WEGMATT LLC

dAISy-catcher AIS Receiver

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1 Disclaimer

dAISy-catcher is a reliable, high-performance AIS Receiver. However, under no circumstances should it be solely relied on for collision avoidance or navigation. It's the user's responsibility to use the product prudently. Neither Wegmatt LLC nor its dealers accept responsibility or liability to the product user or their estate for any accident, loss, injury, or damage whatsoever arising out of the use of this product.

2 Introduction

The dAISy-catcher is a high-performance AIS receiver with integrated low-noise amplifier (LNA).

AIS (automatic identification system) is an automatic tracking system for ships. Ships broadcast their position and other information over VHF[1]. The dAISy-catcher allows you to receive these transmissions, enabling real-time tracking of nearby vessels.

The dAISy-catcher outputs AIS data as a stream of ASCII messages, which are encoded in a marine standard format known as AIVDM sentences[2]. This format is understood by applications and devices like chart plotters[3], marine data aggregators[4], and can be processed by many opensource libraries[5].

The dAISy-catcher is designed to be operated as stand-alone USB device, as add-on board (HAT) mounted on a Raspberry Pi or similar single board computers, or as a module in an embedded system.

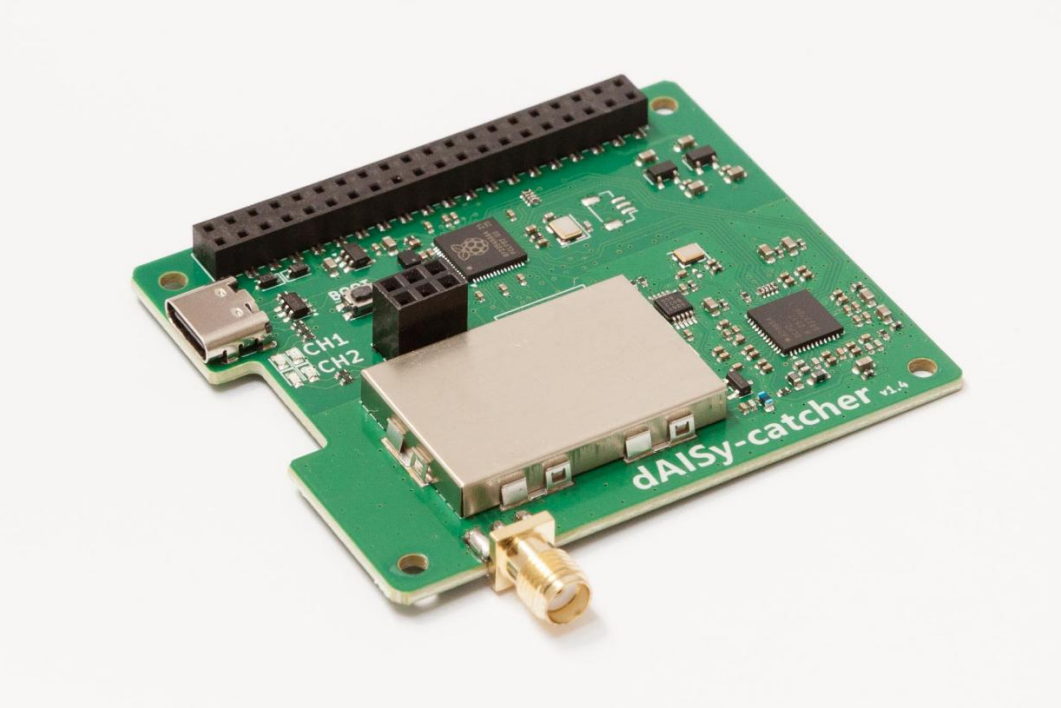

Figure 1: dAISy-catcher AIS receiver

[1] https://en.wikipedia.org/wiki/Automatic_identification_system
[2] https://gpsd.gitlab.io/gpsd/AIVDM.html
[3] https://opencpn.org
[4] https://aiscatcher.org, https://www.aishub.net, https://www.marinetraffic.com, …
[5] https://pypi.org/project/aiscat, https://pypi.org/project/pyais, https://github.com/schwehr/libais, …

3 dAISy-catcher as USB device

The dAISy-catcher can be run as a standalone USB device. When connected to a computer with a USB cable, dAISy-catcher will present itself as a serial device. No drivers are required.

3.1 Windows 10 or newer

When connected to a Windows computer, dAISy-catcher will be detected as a new COM port. You can determine the number assigned to the device in the Device Manager app of Windows.

