



# AIRBORNE MAPPING SOLUTIONS



Reduce cost and improve efficiency of aerial survey with Direct Georeferencing





# Table of Contents

1) POS AV 310 .....	1
2) POS AV 610 .....	3
3) POS AVX 210 .....	5
4) APX-15 EI UAV .....	7
5) APX-15 UAV .....	9
6) APX-20 UAV .....	11
7) Trimble AP+ 18 Air .....	13
8) Trimble AP+ 60 Air .....	15
9) Trimble GNSS Smart Target Base Station .....	17





# POS AV 310

## IMMEDIATE ANSWERS FROM AIRBORNE DIRECT GEOREFERENCING

POS AV is the foremost commercial GNSS-Inertial solution for airborne direct georeferencing. Used with digital cameras, film cameras, LIDAR systems, SAR systems and digital scanners, POS AV precisely measures aerial sensor position and orientation hundreds of times each second, accounting for all motion variables at the exact moment of data capture. In real time or refined in post-processing with the highly productive POSpac Mobile Mapping Suite (MMS) software, data is used to accurately georeference sensor data to the Earth or local mapping frame without ground information, eliminating time-consuming aerotriangulation steps. POS AV is ideally suited to support precision mapping work, especially in inhospitable environments and in rapid response capacities where ground control data may be unavailable or physically impossible to collect.

POS AV integrated precision GNSS with inertial technology is supported by Applanix' industry leading expertise and a continuous dedication to technological innovation. Offering a streamlined and automated data workflow with built-in quality control features, POS AV improves productivity in all aerial mapping applications.

As Applanix is a Trimble Company (NASDAQ: TRMB), POS AV is unique in the marketplace with its ability to receive the Trimble CenterPoint RTX Correction Service. Using RTX, POS AV delivers significant benefits including higher accuracy and speed, lower cost, more uptime and greater reliability.

## Key Features

- ▶ High-performance, survey-grade multi-frequency GNSS receiver
- ▶ Compact, low-power, lightweight, rugged construction
- ▶ High-performance, low profile FAA certified GNSS-L Band antenna
- ▶ Full in-air alignment support
- ▶ Embedded Omnistar SBAS correction service
- ▶ Trimble CenterPoint™ RTX™ correction service available
- ▶ Simple to use and operate with auto-log and auto-start functions
- ▶ POSpac MMS post-processing software bundle includes Carrier Phase DGPS processing, Integrated Inertial/GNSS processing, and optional photogrammetry tools for EO generation, IMU boresight calibration and quality control



## PERFORMANCE SPECIFICATIONS

POS AV Absolute Accuracy Specifications<sup>1</sup> (RMS)

POS AV	310 SPS	310 RTX <sup>2</sup>	310 PP-RTX <sup>4,5</sup>	310 SmartBase Post-processed <sup>6</sup>
Position (m)	1.5 H	< 0.1 H	0.03 H	0.02 H
	3 V	< 0.2 V	0.06V	0.05 V
Velocity (m/s)	0.050	0.050	0.010	0.010
Roll & Pitch (deg)	0.030	0.020	0.015	0.015
True Heading <sup>2</sup> (deg)	0.100	0.080	0.035	0.035

## POS AV Relative Accuracy

POS AV	310
Noise (deg/sqrt(hr))	0.150
Drift (deg/hr) <sup>7</sup>	0.500

## SYSTEM SPECIFICATIONS

## Computer System

Component	Dimensions (L x W x H) mm	Weight kg	Power (incl IMU)	Temperature c	Altitude <sup>8</sup> m
PCS Standard	169x186x68	2.4	18-34 Vdc, 59 W Max	-20 to +55	0 to 7,620

## Inertial Measurement Unit (IMU)

Type	Range	Dimensions (L x W x H) mm	Operational Temperature c	Weight kg
IMU-82 <sup>9</sup>	+/- 10g, +/- 490 dps	116x116x108 (in tophat, provided)	-45 to +55	0.98

## Global Navigation Satellite System (GNSS)

Option	Signals	Data Rate
GPS-17	GPS: L1 C/A, L2C, L2E, L5 GLONASS: L1 C/A, L1 P, L2 C/A, L2 P GALILEO <sup>10</sup> : L1 BOC, E5A, E5B, E5AltBOC QZSS: L1 C/A, L1 SAIF, L2C, L5 SBAS: Simultaneous L1 C/A and L5 L-Band: OmniSTAR VBS, XP, HP and G2, Trimble CenterPoint RTX BeiDou: B1, B2	5 Hz (raw)

## ETHERNET INPUT/OUTPUT

Parameters: ..... Time tag, status, position, attitude, velocity, track and speed, dynamics, performance metrics, raw IMU data (at IMU rate), raw GNSS data  
 Display Port ..... Low rate (1 Hz) UDP protocol output  
 Control Port ..... TCP/IP input for system commands  
 Primary Port ..... Real-time (up to 200 Hz) TCP/IP protocol output  
 Secondary Port ..... Buffered TCP/IP protocol output for data logging to external device

## LOGGING

Parameters: ..... Time tag, status, position, attitude, velocity, track and speed, dynamics, performance metrics, raw IMU data (at IMU rate), raw GNSS data  
 Media: ..... External: Removable 8 Gbyte Flash Disk (2 supplied)  
 Internal: Embedded 4 Gbyte Flash Disk for redundant logging

## RS232 NMEA ASCII OUTPUT

Parameter: ..... NMEA Standard ASCII messages:  
 Position (\$INGGA), Heading (\$INHDT), Track and Speed (\$INVTG), Statistics (\$INGST)  
 Rate ..... Up to 50 Hz (user selectable)

## RS232 HIGH RATE BINARY OUTPUT

Parameter: ..... User selectable binary messages:  
 Time, position, attitude, speed, track, PAV30 output, Yaw Drift Correction  
 Rate ..... Up to IMU Data Rate (user selectable)

## RS232 INPUT INTERFACES

Parameter: ..... Gimbal encoder input, AUX GPS Input (RTK, NavCom)  
 RTCM104 DGPS Corrections Input  
 Rate ..... 1 to IMU Data Rate

## OTHER I/O

1PPS ..... 1 pulse-per-second Time Sync output, normally high, active low pulse  
 Event Input (6) ..... Six time mark of external events. TTL pulses > 1 ms width, max rate 100 Hz

## USER SUPPLIED EQUIPMENT

## PC for POS Controller and Operator Client Ssoftware

- Atom 1.6 GHz or equivalent (minimum)
- Intel Graphics media accelerator 500 or equivalent (minimum)
- 2 GB RAM, 32 GB HDD (minimum)
- Ethernet adapter (RJ45 100 base T), USB Port
- Windows 7

## PC for Mission Planning and optional POSpac Post-processing

- Pentium 4 (32 bits) at 2 GHz or equivalent (recommended minimum)
- 1 GB RAM, 100 GB Free disk space (recommended minimum)
- 2 X USB 2.0 ports for security keys
- Internet Access (for installation, DEM download, optional SmartBase processing)
- Windows 7

<sup>1</sup>Typical performance. Actual results are dependent upon satellite configuration, atmospheric conditions and other environmental effects

<sup>2</sup>Typical mission profile, max RMS error

<sup>3</sup>Trimble RTX service, typical airborne results, subject to regional coverage. Subscription sold separately

<sup>4</sup>POSPac MMS

<sup>5</sup>Post-processed CenterPoint RTX, typical mission performance. Subscription sold separately

<sup>6</sup>May require local gravity model to achieve full accuracy

<sup>7</sup>Attitude will drift at this rate up to a maximum error defined by absolute accuracy in table above

<sup>8</sup>Unpressurized operation

<sup>9</sup>These IMUs are exportable worldwide subject to statutory export declarations, and standard restrictions relating to certain international destinations. Contact your Applanix representative for further information

<sup>10</sup>Developed under the License of European Union and European Space Agency



# POS AV 610

## IMMEDIATE ANSWERS FROM AIRBORNE DIRECT GEOREFERENCING

POS AV is the foremost commercial GNSS-Inertial solution for airborne direct georeferencing. Used with digital cameras, film cameras, LIDAR systems, SAR systems and digital scanners, POS AV precisely measures aerial sensor position and orientation hundreds of times each second, accounting for all motion variables at the exact moment of data capture. In real time or refined in post-processing with the highly productive POSpac Mobile Mapping Suite (MMS) software, data is used to accurately georeference sensor data to the Earth or local mapping frame without ground information, eliminating time-consuming aerotriangulation steps. POS AV is ideally suited to support precision mapping work, especially in inhospitable environments and in rapid response capacities where ground control data may be unavailable or physically impossible to collect.

POS AV integrated precision GNSS with inertial technology is supported by Applanix' industry leading expertise and a continuous dedication to technological innovation. Offering a streamlined and automated data workflow with built-in quality control features, POS AV improves productivity in all aerial mapping applications.

