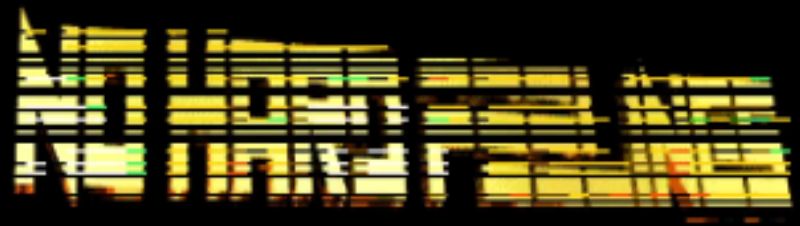
Playing music on the Apple IIGS with NinjaTrackerPlus (NTP)

Jesse Blue / Ninjaforce

www.ninjaforce.com

MEGA DEMO
CREDITS
AUTOMATE
INTRO
BONJOUR TOUS LE MONDE!

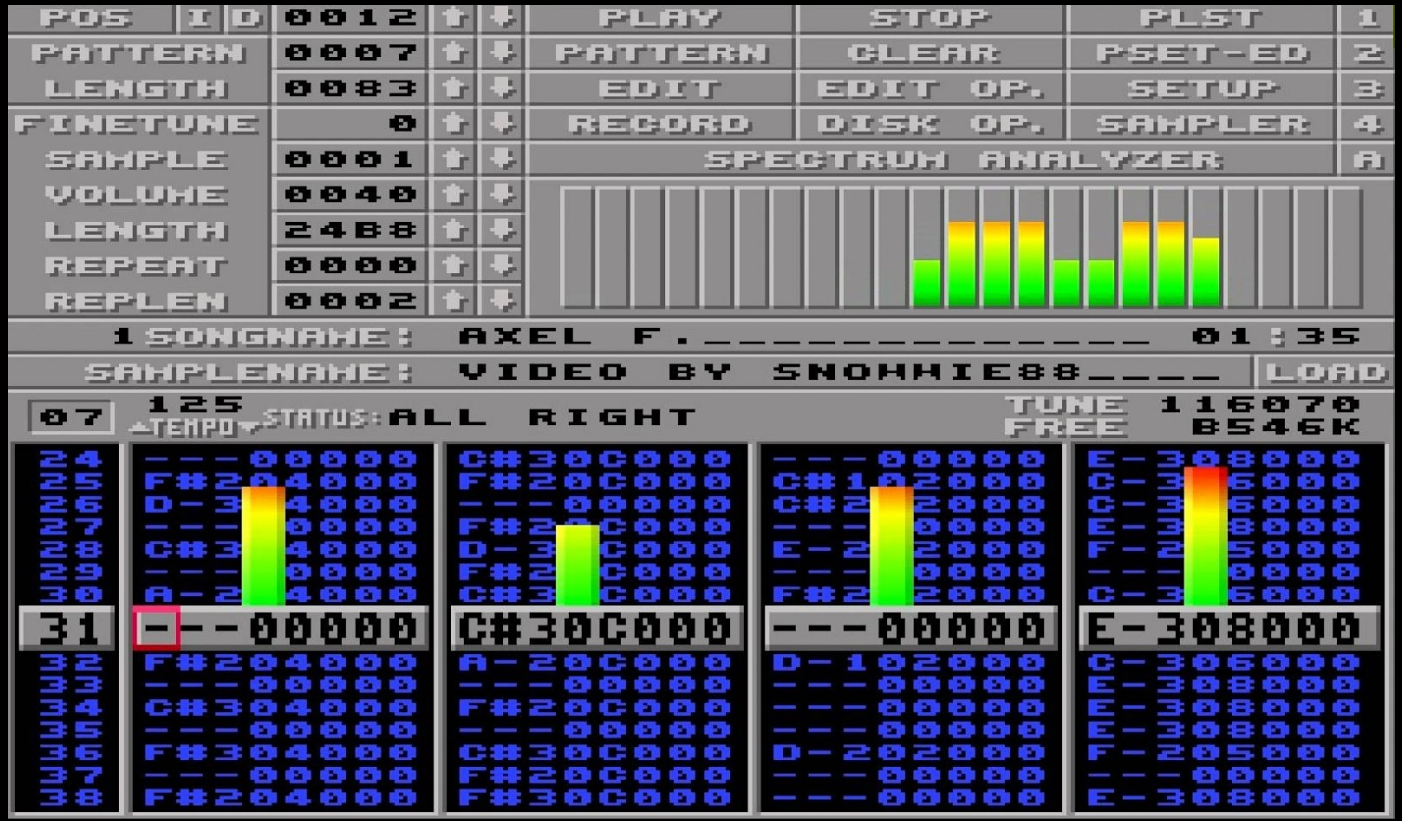


Focus

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

What is NinjaTrackerPlayer (NTP)?

- Music player for tracked music



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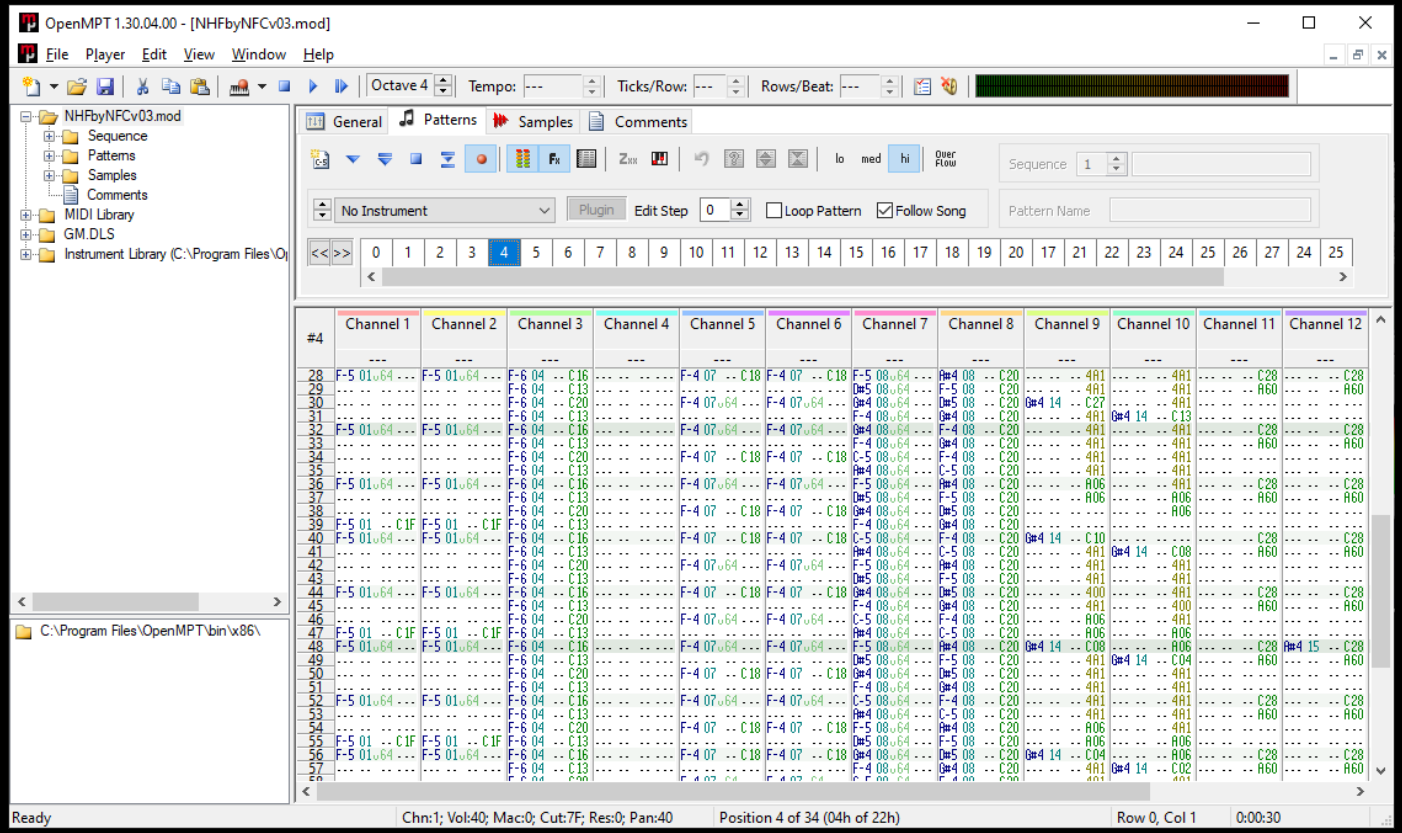
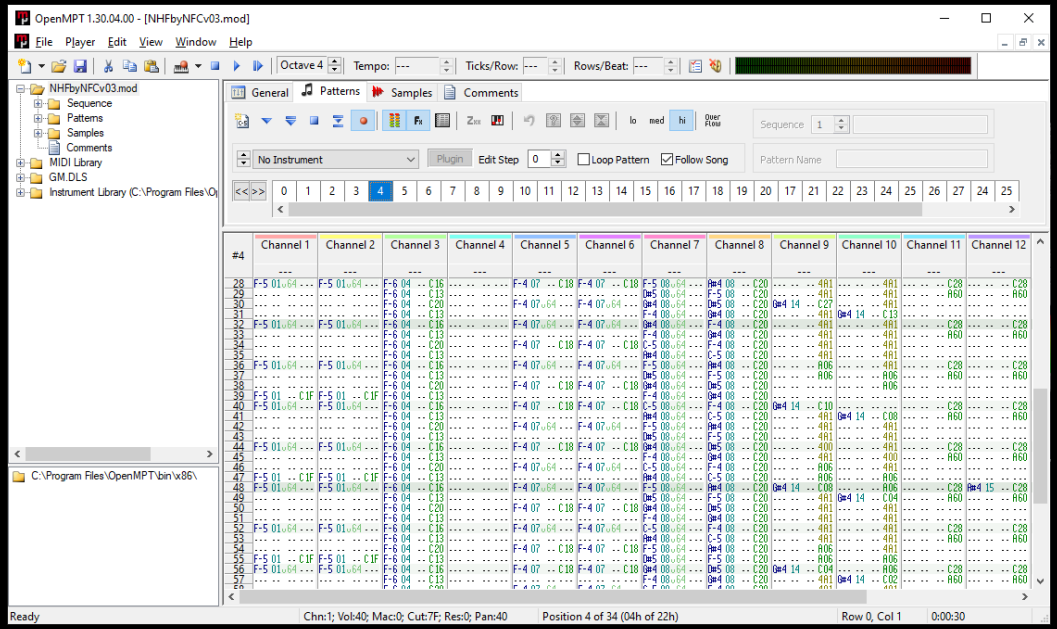


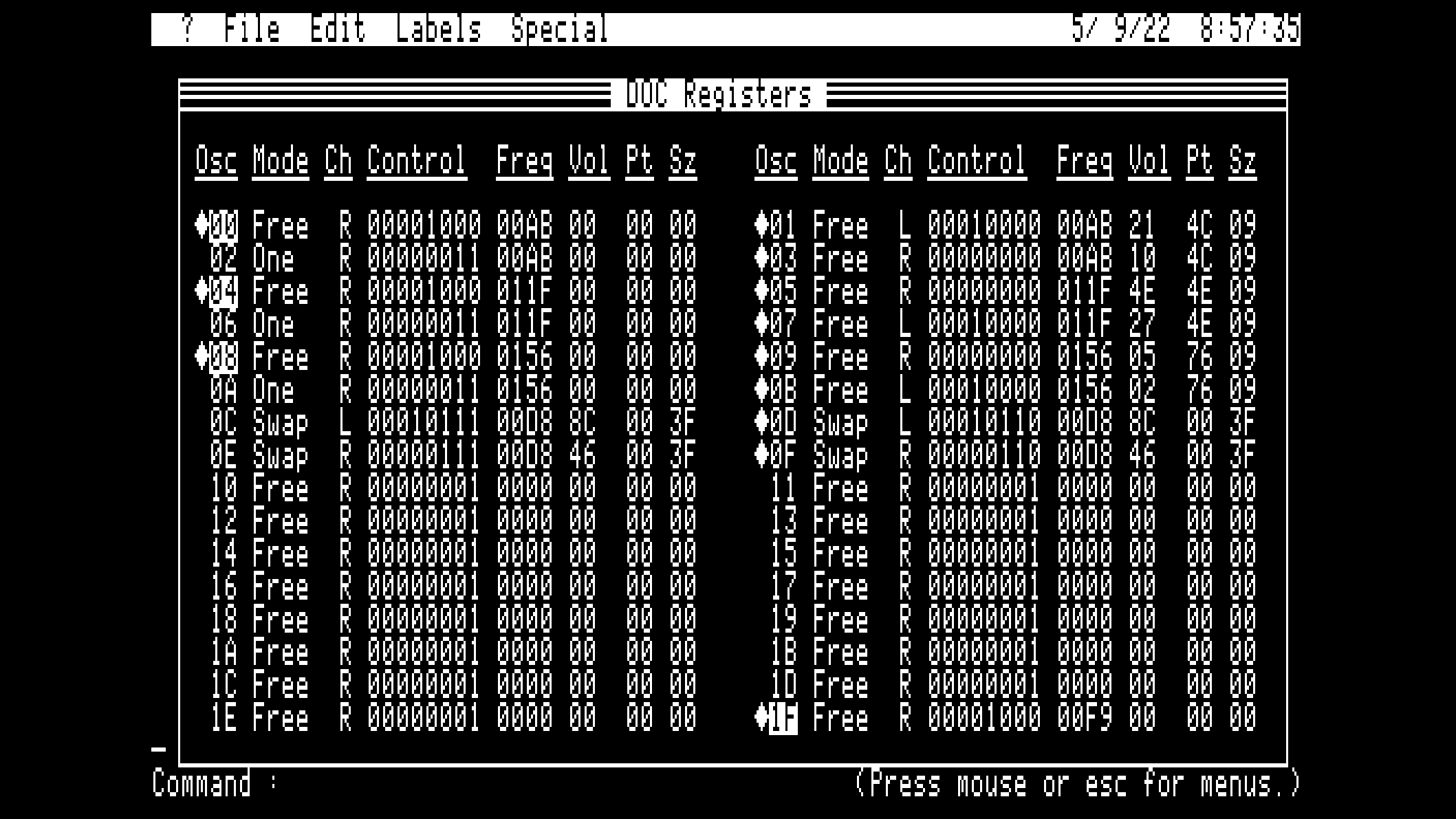
What is NinjaTrackerPlayer (NTP)?

