

# **TRIAXIAL ANGULAR RATE SENSOR**

## **OWNER'S MANUAL**

**PART NUMBER: ARS-E322-1A/80**



**WATSON INDUSTRIES, INC.  
3041 MELBY ROAD  
EAU CLAIRE, WI 54703**

Phone: (715) 839-0628

FAX: (715) 839-8248

email: [support@watson-gyro.com](mailto:support@watson-gyro.com)

# TABLE OF CONTENTS

Introduction.....	3
Product Description .....	3
Installation .....	3
Orientation/Mounting .....	3
Environment.....	4
Power .....	4
Calibration .....	4
Operation .....	4
Initialization .....	4
Normal Operation .....	4
Interface .....	4
RS-232 Output Formats .....	4
Decimal ASCII .....	5
Procedure to Change to Decimal ASCII Format.....	7
Binary Format .....	8
Procedure to Change to Binary Format.....	8
RS-232 INPUT COMMANDS .....	9
Analog Outputs .....	10
Input Commands.....	10
Specifications.....	11
Connections / Dimensions .....	12
Warning .....	13
Appendix A.....	15
Appendix A.1.....	17
Appendix A.2.....	18
Appendix A.3.....	19
Appendix A.4.....	19
Appendix A.5.....	25
Appendix A.6.....	26

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 an added 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, damage is likely to occur.

## Introduction

The ARS-E322-1A/80 is a solid-state, triaxial rate gyro consisting of three (3) single axis, solid-state gyro's, interfaced to a microprocessor which provides bias removal, scale-factor compensation, axis alignment and a Built-In-Test-Equipment (BITE) function. This product is manufactured for military applications through extended testing, EMI/RFI filter enhancements and tightly controlled weight.

## Product Description

The sensor provides complementary analog signals as the primary outputs. The analog output is digitally generated and refreshed 800 times per second. These outputs are also available as serial data on the RS-232 bus.

The microprocessor system, which supports RS-232 serial data communication, allows the sensor to be adjusted using data terminal equipment. A PC running data communications software is all that is needed. See Appendix A more information on the Serial Output.

The gyros are installed nominally orthogonal and final adjustment of cross-axis alignment is carried out using the microprocessor with sensor adjustment-data held in non-volatile memory. This avoids the need for physical adjustment.

Integrating the rate signal over time and subtracting the resulting value from the rate signal provides a bias-free rate signal. The integrator time-constant is held in non-volatile memory and is settable using the RS-232 interface.

The sensor is intended for operation on a balanced gimbal and its mass is carefully controlled by adding ballast to ensure interchangeability without the need to re-balance the entire gimbal assembly.

## Installation

### *Orientation/Mounting*

The connector face of the unit must face positive X direction. The unit has 4 mounting holes tapped for M4 (0.3" depth). A mounting plate is provided for a flat surface mount. If high shock loads are expected (greater than 20G or repeated shocks greater than 10G), appropriate shock mounting should be used to prevent damage. Vibration isolation should be used if operation in 4G or greater vibration environments is expected.

## ***Environment***

Avoid mounting sites that are subject to significant temperature variation over the duration of the test. Temperature variation will induce noticeable rate sensor bias drift.

## ***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 10 VDC and up to 35 VDC. Power draw of the unit is less than 6 Watts. 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 ARS power system is isolated from the ARS signal system.

## ***Calibration***

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

## ***Operation***

### ***Initialization***

At switch-on, the integrator time constant is set to a short time constant and is progressively increased for a preset time to allow the gyro to stabilize. Also at switch-on, a temperature-map bias value is applied to each gyro and the integrator will begin to accumulate the signal from the gyro unless a 'hold' command freezes the action of the integrator.

Bias compensation starts at a 10 second time constant and increases until the end of initialization. Time between switch-on and end of initialization: settable, 30 second nominal.

### ***Normal Operation***

Operating integration constant, settable: 180 seconds nominal.

During normal operations, the ARS will output highly accurate angular rate data for the user to interpret. This data can be output several different ways. The most common way to acquire data from the ARS is to use the differential analog outputs. The analog rate outputs are 20 Volt differential. The data is also available through RS-232 serial output. There are two RS-232 output formats: decimal ASCII and binary. The exact formatting structure is discussed in next section.

## ***Interface***

The ARS has analog, logic, and digital interface capabilities. The mating connector for the ARS-E322-1A/80 is MS27467T-15B-19S.

### ***RS-232 Output Formats***

The nominal interface settings are:

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

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 38400, 19200, or 4800 baud.

The ARS sends a text header during initialization that identifies the unit by part number and by serial number and gives the date of last calibration. This whole message can be temporarily or permanently suppressed or restored by a "\*" command from the interfacing computer.

Data transmission is controlled by either a ":" or a "+" command. If data is not flowing, send a carriage return. If the unit responds with data, the unit is controlled by the ":" command. Sending a ":" should cause the data to free flow.

If the above does not produce a data transmission, send a "+" command. If the data does not flow, then send a carriage return. If a line of data is returned, then sending a ":" should set the data to freely flow. If data still does not flow, check the connections, the terminal settings and unit power connections.

There are two serial data output formats: Decimal ASCII & Binary.

### ***Decimal ASCII***

The nominal RS-232 output consists of a string of decimal ASCII characters sent asynchronously at regular interval. The string is sent with eight data bits, one stop bit and no parity. The number of strings sent per second depends on the baud rate. The contents of the string are formed as follows:

1. A seven character string representing the X Axis Rate starting with a "+" or a "-", followed by two digits, a decimal point, two digits and a space for up to  $\pm 49.99$  degrees/second.
2. A seven character string representing the Y Axis Rate starting with a "+" or a "-", followed by two digits, a decimal point, two digits and a space for up to  $\pm 49.99$  degrees/second
3. A seven character string representing the Z Axis Rate starting with a "+" or a "-", followed by two digits, a decimal point, two digits and a space for up to  $\pm 49.99$  degrees/second
4. A six character string representing the X Axis Rate Bias starting with a "+" or a "-", followed by two digits, a decimal point, one digit and a space for up to  $\pm 49.9$  degrees/second
5. A six character string representing the Y Axis Rate Bias starting with a "+" or a "-", followed by two digits, a decimal point, one digit and a space for up to  $\pm 49.9$  degrees/second
6. A six character string representing the Z Axis Rate Bias starting with a "+" or a "-", followed by two digits, a decimal point, one digit and a space for up to  $\pm 49.9$  degrees/second
7. A four character string representing temperature starting with a "+" or a "-", followed by two digits and a space for the range  $-40$  to  $+88$  degree C.

