Intrepid RESPONSE for FirstNet®

VERTICAL LOCATION USER GUIDE

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VERTICAL LOCATION: OVERVIEW

The vertical location capability in Response is delivered by NextNav's Pinnacle service. The Response app uses the information from Pinnacle to locally display and share vertical location.

There are two screens within the Response app which are used for vertical location. Both can be accessed from the Response Dashboard.

1. **Dashboard:** Load and log into the Intrepid Response for Firstnet application. The Dashboard will be your main point of navigation through the Intrepid Response Application.

2. **Settings Menu:** Click on the 3 lines in the upper left-hand corner to open a new menu on the left of your screen. Here you will see the Altitude Diagnostics option.

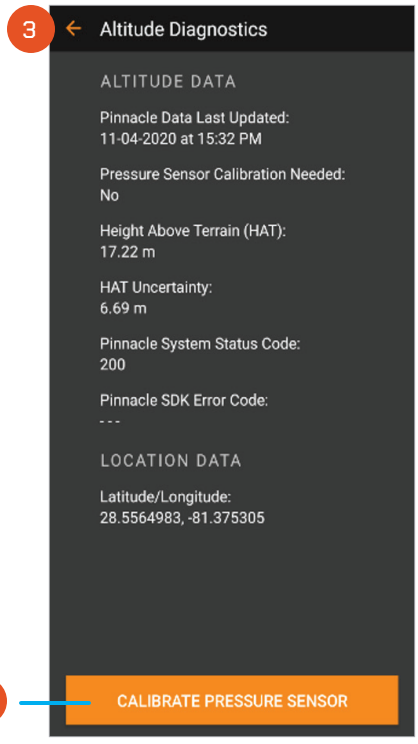
3. **Altitude Diagnostics:** Click the Altitude Diagnostics button to open your Altitude Data menu. Here will be the all the information your device has gathered so far about your altitude and location. Your HAT (or Height Above Terrain) location will be displayed on your user marker on the Google Map Display.

4. **Calibration:** If Calibration is needed, select the Calibrate Pressure Sensor button at the bottom of the Altitude Diagnostics screen.

5. **Map Display:** Select the Map icon on the Dashboard to view live location information for your team directly within the application.

IMPORTANT: To ensure optimum indoor vertical location, keep Wi-Fi on.





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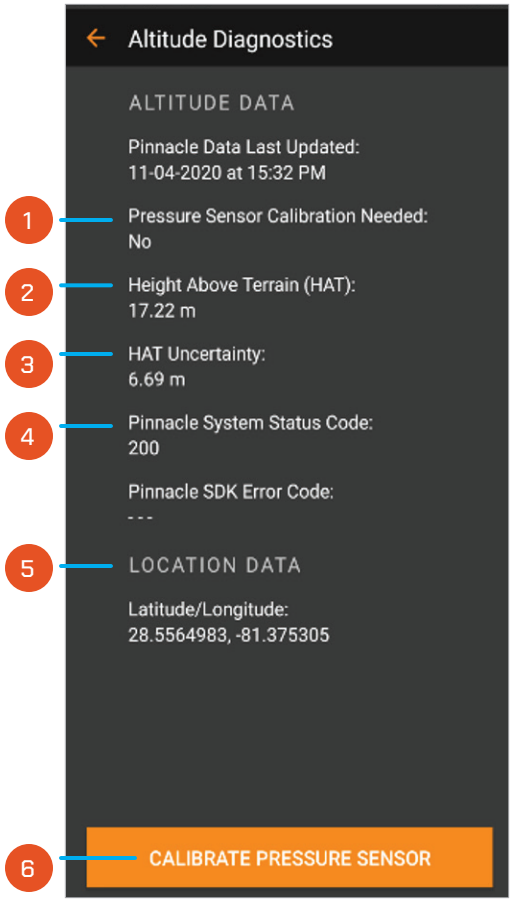
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ALTITUDE DIAGNOSTICS SCREEN

The Altitude Diagnostics screen is accessed through the settings menu in the upper left-hand corner of the Dashboard. Once in the settings menu you'll see an "Altitude Diagnostics" option, which will let you see your own vertical (and horizontal) location, as well as calibrate the device.

