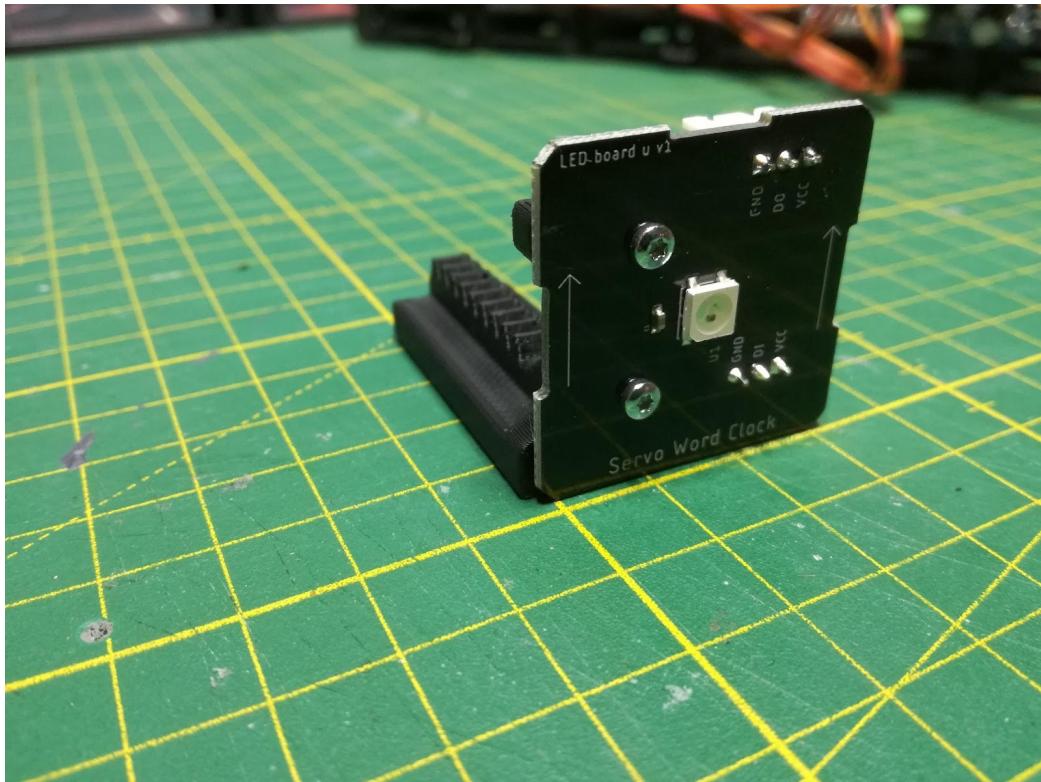


# Assembly Instructions for Servo Wordclock

## 1. attach LED PCBs to gear racks

- lay rack on flat surface so that PCB is flush with bottom of rack
- use screws M2.2 x 6



## 2. assemble housing top and bottom parts

- use epoxy for gluing
- use gluing jig for proper alignment

## 3. attach servos to housing

- cables should point towards LEDs
- use screws included with servos

## 4. prepare PCA9685 servo boards

- a. solder pin headers
- b. solder address jumpers

board no. 1: no solder jumper (binary 00000, Dec 0)

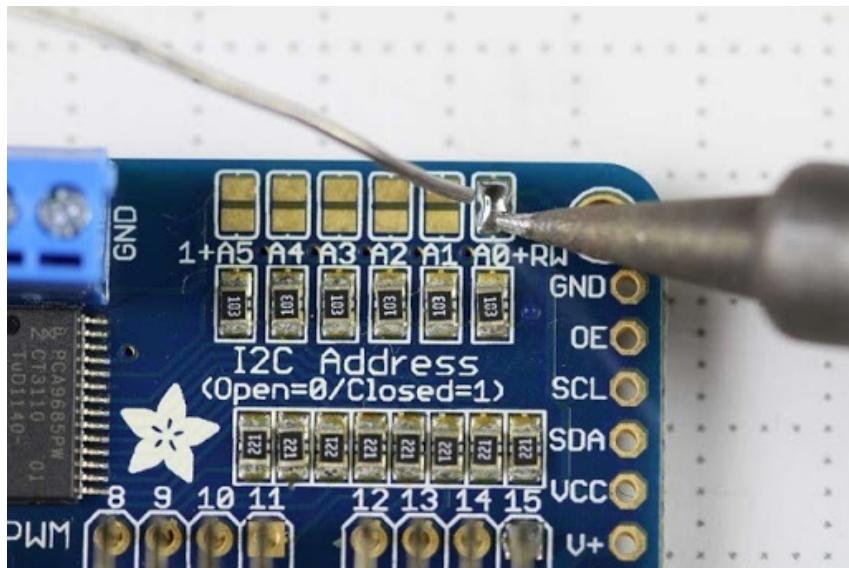
board no. 2: solder jumper A0 (binary 00001, Dec 1)

board no. 3: solder jumper A1 (binary 00010, Dec 2)

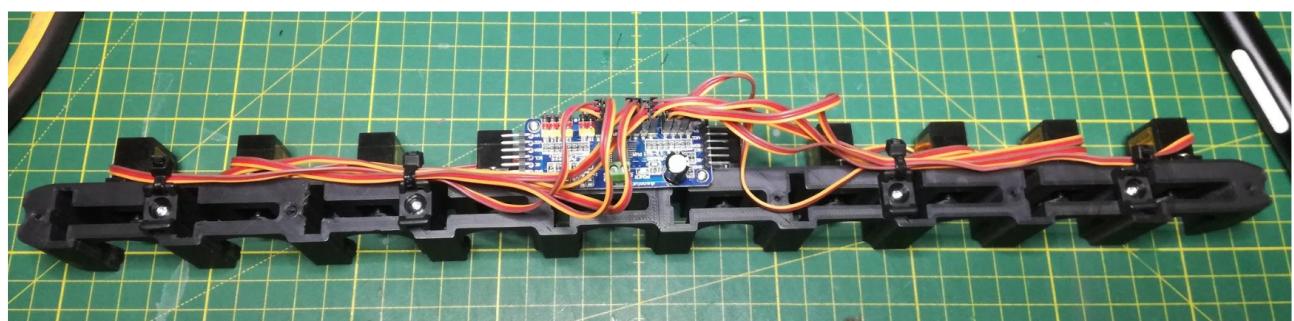
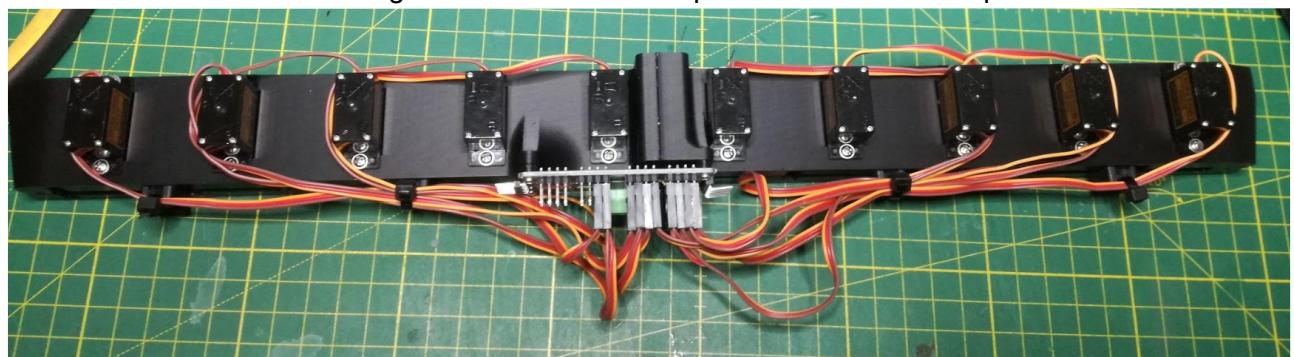
board no. 4: solder jumpers A1, A0 (binary 00011, Dec 3)

