AV V6 User Control, Display, Data and Logging Port Interface Control Document

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1 Scope

This document presents the functional specification of the Control, Display, Data and Logging Ports and data structures used by the Micro POS Computer System (PCS) to communicate with the user over its Control, Display, Data and Logging Ports. The document is separated into specifications of output data groups and input and output control messages that are relevant to the user.

2 Ethernet and Data Acquisition Interfaces

The POS AV provides a mechanism for control and data exchange in the form of control messages and data groups. Control messages direct the POS AV to execute a well-defined action such as mode transition, or start or stop of data acquisition. Data groups contain the data output by the POS AV for the purpose of display on a control computer, recording to a mass storage device, or for real-time processing by another subsystem. The POS AV exchanges all control messages with a user via the POS's Control Port. It outputs all data groups on the Display, Data and Logging Ports.

Applanix provides a *POS Controller* with the POS AV to run on the user's PC-compatible computer running Microsoft Windows 2000/XP/Vista/7. The user's PC is called the *client computer*, and is used to both control the system and allow the user to view POS data via the control messages and data groups specified in this document. The user can create custom control and display software that implements similar functionality. In either case, the program that provides the control and display functions on the client computer will hereafter be referred to as AV-POSView.

The POS AV provides one physical Ethernet interface that has four logical communications ports called the *Display Port*, the *Control Port*, the *Ethernet Real-Time Data Port* and the *Ethernet Logging Data Port*.

The POS AV provides one USB interface for logging POS data to a USB flash drive device called the *Removable Media Logging Port*. In case of OEM hardware platform the *Removable Media Logging Port* is internal USB flash drive device.

The POS AV outputs data in specified group formats defined in the body of this document. Messages are used to both change and describe the system configuration. Both message and group data are output on four ports: Display, Ethernet Real-Time Data, Ethernet Logging Data and USB Flash Drive Logging. Messages are input on the Control Port.

The **Display Port** is a *low rate* UDP output port that is designed to broadcast low rate data and status information for display. AV-POSView reads the message and group data from this port for display purposes. The POS AV is designed to allow multiple AV-POSView programs running on different computers to receive and display data from the PCS. However, only one

AV-POSView at any time can be designated as the master controller and be capable of sending commands to the PCS via the Control Port. This arrangement prevents conflicting controller information from being received by the PCS. The port address for the Display Port is 5600.

The Ethernet Real-Time and Ethernet Logging **Data Ports** are *high rate* TCP/IP output ports that are designed to output multiple data groups at high data rates. To receive data from one of the Data Ports, a computer must connect to it using the TCP/IP socket protocol. Only one computer may be connected to one of the Data Ports at any one time. AV-POSView can log this data to the client computer's hard drive.

The Ethernet Real-Time Data Port has only a small data buffer and so is intended for use in real-time applications where the most current POS AV data is always required. It is intended that real-time applications may not need or be capable of consuming all of the POS AV data at the rate it is generated, yet require low latency POS AV data for correct operation. Thus, it is possible to have data gaps in the POS AV data when using this port.

The Ethernet Logging Data Port has a large data buffer and is therefore intended for applications that cannot tolerate POS AV data gaps. The effect of the buffering, however, is that data on this port will have a greater output latency associated with it. One possible application of this port is POS AV data logging to a mass storage device for later post-mission processing and data analysis.

The port address for the Ethernet Primary Real-Time Data Port number is 5602, Primary 2 Real-Time Data Port number is 5606, and the port address for the Ethernet Logging Data Port is 5603.

The **Logging Port** is a high-rate data port that routes data to its own USB Flash Drive storage medium. The purpose of the Logging Port is to record data for post-mission processing and data analysis.

The user is able to select, from several different options, the data required for output. Each port can be configured to output different data than the other ports. The user is able to change the output options of the Display, Ethernet Real-Time Data, Ethernet Logging Data and USB Drive Logging ports at any time.

The **Control Port** is designed to receive set-up and control commands from AV-POSView and to acknowledge the commands to indicate successful reception of each message. The Control Port is bi-directional and uses the TCP/IP protocol to communicate with AV-POSView. The port address for the Control Port is 5601.

3 Output Groups

3.1 Introduction

The POS AV organizes the data coming from the Display, Data and Logging ports into output groups. Each group contains a block of related data at a specified group rate. The user directs the POS AV via AV-POSView or Control Port messages to include a group or groups containing data items of interest in the Display, Data and Logging port data streams. The output groups have been designed to allow simple parsing and decoding of the output data streams into the selected groups. All groups are framed by ASCII delimiters and have identifiers that uniquely identify each group.

The output data rate on the Display Port is typically once per second or less. This output is intended for updating the Controller display; hence, a higher data output rate is not required. The output data rate on the Data and Logging Ports is group dependent, and has a range from 1 Hz, up to the maximum IMU data rate, which is a function of the IMU type, as listed in Table 14. For certain output groups, it is possible to select, from several options, the output data rate of choice on the Data and Logging ports.

3.2 Output Group Specification

3.2.1 Group Data Rates

There are several output groups defined for the Display, Data and Logging ports. The user can select any of these groups and *may select different groups* for the Display, Data and Logging port. The Standby and Navigate modes shown in Table 1 are defined in the POS AV Installation and Operations Guide.

3.2.2 Group Classification and Numbering Convention

All POS products use the following group numbering convention. The POS AV outputs the group categories shown. Reserved group numbers are assigned to other products.

0-99	Core user data groups
100-199	Reserved
200-299	POS AV specific data groups
300-9999	Reserved
10000-10099	Core raw data groups
10100-10199	Reserved
10200-10299	POS AV raw specific data groups
10300-19999	Reserved
20000	POS Core User diagnostic group
20001 and up	Reserved

Core user data groups comprise groups that contain real-time operational data. During normal operation, these are the only groups that a user would require for observing or recording relevant POS AV data.

Core raw data groups comprise the unaltered data streams from the navigation sensors received by the PCS. The POS AV packages the sensor data into the specified group formats and outputs the groups. These groups are typically used for post-mission processing and analysis.

Table 1: Output Group Data Rates

Group	Contents	Display Port Output Rate (Hz)		Data Port Output Rate (Hz)		Logging Port Output Rate (Hz)	
		Standby	Navigate	Standby	Navigate	Standby	Navigate
POS Data Groups							
1	Aircraft navigation solution	-	1[1]	-	1-200[2]	-	1-200[2]
2	Aircraft navigation performance metrics	-	1[1]	-	1	-	1
3	Primary GPS status	1[1]	1[1]	1	1	1	1
4	Time-tagged IMU data	1	1	200[2]	200[2]	200[2]	200[2]
5	Event 1 data[3]	1	1	1-500	1-500	1-500	1-500
6	Event 2 data[3]	1	1	1-500	1-500	1-500	1-500
7	PPS data[3]	1	1	1	1	1	1
8	Logging status	1	1	1	1	1	1
10	General and FDIR status	1[1]	1[1]	1	1	1	1
11	Secondary GNSS status[4]	1	1	1	1	1	1
12	Auxiliary 1 GPS status	1	1	1	1	1	1
13	Auxiliary 2 GPS status	1	1	1	1	1	1
14	Calibrated installation parameters	-	1	-	1	-	1
17	User time status	1	1	1	1	1	1
20	IIN solution status	-	1	-	1		1
23	Auxiliary 1 GPS display data[3]	1	1	1	1	1	1
24	Auxiliary 2 GPS display data[3]	1	1	1	1	1	1
29	GNSS Receiver OmniSTAR Status	1	1	-	-	-	-
30	Event 3 data[3]	1	1	1-500	1-500	1-500	1-500
31	Event 4 data[3]	1	1	1-500	1-500	1-500	1-500
32	Event 5 data[3]	1	1	1-500	1-500	1-500	1-500
33	Event 6 data[3]	1	1	1-500	1-500	1-500	1-500
99	Versions and statistics	1	1	1	1	1	1
200	Gimbal encoder data	1	1	1-200	1-200	1-200	1-200
201	Target Reference Position Data	1	1	1-200	1-200	1-200	1-200
202	Laser Range Finder Data	1	1	1-10	1-10	1-10	1-10
203	Yaw Drift Correction	1	1	1	1	1	1
206	Event1Sensor Navigation Group	-	-	1-50	1-50	1-50	1-50
207	Event2 Sensor Navigation Group	-	-	1-50	1-50	1-50	1-50
208	Photo ID1 Group	-	-	-	1-200	1-200	1-200
209	Photo ID2 Group	-	-	-	1-200	1-200	1-200
210	Event 1 Real Time POSEO	-	-	1-50	1-50	1-50	1-50
211	Event 2 Real Time POSEO	-	-	1-50	1-50	1-50	1-50
212	Lidar Swats Group	1	1	1-10	1-10	1-10	1-10
213	Dark Image Collection Group	-	-	0-10	0-10	0-10	0-10
214	Lidar Logging on/off Group	-	-	0-10	0-10	0-10	0-10
215	Ethernet Trigger Group	-	-	0-10	0-10	0-10	0-10
222	Reference Frame Position, Velocity, Attitude, Heave & Dynamics	-	1	-	1-200[2]	-	1-200[2]
223	Sensor Frame Position, Velocity, Attitude, Heave & Dynamics	-	1	-	1-200[2]	-	1-200[2]
224	Reference Frame Position, Velocity, and Attitude Performance Metrics	-	1	-	1	-	1
225	Sensor Frame Position, Velocity, and Attitude Performance Metrics	-	1	-	1	-	1
22	Flight Plan status and information	-	-	-	-	-	-

Group	Contents	Display Port Output Rate (Hz)		Data Port Output Rate (Hz)		Logging Port Output Rate (Hz)	
		Standby	Navigate	Standby	Navigate	Standby	Navigate
Raw Data Groups							
10001	Primary GPS data stream	-	-	1-10	1-10	1-10	1-10
10002	IMU data stream	-	-	200[2]	200[2]	200[2]	200[2]
10003	PPS data	-	-	1	1	1	1
10007	Auxiliary 1 GPS data stream			1-10	1-10	1-10	1-10
10008	Auxiliary 2 GPS data stream			1-10	1-10	1-10	1-10
10011	Base 1 GPS data stream[3]	-	-	0-1	0-1	0-1	0-1
10012	Base 2 GPS data stream[3]	-	-	0-1	0-1	0-1	0-1
10201	Raw Laser Range Finder Data	-	-	0-10	0-10	0-10	0-10
10204	Camera Data Stream Out	-	-	0-10	0-10	0-10	0-10
10205	Camera Data Stream In	-	-	0-10	0-10	0-10	0-10
10206	Raw Sensor Data Out	-	-	0-10	0-10	0-10	0-10
10207	Raw Sensor Data In	-	-	0-10	0-10	0-10	0-10

1. *These groups are the minimum output of the Display Port for driving* AV-POSView *display, and cannot be de-selected.*
2. *The maximum Navigation Solution data rate is related to the IMU data rate and hence to the IMU type. Refer to Table* 14 *for further information relating the IMU data rate and IMU type. The typical IMU data rate is 200 Hz.*
3. *Groups are only posted when data are available.*
4. *Group 11 is available only in products with dual antenna configuration.*

3.2.3 Group Format

The structure of each output group is defined in this section. The group structure is the same for all groups and consists of a *header*, *data* and *footer*. Table 2 presents the complete group format, showing the header and footer separated by the data. The next section specifies the data for each group.

Table 2: Group format

Item	Bytes	Format	Value	Units
Group start	4	char	$GRP	N/A
Group ID	2	ushort	Group number	N/A
Byte count	2	ushort	Group dependent	bytes
Time/Distance Fields	26	*See* Table 3		
Data	*Group dependent size and format*			
Pad	0 to 3	byte	0	N/A
Checksum	2	ushort	N/A	N/A
Group end	2	char	$#	N/A

Table 3: Time and distance fields

Item	Bytes	Format	Value	Units
Time 1	8	double	N/A	seconds
Time 2	8	double	N/A	seconds
Distance tag	8	double	N/A	meters

Item	Bytes	Format	Value			Units
Time types	1	byte	Time 1 Select	Value in bits 0-3		
			Time 1: POS time	0		
			Time 1: GPS time	1	(default)	
			Time 1: UTC time	2		
			Time 2 Select	Value in bits 4-7		
			Time 2: POS time	0	(default)	
			Time 2: GPS time	1		
			Time 2: UTC time	2		
			Time 2: User time	3		
Distance type	1	byte	Distance Select	Value		
			N/A	0		
			POS distance	1	(default)	

The *header* consists of the following components:

- ASCII group start ($GRP)
- group identification (Group ID) number
- byte count
- time/distance fields

The *group identification* or *Group ID* is a short unsigned integer equal to the group number having the group numbering convention described in Section 3.2.2.

The *byte count* is a short unsigned integer that includes all fields in the group except the $GRP delimiter, the Group ID and the byte count. Therefore, the byte count will always be 8 bytes less than the length of the group.

The *time/distance fields* are shown in
Table 3. These occupy 26 bytes, and have the same format across all groups. They comprise the following:

- Time 1
- Time 2
- Distance tag, and time and distance type flags.

Time 1 is the POS AV system time of validity of the data in the group, given in one of the following time bases:

- POS time (time in seconds since power-on)
- GPS seconds of the week

- UTC seconds of the week

The user can select any of these times for Time 1. Time 1 is set to POS time on power-up, and changes to the user selected time base once the primary GPS receiver has locked on to a sufficient number of satellites to compute a time solution.

Time 2 is the POS AV system time of validity of the data in the group, given in one of the following time bases:

- POS time (time in seconds since power-on)
- GPS seconds of the week
- UTC seconds of the week
- User time

User time is specified by the user, with the procedure to set user time described in the POS AV Installation and Operation Manual. It allows the groups to be time tagged with an external computer's time clock. The Time 2 field is always set to POS time for the raw (10000) series of data groups.
Distance tag is the distance of validity of the data in the group as determined by one of the following distance measurement sources:

- distance traveled derived from the POS AV blended navigation solution
- Applanix reserved distance tag

The group *data* follows the header. Its format is dependent on the particular group. Some group data lengths are fixed, whereas others may vary. For variable length groups the *byte count* will always be updated to reflect the actual length of the group.

The group is terminated by the *footer,* which consists of the following components:

- a pad (if required)
- checksum
- ASCII group end delimiter ($#).

The *pad* is used to make the total lengths of all groups a multiple of four bytes. The *checksum* is calculated so that the sum of byte pairs cast as short (16 bit) integers over the complete group results in a net sum of zero.

The byte, short, ushort, long, ulong, float, and double formats are defined in

Appendix A: Data Format Description.

The ranges of valid values for group fields that contain numbers are specified using the following notation.

[*a*, *b*] implies the range *a* to *b* including the range lower and upper boundaries. A value *x* that falls in this range will respect the inequality $a \leq x \leq b$.

(*a*, *b*) implies the range *a* to *b* excluding the range lower and upper boundaries. A value *x* that falls in this range will respect the inequality $a < x < b$.

(*a*, *b*] implies the range *a* to *b* excluding the lower boundary and including the upper boundary. A value *x* that falls in this range will respect the inequality $a < x \leq b$.

[*a*, *b*) implies the range *a* to *b* excluding the range lower and upper boundaries. A value *x* that falls in this range will respect the inequality $a \leq x < b$.

If a value *a* or *b* is not given, then there is no corresponding lower or upper boundary. The following are special cases:

(0,) represents all positive numbers (excludes 0)
[0,) represents all non-negative numbers (includes 0)
(, 0) represents all negative numbers (excludes 0)
(, 0] represents all non-positive numbers (includes 0)
(,) represents all numbers in the range of valid numbers.

Group fields that contain numerical values may contain invalid numbers. Invalid byte, short, ushort, long, ulong, float and double values are defined in Table 109 in

Appendix A: Data Format Description. The POS AV will output invalid values in fields containing numerical values for which the POS AV has no valid data. This does not apply to fields containing bit settings.

3.3 Output Group Tables

3.3.1 POS Data Groups

3.3.1.1 Group 1: Aircraft Navigation Solution

This group contains a complete Aircraft navigation solution comprising position, velocity, attitude, track, speed and dynamics data for the Aircraft. The data in this group is *valid for the position defined by the user-entered reference to Aircraft lever arms*.

Table 4: Group 1: Aircraft navigation solution

Item	Bytes	Format	Value	Units
Group start	4	char	$GRP	N/A
Group ID	2	ushort	1	N/A
Byte count	2	ushort	132	bytes
Time/Distance Fields	26	*See* Table 3		
Latitude	8	double	(-90, 90]	degrees
Longitude	8	double	(-180, 180]	degrees
Altitude	8	double	(,)	meters
North velocity	4	float	(,)	meters/second
East velocity	4	float	(,)	meters/second
Down velocity	4	float	(,)	meters/second
Aircraft roll	8	double	(-180, 180]	degrees
Aircraft pitch	8	double	(-90, 90]	degrees
Aircraft heading	8	double	[0, 360)	degrees
Aircraft wander angle	8	double	(-180, 180]	degrees
Aircraft track angle	4	float	[0, 360)	degrees
Aircraft speed	4	float	[0,)	meters/second
Aircraft angular rate about longitudinal axis	4	float	(,)	degrees/second
Aircraft angular rate about transverse axis	4	float	(,)	degrees/second
Aircraft angular rate about down axis	4	float	(,)	degrees/second
Aircraft longitudinal acceleration	4	float	(,)	meters/second^2
Aircraft transverse acceleration	4	float	(,)	meters/second^2
Aircraft down acceleration	4	float	(,)	meters/second^2

Item	Bytes	Format	Value	Units
Alignment status	1	byte	See Table 5	N/A
Pad	1	byte	0	N/A
Checksum	2	ushort	N/A	N/A
Group end	2	char	$#	N/A

Table 5: Group 1 alignment status

Group 1 Status	Description
0	Full navigation (User accuracies are met)
1	Fine alignment is active (RMS heading error is less than 15 degrees)
2	GC CHI 2 (alignment with GPS, RMS heading error is greater than 15 degrees)
3	PC CHI 2 (alignment without GPS, RMS heading error is greater than 15 degrees)
4	GC CHI 1 (alignment with GPS, RMS heading error is greater than 45 degrees)
5	PC CHI 1 (alignment without GPS, RMS heading error is greater than 45 degrees)
6	Coarse leveling is active
7	Initial solution assigned
8	No valid solution

3.3.1.2 Group 2: Aircraft Navigation Performance Metrics

This group contains Aircraft position, velocity and attitude performance metrics. The data in this group is *valid for the position defined by the user-entered reference Aircraft lever arms*.

All data items in this group are given in RMS values.

Table 6: Group 2: Aircraft navigation performance metrics

Item	Bytes	Format	Value	Units
Group start	4	char	$GRP	N/A
Group ID	2	ushort	2	N/A
Byte count	2	ushort	80	bytes
Time/Distance Fields	26	*See* Table 3		
North position RMS error	4	float	[0,)	meters
East position RMS error	4	float	[0,)	meters
Down position RMS error	4	float	[0,)	meters
North velocity RMS error	4	float	[0,)	meters/second
East velocity RMS error	4	float	[0,)	meters/second
Down velocity RMS error	4	float	[0,)	meters/second
Roll RMS error	4	float	[0,)	degrees
Pitch RMS error	4	float	[0,)	degrees
Heading RMS error	4	float	[0,)	degrees
Error ellipsoid semi-major	4	float	[0,)	meters
Error ellipsoid semi-minor	4	float	[0,)	meters
Error ellipsoid orientation	4	float	(0, 360]	degrees
Pad	2	byte	0	N/A
Checksum	2	ushort	N/A	N/A
Group end	2	char	$#	N/A

3.3.1.3 Group 3: Primary GNSS Status

This group contains status data from the primary GNSS receiver. The group length is variable, depending on the number of primary GPS receiver channels that report data. This group assumes that the primary GNSS receiver contains up to 30 channels, and therefore provides up to 30 channel status fields. Each channel status field has the format given in Table 8. The GNSS receiver type field identifies the primary GNSS receiver in the POS AV from among the GNSS receiver types listed in Table 11 that POS AV supports. The GNSS status field comprises a 4-byte array of status bits whose format depends on the GNSS receiver type. The formats for GNSS receivers supported by the POS AV are given in Table 12.

Table 7: Group 3: Primary GNSS status

Item	Bytes	Format	Value	Units
Group start	4	char	$GRP	N/A
Group ID	2	ushort	3	N/A
Byte count	2	ushort	76 + 20 x (number of channels)	bytes
Time/Distance Fields	26	*See* Table 3		
Navigation solution status	1	byte	*See Table 9*	N/A
Number of SV tracked	1	byte	[0, 30]	N/A
Channel status byte count	2	ushort	[0, 600]	bytes
Channel status	variable	*See Table 8*		
HDOP	4	float	(,)	N/A
VDOP	4	float	(,)	N/A
DGPS correction latency	4	float	[0, 999.9]	seconds
DGPS reference ID	2	ushort	[0, 1023]	N/A
GPS/UTC week number	4	ulong	[0, 9999] 0 if not available	week
GPS/UTC time offset (GPS time – UTC time)	8	double	(,)	seconds
GNSS navigation message latency	4	float	Number of seconds from the PPS pulse to the start of the GNSS navigation data output	seconds
Geoidal separation	4	float	(,)	meters
GNSS receiver type	2	ushort	*See Table 11*	N/A

Item	Bytes	Format	Value	Units
GNSS status	4	ulong	GNSS summary status fields which depend on GNSS receiver type. *See Table 12 for format.* *Trimble BD960/BD982 Status set to 0*	
Pad	2	byte	0	N/A
Checksum	2	ushort	N/A	N/A
Group end	2	char	$#	N/A

Table 8: GNSS receiver channel status data

Item	Bytes	Format	Value	Units
SV PRN	2	ushort	[1, 138]	N/A
Channel tracking status	2	ushort	See Table 10	N/A
SV azimuth	4	float	[0, 360)	degrees
SV elevation	4	float	[0, 90]	degrees
SV L1 SNR	4	float	[0,)	dB
SV L2 SNR	4	float	[0,)	dB

Table 9: GNSS navigation solution status

Status Value	Description	Expected Accuracy
-1	Unknown	N/A
0	No data from Receiver	N/A
1	Horizontal C/A mode (unconstrained vertical position)	75 meters
2	3-dimension C/A mode	75 meters
3	Horizontal DGPS mode (unconstrained vertical position)	1 meter
4	3-dimension DGPS mode	1 meter
5	Float RTK mode	0.25 meters
6	Integer wide lane RTK mode	0.2 meters
7	Integer narrow lane RTK mode	0.02 meters
8	P-Code	10 meters
9	OmniSTAR HP – Mode[1]	0.3 meters
10	OmniSTAR XP - Mode[1]	0.5 meters
11	OmniSTAR VBS-Mode[1]	1 meter
13	OmniSTAR G2 Mode[1]	0.5 meters
14	Trimble RTX Mode[1]	0.05 meters

[1]Applanix Corporation is not responsible for the quality of accuracy of any services supplied by OmniSTAR Inc. or Trimble.

