USER GUIDE

Internet of Things

Aspen™10

With CampbellCloud Connectivity

Revision: 05/2024

RELIABLE MONITORING SINCE 1974

Campbell SCIENTIFIC®

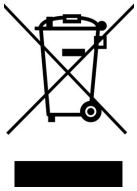
Please read first

About this manual

Please note that this manual was produced by Campbell Scientific Inc. primarily for the North American market. Some spellings, weights and measures may reflect this. In addition, while most of the information in the manual is correct for all countries, certain information is specific to the North American market and so may not be applicable to European users. Differences include the U.S. standard external power supply details where some information (for example the AC transformer input voltage) will not be applicable for British/European use. Please note, however, *that when a power supply adapter is ordered from Campbell Scientific it will be suitable for use in your country*.

Reference to some radio transmitters, digital cell phones and aerials (antennas) may also not be applicable according to your locality. Some brackets, shields and enclosure options, including wiring, are not sold as standard items in the European market; in some cases alternatives are offered.

Recycling information for countries subject to WEEE regulations 2012/19/EU



At the end of this product's life it should not be put in commercial or domestic refuse but sent for recycling. Any batteries contained within the product or used during the products life should be removed from the product and also be sent to an appropriate recycling facility, per The Waste Electrical and Electronic Equipment (WEEE) Regulations 2012/19/EU. Campbell Scientific can advise on the recycling of the equipment and in some cases arrange collection and the correct disposal of it, although charges may apply for some items or territories. For further support, please contact Campbell Scientific, or your local agent.

Table of Contents

1. Introduction

The Aspen™10 Internet of Things (IoT) edge device allows users to easily connect their environmental sensor to ***CampbellCloud™*** (***Cloud***). It is rugged and durable and may be mounted outdoors without the need for a second enclosure. It has an integrated solar panel and internal rechargeable battery, making the Aspen 10 a truly self-sustaining device.

The Aspen 10 is also small and compact, which makes it easy to install in a variety of locations without disturbing the environment it is monitoring. An integrated IoT cellular modem allows the Aspen 10 to transmit data to the cloud, and a global positioning system (GPS) receiver provides automated installation location. A free app, ***CampbellGo™*** (***Go***), enables secure NFC/Bluetooth pairing between a phone and the Aspen 10. This ensures end to end functionality before leaving the installation site.

Throughout this manual, reference to the Aspen 10 also applies to the Aspen 10-XT, unless specifically noted.

2. Precautions

READ AND UNDERSTAND the Safety section at the back of this manual.

An authorized technician shall verify that the installation and use of this product is in accordance to the manufacturer's instructions, recommendations and intended use.

Although the Aspen 10 is rugged, it should be handled as a precision scientific instrument.

There are no user serviceable parts. Changes or modifications to this device not expressly approved by Campbell Scientific may result in damaged equipment or loss of data.

The Aspen 10 has not been approved to be operated in hazardous locations as defined by the National Fire Protection Association (NFPA) 70®, National Electric Code® (NEC).

Maintain a level of calibration appropriate to the application. Campbell Scientific recommends factory recalibration every three years.

Table 2-1: Symbols used on the Aspen 10	
Symbol	Description
⏚	Earth (ground) terminal
⚠	Caution, see Install Aspen 10 (p. 7), Aspen 10 specifications (p. 37) and Safety.

3. Getting started

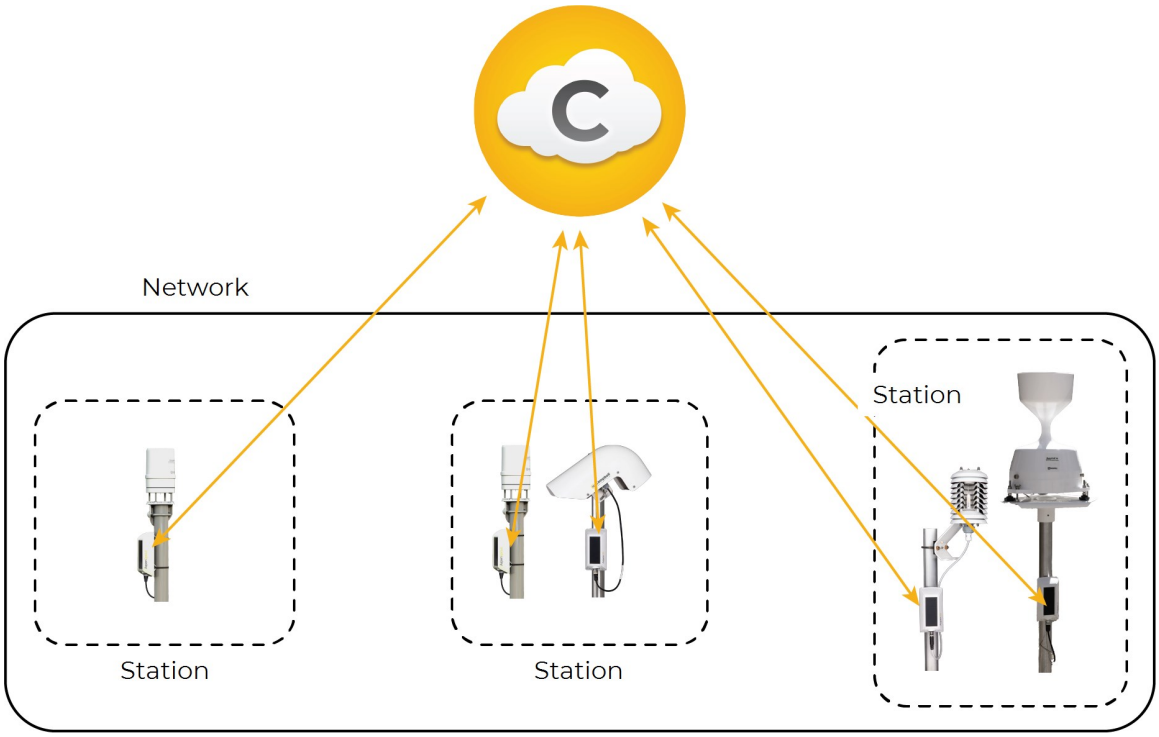
Getting started provides an overview of how to get data from your Aspen 10™ to ***CampbellCloud***.

See instructional videos at: https://www.campbellsci.com/aspen10#videosandtutorials_.

This exercise guides you through the following steps:

- In the office:
  - Setting up a ***CampbellCloud*** organization account
  - Downloading the ***CampbellGo*** app to your smartphone
- In the field:
  - Installing the Aspen 10 with your sensor
  - Setting up ***CampbellGo***
  - Adding the Aspen 10 as an asset
  - Creating a station in the default network
  - Using ***Go*** to view real time data

The following figure shows a network consisting of three stations. Each station has one or more assets associated with it.



4. *CampbellCloud*

The Aspen 10 is set up to automatically send data to ***CampbellCloud***.

To ensure your data is accessible and organized, you will need to join or create an organization account in ***CampbellCloud*** before installing the Aspen 10 in the field.

> NOTE:
> In this context, an organization is an individual, business, or organization that uses ***CampbellCloud*** services to manage a network of stations.

Every ***CampbellCloud*** user must be associated with an organization, either as the account owner or as a user.

If you are **not** the account owner but need to join the account as a user, you should receive an invitation email from **hello@campbell-cloud.com** with instructions to join as a user. For directions on joining an existing organization account, proceed to Join a CampbellCloud organization account (p. 5).

NOTE:
The organization account owner will be responsible for providing the subscription-management billing information.

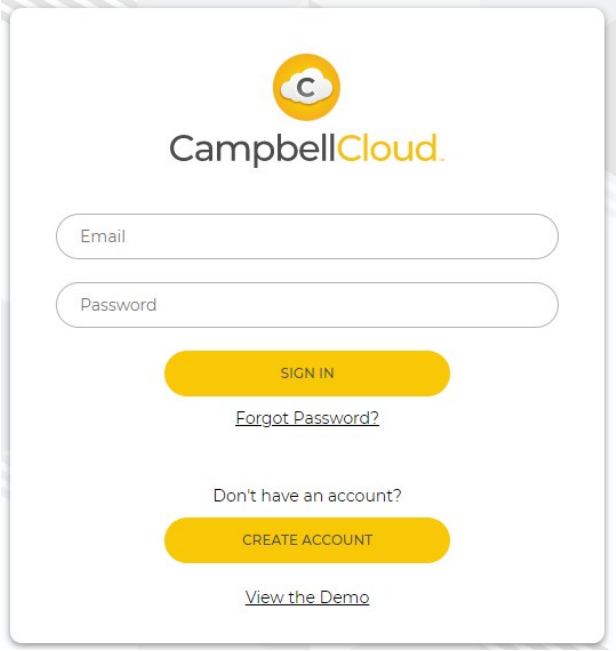
CAUTION:
If you or your organization already has a ***CampbellCloud*** organization account do not create another one.

4.1 Create a *CampbellCloud* organization account

If you or your organization already has a ***CampbellCloud*** organization account do not create another one. Individuals on one account cannot view data from separate accounts.

