

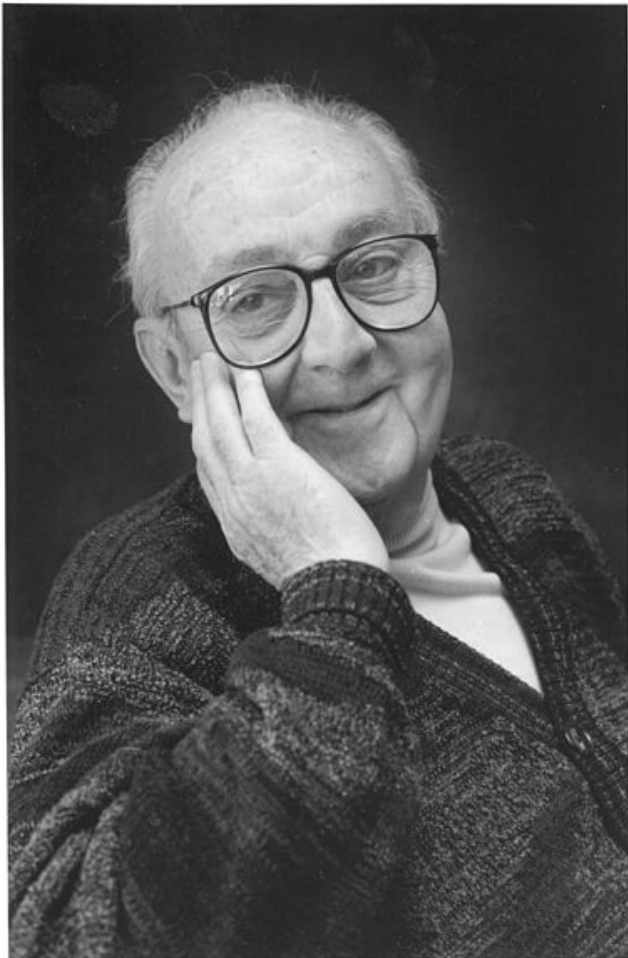
Preamble



"All models are **WRONG**, but some are **USEFUL**"

a citation attributed to late George E.P. Box.

•



Born 18 October 1919

Died 28 March 2013

Fields Statistics

Institutions

ICI

Princeton University

University of Wisconsin–Madison

Alma mater : University College London

Known for

Response-surface methodology

Box–Jenkins method

Box–Cox transformation

NAPA



A High Level Simulator of Mixed-Signal Systems



Outline

NAPA through a simple example

main netlist

cell

primitive

user function

time domain simulation

smart tool

synchronization

A realistic example

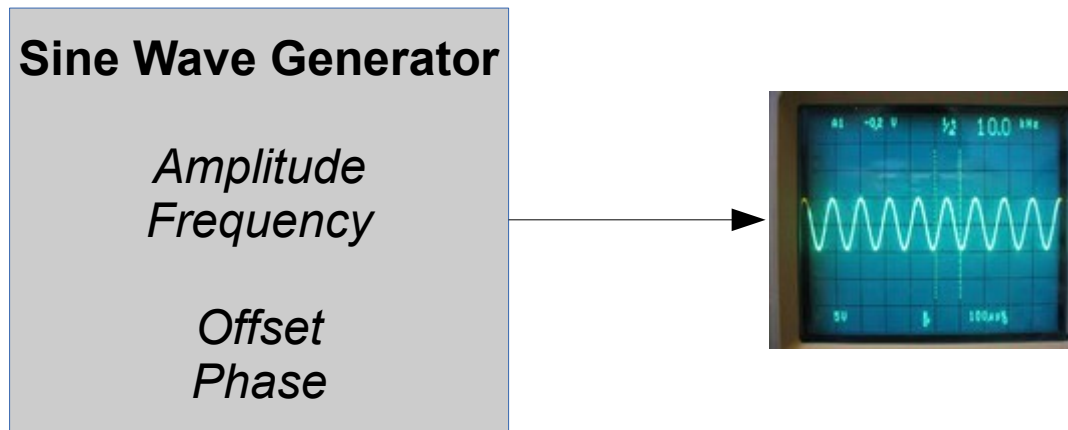
cell generator

multirate transfer function

more...

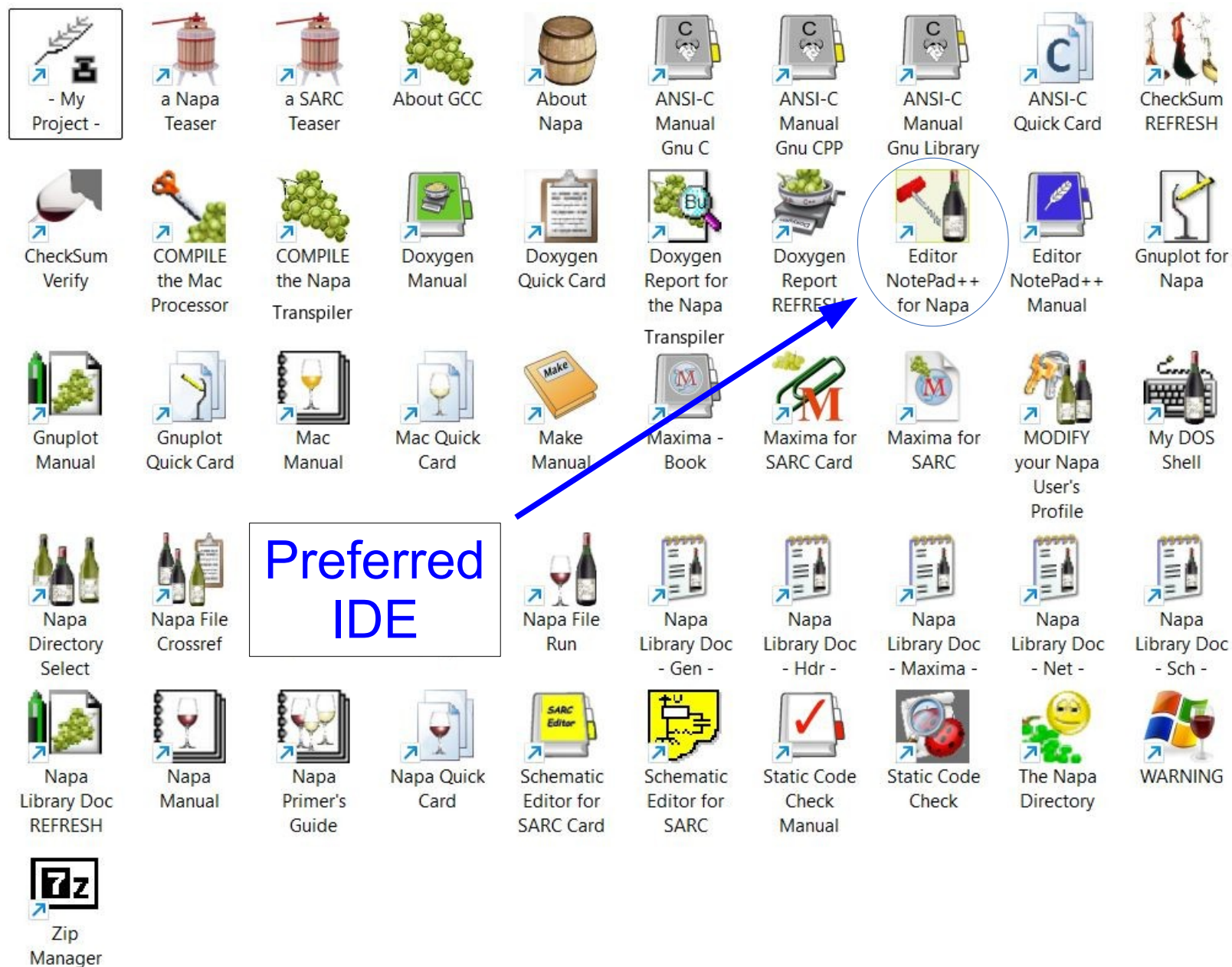
Open conclusion

A Simple Example : Generate a Sine Wave



We will show how we may easily adapt NAPA to address a specific user concern.

Preferred Environment : Windows 11, 64 bits



(Napa Vineyard)



First Contact with NAPA

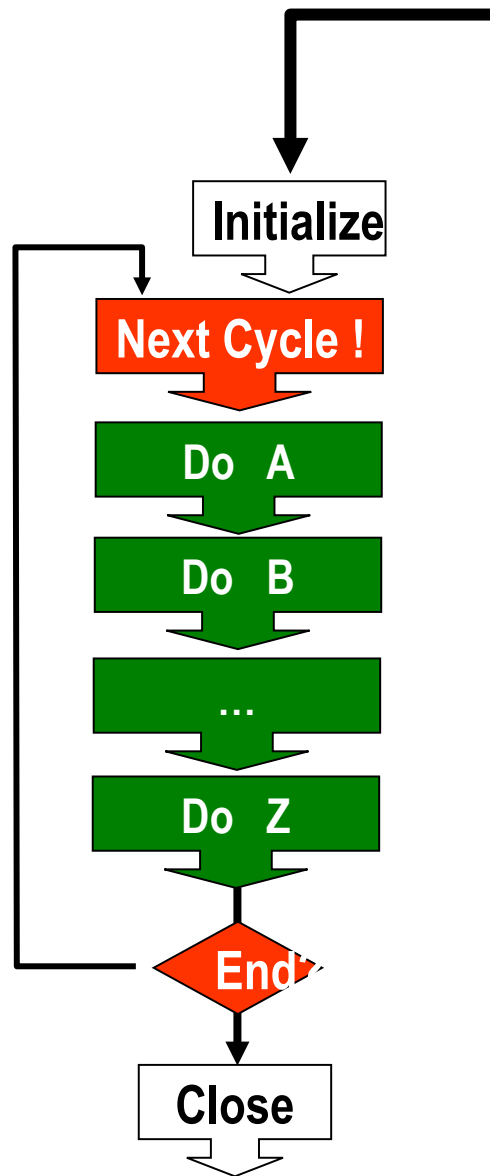
Generate a sine wave, frequency 12.3456 kHz, offset 1.0V, amplitude 2.0V (pk)

```
1  title "sine"
2
3
4  header <napatool.hdr>
5
6  fs 1.0e6
7
8  node (s) sine 1.0 2.0 12345.6 0.0
9
10 terminate 1000000000 <= LOOP_INDEX
```

User Defined length: 158 lines: 10 Ln: 6 Col: 14 Pos: 66 Windows (CR LF) UTF-8 INS

Tips : to transpile and execute, i.e to simulate, press 'Alt R' from the NAPA netlist

NAPA is a Cycle-Based Simulator Writer



Flow **transpiled before execution**

Crystal clear flow

DATA Domain !
Control Domain ?

**Mixed Signal
Data Processing**

FFT friendly

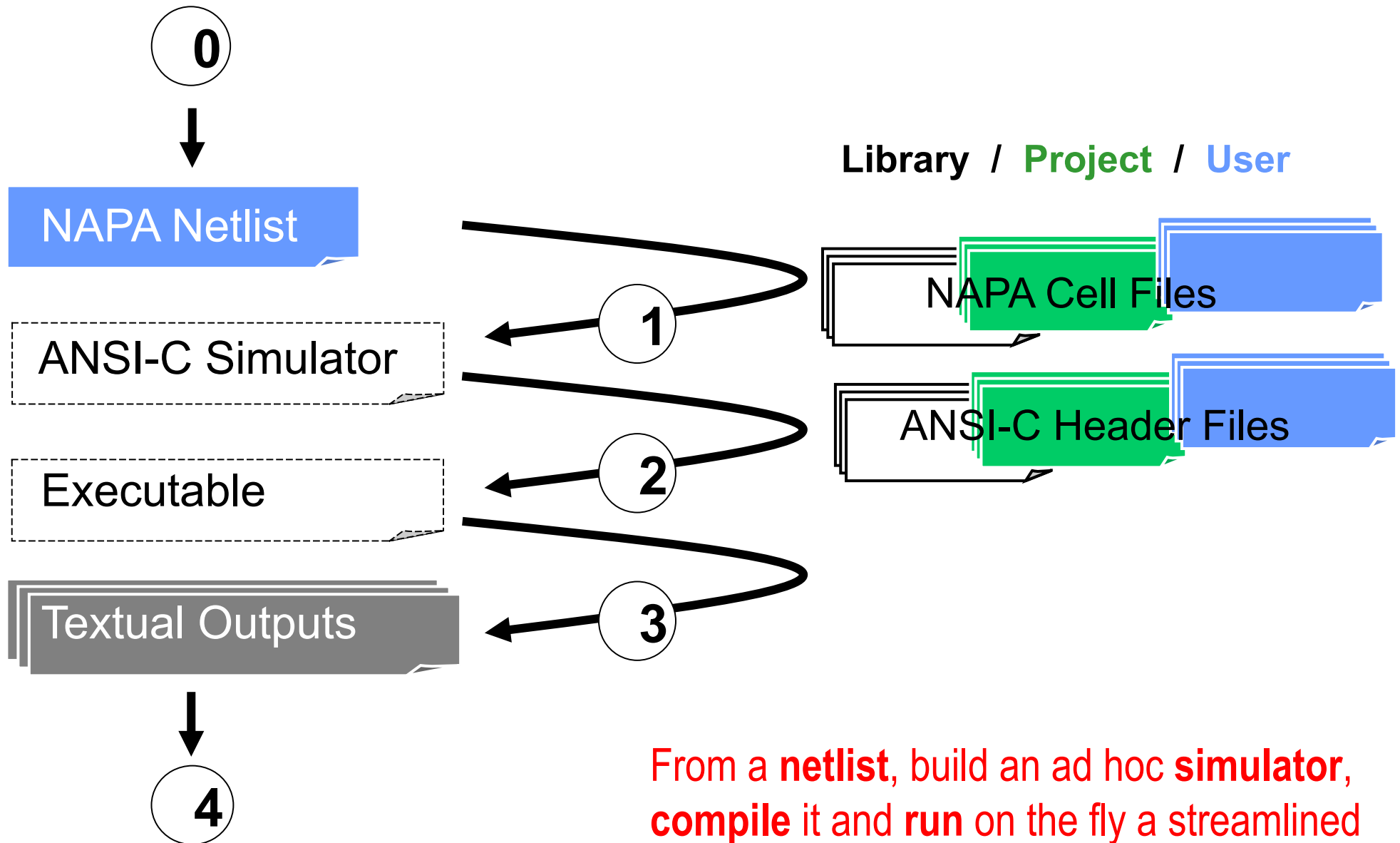
Hazard free

Cycle accurate by construction

Very fast

Static loops detected and rejected

NAPA File Structure and Work Flow



From a **netlist**, build an ad hoc **simulator**,
compile it and **run** on the fly a streamlined
fast **executable**.



```
*C:\Simulate_Examples\teaser1.nap - Notepad++
File Edit Search View Encoding Language Settings Tools Macro Run Plugins Window ?
teaser1.nap
1
2 title "sine"
3
4 header <napatool.hdr>
5
6 fs 1.0e6
7
8 node (s) sine 1.0 2.0 12345.6 0.0
9
10 terminate 1000000000 <= LOOP_INDEX
User Defined length: 158 lines: 10 Ln: 6 Col: 14 Pos: 66 Windows (CR LF) UTF-8 INS
```

NAPA transpilation

file "teaser1.c"

```
...
    napa_abs_loop = 0.0L;

    do {
napa_abs_time  = napa_abs_loop * 1.0000000000000000e-006L;

        d_node_s = 1.0 + (2.0) *
((R_TYPE) sinl(77569.692528316305093483152L * napa_abs_time));

        napa_abs_loop++;
    } while (!TERMINATE);
    ...
```

ANSI-C code

Tips : toggle to the ANSI-C code, press 'Alt T' from the NAPA netlist



```
NAPA Compile and Run: Sour  × + ▾

[teaser1] **** MAC Preprocessor Running ****
[teaser1] **** NAPA Transpiler Running ****
[teaser1] **** GCC Compiler Running ****
[teaser1] **** Ad Hoc Simulator Running ****

****
**** sine
****

****
**** Working Directory:      "C:\Simulate_Examples"
****

**** Random Seed [I] :      876722465 ****
**** Output Tag [O] :      440259944 ****

**** NAPA Transpiler :      V4.50 for Win64 ****
**** Main Netlist :      teaser1.tmp ****
**** Simulator Time :      1.000000 ks ****
**** Simulator Index :      1 000 000 000 ****
**** Run Time I/O :      ****
    -> teaser1.log          [ 0] ****

**** Stopwatch :      H00:M00:S02.389 ****

**** LOG File Ready :      teaser1.log ****

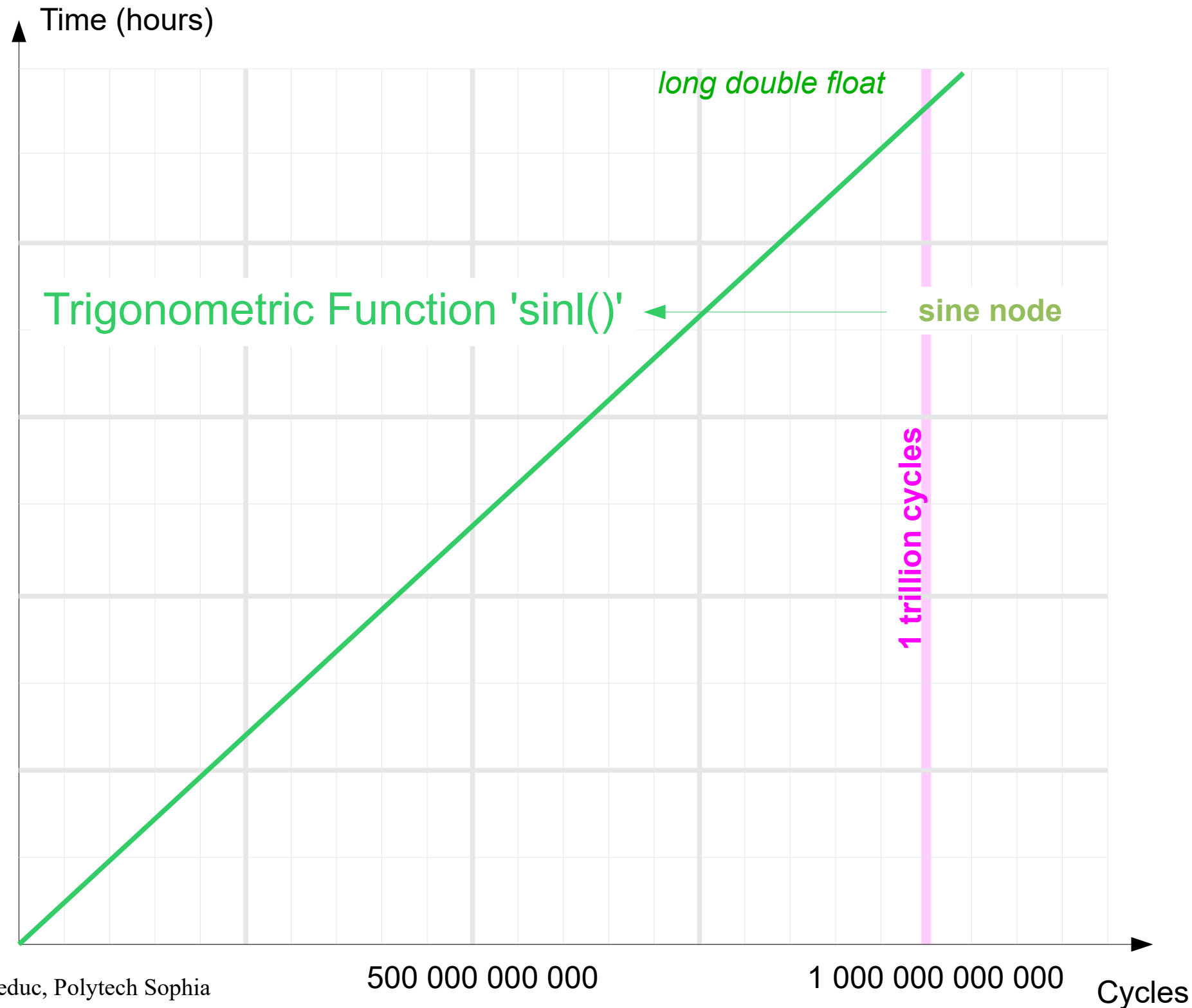
**** Normal Termination      ****

[teaser1]
Press Enter to continue . . . |
```

The simulation
running on the screen

*Preprocess
NAPA Transpile
C Compile
Binary Execution*

*1 billion cycles
in 2.4 seconds*





We will implement a few ideas to generate a sine wave.

It is a good opportunity to show how to ^{*test*}~~taste~~ NAPA ...



[Mathematics Do Help]



A sine wave is more than a set of sines, it is a sequence of sines where each sine value is correlated to the previous ones. It is therefore possible to take profit of this quality.

We will use a **RESONATOR** to produce the sine wave and saves a precious computation time.

