Commands and Logs Reference Book

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CLAP-B

Compact Size GNSS/INS

High Precision Integrated Navigation OEM Board

Revision History

Version	Revision History	Date
R1.0	Initial released revision	2020-03
P2.0.0	1.2.5 RAWIMU: update CLAB-B6 IMU info	2020-03

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Foreword

This document describes the reference commands and logs, receiver default configurations, and related usage examples of CLAP-B series products.

Audience

This manual is applied to the technical personnel, who possess the expertise of GNSS receivers and inertial integrated navigation systems.

Contents

1 Common Output Messages

This chapter describes the default common output commands of CLAP-B series products, refer to *Unicore Reference Commands Manual for High Precison GNSS Board and Module* for other more commands and details.

Table 1-1 COM1_RS232 Data Output (Baud Rate: 460800)

Output COM	Command	Format	Frequency
COM1	LOG COM1 GPGGA ONTIME 1	NMEA	1Hz
COM1	LOG COM1 GPGSA ONTIME 1	NMEA	1Hz
COM1	LOG COM1 GPRMC ONTIME 1	NMEA	1Hz
COM1	LOG COM1 GPHDT ONTIME 1	NMEA	1Hz
COM1	LOG COM1 GPGSV ONTIME 1	NMEA	1Hz
COM1	LOG COM1 INSPVAB ONTIME 0.01	Binary	100Hz
COM1	LOG COM1 BESTGNSSPOSB ONTIME 1	Binary	1Hz
COM1	LOG COM1 HEADINGB ONTIME 1	Binary	1Hz
COM1	LOG COM1 RAWIMUXB ONTIME 0.01	Binary	100Hz
COM1	LOG COM1 RANGEB ONTIME 1	Binary	1Hz
COM1	LOG COM1 RANGEB_1 ONTIME 1	Binary	1Hz
COM1	LOG COM1 GPSEPHEMB ONTIME 1800	Binary	1800s
COM1	LOG COM1 GLOEPHEMERISB ONTIME 1800	Binary	1800s
COM1	LOG COM1 BDSEPHEMERISB ONTIME 1800	Binary	1800s
COM1	LOG COM1 GALEPHEMERISB ONTIME 1800	Binary	1800s

Table 1-2 COM3 Data Input (Baud Rate: 115200)

COM	Data (Standard Input)	Format	Frequency
COM3	RTCM3.x	RTCM Binary	

Table 1-3 COM3 Data Output (Baud Rate: 115200)

Data Output Port	Output Data	Format	Frequency
COM3	LOG COM3 GPGGA ONTIME 1	NMEA0183	1Hz

Note: the above are only recommended configurations. COM1, COM2, and COM3 can be configured to output logs or receive differential data as required.

1.1 NMEA0183 Message Output

This chapter introduces NMEA0183 output, refer to *Unicore Reference Commands Manual for High Precison GNSS Board and Module* for details.

Command	Description	Remark
GPGGA	GNSS Integrated Navigation Data Output by GPGGA	When INS is enabled, GPGGA position could be calculated by joint positioning or standalone GNSS positioning or standalone INS positioning. The seventh field of GPGGA is the quality indicator. When GGA output frequency is higher than GNSS's, the update interval depends on the GNSS frequency. Which means that the output of 100Hz GPGGA is all GNSS marked if GNSS outputs at 5Hz and INS outputs at 100Hz. Only when the satellite loses lock longer than twice the 200ms of the GNSS cycle, that is, no GNSS signal received in 400ms, it is marked as 6. Otherwise, the combined mark is output based on the 1 , 2, 4, 5 of satellite navigation
GPGSA	DOP and active satellites	
GPRMC	GNSS recommended data	Position, velocity in RMC could be results of joint positioning or standalone GNSS positioning or standalone INS positioning when INS is enbled.
GPHDT	GNSS dual-antenna heading log	
GPHDT2	GNSS heading log between the master antenna and the base station	

1.2 Compatible Messages

CLAP-B series products comply with the following logs. Please refer to *Unicore Reference Commands Manual for High Precison GNSS Board and Module*for 32-bit CRC, detailed data structure and syntax.

Log	Description	Remark
INSPVA	INS position, velocity and attitude	
INSPVAS	Short INS position, velocity and attitude	
INSPVAX	Extended INS position, velocity and attitude	
BESTGNSSPOS	Best GNSS position	
BESTGNSSVEL	Best available GNSS velocity	
HEADING	Heading information	
RAWIMU	Raw IMU data	
RAWIMUS	Short raw IMU data	
RAWIMUSX	IMU data extended	
RAWIMUX	IMU data extended	Output frequency: 1Hz, 5Hz, 10Hz, 20Hz, 50Hz, 100Hz, maximum value: 100Hz
RANGE	Master antenna raw observations	
RANGEB_1	Slave antenna raw observations	
RAWEPHEM	Raw GPS ephemeris	
GPSEPHEM	GPS ephemeris	
GLOEPHEMERIS	GLONASS ephemeris	
BDSEPHEMERIS	BeiDou ephemeris	
GALEPHEMERIS	GALILEO ephemeris	

1.2.1 INSPVAS – Short INS Position, Velocity and Attitude

This log is the simplified outputs of INS.

Message ID: 508

Recommended Input:

LOG INSPVASA ONTIME 1

ASCII Example:

%INSPVASA,1264,144059.000; 1264,144059.002135700,51.116680071,-114.037929194,515.286704183,277.896368884, 84.915188605,-8.488207941,0.759619515,-2.892414901,6.179554750,INS_ALIGNMENT_COMPLETE *855d6f76

Table 1-4 INSPVAS Data Structure

ID	Field	Description	Format	Binary Bytes	Binary Offset
1	INSPVAS	Log header		H	0
2	Week	GNSS week	Ulong	4	H
3	Seconds	Seconds from week start	Double	8	H+4
4	Latitude	Latitude (WGS84) [degrees]	Double	8	H+12
5	Longitude	Longtitude (WGS84) [degrees]	Double	8	H+20
6	Height	Ellipsoidal height (WGS84) [m]	Double	8	H+28
7	North Velocity	Velocity in a northbound direction (a negative value implies a southerly direction) [m/s]	Double	8	H+36
8	East Velocity	Velocity in an eastbound direction (a negative value implies a westbound direction) [m/s]	Double	8	H+44
9	Up Velocity	Velocity in an up direction [m/s]	Double	8	H+52
10	Roll	Right-handed rotation from local level around y-axis in degrees	Double	8	H+60
11	Pitch	Right-handed rotation from local level around x-axis in degrees	Double	8	H+68

ID	Field	Description	Format	Binary Bytes	Binary Offset
12	Azimuth	Left-handed rotation around z-axis in degrees clockwise from north This is the inertial azimuth calculated from the IMU gyros and the SPAN filters.	Double	8	H+76
13	Status	INS Status, refer to Table 1-5 INS Solution Status	Enum	4	H+84
14	xxxx	32-bit CRC	Hex	4	H+88
15	[CR][LF]	Sentence Terminator (ASCII only)			

Table 1-5 INS Solution Status

Binary	Field	Description
0	INS_INACTIVE	IMU logs are present, but the alignment routine has not started; INS is inactive.
1	INS_ALIGNING	INS is in alignment mode.
2	INS_HIGH_VARIANCE	The INS solution is in navigation mode but the azimuth solution error has exceeded the threshold. The default threshold is 2 degrees for most IMUs. The solution is still valid but you should monitor the solution uncertainty in the INSSTDEV log. You may encounter this state during times when the GNSS, used to aid the INS, is absent.
3	INS_SOLUTION_GOOD	The INS solution is in navigation mode and the INS solution is good.
6	INS_SOLUTION_FREE	The INS solutionis in navigation mode and the GNSS solution is suspected to be erroneous. This may be due to multipath or limited satellite visibility. The intergrated filter has rejected the GNSS position and is waiting for the solution quality to improve.
7	INS_ALIGNMENT_COMPLETE	The INS filter is in navigation mode, but the vehicle has not performed enough required movement to complete the system calibration/setup.