As Applanix is a Trimble Company (NASDAQ: TRMB), POS AV is unique in the marketplace with its ability to receive the Trimble CenterPoint RTX Correction Service. Using RTX, POS AV delivers significant benefits including higher accuracy and speed, lower cost, more uptime and greater reliability.

## Key Features

- ▶ High-performance, survey-grade multi-frequency GNSS receiver
- ▶ Compact, low-power, lightweight, rugged construction
- ▶ High-performance, low profile FAA certified GNSS-L Band antenna
- ▶ Full in-air alignment support
- ▶ Embedded Omnistar SBAS correction service
- ▶ Trimble CenterPoint™ RTX™ correction service available
- ▶ Simple to use and operate with auto-log and auto-start functions
- ▶ POSpac MMS post-processing software bundle includes Carrier Phase DGPS processing, Integrated Inertial/GNSS processing, and optional photogrammetry tools for EO generation, IMU boresight calibration and quality control



## PERFORMANCE SPECIFICATIONS

### POS AV Absolute Accuracy Specifications<sup>1</sup> (RMS)

POS AV	610 SPS	610 RTX <sup>2</sup>	610 PP-RTX <sup>4,5</sup>	610 SmartBase Post-processed <sup>4</sup>
Position (m)	1.5 H	< 0.1 H	0.03 H	0.02 H
	3 V	< 0.2 V	0.06V	0.05 V
Velocity (m/s)	0.030	0.030	0.005	0.005
Roll & Pitch (deg)	0.005	0.005	0.0025 <sup>6</sup>	0.0025 <sup>6</sup>
True Heading <sup>2</sup> (deg)	0.030	0.020	0.005	0.005

### POS AV Relative Accuracy

POS AV	610
Noise (deg/sqrt(hr))	0.005
Drift (deg/hr) <sup>7</sup>	< 0.010

## SYSTEM SPECIFICATIONS

### Computer System

Component	Dimensions (L x W x H) mm	Weight kg	Power (incl IMU)	Temperature c	Altitude <sup>8</sup> m
PCS Standard	169x186x68	2.4	18-34 Vdc, 59 W Max	-20 to +55	0 to 7,620

### Inertial Measurement Unit (IMU)

Type	Range	Dimensions (L x W x H) mm	Operational Temperature c	Weight kg
IMU-57 <sup>9</sup>	+/- 10g, +/- 490 dps	179 x 126 x 127	-40 <sup>11</sup> to +55	2.6

### Global Navigation Satellite System (GNSS)

Option	Signals	Data Rate
GPS-17	GPS: L1 C/A, L2C, L2E, L5 GLONASS: L1 C/A, L1 P, L2 C/A, L2 P GALILEO <sup>10</sup> : L1 BOC, E5A, E5B, E5AltBOC QZSS: L1 C/A, L1 SAIF, L2C, L5 SBAS: Simultaneous L1 C/A and L5 L-Band: OmniSTAR VBS, XP, HP and G2, Trimble CenterPoint RTX BeiDou: B1, B2	5 Hz (raw)

## ETHERNET INPUT/OUTPUT

Parameters: Time tag, status, position, attitude, velocity, track and speed, dynamics, performance metrics, raw IMU data (at IMU rate), raw GNSS data  
 Display Port: Low rate (1 Hz) UDP protocol output  
 Control Port: TCP/IP input for system commands (at IMU rate), raw GNSS data  
 Primary Port: Real-time (up to 200 Hz) TCP/IP protocol output  
 Secondary Port: Buffered TCP/IP protocol output for data logging to external device

## LOGGING

Parameters: Time tag, status, position, attitude, velocity, track and speed, dynamics, performance metrics, raw IMU data (at IMU rate), raw GNSS data  
 Media: External: Removable 8 Gbyte Flash Disk (2 supplied)  
 Internal: Embedded 4 Gbyte Flash Disk for redundant logging

## RS232 NMEA ASCII OUTPUT

Parameter: NMEA Standard ASCII messages: Position (\$INGGA), Heading (\$INHDT), Track and Speed (\$INVTG), Statistics (\$INGST)  
 Rate: Up to 50 Hz (user selectable)

## RS232 HIGH RATE BINARY OUTPUT

Parameter: User selectable binary messages: Time, position, attitude, speed, track, PAV30 output, Yaw Drift Correction  
 Rate: Up to IMU Data Rate (user selectable)

## RS232 INPUT INTERFACES

Parameter: Gimbal encoder input, AUX GPS Input (RTK, NavCom), RTCM104 DGPS Corrections Input  
 Rate: 1 to IMU Data Rate

## OTHER I/O

1PPS: 1 pulse-per-second Time Sync output, normally high, active low pulse  
 Event Input (6): Six time mark of external events. TTL pulses > 1 ms width, max rate 100 Hz

## USER SUPPLIED EQUIPMENT

### PC for POS Controller and Operator Client Ssoftware

- Atom 1.6 GHz or equivalent (minimum)
- Intel Graphics media accelerator 500 or equivalent (minimum)
- 2 GB RAM, 32 GB HDD (minimum)
- Ethernet adapter (RJ45 100 base T), USB Port
- Windows 7

### PC for Mission Planning and optional POSpac Post-processing

- Pentium 4 (32 bits) at 2 GHz or equivalent (recommended minimum)
- 1 GB RAM, 100 GB Free disk space (recommended minimum)
- 2 X USB 2.0 ports for security keys
- Internet Access (for installation, DEM download, optional SmartBase processing)
- Windows 7

<sup>1</sup>Typical performance. Actual results are dependent upon satellite configuration, atmospheric conditions and other environmental effects

<sup>2</sup>Typical mission profile, max RMS error

<sup>3</sup>Trimble RTX service, typical airborne results, subject to regional coverage. Subscription sold separately

<sup>4</sup>POSPac MMS

<sup>5</sup>Post-processed CenterPoint RTX, typical mission performance. Subscription sold separately

<sup>6</sup>May require local gravity model to achieve full accuracy

<sup>7</sup>Attitude will drift at this rate up to a maximum error defined by absolute accuracy in table above

<sup>8</sup>Unpressurized operation

<sup>9</sup>These IMUs are exportable worldwide subject to statutory export declarations, and standard restrictions relating to certain international destinations. Contact your Applanix representative for further information

<sup>10</sup>Developed under the License of European Union and European Space Agency

<sup>11</sup>IMU must be at -20 deg C or higher at power-on



# POS AVX 210

GNSS-INERTIAL SOLUTIONS FOR EFFICIENT, HIGH-ACCURACY MAPPING

The Applanix POS AVX 210 is a GNSS-Inertial solution designed to reduce the cost and improve the efficiency of mapping with small and medium format cameras. The single rugged enclosure contains a precision GNSS receiver and inertial sensor components, logging capability, interface for mapping sensors and TrackAir Flight Management System.

The POS AVX 210 is fully supported by POSpac MMS, powerful GNSS/Inertial processing software featuring the advanced Applanix SmartBase™ and Applanix In-Fusion™ technology for increased productivity.

## COST EFFECTIVE AND HIGH PERFORMANCE

The POSAVX 210 offers a Direct Georeferencing solution for improved efficiency and high accuracy of mapping with small and medium format digital cameras and low altitude LiDAR sensors.

- Reduce/eliminate GCPs
- Reduce Sidelap

## Key Features

- ▶ Compact and rugged enclosure with survey-grade multi-frequency GNSS receiver and MEMS inertial components
- ▶ Applanix IN-Fusion™ GNSS-Inertial and SmartCal™ compensation technology for superior position and orientation performance
- ▶ Compatible with TrackAir Flight Management System (NanoTrack)
- ▶ Supported by POSpac MMS industry leading software for Direct Georeferencing of airborne mapping sensors
- ▶ RTK position combined with high accuracy orientation



## TECHNICAL SPECIFICATIONS

- Advanced Applanix IN-Fusion™ GNSS-Inertial integration technology
- Solid-state MEMS inertial sensors with Applanix SmartCal™ compensation technology
- Advanced Trimble GNSS survey technology
- 336 Channels
  - GPS: L1 C/A, L2C, L2E, L5
  - GLONASS: L1 C/A, L2 C/A, L3 CDMA
  - BeiDou: B1, B2
  - Galileo: E1, E5A, E5B, E5AltBOC
  - QZSS: L1 C/A, L1 SAIF, L2C, L5
  - SBAS: L1 C/A, L5
- High precision multiple correlator for GNSS pseudorange measurements
- Unfiltered, unsmoothed pseudorange measurements data for low noise, low multipath error, low time domain correlation and high dynamic response
- Very low noise GNSS carrier phase measurements with <1 mm precision in a 1 Hz bandwidth
- Proven Trimble low elevation tracking technology
- 100 Hz real-time position and orientation output
- IMU data rate 200 Hz
- Navigation output format: ASCII (NMEA-0183), Binary (Trimble GSOF)
- Supported Reference input: CMR, CMR+, sCMRx, RTCM 2.1, 2.2, 2.3, 3.0, 3.1
- Support for POSpac MMS post-processing software (sold separately)
- No export permit required