Table 10: GNSS channel status

Channel Status	Description
0	L1 idle
1	reserved
2	L1 acquisition
3	L1 code lock
4	reserved
5	L1 phase lock (full performance tracking for L1-only receiver)
6	L2 idle
7	reserved
8	L2 acquisition
9	L2 code lock
10	reserved
11	L2 phase lock (full performance tracking for L1/L2 receiver)

Table 11: GNSS receiver type

GPS type	Description
0	No receiver
1 to 15	Reserved
16	Trimble BD960
17	Trimble BD982

Table 12: Trimble BD960/BD982

Item	Bytes	Format	Failure
Status of Receiver	4	chars	Description Value *Trimble BD960/BD982 Status set to 0*

3.3.1.4 Group 4: Time-tagged IMU Data

This group consists of time-tagged IMU data. This IMU data is suitable for use with the Applanix POSPac post-processing software package. The IMU type is Applanix's type designation, and is used by POSPac to post-process the IMU data correctly. The IMU status word contains status bits as generated by the IMU. U.S. and Canadian export control laws prohibit publication of the IMU status word format.

Table 13: Group 4: Time-tagged IMU data

Item	Bytes	Format	Value	Units
Group start	4	char	$GRP	N/A
Group ID	2	ushort	4	N/A
Byte count	2	ushort	60	bytes
Time/Distance Fields	26	*See* Table 3		
IMU data	24	byte	N/A	N/A
Data status	1	byte	Bit (set) Status 0 1 bad raw IMU frame 1 2 bad raw IMU frames 2 3 bad raw IMU frames	
IMU type	1	byte	0-255	
POS IMU data rate *(future use)*	1	byte	Value Data Rate (Hz) 0 50 1 100 2 200 3 400 4 125 5 500	
IMU status	2	ushort	IMU summary status word	
Pad	1	byte	0	N/A
Checksum	2	ushort	N/A	N/A
Group end	2	char	$#	N/A

Table 14: POS IMU data rate by IMU type

IMU type	POS IMU data rate (Hz)
7, 8	200
17	100
21, 29, 31, 40, 42, 46	200

3.3.1.5 Group 5: Event 1

The time and distance fields in this group indicate the time and distance of Event 1 discrete signals that the POS AV receives. A client can use this message to attach GPS/UTC time to external events.

Table 15: Group 5: Event 1

Item	Bytes	Format	Value	Units
Group start	4	char	$GRP	N/A
Group ID	2	ushort	5	N/A
Byte count	2	ushort	36	bytes
Time/Distance Fields	26	*See* Table 3		
Event pulse number	4	ulong	[0,)	N/A
Pad	2	byte	0	N/A
Checksum	2	ushort	N/A	N/A
Group end	2	char	$#	N/A

3.3.1.6 Group 6: Event 2

The time and distance fields in this group indicate the time and distance of Event 2 discrete signals that the POS AV receives. A client can use this message to attach GPS/UTC time to external events.

Table 16: Group 6: Event 2

Item	Bytes	Format	Value	Units
Group start	4	char	$GRP	N/A
Group ID	2	ushort	6	N/A
Byte count	2	ushort	36	bytes
Time/Distance Fields	26	*See* Table 3		
Event pulse number	4	ulong	[0,)	N/A
Pad	2	byte	0	N/A
Checksum	2	ushort	N/A	N/A
Group end	2	char	$#	N/A

3.3.1.7 Group 7: PPS Time Recovery and Status

The time and distance fields in this group indicate the time and distance of the PPS from the primary GNSS receiver. The PPS count is the number of PPS messages since power-up and initialization of the GNSS receivers. The time synchronization status field indicates the status of POS AV synchronization to the PPS time provided by the primary GNSS receiver as follows:

No synchronization indicates that the POS AV has not synchronized to GPS time. This is the case if the GNSS receiver has not initialized and provided time recovery data to the POS AV.

Synchronizing indicates that the POS AV is in the process of synchronizing to GPS time. This lasts on the order of 10-20 seconds as the POS AV establishes its internal clock offset and drift parameters.

Fully synchronized indicates that the POS AV has established synchronization to GPS time with less than 10 microseconds error, and is maintaining the synchronization once per second.

Using old offset indicates that the POS AV is using the last good clock offset to compute GPS times. The POS AV has either not received a PPS or time recovery message or has rejected erroneous GPS time synchronization data.

This data provides for PPS time recovery of any of the time bases supported by the POS AV. It allows an external device to acquire GPS or UTC time, or to relate GPS time to POS AV time.

Table 17: Group 7: PPS Time Recovery and Status

Item	Bytes	Format	Value	Units
Group start	4	char	$GRP	N/A
Group ID	2	ushort	7	N/A
Byte count	2	ushort	36	bytes
Time/Distance Fields	26	*See* Table 3		
PPS count	4	ulong	[0,)	N/A
Time synchronization status	1	byte	0 Not synchronized 1 Synchronizing 2 Fully synchronized 3 Using old offset	
Pad	1	byte	0	N/A
Checksum	2	ushort	N/A	N/A
Group End	2	char	$#	N/A

3.3.1.8 Group 8: Logging Parameters and Status

This group describes the status of data logging through the logging port. This information allows the user to determine the amount of disk space and time used and remaining.

Table 18: Group 8: Logging Information

Item	Bytes	Format	Value	Units
Group start	4	char	$GRP	N/A
Group ID	2	ushort	8	N/A
Byte count	2	ushort	4848	N/A
Time/Distance Fields	26		*See* Table 3	
Disk Kbytes remaining	4	ulong	[0,)	Kbytes
Disk Kbytes logged	4	ulong	[0,)	Kbytes
Disk logging time remaining	4	float	[0,)	Seconds
Disk Kbytes total	4	ulong	[0,)	Kbytes
Logging State	1	byte	0 Standby 1 Logging 2 Buffering 255 Invalid	
Pad	1	byte	0	N/A
Checksum	2	ushort	N/A	N/A
Group End	2	char	$#	N/A

3.3.1.9 Group 10: General Status and FDIR

This group is used to output general and Fault Detection, Isolation and Reconfiguration (FDIR) status information. AV-POSView decodes and displays the sensor hardware status output in this group. The following is a brief description of group contents.

General Status A contains bit-encoded status information from the following processes: integrated navigation, data logging and generic hardware.

General Status B contains bit-encoded status information from the following processes: primary GNSS data input, secondary GNSS data input, auxiliary GPS data input.

General Status C contains bit-encoded information from the following processes: integrated navigation, base GNSS messages (RTCM and CMR) input.

FDIR Level 1, similar to a built-in test, reports problems in communications between the sensors and the PCS.

FDIR Level 2, the direct reasonableness test, compares the sensor data against reasonable magnitude limits for the POS-instrumented Aircraft.

FDIR Level 3, the direct comparison test, compares IMU data against aiding sensor data and identifies unreasonable differences when they occur.

FDIR Level 4, the residual test, monitors the measurement residuals from the Kalman filter and rejects measurements that fall outside a specified 95% confidence level. Consistent measurement rejection indicates a potential IMU or aiding sensor failure.

FDIR Level 5, the indirect reasonableness test, monitors Kalman filter estimates of inertial sensor errors and installation errors. Soft sensor failures appear as slow increases in these errors. If a threshold is exceeded, a sensor failure is flagged.

Table 19: Group 10: General and FDIR status

Item	Bytes	Format	Value	Units
Group start	4	char	$GRP	N/A
Group ID	2	ushort	10	N/A
Byte count	2	ushort	60	bytes
Time/Distance Fields	26	*See* Table 3		

Item	Bytes	Format	Value	Units
General Status A	4	ulong	Coarse leveling active	bit 0: set
			Coarse leveling failed	bit 1: set
			Quadrant resolved	bit 2: set
			Fine align active	bit 3: set
			Inertial navigator initialized	bit 4: set
			Inertial navigator alignment active	bit 5: set
			Degraded navigation solution	bit 6: set
			Full navigation solution	bit 7: set
			Initial position valid	bit 8: set
			Reference to Primary GNSS Lever arms = 0	bit 9: set
			Reference to Sensor 1 Lever arms = 0	bit 10: set
			Reference to Sensor 2 Lever arms = 0	bit 11: set
			Logging Port file write error	bit 12: set
			Logging Port file open	bit 13: set
			Logging Port logging enabled	bit 14: set
			Logging Port device full	bit 15: set
			RAM configuration differs from NVM	bit 16: set
			NVM write successful	bit 17: set
			NVM write fail	bit 18: set
			NVM read fail	bit 19: set
			CPU loading exceeds 55% threshold	bit 20: set
			CPU loading exceeds 85% threshold	bit 21: set
			Free inertial mode	bit 22: set
			GPS only mode e	bit 23: set
			Reserved	bits: 24-31

Item	Bytes	Format	Value	Units
General Status B	4	ulong	User attitude RMS performance	bit 0: set
			User heading RMS performance	bit 1: set
			User position RMS performance	bit 2: set
			User velocity RMS performance	bit 3: set
			Reserved	bit 4: set
			Reserved	bit 5: set
			Reserved	bit 6: set
			Reserved	bit 7: set
			Reserved	bit 8: set
			Reserved	bit 9: set
			Reserved	bit 10: set
			Reserved	bit 11: set
			Reserved	bit 12: set
			Primary GNSS navigation solution in use	bit 13: set
			Primary GNSS initialization failed	bit 14: set
			Primary GNSS reset command sent	bit 15: set
			Primary GNSS configuration file sent	bit 16: set
			Primary GNSS not configured	bit 17: set
			Primary GNSS in C/A mode	bit 18: set
			Primary GNSS in Differential mode	bit 19: set
			Reserved	bit 20: set
			Reserved	bit 21: set
			Reserved	bit 22: set
			Reserved	bit 23: set
			Reserved	bit 24: set
			Auxiliary GNSS navigation solution in use	bit 25: set
			Auxiliary GNSS in P-code mode	bit 26: set
			Auxiliary GNSS in Differential mode	bit 27: set
			Auxiliary GNSS in float RTK mode	bit 28: set
			Auxiliary GNSS in wide lane RTK mode	bit 29: set
			Auxiliary GNSS in narrow lane RTK mode	bit 30: set
			Primary GNSS in P-code mode	bit 31: set

Item	Bytes	Format	Value	Units
General Status C	4	ulong	Reserved	bit 0: set
			Reserved	bit 1: set
			Reserved	bit 2: set
			Reserved	bit 3: set
			Reserved	bit 4: set
			Reserved	bit 5: set
			RTCM differential corrections in use	bit 6: set
			RTCM RTK messages in use	bit 7: set
			Reserved	bit 8: set
			CMR RTK messages in use	bit 9: set
			IIN in DR mode	bit 10: set
			IIN GNSS aiding is loosely coupled	bit 11: set
			IIN in C/A GNSS aided mode	bit 12: set
			IIN in RTCM DGPS aided mode	bit 13: set
			IIN in code DGPS aided mode	bit 14: set
			IIN in float RTK aided mode	bit 15 set
			IIN in wide lane RTK aided mode	bit 16: set
			IIN in narrow lane RTK aided mode	bit 17: set
			Received RTCM Type 1 message	bit 18: set
			Received RTCM Type 3 message	bit 19: set
			Received RTCM Type 9 message	bit 20: set
			Received RTCM Type 18 messages	bit 21: set
			Received RTCM Type 19 messages	bit 22: set
			Received CMR Type 0 message	bit 23: set
			Received CMR Type 1 message	bit 24: set
			Received CMR Type 2 message	bit 25: set
			Received CMR Type 94 message	bit 26 set
			Reserved	bit 27: set
			Reserved	bit: 28-31

Item	Bytes	Format	Value	Units
FDIR Level 1 status	4	ulong	IMU-POS checksum error	bit 0: set
			IMU status bit set by IMU	bit 1: set
			Successive IMU failures	bit 2: set
			IIN configuration mismatch failure	bit 3: set
			Primary GNSS not in Navigation mode	bit 5: set
			Primary GNSS not available for alignment	bit 6: set
			Primary data gap	bit 7: set
			Primary GNSS PPS time gap	bit 8: set
			Primary GNSS time recovery data not received	bit 9: set
			Primary GNSS observable data gap	bit 10: set
			Primary ephemeris data gap	bit 11: set
			Primary GNSS excessive lock-time resets	bit 12: set
			Primary GNSS missing ephemeris	bit 13: set
			Primary GNSS SNR failure	bit 16: set
			Base GNSS data gap	bit 17: set
			Base GNSS parity error	bit 18: set
			Base GNSS message rejected	bit 19: set
			Secondary GNSS data gap	bit 20: set
			Secondary GNSS observable data gap	bit 21: set
			Secondary GNSS SNR failure	bit 22: set
			Secondary GNSS excessive lock-time resets	bit 23: set
			Auxiliary GNSS data gap	bit 25: set
			Reserved	bit 26: set
			Gimbal data gap	bit 27: set
			Reserved	bit 28: set
			IIN WL ambiguity error	bit 30: set
			IIN NL ambiguity error	bit 31: set
			Reserved	bits: 4, 14-15, 24, 28, 29
FDIR Level 1 IMU failures	2	ushort	Shows number of FDIR Level 1 Status IMU failures (bits 0 or 1) = Bad IMU Frames	

Item	Bytes	Format	Value	Units
FDIR Level 2 status	2	ushort	Inertial speed exceeds maximum Primary GBSS velocity exceeds maximum Primary GNSS position error exceeds maximum Auxiliary GNSS position error exceeds max. Reserved Reserved	bit 0: set bit 1: set bit 2: set bit 3: set bit 4: set bits: 5-15
FDIR Level 3 status	2	ushort	Reserved	bits: 0-15
FDIR Level 4 status	2	ushort	Primary GNSS position rejected Primary GNSS velocity rejected Reserved Auxiliary GNSS data rejected Reserved Primary GNSS observables rejected Reserved	bit 0: set bit 1: set bit 2: set bit 3: set bit 4: set bit 5: set bits: 6-15
FDIR Level 5 status	2	ushort	X accelerometer failure Y accelerometer failure Z accelerometer failure X gyro failure Y gyro failure Z gyro failure Reserved Excessive primary GPS lever arm error Excessive auxiliary 1 GPS lever arm error Excessive auxiliary 2 GPS lever arm error Excessive POS position error RMS Excessive primary GPS clock drift Reserved	bit 0: set bit 1: set bit 2: set bit 3: set bit 4: set bit 5: set bit 6: set bit 7: set bit 8: set bit 9: set bit10:set bit11:set bits: 12-15

Item	Bytes	Format	Value	Units
Extended Status	4	ulong	Primary GPS in Omnistar HP mode Primary GPS in Omnistar XP mode Primary GPS in Omnistar VBS mode Primary GPS in PPP mode Aux. GPS in Omnistar HP mode Aux. GPS in Omnistar XP mode Aux. GPS in Omnistar VBS mode Aux. GPS in PPP mode Primary GPS in Omnistar G2 mode Primary GPS in Trimble RTX mode Reserved	bit 0: set bit 1: set bit 2: set bit 3: set bit 4: set bit 5: set bit 6: set bit 7: set bit 12 set bit 13 set bits: 8-11 14-31
Pad	0	byte	0	N/A
Checksum	2	ushort	N/A	N/A
Group end	2	char	$#	N/A

3.3.1.10 Group 11: Secondary GNSS Status

This group contains status data from the secondary GNSS receiver. The group length is variable, depending on the number of secondary GNSS receiver channels that report data. This group assumes that the secondary GNSS receiver contains up to 30 channels, and therefore provides 30 channel status fields. Each channel status field has the format given in Table 8. The *GNSS navigation message latency* field contains the time between the PPS pulse and the start of the GNSS navigation data output

Table 20: Group 11: Secondary GNSS status

Item	Bytes	Format	Value	Units
Group start	4	char	$GRP	N/A
Group ID	2	ushort	11	N/A
Byte count	2	ushort	76 + 20 x (number of channels)	bytes
Time/Distance Fields	26	*See* Table 3		
Navigation solution status	1	byte	*See Table 9*	N/A
Number of SV tracked	1	byte	[0, 30]	N/A
Channel status byte count	2	ushort	[0, 600]	bytes
Channel status	variable	*See Table 8*		
HDOP	4	float	(0,)	N/A
VDOP	4	float	(0,)	N/A
DGPS correction latency	4	float	[0, 99.9]	seconds
DGPS reference ID	2	ushort	[0, 1023]	N/A
GPS/UTC week number	4	ulong	[0, 9999] 0 if not available	week
GPS/UTC time offset (GPS time – UTC time)	8	double	(, 0]	seconds
GNSS navigation message latency	4	float	[0,)	seconds
Geoidal separation	4	float	(,)	meters
GNSS receiver type	2	ushort	*See Table 11*	N/A
GNSS status	4	ulong	GNSS summary status fields which depend on GNSS receiver type. *Trimble BD960 Status set to 0*	

Item	Bytes	Format	Value	Units
Pad	2	byte	0	N/A
Checksum	2	ushort	N/A	N/A
Group end	2	char	$#	N/A

3.3.1.11 Group 12: Auxiliary 1 GNSS Status

This group contains data from an optional auxiliary 1 external GNSS receiver. The group is variable in length because it is dependent upon the number of satellites that the auxiliary 1 GNSS receiver is tracking. This group assumes that the auxiliary 1 GNSS receiver contains up to 12 channels, and therefore provides 12 channel status fields. The center section of this group grows with increasing number of satellites tracked.

3.3.1.12 Group 13: Auxiliary 2 GNSS Status

This group contains data from an optional auxiliary 2 external GNSS receiver. The group has the same format as Group 12. Table 21 specifies the format for both Groups 12 and 13

Table 21: Group 12/13: Auxiliary 1/2 GPS status

Item	Bytes	Format	Value	Units
Group start	4	char	$GRP	N/A
Group ID	2	ushort	12 or 13	N/A
Byte count	2	ushort	72 + 20 x (number of channels)	bytes
Time/Distance Fields	26	*See* Table 3		
Navigation solution status	1	byte	*See Table 9*	N/A
Number of SV Tracked	1	byte	[0, 12]	N/A
Channel status byte count	2	ushort	[0,)	bytes
Channel status	variable	*See Table 8*		
HDOP	4	float	(0,)	N/A
VDOP	4	float	(0,)	N/A
DGPS correction latency	4	float	(0,)	seconds
DGPS reference ID	2	ushort	[0, 1023]	N/A
GPS/UTC week number	4	ulong	[0, 9999] 0 if not available	week

Item	Bytes	Format	Value	Units
GPS time offset (GPS time – UTC time)	8	double	(, 0]	seconds
GNSS navigation message latency	4	float	[0,)	seconds
Geoidal separation	4	float	N/A	meters
NMEA messages Received	2	ushort	Bit (set) NMEA Message 0 GGA (GPS position) 1 GST (noise statistics) 2 GSV (satellites in view) 3 GSA (DOP & active SVs) 4-7 Reserved	
Aux 1/2 in Use	1	byte	0 Not in use 1 In use	N/A
Pad	1	byte	0	N/A
Checksum	2	ushort	N/A	N/A
Group end	2	char	$#	N/A

3.3.1.13 Group 17: User Time Status

This group contains status information about user time synchronization.

Table 22: Group 17: User Time Status

Item	Bytes	Format	Value	Units
Group start	4	char	$GRP	N/A
Group ID	2	ushort	17	N/A
Byte count	2	ushort	40	bytes
Time/Distance Fields	26	*See* Table 3		
Number of Time Synch message rejections	4	ulong	[0,)	N/A
Number of User Time resynchronizations	4	ulong	[0,)	N/A
User time valid	1	byte	1 or 0	N/A
Time Synch message received	1	byte	1 or 0	N/A
Pad	0	byte	0	N/A
Checksum	2	ushort	N/A	N/A
Group end	2	char	$#	N/A

3.3.1.14 Group 20: IIN Solution Status

This group contains the IIN observables processing status and relevant data. The following are descriptions of some of the fields.

The *number of satellites* field gives the number of satellites in the IIN solution. The *a priori PDOP* is the PDOP of the satellite constellation selected by IIN before processing. The *baseline length* is the computed distance between the primary GNSS antenna and the reference GNSS antenna. The *IIN processing status* describes the status of the current IIN solution. The 12 *PRN assignment* fields give the satellite PRN used in each observables processing channel in the IIN solution. The *L1 cycle slip flag* field contains a bit array whose bits when set, indicate an L1 cycle slips in the observables processing channels. The *L2 cycle slip flag* field contains a bit array whose bits when set, indicate L2 cycle slips in observables processing channels. In each bit array, bit (*k*-1) indicates the cycle slip status of processing channel *k*.

Table 23: Group 20: IIN solution status

Item	Bytes	Format	Value	Units
Group start	4	char	$GRP	N/A
Group ID	2	ushort	20	N/A
Byte count	2	ushort	60	bytes
Time/Distance Fields	26	*See* Table 3		
Number of satellites	2	ushort	[0, 12]	N/A
A priori PDOP	4	float	[0, 999]	N/A
Baseline length	4	float	[0,)	meters
IIN processing status	2	ushort	1 Fixed Narrow Lane RTK 2 Fixed Wide Lane RTK 3 Float RTK 4 Code DGPS 5 RTCM DGPS 6 Autonomous (C/A) 7 GNSS navigation solution 8 No solution	
PRN assignment	12	12 byte	Each byte contains 0-40 where 0 = unassigned PRN 1-40 = PRN assigned to channel	
L1 cycle slip flag	2	ushort	Bits 0-11: $(k\text{-}1)^{th}$ bit set to 1 implies L1 cycle slip in channel *k* PRN. Example: Bit 3 set to 1 implies an L1 cycle slip in channel 4. Bits 12-15 are not used.	