....

board no. 11: solder jumpers A3, A1 (binary 01010, Dec 10)



5. attach PCA9685 boards and zip tie mounts
  - use M2.5 x 2.5 spacers for servo boards
  - use screws M2.2 x 6 for servo boards and zip tie mounts
  - screw terminals on PCA9685 boards should point away from the servos
6. attach servo cables to boards
  - ch 0 on board is connected to servo on the right end in the picture below
  - cables can be guided and fixed with zip ties as shown in the picture below



7. zeroing all servos
  - a. upload the code *Servo-Word-Clock\code\servo\_zeroing\servo\_zeroing.ino* to ESP8266
  - b. connect ESP8266 to PCA9685 board  
VCC -> 3.3V  
V+ -> Vin

- GND -> GND  
 SDA -> D2  
 SCL -> D1
- c. power ESP8266 through USB port
  - d. all servo motors will go to maximum position one by one
  - e. disconnect ESP8266 from USB port within two seconds after servos have moved
  - f. keep ESP8266 connected to PCA9685 board (see step 9.d. below)
8. connect all LED PCBs
- use short JST cables
  - polarity does not matter but for clarity plug the red cable into VCC



9. insert gear racks and attach round gears
- a. to reduce friction you can use a dry lubricant like teflon spray
  - b. align gear racks with alignment jig as shown below
  - c. attach round gear with screw included with servo; alignment jig should stay in place so that servo gears will not accidentally move when screw is fastened
  - d. after all gears were attached, remove alignment jig and reconnect ESP8266 to power via USB
    - i. all motors will stay at the same position for some time
    - ii. after few seconds all servos will move to the minimum position
    - iii. disconnect ESP8266 from servo board

**Important Note:** The minimum and maximum positions may differ for different servo brands. In this case you need to adjust the values SERVOMIN and SERVOMAX in the files `Servo-`

*Word-Clock\code\servo\_zeroing\servo\_zeroing.ino* and also in the main code in *Servo-Word-Clock\code\ServoWordClockESP8266\LedMatrix\_functions.h*

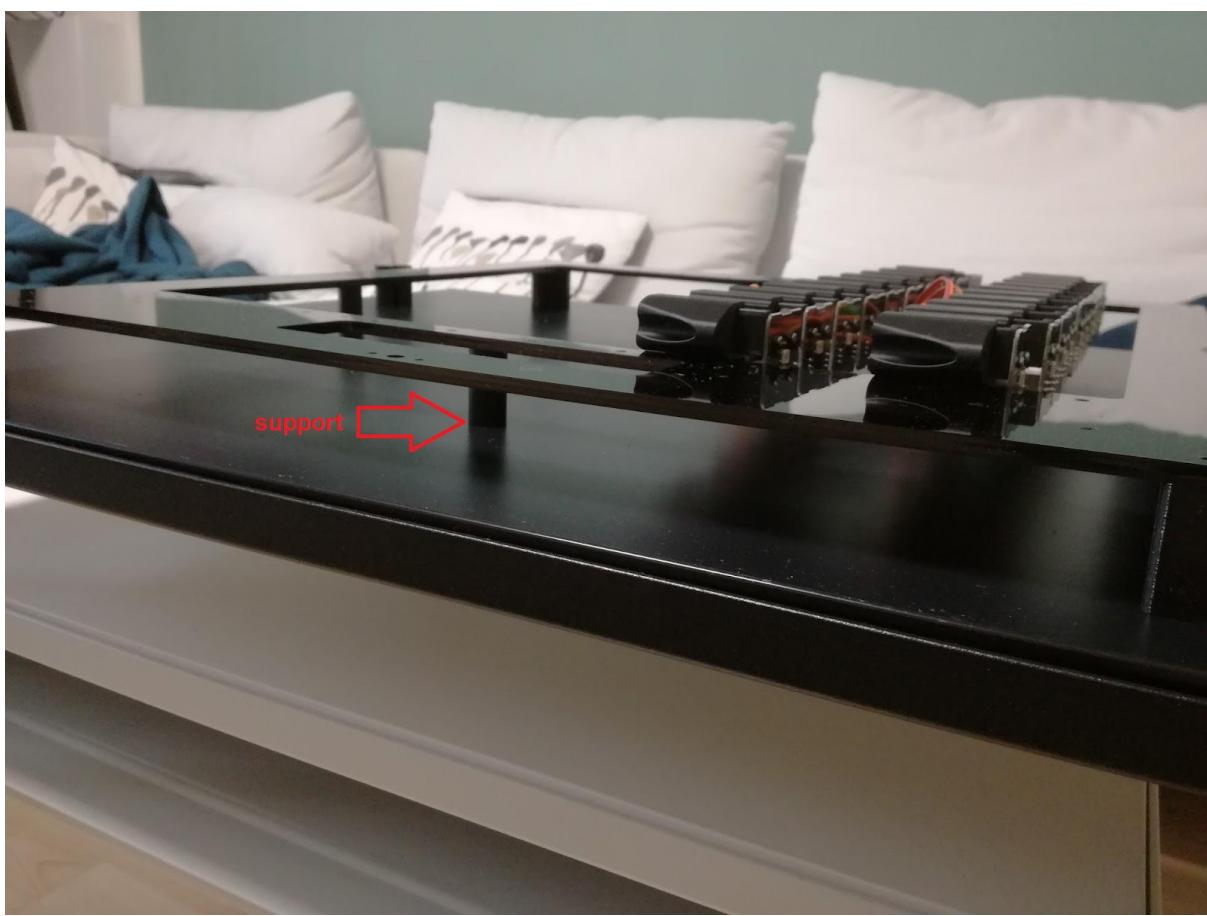


10. the shorter column with only 4 servos does not have its own PCA9685 board; for steps 7. and 9. you can connect the servos to the spare channels on another board
11. attach snap fit letter boxes to LED PCBs
  - if you look at the matrix of letters from the front the servo board with address 0 should be located on the right, the one with address 10 on the left; the servos connected to channel 0 should be on the top and channel 9 on the bottom

