PySNES –
EIN SNES Emulator in PYTHON

Homebrew

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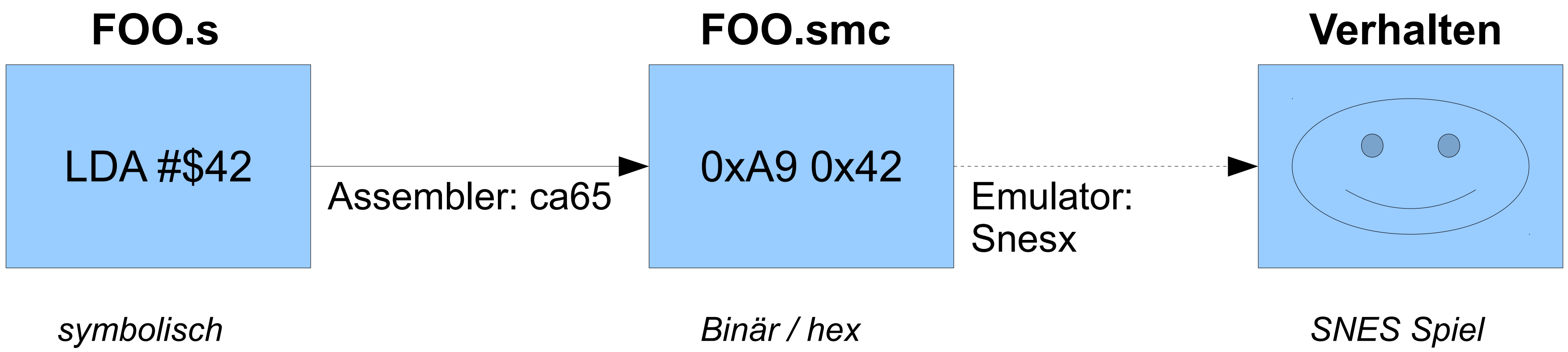
- **TODO**: SNES Starter Kit und Sonstiges
- **TODO**: xKas

Homebrew

- Homebrew ist das Schreiben von „selbstgebrauten“ SNES ROMs. Diese werde i.d.R in einem Emulator oder sogar auf echter Hardware ausgeführt
- Motivation: Testcases für Emulator schreiben

CC65 Intro

- CC65 ist eine Sammlung von Tools um 62X Programm zu erzeugen, also auch SNES ROMs
- Download: https://sourceforge.net/projects/cc65/
- CC65 Tools im Ordner bin
  - Assembler mit ca65 XXX.s
  - Linker mit ld65 -C CONF.cfg -o XXX.smc XXX.o
- Dokumentation im Ordner html/index.html
- Beispiel: https://wiki.superfamicom.org/basic-ca65-usage-for-snes-programming