8. A two digit string representing the Diagnostic Flags:  
The first digit represents the Mode:

First Digit	Delay to Bias Bias Correction	Double Space Bar entered	
3	On	Yes	2 + 1
2	On	No	2
1	Off	Yes	1
0	Off	No	

“2” Delay to First Bias On  
“1” Double Space bar entered

The second digit indicates Rate Bias Limit exceeded:

“4” X Axis Rate Bias Limit  
“2” Y Axis Rate Bias Limit  
“1” Z Axis Rate Bias Limit

Second Digit	X Axis Rate Bias Limit Exceeded	Y Axis Rate Bias Limit Exceeded	Z Axis Rate Bias Limit Exceeded	
7	Yes	Yes	Yes	4 + 2 + 1
6	Yes	Yes	No	4 + 2
5	Yes	No	Yes	4 + 1
4	Yes	No	No	4
3	No	Yes	Yes	2 + 1
2	No	Yes	No	2
1	No	No	Yes	1
0	No	No	No	

“4” X Rate Bias Limit  
“2” Y Rate Bias Limit  
“1” Z Rate Bias Limit

9. A two digit string representing the Status Flags:  
The first digit represents the Condition:

First Digit	Hold Condition	Initialization	BITE Flag	
7	On	Yes	On	4 + 2 + 1
6	On	Yes	Off	4 + 2
5	On	No	On	4 + 1
4	On	No	Off	4
3	Off	Yes	On	2 + 1
2	Off	Yes	Off	2
1	Off	No	On	1
0	Off	No	Off	

“4” Hold Condition  
“2” In Initialization  
“1” BITE Flag On

The second digit indicates Input Commands:

- “4” Set Command
- “2” Hold Command
- “1” Scale Command

Second Digit	Set Command	Hold Command	Scale Command	
7	On	On	On	4 + 2 + 1
6	On	On	Off	4 + 2
5	On	Off	On	4 + 1
4	On	Off	Off	4
3	Off	On	On	2 + 1
2	Off	On	Off	2
1	Off	Off	On	1
0	Off	Off	Off	

“4” Set Command  
 “2” Hold Command  
 “1” Scale Command

10. 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:

+02.49	-05.03	+20.47	+00.3	-00.5	-01.6	+25	00	00	<CR>
X Axis Rate (1)	Y Axis Rate (2)	Z Axis Rate (3)	X Axis Rate Bias (4)	Y Axis Rate Bias (5)	Z Axis Rate Bias (6)	Temp (7)	Diagnostic Flags (8)	Status Flags (9)	(10)
space	space	space	space	space	space	space	space	space	

***Procedure to Change to Decimal ASCII Format***

Hook the unit up to your computers serial port.  
 Use hyperterminal program to interface with unit.

Turn on unit. Wait for 2 seconds.  
 Hit the space bar twice.  
 Wait for the initialization to end (30 seconds nominal, unless settings are changed).

Now the unit will take in the keyboard commands.  
 To toggle the serial output enable send a colon (: ) or plus (+) as required. (see RS-232 INPUT COMMANDS Section)  
 To change to the decimal ASCII format, first type in the underline character (\_).  
 This will temporarily change the unit to the decimal ASCII format.  
 To save this change in non-volatile memory, type in the double quote character (“).  
 This means the unit will automatically start up in the decimal ASCII mode.

## Binary Format

The other output format available is a binary format. The binary format provides generally the same angular rate information as the decimal ASCII format, but in a compact binary file format. In this format, there are up to 4 words sent that represent 3 fourteen bit output channels and optional 14 bit Flag Set. This format is for highly experienced users only.

### 1st Data Word (X Axis Rate)

Upper Byte							
Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
"0"	X	X	X	X	X	X	X

Lower Byte							
Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
"1"	X	X	X	X	X	X	X

### 2nd Data Word (Y Axis Rate)

Upper Byte							
Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
"1"	X	X	X	X	X	X	X

Lower Byte							
Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
"1"	X	X	X	X	X	X	X

### 3rd Data Word (Z Axis Rate)

Upper Byte							
Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
"1"	X	X	X	X	X	X	X

Lower Byte							
Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
"1"	X	X	X	X	X	X	X

### Optional 4<sup>th</sup> Word (Flag Set)

Upper Byte							
Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
"1"	XX	XX	XX	XX	XX	XX	XX
	Flag	Flag	Flag	Flag	Flag	Flag	Flag

Lower Byte							
Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
"1"	XX	XX	XX	XX	XX	XX	XX
	Flag	Flag	Flag	Flag	Flag	Flag	Flag

The most significant bit (MSB) of the upper byte of the First Word is cleared to "0". The rest of the bytes in the binary data frame have the MSB set to "1". This allows you to synchronize to the binary data frame. As the data words are received, the lower byte is shifted left to shift out the MSB. The upper byte is then connected to the lower as a 16 bit word. This word is then shifted left to shift out the MSB. What remains is a signed fractional word with a resolution of 13 bits plus a sign bit.

### Procedure to Change to Binary Format

Hook the unit up to your computers serial port.

Use hyperterminal program to interface with unit.

Turn on unit. Wait for the 5 seconds.

Hit the space bar twice. (20 ms between characters)

Wait for the initialization to end.

Now the unit will take in the keyboard commands.

To toggle the serial output enable send a colon (: ) or plus (+) as required. (see RS-232 INPUT COMMANDS Section) To change to the binary format, first type in the caret character (^). This will temporarily change the unit to the binary format. To save this change, type in the double quote character (“). This means the unit will automatically start up in the binary mode.

