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# AssetPack 3™ User Manual

V7.0.2



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## Revision History

Revision	Date of Release	Purpose
Initial Draft	12/03/2014	Initial Release for beta testing
Version 1.0	2/1/2015	Update for customer distribution
Version 4.0	2/15/2015	Update based on FAQs
Version 4.1	2/26/2015	Corrections to Specifications Appendix
Version 4.1.1	3/1/2015	Updates to miscellaneous specifications and certification details
Version 4.1.2	6/15/2015	
Version 4.1.3	9/30/2015	
Version 5.0	3/10/2016	Update to Tracker / Hub architecture
Version 5.0.1	5/3/2016	Wall mounting material compatible with VHB tape
Version 6.0	10/3/2016	Update for HUB
Version 6.1.1	10/16/2016	Revision for UL Safety
Version 6.1.2	10/25/2016	Revision of Format
Version 7.0	01/18/2018	Updated for ATEX Zone 2
Version 7.0.1		
Version 7.0.2	10/05/2018	Revision of Format

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## Table of Contents

Revision History .....	2
Introduction .....	4
Product Features .....	5
AP3 Feature Overview .....	5
SETUP .....	5
Device Modes and Activation .....	5
Long-term Storage .....	6
Long-Term Storage Procedure:.....	7
Placing your Unit Outside .....	7
Mounting the AssetPack-3 .....	8
Intrinsic Safety in Hazardous Locations .....	0
Configuration.....	2
FOR DEVELOPERS AND INTEGRATORS ONLY .....	2
Sensors and Part Numbering Conventions .....	2
Additional AP3 Features: .....	5
Pinout Definitions .....	6
6-Pin Connector Arrangement.....	8
OPERATIONS .....	9
Two Way Duplex Operations .....	9
Battery Charging .....	10
Mode Architecture .....	11
Power Save and Power Recovery Modes.....	12
Air Shipping Guidelines .....	13
Troubleshooting / FAQ's .....	13
If no messages have been received from the unit:.....	13
No GPS location or incorrect GPS location .....	14
Appendix A: Technical Support.....	16
Appendix B: RF Radiation Exposure Statement.....	17
Appendix C: Regulatory Notices .....	18
Appendix D: Environmental and Safety .....	20
Specifications .....	21

## Introduction

The AssetPack-3™ (AP3™) is a fully self-contained, highly reliable and environmentally sealed global satellite tracking and sensor monitoring device. On the one hand, it is an “out-of-the-box, move-the-magnet, slap-and-track GPS asset tracker.” On the other, it is a sensor interface, installed at the edge of the industrial Internet of Things (IoT) systems, allowing location data, equipment condition, and environment data to be measured, sent and received by M2M/IoT Resellers and product Integrators.

The AP3 is usually attached to the customer’s equipment with VHB tape, magnet-mount or bolted on. It determines its location using GPS, and then securely transmits that location over the Iridium™ low earth orbit (LEO) satellite network to a secure ground station. This location data, along with any (optional) sensor information, can then be retrieved from secure cloud-based servers and applications from any authorized location in the world, for asset management, improved asset utilization and industrial monitoring purposes.



The AssetPack-3 is reliable, economical, convenient, and highly customizable:

- **Reliable and Secure Satellite Network.** In addition to using GPS to obtain its own position on the earth, the AP3 communicates its information to authorized users via the Iridium Short Burst Data (SBD) Service over a network of 66 orbiting Iridium communications satellites. It does not connect with cell towers or other terrestrial radio infrastructure, and the Iridium constellation covers 100% of the earth’s surface, so the AP3 operates from anywhere and everywhere on the planet (outdoors) without “roaming charges” or other network-related limitations. The Iridium satellite service utilizes a low power, two-way transceiver to send and receive data from around the world to back office servers accessible over the Internet through secure connections.
- **Wireless Operation.** The AP3 is powered by a solar panel and requires no plug-in wires or extra battery harnesses for use. With its solar panels, it operates for 5-7 years (conservatively) without maintenance or battery changes.
- **Remote Operation.** The AP3 is configurable and command-able over the air (OTA), both for field functionality and for OTA software and firmware upgrades.
- **Backup and Alternate Power.** The AP3 can optionally be powered via hardline DC power (vehicle power at 10-18V). The unit has internal Lithium Ion rechargeable batteries for operation. It carefully manages power to stay healthy and to provide an extended lifetime and resilient operating patterns, even in challenging situations and extreme environmental conditions.
- **Flexible Configuration.** The AP3 can also be connected to and monitor multiple analog or discrete sensors as well as use a serial port via flexible Inputs/Outputs (I/O).

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This User's Manual describes how the AssetPack-3 hardware is configured. This document provides a generalized overview only. Consult AssetLink Global for more details and options for relaying data and configuration.



**Please note, if the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired and/or warranties may be compromised.**

## Product Features

The AP3 is a tracking device (GPS) with intelligent onboard processing capability. It also has multiple I/O's, with two analog or digital I/O's and a serial connection.



**For specific configurations for your device, see your customer-specific AP3 User's Manual Configuration Annex, if available.**

## AP3 Feature Overview

- Tracks assets "Everywhere, Forever" with user-customizable transmission rates (subject to power and/or environmental limitations)
- Contains GPS and onboard motion sensors
  - Motion can trigger alternate transmission rate
- Onboard memory for deep data logging
- Internal geofencing for up to 10,000 coordinate points, able to be updated OTA and/or pre-loaded at time of manufacture, can trigger alternate transmission rate
- Comes with device management and maintenance support
- Firmware upgradeable OTA
- Up to two powered or unpowered analog or digital inputs, for example two 4-20 mA inputs, or two temperature sensors
  - Sensor types available depends on specific hardware configuration
- One RS485 serial I/O (capable of monitoring J1939 with adapter)
- Selectable for line power charging in or sensor power out
- Hard line power enabled (10-18 VDC, up to 500mA)
- Sensor programmable logic OTA
- OTA lossless encryption available

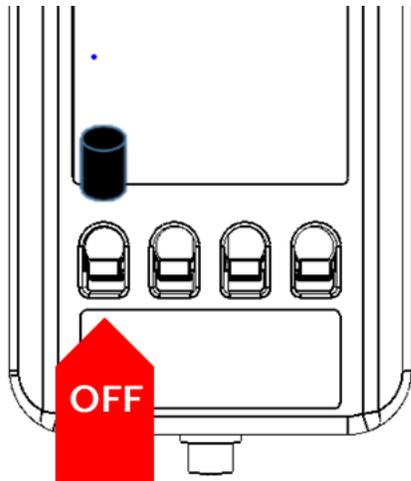
Custom variants are available within each version, based on customer-specific requirements for sensors and firmware setup. See part numbering convention later in this Manual.

