BudgeTronics

CP/M COMPUTER KIT

A complete CP/M computer ready to go after construction.

This is a complete single board CP/M computer kit with a micro SD disk emulator drive, VGA or Composite video out, standard USB keyboard connection, 128KB banked RAM, GPIO expander and an extra serial out if needed.

It can run CP/M 2.2, CP/M 3 , QP/M 2.71, UCSD Pascal, Forth, Collapse OS, BASIC and more.

This CP/M computer kit is based on two open source projects which where combined and made into a single board computer design. The Z80MBC2 https://hackaday.io/project/159973-z80-mbc2-a-4-ics-homebrew-z80-computer designed by Fabio Defabis aka Just4fun and the ASCII video terminal From Geoff Graham https://geoffg.net/terminal.html with updated software from David Hansel https://github.com/dhansel/TerminalUSB for the use of a USB keyboard instead of the harder to get PS/2 keyboards.

The kit contains all the needed parts and the two already programmed micro controllers (Atmega 32 for Z80MBC2 circuit and the PIC32MX for the ASCII terminal circuit). All complete with a Plexiglas housing to make it a nice finished computer.

PARTSLIST CP/M COMPUTER

CONSTRUCTION MATERIAL
1x PCB 17,5cm x 11,5cm
2x sheets of Plexiglas
4x 15mm distant holders with screw end
4x 20mm distant holders with screw end
4x m3 nuts
4x m3 screws
4x Rubber feet

RESISTORS
1x 39 ohm
1x 82 ohm
1x 150 ohm
1x 220 ohm
1x 330 ohm
3x 390 ohm
1x 470 ohm
2x 680 ohm
3x 1k ohm
1x 1k2 ohm
4x 4k7 ohm
10x 10k ohm
1x 100k ohm
2x 8x10K resistor network

CAPACITORS
2x 22pf
2x 27pf
10x 100nf
3x 10uf tantalum capacitor
2 x 100uf electrolytic capacitor

DIODES and LEDS
1x 1n4001
2x 1n4148
3x 1n5817
1x blue LED
1x red LED
2x white or warm white LED
1x green LED

1x green/blue LED
2x yellow/green LED

INTEGRATED CIRCUITS
1x 74hc00
1x Z80 CPU
1x Atmega 32A (programmed)
1x PIC32MX250F128 (programmed)
1x 128Kb RAM
1x MCP23017 GPIO
1x 5 Volt regulator
1x 3.3V regulator MCP1700-3302
2x 2n2907

IC SOCKETS
2x 40 pins ic socket
2x 28 pins ic socket
1x 14 pins ic socket
1x 32 pins ic socket

HEADERS
1x 2x3 header male
1x 2x10 pins header male
1x 40 pins header male
3x jumper

CONNECTORS
1x USB A connector
1x VGA connector
1x Video connector
1x Power connector

MISCELLANEOUS
1x SD card holder module
1 x Micro SD card with CP/M installed
1x real time clock module (no battery)
2x push buttons
1x 8mhz X-tal
1x 16mhz X-tal

CONSTRUCTION

USER

RESET

9 V CENTRE +

RTC MODULE
battery side up

Serial

CTS
NC
NC
GND
+5V
RXD
TXD
DTR

Keyboard

100NF

100NF

1K

1n4001

100UF

Recom 5V
! • !

10K

1K2

1N5817

390

390

1N4148

2N2907

1N5817

1N5817

22PF

16 MHZ

22PF

74HC00

100NF

NC
SCL
SDA
+5V
GND

100NF

baudrate 115200
data 8 bit
parity none
stop 1 bit

VIDEO OUT

USER.BLUE

IOS.GREEN

680

10k

680

4K7

ATMEGA32A

100NF

RxD/TxD to terminal

HALT.RED

2N2907

DMA.WHITE

10k

1K

1K

10k

39

10K

4K7

8x10k

RED
GREEN
BLUE

IO_OP.WHITE

Z80CPU

100NF

VGA CONNECTOR

color select

82

1N4148

KEY.ACTIVITY

8x 10k

SD.DRIVE

10k

10k

10k

330

WWW.BUDGETRONICS.EU

128KB RAM

100NF

vcc
sda
scl
gnd

IOEXP

SS
SCK
MOSI
MISO
+5V
GND

100UF

10UF

150

220

470

10K

100K

4K7

10k

MCP23017

gnd   gnd

GPIO

CP/M computer

SD CARD MODULE

8 MHZ

27PF

100NF

27PF

PIC32MX

100NF

+5V   +5V
GPB   GPA

POWER

10UF

10UF

3.3V regulator

100NF

390

4K7

100NF

The construction of the computer can best be done in the following order:

1. Place all the resistors and check the right value before you solder them.
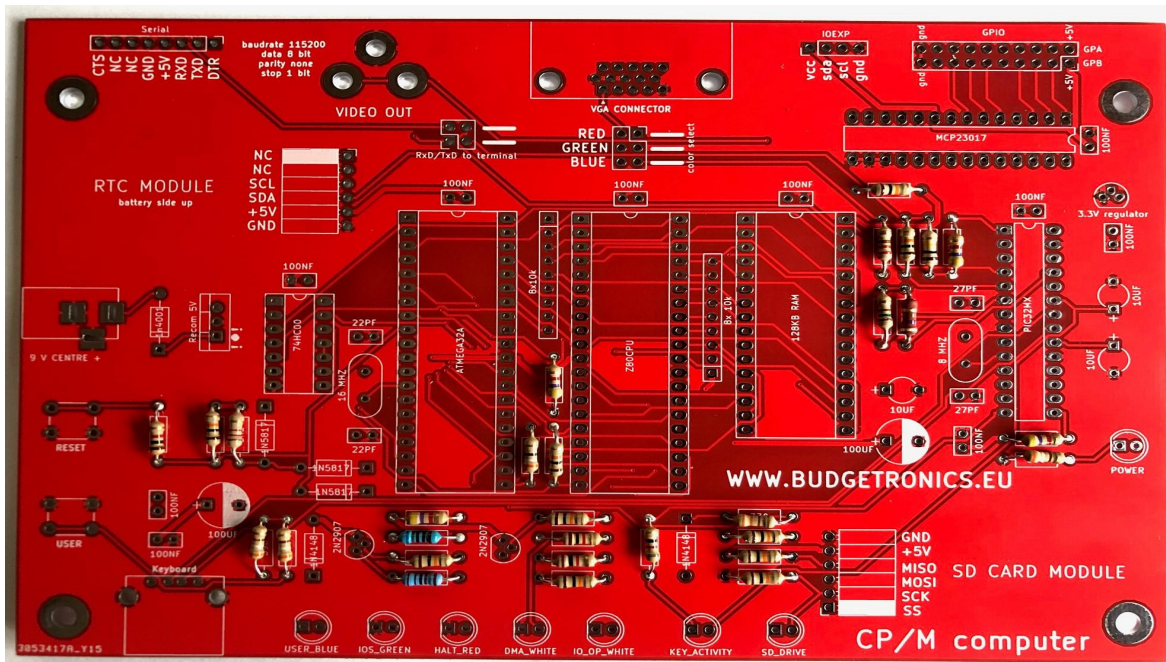
2. Place all the ceramic capacitors and <u>check the values</u> before you solder them.
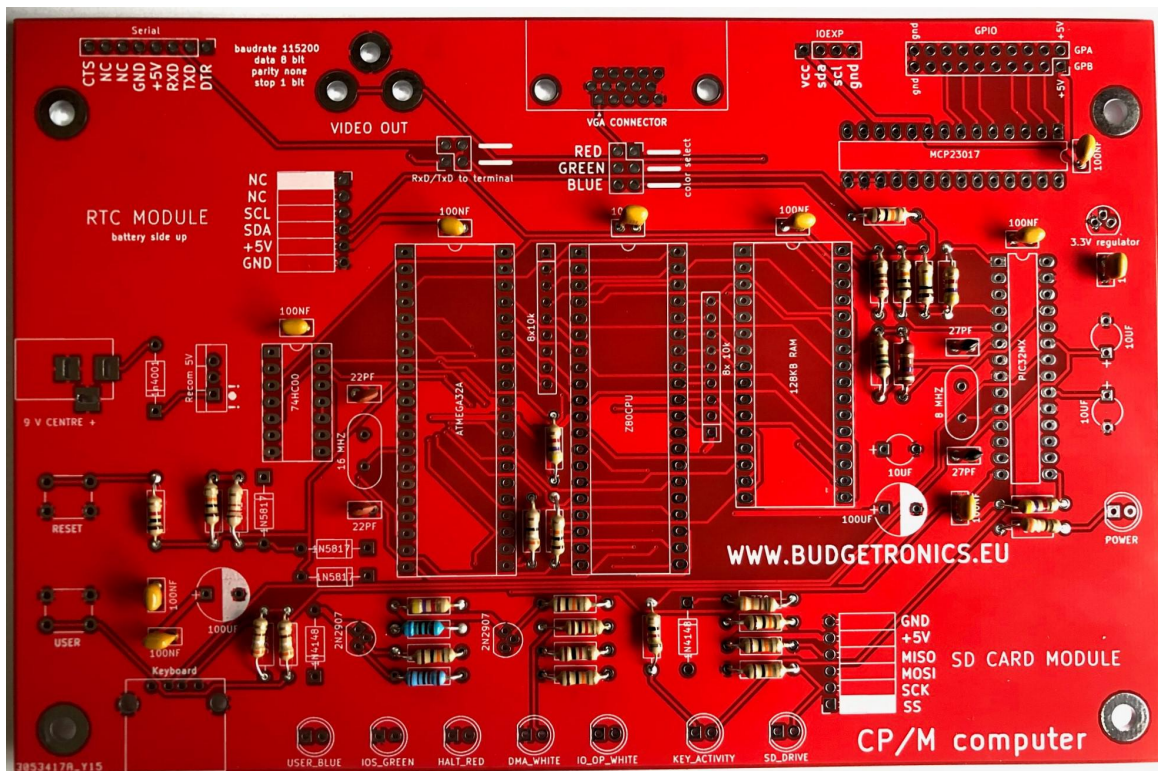
3. Place all the tantalium capacitors and electrolytic capacitors and besides checking the right value also make sure you solder them in the right way because they have a <u>positive and a negative side</u>. Check twice solder once.
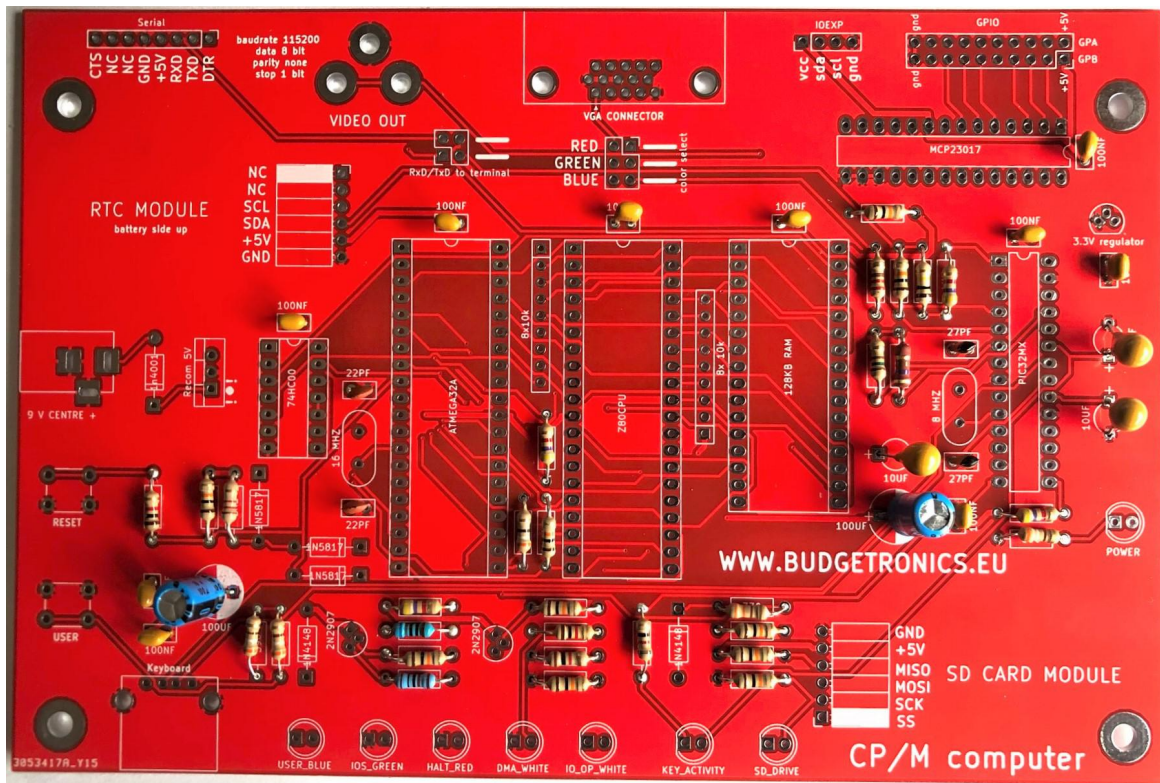

