ARS-G152

Single Axis Angular Rate Gyro
Owner's Manual

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Watson Industries prides itself on solving customer problems and serving their needs in a timely fashion. This manual is intended to facilitate this goal and to provide written information about your product. We ask that you carefully read this manual. Becoming familiar with the manual will help you understand the product's capabilities and limitations, as well as provide you with a basic understanding of its operation. If, after reading the manual, you require further assistance, do not hesitate to call Watson Industries with your questions and comments.

CAUTION!

Watson Sensors are rugged devices that have been used successfully in a number of harsh environments. The components have been qualified to withstand a mechanical shock of 500g 's or greater, and most enclosures provide near that level of protection. However, dropping a sensor from waist height onto a hard floor can cause a shock level of 600g's. At this level, given some resonance, damage is possible.

Introduction

The Watson Industries Angular Rate Gyro represents a significant advancement in inertial sensor technology. It is a highly accurate and rugged device with many advantages over other types of angular rate devices. This manual describes operation of the Watson Industries ARS and also provides useful application information to the system designer.

Product Description

The Watson Industries angular rate gyro is a solid state, single axis angular rate sensor. The gyro provides a voltage proportional to the rate of turn about its sensitive axis. During rotation, positive voltage output occurs in the direction of the rotational arrow indicated in figure 2. There are four analog outputs available (400°/s , 200°/s , 100°/s , 50°/s fullscale). The analog outputs are user selectable between unipolar (0-5 VDC) or bipolar (±5 VDC). The bandwidth is also user adjustable from 5 to 200 Hz. A power supply, providing +8 to +45 Volts DC, is required to operate the unit.

Installation

Orientation

The base of the unit is to be mounted on top of a horizontal surface. The gyro drawing, with pinout, is located in Figure 2. The gyro is a rugged device and will withstand harsh environments. However, due attention needs to be paid to the nature of the sensor and its prime function, which is to measure angular rate.

Mounting

The unit has three 0.12" diameter mounting holes for using three # 4 (or 3 mm) screws. To avoid distortion, the unit must be attached to a clean, flat surface, and the fasteners must be tightened evenly.

Environment:

Avoid mounting sites that are subject to significant temperature variation over the duration of the test. Temperature variation will induce significant rate sensor bias drift, which will reflect in poor angular rate accuracy.

For all applications, it is preferable to install the device where linear dynamic effects are minimized.

Power

This unit has an internal regulator to allow operation over a wide voltage input range. Best operation is obtained at either +12 or +24 VDC level, although operation is fully satisfactory down to +8 VDC and up to +45 VDC. The power ground is already connected internally to the signal ground. Do not connect the ground wires externally. Power consumption of the unit is about 0.7W. Internal capacitors are provided to remove a reasonable level of power line noise, however, capacitors should be added for long power line wiring or if noise is induced from other loads on the circuit. The mating connector is an Amp 1-794617-2 (12 pin).

Calibration

The ARS is calibrated at the factory before it is shipped to the user. It is recommended that the unit be examined, preferably at the factory annually for evaluation and recalibration.

Operation

Initialization

The initialization time typically takes 4 to 5 seconds. During this time, a message is sent from the unit via the RS-232 serial link. This message gives information about the Gyro such as the full model number, serial number, and firmware revision. The message can be read by using a terminal program or by using the terminal mode of Watson Industries' communication software. The initialization message can be suppressed – see the Interface section of this manual for more information (see below). If the message has not been suppressed, it can be read using a terminal program.

Normal Operation

During normal operation, the ARS will output highly accurate rate data for the user to interpret. This data is transmitted in several different ways. The most common way to acquire data from the ARS is to use the RS-232 serial output. There are two RS-232 output formats: decimal and binary. The exact formatting structure is discussed later in the Interface section of this manual. The ARS generates many different data items for output. Any combination of these data items can be selected for transmission via the RS-232 serial link. The ARS also has analog outputs (see Interface section) that can be used to send data to the user.

Interface

The ARS has analog, and digital serial interface capabilities.

RS-232 Output Format

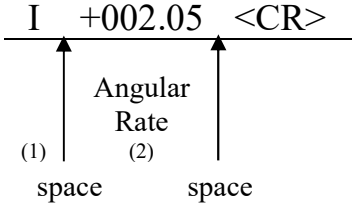
The standard RS-232 output consists of a string of decimal ASCII characters sent asynchronously at regular intervals. By default, the string is sent at 9600 baud with eight data bits, one stop bit and no parity. The mating connector for the RS-232 is an Amp 1-794617-2 (12 pin). The digital output pin map can be found in the Connections section of this manual. The RS-232 signal is referenced to signal ground. The number of strings sent per second depends on the baud rate and the output format. The maximum rate is 800 strings per second. The contents of a typical string are formed as follows: (See Appendix B for information on how to change the data string.)

