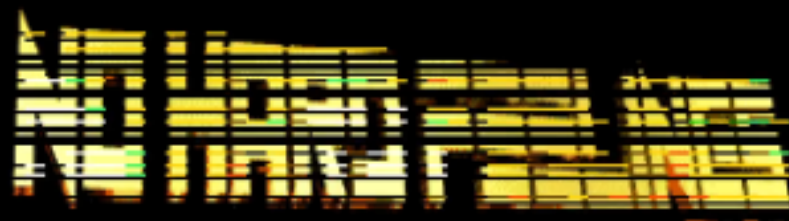


Playing music on the Apple IIGS with NinjaTrackerPlus (NTP)

Jesse Blue / Ninjaforce

www.ninjaforce.com

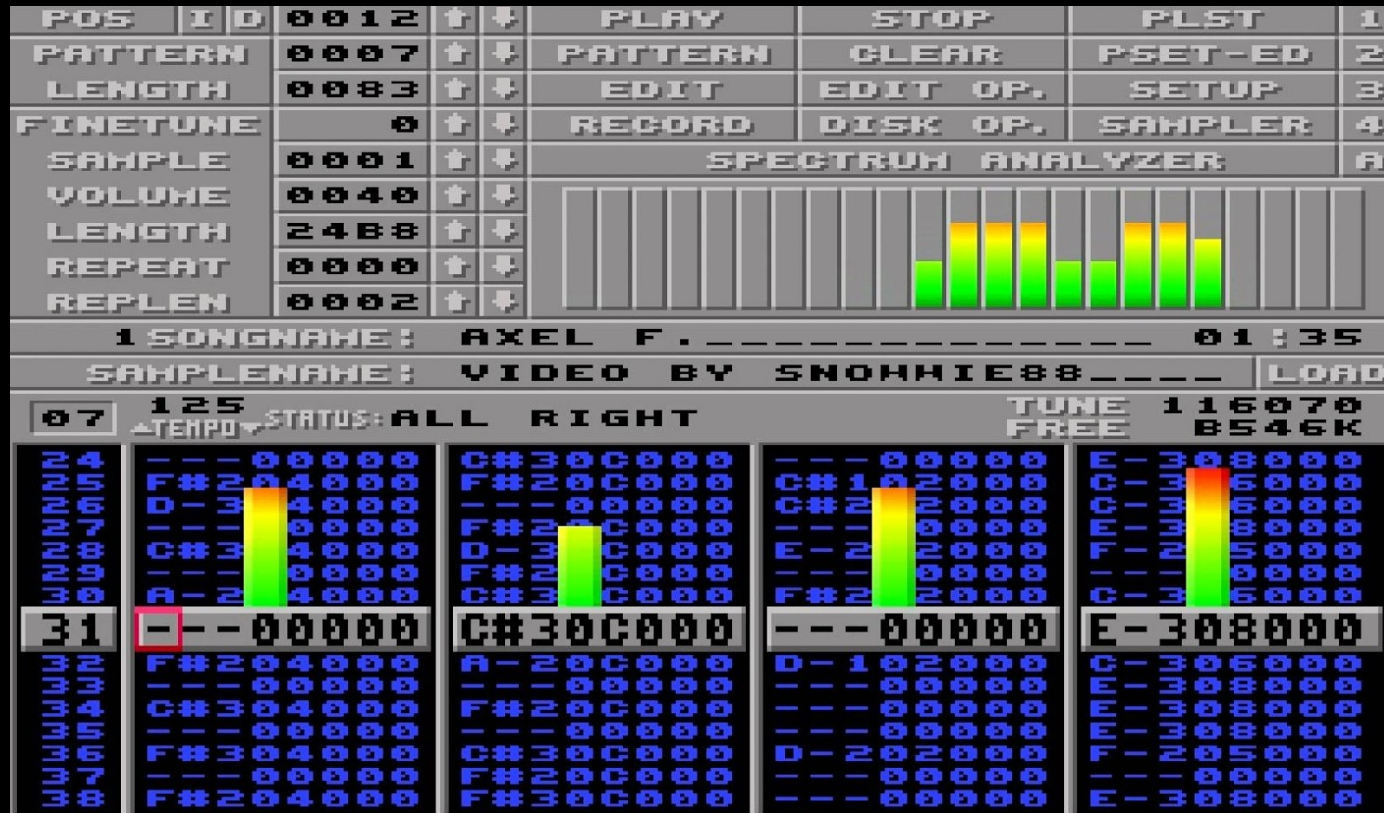


Focus

- musicians (from other platforms)
- IIGS programmers (assembly)
- everybody interested in sound on the GS

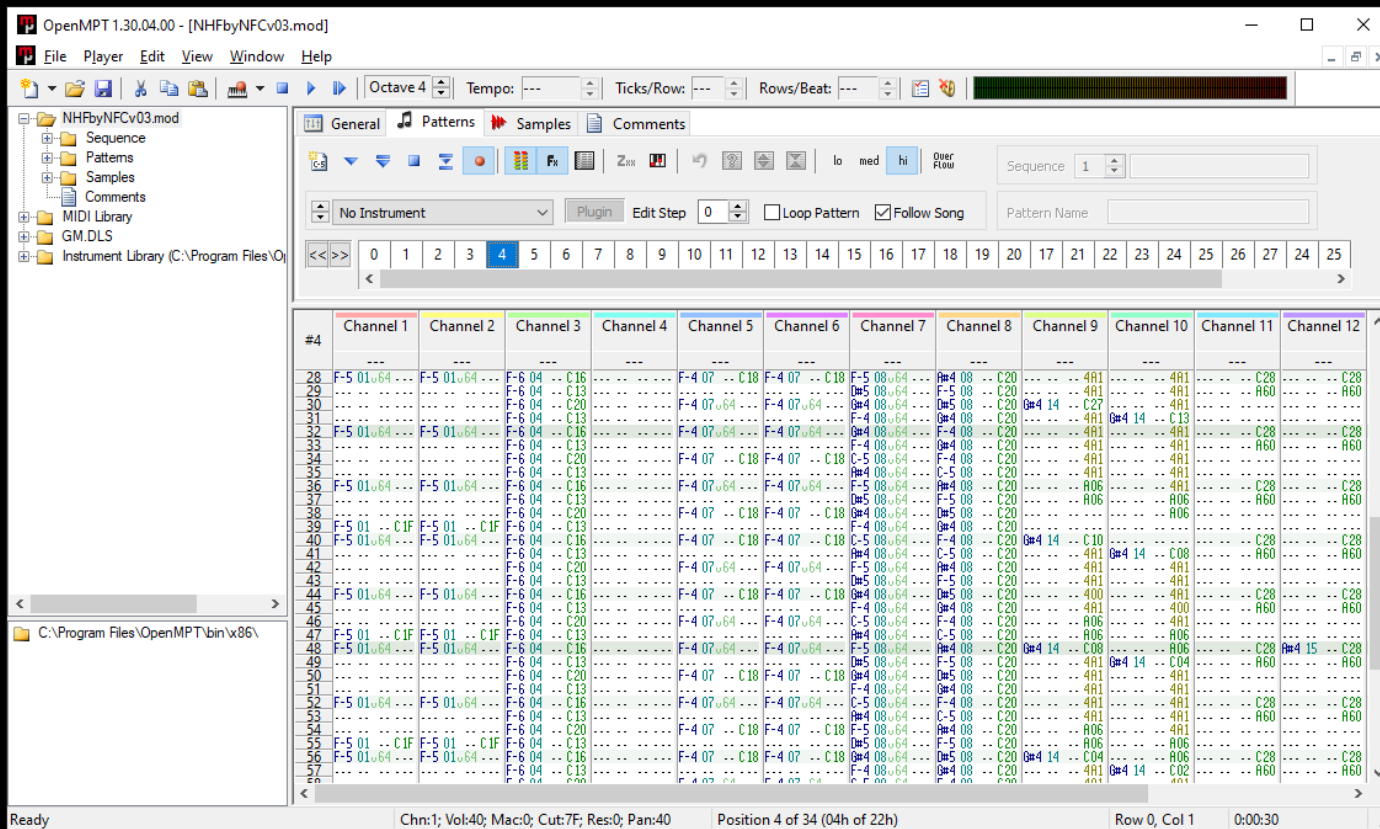
What is NinjaTrackerPlayer (NTP)?

- **Music player for tracked music**



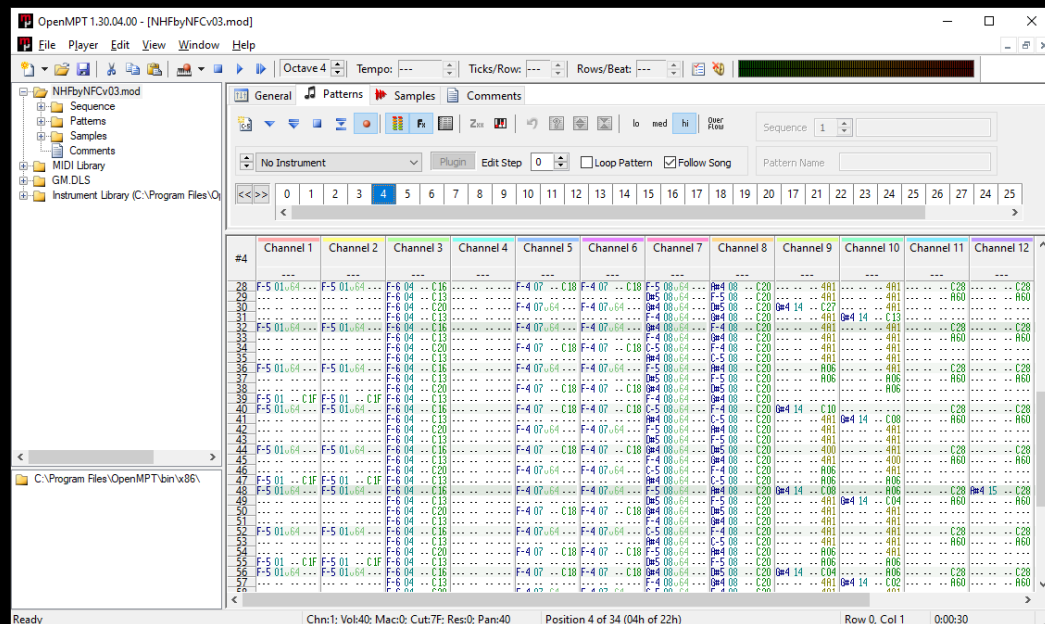
What is NinjaTrackerPlayer (NTP)?

- Music player for tracked music



What is NinjaTrackerPlayer (NTP)?

- Music player for tracked music
- Converter
MOD file => NTP file
 - at ninjaforce.com
 - via PHP script
- Library to play NTP files on the IIGS
 - Merlin32 assembler



IIGS Sound

- Ensoniq 5503 Digital Oscillator Chip (DOC)
- 32 voices (=oscillators) !
- ...but only 64k sound ram

DOU Registers

Osc	Mode	Ch	Control	Freq	Vol	Pt	Sz	Osc	Mode	Ch	Control	Freq	Vol	Pt	Sz
00	Free	R	00001000	00AB	00	00	00	01	Free	L	00010000	00AB	21	4C	09
02	One	R	00000011	00AB	00	00	00	03	Free	R	00000000	00AB	10	4C	09
04	Free	R	00001000	011F	00	00	00	05	Free	R	00000000	011F	4E	4E	09
06	One	R	00000011	011F	00	00	00	07	Free	L	00010000	011F	27	4E	09
08	Free	R	00001000	0156	00	00	00	09	Free	R	00000000	0156	05	76	09
0A	One	R	00000011	0156	00	00	00	0B	Free	L	00010000	0156	02	76	09
0C	Swap	L	00010111	0008	8C	00	3F	0D	Swap	L	00010110	0008	8C	00	3F
0E	Swap	R	00000111	0008	46	00	3F	0F	Swap	R	00000110	0008	46	00	3F
10	Free	R	00000001	0000	00	00	00	11	Free	R	00000001	0000	00	00	00
12	Free	R	00000001	0000	00	00	00	13	Free	R	00000001	0000	00	00	00
14	Free	R	00000001	0000	00	00	00	15	Free	R	00000001	0000	00	00	00
16	Free	R	00000001	0000	00	00	00	17	Free	R	00000001	0000	00	00	00
18	Free	R	00000001	0000	00	00	00	19	Free	R	00000001	0000	00	00	00
1A	Free	R	00000001	0000	00	00	00	1B	Free	R	00000001	0000	00	00	00
1C	Free	R	00000001	0000	00	00	00	1D	Free	R	00000001	0000	00	00	00
1E	Free	R	00000001	0000	00	00	00	1F	Free	R	00001000	00F9	00	00	00

Command :

(Press mouse or esc for menus.)

