HUVVER-AVI™

ARDUINO COMPATIBLE PROGRAMMABLE AIRCRAFT INSTRUMENT *QUICK START GUIDE V2.2*

1. DESCRIPTION

The huVVer-AVI™ is a general-purpose *customizable* aircraft instrument that uses the Espressif Systems ESP-32 microprocessor. Instrument source code is provided for the popular Arduino platform, ensuring long-term support and enhancements from developers world-wide.

Created for experimental aircraft applications, the huVVer-AVI provides a bright 2.4 inch (61 mm) LCD screen, dual RS-232 serial ports, a CAN bus interface, two relay or lamp drivers, two sensor inputs, a pair of stereo audio outputs, and four front-panel pushbuttons that fits into a standard aircraft 2.25” or 3.125” panel cutout. Operating at input voltages from 8 to 35 volts, and withstanding voltage surges of up to +/- 100 volts, the device is ideally suited to aeronautical applications.

Arduino (www.arduino.cc) is an open-source hardware/software integrated development environment (IDE), originally created as an educational tool. It has been widely adopted by small to medium sized companies as the platform of choice for quick-turn development of custom microcontroller applications. Developers worldwide support the millions of Arduino users, providing readily available, low cost hardware and open-source software.

The huVVer-AVI family was developed to be *production-ready prototyping systems*. Fully compatible with the Arduino or Espressif IDE development environments, it provides robust power conditioning and multiple levels of protection from electrostatic discharge, over voltages, and short circuits. The devices fit into standard aviation 2-inch or 3-inch circular instrument cutouts.

Currently, the huVVer-AVI devices require an external Dynon SkyView, Garmin G3X, or Garmin G5 system to provide reliable air, system, and engine data. Future enhancement will use other data sources (both wired and wireless) to provide more flexibility. Of note, MakerPlane (https://MakerPlane.org) and OnSpeed (www.flyonspeed.org) are developing precision ADAHRS systems that will be supported by the huVVer-AVI devices.

Figure 1. More Display Examples (3-inch version)

FEATURES:

- Easy to use, open-source Arduino programmable aircraft instrument.
- Bright 850 cd/m^2 320 x 240 pixel US-made color display.
- Four front panel programmable buttons.
- High performance Espressif ESP-32 dual-core 240 MHz microprocessor with 520 KB SRAM, and 4 MB Flash memory for programs and data.
- 802.11 b/g/n WiFi and Bluetooth V4.2/LE for wireless connections to external devices.
- CAN, dual RS-232 serial, and USB interfaces for wired connections to external devices.
- Operates from 8 to 35 Volts DC with -20 °C to +55 °C ambient temperatures and provides extensive power and I/O conditioning to increase reliability in harsh environments.
- I/O capability
    - Two general purpose (0-5 volt) sensor inputs.
    - Left and Right stereo audio (8-bit) for alarms and signaling. 300 ohm source impedance.
    - Two 50 Volt open-collector I/O channels for driving external lamps or relays, with on-board coil suppression.
    - Two RS-232 Serial ports.
    - One CAN based Two-Wire Automotive Interface (TWAI, compatible with ISO11898-1)
    - One Universal Serial Port (USB) for program development.
    - 5 Volt power output for powering external sensors.

APPLICATIONS:

- Complete, general purpose flight-tested instrument libraries are available from www.huVVer.tech.
- The flight instrument library includes the following
    - Airspeed Indicator,
    - Altimeter,
    - Heading Indicator,
    - Attitude Indicator,
    - AOA indicator, and
    - Various debug pages (to assist in installation and program development).

  Most instruments are configurable to display supplementary information, to change units, or to configure ranges and thresholds.
- Version 2 of the flight instrument library supports Over-The-Air (OTA) wireless updates for downloading new software.

2. BASIC INSTALLATION

For installation, you will need Mil-spec wire, a number of crimp terminals and at least one connector housing. Appropriate terminal crimper, wire cutter and wire stripper tools are also required.