1. A single letter and a space used to indicate the start of the data string. The letter "I" indicates the start of an inertial data string.

2. A eight character string representing the angular rate starting with a space, then a "+" or a "-", followed by three digits, a decimal point and two digits for up to ±399.99 °/second.

3. The string is terminated by a carriage return. There will then be a short interval with no data transmission before the next string begins.

Example:



The data items transmitted can be changed by using the menu system (see Appendix B). More channels are available for output (see Appendix A).

The system is protected from inadvertent write-over of the EEPROM by requiring two spacebar commands during the initialization interval to activate command mode, which is used to access the EEPROM or related functions. See Appendix B for more information.

The baud rate may be changed from the nominal value of 9600 baud by modifying the default value in the EEPROM of the unit to 38.4K, 19.2K, or 4800 baud.

A text header that is sent by the Gyro during initialization identifies the unit by part number and by serial number and gives the date of last calibration. Additionally, a line of text characters that identifies the data channel columns is sent if the serial output is set to ASCII decimal. This whole message can be temporarily (or as a default) suppressed or restored by a "*" command from the interfacing computer. For more information, see the RS-232 Input Commands section.

Data transmission sent by the ADS can also be suppressed or restored by a "+" command from the interfacing computer. This command is typically used when only analog data is used as a noise reduction measure when only analog data is being transmitted. For more information, see the RS-232 Input Commands section.

The other output format available is a binary format. In this mode, the unit provides generally the same information as the decimal ASCII format, but in a compact binary file message. In this format, there are nominally 3 bytes sent that represent 1 twenty-one bit gyro output followed by a carriage return. This format is for highly experienced users only. Information on the binary format can be found in Appendix C. Consult the factory for further details.

RS-232 Input Commands

The RS-232 input commands are provided for the purpose of unit test and installation set-up. Use the same parameters that are used for the RS-232 output (9600 baud ASCII nominal, or as reset in the units EEPROM).

Note: Many commands require command or "Double spacebar mode" in order to access them. For more information on how to activate Command Mode, see the instructions in Appendix B.

These commands are available to the user (others are used at the factory for alignment and calibration):

Char†	Command mode Rqd	Saveable Setting	Description
I	Yes	No	Set the unit to Inertial Mode See the Normal Operation section for more details.
L	Yes	No	Show channel labels The unit will output a line of text showing which channels are currently set for output. The label abbreviations for each channel are defined in Appendix A.
Z	No	No	Reset the count on the timer channel. See Appendix A for more details.
!	No	No	Reinitialize the unit. Starts the reinitialization process for the unit. The unit will not

			reinitialize unless it receives a spacebar character within 2.5 seconds after the "!" command is received.
_	Yes	Yes	Select decimal output format; This is the underscore character "_" See the RS-232 Output Formats section above for more details.
^	Yes	Yes	Select binary output format See Appendix C for more detail on the binary format.
:	Yes	Yes	Toggle serial data output on non-command character The unit will output a line of data whenever it receives a non-command character (such as a carriage return). When this command is received, it will toggle from Off to On; On to Off.‡
+	Yes	Yes	Toggle serial data transmission The unit will not output any data via the RS-232 port. When this command is received, it will toggle from Off to On; On to Off.‡
*	Yes	Yes	Toggle initialization message The unit will not transmit the text header during initialization When this command is received, it will toggle from On to Off; Off to On.
&	Yes	Yes	Activate unit settings menu Transmits a menu which allows any of several operating parameters to be set. See Appendix A for details on settings that can be changed through the menu.
"	Yes	N/A	Save the active settings Any settings that can be saved are placed into EEPROM so the unit will use them as a default the next time it powers on.

† All command characters that are alphabetic letters are treated case-insensitively. For example, the unit will accept an "L" or an "l" character to show the channel labels.

‡ It is possible for both the ":" and the "+" commands to be active at the same time. The "+" command determines whether the sensor is allowed to transmit data. So in this case, the ":" command would also need to be turned off to allow the free flow of data. It should also be noted that if the "+" command is on, the unit will still transmit responses to other command characters. It will also transmit the initialization message, unless that is also toggled off using the "*" command.

The commands "~", "@", "#", "$", '(", ")", "{", "}", "|", "<", ">", "?", "R", "F", "K", "N", and "S" are used by the Watson factory to calibrate the unit and should be used only with the assistance of the factory. If an undesired function is called, a "Q", and sometimes Escape or a Delete will interrupt the command and return to operation with the least disturbance to the system. All other unspecified characters such as carriage return, line feed and space are ignored by the system.

