

VERSION 2.0

15-09-2022

DISH CONTROLLER

© EA3HMJ

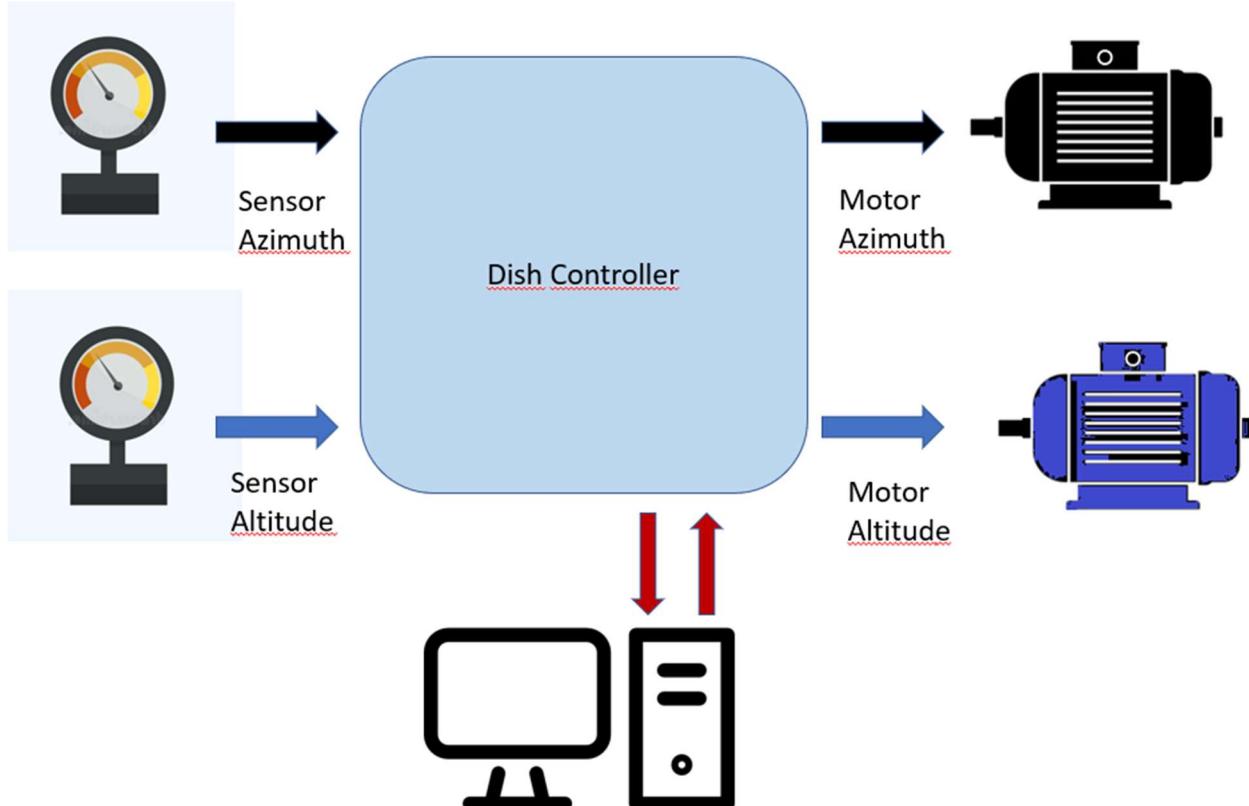
Translated by CT1BYM

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DISH CONTROLLER

INTRODUCTION

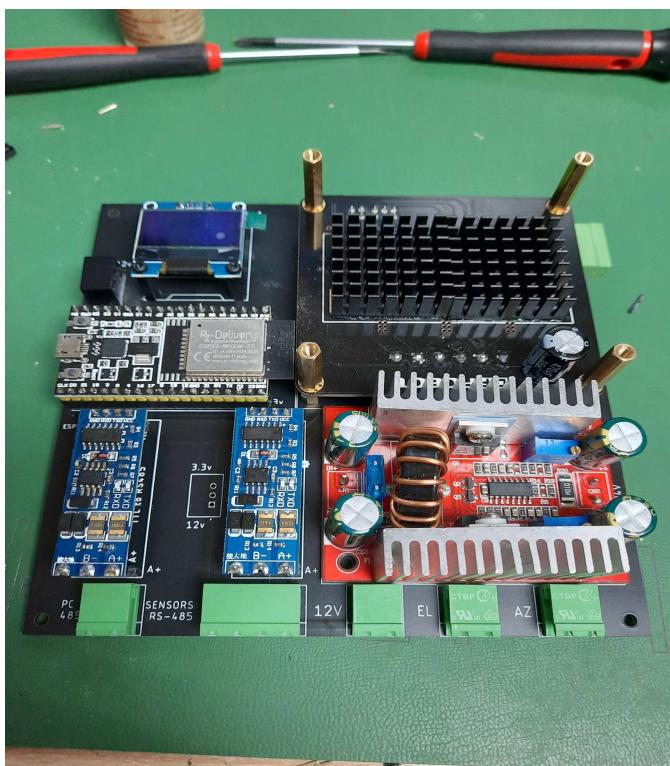
The controller allows to manage two motors with their corresponding position sensors.



This controller is designed to control parabolic dishes that require high tracking precision.

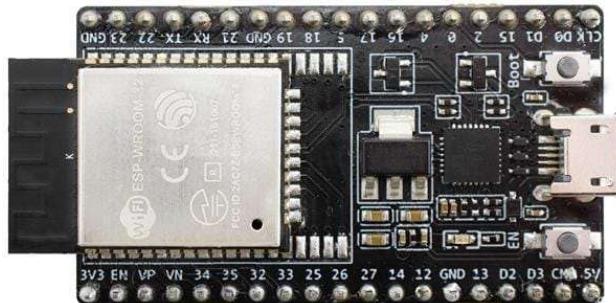
The accuracy of the system is not determined by the controller, instead by the position sensors and motors.

The system can be parameterized with the necessary data to achieve maximum precision.



HARDWARE CONTROLLER

The heart of the controller is the micro ESP32 DevKit C V4.