- 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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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 00D8 8C 00 3F
0E Swap R 00000111 00D8 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
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1A Free R 00000001 0000 00 00 00
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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
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15 Free R 00000001 0000 00 00 00
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1D Free R 00000001 0000 00 00 00
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Command :
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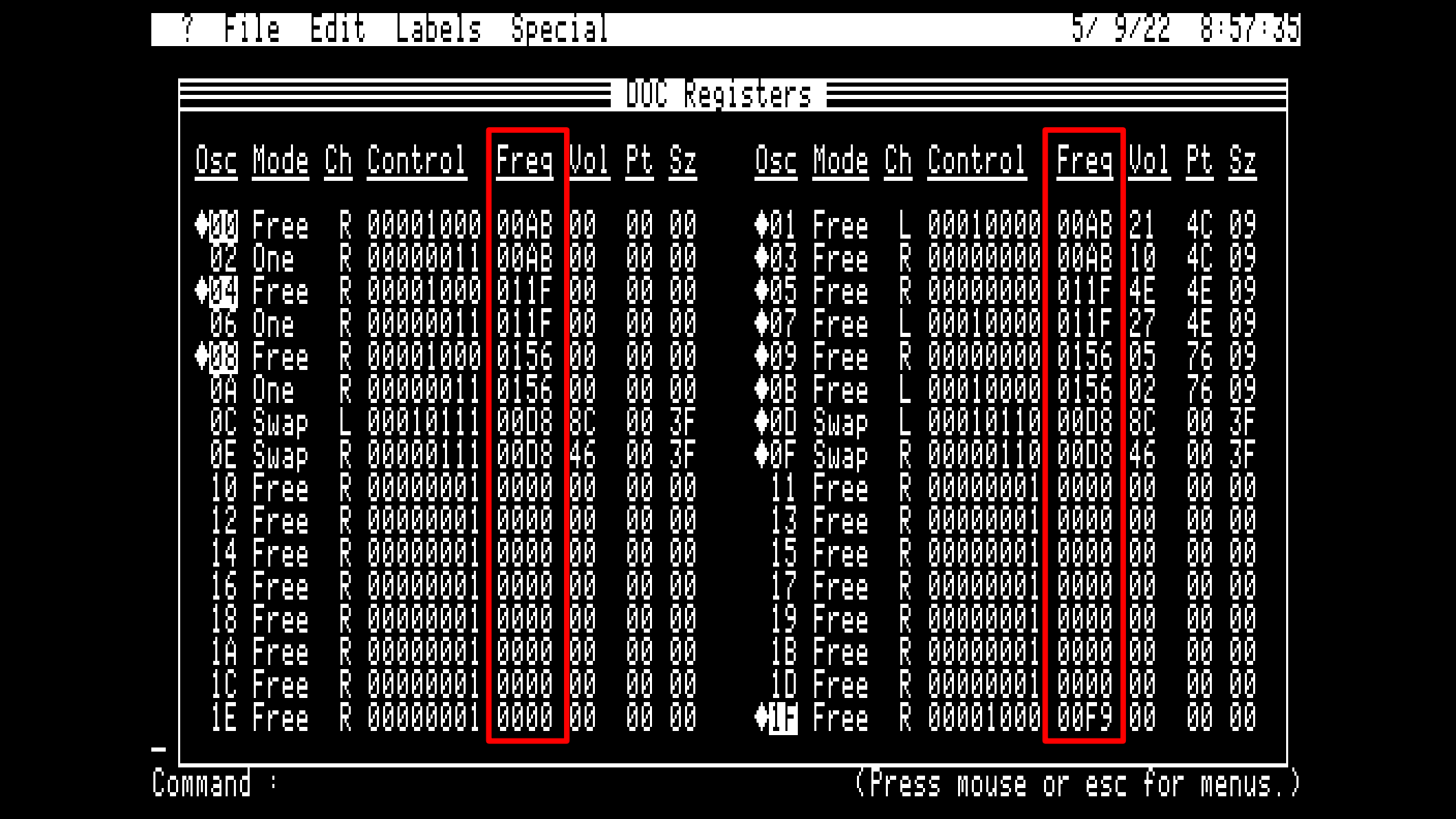
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01 Free L 00010000 00AB 21 4C 09
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09 Free R 00000000 0156 05 76 09
0B Free L 00010000 0156 02 76 09
0D Swap L 00010110 00D8 8C 00 3F
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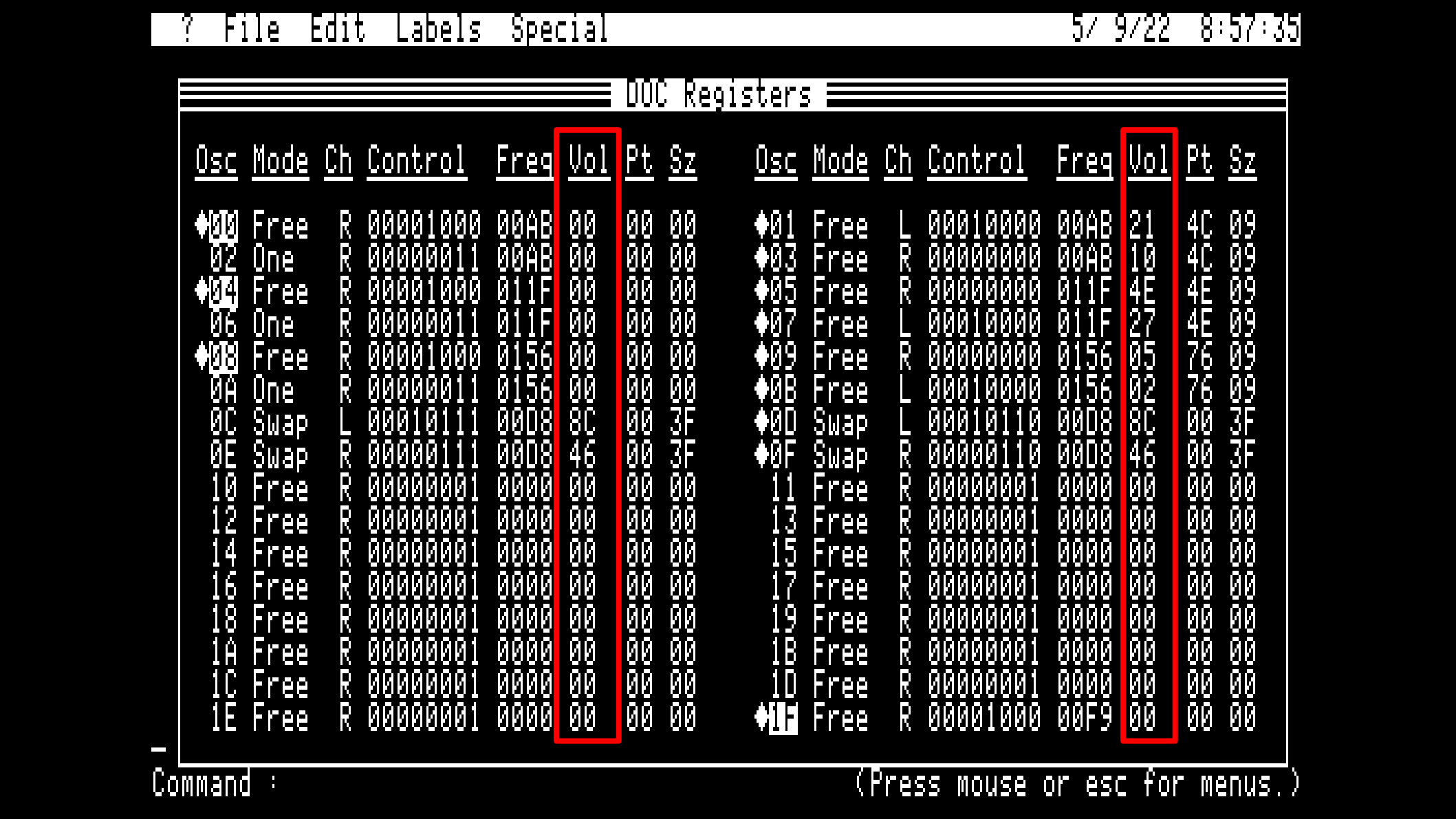
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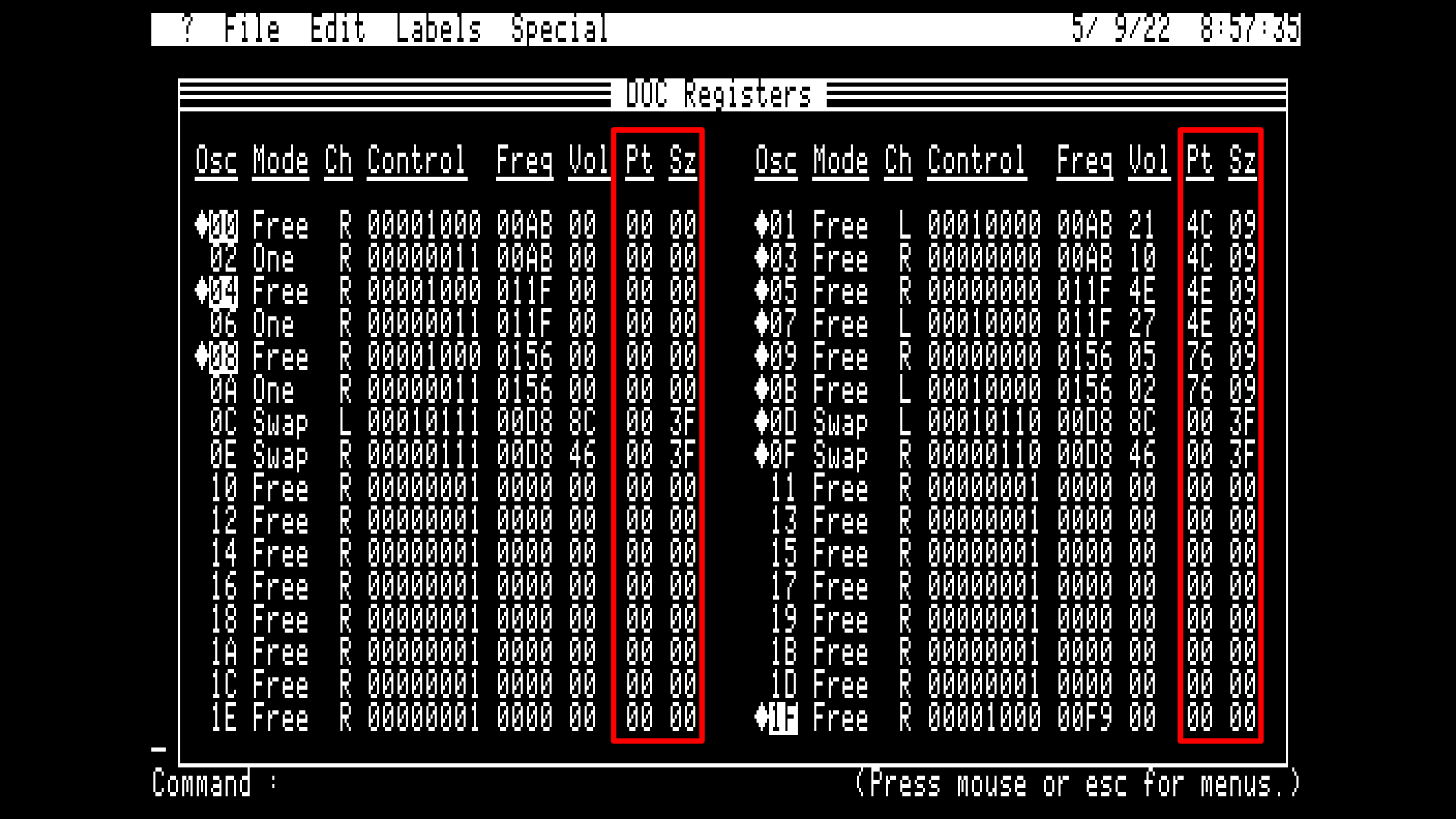
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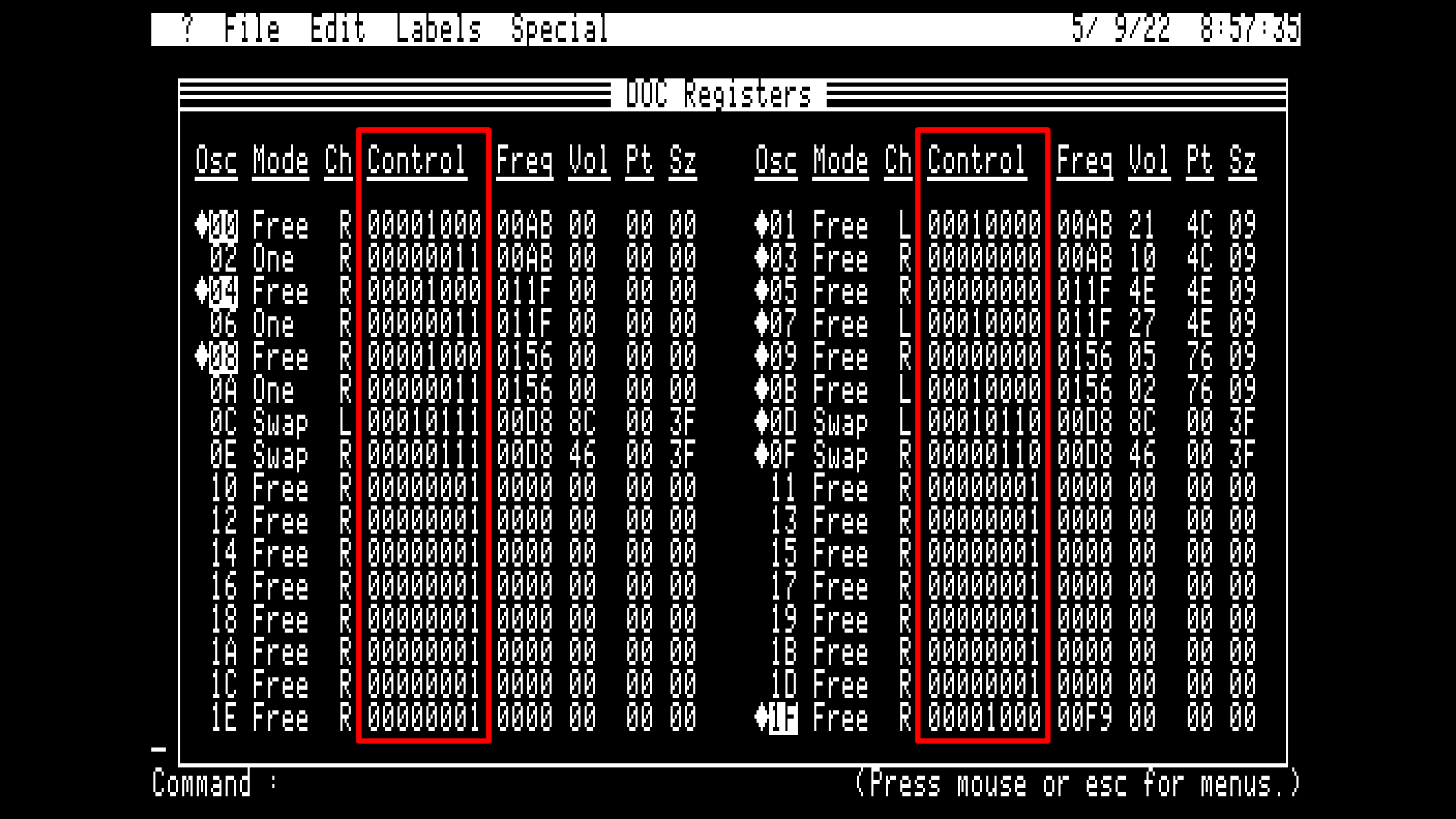
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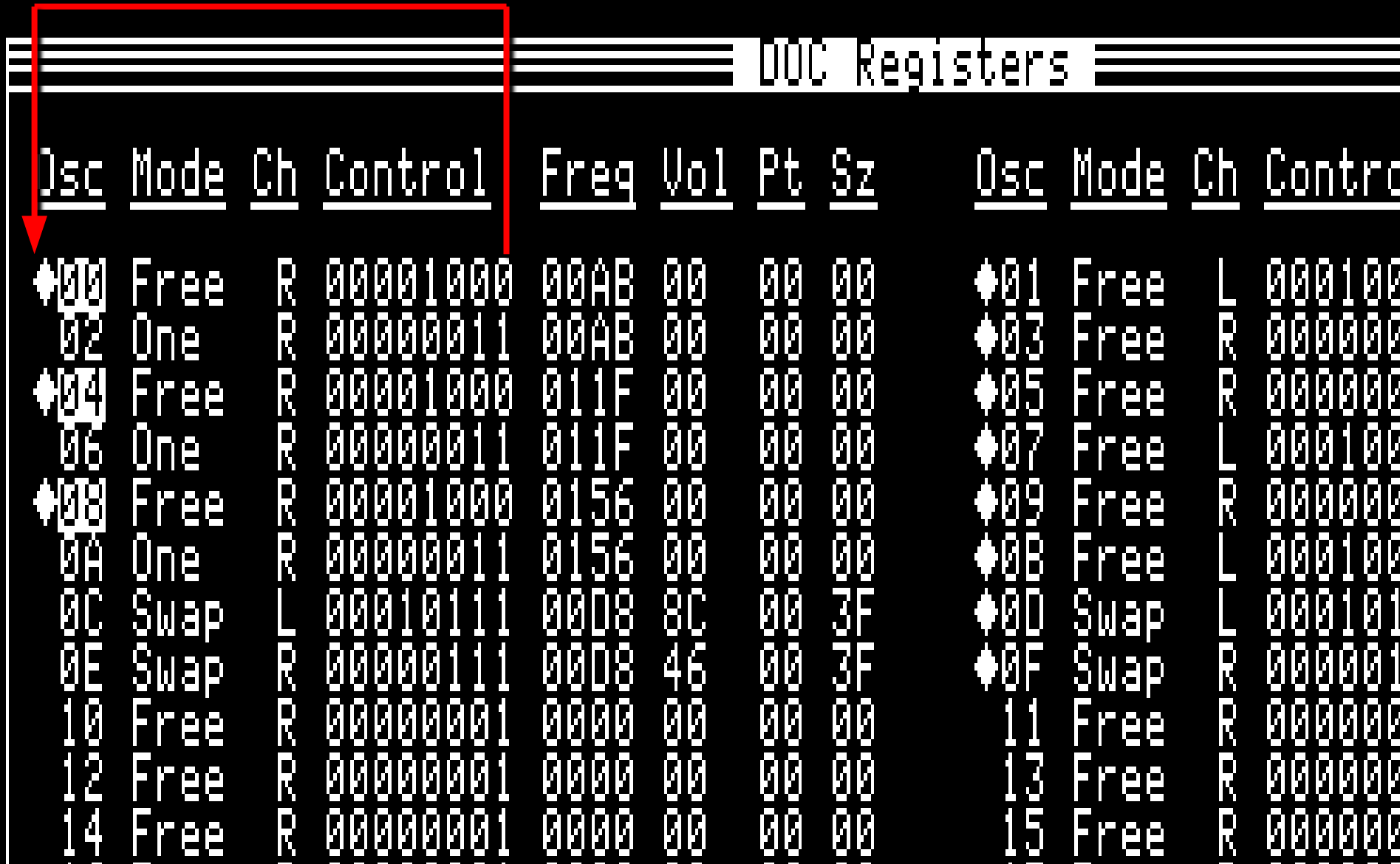
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06 One R 00000011 011F 00 00 00 07 Free L 000100
08 Free R 00001000 0156 00 00 00 09 Free R 000000
0A One R 00000011 0156 00 00 00 0B Free L 000100
0C Swap L 00010111 00D8 8C 00 3F 0D Swap L 000101
0E Swap R 00000111 00D8 46 00 3F 0F Swap R 000001
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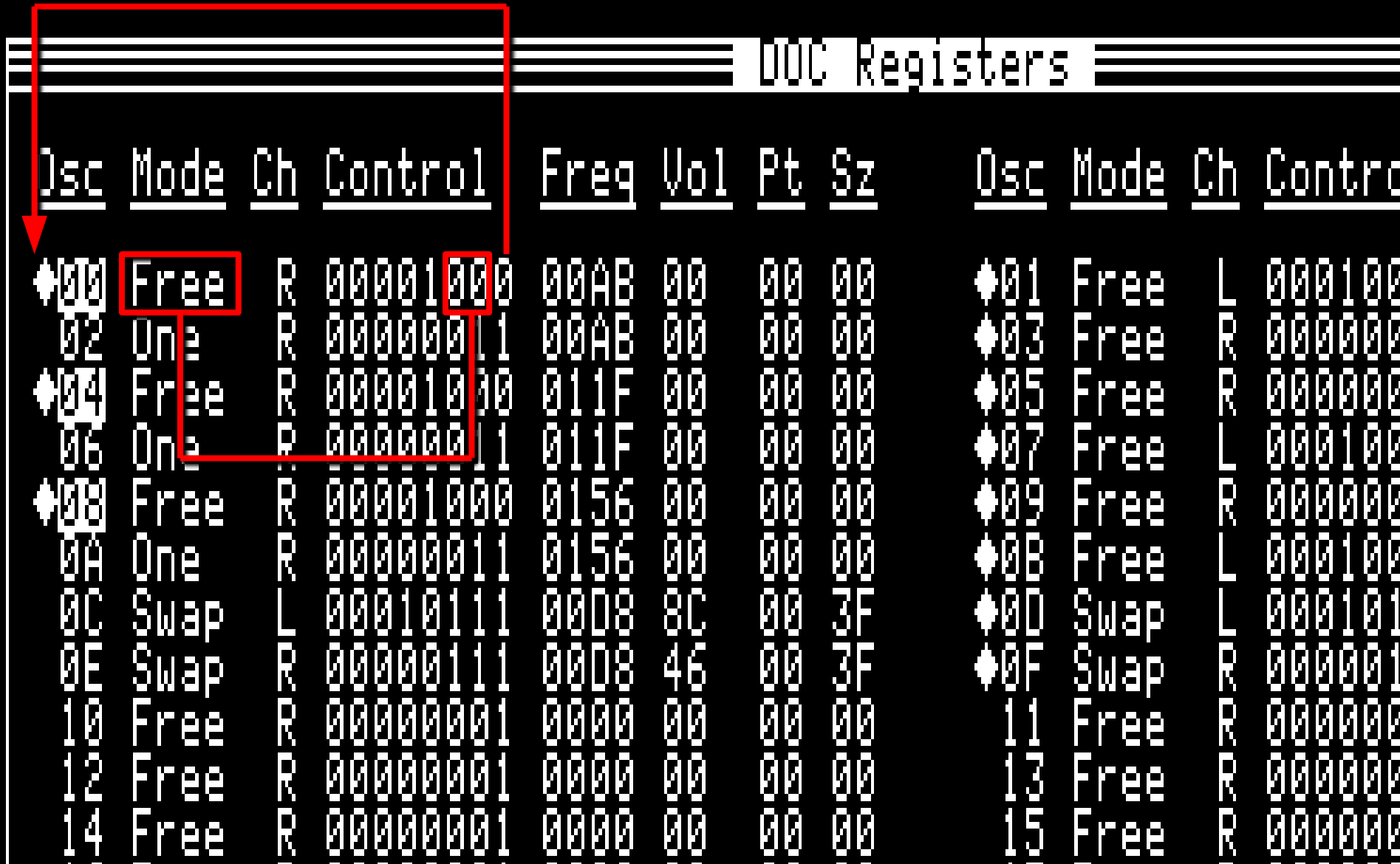
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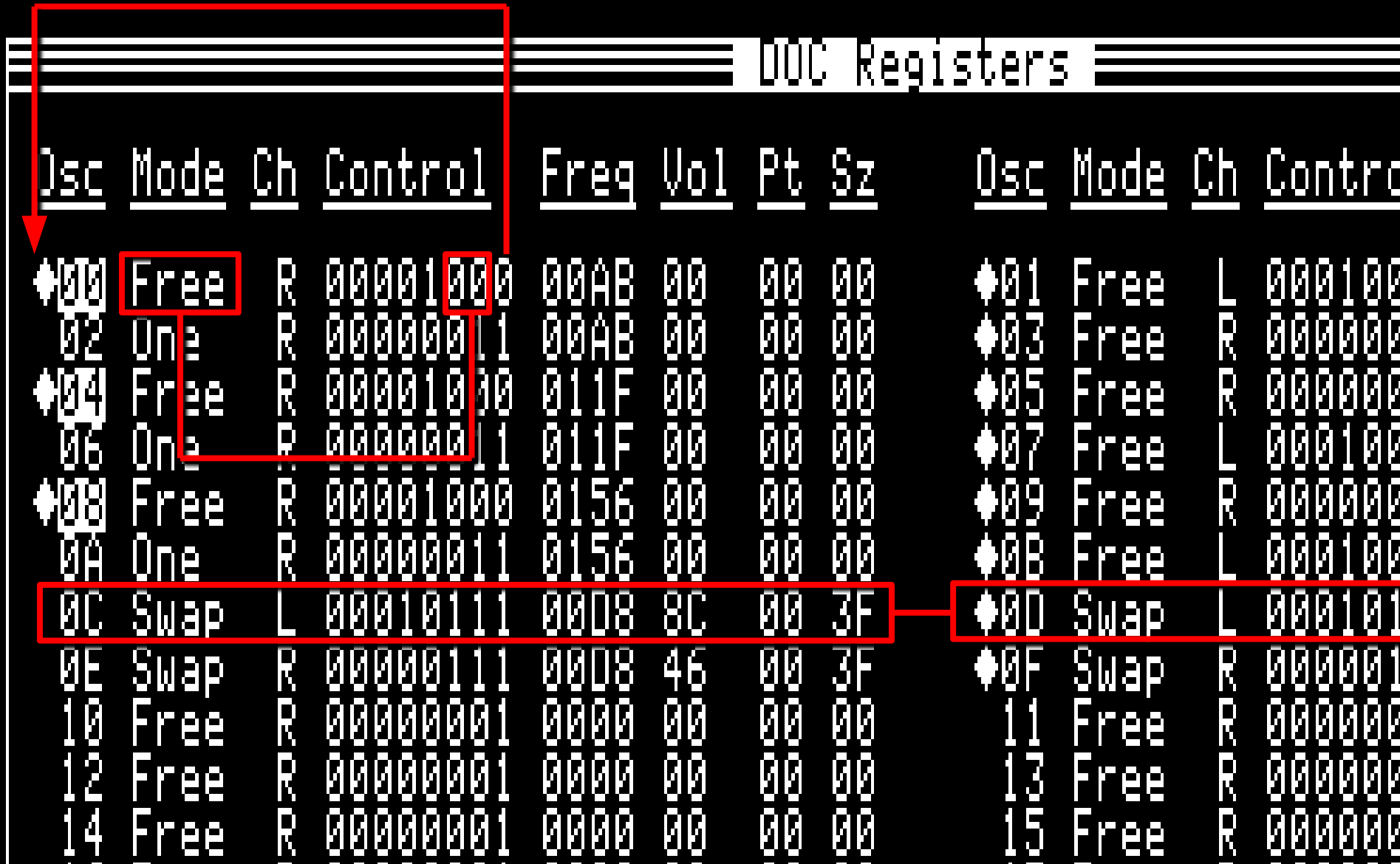
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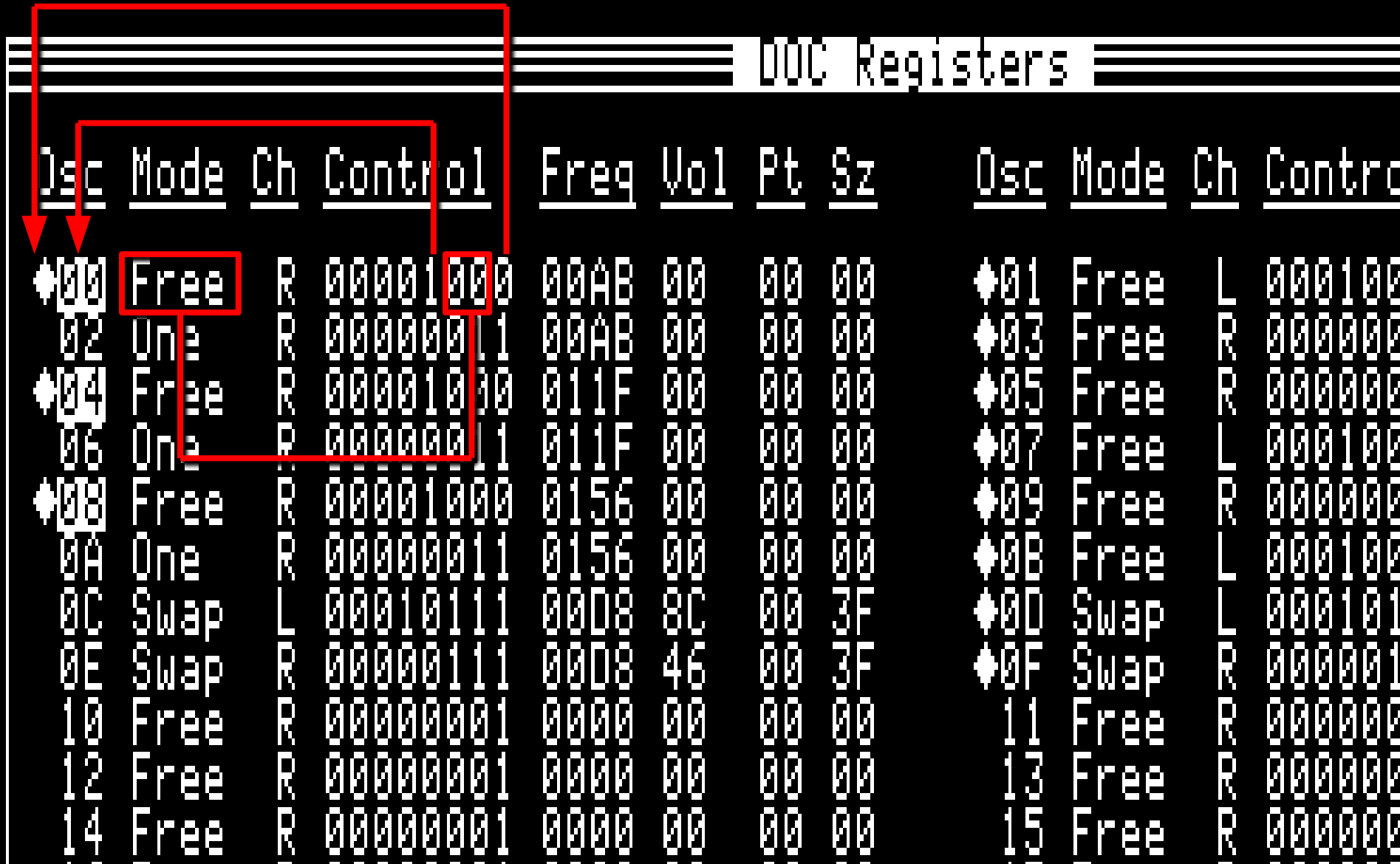
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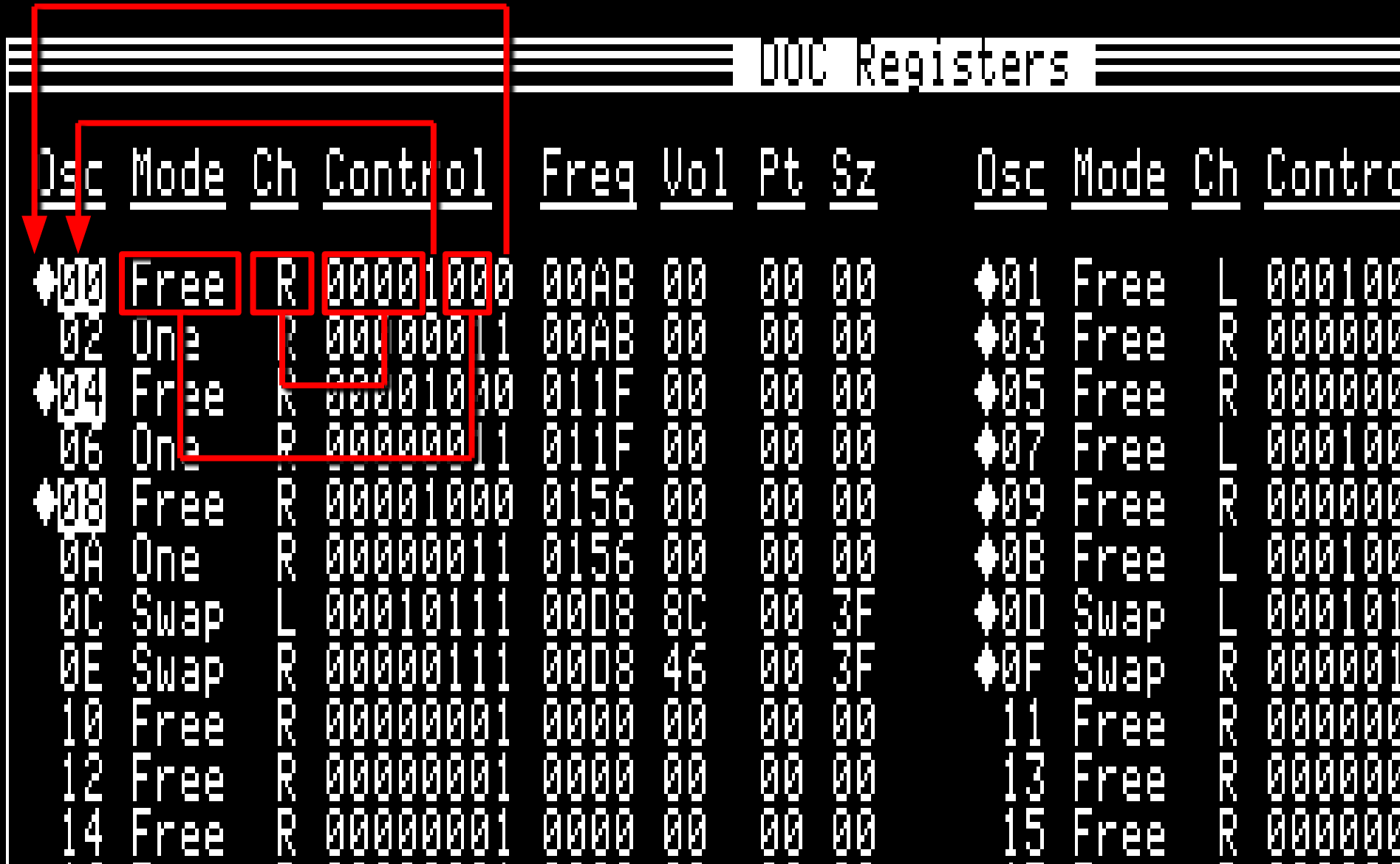
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Sound Ram Wave Data