Crimp Pins: Digikey WM2312-ND. **Note: MakerPlane supplies 10 pins with each instrument.**

Connector Housing: DigiKey WM2006-ND. **Note: MakerPlane supplies two housings with each** instrument.

Wire and wiring supplies: Mil-spec M22759/16-22 (22 AWG single), M27500/20SB1T23 (22 AWG shielded single wire), M27500/22SB2T23 (22 AWG shielded pair), plus a circuit breaker as required. Available from Aircraft Spruce or ProWire USA.





Using the wiring standards defined in FAA publication AC43.13, connect the huVVer-AVI device to aircraft power. Each unit can draw up to 500 mA of peak current, so 22 AWG wire and a 5 Amp fuse or breaker is adequate. Several devices may share one circuit.

Connect Serial Port 2 input (Connector A, pin 4) to any available serial port output from a Dynon SkyView, Garmin G3X, or Garmin G5 system, using their recommended techniques. For short distances (less than two metres or 6 feet), unshielded wire is acceptable. In addition to power and ground, only the serial *input* is used for basic operation. The serial *output* may be 'daisy-chained' to other huVVer-AVI devices, if desired.

The EFIS serial port (if used) must be configured to 115200 bits per second and ADAHRS, (SYSTEM) and EMS output. (Note: Garmin does not support the SYSTEM output mode).

If a WiFi connection to the Dynon SkyView is desired, a Dynon WiFi Adapter must be installed on each SkyView EFIS in your system. Currently, the huVVer-AVI software must be customized for the WiFi credentials of your system. This requires you to modify, compile and load new programs on the huVVer-AVI device. Instructions for this procedure are included in the open-source device software. Your avionics installer may be able to assist.

