

# Z80 Computer

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#### Z80 References

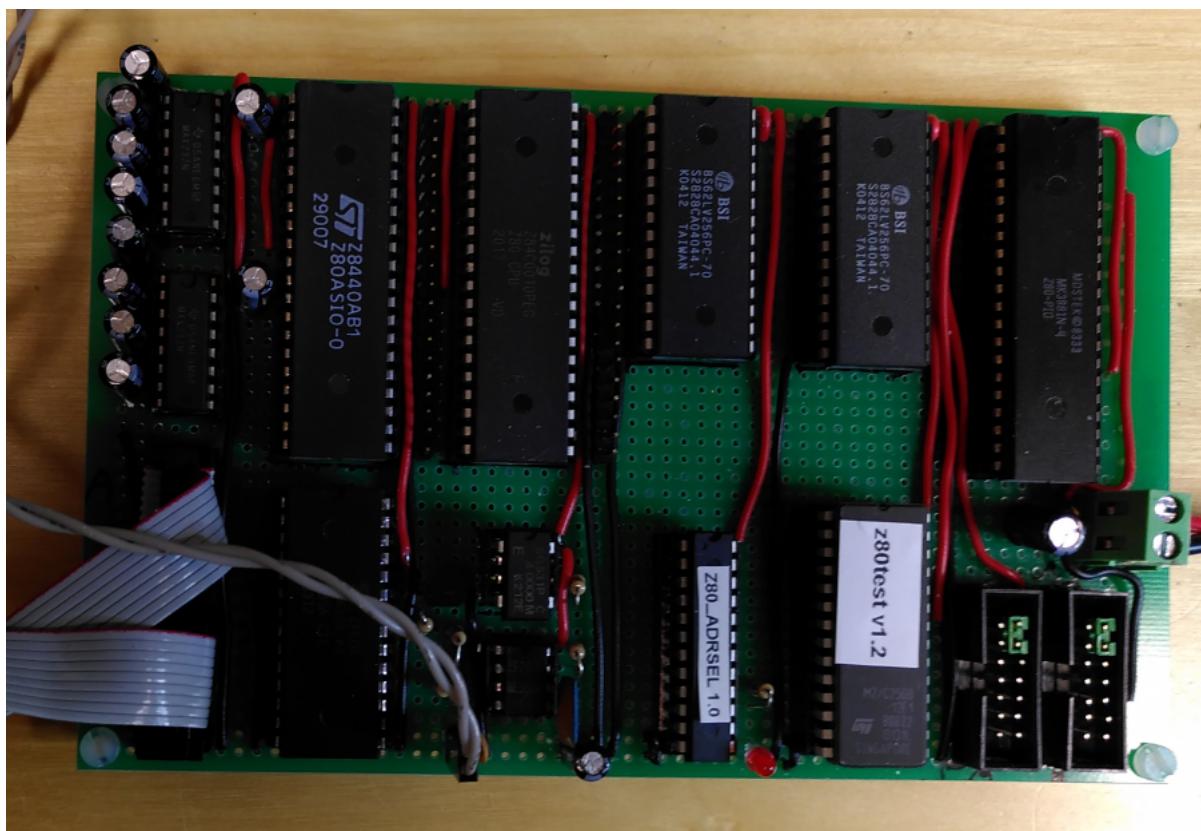
#### Links to Z80 Projects

#### Z80 related components

The following components are/will be available  
Components ordered from DigiKey

# Overview of the Z80 project

2021-02-12, updated 2021-05-24, 2021-06-30



The design is uploaded to GitHub: [hanske/Z80\\_Computer\\_board: A simple Z80 based computer board](https://github.com/hansake/Z80_Computer_board) ([http://github.com/hanske/Z80\\_Computer\\_board](https://github.com/hanske/Z80_Computer_board))

The intention is to do the following:

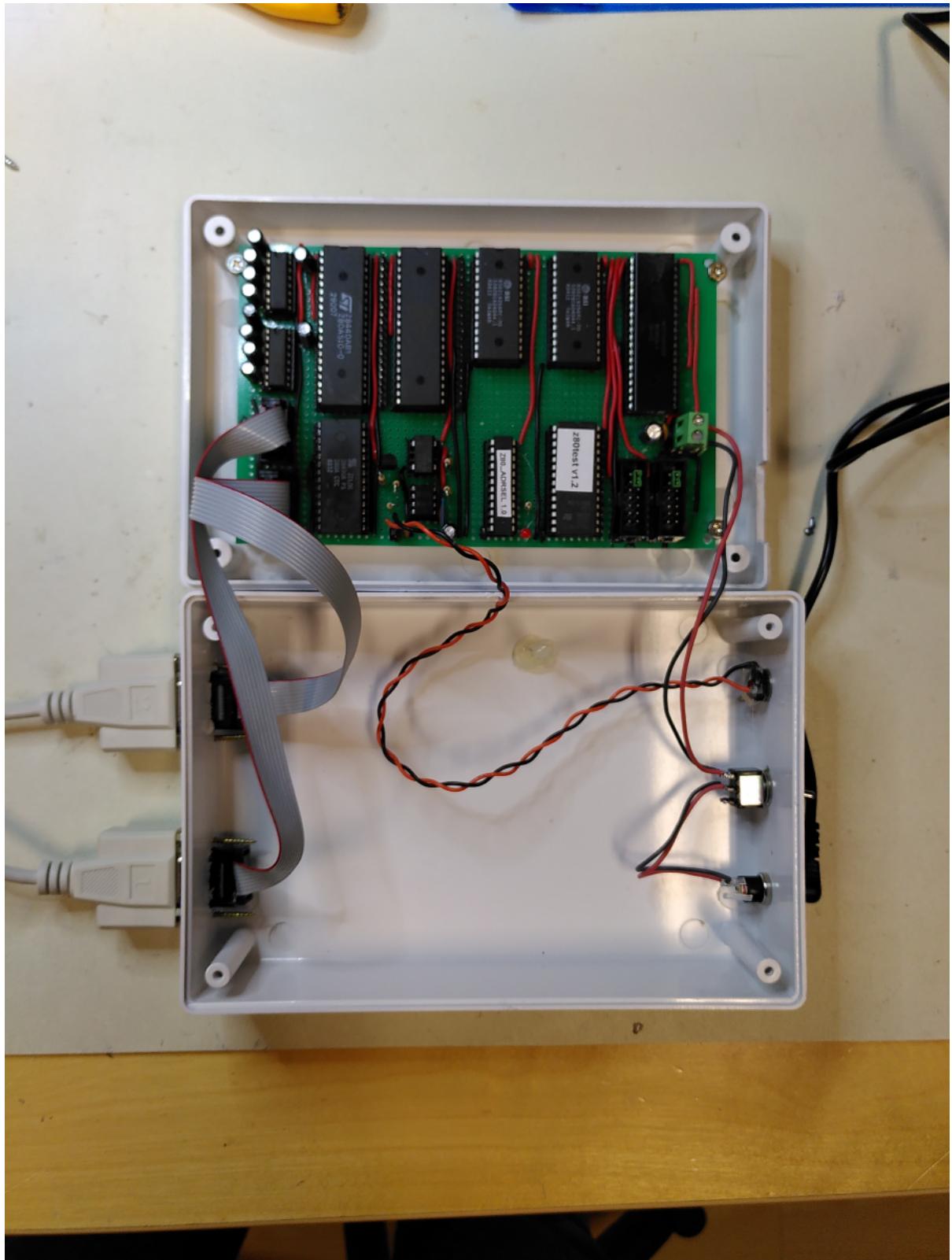
- Design a simple Z80 based computer board with the components that are available
  - [Z80\\_Microprocessor\\_Family\\_Jan90.pdf](http://www.bitsavers.org/components/st_Microelectronics/_dataBooks/Z80_Microprocessor_Family_Jan90.pdf) ([http://www.bitsavers.org/components/st\\_Microelectronics/\\_dataBooks/Z80\\_Microprocessor\\_Family\\_Jan90.pdf](http://www.bitsavers.org/components/st_Microelectronics/_dataBooks/Z80_Microprocessor_Family_Jan90.pdf))
  - [gaby.de/z80/zaks.html](http://gaby.de/z80/zaks.html) (<http://gaby.de/z80/zaks.html>)
  - Thomas Scherrer Z80-Family Official Support Page (<https://www.z80cpu.eu/mirrors/www.z80.info/>)
- The computer board should have:
  - [Z80 CPU Z80 CPU User Manual - um0080.pdf](http://www.zilog.com/docs/z80/um0080.pdf) (<http://www.zilog.com/docs/z80/um0080.pdf>)
  - EPROM memory
  - SRAM memory
    - The higher 32KB of the memory is always RAM
    - the lower 32KB of memory is switched between EPROM and RAM, reset

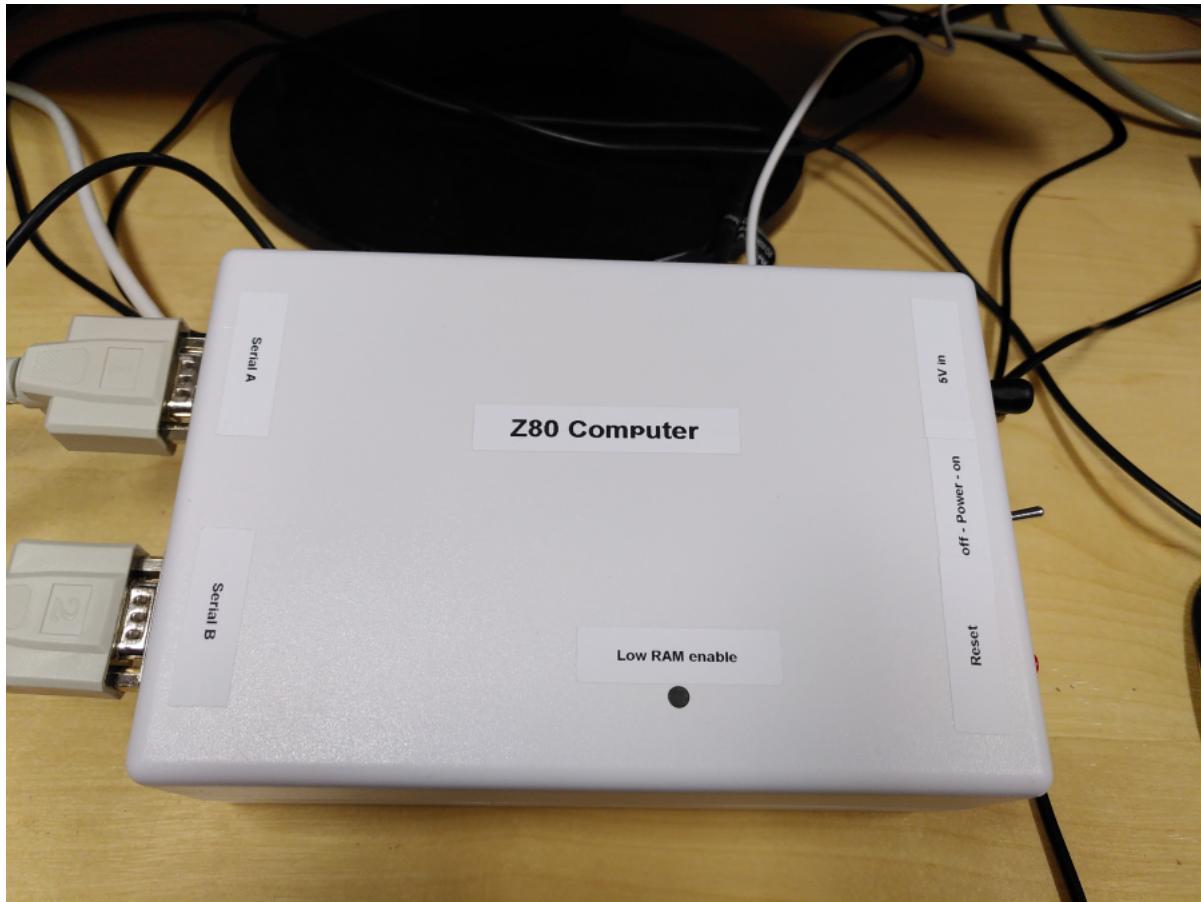
selects EPROM

- to use RAM in low memory the start routine will copy code (BIOS etc) from EPROM to high RAM
- Z80 SIO for RS-232 connection [Zilog Z80-SIO Technical Manual.pdf](http://www.hartetechnologies.com/manuals/Zilog/Zilog%20Z80-SIO%20Technical%20Manual.pdf) (<http://www.hartetechnologies.com/manuals/Zilog/Zilog%20Z80-SIO%20Technical%20Manual.pdf>)
- Z80 CTC for timing and serial channel clock [Z80 CTC - Z80 CTC.pdf](https://arcarch.xmission.com/Tech/Datasheets/Z80%20CTC.pdf) (<https://arcarch.xmission.com/Tech/Datasheets/Z80%20CTC.pdf>)
- Z80 PIO for further use [Zilog Z80-PIO Technical Manual.pdf](https://www.hartetechnologies.com/manuals/Zilog/Zilog%20Z80-PIO%20Technical%20Manual.pdf) (<https://www.hartetechnologies.com/manuals/Zilog/Zilog%20Z80-PIO%20Technical%20Manual.pdf>)
  - Could maybe be used for ATA interface?
  - or even an ISA interface to a controller that handles both FD interface and ATA interface
- Maybe Z80 DMA [Z80 DMA ps0179.pdf](http://www.zilog.com/docs/z80/ps0179.pdf) (<http://www.zilog.com/docs/z80/ps0179.pdf>)
  - Proof-of-concept: DMA controller for MOVE/XMOVE by dmcnaugh · Pull Request #74 · udo-munk/z80pack (<https://github.com/udo-munk/z80pack/pull/74/commits/78896e47e8b7d0e2e1e86380d3eaec8c3b0846d5>)
- For other necessary logical functions a GAL IC should be used: [PAL/GAL Programming](#)
- A crystal oscillator
- A power-on and reset circuit, could be based on a 555 IC
- Maybe. maybe a floppy disk interface?
- The schematic and a simple board layout should be designed with KiCAD
- Wiring should be done with Vero-Wire
- To this project a good C cross compiler and assembler would be nice to have: [Build a Clang-LLVM Z80 Compiler.](#)
- A SIMH based simulator would also be very nice. Could be based on: [simh/AltairZ80 at master · simh/simh · GitHub](#) (<https://github.com/simh/simh/tree/master/AltairZ80>)

2021-07-26

Z80 Computer in enclosure





# Design of the Z80 computer

## Z80 computer components, schematic and layout

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### Z80 computer components

2021-04-03

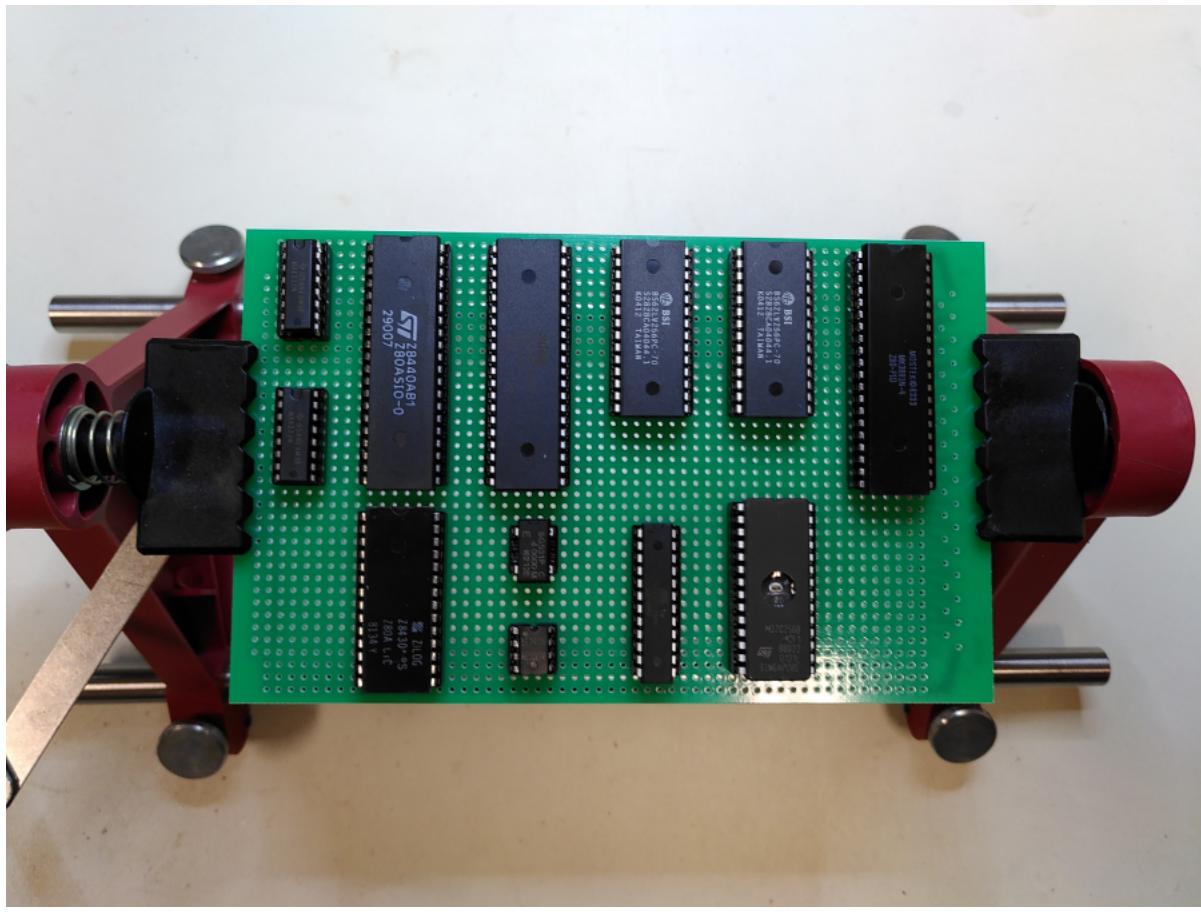
IC components:

- 1x Z80 CPU, Zilog Z84C0010PEG 10MHz
- 1x Z80A SIO/0, Zilog Z-80A SIO/0 / 8440W 0A 4MHz
- 1x Z80A-CTC, Zilog Z80A-CTC 4MHz
- 1x Z80-PIO, Mostek MK3881N-4 4MHz
- 2x SRAM 32Kx8 BSI BS62LV256PC-70 70nS
- 1x EPROM 32x8 ST M27C256 120nS
- 1x 4 MHz Crystal oscillator, ROHS EPSON SG-531P 4.0000MC
- 2x MAX232 RS-232 Transciever, Texas Instruments MAX232N
- 1x 22V10 PLD, Microchip Technology ATF22V10C-15PU
- 1x 555 timer

### Z80 computer component layout

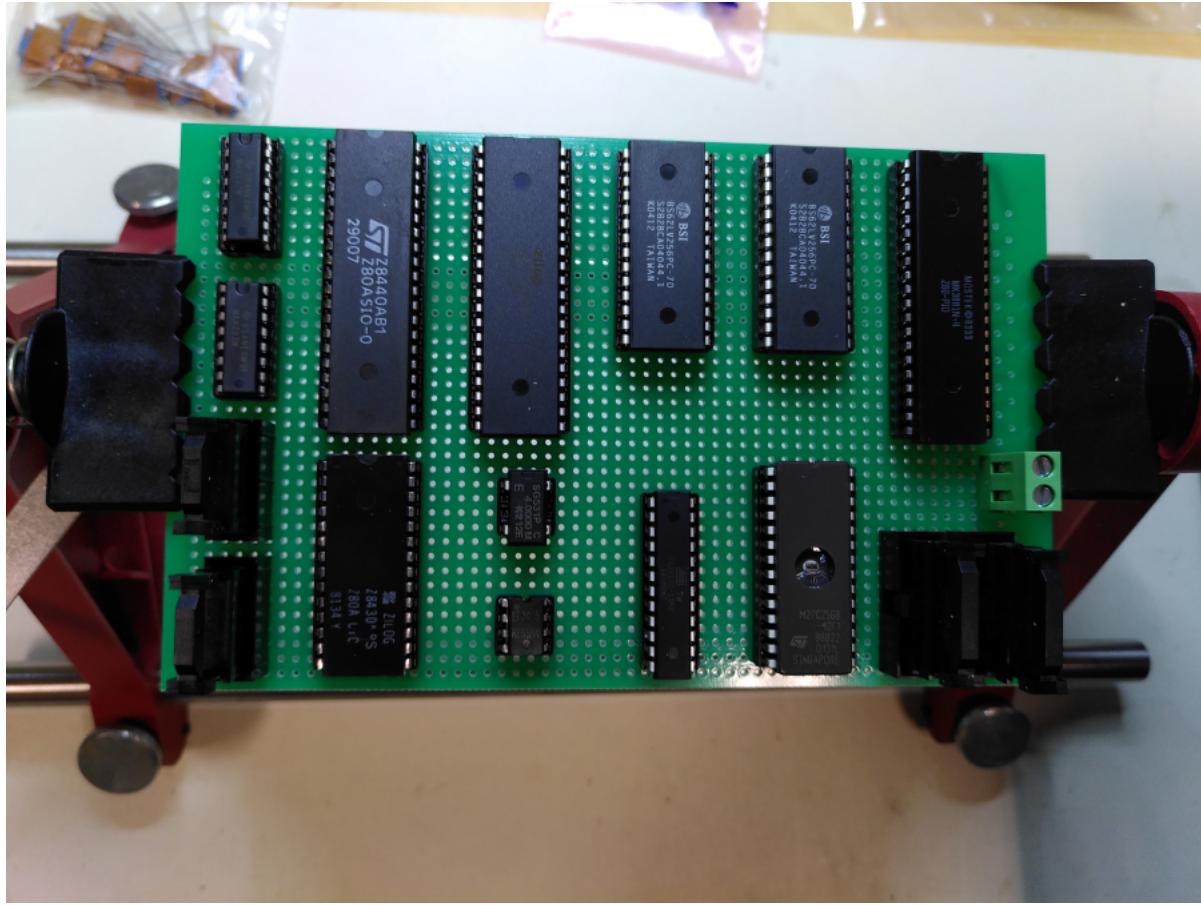
2021-04-03

Z80 computer preliminary component layout:



2021-04-26

Z80 computer final component layout:



## Z80 computer schematic

2021-04-26

Made with KiCAD.

Z80 computer schematic:

[Z80\\_computer\\_schematic\\_2021-04-26.pdf](#) ([http://192.168.42.21/mediawiki/images/f/ff/Z80\\_computer\\_schematic\\_2021-04-26.pdf](http://192.168.42.21/mediawiki/images/f/ff/Z80_computer_schematic_2021-04-26.pdf)) (File:Z80 computer schematic 2021-04-26.pdf)

Z80 computer layout:

[Z80\\_computer\\_layout\\_2021-04-26.pdf](#) ([http://192.168.42.21/mediawiki/images/2/24/Z80\\_computer\\_layout\\_2021-04-26.pdf](http://192.168.42.21/mediawiki/images/2/24/Z80_computer_layout_2021-04-26.pdf)) (File:Z80 computer layout 2021-04-26.pdf)

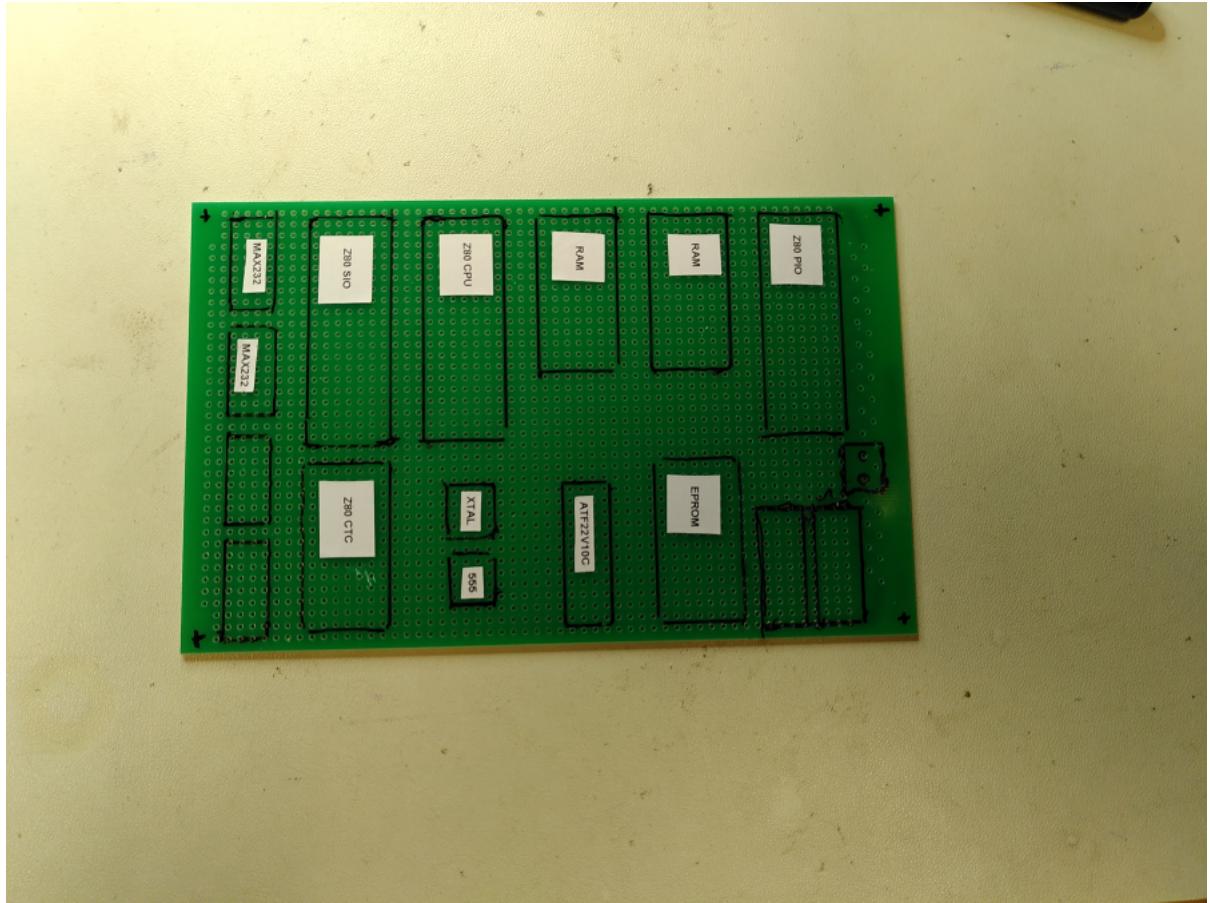
Z80 computer BOM (Bill Of Materials):

[Z80\\_computer\\_bom\\_2021-04-26.pdf](#) ([http://192.168.42.21/mediawiki/images/5/5e/Z80\\_computer\\_bom\\_2021-04-26.pdf](http://192.168.42.21/mediawiki/images/5/5e/Z80_computer_bom_2021-04-26.pdf)) (File:Z80 computer bom 2021-04-26.pdf)