The resonator is implemented as a **2-pole filter** described by the following **difference equation**

$$X_n = (k * X_{n-1}) - X_{n-2}$$

*with $k = 2.0 * \cos(2\pi \text{ fsinewave} / \text{fsampling})$*

To start the oscillator, i.e. to set properly the initial conditions of the difference equation, we will set-up the initial conditions :

$$X_{n-1} = \sin(\text{phase})$$
$$X_{n-2} = \sin(\text{phase} - (2\pi \text{ fsinewave} / \text{fsampling}))$$

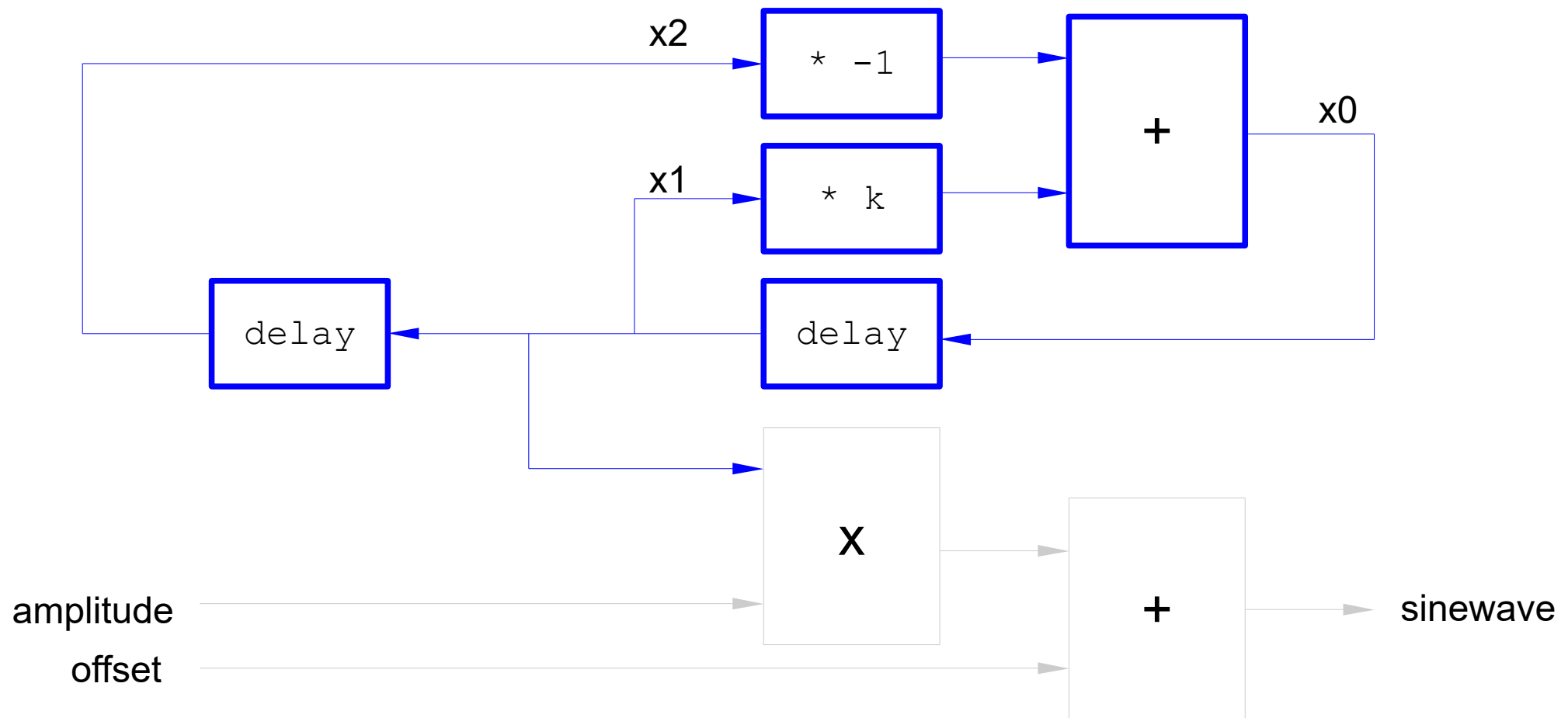
The Second Order Resonator



Sine wave frequency, sine wave phase and sampling frequency

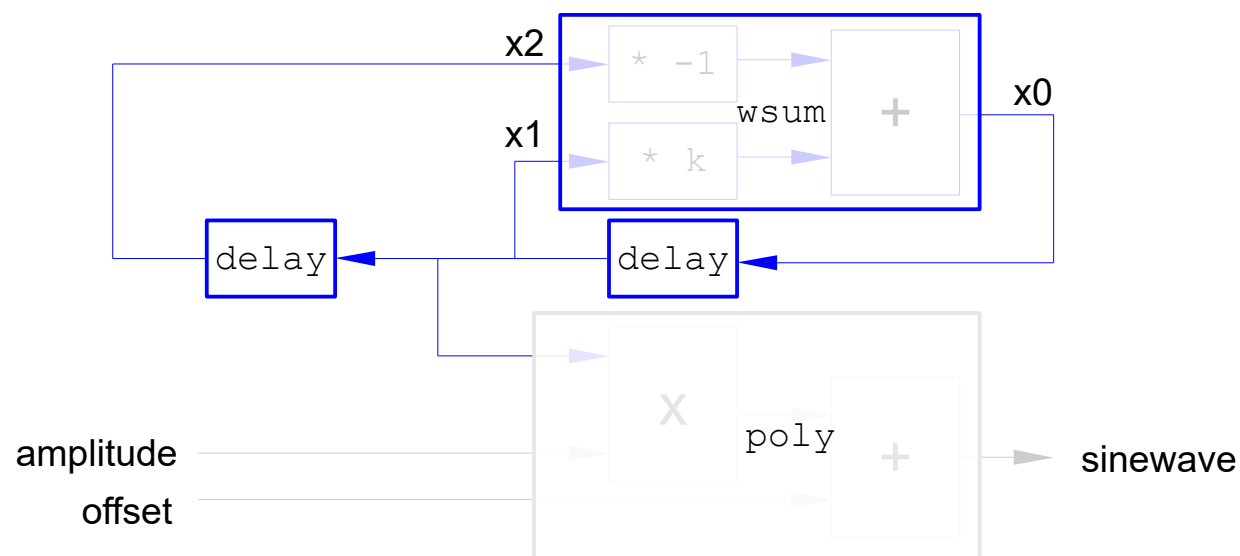


parameter k
initial values for x_1 , x_2





A Direct Description in a NAPA Netlist



```
C:\Simulate_Examples\teaser2.nap - Notepad++
File Edit Search View Encoding Language Settings Tools Macro Run Plugins Window ?
teaser3.net teaser1.nap teaser2.nap
1
2 title "resonator"
3
4 header <napatool.hdr>
5
6 fs 1.0e6
7
8 dvar k 2.0 * cos( _2pi_ * ( 12345.6 / FSL ))
9
10 node x0 wsum k x1 -1.0 x2
11 node x1 delay x0
12 node x2 delay x1
13 node s poly 2.0 1.0 x1
14
15 declare (analog) x0 x1 x2
16
17 init x1 sin(0.0)
18 init x2 sin(0.0 - ( _2pi_ * ( 12345.6 / FSL )))
19
20 terminate 1000000000 <= LOOP_INDEX
21
22 directive LOGFILE
User Defined length: 482 lines: 22 Ln: 1 Col: 1 Pos: 1 Windows (CR LF) UTF-8 INS
```



A Description Using a NAPA Cell



```
C:\Simulate_Examples\teaser3.net - Notepad++
File Edit Search View Encoding Language Settings Tools Macro Run Plugins Window ?
teaser1.nap teaser2.nap teaser3.nap teaser3.net
1 cell_interface $out $off $ampl $freq $phase
2
3 dvar $k 2.0 * cos( _2pi_ * ( $freq / FSL ))
4
5 declare (analog) $x0
6
7 node $x0 wsum $k $x1 -1.0 $x2
8 node $x1 delay $x0
9 node $x2 delay $x1
10
11 node $out poly $ampl $off $x1
12
13 init $x1 sin($phase)
14 init $x2 sin($phase ( _2pi_ * ( $freq / FSL )))
15
User Defined length: 400 lines: 15 Ln: 1 Col: 1 Pos: 1 Windows (CR LF) UTF-8 INS
```

instantiation

```
C:\Simulate_Examples\teaser3.nap - Notepad++
File Edit Search View Encoding Language Settings Tools Macro Run Plugins Window ?
teaser1.nap teaser2.nap teaser3.net teaser3.nap
1
2 header <napatool.hdr>
3
4 title "sine"
5
6 fs 1.0e6
7
8 node s cell sr "teaser3.net" 1.0 2.0 12345.6 0.0
9
10 terminate 1000000000 <= LOOP_INDEX
11
12 directive LOGFILE
13
User Defined length: 218 lines: 13 Ln: 1 Col: 1 Pos: 1 Windows (CR LF) UTF-8 INS
```

The NAPA transpiler flattens the hierarchy before the process.



```
C:\Simulate_Examples\teaser3.exp - Notepad++
File Edit Search View Encoding Language Settings Tools Macro Run Plugins Window ?
teaser3.exp x
1
2  /* ***** EXPANSION OF FILE teaser3.tmp *****
3
4
5  header <napatool.hdr>
6
7  title      "sine"
8
9  fs          1.0e6
10
11 /* >>  node      s    cell  sr    "teaser3.net"  1.0 2.0 12345.6 0.0
12
13  dvar        sr__k    2.0 * cos( _2pi_ * ( 12345.6 / FSL ))
14
15  declare     (analog)    sr__x0
16
17  node        sr__x0    wsum    sr__k sr__x1  -1.0 sr__x2
18  node        sr__x1    delay    sr__x0
19  node        sr__x2    delay    sr__x1
20  node        s    poly    2.0 1.0  sr__x1
21
22  init        sr__x1    sin(0.0)
23  init        sr__x2    sin(0.0 - ( _2pi_ * ( 12345.6 / FSL )))
24
25 /* <<
26
27  terminate   1000000000 <= LOOP_INDEX
28
29  directive   LOGFILE
30
31
32 /* ***** EXPANSION OF FILE teaser3.tmp *****
33
```

User Defined length: 856 lines: 34 Ln: 1 Col: 1 Pos: 1 Windows (CR LF) UTF-8 INS

*Tips : to get an insider view
of the flattening process,*

*press '**Alt E**' from the NAPA netlist*



The NAPA transpiler creates a cross reference of the flattened NAPA netlist.

```
NAPA Cross Reference: Source  x + v

List of Files
A. -> "teaser3.tmp"
B. -> "teaser3.net"

*****

List of Headers
A.2      <- "C:/Simulate/NapaDos/Hdr/napatool.hdr"

Sampling Information
A.6      <- [ main sampling frequency ]

List of Directives
A.12     <- LOGFILE

List of Nodes
A.8      B.11 <- s
A.8      B.7  <- sr__x0
A.8      B.8  <- sr__x1
A.8      B.9  <- sr__x2

List of Variables
A.8      B.3   <- sr__k
A.8      B.13  <- [ init ]
A.8      B.14  <- [ init ]

List of Declarations
A.8      B.5   <- sr__x0

Terminate
A.10     <- [ terminate ]

***** END *****

[teaser3]

****
**** Output in file "teaser3.lst"
****

Press Enter to continue . . .
```



A Description Using a NAPA Primitive

(in fact, this solution is also implemented as a built-in primitive)



C:\Simulate_Examples\teaser1.nap - Notepad++

```
File Edit Search View Encoding Language Settings Tools Macro Run Plugins Window ?
teaser3.nap teaser4.nap teaser1.nap
1
2 title "sine"
3
4 header <napatool.hdr>
5
6 fs 1.0e6
7
8 node (s) sine 1.0 2.0 12345.6 0.0
9
10 terminate 1000000000 <= LOOP_INDEX
11
12 directive LOGFILE
```

User Defined length: 184 lines: 12 Ln: 1 Col: 1 Pos: 1 Windows (CR LF) UTF-8 INS

NAPA Built-in 'sine'

C:\Simulate_Examples\teaser4.nap - Notepad++

```
File Edit Search View Encoding Language Settings Tools Macro Run Plugins Window ?
teaser3.nap teaser4.nap
1
2 title "osc"
3
4 header <napatool.hdr>
5
6 fs 1.0e6
7
8 node (s) osc 1.0 2.0 12345.6 0.0
9
10 terminate 1000000000 <= LOOP_INDEX
11
12 directive LOGFILE
```

User Defined length: 183 lines: 12 Ln: 1 Col: 1 Pos: 1 Windows (CR LF) UTF-8 INS

NAPA Built-in 'osc'



```

1
2  title "osc"
3
4  header <napatool.hdr>
5
6  fs      1.0e6
7
8  node (s)  osc  1.0 2.0 12345.6  0.0
9
10 terminate 1000000000 <= LOOP_INDEX
11
12 directive LOGFILE

```

User Defined length: 183 lines: 12 Ln: 1 Col: 1 Pos: 1 Windows (CR LF) UTF-8 INS

NAPA transpilation

file "teaser4.c"

```

...
h_node_s_factor = 2.0L * cosl(_2PI_*12345.6L/((H_PREC) FSL));
h_node_s_osc0 = 0.0L;
h_node_s_osc1 = -sinl(_2PI_*12345.6L/((H_PREC) FSL));
h_node_s_osc2 = 0.0L;
...
napa_abs_loop = 0.0L;
do {
napa_abs_time = napa_abs_loop * 1.0e-6L;

h_node_s_osc2 = h_node_s_osc1;
h_node_s_osc1 = h_node_s_osc0;
h_node_s_osc0 = (h_node_s_factor * h_node_s_osc1) - h_node_s_osc2;
d_node_s = 2.0 * ((R_TYPE) h_node_s_osc1);
d_node_s += 1.0;

napa_abs_loop++;
} while (!TERMINATE);
...

```

The resonator is implemented internally with 16 bytes long double floats to get the best precision. Output is casted as a double float.



A Description Using a NAPA User Function [*]

[] A function you can write yourself in ANSI-C*



C:\Simulate_Examples\teaser5.nap - Notepad++

File Edit Search View Encoding Language Settings Tools Macro Run Plugins Window ?

teaser3.nap teaser4.nap teaser1.nap **teaser5.nap**

```
1
2  title "osc function"
3
4  header <napatool.hdr>
5  header "/Simulate/Napados/Hdr/User/resonator.hdr"
6
7  fs      1.0e6
8
9  node    s    duser resonator 1.0 2.0 12345.6 0.0
10
11 terminate 1000000000 <= LOOP_INDEX
12
13 directive LOGFILE
```

User Defined length: 245 lines: 13 Ln: 1 Col: 1 Pos: 1 Windows (CR LF) UTF-8 INS

'header' triggers the inclusion of C code in the simulator

inside the file "/Simulate/Napados/Hdr/User/resonator.hdr"

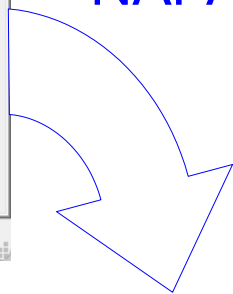
A set of C user functions in appropriate NAPA wrappers

```
check_duser_resonator_04(a,b,c,d,e)
reset_duser_resonator_04(a,b,c,d,e)
init_duser_resonator_04(a,b,c,d,e)
close_duser_resonator_04(a,b,c,d,e)
duser_resonator_04(a,b,c,d,e)
```



```
C:\Simulate_Examples\teaser5.nap - Notepad++
File Edit Search View Encoding Language Settings Tools Macro Run Plugins Window ?
teaser3.nap teaser4.nap teaser1.nap teaser5.nap
1
2 title "osc function"
3
4 header <napatool.hdr>
5 header "/Simulate/Napados/Hdr/User/resonator.hdr"
6
7 fs 1.0e6
8
9 node s duser resonator 1.0 2.0 12345.6 0.0
10
11 terminate 1000000000 <= LOOP_INDEX
12
13 directive LOGFILE
User Defined lengh: 245 lines: 13 Ln: 1 Col: 1 Pos: 1 Windows (CR LF) UTF-8 INS
```

NAPA transpilation



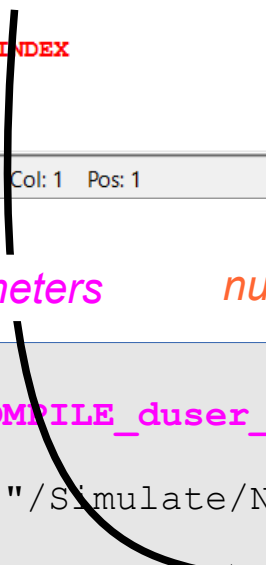
4 parameters

number of this instance in the netlist

file "teaser5.c"

```
...
#define COMPILER_duser_resonator 1
...
#include "/Simulate/Napados/Hdr/napatool.hdr"
...
check_duser_resonator_04(1.0,2.0,12345.6,0.0, 0);
init_duser_resonator_04(1.0,2.0,12345.6,0.0, 0);
...
do {
    napa_abs_time = napa_abs_loop * 1.0e-0L;
    d_node_s = duser_resonator_04(1.0,2.0,12345.6,0.0, 0);
    napa_abs_loop++;
} while (!TERMINATE);
...
close_duser_resonator_04(1.0,2.0,12345.6,0.0, 0);
...
```

instance ID





```
C:\Simulate_Examples\teaser5.nap - Notepad++
File Edit Search View Encoding Language Settings Tools Macro Run Plugins Window ?
teaser3.nap teaser4.nap teaser1.nap teaser5.nap
1
2 title "osc function"
3
4 header <napatool.hdr>
5 header "/Simulate/Napados/Hdr/User/resonator.hdr"
6
7 fs 1.0e6
8
9 node s duser resonator 1.0 2.0 12345.6 0.0
10
11 terminate 1000000000 <= LOOP_INDEX
12
13 directive LOGFILE
User Defined length: 245 lines: 13 Ln: 1 Col: 1 Pos: 1 Windows (CR LF) UTF-8 INS
```

*built_in automatic method to
locate the function using a table*

in a file included in "/Simulate/Napados/Hdr/napatool.hdr"

```
...
#ifdef COMPILE_duser_resonator
#include "/Simulate/Napados/hdr/User/resonator.hdr"
#endif
...
```

file "/Simulate/Napados/Hdr/User/resonator.hdr"

```
check_duser_resonator_04(a,b,c,d,e) ...
reset_duser_resonator_04(a,b,c,d,e) ...
init_duser_resonator_04(a,b,c,d,e) ...
close_duser_resonator_04(a,b,c,d,e) ...
duser_resonator_04(a,b,c,d,e) ...
```



We aimed to get speed, didn't we ?



```
C:\Simulate_Examples\teaser6.nap - Notepad++
File Edit Search View Encoding Language Settings Tools Macro Run Plugins Window ?
teaser3.nap teaser1.nap teaser5.nap teaser6.nap
1
2 title "osc"
3
4 header <napatool.hdr>
5
6 fs 1.0e6
7
8 node (s) osc 1.0 2.0 12345.6 0.0
9
10 terminate 1000000000000 <= LOOP_INDEX
11
12 directive LOGFILE
User Defined length: 186 lines: 12 Ln: 1 Col: 1 Pos: 1 Windows (CR LF) UTF-8 INS
```

1 trillion clock cycles ...

Run Simulation

```
NAPA Compile and Run: Soun
[teaser6] **** MAC Preprocessor Running ****
[teaser6] **** NAPA Transpiler Running ****
[teaser6] **** GCC Compiler Running ****
[teaser6] **** Ad Hoc Simulator Running ****

****
**** osc
****

****
**** Working Directory: "C:\Simulate_Examples"
****

**** Random Seed [I] : 876726756 ****
**** Output Tag [O] : 106343506 ****

**** NAPA Transpiler : V4.50 for Win64 ****
**** Main Netlist : teaser6.tmp ****
**** Simulator Time : 1.00000 Ms ****
**** Simulator Index : 1 000 000 000 000 ****

**** Run Time I/O : ****
-> teaser6.log [ 0] ****

**** Stopwatch : H00:M45:S45.903 ****

**** LOG File Ready : teaser6.log ****

**** Normal Termination ****

[teaser6]
Press Enter to continue . . . |
```

46 minutes



Cool...

But we do not want to
loose precision, do we ?



```
*C:\Simulate_Examples\teaser7.nap - Notepad++

File Edit Search View Encoding Language Settings Tools Macro Run Plugins Window ?

teaser7.c teaser3.nap teaser1.nap teaser5.nap teaser7.nap teaser7.out

1
2  title "accuracy"
3
4  header <napatool.hdr>
5
6  fs      1.0e6
7
8  dvar    freq      12345.6789
9  dvar    ph        rand_uniform(0.0, _2pi_)
10
11 dvar    cond1      LOOP_INDEX >= 1.0e9 - 1000 &update
12 dvar    cond2      LOOP_INDEX >= 1.0e9 &update
13
14 event   prt        cond1 && !cond2
15
16 node    out1        osc      1.0 2.0 freq ph
17 node    out2        sine     1.0 2.0 freq ph
18 node    err         sub      out1 out2
19
20 output  stdout      out1(_Volt) out2(_Volt) err(n_Volt) when prt
21
22 terminate      cond2
23
24 ping
25 directive      LOGFILE
26
```

Sanity Check

&update
&update

Tips :
'dvar' and 'ivar' are constant unless updated.
'event' is automatically updated.

Time domain simulation, output through "stdout"



```

...

napa_abs_loop = 0.0L;

...

dvar_freq    = 12345.6789;
dvar_ph      = rand_uniform(0.0, 2pi_);
dvar_cond1   = LOOP_INDEX>=1.0e9-1000.0;
dvar_cond2   = LOOP_INDEX>=1.0e9;
ivar_prt     = (I_TYPE) (dvar_cond1&&!dvar_cond2);

dnode_out1   = 0.0;
hnode_out1_fctr = cosl(_2PI_*dvar_freq/((H_PREC) FSL)) * 2.0L;
hnode_out1_osc0 = sinl(dvar_ph);
hnode_out1_osc1 = sinl(dvar_ph - (_2PI_*dvar_freq/((H_PREC) FSL)));
hnode_out1_osc2 = 0.0L;
dnode_out2   = 0.0;
dnode_err    = 0.0;

do {

    napa_abs_time = napa_abs_loop * 1.0e-06L;

    dvar_cond1   = LOOP_INDEX>=1.0e9-1000.0;
    dvar_cond2   = LOOP_INDEX>=1.0e9;
    ivar_prt     = (I_TYPE) (dvar_cond1&&!dvar_cond2);

    hnode_out1_osc2 = hnode_out1_osc1;
    hnode_out1_osc1 = hnode_out1_osc0;
    hnode_out1_osc0 = (hnode_out1_fctr * hnode_out1_osc1) - hnode_out1_osc2;
    dnode_out1     = ((R_TYPE) hnode_out1_osc1) * 2.0;
    dnode_out1 += 1.0;
    dnode_out2     = 1.0 + (2.0) * ((R_TYPE) sinl(_2PI_ * ((H_PREC) dvar_freq) * napa_abs_time + ((H_PREC) (dvar_ph)))));
    dnode_err      = (dnode_out1) - (dnode_out2);

    if ( ivar_prt ) {
        (void) fprintf(stdout, "%.15Le % .12e % .12e % .12e\n", napa_abs_time, dnode_out1, dnode_out2, dnode_err*1.0e9);
    }

    napa_abs_loop++;
} while ( !dvar_cond2 );

...