## LAN INPUT/OUTPUT

All Ethernet functions are supported through dedicated IP address (Static or DNS) simultaneously

TCP/IP and UDP	ASCII and Binary data streaming (Time tag, PPS sync, status, position, attitude, velocity, track and speed, dynamics, performance metrics, GNSS data)
HTTP	Web based Control software (GUI) for easy system configuration and low rate display. Support for all common browsers (IE, Safari, Mozilla, Google Chrome, Firefox)
LOGGING:	
Internal Logging	6 GByte Flash memory
External Logging Parameters	USB 2.0 Device port Time tag, status, position, attitude, velocity, track and speed, dynamics, performance metrics, raw IMU data (200Hz), raw GNSS data (5Hz)

## SERIAL INPUT/OUTPUT

2 x RS232 ports

Parameters	ASCII and Binary data streaming (Time tag, PPS sync, status, position, attitude, velocity, track and speed, dynamics, performance metrics, GNSS data), reference input (CMR, CMR+, sCMRx, RTCM), configuration messages
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## Other I/O

PPS(pulse-per-second) Time Sync Pulse output  
Event Input (2) Two time mark of external event

## PERFORMANCE SPECIFICATIONS<sup>2</sup> (RMS ERROR)

Airborne

	SPS	RTX <sup>4</sup>	RTX Post-Processed <sup>5,7</sup>	SmartBase Post-Processed <sup>6</sup>
Position (m)	1.5 H	<0.1 H	0.03 H	0.02 H
	3.0 V	<0.2 V	0.06 V	0.05 V
Velocity (m/s)	0.05	0.03	0.015	0.015
Roll & Pitch (deg)	0.04	0.03	0.025	0.025
True Heading <sup>3</sup> (deg)	0.30	0.18	0.08	0.08

## PHYSICAL CHARACTERISTICS

### Board Set

Size	149 L x 93 W x 43 H mm (nominal)
Weight	0.66 kg
Power	Wide range input 8-28 V DC, typical power consumption of 3.5W at room temperature
Connectors	I/O: DA26, Antenna: TNC (Female)
GNSSAntenna LNA Power Input	AV39 included

## ENVIRONMENTAL CHARACTERISTICS

Temperature	-40 deg C to +75 deg C (Operational) -55 deg C to +85 deg C (Storage)
Measurement Range	+/- 6g <sup>6</sup> , +/- 300 dps
Mechanical Shock	+/- 75g Survival
Operating Humidity	5% to 95% R.H. non-condensing at +60 deg C
Maximum Operating Limits	515 m/sec, 18,000 m
IP rating	IP67

<sup>1</sup> Developed under a License of the European Union and the European Space Agency

<sup>2</sup> Typical performance. Actual results are dependent upon satellite configuration, atmospheric conditions and other environmental effects

<sup>3</sup> Typical survey mission profile, max RMS error. Heading error will increase for low speed rotor applications and when hovering

<sup>4</sup> Trimble RTX service typical airborne results subject to regional coverage. Subscription sold separately.

<sup>5</sup> Post-Processed with POSpac MMS

<sup>6</sup> Sensor bandwidth (-3 dB amplitude) ~ 50 Hz

<sup>7</sup> Post-processed CenterPoint® RTX™, typical mission performance, subscription sold separately

## APPLANIX

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Specifications subject to change without notice.





# APX-15 EI UAV

## GNSS-INERTIAL SOLUTION WITH DUAL IMU'S

The Trimble APX-15 EI UAV is a GNSS-Inertial OEM solution designed to reduce the cost and improve the efficiency of mapping from small Unmanned Aerial Vehicles (UAVs). Comprised of small, low power, precision GNSS and inertial hardware components and POSPac UAV post-mission Differential GNSS-Inertial office software, the APX-15 EI UAV eliminates the need to survey extensive Ground Control Points (GCP's), and reduces the amount of sidelap required to be flown per flight. The innovative APX-15 EI UAV features a precision, survey grade GNSS receiver and dual inertial measurement units with identical performance; one embedded onto the GNSS-inertial board and one as an external unit connected remotely. With this feature the APX-15 EI can compute two sets of orientation for direct georeferencing of two separate sensor payloads, or to provide automatic support for gimbaled platforms without requiring an external interface.

### HIGH ACCURACY, EXTREMELY SMALL PACKAGE

Weighing only 90 grams and measuring just 60 x 67 x 34 mm for the GNSS-Inertial board, and only 15 grams and 43 x 47 x 12 mm for the external IMU, the APX-15 EI UAV can easily be mounted on all types of UAV's and gimbaled platforms. The APX-15 EI UAV computes a real-time navigation solution at 100 Hz using its

embedded IMU while simultaneously logging the raw IMU data from both the internal and external IMU at 200 Hz for post-processing in POSPac UAV. The highly accurate post-processed position and orientation solutions are used for direct georeferencing of cameras, LiDARs and other sensors.

### THE APX-15 EI UAV BRINGS ALL THE BENEFITS OF DIRECT GEOREFERENCING TO UAV PLATFORMS:

- ▶ Turn your UAV into a professional mapping solution
- ▶ Ultra-fast image georeferencing for faster map production and delivery
- ▶ Reduced number of ground control points, saving time and money
- ▶ Consistent, reliable, highly accurate results
- ▶ Increased collection area per flight for greater productivity
- ▶ Redundant navigation solution to autopilot for enhanced safety

### Key Features

- ▶ High-performance Direct Georeferencing solution for improved efficiency and accuracy of mapping from small Unmanned Aerial Vehicles
  - Reduce/eliminate GCPs
  - Reduce sidelap
  - Accurate LiDAR/Camera georeferencing
  - Seamless workflow with gimbaled platforms
- ▶ Compact OEM module complete with survey-grade multi-frequency GNSS receiver and embedded and external IMU's
- ▶ Applanix IN-Fusion™ GNSS-Inertial and SmartCal™ compensation technology for superior position and orientation performance
- ▶ POSPac UAV Differential GNSS Inertial post-processing software for highest accuracy georeferencing
- ▶ RTK real-time position for precision landing and real-time mapping applications
- ▶ Supports all common RTK corrections such as CMR, CMR+, RTCM



## TECHNICAL SPECIFICATIONS

### System Summary

- Advanced Applanix IN-Fusion™ GNSS-Inertial integration technology
- Dual IMU with solid-state MEMS inertial sensors with Applanix SmartCal™ compensation technology
- Advanced Trimble Maxwell Custom GNSS survey technology
- 336 Channels
  - GPS: L1 C/A, L2C, L2E, L5
  - GLONASS: L1 C/A, L2 C/A, L3 CDMA<sup>8</sup>
  - BeiDou: B1, B2
  - Galileo: E1, E5A, E5B, E5AltBOC
  - QZSS: L1 C/A, L1S, L1C, L2C, L5, LEX
  - SBAS: L1 C/A, L5
  - MSS L-band: Trimble RTX, OmniSTAR
- High precision multiple correlator for GNSS pseudorange measurements
- Unfiltered, unsmoothed pseudorange measurements data for low noise, low multipath error, low time domain correlation and high dynamic response
- Very low noise GNSS carrier phase measurements with <1 mm precision in a 1 Hz bandwidth
- Proven Trimble low elevation tracking technology
- 100 Hz position, roll, pitch and heading output
- IMU data rate 200 Hz for both Internal and external IMU
- Navigation output format: ASCII (NMEA-0183), Binary (Trimble GSOF)
- Supported Reference input: CMR, CMR+, sCMRx, RTCM 2.1, 2.2, 2.3, 3.0, 3.1
- Support for POSPac UAV post-processing software (included)
- No export permit required

### LAN INPUT/OUTPUT

All Ethernet functions are supported through dedicated IP address (Static or DNS) simultaneously.

**TCP/IP and UDP** ASCII and Binary data streaming (Time tag, PPS sync, status, position, attitude, velocity, track and speed, dynamics, performance metrics, GNSS data)

**HTTP** Web based Control software (GUI) for easy system configuration and low rate display. Support for all common browsers (IE, Safari, Mozilla, Google Chrome, Firefox)

### SERIAL INPUT/OUTPUT

RS232 level port  
TTL level (3.3 V) port  
Parameters

ASCII and Binary data streaming (Time tag, PPS sync, status, position, attitude, velocity, track and speed, dynamics, performance metrics, GNSS data), reference input (CMR, CMR+, sCMRx, RTCM), configuration messages

### OTHER INPUT/OUTPUT

PPS (pulse-per-second) Time Sync Pulse output  
Event Input (2) Two time mark of external events  
TTL 3.3 V pulses, max rate 50 Hz  
Digital I/O (3) LED drivers with dedicated functionality for systems integrators

### LOGGING

Internal Logging 6 GByte Flash memory  
External Logging USB 2.0 Device port  
Parameters Time tag, status, position, attitude, velocity, track and speed, dynamics, performance metrics, raw IMU data (200 Hz), raw GNSS data

- Developed under a License of the European Union and the European Space Agency
- Typical performance. Actual results are dependent upon satellite configuration, atmospheric conditions and other environmental effects
- Typical survey mission profile, max RMS error. Heading error will increase for low speed rotor applications and when hovering.
- Requires base station and radio link, sold separately
- POSPac UAV, short base line operation
- Sensor bandwidth (-3 dB amplitude) ~ 50 Hz
- Sold separately
- There is no official GLONASS L3CDMA or Galileo E6 ICD. The current tracking capability is based on publicly available information. Full receiver compatibility cannot be guaranteed.
- Not including external IMU
- Performance based upon external IMU
- POSPac UAV/MMS, Post-processed CenterPoint® RTX™, typical mission performance subscription sold separately. The accuracy is subject to quality of GNSS, durational data set, and regional coverage.