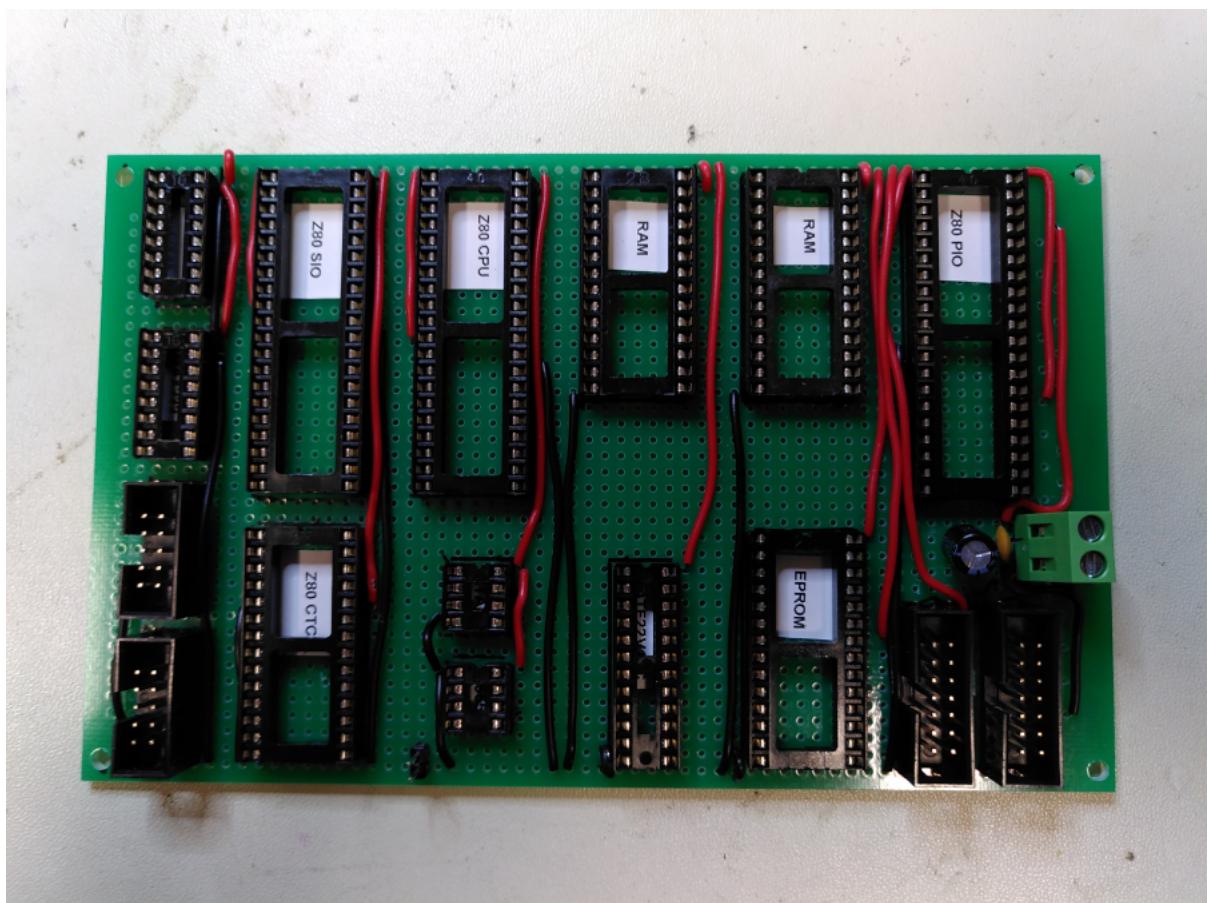
## Z80 computer building steps

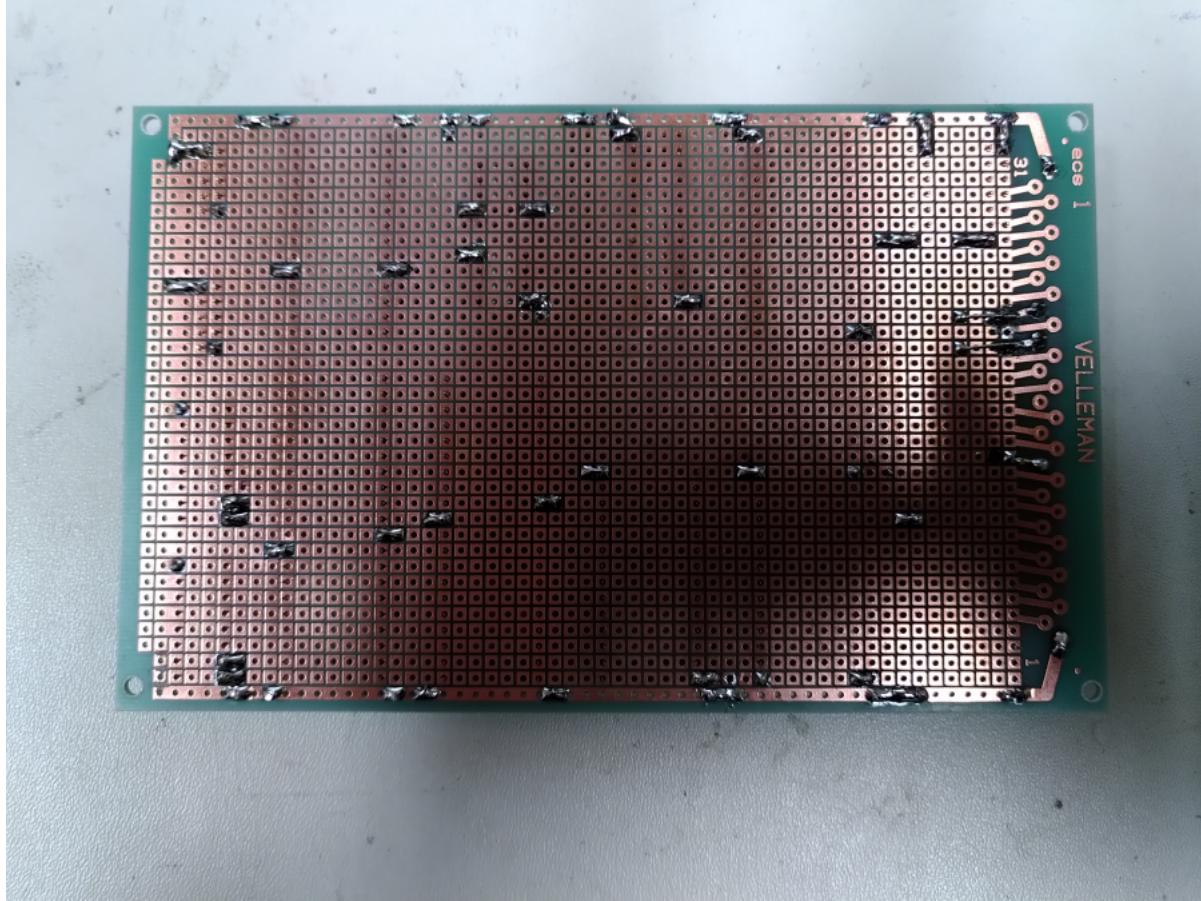
2021-05-03

Z80 computer board



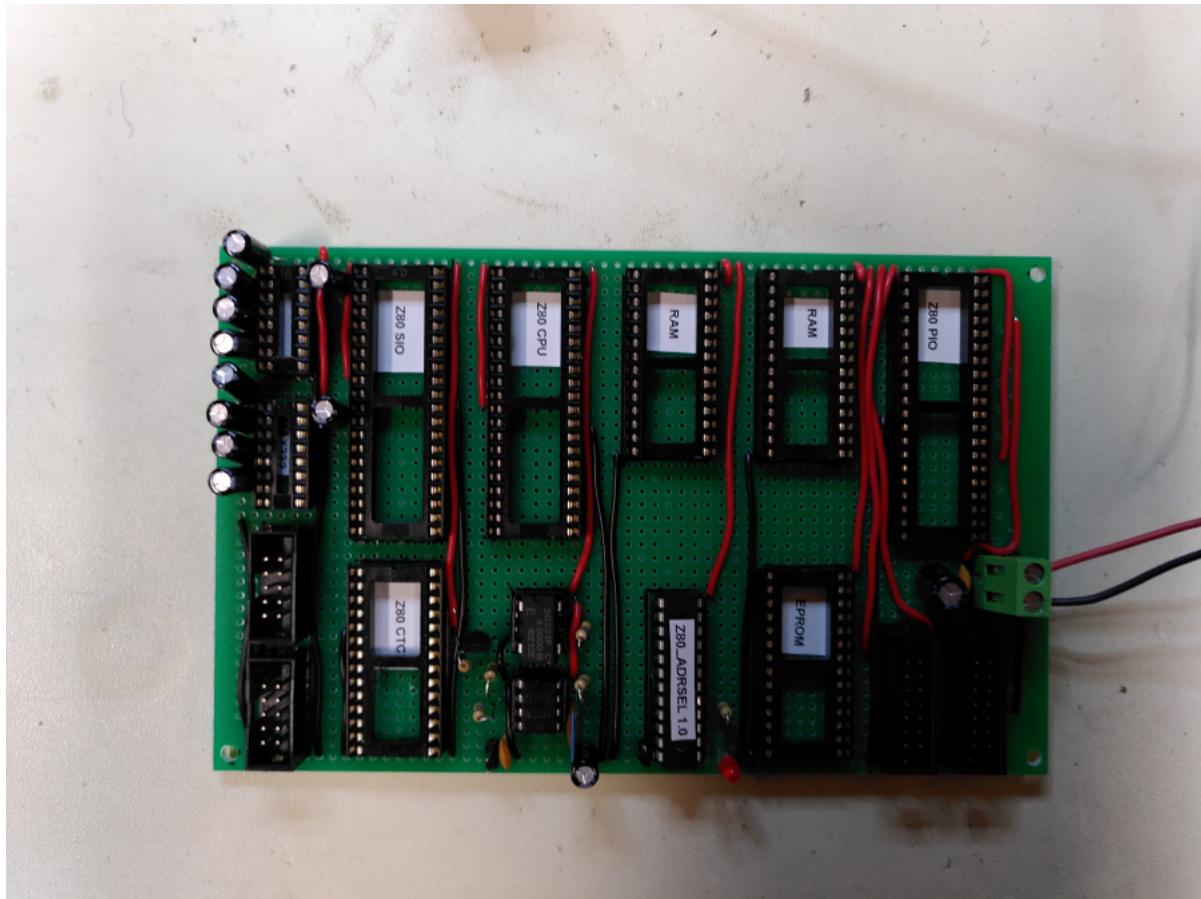
Board with power connections

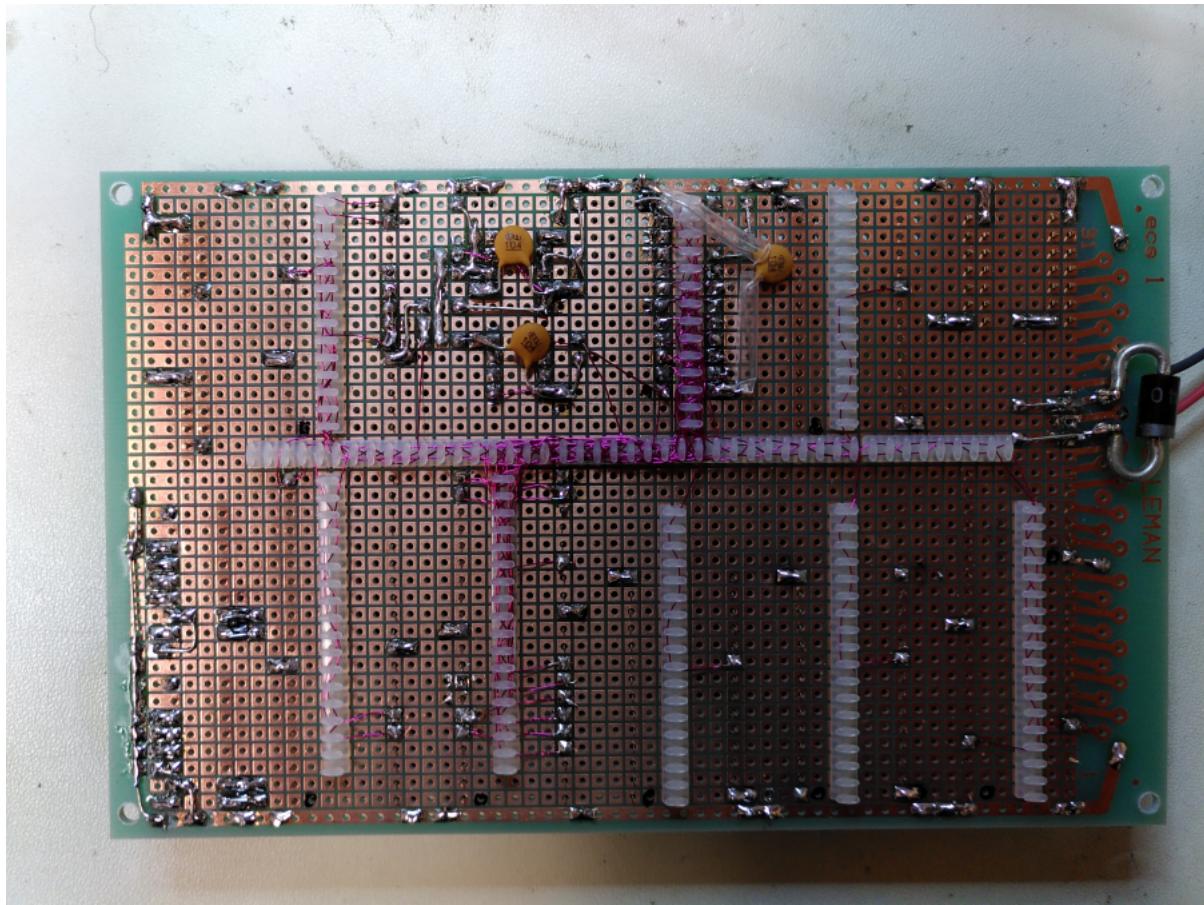




2021-05-10

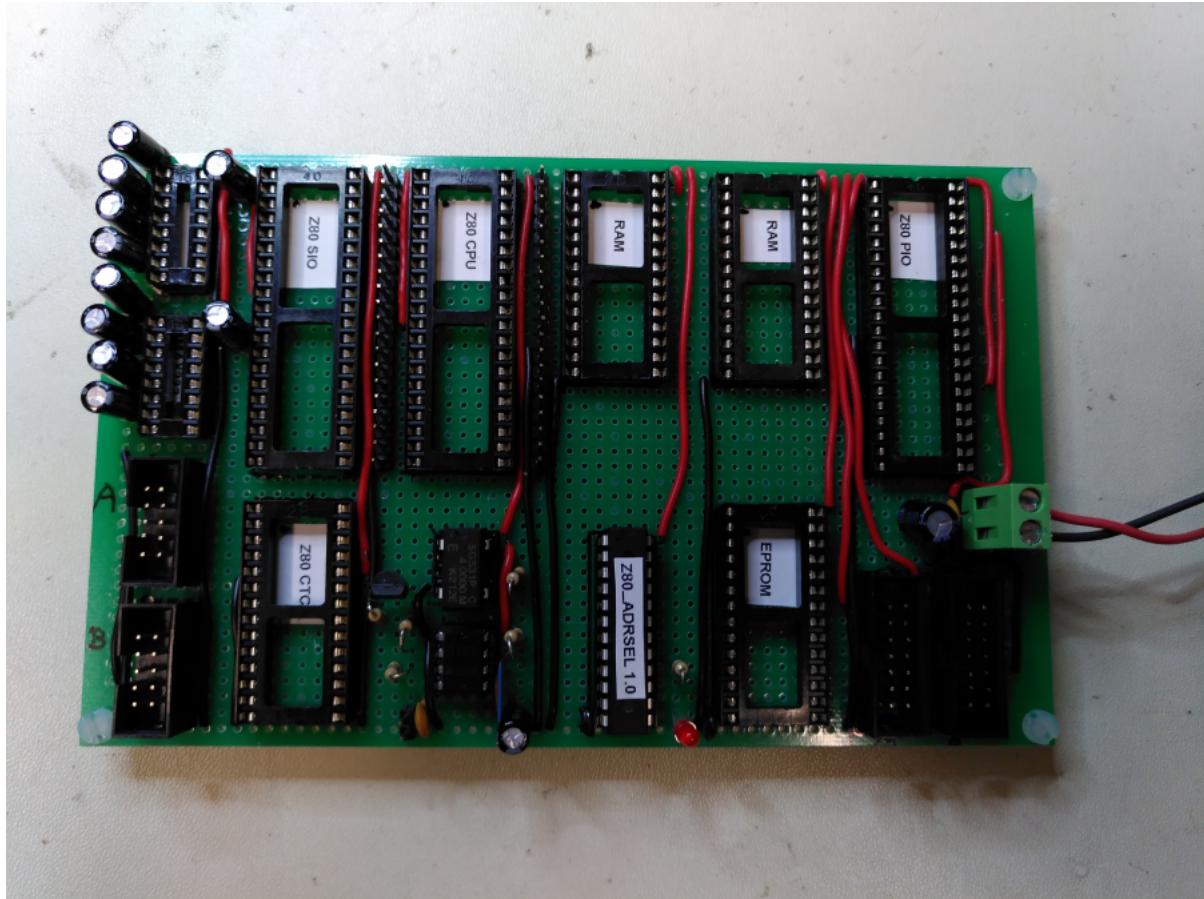
Board with clock and reset

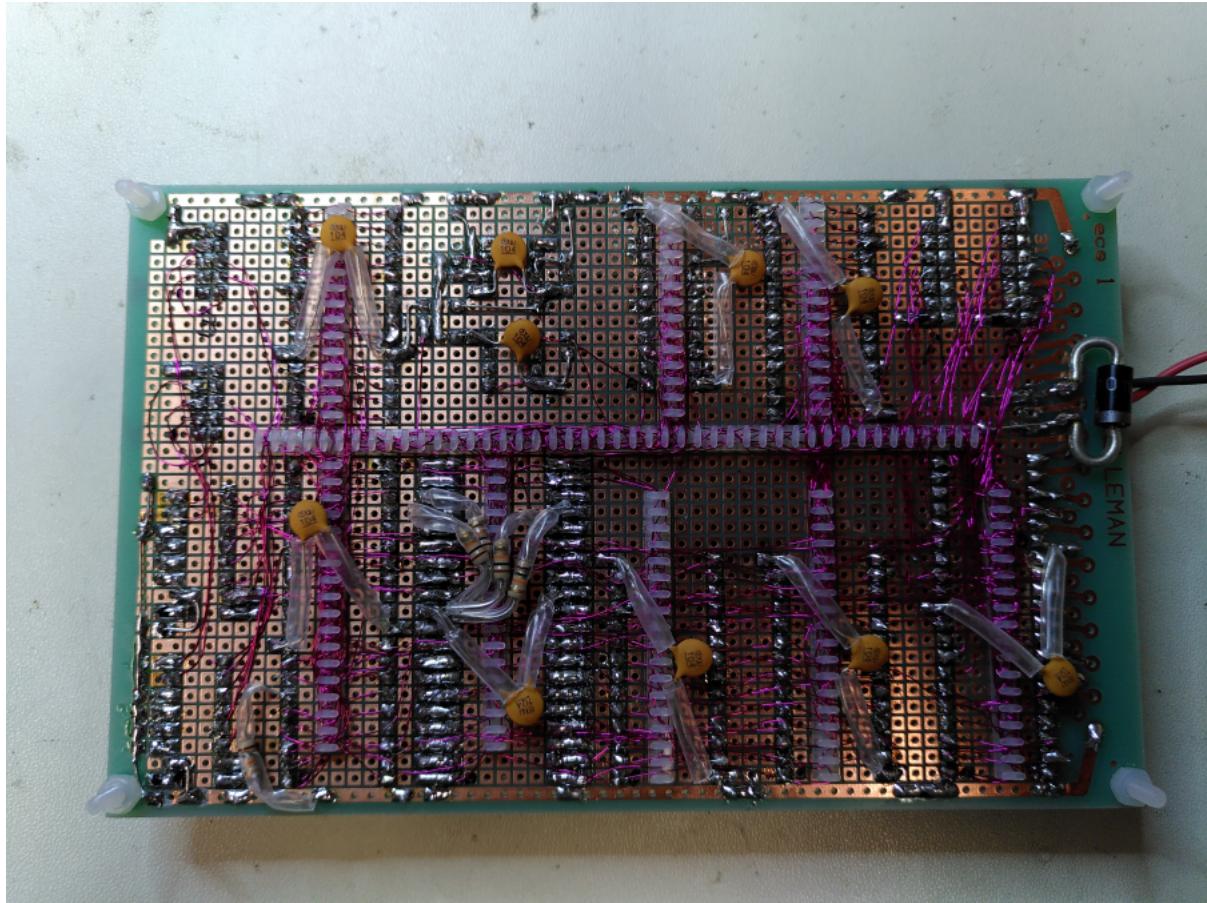




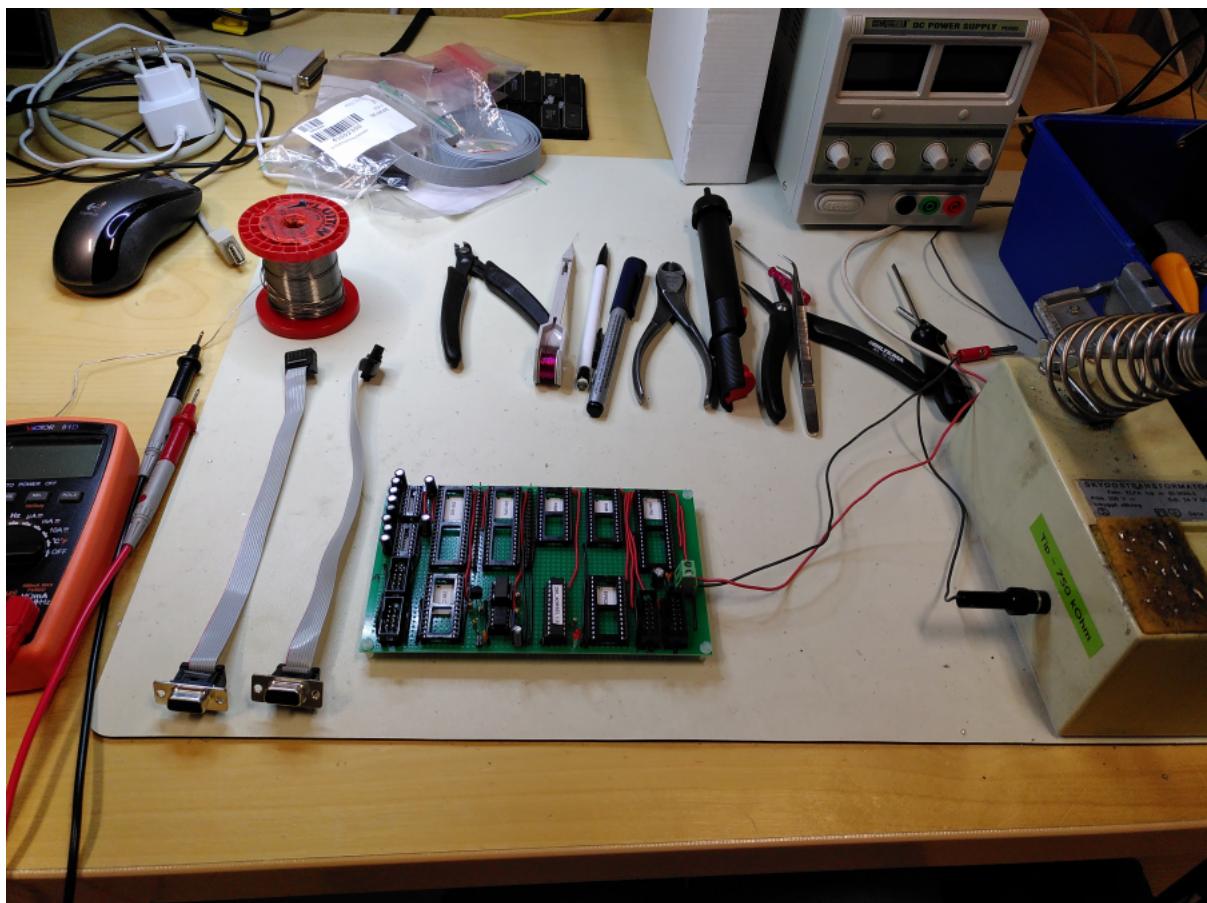
2021-05-16

Completed board





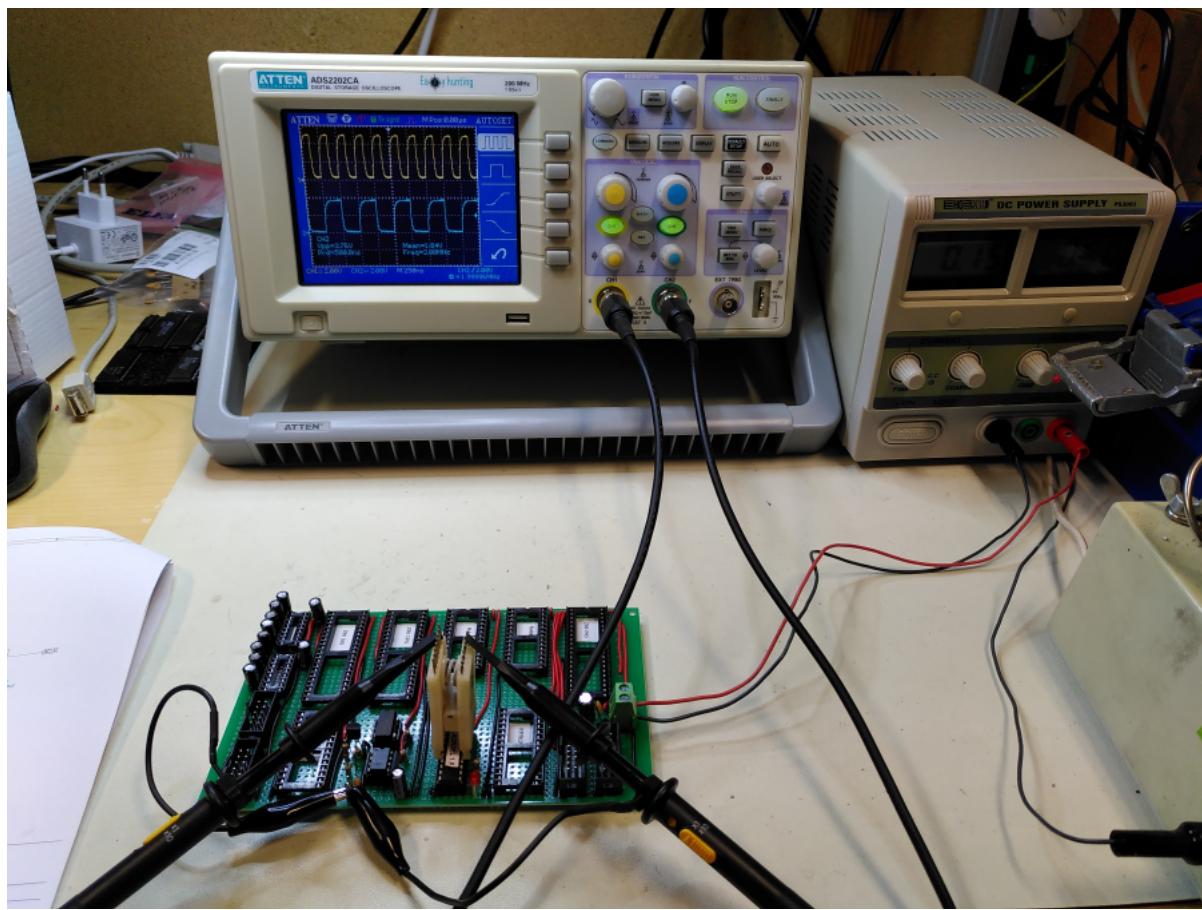
Completed board and tools



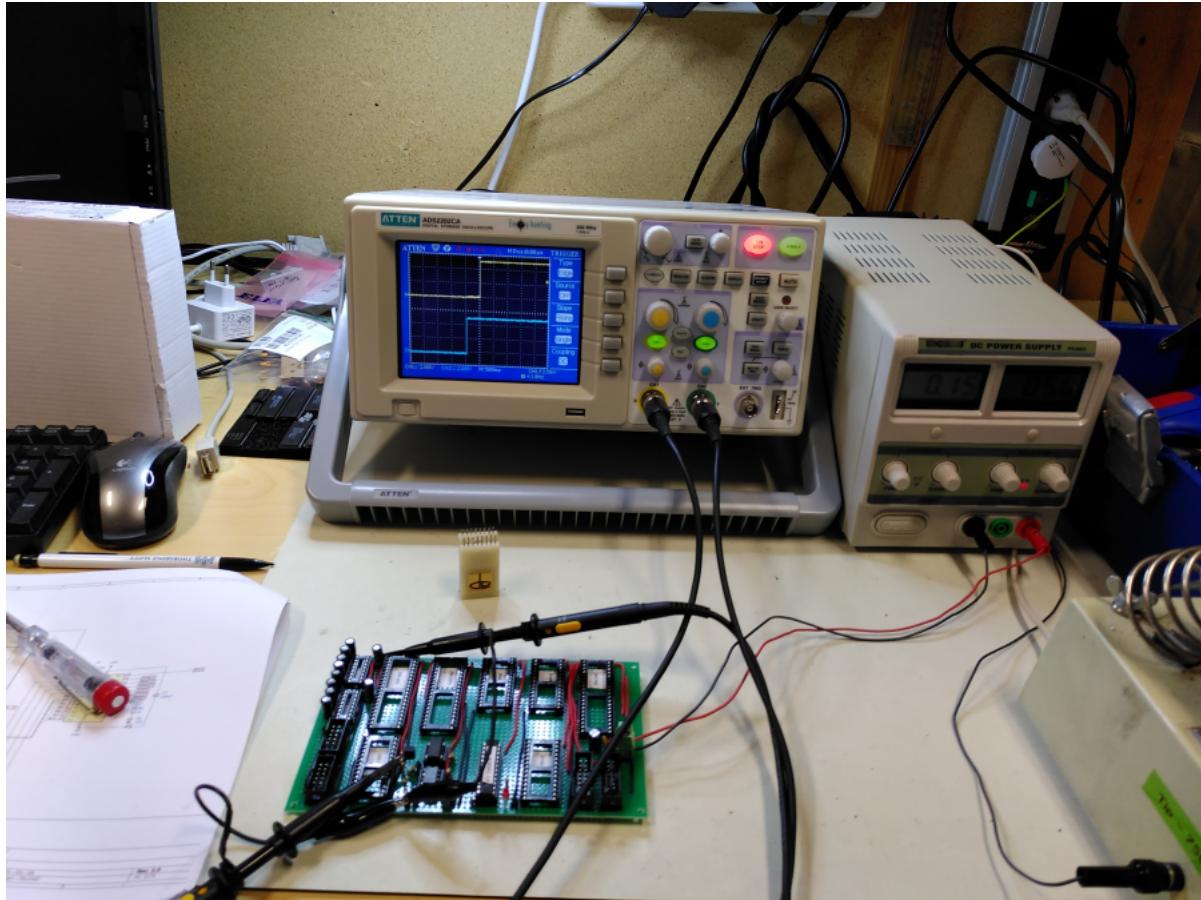
## Z80 computer signal measurements

2021-05-10

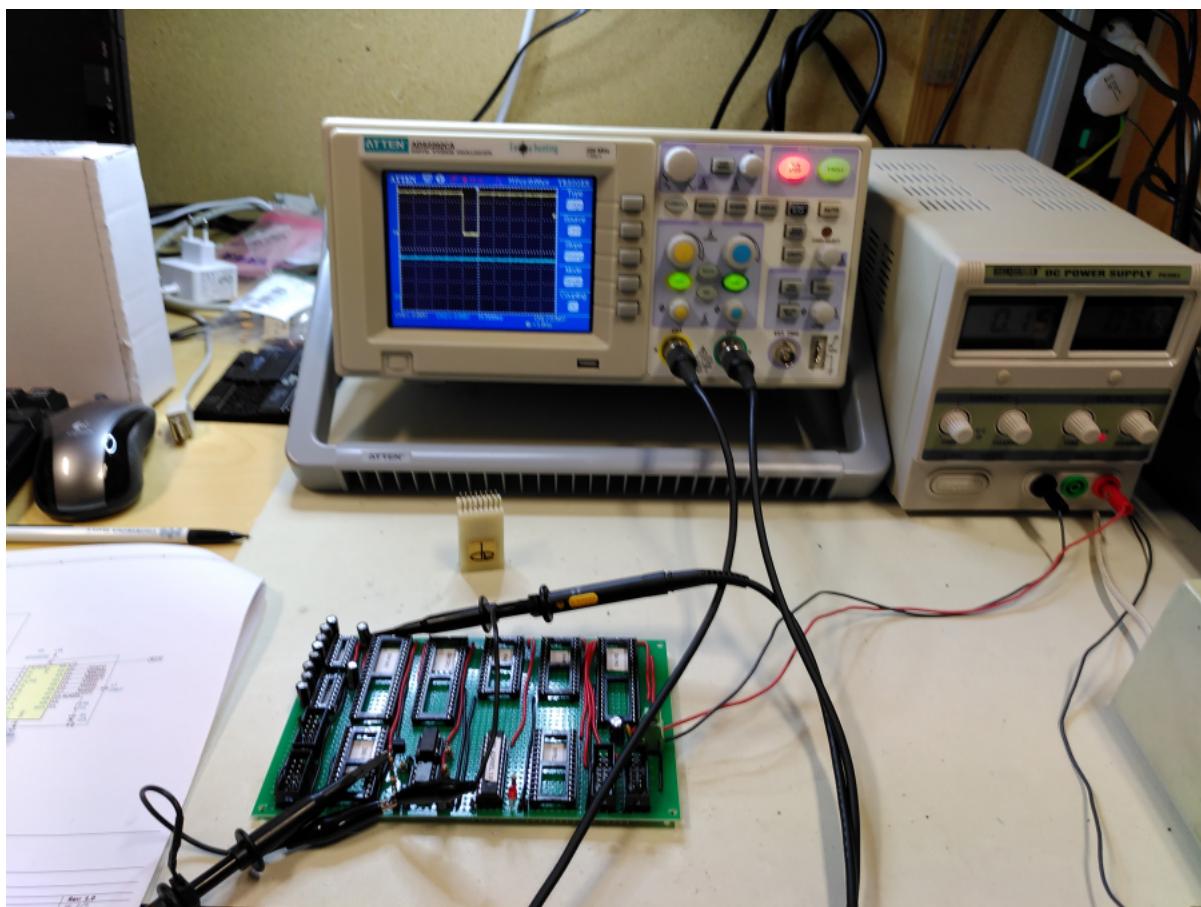
Clock signals, yellow: 4 MHz clock input, blue: 2 MHz clock input to CTC.



Power on reset signal: yellow: reset signal, blue: 5V power.



Manual reset signal: yellow: reset signal.



## ATF22V10C programmable logic for address selection

2021-04-30

Also handles clock divide.

## Z80\_ADRSEL.PLD

```

Name          Z80_ADRSEL;
Partno       U2;
Revision     1.0;
Date         2021-04-30;
Designer    hal;
Company      atHome;
Location     None;
Assembly    None;
Device       G22V10;

/*
 * Inputs: CPU clock, memory and io access signal and addresses
 */
Pin 1 = CLK;
Pin 2 = MREQ;
Pin 3 = IORQ;
Pin 4 = RD;
Pin 5 = WR;
Pin 6 = A2;
Pin 7 = A3;
Pin 8 = A4;
Pin 9 = A5;
Pin 10 = A6;
Pin 11 = A7;
Pin 13 = A15;

/* Outputs: Serial clock to CTC, io and memory enable
 */
Pin 23 = BCLK;
Pin 22 = ROMCE;
Pin 21 = RAMLCE;
Pin 20 = RAMHCE;
Pin 19 = SIOCE;
Pin 18 = CTCCE;
Pin 17 = PIOCE;
Pin 16 = MEMSEL;

/*
 * Logic
 */
/* Divide clock frequency by 2 to get serial clock */

BCLK.D = !BCLK;
BCLK.SP = 'b'0;
BCLK.AR = 'b'0;

/* Decode I/O addresses to select EPROM or RAM in lower 32KB memory */

ROMSEL = !IORQ & !WR & !A2 & !A3 & !A4 & !A5 & !A6 & !A7; /* Write to 0x00 - 0x03 selects EPROM */
RAMSEL = !IORQ & !WR & A2 & !A3 & !A4 & !A5 & !A6 & !A7; /* Write to 0x04 - 0x07 selects RAM */