## **RS-232 INPUT COMMANDS**

The RS-232 input commands are provided for the purpose of unit test and installation set-up. The same parameters are used as for the output (9600 baud ASCII nominal, or as reset in the units EEPROM). There are seven commands intended for use by the user (others are used at the factory for alignment and calibration).

1. An “!” command will reinitialize the unit. Further, the access to initialization is inhibited such that a spacebar command must be sent within 2.5 seconds of the “!” command for initialization to be engaged.
2. An “\_” command will change the output format to decimal ASCII. This change is made non-volatile in the unit on EEPROM by keying in the quote (“) character. Double spacebar at initialization is required for access to this command.
3. A “^” command will change the output format to binary. This change is made non-volatile in the unit on EEPROM by keying in the quote (“) character. Double spacebar at initialization is required for access to this command.
4. A “:” command will toggle the output to send a frame of data upon receiving any non-command character (On to Off; Off to On). This change is made non-volatile in the unit on EEPROM by keying in the quote (“) character. Double spacebar at initialization is required for access to this command.
5. A “+” command will suppress or restore the transmission of data. This command will toggle the data transmission (On to Off; Off to On). Double spacebar at initialization is required for access to this command.
6. An “\*” command will suppress or restore the initialization message in the Decimal ASCII mode. This command will toggle the transmitting of the text header during initialization (On to Off; Off to On). This change is made non-volatile in the unit on EEPROM by keying in the quote (“) character. Double spacebar at initialization is required for access to this command.
7. An “&” command brings up a menu to select baud rates. This change is made non-volatile in the unit on EEPROM by keying in the quote (“) character. Double spacebar at initialization is required for access to this command.

The commands “~”, “@”, “#”, “\$”, “(”, “)”, “{”, “}”, “|”, “<”, “>”, and “?” 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.

### ***Analog Outputs***

The analog output signals are output from a 12 bit digital to analog converter through buffer amplifiers transformer isolated to the outside. The output range for all of the analog output channels is  $\pm 10$  Volts Differential. There is a 20 Volt range between the positive & negative signals. The outputs include:

<u>Data</u>	<u>Pin</u>	<u>Range</u>
+ X Axis Rate	E	$\pm 50^\circ/\text{sec} / \pm 10\text{V}$
- X Axis Rate	F	$\pm 50^\circ/\text{sec} / \mp 10\text{V}$
+ Y Axis Rate	D	$\pm 50^\circ/\text{sec} / \pm 10\text{V}$
- Y Axis Rate	C	$\pm 50^\circ/\text{sec} / \mp 10\text{V}$
+ Z Axis Rate	A	$\pm 50^\circ/\text{sec} / \pm 10\text{V}$
- Z Axis Rate	B	$\pm 50^\circ/\text{sec} / \mp 10\text{V}$

### ***Input Commands***

These commands need to be enabled through the menu (see Appendix A.4). The operational voltage level for each pair of command lines is designed to be 10 Volts differential. The operational range for these inputs (common mode and differential mode) is 100 Volts.

<u>Input Commands</u>	<u>Pin</u>
+ Scale Command	N
- Scale Command	V
+ Hold Command	S
- Hold Command	T
+ Set Command	P
- Set Command	R

The Scale Factor command switches analog output between High & Low Range. The High Range is  $\pm 50^\circ/\text{second}$  full-scale ( $2.5^\circ/\text{sec}$  per Volt). The Low Range is  $\pm 5.0^\circ/\text{second}$  full-scale ( $0.25^\circ/\text{sec}$  per Volt). A +10 Volt differential between the + Scale & -Scale lines will turn on High Range. A -10 Volt differential between the + Scale & -Scale lines will turn on Low Range. With commands enabled and no command present the unit will default to Low Range.

The Hold command stops changes in the bias correction level. A +10 Volt differential between the + Hold & -Hold lines will turn this on. A -10 Volt differential between the + Hold & -Hold lines will turn this off.

The Set command switches to fast bias washout time constant of 1.28 seconds. A +10 Volt differential between the + Set & -Set lines will turn this on. A -10 Volt differential between the + Set & -Set lines will turn this off.

# Specifications

## Angular Rate

Range: Roll, Pitch, Yaw	±50°/sec High	±5°/sec Low
Resolution:	0.002°/sec	
Analog Scale Factor:	2.5°/sec/V High	0.25°/s/V Low
Scale Factor Accuracy:	0.25%	At 20°C
Scale Factor Temp Coefficient:	0.6%	Over temperature range
Bias: Roll, Pitch, Yaw	< ±0.1°/sec	
Bandwidth:	> 70 Hz	90° phase shift, 1.25msec group delay
Noise:	< 0.03°/sec rms	
G-Sensitivity	Negligible	
G <sup>2</sup> -Sensitivity	Negligible	
Hysteresis:	Negligible	

## Environmental

Temperature: Operating	-40°C to +70°C	
Temperature: Storage	-50°C to +85°C	
Vibration: Survival	5g rms	20 Hz to 2 kHz
Shock: Survival	1000g	3ms ½ sine wave
Angular Velocity: Survival	> ±1000°/sec	

## Electrical

Input Power:	10 to 30VDC	6W
Input Current:	250mA @ 24VDC	
Digital Output:	RS-232	
Analog Output:	±10VDC	Differential, 20 V range
Output Impedance:	300 Ohm	Per line

## Physical

Axis Alignment:	< 0.2°	
Size:	3.23"W x 4.85"L x 4.68"H	8.2 x 12.3 x 11.9 (cm)
Weight:	35.3 oz (2.2 lb)	1000 grams (1Kg)
Center of Gravity:	Near geometric center	
Connection:	MS27656T-15B-19P	
Life:	> 30,000 Hrs MTBF	

- Specifications are subject to change without notice.
- This product may be subject to export restrictions. Please consult the factory.

## BITE

Built-In Test Equipment: Continuous monitoring of 90% of potential defects. This monitoring shall include measurement of the bias correction signal and the BITE flag shall be set whenever available range is exhausted.

