METER

ATMOS 41W

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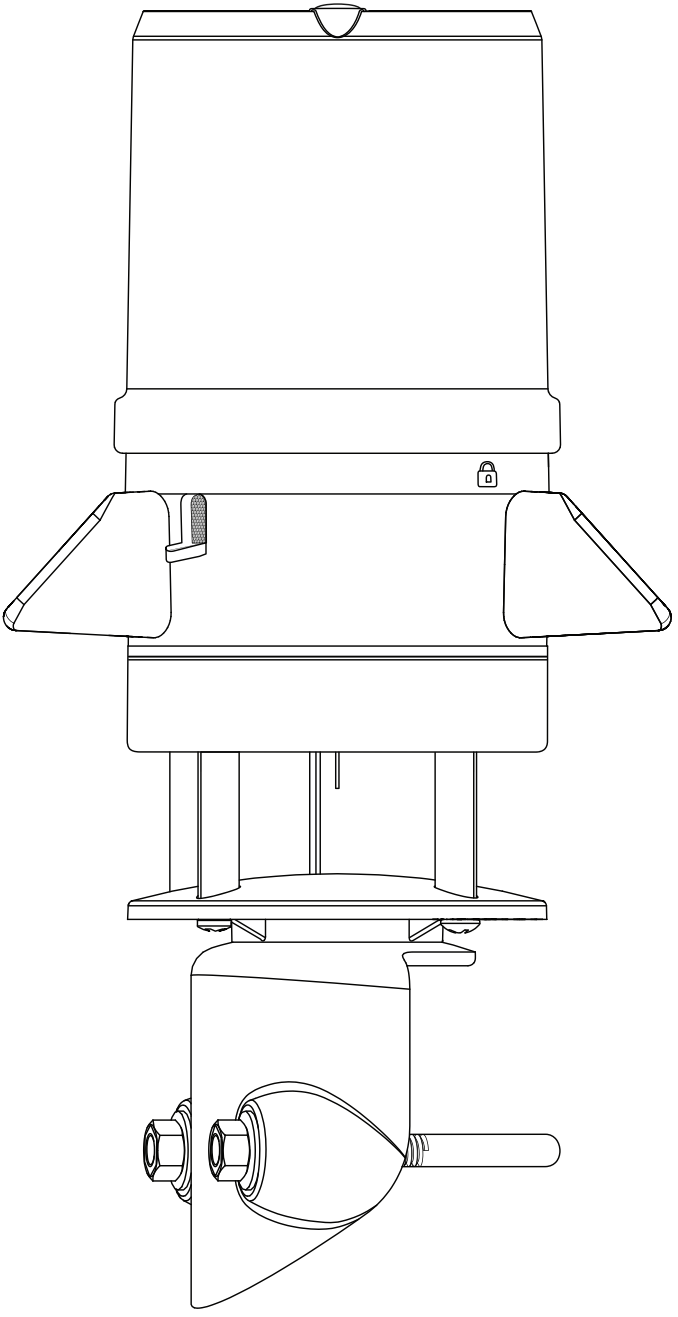


1. INTRODUCTION

Thank you for choosing the ATMOS 41W from METER Group. The ATMOS 41W is part of the ZENTRA System, a collection of data loggers, software, and compatible sensors to measure environmental parameters accurately and cost effectively.

The ATMOS 41W All-in-One Wireless Weather Station is designed for continuous monitoring of environmental variables, including all standard weather measurements (Section 3). The ATMOS 41W measures the following:

- Solar radiation
- Precipitation
- Precipitation electrical conductivity
- Relative humidity / Vapor pressure
- Barometric pressure
- Air temperature (min, max, average)
- Wind speed
- Wind direction
- Maximum wind gust
- Tilt

All sensors and wireless cloud communications are integrated into a single, small form-factor unit, requiring minimal installation effort. A robust design that prevents errors because of wear or fouling make the weather station ideal for long-term, remote installations. ATMOS 41W can be used for a variety of applications:

- Weather monitoring
- Microenvironment monitoring
- Spatially-distributed environmental monitoring
- Crop weather monitoring
- Fire danger monitoring
- Weather networks

Additional advantages include its low-power design that supports the integrated battery-operated wireless cloud communication that uploads data straight to ZENTRA Cloud. A tilt sensor warns the user of out-of-level condition, and no configurations are necessary.

Prior to use, verify all ATMOS 41W system components are included and appear in good condition.

- ATMOS 41W
- V-bolt with 2 washers and 2 nuts
- Double-ended wrench, 13-mm and 8-mm (1/2-in and 5/16-in)
- ZENTRA Cloud Device Subscription information (orange card)
- 6 AA batteries, installed (NiMH rechargeable)

The ATMOS 41W is available with either cellular OR Wi-Fi communication capabilities. When evaluating where to install the ATMOS 41W, METER recommends verifying adequate cellular or Wi-Fi signal for the chosen location. The cellular/Wi-Fi signal must be strong enough for data to be transmitted to ZENTRA Cloud.

2. OPERATION

Please read all instructions before operating the ATMOS 41W to ensure it performs to its full potential. Prior to field installation, please verify all ATMOS 41W components arrived intact.

Please carefully follow the information in Power On and Connect With ZENTRA Utility Mobile on page 4 and Add ATMOS 41W to ZENTRA Cloud on page 7 (Table 1) before taking the device into the field for installation. Test the ATMOS 41W sensor and communications functionality in a lab or office prior to field installation to verify the correct operation of the system.

When moving the device to the field, follow Field Site Preparation on page 10 to enswure a successful installation.

⚠ PRECAUTION

METER sensors are built to the highest standards, but misuse, improper protection, or improper installation may damage the sensor and possibly void the manufacturer's warranty. Before integrating the ATMOS 41W into a system, make sure to follow the recommended installation instructions and have the proper protections in place to safeguard sensors from damage.

2.1 INSTALLATION

Follow the steps listed in Table 1 to set up the ATMOS 41 and start collecting data.

⚠ CAUTION

Never immerse the ATMOS 41W in liquids. This and other misuse, improper protection, or improper installation may damage the ATMOS 41W and void the warranty.

Table 1 Installation

Tools Needed	**Wrench 13-mm and 8mm** (included with the instrument) **Mounting pole** 31.80 to 50.80-mm (1.25 to 2.00-in) diameter Smaller mounts are compatible if washers are added to the V-bolt. United States standard pipe sizes that are compatible are 1.00, 1.25, and 1.50-in. Square tubing with a width of 1.25 to 2.00-in or T-posts can also work as mounting options. **Software** ZENTRA Utility Mobile using Apple® iPhone® or Google Android™ smartphone. For best results, use the latest versions of ZENTRA Utility Mobile software and ATMOS 41W firmware. ZENTRA Utility Mobile will prompt with available updates for software and ATMOS 41W firmware. Consult Section 5.6 for more troubleshooting tips.

Table 1 Installation (continued)

Preparation	**Verify Communication Signal Quality** METER recommends verifying that the chosen location has adequate cellular or Wi-Fi signal. The communication signal must be strong enough for data to be transmitted to ZENTRA Cloud. **Data Access** Data are accessed online via ZENTRA Cloud, a web application used to download, view, and share data as well as to change configurations. The ATMOS 41W requires a paid subscription to use ZENTRA Cloud. Save the orange Device Subscription card included with the ATMOS 41W in a safe location. This card contains the following information for the subscription: • Device serial number • Password • Server name/address where sensor data is stored. **Device Subscription** **Device Serial Number: A4100000** **Device Password: password** **Server: zentracloud.com** Use this unique Device Serial Number and Device Password to subscribe to this device on zentracloud.com **Keep this information in a safe place.** **Do not leave it inside the device case.**
Power On and Connect With ZENTRA Utility Mobile	**Install ZENTRA Utility Mobile** Install on a smartphone or tablet: • Scan the QR code below to open the applicable app store for the mobile device (Apple App Store® online store or Google Play™ store). • Download the application. Apple Store App Google Play Store **Remove Rain Funnel** Press the rain funnel down to compress the internal spring. Twist the funnel counter-clockwise to unlock from the ATMOS 41W base as shown in Section 3.2.2. **⚠ CAUTION** **The rain funnel is connected to the ATMOS 41W by a wire to the main unit—DO NOT disconnect the wire. Carefully move the rain funnel to the side, keeping the wire connected.**

Table 1 Installation (continued)

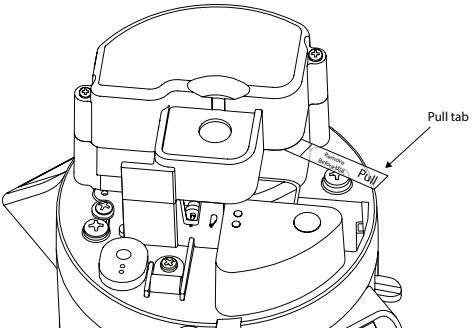
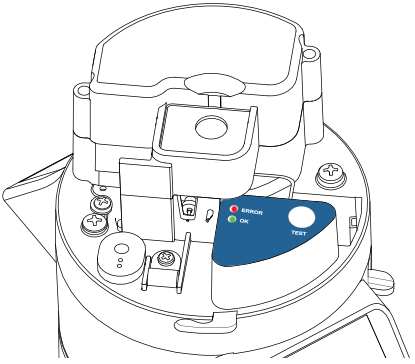
Power On and Connect With ZENTRA Utility Mobile (continued)	**Power Up Device** Pull and remove the clear, plastic pull tab that protrudes from the battery compartment. This will allow contact with the installed batteries and will activate the Bluetooth® connection to allow for communication with ZENTRA Utility Mobile.  The status lights on the blue overlay will start blinking, indicating power is available. **NOTE: The status lights will settle to a short, single green blink every 5 s, signaling the data acquisition component is ready for use.** **Test Bluetooth Module** With the ZENTRA Utility Mobile app open and the ATMOS 41W rain funnel removed, push the **TEST** button on the blue overlay (see image below). The status lights located on the blue overlay will eventually settle to a single, short, green flash approximately every 5 s. This signals the instrument is ready for use (Section 3.2.10). The ATMOS 41W will now be able to collect and report data to ZENTRA Cloud according to settings in ZENTRA Utility Mobile. 

Table 1 Installation (continued)

Power On and Connect With ZENTRA Utility Mobile (continued)	**Connect the ATMOS 41W** In ZENTRA Utility Mobile (Section 2.2), tap **Connect**. Select the desired device. Bluetooth connection will be established and ATMOS 41W and sensor information will be retrieved. **Replace Rain Funnel** Replace the rain funnel by lining up the recesses, press down, and twist clockwise until the padlock icons align and the funnel locks (Figure 17). Be sure the funnel cable and connector are clear of the internal spring and are not pinched before closing. The ATMOS 41W is now ready for use. **Configure the ATMOS 41W Using ZENTRA Utility Mobile** In ZENTRA Utility Mobile, tap on **Configure**. Review the cellular/Wi-Fi data upload setting and the sensor measurement interval. Make changes if desired and save changes (Section 2.2.2). Factory default configuration is 15 min logging interval and 1 h upload. **Verify Readings** In ZENTRA Utility Mobile, tap **Refresh** to show a list of readings. Verify the readings are within expected ranges (Section 2.2.3).
Add ATMOS 41W to ZENTRA Cloud	**Create User Account** Using a web browser, navigate to the server address listed on the orange Device Subscription card. Keep the Device Subscription card close by for use later in this section or if device needs to be added if deleted from the system. **Device Subscription** **Device Serial Number: A4100000** **Device Password: password** **Server: zentracloud.com** Use this unique Device Serial Number and Device Password to subscribe to this device on zentracloud.com **Keep this information in a safe place.** **Do not leave it inside the device case.**

Table 1 Installation (continued)

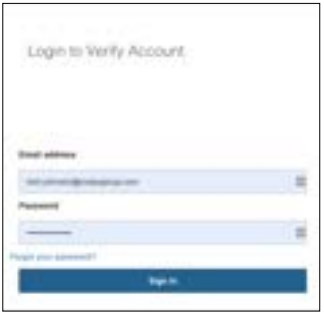
Add ATMOS 41W to ZENTRA Cloud	Select the **Sign Up** button. Enter a **valid email address** and user information.  Accept the **Terms and Conditions**. **Verify User Account** Select the **Sign Up** botton to generate a confirmation email. Click on the hyperlink in the confirmation email to verify the user account.

Table 1 Installation (continued)

Add ATMOS 41W to ZENTRA Cloud (continued)	**Create Organization** Log into ZENTRA Cloud using the user account created above. • Select **Create Organization**. • Enter **Organization name**. • Enter **Role**. • Select **Accept**. **Add Device** Click on **Add New** button. Select the desired **Device** from the menu. Enter the **Device Serial Number** and the **Device Password** from the orange Device Subscription card (remove from funnel and store in safe location). Click the **Create** button to subscribe and add device to the organization.

Table 1 Installation (continued)

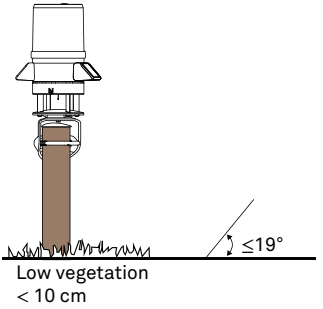
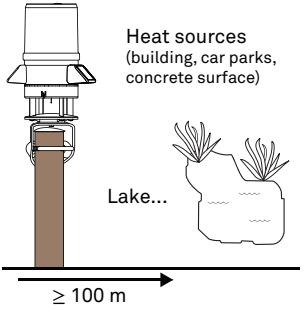
Add ATMOS 41W to ZENTRA Cloud (continued)	**Identify Mounting Location—Landscape** Choose the desired location based on relevant details, including vegetation cover throughout the season, solar exposure, and wildlife and livestock activity.  If adhering to World Meteorological Organization (WMO)[a] siting standards, make sure the mount location has minimal slope and low vegetation height so the pyranometer found on top of the rain funnel will not be covered by shade. **Identify Mounting Location—Interferences** Consider a site far from sources of high electromagnetic interference (EMI), such as high-voltage power transmission lines, metallic objects, sources of heat, bodies of water, and obstructions. EMI sources could adversely affect ATMOS 41W rainfall measurements.  WMO siting standards recommend siting 100 m away from heat sources and bodies of water.

Table 1 Installation (continued)

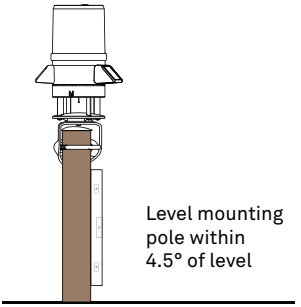
Field Site Preparation	**Check Communications Signal** Once at the field site, check that the cellular or Wi-Fi signal is strong enough to collect and transfer data to ZENTRA Cloud. • Remove the rain funnel. • Press the **TEST** button. • Connect to device in ZENTRA Utility Mobile. • Tap **Test** in ZENTRA Utility Mobile to check the quality of the cellular or Wi-Fi signal before finalizing installation (Section 2.2.3). • Replace the rain funnel. If the cellular/Wi-Fi signal is low or the cellular/Wi-Fi test fails, move to an alternative location (sometimes moving only a few meters is sufficient). If there is significant bird activity at the site, consider using a bird deterrent kit. Contact Customer Support for more information. **Install Mounting Pole** Use a mounting pole with a 31.8- to 50.8-mm (1.25- to 2.0-in) diameter. Prepare the mounting pole to the appropriate height. Many installations require the ATMOS 41W to be mounted 2 m above ground, but mounting height can be adjusted based on the specific application. The mounting pole should be within 4.5° of level.  Level mounting pole within 4.5° of level

Table 1 Installation (continued)

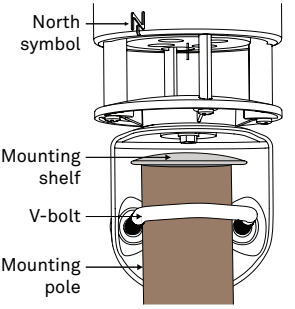
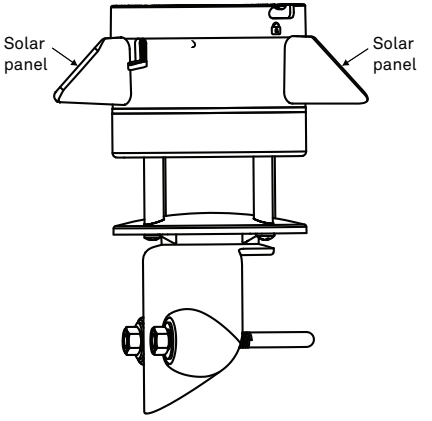
Field Installation	**Mount Toward True North** Place the top of the mounting post under the mounting shelf in the mounting bracket. Orient the **N** engraved on the side of the instrument to point true north (not magnetic north). The ATMOS 41W must be oriented correctly by hand for accurate wind direction measurements.  **Mount and Secure Device** Tighten the V-bolt nuts by hand until hand-tight. Then tighten the nuts further with the 13-mm end of the wrench included. Secure the ATMOS 41W flat and tight against the top of the mounting pole. **⚠ CAUTION** **Do not overtighten the bolt.** 

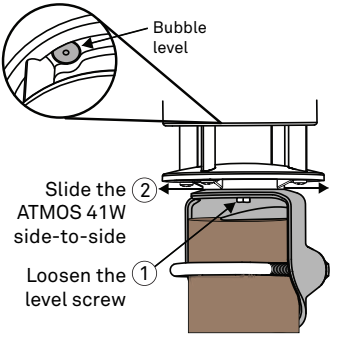
Table 1 Installation (continued)

Field Installation (continued)

Level the Device

Use the bubble level underneath the ATMOS 41W to level the weather station. The weather station angle can be adjusted by (1) loosening the leveling screw attached to the bottom with the 8-mm end of the wrench (included), (2) moving the weather station side to side as needed to level, and then retightening the screw.