MEMSEL.D = (MEMSEL & !ROMSEL) # RAMSEL;
MEMSEL.SP = 'b'0;
MEMSEL.AR = 'b'0;

/* Decode I/O chip addresses */

SIOCE = !(IORQ & !A2 & A3 & !A4 & !A5 & !A6 & !A7); /* Addresses 0x08 - 0x0b selects SIO */
CTCCE = !(IORQ & A2 & A3 & !A4 & !A5 & !A6 & !A7); /* Addresses 0x0c - 0x0f selects CTC */
PIOCE = !(IORQ & !A2 & !A3 & A4 & !A5 & !A6 & !A7); /* Addresses 0x10 - 0x13 selects PIO */

/* Decode memory addresses */

RAMHCE = !(MREQ & A15); /* High 32K RAM */
RAMLCE = !(MREQ & !A15 & MEMSEL); /* Low 32K RAM if selected */
ROMCE = !(MREQ & !A15 & !MEMSEL); /* Low 32K EPROM if selected */

```

Logic generated by WinCupl:

## Z80\_ADRSEL.DOC

```
*****
Z80_ADRSEL
*****  
  
CUPL(WM)      5.0a Serial# 60008009  
Device        g22v10 Library DLIB-h-40-1  
Created       Fri Apr 30 14:43:14 2021  
Name          Z80_ADRSEL  
Partno        U2  
Revision      1.0  
Date          2021-04-30  
Designer      hal  
Company       atHome  
Assembly      None  
Location      None  
  
===== Expanded Product Terms =====  
  
BCLK.d  =>  
    !BCLK  
  
BCLK.ar =>  
    0  
  
BCLK.sp  =>  
    0  
  
CTCCE =>  
    A2 & A3 & !A4 & !A5 & !A6 & !A7 & !IORQ  
  
MEMSEL.d  =>  
    IORQ & MEMSEL  
    # MEMSEL & WR  
    # A2 & MEMSEL  
    # A3 & MEMSEL  
    # A4 & MEMSEL  
    # A5 & MEMSEL  
    # A6 & MEMSEL  
    # A7 & MEMSEL  
    # A2 & !A3 & !A4 & !A5 & !A6 & !A7 & !IORQ & !WR  
  
MEMSEL.ar  =>  
    0  
  
MEMSEL.sp  =>  
    0  
  
PIOCE =>  
    !A2 & !A3 & A4 & !A5 & !A6 & !A7 & !IORQ  
  
RAMHCE =>  
    A15 & !MREQ  
  
RAMLCE =>  
    !A15 & MEMSEL & !MREQ  
  
RAMSEL =>  
    A2 & !A3 & !A4 & !A5 & !A6 & !A7 & !IORQ & !WR  
  
ROMCE =>  
    !A15 & !MEMSEL & !MREQ  
  
ROMSEL =>  
    !A2 & !A3 & !A4 & !A5 & !A6 & !A7 & !IORQ & !WR  
  
SIOCE =>  
    !A2 & A3 & !A4 & !A5 & !A6 & !A7 & !IORQ  
  
BCLK.oe  =>  
    1
```

```

CTCCE.oe =>
1

MEMSEL.oe =>
1

PIOCE.oe =>
1

RAMHCE.oe =>
1

RAMLCE.oe =>
1

ROMCE.oe =>
1

SIOCE.oe =>
1

```

?

