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IEEE Standard Specification Format Guide and Test Procedure for Coriolis Vibratory Gyros

IEEE Aerospace and Electronic Systems Society

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Gyro and Accelerometer Panel



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Gyro and Accelerometer Panel
of the
IEEE Aerospace and Electronic Systems Society

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Abstract: Specification and test requirements for a single-axis Coriolis vibratory gyro (CVG) for use as a sensor in attitude control systems, angular displacement measuring systems, and angular rate measuring systems are defined. A standard specification format guide for the preparation of a single-axis CVG is provided. A compilation of recommended procedures for testing a CVG, derived from those presently used in the industry, is also provided. Informative annexes cover CVG design features and theoretical principles of operation.

Keywords: Coriolis vibratory gyro, force-rebalance mode, gyro, gyroscope, inertial instrument, inertial sensor, MEMS, MEMS gyro, micro-electro-mechanical system, open loop mode, ratiometric output, whole angle mode

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Introduction

This introduction is not part of IEEE Std 1431-2004, IEEE Standard Specification Format Guide and Test Procedure for Coriolis Vibratory Gyros.

This new standard consists of two parts:

Part I is a specification format guide for the preparation of a Coriolis vibratory gyro specification. It provides a common meeting ground of terminology and practice for manufacturers and users. The user is cautioned not to over specify; only those parameters that are required to guarantee proper performance in the specific application should be controlled. In general, the specification should contain only those requirements that can be verified by test or inspection. Parameters in addition to those given in this standard are not precluded.

Part II is a compilation of recommended procedures for testing a Coriolis vibratory gyro. These procedures, including test conditions to be considered, are derived from those currently in use. For a specific application, the test procedure should reflect the requirements of the specification; therefore, not all tests outlined in this standard need be included, nor are additional tests precluded. In some cases, alternative methods for measuring performance characteristics have been included or indicated.

The intent is for the specification writer to extract the applicable test conditions and equipment requirements from clause 11 for inclusion in the appropriate clauses listed under 6.5 of this standard. Similarly, it is intended that the writer extract the applicable test procedures from clause 12 for inclusion in the appropriate clauses listed under 6.6. Part II can also be used as a guide in the preparation of a separate Coriolis vibratory gyro test specification with appropriate clause numbering. In general, the intent is for the specification writer to ensure consistency and traceability between Part II test procedures and Part I requirements for performance, mechanical, electrical, environmental, reliability, and quality assurance. To that end, a test procedure should not be listed in Part II unless a related requirement exists in Part I.

Blank spaces in the text of this document permit the specification writer to insert specific information such as parameter values and their tolerances, clause numbers, etc. Brackets are used to enclose alternative choices of dimensional units, signs, axes, etc. Boxed statements are included for information only and are not part of the specification or test procedures. The terminology used conforms to *The Authoritative Dictionary of IEEE Standards Terms*, Seventh Edition. The units used conform to ANSI/IEEE Std 268-1992, IEEE Standard for Metric Practice. The abbreviation of units conforms to ANSI/IEEE Std 260.1-1993, Standard Letter Symbols for Units of Measurement. The graphic symbols used conform to ANSI/IEEE Std 315-1975, IEEE Standard Graphic Symbols for Electrical and Electronics Diagrams and its supplement ANSI/IEEE Std 315A-1986.

This standard defines the requirements and test procedures for a Coriolis vibratory gyro in terms unique to the Coriolis vibratory gyro. The requirements contained herein cover applications where the Coriolis vibratory gyro is used as an angular motion sensor in navigation and control systems.

The term Coriolis vibratory gyro is accepted to include the electronics necessary to operate the gyro and to condition the output signal. The Coriolis vibratory gyro provides an output proportional to inertial angular rate about its input axis.

Annex A lists various Coriolis vibratory gyro design features for which this format is applicable. The list is not intended to make any suggestion regarding the selection of particular design features that might restrict the free choice of manufacturers.

Annex B is a description of the various types of Coriolis vibratory gyros and their functioning.