The ATMOS 41W must be within approximately ±2° of dead level to accurately measure rainfall and solar radiation.



Reverify Communications Signal

Use ZENTRA Utility Mobile to review instantaneous measurements and verify the sensor is working as expected.

Press **Test** in ZENTRA Utility Mobile to check the quality of the cellular or Wi-Fi signal before finalizing installation.

The ATMOS 41W is now installed and active. Data should be available after the first upload.

2.2 CONNECTING

Connect to the ATMOS 41W via bluetooth with smartphone or tablet and ZENTRA Utility Mobile.

Download ZENTRA Utility Mobile from an app store before going to the field.

- Apple® iPhone®
- Google Android™ smartphone

Add ZENTRA Cloud user credentials to allow uploading data.

2.2.1 BLUETOOTH CONNECTION

The ATMOS 41W rain funnel must be removed in order to press the **TEST** button before establishing a Bluetooth connection.

1. On the mobile device, launch ZENTRA Utility Mobile.
2. Look for the ATMOS 41W in the **Devices Found** window (Figure 1).
3. Select the ATMOS 41W to establish a connection (Figure 2).

Figure 1 Devices Found window

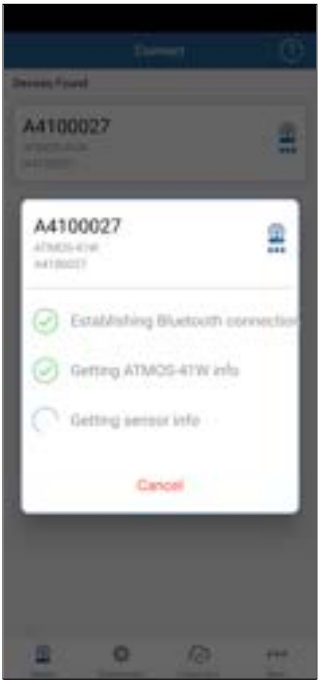


Figure 2 Establishing a connection

Once connected, the ZENTRA Utility Mobile screen will show the sensor information and instantaneous sensor readings (Figure 3).

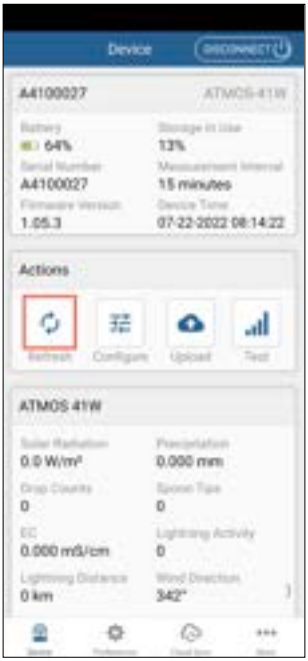


Figure 3 Information and current sensor readings

2.2.2 CONFIGURATION

The measurement interval and upload increments can be adjusted here.

1. On the mobile device, open ZENTRA Utility Mobile.
2. Select the ATMOS 41W.
3. Select **Configure** on the Actions panel (Figure 4).

Figure 4 Select Configure

The **Configure Device** screen will appear (Figure 5).

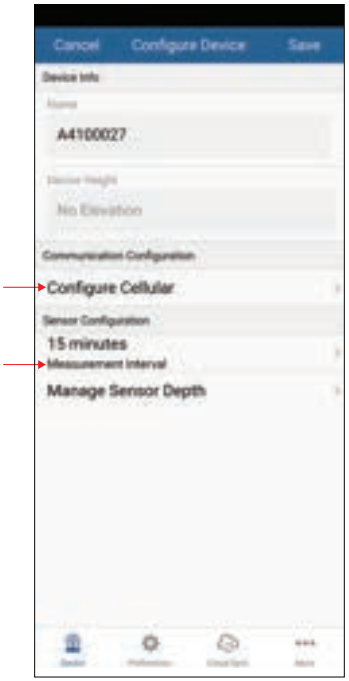


Figure 5 Configure Device information screen

4. **OPTIONAL** Change device name (Figure 5).

   This value is prepopulated with the device serial number. Consider changing the name to the field or plot where the ATMOS 41W is installed.

5. **OPTIONAL** In the **Configure Device** window, set the measurement interval to the desired interval (Figure 5).

   The default measurement interval is set for 15 minutes.

6. Click **Done**.

7. **OPTIONAL** In the **Communication Configuration** section of the **Configure Device**, select **Configure Cellular** (Figure 5).

   In **Configure Cellular** select **Upload Frequency** to open the Selection menu.

8. In the **Selection** menus, choose upload frequency (Figure 6).
   The default cellular configuration is set to upload data every 60 minutes.

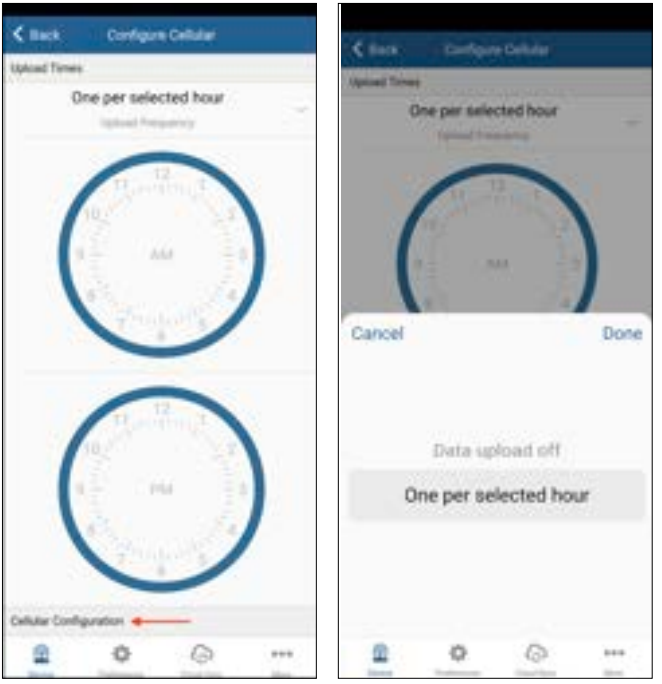


Figure 6 Configure Cellular upload frequency

9. Select **Done**.
10. Select the time segments by clicking the arc segments for the hour intervals.
    The ATMOS 41W will upload data during the selected intervals.
11. Click **OK**.

2.2.3 COMMUNICATION TEST

A successful communication test will confirm that the ATMOS 41W can transmit data to ZENTRA Cloud servers as well as provide the quality of the communication signal. Even a poor connection status allows data to be successfully transferred. Prior to installing the ATMOS 41W, check the cellular or Wi-Fi connection at the installation location:

1. Select the **Test** button on the Actions panel (Figure 7).

   If additional tests are required, press the **Start** button show on the right side of Figure 8.

   If the ATMOS 41W communication test fails, move to a new location and try again. Sometimes, moving just a few meters will provide a successful connection.

2. Click **Close**.

Figure 7 Select Test to begin communications test

The screen shown on the left side of Figure 8 will automatically appear on the mobile device.

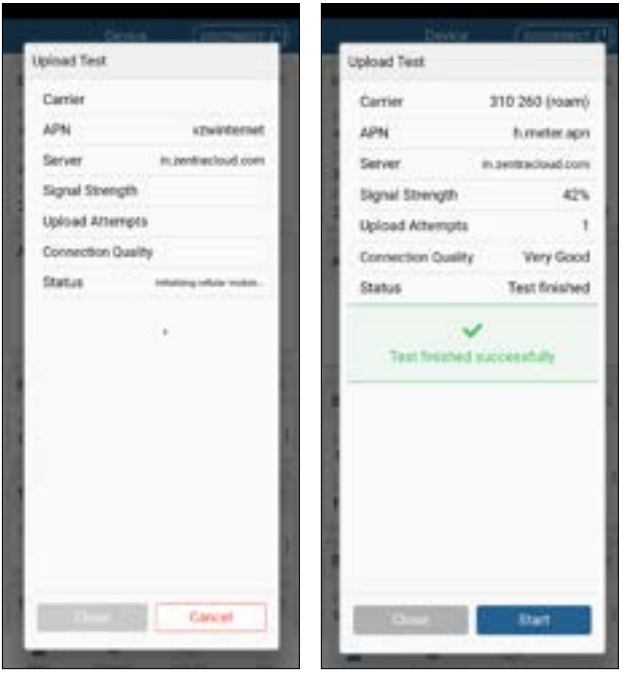


Figure 8 Test status screen

2.2.4 INSTANTANEOUS SENSOR MEASUREMENTS (REFRESH)

ZENTRA Utility Mobile will automatically scan the ATMOS 41W every 30 s and refresh the sensor readings.

ZENTRA Utility Mobile can also take real-time sensor measurements on demand using the **Refresh** function (Figure 9).

This is a critical tool to ensure sensors are installed correctly, to test if a sensor is reading properly, or to evaluate how sensors react to environmental changes. The ATMOS 41W does not store data that it measures with the **Refresh** function.

Figure 9 Refresh function

To force a new scan at any time, swipe down on the main screen or hit the **Refresh** button. The sensor measurement area will refresh.

3. SYSTEM

This section describes the ATMOS 41W All-in-One Wireless Weather Station system and reviews the ATMOS 41W data acquisition hardware features and configuration options. Use this information to help optimize each environmental monitoring setup.

3.1 SPECIFICATIONS

MEASUREMENT SPECIFICATIONS

Solar Radiation	
Range	0–1,750 W/m^2
Resolution	0.1 W/m^2
Accuracy	±5% of measurement typical
Precipitation	
Range	0–1,500 mm/h
Resolution	0.017 mm
Accuracy	±5% of measurement from 0 to 1000 mm/h
Electrical Conductivity	
Range	0–3 mS/cm
Resolution	0.001 mS/cm
Accuracy	The greater of 0.005 mS/cm or 15% of measurement
Vapor Pressure	
Range	0–47 kPa
Resolution	0.01 kPa
Accuracy	Sensor measurement accuracy is variable across a range of temperature and RH. Refer to the chart in Figure 10

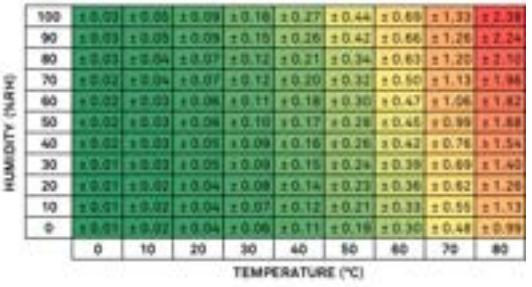


Figure 10 Vapor pressure sensor accuracy

Relative Humidity	
Range	0–100% RH (0.00–1.00)
Resolution	0.1% RH
Accuracy	Sensor measurement accuracy is variable across a range of RH. Refer to the chart in Figure 11

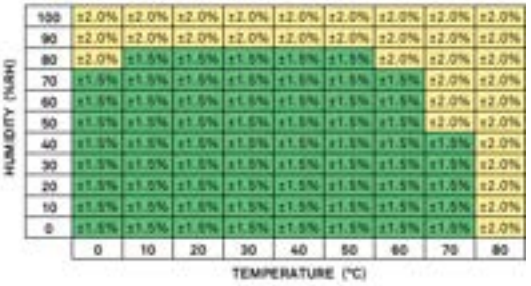


Figure 11 RH sensor accuracy

Humidity Sensor Temperature	
Range	–63 to 80 °C
Resolution	0.1 °C
Accuracy	±0.2 °C
Barometric Pressure	
Range	1–120 kPa
Resolution	0.01 kPa
Accuracy	±0.05 kPa @ 25 °C ±0.1 kPa from –10 to 50 °C ±0.5 kPa below –10 °C and above 60 °C
Air Temperature	
Range	–63 to 60 °C
Resolution	0.1 °C
Sensor Accuracy	±0.2 °C at 25 °C
Measurement Accuracy	±0.6 °C from –20 to 50 °C For more information see Section 3.2.6

Horizontal Wind Speed	
Range	0–30 m/s
Resolution	0.01 m/s
Accuracy	The greater of 0.3 m/s or 3% of measurement
Wind Gust	
Range	0–30 m/s
Resolution	0.01 m/s
Accuracy	The greater of 0.3 m/s or 3% of measurement
Wind Direction	
Range	0°–359.9°
Resolution	0.1°
Accuracy	±5°
Tilt	
Range	0° to 180°
Resolution	0.1°
Accuracy	±1°
GPS Communication	
Type	Integrated 56-channel GPS/QZSS receiver
Update	Daily (automatic) and on-demand (manual)
Accuracy	±3 m, with good sky view
Sensor Measurement Interval	
5 min to 12 h (average or accumulation of more frequent sensor readings (Section 2.2.2).	
Upload Frequency	
Hourly upload with additional charges for more frequent reporting (default) Wi-Fi communication upload after each measurement interval **NOTE: Contact Customer Support for more frequent reporting options. Additional charges may apply.**	
Timekeeping	
Synchronizes automatically and on-demand; GPS, cellular or Wi-Fi, or ZENTRA Utility Mobile.	

COMMUNICATION SPECIFICATIONS

Computer Communication	
Standard USB cable, USB A to micro-USB B	
Cellular Communication	
3G	
Specifications	UMTS 3G 5-band cellular module with 2G fallback.
Coverage	550+ global partner carriers. Cellular and data hosting service provided by METER.
4G LTE-M: USA, Canada, and select other countries Contact Customer Support or a METER sales partner for more information.	
Specifications	4G LTE-M and NB-IoT cellular
Coverage	VERIZON, AT&T®, and T-Mobile in the USA. Select global partner carriers. Cellular and data hosting service provided by METER.
4G LTE Cat 1 Cellular Communication	
Specifications	LTE Cat 1 cellular module with 3G and 2G fallback
Coverage	AT&T, and T-Mobile in the USA. 550+ global partner carriers Cellular and data hosting provided by METER
Wi-Fi Communication	
Specifications	IEEE 802. 11b/g/n 2.4 GHz
Supported Channels	1-11 in the USA and most regions of the world 12-13 when hardware detects ETSI/UKCA region
Supported Wi-Fi Networks	Open personal networks Secure personal networks Secure personal networks using WPA/WPA2/WPA3 Enterprise networks using LEAP and PEAP security methods
Bluetooth Communication	
Bluetooth 5.2—supporting Bluetooth low-energy protocol.	

PHYSICAL SPECIFICATIONS

Dimensions	
Width	16.5 cm (6.5 in)
Height	31.8 cm (12.5 in)
Operating Temperature Range	
Minimum	–40 °C
Typical	NA
Maximum	60 °C

NOTE: Barometric pressure and relative humidity sensors operate accurately at a minimum of –40 °C. Alkaline batteries should be used if temperatures below –40 °C are expected.

Memory Type	
Nonvolatile flash, full data retention with loss of power	
Data Storage	
8 MB (more than 100,000 records)	
Battery Capacity	
6 AA NiMH or alkaline batteries	
Battery Life	
Alkaine	7 months typical for hourly uploads or 4 months with 15-min data upgrade.
NiMH	3+ years with an unobstructed view of the sun. Charging through solar energy harvesting.

COMPLIANCE

EM ISO/IEC 17050:2010 (CE Mark)

3.2 COMPONENTS

The electric components, including the data acquisition and transmission hardware, are housed in a weather-resistant enclosure (IP56 rated) (Figure 12).