Symbol Table

Pin Pol	Variable Name	Ext	Pin	Type	Pterms Used	Max Pterms	Min Level
A2			6	V	-	-	-
A3			7	V	-	-	-
A4			8	V	-	-	-
A5			9	V	-	-	-
A6			10	V	-	-	-
A7			11	V	-	-	-
A15			13	V	-	-	-
BCLK			23	V	-	-	-
BCLK	d		23	X	1	8	1
BCLK	ar		23	X	1	1	1
BCLK	sp		23	X	1	1	1
CLK			1	V	-	-	-
CTCCE			18	V	1	16	1
IORQ			3	V	-	-	-
MEMSEL			16	V	-	-	-
MEMSEL	d		16	X	9	12	1
MEMSEL	ar		16	X	1	1	1
MEMSEL	sp		16	X	1	1	1
MREQ			2	V	-	-	-
PIOCE			17	V	1	14	1
RAMHCE			20	V	1	14	1
RAMLCE			21	V	1	12	1
RAMSEL			0	I	1	-	-
RD			4	V	-	-	-
ROMCE			22	V	1	10	1
ROMSEL			0	I	1	-	-
SIOCE			19	V	1	16	1
WR			5	V	-	-	-
BCLK	oe		23	D	1	1	0
CTCCE	oe		18	D	1	1	0
MEMSEL	oe		16	D	1	1	0
PIOCE	oe		17	D	1	1	0
RAMHCE	oe		20	D	1	1	0
RAMLCE	oe		21	D	1	1	0
ROMCE	oe		22	D	1	1	0
SIOCE	oe		19	D	1	1	0

LEGEND    D : default variable    F : field    G : group  
           I : intermediate variable    N : node    M : extended node  
           U : undefined                   V : variable    X : extended variable  
           T : function

## Simulation of the address selection logic

2021-04-30

## Z80\_ADRSEL.SI

```
Name      Z80_ADRSEL;
PartNo   U2;
Date     2021-04-30;
Revision 1.0;
Designer hal;
Company  atHome;
Assembly None;
Location None;
Device   G22V10;
```

```
ORDER: CLK, BCLK, MREQ, IORQ, RD, WR, A2, A3, A4, A5, A6, A7, A15, ROMCE, RAMLCE, RAMHCE, SIOCE, CTCCE, PIOCE, MEMSEL;
```

### VECTORS:

```
0*111100000000*****
1*011100000000*****
0*011100000000*****
1*111100000000*****
0*111100000000*****
1*101110000000*****
0*101010000000*****
1*101010000000*****
0*111110000000*****
1*111110000000*****
0*011110000000*****
1*011110000000*****
0*111110000000*****
1*111110000000*****
0*111110000000*****
1*101110000000*****
0*101000000000*****
1*101000000000*****
0*111100000000*****
0*011110000000*****
1*011110000000*****
1*011110000000*****
1*111110000000*****
```

## Z80\_ADRSEL.SO

```
CSIM(WM): CUPL Simulation Program
Version 5.0a Serial#
Copyright (c) 1983, 1998 Logical Devices, Inc.
CREATED Fri Apr 30 14:43:25 2021
```

```
LISTING FOR SIMULATION FILE: Z80_ADRSEL.si
```

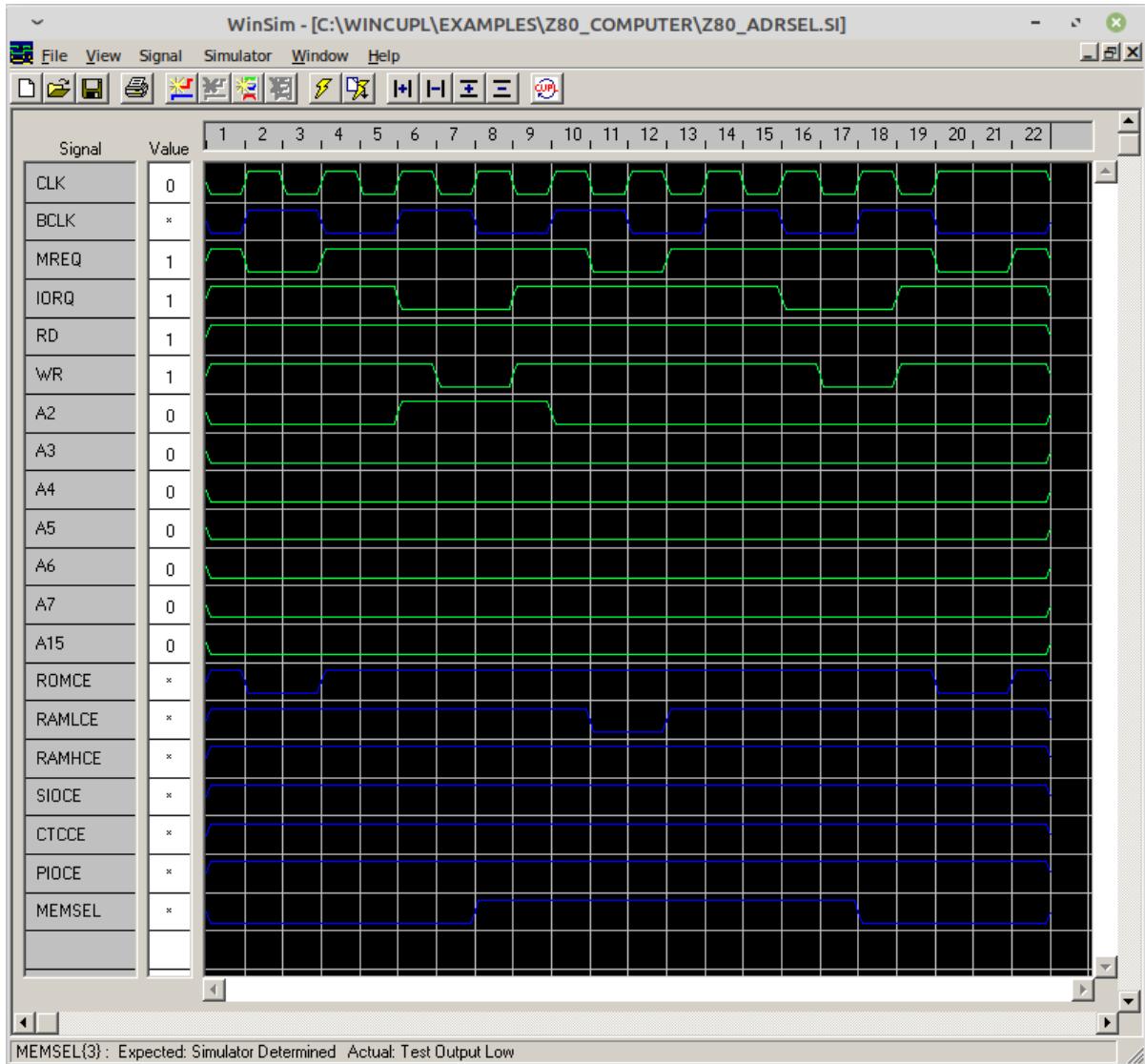
```
1: Name      Z80_ADRSEL;
2: PartNo   U2;
3: Date     2021-04-30;
4: Revision 1.0;
5: Designer hal;
6: Company  atHome;
7: Assembly None;
8: Location None;
9: Device   G22V10;
10:
11:
12: ORDER: CLK, BCLK, MREQ, IORQ, RD, WR, A2, A3, A4, A5, A6, A7, A15, ROMCE, RAMLCE, RAMHCE, SIOCE,
CTCCE, PIOCE, MEMSEL;
13:
14:
```

```
=====
          RR  M
          RAASCPE
          BMI    OMMITIM
          CCR0   AMLHOCOS
          LLERRWAAAAAA1CCCCCCE
          KKQQDR2345675EEEEEEEL
=====
0001: 0L11110000000HHHHHHHL
```

```

0002: 1H01110000000LHHHHHL
0003: 0H01110000000LHHHHHL
0004: 1L11110000000HHHHHHHL
0005: 0L11110000000HHHHHHHL
0006: 1H10111000000HHHHHHHL
0007: 0H10101000000HHHHHHHL
0008: 1L10101000000HHHHHHHH
0009: 0L11111000000HHHHHHHH
0010: 1H11110000000HHHHHHHH
0011: 0H01110000000HLHHHHH
0012: 1L01110000000HLHHHHH
0013: 0L11110000000HHHHHHHH
0014: 1H11110000000HHHHHHHH
0015: 0H11110000000HHHHHHHH
0016: 1L10110000000HHHHHHHH
0017: 0L10100000000HHHHHHHH
0018: 1H10100000000HHHHHHHL
0019: 0H11110000000HHHHHHHL
0020: 1L01110000000LHHHHHHL
0021: 1L01110000000LHHHHHHL
0022: 1L11110000000HHHHHHHL

```



## ATF22V10C programming

2021-04-30

Check the device:

```
hal@LinuxServer:/mnt/DiskStation_2/files/hal/Electronic_design/Z80_Computer/PLDdesigns/Z80_computer$
```

```
afterburner i -t ATF22V10C  
PES info: Atmel ATF22V10C VPP=10.0 Timing: prog=10 erase=25
```

### Program and verify the device

```
hal@LinuxServer:/mnt/DiskStation_2/files/hal/Electronic_design/Z80_Computer/PLDdesigns/Z80_computer$ afterburner w -f Z80_ADRSEL.jed -t ATF22V10C  
hal@LinuxServer:/mnt/DiskStation_2/files/hal/Electronic_design/Z80_Computer/PLDdesigns/Z80_computer$ afterburner v -f Z80_ADRSEL.jed -t ATF22V10C
```

(Needed to program a few times before verification was ok.)

## Read the device

# Z80 test programs

2021-05-21

# Z80 computer test programs

# **Thoughts and details about the Z80 computer**

## Power decoupling

2021-04-14

- [avkopplingskondensator ? - Svenska ElektronikForumet](https://elektronikforumet.com/forum/viewtopic.php?t=14967) (<https://elektronikforumet.com/forum/viewtopic.php?t=14967>)
- [hal@Perceval:/mnt/DiskStation\\_2/files/hal/Electronic\\_design/Power\\_decoupling/](mailto:hal@Perceval:/mnt/DiskStation_2/files/hal/Electronic_design/Power_decoupling/)

## Z80 Memory Timing

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- [Z80 and video chip contending for random access - Retrocomputing Stack Exchange](https://retrocomputing.stackexchange.com/questions/4846/z80-and-video-chip-contending-for-random-access) (<https://retrocomputing.stackexchange.com/questions/4846/z80-and-video-chip-contending-for-random-access>)

"at the next negative edge, the Z80 samples the WAIT line. If it isn't asserted, it reads the memory contents on the next positive edge after that, which is to say at the start of cycle T3, a full cycle and a half after it signaled the memory request. Perhaps not coincidentally, this is 375ns for a 4MHz Z80A."

- [Dynamic RAM Design and Interfacing](http://www.piclist.com/techref/mem/dram/oldinstead.html) (<http://www.piclist.com/techref/mem/dram/oldinstead.html>)

## Power on Reset

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2020-11-19

Using a NE555 (and a transistor to invert the reset signal) seems like a good idea.

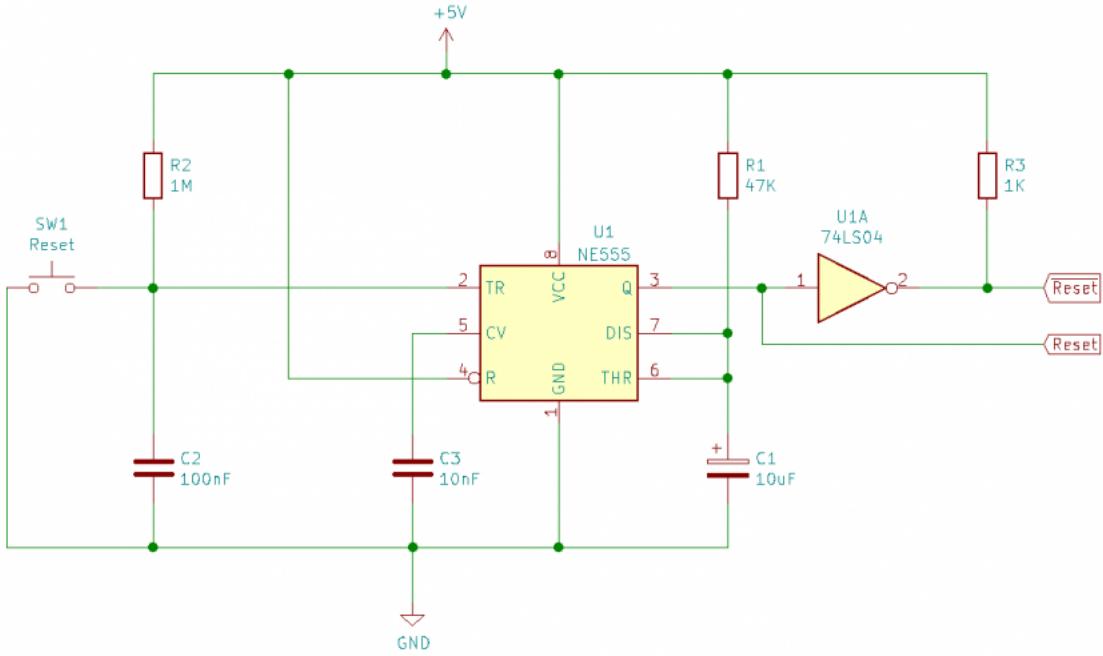
- [Silverlight Developer » Blog Archive NE555 Power on Reset - Silverlight Developer](https://blog.mark-stevens.co.uk/2020/01/ne555-power-on-reset/) (<https://blog.mark-stevens.co.uk/2020/01/ne555-power-on-reset/>)
- [Z80 Power-on reset circuits - Dr. Scott M. Baker](https://www.smbaker.com/z80-power-on-reset-circuits) (<https://www.smbaker.com/z80-power-on-reset-circuits>)
- [Why is the RESET pin set up like this in this Z80 schematic? - Electrical Engineering Stack Exchange](https://electronics.stackexchange.com/questions/420920/why-is-the-reset-pin-set-up-like-this-in-this-z80-schematic) (<https://electronics.stackexchange.com/questions/420920/why-is-the-reset-pin-set-up-like-this-in-this-z80-schematic>)

Reset & Watchdog

- [TPS3813 data sheet, product information and support | TI.com](https://www.ti.com/product/TPS3813) (<https://www.ti.com/product/TPS3813>)

2020-04-12

Reset circuit schematic



2021-07-26

The manual reset button does not reset the ATF22V10C, this has to be corrected as if reset is pressed while low RAM is selected, the EPROM start routines does not work. The registers in the Atmel ATF22V10Cs are designed to reset during power-up.

## Pull-up resistors

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2021-04-19

10k pull-up is proposed: [cpu - Z80, do I need a resistor for pins to Vcc? - Retrocomputing Stack Exchange \(https://retrocomputing.stackexchange.com/questions/18354/z80-do-i-need-a-resistor-for-pins-to-vcc\)](https://retrocomputing.stackexchange.com/questions/18354/z80-do-i-need-a-resistor-for-pins-to-vcc)

2021-05-26

A 10k pull-up to the /INT signal seems necessary and was added.

## Memory and I/O address decoding

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2021-04-13

- [Programming the memory and I/O address decoder PLD - Z80 Project with AVR system controller \(https://z80avrproject.wordpress.com/2016/10/20/programming-the-memory-and-io-address-decoder-pld/\)](https://z80avrproject.wordpress.com/2016/10/20/programming-the-memory-and-io-address-decoder-pld/)
- [Z80\\_Build\\_Circuits\\_Index\\_0 \(http://zed80.com/Z80-RETRO/Resources/Circuits/Z80\\_Circuits\\_Index\\_0.htm\)](http://zed80.com/Z80-RETRO/Resources/Circuits/Z80_Circuits_Index_0.htm)
- [linker3000/Z80-Board: Z80 computer wirewrapped on perfboard + Some game and utility programs \(https://github.com/linker3000/Z80-Board\)](https://github.com/linker3000/Z80-Board)

2021-04-14

The ATF22V10 is used to:

- Divide CLK/2 to get BCLK for CTC to drive baudrate for SIO
  - Clock divider /2, Gal22v10B and wincupl - Page 1 (<https://www.eevblog.com/forum/microcontrollers/clock-divider-2-gal22v10b-and-wincupl/>)
  - embedded - Making a Simple 2-Bit Asynchronous counter in WinCupl - Stack Overflow (<https://stackoverflow.com/questions/2991701/making-a-simple-2-bit-a-synchronous-counter-in-wincupl>)
- Decode RAM and EPROM address
  - The EPROM and first RAM is switched by writing to one I/O address for using RAM and another I/O address for using EPROM in the lower 32MB of the memory.
  - At power-on EPROM is selected
  - according to: 22v10.pdf (<http://www.da.isy.liu.se/vanheden/pdf/22v10.pdf>): "All flip-flops power up to a logic LOW for predictable system initialization."
  - this is valid for PALCE22V10, should be tested for ATF22V10C
- Decode I/O addresses
  - There are two special I/O addresses for switching RAM and EPROM (see above)
  - If it is not possible to make a memory selection signal with 22v10 the PIO could be used to select type of memory in the lower 32K. The reset state of the PIO outputs is high impedance, a pull-up resistor could be used to select EPROM at start-up.
  - This method was not used, instead the PLD decodes I/O writes to select EPROM or RAM.