FOO.s

LDA #$42

Assembler: ca65

FOO.smc

0xA9 0x42

Emulator:
Snesx

Verhalten

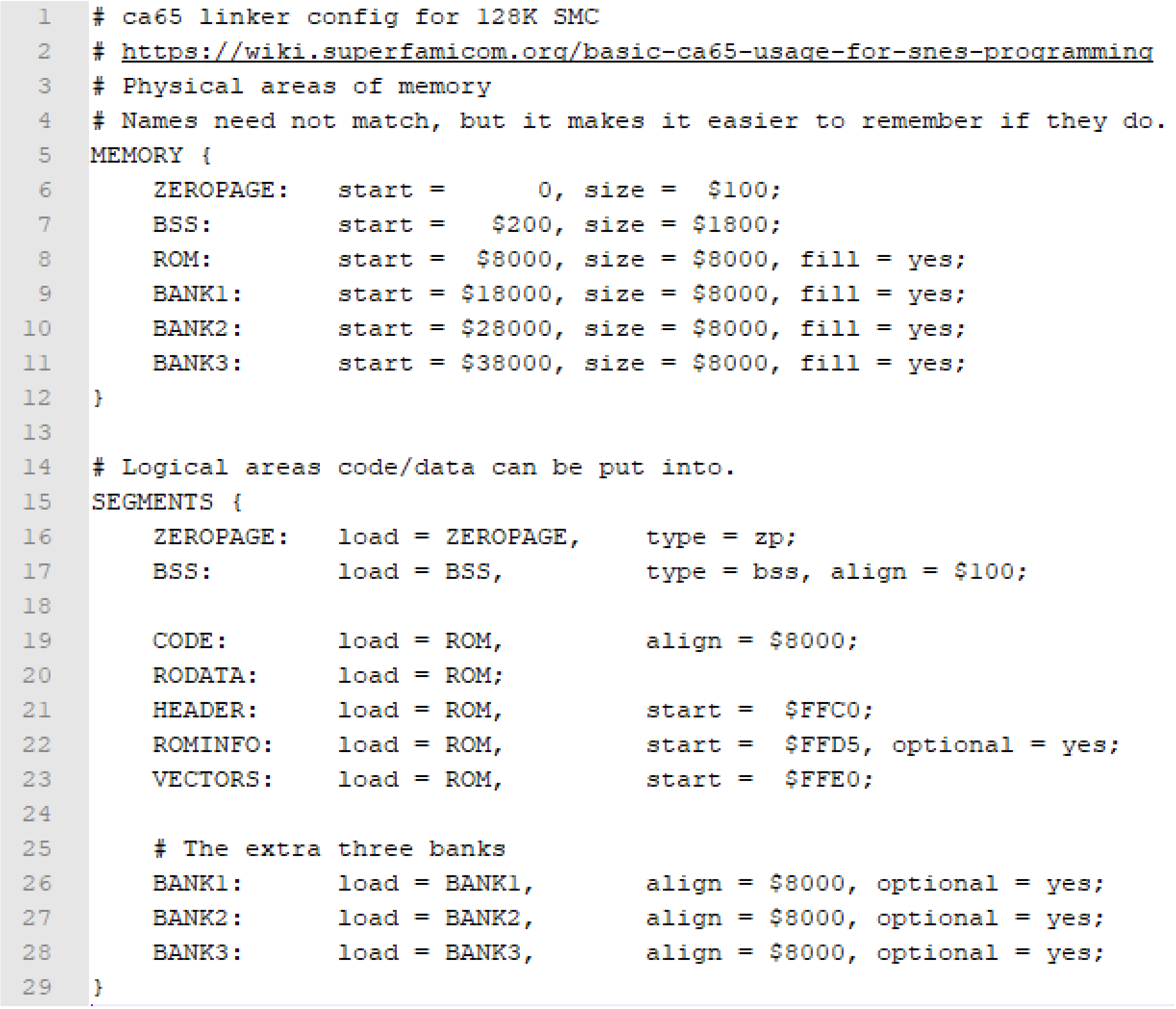
symbolisch

Binär / hex

SNES Spiel

CC65 Intro

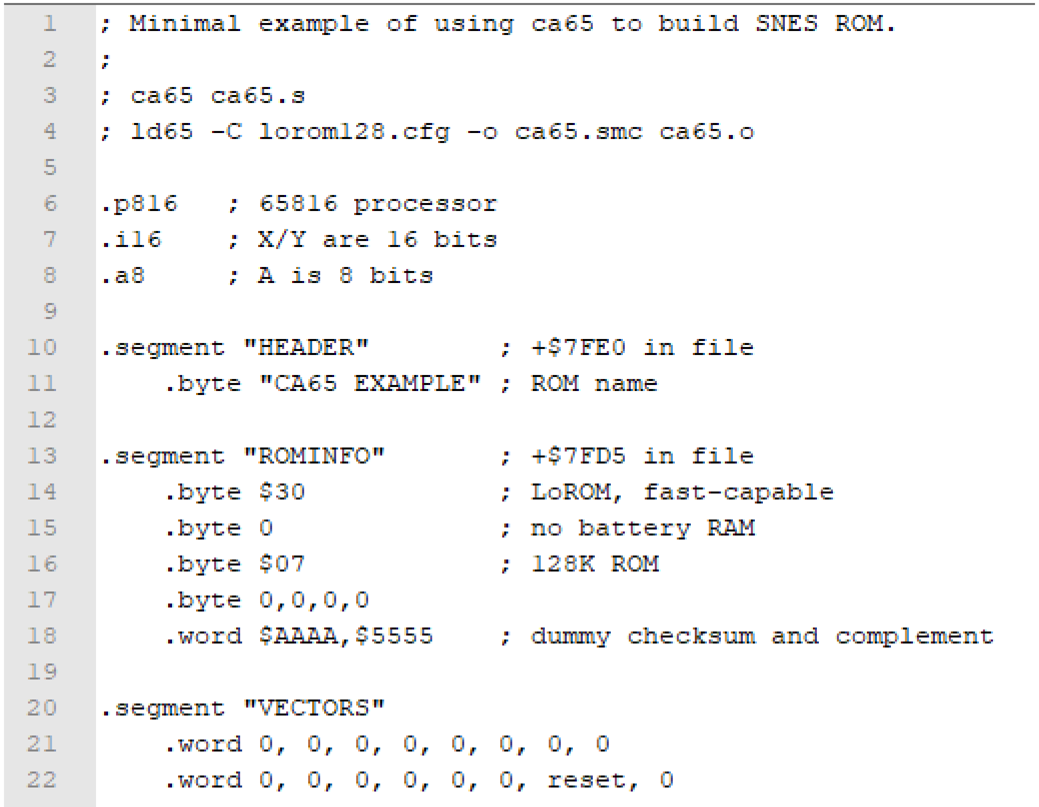
Linker Konfig Datei:



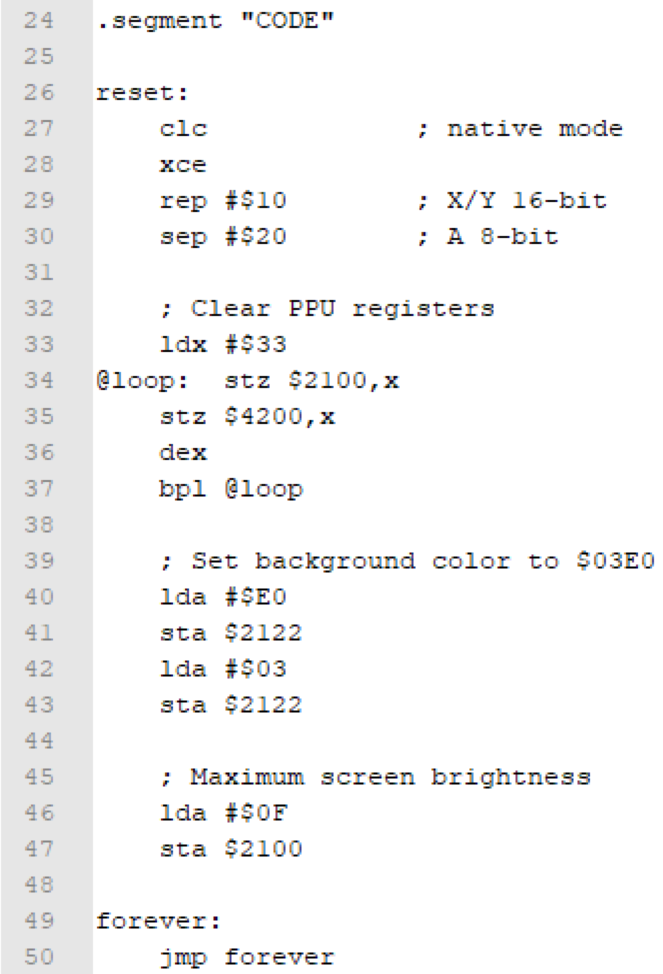
```
# ca65 linker config for 128K SMC
# https://wiki.superfamicom.org/basic-ca65-usage-for-snes-programming
# Physical areas of memory
# Names need not match, but it makes it easier to remember if they do.
MEMORY {
    ZEROPAGE:   start =      0, size =  $100;
    BSS:        start =   $200, size = $1800;
    ROM:        start =  $8000, size = $8000, fill = yes;
    BANK1:      start = $18000, size = $8000, fill = yes;
    BANK2:      start = $28000, size = $8000, fill = yes;
    BANK3:      start = $38000, size = $8000, fill = yes;
}

# Logical areas code/data can be put into.
SEGMENTS {
    ZEROPAGE:   load = ZEROPAGE,    type = zp;
    BSS:        load = BSS,         type = bss, align = $100;

    CODE:       load = ROM,         align = $8000;
    RODATA:     load = ROM;
    HEADER:     load = ROM,         start =  $FFC0;
    ROMINFO:    load = ROM,         start =  $FFD5, optional = yes;
    VECTORS:    load = ROM,         start =  $FFE0;

    # The extra three banks
    BANK1:      load = BANK1,       align = $8000, optional = yes;
    BANK2:      load = BANK2,       align = $8000, optional = yes;
    BANK3:      load = BANK3,       align = $8000, optional = yes;
}
```

