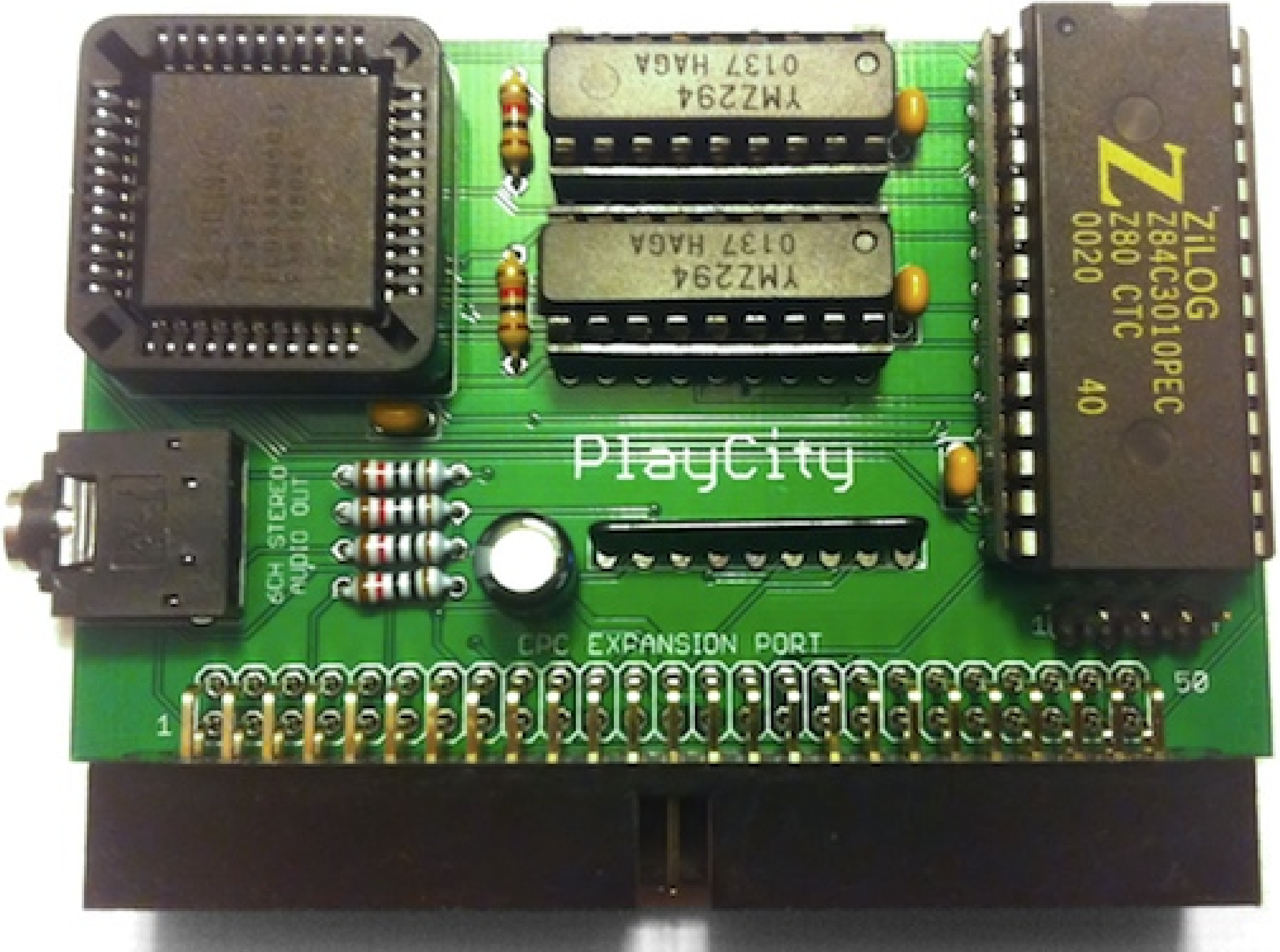
YMZ294
0137 HAGA
YMZ294
0137 HAGA
ZiLOG
Z84C3010PEC
Z80 CTC
0020
40
PlayCity
6CH STEREO
AUDIO OUT
CPC EXPANSION PORT
1
50
1

PlayCity

Introduction

The PlayCity is a CPC expansion with these features:

- 6 audio channels sound with programmable frequency (stereo line out and speaker mono mix in).
- 4 counter/timer channels for programmable interrupt (including NMI).
- IM2 vectorized interrupt support.
- Raster lines interrupt support.
- CRTC hardware CURSOR interrupt support.
- The LIGHT PEN/GUN connector.

Hardware Installation

- Power OFF your Amstrad / Schneider CPC.
- Attach the PlayCity board to one free MotherX4 slot.
- Turn ON your computer, and enjoy!

Peripheral Soft Reset

All expansion peripherals should be reset when an output is performed to I/O port **$F8FF**.

