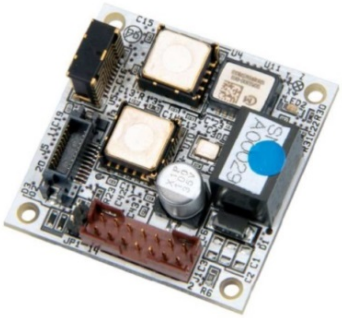
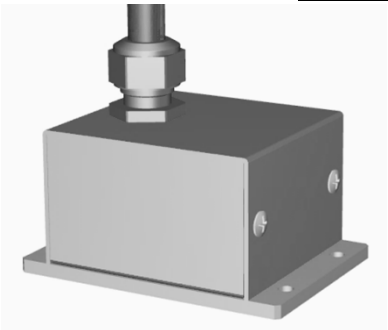
3-axis Inertial Measurement Unit

AU7684N2x00/TAG300N2x00/TAG289N2x00

Support Manual for GNSS/INS/VS Mode



AU7684 (PCB Type)



TAG289 (Compact Case Type)

TAG300 (Waterproof Case Type)

TAMAGAWA SEIKI CO., LTD.

TAMAGAWA TRADING CO., LTD

Revision History

Rev	Date	Page	Reason of Correction
—	2020.01.10	—	The document is released.
2	2020.03.12	—	The new product “TAG289” is added.
3	2021.08.21	P16	Change contact information .

Table of Content

Introduction

This manual provides the operating procedures and cautions for the small 3-axis Inertial Measurement Unit (IMU) AU7684, TAG300 and TAG289 GNSS/INS/VS mode. Please read this document along with the product specification before using the device. Regarding Leveling operation mode, please refer to the document "Support Manual (Leveling Mode)".

Contents

- **AU7684N2x00/TAG300N2x00/TAG289N2x00**, which are an Inertial Measurement Units (IMU) incorporating 3-axis MEMS gyroscopes and 3-axis integrated MEMS accelerometer. The device measures acceleration and angular rate along the X, Y, & Z axes of the sensor, attitude and heading angle.
- **EU8937 and EU8940 Interface Cable (sold separately)**
  There are 2 types of interface cable for each model. The one is loose wire type and the other is connector type for external GPS module.
  TAG289 Interface cable is attached to the product. You do not need to buy a cable separately.
- **External GPS Module (KGM-810GRB1_PS_917/Position) (available in market)**
  Regarding the inquiries and purchases, please refer to section 3 in this manual.
  The AU7684 series and TAG300 series can output GPS information (latitude, longitude, altitude, direction, speed, UTC time, etc.) by connecting a GPS module. The information is also utilized for the calculation to reduce attitude and heading errors.

Note: if you need to use USB, please use RS232C-USB conversion cable available in the market. Also, power source of 8-28 VDC should be prepared by customer.

Reference Documents

- SPC016028W00_Specification_AU7684N2x00
- SPC016108W00_Specification_TAG300N2x00
- SPC016246W00_Specification_TAG289N2x00
- InsMon Software Install Manual
- Support Manual (Leveling Mode)

Downloads (URL: http://mems.tamagawa-seiki.com/en/download/)

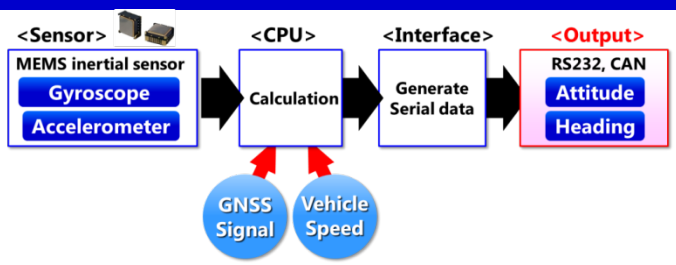
- InsMon Software

Operation mode

In this model, both GNSS/INS/VS Mode and Leveling Mode can be used. Please refer to the product specification for the instruction of operation mode change.

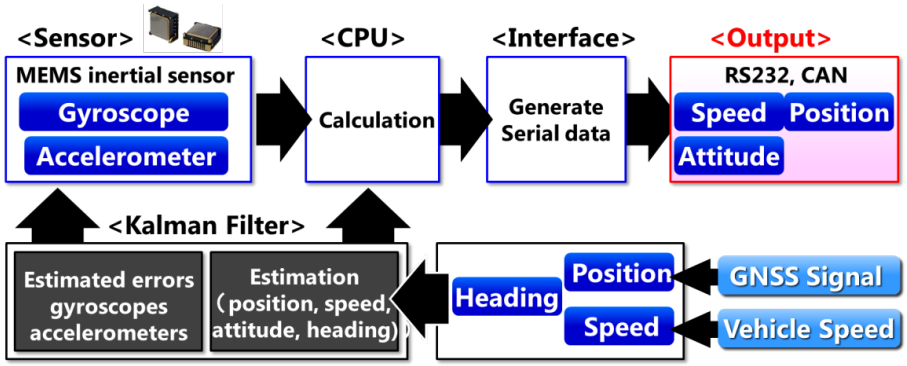
*The initial setting is Leveling mode

Leveling Mode



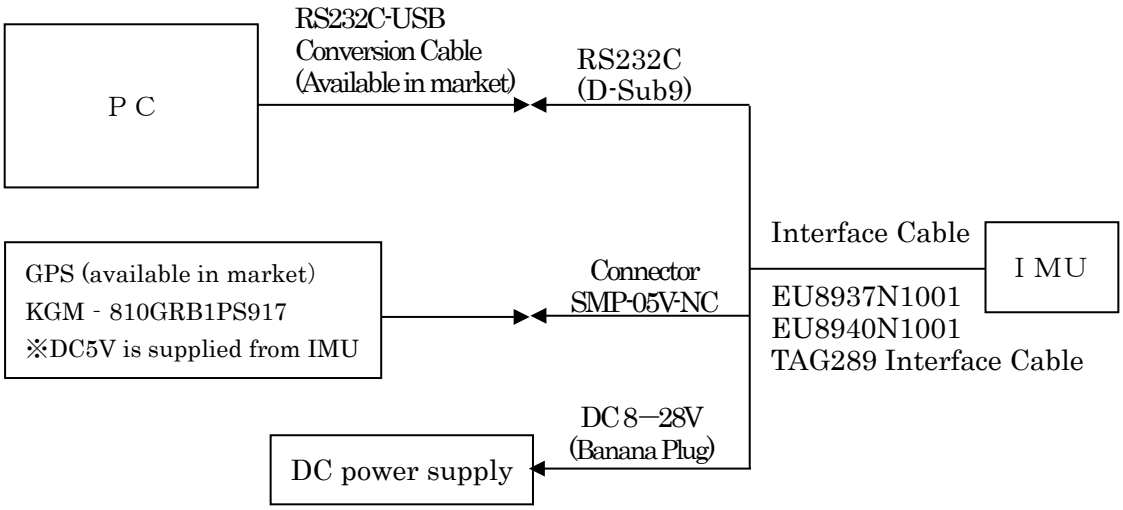
- The IMU calculates attitude (roll & pitch) and heading (yaw) from 3-axis of angular rate and acceleration. The feature of leveling mode is stable output of attitude angle (roll & pitch) for long hours.
- The heading (yaw) angle is calculated by integrating Z-axis of angular rate. Therefore, it may gradually be drifted over time. It is recommended to perform offset cancel regularly to suppress heading (yaw) angle drift.
- The leveling mode is performed on condition that the device is not moving. If the device is affected by acceleration or centrifugal force, the attitude angle may be deteriorated. This deterioration is suppressed by entering vehicle speed and GNSS signal from external devices.

