ICflyAHRSII

Attitude Heading Reference System

The ICflyAHRSII is an Attitude Heading Reference System. It continuously monitors its orientation and transmits all orientation related data via Wi-Fi or Serial Port to your target device (e.g. mobile phone / tablet).

Furthermore the ICflyAHRSII can function as an interface between your target device and several avionics like an auto pilot or the ADS-B/FLARM® collision avoidance system.

The professionally calibrated 3-axis gyros, accelerometers and magnetometers lead to precise and reliable attitude and heading information.

The ICflyAHRSII standard version can be upgraded with pressure sensors for static and dynamic pressure, to provide precise altitude and speed information.

Features

- **Roll**: ±180°, Resolution 0.1°, 10Hz Refresh Rate
- **Pitch**: ± 90°, 0.1°, 10Hz Refresh Rate
- **Magnetic heading** 0° to 360°, 0.1°, 10Hz
- **Slip Angle** (Inclination) ±90°, 0.1°, 10Hz
- **Turn Rate** (turn coordinator) ±2000°/s max.
- **G Meter**: ±16g
- **Altimeter:** calculated from static pressure input, output in ft (only with optional pressure sensors mounted)
- **Climb rate:** calculated from static pressure input, output in ft/min (optional)
- **IAS:** calculated from dynamic pressure input (connect to Pitot-Static system of Aircraft), output in kts, Res. 1 kt (optional)
- Pressure fittings 1/8" 5mm hose fittings for pressure inputs (optional)
- Internal rechargeable battery:
  - more than 10 hours of operation time
  - charging cycle of less than 8 hours
 - charge from 8-24VDC or micro-USB-B with provided adapter

CAUTION

- This product is NOT an FAA certified instrument
- **This product must NOT be used as primary or backup flight instrument**
- Keep temperature within –20℃ to +60℃
- Keep away from direct sunlight
- Li-Ion batteries are volatile. Failure to read and follow the s**afety instructions** included in this package may result in fire, personal injury and damage to property if used improperly

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1. Connections

The ICflyAHRSII provides a male 15-pin D-sub connector. The pin assignment is listed in the table below.
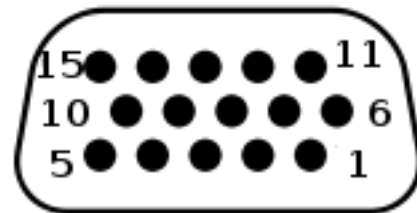
Pin Number	Function	Description
1	+3V3	DC output
2	GND	Ground
3	GPIO 0	Output coupled to active LED (low active)
4	RX1	RS232
5	TX1	RS232
6	+3V3	DC output
7	GND	Ground
8	PWR/SW Button	Control button (low active)
9	RX2	RS232
10	TX2	RS232
11	Vin1	8-24V DC
12	Vin2	Polarity not important
13	Vusb	5V input voltage
14	D-	USB/GPIO
15	D+	USB/GPIO
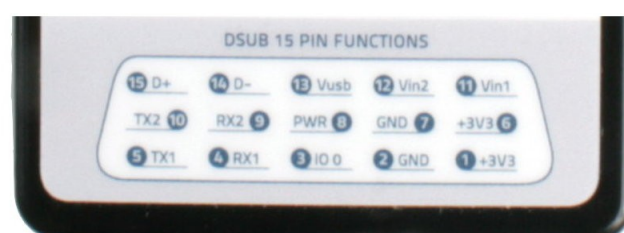
2. Installation/ Quick start guide

Follow these instructions for proper installation:

- **Charge** your IC*fly*AHRS*II* completely before first operation. (see chapter 3: Battery & Charging)
- **Dynamic pressure data (IAS,** optional**):** Connect the dynamic pressure line of aircrafts Pilot-Static-System to the corresponding dynamic pressure port of the IC*fly*AHRS*II* (marked as DYN.P on the label). Indicated airspeed will be available if the dynamic pressure line is connected!
- **Static pressure data (Altimeter,** optional**):** Connect the static pressure line of the aircraft to the static pressure port of the IC*fly*AHRS*II* (marked as STAT.P on the label).