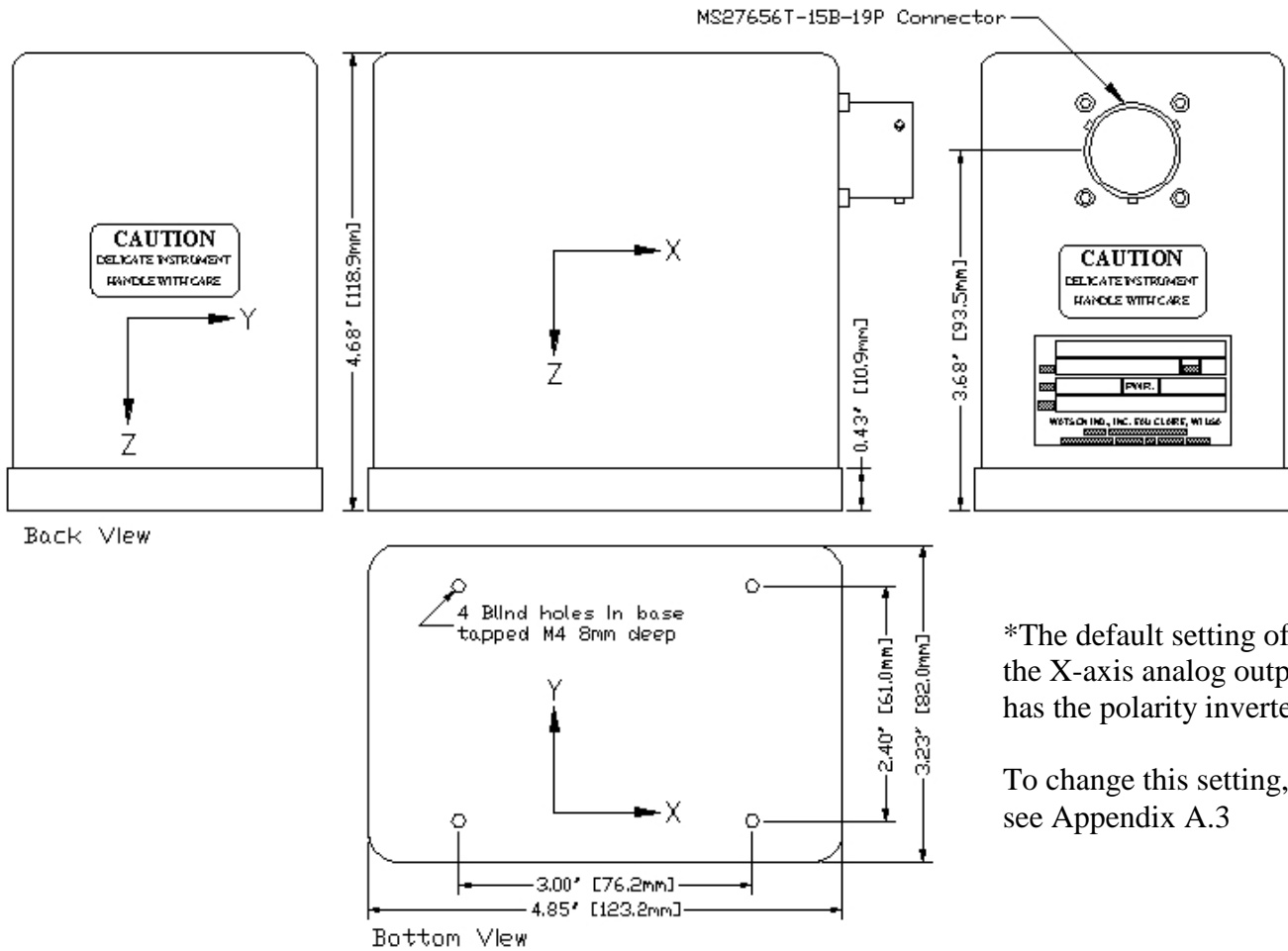
## Flags

BITE Flag:	Turns on during rate overrange (>50°/sec) or when the bias is greater than 25°/sec. The BITE Flag stays on for 2 seconds (settable) after the condition is over.
HOLD Flag:	Hold condition starts when the rate exceeds 3°/sec (settable). The Hold Flag stays on for 5 seconds (settable) after Rate is within limits.

# Connections / Dimensions

The connector is MIL-C-38999 Series 1, type MS-27656T-15B-19P. The pin assignments are as follows:

- |                               |  |
|-------------------------------|--|
| Pin A - +Z Axis Rate Output   | Pin L - RS-232 Serial Data Input         |
| Pin B - -Z Axis Rate Output   | Pin M - RS-232 Serial Data Output        |
| Pin C - -Y Axis Rate Output   | Pin N - Positive (+) Scale Command       |
| Pin D - +Y Axis Rate Output   | Pin P - Positive (+) Set Command         |
| Pin E - +X Axis Rate Output * | Pin R - Negative (-) Set Command         |
| Pin F - -X Axis Rate Output * | Pin S - Positive (+) Hold Command        |
| Pin G - +B.I.T.E. Output      | Pin T - Negative (-) Hold Command        |
| Pin H - -B.I.T.E. Output      | Pin U - RS-232 Serial Data Signal Ground |
| Pin J - +12 or +24 Volt Power | Pin V - Negative (-) Scale Command       |
| Pin K - Power Ground          |  |



\*The default setting of the X-axis analog output has the polarity inverted.

To change this setting, see Appendix A.3

**ARS-E322-1A/80**  
**Figure 1**

## **Warning**

Rough handling, dropping, or miswiring this unit is likely to cause damage.

### **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 two full years 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 which 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.

## SERVICE

Watson Industries, Inc. has no service outlets. All service is performed at the factory. In order to insure prompt service, prior to returning units for repair please call, write or fax:

Watson Industries, Inc.  
3041 Melby Road  
Eau Claire, WI 54703  
ATTN: Service Department  
Telephone: (715) 839-0628  
Fax: (715) 839-8248  
Email: support@watson-gyro.com

All sensors returned under warranty will be repaired (or replaced at the sole option of Watson Industries) at no cost to the customer other than shipping charge from customer to Watson Industries (plus any export and transportation charges outside the United States).