DOC Registers

Osc	Mode	Ch	Control	Freq	Vol	Pt	Sz	Osc	Mode	Ch	Control	Freq	Vol	Pt	Sz
00	Free	R	00001000	00AB	00	00	00	01	Free	L	00010000	00AB	21	4C	09
02	One	R	00000011	00AB	00	00	00	03	Free	R	00000000	00AB	10	4C	09
04	Free	R	00001000	011F	00	00	00	05	Free	R	00000000	011F	4E	4E	09
06	One	R	00000011	011F	00	00	00	07	Free	L	00010000	011F	27	4E	09
08	Free	R	00001000	0156	00	00	00	09	Free	R	00000000	0156	05	76	09
0A	One	R	00000011	0156	00	00	00	0B	Free	L	00010000	0156	02	76	09
0C	Swap	L	00010111	0008	8C	00	3F	0D	Swap	L	00010110	0008	8C	00	3F
0E	Swap	R	00000111	0008	46	00	3F	0F	Swap	R	00000110	0008	46	00	3F
10	Free	R	00000001	0000	00	00	00	11	Free	R	00000001	0000	00	00	00
12	Free	R	00000001	0000	00	00	00	13	Free	R	00000001	0000	00	00	00
14	Free	R	00000001	0000	00	00	00	15	Free	R	00000001	0000	00	00	00
16	Free	R	00000001	0000	00	00	00	17	Free	R	00000001	0000	00	00	00
18	Free	R	00000001	0000	00	00	00	19	Free	R	00000001	0000	00	00	00
1A	Free	R	00000001	0000	00	00	00	1B	Free	R	00000001	0000	00	00	00
1C	Free	R	00000001	0000	00	00	00	1D	Free	R	00000001	0000	00	00	00
1E	Free	R	00000001	0000	00	00	00	1F	Free	R	00001000	00F9	00	00	00

Command :

(Press mouse or esc for menus.)

DOC Registers

Osc	Mode	Ch	Control	Freq	Vol	Pt	Sz	Osc	Mode	Ch	Control	Freq	Vol	Pt	Sz
00	Free	R	00001000	00AB	00	00	00	01	Free	L	00010000	00AB	21	4C	09
02	One	R	00000011	00AB	00	00	00	03	Free	R	00000000	00AB	10	4C	09
04	Free	R	00001000	011F	00	00	00	05	Free	R	00000000	011F	4E	4E	09
06	One	R	00000011	011F	00	00	00	07	Free	L	00010000	011F	27	4E	09
08	Free	R	00001000	0156	00	00	00	09	Free	R	00000000	0156	05	76	09
0A	One	R	00000011	0156	00	00	00	0B	Free	L	00010000	0156	02	76	09
0C	Swap	L	00010111	0008	8C	00	3F	0D	Swap	L	00010110	0008	8C	00	3F
0E	Swap	R	00000111	0008	46	00	3F	0F	Swap	R	00000110	0008	46	00	3F
10	Free	R	00000001	0000	00	00	00	11	Free	R	00000001	0000	00	00	00
12	Free	R	00000001	0000	00	00	00	13	Free	R	00000001	0000	00	00	00
14	Free	R	00000001	0000	00	00	00	15	Free	R	00000001	0000	00	00	00
16	Free	R	00000001	0000	00	00	00	17	Free	R	00000001	0000	00	00	00
18	Free	R	00000001	0000	00	00	00	19	Free	R	00000001	0000	00	00	00
1A	Free	R	00000001	0000	00	00	00	1B	Free	R	00000001	0000	00	00	00
1C	Free	R	00000001	0000	00	00	00	1D	Free	R	00000001	0000	00	00	00
1E	Free	R	00000001	0000	00	00	00	1F	Free	R	00001000	00F9	00	00	00

Command :

(Press mouse or esc for menus.)

DOC Registers

Osc	Mode	Ch	Control	Freq	Vol	Pt	Sz
00	Free	R	00001000	00AB	00	00	00
02	One	R	00000011	00AB	00	00	00
04	Free	R	00001000	011F	00	00	00
06	One	R	00000011	011F	00	00	00
08	Free	R	00001000	0156	00	00	00
0A	One	R	00000011	0156	00	00	00
0C	Swap	L	00010111	0008	8C	00	3F
0E	Swap	R	00000111	0008	46	00	3F
10	Free	R	00000001	0000	00	00	00
12	Free	R	00000001	0000	00	00	00
14	Free	R	00000001	0000	00	00	00
16	Free	R	00000001	0000	00	00	00
18	Free	R	00000001	0000	00	00	00
1A	Free	R	00000001	0000	00	00	00
1C	Free	R	00000001	0000	00	00	00
1E	Free	R	00000001	0000	00	00	00

Osc	Mode	Ch	Control	Freq	Vol	Pt	Sz
01	Free	L	00010000	00AB	21	4C	09
03	Free	R	00000000	00AB	10	4C	09
05	Free	R	00000000	011F	4E	4E	09
07	Free	L	00010000	011F	27	4E	09
09	Free	R	00000000	0156	05	76	09
0B	Free	L	00010000	0156	02	76	09
0D	Swap	L	00010110	0008	8C	00	3F
0F	Swap	R	00000110	0008	46	00	3F
11	Free	R	00000001	0000	00	00	00
13	Free	R	00000001	0000	00	00	00
15	Free	R	00000001	0000	00	00	00
17	Free	R	00000001	0000	00	00	00
19	Free	R	00000001	0000	00	00	00
1B	Free	R	00000001	0000	00	00	00
1D	Free	R	00000001	0000	00	00	00
1F	Free	R	00001000	00F9	00	00	00

Command :

(Press mouse or esc for menus.)

DOC Registers

Osc	Mode	Ch	Control	Freq	Vol	Pt	Sz	Osc	Mode	Ch	Control	Freq	Vol	Pt	Sz
00	Free	R	00001000	00AB	00	00	00	01	Free	L	00010000	00AB	21	4C	09
02	One	R	00000011	00AB	00	00	00	03	Free	R	00000000	00AB	10	4C	09
04	Free	R	00001000	011F	00	00	00	05	Free	R	00000000	011F	4E	4E	09
06	One	R	00000011	011F	00	00	00	07	Free	L	00010000	011F	27	4E	09
08	Free	R	00001000	0156	00	00	00	09	Free	R	00000000	0156	05	76	09
0A	One	R	00000011	0156	00	00	00	0B	Free	L	00010000	0156	02	76	09
0C	Swap	L	00010111	0008	8C	00	3F	0D	Swap	L	00010110	0008	8C	00	3F
0E	Swap	R	00000111	0008	46	00	3F	0F	Swap	R	00000110	0008	46	00	3F
10	Free	R	00000001	0000	00	00	00	11	Free	R	00000001	0000	00	00	00
12	Free	R	00000001	0000	00	00	00	13	Free	R	00000001	0000	00	00	00
14	Free	R	00000001	0000	00	00	00	15	Free	R	00000001	0000	00	00	00
16	Free	R	00000001	0000	00	00	00	17	Free	R	00000001	0000	00	00	00
18	Free	R	00000001	0000	00	00	00	19	Free	R	00000001	0000	00	00	00
1A	Free	R	00000001	0000	00	00	00	1B	Free	R	00000001	0000	00	00	00
1C	Free	R	00000001	0000	00	00	00	1D	Free	R	00000001	0000	00	00	00
1E	Free	R	00000001	0000	00	00	00	1F	Free	R	00001000	00F9	00	00	00

Command :

(Press mouse or esc for menus.)

UUC Registers

Osc Mode Ch Control

Freq

Vol

Pt

Sz

Osc

Mode

Ch

Control

♦00 Free R 00001000

02 One R 00000011

♦04 Free R 00001000

06 One R 00000011

♦08 Free R 00001000

0A One R 00000011

0C Swap L 00010111

0E Swap R 00000111

10 Free R 00000001

12 Free R 00000001

14 Free R 00000001

00AB 00 00 00

00AB 00 00 00

011F 00 00 00

011F 00 00 00

0156 00 00 00

0156 00 00 00

0008 8C 00 3F

0008 46 00 3F

0000 00 00 00

0000 00 00 00

0000 00 00 00

0000 00 00 00

0000 00 00 00

0000 00 00 00

0000 00 00 00

0000 00 00 00

0000 00 00 00

0000 00 00 00

0000 00 00 00

0000 00 00 00

0000 00 00 00

0000 00 00 00

0000 00 00 00

0000 00 00 00

♦01 Free L 00010000

♦03 Free R 00000000

♦05 Free R 00000000

♦07 Free L 00010000

♦09 Free R 00000000

♦0B Free L 00010000

♦0D Swap L 00010101

♦0F Swap R 00000101

11 Free R 00000000

13 Free R 00000000

15 Free R 00000000

UUC Registers

Osc Mode Ch Control

Freq Vol Pt Sz

Osc Mode Ch Control

*00 Free R 00001000
 02 One R 00000011
 *04 Free R 00001000
 06 One R 00000011
 *08 Free R 00001000
 0A One R 00000011
 0C Swap L 00010111
 0E Swap R 00000111
 10 Free R 00000001
 12 Free R 00000001
 14 Free R 00000001

00AB 00 00 00
 00AB 00 00 00
 011F 00 00 00
 011F 00 00 00
 0156 00 00 00
 0156 00 00 00
 0008 8C 00 3F
 0008 46 00 3F
 0000 00 00 00
 0000 00 00 00
 0000 00 00 00

*01 Free L 00010000
 *03 Free R 00000000
 *05 Free R 00000000
 *07 Free L 00010000
 *09 Free R 00000000
 *0B Free L 00010000
 *0D Swap L 00010101
 *0F Swap R 00000101
 11 Free R 00000000
 13 Free R 00000000
 15 Free R 00000000

UUC Registers

<u>Osc</u>	<u>Mode</u>	<u>Ch</u>	<u>Control</u>	<u>Freq</u>	<u>Vol</u>	<u>Pt</u>	<u>Sz</u>	<u>Osc</u>	<u>Mode</u>	<u>Ch</u>	<u>Control</u>
*00	Free	R	00001000	00AB	00	00	00	*01	Free	L	0001000
02	One	R	00000001	00AB	00	00	00	*03	Free	R	0000000
*04	Free	R	00001000	011F	00	00	00	*05	Free	R	0000000
06	One	R	00000001	011F	00	00	00	*07	Free	L	0001000
*08	Free	R	00001000	0156	00	00	00	*09	Free	R	0000000
0A	One	R	00000001	0156	00	00	00	*0B	Free	L	0001000
0C	Swap	L	00010111	0008	8C	00	3F	*0D	Swap	L	0001011
0E	Swap	R	00000111	0008	46	00	3F	*0F	Swap	R	0000011
10	Free	R	00000000	0000	00	00	00	11	Free	R	0000000
12	Free	R	00000000	0000	00	00	00	13	Free	R	0000000
14	Free	R	00000000	0000	00	00	00	15	Free	R	0000000

UUC Registers

Osc Mode Ch Control

Freq Vol Pt Sz

Osc Mode Ch Control

*00 Free R 00001000
 02 One R 00000011
 *04 Free R 00001000
 06 One R 00000011
 *08 Free R 00001000
 0A One R 00000011
 0C Swap L 00010111
 0E Swap R 00000011
 10 Free R 00000001
 12 Free R 00000001
 14 Free R 00000001

00AB 00 00 00
 00AB 00 00 00
 011F 00 00 00
 011F 00 00 00
 0156 00 00 00
 0156 00 00 00
 0008 8C 00 3F
 0008 46 00 3F
 0000 00 00 00
 0000 00 00 00
 0000 00 00 00

*01 Free L 000100
 *03 Free R 000000
 *05 Free R 000000
 *07 Free L 000100
 *09 Free R 000000
 *0B Free L 000100
 *0D Swap L 000101
 *0F Swap R 000001
 11 Free R 000000
 13 Free R 000000
 15 Free R 000000

UUC Registers

Osc Mode Ch Control

Freq Vol Pt Sz

Osc Mode Ch Control

*00 Free R 00001000
 02 One R 00000011
 *04 Free R 00001000
 06 One R 00000011
 *08 Free R 00001000
 0A One R 00000011
 0C Swap L 00010111
 0E Swap R 00000011
 10 Free R 00000001
 12 Free R 00000001
 14 Free R 00000001

00AB 00 00 00
 00AB 00 00 00
 011F 00 00 00
 011F 00 00 00
 0156 00 00 00
 0156 00 00 00
 0008 8C 00 3F
 0008 46 00 3F
 0000 00 00 00
 0000 00 00 00
 0000 00 00 00

*01 Free L 000100
 *03 Free R 000000
 *05 Free R 000000
 *07 Free L 000100
 *09 Free R 000000
 *0B Free L 000100
 *0D Swap L 000101
 *0F Swap R 000001
 11 Free R 000000
 13 Free R 000000
 15 Free R 000000