In the Settings Menu, tap on the first item – Altitude Diagnostics.

In the altitude diagnostics menu, you'll see several data lines of important information.



1. The "Pressure Sensor Calibration Needed" item will tell you if you need to calibrate the sensor to improve the accuracy of vertical location data.

2. Height Above Terrain (HAT) tells you the altitude of your device in relation to ground level at your location.

3. HAT Uncertainty provides a metric of confidence about the quality of your altitude.

4. Pinnacle status codes

a. Pinnacle System Status code: This indicates if the Pinnacle service is working well or if there are any issues.

b. Pinnacle SDK Error code : This indicates if there is any device specific issue(s) that prevents the Pinnacle service from delivering vertical location information.

5. Your current latitude and longitude as provided by the Response application are displayed.

6. At the bottom of this menu, you'll see the "Calibrate Pressure Sensor" button, which will walk you through the process of calibrating the barometric pressure sensor in your device. (See below for further details on the calibration process.)

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MAP DISPLAY

The map display can be accessed through the "MAP" button in the middle of the Dashboard. This display will show you the vertical and horizontal location of everyone in your channel. To choose a channel, you must visit the channel menu, which can be accessed through the "Channel" button (the circle with three dots in it) in the upper right-hand corner of the Dashboard.

1. Each person is displayed on the map as a small card with the call sign they have registered with the administrator. If you tap on the small card, the larger information card will appear with the person's location data.

2. The top two measurements on the information card are the person's x/y location, listed as coordinates.

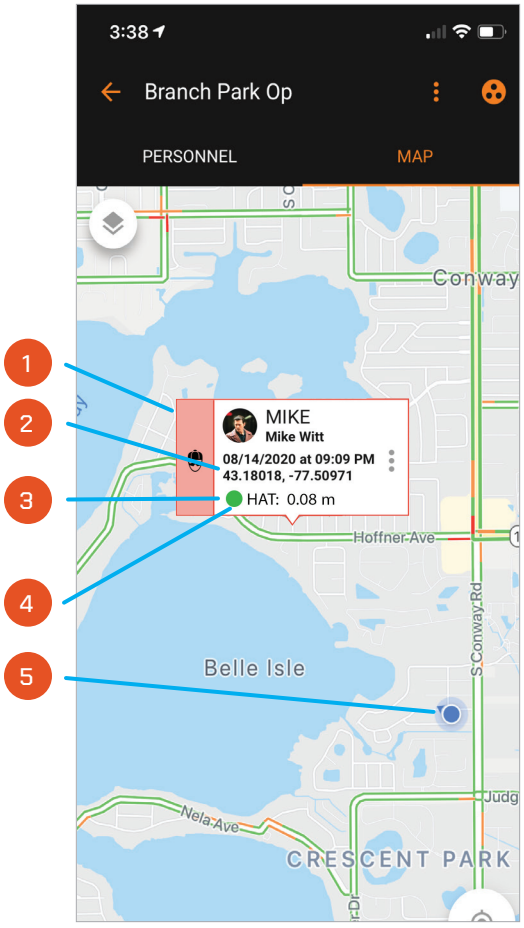
3. The bottom measurement is the person's vertical location, listed as "Height Above Terrain" (HAT), or height above ground level. The measurements are listed in meters by default.

a. To change the measurement units, go to the "options" screen, which is located in the three vertical dot icon in the upper right-hand corner of the map display.

b. At the bottom of the menu, you'll see options for imperial measurements if this is what you prefer.

i. Changing the units affects both horizontal and vertical location measurements.

i. Changing the unit of measurement will apply to everyone displayed on your device only. It will not change the unit of measurement for how you are displayed on other peoples' devices.



4. The dot to the left of the HAT measurement indicates the quality of the height measurement. (See below for additional details.)

5. Your own horizontal location is represented by a blue dot on this screen. To see your own vertical location, go to the altitude diagnostics menu as detailed above.