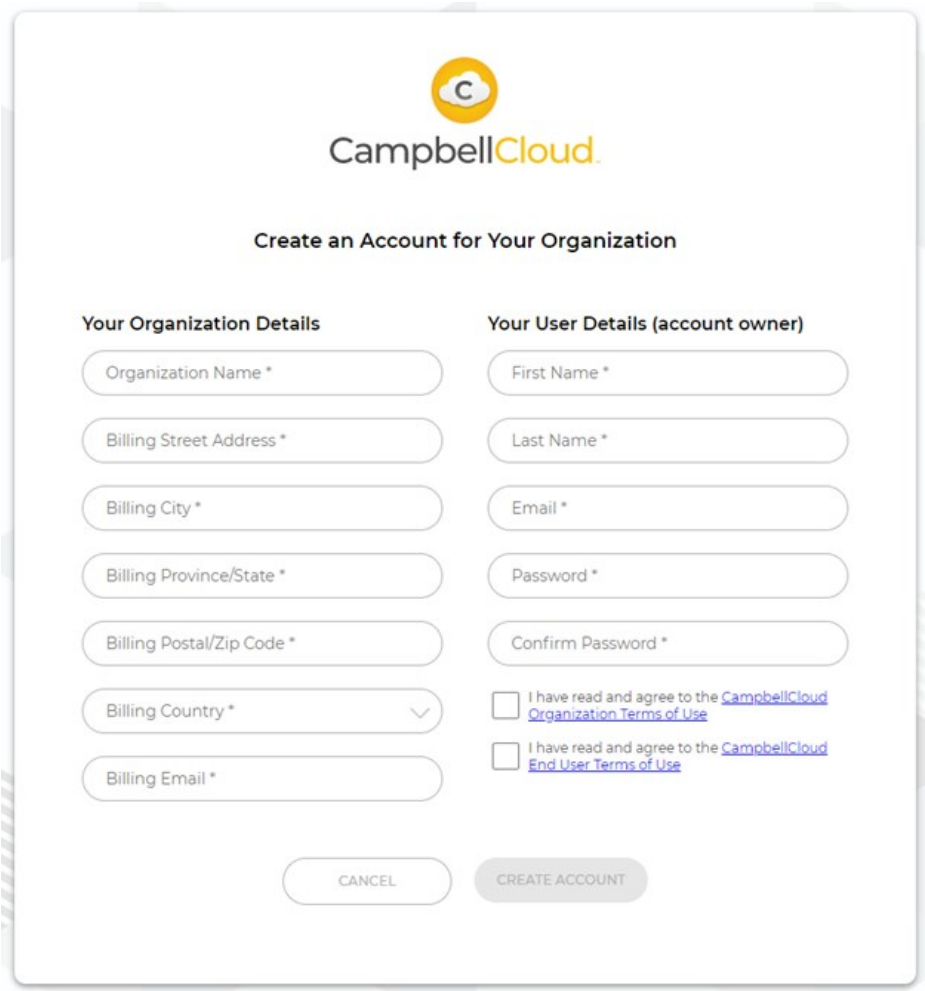
If you are the organization administrator, follow these steps to create an organization account, which will also be your user account:

1. Using a web browser go to https://iot.campbell-cloud.com.
2. Click **REGISTER**.
3. Click **CREATE ACCOUNT**.



4. If you are the person who will be responsible for the organization account click **CONTINUE TO SIGN UP**.

5. Fill out the form.



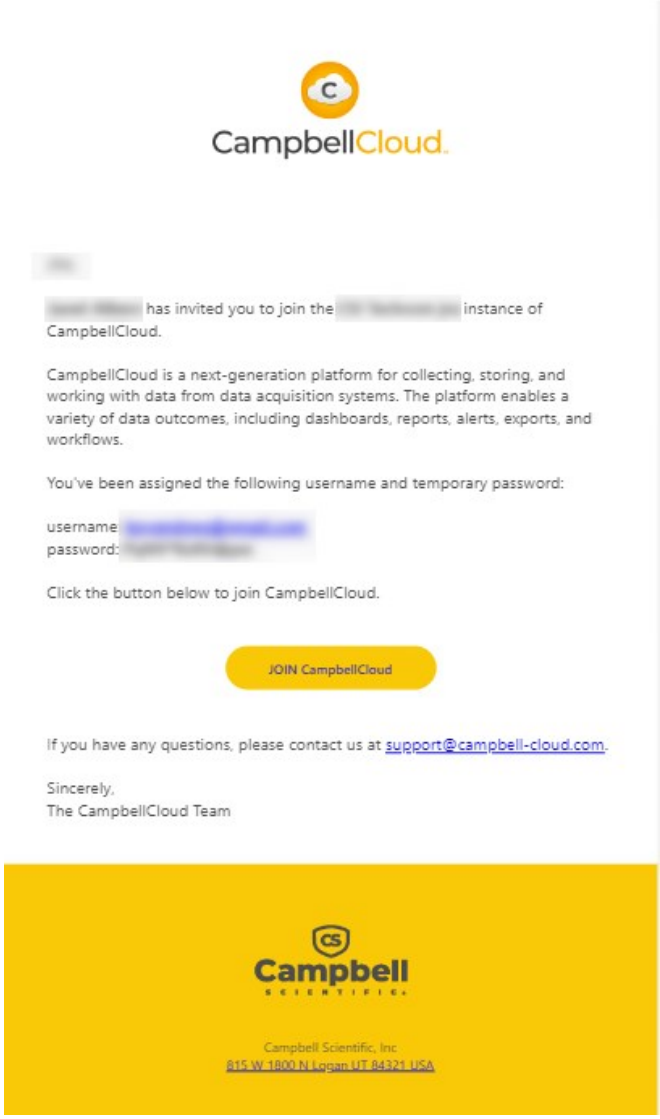
6. Read and select the check box for each agreement.
7. Click **CREATE ACCOUNT**.
8. You should receive an email confirmation from `hello@campbell-cloud.com`.
9. Click **Verify your email**. A new browser tab will open.
10. Click **SIGN IN** and proceed to *CampbellCloud*.

4.2 Join a *CampbellCloud* organization account

Every user must be associated with an organization. Your organization administrator will invite you to be a member. Shortly thereafter you will receive an email from `hello@campbell-cloud.com`.

> **NOTE:**
> Organization administrators are automatically set up as users. If you are the administrator proceed to Install Aspen 10 (p. 7).

The email you receive should look similar to the following:



CampbellCloud.

[redacted] has invited you to join the [redacted] instance of CampbellCloud.

CampbellCloud is a next-generation platform for collecting, storing, and working with data from data acquisition systems. The platform enables a variety of data outcomes, including dashboards, reports, alerts, exports, and workflows.

You've been assigned the following username and temporary password:

username: [redacted]
password: [redacted]

Click the button below to join CampbellCloud.

JOIN CampbellCloud

If you have any questions, please contact us at support@campbell-cloud.com.

Sincerely,
The CampbellCloud Team

Campbell
SCIENTIFIC

Campbell Scientific, Inc
815 W 1800 N Logan UT 84321 USA

Click the button to **JOIN CampbellCloud**.

Your organization administrator assigned you to one or more security groups. Each security group has a defined set of permissions. Contact your organization administrator for more information.

4.3 API

CampbellCloud can be accessed through API calls. For more information see: https://campbell-cloud.com/api/v1/docs/.

> TIP:
> The API can be used to integrate ***Cloud*** with an existing external software system, and will require the skills of a developer familiar with API integration.

5. Install Aspen 10

The Aspen 10 is weatherproof and requires no additional enclosure. When installing the integrated solar panel, ensure it is positioned in an area receiving a minimum of four hours of sunlight daily. Orient the Aspen 10 solar panel towards the equator or in the most optimal direction for solar exposure. See Figure 5-1 (p. 8) for the recommended orientation based on latitude. Check for any obstructions such as trees that may block sunlight to the horizon. Tilt spacers of 10° and 45° are available to optimize the solar panel angle for specific installations.

If there are obstructions to the rising or setting sun and you need to rely on the sun at its azimuth for solar charging, we recommend using the 45° mounting accessory and orient the solar panel toward the equator.

See https://www.campbellsci.com/videos/cloud16 for an installation demonstration.

Figure 5-1. Recommended solar panel orientation

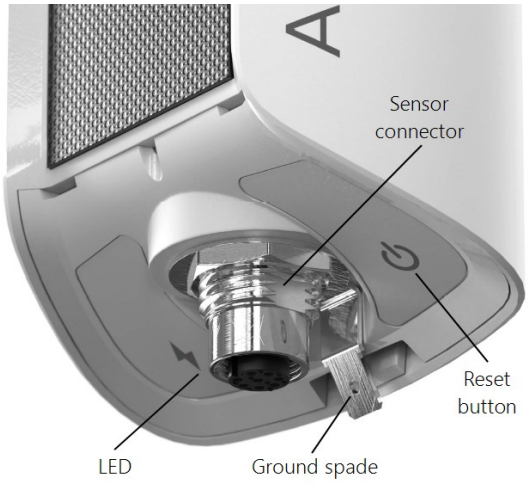
The following image shows a typical installation of an Aspen 10 with a RainVue sensor.

5.1 Mounting

1. If needed, install the 10° or 45° tilt spacer, see Figure 5-1 (p. 8).

2. Use simple cable ties (included) to mount the Aspen 10 to a vertical post.

3. Connect the sensor to the Aspen 10. Hand tighten the connectors.



An AQ-cable allows automatic identification of any sensor with an SDI-12 identification. See the following table, or the sensor ordering details, for whether an AQ-conversion cable is

required. Additionally, use an AQ-extension extension cable if the Aspen 10 cannot be collocated with the sensor.

