Atlas User Guide

Version 1.5

Revision History

Version	Date	SW Version	Description
1.0	2020-11-1	v1.0.0+	Initial version
1.1	2020-12-1	v1.8.0+	● Added coarse calibration specification and calibration procedure details ● Documented REST API
1.2	2021-3-4	v1.12.0+	● Changed REST device status `error` field to `notices` array ● Added additional modes to REST `clear_state` message ● Added details about recording FusionEngine output
1.3	2021-5-28	v1.13.0+	● Changed `/v1/device/status` response ○ Renamed `developer_mode_enabled` to `developer_features_enabled` ○ Moved `notices` to the top of the message
1.4	2021-8-27	v1.14.0+	● Changed `/v1/log/status` response ○ Added `log_sequence_num` to logs entries
1.5	2022-2-8	v1.15.1+	● Updated device panel drawings ● Added REST commands for settings import/export and GNSS corrections source configuration

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1. Introduction

This guide will familiarize you with the Point One Atlas inertial navigation system and provide step-by-step instructions for using it.

To use Atlas you will need:
- An Atlas device
- An Ethernet or Wi-Fi network with an internet connection
    - Ethernet required for initial setup
- A computer or tablet device
- A GNSS antenna
    - Triple-frequency (L1/L2/L5) recommended
- A connection to your vehicle's CAN bus, used for wheel speed measurements
    - Recommended for best performance, but not required

> Note: CAN message formats vary by manufacturer and vehicle model/year. Please contact Point One to enable support for your vehicle's CAN data.

1.1 Getting Started
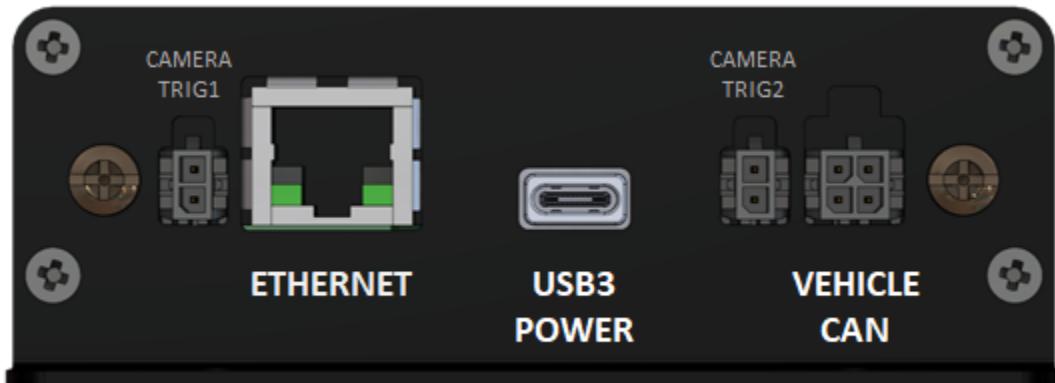
Follow these steps to begin using your new Atlas device:

1. Rigidly mount the device and carefully measure the lever arms as described in Section 1.3.
2. Connect the device to a GNSS antenna and an Ethernet network as described in Section 1.2.
    - Note: The Ethernet network must have DHCP and an available internet connection. For normal operation Atlas can use a Wi-Fi connection and/or static IP address, but it does not currently support Wi-Fi or static IP for initial setup.
3. Connect power to the device.
4. Scan the QR code on the top of the device with a computer or tablet on the same network as Atlas, then follow the listed URL. This will automatically detect the IP address assigned to your device and take you to the device's user interface webpage.
    - Note: If you are not on the same network as your Atlas device, the webpage referenced by the QR code will simply display Atlas's assigned local IP address, which you can enter into a browser manually.
    - It may take up to 30 seconds for Atlas to boot before the web page displays the IP address.
5. On the UI menu, select **Settings**, then enter the device orientation and lever arms you measured in step 1 and click **Save**.
    - By default, Atlas outputs the position of the body frame (center of the rear axle). You can configure the output lever arm to relocate the position to anywhere you would like on the vehicle.

6. Navigate to the **Map View** page.
7. Click the **Start Navigating** button.

Note: The GNSS antenna must be outside in view of the sky for the device to navigate for the first time.

1.2 Connections

Figure 1: Atlas back panel connections.

Figure 1 shows the available connections on the back panel of your Atlas device. Atlas can be powered either via USB C or through the 4-pin CAN connector.

