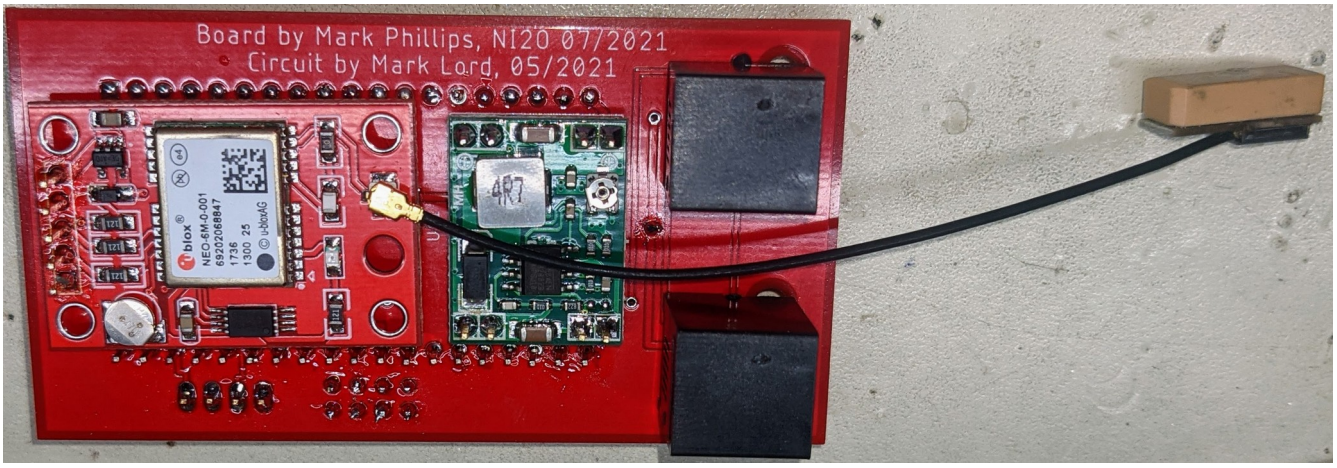
Construction Notes for Homebrew WiFi/Bluetooth/GPS accessory for Celestron telescope mounts



Circuit and firmware by Mark Lord.
Printed Circuit Board by Mark Phillips, NI2O

Version 1.01

Name	Date	Comments
Mark Phillips	07/072021	Initial document creation
Mark Phillips	10/07/2021	Publication

1.0 Abstract

Celestron telescope mounts supporting the NexStar+ hand controller protocol have various capabilities not included with the initial purchase. These features are available as additional hardware purchases and include such things as GPS time and location sensing, WiFi mount control, Serial computer interface etc.

It is the aim of this project to create a single home made accessory that will enable Celestron mount owners to enable these additional features at a reasonable cost.