> **CAUTION:**
> Hand tighten only! Using tools to tighten the connectors can permanently weld the stainless steel connectors together.

Table 5-1: Connector cables

Sensor	Connect directly	Use AQ-conversion cable
ClimaVue 50		✓
CS320		✓
CS451	A151 termination box required https://www.campbellsci.com/a151	
HygroVue 10		✓
RainVue 10		✓
RainVue 20		✓
SnowVue 10		✓
SoilVue 10		✓
TempVue 20	✓	
Wintersense SDI-12	✓	

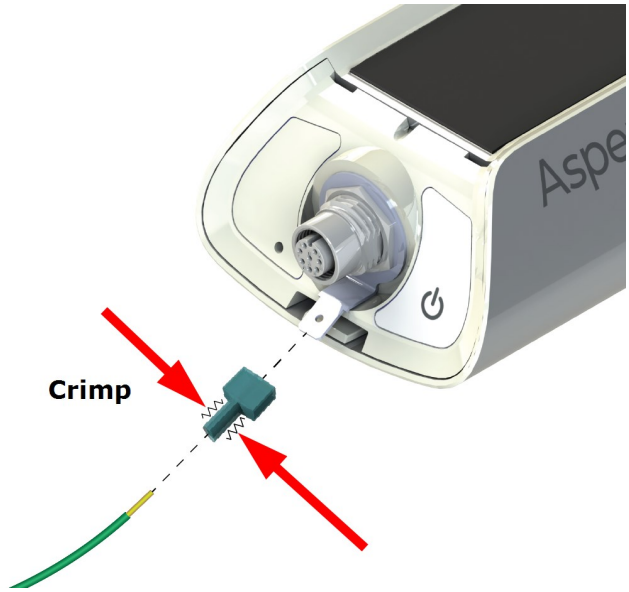
4. The LED will flash red and blue indicating the Aspen 10 is turning on, reading the sensor identification and obtaining a recipe (program and settings). See LED indicator (p. 18) and Recipes (p. 23) for more information.

> **WARNING:**
> The Aspen 10 sensor connector is for Campbell Scientific approved sensors and cable only. The connector is rated for 12 VDC@ 210 mA max. Cable is rated for 30 VDC. Connections to an unsuitable sensor, cable, or device may result in damaged equipment or loss of data. Go to www.campbellsci.com for a list of compatible sensors and cables.

5.2 Grounding

Earth grounding is recommended when sensors are installed at distances greater than 10 meters (33 feet) from the Aspen 10. This helps to stabilize the ground potential of the Aspen 10 and divert electrical transients away from its electronics. For this purpose, Campbell Scientific recommends using 14 AWG wire.

Install a ground rod near the Aspen 10. If there is a hard-pan layer that cannot be penetrated, insert the rod at an angle. Attach one end of the ground wire to the insulated push-on ground terminal by crimping it, and then slide it onto the ground spade. Secure the other end of the ground wire to the ground rod.



> DANGER:
> Contact local utilities for the location of buried utility lines before digging or driving ground rods.

Ensure all local electrical codes are followed by having electrical equipment and grounding installed by a licensed electrician.

6. *CampbellGo*

CampbellGo enables secure NFC/Bluetooth pairing between a smartphone and the Aspen 10. The Go app simplifies the installation process with real-time sensor readings, diagnostic tools, and data-to-cloud delivery information while you are on-site.

If prompted by your phone, allow Bluetooth communications.

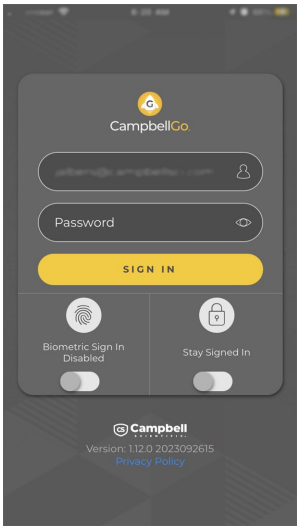
6.1 Install app

Install the *CampbellGo* app on the smartphone you will use for field work. The app is free and available through the Apple App Store or Google Play Store.

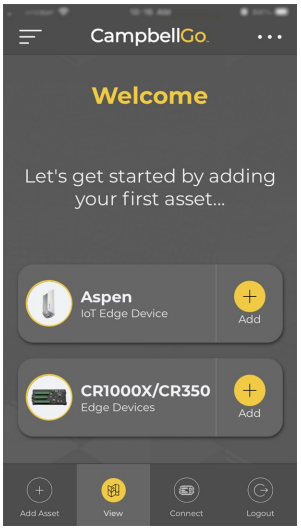
6.2 Create an asset

An asset is a device, data source, or other equipment associated with a station in *CampbellCloud*. The Aspen 10 is an asset. A station may contain one or many assets.

1. Open *CampbellGo* on your phone.
2. Enter your *CampbellCloud* user name and password.
3. Tap **SIGN IN**.

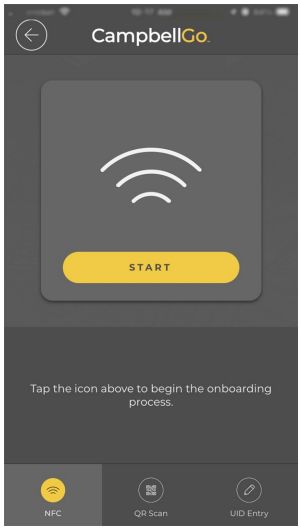


4. Because you have not yet added an asset, *Go* prompts you to add one. Tap **Add** Aspen 10.



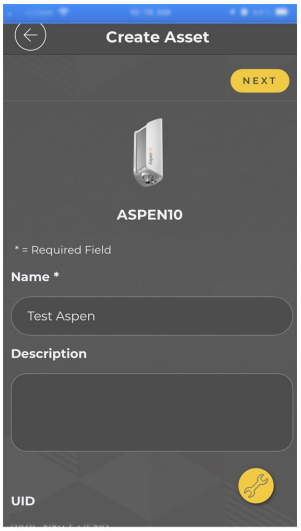
5. There are three ways to onboard the Aspen 10 asset: NFC, QR Scan, and UID Entry. **NFC** and **QR Scan** require use of a smartphone with those capabilities. For **UID Entry**, you will need the device UID that is printed below the QR code on the back of the Aspen 10.

6. If it is not already selected, tap **NFC** then **START**. The procedures for **QR Scan** and **UID Entry** are similar.

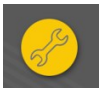


7. Hold your phone close to the NFC tap icon))) on the side of the Aspen 10 until it vibrates and connects.

8. Go will identify the asset. Then enter a **Name**, (optional) **Description**, and (optional) labels.

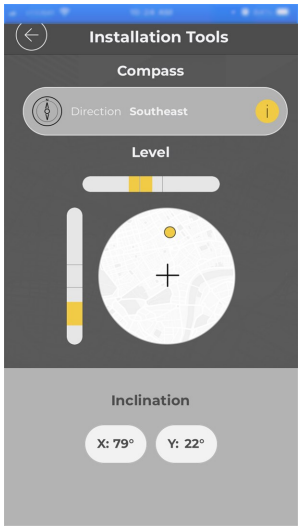


9. Tap **NEXT**.
10. This is a good time to check the orientation and angle of your installed Aspen 10. Tap the Installation Tool icon at the bottom right corner of the screen.



11. Hold your smartphone to the Aspen 10 solar panel.

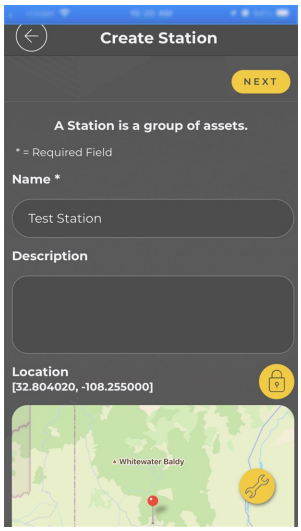
12. Adjust the installation direction and angle. See Recommended solar panel orientation (p. 8).



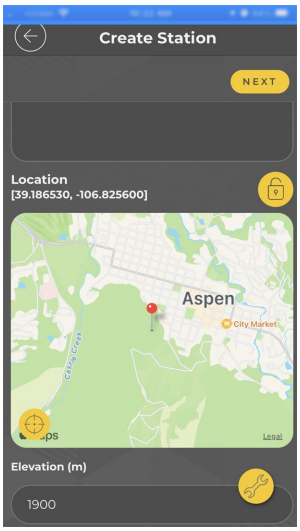
6.3 Create a station

A station is a location configured to manage assets and record measurements. A network may contain one or many stations.

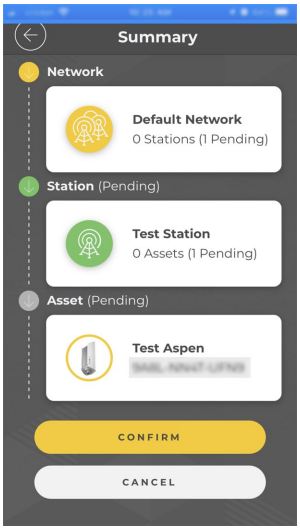
1. After creating an asset you are prompted to create a station. Enter a **Name**, (optional) **Description**, and other (optional) information.