4. Place all the diodes and also check the <u>right type and the right orientation</u>. The stripe on the diode must be placed on the stripe as seen on the PCB.
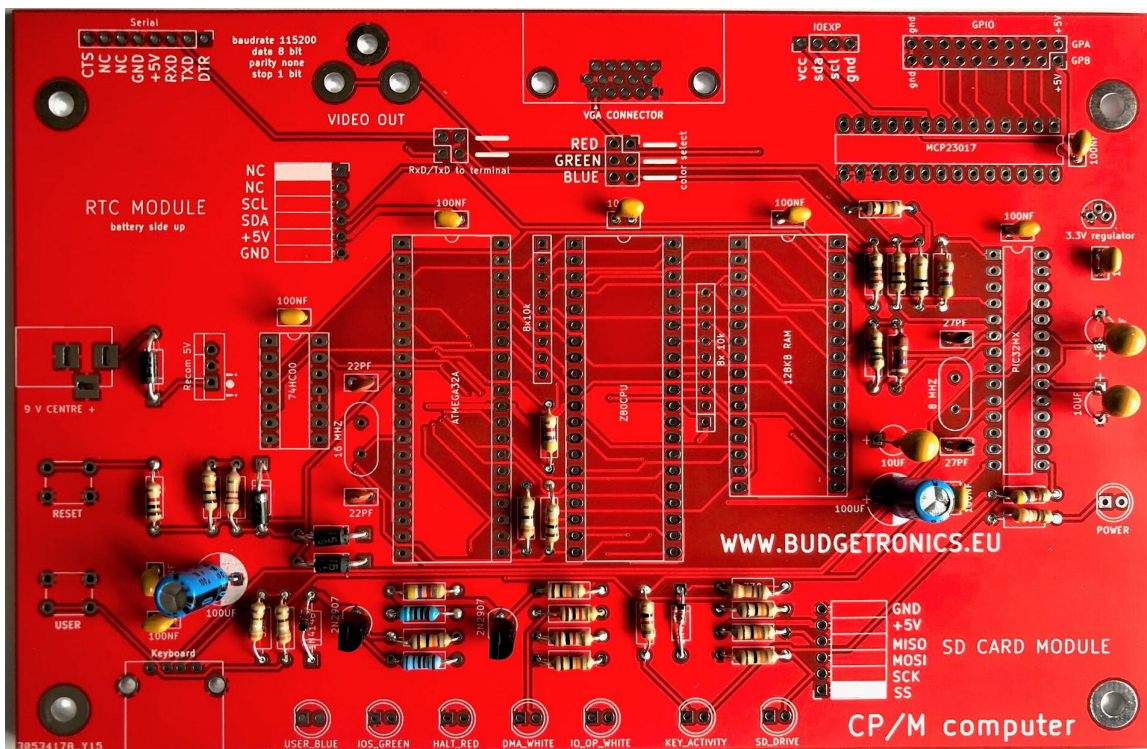
5. Place the transistors and make sure to look at the type name **so do NOT mistake them from the MCP1700 power regulator** which looks the same but will not work as a transistor. Place them precisely as shown on the PCB.
6. Place the 3.3V MCP1700 power regulator
7. Place the two quartz x-tals and notice they have two different MHz readings.
8. Solder in the two resistor networks and take care you do this with the right orientation. On the network part you see a dot on one side. This dot side must be placed in the SQUARE solder hole which is different for both networks on the PCB. One is on the upside and the other one on the downside of the PCB. Look twice before soldering.
9. Solder in all the IC sockets. Your PCB should look now exactly as pictured below.
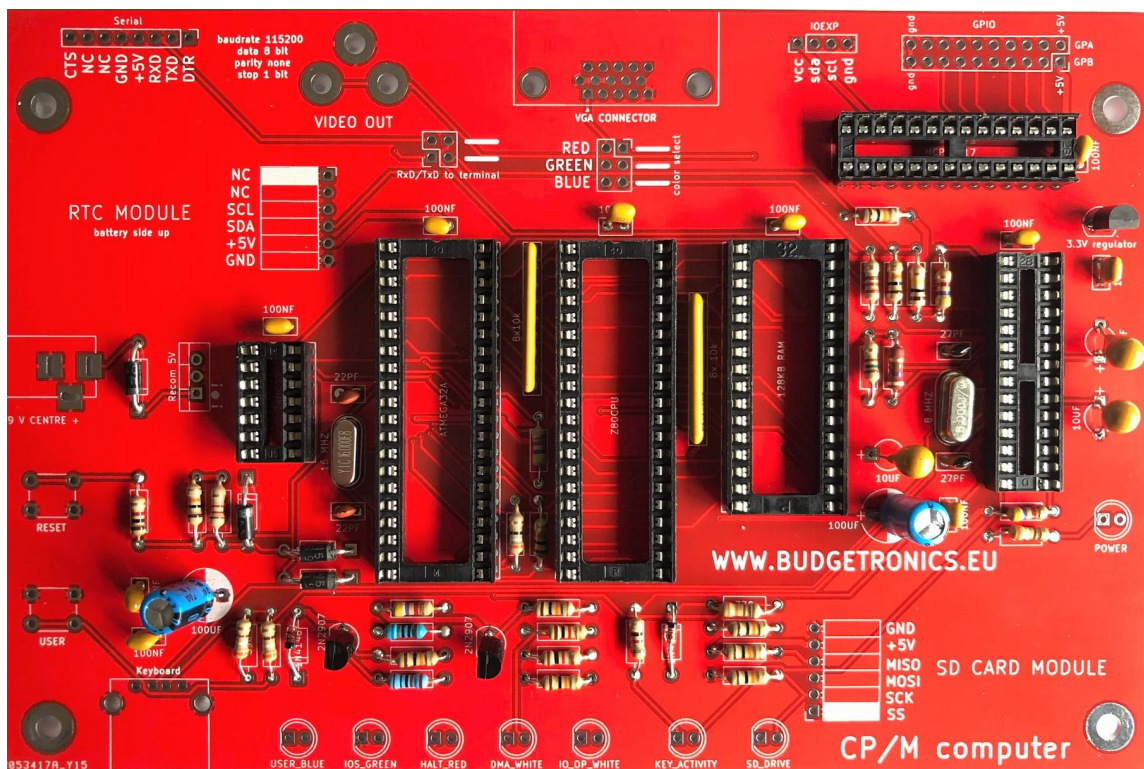