Item	Bytes	Format	Value	Units
L2 cycle slip flag	2	ushort	Bits 0-11: $(k\text{-}1)^{th}$ bit set to 1 implies L2 cycle slip in channel *k* PRN. Example: Bit 3 set to 1 implies an L2 cycle slip in channel 4. Bits 12-15 are not used.	
Pad	2	byte	0	N/A
Checksum	2	ushort	N/A	N/A
Group end	2	char	$#	N/A

3.3.1.15 Group 23: Auxiliary 1 GNSS Display Data

This group contains the auxiliary 1 GNSS receiver data stream, containing the NMEA strings requested by the PCS from the receiver plus any other bytes that the receiver inserts into the stream. The length of this group is variable. It is identical to group 10007 except for the time2 restriction and the fact it is intended for display only.

3.3.1.16 Group 24: Auxiliary 2 GNSS Display Data

This group contains the auxiliary 2 GNSS receiver data stream, containing the NMEA strings requested by the PCS from the receiver plus any other bytes that the receiver inserts into the stream. The length of this group is variable. It is identical to group 10008 except for the time2 restriction and the fact it is intended for display only.

Table 24: Group 23/24: Auxiliary 1 and 2 GNSS raw display data

Item	Bytes	Format	Value	Units
Group start	4	char	$GRP	N/A
Group ID	2	ushort	10007 or 10008	N/A
Byte count	2	ushort	variable	bytes
Time/Distance Fields	26	*See* Table 3		
reserved	6	byte	N/A	N/A
Variable message byte count	2	ushort	[0,)	bytes
Auxiliary GNSS raw data	*variable*	*char*	*N/A*	*N/A*
Pad	0-3	byte	0	N/A
Checksum	2	ushort	N/A	N/A
Group end	2	char	$#	N/A

3.3.1.17 Group 29: GNSS Receiver OmniSTAR Status

This group contains the GNSS Receiver OmniSTAR status. This Group is output at a frequency of 1 Hz, however the contents update every 30 seconds. This Group is only applied to the primary GNSS receiver.

Table 25: Group 29: GNSS Receiver OmniSTAR Status

Item	Bytes	Format	Value	Units
Group start	4	char	$GRP	N/A
Group ID	2	ushort	29	N/A
Byte count	2	ushort	62	bytes

Item	Bytes	Format	Value	Units
Time/Distance Fields	26		*See* Table 3	
OmniSTAR Status	1	byte	0 OmniSTAR off 1-2 Test Mode 3-4 Searching Mode 5 Tracking Initialization 6 Verifying Data Stream 7 Fully Tracking Satellite 4-255 Reserved	N/A
Satellite ID	1	byte	(0,100) Special ID 100 Custom satellite 110 Automatically choose satellite	N/A
Frequency of the satellite	4	ulong	Satellite Frequency	Hz
Bit Rate of the satellite	2	ushort	Data transfer rate	bit/sec
HP/XP - OmniSTAR library active flag	1	byte	0 Not Active 1 Active	N/A
HP/XP - Engine mode used by the library (Not applicable to RTX)	1	byte	1 HP 2 XP 3 G2 4 HP+G2 5 HP+XP	N/A
HP/XP Subscription starting date - year	2	ushort	0 for no valid subscription	N/A
Subscription starting date - month	1	byte	1-12 or 0 for no valid subscription	N/A

Item	Bytes	Format	Value	Units
Subscription starting date - day	1	byte	1-31 or 0 for no valid subscription	N/A
HP/XP/RTX Subscription expiration date - year	2	ushort	0 for no valid subscription	N/A
Subscription expiration date – month	1	byte	1-12 or 0 for no valid subscription	N/A
Subscription expiration date - day	1	byte	1-31 or 0 for no valid subscription	N/A
Subscribed engine mode (Not applicable to RTX)	1	byte	1 HP 2 XP 3 G2 4 HP+G2 5 HP+XP	N/A
Reserved	4	byte	Reserved	N/A
Reserved	4	byte	Reserved	N/A
HP/XP status - Receiver Operation Mode (Not applicable to RTX)	1	byte	1 Static 2 kinematic	N/A
HP/XP status - OmniSTAR Operation Mode (Not applicable to RTX)	1	byte	0 Kinematic 1 Static 2 OmniSTAR not ready	N/A
Reserved	1	byte	Reserved	N/A
Reserved	1	byte	Reserved	N/A
Reserved	1	byte	Reserved	N/A
Pad	0	byte	0	N/A
Checksum	2	ushort	N/A	N/A
Group end	2	char	$#	N/A

3.3.1.18 Group 30/31/32/33: Events 3/4/5/6

The time and distance fields in this group indicate the time and distance of Event ‘n’ discrete signals that the POS receives. A client can use this message to attach GPS/UTC time to external events.

Table 26: Group 30/31/32/33: Events 3/4/5/6

Item	Bytes	Format	Value	Units
Group start	4	char	$GRP	N/A
Group ID	2	ushort	30 or 31 or 32 or 33	N/A
Byte count	2	ushort	36	bytes
Time/Distance Fields	26	*See Table* 3		
Event pulse number	4	ulong	[0,)	N/A
Pad	2	byte	0	N/A
Checksum	2	ushort	N/A	N/A
Group end	2	char	$#	N/A

3.3.1.19 Group 99: Version and statistics

This group provides feedback of the current statistics and software and hardware version numbers of the POS AV. This group contains operational statistics such as total hours of operation, number of runs, average run length, and longest run.

Table 27: Group 99: Versions and statistics

Item	Bytes	Format	Value	Units
Group Start	4	Char	$GRP	N/A
Group ID	2	ushort	99	N/A
Byte Count	2	ushort	332	bytes
Time/Distance Fields	26	*See* Table 3		
System version	120	Char	Product – Model, Version, Serial Number, Hardware version, Software release version – Date, ICD release version, Operating system version, IMU type , Primary GPS type (Table 11), Secondary GPS type (Table 11) Gimbal type [,Option mnemonic– expiry time] [,Option mnemonic– expiry time] ….. Example: AV-410,VER6,S/N2021,HW5-10, SW01.11-Aug26/ICD4.07, OS6.4.1,IMU7,PGPS13,SGPS0, GIM0,RT-0	
Primary GNSS version	80	char	Available information is displayed, eg: • Model number • Serial number • Hardware configuration version • Software release version • Release date	

Item	Bytes	Format	Value	Units
Secondary GNSS version	80	Char	Available information is displayed, eg: • Model number • Serial number • Hardware configuration version • Software release version • Release date	
Total hours	4	float	[0,) 0.1 hour resolution	hours
Number of runs	4	ulong	[0,)	N/A
Average length of run	4	float	[0,) 0.1 hour resolution	hours
Longest run	4	float	[0,) 0.1 hour resolution	hours
Current run	4	float	[0,) 0.1 hour resolution	hours
Pad	2	short	0	N/A
Checksum	2	ushort	N/A	N/A
Group End	2	char	$#	N/A

3.3.1.20 Group 200: Gimbal Encoder Data

This group contains the gimbal encoder data read from selected COM port. The sequence of rotation starting from aircraft frame is as follows:Tz,Ty,Tx. All angles are positive clockwise.

Table 28: Group 200: Gimbal Encoder Data

Item	Bytes	Format	Value	Units
Group Start	4	char	$GRP	N/A
Group ID	2	ushort	200	N/A
Byte Count	2	ushort	56	N/A
Time/Distance Fields	26	*See* Table 3		
Tx	8	double	N/A	deg
Ty	8	double	N/A	deg
Tz	8	double	N/A	deg
Pad	2	byte	0	N/A
Checksum	2	ushort	N/A	N/A
Group End	2	char	$#	N/A

3.3.1.21 Group 201: Target Reference Position Data

This group contains the computed Target Reference Position data.

Table 29: Group 201: Target Reference Position Data

Item	Bytes	Format	Value	Units
Group Start	4	char	$GRP	N/A
Group ID	2	ushort	201	N/A
Byte Count	2	ushort	72	N/A
Time/Distance Fields	26		*See* Table 3	
Target Latitude	8	double	-90 < to ≤ 90	deg
Target Longitude	8	double	-180 < to ≤ 180	deg
Target Altitude	8	double	N/A	m
Target Range	8	double	N/A	m
Target Bearing	8	double	-180 < to ≤ 180	deg
Status	2	ushort	Postion Valid bit 0: set Range from Laser bit 1: set Range from Radar Altimeter and flat earth bit 2: set Range from GPS and flat earth bit 3: set Spare bits: 4-15	
Pad	0	byte	N/A	N/A
Checksum	2	ushort	N/A	N/A
Group End	2	char	$#	N/A

3.3.1.22 Group 202: Laser Range Finder Data

This group contains the Laser Range Finder data decoded from LRF input.

Table 30: Group 202: Laser Range Finder Data

Item	Bytes	Format	Value	Units
Group start	4	char	$GRP	N/A
Group ID	2	ushort	202	N/A
Byte Count	2	ushort	48	bytes
Time/Distance Fields	26	*See* Table 3		
Laser Range	8	double	N/A	m
Radar Altitude	8	double	N/A	m
Status	2	ushort	Laser Range Valid bit 0: set Radar Altitude Valid bit 1: set Spare bits: 3-15	
Pad	0	byte	N/A	N/A
Checksum	2	ushort	N/A	N/A
Group end	2	char	$#	N/A

3.3.1.23 Group 203: Yaw Drift Correction

This group contains the output from the platform yaw drift correction. This output is applied to the yaw command signal of stabilized mount in order to steer the heading of the platform to the heading desired by user, or steer the heading of the platform so that it always follows the mean track of the aircraft. This output is designed for traditional mounts. The yaw drift correction internally is calculated at the rate of IMU, but the group is available for logging at the rate of 1Hz.

Table 31: Group 203: Yaw Drift Correction

Item	Bytes	Format	Value	Units
Group Start	4	char	$GRP	N/A
Group ID	2	ushort	203	N/A
Byte Count	2	ushort	48	N/A
Time/Distance Fields	26		*See* Table 3	
Yaw Drift Correction	8	double	N/A	deg
Status 1	1	byte	**Meaning** / **Value** YDC invalid 0 Follow Mean Track 1 Follow desired heading 2 Follow mean track (w/o int) 3 Follow desired heading (w/o int) 4	N/A
Status 2	1	byte	N/A	sec
Heading Difference	8	double	N/A	deg
Checksum	2	ushort	N/A	N/A
Group End	2	char	$#	N/A

3.3.1.24 Group 206: Event1-based Navigation Solution

This group contains position, velocity, attitude, track, speed and dynamics data for the aircraft at the time of event1 pulse. The data in this group is valid at the centre of the reference frame.

Table 32: Group 206: Event 1 based navigation solution

Item	Bytes	Format	Value	Units
Group start	4	char	$GRP	N/A
Group ID	2	ushort	206	N/A
Byte count	2	ushort	144	bytes
Time/Distance Fields	26		*See* Table 3	
Event pulse #	4	ulong	N/A	N/A

Item	Bytes	Format	Value	Units
Latitude	8	double	-90 < to ≤ 90	deg
Longitude	8	double	-180 < to ≤ 180	deg
Altitude	8	double	N/A	m
Along track velocity	4	float	N/A	m/s
Across track velocity	4	float	N/A	m/s
Down velocity	4	float	N/A	m/s
Roll*	8	double	-180 < to ≤ 180	deg
Pitch*	8	double	-90 < to ≤ 90	deg
Heading*	8	double	0 ≤ to < 360	deg
Geoidal Separation	8	double	N/A	m
Wander angle	8	double	-180 < to ≤ 180	deg
Aircraft track angle	4	float	0 ≤ to < 360	deg
Aircraft speed	4	float	≥ 0	m/s
Angular rate about longitudinal axis*	4	float	N/A	deg/s
Angular rate about transverse axis*	4	float	N/A	deg/s
Angular rate about down axis*	4	float	N/A	deg/s
Longitudinal acceleration*	4	float	N/A	m/s^2
Transverse acceleration*	4	float	N/A	m/s^2
Down acceleration*	4	float	N/A	m/s^2

Item	Bytes	Format	Value	Units
Solution Status*	1	byte	0 Full Nav. (user accuracies met) 1 Fine align (heading RMS < 15 deg) 2 GC CHI 2 (alignment w GPS, RMS heading error > 15 deg) 3 PC CHI 2 (alignment w/o GPS, RMS heading error > 15 deg) 4 GC CHI 1 (alignment w GPS, RMS heading error > 45 deg) 5 PC CHI 1 (alignment w/o GPS, RMS heading error > 45 deg) 6 coarse leveling active 7 initial solution assigned no solution	N/A
Pad	1	byte	0	N/A
Checksum	2	ushort	N/A	N/A
Group end	2	char	$#	N/A

3.3.1.25 Group 207: Event2-based Navigation Solution

This group contains position, velocity, attitude, track, speed and dynamics data for the aircraft at the time of event2 pulse. The data in this group is valid at the centre of the reference frame.

Table 33: Group 207: Event 2 based navigation solution

Item	Bytes	Format	Value	Units
Group start	4	Char	$GRP	N/A
Group ID	2	ushort	207	N/A
Byte count	2	ushort	144	bytes
Time/Distance Fields	26	*See* Table 3		
Event pulse #	4	ulong	N/A	N/A
Latitude	8	double	-90 < to ≤ 90	deg
Longitude	8	double	-180 < to ≤ 180	deg
Altitude	8	double	N/A	m
Along track velocity	4	float	N/A	m/s
Across track velocity	4	float	N/A	m/s
Down velocity	4	float	N/A	m/s
Roll*	8	double	-180 < to ≤ 180	deg

Item	Bytes	Format	Value	Units
Pitch*	8	double	-90 < to ≤ 90	deg
Heading*	8	double	0 ≤ to < 360	deg
Geoidal Separation	8	double	N/A	m
Wander angle	8	double	-180 < to ≤ 180	deg
Aircraft track angle	4	float	0 ≤ to < 360	deg
Aircraft speed	4	float	≥ 0	m/s
Angular rate about longitudinal axis*	4	float	N/A	deg/s
Angular rate about transverse axis*	4	float	N/A	deg/s
Angular rate about down axis*	4	float	N/A	deg/s
Longitudinal acceleration*	4	float	N/A	m/s^2
Transverse acceleration*	4	float	N/A	m/s^2
Down acceleration*	4	float	N/A	m/s^2
Solution Status*	1	byte	0 Full Nav. (user accuracies met) 1 Fine align (heading RMS < 15 deg) 2 GC CHI 2 (alignment w GPS, RMS heading error > 15 deg) 3 PC CHI 2 (alignment w/o GPS, RMS heading error > 15 deg) 4 GC CHI 1 (alignment w GPS, RMS heading error > 45 deg) 5 PC CHI 1 (alignment w/o GPS, RMS heading error > 45 deg) 6 coarse leveling active 7 initial solution assigned 8 no solution	N/A
Pad	1	byte	0	N/A
Checksum	2	ushort	N/A	N/A

Item	Bytes	Format	Value	Units
Group end	2	char	$#	N/A

3.3.1.26 Group 208: Photo ID1

This group contains Camera 1 trigger information. The group is used to generate the photo ID file of the first camera. The group is available for output only for POSTrack product.

Table 34: Group 208: Photo ID1

Item	Bytes	Format	Value	Units
Group Start	4	char	$GRP	N/A
Group ID	2	ushort	208	N/A
Byte Count	2	ushort	60	N/A
Time/Distance Fields	26	*See* Table 3		
Event Number	4	ulong	N/A	N/A
Photo ID	4	ulong	N/A	N/A
Event Time	8	double	N/A	sec
Camera Delay	8	double	N/A	msec
Reserved	4	ulong	N/A	N/A
Pad	2	byte	0	N/A
Checksum	2	ushort	N/A	N/A
Group End	2	char	$#	N/A

3.3.1.27 Group 209: Photo ID2

This group contains Camera 2 trigger information. The group is used to generate the photo ID file of the second camera. It is available only with POSTrack product.

Table 35: Group 209: Photo ID2

Item	Bytes	Format	Value	Units
Group Start	4	char	$GRP	N/A
Group ID	2	ushort	209	N/A
Byte Count	2	ushort	60	N/A
Time/Distance Fields	26	*See* Table 3		
Event Number	4	ulong	N/A	N/A
Photo ID	4	ulong	N/A	N/A
Event Time	8	double	N/A	Sec
Camera Delay	8	double	N/A	Msec
Reserved	4	ulong	N/A	N/A
Pad	2	byte	0	N/A
Checksum	2	ushort	N/A	N/A
Group End	2	char	$#	N/A

3.3.1.28 Group 210: Event1 Real Time POSEO

This group contains georeferenced information in local mapping frame of user choice at the time of event 1.

Table 36: Group 210: Real Time POSEO Event 1

Item	Bytes	Format	Value	Units
Group start	4	char	$GRP	N/A
Group ID	2	ushort	210	N/A
Byte count	2	ushort	132	Bytes
Time/Distance Fields	26	Table 3 defined in PUBS-ICD-003259	*Time/Distance Fields*	
Event	4	long		N/A

Item	Bytes	Format	Value	Units
Easting	8	double		Meter or US feet or International feet
Northing	8	double		Meter or US feet or International feet
Latitude	8	double	-90 < to ≤ 90	deg
Longitude	8	double	-180 < to ≤ 180	deg
Altitude	8	double	Ellipsoid Altitude	Meter or US feet or International feet
Geoidal Separation	8	double		Meter or US feet or International feet
Omega	8	double		Degrees or Gradients or Radians
Phi	8	double		Degrees or Gradients or Radians

Item	Bytes	Format	Value	Units
Kappa	8	double		Degrees or Gradients or Radians
Coordinate Units	1	char	0 – meters 1-US Survey Feet 2-International Feet Applicable to Easting, Northing, Altitude and Geoidal Separation	N/A
Angle Units	1	char	0 – degrees 1 – gradients 2- radians Applicable to Omega, Phi and Kappa	N/A
Reserved1	4	long	N/A	N/A
Reserved2	8	double	N/A	N/A
Reserved3	4	long	N/A	N/A
Reserved4	8	double	N/A	N/A
Pad	0	byte	0	N/A
Checksum	2	ushort	N/A	N/A
Group end	2	char	$#	N/A

3.3.1.29 Group 211: Event 2 Real Time POSEO

This group contains georeferenced information in local mapping frame of user choice at the time of event 2.

Table 37: Group 211: Real Time POSEO Event 2

Item	Bytes	Format	Value	Units
Group start	4	char	$GRP	N/A
Group ID	2	ushort	211	N/A
Byte count	2	ushort	132	bytes
Time/Distance Fields	26	Table 3 defined in PUBS-ICD-003259		
Event	4	long		N/A

Item	Bytes	Format	Value	Units
Easting	8	double		Meter or US feet or International feet
Northing	8	double		Meter or US feet or International feet
Latitude	8	double	-90 < to ≤ 90	deg
Longitude	8	double	-180 < to ≤ 180	deg
Altitude	8	double	Ellipsoid Altitude	Meter or US feet or International feet
Geoidal Separation	8	double		Meter or US feet or International feet
Omega	8	double		Degrees or Gradients or Radians
Phi	8	double		Degrees or Gradients or Radians

Item	Bytes	Format	Value	Units
Kappa	8	double		Degrees or Gradients or Radians
Coordinate Units	1	char	0 – meters 1-US Survey Feet 2-International Feet Applicable to Easting, Northing, Altitude and Geoidal Separation	N/A
Angle Units	1	char	0 – degrees 1 – gradients 2- radians Applicable to Omega, Phi and Kappa	N/A
Reserved1	4	long	N/A	N/A
Reserved2	8	double	N/A	N/A
Reserved3	4	long	N/A	N/A
Reserved4	8	double	N/A	N/A
Pad	0	byte	0	N/A
Checksum	2	ushort	N/A	N/A
Group end	2	char	$#	N/A

3.3.1.30 Group 212: Lidar Swats Display

This group can be used by Flight Management System to display the lidar swats in real time.

Table 38: Group 212: Lidar Swats Display

Item	Bytes	Format	Value	Units
Group Start	4	char	$GRP	N/A
Group ID	2	ushort	212	N/A
Byte Count	2	ushort	136	N/A
Time/Distance Fields	26	Table 3 defined in PUBS-ICD-003259		
Middle Point Altitude Diff	4	float	N/A	M

Item	Bytes	Format	Value	Units
Middle Point Range	4	float	N/A	M
Middle Point Angle	4	float	N/A	M
Middle Point Latitude	8	double	-90 < to ≤ 90	Deg
Middle Point Longitude	8	double	-180 < to ≤ 180	Deg
Middle Point Altitude	4	float	N/A	M
First Point Range	4	float	N/A	M
First Point Angle	4	float	N/A	M
First Point Latitude	8	double	-90 < to ≤ 90	Deg
First Point Longitude	8	double	-180 < to ≤ 180	Deg
First Point Altitude	4	float	N/A	M
Last Point Range	4	float	N/A	M
Last Point Angle	4	float	N/A	M
Last Point Latitude	8	double	-90 < to ≤ 90	Deg
Last Point Longitude	8	double	-180 < to ≤ 180	Deg
Last Point Altitude	4	float	N/A	M
Reserved1	8	double	N/A	
Reserved2	4	float	N/A	
Reserved3	4	float	N/A	
Pad	2	byte	0	N/A
Checksum	2	ushort	N/A	N/A
Group end	2	char	$#	N/A

3.3.1.31 Group 213: Dark Image Collection

The group contains real time information about beginning and the end of the flight line and is used to trigger dark image collection from the camera.

Table 39: Group 213: Dark Image Collection

Item	Bytes	Format	Value	Units
Group start	4	Char	$GRP	N/A
Group ID	2	Ushort	213	N/A
Byte Count	2	Ushort	52	bytes
Time/Distance Fields	26	*See* Table 3		
Counter 1	4	Long	Dark image counter for start of survey line	N/A
Counter 2	4	Long	Dark image counter for end of survey line	N/A
Status	1	Byte	1- line start 2- line end	N/A
Reserved 1	4	Long	N/A	N/A
Reserved 2	8	Double	N/A	N/A
Pad	1	Byte	0	N/A
Checksum	2	Ushort	N/A	N/A
Group end	2	Char	$#	N/A

3.3.1.32 Group 214: Lidar Logging on/off

This group contains lidar logging information from POS that can be used by generic lidar to turn the logging on and off.