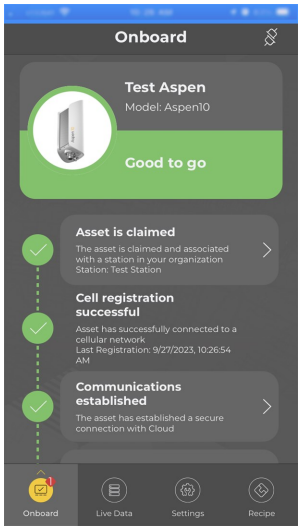
2. (Optional) Enter the station location. Tap the lock/unlock button. In the unlocked position you can tap the location on the map. Tap the lock/unlock button again to save the station location. Enter its elevation in meters.



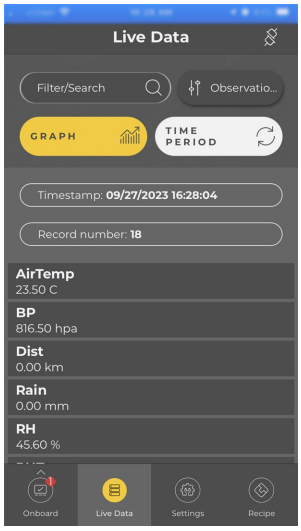
3. Tap **NEXT**.
4. Review the summary screen. Click **CONFIRM**.



5. You will see the progress of your device communicating with *Cloud*. This could take several minutes to complete.

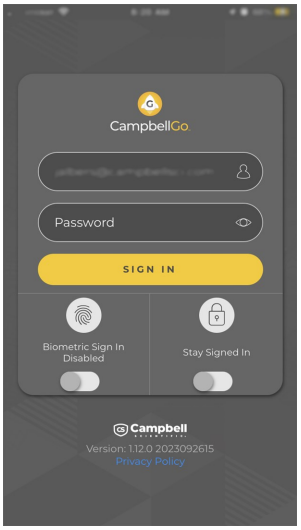


6. Once the process is complete you can view **Live Data** and other features through Go.



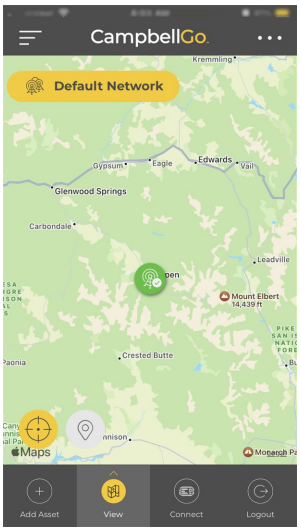
7. Field use

1. Open *CampbellGo* on your phone.
2. Enter your *CampbellCloud* user name and password.
3. Tap **SIGN IN**.

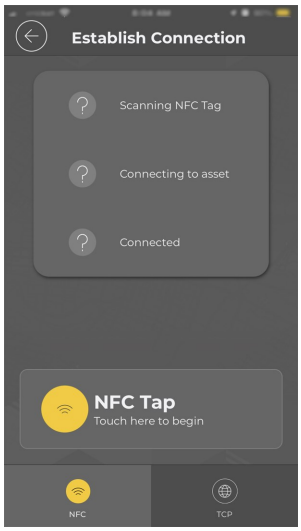


4. Tap **Connect**.

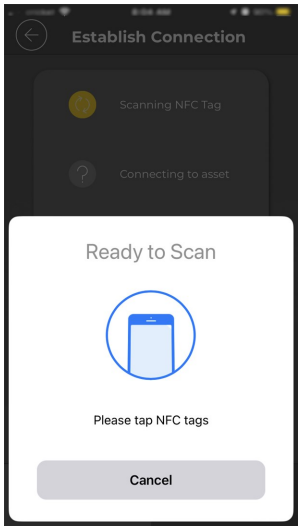
> **NOTE:**
> Your home screen may be different.
> This is a User setting in *CampbellCloud*.



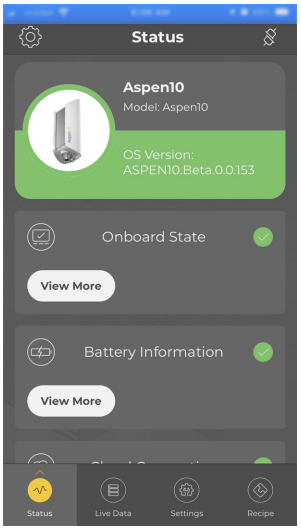
5. Tap **NFC Tap.**



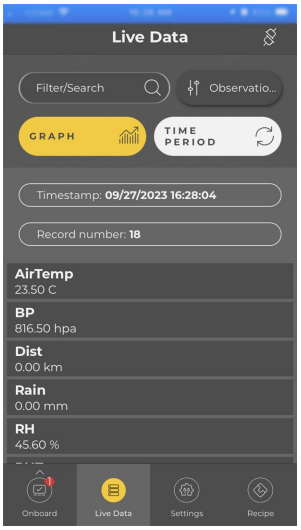
6. Hold your phone close to the NFC tap icon))) on the side of the Aspen 10 until it vibrates and connects.



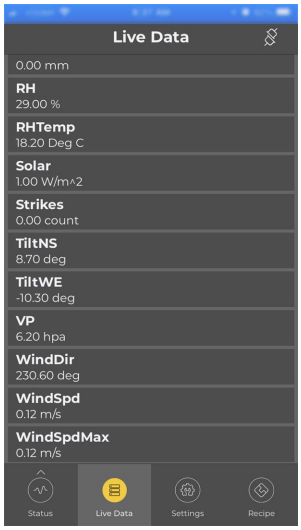
7. Important information on the health of your Aspen 10 is shown on the Status screen. Swipe up to see all fields



8. Select **Live Data**.



9. Swipe up to see all fields.



10. Tap the connection icon to disconnect from the Aspen 10 and return to your home screen.

11. Check the LED. It should periodically flash red and blue for the next ten minutes then turn off. See LED indicator (p. 18) for more information.

8. Observation mode

For efficient field work, observation mode enables an on-site technician to quickly view measurements and upload data to *Cloud* at accelerated rates. Activate observation mode by either using **NFC Connect** in *CampbellGo* for a direct connection to an Aspen 10, or by pressing the **Power** button on the Aspen 10. Upon entering observation mode, the following things occur:

- The Aspen 10 wakes from its low-power mode.
- The internal cellular modem turns on and makes a connection to a cellular network.
- If a recipe is needed it is retrieved from *Cloud*.
- Measurements are taken at a faster rate. See Recipes (p. 23) for sensor specific information.
- Data is stored to the **Observations** table and published to *Cloud*.

Observation mode is automatically exited by closing the *Go* direct connection or after about ten minutes of inactivity.

9. LED indicator

The LED indicator is activated for approximately 10 minutes after the **Power** button is pressed or a direct connection has ended.

For more information on LED behavior, watch a video at: https://www.campbellsci.com/videos/cloud17.

The red LED will turn on according to power and recipe states.

Table 9-1: Red LED activity

State	Description
Off	Aspen 10 running in low-power mode
Off (immediately after **Power** button is pressed or a direct connection attempted)	No power, no recipe running.
One flash every 10 seconds	Powered from internal battery, recipe running

Table 9-1: Red LED activity	
State	Description
Two flashes every 10 seconds	Powered from internal battery with solar recharge active, recipe running
Rapid flashing	Sensor detected, followed by always on while retrieving recipe
Always on	Powered, no recipe running. See Recipes (p. 23).

The blue LED will turn on according to cellular modem communications states.

Table 9-2: Blue LED activity	
State	Description
Off	Aspen 10 running in low-power mode
Off (immediately after **Power** button is pressed or a direct connection attempted)	Cellular modem off, insufficient power, or failure to establish a connection with the provider (periodic retries will occur)
One flash every 10 seconds	Modem actively connected to ***CampbellCloud***
Two flashes every 10 seconds	Modem attempting to establish connection with cellular provider
Three flashes every 10 seconds	Modem determining its location using a global navigation satellite system (GNSS)
Rapid flashing	Modem communications interrupted and modem turning off. Typically caused by pressing the Power button for 3 seconds.
Always on	Cellular modem turning on or off

Typical LED sequence when first installing an Aspen 10 and sensor is shown in the following table.

Table 9-3: Installation LED activity	
Color and state[1]	Description
Red rapid flashing	Sensor first connected
Red always on	No recipe

Table 9-3: Installation LED activity	
Color and state[1]	Description
Red always on, two blue flashes every 10 seconds	Modem connecting with cellular provider
Red always on, one blue flash every 10 seconds	Modem connected to *Cloud*
Red always on. LEDs may go off completely for one to two seconds.	Retrieving recipe, loading program and restarting
One blue flash every two seconds. This will continue for about 10 additional minutes after the **Power** button is pressed or a direct connection has ended. Then the LED will turn off.	Recipe obtained successfully and program running
[1]LED may appear purple when red an blue LEDs are on at the same time.	

10. Maintenance

Occasional glass cleaning improves solar panel efficiency. Use a soft sponge and warm water with a small amount of dish washing detergent to gently clean the solar panel of any dust, grime, or bird droppings. Use a soft, dry cloth to remove any residual water from the panel.

> WARNING:
> Do not submerge the Aspen 10.

11. Tips and troubleshooting

Start with these basic procedures if a system is not operating properly.

