POS AV V6 Installation and Operation Manual

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POS AV V6 Installation and Operation Guide

Congratulations on your purchase of a POS AV system. Applanix develops, manufactures, sells and supports precision products that accurately and robustly measure the position and orientation of vehicles in dynamic environments. Applanix technology, in use by our customers all around the world, is measuring, monitoring and modeling our planet Earth in virtually every environment imaginable. Applanix Position and Orientation System (POS) is essential part in a variety of applications including road profiling, aerial survey and mapping, railroad track maintenance and seafloor mapping. Applanix strives to support customers around the world with exceptional service - anywhere, at anytime.

PUBS-MAN-004809

Revision 7

General Notice

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This manual describes the POS AV in detail and contains full installation and operating instructions.

The manual is an important part of the system. It should remain with the system for use by those who will operate and maintain it.

It is the customer’s responsibility to ensure that there are adequate mounting facilities and carefully plan the component layout. Applanix will not be responsible for damage caused by improper installation or inadequate environmental conditions.

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Liability and Safety Information

Important: All cables connected to the POS AV equipment shall be constructed of (in order of preference): a) high temperature and b) low smoke materials.

Ethernet Cable - Applanix supplies a suitable Ethernet cable. However, if supplied by the customer the cable shall be constructed of braided shielding that is properly terminated with connectors and has a minimum of 90% coverage, and be rated as CAT5 or better.

Serial Cables - COM port cables are not shipped as part of the accessory package. The customer is responsible for supplying and using premium serial cables with the POS AV system. **Important**: The COM port serial cables shall be constructed of braided shielding that is properly terminated with connectors and has a minimum of 90% coverage.

Regulatory Information

Caution: Do not make mechanical or electrical modifications to the POS AV system or any of its components. Changes or modifications not expressly approved by Applanix could void the compliance and negate your authority to operate the product.

Certification was achieved using the following original or replacement equipment supplied by Applanix: GNSS antennas, GNSS antenna cables, Ethernet cable, IMU, IMU cable.

DECLARATION OF CONFORMITY

Manufacturer's Name:	applanix A TRIMBLE COMPANY
Manufacturer's Address:	85 Leek Crescent
	Richmond Hill, Ontario, Canada L4B 3B3
EC Representative's Name:	Applanix Corporation, A Trimble Company
EC Representative's Address:	85 Leek Crescent
	Richmond Hill, Ontario, Canada L4B 3B3
Equipment Model Designation:	POS AV V6
Equipment Description:	POS AV is a fully integrated, turnkey position and orientation system for airborne vehicles.

Application of Council Directive: 2006/95/EC on the harmonization of the laws related to Member States relating to electrical equipment designed for use within certain voltage limits and Council Directive 2004/108/EC on the approximation of the laws related to Member States relating to electromagnetic compatibility.

Referenced Safety Standards:

EN 60950-1: 2006 with Amendments
- A11:2009
- A1:2010
- A12:2011

Referenced EMC Standards:

EN 55022 : 2010
EN 55024 : 2010

FCC Section 15.21 Information to the user.

Changes or modifications not expressly approved by Applanix could void the user's authority to operate the equipment.

FCC Section 15.105 Information to the user.

NOTE: This equipment has been tested and found to comply with the limits for a Class A 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 commercial 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.

Industry Canada

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

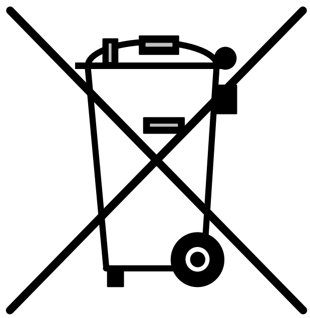
VCCI

　この装置は、情報処理装置等電波障害自主規制協議会（ＶＣＣＩ）の基準に基づくクラスＡ情報技術装置です。この装置は、家庭環境で使用することを目的としていますが、この装置がラジオやテレビジョン受信機に近接して使用されると、受信障害を引き起こすことがあります。
　取扱説明書に従って正しい取り扱いをして下さい。

English Translation: This is a Class A product based on the standard of the Voluntary Control Council for Interference from Information Technology Equipment (VCCI). If this is used near a radio or television receiver in a domestic environment, it may cause radio interference. Install and use the equipment according to the instruction manual.

For Our European Union Customers
A New Recycling Program

Applanix recognizes the importance of minimizing the environmental impacts of our products. We endeavour to meet your needs, not only when you purchase and use our products, but also when you are ready to dispose of them. Applanix is actively pursuing, and will continue to pursue, the expanded use of environmentally friendly materials in all its products. In addition, we have established a convenient and environmentally friendly recycling program.



As Applanix makes additional recycling facilities available for your use, we will post their locations and contact information on our recycling instructions Web page. In the meanwhile see Appendix A, page A-1, for Applanix contact information.

WEEE is Waste Electrical and Electronic Equipment products that operate on electrical power.

About this Document

Text Conventions

The following text conventions are used in this manual:

- Emphasize a term - italic font or bold italic font (e.g. 'An *Inertial Frame* is' or 'An ***Inertial Frame*** is'); a mixture is acceptable but, consistency is preferable
- Referring to another manual or to a file name - italic font (e.g. 'read the *Power Requirements* manual' or 'locate the *start.exe* file')
- Referring to a placard label - regular font (e.g. 'the COM (2) connector')
- Referring to a screen label - bold font (e.g. 'press the **OK** button')
- Path statement - bold font (e.g. 'select **C:\My Computer\ Working Files\.Fields**')
- Menu statement - bold font (e.g. 'select **Insert, AutoText, Closing** window menu' or 'select **Insert | AutoText | Closing** window menu'); a mixture is acceptable but, consistency is preferable
- Web address statement - bold font (e.g. 'select **http://www.applanix.com** from')

Symbols

The following symbols appear in this document:

	Warning - operating procedures, practices, etc., which, if not correctly followed, could result in personal injury or loss of life		Caution - procedures, practices, etc., which, if not correctly followed, could result in damage or destruction of equipment, or loss of data
	Electrostatic Discharge (ESD) sensitive material		Fragile/Breakable
	Hint - provides a suggested method or approach		Electrocution hazard

Document Number

PUBS-MAN-004809, Revision 7, dated 22-February-2017.

References

PUBS-ICD-003259, POS AV V6 Ethernet & Disk Logging Interface Control Document

PUBS-MAN-003760 POSTrack Operation Guide

PUBS-MAN-001409, User Manual

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List of Abbreviations, Synonyms and Symbols

°C	Degree Celsius
°F	Degree Fahrenheit
Ω	Ohm
µs	Microsecond
A	Ampere
ac	Alternating Current
arcmin	Arc Minute (unit of angular measure)
arcsec	Arc Second (unit of angular measure)
ASCII	American Standard Code for Information Interchange
AUX	Auxiliary
BIT	Built-In-Test
BNC	Bayonet Neil-Concelman (British Naval Connector)
bps	Bits Per Second
C/A	Coarse Acquisition
CCD	Charge-Coupled Device
CD	Compact Disk
CD-ROM	Compact Disk – Read Only Memory
cg	Centre of Gravity
cm	Centimetre
CPU	Central Processing Unit
CTS	Clear to Send

D/A	Digital to Analog
DAC	Digital to Analog Converter
dB	Decibel
dc	Direct Current
DCD	Data Carrier Direct
DDE	Dynamic Data Exchange
deg	Degree (plane angle)
DEM	Digital Elevation Model
DGPS	Differential Global Positioning System
dia	Diameter
DIN	Deutsche Industrinorm
DIO	Data I/O
DOP	Dilution of Position
dpi	Dots Per Inch
DSS	Digital Sensor System
ECEF	Earth Centered Earth Fixed
EIB	Events Interface Box
EMI	Electromagnetic Interference
EO	Exterior Orientation
ESD	Electrostatic Discharge
EVO	Event-Based Output
FCS	Flight Management Computer System
FDIR	Fault Detection, Isolation and Reconfiguration
FIN	Free Inertial Navigation
FMS	Flight Management System

ft	Foot
g	Gravity (acceleration due to gravity)
GAMS	GNSS Azimuth Measurement Subsystem
GB	Gigabyte
GMT	Greenwich Mean Time
GND	Ground
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
HDOP	Horizontal Dilution of Precision
HFC	Hardware Flow Control
hr	Hour
Hz	Hertz
I/O	Input/Output
I/P	Input
ICD	Interface Control Document
IEEE	Institute of Electrical and Electronics Engineers
IMU	Inertial Measurement Unit
in	Inch
IP	Internet Protocol
ISA	Industry Standard Architecture
kb	Kilobit
kB	Kilobyte
kbps	Kilobits Per Second
kHz	Kilohertz
lb	Pound

LAN	Local Area Network
LCD	Liquid Crystal Display
LED	Light Emitting Diode
LiDAR	Light Detection and Ranging
LNA	Low Noise Amplifier
long	Longitude
LRF	Laser Range Finder
LVDS	Low Voltage Differential Signal
LWH	Length, Width, Height
m	Metre
Max	Maximum
Mb	Megabit
MB	Megabyte
MHz	Megahertz
Min	Minimum
min	Minute (time interval)
mm	Millimetre
ms	Millisecond
N/C	No Connection
NED	North, East and Down
MEP	Mid-Exposure Pulse
NMEA	National Marine Electronics Association
NRG	No Range Given
NVM	Non-Volatile Memory
O/P	Output

OEM	Original Equipment Manufacturer
OS	Operating System
OTF	On-The-Fly
oz	Ounce
PC	Personal Computer
PCI	Peripheral Component Interconnect
PCMCIA	Personal Computer Memory Card International Association
PCS	POS Computer System
PDOP	Positional Dilution of Precision
POS	Position and Orientation System
POS AV	Position and Orientation System for Airborne Vehicles
POSEO	Position and Orientation System Exterior Orientation
POSPac	Position and Orientation System Post-Processing Package
POSPC	POS Point Cloud Generation
PPS	Pulse Per Second
RAM	Random Access Memory
RAU	Remote Analog Unit
RMS	Root Mean Square
ROM	Read Only Memory
RTCA	Radio Technical Commission for Aeronautics
RTCM	Radio Technical Commission for Maritime Services
RT	Real-Time
RTK	Real-Time Kinematics
RTS	Ready to Sent
s	Second (time interval)

SBAS	Satellite-Based Augmentation System
SBET	Smoothed Best Estimate of Trajectory
SOSR	Sum of Squared Residuals
SV	Space Vehicle
sync	Synchronous
TCP	Transmission Control Protocol
TCP/IP	Transmission Control Protocol/Internet Protocol
TECI	Tracker External Camera Interface
TOV	Time of Validity
TRP	Target Reference Position
TTL	Transistor-Transistor Logic
UDP	Universal Datagram Protocol
UNC	Unified National Course (Thread)
UPS	Uninterrupted Power Supply
UTC	Universal Time Coordinated (or Coordinated Universal Time)
UTM	Universal Transverse Mercator
Vac	Volt Alternating Current
Vdc	Volt Direct Current
VDOP	Vertical Dilution of Precision
W	Watt
wrt	With Respect To
YDC	Yaw Drift Correction

1.0 Introduction

Applanix Position and Orientation System for Airborne Vehicles (POS AV) provides navigation and orientation data for geocoding and georectifying airborne sensor information.

Data such as geographic position (latitude, longitude and attitude), velocity, acceleration, angular rate, orientation (roll and pitch), heading and performance metrics are available in real-time and through post-processing.

The POS AV System is comprised of a POS Computer System (PCS), Inertial Measurement Unit (IMU) and a Global Navigation Satellite System (GNSS) antenna (Figure 1).

Figure 1: POS AV System Components

POS AV System Overview

General

The PCS uses data from an IMU and a GNSS receiver to produce accurate measurements of aircraft navigation parameters and performance metrics.

POS AV has the capability of monitoring sensor health, isolating a sensor that shows degraded performance and reconfiguring itself to maintain optimal performance. Sensor errors are estimated on an ongoing basis using a Kalman filtering technique.

With the use of aerospace technology in both its sensors and data processing, POS AV is designed for reliable operation in a variety of vehicle environments. The system provides continuous data regardless of GNSS availability.

POS AV is controlled by a Microsoft Windows® based controller program or operated in Stand-Alone mode. The controller software is used to configure the system after installation in a new aircraft and once configured, may be used to monitor performance or control the POS AV.

POS AV and the controller software communicate via a thin wire Ethernet interface. Data broadcast from POS AV uses the Universal Datagram Protocol (UDP) permitting multiple computers, on the same Ethernet network, to monitor POS AV simultaneously. Data and commands between the POS AV Controller and the POS AV use Transmission Control Protocol/Internet Protocol (TCP/IP) addressing, thereby preventing other computers from receiving the controller commands.

Data are transmitted to the controller for display once per second. POS AV is also capable of broadcasting high rate data across three TCP/IP Ethernet connections for logging or for real-time use.

A number of serial ports and other interfaces are available for the transmission of navigation and status data. See the External Interfaces description on page 8-1 for more details.

POS AV is able to log data to an external and internal USB Flash Drive. For improved accuracy, the data logged by the POS AV is post-processed using the Applanix Position and Orientation System Post-Processing Package (POSPac Mobile Mapping Suite) software package. Refer to Data Logging on page 6-1 for further information.

Principles of Operation

POS AV uses an IMU and a GNSS receiver as its core navigation sensors.

The POS AV embedded navigation software runs an inertial navigation algorithm that solves Newton's equations of motion using the acceleration and angular rate data from the IMU.

A Kalman Filter compares the inertial solution with corresponding data from the GNSS receiver and uses these comparisons to estimate the inertial navigation errors. The system then adjusts the inertial navigation solution by the Kalman Filter estimated errors.

This process of inertial navigation, navigation error estimation and error correction forms a closed error regulation loop that forces the inertial navigator data to be consistent with the aiding sensor data. When the GNSS receiver provides Real-Time Kinematic (RTK) accuracy, position errors are regulated to centimetre level accuracy while velocity and attitude errors are controlled to similarly small values.

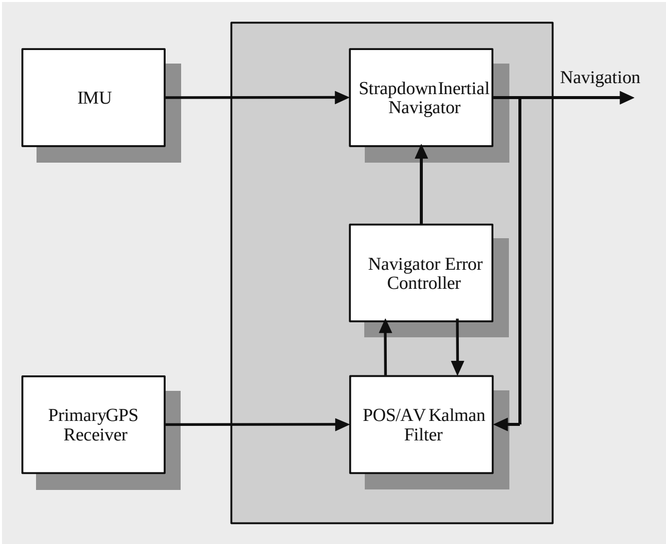


Figure 2: POS AV Aided Inertial Navigation Processing

System Components

- POS Computer System (PCS)
- Multiple Frequency Global Navigation Satellite System (GNSS) receiver (part of the PCS)
- Data logging device (part of the PCS)
- Internal back-up logging device (part of the PCS)
- Inertial Measurement Unit (IMU)
- High Gain (43 dB) GPS/GLONASS/Galileo/L Band antenna
- AV POSView Controller software

Optional Components

- Secondary GNSS capability
- Software capability upgrades through POS options, like mount control, event based navigation output.
- POSPacMMS post-processing software

Upgrade Components

When upgrading from a POS AV V5 to a POS AV V6 system, the following components must be returned to Applanix via RMA (see Appendix A):

- POS AV V5 PCS
- All POS AV V5 cables (except the GNSS antenna cable and IMU cable)

As part of the upgrade, you receive the following components:

1. POS AV V6 PCS
2. All associated I/O, Ethernet, events and power cables
3. Short stub IMU cable, backward compatible with V5 IMU cables.
4. Latest POS AV V6 user manual and documentation
5. New GNSS antenna
6. Latest POS AV V6 firmware and AV POS View controller software

Major Differences between POS AV V5 and POS AV V6:

- POS AV V6 includes the advanced GNSS receiver module with 220 channels capable of tracking most existing frequencies (GPS, GLONASS, Galileo, QZSS, SBAS, L-Band).

- POS AV V6 has been reduced in size, weight and power consumption of overall system.
- POS AV V6 operates on wide input range voltage (20-34Vdc)
- Even though the overall system is significantly smaller, the interface has been expanded with support for 6 time marks input (Event In) signals, 5 COM ports, multiple PPS Out signals.
- All interface lines are completely isolated (each COM port/ Event/PPS… have its own ground signal)

POS Computer System

The PCS is the heart of the system and contains all the data acquisition and processing hardware, single or dual GNSS receivers (depending upon the configuration) and a power supply for the IMU. Data acquired from the sensors are processed to produce real-time aircraft navigation data that is recorded to the logging device for further post-processing by POSPac.

GNSS Receiver

A state of the art GNSS receiver is embedded in PCS housing. It provides position and velocity information to the POS AV and processes differential corrections.

Data Logging Device

The data logging device writes to a removable USB flash disk. The flash disk records mission data that is transferable to any computer with a USB drive.

Internal Back-Up Logging Device

Back-up logging is initiated when data are logged to the removable USB device. The same data selected for logging on removable USB device are stored, in parallel to an internal drive. Once the back-up logging is initiated, it cannot be stopped until the PCS is powered down.

Inertial Measurement Unit

The IMU senses 3-axis acceleration and 3-axis angular rotation, centred at the IMU, and outputs this data as digital incremental velocities and angles. The IMU is a self-contained unit connected to the PCS via the supplied IMU cable.

GNSS Antenna

The GNSS antenna is mounted externally on the top of the aircraft fuselage and provides signals of the Global Navigation Satellite System (GNSS) to the receiver located in the PCS. The POS operates with a high gain antenna. Currently there are two airborne antenna options with different mounting hole patterns:

- AV59 aviation grade high gain antenna (45dB) supports all existing GNSS frequency tracking band as well as ready for future Galileo use. This is default antenna option delivered with the system.
- AV37 aviation grade small form factor high gain antenna (43dB) supports all GPS, GLONASS and L-band frequencies.

POS AV Controller Software

The POS AV Controller is a software program that operates on a PC running Microsoft Windows®. It is used to configure, control and monitor POS AV operation.

Note: To ensure 100% compatibility, install the AV POSView Controller software on an English version of Microsoft Windows®.

Secondary GNSS Receiver Capability

An optional secondary GNSS receiver may be enabled that permits logging of redundant raw GNSS data.

Auxiliary GNSS Receiver

A customer provided external GNSS receiver may be connected to the PCS via any of existing serial ports. The auxiliary GNSS data are used for post-processing and, based on the best solution; the POS AV determines whether to use the data from the auxiliary or the internal primary GNSS receiver. Refer to the serial COM port description and settings for additional information.

In addition, an antenna splitter/blocker is required to connect the POS AV to the same antenna as the auxiliary GNSS. The blocker portion isolates the POS AV from the dc voltage provided by the GIS sensor to power the GNSS antenna. Depending upon the antenna cable length, a Low Noise Amplifier (LNA) may be required for signal strength issues (placed between the POS AV and the splitter/blocker).

If you are using NavCom StarFire™ GIS sensor, please refer to Appendix for configuration details in order to achieve optimal integration with the POS AV.

Note: When sharing one antenna between the AUX GNSS and the POS AV internal primary GNSS receiver, ensure that the Lever Arm data (primary GNSS and AUX1/AUX2 GNSS) are entered in the AV POSView Controller (the same values since one antenna is being used); refer to section System Configuration 5.0.

POSPacMMS Post-Processing Software

POSPacMMS is a set of software tools, available from Applanix, used to obtain the most accurate position and orientation solution from POS AV sensor data.

Since POSPacMMS is not bound by the constraints of real-time processing, the software provides a navigation solution that is more accurate than the real-time navigation solution output by POS AV. The program uses advanced algorithms for forward/reverse processing, enhanced error modelling and carrier phase Differential Global Positioning System (DGPS) processing.

POSPacMMS is available with an optional Position and Orientation System Exterior Orientation (POSEO) module. POSEO is used with photogrammetry systems for computing the exterior orientation of each photo. More information is contained in the *POSPacMMS User Manual*.

Function and Performance

POS AV provides the following functions:

- Motion measurement (real-time position & orientation) and OmniSTAR ready system for improved real time position accuracy
- Installation parameter storage
- Data logging
- AutoStart
- AutoLog
- AutoRecovery
- Fault Detection, Identification and Reconfiguration (FDIR)
- Time tagging

- Event tagging
- Back-up logging

Motion Measurement

One of POS AV's key functions is to provide a real-time navigation solution that includes the following parameters:

- Position (latitude, longitude and altitude)
- Geographic velocity - North, East and Down (NED)
- Orientation (roll, pitch and heading)
- Acceleration (XYZ in the body frame)
- Angular rate

This data may be supplied to a flight management system for platform stabilization and pointing, platform yaw and drift control and other similar applications. In addition, navigating in real-time has the added benefit of checking the sensor data on line.

The POS AV is OmniSTAR ready system. The additional improvement in real time position performance could be achieved through the subscription to OmniSTAR service.

Installation Parameter Storage

POS AV requires that certain parameters be specified in order to operate properly in real-time. POS AV can store these parameters and use them for initialisation on power-up.

Alterations to the operational parameters may be made at any time. Once altered, saving them will permanently retain the new parameters.

Data Logging

Data logging allows the POS AV to store both raw sensor data and real-time processed navigation data on a removable USB Flash Drive (or via the Ethernet) for post-processing. Post-processing enhances data accuracy. The USB drive supports FAT32 format and data are transferable between the PCS and any Microsoft Windows® based computer with USB 2.0 interface running POSPac post-processing software.

AutoStart

Enabling the AutoStart feature automatically transitions POS AV to the Navigate mode after power-up. AutoStart is enabled or disabled using the POS AV Controller.

AutoLog

Enabling the AutoLog feature automatically triggers data logging to an USB Flash Drive after power-up, allowing hands-free operation of the system.

AutoRecovery

AutoRecovery is always enabled. It allows POS AV to recover from a communications error between the PCS and the IMU. Since the IMU is the most important sensor in the sensor suite, errors in communications can cause significant problems. POS AV is designed to deal with certain level of data corruption introduced by noise or power problems on-board the aircraft.

Fault Detection, Isolation and Reconfiguration

The Fault Detection, Isolation and Reconfiguration (FDIR) feature combines POS AV sensor data in a manner that provides the best navigation solution at any point in time. Always active, FDIR is able to monitor the sensors, determine which sensors show degraded performance and recombine the data as necessary.

Time Tagging

POS AV attaches time tags to all of its outputs to permit synchronization with data from other sensors or systems. The time tag is based on Universal Time Coordinated (UTC), GPS, POS time; has a resolution of 1 µs; and has an accuracy of less than 10 µs. Distance tagging is not used by POS AV.

Event Tagging

POS AV can time tag up to six external hardware events through the associated I/O 1,2,3 connectors. These tags are used to synchronize POS AV data with data from other sensors or systems.

Events are tagged with GPS, UTC, POS time. Tagging is accomplished by applying a signal to either the Event 1 to 6 connector; an events timing cable is provided.

Event time tagging occurs when the POS AV detects a rising or falling edge on either Event line (accurate to within 10 µs). The time of the event may be output via the serial ports, the Ethernet, or logged for use in post-processing.

Back-Up Logging

Back-up logging is initiated when data are logged to the external USB Flash Card and remains active, regardless of the external data logging activity, until the PCS is reset or powered-off. Back-up logging stores data to an internal four-gigabyte drive. The back-up logging drive requires no maintenance by the user and continuously deletes the oldest file before writing a new one. Refer the Data Logging – Removable Media and Back-Up topic on page 6-3 for more information.

Modes of Operation

POS AV has two standard modes of operation, Standby and Navigate.

Standby Mode

In the Standby mode the PCS accepts command messages and outputs raw time tagged sensor data, but does not perform any data processing. Therefore, no navigation data are output by the system.The Standby mode is used to record IMU and GNSS data to the external/internal drive for later use with the POSPacMMS post-processing software. In this case, the POS AV functions strictly as a data acquisition system.

Navigate Mode

Either the POS AV Controller or the AutoStart function is used to switch to the Navigate mode. When POS AV enters the Navigate mode it performs an initialisation and alignment of its inertial navigator. Once computing starts, it outputs real-time navigation data.

Flight Checklists

The POS AV Flight Checklists, starting on page G-1, contains steps for flight preparation, in-flight procedures and post flight checklist.

2.0 Hardware Installation

Handle all POS products with extreme care. POS AV contains sensitive components that have special handling requirements. See Unpacking and Handling on page 2-3 for more information.

POS AV Models

Applanix offers four Position and Orientation System for Airborne Vehicles (POS AV) models that provide accuracy levels suitable for the full range of airborne sensors. These models are:

- POS AV 210
- POS AV 310
- POS AV 410
- POS AV 510
- POS AV 610

Optional software that is compatible with each model includes the Position and Orientation System Post-Processing Package (POSPacMMS) and the Position and Orientation System Exterior Orientation (POSEO). POSPacMMS is a post-processing software application that optimally blends integer carrier-phase GNSS data with inertial data. With the addition of the Direct Georeferencing (DG) option (POSEO), the POS AV system can automatically generate plotter-ready Exterior Orientation (EO) data for frame cameras. The POSEO module operates in conjunction with the POSPacMMS post-processing software suite.

Each POS AV system includes the following Applanix supplied components:

- POS Computer System (PCS)

- Global Navigation Satellite System (GNSS) antenna (the GNSS receiver is located inside the PCS)
- Inertial Measurement Unit (IMU)

System Power Requirements

The PCS is the only component connected to an external power source and supplies the necessary power to the other system components.

PCS	**WARNING: PCS will shutdown if aircraft power is not within the specified range.**
Nominal Voltage:	28 Vdc
Voltage Range:	20 to 34 Vdc
Nominal Current:	1.5A at 28Vdc (including the IMU) 3.0A Max at 20Vdc
GNSS Antenna	
Voltage:	Supplied by the GNSS receiver via antenna coaxial cable
IMU	
Voltage:	Supplied by the PCS via IMU cable (See page I-1 for power consumption of the various IMUs)

A single power connector on the PCS rear panel connects to a Direct Current (dc) source. Through the PCS the power is supplied to the internal GNSS receiver and the IMU.

Unpacking and Handling

Handle all POS products with extreme care. POS AV contains sensitive components that have special handling requirements. Read the handling instructions below before removing any items from their shipping container.

All POS AV systems are subject to electrical and mechanical acceptance tests before shipping. Each system is packed in shock-protecting shipping cases to prevent any damage during shipment. It should arrive free of any defects and in operating condition.

Inspect the shipment on arrival to ensure that no damage has occurred. In the event of damage, inform both the shipping company and Applanix immediately.

Remove all items from their shipping cases. Retain the cases for re-use in case the POS AV system is removed from the survey aircraft for storage or repair. The shipped POS AV components are listed on the packing list shipped with the system. Verify that each item is present.

GNSS Antenna

A GNSS antenna is included with the system for connection to the PCS internal GNSS receiver. Handle the antenna with care to avoid scratching or otherwise damaging its ceramic shell. Damage to the ceramic shell can adversely affect the ability of the antenna to receive satellite signals and may degrade the performance of the GNSS receiver.

The POS AV V6 requires the use of a high gain (40-45 dB) GNSS antenna, that comes in two flavours with respect to the form factor. The AV37 (Applanix p/n 10004339) is small form factor airborne high gain 43dB antenna capable of tracking GPS/GLONASS and L-Band frequencies. The AV57 (Applanix p/n

10005200) is circular form factor airborne high gain 45dB capable of tracking all current GPS/GLONASS/L-Band as well as future Galileo frequencies.

Note: The modern GNSS antennas are designed to support wider bandwidths (frequency range) in order to acquire more observable measurements from different Satellite Navigation Systems (not only GPS frequencies), which increases position accuracy and improves performance of the overall solution. Due to advanced functionality to track the additional signals on wider frequency range than traditional GPS only, the antenna is more sensitive to the level of noise generated by other aircraft equipment. It might result in sporadic cycle slip detection. The performance due to cycle slip detection might be subject of the custom aircraft installation and additional tracking equipment installed in close range with respect to POS survey antenna. The specific inline filters to filter out injected noise generated by third party device might be solution to improve the quality of overall installation.

Inertial Measurement Unit

Handle the IMU with care. The POS AV IMU contains calibrated sensors that may be damaged by shock. Do not drop or bump the IMU. Contact Applanix immediately if damage is suspected.

The POS AV IMU is a ruggedized device that is capable of withstanding limited shock or vibrations. Alert anyone performing maintenance in the proximity of the IMU of its sensitivity to shock and vibration.

Some IMU contain spinning mass gyros whose angular rate limits may be exceeded if the IMU is rotated by hand. In such a case, the POS AV will indicate an IMU failure.

Note: Applanix cannot guarantee POS AV system performance if the IMU is mounted on a stabilized platform and the gimbal encoder values are not sent to the POS AV via the serial port.

POS Computer System

As with any computer, handle the PCS with care to avoid damage. Locate the PCS in a rack or mount that provides isolation from both shock and vibration. Avoid areas of excessive humidity.

Installation

Handle all POS products with extreme care. POS AV contains sensitive components that have special handling requirements. See Unpacking and Handling on page 2-3 for more information.

Important:

1. Qualified personnel shall install equipment.
2. The PCS shall be grounded to the aircraft frame via the safety ground screw. Failure to do so may void the warranty.
3. The POS AV system allows for the connection of additional external equipment. This equipment shall be properly grounded to the aircraft frame. Failure to do so may result in a POS AV system malfunction.
4. Power to the POS system should be protected by a user-supplied resettable circuit breaker.

Preparation

Review all of this section prior to beginning the installation of the POS AV system. Provide careful thought to the layout of the components to ensure a trouble-free installation. Provide adequate mounting facilities for each of the POS AV components.

The POS AV system is shipped with a packing list that identifies the contents of the shipping containers. Among these items are manuals for the system and subassemblies.

GNSS Antenna

Using a previously installed antenna with the POS AV system may require any of the following for optimum reception: an antenna splitter kit, a preamplifier or an attenuator. Although the POS AV is capable of using any active GNSS antenna (in the 40-53 dB range), Applanix only guarantees performance if the GNSS antenna shipped with the system is used. Contact Applanix Customer Support for details.

The following are guidelines for installing a generic GNSS antenna. Please read the installation guidelines included with the GNSS Pak envelope that is shipped with the POS AV system. Each GNSS antenna, along with its associated coaxial cable and receiver, is configured for optimum performance.

Mount the GNSS antenna on any upper aircraft surface using the following guidelines:

- GNSS antennas require line-of-sight signals from the GNSS satellites; obstructions may cause signal degradation due to blockage or reflections. Ensure the mounting location is free from obstructions caused by other installed equipment.
- Do not mount the GNSS antenna within one metre of any other antenna.
- Rigidly mount the GNSS antenna to the aircraft fuselage to prevent vibration or twist between the aircraft and the antenna.
- Wrap the GNSS antenna coaxial cable connection with waterproof tape or a silicon sealant. Moisture intrusion will cause signal degradation.

- Avoid scratching or marring the ceramic cover of the GNSS antenna. Abrasions will adversely affect the performance of the GNSS receiver.

After GNSS antenna installation, connect the GNSS antenna to the ANT1 port located on the PCS rear panel.

Stabilized Mount Installation

If the sensor stabilized mount does not provide gimbal data, then mount the GNSS antenna directly over the mount's centre of rotation (±10 cm / ±3 $^{15}/_{16}$ in).

If the antenna cannot be mounted directly above the IMU and no gimbal encoder data are available, turn off stabilization to guarantee best possible performance.

Adequate performance can be obtained (without inputting gimbal encoder values) by mounting the GNSS antenna directly over the IMU.

Note: Not entering the gimbal encoder values causes the computed attitude output in the aircraft body frame to be invalid.

POS Computer System

⚠ **The M5 screws should be used to mount the PCS onto the flat mounting surface.**

Applanix recommends mounting the PCS in a *right side up* orientation. Maintain a minimum of six inches (15 cm) of clearance (top and rear only) for cables and ventilation.

Inertial Measurement Unit

Mount the IMU rigidly to the sensor/camera; do not mount it on any surface that moves, even slightly, in relation to the optical center. The IMU may be located on any frame section and in any orientation. There is no preferred flight direction for the IMU.

Applanix supplies an aluminium-mounting plate, with corresponding top-hats and strain relief, for certain IMUs; refer to the POS AV Diagrams starting on page H-1 for drawing details. The plate is attached to the sensor or camera first, followed by the IMU, the optional IMU top-hat (if applicable) and then by the strain relief. The mounting plate, top-hat and strain relief can be shipped prior to delivery of the remaining POS AV system. Please contact Applanix Customer Support for delivery arrangements, see page A-1.

It is important that the IMU is mounted on this aluminium plate or one with similar thickness to assure proper heat dissipation. Attach the plate to the sensor/camera on a flat surface to avoid vibrations. Applanix Customer Support will mount the IMU on this plate.

Leica RC20/30 Film Camera

Applanix does not recommend permanently mounting the IMU on the camera’s right side (handle). This approach is satisfactory for temporary installations, such as rentals. The preferred location is at the top of the film transport housing (Figure 3). Leica Geosystems can perform the attachment of the plate to the camera. Please contact a Leica Geosystems, GIS and Mapping division representative to arrange for this modification.

Zeiss RMK Top Camera

Attach the IMU to the bottom frame at any location that does not restrict the camera’s movement and is out of the operator’s way (Figure 4).

Figure 3: Leica RC20/30 Film Camera

(Photo courtesy of Air Flight Service, Santa Clara CA)

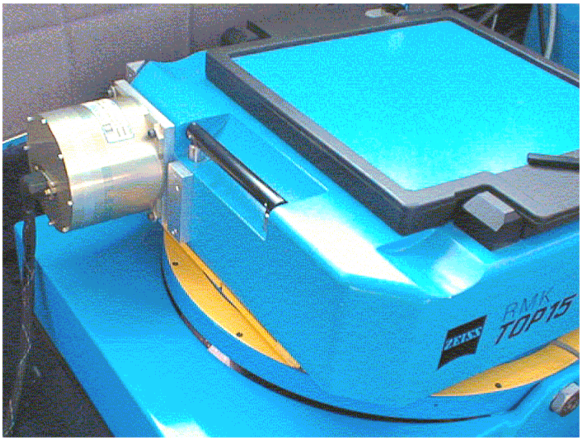


Figure 4: Zeiss RMK Top Camera

(Photo courtesy of Aeromap U.S., Anchorage AK)

Cabling

Power-down the POS AV before connecting or disconnecting any GNSS, power or IMU cables. Failure to do so may result in damage to the PCS or the sensors.

Applanix supplies the necessary cables and adapters for POS AV operation. The cable set includes the following:

- System power cable, 2 m (~6 ½ ft)
- ANT1 coaxial cable, ~10 to 15 m (33 to 49 ft)
- IMU power and data cable, ~5 m (16 ft) standard
- I/O 1/2/3 cables, ~30 cm (~12 in)
- Events cable, ~3 m (10 ft)
- Shielded LAN (Ethernet) cable, ~1.8 m (6 ft)

All the cables are labelled and listed on the packing list. Route the cables away from sources of electrical noise and protect from physical damage. Secure the cables to permanent supports and close to cable connectors to provide relief from shock and vibration due to aircraft movement. Coil and stow excess cable using tie wraps.

Use the most direct path when routing the cables to the PCS and avoid hazards such as:

- Hot surfaces
- Moving surfaces
- Excessive tension caused by suspension movement and flexing (provide cable slack in these areas)
- Sharp or abrasive surfaces
- Corrosive fluids or fuel

- Possible sources of Electromagnetic Interference (EMI) (e.g. electronic equipment)

Figure 5 shows the PCS rear panel and connector locations. Table 1 provides a description of the connectors used in the POS AV.

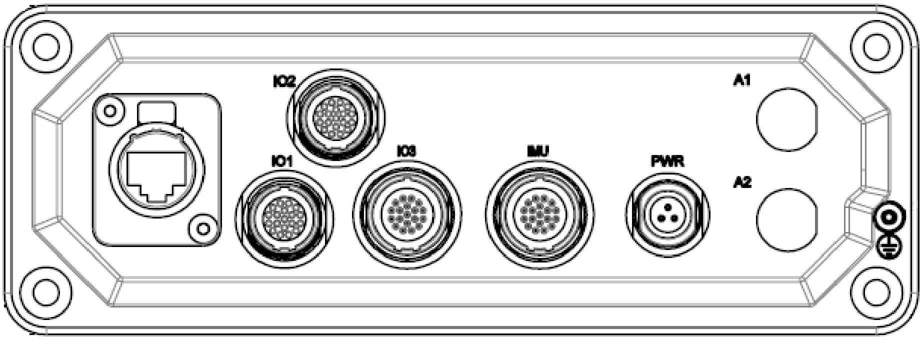


Figure 5: PCS Rear Panel

Table 1: Connector Specifications

Connector	Description
PWR	1.5A at 28Vdc (including the IMU)
A1	Supplies dc power to and receives signals from the primary GNSS antenna
A2	Supplies dc power to and receives signals from the secondary GNSS antenna (optional)
IMU	Supplies dc power and couples data to/from the IMU (see page I-1 for the power consumption of the various IMU)

Connector	Description	
I/O 1	DIO port:	Event 6 I/P
	COM5 port:	RS-232 asynchronous, 2 wire, I/O
	DIFF port:	RS-232 asynchronous, differential corrections I/P
	PPS Out port:	5 V TTL O/P
	PPS In port	Not Currently Supported
I/O 2	DIO port:	Event 5 I/P
	COM2 port:	RS-232 asynchronous, 4 wire, I/O
	COM3 port:	RS-232 asynchronous, 2 wire, I/O
	COM4 port:	RS-232 asynchronous, 2 wire, I/O
	PPS Out port:	5 V TTL O/P
I/O 3	DIO port:	Events 1, 2, 3 & 4 I/P
	COM1 port:	RS-232 asynchronous, 4 wire, I/O
	DIO port:	Strobe 1 & 2 O/P (event out or trigger)
	Power port	12 V dc O/P
8P8C (RJ45)	Ethernet	Control & data I/O

Power Cable

The two wire power cable is connected to a direct current power source. Refer to the Power Connector description on page 8-2 for the connector pin assignment.

IMU Cable

⚠ **Based on supplied IMU Type, the IMU cable attaches through mating connector directly to the bare IMU housing or to the protective IMU tophat. Please make sure that IMU cable is gently tighten to the IMU connector without use of unnecessary force to prevent damage to the IMU cable connector. Do not over**

tighten the Allen screw (IMU Type 7 and 8) or apply additional force to rotate connector once it is in locked position (the rest of IMU types).

The IMU data and power cable interface is provided by the IMU connector on the rear panel of the PCS. An IMU cable is provided with each POS AV system. Cables of various lengths are available from Applanix. Refer to the IMU Connector description on page 8-2 for the connector details.

GNSS Antenna Cable

Route the antenna coaxial cable between the GNSS antenna connector and the A1 port on the rear panel of the PCS. All antennas supplied by Applanix are high gain antennas directly connected to PCS. If for any reason low gain antenna is used, it will require connection to PCS over Low Noise Amplifier (LNA). Locate the LNA as close as possible to the PCS (as opposed to close to the GNSS antenna).

LAN (Ethernet) Cable

POS AV is configured and monitored via an Ethernet link using the AV POSView Controller software running on a user supplied PC. One shielded Ethernet straight through cable is supplied with the POS AV system.

Note: This cable is terminated with a ruggedized Ethernet connector on one end. If you wish to use your own Ethernet cable, the ruggedized Ethernet connector may be removed from the Applanix supplied cable and placed onto any standard Ethernet cable. Refer to the Ethernet (LAN) Connector description on page 8-9 for the connector pin assignment. Refer to page K-1 for assembly instructions.

Event Cable

The 3 m (~10 ft) event timing coaxial cable connects between the user supplied event source and the DIO port. One or two event sources can be timed. Refer to the I/O3 Connector description on page 8-7 for the connector pin assignment.

Storage

When storing the POS AV system for an extended period, ensure the following conditions are maintained:

- Protect the PCS from moisture and excessive humidity (see Appendix I) or temperature extremes beyond the limits of -55 °C to +85 °C (-67 °F to 185 °F)
- Protect the IMU from accidental damage by storing in its original shipping case
- Store all remaining components in their original shipping cases

3.0 AV POSView Software Installation

System Requirements

The computer where the Position and Orientation System for Airborne Vehicles (POS AV) Controller is installed must meet or exceed the hardware and software requirements outlined in Table 2.

Table 2: PC Configuration Requirements

Item	Minimum Requirements	Recording Directly to Hard Disk (via data port)
Processor	Intel Pentium® series or equivalent	Intel Pentium® series or equivalent
Speed	1G Hz	1 GHz
Memory	512 MB RAM	1 GB RAM
Operating System*	*Windows 7.1 SP1, Windows 7 Embedded, Windows 8, and Windows 10*	*Windows 7.1 SP1, Windows 7 Embedded, Windows 8, and Windows 10*
Free Disk Space	8 MB	2 GB
Ethernet Card	10/100 Base-T Ethernet; IEEE 802.3 Standard	10/100 Base-T Ethernet; IEEE 802.3 Standard

***** To ensure 100% compatibility with the AV POSView Controller, use an English version of the Microsoft Windows Operating System.

Install AV POSView Controller

Microsoft Windows® includes drivers for Ethernet support. Ensure that the Ethernet connection is working properly before proceeding.

The installation image that includes AV POSView Controller, matching version of real time firmware and complete set of documentation is available through Applanix web service at www.applanix.com.

Note: If you are using AV POSView Controller, please make sure that release version matches corresponding real time firmware on your PCS.

Start AV POSView Controller

Double-click the **POS AV** screen icon or select **Start, Programs, Applanix, POS AV** on the Widows screen.

Note: For proper POS AV operation the installation parameters must be entered into the AV POSView Controller (see Controller - Enter Installation Parameters on page 5-9).

Exit AV POSView Controller

Double-click the **AV POS View** tool bar icon or select **File, Exit** on the menu bar.

Un-install AV POSView Controller

Select **Start, Control Panel, Settings, Add/Remove Programs** to un-install the AV POSView Controller from the computer.

4.0 Controller - Basic Operation

Prior to the first-time operation of the Position and Orientation System for Airborne Vehicles (POS AV) system, the network configuration of the POS Computer System (PCS) and the installation of the AV POSView Controller software are required.

Controller - PC to PCS Configuration

Start AV POSView Controller

Double-click the **POS AV** screen icon or select **Start, Programs, Applanix, POS AV** on the Windows screen.

Change System IP Address

The PCS ships with a default Internet Protocol (IP) address of **192.168.53.100** (with a subnet mask of 255.255.255.0). Initially, to communicate with the PCS, the controlling Personal Computer (PC) IP address must be set to a unique address in the same subnet. Applanix recommends **192.168.53.1** as the unique address within the subnet, although any unique address (i.e. 192.168.xxx.xxx) may be used for the PC.

The PCS IP address and subnet mask may be changed to any value that suits the users network and follows IP standards, except for addresses in the 155.155.xxx.xxx range.

To configure the AV POSView Controller to operate with the network (Figure 6)

1. Double-click AV POSView screen icon.
2. On AV POSView Controller tool bar, ensure that PCS IP address (**192.168.53.100**) is selected.

3. On AV POSView Controller tool bar, click Connect icon or select **Tools, Connect** from menu bar. The Controller connects to PCS; **Connected** is displayed in screen's status area.
4. On AV POSView Controller menu bar, select **Settings, Installation, POS IP Address**; **POS Internet Address** window opens.
5. Enter a new IP address (one that is valid for your subnet), click **Apply** button (address takes effect immediately).
6. PCS disconnects; **Waiting** or **Monitor** is displayed in screen's status area.
7. On AV POSVIew Controller menu bar, select **Settings, Save Settings**.
8. Exit AV POSView Controller.
9. Restore original PC's IP address.
10. Reboot PC.

The PCS address is now set to match the local subnet and the PC's IP address is returned to its original setting.

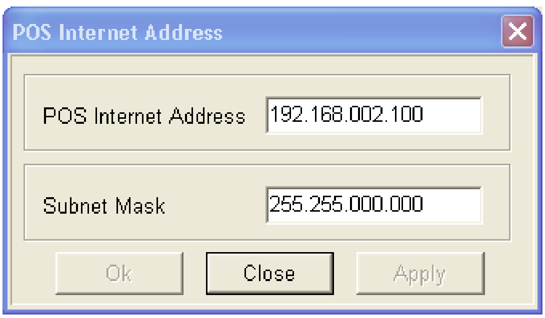


Figure 6: Controller POS Internet Address Window

The subnet must be chosen carefully if UDP unicast is selected as the network protocol for real-time data output. The user specified UDP unicast IP address must be within the same subnet as the POS IP address in order for network communication to be functional. If the UDP unicast IP address is outside the subnet, there will be no real-time output on the port that has UDP unicast selected.

A good rule of thumb is to keep the first three values of the POS and UDP unicast addresses the same unless you must set a custom subnet.

Connect to POS AV

To connect to the POS AV once the PCS and PC IP addresses are configured, perform one of the following:

- On AV POSView Controller menu bar, select **Tools, Connect**
- On AV POSView Controller tool bar, click the Connect icon

The AV POS View Controller connects to the PCS and **Connected** is displayed in the screen’s status area. The Controller window provides status information that is updated once per second.

AV POSView Controller Modes of Operation

The AV POSView Controller operates in either of two modes: Monitor or Connected (Control).

- Monitor mode - Controller displays all data that POS AV outputs over the Ethernet display port. Changes are not permitted to the POS settings. This mode allows several users to monitor the POS data at the same time.
- Connected mode - POS settings can be changed and saved as required.

To toggle the AV POSView Controller's mode of operation, select either the **Tools** menu bar or the appropriate tool bar icon.

Note: Only one PC or laptop running the AV POSView Controller can be in the Connected mode on a particular POS AV unit at any one time.

Corrections over NTRIP

Differential corrections can also be received through the NTRIP client built into POSView. One must have access to an NTRIP caster, or subscribe to a service that provides access to NTRIP caster, in order to receive differential corrections. To access the NTRIP client please select "Tools->NTRIP client":

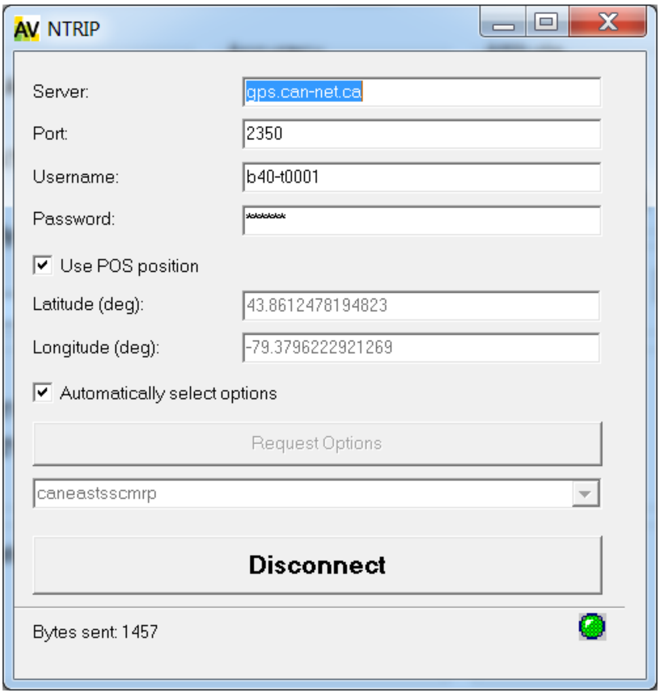


Figure 7: NTRIP Client User Interface

Enter the correct information for Server, Port and login credentials, as advised by the service provider.

Select “Use POS position” if the position transmitted to the caster is to be the same as the POS position. If not, then unchecking the “Use POS position” and enter custom values. Applanix recommends using POS position for this purpose such that the position transmitted to the VRS service is updated as the vessel moves.

Select “Automatically select options” to pick the first available corrections stream from the caster. Applanix recommends examining the available streams and manually selecting the desired one. This may be done by deselecting “Automatically select options” and then clicking “Request Options”. If the information entered is correct, then a list of all available streams from the caster are displayed in the drop down menu below the “Request Options” button. Select the desired corrections stream and then hit the “Connect” button.

The LED on the bottom right will turn green and the POS will receive and decode the corrections.

Save POS AV Settings

Save any changes of the POS AV settings, otherwise, the changes are lost when the POS AV is powered-down. To save changes using AV POSView Controller select **Settings, Save Settings** on the menu bar. The controller indicates when changes are successfully saved.

⚠ **Cycling power during a save operation may result in lost setting changes.**

Exit AV POSView Controller

Click the Exit icon on the tool bar or select **File, Exit** on the menu bar.

Controller Displays

Main Window

Users can monitor or control the POS AV activities from the AV POSView Controller main window. The main window is divided into functional areas that select menus, options and functions, and display operating data and status (Figure 8).

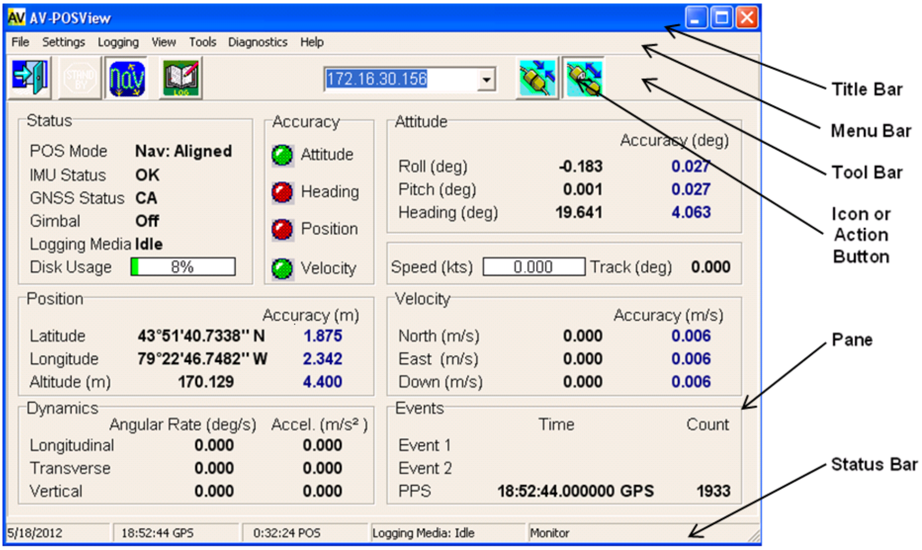


Figure 8: AV POS View Controller Main Window

Menu Bar

Drop-down menus provide access to all the AV POSVIew Controller functions. The AV POSView Controller Menu Options description, starting on page C-1, identifies all menu items.

Tool Bar

The tool bar, Figure 9, permits quick access to commonly used features. From left to right:

- Exit icon
- **Standby** icon
- **Nav** (navigation) icon
- **Log** icon
- POS AV IP address field
- Connect icon
- Monitor icon

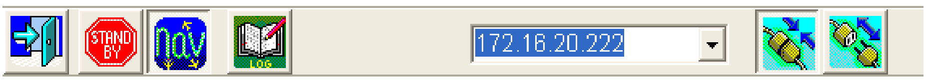


Figure 9: Tool Bar

Status Pane

The **Status** pane shown in Figure 10 displays information about the operational status of the major POS AV components. For a complete list of possible status display messages, refer to AV POSView Controller Status Pane Messages on page D-1**.**

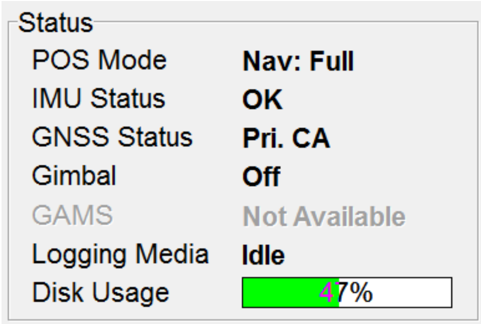


Figure 10: Status Pane

The following provides a brief description of the status elements:

- **POS Mode** - After a transition to the navigate mode, the normal message sequence is from *Levelling Active* to *Degraded* to *Aligned* to *Full*.
- **IMU Status** - The Inertial Measurement Unit (IMU) status indicates *OK*, *Warning* or *Failure*. If the IMU status is not *OK,* it is recommended to immediately power-off the POS AV and examine the IMU cable and cable connections.
- **GNSS Status** - After power-up the GNSS receiver requires approximately two minutes to lock onto the GNSS satellites and begin computing a valid navigation solution. During this initialisation period, the GNSS Status indicator displays *Not Available* or *Data Gap*. Afterwards, the indicator displays at least Pri *C/A* or higher accurate mode depending if differential service is in use
- **Gimbal** - Displays the status of the gimbal port and the incoming gimbal data.
- **GAMS** – Displays the status of GAMS operation. Note this field is only active for AV220 and AV320 systems.

- **Logging Media** - Displays the status of the data logging function.
- **Disk Usage** - The bar indicates the percentage used (filled) of the data logging drive.

Position, Dynamics, Attitude and Velocity Panes

The Position, Dynamics, Attitude and Velocity displays present sensor derived orientation/motion data in three dimensions. Accuracy estimates for many of the values are displayed with their units. Figure 11 provides an example. The accuracies reflect confidence boundaries on the displayed parameters that vary based on the performance level of the POS AV, the number of satellites tracked and whether or not differential corrections are received.

Figure 11: Attitude Pane

Accuracy Pane

The four indicators in the **Accuracy** pane are triggered by user-defined values. Once the threshold level for a particular parameter is reached, the indicator changes colour from red to green. The indicators provide a visual indication of acceptable parameter performance. The threshold settings do not affect POS AV performance. Threshold levels are set by selecting the **Settings, Installation, User Accuracy** from the AV POSView Controller menu bar (Figure 12).

Note: The **Attitude, Position** and **Velocity** indicators are activated once the system resolves the quadrant. The **Heading** indicator is activated once the system indicates *Aligned* (Figure 10).