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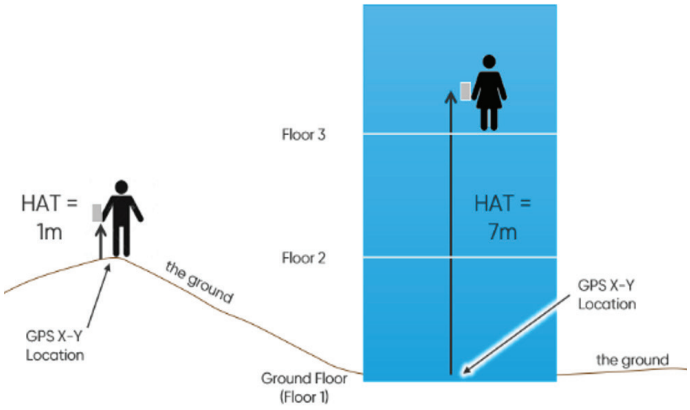
UNDERSTANDING VERTICAL LOCATION

Most people are accustomed to seeing location data displayed in only two dimensions. It's a habit formed through years of using the flat, 2D maps common in most location-based mobile apps. Adding a vertical dimension into the mix takes some getting used to. Here are some tips to help you understand the context of vertical location as it appears in the Response app.

The Concept of Height Above Terrain (HAT)

Height Above Terrain is a technical term for how high above the ground the device is located. For example, when altitude is reported as 1m HAT, it means the device is 1m above the ground level at the X-Y location the device reports.

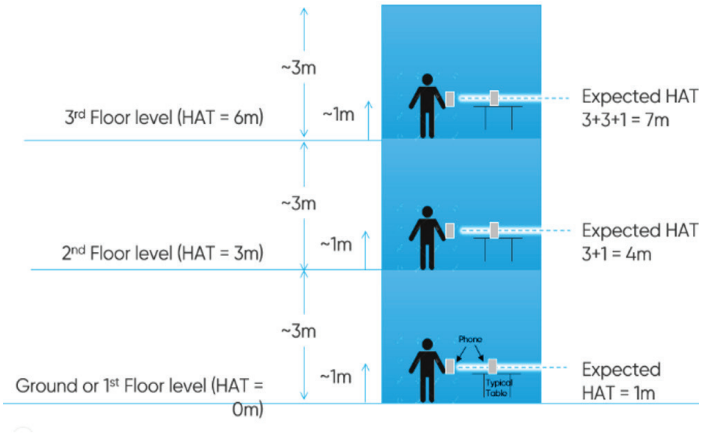
Given that most people typically hold their phone at waist or chest level, for someone standing at ground level looking at their phone, their device would typically report their altitude as 1m HAT.



How HAT relates to Building Floors

HAT is a measurement of where your device is in relation to the ground. Translating that measurement into the floor of a building depends on the unique characteristics of the building and the terrain around the building.

As a general rule of thumb, most building floors are about three meters high. So if a device is shown with an HAT of seven meters, that will usually indicate the person holding the device is on the third floor. (3m 1st floor + 3m 2nd floor + 1m from the person's feet to their hand)



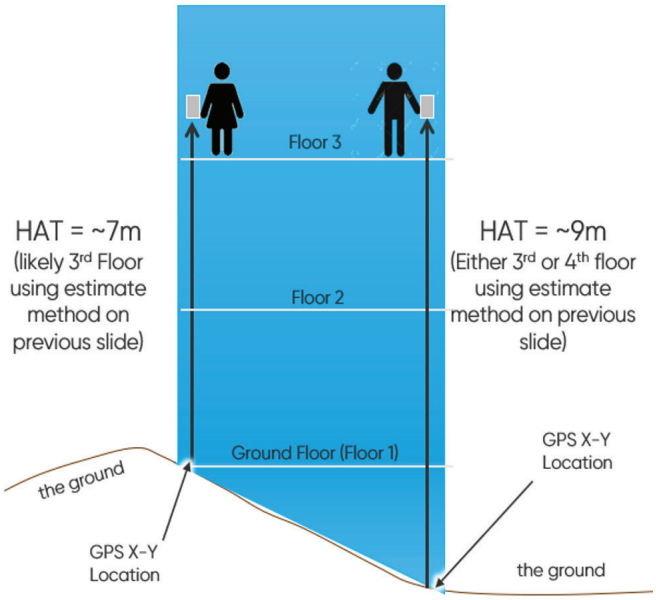
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UNDERSTANDING VERTICAL LOCATION CONT.