## SETUP

### Device Modes and Activation



It is critical that the AP3 magnet is moved to the "ON" position before deployment in the field. If this is not done, the unit is "OFF"; the unit cannot be turned on Over the Air. If the magnet is not moved to the "ON" position, the unit will not function.



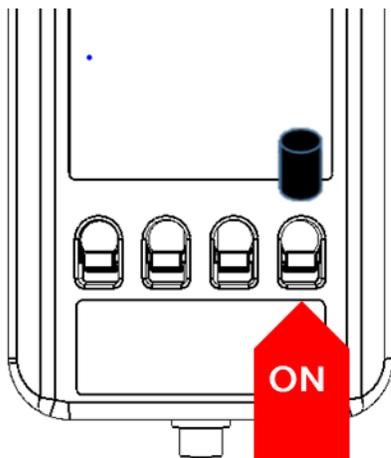
The AP3 is designed to allow users to easily deploy devices. Configuration is as simple as moving the magnet. Test a unit(s) to familiarize yourself with the function of the magnet and the modes before final installation of the unit(s).

When the magnet is moved to ON, a "happy" musical melody will play, followed by a tone indicating the device has been turned on. A deactivation, or "sad" musical tone, will play when the magnet is moved into OFF mode.

Once the device is activated and ON, it can respond to and receive OTA commands.

When the magnet is moved to OFF it is in Storage/Inventory mode. In this mode, the unit will not be able to receive Over The Air (OTA) commands and will not transmit any GPS reports. See the "Long-Term Storage" section for critical

information about storing the unit in OFF mode.



The middle two slots are not used.

If the magnet is removed from the unit, and is then lost or goes missing, the unit will self-activate fifteen (15) seconds after the magnet has been removed from the OFF slot. The unit will operate in the ON mode with no magnet inserted.

However, this should be avoided, as the presence of the magnet in the ON slot helps eliminate risks from stray magnetic fields and any other environmental influences that could trigger an unexpected and unwanted change to the programming of the device.

## Long-term Storage



It is critical that the AP3 magnet is moved to the "OFF" position and charging instructions below are followed prior to long-term storage (>6 months without sky view). **FAILURE TO DO SO WILL VOID THE WARRANTY.**

The AP3 "OFF" mode is designed to keep the rechargeable Lithium-Ion battery safe for long-term storage (for up to two years). The life of the battery in this mode is expected to be two years before recharging is required (placing in sky view). This battery technology and behavior is the same found in cellular phones and laptop computers. **PAY CAREFUL ATTENTION TO THE "LONG TERM STORAGE PROCEDURE" BELOW.**

The OFF mode is almost static, using very little power. In this mode, the unit can go two years before being recharged again.

The unit ships from the factory with a charged battery and in the OFF position, and can be stored indoors for up to two years before action is needed.



**If putting into long-term storage where the unit will not see light or have sky view for greater than 6 months, follow the procedures below:**

### Long-Term Storage Procedure:

1. First, put the magnet in the OFF position. If the magnet has been lost, replacements can be purchased from AssetLink Global.
2. Before placing in storage, charge the battery fully by placing in sunlight (cloudy or winter sun is okay) for a minimum of 35 sun-hours to fully charge the battery. Depending on the latitude and time of year, this process can take up to 14 days.
3. Ensure the storage area is at room temperature and a dry place. (Room temperature is between 15 °C (59 °F) and 30 °C (86 °F))
4. Once per two (2) years, remove the unit from storage and place in sunlight (cloudy or winter sun is okay) for a minimum of 35 sun-hours to fully charge the battery. Depending on the latitude and time of year, this process can take up to 14 days.

## Placing your Unit Outside

Once the magnet is in the "ON" mode slot, place the unit outside. For the unit to successfully transmit messages, the unit should be placed in an area with 80% sky view and the words "THIS SIDE TO SKY" must be visible. This means the unit should be away from buildings and heavy forestry. As a rule of thumb, use the sun as your guide. If the AP3 is in an area that will not get a lot of sunlight, it is possible it will not transmit consistently. A place that gets a lot of sunlight, such as a rooftop or the roof of a vehicle, has a better sky view and will successfully transmit more messages. If you have more than one unit, each unit must be 12 inches (30 cm) apart (side to side, with nothing above or on top of it) to avoid interference.

**NOTE:** Even though a windowsill may get a lot of sunlight, it is not an ideal location to put your AP3. Messages may not transmit because there is a roof directly overhead of the AP3, and many windows have metallic coatings to reflect sun energy, which can interfere with transmissions.



**The AP3 is designed for outdoor use. Do NOT place the AP3 on the dashboard of a car or truck. Do not place in any location where a greenhouse effect (windows allowing sun into a thermally sealed area, creating a "greenhouse") can heat the device to internal temperatures well above +70 C (158 F); the device will not work at this temperature.**

**Mounting Vertically.** Some applications may benefit from vertical mounting, for example to keep clear of snow, for clearance reasons or on open top containers. Mounting vertically is allowed, however there can be negative side effects based on the physics of satellites and the internal AP3 satellite antennae, such that throughput may be reduced.

**Possible risks with vertical orientation include:**

- The GPS performance may degrade as much as ~50m Circular Error Probable (CEP), depending on your location on the earth.
- There could be up to ~20 minute periods of no Iridium satellite in view, dependent on the available view angles.
- There may be less solar power if the vertically-oriented AssetPack3 doesn't always face south in the northern hemisphere, or north in the southern hemisphere, especially if the asset is mobile.

These risks are mitigated by installing the unit with the greatest possible unobstructed sky view.

## Mounting the AssetPack-3

Now that your magnet is in the "ON" position, and you have good sky view outdoors, you can now mount the AssetPack-3.



