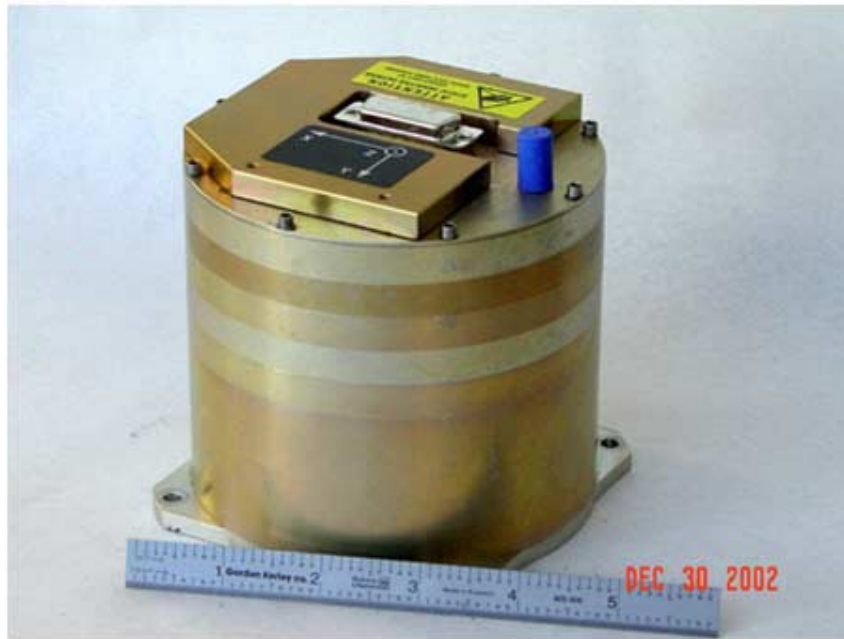


DMARS/GARS System Specifications



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1. System Accuracy

1.1 Attitude Accuracy

	With GPS Active	Without GPS
PITCH	0.2 deg 3σ	0.3 deg/hr drift 1σ
ROLL	0.2 deg 3σ	0.3 deg/hr drift 1σ
YAW	0.2 deg 3σ	0.3 deg/hr drift 1σ

1.2 Resolution

Digitizer	0.4 arsec
Output	20 arcsec (0.06mil)

1.3 Bandwidth (-3db)

50 HZ

1.4 Sample Rate

100 samples, 6axes digitized simultaneously.

1.5 Latency

11mSec

1.6 Position Accuracy

Equal to GPS Accuracy ± 25 meters CEP without SA
Without GPS signal 20 Kn/hr

1.7 Sensor Accuracy

The DMARS/GARS compensated sensors meet the following performance **over the temperature range – 20 deg C to +55 deg C:**

Linear

- bias 200 microg's RMS or less
- bias in-run stability 20 microg's 1 sigma or less, 1 hr or longer correlation time
- scale factor error 200 ppm RMS or less
- axis alignment 75 microrads RMS or less
- random noise 20 microg/sqrt(Hz) or less
- Maximum acceleration $\pm 10g$

Angular

- non g-sensitive bias 0.3 deg/hr RMS or less
- bias in-run stability 0.2 deg/hr 1 sigma or less, 1 hr or longer correlation time
- random noise 0.005 deg/sqrt(hr) or less
- g sensitive drift 0.1 deg/hr/g RMS or less
- scale factor error 200 ppm RMS or less
- axis alignment 100 microrads RMS or less
- Maximum Rate ± 100 deg/sec

RMS = Root Mean Square error (includes mean plus variation about mean)

1 sigma = standard deviation error about mean value

1.8 GPS Accuracy

Please refer to attached Trimble ACEIII GPS data Sheet

The DMARS has been integrated with other vendors GPS such as Novatel, AA, and Intersates.

1.9 System Environment

The DMARS/GARS will operate and deliver valid inertial attitude data over a large range of dynamic conditions.

- Angular Rotation: ± 100 deg/sec
- Angular Acceleration: $\pm 100,000$ deg/sec²
- Linear Acceleration: ± 10 g

1.10 Initialization Requirement

An initial heading angle measures from the true North is required to initialize the DMARS/GARS heading. Pitch and Roll angles are automatically initialized using the GPS information. Zero velocity initialization command may not be required for a normal operation.