Unfortunately, not all buildings have uniform floor heights. Some have higher entry levels or mezzanine floors. Some have large spaces for duct work between floors. Some have entire "mechanical floors". So the estimating technique described above for floor height is not always accurate.

Buildings built on steep slopes also present a particular challenge for vertical location readings. When the surrounding terrain varies, HAT measurements will follow that variation. In the example shown here, the "ground floor" of a building could be different depending on which side you measure from.

Bottom line: HAT provides you with enough information to make an educated assumption about a person's floor location, but keep in mind that it is not exact given the variables described above.



Normal Vertical Location Behavior

The HAT measurement displayed in Response is quite accurate but should not be considered exact (much like GPS in a phone is quite accurate but is not considered exact). Again, much like GPS, there is some uncertainty that comes with the altitude calculation based on a number of conditions at the time of the measurement. That uncertainty is displayed in the map view as a red/yellow/green dot as mentioned above. (See below for more details about the uncertainty measurement.)

You'll see the HAT reading will vary slightly every second or so. This is quite normal and due primarily to natural variations in the barometric sensor in the device and will happen even if the phone is perfectly still. In addition, the stability of the reading can be affected by where and how people hold their phones and other factors.

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CALIBRATION AND VERTICAL LOCATION QUALITY

Why does your Device need to be calibrated?

Most of today's smartphones contain tiny barometers which measure atmospheric pressure. These sensors play a critical role in determining your vertical location. Most smartphone barometers are inexpensive and of relatively low quality. As a result, their measurements tend to "drift" over time if they aren't regularly calibrated against a standard baseline of pressure data.

To a certain extent, the NextNav Pinnacle system which processes your vertical location can correct for the built-in error and "drift" in these sensors. Yet in order to maintain the most accurate, consistent measurements, the application still requires an occasional calibration of the device sensor.

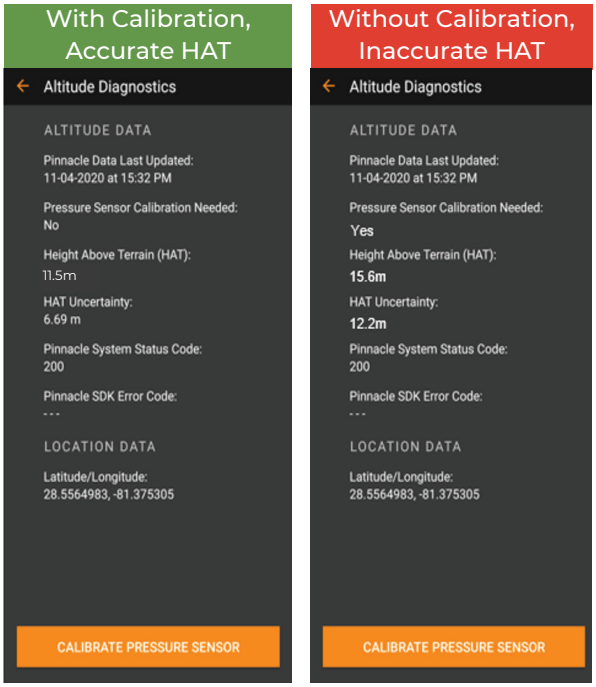
When the sensor "drifts" past a certain threshold, you'll see a reminder asking you to calibrate. It is important to calibrate as soon as possible when seeing the reminder to ensure optimum vertical location performance. You can also calibrate your device even when there's no reminder if you feel vertical location accuracy may improve with calibration.

During normal use of Response, the software may automatically calibrate the sensor without your involvement, under the right conditions. However, there will be times when the algorithms do not adequately calibrate the pressure sensor. When this situation occurs, Response will prompt you via a pop-up message to calibrate. This calibration step is a necessary part of delivering accurate, consistent results.

What if I don't calibrate the sensor?

Response delivers a vertical location measurement whether your device is calibrated or not. Calibration when requested will greatly increase the accuracy of that measurement.