Annex C is a compliance matrix that lists requirements clauses and their corresponding test clauses.

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IEEE Standard Specification Format Guide and Test Procedure for Coriolis Vibratory Gyros

1. Overview

1.1 Scope

Specification and test requirements for a single-axis Coriolis vibratory gyro (CVG) for use as a sensor in attitude control systems, angular displacement measuring systems, and angular rate measuring systems are defined. A standard specification format guide for the preparation of a single-axis CVG is provided. A compilation of recommended procedures for testing a CVG, derived from those presently used in the industry, is also provided. Informative annexes cover CVG design features and theoretical principles of operation.

1.2 Document structure

This standard consists of two parts: Part I is a specification format guide for the preparation of a CVG specification; Part II is a compilation of recommended procedures for testing a CVG.

1.3 Definitions

Except for the terms defined below, *The Authoritative Dictionary of IEEE Standards Terms*, Seventh Edition; IEEE Std 528TM-2001¹; and the model equation of 8.3 define terminology used in this standard.

1.3.1 Angle storage (Coriolis Vibratory Gyro): The angular information stored in a gyro as a result of its dynamics.

1.3.2 Coriolis Vibratory Gyro (CVG): A gyro based on the coupling of a structural, driven, vibrating mode into at least one other structural mode (pickoff) via Coriolis acceleration.

NOTE—CVGs may be designed to operate in open-loop, force-rebalance (i.e., closed-loop) and / or whole angle modes.²

1.3.3 Force-rebalance mode (Coriolis Vibratory Gyro): A mode in which the vibration amplitude of the pickoff is nulled by a signal whose amplitude is proportional to the rotation rate about the input axis (es).

¹Information on references can be found in Clause 2.

²Notes in text, tables, and figures are given for information only, and do not contain requirements needed to implement the standard.

1.3.4 Forcer (Coriolis Vibratory Gyro): A device that exerts a force on a resonator, in response to a command signal.

1.3.5 Open loop mode (Coriolis Vibratory Gyro): A mode in which the vibration amplitude of the pickoff is proportional to the rotation rate about the input axis (es).

1.3.6 Ratiometric output: An output method where the representation of the measured quantity (e.g., voltage, current, pulse rate, pulse width) varies in proportion to a reference quantity.

1.3.7 Whole angle mode (Coriolis Vibratory Gyro): A mode of single-axis operation in which the pickoff output is a measure of the net angle of rotation since initialization.

2. References

This standard shall be used in conjunction with the following publications. When the following standards are superseded by an approved revision, the revision shall apply.

ANSI Std 268-1992³, American National Standard for Metric Practice.

IEEE Std 260.1TM-2004⁴, American National Standard Letter Symbols for Units of Measurement (SI Units, Customary Inch-Pound Units).

IEEE Std 280TM-1985, IEEE Letter Symbols for Quantities Used in Electrical Science and Electrical Engineering.

IEEE Std 315TM-1975, IEEE Graphic Symbols for Electrical and Electronics Diagrams.

IEEE Std 315ATM-1986, IEEE Graphic Symbols for Electrical and Electronics Diagrams (Supplement to ANSI / IEEE Std 315TM-1975).

IEEE Std 528TM-2001, IEEE Standard for Inertial Sensor Terminology.

IEEE Std 647-1995, IEEE Standard Specification Format Guide and Test Procedure for Single-Axis Laser Gyros.

IEEE Std 952TM-1997, IEEE Standard Specification Format Guide and Test Procedure for Single-Axis Interferometric Fiber Optic Gyros.

³ANSI publications are available from the Sales Department, American National Standards Institute, 11 West 42nd Street, 13th Floor, New York, NY 10036, USA

⁴IEEE publications are available from the Institute of Electrical and Electronics Engineers, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331, USA (<http://standards.ieee.org/>).

Part I—Specification format

3. Purpose

This specification defines requirements for a single-axis Coriolis vibratory gyro (CVG) to be used as a sensor in [an inertial measurement unit, _____].