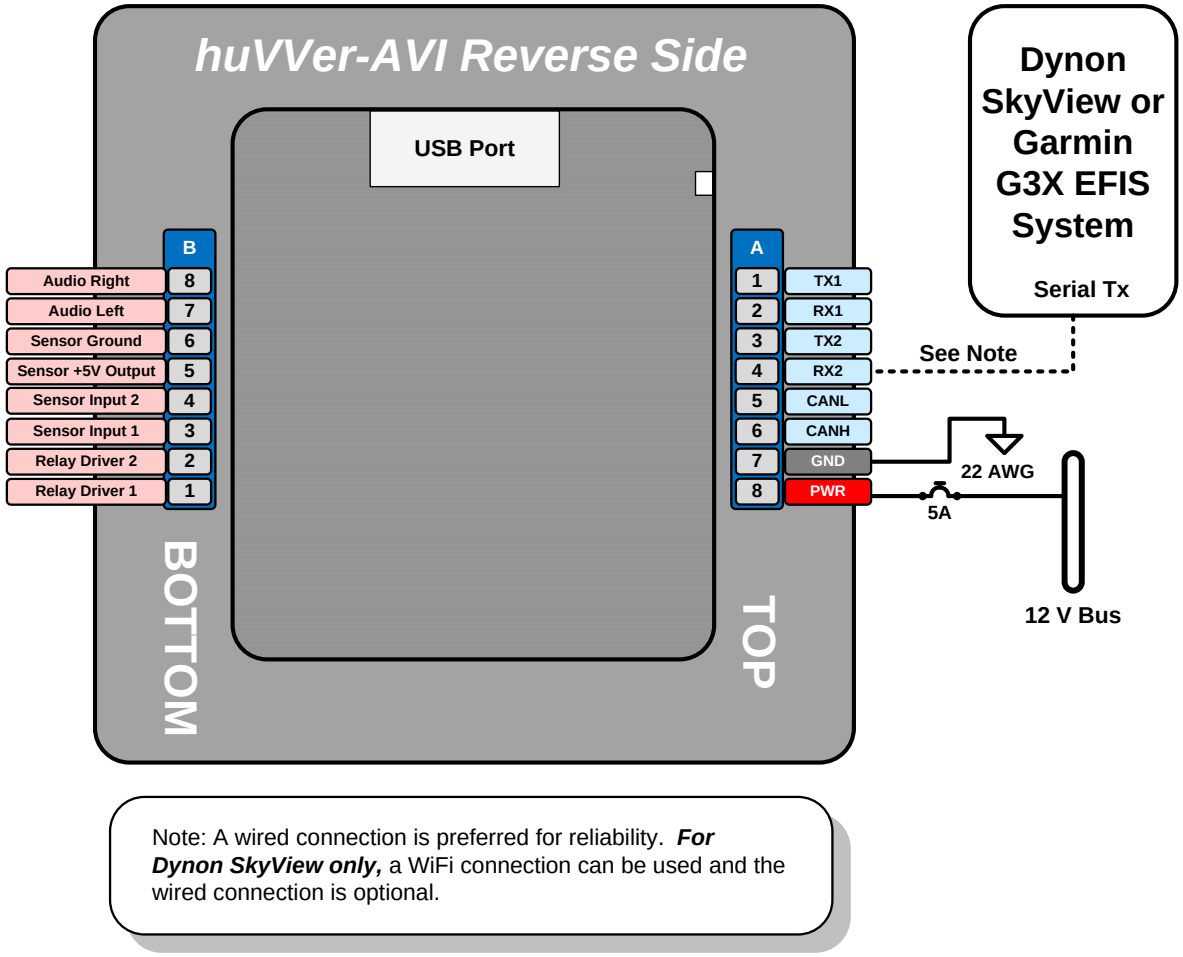


Figure 1. Basic Installation.

3. ADVANCED INSTALLATION

For advanced installation, in addition to the basic power and serial data connections, the following connections are available:

- CAN bus to compatible instruments,
- Audio Left and Right to an audio mixer or intercom system,
- Sensor Inputs to external switches and/or senders,
- Open collector Relay Driver outputs to external lamps or relays.

Some or all of these connections may be required in the future for new features, depending on device software.