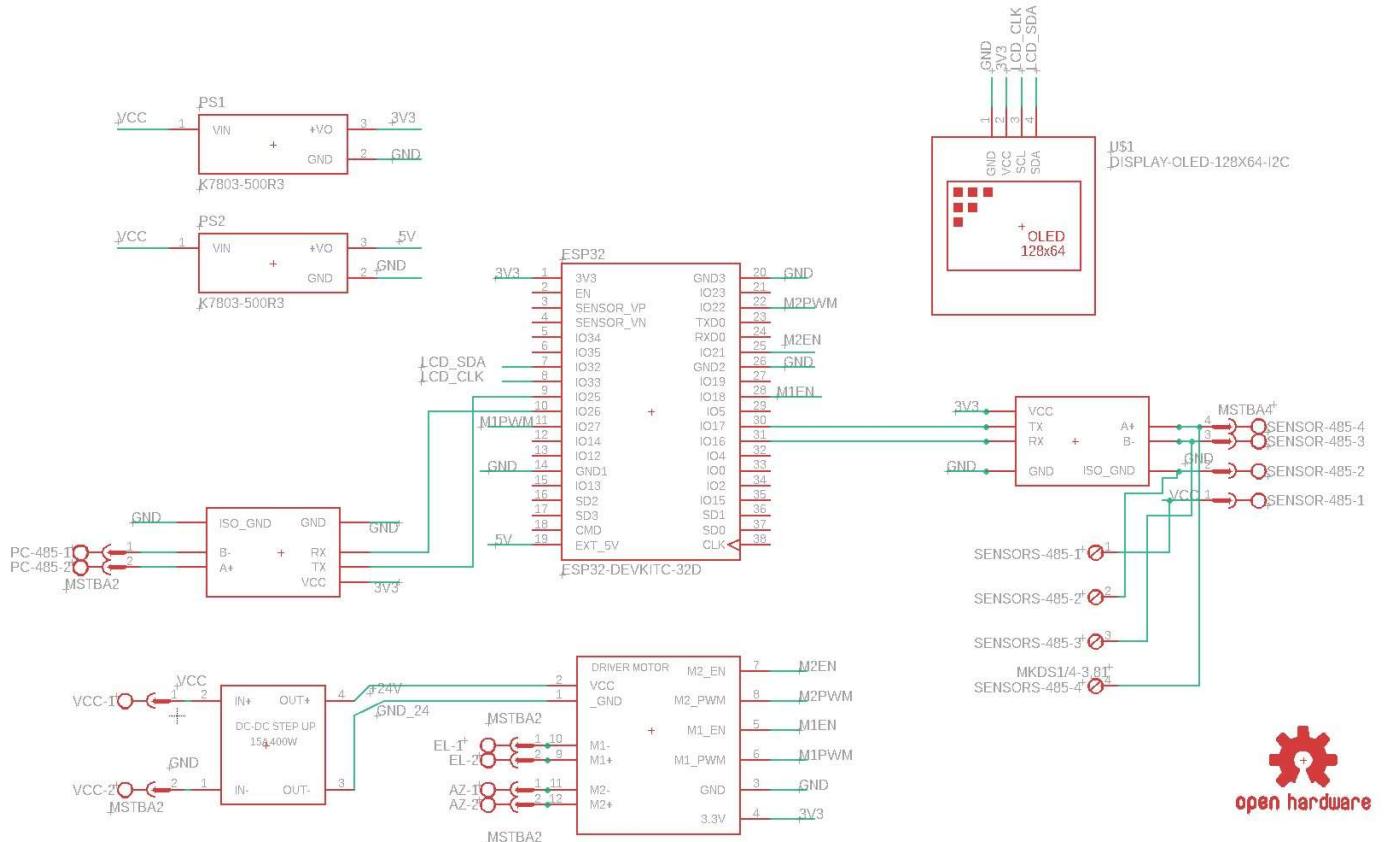
Manufactured by Espressif, it combines in a single microcontroller a CPU with 2 Tensilica LX6 cores, with a clock frequency of up to 240 MHz, and 512 kilobytes of SRAM. It integrates also a radio device for WLAN (802.11b/g/n) and Bluetooth (Classic and LE).

Among the more than 32 GPIO pins, are available: UART, I2C, SPI, DAC, ADC (12 Bit), all GPIO pins can be used as input or output.

Taking advantage of this power and with a few modules more we managed to control the parabola in azimuth and elevation.

It can be found at Amazon at a very reasonable price.

This is an modular assembly and this is the modules connection diagram.



FIRMWARE

The firmware runs on a RTOS multi-core system (real time operating system) that executes different tasks in each core, the distribution of tasks is:

- Core 0
 - Sensor reading
 - Azimut Control
 - Elevation control
- Core 1
 - PC communication
 - Display visualization (if connected).

COMMUNICATIONS

PC communication is made through an RS-485 port at 500,000 bauds.

The easiest way is to use a USB to RS-485 converter, like this model n the picture, which is very cheap.



PROTOCOL

Protocol	
?	A o E
?<ZL><end>	returns current position
?<ZL>+xxx.xx<end>	moving to the specified position
?S<end>	immediate engine stop
?O<end>	returns OffSet
?O+xxx.xx<end>	new offset assign OffSet
?R	reset micro
?K	communication test, returns OK
?D	Default values
?G	Activate-deactivate debug mode
?T	Turn count
?N	returns encoder position
?M	are we moving?
?V	firmware version
?C	decimals number
?0	motor precision or inertia
?1	degrees at which we change the speed from high to low
?2	PWM slow speed
?5	encoder bit number
?6	encoder multiplier
?8	PWM high speed
?9	Rotary sensor type
?X	Bypass mode, sensor configuration
?W	calculates the PWM for the lowest speed the motor is moving at
<end>	CR, LF, space

FIRMWARE UPDATE

To perform the firmware update, we need to connect the PC to the ESP32 through a USB-microUSB cable and know the COM port that the PC assigns. We need to have the CP210x driver installed.

If not, run the installation that is located in the CP210x_Windows_Drivers directory.

Now we execute the update.bat file that is in the “update” directory, passing the COM port where the ESP32 is connected as a parameter. Something similar to this should appear on the screen:

```
C:\Users\Jose A. Soler Amat\Google Drive\Documentos\Program ESP32\update>update.bat com31
esptool.py v4.2.1
Serial port com31
Connecting...
Failed to get PID of a device on com31, using standard reset sequence.

-----
Chip is ESP32-D0WDQ6 (revision 1)
Features: WiFi, BT, Dual Core, 240MHz, VRef calibration in efuse, Coding Scheme None
Crystal is 40MHz
MAC: c8:c9:a3:cc:04:fc
Uploading stub...
Running stub...
Stub running...
Changing baud rate to 921600
Changed.
Configuring flash size...
Flash will be erased from 0x00001000 to 0x00005fff...
Flash will be erased from 0x00008000 to 0x00008fff...
Flash will be erased from 0x0000e000 to 0x0000ffff...
Flash will be erased from 0x00010000 to 0x0005dfff...
Flash params set to 0x022f
Compressed 18880 bytes to 12992...
Wrote 18880 bytes (12992 compressed) at 0x00001000 in 0.5 seconds (effective 276.4 kbit/s)...
Hash of data verified.
Compressed 3072 bytes to 128...
Wrote 3072 bytes (128 compressed) at 0x00008000 in 0.1 seconds (effective 262.1 kbit/s)...
Hash of data verified.
Compressed 8192 bytes to 47...
Wrote 8192 bytes (47 compressed) at 0x0000e000 in 0.1 seconds (effective 524.3 kbit/s)...
Hash of data verified.
Compressed 316976 bytes to 177677...
Wrote 316976 bytes (177677 compressed) at 0x00010000 in 3.4 seconds (effective 747.5 kbit/s)...
Hash of data verified.

Leaving...
Hard resetting via RTS pin...
```

There is an online tool that also allows us to program our ESP32.

<https://espressif.github.io/esptool-js/>

RECOMMENDED AZIMUTH AND ELEVATION SENSORS

I recommend the 58-S8192GKD01 encoder from TWK Elektronik for azimuth.



<https://www.ebay.es/item/TWK-ELEKTRONIK-ROTARY-ENCODER-KBE-58-S8192-G-K-D01-FREE-SHIP/280952453283>