The integrated data acquisition and data transmission components are purpose-built to collect data from the ATMOS 41W. The ATMOS 41W interior (accessible by removing the rain funnel) also contains a **TEST** button (Section 3.2.15) and two status lights, `OK` and `ERROR` (Section 3.2.16). The ATMOS 41W uses six batteries(Section 3.2.13).

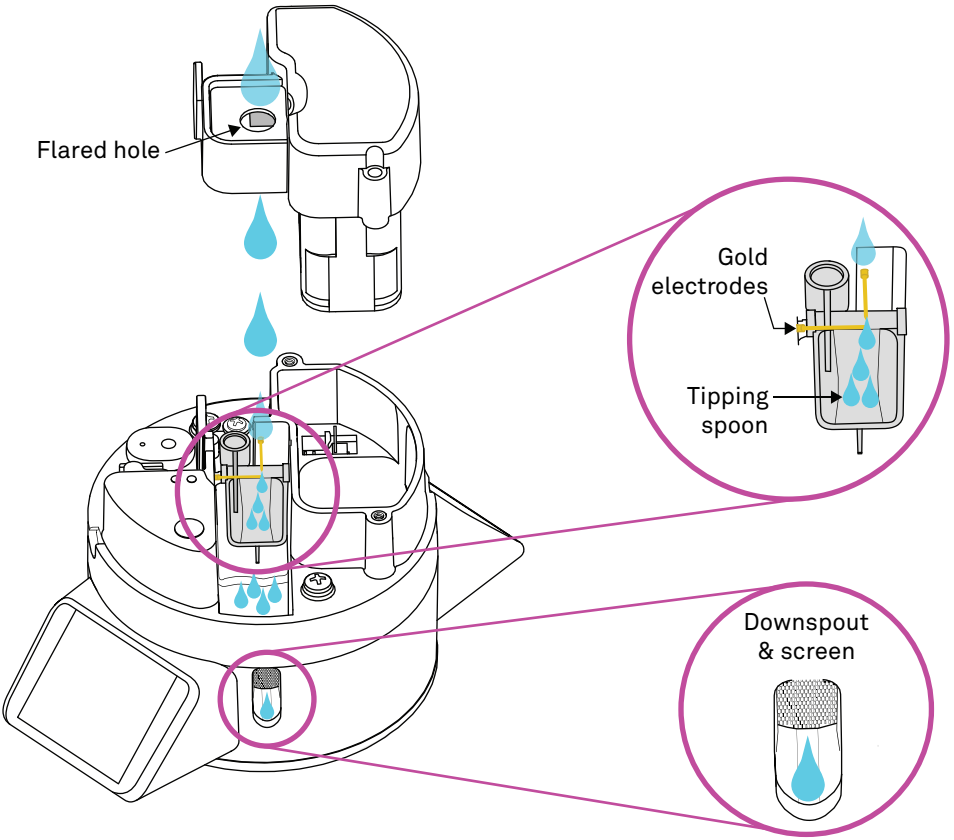


Figure 12 ATMOS 41W interior

3.2.1 PYRANOMETER (SOLAR RADIATION)

Solar radiation is measured by a pyranometer embedded in the lip of the rain gauge funnel at the top of the ATMOS 41W. Designed, manufactured, and calibrated by experts at Apogee Instruments, Inc., the miniature pyranometer uses a silicon-cell sensor to measure the total incoming (direct and diffuse) solar radiation. A carefully developed cosine-correcting

head ensures accurate readings regardless of sun angle, while the painstakingly researched optical filter material balances cost and performance to ensure the silicon-cell provides good accuracy regardless of temperature or sensor age. Silicon-cell sensors have excellent response time to changing radiation conditions and acceptable sensitivity across the solar spectrum (Figure 13), which make them perfect for use on the ATMOS 41W.

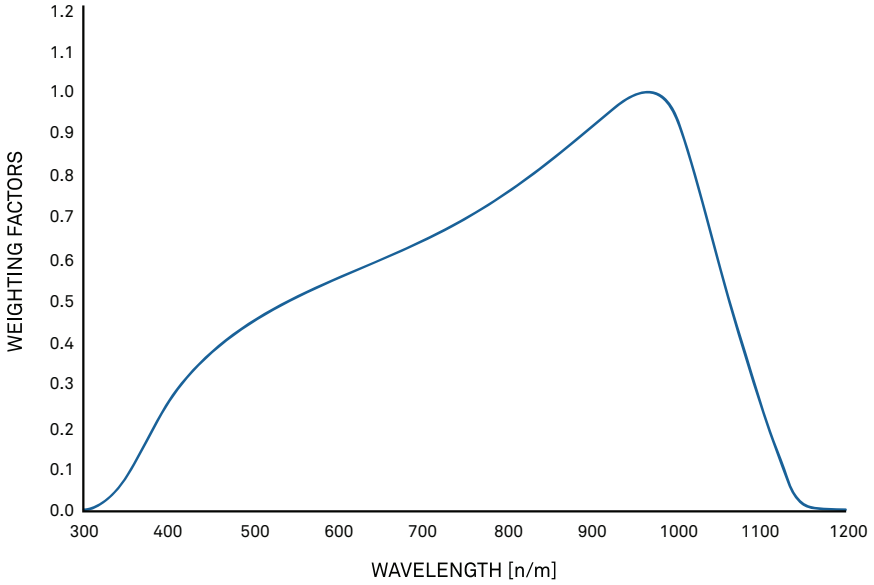


Figure 13 Spectral response estimate of Apogee silicon-cell pyranometers

Spectral response was estimated by multiplying the spectral response of the photodiode, diffuser, and adhesive. Spectral response measurements of diffuser and adhesive were made with a spectrometer, and spectral response data for the photodiode were obtained from the manufacturer.

Leveling the ATMOS 41W is particularly important for accurate solar radiation measurements. Out of level, the pyranometer will overestimate some portions of the day while underestimating others. Ensure accurate solar radiation measurements by carefully leveling the ATMOS 41W at installation (Table 1). Bird droppings and other soiling of the domed sensor surface will cause serious errors in pyranometer measurements. Check the sensor regularly to make sure it is clean, and check data often to identify possible problems. Isopropyl (rubbing) alcohol and a cotton swab work well for cleaning the sensor area (Section 5.4). Microfiber bags work well, too.

IMPORTANT

Do NOT use an abrasive cloth on the sensor surface, as it will scratch which will lead to artificially low pyranometer measurements.

The pyranometer is factory calibrated and the sensor-specific calibration value can be found on the interior of the funnel. This factor has already been added into the ATMOS 41W so there is no need to do anything with it. In the event that this value is needed, it can be found by taking the funnel off the base and checking underneath. Follow the steps in Section 3.2.2.1 to remove the funnel.

When powered on, the ATMOS 41W measures the solar radiation once every 3 s and records the instantaneous values. At the end of the measurement interval, the ATMOS 41W outputs the average of the instantaneous values measured during that measurement interval.

NOTE: Calibration of the pyranometer is recommended every 2 years. Contact Customer Support for more information.

3.2.2 RAIN FUNNEL (PRECIPITATION)

The ATMOS 41W contains a 9.31-cm diameter rain funnel and two methods to measure rainfall. During a rain event, precipitation first goes into the rain funnel where the spring (Figure 14) acts as a filter to keep out large particles but still allows enough flow so water does not back up. After flowing past the spring and into the rain gauge, precipitation flows through the flared hole (Figure 14) to form drops of a consistent and known size that then pass by the drop counter for the primary rainfall measurement.

The drop counter consists of two gold electrodes (Figure 14) that measure each drop formed by the flared hole. Because the flared hole forms a drop of a known size, the ATMOS 41W can calculate water volume from the number of drops counted.

After passing the drop counter, the drops land in the tipping spoon reservoir for a secondary rainfall measurement. The tipping spoon is precisely calibrated to tip with a highly-repeatable water volume. Each time the spoon tips, a magnet passes a Hall-effect sensor and the tip event is recorded.

The ATMOS 41W outputs the total rainfall (in millimeters) that has accumulated during the measurement interval and the maximum intensity recorded over any individual 1-min period during the measurement interval. The dual precipitation measurements allow the ATMOS 41W to simultaneously measure rainfall with high resolution while maintaining accuracy during high intensity events.

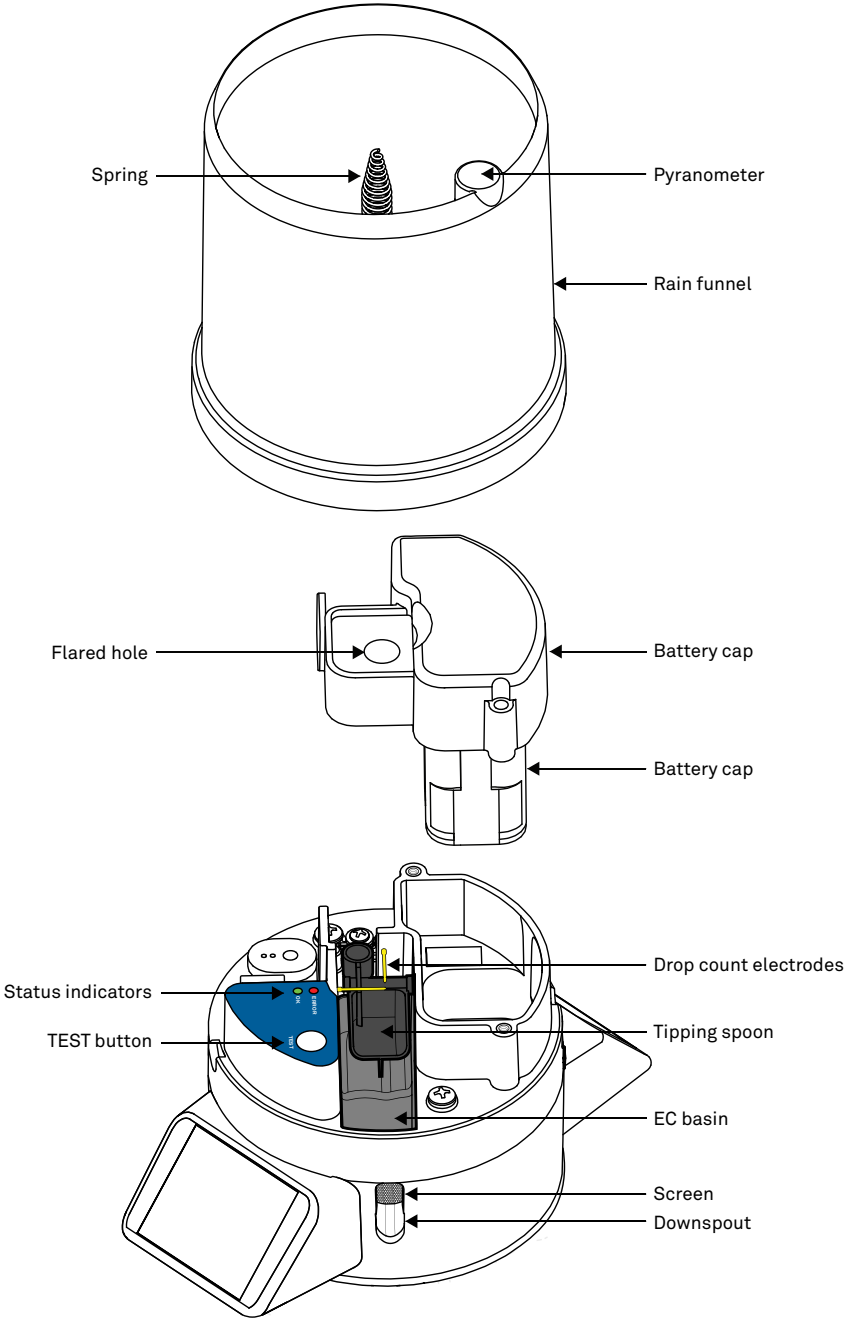


Figure 14 Rain funnel and rain gauge

The drop counter adds robustness and resolution to the precipitation measurement in the following ways:

- **The drop counter does not have moving parts and is not subject to mechanical wear and particulate contamination issues that can cause inaccuracy or complete failure.** The tipping spoon mechanisms do have moving parts with friction surfaces and are subject to mechanical wear and particulate contamination issues.
- **The drop counter ensures that any water that comes through the funnel is counted in the total.** The resolution of the drop counter is 0.017 mm, which is an order of magnitude better than conventional tipping spoon gauges. Small amounts of rainfall that are insufficient to cause the spoon to tip can evaporate over time and therefore, never be counted in the rainfall total.

The tipping spoon adds robustness to the ATMOS 41W rainfall measurement in the following ways:

- Extends the measurement range to capture extreme rainfall events of up to 1,500 mm/hr (the drop-counting method becomes unreliable at extremely high rainfall rates [>400 mm/hr]).
- Extends the off-level tolerance for rainfall measurement. If the ATMOS 41W is off-level by significantly more than 2 degrees, drops can miss the gold pins and will not be counted.
- The tipping spoon is not susceptible to electromagnetic interference (EMI). In some extreme cases, close proximity lightning or other strong sources of EMI can manifest as artificial drops to the drop counters.

IMPORTANT

The ATMOS 41W must be within approximately ±2° of dead level to measure rainfall with the best resolution. If not within this range, drops from the flared hole can miss the gold electrodes entirely.

3.2.2.1 REMOVE RAIN FUNNEL

The rain funnel may occasionally need to be removed in the following instances:

- Starting (or restarting) the Bluetooth connection (Section 2.2.1),
- Cleaning (Section 5.4),
- Replacing the rain funnel for pyranometer recalibration.

The rain funnel locks in place using two pegs on the side of the rain funnel. To remove the rain funnel do the following:

1. Discharge static electricity from the ATMOS 41W body by touching any conductive material not isolated from the ground (e.g., metal pole).

   NOTE: An electrostatic discharge (ESD) can damage ATMOS 41W electronics.
2. Press the rain funnel down to compress the internal spring.
3. Twist counter-clockwise to unlock from the ATMOS 41W base until the lock/unlock graphic located on the side of the rain gauge funnel is lined up with the notch on the interface plate (Figure 15).
4. Carefully lift off the rain funnel.

⚠ CAUTION

Remove the rain funnel carefully to avoid damaging the pyranometer connector wire.

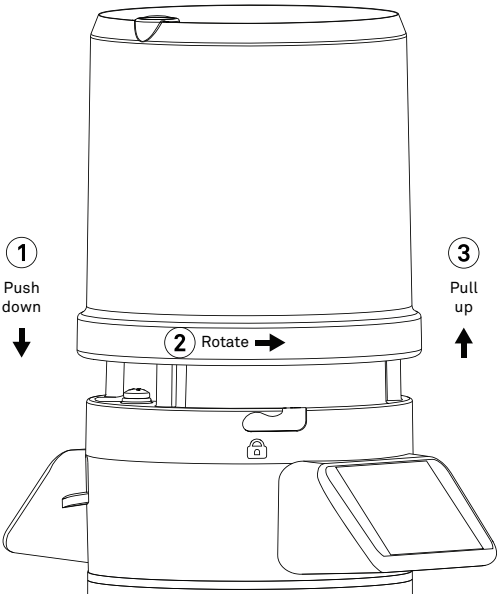


Figure 15 Removing ATMOS 41W rain funnel

3.2.2.2 DISCONNECT PYRANOMETER AND RAIN FUNNEL

Before removing the rain funnel completely, carefully disconnect the pyranometer from the ATMOS 41W base by disconnecting the pyranometer connector as described below and shown in Figure 16.

1. Press in the tabs on both sides of the connector locking mechanism with a sharp-pointed object (e.g., a ballpoint pen).
2. Once the tabs are released, pull the connectors apart.
3. Place the rain funnel aside.

IMPORTANT

Unplug the pyranometer connector inside the rain funnel before fully removing the funnel (Figure 16).

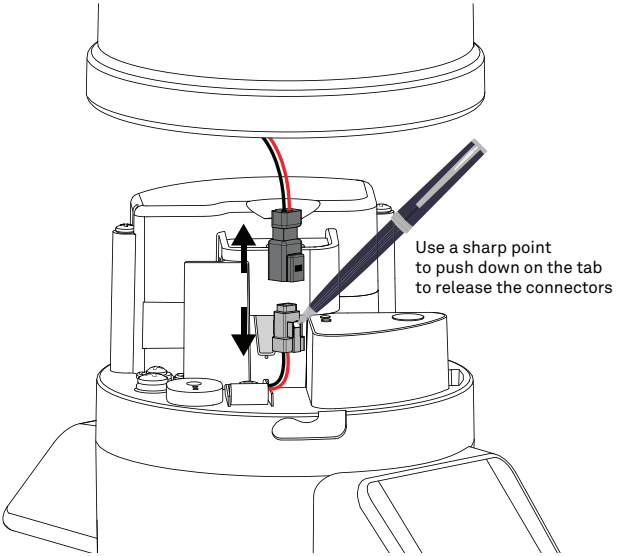


Figure 16 Disconnect pyranometer connector

3.2.2.3 REATTACH PYRANOMETER AND RAIN FUNNEL

The following instructions explain how to replace the rain funnel. Before replacing the funnel, do the following:

1. Reattach the pyranometer connector by mating the two halves of the white connector and seating them firmly together until the tabs lock (Figure 17).

