InsCore Protocol

Abstract

This document defines the data input and output protocols for the InsCore product.

Revision History

Version	Date	Description
1	Jan 23, 2020	Original document about data interface for Inscore
2	Feb 10, 2020	Add sync pulse message
3	May 24, 2021	Add command to switch to different output
4	Jan 10, 2022	Adjustment
5	Mar 07, 2023	Stable 50Hz features
6	Sep 22, 2023	Accept UART Odo input

Contents

1 General Description of Data Format

- The GNSS and MEMS inertial sensor integrated system accepts input commands from the host for the system's configuration purpose. The input commands are organized in binary sequence. It is recommended to keep the default configurations to have the system running in the optimal performance.

- The GNSS/MEMS system supports outputs in both text and binary formats in default. The text format can be optionally turned off by the related input command.

- The input and output messages in binary format follow the description of message packet structure in Table 1.1. The Sync1 and Sync 2 are 0x50 and 0x42, respectively. Two bytes of checksum are computed based on the algorithm shown in Figure 1.1. The checksum covers *payload* bytes only.

- Typically, message IDs from 0x00 to 0xDF are used for output information, and message IDs from 0xE0 to 0xFF are used for input commands, unless otherwise indicated.

- All messages in binary format are in unsigned 8 Bit Binary Data, unless otherwise indicated. All multi-byte values are ordered in Little Endian format, unless otherwise indicated.

Table 1.1 PBDR message block structure

Sync 1	Sync 2	ID	Payload length (2 bytes)	payload	Checksum A	Checksum B

Sync 1: 0x50 Sync 2: 0x42

Figure 1.1 Checksum Algorithm

```
void MsgCheckSum(char *pBuf, unsigned short cnt, unsigned char *ckA, unsigned char *ckB)
{
   unsigned short Sum = 0, i;
   for(i=0; i<cnt; i++)
   {
     Sum += pBuf[i];
   }

   *cKA = (unsigned char)(Sum & 0xFF);
   *cKB = (unsigned char)((Sum & 0xFF00) >> 8);

   return;
}
```

2 Input Messages

2.1 Revert to Manufactory Settings

Name	*Bytes*	*Description*
Sync 1	1	
Sync 2	1	
ID	1	0xE0 – Revert Manufactory
Payload Length	2	1
para	1	1
Check Sum 1	1	
Check Sum 2	1	

2.2 Dual-Antenna GNSS Heading Input

Note: Only support on Inscore 2.0 or higher product.

- Dual-antenna relative position config Input

  Note: dual-antenna feature ONLY accepts **HDT format input

```
dual-antenna relative position definition
rA:    rover antenna
baseA: base antenna

-------------- rA 0 --------------
-------------- |  ----------------
-------------- |  ----------------
---  rA 3 -- baseA ---- rA 1 -----
-------------- |  ----------------
-------------- |  ----------------
-------------- rA 2 --------------
```

Rover antenna ***default*** position definition: **rA 0**

Name	*Bytes*	*Description*
Sync 1	1	
Sync 2	1	
ID	1	0xE2 – dual atn direction
Payload Length	2	1
IMU **X**-axis Direction	1	0: r0 1: r1 2: r2

		3：r3
Check Sum 1	1	
Check Sum 2	1	

2.3 Set Navigation Rate

Note: support only on premium plus version.

Name	*Bytes*	*Description*
Sync 1	1	
Sync 2	1	
ID	1	0xE4 – data rate configuration
Payload Length	2	1
Data Rate	1	0: 1Hz 1: 10Hz 2: 20Hz
Check Sum 1	1	
Check Sum 2	1	

2.4 IMU Axis Setting

Default: non-NMEA message is ON

Name	*Bytes*	*Description*
Sync 1	1	
Sync 2	1	
ID	1	0xE5– IMU Axis setting
Payload Length	2	1
Axis config	1	1: free axis 0~8(except 1): fixed axis, see table.1 for details
Check Sum 1	1	
Check Sum 2	1	

2.5 Forced Cold Reset

Note: The host can forcibly reset the system, which is yet not recommended.

The cold reset command is issued to Inscore, its apriori information, such as calibration, will be lost. Some soaking time is required for the first reliable fix.