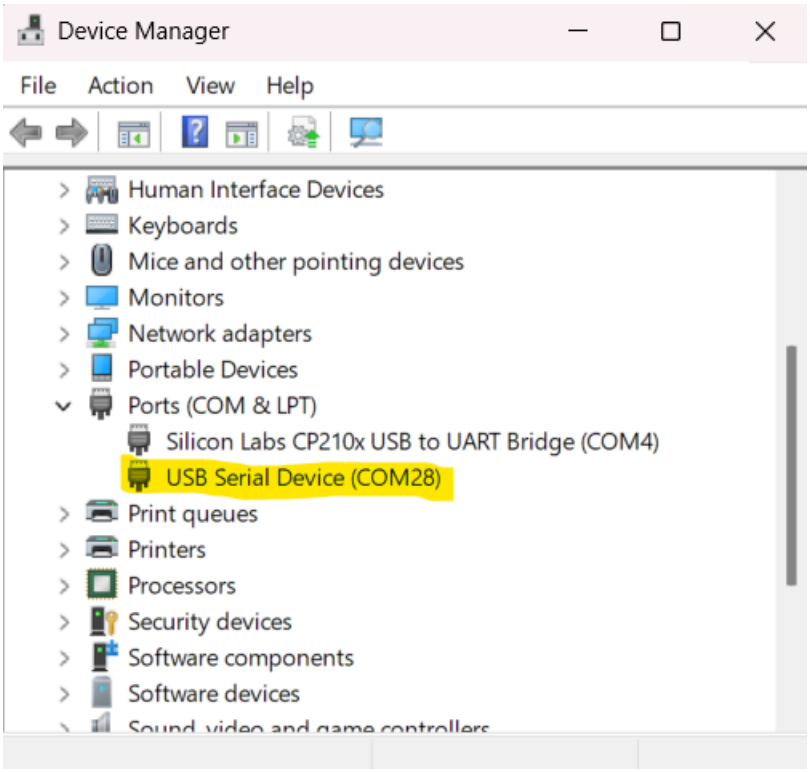

Figure 2: Screenshot of Windows Device Manager, with dAISy-catcher detected as USB Serial Device on port COM28

You can verify the serial connection with a serial terminal program, like for example Putty. Open a new serial connection with the speed of 115200 baud.

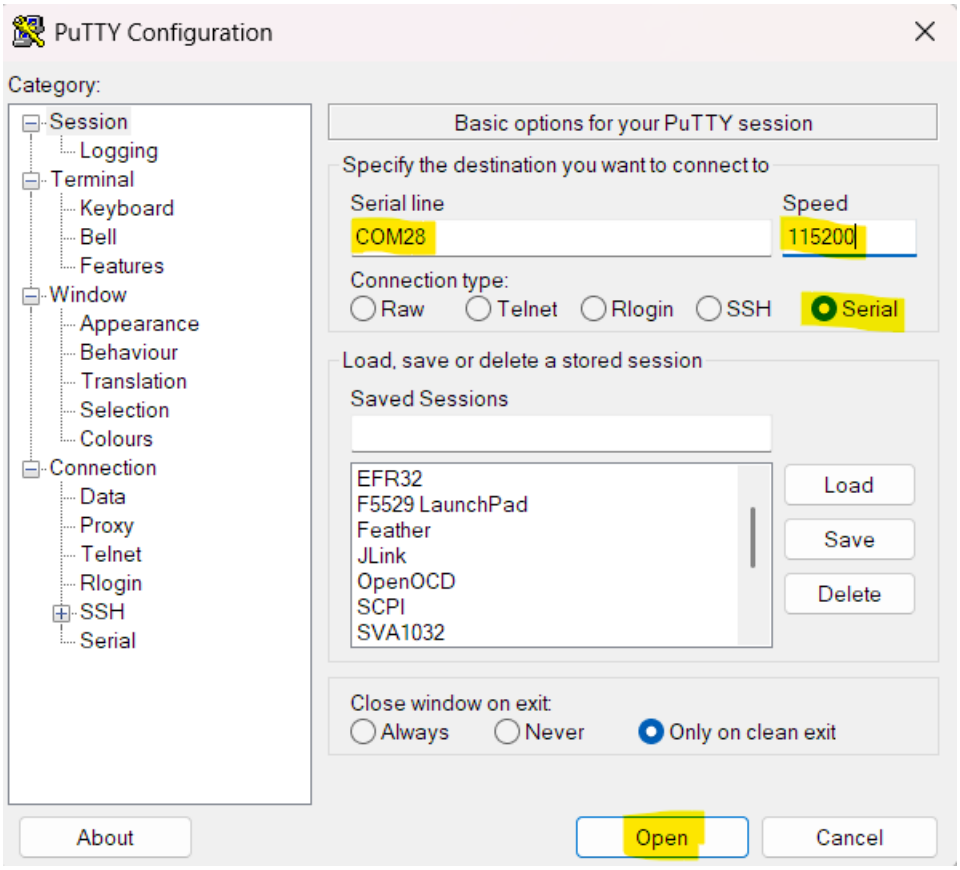

Figure 3: Connecting to serial port with Putty

If the serial connection is working, typing `v` and `ENTER` will show the version of the firmware running on the dAISy-catcher.

```
v
dAISy-catcher Firmware v1.0.0+f88208d PROD
Board: HAT v1.0
```

3.2 MacOS X

When connected to a computer running MacOS X, dAISy-catcher will be detected as a USB modem. You can determine the name assigned to the device by launching the Terminal app and typing

```
ls /dev/*usb*
```

The dAISy-catcher will be listed with a name like

```
/dev/cu.usbmodemXYZ
```

where `XYZ` is a number assigned by Mac OSX.