If there are problems with the system "hanging up" during the binary output mode, check for crosstalk between the serial transmit and receive line in your installation. In addition, check to see that the communications program used is not sending an echo. This will not happen in the decimal or hexadecimal modes because command characters recognized by the system are not produced in those modes.

Analog Outputs

Analog signal is output from a 14 bit digital to analog converter through an operational amplifier. Each analog output has a 300 ohm resistor in series to eliminate oscillations from high capacitance loads. The output range for the analog output channels are user selectable between unipolar (0-5 VDC) or bipolar

(±5 VDC). See Appendix B for information on selecting unipolar or bipolar output. The analog outputs are referenced to the common signal ground Pin 8. The analog outputs can be found on the 12-pin connector. The outputs include:

Signal	Pin	Format	Range	Output	Zero Ref (0°/sec)	Scale Factor		Resolution
Angular Rate 1	10	Unipolar	±400°/sec	0 to 5 VDC	2.5 VDC	160°/sec/Volt	6.25mV/°/s	0.05°/sec
		Bipolar	±400°/sec	±5 VDC	0.0 VDC	80°/sec/Volt	12.5mV/°/s	0.05°/sec
Angular Rate 2	3	Unipolar	±200°/sec	0 to 5 VDC	2.5 VDC	80°/sec/Volt	12.5mV/°/s	0.024°/sec
		Bipolar	±200°/sec	±5 VDC	0.0 VDC	40°/sec/Volt	25mV/°/s	0.024°/sec
Angular Rate 3	9	Unipolar	±100°/sec	0 to 5 VDC	2.5 VDC	40°/sec/Volt	25mV/°/s	0.012°/sec
		Bipolar	±100°/sec	±5 VDC	0.0 VDC	20°/sec/Volt	50mV/°/s	0.012°/sec
Angular Rate 4	2	Unipolar	±50°/sec	0 to 5 VDC	2.5 VDC	20°/sec/Volt	50mV/°/s	0.006°/sec
		Bipolar	±50°/sec	±5 VDC	0.0 VDC	10°/sec/Volt	100mV/°/s	0.006°/sec

Built in Test Digital Output

Built-In Test is an active low digital output that continuously monitors the internal sensors for faults. This signal is available on pin 5 of the connector. This output is High (5VDC) when the unit is operating normally. This output is Low (ground) when a fault is indicated. Flag reset is normal operation. The fault condition is set if the Angular Rate sensor has failed or the sensors temperature range has been extended.

Specifications

Angular Rate

Ranges:	±100°/sec (Selectable)	See table above
Resolution:	0.012°/sec (Based on range selected)	See table above
Analog Scale Factor:	50mV/°/sec (Based on range selected)	See table above
Scale Factor Accuracy:	0.2%	At constant room temperature
Scale Factor Temp Coefficient:	0.1%	Over temperature range
Bias:	±0.1°/sec	At room temp
Bias: Over Temp Range	±0.2°/sec	
Warmup Drift:	±0.25°/sec	
Non-Linearity:	< 0.15%	Full scale range
Bandwidth:	70 Hz (Typical)	User selectable 5 to 200 Hz
Noise:	< 0.05°/sec rms	1 Hz to 100 Hz

Environmental

Temperature: Operating	-40°C to +85°C	
Temperature: Storage	-55°C to +85°C	
Vibration: Operating	5g rms	20 Hz to 2 KHz
Vibration: Survival	10g rms	20 Hz to 2 KHz
Shock: Survival	500g	10mS ½ sine wave

Electrical

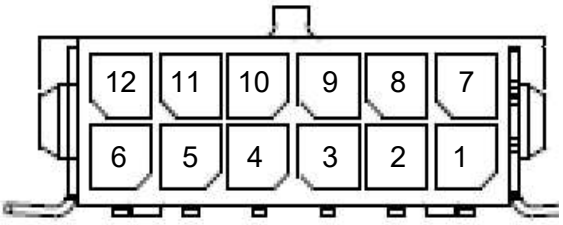
Frame Rate:	800 Hz	Maximum
Startup Time: Data	5 sec	
Startup Time: Fully operational	10 sec	
Input Power:	8 to 45VDC	0.7W
Input Current:	45mA @ 12VDC	20mA @ 24VDC
Digital Output:	RS-232	±399.99°/s Range
Analog Output:	User Selectable	±5VDC Bipolar; 0-5VDC Unipolar
Analog Output Impedance:	300 Ohm	Per line

Physical

Size: Including Mounting Flanges	1.2"W x 2.8"L x 1.35"H	3.0 x 7.1 x 3.4 (cm)
Weight:	2.1 oz	60 grams
Connection:	Amp 4-794627-2 (12 pin)	Mating Connector Incl.