GNSS/INS/VS Mode

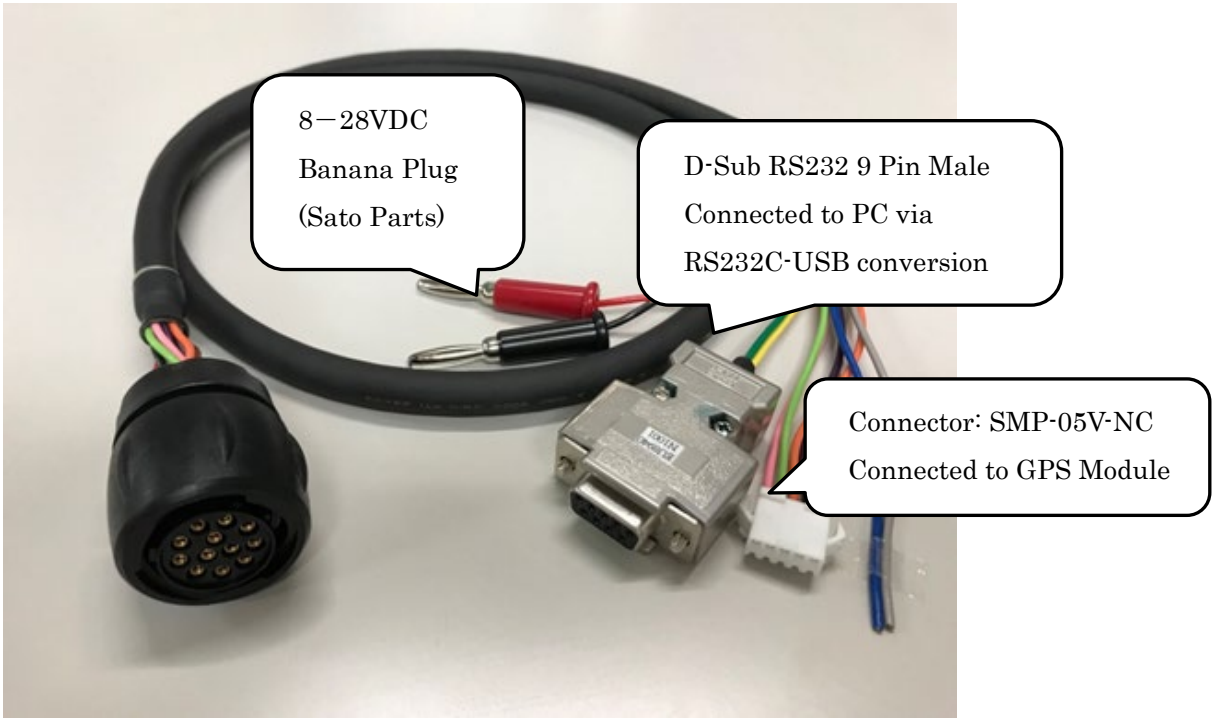


- The calculation is performed by combining gyroscopes and accelerometers (INS data), external GNSS data and vehicle speed.
- The error of gyroscopes and accelerometers are estimated by a difference of INS data and GNSS/VS output. In this mode, the accuracy of attitude angle is improved, and it enables to output the position data even in GNSS-denied environment.
- The connection of GNSS to IMU is needed to operate this mode. If GNSS is not connected to IMU for a certain period of time, this mode may not be performed. It is also recommended that the vehicle speed be entered into IMU from external devices. By doing so, the dynamic accuracy is improved.

Example of PC connection



Block Diagram of PC connection



Interface Cable (P/N: EU8940N1001)

1 InsMon Setup

- **How to setup the application**

  Download InsMon corresponding to the applicable model from the following URL, and unzip it to desktop or My Documents, etc.

  http://mems.tamagawa-seiki.com/en/download/

  If you use GNSS/INS/VS Mode

  Please use InsMon_AU7684N2x00_TAG300N2x00_RAW Folder.

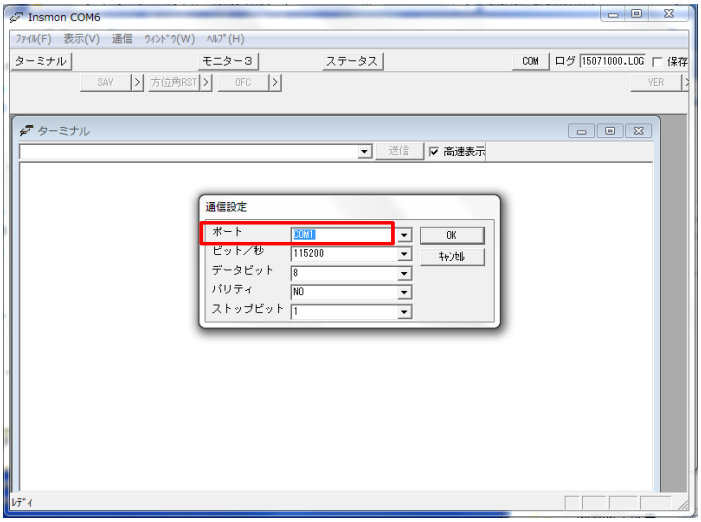
  If you use Leveling Mode

  Please use InsMon_AU7684N2x00_TAG300N2x00_BIN Folder.

- **COM Port setting**

  1) Click [Communication] → [Disconnect] and disconnect the communication.

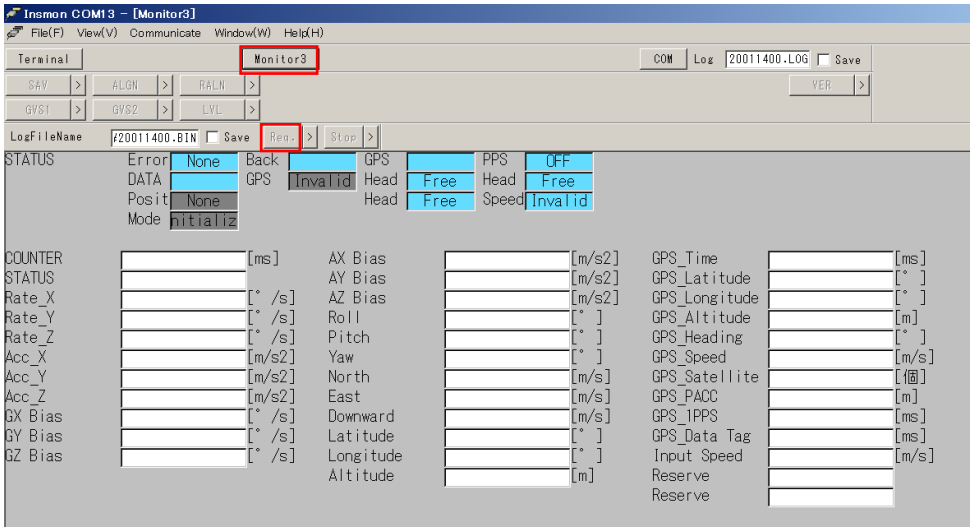
  2) Click [Communication] → [Setting] and select the COM port# which you are using. Please do not change any other settings except for COM port#.



  3) Click [Communication] → [Connect]

- **Measurement**

1) Click [Monitor 3] and following screen is displayed. If you connect the IMU properly, angular velocity, acceleration and attitude angle are displayed.



You can also change the Frequency from [>] button next to [Req.] button. The maximum output is 50Hz. The frequency that can be received is the values obtained by dividing 50 by an integer. For example, 50, 25, 10, 5, 2..., etc.
In case of less than 1Hz, 0.5Hz, 0.2Hz, and 0.1Hz are available.

- **Data Saving**

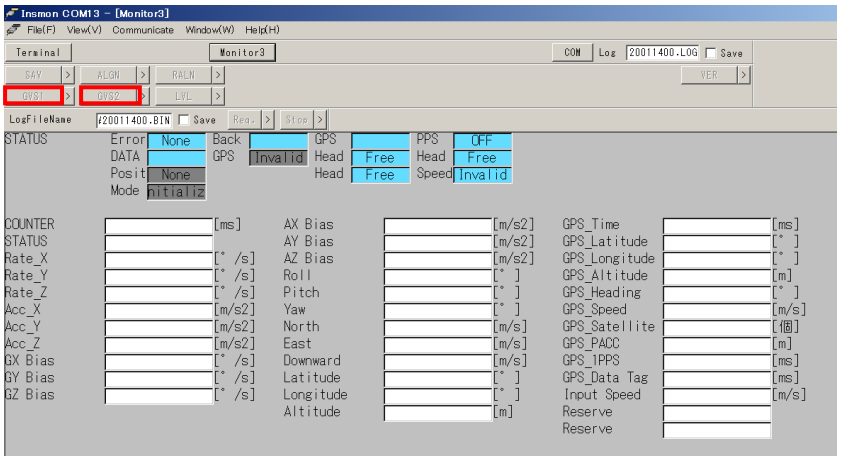
1) Input the title of file and click the save checkbox. Only BIN file can be used.
2) Press the “Req.” button and start data reception. Press “Stop” button or uncheck the checkbox when you finish data saving. The data is created in the same folder as the exe file.
3) After measuring, you can convert a BIN file into csv file by converting Binary to Text. You can also decimate the acquired data the by changing conversion rate, initial setting of which is 1.