Sound Ram Wave Data

MOD

8 bit mono sound

IIGS

+127

255

0

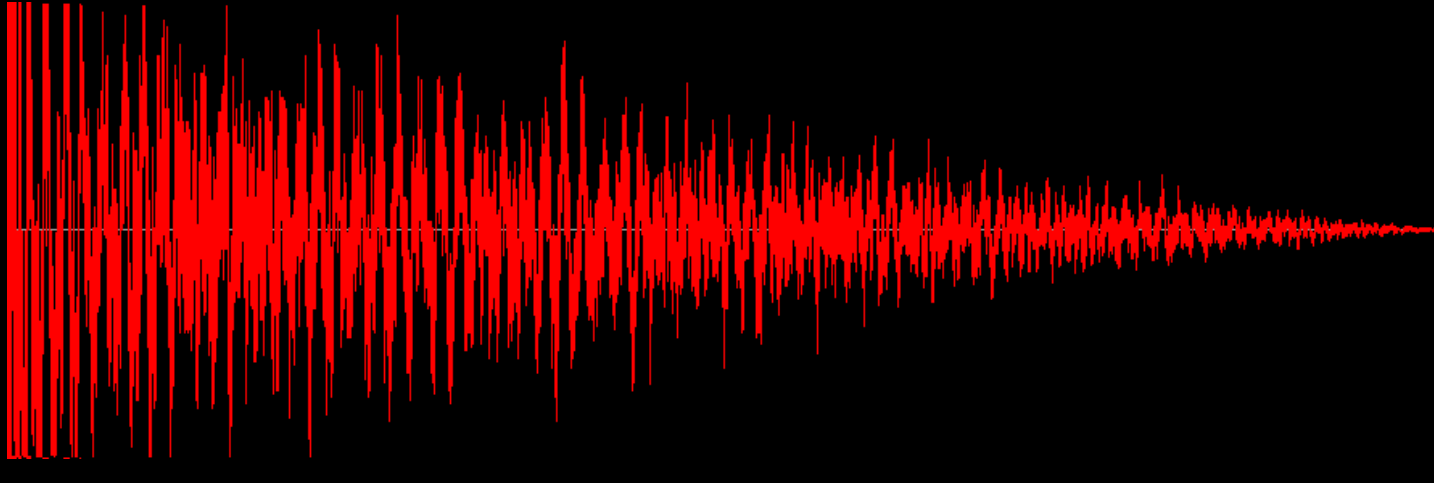
128

-128

1

Signed 8 bit PCM

Unsigned 8 bit PCM



Sound Ram Wave Data

MOD

8 bit mono sound

IIGS

+127

255

0

128

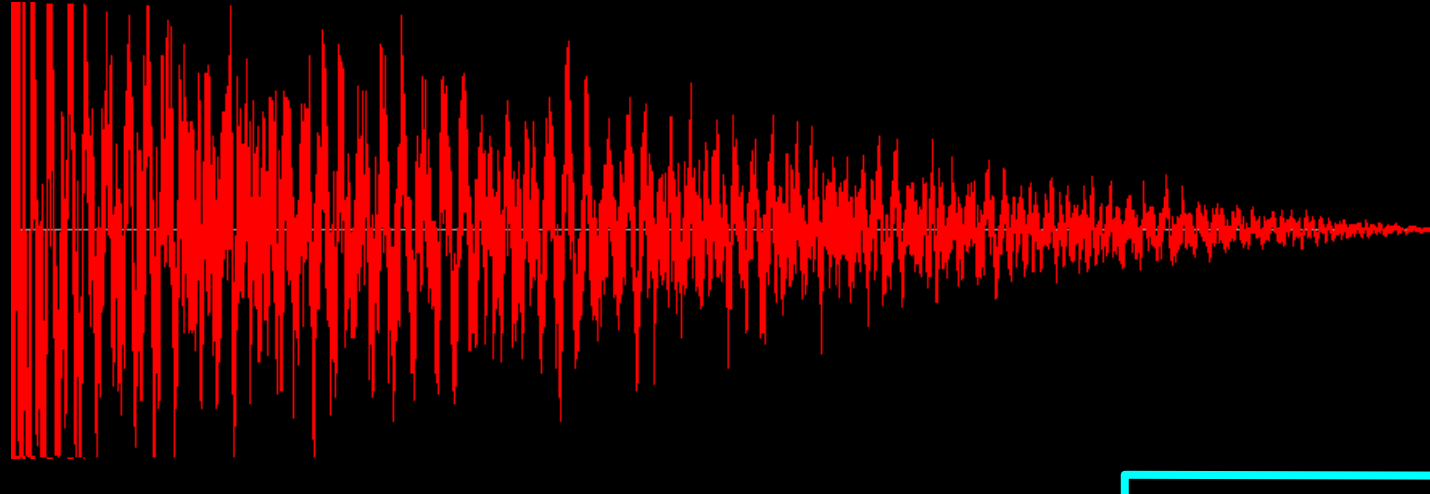
-128

1

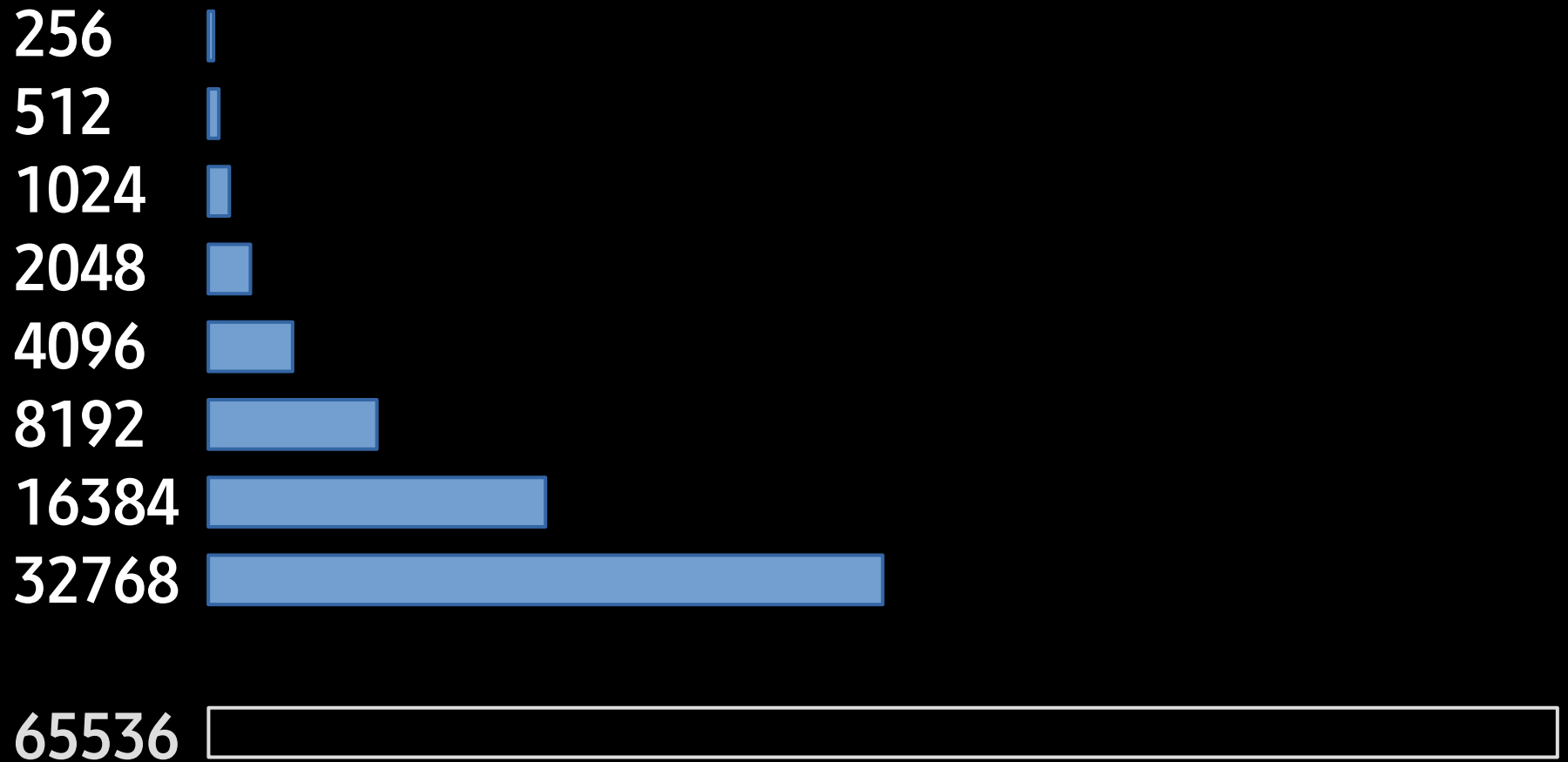
0 = STOP !!!

