the key and velocity range of this instrument zone*/ if **(! ignoreIZ &&** fluid_inst_zone_inside_range(inst_zone, key, vel) && (sample != NULL)) { /* this is a good zone. allocate a new synthesis process and initialize it */ voice = fluid_synth_alloc_voice(synth, **inst_zone**, chan, key, vel); if (voice == NULL) { return FLUID_FAILED; }
done	Test
to do	**comments**
	src/synth/fluid_synth_monoc
done	Add de #include "fluid_defsfont.h"

3.10.16. Implementation of portamento request

to do	**comments**
to do	**src/synth/fluid_synth_mono.c** **src/synth/fluid_chan.h** **src/synth/fluid_synth.c**
done	In fluid_chan.h add /* Macros interface to monophonic list variables */ /* ChanPrevNote() return the note in iLast entry of the monophonic list */ #define InvalidNote 255 #define IsValidNote(n) (n == InvalidNote) #define ChanPrevNote (chan) (chan->monolist[chan->iLast].note) #define ChanClearPrevNote (chan) (chan->monolist[chan->iLast].note = InvalidNote) /* End of interface to monophonic list variables */
done	In fluid_chan.c - fluid_channel_init() add

	ChanClearLastNote(chan); /* Mark last note invalid */
done	In fluid_synth.c- fluid_synth_noteoff_LOCAL() if(key == ChanLastNote (channel)) fluid_channel_clear_monolist(channel);
done	In fluid_synth_mono.c, add GetFromKeyPortamentoLegato(channel, defaultFromkey)
done	fluid_synth_mono.c- fluid_synth_noteon_mono_staccato calling GetFromKeyPortamentoLegato() fluid_synth_noteon_mono_legato calling GetFromKeyPortamentoLegato()
done	fluid_synth.c- new_fluid_synth() init de fromkey_portamento to InvalidNote
done done	In fluid_synth_mono.c • Add ValidInvalidLastNoteStaccato(). • In fluid_synth.c-fluid_synth_noteoff_LOCAL() poly – mono call ValidInvalidPrevNoteStaccato()
	Implementation CC PTC in fromkey portamento
done	In fluid_chan.h , add macros: #define clearPortamentoCtrl(_c) ((_c)->cc[PORTAMENTO_CTRL] = InvalidNote) #define PortamentoCtrl(_c) ((_c)->cc[PORTAMENTO_CTRL])
done	In fluid_chan.c , In fluid_channel_init_ctrl() – init PORTAMENTO_CTRL to InvalidNote;
done	In fluid_synth_mono.c – GetFromKeyPortamentoLegato Add CC PTC in GetFromKeyPortamentoLegato()
done done	• In fluid_synth.c, declaration fluid_synth_noteon_mono_legato() extern. • In fluid_synth.c- fluid_synth_noteon_LOCAL call fluid_synth_noteon_mono_legato()

	Add mode legato "Retrigger _1" normal release
	fluidsynth-1.1.6/include/fluidsynth/synth.h enum LegatoMode { /* Release previous note (fast release), start a new note */ RETRIGGER_0, /* mode 0 */ /* Release previous note (normal release), start a new note */ RETRIGGER_1, /* mode 1 */ /* On n2,n3,.. retrigger in attack section using current value and shape attack using current dynamic */ MULTI_RETRIGGER, /* mode 2 */ /* On n2,n3,.stay in current value section and shape current section using current dynamic */ SINGLE_TRIGGER_0, /* mode 3 */ /* On n2,n3,.stay in current value section using current dynamic (don't shape adsr) */ SINGLE_TRIGGER_1, /* mode 4 */ LEGATOMODE_NBR };
	fluidsynth-1.1.6/src/synth/fluid_voice.h Update void fluid_update_release(fluid_voice_t* voice, unsigned char flags) **fluidsynth-1.1.6/src/synth/fluid_voice.c** Add parameter flags dans fluid_update_release(fluid_voice_t* voice, unsigned char flags)
	fluidsynth-1.1.6/src/synth/fluid_synth_mono.c In fluid_synth_noteon_mono_legato() **case RETRIGGER_0: /* mode 0 */**

	fluid_update_release(voice,0); /* fast release */ **break;** **case RETRIGGER_1: /* mode 0 */** **fluid_update_release(voice,1); /* normal release */** **break;** else { /* tokey note is outside the voice range, so the voice is released */ **fluid_update_release(voice,legatomode);** }
	fluidsynth-1.1.6/src/synth/fluid_synth_polymono.c char * nameLegatomode[LEGATOMODE_NBR]={ "(0)retrigger_0","(1)retrigger_1","(2)multi-retrigger", "(3)single-trigger_0","(4)single-trigger_1"