- **Change the operation from Leveling mode to GNSS/INS/VS mode**

(1) With IMU connected to the computer, press [GNSS/INS/VS] or [GNSS/INS] in command bar.

(2) Press [×] and close InsMon. After turning off the power, restart the device. Execute exe file in InsMon_AU7684N2x00_TAG300N2x00_RAW folder.

(3) Check COM port setting and press [Req] in Monitor 3. If you connect the IMU properly, data transmission will start. The connection of GNSS module to the device is required for GNSS/INS/VS mode or GNSS/INS mode. The applicable GNSS module is stated in page 15 in this manual.

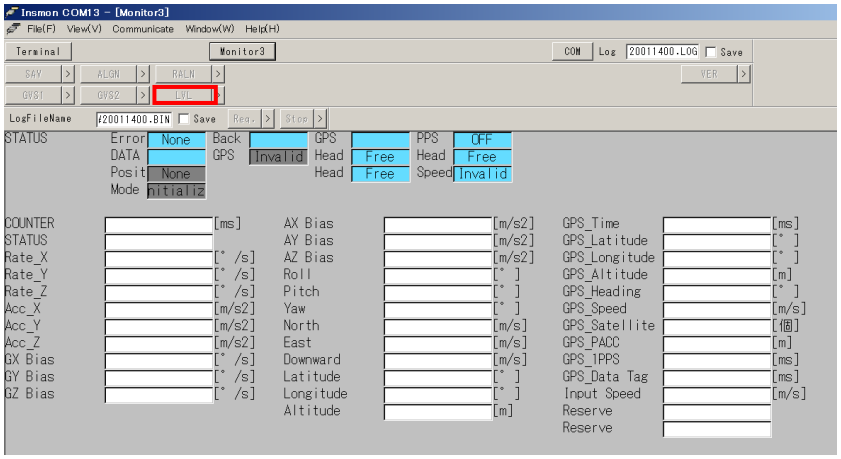


- **Change the operation from GNSS/INS/VS mode to Leveling mode**

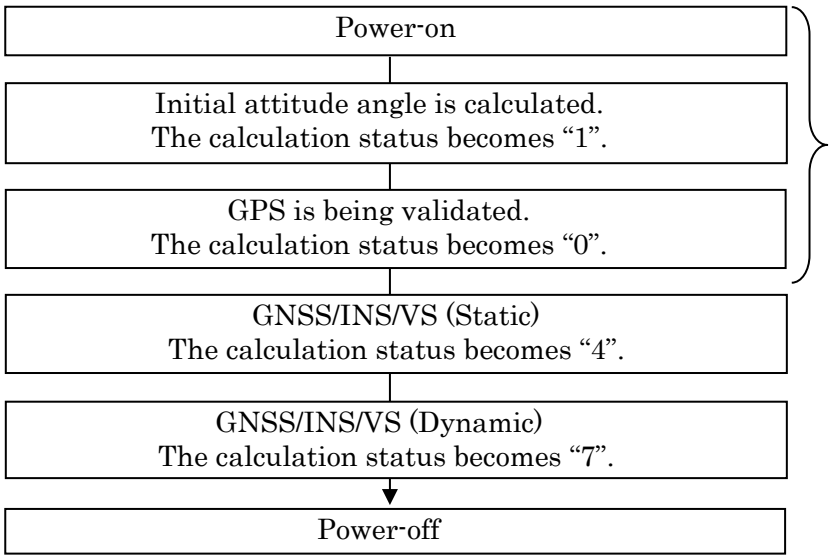
(1) With IMU connected to the computer, press [Leveling] in command bar.

(2) Press [×] and close InsMon. After turning off the power, restart the device. Execute exe file in InsMon_AU7684N2x00_TAG300N2x00_BIN folder.

(3) Check COM port setting and press [Req] in Monitor 3. If you connect the IMU properly, data transmission will start.



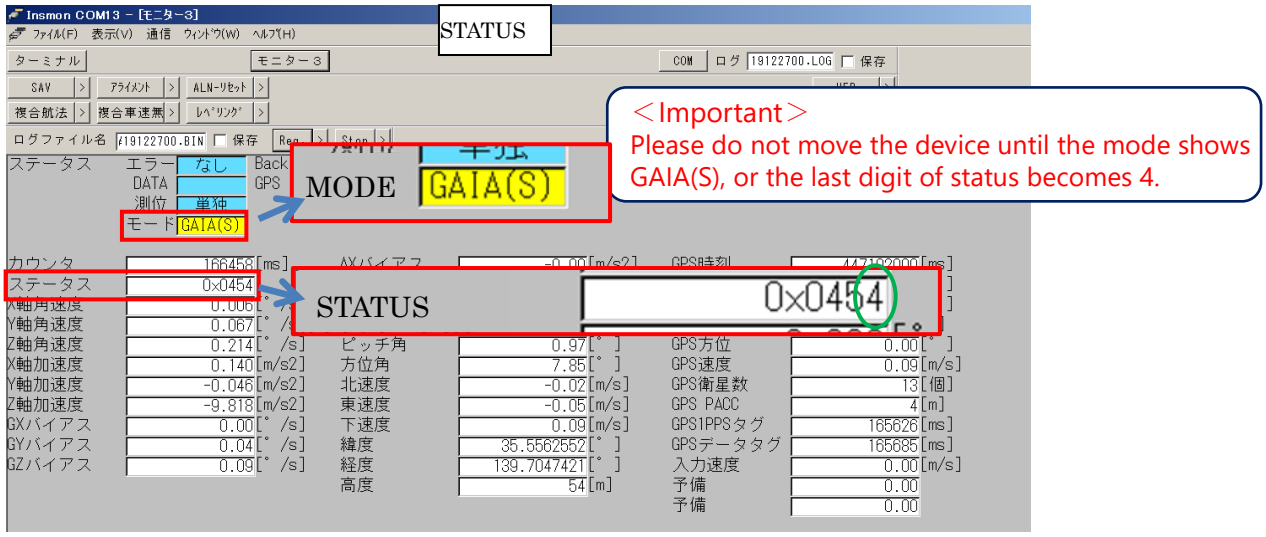
- **Operation Procedure of GNSS/INS/VS mode**



Please do not move the device during the period.
The calculation status becomes “4” and you can move the device.
Please move forward along with X axis of the device for the first movement.

Keep GPS well received during measurement. GNSS-denied environment should be avoided.

In GNSS/INS/VS mode, calculation of initial attitude angle and GPS validation are processed after power-on. Please do not move IMU until GPS is validated. If IMU is moved during this period, the initial process is not performed well and it may cause an error of estimation. In the software InsMon, you can check it in monitor 3.



You can also check the status by RAW data output. For more details, please check the product specification.