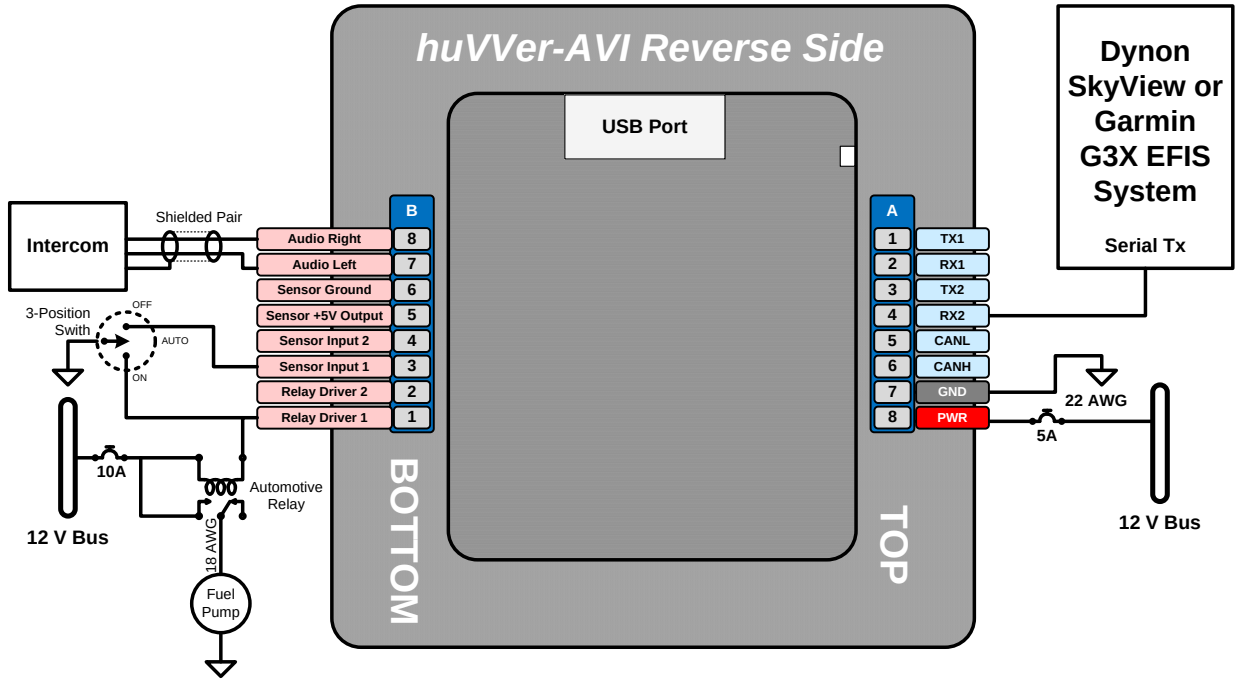


Figure 2. Advanced Installation, Fuel Pump Controller Example

AUTOMATIC FUEL PUMP CONTROLLER

Figure 2 shows an example of how the huVVer-AVI may be configured as a general purpose automatic fuel pump controller, in addition to normal display functions such as a fuel computer (tank levels, fuel pressure, flow rate, time remaining, etc.). Note: This example will require customized software development.

The fuel pump switch has Off, Auto and On positions. Fuel pressure is derived from the fuel pressure information contained in the EFIS data stream. In the On position, the fuel pump switch directly controls the fuel pump relay without software intervention. In the Off or Auto positions, the fuel pump is controlled in software. The software detects when fuel pressure is too low. Then, the pump is turned on by using the Relay 1 (OC1) pin.

Of note, this wiring configuration allows the 3-position switch to override the huVVer-AVI output during engine startup.