Table 40: Group 214: Lidar logging on/off

Item	Bytes	Format	Value	Units
Group Start	4	char	$GRP	N/A
Group ID	2	ushort	214	N/A
Byte Count	2	ushort	60	N/A
Time/Distance Fields	26	Table 3		
Reserved	1	byte	0	N/A
External Device Logging	1	byte	0- Turn logging off (end of survey line) 1- Turn logging on (start of survey line)	N/A
Flight Line	4	long	Current Flight Line Number	N/A
Reserved 1	4	long	0	N/A
Reserved 2	4	float	0	N/A
Reserved 3	8	double	0	N/A
Reserved 4	8	double	0	N/A
Pad	0		N/A	N/A
Checksum	2	ushort	N/A	N/A
Group end	2	char	$#	N/A

3.3.1.33 Group 215: Ethernet Trigger Group

This group can be used as a software equivalent of the hardware TTL pulse for triggering of the camera. Applicable delay based on the network load applies.

Table 41: Group 215: Ethernet Trigger Group

Item	Bytes	Format	Value	Units
Group Start	4	char	$GRP	N/A
Group ID	2	ushort	215	N/A
Byte Count	2	ushort	52	N/A
Time/Distance Fields	26	Table 3		
Counter	4	ulong	Counter starts from 0 and increments for each photo position	N/A
Reserved1	4	long	0	N/A
Status	1	byte	0- Single Photo 1- Planned Photo	N/A
Reserved 2	4	long	0	N/A
Reserved 3	8	float	0	N/A
Pad	1		N/A	N/A
Checksum	2	ushort	N/A	N/A
Group end	2	char	$#	N/A

3.3.1.34 Group 222: Reference Frame Position, Velocity, Attitude & Dynamics

This group contains position, velocity, attitude, track, speed and dynamics data for the Reference frame.

Table 42: Group 222: Reference Frame Position, Velocity, Attitude, Heave & Dynamics

Item	Bytes	Format	Value	Units
Group start	4	char	$GRP	N/A
Group ID	2	ushort	222	N/A
Byte count	2	ushort	128	Bytes
Time/Distance Fields	26	*See* Table 3		
Latitude	8	double	-90 < to ≤ 90	deg
Longitude	8	double	-180 < to ≤ 180	deg
Altitude	8	double	N/A	m
Along track velocity	4	float	N/A	m/s
Across track velocity	4	float	N/A	m/s
Down velocity	4	float	N/A	m/s
Roll*	8	double	-180 < to ≤ 180	deg
Pitch*	8	double	-90 < to ≤ 90	deg
Heading*	8	double	0 ≤ to < 360	deg
Wander angle	8	double	-180 < to ≤ 180	deg
Reserved	4	float	N/A	N/A
Angular rate about longitudinal axis*	4	float	N/A	deg/s
Angular rate about transverse axis*	4	float	N/A	deg/s
Angular rate about down axis*	4	float	N/A	deg/s
Longitudinal acceleration*	4	float	N/A	m/s^2
Transverse acceleration*	4	float	N/A	m/s^2
Down acceleration*	4	float	N/A	m/s^2
Pad	2	byte	0	N/A
Checksum	2	ushort	N/A	N/A
Group end	2	char	$#	N/A

3.3.1.35 Group 223: Sensor Frame Position, Velocity, Attitude& Dynamics

This group contains position, velocity, attitude, track, speed and dynamics data in the Sensor frame. The Sensor frame is defined with the respect to Reference frame (shifted by lever arm vector and rotated by specified mounting angles in the Message 219). *The group output is applicable only in the case when gimbal mount is selected on COM port.*

Table 43: Group 223: Sensor Frame Position, Velocity, Attitude & Dynamics

Item	Bytes	Format	Value	Units
Group start	4	char	$GRP	N/A
Group ID	2	ushort	223	N/A
Byte count	2	ushort	128	Bytes
Time/Distance Fields	26	*See* Table 3		
Latitude	8	double	-90 < to ≤ 90	deg
Longitude	8	double	-180 < to ≤ 180	deg
Altitude	8	double	N/A	m
Along track velocity	4	float	N/A	m/s
Across track velocity	4	float	N/A	m/s
Down velocity	4	float	N/A	m/s
Roll*	8	double	-180 < to ≤ 180	deg
Pitch*	8	double	-90 < to ≤ 90	deg
Heading*	8	double	0 ≤ to < 360	deg
Wander angle	8	double	-180 < to ≤ 180	deg
Reserved	4	float	N/A	N/A
Angular rate about longitudinal axis*	4	float	N/A	deg/s
Angular rate about transverse axis*	4	float	N/A	deg/s
Angular rate about down axis*	4	float	N/A	deg/s
Longitudinal acceleration*	4	float	N/A	m/s^2
Transverse acceleration*	4	float	N/A	m/s^2
Down acceleration*	4	float	N/A	m/s^2
Pad	2	byte	0	N/A
Checksum	2	ushort	N/A	N/A

Item	Bytes	Format	Value	Units
Group end	2	char	$#	N/A

3.3.1.36 Group 224: Reference Frame Position, Velocity, and Attitude Performance Metrics

This group contains Reference frame position, velocity and attitude performance metrics. All data in this group are RMS values.

Table 44: Group 224: Reference Frame Position, Velocity, and Attitude Performance Metrics

Item	Bytes	Format	Value	Units
Group start	4	char	$GRP	N/A
Group ID	2	ushort	224	N/A
Byte count	2	ushort	68	bytes
Time/Distance Fields	26	*See* Table 3		
N position RMS	4	float	≥0	m
E position RMS	4	float	≥0	m
D position RMS	4	float	≥0	m
Along track velocity RMS error	4	float	≥0	m/s
Across track velocity RMS error	4	float	≥0	m/s
Down velocity RMS error	4	float	≥0	m/s
Roll RMS error*	4	float	≥0	deg
Pitch RMS error*	4	float	≥0	deg
Heading RMS error*	4	float	≥0	deg
Pad	2	byte	0	N/A
Checksum	2	ushort	N/A	N/A
Group end	2	char	$#	N/A

3.3.1.37 Group 225: Sensor Frame Position, Velocity, and Attitude Performance Metrics

This group contains Sensor frame position, velocity and attitude performance metrics. All data in this group are RMS values.

Table 45: Group 225: Reference Frame Position, Velocity, and Attitude Performance Metrics

Item	Bytes	Format	Value	Units
Group start	4	char	$GRP	N/A
Group ID	2	ushort	225	N/A
Byte count	2	ushort	68	bytes
Time/Distance Fields	26	*See* Table 3		
N position RMS	4	float	≥0	m
E position RMS	4	float	≥0	m
D position RMS	4	float	≥0	m
Along track velocity RMS error	4	float	≥0	m/s
Across track velocity RMS error	4	float	≥0	m/s
Down velocity RMS error	4	float	≥0	m/s
Roll RMS error*	4	float	≥0	deg
Pitch RMS error*	4	float	≥0	deg
Heading RMS error*	4	float	≥0	deg
Pad	2	byte	0	N/A
Checksum	2	ushort	N/A	N/A
Group end	2	char	$#	N/A

3.3.1.38 Group 226: Flight Plan status and information

This group group will provide specific information and status of the executed flight plan (Project name, Area or Flight plan name, selected line) to the end user (integrator) in real time.

Table 46: Group 226: Flight Plan status and information

Item	Bytes	Format	Value	Units
Group start	4	char	$GRP	N/A
Group ID	2	ushort	226	N/A
Byte count	2	ushort	108	bytes
Time/Distance Fields	26	*See ICD Document Table 3*		
Project Name	24	char	Array of ascii characters representing the project name	
Flight Plan Name	24	char	Array of ascii characters representing the flight plan name	
Total Number of Runs (lines) in Flight Plan	4	long	Total number of runs in the flight plan, remains constant for entire mission.	
Active Flight Line	4	long	Active Flight Line (run) number	
Status of the Active Line	2	ushort	0- Start of the survey line 1- End of the survey line 2- Survey line aborted	
Number of the Planned Photos in Active Line	4	long	Constant for active run at the beginning and at the end of the run. 0 if the flight line contains no photos	
Number of Taken Photos in Flight Line	4	long	0 if the Status filed is 0 (Start of survey line) Actual number of taken photos in the line.	
Reserved 1	8	double	0	
Reserved 2	4	long	0	
Checksum	2	ushort	N/A	N/A
Group end	2	char	$#	N/A

3.3.2 Raw Data Groups

3.3.2.1 Group 10001: Primary GPS Data Stream

This group contains the primary GNSS receiver data as output by the receiver. The length of this group is variable. The GNSS data stream is packaged into the group as it is received, irrespective of GNSS message boundaries. The messages contained in this group will depend on the primary GNSS receiver that the POS AV uses. If a data extraction process concatenates the data components from these groups into a single file, then the resulting file will be the same as a file of data recorded directly from the primary GPS receiver.

Table 47: Group 10001: Primary GNSS data stream

Item	Bytes	Format	Value	Units
Group start	4	char	$GRP	N/A
Group ID	2	ushort	10001	N/A
Byte count	2	ushort	variable	bytes
Time/Distance Fields	26	*See* Table 3		
GNSS receiver type	2	ushort	See Table 11	N/A
reserved	4	long	N/A	N/A
Variable message byte count	2	ushort	[0,)	bytes
GNSS Receiver raw data	*variable*	*char*	*N/A*	*N/A*
Pad	0-3	byte	0	N/A
Checksum	2	ushort	N/A	N/A
Group end	2	char	$#	N/A

3.3.2.2 Group 10002: Raw IMU Data

This group contains the IMU data as output by the IMU directly. The length of this group is variable.

The IMU header field contains 6 characters of which the first 4 are "$IMU" and the last two are the IMU type number in ASCII format (example: "$IMU01" identifies IMU type 1). The Data checksum is a 16-bit sum of the IMU data. The POS AV provides this checksum in addition to the possible IMU-generated checksums in the IMU data field. U.S. and Canadian export control laws prevent the publication of the IMU data field formats for the different IMU's that the POS AV supports.

Table 48: Group 10002: Raw IMU data

Item	Bytes	Format	Value	Units
Group start	4	char	$GRP	N/A
Group ID	2	ushort	10002	N/A
Byte count	*variable*	ushort	variable	bytes
Time/Distance Fields	26	*See* Table 3		
IMU header	6	char	*$IMUnn* where *nn* identifies the IMU type.	
Variable message byte count	2	ushort	[0,)	bytes
IMU raw data	*variable*	*byte*	*N/A*	*N/A*
Data Checksum	2	short	N/A	N/A
Pad	*variable*	byte	0	N/A
Checksum	2	ushort	N/A	N/A
Group end	2	char	$#	N/A

3.3.2.3 Group 10003: Raw PPS

This group contains the raw PPS data that the POS AV generates. The time of the PPS is given in the Time/Distance fields.

Table 49: Group 10003: Raw PPS

Item	Bytes	Format	Value	Units
Group start	4	char	$GRP	N/A
Group ID	2	ushort	10003	N/A
Byte count	2	ushort	36	bytes
Time/Distance Fields	26	*See* Table 3		
PPS pulse count	4	ulong	[0,)	N/A
Pad	2	byte	0	N/A
Checksum	2	ushort	N/A	N/A
Group end	2	char	$#	N/A

3.3.2.4 Group 10007: Auxiliary 1 GNSS Data Stream

This group contains the auxiliary 1 GNSS receiver data stream, containing the NMEA strings requested by the PCS from the receiver plus any other bytes that the receiver inserts into the stream. The length of this group is variable. If a data extraction process concatenates the data components from these groups into a single file, then the resulting file will be the same as an ASCII file of NMEA strings recorded directly from the auxiliary 1 GNSS receiver.

3.3.2.5 Group 10008: Auxiliary 2 GNSS Data Stream

This group contains the auxiliary 2 GNSS receiver data stream, containing the NMEA strings requested by the PCS from the receiver plus any other bytes that the receiver inserts into the stream. The length of this group is variable. If a data extraction process concatenates the data components from these groups into a single file, then the resulting file will be the same as an ASCII file of NMEA strings recorded directly from the auxiliary 2 GNSS receiver.

Table 50: Group 10007/10008: Auxiliary 1 and 2 GNSS data streams

Item	Bytes	Format	Value	Units
Group start	4	char	$GRP	N/A
Group ID	2	ushort	10007 or 10008	N/A
Byte count	2	ushort	variable	bytes
Time/Distance Fields	26	*See* Table 3		
reserved	2	byte	N/A	N/A
reserved	4	long	N/A	N/A
Variable message byte count	2	ushort	[0,)	bytes
Auxiliary GNSS raw data	*variable*	*char*	*N/A*	*N/A*
Pad	0-3	byte	0	N/A
Checksum	2	ushort	N/A	N/A
Group end	2	char	$#	N/A

3.3.2.6 Group 10011: Base GNSS 1 Data Stream

This group contains the message data stream the POS AV receives as differential corrections. The length of this group is variable and dependent on the messages received by the PCS. If a data extraction process concatenates the data components from this group into a single file, then the resulting file will be the same as a file of data captured from the serial data stream connected to a differential corrections port.

3.3.2.7 Group 10012: Base GNSS 2 Data Stream

This group contains the message data stream the POS AV receives as differential corrections. The length of this group is variable and dependent on the messages received by the PCS. If a data extraction process concatenates the data components from this group into a single file, then the resulting file will be the same as a file of data captured from the serial data stream connected to a differential corrections port.

Table 51: Group 10011/10012: Differential corrections data stream

Item	Bytes	Format	Value	Units
Group start	4	char	$GRP	N/A
Group ID	2	ushort	10011 or 10012	N/A
Byte count	2	ushort	variable	bytes
Time/Distance Fields	26	*See* Table 3		
reserved	6	byte	N/A	N/A
Variable message byte count	2	ushort	[0,)	bytes
Base GPS raw data	*variable*	*byte*	*N/A*	*N/A*
Pad	0-3	byte	0	N/A
Checksum	2	ushort	N/A	N/A
Group end	2	char	$#	N/A

3.3.2.8 Group 10201: Raw LRF Data

This group contains the raw data output from Laser Range Finder (LRF) to POS.

Table 52: Group 10201: Raw LRF Data

Item	Bytes	Format	Value	Units
Group Start	4	char	$GRP	N/A
Group ID	2	ushort	10201	N/A
Byte Count	2	ushort	44	N/A
Time/Distance Fields	26		*See* Table 3	
LRF Header	2	ushort	0x0220	N/A
Laser Range	4	ulong	0.01m	m/bit
Radar Height	4	ulong	0.01m	m/bit
Status	2	ushort	N/A	N/A
LRF Checksum	2	ushort	N/A	N/A
Pad	0	byte	N/A	N/A
Checksum	2	ushort	N/A	N/A
Group End	2	char	$#	N/A

3.3.2.9 Group 10204: Raw Camera Out

This group contains the raw data output from the camera to POS

Table 53:Group 10204: Raw Camera Out

Item	Bytes	Format	Value	Units
Group Start	4	char	$GRP	N/A
Group ID	2	ushort	10204	N/A
Byte Count	2	ushort	136	N/A
Time/Distance Fields	26	*See* Table 3		
Camera Type	2	ushort	0 – Vexcel (all types)	N/A
Raw dataByte Count	2	ushort	Byte count of used fields in raw data 1-102	N/A
Raw data	102	char	Raw camera data out	N/A
Pad	0	byte	N/A	N/A
Checksum	2	ushort	N/A	N/A
Group End	2	char	$#	N/A

3.3.2.10 Group 10205: Raw Camera In

This group contains the raw data stream sent to the camera using Message 221 over assigned serial port.

Table 54:Group 10205: Raw Camera In

Item	Bytes	Format	Value	Units
Group Start	4	char	$GRP	N/A
Group ID	2	ushort	10205	N/A
Byte Count	2	ushort	240	N/A
Time/Distance Fields	26	*See* Table 3		
Reserved	2	ushort	N/A	N/A
Camera Type	2	ushort	From Message 221	
Raw dataByte Count	2	ushort	Byte count of used fields in raw data 1-202	N/A
Raw data	202	char	Raw camera data out	N/A
Pad	2	byte	0	N/A
Checksum	2	ushort	N/A	N/A
Group End	2	char	$#	N/A

3.3.2.11 Group 10206: Raw Sensor Out

This group contains the raw data output from the Sensor to POS over serial port.

Table 55: Group 10206: Raw Sensor Out

Item	Bytes	Format	Value	Units
Group Start	4	char	$GRP	N/A
Group ID	2	ushort	10206	N/A
Byte Count	2	ushort	136	N/A
Time/Distance Fields	26	Table 3 defined in PUBS-ICD-003259		
Reserved	2	ushort	0	N/A
Raw data Byte Count	2	ushort	Byte count of used fields in raw data 1-102	N/A
Raw data	102	char	Raw Sensor data out	N/A
Pad	0		N/A	N/A
Checksum	2	ushort	N/A	N/A
Group End	2	char	$#	N/A

3.3.2.12 Group 10207: Raw Sensor In

This group contains raw data stream sent to the sensor using Message 222 over assigned serial port.

Table 56: Group 10207: Raw Sensor In

Item	Bytes	Format	Value	Units
Group Start	4	Char	$GRP	N/A
Group ID	2	ushort	10207	N/A
Byte count	2	ushort	256	N/A
Time/Distance Fields	26	Table 3 defined in PUBS-ICD-003259		
Reserved 0	2	ushort	Can be used for diagnostic purposes	
Reserved 1	2	ushort	Copy of Reserved field from Message 222	
Time	8	double	Copy of Time field from Message 222	
Raw Data Byte Count	2	ushort	Copy of the Raw Data Byte Count from Message 222	
Raw Data In	202	char	Copy of Raw Data In from the Message 222	N/A
Pad	0		N/A	N/A
Checksum	2	ushort	N/A	N/A
Message end	2	char	$#	N/A

4 Message Input and Output

4.1 Introduction

The POS AV uses the Control Port to receive control messages from AV-POSView and to acknowledge successful receipt of the messages. The Control Port is bi-directional and uses the TCP/IP protocol to communicate with the control and display software.

Each message sent to the POS AV causes the POS AV to initiate an action. When the POS AV receives and validates a message, it replies to the AV-POSView by sending an 'Acknowledge' message, Message ID 0, on the Control Port over which it received the message. The Acknowledge message protocol is defined below. The purpose of the Acknowledge message is to inform AV-POSView that the POS AV has received a message, and has either accepted or rejected it. In addition, POS AV will also output a message echo on each of the Display, Data and Logging ports to indicate the current system state, regardless of whether the action was successful or not.

4.2 Message Output Data Rates

The POS AV periodically generates copies (echoes) of received control messages or internally generated messages at maximum frequencies described in Table 57. This output allows an AV-POSView to monitor the current state of the configuration of the POS AV. The content of the output messages reflects the current state of the POS AV. Thus, if the state of the system changes, as part of the normal operations, it will be reflected in the next set of echo messages from the POS AV.

4.2.1 Message Numbering Convention

All POS products use the following message numbering convention. The micro POS AV outputs the message categories shown. Reserved message numbers are assigned to other products or previous versions of POS products. In particular, loosely coupled POS AV core messages occupy the namespace range 1-19. All messages specific to POS products occupies the namespace range 100-19999.

0	Acknowledge message
1-19	Reserved
20-49	Installation parameter set-up messages
50-79	Processing control messages
80-89	Reserved
90-99	Program control override messages
100-199	Reserved
200-299	AV specific messages
300-and on	Reserved

The **Acknowledge message** is the message that the POS AV sends as a reply to a message from AV-POSView. It is described in detail in Section 4.4.1.1 of this document.

Installation parameter set-up messages comprise all messages that the user sends via AV-POSView to implement a particular installation of the POS AV. AV-POSView would not normally send these messages once the installation is completed. Messages 20-29 are signal processing parameter set-up messages. These specify sensor installation parameters and user accuracies. Messages 30-49 are hardware control messages. These specify communication control parameters and real-time message selections.

Processing control messages comprise all messages that the user requires to control and monitor the POS AV during a navigation session. These include navigation mode control, data acquisition control and possibly initialization of navigation quantities if no GPS signal is available.

Program control override messages allow the user to directly control functions that the POS AV normally performs automatically. The user would send a program control override message only under special circumstances. For example, the user may believe that the primary or secondary GNSS receiver has lost its configuration, and chooses to manually command the POS AV to re-configure the receiver. This message category also includes control messages that alter the normal operation or output of the POS AV for diagnosis purposes. The actions induced by these messages are not part of the normal POS AV operation and should be interpreted only by qualified Applanix service personnel.