### TRIMBLE APPLANIX

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## INERTIAL MEASUREMENT UNITS (IMU)

IMU Type	Range <sup>6</sup>	Temperature <sup>c</sup>	Power	Size mm	Weight g
Internal onboard IMU59	+/-6g, +/-350dps	-40 - +75	n/a	n/a	n/a
External IMU69	+/-6g, +/-350dps	-20 - +60	4.4 to 16 VDC (1W max)	43 x 47 x 12 (L x W x H)	15

## PERFORMANCE SPECIFICATIONS<sup>2</sup> (RMS ERROR)

### Unmanned Airborne Vehicle Applications

	SPS <sup>10</sup>	RTK <sup>4,10</sup>	PP-RTX <sup>11</sup>	Post-Processed <sup>5,10</sup>
Position (m)	1.5 - 3.0	0.02 - 0.05	0.03 - 0.06	0.02 - 0.05
Velocity (m/s)	0.05	0.02	0.015	0.015
Roll & Pitch (deg)	0.04	0.03	0.025	0.025
True Heading <sup>3</sup> (deg)	0.30	0.18	0.08	0.080

## PHYSICAL CHARACTERISTICS

Size<sup>9</sup> ..... 67 L x 60 W x 34 H mm  
Weight<sup>9</sup> ..... 90 grams  
Power<sup>9</sup> ..... Wide range input 9-30 V DC, typical power consumption of 4W at room temperature  
Connectors ..... I/O: 44 Pin Header Samtec TMM-122-03-S-S-MW (mating part FCI 90311-044LF)  
IMU Connector: Molex 503148 (mating part Molex 503149)  
Antenna Port: ..... Connector: MMCX receptacle  
Output Voltage: 3.3 V DC to 5 V DC  
Maximum Current: 400 mA  
Minimum Input Signal Strength: 32 dB (>35 dB Recommended)

## ENVIRONMENTAL CHARACTERISTICS

Temperature: ..... -40 deg C to +75 deg C (Operational)  
..... -55 deg C to +85 deg C (Storage)  
Mechanical Shock: ..... +/- 75g Survival  
Operating Humidity: ..... 5% to 95% R.H. non-condensing at +60 deg C  
Maximum Operating Limits: ..... 515 m/sec  
18,000 m

## ADDITIONAL ACCESSORIES<sup>7</sup>

Evaluation Kit (Development Board)

## POSPAC UAV OFFICE SOFTWARE

- Post-processed Differential GNSS-Inertial SW for APX-15 EI
- 200 Hz Navigation solution (Position, Velocity, Orientation, Rates, Accelerations)
- Applanix IN-Fusion GNSS-Integration technology
- Full support for UAV dynamic models
- Single Base Differential GNSS-Inertial processing
- Forward and reverse processing with optimal Smoother with support for Applanix SmartBase virtual reference station module<sup>7</sup>
- Support for PP-RTX<sup>11</sup>

Specifications subject to change without notice.



# APX-15 UAV

## VERSION 3 , SINGLE BOARD GNSS-INERTIAL SOLUTION

The Trimble APX-15 UAV is a GNSS-Inertial OEM solution designed to reduce the cost and improve the efficiency of mapping from small Unmanned Aerial Vehicles (UAVs). Comprised of a small single OEM board containing a precision GNSS receiver and inertial sensor components plus post-mission Differential GNSS-Inertial office software, the Trimble APX-15 UAV eliminates the need to survey extensive Ground Control Points (GCP's), and reduces the amount of sidelap required to be flown, thus increasing the area flown per mission.

### HIGH ACCURACY, EXTREMELY SMALL PACKAGE

Measuring just 60 x 67 mm and weighing only 60 grams, the Applanix APX-15 UAV provides unparalleled performance in an extremely small package. And with the included POSPac UAV post-mission software, it produces a highly accurate position and orientation solution for direct georeferencing of cameras, LiDARs and other UAS sensors.

### THE APX-15 UAV BRINGS ALL THE BENEFITS OF DIRECT GEOREFERENCING TO UAV PLATFORMS:

- ▶ Turn your UAV into a professional mapping solution
- ▶ Ultra-fast image georeferencing for faster map production and delivery
- ▶ Reduced number of ground control points, saving time and money
- ▶ Consistent, reliable, highly accurate results
- ▶ Increased collection area per flight for greater productivity
- ▶ Redundant navigation solution to autopilot for enhanced safety

### Key Features

- ▶ High-performance Direct Georeferencing solution for improved efficiency and accuracy of mapping from small Unmanned Aerial Vehicles
  - Reduce/eliminate GCP's
  - Reduce sidelap
  - Accurate LiDAR georeferencing
- ▶ Compact single-board OEM module complete with survey-grade multifrequency GNSS receiver and MEMS inertial components
- ▶ Applanix IN-Fusion™ GNSS-Inertial and SmartCal™ compensation technology
- ▶ POSPac UAV Differential GNSS Inertial post-processing software for highest accuracy
- ▶ RTK real-time position for precision landing applications
- ▶ Supports all common RTK corrections such as CMR, CMR+, RTCM



## TECHNICAL SPECIFICATIONS

### System Summary

- Advanced Applanix IN-Fusion™ GNSS-Inertial integration technology
- Solid-state MEMS inertial sensors with Applanix SmartCal™ compensation technology
- Advanced Trimble Maxwell Custom GNSS survey technology
- 336 Channels
  - GPS: L1 C/A, L2C, L2E, L5
  - GLONASS: L1 C/A, L2 C/A, L3 CDMA<sup>8</sup>
  - BeiDou: B1, B2
  - Galileo: E1, E5A, E5B, E5AltBOC
  - QZSS: L1 C/A, L1S, L1C, L2C, L5, LEX
  - SBAS: L1 C/A, L5
  - MSS L-band: Trimble RTX, OmniSTAR
- High precision multiple correlator for GNSS pseudorange measurements
- Unfiltered, unsmoothed pseudorange measurements data for low noise, low multipath error, low time domain correlation and high dynamic response
- Very low noise GNSS carrier phase measurements with <1 mm precision in a 1 Hz bandwidth
- Proven Trimble low elevation tracking technology
- 100 Hz position, roll, pitch and heading output
- Generic Gimbal and Autopilot support
- IMU data rate 200 Hz
- Navigation output format: ASCII (NMEA-0183), Binary (Trimble GSOF)
- Supported Reference input: CMR, CMR+, sCMRx, RTCM 2.1, 2.2, 2.3, 3.0, 3.1
- Support for POSPac UAV post-processing software (included)
- No export permit required

### LAN INPUT/OUTPUT

All Ethernet functions are supported through dedicated IP address (Static or DNS) simultaneously.

TCP/IP and UDP ASCII and Binary data streaming (Time tag, PPS sync, status, position, attitude, velocity, track and speed, dynamics, performance metrics, GNSS data)

HTTP Web based Control software (GUI) for easy system configuration and low rate display. Support for all common browsers (IE, Safari, Mozilla, Google Chrome, Firefox)

### SERIAL INPUT/OUTPUT

RS232 level port  
TTL level (3.3 V) port

Parameters ASCII and Binary data streaming (Time tag, PPS sync, status, position, attitude, velocity, track and speed, dynamics, performance metrics, GNSS data), reference input (CMR, CMR+, sCMRx, RTCM), configuration messages, Gimbal Encoder and Autopilot input support.