**Make sure the magnet is moved to the "ON" slot before mounting. After the unit is mounted, it is not easily removed, and IT WILL NOT FUNCTION IF THE MAGNET IS NOT MOVED TO THE "ON" SLOT.**

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Surface Preparation for applying VHB Tape (the AP3 is usually shipped with VHB tape already mounted on the back side, as shown below):

1. ONLY use the 3M VHB tape provided or 3M part number 5952.

2. [IF YOU MUST ATTACH VHB TAPE TO THE AP3: If the unit has old VHB tape still attached, you must first clean the AP3 as described in steps 3 and 4 and then remove the liner of the VHB tape and apply it to the underside of the unit. Use a roller or the heel of your hand to firmly press the tape into place.]
3. DE-GREASE THE MOUNTING SURFACE OF THE ASSET: Thoroughly clean the surface area of the asset where the AP3 will be mounted. Make sure the area is large enough to accommodate the entire surface of the tape. Scrub the area, use a cleaner (and degreaser, if necessary, like Orange Blast™), and an abrasive sponge to remove the grease and clean the area.
4. CLEAN THE MOUNTING AREA: Wipe the area completely dry and clean with a lint-free cloth.
5. ATTACH THE AP3: Remove the VHB tape liner from the AP3-tape, place the device on the mounting surface area, and apply firm downward pressure to all surfaces of the device for at least two minutes. The tape will be completely secure within 72 hours (only 50% within one hour, and 90% within 24 hours; please Google “3M VHB Installation Instructions” for further details).
6. If a primer is required to prepare the surface for use of an adhesive, please Google “3M VHB Installation Instructions” for instructions on surface preparation.



**Note:** When using VHB tape (3M part number 5952), it should only be used on the following surfaces:

- Polycarbonate
- Coated Polycarbonate(@)
- Aluminum
- Acrylic/Polyurethane paint
- Galvanized steel
- Polyester paint
- Epoxy/Polyester paint
- Epoxy paint
- Silane Coated Glass
- Uncoated Glass
- Stainless Steel
- Enameled Steel
- Glass Epoxy
- Polybutylene terephthalate
- Nylon
- Polyphenylene ether (PPE)



Dual-sided VHB Tape per the specifications in this section is the mounting method assumed for UL 61010 Safety certification.



AssetLink is not responsible for mounting of the device to customer equipment and potential liability arising from the installation. Be sure to consult with your company personnel to avoid damaging equipment and to ensure installation is safe.

## Intrinsic Safety in Hazardous Locations

The AP3 is certified for:

- ANSI/ISA 12.12.01-2000 Class I, Division 2, Groups A-D,
- CAN/CSA C22.2 No. 213 Class I, Division 2 Groups A-D, and
- ATEX Zone 2, when installed with the AP3 ATEX Cage



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Must be installed with ATEX Zone 2 Cage for ATEX compliance

When used without any connections or external wiring or components, the unit requires no special modifications or treatment to operate safely in the Class 1, Division 2 environment.



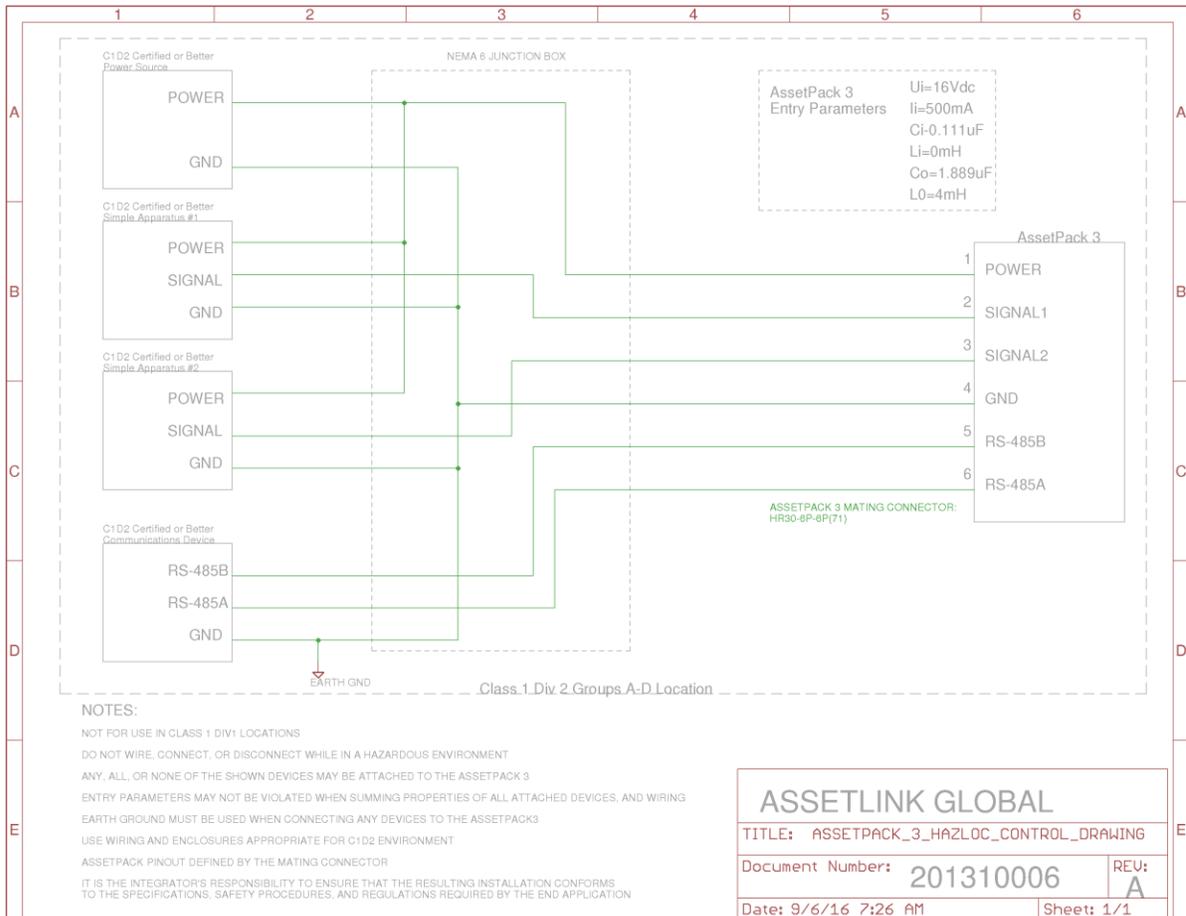
The ATEX cage must be used with the AP3 to safely operate in an ATEX Zone 2 environment. For Class 1, Division 2 operation the AP3 may be used as-is.

With the ATEX Cage, when used without any connections or external wiring or components, the unit requires no special modifications or treatment to operate safely in the ATEX Zone 2 environment.



**If using ATEX cage: Clean ATEX cage with a damp cloth only, do not clean with a dry cloth. The plastic cover on the ATEX cage can gain an electrostatic charge in the case of unusual manual rubbing of the surface.**

When connecting to a power source or any other sensor or device in a hazardous environment, the installer must be sure to follow the control drawing below.



**When attaching sensors and other inputs/attachments to the AP3 for use in a Class 1 Division 2 or ATEX hazardous environment, the following entry parameters may NOT be violated when summing the properties of all attached devices and wiring:**

AssetPack 3	Ui=16Vdc
Entry Parameters	li=500mA
	Ci=0.111uF
	Li=0mH
	Co=1.889uF
	L0=4mH



It is the User's responsibility to ensure that the final installation conforms to the specifications, safety procedures, and regulations required by the end application.