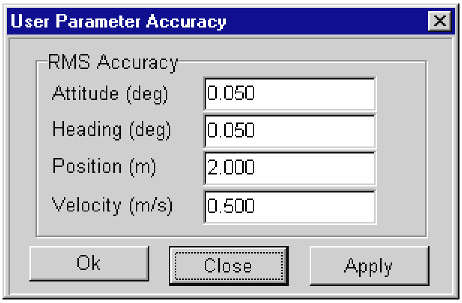


Figure 12: Accuracy Pane and User Parameter Accuracy Window

Events Pane

The **Events** pane, Figure 13, displays the Universal Time Coordinated (UTC) or GPS time of the two most recent signals (Events 1 and 2) from sources external to the POS AV system. Four additional Event signals 3-6 are available, but not displayed in the main AV POSView Controller window. Please refer to menu View->Events Data form for display. In addition, the Pulse Per Second (**PPS**) row displays the UTC/GPS time of the most recent PPS pulse transmitted by the primary GNSS receiver. The **Count** field, for the PPS, indicates the total number of signals recorded from the GNSS receiver; while for Events 1 and 2, it indicates the total number of event pulses.

Note: The **Events** pane displays UTC, GPS or POS time depending upon the user selection. The user determines the time format by selecting **Settings, Installation, Tags Multipath & AutoStart** from the menu bar.

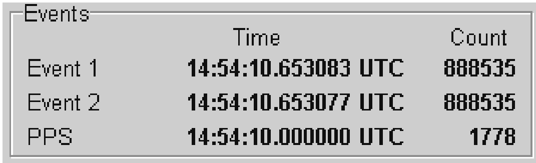


Figure 13: Events Group

Speed Pane

Figure 14, **Speed** pane, shows the current speed in knots (to a maximum of 300 knots) and the direction of the velocity vector (track) in degrees. When the aircraft does not encounter a crosswind, the **Track** reading should be similar to the displayed heading in the **Attitude** pane (Figure 11).

Figure 14: Speed Pane

Status Bar

The status bar is located at the bottom of the AV POSView Controller window (Figure 15). The current date, GPS time, time since POS power-up, Logging Media status and the AV POSView Controller program connection status are shown.

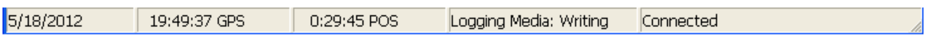


Figure 15: Status Bar

Sensor Data

Statistics Window

POS AV program and hardware statistics are displayed in this window (Figure 16). To display the window select **View, Statistics** on AV POSView Controller menu bar.

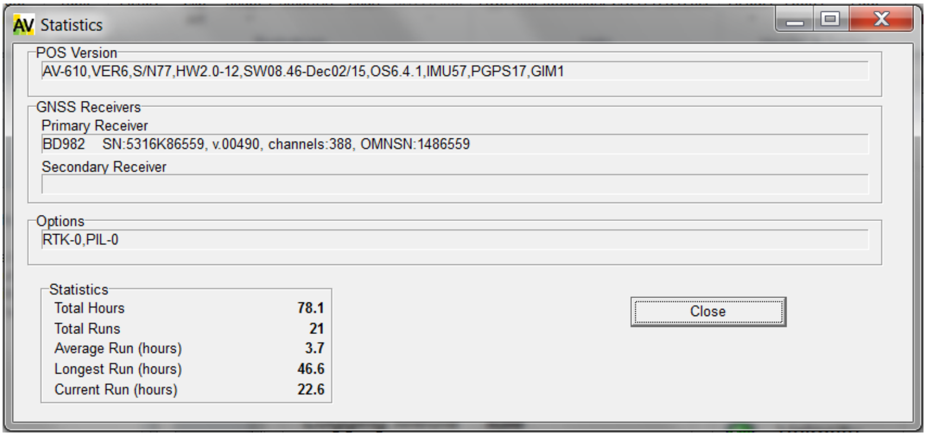


Figure 16: Statistics Window

The following provides a brief description of the window contents:

- **POS Version** pane - Shows the product, model, system version, serial number, hardware version, firmware version, dates of release, Interface Control Document (ICD) revision number, Operating System (OS) version, IMU type, primary GNSS type and secondary GNSS type (if applicable).
- **GNSS Receivers** pane - Indicates the primary and secondary GNSS receiver types, serial number, software version, supported number of channels and OmniSTAR serial number.
- **Options pane –** displays any purchased options.
- **Statistics** pane - Displays the POS AV operation history.

Fault Detection Window

Fault Detection, Isolation and Reconfiguration (FDIR) enable POS AV to combine sensor data in a manner that provides the best solution for the current data quality. Thus, the solution is always optimum at any point in time.

POS AV continually monitors its sensors to identify the sensors that show degraded performance and recombine the data as necessary to produce the best solution available.

The Fault Detection window, Figure 17, displays the status of various POS AV system functions that the FDIR routines diagnose. Three tabs are available: the **General** tab for an over all system health indication; the **IMU and GNSS** receiver tabs for a more detailed diagnosis. To display the Fault Detection window select **View, Faults** on the AV POSView Controller menu bar. A fault is present when the screen indicator is red. Some faults remain on (once set) while others are transitory.

Note the following:

- A tab with an asterisk indicates that one or more faults occurred relating to the listed fields.
- A greyed out field indicates that the item does not apply.
- Some IMU or GNSS types do not output any status information. In this case, the respective tab will not appear.

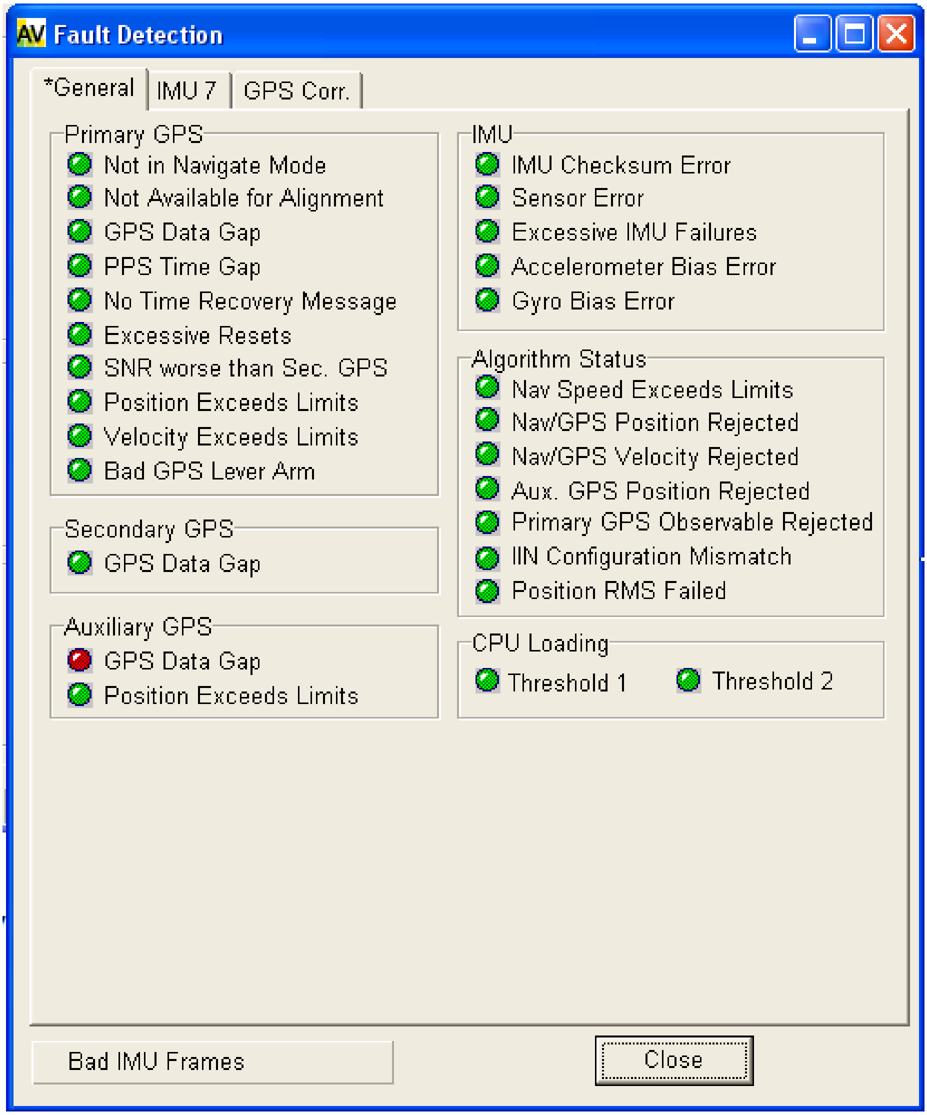


Figure 17: Fault Detection Window

Message Log Window

Firmware located in the PCS, controls and monitors the overall system operation. As a result, the POS AV Controller records many system events and stores them in a Message Log file (Figure 18). To display the message log file select **View, Message Log** on the POS AV Controller menu bar. Refer to the Message Log Definitions on page B-1 for a list of messages and their descriptions.

Note: The message log file may be saved for future reference or sent to Applanix Customer Support.

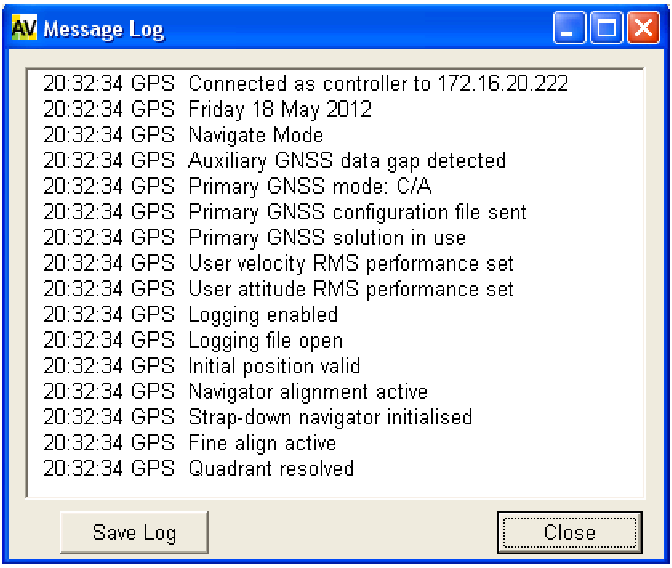


Figure 18: Message Log Window

Reference & Sensor Frame Navigation Window

Access the Reference and Sensor Frame Navigation window by selecting **View, Sensor Navigation** from the AV POSView Controller menu bar. The window, Figure 19, displays position, attitude, velocity and dynamics data of the reference body or sensor frame. The **Wander Angle** and **Heave** fields are not used.

Note: If the Reference/Sensor Frame Navigation window displays no data when it is selected, perform the following steps:

1. Close Reference/Sensor Frame Navigation window.
2. Switch controller from Monitor to Connect mode by using tool bar icons.
3. Open Reference/Sensor Frame Navigation window, data should now be displayed.

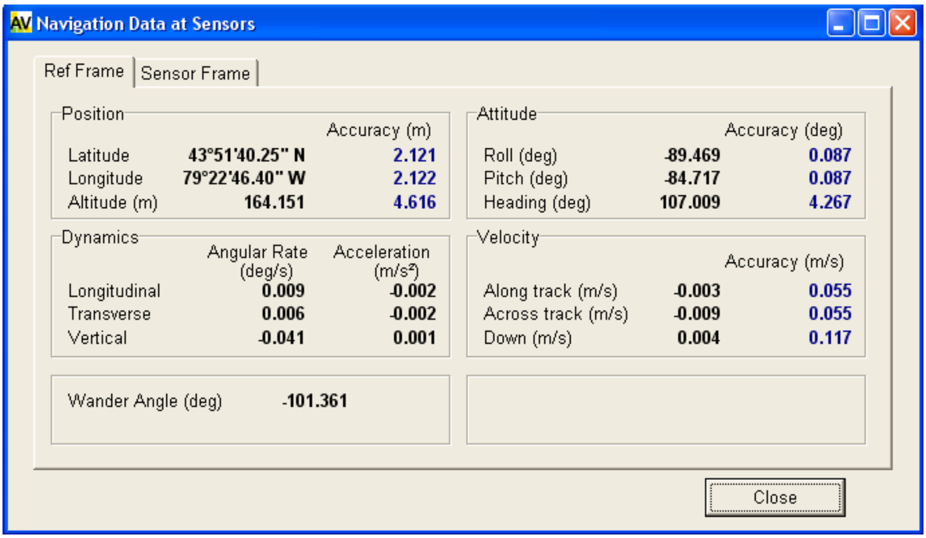


Figure 19: Reference and Sensor Frame Navigation Window

Yaw Drift Correction Window

POS operators, using a stabilized platform, may provide the Yaw Drift Correction window with drift corrections from POS AV. The POS AV automatically steers the platform heading either to the desired heading or to the mean aircraft track angle defined by the horizontal velocity vector. The default correction method is the **Follow Mean Track** option. Yaw Drift Correction (YDC) is output from the Ethernet port, COM2 serial port, and the analog port. Once the YDC is enabled[1] (by selecting **Settings, Yaw Drift Correction** on AV POSView Controller menu bar) the Yaw Drift Correction window is updated (Figure 20).

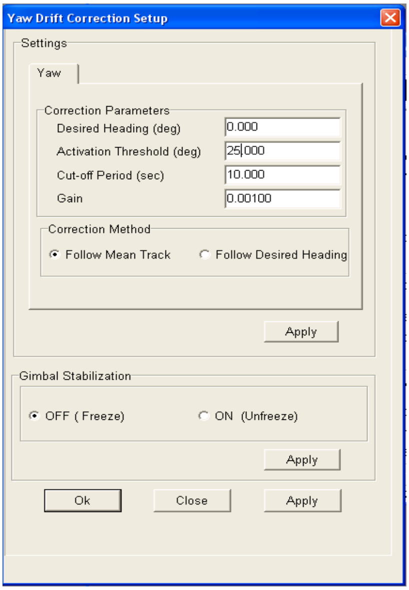


Figure 20: Yaw Drift Correction Windows

[1] The yaw drift correction is enabled using the POSConfig Utility. This option requires an authorization code to enable software funcionality. The authorization code must be purchased from Applanix.

Gimbal Encoder Data Window

When POS AV receives raw gimbal data from the gimbal sensor (through one of the gimbal message formats) via the selected COM port, the Gimbal Encoder Data Window is updated (Figure 21). For more information, refer to the description on page 8-23 and the Gimbal Encoder Input messages formats starting on page F-32.

To display the window select **View, Gimbal Data** on AV POSView Controller menu bar.

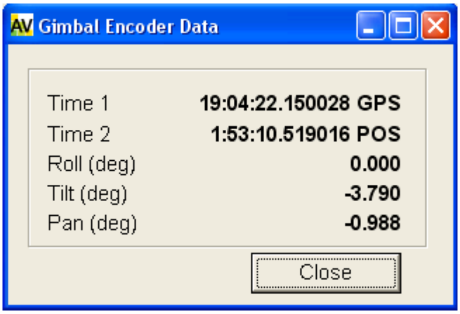


Figure 21: Gimbal Encoder Data Window

Command Reply Window

Provides the status of the POS AV messages (Figure 22). To view the Command Reply window select **View, Command Reply** from AV POSView Controller menu bar.

If the controller rejects a message sent from POS, the following is displayed in the Command Reply window:

- The **Message ID** field indicates the message number
- The **Response** field indicates the type of message rejection
- The **Parameter** field indicates the message item

Refer to the *POS AV V6 Ethernet & Disk Logging ICD, PUBS-ICD-003259*, for a description of the message ID.

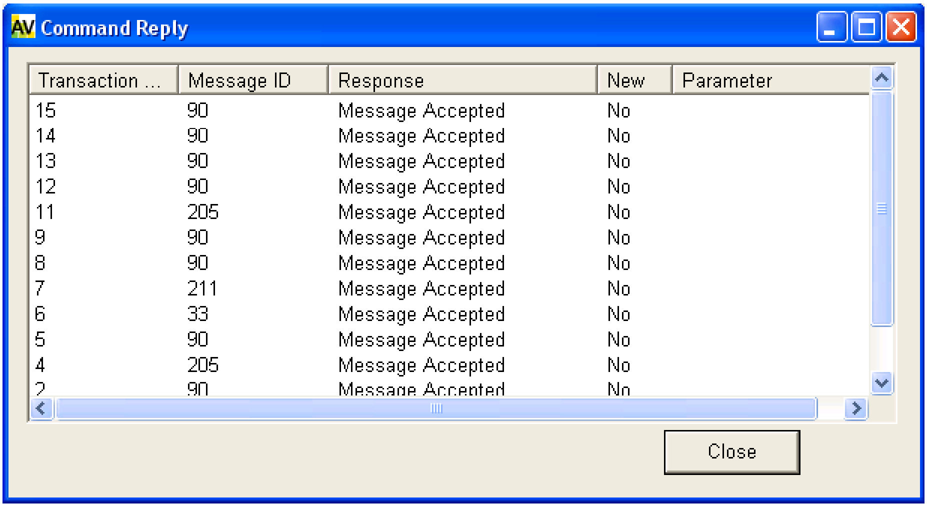


Figure 22: Command Reply Window

GNSS Reset

The POS AV GNSS receiver may be reset from the AV POSView Controller; select **Tools, Reset GNSS** on the controller menu bar. This action sends a reset command to the GNSS receiver. Once the receiver locks on to the satellites, POS AV resumes using the GNSS data. It might take up to two minutes for receiver itself to re-acquire the satellite lock following the reset command.

The reset feature is a last resort used in the event that a receiver exhibits abnormal behaviour. Abnormal indications include an inability to track satellites (indicated on the Controller **Status** pane and the Message Log window), failure to compute or failure to output a valid navigation solution for a prolonged period. Prior to using the reset feature, verify the serviceability of the connections and cabling.

5.0 System Configuration

Installation Parameters

General

Once the Inertial Measurement Unit (IMU), Global Navigation Satellite System (GNSS) antenna and POS Computer System (PCS) are installed, position and orientation measurements are performed.

Two types of measurements are required:

- Lever arms - vector displacement between two body frames
- Mounting angles - differences in orientation between two body frames

The correct measurements must be entered into the PCS using AV POSView Controller software. This is necessary after any system component installation or change, or the first time the system is powered-on after a new installation. See the Controller - Enter Installation Parameters description on page 5-9 for more information on storing installation parameters in the POS AV.

Accurate measurements of the mounting parameters are necessary to ensure optimum POS AV performance. Four sets of parameters require measurement and declaration before POS AV can navigate. These parameters are:

- Lever Arm - reference frame origin to IMU lever arm
- Lever Arm - reference frame origin to GNSS antenna lever arm
- Mounting Angles - IMU body frame with respect to reference body frame
- Mounting Angles - reference body frame with respect to aircraft body frame

The accuracy requirements of these measurements are important. Mounting angles (known as misalignment or boresight angles) are measured to the accuracy expected from the POS AV system. For example, if aircraft roll has a required accuracy of 0.05 degrees, then the IMU body frame with respect to the reference body frame mounting angles must be better than 0.05 degrees. If the accuracy of the measurements does not meet requirements, then a constant angular offset is present in the output and the error may manifest itself as a lever arm error.

Mounting angle measurements are usually performed by lab calibration or a boresighting flight. Contact Applanix Customer Support for more information on measuring mounting angles.

Please refer to the POS AV Diagrams starting on page H-1 for accurate measurement details of the various IMU and GNSS antennas.

Applanix Position and Orientation System Post-Processing Package (POSPacMMS) post-processing software may be used to refine the installation parameter estimates. Contact Applanix Customer Support for more information on POSPacMMS post-processing software.

Body Frame Definitions

Sensor components of the POS AV system require referencing between the equipment that they are providing positional information for and themselves. Each sensor/equipment has three-dimensional orientation characteristics that describe its body frame. All items employ the right-hand orthogonal coordinate system that defines the direction of the body frame’s x, y and z-axis.

Reference Body Frame

The reference body frame is defined as the right-hand orthogonal coordinate system with its origin at the centre of a location to which a related sensor is referenced. For example, using the IMU mounted on a scanner, the origin of the reference body frame is at the scanner perspective centre. Using a gimbal platform, the origin of the reference body frame is at the centre of rotation of the platform. Ideally, the sensor axis are fixed to the reference body frame, with the x-axis normally in the forward direction (nose), the y-axis to the right (starboard) and the z-axis pointing down.

IMU Body Frame

The IMU body frame is defined as the right-hand orthogonal coordinate system with its origin at the volumetric centre of the IMU top-hat, at a specific height from the IMU base plate. The IMU frame axis are fixed to the IMU and are labelled on the IMU top-hat (Figure 23) Refer to the POS AV Diagrams starting on page H-1 for IMU internal measurements and centre of origin heights for each IMU.

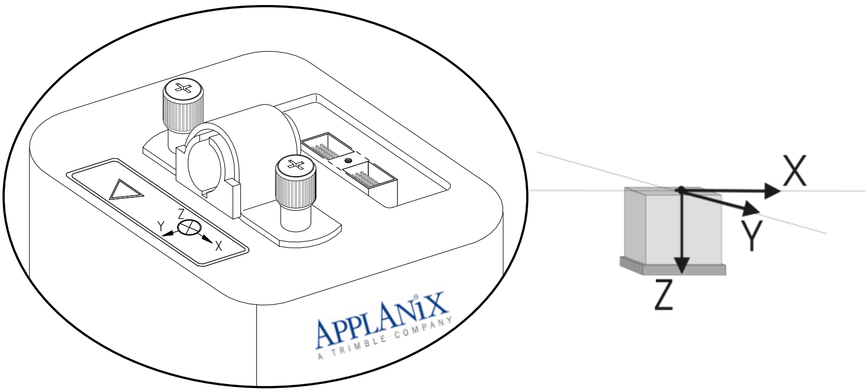


Figure 23: IMU Body Frame

Aircraft Body Frame

The aircraft body frame is defined as the right-hand orthogonal coordinate system with its origin at the aircraft's centreline. The three axis are referenced to the aircraft's vertical and horizontal planes where the:

- X-axis is parallel to the horizontal plane and extends towards the nose - called the aircraft longitudinal axis (nose through tail), any rotation about this axis is called 'roll'.
- Y-axis is parallel to the horizontal plane and extends towards the starboard (right) wing - called the aircraft lateral axis (wing tip through wing tip), any rotation about this axis is called 'pitch'.
- Z-axis is parallel to the vertical plane and extends down - called the aircraft vertical axis (vertically through the center of gravity when the aircraft is in level flight), any rotation about this axis is called 'yaw'.

Lever Arms

The distance between two body frames, as measured between their reference points (body frame origins), is a three-dimensional vector.

Lever Arm - Reference Frame Origin to IMU

The reference frame origin to the IMU lever arm is a three-dimensional vector defining the displacement from the reference point (origin of the reference body frame) to the origin of the IMU body frame (Figure 24). This displacement is resolved in the reference body frame.

Record the following three measurements for the IMU in the reference body frame:

X component: The distance in the horizontal plane (forward or reverse direction) from the reference point to the IMU origin (target). A positive value implies the IMU is forward of the reference point.

Y component: The distance in the horizontal plane (left or right direction) from reference point to the IMU origin (target). A positive value implies the IMU is to the right of the reference point.

Z component: The distance in the vertical plane (up or down) from the reference point to the IMU origin (target). A positive value implies the IMU is below the reference point.

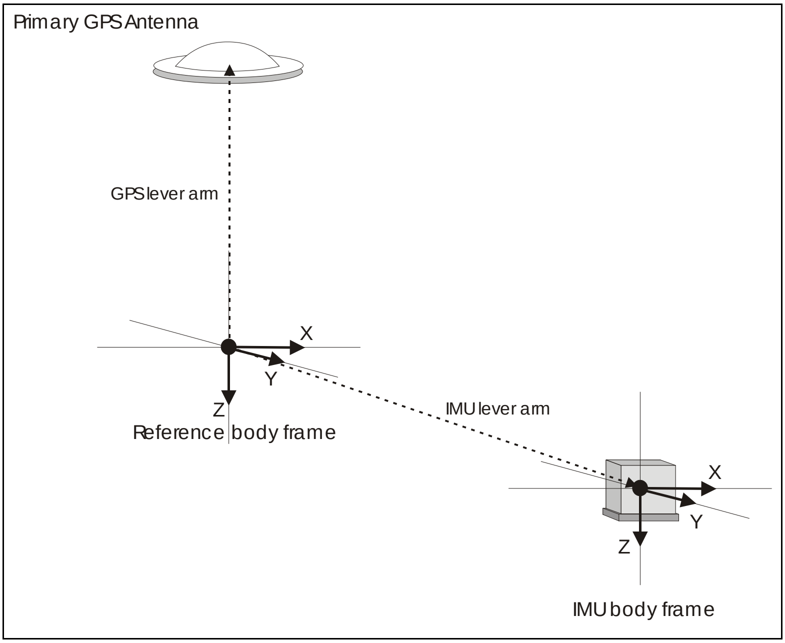


Figure 24: Lever Arms

Example: The reference body frame is defined as: x-axis forward, y-axis right (starboard) and z-axis down with the reference point (origin) in the three-dimensional centre of the aircraft. The IMU is installed on a scanner 0.5 metres behind the reference point, 0.0 metres to the right of the scanner body frame origin and 0.5 metres above the reference point. The reference point to IMU lever arm components are -0.5, 0.0, -0.5 metres.

Lever Arm - Reference Frame Origin to GNSS Antenna

The reference frame origin to the GNSS antenna lever arm is a three-dimensional vector defining the displacement from the reference point (origin of the reference body frame) to the phase centre of the primary GNSS antenna (Figure 24). This displacement is resolved in the aircraft body frame.

Mounting Angles

Mounting angles are defined as physical angular offsets of a body frame with respect to a second body frame (Figure 25).

These angles define the Tait-Bryan sequence of rotations that bring the first body frame into alignment with the second. For example, when defining body frame A with respect to B, the mounting angles would be the sequence of rotations of body frame B to bring it into alignment with body frame A. The orientation angles follow the sequence of rotation given as follows: right-hand rotation of θ_z about the z-axis of body frame B, followed by a rotation of θ_y about the once rotated y-axis, followed by a rotation of θ_x about the twice-rotated x-axis. Refer to the Tait-Bryan Sequence description on page E-1 for more information.

Make note of all measured mounting angles for later input into the POS AV and store these measurements in a secure place for future reference.

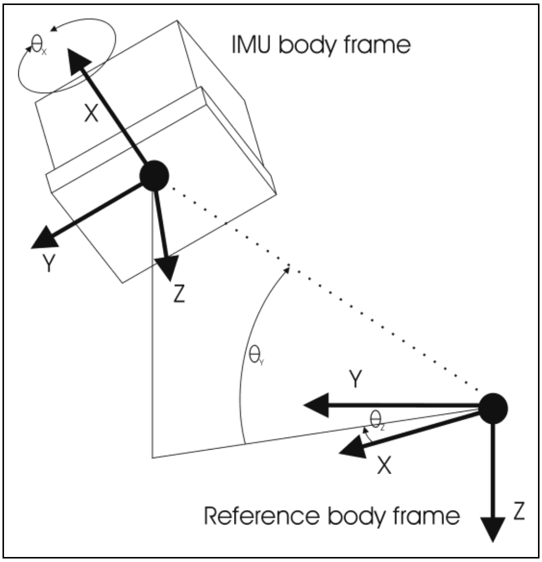


Figure 25: IMU/Reference Body Frame Mounting Angles

Body Frame - IMU with respect to Reference

Figure 25 shows the IMU and the reference body frames in different orientations. The sequence of rotations to bring the reference body frame into alignment with the IMU body frame will require measurement.

As the accuracy requirement between the IMU and the reference body frames increases, a proportionally higher accuracy requirement is needed in the orientation angle measurement. This can involve measuring the mounting angles with precision boresight measurement instruments or through a boresighting flight. Awareness of this precision during installation can simplify measurement by the judicious placement of the IMU relative to the reference body frame.

Body Frame - Reference with respect to Aircraft

If the axis of the reference and aircraft body frames do not align, then the reference body frame must be defined with respect to the aircraft body frame. Follow the procedure and suggestion for the Body Frame - IMU with respect to Reference description above for mounting angle measurements.

Controller - Enter Installation Parameters

General

Enter the hardware configuration data into the AV POSView Controller once the distance and orientation measurements are complete for the IMU, GNSS antenna and any other required sensors. Refer to the Controller - Basic Operation description on page 4-1 for instructions on powering-up the PCS and starting the AV POSView Controller. A description of Figure 26 is located in the Controller Displays description on page 4-6.

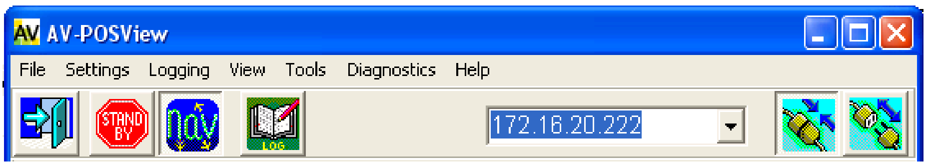


Figure 26: AV POSView Controller Title, Menu and Tool Bars

Lever Arms and Mounting Angles

Enter the lever arm and mounting angle installation measurements into the PCS using the AV POSView Controller software. Select **Settings, Installation, Lever Arms & Mounting** on the controller menu bar to display the Lever Arm and Mounting Angles window (Figure 27).

The data collected for the System Configuration on page 5-1 is input into the appropriate fields. When complete, click the **OK** button and save the settings.

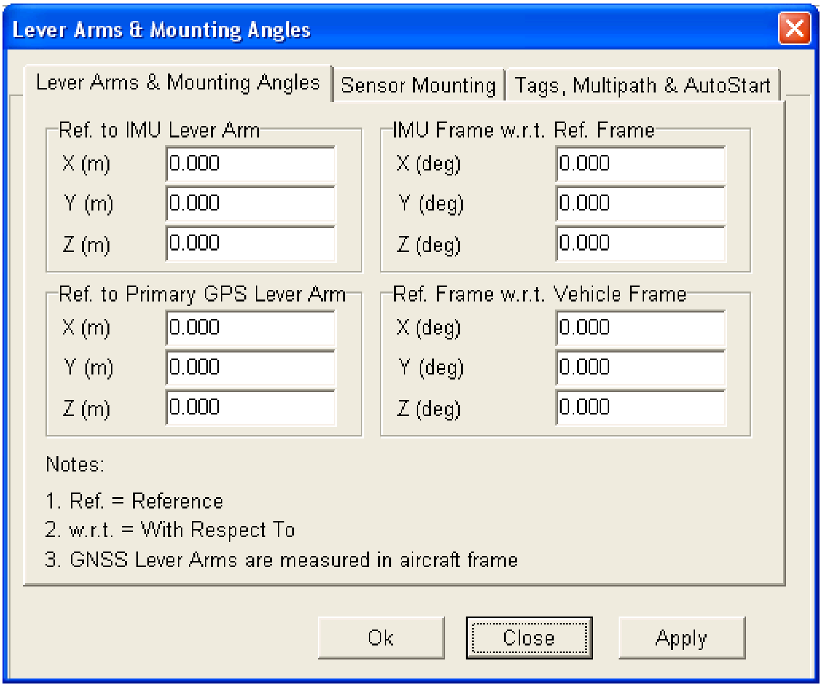


Figure 27: Controller Lever Arm and Mounting Angles Window

User Accuracy Settings

Select **Settings, Installation, User Accuracy** on the AV POSView Controller menu bar to display the User Parameter Accuracy window (Figure 28). Enter the values into the fields, click the **OK** button and save the settings. Refer to the Accuracy Pane description on page 4-9 for more information on their usage.

Applanix presents the values for acceptable Course/Acquisition (C/A) operation. The settings may require adjustment for Differential Global Positioning System (DGPS) operation to compensate for the increased accuracies.

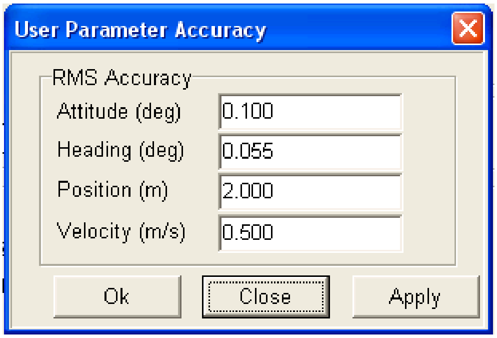


Figure 28: Controller User Parameter Accuracy Window

Time and Distance Tags

Enter the parameters for the time and distance tags in the **Tags, Multipath & AutoStart** window (Figure 29). Select **Settings, Installation, Lever Arm and Mounting Angle** on the AV POSView Controller menu bar to display the window.

Time Tag 1 and 2 Panes

All POS data are marked with one of four time tags: POS time, GPS time, Universal Time Coordinated (UTC) or User time.

Note: UTC and GPS times are not identical. Due to the occasional need for the addition of a leap second to UTC, there is an integer difference between UTC and GPS time. Transitions between the seconds are precisely coincident between the two times.

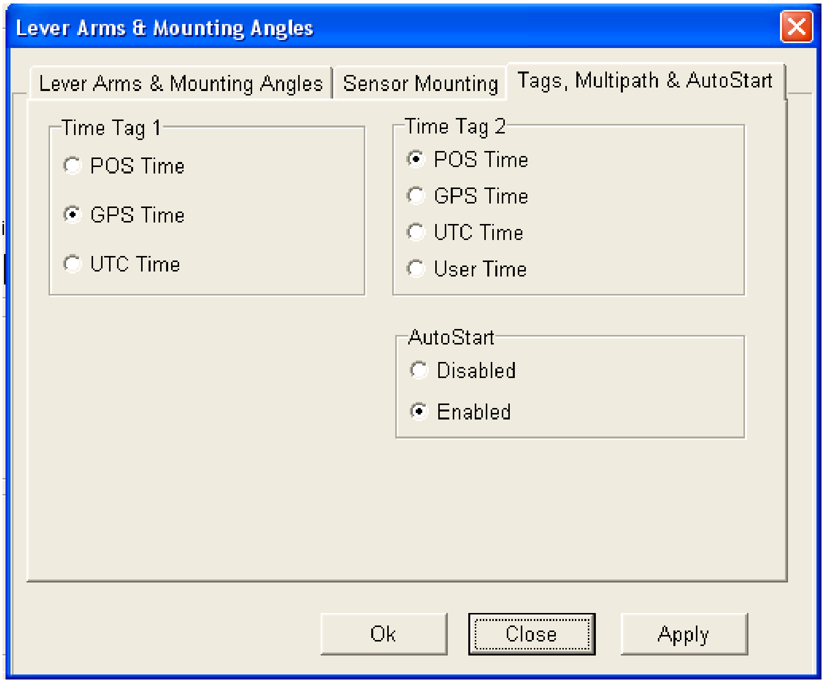


Figure 29: Controller Tags, Multipath & AutoStart Window

Event &PPS Settings

Select **Settings, Events** on the AV POSView Controller menu bar to display the Events window (Figure 30). Select the polarity of the edge trigger for a particular event, then enter a Guard Time value and click the **OK** button to save the settings. Refer to the Events Pane description on page 4-10 for more information on its usage.

In order to prevent the PCS from registering multiple events, usually due to noise or ringing, a value is entered into the Guard Time field. The value selected prevents the retriggering of the PCs event circuitry for the duration of the guard time setting; 100 ms guard time is common. The field for navigation shift entry is relevant only in the case when real time software option Event Based Navigation Output is enabled in real time firmware where user can specify constant time shift applicable for calculation of the navigation output driven by Event 1 and 2 pulse occurrence.

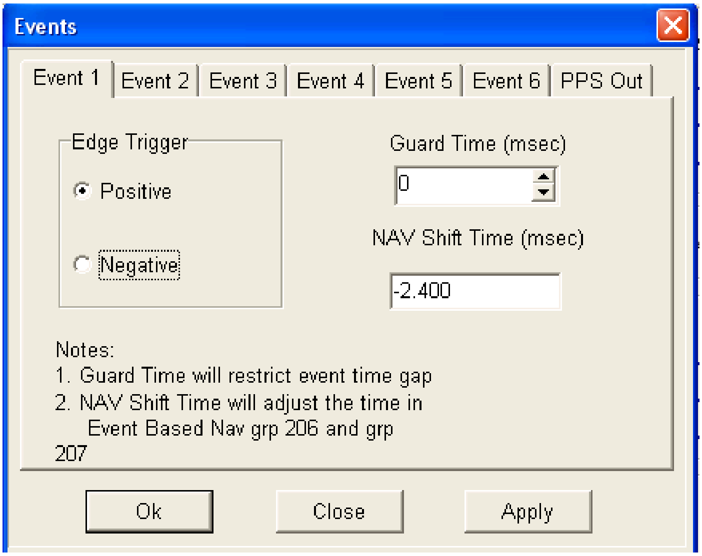


Figure 30: Controller Events Window

In addition to Events configuration POS AV V6 offers configuration control over the shape of the external TTL PPS pulse (Figure 31). The pulse polarity can be selected as positive (the rising edge), negative (the falling edge) or pass through pulse which represents the native Trimble receiver pulse with positive polarity and length of about 5µSec. The width of the pulse can be configured as minimum 1mSec and maximum 500 mSec.

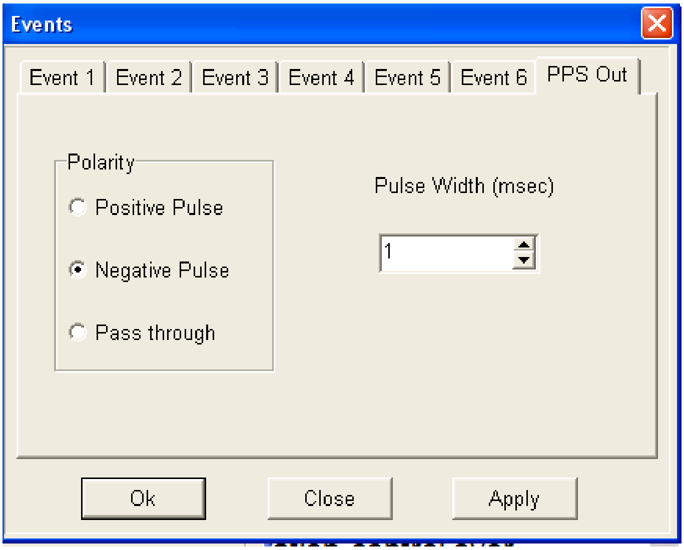


Figure 31: PPS Out Configuration

GNSS Receiver Set-Up

The **GNSS Receiver Configuration** window, Figure 32, is accessed by selecting **Settings, Installation, GNSS Receiver** on the AV POSView Controller menu bar. The tabs for the primary and secondary units provide selection of the following parameters:

- **GNSS Output Rate** field - configures the output frequency of the GNSS raw observable messages
- **GNSS 1 Port** pane – configures COM port properties of the receiver DIFF port - permits the changing of baud rate and protocol. This port can be used for upgrade of the receiver firmware or to stream in differential corrections to the receiver.

- **Auto Configuration** pane - enable or disable the automatic reconfiguration feature (POS detects when the selected GNSS receiver is improperly configured and automatically reconfigures the receiver for use with POS)

Note: Only the GNSS receiver parameters are adjustable (**GNSS Output Rate**, **GNSS 1 Port, Auto Configuration**, etc.). The GNSS receiver type is not reflected in configuration window, since the selection is fixed and configured using the POSConfig utility.

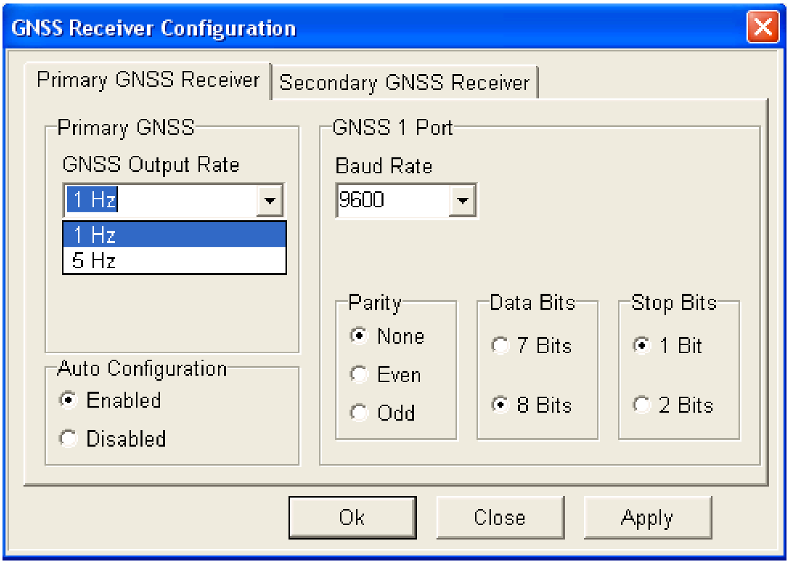


Figure 32: Controller GNSS Receiver Configuration Window

Save Settings

Save the POS AV parameters after any changes, otherwise the changes are lost when the POS AV is powered-down. Each time the POS AV is powered-up, the settings default to the last stored parameters. To save changes, select

Settings, Save Settings from the AV POSView Controller menu bar. The controller indicates when the settings are successfully saved (may take up to 30 seconds to save the settings).

Cycling power while saving may result in lost settings.

Power-Down and Power-Up

Once the configuration is completed and saved, power-down and reboot the POS AV to verify that the changes are saved.

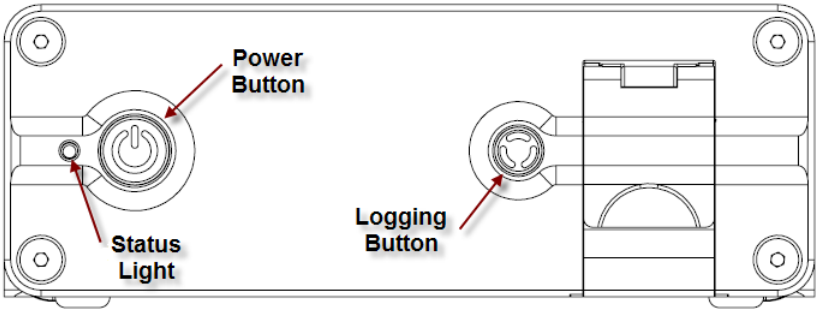


Figure 33: PCS Switches and Indicators

Power-Down

- Exit the AV POSView Controller
- Press and hold the power button for two seconds. The location of the power button is indicated on Figure 33.

Power-Up (Reboot)

- Wait 10 seconds
- Press and hold the power button for 2 seconds

- The light incorporated into the power switch illuminates when the PCS is operating
- Connect to the PCS through AV POSView controller
- Verify that all parameters are correct

Make Changes

It is always possible to change the operating parameters of the POS AV system. All changes to parameters take effect immediately. To make the changes permanent, save them by selecting **Settings, Save Settings** on the AV POSView Controller menu bar.

Manage Multiple Configurations

The controlling PC hard drive is used to store multiple configurations. Select **File, Store POS Settings on PC** on the AV POSView Controller menu bar, specify the file name and save location, then click the **SAVE** button. Repeat this for each configuration.

To load a particular POS AV configuration from the PC hard disk, choose **File, Load POS Settings on PC**, highlight the file to load and click the **OK** button. POS AV is automatically configured with the settings contained in the configuration file.

POS Loader

The POS Loader is used to upgrade the POS AV real time firmware; Applanix sends the loader and update software in a zipped file along with the authorization codes. Contact Applanix Customer Support (page A-1) about the latest version of the firmware upgrade for your system.

Installation

Ensure that all Windows based firewalls and anti-spyware utilities are disabled during the operation of the POS Loader. The following outlines the steps:

1. Windows based PC with LAN (Ethernet) connection to PCS requiring update and running any version of AV POSView Controller.
2. Supply PCS, requiring update, with operating power; IMU or GNSS connections are not required.
3. Change Internet Protocol (IP) address of Windows based PC to match IP address range of PCS (default IP address of PCS is 192.168.53.100 and subnet mask is 255.255.255.000).
4. Copy zipped firmware upgrade file to a location of your choice and unzip its contents.
5. Open and read *.txt* files.
6. Run *Loader.exe* file, see Figure 34.

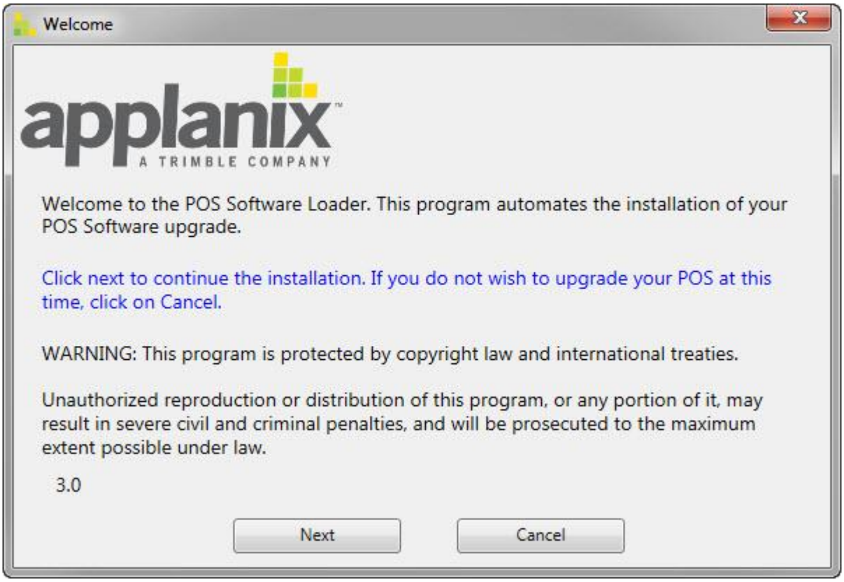


Figure 34: POS Loader Welcome Window

7. Select **Next** to display License window, see Figure 35.

Figure 35: POS Loader License Window

8. Read License Agreement for End Users and click **Next** button to display Figure 36. Select IP address of the PCS to proceed.

Figure 36: POS Loader Select POS Window

9. Select **Next** to display Authorization window, see Figure 37. Enter your 13 digit code into Authorization Code field.

Figure 37: POS Loader Authorization POS Window

10. Click **Next** button to enter authorization code and initiate firmware loading. Figure 38 displays Loading progress window.

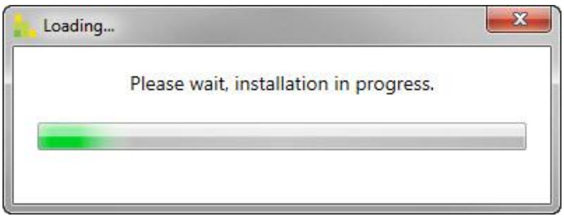


Figure 38: POS Loader Loading Window

11. Once firmware is loaded, it must be unpacked and installed; see Figure 39. Power-down (page 5-16) PCS, wait for 10 seconds and then power-up PCS. *Please read entire window*.

Figure 39: POS Loader Data Transfer Successful Window

12. Press button titled "**Cycle POS Power, then press this Button"** located at bottom of the screen. The window shown in **Error! Reference source not found.** is displayed while firmware is unpacked and installed.

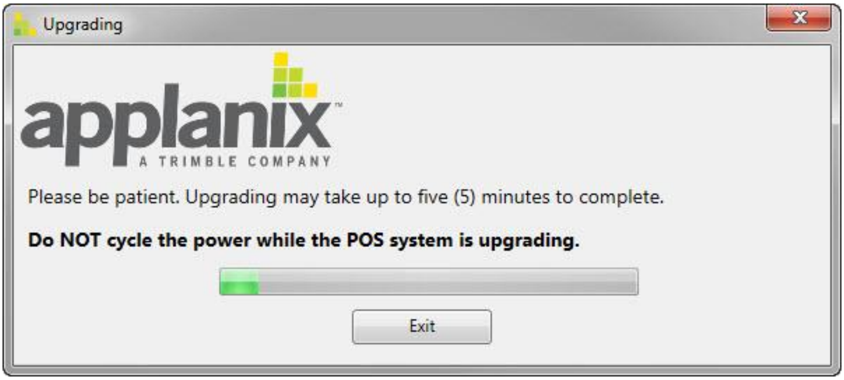


Figure 40: POS Loader Unpacking

13. When firmware is unpacked and installed, Success window is displayed; see Figure 41. *Please read entire window*.

Figure 41: POS Loader Success Window

POSConfig Utility

POSConfig is used to change the PCS settings such as POS AV model, IMU or GNSS types, or enable specific options[2]. Contact Applanix Technical Support and Service before using, refer to page A-1 for details.

The following options are currently available:

- 04 Yaw Drift Correction (YDC)
  Enables the automatic steering of a stabilized mount, using the real-time navigation solution. Refer to the Specification for Yaw Drift Control description on page J-1 for details.
- 11 Event Based Navigation Output (EVO)
  Enables the output of the navigation solution (position and attitude) in real time at the time of the Event 1 and Event 2 pulse occurance.
- 20 Flight Management System (FMS)
  Enables the Ethernet software interface (dedicated control and data port) for communication with Flight Management System and software triggering mechanism in real time firmware (refer to the POSTrack V6, starting on page L-1, for details).
- 22 Generic LiDAR Support (LID)
  Enables automatic LiDAR logging control on/off based on start/end of the survey line.

[2] These options require an authorization code to enable. The authorization code must be purchased from Applanix.

Run POSConfig Utility

The following provides instructions to run *PosConfig.exe* to configure the PCS for the correct POS model, GNSS receiver, IMU type and other options.

Note: Ensure that firewalls and anti-spyware utilities are disabled before running POS Config.

1. Ensure POS AV system is properly connected and operational.
2. Power-up POS AV system.
3. Execute *PosConfig.exe* application; Select POS window opens (Figure 42).

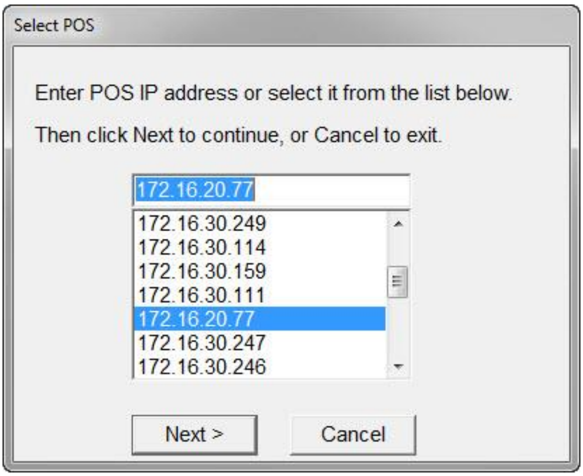


Figure 42: POSConfig Select POS Window

4. Select a POS IP Address and click **Next** button (an IP address may be entered manually); POS Config window opens (Figure 43).
5. Click **Change Model** button (Figure 43) to select a different POS model. Available models are 610, 510, 410, 310; 'AV' is not

changeable. Changing models requires an authorization code that must be purchased from Applanix.

6. Select **IMU Type** from drop-down menu (Figure 43).

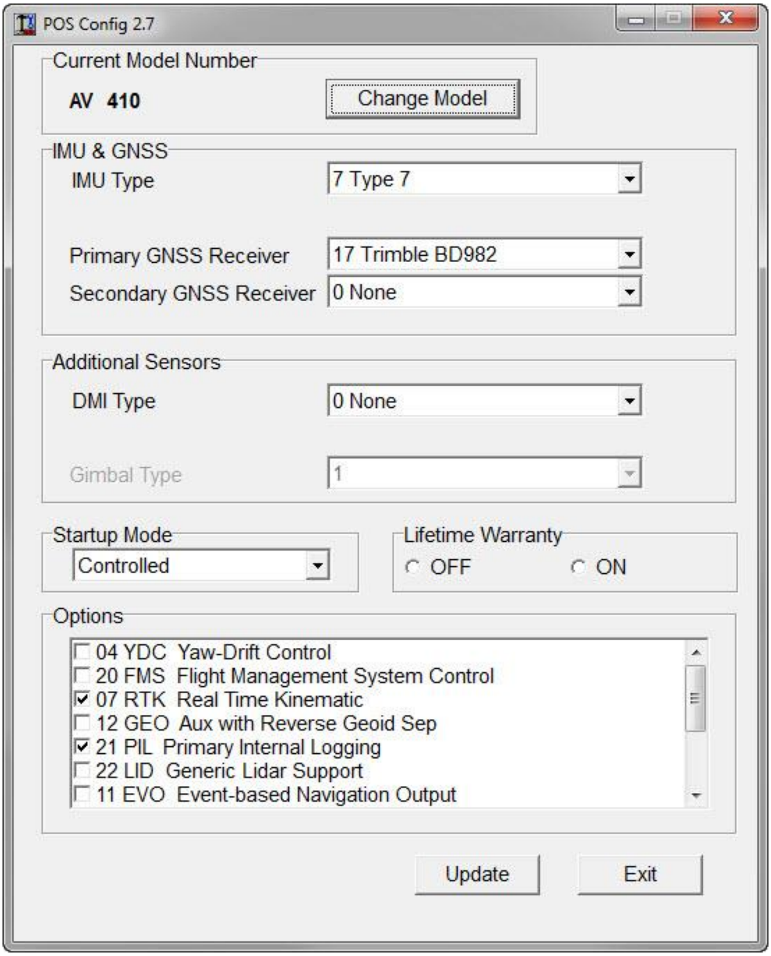


Figure 43: POSConfig Parameter Window

7. Select **Primary GNSS Receiver** type from drop-down menu (Figure 43).
8. Select **Secondary GNSS Receiver** type from drop-down menu (Figure 43).
9. Select applicable **Options** (Figure 43).
10. Click **Update** button - a prompt for an Authorization Code appears - please enter the code. Once operation is complete, Success window opens (Figure 44).
11. Click **Exit** button (Figure 44).
12. Recycle POS AV system power.

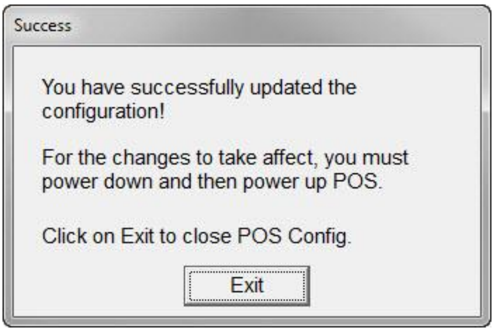


Figure 44: POSConfig Success Window

Warning: Do not power-down the POS AV system until POSConfig notifies that reconfiguration is complete (Figure 44).

6.0 Data Logging

General

Data logging permits the recording of Position and Orientation System for Airborne Vehicles (POS AV) real-time and raw data to a storage media for post-processing. The media may be a high rate transfer across an Ethernet data port to a file on an external Personal Computer (PC) or to an USB flash drive.

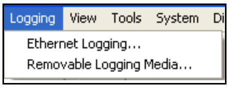
Back-up logging is initiated when data are logged to the USB flash drive and remains active, regardless of the USB data logging activity, until the PCS is reset or powered-off; refer to page 6-3 for more information.