### OTHER INPUT/OUTPUT

PPS (pulse-per-second) Time Sync Pulse output

Event Input (2) Two time mark of external events  
TTL 3.3 V pulses, max rate 50 Hz

Digital I/O (3) LED drivers with dedicated functionality for systems integrators

## LOGGING

Internal Logging 6 GByte Flash memory  
External Logging USB 2.0 Device port  
Parameters Time tag, status, position, attitude, velocity, track and speed, dynamics, performance metrics, raw IMU data (200 Hz), raw GNSS data (5 Hz)

## PERFORMANCE SPECIFICATIONS<sup>2</sup> (RMS ERROR)

### Unmanned Airborne Vehicle Applications

	SPS	RTK <sup>4</sup>	PP-RTX <sup>9</sup>	Post-Processed <sup>5</sup>
Position (m)	1.5 - 3.0	0.02 - 0.05	0.03 - 0.06	0.02 - 0.05
Velocity (m/s)	0.05	0.02	0.015	0.015
Roll & Pitch (deg)	0.04	0.03	0.025	0.025
True Heading <sup>3</sup> (deg)	0.30	0.18	0.08	0.080

## PHYSICAL CHARACTERISTICS

Size ..... 67 L x 60 W x 15 H mm (nominal)  
Weight ..... 60 grams  
Power ..... Wide range input 9-30 V DC, typical power consumption of 3.5W at room temperature  
Connectors ..... I/O: 44 Pin Header Samtec TMM-122-03-S-S-MW (mating part FCI 90311-044LF)  
Antenna Port: ..... Connector: MMCX receptacle  
Output Voltage: 3.3 V DC to 5 V DC  
Maximum Current: 400 mA  
Minimum Input Signal Strength: 32 dB (>35 dB Recommended)

## ENVIRONMENTAL CHARACTERISTICS

Temperature: ..... -40 deg C to +75 deg C (Operational)  
..... -55 deg C to +85 deg C (Storage)  
Measurement Range: ..... +/- 6g<sup>6</sup>, +/- 300 dps  
Mechanical Shock: ..... +/- 75g Survival  
Operating Humidity: ..... 5% to 95% R.H. non-condensing at +60 deg C  
Maximum Operating Limits: ..... 515 m/sec  
18,000 m

## ADDITIONAL ACCESSORIES<sup>7</sup>

Evaluation Kit (Development Board)

## POSPAC UAV OFFICE SOFTWARE

- Post-processed Differential GNSS-Inertial SW for APX-15
- 200 Hz Navigation solution (Position, Velocity, Orientation, Rates, Accelerations)
- Applanix IN-Fusion GNSS-Integration technology
- Full support for UAV dynamic models
- Single Base Differential GNSS-Inertial processing
- Forward and reverse processing with optimal Smoother
- Support for Applanix SmartBase virtual reference station module<sup>7</sup>
- Support for PP-RTX<sup>9</sup>

Specifications subject to change without notice.

1 Developed under a License of the European Union and the European Space Agency  
2 Typical performance. Actual results are dependent upon satellite configuration, atmospheric conditions and other environmental effects  
3 Typical survey mission profile, max RMS error. Heading error will increase for low speed rotor applications and when hovering.  
4 Requires base station and radio link, sold separately  
5 POSPac UAV, short base line operation  
6 Sensor bandwidth (-3 dB amplitude) ~ 50 Hz  
7 Sold separately  
8 There is no official GLONASS L3CDMA or Galileo E6 ICD. The current tracking capability is based on publicly available information. Full receiver compatibility cannot be guaranteed.  
9 POSPac UAV/MMS, Post-processed CenterPoint® RTX™, typical mission performance subscription sold separately. The accuracy is subject to quality of GNSS, durational data set, and regional coverage.

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# APX-20 UAV

## HIGH PERFORMANCE GNSS-INERTIAL SOLUTION WITH DUAL IMU'S

The Trimble APX-20 UAV is a GNSS-Inertial OEM solution designed to reduce the cost and improve the efficiency of mapping from small Unmanned Aerial Vehicles (UAVs). Comprised of small, low power, precision GNSS and inertial hardware components and POSPac UAV post-mission Differential GNSS-Inertial office software, the APX-20 UAV eliminates the need to survey extensive Ground Control Points (GCP's), and reduces the amount of sidelap required to be flown per flight. The innovative APX-20 UAV features a precision, survey grade GNSS receiver and dual inertial measurement units: one embedded onto the GNSS-inertial board and one as an external unit mounted on the sensor to be georeferenced. With this feature the APX-20 UAV automatically supports integration on gimballed platforms without requiring an external interface to an autopilot or the mount itself.

### HIGH ACCURACY, EXTREMELY SMALL PACKAGE

Weighing only 90 grams, and measuring just 60 x 67 x 34 mm for the GNSS-Inertial board, and only 330 grams and just 61 x 68 x 65 mm for the external IMU, the APX-20 UAV provides unparalleled performance in an extremely small and lightweight package. The APX-20 UAV computes a real-time navigation

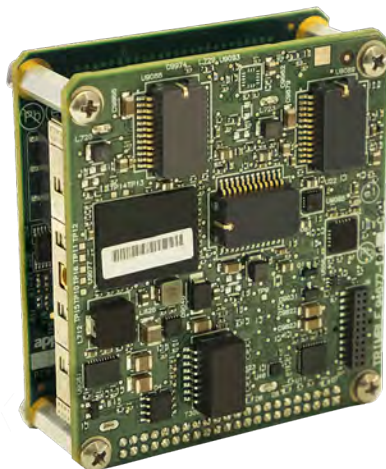
solution at 100 Hz using its embedded IMU while simultaneously logging the raw IMU data from both the internal and external IMU at 200 Hz for post-processing in POSPac UAV. The highly accurate post-processed position and orientation solutions are used for direct georeferencing of cameras, LiDARs and other sensors.

### THE APX-20 UAV BRINGS ALL THE BENEFITS OF DIRECT GEOREFERENCING TO UAV PLATFORMS:

- ▶ Turn your UAV into a professional mapping solution
- ▶ Ultra-fast image georeferencing for faster map production and delivery
- ▶ Reduced number of ground control points, saving time and money
- ▶ Consistent, reliable, highly accurate results
- ▶ Increased collection area per flight for greater productivity
- ▶ Redundant navigation solution to autopilot for enhanced safety

## Key Features

- ▶ High-performance Direct Georeferencing solution for improved efficiency and accuracy of mapping from small Unmanned Aerial Vehicles
  - Reduce/eliminate GCP's
  - Reduce sidelap
  - Accurate LiDAR/Camera georeferencing
  - Seamless workflow with gimballed platforms
- ▶ Compact OEM module complete with survey-grade multi-frequency GNSS receiver and embedded and external IMU's
- ▶ Applanix IN-Fusion™ GNSS-Inertial and SmartCal™ compensation technology for superior position and orientation performance
- ▶ POSPac UAV Differential GNSS Inertial post-processing software for highest accuracy georeferencing
- ▶ RTK real-time position for precision landing and real-time mapping applications
- ▶ Supports all common RTK corrections such as CMR, CMR+, RTCM



## TECHNICAL SPECIFICATIONS

### System Summary

- Advanced Applanix IN-Fusion™ GNSS-Inertial integration technology
- Dual IMU with solid-state MEMS inertial sensors with Applanix SmartCal™ compensation technology
- Advanced Trimble Maxwell Custom GNSS survey technology
- 336 Channels
  - GPS: L1 C/A, L2C, L2E, L5
  - GLONASS: L1 C/A, L2 C/A, L3 CDMA<sup>8</sup>
  - BeiDou: B1, B2
  - Galileo: E1, E5A, E5B, E5AltBOC
  - QZSS: L1 C/A, L1S, L1C, L2C, L5, LEX
  - SBAS: L1 C/A, L5
  - MSS L-band: Trimble RTX, OmniSTAR
- High precision multiple correlator for GNSS pseudorange measurements
- Unfiltered, unsmoothed pseudorange measurements data for low noise, low multipath error, low time domain correlation and high dynamic response
- Very low noise GNSS carrier phase measurements with <1 mm precision in a 1 Hz bandwidth
- Proven Trimble low elevation tracking technology
- 100 Hz position, roll, pitch and heading output
- IMU data rate 200 Hz for both Internal and external IMU
- Navigation output format: ASCII (NMEA-0183), Binary (Trimble GSOF)
- Supported Reference input: CMR, CMR+, sCMRx, RTCM 2.1, 2.2, 2.3, 3.0, 3.1
- Support for POSPac UAV post-processing software (included)
- No export permit required

### LAN INPUT/OUTPUT

All Ethernet functions are supported through dedicated IP address (Static or DNS) simultaneously.

