



GyrAnt

Application Notes

Version 1.0

Last Revised July 5, 2012

**All contents in this manual are copyrighted by JAVAD GNSS.
All rights reserved. The information contained herein may not be used, accessed, copied,
stored, displayed, sold, modified, published, or distributed, or otherwise reproduced without express written
consent from JAVAD GNSS**

GYRANT APPLICATION NOTES

1. Overview

GyrAnt combines an Inertial Measurement Unit (IMU) and a GNSS antenna. The IMU consists of three gyro sensors and three accelerometers oriented along mutually orthogonal axes placed in a water-resistant aluminum antenna housing. The IMU provides measurements of angular velocity and acceleration. The accelerometers used are biaxial XY SCA-1000 and biaxial ZY SCA-1020 (in the second accelerometer, only measurements along Z-axis are used). The gyroscopes are Analog Devices ADXRS 652. The IMU consists of a power supply, ADC, and a processor controlling inertial data sampling and sending the measurements through the RS-422 and CAN ports. Compensation for temperature zero drift and calibration of the scale factors and sensor axes misalignment are implemented in the IMU. The sampling rate is 100 Hz.

The system consisting of GyrAnt and a GNSS receiver makes it possible to improve the position and velocity estimates and provides the attitude estimate. The system operates both in the standalone and DGPS modes. Switching to the DGPS mode does not require any special settings.

2. Interface

The sensor measurements are transmitted simultaneously via the CAN port at 500 kbit/s rate and via the RS-422 port at fixed baud rate 115200 bit/s. The M12 connector pinout is shown in Table 1.

Table 1.

Pin #	Signal	I/O	Description
1	PWR	I	+10 to +40 VDC Power Input
2	GND		Power Ground
3	TXDD+	O	RS-422 port TXD+ line
4	TXDD-	O	RS-422 port TXD- line
5	RXDD+	I	RS-422 port RXD+ line
6	RXDD-	I	RS-422 port RXD- line
7	CANH	I/O	CAN port CAN-H line
8	CANL	I/O	CAN port CAN-L line

The IMU axes of sensitivity form an orthogonal reference frame as shown in Figure 1.

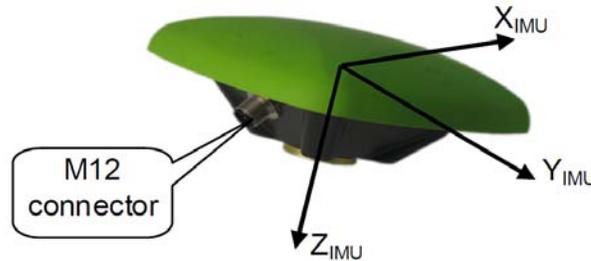


Figure 1.

The binary message ‘MI’ of the jps type transmitted via the RS422 port has the following structure:

[MI] Measurements Inertial

```
struct MI {17} {
    u2 ax; // Acceleration along the XIMU axis
    u2 ay; // Acceleration along the YIMU axis
    u2 az; // Acceleration along the ZIMU axis
    u2 wx; // Angular velocity along the XIMU axis
    u2 wy; // Angular velocity along the YIMU axis
    u2 wz; // Angular velocity along the ZIMU axis
    u2 t1; // Temperature of the accelerometer ‘X-Y’
    u2 t2; // Temperature of the accelerometer ‘Y-Z’
    u1 cs; // Checksum
};
```

Two messages, id=0x090 and id=0x098, are transmitted via the CAN port. The content of the messages is described below.

Id 0x090

Bit	Data
63..48	Acceleration along the Z _{IMU} axis
47..32	Acceleration along the Y _{IMU} axis
31..16	Acceleration along the X _{IMU} axis
15..08	Reserved
07..00	Temperature of the accelerometer ‘X-Y’

Id 0x098

Bit	Data
31..16	Angular velocity along the Z_{IMU} axis
47..32	Angular velocity along the Y_{IMU} axis
63..48	Angular velocity along the X_{IMU} axis
15..08	Reserved
07..00	Temperature of the accelerometer 'Y-Z'

Warning: *Not to lose the calibration parameters, do not disassemble GyrAnt.*

3. Installing GyrAnt

Mount GyrAnt firmly on the vehicle body at a place where the vibration is minimal and connect the antenna cable and the communication cable to the GNSS receiver. The GyrAnt's X-Y plane should be parallel to the floor plane of the vehicle, with the GyrAnt's X-axis (X_{IMU}) being parallel to the longitudinal axis of the vehicle and oriented in the nose direction of the vehicle (Fig. 2).

Configure the system using commands described in Section 4.

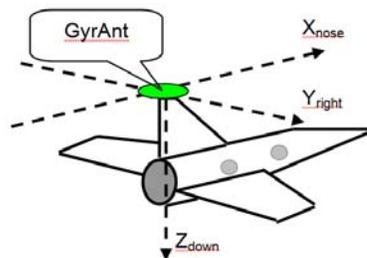


Figure 2.

After switching power on, the system turns to the initialization stage, which lasts about 5 s. It is desirable to provide immobility of GyrAnt during this time. Start motion in the forward direction (positive direction of the longitudinal axis of the vehicle) and keep it for a few seconds. If these requirements are not satisfied, the initial heading and sensor biases of the IMU can be estimated incorrectly.

4. Setting JAVAD GNSS receiver for integration with GyrAnt

This section describes the command interface with the JAVAD GNSS receiver.