Do not wire, connect or disconnect while in a Hazardous Environment.



Earth-Ground must be used when connecting any devices to the AP3 for use in a hazardous environment. If using the ATEX cage, the cage itself should either be mounted to a grounded metallic part or use a separate bonding jumper to an adjacent grounded part.



Use only wiring, enclosures and attached devices and sensors appropriate for a Class 1 Division 2 Hazardous Environment if deploying in that environment. Use only wiring, enclosures and attached devices and sensors appropriate for an ATEX Zone 2 Hazardous Environment if deploying in that environment.



The AP3 is to be used in an ambient temperature range of:  $-40C < T_{amb} < +70C$  ( $-40 F < T < 158 F$ ). For ATEX installations only, the AP3 is to be used in an ambient temperature range of:  $-40C < T_{amb} < +65C$  ( $-40 F < T < 149 F$ ).

## Configuration

### FOR DEVELOPERS AND INTEGRATORS ONLY

### Sensors and Part Numbering Conventions

Although most customers use the same (Standard) AP3 configuration, the AP3 is designed to accommodate many variations of the hardware product, including custom sensor

configurations; and AssetLink’s internal AP3 part numbering system reflects those options such that part numbers indicate each customer’s exact, specified AP3 design.



**The specific sensor types that can be connected to your AP3 depends on the specific hardware configuration of your AP3, which is customized (if desired) at the factory. Once your unit is built and shipped, only your chosen sensor types can be used.**

The configuration for your specific device will be found in the AP3 User’s Manual Configuration Annex.

**The Standard AP3 Configuration:**

The standard off-the-shelf configuration is the “AP3-HUB”.

The AP3-HUB is a C3-6P-DOOR-0383-4-T-V-M-S.

The part number is made up of five sections, with each section joined by a hyphen. Multiple options may be added to the end of the part number resulting in additional hyphenations. Note that the part number does not define software options or accessories; software and accessories are configured and numbered separately, and can significantly change the functionality of hardware, depending on the application.

If there is a notation after a “/” in the part number followed by three letters, this refers to a custom firmware version. For example, “AP3 HUB/XXX” or “C3-6P-DOOR-DOOR-4-T-V-M-S/XXX”. In this scenario, XXX refers to a specific custom firmware version. This will not always be used. Please see your AP3 User’s Manual Configuration Annex for more details.

Part Number Table:

Core Device	External (I/O) Connections	Sensor 1 Voltage Range + Shunt	Sensor 2 Voltage Range + Shunt	Battery Type	Options
C3 – Duplex based core (2-way)	(6P) – 6 Pin circular connector	Select a voltage range and shunt for each available sensor.		(4) – 7.2V 5.3Ahr Secondary Battery (long case)	(X) – No options
C2 – Simplex based core (1-way)	(2T) – 2 Terminals  (3T) – 3	A/D Voltage Range Options 17 – 0-1.65V Range 03 – 0-3.3V Range 05 – 0-5.0V Range 15 – 0-15V Range			(T) – On board temperature sensor  (V) – On

	Terminals	30 – 0-30V Range		board vibration/ motion sensor
	(X) – Track Only, no connections	Current Shunt Resistor Selection: 68 - 68 ohm shunt 83 – 82.5 ohm shunt 17 – 165 ohm shunt 4K - 4.53K shunt 10 – 10K shunt NP – Not Populated		(M) – On board EEPROM memory
		DOOR – Door lock sensor (332K pull-up). In more general terms this is a closed circuit loop that triggers when opened/closed.		(S) – Solar charging system
		RWDL – Resistive Wire Door Lock		(F) – Magnet or Screw Feet Mounting Brackets

#### Examples:

C3-6P-DOOR-174K-4-T-V-M-S

This is a duplex device with a 1.7V A/D and a door sensor, a 4.53K shunt, a standard on board temperature sensor, motion sensor, memory and a solar panel / rechargeable battery (a variant of the standard AP3).

C3-6P-15NP-30NP-4-T-V-M-S

This is a duplex device with a 15V A/D, no shunt, 30V A/D, no shunt, temperature sensor, motion sensor, memory and a solar panel / rechargeable battery (a variant of the standard AP3).

#### Useful Combinations:

Using a 1.7V A/D with a 4.53K shunt is perfect for a AD592 type current based temperature sensor. This will measure a maximum current of 375uA, which is 100C with a AD592. The 7.2V battery on the AP3 will directly power the AD592.

Using a 1.7V A/D with a 68.1 shunt is the best choice for a 4-20mA sensor. This will provide a maximum current reading of 25mA. Choose a battery sufficient to power the sensor or provide power through an external source.

Using a 15V A/D range is intended for use with 12V electrical systems, likewise the 30V range

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is intended for use with 24V electrical systems.

**Restrictions:**

- Except for custom deployments, the C2, X, 2T and 3T options are not available off the shelf.
- RS-485 is only and always available in the 6P configuration. This can optionally include MODBUS capability or CANBUS/J1939 capability.
- Voltage or Current sensors are not available in the 2T connection configuration
- Voltage A/D ranges are limited to 1.7V, 3.3V, 5.0V in the 3T versions. 15V and 30V is available in the 6P version.
- The sensors can be used as digital inputs in the 3.3V or 5.0V ranges.
- The 7.2V rechargeable battery is only available for the AP3 core
- The Solar charging system requires the use of the 7.2V rechargeable battery

**Understanding Voltage Readings:**

- 8.2V - 8.0V - is fully charged. This is the default operating battery level
- 7.8V - 7.6V - is mostly charged.
- 7.4V - 7.0V - the unit is in power save mode/low battery.
- 6.8V - 6.2V - the unit is into power recovery mode, just sending a once per day 'help' message.
- 6.0V - 0 - the battery is dead, and battery is being damaged.

## Additional AP3 Features:

All versions of the AP3 have a standard on-board motion sensor, on-board temperature sensor, and flash memory which enables further features such as on-board geofencing.

**Motion:** Typically motion is sensed via an internal GPS check every 5 minutes. If the difference between two checks is greater (less) than 200m, the unit considers itself in motion (stopped). The distance parameter can be tuned. This alert can then trigger other actions including GPS checks, messages, mailbox checks, a different transmission schedule altogether, etc., depending on the on-board programming. Alternatively, an on-board motion sensor is designed for mobile assets and can trigger an alert or a change in behavior when motion is sensed. This sensor is based on vibration and also can detect vibrating equipment or high winds. If the motion sensor is going to be active, the unit should be mounted either on the top of the vehicle or on the front or back vertical side of the vehicle (relative to the direction of motion).