Signed 8 bit PCM

Unsigned 8 bit PCM



Wave Lengths



Wave Lengths

256

512

1024

2048

4096

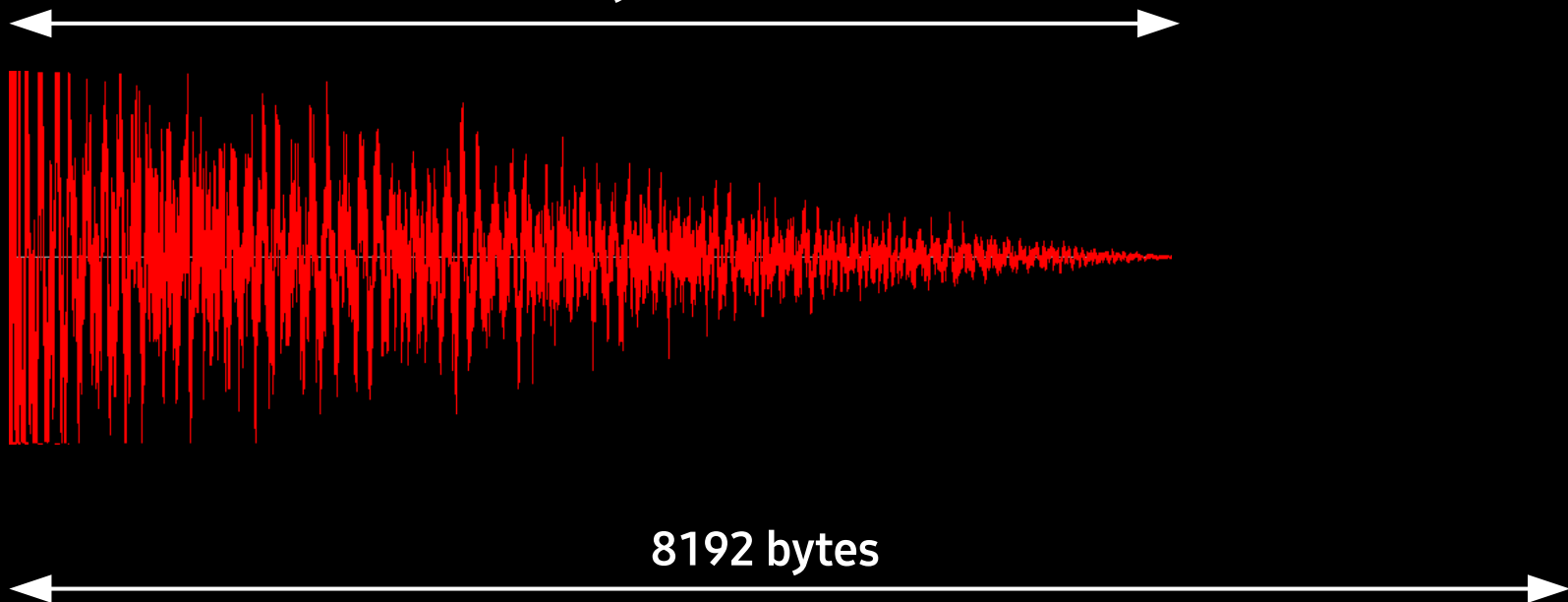
8192

16384

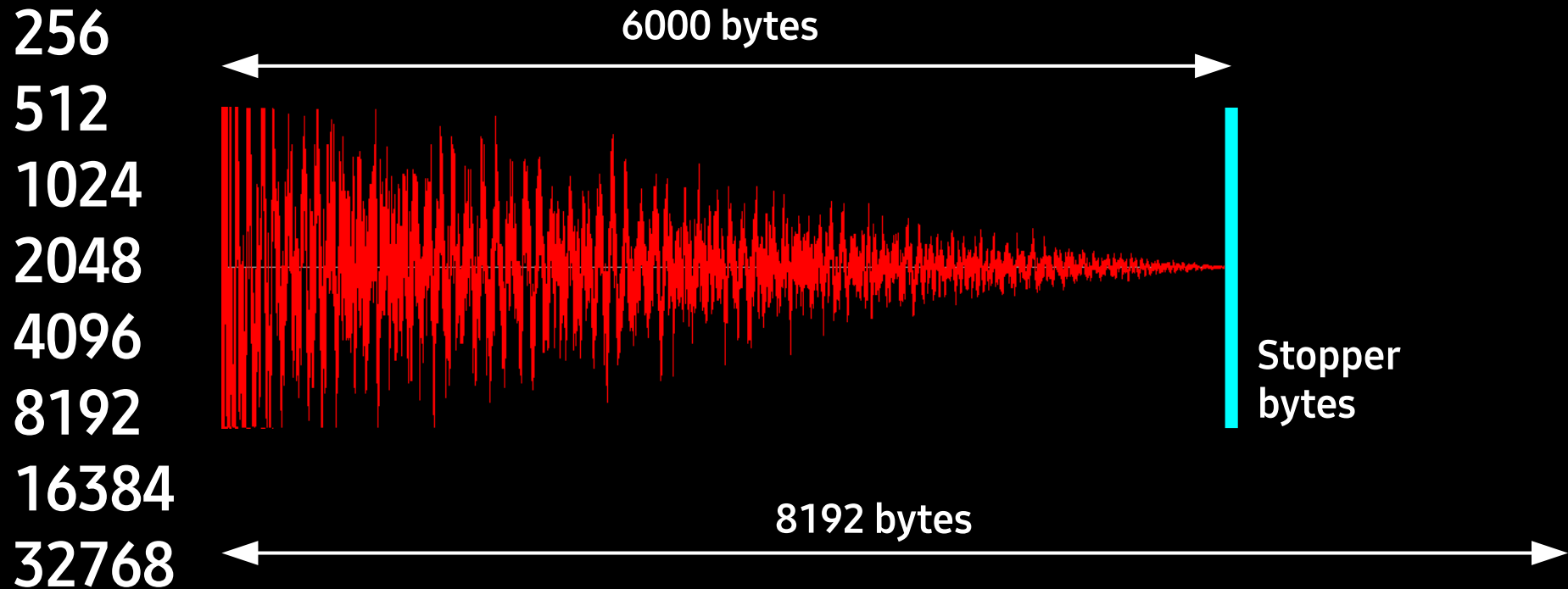
32768

6000 bytes

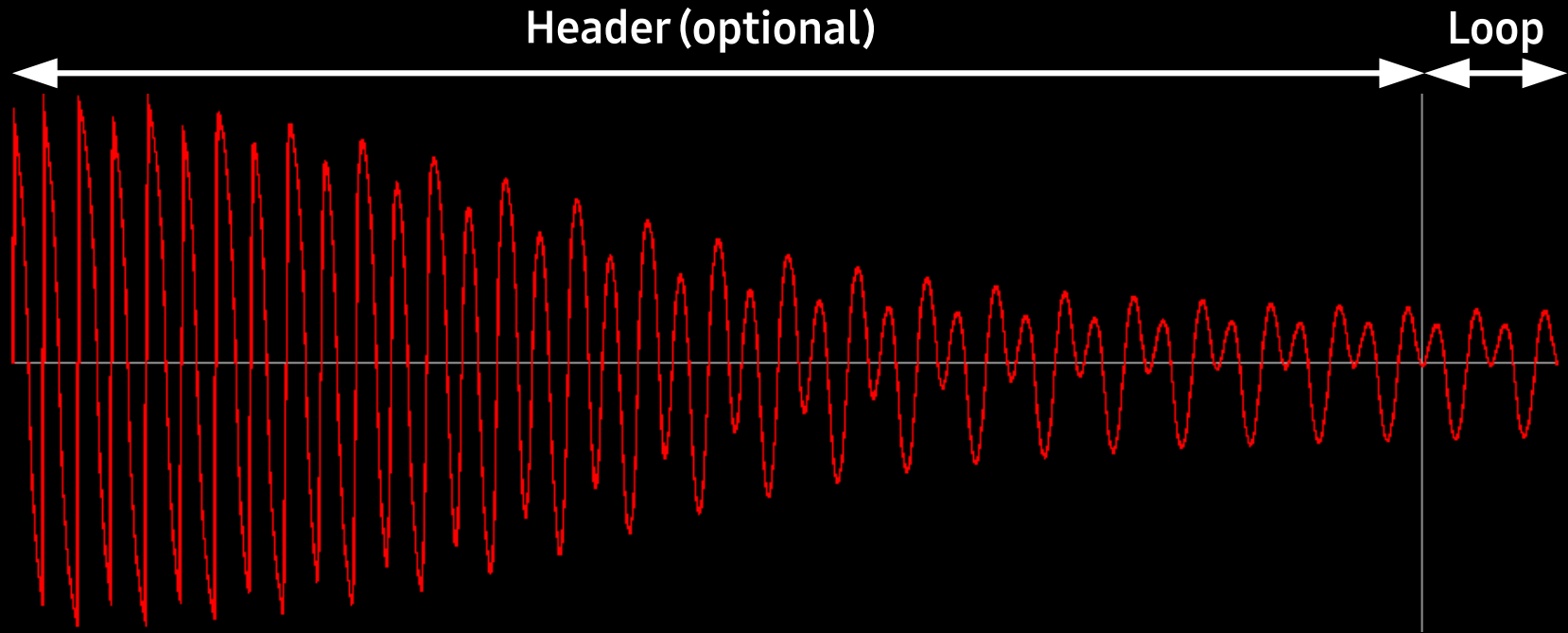
8192 bytes



Wave Lengths

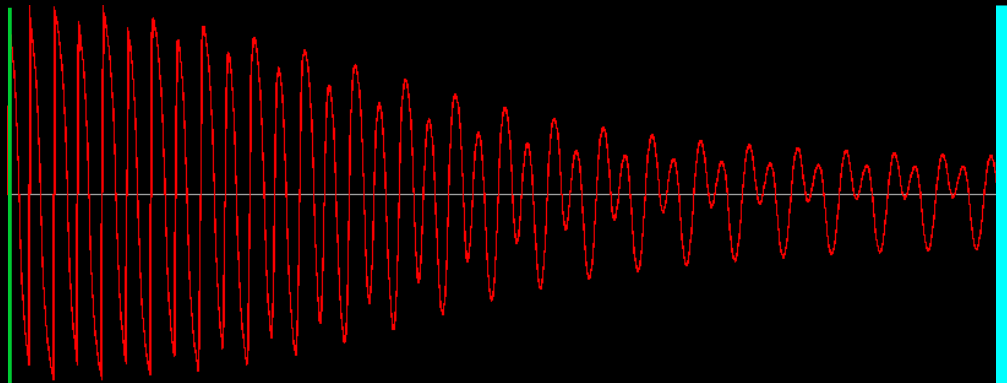


Looped Instruments



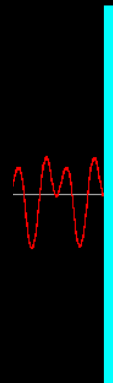
Looped Instruments

Oscillator A: swap



NTP Instrument 1: Header

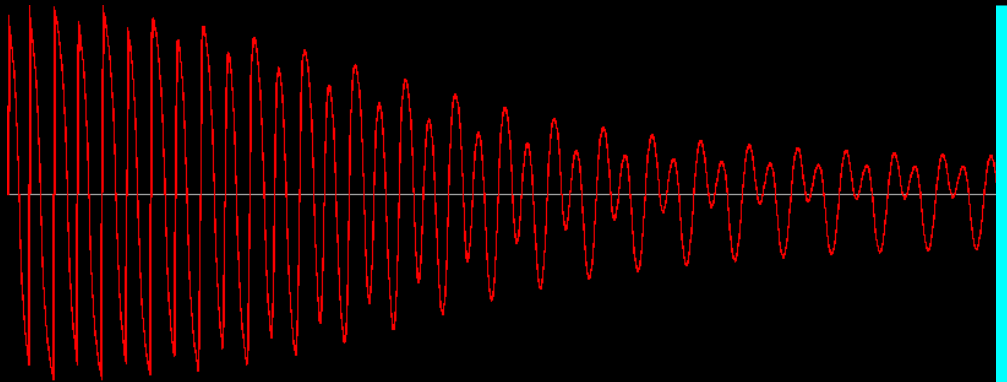
Oscillator B: swap



NTP Instrument 2: Loop

Looped Instruments

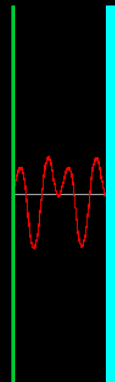
Oscillator A: swap



NTP Instrument 1: Header



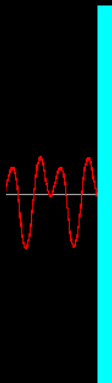
Oscillator B: swap



NTP Instrument 2: Loop

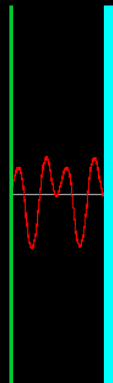
Looped Instruments

Oscillator A: swap



NTP Instrument 2: Loop

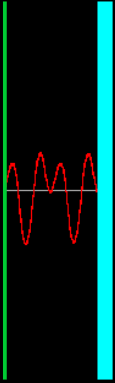
Oscillator B: swap



NTP Instrument 2: Loop

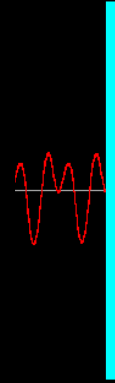
Looped Instruments

Oscillator A: swap



NTP Instrument 2: Loop

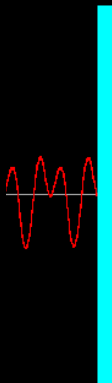
Oscillator B: swap



NTP Instrument 2: Loop

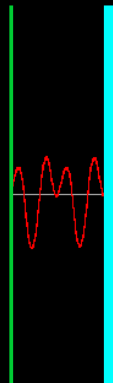
Looped Instruments

Oscillator A: swap



NTP Instrument 2: Loop

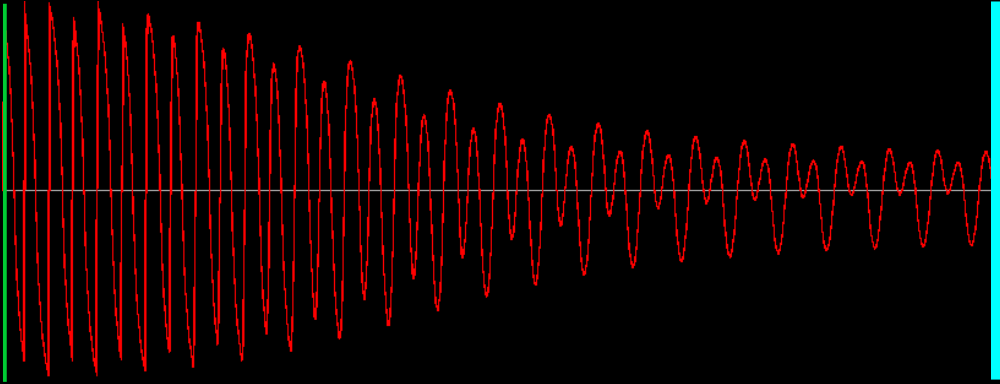
Oscillator B: swap



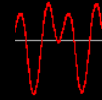
NTP Instrument 2: Loop

Looped Instruments

Oscillator A: swap



Oscillator B: free run



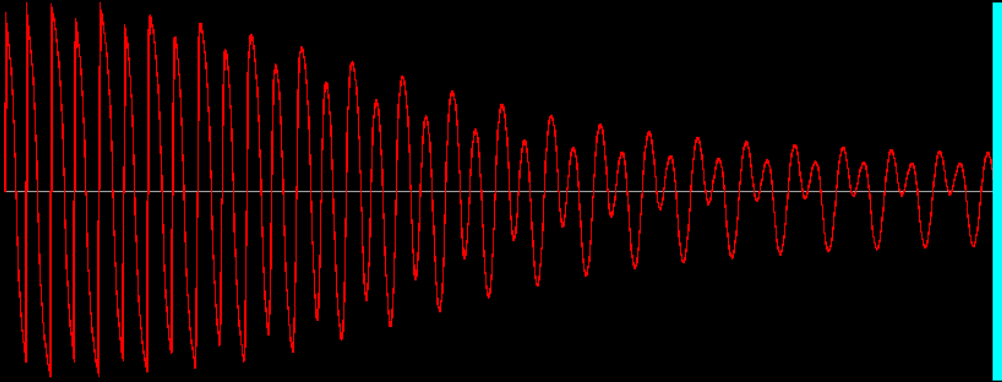
NTP Instrument 1: Header

NTP Instrument 2: Loop

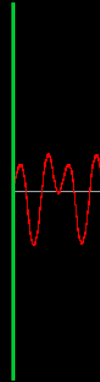
with ideal size
256 / 512 / 1024 / ...

Looped Instruments

Oscillator A: swap



Oscillator B: free run



NTP Instrument 1: Header

NTP Instrument 2: Loop

with ideal size
256 / 512 / 1024 / ...

Swap Mode Bug

<u>Osc</u>	<u>Mode</u>	<u>Ch</u>	<u>Control</u>	<u>Freq</u>	<u>Vol</u>	<u>Pt</u>	<u>Sz</u>
♦00	Free	R	00001000	00AB	00	00	00
02	One	R	00000011	00AB	00	00	00
♦04	Free	R	00001000	011F	00	00	00
06	One	R	00000011	011F	00	00	00
♦08	Free	R	00001000	0156	00	00	00
0A	One	R	00000011	0156	00	00	00
0C	Swap	L	00010111	0008	8C	00	3F
0E	Swap	R	00000111	0008	46	00	3F
10	Free	R	00000001	0000	00	00	00

<u>Osc</u>	<u>Mode</u>	<u>Ch</u>	<u>Control</u>	<u>Freq</u>	<u>Vol</u>	<u>Pt</u>	<u>Sz</u>
♦01	Free	L	00010000	00AB	21	4C	09
♦03	Free	R	00000000	00AB	10	4C	09
♦05	Free	R	00000000	011F	4E	4E	09
♦07	Free	L	00010000	011F	27	4E	09
♦09	Free	R	00000000	0156	05	76	09
♦0B	Free	L	00010000	0156	02	76	09
♦0D	Swap	L	00010110	0008	8C	00	3F
♦0F	Swap	R	00000110	0008	46	00	3F
11	Free	R	00000001	0000	00	00	00

Swap Mode Bug

<u>Osc</u>	<u>Mode</u>	<u>Ch</u>	<u>Control</u>	<u>Freq</u>	<u>Vol</u>	<u>Pt</u>	<u>Sz</u>		<u>Osc</u>	<u>Mode</u>	<u>Ch</u>	<u>Control</u>	<u>Freq</u>	<u>Vol</u>	<u>Pt</u>	<u>Sz</u>
00	Free	R	00001000	00AB	00	00	00	→	01	Free	L	00010000	00AB	21	4C	09
02	Free	R	00000011	00AB	00	00	00	→	03	Free	R	00000000	00AB	10	4C	09
04	Free	R	00001000	011F	00	00	00	→	05	Free	R	00000000	011F	4E	4E	09
06	Free	R	00000011	011F	00	00	00	→	07	Free	L	00010000	011F	27	4E	09
08	Free	R	00001000	0156	00	00	00	→	09	Free	R	00000000	0156	05	76	09
0A	Free	R	00000011	0156	00	00	00	→	0B	Free	L	00010000	0156	02	76	09
0C	Swap	L	00010111	0008	8C	00	3F		0D	Swap	L	00010110	0008	8C	00	3F
0E	Swap	R	00000111	0008	46	00	3F		0F	Swap	R	00000110	0008	46	00	3F
10	Free	R	00000001	0000	00	00	00		11	Free	R	00000001	0000	00	00	00