In the case of units not under warranty, a flat repair fee will be charged. This fee can be determined by contacting Watson Industries. Modified units or those subjected to extreme abuse may be returned to the customer unrepared.

## Appendix A

To change output formats and various other parameters, hook the unit up to your computers serial port. Use a terminal program (i.e. Hyperterminal) to interface to the unit.

Turn on unit. Wait for 5 seconds.

Hit the space bar twice. (20 ms between characters)

Wait for the initialization to end.

Now the unit will take in the keyboard commands.

Typing ‘&’ will bring up this main menu:

```
TYPE IN THE NUMBER OF YOUR SELECTION (OR 'Q' TO QUIT):
 1 = ADJUST TIMING
 2 = SET DECIMAL OUTPUT FORMAT
 3 = SET ANALOG OUTPUT FORMAT
 4 = CHANGE COMMAND MODE
 5 = CHANGE THRESHOLDS OR MAIN TIME CONSTANT
 6 = SET NEW BAUD RATE
```

Typing in a ‘1’ brings up this menu:

```
TYPE IN THE NUMBER OF YOUR SELECTION (OR 'Q' TO QUIT):
 1 = ADJUST START TIME CONSTANT
 2 = ADJUST DELAY TO FIRST BIAS
 3 = ADJUST WARM UP TIME
 4 = ADJUST B.I.T.E. PERSISTENCE
 5 = ADJUST HOLD PERSISTENCE
```

For more information on this menu see Appendix A1

Typing in a ‘2’ brings up this menu:

```
TYPE IN THE NUMBER OF YOUR SELECTION (OR 'Q' TO QUIT):
 1 = RATES ONLY
 2 = RATES AND FLAGS
 3 = RATES, BIASES, TEMPERATURE AND FLAGS
```

For more information on this menu see Appendix A2

Typing in a ‘3’ brings up this menu:

```
TYPE IN THE NUMBER OF YOUR SELECTION (OR 'Q' TO QUIT):
 1 = REVERSE X AXIS RATE
 2 = REVERSE Y AXIS RATE
 3 = REVERSE Z AXIS RATE
```

For more information on this menu see Appendix A3

Typing in a '4' brings up this menu:

TYPE IN THE NUMBER OF YOUR SELECTION (OR 'Q' TO QUIT):  
1 = COMMAND MODES  
2 = LOGIC INPUT POLARITIES  
3 = SERIAL INPUT PRESETS:

For more information on this menu see Appendix A4

Typing in a '5' brings up this menu:

TYPE IN THE NUMBER OF YOUR SELECTION (OR 'Q' TO QUIT):"  
1 = SET BIAS INHIBIT THRESHOLD  
2 = SET B.I.T.E. BIAS THRESHOLD  
3 = SET MAIN WASHOUT TIME CONSTANT

For more information on this menu see Appendix A5

Typing in a '6' brings up this menu:

TYPE IN THE NUMBER OF YOUR SELECTION (OR 'Q' TO QUIT):  
(EFFECTIVE NEXT POWER-UP)  
1 = 38.4 K BAUD  
2 = 19.2 K BAUD  
3 = 9.6 K BAUD  
4 = 4.8 K BAUD

For more information on this menu see Appendix A6

## Appendix A.1

To adjust timing, type '1' at the main menu.  
This will bring up the menu:

```
TYPE IN THE NUMBER OF YOUR SELECTION (OR 'Q' TO QUIT):
  1 = ADJUST START TIME CONSTANT
  2 = ADJUST DELAY TO FIRST BIAS
  3 = ADJUST WARM UP TIME
  4 = ADJUST B.I.T.E. PERSISTANCE
  5 = ADJUST HOLD PERSISTANCE
```

To adjust start time constant, type '1'.  
This is the time the unit waits from power up until it starts warm up.  
The following message will appear:

```
THE CURRENT SETTING IN SECONDS IS: 00.5
TYPE IN NEW TIME TO TENTHS OF SECONDS (OR 'Q' TO QUIT)
  (UP TO 3 DIGITS):
```

To change, type in the new time in tenths of seconds  
(e.g. to change to 5.0 seconds type '050' or '50' followed by <CR>)  
The limit is 0.0 to 25.5 seconds. Nominal value is 0.5 seconds.

To adjust delay to first bias, type '2'.  
This is the time the unit waits after data starts until the first bias estimate is applied to correct the rate sensors.  
The following message will appear:

```
THE CURRENT SETTING IN SECONDS IS: 060
TYPE IN NEW TIME IN SECONDS (OR 'Q' TO QUIT)
  (UP TO 3 DIGITS):
```

To change, type in the new time in tenths of seconds  
(e.g. to change to 6 seconds type '006' or '06' followed by <CR>)  
The limit is 0 to 255 seconds. Nominal value is 60 seconds.

To adjust warm up time, type '3'.  
This is the time it takes the unit to step through sequentially adjusted time constant and hold limits until final settings.  
The following message will appear:

```
THE CURRENT SETTING IN SECONDS IS: 005
TYPE IN NEW TIME IN SECONDS (OR 'Q' TO QUIT)
  (UP TO 3 DIGITS):
```

To change, type in the new time in seconds  
(e.g. to change to 10 seconds type '010' or '10' followed by <CR>)  
The limit is 0 to 999 seconds. Nominal value is 5 seconds.

To adjust B.I.T.E. persistence, type '4'.

This is the time the BITE Flag stays on after the condition (either over-range condition or bias > rate bias limit) is over.

The following message will appear:

```
THE CURRENT SETTING IN SECONDS IS: 01.0
TYPE IN NEW TIME TO TENTHS OF SECONDS (OR 'Q' TO QUIT)
(UP TO 3 DIGITS):
```

To change, type in the new time in tenths of seconds

(e.g. to change to 2.5 seconds type '025' or '25' followed by <CR>)

The limit is 0.0 to 99.9 seconds. Nominal value 1.0 seconds.

To adjust HOLD persistence, type '5'.

This is the time the HOLD Flag stays on after the condition (either after hold command or the rate exceeds the rate hold threshold) is over.