Table 57: Control messages output data rates

Message	Contents	Display Port		Data Port		Logging Port	
		Standby	Navigate	Standby	Navigate	Standby	Navigate
0	Acknowledge	-	-	-	-	-	-
Installation Parameter Set-up Messages							
20	General installation parameters[1]	1.0	1.0	0.1	0.1	0.1	0.1
22	Aiding sensor installation parameters[1]	1.0	1.0	0.1	0.1	0.1	0.1
24	User accuracy specifications[1]	1.0	1.0	0.1	0.1	0.1	0.1
30	Primary GNSS set-up[1]	1.0	1.0	0.1	0.1	0.1	0.1
31	Secondary GPS set-up[1]	1.0	1.0	0.1	0.1	0.1	0.1
32	Set POS IP address[1]	1.0	1.0	0.1	0.1	0.1	0.1
33	Event discretes set-up[1]	1.0	1.0	0.1	0.1	0.1	0.1
34	COM port set-up[1]	1.0	1.0	0.1	0.1	0.1	0.1
35	NMEA message select[1]	1.0	1.0	0.1	0.1	0.1	0.1
36	Binary message select[1]	1.0	1.0	0.1	0.1	0.1	0.1
41	Integrated DGPS Source Control[1]	1.0	1.0	0.1	0.1	0.1	0.1
210	Gimbal message select[1]	1.0	1.0	0.1	0.1	0.1	0.1
211	Event1/2 Shift Message[1]	1.0	1.0	0.1	0.1	0.1	0.1
212	Event1POSEO Settings [1]	1.0	1.0	0.1	0.1	0.1	0.1
213	Event1 Mapping Frame Settings [1]	1.0	1.0	0.1	0.1	0.1	0.1
214	Event2 POSEO Settings [1]	1.0	1.0	0.1	0.1	0.1	0.1
215	Event2 Mapping Frame Settings [1]	1.0	1.0	0.1	0.1	0.1	0.1
219	Sensor Frame Installation parameters[1]	1.0	1.0	0.1	0.1	0.1	0.1
Processing Control Messages							
50	Navigation mode control	1.0	1.0	0.1	0.1	0.1	0.1
51	Display Port control[1]	1.0	1.0	0.1	0.1	0.1	0.1
52	Primary Data Port control[1]	1.0	1.0	0.1	0.1	0.1	0.1
53	Logging Port control[1]	1.0	1.0	0.1	0.1	0.1	0.1
54	Save/restore parameters command	-	-	-	-	-	-
55	Time synchronization control	1.0	1.0	0.1	0.1	0.1	0.1
57	Installation calibration control	-	-	-	-	-	-
61	Secondary Data Port control[1]	1.0	1.0	0.1	0.1	0.1	0.1
62	Third Data Port control[1]	1.0	1.0	0.1	0.1	0.1	0.1
201	Platform Yaw Drift Correction command[1]	1.0	1.0	0.1	0.1	0.1	0.1
203	FMS Data Port Control[1]	1.0	1.0	0.1	0.1	0.1	0.1
206	Lidar logging on/off message[1]	1.0	1.0	0.1	0.1	0.1	0.1
218	External Ground Points	1.0	1.0	0.1	0.1	0.1	0.1
20200	Gimbal Encoder Input	1.0	1.0	0.1	0.1	0.1	0.1
Program Control Override Messages							
90	Program control	-	-	-	-	-	-
91	GPS control	-	-	-	-	-	-
92	Integration diagnostics control	1.0	1.0	0.1	0.1	0.1	0.1
93	Aiding sensor integration control	1.0	1.0	0.1	0.1	0.1	0.1
204	FMS Camera Trigger Control	-	-	-	-	-	-
205	Gimbal Control Message	1.0	1.0	0.1	0.1	0.1	0.1
208	Camera 1 Message	1.0	1.0	0.1	0.1	0.1	0.1
209	Camera 2 Message	1.0	1.0	0.1	0.1	0.1	0.1
221	Raw Camera in data stream	1.0	1.0	0.1	0.1	0.1	0.1
222	Raw Sensor in data stream	1.0	1.0	0.1	0.1	0.1	0.1

* Maximum rate

[1] *Message is saved to Non-Volatile Memory (NVM).*

4.3 Message Format

4.3.1 Introduction

All control messages have the format described in Table 58. The messages consist of a *header*, the message *body* and *footer*. The next section describes the specific message formats.

Table 58: Message format

Item	Bytes	Format	Value	Units
Message start	4	char	$MSG	N/A
Message ID	2	ushort	Message dependent	N/A
Byte count	2	ushort	Message dependent	N/A
Transaction number	2	ushort	Input: Transaction number Output: [65533, 65535]	N/A
Message body	*Message dependent format and content.*			
Pad	0	byte	0	N/A
Checksum	2	ushort	N/A	N/A
Message end	2	char	$#	N/A

The *header* consists of the following components:

- an ASCII string ($MSG)
- unique message identifier
- byte count
- transaction number.

The *byte count* is a short unsigned integer that includes the number of bytes in all fields in the message except the Message start ASCII delimiter, the Message ID and the byte count. Therefore, the byte count will always be 8 bytes less than the length of the complete message.

The *transaction number* is a number, which is attached to the input message by the client. The POS AV returns this number to the user in the *Acknowledge* message (ID 0). This mechanism shall allow the client to know which message the POS AV is responding to. This number must be between 0 and 65535.

The message body falls between the header and footer. While many messages have a message body, it is not a requirement of the protocol. Message without bodies may in themselves act as events, or messages may use the body to command a particular state.

Messages end with a *footer* that contains a pad, a checksum and an ASCII delimiter ($#).

The *pad* is used to make each message length a multiple of four bytes. The *checksum* is

calculated so that short (16 bit) integer addition of sequential groups of two bytes results in a net sum of zero.

Parameters flagged as default are the factory settings.

The byte, short, ushort, long, ulong, float and double formats are defined in

Appendix A: Data Format Description.

The ranges of valid values for message fields that contain numbers are specified in the same way as for numerical group fields.

Message fields that contain numerical values may contain invalid numbers. Invalid byte, short, ushort, long, ulong, float and double values are defined in Table 109 in

Appendix A: Data Format Description. The POS AV will ignore invalid values that it receives in fields containing numerical values. This does not apply to fields containing bit settings.

4.4 Messages Tables

4.4.1 General Messages

The following tables list the format that the POS AV expects for each message input and provides for each message output.

4.4.1.1 Message 0: Acknowledge

The POS AV responds to a user control message with the Acknowledge message in three possible ways described below:

1. The control message from AV-POSView triggers a change of state within the POS AV. Some changes of state such as navigation mode transitions may require several seconds to complete. The POS AV sends Message 0: Acknowledge indicating that the transition is in progress but not necessarily complete. For example, the POS AV replies to a message commanding the POS AV to transition to Navigate mode as soon as the mode transition begins.

2. The control message from AV-POSView contains new POS AV installation or set-up parameters that replace the parameters currently used by the POS AV. The Acknowledge message then indicates whether the POS AV has received and begun to use the new parameters. The POS AV will respond with Message 0: Acknowledge only when it has begun to use the new parameters.

3. The control message from AV-POSView starts the transmission of one or more groups of data. The Acknowledge message indicates the successful completion of the requested action. The POS AV will subsequently transmit the requested groups on the Display, Data, and/or Logging ports. If the data for one or more of the requested groups are not current at the time of request, the POS AV outputs the group(s) with stale fields set to invalid values as described in Table 109. Message 0: Acknowledge will indicate if the data for a requested group is available (not yet implemented).

The *New Parameters Status* field indicates if the message being acknowledged has changed the POS AV parameters. This allows AV-POSView to prompt the user to direct the POS AV to save the parameters to non-volatile memory if the user has not already done so before commanding a Standby mode transition or system shutdown.

The POS AV sets the *Parameter Name* to the name of a parameter that it has rejected or to a null string if it did not reject any parameters.

The Message 0 Acknowledge is not saved in NVM.

Table 59: Message 0: Acknowledge

Item	Bytes	Format	Value	Units
Message start	4	char	$MSG	N/A
Message ID	2	ushort	0	N/A
Byte count	2	ushort	44	N/A
Transaction number	2	ushort	Transaction number sent by client.	N/A
ID of received message	2	ushort	Any valid message number.	N/A
Response code	2	ushort	*See Table 60*	N/A
New parameters status	1	byte	**Value** **Message** 0 No change in parameters 1 Some parameters changed 2-255 Reserved	N/A
Parameter name	32	char	Name of rejected parameter on parameter error only	N/A
Pad	1	bytes	0	N/A
Checksum	2	ushort	N/A	N/A
Message end	2	char	$#	N/A

Table 60 : Message response codes

Field Value	Field Name	Description
0	Not applicable	The message is not applicable to the POS AV.
1	Message accepted	The POS AV has properly accepted the message from AV-POSView.
2	Message accepted – too long	The POS AV has accepted the messaged from AV-POSView. This is a warning that the POS AV expected a shorter message than the one received. This could be caused if the POS AV and AV-POSView have different ICD versions.
3	Message accepted – too short	The POS AV has accepted the messaged from AV-POSView. This is a warning that the POS AV expected a longer message than the one received. This could be caused if the POS AV and AV-POSView have different ICD versions.
4	Message parameter error	The message contains one or more parameter errors.
5	Not applicable in current state	The POS AV cannot process the message or cannot output data requested in its current state.
6	Data not available	The requested data is not available from the POS AV.
7	Message start error	The message does not have the proper header "$MSG".
8	Message end error	The message does not have the proper footer "$#".
9	Byte count error	The byte count of the message is too large for the POS AV's internal buffer.
10	Checksum error	The message checksum validation failed.
11-65535	Reserved	Reserved

4.4.2 Installation Parameter Set-up Messages

4.4.2.1 Message 20: General Installation and Processing Parameters

This message contains general installation parameters that the POS AV requires to correctly process sensor data and output the computed navigation data. The POS AV accepts this message at any time. The parameters contained in this message become part of the processing parameters (referred to as "settings") that the POS AV saves to NVM.

The following are brief descriptions of the parameters that this message contains.

Time Tag Selection

The *Time Tag Type* field selects the time tag types used for Time 1, Time 2 and Distance fields in the Time/Distance fields in each group (see
Table 3). The user can select POS, GPS or UTC time for Time 1 and POS, GPS, UTC or User time for Time 2.

Selection of **GPS time** directs the POS AV to set the selected Time 1 or Time 2 field in all groups to the GPS seconds of the current week. The GPS week number can be obtained from Group 3: Primary GNSS status.

Selection of **UTC time** directs the POS AV to set the selected Time 1 or Time 2 field in all groups to the UTC seconds of the current week. UTC seconds of the week will lag GPS seconds of the week by the accumulated leap seconds since the startup of GPS at which time the two times were synchronized.

AutoStart Selection

The *Select/Deselect Autostart* field directs the POS AV to enable or disable the AutoStart function. When AutoStart is enabled, the POS AV enters Navigate mode immediately on power-up using the parameters stored in its NVM. When Autostart is disabled, the POS AV enters Standby mode on power-up. The user must explicitly command a transition to Navigate mode.

Lever Arms and Mounting Angles

This message contains a series of fields that contain lever arm components and mounting angles. These define the positions and orientations of the IMU and aiding sensors (GNSS antennas) with respect to user-defined reference and Aircraft coordinate frames. These coordinate frames and the installation data contained in this message are defined for an IMU that is rigidly mounted to the Aircraft.

The *Aircraft frame* is a right-handed coordinate frame that is fixed to the Aircraft. The X-Y-Z axes are directed along the forward, right and down directions of the Aircraft. On a vessel, these are the forward along beam, starboard and vertical directions. On an aircraft, these are the

forward, right-wing and vertical directions.
The *reference frame* is a user-defined coordinate frame whose navigation solution the POS AV computes. It can be thought of as defining the desired position and orientation of the IMU. It is also the coordinate frame in which the relative positions and orientations of the IMU and aiding sensors are measured. Its origin coincides with the Aircraft frame origin, however it is not necessarily aligned with the Aircraft frame.

The *IMU frame* is a right-handed coordinate frame whose X-Y-Z axes coincide with the inertial sensor input axes. The IMU delivers inertial data resolved in the IMU frame to the PCS. The position and orientation of the IMU frame is fixed with respect to the Aircraft frame when the user mounts the IMU. Practical considerations may limit the choices in IMU location, in which case the actual position and orientation of the IMU frame may differ from a desired position and orientation.

The interpretations of the lever arm and orientation fields are as follows:

Reference to IMU lever arm components

These are the X-Y-Z distances from the user-defined reference frame origin to the IMU inertial sensor assembly origin, resolved in the *reference frame*.

Reference to Primary GNSS lever arm components

These are the X-Y-Z distances measured from the user-defined reference frame origin to the phase center of the primary GNSS antenna, resolved in the *aircraft frame*.

Reference to Auxiliary 1 GNSS lever arm components

These are the X-Y-Z distances measured from the user-defined reference frame origin to the phase center of the auxiliary 1 GNSS antenna, resolved in the *aircraft frame*. The POS AV uses these lever arm components whenever it processes data from an optional auxiliary 1 GNSS receiver. If the POS AV does not receive auxiliary 1 GNSS data, then it does not use these parameters.

Reference to Auxiliary 2 GNSS lever arm components

These are the X-Y-Z distances measured from the user-defined reference frame origin to the phase center of the auxiliary 2 GNSS antenna, resolved in the *aircraft frame*. The POS AV uses these lever arm components whenever it processes data from an optional auxiliary 2 GNSS receiver. If the POS AV does not receive auxiliary 2 GNSS data, then it does not use these parameters.

IMU with respect to Reference frame mounting angles

These are the angular offsets (θ_x, θ_y, θ_z) of the IMU frame with respect to the reference frame when the IMU is rigidly mounted to the Aircraft. The angles define the Euler

sequence of rotations that bring the reference frame into alignment with the IMU frame. The angles follow the Tate-Bryant sequence of rotation, given as follows:

1. right-hand screw rotation of θ_z about the z axis
2. right-hand screw rotation of θ_y about the once rotated y axis
3. right-hand screw rotation of θ_x about the twice rotated x axis.

The angles θ_x, θ_y, and θ_z may be thought of as the roll, pitch, and yaw of the IMU body frame with respect to the user IMU frame.

Reference Frame with respect to Aircraft Frame mounting angles

These are the angular offsets (θ_x, θ_y, θ_z) of the reference frame with respect to Aircraft frame. The angles define the Euler sequence of rotations that bring the Aircraft frame into alignment with the reference frame. The angles follow the Tate-Bryant sequence of rotation, given as follows:

4. right-hand screw rotation of θ_z about the z axis
5. right-hand screw rotation of θ_y about the once rotated y axis
6. right-hand screw rotation of θ_x about the twice rotated x axis.

The angles θ_x, θ_y, and θ_z may be thought of as the roll, pitch, and yaw of the reference frame with respect to the Aircraft frame.

Multipath Setting

The Multipath Environment field directs the POS AV to set its processing parameters for one of three multipath levels impinging on primary, secondary and auxiliary GNSS antennas. These are LOW, MEDIUM and HIGH multipath. This field allows the user to select the multipath environment which best describes the present multipath conditions. POS uses this information to scale the RMS errors on the position and velocity outputs reported to the user to ensure that the reported errors are reasonable. If the user selects *LOW*, the POS AV assumes virtually no multipath error in the primary, secondary and auxiliary GNSS data. If the user selects *MEDIUM* or *HIGH*, the POS AV assumes respectively moderate or severe multipath errors, and accounts for these in its GNSS processing algorithms.

Table 61: Message 20: General Installation and Processing Parameters

Item	Bytes	Format	Value	Units
Message start	4	char	$MSG	N/A
Message ID	2	ushort	20	N/A
Byte count	2	ushort	84	N/A
Transaction Number	2	ushort	Input: Transaction number Output: [65533, 65535]	N/A

Item	Bytes	Format	Value	Units
Time types	1	byte	Value (bits 0-3) Time type 1 0 POS time 1 GPS time (default) 2 UTC time 1 Reserved Value (bits 4-7) Time type 2 0 POS time (default) 1 GPS time 2 UTC time 3 User time 4-16 Reserved	
Distance type	1	byte	Value State 0 N/A 1 POS distance (default) 2 DMI distance 3-255 Reserved	
Select/deselect AutoStart	1	byte	Value State 0 AutoStart disabled (default) 1 AutoStart enabled 2-255 Reserved	
Reference to IMU X lever arm	4	float	(,) default = 0	meters
Reference to IMU Y lever arm	4	float	(,) default = 0	meters
Reference to IMU Z lever arm	4	float	(,) default = 0	meters
Reference to Primary GNSS X lever arm	4	float	(,) default = 0	meters
Reference to Primary GNSS Y lever arm	4	float	(,) default = 0	meters
Reference to Primary GNSS Z lever arm	4	float	(,) default = 0	meters
Reference to Auxiliary 1 GNSS X lever arm	4	float	(,) default = 0	meters
Reference to Auxiliary 1 GNSS Y lever arm	4	float	(,) default = 0	meters
Reference to Auxiliary 1 GNSS Z lever arm	4	float	(,) default = 0	meters
Reference to Auxiliary 2 GNSS X lever arm	4	float	(,) default = 0	meters
Reference to Auxiliary 2 GNSS Y lever arm	4	float	(,) default = 0	meters

Item	Bytes	Format	Value	Units
Reference to Auxiliary 2 GNSS Z lever arm	4	float	(,) default = 0	meters
X IMU wrt Reference frame mounting angle	4	float	[-180, +180] default = 0	degrees
Y IMU wrt Reference frame mounting angle	4	float	[-180, +180] default = 0	degrees
Z IMU wrt Reference frame mounting angle	4	float	[-180, +180] default = 0	degrees
X Reference frame wrt Aircraft frame mounting angle	4	float	[-180, +180] default = 0	degrees
Y Reference frame wrt Aircraft frame mounting angle	4	float	[-180, +180] default = 0	degrees
Z Reference frame wrt Aircraft frame mounting angle	4	float	[-180, +180] default = 0	degrees
Multipath environment	1	byte	Value: Multipath 0: Low 1: Medium 2: High (default) 3-255: Reserved	
Pad	2	byte	0	N/A
Checksum	2	ushort	N/A	N/A
Message end	2	char	$#	N/A

4.4.2.2 Message 30: Primary GNSS Setup

This message contains the setup parameters for the primary GNSS receiver. The POS AV accepts this message at anytime. The parameters contained in this message become part of the processing parameters (referred to as "settings") that the POS AV saves to NVM.

The *Select/Deselect GNSS AutoConfig* field directs the POS AV to reconfigure the primary GNSS receiver if the POS AV detects that the primary GNSS configuration is incorrect. If the user chooses to disable auto-configuration, then the user must configure the primary GNSS receiver manually.
The *Primary GNSS COM1 Output Message Rate* field specifies the rate at which the primary GPS receiver outputs messages over its COM1 port to the POS AV.

Table 62: Message 30: Primary GPS Setup

Item	Bytes	Format	Value	Units
Message start	4	char	$MSG	N/A
Message ID	2	ushort	30	N/A
Byte count	2	ushort	16	N/A
Transaction number	2	ushort	Input: Transaction number Output: [65533, 65535]	N/A
Select/deselect GNSS AutoConfig	1	byte	Value — State 2 — AutoConfig disabled 3 — AutoConfig enabled (default) 2-255 — Reserved	
Primary GNSS COM1 port message output rate (not supported)	1	byte	Value — Rate (Hz) 1 — 1 (default) 2 — 2 3 — 3 4 — 4 5 — 5 10 — 10 11-255 — Reserved	
Reserved	1	byte	Reserved	
Reserved	4	byte	Reserved	
Reserved	1	byte	Reserved	

Item	Bytes	Format	Value	Units
Antenna type	2	ushort	The values listed below are only valid for the BD982 receiver Value Type 0 Unknown 201 AV39 202 AV37 203 AV59	N/A
Checksum	2	ushort	N/A	N/A
Message end	2	char	$#	N/A

4.4.2.3 Message 32: Set POS IP Address

This message installs a new IP address and subnet mask in the POS AV. The POS AV accepts this message at anytime. The parameters contained in this message become part of the processing parameters (referred to as "settings") that the POS AV immediately saves to NVM.

When POS AV has installed the new IP address and subnet mask, it will disconnect from any connected controller and begin using the new IP address and subnet mask. The changes take effect immediately upon receipt of the message; a POS AV restart (either by software or by power cycle) is not required.

It is also worth noting that POS AV does not retain any previous values that may have previously been set for the IP address and subnet mask, only current values are stored. Therefore, restoring USER or FACTORY NVM settings will not change the IP address, or the subnet mask.

Table 63: Message 32: Set POS IP Address

Item	Bytes	Format	Value	Units
Message start	4	char	$MSG	N/A
Message ID	2	ushort	32	N/A
Byte count	2	ushort	16	N/A
Transaction number	2	ushort	Input: Transaction number Output: [65533, 65535]	N/A
IP address: Network part 1	1	byte	[1, 126] Class A (typical subnet mask 255.0.0.0) [128, 191] Class B (typical subnet mask 255.255.0.0 [192, 223] Class C (typical subnet mask 255.255.255.0) default = 129	N/A
IP address: Network part 2	1	byte	[0, 255] default = 100	N/A
IP address: Host part 1	1	byte	[0, 255] default = 000	N/A
IP address: Host part 2	1	byte	[1, 253] default = 231	N/A
Subnet mask: Network part 1	1	byte	[255] default = 255	N/A
Subnet mask: Network part 2	1	byte	[255] default = 255	N/A
Subnet mask: Host part 1	1	byte	[0, 255] default = 255 * see conditions below	N/A

Item	Bytes	Format	Value	Units
Subnet mask: Host part 2	1	byte	[0, 255] default = 0 * see conditions below	N/A
Pad	2	byte	0	N/A
Checksum	2	ushort	N/A	N/A
Message end	2	char	$#	N/A

* Not only must the host parts of the subnet mask be within the ranges specified, but if the 2 host fields are considered as one 16 bit word, then any bit that is set may not have a cleared bit to its left. This results in the following valid subnet masks:

255.255.0.0
255.255.128.0
255.255.192.0
255.255.224.0
255.255.240.0
255.255.248.0
255.255.252.0
255.255.254.0
255.255.255.0
255.255.255.128
255.255.255.192
255.255.255.224
255.255.255.240
255.255.255.248
255.255.255.252
255.255.255.254

4.4.2.4 Message 33: Event Discrete Setup

This message directs the POS AV to set the senses of the signals for the Event 1 and 2 discrete triggers. The user can select either positive or negative edge trigger for each event. The POS AV accepts this message at anytime. The parameters contained in this message become part of the processing parameters (referred to as "settings") that the POS AV saves to NVM.