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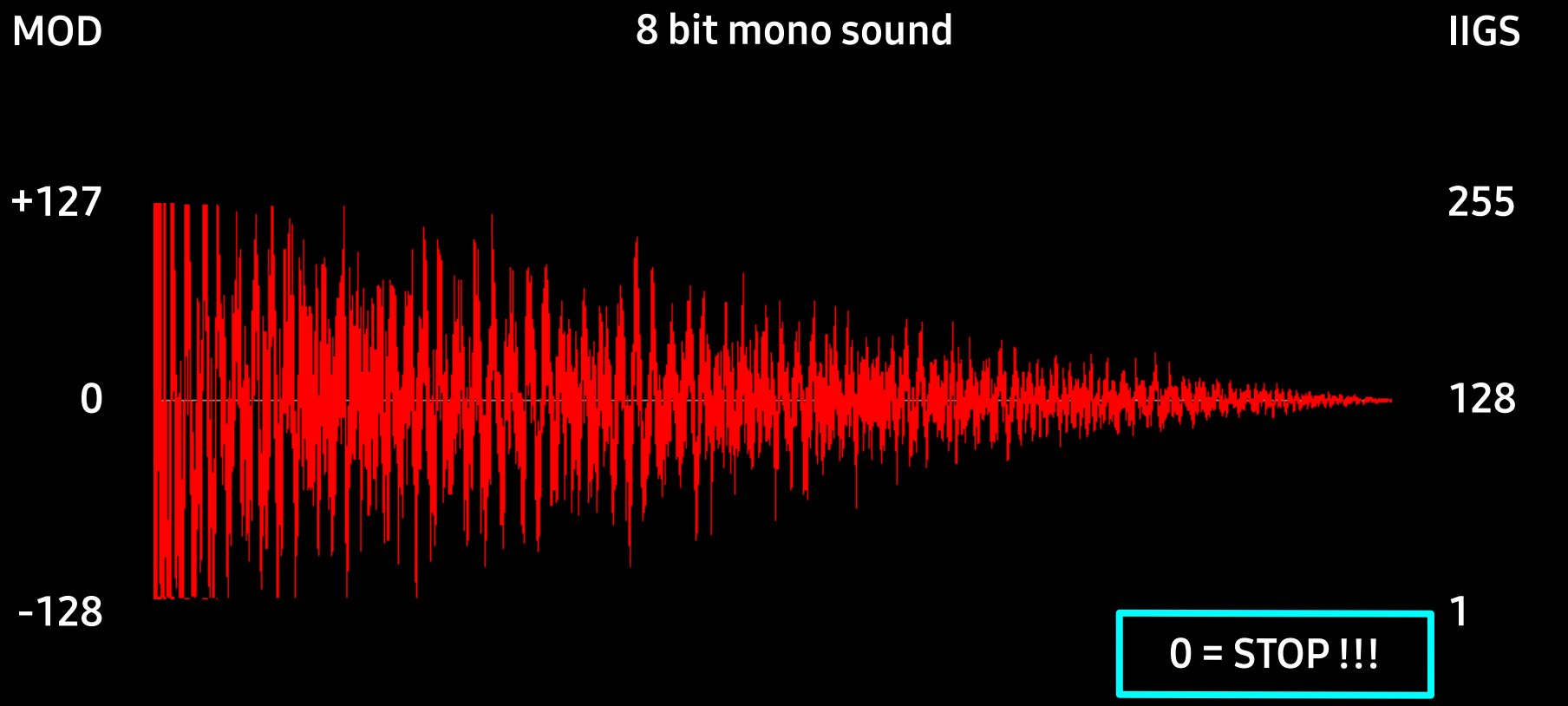
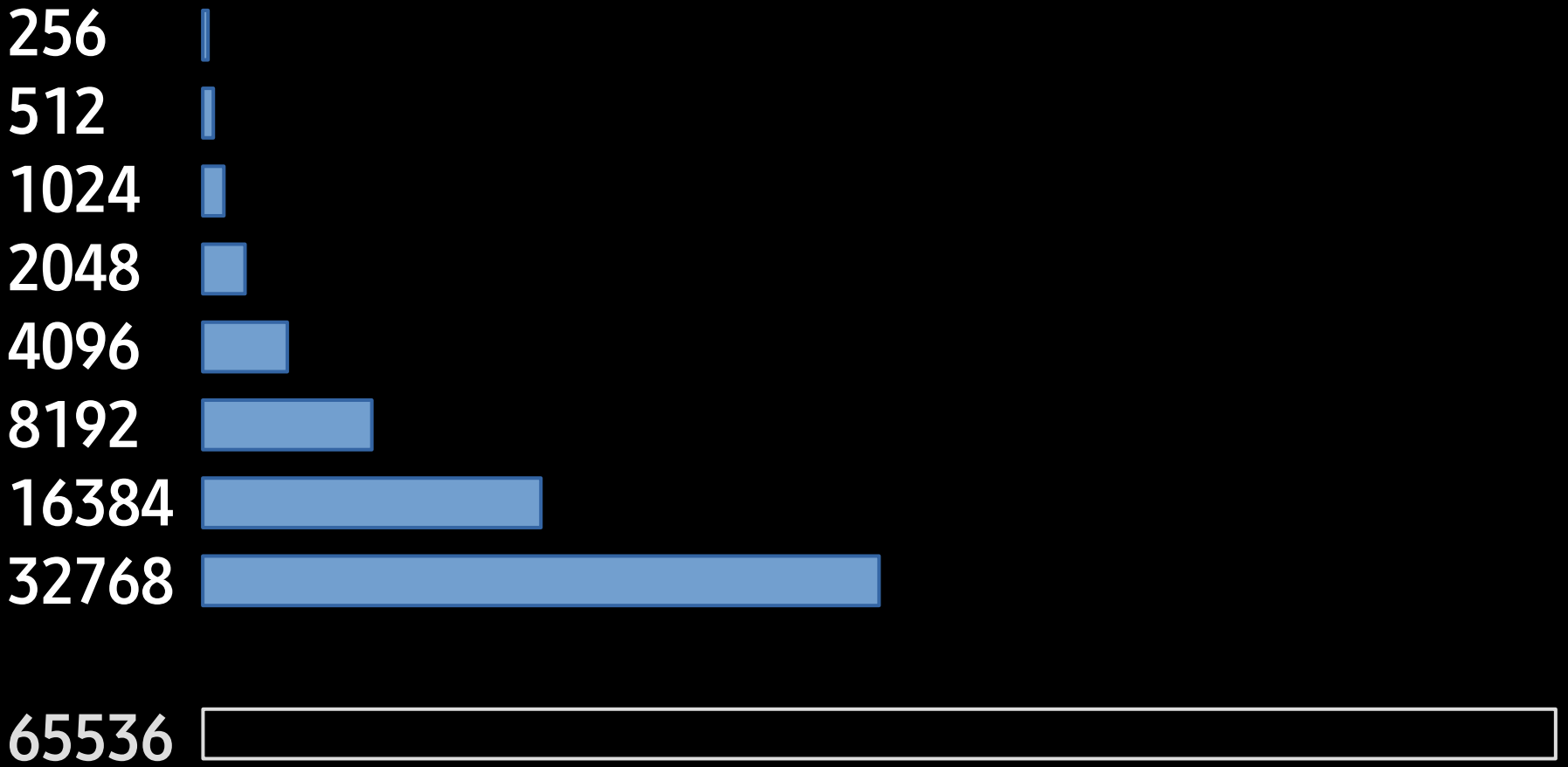