3.10.17. API portamento mode

to do	**comments**
	\fluidsynth-1.1.6\src\ fluid_chan.h
done	Add ***portamentomode*** in struct _fluid_channel_t
done	*(* acces to channel portamento mode */* *(* SetChanPortamentoMode set the portamento mode for a MIDI channel */* #define SetChanPortamento(chan,mode) \ (chan->portamentomode = mode) *(* GetChanPortamentoMode get the portamento mode for a MIDI channel */* #define GetChanPortamento(chan) (chan->legatomode) *(* End of macros interface to portamento mode variables */*

to do	**comments**
	\fluidsynth-1.1.6\src\synth\fluid_chan.c
done	In fluid_chan.c - fluid_channel_init(fluid_channel_t* chan) init portamento mode.

to do	**comments**
	\fluidsynth-1.1.6\include\fluidsynth\synth.h
done	/* API: portamento mode */ *(* Macros interface to portamento mode variable */* enum PortamentoMode { /* Portamento on each note (staccato or legato) */ EACH_NOTE, /* mode 0 */ /* Portamento only on legato note */ LEGATO_ONLY, /* mode 1 */ /* Portamento only on staccato note */ STACCATO_ONLY, /* mode 2 */ STACCATOTOMODE_NBR };

done	int fluid_synth_set_portamento_model(fluid_synth_t* synth, int chan, int portamentomode) int fluid_synth_get_ portamento_model(fluid_synth_t* synth, int chan, int * portamentomode)

to do	**comments**
	fluidsynth-1.1.6\src\synth\fluid_synth_polymono.c
done	function **fluid_synth_set_portamento_mode()**
done	function **fluid_synth_get_ portamento_mode()**

3.10.18. commands_portamento mode

to do	**comments**
	fluidsynth-1.1.6\src\bindings\fluid_cmd.c
done	add entry in fluid_commands
	fluidsynth-1.1.6\src\bindings\fluid_cmd.h
done	add functions declaration

to do	**comments**
	fluidsynth-1.1.6\src\synth\fluid_synth_polymono.c
done	**portamentomode** test Ok
done	**setportamentomode** chan1 Mode1 [chan2 Mode2 ….] test Ok

3.10.19. Implementation Breath Sync noteOn/noteOff

see 3.4.5

to do	**comments**
	fluidsynth-1.1.6\include\fludsynth\synth.h
done	add #define BREATH_SYNC 0x40 /* b6, 1: BreathSyn On */ #define IsBreathSync(breath) (breath & BREATH_SYNC) #define SetBreathSync(breath) (breath |= BREATH_SYNC) #define ResetBreathSync(breath) (breath &= ~ BREATH_SYNC)
	fluidsynth-1.1.6\src\synth\fluid_chan.h
done	1)change #if 1 #define MASK_BREATH_MODE (BREATH_POLY|BREATH_MONO|BREATH_SYNC) #else #define MASK_ BREATH_MODE (BREATH_POLY|BREATH_MONO) #endif #if 1 #define fluid_channel_breath_msb(_c) ((_c)->cc[BREATH_MSB] > 0) #endif 2) add

