Airspeed Indicator on a 3.5-inch LCD screen and ESP32 S3 Microcontroller (Implemented as a Mobiflight Community Device)

1. Introduction:

This is an Airspeed Indicator (ASI) for use with Flight Simulation displayed on a 3.5-inch LCD screen implemented as a Mobiflight community device for easy integration with flight simulators such as MSFS 2020 and X Plane. It uses an ESP32 S3 N16R8 microcontroller to drive the graphics and the firmware:

The motivations for implementing this device:

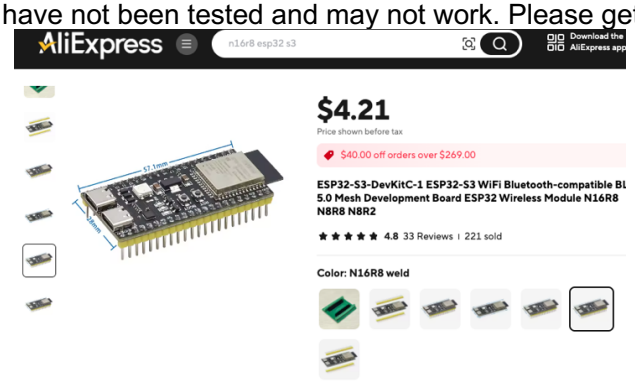
- Low cost and easy to build while providing an awesome flight simulator experience
- Minimal mechanical components (low noise)
- Minimal components and skills required (just wiring and uploading of firmware, and maybe 3D printing design if you want to design your own case/panel).
- Can be placed anywhere in the panel without the constraints of a large monitor
- Most of all, to have fun, and… Mobiflight rocks!!

For questions, please join the Mobiflight Discord server and go to the “custom-devices“ channel.

Most important of all, have fun, and…. Mobiflight rocks!!!

2. Hardware:

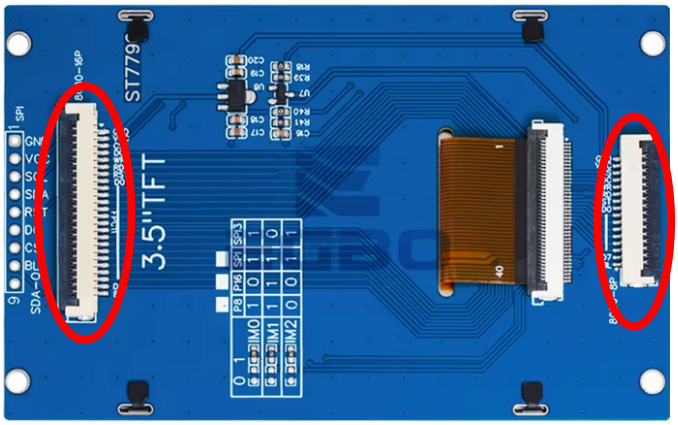
- **ESP32 S3 N16R8 variant**
  Note: Other variants have not been tested and may not work. Please get this specific variant



  For example, you can order the ESP32 S3 N16R8 variant from the following:
  - https://tinyurl.com/at2ubb9a
  - https://tinyurl.com/46rwnp9p

- **3.5-inch LCD screen with the ST7796 or ST7796S driver**
  Note: Other LCD screens with a different driver will not work!
  For example, you can order the LCD screens from the following:
  - https://tinyurl.com/3z6y7kcu
  - https://tinyurl.com/3aac2f63

  Currently, this device uses the serial SPI interface, but it is highly recommended to get a 3.5-inch LCD screen that also has a parallel interface option, as this might be implemented in the future. See an example of LCD screen with the parallel interface (encircled in red) below:



- **Other hardware**
  - Wires, USB connectors, etc.

- **ESP32 S3 and LCD Screen (ST7796/ST7796S) PIN connections**
  Connect the 3.5-inch LCD display pins to the corresponding ESP32 S3 GPIO pins according to the table below:

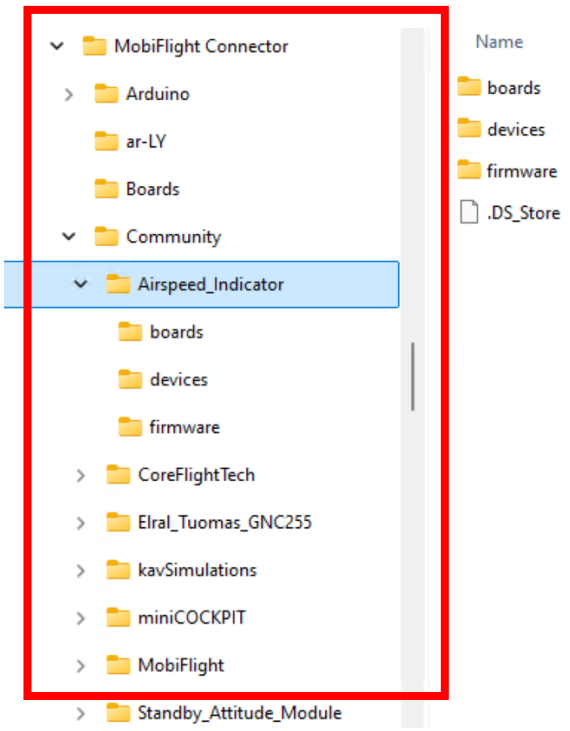
ESP32 S3 GPIO Pin	3.5-in LCD (ST7796/ST7796S) Pin
3V3	VCC
GND	GND
7	CS
6	RESET
15	DC/RS
17	SDI(MOSI)
18	SCK
13	LED