2 Output/ Input

2.1 Serial data outputs

Two sets of serial data links are available simultaneously.

(1) RS232 TX & RX

The default serial data input and output has a protocol as follows:

- Pin 19, 20 and 21
- Asynchronous RS232
- 115.2 Kbaud
- No parity 8 Bit 1 Stop

(2) RS422 High Speed Link

DMARS/GARS has a set of high-speed communication (998 Kbaud) links to RS422 TX, CLK and RTI signals. These signals are always available as a default on pin 5,6,7,8,9, 24 and 25. RX to DMARS/GARS is not available in this link.

2.2 TX Message Format

These messages are available in both RS232 TX and RS422 TX.

Output has 100 frames per second and has 26 bytes data stream consisting of:

Byte #	Signal Description	Scale Factor	Range
1	Preamble	Fixed number	7EH
2	Address	Fixed number	FFH
3	Up count	Increment by 1 per frame	0 to 99 Synch with GPS 1PPS
4	Status		See note 1
5	Pitch Angle H	$2^{15} = 180.0 \text{ deg}$	$\pm 90 \text{ deg}$
6	Pitch Angle L		
7	Roll Angle H	$2^{15} = 180.0 \text{ deg}$	$\pm 180 \text{ deg}$
8	Roll Angle L		
9	Yaw Angle H	$2^{15} = 180.0 \text{ deg}$	$\pm 180 \text{ deg}$
10	Yaw Angle L		
11	Pitch Rate H	$2^{15} = 100.0 \text{ deg/sec}$	$\pm 100 \text{ deg/sec}$
12	Pitch Rate L		
13	Roll Rate H	$2^{15} = 100.0 \text{ deg/sec}$	$\pm 100 \text{ deg/sec}$
14	Roll Rate L		
15	Yaw Rate H	$2^{15} = 100.0 \text{ deg/sec}$	$\pm 100 \text{ deg/sec}$
16	Yaw Rate L		
17	Slow Data Field MSB 7	Double Precision Data Field	
18	Slow Data Field 6		
19	Slow Data Field 5		
20	Slow Data Field 4		
21	Slow Data Field 3		
22	Slow Data Field 2		
23	Slow Data Field 1		

24	Slow Data Field LSB 0		
25	SDID, Slow Data ID		
26	CS	Exclusive or byte 1 to 25	00-FF

Note 1: Status Byte

- MSB bit 7 1 = BITE OK
bit 6 1 = Gyro Enables
bit 5 1 = temp not too high
bit 4 1 = temp not too low
bit 3 1 = GPS ready
bit 2 1 = Navigation ready
bit 1 1 = TBD
- LSB bit 1 1 = TBD

Slow data field default output when UP counts are:

0	10	20	30	40	50	60	70	80	90	Latitude/ Double Precision	Degree
1	11	21	31	41	51	61	71	81	91	Longitude/ Double Precision	Degree
2	12	22	32	42	52	62	72	82	92	Altitude/ Double Precision	Meter
3	13	23	33	43	53	63	73	83	93	Velocity North/ Double Precision	M/Sec
4	14	24	34	44	54	64	74	84	94	Velocity East/ Double Precision	M/Sec
5	15	25	35	45	55	65	75	85	95	Velocity Up/ Double Precision	M/Sec
6	16	26	36	46	56	66	76	86	96	Requested Data 1	
7	17	27	37	47	57	67	77	87	97	Requested Data 1	
8	18	28	38	48	58	68	78	88	98	Requested Data 1	
9	19	29	39	49	59	69	79	89	99	Requested Data 1	

The requested data fields are responding data from input request, please refer to IS-PC-CDU interface software document where SDID and FC further define slow data field.

The requested data may include GPS or UTC time, measurement error, and/or other GPS information.

2.3 RX Message Format

RX Message is an ASCII code somewhat similar to NMEA 0183 format for RS232 RX input.

\$IDMSG,D1,D2,D3,D4.....Dn*CS[CR][LF]

“\$” The “\$” signifies the start of a message

ID The talker identification is a two letter mnemonics which describes the source of the navigation information. The GP identification signifies a GPS source, the IN identification signified inertial systems.