   NOTE: The connector is keyed and will only connect if oriented correctly.

2. Check to be sure the downspout screen is in place on the water exit downspout (Figure 18) before replacing the rain funnel.

   NOTE: This keeps insects out of the interior of the instrument.

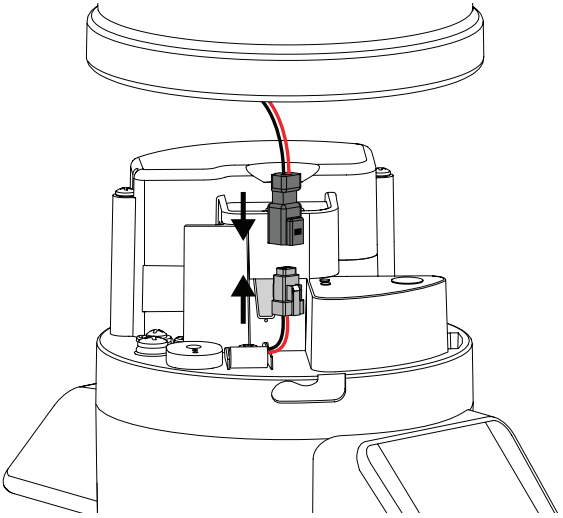


Figure 17 Pyranometer cable connector

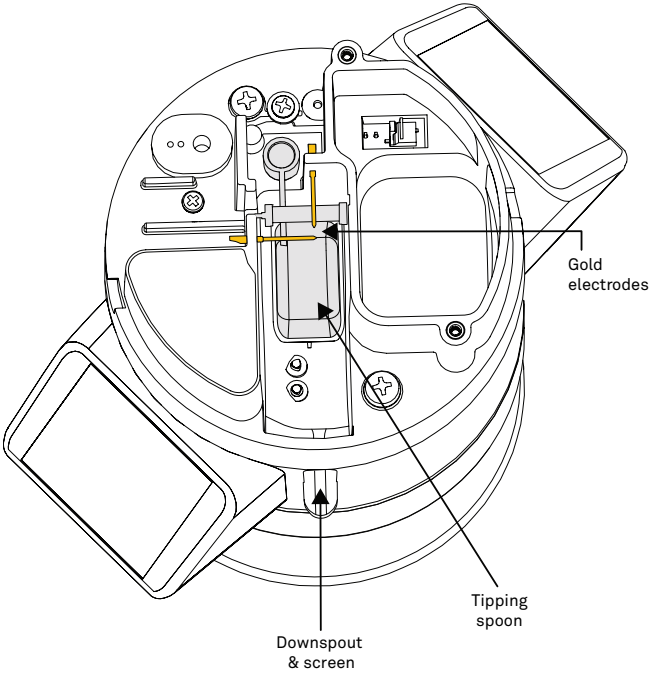


Figure 18 Downspout and screen

3.2.3 ELECTRICAL CONDUCTIVITY (EC)

The ATMOS 41W has a small basin that collects a sample of the precipitation stream as the tipping spoon empties. Two small sensing electrodes measure the electrical conductivity (EC) of the water in this basin every time the rainfall tipping spoon tips and records the instantaneous values. At the end of the measurement interval, the ATMOS 41W outputs the average of the instantaneous values measured during that measurement interval. Measurement intervals with no spoon tips are represented with a 0 value reported for EC.

There are several factors that affect the EC of the water in the measurement basin. The most important of these and the quantity that is most desirable to measure is the EC of the precipitation or irrigation water itself. However, the presence of atmospheric depositions and especially biological substances (e.g., bird droppings) in the funnel will heavily influence the EC of the water in the basin until those compounds are completely flushed from the system. In the case of bird droppings, this may not happen completely even after several precipitation events. Please see Section 5.4 for instructions on cleaning the funnel.

Residual water and concentrated solutes in the measurement basin will also influence the EC measurement until the residual water and solutes are completely flushed from the basin. Additionally, microbial activity in the measurement basin can lead to biofouling of the electrodes, which can compromise their ability to measure EC. Please see Section 5.4 for instructions on cleaning the EC electrodes.

If an accurate measure of precipitation and irrigation water EC is desired, it is critical to keep both the funnel and the EC measurement basin clean between precipitation and irrigation events. Ignore data from early in the event until the whole system is flushed and the measurement basin is filled with uncompromised precipitation and irrigation water.

Even if the funnel and measurement basin are not routinely cleaned, the EC of the solution passing through the measurement basin during precipitation events can be used as an indicator that the funnel has been polluted by bird droppings and needs to be cleaned for proper rainfall measurement.

3.2.4 VAPOR PRESSURE AND RELATIVE HUMIDITY

The vapor pressure sensor (Figure 19) on the ATMOS 41W is located behind the circular Teflon® screen in the same housing as the sonic transducers. The Teflon screen protects the sensor from liquid water and dust while allowing water vapor to freely pass to the sensor and equilibrate with ambient vapor pressure. The sensor measures relative humidity (RH) and temperature in addition to computing vapor pressure.

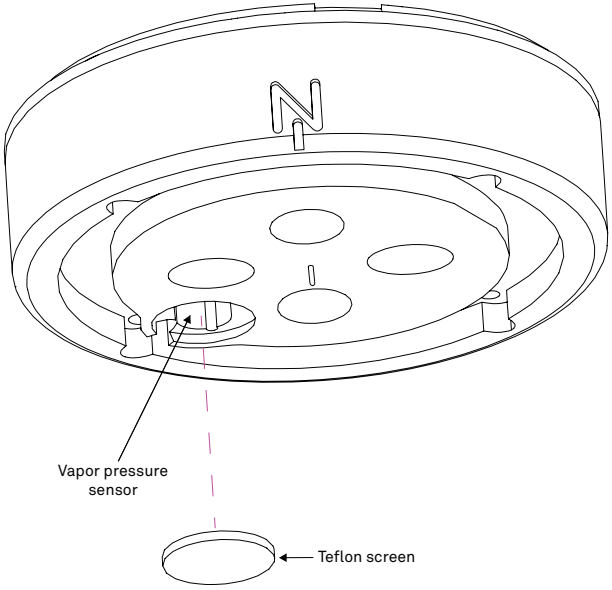


Figure 19 Vapor pressure sensor

If the relative humidity of the air is desired, it can be computed using Equation 1

$$RH_{r,air} = \frac{e_a}{e_s(T_{air})} \quad \textbf{Equation 1}$$

where e_a is the vapor pressure of the air, from the ATMOS 41W, and $e_s(T_{air})$ is saturation vapor pressure at the air temperature given by the ATMOS 41W.

The saturation vapor pressure is calculated using the Magnus-Tetens equation (Equation 2) with the following coefficients described by Buck (1981).

$$e_s T_{air} = a\,exp\left(\frac{bT_{air}}{c + T_{air}}\right) \quad \textbf{Equation 2}$$

Water	a = 0.611 kPa	b = 17.502	c = 240.97 °C	T_{air} = Temperature in °C
Ice	a = 0.611 kPa	b = 21.87	c = 265.5 °C	T_{air} = Temperature in °C

Unlike relative humidity, vapor pressure does not depend on temperature, and is generally conservative over time and space. The vapor pressure of the atmosphere near the relative humidity sensor is the same as the vapor pressure at the relative humidity sensor, even if the relative humidity sensor is not at the same temperature as the atmosphere. Additionally, it is the vapor pressure of the atmosphere (not RH) that controls the rate of vapor phase water transport (e.g., evaporation, transpiration, and distribution of water vapor). Therefore, vapor pressure is a much more useful measure of atmospheric moisture than relative humidity.

The METER ZENTRA system calculates and outputs vapor pressure deficit (VPD) in the standard data stream. VPD is simply $e_s(T_{air})-e_a$ and gives a good indication of evaporative demand.

When powered on, the ATMOS 41W measures the vapor pressure once every 3 s and records the instantaneous values. At the end of the measurement interval, the ATMOS 41W outputs the average of the instantaneous values measured during that measurement interval.

3.2.5 BAROMETRIC PRESSURE

The barometric pressure sensor is located behind the Teflon screen next to the relative humidity sensor. It measures the atmospheric pressure of the environment where the ATMOS 41W is located. With a range from 1 to 120 kPa, the sensor is suitable for measurement across a wide range of elevations, but keep in mind that the magnitude of sensor output will depend chiefly on the installation altitude with subtle changes caused by weather.

When powered on, the ATMOS 41W measures the barometric pressure once every 60 s and records the instantaneous values. At the end of the measurement interval, the ATMOS 41W outputs the average of the instantaneous values made during that measurement interval.

3.2.6 AIR TEMPERATURE

The ATMOS 41W temperature measurement (Figure 20) is made in the center of the anemometer area where a small stainless steel needle containing a tiny temperature sensor (thermistor) extends from the middle of the four sonic transducers in the center of the anemometer. Unlike most air temperature measurements, the weather station sensor is not covered with louvered plates to protect from solar heating. Instead, it sits in open air, with nontraditional radiation shielding from the instrument body. The ATMOS 41W is able to calculate the air temperature more accurately than sensors in traditional louvered radiation shields because solar radiation and the wind speed are known. These are the two main parameters that determine the error between measured air temperature and the actual air temperature. Therefore, it is possible to solve the energy balance to reproduce what the actual air temperature should be based on the solar load of the body and the convective cooling of that temperature sensor.

When powered on, the ATMOS 41W measures the air temperature once every 3 s and records the instantaneous values. At the end of the measurement interval, the ATMOS 41W outputs the average of the instantaneous values measured during that measurement interval and the minimum and maximum instantaneous air temperature measurements.

NOTE: The ATMOS 41W body and especially the temperature sensor should not be painted or coated.

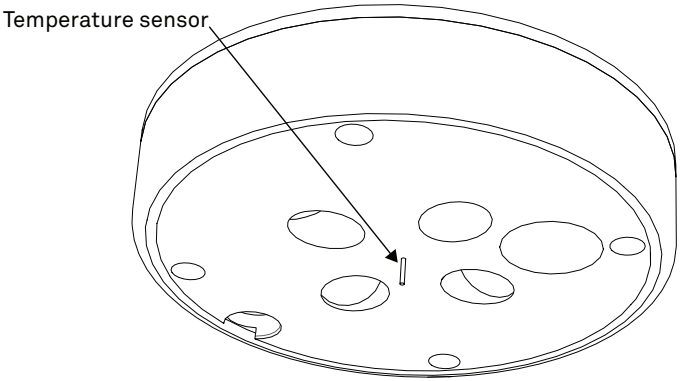


Figure 20 Temperature sensor

AIR TEMPERATURE THEORY

The ATMOS 41W uses an energy balance correction to adjust measured temperature to actual air temperature according to Equation 3.

$$T_{corr} = T_{uncorr} - \left(\frac{\alpha_S S_t}{c_p k \sqrt{u / d}} \right) \qquad \text{Equation 3}$$

where:

α_s = the absorptivity of the surface to solar radiation
S_t = the total solar radiation measured
c_p = 29.3 J mol^{-1} C^{-1}, k is a constant
u = the wind speed
d = the characteristic dimension

Although these values can be assumed, some (α_s and k) were optimized using a Levenberg Marquardt Least Squares analysis. Optimal air temperature was obtained using an Apogee TS-100 Aspirated Radiation Shield. Data were collected over several weeks and final values are shown in Table 2.

NOTE: A maximum value optimization for S_t was added because radiation values higher than that cause the corrected temperature to deviate from actual values more than when a maximum S_t was used.

Table 2 Optimized values for air temperature correction

a_s	d (m)	k	c_p (J mol^{-1}K^{-1})	Max S_t (W/m^2)
0.295	0.00083	0.0984	29.3	352.3

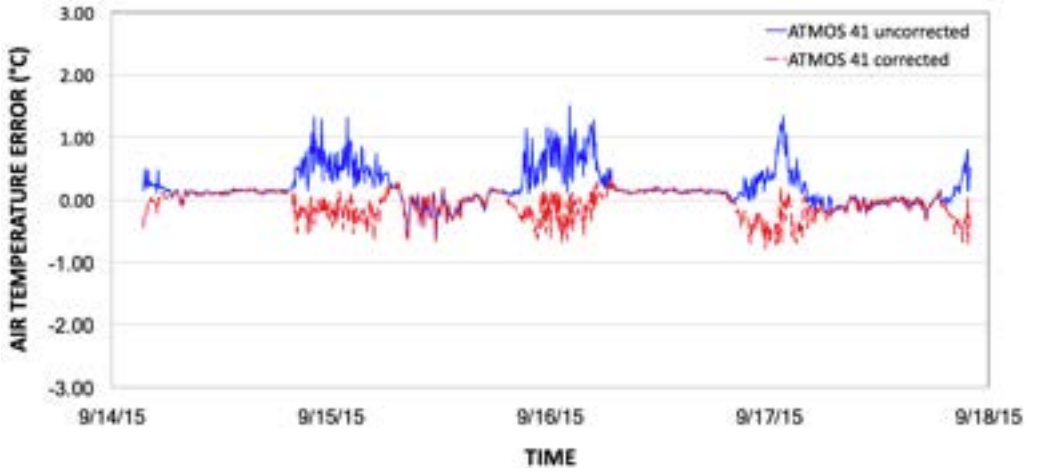


Figure 21 Corrected air temperature comparison with the aspirated radiation shield using 1-min measurement intervals

Figure 21 shows the results from the temperature correction compared to the aspirated temperature, which shows data sampled at 1 min and not averaged over time. The estimated accuracy of the air temperature measurement, based on two standard deviations (95% confidence interval), is 0.6 °C. To provide an idea of how comparable the data are, a concurrently tested temperature sensor in a radiation shield (typical measurement approach) showed an accuracy of 0.66 °C, also based on a two-standard deviation estimate. Thus, the temperature correction of the ATMOS 41W appears to give a better estimate of actual air temperature than the generally accepted radiation shield technique.

NOTE: Without correction, the accuracy of the temperature measurement is ±2 °C.

3.2.7 WIND SPEED AND DIRECTION

The space underneath the rain gauge is where the ATMOS 41W measures wind speed and direction. Ultrasonic signals emitted from transducers at right angles to each other bounce off the lower convex surface (Figure 22) and back up to the opposite sensor. The speed of sound is affected by the wind, and the wind speed is calculated by measuring differences in the time it takes for sound to travel back and forth between sensors.

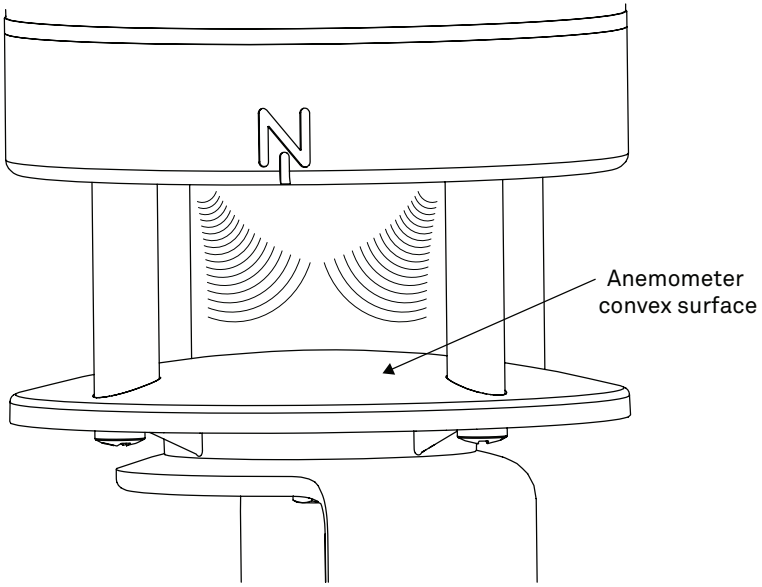


Figure 22 Anemometer

When powered on, the ATMOS 41W measures the wind speed and direction once every 3 s and records the instantaneous wind vector components. At the end of the measurement interval, the ATMOS 41W outputs the average of the instantaneous values for wind speed and direction and the maximum instantaneous wind speed value for wind gusts.

