

# External HAMMR IMU Manual

Setup (1), Menu (1), Menu Options (1-3), How to Calibrate (3-4), Micro SD Card (4-5), Errors (5)

## Setup

- Unscrew the top of the box and insert a micro SD card into the Teensy Arduino.
  - Attach the GPS antenna to the SMA port on the box.
  - Place the GPS antenna near HAMMR's GPS antenna.
  - Plug the External IMU into a power source with the USB cable.
  - Calibrate the IMU (See "How to Calibrate" (Pg. 3-4).)
    - **Warning:** The magnetometer may refuse to calibrate if you didn't calibrate the Gyroscope first. If this happens, reset the Arduino by unplugging the USB power source and plugging it back in.
  - Wait for the GPS to find a satellite fix, this may take several minutes. You can now put the external IMU into its holder on HAMMR.
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## Menu

- After setup, the Arduino will send you to the menu where you will have 3 options. (Scan, Calibrate, Euler Angle )
  - You can navigate the menu by turning the Rotary Encoder (dial next to the LCD screen) and pushing down on the push button (built into the Rotary Encoder.)
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## Scanning (Menu Option "Start Scan")

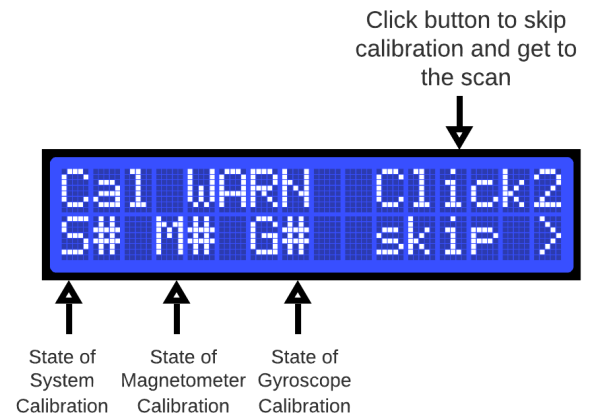
**Important Information:** Always start the scan *before* you start HAMMR, end the scan *after* HAMMR has stopped scanning.



- To start a scan, select the option **(1) Start Scan**.
  - **Warning:** Make sure you have put a micro SD card into the Arduino, that is where the information from the scan will be recorded. You can take the card out once you have stopped the scan, but make sure you put it back in before the next scan.

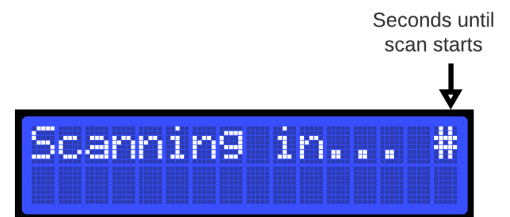
## Calibration Warning Screen

- You may get a **Cal WARN** screen, this means the IMU is not fully calibrated.
- You can calibrate the IMU without exiting the current screen (See “How to Calibrate” (Pg. 3-4).)
- This is not a mandatory calibration, you can skip this calibration by pressing the push button.



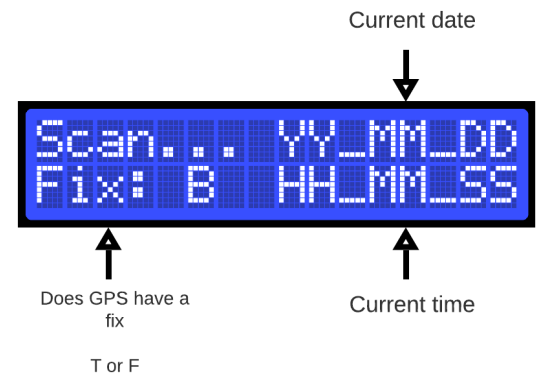
## Scanning in... Screen

- This is needed to make sure the first few time stamps are correct.
- The scan will start after the countdown.



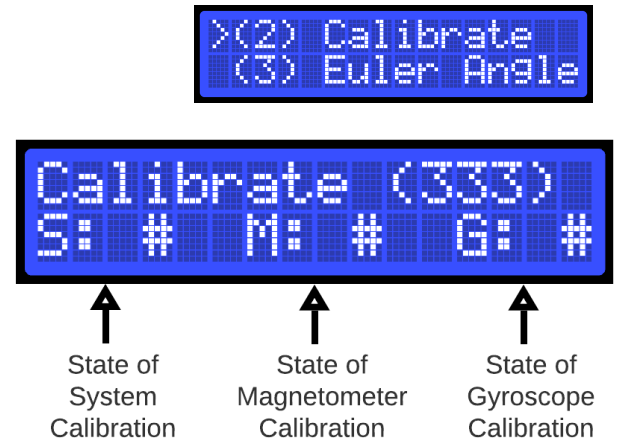
## Scanning Screen

- Once you see this screen, the scan has started.
- You will be able to see the current date and time and whether or not the GPS has a fix on 2 or more satellites.
  - **Warning:** Don't be alarmed if the fix is false. As long as a fix was found at some point since the Arduino was turned on, the time should be correct.
- The scan doesn't turn off on its own. *Press the push button to stop the scan and go back to the main menu.*