Note: Powering Atlas via USB C requires a 2A-capable power adapter. Atlas may not work reliably with some USB hubs. We recommend using the included power adapter.

The CAN bus connector is oriented as follows:
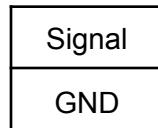
CAN H	CAN L
Vin	GND

Table 1: CAN bus pinout.
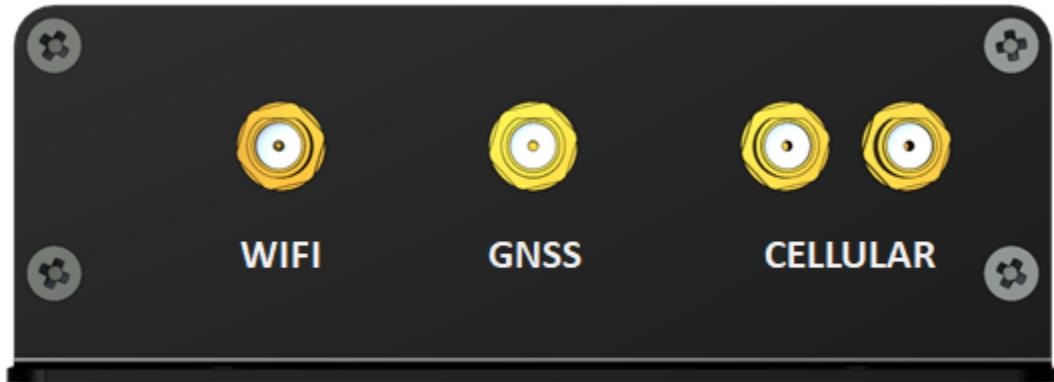
The CAN H and CAN L connectors are *not* terminated with a 120 ohm resistor.

The Vin pin on the CAN connector may be used to power Atlas. It can accept DC voltage levels from +5.5V to +55V, and is typically connected to the vehicle's +12V auxiliary power bus. The Vin pin can be omitted if Atlas is powered via USB C and vice versa.

The camera triggers are +3.3V signals, oriented as follows

| Signal |
|--------|
| GND |

Table 2: Camera trigger pinout.

Figure 2: Atlas front panel connections.

The front panel of the device, shown in Figure 2, has four SMA RF connectors. The left-most connector is for an external Wi-Fi antenna (included). Note the Wi-Fi SMA connector is the "reverse polarity" variant.

The middle connector is for the GNSS antenna. It is designed to be used with a powered antenna/LNA, and provides a 3.3V DC supply voltage.
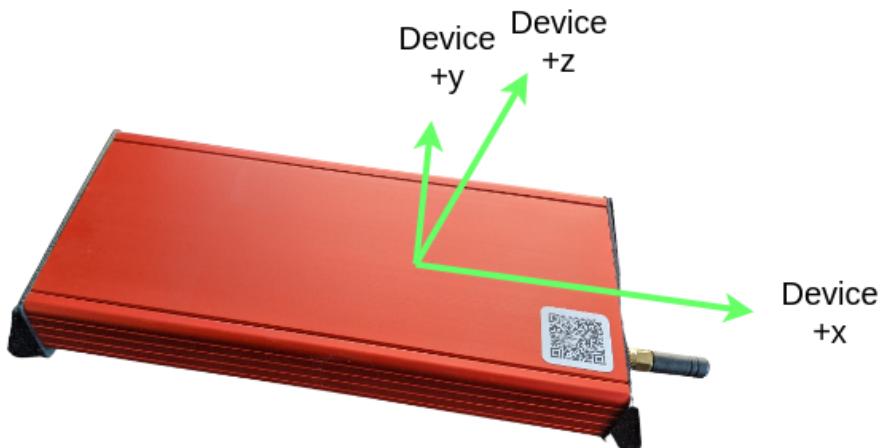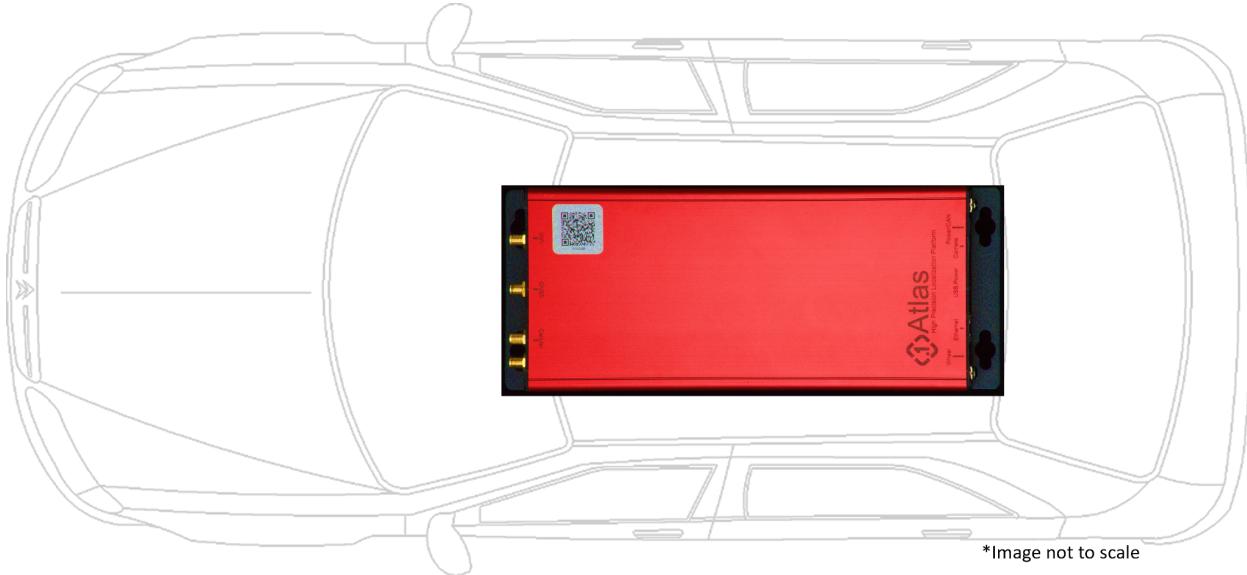
Warning: If your antenna is already powered by another source (another GNSS receiver, powered bias-T, etc.), you must attach a DC block between the power source and the Atlas antenna connection to avoid damage to the Atlas GNSS receiver.