Note: The Ethernet Real time 1 and Real Time 2 data ports are used to output data as close to real-time as possible. They are intended to provide real time information to the end user and not used to store post processed data.

Note: The Ethernet data port is buffered and could be used for reliable data logging.

AV POSView Controller

To access the logging configuration and control menus, select **Logging, Ethernet Logging** or **Removable Logging Media** on the AV POSView Controller menu bar. The logging windows (Figures 45, 46) permit the selection of data groups to be recorded and define the logging rate for certain data groups.



Note: To use the logged data with the Position and Orientation System Post-Processing Package (POSPacMMS), click the **POSPac** button to select all the groups required for post-processing.

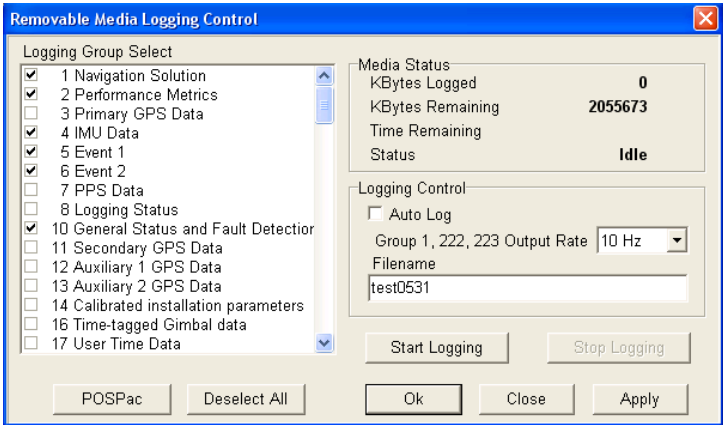


Figure 45: Removable Media Logging Window

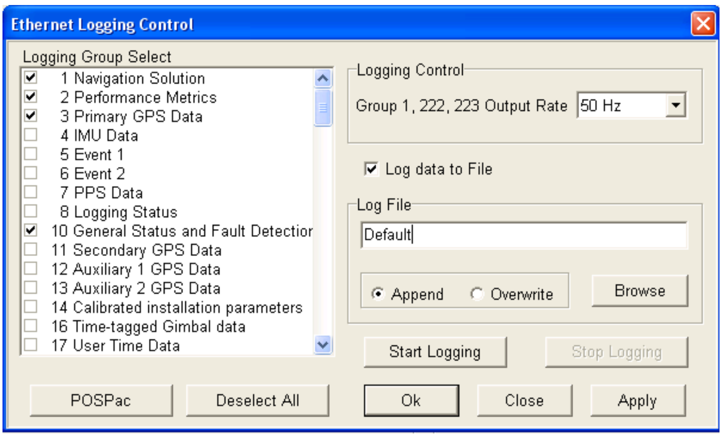
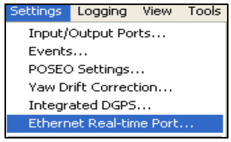


Figure 46: Ethernet Logging Control Window

To access Real Time Data Port 1 and 2 configuration and control menus, select **Settings**, **Ethernet Real Time Data Port** on AV POSView Controller menu bar. The selection of the groups is limited only to the groups for real time control purposes, no raw groups can be selected for output on the ports. Logging can be achieved through End User application only.



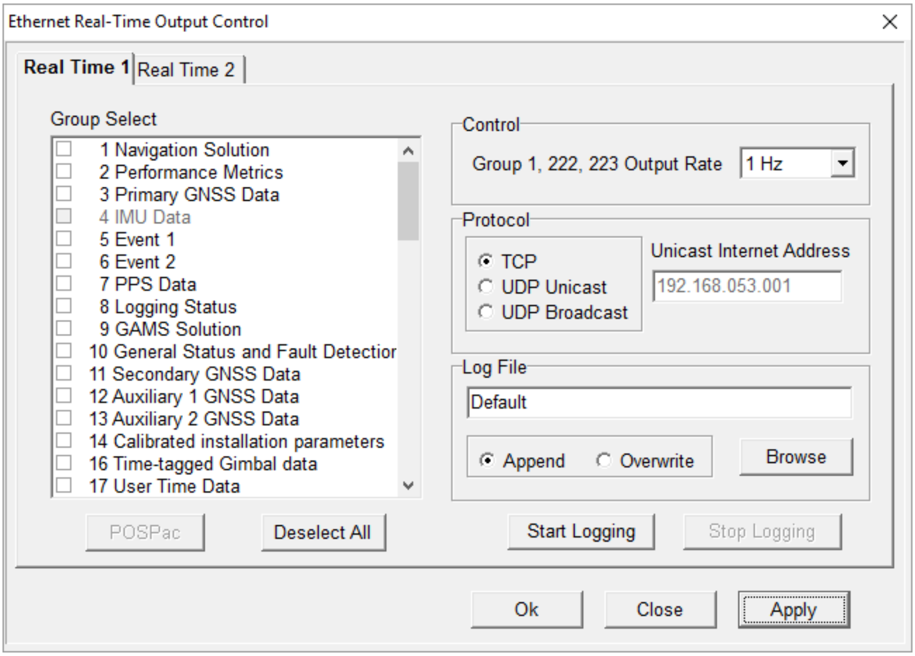


Figure 47: Ethernet Logging Control Window - Secondary

Data Logging – Removable Media and Back-Up

The POS AV contains a removable USB flash drive (4 GB) and an internal memory device (4 GB), both dedicated to data logging.

Important: POS AV V6 only supports USB Flash Drive originally delivered with the system or obtained through the Applanix Customer Support channel.

Note 1: The logging performance can not be guaranteed with non-Applanix Certified USB drives.

The 4 GB internal memory device functions as a circle buffer and is used to back-up the last data logged during a mission. Back-up logging is automatic and does not require any user maintenance. Once the user starts logging on removable drive, back-up logging will log the same data as the USB drive and continues to back-up the data until the system is reset or powered-off.

The first file of each back-up data file set begins with a *.000* extension. The file naming convention used by the PCS is *XXXXXXXXMMDD_HHMMSS* where *XXXXXXXX* is the filename selected for the USB drive logging (up to 17 characters), and *MMDDYYHHMMSS* is the month, day, hour, minute and second in Universal Time Coordinated (UTC).

Note: Prior to downloading internal files from POS, please ensure that all Windows based firewalls and anti-spyware utilities are temporarily disabled.

Access the back-up drive by using Windows Internet Explorer or any FTP client software (e.g. FileZilla) and the following procedure:

1. Connect the power and Ethernet cables to the POS AV (see page 2-10); the IMU or the GNSS are not required.
2. Make sure Ethernet cable is connected between the POS AV and the laptop.
3. Power-up the POS unit (see page 5-16).
4. Configure the laptop to be in the same IP range as the POS AV. See page 4-1 for details.

5. Open the Ftp Client and make sure that data transfer mode is set to Binary, enter POS IP address and use the following credentials

   User Name: guest

   Password: applanix

6. Highlight the desired files and drag to download the files to a location on the laptop.

Note: The data transfer from internal memory card should be initiated at the end of the mission. The real time performance and logging data integrity can not be guaranteed during data transfer.

Insert an USB Flash Drive

The USB flash drive can be inserted into the USB shuttle bay at any time (i.e. with PCS power-on or off). The shuttle allows the USB flash drive to be entirely enclosed by the PCS housing. Insert the USB flash drive into the bay (Figure 48) ensuring that the card is facing up, Applanix logo showing. The shuttle mechanism will move back to its innermost position, at which point the USB flash drive must be pressed into the connector. The logging bay door should close without hitting the USB flash drive if it is properly seated in the connector.

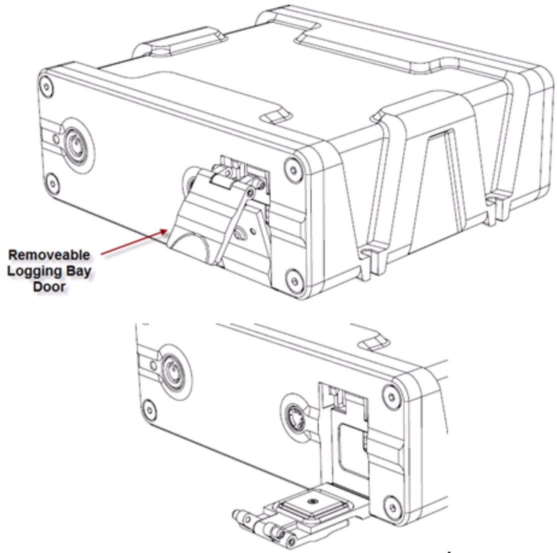


Figure 48: PC Card Drive Bay

Start Logging – Removable Media

AutoLog

If AutoLog is enabled (refer to AutoLog on page 7-2):

- Logging starts automatically when the POS Computer System (PCS) is powered-up and the Global Navigation Satellite System (GNSS) data are available
- If there is no USB flash drive in the logging bay, the logging light will turn red; if this occurs, insert a drive to force a manual logging start

Manual Start

Press the Logging button on the PCS front panel and hold for at least two seconds.

Alternate methods to start logging are to click the **LOG** icon on the AV POSView Controller tool bar or click the **Start Logging** button in the appropriate logging control window.

A description of the logging switches and status lights are located on page 7-3, under PCS Switches and Indicators.

Stop Logging – Removable Media

Logging is stopped manually by pressing the Logging button on the PCS front panel and holding for at least 2 seconds. Logging stops after about six seconds.

An alternate method to stop logging is to click the AV POSView **Stop Logging** button on the Removable Media Logging Control. Stopping and starting data logging to the USB drive causes a new file to be created with the same kernel name and is treated as a new mission.

Note: Once Removable media Logging has stopped, the back-up logging continues until the system is reset or powered-off.

Logged Data

Data are logged to the removable media in approximately 12-Megabyte (MB) files.

Remove the USB flash drive

⚠ **Do not remove a USB flash drive from the logging bay when the logging light is on; the PCS may still be writing to the device. If the USB flash drive is removed when the logging light is on, there is a chance that all mission data will be lost.**

Stop logging before attempting to remove the USB flash drive from the logging bay. When the logging light is off, open the logging bay door, press in on the USB flash drive and then release. The shuttle mechanism will partly eject the stick to a point where it is possible to remove it from the connector

Note: It may take several seconds after a request to stop logging for the PCS to stop recording to the USB flash drive and the logging light to extinguish.

Ethernet Logging

Ethernet logging is performed using the AV POSView Controller or other custom designed software with an interface that conforms to the *POS AV V6 Ethernet & Disk Logging ICD* specification. Data are output for Ethernet logging on the LAN data logging port.

Output data on the Ethernet-based data port (5603), is internally buffered by POS AV to prevent the occurrence of data gaps. Use this port for reliable data logging.

Data output on the Ethernet-based Real Time 1 and Real Time 2 data ports is pseudo real-time and is not internally buffered by POS AV. Data packets may be lost due to network congestion, CPU overload, etc.

Note: The logging of the data output on the Real Time Ports can not be performed through AV POSView Controller. The Real Time Ports are used for Real Time control applications, they are not intended to log data for postprocessing.

Note: Ethernet logging is not backed-up internally. A user may decide to log both Ethernet and Removable Media for redundancy.

Note: Ethernet data logging cannot be started or stopped using the Logging button on the front panel of the PCS.

Figure 49 shows the Ethernet Logging Control Window.

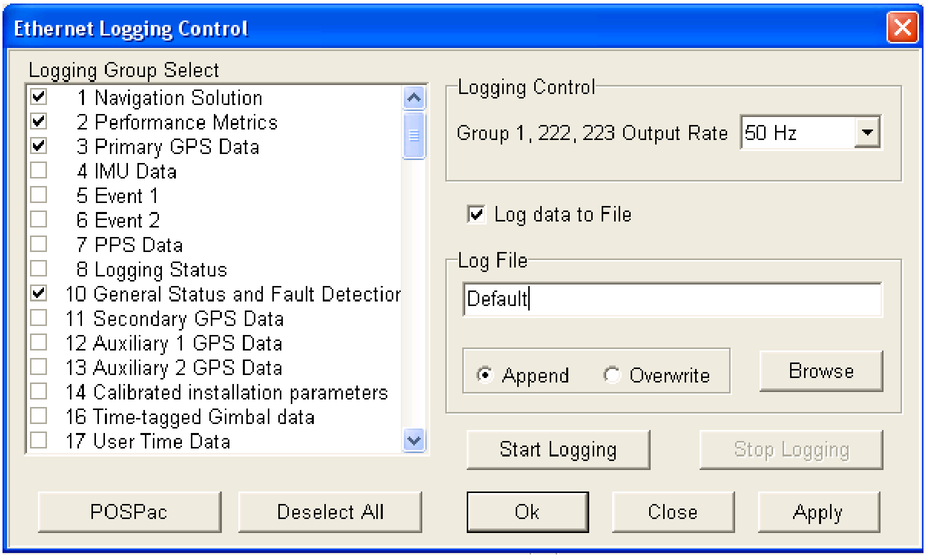


Figure 49: Ethernet Logging Control Window

Start Logging - Ethernet Data Port

To start Ethernet data logging (Figure 49):

- Select the **Log data to File** check box
- Select the groups for output
- In the **Log File** pane select a file name or browse to locate a file
- Select the **Start Logging** button

Stop Logging - Ethernet Data Port

To stop Ethernet data logging (Figure 49) select select the **Stop Logging** button.

7.0 Stand-Alone Operation

General

Stand-Alone operation refers to using the Position and Orientation System for Airborne Vehicles (POS AV) system without the AV POSVIew Controller software. Navigate mode is selected once initial configuration and installation parameter set-up is complete. At this point, the POS AV system may be operated without instructions from the AV POSView Controller. This allows data to be collected without the POS being connected to a PC.

Saving the POS AV configuration using the controller (prior to Stand-Alone operation) retains the previously enabled output ports. The system starts outputting data when the green Status light, located on the POS Computer System (PCS) front panel, begins flashing green.

Ethernet data output commences once the PCS is powered-on and only contains POS AV status and time until the Status light starts flashing green.

The POS LV status is determined from the Status light on the PCS front panel when the LV-POSView software is not monitoring the outputs.

AutoStart

Enabling the AutoStart feature during start-up automatically transitions POS AV to the Navigate mode.

Note: The AutoStart feature is a default factory setting.

To enable the AutoStart mode:

1. On AV POSView Controller menu bar, select **Settings, Installation, Tags, Multipath & AutoStart**.

Lever Arms & Mounting Angles window opens with **Tags, Multipath & AutoStart** tab active.

2. In **AutoStart** pane, select **Enabled.**

3. Click **OK** button.

4. On AV POSView Controller menu bar, select **Settings, Save Settings.**

Changes to AutoStart status are saved.

The next time POS AV is powered-up, it will automatically transition to the Navigate mode. The user is not required to connect to POS AV again.

If AutoStart is not enabled, POS AV remains in the Standby mode and the user is required to connect to POS AV using the AV POSView Controller.

AutoLog

Data logging to a removable media may be controlled without using the AV POSView Controller. Logging begins once there is adequate GNSS information available.

Note: Back-up logging automatically starts with Removable media logging and does not stop until the system is reset or powered-off.

To enable the AutoLog mode:

1. On AV POSView Controller menu bar, select **Logging, Removable Logging Media.**

PC Card Logging Control window opens.

2. On **Logging Control** pane, select **Auto Log**.

3. Click **OK** button.

4. On AV POSView Controller menu bar, select **Settings, Save Settings**.

Changes to AutoLog status are saved.

Note: AutoStart must be active for AutoLog to function and AutoLog is only available for logging on removable media.

During the next PCS power-up, the PCS automatically transitions to Navigate mode once coarse levelling is complete. When the GNSS becomes available and the system is in the Navigate Mode, POS AV starts logging data to the USB flash drive.

To stop data logging:

Perform one of the following steps:

- On PCS front panel, press and hold logging switch for at least two seconds
- On AV POSView Controller tool bar, click **Log** icon then click **Stop Logging** button

Note: Data logging stops automatically when the USB flash drive is full. Back-up data logging continues until the PCS is reset or powered-off.

PCS Switches and Indicators

Front Panel Switches

The PCS has two switches: Power and Logging (Figure 50). The Power switch controls the application of operating power to the PCS and illuminates the power button light when enabled. The Logging switch is used to start and stop removable media logging.

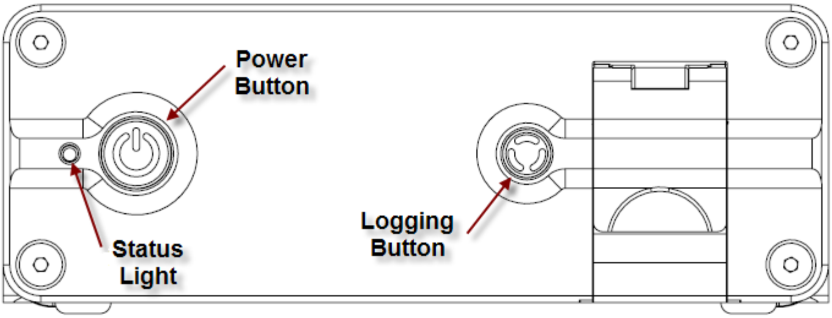


Figure 50: PCS Switches and Indicators

Front Panel Indicators

The front panel Status and Logging indicators have three different colours (red, amber and green) and three states (flashing, steady-on and steady-off). This provides multiple light patterns to indicate the status. The following list identifies the front panel indicators (Figure 50) and their indicated status.

Table 3: PCS Front Panel Lights

Status light - indicates current status of POS AV:	
Steady red:	POS AV failure - shows red when PCS is first powered-on. Changes to a valid condition when PCS internal program begins to run, but will turn red again if there is a fault in PCS. If a fault occurs, do not power-off PCS. Refer to **Fault Detection** window of controller program
Steady amber:	Standby mode - POS AV is waiting for instructions.
Flashing amber:	Navigate mode - initialising and aligning attitude (coarse levelling).

Flashing green:	Navigate mode - degraded attitude performance. Attitude measurements are acceptable but do not meet user-set accuracy limits.
Steady green:	Navigate mode - normal system operation. System meets accuracy limits set by user for position, velocity, attitude and heading.
Logging light - indicates status of removable media logging:	
Off:	Logging inactive
Steady green:	Logging active, media is <80% full
Steady amber:	Logging active, media is >80% full
Steady red:	Error writing to storage media
Power light - illuminates white when the PCS is operating.	

8.0 External Interfaces

General

This section describes the interface configuration and signal characteristics of the ports located on the rear panel of the POS Computer System (PCS). Figure 51 shows the PCS rear panel and the connector locations.

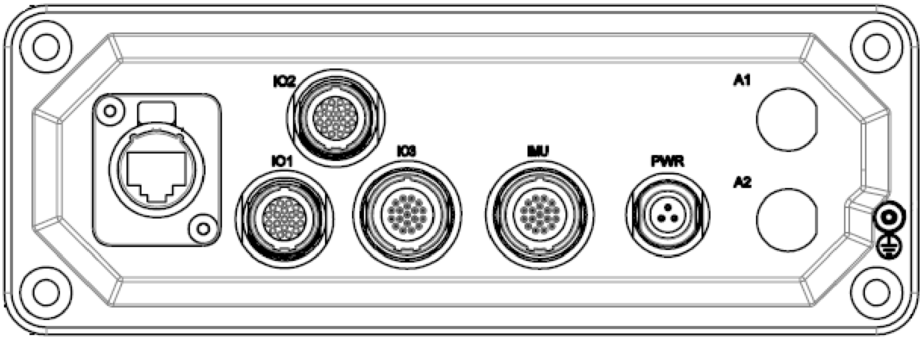


Figure 51: PCS Rear Panel

The majority of connectors on POS AV V6 are high quality, push-pull, IP67 Lemo ® connectors. These connectors use spring loaded latches that engage when the connector is pushed fully into the socket. Once engaged the connector is very secure against shock, vibration and pulling on the cable, ensuring a reliable connection. To disengage the connector you must pull back on the outer release sleeve. Since pulling back on the release sleeve often results in some force on the entire connector body the latches can experience some friction and not retract smoothly. If possible it is better to hold the cable forward while pulling back on the release sleeve and then sliding the connector out of the socket. Applying excess force could damage the latch mechanism.

Power Connector

Physical Interface

A two metre (6.5 ft) shielded cable connects the PCS to the input direct current power source. Table 4 provides the power connector pin assignments.

Table 4: Power Connector Pin Assignment

PIN	Pin Description
1	+VIN
2	N/C
3	Return

POS LV Receptacle: Lemo HES-1F-303-CLDP 3 pin male (shown)		Cable Plug: Lemo FGS.1F.303.CLM

IMU Connector

Physical Interface

A proprietary shielded cable, supplied with the system, connects the IMU to the PCS. Ensure the cable is secure by locking the connector shell to the base. The default cable length is five meters.

POS AV V6 only supports IMU types 7and 8 with Serial Numbers 400601 and greater.
Do not disconnect the IMU cable while the PCS is powered on, it might result in the damage of the IMU or PCS hardware.

I/O1 Connector

A 30 cm (12 in) shielded I/O1 cable, Applanix p/n 10005246 (octopus style) connects the PCS to various inputs and outputs. The following ports are available from the I/O 1 cable: COM5, DIFF, Event 6, PPS In and PPS out. Refer to Table 5.

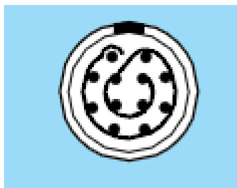
Table 5: I/O1 Connector Pin Assignment

Mating LEMO Connector		I/O1 Cable Mapping		Signal Type	Signal Direction (wrt PCS)
Pin	**Description**	**Pin**	**Connector**		
1	COM 5 RX (receive data)	2	DE9 (male)	RS-232	Input
2	COM 5 TX (transmit data)	3		RS-232	Output
9	GND (signal ground)	5		N/A	N/A

Mating LEMO Connector		I/O1 Cable Mapping		Signal Type	Signal Direction (wrt PCS)
Pin	**Description**	**Pin**	**Connector**		
3	DIFF RX (receive data)	2	DE9 (male)	RS-232	Input
4	DIFF TX (transmit data)	3		RS-232	Output
10	GND (signal ground)	5		N/A	N/A
7	Event 6 In	4	DE9 (female)	** see notes	Input
8	Event 6 In Return	9		N/A	N/A
11	PPS Out		BNC (female)	5V TTL	Output
12	PPS Out Return			N/A	N/A
6	PPS In		BNC (female)	** see notes	Input
5	PPS In Return			N/A	N/A

POS AV Rear Panel(shown in picture):
Lemo HES.2F.312.CLDP

Mating Connector:
Lemo FGS.2F.312.CLM



** All Event Inputs are optically isolated digital inputs.
** Inputs (and their return lines) are not referenced and are independent of internal POS power supplies and GND.
** Event inputs can be triggered from an external 3 – 50 Vdc source capable of supplying a minimum of 1 mA of sourcing or sinking current.

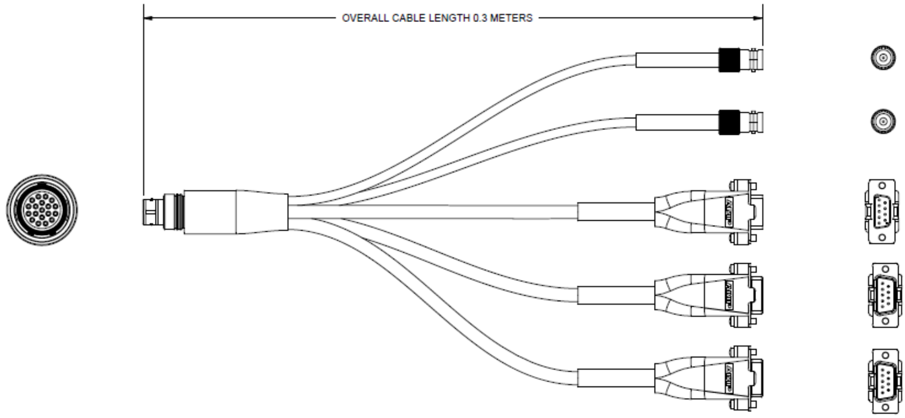


Figure 52: I/O1 Cable

I/O2 Connector

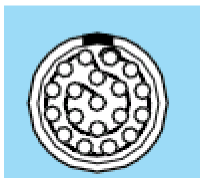
A 30 cm (12 in) shielded I/O cable (octopus style), Applanix p/n 10005245 connects the PCS to various inputs and outputs. The following ports are available from the I/O 2 cable: COM 2, 3 & 4, Event 5 and PPS out. Please refer to Table 6.

Table 6: I/O2 Connector Pin Assignment

<table>
<tr><th colspan="2">Mating LEMO Connector</th><th colspan="2">I/O2 Cable Mapping</th><th rowspan="2">Signal Type</th><th rowspan="2">Signal Direction (wrt PCS)</th></tr>
<tr><th>Pin</th><th>Description</th><th>Pin</th><th>Connector</th></tr>
<tr><td>4</td><td>COM2 RX (receive data)</td><td>2</td><td rowspan="4">DE9 (male)</td><td>RS-232</td><td>Input</td></tr>
<tr><td>2</td><td>COM2 TX (transmit data)</td><td>3</td><td>RS-232</td><td>Output</td></tr>
<tr><td>1</td><td>COM2 RTS (ready to send)</td><td>7</td><td>RS-232</td><td>Output</td></tr>
<tr><td>3</td><td>COM2 CTS (clear to send)</td><td>8</td><td>RS-232</td><td>Input</td></tr>
</table>

Mating LEMO Connector		I/O2 Cable Mapping		Signal Type	Signal Direction (wrt PCS)
Pin	**Description**	**Pin**	**Connector**		
15	COM2 GND (signal ground)	5		N/A	N/A
6	COM3 RX (receive data)	2	DE9 (male)	RS-232	Input
7	COM3 TX (transmit data)	3		RS-232	Output
16	COM3 GND (signal ground)	5		N/A	N/A
13	COM4 RX (receive data)	2	DE9 (male)	RS-232	Input
5	COM4 TX (transmit data)	3		RS-232	Output
11	COM4 GND (signal ground)	5		N/A	N/A
10	Event 5 In	4	DE9 (female)	** see notes	Input
9	Event 5 In Return	9		N/A	N/A
12	PPS Out		BNC (female)	5V TTL	Output
14	PPS Out Return			N/A	N/A

POS AV Rear Panel (shown in picture):
Lemo HEP.2F.319.CLNP



Mating Connector:
Lemo FGP.2F.319.CLC

** All Event Inputs are optically isolated digital inputs.
** Inputs (and their return lines) are not referenced and are independent of internal µPOS power supplies and GND.
** Event inputs can be triggered from an external 3 – 50 Vdc source capable of supplying a minimum of 1 mA of sourcing or sinking current.

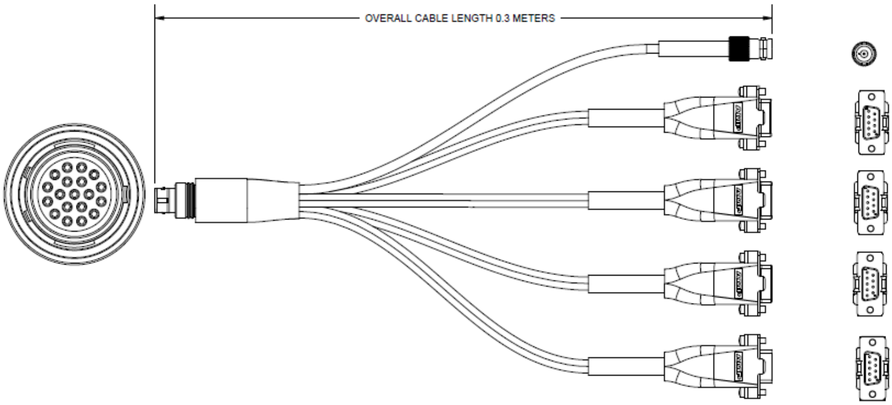


Figure 53: I/O2 Cable

I/O3 Connector

A 30 cm (12 in) shielded I/O3 cable (octopus style), Applanix p/n 10005244 connects the PCS to various inputs and outputs. The following ports are available from the I/O3 cable: COM 1, Event 1, 2, 3, & 4 and Strobe out 1 & 2. Please refer to Table 7.

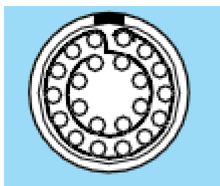
Table 7: I/O3 Connector Pin Assignment

Mating LEMO Connector		IO3 Cable Mapping		Signal Type	Signal Direction (wrt PCS)
Pin	**Description**	**Pin**	**Connector**		
7	COM1 RX (receive data)	2	DE9 (male)	RS-232	Input
8	COM1TX (transmit data)	3		RS-232	Output
9	COM1RTS (ready to send)	7		RS-232	Output
10	COM1CTS (clear to send)	8		RS-232	Input
11	COM1GND (signal ground)	5		N/A	N/A

Mating LEMO Connector		IO3 Cable Mapping		Signal Type	Signal Direction (wrt PCS)
Pin	Description	Pin	Connector		
1	Event 1 In	2	DE9 (female)	** see notes	Input
2	Event 1 In Return	7		N/A	N/A
3	Event 2 In	3		** see notes	Input
4	Event 2 In Return	8		N/A	N/A
12	Strobe 1 Out (Trigger)	5		5V TTL	Output
13	Strobe 1 Out Return	9		N/A	N/A
16	Event 3 In	2	DE9 (female)	** see notes	Input
17	Event 3 In Return	7		N/A	N/A
18	Event 4 In	3		** see notes	Input
19	Event 4 In Return	8		N/A	N/A
14	Strobe 2 Out	5		5V TTL	Output
15	Strobe 2 Out Return	9		N/A	N/A
5	Reserved	N/A		N/A	N/A
6	Reserved			N/A	N/A

POS AV Rear Panel
(shown in picture):
Lemo HEN-3F-322-CLNP

Mating Connector:
Lemo FGN.3F.322.CLC



** All Event Inputs are optically isolated digital inputs.

** Inputs (and their return lines) are not referenced and are independent of internal µPOS power supplies and GND.

** Event inputs can be triggered from an external 3 – 50 Vdc source capable of supplying a minimum of 1 mA of sourcing or sinking current.

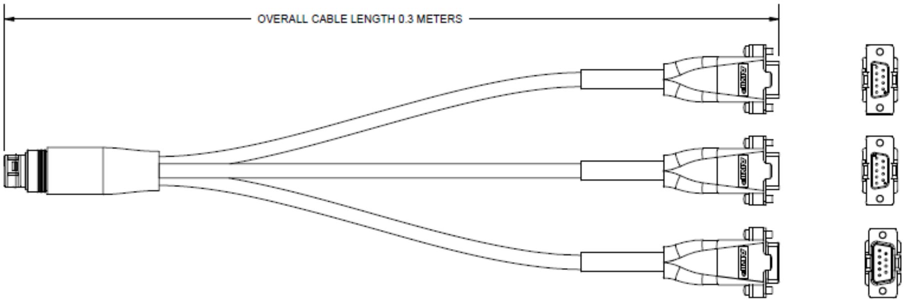
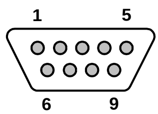
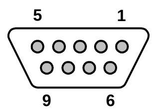


Figure 54: I/O3 Cable

Pin enumeration for both versions of DE9 connectors (male and female) are presented in the Table 8.

Table 8: DE9 Connector Pin Assignment

DE9 (male)	
DE9 (female)	

Ethernet (LAN) Connector

A 10/100 Base-T Ethernet interface provides communication between the PCS and other computers through rugged RJ45 type of the connector. It is used for monitoring or controlling the system. The Ethernet port supports both the Transmission Control Protocol/Internet Protocol (TCP/IP) and the Universal Datagram Protocol (UDP).

The LAN (Ethernet) interface provides a means for configuring and monitoring the POS AV. This interface conforms to the Institute of Electrical and Electronics Engineers (IEEE) standard 802.3 and comprises the following three ports:

- Control port - transmits configuration information to POS AV and operates in conjunction with the Display port - TCP/IP
- Display port - provides data at a 1 Hz rate for use by the POS AV Controller software - UDP
- Real Time Data ports - provide the navigation output on high rate for application control purposes- TCP/IP (real-time)
- Logging Data port - provides the same data as the Display port, at rates up to 200 Hz - TCP/IP (buffered)

Note: The data output from the display port is broadcast using the UDP protocol and may be captured by any host on the physical Ethernet network (regardless of the IP address of the host).

The data available on the Ethernet connection (for both display and data ports) is organized into a group structure. Each port is configured independently in terms of the groups that are output. Only those groups selected for a port are output on that port.

Refer to the Ethernet Logging description on page 6-8 for information on selecting data groups for output. Please refer to the *POS AV V6 Ethernet & Disk Logging ICD* if the data are used with software other than the AV POSView Controller.

Antenna Connectors

ANT1 and ANT2 Connectors

Signals from a GNSS antenna are coupled to its respective GNSS receiver by the ANT1 or the ANT2 (optional) port located on the rear panel of the PCS.

Each GNSS antenna is connected to its respective receiver using a 10 m (33 ft) RG-303 cable. Applanix supplies a cable for each GNSS installation. The GNSS antenna connectors and the PCS antenna ports are female TNC connectors. RG-400 (50 ohm) cable may be used as an alternate to RG-303 cable if replacement is necessary.

Refer to the Installation description on page 2-5 for GNSS antenna installation and cable routing procedures.

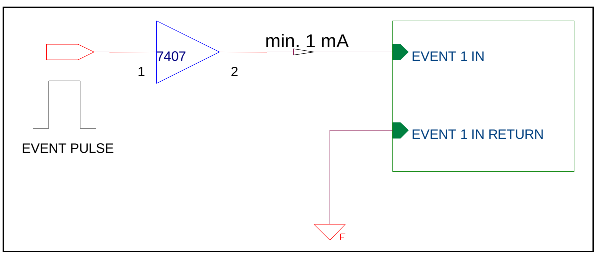
Signal Description by Functionalities

This section includes the description of the signals available on all three octopus style of the cables I/O 1/2/3 by their functionalities.

Event Inputs

Six independently isolated event inputs are available on each IO cable. Digital pulses in the range of 3 to 50 Vdc will trigger the event time tagging.

Examples with possible configurations of Events inputs are shown in Figure 55.



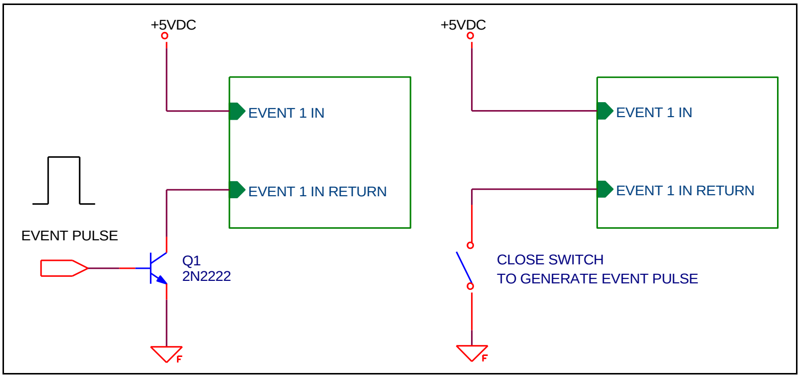


Figure 55: Event Input Examples

DIFF Port

Differential port provides direct serial link (RS232) to GNSS receiver. The port can be used for receiver firmware upgrade or to supply differential correction to receiver to achieve higher accuracy positioning mode.

Differential corrections in Radio Technical Commission for Maritime Services (RTCM) standard 104 types 1, 2, 5, 6, 9, 16, 18 and 19 formats are accepted. POS AV supports the standard *6 of 8* format for RTCM-104 corrections; where data bits 1 through 6 contain data, bit 7 is set to a mark and bit 8 is set to a space.

Other accepted formats include:

- RTCM message types 18 and 19
- Compact Measurement Record (CMR)
- Radio Technical Commission for Aeronautics (RTCA)
- The DIFF port may be configured to match the data rate and protocol of the available differential corrections using the AV POSView Controller software, refer to the GNSS Receiver Set-Up description on page 5-14. Table 9 lists the factory port settings.

Table 9: DIFF Port Settings

Setting	Value
Baud Rate	9600
Parity	None
Data Bits	8
Start Bits	1
Stop Bits	1

Note: The DIFF port parameters are set-up using the POS AV Controller software.

PPS Outputs

The PCS uses the one Pulse Per Second (PPS) signal from a GNSS receiver for internal timing requirements. A user customizable version of this signal is provided on the connector to allow external equipment to be synchronized with POS AV. A dialog in AV POSView allows control of the polarity and pulse width of the PPS output signal.

⚠ **The PPS output port is an active circuit. Ensure that an 'input signal' is NOT connected to the PPS output port, otherwise damage may result.**

The 1PPS signal is a TTL level strobe that occurs at a 1 Hz rate. The leading edge of the strobe is coincident with the exact GPS second. The corresponding time message that specifies the UTC time of the 1PPS is available in multiple formats from any COM or Ethernet port by selecting the desired configuration through AV POSView.

COM Ports Set up

The interface includes five RS232 COM ports in total. Table 10 identifies the possible configurations for the I/O connector COM ports (default in bold).

Table 10: COM Ports Configuration

Setting	Value
Interface	**RS232**
Baud Rate	2400 to 115200 (**9600**)
Parity	**None**
Data Bits	**8**
Stop Bits	**1**
Flow Control	**None**

Configuration of each of the five serial COM ports is performed through the AV POSView Controller (Settings->Input/Output Ports..). The following lists the configuration choices:

- Selecting the input and output functionality for each port
- Setting the update rate for selected output data formats
- Setting the baud rate for the ports

NMEA Output Data Format

The POS Computer System (PCS) outputs data on the selected COM port using the NMEA standard 0183 format. The supported NMEA message formats are listed in Table 11. POS AV has several different sentence formats available for output to third party equipment. Any or all of the sentences are available for output. Refer to the COM Ports Message Format starting on page F-1 for a description of the message sentences. In the **NMEA** pane, select values for the **Update Rate** and **Talker ID** for the NMEA output message (Figure 56).

Table 11: NMEA Output Messages

Message	Output
GST	Pseudo-range measurement noise statistics
GGA	Position
HDT	Heading
ZDA	Timing and date
$EVT1	Timed event #1 *
$EVT2	Timed event #2 *
VTG	Track and speed
PASHR	Attitude
GGA2	Position data, with GNSS fix, geoidal separation
PPS	PPS, UTC time, PPS time recovery
GGK	GNSS Fix
RMC	NMEA Recommended Minimum Specific Navigation Data
PAPLEVT1	Event 1 based navigation output*
PAPLEVT2	Event 2 based navigation output*

***** Not a NMEA 0183 message.

Note: Commas separate all fields and in instances where values have no set maximum, the value is listed as No Range Given (NRG). All real-time position and orientation message strings output to a selected port are with respect to the Reference Body Frame.

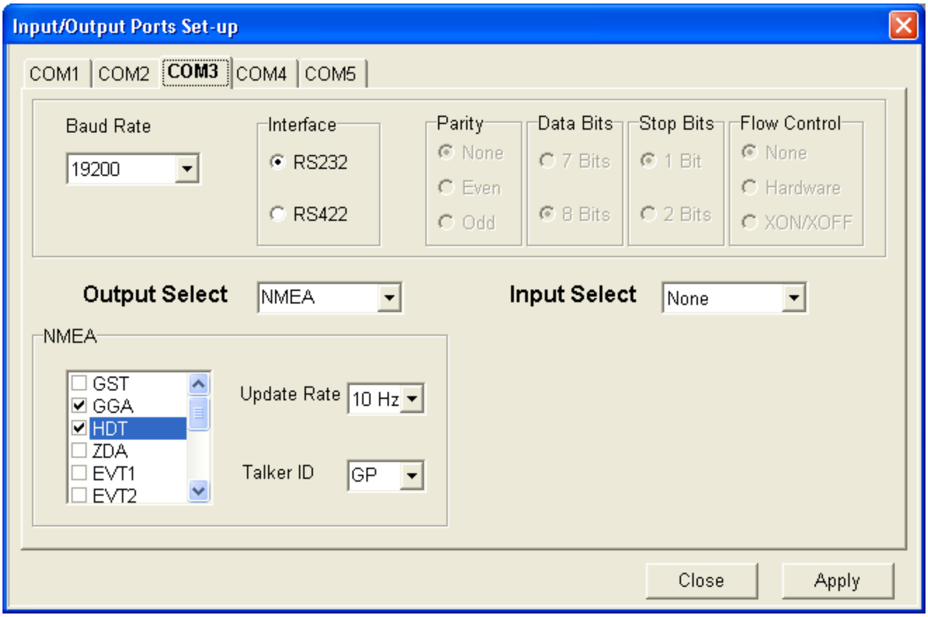


Figure 56: Input Output Ports Set-up – NMEA Output

Binary Output Data Format

The PCS outputs real-time binary data on the selected COM port in any of several predefined formats. The format is selected from the Formula Select menu and the output frequency is set by selecting a value for the **Update Rate** field (Figure 57). The available message strings are listed in Table 12, and their formats are described in COM Ports Message Format starting on page F-20.

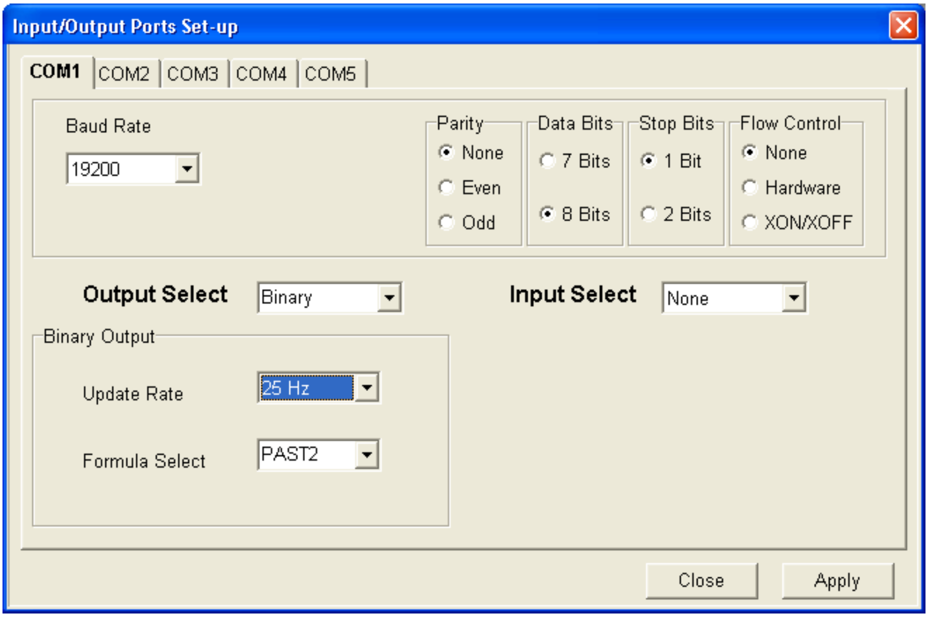


Figure 57: Input/Output Ports Set-up - Binary Output

Table 12: Binary Output Messages

Message	Output
None	No selection made
ATT01	Attitude of Reference Frame
AZMNT	Attitude and Yaw Drift Correction for Azimuth Mount
POSATT	Position and Attitude of Reference Frame
POSATT2	Position and Attitude of Reference Frame
POSATT3	Position, Attitude of Reference Frame, and Roll Rate of Reference Frame
PAST1	Position, Attitude, Speed, and Track of Reference Frame

Message	Output
PAST2	Position, Attitude, Speed, Track, Acceleration of Reference Frame; contains checksum
PAV30	Attitude (Roll, Pitch, Yaw Drift Correction); contains checksum
RDR1	Position and Orientation for Land Radar Applications
PPS	Time of Last PPS Pulse
TM1B	Time Recovery Message in TM1B Format, for backwards compatibility

Note: Only one message can be output at a time.

Ethernet-Serial Message Convertor

This functionality provides bi-directional capability to convert the content of specific ICD Message 222 sent to POS AV over Ethernet Control port to the serial data stream on assigned COM port. Simultaneously can be used in opposite direction to read the data stream received from assigned COM port and convert the content to the specific ICD Group 10206. Please refer to POS AV Ethernet ICD for group and message definition. It is particularly useful for third party application to control sensor with the serial port using Ethernet communication with POS AV. Please refer to Figure 58 for COM port setup.

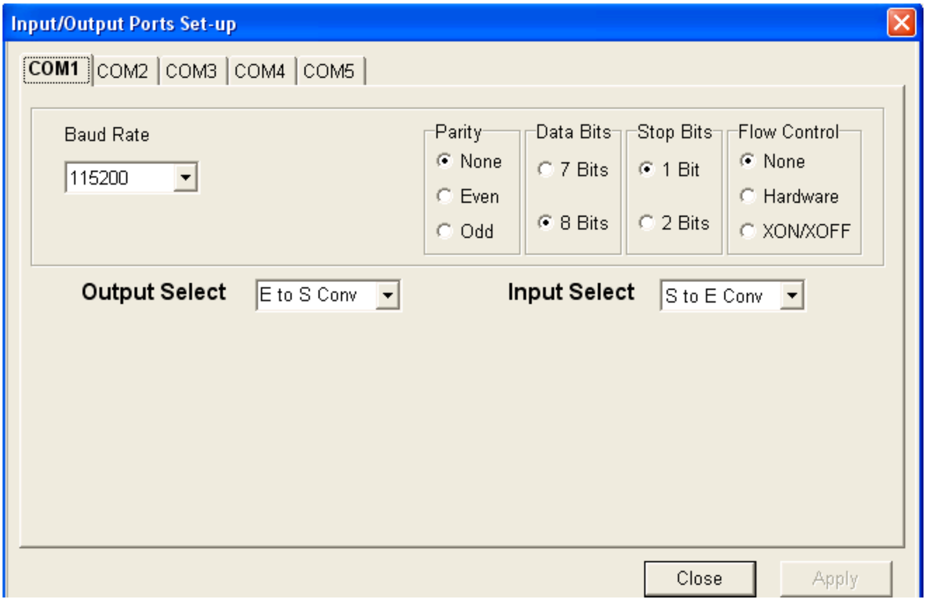


Figure 58: Ethernet-Serial Convertor

Aux 1/2 GPS Input Data Format

The PCS inputs data on the selected COM port from an auxiliary GNSS receiver if the Aux1/2 GPS is selected as input (Figure 59 and Figure 60). The auxiliary GNSS receiver must be configured to output specific NMEA strings (GGA, GST, GSV, GSA) on its COM port prior to connecting it to the PCS. If the auxiliary 1 or 2 GPS inputs provide more accurate position information than the primary GNSS receiver, then the PCS will use the best auxiliary GNSS information. Note that the PCS still relies on the internal primary GNSS for timing information, therefore the system cannot run with only Aux GNSS input.

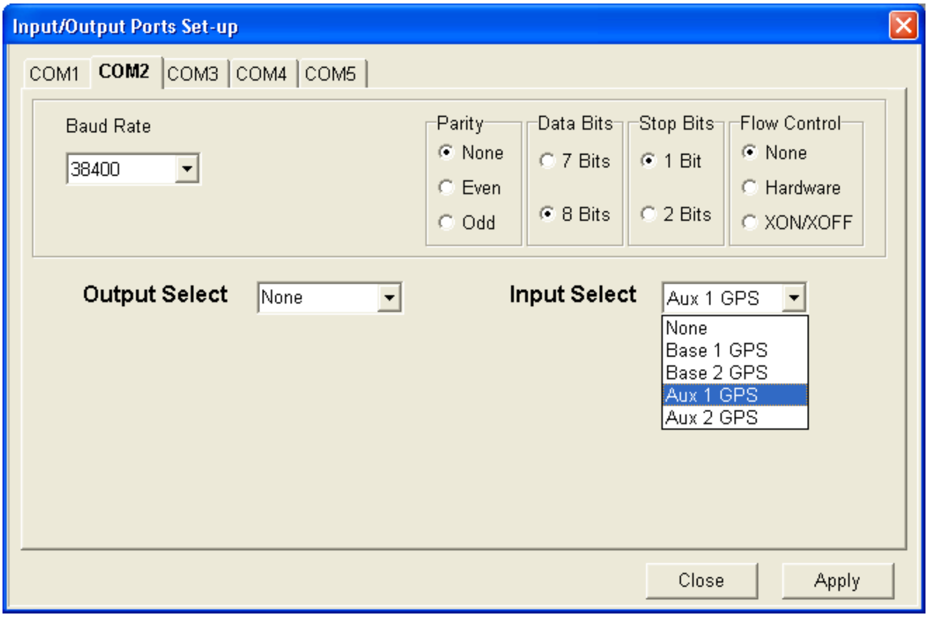


Figure 59: Input/Output Ports Set-up - Aux 1 GPS Input

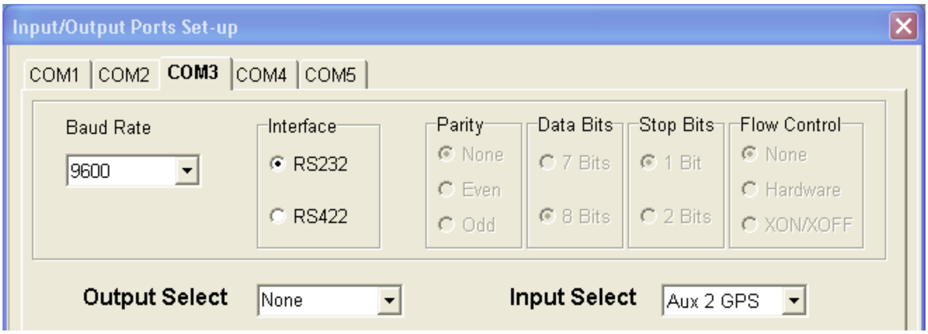


Figure 60: Input/Output Ports Set-up - Aux 2 GPS Input

Gimbal Support Over Serial Port

The COM port can be set-up to receive gimbal encoder values when the IMU is mounted on a stabilized platform. The gimbal values are used to translate the position and velocity measurements of the GNSS antenna to the IMU. In addition, gimbal values are used by the POS AV to compute the absolute orientation of the aircraft with respect to the Earth

Different gimbal platform messages (Table 13) may be received by the PCS. The format of these digital messages is described in the COM Ports Message Format description on page F-1.

Table 13: Gimbal Support

Message	Input
GSM3000/4000	GSM3000/4000 gimbal encoder input
GIM01	Gimbal encoder input
GIM02	Gimbal encoder input
TAS	TAS encoder input
Z/I	Z/I encoder input
PAV 30/80	Encoder input (specific to PAV30 and PAV 80)
Azimuth Mount	Azimuth mount encoder input (specific to the DSS azimuth mount)
PV SU	Gimbal encoder input specific to PV LAB

The update rate for the gimbal encoder data are selected to maintain a constant flow of messages to selected COM port, refer to Table 14.

Table 14: Gimbal Encoder Data Update Rate and Latency

Parameter	Value
Minimum Suggested Update Rate	20 Hz
Maximum Update Rate	200 Hz
Maximum Latency	5 ms

Note: The minimum data rate of 20 Hz assumes that the gimbal has a minimum cut-off frequency of 20 Hz.

In order to obtain the maximum possible position and orientation accuracy between POS and a gimbal platform, the angular rates and angular acceleration of the gimbal platform should be limited to the value specified in Figure 61 for a given lever arm distance from the IMU to the GNSS antenna.

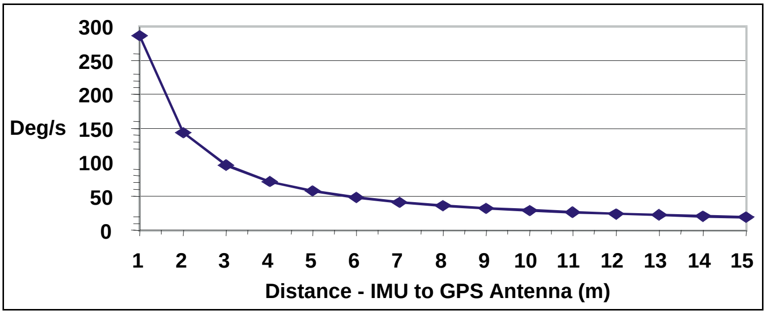


Figure 61: Lever Arm distance

Figure 62 shows the available gimbal selections. Please note that some of the gimbal mounts require bidirectional communication in order to perform levelling control and supply yaw drift correction in real time, therefore the Output Select is automatically set to Gimbal.

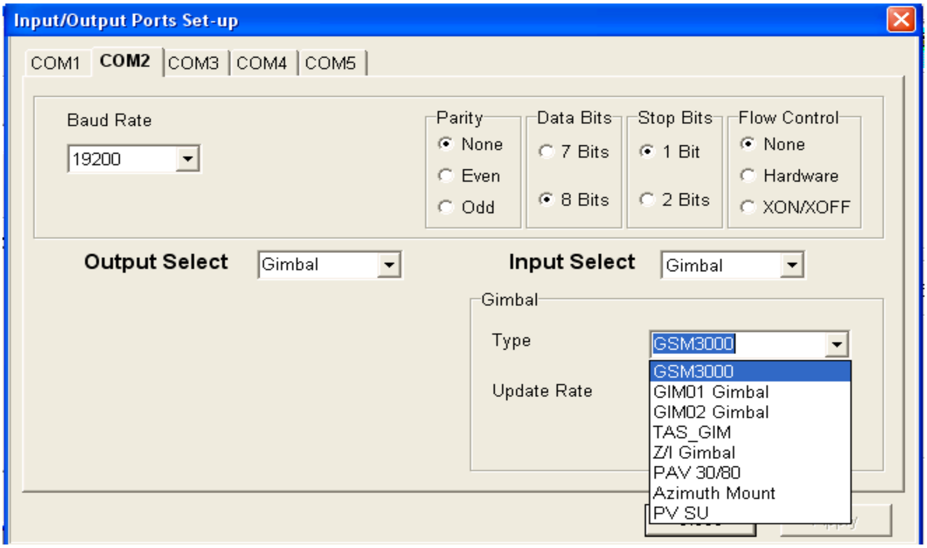


Figure 62: Gimbal Selection

9.0 Maintenance

Voltages present in the POS AV system are sufficient to cause serious injury or death.

Important:

1. Equipment shall be serviced only by qualified personnel.
2. The PCS shall be grounded via the safety ground screw.
3. Power to the POS system should be protected by a user-supplied, resettable circuit breaker

GNSS Antennas

Do not place metallized labels on the radome. Signal attenuation will result.

Keep the weatherable polymer antenna domes clean and free of decals. Once a year inspect the antennas for damaged surfaces and check the cables for loose connectors or frayed insulation. Replace any damaged components. No further maintenance is required.

Inertial Measurement Unit

Handle the IMU with care. The POS AV IMU contains components that may be damaged by shock. Do not drop or bump the IMU.