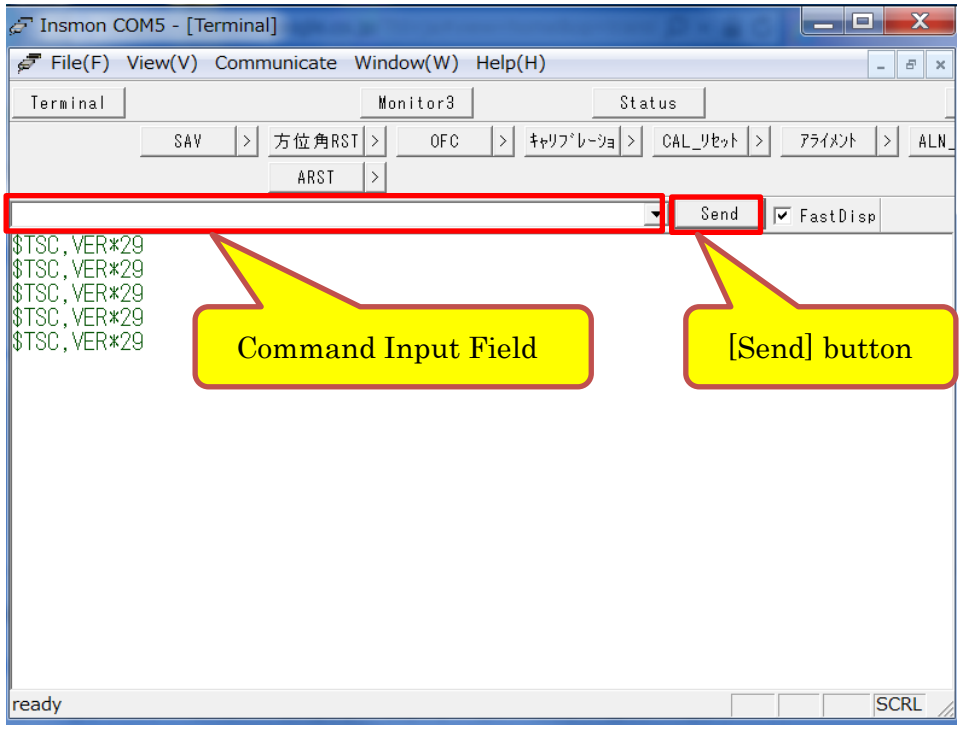
- **Command Input**

(1) With IMU being connected, press [Stop] button in monitor 3.

(2) Press [Terminal] button and enter the command in the command field. Press [Send] button to send commands. Checksum can be omitted

Ex) MVEL command (GPS dependence speed setting to 0.5m/s)

$TSC,MVEL,0.5*CC<CR><LF>



Command List Example

- Save current setting Command: $TSC,SAV
- Yaw dead zone setting command: TSC,YAWF,a (a: deg/sec)
- Alignment Compensation Command: $TSC,ALGN
- GNSS/INS/VS Mode: $TSC,GVS1
- Setting Initializing Command: $TSC,ARST

※While the terminal display is opened, CPU load is increased. After sending command, it is recommended to close the terminal display.

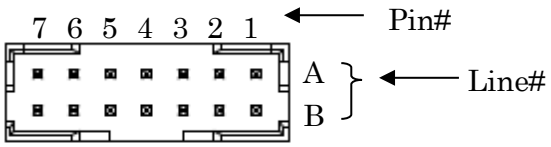
2 Interface Cable

If customer prepares a harness to be connected to the IMU, please refer to the following pin assignment and connector part. Please also check section 2.3 in case that customer use our interface cable sold separately.

2.1 AU7684 Harness connection

AU7684 J1 Connector Pin Assignment

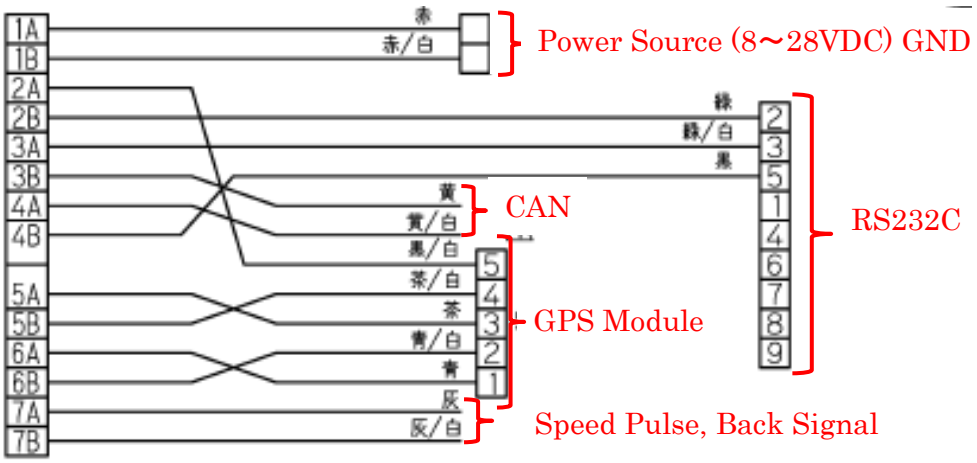
Pin#	Signal	Remark
1A	Power Source	8V～28V DC
1B	Power Source 0V	Connected to Signal GND
2A	+5V	
2B	RS232 TXD	
3A	RS232 RXD	
3B	CAN H	
4A	CAN L	
4B	GND	
5A	GPS TX ※	
5B	GPS RX ※	
6A	PPS IN ※	
6B	GND	
7A	BACK	
7B	PULSE	



J1(JST : LY20-14P-DT1-P1E-BR)

Diagram of AU7684 Harness

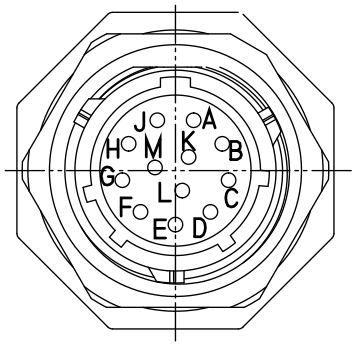
JST : LY10-DC14BR



2.2 TAG300 Harness connection

TAG300 J1 Connector Pin Assignment

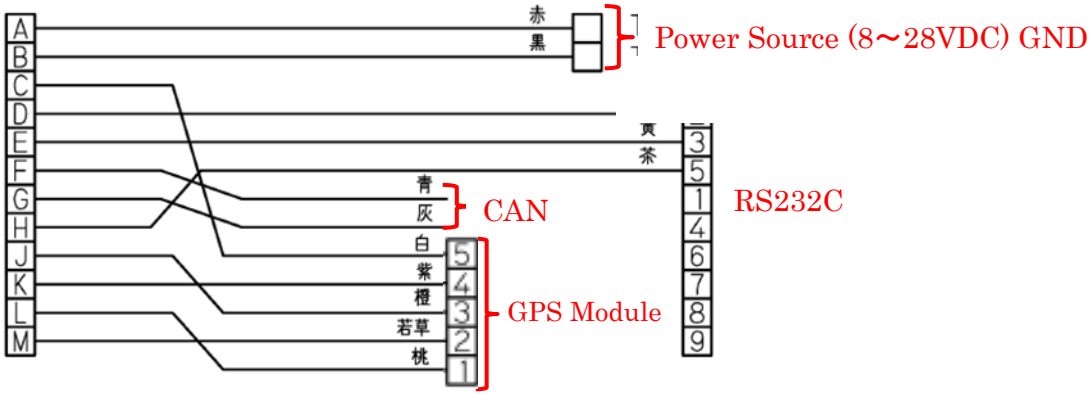
Pin#	Signal	Remark
A	Power Source	8V～28V DC
B	Power Source 0V	Connected to Signal GND
C	+5V	for GPS Power-supply
D	RS232 TXD	
E	RS232 RXD	
F	CAN H	
G	CAN L	
H	GND	
J	GPS TX ※	RS232 Level
K	GPS RX ※	RS232 Level
L	PPS IN ※	
M	GND	



J1(SOURIAU：UTS71412P)