In the illustration on the right, you'll see two devices – one that has been recently calibrated, and one that has not. In this example, the actual location of the phone is 11m HAT. The calibrated phone HAT reading is 11.5m HAT, whereas the uncalibrated phone HAT reading is 15.6m HAT, with a much larger error because it is not calibrated. Over time, this error will increase to the point that the HAT measurement becomes less meaningful for everyday use.

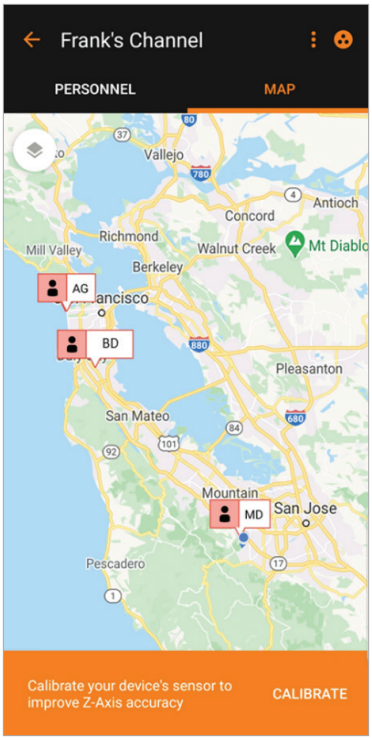


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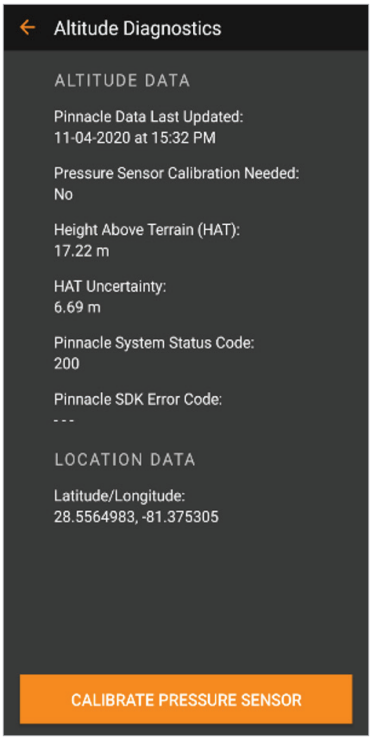
HOW TO CALIBRATE THE SENSOR IN YOUR DEVICE

1. Response will prompt you to calibrate while you are using the app. For example, you will see a message pop up like the one shown at right. To calibrate, simply touch the "calibrate" button in the right half of this message.

2. If you dismiss the automated Response message and chose to calibrate at a more convenient time, you can navigate to the altitude diagnostics screen. On that screen, to calibrate your device, simply tap the "calibrate pressure sensor" button at the bottom of the screen. You will likely see an improvement in vertical accuracy immediately after you calibrate, and we recommend you do not delay calibrating when prompted if vertical location accuracy is important to you at that time.



1



2

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HOW TO CALIBRATE THE SENSOR IN YOUR DEVICE CONT.

For maximum accuracy, it's important to provide the sensor with ideal conditions to form a proper baseline. Here are the critical steps you can take to ensure proper calibration:

1. Start by finding the proper place to calibrate your device. You must be outside. You should stand at least ten feet or more from any building, structure, or overhang. The ideal place is a flat, open area where nothing is above you. Since wind changes the atmospheric pressure around you in unpredictable ways, the ideal place for calibration is a calm area where the is little or no wind.

2. The app will then prompt you to confirm your horizontal location. The app will approximate your current location based on x-y data from your device, and display that location as a blue dot. That blue dot is only for reference to help orient you to approximately where you are standing. You are then asked to place the pin exactly where you are standing by dragging the pin to your actual current location on the map. The pin cannot be placed on a building footprint, or the calibration will fail.

3. When the device is calibrating, it's important to remain as still as possible. This allows the sensor to create a baseline measurement with a minimum of variation.



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HOW TO CALIBRATE THE SENSOR IN YOUR DEVICE CONT.

Calibration Messages

When the calibration process is complete, you'll see one of four messages.

