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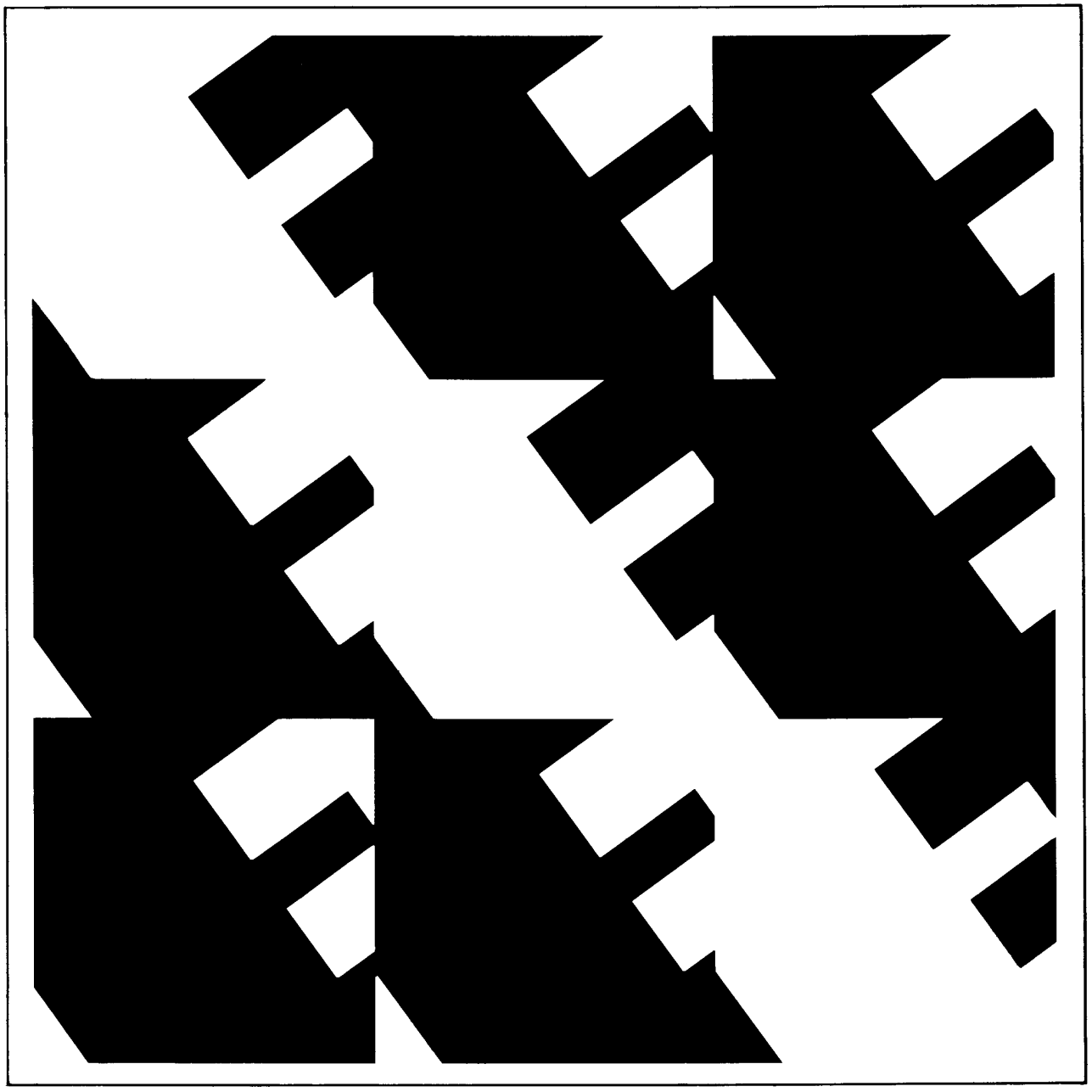
IEEE Test Procedure for Single-Degree-of-Freedom Spring-Restrained Rate Gyros



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The Institute wishes to acknowledge its indebtedness to those who have so freely given of their time and knowledge and have conducted experimental work on which many of the IEEE publications are based.