The ATMOS 41W measures wind speed every 3 s and keeps a running average of the last 10 measurements. If an instantaneous measurement is more than eight times the running average, the instantaneous measurement is rejected. It is not reported as the maximum gust or included in the data that are averaged over the output interval. For normal ATMOS 41W use cases, this is an effective method for eliminating inaccuracy resulting from spurious spikes in wind speed (e.g., bumblebee checking out the ultrasonic path). In special use cases where data are output frequently and large step changes in wind speed are present (e.g., turning on a wind tunnel), this spike rejection algorithm may result in an error code being output temporarily.

WIND SPEED AND DIRECTION THEORY

The theory behind the anemometer comes from Campbell and Unsworth (1979). The speed c (m/s) of sound in still air depends on air temperature T (K), vapor pressure e (kPa), and atmospheric pressure p (kPa), as shown in Equation 4.

$$c = 20.067\sqrt{T\left(1+\frac{0.32e}{p}\right)} \qquad \textbf{Equation 4}$$

For a given sound path length, d (m), the number of wavelengths, n, in still air is determined with Equation 5.

$$n = \frac{vd}{c} \quad \textbf{Equation 5}$$

Here v is the frequency of the sound (Hz). When the air is moving, the speed of sound is the sum of the wind speed and the speed of sound in still air. The anemometer transmits a sound pulse in a forward direction, then a similar pulse in the reverse direction. The difference in n between the two points is computed. If the vector magnitude of the wind in the direction of the sound is u (m/s), then

$$n - \Delta n_{+} = \frac{vd}{c+u} \quad \textbf{Equation 6}$$

$$n + \Delta n_{-} = \frac{vd}{c-u} \quad \textbf{Equation 7}$$

for sound traveling with and against the wind. Subtracting the result of Equation 6 from the results of Equation 7 creates Equation 8.

$$\Delta n = \Delta n_{-} + \Delta n_{+} = \frac{2vdu}{c^2 - u^2} \quad \textbf{Equation 8}$$

Even at the maximum wind speeds for the anemometer, $u2$ is only about 1% of $c2$, so the equation can be simplified as shown in Equation 9.

$$u \cong \frac{c^2}{2vd}\Delta n \quad \textbf{Equation 9}$$

This is the basic equation for the anemometer. Delta (Δ) n is proportional to the phase difference between the forward and reverse sound pulses. The sound comes from a 40 kHz ultrasonic transducer in the head of the anemometer. A sound pulse is transmitted diagonally across the anemometer, bouncing off the convex plate. The sound pulse is then received by another transducer in the anemometer head that is opposite the first. Once the sound pulse is received, the receiver becomes the transmitter and the process is repeated. Two more sensors, mounted at 90 degrees from the first two, give the other horizontal component of the wind. The sound travels a total distance of about 72 mm from transmitter to receiver, but d in the equations is just the horizontal distance, which is 40 mm.

If u is the magnitude of the wind vector in the east-west direction (east +), and v is the magnitude in the north-south direction (north +), then the wind speed is computed with Equation 10.

$$S = \sqrt{\overline{u}^2 + \overline{v}^2} \quad \textbf{Equation 10}$$

Where the overbar indicates an average of the values sampled every 3 s, wind direction is computed with Equation 11.

$$\theta = tan^{-1}(\overline{v} / \overline{u})$$ **Equation 11**

The wind measurement through more frequent SDI-12 commands requires 42 ms to complete. An additional 60 ms are required for the computations to determine phase differences. The anemometer samples every 3 s (or more often if requested). The gust speed reported is the highest instantaneous wind speed measured during the selected averaging interval (must be >20 s or gusts will equal speed).

The ATMOS 41W uses a wind speed spike rejection scheme to protect against the inclusion of spurious wind speed spikes in the averaged wind speed data. The ATMOS 41W measures wind speed every 3 s and keeps a running average of the last 10 measurements. If an instantaneous measurement is more than eight times the running average, then the instantaneous measurement is rejected and not reported as the maximum gust or included in the data that are averaged over the output interval.

For normal ATMOS 41W use cases, this is an effective method for eliminating inaccuracy resulting from spurious spikes in wind speed (e.g., bumblebee investigating the ultrasonic path). In special use cases where data are output frequently and large step changes in wind speed are present (e.g., turning on a wind tunnel), this spike rejection algorithm may result in an error code being output.

NOTE: Cup anemometers average over a much longer interval than 42 ms, so the gusts measured with a sonic anemometer will have a larger peak-to-mean ratio than one would see with a cup anemometer.

3.2.8 TILT SENSOR

The ATMOS 41W is also equipped with a tilt sensor similar to those found in smartphones. The primary use of the tilt sensor data is to ensure the ATMOS 41W remains level at all times. Regularly check tilt data to ensure the ATMOS 41W is level; if it has tilted, return to the site and level again. Even a slightly off-level ATMOS 41W will cause errors in the solar radiation measurement, and a 2° tilt can cause large errors in the rainfall measurement. Although this sensor may be used to level the instrument, it is much easier to use the small bubble level on the bottom of the anemometer plate. The ATMOS 41W comes with an adjustable leveling bracket, requiring only a 5/16-in (8-mm) wrench to adjust.

When powered on, the ATMOS 41W measures the tilt once every 60 s and records the instantaneous values. At the end of the measurement interval, the ATMOS 41W outputs the average of the instantaneous values measured during that measurement interval.

3.2.9 SOLAR PANELS

The ATMOS 41W comes with two integrated solar panels on the west and east orientation. These allow the rechargeable NiMH AA batteries to recharge, and allow long-term deployment with minimal interaction. While the west to east solar panel orientation is suboptimal for solar recharge, the ATMOS 41W is designed to have a low power draw such

that the solar panels allow for long term recharge under most natural light conditions. There may be local obstructions that make another orientation more favorable, however, failure to orient the instrument to true north will result in erroneous wind direction measurements. The ATMOS 41W will charge the batteries even during periods of low light levels (e.g., winter time or heavy overcast conditions).

When considering install location, take into consideration mature vegetation that could cause shadowing of the panels (Figure 23) reducing solar exposure.

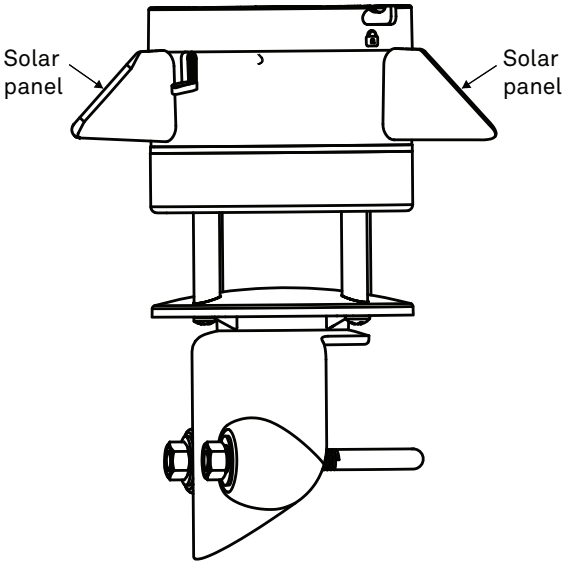


Figure 23 Solar panels

3.2.10 GPS RECEIVER

The ATMOS 41W has a built-in GPS receiver that provides the latitude, longitude, and altitude of the instrument. It is designed to provide time fix and location metadata for the environmental monitoring location. The ATMOS 41W enables the GPS receiver once per day. If the instrument determines its location has not changed, it turns off the GPS receiver to save power. If the instrument detects a change, it keeps the GPS receiver powered for as long as 15 min to improve the accuracy of the location fix. Pressing the **TEST** button triggers the GPS receiver to evaluate changes in location (Section 3.2.15).

3.2.11 TIMEKEEPING

The ATMOS 41W keeps track of time using Universal Time Coordinated (UTC) s. All models can synchronize time using ZENTRA Utility Mobile. Additionally, the ATMOS 41W synchronizes time using the GPS receiver or the enabled communication network. The ATMOS 41W

prioritizes using GPS time since this will be the most accurate; however, the instrument will fall back to the other sources of time when the ATMOS 41W does not have a good GPS time fix.

Data collected by the ATMOS 41W uses the UTC time for the timestamp on each saved sensor record. ZENTRA Cloud displays these data using local time based on where the instrument is installed.

3.2.12 DATA STORAGE

The ATMOS 41W stores up to 8 MB of data for on-board integrated sensors (Section 3.2). External sensors cannot be used with the ATMOS 41W.

When the ATMOS 41W memory is full, it begins overwriting the oldest data stored. Data storage capacity varies between 16 months to several years depending on the set measurement interval. ZENTRA Utility Mobile software displays the percentage of storage used on the main information page (Figure 3).

The ATMOS 41W data memory is nonvolatile flash. Removing the batteries or rebooting the instrument(Section 3.2.14) will not erase stored sensor measurement data.

3.2.12.1 SENSOR MEASUREMENT INTERVAL

The user-defined sensor measurement interval controls how often the ATMOS 41W records sensor data to internal nonvolatile data storage. The interval applies to all inputs on the ATMOS 41W (i.e., the ATMOS 41W cannot store data for one sensor at a faster rate than another sensor). The measurement interval is controlled in the Sensor Configuration tab of ZENTRA Utility Mobile (Section 2.2.2).

The measurement interval works relative to the ATMOS 41W internal real-time, 24-h clock. For example, a measurement interval of 60 min results in the ATMOS 41W storing data every hour, on the hour (e.g., 12:00 am, 1:00 am, ..., 10:00 pm). The ATMOS 41W minimum measurement interval is 5 min and the maximum measurement interval is 12 h. For most applications, a measurement interval of 15 min is appropriate.

The ATMOS 41W makes measurements of each sensor at the intervals described in Table 3. When the ATMOS 41W internal clock reaches the user-configured measurement interval, the ATMOS 41W processes and stores the results from all the instantaneous sensor readings taken since the end of the last measurement interval interval. For most sensors, the stored results are a simple average of the instantaneous readings. For the event-based sensors (e.g., rain gauge), the ATMOS 41W stores summed sensor readings at the end of the measurement interval.

NOTE: Setting the ATMOS 41W measurement interval to Off (not logging) turns off sensor measurement, data storage, and data uploads.

The ATMOS 41W stores encoded data for each sensor to make data storage and transmitting convenient. ZENTRA software automatically decodes the sensor data to display them correctly.

3.2.12.2 INTERNAL SENSOR MEASUREMENT FREQUENCY

The ATMOS 41W has a data acquisition system that records measurements from the individual sensors at predefined frequencies as described in Table 3 below. When the user-defined sensor measurement interval (Section 3.2.12.1) is reached, the measurements are processed into the appropriate accumulations, averages, and maximums and output to final storage for transmission to ZENTRA Cloud. Table 3 describes the internal measurement timing and data type reported for each ATMOS 41W sensor.

Table 3 ATMOS 41W Internal Measurement Frequency and Reported Data Type

Measurement	Data Measurement Frequency	Data Reported to ZENTRA Cloud Each Measurement Interval (m = number of minutes in measurement interval)
Solar radiation	3 s	Average of 20m instantaneous solar radiation measurements
Wind speed	3 s	Wind run is calculated from average of 20m saved values of both horizontal wind vectors.
Wind direction	3 s	Weighted direction calculated from 20m saved values of both horizontal wind vectors
Wind gust	3 s	Maximum wind gust recorded over 20m measurements during measurement interval
Vapor pressure	10 s	Average of 20m instantaneous vapor pressure measurements
Rainfall	Each drop/spoon tip	Accumulation of rainfall over measurement interval
Maximum rainfall rate	1 min	Maximum rainfall accumulation recorded for a single 1-min period multiplied by 60 min/h
Air temperature	3 s	Average of 20m instantaneous temperature measurements
Maximum air temperature	3 s	Maximum temperature recorded over 20m measurements during measurement interval
Barometric pressure	10 s	Average of m instantaneous barometric pressure measurements
Electrical conductivity	Each spoon tip	Average of instantaneous electrical conductivity measurements during measurement interval
Orientation	60 s	Average of m instantaneous tilt measurements

3.2.13 BATTERIES

The ATMOS 41W is designed to use either AA NiMH rechargeable batteries or AA alkaline nonrechargeable batteries. The instrument auto detects the type of batteries installed and automatically adjusts the internal thresholds to represent 100% and 0% battery power.

⚠ CAUTION

DO NOT mix NiMH and alkaline batteries together and DO NOT mix new and old alkaline batteries together. Either of these situations causes battery leakage.

Use NiMH batteries if the ATMOS 41W will be installed in a solar rich area, where it can harvest solar energy to charge NiMH batteries. Orient the ATMOS 41W to true north. This will expose the solar panel to orient west and east. There may be local obstructions that make another orientation more favorable, however, failure to orient the instrument to true north will result in erroneous wind direction measurements. The ATMOS 41W will charge the batteries even during periods of low light levels (e.g., winter time or heavy overcast conditions). For extended periods of low light, the incoming energy may be lower than the energy needed to operate the instrument . The batteries will buffer the energy needs of the instrument for several months and will return to full capacity as the incoming energy exceeds the energy needed to operate the instrument.

Use alkaline batteries if the ATMOS 41W will be installed in a location where the harvested solar energy is not sufficient to keep the NiMH batteries charged. Alkaline batteries will last longer than NiMH batteries that are not being charged (6 to 7 months for typical configurations uploading data once per hour).

The ATMOS 41W is designed to prioritize sensor measurements over both the GPS and cellular or Wi-Fi communications features. If the battery level reaches a critical threshold (showing 0% in software), the ATMOS 41W will continue to make sensor measurements until the battery charge is too low to provide power to the integrated sensors. When new batteries are installed or recharged, the GPS receiver and cellular/Wi-Fi radio functionality will automatically start working again.

Logged data are stored with nonvolatile flash memory and will not be lost if battery power fails. However, power must be restored to the instrument to upload data.

To change batteries, follow the steps listed below (Section 3.2.13.1).

3.2.13.1 REMOVE BATTERY COVER AND PACK

1. Remove the rain funnel (Section 3.2.2.1).
2. Locate the battery cap.
3. Remove the two screws with a Phillips screwdriver.
4. Life off the cap (Figure 24)

   The battery pack will most likely come up with the cap.

   NOTE: Be careful not to damage the battery pack wire when disconnecting as the battery pack is removed.

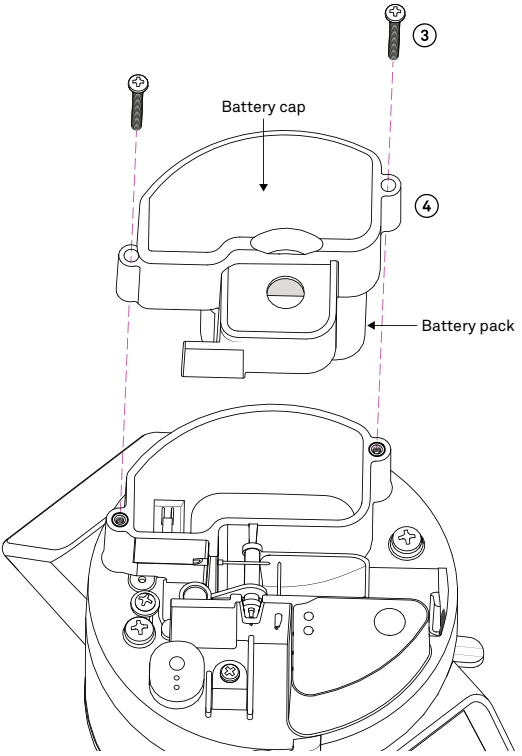


Figure 24 Battery cap removal

5. Slide the battery pack out of the battery cap (Figure 25).

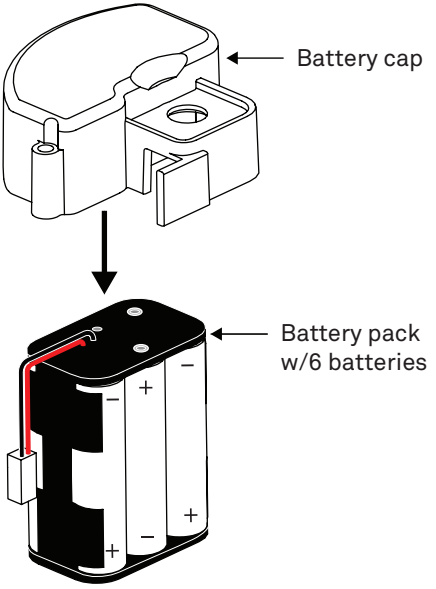


Figure 25 Battery pack removed from cap

6. Replace batteries.

NOTE: Make sure replaced battery polarity and battery pack orientation are correct.