"Thank you for optimizing your device altitude"

- This message indicates **Calibration PASSED**
- Your device is calibrated and ready to use

"Unable to successfully Calibrate" – "Please try a different place"

- This message indicates **Calibration FAILED**
- If your pin was placed on a building, or the terrain you're on is too steep, or you're outside of the vertical location service area, you'll see this message. Try moving to a flatter place, and make sure to place the pin in the open area where you're standing. You may also want to check that you are in the service area.

"Unable to successfully Calibrate" – "Network connection not available"

- This message indicates **Calibration FAILED**
- You'll see this message if there's no data connection from your device to a cellular or data network. Try checking your LTE and data connections.

"Unable to successfully Calibrate" – "Pressure sensor data not stable"

- This message indicates **Calibration FAILED**
- You'll see this message if the phone was moved around too much during the calibration process, or if wind resulted in too much change in the sensor readings. Try moving to a place where there's no wind and hold the device as steady as you can.

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VERTICAL LOCATION UNCERTAINTY

The term **"location uncertainty"** is used to describe statistical confidence for any vertical location measurement.

An uncertainty measurement is derived by combining the error contribution from different elements of the system used to calculate vertical location. These include the phone's barometer calibration status, measurement quality, location of the phone, altitude station network measurement quality and other factors.

In many 2D mapping applications, the size of the "blue dot" which shows your location is a visual indicator of uncertainty. The larger the blue dot, the lower confidence that your exact location is being displayed. The uncertainty measurement for vertical location is indicated in Response by a red/yellow/green dot shown on the user card displayed in the map view.

General Overview:

Here is a general overview of what the different color dots mean when it comes to uncertainty of a person's vertical location being viewed on the map (remember, you are viewing the uncertainty of their vertical location, not your own):

Green dot: "Good" location confidence (about one floor)
Yellow dot: "Okay" location confidence (1-2 floors)
Red dot: "Poor" location confidence (2+ floors)

On the altitude diagnostics screen, the uncertainty of your own vertical location can be observed. Here, instead of being displayed as a colored dot, an absolute number is used for your own uncertainty.

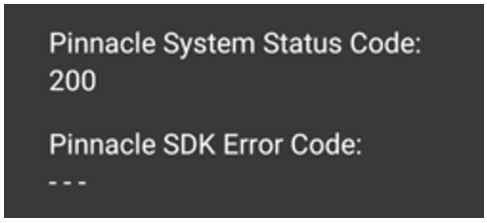
Since the altitude uncertainty measurement comes from a combination of factors that are unique to each phone, it will vary from device to device. Two devices placed side-by-side may have very different uncertainty measurements associated with them. How recently the phone was calibrated affects the measurement uncertainty. In some cases, changing weather conditions or micro-climates will prompt greater uncertainty. In others, the brand of barometer used in a particular phone may involve more frequent "drift" in measurements. Hilly terrain can also prompt uncertainty, as the system finds it difficult to measure where "ground level" truly lies.

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STATUS CODES

Below are the status and error codes associated with Response that may appear on the Altitude diagnostic screen in the fields described earlier.

Normal operation is identified as shown:



Pinnacle Service Area Coverage Map: https://nn-att-coverage.s3.us-east-2.amazonaws.com/att2.html

A Status Code of **600** means you're not in a service area, and a **200** means things are operating as expected, and if you are having difficulty and getting a different code, then to please provide that info to support at support@intrepid-networks.com so we can better support you.

Pinnacle System Status Codes:

These appear in the Altitude Diagnostics tab, in the fifth item from the top. If you reach out for customer support, you may get asked which of these status codes is present.

Code	Description
200	System is normal
400	Cloud server error
600	X-Y location is outside Pinnacle service area
610	Pinnacle assistance data is not available
620	Pinnacle calibration data is not available
630	Combination of 610 and 620 Codes
640	Pinnacle calibration data is stale

Pinnacle SDK Error Code:

The Pinnacle SDK Error Codes appear in the Altitude Diagnostics tab, in the fifth item from the top, below the Pinnacle System Status code field. If you reach out for customer support, you may get asked if there is a Pinnacle SDK Error Code reading. The SDK Error Code will be a 3-digit number in the form of "8xx" or "4xx."

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