Wave Lengths



Wave Lengths

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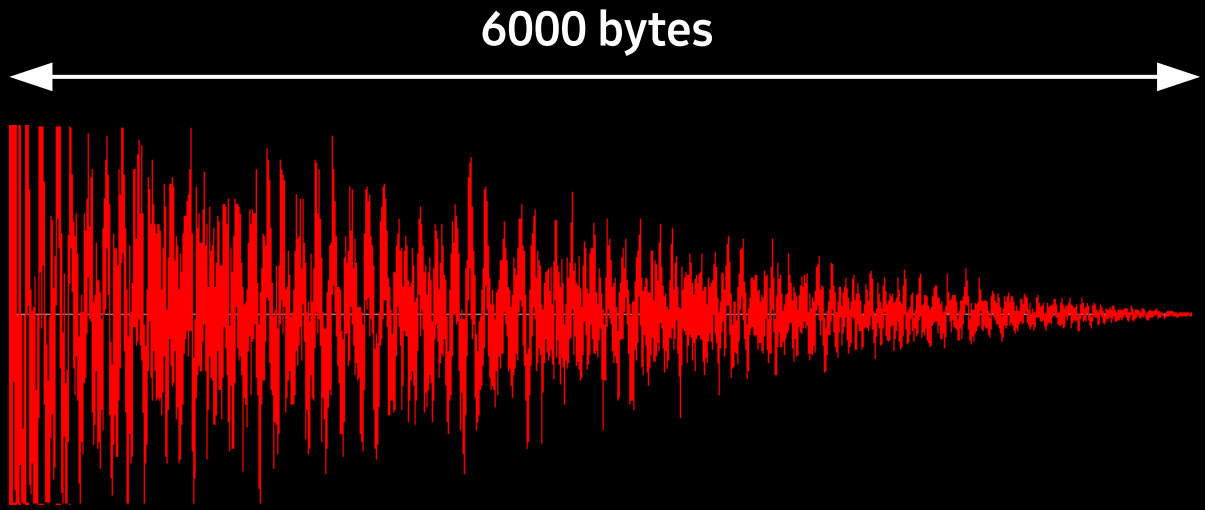

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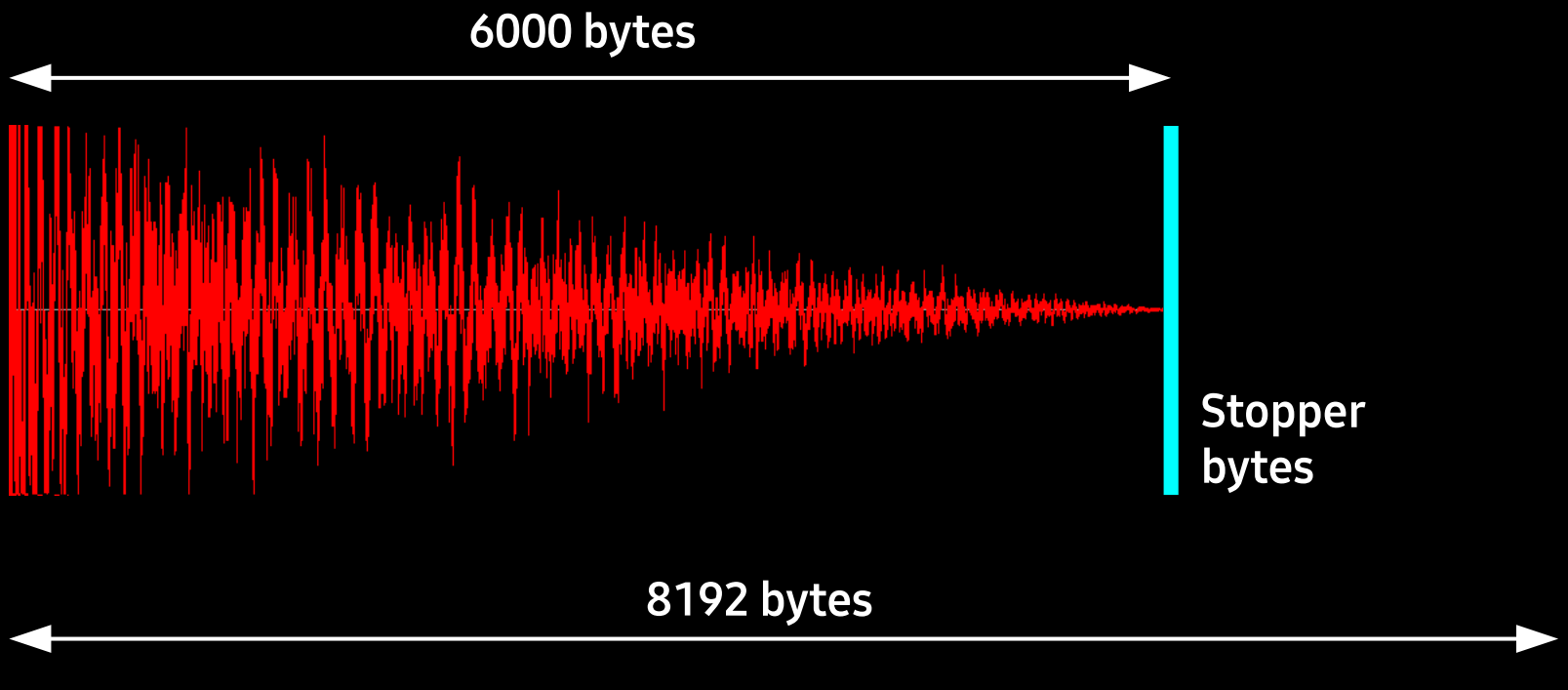
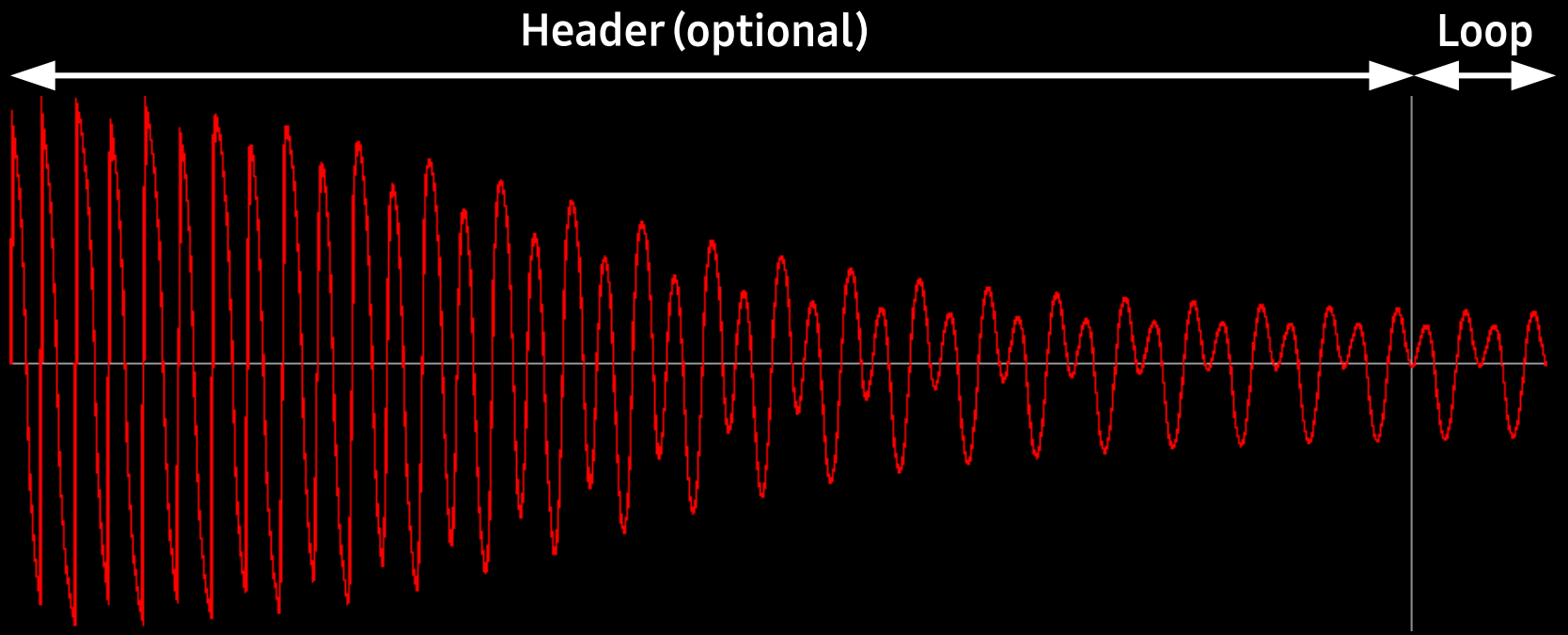
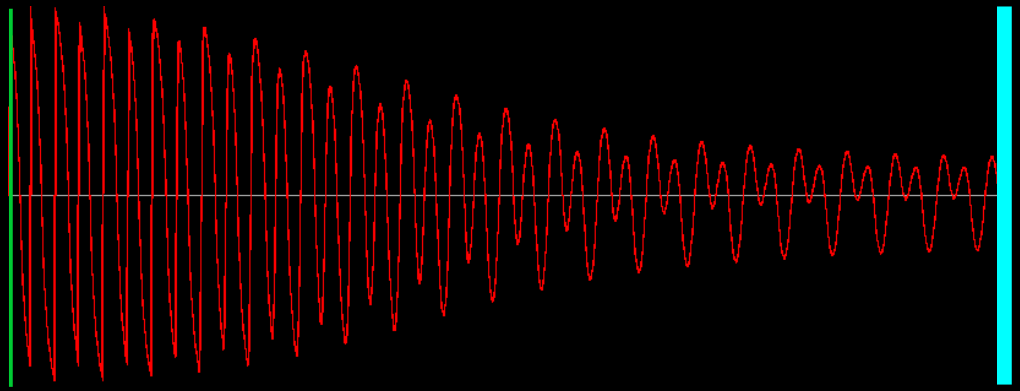


Looped Instruments

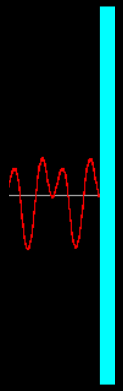


Looped Instruments

Oscillator A: swap



Oscillator B: swap



NTP Instrument 1: Header

NTP Instrument 2: Loop

Looped Instruments

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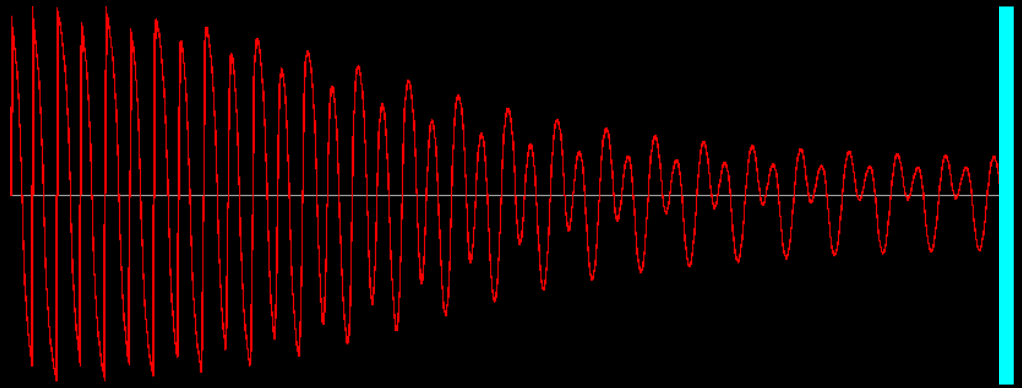
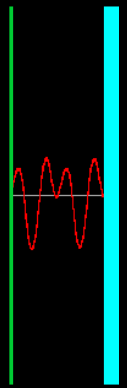


Oscillator B: swap



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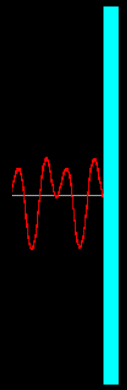
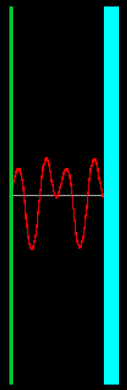


NTP Instrument 2: Loop

Oscillator B: swap



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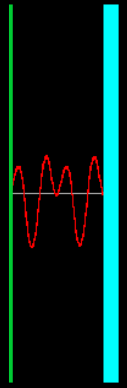
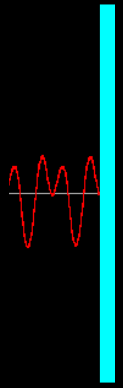


NTP Instrument 2: Loop

Oscillator B: swap



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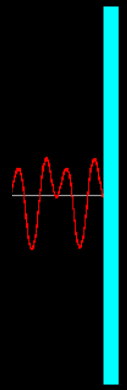

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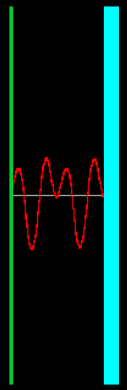

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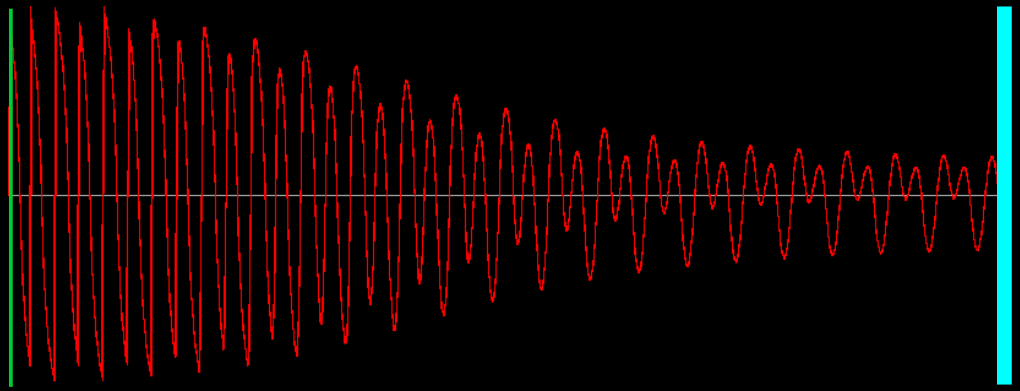
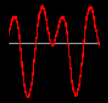
Looped Instruments

Oscillator A: swap



Oscillator B: free run



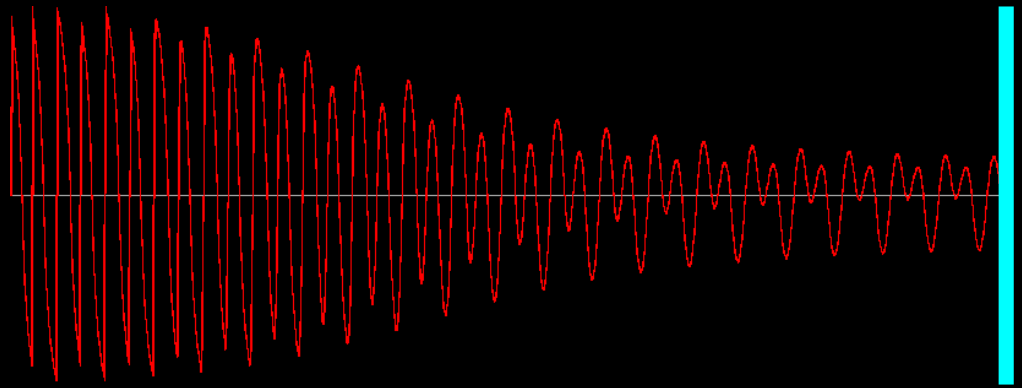
NTP Instrument 1: Header

NTP Instrument 2: Loop

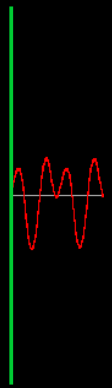
with ideal size
256 / 512 / 1024 / ...