This Test Procedure and the Specification Format for Single-Degree-of-Freedom Spring-Restrained Rate Gyros (IEEE Standards Publication No. 292) represent a group effort on a large scale. They were generated as projects of the Gyro and Accelerometer Panel from May of 1962 to November of 1967. The Gyro and Accelerometer Panel (GAP) affiliated with the IEEE in May of 1965 and is now a part of the IEEE Aerospace and Electronic Systems Group. A total of 238 individuals attended 30 GAP meetings while these documents were in preparation. Fifty-one individuals attended six meetings or more and provided 61 percent of the total attendance of 916. These people are listed here.

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W. E. Bachman
R. Broderson
J. T. Bull
A. T. Campbell,
GAP Chairman, 1965
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R. Goodstein,
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C. O. Swanson,
GAP Chairman, 1968
C. I. Thornburg
R. S. Vaughn
J. Volk
L. F. Warnock
W. M. Weil
A. E. Willis

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IEEE Test Procedure for

SINGLE-DEGREE-OF-FREEDOM SPRING-RESTRAINED RATE GYROS

1. INTRODUCTION

This Test Procedure is a compilation of recommended rate gyro test procedures derived from those currently in use, including test conditions to be considered. In some cases alternate methods for measuring a performance characteristic have been included. In selecting among the alternates, attention should be paid to the intended application of the gyro, available test facilities, and the standard methods in use by the test facility. This document is intended to be a guide in the preparation of Section 4 of a specification that follows the format of IEEE Standards Publication No. 292, Specification Format for Single-Degree-of-Freedom Spring-Restrained Rate Gyros. The intent is for the specification writer to extract the applicable test conditions and equipment from Section 3 of this document for inclusion in the paragraphs concerning test conditions and equipment corresponding to paragraph 4.5 of the Specification Format. Similarly, it is intended that the writer extract the applicable test procedures from Section 4 of this Procedure for inclusion in the paragraphs concerning test procedures, corresponding to the paragraphs listed under paragraph 4.6 of the Specification Format. This Test Procedure can also be used as a guide in the preparation of a rate gyro test specification, but would require reorganization into the proper Specification Format.

Blanks have been used in this document for two distinct purposes. One purpose is to provide for selection of specific values of test parameters and their tolerances. Other blanks are to be filled in with the number of the applicable paragraph from Requirements Section 3 of the specification being written.

Aerospace Industries Association EETC Report No. 5 (Revision A), "Standard Gyro Terminology"* has been utilized in the preparation of this Test Procedure. Although this Procedure is limited to electrically energized single-degree-of-freedom spring-restrained rate gyros, it can be used as a guide in the preparation of Test Procedures for other types of rate gyros.

2. FUNCTION AND APPLICATION OF THE RATE GYRO

The rate gyro considered in this document is a single-degree-of-freedom gyro with an elastic restraint about the output axis. An angular rate about the input axis produces a gyroscopic torque about the output axis that is opposed by a restoring torque exerted by the elastic restraint element. Static equilibrium is reached when the gyroscopic torque about the output axis is exactly balanced by the elastic restraint. The resultant angular rotation of the gimbal relative to the case produces an output signal proportional to the angular rate about the input axis. Output axis damping is generally employed.

The rate gyro is normally used as a sensing element to provide electric angular-rate signals in control or indicating systems.

The dynamics of the gyro are expressed by an equation given in paragraph 6.3, IEEE Standards Publication No. 292, Specification Format for Single-Degree-of-Freedom Spring-Restrained Rate Gyros.

3. TEST CONDITIONS AND TEST EQUIPMENT

3.1 Standard Test Conditions

Unless otherwise stated the following conditions apply.

3.1.1 Ambient Environment

3.1.1.1 Atmospheric Conditions

Pressure _____ ± _____ inHg (N/m^2).
Ambient temperature _____ ± _____ °C.
Relative humidity _____ percent to _____ percent.

3.1.1.2 Magnetic Field

Horizontal component _____ gauss (milliteslas) max.
Vertical component _____ gauss (milliteslas) max.
Method of measurement shall be as specified in _____.

3.1.1.3 Radiation. All tests are to be performed under radiation conditions as specified in _____.
(List type of radiation and applicable intensity limits.)

3.1.1.4 Vibration

Acceleration _____ *g* max.
Frequency range _____ hertz to _____ hertz.
(Above limits apply to each of the three axes of a coordinate system.)