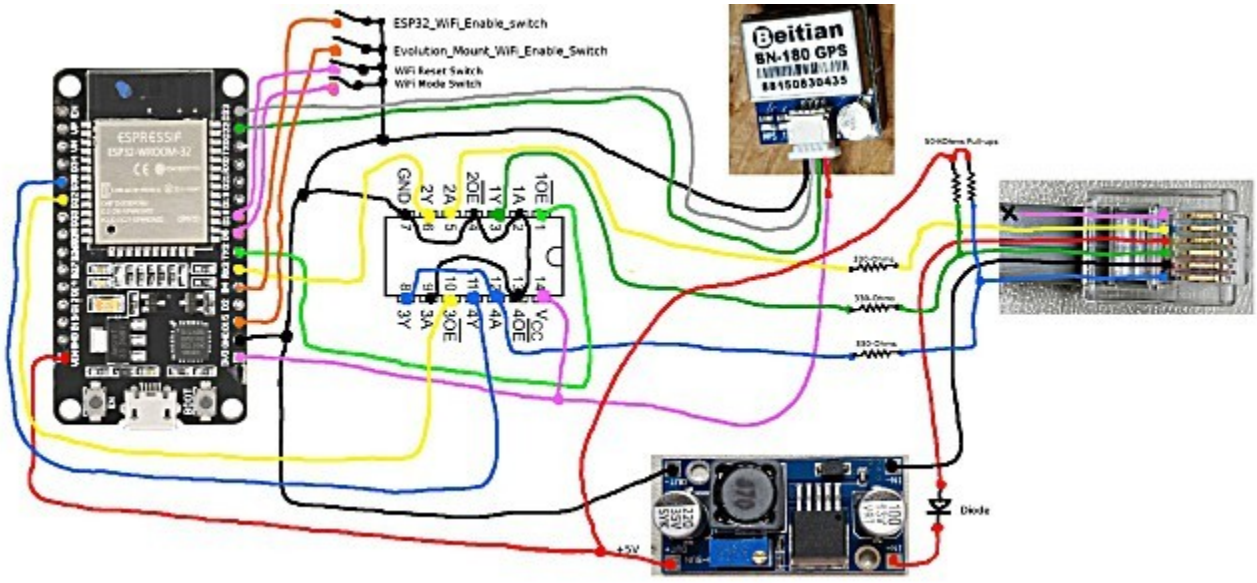
2.0 Solution

Using the ESP32 microprocessor allows us to not only communicate with the Mount but also bridge other accessories onto the Mount. Commonly available development boards are available that not only contain the microprocessor but also WiFi and Bluetooth antennas. These boards are similar on concept to the Arduino in that they are a carrier board with all of the ESP32 control lines brought out to the edge of a PCB.

The addition of a GPS receiver board, switch mode power supply board, OLED display board and possibly Ethernet boards are possible. No modifications to the mount are required. The accessory plugs directly into the Hand Controller port on the mount thus preserving manufacturers warranties etc.

The use of Common-Off-The-Shelf (COTS) components will greatly reduce both the cost and also the construction skills required for this project. The firmware (software that runs inside the microprocessor) is available for your own modification

3.0 Construction



3.1 acquiring required components

The latest information on this project can be found at the Cloudy Nights amateur astronomy website here https://www.cloudynights.com/topic/743750-homebrew-wifibluetooth-accessory-for-aux-bus/

3.1.1 Bill of Materials (BOM)

You will require the following components to complete this project;

Printed Circuit Board https://github.com/g7ltt/Celestron-GPS-WiFi-BT-Interface
Firmware http://rtr.ca/esp32_wifi+bt+gps/
“Red” NEO6M GPS receiver board (check ebay and Amazon)
ESP32S Development Board “C” (Amazon/ebay etc)
MPT1584 Buck Convertor DC-DC power supply (Amazon/ebay etc)
4 off 10K 0805 SMD resistors (Amazon/ebay etc)
3 off 330R 0805 SMD resistors (Amazon/ebay etc)
74HC125PW TSSOP Quad line driver (Amazon/ebay etc)
4 pin header (Amazon/ebay etc)
5 pin header (Amazon/ebay etc)
“4x2” pin header and jumpers (Amazon/ebay etc)
4 off 2 pin header (Amazon/ebay etc)
2 off RJ11 6P6C PCB mounted sockets (Amazon/ebay etc)
RJ11 6P6C male-male extension cable (straight - not rolled!!) (Amazon/ebay etc)

Optional components;