- Specifications are subject to change without notice.
- This product may be subject to export restrictions. Export Classification ECCN 7A994

Connections



12 Pin Connector

Pin	Description
1	RS-232 TXD
2	Angular Rate Analog Output 4 (±50°/sec range)
3	Angular Rate Analog Output 2 (±200°/sec range)
4	No Connection
5	Built in Test (BIT) Output
6	Power Ground
7	RS-232 RXD
8	Signal Ground
9	Angular Rate Analog Output 3 (±100°/sec range)
10	Angular Rate Analog Output 1 (±400°/sec range)
11	Factory use (Do not Connect)
12	+Vin Power +8 to +45 VDC)

The RS-232 serial and analog output connections are referenced to Signal Ground on pin 8. The power ground is already connected internally to the signal ground.

The mating connector is made by Amp-Tyco Electronics. One mating connector is included with each sensor. Each connector consists of two parts: the connector receptacle and the receptacle contacts (Qty 12). Additional connectors may be purchased from Amp-Tyco Electronics or electronics vendors such as Digikey and Mouser.

Connector Receptacle Housing:

Vendor	Part Number
AMP-Tyco	1-794617-2
Digikey	A30298-ND
Mouser	571-1794617-2

26-30 AWG Contacts (Qty 12):

Vendor	Part Number
AMP-Tyco	1-794611-2
Digikey	A33279-ND
Mouser	571-1-794611-2

Dimensions

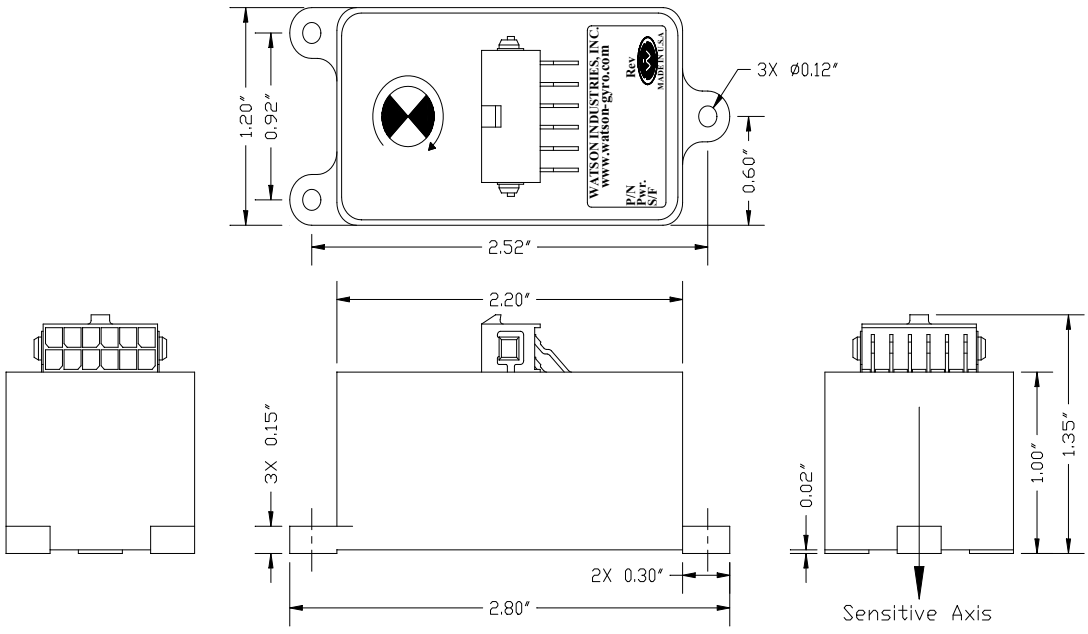


Figure 2 – ARS-G152 Dimensions

WARNING

Rough handling or dropping of this unit is likely to cause damage.
Over-voltage and/or miswiring of this unit will cause damage.
This unit should be protected against prolonged exposure to high humidity and/or salt air environments.

DISCLAIMER

The information contained in this manual is believed to be accurate and reliable; however, it is the user's responsibility to test and to determine whether a Watson Industries' product is suitable for a particular use.

Suggestion of uses should not be taken as inducements to infringe upon any patents.

WARRANTY

Watson Industries, Inc. warrants, to the original purchaser, this product to be free from defective material or workmanship for a period of two full years from the date of purchase. Watson Industries' liability under this warranty is limited to repairing or replacing, at Watson Industries' sole discretion, the defective product when returned to the factory, shipping charges prepaid, within one full year from the date of purchase. The warranty described in this paragraph shall be in lieu of any other warranty, express or implied, including but not limited to any implied warranty of merchantability or fitness for a particular purpose.

Excluded from any warranty given by Watson Industries are products that have been subject to abuse, misuse, damage or accident; that have been connected, installed or adjusted contrary to the instructions furnished by seller; or that have been repaired by persons not authorized by Watson Industries.