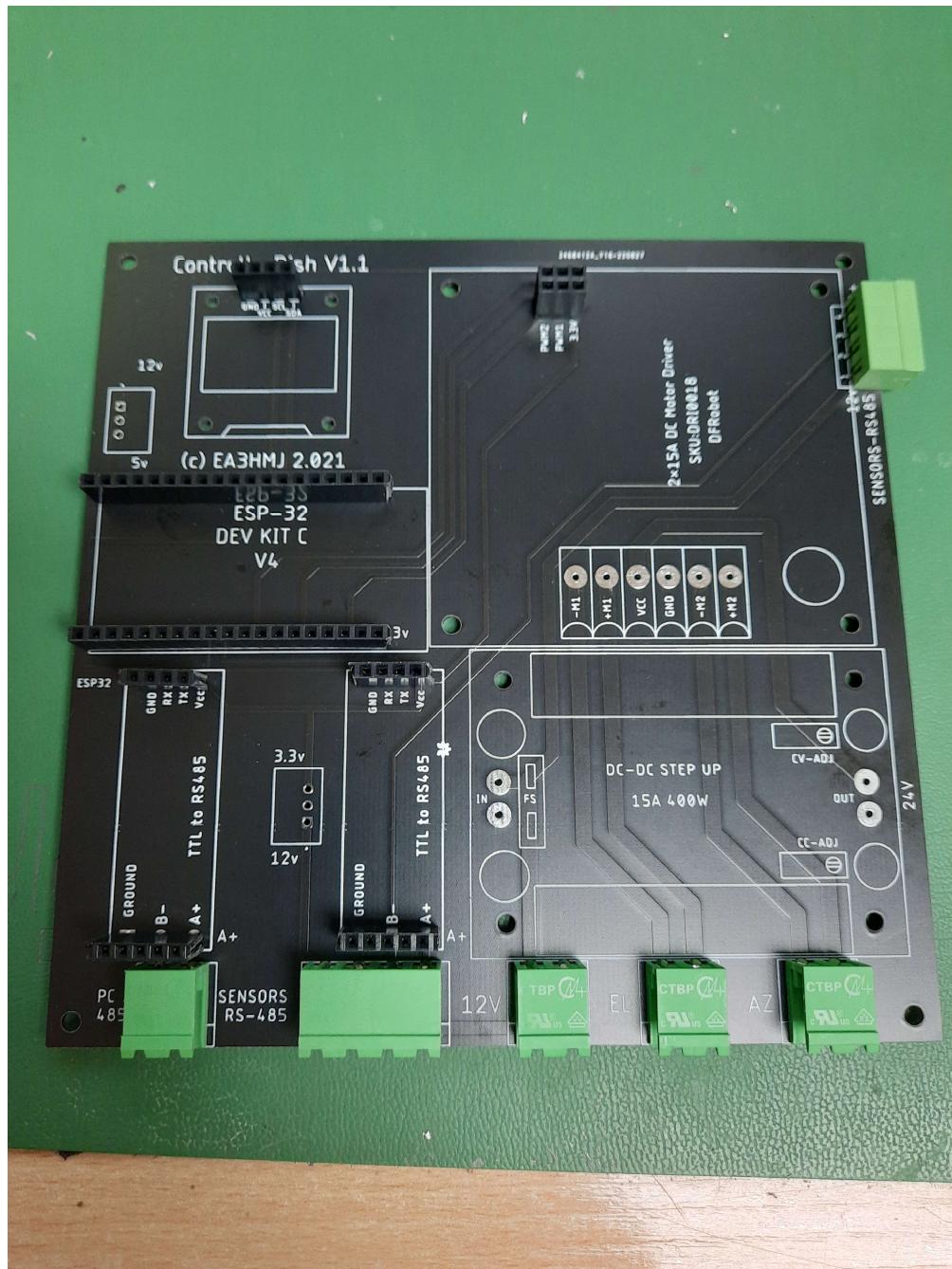
For elevation, the SOLAR-360 encoder in its RS-485 Modbus model, preferably.



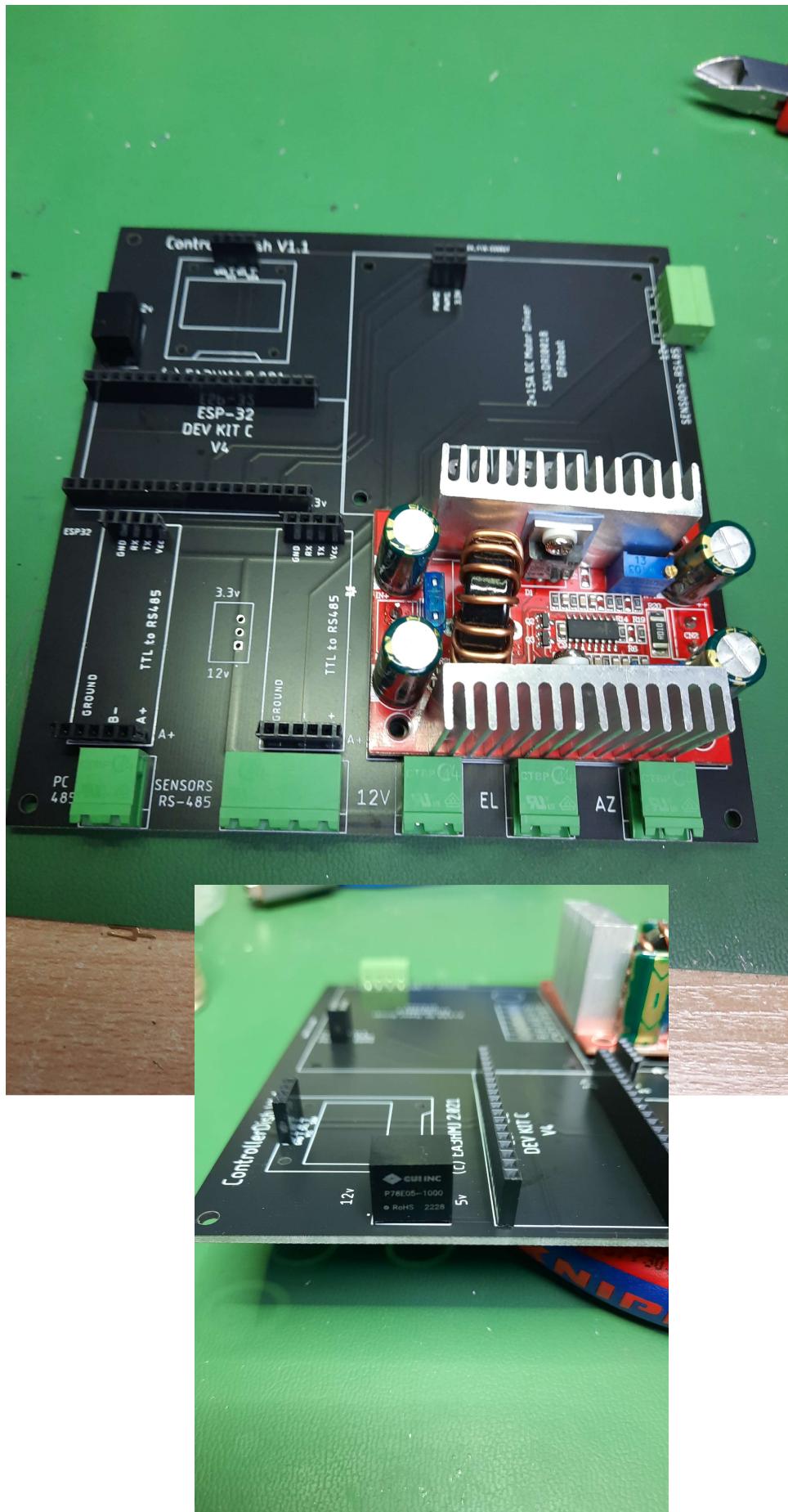
<https://www.leveldevelopments.com/products/inclinometers/inclinometer-sensors/single-axis-inclinometer-sensors/solar-360-series/solar-360-2-rs485m-inclinometer-sensor-single-axis-180-rs485-modbus-with-tc/>