Swap Mode Bug

<u>Osc</u>	<u>Mode</u>	<u>Ch</u>	<u>Control</u>	<u>Freq</u>	<u>Vol</u>	<u>Pt</u>	<u>Sz</u>		<u>Osc</u>	<u>Mode</u>	<u>Ch</u>	<u>Control</u>	<u>Freq</u>	<u>Vol</u>	<u>Pt</u>	<u>Sz</u>
00	Free	R	00001000	00AD	00	00	00	→	01	Free	L	00010000	00AB	21	4C	09
02	Free	R	00000011	00AD	00	00	00	→	03	Free	R	00000000	00AB	10	4C	09
04	Free	R	00001000	011F	00	00	00	→	05	Free	R	00000000	011F	4E	4E	09
06	Free	R	00000011	011F	00	00	00	→	07	Free	L	00010000	011F	27	4E	09
08	Free	R	00001000	0156	00	00	00	→	09	Free	R	00000000	0156	05	76	09
0A	Free	R	00000011	0156	00	00	00	→	0B	Free	L	00010000	0156	02	76	09
0C	Swap	L	00010111	0008	8C	00	3F	→	0D	Swap	L	00010110	0008	8C	00	3F
0E	Swap	R	00000011	0008	46	00	3F		0F	Swap	R	00000010	0008	46	00	3F
10	Free	R	00000001	0000	00	00	00		11	Free	R	00000001	0000	00	00	00

Swap Mode Bug

<u>Osc</u>	<u>Mode</u>	<u>Ch</u>	<u>Control</u>	<u>Freq</u>	<u>Vol</u>	<u>Pt</u>	<u>Sz</u>		<u>Osc</u>	<u>Mode</u>	<u>Ch</u>	<u>Control</u>	<u>Freq</u>	<u>Vol</u>	<u>Pt</u>	<u>Sz</u>
00	Free	R	00001000	00AB	00	00	00	→	01	Free	L	00010000	00AB	21	4C	09
02	Free	R	00000011	00AB	00	00	00	→	03	Free	R	00000000	00AB	10	4C	09
04	Free	R	00001000	011F	00	00	00	→	05	Free	R	00000000	011F	4E	4E	09
06	Free	R	00000011	011F	00	00	00	→	07	Free	L	00010000	011F	27	4E	09
08	Free	R	00001000	0156	00	00	00	→	09	Free	R	00000000	0156	05	76	09
0A	Free	R	00000011	0156	00	00	00	→	0B	Free	L	00010000	0156	02	76	09
0C	Free	L	00010000	0008	00	00	3F	→	0D	Swap	L	00010110	0008	8C	00	3F
0E	Swap	R	00000111	0008	46	00	3F	→	0F	Swap	R	00000110	0008	46	00	3F
10	Free	R	00000001	0000	00	00	00	→	11	Free	R	00000001	0000	00	00	00

No way back!

Swap Mode Bug

<u>Osc</u>	<u>Mode</u>	<u>Ch</u>	<u>Control</u>	<u>Freq</u>	<u>Vol</u>	<u>Pt</u>	<u>Sz</u>		<u>Osc</u>	<u>Mode</u>	<u>Ch</u>	<u>Control</u>	<u>Freq</u>	<u>Vol</u>	<u>Pt</u>	<u>Sz</u>
00	Free	R	00001000	00AB	00	00	00	→	01	Free	L	00010000	00AB	21	4C	09
02	Free	R	00000011	00AB	00	00	00	→	03	Free	R	00000000	00AB	10	4C	09
04	Free	R	00001000	011F	00	00	00	→	05	Free	R	00000000	011F	4E	4E	09
06	Free	R	00000011	011F	00	00	00	→	07	Free	L	00010000	011F	27	4E	09
08	Free	R	00001000	0156	00	00	00	→	09	Free	R	00000000	0156	05	76	09
0A	Free	R	00000011	0156	00	00	00	→	0B	Free	L	00010000	0156	02	76	09
0C	Free	L	00010000	0008	00	00	3F	→	0D	Swap	L	00010110	0008	8C	00	3F
0E	Swap	R	00000011	0008	46	00	3F	→	0F	Swap	R	00000110	0008	46	00	3F
10	Free	R	00000000	0000	00	00	00	→	11	Free	R	00000001	0000	00	00	00

No way back!

Click

Swap Mode Bug

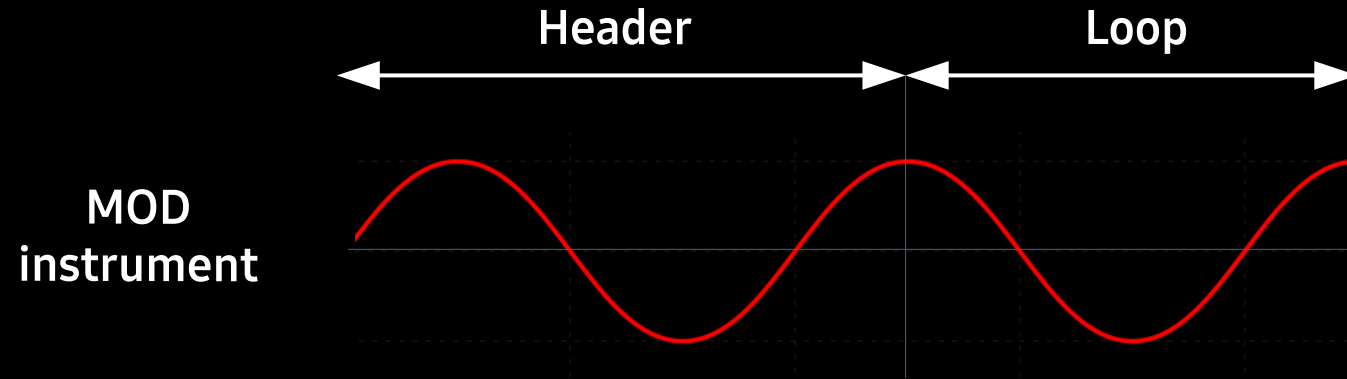
<u>Osc</u>	<u>Mode</u>	<u>Ch</u>	<u>Control</u>	<u>Freq</u>	<u>Vol</u>	<u>Pt</u>	<u>Sz</u>	<u>Osc</u>	<u>Mode</u>	<u>Ch</u>	<u>Control</u>	<u>Freq</u>	<u>Vol</u>	<u>Pt</u>	<u>Sz</u>
00	Free	R	00001000	0000	00	00	00	00	Free	R	00000000	0156	05	4C	09
02	Free	R	00001000	0000	00	00	00	02	Free	R	00000000	0156	05	4C	09
04	Free	R	00001000	0000	00	00	00	04	Free	R	00000000	0156	05	4E	09
06	Free	R	00001000	0000	00	00	00	06	Free	R	00000000	0156	05	4E	09
08	Free	R	00001000	0000	00	00	00	08	Free	R	00000000	0156	05	4E	09
0A	Free	R	00001000	0000	00	00	00	0A	Free	R	00000000	0156	05	76	09
0C	Free	R	00001000	0000	00	00	00	0C	Free	R	00000000	0156	02	76	09
0E	Swap	R	00000111	0008	46	00	3F	0D	Swap	L	00010110	0008	8C	00	3F
10	Free	R	00000001	0000	00	00	00	0F	Swap	R	00000110	0008	46	00	3F
11	Free	R	00000001	0000	00	00	00	11	Free	R	00000001	0000	00	00	00

Apple IIGS Technote #11
Ensoniq DOC Swap-Mode Anomaly

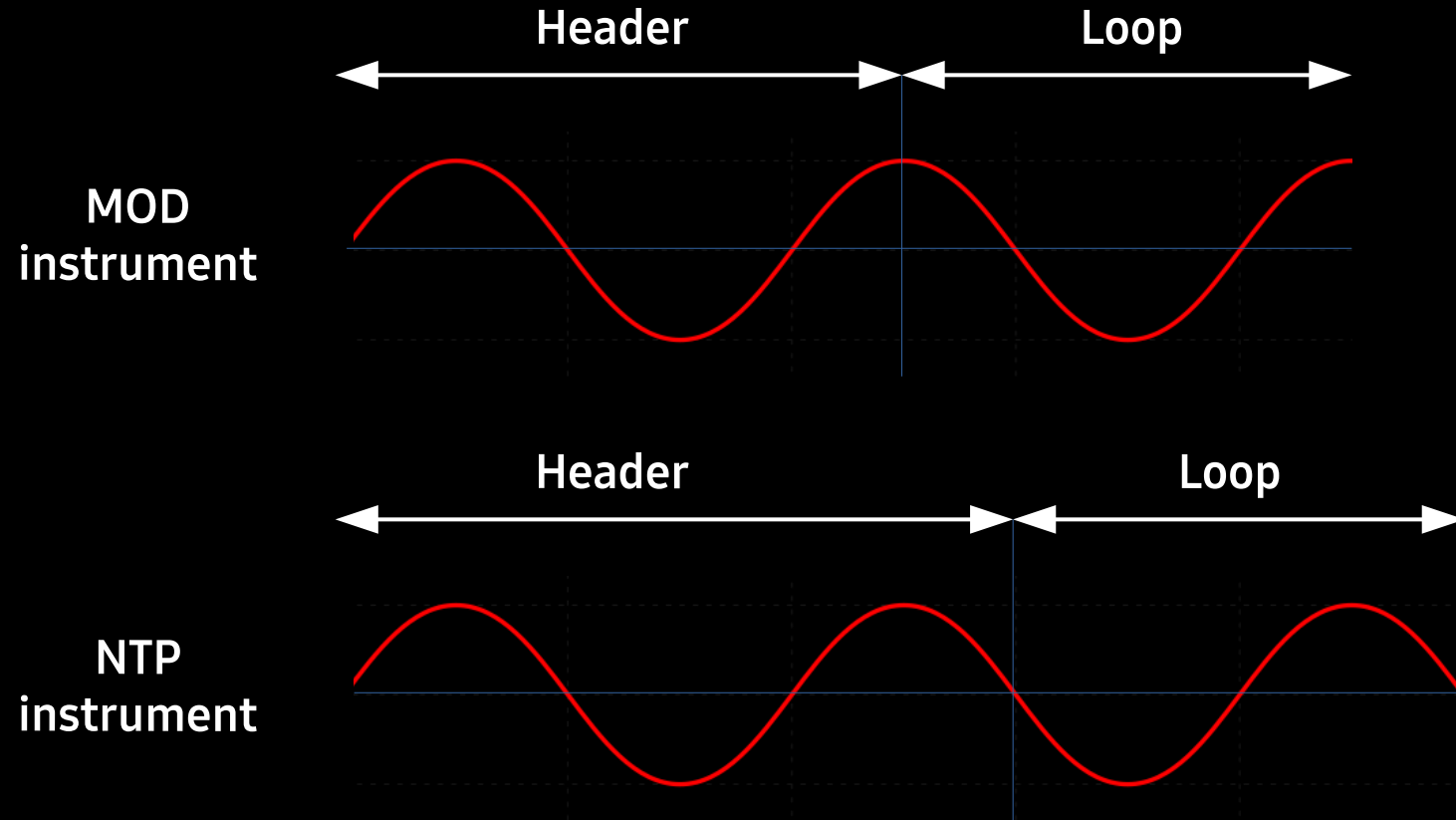
Click

No way back!