The IMU is a sealed unit and requires no maintenance. The Status light on the POS Computer System (PCS) front panel will be red or amber if the IMU has had a catastrophic failure. Connect to the PCS with AV POSView and check the **Faults** and **IMU Data** under **View** on the POSView tool bar item and **IMU** under the **Diagnostics** tool bar item. In case of failure inspect the IMU cable for damage. Contact Applanix Customer Support for assistance.

POS Computer System

The PCS requires minimal maintenance. Ideally, the PCS should be mounted in a vibration-isolated rack; if not, the PCS should be examined for vibration stress (such as loosened screws). Tighten all the screws and connectors. Inspect all the cables for wear or damage. Inspect the cable tie-downs to ensure that the cables are secure and out of the way.

10.0 Troubleshooting

Symptom	Cause	Solution
The System light turns red again after power-up	• This may indicate a failure in the PCS • Repeated instances of this light turning red are usually an indication of poor quality aircraft power	• Turn off the PCS power and turn it back on again after 5 seconds • A UPS is strongly recommended for POS AV installations
Open controller software and IP address of the POS is not automatically populated	Network problem	Make sure that IP addresses of the computer and POS are in the same range.
A Solid red light on the LOG DATA button is displayed	There is a problem writing to the USB drive	• Make sure that Applanix supplied USB drive is used • The drive is full • Replace the drive
Logging will not start from the 'LOG DATA' button	The button needs to be pressed for at least two seconds in order to start logging.	Refer to Data Logging – on page 6-3
GNSS not tracking satellites or unable to output a valid navigation solution	• GNSS receiver • Cable faults or bad connections • Damaged antenna	• First check the cables and all connection to the PCS • If there is no problem then reset the GNSS receiver, refer to GNSS Reset on page 4-19

APPENDICES

Appendix A

Technical Support and Service

Contact Applanix

Applanix Corporation

85 Leek Crescent

Richmond Hill, ON, Canada

L4B 3B3

Tel: (905) 709-4600

Fax: (905) 709-6027

Web site: http://www.applanix.com

How to Reach Technical Support

For technical support on POS regarding installation or operation, contact Applanix technical support at the numbers listed on our Web site. On the home page, select **Customer Support**. If voice communication is required, select the **Contact Customer Support** link. For general inquiries, please visit our Web site or call (905) 709-4600.

Returns

In the event that it becomes necessary to return any component of the POS system for repair, please follow the procedure below.

1. Call your Applanix Corporation Customer Support Representative and request a Return Material Authorization (RMA) number and shipping instructions.
2. Carefully disconnect and remove the part(s) to be returned.
3. Pack the part(s) to be returned in their original packing containers. If the original containers are not available, make sure the part(s) are packed in hard cases with shock and vibration protection. Applanix will not be responsible for damage to the parts during shipment.
4. Address shipping containers to:

    Applanix Corporation

    85 Leek Crescent

    Richmond Hill, ON, Canada

    L4B 3B3

    RMA #

    CANADIAN GOODS RETURNING FOR REPAIR

Please DO NOT ship any POS components to Applanix without an RMA number.

Appendix B

Message Log Definitions

The **Message Log** window is accessed from the AV POSView Controller main window by selecting ***View, Message Log*** on the menu bar. The following is a list of valid messages.

Message	Definition
Auxiliary GPS data gap cleared	Gap discontinued.
Auxiliary GPS data gap detected	Gap in GPS data. This is normal if it occurs for short periods.
Auxiliary GPS mode: differential	The attached auxiliary GPS receiver is operating in differential mode.
Auxiliary GPS mode: Float RTK	The attached auxiliary GPS receiver is operating in float RTK mode.
Auxiliary GPS mode: Narrow Lane RTK	The attached auxiliary GPS receiver is operating in narrow lane RTK mode.
Auxiliary GPS mode: P-Code	The attached auxiliary GPS receiver is operating in P-code mode.
Auxiliary GPS mode: Wide Lane RTK	The attached auxiliary GPS receiver is operating in wide lane RTK mode.
Auxiliary GPS position failure	Auxiliary GPS reports horizontal position error >1000 m. Problem will eventually correct itself.
Auxiliary GPS position failure cleared	Flag reset.
Auxiliary GPS position measurement rejected	Position reported between IMU and GPS is inconsistent. GPS lever arms are likely incorrect in installation data.
Auxiliary GPS position reject cleared	Flag reset.

Message	Definition
Auxiliary GPS solution in use	Data from the auxiliary GPS receiver is being used by the PCS.
Auxiliary GPS solution NOT in use	Data from the auxiliary GPS receiver is not being used by the PCS.
Bad GPS lever arm error	Primary GPS antenna lever arm values are invalid.
Bad GPS lever arm error cleared	Flag reset.
Coarse levelling active	Used to indicate when POS AV is in its coarse levelling routine that is used to find an estimate of local level. This routine is executed upon entering Navigate mode.
Coarse levelling complete	Successful completion of coarse levelling routine.
Coarse levelling failed	Indicates that the routine was unable to find a solution due to excessive vehicle motion.
Coarse levelling fail cleared	Flag reset.
Degraded navigation set	Indicates that POS AV is estimating heading; attitude performance is OK but not optimal.
Degraded navigation cleared	Flag reset.
Diagnostic mode	The system outputs user defined attitude values for roll, pitch and heading.
Ephemeris data gap detected	One or more expected ephemeris lists not received by the GPS receivers.
Ephemeris data gap cleared	Flag reset.
Fine align active	POS AV begins accurate algorithm to estimate vehicle heading.

Message	Definition
Free inertial mode set	POS entered the free inertial mode.
Free inertial mode cleared	POS returned to standard navigation mode from free inertial mode.
Full navigation set	Indicates everything OK, roll and pitch errors <4.5 arcmin.
Full navigation cleared	Flag reset.
Flag Reset	Status change.
GPS available for alignment	Flag reset.
GPS data gap cleared	Gap discontinued.
GPS data gap detected	Gap in GPS data. This is normal if it occurs for shot periods.
GPS Datum parameters corrected	GNSS Datum parameters corrected
GPS Datum parameters incorrect	GNSS Datum parameters incorrect
GPS excess resets	GNSS excess resets
GPS excess resets cleared	Flag reset
GPS in navigate mode	Receiver in Navigate mode.
GPS not available for alignment	POS AV failed to receive GPS data for >60 s.
GPS not in navigate mode	GPS receiver has not entered Navigate mode. Still searching for satellites.
GPS position failure	GPS reports horizontal position error >1000 m. Problem will eventually correct itself.
GPS position failure cleared	Flag reset.
GPS position measurement rejected	Position reported between IMU and GPS are inconsistent. Likely GPS lever arms are incorrect in installation data.

Message	Definition
GPS position measurement reject cleared	Flag reset.
GPS tracking elevation limit incorrect	GPS receiver is not configured.
GPS tracking elevation limit corrected	Flag reset.
GPS velocity failure	GPS reports speed >35 m/s. Problem will probably correct itself.
GPS velocity failure cleared	Flag reset.
GPS velocity measurement rejected	Velocity reported between IMU and GPS are inconsistent. Likely GPS lever arms are incorrect in installation data.
GPS velocity measurement reject cleared	Flag reset.
IMU failure	IMU status test failure set by IMU sensor.
IMU failure cleared	Flag reset.
IMU/POS checksum error	Error in data checksum between POS AV and IMU.
IMU/POS checksum error cleared	Flag reset.
Initial position invalid	Geographic position supplied by GPS is invalid.
Initial position valid	Geographic position supplied by GPS is valid.
Invalid mode	PCS error transitioning between Standby and Navigate modes.
AV POSView Controller out of resources, log cleared	Message Log deleted.
Multiple consecutive IMU failures	Communication problems between IMU and PCS. Check cable.

Message	Definition
Multiple consecutive IMU failures cleared	Flag reset.
Navigate mode	POS AV operating in Navigate mode.
Navigator alignment active	Indicates that the algorithm used to obtain a rough estimate of the vehicle's heading is active. If GPS is not available for more than 10 s, POS AV will return to coarse levelling.
Navigator alignment cleared	Flag reset.
No Primary GPS data	The PCS is not receiving data from the primary GPS receiver.
NVM read fail set	NVM fail. Parameters cannot be saved.
NVM read fail cleared	Flag reset.
NVM write fail	NVM write failed, try again.
NVM write successful	RAM parameters successfully saved to NVM.
PC Card logging device full	PC Card full.
PC Card logging disabled	PC Card logging disabled.
PC Card logging enabled	PC Card logging enabled.
PC Card logging file closed	PC Card logging stopped.
PC Card logging file open	PC Card logging started.
PC Card logging file write error	Error logging to PC Card.
PC Card logging file write error cleared	Flag reset.
POS Message Log	POS message log was accessed.
PPS time gap cleared	Gap discontinued.

Message	Definition
PPS time gap	Gap in PPS signal. This is normal if it occurs for shot periods.
Pri-Aux GPS difference of position exceeds limits	GPS receiver position data difference exceeds tolerance.
Pri-Aux GPS difference of position error cleared	Flag reset.
Primary GPS configuration file sent	File to configure GPS receiver for POS AV use was sent to receiver.
Primary GPS Initialization Failed	POS AV failed to receive initialization data from GPS.
Primary GPS Initialization Failed Cleared	Flag reset.
Primary GPS mode: C/A	GPS receiver in Stand-Alone operation - no differential corrections is being processed.
Primary GPS mode: differential	Primary GPS receiver is in differential mode.
Primary GPS mode: Float RTK	Primary GPS receiver is in float RTK mode.
Primary GPS mode: Narrow Lane RTK	Primary GPS receiver is in narrow lane RTK mode.
Primary GPS mode: Wide Lane RTK	Primary GPS receiver is in wide lane RTK mode.
Primary GPS not configured	Receiver did not respond to configuration message.
Primary GPS raw observable data gap detected	Primary GPS receiver data gap.
Primary GPS raw observable data gap cleared	Flag reset.
Primary GPS reset	GPS reset message sent to receiver to clear receiver problem.

Message	Definition
Primary GPS reset cleared	Flag reset.
Primary GPS solution in use	Primary GPS data are in use by the PCS.
Primary GPS solution NOT in use	Primary GPS data are not in use.
Quadrant resolved	POS AV has determined the heading of the vehicle to within one quadrant (i.e. 90 degrees).
Quadrant resolved cleared	Flag reset.
Secondary GPS data gap cleared	Gap discontinued.
Secondary GPS data gap detected	Gap in GPS data. This is normal if it occurs for short periods.
Secondary GPS raw observable data gap detected	Data gap detected in secondary GPS receiver.
Secondary GPS raw observable data gap cleared	Flag reset.
Secondary GPS solution in use	Secondary GPS data in use.
Secondary GPS solution NOT in use	Secondary GPS data not in use.
Speed out of range fault	Navigation algorithm speed is out of range (speed >35 m/s). Algorithm will reset itself.
Speed out of range fault cleared	Flag reset.
Standby mode	POS AV operating in Standby mode.
Strap down navigator initialized	POS AV completes coarse levelling and navigator begins running.
Strap down navigator initialized cleared	Flag reset.
Time Recovery message NOT received	UTC time of next PPS not received.
Time Recovery message received	UTC time of next PPS received.

Message	Definition
User attitude RMS performance cleared	Attitude accuracy threshold reset.
User attitude RMS performance set	Attitude accuracy threshold set.
User heading RMS performance cleared	Heading accuracy threshold reset.
User heading RMS performance set	Heading accuracy threshold set.
User position RMS performance cleared	Position accuracy threshold reset.
User position RMS performance set	Position accuracy threshold set.
User velocity RMS performance cleared	Velocity accuracy threshold reset.
User velocity RMS performance set	Velocity accuracy threshold set.
X Accel bias estimate out of range	The Kalman Filter's estimate of the X Accelerometer Bias is outside the allowable range of 4000 µg.
X Accel bias estimate error cleared	Flag reset.
X Gyro bias estimate out of range	The Kalman Filter's estimate of the X Gyro Bias is outside the allowable range of 20 deg/hr.
X Gyro bias estimate error cleared	Flag rest.
Y Accel bias estimate out of range	The Kalman Filter's estimate of the Y Accelerometer Bias is outside the allowable range of 4000 µg.
Y Accel bias estimate error cleared	Flag reset.
Y Gyro bias estimate out of range	The Kalman Filter's estimate of the Y Gyro Bias is outside the allowable range of 20 deg/hr.
Y Gyro bias estimate error cleared	Flag reset.

Message	Definition
Z Accel bias estimate out of range	The Kalman Filter's estimate of the Z Accelerometer Bias is outside the allowable range of 4000 µg.
Z Accel bias estimate error cleared	Flag reset.
Z Gyro bias estimate out of range	The Kalman Filter's estimate of the Z Gyro Bias is outside the allowable range of 20 deg/hr.
Z Gyro bias estimate error cleared	Flag reset.

Appendix C

AV POSView Controller Menu Options

Table 15: File Menu Options

File Submenu Selection	Lower Menu Selection	Description
Load POS Settings from PC		Loads installation settings and logging parameters for POS AV from the computer running AV POSView Controller
Store POS Settings on PC		Saves installation settings and logging parameters for POS AV to the computer running AV POSView Controller.
Save Message Log		Saves the Message Log file.
Exit (Alt + F4)		Exits AV POSView Controller. Pressing Alt+F4 or clicking on the Windows close button on the top right corner of the window will also exit AV POSView Controller.

Table 16: Settings Menu Options

Settings Submenu Selection	Lower Menu Selection	Description
Input/Output Ports		Selection of input and output variable setting for COM1 to COM5
Events		Sets trigger edge for event in marking, event guard time and PPS out pulse parameters.

Settings Submenu Selection	Lower Menu Selection	Description
Yaw Drift Correction		Provides input window for settings of the filter parameters (Desired Heading, Activation Threshold, Cut-off Period and Gain, selection between Follow Mean Track and Follow Desired Heading). Settings for the on/off mount stabilization.
Integrated DGPS		OmniStar Settings
Ethernet Real Time Port		Group output selectionfor Ethernet real time port 1 and 2.
Installation	Lever Arms & Mounting	Provides input window for measured lever arms and mounting angle values. Gives access to Lever Arms, Mounting Angles.
	Tags, Multipath & AutoStart	Provides access to Time and Distance Tag settings and whether AutoStart feature is enabled or disabled.
	GNSS Receiver	GNSS receiver settings.
	User Accuracy	Accuracy threshold settings used for Main Window accuracy indicators.
	POS IP Address	IP Address setting.
Display Port		Manual Control of messages sent out over the display port.
Save Settings		Saves installation settings to the PCS.
Restore Settings	User Settings	Allows restoration of previously saved settings.

Settings Submenu Selection	Lower Menu Selection	Description
	Factory Default	Allows restoration of the factory default settings.

Table 17: Logging Menu Options

Logging Submenu Selection	Lower Menu Selection	Description
Ethernet Logging		Configure and control Ethernet logging.
Removable Logging Media		Configure and control Removable Logging Media.

⚠ **Logging high rate data to both an Ethernet port and a USB flash drive simultaneously can overload POS AV and result in a loss of data.**

Table 18: View Menu Options

View Submenu Selection	Lower Menu Selection	Description
Message Log		Displays the Message Log file.
Sensor Navigation		Displays the Navigation solution that is valid in the Reference and Sensor body frames.
GNSS Data		Displays status of GNSS satellites tracked.
IIN Solution		Displays status of the blended navigation solution.
GNSS & Nav Data		Displays status of GNSS satellites tracked and status of the blended navigation solution.
IMU Data		Displays IMU data.
Event Data		Displays event counts for all events.

View Submenu Selection	Lower Menu Selection	Description
Faults		Displays POS AV faults.
Statistics		Displays POS AV loading statistics. Also displays system information such as serial numbers, software versions and run time.
Gimbal Data		Displays time tagged current gimbal orientation data (roll, tilt, pan, time).
Yaw Drift Correction		Displays current yaw drift correction value and status.
Position Plot		Plots reference body frame origin of current position on a latitude/longitude map.
Integrated DGPS		Displays the OmniStar information (subscription status, satellite information)
Command Reply		Displays log of confirmations or rejections of commands received by POS AV from AV POSView Controller (Transaction number, message ID, Response, New, Parameter).

Table 19: Tools Menu Options

Tools Submenu Selection	Lower Menu Selection	Description
Options		User preferences.
Configuration		Allows manual configuration of the navigation data integration.
Configure GNSS		Sends commands to configure the receivers.
Reset GNSS		Sends commands to reset the receivers.

Tools Submenu Selection	Lower Menu Selection	Description
Reset		Reset is equivalent to cycling the PCS power, with the exception that GNSS, IMU data are available immediately after reset; do not use unless POS AV exhibits inexplicable behaviour and all other options have been exhausted (e.g. Cables and Connectors checked for shorts or failures).
Shutdown		File systems are synchronized; Prepares POS AV for power-off.
Delete Files		Deletes files from logging media

Table 20: Diagnostic Menu

System Submenu Selection	Lower Menu Selection	Description
Primary GNSS		Displays connectivity status of the Primary GNSS.
Secondary GNSS		Displays connectivity status of the Secondary GNSS.
Aux GNSS		Displays connectivity status of the auxiliary GNSS receivers.
Control Port		Displays statistics on the Ethernet control port.
Display, Data and NVM		Displays statistics on the Ethernet Display, Data Port 1 (real-time) and Ethernet Logging Port (buffered) and on the Non-Volatile memory (NVM).
Time & Pulses		Displays statistics on POS timing, discrete data pulses.

System Submenu Selection	Lower Menu Selection	Description
IMU		Displays statistics on raw IMU data.
NMEA & Binary Output		Displays statistics on COM port facilities.
Other		Displays statistics on other system functions.

Table 21: Help Menu Options

Help Submenu Selection	Lower Menu Selection	Description
About		Lists information about POS AV Controller.

Appendix D

AV POSView Controller Status Pane Messages

Table 22: POS Mode Indicator

POS Mode Message	Description
Navigate	POS AV is operating in navigate mode.
Levelling Failed	POS AV was unable to determine vehicle orientation (roll and pitch). This is usually due to gaps in GNSS data or receipt of incorrect GNSS data from receivers.
Levelling Active	POS AV is in process of determining vehicle orientation.
Nav: Degraded	POS AV is operating in degraded navigation mode. Roll and pitch errors are greater than 0.05 degree.
Nav: Full	POS AV is operating in full navigation mode. Roll and pitch errors are less that 0.075 degree.
Nav: Aligned	POS AV is operating in heading aligned mode. Heading error is below 10 degrees and being continuously improved.
S/D Initialized	Strapdown navigator is initialized.

Table 23: IMU Status Indicator

IMU Status Message	Description
OK	IMU functioning correctly.
Warning	IMU not functioning properly. Power-down, disconnect IMU and contact Applanix Customer Support.

IMU Status Message	Description
Failure	IMU not functioning properly. Power-down, disconnect IMU and contact Applanix Customer Support.

Table 24: GNSS Status Indicator

GNSS Status Message	Description
DR	The system provides a navigate solution without GNSS aiding.
GPS NAV	IIN GNSS aiding is loosely coupled.
Pri C/A	The GNSS receivers are providing positional data without differential correction.
Pri DGPS	The GNSS receivers are providing positional data enhanced by real-time differential correction.
Pri FLOAT RTK	Real-time positional data are being generated with float ambiguity resolution.
Pri FIXED RTK	Real-time positional data are being generated with fixed ambiguity resolution.
Aux. Data Gap	Aux receiver Data Gap
Aux. NL RTK	The auxiliary GNSS receiver is providing real-time positional data using narrow lane ambiguity resolution.
Aux. WL RTK	The auxiliary GNSS receiver is providing real-time positional data using wide lane ambiguity resolution.
Aux. Float RTK	The auxiliary GNSS receiver is providing real-time positional data using float ambiguity resolution.
Aux. DGPS	The auxiliary GNSS receiver is providing positional data enhanced by a differential correction signal.
Aux. C/A	The auxiliary GNSS receiver is providing positional data without differential correction.

Table 25: Gimbal Status Indicator

Gimbal Status Message	Description
On: OK	Gimbal port is enabled and data are available.
On: Not in Use	Gimbal port is enabled, but data are not used in real-time. Usually related to a timing issue.
On: Data Gap	Gimbal port is enabled, but there is no data.
Off	Gimbal port is disabled.

Table 26: Logging Media Status Indicator

PC Card Status Message	Description
Idle	Logging Media is not currently in use.
Buffering	PCS is buffering data in preparation for data logging.
Writing	Data are being logged on the media
Device Full	Media is full.
Write Error	Error occurred while attempting to write on the Logging media. Ensure that disk is correctly inserted into drive and that disk is not full. This message may also appear if disk is damaged.
Invalid	Disk in logging device is not compatible.

Appendix E

Tait-Bryan Sequence

Locate the X1, Y1 and Z1 axis and the XY, YZ, ZX planes of the IMU reference frame. Locate the user frame axis X2, Y2, Z2 (Figure 63). To bring the IMU into alignment with the user frame, rotate the user frame about its Z2 axis until the Y2 axis is in the YZ plane of the IMU (Figure 64). Rotate the user frame about its Y2 axis (already once rotated), until the X2 axis direction is parallel to the X1 axis direction. Rotate the user frame about its X2 axis (already twice rotated) until the Y2 axis is parallel to the Y1 axis.

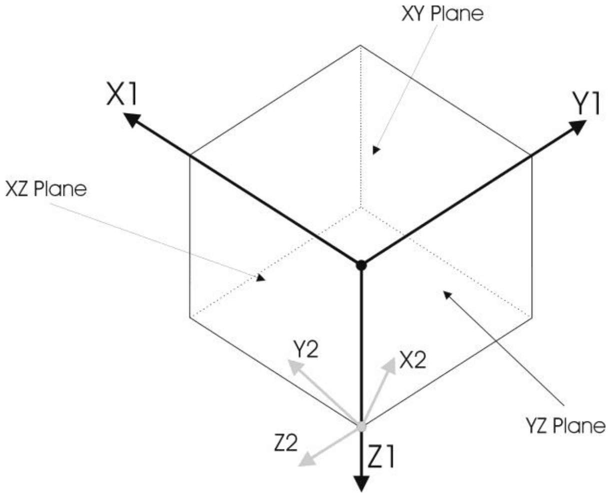
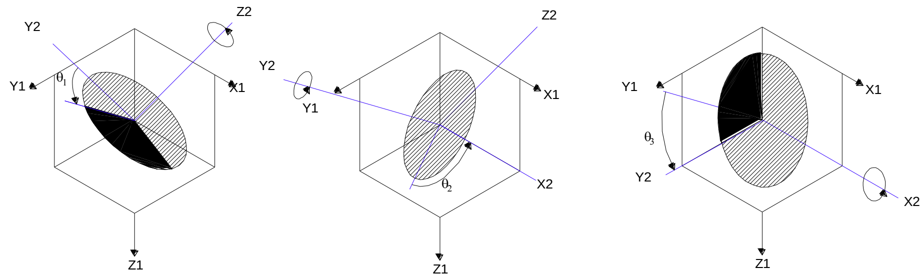


Figure 63: Tait-Bryan Planes and Axis



This indicates the area of the circle defined by the angle θ that is in front of the 3D matrix.

This indicates the area of the circle defined by the angle θ that is behind the 3D matrix.

Figure 64: Tait-Bryan Rotations Diagram

Yaw is the angle θ_1 from the first rotation. Pitch is the angle θ_2 from the second rotation and Roll is the third rotation angle θ_3, shown in the diagram above.

Appendix F

COM Ports Message Format

NMEA and Binary Message Formats

Note: Multiple NMEA messages can be output simultaneously on a given COM port, but only one Binary message can be output at a time on a given COM port. The string tt represents the ID that is user settable form AV POS View Controller as “GP” or “IN”. Please refer to Figure 65 corresponding settings.

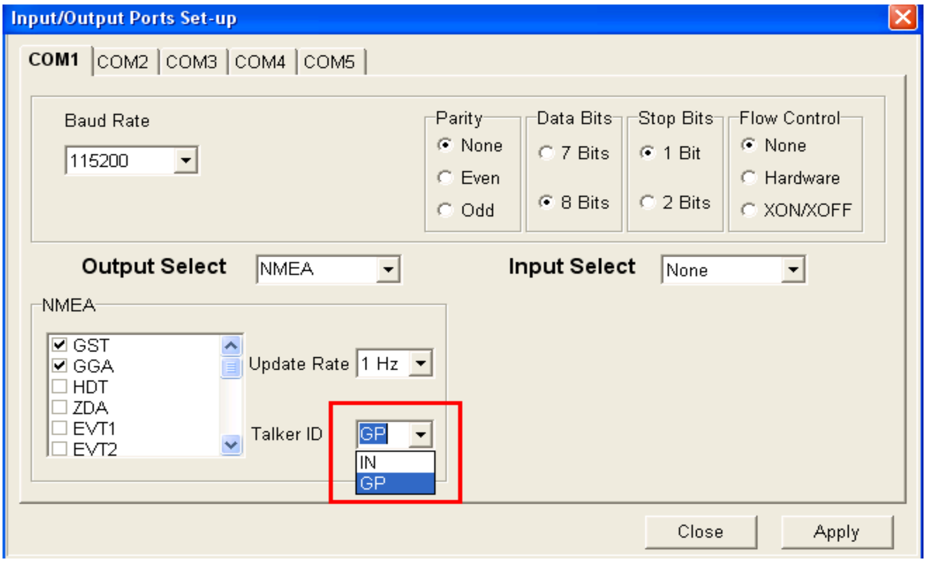


Figure 65: Talker ID

NMEA Checksum Field

The checksum field is transmitted in all sentences, is the last field in a sentence and follows the checksum delimiter character ‘*’. It is the 8-bit exclusive OR (no start or stop bits) of all the characters in a sentence, including the ‘**,**’ delimiters, between but not including the ‘$’ and the ‘*****’ delimiters. The hexadecimal value of the most significant and the least significant 4 bits of the result is converted to two ASCII characters (0-9, A-F) for transmission; the most significant character is transmitted first.

NMEA Port GST Message Format

The GST pseudo range measurement noise statistics data are translated in the position domain in order to give statistical measures of quality of the position solution.

It is output in the following ASCII NMEA format:

Table 27: NMEA GST Message Format

$ttGST,hhmmss.sss,,ssss.s,,ssss.s,ooo.o,l.l,y.y,a.a*hh<CR><LF>

Item	Definition	Value	Units
$ttGST	Header with talker ID	$ttGST	tt = IN or GP
hhmmss.sss	UTC time of position	NRG	hours / minutes / seconds. decimal seconds
Null	Not supported	Null	N/A
ssss.s (-ssss.s)	Standard deviation of semi- major axis of error ellipse	NRG	metres
ssss.s (-ssss.s)	Standard deviation of semi-minor axis of error ellipse	NRG	metres
ooo.o	Orientation of semi-major axis of error ellipse	0 to 359.9	degrees from True North
l.l (-llll.l)	Standard deviation of latitude	NRG	metres

Table 27: NMEA GST Message Format

$ttGST,hhmmss.sss,,ssss.s,,ssss.s,ooo.o,l.l,y.y,a.a*hh<CR><LF>

Item	Definition	Value	Units
y.y (-yyyy.y)	Standard deviation of longitude	NRG	metres
a.a (-aaa.a)	Standard deviation of altitude	NRG	metres
*hh	Checksum	Hexadecimal value (NRG)	N/A
<CR><LF>	Carriage return & line feed	<CR><LF>	N/A

NRG stands for No Range Given.

Note: In the case of the all fields except Orientation, Checksum and UTC time of position, leading digits are added as required (i.e. if the value exceeds 9.9).

NMEA Port GGA Message Format

The GGA position data are output in the following ASCII NMEA format:

Table 28: NMEA GGA Message Format

$ttGGA,hhmmss.sss,llll.lllll,a,yyyyy.yyyyy,b,t,nn,v.v,x.x,M,,,cc.c,rrrr*hh<CR><LF>

Item	Definition	Value	Units
$ttGGA	Header with talker ID	$ttGGA	tt = IN or GP
hhmmss.sss	UTC time of position	NRG	hours / minutes / seconds. decimal sec
llll.lllll	Latitude	0° to +90°	degrees / minutes. decimal min
a	N (North) or S (South)	N or S	N/A

Table 28: NMEA GGA Message Format

$ttGGA,hhmmss.sss,llll.lllll,a,yyyyy.yyyyy,b,t,nn,v.v,x.x,M,,,cc.c,rrrr*hh<CR><LF>

Item	Definition	Value	Units
yyyyy.yyyyy	Longitude	0° to +180°	degrees / minutes. decimal min
b	E (East) or W (West)	E or W	N/A
t	GPS Quality Indicator	0 to 8 (see Table 29)	N/A
nn	Number of Satellites used in the fix	0 to 32	N/A
v.v	HDOP	NRG	N/A
xxxx.xx	Altitude of the IMU above or below mean sea level; a leading “-” indicates below	NRG	metres
M	Units of Measure = metres	M	N/A
null	Geoidal Separation = (WGS-84 Earth ellipsoid- mean sea level); a leading “-” indicates below	NRG	metres
null	Units of Measure = metres	M	N/A
cc.c (null if not DGPS mode)	Age of differential corrections in seconds since last RTCM-104 message.	0 to 99.9	seconds
rrrr (null if not DGPS mode)	DGPS reference station ID	0000 to 1023	N/A
*hh	Checksum	Hexadecimal value (NRG)	N/A
<CR><LF>	Carriage return & line feed	<CR><LF>	N/A

NRG stands for No Range Given.

Note: In the case of the HDOP and IMU Altitude, leading digits are added as required (i.e. if the value exceeds 9.9).

Table 29: GPS Quality Indicator Values

Value	GPS Mode
0	Fix not available or invalid
1	GPS SPS mode, fix available
2	Differential GPS, SPS mode fix valid
3	GPS PPS mode, fix valid (not supported)
4	RTK Satellite system used in RTK mode with Fixed integers
5	Float RTK satellite system used in RTK mode with floating integers
6	Estimated (dead reckoning) mode
7	Manual Input mode (Not Supported)
8	Simulated mode (Not Supported)

NMEA Port HDT Message Format

The HDT heading data are output in the following ASCII NMEA format:

Table 30: NMEA HDT Message Format

$ttHDT,xxx.x,T*hh<CR><LF>

Item	Definition	Value	Units
$ttHDT	Header with talker ID	$ttHDT	tt = IN or GP
xxx.x	True vehicle heading	0 to 359.9	degrees. decimal degrees
T	True	T	N/A

Table 30: NMEA HDT Message Format

$ttHDT,xxx.x,T*hh<CR><LF>

Item	Definition	Value	Units
*hh	Checksum	Hexadecimal value (NRG)	N/A
<CR><LF>	Carriage return & line feed	<CR><LF>	N/A

NRG stands for No Range Given.

NMEA Port ZDA Message Format

The ZDA provides time and date information. It is output in the following ASCII NMEA format:

Table 31: NMEA ZDA Message Format

$ttZDA,hhmmss.sss,dd,mm,yyyy,,*hh<CR><LF>

Item	Definition	Value	Units
$ttZDA	Header with talker ID	$ttZDA	tt = IN or GP
hhmmss.sss	UTC time of data string	NRG	Hours / minutes / seconds. decimal sec
dd	Day of the month	01 to 31	N/A
mm	Month of the year	01 to 12	N/A
yyyy	Year	1993 to 9999	N/A
Null	Local time zone hours		Hours (not supported)
Null	Local time zone minutes		Minutes (not supported)
*hh	Checksum	Hexadecimal value (NRG)	N/A

Table 31: NMEA ZDA Message Format

$ttZDA,hhmmss.sss,dd,mm,yyyy,,*hh<CR><LF>

Item	Definition	Value	Units
<CR><LF>	Carriage return and line feed	<CR><LF>	N/A

NRG stands for No Range Given.

NMEA Port $EVT1 and $EVT2 Message Format

$EVT1 and $EVT2 provides event timing. Although not NMEA 0183 messages, each event time message is compatible with the standard. The following identifies their output ASCII format:

Table 32: $EVT1 Message Format

$EVT1,ssssss.ssssss,t,xxxxxxxx,*hh<CR><LF>

Item	Definition	Value	Units
$EVT1	Header	$EVT1	N/A
ssssss. ssssss	UTC time of data string	N/A	seconds. decimal seconds of the week (variable length)
t	Time tag	G or U	GPS or UTC time
xxxxxxxx	Event counter	0 to 999999	N/A
*hh	Checksum	Hexadecimal value (NRG)	N/A
<CR><LF>	Carriage return and line feed	<CR><LF>	N/A

Table 33: $EVT2 Message Format

$EVT2,ssssss.ssssss,t,xxxxxxxx,*hh<CR><LF>

Item	Definition	Value	Units
$EVT2	Header	$EVT2	N/A
ssssss. ssssss	UTC time of data string	N/A	seconds. decimal seconds of the week (variable length)
t	Time tag	G or U	GPS or UTC time
xxxxxxxx	Event counter	0 to 999999	N/A
*hh	Checksum	Hexadecimal value (NRG)	N/A
<CR><LF>	Carriage return and line feed	<CR><LF>	N/A

NMEA Port VTG Message Format

The VTG track and speed data are output in the following ASCII NMEA format:

Table 34: NMEA VTG Message Format

$ttVTG,xxx.x,T,,M,n.n,N,k.k,K*hh<CR><LF>

Item	Definition	Value	Units
$ttVTG	Header with talker ID	$ttVTG	tt = IN or GP
xxx.x	True vehicle track	0 to 359.9	degrees. decimal degrees
T	True	T	N/A
Null	Not supported	Null	N/A

Table 34: NMEA VTG Message Format

$ttVTG,xxx.x,T,,M,n.n,N,k.k,K*hh<CR><LF>

Item	Definition	Value	Units
M		M	N/A
n.n (-nnnn.n)	Speed	NRG	knots
N	Knots	N	N/A
k.k (-kkkk.k)	Speed	NRG	km/hr
K	Kilometres	K	N/A
*hh	Checksum	N/A	N/A
<CR><LF>	Carriage return & line feed	<CR><LF>	N/A

NRG stands for No Range Given.

Note: In the case of the speed fields, leading digits are added as required (i.e. if the value exceeds 9.9 or is negative).

NMEA $PASHR Message Format

The $PASHR provides attitude data. It is output in the following ASCII NMEA format:

Table 35: NMEA $PASHR Message Format

$PASHR,hhmmss.sss,xxx.xx,T,RRR.RR,PPP.PP,HHH.HH,
a.aaa,b.bbb,c.ccc,d,e,*hh<CR><LF>

Item	Definition	Value	Units
$PASHR	Header	$PASHR	N/A
hhmmss.sss	UTC time of data string	N/A	Hours / minutes / seconds. decimal sec
xxx.xx	True Heading	0 to 359.99	degrees. decimal degrees

Table 35: NMEA $PASHR Message Format

$PASHR,hhmmss.sss,xxx.xx,T,RRR.RR,PPP.PP,HHH.HH,
a.aaa,b.bbb,c.ccc,d,e,*hh<CR><LF>

Item	Definition	Value	Units
T	True	T	N/A
RRR.RR	Roll	-90.00 to +90.00	degrees
PPP.PP	Pitch	-90.00 to +90.00	degrees
HHH.HH	Heading (Not supported)	0 to 359.99	degrees
a.aaa	Roll accuracy	0 to 9.999	degrees
b.bbb	Pitch accuracy	0 to 9.999	degrees
c.ccc	Heading accuracy	0 to 9.999	degrees
d	Flag: GPS quality	0, 1 or 2	0 = no aiding 1 = GPS aiding 2 = GPS & GAMS aiding
e	Flag: IMU state	0 or 1	0 = IMU bad 1 = IMU ok
*hh	Checksum	Hexadecimal value (NRG)	N/A
<CR><LF>	Carriage return and line feed	<CR><LF>	N/A

NRG stands for No Range Given.

NMEA PORT GGA2 Message Format

The GGA2 position data are output in the following ASCII NMEA format:

Table 36: NMEA GGA2 Message Format

$ttGGA,hhmmss.ss,llll.llll,a,yyyyy.yyyy,b,t,nn,v.v,xxxx.x,m,
gggg.g,m,ccc,rrrr*hh<CR><LF>

Items	Definition	Values	Units
$ttGGA2	Header with talker ID	$ttGGA	tt = IN or GP
hhmmss.ss	UTC Time of position	NRG	hours / minutes / seconds. decimal sec
llll.llll	Latitude	0º to 90º	degrees / minutes. decimal min
a	N (North) or S (South)	N or S	N/A
yyyyy.yyyy	Longitude	0º to 180º	degrees / minutes. decimal min
b	E (East) or W (West)	E or W	N/A
t	GPS Quality Indicator	0 to 8 (see Table 32)	N/A
nn	Number of Satellites used in the fix	0 to 32	N/A
v.v	HDOP	NRG	N/A
xxxx.x	Altitude of IMU above or below mean sea level; a leading “-“ indicates below	NRG	metres
m	Units of Measure = metres	M	N/A

Table 36: NMEA GGA2 Message Format

$ttGGA,hhmmss.ss,llll.llll,a,yyyyy.yyyy,b,t,nn,v.v,xxxx.x,m,
gggg.g,m,ccc,rrrr*hh<CR><LF>

Items	Definition	Values	Units
gggg.g	Geoidal Separation = (WGS-84 Earth Ellipsoid-mean sea level); a leading "-" indicates below	NRG	metres
m	Units of Measure = metres	M	N/A
ccc (null if not DGPS mode)	Age of differential corrections in second since last RTCM-104 message	0 to 999	seconds
rrrr (null if not DGPS mode)	DGPS reference station ID	0000 to 1023	N/A
*hh	Checksum	Hexadecimal value (NRG)	N/A
<CR><LF>	Carriage return & Line feed	<CR><LF>	N/A

NRG stands for No Range Given.

Note: In the case of the HDOP and IMU Altitude, leading digits are added as required (i.e. if the value exceeds 9.9).

NMEA Port PPS Message Format

The PPS data are output in the following ASCII NMEA format:

Table 37: NMEA PPS Message Format

$ttPPS,hhmmss.ss,dddddd,wwwwww,fff.ff,pppppp,*hh<CR><LF>

Items	Definition	Values	Units
$ttPPS	Header with talker ID	$ttPPS	tt = IN or GP
hhmmss.ss	UTC time of PPS	NRG	hours / minutes / seconds. decimal sec
dddddd	Day offset	NRG	days
wwwwww	GPS week	NRG	weeks
fff.ff	UTC time offset	NRG	seconds
pppppp	PPS count	NRG	N/A
*hh	Checksum	Hexadecimal value (NRG)	N/A
<CR><LF>	Carriage return & Line feed	<CR><LF>	N/A

NRG stands for No Range Given.

NMEA Port GGK Message Format

The GGK position data are output in the following ASCII NMEA format:

Table 38: NMEA GGK Message Format

$ttGGK,hhmmss.sss,ddmmyy,llll.lllll,a,yyyyy.yyyy,b,t,nn,v.v,
EHTxxxx.xx,m*hh<CR><LF>

Items	Definition	Values	Units
$ttGGK	Header with talker ID	$ttGGK	tt = IN or GP
hhmmss.sss	UTC time	NRG	hours / minutes / seconds. decimal sec
ddmmyy	UTC Date	NRG	day / month / year

Table 38: NMEA GGK Message Format

$ttGGK,hhmmss.sss,ddmmyy,llll.lllll,a,yyyyy.yyyy,b,t,nn,v.v,
EHTxxxx.xx,m*hh<CR><LF>

Items	Definition	Values	Units
llll.lllll	Latitude	0^o to 90^o	degrees / minutes. decimal min
a	N (North) or S (South)	N or S	N/A
yyyyy.yyyy	Longitude	0^o to 180^o	degrees / minutes. decimal min
b	E (East) or W (West)	E or W	N/A
t	GPS Quality Indicator	0 to 8 (See Table 32)	N/A
nn	Number of Satellites used in fix	0 to 32	N/A
v.v	PDOP	NRG	N/A
EHTxxxx.xx	Ellipsoidal height	EHTxxxx.xx	metres
m	Units of measure = metres	M	N/A
*hh	Checksum	*hh	N/A
<CR><LF>	Carriage return & Line feed	<CR><LF>	N/A

NRG stands for No Range Given

NMEA Port RMC Message Format

The RMC navigation data are output in the following ASCII NMEA format:

Table 39: NMEA RMC Message Format

$ttRMC,hhmmss.ssss,v,llll.lllll,a,yyyyy.yyyyy,b,sssss.s,
hhh.h,ddmmyy,,,c*hh<CR><LF>

Items	Definition	Values	Units
$ttRMC	Header with talker ID	$ttRMC	tt = IN or GP
hhmmss.ssss	UTC time of navigation data	NRG	hours / minutes / seconds. decimal sec
v	A (Valid) or V (Not valid)	A or V	N/A
llll.lllll	Latitude	0º to 90º	degrees / minutes. decimal min
a	N (North) or S (South)	N or S	N/A
yyyyy.yyyyy	Longitude	0º to 180º	degrees / minutes. decimal min
b	E (East) or W (West)	E or W	N/A
sssss.s	Speed in knots	NRG	knots
hhh.h	Heading	0º to 359.9º	degrees
ddmmyy	Date of navigation data	NRG	days/ months/ year
c	Mode indicator	See Table 43	N/A
*hh	Checksum	Hexadecimal value	N/A
<CR><LF>	Carriage return & Line feed	<CR><LF>	N/A

NRG stands for No Range Given.

Table 40: RMC Mode Indicator Values

Value	777777RMC Mode
a	Autonomous
d	Differential
e	Dead reckoning
n	Not valid

NMEA Port $PAPLEVT1 and $PAPLEVT2 Message Format

The event based navigation solution is available for output only if the real time software option EVO-11 is enabled.

The event-based Event1/2 messages, contain position and attitude information at the time of the event 1 and event2 pulse occurrence. All navigation parameters are computed in reference frame using the following ASCII NMEA format:

Table 41: $PAPLEVT1 Message Format

$PAPLEVT1**,** ssssss.ssssss,t,cccccccc,llll.lllll,a,yyyyy.yyyyy,b,xxxx.xx, M,gg.ggg,M,rrr.rr,ppp.pp,hhh.hh*hh<CRLF>

Item	Definition	Value	Units
$PAPLEVT1	Header	$PAPLEVT1	N/A
ssssss. ssssss	Time of Validity	NRG	seconds. decimal seconds of week
t	Time tag	G or U	GPS or UTC time
cccccccc	Event counter	0 to 99999999	N/A

Table 41: $PAPLEVT1 Message Format

$PAPLEVT1**,** ssssss.ssssss,t,cccccccc,llll.lllll,a,yyyyy.yyyyy,b,xxxx.xx,
M,gg.ggg,M,rrr.rr,ppp.pp,hhh.hh*hh<CRLF>

Item	Definition	Value	Units
llll.lllll	Latitude	0° to +90°	degrees / minutes. decimal minutes
a	N (North) or S (South)	N or S	N/A
yyyyy.yyyyy	Longitude	0° to +180°	degrees / minutes. decimal minutes
b	E (East) or W (West)	E or W	N/A
xxxx.xx	Altitude of the IMU above or below mean sea level; a leading "-" indicates below mean sea level	NRG	metres
M	Units of measure	M	metres
gg.ggg	Geoidal Separation = WGS-84 Earth ellipsoid mean sea level; a leading "-" indicates below mean sea level	NRG	metres
M	Units of measure	M	metres
rrr.rr	Roll	-90.00 to +90.00	degrees
ppp.pp	Pitch	-90.00 to +90.00	degrees
hhh.hh	Heading	0 to 359.99	degrees

Table 41: $PAPLEVT1 Message Format

$PAPLEVT1**,** ssssss.ssssss,t,cccccccc,llll.lllll,a,yyyyy.yyyyy,b,xxxx.xx,
M,gg.ggg,M,rrr.rr,ppp.pp,hhh.hh*hh<CRLF>

Item	Definition	Value	Units
*hh	Checksum	Hexadecimal value (NRG)	N/A
<CRLF>	Carriage return & line feed	<CRLF>	N/A

NRG stands for No Range Given.

Note: In the case of the HDOP and IMU Altitude, leading digits are added as required (i.e. if the value exceeds 9.9).

Table 42: $PAPLEVT2 Message Format

$PAPLEVT2**,** ssssss.ssssss,t,cccccccc,llll.lllll,a,yyyyy.yyyyy,b,xxxx.xx,
M,gg.ggg,M,rrr.rr,ppp.pp,hhh.hh*hh<CRLF>

Item	Definition	Value	Units
$PAPLEVT2	Header	$PAPLEVT2	N/A
ssssss. ssssss	Time of Validity	NRG	seconds. decimal seconds of week
t	Time tag	G or U	GPS or UTC time
cccccccc	Event counter	0 to 99999999	N/A
llll.lllll	Latitude	0° to +90°	degrees / minutes. decimal minutes
a	N (North) or S (South)	N or S	N/A
yyyyy.yyyyy	Longitude	0° to +180°	degrees / minutes. decimal minutes
b	E (East) or W (West)	E or W	N/A

Table 42: $PAPLEVT2 Message Format

$PAPLEVT2**,** ssssss.ssssss,t,cccccccc,llll.lllll,a,yyyyy.yyyyy,b,xxxx.xx,
M,gg.ggg,M,rrr.rr,ppp.pp,hhh.hh*hh<CRLF>

Item	Definition	Value	Units
xxxx.xx	Altitude of the IMU above or below mean sea level; a leading “-” indicates below mean sea level	NRG	metres
M	Units of measure	M	metres
gg.ggg	Geoidal Separation = WGS-84 Earth ellipsoid mean sea level; a leading “-” indicates below mean sea level	NRG	metres
M	Units of measure	M	metres
rrr.rr	Roll	-90.00 to +90.00	degrees
ppp.pp	Pitch	-90.00 to +90.00	degrees
hhh.hh	Heading	0 to 359.99	degrees
*hh	Checksum	Hexadecimal value (NRG)	N/A
<CRLF>	Carriage return & line feed	<CRLF>	N/A

NRG stands for No Range Given.

Note: In the case of the HDOP and IMU Altitude, leading digits are added as required (i.e. if the value exceeds 9.9).

Binary Output Port Position, Attitude, Speed, Track and Acceleration Output: PAST2 Message Format

PAST2 is a 40-byte message containing time, position, attitude, speed, track and acceleration of the Reference Frame. Unlike some of the other COM (2) messages, it also contains a checksum.

A description of the output message is given in the following table:

Table 43: PAST2 Message Format

Item	Byte	Format	Value	Units
Header LSB	0	Byte	0x00	N/A
Header MSB	1	Byte	0x96	N/A
Time of Validity	2-9	Double	UTC seconds of the week or elapsed seconds if GPS not available	seconds
Roll LSB	10	Byte	LSB: 0.01° Range: ± 180°	degree/bit
Roll MSB	11	Byte		
Pitch LSB	12	Byte	LSB: 0.01° Range: ± 180°	degree/bit
Pitch MSB	13	Byte		
Heading LSB	14	Byte	LSB: 0.01° Range: 0° to 359.99°	degree/bit
Heading MSB	15	Byte		
Latitude	16-19	Long	LSB: 0.001 arcsec Range: -90° to + 90°	arcsec/bit
Longitude	20-23	Long	LSB: 0.001 arcsec -180° to + 180°	arcsec/bit
Altitude	24-27	Long	LSB: 0.01m Range: -1000.0 m to 20000 m	m/bit
Speed LSB	28	Byte	LSB: 0.01m/s	m/s/bit

Table 43: PAST2 Message Format

Item	Byte	Format	Value	Units
Speed MSB	29	Byte	Range: 0 to 300 m/s	
Track LSB	30	Byte	LSB: 0.01° Range: 0° to 359.99°	deg/bit
Track MSB	31	Byte		
Long Accel LSB	32	Byte	LSB: 0.0005 m/s^2	m/s^2/bit
Long Accel MSB	33	Byte		
Tran Accel LSB	34	Byte	LSB: 0.0005 m/s^2/bit	m/s^2/bit
Tran Accel MSB	35	Byte		
Down Accel LSB	36	Byte	LSB: 0.0005 m/s^2	m/s^2/bit
Down Accel MSB	37	Byte		
Checksum LSB	38	Byte	N/A	N/A
Checksum MSB	39	Byte		

Checksum calculation: Bytes 0 & 1 are ignored. Bytes 2 to 37 are added. Bytes 38 & 39 contain the checksum.

Binary Output Port RDR1 Message Format

The RDR message outputs sensor position and orientation for Land Radar applications.

Table 44: RDR1 Message Format

Item	Byte	Format	Value	Units
Header LSB	0	Byte	0x55	N/A
Header MSB	1	Byte	0xBB	N/A
Byte Count	2-3	Short	46	N/A
SIDC	4	Byte	0x03	N/A

Table 44: RDR1 Message Format

Item	Byte	Format	Value	Units
SIDC	5	Byte	IP Address	N/A
MIDC – LSB	6	Byte	0x00	N/A
MIDC - MSB	7	Byte	0x8B	N/A
Date – Day	8	Byte		N/A
Date – Month	9	Byte		N/A
Date - Year	10-11	Short		N/A
Time	12-19	Double		seconds
Roll - MSB	20	Byte	LSB: 0.005495	deg/bit
Roll – LSB	21	Byte	LSB: 0.005495	deg/bit
Pitch – MSB	22	Byte	LSB: 0.005495	deg/bit
Pitch – LSB	23	Byte	LSB: 0.005495	deg/bit
Heading – MSB	24	Byte	LSB: 0.005495	deg/bit
Heading - LSB	25	Byte	LSB: 0.005495	deg/bit
Latitude	26-29	Long	LSB: 0.00035	arcsec/bit
Longitude	30-33	Long	LSB: 0.00035	arcsec/bit
Altitude	34-37	Long	LSB: 0.01	m/bit
Status A	38-41	Bits	As per ICD – general status A	
Status B	42-45	Bits	As per ICD – general status B	
CRC	46-47	Short		N/A

CRC calculation: Bytes 0 & 1 are ignored. Bytes 2 to 45 are added. Bytes 46 (MSB) & 47 (LSB) contain the CRC.

Binary Output PPS Message Format

PPS is a 24-byte message containing time, UTC offset, week number and PPS count.

A description of the output message is given in the following table:

Table 45: PPS Message Format

Item	Byte	Format	Value	Units
Header LSB	0	Byte	0x00	N/A
Header MSB	1	Byte	0x99	N/A
PPS Time	2-9	Double	UTC seconds of the week or elapsed seconds if UTC not available	seconds
Week	10-13	Int		N/A
UTC offset	14-17	Float		seconds
PPS hits	18-21	Int		N/A
Checksum	22-23	Short		N/A

Checksum calculation: Bytes 0 & 1 are ignored. Bytes 2 to 23 are added. Bytes 22 & 23 contain the checksum.

Binary Output- Time Recovery : Time Recovry TM1B

TM1B is a 52-byte message containing week number, seconds of the week, and UTC offset.

A description of the output message is given in the following table:

Table 46: TM1B Message Format

Item	Byte	Format	Value	Units
Header 1	0	Byte	0xAA	N/A
Header 2	1	Byte	0x44	N/A
Header 3	2	Byte	0x11	N/A
Checksum	3	Byte		N/A
ID	4-7	Int	3	N/A
Length	8-11	Int	52	N/A
Week	12-15	Int		N/A
Seconds of week	16-23	Double	GPS seconds of the week or elapsed seconds if GPS not available	seconds
Clock offset	24-31	Double	Clock offset error reported by GNSS	seconds
Clock offset standard deviation	32-39	Double		N/A
UTC offset	40-47	Double		seconds
Clock model status	48-51	Int	0 (not supported)	N/A

Checksum calculation: Bytes 0 & 1 are ignored. Bytes 2 to 23 are added. Bytes 22 & 23 contain the checksum.

Binary Output- Attitude: ATT01 Message Format

This is a 16-byte message containing the Reference Frame attitude. The data portion of the message is arranged as a group of sixteen-bit words, with the low byte transmitted first.

A description of the 16-byte message is given below:

Table 47: ATT01 Message Format

Item	Byte	Format	Value	Units
Header LSB	0	byte	0x00	N/A
Header MSB	1	byte	0x91	N/A
Time of Validity	2-9	double	UTC seconds of the week or elapsed seconds is GPS not available	seconds
Roll LSB	10	byte	LSB:0.01° Range: ± 180°	deg/bit
Roll MSB	11	byte		
Pitch LSB	12	byte	LSB: 0.01° Range: ±180°	deg/bit
Pitch MSB	13	byte		
Heading LSB	14	byte	LSB: 0.01° Range: 0° to 359.99°	deg/bit
Heading MSB	15	byte		

Binary Output- Position and Attitude: POSATT & POSATT2 Message Formats

The POSATT and POSATT2 messages output position and attitude of the Reference Frame. They are both 28 byte messages. POSATT2 is identical to the POSATT message with the exception of the position (Latitude, Longitude and Altitude) LSB values.

A description of the 28-byte output message is given in the following table:

Table 48: POSATT & POSATT2 Message Format

Item	Byte	Format	Value	Units
Header LSB	0	byte	0x00	N/A
Header MSB	1	byte	0x92	N/A
Time of Validity	2-9	double	UTC seconds of the week or elapsed seconds if GPS not available	seconds
Roll LSB	10	byte	LSB: 0.01° Range: ±180°	deg/bit
Roll MSB	11	byte		
Pitch LSB	12	byte	LSB: 0.01° Range: ±180°	deg/bit
Pitch MSB	13	byte		
Heading LSB	14	byte	LSB: 0.01° Range: 0° to 359.99°	deg/bit
Heading MSB	15	byte		
Latitude	16-19	long	POSATTT: LSB: 0.001 arcsec POSATTT2: LSB: 0.00035 arcsec Range: -90° to +90°	arcsec/bit

Table 48: POSATT & POSATT2 Message Format

Item	Byte	Format	Value	Units
Longitude	20-23	long	POSATTT: LSB: 0.001 arcsec POSATTT2: LSB: 0.00035 arcsec Range: -180° to +180°	arcsec/bit
Altitude	24-27	long	POSATT: LSB: 0.1 m POSATT2: LSB: 0.01 m Range: -1000.0 m to 20000 m	m/bit

Binary Output - Position, Attitude and Roll Rate: POSATT3 Message Format

The POSATT3 message outputs position, attitude and roll rate of the Reference Frame. A description of the 30-byte output message is given in the following table:

Table 49: POSATT3 Message Format

Item	Byte	Format	Value	Units
Header LSB	0	byte	0x00	N/A
Header MSB	1	byte	0x94	N/A
Time of Validity	2-9	double	UTC seconds of the week or elapsed seconds if GPS not available	seconds
Roll LSB	10	byte	LSB: 0.01° Range: ±180°	deg/bit
Roll MSB	11	byte		
Pitch LSB	12	byte	LSB: 0.01° Range: ±180°	deg/bit
Pitch MSB	13	byte		
Heading LSB	14	byte	LSB: 0.01°	deg/bit

Table 49: POSATT3 Message Format

Item	Byte	Format	Value	Units
Heading MSB	15	byte	Range: 0° to 359.99°	
Latitude	16-19	long	LSB: 0.001 arcsec Range: -90° to + 90°	arcsec/bit
Longitude	20-23	long	LSB: 0.001 arcsec -180° to +180°	arcsec/bit
Altitude	24-27	long	LSB: 0.01 m Range: -1000.0 m to 20000 m	m/bit
Roll Rate LSB	28	byte		
Roll Rate MSB	29	byte	LSB: 0.001 deg/s Range: ± 32 deg/s	deg/s/bit
Roll Rate MSB	29	byte		

Binary Output - Position, Attitude, Speed and: PAST1 Message Format

PAST1 is a 32-byte message that contains time, position, attitude, speed and track of the Reference Frame.

