"Sandra Bullock"

Vice snapshot with CCS64 palette

Made with the GIMP from a KM photo
and converted to C64 160x200
Multicolor Mode Bitmap
by Stefano Tognon
in 2002

"Here we are again!"
...

Free Software Group

SoTDin 2
version 1.00
21 November 2002

General Index

Editorials

Stefano Tognon <ice00@libero.it>

Hi, again.

In this new issue of SIDin I presents two reverse engineering works about two fantastic sid tunes: Lazy Jones and Driller. Even if you probably already know how the two authors made the sound in the tunes, maybe someone could be interesting too.

I hope that David and Matt (Matt! Where are you?) take this work for that is: a big recognition for their fantastic work in the C64 scene!

Remember that the right of the presented code remain to the two authors, so contact them if you want to get a business use of it.

See you at the next issue.
Bye

News

Some various news of players, programs and competition:

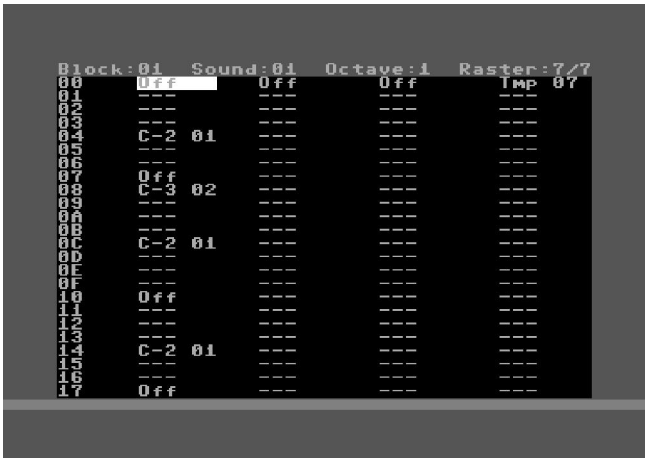
- Sidplay2/w
- JohnPlayer 1.6 and 2 beta
- PSID64 0.5
- TSID2 0.1
- Ninjatrk 1.0/1.01/1.02
- HVSC 5.1
- Audio::SID 3.01 & SIDedit 3.01
- The Sid Compo II

Sidplay2/w

Released on 20 Oct 2002 this new version of the Windows sid player supports the new RSID file format. RSID is just a PSID (with the new PSIDv2NG extension) that require a real C64 environment to run (Real SID). As a real C64 rip can crash old sid player, changing the PSID header in RSID allow that player to not find the sid as valid and so it did not crash.

Download from: http://www.student.nada.kth.se/~d93-alo/c64/spw

JohnPlayer 1.6/2.0b



The music player editor of Aleksi Eeben is at version 1.6. This player uses only 7 rasterline, so it is very indicate for demo that need to use few rasterlines for the music.

It is also available a 2.0 beta version that has some advantage in the steps of sound table and sequencer, but now use 8 rasterlines.

Download the player from:
http://www.student.oulu.fi/~aeeben/

PSID64 0.5

Released at 7 Nov 2002 this new version of the program that generate a C64 executable program from a sid file now support the RSID files.

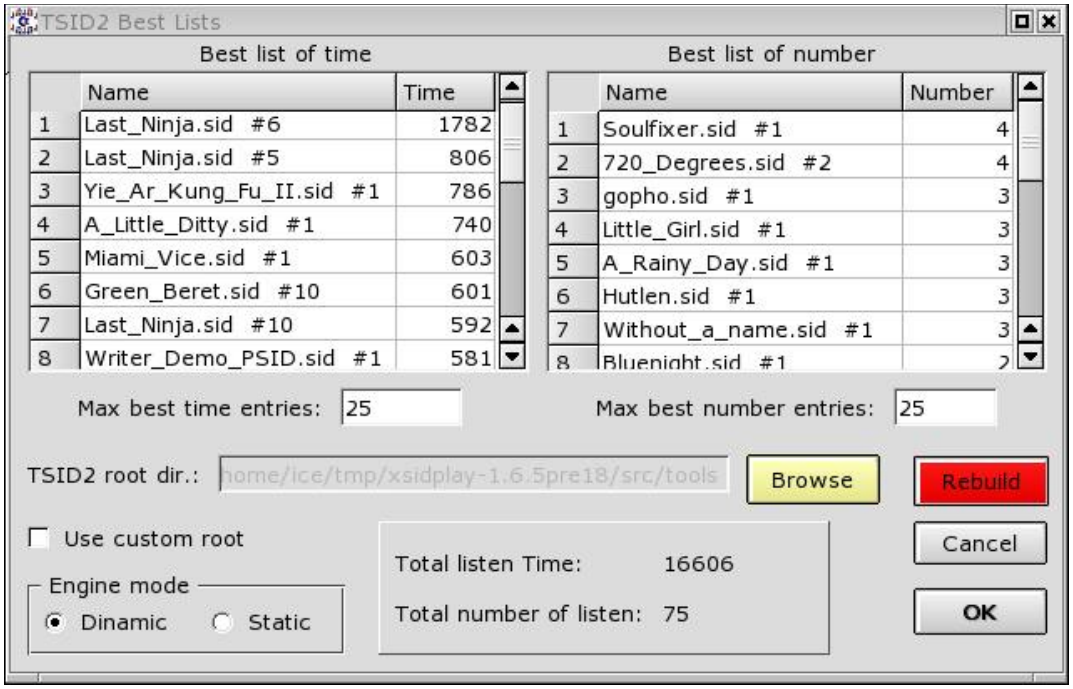
You can now listen to the real C64 rips on your C64 :-)

Download from http://sf.net/projects/psid64

TSID2 0.1

After some very long delay, finally a preliminary version of TSID2 (Time Sid Manager next generation) library is available on Linux system. The library store you listening statistic about sid tunes from a patched sid player, so you can look for your best sids.

It is totally based onto MD5 fingerprinter, so it can manages even reordered collection of sid tunes. You can use a patched xsidplay-1.6.5pre18 version that shows all the features of the new library.



Download all the stuff from http://sf.net/projects/tsid

Ninjatrk 1.0/1.01/1.02

Released on 1 Nov 2002 this is a new tracker by Lasse Öörni (Cadaver).

This tracker use only 10 rasterline and is optimized even for use very little quantity of memory.

It is a player that can be used for demo programs where memory and rasterlines are limited.

Version 1.01 was released 2 weeks later and version 1.02 some days after.

The last version has only 8 rasterlines even during badlines, so it is now more interesting.

Download from:
http://covertbitops.c64.org/tools/ninjatrk.zip

HVSC 5.1

Released on 26/10/2002 the upgrade 33 of HVSC contains the real rip (RSID).
After this update, the collection should contain 19,203 SID files!
This update contains:

```
504 new SIDs
 49 fixed/better rips
 90 fixes of PlaySID/Sidplay1 specific SIDs
  7 repeats/bad rips eliminated
317 SID credit fixes
```

Download the collection/upgrade from: http://www.hvsc.c64.org

Audio::SID 3.01 & SIDedit 3.01

The LaLa perl module for managing sid file (Audio::SID) and the graphical program SIDedit is now at version 3.01.

SIDedit is a Perl/Tk GUI application that allows to read, write and edit binary SID files: the definitive utility for a SID ripper!

This version has some bug fixes and the support of RSID file format.

Download from the Lala site: http://lala.c64.org

The SID Compo II

The c64.sk Music Competition, from 8 October to 4 November 2002 has reached 30 entries from 13 counties and some other bonus tunes!

This year the competition was open to all the kind of music players, while the previous (Goattrk compo) was open only to Goattrk player.

Here the final classification:

PLACE	PTS	HANDLE / GROUP / SONG NAME / TIME
1	490	Dane / Crest trial_and_error
2	465	Vip/ Padua / Role / WOW / Cyber Zound Prancah
3	452	DaFunk / Onslaught Euro(S)cream
4	439	GH lafrique
	439	Yodelking of Defiers & UL-Tomten Banankorv
5	425	Dr.Voice / Magic_Carpet_Ride
6	420	Trance / X-Stayle Way_of_the_Saint
	420	No-XS / Toondichters Still_in_April
7	409	Cadaver / CovertBitops TheConsultant
8	395	Jammer / MSL / Samar Sky_Flight
9	388	Oedipus Wings_of_Death
10	382	Makt One / Fairlight NagChampa
	382	Sidder / MultiStyle Labs / Role MrPivo
11	379	Aleksi Eeben / CNCD RoundBlueRath
12	378	Smalltown Boy / MultiStyle Labs coffee
13	377	Luca / Fire mindfixer
14	375	Dalezy / Creators / Rebels midnightrun
15	371	A Life in Hell /WOW / Unreal internalise
16	370	Mr.Death / Creators Russian_Cow_Moolok
17	368	Mermaid / Creators / Crest in_die_Dunkelheit
18	362	Richard / TND / Civitas / PTV TwiceDelight
19	348	St0fF / N30PLA51A Wektag
20	324	Waz / Padua Very_Doubtful_Space
21	322	TDS / Creators Level_Zero
22	317	hukka / Exec kauppa
23	313	CeRRor / Ex-Xentax CerroR_MoS
24	306	pOnToNiuS Poke
25	290	Pater PI/ Church64 Star_Fox_Corneria
26	279	Alias Medron / Padua / Samar relax
27	252	Six of DLoC /Dark Lords of Chaos Hi6i11y H34v3n!

See the even at: http://www.c64.sk/index.php?content=article.php&articleid=57&id=832

Lasse Öörni (Cadaver) Interview!

by Stefano Tognon

In this second issue, I present this interview with Lasse that occurs with some emails in November of this year. I like the Cadever's works: fantastic games with a wonderful atmosphere like in MW series (e.g. I like the rain, or the day/night effect you can found in them) and a series of crossdevelop tools and music players.

Hello, Lasse,
Before starting say something about your real life: where do you live, what do you do...

I live near Oulu, Finland, and study physics/math/chemistry/computer science in the Oulu university (I aim to be a teacher)

Well, you are probably know to the most by having created many bigs games for the C64: Escape From New York, BOFH:Servers Under Siege, Metal Warrior: you had wrote anything from engines, graphics, musics. Maybe you are one of the last full coder around that use however the modern technology (crossdevelop)?

This is an interesting question, because I started "serious" or C64 coding and crossdeveloping quite late, in 1998, after a break of several years;
before that I never got anything noteworthy done on the C64. So I guess that makes me quite a newcomer. :)

But there are several coders using crossdevelopment, and more are picking it up, and big demos & games are being created, so perhaps I wouldn't like to say "one of the last".

How about your players? You had created Music driver, SadoTracker, Goattrk and Ninjatrk. Why you had write so many players?

I've been steadily improving as a coder, so each time, when starting a new game project, I also wanted to rewrite the playroutine for memory or speed (rastertime) gain. Sometimes, I even wrote editors :)

I thought Goattracker would be the ultimate for my personal use, because it was fast & easy to compose on, but finally I had to realize that music made with it takes too much memory (because of the patterns, they're like in Amiga/PC tracker programs). So I started the quest for the extremely optimized playroutine/musicdata combination (Ninjatracker) :)

Speaking about music: what we must expect from you now? Another player? Other features to one of your player (e.g. something had asked for digi-sample support in your player)?

I have no experience of sample coding (although I guess it's not too hard), so it's unlikely they'd be featured in my editor(s). Also, Goattracker has kind of reached the peak in ease-of-use vs. features (it is missing step-programming for sounds, that would add versatility at the cost of easiness), and Ninjatracker in speed & size, so at least now I can't see the need/possibility for another player.

So, you can hope/expect that I make good music for MW4 :)
(there are also other non-C64 related guys making music for it, I'll then arrange it for C64 as necessary -- same system as with MW3)

Now some quick final (standard) questions:

Real machine vs emulator: what do you think of?

Real machine is better for gaming sessions, that' s for sure. :)
And a real SID is very much preferable for composing.
But emulators are very powerful tools in testing your programs.

What is the worst sid that you compose and the better one?

Worst is probably the music from Advanced Action Movie Simulator, it was done that way on purpose (crapgame-compo)

About best I don' t know, MW2 has some nice melodies in a couple of tunes.

Who are your best sid authors?

Quite the usual; Rob Hubbard, Martin Galway, Matt Gray, Jonathan Dunn (this guy composed the ultimate war-feeling/heroic SIDs), Reyn Ouwehand

What are the best sids ever in your opinion?

Hubbard' s Sanxion loader, and the various Ocean Loaders evoke the most feeling in me :)
Platoon, Last Ninja 2 & Last Ninja 3 soundtracks contain also nothing but brilliant tunes to me. Usually, it' s not the technicality that I care most of, but rather the melodies and the atmosphere.

Finally, many thanks for the time you give for this interview,
and now you can say any things you want for concluding this interview :)

Ok, this goes for any C64 gamedevelopers. Beware of 2 things that will get your project cancelled, by mysterious hand of fate:
1) planning to do a Zelda project with bitmap scrolling
2) trying to do another Turrican for C64 :)

Webography:

Covert BitOps site:
http://covertbitops.c64.org/

Lasse Öörni homepage
http://www.student.oulu.fi/~loorni/

What to say about this game? Fantastic.

It was simple but very original and with a music that I think all who play it did not forget. Now I simply show you how David made this music. You probably will be surprise to see a so simple engine gives this magic music: maybe it is all David talent!

First of all: the reverse engineering work is based onto the Sid rip present in HVSC. How you see it is not complete with the sound SX: however it is just what we need.

If you look at the code you can see that the engine is very simple:

- The 20 music peaces are with the same length (the first is a case we see after): 80h bytes of data.
- Each peaces of music contains the low/high frequency to set in the sid registers for the 2 voices used (so 4 bytes).
- There' s not a note duration: each notes have the same length.
- There' snot special SID effect: all the notes use the same setting: Attack/Decay of 66h and 21h wave form.
- As the Decay/Released is not set (so 0), there' sa simple 20h to 21h setting in the wave form when the note changes.
- Tune 1 is an exception: it is the running of tune 10 and 11 in sequences.

So from where comes the beautiful sound? I think from the music notes themselves!

Maybe David had used some frequencies that give a better result using a little less or high values from the expected. However this require me many times for investigated; so look at the code and judge from yourself.

The Code

This code is a reverse engineering works, so contact the copyright owner author for making any business use of it.