3.1.2 Installation Requirements. The mounting fixture should be designed to simulate the application conditions.

3.1.2.1 Thermal Conditions. All tests shall be performed with the unit at thermal equilibrium as evidenced by _____. The unit operating temperature shall be _____ ± _____ °C. Determination of the temperature shall be as specified in _____.

3.1.2.2 Mechanical Conditions. The test unit shall be mounted in such a way that the alignment of its three reference axes with respect to the test fixture is maintained

* Available from National Standards Association, Inc., 1321 Fourteenth St. N.W., Washington, D. C. 20005.

within ± _____ degrees under all specified test conditions. The three reference axes of the test unit are those defined by the external case markings and/or mounting surfaces.

3.1.3 Electrical Requirements

3.1.3.1 Spin Motor

Frequency _____ ± _____ hertz.
Type of connection _____ (e.g., 3 phase, 3 wire delta).
Line-to-line voltage _____ ± _____ volts.
Phase angle _____ ± _____ degrees.
Wave characteristic shall be _____.
Source impedance _____ ± _____ ohms.

3.1.3.2 Pickoff

Frequency _____ ± _____ hertz.
Voltage (current) _____ ± _____ volts (mA).
Maximum voltage (current) waveform distortion _____.
Source impedance _____ ± _____ ohms (e.g., series choke).
Load impedance _____ ± _____ ohms (e.g., phase shift network).

3.1.3.3 Self-Test Torquer

Frequency _____ ± _____ hertz.
Pattern current _____ ± _____ mA.
Maximum pattern current waveform distortion _____.
Pattern source impedance _____ ± _____ ohms.
Control source impedance _____ ± _____ ohms.

3.1.3.4 Rotor Rotation Detector

Frequency _____ ± _____ hertz.
Voltage (current) _____ ± _____ volts (mA).
Source impedance _____ ± _____ ohms.
Load impedance _____ ± _____ ohms.

3.1.3.5 Warm-Up Heater

Frequency _____ ± _____ hertz.
Voltage _____ ± _____ volts.

3.1.3.6 Maintenance Heater

Frequency _____ ± _____ hertz.
Voltage _____ ± _____ volts.
Type of control _____.

3.1.3.7 Temperature Sensor

Frequency _____ ± _____ hertz.
Voltage _____ ± _____ volts.

3.1.3.8 Phasing and Interconnection. Interconnection and grounding shall be as specified on schematic diagram _____.

3.1.4 Starting Procedure

3.1.4.1 Warm-Up Time. Unless otherwise specified, a warm-up time of _____ seconds is allowed before starting the tests of Section 4.

3.1.4.2 Starting Sequence. The sequence of operations required to bring the gyro and the test equipment to operating conditions shall be _____.

3.2 Test Equipment

3.2.1 General Requirements. The selection of the test equipment shall be based on accuracy requirements compatible with the performance specifications. Similarly, the bandpass of the measuring devices used shall be chosen so as to provide information only within the frequency spectrum of interest for the tests.

3.2.2 Description of the Test Equipment. All special-purpose or commercial test equipment shall be listed by name, manufacturer, model, part number, or performance requirement.

4. TEST PROCEDURES

4.1 Examination of the Product

The gyro shall be inspected visually and dimensionally for proper identification, surface finish, and for defects in workmanship to determine that it conforms to paragraph _____.

4.2 Impedance Test

4.2.1 Purpose. The purpose of this test is to measure the alternating-current impedance of electrocapacitive and electroinductive circuits and the direct-current resistance of resistors and conductors.

4.2.2 Test Equipment. The following test equipment from paragraph 3.2 is required for this test:

Impedance bridge with frequency generator adjustable to the nominal operating signal frequency,
Direct-current resistance bridge or other suitable current measuring system.

4.2.3 Test Setup and Procedure. The gyro shall be allowed to reach thermal equilibrium at the temperature specified in paragraph _____ so that the final value will not be affected by changing temperature. Measure all gyro impedances specified in paragraph _____. The test current through the circuit shall be as small as practical considering the sensitivity of the measuring instruments. The test current shall be applied uninterrupted for _____ ± _____ seconds.

4.2.4 Test Results. The impedance quantities measured shall be recorded and shall conform to the requirements of paragraphs _____.

4.3 Dielectric Test

4.3.1 Purpose. The purpose of this test is to ascertain that a circuit element or component part of the gyro can operate safely at its rated voltage and withstand momentary overpotentials due to switching, surges, etc., by measuring the leakage current between isolated circuits and between the gyro case and the circuits isolated from the gyro case.