A description of the output message is given in the following table:

Table 50: PAST1 Message Format

Item	Byte	Format	Value	Units
Header LSB	0	byte	0x00	N/A
Header MSB	1	byte	0x93	N/A
Time of Validity	2-9	double	UTC seconds of the week or elapsed seconds if GPS not available	seconds

Table 50: PAST1 Message Format

Item	Byte	Format	Value	Units
Roll LSB	10	byte	LSB: 0.01° Range: ±180°	deg/bit
Roll MSB	11	byte		
Pitch LSB	12	byte	LSB: 0.01° Range: ±180°	deg/bit
Pitch MSB	13	byte		
Heading LSB	14	byte	LSB: 0.01° Range: 0° to 359.99°	deg/bit
Heading MSB	15	byte		
Latitude	16-19	long	LSB: 0.001 arcsec Range: -90° to + 90°	arcsec/bit
Longitude	20-23	long	LSB: 0.001 arcsec -180° to +180°	arcsec/bit
Altitude	24-27	long	LSB: 0.01m Range: -1000.0 m to 20000 m	m/bit
Speed LSB	28	byte	LSB: 0.01 m/s Range: 0 to 300 m/s	m/s/bit
Speed MSB	29	byte		
Track LSB	30	byte	LSB: 0.01° Range: 0° to 359.99°	deg/bit
Track MSB	31	byte		

Binary Output - PAV30: PAV30 Message Format

PAV30 supplies roll and pitch for stabilization, and yaw drift control for the camera heading control.

A description of the output message is given in the following table:

Table 51: PAV30 Message Format

Item	Byte	Format	Value	Units
Header LSB	0	byte	0x00	
Header MSB	1	byte	0x97	
Roll LSB	2	byte	LSB: 0.001° Range: ±30.0°	deg/bit
Roll MSB	3	byte		
Pitch LSB	4	byte	LSB: 0.001° Range: ±30.0°	deg/bit
Pitch MSB	5	byte		
Yaw Drift Correction LSB*	6	byte	LSB: 0.001° Range: ±30.0°	deg/bit
Yaw Drift Correction MSB*	7	byte		
Status 1	8	byte	Value Meaning 0 YDC = invalid 1 YDC = follow mean track 2 YDC = follow desired heading	
Status 2	9	byte	Reserved	
Checksum LSB	10	byte	Sum of bytes 2 to 9	
Checksum MSB	11	byte		

The Status byte is set as follows:

- When Yaw Drift Control (YDC) option is not activated and system is not in fine alignment mode or system is stationary, status byte is set to 0.
- When YDC correction method is set to ‘follow mean track’, status byte is set to 1.
- When YDC correction method is set to ‘follow desired heading’, status byte is set to 2.

***** Yaw drift correction is the heading difference (unfiltered correction).

Binary Output- Azimuth: Azimuth Message Format

Azimuth supplies roll and pitch for stabilization, and azimuth control for camera heading control of the DSS Azimuth Mount.

A description of the output message is given in the following table:

Table 52: Azimuth Message Format

Item	Byte	Format	Value	Units
Header LSB	0	byte	0x00	
Header MSB	1	byte	0x98	
Roll LSB	2	byte	LSB: 0.001° Range: ±30.0°	deg/bit
Roll MSB	3	byte		
Pitch LSB	4	byte	LSB: 0.001° Range: ±30.0°	deg/bit
Pitch MSB	5	byte		
Yaw Drift Correction LSB*	6	byte	LSB: 0.001° Range: ±30.0°	deg/bit
Yaw Drift Correction MSB*	7	byte		
Status 1	8	byte	Value Meaning 0 YDC = invalid 1 YDC = follow mean track 2 YDC = follow desired heading	
Status 2	9	byte	Reserved	

Table 52: Azimuth Message Format

Item	Byte	Format	Value	Units
Checksum LSB	10	byte	Sum of bytes 2 to 9	
Checksum MSB	11	byte		
The Status byte is set as follows: • When Yaw Drift Control (YDC) option is not activated, system is not in fine alignment mode and within activation threshold, or system is stationary, status byte is set to 0. • When YDC correction method is set to ‘follow mean track’, status byte is set to 1. • When YDC correction method is set to ‘follow desired heading’, status byte is set to 2. ***** Yaw drift correction is the heading difference (unfiltered correction).				

COM Gimbal Messages

Gimbal Encoder Input: GIM01& PVSU Message Format

The GIM01&PVSU input message consists of raw gimbal data (roll, tilt, pan) from the gimbal sensor.

A description of the input message is given in the following table:

Table 53: GIM01 Message Format

Item	Byte	Format	Value	Units
Header LSB	0	byte	0x03	N/A
Header MSB	1	byte	0x10	N/A
ID LSB *****	2	byte	0x02	N/A
ID MSB	3	byte	0x28	N/A
Pan LSB *****	4	byte	Range: ±180°	deg/bit
Pan MSB	5	byte		

Tilt LSB *	6	byte	Range: ±180°	deg/bit
Tilt MSB	7	byte		
Roll LSB	8	byte	Range: ±180°	deg/bit
Roll MSB	9	byte		
Reserved	10-19	N/A	N/A	N/A

* The Pan, Tilt and Roll angles are represented by a 16-bit 2's complement format. The following is the range of each value (also see Figure 66):
  7FFFh = +180°   0000h = 0°   8000h = -180°

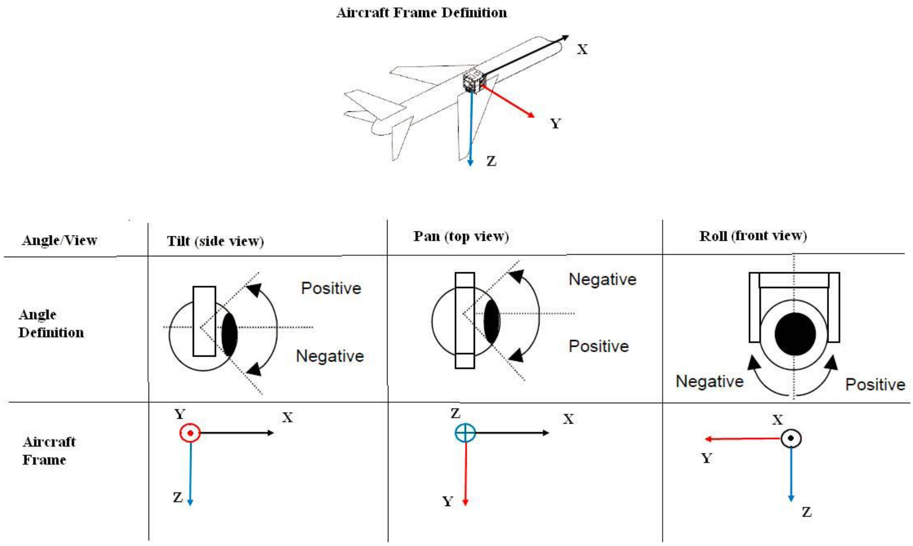


Figure 66: Pan, Tilt and Roll Definitions

Gimbal Encoder Input: GIM02 Message Format

The GIM02 input message consists of raw gimbal data (dome, yaw, pan, tilt) from the gimbal sensor.

A description of the input message is given in the following table:

Table 54: GIM02 Message Format

Item	Byte	Format	Value	Units
Header LSB	0	byte	0x03	N/A
Header MSB	1	byte	0x10	
ID LSB	2	byte	0x00	N/A
ID MSB	3	byte	0x28	
Dome LSB	4	byte	Range: ±180°	deg/bit
Dome MSB	5	byte		
Yaw LSB	6	byte	Range: ±180°	deg/bit
Yaw MSB	7	byte		
Pan LSB	8	byte	Range: ±180°	deg/bit
Pan MSB	9	byte		
Tilt LSB	10	byte	Range: ±180°	deg/bit
Tilt MSB	11	byte		
Checksum	12-13	N/A	16 bit summation of bytes 2 to 11	N/A

PAV30/80 Gimbal Encoder Input: P30/80_GIM Message Format

The P30_GIM input message consists of gimbal encoder angular data (Tx, Ty, Tz) that defines the rotations between the aircraft and ground. PAV 30/80 supplies gimbal encoder input to POS for dynamic lever arm computation.

The gimbal PAV 30/80 message input must be sampled at the PPS pulse(1 Hz rate), see Table 5 on page 8-3.

A description of the input message is given in the following table:

Table 55: P30/80_GIM Message Format

Item	Byte	Format	Value	Units
Header LSB	0	byte	0x00	
Header MSB	1	byte	0x98	
Encoder Angle Tx LSB	2	byte	LSB: 0.01° Range: ±10.0°	deg/bit
Encoder Angle Tx MSB	3	byte		
Encoder Angle Ty LSB	4	byte	LSB: 0.01° Range: ±10.0°	deg/bit
Encoder Angle Ty MSB	5	byte		
Encoder Angle Tz LSB	6	byte	LSB: 0.01° Range: ±30.0°	deg/bit
Encoder Angle Tz MSB	7	byte		
Checksum LSB	10	byte	Sum of bytes 2 to 9	
Checksum MSB	11	byte		
The PAV30 and PAV80 gimbal encoder angles define the rotations from the aircraft to the ground in the following sequence: Tx, Ty, Tz.				

Azimuth Mount Input Message Format

A description of the input message is given in the following table:

Table 56: Azimuth Mount Message Format

Item	Byte	Format	Value	Units
Header LSB	0	byte	0x00	N/A
Header MSB	1	byte	0x99	N/A
Encoder Angle Tz	2-6	5 ASCII char	-9999 to 9999 degrees scaled up by 100	degrees
Status	7-9	3 ASCII char	N/A	N/A
Where: byte 0 = 0X00 byte 1 = 0X99 bytes 2 to 6 = ASCII characters for data scaled up by 100, padded with leading spaces as required bytes 7 to 9 = ASCII characters for status, padded with leading spaces as required				

Appendix G

POS AV Flight Checklists

This section outlines a typical flight procedure.

Flight Preparation

X	Step
	Bring several Applanix certified USB flash cards and store them appropriately until use.
	Check laptop PC battery before starting flight. Have an extra battery available in case the laptop's battery discharges completely during data collection.
	Enter all appropriate flight data in the POS AV Flight Profile Form on page G-5. This information will be required if Applanix Technical Support and Service are asked to troubleshoot logged data.
	Check that all cables are connected and secured neatly out of the way.
	Power-on all equipment and verify that there are no errors.
	Position the aircraft away from hangars and other obstructions to reduce GNSS multipath reception.
	The initial position should be valid. The GNSS status display should read OK (this can take a few minutes). Course levelling should be finished.
	If you are using the POS AV Event tagging function, verify that the correct Event polarity is selected in the Events window (**Settings, Events**) in the AV POSView Controller. Connect to the POS AV via the Controller, trigger the camera several times, and verify the increasing Events Count in the AV POSView Controller main window (Figure 8, page 4-6).

X	Step
	Ensure that the correct mounting installation parameters and time tag settings are entered in the AV POSView Controller (**Settings, Installation, Lever Arm & Mounting**).
	Ensure that the COM ports are pre-configured to the appropriate settings in the AV POSView Controller (**Settings, Input/Output Ports, Serial/Analog**). This is important when connecting to external onboard devices such as stabilized mounts, flight management systems, etc.
	If the POS AV controls a stabilized mount, ensure that the yaw drift settings are set in the AV POSView Controller (**Settings, Yaw Drift Correction**).
	Select **Removable Media Logging** from the **Logging** pull-down menu in the AV POSView Controller menu bar and verify that the required data groups are selected (select the POSPac button as a minimum). Click the **Start Logging** button and verify that the data are being written to removable media (Table 3, page 7-4).
	Applanix recommends saving all settings in the POS AV. This ensures that the latest settings are installed during the next power-up (**Settings, Save Settings**).
	Ensure that the GNSS Differential Corrections Base Station (if used) is on and receiving/transmitting data.
	Log 5-10 minutes of GNSS data to resolve ambiguities before departure.
	Take off. The PCS front panel SYSTEM light should be flashing green or solid green within 5 minutes of departure.

In-Flight Procedures

Stand-Alone Mode

X	Step
	Switch off the laptop to conserve battery power.

X	Step
	Monitor POS AV using the PCS front panel status lights.
	Use the LOG switch on the front of the PCS to start and stop data logging to the removable media.

Controller Monitor Mode

X	Step
	Monitor the position, speed, heading, pitch and roll displays and compare them to the aircraft indicators.
	Monitor the AV POSView Controller Fault Detection windows for error flags (Figure 17, page 4-14).
	Monitor the Event counts on the AV POSView Controller main window and compare them to the camera releases.

In-Flight Restart

If power is interrupted during the flight or there is a serious IMU failure (i.e. the IMU light turns red on the PCS or the POS AV Controller Fault Detection windows indicate errors), restart the flight using the following procedure.

⚠ **Do not remove the USB flash drive from the drive when the logging light is on.**

X	Step
	Stop logging data. The USB drive does not need to be removed. Switch the PCS power-off, wait 10 seconds, then power-up the PCS.
	Fly straight and level at a constant speed for 2-3 minutes until the PCS SYSTEM light flashes green or the POS status display indicates that the system is Initialized.
	Start data logging. Fly strait and level for 2-3 minutes and then fly an S-turn.

X	Step
	Now that the POS AV is initialized, continue the survey.
	POS AV is ready when the PCS SYSTEM light is solid or flashing green and/or the POS Status is displayed as **OK** in the POS AV Controller main window. This step takes approximately 5 minutes.

Post Flight Checklist

X	Step
	Stop the aircraft away from the hangar or other obstructions to minimize GNSS multipath reception.
	Continue logging data for 5-10 minutes.
	Stop logging data and remove the USB flash drive (refer to the Data Logging description on page 6-1 for detailed instructions).
	Download the internally logged back-up data from the POS AV to the laptop (if necessary), refer to Data Logging – Removable Media and Back-Up on page 6-3 for instructions.
	Power-off all POS AV equipment.

POS AV Flight Profile Form

Flight Information

Flight No.: ____________________ **Date:** ____________

Location: ____________________

Datum: ____________________

Base Station Information

Latitude: ____________________ **North/South**

Longitude: ____________________ **West/East**

Altitude: ____________________ **Metres**

Altitude Measurement: **Geoidal** ☐ **Ellipsoidal** ☐

Antenna Height: ____________________ **Metres**

Lever Arms

Lever Arm	Reference to IMU (Metres)	Reference to GNSS (Metres)
X		
Y		
Z		

Misalignment Angles

Mounting Angle	IMU respect to Reference Frame (Degrees)	Reference with respect to Aircraft Body Frame (Degrees)
X		
Y		
Z		

Photogrammetry

Camera Type: ______________________________

Mapping Coordinates Units: **Metres** ☐ **US Survey Feet** ☐

International Feet ☐

Appendix H

POS AV Diagrams

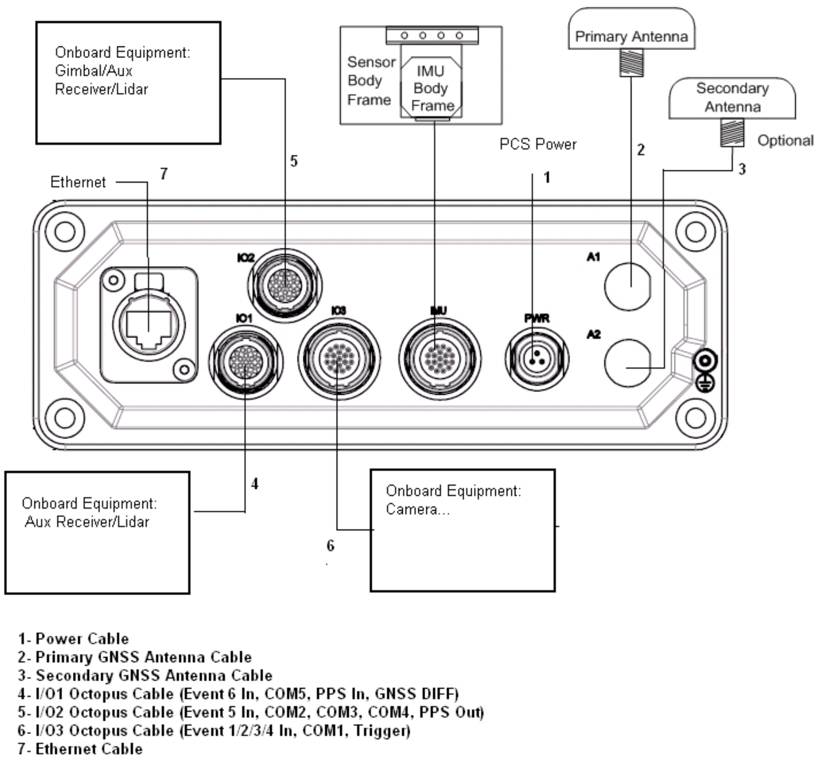


Figure 67: POS AV Interconnect Diagram

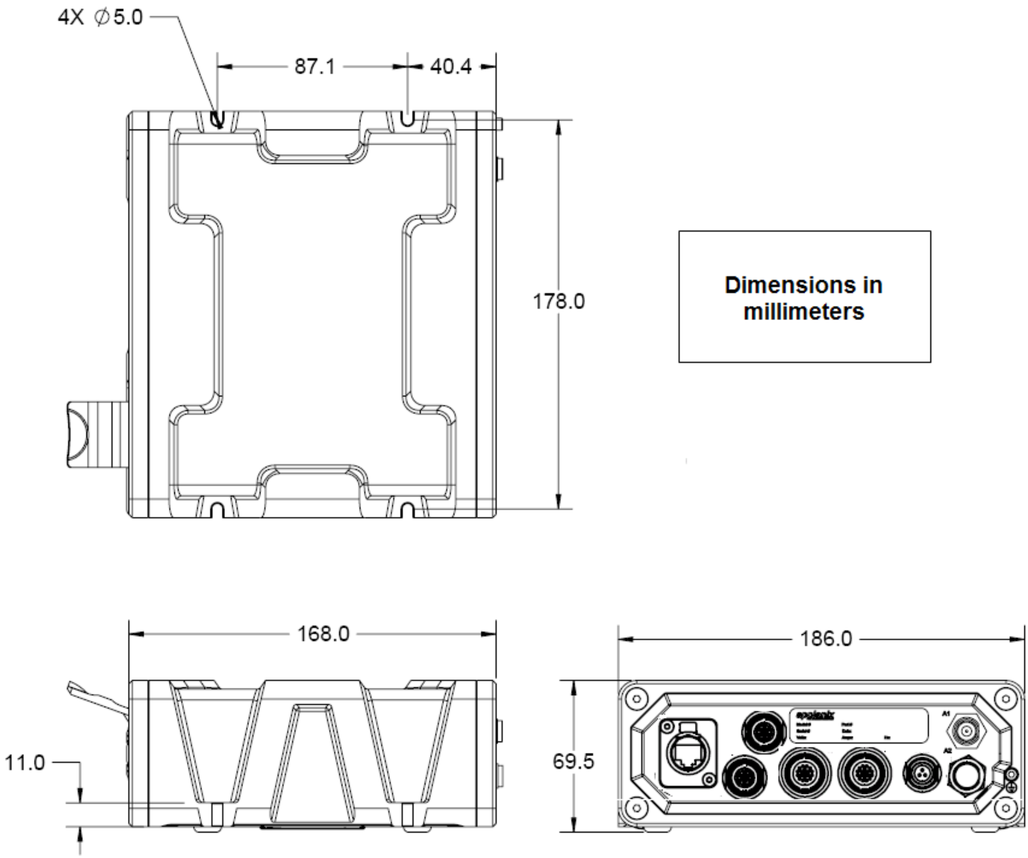


Figure 68: PCS Outline Diagram

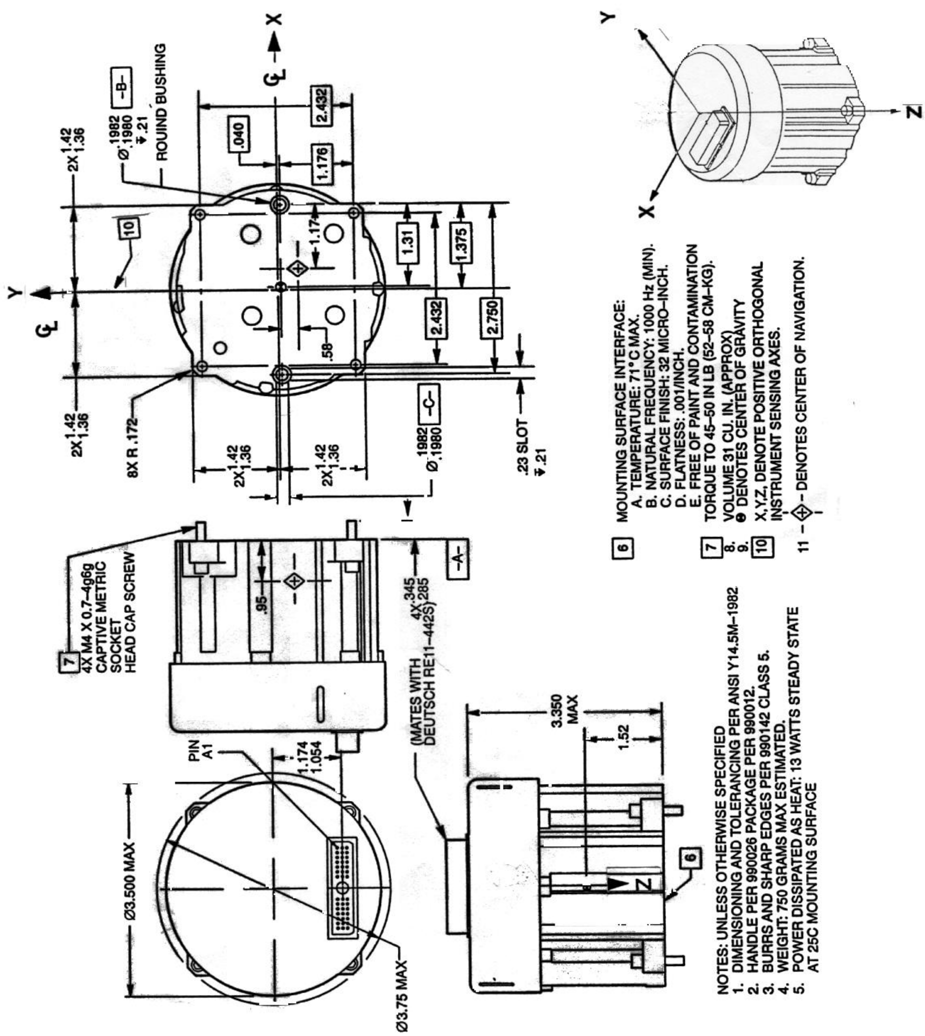


Figure 69: IMU Types 7, 8 Outline Diagram

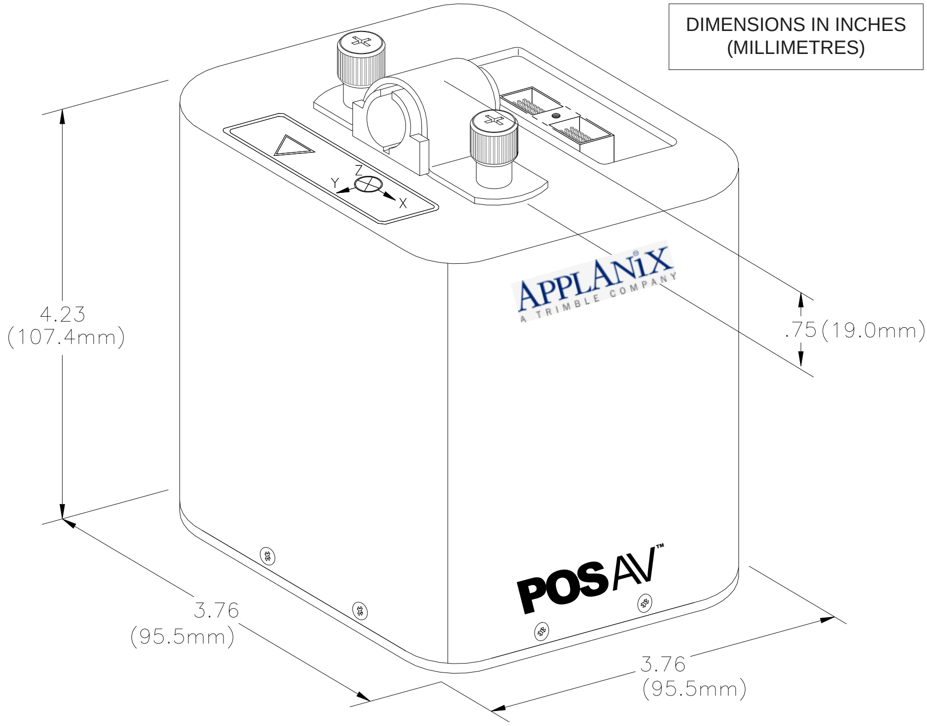


Figure 70: IMU Types 7, 8 Top-Hat Diagram

The sensing centre is located in the Centre of Navigation of IMU types 7, 8 top-hat. Please refer to Figure 69.

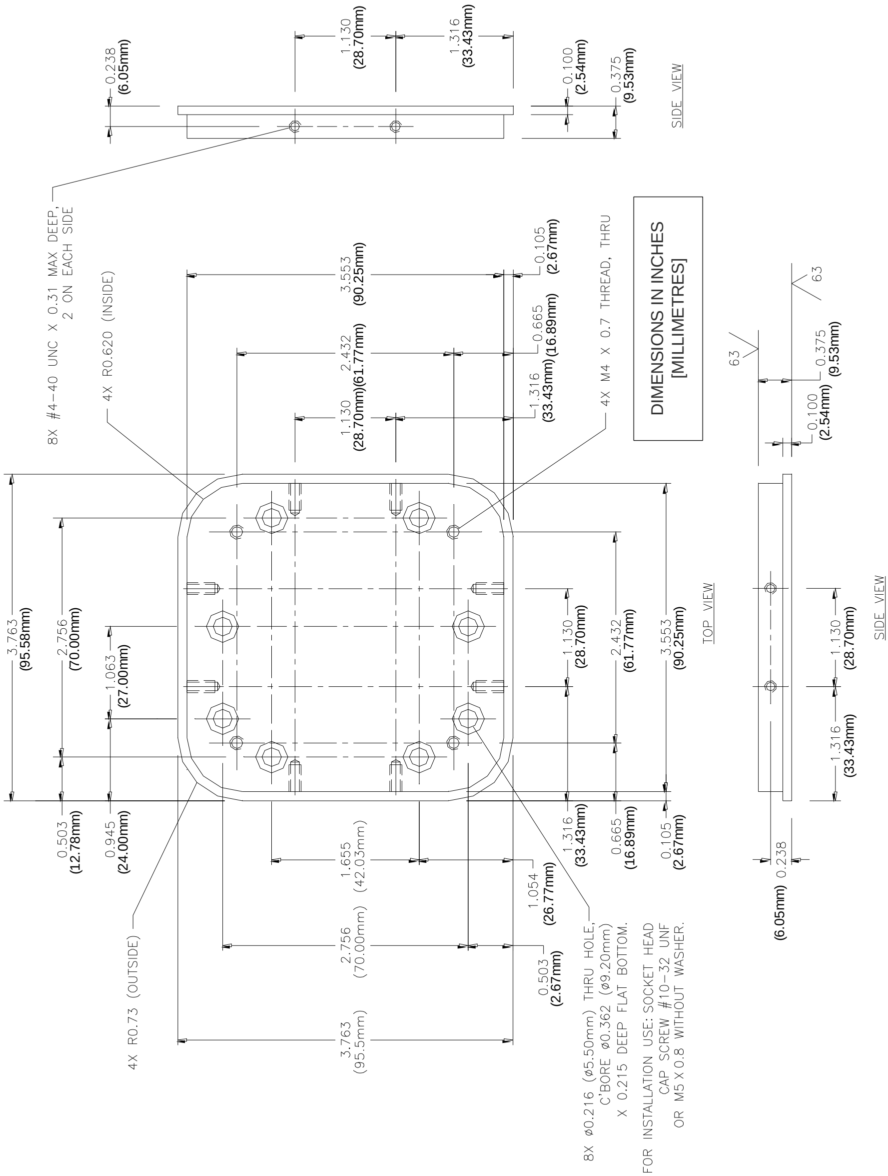
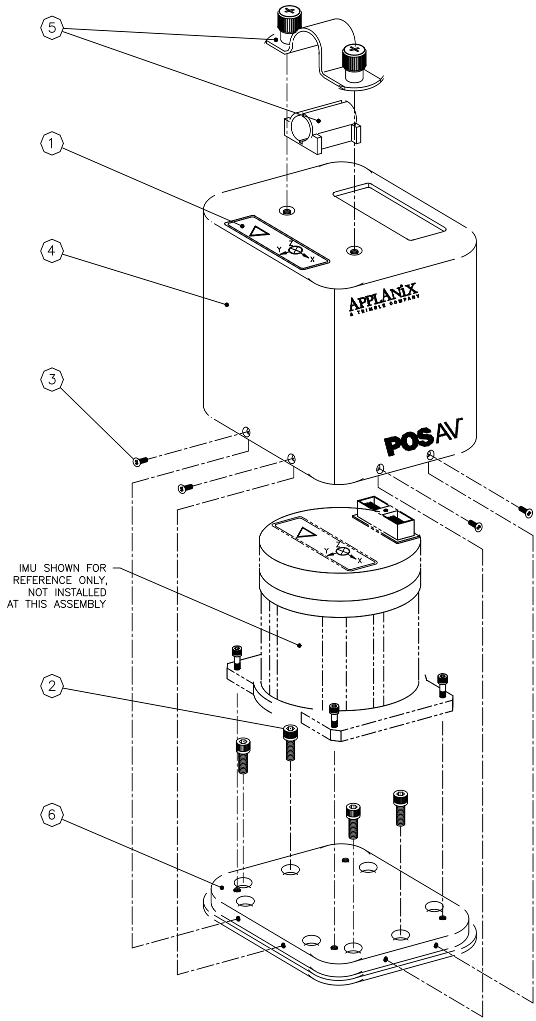


Figure 71: IMU Types 7, 8 Mounting Plate Diagram



1	6	10003340	PLATE, IMU MOUNT, LN200
1	5	10003339	BRACKET, CABLE STRAIN RELIEF ASSY
1	4	10003284	TOP HAT, LN200 mPOS
8	3	10002784	SCREW, 4-40 X 5/16, FLAT HEAD, PHILLIPS
4	2	10002780	SCREW M5 X 12mm, SOCKET HEAD
1	1	10002217	LABEL, IMU AXIS
QTY	ITEM	PART	DESCRIPTION

Figure 72: IMU Types 7, 8 Top-Hat Assembly Diagram

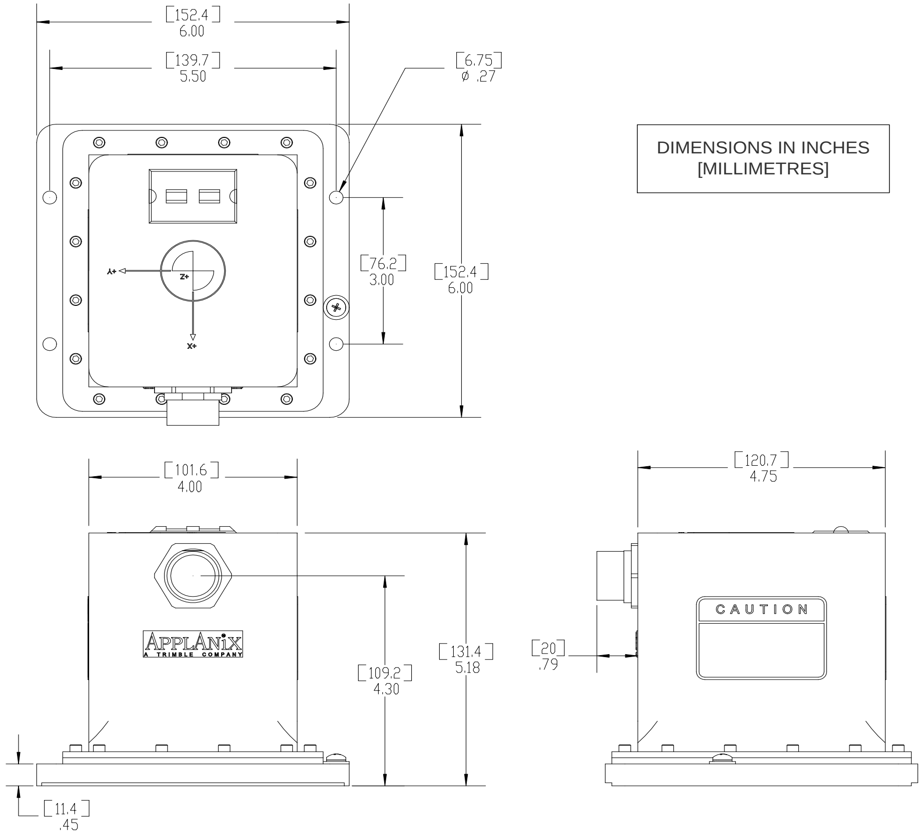


Figure 73: Environmental Assembly - Top-Hat

Sensing centre location relative to the IMU axis label (decal) for the environmental top-hat:

IMU Type	X-axis	Y-axis	Z-axis	Units
2, 7, 8 and 15	0.46 / 11.68	-0.22 / -5.59	-3.78 / -96.01	in / mm
5, 18 and 23	-0.29 / -7.37	0 / 0	-2.84 / -72.14	in / mm

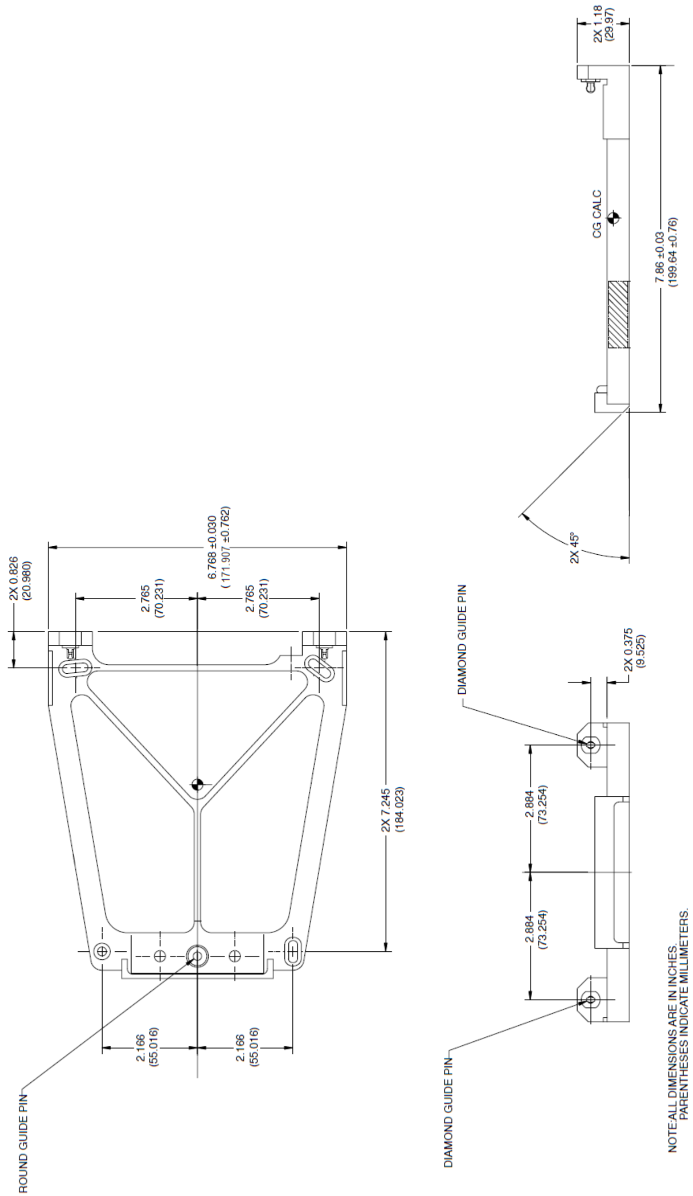


Figure 74: IMU Type 21 Mounting Tray Outline

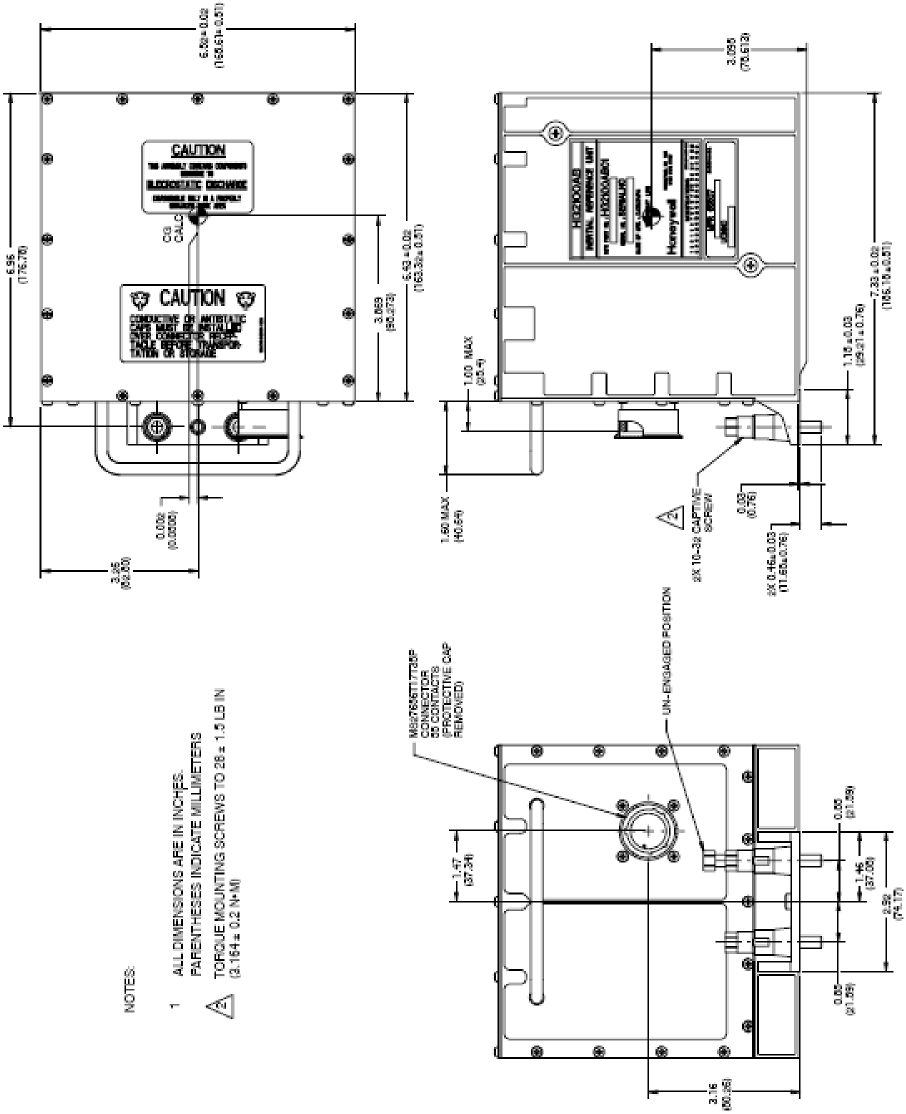


Figure 75: (1 of 2) IMU Type 21 Outline - Top, Side and Front Views

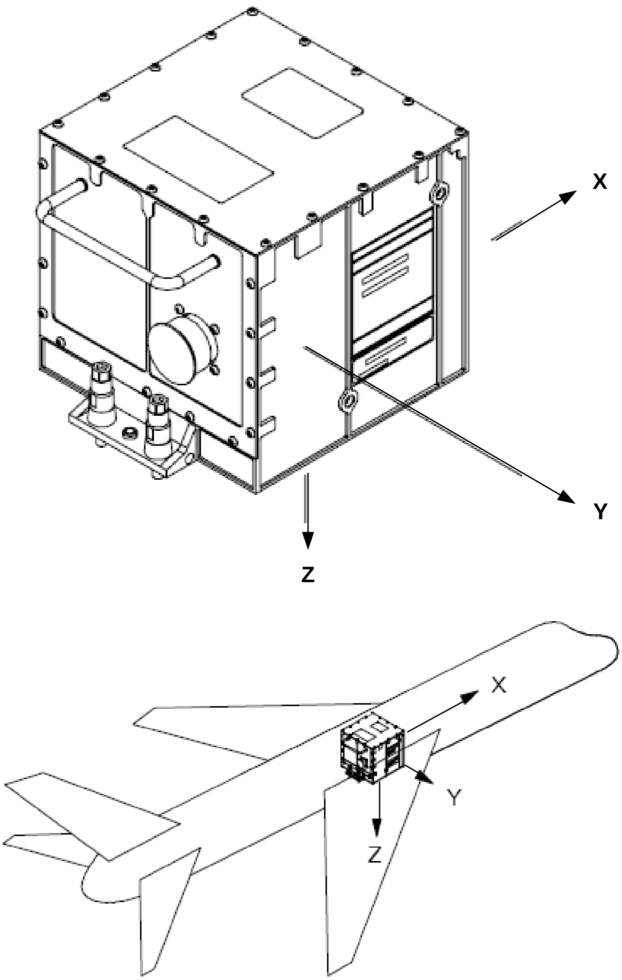


Figure 76: (2 of 2) IMU Type 21 Outline - Rear View

The sensing centre is displayed on IMU type 21 and is located at height of 3.095 in (78.613 mm) above the mounting plate.

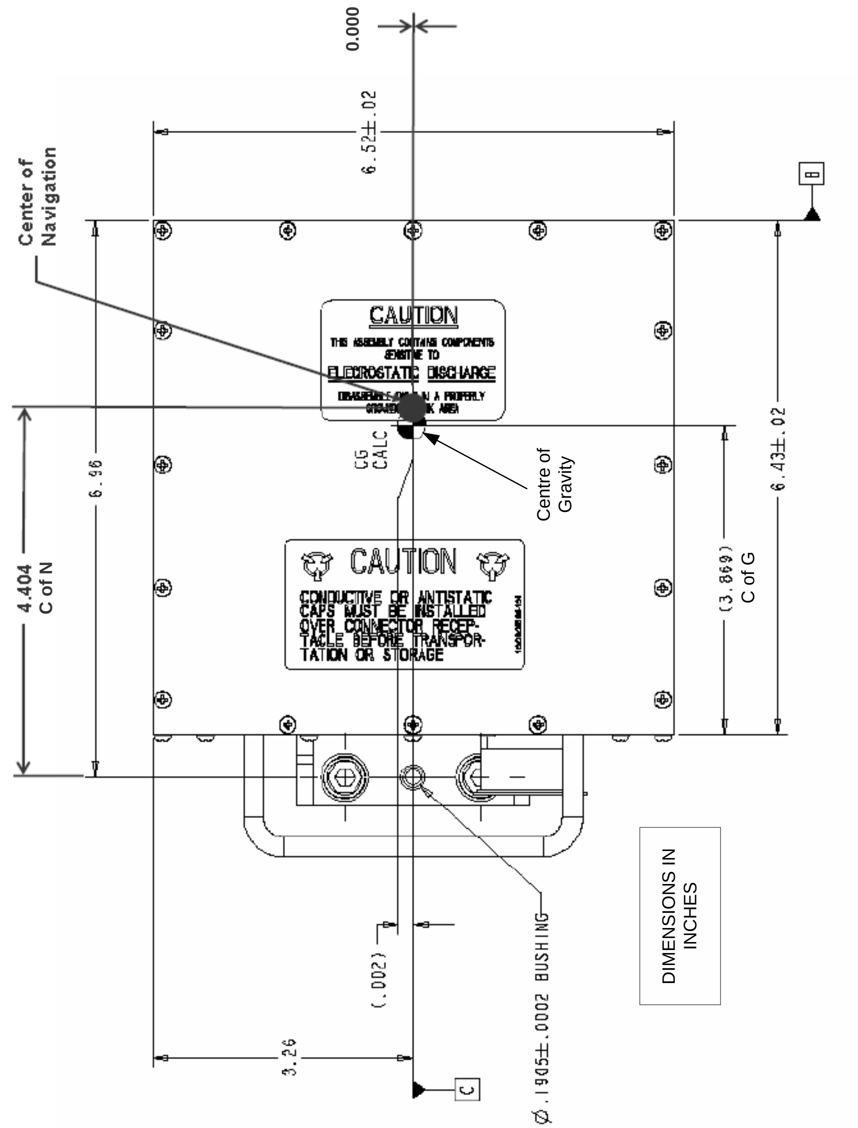


Figure 77: (1 of 2) IMU Type 21 Sensing Centre Diagram

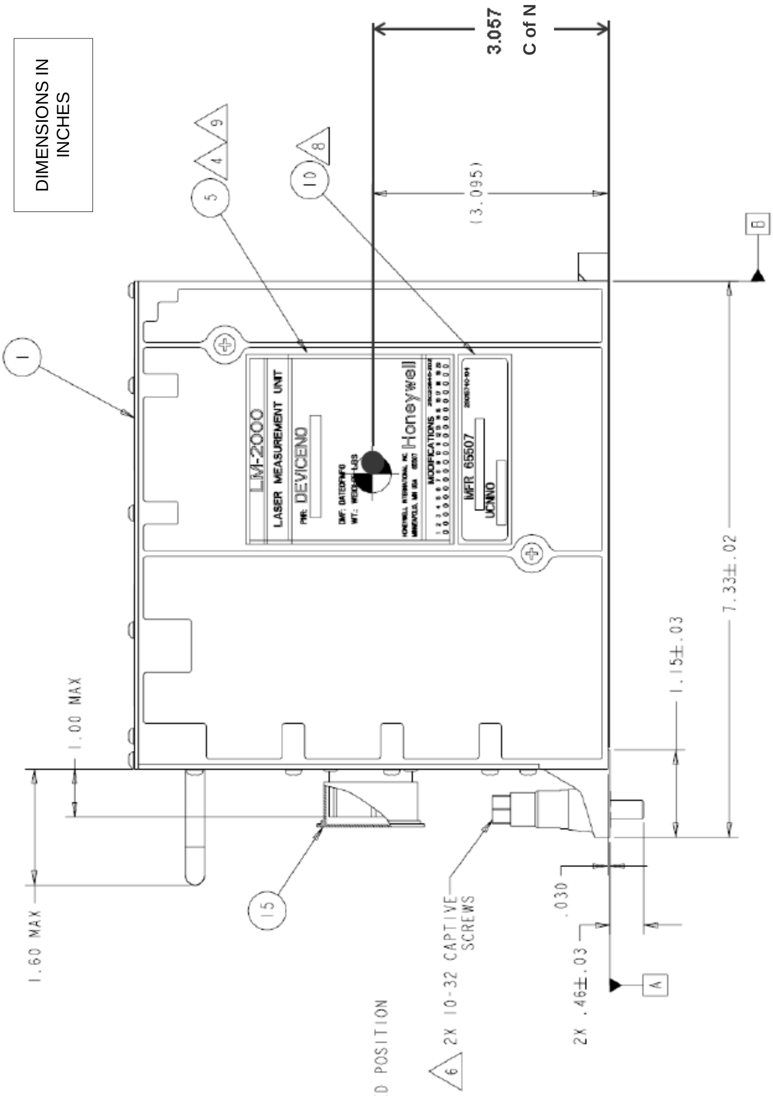


Figure 78: (2 of 2) IMU Type 21 Sensing Centre Diagram

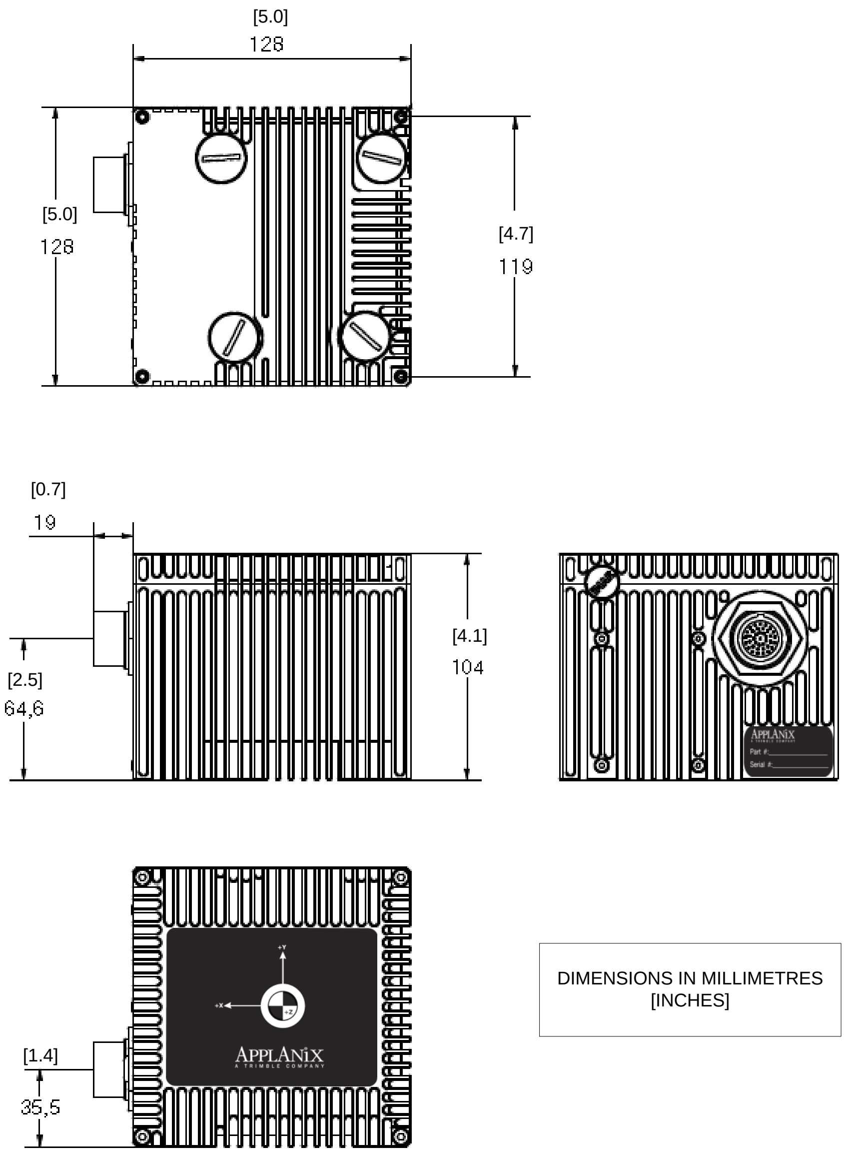


Figure 79: (1 of 2) IMU Type 29 Outline Diagram (without Adapter Plate)

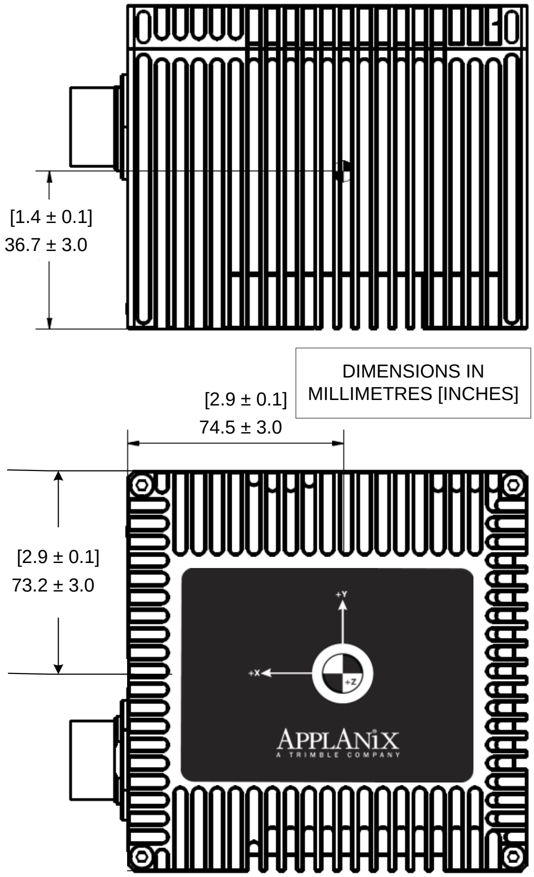


Figure 80: (2 of 2) IMU Type 29 Sensing Centre Diagram (without Adapter Plate)

5	10002780	SCR M5 X 12MM LG SOCKET HD PHILL SS	4
4	10004076	WASHER FLAT M6 X 12 MM OD X 1.4MM THK SS	4
3	10004075	SCR M6X 18MM LG CAPTIVE 8 MM LG THREAD HEX SOCKET SS	4
2	10004082	IMU TYPE 26	1
1	10004078	ADAPTOR PLATE IMU TYPE 26	1
ITEM NO.	PART NUMBER	DESCRIPTION	QTY.