MOUNTING

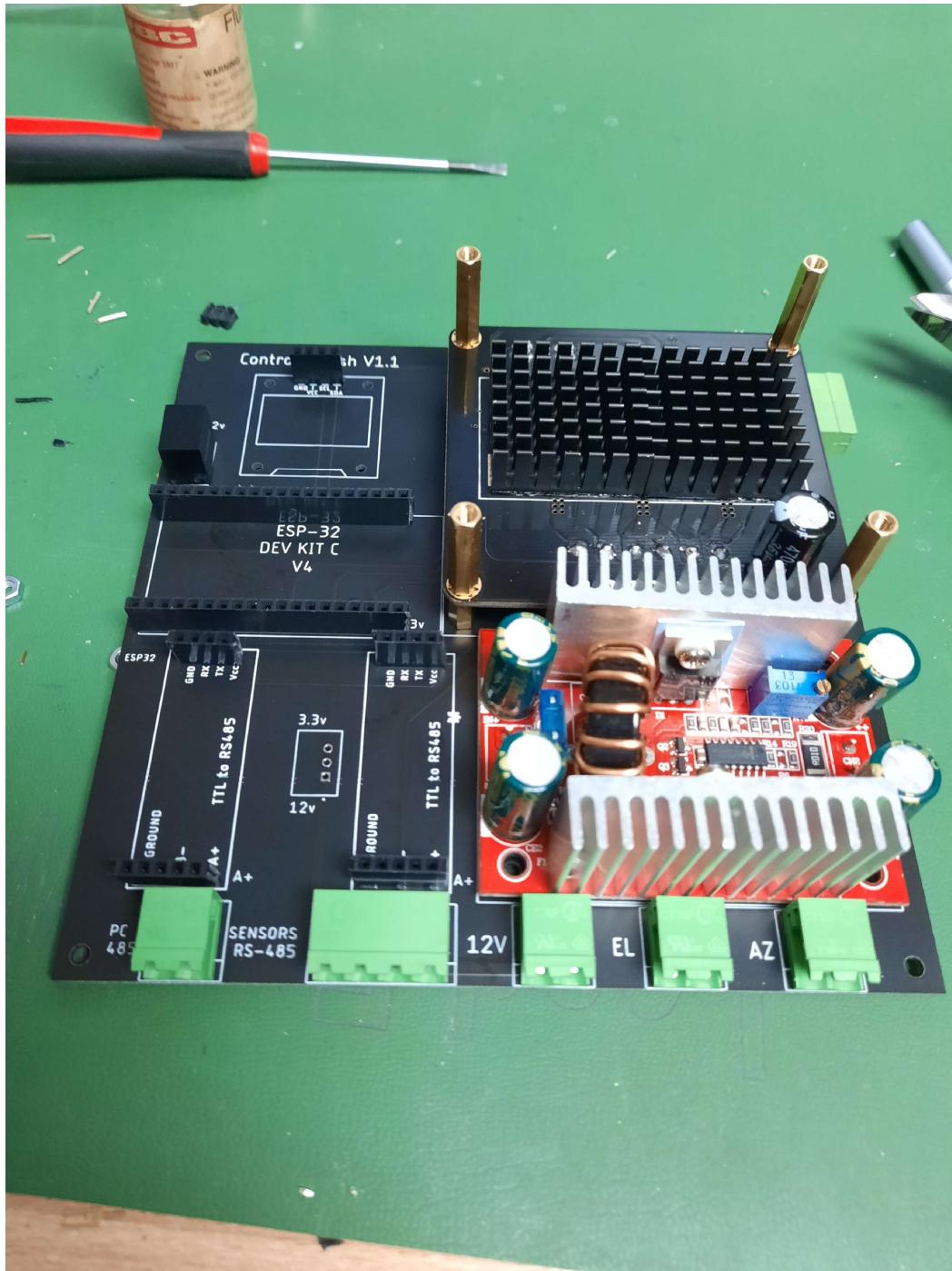
The connectors and interconnection pins with the modules are assembled.



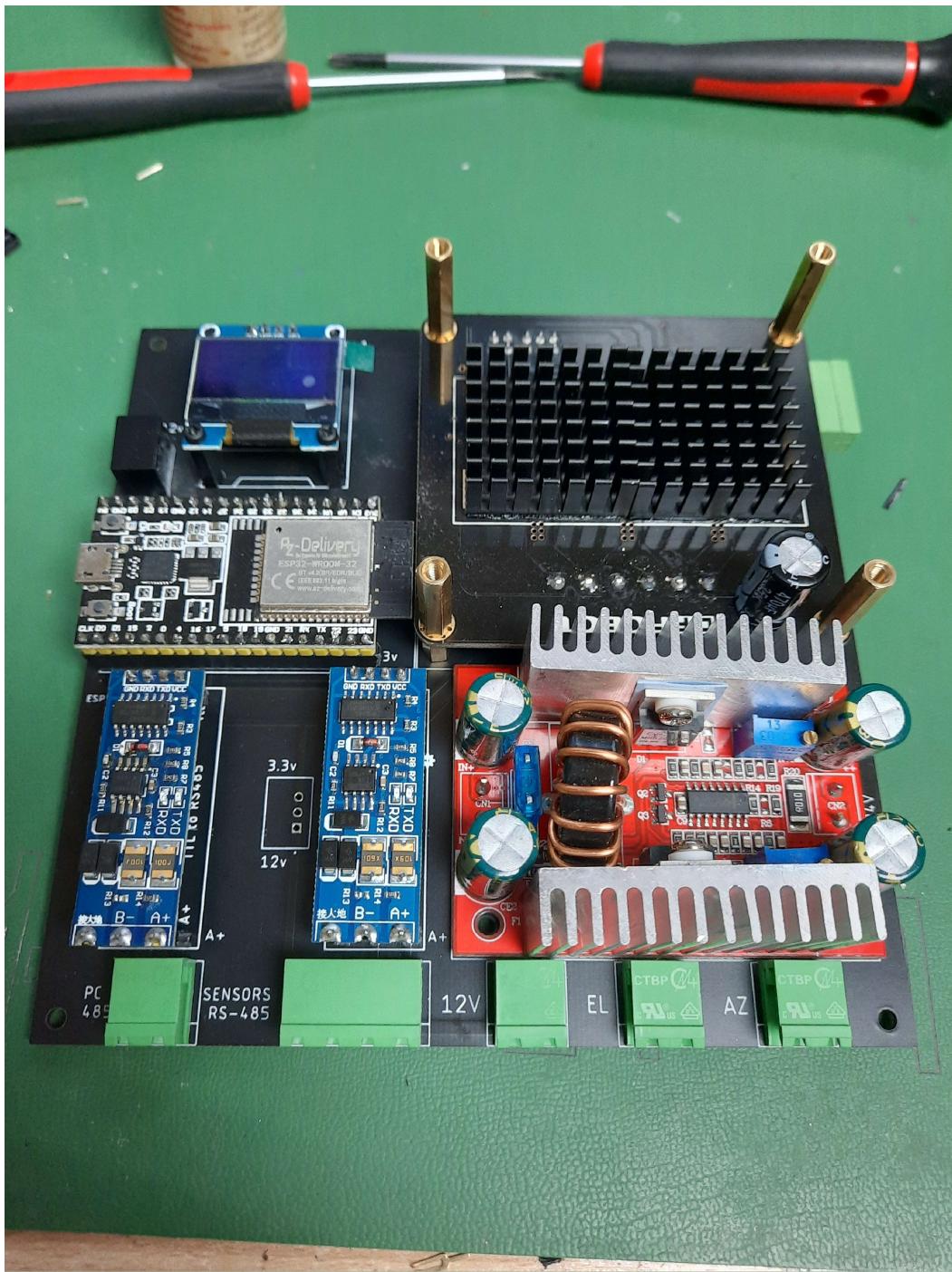
We mount the DC-DC module from 12V to 5V and the one that goes up from 12V to 24V for the motors and adjust the output value to 24V.



We continue with the motor controller.



Finally, we install the micro, the OLED screen and the RS232 to RS485 modules.