Watson Industries reserves the right to discontinue models, to change specifications, price or design of this product at any time without notice and without incurring any obligation whatsoever.

The purchaser agrees to assume all liabilities for any damages and/or bodily injury that may result from the use, or misuse, of this product by the purchaser, his employees or agents. The purchaser further agrees that seller shall not be liable in any way for consequential damages resulting from the use of this product.

No agent or representative of Watson Industries is authorized to assume, and Watson Industries will not be bound by any other obligation or representation made in connection with the sale and/or purchase of this product.

PRODUCT LIFE

The maximum expected life of this product is 20 years from the date of purchase. Watson Industries, Inc. recommends the replacement of any product that has exceeded the product life expectation.

Customer Service

All repairs, calibrations and upgrades are performed at the factory. Before returning any product, please contact Watson Industries to obtain a Returned Material Authorization number (RMA).

Return Address & Contact Information

Watson Industries, Inc.
3035 Melby Street
Eau Claire, WI 54703
ATTN: Service Department
Telephone: (715) 839-0628 Fax: (715) 839-8248 email: support@watson-gyro.com

Returning the Product

Product shall be packaged making sure there is adequate packing around all sides. Correspondence shall include:

- Customer's Name and Address
- Contact Information
- Equipment Model Number
- Equipment Serial Number
- Description of Fault

It is the customer's responsibility to pay all shipping charges from customer to Watson Industries, including import and transportation charges.

Appendix A

The following outputs are available via the RS-232 serial link. Their full-scale ranges are listed for both decimal and binary format.

Inertial Output	Label	Full Scale Decimal	Full Scale Binary
Time Since Reset	TM	65535	16383
Angular Rate	XR	±399.99 º/s	±400 º/s
Temperature	TP	-40º to 88ºC	-40º to 88ºC (7 bit)
Flag Bits	FL	3 ASCII chars representing Octal digits	1 byte
Status Bits	ST	3 ASCII chars representing Octal digits	1 byte
Built In Test (BIT) Status Bits	BT	3 ASCII chars representing Octal digits	1 byte

The Flag Bits contain the following information:

Bit	Description (If Set)
0	Unused
1	Unused
2	Unit Temp Out of Range Flag
3	BIT Test Flag
4	Angular Rate Out of Range Flag
5	Unused
6	Checksum Error Flag
7	Unused

Example: The Flag channel output in ASCII Decimal is “020”

Octal Digit	0		2			0		
Binary Equivalent	0	0	0	1	0	0	0	0
Flag Bit #	7	6	5	4	3	2	1	0

This translates into the information below:

Bit 7	Reset	
Bit 6	Reset	No Checksum Error
Bit 5	Reset	
Bit 4	Set	Angular Rate Out Range (>400 º/s)
Bit 3	Reset	No BIT Error
Bit 2	Reset	Unit Temp in Range (-40º to +85º C)
Bit 1	Reset	
Bit 0	Reset	

The Status Bits contain the following information:

Bit	Description
0	Unused
1	Unused
2	Unused
3	Unused
4	If set, Unit is in Initialization
5	Unused
6	If set, Command Mode is Selected
7	Unused

Example: The Status channel output in ASCII Decimal is “120

Octal Digit	1		2			0		
Binary Equivalent	0	1	0	1	0	0	0	0
Status Bit #	7	6	5	4	3	2	1	0

This translates into the information below:

Bit 7	Reset	
Bit 6	Set	Command mode active
Bit 5	Reset	
Bit 4	Set	In Initialization
Bit 3	Reset	
Bit 2	Reset	
Bit 1	Reset	
Bit 0	Reset	

The Built In Test (BIT) Status Bits contain the following information:

Bit	Description
0	Unused
1	Unused
2	Unused
3	If set, Sensor Temperature out of range
4	If set, Angular Rate Sensor Failure
5	Unused
6	Unused
7	Unused

Example: The BIT Test channel output in ASCII Decimal is “020”

Octal Digit	0		2			0		
Binary Equivalent	0	0	0	1	0	0	0	0
BIT Status Bit #	7	6	5	4	3	2	1	0

This translates into the information below:

Bit 7	Reset	
Bit 6	Reset	
Bit 5	Set	
Bit 4	Set	Rate Sensor Failure
Bit 3	Reset	Temp Sensor in range
Bit 2	Reset	
Bit 1	Reset	
Bit 0	Reset	

Appendix B

Activating Command Mode (Double Spacebar Mode)

1) Connect the unit to a DC power source that is off.
2) The viewing computer needs a valid bi-directional RS-232 serial port. Connect the serial port of the Watson sensor to the computer's serial port.
3) Open a terminal program (such as HyperTerminal) to interface with the unit. The default baud rate of the unit is 9600 baud. Make sure the computer's serial port is open.
4) Power-on the unit. A startup message will be transmitted by the unit and will appear in the terminal window unless it has been suppressed (See RS-232 Input Commands above).
5) During initialization, hit the space bar twice within close succession.