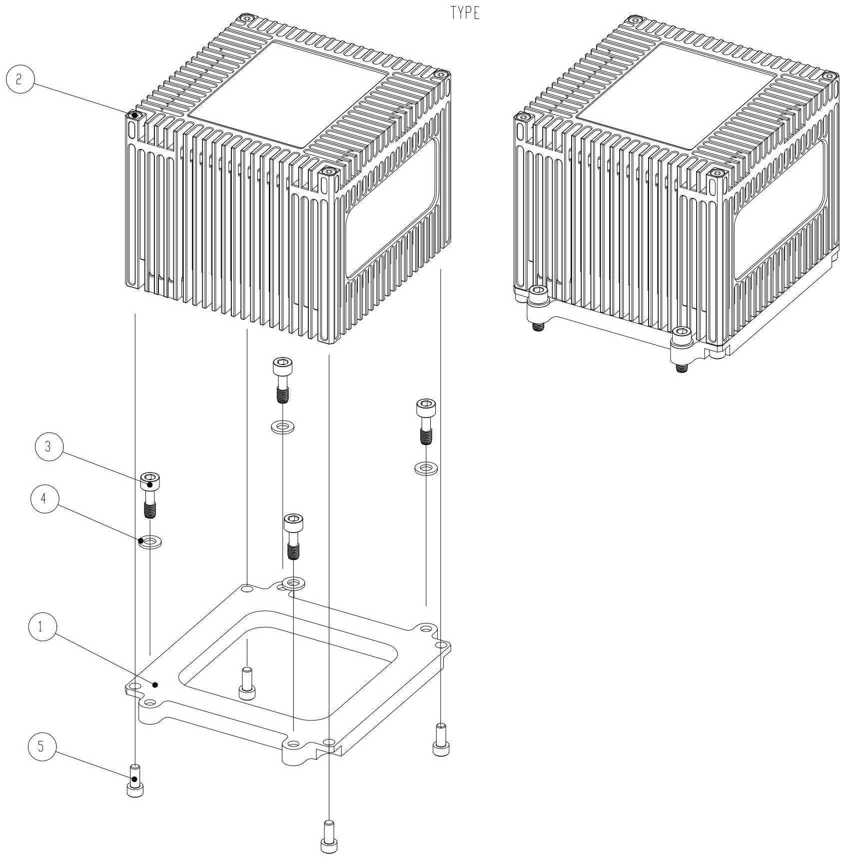


Figure 81: (1 of 2) IMU Type 29 Adapter Plate

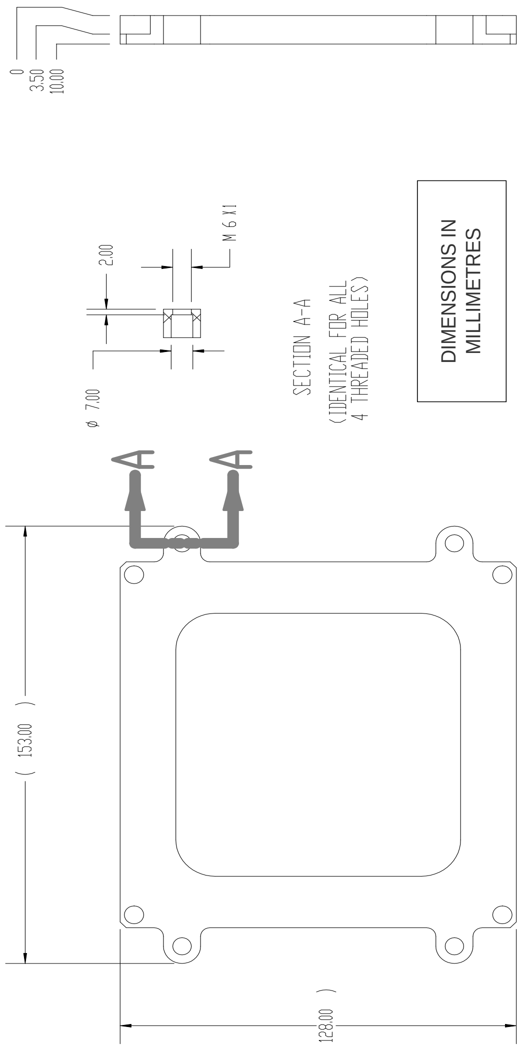


Figure 82: (2 of 2) IMU Type 29 Adapter Plate

Note: IMU-29 is no longer available from Applanix, but all existing IMUs in the field coupled with POS AV V5 are fully upgradable to POS AV V6.

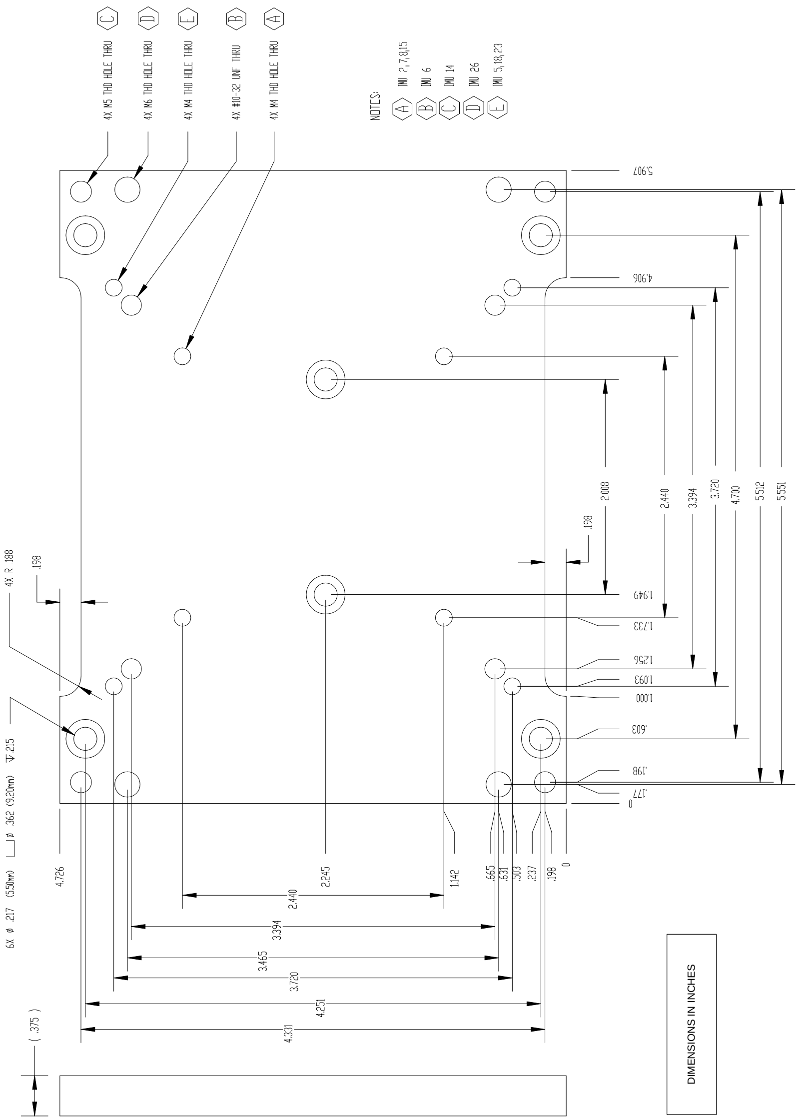


Figure 83: Universal Mounting Plate (Old) Diagram

Supports IMU types 2, 5, 6, 7, 8, 14, 15, 18, 23 & 26

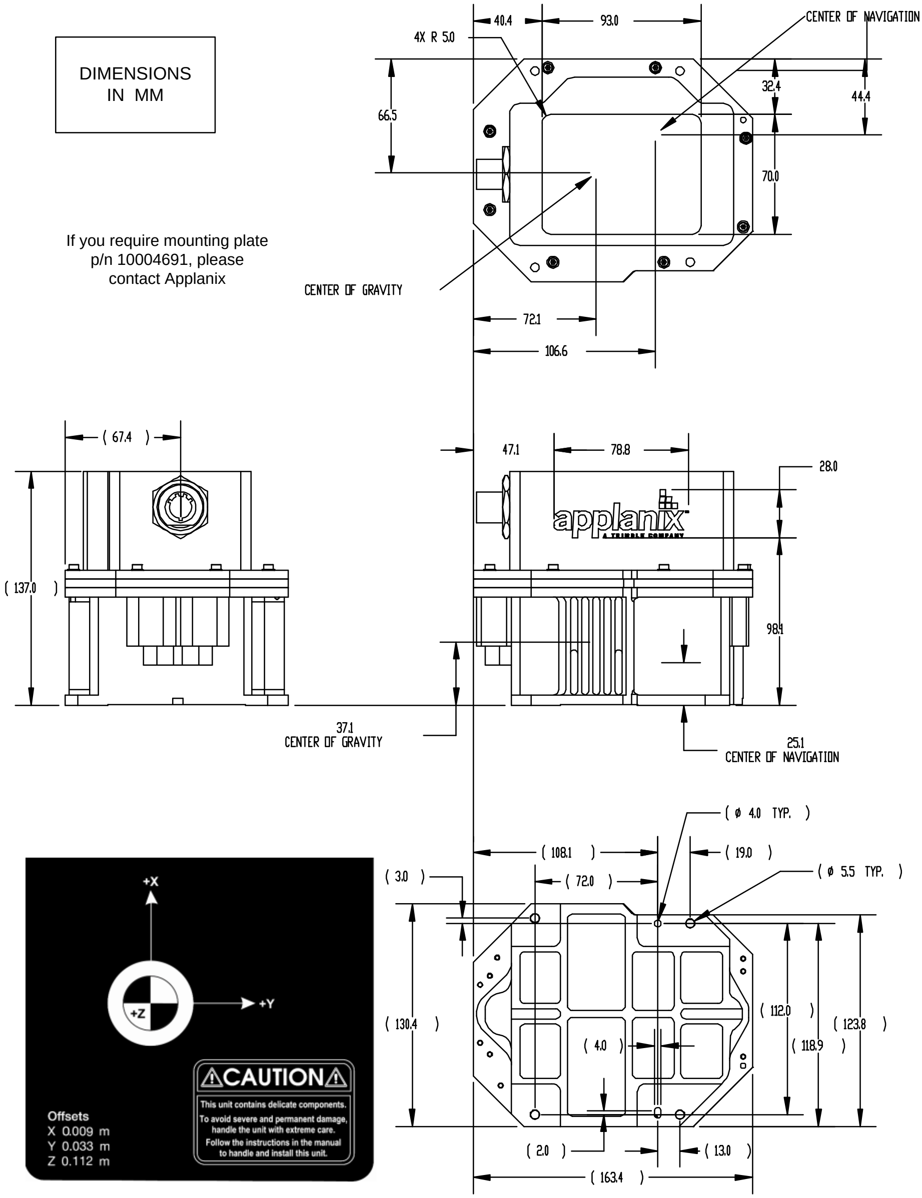


Figure 84: IMU Type 31 Diagram

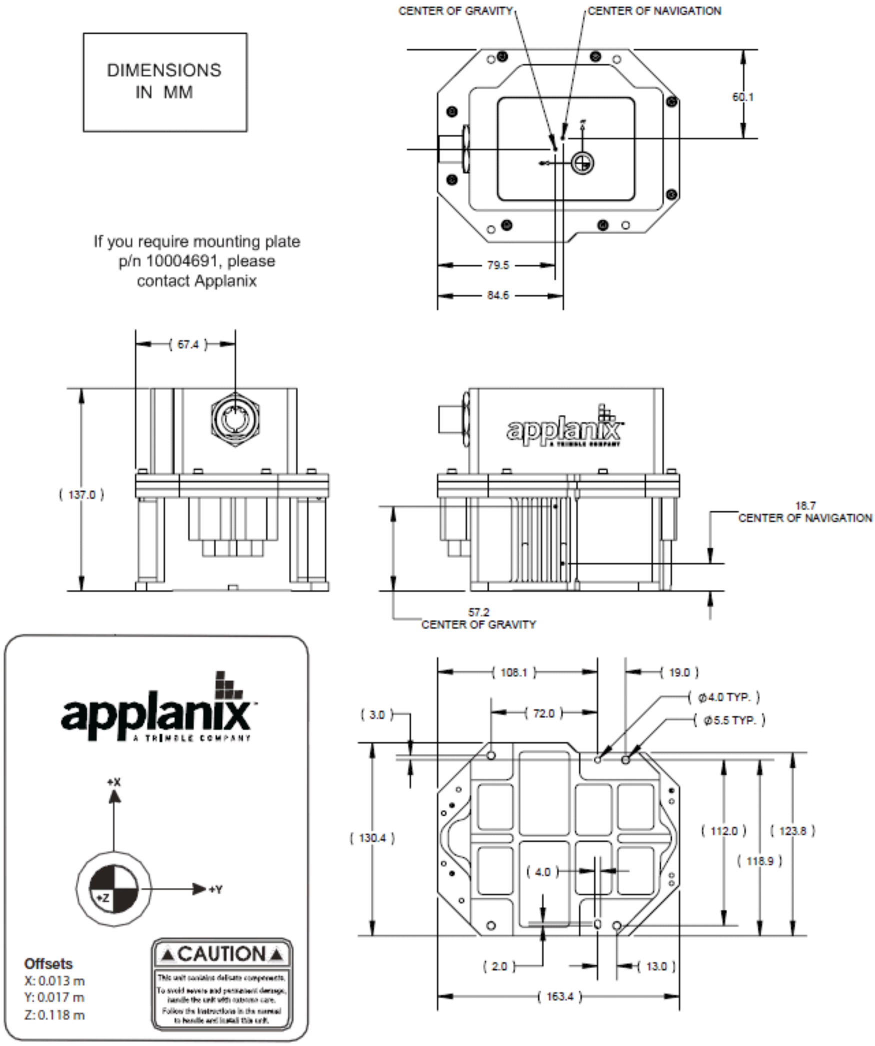
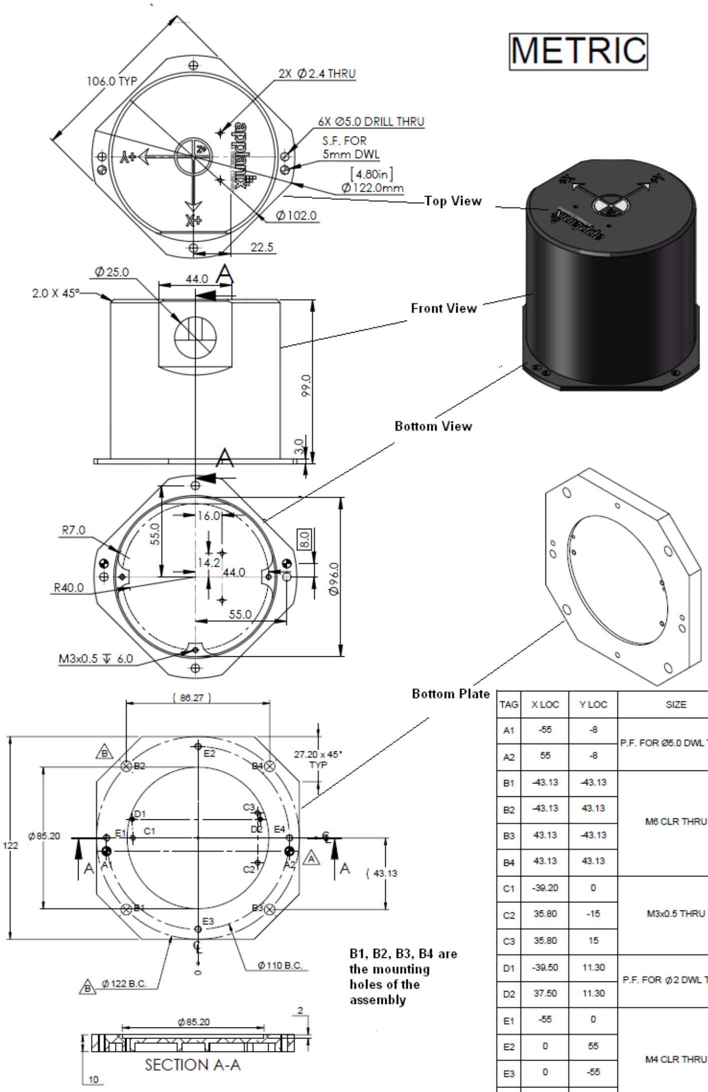


Figure 85: IMU Type 40 Diagram



TAG	X LOC	Y LOC	SIZE
A1	-55	-8	P.F. FOR Ø5.0 DWL THRU
A2	55	-8	
B1	-43.13	-43.13	M6 CLR THRU
B2	-43.13	43.13	
B3	43.13	-43.13	
B4	43.13	43.13	
C1	-39.20	0	M3x0.5 THRU
C2	35.80	-15	
C3	35.80	15	
D1	-39.50	11.30	P.F. FOR Ø2 DWL THRU
D2	37.50	11.30	
E1	-55	0	M4 CLR THRU
E2	0	55	
E3	0	-55	
E4	55	0	

Figure 86: IMU Type 42 & 64 Diagram

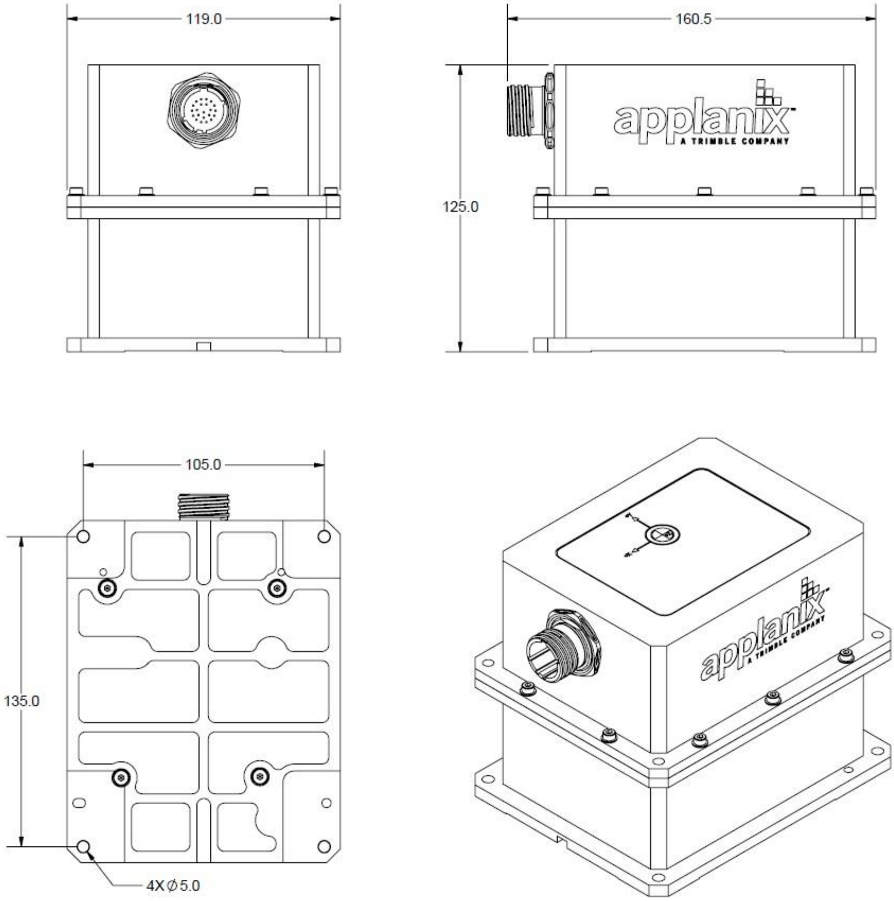


Figure 87: IMU Type 46 and 80 Diagram

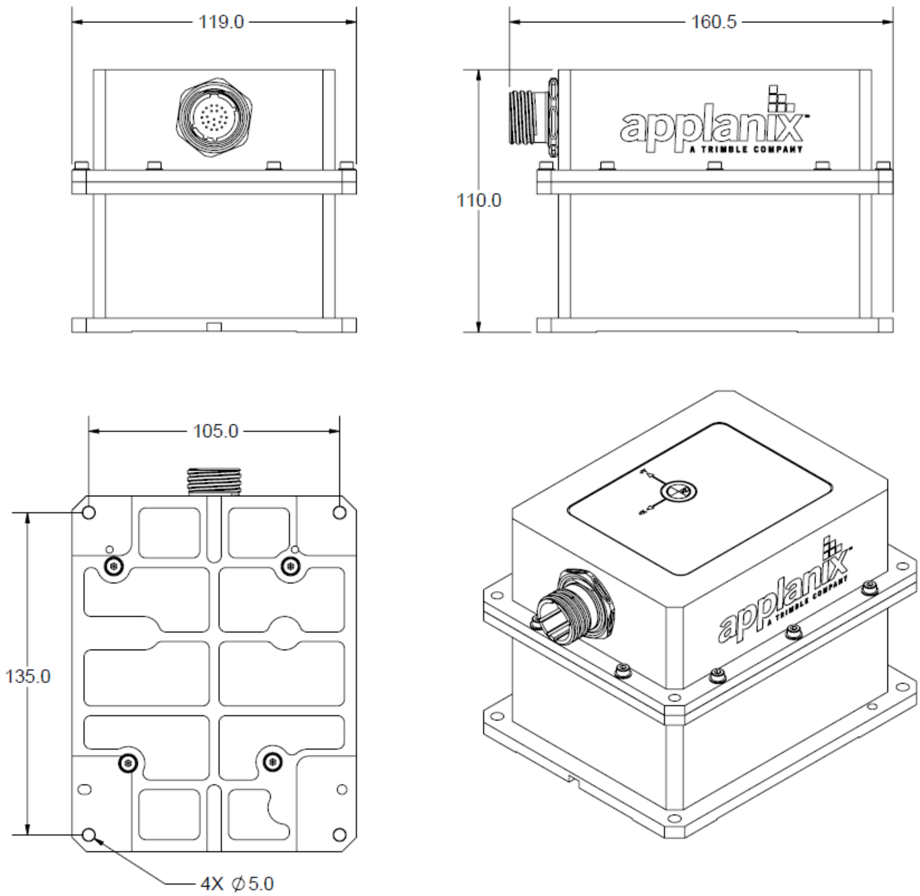


Figure 88: IMU Type 52 Diagram

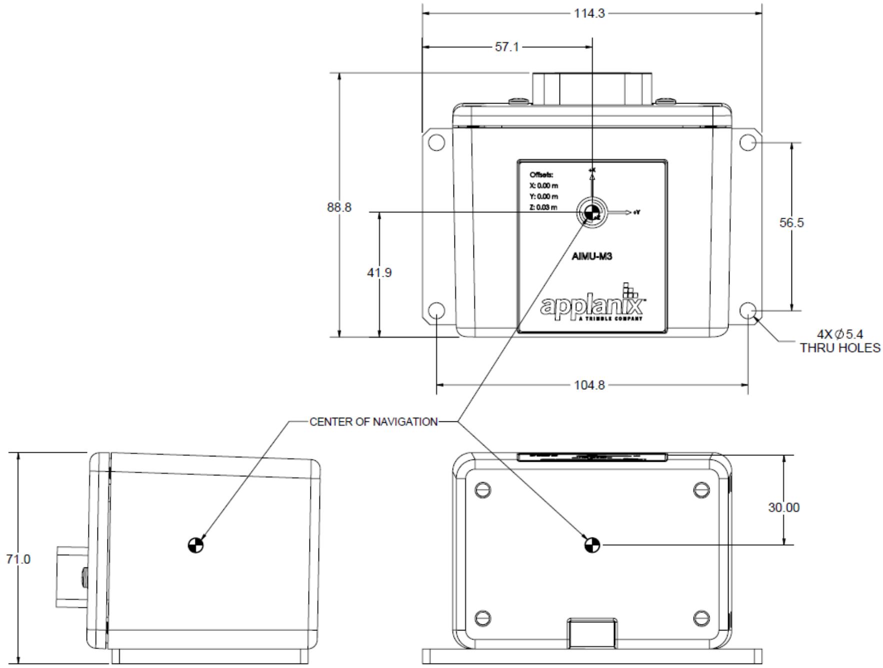


Figure 89: IMU Types 55 and 56 Diagram

This IMU is available for OEM configurations only.
It is not available with a PCS.

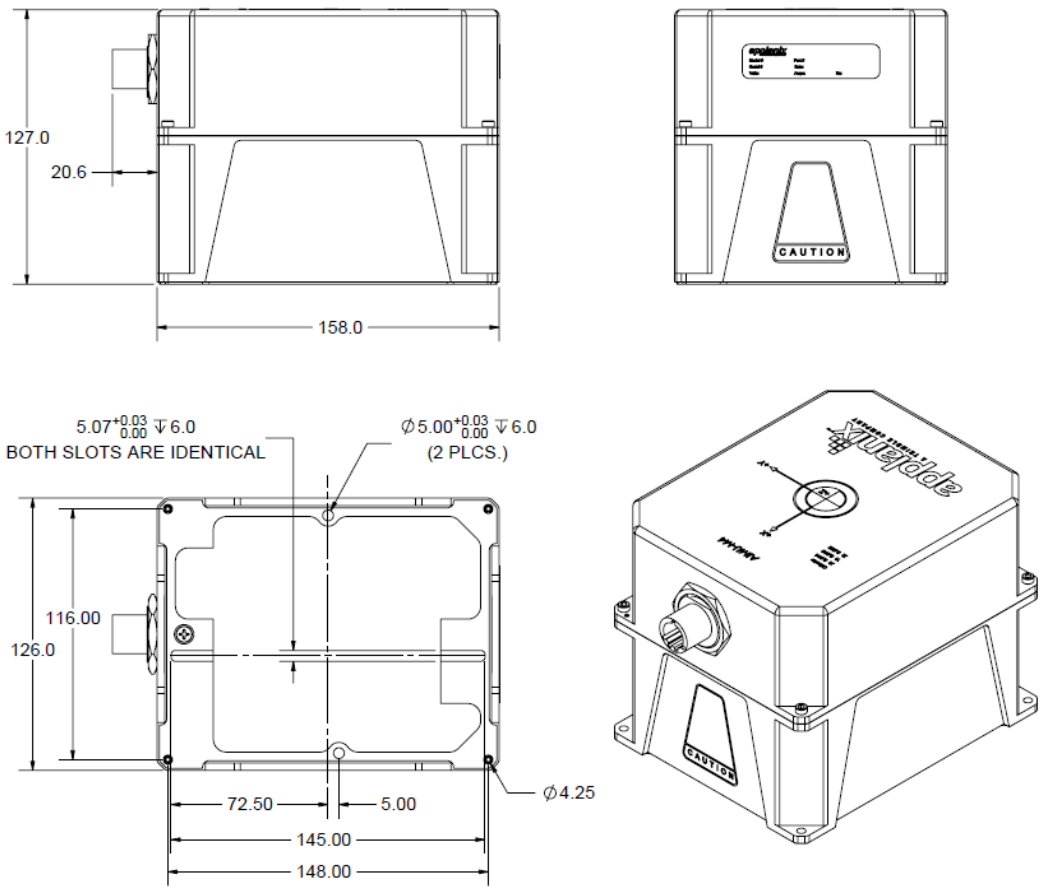


Figure 90: IMU Type 44 & 57 Diagram

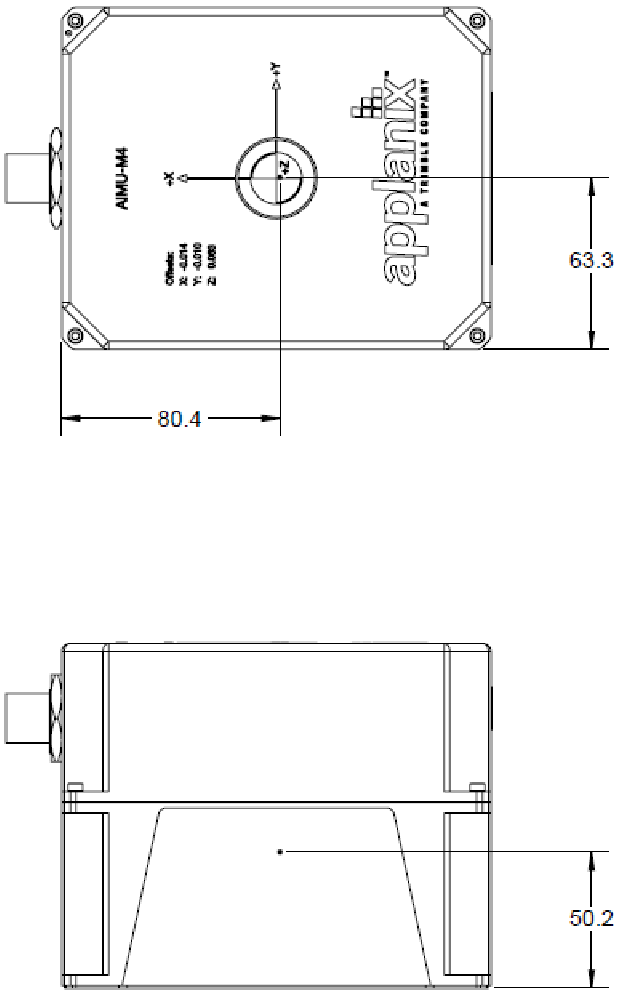


Figure 91: IMU Type 44 & 57 Centre of Gravity Diagram

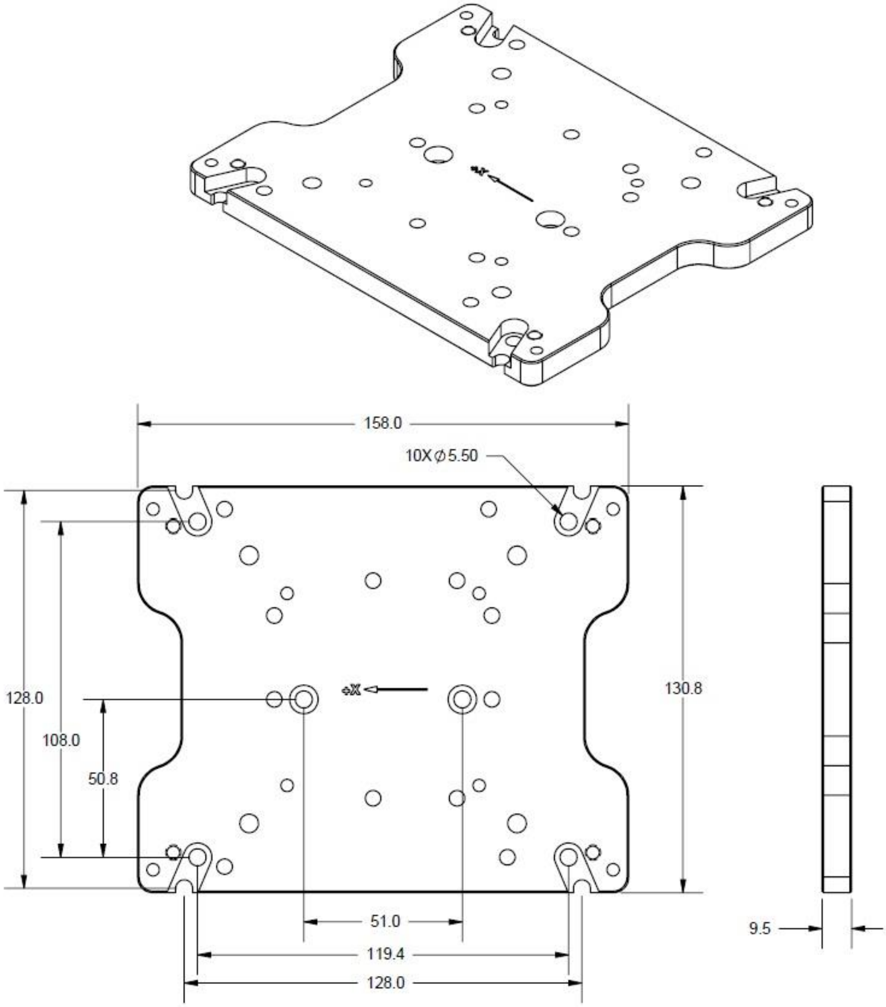


Figure 92: Universal Mounting Plate Diagram

Supports IMU types 8, 8 in top-hat kit, 31, 40, 42, 44, 46, 52

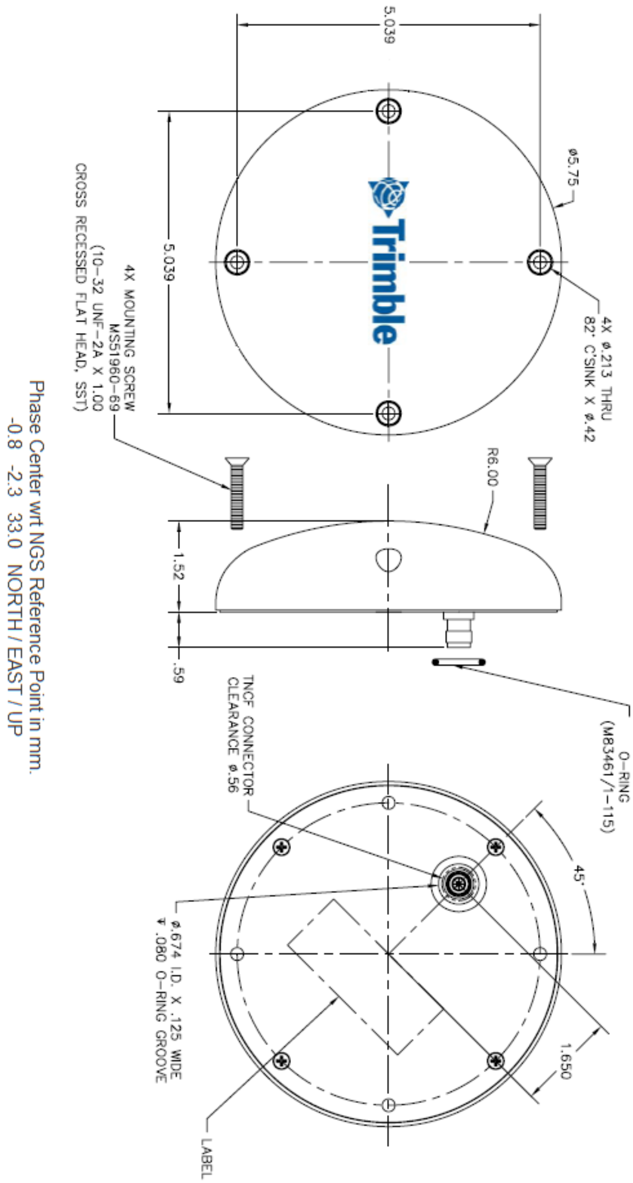


Figure 93: GNSS/LBand/OmniStar Antenna Diagram

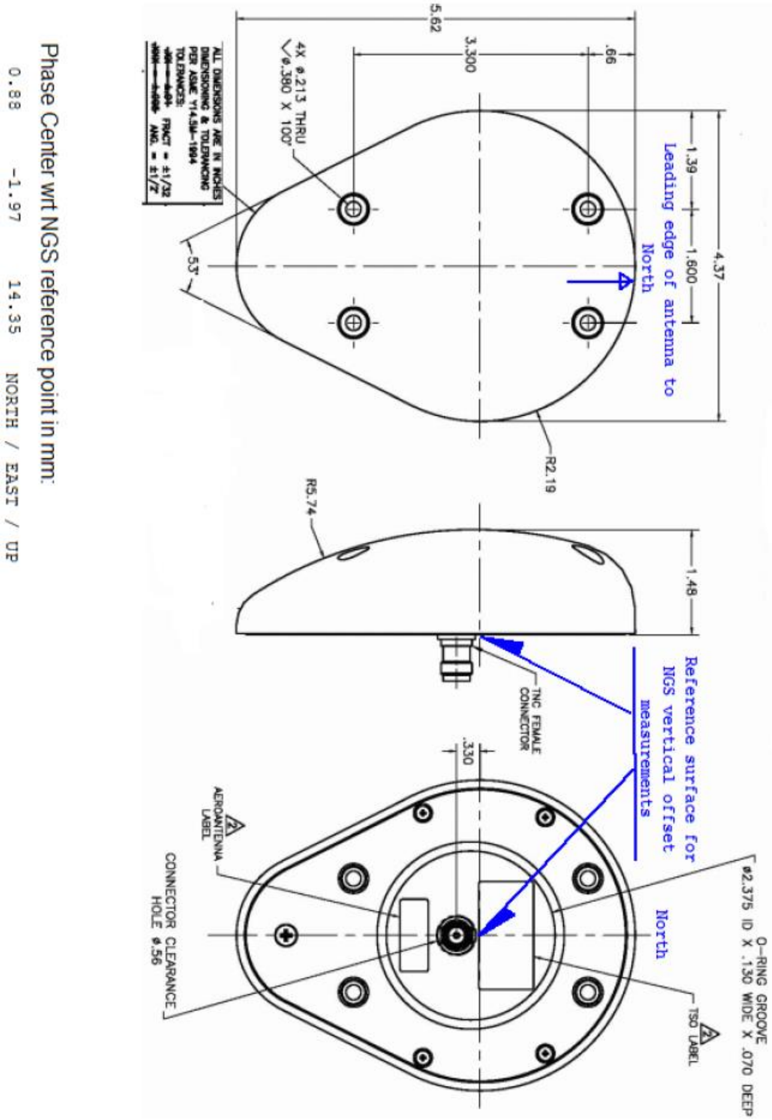


Figure 94: GNSS/LBand/OmniStar Teardrop Antenna Diagram

Appendix I

POS AV Specifications

Specifications for the POS AV components are listed below. Obtain performance specifications from Applanix.

GPS/GLONASS/Galileo Compass/ L Band Antenna

Size:	Circular Shape: Ø 146 mm, H = 39 mm Ø 5.75 in, H = 1.52 in
Weight:	283 g (~10 oz [international])
Power:	Receives operating power from GNSS receiver (5 to 18 Vdc)
Operating Temperature:	-55 °C to +85 °C (-67 °F to +185 °F)
Frequency:	1570 ±45 MHz to 1206 ±46 MHz
Band Rejection:	20 dB @ 250MHz
Gain:	45 dB (high gain)
Altitude:	≤16,764 m (55,000 ft)
Connector:	TNCF
Finish:	Fluid resistant
Polarization:	Right Hand Circular
VSWR:	≤2.0:1
Impedance:	50 Ohms

GNSS Receiver Type 17

GNSS Channels:	220
Frequency:	GPS+ GLONASS+Galileo+LBand
Raw Data Output:	5 Hz
Supported Antennas:	High gain GPS/GLONASS/Galileo/L-band antenna

IMU Types 7 and 8

Size:	9.7 cm (diameter) by 8.6 cm (high) 3.8 in (diameter) by 3.4 in (high)
Weight:	1 kg (with top-hat and plate) (~2 lb [international])
Power Source:	Receives operating power from PCS
Power Consumption:	20 W Max
Operating Temperature:	-54 °C to +71 °C (-65 °F to +160 °F)
Storage Temperature:	-62 °C to +85 °C (-80 °F to +185 °F)
Relative Humidity:	0 to 100%, sealed unit
Shock:	90 g (~883 m/s^2)

IMU Type 21

Size:	L = 16.3 cm, W = 16.5 cm, H = 16.3 cm L = 6.4 in, W = 6.5 in, H = 6.4 in
Weight:	4.49 kg (~9.90 lb [international])
Power Source:	Receives operating power from PCS
Power Consumption:	28 W Max
Operating Temperature:	-40 °C to +70 °C (-40 °F to +158 °F)
Relative Humidity:	95%
Shock:	6 g / 11 ms

IMU Type 31 and 40

Size:	163.4x130.4x138 mm (nominal)
Weight:	2.5 kg
Power Source:	Receives operating power from PCS
Power Consumption:	33 W Max
Operating Temperature:	-20 °C to +55 °C
Relative Humidity:	RTCA/DO -160F Section 6, Category A
Shock:	RTCA/DO -160F Section 7, Category B

IMU Type 42 & 64

Size:	120x120x110 mm (nominal)
Weight:	1.25 kg
Power Source:	Receives operating power from PCS
Power Consumption:	8 W Max
Operating Temperature:	-20 °C to +55 °C
Relative Humidity:	RTCA/DO-160F[2], Section 6, Category: A
Shock:	RTCA/DO-160F[2], Section 7, Category: B - operational shock: 6g/11ms/6 times per direction - crash safety: 20g/11ms/1 time per direction

IMU Type 46

Size:	161x120x126 mm (nominal)
Weight:	2.2 kg
Power Source:	Receives operating power from PCS
Power Consumption:	33 W Max
Operating Temperature:	-20 °C to +55 °C
Relative Humidity:	RTCA/DO -160F Section 6, Category A
Shock:	RTCA/DO -160F Section 7, Category B

IMU Type 52

Size:	161x120x111 mm (nominal)
Weight:	1.85 kg
Power Source:	Receives operating power from PCS
Power Consumption:	33 W Max
Operating Temperature:	-20 °C to +55 °C
Relative Humidity:	RTCA/DO -160F Section 6, Category A
Shock:	RTCA/DO -160F Section 7, Category B

IMU Type 55 & 56

Size:	90x115x72 mm (nominal)
Weight:	0.75 kg
Power Source:	OEM required to provide 12V
Power Consumption:	1 W Max
Operating Temperature:	-20 °C to +55 °C

IMU Type 44 & 57

Size:	158x126x127 mm (nominal)
Weight:	2.6 kg
Power Source:	Receives operating power from PCS
Power Consumption:	15 W Max
Operating Temperature:	-20 °C to +55 °C

IMU Type 80

Size:	161x120x126 mm (nominal)
Weight:	1.9 kg
Power Source:	Receives operating power from PCS
Power Consumption:	33 W Max
Operating Temperature:	-20 °C to +55 °C
Relative Humidity:	RTCA/DO -160F Section 6, Category A

Shock: RTCA/DO -160F Section 7, Category B

Table 57: POS AV V6 Environmental Specifications

The POS AV V6 system is manufactured to meet the following environmental specifications for aircraft use:	
Environmental Specification	**Description**
Operating Temperature:	-20 °C to + 55 °C (-4 °F to 131 °F)
Storage Temperature:	-55 °C to +85 °C (-67 °F to 185 °F)
Operating Altitude:	0 to 7620m (0 to 25,000 feet)
Temperature Variation:	RTCA/DO-160E, Section 5, Category C
Humidity:	RTCA/DO-160E, Section 6, Category A
Operational Shocks and Crash:	
Operational Shock:	6 g / 11 ms / 6 times per direction
Crash Safety:	15 g / 11 ms / 1 time per direction
Vibration:	RTCA/DO-160E, Section 8, Zone 2, Category M & Category F and F1
Power Input:	RTCA/DO-160E, Section 16, Category B, 28 V DC
Voltage Spikes:	RTCA/DO-160E, Section 17, Category A, ±600 V on power line and ground line
Audio Frequency Conducted Susceptibility Power Input:	RTCA/DO-160E, Section 18, Category Z

The POS AV V6 system is manufactured to meet the following environmental specifications for aircraft use:	
Environmental Specification	**Description**
Induced Signal Susceptibility: Radio Frequency Susceptibility (radiated and conducted):	EN 55022: 1998 + amendment A1: 2000 + amendment A2: 2003, Class A EN 55024: 1998 + amendment A1: 2001 + amendment A2: 2003
Emission of Radio Frequency Energy:	FCC 47 CFR Part 15, Subpart B for Class A, Digital Devices ICES-003 Issue 4 February 2004, Class A VCCI V-3/2005.04 Normative Annex 1: Technical Requirements, Class A

I/O

Ethernet (100 base-T)

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 IMU Rate) 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 4 Gbyte Flash Disk (2 supplied),
Internal: Embedded 4 Gbyte Flash Disk for redundant logging

RS232 NMEA ASCII Output

Parameters 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

Parameters 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 Starfire, OmniStar HP),
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 msec width, max rate 100 Hz

Appendix J

Specification for Yaw Drift Control

1. Introduction

This note describes the specifications for the Yaw Drift Correction (YDC) output of POS AV. The YDC output automatically controls the yaw of stabilized mounts in order to correct for aircraft crab and yaw gyro drift[3].The functionality is available through POS AV software option YDC-04.

2. Description

The YDC feature of Position and Orientation System for Airborne Vehicles (POS AV) is designed to automatically steer the yaw of a stabilized mount using its real-time navigation solution. In addition to that it provides the levelling capability on roll and pitch if supported by particular type of thegimbal mount. The mount can be steered either to follow a predefined heading with respect to the Earth or to follow the mean track angle from North defined by the horizontal velocity vector of the aircraft. The output is designed for use with traditional aerial camera stabilized mounts, not for the pod type mounts (such as Wescam's camera equipment).

YDC is automatically activated and de-activated by the POS when it detects that the aircraft has entered or exited straight and level flight. When de-activated, the YDC will return to zero with a time constant defined by the YDC algorithm. In addition, the YDC will only be activated if the system is in the

[3] Real-time applications require accurate initialization settings to be entered into the POS AV Controller. Refer to the Installation Parameters description starting on page 5-1.

Aligned mode. Positive angles are defined as clockwise from the zero point of the yaw encoder.

Important: YDC must be enabled via the POSConfig software by selecting the YDC Output option. If the YDC has been enabled, the Statistics Window will show a YDC-0 option in the POS Version string (Figure 95).

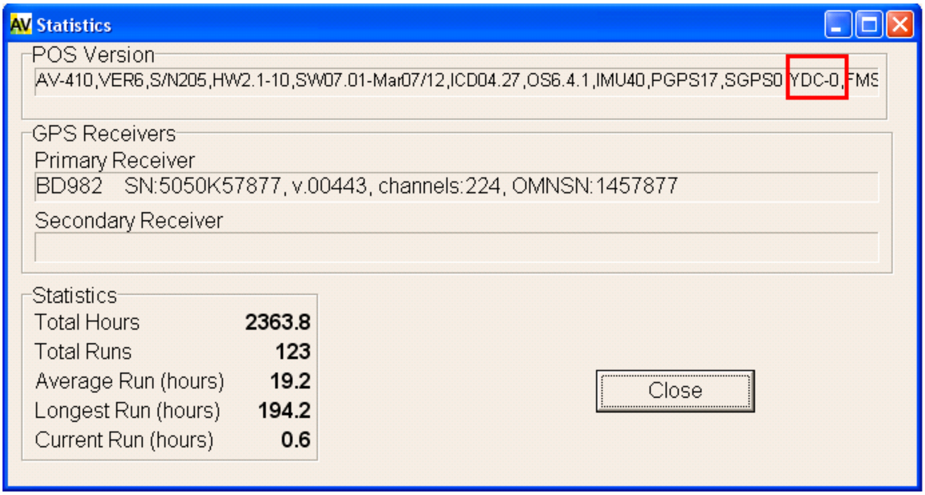


Figure 95: Statistics Window

3. Set-Up

YDC is set-up via Message 201 over the Ethernet control port or via the AV POSView Controller by selecting **Settings, Yaw Drift Correction** (Figure 96).

Message 201 is used to set-up the platform YDC algorithm. The user can choose from one of two methods for controlling the platform yaw drift.

Method 1 - Follow Mean Track. The yaw of the platform is continuously steered so that it equals the mean track of the aircraft defined by the horizontal velocity vector. This method requires no input from the operator or

Flight Management System (FMS) regarding the desired track of the current flight line.

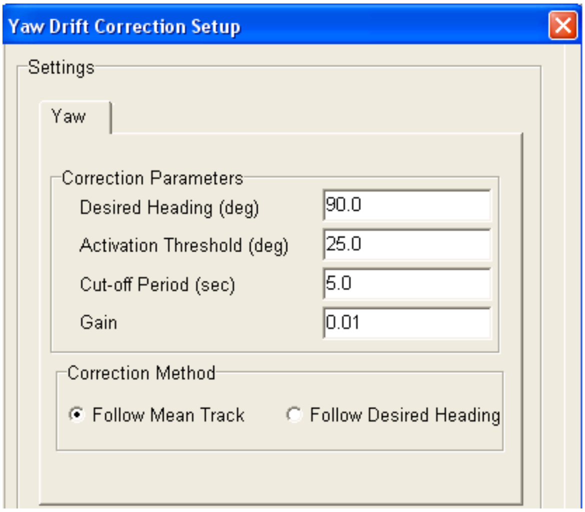


Figure 96: Yaw Drift Correction Setup Window

Figure 97 shows method 1 where the platform is steered to follow the mean track angle of the aircraft, ψ_T, which is defined by the velocity vector over ground and is different from the heading of the aircraft given by ψ.

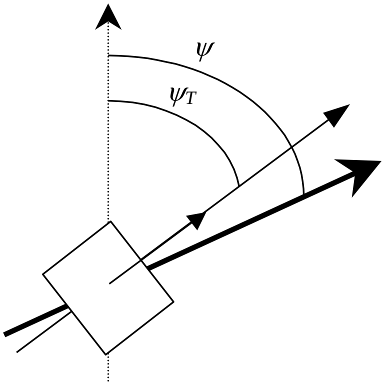


Figure 97: Follow Mean Track

Method 2 - Follow Desired Heading. The user sets the Desired Heading of the next flight line. POS then steers the yaw of the platform so that the platform heading is always equal to the desired heading. The Activation Threshold defines the region about the desired heading where the YDC is active. The setting for Desired Heading under Correction Parameter is only relevant if Correction Method correspond to Follow Desired Heading.

Note: If this method is chosen and the operator does not send the desired heading in time for the current line, POS AV will default to Method 1.

Figure 98 shows method 2 where the platform is steered to follow a desired heading, defined by ψ_D, which is different from both the mean track angle, ψ_T, and the heading of the aircraft, ψ. This is particularly useful if the platform is pointing sideways.

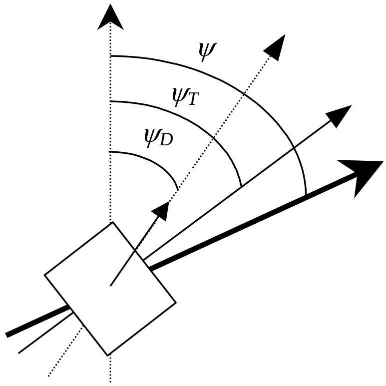


Figure 98: Follow Desired Heading

The Cut-off Period is the tracking filter cut-off in seconds. POS AV will average down the aircraft yaw motion over this period to compute a low frequency or constant drift correction. The Gain is then used to scale the drift correction output. The longer the cut-off period and the smaller the gain, the slower the tracking response.

The drift correction output is designed to be superimposed over the signal of the yaw gyro of the stabilized mount and then fed into its control loop. Hence the cut-off period is chosen to match the bandwidth of the control loop.

A typical cut-off period is five seconds with a gain of 0.005. These values can be optimized by the user depending upon the type of platform and aircraft.

4. Ethernet Output

YDC is output on the Ethernet ports in Group 203. This output is applied to the yaw command signal of a stabilized platform in order to either steer the heading of the platform to the heading desired by the user or to steer the heading of the platform so that it always follows the mean track of the aircraft. This output is designed for use with traditional aerial camera stabilized mounts, not for the pod type mounts (such as Wescam's camera equipment).

Note: When using the Ethernet output to apply the YDC, it is recommended that the Real Time Data port be used in order to minimize latency effects.

The current YDC (deg), YDC Status and Heading Difference (deg [drift]) may be viewed by selecting **View, Yaw Drift Correction** on the POS AV Controller (Figure 99).

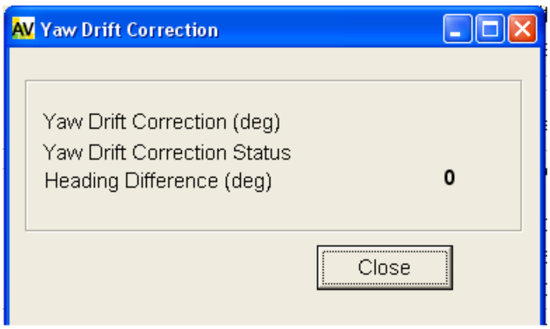


Figure 99: Yaw Drift Correction Window

5. T-AS Stabilized Mount

T-AS stabilized mount is supported through POS AV digital interface RS-232 on COM 1 and COM2.

POS AV interfaces to the Z/I Imaging T-AS stabilized mount via an external T-AS Digital Interface Box. The Digital Interface Box, provided by Z/I Imaging, connects to the POS AV COM port. YDC output is at 4 Hz and its gimbal encoder input is at 2 Hz. See for the correct settings on Figure 100:

- Select **Settings, Input/Output Ports** on the AV POSView Controller menu bar
- Select the **COM2** tab
- Select **TAS_GIM** in the **Message Select** drop-down field

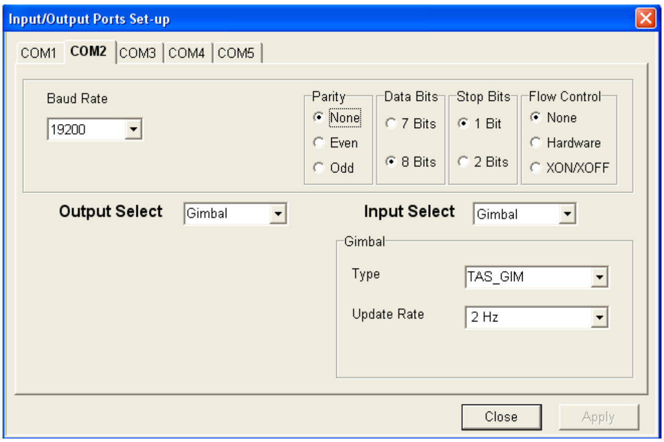


Figure 100: Input and Output Port Settings-TAS

Note: When ordering the T-AS Digital Interface Box from Z/I Imaging, please ordered it **pre-configured for RS-232 hardware triggering**.

YDC CONFIGURATION FOR T-AS MOUNT

Use the following YDC set-up for the T-AS mount; refer to Figure 101

- Select **Settings, Yaw Drift Correction** on the POS AV Controller
- Duplicate the settings of the **Cut-off Period** and **Gain** fields

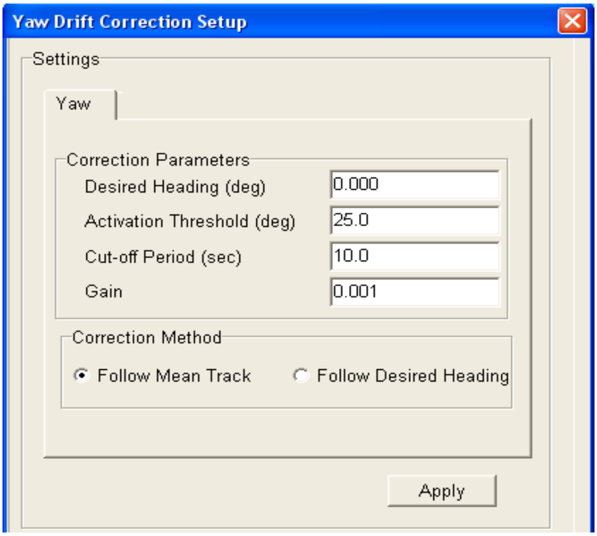


Figure 101: Yaw Drift Correction Settings - T-AS Mount

6. POS AV and Intergraph Z/I Mount

POS AV is used to provide Yaw drift correction as well as levelling corrections for roll and pitch to the Intergraph Z/I mount. It is supported. Supported firmware of Z/I mount is 1.2 or higher.