4. HARDWARE

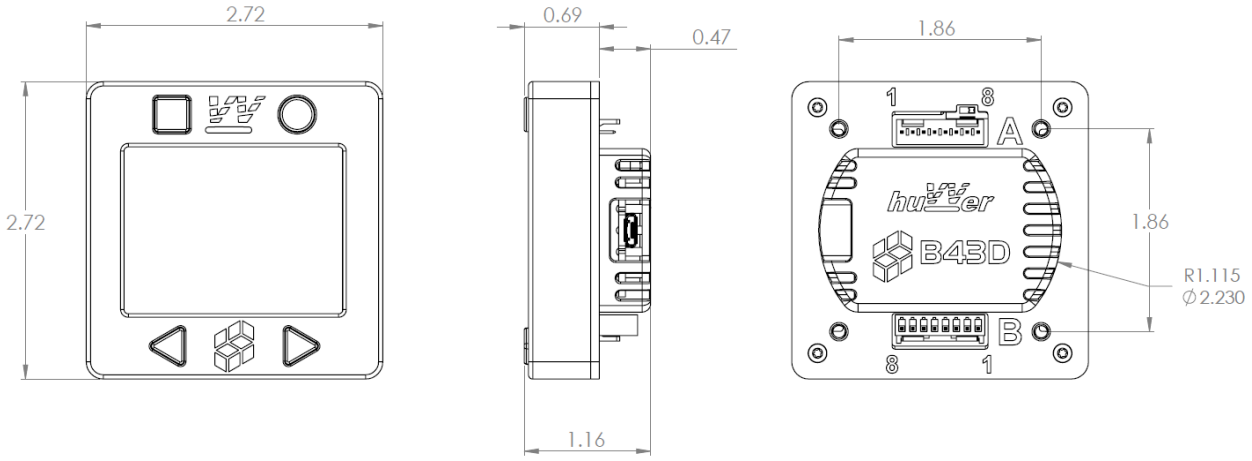
PIN DESCRIPTION

CONNECTOR A			
Pin Number	**Pin Name**	**ESP32 Function**	**Pin Description**
1	TX1	IO22	Serial RS-232 Transmit Port #1.
2	RX1	IO21	Serial RS-232 Receive Port #1.
3	TX2	IO17	Serial RS-232 Transmit Port #2 (preferred).
4	RX2	IO16	Serial RS-232 Receive Port #2 (preferred).
5	CANL	IO14 Tx & IO27 Rx	Can bus L pin. Internal ESP32 pin IO22 controls the CAN driver (See Appendix A).
6	CANH	IO14 Tx & IO27 Rx	Can bus H pin. Internal ESP32 pin IO22 controls the CAN driver (See Appendix A).
7	GND	Avionics Ground	Connect to Avionics Ground.
8	PWR	Power	8 to 35 Volt power input.

CONNECTOR B			
Pin Number	**Pin Name**	**ESP32 Function**	**Pin Description**
1	AUDR	IO26	Audio output, right channel, 300 ohm impedance.
2	AUDL	IO25	Audio output, left channel, 300 ohm impedance.
3	GND	Signal Ground	Ground for external sensors.
4	+5V	Sensor bias Voltage	Bias voltage for external sensors (500 mA maximum). Not an input.
5	X2	IO33	External sensor input 2 (0 to 5 Volt range). Pulled up to 5 Volts internally through a 300 ohm resistor.
6	X1	IO32	External sensor input 1 (0 to 5 Volt range). Pulled up to 5 Volts internally through a 300 ohm resistor.
7	OC2	IO12	Relay or Lamp driver 2. Open collector drive.
8	OC1	IO4	Relay or Lamp driver 1. Open collector drive.

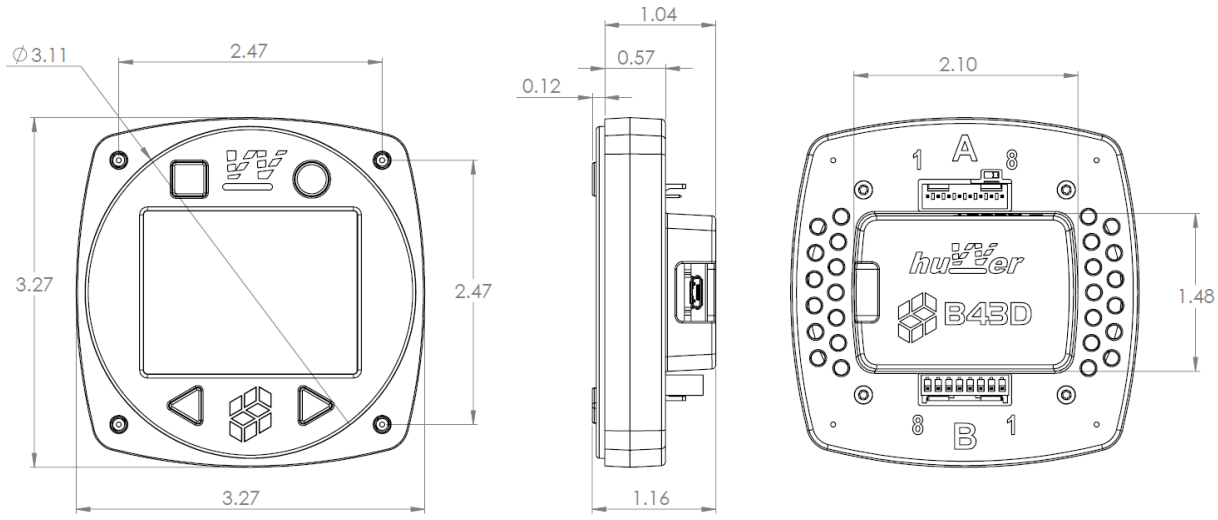
INSTRUMENT INSTALLATION DIMENSIONS

HUVVER-AVI-2 (2.25" AVIATION INSTRUMENT CUTOUT)



Note: The huVVer-AVI-2 is recommended for fascia mounting only.