The two connectors on the right are for an optional cellular antenna, used to connect to the internet by Atlas devices configured with an internal cellular model in order to receive GNSS corrections data.

Note that the Atlas cellular connection cannot currently be used to serve map data or provide internet access to other connected devices such as a laptop.

1.3 Installation

1.3.1 Orientation

*Image not to scale


Figure 3: Recommended device orientation.
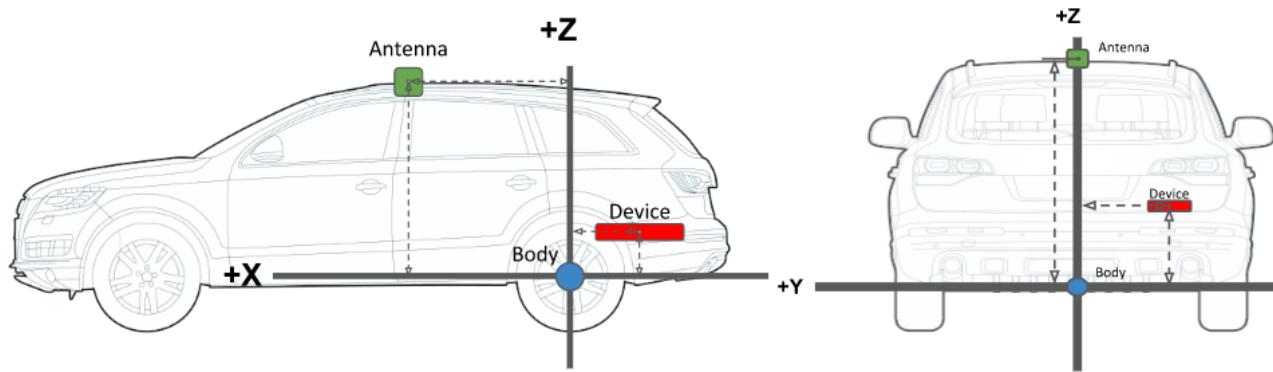
Both Atlas and the GNSS antenna must be mounted rigidly to your vehicle. The device calibration procedure will estimate the angle between the device (IMU) axes and the vehicle body axes (see Section 1.3.3). For best performance, you should try to install it so that the device axes are aligned as closely with the vehicle axes as possible.

Note: If the device lever arm or orientation changes (i.e., Atlas is moved), the existing calibration will no longer be valid and the device will need to be recalibrated.