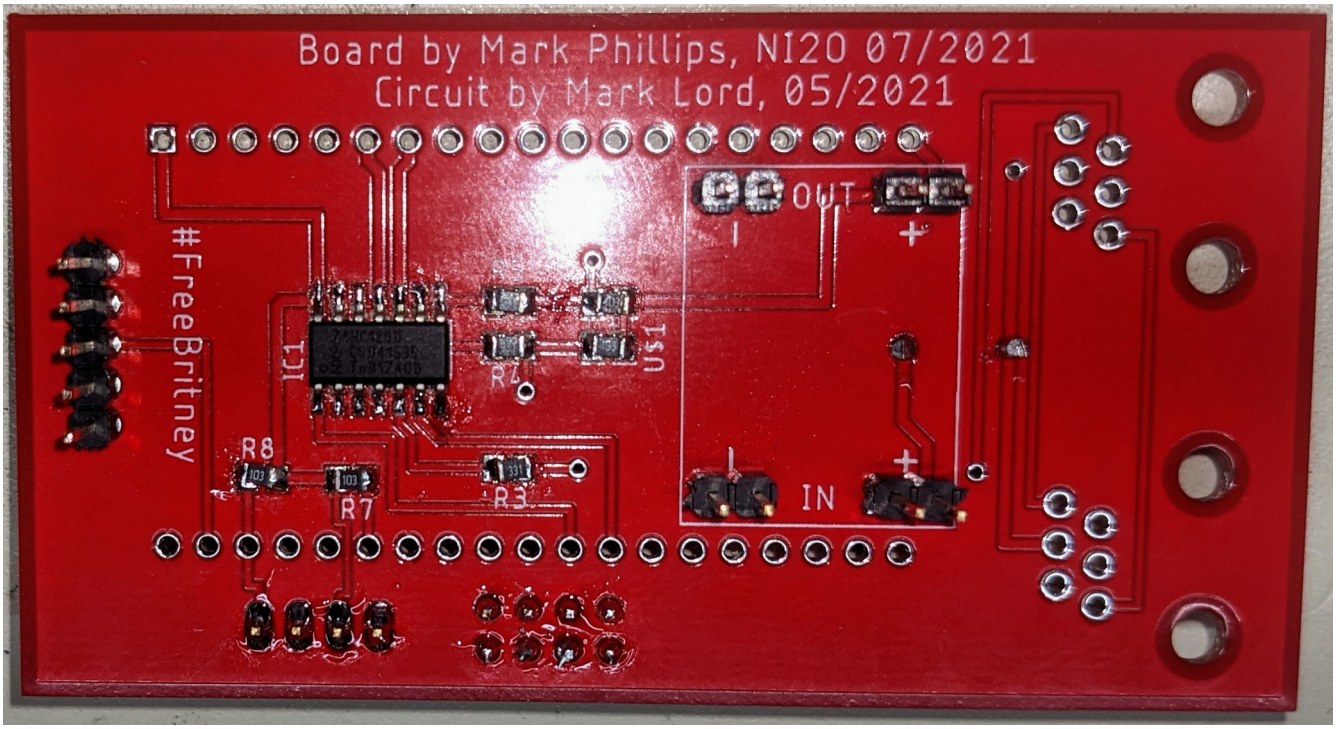
0.96” OLED display module
Enclosure
Switches, LED lights