I have also noted that the game was ripped from a cracked version of the game, as it contains a faulty track (not used in the rip, but present). You can see this track at the end of the listing at the *wrong* label, and you can listen to it if you change the source and you active it again.

```
  processor 6502
  org 1921

 .byte "PSID"
 .word $0200          ; version 2
 .word $7C00          ; data offset
 .byte #>init
 .byte #<init
 .byte #>init
 .byte #<init
 .byte #>IRQ
 .byte #<IRQ
 .word $1500          ; 21 song
 .word $0100          ; default song
```

```
 .word $FFFF
 .word $FFFF
 .byte "lazy Jones",0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
 .byte "David Whittaker",0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
 .byte "1984 Terminal Software",0,0,0,0,0,0,0,0,0,0
 .word $0000
 .word $0000
 .word $0000

MUSIC = $03E0            ; 1=play music
INDEX = $03E1            ; index to freq. pattern
DELAY = $03E3            ; delay (speed of tune)
PATTL = $03E4            ; low pointer of pattern
PATTH = $03E5            ; high pointer of pattern

init:
       cmp  #$00
       beq  first
       tax
       lda  #$80
       sta  COMP+1
       lda  tableLo,x
       sta  LOP+1
       lda  tableHi,x
       sta  HIP+1
       jmp  initEngine

first:
       lda  #$00
       sta  COMP+1
       lda  #<Tune1
       sta  LOP+1
       lda  #>Tune1
       sta  HIP+1
       jmp  initEngine

tableLo:
  .byte <Tune1, <Tune2, <Tune3, <Tune4
  .byte <Tune5, <Tune6, <Tune7, <Tune8
  .byte <Tune9, <Tune10, <Tune11, <Tune12
  .byte <Tune13, <Tune14, <Tune15, <Tune16
  .byte <Tune17, <Tune18, <Tune19, <Tune20
  .byte <Tune21

tableHi:
  .byte >Tune1, >Tune2, >Tune3, >Tune4
  .byte >Tune5, >Tune6, >Tune7, >Tune8
  .byte >Tune9, >Tune10, >Tune11, >Tune12
  .byte >Tune13, >Tune14, >Tune15, >Tune16
  .byte >Tune17, >Tune18, >Tune19, >Tune20
  .byte >Tune21

IRQ:
       lda  MUSIC                ; read music flag
       beq  exit                 ; 0=not play
       dec  DELAY                ; dec delay for speed
       bne  exit
       lda  #$0C
       sta  DELAY                ; init the delay (speed) of tune
       ldy  #$00
       lda  ($B4),y              ; read low frequency
       beq  skip1                ; zero?
       sta  $D400                ; Voice 1: Frequency control (lo byte)
       iny
       lda  ($B4),Y              ; read high freqeuncy
       sta  $D401                ; Voice 1: Frequency control (hi byte)
       lda  #$20
       sta  $D404                ; Voice 1: Control registers
       lda  #$21
       sta  $D404                ; Voice 1: Control registers

skip1:
       lda  $B4
       clc
       adc  #$02
       sta  $B4
       lda  $B5
       adc  #$00
       sta  $B5
       ldy  #$00
       lda  ($B4),Y              ; read low frequency
       beq  skip2                ; zero?
       sta  $D407                ; Voice 2: Frequency control (lo byte)
       iny
       lda  ($B4),Y              ; read high freqeuncy
       sta  $D408                ; Voice 2: Frequency control (hi byte)
       lda  #$20
       sta  $D40B                ; Voice 2: Control registers
       lda  #$21
       sta  $D40B                ; Voice 2: Control registers
```

Tables with pointers to the tunes patterns

```
skip2:
       lda  $B4
       clc
       adc  #$02
       sta  $B4
       lda  $B5
       adc  #$00
       sta  $B5
       inc  INDEX                ; inc index by 4
       inc  INDEX
       inc  INDEX
       inc  INDEX
       lda  INDEX
COMP:
       cmp  #$80                 ; end of pattern?
       bne  exit
       lda  #$00
       sta  INDEX                ; set pointer to the begin
       lda  PATTL                ; repristinate pattern pointer
       sta  $B4
       lda  PATTH
       sta  $B5

exit:  jmp  $EA31                ; Default hardware interrupt (IRQ)

setAD:
       lda  #$1F
       sta  $D418                ; Select volume and filter mode
       lda  #$66
       sta  $D405                ; Generator 1: Attack/Decay
       sta  $D40C                ; Generator 2: Attack/Decay
       sei
       lda  #<IRQ
       sta  $0314                ; Vector: Hardware Interrupt (IRQ)
       lda  #>IRQ
       sta  $0315                ; Vector: Hardware Interrupt (IRQ)
       cli
       rts

initEngine:
       lda  #$01
       sta  MUSIC                 ; play music
       lda  #$00
       sta  INDEX                 ; reset index pointer
       lda  #$0C
       sta  DELAY                 ; set delay (speed of tune)
LOP:
       lda  #$00
       sta  PATTL
       sta  $B4
HIP:
       lda  #$1C
       sta  PATTH
       sta  $B5
       lda  #$FF
       sta  $D416                 ; Filter cut frequency: hi byte
       lda  #$03
       sta  $D417                 ; Filter resonance control/voice input control
       jsr  setAD
       rts

 org 2400
Tune2:
  .byte $D5, $07,  $D2, $0F
  .byte $BE, $0F,  $E6, $0F
  .byte $D5, $07,  $FD, $07
  .byte $D2, $0F,  $D1, $12
  .byte $D5, $07,  $FD, $07
  .byte $D2, $0F,  $C3, $11
  .byte $D5, $07,  $FD, $07
  .byte $BE, $0F,  $E6, $0F
  .byte $47, $06,  $D1, $12
  .byte $7B, $0C,  $A3, $0C
  .byte $33, $06,  $5B, $06
  .byte $7B, $0C,  $A3, $0C
  .byte $33, $06,  $5B, $06
  .byte $7B, $0C,  $A3, $0C
  .byte $33, $06,  $5B, $06
  .byte $7B, $0C,  $A3, $0C
  .byte $E9, $07,  $D2, $0F
  .byte $BE, $0F,  $E6, $0F
  .byte $D5, $07,  $FD, $07
  .byte $D2, $0F,  $D1, $12
  .byte $D5, $07,  $FD, $07
  .byte $D2, $0F,  $C3, $11
  .byte $D5, $07,  $FD, $07
  .byte $BE, $0F,  $E6, $0F
  .byte $68, $09,  $DA, $0B
  .byte $BD, $12,  $E5, $12
```

