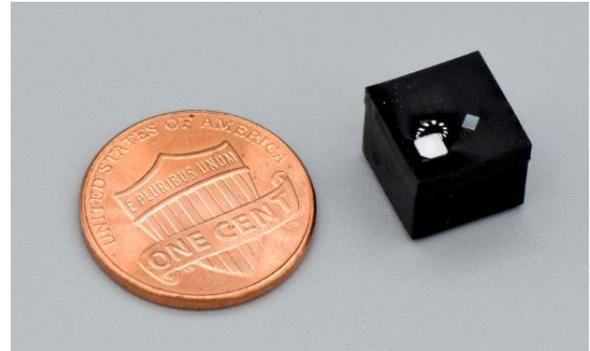**◆◆ Cube**Works

CubiSens^{TM} N-Series AH100 Asset Tracker
User Manual & Datasheet

Key Features

- Millimeter-Scale Form Factor (10 x 10 x 8 mm^3)
- 5+ Years of Battery Life
- Fully Wireless Operation
- 3-axis Motion Detection
- Accurate Humidity & Temperature Sensing
- Up to 100m LoS Wireless Communication (Uplink)
- Optical Communication (Downlink)
- Automatic Motion Alarm Muting

CubiSens N-Series AH100

Product Description

CubiSens^{TM} N-series AH100 Asset Tracker (AH100 in short) is a millimeter-scale wireless sensor for continuous detection of motion, temperature, and humidity. Measuring 10 x 10 x 8 mm^3, the AH100 is capable of transmitting up to 70m in distance and last 5+ years in operation. Motion detection is based on a 3-axis accelerometer measurement and the detection sensitivity is configurable. Humidity and temperature can be measured with 1.5% and 0.2˚C accuracy, respectively, and the measurement interval is configurable. In order to protect unnecessary battery drainage in a high-vibration environment or continued movement, automatic motion alarm muting is implemented with a configurable alarm trigger count. Typical battery life at 25˚C and 10-minute check-in time is over 5 years.

Important Warnings for Use

- **Direct Sunlight Exposure:** Direct exposure to sunlight can cause malfunction and must be avoided.
- **Temperature Exposure**: The AH100 is designed for indoor usage (10-55˚C). Optical communication must be performed in room temperature environment (21-27˚C). Please refer to Table 1 for details on other temperature limits. Please allow 10-15 minutes for the unit to acclimate to a new temperature environment in case of an abrupt temperature change (e.g. outdoor → indoor). Battery life also varies depending on the exposed temperature, as shown in Table 2.
- **Manual Handling**: Each unit is coated to protect the electronics from manual handling. However, holding the unit can shift radio frequency of the integrated antenna and temporarily hamper wireless communication.
- **Water Exposure**: For proper operation of the humidity sensor and wireless radio, the AH100 should not be submerged in water. Please make sure to completely air dry the unit for proper operation after accidental exposure to water.
- **Positioning**: The radio performance of AH100 depends on sensor orientation and receiver antenna orientation. Furthermore, placing the sensor on metal may either enhance or reduce radio distance depending on orientation. Please refer to "Wireless Performance" section for details.

CubeWorks

Technical Specifications

Dimensions (W x L x H)	10 x 10 x 8 mm^3
Weight	1.9 g
Motion Detection Sensitivity	Configurable, Minimum 1m*g*, Default 256m*g*
Humidity Sensor Accuracy	± 1.5%RH
Temperature Sensor Accuracy	± 0.2˚C
Battery Life	7 years at 25 ˚C (See Table 2)
Shelf Life	Minimum 7 years
Wireless Communication	100m Line-of-Sight to Receiver
Radio Frequency	915 MHz (US Version)
Encapsulation Material	Biocompatible Epoxy
Operation Temperature	10˚C - 55˚C
Storage Temperature	15˚C - 25˚C
Optical Communication Temperature	21˚C - 27˚C

Table 1: AH100 Technical Specifications

Temperature	Estimated Battery Life*
10˚C	9.8 Years
20˚C	8.2 Years
25˚C	7.4 Years
30˚C	6.6 Years
40˚C	5.0 Years
50˚C	3.6 Years