**Ambient Temperature:** The temperature sensor works to sense local ambient temperature in the device. This is used to provide temperature data inside the unit, to post-calibrate certain types of sensors when data is received, and to tailor power management in extreme environments outside the normal operating range of the battery. It is also used for diagnostics on the device as needed.

**Flash Memory:** The unit has a non-volatile flash memory element on board to store geofence

data, backup Firmware images, perform deep data logging, and other elements as needed. This can be used to support safe partial and full Firmware updates OTA, among other remote activities.

**Onboard Geofencing:** Onboard Geofencing uses onboard memory to store the data required for the geofence settings. The unit can store over 10,000 latitude/longitude points. These points can be organized into geofences having the shape of complex irregular polygons, circles, rectangles, or route lines. Onboard geofencing allows a GPS check and comparison against onboard geofence points without sending a message, with fence violations (keep-in or keep-out) triggering a message or other custom behavior as desired. The frequency of geofence checks can be adjusted and can be different from the frequency of transmission. Geofence definitions can be modified over the air. Geofences can be nested inside one another, and can be defined as “keep out” fences or “stay in” fences for the purposes of alert triggering.

**Encryption:** An over the air (OTA) light encryption is available as an option for data security with low data overhead. An optional additional AES 256-bit encryption is available, if pre-configured and pre-requested. This extra AES 256-bit option has a larger impact on the message size and cost of service (more bits transmitted for the same amount of messages, to accommodate encryption overhead).

## Pinout Definitions

Note the AP3 has the ability to self-power some sensors directly from its onboard power system. This avoids having to separately power sensors in the field.

Signal Name	AP3 HUB Pin number
Power in/out	1
Signal 1	2
Signal 2	3
Ground	4
RS-485B	5
RS-485A	6

Signal Name	Functional Description
Power in/out	Momentary power output for sensors, battery charging power input
Signal 1	Configurable as Analog Voltage or Current, Digital In or Out, Door, or TTL-level UART (actual sensor capabilities defined by the AP3 hardware configuration) In 3T versions this pin switches between the above configurations to provide an analog input and TTL UART.

	In 2T versions, this pin is used to power a dry contact, such as a wire loop or door switch. It also functions as a TTL UART.
Signal Name	Functional Description (continued)
Signal 2	Configurable as Analog Voltage or Current, Digital In or Out, Door, or TTL-level UART
Ground	0 Voltage Reference
RS-485B	RS-485 serial connections, no terminating resistor.
RS-485A	

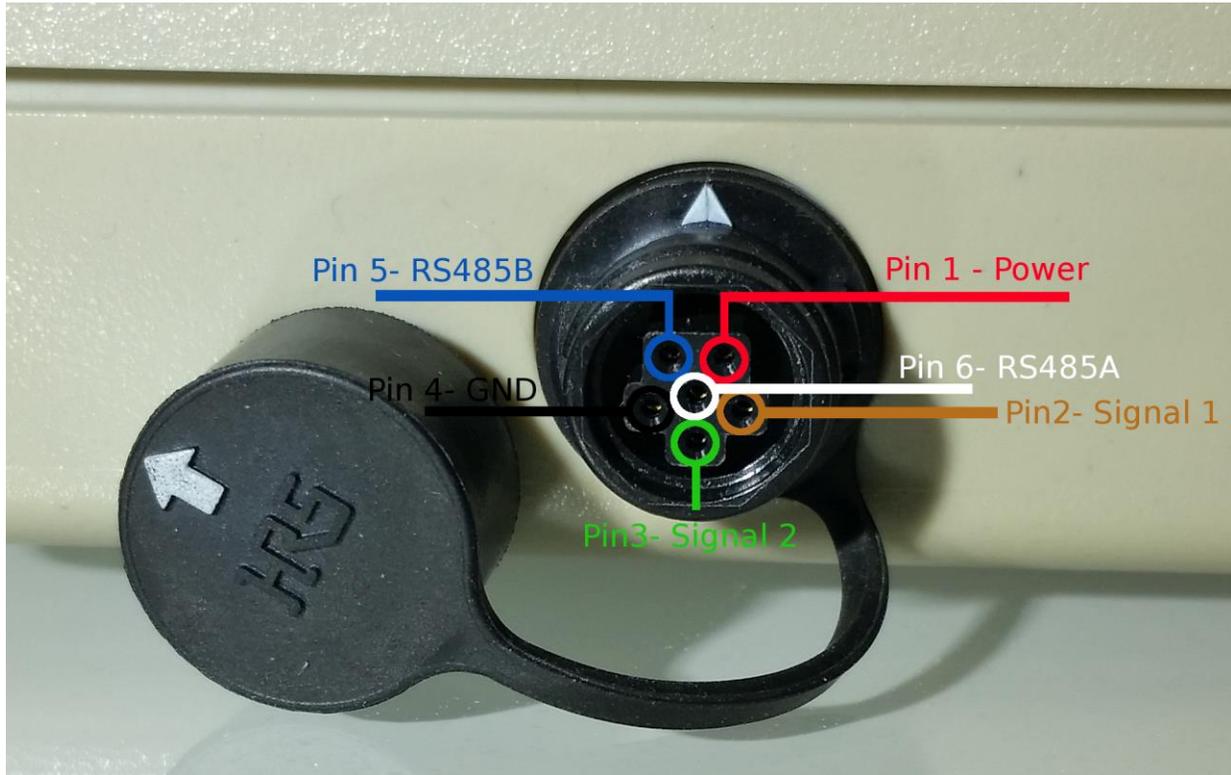
Signal Name	Electrical Specifications (continued)
Power in/out	<b>Output Specifications</b> <i>Only enabled while device is measuring the sensors</i> Nominal voltage = Battery – 0.7V Max output voltage = 8.4; no load Min output voltage = 5.3; when battery is nearly dead Output Current Limit = 80mA +/-20mA; higher output currents available
	<b>Input Specifications</b> Min voltage for charging = 10.0V Max voltage = 18.0V; 0.5A PTC and 18V TVS protected Max current consumption = 0.5A Nominal power consumption = 5W; while charging Nominal current consumption when idling = 0.01A
Signal 1 & 2	<b>Analog Voltage Configuration</b> Input series resistance to A/D = 100 ohms Resistance to ground = 332Kohms Voltage protection = 3.3V standoff / 5.0V clamp A/D resolution = 10 bits; Starting from 0V, up to 3.3V
	<b>Analog Current Configuration</b> Input series resistance to A/D = 100 ohms Resistance to ground at pin= 68.1, 82.5, 4.53K; Selected at build Voltage protection = 3.3V standoff / 5.0V clamp A/D resolution = 10 bits; Starting from 0V, up to 3.3V
	<b>Digital Input Configuration</b> Input series resistance = 100 ohms Resistance to ground = 332Kohms, or 332Kohms Pull up to 3.3V Voltage protection = 3.3V standoff / 5.0V clamp
	<b>Digital Output Configuration</b> Output series resistance = 100 ohms Resistance to ground = 332Kohms Voltage protection = 3.3V standoff / 5.0V clamp