   Note: The sensor initialization time begins after the startup message is transmitted. Typically, this time period lasts 5 seconds, but could be as long as 127 seconds depending on your sensor.

6) Wait until after initialization is finished. At this point, command mode will be activated and the unit will accept keyboard commands.

   Note: Most Watson sensors have initialization times that are shorter than 30 seconds. Any extra keystrokes (other than two spacebars) sent during initialization will deactivate command mode.

**It can often take a few attempts to get the hang of step 5. Repeat steps 4-6 until successful.

Determining Output Channels

1) Activate Command Mode (See above)
2) Typing '&' will bring up the main menu:

```
TYPE IN THE NUMBER OF YOUR SELECTION (OR 'Q' TO QUIT):
    1 = SET OUTPUT CHANNELS
    2 = LIST CURRENT OUTPUT CHANNEL SELECTION
    3 = SET ANALOG VOLTAGE RANGE
    4 = SET OUTPUT BANDWIDTH
    5 = SET BINARY OUTPUT FORMAT
    6 = SET NEW BAUD RATE
```

3) Typing in '2' will show which channels are currently active.

Setting Output Channels

1) Activate Command Mode (See above).
2) Type '&'(this will bring up the main menu again).
3) Now type '1' to set up channels.
   The following message will appear:

```
TO SET FOR OUTPUT FOR ANY OF THE FOLLOWING DATA ITEMS, PRESS Y
TO AVOID ANY OF THE FOLLOWING DATA ITEMS, PRESS N
TO QUIT AND DISREGARD ANY OTHER DATA, PRESS Q

*** DO YOU WANT TO PROCEED?  (Y/N/Q)
```

4) To proceed type 'Y'. Stop this process by typing either ‘N’ or ‘Q’.
   If ‘Y’ is pressed, each channel will come up one at a time.
   For example:

```
DO YOU WANT OUTPUT TIME SINCE RESET?
```

5) Type 'Y' to output the channel, type 'N' to remove the channel.
   After the last channel is listed, this message will appear:

```
        Y = GOBACK, N = INSTALL DATA & QUIT, Q = QUIT
            DO YOU WANT TO TRY TO SET DATA AGAIN?
```

6) To accept the new channels type 'N'. Typing a ‘Y’ with start the command sequence over. Typing a ‘Q’ at any time in the sequence will quit without updating the channels.

   Changes made will not change the non-volatile settings. To make these new settings the default value, send a Quotation Mark (“).

7) Press the space bar after quitting or updating the new channels to restart the data flow.

Setting Output Format

There are two output formats:

Decimal output – “_” Command.
Binary output – “^” Command.

To change the output format:

1) Activate Command Mode (See above).
2) Press the key Command corresponding to the format you want to switch into.
   To make this output format the default the next time you power the unit on, send a Quotation Mark (“).
3) Press the space bar to resume data transmission.

Setting Analog Voltage Range

1) Activate Command Mode (See above).
2) Type '&'(this will bring up the main menu again).
3) Now type ‘3’to update the analog output voltage range

This will bring up the menu:

```
    THE CURRENT SETTING IS: BIPOLAR

SELECT ANALOG VOLTAGE RANGE (OR 'Q' TO QUIT):
          1 = UNIPOLAR 0 TO 5 VDC RANGE (0 DEG/SEC = 2.5VDC)
          2 = BIPOLAR +/-5 VDC RANGE (0 DEG/SEC = 0.0VDC)
```

4) To change the analog voltage range to Unipolar, type ‘1’ at this menu.
   To change the analog voltage range to Bipolar, type ‘2’ at this menu.

5) Changes made will not change the non-volatile settings. To make these new settings the default value, send a Quotation Mark (“).

6) Press the space bar after quitting or updating the output range to restart the data flow.

Setting Output Bandwidth

1) Activate Command Mode (See above).
2) Type '&'(this will bring up the main menu again).
3) Now type ‘4’ to change the output bandwidth.

This will bring up the menu:

```
THE CURRENT SETTING IS:  070 Hz
TYPE IN NEW BANDWIDTH IN Hz (OR 'Q' TO QUIT):
  (UP TO 3 DIGITS - RANGE 5 TO 200):
```

4) To change type in the new bandwidth in Hz, followed by an <Enter> if typing in less than 3 digits.
(e.g. to change to 50 Hz type in ‘50’ followed by <Enter> or ‘050’)
(e.g. to change to 5 Hz type in ‘5’ followed by <Enter> or ’05’ followed by <Enter> or ‘005’)
(e.g. to change to 100 Hz type in ‘100’)

5) Changes made will not change the non-volatile settings. To make these new settings the default value, send a Quotation Mark (“).