Looped Instruments

Oscillator A: swap



Oscillator B: free run



NTP Instrument 1: Header

NTP Instrument 2: Loop

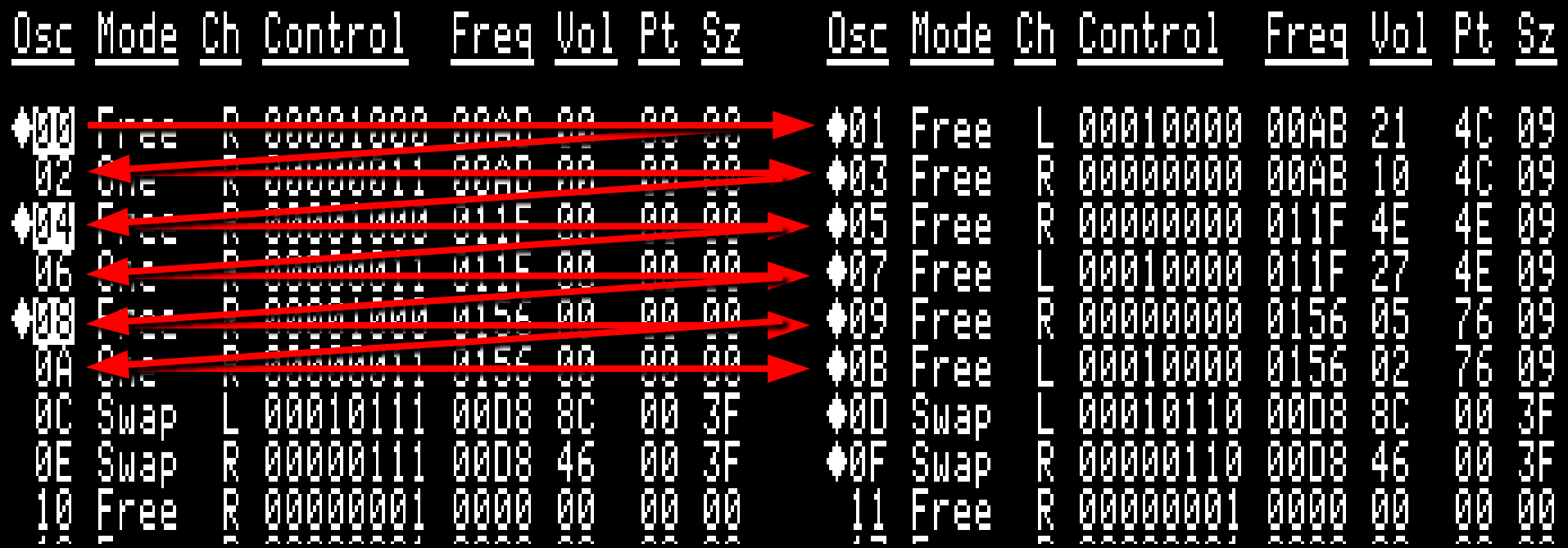
with ideal size
256 / 512 / 1024 / ...

Swap Mode Bug

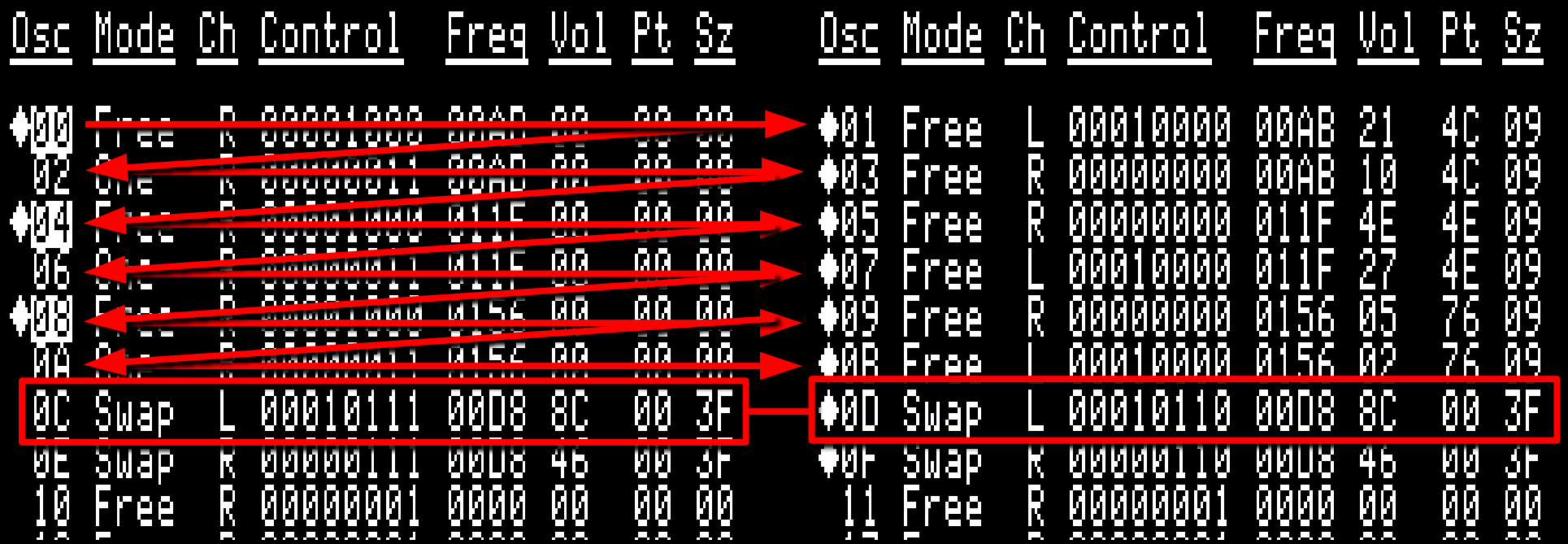
Osc	Mode	Ch	Control	Freq	Vol	Pt	Sz
♦00	Free	R	00001000	00AB	00	00	00
02	One	R	00000011	00AB	00	00	00
♦04	Free	R	00001000	011F	00	00	00
06	One	R	00000011	011F	00	00	00
♦08	Free	R	00001000	0156	00	00	00
0A	One	R	00000011	0156	00	00	00
0C	Swap	L	00010111	00D8	8C	00	3F
0E	Swap	R	00000111	00D8	46	00	3F
10	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	00D8	8C	00	3F
♦0F	Swap	R	00000110	00D8	46	00	3F
11	Free	R	00000001	0000	00	00	00