1. Review your Aspen 10 **Health & Status**. See Status (p. 21) for more information.
2. Ensure your system is well grounded. See Grounding (p. 11). The symptoms of a poorly grounded system range from bad measurements, to intermittent communications, to damaged hardware.

3. Check wires and cables for the following:
    - Loose connection points. Disconnect and reconnect the sensor. Observe the LED indicator (p. 18).
    - Faulty connectors
    - Cut wires
    - Damaged insulation, which allows water to migrate into the cable. Water, whether or not it comes in contact with wire, can cause system failure. Water may increase the dielectric constant of the cable sufficiently to impede sensor signals, or it may migrate into the sensor, which will damage sensor electronics.
4. Press the **Power** button and observe the LED indicator (p. 18) to understand the current state of the Aspen 10.
5. There are no user serviceable parts. Changes or modifications to this device not expressly approved by Campbell Scientific may result in damaged equipment or loss of data.

12. Status

The **Status** table is an automatically created data table. In *CampbellCloud* view the **Status** table fields under **Assets** > **Summary**.

BattCapacity

Estimated remaining battery capacity (Ah).

BattCharge

Amount of charge the solar panel added to the battery (W).

Current (BattCurrent)

Average current flow out of the battery (A).

State of Charge (BattStateOfCharge)

Estimated remaining battery capacity (%). The ratio of **BattCapacity** to the full battery capacity. This is similar to the amount of fuel remaining in the tank.

State of Health (BattStateOfHealth)

Value reported by the fuel gauge indicating how much the battery has degraded (%). 100% indicates a new, healthy, battery.

Temperature (BattTemp)

Current battery temperature (°C). Updates once per minute, when viewing the **Status** table, or programatically.

Voltage (BattVoltage)

Voltage (VDC) of the battery powering the system. Updates once per minute, when viewing the **Status** table, or programatically.

Hourly Allowed Up Time (CellHrlyAllowedUpTime)

Estimated time per hour that the cellular modem may be on (seconds). This is automatically reduced as the battery health (BattStateOfHealth) declines.

Hourly Up Time (CellHrlyUpTime)

Estimated time per hour that the cellular modem was on (seconds). Resets hourly, with a button press, or direct communications.

When this exceeds the **(CellHrlyAllowedUpTime)** the modem will not attempt communications. However, the Aspen 10 will not interrupt communications when the threshold is met.

Time Taken to Register (CelLastRegTime)

The last time it connected, how much time it took the modem to connect to the cellular network (seconds).

Last Up Time (CellLastUpTime)

The last time it connected, how much time the modem was connected to the cellular network (seconds).

Cell Operator (CellOperator)

Name of the cellular provider, or operator, the modem is connecting to.

Signal Quality (CellSigQuality)

A unit-less number indicating the signal quality of the modem. Ranges expected:

Excellent: 0 to >-9
Good: -7 to -9 to -12
Fair to Poor: -11 to -13 or less

Signal Strength (CellSigStrength)

The signal strength of the modem (-dBm). Ranges expected:

Excellent: -90dBm or less
Good: -90dBm to -105dBm
Fair: -106dBm to -115dBm
Poor: >-115dBm

Number of GNSS satellites in view (GNSSNumSat)

Unit-less number of global navigation satellite system (GNSS) satellites in view.

Success Rate (MQTTSuccessRate)

Successful attempts to communicate with ***CampbellCloud*** (%).

13. Recipes

The Aspen 10 must have a recipe in order to make measurements, store data, and publish data to *CampbellCloud*. Aspen 10 recipes contain programs that are executed on a precise schedule, based on the Aspen 10 internal clock. On a time interval, specified in the recipe, the Aspen 10 stores data in tables and copies it to *Cloud*. The **Observations** table is only written to when in observation mode. See Observation mode (p. 18) for more information.

When the Aspen 10 does not have a recipe it automatically retrieves one from *Cloud* when the sensor is first connected. The following sections describe the data intervals and measurements associated with different sensor recipes.

Measurement Properties in *CampbellCloud* define the units of the measurements that the software receives. Set measurement Classifications and Subclassifications in *CampbellCloud* **Assets** > **Measurement Properties**. These settings, along with *Cloud* **My Settings** > **Unit Preferences**, determine how your measurements are displayed throughout *Cloud*. See https://campbell-cloud.com/classifications for a complete listing of Classifications and Subclassifications.

Use the following sections to determine the recommended Classifications, Subclassifications, Aggregate, and Units for your sensor:

13.1 ClimaVue™50

Table 13-1: ClimaVue™50 recipe data intervals

Name	Description	Measurement interval	Publish to *CampbellCloud* interval
ClimaVUE50	Sample of all measurements	Five minutes	Ten minutes (two measurement intervals)
Observations	Sample of all measurements	20 seconds when in observation mode	20 seconds when in observation mode

Table 13-2: ClimaVue™50 recipe measurements

Measurement	Description	Code	Classification	Subclassification	Units	Aggregate
Solar	Solar flux density	09000104	Irradiance		W/m^2	Average
Rain[1]	Precipitation	05010104	Precipitation	Accumulated precipitation	mm	Total
Strikes	Lightning strike count	18010006	Lightning	Lightning strike count	Count	Total
Dist	Strike distance	19010104	Lightning	Lightning strike distance	km	Average
WindSpd	Wind speed	03060104	Wind	Mean horizontal wind speed	m/s	Average
WindDir	Wind direction	04010104	Wind	Wind direction	°	Average
WindSpdMax	Wind speed max.– 10 second gust	03050103	Wind	Wind gust	m/s	Maximum
AirTemp	Air temperature	01010104	Temperature	Air temperature (near surface)	°C	Average
VP	Vapor pressure	0c050104	Pressure	Vapor pressure	hPa	Average

Table 13-2: ClimaVue™50 recipe measurements

Measurement	Description	Code	Classification	Subclassification	Units	Aggregate
BP	Barometric pressure (absolute)	0c010104	Pressure	Air pressure (near surface)	hPa	Average
RH	Relative humidity	02010104	Relative humidity	Relative humidity	%	Average
RHTemp	Temperature (temperature/humidity sensor)	01010104	Temperature	Air temperature (near surface)	°C	Average
TiltNS	Tilt North(+)/South(–) orientation	24010101	Angle	Sensor angle	°	Sample
TiltWE	Tilt West(+)/East(–) orientation	24010101	Angle	Sensor angle	°	Sample

[1] The recommended resolution for this measurement is 3 or more decimal places.

13.2 CS320

Table 13-3: CS320 recipe data intervals

Name	Description	Measurement interval	Publish to *CampbellCloud* interval
CS320	Sample of all measurements	One minutes	Ten minutes (ten measurement intervals)
Observations	Sample of all measurements	15 seconds when in observation mode	15 seconds when in observation mode

Table 13-4: CS320 recipe measurements

Measurement	Description	Code	Classification	Subclassification	Units	Aggregate
Irradiance	Solar radiation	09040101	Irradiance	Global horizontal irradiance	W/m^2	Sample
Vout	Raw millivolts	1b040201	Power	Voltage measurement	mV	Sample
Temp	Sensor temperature	01080101	Temperature	Internal sensor temperature	°C	Sample
Tilt	Detector angle	24010101	Angle	Sensor angle	°	Sample

13.3 CS451

Table 13-5: CS451 recipe data intervals

Name	Description	Measurement interval	Publish to *CampbellCloud* interval
CS451	Sample of all measurements	Five minutes	Ten minutes (two measurement intervals)
Observations	Sample of all measurements	20 seconds when in observation mode	20 seconds when in observation mode

Table 13-6: CS451 recipe measurements

Measurement	Description	Code	Classification	Subclassification	Units	Aggregate
Depth	Water depth	0d030301	Depth	Water depth	m	Sample
Stage_Offset	Calculated based on user input of Target_ stage and initial water depth reading	0d030301	Depth	Water depth	m	Sample
Stage	Depth + Stage_Offset	0d030301	Depth	Water depth	m	Sample

Table 13-6: CS451 recipe measurements

Measurement	Description	Code	Classification	Subclassification	Units	Aggregate
Pressure	Water pressure	0c090301	Pressure	Water pressure	kPa	Sample
Temp	Water temperature	01080101	Temperature	Internal sensor temperature	°C	Sample

13.4 HygroVue™10

Table 13-7: HygroVue™10 recipe data intervals

Name	Description	Measurement interval	Publish to *CampbellCloud* interval
HygroVUE10	Sample of all measurements	Five minutes	Ten minutes (two measurement intervals)
Observations	Sample of all measurements	20 seconds when in observation mode	20 seconds when in observation mode

Table 13-8: HygroVue™10 recipe measurements

Measurement	Description	Code	Classification	Subclassification	Units	Aggregate
Temp	Temperature	01010101	Temperature	Air Temp (near surface)	°C	Sample
RH	Relative humidity	02010101	Relative humidity	Relative Humidity	%	Sample

13.5 RainVue™10-IN and RainVue™20-IN

TIP:
Use this section for tipping volume option **-IN**, a RainVue with a **0.01 in tip**. Find the option type on the label near cable connector.