A description of the design features of a single-axis CVG is presented in Annex A and principles of operation in Annex B. The CVG may include electronics necessary to operate the gyro and condition the output signal. A CVG can be either a macroscopic device or a micro-electro-mechanical system (MEMS).

4. Applicable documents

The following documents form a part of the specification to the extent specified herein. In the event of any conflict between the requirements of this specification and the listed documents, the requirements of this specification shall govern.

Give identification number, title, date of issue, and revision letter of each listed document.

4.1 Specifications

4.1.1 Government

MIL-P-116H	Methods of Preservation
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4.1.2 Industry/technical

4.1.3 Company

4.2 Standards

4.2.1 Government

MIL-STD-105	Sampling Procedure and Tables for Inspection by Attributes.
MIL-STD-461	Electromagnetic Interference Characteristics, Emission, and Susceptibility Requirements for the Control of Electromagnetic Interference.
MIL-STD-462	Electromagnetic Interference Characteristics, Measurement of.
MIL-STD-704C	Aircraft Electrical Power Characteristics.
MIL-STD-781C	Reliability Design Qualification and Production Acceptance Tests: Exponential Distribution.
MIL-STD-785B Notice 2	Reliability Program for Systems and Equipment Development and Production.
MIL-STD-810	Environmental Test Methods and Engineering Guidelines.
MIL-STD-883	Test Method Standard Microcircuits

4.2.2 Industry/technical

IEEE Std 100-1996	IEEE Standard Dictionary of Electrical and Electronics Terms
IEEE Std 528-2001	IEEE Standard for Inertial Sensor Terminology
IEEE Std C62.38-1994	IEEE Guide on Electrostatic Discharge (ESD): ESD Withstand Capability Evaluation Methods (for Electronic Equipment Subassemblies)
CEI/IEC 61000-4-2, 2001-04	Electromagnetic Compatibility (EMC) – Testing and measurement techniques – Electrostatic discharge immunity test.
EMC Directive 89/336/EEC	Council Directive on the Approximation of the Laws of the Member States Relating to Electromagnetic Compatibility
CDF-AEF-Q100-003	Machine Model Electrostatic Discharge Test

4.2.3 Company

4.3 Drawings

4.3.1 Government

4.3.2 Industry/technical

4.3.3 Company

4.4 Bulletins

4.4.1 Government

4.4.2 Industry/technical

4.4.3 Company

4.5 Other publications

Other applicable documents should be listed under the appropriate paragraph.

5. Requirement

5.1 Description

The major components of the CVG herein specified are: a _____ resonant mode structure, a drive excitation mechanism, a pickoff mechanism, electronics, and a case. The CVG may also have the following additional major components: drive-pickoff, forcer, servo electronics, temperature sensor, damping means, vibration isolation, and over-range protection.

To fill in the blanks, refer to Annex A for examples.

5.2 General requirements

5.2.1 Precedence

In the event of conflict among the purchase agreement, this specification and other documents referred to herein, the order of precedence shall be as follows:

- a) Purchase agreement
- b) This specification and its applicable drawings (see 5.4.2 and 5.5.1)
- c) Other applicable documents (see 4).

5.2.2 Deliverables

The deliverables include the gyro plus its numerical data, such as bias, scale factor, and input axis misalignment.

5.2.3 Other

List other applicable general requirements.

5.3 Performance

Performance characteristics shall be as specified in this subclause.

The tolerances include a summation of manufacturing and test errors, and environmental effects. Any exception due to environmental effects will be listed in _____.

When required by the application, the sensitivity of a gyro characteristic to variations in voltage, frequency, temperature, or other variables should be included in the paragraph specifying that characteristic. Where applicable, the operating conditions under which each requirement applies should be stated.

5.3.1 Input rate limits

The input rate limits about the gyro input axis shall be $\pm$ _____ [$^{\circ}/s$, rad/s].