Swap Mode Bug

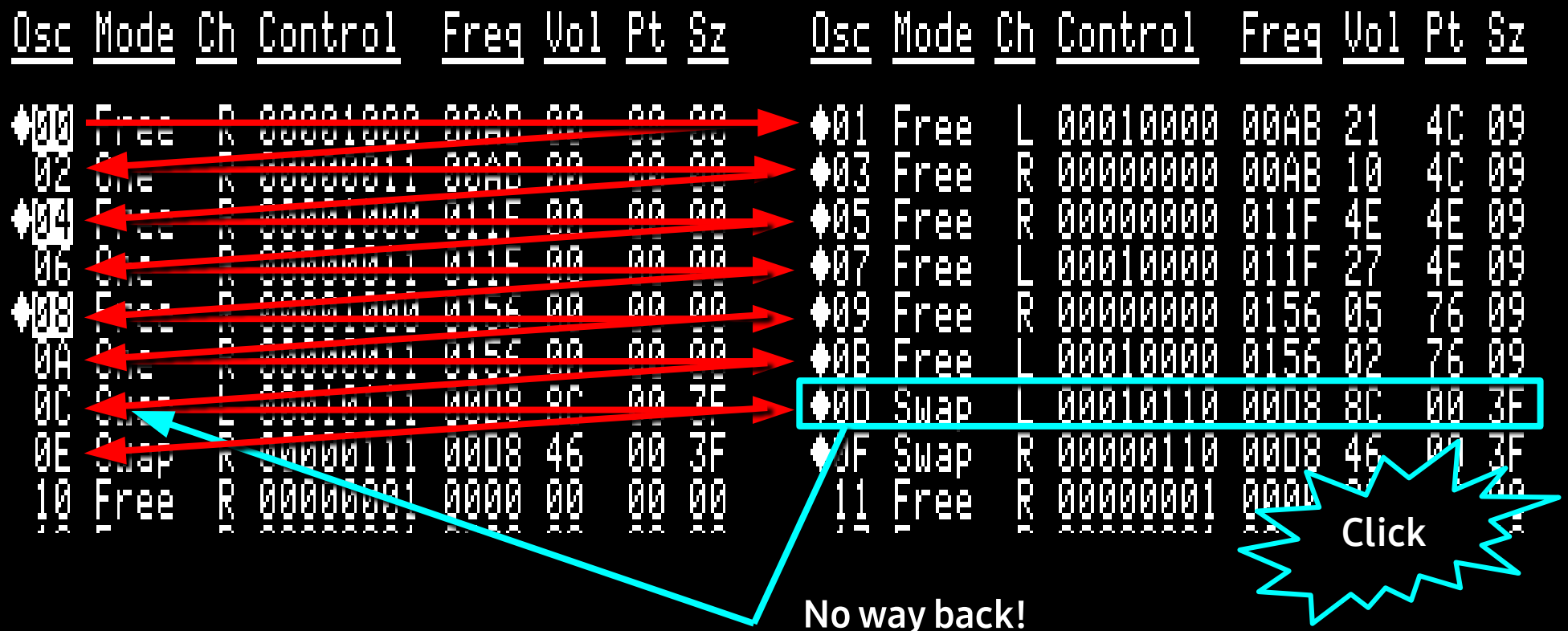


Swap Mode Bug

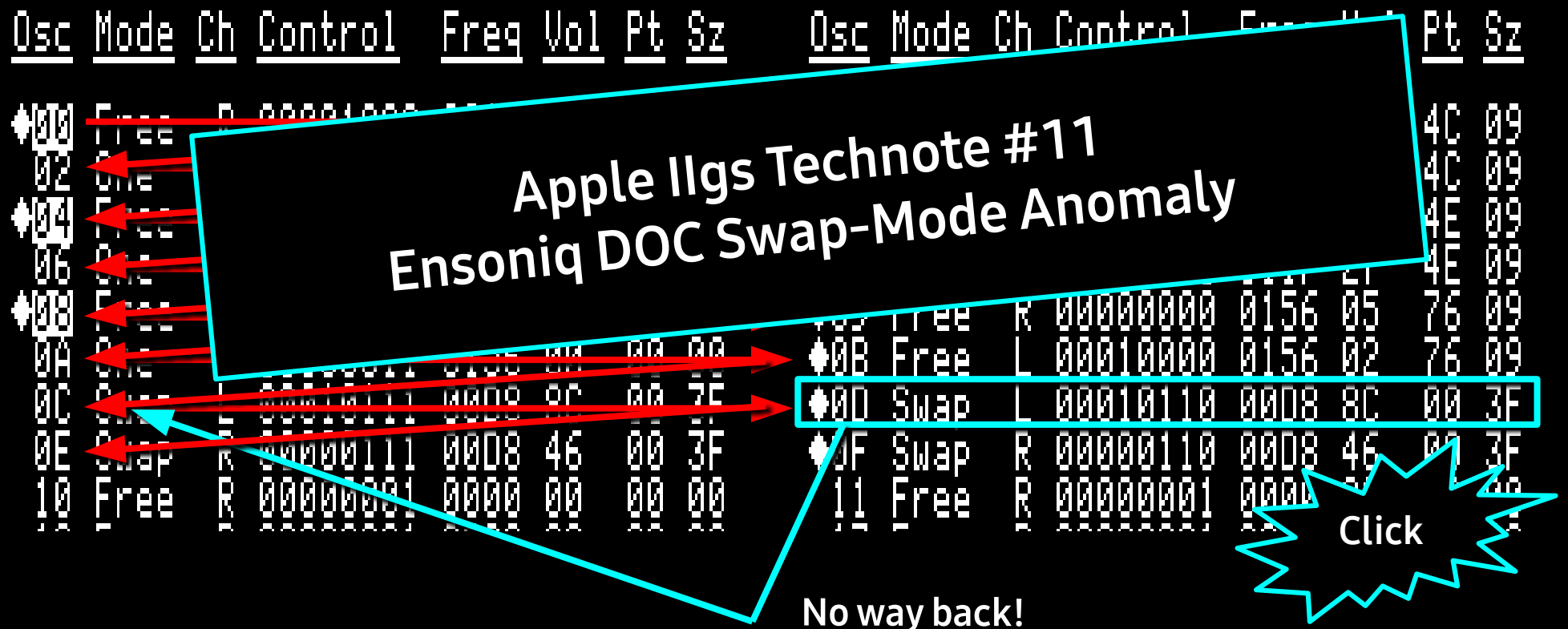


Swap Mode Bug

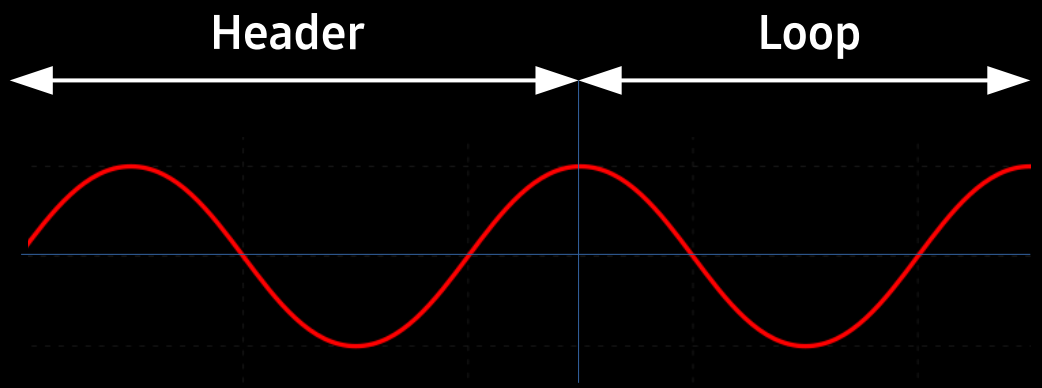
Swap Mode Bug



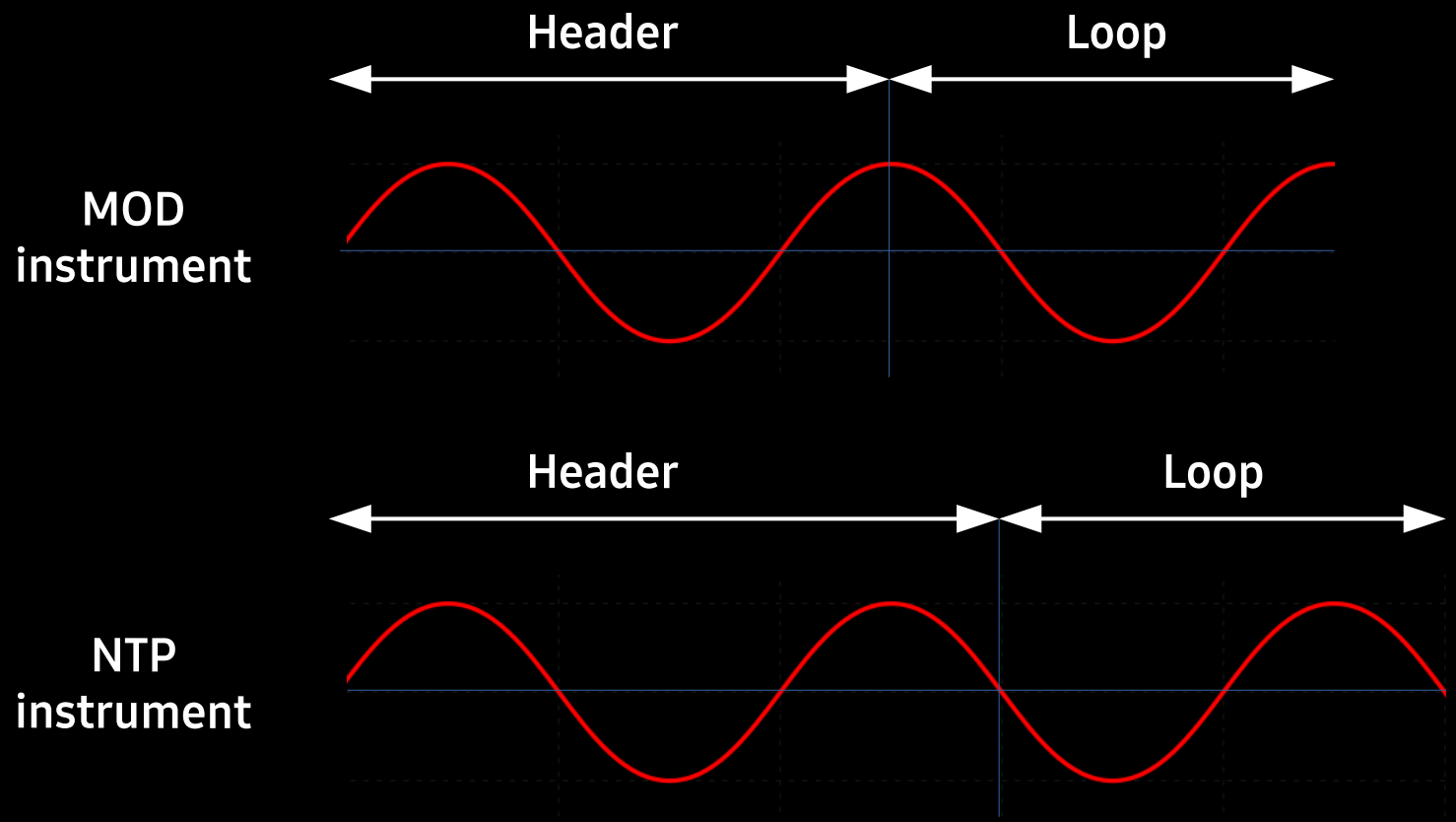
Swap Mode Bug



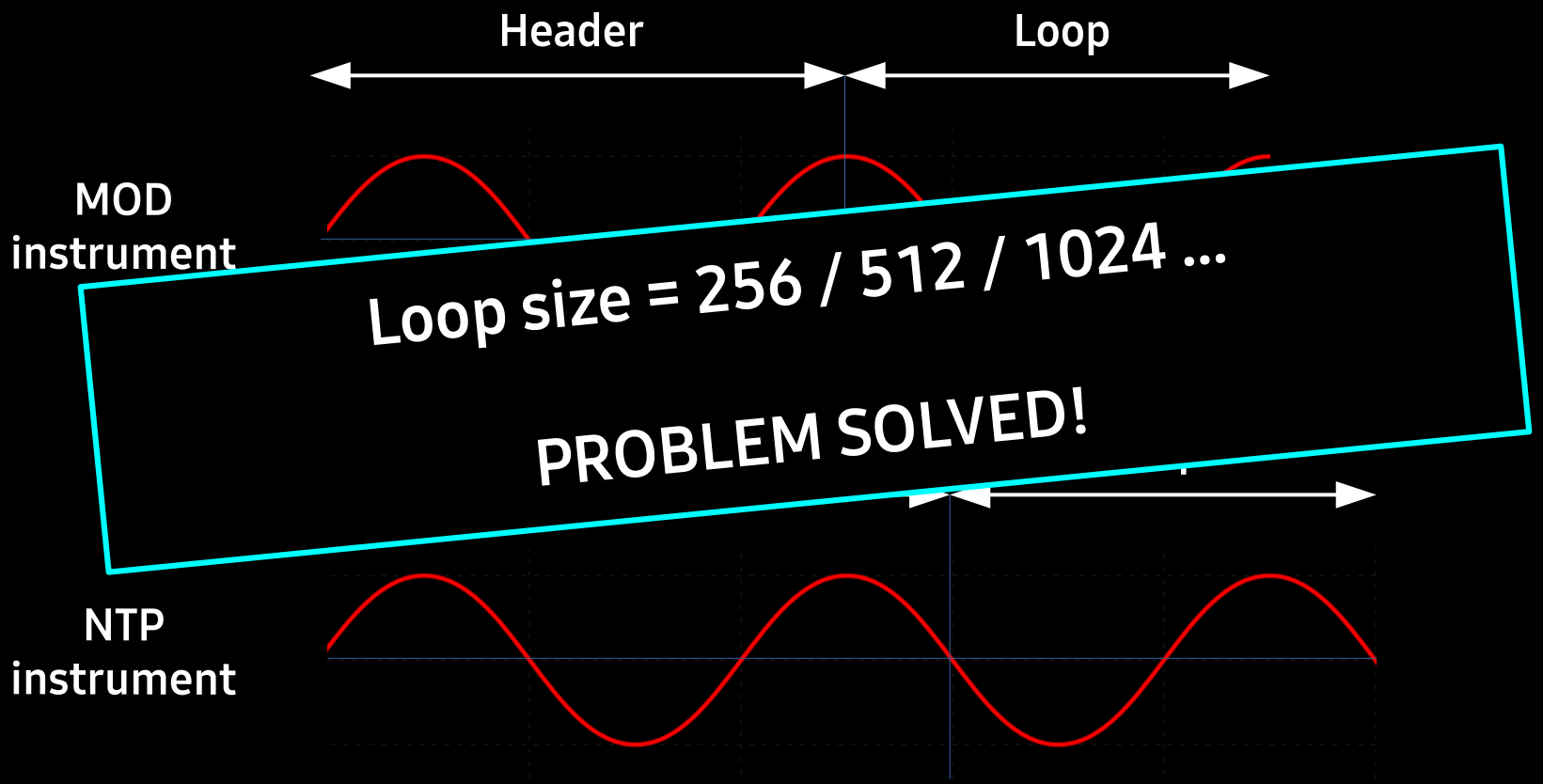
Swap Mode Bug



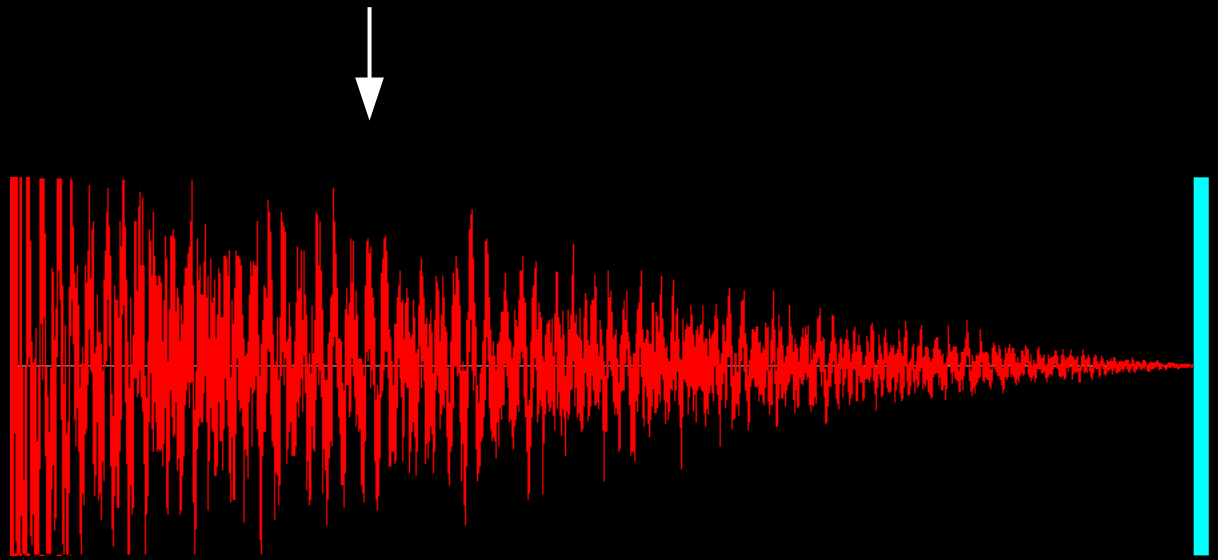
Swap Mode Bug



Swap Mode Bug



Playing Waves



One Pointer per Osc.

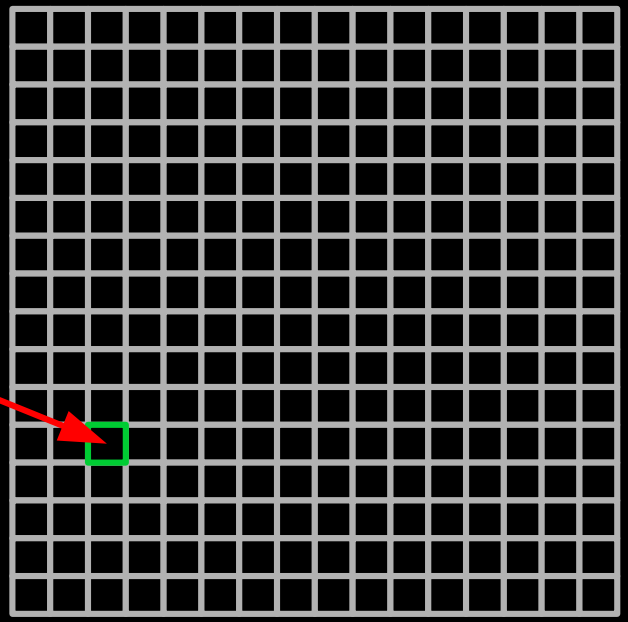
Start on page boundary

Step Size = Frequency

Playing Waves

Wave Size: 256 Bytes	Address Bus Resolution: 0

Pointer Register
[11000010]



64KB Sound Ram

Final address: $B2 00

Playing Waves

Wave Size: 256 Bytes	Address Bus Resolution: 0

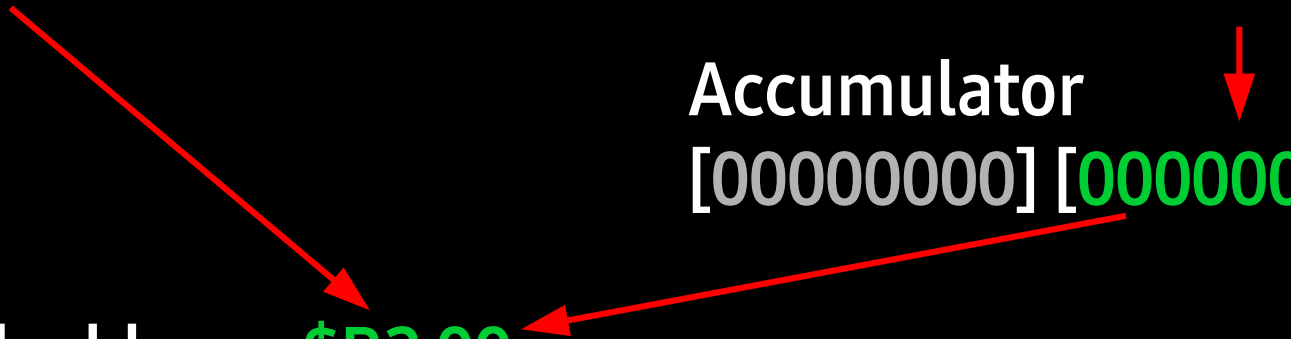
Pointer Register
[11000010]

Frequency
[00000001] [10000000]

Add

Accumulator
[00000000] [00000000] [00000000]

Final address: $B2 00



Playing Waves

Wave Size: 256 Bytes	Address Bus Resolution: 0

Pointer Register
[11000010]

Frequency
[00000001] [10000000]

Accumulator
[00000000] [00000001] [10000000]

Add

Final address: $B2 01

Playing Waves

Wave Size: 256 Bytes	Address Bus Resolution: 0

Pointer Register
[11000010]

Frequency
[00000001] [10000000]

Accumulator
[00000000] [00000011] [00000000]

Add

Final address: $B2 03

Playing Waves

Wave Size: 256 Bytes	Address Bus Resolution: 0

Pointer Register
[11000010]

Frequency
[00000001] [10000000]

Accumulator
[00000000] [00000100] [10000000]

Add

Final address: $B2 04

Playing Waves

Wave Size: 256 Bytes	Address Bus Resolution: 0

Pointer Register
[11000010]

Frequency
[00000001] [10000000]

Accumulator
[00000000] [00000101] [10000000]

Add

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
[000001**1**00]

Frequency
[00000000] [00000000]

Accumulator
[000000**0**0] [**0**0000000] [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
[10000000]

Frequency
[00000000] [00000000]

Accumulator
[00000000] [00000000] [00000000]

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

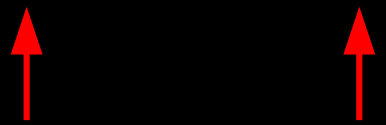
Playing Waves

Wave Size: 256 Bytes	Address Bus Resolution: 1

Pointer Register
[00000000]

Frequency
[00000000] [00000000]

Accumulator
[00000000] [00000000] [00000000]



Final address: $00 00

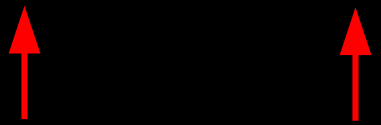
Playing Waves

Wave Size: 256 Bytes	Address Bus Resolution: 2

Pointer Register
[00000000]

Frequency
[00000000] [00000000]

Accumulator
[00000000] [00000000] [00000000]



Final address: $00 00

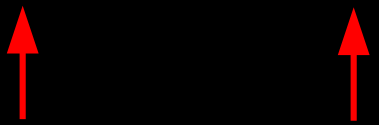
Playing Waves

Wave Size: 256 Bytes	Address Bus Resolution: 3

Pointer Register
[00000000]

Frequency
[00000000] [00000000]

Accumulator
[00000000] [00000000] [00000000]



Final address: $00 00

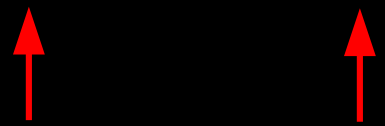
Playing Waves

Wave Size: 256 Bytes	Address Bus Resolution: 4

Pointer Register
[00000000]

Frequency
[00000000] [00000000]

Accumulator
[00000000] [00000000] [00000000]



Final address: $00 00

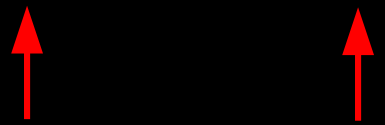
Playing Waves

Wave Size: 256 Bytes	Address Bus Resolution: 5

Pointer Register
[00000000]

Frequency
[00000000] [00000000]

Accumulator
[00000000] [00000000] [00000000]



Final address: $00 00

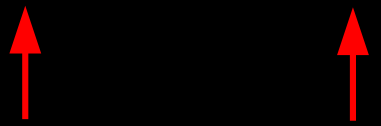
Playing Waves

Wave Size: 256 Bytes	Address Bus Resolution: 6

Pointer Register
[00000000]

Frequency
[00000000] [00000000]

Accumulator
[00000000] [00000000] [00000000]



Final address: $00 00

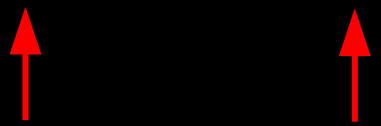
Playing Waves

Wave Size: 256 Bytes	Address Bus Resolution: 7

Pointer Register
[00000000]

Frequency
[00000000] [00000000]

Accumulator
[00000000] [00000000] [00000000]



Final address: $00 00

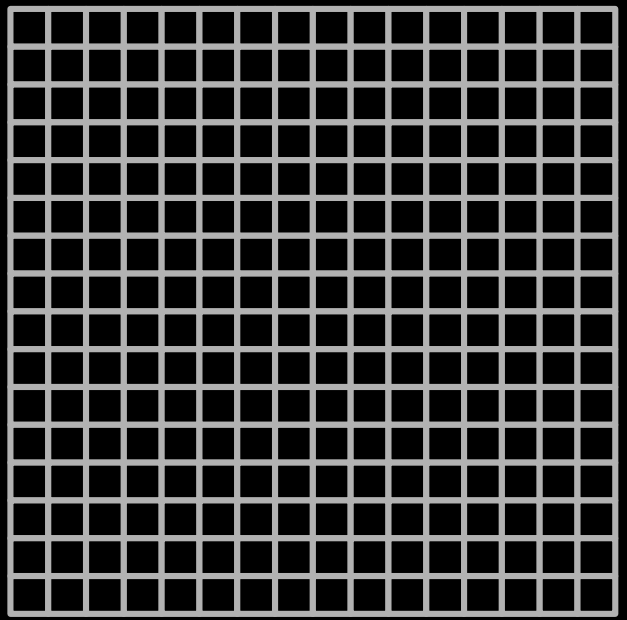
Breathe

NTP Converter Magic

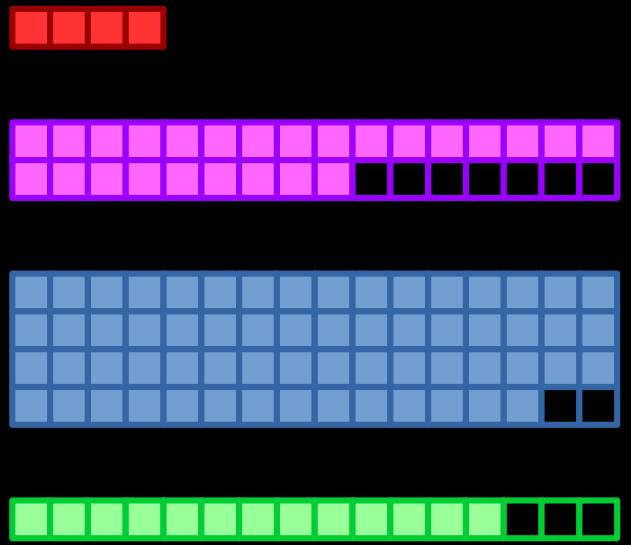
- Convert instruments
- Add stopper bytes
- Split instruments
- Pick oscillator modes
- Mitigate swap mode bug
- Arrange waves in sound ram