10. Place the LEDS and check the colors first before you place them (use a 3 volt button battery). The USERLED <u>must be blue or white.</u> The short leg of the LED is the negative side which is placed at the flattened side of the LED indication on the PCB. The negative side is also indicated by a square solder pad.
11. Take the RTC clock module and take away the SMD resistor from the trickle charger circuit top right. This will stop the charging of the button cell which otherwise could be overloaded and in very rare cases explode. It is easily done and the button cell will last for years (if its good quality) with no charging circuit. Just put the soldering iron on the SMD resistor and the solder will melt and you can slide it off.
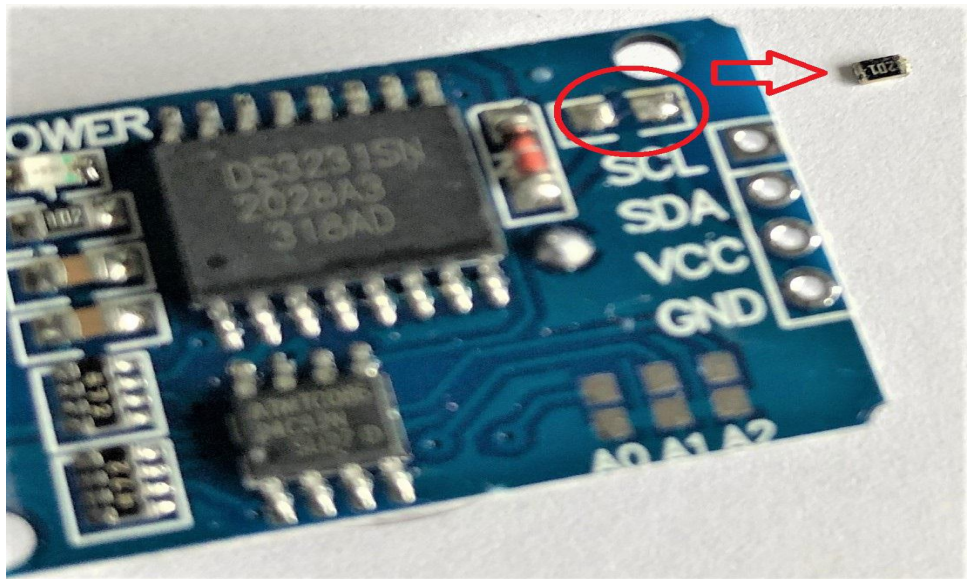
12. Solder the real time clock module in but bend the angled header straight so it will lay flat on the PCB. BATTERY SIDE UP!!!
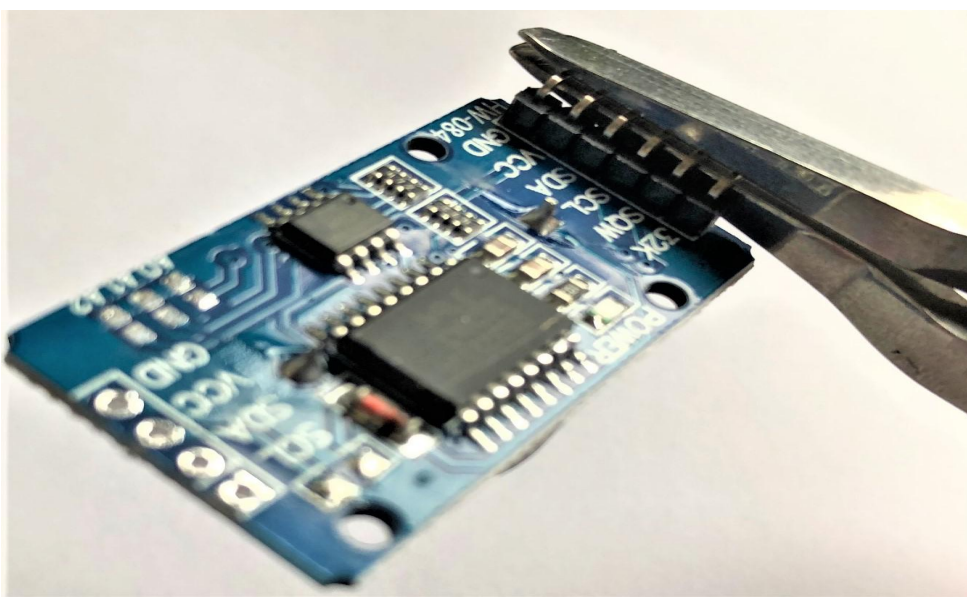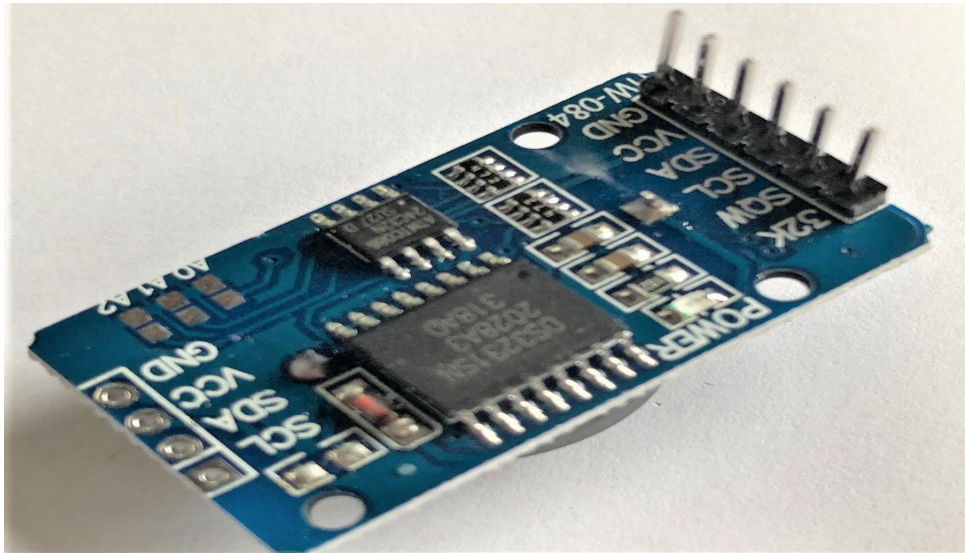
13. Place the SD card module. To do this in a nice way which looks great you have to do some fiddling with it. The SD card side will go up and the angled header will be cut off. Because on the solder side of the header there is just enough pin length to place in the SD card solder holes on the PCB. They will not get through all the way. But if you push