The following message will appear:

```
THE CURRENT SETTING IN SECONDS IS: 05.0
TYPE IN NEW TIME TO TENTHS OF SECONDS (OR 'Q' TO QUIT)
(UP TO 3 DIGITS):
```

To change, type in the new time in tenths of seconds

(e.g. to change to 3.0 seconds type '030' or '30' followed by <CR>)

The limit is 0.0 to 99.9 seconds. Nominal value is 5.0 seconds.

**Note: Input values outside the limit range or Quit command are rejected (with '\*\*\* ERROR \*\*\*' message) and the unit returns to the previous menu**

## Appendix A.2

To set Decimal output format, type '2' at the main menu.

This will bring up the menu:

```
TYPE IN THE NUMBER OF YOUR SELECTION (OR 'Q' TO QUIT):
1 = RATES ONLY
2 = RATES AND FLAGS
3 = RATES, BIASES, TEMPERATURE AND FLAGS:
```

To change to decimal output with the X Rate, Y Rate & Z Rate - type '1'.

Example:

+02.49	-05.03	+20.47	<CR>
X Axis Rate	Y Axis Rate	Z Axis Rate	

To change to decimal output with the X Rate, Y Rate, Z Rate & Status Flags - type '2'.

Example:

+02.49	-05.03	+20.47	00	<CR>
--------	--------	--------	----	------

X Axis Rate	Y Axis Rate	Z Axis Rate	Status Flags
----------------	----------------	----------------	-----------------

To change to decimal output with the X Rate, Y Rate, Z Rate, X Rate Bias, Y Rate Bias, Z Rate Bias, Temp, Diagnostic & Status Flags - type '3'.

Example:

+02.49	-05.03	+20.47	+00.3	-00.5	-01.6	+25	00	00	<CR>
X Axis Rate	Y Axis Rate	Z Axis Rate	X Axis Rate Bias	Y Axis Rate Bias	Z Axis Rate Bias	Temp	Diagnostic Flags	Status Flags	

## Appendix A.3

To set the analog output polarity, type '3' at the main menu.  
This will bring up the menu:

TYPE IN THE NUMBER OF YOUR SELECTION (OR 'Q' TO QUIT):  
 1 = REVERSE X AXIS RATE  
 2 = REVERSE Y AXIS RATE  
 3 = REVERSE Z AXIS RATE

The analog angular rate output polarity can be switched.  
 To change the polarity of X Axis Rate, type '1'.  
 To change the polarity of Y Axis Rate, type '2'.  
 To change the polarity of Z Axis Rate, type '3'.  
 This allows the unit to be installed backwards or upside down.

## Appendix A.4

To change command mode, type '4' at the main menu.  
This will bring up the menu:

TYPE IN THE NUMBER OF YOUR SELECTION (OR 'Q' TO QUIT):  
 1 = COMMAND MODES  
 2 = LOGIC INPUT POLARITIES  
 3 = SERIAL INPUT PRESETS:

To update command mode, type '1'.  
The following message will appear:

TO SELECT ACCESS FOR ANY OF THE FOLLOWING COMMAND ITEMS, PRESS Y  
 TO AVOID ANY OF THE FOLLOWING COMMAND ITEMS, PRESS N  
 TO QUIT AND DISREGARD ANY OTHER COMMANDS, PRESS Q

ALLOW SERIAL COMMANDS INSTEAD OF LOGIC INPUTS?

Type 'Y' to enable the command input from the serial port. This disables the logic input commands.

Typing an 'N' enables the logic input commands and disables serial port commands.

This will bring up the next line:

TO SELECT ACCESS FOR ANY OF THE FOLLOWING COMMAND ITEMS, PRESS Y  
TO AVOID ANY OF THE FOLLOWING COMMAND ITEMS, PRESS N  
TO QUIT AND DISREGARD ANY OTHER COMMANDS, PRESS Q

ALLOW SERIAL COMMANDS INSTEAD OF LOGIC INPUTS? Y  
ALLOW EXTERNAL FAST WASHOUT COMMAND?

Type 'Y' to enable the fast washout command. This allows the Set Command lines to be active. Placing the +Set line to +10 Volts with respect to the - Set line will change wash out time constant to 1.28 seconds. Placing the +Set line to -10 Volts with respect to the - Set line will resume the original time constant.  
Typing an 'N' disables this command.

This will bring up the next line:

TO SELECT ACCESS FOR ANY OF THE FOLLOWING COMMAND ITEMS, PRESS Y  
TO AVOID ANY OF THE FOLLOWING COMMAND ITEMS, PRESS N  
TO QUIT AND DISREGARD ANY OTHER COMMANDS, PRESS Q

ALLOW SERIAL COMMANDS INSTEAD OF LOGIC INPUTS? Y  
ALLOW EXTERNAL FAST WASHOUT COMMAND? Y  
ALLOW EXTERNAL BIAS CORRECTION INHIBIT COMMAND?

Type 'Y' to enable the external Hold Command. This allows the Hold Command C lines to be active. Placing the +Hold line to +10 Volts with respect to the - Hold line will will inhibit the rate bias correction. Placing the +Hold line to -10 Volts with respect to the - Hold line will resume the bias correction process.  
Typing an 'N' disables this command.

This will bring up the next line:

TO SELECT ACCESS FOR ANY OF THE FOLLOWING COMMAND ITEMS, PRESS Y  
TO AVOID ANY OF THE FOLLOWING COMMAND ITEMS, PRESS N  
TO QUIT AND DISREGARD ANY OTHER COMMANDS, PRESS Q

ALLOW SERIAL COMMANDS INSTEAD OF LOGIC INPUTS? Y  
ALLOW EXTERNAL FAST WASHOUT COMMAND? Y  
ALLOW EXTERNAL BIAS CORRECTION INHIBIT COMMAND? Y  
ALLOW EXTERNAL SCALE FACTOR COMMAND?

Type 'Y' to enable the external Scale Factor Command. This allows the Scale Command lines to be active. Placing the +Scale line to +10 Volts with respect to the - Scale line will change the scale factor on the analog rate data to High Range(2.5 %/sec per Volt). Placing the +Scale line to -10 Volts with

respect to the – Scale line will change the scale factor on the analog rate data to Low Range(0.25 °/sec per Volt). The default scale is Low Range.  
Typing an ‘N’ disables this command.