## Test PLD programming

2021-04-15

## Clock frequency divider

2021-04-15

Test programmer and IC:

```
hal@LinuxServer:~/Z80_computer$ afterburner i -t ATF22V10C
PES info: Atmel ATF22V10C VPP=10.0 Timing: prog=10 erase=25
```

Compile the logic with WinCupl.

### CLOCK\_DIVIDER.PLD

```
Name          clock_divider;
Partno       U;
Revision     01;
Date         2021-04-14;
Designer    hal;
Company     atHome;
Location    None;
Assembly   None;
Device      g22v10;

/*****************************************/
```

```

/*
 *      Clock divider (and address decoder)
 */
/*
 ****
 */

/*
 * Inputs: define inputs
 */
Pin 1 = clk;

/*
 * Outputs: define outputs
 */
Pin 23 = bclk;

/*
 * Logic: create flip-flop
 */
bclk.d = !bclk;           /* divider */

```

Two warnings were given:

```

[0016cb] Please note: no expression assigned to: bclk.ar
[0016cb] Please note: no expression assigned to: bclk.sp

```

By clicking on the warning message the following information is shown:

```

Code: 0016cb  Level: Warning
Message: no expression assigned to: "variable"
Description: The variable requires an output expression assignment. This warning message is commonly
given when all outputs in a bank have the same capability (reset, preset, and so on) and not all the
variables have been assigned the same expression. It is given to remind the user that all outputs will be
affected.
Information: This warning may be suppressed by assigning the variable to 'b'0 or 'b'1 as appropriate.

```

Program and verify the JEDEC file on the IC.

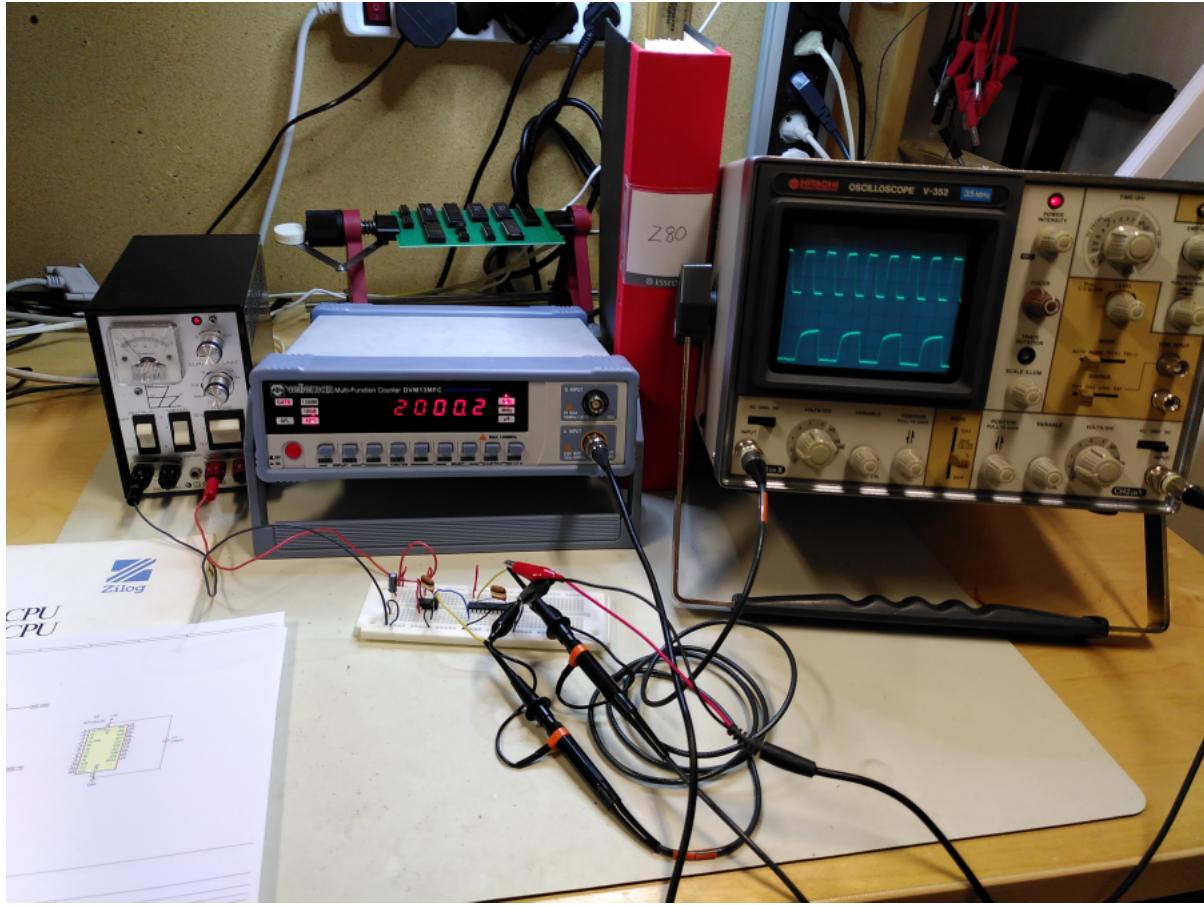
```

hal@LinuxServer:~/Z80_computer$ afterburner w -f clock_divider.jed -t ATF22V10C
hal@LinuxServer:~/Z80_computer$ afterburner v -f clock_divider.jed -t ATF22V10C
hal@LinuxServer:~/Z80_computer$

```

No output from commands means that all is ok.

Test output frequency and waveform:



Erase IC after test:

```
hal@LinuxServer:~/Z80_computer$ afterburner e -t ATF22V10C
```

2021-04-25

Simulate the clock divider with WinSim

clock\_divider.si

```
Name      clock_divider;
PartNo   U;
Date     2021-04-14;
Revision 01;
Designer hal;
Company  atHome;
Assembly None;
Location None;
Device   g22v10;
```

```
ORDER: clk, bclk;
```

VECTORS:

```
0*
1*
0*
1*
0*
1*
0*
1*
0*
1*
```

## CLOCK\_DIVIDER.sim

```
%SIGNAL
PIN 23 = bclk
PIN 1 = clk
%END

%FIELD
%END

%EQUATION
bclk.d =>
bclk

bclk.oe =>
1

%END
```

## CLOCK\_DIVIDER.so

```
CSIM(WM): CUPL Simulation Program
Version 5.0a Serial#
Copyright (c) 1983, 1998 Logical Devices, Inc.
CREATED Sun Apr 25 16:29:53 2021
```

LISTING FOR SIMULATION FILE: clock\_divider.si

```
1: Name      clock_divider;
2: PartNo   U;
3: Date     2021-04-14;
4: Revision 01;
5: Designer hal;
6: Company  atHome;
7: Assembly None;
8: Location None;
9: Device   g22v10;
10:
11:
12: ORDER: clk, bclk;
13:
14:
```

```
=====
b
cc
ll
kk
=====
```

```
0001: 0L
0002: 1H
0003: 0H
0004: 1L
0005: 0L
0006: 1H
0007: 0H
0008: 1L
0009: 0L
0010: 1H
```

## Serial I/O & baud-rate generator

2021-04-13

- LM80C: Z80 SIO and serial communication – LEONARDOMILIANI.com (<https://www.leonardomiliani.com/en/2019/lm80c-z80-sio-e-comunicazione-seriale/>)
- linker3000/Z80-Board: Z80 computer wirewrapped on perfboard + Some game and utility programs (<https://github.com/linker3000/Z80-Board>)

- [LM80C: Z80 CTC and interrupts – LEONARDOMILIANI.com \(https://www.leonardomiliani.com/en/2019/english-lm80c-z80-ctc-and-interrupts/\)](https://www.leonardomiliani.com/en/2019/english-lm80c-z80-ctc-and-interrupts/)
- [How to program the z80 CTC | Manualzz \(https://manualzz.com/doc/14618543/how-to-program-the-z80-ctc\)](https://manualzz.com/doc/14618543/how-to-program-the-z80-ctc)

Using the CTC with internal prescaler will not work as the prescaler uses only divide by 16 or 256 which will not give the right serial rate. The Tc input frequency to the CTC must not be higher than half the clock frequency.

The Tx/Rx clock input to the SIO must at least be 16 times the baud-rate.

Example with 4MHz xtal oscillator and 9600 baud:  $4000000/(9600*2*16) = 13.0208$  Using a CTC divider of 13 this will give a baud-rate of  $4000000/(2*16*13) = 9615$  baud which hopefully is close enough. If this is not exact enough, another xtal oscillator must be selected. This one would work: [SG-531P 3.6864MC:ROHS EPSON | Kristaller, oscillatorer, resonatorer | DigiKey \(https://www.digikey.se/product-detail/sv/epson/SG-531P-3-6864MC-ROHS/SER1223-ND/1021916\)](https://www.digikey.se/product-detail/sv/epson/SG-531P-3-6864MC-ROHS/SER1223-ND/1021916).

2021-04-16

The following signals are connected for each serial channel:

- Rx - SIO RXD
- Tx - SIO TXD
- RTS - SIO RTS
- CTS - SIO CTS
- DTR and DSR are connected in the external contact

Serial connector IDC to DB9

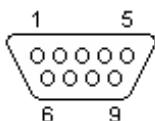
- [Assembling Serial IDC to DB9 Cable \(https://developer.toradex.com/knowledge-base/assembling-serial-idc-to-db9-cable\)](https://developer.toradex.com/knowledge-base/assembling-serial-idc-to-db9-cable)

Serial pinout, female D-sub, to work with straight cable from 9-pin D-sub in PC. The PC is DTE and the Z80 computer is DCE.

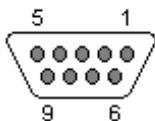
## Serial (PC 9)

Also known as EIA/TIA 574.

### Pinout



9 PIN DE-9 MALE at the Computer.

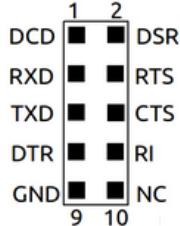


9 PIN DE-9 FEMALE at the Cable.

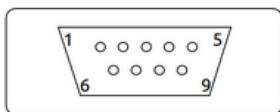
Pin	Name	RS232	V.24	Dir	Description
1	(D)CD	CF	109	←	(Data) Carrier Detect
2	RXD	BB	104	←	Receive Data
3	TXD	BA	103	→	Transmit Data
4	DTR	CD	108.2	→	Data Terminal Ready
5	GND	AB	102	—	System Ground
6	DSR	CC	107	←	Data Set Ready
7	RTS	CA	105	→	Request to Send
8	CTS	CB	106	←	Clear to Send
9	RI	CE	125	←	Ring Indicator

#### Notes:

- Direction is DTE (Computer) relative DCE (Modem).
- RS232 column is RS232 circuit name.
- V.24 column is ITU-TSS V.24 circuit name.



IDC pinout



PIN	SIGNAL
1	DCD
2	RXD
3	TXD
4	DTR
5	GND
6	DSR
7	RTS
8	CTS
9	RI

DB9 pinout

## Parallel port

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2021-05-22

If the PIO is configured in Output Mode (Mode 0) and connecting the Ready line to the Strobe line, a strobe with a duration of one clock period is generated with no other logic required.

## Floppy Disk Controller

---

2021-02-13

TODO maybe.

How may this be implemented?

- Using old PC ISA board? (I have three FD/HD controller boards, on where the ICs are socketed so it may be used as a component source)
  - I have one ISA board (DT-3767) with IDE and FD interface, the FDC IC is SMC37C65B
  - According to the reference below: Western Digital WD37C65, SMC FDC37C65, or GoldStar GM82C765B floppy disk controllers are equivalent.
- New controller design with FDC IC?
- ...?

References:

- [ISA Floppy Disk and Serial Controller - Malinov Family Web Presence](http://www.malinov.com/Home/sergeys-projects/isa-fdc-and-uart) (<http://www.malinov.com/Home/sergeys-projects/isa-fdc-and-uart>)
- [Zeta SBC V2 - Malinov Family Web Presence](http://www.malinov.com/Home/sergey-s-projects/zeta-sbc-v2) (<http://www.malinov.com/Home/sergey-s-projects/zeta-sbc-v2>)

- [DT-3767 \(https://arvutimuuseum.ee/th99/c/C-D/20330.htm\)](https://arvutimuuseum.ee/th99/c/C-D/20330.htm)
- [Francis' home page - 1.44MB floppy disk controller project \(http://www.g-photo.net/projects/wd\\_fdc/wd\\_fdc.htm\)](http://www.g-photo.net/projects/wd_fdc/wd_fdc.htm)
- [Industry Standard Architecture - Wikipedia \(https://en.wikipedia.org/wiki/Industry\\_Standard\\_Architecture#ISA\\_bus\\_architecture\)](https://en.wikipedia.org/wiki/Industry_Standard_Architecture#ISA_bus_architecture)
- [WD37C65C datasheet \(https://datasheetspdf.com/pdf-file/503579/WesternDigital/WD37C65C/1\)](https://datasheetspdf.com/pdf-file/503579/WesternDigital/WD37C65C/1)
- [Programming the NEC µPD765 and Intel 82072/7 Floppy Disk Controller \(https://www.isdaman.com/alsos/hardware/fdc/floppy.htm\)](http://www.isdaman.com/alsos/hardware/fdc/floppy.htm)
- [floppy\\_drives deramp.com \(https://deramp.com/downloads/floppy\\_drives/\)](https://deramp.com/downloads/floppy_drives/)

## Hard Disk ATA controller

---

2021-02-13

TODO maybe.

How may this be implemented?

- Using old PC ISA board DT-3767?
- New design?
- [Parallel ATA - Wikipedia \(https://en.wikipedia.org/wiki/Parallel\\_ATA#IDE\\_and\\_ATA-1\)](https://en.wikipedia.org/wiki/Parallel_ATA#IDE_and_ATA-1)
- [WD1003-WA2 Hard Disk/Floppy Controller Settings and Configuration \(https://stason.org/TULARC/pc/hard-disk-floppy-controllers/U-Z/WESTERN-DIGITAL-CORPORATION-Two-ST506-412-MFM-devi.html\)](https://stason.org/TULARC/pc/hard-disk-floppy-controllers/U-Z/WESTERN-DIGITAL-CORPORATION-Two-ST506-412-MFM-devi.html)

Since the original ATA interface is essentially just a 16-bit ISA bus in disguise, the bridge was especially simple in case of an ATA connector being located on an ISA interface card. The integrated controller presented the drive to the host computer as an array of 512-byte blocks with a relatively simple command interface. This relieved the mainboard and interface cards in the host computer of the chores of stepping the disk head arm, moving the head arm in and out.

References:

- [DT-3767 \(https://arvutimuuseum.ee/th99/c/C-D/20330.htm\)](https://arvutimuuseum.ee/th99/c/C-D/20330.htm)
- [arvutimuuseum.ee/th99/c/c16ide\\_t.htm \(https://arvutimuuseum.ee/th99/c/c16ide\\_t.htm\)](https://arvutimuuseum.ee/th99/c/c16ide_t.htm)
- [WD1003-WA2 Hard Disk/Floppy Controller Settings and Configuration \(https://stason.org/TULARC/pc/hard-disk-floppy-controllers/U-Z/WESTERN-DIGITAL-CORPORATION-Two-ST506-412-MFM-devi.html\)](https://stason.org/TULARC/pc/hard-disk-floppy-controllers/U-Z/WESTERN-DIGITAL-CORPORATION-Two-ST506-412-MFM-devi.html)
- [mame/hdc92x4.cpp at master · mamedev/mame \(https://github.com/mamedev/mame/blob/master/src/devices/machine/hdc92x4.cpp\)](https://github.com/mamedev/mame/blob/master/src/devices/machine/hdc92x4.cpp)
- [cosam.org - ATA/IDE Interface \(http://www.cosam.org/projects/z80/ata.html\)](http://www.cosam.org/projects/z80/ata.html)
- [An 8-bit IDE interface @ RetroLem \(http://blog.retrolem.co.uk/electronics-articles/an-8-bit-ide-interface/\)](http://blog.retrolem.co.uk/electronics-articles/an-8-bit-ide-interface/)
- [Francis' home page - IDE interface project \(http://www.g-photo.net/projects/ide/ide.htm\)](http://www.g-photo.net/projects/ide/ide.htm)
- <http://blog.retrolem.co.uk/electronics-articles/an-8-bit-ide-interface/>

# SD Card interface

---

2021-08-18

TODO maybe.