Now all the list of frequencies to play

```
   .byte $54, $09,  $7C, $09
   .byte $BD, $12,  $E5, $12
   .byte $54, $09,  $7C, $09
   .byte $BD, $12,  $E5, $12
   .byte $54, $09,  $7C, $09
   .byte $BD, $12,  $E5, $12

Tune3:
   .byte $E9, $07,  $B5, $17
   .byte $D2, $0F,  $B5, $17
   .byte $E9, $07,  $1F, $15
   .byte $D2, $0F,  $D1, $12
   .byte $D5, $07,  $1F, $15
   .byte $D2, $0F,  $B5, $17
   .byte $D5, $07,  $FD, $07
   .byte $BE, $0F,  $E6, $0F
   .byte $68, $09,  $A2, $25
   .byte $D1, $12,  $31, $1C
   .byte $68, $09,  $B5, $17
   .byte $D1, $12,  $1F, $15
   .byte $68, $09,  $B5, $17
   .byte $BD, $12,  $1F, $15
   .byte $54, $09,  $7C, $09
   .byte $BD, $12,  $B5, $17
   .byte $D9, $05,  $F7, $05
   .byte $C6, $0B,  $EE, $0B
   .byte $D9, $05,  $F7, $05
   .byte $C6, $0B,  $EE, $0B
   .byte $D9, $05,  $F7, $05
   .byte $C6, $0B,  $EE, $0B
   .byte $ED, $05,  $B5, $17
   .byte $DA, $0B,  $C3, $11
   .byte $D9, $05,  $F7, $05
   .byte $C6, $0B,  $EE, $0B
   .byte $D9, $05,  $C3, $11
   .byte $C6, $0B,  $EE, $0B
   .byte $D9, $05,  $F7, $05
   .byte $C6, $0B,  $EE, $0B
   .byte $D9, $05,  $F7, $05
   .byte $C6, $0B,  $EE, $0B

Tune4:
   .byte $0C, $07,  $18, $0E
   .byte $0E, $0E,  $2C, $0E
   .byte $0C, $07,  $D2, $0F
   .byte $18, $0E,  $C3, $11
   .byte $0C, $07,  $C3, $11
   .byte $18, $0E,  $D1, $12
   .byte $0C, $07,  $C3, $11
   .byte $18, $0E,  $D2, $0F
   .byte $ED, $05,  $DA, $0B
   .byte $C6, $0B,  $EE, $0B
   .byte $ED, $05,  $18, $0E
   .byte $C6, $0B,  $EE, $0B
   .byte $ED, $05,  $D2, $0F
   .byte $C6, $0B,  $EE, $0B
   .byte $E3, $05,  $F7, $05
   .byte $C6, $0B,  $EE, $0B
   .byte $0C, $07,  $18, $0E
   .byte $0E, $0E,  $2C, $0E
   .byte $0C, $07,  $D2, $0F
   .byte $18, $0E,  $C3, $11
   .byte $0C, $07,  $C3, $11
   .byte $18, $0E,  $D1, $12
   .byte $0C, $07,  $C3, $11
   .byte $18, $0E,  $D2, $0F
   .byte $ED, $05,  $DA, $0B
   .byte $C6, $0B,  $EE, $0B
   .byte $ED, $05,  $18, $0E
   .byte $C6, $0B,  $EE, $0B
   .byte $ED, $05,  $B5, $17
   .byte $DA, $0B,  $D2, $0F
   .byte $ED, $05,  $B5, $17
   .byte $DA, $0B,  $A5, $1F

Tune5:
   .byte $47, $06,  $1E, $19
   .byte $7B, $0C,  $A3, $0C
   .byte $3D, $06,  $51, $06
   .byte $8F, $0C,  $31, $1C
   .byte $3D, $06,  $51, $06
   .byte $7B, $0C,  $A3, $0C
   .byte $47, $06,  $DF, $1D
   .byte $7B, $0C,  $A3, $0C
   .byte $F7, $09,  $1E, $19
   .byte $DB, $13,  $03, $14
   .byte $E3, $09,  $0B, $0A
   .byte $EF, $13,  $31, $1C
   .byte $E3, $09,  $0B, $0A
   .byte $DB, $13,  $03, $14
```

```
   .byte $F7, $09,  $DF, $1D
   .byte $DB, $13,  $03, $14
   .byte $77, $07,  $1E, $19
   .byte $DB, $0E,  $03, $0F
   .byte $6D, $07,  $81, $07
   .byte $EF, $0E,  $31, $1C
   .byte $6D, $07,  $81, $07
   .byte $DB, $0E,  $03, $0F
   .byte $77, $07,  $DF, $1D
   .byte $DB, $0E,  $03, $0F
   .byte $68, $09,  $1E, $19
   .byte $BD, $12,  $E5, $12
   .byte $54, $09,  $7C, $09
   .byte $D1, $12,  $31, $1C
   .byte $54, $09,  $7C, $09
   .byte $BD, $12,  $E5, $12
   .byte $0C, $07,  $DF, $1D
   .byte $04, $0E,  $2C, $0E

Tune6:
   .byte $61, $08,  $1F, $15
   .byte $AF, $10,  $D7, $10
   .byte $4D, $08,  $75, $08
   .byte $C3, $10,  $60, $16
   .byte $4D, $08,  $75, $08
   .byte $AF, $10,  $D7, $10
   .byte $61, $08,  $1F, $15
   .byte $AF, $10,  $D7, $10
   .byte $47, $06,  $D1, $12
   .byte $7B, $0C,  $A3, $0C
   .byte $3D, $06,  $51, $06
   .byte $8F, $0C,  $1F, $15
   .byte $3D, $06,  $51, $06
   .byte $7B, $0C,  $A3, $0C
   .byte $47, $06,  $D1, $12
   .byte $7B, $0C,  $A3, $0C
   .byte $98, $05,  $C3, $10
   .byte $1C, $0B,  $44, $0B
   .byte $8E, $05,  $A2, $05
   .byte $30, $0B,  $D1, $12
   .byte $8E, $05,  $A2, $05
   .byte $1C, $0B,  $44, $0B
   .byte $98, $05,  $C3, $10
   .byte $1C, $0B,  $44, $0B
   .byte $47, $06,  $D1, $12
   .byte $7B, $0C,  $A3, $0C
   .byte $3D, $06,  $51, $06
   .byte $8F, $0C,  $1E, $19
   .byte $3D, $06,  $51, $06
   .byte $7B, $0C,  $A3, $0C
   .byte $47, $06,  $A5, $1F
   .byte $7B, $0C,  $A3, $0C

Tune7:
   .byte $30, $04,  $D1, $12
   .byte $4D, $08,  $75, $08
   .byte $30, $04,  $1F, $15
   .byte $61, $08,  $C3, $10
   .byte $26, $04,  $3A, $04
   .byte $4D, $08,  $75, $08
   .byte $30, $04,  $1F, $15
   .byte $4D, $08,  $75, $08
   .byte $B4, $04,  $D1, $12
   .byte $54, $09,  $7C, $09
   .byte $B4, $04,  $C3, $10
   .byte $68, $09,  $18, $0E
   .byte $AA, $04,  $BE, $04
   .byte $54, $09,  $7C, $09
   .byte $AA, $04,  $BE, $04
   .byte $54, $09,  $7C, $09
   .byte $98, $05,  $60, $16
   .byte $1C, $0B,  $44, $0B
   .byte $98, $05,  $60, $16
   .byte $30, $0B,  $60, $16
   .byte $8E, $05,  $A2, $05
   .byte $1C, $0B,  $44, $0B
   .byte $98, $05,  $60, $16
   .byte $1C, $0B,  $44, $0B
   .byte $47, $06,  $60, $16
   .byte $8F, $0C,  $1F, $15
   .byte $3D, $06,  $51, $06
   .byte $8F, $0C,  $1F, $15
   .byte $3D, $06,  $51, $06
   .byte $7B, $0C,  $A3, $0C
   .byte $3D, $06,  $51, $06
   .byte $7B, $0C,  $A3, $0C

Tune8:
   .byte $47, $06,  $D2, $0F
   .byte $7B, $0C,  $A3, $0C
```

```
   .byte $47, $06,  $18, $0E
   .byte $7B, $0C,  $A3, $0C
   .byte $30, $04,  $C3, $10
   .byte $4D, $08,  $75, $08
   .byte $30, $04,  $D1, $12
   .byte $61, $08,  $1F, $15
   .byte $47, $06,  $D2, $0F
   .byte $7B, $0C,  $A3, $0C
   .byte $47, $06,  $18, $0E
   .byte $7B, $0C,  $A3, $0C
   .byte $61, $08,  $C3, $10
   .byte $AF, $10,  $D7, $10
   .byte $4D, $08,  $75, $08
   .byte $AF, $10,  $D7, $10
   .byte $47, $06,  $D2, $0F
   .byte $7B, $0C,  $A3, $0C
   .byte $47, $06,  $18, $0E
   .byte $7B, $0C,  $A3, $0C
   .byte $30, $04,  $C3, $10
   .byte $4D, $08,  $75, $08
   .byte $30, $04,  $D1, $12
   .byte $61, $08,  $1F, $15
   .byte $0C, $07,  $18, $0E
   .byte $04, $0E,  $2C, $0E
   .byte $0C, $07,  $C3, $10
   .byte $18, $0E,  $1F, $15
   .byte $61, $08,  $C3, $10
   .byte $AF, $10,  $D7, $10
   .byte $61, $08,  $1F, $15
   .byte $C3, $10,  $1E, $19

Tune9:
   .byte $47, $05,  $1E, $19
   .byte $7B, $0A,  $A3, $0A
   .byte $47, $05,  $1E, $19
   .byte $8F, $0A,  $B5, $17
   .byte $47, $06,  $1F, $15
   .byte $7B, $0C,  $A3, $0C
   .byte $0C, $07,  $1F, $15
   .byte $18, $0E,  $D1, $12
   .byte $47, $05,  $C3, $10
   .byte $7B, $0A,  $A3, $0A
   .byte $47, $05,  $C3, $10
   .byte $8F, $0A,  $D2, $0F
   .byte $F4, $03,  $18, $0E
   .byte $D5, $07,  $FD, $07
   .byte $B4, $04,  $18, $0E
   .byte $68, $09,  $DA, $0B
   .byte $47, $05,  $1E, $19
   .byte $7B, $0A,  $A3, $0A
   .byte $47, $05,  $1E, $19
   .byte $8F, $0A,  $A5, $1F
   .byte $47, $06,  $1F, $15
   .byte $9F, $0C,  $C7, $0C
   .byte $0C, $07,  $1F, $15
   .byte $18, $0E,  $1E, $19
   .byte $E9, $07,  $87, $21
   .byte $BE, $0F,  $E6, $0F
   .byte $E9, $07,  $87, $21
   .byte $D2, $0F,  $A5, $1F
   .byte $0C, $07,  $31, $1C
   .byte $04, $0E,  $2C, $0E
   .byte $47, $06,  $1E, $19
   .byte $7B, $0C,  $A3, $0C

Tune1:
Tune10:                          ; also tune 1 (with tune 11)
                                 ; .=low ^=hi
   .byte $26, $04,  $3A, $04     ; . H1  C2
   .byte $4D, $08,  $75, $08     ; . H2  C3
   .byte $30, $04,  $8F, $0C     ; ^ H1  F#3
   .byte $61, $08,  $8F, $0A     ; ^ H2  D#3
   .byte $30, $04,  $61, $08     ; ^ H1  H2
   .byte $4D, $08,  $75, $08     ; . H2  C3
   .byte $30, $04,  $C3, $10     ; ^ H1  H-3
   .byte $4D, $08,  $75, $08     ; . H2  C3
   .byte $30, $04,  $8F, $0A     ; ^ H1  D#3
   .byte $61, $08,  $30, $0B     ; ^ H2  E3
   .byte $30, $04,  $DA, $0B     ; ^ H1  F3
   .byte $61, $08,  $8F, $0C     ; ^ H2  F#3
   .byte $30, $04,  $61, $08     ; ^ H1  H2
   .byte $4D, $08,  $75, $08     ; . H2  C3
   .byte $26, $04,  $3A, $04     ; . H1  C2
   .byte $4D, $08,  $75, $08     ; . H2  C3
   .byte $30, $04,  $8F, $0A     ; ^ H1  D#3
   .byte $61, $08,  $30, $0B     ; ^ H2  E3
   .byte $30, $04,  $DA, $0B     ; ^ H1  F3
   .byte $61, $08,  $8F, $0C     ; ^ H2  F#3
   .byte $30, $04,  $30, $0B     ; ^ H1  E3
   .byte $4D, $08,  $75, $08     ; . H2  C3
```

```
   .byte $30, $04,  $8F, $0A     ; ^ H1  D#3
   .byte $4D, $08,  $75, $08     ; . H2  C3
   .byte $30, $04,  $61, $08     ; ^ H1  H2
   .byte $4D, $08,  $75, $08     ; . H2  C3
   .byte $30, $04,  $C3, $10     ; ^ H1  H-3
   .byte $61, $08,  $8F, $0C     ; ^ H2  F#3
   .byte $26, $04,  $3A, $04     ; . H1  C2
   .byte $4D, $08,  $75, $08     ; . H2  C3
   .byte $26, $04,  $3A, $04     ; . H1  C2
   .byte $4D, $08,  $75, $08     ; . H2  C3

Tune11:
   .byte $30, $04,  $8F, $0A     ; ^ H1  D#3
   .byte $4D, $08,  $75, $08     ; . H2  C3
   .byte $30, $04,  $8F, $0A     ; ^ H1  D#3
   .byte $61, $08,  $8F, $0A     ; ^ H2  D#3
   .byte $30, $04,  $8F, $0A     ; ^ H1  D#3
   .byte $4D, $08,  $75, $08     ; . H2  C3
   .byte $30, $04,  $30, $0B     ; ^ H1  E3
   .byte $61, $08,  $68, $09     ; ^ H2  ...
   .byte $3D, $06,  $51, $06
   .byte $7B, $0C,  $A3, $0C
   .byte $3D, $06,  $51, $06
   .byte $7B, $0C,  $A3, $0C
   .byte $3D, $06,  $51, $06
   .byte $7B, $0C,  $A3, $0C
   .byte $3D, $06,  $51, $06
   .byte $7B, $0C,  $A3, $0C
   .byte $47, $06,  $68, $09
   .byte $7B, $0C,  $A3, $0C
   .byte $47, $06,  $68, $09
   .byte $8F, $0C,  $8F, $0A
   .byte $47, $06,  $68, $09
   .byte $7B, $0C,  $A3, $0C
   .byte $47, $06,  $61, $08
   .byte $7B, $0C,  $A3, $0C
   .byte $30, $04,  $61, $08
   .byte $4D, $08,  $75, $08
   .byte $30, $04,  $C3, $10
   .byte $61, $08,  $8F, $0C
   .byte $26, $04,  $3A, $04
   .byte $4D, $08,  $75, $08
   .byte $26, $04,  $3A, $04
   .byte $4D, $08,  $75, $08

Tune12:
   .byte $ED, $05,  $C3, $11
   .byte $C6, $0B,  $EE, $0B
   .byte $E3, $05,  $F7, $05
   .byte $DA, $0B,  $EF, $13
   .byte $E3, $05,  $F7, $05
   .byte $DA, $0B,  $B5, $17
   .byte $E3, $05,  $F7, $05
   .byte $DA, $0B,  $EF, $13
   .byte $70, $04,  $4E, $0D
   .byte $CD, $08,  $F5, $08
   .byte $66, $04,  $7A, $04
   .byte $E1, $08,  $EF, $0E
   .byte $66, $04,  $7A, $04
   .byte $E1, $08,  $C3, $11
   .byte $66, $04,  $7A, $04
   .byte $E1, $08,  $EF, $0E
   .byte $ED, $05,  $C3, $11
   .byte $C6, $0B,  $EE, $0B
   .byte $E3, $05,  $F7, $05
   .byte $DA, $0B,  $EF, $13
   .byte $E3, $05,  $F7, $05
   .byte $DA, $0B,  $B5, $17
   .byte $E3, $05,  $F7, $05
   .byte $DA, $0B,  $EF, $13
   .byte $E1, $08,  $DF, $27
   .byte $AF, $11,  $D7, $11
   .byte $CD, $08,  $F5, $08
   .byte $C3, $11,  $86, $23
   .byte $CD, $08,  $F5, $08
   .byte $C3, $11,  $DF, $1D
   .byte $CD, $08,  $F5, $08
   .byte $C3, $11,  $9C, $1A

Tune13:
   .byte $68, $09,  $D1, $12
   .byte $BD, $12,  $E5, $12
   .byte $68, $09,  $31, $1C
   .byte $D1, $12,  $60, $16
   .byte $54, $09,  $7C, $09
   .byte $BD, $12,  $E5, $12
   .byte $68, $09,  $D1, $12
   .byte $BD, $12,  $E5, $12
   .byte $86, $03,  $C3, $10
   .byte $02, $07,  $16, $07
```

```
    .byte $86, $03,  $31, $1C
    .byte $0C, $07,  $1F, $15
    .byte $7C, $03,  $90, $03
    .byte $02, $07,  $16, $07
    .byte $86, $03,  $C3, $10
    .byte $02, $07,  $16, $07
    .byte $47, $06,  $D2, $0F
    .byte $7B, $0C,  $A3, $0C
    .byte $47, $06,  $1E, $19
    .byte $8F, $0C,  $D1, $12
    .byte $3D, $06,  $51, $06
    .byte $7B, $0C,  $A3, $0C
    .byte $3D, $06,  $51, $06
    .byte $7B, $0C,  $A3, $0C
    .byte $23, $03,  $D2, $0F
    .byte $3D, $06,  $51, $06
    .byte $23, $03,  $D1, $12
    .byte $47, $06,  $D2, $0F
    .byte $23, $03,  $A2, $25
    .byte $47, $06,  $87, $21
    .byte $23, $03,  $A5, $1F
    .byte $3D, $06,  $51, $06

Tune14:
    .byte $30, $04,  $87, $21
    .byte $61, $08,  $87, $21
    .byte $30, $04,  $87, $21
    .byte $61, $08,  $87, $21
    .byte $30, $04,  $87, $21
    .byte $61, $08,  $87, $21
    .byte $30, $04,  $87, $21
    .byte $61, $08,  $87, $21
    .byte $30, $04,  $87, $21
    .byte $61, $08,  $3C, $32
    .byte $30, $04,  $87, $21
    .byte $61, $08,  $3C, $32
    .byte $30, $04,  $87, $21
    .byte $61, $08,  $3C, $32
    .byte $30, $04,  $87, $21
    .byte $61, $08,  $3C, $32
    .byte $47, $06,  $3C, $32
    .byte $7B, $0C,  $A3, $0C
    .byte $3D, $06,  $51, $06
    .byte $7B, $0C,  $A3, $0C
    .byte $3D, $06,  $51, $06
    .byte $7B, $0C,  $A3, $0C
    .byte $3D, $06,  $51, $06
    .byte $7B, $0C,  $A3, $0C
    .byte $3D, $06,  $51, $06
    .byte $7B, $0C,  $A3, $0C
    .byte $3D, $06,  $51, $06
    .byte $7B, $0C,  $A3, $0C
    .byte $47, $06,  $3C, $32
    .byte $7B, $0C,  $A3, $0C
    .byte $47, $06,  $3E, $2A
    .byte $7B, $0C,  $A3, $0C

Tune15:
    .byte $FB, $04,  $EF, $13
    .byte $E3, $09,  $0B, $0A
    .byte $F1, $04,  $05, $05
    .byte $F7, $09,  $EF, $0E
    .byte $F1, $04,  $05, $05
    .byte $E3, $09,  $0B, $0A
    .byte $FB, $04,  $EF, $13
    .byte $E3, $09,  $0B, $0A
    .byte $A7, $06,  $EF, $13
    .byte $E3, $09,  $0B, $0A
    .byte $9D, $06,  $B1, $06
    .byte $F7, $09,  $C3, $10
    .byte $9D, $06,  $B1, $06
    .byte $E3, $09,  $0B, $0A
    .byte $A7, $06,  $EF, $13
    .byte $E3, $09,  $0B, $0A
    .byte $77, $07,  $EF, $13
    .byte $DB, $0E,  $F8, $0E
    .byte $6D, $07,  $81, $07
    .byte $EF, $0E,  $D1, $12
    .byte $6D, $07,  $81, $07
    .byte $DB, $0E,  $03, $0F
    .byte $77, $07,  $C3, $10
    .byte $DB, $0E,  $03, $0F
    .byte $EF, $0E,  $D1, $12
    .byte $CB, $1D,  $F3, $1D
    .byte $DB, $0E,  $03, $0F
    .byte $DF, $1D,  $EF, $13
    .byte $DB, $0E,  $03, $0F
    .byte $CB, $1D,  $F3, $1D
    .byte $EF, $0E,  $60, $16
    .byte $CB, $1D,  $F3, $1D
```

```
Tune16:
  .byte $30, $04,  $A2, $25
  .byte $4D, $08,  $75, $08
  .byte $30, $04,  $3E, $2A
  .byte $4D, $08,  $75, $08
  .byte $30, $04,  $87, $21
  .byte $4D, $08,  $75, $08
  .byte $30, $04,  $C3, $10
  .byte $61, $08,  $1E, $19
  .byte $26, $04,  $3A, $04
  .byte $4D, $08,  $75, $08
  .byte $26, $04,  $3A, $04
  .byte $4D, $08,  $75, $08
  .byte $26, $04,  $3A, $04
  .byte $4D, $08,  $75, $08
  .byte $26, $04,  $3A, $04
  .byte $4D, $08,  $75, $08
  .byte $30, $04,  $1E, $19
  .byte $4D, $08,  $75, $08
  .byte $30, $04,  $C3, $10
  .byte $4D, $08,  $75, $08
  .byte $30, $04,  $87, $21
  .byte $4D, $08,  $75, $08
  .byte $30, $04,  $3E, $2A
  .byte $61, $08,  $A2, $25
  .byte $3D, $06,  $51, $06
  .byte $7B, $0C,  $A3, $0C
  .byte $3D, $06,  $51, $06
  .byte $7B, $0C,  $A3, $0C
  .byte $3D, $06,  $51, $06
  .byte $7B, $0C,  $A3, $0C
  .byte $3D, $06,  $51, $06
  .byte $7B, $0C,  $A3, $0C

Tune17:
  .byte $26, $04,  $3A, $04
  .byte $7B, $0C,  $A3, $0C
  .byte $00, $00,  $00, $00
  .byte $1C, $0B,  $44, $0B
  .byte $30, $04,  $8F, $0C
  .byte $E3, $09,  $0B, $0A
  .byte $54, $09,  $7C, $09
  .byte $4D, $08,  $75, $08
  .byte $47, $06,  $E9, $07
  .byte $4D, $08,  $75, $08
  .byte $00, $00,  $00, $00
  .byte $54, $09,  $7C, $09
  .byte $47, $06,  $61, $08
  .byte $C1, $07,  $E9, $07
  .byte $9D, $06,  $B1, $06
  .byte $3D, $06,  $51, $06
  .byte $FB, $04,  $98, $05
  .byte $3D, $06,  $51, $06
  .byte $00, $00,  $00, $00
  .byte $9D, $06,  $B1, $06
  .byte $FB, $04,  $47, $06
  .byte $8E, $05,  $A2, $05
  .byte $F1, $04,  $05, $05
  .byte $8E, $05,  $A2, $05
  .byte $47, $06,  $0C, $07
  .byte $D5, $07,  $FD, $07
  .byte $00, $00,  $00, $00
  .byte $4D, $08,  $75, $08
  .byte $47, $06,  $E9, $07
  .byte $9D, $06,  $B1, $06
  .byte $F1, $04,  $05, $05
  .byte $AA, $04,  $BE, $04

Tune18:
  .byte $ED, $05,  $B5, $17
  .byte $C6, $0B,  $EE, $0B
  .byte $ED, $05,  $1F, $15
  .byte $DA, $0B,  $B5, $17
  .byte $E3, $05,  $F7, $05
  .byte $DA, $0B,  $1F, $15
  .byte $ED, $05,  $B5, $17
  .byte $DA, $0B,  $A5, $1F
  .byte $ED, $05,  $B5, $17
  .byte $C6, $0B,  $EE, $0B
  .byte $ED, $05,  $1F, $15
  .byte $DA, $0B,  $B5, $17
  .byte $E3, $05,  $F7, $05
  .byte $DA, $0B,  $1F, $15
  .byte $ED, $05,  $B5, $17
  .byte $DA, $0B,  $A5, $1F
  .byte $D5, $07,  $FD, $07
  .byte $BE, $0F,  $E6, $0F
  .byte $E9, $07,  $C3, $10
  .byte $D2, $0F,  $D1, $12
```

```
   .byte $E9, $07,  $C3, $10
   .byte $BE, $0F,  $E6, $0F
   .byte $D5, $07,  $FD, $07
   .byte $D2, $0F,  $18, $0E
   .byte $D5, $07,  $D2, $0F
   .byte $BE, $0F,  $E6, $0F
   .byte $D5, $07,  $FD, $07
   .byte $BE, $0F,  $E6, $0F
   .byte $D5, $07,  $FD, $07
   .byte $BE, $0F,  $E6, $0F
   .byte $D5, $07,  $FD, $07
   .byte $BE, $0F,  $E6, $0F

Tune19:
   .byte $30, $04,  $EF, $0E
   .byte $61, $08,  $18, $0E
   .byte $30, $04,  $8F, $0C
   .byte $61, $08,  $8F, $0A
   .byte $26, $04,  $3A, $04
   .byte $61, $08,  $F7, $09
   .byte $30, $04,  $8F, $0A
   .byte $4D, $08,  $75, $08
   .byte $30, $04,  $C3, $10
   .byte $61, $08,  $EF, $0E
   .byte $30, $04,  $8F, $0C
   .byte $61, $08,  $8F, $0A
   .byte $26, $04,  $3A, $04
   .byte $4D, $08,  $75, $08
   .byte $26, $04,  $3A, $04
   .byte $4D, $08,  $75, $08
   .byte $98, $05,  $C3, $10
   .byte $30, $0B,  $EF, $0E
   .byte $98, $05,  $18, $0E
   .byte $30, $0B,  $8F, $0C
   .byte $8E, $05,  $A2, $05
   .byte $1C, $0B,  $44, $0B
   .byte $98, $05,  $8F, $0C
   .byte $1C, $0B,  $44, $0B
   .byte $47, $06,  $EF, $0E
   .byte $8F, $0C,  $18, $0E
   .byte $47, $06,  $8F, $0C
   .byte $8F, $0C,  $8F, $0A
   .byte $3D, $06,  $51, $06
   .byte $8F, $0C,  $F7, $09
   .byte $47, $06,  $8F, $0A
   .byte $7B, $0C,  $A3, $0C

Tune20:
   .byte $AA, $04,  $BE, $04
   .byte $54, $09,  $7C, $09
   .byte $B4, $04,  $D1, $12
   .byte $54, $09,  $7C, $09
   .byte $B4, $04,  $D1, $12
   .byte $54, $09,  $7C, $09
   .byte $B4, $04,  $D1, $12
   .byte $68, $09,  $C3, $10
   .byte $B4, $04,  $1F, $15
   .byte $54, $09,  $7C, $09
   .byte $B4, $04,  $D1, $12
   .byte $68, $09,  $18, $0E
   .byte $AA, $04,  $BE, $04
   .byte $68, $09,  $D1, $12
   .byte $AA, $04,  $BE, $04
   .byte $54, $09,  $7C, $09
   .byte $8E, $05,  $A2, $05
   .byte $1C, $0B,  $44, $0B
   .byte $98, $05,  $C3, $10
   .byte $1C, $0B,  $44, $0B
   .byte $98, $05,  $C3, $10
   .byte $1C, $0B,  $44, $0B
   .byte $98, $05,  $C3, $10
   .byte $30, $0B,  $D1, $12
   .byte $0C, $07,  $C3, $10
   .byte $04, $0E,  $2C, $0E
   .byte $0C, $07,  $18, $0E
   .byte $04, $0E,  $2C, $0E
   .byte $02, $07,  $16, $07
   .byte $04, $0E,  $2C, $0E
   .byte $02, $07,  $16, $07
   .byte $04, $0E,  $2C, $0E

Tune21:
   .byte $1C, $04,  $44, $04
   .byte $61, $08,  $C3, $10
   .byte $30, $04,  $EF, $13
   .byte $61, $08,  $60, $16
   .byte $30, $04,  $1E, $19
   .byte $4D, $08,  $75, $08
   .byte $1C, $04,  $44, $04
   .byte $4D, $08,  $75, $08
```