4.3.2 Test Equipment. The following test equipment from paragraph 3.2 is required for this test:

High-voltage source, either alternating current or direct current, equipped with a voltage-measuring or current-measuring device.

4.3.3 Test Setup and Procedure. Apply _____ ± _____ volts root mean square at _____ hertz or direct current between the insulated portion and the case ground. The test voltage shall be raised from zero to the specified value as uniformly as possible, at a rate of approximately 500 volts root mean square or direct current per second. The test voltage shall be maintained for a period of _____ seconds. At this time, the voltage shall be gradually reduced to avoid surges. During each test the fault indicator shall be monitored for the leakage current.

4.3.4 Test Results. The results shall conform to the requirement of paragraph _____.

4.4 Insulation Resistance Test

4.4.1 Purpose. The purpose of this test is to measure the insulation resistance between the isolated electric circuits and between the gyro case and the circuits isolated from the gyro case.

4.4.2 Test Equipment. The following test equipment from paragraph 3.2 is required for this test:

Megohmmeter.

4.4.3 Test Setup and Procedure. Apply _____ ± _____ volts direct current for a period of _____ ± _____ minutes between the indicated circuits and between the circuits and the gyro case. Record the final resistance reading.

4.4.4 Test Results. The results shall conform to the requirement of paragraph _____.

4.5 Leak Test

4.5.1 Purpose. The purpose of this test is to determine whether external leakage is occurring.

4.5.2 Test Equipment. The following test equipment from paragraph 3.2 is required for this test:

4.5.2.1 Fluid-Filled Gyro
Binocular microscope,
Vacuum enclosure.

4.5.2.2 Gas-Filled Gyro
Helium leak detector or immersion fluid (specify),
Vacuum enclosure.

4.5.3 Test Setup and Procedure

4.5.3.1 Fluid-Filled Gyro. The gyro shall be cleaned of all dirt and grease and placed in a vacuum enclosure at _____ ± _____ torr (N/m^2) and at a gyro temperature of _____ ± _____ °C for a minimum period of _____ hours. The gyro shall then be removed and visually examined at a magnification of _____.

4.5.3.2 Gas-Filled Gyro

(a) The gyro shall be cleaned of all dirt and grease and placed in a vacuum enclosure at _____ ± _____ torr (N/m^2) and stabilized at _____ ± _____ °C gyro temperature. External gas leakage shall then be measured using a helium gas detector. or

(b) The gyro shall be cleaned of all dirt and grease and submerged in fluid and placed in a vacuum enclosure at _____ ± _____ torr (N/m^2) and _____ ± _____ °C temperature for a period of _____ minutes. The presence or absence of a continuous flow of bubbles shall be noted.

4.5.4 Test Results

4.5.4.1 Fluid-Filled Gyro. There shall be no evidence of external fluid leakage.

4.5.4.2 Gas-Filled Gyro

(a) The measured gas leakage rate shall not exceed _____ cm^3/s. or

(b) There shall be no evidence of a steady stream of bubbles after _____ minutes.

4.6 Polarity Test

4.6.1 Purpose. The purpose of this test is to determine the gyro polarity from the input–output relationship with reference to the coordinate polarities, the gyro motor polarity, the pickoff polarity, and the torquer polarity.

4.6.2 Test Equipment. The following test equipment from paragraph 3.2 is required for this test:

Single-axis rate table,
Means of measuring the polarity and magnitude of the gyro output.

4.6.3 Test Setup and Procedure

4.6.3.1 Motor. Mount the gyro with the spin reference axis (SRA) parallel to the table axis and nominally vertical. Connect the gyro to the output measuring equipment. Operate the gyro in accordance with the standard test conditions of paragraph 3.1. Rotate the table at _____ °/s with the input vector in the same direction as the positive spin reference axis. Record the gyro output.

4.6.3.2 Pickoff. Mount the gyro with the input reference axis (IRA) parallel to the table axis and nominally vertical. Connect the gyro to the output measuring equipment. Operate the gyro in accordance with the standard test conditions of paragraph 3.1. Rotate the table at _____ °/s to apply a positive input to the gyro. Record the polarity of the gyro output with respect to the pickoff excitation.