I T L I S A S T I M E      addr. 0  
A C Q U A R T E R Q C      ch. 0  
T W E N T Y F I V E X  
H A L F B T E N F T Q  
P A S T E R U N I N E  
Q N E S I X T H R E E E  
F Q U R F I V E T W O  
E I G H T T E L E V E N  
S E V E N T W E L V E  
T E N S E Q' C L O C K      addr. 0  
addr. 10      ch. 9      ch. 9

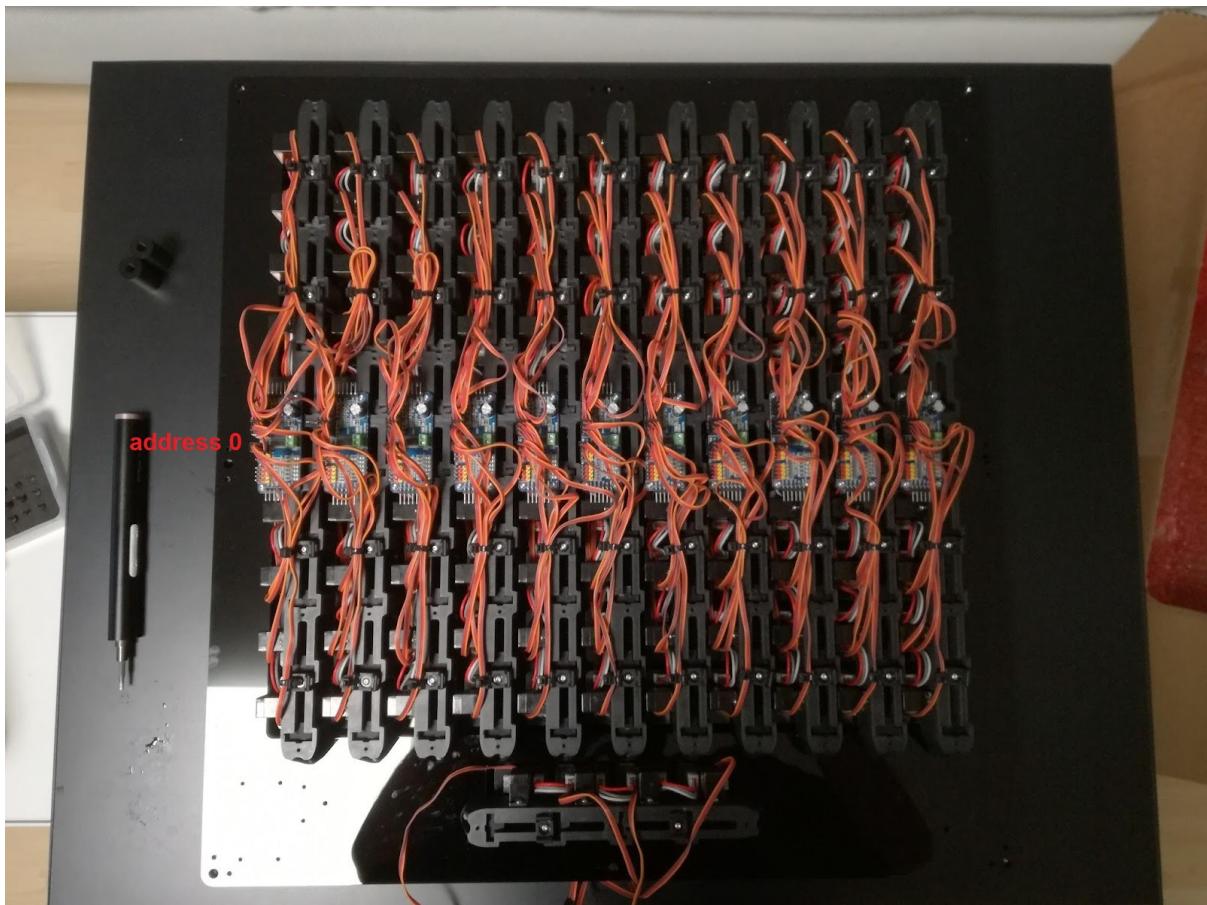
12. prepare center frame

- a. remove protective foil from both sides
- b. place frame on 32mm long columns with the side facing upwards as shown in the picture below; add some spacers in the center to support the frame



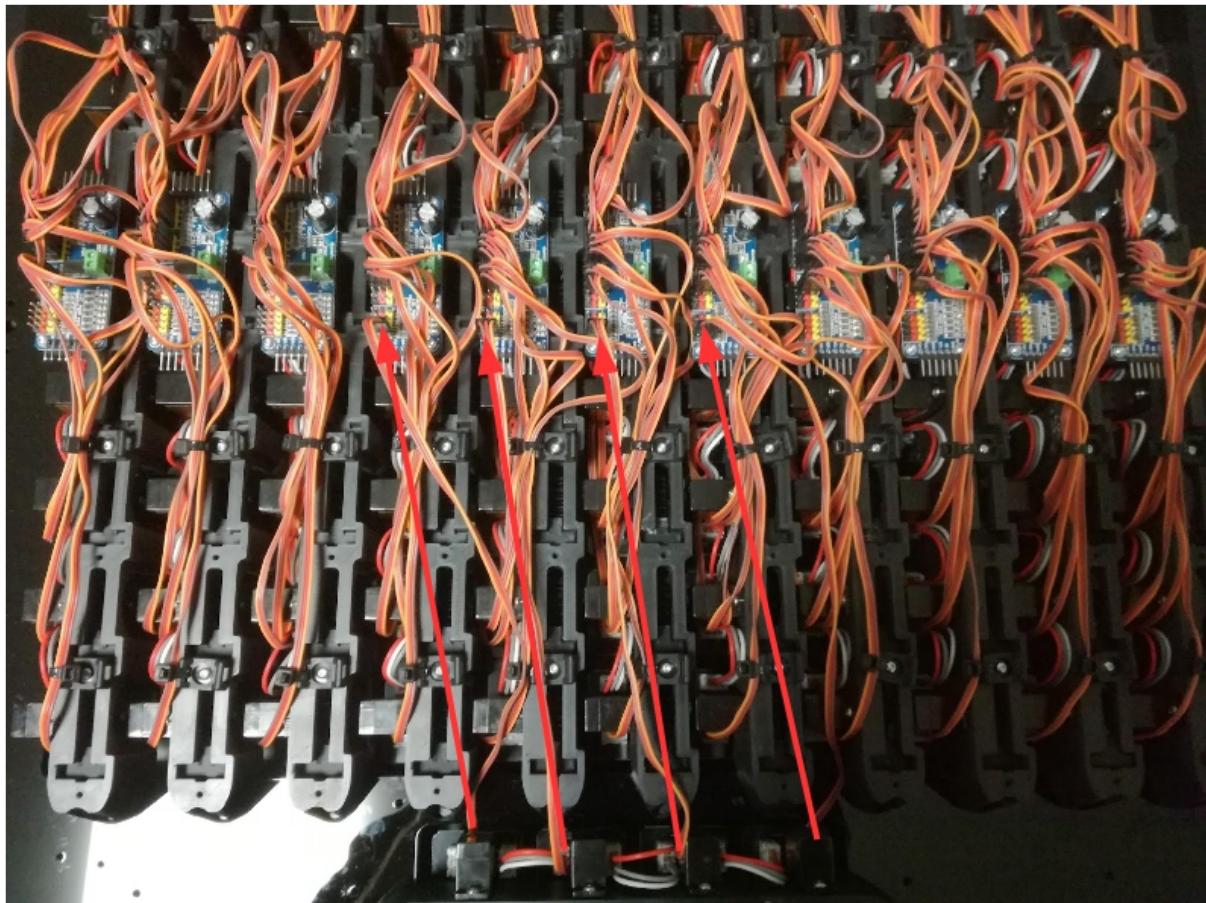
13. attach servo columns to frame

- from the rear view, the servo board with address 0 will be on the leftmost position
- use screws M4x12, holes in frame need to be threaded first