```

1. INITIALIZE SIMULATION

2. INITIALIZE VARIABLES

3. INITIALIZE NODES

LOOP

4. VARIABLE UPDATE

5. NODE UPDATE

6. TIME DOMAIN OUPUT



```
NAPA Compile and Run: Sour x + v

[teaser7] **** MAC Preprocessor Running ****
[teaser7] **** NAPA Transpiler Running ****
[teaser7] **** GCC Compiler Running ****
[teaser7] **** Ad Hoc Simulator Running ****

NAPA Ping Information :      function 'rand_uniform()' from file "C:/Simulate/NapaDos/Hdr/Function/random.hdr"

****
**** accuracy
****

****
**** Working Directory:      "C:\Simulate_Examples"
****

**** Random Seed [I] :      876760345 ****
**** Output Tag [O] :      581589160 ****

**** NAPA Transpiler :      V4.50 for Win64 ****
**** Main Netlist :      teaser7.tmp ****

**** Simulator Time :      1.00000 ks ****
**** Simulator Index :      1 000 000 001 ****

**** Run Time I/O :      ****
-> teaser7.log [ 0] ****
-> stdout [ 0] ****

**** Stopwatch :      H00:M01:S15.427 ****

**** LOG File Ready :      teaser7.log ****

**** Normal Termination ****

[teaser7]
Press Enter to continue
```

(1 billion sampling periods
computed in 1.15 minute)

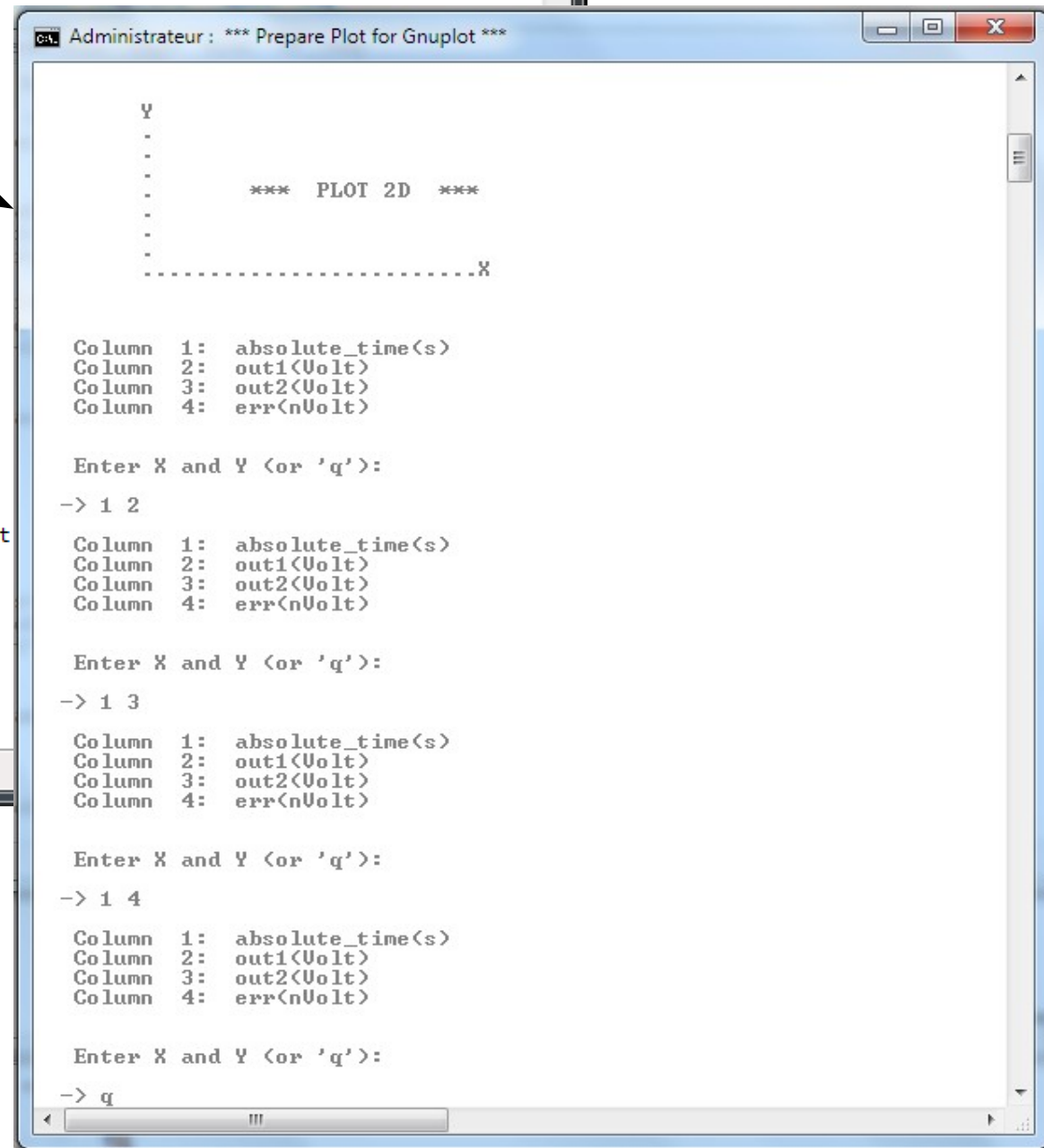
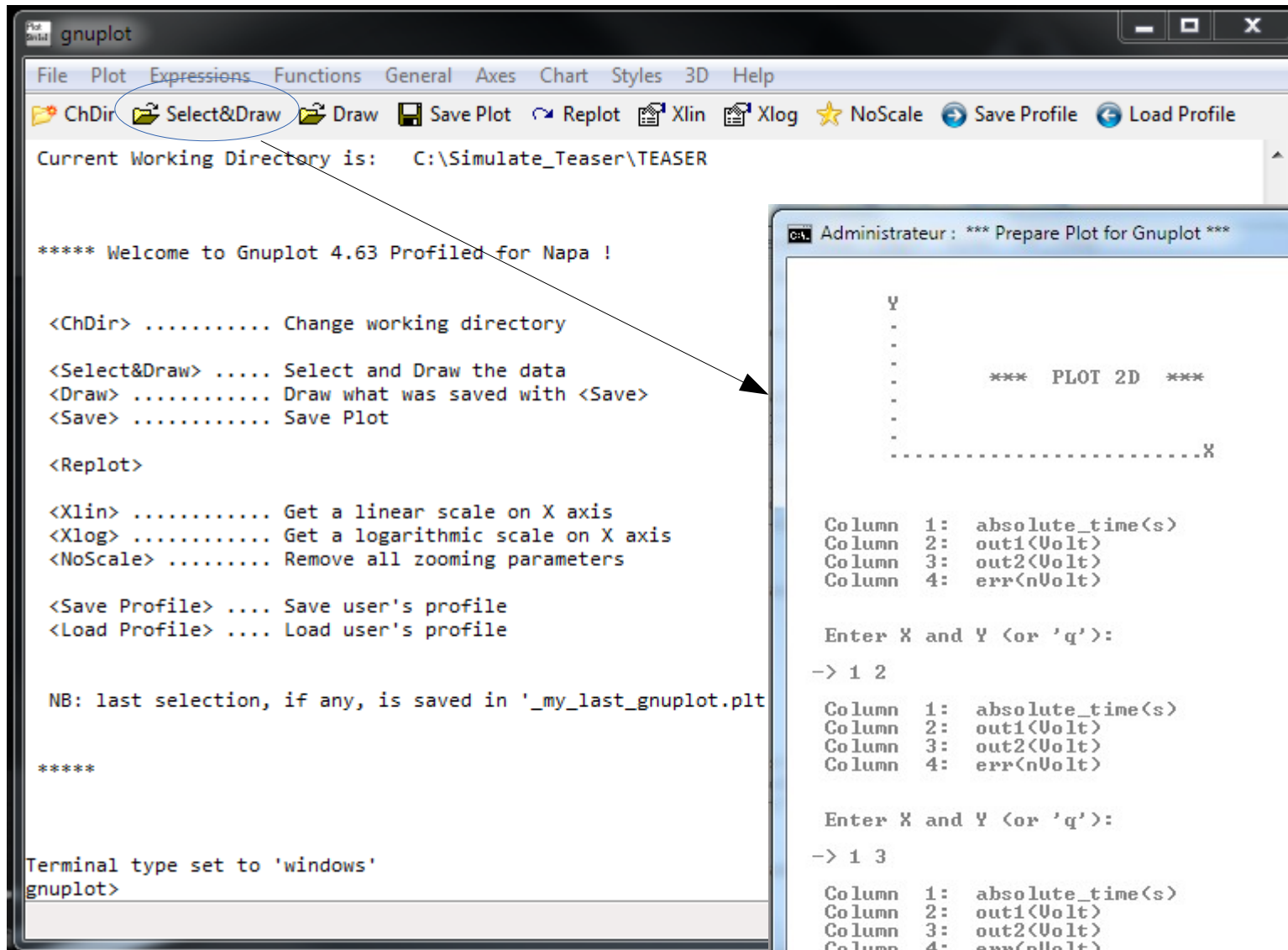
Output redirected from "stdout"

```
C:\Simulate_Examples\teaser7.out - Notepad++

File Edit Search View Encoding Language Settings Tools Macro Run Plugins Window ?

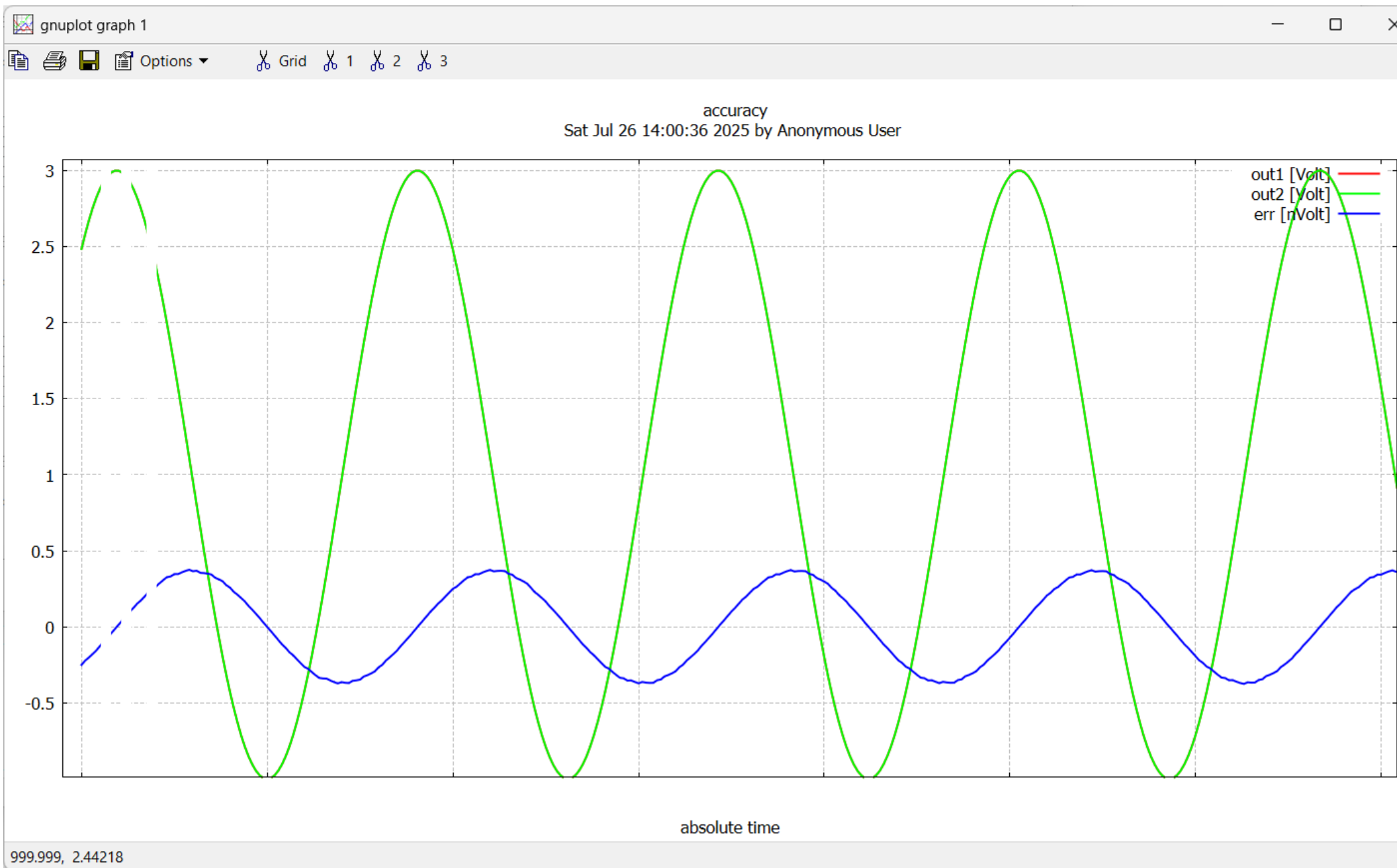
teaser3.nap teaser1.nap teaser5.nap teaser7.c flow.c teaser7.nap

1 # accuracy
2 # (time domain output ) Sampled at 1.00000 MHz
3 # (transpiler version ) NAPA V4.50 for Win64
4 # (source file ) "teaser7.tmp"
5 # (random seed ) 876760345
6 # (number of columns ) 4
7 #
8 #
9 #
10 #
11 #
12 #
13 #
14 # Sat Jul 26 11:04:51 2025 by Anonymous User
15 # absolute_time out1(Volt) out2 err(nVolt)
16 9.999990000000000e+02 2.328660325091e+00 2.328660325360e+00 -2.697051471046e-01
17 9.999990010000000e+02 2.440506718200e+00 2.440506718444e+00 -2.434550339103e-01
18 9.999990020000000e+02 2.543689734568e+00 2.543689734794e+00 -2.260969189649e-01
19 9.999990030000000e+02 2.637588819403e+00 2.637588819610e+00 -2.068221149898e-01
20 9.999990040000000e+02 2.721639252572e+00 2.721639252758e+00 -1.857110021319e-01
21 9.999990050000000e+02 2.795335544888e+00 2.795335545045e+00 -1.564495200057e-01
22 9.999990060000000e+02 2.858234478187e+00 2.858234478320e+00 -1.330051624393e-01
23 9.999990070000000e+02 2.909957770889e+00 2.909957770997e+00 -1.080890932315e-01
24 9.999990080000000e+02 2.950194353032e+00 2.950194353111e+00 -7.860601058951e-02
25 9.999990090000000e+02 2.978702237081e+00 2.978702237133e+00 -5.226352683962e-02
26 9.999990100000000e+02 2.995309973269e+00 2.995309973293e+00 -2.389644038203e-02
27 9.999990110000000e+02 3.011821756875e+00 3.011821756975e+00 -2.016288887551e-02
28 9.999990120000000e+02 3.028233539481e+00 3.028233539631e+00 -1.643033836823e-02
29 9.999990130000000e+02 3.044645322087e+00 3.044645322237e+00 -1.269778786095e-02
30 9.999990140000000e+02 3.061057104693e+00 3.061057104843e+00 -8.96523281827e-03
31 9.999990150000000e+02 3.077468887300e+00 3.077468887450e+00 -5.23268776750e-03
32 9.999990160000000e+02 3.093880669906e+00 3.093880670056e+00 -1.50013271672e-02
33 9.999990170000000e+02 3.110292452512e+00 3.110292452662e+00 -7.26763271672e-03
34 9.999990180000000e+02 3.126704235118e+00 3.126704235268e+00 -3.53508771672e-03
35 9.999990190000000e+02 3.143116017724e+00 3.143116017874e+00 -1.80254271672e-03
36 9.999990200000000e+02 3.159527799900e+00 3.159527800050e+00 -5.76999771672e-04
37 9.999990210000000e+02 3.175939582480e+00 3.175939582630e+00 -2.03745271672e-04
38 9.999990220000000e+02 3.192351365080e+00 3.192351365230e+00 -7.00495271672e-05
39 9.999990230000000e+02 3.208763147680e+00 3.208763147830e+00 -3.27240771672e-05
40 9.999990240000000e+02 3.225174930280e+00 3.225174930430e+00 -1.53986271672e-05
41 9.999990250000000e+02 3.241586712880e+00 3.241586713030e+00 -8.16612271672e-06
42 9.999990260000000e+02 3.258000000000e+00 3.258000000000e+00 -4.4335771672e-06
43 9.999990270000000e+02 3.274411782600e+00 3.274411782750e+00 -2.70103271672e-06
44 9.999990280000000e+02 3.290823565200e+00 3.290823565350e+00 -1.96848771672e-06
45 9.999990290000000e+02 3.307235347800e+00 3.307235347950e+00 -1.23594271672e-06
46 9.999990300000000e+02 3.323647130400e+00 3.323647130550e+00 -5.02689771672e-07
47 9.999990310000000e+02 3.340058913000e+00 3.340058913150e+00 -2.29435271672e-07
48 9.999990320000000e+02 3.356470695600e+00 3.356470695750e+00 -1.56180771672e-07
49 9.999990330000000e+02 3.372882478200e+00 3.372882478350e+00 -8.2866271672e-08
50 9.999990340000000e+02 3.389294260800e+00 3.389294260950e+00 -5.05408271672e-08
51 9.999990350000000e+02 3.405706043400e+00 3.405706043550e+00 -2.32153771672e-08
52 9.999990360000000e+02 3.422117826000e+00 3.422117826150e+00 -1.58899271672e-08
53 9.999990370000000e+02 3.438529608600e+00 3.438529608750e+00 -8.6644771672e-09
54 9.999990380000000e+02 3.454941391200e+00 3.454941391350e+00 -5.43193271672e-09
55 9.999990390000000e+02 3.471353173800e+00 3.471353173950e+00 -2.69938771672e-09
56 9.999990400000000e+02 3.487764956400e+00 3.487764956550e+00 -1.96684271672e-09
57 9.999990410000000e+02 3.504176739000e+00 3.504176739150e+00 -1.23429771672e-09
58 9.999990420000000e+02 3.520588521600e+00 3.520588521750e+00 -5.01183271672e-10
59 9.999990430000000e+02 3.537000304200e+00 3.537000304350e+00 -2.27928771672e-10
60 9.999990440000000e+02 3.553412086800e+00 3.553412086950e+00 -1.54674271672e-10
61 9.999990450000000e+02 3.569823869400e+00 3.569823869550e+00 -8.2421771672e-11
62 9.999990460000000e+02 3.586235652000e+00 3.586235652150e+00 -5.00963271672e-11
63 9.999990470000000e+02 3.602647434600e+00 3.602647434750e+00 -2.77708771672e-11
64 9.999990480000000e+02 3.619059217200e+00 3.619059217350e+00 -1.54454271672e-11
65 9.999990490000000e+02 3.635470999800e+00 3.635470999950e+00 -8.21998271672e-12
66 9.999990500000000e+02 3.651882782400e+00 3.651882782550e+00 -5.00000000000e-12
67 9.999990510000000e+02 3.668294565000e+00 3.668294565150e+00 -2.77245500000e-12
68 9.999990520000000e+02 3.684706347600e+00 3.684706347750e+00 -1.54491000000e-12
69 9.999990530000000e+02 3.701118130200e+00 3.701118130350e+00 -8.22455500000e-13
70 9.999990540000000e+02 3.717529912800e+00 3.717529912950e+00 -5.00000000000e-13
71 9.999990550000000e+02 3.733941695400e+00 3.733941695550e+00 -2.77245500000e-13
72 9.999990560000000e+02 3.750353478000e+00 3.750353478150e+00 -1.54491000000e-13
73 9.999990570000000e+02 3.766765260600e+00 3.766765260750e+00 -8.22455500000e-14
74 9.999990580000000e+02 3.783177043200e+00 3.783177043350e+00 -5.00000000000e-14
75 9.999990590000000e+02 3.799588825800e+00 3.799588825950e+00 -2.77245500000e-14
76 9.999990600000000e+02 3.816000608400e+00 3.816000608550e+00 -1.54491000000e-14
77 9.999990610000000e+02 3.832412391000e+00 3.832412391150e+00 -8.22455500000e-15
78 9.999990620000000e+02 3.848824173600e+00 3.848824173750e+00 -5.00000000000e-15
79 9.999990630000000e+02 3.865235956200e+00 3.865235956350e+00 -2.77245500000e-15
80 9.999990640000000e+02 3.881647738800e+00 3.881647738950e+00 -1.54491000000e-15
81 9.999990650000000e+02 3.898059521400e+00 3.898059521550e+00 -8.22455500000e-16
82 9.999990660000000e+02 3.914471304000e+00 3.914471304150e+00 -5.00000000000e-16
83 9.999990670000000e+02 3.930883086600e+00 3.930883086750e+00 -2.77245500000e-16
84 9.999990680000000e+02 3.947294869200e+00 3.947294869350e+00 -1.54491000000e-16
85 9.999990690000000e+02 3.963706651800e+00 3.963706651950e+00 -8.22455500000e-17
86 9.999990700000000e+02 3.980118434400e+00 3.980118434550e+00 -5.00000000000e-17
87 9.999990710000000e+02 3.996530217000e+00 3.996530217150e+00 -2.77245500000e-17
88 9.999990720000000e+02 4.012942000000e+00 4.012942000150e+00 -1.54491000000e-17
89 9.999990730000000e+02 4.029353782600e+00 4.029353782750e+00 -8.22455500000e-18
90 9.999990740000000e+02 4.045765565200e+00 4.045765565350e+00 -5.00000000000e-18
91 9.999990750000000e+02 4.062177347800e+00 4.062177347950e+00 -2.77245500000e-18
92 9.999990760000000e+02 4.078589130400e+00 4.078589130550e+00 -1.54491000000e-18
93 9.999990770000000e+02 4.095000913000e+00 4.095000913150e+00 -8.22455500000e-19
94 9.999990780000000e+02 4.111412695600e+00 4.111412695750e+00 -5.00000000000e-19
95 9.999990790000000e+02 4.127824478200e+00 4.127824478350e+00 -2.77245500000e-19
96 9.999990800000000e+02 4.144236260800e+00 4.144236260950e+00 -1.54491000000e-19
97 9.999990810000000e+02 4.160648043400e+00 4.160648043550e+00 -8.22455500000e-20
98 9.999990820000000e+02 4.177059826000e+00 4.177059826150e+00 -5.00000000000e-20
99 9.999990830000000e+02 4.193471608600e+00 4.193471608750e+00 -2.77245500000e-20
100 9.999990840000000e+02 4.209883391200e+00 4.209883391350e+00 -1.54491000000e-20
101 9.999990850000000e+02 4.226295173800e+00 4.226295173950e+00 -8.22455500000e-21
102 9.999990860000000e+02 4.242706956400e+00 4.242706956550e+00 -5.00000000000e-21
103 9.999990870000000e+02 4.259118739000e+00 4.259118739150e+00 -2.77245500000e-21
104 9.999990880000000e+02 4.275530521600e+00 4.275530521750e+00 -1.54491000000e-21
105 9.999990890000000e+02 4.291942304200e+00 4.291942304350e+00 -8.22455500000e-22
106 9.999990900000000e+02 4.308354086800e+00 4.308354086950e+00 -5.00000000000e-22
107 9.999990910000000e+02 4.324765869400e+00 4.324765869550e+00 -2.77245500000e-22
108 9.999990920000000e+02 4.341177652000e+00 4.341177652150e+00 -1.54491000000e-22
109 9.999990930000000e+02 4.357589434600e+00 4.357589434750e+00 -8.22455500000e-23
110 9.999990940000000e+02 4.374001217200e+00 4.374001217350e+00 -5.00000000000e-23
111 9.999990950000000e+02 4.390413000000e+00 4.390413000150e+00 -2.77245500000e-23
112 9.999990960000000e+02 4.406824782600e+00 4.406824782750e+00 -1.54491000000e-23
113 9.999990970000000e+02 4.423236565200e+00 4.423236565350e+00 -8.22455500000e-24
114 9.999990980000000e+02 4.439648347800e+00 4.439648347950e+00 -5.00000000000e-24
115 9.999990990000000e+02 4.456060130400e+00 4.456060130550e+00 -2.77245500000e-24
116 9.999991000000000e+02 4.472471913000e+00 4.472471913150e+00 -1.54491000000e-24
117 9.999991010000000e+02 4.488883695600e+00 4.488883695750e+00 -8.22455500000e-25
118 9.999991020000000e+02 4.505295478200e+00 4.505295478350e+00 -5.00000000000e-25
119 9.999991030000000e+02 4.521707260800e+00 4.521707260950e+00 -2.77245500000e-25
120 9.999991040000000e+02 4.538119043400e+00 4.538119043550e+00 -1.54491000000e-25
121 9.999991050000000e+02 4.554530826000e+00 4.554530826150e+00 -8.22455500000e-26
122 9.999991060000000e+02 4.570942608600e+00 4.570942608750e+00 -5.00000000000e-26
123 9.999991070000000e+02 4.587354391200e+00 4.587354391350e+00 -2.77245500000e-26
124 9.999991080000000e+02 4.603766173800e+00 4.603766173950e+00 -1.54491000000e-26
125 9.999991090000000e+02 4.620177956400e+00 4.620177956550e+00 -8.22455500000e-27
126 9.999991100000000e+02 4.636589739000e+00 4.636589739150e+00 -5.00000000000e-27
127 9.999991110000000e+02 4.653001521600e+00 4.653001521750e+00 -2.77245500000e-27
128 9.999991120000000e+02 4.669413304200e+00 4.669413304350e+00 -1.54491000000e-27
129 9.999991130000000e+02 4.685825086800e+00 4.685825086950e+00 -8.22455500000e-28
130 9.999991140000000e+02 4.702236869400e+00 4.702236869550e+00 -5.00000000000e-28
131 9.999991150000000e+02 4.718648652000e+00 4.718648652150e+00 -2.77245500000e-28
132 9.999991160000000e+02 4.735060434600e+00 4.735060434750e+00 -1.54491000000e-28
133 9.999991170000000e+02 4.751472217200e+00 4.751472217350e+00 -8.22455500000e-29
134 9.999991180000000e+02 4.767884000000e+00 4.767884000150e+00 -5.00000000000e-29
135 9.999991190000000e+02 4.784295782600e+00 4.784295782750e+00 -2.77245500000e-29
136 9.999991200000000e+02 4.800707565200e+00 4.800707565350e+00 -1.54491000000e-29
137 9.999991210000000e+02 4.817119347800e+00 4.817119347950e+00 -8.22455500000e-30
138 9.999991220000000e+02 4.833531130400e+00 4.833531130550e+00 -5.00000000000e-30
139 9.999991230000000e+02 4.849942913000e+00 4.849942913150e+00 -2.77245500000e-30
140 9.999991240000000e+02 4.866354695600e+00 4.866354695750e+00 -1.54491000000e-30
141 9.999991250000000e+02 4.882766478200e+00 4.882766478350e+00 -8.22455500000e-31
142 9.999991260000000e+02 4.899178260800e+00 4.899178260950e+00 -5.00000000000e-31
143 9.999991270000000e+02 4.915590043400e+00 4.915590043550e+00 -2.77245500000e-31
144 9.999991280000000e+02 4.932001826000e+00 4.932001826150e+00 -1.54491000000e-31
145 9.999991290000000e+02 4.948413608600e+00 4.948413608750e+00 -8.22455500000e-32
146 9.999991300000000e+02 4.964825391200e+00 4.964825391350e+00 -5.00000000000e-32
147 9.999991310000000e+02 4.981237173800e+00 4.981237173950e+00 -2.77245500000e-32
148 9.999991320000000e+02 4.997648956400e+00 4.997648956550e+00 -1.54491000000e-32
149 9.999991330000000e+02 5.014060739000e+00 5.014060739150e+00 -8.22455500000e-33
150 9.999991340000000e+02 5.030472521600e+00 5.030472521750e+00 -5.00000000000e-33
151 9.999991350000000e+02 5.046884304200e+00 5.046884304350e+00 -2.77245500000e-33
152 9.999991360000000e+02 5.063296086800e+00 5.063296086950e+00 -1.54491000000e-33
153 9.999991370000000e+02 5.079707869400e+00 5.079707869550e+00 -8.22455500000e-34
154 9.999991380000000e+02 5.096119652000e+00 5.096119652150e+00 -5.00000000000e-34
155 9.999991390000000e+02 5.112531434600e+00 5.112531434750e+00 -2.77245500000e-34
156 9.999991400000000e+02 5.128943217200e+00 5.128943217350e+00 -1.54491000000e-34
157 9.999991410000000e+02 5.145355000000e+00 5.145355000150e+00 -8.22455500000e-35
158 9.999991420000000e+02 5.161766782600e+00 5.161766782750e+00 -5.00000000000e-35
159 9.999991430000000e+02 5.178178565200e+00 5
```