* Battery life estimated with motion detection enabled, check-in every 10 minutes

Table 2: Estimated Battery Life at Different Temperatures

Setup

1. What's in the Box

Each AH100 kit contains the following:

- AH100 Sensors
- CubiSens Gateway
- 915MHz Antenna
- Optical Programmer
- Monitor
- Gateway Power Cable
- Monitor Power Cable
- Ethernet Cable
- DP-HDMI Cable
- USB Cable

CubiSens Gateway

2. Connecting Devices (Normal Operation)

Please follow the steps below to connect the antenna to the gateway and power on the system:

1. Connect the antenna to the ANT1 port
2. Connect the ethernet cable to ETH1 port
3. Plug in the power adapter to Gateway's DC2 port

DC2 and ANT1 ports should be used

3. Connecting Devices (Maintenance Mode)

For maintenance and debugging, please follow the steps below to connect the gateway, antenna, monitor, keyboard, and optical programmer:

1. Connect the antenna to the ANT1 port
2. Connect the ethernet cable to ETH1 port
3. Connect the monitor to the CubiSens Gateway using miniDP-HDMI cable
4. Connect monitor's power cable
5. Connect the wireless keyboard's dongle to USB1 port
6. Connect Optical Programmer to the USB2 or USB3 port
7. Plug in the power adapter to Gateway's DC2 port
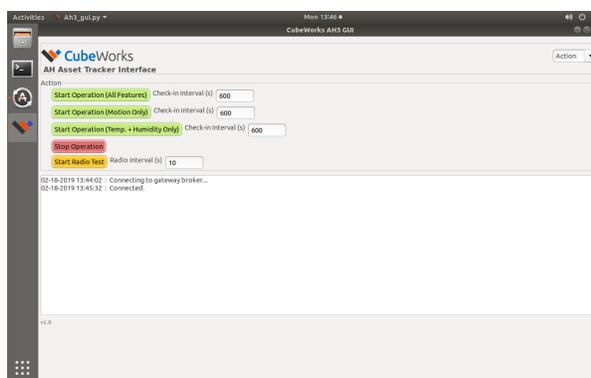
Completed setup for maintenance / debugging

4. Unused Ports

The following ports should not be connected at any time.
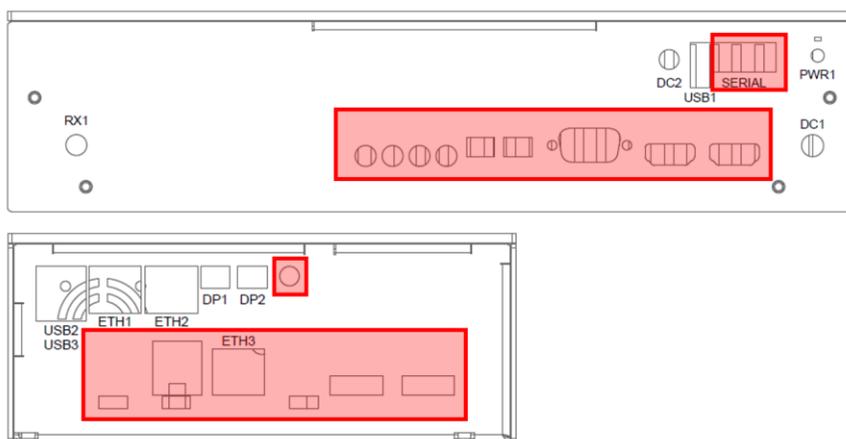
**Ports shown in red box should not be connected at any time**

Operation

1. Optical Interface

AH100 uses an optical programming interface to receive commands and change configurations. Each time a button is pressed on the GUI, an optical packet is transmitted, which is easily identified by the flashing of bright white LED. This process takes 3-5 seconds.

Important Note: Optical communication must be performed indoors in a room without direct sunlight to prevent background illumination and within the temperature range of 21-27°C. If a unit had been exposed to outdoor temperature, please allow at least 10 minutes for the sensor to acclimate to indoor temperature.