We recommend installing Atlas with its x, y, and z axes matching the vehicle body frame (see Section 1.3.3). In this orientation, the top panel (the panel with the QR code sticker) will face up towards the roof of the vehicle and the front panel (the panel with the SMA antenna connectors) will face forward toward the front of the vehicle.

If you orient it differently, make sure to specify the correct orientation when configuring the device settings (see Section 2.1.4).

## 1.3.2 Measuring Lever Arms

Figure 4: Body frame and lever arm definition

Once installed, you must measure the lever arms from the vehicle body frame to both Atlas and the GNSS antenna. For best performance, it is important to measure the lever arms as accurately as possible.

The Atlas body frame is a right-handed coordinate system centered at the middle of the rear axle of the vehicle, and oriented as follows:

> +x - Toward the front of the vehicle
> +y - Toward the left side of the vehicle
> +z - Up

The lever arms are defined as the vector to the sensor from the vehicle body frame origin, resolved in the body frame. For instance, if the Atlas device is located behind and above the rear axle, toward the right-hand side of the vehicle (as in the diagram above), then the Atlas lever arm will have a negative x component, a negative y component, and positive z component. Ideally these measurements will be accurate to better than 5 cm.
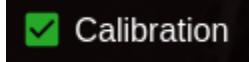
The lever arms should be measured at the nominal phase center of the antenna, and at the nominal center of the IMU within the Atlas device, which is approximately the center of the

chassis. For an exact measurement, mark the top lid 12 cm inward from the USB C connector and 5 cm inward from the long edge of the case. You should measure to this point when configuring the device location.

1.3.3 Device Calibration

When you first use your Atlas device, it will need to be calibrated. The calibration procedure accurately measures the orientation of the device with respect to the vehicle axes by analyzing navigation performance over time. For best calibration results, it is important to measure the lever arms as accurately as possible (see Section 1.3.2).

To calibrate your device, first go to the **Settings** page and specify the device orientation and the lever arms you measured previously. Then, simply turn the device on by clicking **Start Navigating** and drive normally. Depending on your driving and the route you take, the calibration procedure may take some time to converge (typically 50 km or less). Note that turns and other manoeuvers can help the calibration converge faster.

When finished, the calibration indicator on the UI will light up green (see Section 2.1.1) to indicate that the calibration was successful and the system is ready for precision operation.

2. Operating Atlas

This section includes detailed information for using your Atlas device.

2.1 User Interface Overview

2.1.1 Map View

The map view is accessed by clicking the ▲ icon on the left toolbar.
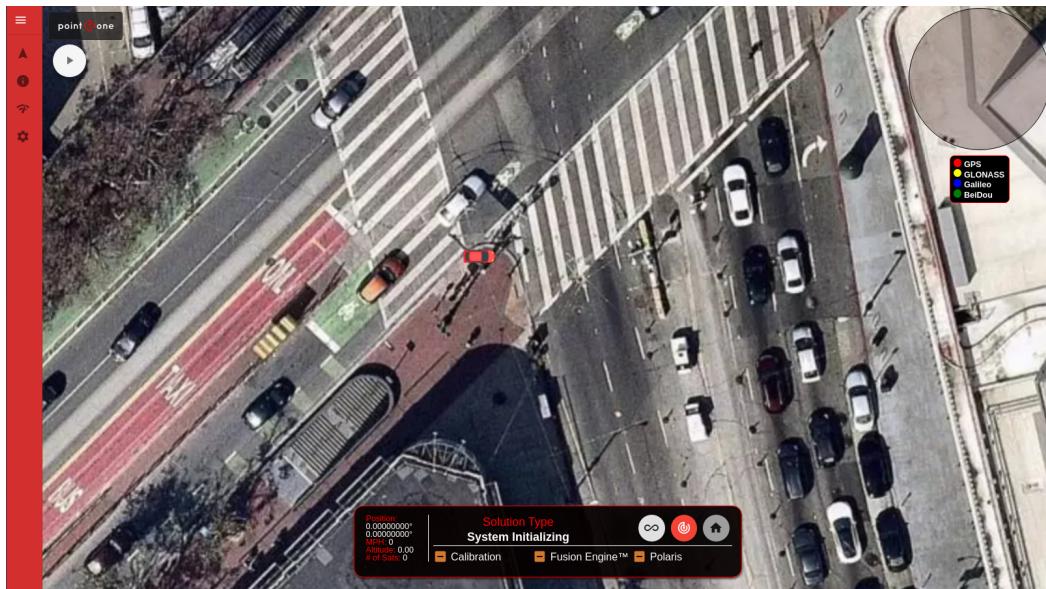
Figure 5: UI map view page.