*Tips : to start Gnuplot,
press 'Alt G' from any file
related to simulation*

Time Domain Output, 2D Plot



**Absolute error between 'sine' and 'osc' less than
0.3 nano Volt after 1 billion simulation steps**



We are now ready to use
the NAPA smart tools !



```
C:\Simulate_Examples\teaser8.nap - Notepad++
File Edit Search View Encoding Language Settings Tools Macro Run Plugins Window ?
teaser1.nap teaser5.nap teaser7.nap teaser7.out teaser8.nap
1
2 title "#n FFT"
3 header <napatool.hdr>
4
5 fs 1.0e6
6
7 dvar freq 12345.6
8 dvar ph rand_uniform( 0.0, _2pi_ )
9
10 node out osc 1.0 2.0 freq ph
11
12 ivar n 4
13 ivar npts1 POWEROF2(20)
14 ivar npts2 100000000
15
16 dvar bw 100.0e6
17
18 tool fft "ffts.out" out 1.0 bw npts1
19 tool synchro npts2
20
21 directive WINDOW BLACKMAN_HARRIS_7
22
23 terminate n <= TOOL_INDEX
24
25 ping
26
U: length: 456 lines: 26 Ln: 1 Col: 1 Pos: 1
```

2 tools automatically synchronised

Tips : 'tool' is a contraction of a regular node syntax: 'node void itool' and is therefore processed as a node

Tips : 'directive' introduces a macro definition in the C code allowing the preprocessor to configure/extend the simulator. Here a FFT windowing function is selected to replace the default.

Analysis : 4 FFT of 2^{20} samples, made every 10^8 samples, processed in 14 seconds

How the Smart Tool Synchronization Is Working ?



Tool is a user defined function with a synchronization mechanism automatically hooked to the simulator.

A simple **state machine** is implemented in tools with 3 main states: 'start', 'run', 'wait',

Tasks are numbered. Tools are asked by the simulator to perform a task. Tools are in waiting state until the simulator is sending a message '**start**'.

All tools start their own task. The output of the tool is the status of its work. The simulator collects these status at the end of each simulation cycle.

The simulation continues until all tools have completed the specified task. A tool having accomplished its task stops and is in '**wait**' state.

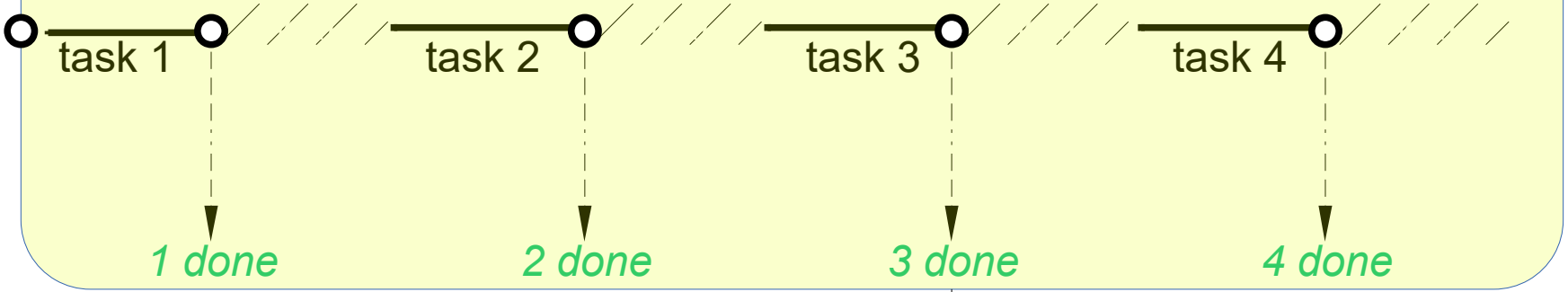
When all tools have accomplished their task, the simulator sends a message to all of them to start the next task.

Variable '**napa_tool_index**' handled by the simulator counts the number of tasks already completed and is often used to control the end of the simulation.

(Note : Macro '**TOOL_INDEX**' is the image of '**napa_tool_index**')

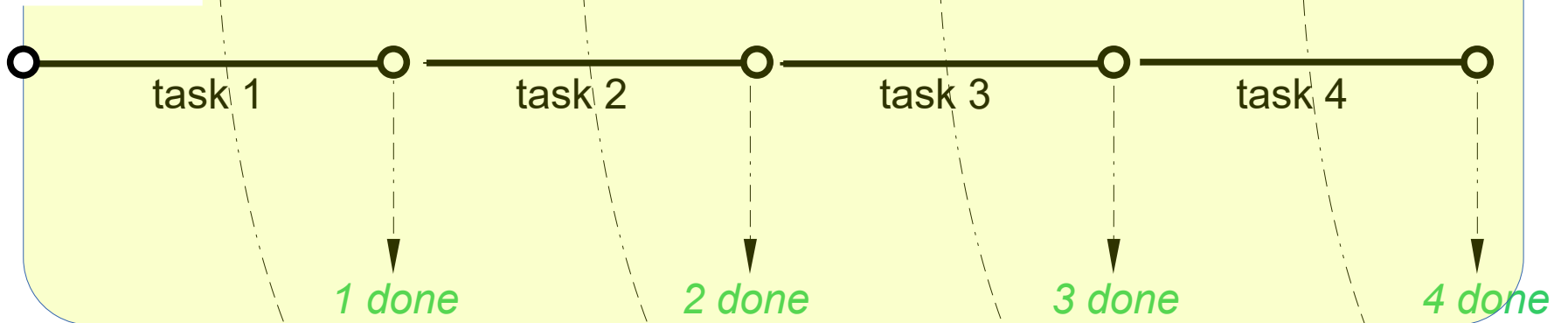
FFT 2^{18} points

tool 1



Count until 10^8

tool 2



do task 1 !

do task 2 !

do task 3 !

do task 4 !

0

1

2

3

4

'napa_tool_index'

0 >= 4 ? NO

1 >= 4 ? NO

2 >= 4 ? NO

3 >= 4 ? NO

4 >= 4 ? END





file "fft.c"

```
...
do {
  napa_rel_time = napa_rel_loop * 1.0e-6L;
  napa_abs_time = napa_abs_loop * 1.0e-6L;

  h_node_out_osc2 = h_node_out_osc1;
  h_node_out_osc1 = h_node_out_osc0;
  h_node_out_osc0 = (h_node_out_factor * h_node_out_osc1) - h_node_out_osc2;
  d_node_out = 2.0 * ((R_TYPE) h_node_out_osc1);
  d_node_out += 1.0;

  napa_msg = &(napa_mailbox[0]);
  napa_msg->o = napa_packet;
  i_node__void0 = itool_fft_05("ffts.out",d_node_out,1.0,d var bw,i var npts1, 0);

  napa_msg = &(napa_mailbox[1]);
  napa_msg->o = napa_packet;
  i_node__void1 = itool_synchro_01(i_var_npts2, 0);

  if ((napa_mailbox[0].o >= napa_packet) && (napa_mailbox[1].o >= napa_packet)) {
    napa_rel_loop = -1.0L;
    napa_tool_index = napa_packet;
    napa_mailbox[0].i = START;
    napa_mailbox[1].i = START;
    napa_packet++;
  }
  napa_rel_loop++;
  napa_abs_loop++;
} while (!TERMINATE);
...
```

The simulator prefills
the individual mailbox output

The simulator prefills
the individual mailbox output

The simulator tests the content
of the mailboxes output which
contains the answer of the tools
and reacts accordingly

The macro '**TERMINATE**' checks '**napa_tool_index**'



```
NAPA Compile and Run: Sour  X + v
NAPA Ping Information :      function 'itool_fft()'      from file "C:/Simulate/NapaDos/Hdr/Tool/fft1.hdr"
NAPA Ping Information :      function 'itool_synchro()'   from file "C:/Simulate/NapaDos/Hdr/Tool/synchro.hdr"
NAPA Ping Information :      function 'rand_uniform()'    from file "C:/Simulate/NapaDos/Hdr/Function/random.hdr"

****
****  4 FFT
****

NAPA Tools Information:      (          fft[0]) Process # 000      <-    1 048 575
NAPA Tools Information:      (      synchro[0]) Process # 000      <-   99 999 999
NAPA Tools Information:      (          fft[0]) Process # 001      <-  101 048 575
NAPA Tools Information:      (      synchro[0]) Process # 001      <-  199 999 999
NAPA Tools Information:      (          fft[0]) Process # 002      <-  201 048 575
NAPA Tools Information:      (      synchro[0]) Process # 002      <-  299 999 999
NAPA Tools Information:      (          fft[0]) Process # 003      <-  301 048 575
NAPA Tools Information:      (      synchro[0]) Process # 003      <-  399 999 999

****
****  Working Directory:      "C:\Simulate_Examples"
****

****  Random Seed [I]   :          876766489  ****
****  Output Tag  [O]   :          60086995  ****

****  NAPA Transpiler   :          V4.50 for Win64  ****

****  Main Netlist      :          teaser8.tmp  ****

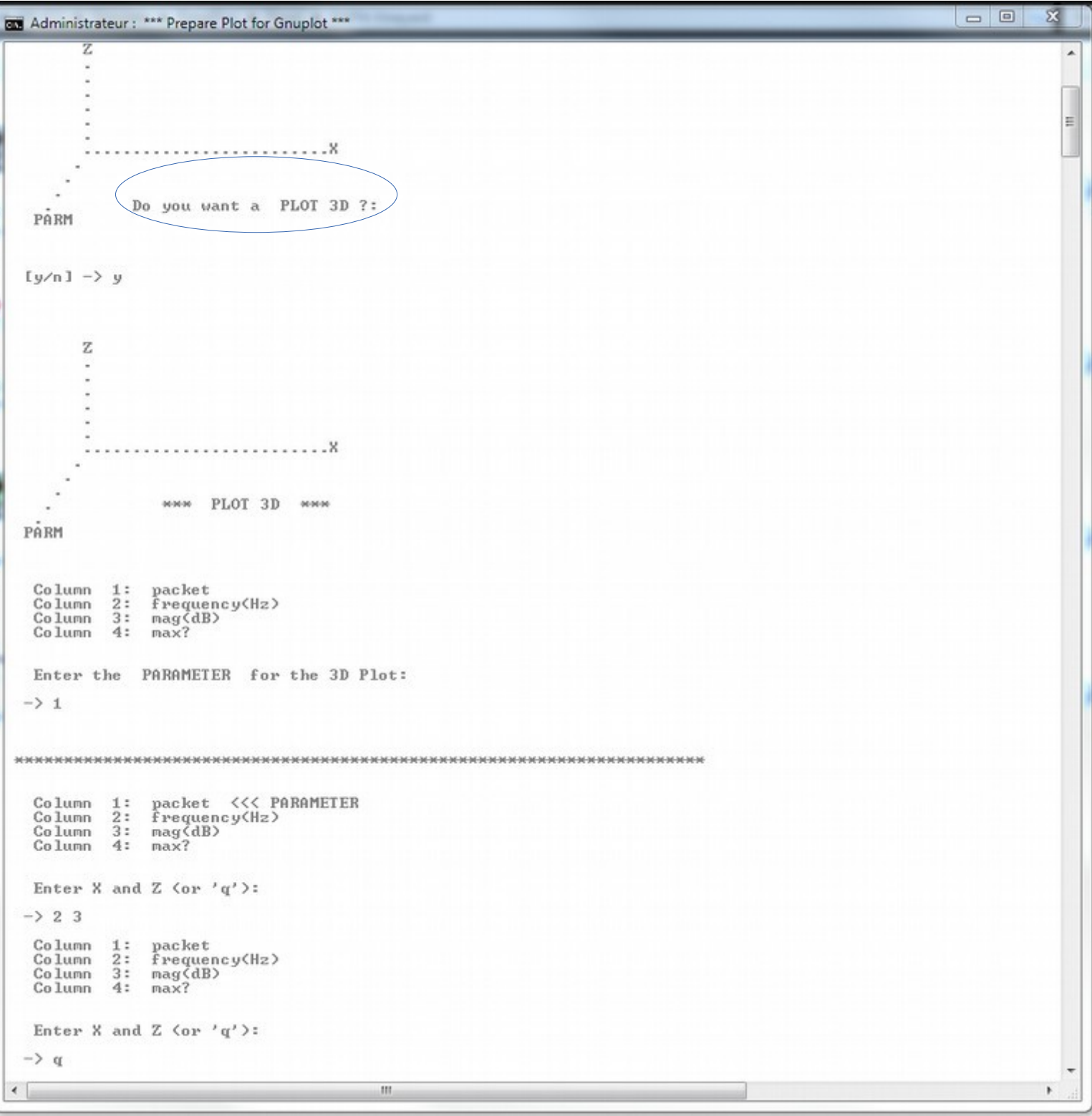
****  Simulator Time    :          400.000  s  ****
****  Simulator Index   :          400 000 000  ****
****  Tool Index        :          4  ****

****  Run Time I/O      :          ****
      ->  ffts.out          [ 0] ****

****  Stopwatch         :          H00:M00:S13.722  ****

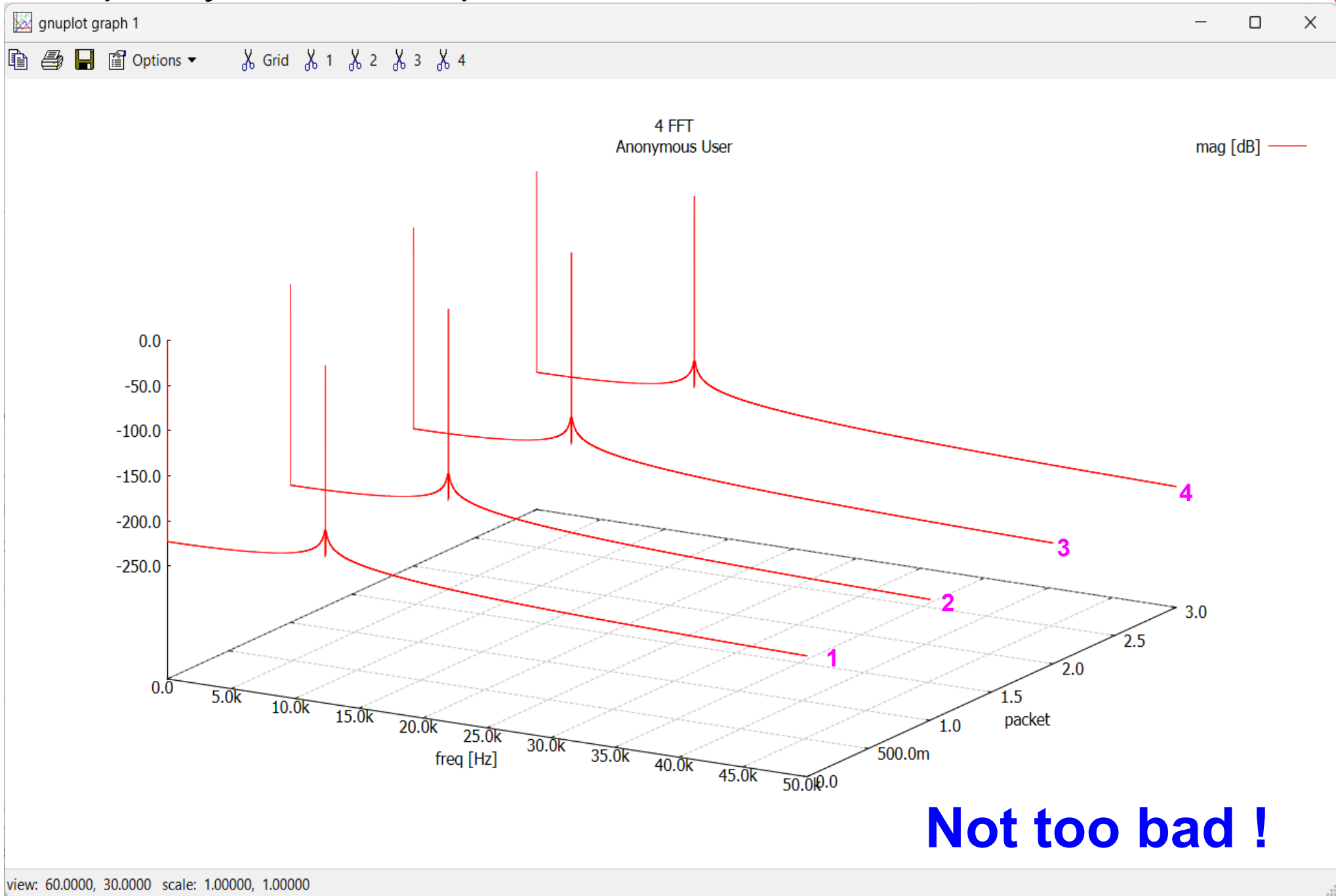
****  Normal Termination          ****

[teaser8]
Press Enter to continue . . . |
```



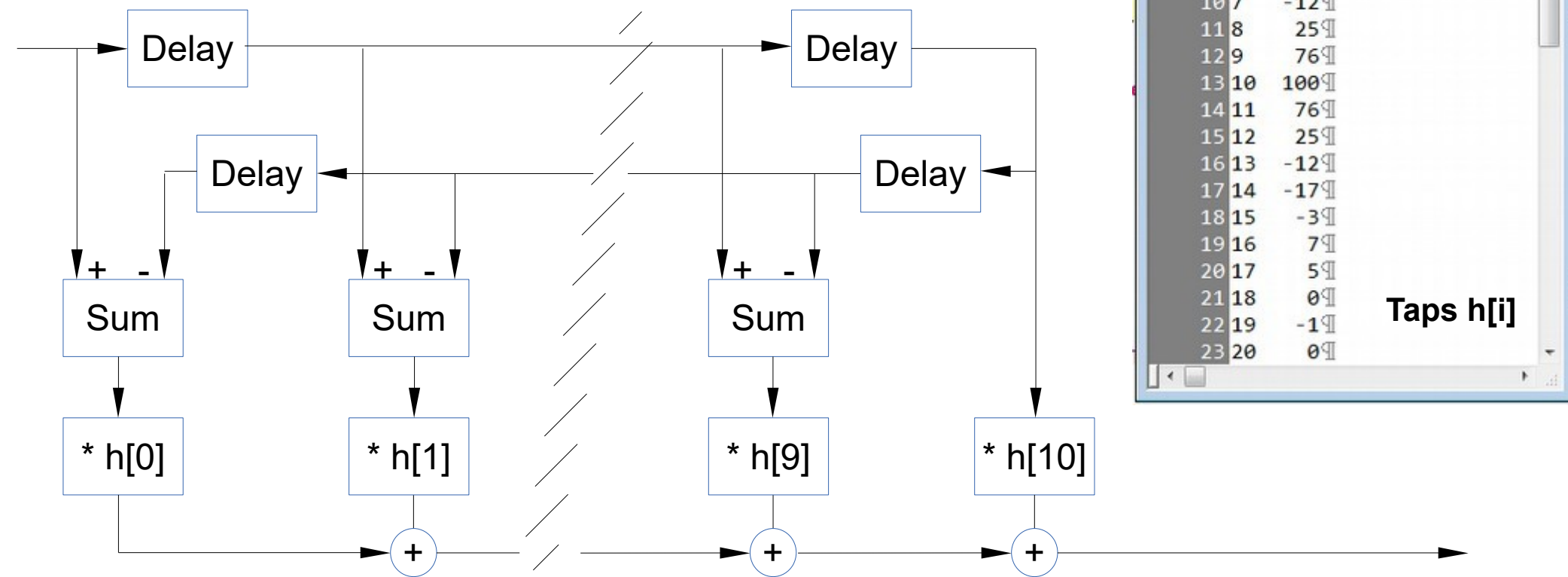
3D Plot

Frequency Domain Output, 3D Plot



Not too bad !