Name	*Bytes*	*Description*
Sync 1	1	
Sync 2	1	
ID	1	0xE6 – forced cold reset

Payload Length	2	1
Cold reset	1	Bit 1: if set, cold reset Bit 0,2~7: reserved
Check Sum 1	1	
Check Sum 2	1	

2.6 Turn ON/OFF debug message

Default: non-NMEA message is ON

Name	*Bytes*	*Description*
Sync 1	1	
Sync 2	1	
ID	1	0xE7 – debug message config
Payload Length	2	1
debug on/off	1	Bit 0: if set, turn off debug output Bit 1~7: reserved
Check Sum 1	1	
Check Sum 2	1	

2.7 Baud Rate Setting

Note: Default baud rate is 115200bps.

Name	*Bytes*	*Description*
Sync 1	1	
Sync 2	1	
ID	1	0xEA – baud rate
Payload Length	2	1
Baud Rate	1	Value = 0: 115200; 3:9600; 4: 230400
Check Sum 1	1	
Check Sum 2	1	

Note： The baud rate setting change would impact the procedure of firmware update, in terms of serial communications, in which the default baud rate needs to be set.

2.8 Input Configuration Saving

The configuration will be saved into non-volatile memory or flash when the most significant bit of the payload is set, except for 2.6, 2.7 and 2.8. This feature only supports on customer's production version.

2.9 External NMEA Sequence Settings

Name	*Bytes*	*Description*
Sync 1	1	
Sync 2	1	
ID	1	0xEE – external input NMEA sequence

Payload Length	2	
Sequence	1	0: GLL as last; 1: GGA as last; 2: RMC as last; 3: GSV as last
Check Sum 1	1	
Check Sum 2	1	

2.10 Example of Frequently Used Configuration Messages

All message commands are in Hex.

- **Revert to manufacture setting**

Manufacturing Setting: 50 42 **E0** 01 00 01 01 00

- **Set Dual-Antenna Relative Position**

Set rover antenna position to 0 and save config: 50 42 **E2** 01 00 80 80 00

Set rover antenna position to 1 and save config: 50 42 **E2** 01 00 81 81 00

Set rover antenna position to 2 and save config: 50 42 **E2** 01 00 82 82 00

Set rover antenna position to 3 and save config: 50 42 **E2** 01 00 83 83 00

- **Navigation Rate** – 1Hz in default

Set to 1Hz and save config : 50 42 **E4** 01 00 80 80 00

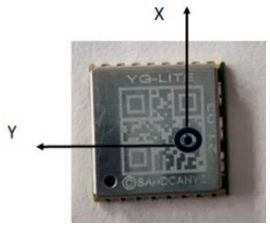
Set to 10Hz and save config: 50 42 **E4** 01 00 81 81 00

Set to 20Hz and save config: 50 42 **E4** 01 00 82 82 00

Set to 50Hz and save config: 50 42 **E4** 01 00 83 83 00 (ONLY valid customized version)

- **IMU Axis**

The physical axis of an Inscore Module



Free Axis config: 50 42 E5 01 00 81 81 00 (default setting)

Fixed Axis config: see below table

Mounting Directions			Config	Note
X	Y	Z		
Forward	Left	Up	50 42 E5 01 00 80 80 00	

Right	Forward	Up	50 42 E5 01 00 82 82 00	
Back	Right	Up	50 42 E5 01 00 83 83 00	
Left	Back	Up	50 42 E5 01 00 84 84 00	
Forward	Right	Down	50 42 E5 01 00 85 85 00	
Right	Back	Down	50 42 E5 01 00 86 86 00	
Back	Left	Down	50 42 E5 01 00 87 87 00	
Left	Forward	Down	50 42 E5 01 00 88 88 00	

- **Forced Reset**

system forced reset: 50 42 **E6** 01 00 03 03 00

- **Turn off Debug message**

Turn Off and save config: 50 42 **E7** 01 00 81 81 00

Turn On and save config: 50 42 **E7** 01 00 80 80 00

- **Change baud rate**

Change to 115200 and save config: 50 42 **EA** 01 00 80 80 00

Change to 230400 and save config: 50 42 **EA** 01 00 84 84 00

- **Set the last sentence of external NMEA input**

Set GLL as the last and save config: 50 42 **EE** 01 00 80 80 00

Set GGA as the last and save config: 50 42 **EE** 01 00 81 81 00

Set RMC as the last and save config: 50 42 **EE** 01 00 82 82 00

Set GSV as the last and save config: 50 42 **EE** 01 00 83 83 00

- **Query Firmware version or current config**

50 42 E3 01 00 00 00 00

2.11 Odometer Speed Input

The InsCore accepts odometer speed information input via UAR-1 messages (ASCII) at 10Hz. The input messages are required working as the following format which starts with $GPODO