You can verify the serial connection with a serial terminal program like for example `screen`. Connect to the dAISy-catcher with

```
screen /dev/cu.usbmodem123 115200
```

If the serial connection is working, typing `v` and `ENTER` will show the version of the firmware running on the dAISy-catcher.

```
v
dAISy-catcher Firmware v1.0.0+f88208d PROD
Board: HAT v1.0
```

Exit `screen` by pressing `CTRL-A`, release the keys, then press `K` (kill session) and then `Y` to confirm.

3.3 Linux and Raspberry Pi

When plugged into the Linux computer, dAISy will automatically show up as a USB CDC serial device. You can determine the name assigned to the device by launching a terminal and typing

```
ls /dev/ttyACM*
```

The dAISy-catcher will be listed with a name like

```
/dev/ttyACMx
```

where `x` is a number assigned by Linux, typically `ttyACM0` if the dAISy-catcher is the only USB serial device connected.

You can verify the serial connection with a serial terminal program like for example `screen`. You may have to install `screen` first by running:

```
sudo apt-get install screen
```

With *screen* installed, connect to the dAISy-catcher with

```
screen /dev/ttyACM0 115200
```

If the serial connection is working, typing `v` and `ENTER` will show the version of the firmware running on the dAISy-catcher.

```
v
dAISy-catcher Firmware v1.0.0+f88208d PROD
Board: HAT v1.0
```

Exit `screen` by pressing `CTRL-A`, release the keys, then press `K` (kill session) and then `Y` to confirm.

4 dAISy-catcher as Raspberry Pi HAT

The dAISy-catcher can be operated as an add-on board (aka HAT) mounted on top of a Raspberry Pi. The dAISy-catcher HAT is compatible with all models of the Raspberry Pi single-board computer.

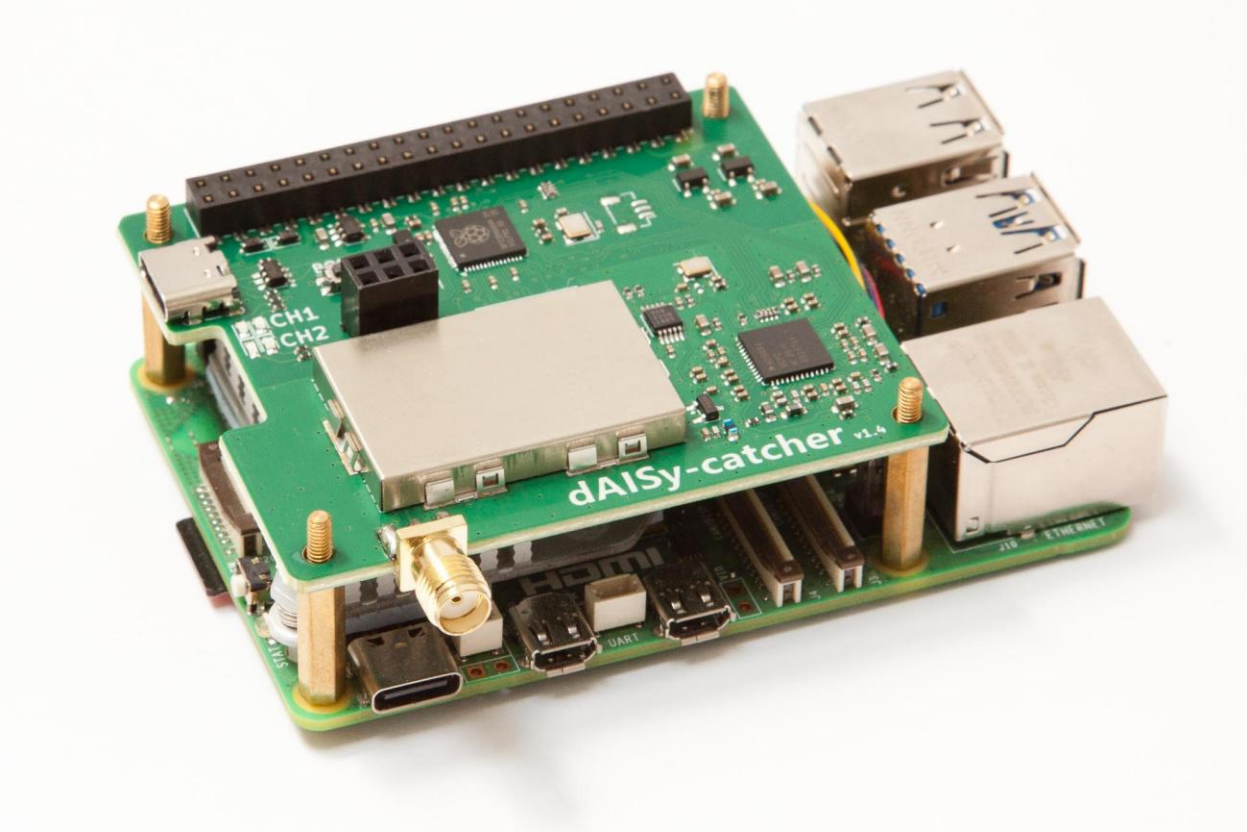

Figure 4: dAISy-catcher mounted as HAT on a Raspberry Pi 5

In this configuration, the dAISy-catcher is powered with 5V from the Raspberry Pi (pins 2, 4, and 6). The HAT communicates with the Pi through `UART0` (pins 8 and 10). No other pins on the GPIO header are used in the default configuration.