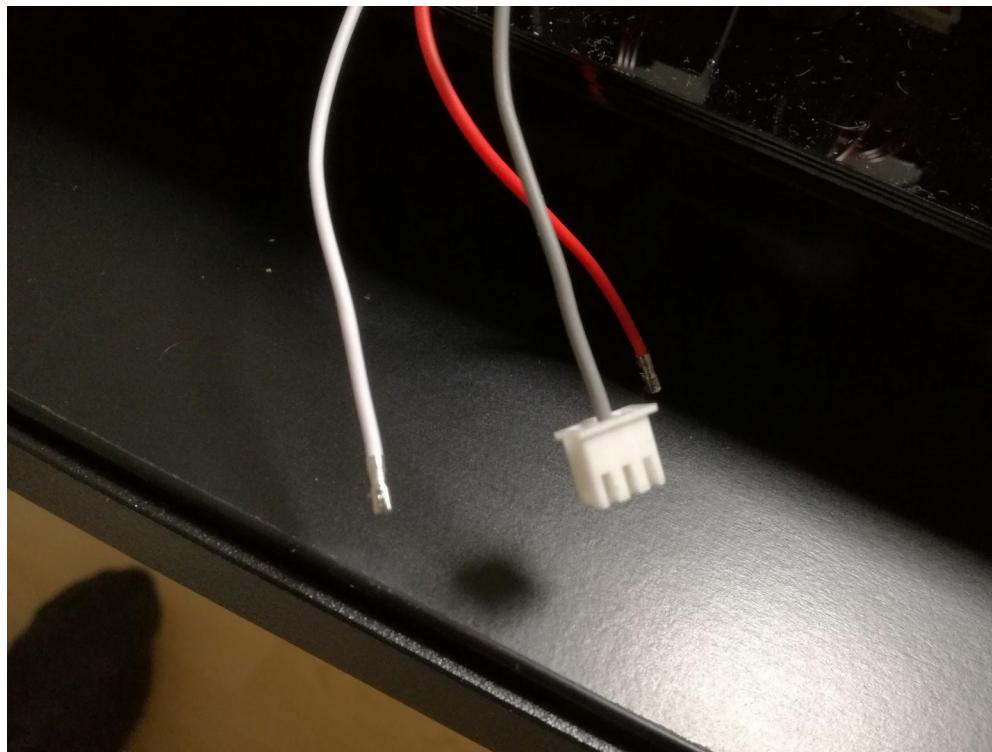
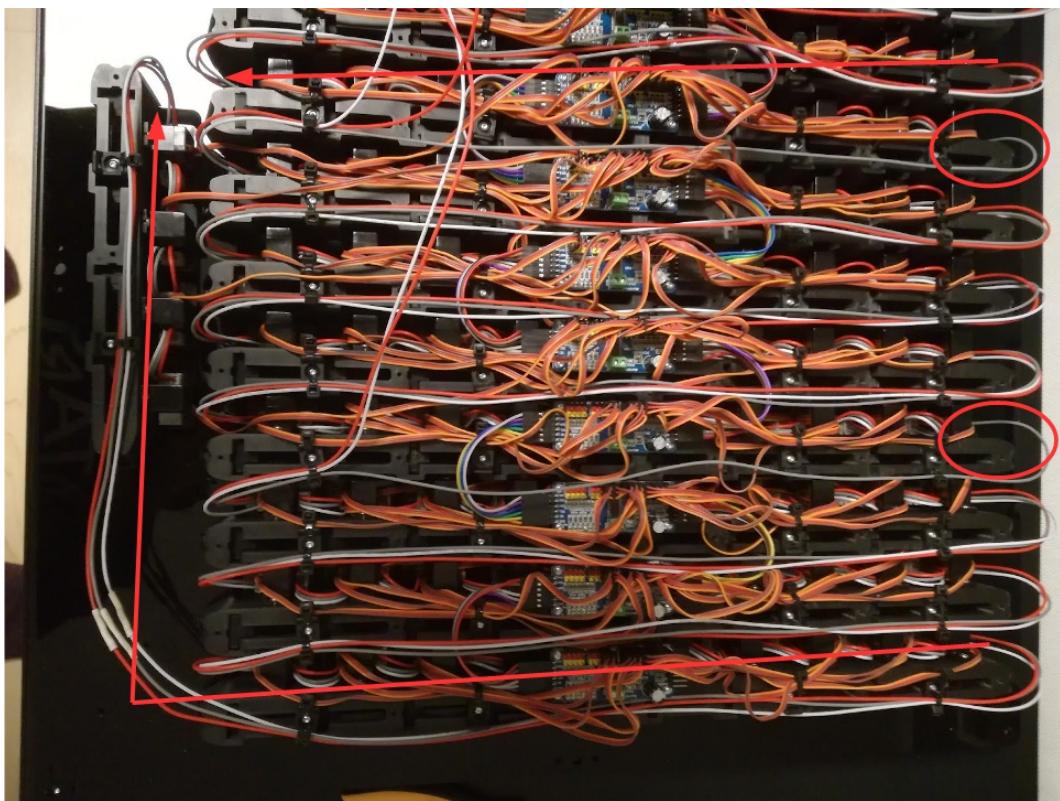
14. attach servos of short column with dots to other servo boards

- dot no. 1 (leftmost position, rear view) connected to ch 15, board address 3
- dot no. 2 connected to ch 15, board address 4
- dot no. 3 connected to ch 15, board address 5
- dot no. 4 (rightmost position, rear view) connected to ch 15, board address 6



#### 15. connect LEDs between columns

- connect first LED (upper position) of column 0 (leftmost position) to last LED (bottom position) of column 1, first LED of column 1 to last LED of column 2 and so on; use long JST cables
- polarity does not matter but for clarity connect red cable to VCC
- later on every second column VCC and GND cables need to be connected to the power supply (see step 20.); therefore remove VCC and GND cables on columns 1, 3, 5, 7 and 9 from the top connector by pulling them out from the JST plug; for these connectors only the data line in the center should remain in the plug (note: in the picture this is only shown for two columns)