Table 64: Message 33: Event Discrete Setup

Item	Bytes	Format	Value	Units
Message start	4	char	$MSG	N/A
Message ID	2	ushort	33	N/A
Byte count	2	ushort	30	N/A
Transaction number	2	ushort	Input: Transaction number Output: [65533, 65535]	N/A
Event 1 trigger	1	byte	Value Command 0 Positive edge (default) 1 Negative edge 2-255 Reserved	
Event 2 trigger	1	byte	Value Command 0 Positive edge (default) 1 Negative edge 2-255 Reserved	
Event 3 trigger	1	byte	Value Command 0 Positive edge (default) 1 Negative edge 2-255 Reserved	
Event 4 trigger	1	byte	Value Command 0 Positive edge (default) 1 Negative edge 2-255 Reserved	
Event 5 trigger	1	byte	Value Command 0 Positive edge (default) 1 Negative edge 2-255 Reserved	
Event 6 trigger	1	byte	Value Command 0 Positive edge (default) 1 Negative edge 2-255 Reserved	
Event 1 Guard Time	2	ushort	0 – 10 000 (default 0)	msec
Event 2 Guard Time	2	ushort	0 – 10 000 (default 0)	msec
Event 3 Guard Time	2	ushort	0 – 10 000 (default 0)	msec

Item	Bytes	Format	Value	Units
Event 4 Guard Time	2	ushort	0 – 10 000 (default 0)	msec
Event 5 Guard Time	2	ushort	0 – 10 000 (default 0)	msec
Event 6 Guard Time	2	ushort	0 – 10 000 (default 0)	msec
PPS Out polarity	1	byte	Value Command 0 Positive pulse (default) 1 Negative pulse 2 Pass through[1] 2-255 Reserved	
PPS Out pulse width	2	ushort	1 – 500 (default 1)	msec
Pad	3	short	0	N/A
Checksum	2	ushort	N/A	N/A
Message end	2	char	$#	N/A

1 – "Pass though" means the PPS Out pulse is identical to the PPS In pulse, whether it is from the internal GNSS or an external PPS source. If this mode is selected the PPS Out pulse width field is ignored.

4.4.2.5 Message 34 : COM Port Setup

This message sets up the communication protocol and selects the input and output content for all available COM ports. It is a variable length message to accommodate POS hardware with varying numbers of COM ports.

When this message is sent to POS it may contain parameters for 1 to 10 COM ports. Any COM port can be assigned. If an assigned COM port is not present it will be ignored. Any COM port or ports can be specified as long as they are listed in ascending order and the Port Mask field has bits set corresponding to each COM port entry. All input selections and the Base GPS output selections must be uniquely assigned to a COM port. NMEA and Real-time Binary outputs may be assigned to any number of COM ports.

When this message is output from POS it always contains parameters for all *n* COM ports available for that particular system, with the current protocol and input/output selections.

Table 65: Message 34: COM Port Setup

Item	Bytes	Format	Value	Units
Message start	4	char	$MSG	N/A
Message ID	2	ushort	34	N/A
Byte count	2	ushort	12 + 8 x *nPorts*	N/A
Transaction number	2	ushort	Input: Transaction number Output: [65533, 65535]	N/A
Number of COM ports	2	ushort	[1,10] Number (*nPorts)* of COM ports assigned by this message.	N/A
COM Port Parameters	8 x *nPorts*	See Table 66 One set of parameters for each of *nPorts* COM port.		
Port mask	2	ushort	Input: Bit positions indicate which port parameters are in message (port parameters must appear in order of increasing port number). Bit 0 ignored Bit n set COMn parameter in message Bit n clear COMn parameter not in message Output: Bit positions indicate which port numbers are available on the PCS for I/O configuration.	
Pad	2	byte	0	N/A
Checksum	2	ushort	N/A	N/A

Item	Bytes	Format	Value	Units
Message end	2	char	$#	N/A

Table 66: COM port parameters

Item	Bytes	Format	Value	Units
Communication protocol	4	See Table 67 Default: 9600 baud, no parity, 8 data bits, 1 stop bit, none		
Input select	2	ushort	Value: Input 0: No input 1: Auxiliary 1 GPS 2: Auxiliary 2 GPS 3: Gimbal 4: Base GPS 1 5: Base GPS 2 6: Camera 7: GNSS 1 8: GNSS 2 9: Ethernet 10: Laser Range Finder 1 11-255: No input	
Output select	2	ushort	Value: Output 0: No output 1: NMEA messages 2: Real-time binary 3: Gimbal Output 4: Base GPS 1 5: Base GPS 2 6: Camera 7: GNSS 1 8: GNSS 2 9: Ethernet 10-255: No output	

Table 67: RS-232/422 communication protocol settings

Item	Bytes	Format	Value
RS-232/422 port baud rate	1	Byte	Value: Rate 0: 2400 1: 4800 2: 9600 3: 19200 4: 38400 5: 57600 6: 76800 7: 115200 8-255: Reserved

Item	Bytes	Format	Value	
Parity	1	Byte	Value	Parity
			0	no parity
			1	even parity
			2	odd parity
			3-255	Reserved
Data/Stop Bits	1	Byte	Value	Data/Stop Bits
			0	7 data, 1 stop
			1	7 data, 2 stop
			2	8 data, 1 stop
			3	8 data, 2 stop
			4-255	Reserved
Flow Control	1	Byte	Value	Flow Control
			0	none
			1	hardware
			2	XON/XOFF
			3-255	Reserved

4.4.2.6 Message 35: NMEA Message Select

This message selects the NMEA messages and the message rate to be output on the NMEA message port identified in Message 34. The COM ports numbers assigned by Message 34 must be the same as COM port numbers specified by this message.

All NMEA messages, assigned to any COM ports specified in Message 34, must be defined in one instance of Message 35. For example, if 4 COM ports are defined for NMEA output by Message 34, then the "Number of NMEA COM ports" field is to be set to 4 and 4 instances of Table 69 must appear before the "Pad", "Checksum" and "Message end" fields.

The POS AV implements generic NMEA selections that all derived POS products have access to. This message may be superseded by a product-specific message in a derived POS product that outputs additional NMEA messages.

Table 68: Message 35: NMEA message select

Item	Bytes	Format	Value	Units
Message start	4	char	$MSG	N/A
Message ID	2	ushort	35	N/A
Byte count	2	ushort	(18 or 20)[1] + 6 x *nPorts*	N/A
Transaction number	2	ushort	Input: Transaction number Output: [65533, 65535]	N/A
Reserved	3	bytes	N/A	N/A
Message update rate	2	ushort	This field is superseded by the corresponding field defined in NMEA COM port parameters	
NMEA message select	4	ulong	This field is superseded by the corresponding field defined in NMEA COM port parameters	
NMEA Talker ID	1	Uchar	Value Talker ID 0 $IN 1 $GP 2-255 Reserved	
Number of NMEA COM ports	1	Uchar	[0,10] Number (*nPorts)* of COM ports assigned by this message.	N/A
NMEA COM ports parameters	6 x *nPorts*	See Table 69 One set of parameters for each of *nPorts* COM port		
Pad	(1 or 3)[1]	byte	0	N/A

[1] This value depends on the number of the *pad* bytes.

Item	Bytes	Format	Value	Units
Checksum	2	ushort	N/A	N/A
Message end	2	char	$#	N/A

Table 69: NMEA COM port parameters

Item	Bytes	Format	Value	Units
COM port number	1	Uchar	The COM port number assigned to output NMEA messages. This must be consistent with the NMEA ports specified by message 34.	
NMEA message select	4	ulong	Bit Format Formula 0 $GST Pseudorange noise statistics 1 $GGA[2] GPS fix 2 $HDT Heading 3 $ZDA NMEA date, time 4 $EVT1 Event 1 time mark 5 $EVT2 Event 2 time mark 6 $VTG Track made good ground speed 7 $PASHR Attitude, Tate-Bryant 8 *reserved* 9 $PRDID Attitude, Tate-Bryant 10-12 *reserved* 13 $GGA2 GPS fix, PPS synchronized 14 $PPS PPS time (Applanix specific) 15 $GGK 16 $RMC NMEA Recommended Minimum Navigation Data 17 $PAPLEVT1 Event 1 Nav solution 18 $PAPLEVT2 Event 2 Nav solution 19 $PAPLPOSEO1 Real time POSEO event 1 20 $PAPLPOSEO2 Real time POSEO event 2	

[1] The number of the *pad* bytes depends on the number of COM ports in Table 69, since the *pad* is used to make each message length a multiple of four bytes. So that, when the number of COM ports is an odd value then the *pad* size is one bytes and when it is even then the *pad* size is three bytes.

[2] *The geoidal separation is set to null to maintain the overall sentence length within the NMEA specification (82 characters) while providing sufficient decimal places for latitude and longitude.*

Item	Bytes	Format	Value		Units
Message update rate	1	Uchar	Value	Rate (Hz)	
			0	N/A	
			1	1 (default)	
			2	2	
			5	5	
			10	10	
			20	20	
			25	25	
			50	50	
			other values	Reserved	

4.4.2.7 Message 36: Binary Message Select

This message selects the binary messages and the message rate to be output on the binary message port identified in Message 34. The COM ports numbers assigned by Message 34 must be the same as COM port numbers specified by this message.

All binary outputs, assigned to any COM ports specified in message 34, must be defined in one instance of message 36. For example, if 4 COM ports are defined for Binary output by Message 34, then the "Number of Binary COM ports" field is to be set to 4 and 4 instances of Table 71 must appear before the "Pad", "Checksum" and "Message end" fields.

The POS AV implements generic binary selections that all derived POS products have access to. This message may be superseded by a product-specific message in a derived POS product that outputs additional binary messages.

Table 70: Message 36: Binary message select

Item	Bytes	Format	Value	Units
Message start	4	char	$MSG	N/A
Message ID	2	ushort	36	N/A
Byte count	2	ushort	(14 or 16)[1] + 6 x *nPorts*	N/A
Transaction number	2	ushort	Input: Transaction number Output: [65533, 65535]	N/A
Reserved	3	byte	N/A	N/A
Message update rate	2	ushort	Superseded by the corresponding field in Binary output COM port parameters	
Binary message select	2	ushort	Superseded by the corresponding field in Binary output COM port parameters	
Number of Binary COM ports	1	Byte	[0,10] Number (*nPorts)* of COM ports assigned by this message.	N/A
Binary output COM port parameters	6 x *nPorts*	See Table 71 One set of parameters for each of *nPorts* COM port		
Pad	(0 or 2)[2]	byte	0	N/A
Checksum	2	ushort	N/A	N/A
Message end	2	char	$#	N/A

[1] This value depends on the pad size.
[2] The number of the *pad* bytes depends on the number of COM ports in Table 71, since the *pad* is used to make each message length a multiple of four bytes. So that, when the number of COM ports is an odd value then the *pad* size is zero bytes and when it is even then the the *pad* size is two bytes.

Table 71: Binary output COM port parameters

Item	Bytes	Format	Value	Units
COM port number	1	Uchar	The number of COM port assigned to output binary messages	
Binary message select	4	ulong	Value / Message 0 Gimbal loop back (default) 1 RDR1 2 PAST2 3-10 Reserved 11 ATT01 12 POSATT 13 POSATT2 14 POSATT3 15 PAST1 16 PPS 17 TM1B 18 AZMNT 19 PAV30 20 TRP 21-255 Reserved	
Message update rate	1	Uchar	Value / Rate (Hz) 0 N/A 1 1 (default) 2 2 5 5 10 10 20 20 25 25 50 50 100 100 200 200 other values Reserved	

The following are messages selected by the *Binary message select* field:

The *Gimbal Loopback* diagnostic message contains roll, pitch and heading that are compatible with the POS AV generic gimbal input data format. The user can connect an RS-232 cable from the output port that issues the Gimbal Loopback message to the gimbal data input port and thereby conduct a full test of the gimbal processing function.

4.4.2.8 Message 41: Primary GNSS Receiver Integrated DGPS Source Control

This message is used to specify settings related to the source or service provider of *Integrated DGPS* corrections. The parameters contained in this message become part of the processing parameters (referred to as "settings") that the POS AV saves to NVM.

The *Beacon Channel 0 Frequency* field is the frequency of channel 0 for manual beacon mode and DGPS source auto-switching mode (units of 0.1 kHz). Value 0 corresponds to information unchanged.

The *Beacon Channel 1 Frequency* field is the frequency of channel 1 for manual beacon mode and DGPS source auto-switching mode (units of 0.1 kHz). Value 0 corresponds to information unchanged.

The *Satellite ID* field is the identification number from the list provided by the interface [1-20] and 0 when values are unchanged and 255 in the case that the user enters manually the frequency and bit rate values.

The *Satellite bit rate* field is the satellite bit rate (600, 1200 or 2400 baud).

The *Satellite frequency* field is the frequency of the satellite being used to provide DGPS corections (value 0 implies unchanged).

The *OmniSTAR Activation Code* field is the ASCII numeric user activation code provided by OmniSTAR upon subscription.

Table 72: Message 41: Primary GNSS Receiver Integrated DGPS Source Control

Item	Bytes	Format	Value	Units
Message start	4	char	$MSG	N/A
Message ID	2	ushort	41	N/A
Byte count	2	ushort	52	N/A
Transaction number	2	ushort	Input: Transaction number Output: [65533, 65535]	N/A

Item	Bytes	Format	Value	Units
DGPS source mode	1	byte	Source mode for DGPS corrections: 0 Disabled 1 Beacon differential only 2 OmniStar VBS only 3 Reserved 4 Automatic switching between beacon and satellite DGPS sources 5 OmniStar XP only 6 OmniStar HP only 7 OmniStar Auto mode 8-255 Reserved	N/A
Beacon Acquisition Mode	1	byte	Beacon mode used to acquire DGPS signals : 0 Channel disabled 1 Manual mode 2 Auto Distance mode 3 Auto Power mode 4–255 Reserved	N/A
Beacon Channel 0 Frequency	2	ushort	[2835-3250]	10 * kHz
Beacon Channel 1 Frequency	2	ushort	[2835-3250]	10 * kHz
Satellite ID	1	byte	0-8 Reserved 9 OmniStar Auto ID Search 10–255 Reserved	N/A
Satellite bit rate	2	ushort	[600, 1200, 2400]	baud
Satellite frequency	8	double	[1500e6-1600e6]	Hz
Request Database Source	1	byte	0 Unknown 1 Beacon Stations 2 LandStar Stations 3-255 Reserved	N/A
Landstar Correction Source	1	byte	0 Unknown 1 LandStar Stations 2 LandStar Network 3-255 Reserved	N/A

Item	Bytes	Format	Value	Units
OmniSTAR Activation Code	26	byte	0 Unknown (0,) Enter service Provider Activation Information	N/A
Pad	1	byte	0	N/A
Checksum	2	ushort	N/A	N/A
Message end	2	char	$#	N/A

4.4.2.9 Message219: Sensor Frame Definition

This message contains installation parameters that the POS AV requires to correctly process the data and output the navigation parameters in Sensor frame. The parameters contained in this message become part of the processing parameters (referred to as "settings") that the POS AV saves to NVM.
The *sensor frame* is a user-defined coordinate frame with respect to *reference frame*.

The interpretations of the lever arm and orientation fields are as follows:

Reference to Sensor lever arm components

These are the X-Y-Z distances from the user-defined reference frame origin to the origin of sensor frame. The distances are resolved in the *reference frame*.

Sensor Frame with respect to Reference Frame mounting angles

These are the angular offsets (θ_x, θ_y, θ_z) of the sensor frame with respect to reference frame. The angles define the Euler sequence of rotations that bring the reference frame into alignment with the sensor frame. The angles follow the Tate-Bryant sequence of rotation, given as follows:

1. right-hand screw rotation of θ_z about the z axis
2. right-hand screw rotation of θ_y about the once rotated y axis
3. right-hand screw rotation of θ_x about the twice rotated x axis.

The angles θ_x, θ_y, and θ_z may be thought of as the roll, pitch, and yaw of the sensor frame with respect to the reference frame.

Table 73: Message 219: Sensor Frame Definition

Item	Bytes	Format	Value	Units
Message start	4	char	$MSG	N/A
Message ID	2	ushort	219	N/A
Byte count	2	ushort	56	N/A
Transaction Number	2	ushort	Input: Transaction number Output: [65533, 65535]	N/A
Reference to Sensor X lever arm	4	float	(,) default = 0	meters
Reference to Sensor Y lever arm	4	float	(,) default = 0	meters
Reference to Sensor Z lever arm	4	float	(,) default = 0	meters
X Sensor frame wrt Reference frame mounting angle	4	float	[-180, +180]default = 0	degrees
Y Sensor frame wrt Reference frame mounting angle	4	float	[-180, +180]default = 0	degrees
Z Sensor frame wrt Reference frame mounting angle	4	float	[-180, +180]default = 0	degrees
Reserved 1	4	float	0	N/A
Reserved 2	4	float	0	N/A
Reserved 3	4	float	0	N/A
Reserved 4	4	float	0	N/A
Reserved 5	4	float	0	N/A
Reserved 6	4	float	0	N/A
Pad	2	byte	0	N/A
Checksum	2	ushort	N/A	N/A
Message end	2	char	$#	N/A

4.4.2.10 Message 211: Events Shift Message

This message provides information about corresponding event shift that will be used to adjust the time in Event Based Navigation Solution (group 206 and 207).

Table 74: Message 211: Event Shift Message

Item	Bytes	Format	Value	Units

Item	Bytes	Format	Value	Units
Message start	4	Char	$MSG	N/A
Message ID	2	ushort	20211	N/A
Byte count	2	ushort	32	N/A
Transaction #	2	ushort	Input: Transaction number set by client Output: N/A	N/A
Event 1 Shift	4	Float	-500 – 500	msec
Event 2 Shift	4	Float	-500 – 500	msec
Reserved	4	Float	0	N/A
Reserved	4	Float	0	N/A
Reserved	4	Long	0	N/A
Reserved	4	Long	0	N/A
Pad	2	Byte	0	N/A
Checksum	2	ushort	N/A	N/A
Message end	2	Char	$#	N/A

4.4.2.11 Message 212: Event 1 POSEO Settings

This message provides definition of Omega Phi Kappa, boresight angles, lever arms and local mapping frame shift for event1 Real time POSEO.

Table 75: Message 212: Real Time POSEO Settings Event1

Item	Bytes	Format	Value	Units
Message start	4	Char	$MSG	N/A
Message ID	2	ushort	20212	N/A
Byte count	2	ushort	96	N/A
Transaction #	2	ushort	Input: Transaction number set by client Output: N/A	N/A
1st rotation axis	1	Byte	**Value** **Axis** 0 X 1 Y 2 Z	N/A

Item	Bytes	Format	Value	Units
1st rotation angle	1	Byte	**Value** **Angle** 0 Omega 1 Phi 2 Kappa	N/A
2nd rotation axis	1	Byte	**Value** **Axis** 0 X 1 Y 2 Z	N/A
2nd rotation angle	1	Byte	**Value** **Angle** 0 Omega 1 Phi 2 Kappa	N/A
3rd rotation axis	1	Byte	**Value** **Axis** 0 X 1 Y 2 Z	N/A
3rd rotation angle	1	Byte	**Value** **Angle** 0 Omega 1 Phi 2 Kappa	N/A
Kappa Cardinal Rotation	4	Float	N/A	deg
Boresight Angle tx	4	Float	(default 0)	arcmin
Boresight Angle ty	4	Float	(default 0)	arcmin
Boresight Angle tz	4	Float	(default 0)	arcmin
Boresight Angle Standard Deviation tx	4	Float	(default 600)	N/A

Item	Bytes	Format	Value	Units
Boresight Angle Standard Deviation ty	4	Float	(default 600)	N/A
Boresight Angle Standard Deviation tz	4	Float	(default 600)	N/A
X Lever Arm from center of Aircraft frame	4	Float	(default 0)	m
Y Lever Arm from center of Aircraft frame	4	Float	(default 0)	m
Z Lever Arm from center of Aircraft frame	4	Float	(default 0)	m
Units for Local mapping frame shift	1	Byte	0 – meters 1- US Survey Feet 2- International Feet	N/A
X Local mapping frame shift	4	Float	(default 0)	Meter or US Feet or International Feet
Y Local mapping frame shift	4	Float	(default 0)	Meter or US Feet or International Feet
Z Local mapping frame shift	4	Float	(default 0)	Meter or US Feet or International Feet
Output Coordiante Unit	1	Byte	0 – meters 1- US Survey Feet 2- International Feet	N/A
Output Angle Unit	1	Byte	0 – degrees 1- gradiants 2- radians	N/A
Reserved1	2	ushort	N/A	N/A

Item	Bytes	Format	Value	Units
Reserved2	2	ushort	N/A	N/A
Reserved3	4	Float	N/A	N/A
Reserved4	4	Float	N/A	N/A
Reserved5	8	double	N/A	N/A
Reserved6	8	double	N/A	N/A
Pad	1	Byte	N/A	N/A
Checksum	2	ushort	N/A	N/A
Message end	2	Char	$#	N/A

4.4.2.12 Message 213: Event 1 Mapping Frame Message

This message provides information of selected mapping frame parameters for Event 1 Real Time POSEO.

Table 76: Message 213: Real Time POSEO Mapping Frame Settings Event1

Item	Bytes	Format	Value	Units
Message start	4	char	$MSG	N/A
Message ID	2	ushort	20213	N/A
Byte count	2	ushort	632	N/A
Transaction #	2	ushort	Input: Transaction number set by client Output: N/A	N/A
Grid	70	char	**Selected Greed:** (Default) "Universal Transverse Mercator =UTM Universal Transverse Mercator"	N/A
Zone	180	char	**Selected Zone:** (Default) "UTM North 01 (180W to 174W) =UTM Zone 01N (180 W to 174 W)=WGS84 =TM=W 177 00 0.0=N 00 00 0.0=0.9996=500000=0"	N/A
Datum	150	char	**Selected Datum:** (Default) "WGS84 =WGS 1984=WGS84 =7 Parameter=0.0=0.0=0.0=1.0=0.0=0.0=0.0= x=y=z=0"	N/A
Ellipsoid	60	char	**Selected Ellipsoid:** (Default) "WGS84 =World Geodetic System 1984=6378137.0=298.257223563"	N/A

Item	Bytes	Format	Value	Units
Local transformation	150	char	**Selected Local Transformation:** (Default) "NONE=NONE=7 Parameters=0.0=0.0=0.0=1.0=0.0=0.0=0.0"	N/A
Reserved 1	4	long	N/A	N/A
Reserved 2	4	long	N/A	N/A
Reserved 3	4	float	N/A	N/A
Reserved 4	4	float	N/A	N/A
Checksum	2	ushort	N/A	N/A
Message end	2	char	$#	N/A

4.4.2.13 Message 214: Event 2 POSEO Settings

This message provides definition of Omega Phi Kappa, boresight angles, lever arms and local mapping frame shift for event2 Real time POSEO.