To use the optical programming interface:

1. Confirm blue indicator light flashing on the optical programmer.
2. Place AH100 sensor on the indented section of the optical programmer.
3. The AH100 sensor needs to be placed with the top side facing down, so that the light sensor faces the programmer (see picture below).
4. Click on appropriate button on the GUI as explained below.
5. Wait until the white LED stops blinking (optical packet transmitted) before clicking any other buttons.
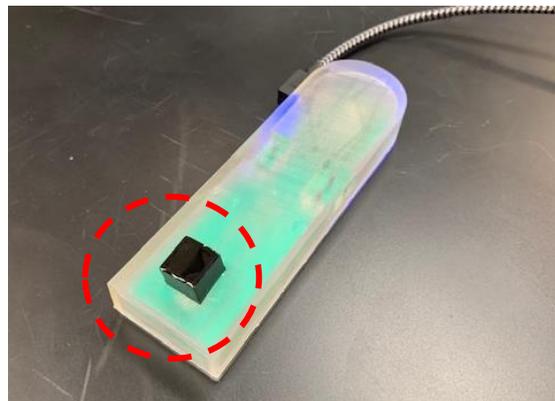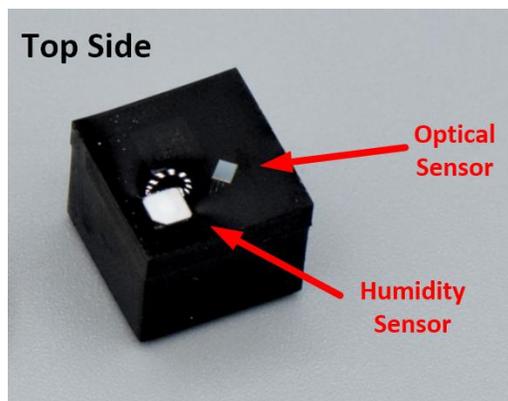

AH100's optical sensor should face the optical programmer's LED

2. Gateway Software

The Gateway Software decodes transmitted radio packets from AH100 sensors. The decoded information is displayed on the terminal screen and is also saved in a log file. An example screen output is shown in the screenshot below.

Each packet contains information about the type of packet (Operation Started / Operation Stopped / Motion Alert / Motion Muted / Check-in, etc.) and the Tag ID.
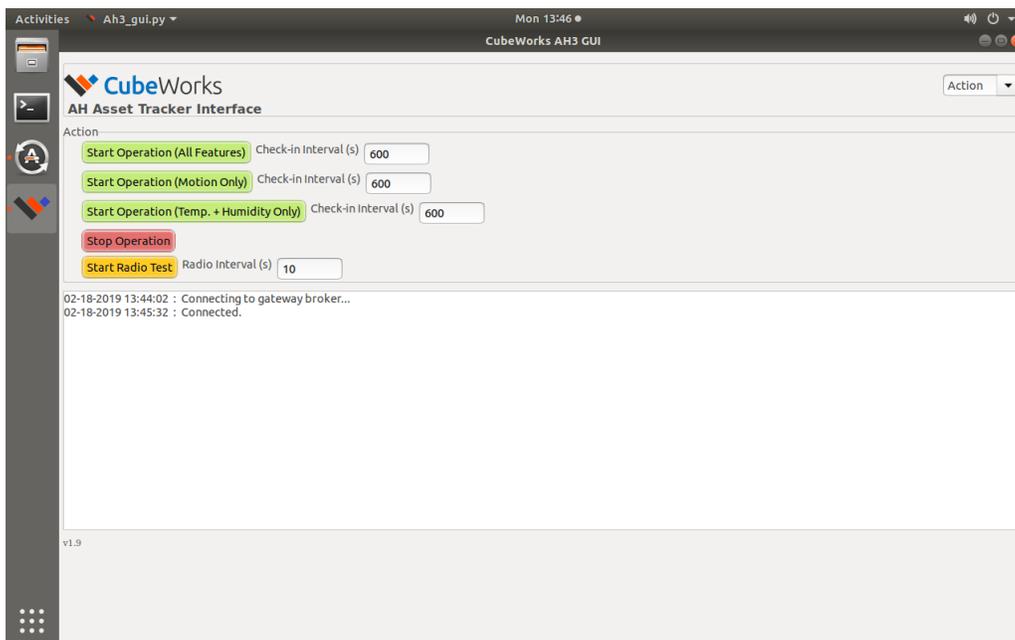
Example Screen Capture of the AH100 GUI Software

3. Starting Sensor Operation

AH100 Asset Tracker has 4 modes of operation:

1. **All Features (Motion Detection + Temp/Humidity Measurement)**
2. **Motion Only**
3. **Temp+Humidity Only**
4. **Radio Test**

The check-in interval should be entered prior to pressing on the start buttons. Any configuration to the operation such as the motion sensitivity settings or automatic motion muting trigger count need to be updated before starting the operation.