Binary	Field	Description
8	DETERMINING_ORIENTATION	INS is determining the IMU axis aligned with gravity.
9	WAITING_INITIALPOS	The INS filter has determined the IMU orientation and is awaiting an initial position estimate to begin the alignment process.
10	WAITING_AZIMUTH	The INS filer has estimated the orientation, initial biases, initial position and valid roll/pitch. Will not proceed until initial azimuth is entered.
11	INITIALIZING_BIASES	The INS filter is estimating initial biases during the first 10 seconds of stationary data.
12	MOTION_DETECT	The INS filter has not completely aligned, but has detected motion.

1.2.2 INSPVAX – Extended INS Position, Velocity and Attitude

This log is used to output the integrated navigation results and deviations.

Message ID: 1465

Recommended Input:

LOG INSPVAXA ONTIME 1

ASCII Example:

#INSPVAXA,COM1,0,73.5,FINESTEERING,1695,309428.000,00000040,4e77,43562;
INS_SOLUTION_GOOD,INS_PSRSP,51.11637873403,-114.03825114994,1063.6093,-16.9000, -0.0845,-0.0464,-0.0127,0.138023492,0.069459386,90.000923268,0.9428,0.6688,1.4746,0.0430,0.0518,0.0521,0.944295466,0.944567084,1.000131845,3,0*e877c178

Table 1-6 INSPVAX Data Structure

ID	Field	Description	Format	Binary Bytes	Binary Offset
1	INSPVAX	Log header		H	0
2	INS Status	INS solution status, refer to Table 1-5 INS Solution Status	Enum	4	H
3	Pos Type	Position type, refer to Table 1-7 Position or Velocity Type	Enum	4	H+4

ID	Field	Description	Format	Binary Bytes	Binary Offset
4	Latitude	Lattitude (WGS84) [degrees]	Double	8	H+8
5	Longitude	Longtitude (WGS84) [degrees]	Double	8	H+16
6	Height	Height above mean sea level [m]	Double	8	H+24
7	Undulation	Undulation, the distance between the geoid and the WGS84 ellipsoid. The geoid is positive when it is above the ellipsoid, otherwise, it is negative [m]	Float	4	H+32
8	North Velocity	Velocity in a northbound direction (a negative value implies a southerly direction) [m/s]	Double	8	H+36
9	East Velocity	Velocity in an eastbound direction (a negative value implies a westbound direction) [m/s]	Double	8	H+44
10	Up Velocity	Velocity in an up direction [m/s]	Double	8	H+52
11	Roll	Right-handed rotation from local level around y-axis in degrees	Double	8	H+60
12	Pitch	Right-handed rotation from local level around x-axis in degrees	Double	8	H+68
13	Azimuth	Left-handed rotation around z-axis in degrees clockwise from north This is the inertial azimuth calculated from the IMU gyros and the SPAN filters.	Double	8	H+76
14	Latσ	Latitude standard deviation [m]	Float	4	H+84
15	Longσ	Longitude standard deviation [m]	Float	4	H+88
16	Heightσ	Height standard deviation [m]	Float	4	H+92
17	North Velσ	North velocity standard deviation [m/s]	Float	4	H+96
18	East Velσ	East velocity standard deviation [m/s]	Float	4	H+100
19	Up Velσ	Up velocity standard deviation [m/s]	Float	4	H+104
20	Rollσ	Roll standard deviation [degrees]	Float	4	H+108
21	Pitchσ	Pitch standard deviation [degrees]	Float	4	H+112

ID	Field	Description	Format	Binary Bytes	Binary Offset
22	Azimuthσ	Azimuth standard deviation [degrees]	Float	4	H+116
23	Ext sol stat	Extended solution statuse, refer to Table 1-8 Extended Solution Status	Hex	4	H+120
24	Time Since Update	Elapsed time since the last ZUPT or position update [seconds]	Ushort	2	H+124
25	xxxx	32-bit CRC	Hex	4	H+126
26	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

Table 1-7 Position or Velocity Type

Binary	Field	Description
0	NONE	No solution
1-51	Reserved	Reserved
52	INS	INS position solution
53	INS_PSRSP	Intergrated solution of INS and single point positioning – no DGPS correction
54	INS_PSRDIFF	Intergrated solution of INS and DGPS
55	INS_RTKFLOAT	Intergrated solution of INS and the RTK floating
56	INS_RTKFIXED	Intergrated solution of INS and the RTK fixed
57-74	Reserved	Reserved

Table 1-8 Extended Solution Status

Bit	Hex Mask	Description
0	0x00000001	Position update is used in the last update epoch
1	0x00000002	Phase update is used in the last update epoch
2	0x00000004	ZUPT update is used in the last update epoch
3	0x00000008	Odometer update is used in the last update epoch

Bit	Hex Mask	Description
4	0x00000010	Heading alignment (ALIGN) update is used in the last update epoch
5	0x00000020	Reserved
6	0x00000040	Convergence error estimates for inertial solutions
7	0x00000080 - 0x80000000	Reserved

1.2.3 BESTGNSSPOS – Best GNSS Position

This log contains the best available GNSS position (without INS) computed by the receiver. In addition, it reports several status indicators, including differential age, which is useful in predicting anomalous behavior brought about by outages in differential corrections. A differential age of 0 indicates that no differential correction was used.

With the system operating in an RTK mode, this log reflects the latest low latency solution for up to 60 seconds after reception of the last base station observations. After this 60 second period, the position reverts to the best solution available and the degradation in accuracy is reflected in the standard deviation fields. If the system is not operating in an RTK mode, pseudorange differential solutions continue for the time specified in the DGPS timeout command

Message ID: 1429

Recommended Input:

LOG BESTGNSSPOSA ONTIME 1

Table 1-9 BESTGNSSPOS Data Structure

ID	Field	Description	Format	Binary Bytes	Binary Offset
1	BESTGNSSPOS	Log header		H	0
2	Sol Status	Solution status, see Table 1-11 GNSS Solution Status	Enum	4	H
3	Pos Type	Position Type, see Table 1-10 GNSS Position or Velocity Type	Enum	4	H+4