	#if 1 #define IsChanBreathSync(chan) IsBreathSync(chan->mode) #define ChanClearPreviousBreath(chan) (chan->previous_cc_breath = 0) #endif #if 1 #define ChanLastVel(chan) (chan->monolist[chan->iLast].vel) #endif 3)In _fluid_channel_t add int previous cc_breath; /**< Previous Breath */
	fluidsynth-1.1.6\src\synth\fluid_chan.c
done	in fluid_channel_init_ctrl() ChanClearPreviousBreath(chan);/* Reset previous breath */
	fluidsynth-1.1.6\src\synth\fluid_synth_polymono.c
done	adding in fluid_handle_breathmode(), fluid_handle_setbreathmode()
	fluidsynth-1.1.6\src\synth\fluid_synth_mono.c
	1)add functions LegatoOnOff(), BreathOnOff()
	fluidsynth-1.1.6\src\synth\fluid_synth.c
done	1)In fluid_synth.c, declaration extern int BreathOnOff(). 2) Remove external declaration fluid_channel_keep_lastnote_monolist(), 3) Add external declaration LegatoOnOff(),BreathOnOff() 4) Adding in fluid_synth_cc_LOCAL() call BreathOnOff(). 5) Adding in fluid_synth_cc_LOCAL 5) case LEGATO_SWITCH: /* Special handling of the monophonic list */ call LegatoOnOff().
	fluidsynth-1.1.6\src\synth\fluid_synth_mono.c
done	Adding in fluid_synth_noteon_mono_LOCAL() int fluid_synth_noteon_mono_LOCAL(fluid_synth_t* synth, int chan, int key, int vel) { int status; fluid_channel_t* channel = synth->channel[chan]; if (!IsChanBreathSync(channel) || fluid_channel_breath_msb(channel)) { } else { /* Add note to the monophonic list */ fluid_channel_add_monolist(channel,(unsigned char)key, (unsigned char)vel); return FLUID_OK; } }
done	Adding in fluid_synth_noteoff_mono_LOCAL ()

3.10.20. Using fluidsynth router to simulate a Breath controller using volume pedal

Using fluidsynth applicationconsole, you need to enter the following commands in the shell to instruct the router.

Remove current rules (to remove cc sustain events):
router_clear
Set the rule to transform CC volume MSB (7d) to CC breath MSB (2d)
router_begin **cc**
router_par1 7 7 0 2
router_end
Set the rules to pass through other messages types (note, prog, pbend, cpress, kpress)
router_begin note
router_end
router_begin prog
router_end
router_begin pbend
router_end
router_begin cpress
router_end
router_begin kpress
router_end

3.11. Part 3: Appendices for understanding implementations in FS.

This chapter is useful for developper or reviewer . It help to localize the relations between the polyphonic and monophonic functionalities inside FluidSynth sources file.

Note that finding monophonic behavior a bit difficult to understand is a normal situation because it is due to the normal behavior of monophonic instrument particularly when this instrument is played in a legato manner.

If you are not familiar with monophonic instrument behavior chapter 3.2 should help you to get more confident.