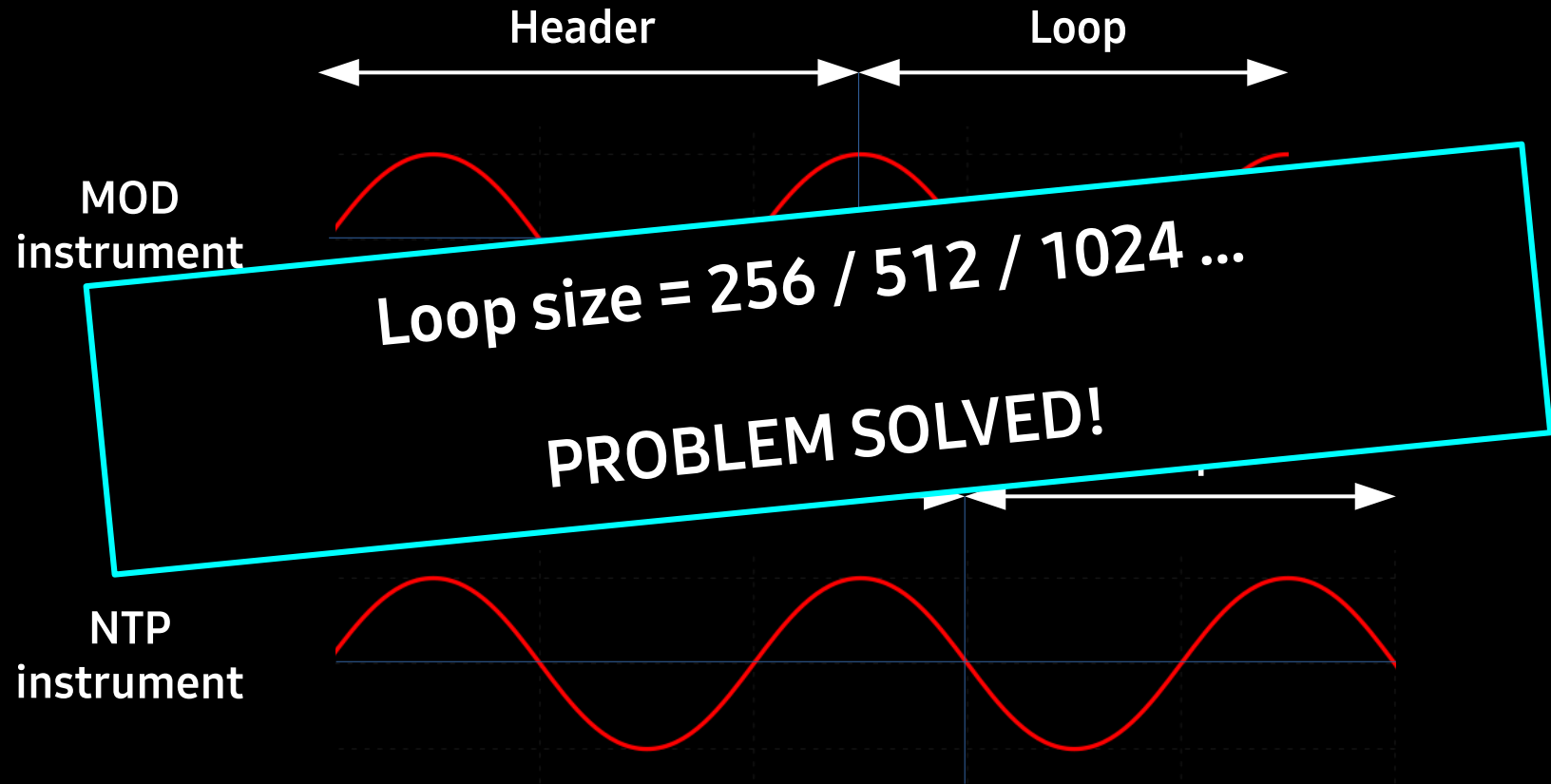
Swap Mode Bug



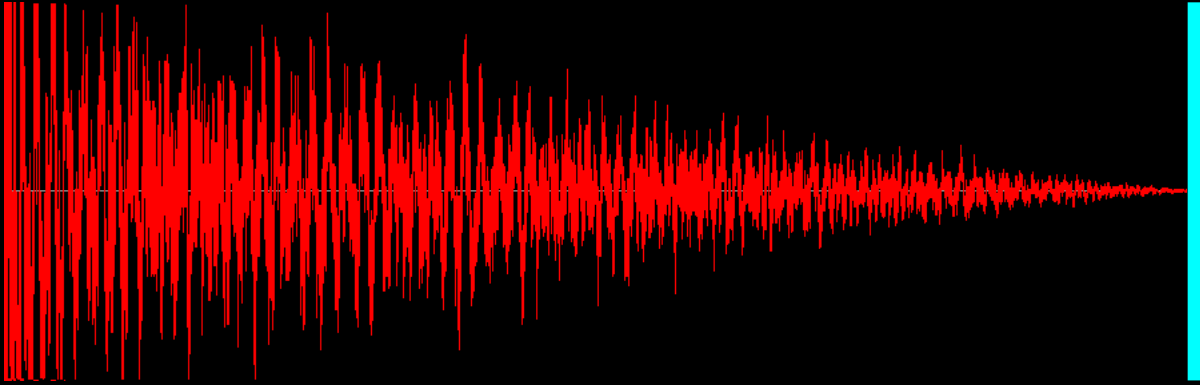
Swap Mode Bug



Swap Mode Bug



Playing Waves



One Pointer per Osc.

Start on page boundary

Step Size = Frequency

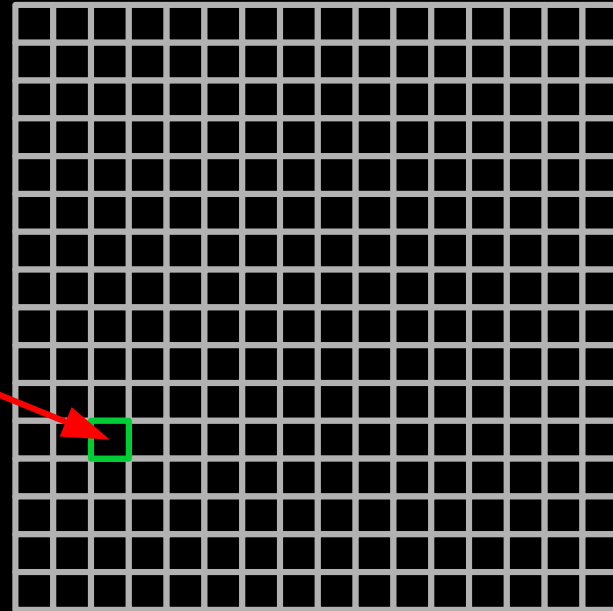
Playing Waves

Wave Size: 256 Bytes

Address Bus Resolution: 0

Pointer Register
[11000010]

Final address: \$B2 00



64KB Sound Ram

Playing Waves

Wave Size: 256 Bytes

Address Bus Resolution: 0

Pointer Register
[11000010]

Frequency
[00000001] [10000000]

Accumulator
[00000000] [00000000] [00000000]

↓ Add ↓

Final address: \$B2 00



Playing Waves

Wave Size: 256 Bytes

Address Bus Resolution: 0

Pointer Register
[11000010]

Frequency
[00000001] [10000000]

Accumulator



Add



[00000000] [00000001] [10000000]

Final address: \$B2 01

Playing Waves

Wave Size: 256 Bytes

Address Bus Resolution: 0

Pointer Register
[11000010]

Frequency
[00000001] [10000000]

Accumulator ↓ Add ↓
[00000000] [00000011] [00000000]

Final address: \$B2 03

Playing Waves

Wave Size: 256 Bytes

Address Bus Resolution: 0

Pointer Register
[11000010]

Frequency
[00000001] [10000000]

Accumulator ↓ Add ↓
[00000000] [00000100] [10000000]

Final address: \$B2 04

Playing Waves

Wave Size: 256 Bytes

Address Bus Resolution: 0

Pointer Register
[11000010]

Frequency
[00000001] [10000000]

Accumulator ↓ Add ↓
[00000000] [00000101] [10000000]

Final address: \$B2 05

Playing Waves

Wave Size: 512 Bytes

Address Bus Resolution: 0

Pointer Register

[00000010]



Frequency

[00000000] [00000000]

Accumulator

[00000000] [00000000] [00000000]



Final address: \$02 00

Playing Waves

Wave Size: 1024 Bytes

Address Bus Resolution: 0

Pointer Register

[00000100]



Frequency

[00000000] [00000000]

Accumulator

[00000000] [00000000] [00000000]



Final address: \$04 00

Playing Waves

Wave Size: 2048 Bytes

Address Bus Resolution: 0

Pointer Register

[00001000]



Frequency

[00000000] [00000000]

Accumulator

[00000000] [00000000] [00000000]



Final address: \$08 00

Playing Waves

Wave Size: 4096 Bytes

Address Bus Resolution: 0

Pointer Register

[00010000]



Frequency

[00000000] [00000000]

Accumulator

[00000000] [00000000] [00000000]



Final address: \$10 00

Playing Waves

Wave Size: 8192 Bytes

Address Bus Resolution: 0

Pointer Register

[00100000]



Frequency

[00000000] [00000000]

Accumulator

[00000000] [00000000] [00000000]



Final address: \$20 00

Playing Waves

Wave Size: 16384 Bytes

Address Bus Resolution: 0

Pointer Register

[01000000]



Frequency

[00000000] [00000000]

Accumulator

[00000000] [00000000] [00000000]



Final address: \$40 00

Playing Waves

Wave Size: 32768 Bytes

Address Bus Resolution: 0

Pointer Register

[100000000]



Frequency

[000000000] [000000000]

Accumulator

[000000000] [000000000] [000000000]



Final address: \$80 00

Playing Waves

Wave Size: 256 Bytes

Address Bus Resolution: 0

Pointer Register
[00000000]

Frequency
[00000000] [00000000]

Accumulator
[00000000] [00000000] [00000000]

Final address: \$00 00

Playing Waves

Wave Size: 256 Bytes

Address Bus Resolution: 1

Pointer Register
[00000000]

Frequency
[00000000] [00000000]

Accumulator
[00000000] [00000000] [00000000]

Final address: \$00 00



Playing Waves

Wave Size: 256 Bytes

Address Bus Resolution: 2

Pointer Register
[00000000]

Frequency
[00000000] [00000000]

Accumulator
[00000000] [00000000] [00000000]

Final address: \$00 00



Playing Waves

Wave Size: 256 Bytes

Address Bus Resolution: 3

Pointer Register
[00000000]

Frequency
[00000000] [00000000]

Accumulator
[00000000] [00000000] [00000000]

Final address: \$00 00



Playing Waves

Wave Size: 256 Bytes

Address Bus Resolution: 4

Pointer Register
[00000000]

Frequency
[00000000] [00000000]

Accumulator
[00000000] [00000000] [00000000]

Final address: \$00 00



Playing Waves

Wave Size: 256 Bytes

Address Bus Resolution: 5

Pointer Register
[00000000]

Frequency
[00000000] [00000000]

Accumulator
[00000000] [00000000] [00000000]

Final address: \$00 00



Playing Waves

Wave Size: 256 Bytes

Address Bus Resolution: 6

Pointer Register
[00000000]

Frequency
[00000000] [00000000]

Accumulator
[00000000] [00000000] [00000000]

Final address: \$00 00



Playing Waves

Wave Size: 256 Bytes

Address Bus Resolution: 7

Pointer Register
[00000000]

Frequency
[00000000] [00000000]

Accumulator
[00000000] [00000000] [00000000]



Final address: \$00 00

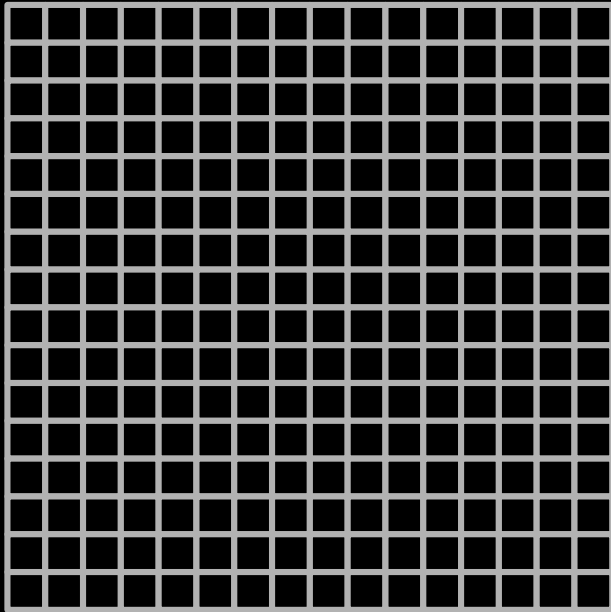
Breathe

NTP Converter Magic

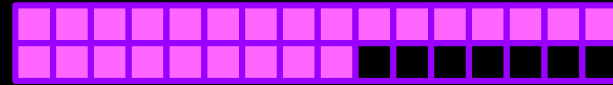
- Convert instruments
- Add stopper bytes
- Split instruments
- Pick oscillator modes
- Mitigate swap mode bug
- Arrange waves in sound ram