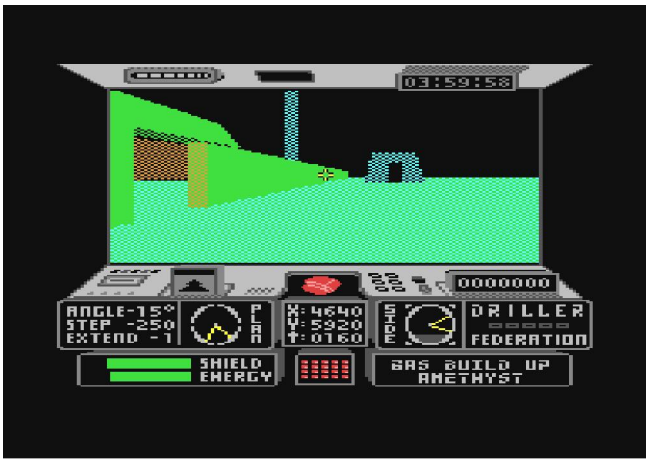
```
   .byte $1C, $04,  $44, $04
   .byte $61, $08,  $C3, $10
   .byte $30, $04,  $EF, $13
   .byte $61, $08,  $60, $16
   .byte $30, $04,  $1E, $19
   .byte $61, $08,  $9C, $1A
   .byte $30, $04,  $1E, $19
   .byte $61, $08,  $EF, $13
   .byte $98, $05,  $60, $16
   .byte $1C, $0B,  $44, $0B
   .byte $84, $05,  $AC, $05
   .byte $1C, $0B,  $44, $0B
   .byte $47, $06,  $EF, $13
   .byte $7B, $0C,  $A3, $0C
   .byte $47, $06,  $1E, $19
   .byte $7B, $0C,  $C3, $10
   .byte $26, $04,  $3A, $04
   .byte $4D, $08,  $75, $08
   .byte $1C, $04,  $44, $04
   .byte $4D, $08,  $75, $08
   .byte $1C, $04,  $44, $04
   .byte $4D, $08,  $75, $08
   .byte $1C, $04,  $44, $04
   .byte $4D, $08,  $75, $08

wrong:
   .byte $3F, $3F,  $37, $7F
   .byte $6F, $7F,  $6F, $1F
   .byte $FC, $FC,  $EC, $FE
   .byte $F6, $FE,  $F6, $F8
   .byte $E0, $FF,  $EF, $FF
   .byte $EF, $EF,  $FF, $E0
   .byte $07, $FF,  $F7, $FF
   .byte $F7, $F7,  $FF, $07
   .byte $00, $00,  $18, $3C
   .byte $3C, $3C,  $18, $00
   .byte $3E, $63,  $C6, $C0
   .byte $E0, $F1,  $7F, $3E
   .byte $00, $00,  $3C, $66
   .byte $C6, $C7,  $6C, $38
   .byte $00, $00,  $3C, $66
   .byte $CC, $C1,  $66, $3C
   .byte $30, $30,  $32, $6D
   .byte $78, $F0,  $D9, $CE
   .byte $60, $60,  $61, $F3
   .byte $C6, $C6,  $CE, $7B
   .byte $01, $03,  $B0, $F3
   .byte $63, $66,  $6E, $B7
   .byte $98, $18,  $19, $33
   .byte $31, $70,  $B6, $1B
   .byte $00, $00,  $F0, $18
   .byte $80, $60,  $33, $E3
   .byte $00, $00,  $00, $00
   .byte $FF, $00,  $00, $00
   .byte $18, $18,  $18, $18
   .byte $18, $18,  $18, $18
   .byte $00, $00,  $00, $00
   .byte $0F, $1C,  $18, $18
```

Conclusion

Well, as you see this is a very simple engine music (I can say that it is the most simple I had seen until now). However don' forget that the game is from 1984, so it was develop at the beginning of the Commodore time.

The last thing you may want to know is that this engine use a maximum of 4 rasterlines when it is piking a new note, and only 1 rasterline in the other case.

Driller is one of the tune that I listen more often in the past. I built a special cable for recording the tune in the stereo from the C64, for listen it every day.



Else this tune is that make me found the HVSC in the net in late ' 99when I search for a Driller image file, and I so found that I' mnot the unique people that was listen to sid music.

Th code presented is a my reverse engineering work about the psid rip of Driller that is present in the HVSC. So this is probably not a 100% version of the engine, as the rip did not contains the sound fx. However in the code you can see a not used notes pattern.

I have not yet investigate how the Matt' sengine is evolved during the time, however Matt had used other music engine like RockMonitor 2/3 and MusicMaster.

Songs

The engine is based onto songs. There is a table (*songs*) shows below where there are to insert the pointers to the songs tracks.

```
songs =*
ltr1:
  .byte $00
  .byte <drillerMainTr1

htr1:
  .byte $00
  .byte >drillerMainTr1

ltr2:
  .byte $00
  .byte <drillerMainTr2

htr2:
  .byte $00
  .byte >drillerMainTr2

ltr3:
  .byte $00
  .byte <drillerMainTr3

htr3:
  .byte $00
  .byte >drillerMainTr3
```

Song 0 is for setting the sound to zero volume, where other number set the tracks for that song (in Driller song 1 is the main theme). You have to add the pointers (low/high) if you want to have more songs used by the engine.

For playing one song is simple: set his number in the *songsNumber* variable. The engine will start the selected song and the variable will be set to $AB (that means current song).

Tracks and pattern

Each songs is made by 3 tracks and each tracks contains the number of the pattern to play. For examples:

```
drillerMainTr1:
  .byte $01, $01, $07, $09
  .byte $09, $09, $01, $07
```

In the first track of the song 1, it is to play in sequence the patterns 01, 01, 07, 09 ... and so on. Two special pattern numbers are reserved: $FF restart the execution of the track, while the $FE stop the sound when it is reached.

Each pattern is a pointer to data contains notes (as we will see in next paragraph), so this pointer are to be declared in two tables: *patptl* and *patpth*:

```
;low pointers
patptl =*
  .byte <pnt00
  .byte <pnt01
  .byte <pnt02
...

;high pointers
patpth =*
  .byte >pnt00
  .byte >pnt01
  .byte >pnt02
...
```

Notes

Each patterns contain the sequences of notes to play.

byte	***description***
$00	Made gate = 0 for the previous note
$xx	The *xx* number of note to play
$FA nn	Select instrument number *nn*
$FB mm	Make a negative portamento of value *mm*
$FC pp	Make a positive portamento of value *pp*
$FD kk	Set the duration of notes to *kk*
$FF	End of notes in this pattern

Let I make some examples of pattern and data:

```
pnt27 =*
  .byte $FA, $0C
  .byte $FD, $01
  .byte $31, $3D, $49, $3D
  .byte $31, $3D, $49, $3D
  .byte $FF
```

In this pattern, it is selected to use the instrument $0C, then to use a very short sound duration

($01) and so to play notes number $31, $3D, $49, $3D

```
pnt18 =*
   .byte $FA, $13
   .byte $FD, $07
   .byte $FC, $37, $45
   .byte $FD, $2F
   .byte $47
   .byte $FD, $07
   .byte $FB, $7F, $47
...
```

In this pattern it is select instrument number $13, length of $07, a positive portamento on note $45 with intensity $37. Then note $47 is played for $2F time and then, for $07 time a negative portamento of intensity $7F is apply to note $47.

A special case is note $00. When this note is reached, the previous note is played with the same settings, but with the gate bit set to 0, so the release phase will start. You can heart this effect in the last long sound at the end of the tune.

Instruments

The instruments contains many timbre effect like arpeggio, pulse wave routine and waveforms switch routine (useful for drum sound). Else it contains portamento and vibrato effects that can be apply to the instruments.

The instruments are specified by compiling two tables of 8 bytes each.

In the first there are to insert these values:

Byte	Descripition
Hi/Lo pulse of Wave waveform	If you use a rectangular waveform, this byte specify the pulse it may use. As the pulse is set by two sid registers, here there is only two nibble used as in this examples: value: xxyy (xx and yy = nibble) low of pulsed set: xx00 high of pulsed set: 00yy
Control register	This is the value used for setting the sid control register for this instrument
Attack/Decay	The AD sid value for the instrument
Sustain/Release	The SR sid value for the instrument

Byte	Description
Wave amplitude inc/dec value	This value is for rectangular waveform and control how much increment/decrement must be used for a pulse variable effect (you can think it as the speed step of variation of the duty cycle). The direction of the variation is changed when reaching the max and min value for the pulse width. These value are hardcore in the engine and are 08 for the min and 0E for the max (so the high byte of pulse goes from $08 to $0E - pulse from 2048 to 3584-).
hi/lo value for arpeggio effect	This control the arpeggio effect to apply to the note. The value xxyy is to be see as: xx: the number of notes to add in sequence for the arpeggio yy: the pointer index to a table that contains the values to add to the note See the example for how the table can be compiled
Control register	Control register set at the end of the note, but in the same frame of when setting the new note.
Instrument effects	This is a bits field value that control witch effects to apply: bit 0: (1) a frequency/wave effect bit 1: (2) re-set instrument pulse at each new note bit 3: (4) waveform switch

The second table contains the other values that can be set for the instruments:

Byte	Description
vibrato freq. value	Value of the vibrato frequency used for add/sub
vibrato length	Length of the vibrato effect (see example)
Control register	Control used for the first two frames when effect of bit 2 is on, and even when effect of bit 1 is on
portamento value	Value of the portamento: it is added/subtracted from the LOW of HIGH byte of frequency according to the portamento flag
portamento flag	This byte specify the type of instrument portamento to achieve: $00: no portamento for the instrument *$01*: negative portamento LOW *$02*: positive portamento LOW *$03*. negative portamento HIGH *$xx*: positive portamento HIGH

Byte	Description
length	duration cycle for effect 1
0	Not used
0	Not used

Arpeggio

Now I illustrate how to use the arpeggio table.
First, It can be create a table like this:

```
PointerLo:
   .byte   <Table0
PointerHi:
   .byte   >Table0
   .byte   <Table1
   .byte   >Table1
   .byte   <Table2
   .byte   >Table2
```

Then it must be create the sequence of values (halftone) to add for the arpeggio:

```
Table0:
  .byte   $00, $08, $12    ; length to use is 3
Table1:
  .byte   $00, $08         ; length to use is 2
Table2:
   .byte  $00, $04, $08    ; length to use is 3
```

So, a value of 30 in the arpeggio effect means: use arpeggio' sTable0 and 3 values, while a value of 22 means: use arpeggio' s Table2 and 2 values (instead of the 3 inserted in the table).

As you can see this method allow to use a very complex arpeggio effect in the tune

Vibrato

The vibrato routine is quite complex as it is very configurable. You can set the frequency value and the length (intensity) of the vibrato (the byte 0 and 1 in the instrument table 2).

Let me call V the first value and L the second one and F the actual frequency. The vibrato routine made so this cycle:

0	1	2	3	4
F=F-V	F=F+V	F=F+V	F=F-V	F=F-V
(L times)	(L times)	(L times)	(L times)	(L times)
F=F-V	F=F+V	F=F+V	F=F-V	F=F-V

The cycle start from 0, but when reached 4 it restart from position 1.

So as examples a value of V=10 and L=2 with an A4 note (440Hz) will produce this sequence of frequency:
430, 420, 430, 440, 450, 460, 450, 440, 430, 420, 430, ecc.

Special Effects

As we see in the first instrument' stable, there are some effects that are activated by the last byte that are associated with the instrument:

- bit 0: This bit activated a frequency/wave effect that use byte 5 of second table as parameter.
- bit 1: Use the wave pulse set in the instrument at each note that are to be played. If this bit is not set, the last pulsed that was used in the last note is replicated for the new note.
- bit 2: Waveform switch: when this is set in the first two frames it is used the waveform that comes for the control register in the byte 3 of the second instrument table. Then the normal waveform is used.

So, bit 1 is to be used for maintaining the timbre of the instrument for each note or for not having a difference in the sound from one note to another. Bit 2 is to be used for drums effect.

Bit 0 if for making a effect that I don' tknow how to call, but I can describe: essentially the sound at a given frequency is played with control register from byte 2 of second table and after with a noise sound that is played with a high frequency that is constantly decrease and putted out after an xor-operation to 23h constant. This sequence continue and the length of the decrease seems given by the 5° byte of the second table (but the code seems to use a different comportment) .