The standard mode of operation is the **All Features** operation, in which the continuous motion detection and periodic measurement of temperature and humidity are both enabled. If either motion detection or temp+humidity measurement is not required, **Temp+Humidity Only** mode or **Motion Only** mode can be used, respectively. **Temp+Humidity Only** mode has the lowest power consumption, and can extend the battery life.

In **Radio Test** the unit will periodically send a beacon radio packet indefinitely. This mode can be used for wireless testing and sensor positioning.

Important Note: Radio Test mode will continue indefinitely until "Stop Operation" button is pressed.

To start **All Features / Motion Only / Temp+Humidity Only** sensing operation:

1. Place AH100 sensor on the Optical Programmer, face down
2. Go to "Action" tab in the GUI
3. As needed, change the desired check-in interval (Default is 600 seconds, or 10 minutes)
4. Press the desired start button
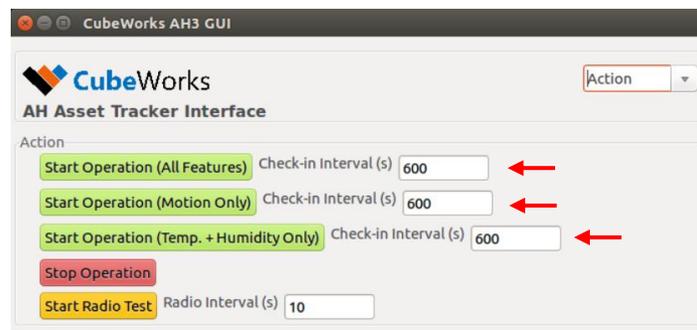
Starting AH100 Sensing Operation

To start **Radio Test** mode:
1. Place AH100 sensor on the Optical Programmer, face down
2. Go to "Action" tab in the GUI
3. Enter the desired wakeup interval between radio packets
4. Press the "Start Radio Test" button

Starting Radio Test Mode

4. Stopping Sensor Operation

To stop AH100 sensor operation or radio test operation:

1. Place AH100 sensor on the optical programmer, face down
2. Press "Stop Operation" button
3. A "Operation Stopped" packet will be transmitted by the AH100 unit
4. AH100 is now ready for configuration or starting another operation

Important Note: If any of the buttons on "Configuration" or "Debug" tabs are pressed while the sensor is placed on the optical programmer and the sensor was in the middle of an operation (motion or light change sensing), the sensor operation will be stopped as well.

Stopping AH100 Sensing Operation / Radio Test

5. Motion Detection Sensitivity Setting

The motion sensor inside AH100 can be configured for different sensitivity. The range is 64-2047. Lower number indicates a more sensitive setting, where each LSB corresponds to 1mg. The default value is 96. Using lower value than the default may result in false triggers under certain conditions.
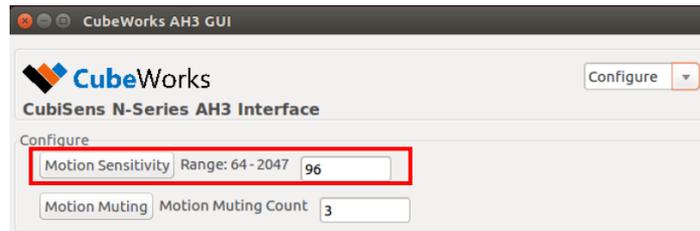
Configuring Motion Sensitivity

6. Automatic Motion Alarm Muting

The AH100 activity detector features an automatic motion alarm muting function, which prevents excessive battery drainage from continued motion triggers. This can be useful if the sensor is exposed to a high vibration environment for extended periods of time (such as driving) or if the motion sensitivity setting is set incorrectly. If the time between consecutive motion detection events is less than 50% of the Check-in interval, the motion muting count will be incremented. If this count exceeds the user-defined threshold (3 by default), motion detection will be "muted", meaning no further motion detected messages will be sent until the next wakeup event (e.g. check-in). The motion muting count will be reset at the next wakeup event.