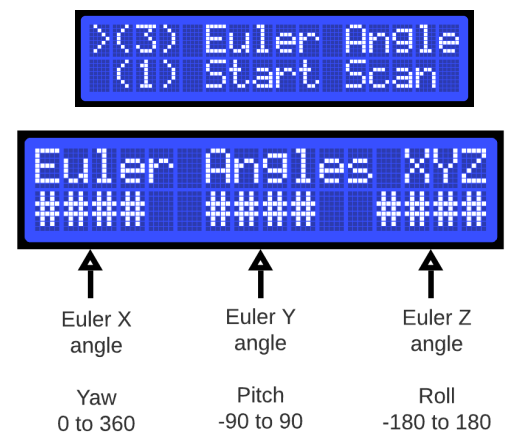
## Menu Option “Calibrate”

- **(2) Calibrate** lets you see the state of calibration and calibrate the IMU.
- Follow the steps in “How to calibrate” (Pg. 3-4) and once fully calibrated, you will be sent back to the main menu.
- This is not a mandatory calibration, you can exit this calibration by pressing the push button to go back to the menu.



## Menu Option “Euler Angle”

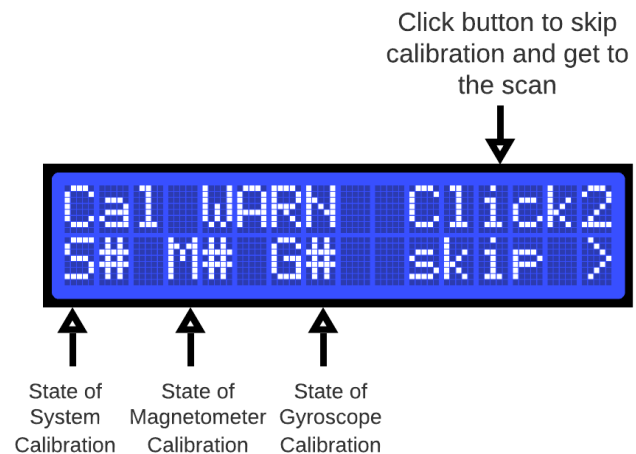
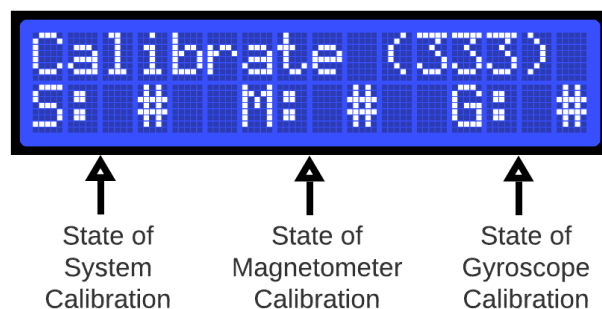
- **(3) Euler Angle** lets you see the current Euler angles the IMU is measuring.
- You can exit this by pressing the push button and you'll go back to the main screen.



## How to Calibrate

- To fully calibrate the IMU you will need to get the Gyroscope, Magnetometer, and System to a calibration state of 3.
- 0 is not calibrated, 1-2 is in the process of becoming calibrated, and 3 is fully calibrated.
- Calibration should be done in this order ↓

- **Gyroscope:** Set the External IMU on a relatively flat surface and keep it still until its state turns to 3.
- **Magnetometer:** Pick up the External IMU and turn it around in all 3 Euler angles (Yaw, Pitch, Roll) until its state turns to 3. This may take a few tries.
  - Example: Turn it upside down, tilt it to the right, tilt it forwards.
- **System:** System is the IMU finding magnetic north. This is easier to get in a clear/open area. You calibrate this by basically waving it around in the air until something changes with the System state number. Once you get a 1 or a 2, slowly move it around in the nearby area to get it to 3.



## Micro SD Card Information

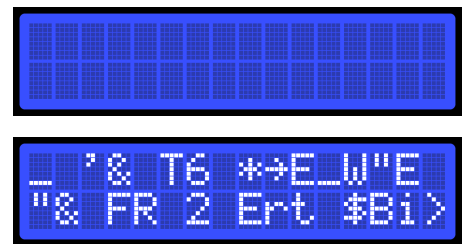
- The micro SD can be removed or inserted whenever the External IMU is not currently scanning or in any of the scan screens.
  - **Warning:** Taking the card out during a scan can corrupt the files and/or cause other errors.
- For each scan, a folder is created for the date (unless a folder for the day exists) named YY\_MM\_DD. Inside the folder for the day, there will be a .csv file named HH\_MM\_SS representing the time the scan started.
- The Arduino takes measurements at around 10Hz. For every measurement, there will be a line in the CSV file that has (in order)...

- The time converted to Unix time (10 digit integer)
  - The heading (Euler x) (0 - 359.99)
  - The pitch (Euler Y) (-179.99 - 179.99)
  - The roll (Euler Z) (-89.99 - 89.99)
  - State of the system calibration (0 - 3)
  - State of the magnetometer calibration (0 - 3)
  - State of the gyroscope calibration (0 - 3)
  - Does the GPS have a fix? (1(yes) - 0(no))
  - The Euler measurements will not be as accurate if the calibration states are not all 3.
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## Errors

### Screen Errors

- Frozen screens, corrupted text, and blank screens can be caused by multiple things, the easiest way to fix this is to restart the Arduino by unplugging the USB cable and plugging it back in.



### Wiring

- If something is not working or not responding, it may be helpful to check the wiring.