This will bring up the next line:

TO SELECT ACCESS FOR ANY OF THE FOLLOWING COMMAND ITEMS, PRESS Y  
TO AVOID ANY OF THE FOLLOWING COMMAND ITEMS, PRESS N  
TO QUIT AND DISREGARD ANY OTHER COMMANDS, PRESS Q

ALLOW SERIAL COMMANDS INSTEAD OF LOGIC INPUTS? Y  
ALLOW EXTERNAL FAST WASHOUT COMMAND? Y  
ALLOW EXTERNAL BIAS CORRECTION INHIBIT COMMAND? Y  
ALLOW EXTERNAL SCALE FACTOR COMMAND? Y  
ALLOW HOLD TO BE ON WHEN SCALE IS CALLED?

Type ‘Y’ to enable the Hold Command to stay on while a Scale Factor Command is called.

Typing an ‘N’ disables this command.

This will bring up the next line:

TO SELECT ACCESS FOR ANY OF THE FOLLOWING COMMAND ITEMS, PRESS Y  
TO AVOID ANY OF THE FOLLOWING COMMAND ITEMS, PRESS N  
TO QUIT AND DISREGARD ANY OTHER COMMANDS, PRESS Q

ALLOW SERIAL COMMANDS INSTEAD OF LOGIC INPUTS? Y  
ALLOW EXTERNAL FAST WASHOUT COMMAND? Y  
ALLOW EXTERNAL BIAS CORRECTION INHIBIT COMMAND? Y  
ALLOW EXTERNAL SCALE FACTOR COMMAND? Y  
ALLOW HOLD TO BE ON WHEN SCALE IS CALLED?N  
ASSERT B.I.T.E. WHILE INTIALIZING?

Type ‘Y’ to enable B.I.T.E. Flag to be active during initialization.

Typing an ‘N’ disables this command.

This will bring up the next line:

TO SELECT ACCESS FOR ANY OF THE FOLLOWING COMMAND ITEMS, PRESS Y  
TO AVOID ANY OF THE FOLLOWING COMMAND ITEMS, PRESS N  
TO QUIT AND DISREGARD ANY OTHER COMMANDS, PRESS Q

ALLOW SERIAL COMMANDS INSTEAD OF LOGIC INPUTS? Y  
ALLOW EXTERNAL FAST WASHOUT COMMAND? Y  
ALLOW EXTERNAL BIAS CORRECTION INHIBIT COMMAND? Y  
ALLOW EXTERNAL SCALE FACTOR COMMAND? Y  
ALLOW HOLD TO BE ON WHEN SCALE IS CALLED? N  
ASSERT B.I.T.E. WHILE INTIALIZING? N  
ALLOW A/C B.I.T.E.?

Type ‘Y’ to enable the AC B.I.T.E. (It is an AC signal instead of a DC Level.) The AC signal is 400 Hz 5 volt square wave.

Typing an ‘N’ disables this command.

This will bring up the last lines:

TO SELECT ACCESS FOR ANY OF THE FOLLOWING COMMAND ITEMS, PRESS Y  
TO AVOID ANY OF THE FOLLOWING COMMAND ITEMS, PRESS N  
TO QUIT AND DISREGARD ANY OTHER COMMANDS, PRESS Q

ALLOW SERIAL COMMANDS INSTEAD OF LOGIC INPUTS? Y  
ALLOW EXTERNAL FAST WASHOUT COMMAND? Y  
ALLOW EXTERNAL BIAS CORRECTION INHIBIT COMMAND? Y  
ALLOW EXTERNAL SCALE FACTOR COMMAND? Y  
ALLOW HOLD TO BE ON WHEN SCALE IS CALLED? N  
ASSERT B.I.T.E. WHILE INITIALIZING? N  
ALLOW A/C B.I.T.E.? N

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

Type 'N' to update the enable status of these commands. Typing 'Q' will quit without update the command status. Typing an 'Y' starts the command menu sequence over.

Referencing this submenu:

TYPE IN THE NUMBER OF YOUR SELECTION (OR 'Q' TO QUIT):

- 1 = COMMAND MODES
- 2 = LOGIC INPUT POLARITIES
- 3 = SERIAL INPUT PRESETS:

To change logic input polarities, type '2'.

The following message will appear:

TO SELECT ACCESS FOR ANY OF THE FOLLOWING COMMAND ITEMS, PRESS Y  
TO AVOID ANY OF THE FOLLOWING COMMAND ITEMS, PRESS N  
TO QUIT AND DISREGARD ANY OTHER COMMANDS, PRESS Q

REVERSE SET COMMAND?

Type 'Y' to invert the polarity of the Set logic input command.  
Typing an 'N' leaves the polarity of the Set logic input command unchanged.

This will bring up the next line:

TO SELECT ACCESS FOR ANY OF THE FOLLOWING COMMAND ITEMS, PRESS Y  
TO AVOID ANY OF THE FOLLOWING COMMAND ITEMS, PRESS N  
TO QUIT AND DISREGARD ANY OTHER COMMANDS, PRESS Q

REVERSE SET COMMAND? N  
REVERSE HOLD COMMAND?

Type 'Y' to invert the polarity of the Hold logic input command.  
Typing an 'N' leaves the polarity of the Hold logic input command unchanged.

This will bring up the next line:

TO SELECT ACCESS FOR ANY OF THE FOLLOWING COMMAND ITEMS, PRESS Y  
TO AVOID ANY OF THE FOLLOWING COMMAND ITEMS, PRESS N  
TO QUIT AND DISREGARD ANY OTHER COMMANDS, PRESS Q

REVERSE SET COMMAND? N  
REVERSE HOLD COMMAND? N  
REVERSE SCALE COMMAND?

Type 'Y' to invert the polarity of the Scale logic input command.  
Typing an 'N' leaves the polarity of the Scale logic input command unchanged.