  If the aircraft does not have a pressurized cabin, the static port of the IC*fly*AHRS*II* can be left open (in this case cabin pressure is used to calculate the altitude).
- **Align** the arrow/airplane symbol (located on the label) with the roll axis of your plane
- **Install** the device as leveled as possible drawn to flight position (see Chapter 6: Calibration for software-compensation of unleveled mounting)
- The label should face upwards
- **Moun**t the module as close as possible to the center of your airplane
- Try to mount the IC*fly*AHRS*II* as far away from ferrous parts as possible (these will have an impact on magnetometer / heading precision)
- Download & install your desired app on your mobile device
- Switch on the IC*fly*AHRS*II* (see chapter 4: Power Button)
- Connect to your IC*fly*AHRS*II* via Wi-Fi (see chapter 8: Connecting)
- The IC*fly*AHRS*II* comes precalibrated for leveled mounting so you can start right away
- If you cannot mount the device leveled to ground, it is necessary to execute the "Calibrate Ground Pitch" procedure once while the airplane stands still.
- Once you are air-borne and in a leveled flight attitude set the Air Pitch Offset to compensate any offsets between flying and ground attitude (see Chapter 6: Calibration & Configuration menu)
- Your IC*fly*AHRS*II* is now ready to operate

3. Battery & Charging

The ICflyAHRSII contains a rechargeable Li-Ion battery. It can be charged over USB with the provided USB adapter (picture below) or an external power supply (8–24VDC) on pins 11 and 12.
Power supply can also be ensured by connecting either Vin1 or Vin2 and GND. (polarity not important)
The ICflyAHRSII refuses to operate from battery if the charge state falls below 5%. Connect USB or an external supply to run the module and recharge the battery.
A fully charged battery ensures a minimum operating time of 10 hours.

The lower battery LED indicates the charging state:
LED ON: charging in process
LED OFF: battery fully charged

The upper battery LED indicates the power state:
LED color oscillates: powered by USB or Vin
LED static color: refer to table below

LED	Charge state	Minimum operating time left
Green	>80%	10 hours
Orange	30% - 80%	3 hours
Red	10% - 30%	1 hour
Red (blinking)	<10%	<1 hour

4. Power Button

To activate the IC*fly*AHRS*II* you can either use the provided USB Adapter with integrated push button or you can connect a push button between pin 8 of the D-sub connector and GND.
The several functions of the power button are selected by press and hold the button for a defined time.
The table below shows the holding-time of the power button and the assigned function.

	Hold for ... seconds	Released after ... seconds
< 2 seconds	'Active'-LED goes ON	(No state change)
2 − 5 seconds	'Active'-LED blinks	Power ON, If already ON: Restart sensors
5 − 20 seconds	'Active'-LED goes OFF	Power OFF
20-23 seconds	'Active'-LED blinks again	Wi-Fi reset of SSID and PASS

The reset of Wi-Fi credentials can be used if you lost your current settings. These are reset to delivery values as given in Chapter 8. Calibration data is not influenced by this reset functionality.

5. Operation

While Vin or USB is connected the module is always on. Alternatively power on with a power button.
On Power Up, the Wi-Fi and Calib LED turn yellow until Wi-Fi is initialized.
Afterwards the Calib LED blinks while the module prepares the sensors for operation.
As soon as the Module is ready to operate, the Active LED starts blinking, and the module transmits data on the configured channels. (see Chapter 6; Calibration & Configuration menu)

LED	'Blinking'	'ON'
'Wi-Fi'	---	Yellow: WLANinitializing Green: WLAN running Red: Error on WLAN start
Calib	Start Up	Calibration running
'Active'	Module is operating	---

LED signal on GPIO 0 pin:
A signal equivalent to the 'Active' LED state is output on the 'GPIO 0' pin.

You can mount a LED between one of the 3.3V output pins and 'GPIO 0' to relay the signal away from the mounting position of your IC*fly*AHRS*II*.