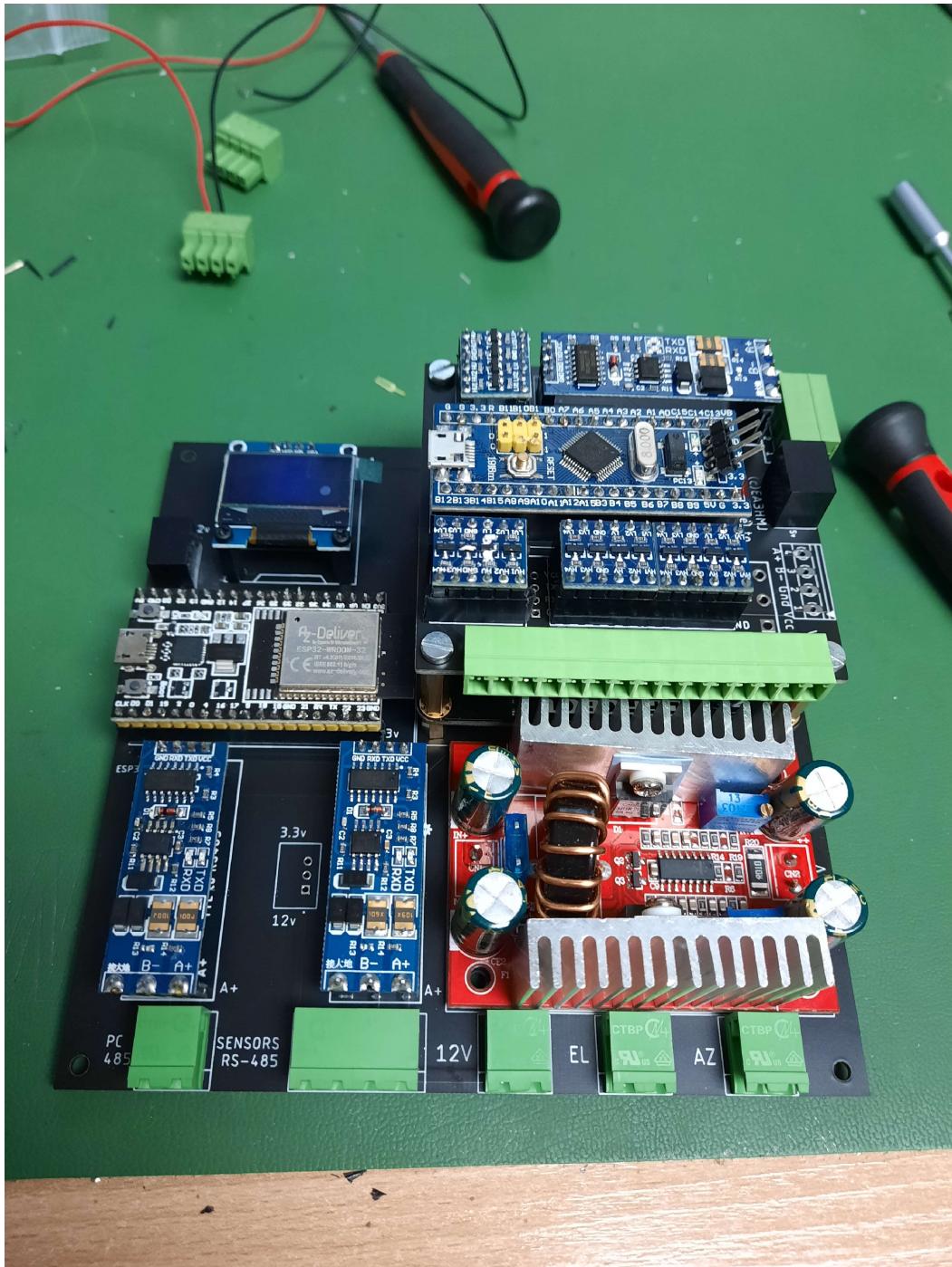


And all is ready to go!

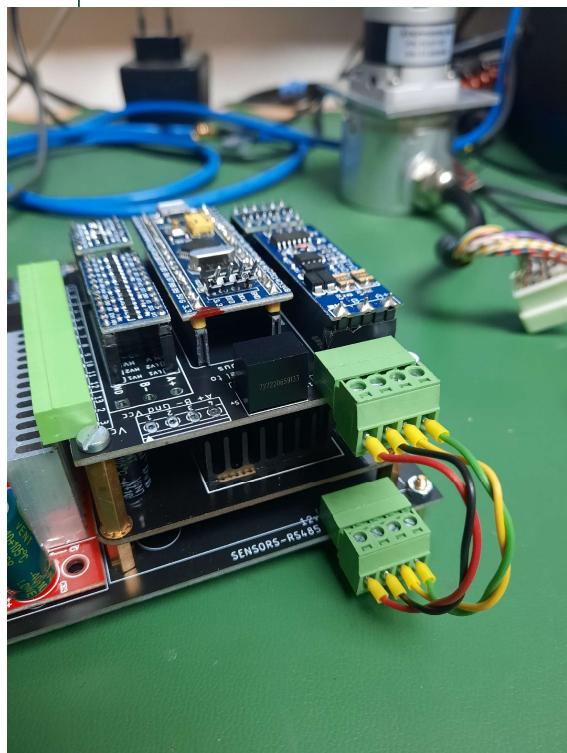
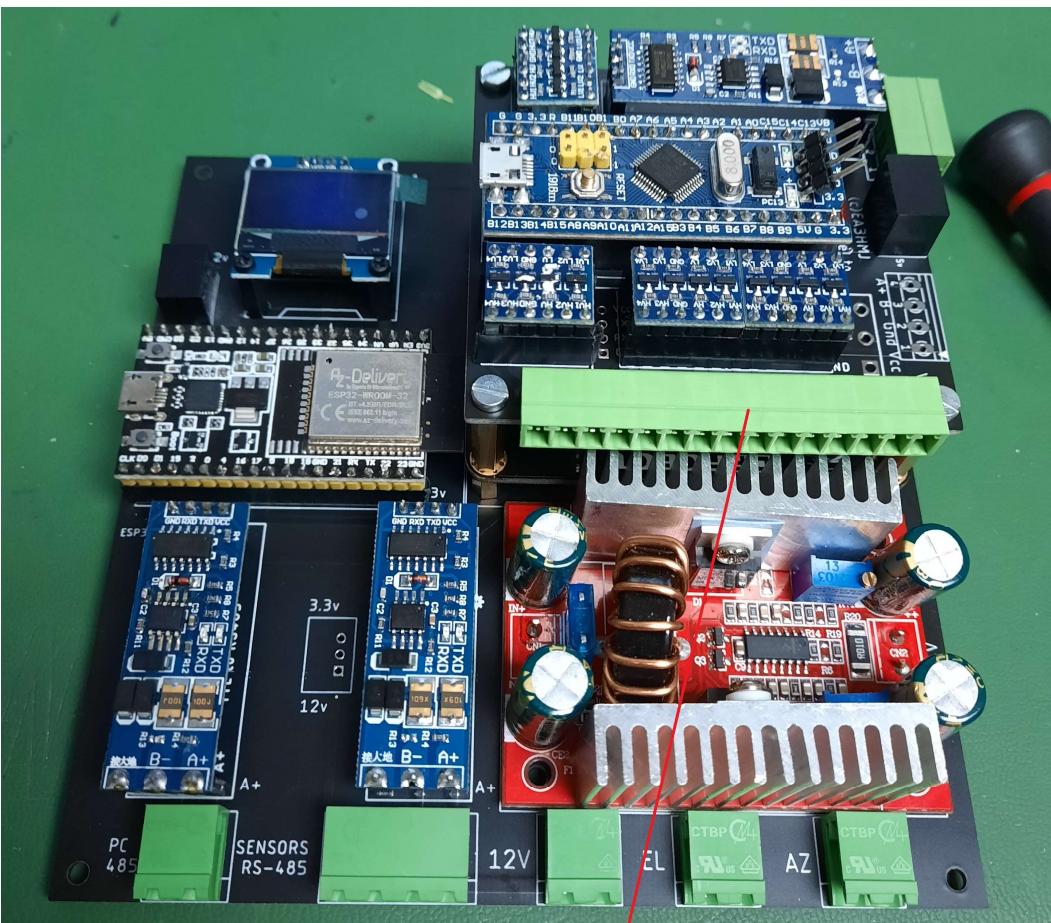
PARALLEL TO RS485 MODBUS CONVERTER

If we use a TWK Elektronik 58-S8192GKD01 absolute optical encoder for azimuth, we must use the interface to convert from parallel to modbus.