Note: The dAISy-catcher can be combined (stacked) with another HAT, if it DOES NOT also use pins 8 and 10. A workaround in case of a conflict is to operate the dAISy-catcher as a USB device. In that scenario, the dAISy-catcher can still be stacked, but should be NOT connected to the GPIO header.

4.1 Assembly

The dAISy-catcher is mounted with the component-side up. A 2x20 pin GPIO stacking header is required for spacing, and standoffs to secure the HAT in place.

The recommended order of assembly is, to first install the stacking header and standoffs on the Raspberry Pi. With both installed, carefully push the dAISy-catcher down onto the header.

4.2 Configuration

If you are using the dAISy-catcher on a Raspberry Pi with a recent version of Raspberry Pi OS, use the `raspi-config` tool to configure the serial port through which the Raspberry Pi communicates with the dAISy-catcher.

Open a terminal window on your Raspberry Pi and type:

```
sudo raspi-config
```

This will launch the Raspberry Pi Software Configuration Tool. Then enable the serial port by navigating through the following steps:

`3 Interface Options` -> `I6 Serial Port`
-> `<No>` (no login shell on serial) -> `<Yes>` (enable serial hardware) -> `<Ok>`
-> `<Finish>` -> `<Yes>` (reboot)

After completing the reboot, AIS data is available using the following parameters:

Raspberry Pi	Pi 4, 3, Zero	Pi 5
Serial port	/dev/serial0	/dev/ttyAMA0
Baud rate	115200	115200
Data bits	8	8
Parity	None	None
Stop bits	1	1
Flow control	None	None

Table 1: Raspberry Pi serial port configuration

Use this information to configure applications that process the AIS data. Keep in mind that only one application at a time can connect to a serial port.

You can verify the serial connection with a serial terminal program like for example `screen`. You may have to install `screen` first by running:

```
sudo apt-get install screen
```

With `screen` installed, connect to the dAISy-catcher on a Raspberry Pi 5 with:

```
screen /dev/ttyAMA0 115200
```

or for Raspberry Pi 4:

```
screen /dev/serial0 115200
```

If the serial connection is working, typing `v` and `ENTER` will show the version of the firmware running on the dAISy-catcher.

```
v
dAISy-catcher Firmware v1.0.0+f88208d PROD
Board: HAT v1.0
```

Exit `screen` by pressing `CTRL-A`, release the keys, then press `K` (kill session) and then `Y` to confirm.

5 Using the dAISy-catcher

Using the dAISy-catcher is as simple as connecting it to an antenna, a computer and starting your AIS capable application of choice. When powered-up, dAISy-catcher automatically starts to listen for AIS transmissions and outputs received messages on its serial port.

Note that there is no output when no AIS messages are received.

5.1 Interpreting the status LEDs

The dAISy-catcher has 4 LEDs, a green and red LED per AIS channel.

The LEDs can be turned off with the command `ce0`.

Short GREEN flash every 5 seconds

The dAISy-catcher will very briefly blink both green LEDs every 5 seconds to indicate that everything is ok.

Long GREEN flash on CH1 or CH2

Yay! The dAISy-catcher received a valid AIS message.

For every message received and passing all error checks, the green LED of the channel on which the message was received will turn on for ¼ second. At the same time, the dAISy-catcher will output the received message on the serial interface.

RED flash on CH1 or CH2

This indicates that the radio receiver detected a strong signal.

The dAISy-catcher is a very sensitive AIS receiver, so a “strong” signal is higher than -60 dBm. At this level an automatic mechanism temporarily attenuates (turns down the volume of) the signal and the red CH1 LED will turn on. With even stronger signals higher than -42 dBm, a 16 dB step attenuator will be enabled and the red CH2 LED turns on. Signal attenuation has a negative impact on the reception of weaker signals.

Intermittent red blinks are normal when in close range of AIS targets.

It is important to watch the red LEDs when using an external amplifier. If one or both red LEDs turn on for most AIS messages, or even stay on permanently, it indicates that the external amplifier is probably not necessary or even counterproductive.

If one or both red LEDs stay on permanently without external amplification, it may indicate that there is strong RF interference. See chapter 10.4 Radio frequency noise for possible remedies.

No LED activity

The dAISy-catcher may not receive power. Check all connections.

If the dAISy-catcher does output AIS messages, but the LEDs do not blink, the LEDs may have been turned off by configuration. See the command `ce` to control LEDs.

If the dAISy-catcher does not output AIS messages, receiving AIS message may have been disabled by configuration. See the command `co` to control AIS output (and indirectly the green LEDs).

Another possibility is that the dAISy-catcher failed to boot or crashed. In this case, remove power. Plug it in again and see if this resolves the problem. If the condition persists, there might be a hardware issue with your device. Please contact us.

5.2 Command interface

The dAISy-catcher includes a command interface for configuration. The command interface is accessed over the same serial connection as the AIS data, using a terminal program like for example `Putty` or `screen`.