The positive and negative input rate limits need not be equal. Multiple rate limits may be specified. It may be important to specify the maximum input rate or angular acceleration that can be applied to the gyro without damage.

5.3.2 Gyro scale factor

_____ [$^{\circ}/s/V$, $^{\circ}/s/Hz$, _____] $\pm$ _____ [ppm, %, _____] .

In some applications it may be more appropriate to express the scale factor as the inverse of that stated above.

For gyros operating in the ratiometric output mode, the nominal scale factor should be measured at a specified reference voltage. The output scale factor is then inversely proportional to the ratio of the reference voltage to the power supply voltage.

In the whole angle mode, the scale factor is specified in units of angular change per LSB.

Different values and tolerances may be specified for different input ranges. The scale factor range includes the manufacturing tolerance. The test procedure will result in a nominal scale factor that is defined in the model equation in 8.3.

5.3.2.1 Gyro scale factor errors

5.3.2.1.1 Linearity error

_____ [ppm, %] of full scale and/or _____ [ppm, %] of output, [maximum, 1σ , _____].

Linearity error is the residual error remaining after a linear fit. This includes both systematic and nonsystematic errors.

In some applications, nonlinearity may be specified. Nonlinearity involves only systematic deviations from a straight line.

5.3.2.1.2 Asymmetry error

The difference between the scale factor measured with positive input rates and negative input rates shall not exceed _____ [ppm, %] of half the sum of the magnitudes of the scale factor determined for positive and negative inputs.

5.3.2.1.3 Repeatability

_____ [ppm, %], [maximum spread, 1σ , _____].

Repeatability involves changes in scale factor measurements made under the same operating conditions that occur between periods of operation. Thermal cycles and other environmental exposures, shut downs, time between runs, remounting, and additional factors pertinent to the particular application should be specified.

5.3.2.1.4 Stability

_____ [ppm, %], [maximum spread, 1σ , _____] for _____ [hours, days, _____].

Stability is the variation in scale factor over a specified time of continuous operation. Ambient temperature, power supply and additional factors pertinent to the particular application should be specified.

5.3.2.1.5 Hysteresis

- a) *Temperature* _____ ppm maximum over the range _____ °C to _____ °C.
 b) *Rate* _____ ppm maximum over an input range of _____ [°/s , rad/s].

5.3.2.1.6 Other errors

Gyros operating in the ratiometric output mode may exhibit an error associated with deviations from the expected ratiometric relationship. Gyros operating in whole angle mode may exhibit modelable periodic scale factor errors associated with the internal device geometry. This effect can be observed as a variation in scale factor associated with the net angular rotation since turn on.

5.3.2.2 Gyro scale factor sensitivities

5.3.2.2.1 Temperature

The change in gyro scale factor resulting from a change in steady state operating temperature shall not exceed _____ ppm from that measured at _____ °C over the range _____ °C to _____ °C.

5.3.2.2.2 Acceleration, S_a

The change in gyro scale factor shall not exceed _____ ppm when subjected to a constant acceleration of _____ m/s^2 along any axis.

5.3.2.2.3 Other sensitivities

Additional sensitivities may be specified such as those due to variations in supply voltage (including frequency, voltage, ripple, starting and operating current), rate of temperature change, temperature gradient, orientation, acceleration, vibration, magnetic field, radiation, and other environments pertinent to the particular application.

5.3.3 Drift rate, D

5.3.3.1 Systematic drift rate

Gyros can be specified in three ways: (1) not intended to be compensated, (2) compensated internally by the manufacturer, (3) compensated externally. For (3), the specification limits reflect performance after implementing a specific model and/or coefficients provided by either the manufacturer or the user.

5.3.3.1.1 Bias, D_F

- _____ [$\pm$, _____], [°/h, °/s, rad/s]
 a) Trend: _____ [(°/h)/h, _____] over _____ [h, _____]

If trend is not specified, then bias represents the performance expected between calibrations or during the lifetime. Trend represents a predictable, linear, long-term change from the bias measured at the time of acceptance.

b) Repeatability: _____ [$^{\circ}/h$, _____] [peak-to-peak, 1σ , _____]

Repeatability involves changes in bias measurements made under the same operating conditions that occur between periods of operation. Thermal cycles and other environmental exposures, shut downs, time between runs, remounting, and additional factors pertinent to the particular application should be specified.