	<b>Door (Dry Contact) Configuration</b> Series resistance = 100 ohms 332Kohms Pull up to 3.3V Voltage protection = 3.3V standoff / 5.0V clamp Signal shunted to ground is normal condition, Open is alert condition.
<b>Signal Name</b>	<b>Electrical Specifications (continued)</b>
Ground	0V Reference
RS-485B	RS-485 Complementary I/O
RS-485A	Voltage clamped to 5V No terminating resistor Static protection to +/-15KV Serial Speed = 9600bps

## 6-Pin Connector Arrangement

The following illustration identifies the pin numbers that coincide with the cable that is the mating part with the 6-pin connector on the units. This is a view of the female connector on the outside of the AP3 itself. Pins start with 1 (Power) on the upper right, and progress clockwise around to 2 (Signal 1), 3 (Signal 2), 4 (Ground), and 5 (RS485B), with pin 6 (RS485A) in the center.

The manufacturer part number for this connector is HR30-6P-6P(71).



## OPERATIONS

### Two Way Duplex Operations

The AP3 is a two-way communications device. Modes in the unit define how the unit behaves, including (but not limited to) the frequency of location (GPS) transmissions from the device, which generates lat/lon position information. Other sensor-related data can be transmitted as well, based on firmware settings and customization.

In order to listen for potential commands while in the field, the unit utilizes a wake-sleep cycle. This cycle wakes the receiver up periodically (per programming configuration) to check for an incoming command ("mailbox check") from the Iridium satellite network. An incoming command to the unit could be a location query, a sensor query, an output command, or a change in mode Over The Air, among other possibilities.

No matter what Active Mode the unit is in (except OFF), the default setting is that the unit will wake up and check in with the satellite network on its predetermined schedule, by default. This results in a predictable average response time when the unit is queried from the data portal or via the network. In Power Save modes, the unit checks in much less frequently.

NOTE: The solar power system is designed to support a maximum of four check-ins with the network every hour, around the clock, UNLESS IT HAS ENTERED A POWER SAVE MODE, IN WHICH CASE IT WILL CHECK IN LESS FREQUENTLY (see below), or unless it is pre-programmed in coordination with the user for a less power intensive mode due to known low-sun locations. Discuss any desired changes in this parameter with your AssetLink representative.

## Battery Charging

The AP3 has an internal Lithium Ion rechargeable battery. The device Firmware is designed to prevent the batteries from fully discharging, in order to preserve their integrity over the long lifetime of the unit. Therefore, when the term “fully discharged” is used in this manual, it refers to the lowest point of allowable battery discharge per the on-board power system.

The rechargeable batteries in the AP3 series of products are the same chemistry and type as a typical laptop battery. Just as with a laptop, after many years of use the battery will no longer be able to hold a charge for as long as it did when it was fresh and new. Under normal conditions, in temperate climates, users may notice this degradation after 7-10 years of life in the field. In colder climates, or operating scenarios where the units drain and recharge their batteries repeatedly due to indoor storage of the units without turning them off, for example, this degradation may become noticeable in 5-7 years or sooner.

The impact of this aging will be that the unit may move into power save mode more often in situations where there is a lack of sun or available power. This can be addressed, and battery life improved, by an Over The Air programming change to reduce the frequency of mailbox checks, or sensor checks if connected sensors are being used.

From a fully discharged state, the internal batteries require the following time to recharge to a fully charged state.

Time to fully recharge from empty (Line Power)	Time to fully recharge from empty (Sun only)
8 hours	35 sun-hours

From a fully charged state, in a no-sun situation (solar panel completely covered), the internal batteries will power the device for the following durations. See the following sections for a description of modes and power save behavior. AssetLink is constantly working to improve power save mode behaviors, and so these modes are being constantly improved. If the unit transitions to one of these modes, a message is sent by the unit to inform the customer (via the AssetLink data portal) so that action can be taken to clear the solar panel and/or regain sun exposure. Exact time in each mode depends on the specific configuration of the mode (number of transmissions per day, sensor checks, geofence checks, etc.).

Time in Active Mode (no sun situation)	Time in Power Save Mode (no sun situation)	Time in Power Recovery Mode (no sun situation)
~1 week	~60 days	300 days

## Mode Architecture

When the AP3 is activated, it goes into a default ON mode. This default ON mode is defined in your AP3 User's Manual Configuration Annex, based on the default programming of the unit for your application (for example, "every 12 hours", or "every hour"). Depending on the unit programming, also defined in the Configuration Annex, this mode may change when triggered by a sensor within or connected to the device. For example, detecting motion in one mode can automatically trigger the unit to move to a different mode, and then detecting no-motion can trigger the unit back to the first mode. Other sensor/sensed attributes can include geofence violations, sensor thresholds, discrete signals, battery voltage levels, etc.

Changes from one mode to another can also be commanded OTA.

The AP3 holds seven (7) Active Modes, each of which has its own transmission schedule, mailbox check schedule, and other internal logic. Not all 7 Active Modes are used in a given deployment. Each of the 7 Active Modes is paired with its own Power-Save mode, which is typically similar to its Active Mode in terms of schedule and behavior, but typically targets a power consumption of half to 1/6 of its corresponding active mode. All modes are modifiable OTA by AssetLink or other trained and authorized personnel.

Each mode employs a predetermined communications heartbeat. Unless triggered by an external stimulus (discrete signal, sensor threshold trigger, etc.) all communications from the unit happens on a 15-minute cycle, where some cycles activate the unit for operation and some do not. In normal Active Modes, the unit communicates with the satellite network periodically to check if there are inbound (to the unit) commands that it should download to take some action (this is known as a "mailbox check"). Furthermore, each Active Mode is set to have some schedule of active GPS location messaging with the network. The minimum number of transmissions per day for an Active Mode is one (1), to provide a daily heartbeat so its users know that it is functional. A given Active Mode can be configured to transmit a location message a certain number of times per day, or on a fixed schedule where certain 15-minute heartbeats are selected for transmission throughout the day, up to every 15 minutes around the clock.

Two modes are held in reserve for factory use and are not accessible to users.