Name	*Bytes*	*Description*
String ID	String	$GPODO
Time Stamp	int	Unit：100ms
Speed	Float	m/s
Gear Shift	char	0：Drive (D)；1：Revers (R)
Check Sum	*Hex	From $ (not including) to *(not including), aka same as NMEA checksum

e.g. $GPODO,210000,9.3,0*68

3 Output Messages

Subject to the limits of the output baud rate, the output messages vary in higher baud rate, aka, not all messages are available at high baud rate. The customized message output is acceptable.

3.1 Text Format Output

3.1.1 Navigation results in proprietary format

Name	*Bytes*	*Description*
Message ID	$PBSOL	
Message subID	UINT8	0x01
UTC Year	UINT16	
UTC Month	UINT8	
UTC Day	UINT16	
UTC Hour	UINT8	
UTC Minutes	UINT8	
UTC millisecond	UINT16	
Sensor Time	UINT32	In ms
GPS week number	UINT16	(GPS week)
TOW	UINT32	In msec
NavModeInfo	UINT32	0x00: no nav; bit 0: reserved bit 1: gnss only bit 2: sensor only bit 3: combined solution bit 4~6: reserved bit 7: mag in use bit 8: baro in use bit 9: odo in use bit 10: dual-antenna in use bit 11: reserved bit 12: DGNSS in use bit 13: RTK in use (fix) bit 14: RTK in use (float) bit 15: reserved bit 16 ~31: reserved
Latitude	INT32	in degree, scale *10^7
Longitude	INT32	In degree, scale *10^7
Altitude ellipsoid	INT32	Ellipsoid altitude in centimeter
Altitude msl	INT32	Mean sea level altitude in cm
Vn	INT32	In cm/s

Ve	INT32	In cm/s
Vd	INT32	In cm/s
Ground Speed	UINT32	Speed over ground in cm/s
Traveled distance	UINT32	In cm
Roll	INT32	Roll, in deg, scale *100
Pitch	INT32	Pitch, in deg, scale *100
Heading (yaw)	INT32	Heading (0~360) in deg, scale *100
Reserved	INT32	
Reserved	INT32	
North Uncertainty	UINT16	In cm
East Uncertainty	UINT16	In cm
Down Uncertainty	UINT16	In cm
Vn Uncertainty	UINT16	In cm
Ve Uncertainty	UINT16	In cm
Vd Uncertainty	UINT16	In cm
Roll uncertainty	UINT16	In deg, scaled * 100
Pitch uncertainty	UINT16	In deg, scaled * 100
Yaw uncertainty	UINT16	In deg, scaled * 100
Misalignment angle roll	INT16	In deg, scaled * 100
Misalignment angle pitch	INT16	In deg, scaled * 100
Misalignment angle yaw	INT16	In deg, scaled * 100

Note: attitude is valid only if NOT in gnss only mode.

3.1.2 Navigation results in NMEA format

Standard NMEA format for $GGA and $RMC. The NMEA check sum algorithm is shown in Figure 3.1.

NMEA Talker ID

GNSS configuration	*Talker ID*
Any combination	GN
GPS/SBAS/QZSS only	GP
GLONASS only	GL
BDS only	GB or BD
GALILEO ONLY	GA

Figure 3.1 NMEA Checksum Algorithm

```
void NMEACheckSum(char *pBuf)
{
    unsigned char ckSum = 0;

    pBuf++; /* skip the $ sign */

    while (*pBuf != '\0')
    {
        ckSum ^= *pBuf++;
    }
}
```