This interface is mounted on top of the motor controller, for this we will add some 20mm long M3 spacers to support the azimuth encoder module.



CONTROLLER CONECTIONS



We must connect controller with the interface.

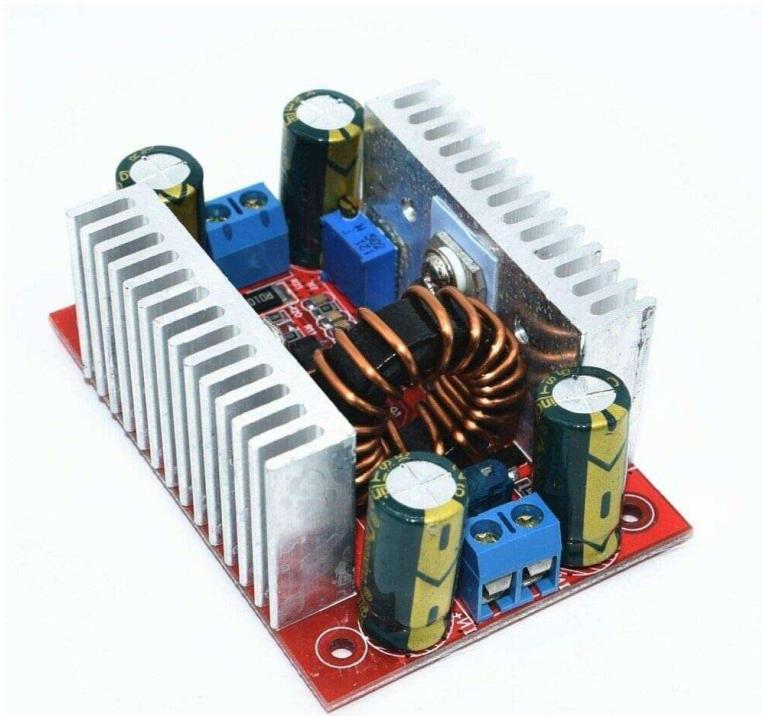
MOTORS MODULE MODIFICATIONS



We will puncture the module on the upper face, so we must remove the power supply and motors connectors. Then we change the electrolytic capacitor to the lower face.

Two 2-pin pluggable connectors are mounted on the lower face for motors connections, the two in the center are left empty.

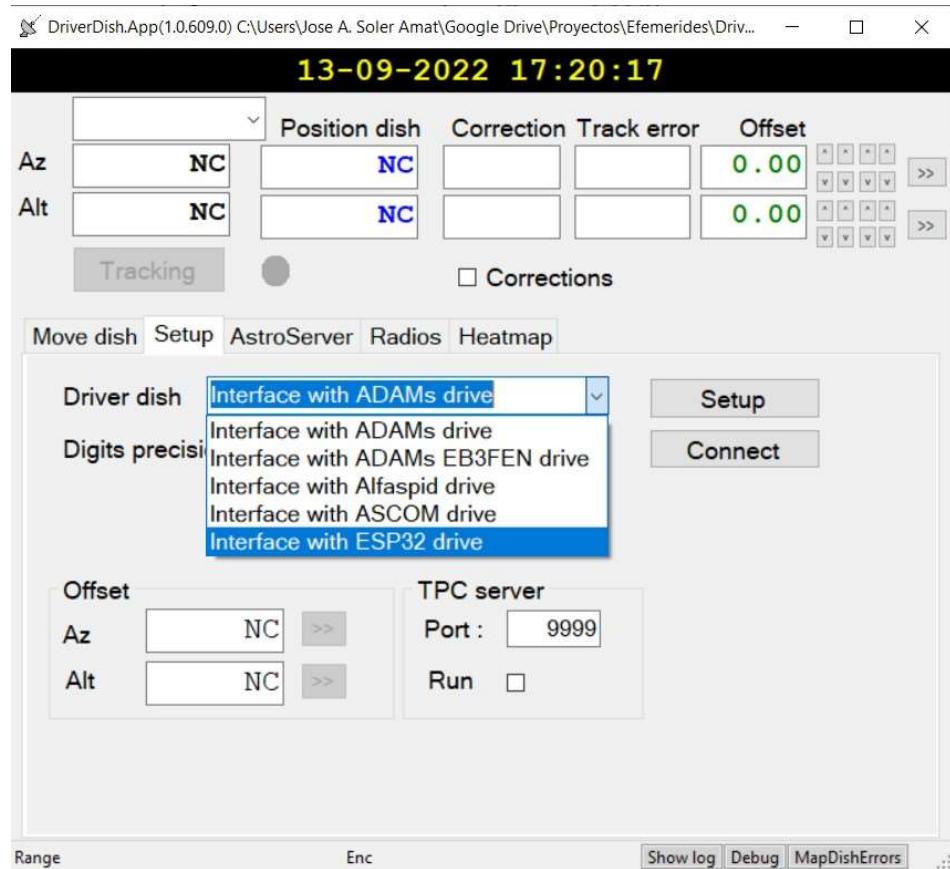
DC/DC MODULE MODIFICATION



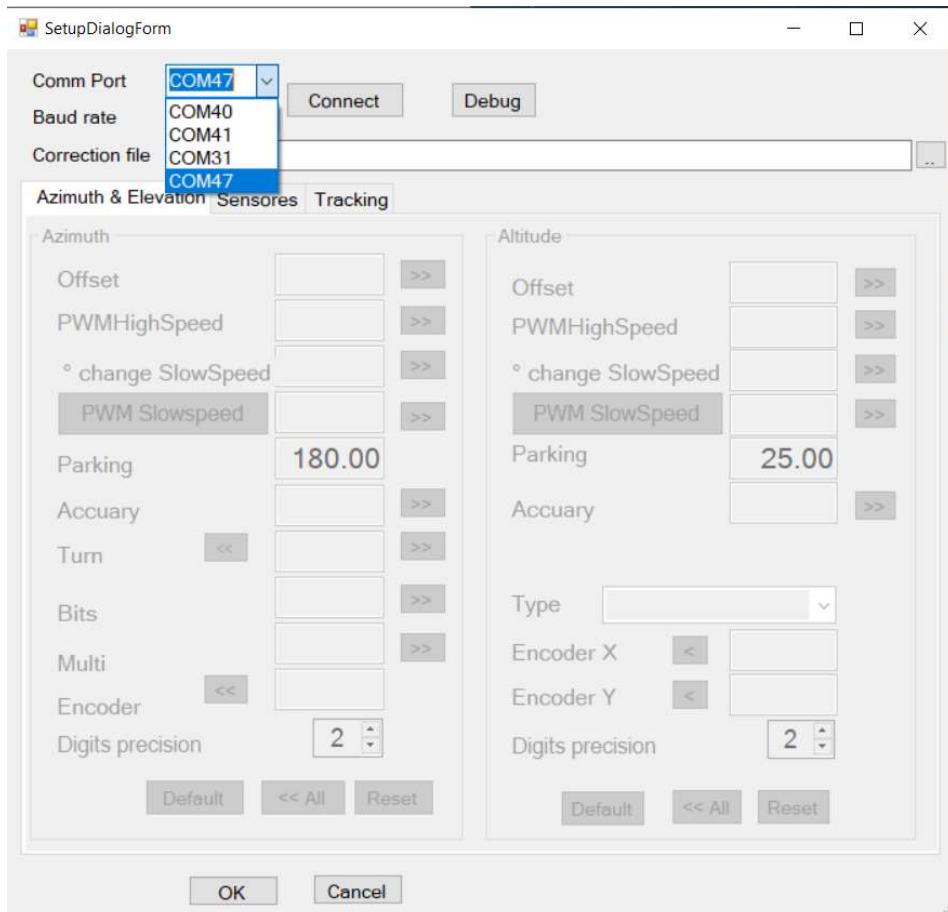
We remove the two power connectors from this module.