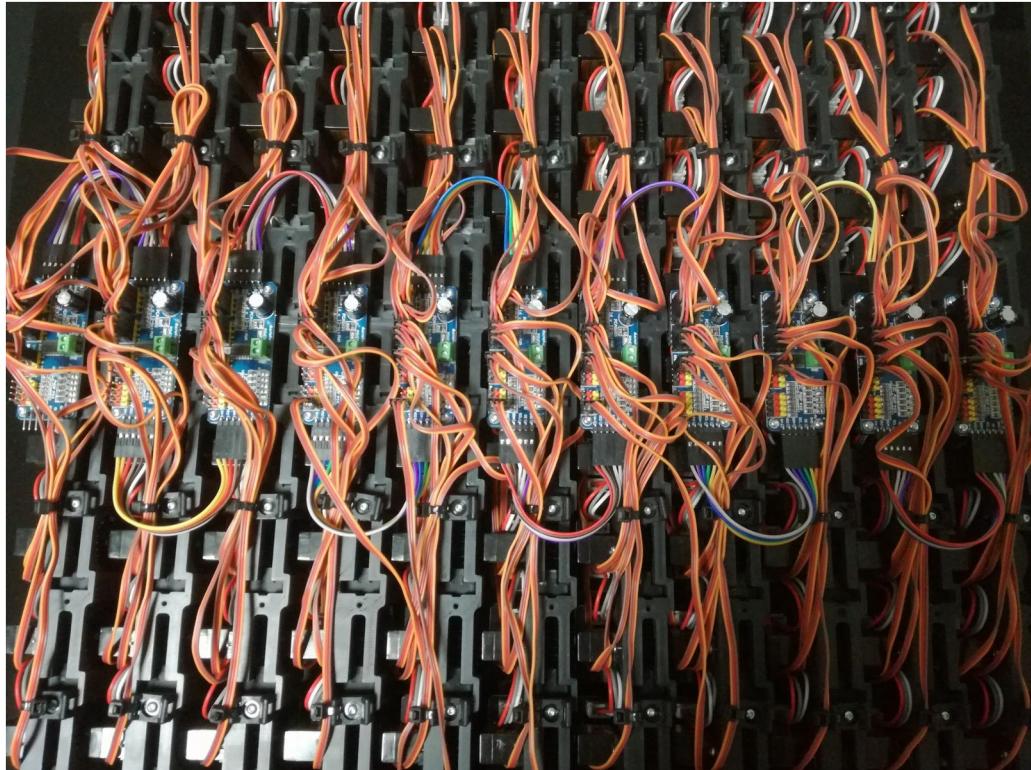
16. connect LEDs on the dot row

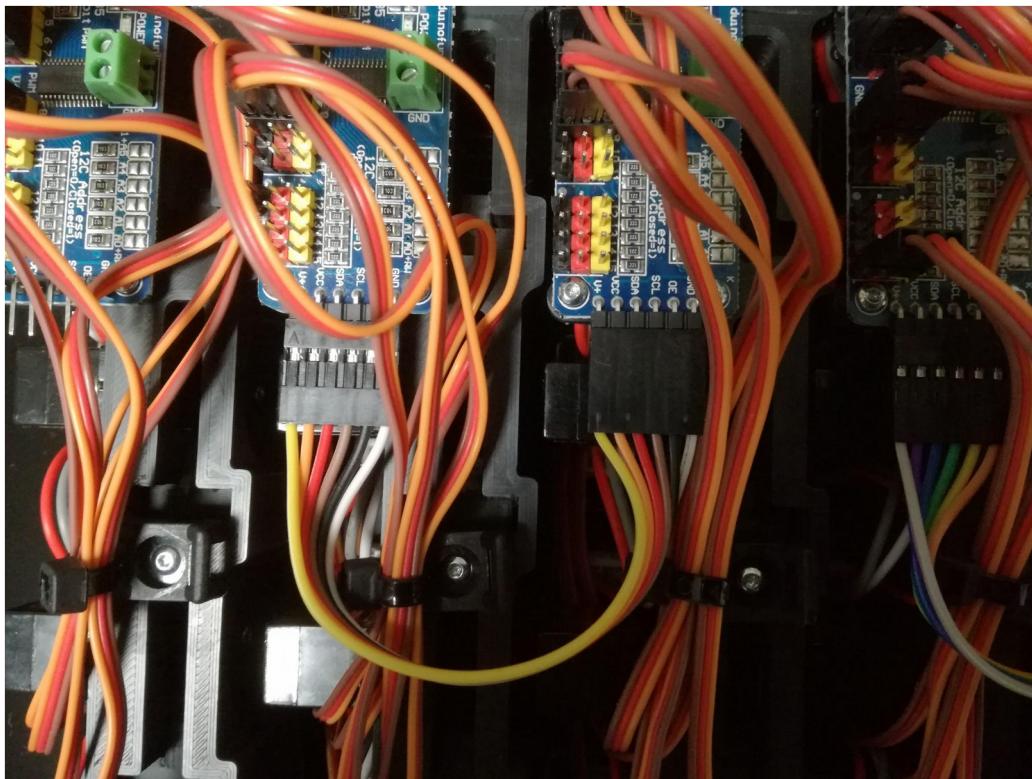
- dot 1 (leftmost position) should be connected to column 10 (rightmost position)

- for this you need to increase the length of the JST cable by soldering two of them together; shorten the cable to the proper length but keep the rest for later
- fasten LED cables and servo cables on dot row with zip ties

17. interconnect all servo boards

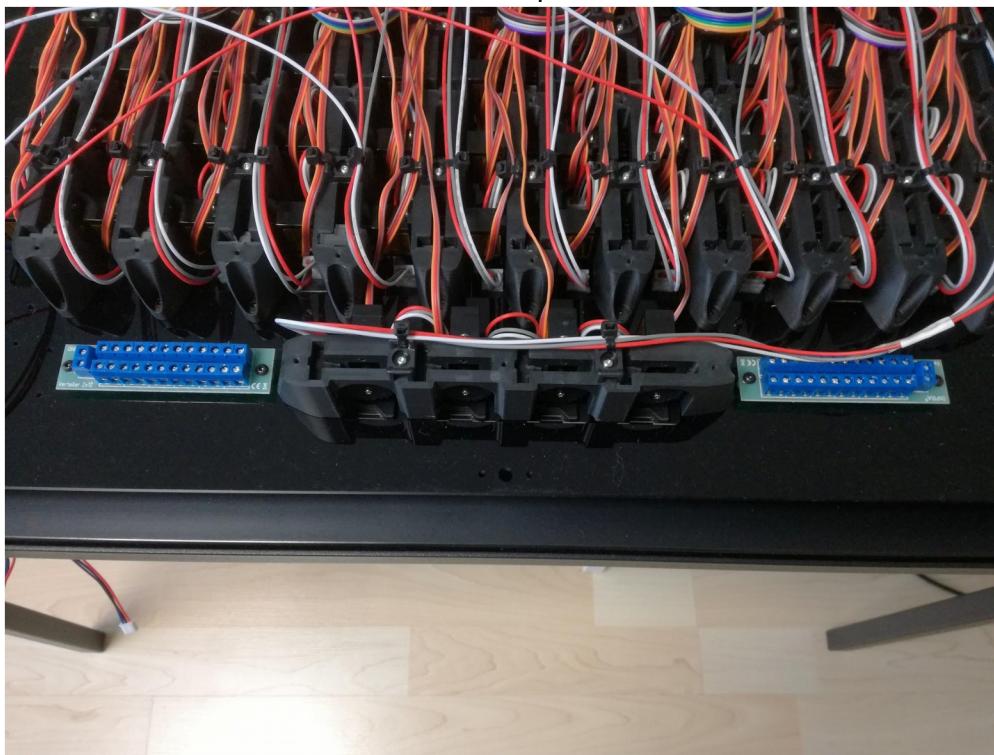
- use 1x6 dupont cables
- take care of correct polarity