ID	Field	Description	Format	Binary Bytes	Binary Offset
4	Latitude	Latitude [degrees]	Double	8	H+8
5	Longitude	Longtitude [degrees]	Double	8	H+16
6	Height	Height above mean sea level [m]	Double	8	H+24
7	Undulation	Undulation, the distance between the geoid and the WGS84 ellipsoid. The geoid is positive when it is above the ellipsoid, otherwise, it is negative [m]	Float	4	H+32
8	Datum ID	Coordinate type	ENUM	4	H+36
9	Lat σ	Latitude standard deviation [m]	Float	4	H+40
10	Lon σ	Longitude standard deviation [m]	Float	4	H+44
11	Hgt σ	Height standard deviation [m]	Float	4	H+48
12	Stn ID	Base station ID	Char[4]	4	H+52
13	Diff_age	Differential age [seconds]	Float	4	H+56
14	Sol_age	Solution age [seconds]	Float	4	H+60
15	#SVs	Number of satellites tracked	Uchar	1	H+64
16	#solnSVs	Number of satellite involved in positioning	Uchar	1	H+65
17	Reserved	Reserved	Uchar	1	H+66
18	Reserved	Reserved	Uchar	1	H+67
19	Reserved, PDOP*10 is used for now (which means that it needs to be multiplied by a scale factor of 0.1 when decoding)		Uchar	1	H+68
20	ext sol stat	Extended solution status	Hex	1	H+69
21	Galileo and BeiDou sig mask	Signal mask used in Galileo and BeiDou	Hex	1	H+70
22	GPS and GLONASS sig mask	Signal mask used in GPS and GLONASS	Hex	1	H+71
23	xxxx	32-bit CRC（ASCII and Binary only）	Hex	4	H+72
24	[CR][LF]	Sentence terminator (ASCII only)			

Table 1-10 GNSS Position or Velocity Type

Binary	ASCII	Description
0	NONE	No solution
1	FIXEDPOS	Position has been fixed by the FIX position command
2	FIXEDHEIGHT	Will be supported in the future
8	DOPPLER_VELOCITY	Velocity computed using instantaneous Doppler
16	SINGLE	Single point position
17	PSRDIFF	Pseudorange differential solution
18	SBAS	SBAS positioning
32	L1_FLOAT	Floating L1 ambiguity solution
33	IONOFREE_FLOAT	Floating ionosphere ambiguity solution
34	NARROW_FLOAT	Floating narrow-lane ambiguity solution
48	L1_INT	Integer L1 ambiguity solution
49	WIDE_INT	Integer wide-lane ambiguity solution
50	NARROW_INT	Integer narrow-lane ambiguity solution
52	INS	INS position solution
53	INS_PSRSP	Intergrated solution of INS and single point positioning – no DGPS correction
54	INS_PSRDIFF	Intergrated solution of INS and DGPS
55	INS_RTKFLOAT	Intergrated solution of INS and the RTK floating
56	INS_RTKFIXED	Intergrated solution of INS and the RTK fixed

Table 1-11 GNSS Solution Status

Solution Status		Description
0	SOL_COMPUTED	Solution computed
1	INSUFFICIENT_OBS	Insufficient observations
2	NO_CONVERGENCE	No convergence
4	COV_TRACE	Covariance trace exceeds maximum (trace > 1000 m)

1.2.4 BESTGNSSVEL – Best GNSS Velocity

This log contains the best available GNSS velocity (without INS) computed by the receiver. In addition, it reports velocity status indicators, which is of great use for indicating the validity of corresponding data. The speed measurement sometimes causes related latency.

Message ID: 1430

Recommended Input:

LOG BESTGNSSVELA ONTIME 1

LOG Message Output:

#BESTGNSSVELA,COM1,0,61.0,FINE,1337,334167.000,00000000,827B,1984;SOL_COMPUTED,PSRDIFF,0250,4.000,0.0206,227.712486,0.0493,0.0*0E68BF05

Table 1-12 BESTGNSSVEL Data Structure

ID	Field	Description	Format	Binary Bytes	Binary Offset
1	BESTGNSSVEL header	Log header		H	0
2	sol status	Solution status, see Table 1-11 GNSS Solution Status	Enum	4	H
3	vel type	Velocity Type, see Table 1-10 GNSS Position or Velocity Type	Enum	4	H+4
4	latency	The value of the latency calculated from the speed time scale. Subtracting it from the epoch time will provide more accurate result.	Float	4	H+8
5	age	Differential age, s	Float	4	H+12
6	hor spd	Horizontal speed over ground, m/s	Double	8	H+16
7	trk gnd	Actual direction of motion over ground (track over ground) with respect to True North, deg	Double	8	H+24
8	vert spd	Vertical speed, m/s. Where positive values indicate increasing altitude (up) and negative values indicate decreasing altitude (down)	Double	8	H+32
9	Reserved	Reserved	UINT	4	H+40
10	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+44

ID	Field	Description	Format	Binary Bytes	Binary Offset
11	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

1.2.5 RAWIMU – Raw IMU Data

This log contains an IMU status indicator and the measurements from the accelerometers and gyros with respect to the IMU enclosure frame. Output frequency could be configured as 1Hz, 5Hz, 10Hz, 20Hz, 50Hz and 100Hz. The maximum value is 100Hz.

Note: for CLAP-B7, multiply the value of accelerometer measurement field by the scale factor listed in Table 1-14 Raw IMU Scale Factor to get the velocity increment in 10s. If the accelerated velocity in m/s^2 is required, multiply the velocity increment of IMU by 100; Multiply the value of gyro measurement field by the scale factor listed in Table 1-14 Raw IMU Scale Factor to get the angle increment in 10s. If the angular velocity in deg/s is required, multiply the angle increment of IMU by 100.

For CLAP-B6, multiply the value of accelerometer measurement field by the scale factor listed in Table 1-14 Raw IMU Scale Factor to get the accelerated velocity in mG. If the accelerated velocity in m/s^2 is required, multiply by 0.0098065 ($1mG=0.0098065m/s^2$) ; Multiply the value of gyro measurement field by the scale factor listed in Table 1-14 Raw IMU Scale Factor to get the angular velocity in deg/s.

Message ID: 268

Recommended Input:

log rawimua ontime 0.01

ASCII Example:

#RAWIMUA,COM1,0,68.5,FINESTEERING,1724,219418.009,004c0040,6125,30019;1724,219418.008755000,00000077,64732,56,298,8,28,-3*7378486f

Table 1-13 RAWIMU Data Structure

ID	Field	Description	Format	Binary Bytes	Binary Offset
1	RAWIMU header	Log header	-	H	0
2	Week	GNSS week	Ulong	4	H
3	Seconds Into Week	Seconds from week start	Double	8	H+4
4	IMU Status	IMU status. This field is given in a fixed length (n) array of bytes in binary, but in ASCII or Abbreviated ASCII is converted into 2-character hexadecimal pairs. See Table 1-16 IMU Status for raw IMU status.	Hex Ulong	4	H+12
5	Z Accel Output	Accelerometer measurement changes along Z axis. See Table 1-14 Raw IMU Scale Factor for the accelerometer measurement scale factor of each IMU type.	Long	4	H+16
6	- (Y Accel Output)	- (Accelerometer measurement changes along Y axis). See Table 1-14 Raw IMU Scale Factor for the accelerometer measurement scale factor of each IMU type. A negative value implies the output is along the positive y-axis marked on the IMU. A positive value implies the change is in the direction opposite to that of the y-axis marked on the IMU.	Long	4	H+20
7	X Accel Output	Accelerometer measurement changes along X axis. See Table 1-14 Raw IMU Scale Factor for the accelerometer measurement scale factor of each IMU type.	Long	4	H+24