Typing the `h` and pressing `ENTER` will list the available commands with a short description.

See chapter 6 for detailed documentation of the command interface.

5.3 Firmware update

The firmware of the dAISy-catcher can be updated over USB.

The update process can be initiated in two ways:

1. Keep the `BOOT` button pressed while connecting the dAISy-catcher to USB.
2. Connect to the dAISy-catcher with a serial terminal and type `Bu` and press `ENTER`.

In both cases, the computer will detect a new USB drive with the name `RP2350`.

The firmware is updated by copying the provided `.uf2` file to the USB drive. After the file transfer is complete, the USB drive will automatically disconnect, and the dAISy-catcher will reboot.

Your dAISy-catcher should now run the new firmware.

6 Command Interface

The dAISy-catcher includes a command interface for configuration. The command interface is accessed over the same serial connection as the AIS data, using a terminal program like for example `Putty` or `screen`.

Commands are one or two characters, followed by optional parameters. The command is run after pressing `ENTER`. Commands can be prefixed with `@` to suppress echoing of the input, which can be helpful when programmatically interacting with the command interface.

Tip: It can be distracting to use the command interface while being interrupted by incoming AIS messages. The reception of AIS messages can be temporarily disabled with the command `co4`.

6.1 h – help

The command `h` lists the available commands with a short description.

```
h
Available commands:
  h: help
  v: Version information
  s: System status
  c: AIS receiver configuration
Type 'h<command>' for more details on a specific command.
Start line with @ to suppress echo.
```

Prefixing another command with `h` will display the help text for that command.

```
hs
System status
Usage:
 s  - show system status
 s+ - show detailed system status
 sr - reset system statistics
```

Note that advanced commands are hidden in the help output if verbose or debug output are disabled. See the command `cd` in chapter 6.4.

6.2 v – version

The command `v` returns version information about the firmware currently running on the dAISy-catcher.

```
v
dAISy-catcher Firmware v1.0.0+f88208d PROD
Board: HAT v1.0
```

6.3 s – system status

Commands starting with `s` display system status and statistics.

Command	Description
s	Brief status, outputs up-time, selected AIS bands, total number of messages received, minimum and maximum signal strength, and most recent error message.

s+	Detailed status, outputs additional system information and statistics
sr	Resets statistics and counters, like number of messages received, minimum and maximum signal strength, etc.

Table 2: System status commands

6.4 c – configuration

The settings of the dAISy-catcher are updated and managed with commands starting with `c`.

Configuration management:

Command	Description
c?	Displays the current values of all configuration settings.
c#	Saves the current settings as power-on default.
c!	Resets the current settings and power-on default to factory presets.

Table 3: Commands for configuration management

The dAISy-catcher is controlled by a list of configuration settings. The current value of a specific setting can be queried by just sending the command without a value.

Note that advanced and low-level configuration settings are hidden in the help output if verbose or debug output are disabled (see the command `cd`).

Basic configuration settings cover the basic operation of the dAISy-catcher.

Command	Values	Description
co	0-4	Output format (see chapter 7 for more information) 0. NMEA AIVDM sentence (default) 1. NMEA AIVDM sentence with tag block containing metadata 2. JSON format, including NMEA sentence and metadata 3. NMEA AIVDM sentence plus PWEGA sentence with metadata 4. Disable output of AIS messages
cd	0-2	Verbose and debug output 0. Disabled (default) 1. Verbose: will show advanced commands and configuration settings 2. Debug: will show low-level system messages and settings
cb	0-1	AIS band selection 0. Regular: 161.975 MHz - 162.025 MHz (default) 1. Long-range AIS (LRA): 156.775 MHz - 156.825 MHz
cu	4800 - 1000000	Baudrate for UART1, typically used to connect the optional GNSS add-on. Default is 9600 baud.
cg	0-1	Output data received from the optional GNSS add-on 0. Disabled (default) 1. Enabled

Table 4: Commands to change basic configuration settings

Advanced configuration settings are items you may adjust to fit your requirements.

Command	Values	Description
ck	A-Z, 0-9	Channel designator for AIS messages received in the LRA band (cb1). The default setting is C, which uses C and D for LRA channels 1 and 2.

ce	0-3	Control LED activity, see chapter 5.1 for more information about the LEDs 0. Disable all LEDs 1. Enable LED activity (default) 2. Only enable red LEDs, indicating system status 3. Only enable green LEDs, indicating incoming AIS messages
cv	0-1	Extended validation of AIS messages 0. Disabled 1. Enabled, messages with invalid length will be discarded

Table 5: Commands to change advanced configuration settings

Low-level configuration settings are for experimentation and may negatively impact performance of the AIS receiver.

Command	Values	Description
cf	0-1, a	16dB front-end attenuator 0. Disabled 1. Enabled a. Automatically controlled based on detected signal strength (default)
cs	0-1	Low-side or high-side LO Changing the AIS band with cb will automatically set the most appropriate LO (high-side for regular AIS, low-side for LRA). With this command the LO can be forced to a specific side.
ca	16, 24	Resolution of ADC in bits 16. 16 bits (default) 24. 24 bits In our testing, setting the resolution to 24 bits did not improve performance.
cm	0-2	Single or dual core processing 0. Single core (default) 1. Dual core, both AIS decoders run on 2nd core 2. Dual core, channel 1 decoded on 1st, channel 2 on 2nd core With the current firmware, a single processor core is sufficient to run the dual-channel AIS decoder.