The wire connecting the battery pack to the unit will be oriented up (Figure 26).

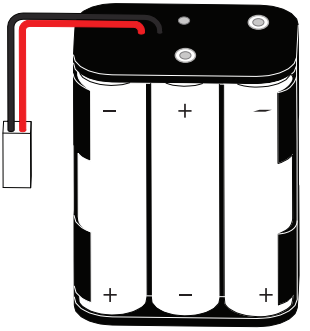


Figure 26 Battery polarity and pack orientation

3.2.13.2 REPLACE BATTERY PACK AND COVER

1. Hold the battery pack with the cable as shown in Figure 27.

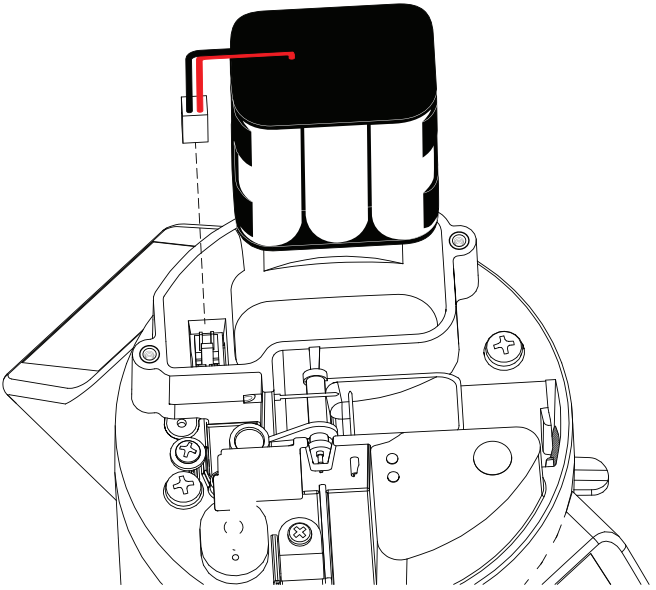


Figure 27 Battery pack with cable oriented for replacement

2. Attach the cable connector to the 2-pin connection inside the battery compartment.
3. Place the battery pack into the battery compartment.
4. Replace the battery cap over the battery pack.

   The cap fits very tight around the battery pack. It might need to be angled somewhat to get it to cover the pack.

   NOTE: Be careful to not pinch the cable wire when putting the battery cap on.
5. Replace the two screws in the cap to secure it tight enough for a complete seal.

3.2.14 TEST BUTTON

The **TEST** button functions in two ways.

- Reboots the ATMOS 41W and performs a self-test.
- Turns on the Bluetooth module for communication between the instrument and ZENTRA Utility Mobile.

To access the **TEST** button, remove the rain funnel (Section 3.2.2.1) and press the **TEST** button (Figure 28) to initiate the self-test sequence. The self-test can take 60 s or more if testing communications over the cellular or Wi-Fi network.

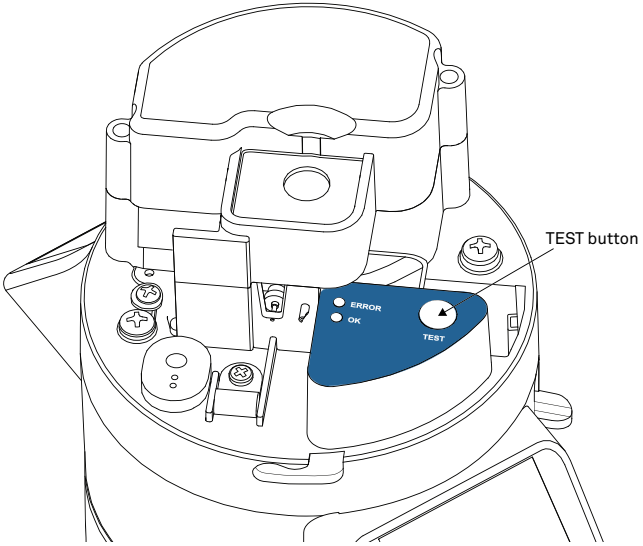


Figure 28 TEST button

The following actions are part of the self-test sequence. This sequence happens after replacing batteries or pressing the **TEST** button:

1. Reboot the ATMOS 41W.

   This ensures the internal software restarts and operates in the expected way. Both status lights stay on during the reboot. This reboot will not erase data or reset settings.

2. Perform basic functionality testing on internal systems, and evaluate the amount of charge in the battery Table 4.

Table 4 Internal System Functionality Testing

Internal Tests	Light Indication
Request current time and location fix (Section 3.2.11).	Green and red light blink slowly together while test running
Establish internet connection over a cellular or Wi-Fi network and attempt to communicate with ZENTRA cloud.	Green and red light blink slowly together while test running
Enable Bluetooth module to allow connection with ZENTRA Utility Mobile.	Green and red light blink slowly together while test running
Test success	Green light solid for ~20 s
Test failure Possible failure reasons: • corrupt ATMOS 41W firmware • low battery power • unsuccessful cellular of Wi-Fi communications	Red light solid

Table 4 Internal System Functionality Testing (continued)

Internal Tests	Light Indication
Wi-Fi network connection	Light Indication: If no WiFi connection has been previously made, the redlight will blink until a successful connection has been made.

Use ZENTRA Utility Mobile to identify where the self-tests may have failed (Section 4.1) or consult troubleshooting (Table 7) to resolve sensor errors.

3.2.15 STATUS LIGHTS

Status lights (Figure 29) are located near the **TEST** button and indicate the status of the ATMOS 41W. There are several possible status states shown in Table 5:

Table 5 Status Lights

Status Lights	Actions	Indication
Green OK light	Short single blink every 5 s	Inidcates ATMOS 41W configured to acquire sensor data
Green and red lights	Blink together during self test procedure after pressing **TEST** button or when using cellular or Wi-Fi module	Running functionality tests
Green OR red light	Solid at end of self-test sequence	Indicates the results of the tests
Lights remain OFF		Indicates data acquisition measurement is set to OFF (not acquiring data)

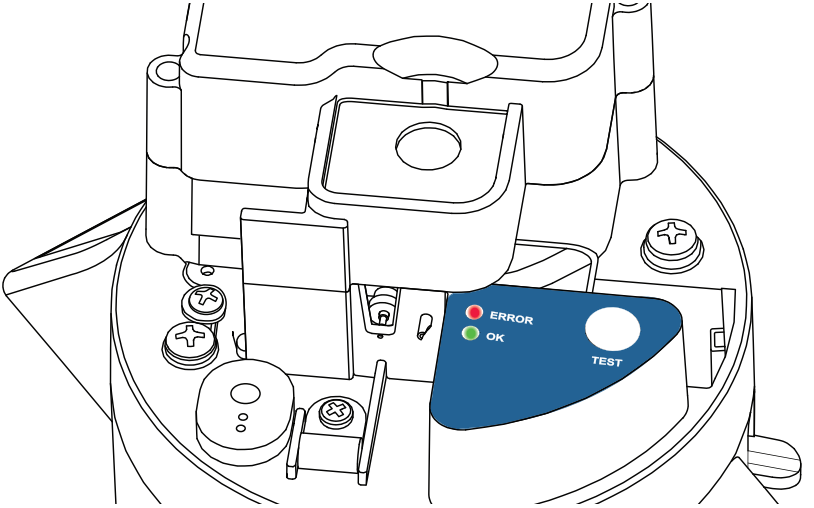


Figure 29 Status lights

3.2.16 CELLULAR COMMUNICATIONS

The ATMOS 41W has a built-in cellular module for uploading measurement data to ZENTRA Cloud. This allows for near real-time monitoring of the environment at the measurement site.

The ATMOS 41W powers the cellular module only long enough to upload the data collected since the last time the instrument successfully reported. During these upload times, the ATMOS 41W transfers data to ZENTRA Cloud, retrieves any pending settings changes, and occasionally performs system updates to the instrument.

Upload session frequency and timing can be changed in ZENTRA Utility mobile (Section 2.2.2) or ZENTRA Cloud. The default setting is for the ATMOS 41W to upload data once per hour at a random time within each hour of the day. Less frequent uploads conserve battery power.

NOTE: Contact Customer Support or a METER sales partner for more information if more frequent uploads are needed.

The ATMOS 41W is available with either a 3G or 4G LTE-M cellular communication module and is configured to operate with more than 550 roaming partner networks in 190 countries.

Please contact Customer Support or a METER sales partner for more information on the configuration that is best for the location where you plan to deploy the instrument.

3.3 WI-FI COMMUNICATIONS

This section reviews the ATMOS 41W communications and configurations for Wi-Fi.

3.3.1 CONFIGURING ATMOS 41W FOR WI-FI NETWORKS

An ATMOS 41W logger using Wi-Fi for communications with ZENTRA Cloud operates much the same as the cellular-enabled version of the hardware as documented throughout this manual. The key difference is a ATMOS 41W with Wi-Fi hardware requires the relevant settings to enable a connection to a Wi-Fi network. This is done using ZENTRA Utility Mobile.

Use ZENTRA Utility Mobile to configure the ATMOS 41W for a Wi-Fi network. The process starts the same for all supported Wi-Fi network types.

Press the TEST button on the logger to enable Bluetooth communications. Choose the ATMOS 41W from the Connect screen in the app. ZENTRA Utility will connect to the ATMOS 41W and retrieve the current configuration and status.

Figure 30 ATMOS 41W connection process

Tap `Configure` on the main screen. Then tap `Configure Wi-Fi Network` to start the connection process. ZENTRA Utility asks the ATMOS 41W for a list of Wi-Fi networks within range of the logger.

Figure 31 Wi-Fi network list

ZENTRA Utility lists up to 12 of the Wi-Fi networks reported by the ATMOS 41W. Secure networks that require a passphrase are shown with a lock icon. Tap the name of the network to select the network ATMOS 41W should be used to communicate with ZENTRA Cloud.

There are several reasons a desired Wi-Fi network isn't shown on the list. The signal strength may not be strong enough because the ATMOS 41W is not close enough to the access point. The ATMOS 41W is compatible with IEEE 802. 11b/g/n 2.4 GHz Wi-Fi networks. The ATMOS 41W cannot join a network using only the 5 GHz bands. The network may not be broadcasting the name. See Section 3.3.5 for how to configure the ATMOS 41W for a hidden Wi-Fi network.

The Wi-Fi hardware inside the ATMOS 41W auto-detects which regulatory region where it is operating. For many locations in the world, including the USA, the module disables Wi-Fi channels 12 & 13. Check the Wi-Fi access point configuration to verify it is not using channels 12 & 13 (or set to auto-select the channel when channels 12 & 13 are an option). The ATMOS 41W only supports channels 12 & 13 when deployed in the ETSI/UKCA region.

3.3.2 OPEN NETWORK CONFIGURATION

The ATMOS 41W is compatible with personal Wi-Fi networks that are not secured. This type of network doesn't require a passphrase.

NOTE: Some open networks employ a captive portal. The ATMOS 41W is not compatible with this type of network.

Figure 32 Configuration of open network

Tap `Join` to send the network settings to ATMOS 41W. The logger proceeds to connect to this Wi-Fi network and communicate with ZENTRA Cloud. ZENTRA Utility Mobile will report any errors.

3.3.3 SECURED PERSONAL NETWORK CONFIGURATION

The ATMOS 41W is compatible with personal secured Wi-Fi networks. These are the most common kind of networks used in homes and small businesses. This type of network requires a passphrase that is at least 8 characters long.

Figure 33 Configuration of personal secured network

Enter the passphrase and then Tap `Join` to send the network settings to ATMOS 41W. The logger proceeds to connect to this Wi-Fi network and communicate with ZENTRA Cloud. ZENTRA Utility Mobile will report any errors.

3.3.4 SECURED ENTERPRISE NETWORK CONFIGURATION

The ATMOS 41W is compatible with some Wi-Fi networks employing enterprise security. These types of networks are used in larger businesses and universities. Typically, enterprise networks require IT professionals to deploy and support. The ATMOS 41W is compatible with enterprise networks that are secured by a username and password using LEAP and PEAP methods. See Section 3.3.6 for networks that require authentication with certificates.

Figure 34 Configuration of an enterprise network

Enter the username, password, and security type and then Tap `Join` to send the network settings to ATMOS 41W. The logger proceeds to connect to this Wi-Fi network and communicate with ZENTRA Cloud. ZENTRA Utility Mobile will report any errors.

3.3.5 HIDDEN WI-FI NETWORK CONFIGURATION

Some Wi-Fi networks are configured not to broadcast their network name. These are known as hidden networks. These networks could be secured with personal or enterprise authentication methods. The ATMOS 41W is compatible with hidden personal networks and is also compatible with hidden enterprise networks described in (Section 3.3.3) above.

Figure 35 Configuration of hidden personal network

Connecting to a hidden Wi-Fi network requires you to enter the network name and security credentials. Consult your IT professional if you are unsure of the settings to use with the hidden network. Tap `Join` to send the network settings to ATMOS 41W. The logger proceeds to connect to this Wi-Fi network and communicate with ZENTRA Cloud. ZENTRA Utility Mobile will report any errors.

3.3.6 INCOMPATIBLE NETWORKS

The ATMOS 41W is not compatible with the following types of Wi-Fi networks. Consult an IT specialist for assistance if the network intended to be used with the ATMOS 41W is one of the following incompatible networks.

The ATMOS 41W is not compatible with Wi-Fi networks that employ captive portal technology. Captive portals are commonly used with open Wi-Fi networks to present a network login page or to require a compliance agreement with an acceptable use policy before allowing network access. The ATMOS 41W is unable to interact with these requirements. It is not possible for ZENTRA Utility mobile to identify networks using a captive portal. During the configuration process, ZENTRA Utility Mobile will likely alert that the ATMOS 41W does not have internet access even if it successfully connected to the Wi-Fi network.

Suggested work around for networks using a captive portal: provide the network administrator with the MAC address for the ATMOS 41W so it can be added to the network whitelist.

The ATMOS 41W is not compatible with enterprise Wi-Fi networks that require security certificates to be loaded onto the clients using the network. These networks typically use certificates instead of usernames and passwords to enable network access. Networks secured with the EAP-TLS method is an example of an incompatible network. ZENTRA Utility Mobile and the ATMOS 41W do not currently support transferring security certificates to the Wi-Fi module embedded in the ATMOS 41W.

Suggested work around for networks using security certificates: work with your IT professional to deploy a dedicated Wi-Fi network for the ATMOS 41W hardware that uses supported network security.

The ZL6 is not compatible with networks that require the hardware to use statically assigned IP address configuration. It is not currently possible to configure the ZL6 to use a static IP address with ZENTRA Utility Mobile. The ZL6 only interacts with ZENTRA Cloud over the internet so a dynamically allocated IP address is sufficient.

Suggested work around for networks requiring static IP address: provide the network administrator with the MAC address for the ZL6 so it can be given a fixed IP address via DHCP.

3.4 LIMITATIONS

This section describes limiting factors or conditions for proper ATMOS 41W functionality. Limitations occur mostly from more extreme or prolonged weather conditions but also some cases of electromagnetic interference from power transmission lines.

3.4.1 SNOW AND ICE ACCUMULATION

The ATMOS 41W is not heated, so it will not measure frozen precipitation until snow and ice that have accumulated in the funnel melt. In locations with heavy snowfall or long periods below freezing, it is almost certain that snow accumulation will fill the funnel and no longer accumulate, leading to inaccurate precipitation measurements even when the precipitation melts. Accumulation of snow, ice, or frost will also adversely affect the accuracy of the solar radiation measurement and can compromise the wind measurements if accumulation occurs in the anemometer acoustic pathway or on the convex base plate (Section 3.2.7). See the application note How does the ATMOS 41W perform under below freezing and snowy conditions (meter.ly/41w-freezing-snow) for more information on ATMOS 41W performance in high-latitude winter.

3.4.2 HEAVY RAIN AND STRONG WIND

During strong storm events, water can splash off of the convex bottom surface of the anemometer envelope and interrupt the signal passing between the sonic transducers. The convex shape helps minimize splashing and reduces the likelihood that the wind measurements are interrupted. Additionally, specially treated hydrophobic porous polyethylene membranes protect the ultrasonic transducers from direct splashing. Despite these features, heavy rain and strong wind can still cause water to reach the membranes and also cause temporary water buildup on the convex surface. The hydrophobic nature of the transducer protective membranes and the quick-drying ability of the convex surface should limit wind measurement interruptions to heavy rain events and should bring wind measurement back online soon after extreme conditions abate.

3.4.3 ELECTROMAGNETIC INTERFERENCE

ATMOS 41W rainfall measurements can be adversely affected by high level Electromagnetic Interference (EMI), such as that produced by high voltage power transmission lines. Be sure to locate the ATMOS 41W far from such sources of EMI.