This makes it possible, in combination with a switch connected to the power button pin (Chapter 4), to mount the controls for your IC*fly*AHRS*II* next to other instruments within your plane.

# 6. Calibration & Configuration menu

The IC*fly*AHRS*II* provides a web browser based calibration and configuration menu. After powering up the module and connecting your target device to the Wi-Fi network (see chapter 8: Connecting), start your web browser and enter the address: **169.254.1.1** in the address bar to access the calibration and configuration menu of the IC*fly*AHRS*II*. Some browsers may require you to type **http://169.254.1.1.** In the top right corner you can see the hardware and software version of your IC*fly*AHRS*II*. The menu, as you can see in the picture below, is divided into subsections.

General behavior:
In case of an internal communication error, a value may show "INV" instead of a valid one. Simply reload the page to reread the values.

Button color coding:

- Green: On/Value up to date

- Yellow: Value valid but maybe not up to date
  (e.g. restored former calibration data at power up)

- Red: Value invalid
  (e.g. never before calibrated Accelerometer)

- Cyan: Action awaits confirmation

- Blue: Error in internal communication. Reload page to fix
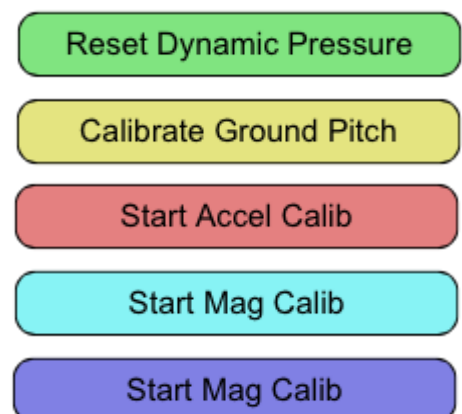
Starting actions requiring confirmation:
Actions which alter the calibration tables possibly inflicting inaccurate calculations require a confirmation to actually be executed. The procedure is shown below.
After clicking the button once it will switch to cyan signaling the 'wait for confirmation' state.
When clicking a cyan button the action will be executed.

Module busy page:
While the ICflyAHRSII executes time consuming actions (e.g. calibrations) it can not correctly serve HTTP Requests. During this time the intermediate page shown on the right is displayed.
This page will reload itself every 10 seconds if your browser supports javascript.
You can force a reload by using the printed out link and need to do so if javascript is not available.
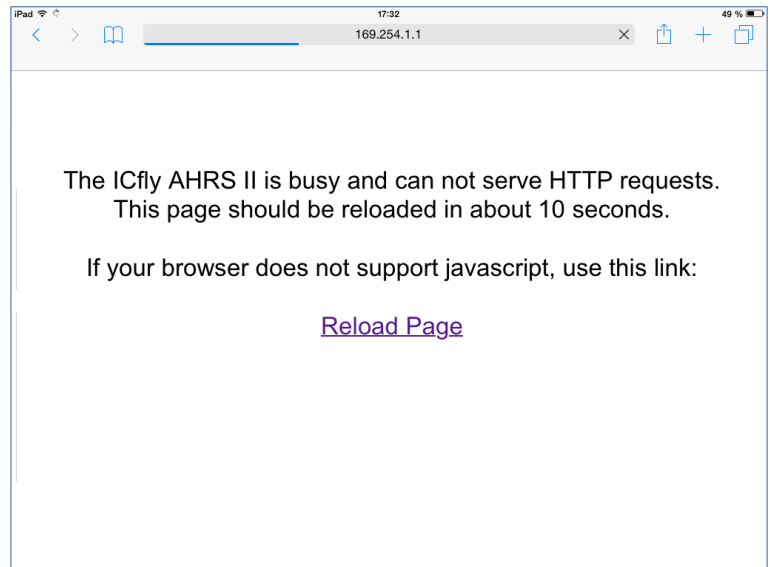
Unavailable components:
Controls for components not available on the current module are displayed with reduced opacity.
For example a module without pressure sensors will display the section as shown on the right.

Battery and supply voltage:
At the top of the page the current charge of the battery is displayed. Besides it the Vin icon is visible if an external supply voltage Vin/USB is connected.