3.1.2.1 NMEA -- $GNGGA

Name	*Unit*	*Format*	*Example*	*description*
Sentence Identifier		String	$GNGGA	Global Positioning System Fix Data
Time		hhmmss.sss	170834.000	17:08:34 UTC
Latitude		ddmm.mmmmmm	4124.896312	41d 24.896312' N
NS		Character	N	North/south indicator
Longitude		dddmm.mmmmmm	12151.683854	121d 51.683854' E
EW		Character	E	east/west indicator
Fix Quality: - 0 = Invalid - 1 = SPS fix - 2 = DGPS fix - 4 = RTK fixed - 5 = RTK float - 6 = DR only		digit	1	Data is from a GNSS fix
Number of Satellites		numeric	09	9 Satellites are in view
Horizontal Dilution of Precision (HDOP)		Numeric	1.5	Relative accuracy of horizontal position
Altitude	M	numeric	280.2	280.2 meters above mean sea level
Unit of altitude		character	M	Meter
geoSep (Geoid separation)	M	numeric	34.0	Difference between ellipsoid and mean sea level
Unit of geoSep		character	M	meter
Time since last DGPS update	sec	numeric	blank	No last update
DGPS reference station id		numeric	blank	No station id
Checksum		Hex	*75	

3.1.2.2 NMEA -- $GNRMC

Name	*Unit*	*Format*	*Example*	*Description*
Sentence Identifier		String	$GNRMC	
Time		hhmmss.sss	170834.000	
Status		Character	A	
Latitude		ddmm.mmmmmm	4124.896312	
NS		character	N	
Longitude		dddmm.mmmmmm	12151.683854	
EW		character	E	
SOG	knots	numeric	0. 004	
COG	Degree	numeric	77.52	
Date		ddmmyy	210816	
Mv	Degree	numeric	Blank	
mvEW		character	blank	
PosMode		character		
Checksum		Hex	*68	

3.1.2.3NMEA -- $GNATT

Note: 3D attitude message

Name	*Unit*	*Format*	*Example*	*Description*
Sentence Identifier		String	$GNATT	
Time		hhmmss.sss	170834.000	17:08:34 UTC
Status		Character	1	0: invalid 1: valid
Roll Angle	degree	2 decimal places	-4.89	range ±90, right side down defined as positive
Pitch Angle	degree	2 decimal places	3.12	range ±90, head up defined as positive
Heading Angle	degree	2 decimal places	124.05	range 0~360, to true North, counter clockwise defined as positive
Roll Angle uncertainty	degree	2 decimal places	0.43	range 0~360
Pitch Angle uncertainty	degree	2 decimal places	0.81	range 0~360

Heading Angle uncertainty	degree	2 decimal places	1.22	range 0~360
Checksum		Hex	*68	Used by program to check for transmission errors

3.1.3 Raw data for analysis/debug purpose

The debug message output varies along with settings and firmware versions.

3.1.3.1 Sensor Data -- $PSNSR,21

Name	*Bytes*	*Description*
Message ID	$ PSNSR	
SensorType	UINT8	21: mixed DR sensor
numSets	UINT8	Number of data set
Repeat by numSets times, N = 0~ (numSets-1)		
timeTag[N]	UINT32	Sensor time stamp in ms
Gyro_X[N]	INT32	In deg/s, scale *10^3
Gyro_Y[N]	INT32	In deg/s , scale *10^3
Gyro_Z[N]	INT32	In deg/s , scale *10^3
Accel_X[N]	INT32	In m/s^2, scale *10^3
Accel_Y[N]	INT32	In m/s^2 , scale *10^3
Accel_Z[N]	INT32	In m/s^2 , scale *10^3
Odometer[N]	UINT32	In cm/s
Reverse[N]	UINT8	0: forward; 1:reverse

3.1.3.2Sensor Raw Data -- $PSNSR,23

Note: This message is for raw sensor data. The entire block is comprised of multiple messages.

Name	*Bytes*	*Description*
Message ID	$ PSNSR	
SensorType	UINT8	23: raw sensor data
TimeTag	UINT32	Time stamp for sensor
Gyro_X	INT32	In deg/s, scale *10^3
Gyro_Y	INT32	In deg/s , scale *10^3
Gyro_Z	INT32	In deg/s , scale *10^3
Accel_X	INT32	In m/s^2, scale *10^3
Accel_Y	INT32	In m/s^2 , scale *10^3
Accel_Z	INT32	In m/s^2 , scale *10^3

3.1.3.3 Message block end -- $PBLKEND

Note: This is a message indicating end of epoch.

Field	*Type*	*Description*
Message ID	String	$PBLKEND
EndFlag-1	integer	255
EndFlag-2	integer	Unix time stamp in sec or 255

END