ID	Field	Description	Format	Binary Bytes	Binary Offset
8	Z Gyro Output	Gyro measurement changes along Z axis, right-handed. See Table 1-14 Raw IMU Scale Factor for the gyro measurement scale factor of each IMU type.	Long	4	H+28
9	- (Y Gyro Output)	- (Gyro measurement changes along Y axis). See Table 1-14 Raw IMU Scale Factor for the gyro measurement scale factor of each IMU type. A negative value implies the output is along the positive y-axis marked on the IMU. A positive value implies the change is in the direction opposite to that of the y-axis marked on the IMU.	Long	4	H+32
10	X Gyro Output	Gyro measurement changes along X axis, right-handed. See Table 1-14 Raw IMU Scale Factor for the gyro measurement scale factor of each IMU type.	Long	4	H+36
11	xxxx	32-bit CRC	Hex	4	H+40
12	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

Table 1-14 Raw IMU Scale Factor

IMU	Gyro Scale Factor	Accelerometer Scale Factor
ADIS16470	$2160/2^{31}$ deg/LSB	$400/2^{31}$ m/s/LSB
EPSON G365	0.0151515/2^16 deg/s/LSB	$0.4/2^{16}$ mG/LSB

Table 1-15 IMU Type

ID	Field	Description
0	UNKNOWN	Unknown IMU type (default)
74	ADIS16470	Analog Devices ADIS16470

ID	Field	Description
82	EPSONG365	EPSON G365

Table 1-16 IMU Status

Nibble	Bit	Mask	Description	Range Value
N0	0	0x00000001	Alarm Status Flag	
	1	0x00000002	Reserved	
	2	0x00000004		
	3	0x00000008	SPI Communication Error	0 = Passed, 1 = Failed
N1	4	0x00000010	Sensor Over-Range	0 = Passed, 1 = One of more sensors over-ranged
	5	0x00000020	Initial Self Test Failure	0 = Passed, 1= Failed
	6	0x00000040	Flash Memory Failure	0 = Passed, 1 = Failed
	7	0x00000080	Processing Overrun	0 = Passed, 1 = Failed
N2	8	0x00000100	Self Test Failure – X-axis gyro	0 = Passed, 1 = Failed
	9	0x00000200	Self Test Failure – Y-axis gyro	0 = Passed, 1 = Failed
	10	0x00000400	Self Test Failure – Z-axis gyro	0 = Passed, 1 = Failed
	11	0x00000800	Self Test Failure – X-axis accelerometer	0 = Passed, 1 = Failed
N3	12	0x00001000	Self Test Failure – Y-axis accelerometer	0 = Passed, 1 = Failed
	13	0x00002000	Self Test Failure – Z-axis accelerometer	0 = Passed, 1 = Failed
	14	0x00004000	Reserved	
	15	0x00008000		
N4	16	0x00010000	IMU temperature: Signed 2-byte value (SHORT) ADIS16470: 0°C = 0x0000 1 LSB = 0.1 ºC	
	17	0x00020000		
	18	0x00040000		
	19	0x00080000		
N5	20	0x00100000	EPSONG365： 35°C = 0x0000 T[°C]=SF*(A-2634)+25;	
	21	0x00200000		
	22	0x00400000		

Nibble	Bit	Mask	Description	Range Value
	23	0x00800000	SF= -0.0037918 A indicates the temperature sensor output (to decimal)	
N6	24	0x01000000		
	25	0x02000000		
	26	0x04000000		
	27	0x08000000		
N7	28	0x10000000		
	29	0x20000000		
	30	0x40000000		
	31	0x80000000		

1.2.6 RAWIMUS – Short Raw IMU Data

This log is the short header version of the RAWIMU log. Output frequency could be configured as 1Hz, 5Hz, 10Hz, 20Hz, 50Hz and 100Hz. The maximum value is 100Hz.

Message ID: 325

Recommended Input:

log rawimusa ontime 0.01

ASCII Example:

%RAWIMUSA,1105,425384.180;1105,425384.156166800,111607,43088060,430312, -3033352,-132863,186983,823*5aa97065

Table 1-17 RAWIMUS Data Structure

ID	Field	Description	Format	Binary Bytes	Binary Offset
1	RAWIMUS header	Log header	-	H	0
2	Week	GNSS week	Ulong	4	H
3	Seconds Into Week	Seconds from week start	Double	8	H+4
4	IMU Status	IMU status. This field is given in a fixed length (n) array of bytes	Hex Ulong	4	H+12

ID	Field	Description	Format	Binary Bytes	Binary Offset
		in binary, but in ASCII or Abbreviated ASCII is converted into 2-character hexadecimal pairs. See Table 1-16 IMU Status for raw IMU status.			
5	Z Accel Output	Accelerometer measurement changes along Z axis. See Table 1-14 Raw IMU Scale Factor for the accelerometer measurement scale factor of each IMU type.	Long	4	H+16
6	- (Y Accel Output)	- (Accelerometer measurement changes along Y axis). See Table 1-14 Raw IMU Scale Factor for the accelerometer measurement scale factor of each IMU type. A negative value implies the output is along the positive y-axis marked on the IMU. A positive value implies the change is in the direction opposite to that of the y-axis marked on the IMU.	Long	4	H+20
7	X Accel Output	Accelerometer measurement changes along X axis. See Table 1-14 Raw IMU Scale Factor for the accelerometer measurement scale factor of each IMU type.	Long	4	H+24
8	Z Gyro Output	Gyro measurement changes along Z axis, right-handed. See Table 1-14 Raw IMU Scale Factor for the gyro measurement scale factor of each IMU type.	Long	4	H+28
9	- (Y Gyro Output)	- (Gyro measurement changes along Y axis). See Table 1-14 Raw IMU Scale Factor for the gyro measurement scale factor of each IMU type. A negative value implies the	Long	4	H+32

ID	Field	Description	Format	Binary Bytes	Binary Offset
		output is along the positive y-axis marked on the IMU. A positive value implies the change is in the direction opposite to that of the y-axis marked on the IMU.			
10	X Gyro Output	Gyro measurement changes along X axis, right-handed. See Table 1-14 Raw IMU Scale Factor for the gyro measurement scale factor of each IMU type.	Long	4	H+36
11	xxxx	32-bit CRC	Hex	4	H+40
12	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

1.2.7 RAWIMUSX – Extended Raw IMU Data

This is the short header version of the extended RAWIMUX log intended for use with post-processing. Output frequency could be configured as 1Hz, 5Hz, 10Hz, 20Hz, 50Hz and 100Hz. The maximum value is 100Hz.