Sound Ram Tetris

- Smallest unit 256 bytes



64KB Sound Ram



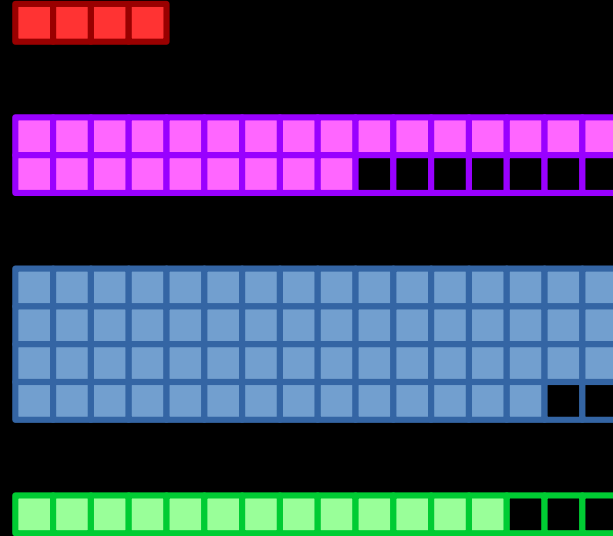
Instruments

Sound Ram Tetris

- Smallest unit 256 bytes



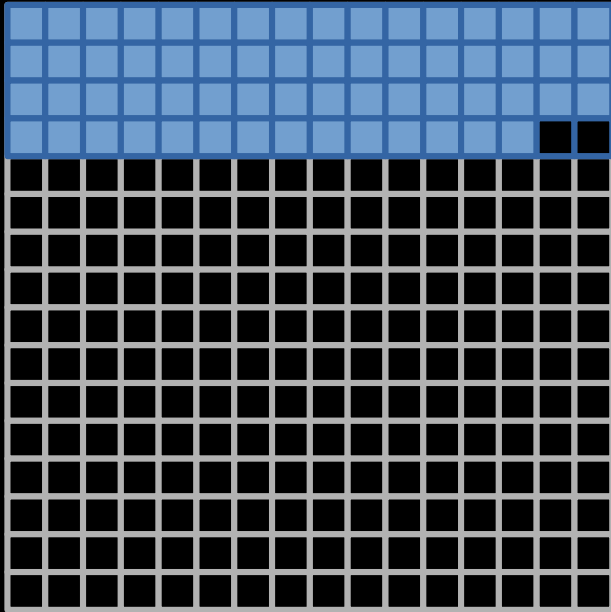
64KB Sound Ram



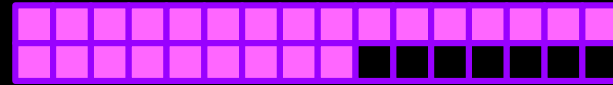
Instruments

Sound Ram Tetris

- Smallest unit 256 bytes



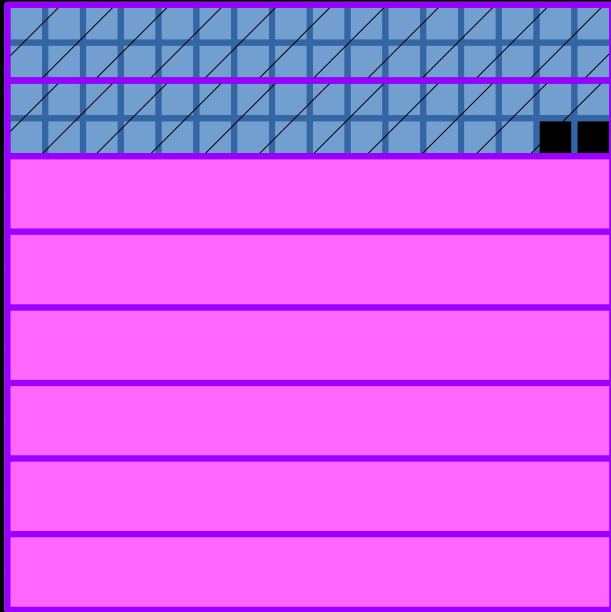
64KB Sound Ram



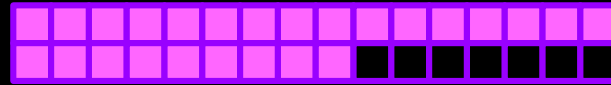
Instruments

Sound Ram Tetris

- Smallest unit 256 bytes



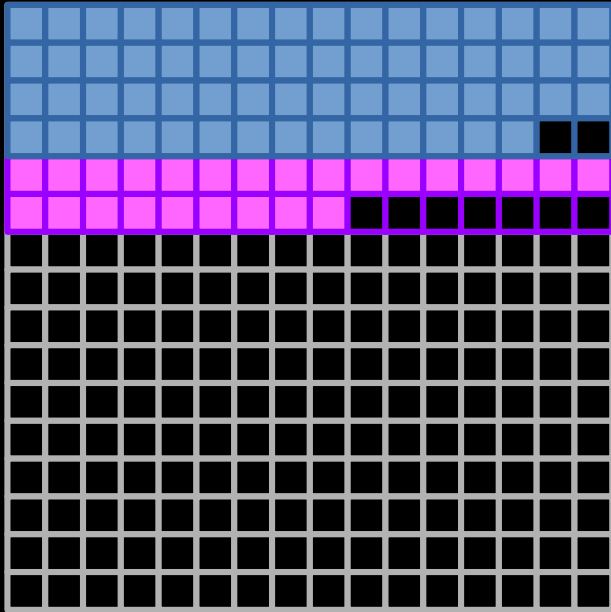
64KB Sound Ram



Instruments

Sound Ram Tetris

- Smallest unit 256 bytes



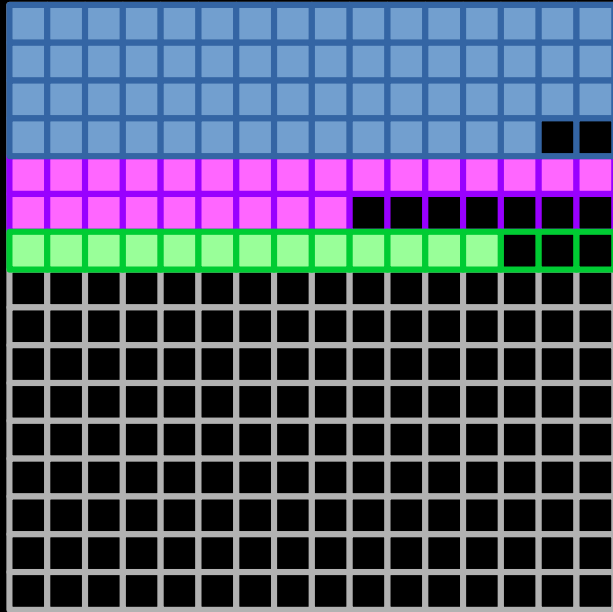
64KB Sound Ram



Instruments

Sound Ram Tetris

- Smallest unit 256 bytes



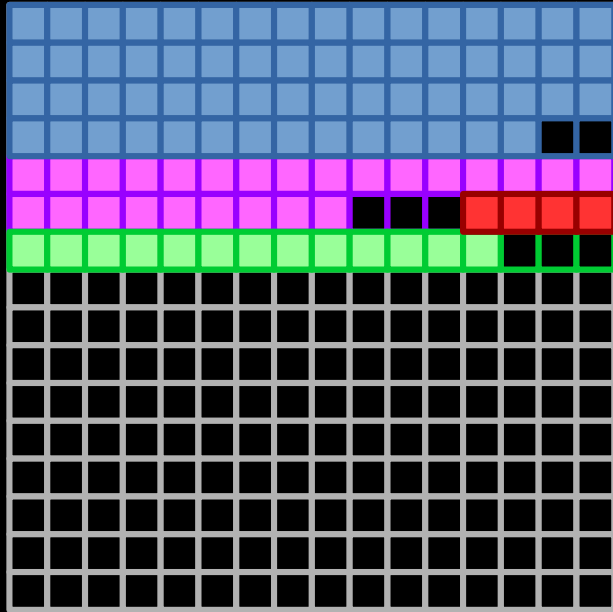
64KB Sound Ram



Instruments

Sound Ram Tetris

- Smallest unit 256 bytes

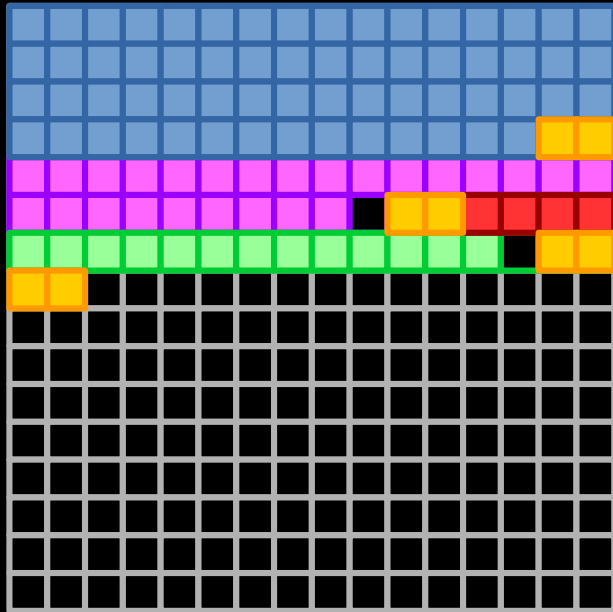


64KB Sound Ram

Instruments

Streaming!

- Smallest unit 256 bytes

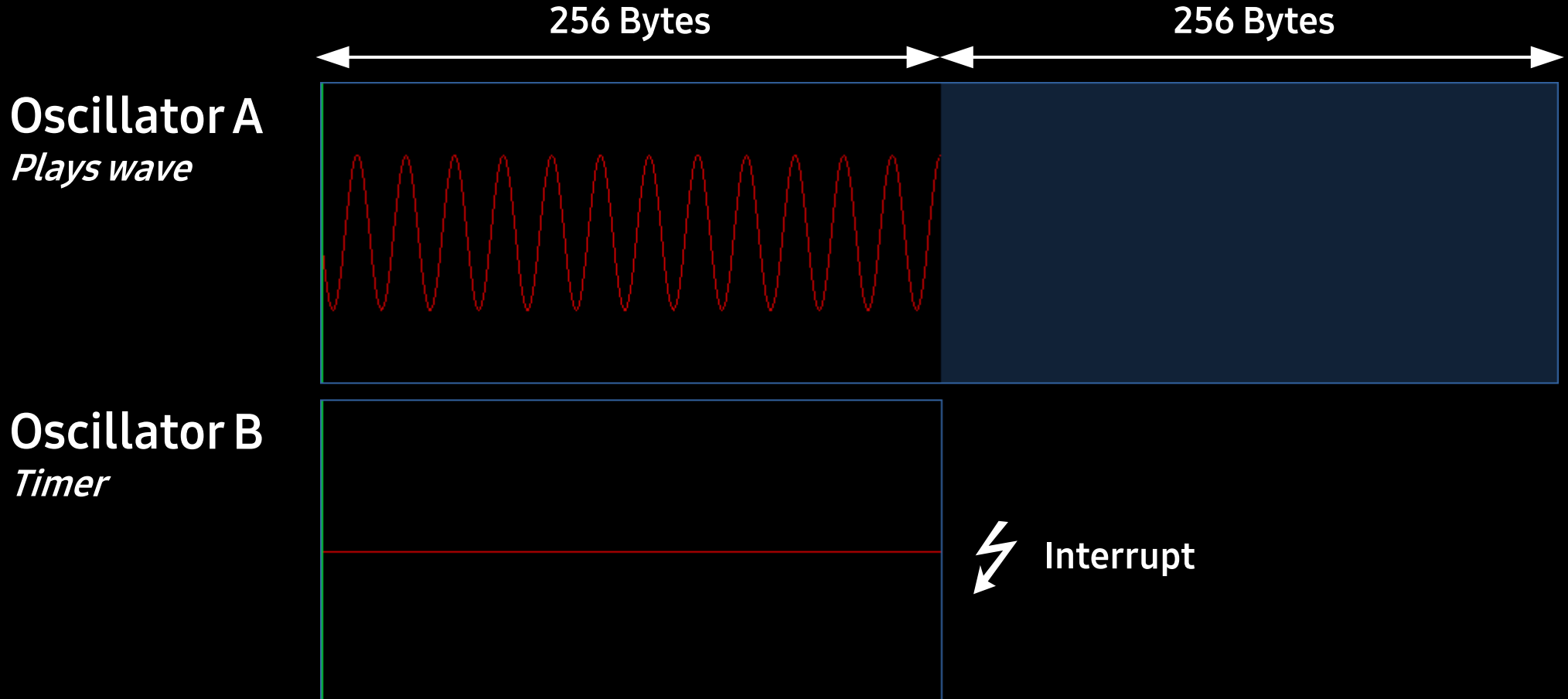


64KB Sound Ram

 Stream buffers

- one per track
- 512 bytes each
- placed like regular instruments

Streaming!



Streaming!

Pros

- Any sample size is fine
- 4 tracks play fine
- Supports effect #9
sample offset

Cons

- Eats processor time
- Limits unknown

NTP Evolution

NTP Evolution

Version 1.2

- instruments in sound ram
- support for up to 15 tracks
- 28 effects supported (out of 31)
- online converter

Used in „No Hard Feelings“ for Revision 2021

NTP Evolution

Version 1.3

- streaming instruments
- 30 effects supported (out of 31)
- channel doubling

NTP Evolution

Version 1.4

- support for up to 31 tracks

...

31 Tracks

- How many Oscillators does each instrument require?

What	Ideal size	Oscillators
One shot	-	1
Loop only	yes / no	1 / 2
Header and Loop	-	2
Streamed	-	2

- Which tracks contain which instruments?

→ 1-osc-track or 2-osc-track

NTP Evolution

Version 1.4

- support for up to 31 tracks
- master volume
- stream sound
- conversion information

ninjaforce.com/ntp

TL; DR

Programmers:

- Need speed?
Yes = only sound ram
No = streaming allowed
- Sound FX?

Musicians:

- Loop size = 256, 512, ... !!!
- Only 64k for instruments?
- How many tracks?

Lessons Learned

Turning it off and on again

#4	Channel 2	Channel 3	Channel 4	Channel 5	C
	---	---	---	---	
0	F-5 01 64 ---	F-6 04 -- C16	F-6 06 64 ---	F-4 07 64 ---	F-4
1	---	F-6 04 -- C13			---
2	---	F-6 04 -- C18			F-4
3	---	F-6 04 --			---
4	F-5 01 64 ---	F-6 04 -- C13		F-4 07 64 ---	F-4
5	---	F-6 04 -- C20			---
6	---	F-6 04 -- C13		F-4 07 -- C18	F-4
7	F-5 01 -- C16	F-6 04 -- C13			---
8	F-5 01 64 ---	F-6 04 -- C16		F-4 07 -- C18	F-4
9	---	F-6 04 -- C13			---
10	---	F-6 04 -- C20		F-4 07 64 ---	F-4
11	---	F-6 04 -- C13			---
12	F-5 01 64 ---	F-6 04 -- C16		F-4 07 -- C18	F-4
13	---	F-6 04 -- C13			---
14	---	F-6 04 -- C20		F-4 07 64 ---	F-4
15	F-5 01 -- C16	F-6 04 -- C13			---
16	F-5 01 64 ---	F-6 04 -- C16		F-4 07 64 ---	F-4
17	---	F-6 04 -- C13			---
18	---	F-6 04 -- C20		F-4 07 -- C18	F-4
19	---	F-6 04 -- C13			---

Not played!!!