To change this threshold:

1. Go to the "Configure" tab
2. Enter the "Motion Muting Count" value
3. Press "Motion Muting" button
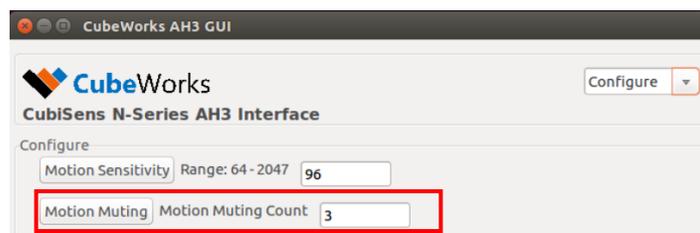
**Configuring Automatic Alarm Muting Count**

Wireless Performance

1. Environmental Factors

Contact with water should be avoided during operation to ensure proper operation. Exposure to water will shift radio frequency of the integrated antenna and hamper wireless communication. The gateway is optimized to a limited frequency band for optimal performance; therefore, significant shifts in radio frequency will prevent transmitted packets from being received.

Placing the sensor on a metal surface can either enhance or degrade wireless distance depending on the orientation and surrounding environment.

2. Sensor Orientation and Polarization

AH100's wireless performance depends on the orientation of the sensor relative to the location of the Gateway. The antenna is designed to be omni-directional, with a null in one axis. The weakest radio wave propagation is along the Z axis (red arrow) in the diagram below. The strongest propagation is along the plane formed by X and Y axes (blue and green arrows). To achieve best wireless performance, AH100 unit should be oriented so that the Z axis (red arrow) is perpendicular to the line connecting the AH100 and the antenna of the radio receiver. Orientation of the antenna on the Gateway relative to the orientation of the AH100 is equally important for strong radio reception. The antenna of the Gateway should be rotated such that it is parallel to the plane formed by the X and Y axes for optimal reception. Note that if multiple AH100's are deployed it is preferred to keep them all aligned to the same X-Y plane.
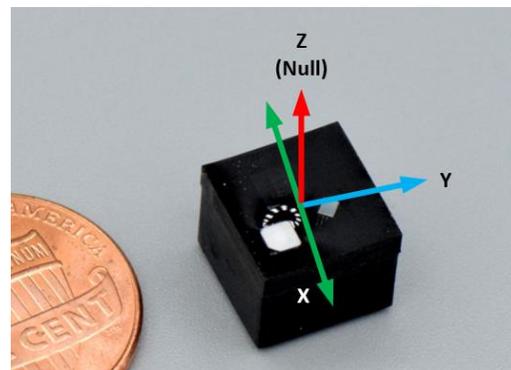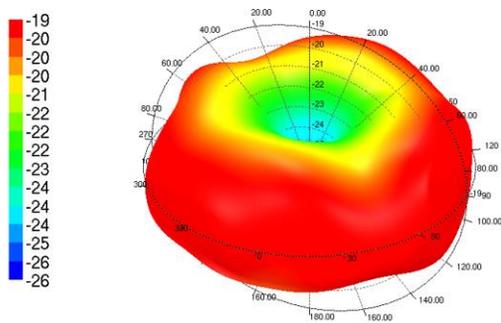
AH100 Antenna Radiation Pattern & Orientation

CubeWorks

FCC Compliance Statement

FCC ID: 2ASD7-AH100-0

CAUTION: Changes or modifications not expressly approved could void your authority to use this equipment This device complies with Part 15 of the FCC Rules. Operation to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation

This information can also be accessed in the GUI by following these steps:

> **Starting from the main page of the GUI:**

>> Step 1: Click on the drop-down button on the top right corner of the GUI

>> Step 2: Select the "Regulatory" menu

>> Step 3: The FCC ID and warning statement is shown