3. Software:

- **Mobiflight**
  - https://www.mobiflight.com/en/index.html
- **Mobiflight Airspeed Module custom firmware**
  - See the instructions below for downloading and installing the custom firmware

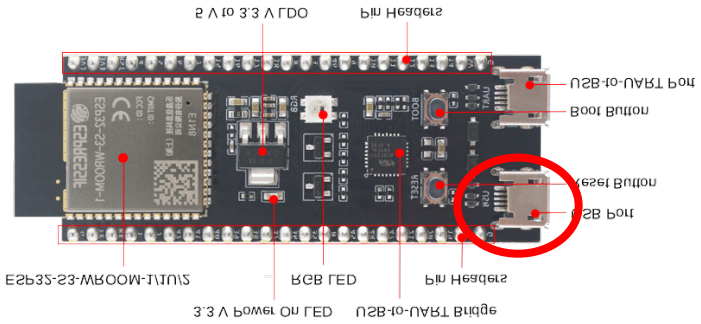
4. Downloading the Mobiflight Airspeed Indicator custom firmware:

- Download the Mobiflight **Airspeed Indicator** custom firmware from the link below:
  https://github.com/savesabanal01/Mobiflight-Airspeed_Indicator-ESP32-S3/tree/Airspeed_Indicator
  Go to the folder “firmware” and download Airspeed_Indicator_2.5.2.zip
- Open your Windows Explorer, using Win+E
- In the file path window, paste %LocalAppData%\MobiFlight\MobiFlight Connector\Community
- Extract the Airspeed_Indicator_2.5.2.zip to this folder. The file structure should look like the one below (make sure that the “Airspeed_Indicator” folder is directly under “Community”):

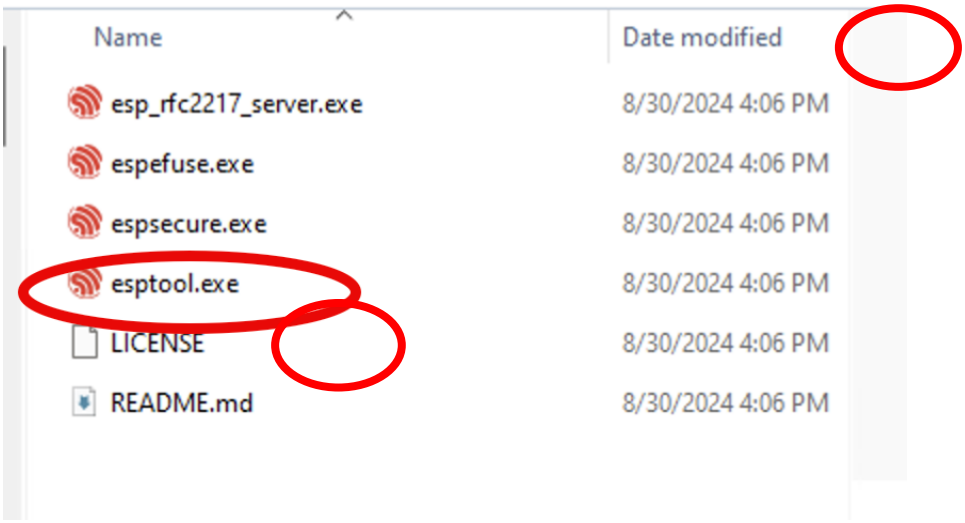


5. Flashing the Mobiflight AirspeedIndicator custom firmware to the ESP32 S3:

- *Important Note! Please make sure that Mobiflight is shut down.*
- Connect the ESP32 S3 to your PC using the USB port in (highlighted in red) in the picture below:

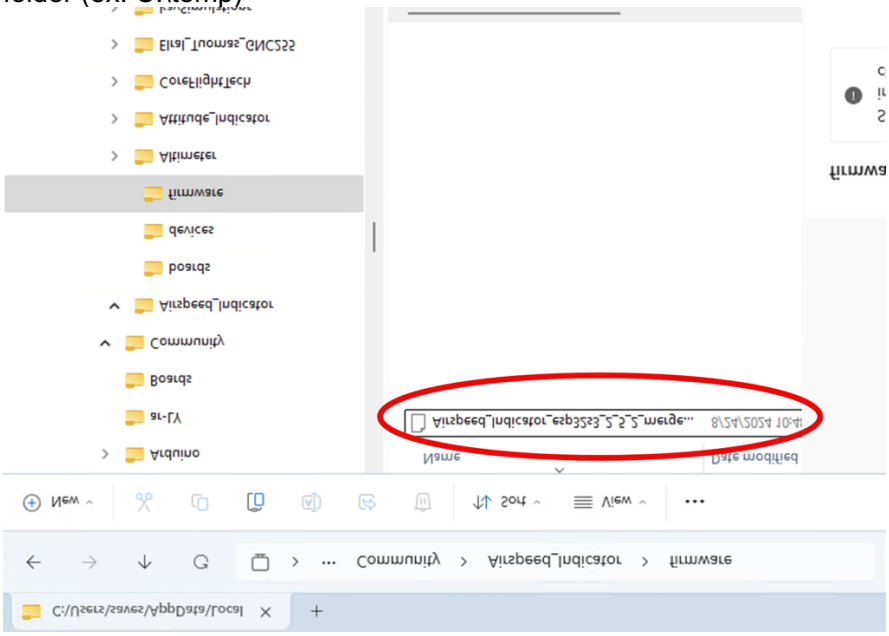


- To flash the firmware, we need to use the esptool tool. Please download the esptool-v4.7.0-win64.zip file from https://github.com/espressif/esptool/releases
- Extract the esptool-v4.7.0-win64.zip and look for the esptool.exe file (see below) and copy this to a working folder (for ex. C:\temp)



- Find the “Airspeed_Indicator_esp32s3_2_5_2_merged.bin” file, which is in the “Airspeed Indicator” -> “firmware" folder that you extracted previously.

  Hint: It is under: *C:\Users\<username>\AppData\Local\MobiFlight\MobiFlight Connector\Community\Airspeed_Indicator\firmware* and copy this to the working folder (ex. C:\temp)



- From the working folder (ex. C;\temp), execute the following command to flash the firmware

.\esptool --chip esp32s3 --port=<COMxx> --baud 460800 --before default_reset --after hard_reset write_flash -z --flash_mode dio --flash_freq 80m --flash_size 16MB 0x00 .\Airpeed_Indicator_esp32s3_2_5_2_merged.bin

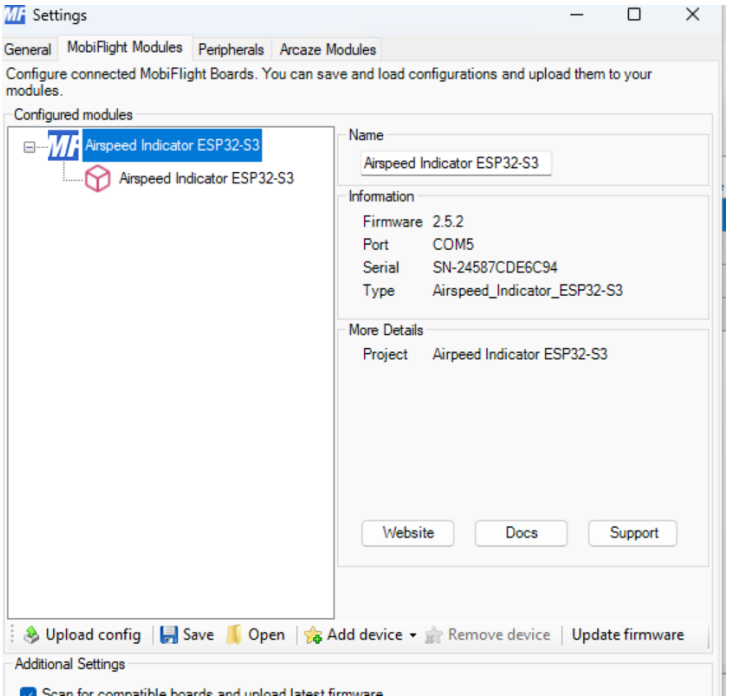
Note: COMxx should be your correct port number, for example, COM5. The full command should look like below

.\esptool --chip esp32s3 --port=COM5 --baud 460800 --before default_reset --after hard_reset write_flash -z --flash_mode dio --flash_freq 80m --flash_size 16MB 0x00 .\Airspeed_Indicator_esp32s3_2_5_2_merged.bin

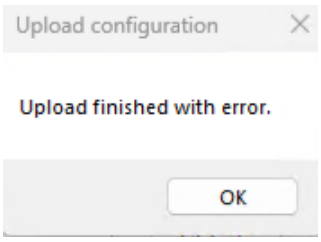
- Wait for the firmware flashing process to complete (the process may look like it is hanging, but be patient and wait for it to complete