CC65 Intro

65816 Assembler Datei:



```
; Minimal example of using ca65 to build SNES ROM.
;
; ca65 ca65.s
; ld65 -C lorom128.cfg -o ca65.smc ca65.o

.p816   ; 65816 processor
.i16    ; X/Y are 16 bits
.a8     ; A is 8 bits

.segment "HEADER"        ; +$7FE0 in file
    .byte "CA65 EXAMPLE" ; ROM name

.segment "ROMINFO"       ; +$7FD5 in file
    .byte $30            ; LoROM, fast-capable
    .byte 0              ; no battery RAM
    .byte $07            ; 128K ROM
    .byte 0,0,0,0
    .word $AAAA,$5555    ; dummy checksum and complement

.segment "VECTORS"
    .word 0, 0, 0, 0, 0, 0, 0, 0
    .word 0, 0, 0, 0, 0, 0, reset, 0
```



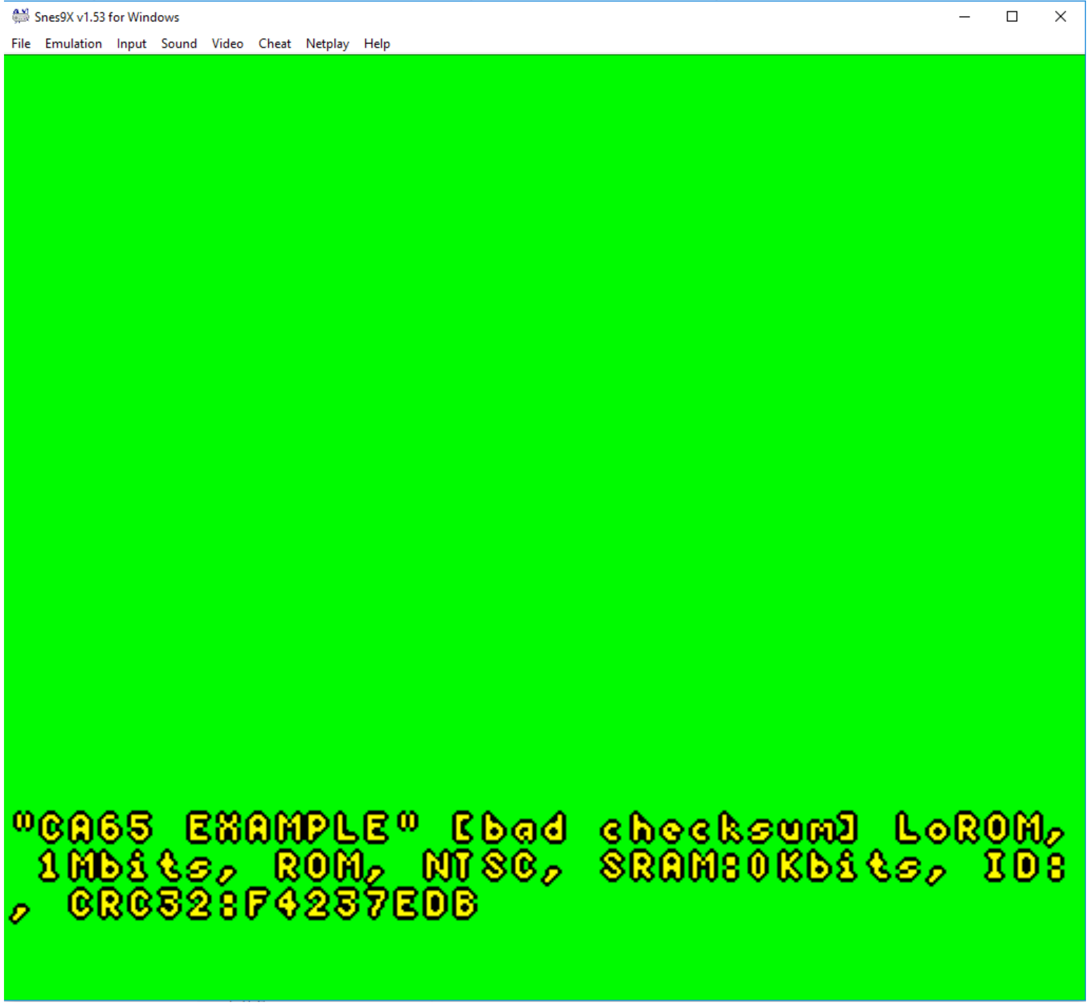
```
.segment "CODE"

reset:
    clc             ; native mode
    xce
    rep #$10        ; X/Y 16-bit
    sep #$20        ; A 8-bit

    ; Clear PPU registers
    ldx #$33
@loop:  stz $2100,x
    stz $4200,x
    dex
    bpl @loop

    ; Set background color to $03E0
    lda #$E0
    sta $2122
    lda #$03
    sta $2122

    ; Maximum screen brightness
    lda #$0F
    sta $2100

forever:
    jmp forever
```

ca65 ca65.s
ld65 -C lorom128.cfg -o ca65.smc ca65.o

CC65 Intro

Erzeugte ca65.smc Datei testen (Bsp. Snes9X)

