

# **TRIAXIAL ANGULAR RATE SENSOR**

## **OWNER'S MANUAL**

**PART NUMBER: ARS-E332-3A**



**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

Product Description .....	3
Principles of Operation.....	3
Installation .....	4
Orientation/Mounting .....	4
Environment.....	4
Power .....	4
Calibration .....	4
Specifications:.....	5
Connections / Dimensions .....	5
Warning .....	7

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.

## Product Description

The ARS-E332-3A is a solid-state, triaxial rate gyro consisting of three (3) single axis, solid-state gyros. The sensor provides analog signals for X, Y & Z angular Rate. The gyros are installed nominally orthogonal.

## Principles of Operation

Gyroscopes (Gyros) are used to measure angular motion. Vibrating Structure Gyros are solid-state devices that provide an output voltage proportional to the rate of turn applied to the sensitive axis.

All the vibrating structure devices described here work on the basic principle of detecting coriolis forces. These forces are generated when a moving particle is rotated.

To use the coriolis effect to detect angular rotation, a solid structure is forced to vibrate normally at its resonant frequency. This is achieved by applying an alternating voltage to the primary electrodes. The vibration provides the structure with a linear velocity component. When the structure is rotated, the coriolis forces cause the vibration motion of the structure to be coupled to another vibration mode or plane of the structure. The magnitude of this secondary vibration is proportional to the angular rate of turn.

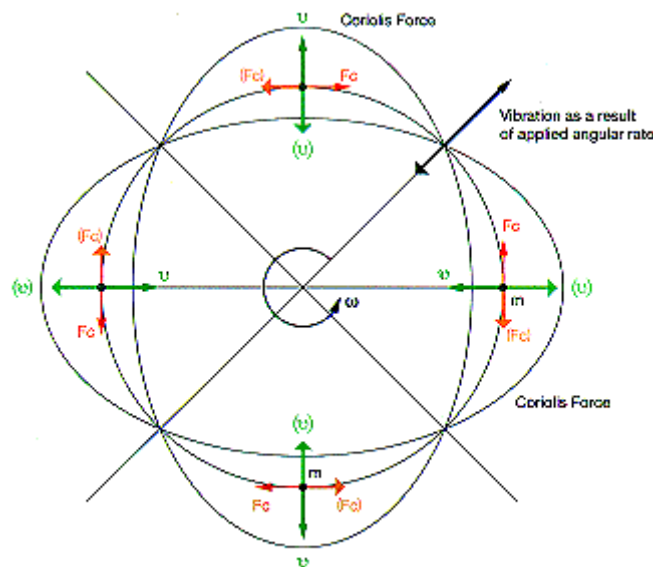


Figure 1

The Gyros are of the shell type i.e. cylinders or rings. Figure 1 shows the vibration pattern at the end of the shell. Rotational motion produces coriolis forces which couple the vibration to a point 45 degrees relative to the driven axis. A secondary pickoff is used to determine the vibration at the 45 degree points. The output from the secondary pickoff is proportional to the rate of turn.