Message ID: 1462

Recommended Input:

log rawimusxb ontime 0.01

ASCII Example:

%RAWIMUSXA,1692,484620.664;00,11,1692,484620.664389000,00801503,43110635,-817242, -202184,-215194,-41188,-9895*a5db8c7b

Table 1-18 RAWIMUSX

ID	Field	Description	Format	Binary Bytes	Binary Offset
1	RAWIMUSX header	Log header	-	H	0

ID	Field	Description	Format	Binary Bytes	Binary Offset
2	IMU Error	Symplified IMU error tag 01- an IMU error occurs 00 - IMU works normally If an IMU error occurrs, check the IMU status data field, and the output of the data field is hex.	Uchar	1	H
3	IMU Type	IMU Type identifier, refer to Table 1-15 IMU Type.	Uchar	1	H+1
4	Week	GNSS week	Ushort	2	H+2
5	Seconds Into Week	Seconds from week start	Double	8	H+4
6	IMU Status	IMU status. This field is given in a fixed length (n) array of bytes, in binary but in ASCII or Abbreviated ASCII is converted into 2-character hexadecimal pairs. See Table 1-16 IMU Status for raw IMU status.	Hex Ulong	4	H+12
7	Z Accel Output	Accelerometer measurement changes along Z axis. See Table 1-14 Raw IMU Scale Factor for the accelerometer measurement scale factor of each IMU type.	Long	4	H+16
8	- (Y Accel Output)	- (Accelerometer measurement changes along Y axis). See Table 1-14 Raw IMU Scale Factor for the accelerometer measurement scale factor of each IMU type. A negative value implies the output is along the positive y-axis marked on the IMU. A positive value implies the change is in the direction opposite to that of the y-axis marked on the IMU.	Long	4	H+20
9	X Accel Output	Accelerometer measurement changes along X axis. See Table 1-14 Raw IMU Scale Factor for the accelerometer measurement scale factor of each IMU type.	Long	4	H+24

ID	Field	Description	Format	Binary Bytes	Binary Offset
10	Z Gyro Output	Gyro measurement changes along Z axis, right-handed. See Table 1-14 Raw IMU Scale Factor for the gyro measurement scale factor of each IMU type.	Long	4	H+28
11	- (Y Gyro Output)	- (Gyro measurement changes along Y axis). See Table 1-14 Raw IMU Scale Factor for the gyro measurement scale factor of each IMU type. A negative value implies the output is along the positive y-axis marked on the IMU. A positive value implies the change is in the direction opposite to that of the y-axis marked on the IMU.	Long	4	H+32
12	X Gyro Output	Gyro measurement changes along X axis, right-handed. See Table 1-14 Raw IMU Scale Factor for the gyro measurement scale factor of each IMU type.	Long	4	H+36
13	xxxx	32-bit CRC	Hex	4	H+40
14	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

1.2.8 RANGE – Original Observations

The RANGE log contains the channel measurements for the currently tracked satellites. For the products of single board with dual-antenna, this log is corresponding to the measurements of moving base station (antenna A).

If multiple signals are being tracked for a given PRN, the measurement with the same PRN appears in the RANGE logs. These measurements can be differentiated by bits 21-25 of channel tracking status.

Message ID: 43

Recommended Input:

LOG RANGEA ONTIME 1

Table 1-19 RANGE Data Structure

ID	Field	Description	Format	Binary Bytes	Binary Offset
1	RANGE header	Log header		H	0
2	# obs	Observations number	Long	4	H
3	PRN/ slot	Satellite PRN number (GPS: 1 to 32; GLONASS: 38 to 61; BDS 1 to 63; Galileo 1 to 38; SBAS 120 to 141, 183 to 187, QZSS: 193 to 197)	UShort	2	H+4
4	glofreq	(GLONASS Frequency + 7), GPS, BDS and Galileo are not supported.	Ushort	2	H+6
5	psr	Pseudorange measurement (m)	Double	8	H+8
6	psr std	Pseudorange measurement standard deviation (m)	Float	4	H+16
7	adr	Carrier phase, in cycles (accumulated Doppler range)	Double	8	H+20
8	adr std	Estimated carrier phase standard deviation (cycles)	Float	4	H+28
9	dopp	Instantaneous Doppler frequency (Hz)	Float	4	H+32
10	C/No	Carrier to noise density ratio C/No=10[log10(S/N0)] (dB-Hz)	Float	4	H+36
11	locktime	Number of seconds of continuous tracking (no cycle slipping)	Float	4	H+40
12	ch-tr-status	Tracking status, refer to Table 1-21 Channel Tracking Status	Ug	4	H
13…	Next PRN offset = H + 4 + (#obs x 44)				
variable	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+4+ (#obs x 44)
variable	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

Table 1-20 Tracking State

State	Description	State	Description
0	Reserved	7	Reserved
1	Reserved	8	Reserved

State	Description	State	Description
2	Reserved	9	Reserved
3	Reserved	10	Reserved
4	L1 phase-locked loop	11	L2 phase-locked loop
5	Reserved	19	Reserved
6	Reserved		

Table 1-21 Channel Tracking Status

Nibble #	Bit #	Mask	Description	Range Value
N0	0	0x00000001	Reserved	
	1	0x00000002		
	2	0x00000004		
	3	0x00000008		
N1	4	0x00000010		
	5	0x00000020	SVchannel number	0-n (0 = first, n = last) n depends on the receiver
	6	0x00000040		
	7	0x00000080		
N2	8	0x00000100		
	9	0x00000200		
	10	0x00000400	Phase lock flag	0 = Not locked, 1 = locked
	11	0x00000800	Reserved	
N3	12	0x00001000	Code locked flag	0 = Not locked, 1 = locked
	13	0x00002000	Reserved	
	14	0x00004000		
	15	0x00008000		
N4	16	0x00010000	Satellite system	0 = GPS 1 = GLONASS 2 = SBAS 3 = GAL 4 = BDS 5 = QZSS 6-7 = Reserved
	17	0x00020000		
	18	0x00040000		
	19	0x00080000	Reserved	

Nibble #	Bit #	Mask	Description	Range Value
N5	20	0x00100000	Reserved	
	21	0x00200000	Signal type	Depend on the supported satellite system: GPS: 0 = L1 C/A 9 = L2P (Y) 3 = L1C pilot 11 = L1C data semicodeless 6 = L5 data 14 = L5 pilot 17 = L2C (L) GLONASS: 0 = L1 C/A 5 = L2 C/A QZSS: 0 = L1 C/A 6 = L5 data 14 = L5 pilot 17 = L2C (L) 27 = L2C (L) BDS: 0 = B1I 4 = B1Q 8 = B1C 5 = B2Q 17 = B2I 12 = B2A 6 = B3Q 21 = B3I GAL: 1 = E1B 2 = E1C 12 = E5A pilot 17 = E5B pilot SBAS: 0 = L1 C/A 6 = L5 (I)
	22	0x00400000		
	23	0x00800000		
N6	24	0x01000000		
	25	0x02000000		
	26	0x04000000	Reserved	
	27	0x08000000	Reserved	
N7	28	0x10000000	Reserved	
	29	Reserved	Reserved	
	30	0x40000000	Reserved	
	31	0x80000000	Reserved	

a. Grouping: each channel has a channel associated with it (L1/L2 or B1/B2/B3 grouped)

1.2.9 RANGEB_1 – Raw Observations

RANGEB_1 includes the tracked channel measurements of the single board product with dual-antenna (ANT2), RANGEB and RANGEB_1 differ by “Message Type” in the log header. RANGEA and RANGEA_1 are ASCII logs, and can be identified by log header.

If multiple signals are being tracked for a given PRN, the measurement with the same PRN appears in the RANGE logs. These measurements can be differentiated by bits 21-25 of channel tracking status.