Das Programm erzeugt einen grünen Bildschirm



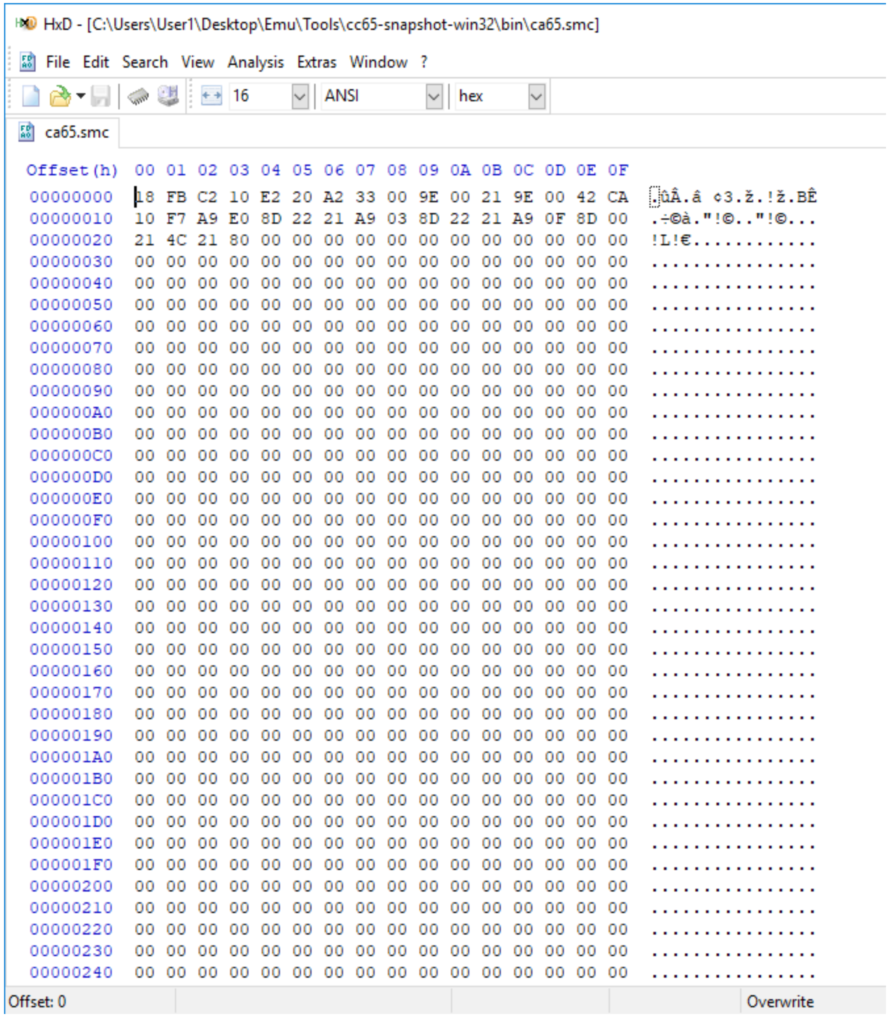
```
"CA65 EXAMPLE" [bad checksum] LoROM,
 1Mbits, ROM, NTSC, SRAM:0Kbits, ID:
, CRC32:F4237EDB
```

CC65 Code

ca65.smc Inhalt:

18 FB C2 10 E2 20 A2 33 00 9E 00 21 9E 00 42 CA 10 F7 A9 E0 8D 22 21 A9 03 8D 22 21 A9 0F 8D 00 21 4C 21 80

Inhalt mit Hexeditor: (Bsp HxD)


HxD - [C:\Users\User1\Desktop\Emu\Tools\cc65-snapshot-win32\bin\ca65.smc]
File Edit Search View Analysis Extras Window ?
16
ANSI
hex
ca65.smc
Offset: 0
Overwrite

```
Offset(h) 00 01 02 03 04 05 06 07 08 09 0A 0B 0C 0D 0E 0F

00000000  18 FB C2 10 E2 20 A2 33 00 9E 00 21 9E 00 42 CA  .ûÂ.â ¢3.ž.!ž.BÊ
00000010  10 F7 A9 E0 8D 22 21 A9 03 8D 22 21 A9 0F 8D 00  .÷©à."!©.."!©...
00000020  21 4C 21 80 00 00 00 00 00 00 00 00 00 00 00 00  !L!€............
00000030  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  ................
00000040  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  ................
00000050  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  ................
00000060  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  ................
00000070  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  ................
00000080  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  ................
00000090  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  ................
000000A0  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  ................
000000B0  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  ................
000000C0  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  ................
000000D0  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  ................
000000E0  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  ................
000000F0  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  ................
00000100  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  ................
00000110  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  ................
00000120  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  ................
00000130  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  ................
00000140  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  ................
00000150  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  ................
00000160  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  ................
00000170  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  ................
00000180  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  ................
00000190  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  ................
000001A0  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  ................
000001B0  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  ................
000001C0  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  ................
000001D0  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  ................
000001E0  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  ................
000001F0  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  ................
00000200  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  ................
00000210  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  ................
00000220  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  ................
00000230  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  ................
00000240  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  ................
```

CC65 Code

ca65.smc Inhalt:

```
18 FB C2 10 E2 20 A2 33 00 9E 00 21 9E 00 42 CA 10 F7 A9 E0 8D 22 21 A9 03 8D 22 21 A9 0F 8D 00 21 4C 21 80
```

Disassembliert:

```
0x00: CLC
```

CC65 Code

ca65.smc Inhalt:

```
18 FB C2 10 E2 20 A2 33 00 9E 00 21 9E 00 42 CA 10 F7 A9 E0 8D 22 21 A9 03 8D 22 21 A9 0F 8D 00 21 4C 21 80
```

Disassembliert:

```
0x00: CLC
0x01: XCE
```

CC65 Code

ca65.smc Inhalt:

```
18 FB C2 10 E2 20 A2 33 00 9E 00 21 9E 00 42 CA 10 F7 A9 E0 8D 22 21 A9 03 8D 22 21 A9 0F 8D 00 21 4C 21 80
```

Disassembliert:

```
0x00: CLC
0x01: XCE
0x02: REP
```

CC65 Code

ca65.smc Inhalt:

```
18 FB C2 10 E2 20 A2 33 00 9E 00 21 9E 00 42 CA 10 F7 A9 E0 8D 22 21 A9 03 8D 22 21 A9 0F 8D 00 21 4C 21 80
```

Disassembliert:

```
0x00: CLC
0x01: XCE
0x02: REP 0b00010000
```

CC65 Code

ca65.smc Inhalt:

```
18 FB C2 10 E2 20 A2 33 00 9E 00 21 9E 00 42 CA 10 F7 A9 E0 8D 22 21 A9 03 8D 22 21 A9 0F 8D 00 21 4C 21 80
```

Disassembliert:

```
0x00: CLC
0x01: XCE
0x02: REP 0b00010000
0x04: SEP
```

CC65 Code

ca65.smc Inhalt:

```
18 FB C2 10 E2 20 A2 33 00 9E 00 21 9E 00 42 CA 10 F7 A9 E0 8D 22 21 A9 03 8D 22 21 A9 0F 8D 00 21 4C 21 80
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```
0x00: CLC
0x01: XCE
0x02: REP 0b00010000
0x04: SEP 0b00100000
```