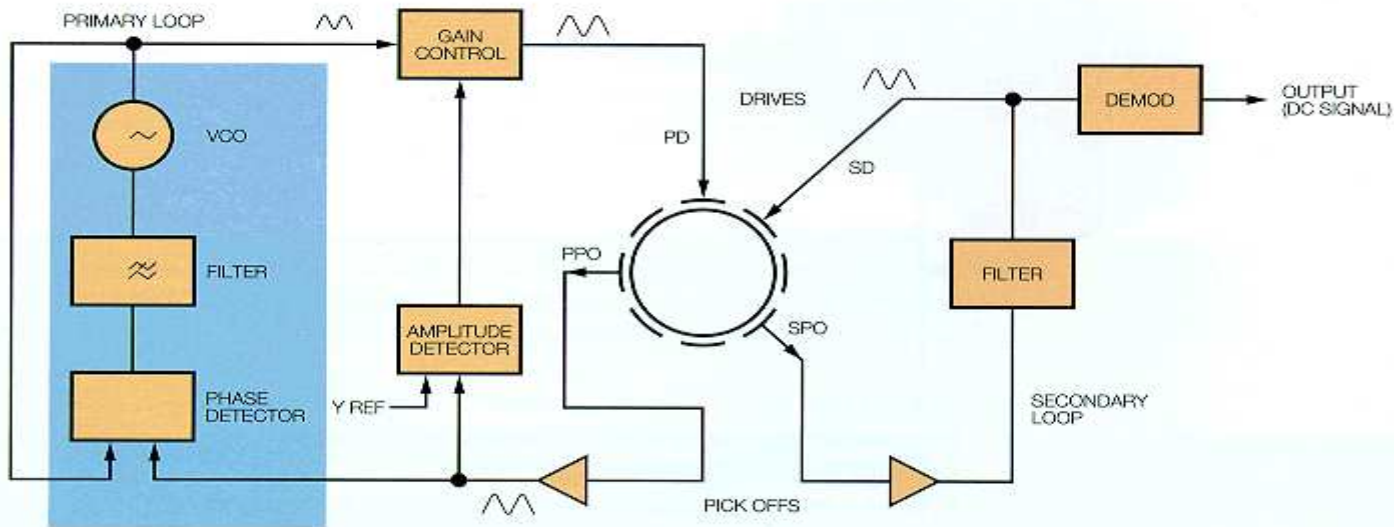


Figure 2

Figure 2 shows the block diagram for the Gyro. A primary pick off is used to provide feedback to keep the primary loop frequency at resonance and at constant amplitude. A second closed loop, comprising a secondary pick off and a secondary drive is used to null the rotated vibration and to provide an output directly proportional to the applied rate. These closed loop techniques greatly improve the performance of the device.

## Installation

### **Orientation/Mounting**

The unit has 3 mounting holes tapped for 6-32 (0.25" 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**

Best operation is obtained at 12 VDC or 24 VDC level, although operation is fully satisfactory down to 10 VDC and up to 30 VDC. Power draw of the unit is approximately 3.6Watts. 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.

### **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.

## Specifications:

### Angular Rate

Range: Roll, Pitch, Yaw	±100°/sec	
Resolution:	0.025°/sec	
Analog Scale Factor:	20°/sec/V	
Scale Factor Accuracy:	1%	Constant temperature
Scale Factor Temp Coefficient:	±1%	Over temperature range
Bias: Zero Bias	±1.0°/sec	
Bias: Over Temp Range	±1.0°/sec	
Non-Linearity:	< 0.03%	Full scale range
Bandwidth:	> 50 Hz	
Noise:	< 0.03°/sec rms	

### 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

Startup Time: Data	< 300 mS	
Input Power:	10 to 30VDC	3.6W
Input Current:	300mA @ 12VDC	
Analog Output	±5VDC	
Output Impedance:	1000 Ohm	