Message ID: 43

Recommended Input:

LOG RANGEA_1 ONTIME 1

Table 1-22 RANGEB_1 Data Structure

ID	Field	Description	Format	Binary Bytes	Binary Offset
1	RANGE_1 H header	Log header		H	0
2	# obs	Observations number	Long	4	H
3	PRN/ slot	Satellite PRN number (GPS: 1 to 32; GLONASS: 38 to 61; BD2 1 to 37; SBAS 120 to 141, 183 to 187, QZSS: 193 to 197)	UShort	2	H+4
4	glofreq	(GLONASS Frequency + 7), GPS and BD2 are not supported.	Ushort	2	H+6
5	psr	Pseudorange measurement (m)	Double	8	H+8
6	psr std	Pseudorange measurement standard deviation (m)	Float	4	H+16
7	adr	Carrier phase, in cycles (accumulated Doppler range)	Double	8	H+20
8	adr std	Estimated carrier phase standard deviation (cycles)	Float	4	H+28
9	dopp	Instantaneous Doppler frequency (Hz)	Float	4	H+32
10	C/No	Carrier to noise density ratio C/No = 10[log10(S/N0)] (dB-Hz)	Float	4	H+36
11	locktime	Number of seconds of continuous tracking (no cycle slipping)	Float	4	H+40
12	ch-tr-status	Tracking status, refer to Table 1-21 Channel Tracking Status	Ug	4	H
13…	Next PRN offset = H + 4 + (#obs x 44)				
variable	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+4+ (#obs x 44)
variable	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

1.2.10 RAWEPHEM – GPS Ephemeris

This log contains the raw binary information for subframes one, two and three from the GPS satellite L1 C/A signal with the parity information removed. Each subframe is 240 bits long (10 words-24 bits each) and the log contains a total 720 bits (90 bytes) of information (240 bits x 3 subframes). This information is preceded by the PRN number of the satellite from which it originated. This message is not generated unless all 10 words from all 3 frames have passed parity.

Ephemeris data which Time of Ephemeris (TOE) is older than six hours is not shown. Multiple logs are output, one for each GPS satellite with collected ephemeris information.

Message ID: 41

Recommende Input:

LOG RAWEPHEMA ONCHANGED

Table 1-23 RAWEPGEMB Data Structure

ID	Field	Description	Format	Binary Bytes	Binary Offset
1	RAWEPHEM header	Log header		H	0
2	prn	Satellite PRN number	Ulong	4	H
3	ref week	Ephemeris reference week number	Ulong	4	H+4
4	ref secs	Ephemeris reference time (s)	Ulong	4	H+8
5	subframe1	Subframe 1 data	Hex[30]	30	H+12
6	subframe2	Subframe 2 data	Hex[30]	30	H+42
7	subframe3	Subframe 3 data	Hex[30]	30	H+72
8	xxxx	32-bit CRC (ASCII and Binary only)	Hex	4	H+102
9	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

1.2.11 BDSEPHEMERIS – BDS Ephemeris

This log contains a single set of BDS ephemeris.

Message ID: 1696

Recommended Input:

LOG BDSEPHEMERISA ONCHANGED

LOG Message Output

#BDSEPHEMERISA,COM1,0,28.0,FINE,2088,118200.000,0,8956911,18;1,732,4.00000000e+00,0,1.420000000e-08,-1.040000000e-08,0,115200,3.75381e-04,4.52793e-11,0.00000e+00,1,115200,6.493313566e+03,2.5114254095e-04,2.3302537942e+00,-4.423041380e-09,-2.890949259e+00,-1.162821899e+00,5.61630537e-09,1.0751907920e-01,-3.535861569e-11,7.695984095e-06,-2.247467637e-05,6.79265625e+02,2.36703125e+02,6.984919310e-09,-1.168809831e-07*d28d8e24

Table 1-24 BDSEPHEMERIS Data Structure

ID	Field	Description	Format	Binary Bytes	Binary Offset
1	BDSEPHEMERIS header	Log header		H	0
2	PRN	Satellite PRN (BD2 1 to 37)	Ulong	4	H
3	Week	Week	Ulong	4	H+4
4	URA	User range accuracy (meters). An algorithm is introduced in ICD to convert the URA index transmitted in the raw ephemeris to a nominal standard deviation.	Double	8	H+8
5	Health1	Autonomous satellite health flag. 0 means broadcasting satellite is functioning fine and 1 means not.	Ulong	4	H+16
6	tgd1	Equipment group delay differential for the B1 signal (seconds)	Double	8	H+20

ID	Field	Description	Format	Binary Bytes	Binary Offset
7	tgd2	Equipment group delay differential for the B2 signal (seconds)	Double	8	H+28
8	AODC	Age of data, clock	Ulong	4	H+36
9	Toc	Reference time of clock parameters	Ulong	4	H+40
10	af0	Parameters of satellite clock bias, s	Double	8	H+44
11	af1	Parameters of satellite clock rate, s/s	Double	8	H+52
12	af2	Parameters of satellite clock drift, s/s/s	Double	8	H+60
13	AODE	Age of data, ephemeris	Ulong	4	H+68
14	Toe	Reference time of ephemeris parameters * (seconds from week start of BDS clock), s	Ulong	4	H+72
15	RootA	Square root of semi-major axis , sqrt(m)	Double	8	H+76
16	Ecc	Eccentricity	Double	8	H+84
17	ω	Argument of perigee, rad	Double	8	H+92
18	ΔN	Correction value of satellite average angular velocity, rad/s	Double	8	H+100
19	M0	Mean anomaly at reference time, rad	Double	8	H+108
20	Ω0	Longitude of ascending node of orbital, rad	Double	8	H+116
21	Ω dot	Longitude rate of ascending node of orbital, rad/s	Double	8	H+124
22	I0	Inclination angle at reference time, rad	Double	8	H+132
23	IDOT	inclination angle rate, rad/s	Double	8	H+140
24	Cuc	Latitude argument (cosine amplitude, rad)	Double	8	H+148
25	Cus	Latitude argument (sine amplitude, rad)	Double	8	H+156
26	crc	Orbit radius (cosine amplitude, m)	Double	8	H+164

ID	Field	Description	Format	Binary Bytes	Binary Offset
27	crs	Orbit radius (sine amplitude, m)	Double	8	H+172
28	cic	inclination (cosine amplitude, rad)	Double	8	H+180
29	cis	inclination (sine amplitude, rad)	Double	8	H+188
30	xxxx	32-bit CRC (ASCII and Binary only)	Ulong	4	H+196
31	[CR][LF]	Sentence terminator (ASCII only)	-	-	-

1.3 CLAP-B Self-Defined Messages

1.3.1 CLAP-B Self-Defined Message Structure

The self-defined log structure of CLAP-B series products is shown in the following table.