CC65 Code

ca65.smc Inhalt:

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Disassembliert:

```
0x00: CLC
0x01: XCE
0x02: REP 0b00010000
0x04: SEP 0b00100000
0x06: LDX
```

CC65 Code

ca65.smc Inhalt:

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18 FB C2 10 E2 20 A2 33 00 9E 00 21 9E 00 42 CA 10 F7 A9 E0 8D 22 21 A9 03 8D 22 21 A9 0F 8D 00 21 4C 21 80
```

Disassembliert:

```
0x00: CLC
0x01: XCE
0x02: REP 0b00010000
0x04: SEP 0b00100000
0x06: LDX 0x0033
```

CC65 Code

ca65.smc Inhalt:

```
18 FB C2 10 E2 20 A2 33 00 9E 00 21 9E 00 42 CA 10 F7 A9 E0 8D 22 21 A9 03 8D 22 21 A9 0F 8D 00 21 4C 21 80
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Disassembliert:

```
0x00: CLC
0x01: XCE
0x02: REP 0b00010000
0x04: SEP 0b00100000
0x06: LDX 0x0033
0x09: STZ
```

CC65 Code

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```

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0x06: LDX 0x0033
0x09: STZ 0x2100
0x0C: STZ 0x4200
0x0F: DEX
0x10: BPL
```

CC65 Code

ca65.smc Inhalt:

```
18 FB C2 10 E2 20 A2 33 00 9E 00 21 9E 00 42 CA 10 F7 A9 E0 8D 22 21 A9 03 8D 22 21 A9 0F 8D 00 21 4C 21 80
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0x10: BPL 0xF7
```

CC65 Code

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```
18 FB C2 10 E2 20 A2 33 00 9E 00 21 9E 00 42 CA 10 F7 A9 E0 8D 22 21 A9 03 8D 22 21 A9 0F 8D 00 21 4C 21 80
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0x09: STZ 0x2100
0x0C: STZ 0x4200
0x0F: DEX
0x10: BPL 0xF7
0x12: LDA
```

CC65 Code

ca65.smc Inhalt:

```
18 FB C2 10 E2 20 A2 33 00 9E 00 21 9E 00 42 CA 10 F7 A9 E0 8D 22 21 A9 03 8D 22 21 A9 0F 8D 00 21 4C 21 80
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```

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ca65.smc Inhalt:

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0x09: STZ 0x2100
0x0C: STZ 0x4200
0x0F: DEX
0x10: BPL 0xF7
0x12: LDA 0xE0
0x14: STA 0x2122
```

CC65 Code

ca65.smc Inhalt:

```
18 FB C2 10 E2 20 A2 33 00 9E 00 21 9E 00 42 CA 10 F7 A9 E0 8D 22 21 A9 03 8D 22 21 A9 0F 8D 00 21 4C 21 80
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0x0C: STZ 0x4200
0x0F: DEX
0x10: BPL 0xF7
0x12: LDA 0xE0
0x14: STA 0x2122
0x17: LDA
```

CC65 Code

ca65.smc Inhalt:

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18 FB C2 10 E2 20 A2 33 00 9E 00 21 9E 00 42 CA 10 F7 A9 E0 8D 22 21 A9 03 8D 22 21 A9 0F 8D 00 21 4C 21 80
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Disassembliert:

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0x0C: STZ 0x4200
0x0F: DEX
0x10: BPL 0xF7
0x12: LDA 0xE0
0x14: STA 0x2122
0x17: LDA 0x03
```

CC65 Code

ca65.smc Inhalt:

```
18 FB C2 10 E2 20 A2 33 00 9E 00 21 9E 00 42 CA 10 F7 A9 E0 8D 22 21 A9 03 8D 22 21 A9 0F 8D 00 21 4C 21 80
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Disassembliert:

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```

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ca65.smc Inhalt:

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Disassembliert:

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0x09: STZ 0x2100
0x0C: STZ 0x4200
0x0F: DEX
0x10: BPL 0xF7
0x12: LDA 0xE0
0x14: STA 0x2122
0x17: LDA 0x03
0x19: STA 0x2122
0x1B: LDA
```

CC65 Code

ca65.smc Inhalt:

```
18 FB C2 10 E2 20 A2 33 00 9E 00 21 9E 00 42 CA 10 F7 A9 E0 8D 22 21 A9 03 8D 22 21 A9 0F 8D 00 21 4C 21 80
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Disassembliert:

```
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0x0C: STZ 0x4200
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0x10: BPL 0xF7
0x12: LDA 0xE0
0x14: STA 0x2122
0x17: LDA 0x03
0x19: STA 0x2122
0x1C: LDA 0x0F
```

CC65 Code

ca65.smc Inhalt:

```
18 FB C2 10 E2 20 A2 33 00 9E 00 21 9E 00 42 CA 10 F7 A9 E0 8D 22 21 A9 03 8D 22 21 A9 0F 8D 00 21 4C 21 80
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Disassembliert:

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0x00: CLC
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0x04: SEP 0b00100000
0x06: LDX 0x0033
0x09: STZ 0x2100
0x0C: STZ 0x4200
0x0F: DEX
0x10: BPL 0xF7
0x12: LDA 0xE0
0x14: STA 0x2122
0x17: LDA 0x03
0x19: STA 0x2122
0x1C: LDA 0x0F
0x1E: STA
```

CC65 Code

ca65.smc Inhalt:

```
18 FB C2 10 E2 20 A2 33 00 9E 00 21 9E 00 42 CA 10 F7 A9 E0 8D 22 21 A9 03 8D 22 21 A9 0F 8D 00 21 4C 21 80
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Disassembliert:

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0x09: STZ 0x2100
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0x0F: DEX
0x10: BPL 0xF7
0x12: LDA 0xE0
0x14: STA 0x2122
0x17: LDA 0x03
0x19: STA 0x2122
0x1C: LDA 0x0F
0x1E: STA 0x2100
```

CC65 Code

ca65.smc Inhalt:

```
18 FB C2 10 E2 20 A2 33 00 9E 00 21 9E 00 42 CA 10 F7 A9 E0 8D 22 21 A9 03 8D 22 21 A9 0F 8D 00 21 4C 21 80
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Disassembliert:

```
0x00: CLC
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0x02: REP 0b00010000
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0x06: LDX 0x0033
0x09: STZ 0x2100
0x0C: STZ 0x4200
0x0F: DEX
0x10: BPL 0xF7
0x12: LDA 0xE0
0x14: STA 0x2122
0x17: LDA 0x03
0x19: STA 0x2122
0x1C: LDA 0x0F
0x1E: STA 0x2100
0x21: JMP
```

CC65 Code

ca65.smc Inhalt:

```
18 FB C2 10 E2 20 A2 33 00 9E 00 21 9E 00 42 CA 10 F7 A9 E0 8D 22 21 A9 03 8D 22 21 A9 0F 8D 00 21 4C 21 80
```

Disassembliert:

```
0x00: CLC
0x01: XCE
0x02: REP 0b00010000
0x04: SEP 0b00100000
0x06: LDX 0x0033
0x09: STZ 0x2100
0x0C: STZ 0x4200
0x0F: DEX
0x10: BPL 0xF7
0x12: LDA 0xE0
0x14: STA 0x2122
0x17: LDA 0x03
0x19: STA 0x2122
0x1C: LDA 0x0F
0x1E: STA 0x2100
0x21: JMP 0x8021
```

CC65 Code

ca65.smc Inhalt:

```
18 FB C2 10 E2 20 A2 33 00 9E 00 21 9E 00 42 CA 10 F7 A9 E0 8D 22 21 A9 03 8D 22 21 A9 0F 8D 00 21 4C 21 80
```

Disassembliert:

```
0x00: CLC                ; Clear Carry Flag
0x01: XCE                ; Switch Carry Flag and E Flag. E=0 means 16 Bit native Mode
0x02: REP 0b00010000     ; Reset Processor Status Bits. Sets X Flag=0. X and Y operate in 16 Bit Mode
0x04: SEP 0b00100000     ; Set Processor Status Bits. Set M Flag=1. A operate in 8 Bit Mode
0x06: LDX 0x0033         ; Store a 0x33 (0b00110011) in the X register
0x09: STZ 0x2100         ; Move a Zero to memory address 0x2100+x
0x0C: STZ 0x4200         ; Move a Zero to memory address 0x4200+x
0x0F: DEX                ; Decrement X. X=X-1
0x10: BPL 0xF7           ; Jump to 0x09 if N Flag is 0 (That means X>0) 0xF7 is a -9 0x12+0xF7=0x09
0x12: LDA 0xE0           ; Load A. Store a 0xE0  (0b11100000) in the A register
0x14: STA 0x2122         ; Move a 0xE0 to the memory adress 0x2122
0x17: LDA 0x03           ; Load A. Store a 0x03  (0b00000111) in the A register
0x19: STA 0x2122         ; Move a 0x03 to the memory adress 0x2122
0x1C: LDA 0x0F           ; Load A. Store a 0x0F  (0b00001111) in the A register
0x1E: STA 0x2100         ; Move a 0x0F to the memory adress 0x2100
0x21: JMP 0x8021         ; Jump to 0x8021 (im LoRom = 0x0021)
```

CC65 Code

ca65.smc Inhalt:

```
18 FB C2 10 E2 20 A2 33 00 9E 00 21 9E 00 42 CA 10 F7 A9 E0 8D 22 21 A9 03 8D 22 21 A9 0F 8D 00 21 4C 21 80
```

Pseudo Code:

```
0x00: CLC                    ; Modus: Native 16 Bit,
0x01: XCE                    ; Modus: X/Y Register 16 Bit, A Register 8 Bit
0x02: REP 0b00010000         ;
0x04: SEP 0b00100000         ; do {
0x06: LDX 0x0033             ;       X = 0x33
0x09: STZ 0x2100             ;       RAM[2100+x] = 0
0x0C: STZ 0x4200             ;       RAM[4200+x] = 0
0x0F: DEX                    ;       X=X-1
0x10: BPL 0xF7               ; while(X>0)
0x12: LDA 0xE0               ; RAM[2122] = 0x30E0
0x14: STA 0x2122             ;
0x17: LDA 0x03               ;
0x19: STA 0x2122             ;
0x1C: LDA 0x0F               ; RAM[2100] = 0x0F
0x1E: STA 0x2100             ;
0x21: JMP 0x8021             ; while(true) {}
```

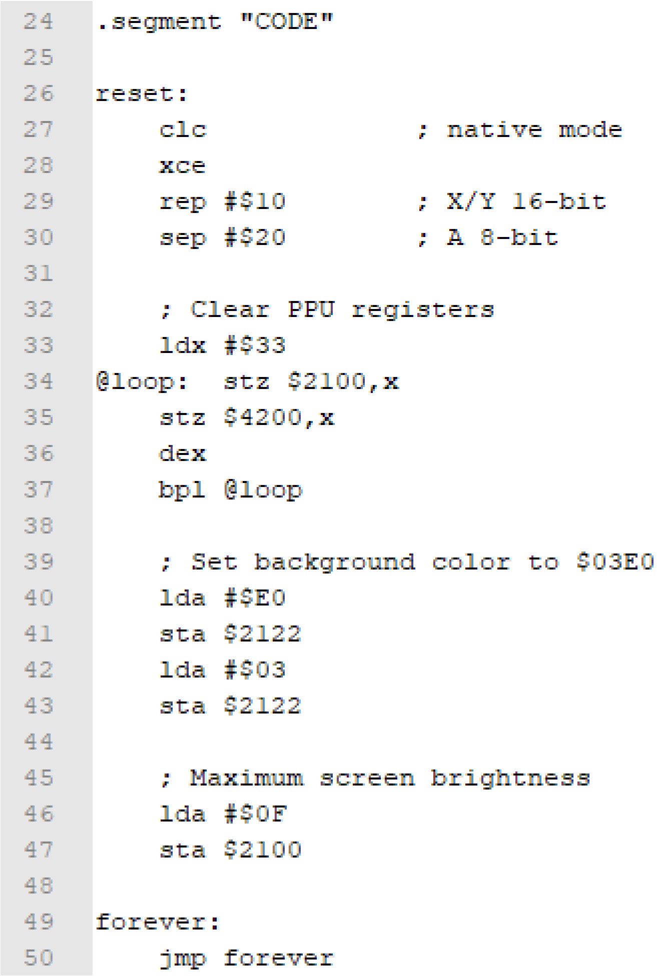
CC65 Code

ca65.smc Inhalt:

18 FB C2 10 E2 20 A2 33 00 9E 00 21 9E 00 42 CA 10 F7 A9 E0 8D 22 21 A9 03 8D 22 21 A9 0F 8D 00 21 4C 21 80

Pseudo Code:

```
0x00: CLC                   ; Modus: Native 16 Bit,
0x01: XCE                   ; Modus: X/Y Register 16 Bit, A Register 8 Bit
0x02: REP 0b00010000        ;
0x04: SEP 0b00100000        ; do {
0x06: LDX 0x0033            ;       X = 0x33
0x09: STZ 0x2100            ;       RAM[2100+x] = 0
0x0C: STZ 0x4200            ;       RAM[4200+x] = 0
0x0F: DEX                   ;       X=X-1
0x10: BPL 0xF7              ; while(X>0)
0x12: LDA 0xE0              ; RAM[2122] = 0x30E0
0x14: STA 0x2122            ;
0x17: LDA 0x03              ;
0x19: STA 0x2122            ;
0x1C: LDA 0x0F              ; RAM[2100] = 0x0F
0x1E: STA 0x2100            ;
0x21: JMP 0x8021            ; while(true) {}
```



```
.segment "CODE"

reset:
    clc             ; native mode
    xce
    rep #$10        ; X/Y 16-bit
    sep #$20        ; A 8-bit

    ; Clear PPU registers
    ldx #$33
@loop:  stz $2100,x
    stz $4200,x
    dex
    bpl @loop

    ; Set background color to $03E0
    lda #$E0
    sta $2122
    lda #$03
    sta $2122

    ; Maximum screen brightness
    lda #$0F
    sta $2100

forever:
    jmp forever
```

CC65 Konfigurationsdatei

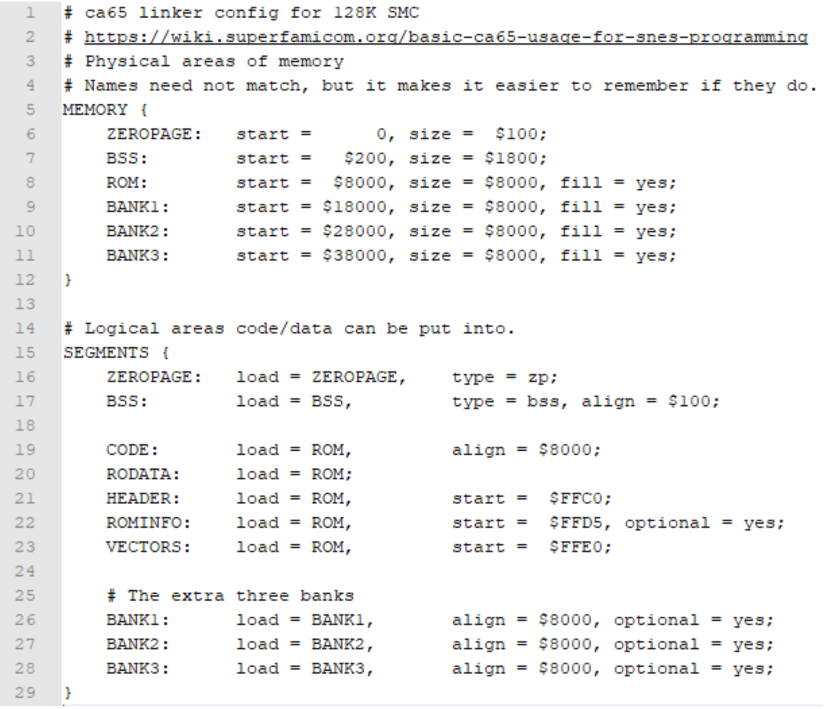
lorom128.cfg:

- Die Datei enthält Konstanten, welche
  Man später im Code (insb. Header nutzen kann)
- Zwei Abschnitte: MEMORY und SEGMENTS
- Physikalische ROM Adresse (MEMORY): Dort packt der Assembler den Code in die smc Datei
- Logische Adresse (SEGMENTS): Referenziert die Konstanten aus Memory um andere Konstanten Zu definieren. Diese nutzt der Assembler um Adressen umzurechnen.

- Beispiel: Der Code beginnt bei 0x0000 in der smc Datei. Sprünge finden aber zu 0x8000 statt, da 0x8000 (im LoROM) die logische Adresse von 0x0000 ist. (z.B. JMP 0x8021 springt zu 0x0021)

- Die ROM hat eine Größe von 128 KByte. Die letzte Adresse ist 0x1FFFF. Eine Bank ist 32KByte groß. D.h. 4 Bänke (Bank 0 – Bank 3)

- In LoROM beginnt der Header bei 0xFFC0 (siehe MemMap Slides)

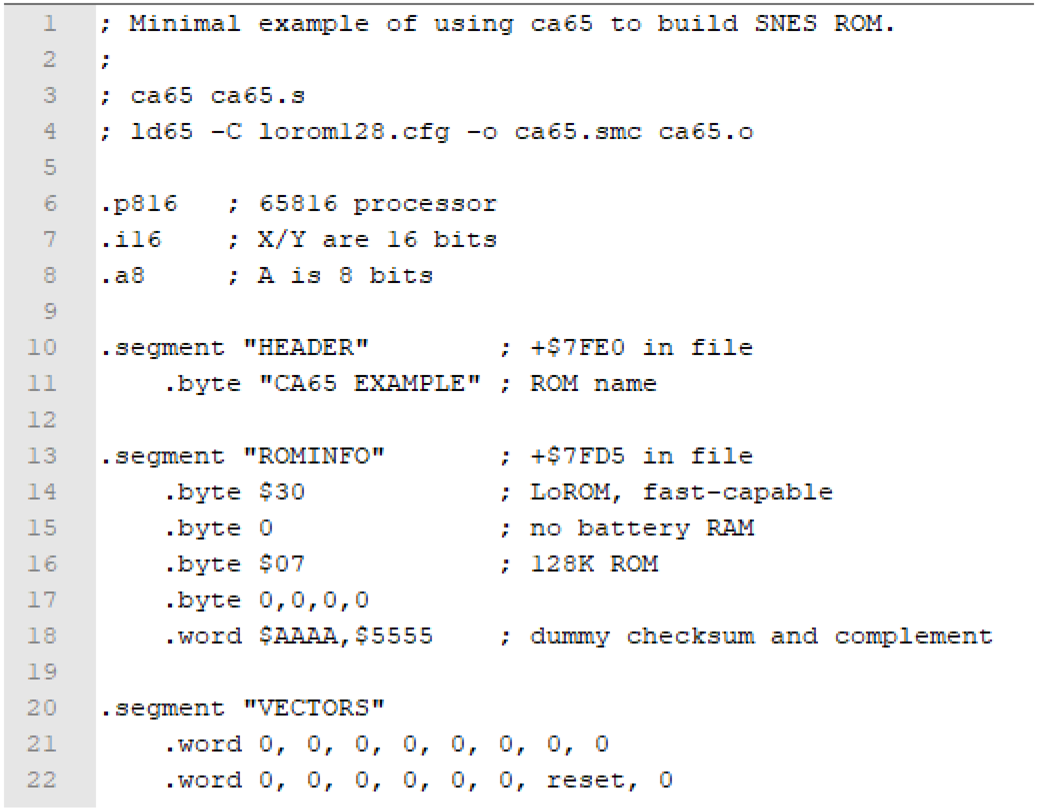