Turning it off and on again

#4	Channel 2	Channel 3	Channel 4	Channel 5	C
	---	---	---	---	
0	F-5 01 64 ---	F-6 04 -- C16	F-6 06 64 ---	F-4 07 64 ---	F-4
1	---	F-6 04 -- C13			---
2	---	F-6 04 --		C18	F-4
3	---	F-6 04 --			---
4	F-5 01 64 ---	F-6 04 --		64 ---	F-4
5	---	F-6 04 -- C13			---
6	---	F-6 04 -- C20		F-4 07 -- C18	F-4
7	F-5 01 -- C1F	F-6 04 -- C13			---
8	F-5 01 64 ---	F-6 04 -- C16		F-4 07 -- C18	F-4
9	---	F-6 04 -- C13			---
10	---	F-6 04 -- C20		F-4 07 64 ---	F-4
11	---	F-6 04 -- C13			---
12	F-5 01 64 ---	F-6 04 -- C16		F-4 07 -- C18	F-4
13	---	F-6 04 -- C13			---
14	---	F-6 04 -- C20		F-4 07 64 ---	F-4
15	F-5 01 -- C1F	F-6 04 -- C13			---
16	F-5 01 64 ---	F-6 04 -- C16		F-4 07 64 ---	F-4
17	---	F-6 04 -- C13			---
18	---	F-6 04 -- C20		F-4 07 -- C18	F-4
19	---	F-6 04 -- C13			---

WTF?

New note:

Stop Oscillator

Start Oscillator

Turning it off and on again

#4	Channel 2	Channel 3	Channel 4	Channel 5	C
	---	---	---	---	
0	F-5 01 064 ---	F-6 04 -- C16	F-6 06 064 ---	F-4 07 064 ---	F-4
1	---	F-6 04 -- C13	---	---	---
2	---	F-6 04 --	---	---	---
3	---	F-6 04 --	---	---	---
4	F-5 01 064 ---	F-6 04 --	---	---	F-4
5	---	F-6 04 -- C13	---	---	---
6	---	F-6 04 -- C20	---	F-4 07 -- C18	F-4
7	F-5 01 -- C1F	F-6 04 -- C13	---	---	---
8	F-5 01 064 ---	F-6 04 -- C16	---	F-4 07 -- C18	F-4
9	---	F-6 04 -- C13	---	---	---
10	---	F-6 04 -- C20	---	F-4 07 064 ---	F-4
11	---	F-6 04 -- C13	---	---	---
12	F-5 01 064 ---	F-6 04 -- C16	---	F-4 07 -- C18	F-4
13	---	F-6 04 -- C13	---	---	---
14	---	F-6 04 -- C20	---	F-4 07 064 ---	F-4
15	F-5 01 -- C1F	F-6 04 -- C13	---	---	---
16	F-5 01 064 ---	F-6 04 -- C16	---	F-4 07 064 ---	F-4
17	---	F-6 04 -- C13	---	---	---
18	---	F-6 04 -- C20	---	F-4 07 -- C18	F-4
19	---	F-6 04 -- C13	---	---	---

WTF?

Stop Oscillator

Osc Mode Ch Control

00 Free R 000000001

Start Oscillator

Turning it off and on again

#4	Channel 2	Channel 3	Channel 4	Channel 5	C
	---	---	---	---	
0	F-5 01 064 ---	F-6 04 -- C16	F-6 06 064 ---	F-4 07 064 ---	F-4
1	---	F-6 04 -- C13	---	---	---
2	---	F-6 04 --	---	---	---
3	---	F-6 04 -- C18	---	---	F-4
4	F-5 01 064 ---	F-6 04 --	---	---	F-4
5	---	F-6 04 -- C13	---	---	---
6	---	F-6 04 -- C20	---	F-4 07 -- C18	F-4
7	F-5 01 -- C1F	F-6 04 -- C13	---	---	---
8	F-5 01 064 ---	F-6 04 -- C16	---	F-4 07 -- C18	F-4
9	---	F-6 04 -- C13	---	---	---
10	---	F-6 04 -- C20	---	F-4 07 064 ---	F-4
11	---	F-6 04 -- C13	---	---	---
12	F-5 01 064 ---	F-6 04 -- C16	---	F-4 07 -- C18	F-4
13	---	F-6 04 -- C13	---	---	---
14	---	F-6 04 -- C20	---	F-4 07 064 ---	F-4
15	F-5 01 -- C1F	F-6 04 -- C13	---	---	---
16	F-5 01 064 ---	F-6 04 -- C16	---	F-4 07 064 ---	F-4
17	---	F-6 04 -- C13	---	---	---
18	---	F-6 04 -- C20	---	F-4 07 -- C18	F-4
19	---	F-6 04 -- C13	---	---	---

Much better!

1. Stop Oscillator

~~Osc Mode Ch Control~~
~~00 Free R 00000001~~

Osc Mode Ch Control
00 One R 00000011

2. Start Oscillator

Vexing Volume Vibrato

- Play note F-6
- Instrument 05 (default volume 32)
- Reduce volume by 8 every tick

#2	Channel 1	Channel 2	Channel 3	Channel 4
	---	---	---	---
0	D-5 01 ₆₄ A08	D-6 03 ₄₈ F05	D-6 07 ₂₄ A04	F-6 05 ₃₂ A08
1 A08	D-6 08 ₁₆ A04	... 05 .. A08
2	D-6 01 ₆₄ A0F	D-6 10 ₆₄ ...	C-6 07 ₂₄ A04	... 05 .. A08
3	D-5 C10	D-6 08 ₁₆ A04	... 05 .. A08
4	D-5 01 ₆₄ A0F	D-6 13 ₄₈ ...	A-5 07 ₂₄ A04	... 05 .. A08
5	D-6 01 ₆₄ A0F	C-6 08 ₁₆ A04	... 05 .. A08
6	C-5 01 ₆₄ A0F	D-6 10 ₆₄ ...	G-5 07 ₂₄ A04	... 05 .. A08
7	D-6 C10	D-6 10 .. C20	A-5 08 ₁₆ A04	... 05 .. A08
8	A-4 01 ₆₄ A08	D-6 03 ₄₈ ...	D-5 07 ₂₄ A04	... 05 .. A08
9 A08	G-5 08 ₁₆ A04	... 05 .. A08
10	A-5 01 ₆₄ A0F	D-6 03 ₄₈ ...	C-5 07 ₂₄ A04	... 05 .. A08
11	A-4 C10	D-5 08 ₁₆ A04	... 05 .. A08
12	C-5 01 ₆₄ A08	D-6 13 ₄₈ ...	A-4 07 ₂₄ A04	... 05 .. A08
13 A08	C-5 08 ₁₆ A04	... 05 .. A08
14	C-6 01 ₆₄ A0F	D-6 10 ₆₄ ...	G-4 07 ₂₄ A04	... 05 .. A08
15	C-5 C10	A-4 08 ₁₆ A04	... 05 .. A08
16	D-5 01 ₆₄ A08	D-6 03 ₄₈ ...	C-5 07 ₂₄ A04	D#6 06 ₃₂ A08
17 A08	G-4 08 ₁₆ A04	... 06 .. A08
18	D-6 01 ₆₄ A0F	D-6 10 ₆₄ ...	A-4 07 ₂₄ A04	... 06 .. A08
19	D-5 C10	C-5 08 ₁₆ A04	... 06 .. A08

- Set volume to instrument default (32)
- Reduce volume by 8 every tick

Don't be too fast

1/1/22 14:29

UUC Registers

Mode	Ch	Control	Freq	Vol	Pt	Sz	Osc	Mode	Ch	Control	Freq	Vol	Pt	Sz
Free	R	00001000	00AB	00	00	80	01	Free	L	00010000	00AB	FF	4E	89
Free	R	00001000	0156	00	00	80	03	Free	R	00000000	011F	6C	74	89
Free	R	00001000	0156	00	00	80	05	Free	R	00000000	0156	8C	78	89
Swap	L	00010111	0008	EC	00	BF	07	Swap	L	00010110	0008	EC	00	BF
Free	R	000000001	0000	00	00	80	09	Free	R	000000001	0000	00	00	80
Free	R	000000001	0000	00	00	80	0B	Free	R	000000001	0000	00	00	80
Free	R	000000001	0000	00	00	80	0D	Free	R	000000001	0000	00	00	80
Free	R	000000001	0000	00	00	80	0F	Free	R	000000001	0000	00	00	80
Free	R	000000001	0000	00	00	80	11	Free	R	000000001	0000	00	00	80
Free	R	000000001	0000	00	00	80	13	Free	R	000000001	0000	00	00	80
Free	R	000000001	0000	00	00	80	15	Free	R	000000001	0000	00	00	80
Free	R	000000001	0000	00	00	80	17	Free	R	000000001	0000	00	00	80
Free	R	000000001	0000	00	00	80	19	Free	R	000000001	0000	00	00	80

Don't be too fast

1/1/22 14:29

UUC Registers

Mode	Ch	Control	Freq	Vol	Pt	Sz	Osc	Mode	Ch	Control	Freq	Vol	Pt	Sz
Free	R	00001000	0000	00	00	80	01	Free	L	00010000	0000	FF	4E	89
Free	R	00001000	0156	00	00	80	03	Free	R	00000000	011F	6C	74	89
Free	R	00001000	0136	00	00	80	05	Free	R	00000000	0136	8C	78	89
Swap	L	00010111	0008	EC	00	BF	07	Swap	L	00010110	0008	EC	00	BF
Free	R	00000000	0000	00	00	80	09	Free	R	00000000	0000	00	00	80
Free	R	00000000	0000	00	00	80	0B	Free	R	00000000	0000	00	00	80
Free	R	00000000	0000	00	00	80	0D	Free	R	00000000	0000	00	00	80
Free	R	00000000	0000	00	00	80	0F	Free	R	00000000	0000	00	00	80
Free	R	00000000	0000	00	00	80	11	Free	R	00000000	0000	00	00	80
Free	R	00000000	0000	00	00	80	13	Free	R	00000000	0000	00	00	80
Free	R	00000000	0000	00	00	80	15	Free	R	00000000	0000	00	00	80
Free	R	00000000	0000	00	00	80	17	Free	R	00000000	0000	00	00	80
Free	R	00000000	0000	00	00	80	19	Free	R	00000000	0000	00	00	80

FAIL

Don't be too fast

1/1/22 14:29

000 Registers

Mode	Ch	Control	Freq	Vol	Pt	Sz	Osc	Mode	Ch	Control	Freq	Vol	Pt	Sz
Free	R	00001000	0000	00	00	80	01	Free	L	00010000	0000	FF	4E	89
Free	R	00001000	0156	00	00	80	03	Free	R	00000000	011F	6C	74	89
Free	R	00001000	0136	00	00	80	05	Free	R	00000000	0136	8C	78	89
Swap	L	00010111	0008	EC	00	BF	07	Swap	L	00010110	0008	EC	00	BF
Free	R	00000000	0000	00	00	80	09	Free	R	00000001	0000	00	00	80
Free	R	00000000	0000	00	00	80	0B	Free	R	00000001	0000	00	00	80
Free	R	00000000	0000	00	00	80	0D	Free	R	00000001	0000	00	00	80
Free	R	00000000	0000	00	00	80	0F	Free	R	00000001	0000	00	00	80
Free	R	00000000	0000	00	00	80	11	Free	R	00000001	0000	00	00	80
Free	R	00000000	0000	00	00	80	13	Free	R	00000001	0000	00	00	80
Free	R	00000000	0000	00	00	80	15	Free	R	00000001	0000	00	00	80
Free	R	00000000	0000	00	00	80	17	Free	R	00000001	0000	00	00	80
Free	R	00000000	0000	00	00	80	19	Free	R	00000001	0000	00	00	80

FAIL

- Direct Page: \$C000 → sta DP
- Auto Increment Mode

Don't be too fast

1/1/22 14:29

DOC Registers

Mode	Ch	Control	Freq	Vol	Pt	Sz	Osc	Mode	Ch	Control	Freq	Vol	Pt	Sz
Free	R	00001000	0000	00	00	80	01	Free	L	00010000	0000	FF	4E	89
Free	R	00001000	0156	00	00	80	03	Free	R	00000000	011F	6C	74	89
Free	R	00001000	0136	00	00	80	05	Free	R	00000000	0136	8C	78	89
Swap	L	00010111	0008	EC	00	BF	07	Swap	L	00010110	0008	EC	00	BF
Free	R	00000000	0000	00	00	80	09	Free	R	00000001	0000	00	00	80
Free	R	00000000	0000	00	00	80	0B	Free	R	00000000	0000	00	00	80
Free	R	00000000	0000	00	00	80	0D	Free	R	00000000	0000	00	00	80
Free	R	00000000	0000	00	00	80	0F	Free	R	00000001	0000	00	00	80
Free	R	00000000	0000	00	00	80	11	Free	R	00000001	0000	00	00	80
Free	R	00000000	0000	00	00	80	13	Free	R	00000001	0000	00	00	80
Free	R	00000000	0000	00	00	80	15	Free	R	00000001	0000	00	00	80
Free	R	00000000	0000	00	00	80	17	Free	R	00000001	0000	00	00	80
Free	R	00000000	0000	00	00	80	19	Free	R	00000001	0000	00	00	80

FAIL

- Direct Page: \$C000 → sta DP

- Auto Increment Mode

lda frequency,x

sta \$3D

sta \$3D

DOC is busy
(sometimes)

Don't be too fast

...

sta \$3E ;prep pointer

lda frequency,x

sta \$3D

inc \$3E ;increment pointer

sta \$3D



Enough time
for DOC

Future

- More than 31 instruments?
- S3M Support?
- ADSR Support?
- Support for 128k sound ram?
- Register Streams?

Future

- More than 31 instruments?
- S3M Support?
- ADSR Support?
- Support for 128k sound ram?
- Register Streams?

Wrapping Up

- GS sound is special
- Use NTP
- Get in touch

Thank you!

Jesse Blue / Ninjaforce

www.ninjaforce.com