Table 1-25 Unicore ASCII and Binary Log Structure

No	Struct	Description
1	Header	All Unicore message formats have header messages, see Table 1-27 Binary Message Format Header Structure. Three Sync bytes in Header messages, with the total of 24 bytes of header information. Refer to Table 1-26 Binary Message Structure Header Sync Byte for details. Always check the header length when proceeding binary analysis.
2	Data	Data volume. The length of data volumn depends on the message types. Refer to the corresponding message types for details.
3	CRC	Unicore message formats end in 32 bits CRC. Every ASCII or Binary log message contains CRC bits; CRC for ASCII format can be used for all data except the # in the header

Table 1-26 Binary Message Structure Header Sync Byte

Byte	Hex	Decimal
First	0xAA	170
Second	0x44	68
Third	0xB5	181

Table 1-27 Binary Message Format Header Structure

ID	Field	Type	Description	Binary Bytes	Binary Offset
1	Sync	Uchar	Hexadecimal 0xAA	1	0
2	Sync	Uchar	Hexadecimal 0x44	1	1
3	Sync	Uchar	Hexadecimal 0xB5	1	2

ID	Field	Type	Description	Binary Bytes	Binary Offset
4	CPUIDle	Uchar	CPUIDle 0-100	1	3
5	Message ID	Ushort	Message ID	2	4
6	MessageLength	Ushort	Message Length	2	6
7	TimeRef	UChar	Reference time (GPST or BDST)	1	8
8	TimeStatus	Uchar	Time Status	1	9
9	Wn	Ushort	Reference week number	2	10
10	Ms	ULONG	GPS seconds from the beginning of the reference week, accurate to the millisecond	4	12
11	Res	ULONG	Reserved	4	16
12	Version	uchar	Release version	1	20
13	Leap sec	Uchar		1	21
14	DelayMs	Ushort	Output delay time	2	22

Table 1-28 ASCII Header Structure

ID	Field	Type	Description
1	Sync	Char	Sync character. The ASCII message always starts with the “#” character
2	Message	Char	The ASCII name of the log or command of this manual
3	CPUIDle	Uchar	The minimum percentage of time that the processor is idle, calculated once per second
4	TimeRef	Uchar	Reference time of GPS or BDS
5	TimeStatus	Uchar	GPS time quality. The current value is Unknown or Fine, the former indicates that the receiver has not yet calculated the accurate GPS time.
6	Wn	Ushort	GPS reference week number
7	Ms	ulong	GPS seconds from the beginning of the reference week, accurate to the millisecond
8	res	ulong	Reserved
9	version	uchar	Reserved field for Unicore version number

ID	Field	Type	Description
10	Leap sec	uchar	Leap seconds
11	Output Delay	Ushort	Output delay time (Time difference between data output and GNSS satellite signal sampling), μs

1.3.2 CLAP-B Self-Defined Integrated Result Messages

This command outputs integrated position, velocity, attitude and estimate error of CLAP-B series products, and log header is INTERESULT. The header is "#INTERESULTA" in ASCII meassges.

Note: for CLAP-B7, multiply the value of accelerometer measurement field by the scale factor listed in Table 1-14 Raw IMU Scale Factor to get the velocity increment in 10s. If the accelerated velocity in m/s^2 is required, multiply the velocity increment of IMU by 100; multiply the value of gyro measurement field by the scale factor listed in Table 1-14 Raw IMU Scale Factor to get the angle increment in 10s. If the angular velocity in deg/s is required, multiply the angle increment of IMU by 100.

For CLAP-B6, multiply the value of accelerometer measurement field by the scale factor listed in Table 1-14 Raw IMU Scale Factor to get the accelerated velocity in mG. If the accelerated velocity in m/s^2 is required, multiply by 0.0098065 ($1mG=0.0098065m/s^2$); Multiply the value of gyro measurement field by the scale factor listed in Table 1-14 Raw IMU Scale Factor to get the angular velocity in deg/s.

Abbservied ASCII Syntax:

LOG INTERESULTB ONTIME 0.01

Abbservied BINARY Syntax:

LOG INTERESULTA ONTIME 0.01

Message ID: 16000

Table 1-29 CLAP_B Self-defined Message

No	Field	Description	Format	Binary Bytes	Remark
1	header	Log header	-	H=24	See Log Header
2	INS Status	INS solution status, refer to Table 1-5 INS Solution Status	Enum	4	H
3	Pos Type	Position type, refer to Table 1-7 Position or Velocity Type	Enum	4	H+4
4	Latitude	Lattitude (WGS84) [degrees]	Double	8	H+8
5	Longitude	Longtitude (WGS84) [degrees]	Double	8	H+16
6	Height	Ellipsoidal height (WGS84) [m]	Double	8	H+24
7	Undulation	Undulation, the distance between the geoid and the WGS84 ellipsoid. The geoid is positive when it is above the ellipsoid, otherwise, it is negative [m]	Float	4	H+32
8	North Velocity	Velocity in a northbound direction (a negative value implies a southerly direction) [m/s]	Double	8	H+36
9	East Velocity	Velocity in an eastbound direction (a negative value implies a westbound direction) [m/s]	Double	8	H+44
10	Up Velocity	Velocity in an up direction [m/s]	Double	8	H+52
11	Roll	Right-handed rotation from local level around y-axis in degrees	Double	8	H+60

No	Field	Description	Format	Binary Bytes	Remark
12	Pitch	Right-handed rotation from local level around x-axis in degrees	Double	8	H+68
13	Azimuth	Left-handed rotation around z-axis in degrees clockwise from north This is the inertial azimuth calculated from the IMU gyros and the SPAN filters.	Double	8	H+76
14	Latσ	Latitude standard deviation [m]	Float	4	H+84
15	Longσ	Longitude standard deviation [m]	Float	4	H+88
16	Heightσ	Height standard deviation [m]	Float	4	H+92
17	North Velσ	North velocity standard deviation [m/s]	Float	4	H+96
18	East Velσ	East velocity standard deviation [m/s]	Float	4	H+100
19	Up Velσ	Up velocity standard deviation [m/s]	Float	4	H+104
20	Rollσ	Roll standard deviation [degrees]	Float	4	H+108
21	Pitchσ	Pitch standard deviation [degrees]	Float	4	H+112
22	Azimuthσ	Azimuth standard deviation [degrees]	Float	4	H+116
23	Ext sol stat	Extended solution statuse, refer to Table 1-8 Extended Solution Status	Hex	4	H+120
24	Time Since Update	Elapsed time since the last ZUPT or position update [seconds]	Ushort	2	H+124

No	Field	Description	Format	Binary Bytes	Remark
25	IMU Error	Symplified IMU error tag 01-an IMU error occurs 00-IMU works normally If an IMU error occurs, check the IMU status data field, and the output of the data field is hex	Uchar	1	H+126
26	IMU Type	IMU Type identifier, refer to Table 1-15 IMU Type	Uchar	1	H+127
27	Z Accel Output	Accelerometer measurement changes along Z axis. See Table 1-14 Raw IMU Scale Factor for the accelerometer measurement scale factor of each IMU type.	Long	4	H+128
28	- (Y Accel Output)	- (Accelerometer measurement changes along Y axis). See Table 1-14 Raw IMU Scale Factor for the accelerometer measurement scale factor of each IMU type. A negative value implies the output is along the positive y-axis marked on the IMU. A positive value implies the change is in the direction opposite to that of the y-axis marked on the IMU.	Long	4	H+132
29	X Accel Output	Accelerometer measurement changes along X axis. See Table 1-14 Raw IMU Scale Factor for the accelerometer measurement scale factor of each IMU type.	Long	4	H+136

