Technical Manual

Marion GA3390R
INS/GPS Integrated Navigation System

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1. Introduction

The Marion GA3390R is an INS/GPS integrated system that can be used to measure position, velocity, attitude, angular rate and acceleration under dynamic conditions. It is a highly integrated, compact, light, and fully self-contained navigation system. It encloses three gyroscopes, three accelerometers, three magnetometers, a pressure sensor (external and optional), and a GPS receiver. The GA3390R calculates stabilized position and attitude by fusing gyroscope, accelerometer, and GPS information. In its basic operation, it provides raw IMU data such as angular rates and accelerations. It can also provide attitude, position and static pressure, the latter can be used to determine altitude. The data update rate is 100Hz. Internally, it implements a Kalman filter that integrates inertial sensor data and GPS information. A temperature compensation technique is used to improve the angular rate accuracy.

The Marion GA3390R has the following features:

- UART RS-422 output
- Low power consumption
- Compact package
- Fully self-contained
- Position, velocity, attitude output (100Hz maximum)
- Raw rate and acceleration output
- Customized bandwidth (optional)

The Marion GA3390R is highly optimized for the following applications:

- Robotics navigation
- Platform stabilization
- Attitude reference systems
- Control and guidance systems
- Unmanned air vehicles (UAV)
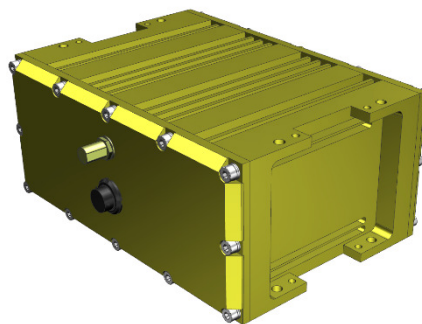- Vehicle instrumentation

Figure 1: Marion GA3390R

NOTICE: We recommend extensive testing of this product before using it in the final application. Specifically, this product should be tested in the same environmental conditions of the intended final use. Furthermore, we strongly recommend caution when using our product in sensitive applications that can cause injures, death or property damage due to the wrong operation of this product, which may be caused by unexpected environmental changes such as temperature, shock, excessive and continuous vibration, etc. These applications include but are not limited to:

- **Aircraft equipment**

- **Air vehicles**

- **Aerospace equipment**

- **Underwater vehicles…**

- **Medical equipment**

- **Transportation equipment**

- **Disaster/crime prevention equipment**

- **Applications which require high reliability and accuracy**

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2. Hardware Description

2.1 System Description

The Marion GA3390R is a compact, light and low-power consumption navigation system. It uses a MEMS type inertial sensor. It incorporates internal voltage regulation to minimize the effects caused by power supply noise. The input voltage range is 6 V to 18 V, we strongly recommend using **12 V** for low power consumption applications and to prevent problems associated with sensor overheating.