```
# ca65 linker config for 128K SMC
# https://wiki.superfamicom.org/basic-ca65-usage-for-snes-programming
# Physical areas of memory
# Names need not match, but it makes it easier to remember if they do.
MEMORY {
    ZEROPAGE:   start =      0, size =  $100;
    BSS:        start =   $200, size = $1800;
    ROM:        start =  $8000, size = $8000, fill = yes;
    BANK1:      start = $18000, size = $8000, fill = yes;
    BANK2:      start = $28000, size = $8000, fill = yes;
    BANK3:      start = $38000, size = $8000, fill = yes;
}

# Logical areas code/data can be put into.
SEGMENTS {
    ZEROPAGE:   load = ZEROPAGE,    type = zp;
    BSS:        load = BSS,         type = bss, align = $100;

    CODE:       load = ROM,         align = $8000;
    RODATA:     load = ROM;
    HEADER:     load = ROM,         start =  $FFC0;
    ROMINFO:    load = ROM,         start =  $FFD5, optional = yes;
    VECTORS:    load = ROM,         start =  $FFE0;

    # The extra three banks
    BANK1:      load = BANK1,       align = $8000, optional = yes;
    BANK2:      load = BANK2,       align = $8000, optional = yes;
    BANK3:      load = BANK3,       align = $8000, optional = yes;
}
```

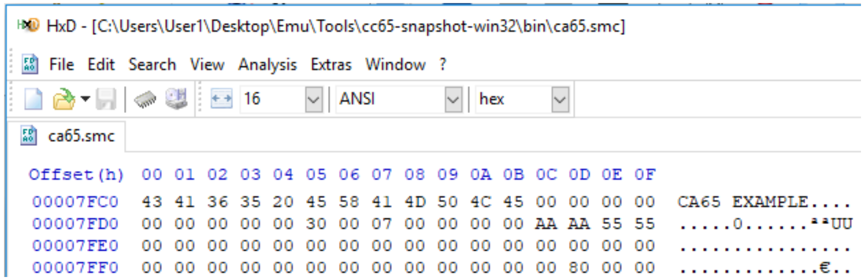
CC65 Header

ca65.s:

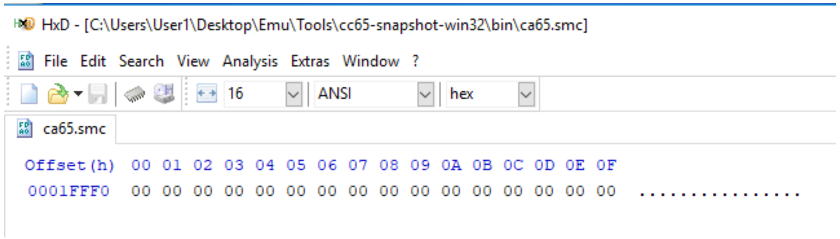
- .segment referenziert Konfig Datei
  Beispiel: ROMINFO ist 0xFFC0
  und CODE ist 0x0000
- Genaue Beschreibung des Headers auf den Memory Map Folien.
- VECTORS sind 16 Bit Zeiger auf (Interrupt-)Programmblöcke. Reset
  Ist der Entry-Point



```
; Minimal example of using ca65 to build SNES ROM.
;
; ca65 ca65.s
; ld65 -C loroml28.cfg -o ca65.smc ca65.o

.p816    ; 65816 processor
.i16     ; X/Y are 16 bits
.a8      ; A is 8 bits

.segment "HEADER"          ; +$7FE0 in file
    .byte "CA65 EXAMPLE" ; ROM name

.segment "ROMINFO"         ; +$7FD5 in file
    .byte $30              ; LoROM, fast-capable
    .byte 0                ; no battery RAM
    .byte $07              ; 128K ROM
    .byte 0,0,0,0
    .word $AAAA,$5555      ; dummy checksum and complement

.segment "VECTORS"
    .word 0, 0, 0, 0, 0, 0, 0, 0
    .word 0, 0, 0, 0, 0, 0, reset, 0
```


HxD - [C:\Users\User1\Desktop\Emu\Tools\cc65-snapshot-win32\bin\ca65.smc]
File Edit Search View Analysis Extras Window ?
16
ANSI
hex
ca65.smc

```
Offset(h) 00 01 02 03 04 05 06 07 08 09 0A 0B 0C 0D 0E 0F

00007FC0  43 41 36 35 20 45 58 41 4D 50 4C 45 00 00 00 00  CA65 EXAMPLE....
00007FD0  00 00 00 00 00 30 00 07 00 00 00 00 AA AA 55 55  .....0......ªªUU
00007FE0  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  ................
00007FF0  00 00 00 00 00 00 00 00 00 00 00 00 00 80 00 00  .............€..
```


HxD - [C:\Users\User1\Desktop\Emu\Tools\cc65-snapshot-win32\bin\ca65.smc]
File Edit Search View Analysis Extras Window ?
16
ANSI
hex
ca65.smc

```
Offset(h) 00 01 02 03 04 05 06 07 08 09 0A 0B 0C 0D 0E 0F
0001FFF0  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  ................
```

Quellen

- Beispiele: https://snescentral.com/homebrew.php
- CC65 Download: https://sourceforge.net/projects/cc65/
- Beispiele: https://wiki.superfamicom.org/basic-ca65-usage-for-snes-programming