5.3.3.1.2 Environmentally sensitive drift rate, E

a) Drift Rate Acceleration Sensitivity, D_a

The change in drift rate shall not exceed _____ [$^{\circ}/h$, _____] when subject to a constant acceleration of _____ m/s^2 along any axis.

b) Drift Rate Temperature Sensitivity, D_T

The drift rate sensitivity to temperature change shall not exceed _____ [$(^{\circ}/h)/^{\circ}C$, _____].

c) Drift Rate Temperature Gradient Sensitivity, $\bar{D}_{\nabla T}$

The drift rate sensitivity to a temperature gradient in any axis shall not exceed _____ [$(^{\circ}/h)/(^{\circ}C/m)$, _____].

d) Drift Rate Temperature Ramp Sensitivity, $D_{\dot{T}}$

The drift rate sensitivity to a temperature ramp shall not exceed _____ [$(^{\circ}/h)/(^{\circ}C/s)$, _____].

e) Temperature Hysteresis

The drift rate sensitivity to thermal loop over the range _____ $^{\circ}C$ to _____ $^{\circ}C$ shall not exceed _____ [$^{\circ}/h$, _____].

f) Vibration Induced Coning, $D_{ca_{VR}}$

The drift rate sensitivity shall not exceed _____ [$(^{\circ}/h)/((m/s^2)^2/Hz)$, $(^{\circ}/h)/(g^2/Hz)$, _____] when subject to a random vibration input in any axis around any CVG eigenfrequency.

g) Vibration Induced Electronics Saturation (Open Loop Mode), $D_{\Delta F a_{\Delta F}}$

The drift rate sensitivity shall not exceed _____ [$(^{\circ}/h)/((m/s^2)^2/Hz)$, $(^{\circ}/h)/(g^2/Hz)$, _____] when subject to a random vibration input in any axis around the difference frequency between CVG eigenfrequencies.

h) Vibration Sensitivity at Drive Frequency (Open Loop Mode), $D_{D a_{VD}}$

The drift rate sensitivity shall not exceed _____ [$(^{\circ}/h)/((m/s^2)^2/Hz)$, $(^{\circ}/h)/(g^2/Hz)$, _____] when subject to a random vibration input in any axis around the CVG drive frequency.

i) Vibration Sensitivity at Pickoff Frequency (Open Loop Mode), $D_{p a_{VP}}$

The drift rate sensitivity shall not exceed _____ [$(^{\circ}/h)/((m/s^2)^2/Hz)$, $(^{\circ}/h)/(g^2/Hz)$, _____] when subject to a random vibration input in any axis around the CVG pickoff frequency.

j) Vibration Sensitivity at Eigenfrequencies $D_{SR}a_{VSR}$

The drift rate sensitivity shall not exceed _____ $[(^{\circ}/h)/((m/s^2)^2/Hz), (^{\circ}/h)/(g^2/Hz), \text{_____}]$ when subject to a random vibration input in any axis around any CVG eigenfrequency.

k) Vibration Sensitivity at Operating Frequency with Cross Axis Input, $D_{RI}a_{VOF} (\omega_{XRA} + \omega_{YRA})$

The drift rate sensitivity shall not exceed _____ $[(^{\circ}/h)/((m/s^2)^2/Hz), (^{\circ}/h)/(g^2/Hz), \text{_____}]$ when subject to a random vibration input in any axis around the pickoff frequency and the angular rate about any axis orthogonal to the input axis.

l) Vibration Sensitivity with Pickoff Asymmetry, $D_{RBB}a_{VBB}$

(Open Loop Mode) The angle random walk sensitivity shall not exceed _____ $[(^{\circ}/\sqrt{h})/((m/s^2)/\sqrt{Hz}), (^{\circ}/\sqrt{h})/(g/\sqrt{Hz}), \text{_____}]$ when subject to a broadband noise input in any axis in the frequency range _____ to _____ Hz.