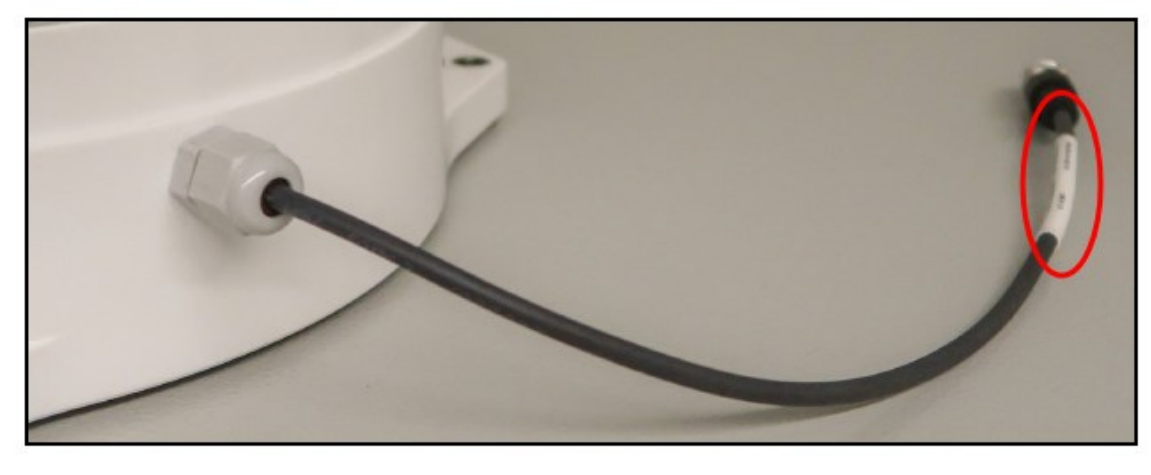


Table 13-9: RainVue™10 and RainVue™20 recipe data intervals

Name	Description	Measurement interval	Publish to *CampbellCloud* interval
RainVUE10 or RainVUE20	Sample of all measurements	Five minutes	Ten minutes (two measurement intervals)
Observations	Sample of all measurements	10 seconds when in observation mode	10 seconds when in observation mode

Table 13-10: RainVue™10 and RainVue™20 recipe measurements
-IN option

Measurement	Description	Code	Classification	Subclassification	Units	Aggregate
Rain	Intensity corrected rain accumulation since last measurement, typically five minutes.	05010406	Precipitation	Accumulated precipitation	in	Total
Tips	Number of raw bucket tips since last measurement, typically five minutes.		Precipitation	Accumulated precipitation	count	Total
TotalAccumulation	Total intensity corrected accumulation over last five minutes. **NOTE:** Not reset when in observation mode.	05010406	Precipitation	Accumulated precipitation	in	Total
AverageIntensity	Average precipitation intensity since last measurement, typically five minutes.	06010301	Precipitation	Precipitation Intensity liquid	in/h	Sample
PeakIntensity	Maximum (peak) intensity since last measurement, typically five minutes.	06010303	Precipitation	Precipitation Intensity liquid	in/h	Maximum

13.6 RainVue™10-MM(2) and RainVue™20-MM(2)

TIP:
Use this section for tipping volume option **-MM** or **-MM2**, a RainVue with a **0.1 mm tip** or **0.2 mm tip**. Find the option type on the label near cable connector.

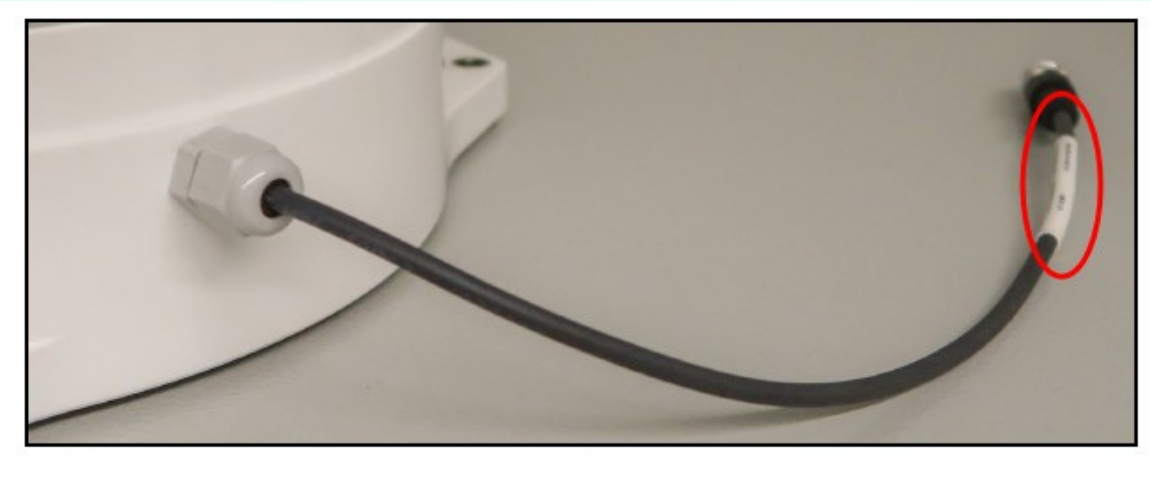


Table 13-11: RainVue™10 and RainVue™20 recipe data intervals			
Name	Description	Measurement interval	Publish to *CampbellCloud* interval
RainVUE10 or RainVUE20	Sample of all measurements	Five minutes	Ten minutes (two measurement intervals)
Observations	Sample of all measurements	10 seconds when in observation mode	10 seconds when in observation mode

Table 13-12: RainVue™10 and RainVue™20 recipe measurements
-MM and -MM2 options

Measurement	Description	Code	Classification	Subclassification	Units	Aggregate
Rain	Intensity corrected rain accumulation since last measurement, typically five minutes.	05010406	Precipitation	Accumulated precipitation	mm	Total
Tips	Number of raw bucket tips since last measurement, typically five minutes.		Precipitation	Accumulated precipitation	count	Total
TotalAccumulation	Total intensity corrected accumulation over last five minutes. NOTE: Not reset when in observation mode.	05010406	Precipitation	Accumulated precipitation	mm	Total
AverageIntensity	Average precipitation intensity since last measurement, typically five minutes.	06010301	Precipitation	Precipitation Intensity liquid	mm/h	Sample
PeakIntensity	Maximum (peak) intensity since last measurement, typically five minutes.	06010303	Precipitation	Precipitation Intensity liquid	mm/h	Maximum

13.7 SnowVue™10

Table 13-13: SnowVue™10 recipe data intervals

Name	Description	Measurement interval	Publish to *CampbellCloud* interval
SnowVUE10	Sample of all measurements	One hour	One hour
Observations	Sample of all measurements	20 seconds when in observation mode	20 seconds when in observation mode

Table 13-14: SnowVue™50 recipe measurements

Measurement	Description	Code	Classification	Subclassification	Units	Aggregate
Distance	Distance to snow	0e010301	Distance	Distance to target	m	Sample
QualityNum	Quality number	2c0a0001	Status	Diagnostics		Sample
ExtTemp	External temperature	01010101	Temperature	Air Temp (near surface)	°C	Sample
IntTemp	Internal temperature	01080101	Temperature	Internal sensor temperature	°C	Sample
IntRH	Internal RH	02000101	Relative humidity		%	Sample
Pitch	Pitch	24010101	Angle	Sensor angle	°	Sample
Roll	Roll	24010101	Angle	Sensor angle	°	Sample
SupplyVolt	Supply voltage	1b010101	Power	Battery voltage	V	Sample
Freq	Resonant frequency(should be 50 kHz)	29000104	Frequency		kHz	Average
AlertFlag	Alert flag 0 = good 1 = transducer outside of normal operating range	2c080001	Status	Measurement alarm		Sample

13.8 SoilVue™10

Table 13-15: SoilVue™10 recipe data intervals

Name	Description	Measurement interval	Publish to *CampbellCloud* interval
SoilVUE	Sample of all measurements	One hour	One hour
Observations	Sample of all measurements	60 seconds when in observation mode	60 seconds when in observation mode

Table 13-16: SoilVue™10 recipe measurements

Measurement	Description	Code	Classification	Subclassification	Units	Aggregate
VWC_5	Volumetric Water Content, 5 cm	21030201	Volume	Volumetric water content	%	Sample
Ka_5	Relative Permittivity, ε, 5 cm	2b010001	Permitivity	Relative permitivity		Sample
Temp_5	Temperature, 5 cm	01040101	Temperature	Soil temperature	°C	Sample
EC_5	Bulk Electrical Conductivity, 5 cm	25010101	Conductivity	Electrical conductivity	dS/m	Sample
VWC_10	Volumetric Water Content, 10 cm	21030201	Volume	Volumetric water content	%	Sample
Ka_10	Relative Permittivity, ε, 10 cm	2b010001	Permitivity	Relative permitivity		Sample
Temp_10	Temperature, 10 cm	01040101	Temperature	Soil temperature	°C	Sample
EC_10	Bulk Electrical Conductivity, 10 cm	25010101	Conductivity	Electrical conductivity	dS/m	Sample
VWC_20	Volumetric Water Content, 20 cm	21030201	Volume	Volumetric water content	%	Sample
Ka_20	Relative Permittivity, ε, 20 cm	2b010001	Permitivity	Relative permitivity		Sample
Temp_20	Temperature, 20 cm	01040101	Temperature	Soil temperature	°C	Sample
EC_20	Bulk Electrical Conductivity, 20 cm	25010101	Conductivity	Electrical conductivity	dS/m	Sample