Diagram of TAG300 Harness

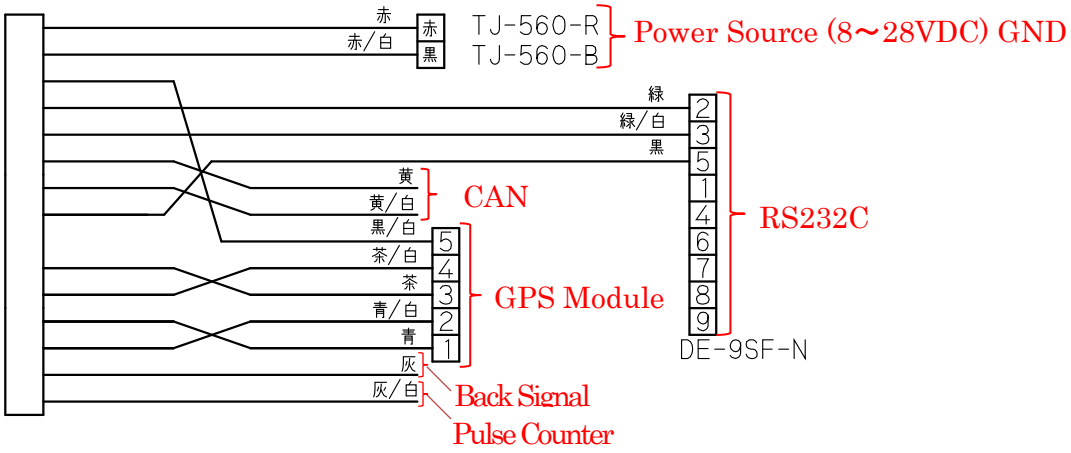
SOURIAU：UTS6GN1412S or UTS6JC1412S



2.3 TAG289 Pin Assignment

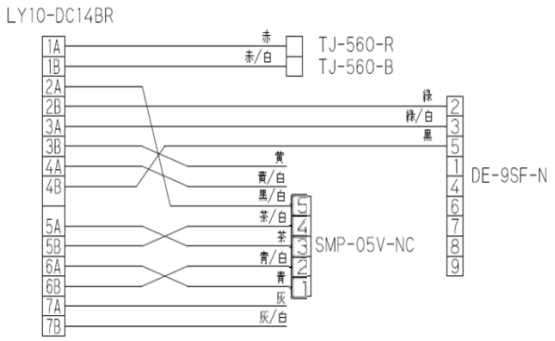
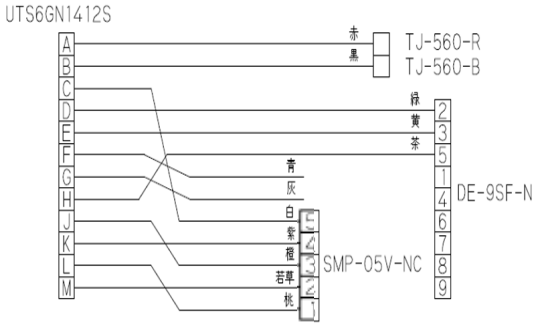
TAG289 Pin Assignment

Connector	Pin#	Signal	Remark
TJ-560-※	Red	Power Source	8V～28V　DC
	Black	Power Source 0V	Connected to Signal GND
DE-9SF-N	2	RS232 TXD	
	3	RS232 RXD	
	5	GND	
SMP-05-NC	1	PPS IN	
	2	GND	
	3	GPS TX	RS232 Level
	4	GPS RX	RS232 Level
	5	+5V	GPS Power Source
Loosen Wire	Yellow	CAN H	
	Yellow/White	CAN L	
	Gray	Discrete Signal	Back Signal
	Gray/White	Discrete Signal	Pulse Count



2.4 Optional Interface Cable

We are preparing for an optional interface cable for AU7684 and TAG300.
Please contact to our sales office as written in the following page.
TAG289 Interface Cable is attached to the product.

AU7684 Interface Cable	TAG 300 Interface Cable
P/N: EU8937N1001 With GPS Module Connector GPS: KGM-810GRB1_PS_917/ Position	**P/N: EU8940N1001** With GPS Module Connector GPS: KGM-810GRB1_PS_917/ Position
	

Note:
If there are unconnected pins, please protect the terminal part with a shrink tube so that the cable terminal part is not short-circuited.

3 External GPS Module

The AU7684 series, TAG300 series and TAG289 series can output GPS signal (latitude, longitude, altitude, direction, speed, UTC time, etc.) by connecting a GPS module. In addition, the GPS speed and GPS direction are utilized for the calculation to reduce Attitude and Heading angle errors.

3.1 Applicable GPS Module

P/N: KGM-810GRB1_PS_917 manufactured by Position

Seller:

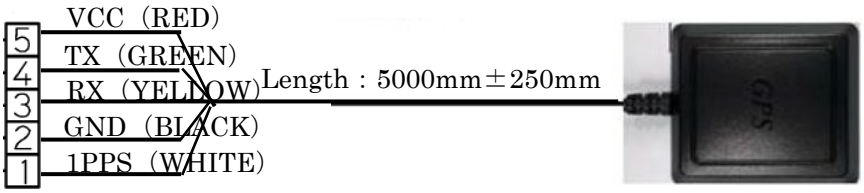
Yukihide Tanaka (Mr.)

CHIYODA ELECTRONIC CO., LTD.

Kanto Sales Office 4-1-20 9F, Higashishukugo, Utsunomiya Shi, Tochigi Ken, 321-0953, Japan

E-Mail : yu-tanaka@cec-chiyoda.co.jp

TEL : +81-28-637-3900 FAX : +81-28-637-3903



Connector SMR-05V-N（JST）

Dimension：44.0×49.8×t 14.3mm

The connection with other GPS module such as C099-F9P/ u-blox can be customized.
For inquiries about availability, please submit the inquiry from our website.
https://mems.tamagawa-seiki.com/en/contact/form/

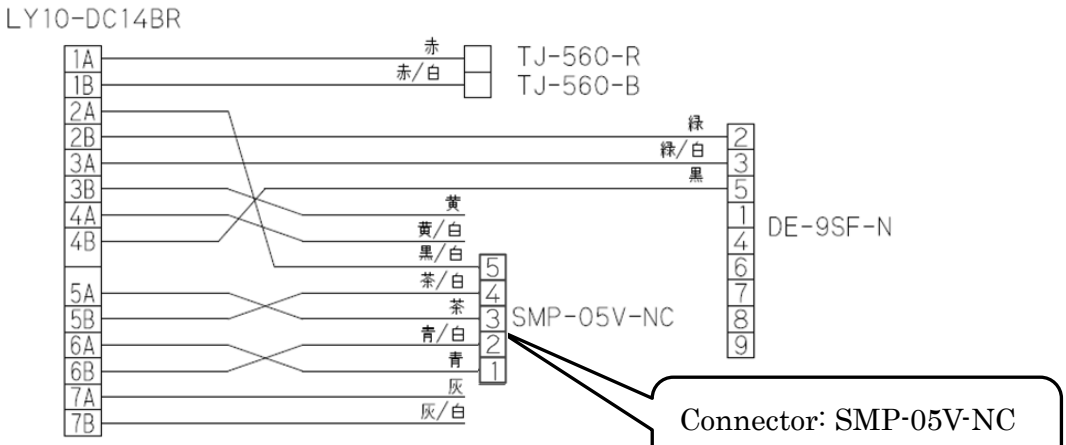
3.2 Connection of AU7684 & External GPS Module (KGM-810GRB1_PS_917)

Please connect the GPS according to the following table.

AU7684 J1 Connector Pin Assignment

Pin#	Signal	Connection to GPS Module
1A	Power Source	
1B	Power Source 0V	
2A	+5V	→Vcc of GPS
2B	RS232 TXD	
3A	RS232 RXD	
3B	CAN H	
4A	CAN L	
4B	GND	
5A	GPS TX ※	→Rx of GPS
5B	GPS RX ※	→Tx of GPS
6A	PPS IN ※	→1PPS of GPS
6B	GND	→GND of GPS
7A	BACK	
7B	PULSE	

When you use EU8937N1001, please follow the instruction below.



EU8937N1001 (AU7684 Interface Cable)

In Leveling mode, you need to make the setting of IMU to validate GPS. Restart the IMU after sending a command to enable the GPS to the IMU using one of the following methods. This operation is not needed in GNSS/VS/INS mode.