Table 77: Message 214: Real Time POSEO Settings Event 2

Item	Bytes	Format	Value	Units
Message start	4	Char	$MSG	N/A
Message ID	2	ushort	20214	N/A
Byte count	2	ushort	96	N/A
Transaction #	2	ushort	Input: Transaction number set by client Output: N/A	N/A
1st rotation axis	1	Byte	**Value** **Axis** 0 X 1 Y 2 Z	N/A
1st rotation angle	1	Byte	**Value** **Angle** 0 Omega 1 Phi 2 Kappa	N/A

Item	Bytes	Format	Value	Units
2nd rotation axis	1	Byte	**Value** **Axis** 0 X 1 Y 2 Z	N/A
2nd rotation angle	1	Byte	**Value** **Angle** 0 Omega 1 Phi 2 Kappa	N/A
3rd rotation axis	1	Byte	**Value** **Axis** 0 X 1 Y 2 Z	N/A
3rd rotation angle	1	Byte	**Value** **Angle** 0 Omega 1 Phi 2 Kappa	N/A
Kappa Cardinal Rotation	4	Float	N/A	deg
Boresight Angle tx	4	Float	(default 0)	arcmin
Boresight Angle ty	4	Float	(default 0)	arcmin
Boresight Angle tz	4	Float	(default 0)	arcmin
Boresight Angle Standard Deviation tx	4	Float	(default 600)	N/A
Boresight Angle Standard Deviation ty	4	Float	(default 600)	N/A

Item	Bytes	Format	Value	Units
Boresight Angle Standard Deviation tz	4	Float	(default 600)	N/A
X Lever Arm from center of Aircraft frame	4	Float	(default 0)	m
Y Lever Arm from center of Aircraft frame	4	Float	(default 0)	m
Z Lever Arm from center of Aircraft frame	4	Float	(default 0)	m
Units for Local mapping frame shift	1	Byte	0 – meters 1- US Survey Feet 2- International Feet	N/A
X Local mapping frame shift	4	Float	(default 0)	Meter or US Feet or International Feet
Y Local mapping frame shift	4	Float	(default 0)	Meter or US Feet or International Feet
Z Local mapping frame shift	4	Float	(default 0)	Meter or US Feet or International Feet
Output Coordiante Unit	1	Byte	0 – meters 1- US Survey Feet 2- International Feet	N/A
Output Angle Unit	1	Byte	0 – degrees 1- gradiants 2- radians	N/A
Reserved1	2	ushort	N/A	N/A
Reserved2	2	ushort	N/A	N/A
Reserved3	4	Float	N/A	N/A
Reserved4	4	Float	N/A	N/A
Reserved5	8	double	N/A	N/A

Item	Bytes	Format	Value	Units
Reserved6	8	double	N/A	N/A
Pad	1	Byte	N/A	N/A
Checksum	2	ushort	N/A	N/A
Message end	2	Char	$#	N/A

4.4.2.14 Message 215: Event 2 Mapping Frame Message

This message provides information of selected mapping frame parameters for Event 2 Real Time POSEO.

Table 78: Message 215: Real Time POSEO Mapping Frame Settings Event2

Item	Bytes	Format	Value	Units
Message start	4	char	$MSG	N/A
Message ID	2	ushort	20215	N/A
Byte count	2	ushort	632	N/A
Transaction #	2	ushort	Input: Transaction number set by client Output: N/A	N/A
Grid	70	char	**Selected Greed:** (Default) "Universal Transverse Mercator =UTM Universal Transverse Mercator"	N/A
Zone	180	char	**Selected Zone:** (Default) "UTM North 01 (180W to 174W) =UTM Zone 01N (180 W to 174 W)=WGS84 =TM=W 177 00 0.0=N 00 00 0.0=0.9996=500000=0"	N/A
Datum	150	char	**Selected Datum:** (Default) "WGS84 =WGS 1984=WGS84 =7 Parameter=0.0=0.0=0.0=1.0=0.0=0.0=0.0= x=y=z=0"	N/A
Ellipsoid	60	char	**Selected Ellipsoid:** (Default) "WGS84 =World Geodetic System 1984=6378137.0=298.257223563"	N/A
Local transformation	150	char	**Selected Local Transformation:** (Default) "NONE=NONE=7 Parameters=0.0=0.0=0.0=1.0=0.0=0.0=0.0"	N/A

Item	Bytes	Format	Value	Units
Reserved 1	4	long	N/A	N/A
Reserved 2	4	long	N/A	N/A
Reserved 3	4	float	N/A	N/A
Reserved 4	4	float	N/A	N/A
Checksum	2	ushort	N/A	N/A
Message end	2	char	$#	N/A

4.4.3 Processing Control Messages

4.4.3.1 Message 50: Navigation Mode Control

This message directs the POS AV to transition to a specified navigation mode. The two basic navigation modes are Standby and Navigate. This message is not saved in NVM.

Table 79: Message 50: Navigation mode control

Item	Bytes	Format	Value	Units
Message start	4	char	$MSG	N/A
Message ID	2	ushort	50	N/A
Byte count	2	ushort	8	N/A
Transaction number	2	ushort	Input: Transaction number Output: [65533, 65535]	N/A
Navigation mode	1	byte	Value — Mode 0 — No operation (default) 1 — Standby 2 — Navigate 3-255 — Reserved	
Pad	1	byte	0	N/A
Checksum	2	ushort	N/A	N/A
Message end	2	char	$#	N/A

4.4.3.2 Message 51: Display Port Control

This message directs the POS AV to output specified groups on the Display Port primarily for the purpose of display of data on AV-POSView.

The *Number of Groups* field contains the number *n* of groups that this message selects. Thereafter follow *n Display Port Output Group Identification* fields, each of which identifies one selected group to be output on the Display Port.

The POS AV always outputs Groups 1, 2, 3 and 10 on the Display Port to provide a minimal set of data for AV-POSView. These cannot be de-selected by omission from this message.

The POS AV accepts this message at anytime. The parameters contained in this message become part of the processing parameters (referred to as "settings") that the POS AV saves to NVM.

Table 80: Message 51: Display Port Control

Item	Bytes	Format	Value	Units
Message start	4	char	$MSG	N/A
Message ID	2	ushort	51	N/A
Byte count	2	ushort	10 + 2 x number of groups (+2 if pad bytes are required)	N/A
Transaction number	2	ushort	Input: Transaction number Output: [65533, 65535]	N/A
Number of groups selected for Display Port	2	ushort	[4, 70] default = 4 *(Groups 1,2,3,10 are always output on Display Port)*	N/A
Display Port output group identification	2	ushort	Group ID to output [1, 65534]	N/A
…	…	ushort	…	N/A
Display Port output group identification	2	ushort	Group ID to output [1, 65534]	N/A
Reserved	2	ushort	0	N/A
Pad	0 or 2	byte	0	N/A
Checksum	2	ushort	N/A	N/A
Message end	2	char	$#	N/A

4.4.3.3 Message 52: Primary Data Port Control

This message directs the POS AV to output specified groups on the Primary Data Port at a specified rate. Default port number is 5602.

The *Number of Groups* field contains the number *n* of groups that this message selects. Thereafter follow *n Data Port Output Group Identification* fields, each of which identifies one selected group to be output on the Data Port.

The *Data Port Output Rate* field selects the output rates of all specified groups from one of several available discrete output rates. The POS AV will output a selected group at the lesser of the user-specified rate or the internal update rate. This will depend on the selected group. For example, if the user selects a group to be output at 50 Hz when the internal update rate of the group data is 1 Hz, then the POS AV will output the selected group at 1 Hz. An exception is Group 4: Time-tagged IMU, which the POS AV will output at the IMU data rate regardless of the user-specified data rate. The available maximum data output rate is related to the IMU data rate and hence the IMU type; refer to Table 14 for further details.

The POS AV accepts this message at anytime. The parameters contained in this message become part of the processing parameters (referred to as "settings") that the POS AV saves to NVM.

Table 81: Message 52/61/62: Primary/Secondary Data Port Control

Item	Bytes	Format	Value	Units
Message start	4	char	$MSG	N/A
Message ID	2	ushort	52 or 61	N/A
Byte count	2	ushort	10 + 2 x number of groups (+2 if pad bytes are required)	N/A
Transaction number	2	ushort	Input: Transaction number Output: [65533, 65535]	N/A
Number of groups selected for Data Port	2	ushort	[0, 70] default = 0	N/A
Data Port output group identification	2	ushort	Group ID to output [1, 65534]	N/A
…	…	ushort	…	N/A
Data Port output group identification	2	ushort	Group ID to output [1, 65534]	N/A

Item	Bytes	Format	Value	Units
Data Port output rate	2	ushort	Value / Rate (Hz) 1 / 1 (default) 2 / 2 10 / 10 20 / 20 25 / 25 50 / 50 100 / 100 200 / 200 (NOT available for IMU type 17.) other values / Reserved	
Pad	0 or 2	byte	0	N/A
Checksum	2	ushort	N/A	N/A
Message end	2	char	$#	N/A

4.4.3.4 Message 53: Logging Port Control

This message controls a data-logging device and directs the POS AV to output specified groups on the Logging Port at a specified rate.

The *Number of Groups* field contains the number *n* of groups that this message selects. Thereafter follow *n Logging Port Output Group Identification* fields, each of which identifies one selected group to be output on the Logging Port.

The *Logging Port Output Rate* field selects the output rates of all specified groups from one of several available discrete output rates. The POS AV will output a selected group at the lesser of the user-specified rate or the internal update rate. This will depend on the selected group. For example, if the user selects a group to be output at 50 Hz when the internal update rate of the group data is 1 Hz, then the POS AV will output the selected group at 1 Hz. An exception is Group 4: Time-tagged IMU, which the POS AV will output at the IMU data rate regardless of the user-specified data rate. The available maximum data output rate is related to the IMU data rate and hence the IMU type; refer to Table 14 for further details.

The *Select/Deselect AutoLog* field directs the POS AV to enable or disable the AutoLog function; when the AutoLog function is enabled, the POS AV begins to record data to the Logging Port using the automatically incrementing filename stored in NVM as soon as the POS AV has powered up and self-initialized. This feature allows the user to operate the POS AV and to record data without having to connect a client computer running AV-POSView.

The *Disk Logging Control* field directs the POS AV to begin and end logging to the logging device connected to the Logging Port. The *Filename Kernel* field sets the logging filename kernel. The POS AV appends the filename kernel with extensions **.000** to **.999** to create filenames on the logging disk. Each file holds about 12MBytes of recorded data. The default filename kernel is **default**.

The POS AV accepts this message at anytime. The parameters contained in this message become part of the processing parameters (referred to as "settings") that the POS AV saves to NVM.

Table 82: Message 53: Logging Port Control

Item	Bytes	Format	Value	Units
Message start	4	char	$MSG	N/A
Message ID	2	ushort	53	N/A
Byte count	2	ushort	76 + 2 x number of groups (+2 if required for pad)	N/A
Transaction number	2	ushort	Input: Transaction number Output: [65533, 65535]	N/A
Number of groups selected for Logging Port	2	ushort	[0, 70] default = 0	N/A

Item	Bytes	Format	Value	Units
Logging Port output group identification	2	ushort	Group ID to Output [1, 65534]	N/A
…	…	ushort	…	N/A
Logging Port output group identification	2	ushort	Group ID to Output [1, 65534]	N/A
Logging Port output rate	2	ushort	Value — Rate (Hz) 1 — 1 (default) 2 — 2 10 — 10 20 — 20 25 — 25 50 — 50 100 — 100 200 — 200 (NOT available for IMU type 17.) other values — reserved	
Select/deselect AutoLog	1	byte	Value — State 0 — AutoLog disabled (default) 1 — AutoLog enabled 2-255 — No action	
Disk logging control	1	byte	Value — Command 0 — Stop logging (default) 1 — Start logging 2 — Clear Logging Media 3-255 — No action	
Filename kernel	32	chars	Filename kernel (default = *default*)	N/A
Reserved	32	bytes	N/A	N/A
Pad	0 or 2	byte	0	N/A
Checksum	2	ushort	N/A	N/A
Message end	2	char	$#	N/A

4.4.3.5 Message 54: Save/Restore Parameters Control

This message directs the POS AV to save the current configuration to non-volatile memory (NVM) or to retrieve the currently saved parameters from NVM. The POS AV accepts this message at anytime. This message itself is not saved in NVM.

If the *Control* field is set to any value other than 1-3, this message has no effect. If the *Control* field is set to 1, the POS AV saves the current parameters to NVM, thereby overwriting the previously saved parameters. If the *Control* field is set to 2, the POS AV retrieves the currently saved parameters into the active parameters for the current navigation session. If the *Control* field is set to 3, the POS AV resets the active parameters to the factory default settings. The previously active parameters are overwritten.

Table 83: Message 54: Save/restore parameters control

Item	Bytes	Format	Value	Units
Message start	4	char	$MSG	N/A
Message ID	2	ushort	54	N/A
Byte count	2	ushort	8	N/A
Transaction number	2	ushort	Input: Transaction number Output: [65533, 65535]	N/A
Control	1	byte	Value Operation 0 No operation 1 Save parameters in NVM 2 Restore user settings from NVM 3 Restore factory default settings 4-255 No operation	
Pad	1	byte	0	N/A
Checksum	2	ushort	N/A	N/A
Message end	2	char	$#	N/A

4.4.3.6 Message 55: User Time Recovery

This message specifies the time of the last PPS in user time to the POS AV. It directs the POS AV to synchronize its User Time with the time specified in the *User PPS Time* field. The POS AV accepts this message at anytime at a maximum rate of once per second.

To establish user time synchronization, the user must send the user time of last PPS to the POS AV with this message after the PPS has occurred. The resolution of time synchronization is one microsecond.

This message is not saved in NVM. The user should provide this message to the POS AV at a 1 Hz rate.

Table 84: Message 55: User time recovery

Item	Bytes	Format	Value	Units
Message start	4	char	$MSG	N/A
Message ID	2	ushort	55	N/A
Byte count	2	ushort	24	N/A
Transaction number	2	ushort	Input: Transaction number Output: [65533, 65535]	N/A
User PPS time	8	double	[0,) default = 0.0	seconds
User time conversion factor	8	double	[0,) default = 1.0	•/seconds
Pad	2	short	0	N/A
Checksum	2	ushort	N/A	N/A
Message end	2	char	$#	N/A

4.4.3.7 Message 61: Secondary Data Port Control

This message directs the POS AV to output specified groups on the Secondary Data Port at a specified rate. The format and content of the message is the same as that of Message 52, and is given by Table 81.

The POS AV accepts this message at anytime. The parameters contained in this message become part of the processing parameters (referred to as "settings") that the POS AV saves to NVM.

4.4.3.8 Message 62: Primary 2 Real Time Port Control

This message directs the POS AV to output specified groups on the Primary 2 Data Port at a specified rate. Default port number is 5602. The format and content of the message is the same as that of Message 52, and is given by Table 81.

The POS AV accepts this message at anytime. The parameters contained in this message become part of the processing parameters (referred to as "settings") that the POS AV saves to NVM.

4.4.4 Program Control Override Messages

4.4.4.1 Message 90: Program Control

This message controls the operational status of the POS AV. The POS AV will accept this message at any time. This message itself is not saved in NVM.

The POS AV interprets the values in the message as follows.

0 The connected POS Controller is alive and the TCP/IP connection is good.
1 Terminate the TCP/IP connection. This allows the POS Controller to disconnect as controller and re-connect later.
100 Reset the GAMS algorithm to clear any pending problems.
101 Reset POS to clear pending problems. All parameters will be loaded from NVM after a reset.
102 Shutdown POS in preparation for power-off. This function allows POS to synchronize its files before the user disconnects the power. The user should ensure that POS settings are saved before beginning the shutdown procedure.

The POS AV continuously monitors the TCP/IP connection between itself and AV-POSView. The POS AV expects to receive at least one message from AV-POSView every 30 seconds or it will automatically terminate the TCP/IP connection. The purpose of this function is for the POS AV to determine if AV-POSView has failed, in which case it can reset the TCP/IP port. This message can be used with a value of 0 as a no operation (NOP) message when no other messages need to be sent to the POS AV.

Table 85: Message 90: Program Control

Item	Bytes	Format	Value	Units
Message start	4	char	$MSG	N/A
Message ID	2	ushort	90	N/A
Byte count	2	ushort	8	N/A
Transaction number	2	ushort	Input: Transaction number Output: [65533, 65535]	N/A
Control	2	ushort	Value Command 000 Controller alive 001 Terminate TCP/IP connection 100 Reset GAMS 101 Reset POS 102 Shutdown POS all other values are reserved	
Pad	0	byte	0	N/A
Checksum	2	ushort	N/A	N/A
Message end	2	char	$#	N/A

4.4.4.2 Message 91: GNSS Control

This message directs the POS AV to configure or reset its internal GNSS receivers. The POS AV will accept this message at any time.

The *Control Command* field when set to *Send GNSS configuration* (0) directs the POS AV to reconfigure the GNSS receivers. The POS AV then sends the configuration script messages to the receivers in the same way as it does during initialization following power-up. The user would use this command if he suspected that an internal GNSS receiver had not initialized correctly or had lost its configuration.

The *Control Command* field when set to *Send reset command* (1) directs the POS AV to send "cold reset" commands to the GNSS receivers. This will direct an internal GNSS receiver to revert to their factory default configurations. The user would use this command to establish a starting point for troubleshooting problems with a GNSS receiver.

Table 86: Message 91: GNSS control

Item	Bytes	Format	Value	Units
Message start	4	char	$MSG	N/A
Message ID	2	ushort	91	N/A
Byte count	2	ushort	8	N/A
Transaction number	2	ushort	Input: Transaction number Output: [65533, 65535]	N/A
Control command	1	byte	Value Command 0 Send primary GNSS configuration 1 Send primary GNSS reset command 2 Send secondary GNSS configuration 3 Send secondary GNSS reset command 4-255 No action	
Pad	1	byte	0	N/A
Checksum	2	ushort	N/A	N/A
Message end	2	char	$#	N/A

4.4.4.3 Message 92: Integration Diagnostics Control

This message directs the POS AV to implement one or more of the following integration control functions:

- The user can select the Reference frame to be the user-defined Reference frame or the IMU frame. This diagnostic function allows the user to output the roll, pitch and heading of the IMU frame.

- The user can output fixed navigation parameters in place of the ones computed by the POS AV. This allows the user to debug his interface with the POS AV using expected data output.

This message is provided for diagnostic purposes only. The POS AV will accept this message at any time. This message is not saved to NVM.

Table 87: Message 92: Integration diagnostics control

Item	Bytes	Format	Value	Units
Message start	4	char	$MSG	N/A
Message ID	2	ushort	92	N/A
Byte count	2	ushort	24	N/A
Transaction number	2	ushort	Input: Transaction number Output: [65533, 65535]	N/A
Output data control	1	byte	Value Command 1 IMU Frame output 2 User parameter output (default) 0, 3-255 No action	
User roll	4	float	[-180, +180] default = 0	degrees
User pitch	4	float	[-180, +180] default = 0	degrees
User heading	4	float	[0, 360) default = 0	degrees
Reserved	4	byte	N/A	N/A
Pad	1	byte	0	N/A
Checksum	2	ushort	N/A	N/A
Message end	2	char	$#	N/A

4.4.4.4 Message 201: Platform Yaw Drift Setup

This message is used to set-up the platform yaw drift correction algorithm. The user can choose from 1 of 2 methods for controlling the platform yaw drift.

Method 0: The yaw of the platform is continuously steered so that it equals the mean track of the aircraft. This method requires no input from the operator regarding the desired track of the current flight line.

Method 1: 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 heading set-point where the yaw drift correction is active. If this method is chosen and the operator does not send the desired heading in time for the current line, POS will default to Method 0.

Methods 2 and 3: Similar to Method 0 and 1 respectively, but POS outputs the heading difference instead of continuously steering the platform.

The cut-off period is the tracking filter cut-off in seconds. The gain is the used to scale the drift correction output.

The drift correction output is designed to be superimposed upon 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.

Table 88: Message 201: Platform Yaw Drift Setup

Item	Bytes	Format	Value	Units
Message start	4	char	$MSG	N/A
Message ID	2	ushort	201	N/A
Byte count	2	ushort	40	N/A
Transaction number	2	ushort	Input: Transaction number Output: [65533, 65535]	N/A
Desired Heading	8	double	0 ≤ to ≤ 360	deg
Activation Threshold	8	double	0 ≤ to ≤ 30	deg
Cut off Period	8	double	0.001 ≤ to ≤ 10,000	sec
Gain	8	double	0.00001 ≤ to ≤ 10,000	N/A

Item	Bytes	Format	Value	Units
Correction Method	1	byte	**Value** **Operation** 0 Follow Mean Track (default) 1 Follow Desired Heading 2 Follow Mean Track (w/o integrator) 3 Follow Desired Heading (w/o integrator)	N/A
Pad	1	byte	0	N/A
Checksum	2	ushort	N/A	N/A
Message end	2	char	$#	N/A

4.4.4.5 Message 202: Free Inertial Mode

The "Free Inertial" mode is a navigation output is based on pure IMU input without aiding sensors (primarily GPS receiver). It is mostly used in airborne applications with SAR (synthetic aperture radar) where relative accuracy applies over short time and navigation solution needs to be smooth and free of GPS noise and residuals.

Table 89: Message 202: Free Inertial Mode Selection Command

Item	Bytes	Format	Value	Units
Message start	4	char	$MSG	N/A
Message ID	2	ushort	202	N/A
Byte count	2	ushort	12	N/A
Transaction #	2	ushort	Input: Transaction number set by client Output: N/A	N/A
Mode Type	1	byte	**Value** **Mode** 0 Regular POS mode 1 Free Inertial Mode	N/A
Reserved	2	ushort	N/A	N/A
Pad	3	byte	N/A	N/A
Checksum	2	ushort	N/A	N/A
Message end	2	char	$#	N/A

4.4.4.6 Message 203: FMS Data Port Selection

This message is used to configure the PCS FMS Ethernet Data port. Note that some groups cannot be determined at every output, while others have a latency which, by definition, means that they will not be available at the same time as other data.

Sample frequency is specified as one of several available discrete output rates. Note that certain groups cannot be output at a variable frequency due to their frequency of availability.

This message is accepted at anytime and may be saved.