This will bring up the last lines:

TO SELECT ACCESS FOR ANY OF THE FOLLOWING COMMAND ITEMS, PRESS Y  
TO AVOID ANY OF THE FOLLOWING COMMAND ITEMS, PRESS N  
TO QUIT AND DISREGARD ANY OTHER COMMANDS, PRESS Q

REVERSE SET COMMAND? N  
REVERSE HOLD COMMAND? N  
REVERSE SCALE COMMAND?

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

Type 'N' to update the status of these commands. Typing 'Q' will quit without updating the command status. Typing an 'Y' starts the logic command polarities sequence over.

Referencing this submenu:

TYPE IN THE NUMBER OF YOUR SELECTION (OR 'Q' TO QUIT):

- 1 = COMMAND MODES
- 2 = LOGIC INPUT POLARITIES
- 3 = SERIAL INPUT PRESETS:

To change serial input presets, type '3'.

The following message will appear:

TO SELECT ACCESS FOR ANY OF THE FOLLOWING COMMAND ITEMS, PRESS Y  
TO AVOID ANY OF THE FOLLOWING COMMAND ITEMS, PRESS N  
TO QUIT AND DISREGARD ANY OTHER COMMANDS, PRESS Q

SET COMMAND DEFAULT ON?

Type 'Y' will cause the unit to default to the Set command on.  
Typing an 'N' causes the unit to default to the Set command off.

This will bring up the next line:

TO SELECT ACCESS FOR ANY OF THE FOLLOWING COMMAND ITEMS, PRESS Y  
TO AVOID ANY OF THE FOLLOWING COMMAND ITEMS, PRESS N  
TO QUIT AND DISREGARD ANY OTHER COMMANDS, PRESS Q

SET COMMAND DEFAULT ON? N  
HOLD COMMAND DEFAULT ON?

Type 'Y' will cause the unit to default to the Hold command on.  
Typing an 'N' causes the unit to default to the Hold command off.

This will bring up the next line:

TO SELECT ACCESS FOR ANY OF THE FOLLOWING COMMAND ITEMS, PRESS Y  
TO AVOID ANY OF THE FOLLOWING COMMAND ITEMS, PRESS N  
TO QUIT AND DISREGARD ANY OTHER COMMANDS, PRESS Q

SET COMMAND DEFAULT ON? N  
HOLD COMMAND DEFAULT ON? N  
SCALE COMMAND DEFAULT ON?

Type 'Y' will cause the unit to default to the Scale command on.  
Typing an 'N' causes the unit to default to the Scale command off.

This will bring up the last lines::

TO SELECT ACCESS FOR ANY OF THE FOLLOWING COMMAND ITEMS, PRESS Y  
TO AVOID ANY OF THE FOLLOWING COMMAND ITEMS, PRESS N  
TO QUIT AND DISREGARD ANY OTHER COMMANDS, PRESS Q

SET COMMAND DEFAULT ON? N  
HOLD COMMAND DEFAULT ON? N  
SCALE COMMAND DEFAULT ON? N

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

Type 'N' to update the status of these command defaults. Typing 'Q' will quit without updating the command defaults. Typing an 'Y' starts the serial input presets sequence over.

Referencing this submenu:

TYPE IN THE NUMBER OF YOUR SELECTION (OR 'Q' TO QUIT):  
1 = COMMAND MODES  
2 = LOGIC INPUT POLARITIES  
3 = SERIAL INPUT PRESETS:

To quit, type 'Q'. This will take you back top the main menu.

## Appendix A.5

To change threshold or main time constants, type '5' at the main menu.

This will bring up the menu:

```
TYPE IN THE NUMBER OF YOUR SELECTION (OR 'Q' TO QUIT):"  
1 = SET BIAS INHIBIT THRESHOLD  
2 = SET B.I.T.E. BIAS THRESHOLD  
3 = SET MAIN WASHOUT TIME CONSTANT
```

To set bias inhibit threshold, type '1'.

This will bring up the menu:

```
TYPE IN THE NUMBER OF YOUR SELECTION (OR 'Q' TO QUIT):  
1 = X AXIS RATE LIMIT  
2 = Y AXIS RATE LIMIT  
3 = Z AXIS RATE LIMIT
```

The analog angular rate limit can be switched.

To change the limit of X Axis Rate, type '1'.

To change the limit of Y Axis Rate, type '2'.

To change the limit of Z Axis Rate, type '3'.

This is the level at which any rate(absolute value) will cause hold command to start.

The following message will appear:

```
THE CURRENT SETTING IN DEGREES/SECONDS IS: 10.0  
TYPE IN NEW SETTING TO TENTHS OF DEGREE/ SECOND (OR 'Q' TO QUIT):
```

To change, type in the new threshold in tenths of degree/second

(e.g. to change to 6.0 degrees/second type '060' or '60' followed by <CR>)

The limit is 0.0 to 99.9 degrees/second. Nominal value is 10.0 degrees/second.

To set BITE bias threshold, type '2'.

This is the level at which any rate bias(absolute value) will cause BITE Flag to turn on.

The following message will appear:

```
THE CURRENT SETTING IN DEGREES/SECONDS IS: 25.0  
TYPE IN NEW SETTING TO TENTHS OF DEGREE/ SECOND (OR 'Q' TO QUIT):
```

To change, type in the new threshold in tenths of degree/second

(e.g. to change to 9.0 degrees/second type '090' or '90' followed by <CR>)

The limit is 0.0 to 99.9 degrees/second. Nominal value is 25.0 degrees/second.

To set main wash bias time constant, type '3'.

This is the time it takes to washout 63% of the remaining bias.

The following message will appear:

```
THE CURRENT SETTING IN SECONDS IS 0082
TYPE IN NEW TIME IN SECONDS (OR 'Q' TO QUIT):
(UP TO 4 DIGITS):
```

To change, type in the time constant in seconds

(e.g. to change to 80 seconds type '0080' , '080' or '80' followed by <CR>)

The limit is 6 to 1146 seconds. Nominal value is 82 seconds.

**Note: Input values outside the limit range or Quit command are rejected (with '\*\*\* ERROR \*\*\*' message) and the unit returns to the previous menu**

## Appendix A.6

To set new baud rate, type '6' at the main menu.

This will bring up the menu:

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

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 the next time the unit is powered up.