4. ZENTRA SOFTWARE

The ATMOS 41W is designed to work with ZENTRA Utility Mobile (Section 4.1) and ZENTRA Cloud (Section 4.2). ZENTRA Utility Mobile communicates with the ATMOS 41W using Bluetooth to configure the ATMOS 41W and upload data to ZENTRA Cloud. ZENTRA Cloud is a web-based application to remotely view and share environmental data, download spreadsheets, and configure the ATMOS 41W remotely.

4.1 ZENTRA UTILITY MOBILE

ZENTRA Utility Mobile for iOS or Android Mobile Devices is a user-friendly interface for configuring and downloading data from the ATMOS 41W that can be used on Apple or Google (Android) smartphones or tablets. With ZENTRA Utility Mobile, the user can connect to ATMOS 41W via Bluetooth to do the following:

- Configure operation parameters
- Test ATMOS 41W cellular/Wi-Fi communications
- Troubleshoot real-time sensor measurements (scan sensors)

ZENTRA Utility Mobile launches with an in-app tutorial to illustrate the important features of the app. Select **More** from **In-App Tutorial** to review this tutorial at any time. Use the **Connect** screen to select the ATMOS 41W and use the ZENTRA Utility Mobile main screen to configure the communication settings and check sensor measurements.

4.2 ZENTRA CLOUD

ATMOS 41W data are accessed online via ZENTRA Cloud, a web application used to download, view, and share data as well as to change configurations.

The ATMOS 41W requires a paid subscription to use ZENTRA Cloud. See Add ATMOS 41W to ZENTRA Cloud on page 7 to learn how to add the ATMOS 41W to ZENTRA Cloud or check out the Getting started guide (meter.ly/zentra-cloud-get-started-guide).

5. SERVICE

This section describes the maintenance of the ATMOS 41W. Troubleshooting solutions and customer services information are also provided.

5.1 UNINSTALLING

Sometimes the ATMOS 41W must be uninstalled to perform routine maintenance, at the end of the field season, or to send in for recalibration.

After removing the instrument from the mounting pole, remove the rain funnel and dump the liquid contents that could be in the EC basin (Figure 35). If the liquid contents are not emptied, the contents of the basin (dirt, bird droppings) will make a mess as the instrument is transported.

5.2 CALIBRATION

- **Solar Radiation**: ATMOS 41W pyranometers are calibrated through side-by-side comparison to the mean of four Apogee model SP-110 transfer standard pyranometers (shortwave radiation reference) under high-intensity discharge metal halide lamps. The transfer standard pyranometers are calibrated through side-by-side comparison to the mean of at least two ISO-classified reference pyranometers under sunlight (clear sky conditions) in Logan, Utah. Each of four ISO-classified reference pyranometers are recalibrated on an alternating yearly schedule (two instruments each year) at the National Renewable Energy Laboratory (NREL) in Golden, Colorado. NREL reference standards are calibrated to the World Radiometric Reference (WRR) in Davos, Switzerland.
- METER recommends using the model from the Clear Sky Calculator (clearskycalculator.com), developed by Apogee Instruments and available on clearskycalculator.com or in the respective app store for a mobile device, to determine uncertainty of the pyranometer on the ATMOS 41W. Should the uncertainty be higher than 5% (or other preferred number) the unit should be replaced with a new funnel/pyranometer. Contact Customer Support.
- A custom pyranometer calibration factor can be calculated using the Clear Sky Calculator. Neither Apogee Instruments nor METER guarantee this method is as accurate as a new unit that has recently been calibrated, but, if done properly, it should result in better than 5% accuracy in the solar radiation measurements.

- **Precipitation**: The drop counting portion of ATMOS 41W rain gauges do not receive individual calibration. The critical parameter for accurate measurement is drop size (which is controlled by the geometry of the rain gauge nozzle), and the rain gauge nozzle is an injection molded piece with static geometry.
    - Individual calibration is performed on the tipping spoon portion of the ATMOS 41W rain gauge. Each spoon is calibrated to tip at the equivalent of precisely 0.34 mm of rainfall during the production process.
    - The functionality of both ATMOS 41W rain gauge measurements is verified at a single rainfall rate during the manufacturing and quality assurance (QA) process. A subsample of rain gauges undergoes a more in-depth accuracy verification each month as part of routine QA procedures.
- **Air Temperature:** The air temperature sensor is specified to be accurate to 0.1 °C by the original manufacturer. All sensors are verified against a NIST-traceable standard thermometer to be within 0.2 °C at the time of manufacture.
- **Vapor Pressure and RH**: ATMOS 41W vapor pressure and relative humidity sensors receive a three-point calibration using a METER WP4C chilled-mirror dew point sensor as the calibration standard at 20%, 50%, and 80% RH. The WP4C is calibrated every 3 months against four salt standards of known RH (Robinson and Stokes 1970) to be accurate to within 0.2% RH.
- **Barometric Pressure:** Each ATMOS 41W barometric pressure sensor is calibrated against the average of three secondary standard Measurement Specialties MS5611 pressure sensors. The MS5611 sensors are calibrated every 3 months against a GE Druck TERPS 8100-series pressure sensor. The GE pressure sensor is calibrated yearly at a certified laboratory with NIST traceability.
- **Wind Speed:** The relationship between wind speed and phase is determined by geometry and the laws of physics. Since the geometry is tightly controlled in manufacture, no individual anemometer calibration is needed. The phase of each ATMOS 41W anemometer is initially set to zero in a zero wind-speed condition. Extensive wind-tunnel and field testing has shown this to result in accurate wind-speed measurements. A subsample of anemometers is checked monthly for accuracy as part of routine QA procedures.
- **Wind Direction:** The ATMOS 41W wind direction measurement depends on the geometry of the ultrasonic transducers and the north orientation indicator on the ATMOS 41W body. This geometry is held to within 0.025-mm specifications through CNC milling procedures. Imprecise orientation of the ATMOS 41W toward north will introduce more error in the wind direction measurement than sensor geometry.
- **Sensor Orientation:** The ATMOS 41W orientation sensor is zeroed against the primary bubble level on the bottom side of the upper anemometer housing.

5.3 RECALIBRATION RECOMMENDATIONS

Table 6 lists the recommended sensor calibration frequencies.

Table 6 Sensor calibration frequencies

Sensor Function	Measurement Drift	Calibration Frequency
Solar radiation	<2% drift/year	Every 2 years[a]
Barometric pressure	0.1 kPa/year (typical)	Every 1–2 years[b]
Relative humidity (RH)	<0.25% RH/year	Every 2 years[b]
All other sensors		Not needed

[a] Calibrated, field-swappable replacement pyranometers are available from METER. Contact Customer Support to purchase a new funnel and consult Instructions for Swapping ATMOS 41W Funnel (meter.ly/41W-funnel-replace) for instructions on field swapping the pyranometer.

[b] ATMOS 41W barometric pressure and vapor pressure/RH sensors and their respective calibrations are housed on a module that sits behind the circular Teflon membrane in the same housing as the sonic transducers (Figure 19). This module is field-swappable, so sensors in need of calibration can be removed and replaced by a module with calibrated sensors. Please contact Customer Supportfor new sensor modules and consult VIDEO: Instructions for swapping ATMOS 41 daughterboard—RH/temperature/barometric pressure sensors (meter.ly/atmos41-swap-RH-daughterboard) for instructions on swapping the sensor module.

5.4 CLEANING AND MAINTENANCE

For more information on thoroughly cleaning the ATMOS 41W, see ATMOS 41W cleaning instructions (https://meter.ly/atmos-cleaning-instructions).

1. Make sure nothing is obscuring the temperature sensor or the sonic transducers shown in Figure 30 (cobwebs, leaves, wasp nests, etc.).

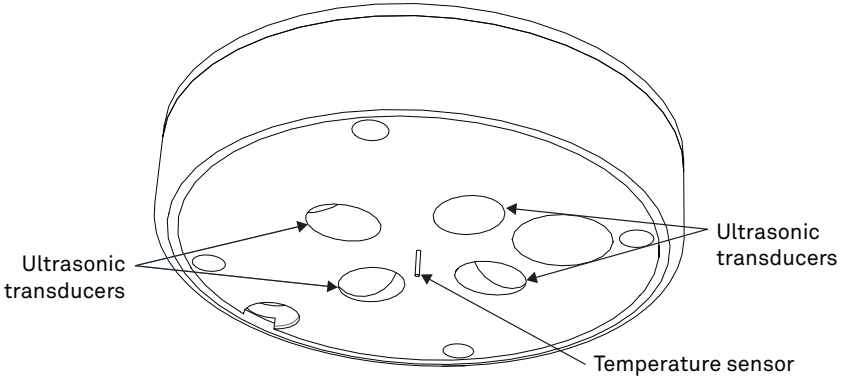


Figure 36 Temperature sensor and ultrasonic transducers

2. Check the following areas to make sure they are clear of miscellaneous environmental, animal (specifically bird droppings) and insect debris, or spider webs:
   a. Ultrasonic transducer openings (Figure 36)
   b. Rain funnel (Figure 37)
   c. Pyranometer (Figure 37)
   d. Convex base plate (Figure 38)

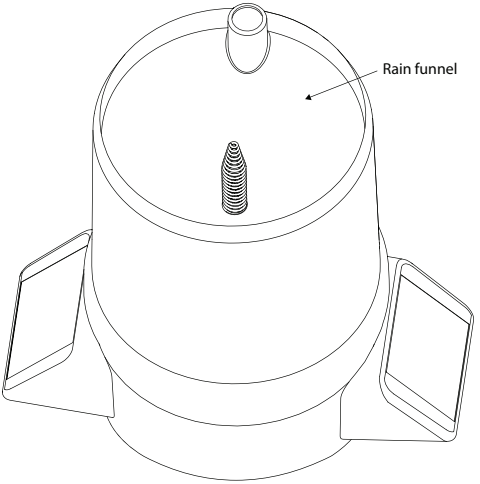


Figure 37 Rain funnel and pyranometer

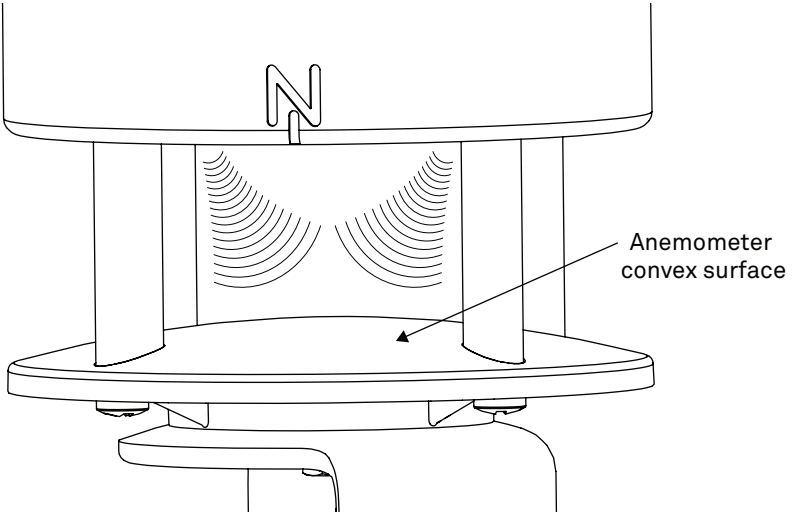


Figure 38 Convex base plate

3. Clean the ATMOS 41W body.
   a. Scrub with light to medium pressure using a warm, damp cloth.
   b. Clean around posts and between crevices using a dry brush.
   c. Check the downspout (Figure 39) for debris.
      If there is debris in the downspout, remove the debris.

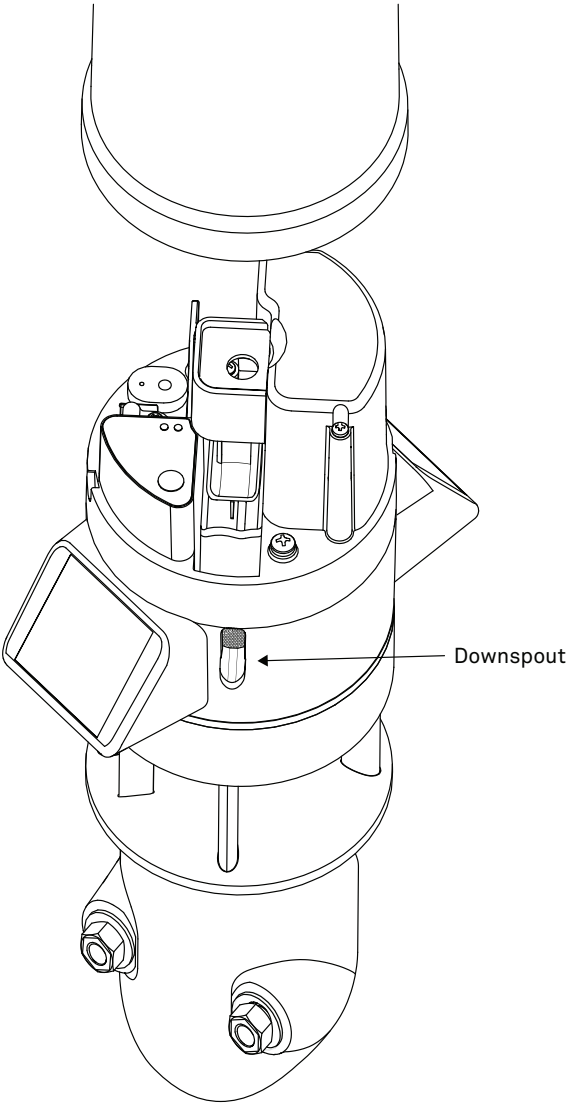


Figure 39 Downspout

d. Observe the Teflon screen (Figure 40)

If the screen is dirty, METER recommends replacing it with a new screen. Contact Customer Support for a replacement Teflon screen.

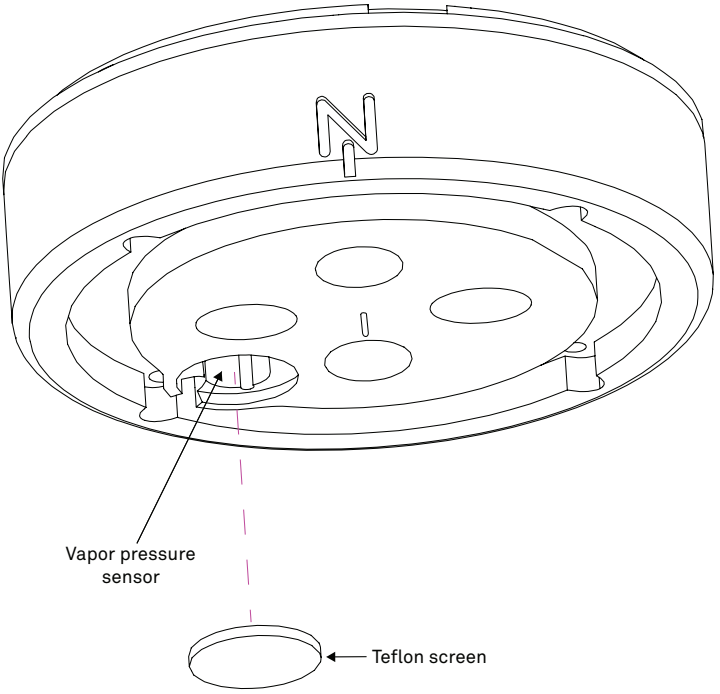


Figure 40 Teflon screen

4. Clean the tipping spoon, precipitation basin, and EC sensor.
   a. Remove the rain funnel (Section 3.2.2.1).
   b. Detach the rain funnel (Section 3.2.2.2).
   c. Locate the tipping spoon, precipitation basin, and EC Sensor (Figure 41).

   NOTE: Do not touch the screws without gloved hands and never contact the sensors with any source of oil or other nonconducting residue.

