KMHLS ChannelMap - 16+29+4

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filename	KMHLS_channel_map_lin
license	BSD
name	KMHLS ChannelMap - 16+29+4
signals.lib/name	Faust Signal Routing Library
signals.lib/version	0.0
version	0.1

This document provides a mathematical description of the Faust program text stored in the `src/KMHLS_channel_map_lin.dsp` file. See the notice in Section 3 (page 4) for details.

1 Mathematical definition of `process`

The *KMHLS_channel_map_lin* program evaluates the signal transformer denoted by `process`, which is mathematically defined as follows:

1. Output signals y_i for $i \in [1, 52]$ such that

$$
\begin{aligned}
y_1(t) &= x_{17}(t) \cdot r_1(t) \\
y_2(t) &= x_{18}(t) \cdot r_1(t) \\
y_3(t) &= x_{19}(t) \cdot r_1(t) \\
y_4(t) &= x_{20}(t) \cdot r_1(t) \\
y_5(t) &= x_{21}(t) \cdot r_1(t) \\
y_6(t) &= x_{22}(t) \cdot r_1(t) \\
y_7(t) &= x_{23}(t) \cdot r_1(t) \\
y_8(t) &= x_{24}(t) \cdot r_1(t) \\
y_9(t) &= x_{25}(t) \cdot r_1(t) \\
y_{10}(t) &= x_{26}(t) \cdot r_1(t) \\
y_{11}(t) &= x_{27}(t) \cdot r_1(t)
\end{aligned}
$$

$$y_{12}(t) = x_{28}(t) \cdot r_1(t)$$
$$y_{13}(t) = x_{29}(t) \cdot r_1(t)$$
$$y_{14}(t) = x_{30}(t) \cdot r_1(t)$$
$$y_{15}(t) = x_{31}(t) \cdot r_1(t)$$
$$y_{16}(t) = x_{32}(t) \cdot r_1(t)$$
$$y_{17}(t) = x_{33}(t) \cdot r_1(t)$$
$$y_{18}(t) = x_{34}(t) \cdot r_1(t)$$
$$y_{19}(t) = x_{35}(t) \cdot r_1(t)$$
$$y_{20}(t) = x_{36}(t) \cdot r_1(t)$$
$$y_{21}(t) = x_{37}(t) \cdot r_1(t)$$
$$y_{22}(t) = x_{38}(t) \cdot r_1(t)$$
$$y_{23}(t) = x_{39}(t) \cdot r_1(t)$$
$$y_{24}(t) = x_{40}(t) \cdot r_1(t)$$
$$y_{25}(t) = x_{41}(t) \cdot r_1(t)$$
$$y_{26}(t) = x_{42}(t) \cdot r_1(t)$$
$$y_{27}(t) = x_{43}(t) \cdot r_1(t)$$
$$y_{28}(t) = x_{44}(t) \cdot r_1(t)$$
$$y_{29}(t) = x_{45}(t) \cdot r_1(t)$$
$$y_{30}(t) = 0$$
$$y_{31}(t) = 0$$
$$y_{32}(t) = 0$$
$$y_{33}(t) = x_1(t) \cdot r_2(t)$$
$$y_{34}(t) = x_2(t) \cdot r_2(t)$$
$$y_{35}(t) = x_3(t) \cdot r_2(t)$$
$$y_{36}(t) = x_4(t) \cdot r_2(t)$$
$$y_{37}(t) = x_5(t) \cdot r_2(t)$$
$$y_{38}(t) = x_6(t) \cdot r_2(t)$$
$$y_{39}(t) = x_7(t) \cdot r_2(t)$$
$$y_{40}(t) = x_8(t) \cdot r_2(t)$$
$$y_{41}(t) = x_9(t) \cdot r_2(t)$$
$$y_{42}(t) = x_{10}(t) \cdot r_2(t)$$
$$y_{43}(t) = x_{11}(t) \cdot r_2(t)$$
$$y_{44}(t) = x_{12}(t) \cdot r_2(t)$$

$$y_{45}(t) = x_{13}(t) \cdot r_2(t)$$
$$y_{46}(t) = x_{14}(t) \cdot r_2(t)$$
$$y_{47}(t) = x_{15}(t) \cdot r_2(t)$$
$$y_{48}(t) = x_{16}(t) \cdot r_2(t)$$
$$y_{49}(t) = x_{46}(t) \cdot r_3(t)$$
$$y_{50}(t) = x_{47}(t) \cdot r_3(t)$$
$$y_{51}(t) = x_{48}(t) \cdot r_3(t)$$
$$y_{52}(t) = x_{49}(t) \cdot r_3(t)$$

