MICROINFINITY

Technical Manual

Marion GA6370R
INS/GPS Integrated Navigation System

2014. 05. 02

http://www.minfinity.com

Contact Info.
EMAIL: support@minfinity.com, **TEL: +82 31 546 7408 FAX: +82 31 546 7409**

Contents

List of Figures

List of Tables

1. Introduction

The Marion GA6370R 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 and a GPS receiver. The GA6370R calculates stabilized position and attitude by fusing gyroscope, accelerometer, magnetometer (external, optional), 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 velocity. The data update rate is 100Hz. Internally, it implements a Kalman filter that integrates inertial sensor data and GPS information.

The Marion GA6370R 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

The Marion GA6370R 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 GA6370R

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**

Disclaimer and Limitation of Liability for Damages.

Microinfinity shall not be liable, under any circumstances, for any special, indirect, incidental, consequential, or contingent damages for any reason, whether or not the buyer has been advised of the possibility of such damages.

2. Hardware Description

2.1 System Description

The Marion GA6370R is a compact, light and low-power consumption navigation system. It uses a RLG(Ring laser Gyro). It incorporates internal voltage regulation to minimize the effects caused by power supply noise. The input voltage range is 19 V to 40 V, we strongly recommend using **28 V** and to prevent problems associated with sensor overheating.

2.2 System Operation

Figure 2 shows a simple system block diagram for the Marion GA6370R. Kalman filter using IMU data and GPS signal are used to update velocity, position and attitude. And the Kalman filter stages are also used to estimate sensor and navigation errors, which are fed back to inertial navigation system to compensate the errors.

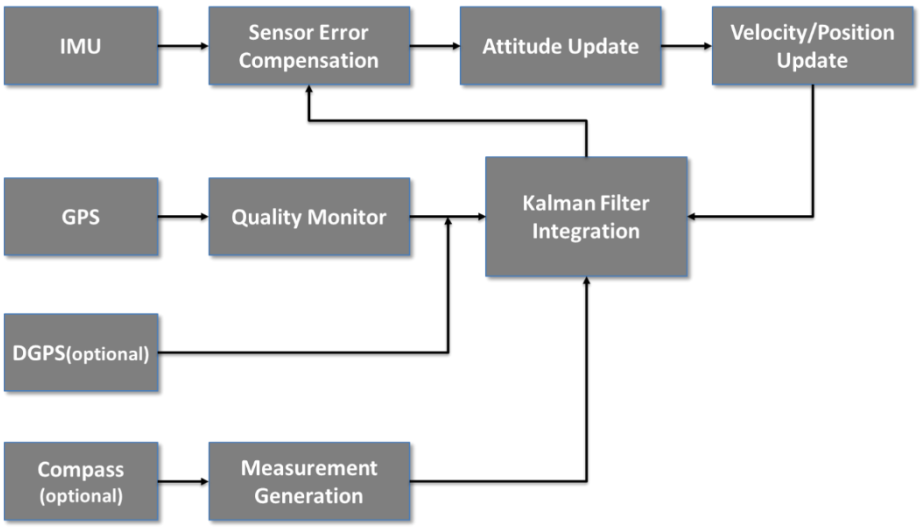

Figure 2: Marion GA6370R system block diagram.

2.3 Pin Description

The Marion GA6370R interfaces using a 32-pin circular connector (see Figure 3) and the pin description is presented in Table 1. The external antenna uses a TNC type connector (see Figure 4).

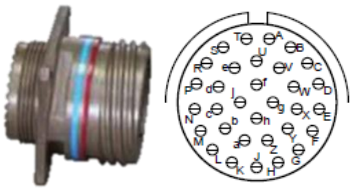

Figure 3: Marion GA6370R connector shape and pin arrangement.

Figure 4: Marion GA6370R GPS antenna connector (TNC type)

Table 1: Marion GA6370R pin description

No.Pin	Pin name	Description	비고
A	FCC_RTN	FCC, RS-422 Return(GND)	
B	FCC_TX+	FCC, RS-422 TX+	
C	DGPS_RX+	DGPS, RS-422 RX+	
D	DGPS_RX-	DGPS, RS-422 RX-	
E	DIS_OUT1	Discrete output 1, TTL	
F	-	-	
G	-	-	
H	-	-	
J	VDC+28V	System power DC+28V	
K	VDC+28V_RTN	System Power DC+28V Return(GND)	
L	VDC+15V	Magnetometer DC+15V	
M	VDC+15V_RTN	Magnetometer DC+15V Return(GND)	