So, an example: if control byte is C, and the cycle is of 1, with high frequency equals to F we have at each clock tick (note that if there' sportamento for the instrument, the F used is the actual value it were reached):

```
D404=C    D401=F
D401=81h  D401=(F-1) xor 23h
```

and so one.

If now the cycle is of 3, we have:

```
D404=C    D401=F
D401=81h  D401=(F-1) xor 23h
D404=C    D401=F
D401=81h  D401=(F-1) xor 23h
D404=C    D401=F
D401=81h  D401=(F-1) xor 23h
```

Note that at the first tick, before setting D404=C the player set D404=control register of instrument at byte 1 of first table.

Even if from this description seems that the length gives not a different result, it is possible that my analysis is faulty (I have not yet experimented this flag)

The Code

This code is a reverse engineering works, so contact the copyright owner author for making any business use of it.

```
; Driller by Matt Gray 1997
; estracted from the sid in HVSC
; NOTE: the prg goes at VIC speed as I use this for misuring rastertime:
; activate the CIA for having the true speed.

.ifdef sid
 .byte "PSID"
 .word $0200          ; version 2
 .word $7C00          ; data offset
 .word $0000          ; load address in cbm format
 .byte >initsongs
 .byte <initsongs
 .byte >serviceMusic
 .byte <serviceMusic
 .word $0100          ; 1 song
 .word $0100          ; default song
 .word $FFFF
 .word $FFFF
 .byte "Driller",0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
 .byte "Matt Gray",0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
 .byte "1988 Incentive",0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0
 .word $0000
 .word $0000
 .word $0000

.byte 00
.byte 09

.org $0900

.else

 ;=================================
 ; PRG start address
 ;=================================
 .byte $01,$08

 ;=================================
 ; BASIC startup program
 ;=================================
 .byte $0b,$08,$e8,$03,$9e,"2061",0,0,0
 .org 2061

  jsr initsongs
  jsr activeCiaIrq
aaa: jmp aaa
.endif

makeMusic =*
      lda  songsNumber
      bne  songNotZero
      sta  $D418                  ; Select volume and filter mode (to 0)
      rts

songNotZero:
      cmp  #$AB                   ; current songs ?
      beq  makeCurrent
      jmp  initTr                 ; init the tracks

initMusic =*
      lda  #$00                   ; clear control register
      sta  $D404                  ; Voice 1: Control registers
      sta  $D40B                  ; Voice 2: Control registers
      sta  $D412                  ; Voice 3: Control registers

      lda  #$0F                   ; full volume
      sta  $D418                  ; Select volume and filter mode

      ldy  #$00
      sty  offsetTr1              ; set track 1 position to the beginning
      sty  offsetTr2              ; set track 2 position to the beginning
      sty  offsetTr3              ; set track 3 position to the beginning
      sty  actNoteLength          ; actual note length duration voice 1
      sty  actNoteLength+$7       ; actual note length duration voice 2
      sty  actNoteLength+$E       ; actual note length duration voice 3
      sty  ptnInd1                ; set pattern index to the beginning
      sty  ptnInd2
      sty  ptnInd3
      iny
      sty  actSpeed               ; actual cycle timer (speed of song)
```

```
      jmp  decCycleTimer

makeCurrent:
      ldy  instrInd,x             ; index of instrument data
      lda  instr1+7,y             ; load instrument effect
      and  #$04                   ; is effect 4?
      beq  noEffect4

; change the control register for making a sound effect
controlEffect:
effect4:
      lda  dur4Eff,x              ; read duration of effect 4 switch
      beq  applyNormalControl

      dec  dur4Eff,x              ; dec duration of effect 4 switch
      lda  instr2+2,y             ; control register
      sta  $D404,x                ; Voice 1: Control registers
      bne  noEffect4

applyNormalControl:
      lda  instr1+1,y             ; control register
      sta  $D404,x                ; Voice 1: Control registers

noEffect4:
      lda  actSpeed               ; actual cycle timer (speed of song)
      bne  noDelayEnd
      dec  actNoteLength,x        ; actual note length duration
      bmi  readPattern            ; jump if note is finished
noDelayEnd:
      jmp  pulseTimbre

; init tracks with selected songs

initTr =*
      ldy  songsNumber            ; load song number (1, 2)
      lda  ltr1,y                 ; set current track 1
      sta  currentTr1+0           ; current track 1 position (base)
      lda  htr1,y
      sta  currentTr1+1           ; current track 1 position (base)

      lda  ltr2,y                 ; set current track 2
      sta  currentTr2+0           ; current track 2 position (base)
      lda  htr2,y
      sta  currentTr2+1           ; current track 2 position (base)

      lda  ltr3,y                 ; set current track 3
      sta  currentTr3+0           ; current track 3 position (base)
      lda  htr3,y
      sta  currentTr3+1           ; current track 3 position (base)

      lda  songSpeed,y            ; read the song speed
      sta  speed                  ; cycle timer (speed of song)
      jmp  initMusic

; decrement the cycle timer (speed of song)
decCycleTimer =*
      cpx  #$0E                   ; is voice 3 ?
      bne  skipDec                ; no, jump
      dec  actSpeed               ; actual cycle timer (speed of song)
      bpl  skipDec                ; jump if positive
      lda  speed                  ; cycle timer (speed of song)
      sta  actSpeed               ; actual cycle timer (speed of song)
skipDec:
      lda  #$AB                   ; current song
      sta  songsNumber
      rts


; give in FD-FE the pattern pointer to a note
readPattern:
      lda  currentTr1+0,x         ; current track 1 position (base)
      sta  $FB
      lda  currentTr1+1,x         ; current track 1 position (base)
      sta  $FC                    ; FB-FC: track pattern pointer

      ldy  offsetTr1,x            ; read actual track position (offset)
      lda  ($FB),y                ; read actual track pattern pointer value
      tay
      lda  patptl,y               ; read pattern pointer low
      sta  $FD
      lda  patpth,y               ; read pattern pointer high
      sta  $FE                    ; FD-FE: pattern pointer

      lda  #$FF
      sta  controlSwitch          ; on ADS

      lda  #$00
      sta  portaFlag,x            ; no portamento
      sta  arpeggioFlag,x         ; no arpeggio
      sta  vibratoFlag,x          ; no vibrato
```

```
; read the pattern value of note to play
readNextPat:
      ldy  ptnInd,x              ; load pattern index of this voice
      lda  ($FD),y               ; read a pattern value
      cmp  #$FD                  ; note length
      bcc  notFD                 ; jump if <$FD

      iny                        ; next pattern value index
      inc  ptnInd,x              ; next (saved) pattern value index
      lda  ($FD),y               ; read a pattern value (note duration)
      sta  noteLength,x          ; store note length duration

incPtnInd:
      inc  ptnInd,x              ; next (saved) patter value index
      bne  readNextPat
notFD:
      cmp  #$FB
      bcc  notFB                 ; jump if <$FB

      cmp  #$FB
      bne  isFC                  ; jump if <>$FB
isFB:
      lda  #$01                  ; negative portamento

storePort:
      sta  portaFlag,x           ; store in portamento flag
      iny                        ; next pattern value index
      inc  ptnInd,x              ; next (saved) pattern value index
      lda  ($FD),y               ; read a pattern value
      sta  portaVal,x            ; store pattern value (portamento)

      lda  #$00
      sta  arpeggioFlag,x        ; no arpeggio
      sta  vibratoFlag,x         ; no vibrato
      beq  incPtnInd

isFC:
      lda  #$02                  ; positive portamento
      bne  storePort             ; store portamento value

notFB:
      cmp  #$FA
      bcc  newNote               ; jump if <$FA

; select new instruments

      iny                        ; next pattern value index
      inc  ptnInd,x              ; next (saved) pattern value index
      lda  ($FD),y               ; read a pattern value (instrument index)

      asl
      asl
      asl                        ; index * 8
      sta  instrInd,x            ; index of instruments data

      tay
      lda  instr1+0,y            ; read Hi/Lo of pulsation amplitude

      pha
      and  #$0F
      sta  hi1Wave,x              ; Wave form pulsation amplitude (hi byte)
      sta  hi2Wave,x              ; Wave form pulsation amplitude (hi byte)
      pla

      and  #$F0
      sta  lo1Wave,x              ; Wave form pulsation amplitude (lo byte)
      sta  lo2Wave,x              ; Wave form pulsation amplitude (lo byte)
      jmp  incPtnInd

newNote:
      sta  rpNote,x               ; store packet note (readed note to play)

      lda  noteLength,x           ; note length duration
      sta  actNoteLength,x        ; actual note length duration

      lda  #$00
      sta  cycleInt,x
      sta  cycleEst,x

      lda  #$02
      sta  dur4Eff,x             ; set duration of effect 4 switch

      ldy  instrInd,x            ; index of instrument data
      lda  instr1+7,y            ; instrument effect
      and  #$02                  ; is effect 2?
      beq  noEffect2

effect2:
      lda  lo2Wave,x             ; Wave form pulsation amplitude (lo byte)
```

```
      sta  lo1Wave,x             ; Wave form pulsation amplitude (lo byte)

      lda  hi2Wave,x             ; Wave form pulsation amplitude (hi byte)
      sta  hi1Wave,x             ; Wave form pulsation amplitude (hi byte)

noEffect2:
      lda  rpNote,x              ; readed note to play
      bne  notZero

      lda  pNote,x               ; note to play
      sta  rpNote,x              ; readed note to play
      lda  #$00
      sta  pNote,x               ; note to play
      ldy  instrInd,x            ; index of instrument data
      dec  controlSwitch
      bne  setVoice

notZero:
      sta  pNote,x               ; note to play
      tay

      lda  frequencyHi,y
      sta  $D401,x               ; Voice 1: Frequency control (hi byte)
      sta  freqHi1Eff,x          ; Voice 1: Frequency control (hi byte) for effect 1
      sta  freqPortHi,x          ; Voice 1: Frequency control (hi byte) for portamento

      lda  frequencyLo,y
      sta  $D400,x               ; Voice 1: Frequency control (lo byte)
      sta  freqLo1Eff,x          ; Voice 1: Frequency control (lo byte)
      sta  freqPortLo,x          ; Voice 1: Frequency control (lo byte) for portamento

      ldy  instrInd,x            ; index of instrument data
      lda  instr1+6,y            ; control register (ADS off)
      sta  $D404,x               ; Voice 1: Control registers

setVoice:
      lda  instr1+1,y            ; control register
      and  controlSwitch         ; change ADS
      sta  $D404,x               ; Voice 1: Control registers

      lda  instr1+2,y            ; read A/D value
      sta  $D405,x               ; Generator 1: Attack/Decay

      lda  instr1+3,y            ; read S/R value
      sta  $D406,x               ; Generator 1: Sustain/Release

      lda  lo1Wave,x             ; Wave form pulsation amplitude (lo byte)
      sta  $D402,x               ; Voice 1: Wave form pulsation amplitude (lo byte)

      lda  hi1Wave,x             ; Wave form pulsation amplitude (hi byte)
      sta  $D403,x               ; Voice 1: Wave form pulsation amplitude (hi byte)

      inc  ptnInd,x              ; next (saved) pattern value index
      ldy  ptnInd,x              ; load pattern value index
      lda  ($FD),y               ; read a pattern value

      cmp  #$FF                  ; end of pattern
      bne  noEndPattern

endPattern:
      lda  #$00
      sta  ptnInd,x              ; set pattern value index to the beginning

      inc  offsetTr1,x           ; next track position (offset)
      ldy  offsetTr1,x

      lda  ($FB),y               ; read next track pattern pointer
      cmp  #$FF                  ; end of pattern ?
      bne  noEndTrack

endTrack:
      lda  #$00
      sta  offsetTr1,x           ; set track position to the beginning
      beq  noEndPattern

noEndTrack:
      cmp  #$FE                  ; end of song (no repeat)
      bne  noEndPattern

      lda  #$00
      sta  songsNumber           ; nothing song to play
      rts

noEndPattern:
      lda  pNote,x               ; note to play
      beq  pulseTimbre
      ldy  instrInd,x            ; index of instrument data
      lda  portaFlag,x           ; portamento flag
      bne  skipSetPort
      lda  instr2+4,y            ; read portamento flag for the instrument
```

```
      beq  skipPortaInstr

      sta  portaFlag,x           ; store portamento flag
      lda  instr2+3,y            ; read portamento value
      sta  portaVal,x            ; portamento value
skipSetPort:
      jmp  testMakePortamento

skipPortaInstr:
      lda  instr1+5,y            ; hi/lo value for arpeggio
      beq  skipArpeggioInit
      jmp  arpeggioInit

skipArpeggioInit:
      sta  arpeggioFlag,x
      lda  instr2+0,y            ; read oscillating frequency value
      beq  noOscEffect
      jmp  vibratoInit

noOscEffect:
      sta  vibratoFlag,x         ; no vibrato
      jmp  decCycleTimer

;================================
; pulse-width timbre routine
;================================
pulseTimbre:
      lda  instr1+4,y            ; Wave amplitude inc/dec value
      sta  ampVar                ; store for late use
      beq  afterWaveShifting

      lda  pulseDirFlag,x
      bne  decWave
      clc
      lda  lo1Wave,x             ; Wave form pulsation amplitude (lo byte)
      adc  ampVar
      sta  lo1Wave,x             ; Wave form pulsation amplitude (lo byte)
      sta  $D402,x               ; Voice 1: Wave form pulsation amplitude (lo byte)

      lda  hi1Wave,x             ; Wave form pulsation amplitude (hi byte)
      adc  #$00
      sta  hi1Wave,x             ; Wave form pulsation amplitude (hi byte)
      sta  $D403,x               ; Voice 1: Wave form pulsation amplitude (hi byte)

      clc
      cmp  #$0E
      bcc  afterWaveShifting
      inc  pulseDirFlag,x
      bne  afterWaveShifting

decWave:
      lda  lo1Wave,x            ; Wave form pulsation amplitude (lo byte)
      sec
      sbc  ampVar
      sta  lo1Wave,x            ; Wave form pulsation amplitude (lo byte)
      sta  $D402,x              ; Voice 1: Wave form pulsation amplitude (lo byte)

      lda  hi1Wave,x            ; Wave form pulsation amplitude (hi byte)
      sbc  #$00
      sta  hi1Wave,x            ; Wave form pulsation amplitude (hi byte)
      sta  $D403,x              ; Voice 1: Wave form pulsation amplitude (hi byte)

      clc
      cmp  #$08
      bcs  afterWaveShifting

      dec  pulseDirFlag,x

afterWaveShifting:
      lda  arpeggioFlag,x        ; test for made arpeggio
      beq  testVibratoEff


;================================
; make the arpeggio
;================================
makeArpeggio:
      lda  lowInd,x              ; low index for arpeggio table
      asl
      tay
      lda  pointerLo,y           ; low pointer of arpeggio table
      sta  adcArp+1
      lda  pointerHi,y           ; high pointer of arpeggio table
      sta  adcArp+2

      lda  actualCycle,x
      cmp  limitCycle,x
      bne  noResetCylce

      lda  #$00
```

```
      sta  actualCycle,x

noResetCylce:
      tay
      lda  rpNote,x              ; readed note to play
      clc
adcArp:
      adc  TableArp0,y           ; add the tone to note to play