$D_{RBB}a_{VBB}$ must be multiplied by the square root of the mission time to get a drift rate result.

(Whole Angle Mode) The angle white noise sensitivity shall not exceed _____ $[(^{\circ}/\sqrt{Hz})/((m/s^2)/\sqrt{Hz}), (^{\circ}/\sqrt{Hz})/(g/\sqrt{Hz}), \text{_____}]$ when subject to a broadband noise input in any axis in the frequency range _____ to _____ Hz.

$D_{RBB}a_{VBB}$ must be multiplied by the square root of the vibration input bandwidth to get a drift rate result.

m) Other Sensitivities

These sensitivities include, but are not limited to, effects due to input power variations including frequency, voltage, ripple, starting and operating current.

5.3.3.2 Random drift rate, D_R

Random drift rate is usually defined in terms of the Allan variance components. See 8.3 and Annex C of either IEEE Standard 647 or IEEE Standard 952. PSD analysis can also be used to determine the random components of gyro drift.

- a) *Angle Random Walk*, (rate white noise) coefficient, N. _____ $^{\circ}/\sqrt{h}$ maximum.
- b) *Bias Instability*, coefficient, B. _____ $^{\circ}/h$ maximum.
- c) *Rate Random Walk*, coefficient, K. _____ $(^{\circ}/h)/\sqrt{h}$ maximum.
- d) *Ramp*, coefficient, R. _____ $(^{\circ}/h)/h$ maximum.
- e) *Quantization noise*, coefficient, Q. _____ $[^{\circ}, \mu rad]$ maximum
- f) *Markov noise*, amplitude coefficient, q_c , _____ $(^{\circ}/h)/\sqrt{h}$ maximum and time constant T_c , _____ h.

For some applications it may be sufficient to specify random drift as the standard deviation of the output in a specified frequency band.

Quantization noise is not present in the analog output CVG.

5.3.4 Input axis alignment

5.3.4.1 IA Misalignment

_____ [", μ rad], maximum with respect to the input reference axis (IRA).

The specific direction of IA misalignment may be important in some applications and should be specified with respect to XRA and YRA gyro case reference axes. Note that these axes are defined in 5.4.3

5.3.4.2 IA Misalignment repeatability

_____ [", μ rad], [maximum spread, 1σ , _____]

Thermal cycles and other environmental exposures, shutdowns, time between runs, remounting, and additional factors pertinent to the particular application should be specified.

5.3.4.3 IA Alignment sensitivities

IA alignment sensitivities may be specified, such as those due to temperature, thermal gradients, rate of temperature change, acceleration, vibration, and additional environments pertinent to the particular application.

5.3.5 Operating temperature

_____ $\pm$ _____ $^{\circ}\text{C}$

The operating temperature above applies only to temperature-controlled gyros. For gyros intended to operate without temperature controls, see 5.6.4.4.

5.3.6 Activation time

5.3.6.1 Turn-on time

The gyro output rate shall be within _____ [$^{\circ}/\text{s}$, %, _____] of the input rate, at an input rate of _____ $^{\circ}/\text{s}$ within _____ [s, _____] after the application of power.

5.3.6.2 Warm-up time

_____ [s, _____], maximum.

The limits of gyro performance during that portion of warm-up time following the turn-on time should be specified for certain applications. These limits could be fixed bounds or functions of time. More than one function may be specified for different temperatures at the time of turn-on, or different functions may be specified for each performance parameter (i.e., scale factor, bias, etc.)

5.3.7 Angle storage

5.3.7.1 Normal operation

The maximum angle stored in the gyro during normal operation shall not exceed _____ $^{\circ}$.

This requirement typically applies to force-rebalance modes of operation.