4.1. If the receiver has a power supply, GyrAnt can be powered from it. To switch the power on, send the command

```
set,pwr/ic/ext,on
```

4.2. The following settings are required to configure the CAN port for reception of the inertial measurements from GyrAnt:

To set the baud rate, send the command

```
set,/par/dev/can/a/rate,500
```

To set the 'command' input mode, send the command

```
set,/par/dev/can/a/imode,cmd
```

If the port `/par/dev/can/b` is used for communication, the commands must be changed accordingly, i.e.

```
set,/par/dev/can/b/rate,500
```

```
set,/par/dev/can/b/imode,cmd
```

4.3. If the RS-422 port is used, then

To set the baud rate, send the command

```
set,/par/dev/ser/<port>/rate,115200
```

Usually, port 'd' is configured as the RS-422 port in the receiver.

To set the 'jps' input mode, send the command

```
set,/par/dev/ser/<port>/imode,jps
```

4.4. If the GNSS data are not available, the solution is obtained based on the IMU data. The following command sets the extrapolation time T in seconds

```
set,/par/pos/ins/texttr,T
```

where T may take values from the range [0..900]; the default value is 900.

If the GNSS data disappear for more than the extrapolation time T, the system stops working and the messages become invalid.

4.5. To substitute the IMU+GNSS data for the GNSS data in all messages (if required), use the command

```
set,/par/pos/ins/subst,[on/off], the default value is off
```

Note: The above settings are stored in the nonvolatile memory of the receiver until the memory is cleared, and it is not required to repeat them upon subsequent uses of the system.

5. Accuracy degradation

Degradation of accuracy for the attitude, position, and velocity caused by outages of the GNSS measurements estimated for noise-like GNSS errors and errors of initial conditions for GyrAnt working in autonomous mode is shown in the Table 2.

Table 2.

Time outage [s]	Velocity vector degradation [m/s]	Horizontal position degradation [m]	Vertical position degradation [m]	Roll degradation [degrees]	Pitch degradation [degrees]	Heading degradation [degrees]
5	0.4	0.9	0.2	0.1	0.1	0.2
15	1.2	8.5	1.1	0.2	0.3	0.5
60	6.5	170.0	16.0	0.5	0.6	0.8

Note: The estimates of degradation are obtained from tests on an airplane.

6. Messages

[at] Attitude

```
struct at {18} {
    u4 time;        // Time [s]
    f4 roll;        // Roll angle [rad]
    f4 pitch;       // Pitch angle [rad]
    f4 heading;     // Heading angle [rad]
    u1 flag;        // Solution validity flag
    u1 cs;          // Checksum
};
```

[AW] Inertial measurements

```
struct AW {29}{
    f4 ax; // Acceleration along the XIMU axis [m/s2]
    f4 ay; // Acceleration along the YIMU axis [m/s2]
    f4 az; // Acceleration along the ZIMU axis [m/s2]
    f4 wx; // Angular velocity along the XIMU axis [rad/s]
    f4 wy; // Angular velocity along the YIMU axis [rad/s]
    f4 wz; // Angular velocity along the ZIMU axis [rad/s]
    f4 t;  // Temperature [deg C]
    u1 cs; // Checksum
};
```

All messages described in GREIS [1] can also be used in the system.

For test purposes, it is convenient to use the special message DB. The DB message has the following structure:

```
struct DB {149} {
    u4 time;        // Time [s]
    u4 num_meas;    // The number of satellites
    f4 roll;        // Roll angle [rad]
    f4 pitch;       // Pitch angle [rad]
    f4 heading;     // Heading angle [rad]
    f4 wxbias;      // Bias of the gyro along the XIMU axis [rad/s]
    f4 wybias;      // Bias of the gyro along the YIMU axis [rad/s]
    f4 wzbias;      // Bias of the gyro along the ZIMU axis [rad/s]
    f4 axbias;      // Bias of the accelerometer along the XIMU axis [m/s2]
    f4 aybias;      // Bias of the accelerometer along the YIMU axis [m/s2]
    f4 azbias;      // Bias of the accelerometer along the ZIMU axis [m/s2]
    f4 ax;          // Acceleration along the XIMU axis [m/s2]
    f4 ay;          // Acceleration along the YIMU axis [m/s2]
};
```

```
f4 az;          // Acceleration along the ZIMU axis [m/s2]  
f4 wx;          // Angular velocity along the XIMU axis [rad/s]  
f4 wy;          // Angular velocity along the YIMU axis [rad/s]  
f4 wz;          // Angular velocity along the ZIMU axis [rad/s]  
f4 vxgps;       // GPS velocity along the X axis of WGS84 [m/s]  
f4 vxins;       // GPS+INS velocity along the X axis of WGS84 [m/s]  
f4 vygps;       // GPS velocity along the Y axis of WGS84 [m/s]  
f4 vyins;       // GPS+INS velocity along the Y axis of WGS84 [m/s]  
f4 vzgps;       // GPS velocity along the Z axis of WGS84 [m/s]  
f4 vzins;       // GPS+INS velocity along the Z axis of WGS84 [m/s]  
f8 xgps;        // x-coordinate of the GPS position in WGS84 [m]  
f8 xins;        // x-coordinate of the GPS+INS position in WGS84 [m]  
f8 ygps;        // y-coordinate of the GPS position in WGS84 [m]  
f8 yins;        // y-coordinate of the GPS+INS position in WGS84 [m]  
f8 zgps;        // z-coordinate of the GPS position in WGS84 [m]  
f8 zins;        // z-coordinate of the GPS+INS position in WGS84 [m]  
f8 dtpr;        // Position error due to GPS receiver clock error [m]  
u1 cs;          // Checksum  
};
```

7. References

[1] GNSS Receiver External Interface Specification (GREIS), <http://www.javad.com>



900 Rock Avenue, San Jose, CA 95131 USA

Phone: +1(408)770-1770

Fax: +1(408)770-1799

www.javad.com

Copyright © JAVAD GNSS, Inc., 2012
All rights reserved. No unauthorized duplication.