2. Input signals x_i for $i \in [1, 49]$
3. User-interface input signals u_{si} for $i \in [1, 3]$ such that
   - floor ring/
     "Volume floor" $u_{s2}(t) \in [\,0, 1\,]$ (default value = 1)
   - lower ring/
     "Volume dome" $u_{s1}(t) \in [\,0, 1\,]$ (default value = 1)
   - subs/
     "Volume bass" $u_{s3}(t) \in [\,0, 1\,]$ (default value = 1)
4. Intermediate signals p_i for $i \in [1, 3]$ and r_i for $i \in [1, 3]$ such that

$$p_1(t) = 0.001 \cdot u_{s1}(t)$$
$$p_2(t) = 0.001 \cdot u_{s2}(t)$$
$$p_3(t) = 0.001 \cdot u_{s3}(t)$$

$$r_1(t) = p_1(t) + 0.999 \cdot r_1(t-1)$$
$$r_2(t) = p_2(t) + 0.999 \cdot r_2(t-1)$$
$$r_3(t) = p_3(t) + 0.999 \cdot r_3(t-1)$$

2 Block diagram of `process`

The block diagram of `process` is shown on Figure 1 (page 11).

3 Notice

- This document was generated using Faust version 2.6.3 on November 11, 2018.
- The value of a Faust program is the result of applying the signal transformer denoted by the expression to which the `process` identifier is bound to input signals, running at the f_S sampling frequency.
- Faust (*Functional Audio Stream*) is a functional programming language designed for synchronous real-time signal processing and synthesis applications. A Faust program is a set of bindings of identifiers to expressions that denote signal transformers. A signal s in S is a function mapping[1] times $t \in \mathbb{Z}$ to values $s(t) \in \mathbb{R}$, while a signal transformer is a function from S^n to S^m, where $n, m \in \mathbb{N}$. See the Faust manual for additional information (http://faust.grame.fr).
- Every mathematical formula derived from a Faust expression is assumed, in this document, to having been normalized (in an implementation-dependent manner) by the Faust compiler.
- A block diagram is a graphical representation of the Faust binding of an identifier I to an expression E; each graph is put in a box labeled by I. Subexpressions of E are recursively displayed as long as the whole picture fits in one page.
- The `KMHLS_channel_map_lin-mdoc/` directory may also include the following subdirectories:
  - `cpp/` for Faust compiled code;
  - `pdf/` which contains this document;
  - `src/` for all Faust sources used (even libraries);
  - `svg/` for block diagrams, encoded using the Scalable Vector Graphics format (http://www.w3.org/Graphics/SVG/);
  - `tex/` for the LaTeX source of this document.

4 Faust code listings

This section provides the listings of the Faust code used to generate this document, including dependencies.

[1] Faust assumes that $\forall\, s \in S, \forall\, t \in \mathbb{Z}, s(t) = 0$ when $t < 0$.

Listing 1: KMHLS_channel_map_lin.dsp

```
declare name  "KMHLS ChannelMap - 16+29+4";
declare version " 0.1 ";
declare author " Henrik Frisk " ;
declare license " BSD ";
declare copyright "(c) dinergy 2018 ";

//---------------`Channel mapping plugin` -------------------------
//
// Channel mapping plugin that takes 52 inputs, although only the 49 first channels are routed.
// These are routed to the Crescendo mixer channel layout.
//
// This version expects the floor ring in the beginning of the input.
//
// Insert this plugin on the master track or similar to get channels to map correctly to the Crescendo, i.e.:
//
// * Channel 1-16 of the input maps to Crescendo 33-48 (Layer B)
// * Channel 17-45 of the input maps to Crescendo 1-29 (Layer A)
// * Channel 46-49 maps to Crescendo 49-52 (Layer B)
//-------------------------------------------------

import("stdfaust.lib");

domevol = hslider("Volume dome", 1., 0., 1., 0.001) : si.smoo;
floorvol = hslider("Volume floor", 1., 0., 1., 0.001) : si.smoo;
bassvol = hslider("Volume bass", 1., 0., 1., 0.001) : si.smoo;

process (d1, d2, d3, d4, d5, d6, d7, d8, d9, d10, d11, d12, d13, d14, d15, d16,
    a1, a2, a3, a4, a5, a6, a7, a8, a9, a10, a11, a12, a13, a14, a15, a16,
    b1, b2, b3, b4, b5, b6, b7, b8,
    c1, c2, c3, c4, c5,
    sub1, sub2, sub3, sub4, x1, x2, x3) = a1, a2, a3, a4, a5, a6, a7, a8, a9, a10, a11, a12, a13, a14, a15, a16,
                b1, b2, b3, b4, b5, b6, b7, b8,
                c1, c2, c3, c4, c5, 0, 0, 0,
                d1, d2, d3, d4, d5, d6, d7, d8, d9, d10, d11, d12, d13, d14, d15, d16,
                sub1, sub2, sub3, sub4
                        : hgroup("lower ring", par(i, 29, _ * domevol)), _, _, _,
                hgroup("floor ring", par(i, 16, _ * floorvol)),
                hgroup("subs", par(i, 4, _ * bassvol));
```