4.6.3.3 Torquer. Connect the gyro to the output measuring equipment. Operate the gyro in accordance with the standard test conditions of paragraph 3.1. Apply a positive input of _____ mA to the torquer. Record

the polarity of the gyro output with respect to the pickoff excitation.

4.6.4 Test Results

4.6.4.1 Motor. The output signal in paragraph 4.6.3.1 shall not exceed _____ volts.

4.6.4.2 Pickoff. In paragraph 4.6.3.2 the result shall conform to the requirement of paragraph _____.

4.6.4.3 Torquer. In paragraph 4.6.3.3 the result shall conform to the requirement of paragraph _____.

4.7 Electrical Null Test

4.7.1 Purpose. The purpose of this test is to determine the magnitude of the electric output of the gyro when that output is at a minimum.

4.7.2 Test Equipment. The following test equipment from paragraph 3.2 is required for this test:

Single-axis rate table or torquer current supply,
Means of measuring the gyro pickoff output (e.g., root-mean-square voltmeter, phase-angle voltmeter, phase-sensitive voltmeter, direct-current voltmeter, oscilloscope, wave analyzer).

4.7.3 Test Setup and Procedure. Mount the gyro on the rate table with the IRA parallel to the rate table axis or mount the gyro in the mounting fixture. Connect the gyro pickoff output to the output measurement equipment. Operate the gyro in accordance with the standard test conditions of paragraph 3.1.

Using the rate table or the torquer current supply, apply a constant _____ (CW, clockwise, CCW, counterclockwise) input rate or equivalent torquer current equal to _____ percent of full scale. Slowly change the input rate or the torquer control current until a minimum _____ (root mean square, peak-to-peak, etc.) electric output is noted and recorded. Repeat the above, except the initial input rate or torquer control current shall be in the opposite direction.

4.7.4 Test Results. The values obtained from both directions shall conform to the requirement of paragraph _____.

4.8 Output Noise (Signal Modulation) Test

4.8.1 Purpose. The purpose of this test is to determine the pickoff output noise (signal modulation) when the input rate is constant.

4.8.2 Test Equipment. The following test equipment from paragraph 3.2 is required for this test:

Precision single-axis rate table (if required),
Means of measuring the table rate,
Means of measuring and/or recording the pickoff output.

4.8.3 Test Setup and Procedure. Mount the gyro on a single-axis rate table affixed to a stable test pad with the IRA up, parallel to the table axis and nominally vertical. Connect the gyro pickoff output to the output measurement/recording equipment. Operate the gyro in accordance with the standard test conditions of paragraph 3.1.

Rotate the rate table at the following rates CW and CCW _____. Measure or record the output of the gyro for a minimum of _____ seconds. Deenergize the gyro.

Remount the gyro in each of the following positions (if required) and, for each position, repeat the above test at zero table input rate.

(a) Output axis (OA) nominally vertical,
(b) SRA nominally vertical.

4.8.4 Test Results. Determine the maximum peak-to-peak output noise (signal modulation) of the gyro output within the specified frequency range. The result shall conform to the requirement of paragraph _____.

4.9 Run-Up Time Test

4.9.1 Motor Characteristics Method

4.9.1.1 Purpose. The purpose of this test is to measure the run-up time of the gyro rotor by measuring the motor running characteristics.

4.9.1.2 Test Equipment. The following test equipment from paragraph 3.2 is necessary for this test:

Timing device,
Means of measuring the rotor speed (e.g., current monitoring device, vibration pickup with equipment for measuring the vibration frequency, rotor rotation detector).

4.9.1.3 Test Setup and Procedure. Operate the gyro in accordance with the standard test conditions of paragraph 3.1 except that the spin motor shall not be energized. Excite the spin motor and simultaneously start the timer. When the rotor reaches a speed of _____ r/min, stop the timer.

4.9.1.4 Test Results. The result shall conform to the requirement of paragraph _____.

4.9.2 Rate Response Method

4.9.2.1 Purpose. The purpose of this test is to measure the run-up time of the gyro rotor by measuring the time required for the gyro output to reach steady state while a constant input rate is being applied.

4.9.2.2 Test Equipment. The following test equipment from paragraph 3.2 is necessary for this test:

Single-axis rate table,
Means of measuring the in-phase component of the gyro output,
Recorder with accurate timing markers,
Means of measuring the table rate.