Sound Ram Tetris

- Smallest unit 256 bytes



64KB Sound Ram

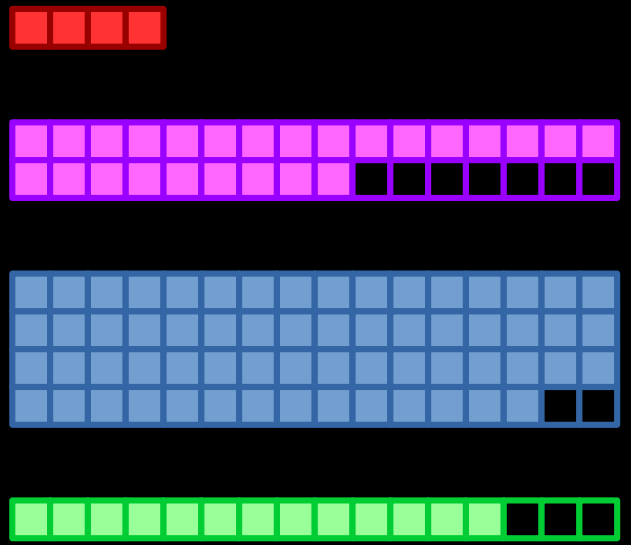


Instruments

Sound Ram Tetris

- Smallest unit 256 bytes

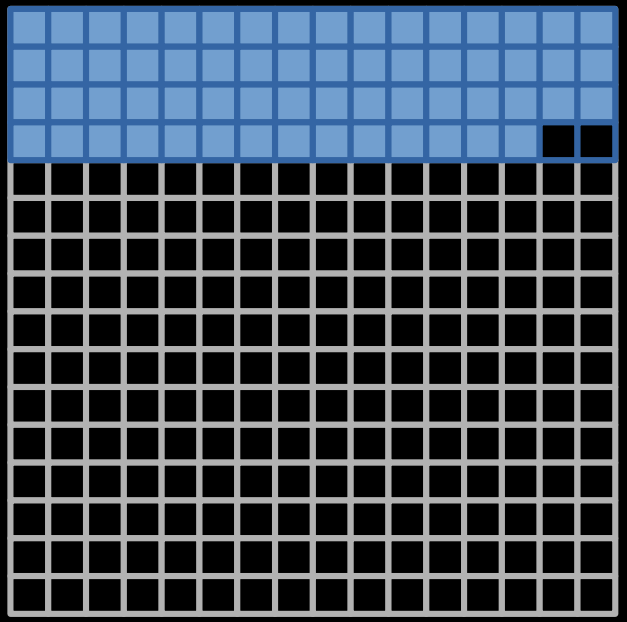
64KB Sound Ram



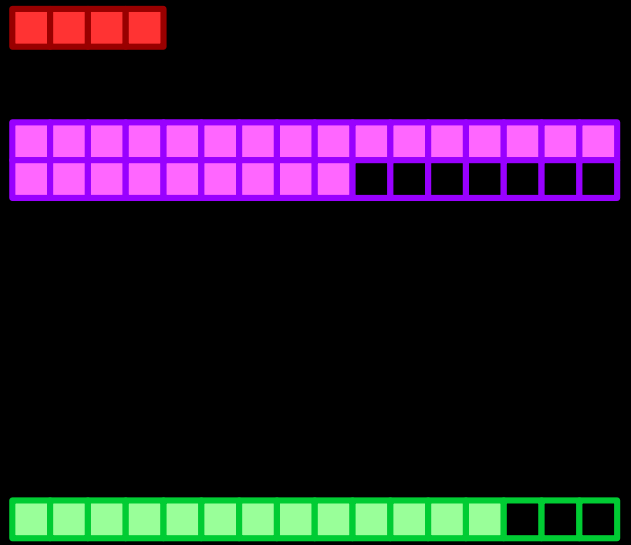
Instruments

Sound Ram Tetris

- Smallest unit 256 bytes



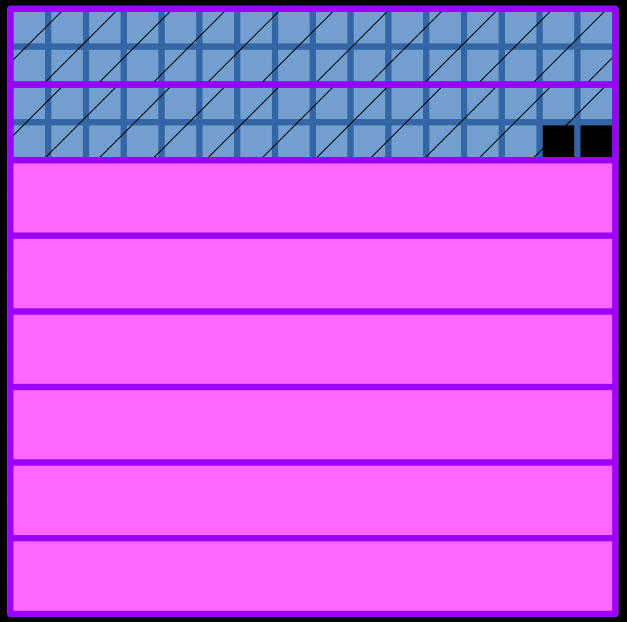
64KB Sound Ram



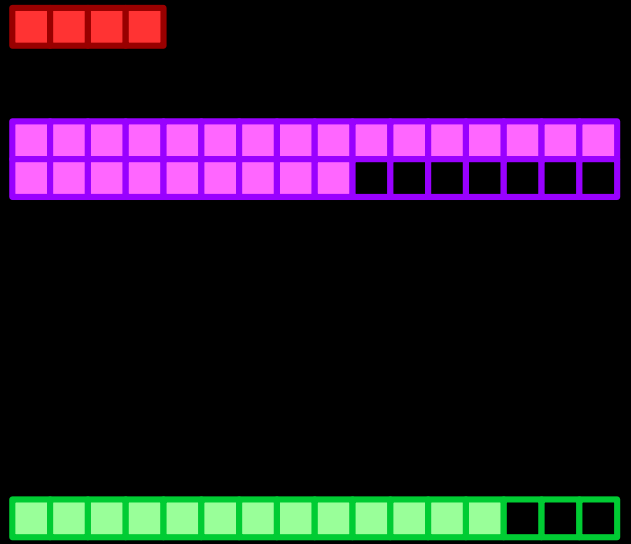
Instruments

Sound Ram Tetris

- Smallest unit 256 bytes



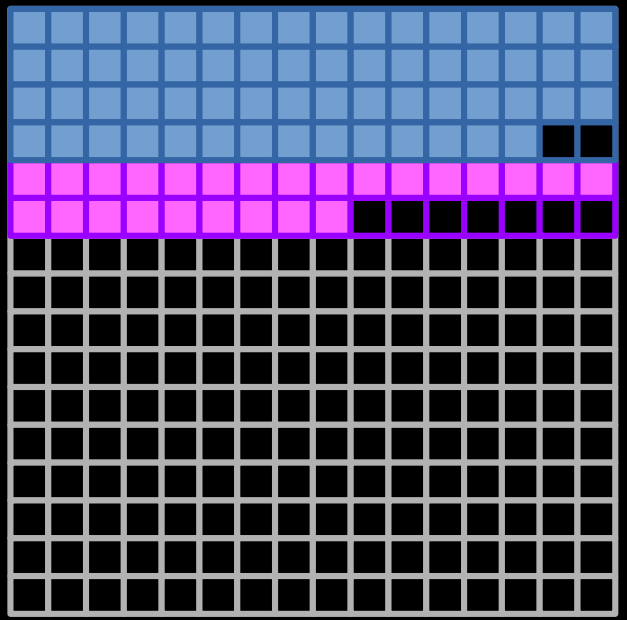
64KB Sound Ram



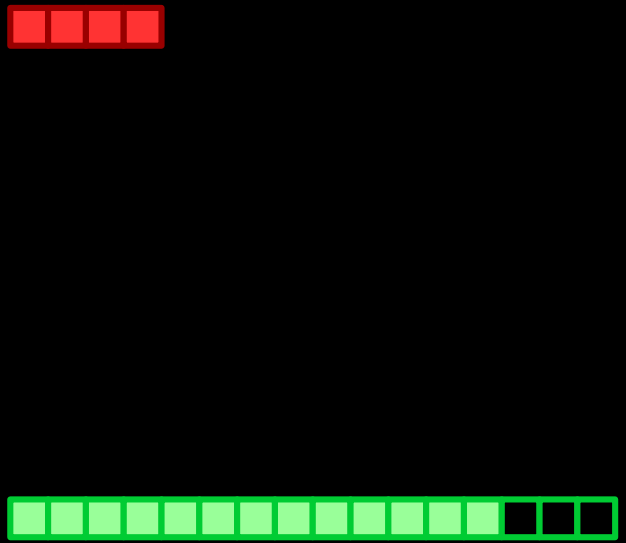
Instruments

Sound Ram Tetris

- Smallest unit 256 bytes



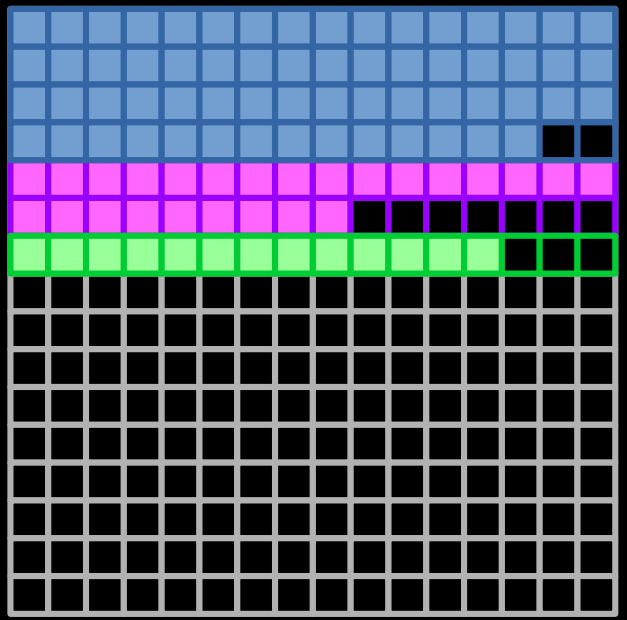
64KB Sound Ram



Instruments

Sound Ram Tetris

- Smallest unit 256 bytes

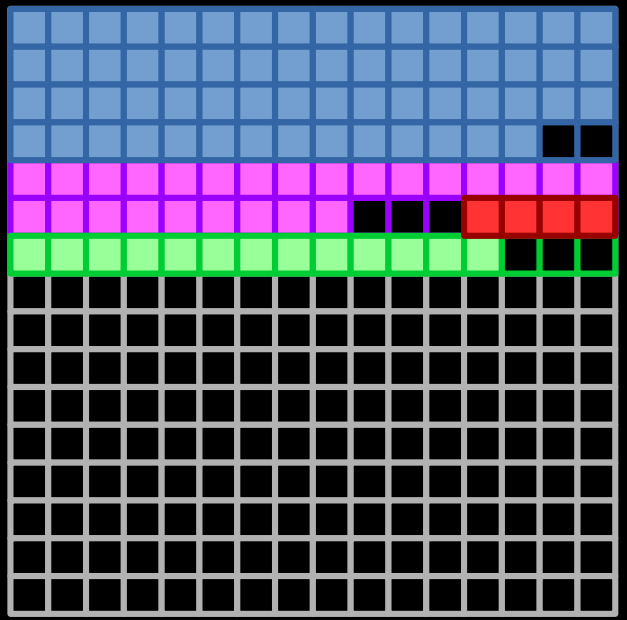


64KB Sound Ram

Instruments

Sound Ram Tetris

- Smallest unit 256 bytes

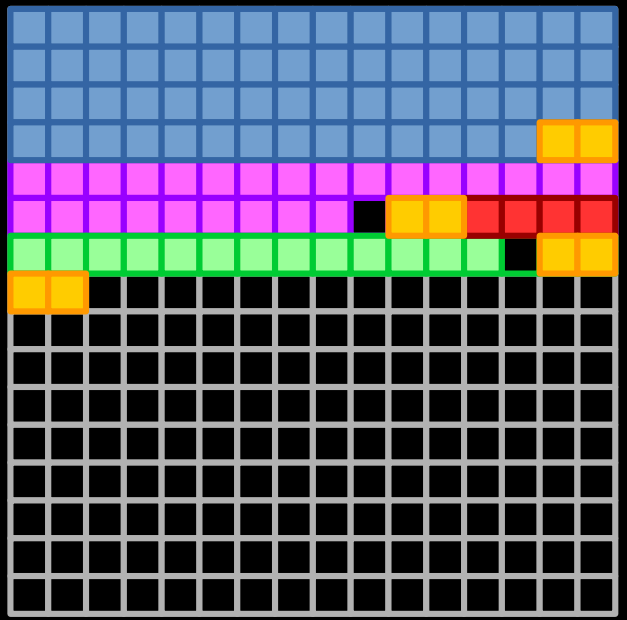


64KB Sound Ram

Instruments

Streaming!

- Smallest unit 256 bytes

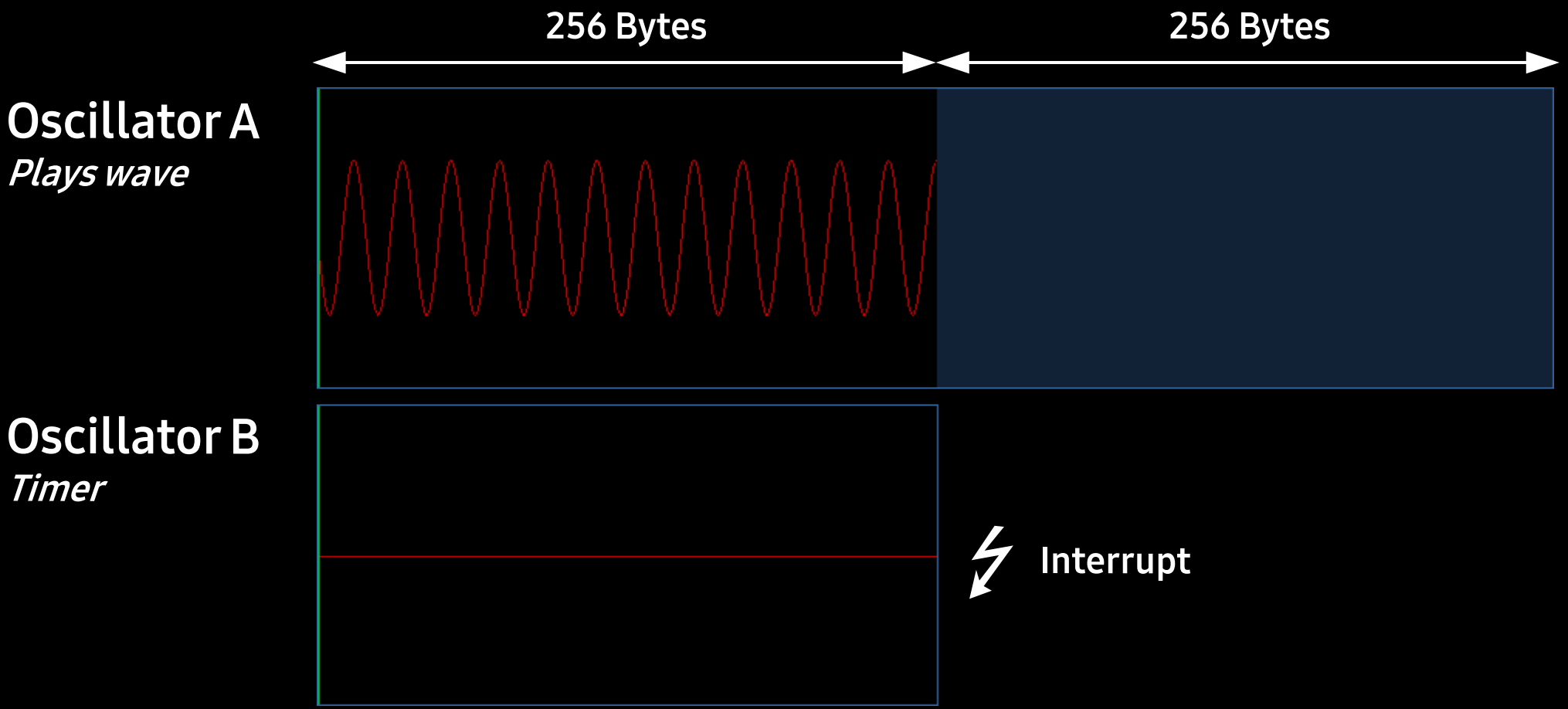


64KB Sound Ram

Stream buffers

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

Streaming!


256 Bytes
256 Bytes
Oscillator A
Plays wave
Oscillator B
Timer
Interrupt

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:

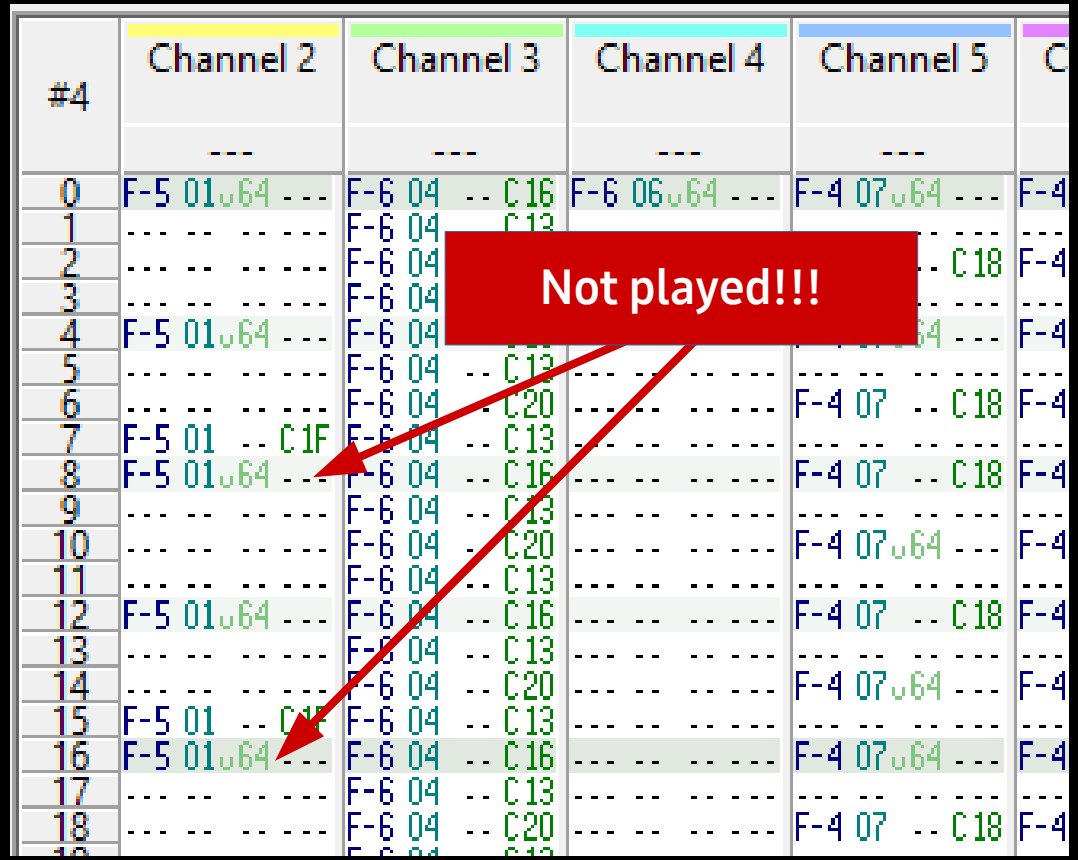
- Need speed?
  Yes = only sound ram
  No = streaming allowed
- Sound FX?

Musicians:

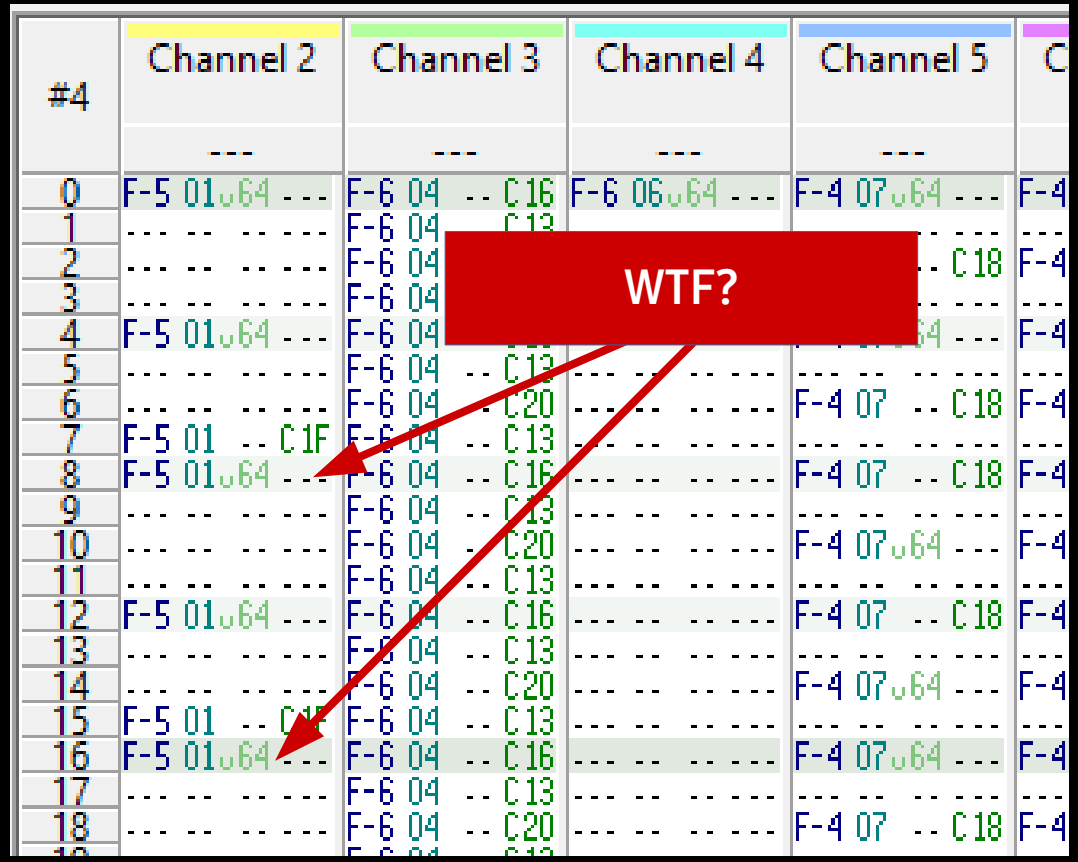
- Loop size = 256, 512, ... !!!
- Only 64k for instruments?
- How many tracks?