Table 6: Command to change low-level configuration settings

6.5 B – reboot

The dAISy-catcher can be rebooted with the commands in this group.

Note that the serial connection will be closed upon reboot.

Command	Description
Br	Immediately reboots the dAISy-catcher.
Bw	Reboots the dAISy-catcher by waiting for the watchdog timeout (10 seconds)
Bu	Reboots the dAISy-catcher as USB drive, ready to receive a firmware update. Note that this state can only be left by uploading a firmware update, or by power-cycling. See chapter 5.3 for more information about firmware updates.

Table 7: Commands to reboot the dAISy-catcher

7 AIS output format

By default, AIS messages are output as industry-standard NMEA 0183 sentences (AIVDM). But the dAISy-catcher also supports output formatting that augments AIS messages with metadata.

The output format can be configured with commands `co0` through `co3`.

7.1 NMEA AIVDM

NMEA sentences of the type AIVDM are what is output by regular AIS receivers, and the default mode of the dAISy-catcher.

```
!AIVDM,1,1,,A,15NcIU?02WG?FB@K>@S2V20V0@:c,0*3A
```

7.2 NMEA AIVDM with NMEA tag block

NMEA tag block is an extension of the NMEA standard that prefixes the AIVDM sentence to include additional metadata about the AIS message.

```
\s:daisycatcher,c:1780372795.729081,rssi:-102.7,fo:2.9*28\!AIVDM,1,1,,A,15N…
```

The dAISy-catcher adds the following fields:

Field	Description
s	Identifier of receiver
c	Time of arrival of the message in Unix epoch seconds with microsecond resolution. This field is omitted if no GNSS add-on is present, or the receiver's clock is not synchronized
rssi	Received signal strength of the message in dBm
Fo	Frequency offset of the message in ppm

Table 8: NMEA tag block fields added by the dAISy-catcher

7.3 JSON

The dAISy-catcher supports a custom JSON format designed to simplify processing of AIS messages and associated metadata.

```
{"class":"AIS","device":"dAISy-catcher","toa":1780372862.427008,"rssi":
-102.7,"fo":2.7,"nmea":["!AIVDM,1,1,,A,15NcIU?02WG?FB@K>@S2V20V0@:c,0*3A"]}
```

The JSON structure for an AIS message contains the following fields:

Field	Description
class	Type of the JSON structure. `AIS` indicates that this is an AIS message.
device	Type of device, in our case always `dAISy-catcher`.
toa	Time of arrival of the message in Unix epoch seconds with microsecond resolution. This field is omitted if no GNSS add-on is present, or the receiver's clock is not synchronized
rssi	Received signal strength of the message in dBm
fo	Frequency offset of the message in ppm
nmea	AIVDM NMEA sentences with the AIS message. This field is an array, with multiple entries for multi-part messages.

Table 9: Fields of the JSON structure for an AIS message

When in this output mode, the dAISy-catcher will also output responses to commands as well as debug and error messages in JSON format. For example, querying the current output mode with the command `co` will respond with:

```
{"class":"config","device":"dAISy-catcher","parameter":"output_format",
"value":2}
```

7.4 NMEA AIVDM with proprietary PWEGA

In this output mode, AIS messages in NMEA AIVDM format are followed by a proprietary NMEA sentence containing the metadata for the AIS message.

```
!AIVDM,1,1,,A,15NcIU?02WG?FB@K>@S2V20V0@:c,0*3A

$PWEGA,,META,1780372887.335403,-102.7,2.8*75
```

The fields of the PWEGA sentence are:

Field	Name	Description
1	$PWEGA	Proprietary prefix for Wegmatt (PWEG) followed by the device type (A)
2	reserved	Reserved for future use, may be empty or contain an integer
3	Type	Sentence type, META indicates that this sentence contains metadata
4	toa	Time of arrival of the message in Unix epoch seconds with microsecond resolution. This field is empty if no GNSS add-on is present, or the receiver's clock is not synchronized
5	rssi	Received signal strength of the message in dBm
6	fo	Frequency offset of the message in ppm

Table 10: Fields of the proprietary PWEGA NMEA sentence

8 Connections

8.1 Serial interface UART0

UART0 is the primary communication interface of the dAISy-catcher. RX/TX are connected to the Raspberry Pi, and available on unpopulated connector J2. The pins are labelled UART0 RX/TX. From the perspective of the dAISy-catcher, RX is the input and TX the output.

UART0 is always enabled and uses 3.3V signal voltage levels at a fixed speed of 115200 bits per second.

Baud rate	115200 fixed
Data bits	8
Parity	None
Stop bits	1
Flow control	None

Table 11 UART0 interface parameters

In normal operation, received AIS messages will be output on this port. In addition, UART0 is used for the command interface.