No.Pin	Pin name	Description	비고
N	IMG_TX	DBG Port, RS-232 TX	
P	IMG_RTN	DBG Port, RS-232 Return(GND)	
R	MAG_RTN	Magnetometer signal, RS-232 Return(GND)	
S	MAG_RX	Magnetometer signal, RS-232 RX	
T	FCC_RX+	FCC, RS-422 RX+	
U	FCC_RX-	FCC, RS-422 RX-	
V	FCC_TX-	FCC, RS-422 TX-	
W	DGPS_RTN	DGPS, RS-422 Return(GND)	
X	DIS_IN 1	Discrete input 1, TTL	
Y	-	-	
Z	-	-	
a	-	-	
b	-	-	
c	-	-	
d	IMG_RX	DBG Port, RS-232 RX	
e	MAG_TX	Magnetometer signal, RS-232 TX	
f	DGPS_TX+	DGPS, RS-422 TX+	
g	DGPS_TX-	DGPS, RS-422 TX-	
h	-	-	
j	GPS_1PPS	GPS 1PPS, Discrete output, LVTTL	

2.4 Mounting Information (Coordinate System)

The Marion GA6370R 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.

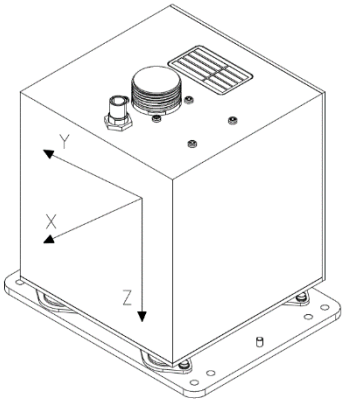

Figure 5: Marion GA6370R coordinates system

3. Software Description

The Marion GA6370R outputs navigation data when system power is applied. The format of navigation data and IBIT command are presented in Table 2, Table 3, and Table 4. Optionally, DGPS can be used. DGPS data format is presented in Table 5.

- IBIT Command and output Baud rate : 230400
- Output rate : up to 100Hz
- Packet form : MSB(Most Significant Bit) First
- Checksum : Exclusive-or

Table 2: Marion GA6370R IBIT Command

Byte Index	Name	Byte Type	Byte Size	Range	Unit	Scale	Resolution	Remark
0	Message Header	Uint16	2	N/A	N/A	N/A	N/A	0xF6F6
2	IBIT Request	Uint8	1	N/A	N/A	N/A	N/A	0xB7
3	Echo Counter	Uint8	1	N/A	N/A	N/A	N/A	0~255
4	Reserved	Uint8	1	N/A	N/A	N/A	N/A	
5	Reserved	Uint8	1	N/A	N/A	N/A	N/A	
6	Checksum	Uint16	2	N/A	N/A	N/A	N/A	Xor

Table 3: Marion GA6370R navigation data Packet

Byte Index	Name	Byte Type	Byte Size	Range	Unit	Scale	Resolution	Remark
0	Message Header	Uint16	2	N/A	N/A	N/A	N/A	0xA6A6
2	ID Number	Uint8	1	N/A	N/A	N/A	N/A	0x00
3	INS time stamp	Uint16	2	0~65535	N/A	N/A	N/A	
5	UTM Y	Float64	8	0~1e7	m	1	0.01	
13	UTM X	Float64	8	0~1e6	m	1	0.01	
21	Latitude	Float64	8	-90~90	Deg	1	1e-7	
29	Longitude	Float64	8	-180~180	Deg	1	1e-7	
37	Height(above MSL)	Float32	4	-1000~6000	m	1	0.1	
41	Roll angle	Int16	2	-180~180	Deg	0.01	0.01	
43	Pitch angle	Int16	2	-90~90	Deg	0.01	0.01	
45	Yaw angle	UInt16	2	0~360	Deg	0.01	0.01	
47	Magnetometer yaw angle	UInt16	2	0~360	Deg	0.01	0.01	
49	N-S velocity	Int16	2	±250	m/s	0.04	0.04	
51	E-S velocity	Int16	2	±250	m/s	0.04	0.04	
53	Vertical velocity	Int16	2	±250	m/s	0.04	0.04	
55	Body longitudinal rate	Int16	2	±1000	Deg/s	0.04	0.04	
57	Body lateral rate	Int16	2	±1000	Deg/s	0.04	0.04	
59	Body normal rate	Int16	2	±1000	Deg/s	0.04	0.04	
61	Body longitudinal acceleration	Int16	2	±37	g	0.005	0.005	
63	Body lateral acceleration	Int16	2	±37	g	0.005	0.005	