the SD card module flat on the PCB and keep it here while soldering the solder side it will make a good soldering connection. In this way the SD card holder stays nice and flat on the PCB. Just use enough solder and let it flow into the solder holes by warming the solder a little bit longer then normal. It will make a good electrical connection this way. Just begin by soldering one pin while keeping the SD card module flat on the PCB. When it stays put you can solder the other pins.
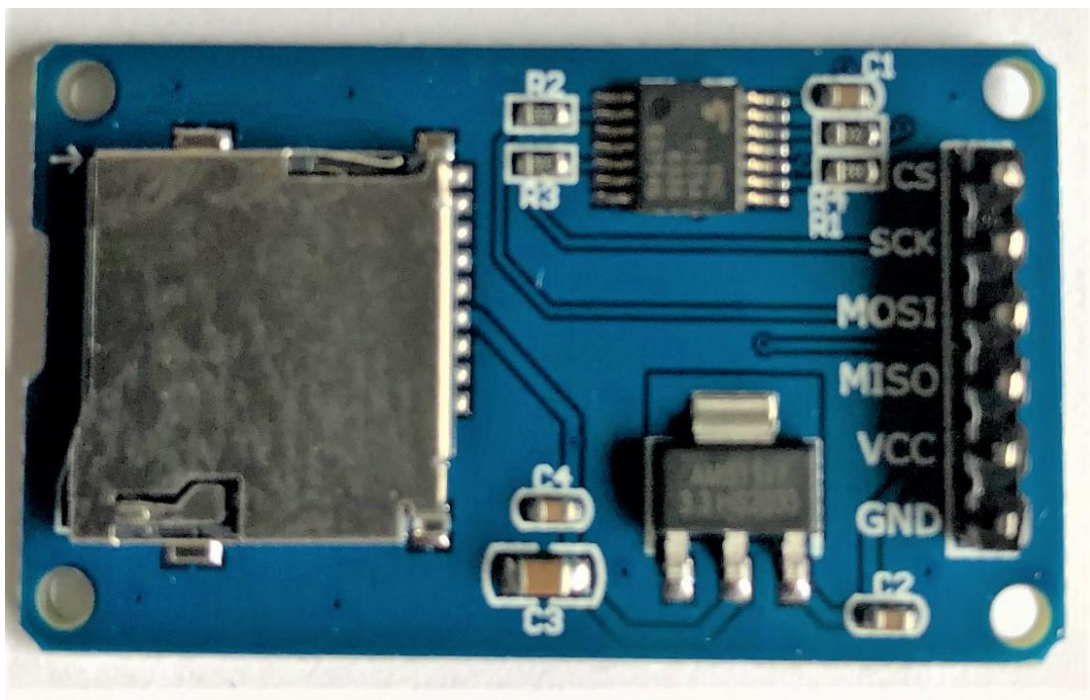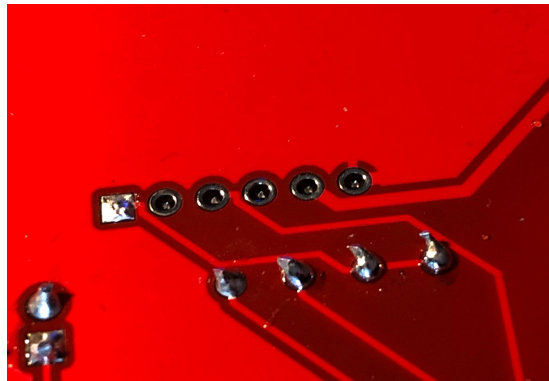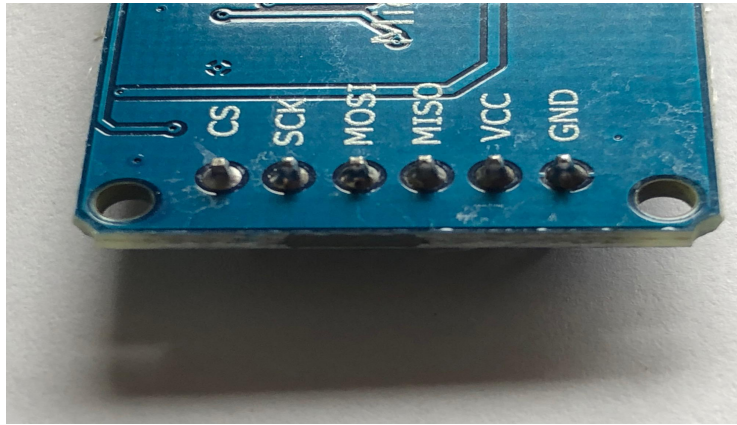
14. Place the 5 Volt voltage regulator and **make sure the dot on the housing of the part is at the same side as the dot on the PCB**. If you connect it the wrong way around the voltage regulator will be destroyed. This is a high quality voltage regulator which does not get hot like the much used 7805 regulator and it can take voltages from 6.5 volts to 36 Volts as an input. Recommended here is a 9 Volts power supply. It can deliver a max of 1 Amps.
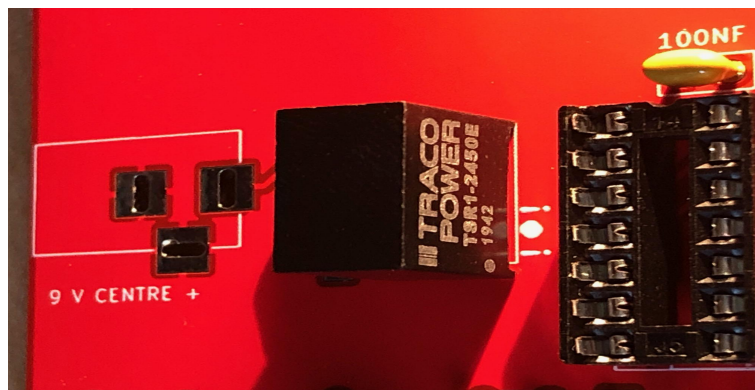
15. Place all the connectors like VGA, Video, Power, USB, the two switches and all the headers. You have to break some of the provided headers to make them fit.
16. If all is done place the IC's in the right sockets. Sometimes you have to bend