Now a Realistic Example

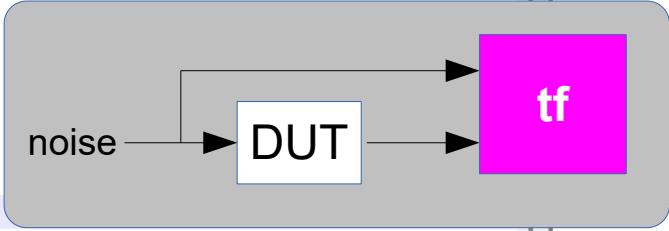


Digital Folded FIR



```
C:\Simulate_Examples\teaser10.nap - Notepad++
File Edit Search View Encoding Language Settings Tools Macro Run Plugins Window ?
teaser10.nap
1
2 title "Transfer function of a symmetrical FIR"
3
4 header <napatool.hdr>
5
6 fs 1.0e6
7
8 directive REPEAT 100
9
10 ivar npts POWEROF2(16)
11
12 node in cell rclk <Noise/rclock.net> 0.5
13 node out generator sfll <fir> "~/fir5.tap" in
14
15 tool tf "tf.out" in 1.0 out 1.0 npts
16
17 terminate 1.0 <= TOOL_INDEX
18
19 ping
20

length: 361 lines: 20 Ln: 10 Col: 26 Pos: 157 Win
```



Digital FIR
Cell generator

Transfer function

RMS of FFTs

On the fly cell generation
using a file containing the taps

```
NAPA Compile and Run: Sour x + v
[teaser10] **** GCC Compiler Running ****
[teaser10] **** Ad Hoc Simulator Running ****

NAPA Ping Information : function 'itool_tf()' from file "C:/Simulate/NapaDos/Hdr/Tool/fft3.hdr"
NAPA Ping Information : function 'rand_bernoulli()' from file "C:/Simulate/NapaDos/Hdr/Function/random.hdr"

****
**** Transfer function of a symmetrical FIR
****

NAPA Tools Information: ( tf[0]] Process # 000.009 <- 262 143
NAPA Tools Information: ( tf[0]] Process # 000.008 <- 524 287
NAPA Tools Information: ( tf[0]] Process # 000.007 <- 786 431
NAPA Tools Information: ( tf[0]] Process # 000.006 <- 1 048 575
NAPA Tools Information: ( tf[0]] Process # 000.005 <- 1 310 719
NAPA Tools Information: ( tf[0]] Process # 000.004 <- 1 572 863
NAPA Tools Information: ( tf[0]] Process # 000.003 <- 1 835 007
NAPA Tools Information: ( tf[0]] Process # 000.002 <- 2 097 151
NAPA Tools Information: ( tf[0]] Process # 000.001 <- 2 359 295
NAPA Tools Information: ( tf[0]] Process # 000 <- 2 621 439

****
**** Working Directory: "C:\Simulate_Examples"
****

**** Random Seed [I] : 876779979 ****
**** Output Tag [O] : 327310774 ****

**** NAPA Transpiler : V4.50 for Win64 ****

**** Main Netlist : teaser10.tmp ****

**** Simulator Time : 2.62144 s ****
**** Simulator Index : 2 621 440 ****
**** Tool Index : 1 ****

**** Run Time I/O : ****

-> tf.out [ 0] ****

**** Stopwatch H00:M00:S01.030 ****

**** Normal Termination ****
```

1.0 second

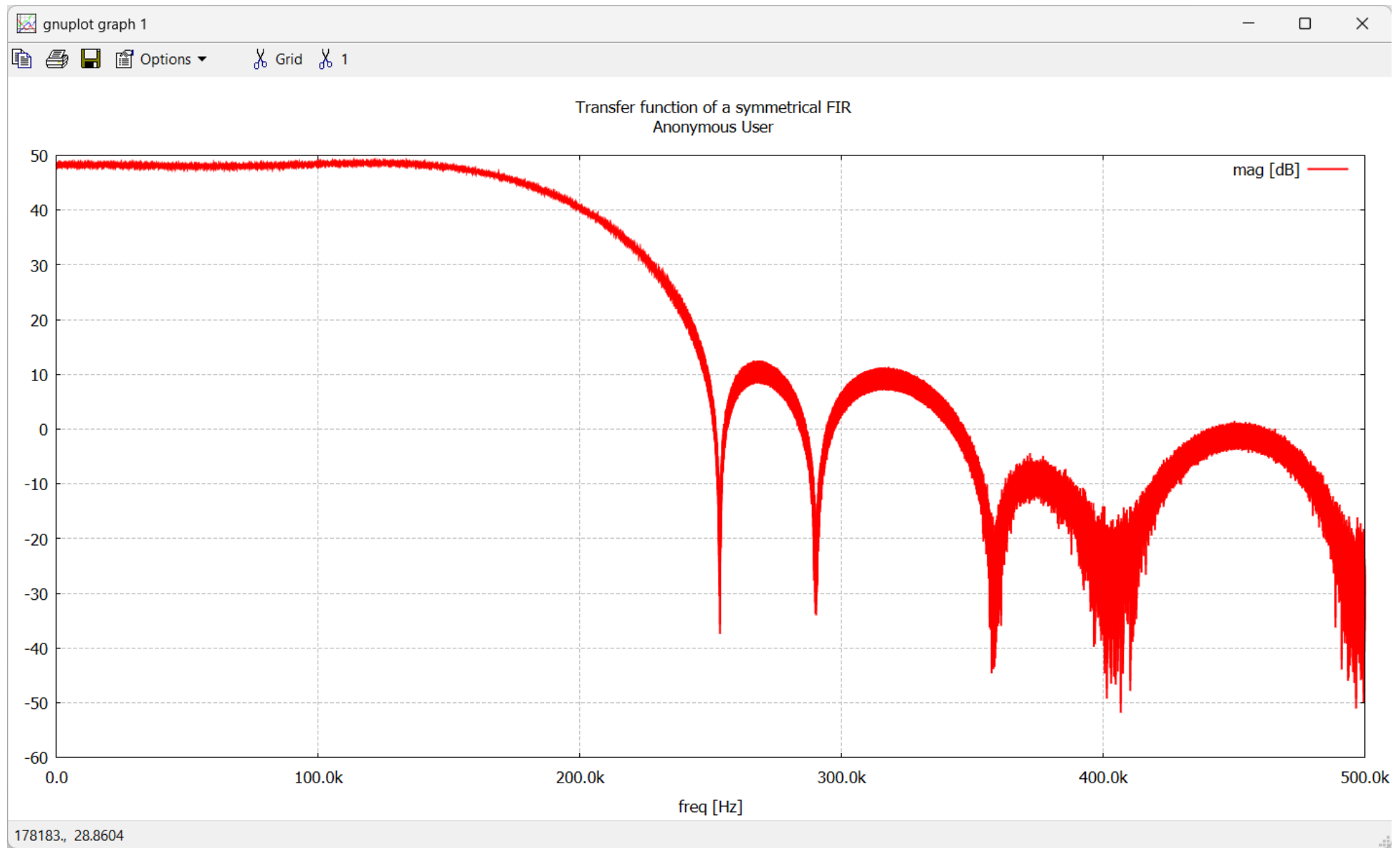


Cell produced on the fly by generator 'fir'

```

1  cell_interface $y $dummy $x
2
3  # Symmetrical Filter
4  # Taps File Name: './fir5.tap'
5  # Creation Time : Sat Jul 26 21:59:19 2025
6  # By Command : C:\Simulate\NapaDos\Gen\fir
7  # Generator Version 3.17
8  # From C source : 'C:\Simulate\NapaDos\Gen\Source\fir.c'
9
10 # FOLDED FIR
11 #
12 #          |          |          |          |          |
13 # x -+----- Delay >-----+ .. +----- Delay >-----+
14 #          |          |          |          |          |
15 #          |          |          |          |          |
16 #          |          |          |          |          |
17 #          |          |          |          |          |
18 #          |          |          |          |          |
19 #          |          |          |          |          |
20 #          |          |          |          |          |
21 #          |          |          |          |          |
22 #          |          |          |          |          |
23 #          |          |          |          |          |
24 #          |          |          |          |          |
25 #          |          |          |          |          |
26 #          |          |          |          |          |
27 #          |          |          |          |          |
28 #          |          |          |          |          |
29 #          |          |          |          |          |
30 #          |          |          |          |          |
31 #          |          |          |          |          |
32 #          |          |          |          |          |
33 #          |          |          |          |          |
34 #          |          |          |          |          |
35 #          |          |          |          |          |
36 #          |          |          |          |          |
37 #          |          |          |          |          |
38 #          |          |          |          |          |
39 #          |          |          |          |          |
40 #          |          |          |          |          |
41 #          |          |          |          |          |
42 #          |          |          |          |          |
43 #          |          |          |          |          |
44 #          |          |          |          |          |
45 #          |          |          |          |          |
46 #          |          |          |          |          |
47 #          |          |          |          |          |
48 #          |          |          |          |          |
49 #          |          |          |          |          |
50 #          |          |          |          |          |
51 #          |          |          |          |          |
52 #          |          |          |          |          |
53 #          |          |          |          |          |
54 #          |          |          |          |          |
55 #          |          |          |          |          |
56 #          |          |          |          |          |
57 #          |          |          |          |          |
58 #          |          |          |          |          |
59 #          |          |          |          |          |
60 #          |          |          |          |          |
61 #          |          |          |          |          |
62 #          |          |          |          |          |
63 #          |          |          |          |          |
64 #          |          |          |          |          |
65 #          |          |          |          |          |
66 #          |          |          |          |          |
67 #          |          |          |          |          |
68 #          |          |          |          |          |
69 #          |          |          |          |          |
70 #          |          |          |          |          |
71 #          |          |          |          |          |
72 #          |          |          |          |          |
73 #          |          |          |          |          |
74 #          |          |          |          |          |
75 #          |          |          |          |          |
76 #          |          |          |          |          |
77 #          |          |          |          |          |
78 #          |          |          |          |          |
79 #          |          |          |          |          |
80 #          |          |          |          |          |
81 #          |          |          |          |          |
82 #          |          |          |          |          |
83 #          |          |          |          |          |
84 #          |          |          |          |          |
85 #          |          |          |          |          |
86 #          |          |          |          |          |
87 #          |          |          |          |          |
88 #          |          |          |          |          |
89 #          |          |          |          |          |
90 #          |          |          |          |          |
91 #          |          |          |          |          |
92 #          |          |          |          |          |
93 #          |          |          |          |          |
94 #          |          |          |          |          |
95 #          |          |          |          |          |
96 #          |          |          |          |          |
97 #          |          |          |          |          |
98 #          |          |          |          |          |
99 #          |          |          |          |          |
100 #          |          |          |          |          |
101 #          |          |          |          |          |
102 #          |          |          |          |          |
103 #          |          |          |          |          |
104 #          |          |          |          |          |
105 #          |          |          |          |          |
106 #          |          |          |          |          |
107 #          |          |          |          |          |
108 #          |          |          |          |          |
109 #          |          |          |          |          |
110 #          |          |          |          |          |
111 #          |          |          |          |          |
112 #          |          |          |          |          |
113 #          |          |          |          |          |
114 #          |          |          |          |          |
115 #          |          |          |          |          |
116 #          |          |          |          |          |
117 #          |          |          |          |          |
118 #          |          |          |          |          |
119 #          |          |          |          |          |
120 #          |          |          |          |          |
121 #          |          |          |          |          |
122 #          |          |          |          |          |
123 #          |          |          |          |          |
124 #          |          |          |          |          |
125 #          |          |          |          |          |
126 #          |          |          |          |          |
127 #          |          |          |          |          |
128 #          |          |          |          |          |
129 #          |          |          |          |          |
130 #          |          |          |          |          |
131 #          |          |          |          |          |
132 #          |          |          |          |          |
133 #          |          |          |          |          |
134 #          |          |          |          |          |
135 #          |          |          |          |          |
136 #          |          |          |          |          |
137 #          |          |          |          |          |
138 #          |          |          |          |          |
139 #          |          |          |          |          |
140 #          |          |          |          |          |
141 #          |          |          |          |          |
142 #          |          |          |          |          |
143 #          |          |          |          |          |
144 #          |          |          |          |          |
145 #          |          |          |          |          |
146 #          |          |          |          |          |
147 #          |          |          |          |          |
148 #          |          |          |          |          |
149 #          |          |          |          |          |
150 #          |          |          |          |          |
151 #          |          |          |          |          |
152 #          |          |          |          |          |
153 #          |          |          |          |          |
154 #          |          |          |          |          |
155 #          |          |          |          |          |
156 #          |          |          |          |          |
157 #          |          |          |          |          |
158 #          |          |          |          |          |
159 #          |          |          |          |          |
160 #          |          |          |          |          |
161 #          |          |          |          |          |
162 #          |          |          |          |          |
163 #          |          |          |          |          |
164 #          |          |          |          |          |
165 #          |          |          |          |          |
166 #          |          |          |          |          |
167 #          |          |          |          |          |
168 #          |          |          |          |          |
169 #          |          |          |          |          |
170 #          |          |          |          |          |
171 #          |          |          |          |          |
172 #          |          |          |          |          |
173 #          |          |          |          |          |
174 #          |          |          |          |          |
175 #          |          |          |          |          |
176 #          |          |          |          |          |
177 #          |          |          |          |          |
178 #          |          |          |          |          |
179 #          |          |          |          |          |
180 #          |          |          |          |          |
181 #          |          |          |          |          |
182 #          |          |          |          |          |
183 #          |          |          |          |          |
184 #          |          |          |          |          |
185 #          |          |          |          |          |
186 #          |          |          |          |          |
187 #          |          |          |          |          |
188 #          |          |          |          |          |
189 #          |          |          |          |          |
190 #          |          |          |          |          |
191 #          |          |          |          |          |
192 #          |          |          |          |          |
193 #          |          |          |          |          |
194 #          |          |          |          |          |
195 #          |          |          |          |          |
196 #          |          |          |          |          |
197 #          |          |          |          |          |
198 #          |          |          |          |          |
199 #          |          |          |          |          |
200 #          |          |          |          |          |
201 #          |          |          |          |          |
202 #          |          |          |          |          |
203 #          |          |          |          |          |
204 #          |          |          |          |          |
205 #          |          |          |          |          |
206 #          |          |          |          |          |
207 #          |          |          |          |          |
208 #          |          |          |          |          |
209 #          |          |          |          |          |
210 #          |          |          |          |          |
211 #          |          |          |          |          |
212 #          |          |          |          |          |
213 #          |          |          |          |          |
214 #          |          |          |          |          |
215 #          |          |          |          |          |
216 #          |          |          |          |          |
217 #          |          |          |          |          |
218 #          |          |          |          |          |
219 #          |          |          |          |          |
220 #          |          |          |          |          |
221 #          |          |          |          |          |
222 #          |          |          |          |          |
223 #          |          |          |          |          |
224 #          |          |          |          |          |
225 #          |          |          |          |          |
226 #          |          |          |          |          |
227 #          |          |          |          |          |
228 #          |          |          |          |          |
229 #          |          |          |          |          |
230 #          |          |          |          |          |
231 #          |          |          |          |          |
232 #          |          |          |          |          |
233 #          |          |          |          |          |
234 #          |          |          |          |          |
235 #          |          |          |          |          |
236 #          |          |          |          |          |
237 #          |          |          |          |          |
238 #          |          |          |          |          |
239 #          |          |          |          |          |
240 #          |          |          |          |          |
241 #          |          |          |          |          |
242 #          |          |          |          |          |
243 #          |          |          |          |          |
244 #          |          |          |          |          |
245 #          |          |          |          |          |
246 #          |          |          |          |          |
247 #          |          |          |          |          |
248 #          |          |          |          |          |
249 #          |          |          |          |          |
250 #          |          |          |          |          |
251 #          |          |          |          |          |
252 #          |          |          |          |          |
253 #          |          |          |          |          |
254 #          |          |          |          |          |
255 #          |          |          |          |          |
256 #          |          |          |          |          |
257 #          |          |          |          |          |
258 #          |          |          |          |          |
259 #          |          |          |          |          |
260 #          |          |          |          |          |
261 #          |          |          |          |          |
262 #          |          |          |          |          |
263 #          |          |          |          |          |
264 #          |          |          |          |          |
265 #          |          |          |          |          |
266 #          |          |          |          |          |
267 #          |          |          |          |          |
268 #          |          |          |          |          |
269 #          |          |          |          |          |
270 #          |          |          |          |          |
271 #          |          |          |          |          |
272 #          |          |          |          |          |
273 #          |          |          |          |          |
274 #          |          |          |          |          |
275 #          |          |          |          |          |
276 #          |          |          |          |          |
277 #          |          |          |          |          |
278 #          |          |          |          |          |
279 #          |          |          |          |          |
280 #          |          |          |          |          |
281 #          |          |
```

generator 'fir'

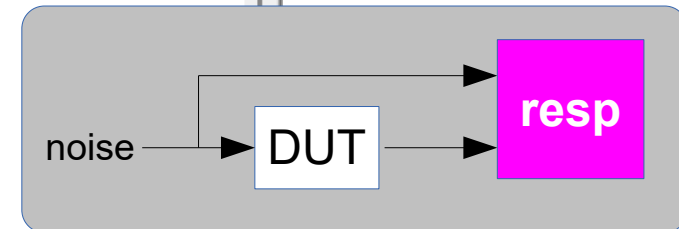


Step and Impulse Response ?



```
C:\Simulate_Examples\teaser11.nap - Notepad++
File Edit Search View Encoding Language Settings Tools Macro Run Plugins Window ? + ▼ X
teaser11.nap
1
2 title "Step and Impulse Response of a symmetrical FIR"
3
4 header <napatool.hdr>
5
6 fs 1.0e6
7
8 directive REPEAT 10
9
10 ivar npts POWEROF2(16)
11
12 node in cell rclk <Noise/rclock.net> 0.5
13 node out generator sfll <fir> "~/fir5.tap" in
14
15 tool resp "rsp.out" in 1.0 out 1.0 npts
16
17 terminate 1.0 <= TOOL_INDEX
18
19 ping
20

length: 369 lines: 20 Ln: 18 Col: 1 Pos: 362 Windows (CR LF) UTF-8 INS
```





```
NAPA Compile and Run: Sour x + v

****
**** Step and Impulse Response of a symmetrical FIR
****

NAPA Tools Information: (      resp[0]) Process # 000.009 <-      65 535
NAPA Tools Information: (      resp[0]) Process # 000.008 <-      131 071
NAPA Tools Information: (      resp[0]) Process # 000.007 <-      196 607
NAPA Tools Information: (      resp[0]) Process # 000.006 <-      262
NAPA Tools Information: (      resp[0]) Process # 000.005 <-      327
NAPA Tools Information: (      resp[0]) Process # 000.004 <-      393
NAPA Tools Information: (      resp[0]) Process # 000.003 <-
NAPA Tools Information: (      resp[0]) Process # 000.002 <-
NAPA Tools Information: (      resp[0]) Process # 000.001 <-
NAPA Tools Information: (      resp[0]) Process # 000 <-

****
**** Working Directory:      "C:\Simulate_Examples"
****

**** Random Seed [I] :      876808659 ****
**** Output Tag [0] :      743084396 ****

**** NAPA Transpiler :      V4.50 for Win64 ****

**** Main Netlist :      teaser11.tmp ****

**** Simulator Time :      655.359 ms ****
**** Simulator Index :      655360 ****
**** Tool Index :      1 ****

**** Run Time I/O :      ****
->  rsp.out      [ 0] ****

**** Stopwatch :      H00:M00:S00.300 ****

**** Normal Termination      ****

[teaser11]
Press Enter to continue . . .
```

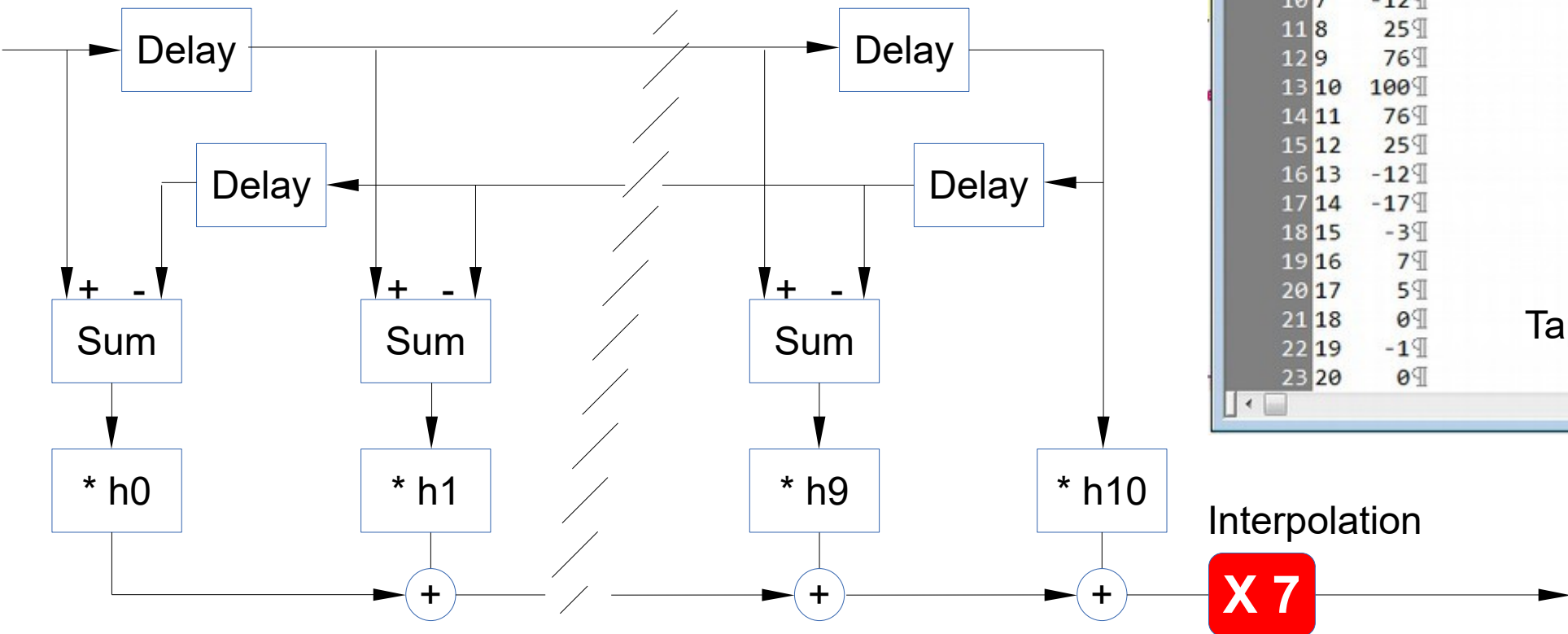
0.3 second



Transfer Function with Interpolation ?