65	Body normal acceleration	Int16	2	±37	g	0.005	0.005	
67	Body longitudinal magnetometer	Int16	2	±2	Gauss	1e-4	1e-4	
69	Body lateral magnetometer	Int16	2	±2	Gauss	1e-4	1e-4	
71	Body normal magnetometer	Int16	2	±2	Gauss	1e-4	1e-4	
73	Gdop	Uint16	2	0~100	N/A	0.1	0.1	
75	Pdop	Uint16	2	0~100	N/A	0.1	0.1	
77	Hdop	Uint16	2	0~100	N/A	0.1	0.1	
79	GPS latitude	Float64	8	-90~90	Deg	1	1e-7	
87	GPS longitude	Float64	8	-180~180	Deg	1	1e-7	
95	GPS Altitude (above MSL)	Float32	4	-1000~6000	m	1	0.1	
99	GPS heading	Uint16	2	0~360	Deg	0.01	0.01	
101	GPS horizontal speed	Uint16	2	0~250	m/s	0.04	0.04	
103	GPS ROC(Rate of Climb)	Int16	2	-250~250	m/s	0.04	0.04	
105	GPS Time	Float32	4	N/A	msec	1	0.001	
109	UTM Longitude Zone	Uint8	1	1~60	N/A	N/A	N/A	
110	PBIT	Uint16	2	N/A	N/A	N/A	N/A	See Table 4.
112	IBIT	Uint16	2	N/A	N/A	N/A	N/A	See Table 4.
114	CBIT	Uint16	2	N/A	N/A	N/A	N/A	See Table 4.
116	Navigation mode	Uint8	1	N/A	N/A	N/A	N/A	See Table 4.
117	GPS status	Uint8	1	N/A	N/A	N/A	N/A	See Table 4.
118	Tracked satellite	Uint8	1	0~60	N/A	N/A	N/A	

	number							
119	Latitude covariance	Float64	8	-	rad^2	data^2	-	
127	Longitude covariance	Float64	8	-	rad^2	data^2	-	
135	Height covariance	Float32	4	-	m^2	data^2	-	
139	Roll covariance	Uint16	2	-	rad^2	(0.001* data)^2	-	
141	Pitch covariance	Uint16	2	-	rad^2	(0.001* data)^2	-	
143	Yaw covariance	Uint16	2	-	rad^2	(0.001* data)^2	-	
145	N velocity covariance	Uint16	2	-	(m/s)^2	(0.04* data)^2	-	
147	E velocity covariance	Uint16	2	-	(m/s)^2	(0.04* data)^2	-	
149	D velocity covariance	Uint16	2	-	(m/s)^2	(0.04* data)^2	-	
151	IBIT response flag	Uint8	1	N/A	N/A	N/A	N/A	0xB7
152	Echo counter	Uint8	1	N/A	N/A	N/A	N/A	
153	Reserved	Uint8	1	N/A	N/A	N/A	N/A	
154	Checksum	Uint16	2	N/A	N/A	N/A	N/A	Xor

Table 4: Bit descriptions of BIT, Navigation Mode, and GPS Status

Name	Bit	Description	Remark
PBIT	D15	Reserved	Set bit = Success, Reserved
	D14	Reserved	
	D13	Reserved	
	D12	Reserved	
	D11	Reserved	
	D10	Reserved	
	D09	Reserved	
	D08	Reserved	
	D07	Magnetometer	
	D06	IMU	
	D05	GPS	
	D04	Internal RAM	
	D03	Internal Flash	
	D02	Input power	
	D01	Magnetometer channel	
	D00	FCC channel	
	D15	Reserved	