5.3.7.2 Over-range operation

The minimum angle storage for an over-range angle rate pulse shall exceed ____°.

This requirement typically applies to force-rebalance modes of operation.

5.3.7.3 Across power interrupt

The magnitude of angular error resulting from an interruption of power of ____ ms shall be less than ____ [°, ____].

This requirement typically applies to force-rebalance and whole angle modes of operation.

5.3.8 Run-down time

The gyro run-down time shall be greater than ____ s.

Run-down time can be used as a measure of hermeticity at manufacture and as part of built-in test capabilities. This characteristic may not be appropriate for all designs or applications.

5.3.9 Output signal polarities

5.3.9.1 Input axis

The positive input axis shall conform to [drawing number ____, Figure ____]

5.3.9.2 Output signals

The output signals representing gyro rotation shall conform to [drawing number ____, Figure ____]

5.3.10 Mechanical isolation

Mechanical isolation may be required to reduce errors caused by vibration sensitivities and to reduce transmission of emitted vibrations.

5.3.11 Transfer function

The transfer function dynamic response shall be within the limits defined by Figure ____.

The transfer function should be described in the form of a phase and gain plot versus rate input frequency.

In some applications it may be more appropriate to specify a bandwidth. Two common ways to specify bandwidth are the frequency at: 1) -3dB gain and 2) -90° phase. Both of these are specified in some applications.

5.3.12 Reference constants

These constants are for reference only. They are not specified independently, because they may vary within the framework of the specification, or because they are difficult or impossible to measure independently in a completed gyro. Nominal values are to be listed.

5.3.12.1 Drive frequency

5.3.12.2 Sense frequency

5.3.12.3 Other resonances

5.3.12.4 Pickoff orientation

The angular separation between the drive and pickoff axes is _____ °.

5.4 Mechanical requirements

Mechanical characteristics shall be as specified hereinafter.

5.4.1 Exterior surface

Requirements controlling surface finish, workmanship, processing, etc., should be specified.

5.4.2 Outline and mounting dimensions

Outline and mounting dimensions, and accuracy requirements of mounting surface shall conform to [drawing number _____, Figure _____].

Specify center of gravity if required.

5.4.3 Gyro axes

The X and Y gyro case reference axes (XRA and YRA) are mutually perpendicular and are located by means of the gyro mounting surface and the reference index on the gyro case [notch, pin, scribe line, _____]. The IRA, XRA and YRA are reference axes defined with respect to the mounting provisions. These axes are nominally parallel to IA, XA and YA respectively, and define a right-handed coordinate system. The IRA is defined relative to the gyro mounting surface and shall conform to [drawing number _____, Figure _____] (see Figure 1).

In some applications for the purpose of measuring environmental sensitivities, it may be important to identify the angle between the XRA and the driven axis.

5.4.4 Weight

_____ ± _____ [g, _____].

Specify those components such as cables, connectors, and electronics which are to be included in the weight.

5.4.5 Seal

The gyro shall be sealed so that the equivalent helium leak rate is less than _____ [cm³/s, _____] when subjected to a pressure of _____ ± _____ Pa and gyro temperature of _____ ± _____ °C for a minimum of _____ minutes.

CVGs may be sealed using vacuum, gas or ambient environment. An appropriate requirement should be inserted depending upon the construction type. In establishing this requirement, consideration should be given to the lifetime.