4.9.2.3 Test Setup and Procedure. Mount the gyro on the rate table with the IRA parallel to the rate table axis and nominally vertical. Operate the gyro in accordance

with the standard test conditions of paragraph 3.1 except that the spin motor shall not be energized. Connect the output of the gyro to the phase-sensitive detector. Connect the phase-sensitive detector to the recorder.

Using the rate table, apply a constant rate of _____ °/s input to the gyro. Start the recorder and then energize the spin motor. When the gyro output has reached a steady state, stop the recorder. This steady-state output shall be greater than _____ volts.

4.9.2.4 Test Results. The run-up time shall be read as the time to the intersection of the recorder trace with a line drawn at _____ percent of the steady-state output. The result shall conform to the requirement of paragraph _____.

4.10 Rotor Rotation Detector (RRD) Test

4.10.1 Purpose. The purpose of this test is to measure the output of the RRD.

4.10.2 Test Equipment. The following test equipment from paragraph 3.2 is required for this test:

Means of measuring the frequency of the RRD output (e.g., amplifier and counter, oscilloscope and audio oscillator),
Means of measuring the amplitude characteristics of the RRD output (e.g., oscilloscope, oscillograph).

4.10.3 Test Setup and Procedure. Excite the gyro in accordance with paragraph 3.1.

4.10.3.1 Pulse Output Type. Connect the RRD to the frequency measuring equipment and measure the repetition rate.

Connect the RRD output to the amplitude-characteristic measuring equipment. Measure the zero-to-peak voltage of the smallest and the largest peaks. Measure the pulse width at _____ volts of the narrowest and the widest pulses.

4.10.3.2 Near Sinusoidal Output Type. Connect the RRD to the output measuring equipment and measure the amplitude of the total output and the frequency and amplitude of the fundamental signal.

4.10.4 Test Results. The results shall conform to the requirements of paragraph _____.

4.11 Power Consumption and Current Starting and Running Test

4.11.1 Purpose. The purpose of this test is to measure the motor starting and running power and current.

4.11.2 Test Equipment. The following test equipment from paragraph 3.2 is required for this test:

Means of measuring power,
Means of measuring current.

4.11.3 Test Setup and Procedure. Mount the gyro on a holding fixture. Operate the gyro in accordance with the standard test conditions of paragraph 3.1 with the exception of spin-motor power. Connect the power and current measuring devices in the circuit between the spin-motor power supply and the spin motor. Actuate the motor power supply to apply starting voltage to the spin motor. Measure the starting power and current. Allow the rotor to reach operational speed. Measure the running power and current.

4.11.4 Test Results. The results shall conform to the requirements of paragraph _____.

4.12 Run-Down Time Test

4.12.1 Purpose. The purpose of this test is to measure the run-down time of the gyro rotor.

4.12.2 Test Equipment. The following test equipment from paragraph 3.2 is necessary for this test:

Timing device,
Means for measuring the rotor speed (e.g., high-impedance monitor for voltage or frequency of the motor back EMF, RRD).

4.12.3 Test Setup and Procedure. Operate the gyro in accordance with the standard test conditions of paragraph 3.1. Remove the spin-motor excitation. Start the timer when the rotor speed reaches _____ r/min. (If the run-down time from operating speed is desired, start the timer simultaneously with the removal of the spin-motor excitation.) Stop the timer when the rotor speed reaches _____ r/min.

4.12.4 Test Results. The result shall conform to the requirement of paragraph _____.

4.13 Rate Transfer Characteristic Test Series

4.13.1 Purpose. The purpose of this test series is to measure the gyro scale factor, the composite error, the hysteresis error, the zero offset, the threshold, and the resolution.

4.13.2 Test Equipment. The following test equipment from paragraph 3.2 is required for this test series:

Single-axis rate table,
Means of measuring the in-phase component of the gyro output,
Means of measuring the table rate,
Means of applying low-frequency current to the self-test torquer (for alternate method number 2, paragraph 4.13.3.2.5, of measuring the zero offset).

4.13.3 Test Setup and Procedures

4.13.3.1 Test Setup. Mount the gyro with the IRA parallel to the rate table axis and nominally vertical. Operate the gyro in accordance with the standard test conditions of paragraph 3.1. Provide correction for effect of earth's rate if applicable. Connect the gyro pickoff output to the output measurement equipment.