Listing 2: stdfaust.lib

```
//################################## stdfaust.lib ########################################
// The purpose of this library is to give access to all the Faust standard libraries
// through a series of environment.
//########################################################################################

an = library("analyzers.lib");
ba = library("basics.lib");
co = library("compressors.lib");
de = library("delays.lib");
dm = library("demos.lib");
dx = library("dx7.lib");
en = library("envelopes.lib");
fi = library("filters.lib");
ho = library("hoa.lib");
ma = library("maths.lib");
ef = library("misceffects.lib");
os = library("oscillators.lib");
no = library("noises.lib");
```

```
pf = library("phaflangers.lib");
pm = library("physmodels.lib");
re = library("reverbs.lib");
ro = library("routes.lib");
sp = library("spats.lib");
si = library("signals.lib");
so = library("soundfiles.lib");
sy = library("synths.lib");
ve = library("vaeffects.lib");
sf = library("all.lib");
```

Listing 3: `signals.lib`

```
//################################### signals.lib ########################################
// A library of basic elements to handle signals in Faust. Its official prefix is 'si'.
//########################################################################################

/************************************************************************
*************************************************************************
FAUST library file, GRAME section

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--------------------------------------------------------------------
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*************************************************************************
*************************************************************************/

ba = library("basics.lib");
ro = library("routes.lib");
si = library("signals.lib");

declare name "Faust Signal Routing Library";
declare version "0.0";

//============================Functions Reference=======================================
//======================================================================================