The map view displays your vehicle's position and status in real time as the system navigates.
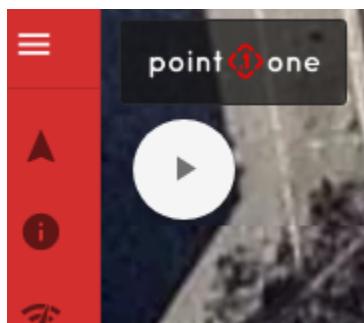
Figure 6: Map view start button.

Use the button in the upper left corner of the display to start and stop the navigation engine. Each time you start navigating, the system begins recording a new data log. See Section 3 for details.
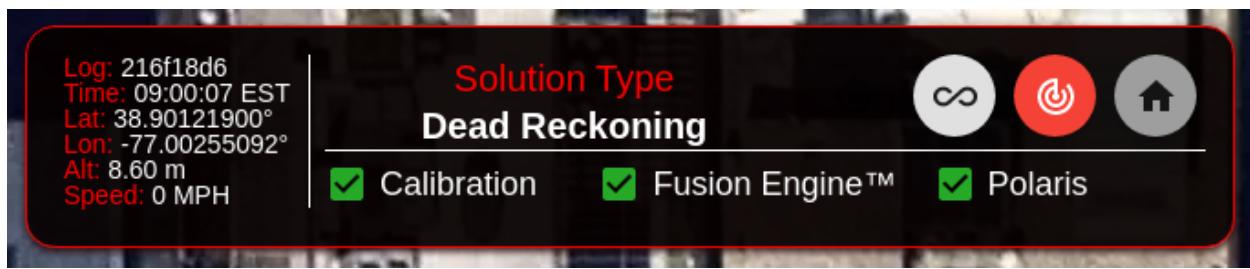
Figure 7: Map view dash panel.

The dash panel shown in Figure 7 provides a detailed view of the current solution in real time when the system is operating.

The **Solution Type** in the center indicates the current navigation mode: GNSS RTK fixed, standalone GNSS, dead reckoning, etc.

The panel on the left shows the current WGS-84 latitude and longitude, vehicle speed in MPH, vehicle altitude (above the WGS-84 ellipsoid), and the number of available GNSS satellites.

The three boxes on the bottom indicate the current calibration status, the status of the navigation engine (running or not), and the status of the connection to the Point One Polaris RTK network.

2.1.2 Device Status View

The device status view is accessed by clicking the icon on the left toolbar.

Figure 8: Device status view panel.

The device status page shows the current software version and status, along with the status of recorded log data (see Section 3.2).

Use the **Start Navigating** button to start and stop the navigation engine.

The **Reset Navigation Engine** button clears the system's knowledge of the position and attitude history by performing a *cold start* of the navigation state. It is typically not necessary to cold start the navigation engine, but this feature may be used when troubleshooting. Performing a cold start does *not* reset the device calibration.

Figure 9: Log action buttons.

By default, Atlas records a log of the incoming sensor data and navigation results as it operates. In the event that you need assistance, logs can be uploaded to Point One by pressing the **Upload** button.

Warning: Log data is not deleted automatically. If the disk fills up, Atlas will continue navigating but will no longer record data for post-processing or troubleshooting.

2.1.3 Detailed Status View

The detailed status view is accessed by clicking the icon on the left toolbar.

REFERENCE STATUS

STATUS:
PACKET AGE: 1604865574.822
NUMBER OF PACKETS: 50

POLARIS RTCM CORRECTIONS

BASE STATION: 664
CORRECTIONS AGE:
0.5536758899688721
GPS SATELLITES: 10
GLONASS SATELLITES: 10

```
{
  "1004": 0.05,
  "1005": 2.9,
  "1074": 0.04,
  "1084": 0.04,
  "1094": 0.02,
  "1114": 0.02,
  "1124": 0.02
}
```

CALIBRATION STATUS

Current stage:
Performing Fine Alignment (2)

Yaw: 0.03 deg
Pitch: 1.29 deg
Roll: -0.43 deg

Distance: -0.0 m (min 7000 m)
Yaw std: 1.00 deg (max 0.3 deg)
Pitch std: 0.13 deg (max 0.08 deg)
Roll std: 0.25 deg [OK]

Figure 10: Example detailed status displays.

The detailed status page shows selected detailed information about the incoming sensor data and the state of the device as it navigates.