3.11.1. Polyphonic and monophonic functions in FluidSynth

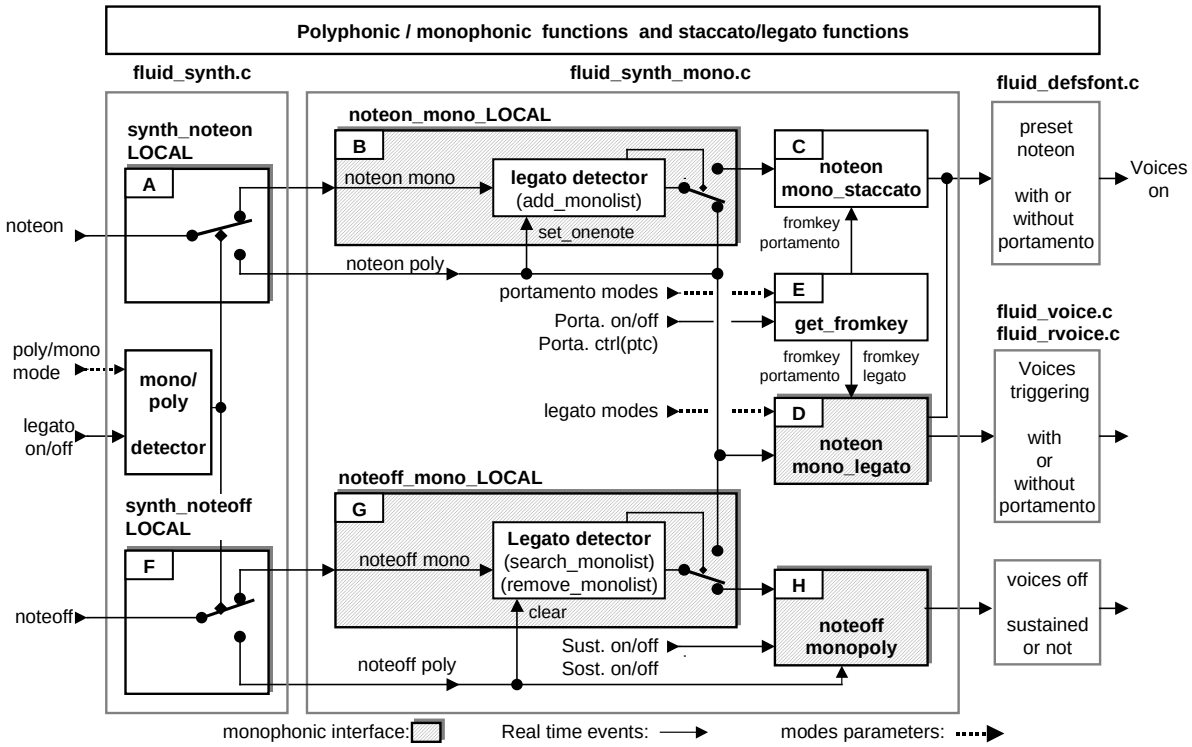


Fig.1: polyphonic and monophonic functions in FluidSynth

The figure Fig.1 shows both the polyphonic and monophonic functions.
MIDI noteOn/note message are received by **fluid_synth_noteon_LOCAL()** function (labelled **A**) and **fluid_synth_noteoff_LOCAL()** function (labelled **F**).

Depending on the poly mode and legato switch state (see 3.1.1, 3.1.2):

- A **noteon** event will be passed to **fluid_synth_noteon_mono_LOCAL()** (labelled **B**) if the channel is in monophic state or to **fluid_synth_noteon_mono_legato()** (labelled **D**) if the channel is in polyphonic state (see note 1).
- Similarly, a **noteoff** event will be passed to **fluid_synth_noteoff_mono_LOCAL ()** (labelled **G**) if the channel is in monophic state or to **fluid_synth_noteoff_monopoly()** (labelled **H**) if the channel is in polyphonic.

Note: There are situations where a noteon poly needs to be played legato,(this is dependant of CC portamento control (PTC). More on this later in chapter 3.11.3).

3.11.2. Monophonic noteon and staccato functions

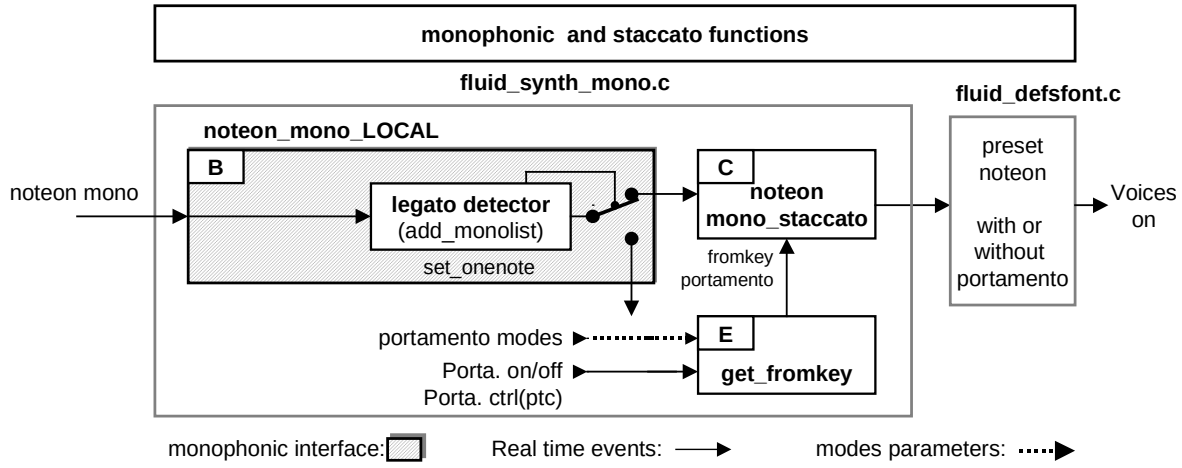


Fig.2: Monophonic and noteon staccato functions in FluidSynth

When a **noteon** mono is received by **fluid_synth_noteon_mono_LOCAL()** function (labelled **B**) it uses the legato detector (see 3.4.3) to determine if the note must be played stacatto or legato.