3.2 Assembly

3.2.1 SMD and headers

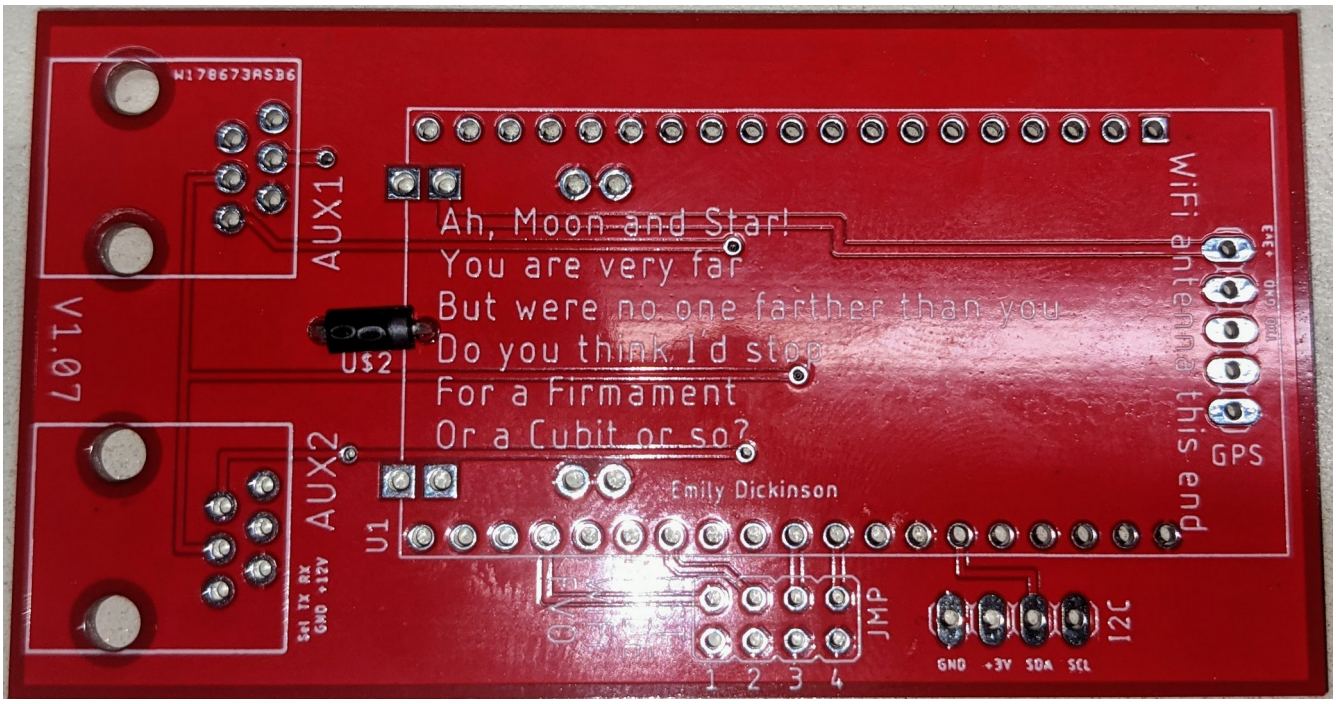
On a clean work surface install the Surface Mount Devices (SMD) onto the reverse side of the PCB. Also install the 4 2 pin headers and the 5 pin header as below.

Elsewhere on your bench connect the MPT1584 DC-DC buck convertor input to a 12 volt power supply (you can MacGyver a feed from your mount if you don’t have 12V available). Connect a DVM volt meter to the output and set it to measure a 5 volt range. Power on the convertor. Insert a small flat blade screwdriver into the screw on the convertor and adjust the output voltage to between 4.8 and 5.2 volts.



3.2.1 Install the DC-DC convertor

Turn the PCB over and install the diode. Ensure the cathode (stripe end) is at the right hand end.