2.1.4 Settings View

The settings view is accessed by clicking the ⚙ icon on the left toolbar.

The settings page includes settings for specifying the device orientation, sensor lever arms, controlling desired output data, resetting the device calibration, and more.

2.1.4.1 Orientation Settings

Before using your Atlas device, you must specify its orientation and location within the vehicle. See Section 1.3 for details.

The available settings include:

- **GNSS Antenna Lever Arm** - The location of the GNSS antenna
- **Device Lever Arm** - The location of the IMU internal to the Atlas device (see Section 1.3.2)
- **Device Orientation** - The coarse (90 degree) rotation of the device with respect to the vehicle body axes (see Section 1.3)

- **Output Lever Arm** - The location where the generated vehicle position solution will be located

All lever arms are measured with respect to the center of the vehicle's rear axle.

Note: If the device lever arm or orientation changes (i.e., Atlas is moved), the existing calibration will no longer be valid and the device will need to be recalibrated.

2.1.4.2 Network Settings

The **Network Settings** panel provides controls for configuring the Atlas Ethernet and Wi-Fi interfaces. You may enable one or both interfaces, and can configure each for static IP or DHCP.

2.2 Starting/Stopping Navigation
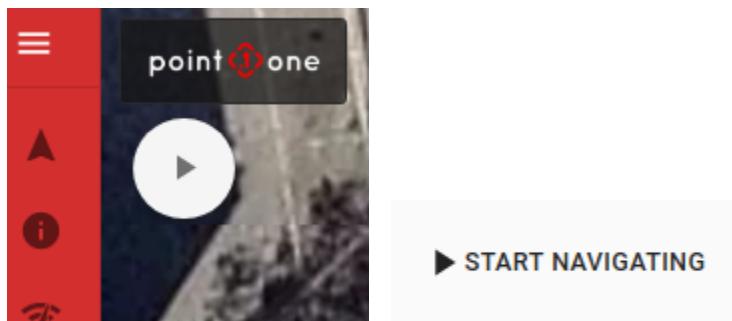
Figure 11: Start/stop buttons.

To begin navigating, click the **Start Navigating** button in the top left corner of the UI **Map View** page, or on the **Device Status** page. When finished, click **Stop Navigating** to stop logging.

If you wish, you can configure the device to start logging automatically when it is powered on by selecting **Start navigating automatically on boot** on the **Settings** page.

2.3 Resetting The Device

Atlas devices support a number of increasingly complete reset modes, which can be accessed on the **Settings** page. They are:

- **Reset Position Data** - Perform a *cold start*, clearing the previous position and attitude information.

- **Reset Navigation Engine** - Clear the previous position and attitude information, along with automatically learned parameters (e.g., the tire inflation).

- **Reset Calibration** reset the navigation engine and the device calibration data. This is typically only necessary if the device or GNSS antenna has moved with respect to the vehicle body.

- **Factory Reset** - Clear the entire device state, including all settings and logged data.

3. Data Interfaces

3.1 Output Interfaces

3.1.1 Point One FusionEngine

Atlas uses the Point One FusionEngine protocol to send and receive data and commands in real time, as well as log data for post-processing. See https://github.com/PointOneNav/fusion-engine-client for message definitions, support source code, and tools for post-processing and data analysis.

To configure the FusionEngine output, go to the **Settings -> Output Settings** panel. From there you can configure which output messages you would like to receive, and your desired output data rate.

The FusionEngine interface can be used in real time by connecting to TCP port 30201, or by sending data to a specified UDP destination hostname/IP address and port. Once connected, you will automatically receive configured data messages as the system operates.

In addition to real-time communication, you can configure the device record FusionEngine messages to disk, generating a `fusion_engine.p1log` binary file. The recorded data can be downloaded later for post-processing.

3.1.1.1 ROS Message Support

FusionEngine supports a selection of messages that are designed to be content-compatible (but not byte-compatible) with corresponding ROS messages for easy integration into ROS. These include the ROS Pose, GPSFix, and IMU messages.

ROS messages can be enabled to be sent along with all other FusionEngine messages on the **Settings -> Output Settings** panel.

3.1.2 NMEA 0183

Atlas also includes support for generating selected messages from the NMEA 0183 standard in real time. To receive NMEA data, connect to TCP port 30200, or configure a UDP destination on the **Settings -> Output Settings** control panel.