Schedule Name	Schedule Number
Reserved	0
Manufacturing	1

Active Mode 1	2
Power-Save 1	3
Active Mode 2	4
Power-Save 2	5
Active Mode 3	6
Power-Save 3	7
Active Mode 4	8
Power-Save 4	9
Active Mode 5	10
Power-Save 5	11
Active Mode 6	12
Power-Save 6	13
Active Mode 7	14
Power-Save 7	15

## Power Save and Power Recovery Modes

Given the range of different environmental conditions it might encounter, the AP3 at times can be asked to do “too much” – meaning, it is using more power than is available relative to the sun conditions at that moment. This can in some situations cause the AP3 to go into a *power-negative budget*. In typical applications the AP3 design handles this by following this logic:

- The unit first descends from *Active Mode N* to *Power-Save Mode N*, and thereafter to *Power-Recovery Mode* if the battery voltage falls further.
- The unit climbs from *Power-Recovery* to *Power-Save Mode N* to *Active Mode N* to *Fully Active Mode N* as the battery voltage rises.

Where N indicates the mode (of the 7 possible Active/Power-Save pairs) it is in at the time of transition.

Power-Save Mode is often defined in cooperation with the customer, dependent on normal operating circumstances, but seeks to retain as much operational relevance as possible to the user.

In Power Recovery, the AP3 will attempt to report exactly once per day. All the remainder of the time, it will be in an extreme low-activity state in an attempt to harvest power. Power Recovery is the floor that ensures that even if the unit is in an extremely disadvantageous power situation, due to its placement or its schedule or both, it will still ultimately recover.

Once the unit starts to rise out of Power Recovery mode, it resumes its progress up the same ladder of the Active and Power-Saving mode pair that it was in when it went into Power Recovery.

## Air Shipping Guidelines

The battery contained in the AP3 is Lithium Ion and the battery pack has passed UN/DOT 38.3 testing (this testing is relevant only when shipping the battery packs alone, outside of the AP3 unit).

Given the size of the packs and the fact they are contained within equipment, the complete devices are covered under IATA shipping guidelines UN3481, P.I. 967, Section II. This means that the AP3 units CAN be shipped by standard air cargo, without any special packaging or shipping restrictions, limitations or requirements, as long as the UN3481, P.I. 967, Section II packing instructions are properly followed.

## Troubleshooting / FAQ's

### If no messages have been received from the unit:

- Has the magnet been moved to turn the unit ON? If the magnet is in the OFF location, the unit cannot receive Over The Air commands and will not transmit at all.
- Has the unit been provisioned on the satellite network? Even if the unit is correctly activated, installed, and transmitting, no messages will come through if the unit has not been provisioned (activated) on the satellite network system. Verify it has been activated properly.
- Did you wait long enough for your message to come through? If you moved the magnet into the ON position and left the AssetPack3 indoors for longer than 20 minutes, you will have missed the first mailbox check-in with the satellite network. Once you place the unit outside, you will have to wait until at least the next 15-minute mailbox check to see a message. If the unit is low on power and in a Power Save mode, or if the mode configuration calls for a different mailbox check schedule, you may need to wait longer – usually either three hours (Power-Save mode) or 24 hours (Power-Recovery mode).
- Did you hear an acknowledgment beep (music) when you moved the magnet to the ON position? If not, and you heard nothing, the battery may be dead and you may have to wait for the unit to charge via the sun or hard line power enough to send a message safely.
- Does your unit have an 80% sky view outdoors? Check to make sure your unit is not blocked by heavy foliage, covered by another piece of equipment or something left on top of the unit, and not too close to a building. Ideally, the AssetPack3 should be an equal distance away from the building as the building is tall, although the unit will transmit from a disadvantaged position given enough time to allow satellites to rotate into position overhead.

- Is your unit right side up and facing at least horizontally, and towards the sky? Be sure that the “This Side to Sky” and the solar panel are facing towards the sun and sky. The unit must not be facing towards the ground or placed under a vehicle.
- Is the unit under an overhang or under a roof? The unit cannot transmit through metal structures and most roofs. Put the unit outdoors.
- Are the units too close together? If you have more than one unit, these units must be spaced 12 inches (30 cm) apart to function properly.
- Is the unit inside a window or otherwise transmitting through glass? In addition to having a disadvantageous sky view, many modern windows have metallic coatings which cut UV rays and heat from the sun, but also can block RF signals. Put the unit outdoors.
- If you fixed all of these problems, but are still not receiving messages, contact Customer Service.

### No GPS location or incorrect GPS location

- Is this the first message the unit is sending after being turned ON? If you are indoors, and you turn the unit ON, the first message to come through might show an erroneous (incorrect or bad) GPS location. This can happen because the unit is looking for GPS satellites in order to get a position fix, but has no sky view. Once your unit is outside and completes a full cycle of a GPS satellite search, the next message you will see will have the correct GPS information.
- Are your units too close together? If you have more than one unit, these units should be spaced 12 inches (30 cm) apart for the GPS to function properly.
- Have you moved the unit a long distance from its last location while it was turned off, or has it been off for a week or more? If so, the GPS may miss its first message while it is getting its GPS fix.
- Does your unit have at least an 80% sky view outdoors? Be advised that there are situations that exist where the sky view is poor, so even though the communications link functions properly, the GPS cannot get a proper fix. This can cause the battery to drain quicker than normal. If you are concerned about this, you could check to make sure that your unit is not blocked by heavy foliage, is not covered by another piece of equipment, that nothing is on top of the unit, or that the unit is not too close to a building. Ideally, the AssetPack3 should be an equal distance away from the building as the building is tall. The GPS will function, even if in a degraded manner (worse GPS fixes, or sometimes no GPS at all) from a disadvantaged position, if it retries after some time, to allow GPS satellites to rotate into a better position overhead. Be aware that this degradation may lead to erroneous (bad) location readings due to reflections of the GPS signal off of nearby buildings.
- Is your unit right side up and facing horizontally, and towards the sky? Be sure the “This Side to Sky” and the solar panel on the unit are correctly oriented, and that the unit is not facing towards the ground or under a vehicle. The positioning may be sufficient to get satellite messages out, but not to read the GPS satellites correctly for a location fix. Giving the unit as clear view of the sky as possible gives it the best

chance of acquiring GPS satellite signals.