CONTROLER SETUP

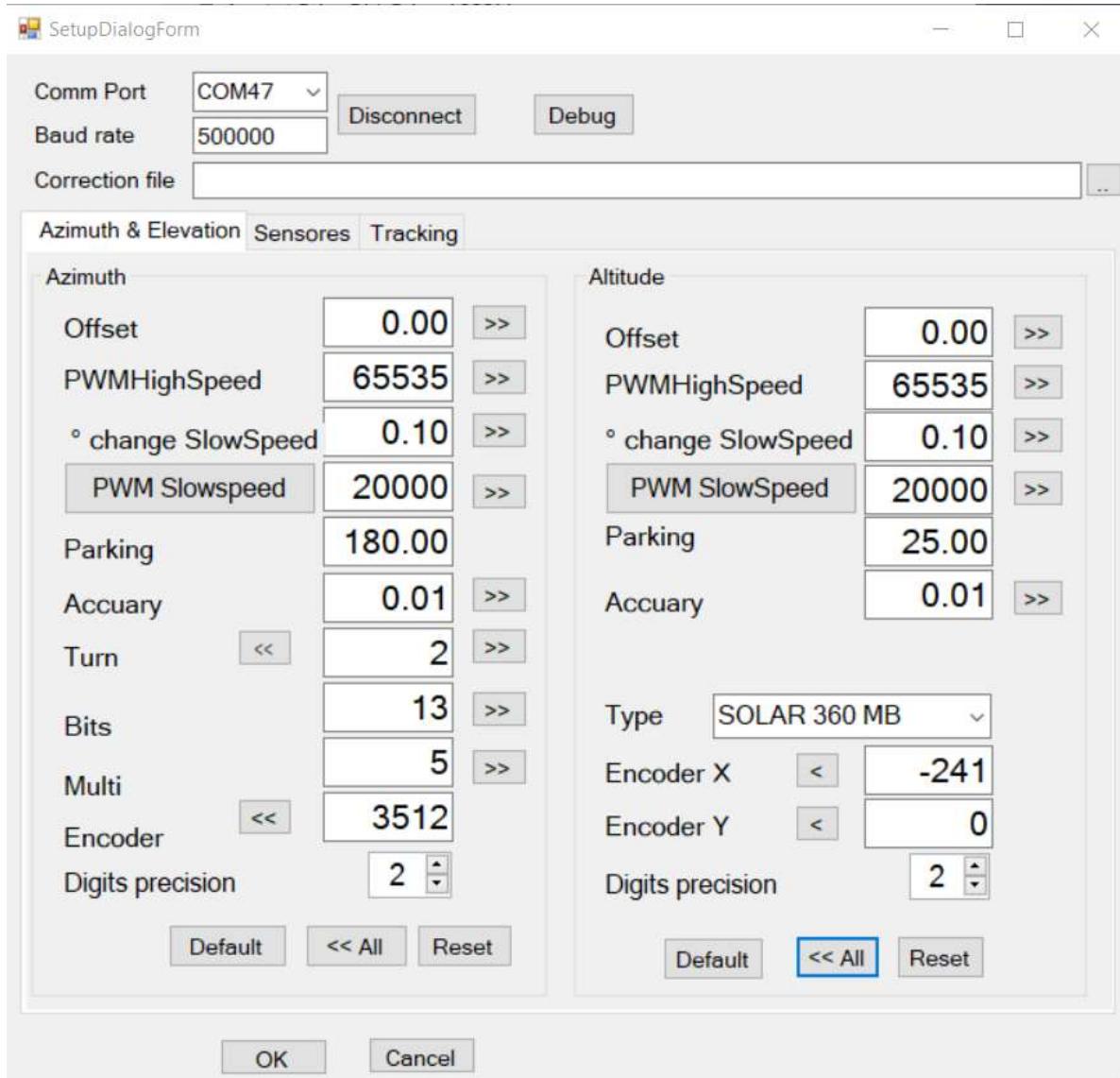
We run the DriverDish.App program and select the ESP32 driver.



Press Setup.



We select the serial port where we have connected the controller and press the Connect button.



If everything is correct, the options will enabled and we click on the <<All buttons for Azimuth and Altitude. This will load the default values.

The **PWM SlowSpeed** buttons calculate the minimum PWM to move the motor, it is helpful to set the value in our system.

Secuencia del movimiento y cambio de velocidad durante un desplazamiento.

Position	Operation	Value
90.00	Current position	
	Move to 100.00	
	Start CW at PWM high speed	65535
99.90	° Change slow speed	0.10
	CW at PWM slow speed	20000
99.99	° accuracy (precision)	0.01
	Stop motor	
100.00	Target position	

On the azimuth encoder configuration, one must define the number of bits and if it has a multiplier to increase the resolution.

The offset parameters are used to set the correct position of the dish. For azimuth we have the turn number of the Encoder (Turn) in case of having a multiplier.

In elevation we must choose the type of Encoder that we use from the list.

PURCHASE LINKS

ESP32 (1)

https://www.amazon.de/AZDelivery-ESP32-Development-Successor-Compatible/dp/B074RGW2VQ/ref=sr_1_1_sspa?adgrpid=83194267838&gclid=Cj0KCQiAuP-OBhDqARIsAD4XHpeSW0eKsyUARDcnBOjoxUDe6NdXFQEm3esHTqf8M8plw1DNTGFVZ0aAntIEALw_wcB&hvadid=394622305324&hvdev=c&hvlocphy=1005424&hvnetw=g&hvqmt=e&hvrand=2820214561532662121&hvtargid=kwd-300234569195&hydadcr=26632_1871232&keywords=esp32&qid=1642084973&sr=8-1-spons&psc=1&smid=A1X7QLRQH87QA3&spLa=ZW5jcnlwdGVkUXVhbGlmaWVyPUExTzNXVUJJM0NBU09UJmVuY3J5cHRIZElkPUEwODg2MTUzMU5BU0FWSkpYQTFZVCZlbnMyeXB0ZWRBZEIkPUEwODMzOTgzWjcxOFICQkFNSVIPJndpZGdldE5hbWU9c3BfYXRmJmFjdGlvbj1jbGlja1JIZGlyZWN0JmRvTm90TG9nQ2xpY2s9dHJ1ZQ==

MOTOR MODULE REGULATOR (1)

<https://www.dfrobot.com/product-796.html>

<https://es.farnell.com/dfrobot/dri0018/m-dulo-controlador-de-motor-dc/dp/3769956>

https://es.aliexpress.com/item/32539380756.html?src=google&albch=shopping&acnt=439-079-4345&isdl=y&slnk=&plac=&mtcp=&albbt=Google_7_shopping&aff_platform=google&aff_short_key=UneMJZVf&gclsrc=aw.ds&&albagn=88888888&&ds_e_adid=438858099982&ds_e_matchtype=&ds_e_device=c&ds_e_network=u&ds_e_product_group_id=743612850914&ds_e_product_id=es32539380756&ds_e_product_merchant_id=105170301&ds_e_product_country=ES&ds_e_product_language=es&ds_e_product_channel=online&ds_e_product_store_id=&ds_url_v=2&ds_dest_url=https://es.aliexpress.com/item/32539380756.html?&albcn=10191226961&albag=102259630536&isSmbAutoCall=false&needSmbHouyi=false&gclid=Cj0KCQiA1KiBBhCcARIsAPWqoSrHdTpKxSwgM9XWePo5AcHG7vpP1FV8QX6EmwMnfLw2KllpgPl06saAhTjEALw_wcB