      tay                        ; calciulate the new freq. to use
      lda  frequencyLo,y
      sta  $D400,x               ; Voice 1: Frequency control (lo byte)
      lda  frequencyHi,y
      sta  $D401,x               ; Voice 1: Frequency control (hi byte)
      inc  actualCycle,x
      jmp  decCycleTimer

testVibratoEff:
      lda  vibratoFlag,x         ; load vibrato flag
      bne  vibratoEffect         ; is to performe vibrato?
      jmp  testMakePortamento

;================================
; make the vibrato
;================================
vibratoEffect:
      lda  countVibFlag,x
      beq  sbcVib
      cmp  #$03
      bcc  adcVib

      sec
      lda  freqPortLo,x          ; Voice 1: Frequency control (lo byte) for portamento
      sbc  oscilFreq,x           ; frequency of oscillation
      sta  freqPortLo,x          ; Voice 1: Frequency control (lo byte) for portamento
      sta  $D400,x               ; Voice 1: Frequency control (lo byte)

      lda  freqPortHi,x          ; Voice 1: Frequency control (hi byte) for portamento
      sbc  #$00
      sta  freqPortHi,x          ; Voice 1: Frequency control (hi byte) for portamento
      sta  $D401,x               ; Voice 1: Frequency control (hi byte)

      dec  actualVibCount,x
      bne  exitVib1

      lda  vibCount,x            ; read stored value of count
      sta  actualVibCount,x      ; set to actual
      inc  countVibFlag,x
      lda  countVibFlag,x
      cmp  #$05
      bcc  exitVib1

      lda  #$01
      sta  countVibFlag,x
exitVib1:
      jmp  decCycleTimer

sbcVib:
      sec
      lda  freqPortLo,x          ; Voice 1: Frequency control (lo byte) for portamento
      sbc  oscilFreq,x           ; frequency of oscillation
      sta  freqPortLo,x          ; Voice 1: Frequency control (lo byte) for portamento
      sta  $D400,x               ; Voice 1: Frequency control (lo byte)

      lda  freqPortHi,x          ; Voice 1: Frequency control (hi byte) for portamento
      sbc  #$00
      sta  freqPortHi,x          ; Voice 1: Frequency control (hi byte) for portamento
      sta  $D401,x               ; Voice 1: Frequency control (hi byte)

      dec  actualVibCount,x
      bne  exitVib2

      lda  vibCount,x            ; read stored count value
      sta  actualVibCount,x
      inc  countVibFlag,x
exitVib2:
      jmp  decCycleTimer

adcVib:
      clc
      lda  freqPortLo,x          ; Voice 1: Frequency control (lo byte) for portamento
      adc  oscilFreq,x           ; frequency of oscillation
      sta  freqPortLo,x          ; Voice 1: Frequency control (lo byte) for portamento
      sta  $D400,x               ; Voice 1: Frequency control (lo byte)

      lda  freqPortHi,x          ; Voice 1: Frequency control (hi byte) for portamento
      adc  #$00
      sta  freqPortHi,x          ; Voice 1: Frequency control (hi byte) for portamento
      sta  $D401,x               ; Voice 1: Frequency control (hi byte)

      dec  actualVibCount,x
```

```
      bne  noEffect1

      lda  vibCount,x            ; read stored count value
      sta  actualVibCount,x
      inc  countVibFlag,x
      bne  noEffect1
      jmp  decCycleTimer

testMakePortamento:
      lda  portaFlag,x           ; portamento flag
      beq  testEffect1

      cmp  #$01                  ; negative portamento
      beq  negativePortamento

      cmp  #$02                  ; positive portamento
      beq  positivePortamento

      cmp  #$03
      beq  negativePortamentoHI
      clc
      lda  freqPortHi,x          ; Voice 1: Frequency control (hi byte) for portamento
      adc  portaVal,x            ; add portamento value
      sta  freqPortHi,x          ; Voice 1: Frequency control (hi byte) for portamento
      sta  $D401,x               ; Voice 1: Frequency control (hi byte)
      jmp  testEffect1

negativePortamento:
      clc
      lda  freqPortLo,x          ; Voice 1: Frequency control (lo byte) for portamento
      sbc  portaVal,x            ; sub portamento value
      sta  freqPortLo,x          ; Voice 1: Frequency control (lo byte) for portamento
      sta  $D400,x               ; Voice 1: Frequency control (lo byte)

      lda  freqPortHi,x          ; Voice 1: Frequency control (hi byte) for portamento
      sbc  #$00
      sta  freqPortHi,x          ; Voice 1: Frequency control (hi byte) for portamento
      sta  $D401,x               ; Voice 1: Frequency control (hi byte)
      jmp  testEffect1

negativePortamentoHI:
      sec
      lda  freqPortHi,x          ; Voice 1: Frequency control (hi byte) for portamento
      sbc  portaVal,x            ; sub portamento value
      sta  freqPortHi,x          ; Voice 1: Frequency control (hi byte) for portamento
      sta  $D401,x               ; Voice 1: Frequency control (hi byte)
      jmp  testEffect1

positivePortamento:
      clc
      lda  freqPortLo,x          ; Voice 1: Frequency control (lo byte) for portamento
      adc  portaVal,x            ; add portamento value
      sta  freqPortLo,x          ; Voice 1: Frequency control (lo byte) for portamento
      sta  $D400,x               ; Voice 1: Frequency control (lo byte)

      lda  freqPortHi,x          ; Voice 1: Frequency control (hi byte) for portamento
      adc  #$00
      sta  freqPortHi,x          ; Voice 1: Frequency control (hi byte) for portamento
      sta  $D401,x               ; Voice 1: Frequency control (hi byte)

testEffect1:
      ldy  instrInd,x            ; index of instrument data
      lda  instr1+7,y            ; load instrument effect
      and  #$01                  ; is effect 1?
      beq  noEffect1
      jmp  effect1

noEffect1:
      jmp  decCycleTimer

;==================================
; Voice 1
;
; vibrato flag: 1= on
;
; arpeggio flag: 1= on
;
; portaFlag:
;  1: neg. port. HiLo
;  2: pos. port. HiLo
;  3: neg. port. Hi
;  x: pos. port. Hi
;
; pulseDirFlag: 1 dec, 0 inc
;==================================

vibratoFlag:                     ; vibrato flag (1=on)
  .byte $00

arpeggioFlag:                  ; 1= effect on
```

```
  .byte $00

portaFlag:
  .byte  $00                    ; portamento flag (voice 1)

cycleInt:                       ; internal cycle for effect 1
  .byte $00

cycleEst:                       ; external cycle for effect 1
  .byte $00

ptnInd:
ptnInd1:
  .byte $06                     ; pattern value index (voice 1)

pulseDirFlag:
  .byte $00

;=================================
; Voice 2:
;=================================
  .byte $00
  .byte $00
  .byte $00                     ; portamento flag (voice 2)
  .byte $00
  .byte $00
ptnInd2:
  .byte $06                     ; pattern value index (voice 2)
  .byte $00

;=================================
; Voice 3:
;=================================
  .byte $00
  .byte $00
  .byte $00                     ; portamento flag
  .byte $00
  .byte $00
ptnInd3:
  .byte $00                     ; pattern value index (voice 3)
  .byte $01


;=================================
; Voice 1:
;=================================
portaVal:
  .byte $00                     ; portamento value (voice 1)

r0CE4:                          ; not used
  .byte $00

noteLength:
  .byte $3F                     ; note length duration (voice 1)

instrInd:
  .byte $08                     ; index of instrument data (voice 1)

lo1Wave:
  .byte $BB                     ; Wave form pulsation amplitude (lo byte)

lo2Wave:
  .byte $90                     ; Wave form pulsation amplitude (lo byte)

hi1Wave:
  .byte $02                     ; Wave form pulsation amplitude (hi byte)

;=================================
; Voice 2:
;=================================
  .byte $00                     ; portamento value (Voice 2)
  .byte $00
  .byte $3F                     ; note length duration (voice 2)
  .byte $08                     ; index of instrument data (voice 2)
  .byte $BB                     ; Wave form pulsation amplitude (lo byte)
  .byte $90                     ; Wave form pulsation amplitude (lo byte)
  .byte $02                     ; Wave form pulsation amplitude (hi byte)

;=================================
; Voice 3:
;=================================
  .byte $00                     ; portamento value (voice 3)
  .byte $00
  .byte $3F                     ; note length duration (voice 3)
  .byte $20                     ; index of instrument data (voice 3)
  .byte $F0                     ; Wave form pulsation amplitude (lo byte)
  .byte $90                     ; Wave form pulsation amplitude (lo byte)
  .byte $0C                     ; Wave form pulsation amplitude (hi byte)
```

```
;==================================
; Voice 1:
;==================================
hi2Wave:
  .byte $00                       ; Wave form pulsation amplitude (hi byte)

lowInd:                           ; low index for freq. instrument effect
  .byte $00

currentTr1:                       ; current track 1 position (base)
  .byte <drillerMainTr1
  .byte >drillerMainTr1

offsetTr1:                        ; current track 1 position (offset)
  .byte $00

r0CFD:                            ; not used
  .byte $00

actNoteLength =*
  .byte $3C                       ; actual note length duration

;==================================
; Voice2:
;==================================
  .byte $00
  .byte $00                       ; low index for freq. instrument effect
currentTr2:                       ; current track 2 position (base)
  .byte <drillerMainTr2
  .byte >drillerMainTr2
offsetTr2:                        ; current track 2 position (offset)
  .byte $00
  .byte $00
  .byte $3C                       ; actual note length duration

;==================================
; Voice 3:
;==================================
  .byte $06
  .byte $00                       ; low index for freq. instrument effect
currentTr3:                       ; current track 3 position (base)
  .byte <drillerMainTr3
  .byte >drillerMainTr3
offsetTr3:                        ; current track 3 position (offset)
  .byte $02
  .byte $00
  .byte $3C                       ; actual note length duration

r0D0D:
  .byte $00
  .byte $00

songsNumber =*
  .byte $AB                       ; 0=nothing 1=first, $AB current ?

speed:
  .byte $03                       ; cycle timer (cylce for having 1 note tick)

ampVar:                           ; wave amplitude variation
  .byte $A0

actSpeed:
  .byte $00                       ; actual cycle timer (for having 1 note tick)

controlSwitch:                    ; set ON/OFF the ADS
  .byte $FE


;==================================
; Voice 1
;==================================

freqPortLo:                       ; frequency of portamento lo
  .byte $47                       ; Voice 1: Frequency control (lo byte)

freqLo1Eff:                       ; freq lo for instrument effect 1 ?
  .byte $47                       ; Voice 1: Frequency control (lo byte)

freqHi1Eff:                       ; freq hi for instrument effect 1
  .byte $06                       ; Voice 1: Frequency control (hi byte)

rpNote =*
  .byte $1F                       ; Voice 1: readed note to play

freqPortHi:                       ; frequency of portamento Hi
  .byte $06                       ; Voice 1: Frequency control (hi byte)

limitCycle:                       ; limit of cycle for arpeggio
  .byte $00
```

```
actualCycle:                    ; actual cycle for arpeggio
  .byte $00

;==================================
; Voice 2
;==================================
  .byte $23                     ; frequency of portamento lo
  .byte $23                     ; freq lo for instrument effect 1 ?
  .byte $03                     ; freq hi for instrument effect 1
  .byte $13                     ; Voice 2: readed note to play
  .byte $03                     ; frequency of portamento Hi
  .byte $00                     ; limit of cycle for arpeggio
  .byte $00                     ; actual cycle for arpeggio

;==================================
; Voice 3
;==================================

  .byte $00                     ; frequency of portamento lo
  .byte $00                     ; freq lo for instrument effect 1 ?
  .byte $00                     ; freq hi for instrument effect 1
  .byte $00                     ; Voice 3: readed note to play
  .byte $00                     ; frequency of portamento Hi
  .byte $00
  .byte $00


;==================================
; Voice 1
;==================================

countVibFlag:                   ; counter flag: use for add/sbc of vibrato
 .byte $00

oscilFreq:                      ; frequency of oscillator (for vibrato)
  .byte $00

vibCount:                       ; value of vibrato count
  .byte $00

actualVibCount:                 ; actual value of vibrato count intensity
  .byte $00

r0D2D:
  .byte $00
  .byte $00

pNote =*
  .byte $1F                     ; note to play

;==================================
; Voice 2
;==================================
  .byte $00
  .byte $00
  .byte $00
  .byte $00
  .byte $00
  .byte $00
  .byte $13                     ; note to play

;==================================
; Voice 3
;==================================
  .byte $00
  .byte $00
  .byte $00
  .byte $00
  .byte $00
  .byte $00
  .byte $00                     ; note to play


;==================================
; Voice 1
;==================================
dur4Eff:
  .byte $02                     ; duration of effect 4 switch
  .byte $00
  .byte $00
  .byte $00
  .byte $00
  .byte $00
  .byte $00

;==================================
; Voice 2
;==================================
  .byte $02
  .byte $00
```

```
  .byte $00
  .byte $00
  .byte $00
  .byte $00
  .byte $00

;==================================
; Voice 3
;==================================
  .byte $02
  .byte $00
  .byte $00
  .byte $00
  .byte $00
  .byte $00
  .byte $00

; freq. low

frequencyLo:
  .byte $0C, $1C, $2D, $3E        ; C-0 C#-0 D-0 D#-0
  .byte $51, $66, $7B, $91
  .byte $A9, $C3, $DD, $FA
  .byte $18, $38, $5A, $7D
  .byte $A3, $CC, $F6, $23
  .byte $53, $86, $BB, $F4
  .byte $30, $70, $B4, $FB
  .byte $47, $98, $ED, $47
  .byte $A7, $0C, $77, $E9
  .byte $61, $E1, $68, $F7
  .byte $8F, $30, $DA, $8F
  .byte $4E, $18, $EF, $D2
  .byte $C3, $C3, $D1, $EF
  .byte $1F, $60, $B5, $1E
  .byte $9C, $31, $DF, $A5
  .byte $87, $86, $A2, $DF
  .byte $3E, $C1, $6B, $3C
  .byte $39, $63, $BE, $4B
  .byte $0F, $0C, $45, $BF
  .byte $7D, $83, $D6, $79
  .byte $73, $C7, $7C, $97
  .byte $1E, $18, $8B, $7E
  .byte $FA, $06, $AC, $F3
  .byte $E6, $8F, $F8, $2E

frequencyHi:
  .byte $01, $01, $01, $01
  .byte $01, $01, $01, $01
  .byte $01, $01, $01, $01
  .byte $02, $02, $02, $02
  .byte $02, $02, $02, $03
  .byte $03, $03, $03, $03
  .byte $04, $04, $04, $04
  .byte $05, $05, $05, $06
  .byte $06, $07, $07, $07
  .byte $08, $08, $09, $09
  .byte $0A, $0B, $0B, $0C
  .byte $0D, $0E, $0E, $0F
  .byte $10, $11, $12, $13
  .byte $15, $16, $17, $19
  .byte $1A, $1C, $1D, $1F
  .byte $21, $23, $25, $27
  .byte $2A, $2C, $2F, $32
  .byte $35, $38, $3B, $3F
  .byte $43, $47, $4B, $4F
  .byte $54, $59, $5E, $64
  .byte $6A, $70, $77, $7E
  .byte $86, $8E, $96, $9F
  .byte $A8, $B3, $BD, $C8
  .byte $D4, $E1, $EE, $FD

activeCiaIrq =*
      sei
      lda  #<serviceIrq
      sta  $0314                  ; Vector: Hardware Interrupt (IRQ)
      lda  #>serviceIrq
      sta  $0315                  ; Vector: Hardware Interrupt (IRQ)
      ldx  #$00
      stx  $DC0E                  ; Control register A of CIA #1
      inx
      stx  $D01A                  ; IRQ mask register
      cli
      rts

serviceIrq =*
      lda  #$01
      sta  $D019                  ; Interrupt indicator register
      lda  #$82
      sta  $D012                  ; Reading/Writing IRQ balance value
      lda  #$1B
```