Figure 2 show the staccato situation (where no previous note have been depressed). **noteon** mono event is passed to **fluid_synth_noteon_mono_staccato()** function (labelled **C**).

Before the note been passed to **fluid_preset_noteon()**, fluid_synth_noteon_mono_staccato() must detemine the **from_key_portamento** parameter used by fluid_preset_noteon().

from_key_portamento is returned by **get_fromKey_portamento_legato()** function (labelled E). fromkey_portamento is set to valid/invalid key value depending of the **portamento modes** (see 3.1.7) , **CC portamento On/Off** (see 3.4.9), and **CC portamento control** (PTC) (see 3.4.11).

If from_key_portamento is a valid key, a portamento effect is started inside **fluid_preset_noteon()** (see fluid_voice_calculate_runtime_synthesis_parameters()).

3.11.3. Monophonic noteon and legato fonctions

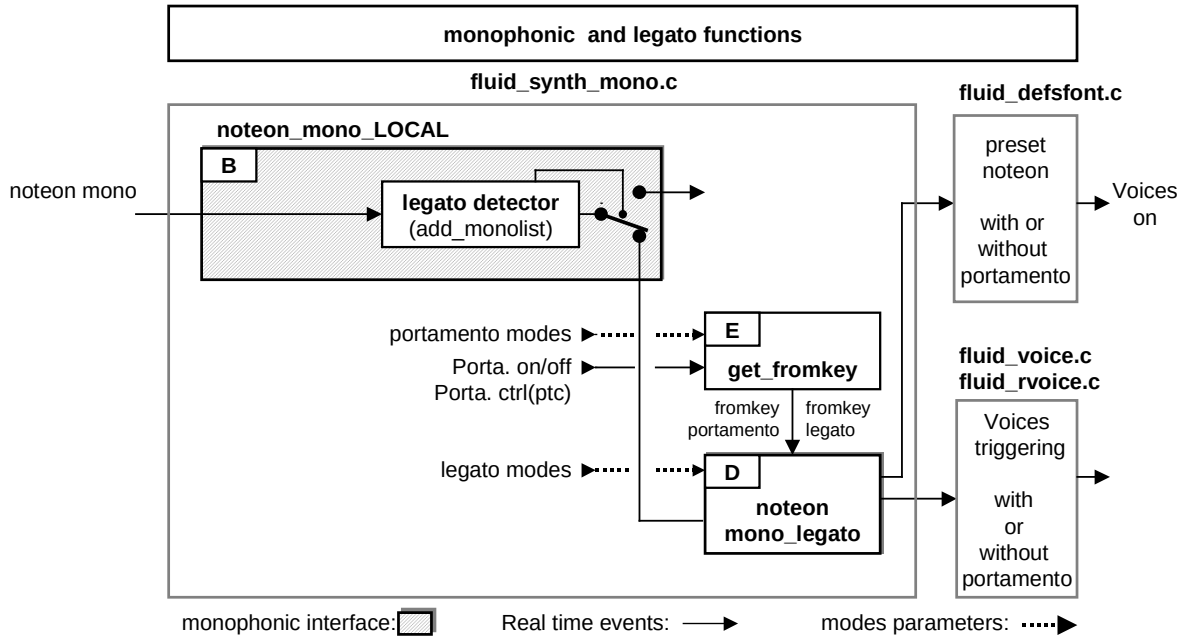


Fig.3: Monophonic and noteon legato functions in FluidSynth

When a **noteon** mono is received by **fluid_synth_noteon_mono_LOCAL()** function (labelled **B**) it uses the legato detector (see 3.4.3) to determine if the note must be played stacatto or legato.