- Via RS232C Refer to specification P23

  Ex) Send Command "$ TSC, GPS, ON" via InsMon
- Via CAN Refer to specification P43 (GPS Valid/ Invalid)

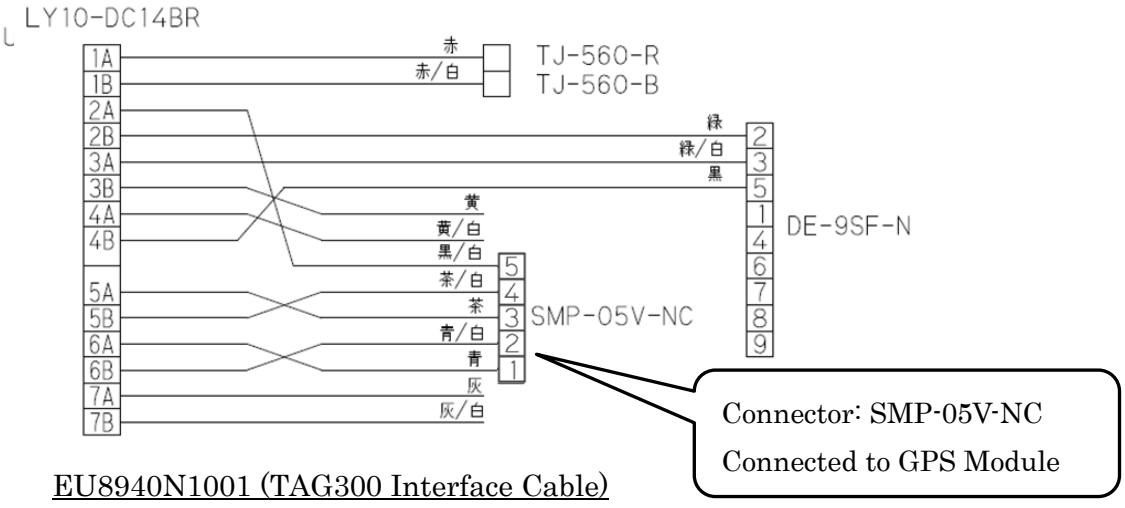
3.3 Connection of TAG300 & External GPS Module

Please connect the GPS according to the following table

TAG300 J1 Connector Pin Assignment (SOURIAU:UTS71412P)

Pin#	Signal	Remark
A	Power Source	
B	Power Source 0V	
C	+5V	→Vcc of GPS
D	RS232 TXD	
E	RS232 RXD	
F	CAN H	
G	CAN L	
H	GND	
J	GPS TX ※	→Rx of GPS
K	GPS RX ※	→Tx of GPS
L	PPS IN ※	→1PPS of GPS
M	GND	→GND of GPS

When you use EU8940N1001, please follow the instruction below.



EU8940N1001 (TAG300 Interface Cable)

In Leveling mode, you need to make the setting of IMU to validate GPS. Restart the IMU after sending a command to enable the GPS to the IMU using one of the following methods. This operation is not needed in GNSS/VS/INS mode.

- Via RS232C Refer to specification P23

  Ex) Send Command "$ TSC, GPS, ON" via InsMon (refer to page 13)

- Via CAN Refer to specification P42 (GPS Valid/ Invalid)

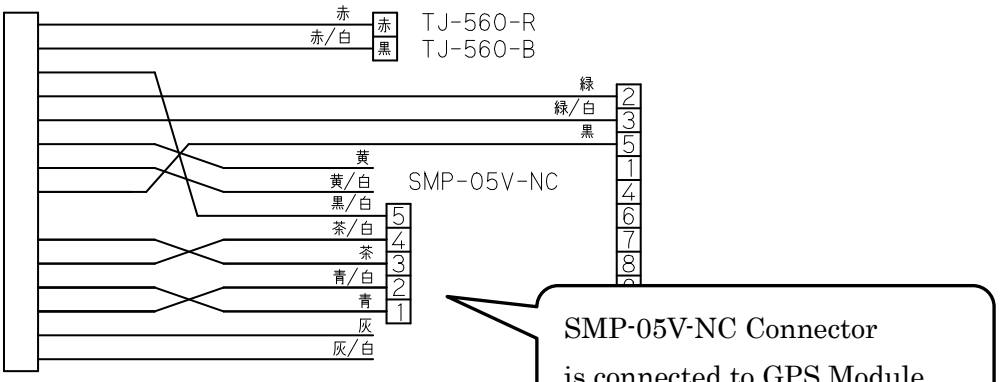
3.4 Connection of TAG289 & External GPS Module

Please connect the GPS according to the following table

TAG289 Pin Assignment

Connector	Pin#	Signal	Remark
TJ-560-※	Red	Power Source	8V～28V　DC
	Black	Power Source 0V	Connected to Signal GND
DE-9SF-N	2	RS232 TXD	
	3	RS232 RXD	
	5	GND	
SMP-05-NC	1	PPS IN	→1PPS of GPS
	2	GND	→GND of GPS
	3	GPS TX	→Rx of GPS
	4	GPS RX	→Tx of GPS
	5	+5V	→Vcc of GPS
Loosen Wire	Yellow	CAN H	
	Yellow/White	CAN L	
	Gray	Discrete Signal	Back Signal
	Gray/White	Discrete Signal	Pulse Count

When you use EU8940N1001, please follow the instruction below.



TAG289 Interface Cable

You need to make the setting of IMU to validate GPS. Restart the IMU after sending a command to enable the GPS to the IMU using one of the following methods.

- Via RS232C Refer to specification P23
  Ex) Send Command "$ TSC, GPS, ON" via InsMon
- Via CAN Refer to specification P43 (GPS Valid/ Invalid)

4 Command List

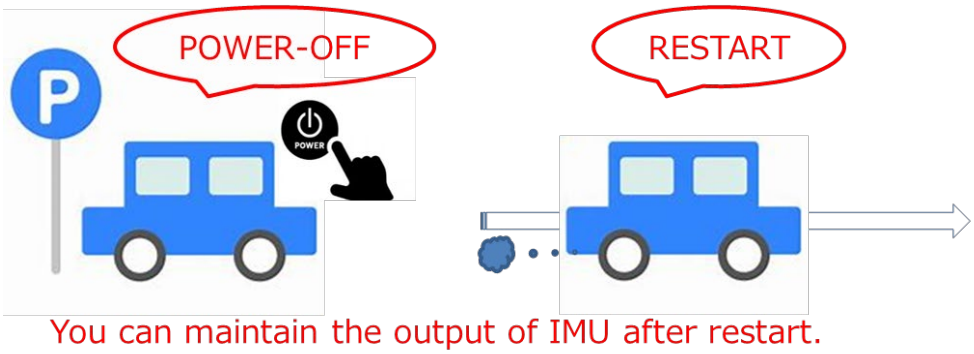
No.	Command	Description	LVL	GNSS	ROM※	Initial Setting	Ref
1	RAW	Raw data output	×	○		−	−
2	BIN	BIN data output	○	○		−	−
3	SAV	Save current setting	○	○	○	−	P19
4	OFC	Offset cancel	○	×		−	−
5	HRST	Heading angle reset	○	×		−	−
6	SPD	Vehicle Speed input	○	○		−	−
7	VER	Software version display	○	○		−	−
8	CAN	CAN communication setting	○	○	○	500kbps 50Hz	−
9	BIAS	Bias display	○	×	○	OFF	−
10	AVET	Averaging time setting	○	○	○	5 sec	−
11	YAWF	Yaw dead zone setting	○	×	○	0.3deg/sec	P20
12	LVLW	Leveling calculation setting	○	×	○	0.1Hz	−
13	LVLR	Leveling constant display	○	×		−	−
14	CAL	Sensor calibration	○	×	○	−	−
15	RCAL	Reset sensor calibration	○	×	○	−	−
16	ALGN	Alignment compensation	○	○	○	−	P21
17	RALN	Alignment compensation reset	○	○	○	−	P21
18	AXIS	Axis setting	○	○	○	Z-axis downward	P22
19	IDN	CAN standard ID setting	○	○	○	−	−
20	JIDN	CAN extension ID setting	○	○	○	−	−
21	CNID	CAN format setting	○	○	○	0:standard format	−
22	CNED	CAN endianness setting	○	○	○	1: Big Endianness	−
23	CNSW	CAN output ON/OFF	○	○	○	−	−
24	GPS	GPS validation	○	×	○	0:GPS invalid	−
25	SVEL	Vehicle speed input setting	○	○	○	0:GPS or CAN/RS232	−
26	LVL	Leveling mode setting	○	○	○	−	−
27	GVS1	GNSS/INS/VS mode setting	○	○	○	−	P23
28	GVS2	GNSS/INS mode setting	○	○	○	−	P23
29	MVEL	GPS dependence speed setting	○	○	○	0.2 m/s	P24
30	ARST	Initialization	○	○	○	−	P24

For items with ○ in ROM area, please turn off the device for about 1 second and restart the power to reflect the setting change.