External supply connected:

Running on battery with 73% charge:

In-Flight section:
- *Reload page:* Reloads the configuration menu and refreshes all values. Pending confirmation is canceled.
- *Set (S) or Reset (R) Air Pitch Offset :* Sets/Resets the offset between flying attitude and ground attitude (This enables to calibrate the ICflyAHRSII in an unleveled position and set this offset at a later time, see Chapter 7: Calibration Routines)
This option is very useful for planes with tail wheel.
The current pitch offset is shown in degrees.

Battery run time:

- Sets how long the device will run on battery while no Vin is present. When this time span elapsed the module will power down.
- When the module is powered on using a power button it will stay on for at least 15 minutes and only afterwards respect this configuration.
- The current value is printed out in minutes if not stated else.

Possible settings:
off: The device will power down immediately after Vin is lost
10s – 6h: Stay on for the configured time span
infinite: power down only when battery exhausted

Serial configuration:
- *Baudrate:* Sets the baudrate of the serial interface (current baudrate shown in brackets)
- *Write data from WLAN:* Enables/disables data transfer from Wi-Fi connections to the serial interface
- *Read data for WLAN:* Enables/disables data transfer from the serial interface to Wi-Fi connections
- *Write AHRS Data:* Enables/disables output of AHRS data on the serial interface

The button color signals the current state of the function:
Green: Function enabled
White: Function disabled

Calibration:

- *Calibrate Ground Pitch:* Stores the modules current orientation as reference (If a high level of motion is detected during this procedure, the IC*fly*AHRS*II* will refuse to update the reference values).
  Colored yellow if current values were restored at power up
  Colored green if calibrated since last power up
- *Reset Dynamic Pressure:* Calibrates the dynamic pressure sensor to zero (optional)
- *Start Accel Calib:* Starts the calibration routine of the accelerometer (see Chapter 7 Calibration Routines)
- *Start Mag Calib:* Starts the calibration routine of the magnetometer (see Chapter 7 Calibration Routines)
- *Measured Alt(ft):* Displays the altitude calculated from measurements with the QNH given below
- *Alt(ft)* and *QNH:* Set current altitude in feet and QNH value for static pressure calibration (optional)
- *Start Static Calib:* Calibrates the static pressure sensor to the altitude and QNH values given above (optional)

Changing Wi-Fi credentials:

Set a new SSID and pass phrase for the device.

1. Set the desired SSID
- 4 to 30 chars

2. Set the new pass phrase
- 8 to 30 chars

3. Confirm the pass phrase

If an error occurs the module will print out an error message as shown below.

When the procedure successfully completes, the wireless interface will restart with the new credentials immediately and you have to reconnect to the network.

7. Calibration routines

Installation calibration routine:
This procedure has to be done after the installation of the ICflyAHRSII in a new orientation.
- Start Ground Pitch Calibration. (see Chapter 6: Calibration & Configuration) This will store the devices current orientation as reference
- Once you are air-borne and in a level flight attitude set the Air Pitch Offset to compensate any orientation differences between flying attitude and ground attitude.

Accelerometer calibration routine:
This procedure will calibrate the IcflyAHRSIIs accelerometer.
The goal of this procedure is to have normalized gravity acting in every axis on the accelerometer. This is done by measuring the gravity while the module is lying on its faces.
The ICflyAHRSII must not be attached for this procedure.
- Start the calibration routine of the accelerometer (see Chapter 6: Calibration & Configuration)
- Place the ICflyAHRSII on a flat, level surface
- Press the power button for a short time (see chapter 4: Power Button)
- Turn the module over to the side
- Press the button again
- Repeat for all six faces of the module (order not important)
  (To calibrate the accelerometer on the two sides with attachment appliances, press the module against an upright surface)

Magnetometer calibration routine:
This procedure will calibrate the IcflyAHRSIIs magnetometer.
The goal of this procedure is to have the maximum of the magnetic field detected in every direction on the magnetometer. This is done by revolving the module in all directions.
The ICflyAHRSII must not be attached for this procedure.
- Before starting the calibration hold the ICflyAHRSII in your hand and as far away as possible from any ferromagnetic material
- Start the calibration routine of the magnetometer (see Chapter 6: Calibration & Configuration)
- While the routine is running (~10sec) revolve the ICflyAHRSII in all directions around its axes as shown in the picture below. Try to reach every possible orientation for the device.