Mount should be connected to POS AV COM2 using original Intergraph cable supplied with the mount p/n *1511-485 Cable 820.*

- Select **Settings, Input/Output Ports** on the AV POSView Controller menu bar
- Select the **COM2** tab
- Select **Z/I Gimbal** in the **Message Select** drop-down field

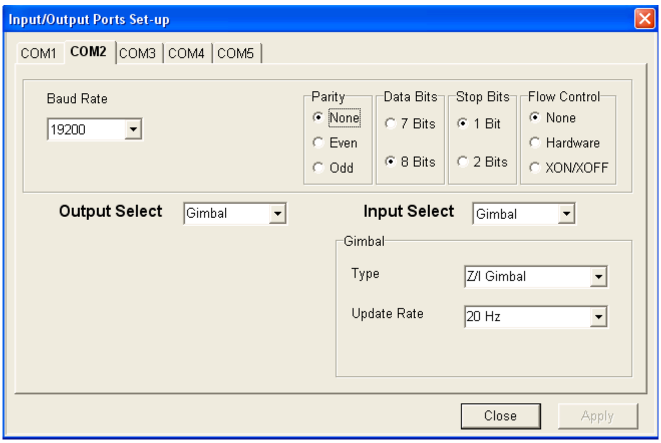


Figure 102: Input and Output Port Settings – Z/I

<u>YDC CONFIGURATION FOR Z/I STABILIZED MOUNT</u>

Use the following YDC set-up for the Z/I Mount stabilized mount:

- Select **Settings, Yaw Drift Correction** on the AV POSView Controller

- Duplicate the settings for the **Cut-off Period** and **Gain** fields

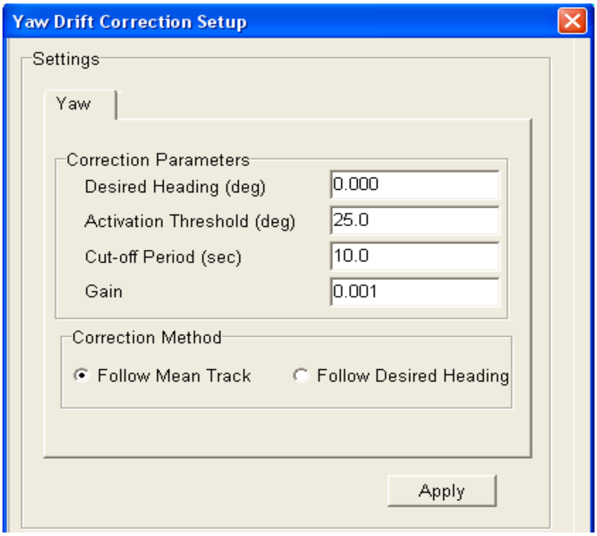


Figure 103: Yaw Drift/Roll/Pitch Correction Setup – Z/I Mount

7. POS AV and the Leica Geosystems PAV30 Stabilized Mount

POS is used to provide the YDC, roll and pitch pointing stabilization to the Leica Geosystems PAV30 stabilized mount for full 3-axis control. To take advantage of this option, the user must either have a new PAV30 mount with the POSOP option or upgrade their mount to the new configuration. Please contact Leica Geosystems for details.

The output from POS AV is applied to the PAV30 stabilized mount via the COM4 serial port interface. Configure the AV POSVIew Controller by selecting **Settings, Input/Output Ports** and the **COM** tabs as on (Figure 104).

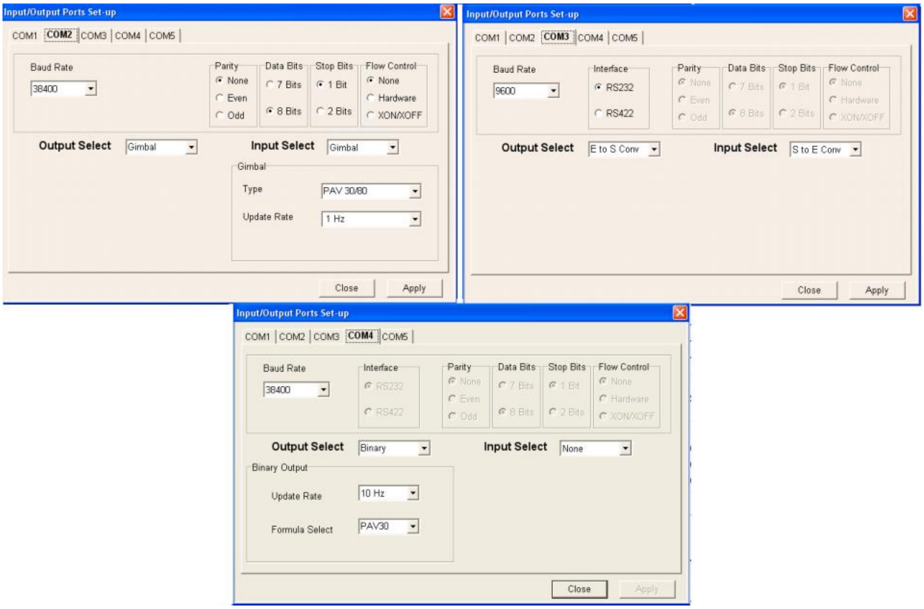


Figure 104: Input and Output Port Settings – PAV30

In addition to controlling the mount, the POS AV can also read the gimbal encoder data from the PAV30 and refine the lever arm computation between the POS Computer System (PCS) antenna and the Inertial Measurement Unit (IMU). The advantage is that with the gimbal data, the GNSS antenna no longer needs to be centered over the camera to within 10 cm (however, this is still recommended). To obtain the gimbal data both the POS AV 1PPS output and the COM2 input are connected to the PAV30. The PAV30 samples the gimbal data at the 1PPS and then transmits it to POS AV via the COM2 port. Please refer to Figure 105 for corresponding PPS output settings under AV POSView Controller **Settings**, **Events**, PPS Out tab settings.

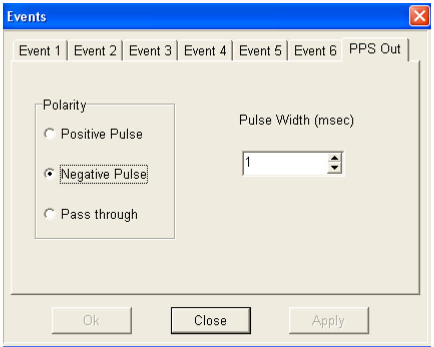


Figure 105: PPS Out Settings – PAV30

Note: COM3 is used with POSTrack option to send gimbal freeze/unfreeze message based on connected FMS. All cables connecting to the POS are provided by Leica Geosystems as part of the POSOP configuration for the PAV30 mount.

YDC CONFIGURATION FOR PAV30 STABILIZED MOUNT

Use the following YDC set-up for the PAV30 stabilized mount (Figure 106):

- Select **Settings, Yaw Drift Correction** on the AV POSView Controller
- Duplicate the settings for the **Cut-off Period** and **Gain** fields

Note: These settings are necessary because the PAV30 stabilized mount has its own filtering mechanism for the drift correction.

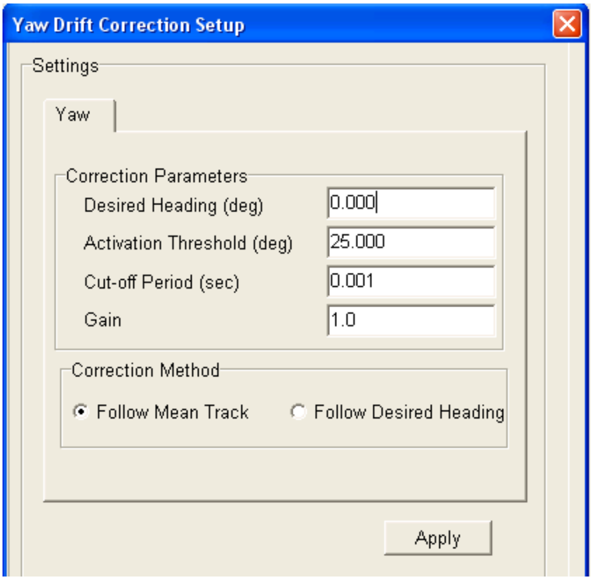


Figure 106: Yaw Drift Correction Setup - PAV30

7. POS AV and the Leica Geosystems PAV80 Stabilized Mount

POS AV provides the attitude (roll/pitch/heading) in reference frame to the Leica Geosystems PAV80 stabilized mount for full 3-axis control. To take advantage of this option, the user must have PAV80 mount with the IMUOP option. Please contact Leica Geosystems for details.

Refer to for high level connection diagram. The mount connects to POS COM2, COM3, COM4 and PPS port.

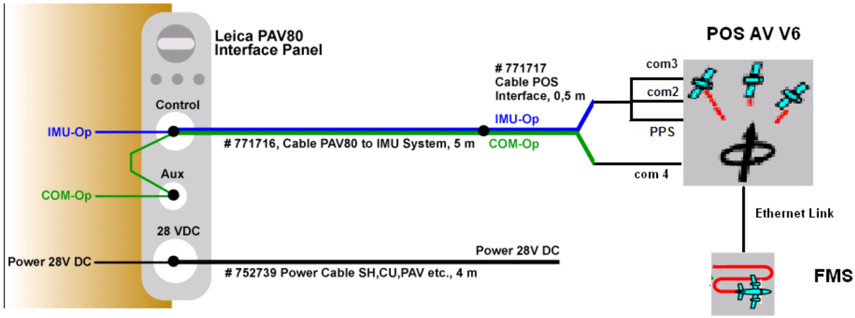


Figure 107: PAV-80 Connection Diagram

The output from POS AV is applied to the PAV80 stabilized mount via the COM4 serial port interface using PAST1 message. Please refer to for corresponding COM port settings.

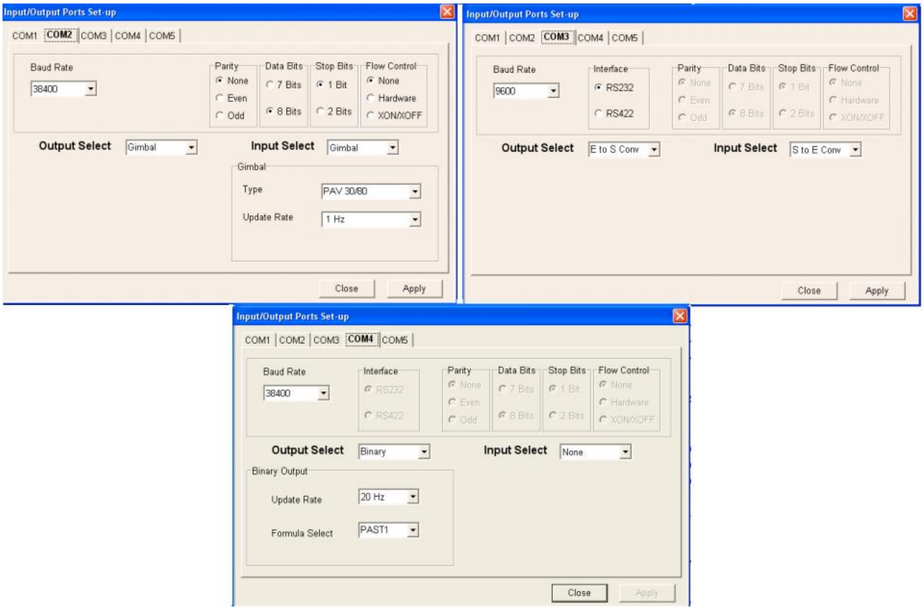


Figure 108: Input and Output Port Settings – PAV80

In addition to controlling the mount, the POS AV can also read the gimbal encoder data from the PAV80 and refine the lever arm computation between the POS Computer System (PCS) antenna and the Inertial Measurement Unit (IMU). The advantage is that with the gimbal data, the GNSS antenna no longer needs to be centered over the camera to within 10 cm (however, this is still recommended). To obtain the gimbal data both the POS AV 1PPS output (**Figure 105**) and the COM2 input are connected to the PAV80. The PAV80 samples the gimbal data at the 1PPS and then transmits it to POS AV via the COM2 port.

Note: COM3 is used with POSTrack option to send gimbal freeze/unfreeze message based on connected FMS. The cables to the POS are provided by Leica Geosystems as part of the IMUOP and COMOP configuration for the

PAV80 mount. There is no need to configure Yaw drift correction in case of PAV80 mount.

8. POS AV and the SOMAG GSM3000/4000 Stabilized Mount

Note: GSM3000 mount firmware version “GSM3000_V4.8.**8**36” is required to control the GSM3000 mount with the POS. The bolded ‘8’ tells indicates that this firmware is intended to be used with the Applanix POS AV. Contact SOMAG for the firmware upgrade.

Note: GSM4000 mount needs to be set up for Interface Protocol 2.0

POS AV is used to provide the YDC, roll and pitch stabilization to the SOMAG GSM3000/4000 stabilized mount for full 3-axis control.

The output from POS AV is applied to the GSM3000/4000 stabilized mount via the COM2 serial port interface. In addition to controlling the mount, the POS AV can also read the gimbal encoder data from the GSM3000 and refine the lever arm computation between the POS Computer System (PCS) antenna and the Inertial Measurement Unit (IMU). The advantage is that with the gimbal data, the GNSS antenna no longer needs to be centered over the camera to within 10 cm (however, this is still recommended). To obtain the gimbal data, the COM2 input must be connected to the GSM3000. The COM port is set-up by selecting **Settings, Input/Output Ports** and the **COM2** tab. Then select **GSM3000/4000** in the **Message Select** drop-down field (Figure 109 and Figure 110).

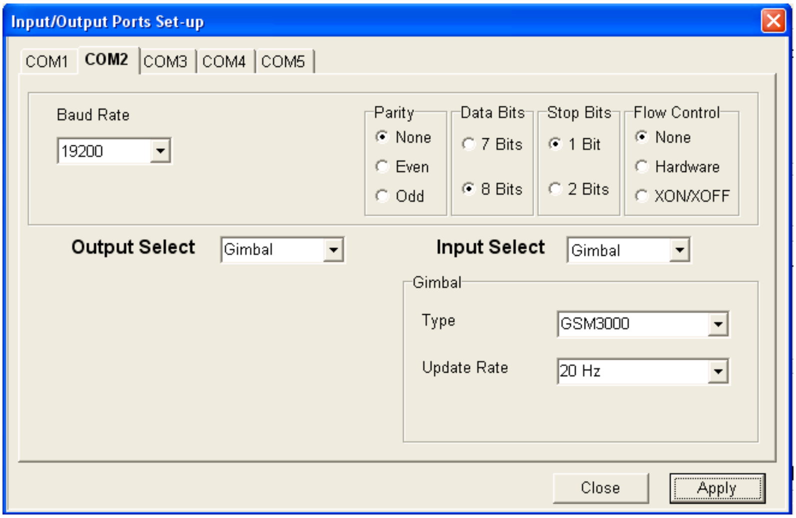


Figure 109: Input and Output Port Settings – GSM3000

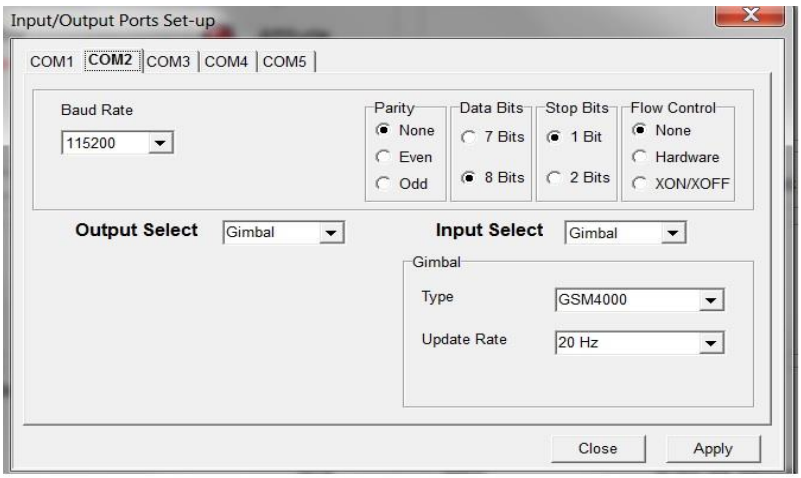


Figure 110: Input and Output Port settings – GSM4000

Note: Only one cable is required for the connection of the GSM3000 mount interface connector to the POS COM2 connector. This cable is provided by Somag with mount.

YDC CONFIGURATION FOR GSM3000/4000 MOUNT

Use the following YDC set-up for the GSM3000/4000 mount (Figure 111):

- Select **Settings, Yaw Drift Correction** on the POS AV Controller
- Duplicate the settings for the **Cut-off Period** and **Gain** fields

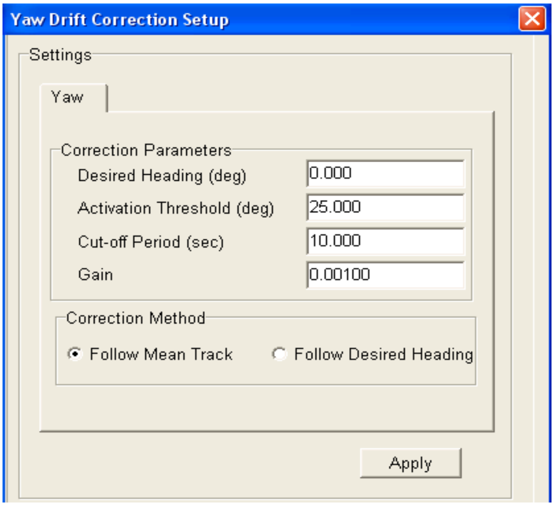


Figure 111: Yaw Drift Correction Setup - GSM3000 Mount

MOUNT CONFIGURATION FOR GSM3000/4000 MOUNT

Use the following mount switch settings to ensure that the GSM3000 will function accordingly when controlled by the POS AV:

Mount Power - ON

Drift Ctrl - ON

Levelling - AUTO

Mode - STAB

Drift – INTGSM4000 mount is supplied with SOMAG tablet for mount set up. Please make sure that Interface Protocol 2.0 is active.

Note: If the GSM3000/4000 is powered-down during flight (e.g. film change on certain cameras), the aircraft must fly level for 70 seconds after the mount is powered-up again (the mount initializes and allows POS to take control of the mount). During this time, the AV POSView Controller reports *GIMBAL ON* or *Not In Use*.

8. Ground Test

Perform the following ground test to verify that the Yaw Drift Corrections are applied to the mount:

- Connect to the POS AV (ensure POS AV is in Nav: Aligned)
- Select **Settings, Yaw Drift Correction** on the AV POSView Controller
- Enter the following values:

Activation Threshold = 25

Cut-off Period = value based on the type of the mount

Gain = values based on the type of mount

Desired Heading = ±25 degrees from the current heading (as shown on the controller main window)

- For stationary test select the method as **Follow Desired Heading**
- The mount steers to the desired heading

9. Troubleshooting

The YDC output displayed in the YDC window (select **View, Yaw Drift Correction**) is 0.0 and not changing:

- If stationary and the **Follow Mean Track** option is selected, the output is always 0.0
- If the **Follow Desired Heading** option is selected and the POS heading is not within the **Activation Threshold** (of the desired heading), the output is always 0.0
- If the POS AV is not in the Aligned mode, the output is always 0.0
- Ensure the YDC option is configured (exception is PAV80 mount)

If the YDC output, displayed in the YDC window (select **View, Yaw Drift Correction**), is changing but the platform is not responding:

- If using a PAV30, ensure the COM outputs is enabled, the PAV30 message is selected and the correct baud rate is selected.
- Check the baud rate configuration on the mount side
- Check all cables

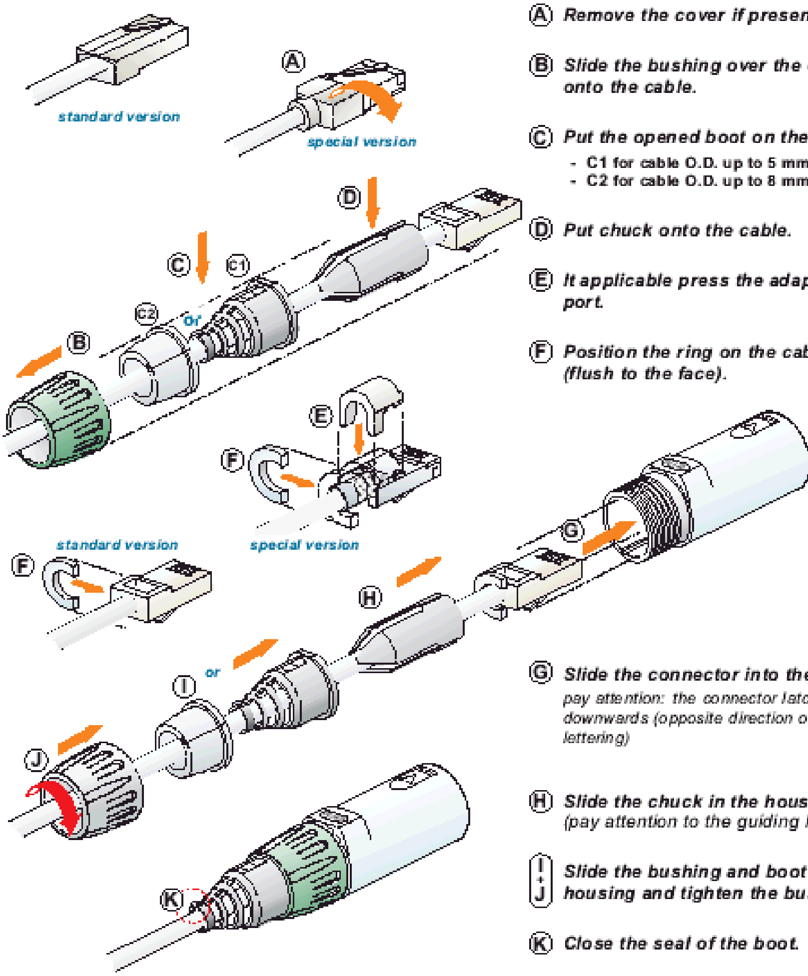
If the platform is responding but is moving back and forth at a high rate:

- For non-PAV30 applications, reduce the **Gain** and increase the **Cut-off Period** until the platform moves slowly and smoothly (i.e. 0.005 and 5.000 seconds)

Appendix K

Ruggedized RJ-45 Data Connector

Assembly Instructions for the NE8MC



Ⓐ *Remove the cover if present.*

Ⓑ *Slide the bushing over the connector onto the cable.*

Ⓒ *Put the opened boot on the cable.*
- C1 for cable O.D. up to 5 mm (0.2")
- C2 for cable O.D. up to 8 mm (0.3")

Ⓓ *Put chuck onto the cable.*

Ⓔ *It applicable press the adapter into the port.*

Ⓕ *Position the ring on the cable end (flush to the face).*

Ⓖ *Slide the connector into the housing.*
pay attention: the connector latch has to point downwards (opposite direction of RJ-45 lettering)

Ⓗ *Slide the chuck in the housing (pay attention to the guiding key).*

I + J *Slide the bushing and boot to the housing and tighten the bushing.*

Ⓚ *Close the seal of the boot.*

Appendix L

POSTrack V6

1. Introduction

POSTrack is the fully integrated, real-time direct georeferencing and Flight Management System (FMS) designed for the airborne geospatial community. It is a blend of the precision of POS AV with the versatility of the Track'air X-track FMS. The compact POSTrack solution offers tight integration of both products. Also included is a touch screen pilot's tablet that allows for pilot-only operation.

The POSTrack V6 consists of:

- POS AV V6 (Standard AV V6 PCS)
- POSTrack Interface Unit (PIU) with embedded Ethernet switch and power distribution for entire system including two tablet computers
- Pilot touch screen tablet computer
- Operator touch screen tablet computer (not included in default configuration)
- Two installations of POSTrack software firmware:
  a) Preinstalled pilot tablet firmware with server capability that enables the system to work in pilot only operation
  b) Operator firmware with client capability licensed to end-user, can be installed on standard Windows laptop or tablet computer available from Applanix as an option component.
- POS AV real time firmware with enabled software options:

a) FMS option that supports network communication with Flight management system and triggering algorithm for the camera

b) YDC option that supports automatic yaw drift correction and mount stabilization

c) LID option that provides lidar on/off logging message in order control the logging based on planned mission

The system offers the flexibility of having two separate views for pilot and operator. Figure 112 shows a view of the POSTrack system.

Figure 112: POSTrack System

Specifications

a) Physical

<u>POSTrack System (PCS and PIU)</u>

Temperature Range: -20 °C to +55 °C

Size: 179 L x 323 W x 68 H mm

Weight: 4.0kg

Power: 20 to 34 Vdc, 110 W max (including IMU, GNSS, pilot’s tablet)

Pilot Touch Screen Tablet

Temperature Range: -20 °C to +50 °C

Size: 40 L x 159 W x 258 H mm

Weight: 1.2 kg

b) Sensor Interfaces

3-axis Mount

Drift Correction:

T-AS with Digital Interface Box (RS-232)

PAV30 (RS-232) (requires POSOP from Leica Geosystems)

PAV80 (RS-232) (requires IMUOP,COMOP from Leica Geosystems)

GSM300 (RS-232)

DSS Azimuth Mount (RS-232)

Z/I Mount (RS232)

Levelling Control: PAV30 (RS-232)

PAV80 (RS232)

GSM3000 (RS-232)

Z/I Mount (RS232)

Gimbal Encoder: PAV30 (RS-232) (requires POSOP from Leica Geosystems)

PAV80 (RS-232) (requires IMUOP from Leica Geosystems)

GSM3000 (RS-232)

DSS Azimuth Mount (RS-232)

Z/I Mount (RS232)

Stabilizer Control: GSM3000 (RS-232)

T-AS with Digital Interface Box (RS-232)

Z/I Mount (RS232)

PAV30/PAV80

Frame Camera

Triggering/MEP: RC20/30

TOP RMK

LMK 1000

LMK 2000 (requires an additional interface module)

Vexcel UltraCam

Generic (5V TTL Triggering/MEP)

Data Interface: RC20/30 (RC20 w/o data annotation) (requires an Extended EDI interface from Leica Geosystems)

TOP RMK (requires a TCU digital interface)

Vexcel UltraCam

DiMAC

LMK1000 (requires additional interface module)

Generic (RS-232)

LiDAR

Logging On/Off: Riegl Q series via Etherent.

2. Set-Up

a) Hardware Configuration

POSTrack consists of two boxes: an PIU (POSTrack Interface Unit) and a standard PCS (POS Computer System) and a touch screen pilot's tablet running server version of the FMS software. The PIU and PCS is powered separately from standard aircraft power through "Y" power cable; refer to Figure 113, page L-7, for the complete system dimensions and detailed front and rear views. The PIU contains an embedded rugged Ethernet switch (1000BaseT) that allows up to five external devices (two tablets, POS AV, LiDARs, additional sensors, etc.) to connect and communicate..

b) Interconnections

Figure 117 shows the generic interconnects between the PIU, the PCS and external system components. Figures 118 through 121 (pages L-12 through L-15) provide a detailed interconnect for the following configurations:

- POSTrack with an RC20/30 camera using a PAV30 mount
- POSTrack with a TOP RMK camera using a T-AS mount analog interface
- POSTrack with an UltraCAM camera using a GSM3000 mount

Note1: To install the Applanix IMU inside the UltraCAM cameras ensure that Vexcel has provided the latest IMU adapter plate; see Figure 114, page L-8. Please contact Vexcel for more information.

Note2: The Mid Exposure Pulses (MEP) generated by the UltraCam cameras has a variable delay that is recognised by POSPac. POSPac automatically generates a PhotoID file during extraction that contains the variable MEP delay. POSEO provides the option of choosing a photoID file that accounts for the variable delay. Choosing to include the variable delay causes the generation of the Exterior Orientation (EO) parameters that compensate for the variable delay.

- POSTrack with an LMK2000 camera using a GSM3000 mount

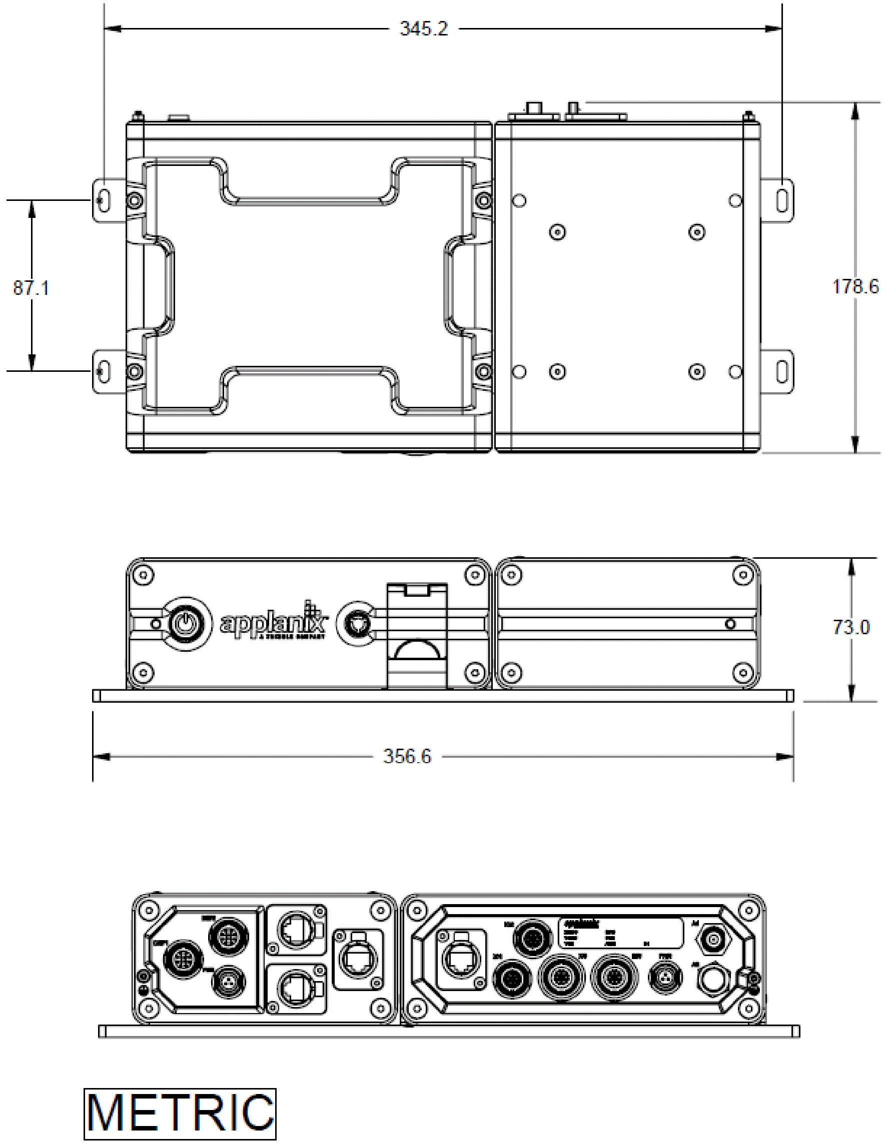
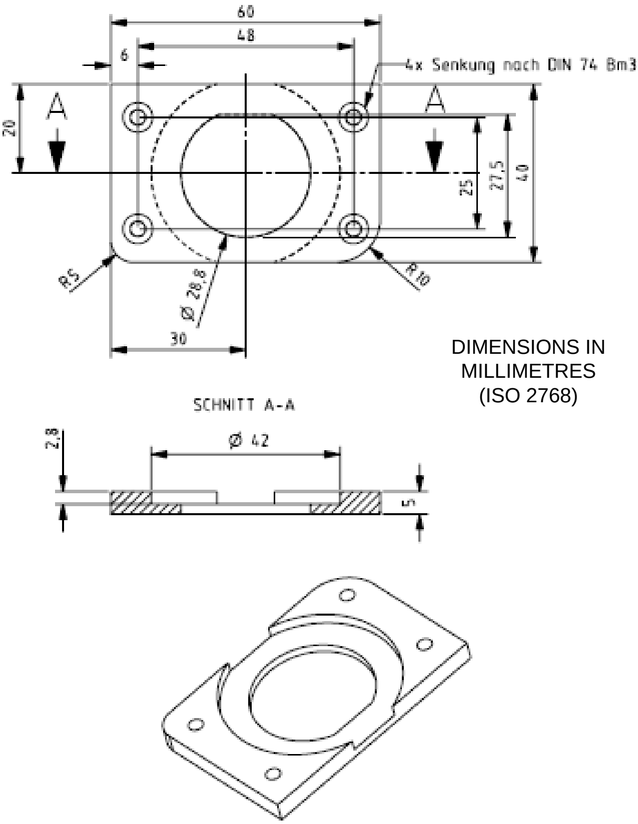


Figure 113: POSTrack System Dimensions



DIMENSIONS IN
MILLIMETRES
(ISO 2768)

Figure 114: UltraCAM IMU Adapter Plate

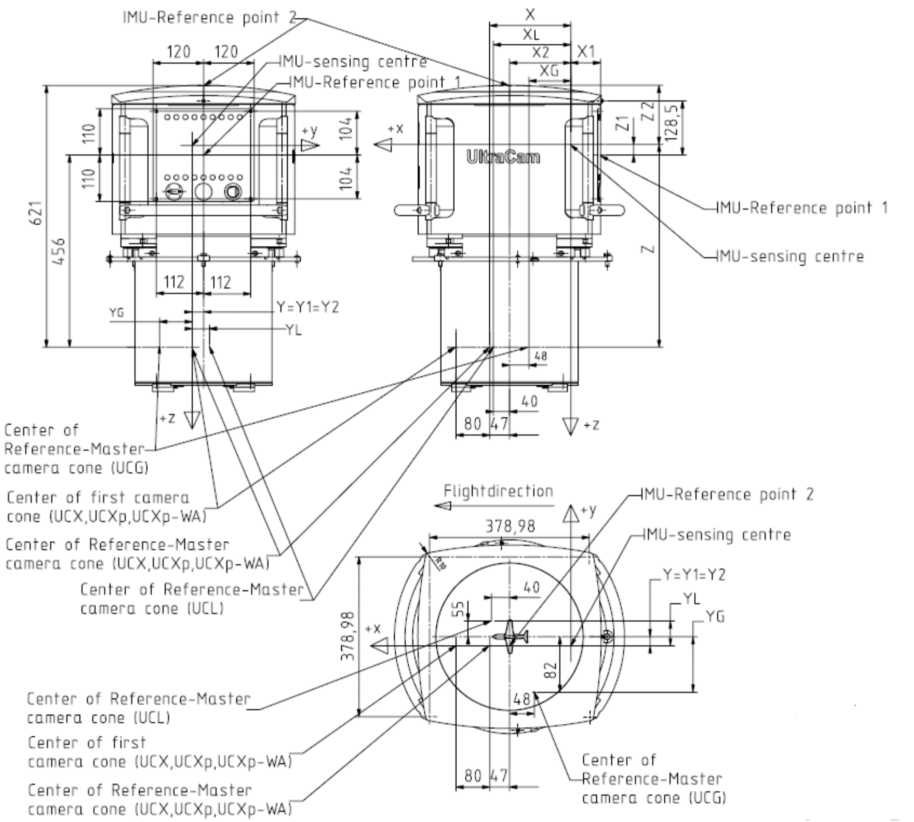


Figure 115: (1 of 2) UltraCAM IMU Offset

IMU-sensing centre x=0; y=0; z=0

Sensor Lever Arm of The UltraCam

Use XL and YL for UltraCamL

Applaix LN200	Applanix AIMU	Applanix SAGEM	Applanix Typ 26 and 29	Applanix Typ 31
XL= 202,9 mm	XL= 196,0 mm	XL= 176,0 mm	XL= 166,6 mm	XL= 186,5 mm
YL= 60,7 mm	YL= 55,0 mm	YL= 70,0 mm	YL= 75,0 mm	YL= 99,0 mm
Z= 470,9 mm	Z= 476,0 mm	Z= 476,0 mm	Z= 473,0 mm	Z= 434,1 mm

Use XG and YG for UltraCamG

Applaix LN200	Applanix AIMU	Applanix SAGEM	Applanix Typ 26 and 29	Applanix Typ 31
XG= 114,9 mm	XG= 108,0 mm	XG= 880, mm	XG= 78,6 mm	XG= 98,5 mm
YG=-76,3 mm	YG=-82,0 mm	YG=-67,0 mm	YG=-62,0 mm	YG=-38,0 mm
Z= 470,9 mm	Z= 476,0 mm	Z= 476,0 mm	Z= 473,0 mm	Z= 434.1 mm

Use X and Y for UltraCamX, UltraCamXp

Applaix LN200	Applanix AIMU	Applanix SAGEM	Applanix Typ 26 and 29	Applanix Typ 31
X= 209,9 mm	X= 203,0 mm	X= 183,0 mm	X= 173,6 mm	X= 193,5 mm
Y= 5,7 mm	Y= 0,0 mm	Y= 15,0 mm	Y= 20,0 mm	Y= 44,1 mm
Z= 470,9 mm	Z= 476,0 mm	Z= 476,0 mm	Z= 473,0 mm	Z= 434,1 mm

If UltraCam (UCX and UCXp not UCL und UCG) is not supported by a flight managment system tha. relies on the full set of metadata including correction formula for midexposure feedback,the reference point will be changed from Reference-Master Cone to the first camera cone in the flight direction.
This would change the refernce coordinates to:

Applaix LN200	Applanix AIMU	Applanix SAGEM	Applanix Typ 26 and 29	Applanix Typ 31
X= 289,9 mm	X= 283,0 mm	X= 263,0 mm	X= 253,6 mm	X= 273,5 mm
Y= 5,7 mm	Y= 0,0 mm	Y= 15,0 mm	Y= 20,0 mm	Y= 44,1 mm
Z= 470,9 mm	Z= 476,0 mm	Z= 476,0 mm	Z= 473,0 mm	Z= 434,1 mm

OFFSETS: Referenze-Point to IMU-sensing centre

Offset IMU-Reference point 1:

Applaix LN200	Applanix AIMU	Applanix SAGEM	Applanix Typ 26 and 29	Applanix Typ 31
X1= -53,0 mm	X1= -60,3 mm	X1= -80,0 mm	X1= -89,4 mm	X1= -69,5 mm
Y1= 5,7 mm	Y1= 0,0 mm	Y1= 15,0 mm	Y1= 20,0 mm	Y1= 44,1 mm
Z1= 14,9 mm	Z1= 20,0 mm	Z1= 20,0 mm	Z1= 17,0 mm	Z1= -21,9 mm

Offset IMU-Reference point 2:

Applaix LN200	Applanix AIMU	Applanix SAGEM	Applanix Typ 26 and 29	Applanix Typ 31
X2= 162,9 mm	X2= 156,1 mm	X2= 136,0 mm	X2= 126,6 mm	X2= 146,5 mm
Y2= 5,7 mm	Y2= 0,0 mm	Y2= 15,0 mm	Y2= 20,0 mm	Y2= 44,1 mm
Z2=-150,5 mm	Z2=-146,0 mm	Z2=-146,0 mm	Z2=-149,0 mm	Z2= -187,5 mm

Figure 116: (2 of 2) UltraCAM IMU Offset

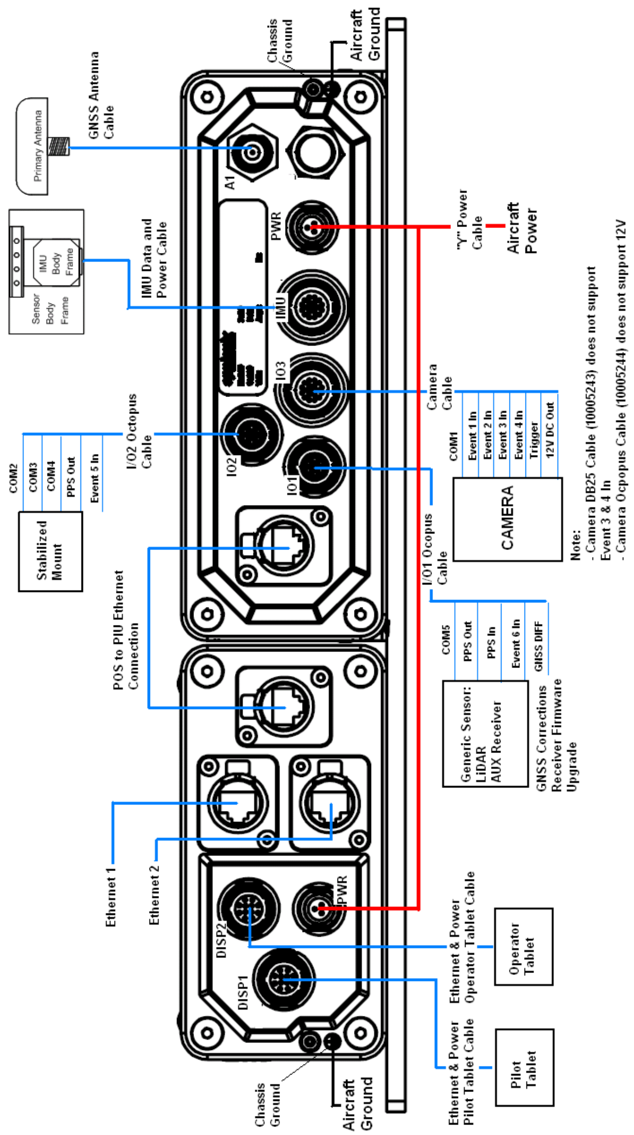


Figure 117: POSTrack System Generic Interconnect Diagram

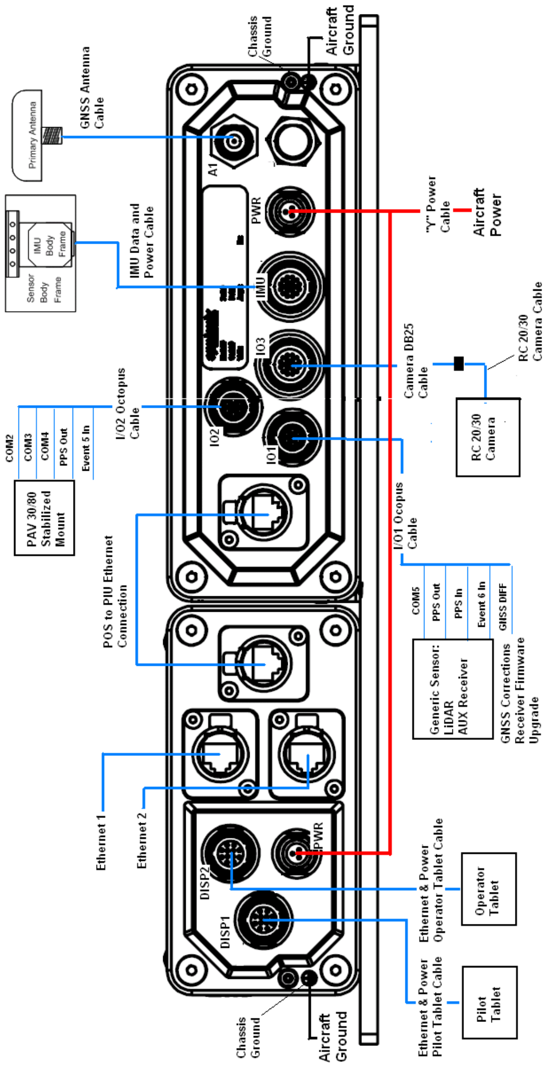


Figure 118: POSTrack with an RC20/30 Camera using a PAV30/80 Mount

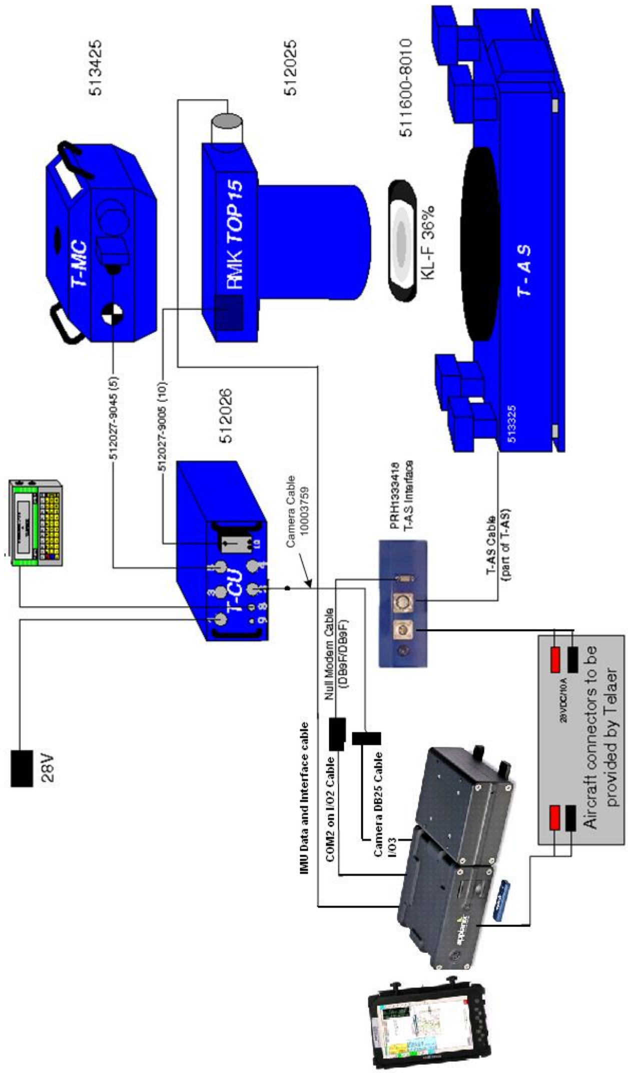


Figure 119: POSTrack with a RMK TOP Camera using a T-AS Mount

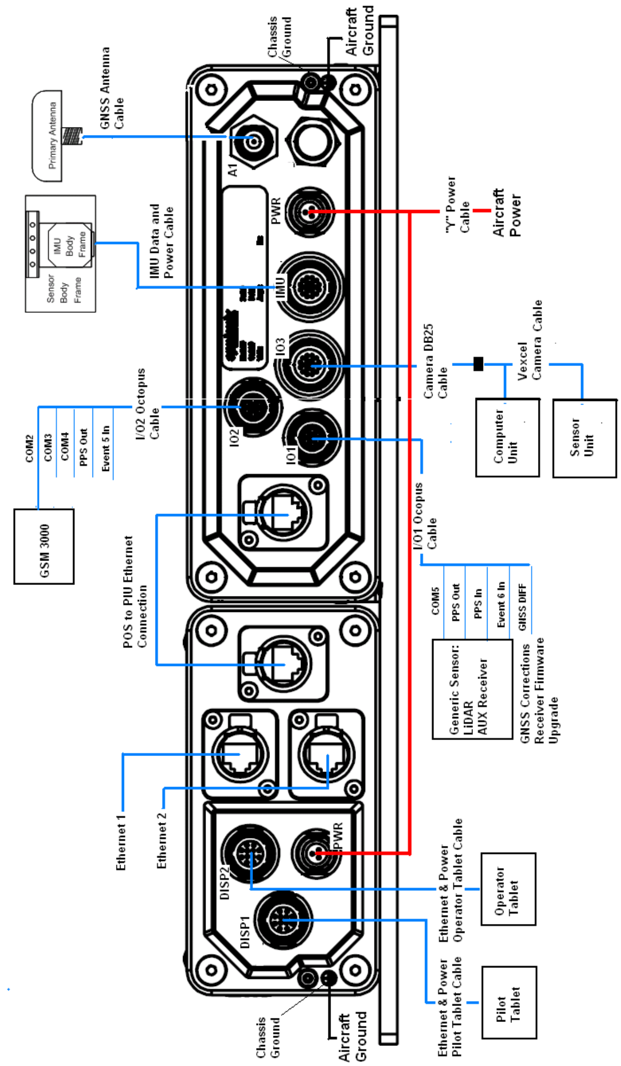


Figure 120: POSTrack with an UltraCAM Camera using a GSM3000 Mount

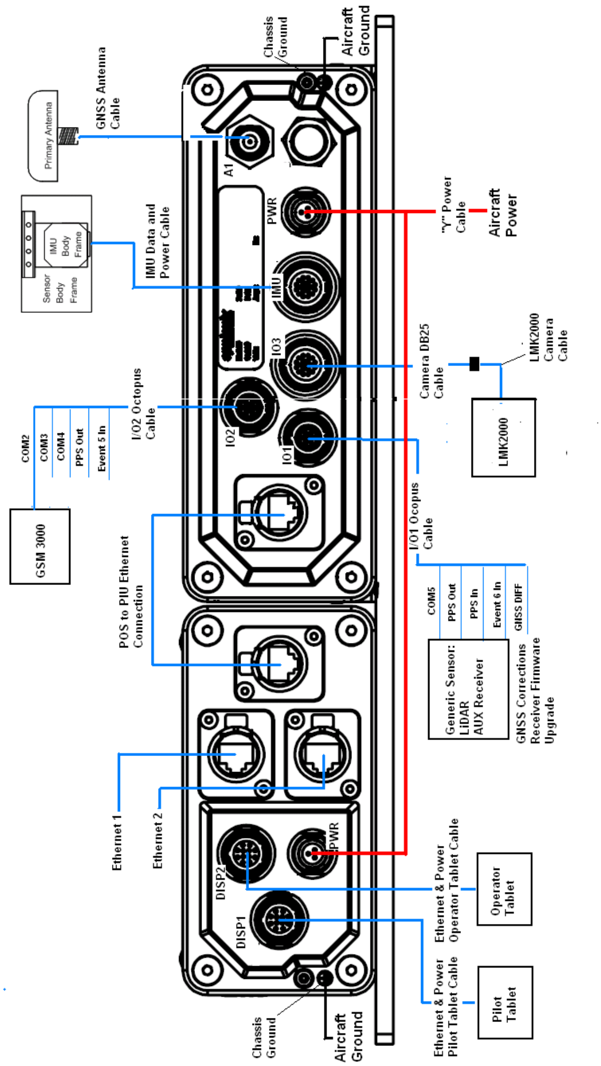


Figure 121: POSTrack with an LMK2000 Camera using a GSM3000 Mount

Table 58 provides the list of supported stabilized mounts with respect to functionality and interface on I/O2 connector of the POS AV V6.

Table 58: POSTrack V6 Mount Interface

Mount	Yaw Drift Control	Roll/Pitch Levelling	COM2	COM3	COM4	PPS
Somag Mounts	Yes	Yes	Yes	N/A	N/A	N/A
PAV30	Yes	Yes	Yes	Yes	Yes	Yes
PAV80	Yes	Yes	Yes	Yes	Yes	Yes
Z/I	Yes	Yes	Yes	N/A	N/A	N/A
TAS	Yes	No	Yes	N/A	N/A	N/A
Azimuth Mount	Yes	No	Yes	N/A	N/A	N/A

The PIU has the following connectors on the rear panel:

1. DISP1- provides Ethernet and power to the Pilot tablet
2. DISP2-provides Ethernet and power to the Operator tablet.
3. PWR-power connector 20-34V DC
4. Ethernet 1/2/3- three rugged RJ45 Ethernet connectors .

The description of the connectors on PCS side, can be found under section External Interfaces on page 8-1.

The I/O3 cable delivered with the POSTrack V6 product is single camera cable about 30cm long that ends with DB-25 connector (Figure 122). It is backward compatible with all existing camera cables.

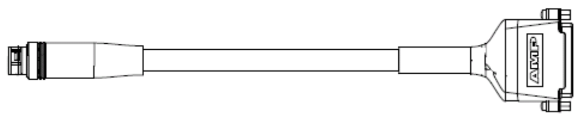


Figure 122: Camera DB-25 Cable

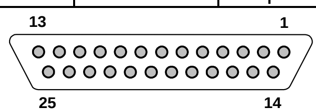
The pin assignments is shown in the Table 59.

Table 59: POSTrack System Camera Cable Pin Assignment

DB-25S Pin	Pin Description	Signal Type	Signal Direction (wrt PCS)
1	N/C (no connection)	N/A	N/A
2	TX (transmit data)	RS-232	Output

DB-25S Pin	Pin Description	Signal Type	Signal Direction (wrt PCS)
3	RX (receive data)	RS-232	Input
4	N/C (no connection)	N/A	N/A
5	RTS (request to send)	RS-232	Output
6	N/C (no connection)	N/A	N/A
7	N/C (no connection)	N/A	N/A
8	GND (signal ground)	RS-232	N/A
9	N/C (no connection)	N/A	N/A
10	EVENT 1 IN	TTL	Input
11	EVENT 2 IN	TTL	Input
12	+12 Vdc	N/A	Output
13	GND (signal ground)	N/A	N/A
14	GND (signal ground)	N/A	N/A
15	N/C (no connection)	N/A	N/A
16	+12 Vdc	N/A	Output
17	N/C (no connection)	N/A	N/A
18	N/C (no connection)	N/A	N/A
19	N/C (no connection)	N/A	N/A
20	EVENT 1 OUT	5V TTL	Output
21	N/C (no connection)	N/A	N/A
22	N/C (no connection)	N/A	N/A
23	EVENT 1 OUT	5V TTL	Output
24	EVENT 1 OUT	5V TTL	Output
25	EVENT 2 OUT	5V TTL	Output

DB-25S (female)
Camera connector, part of I/O cable



The following ports are available on Pilot tablet:

2 x USB 2.0 ports - The ports are used to import/export flight plans, upgrading FMS firmware, etc.). The ports may also be used to connect external interface devices such as a mouse, trackball or keyboard.

Power and standard Ethernet Connectors.

Each POSTrack system comes with the following cables:

- PCS to IMU (5 m), see section 8.0
- PCS to camera (5 m)
- PIU to pilot's tablet (5 m)
- POSTrack (PIU/PCS) power (2 m)
- Short Ethernet (PCS to PIU) cable (0.3 m)
- PCS I/O1 and I/O2 Octopus style cable (0.3 m)

Note 1: POS to GSM3000 cable is supplied by SOMAG AG.

Note 2: POS to PAV30 and PAV80 mount cable is supplied by Leica Geosystems and is included in their POSOP option.

Note 3: RC30 aerial camera data annotation requires an extended EDI interface from Leica Geosystems.

Note 4: TOP RMK aerial camera data annotation requires a TCU digital interface from Z/I Integraph.

Note 5: The Pilot tablet computer is shipped without internal battery.