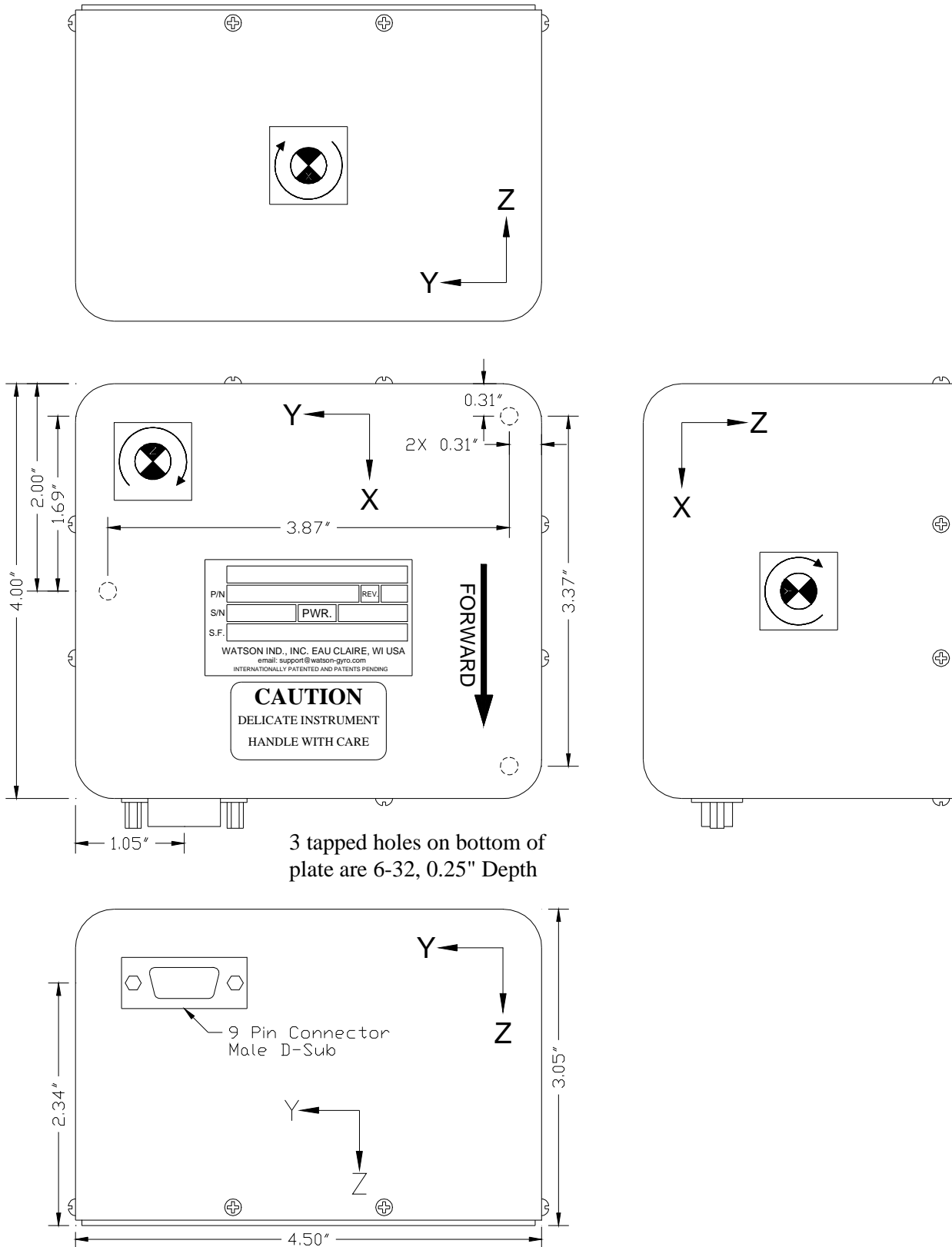
### Physical

Axis Alignment:	< 1°	
Size:	4.00"W x 4.50"L x 3.05"H	10.2 x 11.4 x 7.7 (cm)
Weight:	26oz (1.6lb)	740 grams (0.7Kg)
Connection:	9 pin male "D" subminiature	
Life:	> 50,000 Hrs MTBF	

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

## Connections / Dimensions

ARS-E332-3A Pin out (Male D-sub 9 pin)	
Pin 1	Ground
Pin 2	+12 VDC @ <300 mA
Pin 3 – 5	No connection
Pin 6	X Rate Output *
Pin 7	Y Rate Output *
Pin 8	Z Rate Output *
Pin 9	No Connection
* Rate output:	0.00 VDC @ 0 °/second -5.00 VDC @ -100 °/second 5.00 VDC @ +100 °/second
Scale Factor:	20°/second/Volt
Other scale factors / ranges available	



3 tapped holes on bottom of plate are 6-32, 0.25" Depth

**ARS-E332-3A**  
**Figure 3**

## **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.

### **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.

## 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.