8.2 Serial interface UART1

UART1 is a configurable serial interface. RX/TX are available on the populate connector J3. The pins are labelled UART1 RX/TX. From the perspective of the dAISy-catcher, RX is the input and TX the output.

UART1 is always enabled and uses 3.3V signal voltage levels.

Baud rate	4800-1000000 default: 9600
Data bits	8
Parity	None
Stop bits	1
Flow control	None

Table 12 UART1 interface parameters

The dAISy-catcher supports an optional GNSS add-on connected to UART1. See chapter 9 for more information.

8.3 Antenna connector

The edge-mount antenna connector of the dAISy-catcher is a female SMA connector with standard polarity.

The dAISy-catcher is matched for an antenna with an impedance of 50 ohms, which is standard for marine VHF communication.

9 Time-of-arrival measurement with GNSS

When combined with a GNSS receiver, the dAISy-catcher can report the time-of-arrival of AIS messages. This is currently considered an experimental feature as it is not widely supported by AIS software, but we think it may be of interest to security researchers.

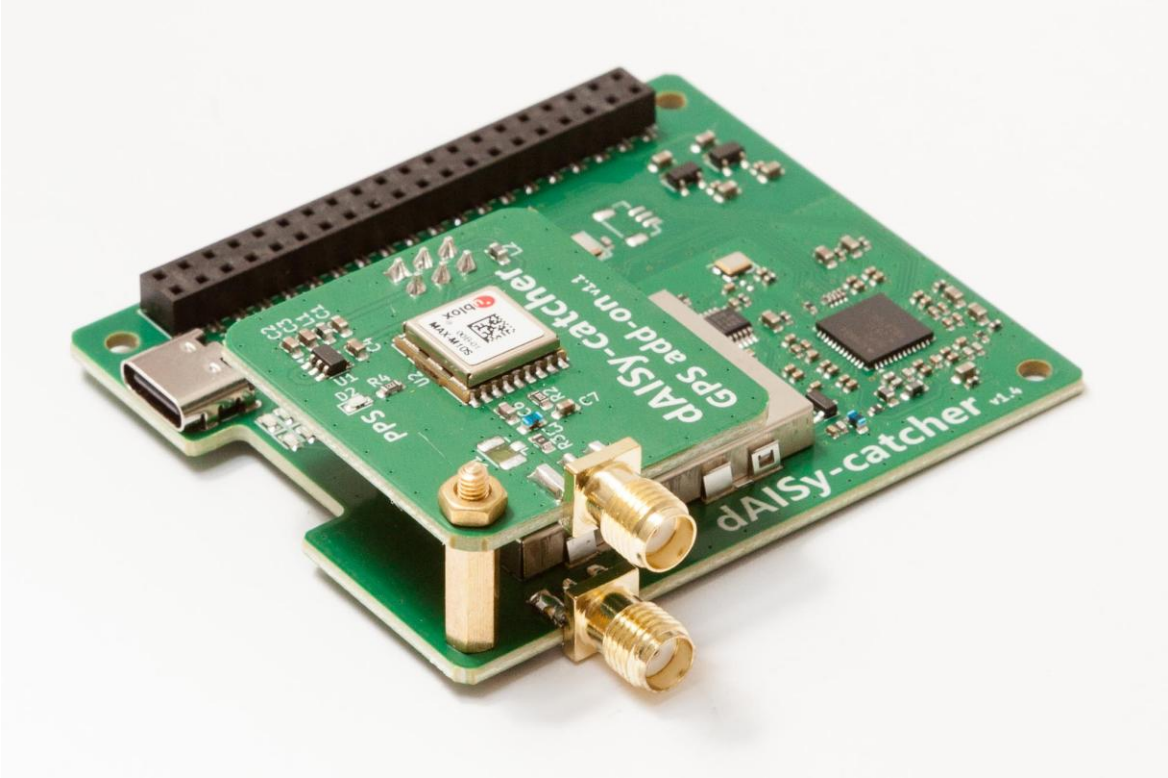

Figure 5: dAISy-catcher with installed GNSS add-on

The dAISy-catcher is using NMEA RMC sentences and the PPS signal from the GNSS add-on to establish a high-precision time basis. This process typically takes 2-3 minutes after the GNSS starts outputting the PPS signal but may take longer depending on the antenna location and RF environment.

Once the dAISy-catcher is synchronized with the GNSS clock, it determines the time of arrival (TOA) of each AIS message with microsecond resolution. This information is output together with the AIS message if one of the enhanced output formats `co1`, `co2` or `co3` is configured.

The dAISy-catcher reports TOA as Unix epoch seconds with 6 decimal places. The timestamp indicates the reception of the end of the training sequence and beginning of start flag, 3.333ms from start of the transmission slot, referenced as T2 in ITU-R M.1371-6[6].

[6] https://www.itu.int/rec/R-REC-M.1371/en section A2-3.2.2.10 Transmission timing

10 Tips for good AIS reception

The dAISy-catcher is a high-performance AIS receiver with best-in-class performance. But even the best AIS receiver will benefit from the following basic measures.

10.1 Location, location, location

Good AIS reception requires line of sight.

A few buildings and trees between you and your targets aren't ideal, but you will still be able to receive many messages. Hills and mountains, however, are almost certain showstoppers. A clear view of the water and your targets is ideal.