6) Press the space bar after quitting or updating the binary format to restart the data flow.

Note: If the value entered is outside the acceptable 5 to 200 Hz range then the following message will be displayed.

```
* * *  ERROR * * *

  THE CURRENT SETTING IS:  070 Hz
  TYPE IN NEW BANDWIDTH IN Hz (OR 'Q' TO QUIT):
     (UP TO 3 DIGITS - RANGE 5 TO 200):
```

Repeat Step 1.

Set Binary Output Format Type

1) Activate Command Mode (See above).
2) Type '&'(this will bring up the main menu again).
3) Now type ‘5’ to update the binary output format.

This will bring up the menu:

```
    THE CURRENT SETTING IS: 3 BYTE

SELECT BINARY OUTPUT FORMAT (OR 'Q' TO QUIT):
          1 = THREE BYTE BINARY OUTPUT FORMAT
          2 = TWO BYTE BINARY OUTPUT FORMAT
```

4) To change the binary output format to three byte, type ‘1’.
   To change the binary output format to two byte, type ‘2’.

   See Appendix C for more information binary formatting.

5) Changes made will not change the non-volatile settings. To make these new settings the default value, send a Quotation Mark (“).

6) Press the space bar after quitting or updating the binary format to restart the data flow.

Setting Baud Rate

1) Activate Command Mode (See above).
2) Type '&'(this will bring up the main menu again).
3) To change the baud rate at which the sensor communicates, type ‘6’ at the main menu.

This will bring up the menu:

```
TYPE IN THE NUMBER OF YOUR SELECTION (OR 'Q' TO QUIT):
(EFFECTIVE IMMEDIATELY - SAVE TO MAKE PERMANENT)
    1 = 38.4 K BAUD
    2 = 19.2 K BAUD
    3 =  9.6 K BAUD
    4 =  4.8 K BAUD
```

4) Change the baud rate to a new setting.

   To change to 38,400 Baud, type ‘1’.
   To change to 19,200 Baud, type ‘2’.
   To change to 9,600 Baud, type ‘3’.
   To change to 4,800 Baud, type ‘4’.

   The baud rate change will take effect immediately. To make the new baud rate the default setting, send a quote symbol (“) using the new baud rate. Otherwise the old baud rate will return the next time the unit is powered up.

   Note: The baud rate of the software that is communicating to the sensor will need to be changed to match the new setting.

5) Press the space bar to resume data transmission.

   Note: The factory settings for serial communications are 9.6K baud with 8 bits and one stop bit, no parity.

Appendix C Binary Output Format

Two Byte Binary Angular Rate Data Format

All of the data words have a high sign bit (bit 7), but the delimiter byte is an ASCII carriage return character that has a low sign bit (bit 7). One word (two bytes) is transmitted per output parameter.

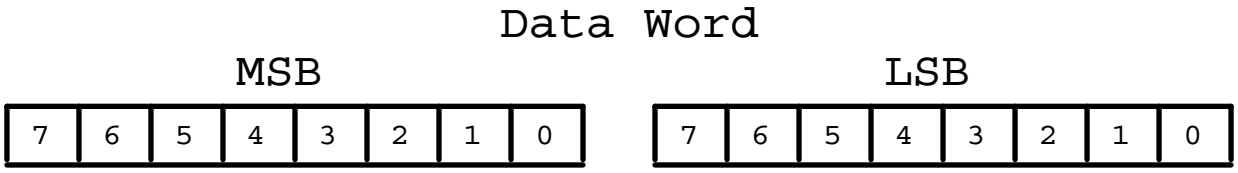
Example: Unit is sending out Angular Rate
The Unit is seeing these conditions:

Angular Rate
-100.24˚/s

Binary Output Format:

Word1	<CR> byte
0xEFBB	0x0D

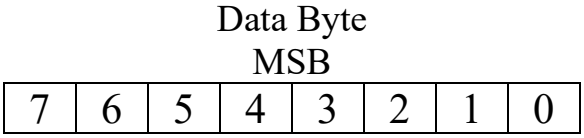
The Carriage return byte is the only byte which has a value less than 128 (0x80). This is the Synchronizing Byte.



Bit 7 of the MSB is set to 1. Bits 6 to 0 of the MSB are the upper 7 bits of the data. (sign plus 6 bits of data)
Bit 7 of the LSB is set to 1. Bits 6 to 0 of the LSB are the lower 7 bits of the data.

After the two byte data word is received, the LSB is shifted left to shift out the 7th bit (always set to 1). The MSB is then connected to the LSB as a 16-bit word. This word is then shifted left to shift out the 7th bit in the MSB (always set to 1). What remains is a signed fractional word with a resolution of 13 bits plus a sign bit. Scale factor: 0.0122 ˚/s /bit

Temperature
In binary, temperature data is transmitted in one byte with separate formatting.