Definition of the used frequencies

```
      sta  $D011                ; VIC control register
      lda  #$01
      sta  $D020                ; Border color
      jsr  serviceMusic
      dec  $D020                ; Border color
      jmp  $EA31                ; Default hardware interrupt (IRQ)

serviceMusic =*
      ldx  #$00                 ; Voice 1
      jsr  makeMusic
      ldx  #$07                 ; Voice 2
      jsr  makeMusic
      ldx  #$0E                 ; Voice 3
      jsr  makeMusic
      rts

  .byte "(C)1987 MATT GRAY"

;================================
; Init the arpeggio routine
;================================
arpeggioInit:
      pha
      and  #$0F
      sta  lowInd,x
      pla
      and  #$F0
      lsr  a
      lsr  a
      lsr  a
      lsr  a
      sta  limitCycle,x

      lda  #$00
      sta  actualCycle,x

      lda  #$01                 ; made on arpeggio
      sta  arpeggioFlag,x

      lda  #$00
      sta  vibratoFlag,x        ; no vibrato
      jmp  decCycleTimer

;================================
; Init the vibrato routine
;================================
vibratoInit:
      sta  oscilFreq,x          ; oscillating frequency value
      lda  instr2+1,y           ; read the count intensity for vibrato
      sta  vibCount,x           ; save count value
      sta  actualVibCount,x
      lda  #$00
      sta  arpeggioFlag,x       ; make arpeggio off
      sta  countVibFlag,x

      lda  #$01
      sta  vibratoFlag,x        ; make vibrato
      jmp  decCycleTimer

;================================
; instruments part 1
; 0: Hi/Lo of Wave form amplitude
; 1: Control register
; 2: A/D value
; 3: S/R value
; 4: Wave amplitude inc/dec value
; 5: hi/lo value for arpeggio
; 6: Control register
; 7: instrument effect
;    1: a frequency effect
;    2: a pulse wave effect
;    4: switch between waveform
;================================

instr1 =*
  .byte $00                     ; Wave form amplitude (Hi/Lo)
  .byte $81                     ; Control: Noise, ADS on
  .byte $0A                     ; A/D
  .byte $00                     ; S/R
  .byte $00
  .byte $00
  .byte $80                     ; Control: Noise, ADS off
  .byte $01                     ; instrument effect

  .byte $90
  .byte $41
  .byte $FE
  .byte $0D
  .byte $25
  .byte $00
```

The first table of instruments definition

```
.byte $40
.byte $02

.byte $00
.byte $81
.byte $FD
.byte $00
.byte $00
.byte $00
.byte $80
.byte $00

.byte $30
.byte $41
.byte $0E
.byte $00
.byte $30
.byte $00
.byte $40
.byte $02

.byte $96
.byte $41
.byte $0E
.byte $00
.byte $A0
.byte $00
.byte $40
.byte $02

.byte $00
.byte $00
.byte $00
.byte $00
.byte $00
.byte $00
.byte $00
.byte $00

.byte $32
.byte $41
.byte $00
.byte $40
.byte $F0
.byte $00
.byte $40
.byte $02

.byte $00
.byte $81
.byte $08
.byte $00
.byte $00
.byte $00
.byte $80
.byte $01

.byte $00
.byte $11
.byte $0D
.byte $00
.byte $00
.byte $00
.byte $10
.byte $00

.byte $90
.byte $41
.byte $0E
.byte $00
.byte $25
.byte $00
.byte $40
.byte $02

.byte $2E
.byte $43
.byte $00
.byte $60
.byte $F5
.byte $00
.byte $40
.byte $04

.byte $70
.byte $41
.byte $0A
.byte $00
.byte $40
.byte $00
```

```
.byte $40
.byte $02

.byte $00
.byte $15
.byte $03
.byte $00
.byte $00
.byte $20
.byte $14
.byte $04

.byte $40
.byte $41
.byte $00
.byte $90
.byte $01
.byte $00
.byte $40
.byte $00

.byte $00
.byte $15
.byte $EE
.byte $00
.byte $00
.byte $00
.byte $14
.byte $00

.byte $98
.byte $41
.byte $09
.byte $00
.byte $00
.byte $00
.byte $40
.byte $01

.byte $21
.byte $41
.byte $0A
.byte $00
.byte $30
.byte $00
.byte $40
.byte $06

.byte $21
.byte $41
.byte $0A
.byte $00
.byte $30
.byte $00
.byte $40
.byte $06

.byte $31
.byte $41
.byte $0E
.byte $00
.byte $10
.byte $00
.byte $40
.byte $02

.byte $23
.byte $41
.byte $00
.byte $A0
.byte $50
.byte $00
.byte $40
.byte $00

.byte $91
.byte $41
.byte $0A
.byte $00
.byte $30
.byte $00
.byte $40
.byte $06

.byte $F1
.byte $41
.byte $0C
.byte $00
.byte $40
.byte $00
```

```
  .byte $40
  .byte $06

;================================
; instruments part 2
; 0: oscillating frequency value (for vibrato)
; 1: length of vibrato intensity (for vibrato)
; 2: Control register for effect 4
; 3: portamento value        |
; 4: portamento flag (1=on)  | portamento for the instrument
; 5: duration cycle for effect 1
; 6: not used
; 7: not used
;================================

instr2 =*
  .byte $00
  .byte $00
  .byte $11                     ; Control: ^, on ADS
  .byte $00                     ; portamento value
  .byte $00                     ; portamento flag
  .byte $03
  .byte $00                     ; not used
  .byte $00                     ; not used

  .byte $00
  .byte $00
  .byte $81
  .byte $00
  .byte $00
  .byte $00
  .byte $00
  .byte $00

  .byte $06
  .byte $50
  .byte $00
  .byte $00
  .byte $00
  .byte $00
  .byte $00
  .byte $00

  .byte $30
  .byte $02
  .byte $81
  .byte $00
  .byte $00
  .byte $00
  .byte $00
  .byte $00

  .byte $40
  .byte $02
  .byte $00
  .byte $00
  .byte $00
  .byte $00
  .byte $00
  .byte $00

  .byte $00
  .byte $00
  .byte $00
  .byte $00
  .byte $00
  .byte $00
  .byte $00
  .byte $00

  .byte $00
  .byte $00
  .byte $81
  .byte $00
  .byte $00
  .byte $00
  .byte $00
  .byte $00

  .byte $00
  .byte $00
  .byte $11
  .byte $41
  .byte $01
  .byte $01
  .byte $00
  .byte $00

  .byte $50
  .byte $02
```

The second table for instruments definition

```
.byte $00
.byte $00
.byte $00
.byte $00
.byte $00
.byte $00

.byte $00
.byte $00
.byte $81
.byte $00
.byte $00
.byte $00
.byte $00
.byte $00

.byte $20
.byte $02
.byte $00
.byte $00
.byte $00
.byte $00
.byte $00
.byte $00

.byte $00
.byte $00
.byte $00
.byte $00
.byte $00
.byte $00
.byte $00
.byte $00

.byte $00
.byte $00
.byte $81
.byte $00
.byte $00
.byte $00
.byte $00
.byte $00

.byte $40
.byte $02
.byte $00
.byte $00
.byte $00
.byte $00
.byte $00
.byte $00

.byte $00
.byte $00
.byte $00
.byte $00
.byte $00
.byte $00
.byte $00
.byte $00

.byte $00
.byte $00
.byte $41
.byte $F0
.byte $01
.byte $01
.byte $00
.byte $00

.byte $10
.byte $02
.byte $43
.byte $00
.byte $00
.byte $00
.byte $00
.byte $00

.byte $00
.byte $00
.byte $00
.byte $00
.byte $00
.byte $00
.byte $00
.byte $00

.byte $A0
.byte $02
```

```
  .byte $00
  .byte $00
  .byte $00
  .byte $00
  .byte $00
  .byte $00

  .byte $60
  .byte $02
  .byte $00
  .byte $00
  .byte $00
  .byte $00
  .byte $00
  .byte $00

  .byte $00
  .byte $00
  .byte $43
  .byte $00
  .byte $00
  .byte $00
  .byte $00
  .byte $00

  .byte $0A
  .byte $02
  .byte $43
  .byte $00
  .byte $00
  .byte $00
  .byte $00
  .byte $00

effect1:
       lda  freqHi1Eff,x          ; Voice 1: Frequency control (hi byte) for effect 1
       beq  noDec
       dec  freqHi1Eff,x          ; Voice 1: Frequency control (hi byte) for effect 1
noDec:
       lda  cycleInt,x
       beq  jmpTestEndCycle

       dec  cycleInt,x
       lda  #$81                  ; noise + ADS
       sta  $D404,x               ; Voice 1: Control registers
       lda  freqHi1Eff,x          ; Voice 1: Frequency control (hi byte) for effect 1
       eor  #$23
       sta  $D401,x               ; Voice 1: Frequency control (hi byte)
       jmp  decCycleTimer

jmpTestEndCycle:
       jmp  testEndCycle

changeFreq:
       lda  freqPortHi,x          ; Voice 1: Frequency control (hi byte) for portamento
       sta  $D401,x               ; Voice 1: Frequency control (hi byte)
       sta  freqHi1Eff,x          ; Voice 1: Frequency control (hi byte) for effect 1
       lda  instr2+2,y            ; control register
       sta  $D404,x               ; Voice 1: Control registers
       jmp  decCycleTimer

testEndCycle:
       lda  cycleEst,x
       cmp  instr2+5,y            ; duration cycle for effect 1
       beq  resetCycle

       inc  cycleInt,x
       inc  cycleEst,x
       bne  changeFreq

resetCycle:
       lda  #$00
       sta  cycleEst,x
       sta  cycleInt,x
       beq  changeFreq

songSpeed =*                      ; cycle for having note tick (for each songs)
  .byte $00
  .byte $03
  .byte $03

; $FF:  repeat the track
; $FE:  end of music

drillerMainTr1:
  .byte $01, $01, $07, $09
  .byte $09, $09, $01, $07
  .byte $07, $0F, $0F, $0F
  .byte $0F, $0F, $0F, $03
  .byte $03, $0F, $0F, $13
```

The definition of the patterns used by each traks are from here

```
  .byte $13, $0F, $13, $0F
  .byte $13, $0F, $13, $0F
  .byte $13, $0F, $0F, $0F
  .byte $0F, $0F, $0F, $0F
  .byte $0F, $0F, $0F, $0F
  .byte $0F, $0F, $0F, $0F
  .byte $0F, $0F, $0F, $0F
  .byte $0F, $0F, $0F, $0F
  .byte $0F, $0F, $1B, $1D
  .byte $1E, $0F, $1B, $1D
  .byte $1E, $0F, $1B, $1D
  .byte $1E, $12, $12, $12
  .byte $12, $24, $24, $21
  .byte $21, $24, $24, $21
  .byte $21, $24, $24, $21
  .byte $21, $24, $24, $21
  .byte $21, $24, $24, $21
  .byte $21, $24, $24, $21
  .byte $21, $24, $24, $21
  .byte $21, $24, $24, $21
  .byte $21, $24, $24, $21
  .byte $21, $24, $24, $21
  .byte $21, $08, $08, $28
  .byte $00, $00, $00, $00
  .byte $00, $FF

drillerMainTr2:
  .byte $03, $03, $08, $0A
  .byte $0D, $0D, $0D, $0D
  .byte $08, $07, $0E, $0E
  .byte $0E, $0E, $0E, $0E
  .byte $0E, $0E, $05, $12
  .byte $12, $12, $12, $14
  .byte $15, $14, $15, $14
  .byte $15, $14, $15, $08
  .byte $17, $17, $17, $17
  .byte $17, $17, $17, $17
  .byte $17, $17, $17, $17
  .byte $07, $07, $1F, $1F
  .byte $1F, $1F, $07, $07
  .byte $00, $00, $25, $25
  .byte $26, $25, $27, $27
  .byte $27, $27, $27, $27
  .byte $27, $27, $06, $06
  .byte $06, $06, $06, $06
  .byte $06, $06, $06, $06
  .byte $28, $00, $00, $00
  .byte $00, $FF

drillerMainTr3:
  .byte $00, $00, $00, $00
  .byte $04, $06, $06, $0C
  .byte $0B, $0C, $0B, $0C
  .byte $0B, $06, $06, $06
  .byte $06, $06, $06, $06
  .byte $06, $06, $06, $06
  .byte $06, $06, $06, $0F
  .byte $0F, $10, $11, $0E
  .byte $0E, $0E, $0E, $0E
  .byte $0E, $0E, $0E, $0E
  .byte $0E, $0E, $0E, $16
  .byte $07, $07, $07, $18
  .byte $19, $19, $1A, $1A
  .byte $08, $08, $1C, $08
  .byte $08, $23, $23, $22
  .byte $22, $23, $23, $22
  .byte $22, $23, $23, $22
  .byte $22, $23, $23, $22
  .byte $22, $23, $23, $22
  .byte $22, $23, $23, $22
  .byte $22, $23, $23, $22
  .byte $22, $23, $23, $22
  .byte $22, $23, $23, $22
  .byte $22, $23, $23, $22
  .byte $22, $07, $07, $0F
  .byte $0F, $0F, $0F, $29
  .byte $00, $00, $00, $00
  .byte $FF

;==================================
; pattern data
;==================================

; format:
; 00             : release gate
; xx             : note xx
; $FA  nn        : select instrument nn
; $FB  mm        : negative portamento (mm)
; $FC  kk        : positive portamento (kk)
; $FD  kk        : duration kk
```

```
; $FF           : end of pattern

pnt00 =*
  .byte $FD, $3F
  .byte $FA, $04
  .byte $00
  .byte $FF

pnt01 =*
  .byte $FA, $01
  .byte $FD, $3F
  .byte $23, $1F, $22, $1E
  .byte $FF

pnt03 =*
  .byte $FA, $01
  .byte $FD, $3F
  .byte $17, $13, $16, $12
  .byte $FF

pnt02 =*
   .byte $FD, $0F
   .byte $FA, $04
   .byte $00
   .byte $FF

pnt04 =*
   .byte $FA, $02
   .byte $FD, $7F
   .byte $25, $25
   .byte $FF

pnt05 =*
   .byte $FA, $0E
   .byte $FD, $3F
   .byte $2F, $2B, $2E
   .byte $FC, $20
   .byte $2A
   .byte $FF

pnt06 =*
   .byte $FA, $06
   .byte $FD, $01
   .byte $42, $3B, $3B, $42
   .byte $3B, $3B, $43, $3B
   .byte $42, $3B, $3B, $42
   .byte $3B, $3B, $43, $3B
   .byte $42, $3B, $3B, $42
   .byte $3B, $3B, $43, $3B
   .byte $42, $3B, $3B, $42
   .byte $3B, $3B, $43, $3B
   .byte $FF

pnt07 =*
   .byte $FA, $01
   .byte $FD, $7F
   .byte $23
   .byte $FF

pnt08 =*
   .byte $FA, $01
   .byte $FD, $7F
   .byte $17, $00
   .byte $FF

pnt09 =*
   .byte $FA, $09
   .byte $FD, $1F
   .byte $17, $13, $12, $0F
   .byte $FF

pnt0A =*
   .byte $FA, $08
   .byte $FD, $0F
   .byte $3E, $39
   .byte $FD, $1F
   .byte $3B
   .byte $FD, $0F
   .byte $3D, $3B
   .byte $FD, $1F
   .byte $3A
   .byte $FD, $7F
   .byte $FB, $01
   .byte $2F
   .byte $FF

pnt0B =*
   .byte $FA, $06
   .byte $FD, $01
```