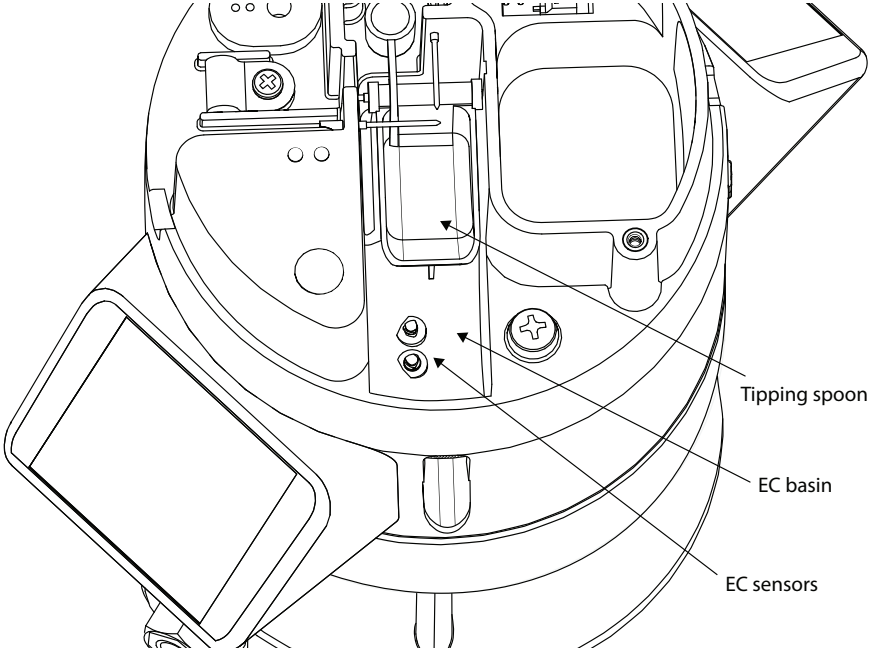


Figure 41 EC basin and EC sensor

d. Gently clean out all residue from the tipping spoon with a cleaning swab. Water or a mild detergent may be used if needed.

   NOTE: Residue left in the tipping spoon can cause error with the tipping spoon calibration. The tipping spoon should be cleaned periodically as needed.

e. Clean out any residue in the basin including the back of the downspout screen.

f. Clean the screws using a mild detergent such as liquid dish soap and a nonabrasive sponge or cloth.

   NOTE: Avoid detergents that contain lotions or moisturizers.

g. Rinse the sensor and screws thoroughly with tap of deionized water.

h. Reattach the rain funnel (Section 3.2.2.3)

Contact Customer Support for a replacement Teflon screen.

⚠ CAUTION

DO NOT immerse the sensor in water. Water may corrode and ruin metal parts inside the sensors.

DO NOT touch the temperature sensor needle (Figure 20).

DO NOT paint the body or any part of the ATMOS 41W.

The temperature sensor needle lead wires are very delicate and can be easily damaged.

Avoid more than light pressure while cleaning the tipping spoon (Figure 41 EC basin and EC sensor on page 65) and the sonic transducers (Figure 30)

Be sure the instrument is level after cleaning

The ATMOS 41W may be returned to METER for maintenance (inspect system or replace old or damaged parts). Select replacement parts (e.g., RH sensor, rain funnel, leveling plate) can also be ordered from METER. Contact Customer Support for more information. ZENTRA Utility mobile makes it easy to send feedback, bug reports, and feature requests to METER (Section 4.1).

The ATMOS 41W requires little maintenance when installed correctly. Be sure to check the ATMOS 41W and sensor data periodically:

- Replace batteries as needed (Section 3.2.14).

  NOTE: Do no mix NiMH and alkaline batteries together. Do not mix new and old batteries together.

- Inspect the battery holders to ensure they are clean and free of corrosion.

  NOTE: Never immerse the ATMOS 41W in liquids or bury the ATMOS 41W. This and other misuse, improper protection, or improper installation may damage the ATMOS 41W and void the manufacturer's warranty.

NiMH batteries should last for several years if they are charging properly. Over a long period of time, NiMH batteries will begin to lose their charge capacity. If dark periods lasting months cause the batteries to discharge too low, it is time to replace the NiMH batteries. When replacing NiMH batteries, use high-quality batteries advertising higher charge capacity. New NiMH batteries may also be purchased from METER. Contact Customer Support to discuss concerns or recommendations.

Alkaline batteries should be replaced when the battery charge nears 0%. Replace batteries with high-quality alkaline batteries. A low-quality battery may not provide the desired battery life for the ATMOS 41W.

NOTE: Installing or replacing the batteries in the ATMOS 41W resets the internal real-time clock. The ATMOS 41W requires a time sync to accurately save a time and date stamp with each sensor measurement record. The ATMOS 41W time can be set from ZENTRA Utility Mobile, the on-board GPS receiver, and the cellular or Wi-Fi network. Press the TEST button after changing the batteries to enable the GPS receiver to acquire a new time and position fix.

5.5 UPDATE FIRMWARE

METER will occasionally release firmware updates that improve ATMOS 41W performance. Updates will be available using ZENTRA Utility Mobile. Please consult with Customer Support about any questions about the necessity or process of updating firmware on ATMOS 41W.

5.6 TROUBLESHOOTING

Although the ATMOS 41W is designed for durability and built to the highest manufacturing standards, problems may occasionally occur. This troubleshooting section details the major problems and their solutions (Table 7). If the problem is not listed or these solutions do not solve the issue, contact Customer Support.

Table 7 Troubleshooting the ATMOS 41W

Problem	Possible Solutions
ATMOS 41W not responding	Press the **TEST** button (Section 3.2.15) on to reset the ATMOS 41W. Check device batteries. Replace alkaline batteries if close to 0%. Recharge NiMH batteries if close to 0%. Check for corrosion or water damage. Check that the seals and gaskets are intact. If the problem persists, contact Customer Support.
Water not flowing through rain gauge	Check spring, downspout screen, and the outflow to ensure there is no lodged debris. If bird droppings are an issue a bird deterrent Kit made for the ATMOS 41W can be added to the unit. Please contact Customer Support for more information.
No wind speed	Check the anemometer pathway to make sure there is no debris blocking the path of the sonic transducer measurement (between transducers and convex base plate). Check the sonic transducers for water build-up; if there is moisture, take a dry cloth and dab it away. Check to see that the convex base plate (Figure 22) is not dirty. Clean by flushing with water and dry with a dry cloth (Section 5.4). Be sure the ATMOS 41W is level.

Table 7 Troubleshooting the ATMOS 41W (continued)

Problem	Possible Solutions
Not reading any precipitation or not measuring precipitation accurately	Remove any debris from the rain funnel. The ATMOS 41W must be within approximately ±2 degrees of dead level (0, 0) in both the X and Y directions to accurately measure rainfall. If not within this range, drops from the flared hole can miss the gold electrodes entirely. Use the internal level measurements that are available in the ATMOS 41W data stream to confirm that the ATMOS 41W is level. Gently twist the rain funnel and remove (Section 3.2.2.1 and Section 3.2.2.2). **NOTE: BE CAREFUL TO UNPLUG THE PYRANOMETER CONNECTOR INSIDE THE FUNNEL BEFORE DETACHING THE FUNNEL COMPLETELY.** Check to make sure that there are no obvious problems and that the gold electrodes are aligned correctly (Figure 18). Check the tipping spoon is free of debris and swings easily under light pressure (Figure 14). The accuracy of the rain gauge measurement can be checked using the procedure described in How to check the drip counter calibration (https://meter.ly/41w-drip-count).
Sensor measurement data does not seem to be correct	Check that measurement unit options are looking at the desired unit type (example %RH vs Vapor Pressure). Contact Customer Support.
Sensor data shows No response in the Scan window or Downloaded data shows #N/A	The raw data measured by the sensor is out of expected range for the sensor. This could be caused by a damaged sensor. If the problem persists, contact Customer Support.
ZENTRA Utility Mobile cannot connect to the device or ATMOS 41W unit not showing in the connect list	Force Close the app and relaunch. Ensure location service is turned on when using a smart device. Ensure the ATMOS 41W has good batteries. Press the TEST button to reset it. Connect to a second Bluetooth device. If the connection works, the problem is likely with the first device.

Table 7 Troubleshooting the ATMOS 41W (continued)

Problem	Possible Solutions
ZENTRA Utility Mobile reports it lost the connection	Force Close the app and relaunch. Snsure location service is turned on when using a smart device. Ensure the ATMOS 41W has good batteries. Press the **TEST** button to reset it. Connect to a second Bluetooth device. If the connection works, the problem is likely with the first device.
ZENTRA Utility Mobile states there is no new data for downloading **or** **Sensor stopped making measurements**	Wait for at least the length of the measurement interval to ensure the instrument had enough time to record data. Ensure the instrument is configured to measure data, i.e., make sure the measurement interval is not set to Off (not logging). Check the battery. The ATMOS 41W will stop making sensor measurements when the batteries are extremely low. Press the TEST button to reset the instrument and try to reconnect after the status lights settle on slow green blinking.
Can data be removed manually and/or physically from the ATMOS 41W?	Contact Customer Support
No pyranometer reading	Carefully remove the funnel Section 3.2.2.1 and Section 3.2.2.2. **NOTE: BE CAREFUL TO UNPLUG THE PYRANOMETER CONNECTOR INSIDE THE FUNNEL BEFORE DETACHING THE FUNNEL.** Make sure the pyranometer plug (Section 3.2.2.3) is plugged in. If the pyranometer connection is accidentally damaged, contact Customer Support.
Red ERROR light and/or green OK light are always on	Check instrument batteries. Press the TEST button to reset the ATMOS 41W. If the problem persists, contact Customer Support.
Red ERROR light is on after pressing the TEST button	See Section 3.2.16 for information on the **TEST** button results and how to further troubleshoot.

Table 7 Troubleshooting the ATMOS 41W (continued)

Problem	Possible Solutions
Cellular uploads stopped working	Press the TEST button to initiate connection with the ATMOS 41W. Run the Cellular Communication Test in ZENTRA Utility Mobile by selecting the **Test** button to determine if there is a communication error. Check the **List Cellular Carriers** function in ZENTRA Utility Mobile to confirm there are cellular carriers operating in the area. To access navigate to "**...**" for **More.** Next select **Device Tools** and from that menu select **List Cellular Carriers**. If the problem persists, contact Customer Support.
ZENTRA Utility Mobile is not listing a desired Wi-Fi network even though the Wi-Fi network is showing on device running ZENTRA Utility Mobile	The Wi-Fi hardware in the ATMOS 41W is compatible with Wi-Fi networks using the 2.4 GHz bands. ATMOS 41W doesn't work with networks using 5 GHz bands. The Wi-Fi radio connection between the ATMOS 41W and the access point maybe too weak. The ATMOS 41W is only able to report information for up to 12 Wi-Fi networks during a scan. Try refreshing the scan. Alternatively use the process for connecting to a hidden network (Section 3.3.5) to configure the ZL6 to your network. The access point is using Wi-Fi channel 12 or 13 in a location where the Wi-Fi hardware determines these channels are unavailable. Change the access point to use a channel number in the range 1 to 11.
The Wi-Fi network at a university/government agency does not seem to be working with the ATMOS 41W	Wi-Fi networks using enterprise security can offer additional challenges for devices like the ATMOS 41W. Consider asking your IT professional to deploy a Wi-Fi access point for the ATMOS 41W that uses a compatible form of network security. Contact customer support or METER sales partner to discuss alternative ways for your ATMOS 41W to upload data to ZENTRA Cloud.
ATMOS 41W uploads to ZENTRA Cloud appears to have stopped working	Try rebooting the Wi-Fi access point/router. ATMOS 41W caches all unsent data to send when the connection is restored. Use the upload test (Section 3.3.1) to evaluate the connection to the Wi-Fi Access Point and ZENTRA Cloud. Use ZENTRA Utility Mobile to re-configure the ATMOS 41W for your network. This step is necessary if the name of your Wi-Fi network changed or if the network passphrase changed.
ATMOS 41W won't commincate directly with user over Wi-Fi	The ATMOS 41W is not available on the Wi-Fi network for interactive communications. The ATMOS 41W only powers the Wi-Fi module long enough to send sensor measurement data and status updates to ZENTRA Cloud after each measurement interval.

5.7 CUSTOMER SUPPORT

NORTH AMERICA

Customer service representatives are available for questions, problems, or feedback Monday through Friday, 7:00 am to 5:00 pm Pacific time.

Email: support.environment@metergroup.com
sales.environment@metergroup.com

Phone: +1.509.332.5600

Fax: +1.509.332.5158

Website: metergroup.com

EUROPE

Customer service representatives are available for questions, problems, or feedback Monday through Friday, 8:00 to 17:00 Central European time.

Email: support.europe@metergroup.com
sales.europe@metergroup.com

Phone: +49 89 12 66 52 0

Fax: +49 89 12 66 52 20

Website: metergroup.com

If contacting METER by email, please include the following information:

Name	Email address
Address	Instrument serial number
Phone	Description of the problem

NOTE: For products purchased through a distributor, please contact the distributor directly for assistance.

5.8 TERMS AND CONDITIONS

By using METER instruments and documentation, you agree to abide by the METER Group, Inc. Terms and Conditions. Please refer to metergroup.com/terms-conditions for details.

APPENDIX A. COMPLIANCE CERTIFICATIONS

This appendix contains compliance statements that apply to the ATMOS 41W.

A.1 USA

This device complies with Part 15 of the FCC Rules. Operation is subject to the following conditions:

1. This device may not cause harmful interference.
2. This device must accept any interference received, including interference that may cause undesired operation.

The ATMOS 41W contains one or more of the following radio modules, listed by their FCC identification numbers:

SH6MDBT40	All ATMOS 41W series (Bluetooth module)
XPYLISAU201 or XPYLISAU200	ATMOS 41W with 3G UMTS cellular module
XPY2AGQN4NNN	ATMOS 41W with 4G LTE-M cellular module
XPYUBX21BE01	ATMOS 41W with 4G LTE Cat 1 cellular module
XPYNINAW1	ATMOS 41W with Wi-Fi module

Changes or modifications to the ATMOS 41W or antenna not expressly approved by METER Group, Inc. could void FCC compliance and thus the user's authority to operate the equipment.

A.2 CANADA

Industry Canada (IC) Notices

This Class B digital apparatus complies with Canadian CAN
\CES-3(B) / NMB-3(B) and RSS-210. Operation is subject to the following two conditions:

- this device may not cause interference
- this device must accept any interference, including interference that may cause undesired operation of the device

The ATMOS 41W contains one or more of the following radio modules, listed by their IC identification numbers:

8017A-MDBT40	All ATMOS 41W series (Bluetooth module)
8595A-LISAU201 or 8595A-LISAU200N	ATMOS 41W with 3G UMTS cellular module
8595A-2AGQN4NNN	ATMOS 41W with 4G LTE-M cellular module
8595A-UBX21BE01	ATMOS 41W with 4G LTE Cat 1 cellular module
8595A-NINAW13	ATMOS 41W with Wi-Fi module

Radio Frequency (RF) Exposure Information

This device has been evaluated and shown compliant with the IC RF Exposure limits under mobile exposure conditions (antennas are greater than 20cm from a person's body).

Avis d'Industrie Canada (IC)

Cet appareil numérique de classe B est conforme aux normes canadiennes CAN ICES-3(B) / NMB- 3(B) et RSS-210.

Son fonctionnement est soumis aux deux conditions suivantes:

- cet appareil ne doit pas causer d'interférence
- cet appareil doit accepter toute interférence, notamment les interférences qui peuvent affecter son fonctionnement

Informations concernant l'exposition aux fréquences radio (RF)

Ce périphérique a été évalué et démontré conforme aux limites d'exposition aux fréquences radio (RF) d'IC lorsqu'il est installé dans des produits hôtes particuliers qui fonctionnent dans des conditions d'exposition à des appareils mobiles (les antennes se situent à plus de 20 centimètres du corps d'une personne).

Changes or modifications to the ATMOS 41W or antenna not expressly approved by METER Group, Inc. could void Industry Canada (IC) compliance and thus the user's authority to operate the equipment.

A.3 EUROPEAN UNION

R&TTED and European Conformance CE mark

Radiofrequency radiation exposure Information: this equipment complies with radiation exposure limits prescribed for an uncontrolled environment for fixed and mobile use conditions. This equipment should be installed and operated with a minimum distance of 20 cm between the radiator and the body of the user or nearby persons. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter except as authorized in the certification of the product.

A full CE declaration of conformity for the ATMOS 41W is available on request from METER Group.

A.4 JAPAN

TELEC (Japan)

The ATMOS 41W contains one or more of the following radio modules that are TELEC/JATE certified.

All ATMOS 41W series (Bluetooth module)

- Technical Requirements certified type number: 201-160496

ATMOS 41W with TELEC-approved 3G UMTS cellular module

- Technical Conditions certified type number: AD120274003
- Technical Requirements certified type number: 003-120375

ATMOS 41W with 4G LTE-M cellular module

- Technical Conditions certified type numbers: D180083003
- Technical Requirements certified type number: 003-180155

ATMOS 41W with 4G LTE Cat 1 cellular module

- Technical Conditions certified type numbers: D220006003
- Technical Requirements certified type number: 003-220017

ATMOS 41W with Wi-Fi module

- Technical Requirements certified type number: 204-810001

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