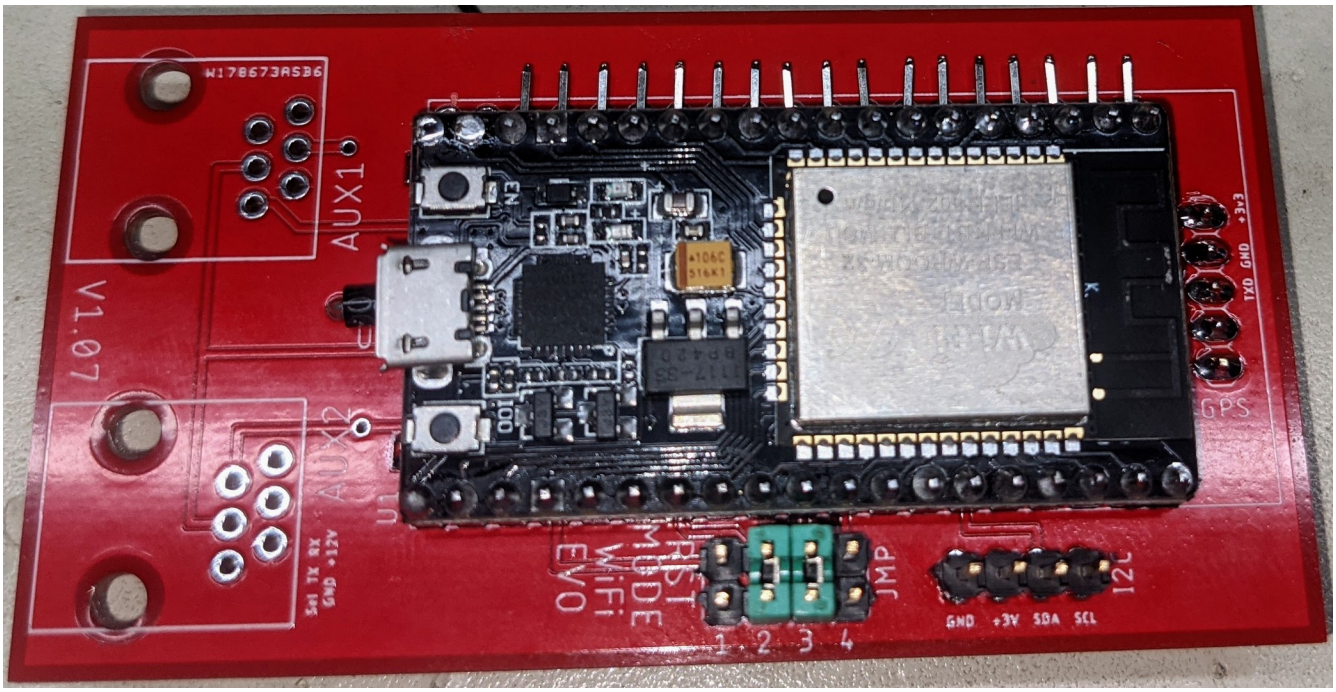


Turn the board over again and install the DC-DC convertor. Refer to the picture below for the correct orientation. The DC-Dc board mounts onto the 4 2 pin headers.

3.2.2 Install the ESP32 microprocessor

Turn the board over again and install the 4x2 pin header/jumpers and the 4 pin header.

ESP32 microprocessor board. Ensure that the WiFi antenna points to the right of the PCB.



3.2.3 Install the RJ11 connectors

Install the RJ11 sockets on the end of the board. Ensure the hole in the socket faces away from the board.

4.0 Install the Firmware

4.1 Install/Configure Arduino IDE

It is without the scope of this document to teach the reader how to install and configure their computer with the Arduino IDE software. In addition to the software builders should also install the ESP32 extensions so as to allow for the project firmware to be uploaded to the microprocessor.

The latest Firmware can be found here http://rtr.ca/esp32_wifi+bt+gps/esp32_wifi.ino and in turn contains instructions to aid in the setting of the Arduino IDE and uploading.

5.0 Testing

5.1 Test accessory with your telescope mount

Deploy your mount outside and connect it up to a well regulated power supply (internal batteries have a tendency to fail quickly). Do not connect the hand controller or turn the mount on yet.

5.1.1 Test the Hand Controller

Connect the accessory into the Hand Controller port on your mount. Ensure to position the antenna upwards.

Connect the Hand Controller to the remaining port on the accessory.

Turn on your mount. With a little luck your hand controller will spring to life. Check that its functions are all OK. Do not set the date/time or location.

5.1.2 Test the GPS

Wait a few minutes until the LED on the GPS board flashes once per second (signals GPS acquisition). Now change the Hand Controller settings to look for a GPS receiver. Check that the time/date and location have been set by the GPS.

5.1.3 Test the WiFi

Using the Celestron SkyPortal app on your cellphone, look for and connect to the WiFi signal being sent out from the accessory. Once connected steer the mount to any location via the app. If you have your telescope loaded onto your mount, try an alignment via the app. Note that the WiFi service presented by the accessory is NOT connected to the Internet.

5.1.4 Test the Bluetooth

This part requires that you are using a laptop of some sort (Win/Mac/Linux are all supported). Using your Bluetooth browser on the laptop locate and connect to the Bluetooth signal being sent out from the accessory. Create a serial or comm port from the new Bluetooth device found by your laptop. Using your favorite telescope software such as Celestron’s CPWI, configure it to use the new Bluetooth serial port and then drive the mount to any position.