Bit 7 of the MSB is set to 1. Bits 6 to 0 are the upper 7 bits of the data.
As the data byte is received, The upper Bit(7) is removed . What remains is a byte that is 0 to 0x7F for –40 to +87 deg C.

To convert binary data:

Angular Rate
0xEFBB

Split each word into two bytes:

Angular Rate
0xEF 0xBB

Remove the most significant bit from each byte:

Angular Rate
0x6F 0x3B

Shift lower byte left once (to remove 1 bit space between bytes):

Angular Rate
0x6F 0x76

Shift lower & upper bytes left once (to remove 1 bit space at top of high byte):

Angular Rate
0xDF 0xEC

Convert from hexadecimal to decimal counts:

Angular Rate
57324

Correct bank, elevation, and angular rates for the sign
If >32767 then subtract 65536 from the data

X Rate
-8212

Convert to units: counts * scale factor
For Angular Rate: Scale factor is: (400 ˚/s) / 32768 counts; this is the full scale in °/s divided by 15 bits full scale (2^{15})

Angular Rate
-100.24 ˚/s

The nominal interface settings are:

```
9600 Baud
8 Bit Data
1 Start Bit
1 Stop Bit
No Parity
```

Three Byte Binary Angular Rate Data Format

All of the data words have a high sign bit (bit 7), but the delimiter byte is an ASCII carriage return character that has a low sign bit (bit 7). Three bytes are transmitted per output parameter.

Example: Unit is sending out Angular Rate
The Unit is seeing these conditions:

Angular Rate
100.23˚/s

Binary Output Format:

Byte 1	Byte 2	Byte 3	<CR> byte
0x90	0x84	0xDB	0x0D

The Carriage return byte is the only byte which has a value less than 128 (0x80). This is the Synchronizing Byte.

3 Byte Binary Angular Rate Data Format																								
7	6	5	4	3	2	1	0		7	6	5	4	3	2	1	0		7	6	5	4	3	2	1	0
High Byte									Middle Byte									Low Byte							

Bit 7 of the High Byte is set to 1. Bits 6 to 0 of the High Byte are the upper 7 bits of the data. (sign plus 6 bits of data)
Bit 7 of the Middle Byte is set to 1. Bits 6 to 0 of the Middle Byte are the next 7 bits of the data.
Bit 7 of the Low Byte is set to 1. Bits 6 to 0 of the Low Byte are last 7 bits of the data.
After the 3 byte data word is received, the Low Byte is shifted left to shift out the 7th bit(always set to 1). The Middle Byte is then connected to the Low Byte as a 16 bit word. This 16 bit word is then shifted left to shift out the 7th bit in the Middle Byte (always set to 1). The High Byte is then connected to the 16 bit word to form a 24 bit "word". This 24 bit "word" is then shifted left to shift out the 7th bit in the High Byte (always set to 1). What remains is a signed fractional 3 byte answer with a resolution of 20 bits plus a sign bit. Scale factor: 0.000381 ˚/s /bit

```
0x7FFFF8 = +399.999 ˚/s
0x7FFFF0 = +399.996 ˚/s
…
0x000008 =  +0.0004 ˚/s
0x000000 =  +0.0000 ˚/s
0xFFFFF8 =  -0.0004 ˚/s
…
0x800008 = -399.996 ˚/s
0x800000 = -400.000 ˚/s
```

To convert binary data:

Angular Rate		
Byte 1	Byte 2	Byte 3
0x90	0x84	0xDB

Shift Byte 3 left once to remove the high bit (bit 7) of the low byte:

Angular Rate		
Byte 1	Byte 2	Byte 3
0x90	0x84	0xB6

Shift lower Word (Byte2:Byte3) left once to remove the high bit (bit 7) of the middle byte:

Angular Rate		
Byte 1	Byte 2	Byte 3
0x90	0x09	0x6C

Shift all 3 bytes left once to remove the high bit (bit 7) of the high byte:

Angular Rate		
Byte 1	Byte 2	Byte 3
0x20	0x12	0xD8

Convert from hexadecimal to decimal counts:

Angular Rate
2101976

Correct angular rate for the sign
If >8388607 then subtract 16777216 from the data

Angular Rate
2101976

Convert to units: counts * scale factor
For Angular Rate: Scale factor is: (400 ˚/s) / 8388608 counts; this is the full scale in °/s divided by 23 bits full scale (2^{23})

Angular Rate
100.23 ˚/s

The nominal interface settings are:

```
9600 Baud
8 Bit Data
1 Start Bit
1 Stop Bit
No Parity
```