2.2 System Operation

Figure 2 shows a simple system block diagram for the Marion GA3390R. The analog signals from the MEMS inertial sensors are digitalized using a fast and precise A/D converter. The Kalman filter stages are used to estimate sensor and navigation errors, which are fed back to inertia navigation system to compensate the errors. ADS(Air Data System) is optional function. It works with command input containing air data.
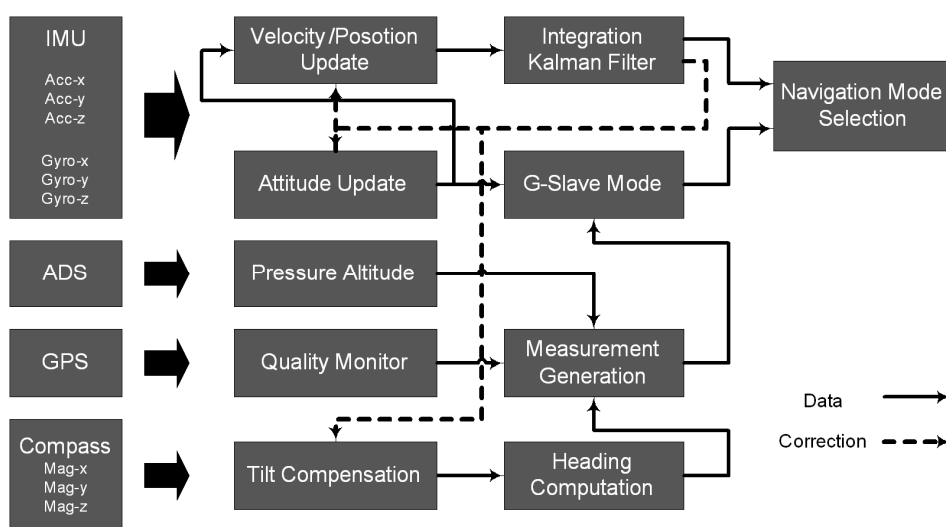
Figure 2: Marion GA3390R system block diagram.

2.3 Pin Description

The Marion GA3390R interfaces using a 10-pin circular connector (see Figure 3) and the pin description is presented in Table 1. The external antenna uses a SMA type connector (see Figure 4).

Figure 3: Marion GA3390R connector shape and pin arrangement (SJMVG501-10SX)

Figure 4: Marion GA3390R GPS antenna connector (SMA type)

Table 1: Marion GA3390R pin description

No.Pin	Pin name	Description	비고
1	VDC+12V	System power DC+12V	
2	VDC+12V	System power DC+12V	
3	VDC+12V RTN	System Power DC+28V Return(GND)	

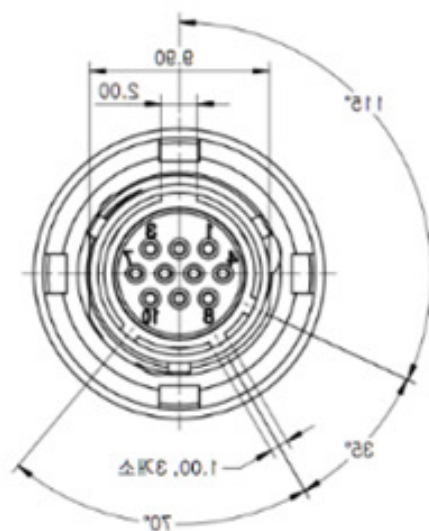| No.Pin	Pin name	Description	비고
4	VDC+12V RTN	System Power DC+28V Return(GND	
5	NAVI_TX+	Navigation Data, RS-422 TX+	
6	NAVI_TX-	Navigation Data, RS-422 TX-	
7	CMD_RX+	Command, RS-422 RX+	
8	CMD_RX-	Command, RS-422 RX-	
9	GPS_1PPS_RTN	GPS 1PPS Return	
10	GPS_1PPS	GPS 1PPS, Discrete output, LVTTL	

2.4 Mounting Information (Coordinate System)

The Marion GA3390R uses the right handed coordinate system as shown in Figure 5. To obtain accurate attitude, it must mount properly, otherwise it can introduce attitude errors. Other coordinate systems are available as an option.
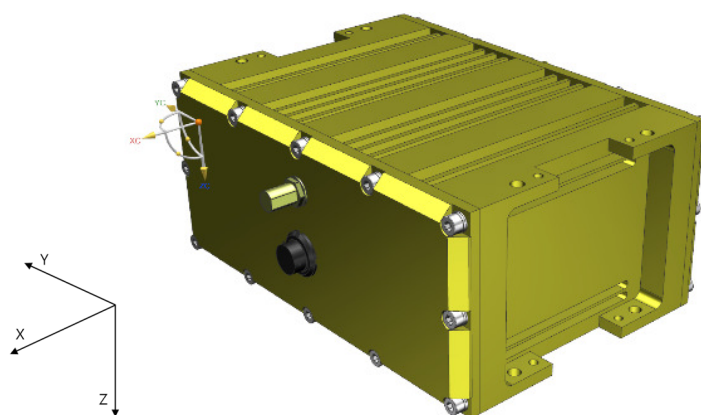

Figure 5: Marion GA3390R coordinates system

3. Software Description

The Marion GA3390R outputs navigation data when system power is applied. Functional command input and the format of navigation data are presented in 6. Appendix A.