8. Connecting

The IC*fly*AHRS*II* offers data readout via Wi-Fi and serial interfaces.

Connecting via Wi-Fi:
After powering up, the IC*fly*AHRS*II* opens a WLAN-Network:
  Network ID: ICfly_AHRSII **access key:** 12 345 678

After connecting to this network the data stream can be received via TCP:
  Host IP: 169.254.1.1 **TCP-Port:** 2000

The ICFlyAHRSII can handle up to three parallel connections. Exceeding this limit can lead to erroneous data transmissions or in extreme cases to a reset of the modules Wi-Fi interface.

Connecting via serial interface:
The IC*fly*AHRS*II* provides two serial interfaces to exchange data with other devices like an autopilot or an ADS-B/FLARM® collision avoidance system.
The serial interfaces can be configured using the configuration menu. (see Chapter 6: Calibration and Configuration menu)

If enabled through the configuration menu, data from the serial interfaces is read in line based.
A Wi-Fi packet is sent out when the new line character '\n' is received on the serial interface.
To prevent interference with AHRS data, the line length is limited to 476 characters.

Serial interface 1 is preconfigured with 19 200 baud to read data from a TRX-1500 Traffic Sensor.
(see Chapter 9: Serial interfaces)
Serial interface 2 is preconfigured with 4800 baud to print out data delivered over Wi-Fi connections (e.g. navigational data generated by a connected app for an autopilot)
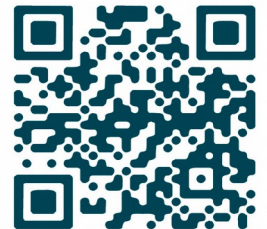
Data included in the AHRS data stream:
$APPOWER: voltage, battery percent
$RPYL: roll Rate, pitch, heading, slip Angle, turn Rate, g Load
$APENV1: air Speed, altitude, vertical Speed

Recommended Apps:
- ICfly Instrument by In-Circuit, for iOS
- Sky-Map
- Air Navigation Pro
- and all Apps that work with the standard NMEA sentences $RPYL and $APENV1

9. Serial Interfaces

There are two RS232 ports available on the ICflyAHRSII. This enables the ICflyAHRSII to be usable as very flexible dual-RS232-to-Wi-Fi bridge. Both RS232 interfaces can be configured individually. The transmission format for both ports is 8,N,1 (8 Databits, No parity, 1 Stop-bit).

The user can select whether to
- output data from Wi-Fi connections (e.g. autopilot data)
- read data and bridge it to Wi-Fi connections
- output AHRS data

Serial1 Configuration
Baudrate (currently **19200**)
[19200 ▼] [Set]
Write data from WLAN
Read data for WLAN
Write AHRS data

Serial2 Configuration
Baudrate (currently **4800**)
[4800 ▼] [Set]
Write data from WLAN
Read data for WLAN
Write AHRS data

The drawing below shows how to connect a TRX-1500 Traffic Sensor to an ICflyAHRSII. The ICflyAHRSII receives the traffic data for ADSB/FLARM and the GPS-Data via RS232 and transmits it embedded in the AHRS data stream to connected Wi-Fi devices.