DC/DC CONVERTER 400W (1)

https://www.amazon.es/gp/product/B07VN9Z8G2/ref=ox_sc_act_title_2?smid=A3U3NV7MT8POQS&psc=1

RS232 TO RS485 MODULE (SELFMANAGED) (2)

https://es.aliexpress.com/item/32707755990.html?src=google&albch=shopping&acnt=439-079-4345&isdl=y&slnk=&plac=&mtcp=&albbt=Google_7_shopping&aff_platform=google&aff_short_key=UneMJZVf&gclsrc=aw.ds&&albagn=88888888&&ds_e_adid=475827849334&ds_e_matchtype=&ds_e_device=c&ds_e_network=u&ds_e_product_group_id=855473407372&ds_e_product_id=es32707755990&ds_e_product_merchant_id=107407105&ds_e_product_country=ES&ds_e_product_language=es&ds_e_product_channel=online&ds_e_product_store_id=&ds_url_v=2&ds_dest_url=https://es.aliexpress.com/item/32707755990.html?&albcn=11489913537&albag=114956049489&isSmbAutoCall=false&needSmbHouyi=false&gclid=Cj0KCQjwrsGCBhD1ARIsALILBYrQz8ac3gJ9uLeXPPGIhVvi6a_5ILdqH--IhWLW_ciD0QVMxztG5kaAsyVEALw_wcB

DC/DC MODULE 5.0V (1)

<https://www.mouser.es/ProductDetail/CUI-Inc/P78E05-1000?qs=sGAEPiMZZMsc0tfZmXiUnQ%252BwKzhbvwnuWZaC%252BvijOH8Qr0CL%2FA8o3g%3D%3D>

4 PIN CONNECTOR 3.81MM (1)

https://www.amazon.es/3-81mm-pernos-Staight-Bloques-Conectores/dp/B01EZMZXTG/ref=sr_1_14?_mk_es_ES=%C3%85M%C3%85%C5%BD%C3%95%C3%91&dchild=1&keywords=pi_tch+3.81&qid=1615983833&sr=8-14

2 PIN CONNECTOR 3.81 MM (4)

https://www.amazon.es/5pairs-KF2EDG-3-81mm-Tornillo-terminal/dp/B01EZQASXI/ref=sr_1_46?_mk_es_ES=%C3%85M%C3%85%C5%BD%C3%95%C3%91&criid=MMVIQ0YAYOJD&keywords=3.81mm+2P&qid=1642148643&sprefix=3.81mm+2p%2Caps%2C344&sr=8-46

SIMPLE 2.54MM PCB CONNECTION ASSORTMENT (VARIOUS SIZES)

https://www.amazon.es/dp/B07Q1XBGFB>tag=amz-mkt-chr-es-21&ascsubtag=1ba00-01000-org00-win10-other-nomod-es000-pcomp-feature-scomp-wm-5&ref=aa_scomp

2.54 MM DOUBLE PCB CONNECTION ASSORTMENT (1 2X3)

https://www.amazon.es/Aussel-Piezas-Surtido-Arduino-Apilable/dp/B01MPXO2HX/ref=sr_1_29?_mk_es_ES=%C3%85M%C3%85%C5%BD%C3%95%C3%91&clid=49BDE12MCJYT&keywords=pin%2Bhembra%2BPCB%2B2.54mm%2Bdoble%2B2x3%2Bpines&qid=1642148507&s=electronic&sprefix=pin%2Bhembra%2Bpcb%2B2.54mm%2Bdoble%2B2x3%2Bpines%2Celectronics%2C134&sr=1-29&th=1

SEPARATORS M3 ASSORTMENT (4 OF 20MM)

https://www.amazon.es/YIXISI-Hexagonal-Espaciador-Separador-Reparaci%C3%B3n/dp/B0942FV9GQ/ref=sr_1_1_sspa?_mk_es_ES=%C3%85M%C3%85%C5%BD%C3%95%C3%91&clid=HOOXZHGR2PC&keywords=surtido%2Bseparadores%2BM3&qid=1642148937&suffix=surtido%2Bseparador%2Bm3%2Caps%2C104&sr=8-1-spons&spLa=ZW5jcnlwdGVkUXVhbGlmaWVvPUE0RDBPWIA4Q1VZNEcmZW5jcnlwdGVkSWQ9QTA1MTExNTVHUTVGMIIVTIVWNzgmZW5jcnlwdGVkQWRJZD1BMDE0MTQ5MjM4S1FHNjQzWkM5WUgmd2lkZ2V0TmFtZT1zcF9hdGYmYWN0aW9uPWNSaWNrUmVkaXJIY3QmZG9Ob3RMb2dDbGljaz10cnVI&th=1

CIRCULAR CONNECTORS IP68 (3 OF 2PIN, 1 OF 4 PIN)

https://es.aliexpress.com/item/32883890801.html?spm=a2g0o.productlist.0.0.71042179hnXxIC&algo_pvid=3f2ab446-0187-4f3c-b373-27b7c90f66e0&algo_exp_id=3f2ab446-0187-4f3c-b373-27b7c90f66e0-2&pdp_ext_f=%7B%22sku_id%22%3A%2265644005055%22%7D&pdp_npi=2%40dis%21EUR%211.63%211.61%21%212.0%21%21%402100bdd16630525349307704ee23f%2165644005055%21sea&curPageLogUid=Ui8BWV3m4AKH

https://es.aliexpress.com/item/32988174065.html?spm=a2g0o.productlist.0.0.378d7570922NHT&algo_pvid=cefc936-c520-4ba0-b7c2-cd119e2352bd&algo_exp_id=cefc936-c520-4ba0-b7c2-cd119e2352bd-48&pdp_ext_f=%7B%22sku_id%22%3A%2266791335416%22%7D&pdp_npi=2%40dis%21EUR%211.98%211.88%21%212.58%21%21%402100bdf116630524472994209e81f8%2166791335416%21sea&curPageLogUid=6AegeCGZ73ah

CIRCULAR CONNECTOR IP68 16 PIN (1)

https://es.aliexpress.com/item/33002514374.html?spm=a2g0o.productlist.0.0.588248f29DI7Zh&algo_pvid=7dcc7f2b-6d59-48f6-a199-bfd4741fd28b&algo_exp_id=7dcc7f2b-6d59-48f6-a199-bfd4741fd28b-26&pdp_ext_f=%7B%22sku_id%22%3A%2267001233806%22%7D&pdp_npi=2%40dis%21EUR%217.34%216.97%21%21%213.21%21%21%402100bdd516630528521611949e53ab%2167001233806%21sea&curPageLogUid=4KZ42QSgoi2P

https://es.aliexpress.com/item/33005228660.html?spm=a2g0o.productlist.0.0.3dee2c41Pa0XWU&algo_pvid=f988b3a3-b617-478c-ae72-deb19d680df2&algo_exp_id=f988b3a3-b617-478c-ae72-deb19d680df2-12&pdp_ext_f=%7B%22sku_id%22%3A%2267052886580%22%7D&pdp_npi=2%40dis%21EUR%215.94%215.65%21%21%212.58%21%21%402100bdd516630529145151923e52b6%2167052886580%21sea&curPageLogUid=TfmX0v7IYdVI

CONTAINER CABINET (1)

<https://www.safybox.com/es/safybox-bres/187-bres-325.html>