- Command and output Baud rate : 230400

- Output rate : up to 100Hz

- Packet form : MSB(Most Significant Bit) First

- Checksum : CRC16

4. System Operation

4.1 Operating Modes

The Marion GA3390R has 3 different operating modes.

Coarse/fine alignment mode

The coarse/fine alignment mode is needed to estimate the system initial states such as position, attitude and inertial sensor initial errors (i.e. gyroscope rate bias). The coarse/fine alignment mode is an essential procedure for the INS/GPS integrated mode, and takes about one minute under static conditions..

INS/GPS integrated mode

The INS/GPS integrated navigation mode is the Marion GA3390R most important one. In this mode, the position and velocity error are compensated using GPS position information. Furthermore, attitude error (including heading), time varying inertial sensor bias and scale factor errors can be compensated. In this mode, the navigation error is not influenced by system dynamics contrary to the AHRS mode. The system automatically selects between the INS/GPS and the AHRS mode depending on the GPS operating status.

AHRS mode

If GPS information is not available, the system operates in AHRS mode. This mode gives attitude information with bounded error, however it is influenced by the system dynamic. Therefore, the attitude error is expected to be larger than the observed in the INS/GPS integrated mode.

Figure 6 shows the mode changing cycle for the Marion GA3390R.
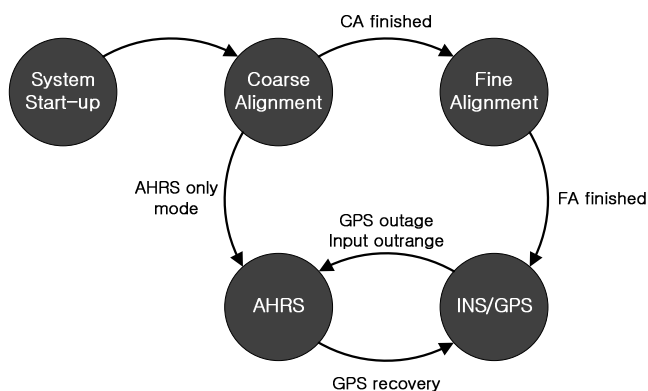
4.2 System start-up

Figure 6: Marion GA3390R mode changing cycle

The Marion GA3390R startup time (coarse/fine alignment) is less than 60 seconds for INS/GPS integrated navigation mode.

WARNING: The Marion GA3390R must remain stationary during the startup time, failing to do so will introduce errors.

5. System Characteristics

Table 2, Table 3, Table 4, and Table 5 summarize the main characteristics of the Marion GA3390R. The specifications are subject to change without notice and several parameters can be changed per customer request as an option.

5.1 Physical Characteristics

Table 2: Marion GA3390R physical characteristics.

Characteristic	Value	Unit
Size (L, W, H)	145.0 × 115.5 × 65.0(Including connector)	mm
Weight	< x.x	kg

5.2 Environmental Characteristics

Table 3: Marion GA3390R environmental characteristics.

Characteristic	Value
Pressure	-
Vibration	-
Humidity	-
Temperature	-
Electromagnetic waves	-

5.3 Electrical Characteristics

Table 4: Marion GA3390R electrical characteristics.