18. attach long screw terminals to frame

- use included spacers
- use screws M3x12, holes in frame need to be threaded first
- for correct orientation see picture below



19. interconnect both screw terminals

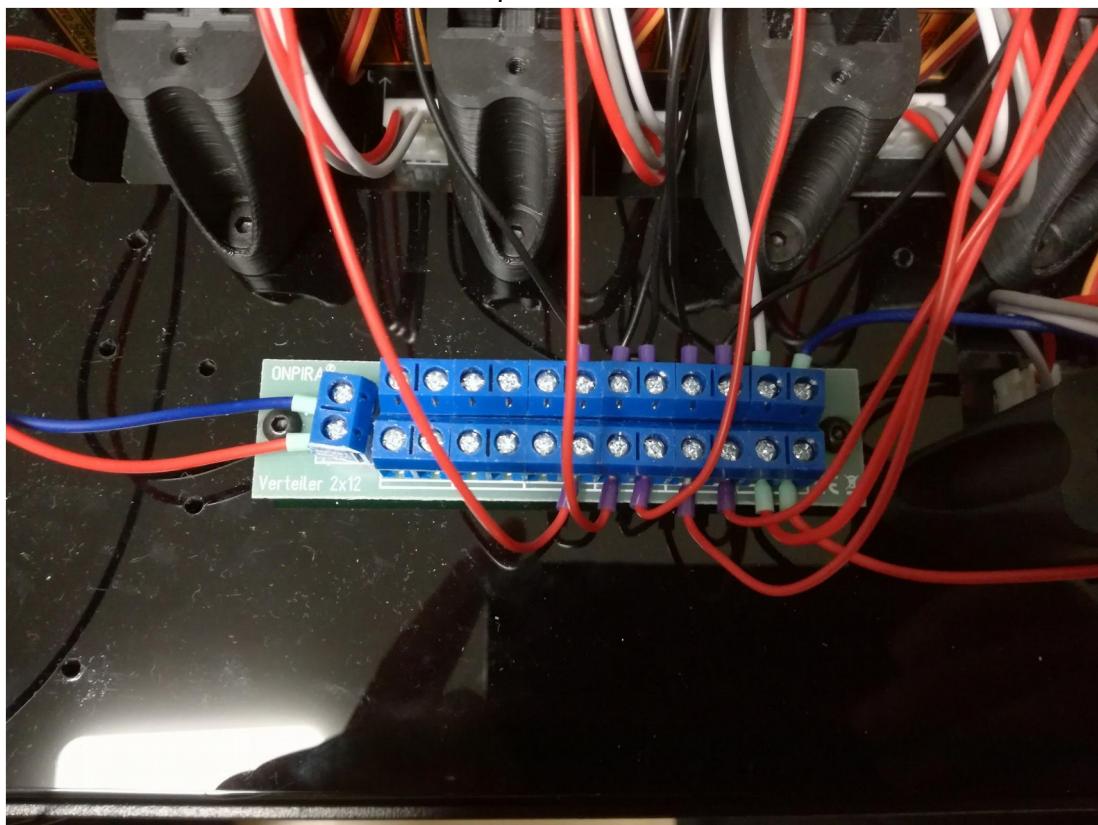
- prepare red and black cable with cross section 0.34mm<sup>2</sup> with cables sleeves (green color) on both ends; you can use the rest of the LED cable from step 16.