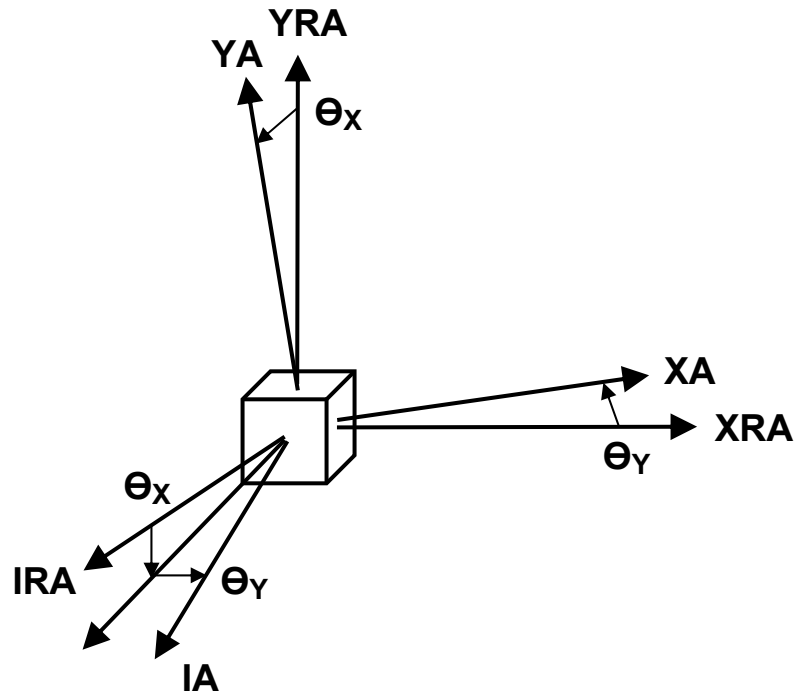


Figure 1—Gyro axes and misalignment angles

5.4.6 Identification of product

The gyro shall be identified on the surface and in the manner indicated in drawing number _____. Identification shall include:

- Coriolis vibratory gyro or CVG
- Specification number
- Unit serial number.
- Axes identification marking as shown in [drawing number _____, Figure _____].
- Manufacturer's name or symbol.

The purchase agreement may require additional identification such as date of manufacture and safety warnings.

5.4.7 Acoustic noise

The acoustic noise emissions shall conform to _____.

5.5 Electrical interface requirements

Electrical characteristics shall be as specified in this subclause.

5.5.1 Schematic

An interface control drawing should be provided which specifies the test points and pin connections by function and includes appropriate voltage, polarity and other electrical information.

5.5.2 Impedances

The gyro impedances shall be _____ Ω .

Load impedances and impedances of excitation, monitoring, temperature sensing and test circuits should be individually specified.

5.5.3 Input power

The input power shall not exceed _____ W.

Requirements, including tolerances, for such parameters as frequency, voltage, ripple, starting and operating current should be specified. Transient conditions may need to be specified.

Gyros with thermal controls may exhibit substantial changes in input power requirements during warm up and over the operating temperature range.

5.5.4 Test points

Test points required for monitoring and testing of the gyro should be specified. These may include excitation voltages, pickoff, forcer or control signals, or temperature sensor(s). Any special buffering or scaling requirements should be specified.

5.5.5 Grounding

Electrical grounding requirements (for example, requirements for isolation between input, output power returns and the grounding requirements for shields, chassis and critical components) should be specified.

5.5.6 Output signals

The type and characteristics of output signal(s) required, such as analog voltage or current, parallel or serial digital, or incremental angle pulses should be specified. For example:

- a) Type: Pulses indicating positive angular increments on one signal line and pulses indicating negative angular increments on a second line.
- b) Characteristics:
 - 1) Source impedance
 - 2) Load impedance
 - 3) Wave shape (see Figure 2)
 - 4) Maximum pulse rate

5.5.7 Temperature sensors

The output of the temperature sensor(s) shall be _____ $\pm$ _____ [V, _____] in the operating temperature range specified in 5.6.4.4 of this standard. The temperature rise of the sensor due to self-heating shall not exceed _____ $^{\circ}\text{C}$. The scale factor of the temperature sensor(s) shall be $[\pm$ _____ $\pm$ _____ [V/ $^{\circ}\text{C}$, _____].

Thermistors and resistors (ohms), thermocouples (V), resonators (Hz), integrated circuits (μA) or other temperature sensors may be specified. Temperature sensors may be built into the gyro for use in characterizing its temperature sensitivity. If sensors are required, specify quantity, locations and characteristics. The temperature range over which the scale factor should be specified is given by 5.3.5 for