All the patterns of notes start from here

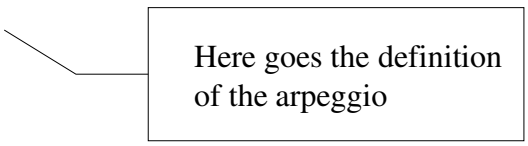
```
    .byte $3D, $36, $36, $3D
    .byte $36, $36, $3E, $36
    .byte $3D, $36, $36, $3D
    .byte $36, $36, $3E, $36
    .byte $3A, $33, $33, $3A
    .byte $33, $33, $3B, $33
    .byte $3A, $33, $33, $3A
    .byte $33, $33, $3B, $33
    .byte $FF

pnt0C =*
   .byte $FA, $06
   .byte $FD, $01
   .byte $42, $3B, $3B, $42
   .byte $3B, $3B, $43, $3B
   .byte $42, $3B, $3B, $42
   .byte $3B, $3B, $43, $3B
   .byte $3E, $37, $37, $3E
   .byte $37, $37, $3F, $37
   .byte $3E, $37, $37, $3E
   .byte $37, $37, $3F, $37
   .byte $FF

pnt0D =*
   .byte $FA, $0A
   .byte $FD, $01
   .byte $3B, $3A, $39, $38
   .byte $39, $3A, $3B, $3A
   .byte $39, $38, $39, $3A
   .byte $3B, $3A, $39, $38
   .byte $39, $3A, $3B, $3A
   .byte $39, $38, $39, $3A
   .byte $3B, $3A, $39, $38
   .byte $39, $3A, $3B, $3A
   .byte $FF

pnt0E =*
   .byte $FA, $07
   .byte $FD, $01
   .byte $2D
   .byte $FD, $03
   .byte $2D
   .byte $FD, $0D
   .byte $2D
   .byte $FD, $03
   .byte $2D
   .byte $FD, $07
   .byte $FA, $00
   .byte $2D
   .byte $FA, $07
   .byte $FD, $01
   .byte $2D
   .byte $FD, $03
   .byte $2D
   .byte $FD, $0D
   .byte $2D
   .byte $FD, $03
   .byte $2D
   .byte $FD, $07
   .byte $FA, $00
   .byte $2D
   .byte $FF

pnt0F =*
   .byte $FA, $0B
   .byte $FD, $01
   .byte $23, $23, $23, $23
   .byte $23, $23, $23, $23
   .byte $23, $23, $23, $23
   .byte $23, $23, $23, $23
   .byte $23, $23, $23, $23
   .byte $23, $23, $23, $23
   .byte $23, $23, $23, $23
   .byte $23, $23, $23, $23
   .byte $FF

pnt10 =*
   .byte $FA, $0B
   .byte $FD, $01
   .byte $22, $22, $22, $22
   .byte $22, $22, $22, $22
   .byte $22, $22, $22, $22
   .byte $22, $22, $22, $22
   .byte $22, $22, $22, $22
   .byte $22, $22, $22, $22
   .byte $22, $22, $22, $22
   .byte $FF

pnt11 =*
```

```
    .byte $FA, $0B
    .byte $FD, $01
    .byte $25, $25, $25, $25
    .byte $25, $25, $25, $25
    .byte $25, $25, $25, $25
    .byte $25, $25, $25, $25
    .byte $25, $25, $25, $25
    .byte $25, $25, $25, $25
    .byte $25, $25, $25, $25
    .byte $FF

pnt12 =*
   .byte $FA, $0A
   .byte $FD, $01
   .byte $3B, $37, $36, $34
   .byte $3B, $37, $36, $34
   .byte $3B, $37, $36, $34
   .byte $3B, $37, $36, $34
   .byte $3B, $37, $36, $34
   .byte $3B, $37, $36, $34
   .byte $3B, $37, $36, $34
   .byte $3B, $37, $36, $34
   .byte $FF

pnt13 =*
   .byte $FA, $0B
   .byte $FD, $01
   .byte $1F, $1F, $1F, $1F
   .byte $1F, $1F, $1F, $1F
   .byte $1F, $1F, $1F, $1F
   .byte $1F, $1F, $1F, $1F
   .byte $1F, $1F, $1F, $1F
   .byte $1F, $1F, $1F, $1F
   .byte $1F, $1F, $1F, $1F
   .byte $1F, $1F, $1F, $1F
   .byte $FF

pnt14 =*
   .byte $FA, $06
   .byte $FD, $01
   .byte $3F, $3B, $36, $3F
   .byte $3B, $36, $3F, $3B
   .byte $3F, $3B, $36, $3F
   .byte $3B, $36, $3F, $3B
   .byte $3F, $3B, $36, $3F
   .byte $3B, $36, $3F, $3B
   .byte $3F, $3B, $36, $3F
   .byte $3B, $36, $3F, $3B
   .byte $FF

pnt15 =*
   .byte $FA, $06
   .byte $FD, $01
   .byte $3E, $3B, $37, $3E
   .byte $3B, $37, $3E, $3B
   .byte $3E, $3B, $37, $3E
   .byte $3B, $37, $3E, $3B
   .byte $3E, $3B, $37, $3E
   .byte $3B, $37, $3E, $3B
   .byte $3E, $3B, $37, $3E
   .byte $3B, $37, $3E, $3B
   .byte $FF

pnt16 =*
   .byte $FA, $0D
   .byte $FD, $1F
   .byte $37, $36, $39, $37
   .byte $36, $2F, $2F, $32
   .byte $FF

pnt17 =*
   .byte $FA, $10
   .byte $FD, $01
   .byte $23, $23, $2A, $2A
   .byte $28, $28, $2A, $2A
   .byte $26, $26, $2A, $2A
   .byte $28, $28, $2A, $2A
   .byte $23, $23, $2A, $2A
   .byte $28, $28, $2A, $2A
   .byte $26, $26, $2A, $2A
   .byte $28, $28, $2A, $2A
   .byte $FF

pnt18 =*
   .byte $FA, $13
   .byte $FD, $07
   .byte $FC, $37, $45
   .byte $FD, $2F
   .byte $47
```

```
   .byte $FD, $07
   .byte $FB, $7F, $47
   .byte $FD, $37
   .byte $42
   .byte $FD, $07
   .byte $FB, $80
   .byte $42
   .byte $FF

pnt19 =*
   .byte $FA, $13
   .byte $FD, $1F
   .byte $3B
   .byte $FD, $0F
   .byte $39, $37
   .byte $FD, $3F
   .byte $36
   .byte $FF

pnt1A =*
   .byte $FA, $13
   .byte $FD, $1F
   .byte $34
   .byte $FD, $0F
   .byte $32, $31
   .byte $FD, $3F
   .byte $2F
   .byte $FF

pnt1B =*
   .byte $FA, $0B
   .byte $FD, $01
   .byte $1B, $1B, $1B, $1B
   .byte $1B, $1B, $1B, $1B
   .byte $1B, $1B, $1B, $1B
   .byte $1B, $1B, $1B, $1B
   .byte $1B, $1B, $1B, $1B
   .byte $1B, $1B, $1B, $1B
   .byte $1B, $1B, $1B, $1B
   .byte $FF

pnt1C =*
   .byte $FA, $01
   .byte $FD, $1F
   .byte $3B
   .byte $FD, $0F
   .byte $3A, $36
   .byte $FD, $2F
   .byte $36
   .byte $FD, $0F
   .byte $38
   .byte $FD, $1F
   .byte $38, $2F, $31
   .byte $FD, $0F
   .byte $33, $34
   .byte $FD, $7F
   .byte $36, $36
   .byte $FF

pnt1D =*
   .byte $FA, $0B
   .byte $FD, $01
   .byte $1C, $1C, $1C, $1C
   .byte $1C, $1C, $1C, $1C
   .byte $1C, $1C, $1C, $1C
   .byte $1C, $1C, $1C, $1C
   .byte $1C, $1C, $1C, $1C
   .byte $1C, $1C, $1C, $1C
   .byte $1C, $1C, $1C, $1C
   .byte $1C, $1C, $1C, $1C
   .byte $FF

pnt1E =*
   .byte $FA, $0B
   .byte $FD, $01
   .byte $1E, $1E, $1E, $1E
   .byte $1E, $1E, $1E, $1E
   .byte $1E, $1E, $1E, $1E
   .byte $1E, $1E, $1E, $1E
   .byte $1E, $1E, $1E, $1E
   .byte $1E, $1E, $1E, $1E
   .byte $1E, $1E, $1E, $1E
   .byte $1E, $1E, $1E, $1E
   .byte $FF

pnt1F =*
   .byte $FA, $09
   .byte $FD, $3F
   .byte $23, $1B, $1C, $1E
```

```
   .byte $FF

pnt20 =*
   .byte $FA, $01
   .byte $FD, $7F
   .byte $17, $17
   .byte $FF

   .byte $21, $26
   .byte $FD, $11
   .byte $28
   .byte $FF

pnt21 =*
   .byte $FA, $15
   .byte $FD, $01
   .byte $1F, $1F
   .byte $FD, $03
   .byte $1F
   .byte $FA, $0F
   .byte $FD, $01
   .byte $2E, $27
   .byte $FA, $15
   .byte $1F
   .byte $FD, $03
   .byte $1F
   .byte $FD, $01
   .byte $1F
   .byte $FD, $03
   .byte $1F
   .byte $FD, $01
   .byte $FA, $0F
   .byte $2F
   .byte $FA, $15
   .byte $1A, $1D, $1F
   .byte $FF

pnt22 =*
   .byte $FA, $09
   .byte $FD, $01
   .byte $13, $13
   .byte $FD, $03
   .byte $13
   .byte $FD, $01
   .byte $FA, $00
   .byte $2E, $27
   .byte $FA, $09
   .byte $13
   .byte $FD, $03
   .byte $13
   .byte $FD, $01
   .byte $13
   .byte $FD, $03
   .byte $13
   .byte $FD, $01
   .byte $13, $10, $11, $13
   .byte $FF

pnt23 =*
   .byte $FA, $09
   .byte $FD, $01
   .byte $17, $17
   .byte $FD, $03
   .byte $17
   .byte $FD, $01
   .byte $FA, $00
   .byte $2E, $27
   .byte $FA, $09
   .byte $17
   .byte $FD, $03
   .byte $17
   .byte $FD, $01
   .byte $17
   .byte $FD, $03
   .byte $17
   .byte $FD, $01
   .byte $17, $12, $15, $17
   .byte $FF

pnt24 =*
   .byte $FA, $15
   .byte $FD, $01
   .byte $23, $23
   .byte $FD, $03
   .byte $23
   .byte $FA, $0F
   .byte $FD, $01
   .byte $2E, $27
   .byte $FA, $15
   .byte $23
```

```
  .byte $FD, $03
  .byte $23
  .byte $FD, $01
  .byte $23
  .byte $FD, $03
  .byte $23
  .byte $FD, $01
  .byte $FA, $0F
  .byte $2F
  .byte $FA, $15
  .byte $1E, $21, $23
  .byte $FF

pnt25 =*
  .byte $FA, $0A
  .byte $FD, $39
  .byte $47
  .byte $FD, $01
  .byte $46, $45, $44
  .byte $FD, $39
  .byte $43
  .byte $FD, $01
  .byte $44, $45, $46
  .byte $FF

pnt26 =*
  .byte $FA, $12
  .byte $FD, $3F
  .byte $3B, $43, $42, $3E
  .byte $3B, $37, $36, $2F
  .byte $FF

pnt27 =*
  .byte $FA, $0C
  .byte $FD, $01
  .byte $31, $3D, $49, $3D
  .byte $31, $3D, $49, $3D
  .byte $FF

pnt28 =*
  .byte $FA, $01
  .byte $FD, $7F
  .byte $17, $00, $00, $00
  .byte $FF

pnt29 =*
  .byte $FA, $01
  .byte $FD, $7F
  .byte $23, $00, $00, $00
  .byte $FF

;=========================
; arpeggio pointers table
;=========================
pointerLo:
  .byte <TableArp0

r157B:
pointerHi:
  .byte >TableArp0


TableArp0:
  .byte $00, $0C, $18

;pointers to the patterns

;low pointers
patptl =*
  .byte <pnt00
  .byte <pnt01
  .byte <pnt02
  .byte <pnt03
  .byte <pnt04
  .byte <pnt05
  .byte <pnt06
  .byte <pnt07
  .byte <pnt08
  .byte <pnt09
  .byte <pnt0A
  .byte <pnt0B
  .byte <pnt0C
  .byte <pnt0D
  .byte <pnt0E
  .byte <pnt0F
  .byte <pnt10
  .byte <pnt11
  .byte <pnt12
  .byte <pnt13
  .byte <pnt14
```



```
   .byte <pnt15
   .byte <pnt16
   .byte <pnt17
   .byte <pnt18
   .byte <pnt19
   .byte <pnt1A
   .byte <pnt1B
   .byte <pnt1C
   .byte <pnt1D
   .byte <pnt1E
   .byte <pnt1F
   .byte <pnt20
   .byte <pnt21
   .byte <pnt22
   .byte <pnt23
   .byte <pnt24
   .byte <pnt25
   .byte <pnt26
   .byte <pnt27
   .byte <pnt28
   .byte <pnt29

;high pointers

patpth =*
   .byte >pnt00
   .byte >pnt01
   .byte >pnt02
   .byte >pnt03
   .byte >pnt04
   .byte >pnt05
   .byte >pnt06
   .byte >pnt07
   .byte >pnt08
   .byte >pnt09
   .byte >pnt0A
   .byte >pnt0B
   .byte >pnt0C
   .byte >pnt0D
   .byte >pnt0E
   .byte >pnt0F
   .byte >pnt10
   .byte >pnt11
   .byte >pnt12
   .byte >pnt13
   .byte >pnt14
   .byte >pnt15
   .byte >pnt16
   .byte >pnt17
   .byte >pnt18
   .byte >pnt19
   .byte >pnt1A
   .byte >pnt1B
   .byte >pnt1C
   .byte >pnt1D
   .byte >pnt1E
   .byte >pnt1F
   .byte >pnt20
   .byte >pnt21
   .byte >pnt22
   .byte >pnt23
   .byte >pnt24
   .byte >pnt25
   .byte >pnt26
   .byte >pnt27
   .byte >pnt28
   .byte >pnt29

songs =*
ltr1:
   .byte $00
   .byte <drillerMainTr1

htr1:
   .byte $00
   .byte >drillerMainTr1

ltr2:
   .byte $00
   .byte <drillerMainTr2

htr2:
   .byte $00
   .byte >drillerMainTr2

ltr3:
   .byte $00
   .byte <drillerMainTr3

htr3:
```

The tables of songs with pointers to the tracks for each voices

```
  .byte $00
  .byte >drillerMainTr3

  .byte $00

initsongs =*
      lda  #$01             ; first song
      sta  songsNumber
      rts
```

Conclusion

May be now you know better how Matt had created a so beautiful sound.

However, you should experiment with the source if you want to understand better how the engine works.

The last thing is rasterlines: the minimum used is of 10 (used when creating the sound effects), while when reading new notes/patterns, the maximum grown until 34!

Finally, as far as I know, the Matt's engine was used in the past even by Tomas Danko and Jon Wells for a total of 11 tunes.

Din 2 end