3. Upgrade Path

POSTrack has an upgrade path. Here are the possibilities:

i. If you own a POS AV V4 with a Track'air EZtrack system you can return the following to Applanix**:**

- The POS AV V4 PCS
- All the POS AV V4 cables (except GNSS antenna cable)
- All the EZtrack components, including the pilot's display and cables

And as part of the upgrade, you will receive:

- A complete POSTrack (PIU and POS AV V6 PCS) without IMU sensor
- All associated I/O, data, and power cables, including new IMU cable for associated IMU type
- Pilot tablet computer with yoke mount
- High gain GNSS antenna
- The latest POS AV V6 User Manual and Documentation
- The latest POS AV V6 Firmware and Controller software
- A license upgrade for the new POSTrack software 4.xx

ii. If you own a POS AV V5 with a Track'air EZtrack or TrackAir XTrack system you can return the following to Applanix:

- All the EZtrack/XTrack components, including the pilot's display and cables
- The POS AV V5 cables (except GNSS antenna cable and IMU cable)
- The POS AV V5 PCS

As part of the upgrade, you will receive:

- A complete POSTrack (PIU and POS AV V6 PCS) without IMU sensor
- Pilot tablet computer with yoke mount
- High gain antenna
- All the associated I/O and power cables including short stub IMU cable that provides backward compatibility with already installed V5 IMU cables
- A license upgrade for the new POSTrack software 4.xx

iii. If you own a POSTrack V5 system you can return the following to Applanix:

- Entire POSTrack V5, including the pilot's display and cables
- Keep existing Camera, GNSS and IMU cable

As part of the upgrade, you will receive:

- A complete POSTrack V6 (PIU and POS AV V6 PCS) without IMU sensor
- Pilot tablet computer with yoke mount
- All the associated I/O and power cables including short stub IMU cable that provides backward compatibility with already installed V5 IMU cables
- A license upgrade for the new POSTrack software 4.xx

Note: Please contact Applanix Customer Support (see Appendix A) prior to connecting other camera cables to POSTrack.

4. POSTrack Software

Do not install any software on the Pilot tablet unless it is specifically designed for the POSTrack and provided by Applanix. Otherwise, failure of the system can occur.

Important: For POSTrack to operate, confirm that the PCS is operating with the following:

- POS firmware version 1.9 (or greater)
- POSConfig option 4 (YDC) is enabled
- POSConfig option 20 (FMS) is enabled
- POSConfig option 22 (LID) is enabled
- AV POSView Controller version 1.9

Please contact customer support (see Appendix A) for upgrades if you have not received them with your system.

The FMS software consists of planning and real time operation such as pilot guidance and automatic camera triggering based on pre-planned intervals. Please refer to PUBS-MAN-003760 (POSTrack User Guide) for more information.

The FMS software comes with two different firmware installations:

- Flight Computer System (FCS) Firmware that is installed on the Main Computer used in real time operation (Tablet Display, SR820)
- Office or Operator Software, usually installed on the office or operator computer. For user convenient multiple computers can be registered with the same license.

The pilot tablet (FCS), part of the POSTrack system, ships with the following software pre-installed:

- X-track snapSHOT32 (flight navigation and camera triggering)
- X-track snapBASE32 (flight planning)
- X-track snapPLAN32 (coordinates entry utility)
- X-track snapXYZ32 (database management and maintenance)
- Latest AV POSView Controller (see section 4.0)
- Virtual Keyboard (displays a keyboard for typing characters)
- RClick (next touch command is a right click)

Refer to the snapSHOT32, snapBASE32, snapPLAN32 and snapXYZ32 user manuals (PUBS-MAN-003760) for details on how to operate each software module.

5. POSTrack Operation

Before flight ensure the security of all POSTrack system hardware and connections (i.e. PCS,PIU, tablet, optional laptop)

Note 1: Applanix recommends the following: power-up sequence - stabilized mounts first, PCS, Pilot tablet and the Camera/LiDAR/Sensor; upon cessation of a flight, the power-down sequence - camera equipment first, Pilot tablet, PCS and the stabilized mounts (opposite to the power-up sequence.

Note 2: Please make sure that pilot tablet is removed from the yoke during take off and landing.

POSTrackV6 (similar as POSTrack V5) provides two different modes of operation:

- Pilot Only Mode:

  This is the case when only one external computer is on the network. This is the Main Computer provided by Applanix, often referred as Pilot tablet. It acts as FCS (Flight Computer System) and runs Server version of the POSTrack firmware.

- Client-Server Mode:

  The additional Client Computer has been added to the network beside the Main Computer for the purpose of Operator display. It runs the Client version of the POSTrack firmware. The additional tablet is optional. Applanix can supply tablet with the Ethernet and power cable for direct connection to PIU. In the case of two tablet computers user can decide which tablet to use for pilot guidance and which one as operator display.

Note: If two Tablets are used (one for Pilot and one for Operator) it is important to label them as Main (FCS) and Client Computer.

PILOT ONLY CONFIGURATION

This operation involves only the Main Computer, which must be the Tablet Display supplied by Applanix.

The pilot has full control over the system via the touch screen pilot's display, which is used by the pilot to load the flight plans and select the flight lines during a mission.

Very first time prior to using the software to communicate with the PCS, configuration of the IP addresses and sensors is required.

Procedure:

<u>IP Address and Sensor Configuration</u>

Start the SnapSHOT utility on the Tablet Display and chose Configuration option “Change Configuration”, as indicated on Figure 123.

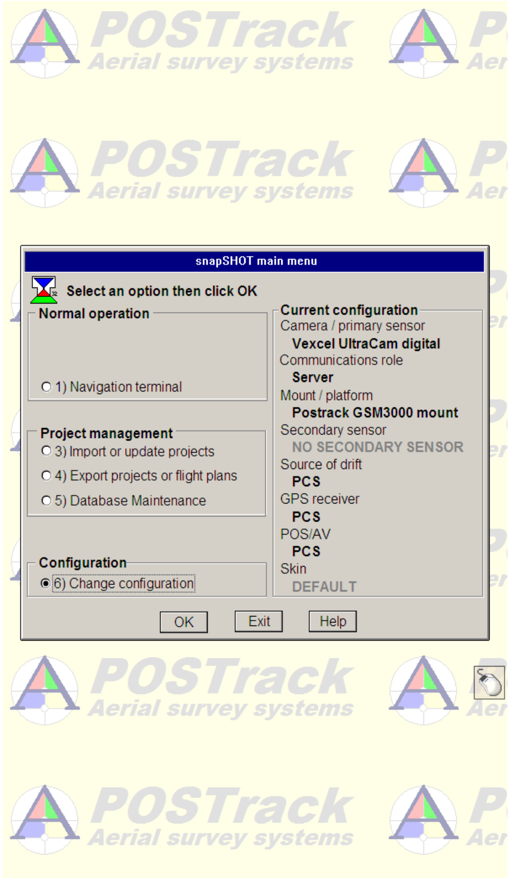


Figure 123: snapSHOT32 Main Menu - Pilot's Display

In the "General Configuration" form select desired camera under Primary Sensor. If operation requires a stabilized mount, it can be selected under Mount properties. In order to configure or verify the IP addresses click on the bar *"Set Applanix FCS and PCS IP addresses"*. Please refer to Figure 124.

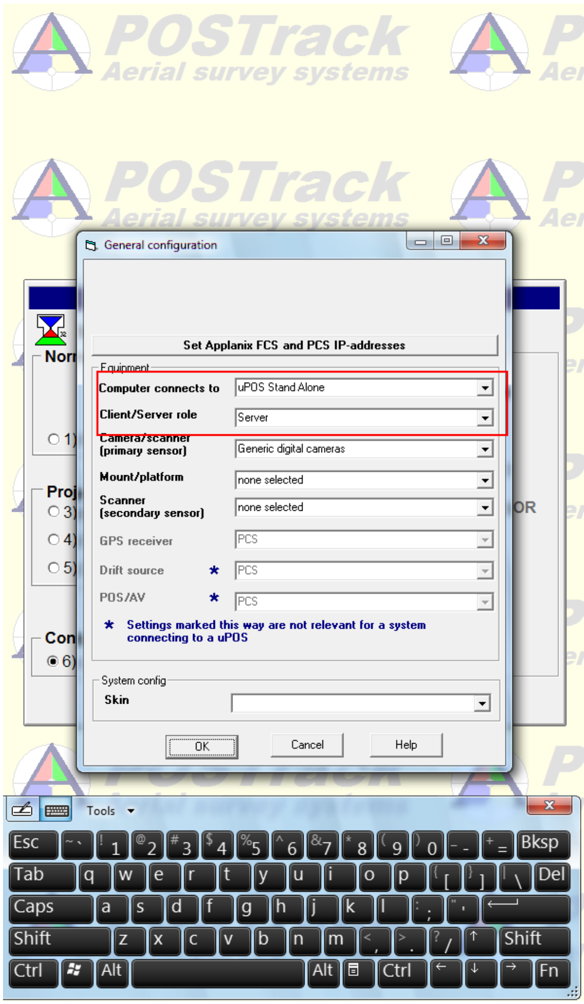


Figure 124: General Configuration Display – Pilot

In case of POSTrack V6 SA, make sure that following properties are set property on the Main computer (Pilot Tablet):

- "Computer connects to": uPOS Stand Alone

- "Client/Server Mode": Server

The PCS and Tablet Display IP addresses can be verified or changed using the "POSTrack Configuration" window. If the PCS is powered up and the static address of Tablet is in the same network range as PCS address, the Snapshot application can auto-detect the POS addrss by clicking on the "Verify" button. As an example, refer to Figure 124, where the PCS address is 172.16.20.222 and Tablet address is 172.16.20.14.

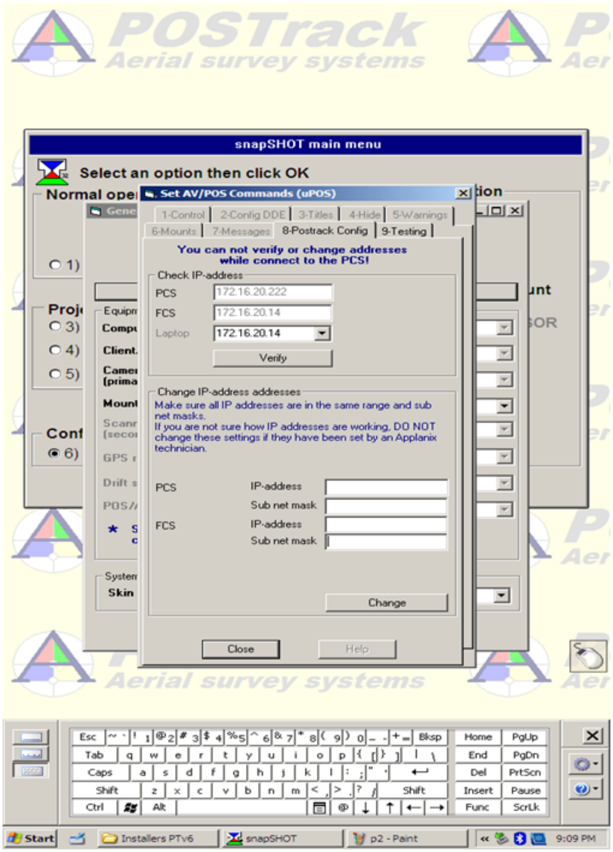


Figure 125: IP Address Configuration

Flight Plan Import

Using the option *"Import or Update Projects"* from the main menu (Figure 123) locate the location of the flight plan that you want to import (usually USB memory stick). Refer to Figure 126 for two easy steps of importing the flight plan.

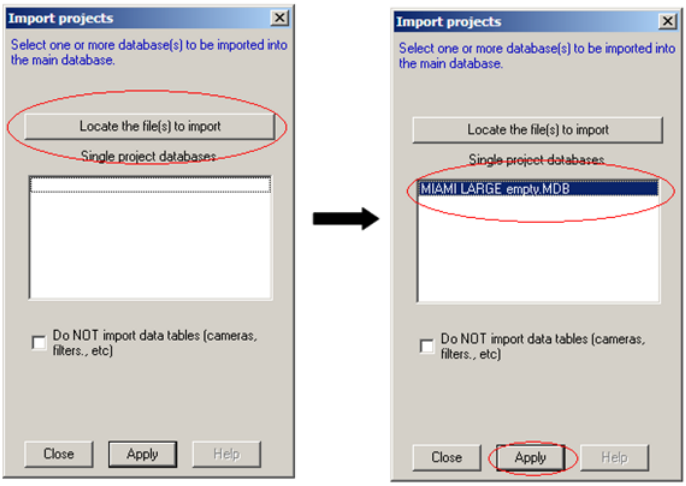


Figure 126: Flight Plan Import

Real Time Operation

Once the flight plan is imported and the system is configured, the FMS software is ready to connect to PCS. Start the SnapShot application, select the *"Navigation Terminal"* option from the main menu (Figure 123), and make sure that PCS is powered up. Then load the flight plan from the data base for real time operation (Figure 127).

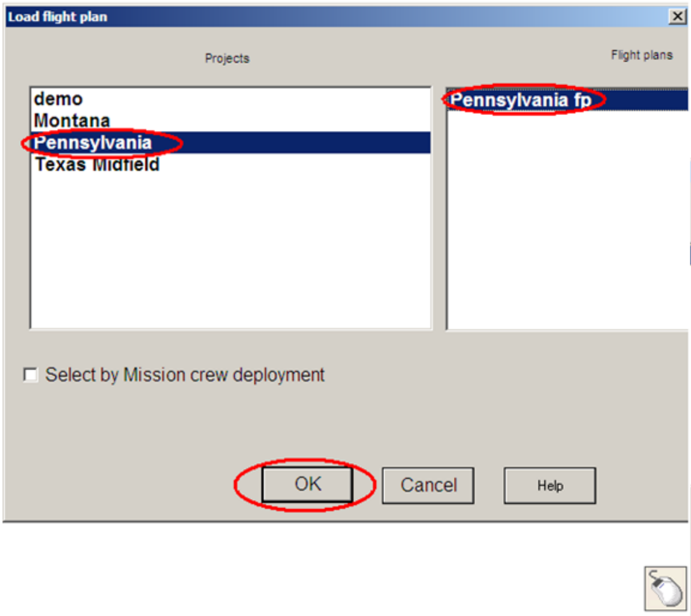


Figure 127: Loading the Flight Plan

The flight plan will be loaded as a background in SnapShot.

Using the GPS button 20, connect to the PCS. If the selected camera type provides the status, following the connection to PCS the status will be displayed in Camera Status bar.

Select **Equipment, Applanix POS, Show configuration form** menu bar (Figure 128, page L-31) to display Set AV/POS Commands display (Figure 129, page L-32). Check following items on 9 tabs:

- Verify that desired POS logging groups are selected and that logging is started
- Verify that Yaw Drift Control settings are correct for your mount (refer to Specification for Yaw Drift Control starting on page J-1 for more details)

- Verify that correct mount is selected and that mount settings are correct
- Choose view/hide display of POS status information (i.e. Events, IMU, GPS, etc.)

Note: This window can be opened at any time and is the primary interface to configure/control POS.

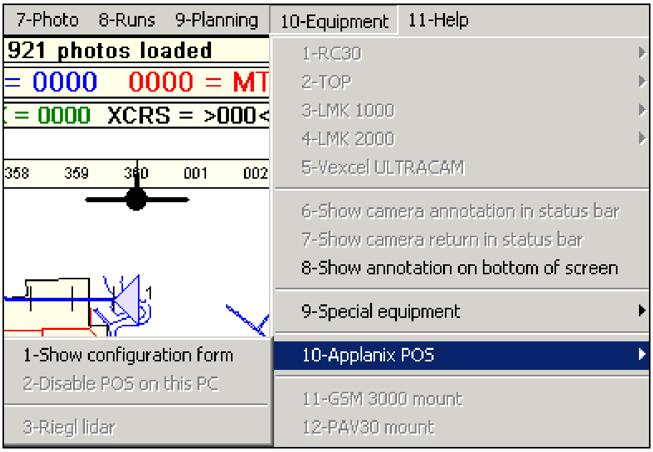


Figure 128: snapSHOT32 Menu - Equipment

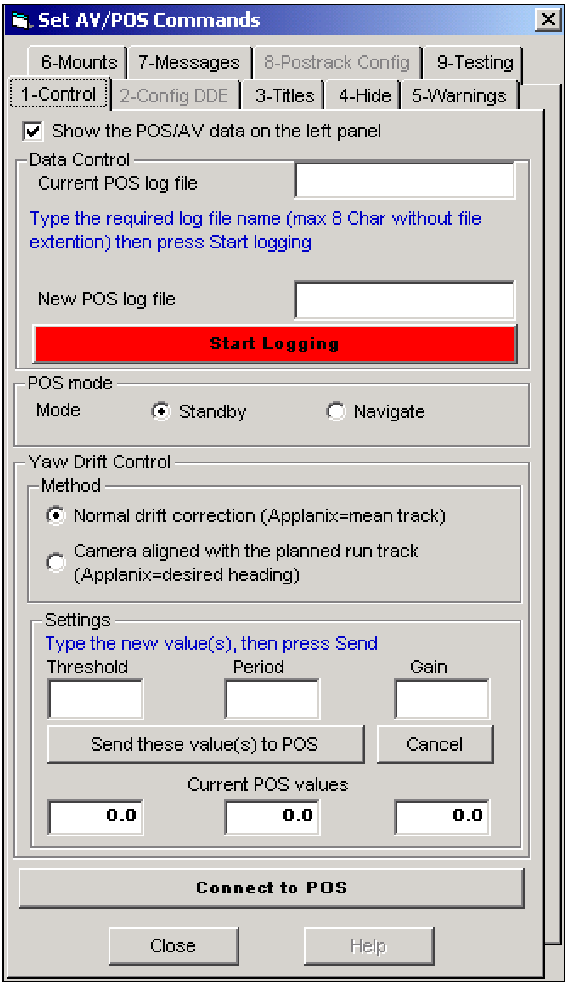


Figure 129: Set AV/POS Commands Display

Select **Tools, Troubleshooting, Make a camera ground test** from menu bar (Figure 130, page L-33). Perform test to ensure that all sensors attached to POSTrack system (mount, camera, etc.) are functioning correctly (Figure 131, page L-33). If everything is operating correctly, a simulation of an airplane will fly along the flight lines, and automatically trigger camera and turn-on/off stabilization where applicable (Figure 132, page L-34).

To stop simulation, click on the **STOP** icon (12) and close simulator window (Figure 132, page L-34).

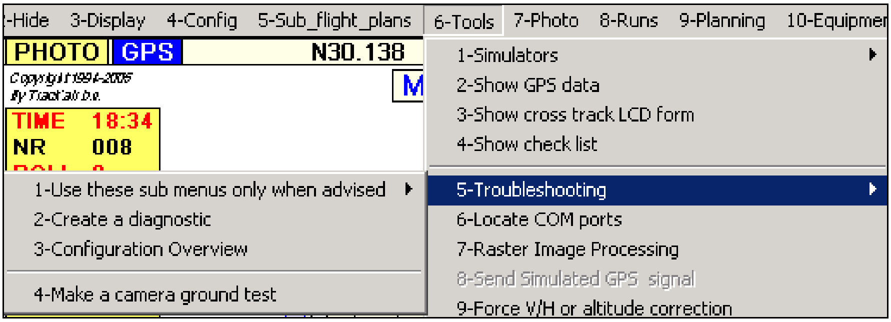


Figure 130: snapSHOT32 Menu - Troubleshooting

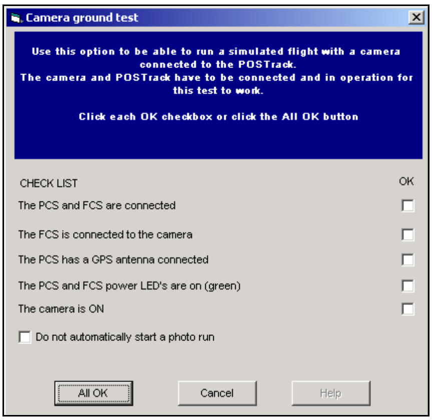


Figure 131: Camera Ground Test Display

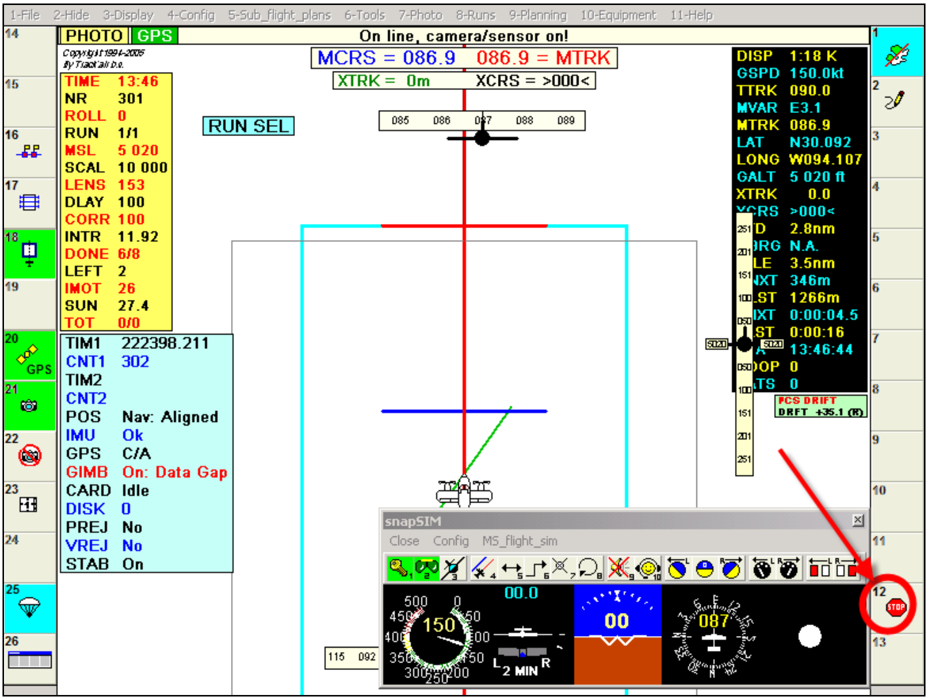


Figure 132: Ground Test Simulation Display

To begin a mission, click on **GPS** icon (20), verify that POS panel appears and that there are no warnings on snapSHOT32 display (Figure 133, page L-35). Next, right-click mouse on desired flight line in order to select the line

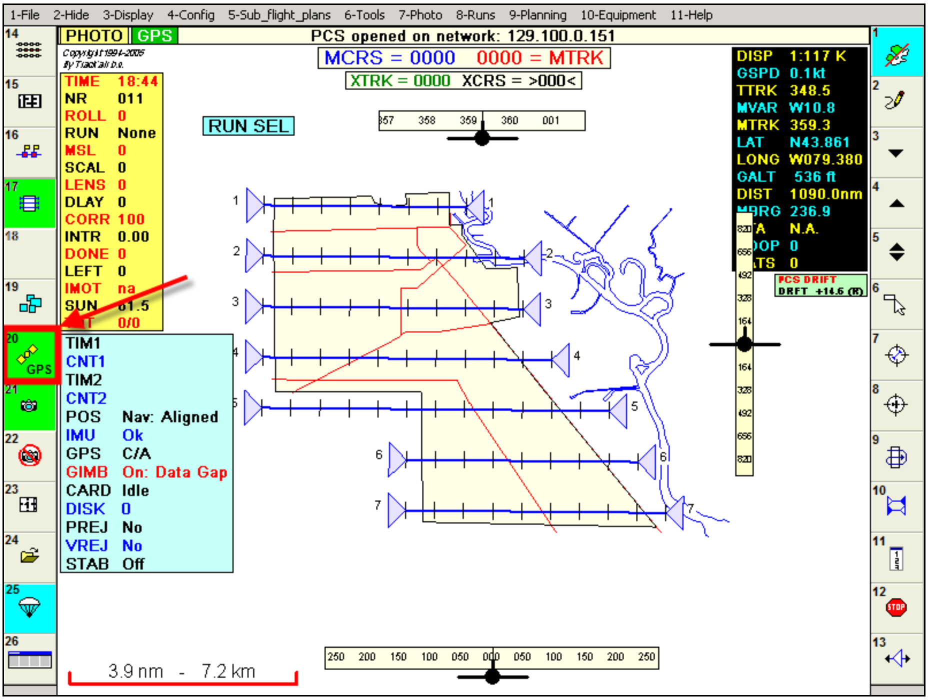


Figure 133: snapSHOT32 Mission Display

Note 1: Any external interface device (mouse, trackball, keyboard, etc.) may be connected to the USB ports of the touch screen pilot's display.

Note 5: More details of software options are available in the X-track snapSHOT32 user manual.

CLIENT SERVER OPERATION

Note: Ensure that firewalls and anti-spyware utilities are disabled before running POSTrack in Pilot/Operator mode. The Operator client software that runs on the laptop communicates with the POSTrack FCS over ports 8000, 8001, 8002, and 8003.

The pilot is able to view and configure the touch screen pilot's display and both (pilot and operator) are able to import, load the flight plan and select or deselect the flight lines during the mission.

Procedure:

Start-up Sequence

- Connect the Client Computer (tablet or laptop) to PIU. In case of Applanix Client tablet use DISP2 connector on PIU that provides Ethernet and power. If the laptop is user supplied, please make sure that only standard Ethernet cable must be connected to PIU. The PIU power lines cannot be used to provide power to third party equipment.
- Power-up Client computer and verify that IP address is in the same range as Main computer (Pilot tablet) and PCS.
- Power-up the POSTrack (PCS and PIU) following the Main computer (pilot tablet.
- Start SnapSHOT32 on the Main computer and perform Sensor Configuration Figure 124.

IP Address Configuration

The Client Computer connects to the Main Computer (Pilot Tablet) using a preconfigured static IP address. The address verification needs to be done on Client side, as shown in Figure 134 and Figure 135.

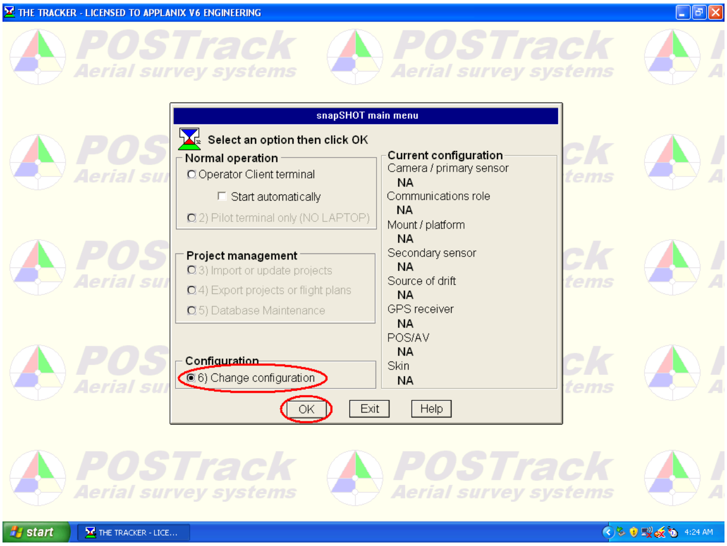


Figure 134: Client Change Configuration

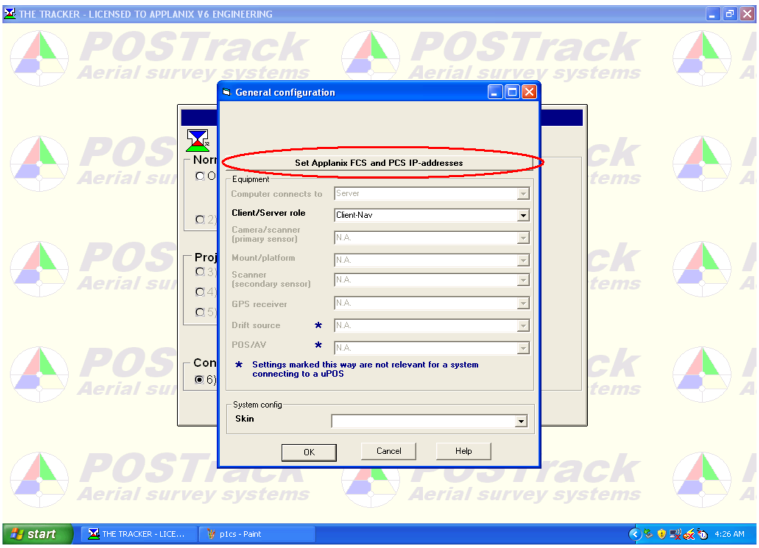


Figure 135: Client IP Address

Once the *"POSTrack Config"* form is opened, before clicking on the *"Verify"* button (Figure 10), make sure that SnapSHOT application on the Main Computer is already started. Click on "Verify" button and the IP addresses will be automatically updated referring to the POS, FCS (Main Computer) and Client Computer address. Follow instructions on the screen to restart the SnapSHOT on both sides (Main and Client computer).

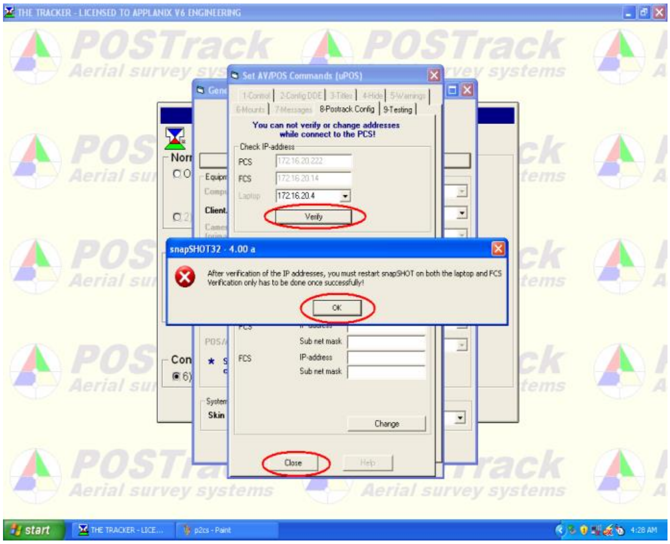


Figure 136: Client Address Verification

<u>Real-Time Operation (Client-Server)</u>

Always make sure that the SnapShot application is running on the Main Computer before connecting the Client. Select the *"Operator Client Terminal"* option Figure 134. Client computer can be connected to Server at any stage and take over the following functionality:

- Importing flight plan to the data base located on the Server computer

- Selecting and loading the flight plan to the SnapSHOT application
- Connecting to POS
- Selecting the survey lines

Figure 137 presents the Client display once the flight plan is loaded.

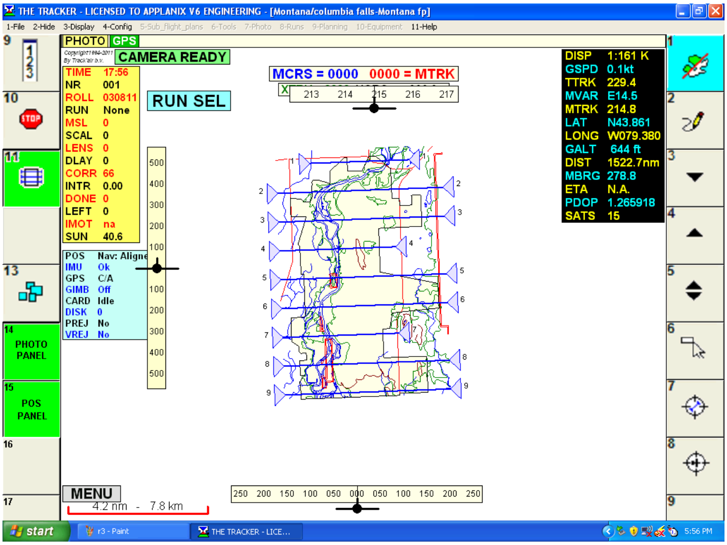


Figure 137: Client Display

Note: The camera ground test simulator can be started only on Main computer Figure 130.

Appendix M

Satellite-Based Augmentation System

Satellite-Based Augmentation Systems (SBAS) are networks of ground relay stations and geostatic satellites designed to receive satellite navigation signals and transmit corrected time and distance measurements. Relay stations are located at known positions worldwide and geostatic satellites continuously maintain a fixed position above the Earth. SBAS corrects satellite navigation signals for atmospheric delays, incorrect satellite positioning and poor geometry. The SBAS is vital to providing the reliability and precision required by aviation and other precision-critical applications.

POS AV V6 currently supports three forms of SBAS:

- WAAS / EGNOS / MSAS that is available on the GNSS card in the POS AV (no external hardware is required)
- NavCom StarFire through support for Auxiliary receiver
- OmniSTAR (no external hardware is required)

Enable WAAS, EGNOS or MSAS

The following steps outline the turn-on procedures for WAAS (North America), EGNOS (Europe), or MSAS (Japan).:

1. Start AV POSView Controller and select **Settings, Installation, GPS Receiver** on menu bar.
2. Select desired SBAS satellite corrections (WAAS / EGNOS / MSAS) and press **OK** button.

   Note: It may take a few minutes to start tracking SBAS satellites.

3. Select **Settings, Save Settings** on POS AV Controller menu bar to make these changes permanent.

OmniSTAR Configuration

OmniSTAR is a wide area differential GNSS service, using satellite broadcast techniques. It offers GNSS correction services that can improve the accuracy of GNSS receiver.

Currently there are three levels of services:

a) VBS (Virtual Base Station)

b) OmniSTAR XP

c) OmniSTAR HP

For more information about services, please visit www.omnistar.com

Applanix recommends XP services that uses satellite orbit and clock correction data independently from reference site location.

To enable OmniSTAR service please go through the check list in order to make sure that your hardware and software are fully compatible.

OmniSTAR enable check list:

1. Ensure that you have LBand capable High Gain antenna. If not, please contact Applanix Customer Support for an upgrade option.
2. Make sure the Primary GNSS receiver is a Trimble BD982 and OmniSTAR serial number is assigned to embedded GNSS receiver. The information is found in the AV POSVIew Controller

(**View | Statistics** [Primary Receiver Label]) as indicated on the Figure 138.

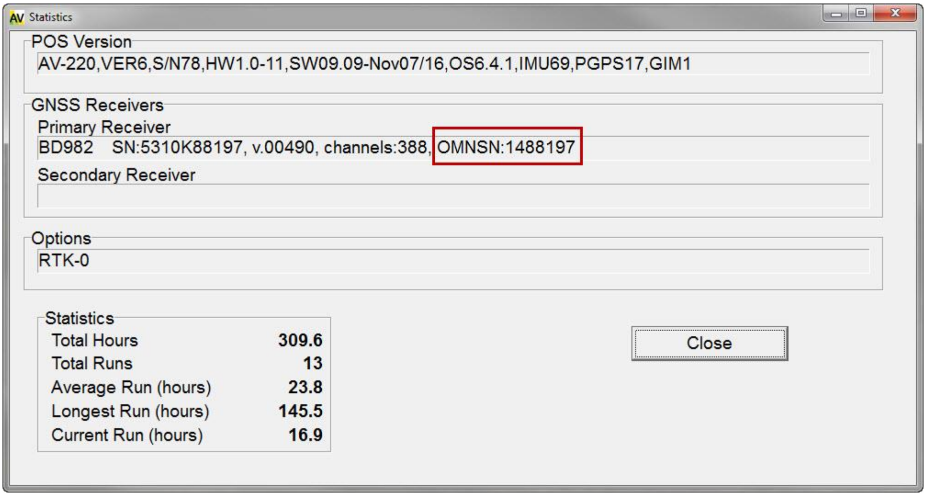


Figure 138: Receiver OmniSTAR Serial Number

3. Call the OmniSTAR representative and provide the receiver name, serial number and type of the service subscription. (Applanix recommends using the XP service).

4. Use the OmniSTAR installation window from the AV POSView Controller (**Settings | SBAS Settings**) to configure the service; see Figure 139.

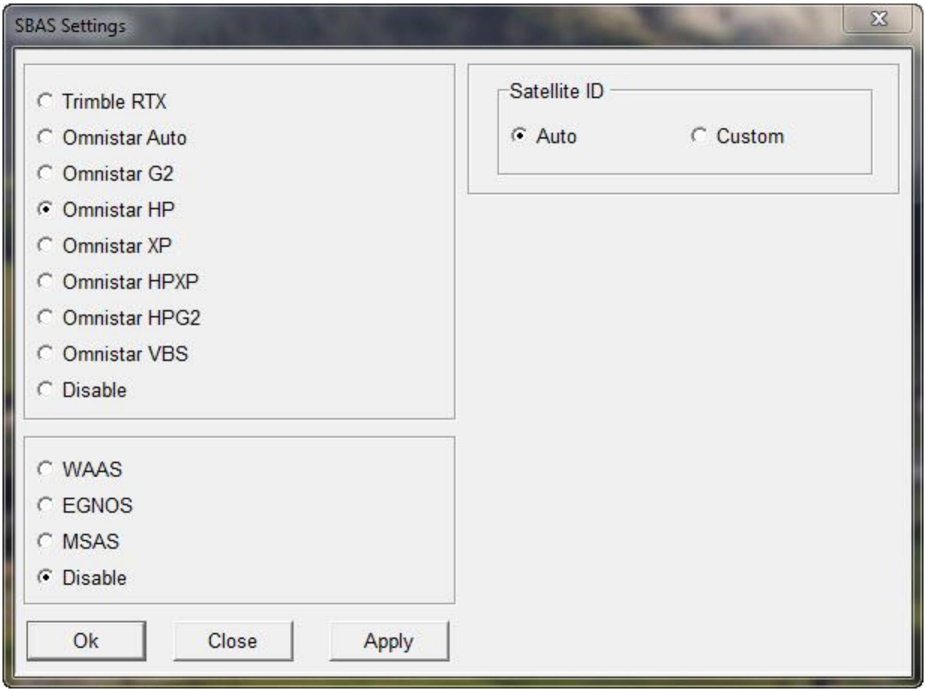


Figure 139: OmniSTAR Settings

Using custom frequencies (**Satellite ID | Custom** option), it is possible to enter the specific satellite frequency and bit rate that depends on your beam and coverage area.

Important

Applanix Corp. is not responsible for the quality or accuracy of any services supplied by OmniSTAR Inc.

Trimble® CenterPoint™ RTX™ Configuration

Trimble® CenterPoint™ RTX™ is a high accuracy GPS Correction Service. It offers GPS correction services that can improve the accuracy of GNSS receiver.

For more information about services, please visit https://www.trimble.com/positioning-services/centerpoint-RTX.aspx

To enable CenterPoint RTX service, please go through the following check list in order to make sure that your hardware and software are fully compatible.

CenterPoint RTX enable checklist:

1. Ensure that you have LBand capable High Gain antenna. If not, please contact Applanix Customer Support for an upgrade option.

2. Ensure the following settings on the AV system:

   - (1) AV firmware is 7.82 or above
   - (2) Receiver type is BD982 (officially supported)
   - (3) Take note of receiver serial number
   - (4) Receiver firmware is 4.84 or above

   The information above is found in the AV POSView Controller (**View | Statistics**) as indicated on the Figure 140.

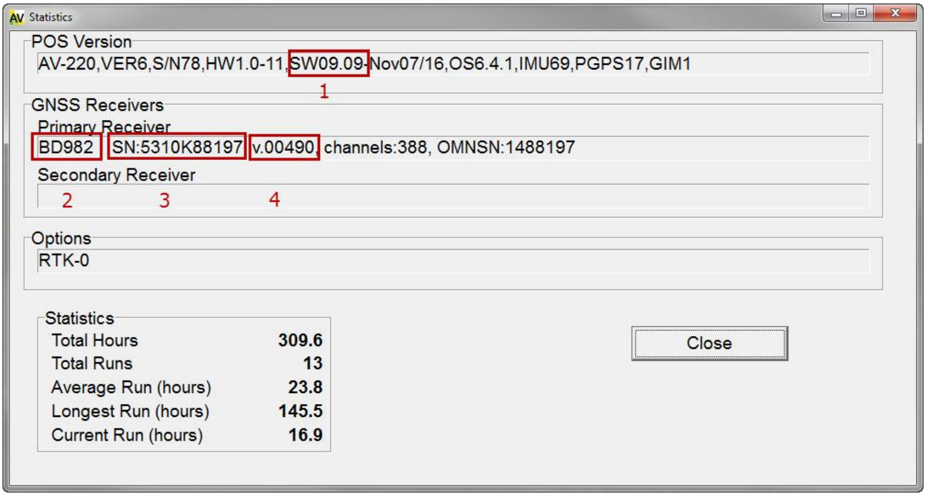


Figure 140: Receiver Serial Number

3. Enable RTX on the AV POSView Controller (**Settings | SBAS Settings**).

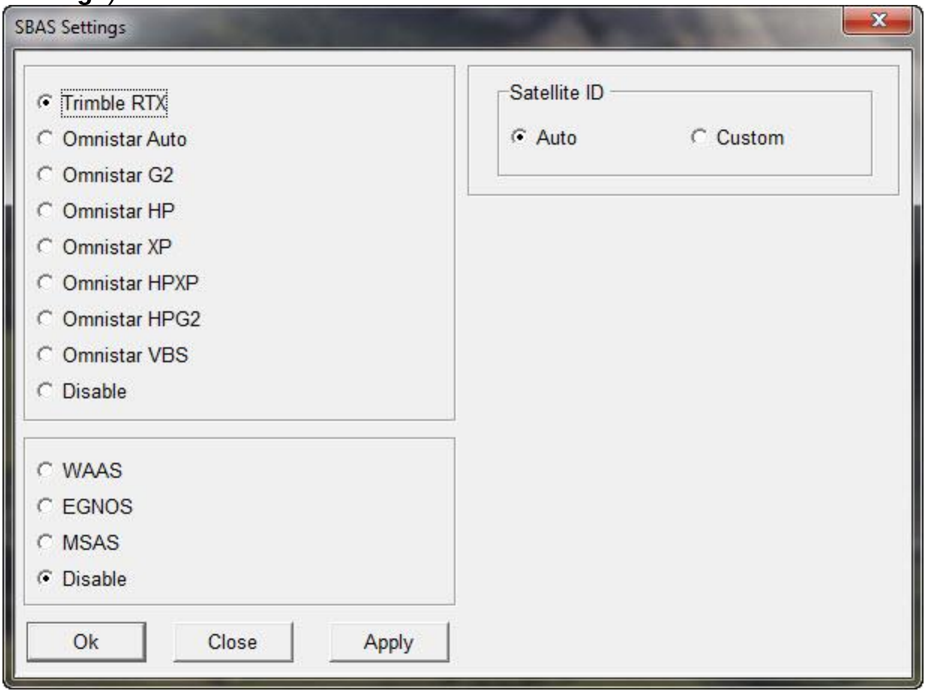


Figure 141: RTX Configuration

Using custom frequencies (**Settings |Satellite ID | Custom** option), it is possible to enter the specific satellite frequency and bit rate that depends on your beam and coverage area.

4. Call the CenterPoint RTX representative and provide the receiver name and the receiver serial number.

5. Once the receiver receives the broadcast. The **GNSS Status** will change to **Pri. Trimble RTX** on the main AV POSView window**.**

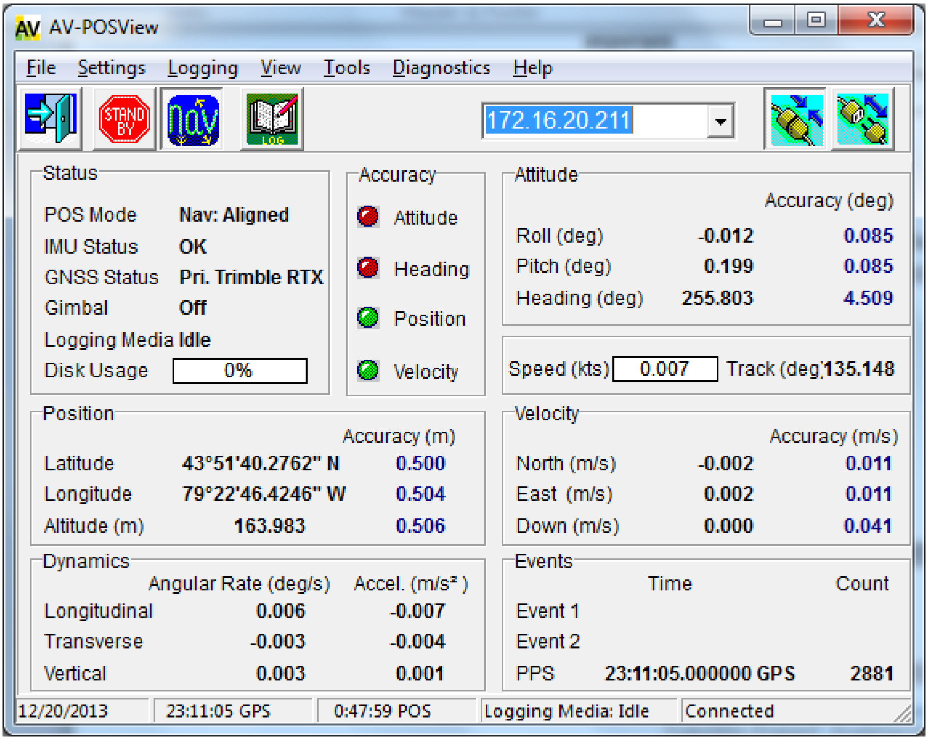


Figure 142: Trimble RTX Status on main window

Important

Applanix Corp. is not responsible for the quality or accuracy of any services supplied by Trimble® CenterPoint™ RTX™.

Appendix N

Transformation of Position

Based on Known Position and Lever Arm Vector

Vector Definition

P:

$$\begin{bmatrix} p0 \\ p1 \\ p2 \end{bmatrix}$$ (known position vector p0 - lat, p1 - lon, p2 - alt)

La:

$$\begin{bmatrix} lx \\ ly \\ lz \end{bmatrix}$$ (lever arm vector)

Cbg:

$$\begin{bmatrix} \cos\Theta\cos\Psi & \sin\Phi\sin\Theta\cos\Psi - \cos\Phi\sin\Psi & \cos\Phi\sin\Theta\cos\Psi + \sin\Phi\sin\Psi \\ \cos\Theta\sin\Psi & \sin\Phi\sin\Theta\sin\Psi + \cos\Phi\cos\Psi & \cos\Phi\sin\Theta\sin\Psi - \sin\Phi\cos\Psi \\ -\sin\Theta & \sin\Phi\cos\Theta & \cos\Phi\cos\Theta \end{bmatrix}$$

Cbg is a transformation matrix to geographic frame where roll, pitch and true heading are defined as (Φ, Θ, Ψ).

Pt:

$$\begin{bmatrix} pt0 \\ pt1 \\ pt2 \end{bmatrix}$$ (transformed position vector pt0 - lat, pt1 - lon, pt2 - alt)

Calculation

$$Pt = \begin{bmatrix} p0 + g[0]/rn \\ p1 + g[1]/(re * c1) \\ p2 - g[2] \end{bmatrix}$$

Where:

g = Cbg*La

c1 = cos(p0)

s1 = sin(p0)

rn = p2 + (a / $\sqrt{1.0 - e2 * s1^2}$)*(1.0-e2)/(1.0-e2*s1 ^{2})

re = p2 + a / $\sqrt{1.0 - e2 * s1^2}$

a = 6378137.0 m // semi-major axis of ellipsoid

e2 = f*(2.0-f) // first eccentricity squared

f = 1/298.257223563 // flattening of the ellipsoid

GLOSSARY

Acceleration of Gravity

Acceleration of Gravity (g), not to be confused with the force of gravity (F_{grav}), is the acceleration experienced by an object when the only force acting upon it is the force of gravity. On and near the Earth's surface, the value for the acceleration of gravity is approximately 9.8 m/s/s. It is the same acceleration value for all objects, regardless of their mass (and assuming that the only significant force is gravity).

Angular Rate

Defines how quickly an angle is changing. The faster the angle changes, the higher the angular rate. Can be expressed as:

$$\frac{\textit{change in angle}}{\textit{duration of angle change}}$$

ASCII

American Standard Code for Information Interchange (ASCII) is a code in which each alphanumeric character is represented as a number from 0 to 127, translated into a 7-bit binary code for the computer.

Attitude Determination

Attitude determination is the process of estimating the orientation of a vehicle (space, air, marine or land) by using known reference points and vehicle attitude. Vehicle attitude sensors supply roll, pitch and yaw data to a computer for processing with navigational data (reference points).

Baseline Vector

X, Y and Z components of the displacement from the primary to secondary GNSS antenna phase centre. The baseline vector is resolved in the vehicle body frame.

Baud Rate

Baud rate, in computer science, is commonly a reference to the speed at which a modem can transmit data. Often incorrectly assumed to indicate the number of bits per second (bps) transmitted, baud rate actually measures the number of events, or signal changes, that occur in one second. Because one event can actually encode more than one bit in high-speed digital communications, baud rate and bits per second are not always synonymous, and the latter is the more accurate term to apply to modems. For example, a so-called 9600-baud modem that encodes four bits per event actually operates at 2400 baud but transmits 9600 bits per second (2400 events times 4 bits per event) and thus should be called a 9600 bps modem.

Bit

The smallest element of computer storage, the bit is a single digit in a binary number (0 or 1). Groups of bits make up storage units in the computer, called ‘characters,’ ‘bytes,’ or ‘words,’ which are manipulated as a group. The most common is the byte, made up of eight bits and equivalent to one alphanumeric character.

Bits are widely used as a measurement for transmission. Ten megabits (Mb) per second means that ten million pulses are transmitted every second. Measurements for storage devices such as disks, files and databases are given in bytes rather than bits.

Byte

The common unit of computer storage from micro to mainframe, the byte is made up of eight binary digits (bits). A ninth bit may be used in the memory circuits as a parity bit for error checking. The term was originally coined to mean the smallest addressable group of bits in a computer (has not always been eight).

C/A

The ‘coarse acquisition’ or ‘clear acquisition’ code modulated onto the GPS L1 signal. This code is a sequence of 1023 pseudorandom binary bi-phase modulations on the GPS carrier at a chipping rate of 1.023 MHz, thus having a code repetition period of 1 millisecond. The code was selected to provide good acquisition properties. Also known as the ‘civilian code’.

Control Port

Accessed via the LAN connector, the control port is designed to receive and acknowledge set-up and control commands from POS AV Controller. The control port is not a physical port. Rather, it is a subset of the Ethernet Interface.

Data Port

Accessed via the LAN connector, the data port is designed to broadcast high rate navigation and raw sensor data. The data port is not a physical port. Rather, it is a subset of the Ethernet Interface.

DGPS

Differential GPS is a technique used to improve positioning or navigation accuracy by determining the positioning error at a known location and subsequently incorporating a corrective factor (by real-time transmission of corrections or by post-processing) into the position calculations of another receiver operating in the same area and simultaneously tracking the same satellites.

Dilution of Precision

Dilution of Precision (DOP) is a dimensionless number that accounts for the purely geometric contribution of the position of the satellites to the uncertainty in a position fix. Standard terms for the GPS application are: GDOP-Geometric Dilution of Precision (three position coordinates plus clock offset in the solution); PDOP-Position Dilution of Precision (three coordinates); HDOP-Horizontal Dilution of Precision (two horizontal coordinates); VDOP-Vertical Dilution of Precision (height only); TDOP-Time Dilution of Precision (clock offset only); RDOP-Relative Dilution of Precision (normalized to 60 seconds).

Display Port

Accessed via the LAN connector, the display port is designed to broadcast low rate (once per second) data and status information for display by POS AV Controller. The display port is not a physical port; it is a subset of the Ethernet Interface.

Dropout

Loss of signal.

Ephemeris

The predictions of current satellite positions transmitted to the user in the data message. A list of accurate positions or locations of a celestial object as a function of time. Available as ‘broadcast ephemeris’ or as post-processed ‘precise ephemeris.’

Force of Gravity

Gravity is a force that exists between the Earth and objects which near it. All objects on Earth experience this force and is represented it by the symbol F_{grav}.

GPS

Global Positioning System (GPS) is a constellation of 24 satellites that allows precise determination of position by analysis of satellite signals.

GPS Time

Highly accurate time system with units of Weeks and Seconds. GPS time is offset from UTC time by an integer number of seconds.

International Foot

The international foot is equal to exactly 30.48 centimetres. See survey foot for additional information.

IP Address

An Internet Protocol (IP) Address is a series of numbers that identifies a specific computer.

Kalman Filter

A Kalman Filter is an algorithm that refines imprecise data to provide a more accurate estimate of a system's current state.

Kinematics

A branch of dynamic theory that deals with aspects of motion apart from mass and force. Technically speaking, real-time kinematic is a GPS Differential mode of operation using carrier phase measurements, as such it is a technique which makes use of the most accurate information delivered by the GPS system. The actual phase observations taken require a preliminary ambiguity resolution before their use. This ambiguity resolution is a crucial aspect of any kinematic system, especially in real-time where velocity should not degrade either the achievable positional performance or the system's overall reliability.

NMEA

National Marine Electronics Association (NMEA) is a standard for interfacing electronic devices. This standard includes the definition of specific message formats.

Point of Validity

The Point of Validity defines the geographical location to which a particular set of data applies.

Post-Processing

Non real-time navigation solution computation from previously collected and recorded raw sensor data.

Pound

The pound (avoirdupois) or international pound is the mass unit defined as exactly 0.45359237 kilograms (or 453.59237 grams). It is part of the avoirdupois system of mass units. There are 16 ounces in a pound (avoirdupois). The pound is equal to exactly 7000 grains, where a grain is officially defined as exactly 0.06479891 gram. The legal definition of the pound in the United Kingdom and Canada are the same as in the United States, and were unified to their current value in 1960.

PPS Mode

Precise Positioning Service (PPS) capable GPS receivers have higher accuracy than C/A code receivers, but are currently only available for military use.

PPS Strobe

The Pulse Per Second Strobe is a TTL-level signal; generated once per second, whose falling edge is coincident with the GPS second.

Pseudo-range

A GPS distance measurement that has not been corrected for differences in synchronization between the satellite and receiver clocks.

Rack Unit

Rack unit is a vertical measurement equal to 1.75 in (4.44 cm) for rack-mounted equipment.

Survey Foot

In 1959 the survey foot was replaced by the international foot, equal to exactly 30.48 centimetres. However, the survey foot remains the basis for precise geodetic surveying in the U.S.

TCP/IP

Transmission Control Protocol/Internet Protocol (TCP/IP) is a routable protocol, and the TCP part of TCP/IP provides transport functions, which ensures that the total amount of bytes sent is received correctly at the other end. It is widely used for real-time voice and video transmissions where erroneous packets are not retransmitted.

The IP part of TCP/IP provides the routing capability. In a routable protocol, all messages contain not only the address of the destination station, but the address of a destination network. This allows TCP/IP messages to be sent to multiple networks within an organization or around the world, hence its use in the worldwide Internet. Every client and server in a TCP/IP network requires an IP address that is either permanently assigned or dynamically assigned at start-up.

Time of Validity

Time of Validity (TOV) defines the exact time at which a particular set of data are current.

TTL Level Signal

TTL Level Signals are DC signals interpreted in a discrete fashion. A signal below 0.8V is interpreted as a LOW, and a signal above 3.3 V is interpreted as a HIGH. TTL signals can be likened to a binary system, where LOW is equivalent to 0, and HIGH is equivalent to 1.

UDP

Universal Datagram Protocol (UDP) is a collection of protocols similar to TCP/IP. Most notable among the differences is that data broadcast in UDP can be read by any computer on the network. In contrast, TCP/IP messages are directed at particular computer.

UTC

Universal Time Coordinated (UTC) time is a precise atomic time system, offset from GPS time by an integer number of seconds. Also known as Greenwich Mean Time (GMT).

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