Atlas currently supports the following NMEA messages:
- GPGGA
- GPRMC
- GPGSA
- GPGSV

3.2 Data Logging

Atlas creates a new log with an automatically generated ID each time you start navigating. Logs contain all incoming sensor data and internal information in a proprietary Point One format, as well as a binary file containing all FusionEngine messages that were generated in real time (if enabled). Data logs are designed to be used for:

- Post-processing data analysis (see Section 3.1.1)
- Customer assistance from Point One

Logs can be downloaded to your local machine by clicking the **Download** button on the **Device Status** page. This will generate a `*.tar.gz` file that you can extract locally. The extracted log directory will contain a `fusion_engine.p1log` file containing FusionEngine message content that you can use for offline analysis. See Section 3.1.1. All other files are meant for Point One internal use only.

If you encounter an issue and require further assistance, you may either download the log and send it, or click the **Upload to Point One** button to send the log to Point One automatically for processing (the device must remain on and connected to the internet while uploading the log). When uploading a log for assistance, please send an email to support@pointonenav.com, detailing any issues you encountered.

3.3 REST Control API

Atlas includes an HTTP REST API, which can be used to programmatically control the device. This is the same interface that is used by the UI to interact with the device. This section outlines the various supported commands and expected responses.

The HTTP interface is hosted on port 80. To use the REST API, send HTTP GET or POST requests to `http://DEVICE_IP/PATH`, where `DEVICE_IP` is the IP address of the Atlas device and `PATH` is the query path for a command listed in the sections below. For example, to start the navigation engine for a device with IP address `1.2.3.4`, issue a POST request to:

```
http://1.2.3.4/api/v1/application/start
```

3.3.1 Device Controls

3.3.1.5 GET /api/v1/device/status

Get the current device status.

Responds with a 200 response and a JSON object as follows:
- `platform_type` - A platform type name (i.e., `Atlas`)
- `platform_version` - The platform version string
- `device_uuid` - The unique ID assigned to the device
- `device_name` - The human-friendly device name
- `sw_release_uuid` - The unique ID of the software release running on the device
- `performing_reset` - `true` if a factory reset is in progress (optional)
- `nav_engine` - Navigation engine (Nautilus) status
    - `version` - The version of the Nautilus software
    - `status` - The current status of the navigation engine: `running`, `stopped`, `unknown`
- `developer_features_enabled` - `true` if developer mode is currently enabled
- `notices` - A list containing the most recent notifications from the device (errors, warnings, etc.). Cleared automatically on return. Each entry is an object containing:
    - `time` - The POSIX timestamp (in seconds) when the error occurred
    - `message` - The message string
    - `type` - The type of message (`info`, `warning`, `error`, `critical`)
    - `id` - A string ID providing context for this message, or `None` if not applicable

Example:

```
$ curl -X GET \
    "http://<IP_ADDRESS>/api/v1/device/status"
```

Response:

```
{"device_name":"bob_loblaw","device_uuid":"40fa62f7a85eb88f5548acf3
a13812c0","nav_engine":{"developer_mode_enabled":false,"log":null,"
notices":[],"status":"stopped","version":"v1.12.0"},"performing_res
et":false,"platform_type":"Atlas","platform_version":"2","sw_releas
e_id":"449f7dbe613b656b20a8e7e196fb4b32"}
```

3.3.1.6 POST /api/v1/device/factory_reset

Perform a factory reset. The navigation engine will be stopped automatically if it is currently running.

When successful, responds with an empty 200 response.

This is the same as `/api/v1/application/clear_state` with `"type":` `"factory_reset"`.

Example:

```
$ curl -X POST \
    "http://<IP_ADDRESS>/api/v1/device/factory_reset"
```

3.3.2 Navigation Engine Controls

3.3.2.1 POST /api/v1/application/start

Start the navigation engine if not running.

When successful, responds with an empty 200 response.

Example:

```
$ curl -X POST \
    "http://<IP_ADDRESS>/api/v1/application/start"
```

3.3.2.2 POST /api/v1/application/stop

Stop the navigation engine if running.

When successful, responds with an empty 200 response.

Example:

```
$ curl -X POST \
    "http://<IP_ADDRESS>/api/v1/application/stop"
```

3.3.2.3 POST /api/v1/application/clear_state

Perform one of the reset operations described in Section 2.3. The navigation engine will be stopped automatically if it is currently running.

When successful, responds with an empty 200 response.