6. Uploading the Mobiflight profiles

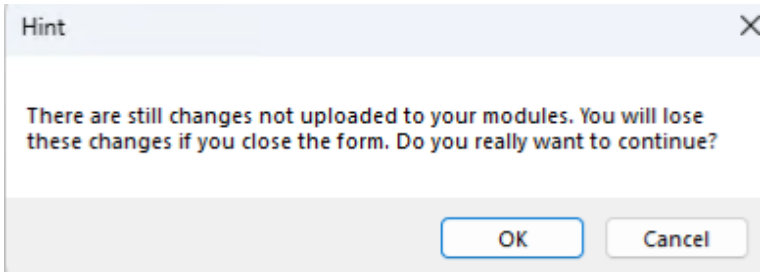
- Download the Mobiflight profiles and save them to your local PC. The profiles can be downloaded from: https://github.com/savesabanal01/Mobiflight-Airspeed_Indicator-ESP32-S3/tree/Airspeed_Indicator/profiles
- The files are Airspeed Indicator ESP32-S3 Xplane.mcc and Airspeed Indicator ESP32-S3.mfmc
- Start Mobiflight, open “Mobiflight Modules”, click “Open” and upload the Airspeed Indicator ESP32-S3.mfmc file to the “Airspeed Indicator ESP32-S3” device (see below):



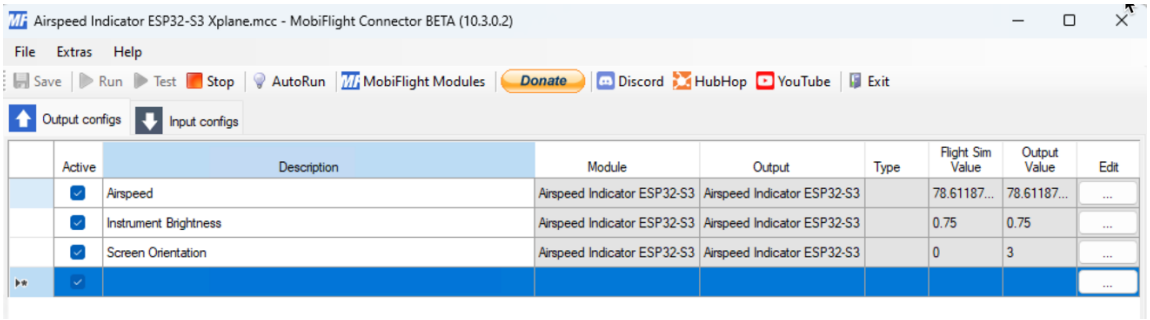
- Now, click “Upload config” and wait for it to finish uploading. You will get an “Upload finished with error” pop-up, but this is fine. Just hit “OK”.



- Now close the Mobiflight Settings pop-up and you will get the error pop-out below, but this is also ok. Just hit “OK”.



- From the Mobiflight main screen, go to Files -> Open, and open the downloaded Airspeed Indicator ESP32-S3 Xplane.mcc. You should get the settings for X Plane as shown below:

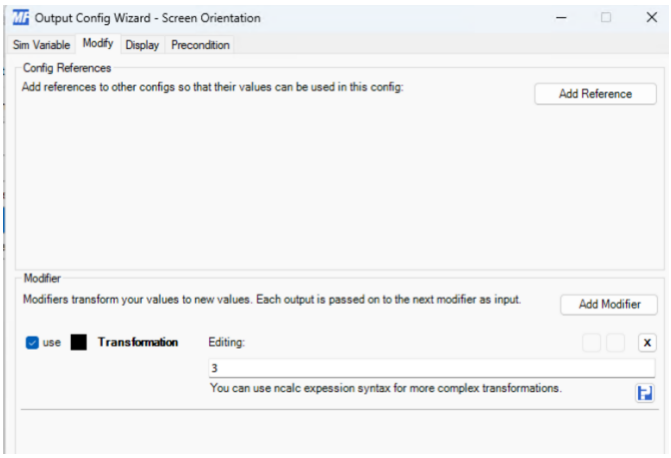


Important Note: *I only have X Plane, so I have not prepared configurations for MSFS2020, but the X Plane datarefs can be replaced by MSFS 2020 variables that correspond to them. Please try it!*

- Now, start your flight simulator, start Mobiflight and have fun!!!

7. Important Notes and Future Directions:

- You can use the other open pins in the ESP32 S3 for buttons, encoders, etc. Just make sure not to use pins 19, 20, 35, 36, and 37 (they have some limitations).
- To change the LCD screen orientation, edit the “Screen Orientation” output config got to Modify –>Transformation, and change the value from “3” to “1”. This will flip the screen (see below)



- These are the following improvements I plan in the future:
  - 8-bit parallel interfacing between the ESP32 S3 and the LCD screen