HUVVER-AVI-3 (3.125" AVIATION INSTRUMENT CUTOUT)



Note: The huVVer-AVI-3 is recommended for flush mounting only. Contact factory for fascia mount option.

5. SOFTWARE

SOFTWARE INSTALLATION

The software for the huVVer family of devices is written in C/C++ on the Arduino software development platform. It is assumed that any developer who wishes to modify the supplied open-source software is familiar with the installation of the Arduino environment, libraries, programming, and debugging. Details are at https://www.arduino.cc/

The huVVer-AVI source code is provided at http://www.huvver.tech/huvver-avi/ . In the future, this will be posted on github, but the huVVer.tech website will always be the primary location for product details and support.

To install the program libraries, download the required .zip files to your PC. **Make sure you rename the files to remove the dash number at the end of the file names such as (-1, -2, etc. that some web manager systems automatically add).** Open the Arduino main program menu **SKETCH:INCLUDE LIBRARY** then select **ADD.ZIP LIBRARY**, then navigate to the downloads location on your computer to select the renamed .zip file(s). Repeat this procedure as required.

In addition to the *GaugeWidgets* library, you must also have either or both of the *huVVerLink* and *M5Stack* libraries installed.

Starting with Release 2 of the software, three additional libraries are required to support OTA uploads. Click on the links below, then click on the green box labeled 'Code' and select Download ZIP. Install as described above.

AsyncTCP.h https://github.com/me-no-dev/AsyncTCP

ESPAsyncWebServer.h https://github.com/me-no-dev/ESPAsyncWebServer

AsyncElegantOTA.h https://github.com/ayushsharma82/AsyncElegantOTA Note, this is also a resident Arduino library and may be enabled from the Arduino **TOOLS: MANAGE LIBRARIES…** menu

Set the **ADDITIONAL BOARDS MANAGER URLS** under the Arduino main menu **FILE:PREFERENCES** to "https://dl.espressif.com/dl/package_esp32_index.json, http://arduino.esp8266.com/stable/package_esp8266com_index.json". **Note: this is not a clickable link. Copy and paste this text inside the quotation marks into the Arduino Preferences field.**

Restart Arduino, then go to **FILE:EXAMPLES** to select the *GaugeWidgets* library and run the *FlightInstruments.ino* sketch in the Examples folder. *We recommend setting the board manager to "**ESP32 Dev Module**" initially, although some of the M5Stack selections will also work (for the M5Stack only). With any selection, **you must turn off PSRAM.***

To change WiFi credentials or to switch between the huVVer-AVI or M5Stack devices, read the top section of the *FlightInstruments.ino* sketch for instructions.

6. MENU SYSTEM

There are 4 menu levels in the huVVer-AVI software:

1. Boot Menu
2. Default Menu
3. List Menu
4. Action Menu

BOOT MENU

The *Boot Menu* is not displayed, but some buttons are active during initial start-up of the device.

- Holding down the Menu ☐ button and the Select ○ button together will restore the System settings to factory defaults.
- When the unit is stuck waiting to connect in WiFi Receive mode, pressing the ○ button will turn off the WiFi receiver and allow the unit to start up. The WiFi Receive mode must be manually re-enabled on the System Configuration page.

DEFAULT MENU (TOP LEVEL)

The *Default Menu* is the main operating mode of the device.

- Pressing the Select ○ button will cycle through the screen brightness levels. Holding the Select ○ button for four seconds will force the device to restart.
- Pressing the Fwd ▶ button will select the next enabled instrument,
- Pressing the Back ◀ button will choose the previous enabled instrument, and
- Pressing the Menu ☐ button will enter the *List Menu*, where device configuration options are listed.