*Just curious, **what if** we do not introduce the zeroes for the interpolation ?*



C:\Simulate_User\Papier\fir5.tap

1	## Digital Filter
2	##
3	0 0
4	1 -1
5	2 0
6	3 5
7	4 7
8	5 -3
9	6 -17
10	7 -12
11	8 25
12	9 76
13	10 100
14	11 76
15	12 25
16	13 -12
17	14 -17
18	15 -3
19	16 7
20	17 5
21	18 0
22	19 -1
23	20 0

Taps

Interpolation

X 7

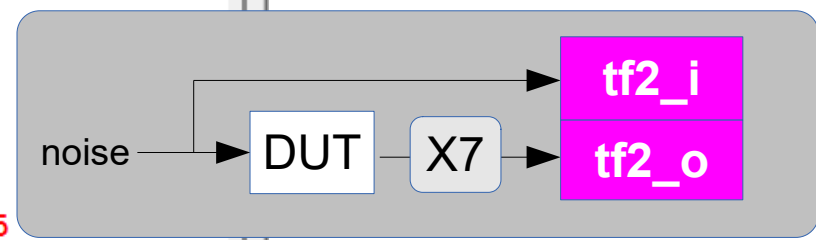
Digital Folded FIR



```
C:\Simulate_Examples\teaser12.nap - Notepad++
File Edit Search View Encoding Language Settings Tools Macro Run Plugins Window ?
teaser12.nap
1
2 title "Multirate transfer function of a symmetrical FIR"
3
4 header <napatool.hdr>
5
6 fs 1.0e6
7
8 directive REPEAT 10
9
10 ivar npts POWEROF2(16)
11 node in cell rclk <Noise/rclock.net> 0.5
12 node out generator sfll <fir> "~/fir5.tap" in
13
14 interpolate 7
15
16 tool tf2_i "tf2.out" in 1.0 npts with in
17 tool tf2_o "tf2.out" out 1.0 npts
18
19 terminate 1.0 <= TOOL_INDEX
20
21 ping
22 debug SAMPLING

length: 459 lines: 22 Ln: 16 Col: 10 Pos: 315 Windows (CR LF) UTF-8 INS
```

Multirate simulation Multirate transfer function



10 RMS of FFT's

Instructions following 'interpolate 7' are computed at 7X frequency defined by 'fs'

Tips : '... with in' relocates the definition of this tool just after the definition of node in', therefore is computed af frequency 'fs'

— @ 1 MHz
— @ 7 MHz



```
NAPA Transpiler Information: (generator)
Generating cell file <./sf11_0.gen>,
through system call: 'C:\Simulate\NapaDos\Gen\fir ./sf11_0.gen ./fir5.tap in'
```

Automatic Cell Generation

```
[teaser12] **** GCC Compiler      Running ****
[teaser12] **** Ad Hoc Simulator Running ****
```

```
NAPA Ping Information :      function 'itool_tf2_i()'      from file "C:/Simulate/NapaDos/Hdr/Tool/fft6.hdr"
NAPA Ping Information :      function 'itool_tf2_o()'      from file "C:/Simulate/NapaDos/Hdr/Tool/fft6.hdr"
NAPA Ping Information :      function 'rand_bernoulli()'    from file "C:/Simulate/NapaDos/Hdr/Function/random.hdr"
```

```
****
**** Multirate transfer function of a symmetrical FIR
****
```

Automatic management of the sampling

```
NAPA Debug Information:      (      sampling)
Fs[ 0] ->      1.00000 MHz
Fs[ 1] ->      7.00000 MHz
```

```
NAPA Tools Information:      (      tf2[0,0]) Process # 000.009      <-      65 535
NAPA Tools Information:      (      tf2[0,0]) Process # 000.008      <-      131 071
NAPA Tools Information:      (      tf2[0,0]) Process # 000.007      <-      196 607
NAPA Tools Information:      (      tf2[0,0]) Process # 000.006      <-      262 143
NAPA Tools Information:      (      tf2[0,0]) Process # 000.005      <-      327 679
NAPA Tools Information:      (      tf2[0,0]) Process # 000.004      <-      393 215
NAPA Tools Information:      (      tf2[0,0]) Process # 000.003      <-      458 751
NAPA Tools Information:      (      tf2[0,0]) Process # 000.002      <-      524 287
NAPA Tools Information:      (      tf2[0,0]) Process # 000.001      <-      589 823
NAPA Tools Information:      (      tf2[0,0]) Process # 000          <-      655 359
```

2x10 RMS of FFT's and 1 IFFT

```
****
**** Working Directory:      "C:\Simulate_Examples"
****

**** Random Seed [I] :      876850753 ****
**** Output Tag [0] :      901017450 ****

**** NAPA Transpiler :      V4.50 for Win64 ****

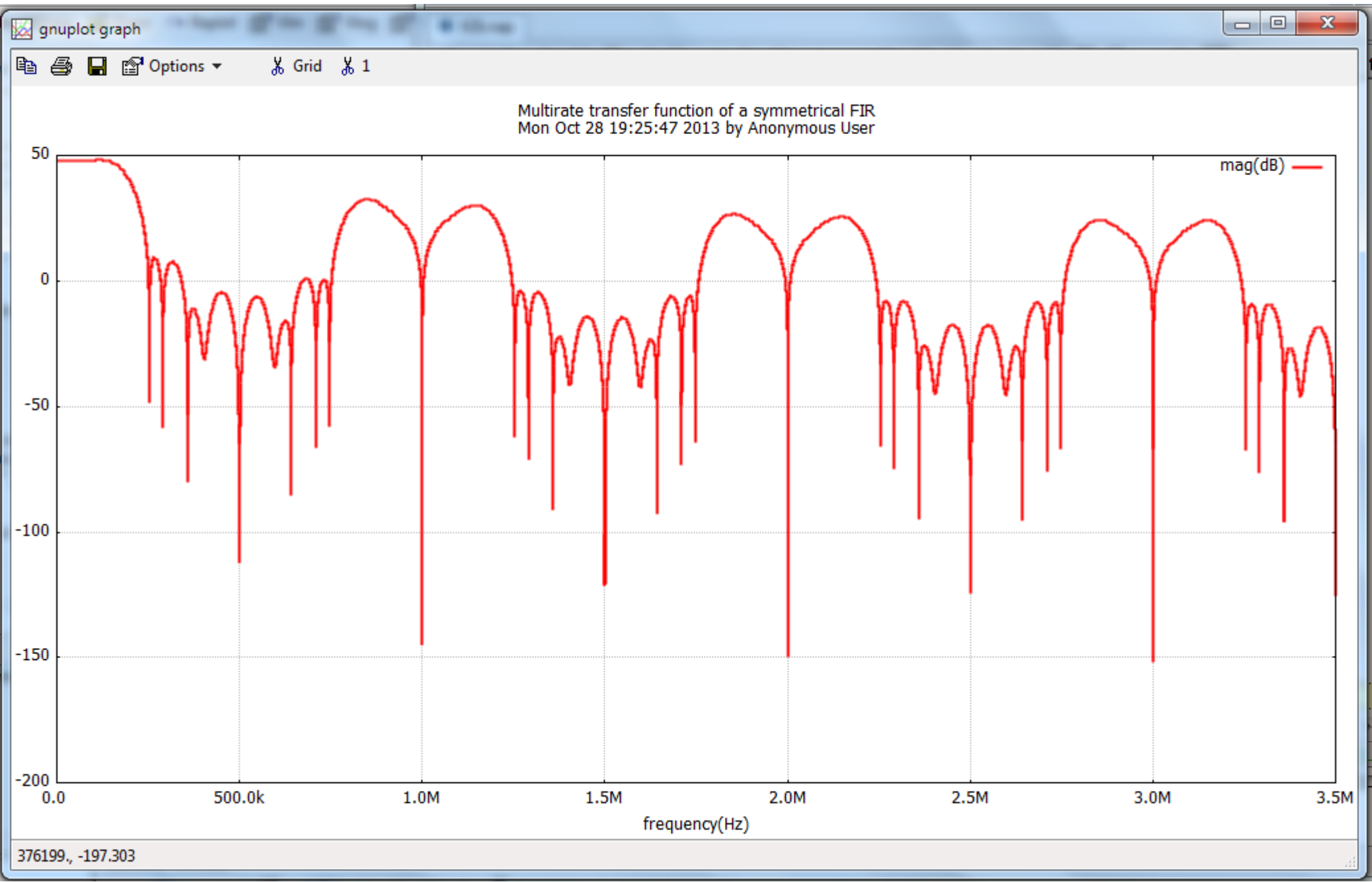
**** Main Netlist :      teaser12.tmp ****

**** Simulator Time :      655.360 ms ****
**** Simulator Index :      655 360 ****
**** Simulator Loops :      4 587 520 ****
**** Tool Index :      1 ****
```

4.6 millions loops in less than 0.7 second



Multirate transfer function





There are much more capabilities than it is described here.

*Just an example :
a continuous
time filter*

Ganging parameters to transmit by record

Time domain inverse Laplace transform

Crimson Editor - [C:\Simulate\NapaDos\Net\FILTER\mfb2.net]

File Edit Search View Document Project Tools Macros Window Help

tf2b.nap mfb2.net

1 cell interface \$out \$in \$r1 \$c2 \$r3 \$r4 \$c5

2

3 *** 2ND ORDER MULTIPLE FEEDBACK CONTINUOUS TIME FILTER

4 *** (also known as "RAUCH Filter")

5 ***

6 ***

7 ***

8 ***

9 ***

10 ***

11 ***

12 ***

13 *** in C2/2

14 ***

15 ***

16 ***

17 ***

18 ***

19 ***

20 ***

21 dvar \$n2 0.0

22 dvar \$n1 0.0

23 dvar \$n0 1.0

24 dvar \$d2 (\$r1)*(\$c2) * (\$r3)*(\$c5)

25 dvar \$d1 (\$r3)*(\$c5) + (\$r1)*(\$c5) + (\$r1)*(\$r3)*(\$c5)/(\$r4)

26 dvar \$d0 (\$r1)/(\$r4)

27 ganging \$Coef[6] \$n0..2 \$d0..2

28

29 node \$out duser ilt \$Coef \$in

Ready

Ln 30, Ch 1

30

ASCII, DOS

READ

REC

COL



```
Crimson Editor - [C:\Simulate_User\Papier\ct_filter.nap]
File Edit Search View Document Project Tools Macros Window Help
ct_filter.nap
1
2 title "Transfer function of a Continuous Time filter"
3
4 header <napatool.hdr>
5
6 fs      1.0e6
7
8 directive REPEAT      10
9
10 ivar npts  POWEROF2(16)
11
12 node in  noise 0.0 1.0
13 node out cell rf <Filter/mfb2.net> in 1.0e6 10.0e6
14
15 tool tf "transfer_function_ct.out" in 1.0 out 1.0
16
17 terminate TOOL_INDEX >= 1
18
19 ping
```

```
Administrateur : NAPA Compile and Run: Source File *** ct_filter.nap ***

[ct_filter] **** MAC Preprocessor Running ****
[ct_filter] **** NAPA Simulator Running ****
[ct_filter] **** GCC Compiler Running ****
[ct_filter] **** User's Simulator Running ****

NAPA Ping Information : 'duser_ilt(>)' from file "/Simulate/NapaDos/Hdr/User/ilt.hdr"
NAPA Ping Information : 'itool_tf(>)' from file "/Simulate/NapaDos/Hdr/Tool/fft3.hdr"

**** Transfer function of a Continuous Time filter

NAPA Tools Information: (      tf[0]) Process # 000.009 <- 65535
NAPA Tools Information: (      tf[0]) Process # 000.008 <- 131071
NAPA Tools Information: (      tf[0]) Process # 000.007 <- 196607
NAPA Tools Information: (      tf[0]) Process # 000.006 <- 262143
NAPA Tools Information: (      tf[0]) Process # 000.005 <- 327679
NAPA Tools Information: (      tf[0]) Process # 000.004 <- 393215
NAPA Tools Information: (      tf[0]) Process # 000.003 <- 458751
NAPA Tools Information: (      tf[0]) Process # 000.002 <- 524287
NAPA Tools Information: (      tf[0]) Process # 000.001 <- 589823
NAPA Tools Information: (      tf[0]) Process # 000      <- 655359

**** Normal Termination ****

**** Random Seed [I] :      691493063 ****
**** Output Tag [O] :      661333592 ****

**** NAPA Transpiler :      U3.01b for Win64 ****
**** Main Netlist :      ct_filter.tmp ****
**** Simulator Index :      655360 ****
**** Simulation Time :      655.359 ms ****

**** Input/Output :      ****
**** -> transfer_function_ct.out [ 0] ****

**** Stopwatch :      H00:M00:S00.326 ****

[ct_filter]

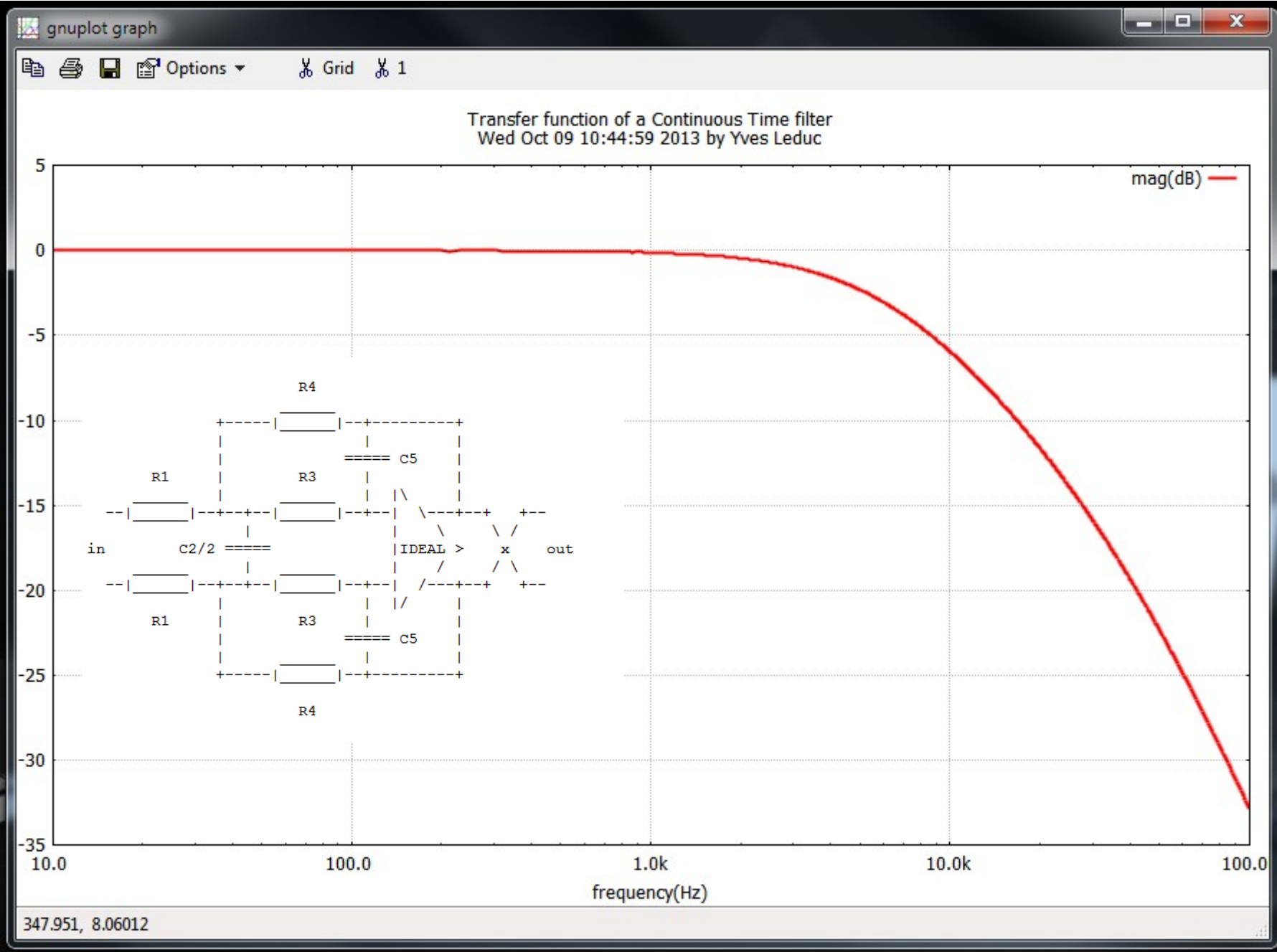
Press Enter to continue . . .
```

0.3 second





Its transfer function





A few Words about NAPA Error Handling



NAPA has an Extensive Set of Errors Verifications.

Undetermined loops are detected.

```
C:\Simulate_User\Papier\geb.nap
1 title "Undetermined loops"
2 header <napatool.hdr>
3
4 fs 1.0
5
6 node a const 1
7 node b sum a c
8 node c gain 2 b
9 node d sum b c
10
11 output stdout a b c d
12
13 terminate LOOP_INDEX >= 1000
```

Run Simulation

Administrateur : NAPA Compile and Run: *** geb.nap ***

```
[geb] **** MAC Preprocessor Running ****
[geb] **** NAPA Transpiler Running ****

NAPA Error: <static loop>

These nodes are involved in one or several static loops:

-> node c
-> node b

Your description is not correct. NAPA is not able to sort
the nodes of your netlist. Check for missing or misspelled
nodes, or loops of nodes containing no delay or only delays

***** NAPA Transpilation Error(s) *****
gmake: *** [geb.c] Error 1

Press Enter to continue . . .
```



Type Mismatches, Syntax Errors are Caught at Transpilation

A syntax error inside a cell is detected and documented here :

```
C:\Simulate_User\Papier\cell.nap
1
2 header <napatool.hdr>
3
4 title "cell"
5
6 fs 1.0e6
7
8 node s cell sr "resonator.net" 1.0 2.0 12345.6 0.0
9
10 terminate LOOP INDEX >= 1000000000
```

Run Simulation

```
C:\Simulate_User\Papier\resonator.net
1 cell interface $out $off $saml $freq $phase
2
3 dvar $k 2.0 * cos(_2pi*($freq / FSL))
4
5 declare (analog) $x0
6
7 node $x0 wsum $k $x1 -1.0 $x2
8 node $x1 delay $x0
9 node $x2 delya $x1
10
11 node $out poly $saml $off $x1
12
13 init $x0 sin($phase)
14 init $x1 sin($phase - (_2pi*($freq / FSL)))
15
```

```
Administrateur : NAPA Compile and Run: *** cell...

[cell] **** MAC Preprocessor Running ****
[cell] **** NAPA Transpiler Running ****

NAPA Error: (node)
-> at line 8 of main netlist
-> at line 9 of file "resonator.net"

unknown node kind <delya>

? <delay>

***** NAPA Transpilation Error(s) *****
gmake: *** [cell.c] Error 1

Press Enter to continue . . .
```

```
Administrateur : NAPA Compile and Run: *** tf2b.nap

**** Multirate transfer function of a symmetrical FIR

NAPA Debug Information: ( sampling)
Fs[ 0] -> 1.00000 MHz
Fs[ 1] -> 7.00000 MHz

NAPA Debug Information: ( tf2_i) DM allocated 16 bytes (+ 16)
NAPA Debug Information: ( tf2_i) DM allocated 48 bytes (+ 32)
NAPA Debug Information: ( tf2_i) DM allocated 88 bytes (+ 40)
NAPA Debug Information: ( tf2_i) DM allocated 104 bytes (+ 16)
NAPA Debug Information: ( tf2_i) DM allocated 128 bytes (+ 24)
NAPA Debug Information: ( tf2_i) DM allocated 138 bytes (+ 10)
NAPA Debug Information: ( tf2_o) DM allocated 154 bytes (+ 16)
NAPA Debug Information: ( tf2_o) DM allocated 186 bytes (+ 32)
NAPA Debug Information: ( tf2_o) DM allocated 226 bytes (+ 40)
NAPA Debug Information: ( tf2_o) DM allocated 242 bytes (+ 16)
NAPA Debug Information: ( tf2_o) DM allocated 266 bytes (+ 24)
NAPA Debug Information: ( tf2_o) DM allocated 277 bytes (+ 11)
NAPA Debug Information: ( tf2_i) DM allocated 3670293 bytes (+ 3670016)
NAPA Debug Information: ( tf2_i) DM allocated 3670293 bytes (+ 0)
NAPA Debug Information: ( tf2_o) DM allocated 7340309 bytes (+ 3670016)
NAPA Debug Information: ( tf2_o) DM allocated 9175325 bytes (+ 1835016)
NAPA Debug Information: ( tf2_o) DM allocated 11010341 bytes (+ 1835016)
NAPA Debug Information: ( tf2_o) DM allocated 12845357 bytes (+ 1835016)
NAPA Debug Information: ( tf2_o) DM allocated 14680373 bytes (+ 1835016)
NAPA Debug Information: ( SC for tf2_o) DM allocated 19267893 bytes (+ 4587520)
NAPA Debug Information: ( tf2_o) DM allocated 19267893 bytes (+ 0)
NAPA Debug Information: ( tf2_o) DM allocated 19267893 bytes (+ 0)
NAPA Debug Information: ( tf2_o) DM allocated 19267893 bytes (+ 0)
NAPA Debug Information: ( tf2_o) DM allocated 19267893 bytes (+ 0)
NAPA Debug Information: ( tf2_o) DM allocated 19267893 bytes (+ 0)
NAPA Debug Information: ( tf2_i) DM allocated 19267893 bytes (+ 0)

NAPA Debug Information: ( tf2_o) DM allocated 19267893 bytes (+ 0)
NAPA Debug Information: ( tf2_o) DM allocated 19267893 bytes (+ 0)
NAPA Debug Information: ( tf2_o) DM allocated 19267893 bytes (+ 0)
NAPA Debug Information: ( tf2_o) DM allocated 19267893 bytes (+ 0)
NAPA Tools Information: ( tf2[0,0]) Process # 000.009 <- 65535
NAPA Debug Information: ( tf2) DM allocated 22937909 bytes (+ 3670016)
NAPA Debug Information: ( tf2) DM allocated 26607925 bytes (+ 3670016)
NAPA Debug Information: ( tf2) DM allocated 30277941 bytes (+ 3670016)
NAPA Debug Information: ( tf2) DM allocated 33947957 bytes (+ 3670016)
NAPA Debug Information: ( fft) DM allocated 37617973 bytes (+ 3670016)
NAPA Debug Information: ( fft) DM allocated 41287989 bytes (+ 3670016)
NAPA Debug Information: ( fft) DM allocated 37617973 bytes (+ 3670016)
NAPA Debug Information: ( fft) DM allocated 33947957 bytes (+ 3670016)
NAPA Debug Information: ( fft) DM allocated 37617973 bytes (+ 3670016)
NAPA Debug Information: ( fft) DM allocated 41287989 bytes (+ 3670016)
NAPA Debug Information: ( fft) DM allocated 37617973 bytes (+ 3670016)
NAPA Debug Information: ( fft) DM allocated 33947957 bytes (+ 3670016)
NAPA Debug Information: ( tf2) DM allocated 30277941 bytes (+ 3670016)
NAPA Debug Information: ( tf2) DM allocated 26607925 bytes (+ 3670016)
NAPA Debug Information: ( tf2) DM allocated 22937909 bytes (+ 3670016)
NAPA Debug Information: ( tf2) DM allocated 19267893 bytes (+ 3670016)
NAPA Tools Information: ( tf2[0,0]) Process # 000.008 <- 131071
NAPA Debug Information: ( tf2) DM allocated 22937909 bytes (+ 3670016)
NAPA Debug Information: ( tf2) DM allocated 26607925 bytes (+ 3670016)
NAPA Debug Information: ( tf2) DM allocated 30277941 bytes (+ 3670016)
NAPA Debug Information: ( tf2) DM allocated 33947957 bytes (+ 3670016)
NAPA Debug Information: ( fft) DM allocated 37617973 bytes (+ 3670016)
NAPA Debug Information: ( fft) DM allocated 41287989 bytes (+ 3670016)
NAPA Debug Information: ( fft) DM allocated 37617973 bytes (+ 3670016)
NAPA Debug Information: ( fft) DM allocated 33947957 bytes (+ 3670016)
NAPA Debug Information: ( fft) DM allocated 37617973 bytes (+ 3670016)
NAPA Debug Information: ( fft) DM allocated 41287989 bytes (+ 3670016)
NAPA Debug Information: ( fft) DM allocated 37617973 bytes (+ 3670016)
NAPA Debug Information: ( fft) DM allocated 33947957 bytes (+ 3670016)
NAPA Debug Information: ( tf2) DM allocated 30277941 bytes (+ 3670016)
NAPA Debug Information: ( tf2) DM allocated 26607925 bytes (+ 3670016)
NAPA Debug Information: ( tf2) DM allocated 22937909 bytes (+ 3670016)
NAPA Debug Information: ( tf2) DM allocated 19267893 bytes (+ 3670016)
```



NAPA has a VERY STRICT control on memory allocation and I/O usage.

Errors are caught on the fly.

Dubious behavior is caught.