4.13.3.2 Test Procedures

4.13.3.2.1 Gyro Scale Factor, Composite Error, Hysteresis Error, and Zero Offset. Rotate the rate table at the following series of rates CW and CCW _____. Start with the positive-input limit, and by the above steps, return to zero, increase to the negative-input limit, return to zero, and increase to the positive limit. The time duration at all rates shall be equal and each rate shall be approached without overshoot. Measure the corresponding pickoff output for each of the input rates. Repeat this cycle _____ times.

4.13.3.2.2 Threshold. Measure the pickoff output at zero-input rate from the rate table. Apply a small change of rate to the gyro equal to a fraction of the specification value for threshold. The table must be capable of making small changes smoothly. Record the new input rate and the change in the gyro output. If insufficient output change is detected, repeat at increased input rates until a change in the output is recorded that is greater than _____ percent of the output expected using the nominal gyro scale factor. This procedure shall be repeated in the opposite direction.

4.13.3.2.3 Resolution. Apply a constant input rate to the gyro, equal to _____ percent of full scale, with the rate table. Apply a small change of rate equal to a fraction of the specification value for resolution. The table must be capable of making small changes smoothly. Record the new input rate and the change in the gyro output. If insufficient output change is detected, repeat at larger changes of the input rate until a change in the output is recorded that is greater than _____ percent of the output expected using the nominal gyro scale factor.

4.13.3.2.4 Zero Offset—Alternate Method 1. With the gyro still mounted on the rate table, remove the gyro hysteresis by oscillating the rate table, CW and CCW. Remove the motor voltage, and continue the oscillation until the rotor comes to a stop. Reorient the gyro so that the OA is nominally vertical. Reapply motor power and operate the gyro in accordance with the standard test conditions of paragraph 3.1. Measure the output voltage. Note the direction of the IRA with respect to the earth's velocity vector.

4.13.3.2.5 Zero Offset—Alternate Method 2. (This method is for measuring the zero offset on those gyros containing a self-test torquer, and will require the use of a low-frequency oscillator.) Mount the gyro with its OA nominally vertical. Operate the gyro in accordance with the standard test conditions of paragraph 3.1. Remove the gyro hysteresis by oscillating the gimbal at _____ hertz, through the application of a suitable torquing current of _____ mA maximum. Slowly decrease the current amplitude to zero. Measure the output voltage. Note the direction of the IRA with respect to the earth's velocity vector.

4.13.4 Test Results

4.13.4.1 Gyro Scale Factor. Obtain the slope of the best straight line that can be fitted by the method of least squares to all the input–output data obtained from the tests according to paragraph 4.13.3.2.1. This result shall conform to the requirement of paragraph _____.

4.13.4.2 Composite Error. Find the maximum deviation of the input–output data as obtained in paragraph 4.13.3.2.1 from the nominal gyro scale factor requirement of paragraph _____. Divide by the output range and multiply by 100. The result shall conform to the requirement of paragraph _____.

4.13.4.3 Hysteresis Error. From the data obtained in paragraph 4.13.3.2.1, determine the difference between outputs for increasing and decreasing inputs at that input for which the difference is maximum. Divide this value by the gyro scale factor determined in paragraph 4.13.4.1. The result shall conform to the requirement of paragraph _____.

4.13.4.4 Zero Offset

4.13.4.4.1 Input–Output Method. From the data obtained in paragraph 4.13.3.2.1, determine the algebraic sum of the outputs when zero input is approached from each of the input limits. Divide this value by twice the gyro scale factor determined in paragraph 4.13.4.1. Algebraically add to the quotient the SRA acceleration-sensitive drift rate determined in paragraph 4.18. Provide correction for the effect of earth's rate if applicable. The result shall conform to the requirement of paragraph _____.

4.13.4.4.2 Alternate Method 1. Divide the data obtained in paragraph 4.13.3.2.4 by the gyro scale factor determined in paragraph 4.13.4.1. Provide correction for the effect of earth's rate if applicable. The result shall conform to the requirement of paragraph _____.

4.13.4.4.3 Alternate Method 2. Divide the data obtained in paragraph 4.13.3.2.5 by the gyro scale factor determined in paragraph 4.13.4.1. Provide correction for the effect of earth's rate if applicable. The result shall conform to the requirement of paragraph _____.