Table 90: Message 203: FMS Data Port Control Command

Item	Bytes	Format	Value	Units
Message start	4	Char	$MSG	N/A
Message ID	2	ushort	203	N/A
Byte count	2	ushort	10 + 2 x #groups (+2 if required for pad)	N/A
Transaction #	2	ushort	Input: Transaction number set by client Output: 65535	N/A
# of Groups Selected for FMS Data Port	2	ushort	0 to 65534 (default = 0)	N/A
FMS Data Port Output Group #1	2	ushort	Group ID to Output 1 to 65534	N/A
…	…	ushort	…	N/A
FMS Data Port Output Group #n	2	ushort	Group ID to Output 1 to 65534	N/A
FMS Data Port Output Rate	2	ushort	**Value** / **Rate (Hz)** 1 / 1 (default) 2 / 2 10 / 10 20 / 20 25 / 25 50 / 50 100 / 100 200 / 200	Hz
Pad	var 0 or 2	byte	0	N/A
Checksum	2	ushort	N/A	N/A
Message end	2	char	$#	N/A

4.4.4.7 Message 204: FMS Camera Trigger Control Command

This command is used by Flight Management System to control the camera trigger pulse generated by POS.

Table 91: Message 204: FMS Camera Trigger Control Command

Item	Bytes	Format	Value	Units
Message start	4	char	$MSG	N/A
Message ID	2	ushort	204	N/A
Byte count	2	ushort	24	N/A
Transaction #	2	ushort	Input: Transaction number set by client Output: N/A	N/A
Tracker MSG1 ID	1	Byte	Not used 0 Begin photo session (SS) 1 Change photo interval (SI) 2 Max num of photos (SM) 3 Single image command (CT) 4 Stop photo session (SP) 5 Pulse polarity (PP) 6 Trigger Length (TL) 7	

<table>
<tr><th>Item</th><th>Bytes</th><th>Format</th><th colspan="2">Value</th><th>Units</th></tr>
<tr><td>Field 1</td><td>4</td><td>Long</td><td colspan="3"><table>
<tr><th>MSG ID</th><th>Value</th><th>Units</th></tr>
<tr><td>1(SS)</td><td>0-604800000</td><td>GPS Time in msec of GPS week</td></tr>
<tr><td>2 (SI)</td><td>MIN-MAX
MIN interval should be defined</td><td>Msec</td></tr>
<tr><td>3 (SM)</td><td>MAX number of photos to the end of triggering interval.</td><td>N/A</td></tr>
<tr><td>4 (CT)</td><td>N/A</td><td>N/A</td></tr>
<tr><td>5 (SP)</td><td>N/A</td><td>N/A</td></tr>
<tr><td>6 (PP)</td><td>-1 – Negative edge
1 – Positive edge</td><td>N/A</td></tr>
<tr><td>7 (TL)</td><td>MIN – 9999
Default is 200
MIN should be defined and depends on minimum interval</td><td>msec</td></tr>
</table></td></tr>
<tr><td>Field 2</td><td>4</td><td>Long</td><td colspan="3"><table>
<tr><th>MSG ID</th><th>Value</th><th>Units</th></tr>
<tr><td>1
(SS)</td><td>MIN-MAX interval</td><td>Msec</td></tr>
<tr><td>2,3,4,5,6,7
(SI,SM,CT,SP,
PP,TL)</td><td>N/A</td><td>N/A</td></tr>
</table></td></tr>
<tr><td>Reserved 1</td><td>4</td><td>Long</td><td colspan="2">0</td><td></td></tr>
<tr><td>Reserved 2</td><td>4</td><td>Long</td><td colspan="2">0</td><td></td></tr>
<tr><td>Pad</td><td>1</td><td>byte</td><td colspan="2">0</td><td>N/A</td></tr>
</table>

Item	Bytes	Format	Value	Units
Checksum	2	ushort	N/A	N/A
Message end	2	char	$#	N/A

4.4.4.8 Message 205: Gimbal Mount Control Command

This command turns on/off the mount stabilization during start/end of the flight (survey) line.

Table 92: Message 205: Gimbal Mount Control Command

Item	Bytes	Format	Value	Units
Message start	4	Char	$MSG	N/A
Message ID	2	ushort	205	N/A
Byte count	2	ushort	16	N/A
Transaction #	2	ushort	Input: Transaction number set by client Output: N/A	N/A
Status Control	1	byte	Value Operation 0 Stabilization Off 1 Stabilization On	N/A
Reserved 1	4	long	0	N/A
Reserved 2	4	long	0	N/A
Pad	1	byte	0	N/A
Checksum	2	ushort	N/A	N/A
Message end	2	char	$#	N/A

4.4.4.9 Message 206: Lidar Logging On/Off Control Command

This command is used by FMS to control the lidar logging On/Off based on start or end of survey line. The command is part of NVM settings.

Table 93: Message 206: Lidar Logging On/Off Control Command

Item	Bytes	Format	Value	Units
Message start	4	Char	$MSG	N/A
Message ID	2	ushort	206	N/A
Byte count	2	ushort	16	N/A
Transaction #	2	ushort	Input: Transaction number set by client Output: N/A	N/A

Item	Bytes	Format	Value	Units
Logging	1	Byte	Lidar Logging off (line end) 0 Lidar Logging on (line start) 1	
Flight Line Number	4	Long		
Reserved	4	Long	0	
Pad	1	byte	0	N/A
Checksum	2	ushort	N/A	N/A
Message end	2	char	$#	N/A

4.4.4.10 Message 208: Camera 1 Message

This message provides information about the last camera 1 trigger. It is used only in POSTrack product configuration.

Table 94: Message 208: Camera 1 Message

Item	Bytes	Format	Value	Units
Message start	4	Char	$MSG	N/A
Message ID	2	ushort	208	N/A
Byte count	2	ushort	36	N/A
Transaction #	2	ushort	Input: Transaction number set by client Output: N/A	N/A
Event Number	4	ulong	Not supported	
Photo ID 1	4	ulong	Corresponding Photo ID number of the camera 1	
Event Time	8	double	Time of the trigger for corresponding Photo ID	sec
Camera Delay 1	8	double	Variable camera delay	msec
Reserved	4	long	0	N/A
Pad	2	byte	0	N/A
Checksum	2	ushort	N/A	N/A
Message end	2	char	$#	N/A

4.4.4.11 Message 209: Camera 2 Message

This message provides information about the last camera 2 trigger. It is used only in POSTrack product configuration.

Table 95: Message 209: Camera 2 Message

Item	Bytes	Format	Value	Units
Message start	4	Char	$MSG	N/A
Message ID	2	ushort	209	N/A
Byte count	2	ushort	36	N/A
Transaction #	2	ushort	Input: Transaction number set by client Output: N/A	N/A
Event Number	4	ulong	Not supported	
Photo ID 1	4	ulong	Corresponding Photo ID number of the camera 2	
Event Time	8	double	Time of the trigger of the corresponding photo ID	sec
Camera Delay 1	8	double	Variable camera delay	msec
Reserved	4	long	0	N/A
Pad	2	byte	0	N/A
Checksum	2	ushort	N/A	N/A
Message end	2	char	$#	N/A

4.4.4.12 Message 210: Gimbal Type Selection Message

This is the set up message for particular gimbal type connected to corresponding COM port.

Table 96: Message 210: Gimbal Type Selection Message

Item	Bytes	Format	Value	Units
Message start	4	char	$MSG	N/A
Message ID	2	ushort	36	N/A
Byte count	2	ushort	(14 or 16)[1] + 6 x *nPorts*	N/A
Transaction number	2	ushort	Input: Transaction number Output: [65533, 65535]	N/A
Reserved	3	byte	N/A	N/A
Message update rate	2	ushort	Superseded by the corresponding field in Gimbal output COM port parameters	
Binary message select	2	ushort	Superseded by the corresponding field in Gimbal output COM port parameters	
Number of Gimbal COM ports	1	Byte	[0,10] Number (*nPorts)* of COM ports assigned by this message.	N/A
Binary output COM port parameters	6 x *nPorts*	See Table 71 One set of parameters for each of *nPorts* COM port		
Pad	(0 or 2)[2]	byte	0	N/A
Checksum	2	ushort	N/A	N/A
Message end	2	char	$#	N/A

Table 97: Binary output COM port parameters

Item	Bytes	Format	Value	Units
COM port number	1	Uchar	The number of COM port assigned to output binary messages	

[1] This value depends on the pad size.

[2] The number of the *pad* bytes depends on the number of COM ports in Table 71, since the *pad* is used to make each message length a multiple of four bytes. So that, when the number of COM ports is an odd value then the *pad* size is zero bytes and when it is even then the the *pad* size is two bytes.

Item	Bytes	Format	Value	Units
Gimbal message select	4	ulong	Value: Message 0: GSM3000 1: GIM 01 2: GIM 02 3: TAS 4: Z/I 5: PAV 30/PAV80 6: Reserved 7: PV Lab	
Message update rate	1	Uchar	Value: Rate (Hz) 0: 1 (default) 1: 2 2: 3 3: 5 4: 10 5: 20 6: 25 7: 50	

4.4.4.13 Message 218 Externally Calculated Ground Points

The message contains lidar raw measurement associated with location of three externally calculated ground points from the same line (far left, far right and middle point). The message could be used by third party software to send information to POS in order to display lidar swats in Flight Management System.

Table 98: Message 218: Externally calculated ground points

Item	Bytes	Format	Value	Units
Message start	4	char	$MSG	N/A
Message ID	2	ushort	218	N/A
Byte count	2	ushort	124	bytes
Transaction #	2	ushort	N/A	N/A
Computation Method	1	char	**0 – External Computation**	
Middle Point Altitude Diff (HAG)	4	float	N/A	m
Middle Point Time Tag	8	double	N/A	sec
Middle Point Range	4	float	N/A	M
Middle Point Angle	4	float	N/A	M
Middle Point Latitude	8	double	-90 < to ≤ 90	Deg
Middle Point Longitude	8	double	-180 < to ≤ 180	Deg
Middle Point Altitude	4	float	N/A	M
First Point Time Tag	8	double	N/A	sec
First Point Range	4	float	N/A	M
First Point Angle	4	float	N/A	M
First Point Latitude	8	double	-90 < to ≤ 90	Deg
First Point Longitude	8	double	-180 < to ≤ 180	Deg
First Point Altitude	4	float	N/A	M

Item	Bytes	Format	Value	Units
Last Point Time Tag	8	double	N/A	sec
Last Point Range	4	float	N/A	M
Last Point Angle	4	float	N/A	M
Last Point Latitude	8	double	-90 < to ≤ 90	Deg
Last Point Longitude	8	double	-180 < to ≤ 180	Deg
Last Point Altitude	4	float	N/A	M
Number of Scan Lines per Sec	2	ushort	N/A	N/A
Number of Points per Scan Line	2	ushort	N/A	N/A
Pad	1	byte	0	N/A
Checksum	2	ushort	N/A	N/A
Message end	2	char	$#	N/A

4.4.4.14 Message 220 Raw Camera in Message

This message contains the raw data passed to the connected camera over Ethernet with camera.

Table 99: Message 220: Raw Camera message

Item	Bytes	Format	Value	Units
Message start	4	Char	$MSG	N/A
Message ID	2	ushort	220	N/A
Byte count	2	ushort	124	N/A
Transaction #	2	ushort	Input: Transaction number set by client Output: N/A	N/A
Reserved	2	ushort	For future use	
Reserved	4	long	For future use	
Reserved	8	double	For future use	
Byte Count	2	ushort	Byte count of used fields in raw data 1-102	
Raw data	102	char	0	N/A
Checksum	2	ushort	N/A	N/A
Message end	2	char	$#	N/A

4.4.4.15 Message 221 Raw Camera in Message

This message contains the raw data passed to the connected camera over selected COM port from Flight Management system.

Table 100: Message 221:Raw Camera in message

Item	Bytes	Format	Value	Units
Message start	4	Char	$MSG	N/A
Message ID	2	ushort	221	N/A
Byte count	2	ushort	220	N/A
Transaction #	2	ushort	Input: Transaction number set by client Output: N/A	N/A
Camera Type	2	ushort	0 – Vexcel	
Time	8	double	Time of the message	sec
Byte Count	2	ushort	Byte count of used fields in raw data 1-202	
Raw data	202	char	0	N/A
Checksum	2	ushort	N/A	N/A
Message end	2	char	$#	N/A

4.4.4.16 Message 222 Raw Sensor in Message

This message can be used by third party software to control any sensor over assigned POS serial port in real time. The message will be formatted and sent over selected COM port to applicable sensor.

Table 101: Message 222: Raw Sensor in message

Item	Bytes	Format	Value	Units
Message start	4	Char	$MSG	N/A
Message ID	2	ushort	222	N/A
Byte count	2	ushort	220	N/A
Transaction #	2	ushort	Input: Transaction number set by client Output: N/A	N/A
Reserved	2	ushort	0	
Time	8	double	Time of the message GPS or UTC in sync with POS Time Tag 1	Sec of week
Raw Data Byte Count	2	ushort	Byte count of used fields in raw data 1-202	
Raw Data In	202	char	N/A	N/A
Pad	0	N/A	N/A	N/A
Checksum	2	ushort	N/A	N/A
Message end	2	char	$#	N/A

4.4.4.17 Message 226 Flight Plan Message

This message is sent by Flight Management System software in real time. It provides specific information and status of the executed flight plan (Project name, Area or Flight plan name, selected line) to the end user (integrator).

Table 102: Message 226: Flight Plan message

Item	Bytes	Format	Value	Units
Message start	4	Char	$MSG	N/A
Message ID	2	ushort	226	N/A
Byte count	2	ushort	92	N/A
Transaction #	2	ushort	Input: Transaction number set by client Output: N/A	N/A
Time	8	double	Current GPS time in seconds of the week	
Project Name	24	char	Array of ascii characters representing the project name	
Flight Plan Name	24	char	Array of ascii characters representing the flight plan name	
Total Number of Runs in Flight Plan	4	long	Total number of runs in the flight plan, remains constant for entire mission.	N/A
Active Flight Line (Run)	4	long	Active Flight Line (run) number	
Status of the Active Line	2	ushort	0- Start of the survey line 1- End of the survey line 2- Survey line aborted	
Number of the Planned Photos in active line	4	long	Constant for active run at the beginning and at the end of the run. 0 if the flight line contains no photos	
Number of taken Photos in the Active Line	4	long	0 if the Status filed is 0 (Start of survey line) Actual number of taken photos in the line.	
Reserved1	8	double	0	
Reserved2	4	long	0	
Checksum	2	ushort	N/A	N/A
Message end	2	char	$#	N/A

4.4.4.18 Message 20200 Gimbal Encoder Input

This message is used to input Gimbal Encoder data to POS when the IMU is mounted on a stabilized platform. Please see the POS/AV Installation and Operation Manual for encoder definitions and data rates.

Gimbal processing using data from the Ethernet is turned on via the Gimbal processing control byte. Once turned on, and Message 20200 is not received within 1 sec, then a gimbal data gap will be declared. The user can turn off Gimbal processing by issuing Message 20200 at least once with the control byte set to 0. Default is 0 (OFF).
The Angle Definition field tells POS how to interpret the 3 encoder angles. Value 0 is for when the IMU is mounted on a "pod" type platform such as a WESCAM mount. In this case the sequence of rotations starting with the aircraft frame is tz, ty, tx. The value 1 is for when the IMU is mounted on a traditional aerial camera stabilized mounts such as the PAV30 or T-AS. In this case the sequence of rotations in tx, ty, tz. All angles are defined as positive clockwise. Please see the POS/AV Installation and Operation Manual for details.

Table 103: Message 20200: Gimbal Encoder Inupt

Item	Bytes	Format	Value	Units
Message start	4	Char	$MSG	N/A
Message ID	2	ushort	20200	N/A
Byte count	2	ushort	44	N/A
Transaction #	2	ushort	Input: Transaction number set by client Output: N/A	N/A
Time 1	8	double	N/A	sec
Time types	1	byte	Value bits 0 – 3 Time1: User time 0 Time 1: GPS time 1 Time 1: UTC time 2 (default)	
Gimbal Processing Control	1	byte	Value Operation 0 Gimbal Processing OFF (def) 1 Gimbal Processing ON	N/A
Encoder Angle Tx	8	double	N/A	deg
Encoder Angle Ty	8	double	N/A	deg
Encoder Angle Tz	8	double	N/A	deg

Item	Bytes	Format	Value	Units
Angle Definition	1	byte	Value Definition 0 tz, ty, tx (default) 1 tx, ty, tz	N/A
Pad	3	byte	0	N/A
Checksum	2	ushort	N/A	N/A
Message end	2	char	$#	N/A

5 Appendix A: Data Format Description

5.1 Data Format

The data format for byte, short, long, float, and double as used in POS are defined as follows:

Byte or Character

Table 104: Byte Format

MSBit							LSBit
7	6	5	4	3	2	1	0

Short Integer

The short integer format of the POS data is the INTEL style byte order as follows:

Table 105: Short Integer Format

MSB		LSB
15 8	7	0
Byte #: 1	0	

Long Integer

The long integer format of the POS data is the INTEL style byte order as follows:

Table 106: Long Integer Format

MSB			LSB
31 24	23 16	15 8	7 0
Byte #: 3	2	1	0

Float and Double

The floating point format of the POS data is the INTEL byte order from the IEEE-754 floating point representation standard as follows:

Table 107: Single-Precision Real Format

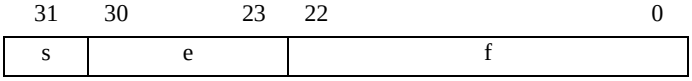
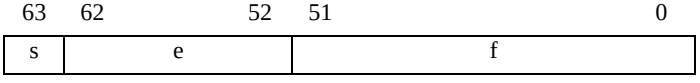
Data format	
	
Field Size in Bits	
Sign (s)	1
Biased Exponents (e)	8
Fraction (f)	23
Total	32
Interpretation of Sign	
Positive Fraction	s=0
Negative Fraction	s=1
Normalized Numbers	
Bias of Biased Exponent	+127 ($7F)
Range of Biased Exponent	[0, 255] ($FF)
Range of Fraction	zero or nonzero
Fraction	1.f (where $f=bit_{22}^{-1}+bit_{21}^{-2}\ldots+bit_{0}^{-23}$)
Relation to Representation of Real Numbers	$(-1)^{s}x2^{e-127}x1.f$
Approximate Ranges	
Maximum Positive Normalised	$3.4x10^{38}$
Minimum Positive Normalised	$1.2x10^{-38}$

Table 108: Double-Precision Real Format

Data format	
	
Field Size in Bits	
Sign (s)	1
Biased Exponents (e)	11
Fraction (f)	52
Total	64
Interpretation of Sign	
Positive Fraction	s=0
Negative Fraction	s=1

Normalized Numbers	
Bias of Biased Exponent	+1023 ($3FF)
Range of Biased Exponent	[0, 2047] ($7FF)
Range of Fraction	zero or nonzero
Fraction	1.f (where $f=bit_{51}^{-1}+bit_{50}^{-2}\ldots+bit_{0}^{-52}$)
Relation to Representation of Real Numbers	$(-1)^{s}x2^{e-1023}x1.f$
Approximate Ranges	
Maximum Positive Normalized	$1.8x10^{308}$
Minimum Positive Normalized	$2.2x10^{-308}$

5.2 Invalid Data Values

Since there are several fields in each group or message, it is possible that one or more numerical fields will be invalid when the group or message is output. The following numerical values should be interpreted as invalid if they are output in any group or message. This does not apply to single or multiple byte fields that are comprised of bit sub-fields.

The hexadecimal value describes the contents of the bytes that represent the invalid decimal value for the type. The invalid values for all integer types are the maximum positive values that the integer types can take.

The invalid value for the floating-point types is any value in the range of NaN (Not a Number) or INF (Infinity) defined by IEEE-754. The value NaN is by definition any float or double having a mantissa set to any nonzero value and an exponent whose bits are all set to 1. The POS AV assigns an invalid float or double in any group by setting all bits representing the float or double set to 1. The POS AV rejects any message that contains any of the invalid integer values in Table 109 or any value in the range of NaN or INF.

Table 109: Invalid data values

Data Type	Hexadecimal Value	Decimal Value
Byte	FF	255 ($=2^8-1$)
Short	7F FF	32767 ($=2^{15}-1$)
Unsigned short (ushort)	FF FF	65535 ($=2^{16}-1$)
Long	7F FF FF FF	2147483647 ($=2^{31}-1$)
Unsigned long (ulong)	FF FF FF FF	4294967295 ($=2^{32}-1$)
Float	FF FF FF FF	NaN
Double	FF FF FF FF FF FF FF FF	NaN

6 Appendix B: Glossary of Acronyms

AGC	automatic gain control
AutoConfig	auto configure
Aux	auxiliary
C/A	course acquisition
char	character
COM(1)	communications port 1
COM(2)	communications port 2
COM(3)	communications port 3
D	down
D/A	Digital-to-Analog
dB	decibels
DCM	direction cosine matrix
deg	degrees
deg/s	degrees/second
DGPS	differential global positioning system
double	double precision floating point
DSP	digital signal processor
E	East
FDIR	Fault Detection, Isolation, and Reconfiguration
float	floating-point precision
GPS	Global Positioning System
H/W	hardware
HDOP	Horizontal Dilution of Precision
Hz	Hertz
I/O	input and output
ICD	interface control document
IMU	Inertial Measurement Unit
IP	Internet Protocol
KF	Kalman filter
lat	latitude
long	longitude
LSB	least significant bit
m	metres
m/s	metres/second
m/s^2	metres/second/second
ms	millisecond
MSB	most significant bit
N	North
N/A	not applicable
NOP	No Operation
NVM	non-volatile Memory
PCS	POS Computer System
POS	Position and Orientation System

POSPAC	Applanix POSPAC post-processing software package
PPS	Pulse per Second
PRN	Pseudo Random Noise
RAM	random access memory
RF	radio frequency
RMS	root-mean-square
RTK	real-time kinematic
RX	receive data
sec	second
SV	space vehicle (GPS satellites)
TCP	Transmission Control Protocol
UDP	User Datagram Protocol
ulong	unsigned long
ushort	unsigned short
UTC	Universal Coordinated Time
VDOP	Vertical Dilution of Precision
wrt	with respect to