Here we are running the simulator with an additional instruction to show the dynamic memory management at work

...
debug DM
...



```

Administrateur : NAPA Compile and Run: *** fft.nap ***

[fft] **** MAC Preprocessor Running ****
[fft] **** NAPA Compiler Running ****
[fft] **** GCC Compiler Running ****
[fft] **** User's Simulator Running ****

**** 4 FFT

NAPA Run Time Warning: (directive)
-> at line 17 of main netlist
Directive <WINDOWING> is not registered

NAPA Run Time Warning: (debug)
-> at line 21 of main netlist
Debugging directive <FFT> has probably no effect

NAPA Tools Information: <      fft[0] Process # 000      <- 262143
NAPA Tools Information: <      fft[0] Process # 001      <- 524287
NAPA Tools Information: <      fft[0] Process # 002      <- 786431
NAPA Tools Information: <      fft[0] Process # 003      <- 1048575

Normal Termination ****

Random Seed [1] : 689830978 ****
Output Tag [0] : 982076502 ****

NAPA Compiler : U3.01 for Win64 ****
in Netlist : fft.tmp ****
Simulator Index : 1048576 ****
Simulation Time : 1.04858 s ****

Input/Output : ****
fft.log [ 0] ****
ffts.out [ 0] ****

...
directive WINDOWING ROSENFELD opwatch : H00:M00:S13.285 ****

...
debug FFT

...
Press Enter to continue . . .

```

NAPA controls also the instructions which appear to be ineffective.

Here the user asks for a 'directive' and a 'debug' instruction which apparently have probably no effect.

...
directive WINDOWING ROSENFELD

...
debug FFT

...



Dedicated Solutions are Implemented for the Modeling and Simulation of :

Analog SWC circuits,

Linear circuits described in Laplace domain,

Linear circuits described with elementary components with occasional percussion,

Limited width digital register arithmetic,

PLL,

etc... etc...



Last but not Least !

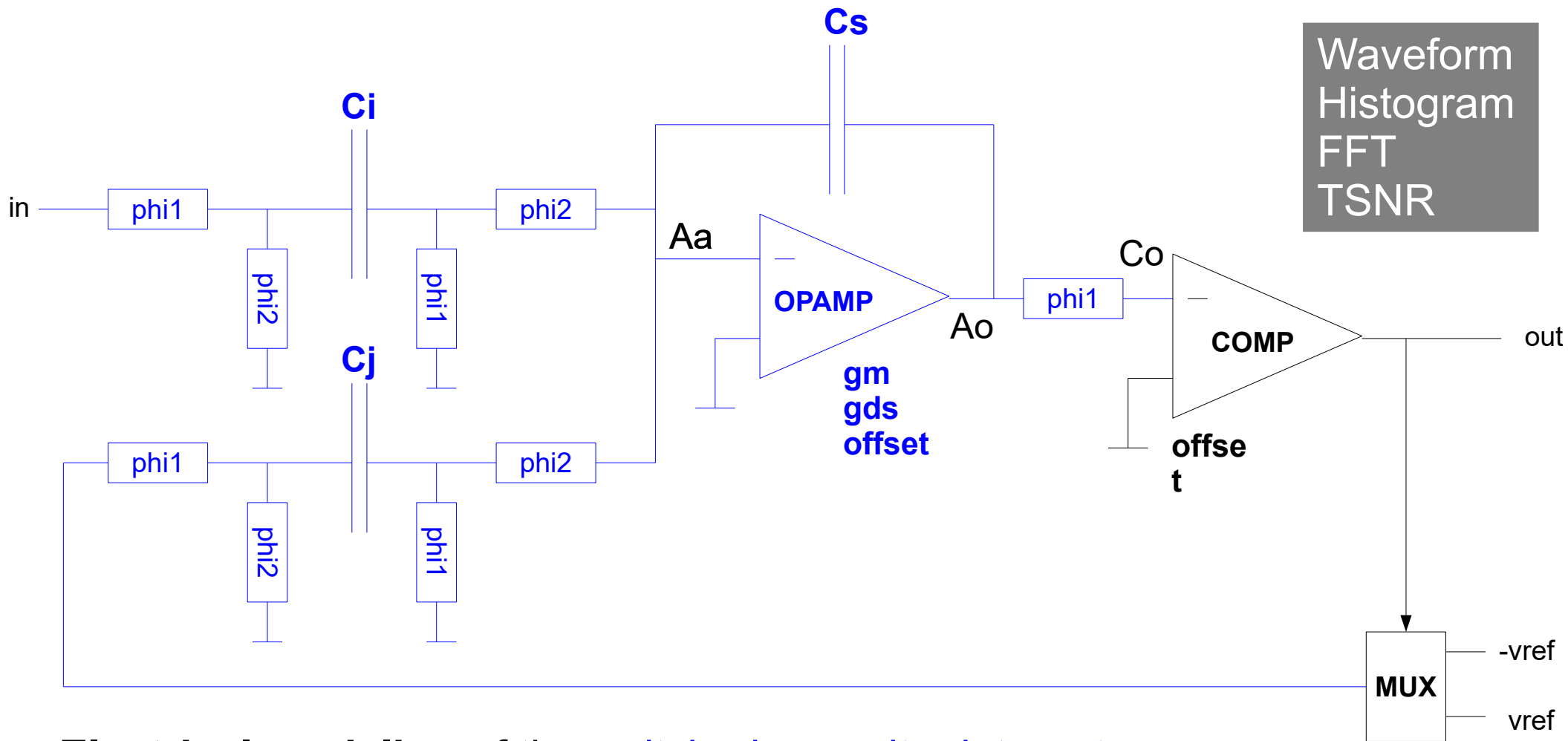
A -very- important NAPA user-defined function 'sarc' uses

'Semi Analytical Recursive Convolution'

to model accurately and simulate linear circuits with on-demand percussion.

In addition to continuous time domain circuits, this function allows the simulation of switched capacitors circuits at the switch level, class D amplifiers, DC-DC converters, etc..

This important solution is developped by Jacques Mequin and desserves a dedicated and detailed presentation.



Electrical modeling of the **switched capacitor integrator**

offset, limited gain, limited bandwidth, parasitic capacitances, switches

Mixed signal modeling of the **modulator** :

integrator, comparator, multiplexer

```

NETLIST ( [V,      Vin,      i,      Gnd      ],      /* the inputs */
          [V,      Vf,       f,      Gnd      ],
          [V,      Avoff,    Ab,      Gnd      ],

          [R,      Ar1ia,    i,      Ai1      ],
          [R,      Ar2ib,    Ai1,     Gnd      ],
          [C,      Aci,      Ai1,     Ai2      ],
          [R,      Ar1ic,    Ai2,     Gnd      ],
          [R,      Ar2id,    Ai2,     Aa       ],
          [R,      Ar1ja,    f,       Aj1      ],
          [R,      Ar2jb,    Aj1,     Gnd      ],
          [C,      Acj,      Aj1,     Aj2      ],
          [R,      Ar1jc,    Aj2,     Gnd      ],
          [R,      Ar2jd,    Aj2,     Aa       ],
          [C,      Aca,      Aa,      Gnd      ],
          [G,      Agm,      Ao,      Gnd,     Aa,     Ab ],
          [R,      Ards,     Ao,      Gnd      ],
          [C,      Aco,      Ao,      Gnd      ],
          [C,      Acs,      Aa,      Ao       ],
          [R,      Cr1,      Ao,      Co       ],
          [C,      Cload,    Co,      Gnd      ] ) ;

OUTPUTS ( V(Aa), V(Ao), V(Co) ) ;      /* the outputs */
AKA( PHI1,  Ar1ia, Ar1ic, Ar1ja, Ar1jc,  Cr1 ) ;
AKA( PHI2,  Ar2ib, Ar2id, Ar2jb, Ar2jd      ) ;

GENERATE_MIMO ( ) ;

```

SD1_core netlist
(MAXIMA)

```
cell_interface    $Voutd    $Vin $Vref    $Clk    $Afile $Cfile
```

```
title " [Analog 1st Order SD Modulator with SARC model] "
```

```
node $PHI1 dalgebra $Clk? $ROff : $ROn // variable resistance
node $PHI2 dalgebra $Clk? $ROn : $ROff // variable resistance
dvar $ROn 1.0e3
dvar $ROff 1.0e9
```

```
dvar $a 1.0 // scaling input
dvar $g 1.0 // scaling reference
dvar $Aci $a*$Acs
dvar $Acj $g*$Acs
dvar $Acs 5.0e-12
dvar $ibias 125.0e-6 // opamp bias current
data $Afile $Agm $Ards $VoffA $Aca $Aco $ibias
```

```
ganging $parms[] $Aca $Aci $Acj $Aco $Acs $Ck $PHI1 $PHI2 $Ards $Agm
node $tag duser sarc SD1_core() $parms $VoffA $fdbck $Vin
node ($Aa) duser sarc $tag (V@Aa)
node ($Ao) duser sarc $tag (V@Ao)
node ($Co) duser sarc $tag (V@Co)
```

```
data $Cfile $VoffC $Ck
node $Cod delay $Co
node $Voutd comp $Cod $VoffC
node $fdbck mux $Voutd $Vref -$Vref
```

SD1 modulator cell netlist

```

data_interface    $gm $rds $off $ca $co $ib

declare    (true)    (100.0e-6 <= $ib) && (150.0e-6 >= $ib)

dvar    $gds    26.0e-9 - 2.4e-15*$ib    - 4.6e-24*$ib*$ib    &update
dvar    $rds    1.0/$gds    &update

dvar    $gm    300.0e-6 - 230.0e-9*SQRT($ib) + 1.2e-12*$ib    &update

dvar    $ca    0.2e-12    &constant
dvar    $co    0.4e-12    &constant

dvar    $off    rand_normal(0.0, 3.0e-3)

```

opamp data cell netlist

```

data_interface    $off $cin

dvar    $cin    0.5e-12    &constant

dvar    $off    rand_normal(0.0, 2.0e-3)

```

comparator data cell netlist

```

header <napatool.hdr>
title  "Analysis in Time Domain"

fs      2.0e6
node    Clk      clock  "01"
string  opfile1   "transconductance_opamp.dat"
string  opfile2   "comparator.dat"

interpolate fs      200                      // compute 200 samples per phase
node    Vin      dc      0.123456789
node    Vrefa    dc      (analog)  1.0
node    Vout     cell    sd1  "../sd1.net"  Vin Vrefa  Clk  opfile1..2

output  "time.out"      Aa Ao  Co  Vin Vout  Clk

nominal      fs

terminate    20 <= LOOP_INDEX

alias  Aa    sd1__Aa
alias  Ao    sd1__Ao
alias  Co    sd1__Co

debug  SAMPLING  SARC_INFO
ping

```

NAPA Simulation
(Waveforms)



```

header <napatool.hdr>
title  "Histogram Analysis in Time Domain"

fs      2.0e6
node    Clk      clock  "01"
string  opfile1  "transconductance_opamp.dat"
string  opfile2  "comparator.dat"

dvar    ampldb   -6.0
dvar    ampl     DB2LIN(ampldb, 1.0)
dvar    freq     1234.56789
dvar    ph       rand_uniform(0.0, _2pi_)

interpolate fs    200

node    Vin      osc    0.0  ampl  freq  ph
node    Vrefa     dc     (analog) 1.0
node    Vout      cell   sd1  "./sd1.net"  Vin Vrefa Clk  opfile1..2
tool    histoval  "histo.out"  Ao Vrefa  -3.0  3.0  100

nominal      fs

terminate    10000  <=  LOOP_INDEX

alias  Ao    sd1__Ao
debug  SAMPLING  SARC_INFO
ping

```

NAPA Simulation
(Histogram)



```

header <napatool.hdr>
title  "FFT Analysis"

fs      2.0e6
node    Clk      clock  "01"
string  opfile1   "transconductance_opamp.dat"
string  opfile2   "comparator.dat"

dvar    ampldb    -6.0
dvar    ampl      DB2LIN(ampldb, Vrefa)
dvar    freq      1234.56789
dvar    ph        rand_uniform(0.0, _2pi_)

interpolate fs      200
node    Vin        osc   0.0  ampl  freq  ph
node    Vrefa      dc    (analog)  1.0
node    Voutd      cell  sd1  "./sd1.net"  Vin Vrefa  Clk  opfile1..2
node    Vrefd      dc    (digital)  1

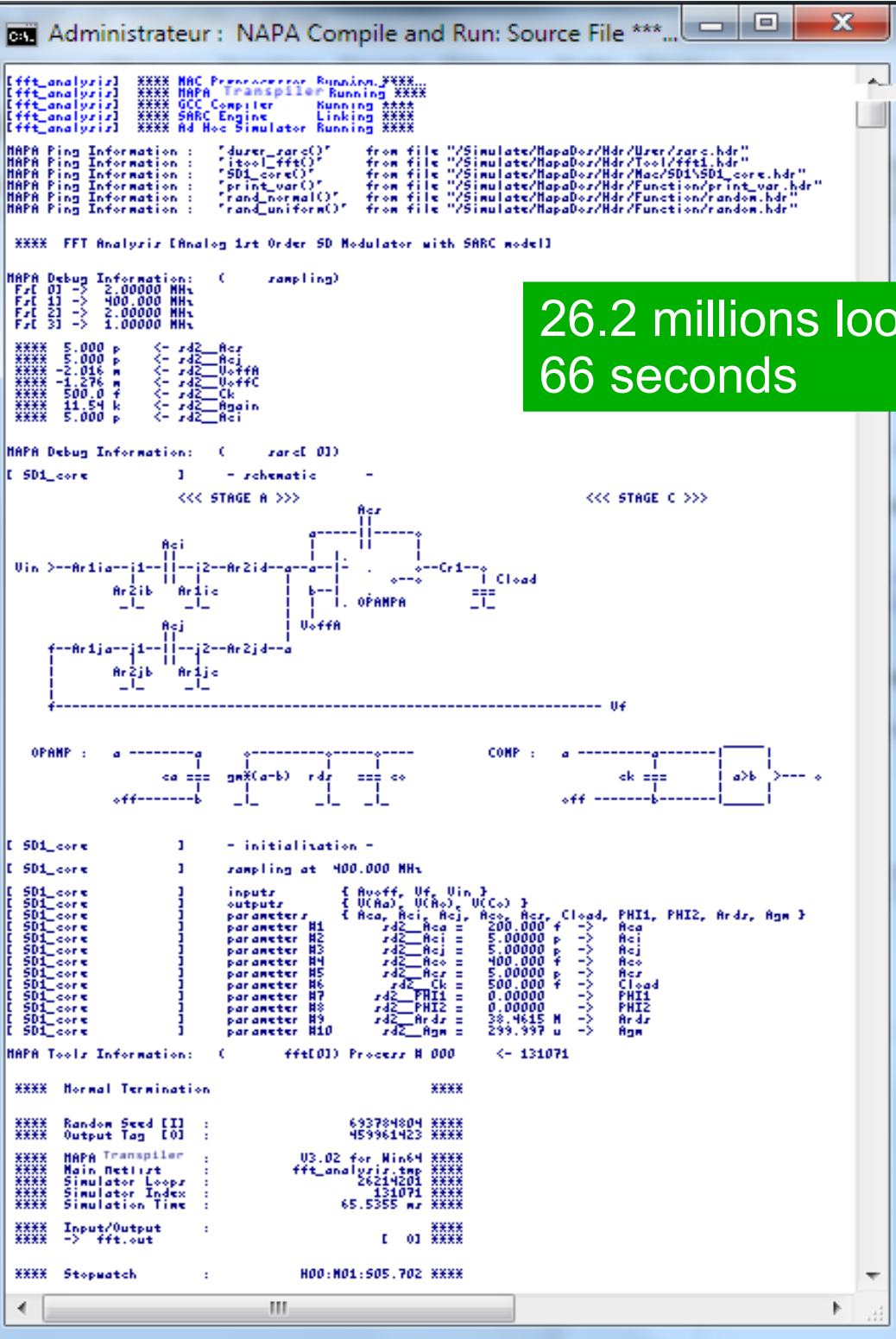
decimate fs      2  1
ivar    npts      POWEROF2(16)
tool    fft       "fft.out"  Voutd Vrefd  npts

terminate 1 <= TOOL_INDEX

debug    SAMPLING  SARC_INFO
ping

```

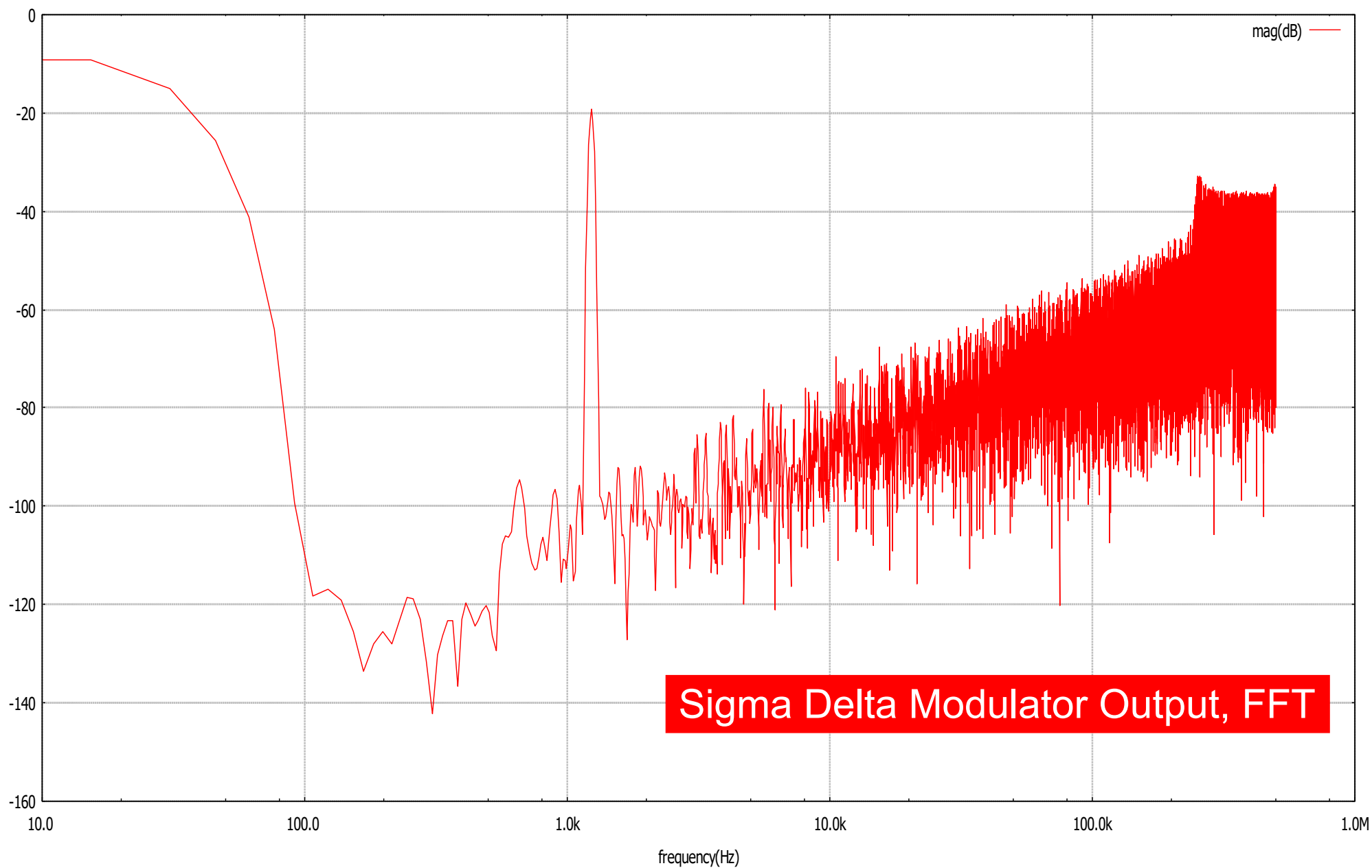
NAPA Simulation (FFT)



26.2 millions loops
66 seconds



FFT Analysis [Analog 1st Order SD Modulator with SARC model]
Yves Leduc



```

header <napatool.hdr>
title "TSNR Analysis"

fs      2.0e6
node    Clk      clock    "01"
string  opfile1   "transconductance_opamp.dat"
string  opfile2   "comparator.dat"

dvar     ampldb   LINSWEEP(TOOL_INDEX, -50.0, 0.0, 26)    &update &export
dvar     ampl     DB2LIN(ampldb, 1.0)                    &update
dvar     freq     1234.56789                             &constant
dvar     ph       rand_uniform(0.0, _2pi_)               &constant

interpolate fs      200
node     Vin       osc      0.0  ampl  freq  ph
node     Vrefa     dc       (analog)  1.0
node     Voutd     cell     sd1  "./sd1.net"    Vin Vrefa  Clk  opfile1..2
node     Vrefd     dc       (digital)  1

decimate fs      2    1
ivar     npts     POWEROF2(16)
tool     tsnr     "tsnr.out"    Voutd Vrefd  8.0e3  npts

terminate 0.0 <= ampldb

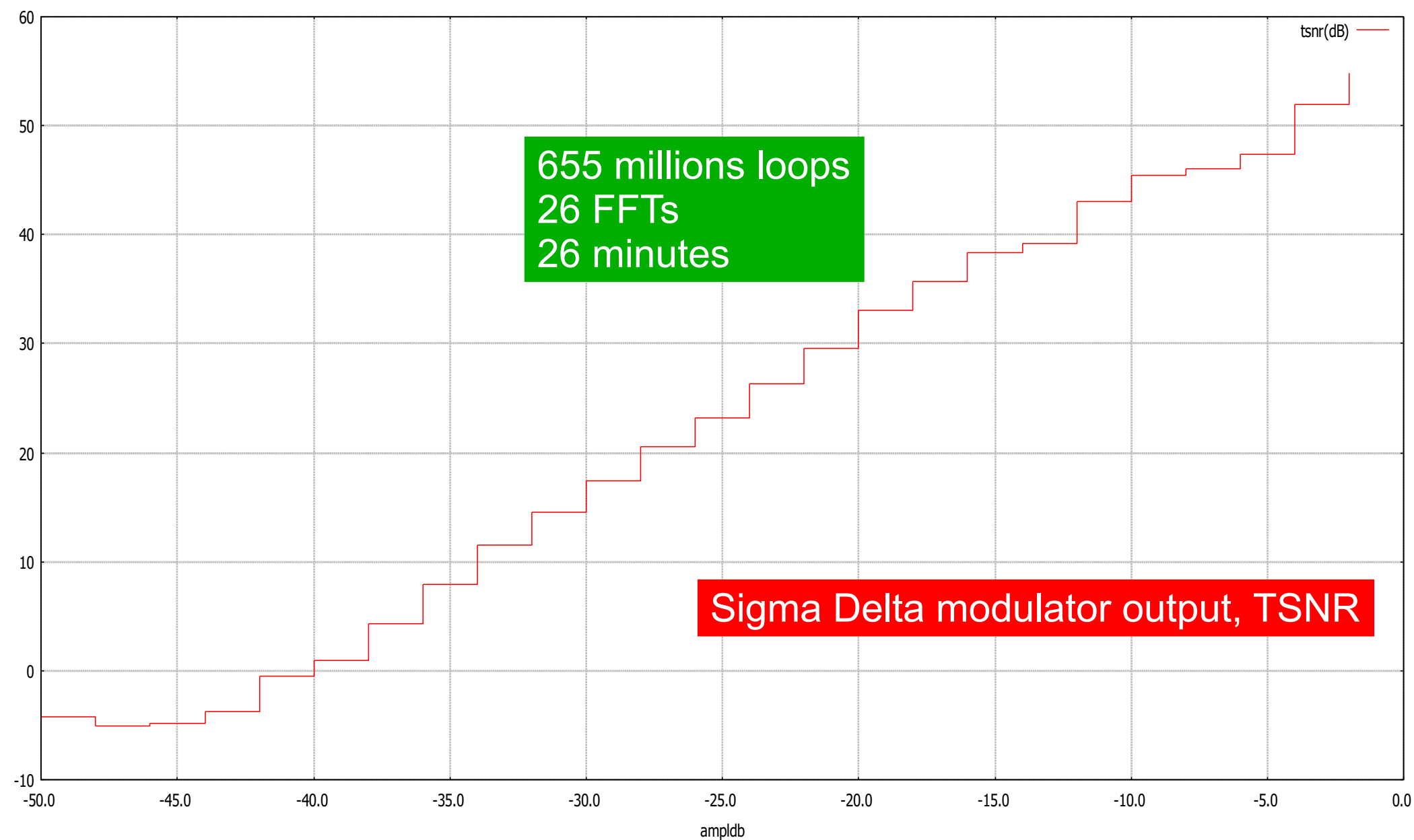
debug    SAMPLING  SARC_INFO
ping

```

NAPA Simulation
TSNR



TSNR Analysis [Analog 1st Order SD Modulator with SARC model]
Yves Leduc





NAPA Has MANY Other Nice Features.