Lessons Learned

Turning it off and on again



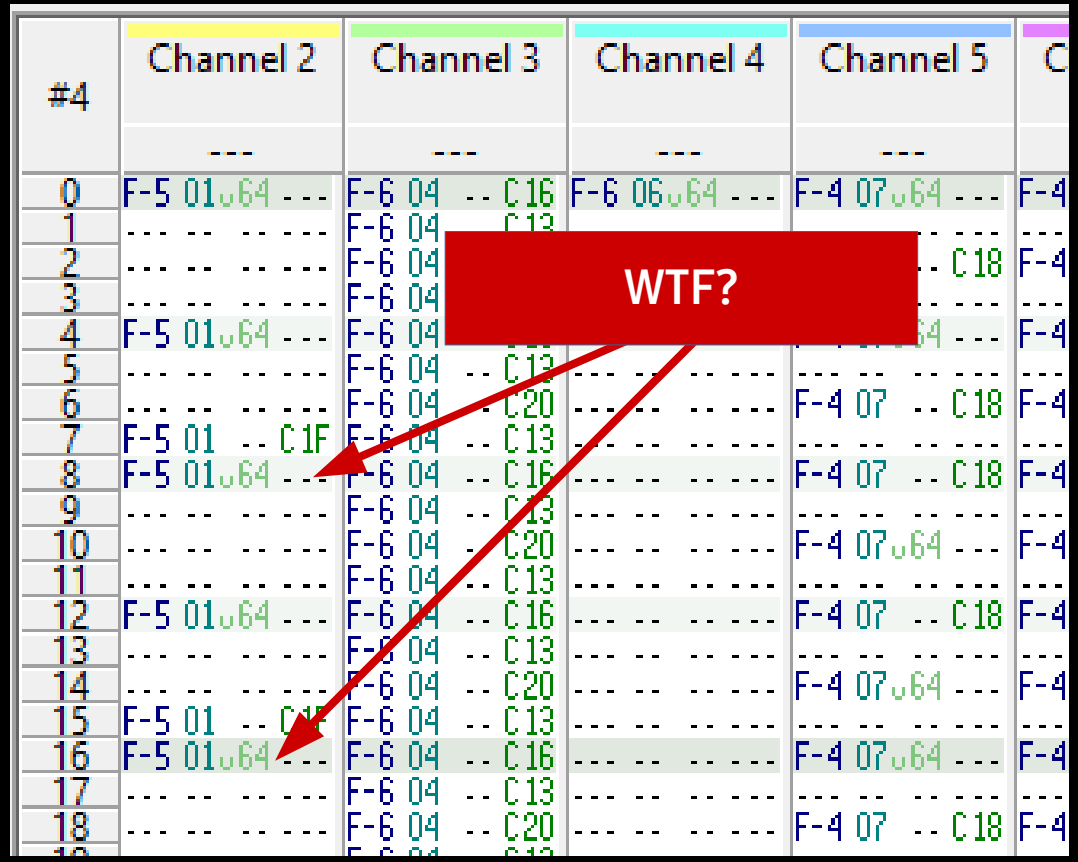
Turning it off and on again



New note:

Stop Oscillator
Start Oscillator

Turning it off and on again

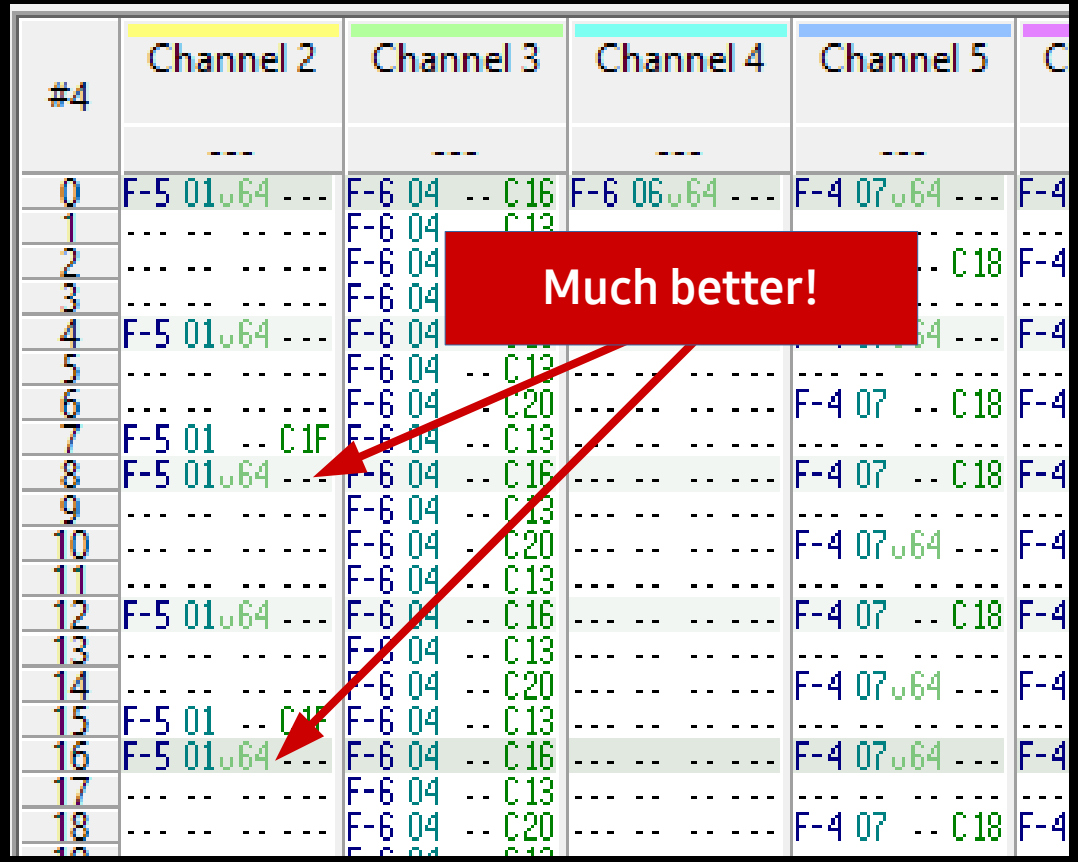


Stop Oscillator

Osc	Mode	Ch	Control
00	Free	R	00000001

Start Oscillator

Turning it off and on again



1. Stop Oscillator

~~Osc Mode Ch Control~~

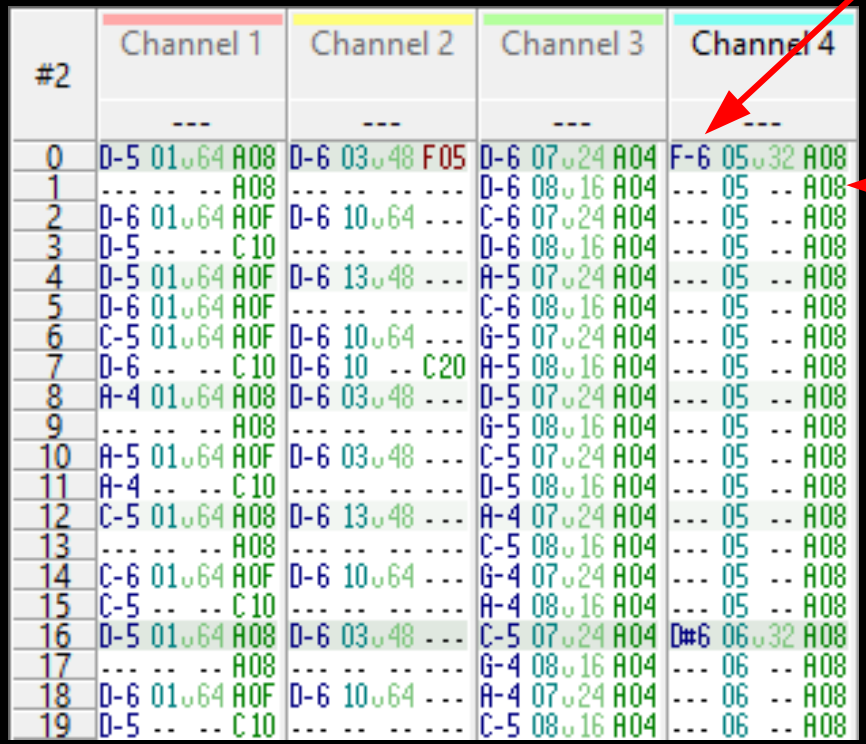
~~00 Free R 00000001~~

Osc Mode Ch Control

00 One R 00000011

2. Start Oscillator

Vexing Volume Vibrato

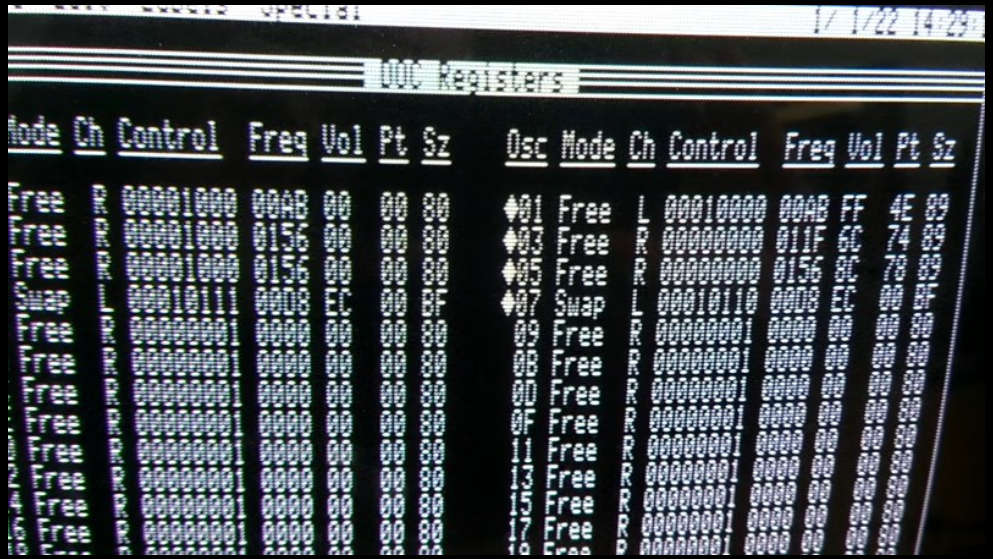


#2	Channel 1	Channel 2	Channel 3	Channel 4
	---	---	---	---
0	D-5 01 v64 A08	D-6 03 v48 F05	D-6 07 v24 A04	F-6 05 v32 A08
1	--- -- -- A08	--- -- -- ---	D-6 08 v16 A04	--- 05 -- A08
2	D-6 01 v64 A0F	D-6 10 v64 ---	C-6 07 v24 A04	--- 05 -- A08
3	D-5 -- -- C10	--- -- -- ---	D-6 08 v16 A04	--- 05 -- A08
4	D-5 01 v64 A0F	D-6 13 v48 ---	A-5 07 v24 A04	--- 05 -- A08
5	D-6 01 v64 A0F	--- -- -- ---	C-6 08 v16 A04	--- 05 -- A08
6	C-5 01 v64 A0F	D-6 10 v64 ---	G-5 07 v24 A04	--- 05 -- A08
7	D-6 -- -- C10	D-6 10 -- C20	A-5 08 v16 A04	--- 05 -- A08
8	A-4 01 v64 A08	D-6 03 v48 ---	D-5 07 v24 A04	--- 05 -- A08
9	--- -- -- A08	--- -- -- ---	G-5 08 v16 A04	--- 05 -- A08
10	A-5 01 v64 A0F	D-6 03 v48 ---	C-5 07 v24 A04	--- 05 -- A08
11	A-4 -- -- C10	--- -- -- ---	D-5 08 v16 A04	--- 05 -- A08
12	C-5 01 v64 A08	D-6 13 v48 ---	A-4 07 v24 A04	--- 05 -- A08
13	--- -- -- A08	--- -- -- ---	C-5 08 v16 A04	--- 05 -- A08
14	C-6 01 v64 A0F	D-6 10 v64 ---	G-4 07 v24 A04	--- 05 -- A08
15	C-5 -- -- C10	--- -- -- ---	A-4 08 v16 A04	--- 05 -- A08
16	D-5 01 v64 A08	D-6 03 v48 ---	C-5 07 v24 A04	D#6 06 v32 A08
17	--- -- -- A08	--- -- -- ---	G-4 08 v16 A04	--- 06 -- A08
18	D-6 01 v64 A0F	D-6 10 v64 ---	A-4 07 v24 A04	--- 06 -- A08
19	D-5 -- -- C10	--- -- -- ---	C-5 08 v16 A04	--- 06 -- A08

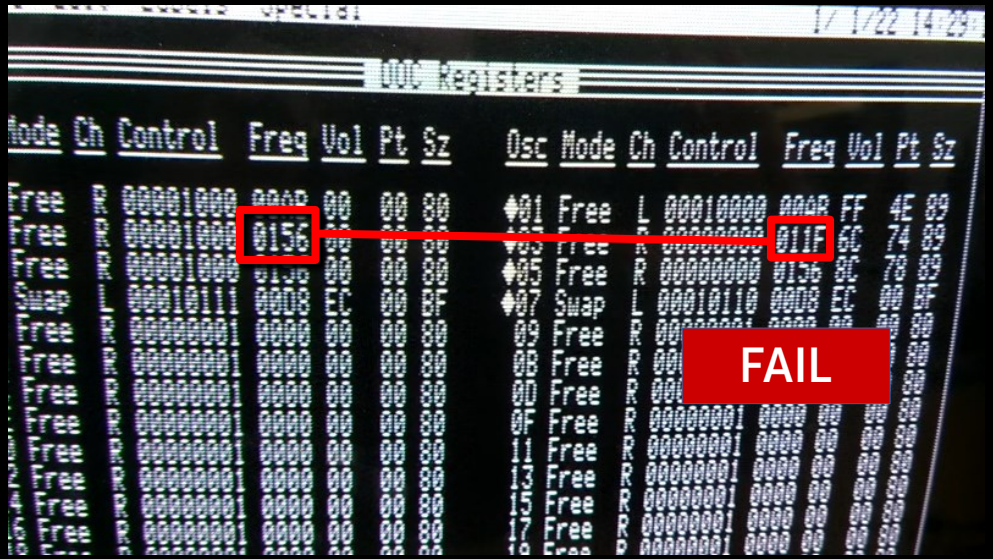
- Play note F-6
- Instrument 05 (default volume 32)
- Reduce volume by 8 every tick

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

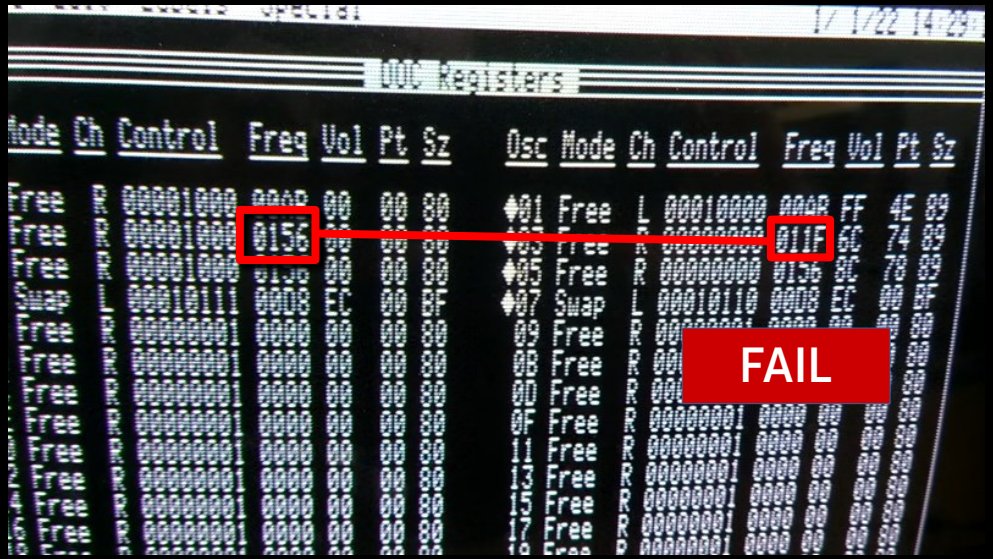
Don’t be too fast



Don’t be too fast

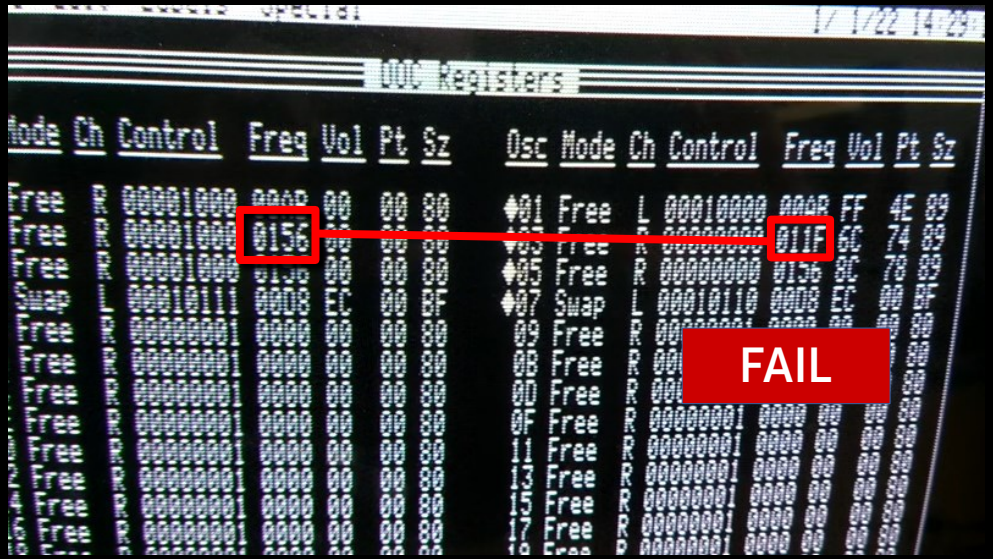


Don’t be too fast



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

Don’t be too fast



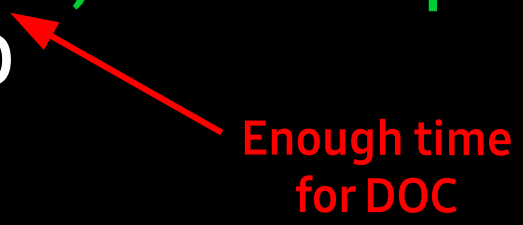
- Direct Page: $C000 → sta DP
- Auto Increment Mode

```
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
```



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?
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Wrapping Up

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

Thank you!

Jesse Blue / Ninjaforce

www.ninjaforce.com