IBIT	D14	Reserved	Set bit = Success, Reserved
	D13	Reserved	
	D12	Reserved	
	D11	Reserved	
	D10	Reserved	
	D09	Reserved	
	D08	Reserved	
	D07	Magnetometer	
	D06	IMU	
	D05	GPS	
	D04	Reserved	
	D03	Reserved	
	D02	Input power	
	D01	Magnetometer channel	
	D00	FCC channel	
CBIT	D15	Reserved	Set bit = Success, Reserved
	D14	Reserved	
	D13	Reserved	
	D12	Reserved	
	D11	Reserved	
	D10	Reserved	
	D09	Reserved	
	D08	Reserved	
	D07	Magnetometer	
	D06	IMU	
	D05	GPS	
	D04	Reserved	
	D03	Reserved	
	D02	Input power	
	D01	Reserved	
	D00	Reserved	
Navigation Mode	D07	Reserved	Set bit = Mode
	D06	Reserved	
	D05	Reserved	
	D04	Reserved	
	D03	Reserved	
	D02	INS	
	D01	GPS/INS	
	D00	Initial Alignment	
GPS Status	D07	Reserved	Set bit = Mode
	D06	Reserved	
	D05	Reserved	
	D04	Reserved	
	D03	DGPS	
	D02	3D Fix	
	D01	2D Fix	
	D00	Unfix	

Table 5: Marion GA6370R DGPS packet

- RTCM Recommended Standards for Differential GNSS (Global Navigation Satellite Systems) Service, Version 2.3.

4. System Operation

4.1 Operating Modes

The Marion GA6370R 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 3 minutes under static conditions..

INS/GPS integrated mode

The INS/GPS integrated navigation mode is the Marion GA6370R 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..

INS mode

If GPS information is not available, the system operates in INS mode. This mode gives navigation information with unbounded error. Therefore, the navigation 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 GA6370R.

4.2 System start-up

The Marion GA6370R startup time (coarse/fine alignment) is less than 180 seconds for INS/GPS integrated navigation mode.

WARNING: The Marion GA6370R must remain stationary during the startup time, failing to do so will introduce errors.

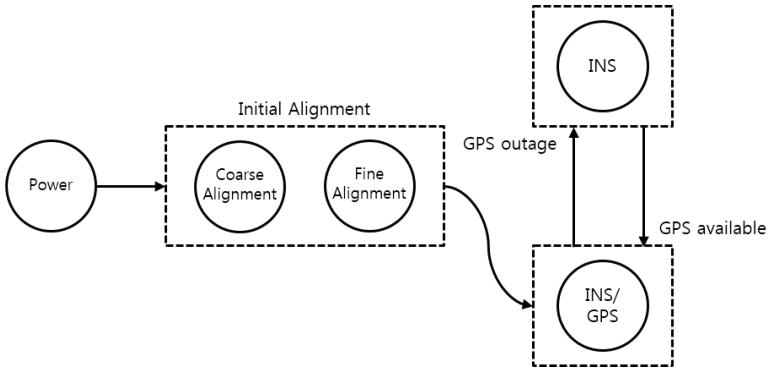

Figure 6: Marion GA6370R mode changing cycle

5. System Characteristics

Table 6, Table 7, Table 8, and Table 9 summarize the main characteristics of the Marion GA6370R. 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 6: Marion GA6370R physical characteristics.

Characteristic	Value	Unit
Size (L, W, H)	139.0 × 179.0 × 183.5(Including connector)	mm
Weight	< 3.0	kg

5.2 Environmental Characteristics

Table 7: Marion GA6370R environmental characteristics.

Characteristic	Value
Pressure	5Km
Vibration	MILSTD-810F, Method 514.5, procedure I, category 13
Humidity	MIL-STD-810F, Method 507.4, modified
Temperature	MIL-STD-810F, Method 501.4 MIL-STD-810F, Method 502.4
Electromagnetic waves	MIL-STD 461E (RE,RS,CE,CS)

5.3 Electrical Characteristics

Table 8: Marion GA6370R electrical characteristics.

Parameter		Condition	Value			Unit
			Min.	Typ.	Max.	
Power	INPUT VOLTAGE	Operating	19		40	V
		Recommended		28		V
	CURRENT	@ 28 V		400	1000	mA
	POWER	@ 28 V		<12		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

CAUTION

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 9: Marion GA6370R mechanical characteristic

Characteristic	Name	Value	Unit
Input range	Rate	± 1000	deg/sec
	Acceleration	± 37	g
Scale Factor	Gyro	150	ppm
	Accelerometer	300	ppm
Bias	Gyro	1	deg/hr
	Accelerometer	1	mG
Position error	Horizontal	<3.0	m[CEP]
	Vertical	<6.0	m[RMS]
Velocity error	Horizontal	<0.5	m/s[RMS]
	Vertical	<1.0	m/s[RMS]
Attitude error	Roll	<0.1	deg[RMS]
	Pitch	<0.1	deg[RMS]
	Heading	<1.0	deg[RMS]