*They are listed in the **NAPA User's Manual** and in the NAPA Quick Card.*

*The **NAPA Primer Booklet** describes in details the advanced features of NAPA.*

They deserve a visit !





alias	fs	<i>ping</i>
array	ganging	post
<i>assert</i>	<i>gateway</i>	random_seed
<i>call</i>	header	<i>restart</i>
command_line	init	<i>stuck</i>
<i>comment</i>	inject	string
data	<i>input</i>	<i>synchronize</i>
debug	cell_interface	terminate
decimate	data_interface	title
declare	interlude	tool
directive	interpolate	<i>ts</i>
drop	ivar	update
<i>dump</i>	<i>load</i>	void
dvar	<i>napa_version</i>	<i>warning</i>
<i>error</i>	node	#*
event	nominal	
export	opcode	
<i>format</i>	output	

NAPA Instructions



adc	clip	<i>fznand</i>	muller	<i>rom2</i>
algebra	clock	<i>fznor</i>	mux	rshift
alu	comp	<i>fznot</i>	nand	rshift1
and	const	<i>fzxnor</i>	noise	rshift2
average	copy	<i>fzxor</i>	nor	sign
bshift	cosine	gain	not	sine
btoi	dac	generator	offset	square
buffer	dalgebra	hold	or	step
bwand	dc	ialgebra	osc	sub
bwbuffer	delay	integrator	poly	sum
bwinv	differentiator	inv	prod	test
bwnand	div	itob	quant	toggle
bwnor	dtoi	itod	ram	track
bwnot	<i>dtool</i>	itool	<i>ram2</i>	triangle
bwor	duser	iuser	rect	trig
bwxnor	equal	latch	register	uadc
bwxor	<i>fzand</i>	lshift	relay	udac
cell	<i>fzbuffer</i>	max	rip	wsum
change	<i>fzinv</i>	merge	rom	xnor
	<i>fzor</i>	min		xor
		mod		zero

NAPA Nodes

ABS(x)
SIGN(x)
MIN(x,y)
MAX(x,y)
LIMIT(x,l,h)
ISINSIDE(x,l,h)
ISOUTSIDE(x,l,h)
ISEQUAL(x,y)
ISNOTEQUAL(x,y)
ISTIME(t)
ISSMALL(x)
ISNOTSMALL(x)
ISEVEN(x)
ISODD(x)
ISINTEGER(x)
ISPOWEROF2(n)
POWEROF2(n)
MODULO(x,y)
SIN(x)
COS(x)
SQRT(x)
LOG(x)
POW(x,y)
ROOT(x,y)
LOG10(x)
POW10(x)
D2I(x)
I2D(n)
DB2LIN(x,r)
LIN2DB(x,r)
DB2POW(x,r)
POW2DB(x,r)
RAD2DEG(x)
DEG2RAD(x)
LENGTH(s)
LINDOMAIN(c,b,e)
LOGDOMAIN(c,b,e)
LINSWEEP(c,b,e,n)
LOGSWEEP(c,b,e,n)
RAND_01()
RAND_01_X()
FSS(nseg)
STS(nseg)
IO_MANAGER(c,f,n,s,t)
ISDELAYED(f,i)
ISOPTION(f,i,o)
ISNOTOPTION(f,i)
PING(fun)



Built-in C Macros

Activation\chirp.net	Butterworth\LP8.net	Filter\1p1z.net	Filter\filt11.net
Activation\chirp2.net	Butterworth\LP9.net	Filter\2p2z.net	Filter\filt22.net
Activation\chirp2_g.net	CDSD\m1.net	ISD\m.net	Filter\filt33.net
Activation\chirp_g.net	CDSD\m11.net	Latch\DFF1.net	Filter\lp1.net
Activation\pulse.net	CDSD\m2.net	Latch\DFF2.net	Filter\lprc1.net
Activation\resonator.net	Cell\1.net	Latch\SR.net	Filter\lprc2.net
Activation\sigmoid.net	Cell\2.net	Logic\adder.net	Filter\ma.net
Activation\step.net	Cell\3.net	Logic\adder2b.net	Filter\mfb2.net
Activation\three_phase.net	Cell\4.net	Logic\adder3b.net	Filter\nyq365.tap
Activation\triangle.net	Cell\5.net	Logic\add_evn.net	Filter\nyquist.net
Adder\i1.net	Cell\6.net	Logic\add_gen.net	Integrator1\d1.net
Adder\i1_a.net	Cell\d1.net	Logic\add_odd.net	Integrator1\d1i1.net
Adder\i2.net	Cell\d2.net	Logic\carry.net	Integrator1\d1i1_a.net
Adder\i2_a.net	Cell\d3.net	Logic\half_adder.net	Integrator1\d1i1_ac.net
Adder\i3.net	Cell\d4.net	Logic\sum.net	Integrator1\d1_a.net
Adder\i3_a.net	Cell\d5.net	Measure\energy.net	Integrator1\d1_ac.net
Adder\i4.net	Cell\d6.net	Measure\freq.net	Integrator1\d1_r.net
Adder\i4_a.net	Comparator\1_h.net	Measure\slope.net	Integrator1\d2.net
ASD\m1.net	Comparator\2.net	Misc\adder.net	Integrator1\d2_a.net
ASD\m11.net	Comparator\2_a.net	Misc\channel.net	Integrator1\d2_ac.net
ASD\m2.net	Comparator\2_h.net	Misc\cint.net	Integrator1\d2_r.net
ASD\m211.net	Comparator\3.net	Misc\cintd.net	Integrator1\d3.net
ASD\m21_va.net	Comparator\d1_h.net	Misc\gdelay.net	Integrator1\d3_a.net
ASD\m22_va.net	Comparator\d2.net	Misc\GTswitch.net	Integrator1\d3_ac.net
ASD\m22_vc.net	Comparator\d2_a.net	Misc\intdz.net	Integrator1\d3_r.net
ASD\m2ff.net	Comparator\d2_h.net	Misc\intm.net	Integrator1\d4.net
Bessel\LP1.net	Comparator\d3.net	Misc\intz.net	Integrator1\d4_a.net
Bessel\LP2.net	Counter\bincount.net	Misc\rv1.net	Integrator1\d4_ac.net
Bessel\LP3.net	Counter\counter.net	Modulation\am.net	Integrator1\i1.net
Bessel\LP4.net	Counter\counter2.net	Modulation\am2.net	Integrator1\i1_a.net
Bessel\LP5.net	Counter\edgecount.net	Modulation\fm.net	Integrator1\i1_ac.net
Bessel\LP6.net	Counter\modcnt.net	Modulation\fm2.net	Integrator1\i1_ct.net
Bessel\LP7.net	Counter\modcnt2.net	Modulation\phm.net	Integrator1\i2.net
Bessel\LP8.net	Counter\modcntr.net	Noise\jitter.net	Integrator1\i2_a.net
Biquad\Martin_Sedra.net	Counter\modcntr2.net	Noise\ktoverc.net	Integrator1\i2_ac.net
Biquad\SWC.net	DC_removal\dc0.net	Noise\pink.net	Integrator1\i2_ct.net
Biquad\SWC1.net	DC_removal\dc1.net	Noise\rclock.net	Integrator1\i3.net
Biquad\SWC2.net	DC_removal\dc2.net	Noise\red.net	Integrator1\i3_a.net
Biquad\z.net	DC_removal\dc4.net	Processor\bbh.net	Integrator1\i3_ac.net
Butterfly\4.net	Detect\d.net	Processor\bbh4.net	Integrator1\i3_ct.net
Butterfly\4b.net	Detect\ud.net	PWL\d.net	Integrator1\i4.net
Butterfly\4b_hl.net	Detect\ud.net	PWL\i.net	Integrator1\i4_a.net
Butterworth\LP1.net	Differentiator\1.net	PWM\1.net	Integrator1\i4_ac.net
Butterworth\LP10.net	DSD\m1.net	PWM\2.net	Integrator1\i4_ct.net
Butterworth\LP2.net	DSD\m11.net	PWM\3.net	Integrator2\1.net
Butterworth\LP3.net	DSD\m2.net	PWM\4.net	Integrator2\1_a.net
Butterworth\LP4.net	DWA\16_d.net	Range\max.net	Integrator2\1_ac.net
Butterworth\LP5.net	DWA\4_d.net	Range\max_z.net	Integrator2\2.net
Butterworth\LP6.net	DWA\8.net	Range\min.net	Integrator2\2_a.net
Butterworth\LP7.net	DWA\8_d.net	Range\min_z.net	Integrator2\2_ac.net
		Range\width.net	Integrator2\3.net
		Sequence\A.net	Integrator2\3_a.net



Integrator2\3_ac.net
Integrator2\4.net
Integrator2\4_a.net
Integrator2\4_ac.net
Sequence\ag.net
Sequence\g.net
Sinc\sinc.net
Sinc\sinc4.net
chebycheff\LP1a.net
Tchebycheff\LP1b.net
Tchebycheff\LP2a.net
Tchebycheff\LP2b.net
Tchebycheff\LP3a.net
Tchebycheff\LP3b.net
Tchebycheff\LP4a.net
Tchebycheff\LP4b.net
Tchebycheff\LP5a.net
Tchebycheff\LP5b.net
Tchebycheff\LP6a.net
Tchebycheff\LP6b.net
Tchebycheff\LP7a.net
Tchebycheff\LP7b.net
Tchebycheff\LP8a.net
Tchebycheff\LP8b.net
Thermometer\2.net
Thermometer\2b.net
Thermometer\4.net
Thermometer\4b.net
Thermometer\8.net
Thermometer\8b.net
Toggling\d.net
Toggling\i.net
Twist\twist.net
Twist\twist_bit.net
WFilter\A.net
WFilter\B.net
WFilter\C.net
WFilter\D.net
WFilter\Z.net

Adder_op1.dat
 Adder_op2.dat
 Array\10x1.dat
 Array\10x2.dat
 Array\10x3.dat
 Array\11x1.dat
 Array\11x2.dat
 Array\11x3.dat
 Array\12x1.dat
 Array\12x2.dat
 Array\12x3.dat
 Array\13x1.dat
 Array\13x2.dat
 Array\14x1.dat
 Array\14x2.dat
 Array\15x1.dat
 Array\15x2.dat
 Array\16x1.dat
 Array\16x2.dat
 Array\17x1.dat
 Array\18x1.dat
 Array\1x1.dat
 Array\1x10.dat
 Array\1x11.dat
 Array\1x12.dat
 Array\1x13.dat
 Array\1x14.dat
 Array\1x15.dat
 Array\1x16.dat
 Array\1x17.dat
 Array\1x18.dat
 Array\1x2.dat
 Array\1x3.dat
 Array\1x4.dat
 Array\1x5.dat
 Array\1x6.dat
 Array\1x7.dat
 Array\1x8.dat
 Array\1x9.dat
 Array\2x1.dat
 Array\2x10.dat
 Array\2x12.dat
 Array\2x13.dat
 Array\2x14.dat
 Array\2x15.dat
 Array\2x16.dat
 Array\2x11.dat

Array\2x2.dat
 Array\2x3.dat
 Array\2x4.dat
 Array\2x5.dat
 Array\2x6.dat
 Array\2x7.dat
 Array\2x8.dat
 Array\2x9.dat
 Array\3x1.dat
 Array\3x10.dat
 Array\3x11.dat
 Array\3x12.dat
 Array\3x2.dat
 Array\3x3.dat
 Array\3x4.dat
 Array\3x5.dat
 Array\3x6.dat
 Array\3x7.dat
 Array\3x8.dat
 Array\3x9.dat
 Array\4x1.dat
 Array\4x2.dat
 Array\4x3.dat
 Array\4x4.dat
 Array\4x5.dat
 Array\4x6.dat
 Array\4x7.dat
 Array\4x8.dat
 Array\4x9.dat
 Array\5x1.dat
 Array\5x2.dat
 Array\5x3.dat
 Array\5x4.dat
 Array\5x5.dat
 Array\5x6.dat
 Array\5x7.dat
 Array\6x1.dat
 Array\6x2.dat
 Array\6x3.dat
 Array\6x4.dat
 Array\6x5.dat
 Array\6x6.dat
 Array\7x1.dat
 Array\7x2.dat
 Array\7x3.dat
 Array\7x4.dat
 Array\7x5.dat
 Array\8x1.dat
 Array\8x2.dat

Array\8x3.dat
 Array\8x4.dat
 Array\9x1.dat
 Array\9x2.dat
 Array\9x3.dat
 Array\9x4.dat
 Array\c2_a.dat
 Array\c3_a.dat
 Array\c4_a.dat
 Array\c4_b.dat
 Array\c5_a.dat
 Array\c5_b.dat
 ASD_cmp2.dat
 ASD_cmp3.dat
 ASD_cmp4.dat
 ASD_cmp5.dat
 ASD_cmp6.dat
 ASD_m1.dat
 ASD_m11.dat
 ASD_m2.dat
 ASD_m211.dat
 ASD_m21_va.dat
 ASD_m22_va.dat
 ASD_m22_vc.dat
 ASD_m2ff.dat
 ASD_op1.dat
 ASD_op2.dat
 ASD_op3.dat
 ASD_op4.dat
 ASD_op5.dat
 Biquad_Martin_Sedra.dat
 Comparator_cmp1.dat
 Comparator_cmp2.dat
 Integrator1_op1.dat
 Integrator1_op2.dat
 Integrator1_op3.dat
 Integrator1_opreal.dat
 Integrator2_op1.dat
 Integrator2_op2.dat



Data Cells

acosh
arithmetic_mean
arithmetic_geometric_mean
asinh
atanh
bessel_i
bessel_j
bessel_k
bessel_y
c2f
c2k
centroidal_mean
choice_between_i
choice_between_d
choice_between_s
coherent
coherent_lindomain
coherent_linsweep
coherent_logdomain
coherent_logsweep
cmp3
compress_A_law
compress_A_law2
compress_mu_law
compress_mu_law2
contraharmonic_mean
db2lin
db2pow
d2i
dec2bin
deg2rad
diode_lv
diode_Ri
diode_Rv
diode_Vi
dirac
dirac2
ET12
expand_A_law
expand_A_law2
expand_mu_law
expand_mu_law2
f2c
factorial
gaussian
geometric_mean
halton
hardlimiter
harmonic_mean
heronian_mean

GCD
I2d
isign
ispowerof2
k2c
LCM
lin2db
lindomain
linsweep
logdomain
log_factorial
logsweep
parallel_R
parallel_C
pow2db
p2t
kt
powerof2
prompt_for_double
prompt_for_long
prompt_for_yes_no
QR_01
QR_01_x
QR_gaussian
QR_normal
QR_uniform
QR_uniform_x
rad2deg
rand_01
rand_01_x
rand_bernoulli
rand_binomial
rand_chisquare
rand_equilike
rand_erlang
rand_exponential
rand_gaussian
rand_halfnormal
rand_geometric
rand_lognormal
rand_normal
rand_pascal
rand_poisson
rand_rayleigh
rand_uniform
rand_uniform_x
randomize_array
reldif
rnoise
root_mean_square
round_it
serie_R

serie_C
serie_L
sinc
smoothlimiter
softlimiter
stuck_array
stuck_part_of_array
switch_i
switch_d
t2p
thermometric
vandercomput
vt

A_CONSTANT
ARITHMETIC_MEAN
ARITHMETIC_GEOMETRIC_MEAN
C0
C2F
C2K
CENTROIDAL_MEAN
CONTRAHARMONIC_MEAN
D2I
EV
EPSILON0
F2C
G
KT
GEOMETRIC_MEAN
H
HARMONIC_MEAN
HERONIAN_MEAN
I2D
K
K2C
ME
MU_CONSTANT
MU0
print_string
print_var
print_var_and_string
Q
RNOISE
ROOT_MEAN_SQUARE
SYSTEM_TIME
VT
Z0



*and hundreds of
ressources functions*

C Functions and Macros

iuser_arithmetic_average
 duser_arithmetic_average
 duser_coherentwave
 duser_comb
 duser_ctm
 iuser_dem
 duser_dp11
 duser_dsinc
 duser_entropy
 duser_fir
 iuser_fir
 duser_fir_in
 duser_fir_out
 duser_fm
 iuser_fm
 duser_geometric_average
 duser_harmonic_average
 duser_ifft
 duser_ilt
 duser_ilt2
 iuser_lfsr
 duser_median
 iuser_median
 duser_intreal
 duser_multitone
 duser_pink
 duser_pulse
 duser_pwl
 iuser_pwl
 duser_read
 duser_read2
 iuser_read
 iuser_read2
 duser_resonator
 duser_rms_average
 iuser_sequence
 duser_sarc
 duser_sine
 iuser_stable
 duser_sun
 duser_synchro_lindomain
 duser_synchro_logdomain
 duser_synchro_linsweep
 duser_synchro_log sweep
 duser_synchro_readsweep
 iuser_wave1x16_in
 iuser_wave1x16_out
 iuser_wave2x16_in
 iuser_wave2x16_out

itool_autocorr
 itool_cfft
 itool_cgft
 itool_cwin
 itool_disto
 itool_enbw
 itool_fft
 itool_fft_cs
 itool_freq
 itool_gdel
 itool_gft
 itool_hdecomp
 itool_histobin
 itool_history
 itool_histogram
 itool_histoslp
 itool_histoal
 itool_icn
 itool_i2decomp
 itool_i3decomp
 itool_im2
 itool_im3
 itool_inform
 itool_lag
 itool_lin
 itool_lsp
 itool_lspwin
 itool_output
 itool_pdetect
 itool_ps
 itool_quinn2
 itool_resp
 itool_rms
 itool_sinewave
 itool_statslp
 itool_statval
 itool_synchro
 itool_tdecomp
 itool_tf
 itool_tf2_i
 itool_tf2_o
 itool_tfp
 itool_tsnr
 itool_win
 itool_xcorr

post_extrema
 post_eye
 post_histo
 post_join
 post_prune
 post_select
 post_sort
 post_spice
 post_stat
 post_wcpk
 post_wcpk_pw
 |
 post_zip



User Functions and Smart Tools

Conclusions



**NAPA is a Fully Open
High Level Mixed Signal Simulator.**

**You are the pilot.
Your creativity is your limitation.**

**SIMULATE WITH MODERATION
*and intelligence...***

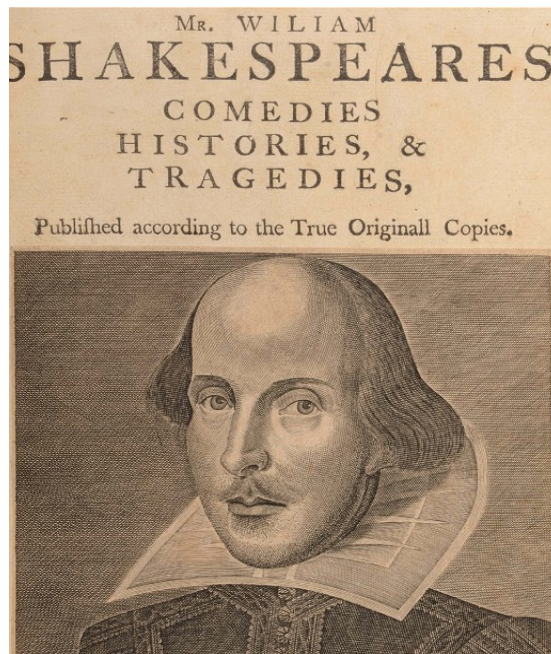
Questions ?



The Last Words



" Good model is a good familiar creature
if it be well used " [1]



[1] 309 Come, come, good wine is a good familiar creature
310 if it be well used"

William Shakespeare (1564-1616)
Othello, II. lii



Thank You !

“UNIVERSITY WARNING: (1) According to the Surgeon General, students should not abuse of simulators during their cursus because of the risk of brain defects. (2) Use of simulators impairs your ability to drive a car or operate a mobile phone, and may cause severe service disruptions”



Appendix



HWiNFO64 @ ASUS B33E - System Summary

CPU



Intel Core i5-2450M

CPU #0 ▾

Stepping

J1

Cores

2

Codename

Sandy Bridge-MB SV

Logical

4

Cache

2x32 + 2x32 + 2x256 + 3M

µCU

25

Prod. Unit

Platform

Socket G2 (rPGA988B)

TDP

35 W

SSPEC

SR0CH,SR04X

Features

MMX	3DNow!	3DNow!-2	SSE	SSE-2	SSE-3	SSSE-3
SSE4A	SSE4.1	SSE4.2	AVX	AVX2	AVX-512	
BMI2	ABM	TBM	FMA	ADX	XOP	
DEP	VMX	SMX	SMEP	SMAP	TSX	MPX
EM64T	EIST	TM1	TM2	HTT	Turbo	
AES-NI	RDRAND	RDSEED	SHA			

Operating Point

Clock

Ratio

Bus

VID

CPU LFM (Min)

800.0 MHz

8.00x

100.0 MHz

-

CPU HFM (Max)

2500.0 MHz

25.00x

100.0 MHz

-

CPU Turbo

3100.0 MHz

31.00x

100.0 MHz

-

CPU Status

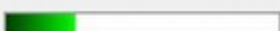
-

-

99.8 MHz

0.7705 V

Core0



Clock

798 MHz

Ratio

8.00x

ThermMon

OK

Core1



Clock

798 MHz

Ratio

8.00x

ThermMon

OK

Drives

Interface	Model
SATA 3 Gb/s	WDC WD5000BPKT-80PK4T0 [500 GB, 16MB]
SATA 1.5 Gb/s	MATSHITADVD-RAM UJ8A2ASW [DVD+R DL]

GPU



Intel Sandy Bridge-MB GT2+ - Integrated Grap

Intel HD Graphics 3000

Sandy Bridge GT2+

PCI

GPU #0 ▾

2108 MB

ROPs

Shaders

Current Clocks (MHz)

GPU

650.0

Memory

665.0

Shader

-

Motherboard

ASUS B33E

Chipset

Intel HM65 (Cougar Point) [B3]

BIOS

02/17/2012

BIOS Version

B33E.206

Memory

Size

8192 MB

Type

DDR3 SDRAM

Current Timing

Clock

665.3 MHz

=

6.67

x

99.8 MHz

Mode

Dual-Channel

CR

1T

Timing

9

-

9

-

9

-

24

tRC

tRFC

107

Modules

[#0] Hynix (Hyundai) HMT351S6CFR8C-H9 ▾

Size

4096 MB

Clock

667 MHz

ECC

N

Type

PC3-10600 DDR3 SDRAM SO-DIMM

Freq	CL	RCD	RP	RAS	RC	Ext.	V
666.7	9	9	9	24	33	-	1.50
600.0	8	8	8	22	30	-	1.50
533.3	7	7	7	20	27	-	1.50
400.0	6	6	6	15	20	-	1.50
333.3	5	5	5	12	17	-	1.50

OS

Microsoft Windows 7 Professional (x64) Build 7601

Close

FYI, my computer