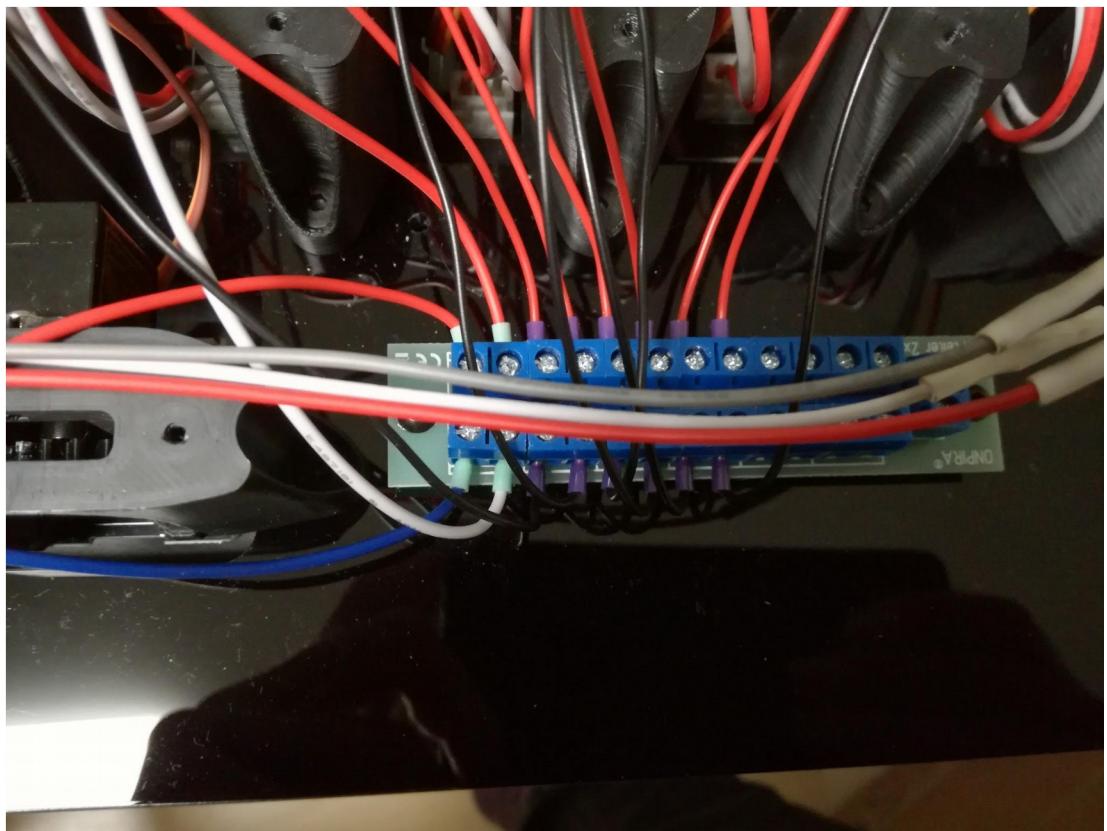
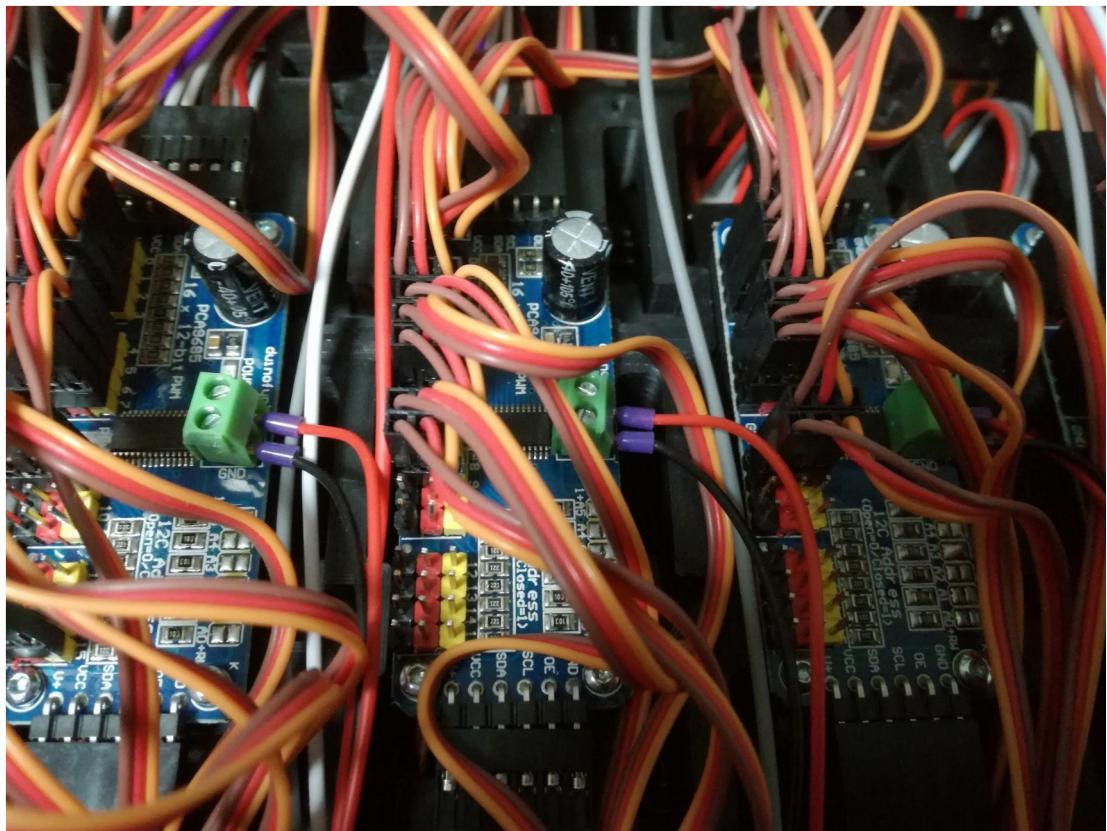
20. connect power supply for LEDs

- attach cable sleeves (green color) to VCC and GND cables of rows 1, 3, 5, 7, and 9 (see step 15.)
- take care of correct polarity

21. connect power supply for servo boards

- prepare cable with 0.22mm<sup>2</sup> cross section and cable sleeves (purple color) on both ends
- take care of correct polarity
- fasten all cables with zip ties



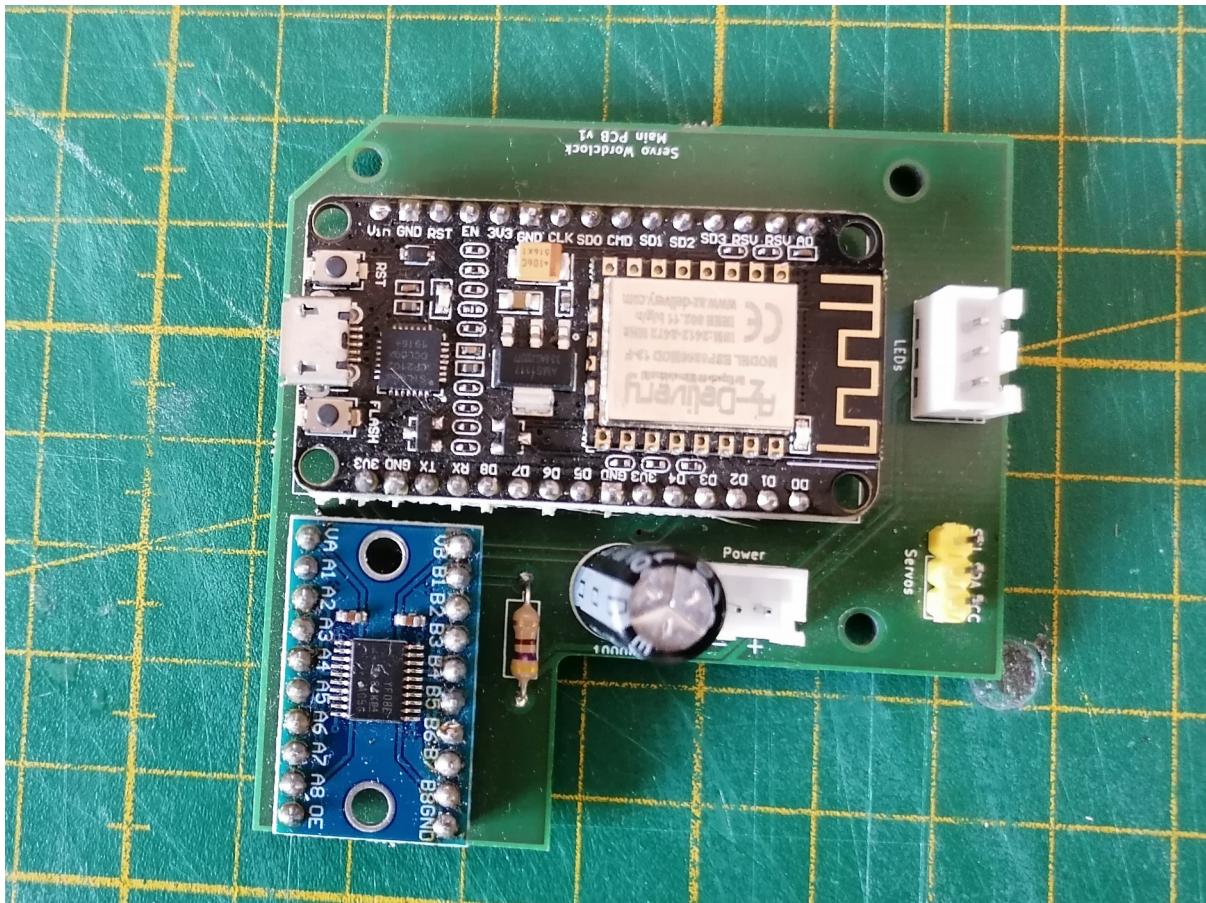


22. Upload Servo Wordclock firmware to ESP8266

- Follow instructions in Servo-Word-Clock\code\README.MD

**23. Prepare main PCB**

- Solder all components to main PCB as shown in the picture below
- take care of proper polarity for the capacitor
- take care of proper orientation of the level shifter