```

```
//---------------------------------`(si.)bus`-------------------------------------
// n parallel cables.
// `bus` is a standard Faust function.
//
// #### Usage
//
// ```
// bus(n)
// bus(4) : _,_,_,_
// ```
//
// Where:
//
// * `n`: is an integer known at compile time that indicates the number of parallel cables.
//-------------------------------------------------------------------------------
bus(2) = _,_; // avoids a lot of "bus(1)" labels in block diagrams
bus(n) = par(i, n, _);


//--------------`(si.)block`--------------
// Block - terminate n signals.
// `block` is a standard Faust function.
//
// #### Usage
//
// ```
// _,_,... : block(n) : _,...
// ```
//
// Where:
//
// * `n`: the number of signals to be blocked
//--------------------------------------
block(n) = par(i,n,!);


//-----------------------------`(si.)interpolate`--------------------------------
// Linear interpolation between two signals.
//
// #### Usage
//
// ```
// _,_ : interpolate(i) : _
// ```
//
// Where:
//
// * `i`: interpolation control between 0 and 1 (0: first input; 1: second input)
//-------------------------------------------------------------------------------
interpolate(i) = *(1.0-i),*(i) : +;

//------------------------`(si.)smoo`-----------------------------------------
// Smoothing function based on `smooth` ideal to smooth UI signals
// (sliders, etc.) down.
// `smoo` is a standard Faust function.
//
// #### Usage
//
// ```
// hslider(...) : smoo;
// ```
//-------------------------------------------------------------------------
smoo = si.smooth(0.999);


//-----------------------`(si.)polySmooth`-------------------------------
// A smoothing function based on `smooth` that doesn't smooth when a
// trigger signal is given. This is very useful when making
```

```
// polyphonic synthesizer to make sure that the value of the parameter
// is the right one when the note is started.
//
// #### Usage
//
// ```
// hslider(...) : polysmooth(g,s,d) : _
// ```
//
// Where:
//
// * `g`: the gate/trigger signal used when making polyphonic synths
// * `s`: the smoothness (see `smooth`)
// * `d`: the number of samples to wait before the signal start being
//     smoothed after `g` switched to 1
//------------------------------------------------------------------
polySmooth(g,s,d) = smooth(s*((g==(g@d)) | (g == 0)));

//-----------------------`(si.)smoothAndH`-------------------------------
// A smoothing function based on `smooth` that holds its output
// signal when a trigger is sent to it. This feature is convenient
// when implementing polyphonic instruments to prevent some
// smoothed parameter to change when a note-off event is sent.
//
// #### Usage
//
// ```
// hslider(...) : smoothAndH(g,s) : _
// ```
//
// Where:
//
// * `g`: the hold signal (0 for hold, 1 for bypass)
// * `s`: the smoothness (see `smooth`)
//------------------------------------------------------------------
smoothAndH(t,s) = smooth(s*t) : ba.sAndH(t);

//-----------------------------`(si.)bsmooth`-----------------------------
// Block smooth linear interpolation during a block of samples.
//
// #### Usage
//
// ```
// hslider(...) : bsmooth : _
// ```
//------------------------------------------------------------------------
bsmooth(c) = +(i) ~ _
with {
    i = (c-c@n)/n;
    n = min(4096, max(1, fvariable(int count, <math.h>)));
};

//--------------------------------`(si.)dot`---------------------------------------
// Dot product for two vectors of size n.
//
// #### Usage
//
// ```
// _,_,_,_,_,_ : dot(n) : _
// ```
//
// Where:
//
// * `n`: size of the vectors (int, must be known at compile time)
//-----------------------------------------------------------------------------
dot(n) = ro.interleave(n,2) : par(i,n,*) :> _;

// end GRAME section
```

```
//##############################################################################################
/*****************************************************************************
FAUST library file, jos section

Except where noted otherwise, The Faust functions below in this
section are Copyright (C) 2003-2017 by Julius O. Smith III <jos@ccrma.stanford.edu>
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[CCA4I](https://creativecommons.org/licenses/by/4.0/) license (TODO: if/when Romain agrees!)

*****************************************************************************/
//-------------------`(si.)smooth`-----------------------------------
// Exponential smoothing by a unity-dc-gain one-pole lowpass.
// `smooth` is a standard Faust function.
//
// #### Usage:
//
// ```
// _ : smooth(tau2pole(tau)) : _
// ```
//
// Where:
//
// * `tau`: desired smoothing time constant in seconds, or
//
// ```
// hslider(...) : smooth(s) : _
// ```
//
// Where:
//
// * `s`: smoothness between 0 and 1. s=0 for no smoothing, s=0.999 is "very smooth",
// s>1 is unstable, and s=1 yields the zero signal for all inputs.
// The exponential time-constant is approximately 1/(1-s) samples, when s is close to
// (but less than) 1.
//
// #### Reference:
//
// <https://ccrma.stanford.edu/~jos/mdft/Convolution_Example_2_ADSR.html>
//-----------------------------------------------------------
smooth(s) = *(1.0 - s) : + ~ *(s);

//--------------------------------`(si.)cbus`-----------------------------------
// n parallel cables for complex signals.
// `cbus` is a standard Faust function.
//
// #### Usage
//
// ```
// cbus(n)
// cbus(4) : (r0,i0), (r1,i1), (r2,i2), (r3,i3)
// ```
//
// Where:
//
// * `n`: is an integer known at compile time that indicates the number of parallel cables.
// * each complex number is represented by two real signals as (real,imag)
//-------------------------------------------------------------------------------
cbus(1) = (_,_);
cbus(n) = par(i, n, (_,_));

//--------------------------------`(si.)cmul`-----------------------------------
// multiply two complex signals pointwise.
// `cmul` is a standard Faust function.
//
```

```
// #### Usage
//
// ```
// (r1,i1) : cmul(r2,i2) : (_,_);
// ```
//
// Where:
//
// * Each complex number is represented by two real signals as (real,imag), so
// - `(r1,i1)` = real and imaginary parts of signal 1
// - `(r2,i2)` = real and imaginary parts of signal 2
//------------------------------------------------------------------------------
cmul(r1,i1,r2,i2) = (r1*r2 - i1*i2), (r1*i2 + r2*i1);

// end jos section
/************************************************************************
FAUST library file, further contributions section
All contributions below should indicate both the contributor and terms
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elsewhere among the libraries. It is expected that all software will be
released under LGPL, STK-4.3, MIT, BSD, or a similar FOSS license.
************************************************************************/

//-------------`(si.)lag_ud`---------------
// Lag filter with separate times for up and down.
//
// #### Usage
//
// ```
// _ : lag_ud(up, dn, signal) : _;
// ```
//-----------------------------------------------------
// Author: Jonatan Liljedahl
// License: STK-4.3
// MarkDown: Romain Michon
lag_ud(up,dn) = _ <: ((>,ba.tau2pole(up),ba.tau2pole(dn):select2),_:si.smooth) ~ _;

// end further further contributions section
```