No	Field	Description	Format	Binary Bytes	Remark
30	Z Gyro Output	Gyro measurement changes along Z axis, right-handed. See Table 1-14 Raw IMU Scale Factor for the gyro measurement scale factor of each IMU type.	Long	4	H+140
31	- (Y Gyro Output)	- (Gyro measurement changes along Y axis). See Table 1-14 Raw IMU Scale Factor for the gyro measurement scale factor of each IMU type. A negative value implies the output is along the positive y-axis marked on the IMU. A positive value implies the change is in the direction opposite to that of the y-axis marked on the IMU.	Long	4	H+144
32	X Gyro Output	Gyro measurement changes along X axis, right-handed. See Table 1-14 Raw IMU Scale Factor for the gyro measurement scale factor of each IMU type.	Long	4	H+148
33	GPS_SatNUM	Number of GPS satellites involved in positioning	Uchar	1	H+152
34	BD_SatNUM	Number of BD satellites involved in positioning	Uchar	1	H+153
35	GLO_SatNUM	Number of GLONASS satellites involved in positioning	Uchar	1	H+154
36	GAL_SatNUM	Number of Galileo satellites involved in positioning	Uchar	1	H+155

No	Field	Description	Format	Binary Bytes	Remark
37	RTK_Delay	Differential delay in seconds. Output 0 when no difference is made)	Float	4	H+156
38	GDOP	GDOP	Float	4	H+160
39	Remain_float_1	Reserved	Float	4	H+164
40	Remain_float_2	Reserved	Float	4	H+168
41	Remain_ double_1	Reserved	Double	8	H+172
42	Remain_char_1	Reserved	uchar	1	H+180
43	Remain_char_2	Reserved	uchar	1	H+181
44	Remain_char_3	Reserved	uchar	1	H+182
45	Remain_char_4	Reserved	uchar	1	H+183
46	xxxx	32-bit CRC	HEX	4	H+184
47	[CR][LF]	Sentence terminator (ASCII only)	-		-

1.4 Instructions for High-Precision Products Reference Commands

1.4.1 Scope

For other setting instructions, please refer to *Unicore Reference Commands Manual for High Precison GNSS Board and Module*. The functions of base station, moving base station, Heading2 and standalone positioning of the slave antenna require custom authorization before use. The general version of CLAP-B does not include these four functions. That is, *Unicore Reference Commands Manual for High Precison GNSS Board and Module* is exclusive of the above four commands.

1.1 Base Station Configuration

1.3 Moving Base Configuration

1.5 Heading2

3.2 Fixed Base Station with Precise Coordinates

3.3 Self-Optimizing Base Station Mode

3.4 Base Station Mode without Parameters

3.5 Set Base Station ID

3.7 Moving Base Mode Configuration

3.9 Heading2 Configuration Command

7.2.5 KSXT - Log Output

7.3.14 ANTENNA Detect

9.1 ANTENNADELTAHEN - Antenna Height

9.3 BASEANTENNAMODEL - Base Antenna

9.4 CLOCKSWITCH - Configure External Clock

9.6 FIX - Set Base Coordinates

9.9 MOVINGBASESTATION – Set the Moving Base Station

9.17.12 GALFNAVRAWPAGE - Galileo F/NAV Page Data

9.17.18 HEADING2 - Multi-Rover Heading Information

9.17.24 TDIFPOS - Joint Smooth Position

9.17.25 TDIFVEL- Joint Smooth Velocity

9.17.26 QZSSRAWSUBFRAME – QZSS Heading Subframe Data

9.17.29 RANGECMP2 - Compressed Version of the RANGE Log

9.17.33 SATVIS - Visible Satellite

9.17.42 RAWBD3SUBFRAME – BD3 Subframe Data

9.17.45 GPHPR - Attitude Parameters

9.17.46 CLOCKSWITCH - Clock State Query

Appendix 2 RTCM V2 Differential Corrections

Appendix 3 RTCM V3 Differential Corrections

In addition to the above, other logs and commands are supported.

1.4.2 Discrepancy

Because the CLAP-B series products output integrated navigation results, there are some discrepancies in *Unicore Reference Commands Manual for High Precison GNSS Board and Module*.

For velocity and position, GPGGA, GNGGA, GPRMC, BESTPOS, BESTVEL, BESTXYZ and AGRIC use the same logic, coupling with INS enable command. When INS is enabled and enters positioning process, the output depends on the best available results and could be output by integrated positioning, standalone GNSS positioning or standalone INS positioning. If INS is disabled, the output comes from GNSS positioning only.

For the heading and pitch, the heading logic in BESTVEL and GPVTG is the same, that is, coupled with the INS enable command. When INS is enabled and enters positioning process, the output includes the best available results, which may be the intergrated positioning, GNSS or INS. If INS is disabled, the output comes from GNSS positioning only.

HEADING, GPHDT: dual-antenna heading

INSPVA, INSPVAS, INSPVAX: Intergrated or INS position, velocity and attitude

RAWIMU, RAWIMUS, RAWIMUSX, RAWIMUX: The output needs to be connected to the GNSS antenna first to ensure that the accurate GNSS time can be received before the output.

RANGE, BESTGNSSPOS and other GNSS-related commands can reach up to 20Hz when the INS is disabled and up to 5Hz when the INS is enabled.

GPGGA\BESTPOS\INSPVA output logic is shown as below

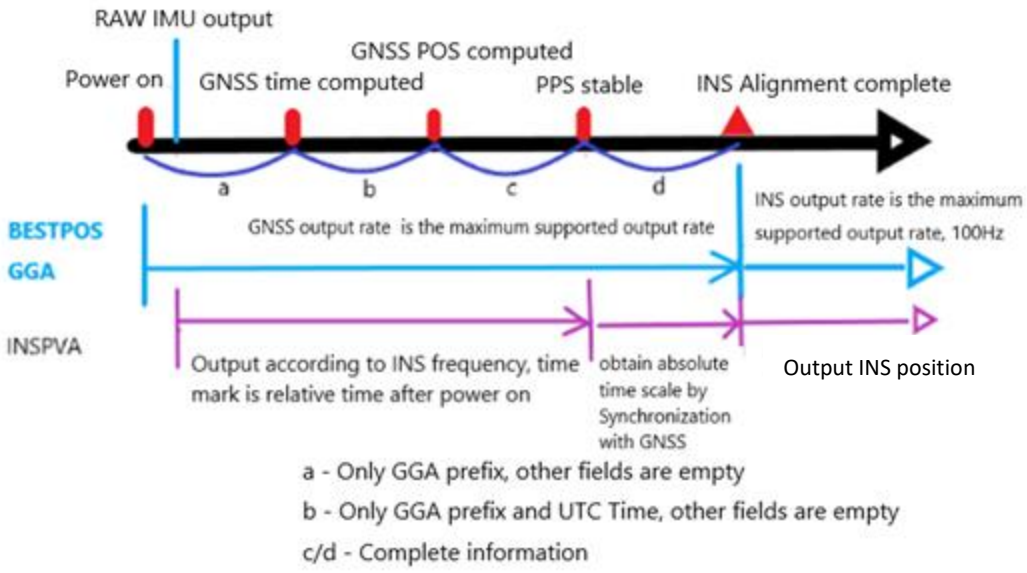

Figure 1-1 GPGGA\BESTPOS\INSPVA Output Logic

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