5.5 Mechanical Characteristic

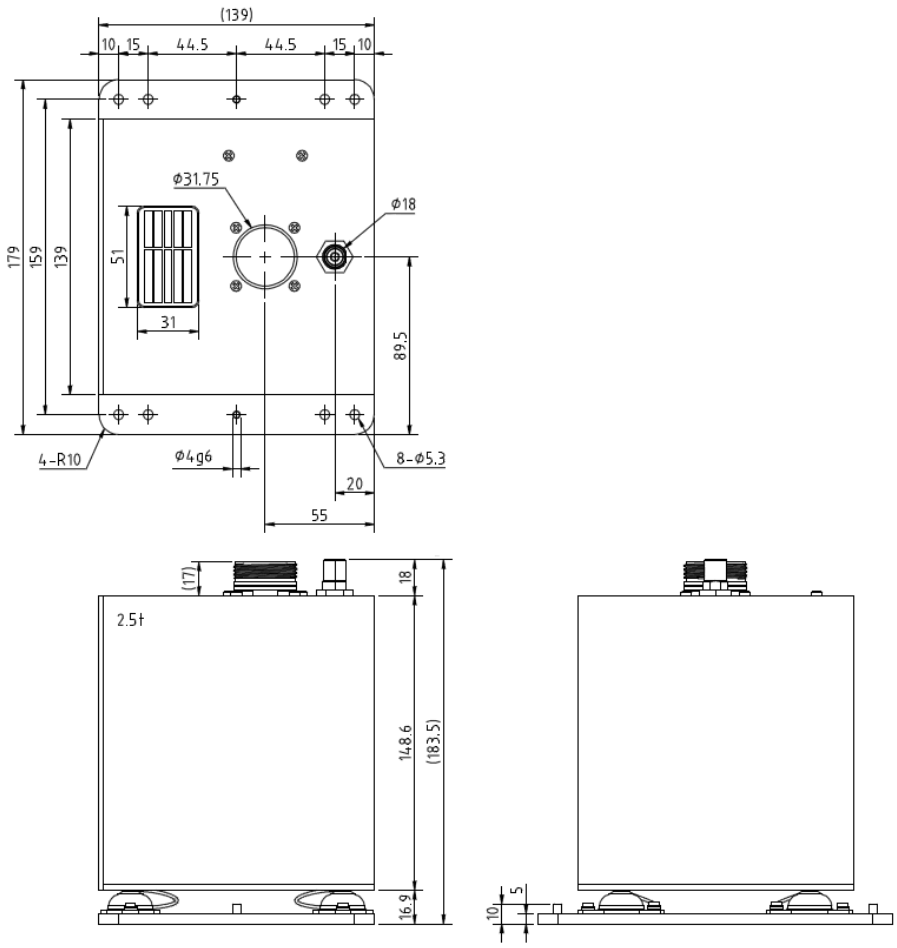

Figure 7: Marion GA6370R mechanical characteristic (unit: mm)

Contact Information

Corporate Office

Microinfinity Co., Ltd.

11F KANC, 906-10, Iui-dong,

Yeongtong-gu, Suwon-si

Gyeonggi-do, 443-270, Korea

Tel : +82 31 546 7408

Fax : +82 31 546 7409

Email : support@minfinity.com

USA support

2489 Bunker Hill Rd. Ann Arbor, MI 48105, USA

Tel : +1-734-223-5904

Fax : +1-866-400-3125

Email : usa.support@minfinity.com

Homepage: http://www.minfinity.com

CUSTOMER RESPONSE

It is our intention to provide you with the best documentation possible to ensure successful use of Microinfinity products. If you wish to provide your comments on organization, clarity, subject matter, and ways in which our documentation can better serve you, please let us know your opinion. Please list the following information, and use this outline to provide us with your comments about this manual and product.

1. What are the best features of this document and product?

2. Does this document meet your hardware and software development needs?, If not please explain.

3. Do you find the organization of this data sheet easy to follow? , If not please explain.

4. What additions to the data sheet do you think would enhance the structure and subject?

5. What deletions from the data sheet could be made without affecting the overall usefulness?

6. Is there any incorrect or misleading information? Please let us know what and where.

7. How would you improve this document?

8. How would you improve our software, systems, and products?

9. Other Comments?

From:

Name

Company

Address

City / State / ZIP / Country

Telephone: (_____) _____ - _____

Application (optional):

Would you like a reply? Y N

Questions:

FAX: (_____) _____ - _____