Table 13-16: SoilVue™10 recipe measurements

Measurement	Description	Code	Classification	Subclassification	Units	Aggregate
VWC_30	Volumetric Water Content, 30 cm	21030201	Volume	Volumetric water content	%	Sample
Ka_30	Relative Permittivity, ε, 30 cm	2b010001	Permitivity	Relative permitivity		Sample
Temp_30	Temperature, 30 cm	01040101	Temperature	Soil temperature	°C	Sample
EC_30	Bulk Electrical Conductivity, 30 cm	25010101	Conductivity	Electrical conductivity	dS/m	Sample
VWC_40	Volumetric Water Content, 40 cm	21030201	Volume	Volumetric water content	%	Sample
Ka_40	Relative Permittivity, ε, 40 cm	2b010001	Permitivity	Relative permitivity		Sample
Temp_40	Temperature, 40 cm	01040101	Temperature	Soil temperature	°C	Sample
EC_40	Bulk Electrical Conductivity, 40 cm	25010101	Conductivity	Electrical conductivity	dS/m	Sample
VWC_50	Volumetric Water Content, 50 cm	21030201	Volume	Volumetric water content	%	Sample
Ka_50	Relative Permittivity, ε, 50 cm	2b010001	Permitivity	Relative permitivity		Sample
Temp_50	Temperature, 50 cm	01040101	Temperature	Soil temperature	°C	Sample
EC_50	Bulk Electrical Conductivity, 50 cm	25010101	Conductivity	Electrical conductivity	dS/m	Sample

13.9 TempVue™20

Table 13-17: TempVue™20 recipe data intervals

Name	Description	Measurement interval	Publish to *CampbellCloud* interval
TempVue20	Sample of all measurements	60 second average of 4 previous 15-second measurements.	Ten minutes (ten measurement intervals)
Observations	Sample of all measurements	15 seconds when in observation mode	15 seconds when in observation mode

Table 13-18: TempVue™20 recipe measurements

Measurement	Description	Code	Classification	Subclassification	Units	Aggregate
AirTemp60Sec	60 second average of 4 previous 15-second measurements	01010104	Temperature	Air temperature (near surface)	°C	Average
AirTempCode	Error flag where: 0 = No error 1 = Suspect reading 2 = Error reading 4 = Sensor stuck 8 = Sensor error	2c0a0001	Status	Diagnostics	N/A	Sample

13.10 Wintersense™SDI-12

Table 13-19: Wintersense SDI-12 recipe data intervals

Name	Description	Measurement interval	Publish to *CampbellCloud* interval
Wintersense	Sample of all measurements	Eight second average at the top of a five minute interval	Ten minutes (two measurement intervals)
Observations	Sample of all measurements	20 seconds when in observation mode	20 seconds when in observation mode

Table 13-20: Wintersense recipe measurements

Measurement	Description	Code	Classification	Subclassification	Units	Aggregate
SurfaceTemp	Surface temperature	010b0101	Temperature	Road surface temp (non-invasive)	°C	Sample
AirTemp	Air temperature	01010101	Temperature	Air Temp (near surface)	°C	Sample
RH	Air relative humidity	02010101	Relative humidity	Relative Humidity	%	Sample
DewPointTemp	Dew point temperature	01020101	Temperature	Dew point temperature	°C	Sample
Angle	Tilt	24010101	Angle	Sensor angle	°	Sample
SupplyVoltage	Supply voltage	1b010101	Power	Battery voltage	V	Sample
SensorTemp	Sensor body temperature	01080101	Temperature	Internal sensor temperature	°C	Sample

14. Aspen 10 specifications

Electrical specifications are valid over a -20 to +60 °C (noted as ST), unless otherwise specified. Extended electrical specifications (noted as XT) are valid over a -40 to +75 °C. Recalibration is recommended every three years. Critical specifications and system configuration should be confirmed with Campbell Scientific before purchase.

14.1 System specifications

Processor: 32-Bit Arm Cortex CPU

Memory:

- 2 MB flash
- 640 KB SRAM

Program Execution Period: 1 s to one day; 1 s increments

Real-Time Clock:

- Resolution: ±1 s
- Accuracy: ±1 s
- Synchronized with *CampbellCloud* once per day

14.2 Physical specifications

Dimensions 16.2 x 8.0 x 5.8 cm (6.4 x 3.2 x 2.3 in)

Weight/Mass:

- ST: 395 g (0.9 lb)
- XT: 352 g (0.8 lb)

Case Material:

- High-impact-resistant and UV-resistant ASA, recycle code 7
- IP65 water resistant, Gore-Tex breathability
- IK06 (equivalent to an impact energy level of 1 J). Test conducted using the pendulum and sphere method

14.3 Power requirements

Protection: Power inputs and outputs are protected against surge, over-voltage, over-current, and reverse power. IEC 61000-4 Class 4 level.

Charge Source:

- **Integrated solar panel**: Maxeon Gen V

> **NOTE:**
> May take up to 72 hours of full sun to charge a fully discharged battery.

Battery:

Charge and discharge characteristics controlled internally according to battery type.

- **-20 to +60 °C (ST)**: 3.2 VDC, 7.2 Ah, Li-Po
  PHD26650: After 3000 charge/discharge cycles, the capacity remains above 80% of initial capacity.
  Battery stops charging below -10 °C and above 60 °C.
- **-40 to +75 °C (XT)**: 3.65 VDC, 5.6 Ah, Li-ion
  Saft MP176065 xtd: After 1500 charge/discharge cycles, the capacity remains above 80% of initial capacity.
  Battery stops charging below -30 °C and above +75 °C.

Average Current Drain @ 3.2 VDC:

- **Deep sleep**: <0.35 uA
- **Idle**: <1 mA
- **Sensor power supply current at no load**
  - 5 VDC: 10 uA (ultra-low power)
  - 5 VDC: 5 mA
  - 8 VDC: 14.3 mA
  - 12 VDC: 30 mA

Cellular Module (Cat M1) On. Additional Current Contribution: 50 to 150 mA

- **Idle**: 1.7 µA
- **Receive**: 21.2 µA
- **Transmit**: 219 mA

BLE Active: 4 mA average

GPS: included w/ cellular

14.4 Power output

Regulated 5, 8, or 12 VDC. Disabled when battery capacity <0.5 Ahr.

Pin: 5

Current limit:

- **5 VDC**: 30 mA (ultra-low power)
- **5 VDC**: 210 mA
- **8 VDC**: 210 mA
- **12 VDC**: 210 mA

14.5 Digital input/output specifications

Terminals configurable for SDI-12.

Terminals: **Pin 6, 7**

Maximum Input Voltage: ±20 V

14.6 Communications

Protocols: SDI-12

Internet Protocols: HTTP(S), MQTT

Near-field Communications (NFC): Target device compatible with ***CampbellGo***

Bluetooth Low Energy (BLE):

- Compatible with ***CampbellGo***
- Maximum distance: 50 m (165 ft)

SDI-12: Two SDI-12 compliant terminals meet SDI-12 Standard v 1.4.

- **Pins**: 6,7

14.6.1 Cellular

Table 14-1: Maximum speed		
	Download (kbps)	Upload (kbps)
Cat M1	588	1119
Cat NB1	32	70
Cat NB2	127	158.5

14.7 Standards compliance specifications

View compliance and conformity documents at www.campbellsci.com/aspen10.

Shock and Vibration: ASTM D4169

Protection: IP65

EMI and ESD protection:

- **Immunity**: Meets or exceeds following standards:
  - **ESD**: per IEC 61000-4-2; ±15 kV air, ±8 kV contact discharge
  - **Radiated RF**: per IEC 61000-4-3; 10 V/m, 80-1000 MHz
  - **EFT**: per IEC 61000-4-4; 4 kV power, 4 kV I/O
  - **Surge**: per IEC 61000-4-5; 4 kV power, 4kV I/O
  - **Conducted RF**: per IEC 61000-4-6; 10 V power, 10 V I/O
- Emissions and immunity performance criteria available on request.

Safety: IEC 61010-1:2010, IEC 61010-1:2010/AMD1:2016

14.8 Environmental conditions

The Aspen 10 can be operated safely under the following conditions.

Location: outdoor

Location: wet environment as defined by IEC 61010-1

Maximum elevation: 4,000 m (13,100 ft)

Temperature:

- **Standard (ST)**: -20 to +60 °C
- **Extended (XT)**: -40 to +75 °C

Relative humidity: up to and including condensing environments

Pollution degree: 2 as defined by IEC 61010-1

Appendix A. Glossary

A

API

Application Programming Interface

application

Also called app for short. A group of functions for related tasks

asset

Primarily this is a data source such as a data logger or Aspen 10. It can also be another piece of hardware.

D

data source

An asset that sends data to CampbellCloud. This includes data loggers and the Aspen 10 edge device.

N

network

A group of one or more stations

NFC

Near field communications

O

onboard

A collective term for the tasks that have to complete successfully in order for a data source asset to be correctly configured and send data to CampbellCloud. These tasks may be automated or require manual user input depending on the data source type. For Aspen 10 data sources, these tasks include asset claiming, automated sensor identification, cellular communications registration, secure Cloud communications, program retrieval, successful sensor measurement, and confirmation that Cloud received data.

organization

An entity (individual, business, or group) that uses CampbellCloud services to manage a network of stations owned by the entity. Every user must be associated with an organization.

Q

QR code

Quick response barcode

R

recipe

A set of files that include the Aspen 10 program, settings and configuration for a specific sensor and application.