**TCP/IP and UDP** ASCII and Binary data streaming (Time tag, PPS sync, status, position, attitude, velocity, track and speed, dynamics, performance metrics, GNSS data)

**HTTP** Web based Control software (GUI) for easy system configuration and low rate display. Support for all common browsers (IE, Safari, Mozilla, Google Chrome, Firefox)

### SERIAL INPUT/OUTPUT

RS232 level port  
TTL level (3.3 V) port  
Parameters

ASCII and Binary data streaming (Time tag, PPS sync, status, position, attitude, velocity, track and speed, dynamics, performance metrics, GNSS data), reference input (CMR, CMR+, sCMRx, RTCM), configuration messages

### OTHER INPUT/OUTPUT

PPS (pulse-per-second) Time Sync Pulse output  
Event Input (2) Two time mark of external events  
TTL 3.3 V pulses, max rate 50 Hz  
Digital I/O (3) LED drivers with dedicated functionality for systems integrators

### LOGGING

Internal Logging 6 GByte Flash memory  
External Logging USB 2.0 Device port  
Parameters Time tag, status, position, attitude, velocity, track and speed, dynamics, performance metrics, raw IMU data (200 Hz), raw GNSS data

- 1 Developed under a License of the European Union and the European Space Agency
- 2 Typical performance. Actual results are dependent upon satellite configuration, atmospheric conditions and other environmental effects
- 3 Typical survey mission profile, max RMS error. Heading error will increase for low speed rotor applications and when hovering.
- 4 Requires base station and radio link, sold separately
- 5 POSPac UAV, short base line operation
- 6 Sensor bandwidth (-3 dB amplitude) ~ 50 Hz
- 7 Sold separately
- 8 There is no official GLONASS L3CDMA or Galileo E6 ICD. The current tracking capability is based on publicly available information. Full receiver compatibility cannot be guaranteed.
- 9 Not including external IMU
- 10 Performance based upon external IMU
- 11 POSPac UAV/MMS, Post-processed CenterPoint® RTX™, typical mission performance subscription sold separately. The accuracy is subject to quality of GNSS, durational data set, and regional coverage.

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## INERTIAL MEASUREMENT UNITS (IMUS)

IMU Type	Range <sup>6</sup>	Temperature <sup>c</sup>	Power	Size mm	Weight g
Internal onboard IMU59	+/-6g, +/-350dps	-40 - +75	n/a	n/a	n/a
External IMU82	+/-10g, +/-490dps	-40- +85	4.75 to 36 VDC (4W max)	61 x 68 x 65 (L x W x H)	330

## PERFORMANCE SPECIFICATIONS<sup>2</sup> (RMS ERROR)

### Unmanned Airborne Vehicle Applications

	SPS <sup>10</sup>	RTK <sup>10</sup>	PP-RTX <sup>11</sup>	Post-Processed <sup>5,10</sup>
Position (m)	1.5 - 3.0	0.02 - 0.05	0.03 - 0.06	0.02 - 0.05
Velocity (m/s)	0.05	0.015	0.01	0.010
Roll & Pitch (deg)	0.03	0.025	0.015	0.015
True Heading <sup>3</sup> (deg)	0.10	0.08	0.035	0.035

## PHYSICAL CHARACTERISTICS

Size<sup>9</sup> ..... 67 L x 60 W x 34 H mm  
Weight<sup>9</sup> ..... 90 grams  
Power<sup>9</sup> ..... Wide range input 9-30 V DC, typical power consumption of 4W at room temperature  
Connectors ..... I/O: 44 Pin Header Samtec TMM-122-03-S-S-MW (mating part FCI 90311-044LF)  
IMU Connector: Molex 503148 (mating part Molex 503149)  
Antenna Port: ..... Connector: MMCX receptacle  
Output Voltage: 3.3 V DC to 5 V DC  
Maximum Current: 400 mA  
Minimum Input Signal Strength: 32 dB (> 35 dB Recommended)

## ENVIRONMENTAL CHARACTERISTICS

Temperature: ..... -40 deg C to +75 deg C (Operational)  
..... -55 deg C to +85 deg C (Storage)  
Mechanical Shock: ..... +/- 75g Survival  
Operating Humidity: ..... 5% to 95% R.H. non-condensing at +60 deg C  
Maximum Operating Limits: ..... 515 m/sec  
18,000 m

## ADDITIONAL ACCESSORIES<sup>7</sup>

Evaluation Kit (Development Board)

## POSPAC UAV OFFICE SOFTWARE

- Post-processed Differential GNSS-Inertial SW for APX-20
- 200 Hz Navigation solution (Position, Velocity, Orientation, Rates, Accelerations)
- Applanix IN-Fusion GNSS-Integration technology
- Full support for UAV dynamic models
- Single Base Differential GNSS-Inertial processing
- Forward and reverse processing with optimal Smoother with support for Applanix SmartBase virtual reference station module<sup>7</sup>
- Support for PP-RTX<sup>11</sup>

Specifications subject to change without notice.



# TRIMBLE AP+ 18 AIR

## NEXT GENERATION EMBEDDED GNSS-INERTIAL SOLUTION FOR ROBUST AIRBORNE POSITIONING AND DIRECT GEOREFERENCING

POWERFUL ENOUGH FOR USE ON MANNED PLATFORMS YET SMALL ENOUGH FOR USE ON UNMANNED AERIAL VEHICLES (UAVS)

The Trimble AP+ Air GNSS-inertial system is comprised of next-generation compact, low-power hardware, featuring dual embedded survey-grade GNSS chipsets, an onboard inertial measurement unit (IMU), an external IMU, and the all-new Applanix IN-Fusion+ GNSS-aided inertial firmware.

### INTEGRATE ONCE, USE MANY

The “Integrate once, use many” concept means a single hardware platform can be used to build a complete range of mapping payloads, from UAV to manned aircraft, using the same design. This consistency saves costs associated with design and integration.

The Trimble AP+ Air is configurable to support the Direct Georeferencing accuracy demands of everything from low-flying UAVs to high-altitude manned platforms. Compatible with photogrammetric cameras, LiDAR, hyperspectral and multispectral cameras, Synthetic Aperture Radar and virtually any other type of airborne remote sensor, the

Trimble AP+ Air is a powerful, compact, and versatile solution. Easily integrated with any type of platform, AP+ Air saves significant costs in all types of surveys.

### THE BEST SOLUTION JUST GOT BETTER

The Trimble AP+ Air OEM solution is fully supported by the industry-leading Applanix POSPac MMS post-processing software, featuring Post-Processed Trimble CenterPoint® RTX™ for centimeter position accuracy without base stations, making it the ultimate solution for integrators wishing to produce a highly efficient airborne mapping system. For LiDAR integrators, the Trimble AP+ Air OEM is fully compatible with the POSPac MMS LiDAR QC Tools for UAV.



### Key Features

- ▶ “Integrate once, use many” concept means a single platform can be used to build a complete range of mapping payloads, from UAV to manned aircraft, using the same design, which saves costs
- ▶ Reduced SWaP
  - 54% smaller footprint, 64% lighter, 75% less power
- ▶ Next generation, survey-grade GNSS receiver
- ▶ Dual inertial support (onboard and external) for simple gimbal mount support
- ▶ Two antenna heading support
- ▶ Next generation In-Fusion+ Aided-Inertial Firmware
- ▶ Completely configurable, from entry-level UAV applications, all the way up to high-accuracy solutions for high altitude LiDAR mapping

## TECHNICAL SPECIFICATIONS

### System Summary

- Applanix IN-Fusion™ GNSS-inertial integration technology
- Onboard IMU with solid state MEMS inertial sensor and Applanix SmartCal™ compensation technology
- Advanced Trimble Maxwell Custom GNSS survey technology with 2 x 336 tracking channels
- Optional Dual Antenna, GAMS (GNSS Azimuth Measurement System) included
- Primary Antenna
  - GPS: L1 C/A, L2C, L2E, L5
  - GLONASS: L1 C/A, L2 C/A, L3 CDMA<sup>6</sup>
  - BeiDou: B1, B2, B3<sup>8</sup>
  - Galileo<sup>7</sup>: E1, E5A, E5B, E5AltBOC, E6<sup>9</sup>
  - IRNSS: L5
  - QZSS: L1 C/A, L1S, L1C, L2C, L5, LEX
  - SBAS: L1 C/A, L5
  - MSS L-Band: Trimble RTX
- Secondary Antenna:
  - GPS: L1 C/A, L2C, L2E, L5
  - GLONASS: L1 C/A, L2 C/A, L3 CDMA
  - BeiDou: B1, B2, B3<sup>8</sup>
  - Galileo<sup>7</sup>: E1, E5A, E5B, E5AltBOC, E6
  - IRNSS: L5
  - QZSS: L1 C/A, L1S, L1C, L2C, L5, LEX
  - SBAS: L1 C/A, L5
- High-precision multiple correlator for GNSS pseudorange measurements
- Unfiltered, unsmoothed pseudorange measurements data with low noise, low multipath error, low time domain and high dynamic response
- Very low noise GNSS carrier phase measurements with <1 mm precision in a 1Hz bandwidth
- Proven Trimble low elevation tracking technology
- Real-time GNSS L1, SBAS positioning mode
- Real-time 100Hz position, attitude output, 200 Hz IMU data rate logging
- Navigation output format: ASCII (NMEA-0183), binary (Trimble GSOF)
- RTK license support for Reference Inputs CMR, CMR+, sCMRx, RTCM 2.1, 2.2, 3.0, 3.1, 3.2, sold separately
- Upgradable to external IMU models
- Supported by POSPac MMS
- No export permit required

### LAN INPUT/OUTPUT

All Ethernet functions are supported through dedicated IP address (static or DNS) simultaneously including web-based control GUI access and real-time data streaming