MSG The message identification is a three letter mnemonic which describes the message content and the number and order of the data field.
“;” Comas serve as delimiters for the data fields.
Dn Each message contains multiple data fields (Dn) which are delimited by commas.
“*” The asterisk serves as a checksum delimiter.
CS It is a two ASCII characters which indicates the hexadecimal value of an exclusive “or” from “\$” to “*” checksum.
[CR][LF] The carriage return [CR] and line feed [LF] combination terminate the message.

For example;

To input Heading information to DMARS/GARS,
\$INHUD, -178.455*75[CR][LF]
To input zero velocity align command,
\$INZVA*44[CR][LF]
To input pitch misalignment angle from vehicle to DMARS,
\$INAAP, -0.02*44[CR][LF]

Other message commands are described in the IS-PC-CDU document which will be provided with the DMARS/GARS unit.

2.4 Input and Command

There are 4 data types to DMARS (DMARS Rx input).Please refer to IS-PC-CDU software document for further details.

1. Command:

- Reset system**
- No motion align**
- Sensor bias update

2. Data input:

- Current position input
- Way point input
- Attitude input
- Heading input**
- Velocity input
- Datum input
- Misalignment change

3. Data request:

Other datum or data sets are may be reported in the slow data request field.

4. Output format modification:

2.5 Interface Software PC-CDU (IS-PC-CDU)

Inertial Science, Inc. will provide a PC window comparable Control and Display (CDU) interface software as a package of DMARS/GARS system. This software is designed to handle and display RS232 RX and TX communication. Via this input command, data input, output data request are easily handled. A complete output format may be reprogrammed by using IS-PC-CDU.

2.6 DMARS/GARS Connector Pin Assignment

Connector Type (26 pin high density D-type male connector)

Pin #	description	remarks
1	+28V	power input¹
2	+28V	power input¹
3	28V RTN	power return¹
4	28V RTN	power return¹
5	Shield GND	
6	TxC (+)	RS-422 synchronous clock
7	TxC (-)	RS-422 synchronous clock
8	TxD (-)	RS-422 transmitting data
9	TxD (+)	RS-422 transmitting data
10	GND	ground
11	GND	ground
12	MOD_SW	Boot-up memory bank selection switch (Factory use only)
13	GND	Ground (Factory use only)
14	Vpp	+12V EEPROM programming power input (Factory use only)
15	Vpps	+12V EEPROM programming power supply (Factory use only)
16	TxS5	RS-232 Gatar Tx (Factory use only)
17	RxS5	RS-232 Gatar Rx (Factory use only)
18	COM	RS-232 Gatar common (Factory use only)
19	TxMON	RS-232 Tx
20	RxMON	RS-232 Rx
21	COM	RS-232 common
22		Not used
23		Not used
24	RTI (-)	RS-422, Time of Validity Signal
25	RTI (+)	RS-422, Time of Validity Signal
26	GND	Shield and Case ground

Only bold lettered pins may be required for this proposal

Note 1. AWG 26 Gauge or thicker wires are recommended.

3 System Description

3.1 System Configuration

The DMARS/GARS consists of a DMARS unit, GPS antenna and IS-PC-CDU program. DMARS/GARS inertial section consists of electronics and a sensor section.

The electronics section consists of

- Gyro electronics and temperature monitor and control circuits
- Digitizer and counter electronics
- 68020/6888 base processor
- Trimble GPS Cad
- Interface Electronics
- Power Inverter

The sensor Assembly section is consists of

- Temperature controlled mounting block
- Two dynamically tuned gyroscopes.
- Three pendulus accelerometers
- Shock Isolation hardware

3.2 Coordinate system

The DMARS employs a right-hand-coordinate system which defines the Pitch, Roll and Yaw axes parallel to the vehicles long axis, right-hand side axis and up axis, respectively. When the vehicle is facing the North, its Pitch, Roll and Yaw axes are paralleled to East, North and Up of the local coordinate. The default order of the Euler angle rotation is Yaw, Roll and Pitch, therefore the Pitch angle is limited to ± 90 degree meanwhile the yaw and Roll are defined in ± 180 degree.

Other sequences of rotation are programmable by using IC-PC-CDU program.

3.3 Earth Model:

The DMARS/GARS employs WGS84 earth model as a default. Other Datum may be used via IS-PC-CDU windows program.

3.4 Embedded GPS

The DMARS/GARS contains a Trimble ACE III or an equivalent GPS card. The GPS power, signals and battery are internally connected to the DMARS electronics. The operation of GPS is handled by the DMARS processor. But the GPS may be controlled by using the IS-PC-CDU program.