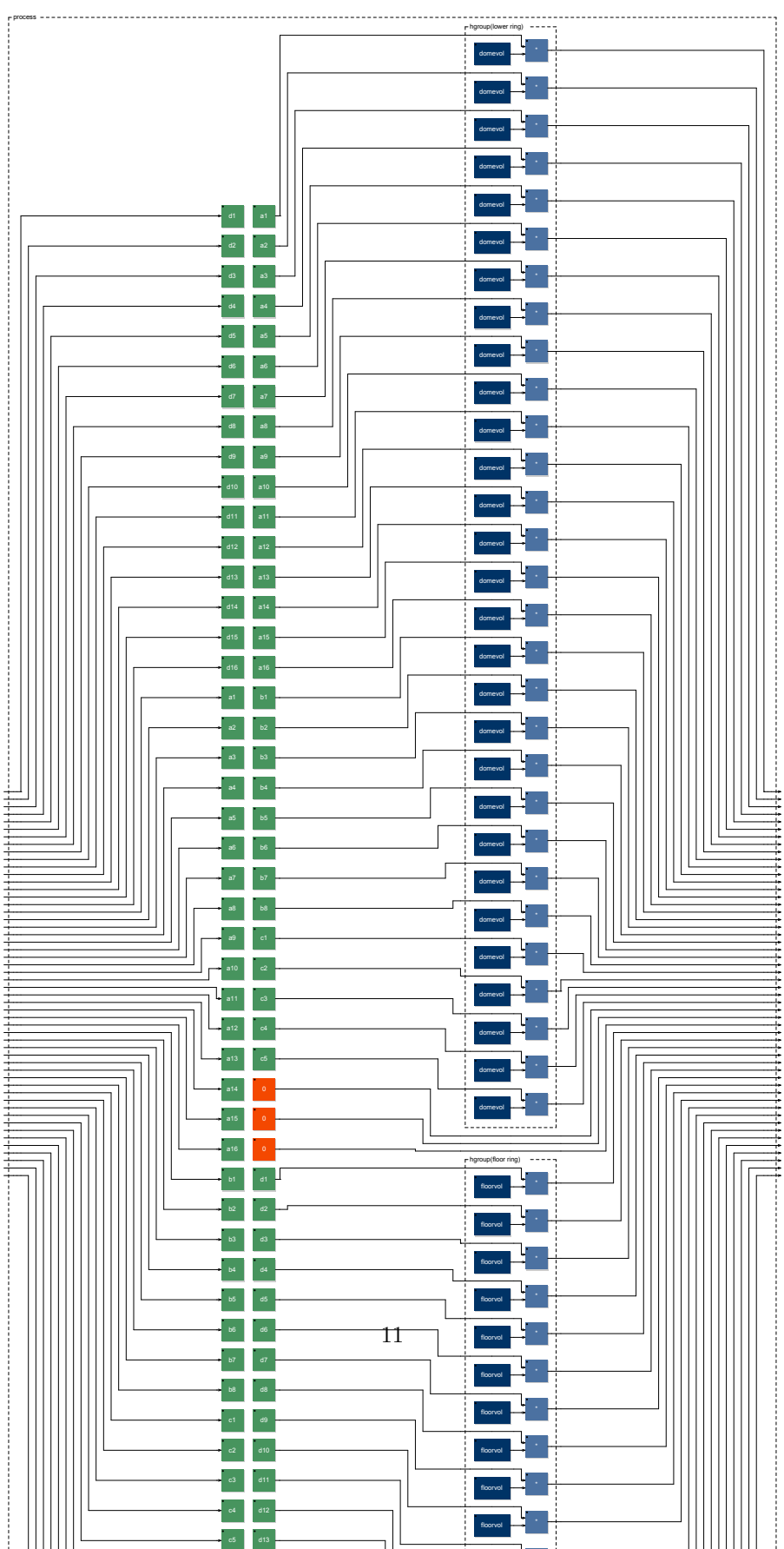
process
hgroup(lower ring)
domevol
*
d1
a1
d2
a2
d3
a3
d4
a4
d5
a5
d6
a6
d7
a7
d8
a8
d9
a9
d10
a10
d11
a11
d12
a12
d13
a13
d14
a14
d15
a15
d16
a16
a1
b1
a2
b2
a3
b3
a4
b4
a5
b5
a6
b6
a7
b7
a8
b8
a9
c1
a10
c2
a11
c3
a12
c4
a13
c5
a14
0
a15
0
a16
0
hgroup(floor ring)
floorvol
b1
d1
b2
d2
b3
d3
b4
d4
b5
d5
b6
d6
b7
d7
b8
d8
c1
d9
c2
d10
c3
d11
c4
d12
c5
d13