TCP/IP and UDP      ASCII and binary data streaming (time tag, PPS sync, status, position, attitude, velocity, track and speed, dynamics, performance metrics, GNSS data), configuration messages

HTTP      Web-based control software (GUI) for easy system configuration and low rate display. Support for all common browsers (IE, Safari, Mozilla, Google Chrome, Firefox)

### SERIAL INPUT/OUTPUT

RS232 ports (baud rates up to 460,800)      ASCII and binary data streaming (time tag, PPS sync, status, position, attitude, velocity, track and speed, dynamics, performance metrics, GNSS data), reference input (CMR, CMR+, sCMRx, RTCM), configuration messages

USB 2.0 Device Configuration      ASCII and binary data streaming (time tag, PPS sync, status, position, attitude, velocity, track and speed, dynamics, performance metrics, GNSS data), configuration messages

## OTHER INPUT/OUTPUT

- PPS (pulse-per-second) Time synchronization
- Event Input (2)      Two time marks for external events, TTL 3.3V, 50 Hz max rate
- Digital I/O (3)      LED drivers with dedicated functionalities for system integrators
- External IMU Interface      Dedicated signals for external IMU support

## LOGGING

- Internal Logging      6 GB flash memory
- External Logging      USB 2.0 host configuration support for removable USB device
- Parameters      Time tag, status, position, attitude, velocity, track and speed, dynamics, performance metrics, raw IMU data (200 Hz), raw GNSS data (5 Hz)

## PERFORMANCE SPECIFICATIONS

### Absolute Accuracy Specifications<sup>1</sup> (RMS)

Airborne Application					
	SPS	SBAS <sup>9</sup>	RTX <sup>3</sup>	Post-Processed-RTX <sup>5</sup>	Post-Processed <sup>4</sup>
Position (m)	1.5 H 3 V	0.50 H 0.85 V	0.04 H 0.08 V	0.03 H 0.06 V	0.02 H 0.05 V
Velocity (m/s)	0.050	0.050	0.050	0.015	0.015
Roll & Pitch (deg)	0.040	0.035	0.030	0.025	0.025
True Heading <sup>2</sup> (deg)	0.150	0.130	0.100	0.080	0.080

## PHYSICAL CHARACTERISTICS

- Size      100x60x21 mm
- Weight      100 g
- Power      7W max, 8-34V DC or 3.3V DC
- Connectors      Samtec LSHM-140-03.0-L-DV-A-N
- Antenna Port      2 x MMCX receptacle
- Output Voltage: Primary 7.5 VDC
- Secondary 5 VDC
- Maximum Current: 400 mA
- Minimum Input Signal Strength: 32 dB (>35 dB recommended)

## ENVIRONMENTAL CHARACTERISTICS

- Temperature      -40°C to +75°C (Operational)
- 55°C to +85°C (Storage)
- GNSS Operating Limit      515 m/sec, 18,000 m

## ADDITIONAL ACCESSORIES

- Evaluation Kit      Includes development board, power supply, and short antenna cables (sold separately)

## INERTIAL MEASUREMENT UNITS (IMUS)

Type	Range	Temp °C (Operational)	Power	Size (L x W x H) mm	Weight (kg)
Internal Onboard IMU-79	+/-6 g +/-350 dps	-40 to +75	n/a	n/a	n/a

Specifications subject to change without notice.

1 Typical performance. Actual results are dependent upon satellite configuration, atmospheric conditions and other environmental effects.  
 2 Typical mission profile, max RMS error (requires GAMS with 1 m baseline separation for low speed or stationary applications).  
 3 Real-time Trimble CenterPoint® RTX™ correction service, typical airborne results, subject to regional coverage. Subscription sold separately, requires RTK license.  
 4 POSPac MMS, Single Base station or SmartBase.  
 5 POSPac MMS, Post-Processed Trimble CenterPoint® RTX™, typical mission performance subscription sold separately. The accuracy is subject to quality of GNSS, data set duration, and regional coverage.  
 6 There is no official GLONASS L3CDMA or Galileo E6 ICD. The current tracking capability is based on publicly available information. Full receiver compatibility cannot be guaranteed.  
 7 Developed under a License of the European Union and the European Space Agency.  
 8 The hardware of this product is designed for BeiDou B3 compatibility (trial version) and its firmware will be enhanced to fully support such new signal as soon as officially published ICD becomes available.  
 9 Subject to regional coverage.

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# TRIMBLE AP+ 60 AIR

## NEXT GENERATION EMBEDDED GNSS-INERTIAL SOLUTION FOR ROBUST AIRBORNE POSITIONING AND DIRECT GEOREFERENCING

POWERFUL ENOUGH FOR USE ON MANNED PLATFORMS YET SMALL ENOUGH FOR USE ON UNMANNED AERIAL VEHICLES (UAVS)

The Trimble AP+ Air GNSS-inertial system is comprised of next-generation compact, low-power hardware, featuring dual embedded survey-grade GNSS chipsets, an onboard inertial measurement unit (IMU), an external IMU, and the all-new Applanix IN-Fusion+ GNSS-aided inertial firmware.

### INTEGRATE ONCE, USE MANY

The “Integrate once, use many” concept means a single hardware platform can be used to build a complete range of mapping payloads, from UAV to manned aircraft, using the same design. This consistency saves costs associated with design and integration.

The Trimble AP+ Air is configurable to support the Direct Georeferencing accuracy demands of everything from low-flying UAVs to high-altitude manned platforms. Compatible with photogrammetric cameras, LiDAR, hyperspectral and multispectral cameras, Synthetic Aperture Radar and virtually any other type of airborne remote sensor, the

Trimble AP+ Air is a powerful, compact, and versatile solution. Easily integrated with any type of platform, AP+ Air saves significant costs in all types of surveys.

### THE BEST SOLUTION JUST GOT BETTER

The Trimble AP+ Air OEM solution is fully supported by the industry-leading Applanix POSPac MMS post-processing software, featuring Post-Processed Trimble CenterPoint® RTX™ for centimeter position accuracy without base stations, making it the ultimate solution for integrators wishing to produce a highly efficient airborne mapping system. For LiDAR integrators, the Trimble AP+ Air OEM is fully compatible with the POSPac MMS LiDAR QC Tools for UAV.



## Key Features

- ▶ “Integrate once, use many” concept means a single platform can be used to build a complete range of mapping payloads, from UAV to manned aircraft, using the same design, which saves costs
- ▶ Reduced SWAP
  - 54% smaller footprint, 64% lighter, 75% less power
- ▶ Next generation, survey-grade GNSS receiver
- ▶ Dual inertial support (onboard and external) for simple gimbal mount support
- ▶ Two antenna heading support
- ▶ Next generation In-Fusion+ Aided-Inertial Firmware
- ▶ Completely configurable, from entry-level UAV applications, all the way up to high-accuracy solutions for high altitude LiDAR mapping

## TECHNICAL SPECIFICATIONS

### System Summary

- Applanix IN-Fusion™ GNSS-inertial integration technology
- Onboard IMU with solid-state MEMS inertial sensors and Applanix SmartCal™ compensation technology
- High performance external IMU
- Advanced Trimble Maxwell Custom GNSS survey technology with 2 x 336 tracking channels
- Optional Dual Antenna, GAMS (GNSS Azimuth Measurement System) included
- Primary Antenna
  - GPS: L1 C/A, L2C, L2E, L5
  - GLONASS: L1 C/A, L2 C/A, L3 CDMA<sup>6</sup>
  - BeiDou: B1, B2, B3<sup>8</sup>
  - Galileo<sup>7</sup>: E1, E5A, E5B, E5AltBOC, E6<sup>6</sup>
  - IRNSS: L5
  - QZSS: L1 C/A, L1S, L1C, L2C, L5, LEX
  - SBAS: L1 C/A, L5
  - MSS L-Band: Trimble RTX
- Secondary Antenna:
  - GPS: L1 C/A, L2C, L2E, L5
  - GLONASS: L1 C/A, L2 C/A, L3 CDMA
  - BeiDou: B1, B2, B3<sup>8</sup>
  - Galileo<sup>7</sup>: E1, E5A, E5B, E5AltBOC, E6
  - IRNSS: L5
  - QZSS: L1 C/A, L1S, L1C, L2C, L5, LEX
  - SBAS: L1 C/A, L5
- High-precision multiple correlator for GNSS pseudorange measurements
- Unfiltered, unsmoothed pseudorange measurements data with low noise, low multipath error, low time domain and high dynamic response
- Very low noise GNSS carrier phase measurements with <1 mm precision in a 1 Hz bandwidth
- Proven Trimble low elevation tracking technology
- Real-time GNSS L1, SBAS positioning mode
- Real-time 100 Hz position, attitude output, dual IMU 200 Hz data rate logging
- Navigation output format: ASCII (NMEA-0183), binary (Trimble GSOF)
- RTK license support for Reference Inputs CMR, CMR+, sCMRx, RTCM 2.1, 2.2, 3.0, 3.1, 3.2, sold separately
- Supported by POSPac MMS
- No export permit required