Note: The M5Stack devices only support three buttons: A - ☐, B - ○ and C - ▶. There is no Back ◀ button.

LIST MENU

The *List Menu* is where individual settings are listed.

- Pressing the Menu button ☐ will exit and save any modified settings.
- Pressing the Fwd ▶ or Back ◀ button will cycle through the list.
- Pressing the Select ○ button will select the chosen item for editing and enter the *Action Menu.*

ACTION MENU

The *Action Menu* is for editing the digits of the selected setting.

- Pressing the Select ○ button while editing will cycle through the available digits within a number.
- Pressing the Fwd ▶ or Back ◀ buttons will cycle through the digit values (0-9 or +/-)
- Pressing the Menu □ button will keep the edited value and return to the *List Menu.*

Note: Some settings will automatically restart the device, and others *will require a manual restart before changes to take effect. If required, the restart is performed by holding down the Select ○ button for four seconds while in the Default (top level) Menu*.

7. OVER-THE-AIR (OTA) UPDATES

Beginning with Version 2 of the device software, OTA updates are supported. The following describes how to upload new software using the built-in WiFi capability of the huVVer-AVI devices.

If you are provided with an update file (filename ends in .bin), save it in a known location on your device. It cannot be saved in a cloud server.

To generate your own .bin file directly from the Arduino IDE, your sketch must not be located in the Arduino libraries folder. From the IDE, select SKETCH: EXPORT COMPILED BINARY under the Arduino main menu. This will compile your program and place the object file in your sketch folder. You can move this file to a convenient place, or send it to another device.

UPDATE PROCEDURE

NOTE: some devices assume that whatever network to which you are connected is also linked to the internet, and the following procedure will stall. Try waiting a few minutes for this to clear before proceeding. Make sure your .bin file is located directly in the file system on your device.

1. On the huVVer-AVI, from the System Configuration Menu, set OTA Update to '1', then exit the menu.
2. The unit will automatically restart in OTA Update mode.
3. On your device, connect to the unit's WiFi network 'huVVer-AVI', using the password 'huVVer-AVI'.
4. In a web browser address bar, enter '192.168.4.1/update '.
5. Follow the on-screen instructions to download your .bin file.
6. When the download is complete, the huVVer-AVI unit will restart and execute the updated software. It will be automatically configured to the device settings in effect prior to the OTA update. You can change the device settings from the System Configuration menu. Some items will require a restart to take effect.

Note that there is an OTA Update Instructions page on the huVVer-AVI unit. Also, the System Configuration page provides the appropriate network ssid and password information needed for OTA updates.