S

station

A group of one or more assets

U

UID

Unique identifier

user

Individuals who have been added to an organization account. Users are assigned permissions via the Security Groups application.

Limited warranty

Covered equipment is warranted/guaranteed against defects in materials and workmanship under normal use and service for the period listed on your sales invoice or the product order information web page. The covered period begins on the date of shipment unless otherwise specified. For a repair to be covered under warranty, the following criteria must be met:

1. There must be a defect in materials or workmanship that affects form, fit, or function of the device.

2. The defect cannot be the result of misuse.

3. The defect must have occurred within a specified period of time; and

4. The determination must be made by a qualified technician at a Campbell Scientific Service Center/ repair facility.

The following is not covered:

1. Equipment which has been modified or altered in any way without the written permission of Campbell Scientific.

2. Batteries; and

3. Any equipment which has been subjected to misuse, neglect, acts of God or damage in transit.

Campbell Scientific regional offices handle repairs for customers within their territories. Please see the back page of the manual for a list of regional offices or visit www.campbellsci.com/contact to determine which Campbell Scientific office serves your country. For directions on how to return equipment, see Assistance.

Other manufacturer's products, that are resold by Campbell Scientific, are warranted only to the limits extended by the original manufacturer.

CAMPBELL SCIENTIFIC EXPRESSLY DISCLAIMS AND EXCLUDES ANY IMPLIED WARRANTIES OF

MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. Campbell Scientific hereby disclaims, to the fullest extent allowed by applicable law, any and all warranties and conditions with respect to the products, whether express, implied, or statutory, other than those expressly provided herein.

Campbell Scientific will, as a default, return warranted equipment by surface carrier prepaid. However, the method of return shipment is at Campbell Scientific's sole discretion. Campbell Scientific will not reimburse the claimant for costs incurred in removing and/or reinstalling equipment. This warranty and the Company’s obligation thereunder is in lieu of all other

warranties, expressed or implied, including those of suitability and fitness for a particular purpose. Campbell Scientific is not liable for consequential damage.

In the event of any conflict or inconsistency between the provisions of this Warranty and the provisions of Campbell Scientific's Terms, the provisions of Campbell Scientific's Terms shall prevail. Furthermore, Campbell Scientific's Terms are hereby incorporated by reference into this Warranty. To view Terms and conditions that apply to Campbell Scientific, Logan, UT, USA, see Terms and Conditions. To view terms and conditions that apply to Campbell Scientific offices outside of the United States, contact the regional office that serves your country.

Assistance

Products may not be returned without prior authorization. Please inform us before returning equipment and obtain a **return material authorization (RMA) number** whether the repair is under warranty/guarantee or not. See Limited warranty for information on covered equipment.

Campbell Scientific regional offices handle repairs for customers within their territories. Please see the back page of the manual for a list of regional offices or visit www.campbellsci.com/contact to determine which Campbell Scientific office serves your country.

When returning equipment, a RMA number must be clearly marked on the outside of the package. Please state the faults as clearly as possible. Quotations for repairs can be given on request.

It is the policy of Campbell Scientific to protect the health of its employees and provide a safe working environment. In support of this policy, when equipment is returned to Campbell Scientific, Logan, UT, USA, it is mandatory that a "Declaration of Hazardous Material and Decontamination" form be received before the return can be processed. If the form is not received within 5 working days of product receipt or is incomplete, the product will be returned to the customer at the customer's expense. For details on decontamination standards specific to your country, please reach out to your regional Campbell Scientific office.

> NOTE:
> All goods that cross trade boundaries may be subject to some form of fee (customs clearance, duties or import tax). Also, some regional offices require a purchase order upfront if a product is out of the warranty period. Please contact your regional Campbell Scientific office for details.

Safety

DANGER — MANY HAZARDS ARE ASSOCIATED WITH INSTALLING, USING, MAINTAINING, AND WORKING ON OR AROUND TRIPODS, TOWERS, AND ANY ATTACHMENTS TO TRIPODS AND TOWERS SUCH AS SENSORS, CROSSARMS, ENCLOSURES, ANTENNAS, ETC. FAILURE TO PROPERLY AND COMPLETELY ASSEMBLE, INSTALL, OPERATE, USE, AND MAINTAIN TRIPODS, TOWERS, AND ATTACHMENTS, AND FAILURE TO HEED WARNINGS, INCREASES THE RISK OF DEATH, ACCIDENT, SERIOUS INJURY, PROPERTY DAMAGE, AND PRODUCT FAILURE. TAKE ALL REASONABLE PRECAUTIONS TO AVOID THESE HAZARDS. CHECK WITH YOUR ORGANIZATION'S SAFETY COORDINATOR (OR POLICY) FOR PROCEDURES AND REQUIRED PROTECTIVE EQUIPMENT PRIOR TO PERFORMING ANY WORK.

Use tripods, towers, and attachments to tripods and towers only for purposes for which they are designed. Do not exceed design limits. Be familiar and comply with all instructions provided in product manuals. Manuals are available at www.campbellsci.com You are responsible for conformance with governing codes and regulations, including safety regulations, and the integrity and location of structures or land to which towers, tripods, and any attachments are attached. Installation sites should be evaluated and approved by a qualified engineer. If questions or concerns arise regarding installation, use, or maintenance of tripods, towers, attachments, or electrical connections, consult with a licensed and qualified engineer or electrician.

General

- Protect from over-voltage.
- Protect electrical equipment from water.
- Protect from electrostatic discharge (ESD).
- Protect from lightning.
- Prior to performing site or installation work, obtain required approvals and permits. Comply with all governing structure-height regulations, such as those of the FAA in the USA.
- Use only qualified personnel for installation, use, and maintenance of tripods and towers, and any attachments to tripods and towers. The use of licensed and qualified contractors is highly recommended.
- Read all applicable instructions carefully and understand procedures thoroughly before beginning work.
- Wear a hardhat and eye protection, and take other appropriate safety precautions while working on or around tripods and towers.
- Do not climb tripods or towers at any time, and prohibit climbing by other persons. Take reasonable precautions to secure tripod and tower sites from trespassers.
- Use only manufacturer recommended parts, materials, and tools.

Utility and Electrical

- You can be killed or sustain serious bodily injury if the tripod, tower, or attachments you are installing, constructing, using, or maintaining, or a tool, stake, or anchor, come in contact with overhead or underground utility lines.
- Maintain a distance of at least one-and-one-half times structure height, 6 meters (20 feet), or the distance required by applicable law, whichever is greater, between overhead utility lines and the structure (tripod, tower, attachments, or tools).
- Prior to performing site or installation work, inform all utility companies and have all underground utilities marked.
- Comply with all electrical codes. Electrical equipment and related grounding devices should be installed by a licensed and qualified electrician.
- Only use power sources approved for use in the country of installation to power Campbell Scientific devices.

Elevated Work and Weather

- Exercise extreme caution when performing elevated work.
- Use appropriate equipment and safety practices.
- During installation and maintenance, keep tower and tripod sites clear of un-trained or non-essential personnel. Take precautions to prevent elevated tools and objects from dropping.
- Do not perform any work in inclement weather, including wind, rain, snow, lightning, etc.

Internal Battery

- Be aware of fire, explosion, and severe-burn hazards.
- Misuse or improper installation of the internal lithium battery can cause severe injury.

- Do not recharge, disassemble, heat above 100 °C (212 °F), solder directly to the cell, incinerate, or expose contents to water. Dispose of spent batteries properly.

Use and disposal of batteries

- Where batteries need to be transported to the installation site, ensure they are packed to prevent the battery terminals shorting which could cause a fire or explosion. Especially in the case of lithium batteries, ensure they are packed and transported in a way that complies with local shipping regulations and the safety requirements of the carriers involved.
- When installing the batteries follow the installation instructions very carefully. This is to avoid risk of damage to the equipment caused by installing the wrong type of battery or reverse connections.
- When disposing of used batteries, it is still important to avoid the risk of shorting. Do not dispose of the batteries in a fire as there is risk of explosion and leakage of harmful chemicals into the environment. Batteries should be disposed of at registered recycling facilities.

Avoiding unnecessary exposure to radio transmitter radiation

- Where the equipment includes a radio transmitter, precautions should be taken to avoid unnecessary exposure to radiation from the antenna. The degree of caution required varies with the power of the transmitter, but as a rule it is best to avoid getting closer to the antenna than 20 cm (8 inches) when the antenna is active. In particular keep your head away from the antenna. For higher power radios (in excess of 1 W ERP) turn the radio off when servicing the system, unless the antenna is installed away from the station, e.g. it is mounted above the system on an arm or pole.

Maintenance

- Periodically (at least yearly) check for wear and damage, including corrosion, stress cracks, frayed cables, loose cable clamps, cable tightness, etc. and take necessary corrective actions.
- Periodically (at least yearly) check electrical ground connections.

WHILE EVERY ATTEMPT IS MADE TO EMBODY THE HIGHEST DEGREE OF SAFETY IN ALL CAMPBELL SCIENTIFIC PRODUCTS, THE CUSTOMER ASSUMES ALL RISK FROM ANY INJURY RESULTING FROM IMPROPER INSTALLATION, USE, OR MAINTENANCE OF TRIPODS, TOWERS, OR ATTACHMENTS TO TRIPODS AND TOWERS SUCH AS SENSORS, CROSSARMS, ENCLOSURES, ANTENNAS, ETC.

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