### LAN INPUT/OUTPUT

All Ethernet functions are supported through dedicated IP address (static or DNS) simultaneously including web-based control GUI access and real-time data streaming

TCP/IP and UDP      ASCII and binary data streaming (time tag, PPS sync, status, position, attitude, velocity, track and speed, dynamics, performance metrics, GNSS data), configuration messages

HTTP      Web-based control software (GUI) for easy system configuration and low rate display. Support for all common browsers (IE, Safari, Mozilla, Google Chrome, Firefox)

### SERIAL INPUT/OUTPUT

RS232 ports (baud rates up to 460,800)      ASCII and Binary data streaming (time tag, PPS sync, status, position, attitude, velocity, track and speed, dynamics, performance metrics, GNSS data), reference input (CMR, CMR+, sCMRx, RTCM), configuration messages

USB 2.0 Device Configuration      ASCII and Binary data streaming (time tag, PPS sync, status, position, attitude, velocity, track and speed, dynamics, performance metrics, GNSS data), configuration messages

1 Typical performance. Actual results are dependent upon satellite configuration, atmospheric conditions and other environmental effects.  
 2 Typical mission profile, max RMS error (GAMS not required).  
 3 Real-time Trimble CenterPoint® RTX™ correction service, typical airborne results, subject to regional coverage. Subscription sold separately, requires RTK license.  
 4 POSPac MMS, Single Base station or SmartBase.  
 5 POSPac MMS, Post-processed CenterPoint® RTX™, typical mission performance subscription sold separately. The accuracy is subject to quality of GNSS, data set duration, and regional coverage.  
 6 There is no official GLONASS L3CDMA or Galileo E6 ICD. The current tracking capability is based on publicly available information. Full receiver compatibility cannot be guaranteed.  
 7 Developed under a License of the European Union and the European Space Agency.  
 8 The hardware of this product is designed for BeiDou B3 compatibility (trial version) and its firmware will be enhanced to fully support such new signal as soon as officially published ICD becomes available.  
 9 Does not include external IMU.  
 10 Performance based upon external IMU.  
 11 May require local gravity model to achieve full accuracy.  
 12 Subject to regional coverage.

## OTHER INPUT/OUTPUT

- PPS (pulse-per-second) Time synchronization
- Event Input (2) Two time marks for external events, TTL 3.3V, 50 Hz max rate
- Digital I/O (3) LED drivers with dedicated functionalities for system integrators
- External IMU Interface Dedicated signals for external IMU support

## LOGGING

- Internal Logging 6 GB flash memory
- External Logging USB 2.0 host configuration support for removable USB device
- Parameters Time tag, status, position, attitude, velocity, track and speed, dynamics, performance metrics, raw IMU data (200 Hz), raw GNSS data (5 Hz)

## PERFORMANCE SPECIFICATIONS

### Absolute Accuracy Specifications (RMS)<sup>1,10</sup>

	Airborne Application				
	SPS	SBAS <sup>11</sup>	RTX <sup>3</sup>	Post-Processed-RTX <sup>5</sup>	Post-Processed <sup>4</sup>
Position (m)	1.5 H 3 V	0.50 H 0.85 V	0.04 H 0.08 V	0.03 H 0.06 V	0.02 H 0.05 V
Velocity (m/s)	0.030	0.030	0.030	0.005	0.005
Roll & Pitch (deg)	0.005	0.005	0.003	0.0025 <sup>11</sup>	0.0025 <sup>11</sup>
True Heading <sup>2</sup> (deg)	0.030	0.025	0.010	0.005	0.005

## PHYSICAL CHARACTERISTICS

- Size<sup>9</sup> 100x60x21 mm
- Weight<sup>9</sup> 100 g
- Power<sup>9</sup> 7W max, 8-34V DC or 3.3V DC
- Connectors Samtec LSHM-140-03.0-L-DV-A-N
- Antenna Port 2 x MMCX receptacle
- Output Voltage: Primary 7.5 VDC
- Secondary 5 VDC
- Maximum Current: 400 mA
- Minimum Input Signal Strength: 32 dB (>35 dB recommended)

## ENVIRONMENTAL CHARACTERISTICS

- Temperature -40°C to +75°C (Operational)
- 55°C to +85°C (Storage)
- GNSS Operating Limit 515 m/sec, 18,000 m

## ADDITIONAL ACCESSORIES

- Evaluation Kit Includes development board, power supply, and short antenna cables (sold separately)

## INERTIAL MEASUREMENT UNITS (IMUS)

Type	Range	Temp °C (Operational)	Power	Size (L x W x H) mm	Weight (kg)
Internal Onboard IMU-79	+/-6 g +/-350 dps	-40 to +75	n/a	n/a	n/a
External IMU-57	+/-10 g +/-490 dps	-40 to +60	8 to 36V DC 15W max	179 x 126 x 127	2.6

Specifications subject to change without notice.

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# Trimble GNSS Smart Target Base Station

## HIGH-PERFORMANCE GNSS REFERENCE STATION AND GROUND CONTROL

The Trimble GNSS Smart Target Base Station is an easy to use, survey grade multi-frequency, multi-constellation GNSS reference station complete with a foam Ground Control Target and integrated carrying case. It logs the raw GNSS observables required to do post-processed Differential GNSS positioning along with data logged from Rover receiver in a mapping UAV, and acts as a photo-identifiable Ground Control Point (GCP) for quality control.

Cost effective, simple to operate, and supported by both Applanix POSPac UAV and Trimble UASMaster, the Trimble GNSS Smart Target Base Station makes cm level mapping from UAV's easier than ever.

Simply place the foam target with receiver in the project area, stake it down, and start data logging wirelessly with the included Smart Phone app or web UI. At the end of the mission retrieve the target and download the raw GNSS observable for post-processing. Global coordinates of the base station are automatically surveyed using Trimble Centerpoint™ RTX Post-processing built into the Applanix POSPac UAV software<sup>1</sup>, or if local coordinates are desired the foam target can be centered over a control point with pre-surveyed coordinates.

## Key Features

- ▶ Survey grade GNSS Base station data collection for UAV georeferencing
- ▶ Photo-identifiable target with integrated carrying case for simplified use of Base Station as a Ground Control Point in image processing
- ▶ Fully autonomous and battery operated
- ▶ Long duration with the possibility of recharging during operation
- ▶ Seamless wireless operation through wifi and bluetooth interface
- ▶ Integrated web server with support for all common browsers
- ▶ Supported by an Android App for simplified wireless operation (no cables required)
- ▶ Simple deployment regardless of terrain





## TECHNICAL SPECIFICATIONS

- Trimble GNSS Smart Target Base Station with 220 channel, multi-frequency, multi-constellation GNSS support
- GNSS tracking for all available satellite constellations (GPS, GLONASS, BeiDou, Galileo, QZSS)
- Proven Trimble low noise, low elevation tracking technology
- Onboard, internal storage (50 Mb Flash Memory) for 1 Hz raw measurement logging in Trimble T02 and RINEX format
- Applanix POSPac UAV support for surveying Global coordinates using Trimble Centerpoint™ RTX Post-processing
- Embedded lithium-ion battery
- Continual 4 hours of operation on internal battery, unlimited operation via external standard USB battery (not included)

## INTERFACE

- Aux USB connector for external battery and charge
- Powerbutton with encoded functionalities(On/Off/Reset)
- Wi-fi and bluetooth interfaces
- LED functionalities for status display:
  - Wireless communication
  - Positioning
  - Correction service
  - Battery status

## PERFORMANCE SPECIFICATIONS

- Absolute accuracy of Global Base Station coordinates: < 2 - 5 cm with Trimble Centerpoint™ RTX Post-processing<sup>1,2</sup>
- Relative accuracy of UAV Differential GNSS trajectory: < 1 – 3 cm with POSPac UAV<sup>3</sup>

<sup>1</sup> Requires Internet connection and at least 30 minutes of continuous base data collection

<sup>2</sup> Open sky location

<sup>3</sup> With Trimble APX-15 installed in UAV, baseline dependent

<sup>4</sup> 3 hours duration of battery charge applies in both modes, during operation and off mode

## PHYSICAL CHARACTERISTICS

Size	.....45.5 L x 45.5 W x 10 H cm (nominal)
Weight	.....~1 kg (target included)
Power	.....4 hours of continuous operation with fully charged internal battery
Battery charge time	.....3 hours <sup>4</sup> /unlimited via external USB battery (not included)

## ENVIRONMENTAL CHARACTERISTICS

Temperature	..... -20°C to +50°C (operational)
Battery Charging Temperature	.....+5°C to +50°C
	RoHS and CE standard compliance

## ADDITIONAL ACCESORIES

Adapter cable kit with USB-A socket and universal charger included.



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