

## ISIS-GPS Specifications



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- non g-sensitive bias 20 deg/hr RMS or less
- bias in-run stability 5 deg/hr 1 sigma or less, 1 hr or longer correlation time
- random noise 0.2 deg/sqrt(hr) or less
- g sensitive drift 0.1 deg/hr/g RMS or less
- scale factor error 2000 ppm RMS or less
- axis alignment 1000 microrads RMS or less
- Maximum Rate  $\pm 100$  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 ISIS-GPS has been integrated with another vendor's GPS systems, such as Novatel, AA, or Interstates.

### **1.9 System Environment**

The ISIS-GPS will operate and deliver valid inertial attitude data over a large range of dynamic conditions.

- Angular Rotation:  $\pm 100$  deg/sec
- Angular Acceleration:  $\pm 100,000$  deg/sec<sup>2</sup>
- Linear Acceleration:  $\pm 10$  g

### **1.10 Initialization Requirement**

An initial heading angle measured from true North, is required to initialize the ISIS-GPS heading. Pitch and Roll angles are automatically initialized using the GPS information. The 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

ISIS-GPS 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 ISIS-GPS 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 to the data from the input request, please refer to IS-PC-CDU interface software document where SDID and FC further define slow data fields.

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.

“;” Commas 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 ISIS-GPS,  
\$INHUD, -178.455\*75[CR][LF]

To input zero velocity align command,  
\$INZVA\*44[CR][LF]

To input pitch misalignment angle from vehicle to ISIS-GPS,  
\$INAAP, -0.02\*44[CR][LF]

Other message commands are described in the IS-PC-CDU document which will be provided with the ISIS-GPS unit.

## 2.4 Input and Command

There are 4 data types to ISIS-GPS (ISIS-GPS 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 Windows-compatible Control and Display (CDU) interface software as a package of the ISIS-GPS system. This software is designed to handle and display RS232 RX and TX communication. Via this input command, the data input and output data request are easily handled. A complete output format may be re-programmed by using IS-PC-CDU.

## 2.6 ISIS-GPS Connector Pin Assignment

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

Pin #	description	remarks
<b>1</b>	<b>+28V</b>	<b>power input<sup>1</sup></b>
<b>2</b>	<b>+28V</b>	<b>power input<sup>1</sup></b>
<b>3</b>	<b>28V RTN</b>	<b>power return<sup>1</sup></b>
<b>4</b>	<b>28V RTN</b>	<b>power return<sup>1</sup></b>
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)
<b>19</b>	<b>TxMON</b>	<b>RS-232 Tx</b>
<b>20</b>	<b>RxMON</b>	<b>RS-232 Rx</b>
<b>21</b>	<b>COM</b>	<b>RS-232 common</b>
22		Not used
23		Not used
24	RTI (-)	RS-422, Time of Validity Signal
25	RTI (+)	RS-422, Time of Validity Signal
<b>26</b>	<b>GND</b>	<b>Shield and Case ground</b>

Only bold lettered pins may be required for this proposal

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

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### **3 System Description**

#### **3.1 System Configuration**

The ISIS-GPS consists of an ISIS-GPS unit, GPS antenna and the IS-PC-CDU program. The ISIS-GPS inertial section consists of an electronics section and a sensor section.

The electronics section consists of

- Gyro electronics, temperature monitor and control circuits
- Digitizer and counter electronics
- 68020/68882 base processor
- Trimble GPS Card
- Interface Electronics
- Power Inverter \*(optional)

The sensor Assembly section consists of

- A temperature controlled mounting block.
- Three RRS75 solid-state gyros
- Three solid-state accelerometers
- Shock Isolation hardware

#### **3.2 Coordinate system**

The ISIS-GPS 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 the East, North and Up of the local coordinates. The default order of the Euler angle rotation is Yaw, Roll and Pitch, therefore the Pitch angle is limited to  $\pm 90$  degree meanwhile the Yaw and Roll are defined in  $\pm 180$  degree.

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

#### **3.3 Earth Model:**

The ISIS-GPS employs the WGS84 earth model as a default. Other Datum may be used via the IS-PC-CDU windows program.

#### **3.4 Embedded GPS**

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

### **3.5 GPS Antenna**

The ISIS-GPS is provided with a default antenna. Trimble's active micropath antenna described in the attachment Trimble LASSEN SQ GPS.

### **3.6 Antenna Connection**

The ISIS-GPS is equipped with a SBA type GPS coaxial connector.

## **4 Other Specification**

### **4.1 Power**

The ISIS-GPS 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 ISIS-GPS is via a high density D-type connector. Conec 241A16510 or equivalent. (See attached output connector sheet)

### **4.3 Size**

The ISIS-GPS has the following **maximum** dimensions:

4.3" X 4.3" x 3.0" h

### **4.4 Weight**

The ISIS-GPS weights no more than **2.0 lbs.**

### **4.5 Shock Isolation**

The ISIS-GPS uses shock isolation that meet the following specifications:

Cut-off Frequency: > 60 Hz.

### **4.6 Vibration**

The ISIS-GPS meets the following standard for vibration:

RTCA/DO-160C, section 8

### **4.7 Shock**

The ISIS-GPS 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 ISIS-GPS 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 ISIS-GPS meets the performance specifications over the following temperature range:

-20 deg C to +55 deg C

#### **4.10 Storage Temperature**

The ISIS-GPS meets the following storage temperature requirement:

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

-55 deg C to +85 deg C

#### **4.11 Humidity**

The ISIS-GPS 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 ISIS-GPS operates at altitudes up to 60,000 ft.

#### **4.14 Temperature compensation**

To enhance the performance, the ISIS-GPS 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

ISIS-GPS is calibrated to  $\pm 0.5$  mil radian for all 3 axis of gyros and 3 axis of accelerometers.

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

ISIS-GPS 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 ISIS-GPS 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