Used by the standard BIOS functions **MC_BOOT_PROGRAM** and **MC_START_PROGRAM** (vectors $BD13 and $BD16), in particular a peripheral that generates interrupts. Also used by FutureOS.

The PlayCity board use this feature to be sure that the CTC and YMZs circuits are properly reset before using them.

Light Pen/Gun connector

For making it easier to adapt Light Pens/Guns from other systems or new ones, we added a 4 pins connector to the board. The connections are labeled in the board as VCC (+5V), TR (Trigger or D7), LS (Light Sensor) and GND.

Making the system compatible with Amstrad Magnum Phaser games, the most accuracy light gun system for CPC.

Counter/Timer Circuit

Information

The Z84C30 has four independently programmable counter/timer channels interfaced directly with the Z80 CPU. You can get full information in the CTC datasheet (File:Z80ctc.pdf).

The first thing to consider is how those channels are linked to the PlayCity board.

Channel 0 ($F880)

The channel 0 is exclusively used to generate the frequency of the two embedded soundchips (YMZ294). The input for the trigger (TRG0) is the 4 MHz system clock of the CPC. The output signal (ZC/TO0) is sent to the clock pins of the soundchips.

Channel 1 ($F881)

The channel 1 is typically used to generate raster interrupts. The input (TRG1) is linked to the CRTC CURSOR signal. The output (ZC/TO1) is connected to the NMI pin of the Z80.

Used as a counter, it's synchronized with the CRTC CURSOR signal, generating a smooth high priority rasters interrupt. Used as a timer (prescaler set to 256), its 15.625 kHz signal is scanline-synchronized. That means the time constant is the number of scanlines to wait before to send an NMI.

Channel 2/3 ($F882/$F883)

The channels 2 and 3 are dedicated to general purpose usages. Yes, it's for you! The input for the trigger (TRG2) is the 4 MHz system clock. The output (ZC/TO2) is linked to the trigger for the channel 3 (TRG3). They can be used as 2x 8-bit or 1x 16-bit counter/timer. They generate normal interrupts and allow using the Z80 vector interrupt (mode 2) too.

Coding examples

Each channel is programmed with two bytes; a third is necessary when interrupts are enabled. Once started, the CTC countdown automaticaly reloads its time constant and resume counting. Interrupt processing is simplified because only one vector need to be specified; the CTC internally generates an unique vector for each channel.

Before programming the CTC channels, you need to set the lower byte for the vectorized interrupts.

Vector interrupts

```
; Set Vector lower byte to
0
LD BC,$F880
OUT (C),0
```

Channel 0 example

```
; Set both YMZ294 clocks to sound like the CPC AY-3-
8912
LD BC,$F880
LD HL,$7F01
OUT (C),H ; $7F = Clock generator
OUT (C),L  ; $01 = CPC AY
```

Channel 2 example

```
; Start CTC channel 2 in timer mode (prescalar 256 and set new time
constant)
LD H,%10110111 ; Timer mode and preescalar 256
LD L,1 ; Time constant
LD BC,$F882
OUT (C),H  ; Enable Timer
OUT (C),L ; Set new time constant

; Stop CTC channel 2
LD BC,$F882
LD A,%00000011
OUT (C),A ; Disable Timer
2
```

Channel 2/3 example

```
; Start CTC channel 2 and 3 in 16-bit counter
mode
LD BC,$F882
LD HL,32768 ; Timer constant
LD A,%11110111 ; Counter mode
OUT (C),A ; Enable Timer 2
OUT (C),L ; Set new time constant (lower byte)
INC BC
OUT (C),A ; Enable Timer 3
OUT (C),H ; Set new time constant (high byte)

; Stop CTC channel 2 and 3 (16 bit
mode)
LD BC,$F882
LD A,%00000011
OUT (C),A ; Disable Timer 2
INC BC
OUT (C),A ; Disable Timer 3
```

Don't forget to use RETN for NMI handlers as well as RETI for normal interrupt handlers. In other case, the Z80 CPU will not aknowledge the next interrupt properly.

Audio Channels

Informations

The PlayCity board is populated with two AY compatible soundchips, adding 6 stereo channels. The YMZ294 eliminate the I/O port and improve the CPU interface through /CS, /WR control signals and a 8-bit data bus. Each sound chip can be directly programmed using two dedicated I/O ports for registers and data. No initialization code is required.

By default, the YMZs are clocked at 4 MHz but run internaly at 2 MHz. So, they will sound like an Atari ST, while you don't change the frequency by reprograming the CTC Channel 0.

YMZ294 Registers

They are exactly the same than the PSG, only remember there is not PSG I/O registers ($0E-$0F) in the YMZ.

The registers are write only.

Coding Examples

YMZ Initialization

YMZ_SELECT, select a YMZ register. Use the port **$F984** for the right channels and port **$F988** for the left channels.