- Is the unit under an overhang or under a roof? GPS functions poorly or not at all through metal structures and most roofs, and in some cases it will not function or will provide an erroneous reading even when the satellite messaging link works properly. Put the unit outdoors.
  - Is the unit inside a window or otherwise transmitting through glass? In addition to having disadvantageous sky view, many modern windows have metallic coatings which cut UV rays and heat from the sun, but also can block RF signals. Put the unit outdoors.
  - If you fixed all of these problems, but are still not receiving proper GPS locations, contact customer service.
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**If the AP3 is damaged, remove from service and dispose of safely as electronic waste.**

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## Appendix A: Technical Support

AssetLink Global is committed to customer care and takes great pride in offering high quality technical and customer support services to all our customers.

For technical assistance, contact your direct customer service representative or AssetLink Global's RMA and engineering group below. For returns or repairs, you must obtain an RMA number first.

AssetLink Global, LLC  
50 Alberigi Drive Suite 103  
Jessup PA 18434 USA  
service@assetlinkglobal.com  
+1 (303) 862-8745

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## Appendix B: RF Radiation Exposure Statement

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. End users must follow the specific operating instructions for satisfying RF exposure compliance. The antenna(s) used for this transmitter must be installed to provide a separation distance of at least 20 cm from all persons and must not be co-located or operating in conjunction with any other antenna or transmitter.

## Appendix C: Regulatory Notices

The FCC requires the following notification for the device in compliance with 47CFR 15.105 for this Class B digital device:

Contains FCC ID: Q639603N  
Contains IC ID: 4629A-9603N

The communications modem contained in the AP3 has been tested and found to be compliant with FCC CFR 47 Part 15B and ICES-003, and with the requirements of FCC CFR 47 Part 2, FCC CFR 47 Part 25, and Industry Canada RSS-170.

The communications modem contained in the AP3 has been tested and found to be compliant with the requirements of ETSI EN 301 489-20 in conjunction with ETSI EN 301 489-1, as well as with ETSI EN 301 441.

*The AP3 complies with Part 15 of the FCC rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.*

This Class B digital apparatus complies with Canadian ICES-003.  
Cet appareil numérique de la classe B est conforme à la norme NMB-003 du Canada.

The AP3 has been tested and found to be compliant with FCC CFR 47 Part 15B.

The AP3 has been tested and found to be compliant with Industry Canada CAN ICES-3 (A) / NMB-3 (A).

**NOTE:** This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a residential environment. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/ TV technician for help.

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The AP3 has been tested and found to be compliant with ETSI EN 300 440-2 V1.2.1 (2007-8) and to ETSI EN 301 489-1 with ETSI EN 301 489-17 (Article 3.1(b) of R&TTE Directive).

**CHANGES OR MODIFICATIONS TO THE AP3 NOT EXPRESSLY APPROVED, IN WRITING, BY ASSETLINK GLOBAL WILL VOID ALL WARRANTIES AND USER'S AUTHORIZATION TO USE THE EQUIPMENT.**

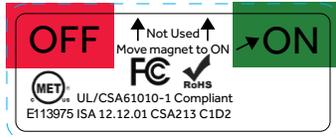
## Appendix D: Environmental and Safety



The AssetPack-3 has been tested and found compliant with NEMA-6 environmental standards.



The NEMA-6 rating meets or exceeds IP67 environmental requirements. National Electronics Manufacturers Association (NEMA) ratings also require additional product features and tests (such as functionality under icing conditions and others) not addressed by IP ratings.



The AP3 is RoHS compliant.

The AP3 has been found to be compliant to IEC61010-1 / EN61010-1 / UL61010-1 / CSA C22.2 No. 61010-1, Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use.

The AP3 holds the CE Mark and the MET Mark for USA and Canada.

The AP3 has been found to be compliant by the non-incendive method of protection to ANSI/ISA 12.12.01-2000 Class I, Division 2 and CAN/CSA C22.2 No. 213 Class I, Division 2 for Groups A-D.

Under the European Union Waste Electrical and Electronic Equipment Directive (WEEE), units in complying countries should be disposed at end of life in a proper electronics recycling facility.



If using the ATEX Cage for impact protection, which is provided by AssetLink, the AP3 has been found to be compliant to ATEX Zone 2 (II 3 G Ex ic nA IIC T6 Gc IP67). This includes compliance with EN 60079-0 (2011) Explosive atmospheres – Part 0: General requirements; EN 60079-11 (2011) Explosive atmospheres – Part 11:

Equipment protection by intrinsic safety "i"; and EN 60079-15 (2010) Explosive atmospheres – Part 15: Equipment protection by type of protection "n".

The device conforms with the dielectric strength requirement of EN 60079-11 §6.3.13.

The label above is placed on the ATEX Cage itself, which must be mounted with the AP3 per instructions in the Hazardous Location section above for ATEX compliance. This cage provides extra impact protection per ATEX requirements.

## Specifications

	<b>AP3-HUB</b>
Enclosure:	12.4" x 3.2" x 1.15" (31.50 x 8.1 x 2.9 cm)
Mass:	18.9 oz. (535g)
Volume:	46 cubic inches (740 cubic centimeters)
Temperature:	-40° C (-40° F) to +70° C (+158° F) operating -40° C (-40° F) to +65° C (+149° F) operating for ATEX Zone 2 use
Humidity:	100% at 50 C, Salt, Fog Testing per MIL STD 810 (design specification)
Vibration/Shock:	MILSTD 810 and SAE J1455 (design specification)
Water and Dust:	NEMA6, IP67, Waterproof, each unit tested with full immersion at 1m depth
External Power	External Power: 10-18V, up to 500 mA Minimum continual power draw of 10 mA at all times when connected
Battery:	7.2V 5.3AHr Secondary Battery
Programming:	Over the Air commands, serial interface, custom factory programming
Mounting:	3M VHB Tape model 5952
Sensor Inputs:	Choice of up to two powered or unpowered analog or digital inputs, such as two 4-20 mA inputs or two temperature sensors RS-485 interface (MODBUS or CANBUS/J1939 capable with adapters)
Communications:	Iridium Short Burst Data 1616-1626.5 MHz Time Domain Duplex TDMA/FDMA
GPS:	Acquisition and tracking sensitivity: -161.5 dBm Cold start (open sky): 33s Hot start (open sky): <2s (typical) Position Accuracy (50% CEP): <5m
Certifications:	FCC CFR parts 15 and 25 Industry Canada (ICES-003) CE Mark ETSI EN 300 440-2 V1.2.1 (2007-8) ETSI EN 301 489-1 with ETSI EN 301 489-17 (Article 3.1(b) of R&TTE Directive)

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	UL/CSA/EN/IEC 61010-1 HazLoc ANSI/CSA 12.12.01-2000 Class I, Division 2 (Non-Incendive Operation) HazLoc ATEX Zone 2 (II 3 G Ex ic nA IIC T6 Gc IP67) (with use of ATEX cage for impact protection)
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