Pin ICflyII	Function ICflyII	Pin TRX1500	Function TRX1500
4	RX1	9	TX2
11	Vin1	11	Vin
2, 12	GND, Vin2	12	GND

Pin	Function ICflyII
1	+3V3
2	GND
3	GPIO 0
4	RX1
5	TX1
6	+3V3
7	GND
8	PWR/SW Button
9	RX2
10	TX2
11	Vin1
12	Vin2
13	Vusb
14	D-
15	D+

TX2(Pin9)

Vin(Pin11)

GND(Pin12)

+9...+24VDC

GND
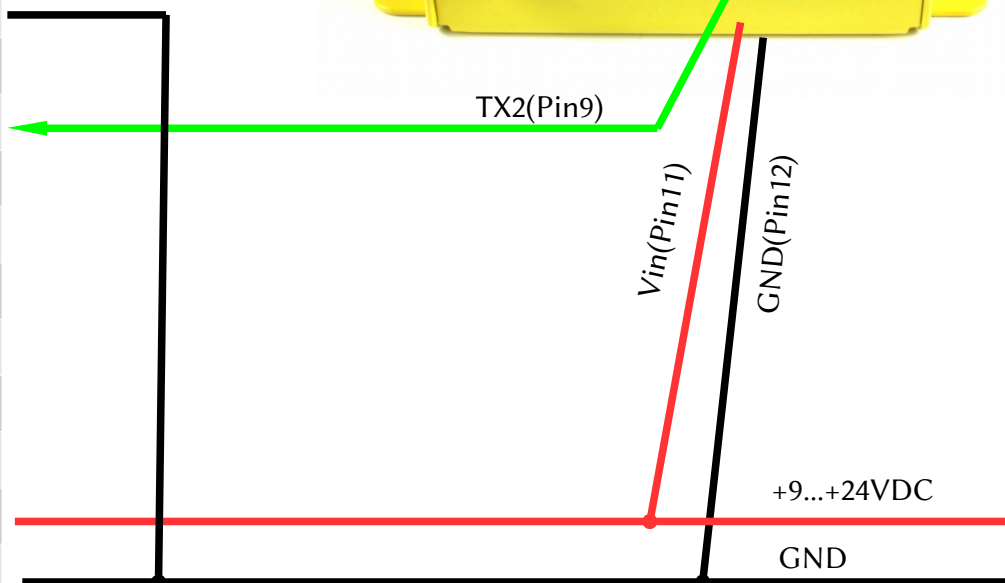
Note: TRX1500 Baudrate=19 200,8,N,1

Accessories

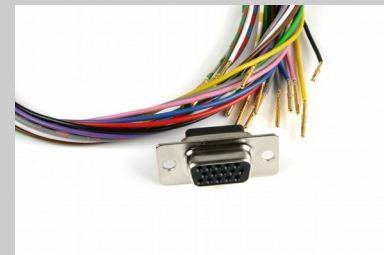| Integrated accessories	
Micro USB adapter with integrated power button Order# 901.375	
LiPo battery pack usable as stand-alone or backup power-source. 3.7V, 1950mAh, over-current protection Order# 303.239	

Optional accessories	
D-SUB HD15 connector with 15x crimped cables Order# 303.325	
Micro USB 2.0 cable length 0.5m Order# 306.044	
Flexible hose 5mm x 1.5mm (only relevant for version with pressure sensors) Order# 303.242	
T-piece 5mm hose size (only relevant for version with pressure sensor) Order# 303.241	

Data connections overview

The ICflyAHRSII can work as relay for Wi-Fi and RS232 data. Up to 2 RS232-receivers and 2 RS232-transmitters can be connected. The device is able to handle 3 Wi-Fi TCP connections in parallel. The connections to the RS232 devices can be configured comfortably on the built-in website.

AHRS/FLARM...

AHRS

Setup

- Up to 3 parallel TCP connections
- Bidirectional data stream for Wi-Fi-to-RS232 bridge

Data from RS232 devices (FLARM/ADSB etc.) is received on RS232 and sent via Wi-Fi

Data for RS232 devices (Autopilot, etc.) is received on Wi-Fi and sent via RS232

FLARM

Certifications

European R&TTE Directive Statements
The IC*fly*AHRS*II* module has been tested and found to comply with Annex IV of the R&TTE Directive 1999/5/EC and is subject of a notified body opinion.

RoHS / WEEE compliant

WEEE-Reg.-Nr. DE 17225017

Version	Date	Changes	Editor
A	2016/02/01	Initial Version	Klause, Träger, Blocher
	2016/04/25	added App informations	Träger