YMZ_WRITE, write a byte in the selected register. Use the port **$F884** for the right channels and port **$F888** for the left channels.

```
; Initialization of the YMZ registers
LD A,$D
.loop_init_ymz
LD BC,YMZ_SELECT
OUT (C),A ; Register
LD BC,YMZ_WRITE
CP 7
JR NZ,.send_zero
LD A,$3F ; Noise and Tone disabled
OUT (C),A ; Write in YMZ R7
LD A,6
JR .loop_init_ymz
.send_zero
OUT (C),0 ; Write 0 in the selected YMZ
register
DEC A
JP P,.loop_init_ymz
```

CTC/YMZ Useful Values

CTC	CTC Out (MHz)	YMZ (MHz)	Computer
$1	2,00	1,00	= CPC
$2	3,00	1,50	
$3	3,33	1,67	
$4	3,50	1,75	= ZX
$5	3,60	1,80	~ MSX
$6	3,67	1,83	
$7	3,71	1,86	
$8	3,75	1,88	
$9	3,78	1,89	
$A	3,80	1,90	
$B	3,82	1,91	
$C	3,83	1,92	

$D	3,85	1,92	
$E	3,86	1,93	
$F	3,87	1,93	
$0	3,98	1,99	~ ST
UNSET	4,00	2,00	= ST

PlayCity coding tips

Interesting tips or "magic tricks" using the board should be documented here. If the code is long, you must put in other wiki page and link it here.

PlayCity detection

We are going to use the NMI interrupt generator to check if our program is running in a CPC with a PlayCity board.

```
; ---------------------------------------------------------------------------
; PlayCity check
; (c) 2013 SyX
; ---------------------------------------------------------------------------

; Constantes
CTC_TIM1            EQU $F881       ; Channel 1 (I: Cursor CRTC | O: NMI)
CTC_START_TIMER256  EQU %00110111
CTC_STOP_CHANNEL    EQU %00000011

; ---------------------------------------------------------------------------
; NOTE: The lower ROM must be disabled before to run this code.
check_playcity
    ; Disable interrupts
    DI

    ; Install NMI handler
    LD   A,$C3                  ; JP $xxxx
    LD   HL,nmi_interrupt
    LD   ($0066),A
    LD   ($0067),HL

    ; Initialize playcity variable to 0
    XOR  A
    LD   (playcity),A

    ; Wait VBlank
    LD   B,$F5
.wait_vbl
    IN   A,(C)
    RRA
    JR   NC,.wait_vbl

    ; Initialize CTC timer 1 (NMI generator)
    LD   HL,32                  ; 32 scanlines
    LD   BC,CTC_TIM1
    LD   A,CTC_START_TIMER256
    OUT  (C),A                  ; Enable Timer
    OUT  (C),L                  ; Set new time constant
    OUT  (C),L                  ; Set new time constant

    ; Extra delay
    LD   IX,33 * 4 - 1          ; Wait 33 scanlines
    CALL wait_scanlines_ix

    LD   A,(playcity)
    OR   A
    JR   NZ,.playcity_detected
    ; No PlayCity detected
    .
    .
    .

.playcity_detected
    .
    .
    .

; ---------------------------------------------------------------------------
nmi_interrupt
    PUSH BC
    PUSH AF

    ; Change playcity variable
    LD   A,$FF
    LD   (playcity),A

    ; Disable CTC timer 1 (NMI generator)
    LD   BC,CTC_TIM1
    LD   A,CTC_STOP_CHANNEL
    OUT  (C),A                  ; Disable Timer

    POP  AF
    POP  BC
    EI
    RETN

; ---------------------------------------------------------------------------
; Wait scanlines
; INPUT:
;   IX: Scanlines to wait * 4 - 1
; ---------------------------------------------------------------------------
wait_scanlines_ix
    DEFS 5,0                                ; (5)

.loop_wait_scanlines_ix
    DEFS 6                                  ; (6)
    DEC  IX                                 ; (3)
    LD   A,IXH                              ; (2)
    OR   IXL                                ; (2)
    JR   NZ,.loop_wait_scanlines_ix         ; (2/3)
                                            ; Total loop --> 16 * (IX -
1) + 15
    RET                                     ; (3)
                                            ; Total Routine --> 64 *
SCANLINES
; ---------------------------------------------------------------------------
playcity
    DEFS 1
```

Downloads

In File:Playcity examples.zip, you will find more examples with full sources of using the CTC, a customized arkos player that let you play songs using an external YMZ and the ReSeT party demo disk that includes a CPC version of the PT3 Turbo Sound player (6 channels song format).

Another example, in File:Test sfx.zip you will find a 3 channels SFX player, you can choose the sound chip to be used by the player.

Software Supporting PlayCity

- List of software supporting the board.