Why not do a SD card interface? Z180 has an interface usable for SPI:  
[Z180\\_Computer#CSI.2FO\\_based\\_SPI\\_.28or\\_i2c.29\\_interface\\_to\\_SD\\_card](#)

- [SPI SD Card Interface for Z80 Systems \(https://www.ecstaticlyrics.com/electronics/SPI/fast\\_z80\\_interface.html\)](#)
- [Micro SD card module using shift registers \(https://groups.google.com/g/rc2014-z80/c/A5lvM31saQo\)](#)
- [A bit disappointed in the Z80 SPI speed | oldduino \(https://oldduino.wordpress.com/2016/05/17/a-bit-disappointed-in-the-z80-spi-speed/\)](#)
- [Eric's Projects - Z-80 SPI \(https://sites.google.com/view/erics-projects/z-80-projects-page/z-80-spi\)](#)
- [Introduction to Bit Banging: SPI communication in Arduino via Bit Banging \(https://circuitdigest.com/article/introduction-to-bit-banging-spi-communication-in-arduino-via-bit-banging\)](#)
- [electricimp/SoftwareSPI: Bit Bang SPI library \(https://github.com/electricimp/SoftwareSPI\)](#)
- [RetroBrew Computers Forum: General Discussion » Z80 SPI fast SD \(https://www.retrobrewcomputers.org/forum/index.php?t=msg&th=581&goto=8520&\)](#)
- [An SPI Master Controller Interface Demo using a Cyclone IV FPGA \(http://s100computers.com/My%20System%20Pages/FPGA%20Board%20V2/V2\\_FPGA\\_CIRCUITS/SPI\\_Master\\_2/SPI\\_Master\\_2.htm\)](#)
- [Overview of Linux kernel SPI support — The Linux Kernel documentation \(https://www.kernel.org/doc/html/latest/spi/spi-summary.html\)](#)
- [Z-One, a Z80 based CP/M machine with SD card storage \(http://www.nomad.ee/micros/z-one/index.shtml\)](#)
- [Micro SD Card Interfacing Tutorial - HandsOn Tech \(https://handsontec.com/index.php/micro-sd-card-interfacing-tutorial/\)](#)
- [In-Depth Tutorial to Interface Micro SD Card Module with Arduino \(https://lastminuteengineers.com/arduino-micro-sd-card-module-tutorial/\)](#)
- [AZDelivery 3 x SPI Reader Micro Storage SD TF Card Memory Card Shield Module Kompatibel med Arduino inklusive e-bok!: Amazon.se: Industrial \(https://www.amazon.se/AZDelivery-Storage-Kompatibel-Arduino-inklusive/dp/B077MCQS9P/ref=asc\\_df\\_B077MCQS9P/?tag=shpngadsglede-21&linkCode=df0&hvadid=476555136704&hvpos=&hvnetw=g&hvrand=771615078225805494&hvpone=&hvptwo=&hvqmt=&hvdev=c&hvdvcndl=&hvlocint=&hvlocphy=9062332&hvtargid=pla-666709036717&psc=1\)](#)
- [How to Use MMC/SDC \(http://elm-chan.org/docs/mmc/mmc\\_e.html\)](#)
- [Robot\\_Control/SdCard.h at master · arduino-libraries/Robot\\_Control \(https://github.com/arduino-libraries/Robot\\_Control/blob/master/src/SdCard.h\)](#)

Why not a SD card with WiFi?

- [Guide to the Best WiFi Enabled SD Memory Card 2020 \(https://nerdtechy.com/best-wifi-sd-card\)](#)

- [32GB ez Share WiFi SDHC Class 10 - Köp på 24.se](https://www.24.se/-minneskort/minneskort/secure-digital-sdsdhcsdxc/32gb-ez-share-wifi-sdhc-class-10) (<https://www.24.se/-minneskort/minneskort/secure-digital-sdsdhcsdxc/32gb-ez-share-wifi-sdhc-class-10>)
- [ez Share Apps User Manual\\_V2.0\\_EN.pdf](https://awesome.nwgat.ninja/ezshare/e%20Share%20Apps%20User%20Manual_V2.0_EN.pdf) ([https://awesome.nwgat.ninja/ezshare/e%20Share%20Apps%20User%20Manual\\_V2.0\\_EN.pdf](https://awesome.nwgat.ninja/ezshare/e%20Share%20Apps%20User%20Manual_V2.0_EN.pdf))
- [Cdrox Micro TF Converter Wifi SD Card Adapter High Quality Camera Photos Wireless Transmit Replacement for Canon](https://www.amazon.se/Cdrox-Converter-Wireless-Transmit-Replacement/dp/B08HD2X3XV/ref=sr_1_1?dchild=1&keywords=sd+card+wifi&qid=1613309299&sr=8-1): Amazon.se: Electronics ([https://www.amazon.se/Cdrox-Converter-Wireless-Transmit-Replacement/dp/B08HD2X3XV/ref=sr\\_1\\_1?dchild=1&keywords=sd+card+wifi&qid=1613309299&sr=8-1](https://www.amazon.se/Cdrox-Converter-Wireless-Transmit-Replacement/dp/B08HD2X3XV/ref=sr_1_1?dchild=1&keywords=sd+card+wifi&qid=1613309299&sr=8-1))
- [LANMU Micro SD till SD-kort förlängningskabel TF minneskort adapter förlängare konverterare för SD/RS-MMC/SDHC/MMC/bil GPS/mini 3D skrivare](https://www.amazon.se/LANMU-f%C3%B6rl%C3%A4ngningskabel-minneskort-f%C3%B6rl%C3%A4ngare-konverterare-f%C3%B6r-SD/RS-MMC/SDHC/MMC/bil-GPS/mini-3D-skriware): Amazon.se: Electronics ([https://www.amazon.se/LANMU-f%C3%B6rl%C3%A4ngningskabel-minneskort-f%C3%B6rl%C3%A4ngare-konverterare/dp/B01C84YKVA/ref=sr\\_1\\_2?dchild=1&keywords=microsd+to+sd+adapter&qid=1613309609&sr=8-2](https://www.amazon.se/LANMU-f%C3%B6rl%C3%A4ngningskabel-minneskort-f%C3%B6rl%C3%A4ngare-konverterare/dp/B01C84YKVA/ref=sr_1_2?dchild=1&keywords=microsd+to+sd+adapter&qid=1613309609&sr=8-2))

Maybe a Compact Flash disk?

- [Z80 8-bit Compact Flash Card Interface | Z80 Computer Project](https://z80project.wordpress.com/2015/07/06/z80-8-bit-compact-flash-card-interface-part-1/) (<https://z80project.wordpress.com/2015/07/06/z80-8-bit-compact-flash-card-interface-part-1/>)
- [8-bit compact flash interface](http://www.waveguide.se/?article=8-bit-compact-flash-interface) « waveguide.se (<http://www.waveguide.se/?article=8-bit-compact-flash-interface>)

AVR and USB

- [Weeks 11-12: AVR USB Devices and Programming](http://fab.cba.mit.edu/classes/863.14/people/andrew_mao/week11/) ([http://fab.cba.mit.edu/classes/863.14/people/andrew\\_mao/week11/](http://fab.cba.mit.edu/classes/863.14/people/andrew_mao/week11/))
- [V-USB - A Firmware-Only USB Driver for Atmel AVR Microcontrollers](http://www.obdev.at/products/vusb/index.html) ([https://www.obdev.at/products/vusb/index.html](http://www.obdev.at/products/vusb/index.html))

## Logic Device Programming

PLD/GAL could be good for logic around the CPU and peripherals.

PAL/GAL Programming

## KiCAD as EDA tool for Z80 computer design

Electronic schematic and PCB design software

Tutorials on KiCAD: [KiCad 5 Tutorial - YouTube](https://www.youtube.com/playlist?list=PL3by7evD3F51fKkyrUbH-PCdwPCWc9F8a) (<https://www.youtube.com/playlist?list=PL3by7evD3F51fKkyrUbH-PCdwPCWc9F8a>)

2020-11-21

Installed on Perceval (Acer laptop) and LinuxServer:

- [Acer\\_Laptop#Install\\_KiCad](#) (as the old system crashed this installation does not exist any longer).
- [LinuxServer\\_-\\_Linux\\_Mint\\_Server#KiCad\\_EDA](#)

Some Z80 schematic symbols are available in the distribution, more are available in:

- [flypie/Z80-CPU-for-KiCAD: Z80 & Z180 CPU for KiCAD DIP/DIL/PLCC/QFP \(https://github.com/flypie/Z80-CPU-for-KiCAD\)](https://github.com/flypie/Z80-CPU-for-KiCAD)
- [How to get a downloaded symbol, footprint or full library into KiCad version 5? - FAQ - KiCad.info Forums \(https://forum.kicad.info/t/how-to-get-a-downloaded-symbol-footprint-or-full-library-into-kicad-version-5/19485\)](https://forum.kicad.info/t/how-to-get-a-downloaded-symbol-footprint-or-full-library-into-kicad-version-5/19485)

2021-01-17

Get started with Z80 computer design using KiCAD

Installed KiCAD again on Perceval  
[Electronic\\_schematic\\_and\\_PCB\\_design\\_software#KiCad\\_installation\\_on\\_Perceval\\_Linux\\_Mint](#).

Started KiCAD and created project /home/hal/KiCAD/Z80\_computer/Z80\_computer.pro

Opened Eeschema and placed Z80CPU and Z80PIO.

Cloned other Z80 family symbols:

```
hal@Perceval:~/sourcecode$ git clone https://github.com/flypie/Z80-CPU-for-KiCAD.git
Cloning into 'Z80-CPU-for-KiCAD'...
remote: Enumerating objects: 142, done.
remote: Total 142 (delta 0), reused 0 (delta 0), pack-reused 142
Receiving objects: 100% (142/142), 153.48 KiB | 734.00 KiB/s, done.
Resolving deltas: 100% (94/94), done.
```

In Eeschema open Symbol Editor, File -> Add Library, open ~/sourcecode/Z80-CPU-for-KiCAD/Zilog\_Z80\_Peripherals.lib This will import several Z80 peripherals.

2021-03-28

In Eeschema open Symbol Editor, File -> Add Library, open ~/sourcecode/Z80-CPU-for-KiCAD/Zilog\_Z80.lib

Opened Eeschema and placed Z80SIO0.

Later moved this library to ~/KiCAD/symbols/Z80

2021-04-08

Downloaded from: [Memory\\_RAM \(https://kicad.github.io/symbols/Memory\\_RAM\)](https://kicad.github.io/symbols/Memory_RAM) Rename to Memory\_SRAM otherwise name conflict. Put in ~/KiCAD/symbols/Memory\_RAM

In Eeschema open Symbol Editor, File -> Add Library, open ~/KiCAD/symbols/Memory\_RAM/Memory\_SRAM.lib

2021-04-09

Made symbol for BS62LV256 based on KM62256CLP in Memory\_SRAM lib.

Made symbol for ATF22V10C and put in ATF lib, based on GAL16V8 in Logic\_Programmable lib.

2021-04-20

When trying to create a BOM an error message was given. It seems that the KiCAD BOM scripts are using "python" instead of "python3".

Installed Python-is-python3 with Software Manager.

Now the BOM scripts work.

# Z80 Software

## Z80 Monitor and OS

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- Retro Software :: Z80 monitor, OS and utilities

2021-02-14

- Porting CP/M to a new computer (<http://cpuville.com/Code/CPM-on-a-new-computer.html>)

## Handling Z80 MMU / overlays

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2021-02-13

Should the Z80 computer implement a simple MMU? There is support in the GNU linker for this:

- Using LD, the GNU linker - Overlays ([https://ftp.gnu.org/old-gnu/Manuals/ld-2.9.1/html\\_node/ld\\_22.html](https://ftp.gnu.org/old-gnu/Manuals/ld-2.9.1/html_node/ld_22.html))

## Other Z80 Programs

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Updated 2021-05-27

- Build a Clang-LLVM Z80 Compiler
- Home · z88dk/z88dk Wiki (<https://github.com/z88dk/z88dk/wiki>)
  - library:interrupts [z88dk] (<https://www.z88dk.org/wiki/doku.php?id=library:interrupts>)
- R.T. Russell's Z80 BBC Basic is now open source (<http://cowlark.com/2019-06-14-bbcbasic-opensource/index.html>)
  - GitHub - sehugg/zmac: zmac z80 assembler (<https://github.com/sehugg/zmac>)
  - zmac - Z-80 Macro Cross Assembler (<http://48k.ca/zmac.html>)
- Retro Software :: CP/M Programs
- Math - z80 Heaven (<http://z80-heaven.wikidot.com/math>)

## Memory mapping for Z80 (and other 16 bit address CPUs)

2021-06-16

Using a 74LS670 to expand the 16 bit address to an 18 bit address with the logical page size of 16 kB.

4-by-4 Register Files With 3-State Outputs datasheet - sn54ls670.pdf ([https://www.ti.com/lit/ds/symlink/sn54ls670.pdf?ts=1623832555462&ref\\_url=https%253A%252F%252Fwww.google.com%252F](https://www.ti.com/lit/ds/symlink/sn54ls670.pdf?ts=1623832555462&ref_url=https%253A%252F%252Fwww.google.com%252F)).

The IC is available at Svebry: 74LS670 (<https://www.svebry.se/product/74ls670>).

## Z80 References

2021-08-28

- Full Z80 Opcode List Including Undocumented Opcodes (<http://mdfs.net/Docs/Comp/Z80/OpList>)

## Links to Z80 Projects

Updated 2021-08-18

- Retro Z80 computer with CP/M-80 (<http://www.stuartball.com/retroz80/RetroZ80.html>)
- Porting CP/M to a new computer (<http://cpuville.com/Code/CPM-on-a-new-computer.html>)
- Yet Another Z180 Project (YAZ180) | feilipu (<https://feilipu.me/2016/05/23/another-z80-project/>)
- RC2014 - Homebrew Z80 Computer (<https://rc2014.co.uk/>)
- RC2014Z80/RC2014: Official RC2014 repository for hardware schematics / software and more! (<https://github.com/RC2014Z80/RC2014>)
- Lumir Vanek - RC2014 (<http://www.valachnet.cz/lvanek/diy/rc2014/index.html>) thorough descriptions of building a Z80 based computer. Also contains test program for DMA
- How to Build a Z80 Computer, Part 1: The CPU | PIC | Maker Pro (<https://maker.pro/pic/projects/z80-computer-project-part-1-the-cpu>)
- How to Build a Z80 Computer, Part 2: Memory | PIC | Maker Pro (<https://maker.pro/pic/projects/build-your-own-z80-computer-project-part-2-memory>)
- How to Build a Z80 Computer, Part 3: EEPROM Programmer | PIC | Maker Pro (<https://maker.pro/pic/projects/z80-project-part-3-eeprom-programmer>)
- Build a Z80 Computer, Part 4: IO & Coding Your First Program | PIC | Maker Pro (<https://maker.pro/pic/projects/z80-project-part-4-basic-io-and-writing-your-first-program>)
- Teensy Z80 - Part 1 - Intro, Memory, Serial I/O and Display | "Domipheus Labs" (<http://labs.domipheus.com/blog/teensy-z80-part-1-intro-memory-serial-io-and-display/>)
- Harte Technologies: CP/M-80 Information and Download Page (<http://www.cpm80.com/>)
- S100 Computers -Z80 CPU Board (<http://www.s100computers.com/My%20System%20Pages/Z80%20Board/Z80%20CPU%20Board.htm>)
- Z180 Memory Management (<http://www.ganssle.com/articles/ammu.htm>)
- One Week Wonder: Z180 MMU-tiny (<http://oneweekwonder.blogspot.com/2017/12/z180-mmum-tiny.html>)