3.5 GPS Antenna

The DMARS/GARS is provided with a default antenna. Trimble's active micropath antenna described in the attachment Trimble ACE III GPS.

3.6 Antenna Connection

The DMARS/GARS is equipped with a SBA type GPS coaxial connector.

4 Other Specification

4.1 Power

The DMARS/GARS operates on +28 V DC \pm 4V power. The total power consumption (including heaters) is less than 60 Watts.

4.2 Connector

The data and power interface to DMARS/GARS is via a high density D-type connector. Conec 241A16510 or equivalent. (See attached output connector sheet)

4.3 Size

The DMARS/GARS has the following **maximum** dimensions:

4.3" X 4.3" x 4.2" h

4.4 Weight

The DMARS/GARS weights no more than **3.1 lbs.**

4.5 Shock Isolation

The DMARS/GARS uses shock isolation that meet the following specifications:

Cut-off Frequency: > 60 Hz.

4.6 Vibration

The DMARS/GARS meets the following standard for vibration:

RTCA/DO-160C, section 8

4.7 Shock

The DMARS/GARS meets the following standards for shock:

RTCA/DO-160C, section 7

Operational Shock: 6g /11 ms/ 6 times per direction

Crash Safety: 15g / 11ms/ 1 time per direction

4.8 Operating Temperature

The DMARS/GARS meets the following operational temperature requirement (power-up and output data):

RTCA/DO-160C, section 4, category A1

-40 deg C to +70 deg C

4.9 Calibrated Temperature

The DMARS/GARS meets the performance specifications over the following temperature range:

-20 deg C to +55 deg C

4.10 Storage Temperature

The DMARS/GARS meets the following storage temperature requirement:

RTCA/DO-160C, section 4, category A1

-55 deg C to +85 deg C

4.11 Humidity

The DMARS/GARS meets the following humidity specification:

RTCA/DO-160C, section 6, category A

4.12 Hermetic Seal option

Hermetic seal option is available

4.13 Altitude

The DMARS/GARS operates at altitudes up to 60000 ft.

4.14 Temperature compensation

To enhance the performance, the DMARS/GARS is equipped with a number of AD590 temperature sensors. Their outputs are digitized and monitored continuously and used to compensate the sensor data. During a factory calibration a set of look-up tables are

generated to track the temperature dependent parameters such as bias and scale factors. Temperatures are monitored to ensure the proper operating environmental condition.

4.15 Mounting and Alignment

DMARS/GARS is calibrated to ± 0.5 mil radian for all 3 axis of gyros and 3 axis of accelerometers. Reference the base plate and base line indicated on the foot print drawing.

Caution: Any high mechanical shock (Greater than 50g 10msec), or exposure to high temperature exceeding 165 deg C, may change the calibrated alignment angle. These conditions may require re-calibration, and/or repair.

4.16 Handling

DMARS/GARS or any other inertial system should be handled with extreme caution. Shock should not exceed 16g 11 msec $\frac{1}{2}$ sine. Storage temperature should not exceed 100 deg C.

Sensor data are digitized continuously and accumulated for 0.00125 sec (800 Hz). Processing navigation equation 200 times per second and report every 100 data frames per second. Other schemes are available upon request.

4.17 Electromagnetic Environment

The DMARS/GARS conforms to the following standards for electromagnetic environment:

Audio Frequency Conducted Susceptibility Power Input	RTCA/DO-160C, section 18, category B (see also *)
Induced Signal Susceptibility	RTCA/DO-160C, section 19, category A (see also *)
Radio Frequency Susceptibility (radiated and conducted)	RTCA/DO-160C, section 20, category V (see also *)
Emission of Radio Frequency Energy	RTCA/DO-160C, section 21, category A (see also **)
Lightning Induced Transient Susceptibility	RTCA/DO-160C, section 22, (see also *)
* CE Conformity: Susceptibility	IEC 801-2 Level 2: Induced Surge Susceptibility IEC 1000-4-3: Radio Frequency Susceptibility IEC 801-4 Level 3: Induced Burst Susceptibility
** CE Conformity: Emission	EN 55022 Class B: Emission of Radio Frequency radiated EN 55022 Class B: Emission of Radio Frequency conducted