the pins of the IC's a bit to make them fit in the socket. You can do this by pressing them in a 90 degree angle against a hard table top. **Make sure you orientate the IC right otherwise they will be destroyed.** The small gap at the top of the IC's must be faced upwards as also is shown on the PCB. The GPIO IC's faces to the right with the small gap also as shown on the PCB.

17. Make sure you place the two jumpers on the Rxd and Txd header and one on the color header. The PCB should look like this:
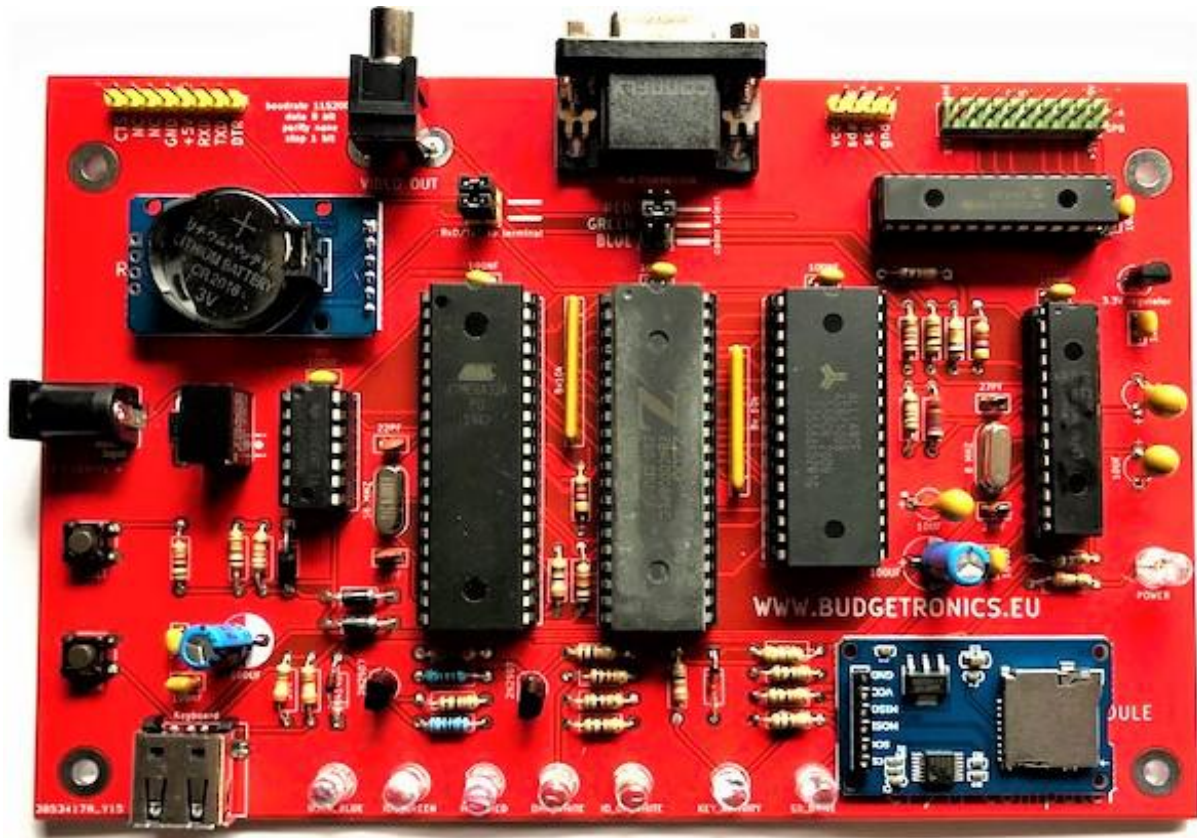
18. Put a CR2016 button battery (not included in kit) in the RTC clock module and put the micro SD cart in the SD card module. Finally put the housing together. The short distance holders on the bottom side and the longer distance holders on top. This way there is enough room to press the reset and user switches with your fingers. Do not forget to place the rubber feet underneath as a finishing touch.