The most important factor is the elevation of the antenna. Sitting at the beach or on the deck of a boat will work. Mounting the antenna on the mast of your boat or standing on the observation deck of a cruise ship is better. A hill overlooking the harbor is great. Climbing that 2000m mountain that towers over the coast is AIS heaven.

In a nutshell: The farther you can see, the better.

10.2 Antenna

If everything else is optimal, almost any antenna tuned to the VHF band will do, even a simple wire cut to length (~92cm). However, a good antenna will greatly improve results.

AIS messages are broadcast on two channels around 162 MHz, which is in the maritime VHF band. This means that any antenna sold as "*marine VHF antenna*" will be a good start.

The short VHF "rubber duck" antennas are cheap and will work at short distance. If you check whether 162 MHz is inside the supported frequency range, you can even ignore the "marine" and save a few bucks. However, the more broadband the antenna, the worse the reception quality.

A step up is the VHF whip antenna. These are steel rods about 90 centimeters (3ft) long. While bulky, these don't cost much more than the "rubber duck" but provide superior range. Two inexpensive options available in the US are TRAM 1600-HC and Shakespeare 5215 which cost US $50-75. Similar antennas should be available locally from electronics retailers or in marine supply stores.

On boats, the AIS antenna should be separated as far as possible from the VHF radio antenna to avoid unnecessary interference. The best separation is achieved by vertically separating the antennas or at least mounting them on opposite sides of a vessel.

To avoid damaging dAISy-catcher with strong transmissions by other devices, the antenna should be mounted at least 3 meters away from, or at least out of the transmitting beam, of high-power transmitters such as radars or other VHF antenna installations.

IMPORTANT: Do NOT directly connect the dAISy-catcher to the same antenna as your VHF radio. This will damage the AIS receiver! To share an existing antenna with a VHF radio, use an ACTIVE splitter. Active splitters protect the AIS receiver by automatically disconnecting it when the VHF radio is transmitting. Several customers reported good results with the inexpensive Glomex RA201 VHF/AIS/Radio Splitter.

10.3 External amplifier

The dAISy-catcher has an integrated low-noise amplifier, and in most scenarios external amplification will not improve reception. To the contrary, external amplification may overload the frontend of the AIS receiver, worsening reception.

External amplification may be beneficial with a very long antenna cable (>10 meters). In this scenario, the external amplifier must be installed near the antenna.

If using an external amplifier, keep an eye on the red CH1 and CH2 LEDs. If these turn on, it is likely that the external amplifier is not having any benefit. See chapter 5.1 for more information about the LEDs.

10.4 Radio frequency noise

The dAISy-catcher has an integrated bandpass filter to reduce the impact of radio frequency noise outside the marine VHF band frequency. But a strong local transmitter or noisy electronics near the antenna can still impact performance.

Interference from a local transmitter can sometimes remedied with an external SAW band-pass filter between antenna and AIS receiver. The downside is a 3-6 dB reduction of received signal strength, which can impact range.

RF noise from noisy electronics is harder to contain, as it is often broadband. Some sources of RF noise we encountered are RGB LED strings, internet over phone wiring (ADSL, VDSL, Vfast), Ethernet over electrical wiring (powerline). If you're not able to turn it off, the best approach is to keep the antenna far away from the noise source.

11 Specifications

Power	
Power input ports	USB-C, Raspberry Pi 2x20 GPIO header
Input voltage	3.7 V - 5.5 V, 5 V recommended
Input current	100mA
Radio	
Independent receivers	1, covering 2 adjacent channels
Frequency bands	AIS: 161.975 MHz, 162.025 MHz Long-range AIS: 156.775 MHz, 156.825 MHz
AIS channels	2 channels, selected by band
Sensitivity	Better than -120 dBm @ 20% PER
Input power, absolute maximum	0 dBm
Input power, recommended maximum	-40 dBm
Bandpass filter	SAW 156.3 - 162.025 MHz pass band, integrated
LNA	23 dB, integrated
RF connector	SMA female
Input impedance	50Ω
Data I/O	
AIS message encoding	NMEA 0183 (AIVDM)
Supported AIS message types	1-28
Serial speed USB / RPi / UART 0	115200 Baud fixed
Serial speed GNSS / UART 1	4800-1M Baud configurable
Serial protocol	8 data bits, no parity, 1 stop bit (8N1)
Serial format USB / RPi / UART 0	NMEA (default), NMEA tag block, JSON configurable
Serial mode UART 1	GNSS input
Serial I/O voltage	3.3 V
Dimensions	
Circuit board without connectors	65 mm x 56 mm
Circuit board with connectors	65 mm x 66 mm x 12 mm
Mounting holes	4x Size: 2.75mm (M2.5) Distance: 58mm x 49mm
See also: https://github.com/raspberrypi/hats/blob/master/hat-board-mechanical.pdf	
Weight	
Circuit board	20 g (0.7 oz)

12 Contact

Our website and online store can be found at: https://wegmatt.com

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Please don't hesitate to contact us if you need support. We also love to hear about your projects and are happy to share your related blog posts, videos, and pictures on our social media.

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