SAV Command (Save current setting)

You can save the output status of IMU by this command. If SAV command is conducted while data is being output, IMU outputs the data without RAW data request from the next startup, and the output cycle will be the same as when the SAV command is executed.

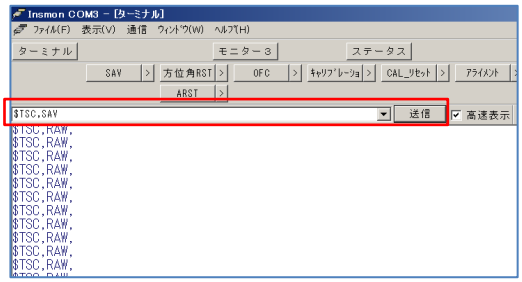
■Usage



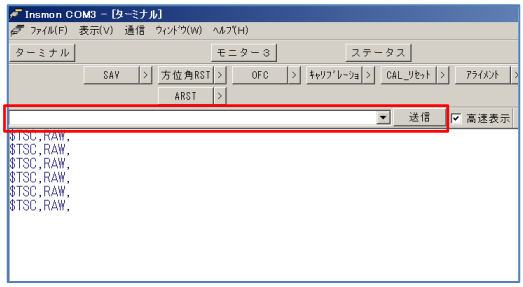
■Setting

Command：$TSC,SAV*2C<CR><LF>

Response：ACK／NAK



Request for RAW data output at your desirable output cycle. Enter the SAV command, and confirm the ACK response.



From the next startup, IMU outputs the data at the same cycle as when the SAV command is executed.

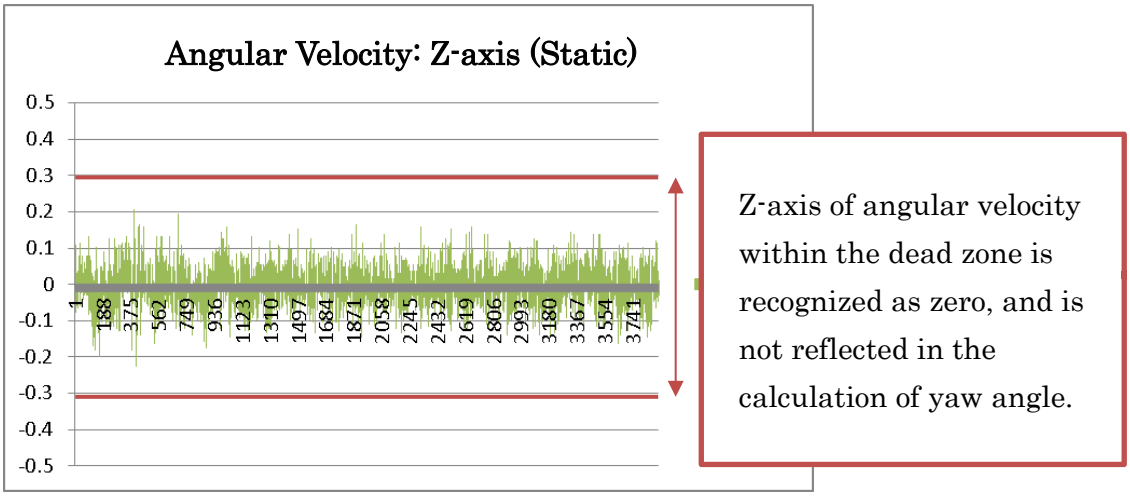
The SAV command is **not** initialized by ARST command (initialization). It is possible to return to the initial setting by resending SAV command with IMU stopped.

YAWF command (Yaw dead zone setting)

In order to suppress the yaw angle drift in static condition, Yaw dead zone can be set. Within the dead zone, the Z-axis angular velocity input is judged to be zero and is not reflected in the calculation of the yaw angle. It is recommended to lower the setting value when you want to measure the low speed range.

■Usage

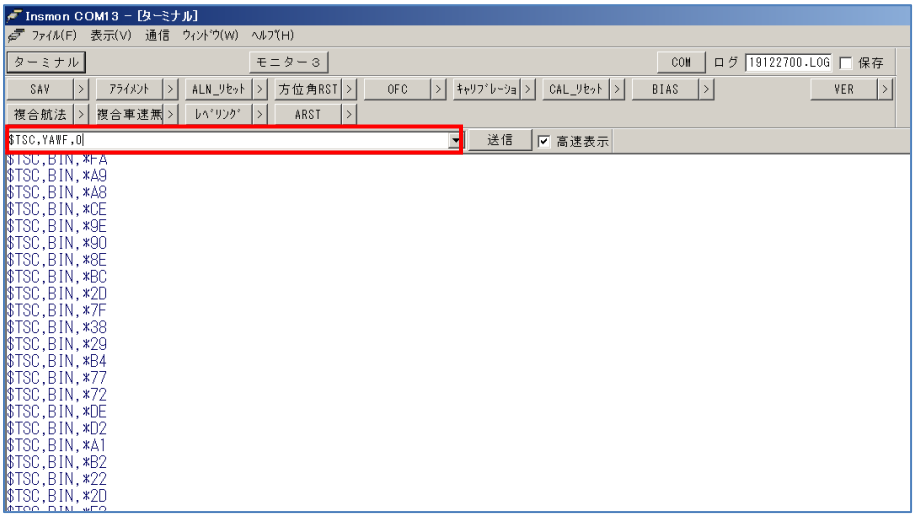
Initial Setting (Dead zone 0.3° /sec)



■Settings

Command: $TSC,YAWF, a*CC<CR><LF> (a: Dead Zone: [deg/sec])

Response: ACK response / NAK response

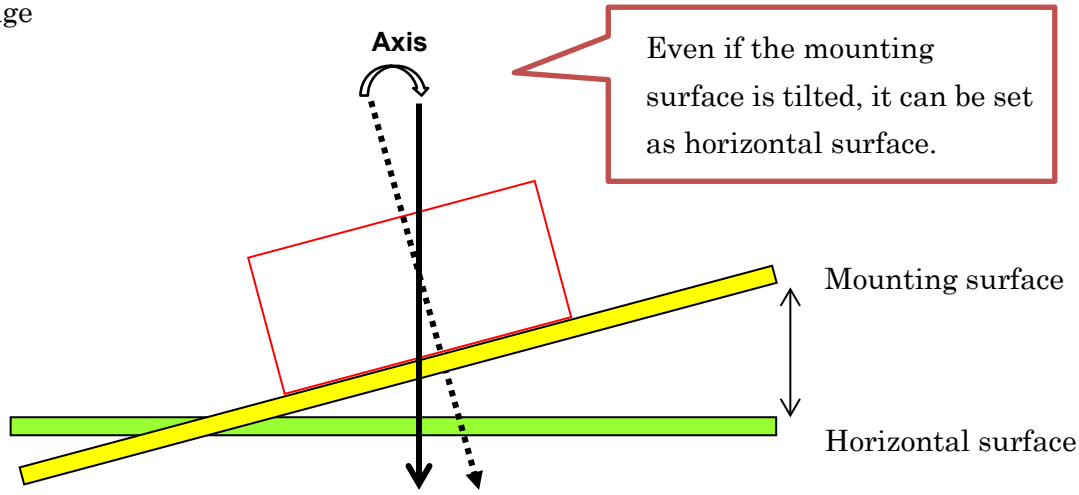


You can send the command from InsMon. Please input the command directly in the command field. Make sure that you can receive Ack message and turn-off the device.

ALGN Command (Alignment compensation)

If there is a mounting error or tilt on the IMU, that position can be set as horizontal attitude. Realignment may not be performed correctly if the previous alignment value is stored. Therefore, please conduct RALN (reset alignment) command and restart IMU before realignment.