Request body:

A JSON object containing a `type` parameter with one of the following values:
- `cold` - Reset the position data
- `nav_engine` - Reset the navigation engine
- `calibration` - Reset the navigation engine and calibration data
- `factory_reset` - Perform a full factory reset

Example:

Reset the device calibration:

```
$ curl -X POST \
    "http://<IP_ADDRESS>/api/v1/application/clear_state" \
    --header "Content-Type: application/json" \
    --data '{
        "type": "calibration"
    }'
```

3.3.2.4 POST /api/v1/application/reset_calibration

Reset the device calibration and previous position state. The navigation engine will be stopped automatically if it is currently running.

When successful, responds with an empty 200 response.

This is the same as `/api/v1/application/clear_state` with `"type": "calibration"`.

Example:

```
$ curl -X POST \
    "http://<IP_ADDRESS>/api/v1/application/reset_calibration"
```

3.3.2.5 GET /api/v1/application/get_corrections_settings

Get the current GNSS corrections settings.

Responds with a 200 response and a JSON object containing the keys described in Section 3.3.2.6.

Example:

```
$ curl -X GET \
  "http://<IP_ADDRESS>/api/v1/application/get_corrections_settings"
```

Response:

```
{"protocol": "ntrip", "ntrip_hostname":
"ntrip.polaris.pointonenav.com", "ntrip_port": 2101,
"ntrip_mountpoint": "polaris", "ntrip_password": "password1234",
"ntrip_username": "p1"}
```

3.3.2.6 POST /api/v1/application/set_corrections_settings

Set the GNSS corrections settings on the device.

When successful, responds with an empty 200 response.

Request body:

A JSON object containing the following values:
  ● `protocol` - The corrections source to be used: `polaris` or `ntrip` [required]

NTRIP parameters (ignored if `protocol` is `polaris`)
  ● `ntrip_hostname` - The hostname of the NTRIP server [required]

- `ntrip_port` - The TCP port of the NTRIP server [required]
- `ntrip_mountpoint` - The name of the desired NTRIP mountpoint [required]
- `ntrip_username` - A username used to authenticate with the NTRIP server [optional]
- `ntrip_password` - A password used to authenticate with the NTRIP server [optional]

Example:

Connect to the Point One Polaris network using the native Polaris protocol:

```
$ curl -X POST \
  "http://<IP_ADDRESS>/api/v1/application/set_corrections_settings" \
  --header "Content-Type: application/json" \
  --data '{
    "protocol": "polaris"
  }'
```

Connect to the Point One Polaris network using NTRIP:

```
$ curl -X POST \
  "http://<IP_ADDRESS>/api/v1/application/set_corrections_settings" \
  --header "Content-Type: application/json" \
  --data '{
    "protocol": "ntrip",
    "ntrip_hostname": "ntrip.polaris.pointonenav.com",
    "ntrip_port": 2101,
    "ntrip_mountpoint": "polaris",
    "ntrip_username": "p1",
    "ntrip_password": "password1234"
  }'
```

3.3.2.7 GET /api/v1/application/export_settings

Export all device settings as a Zip file.

Responds with a 200 response with MIME type `application/zip` and a Zip file containing the exported configuration settings.

Example:

```
$ curl -o settings.zip -X GET \
  "http://<IP_ADDRESS>/api/v1/application/export_settings"
```

Response:
Downloads a file called `config.zip` in the current directory.

3.3.2.8 POST /api/v1/application/import_settings

Import a zip folder containing exported settings files as returned by an `export_settings` request (see Section 3.3.2.7). All current configuration files will be deleted and replaced with the imported files.

When successful, responds with an empty 200 response.

Example:

Import a file called `config.zip` from the current directory.

```
$ curl -X POST \
  "http://<IP_ADDRESS>/api/v1/application/import_settings" \
  --form "file=@config.zip;type=application/zip"
```

Appendix: Recommended Calibration Procedure

- ☐ Drive to an open sky area such as a parking lot
- ☐ Come to a complete stop and stay stationary for about 15 seconds
- ☐ Drive in a figure 8 pattern for about 3-4 minutes, making sure to alternate left and right turns.
- ☐ Come to a complete stop again and wait about 30 seconds.
- ☐ Perform a U-Turn
- ☐ Drive in a figure 8 pattern for about 3-4 minutes, making sure to alternate left and right turns, following your previous route approximately but going in the opposite direction.
- ☐ Come to a complete stop again and wait about 30 seconds.
- ☐ Perform normal driving until the "Calibration" light changes to green. This can take an extended period of time (45 minutes) depending on the distance traveled and the dynamics experienced by the vehicle.