Finished CP/M computer

READ FIRST BEFORE STARTUP!

Important knowledge to remember before you power up after construction:

1. Use a 9 Volts or 12 volts (up to 36 Volts) power supply with center tip positive. The power supply entry is protected by a diode to prevent the wrong polarity of the power supply used.
2. For the CP/M computer a VGA connection is preferred because it has more characters per line then the Composite video output. Composite video can be used but the layout of the screen may sometimes be not exactly right.
3. At least one jumper must be placed on the color select header. You can choose the color you like but most of the times green is used. You can place more then one jumper on the color select header to get different mix colors if you like.
4. When you start up for the first time you have to set the Baud rate of the ASCII terminal so you will not yet see the CP/M computer starting up on screen. Only the startup message of the ASCII terminal is shown and it proves that this part of your computer is already working. Also make sure you did put the two jumpers on the "TxD/RxD to terminal" header positioned as shown with the two white stripes on the PCB otherwise you will not have a connection with the CP/M computer later. To set the right Baud rate press the **SHIFT key together with F12 at the same time** and a setup screen will appear. Choose the right menu item (G) and set the Baud rate to **115200, data: 8 bit,**

Parity: none, Stop: 1 bit. Most of the times you only have to change the Baud rate, all the other settings are already correct but always check. After this press the right menu key (K) to save all the settings. Power the computer down and startup again. If all is well you see CP/M starting up if you have the SD card in the SD card module and placed the two RxD and TxD jumpers.