- [Z80 C code development with Eclipse and z88dk | feilipu \(https://feilipu.me/2016/09/16/z80-c-code-development-with-eclipse-and-z88dk/\)](https://feilipu.me/2016/09/16/z80-c-code-development-with-eclipse-and-z88dk/)
- [A homebrew Z80 microcomputer - Wenzel Jakob, May 2003 \(https://www.mitsuba-rendrer.org/~wenzel/z80/index.html\)](https://www.mitsuba-rendrer.org/~wenzel/z80/index.html)
- [Build Your Own Z80 Computer: Design Guidelines and Application Notes - Steve Ciarcia - Google Böcker \(https://books.google.se/books/about/Build\\_Your\\_Own\\_Z80\\_Computer.html?id=mVQnFgWzX0AC&redir\\_esc=y\)](https://books.google.se/books/about/Build_Your_Own_Z80_Computer.html?id=mVQnFgWzX0AC&redir_esc=y)
- [5V Logic on a Z80 Retrocomputer | Details | Hackaday.io \(https://hackaday.io/project/167522-5v-logic-on-a-z80-retrocomputer/details\)](https://hackaday.io/project/167522-5v-logic-on-a-z80-retrocomputer/details)
- [reZet80/reZet80-DEV: reZet80 DEV - a development system for the low-level Z80 retro enthusiast \(https://github.com/reZet80/reZet80-DEV\)](https://github.com/reZet80/reZet80-DEV)
- [builderpages:plasmo:riz180:riz180r1 \[RetroBrew Computers Wiki\] \(https://www.retrobrewcomputers.org/doku.php?id=builderpages:plasmo:riz180:riz180r1\)](https://www.retrobrewcomputers.org/doku.php?id=builderpages:plasmo:riz180:riz180r1)
- [Z80 Explorer - Baltazar Studios \(https://baltazarstudios.com/z80explorer/\)](https://baltazarstudios.com/z80explorer/)
- [Zilog Z-80 DIY | Facebook \(https://www.facebook.com/groups/546186508918605/permalink/1571987366338509/\)](https://www.facebook.com/groups/546186508918605/permalink/1571987366338509/)
- [ZAP Z80 Alternative Memories - Page 1 \(https://www.eevblog.com/forum/projects/zap-z80-alternative-memories/\)](https://www.eevblog.com/forum/projects/zap-z80-alternative-memories/)
- [A tiny Z80 based computer \(http://www.vaxman.de/projects/tiny\\_z80/\)](http://www.vaxman.de/projects/tiny_z80/)
- [dekuNukem/FAP80: A Z80 retro computer without the retro baggage \(https://github.com/dekuNukem/FAP80\)](https://github.com/dekuNukem/FAP80)
- [reZet80 \(https://reZet80.blogspot.com/\)](https://reZet80.blogspot.com/)
- [Zalt/Under Construction/IDE v0.2 at master · obianjacobi/Zalt · GitHub \(https://github.com/obianjacobi/Zalt/tree/master/Under%20Construction/IDE%20v0.2\)](https://github.com/obianjacobi/Zalt/tree/master/Under%20Construction/IDE%20v0.2)
- [Building CERBERUS 2080, my dream childhood computer - YouTube \(https://m.youtube.com/playlist?list=PLDf2ukIC\\_d2DAXmF9XuOq-uNc2M9ITd\)](https://m.youtube.com/playlist?list=PLDf2ukIC_d2DAXmF9XuOq-uNc2M9ITd)
- [Homebrew Z80 Computer \(Part 5\) - L Break Into Program \(http://www.breakintoprogram.co.uk/projects/homebrew-z80/homebrew-z80-computer-part-5\)](http://www.breakintoprogram.co.uk/projects/homebrew-z80/homebrew-z80-computer-part-5)
- [Casio MX-10 Future Upgrade - Retro Depot \(http://retrodepot.net/?p=12593\)](http://retrodepot.net/?p=12593)
- [Downloads - Retro Depot \(https://retrodepot.net/?page\\_id=510\)](https://retrodepot.net/?page_id=510)
- [reZet80: Welcome to reZet80! \(https://reZet80.blogspot.com/2020/05/welcome-to-reZet80.html\)](https://reZet80.blogspot.com/2020/05/welcome-to-reZet80.html)
- [linker3000/Z80-Board: Z80 computer wirewrapped on perfboard + Some game and utility programs \(https://github.com/linker3000/Z80-Board\)](https://github.com/linker3000/Z80-Board)
- [ZED80\\_Index\\_SBC \(http://zed80.com/Z80-RETRO/index\\_Home.html\)](http://zed80.com/Z80-RETRO/index_Home.html)
- [CERBERUS 2080™ | The Byte Attic™ \(https://www.thebyteattic.com/p/cerberus-2080.html\)](https://www.thebyteattic.com/p/cerberus-2080.html)
- [Build a Z80 Computer from Scratch - YouTube \(https://www.youtube.com/playlist?app=desktop&list=PL-\\_ysBkGwx4rkhgj6vFoWrfl70GmK11n\)](https://www.youtube.com/playlist?app=desktop&list=PL-_ysBkGwx4rkhgj6vFoWrfl70GmK11n)
- [FTP between host and guest | FreeDOS images for VirtualBox \(https://www.lazybrowndog.net/freedos/virtualbox/?page\\_id=157\)](https://www.lazybrowndog.net/freedos/virtualbox/?page_id=157)
- [Cyber-Necromancy \(https://retro.zen-room.org/morrow-micronix\)](https://retro.zen-room.org/morrow-micronix)
- [Cyber-Necromancy - Whitesmith's C \(https://retro.zen-room.org/morrow-micronix/writesmiths-c\)](https://retro.zen-room.org/morrow-micronix/writesmiths-c)
- [cm68/micronix: Morrow Designs Micronix and tools \(https://github.com/cm68/micronix\)](https://github.com/cm68/micronix)
- [GitHub - ntate6630/SC126\\_to\\_MPFI1B\\_Project: MPF-1B add-on for the SC126 \(http](https://ntate6630/SC126_to_MPFI1B_Project)

s://github.com/ntate6630/SC126\_to\_MPFI1B\_Project)

- MatthewWCook/Z80Project: Z80 Computer Project (<https://github.com/MatthewWCook/Z80Project>)
- joelang/z80-sbc: Z80 single board computer with CP/M 2.2 (<https://github.com/joelang/z80-sbc>)
- Designing the RhoCoCo Retro Home COlor COnputer hardware - RevSpace ([https://revspace.nl/Designing\\_the\\_RhoCoCo\\_Retro\\_Home\\_COlor\\_COnputer\\_hardware](https://revspace.nl/Designing_the_RhoCoCo_Retro_Home_COlor_COnputer_hardware))
- Project Gibson (<https://www.trashworldnews.com/project-gibson/>)

## Z80 related components

### The following components are/will be available

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- 1x Z80-CPU (40 pin DIL) Zilog Z80-CPU 2.5MHz [Zilog Z80 microprocessor family \(ht  
tps://www.cpu-world.com/CPUs/Z80/MANUF-Zilog.html\)](https://www.cpu-world.com/CPUs/Z80/MANUF-Zilog.html)
- 1x Z80A SIO/0 (40 pin DIL) Zilog Z-80A SIO/0 / 8440W 0A 4MHz [Support/peripheral  
/other chips - Z80 family \(https://www.cpu-world.com/Support/Z80.html\)](https://www.cpu-world.com/Support/Z80.html)
- 1x Z80A-CTC (28 pin DIL) Zilog Z80A-CTC 4MHz [Support/peripheral/other chips -  
Z80 family \(https://www.cpu-world.com/Support/Z80.html\)](https://www.cpu-world.com/Support/Z80.html)
- 6x Z80A SIO-0 (40 pin DIL) SGS Z8440AB1 / Z80ASIO-0 4MHz [Support/peripheral  
/other chips - Z80 family \(https://www.cpu-world.com/Support/Z80.html\)](https://www.cpu-world.com/Support/Z80.html)
- 6x Z80-PIO (40 pin DIL) Mostek MK3881N-4 4MHz [Support/peripheral/other chips -  
Z80 family \(https://www.cpu-world.com/Support/Z80.html\)](https://www.cpu-world.com/Support/Z80.html)
- 6x Z80A CTC (28 pin DIL) Zilog Z8430A PS / Z80A CTC 4 MHz [Support/peripheral  
/other chips - Z80 family \(https://www.cpu-world.com/Support/Z80.html\)](https://www.cpu-world.com/Support/Z80.html)
- 6x Z80A DMA (40 pin DIL) SGS Z8410AB1 / Z80ADMA 4 MHz [Support/peripheral  
/other chips - Z80 family \(https://www.cpu-world.com/Support/Z80.html\)](https://www.cpu-world.com/Support/Z80.html)
- 2x Z180 (68 pin PLCC) Zilog Z8018010VSC / Z180 MPU 10MHz [Zilog Z8018010VSC  
\(https://www.cpu-world.com/CPUs/Z180/Zilog-Z8018010VSC.html\)](https://www.cpu-world.com/CPUs/Z180/Zilog-Z8018010VSC.html)
- 1x 64B180 (Z180)(64 pin DIL with adapter board) Hitachi HD64180ROP 8MHz?  
[Hitachi HD64180RP8 \(https://www.cpu-world.com/CPUs/Z180/Hitachi-HD64180RP8.  
html\)](https://www.cpu-world.com/CPUs/Z180/Hitachi-HD64180RP8.html)

### EPROM:

- 2x M27C2001-10F1 (32 pin DIL) ST M27C2001 100nS [M27C2001 Datasheet pdf - 2  
MBIT \(256KB X8\) UV EPROM AND OTP ROM - SGS Thomson Microelectronics \(http://  
www.datasheetcatalog.com/datasheets\\_pdf/M/2/7/C/M27C2001.shtml\)](http://www.datasheetcatalog.com/datasheets_pdf/M/2/7/C/M27C2001.shtml)
- 6x M27C256B-12F1 (28 pin DIL) ST M27C256 120nS [M27C256B.pdf \(http://pdf.data  
sheetcatalog.com/datasheet/stmicroelectronics/2384.pdf\)](http://pdf.datasheetcatalog.com/datasheet/stmicroelectronics/2384.pdf)
- 12x 27C64-15 (28 pin DIL) SGS 27C64 150nS [27C64 datasheet - 27C64.PDF \(http://  
pdf.datasheetcatalog.com/datasheet/nationalsemiconductor/DS010331.PDF\)](http://pdf.datasheetcatalog.com/datasheet/nationalsemiconductor/DS010331.PDF)

### SRAM:

- 2x BS62LV1024PC-70 (32 pin DIL) BSI BS62LV1024PC-70 70nS [BS62LV1024  
datasheet \(https://datasheetspdf.com/pdf-file/123572/BrillianceSemiconductor/BS6  
2LV1024/1\)](https://datasheetspdf.com/pdf-file/123572/BrillianceSemiconductor/BS6<br/>2LV1024/1)

- 12x BS62LV256PC-70 (28 pin DIL) BSI BS62LV256PC-70 70nS BS62LV256-2.6 - BS62LV256SIP55-Brilliance-Semiconductor-datasheet-11474061.pdf (<https://datasheet.octopart.com/BS62LV256SIP55-Brilliance-Semiconductor-datasheet-11474061.pdf>)

Z80 CPU to buy, sockets etc:

- Inbyggda - mikroprocessorer | Integrerade kretsar (ICs) | DigiKey (<https://www.digikey.se/products/sv/integrated-circuits-ics/embedded-microprocessors/694?k=zilog%20z80>)

Other components:

- Crystal oscillator SG-615\_531\_E187.pdf - SG-531P\_en.pdf ([https://support.epson.biz/td/api/doc\\_check.php?dl=brief\\_SG-531P&lang=en](https://support.epson.biz/td/api/doc_check.php?dl=brief_SG-531P&lang=en))
- Timer for power on reset: LM555 LM555 Timer datasheet (Rev. D) - lm555.pdf (<https://www.ti.com/lit/ds/symlink/lm555.pdf>)

## Components ordered from DigiKey

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Ordered 2020-11-12, received 2020-11-17.

- Z80: 10x Z84C0010PEG Zilog | Integrerade kretsar (ICs) | DigiKey (<https://www.digikey.se/product-detail/sv/Z84C0010PEG/269-3898-ND/929206/?itemSeq=344728659>)
- 10 MHz Crystal oscillator: 1x SG-531P 10.0000MC:ROHS EPSON | Kristaller, oscillatorer, resonatorer | DigiKey (<https://www.digikey.se/product-detail/sv/SG-531P+10.0000MC%3aROHS/SER1208-ND/1021904/?itemSeq=344732078>)
- 4 MHz Crystal oscillator: 3x SG-531P 4.0000MC: ROHS EPSON | Kristaller, oscillatorer, resonatorer | DigiKey (<https://www.digikey.se/product-detail/sv/SG-531P+4.0000MC%3a+ROHS/SER1203-ND/1021899/?itemSeq=345018179>)
- MAX232 RS-232 Transciever: 6x MAX232N Texas Instruments | Integrerade kretsar (ICs) | DigiKey (<https://www.digikey.se/product-detail/sv/texas-instruments/MAX232N/296-1402-5-ND/277048>)
- 40pin DIP socket: 20x A 40-LC-TR Assmann WSW Components | Kontaktdon | DigiKey (<https://www.digikey.se/product-detail/sv/assmann-wsw-components/A-40-LC-TR/AE10010-ND/821764>)
- 32pin DIP socket: 10x A 32-LC-TR Assmann WSW Components | Kontaktdon | DigiKey (<https://www.digikey.se/product-detail/sv/A+32-LC-TR/123-A32-LC-TR-ND/821761/?itemSeq=345018521>)
- 28pin DIP socket: 20x A 28-LC-TR Assmann WSW Components | Kontaktdon | DigiKey (<https://www.digikey.se/product-detail/sv/A+28-LC-TR/AE10006-ND/821760/?itemSeq=345018474>)
- 68 (4 x 17) Positioner PLCC Uttag Tenn Genomgående hål: 3x PLCC-68-AT Adam Tech | Kontaktdon | DigiKey (<https://www.digikey.se/product-detail/sv/adam-tech/PLCC-68-AT/2057-PLCC-68-AT-ND/9833042>)
- 22V10 PLDer (programmerbar logikenhet) IC 10 Makroceller 24-PDIP: 6x ATF22V10C-15PU Microchip Technology | Integrerade kretsar (ICs) | DigiKey (<https://www.digikey.se/product-detail/sv/microchip-technology/ATF22V10C-15PU/ATF22V10C-15PU-ND/1008580>)

- 14 (2 x 7) Positioner DIP, 0,3" (7,62mm) radavstånd Uttag Tenn Genomgående hål: 10x A 14-LC-TT Assmann WSW Components | Kontaktdon | DigiKey (<https://www.digikey.se/products/sv?keywords=A%2014-LC-TT>)
- 16 (2 x 8) Positioner DIP, 0,3" (7,62mm) radavstånd Uttag Tenn Genomgående hål: 10x A 16-LC-TT Assmann WSW Components | Kontaktdon | DigiKey (<https://www.digikey.se/products/sv?keywords=A%2016-LC-TT>)
- 20 (2 x 10) Positioner DIP, 0,3" (7,62mm) radavstånd Uttag Tenn Genomgående hål: 10x A 20-LC-TT Assmann WSW Components | Kontaktdon | DigiKey (<https://www.digikey.se/product-detail/sv/A+20-LC-TT/AE9998-ND/821752/?itemSeq=345022521>)
- 24 (2 x 12) Positioner DIP, 0,3" (7,62mm) radavstånd Uttag Tenn Genomgående hål: 10x A 24-LC/7-T Assmann WSW Components | Kontaktdon | DigiKey (<https://www.digikey.se/product-detail/sv/A+24-LC%2f7-T/AE10285-ND/1628667/?itemSeq=345023229>)
- 8 (2 x 4) Positioner DIP, 0,3" (7,62mm) radavstånd Uttag Tenn Genomgående hål: 5x A 08-LC-TT Assmann WSW Components | Kontaktdon | DigiKey (<https://www.digikey.se/product-detail/sv/assmann-wsw-components/A-08-LC-TT/AE9986-ND/821740>)
- USB-C (USB TYPE-C) USB 3.2 Gen 2 (USB 3.1 Gen 2, Superspeed + (USB 3.1)) Uttag Kontakt 24 Positioner Ytmontering, högervinklad; genomgående hål: 4x 12401610E4#2A Amphenol ICC (Commercial Products) | Kontaktdon | DigiKey (<https://www.digikey.se/product-detail/sv/amphenol-icc-commercial-products/12401610E4-2A/12401610E4-2ACT-ND/5775520>)
- USB-B (USB TYPE-B) Uttag Kontakt 4 Positioner Genomgående hål, högervinklad: 4x USB-B1HSW6 On Shore Technology Inc. | Kontaktdon | DigiKey (<https://www.digikey.se/product-detail/sv/on-shore-technology-inc/USB-B1HSW6/ED2982-ND/2677743>)
- Stiftlistkontaktdon Genomgående hål 23 positioner 0,100" (2,54mm): 10x PRPC023SAAN-RC Sullins Connector Solutions | Kontaktdon | DigiKey (<https://www.digikey.se/product-detail/sv/sullins-connector-solutions/PRPC023SAAN-RC/S1011EC-23-ND/2775231>)

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