Parameter		Condition	Value			Unit
			Min.	Typ.	Max.	
Power	INPUT VOLTAGE	Operating	6		18	V
		Recommended		12		V
	CURRENT	@ 12 V		416	667	mA
	POWER	@ 12 V		<5	<8	W
Signal		Digital Output	RS-422 [1]			
Data Rate		Adjustable			100	Hz

(1) Default: 230,400 bps, 8 data bit, 1 stop bit, and no parity

<u>CAUTION</u>

ESD (electrostatic discharge) sensitive device. Electrostatic charges as high as 4000 V readily accumulate on the human body and test equipment and can discharge without detection. Permanent damage may occur on devices subjected to high-energy electrostatic discharges. Therefore, proper ESD precautions are recommended to avoid performance degradation or loss of functionality.

5.4 Performance Characteristics

Table 5: Marion GA3390R mechanical characteristic

Characteristic	Name	Value	Unit
Input range	Rate	± 150	deg/sec
	Acceleration	± 10	g
Position error	Horizontal	<5.0	m[CEP]
	Vertical	<10.0	m[RMS]
Velocity error	Horizontal	<0.5	m/s[RMS]
	Vertical	<1.0	m/s[RMS]
Attitude error	Roll(w/o GPS)	<0.5(2.0)	deg[RMS]
	Pitch(w/o GPS)	<0.5(2.0)	deg[RMS]
	Heading(w/o GPS)	<1.0(2.0)	deg[RMS]

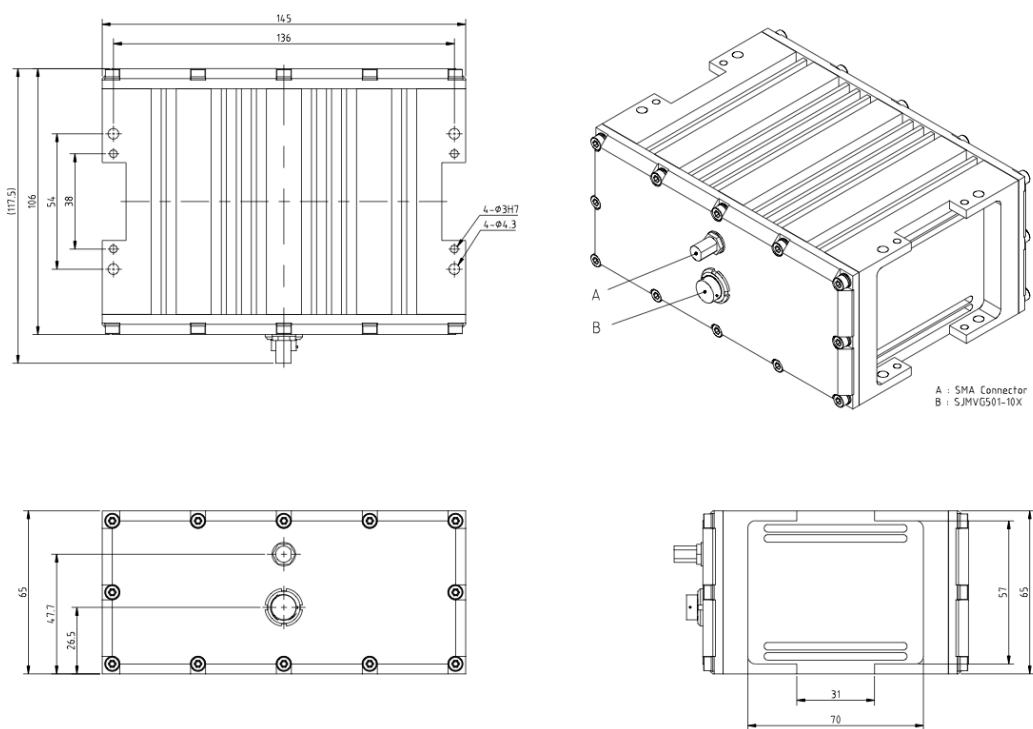## 5.5 Mechanical Characteristic

Figure 7: Marion GA3390R mechanical characteristic (unit: mm)

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