5. Pressing the reset key and keep it pressed down while also pressing the User switch will give you a selection menu for the CP/M computer. Here you can set the real time clock, the disk to use, programming language and more.

6. Connect a USB keyboard when the computer is powered down. If you connect the USB keyboard while power is already ON then the USB keyboard will not always be recognized by the ASCII terminal.
7. Most USB Keyboards will work but not the keyboards with a USB hub integrated. If you are not sure the keyboard works look at the key activity LED while pressing keys. If this LED go's out for a fraction of a second while pressing a key the keyboard is recognized.
8. You can only connect to VGA or to Composite video so **not** both at the same time. If you want to switch between VGA and Composite video you have to power down and power up again so the ASCII terminal senses which output is

used and switches to that output. This is only done at startup.

9. The Serial header can be used to connect the computer to a terminal program on, for example, your PC. Best is to lift the two "TxD/RxD to terminal" jumpers from the headers in this case to switch of the data stream to the ASCII terminal but sometimes it also works if you leave the headers on.

10. The Serial header has a **5 volt <u>OUTPUT</u> so this is <u>NOT an INPUT!!</u>** Power can only be provided through the power bus on the left side of the computer. The PCB states 9 volts is needed with a positive center. But the provided voltage regulator can handle voltages from 6 to 24 volts without trouble. So **<u>never put a voltage on the serial header</u>** and only use it as an output to provide power to an external device if needed.

11. The ASCII terminal can be used separately from the CP/M computer if needed. Just remove the "TxD/RxD to terminal" jumpers and make a connection with the Rxd and Txd to the other device you want to connect to. Do not forget to also connect to common ground at both devices. The two pin connections on the left side go to the CP/M computer circuit and the two on the right side to the ASCII terminal circuit. See all specifications for the ASCII terminal circuit below.

Specifications for the ASCII terminal

- ASCII video display terminal with VT100 and VT52 emulation
- VGA or Composite Video output with automatic switch over. Composite can be PAL or NTSC.
- VGA can display 24 lines x 80 characters or an extended resolution of 36 lines x 80 characters
- Composite video can display 18 lines x 48 characters (PAL) or 15 lines x 44 characters (NTSC)
- Standard USB compatible keyboard input with support for standard US keyboard layout or French, German, Italian, Belgian, Russian or United Kingdom keyboard layouts
- TTL or RS232 serial input/output. Baud rates from 40 to 1,000,000 bits per second with odd, even or no parity and one or two stop bits
- Extended VT100 terminal emulation. Extensions include graphics codes for drawing lines, boxes and circles (which can be hollow or filled)
- Graphics resolution is 480x288 pixels in VGA 25 line mode, 480x432 pixels in VGA 36 line mode, 288x216 in PAL composite and 264x180 pixels in NTSC composite mode
- Three built in fonts (standard, large and jumbo) and four character attributes (normal, underline, reverse and invisible)

CP/M

There is a lot of information about CP/M on the Internet so we will not give much explanation here, Here we will only show some much used commands to set your first steps with CP/M.

DIR ‹filespec›	Produces a list of files matching the ‹filespec›, if no filespec is entered, the result is the same as *.*, i.e., all files on the currently logged disk. The command accepts similar wildcards as DOS.
	Note, CP/M 2.2 has no concept of directories, all files are in the "root" area of the disk. Other target disks can be selected, e.g., DIR C:*.* will list all files on drive C:
	System files are not shown by the DIR command. (See STAT).
ERA ‹filespec›	Deletes the file(s) specified by ‹filespec›. Wildcards are allowed.
REN ‹new› = ‹old›	Renames the ‹old› filespec to the ‹new›. Wildcards are allowed.
SAVE ‹pages› ‹file›	Saves a copy of memory to file. ‹pages› is the number of 256 byte pages starting at address 100(h) to save and ‹file› is the filename to save the data to.
TYPE ‹filename›	Copies the named text file to the console (screen)
USER ‹area›	The system has "user areas" numbered from 0 to 15. On start-up, the User area is set to "0". The DIR command displays files in the current user area and only programs in the current user area can be executed. The USER command is used to select another User area.

Executable (.COM) Programs

In addition to its internal commands, CP/M distributions included a number of executable programs which were required to perform basic operations such as copying files as well as editing, assembling and linking files to create new programs.

Program (Transient Command)	Function / Description
ED.com	Text File Editor, just say "*NO*", there are far better editors available
PIP.com Usage pip <dest> = <src> e.g. PIP A:=B:*.COM	Peripheral Interchange Program, used for, e.g., copying files Copies the source file(s) to the destination Copies all .COM files on B: to A:
STAT.com	The STAT program can be used to display and change serial device, disk and file settings.

The C/PM computer starts with an A: prompt. This is disk image A. If you type B: you go to another disc image and so on.
You can also change the Disk set (disk set starts standard with disk set 0) when you are in the select menu mode after pressing the reset and user button at the same time choose menu 8 to set another disk set. After that you see other disk sets from

A: and up on the SD card. The provided SD card has some programs on them to try out. You can also make your own disk image on the SD card with a program called CPMTOOLS, this is very well explained here https://www.instructables.com/Z80-mbc2-Virtual-Disks-Copying-Files/ but also on other places on the Internet.

HAVE FUN!