Figure 3 show the legato situation (where a previous note have been depressed). the noteon mono is passed to **fluid_synth_noteon_mono_legato()** function (labelled **D**).

fluid_synth_noteon_mono_legato() must detemine the **from_key_portamento** and **fromkey_legato** parameters used by fluid_preset_noteon() function or the voice triggering functions.

from_key_portamento and **fromkey_legato** are returned by **get_fromKey_portamento_legato()** function (labelled E). fromkey_portamento is set to valid/invalid key value depending off the **portamento modes** (see 3.1.7) , **CC portamento On/Off** (see 3.4.9), and **CC portamento control** (PTC) (see 3.4.11).

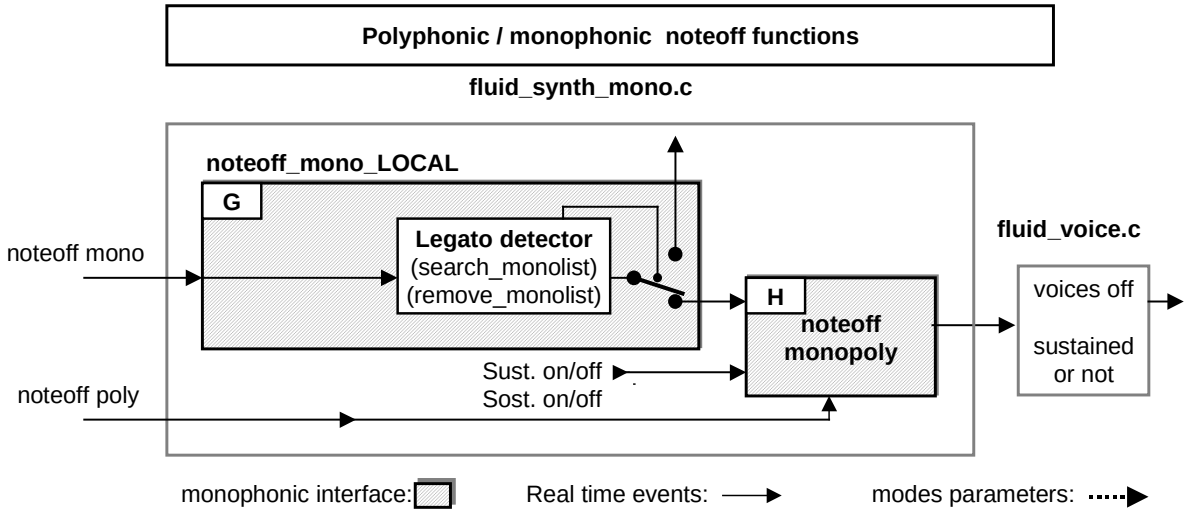
Then depending of the legato modes (see 3.1.4) **fluid_synth_noteon_mono_legato()** will call the appropriate trigering functions: fluid_voice_update_release() , fluid_voice_update_multi_retrigger_attack(),fluid_voice_update_single_trigger0, fluid_voice_update_single_trigger1.

3.11.4. Monophonic noteoff and legato functions

When a **noteoff** mono is received by **fluid_synth_noteoff_mono_LOCAL()** function (labelled **G**) it uses the legato detector (see 3.4.3) to determine if the note must be played stacatto or legato.

The situation is the similar as on noteOn mono (see 3.11.3) except that now **fluid_synth_noteon_mono_legato()** function (labelled **D**) is called by fluid_synth_noteoff_mono_LOCAL().

3.11.5. Monophonic-polyphonic noteoff functions



When a **noteon** mono is received by **fluid_synth_noteoff_mono_LOCAL()** function (labelled **G**) it uses the legato detector (see 3.4.3) to determine if the note must be played stacatto or legato.

Figure 3 show the staccato situation (where a no previous note have been depressed). the noteoff mono is passed to **fluid_synth_noteoff_monopoly()** function (labelled **H**).

fluid_synth_noteoff_monopoly() have the same behavior when the **noteoff** is **poly** of **mono**, except that for mono noteoff, if any pedal (sustain or sostenuto) is depressed, the key is memorized. This is neccessary when the next mono note will be played staccato, as any current mono note currently sustained will need to be released (see fluid_synth_noteon_mono_staccato()).

Note also that for a monophonic legato passage, the function is called only when the last noteoff of the passage occurs. That means that if sustain or sostenuto is depressed, only the last note of a legato passage will be sustained.