■Usage

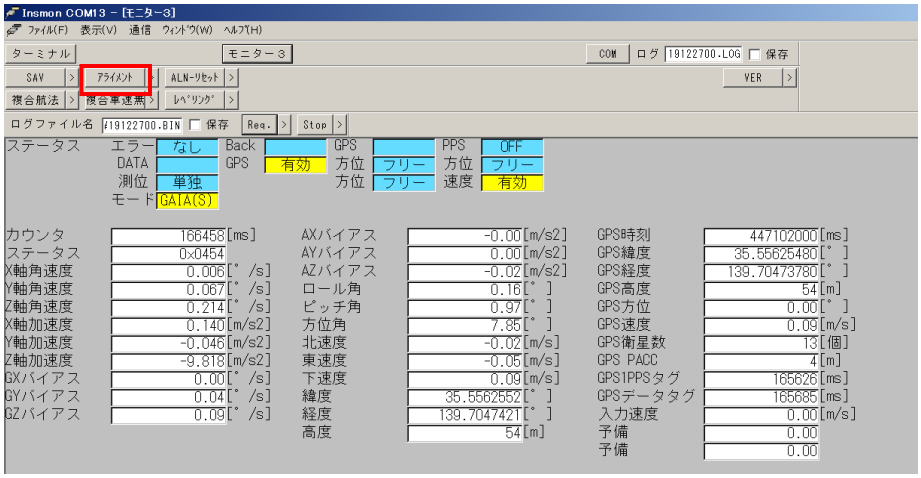


By sending RALN command (Alignment compensation reset), it is possible to return to the initial setting.

■Setting

Command: $TSC,ALGN*6C<CR><LF>

Response: ACK response / NAK response



You can send the command from InsMon. Please click [ALGN] button. Make sure that you can receive Ack message and turn-off the device.

AXIS Command (Axis setting)

The axis definition can be changed by this command. In case you need to install IMU in a vertical direction, please send this command. The definition of axis is specified as follows.

Command: $TSC,AXIS,a*CC<CR><LF>

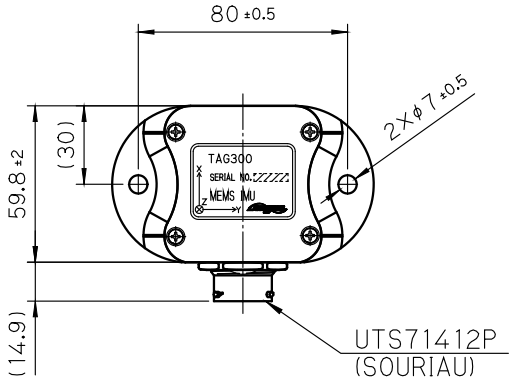
a: Axis setting

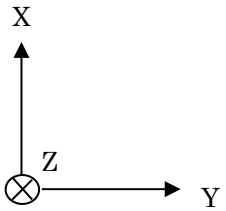
1: Positive Z-axis points down into the ground (Initial setting)

2: Positive X-axis is reverted to Positive Z-axis.

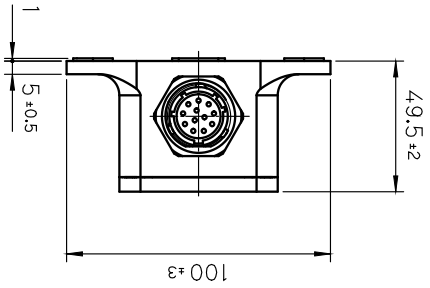
3: Positive Y-axis is reverted to Positive Z-axis.

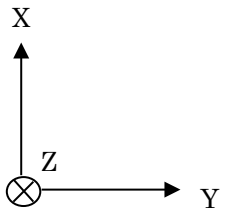
1: Positive Z-axis points down into the ground.



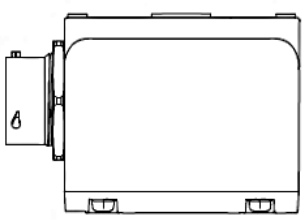


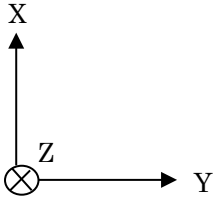
2: Positive X-axis is reverted to Positive Z-axis.





3: Positive Y-axis is reverted to Positive Z-axis.



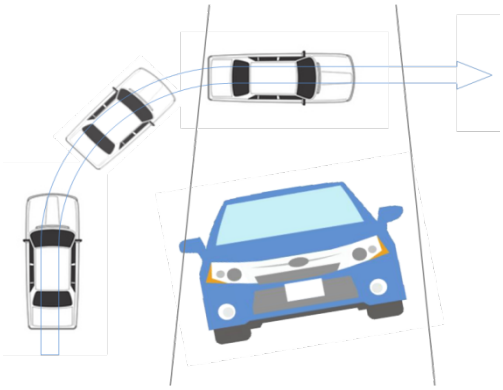


GVS Command (GNSS/INS/VS Mode)

You can change the operation mode to GNSS/INS/VS mode by this command. The initial setting is Leveling mode, so it is necessary to make a setting to use GNSS/INS/VS mode. There are 2 types of GNSS/INS/VS mode, which are GNSS/INS/VS (GVS1) and GNSS/INS (GVS2). If you input the vehicle speed from an external device, the position accuracy gets better.

■Usage

Dead-reckoning



Accurate attitude angle measurement during cornering

■Setting

GVS1 command (GNSS/INS with vehicle speed)

Command: $TSC,GVS1*1B<CR><LF>

Response: ACK response / NAK response

GVS2 command (GNSS/INS without vehicle speed)

Command: $TSC,GVS2*CC<CR><LF>

Response: ACK response / NAK response

※Please be careful that the initial setting is Leveling Mode.

※Please refer to section 1 in this manual for switching the operation mode by InsMon.

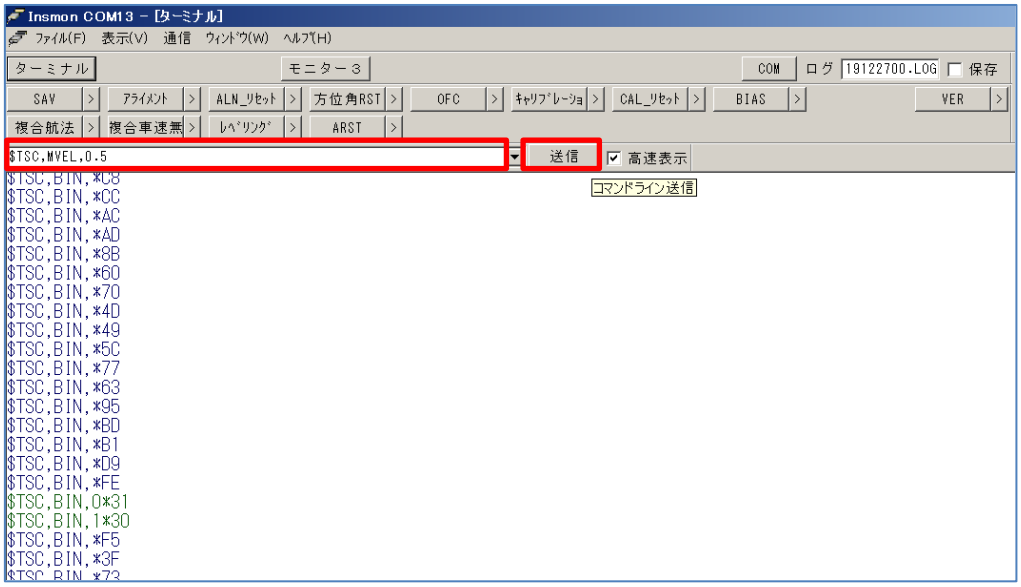
MVEL Command (GPS Dependence Speed)

This command changes the GPS Dependence Speed. If the GPS speed exceeds the setting value, the IMU will trust the GPS and follows the GPS heading. The accuracy of the GPS heading may be deteriorated as the vehicle speed gets slower. The device measures the yaw angle by integrating the angular velocity of Z axis when GPS speed does not reach the setting value. The initial setting is 0.2m/s.

■Setting

Command: $TSC,MVEL,a*CC<CR><LF>

Response: ACK response / NAK response



You can send the command from InsMon. Please input the command directly in the command field. Make sure that you can receive Ack message and turn-off the device.

ARST Command (Initialization)

This command resets all settings **except for SAV command**. It will be validated from the next startup.

■Setting

Command: $TSC,ARST*7C <CR><LF>

Response: ACK response / NAK response