8. APPENDIX A. QUICK REFERENCE

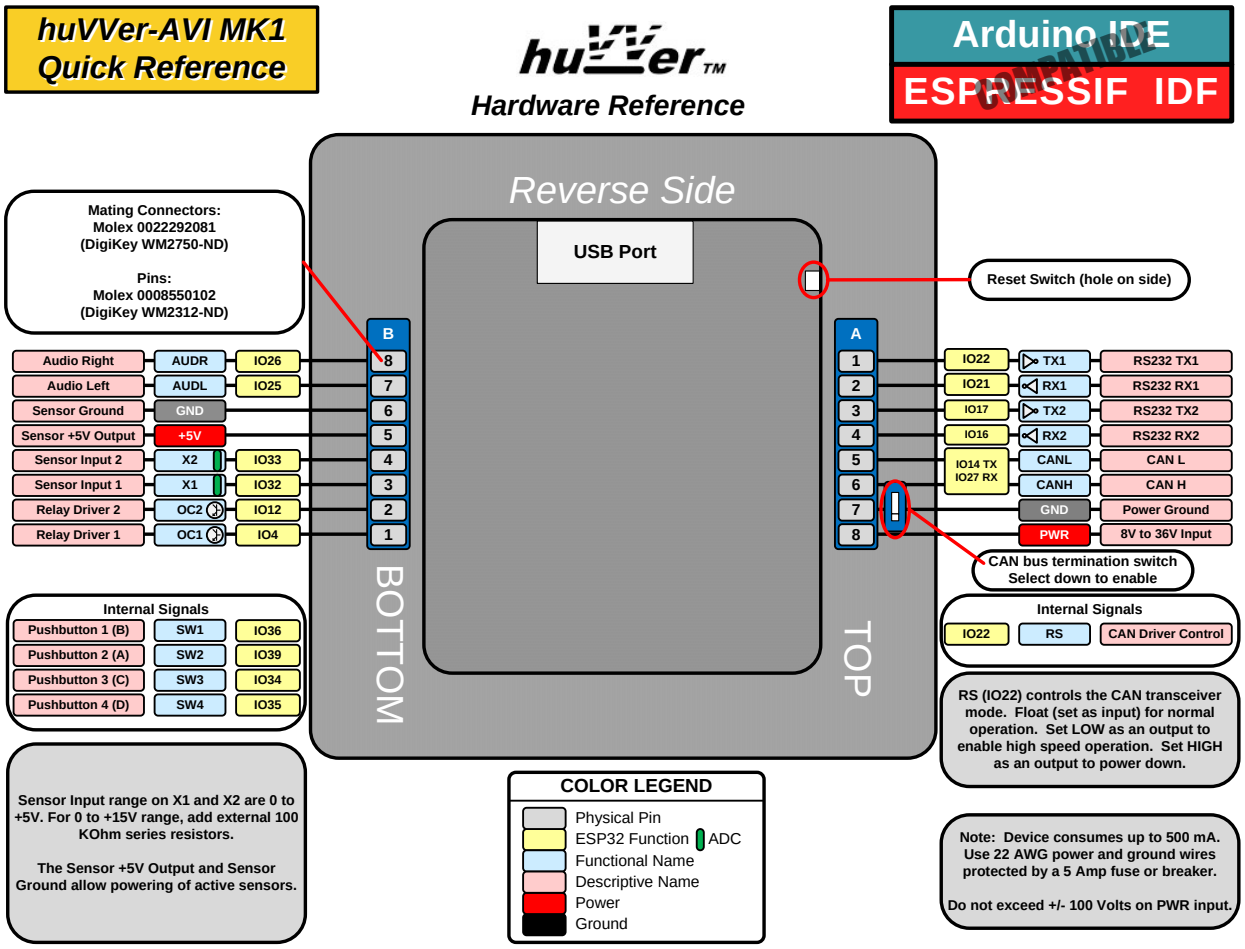


Figure 4. huVVer-AVI Quick Reference Diagram

9. SOURCING INFORMATION

To purchase a fully assembled and tested device, contact MakerPlane (https://MakerPlane.org).

Models available:

huVVer-AVI-3. Fits into a standard 3.125" aircraft instrument hole. Approximately 3.27" square (83.1 mm square). Flush mounting supported. Fascia mounting requires simple modification-- contact factory for more details.

huVVer-AVI-2. Fits into a standard 2.25" aircraft instrument hole. Approximately 2.72" square (69.1 mm square). Only fascia mounting is supported.

10. DOCUMENT REVISION HISTORY

Issue Number	Date	Purpose
VXD-2103001V1A	March 6, 2021	Product Release. Software Version 1.0
VXD-2103001V1B	April 3, 2021	Added documentation for Garmin G5 support
VXD-2103001V2A	April 26, 2021	Restructured Menu system, System Configuration page and added Over-The-Air (OTA) program update capability. Software Version 2.0
VXD-2103001V2B	April 30, 2021	Minor changes to the System Configuration menu to make it compatible with the M5Stack. Improved graphics for pop-up status information. Software Version 2.1
VXD-2103001V2C	May12, 2021	Minor changes to the System Configuration menu to improve legibility and minor changes to this document. Version 2.2

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