**24. Attach main PCB to frame**

- PCB goes in bottom left corner
- use M2.5x5.5 spacers and M2.5x12 screws, holes in frame need to be threaded first

**25. Connect main PCB**

- connect power on main PCB to screw terminal on frame (take care of proper polarity)
- connect first servo board
- connect first LED

**26. place long columns on frame**

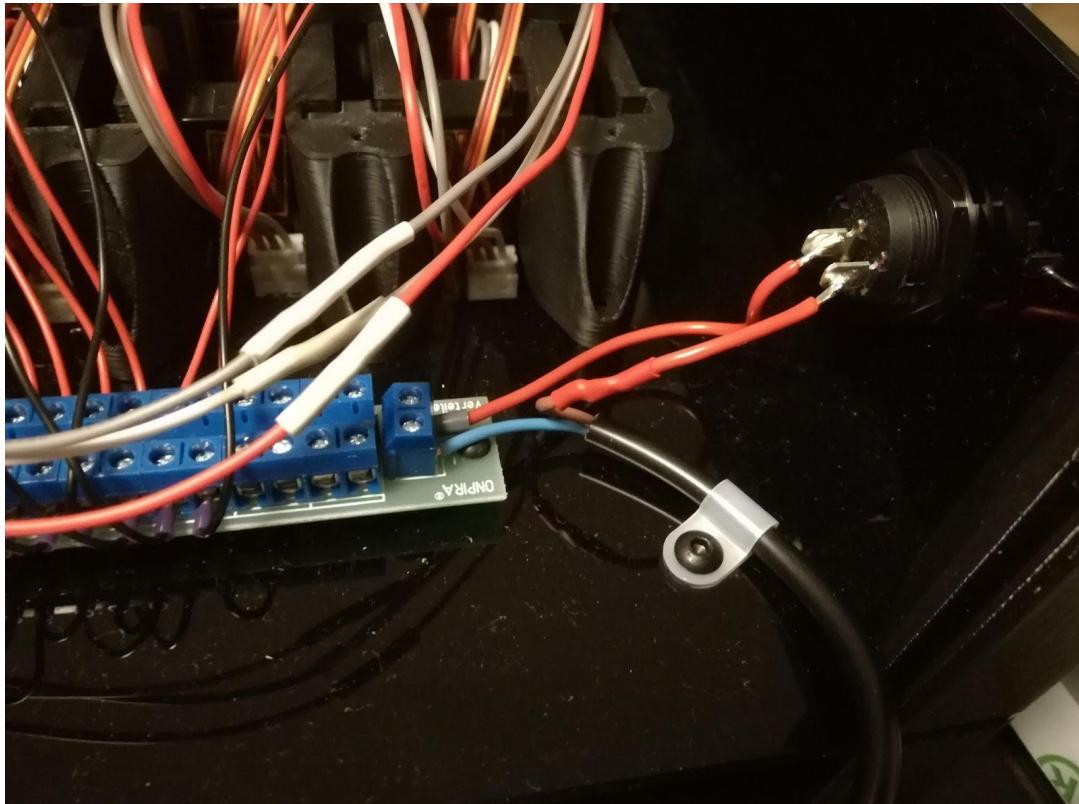
- a. column with cable feed through should be placed on bottom right corner (rear view)
- b. center columns with shorter slot go on left/right side
- c. center columns with longer slot go on top/bottom side

**27. insert side panel with hole for switch into bottom right corner**

**28. attach switch to side panel**

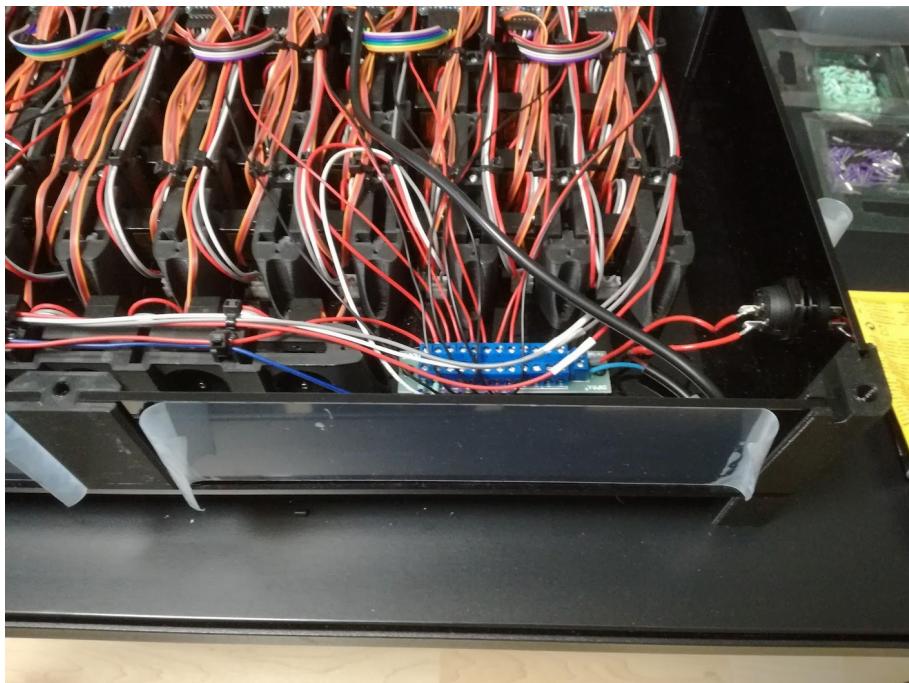
29. attach DC cable to switch and screw terminal

- a. solder positive voltage line (brown) to switch or attach with 4.8mm cable shoes (not included)
- b. solder cable with 0.5mm<sup>2</sup> cross section to switch (or use cable shoe) and attach other side to screw terminal (use cable sleeve)
- c. attach negative voltage line (blue) directly to screw terminal
- d. attach 3D printed cable holder to frame as strain relief (note: picture shows different cable holder)



30. insert all remaining side panels

- a. you can leave the protective foil on the outside and remove it later



31. prepare back panel

- a. remove protective foil from side without engraving
- b. glue 3D printed boxes on side without engraving



32. attach back panel

- a. use M6x90 screws for corner columns
- b. use M6x16 screws on both sides for center columns



**33. prepare screen**

- a. remove protective foil from one side
- b. attach self-adhesive diffusor film in center; spray panel with soap water to avoid bubbles



34. attach screen

- use M6x16 screws

35. Done!

- Remove the remaining protective foil
- connect clock to power supply
- follow instructions in *Servo-Word-Clock\code\manual.pdf*