4.13.4.5 Threshold. The input rate determined in paragraph 4.13.3.2.2 shall conform to the requirement of paragraph _____.

4.13.4.6 Resolution. The change in the input rate determined in paragraph 4.13.3.2.3 shall conform to the requirement of paragraph _____.

4.14 Limit Stops Test

4.14.1 Purpose. The purpose of this test is to determine the setting of the limit stops.

4.14.2 Test Equipment. The following test equipment from paragraph 3.2 is required for this test:

Single-axis rate table,
Means of measuring the in-phase component of the gyro output,
Means of measuring the table rate.

4.14.3 Test Setup and Procedure. Mount the gyro with the IRA parallel to the rate table axis and nominally vertical. Operate the gyro in accordance with the standard test conditions of paragraph 3.1. Gradually increase the input rate beyond the positive-input limit until the pickoff output remains essentially constant for an incremental increase in the input rate. Record the input rate or the output voltage. Repeat the above for negative-input rates.

4.14.4 Test Results. If the input rate is not measured directly, calculate the limit stop setting in °/s by dividing the gyro output for each direction of rotation by the gyro scale factor determined in paragraph 4.13.4.1. These values shall conform to the requirement of paragraph _____.

4.15 Pickoff Phase Shift Test

4.15.1 Purpose. The purpose of this test is to determine the pickoff-output phase shift relative to the pickoff excitation as a function of the input rate.

4.15.2 Test Equipment. The following test equipment from paragraph 3.2 is required for this test:

Single-axis rate table,
Means of measuring the phase shift between the pickoff output and the pickoff excitation.

4.15.3 Test Setup and Procedure. Mount the gyro with the IRA parallel to the table axis and nominally vertical. Operate the gyro in accordance with the standard test conditions of paragraph 3.1. Connect the gyro to the output measuring equipment. Measure the phase shift at CW and CCW rates of _____ °/s.

4.15.4 Test Results. The results shall conform to the requirements of paragraph _____.

4.16 Switching Rate Test

4.16.1 Purpose. The purpose of this test is to determine if the rate switch operates at the specified steady-state rates and has the proper dynamic characteristics.

4.16.2 Test Equipment. The following test equipment from paragraph 3.2 is required for this test:

Single-axis rate table,
Means of measuring the table rate,
Means of determining the times at which the rate switch contacts open and close.

4.16.3 Test Setup and Procedure. Mount the gyro with the IRA parallel to the rate table axis and nominally vertical. Operate the gyro in accordance with the standard test conditions of paragraph 3.1. Apply a positive rate of _____ °/s, achieving this rate within _____ seconds. Measure the time required for the rate-switching contacts _____ to (open, close) after initiating the rate change. Decrease the rate to _____ °/s within _____ seconds. Measure the time required for contacts _____ to return to normal after initiating the rate change. Repeat for the following positive rate (s) and negative rate (s) _____.

4.16.4 Test Results. The results shall conform to the requirements of paragraph _____.

4.17 Self-Test Torquer Test

4.17.1 Purpose. The purpose of this test is to determine the command rate scale factor.

4.17.2 Test Equipment. The following test equipment from paragraph 3.2 is required for this test:

Means of measuring the in-phase component of the gyro output,
Torquer current supply,
Means of measuring torquer current.

4.17.3 Test Setup and Procedure. Operate the gyro in accordance with the standard test conditions of paragraph 3.1. Excite the torquer control winding with the following current level(s), _____ mA, in both the positive and the negative directions. Start with the largest positive input, and by the above steps return to zero, increase by the above steps to the largest negative input, return to zero, and increase to the largest positive input. Measure the corresponding pickoff output for each of the current levels. Repeat this cycle _____ times.

4.17.4 Test Results. Obtain the slope of the best straight line that can be fitted by the method of least squares to all the data. Divide by the gyro scale factor determined in paragraph 4.13.4.1. The result shall conform to the requirement of paragraph _____.

4.18 Acceleration-Sensitive Drift Rate Tests

4.18.1 Acceleration-Sensitive Coefficient, Tumble Test Method.

4.18.1.1 Purpose. The purpose of this test is to determine the acceleration-sensitive drift rate coefficient.

4.18.1.2 Test Equipment. The following test equipment from paragraph 3.2 is required for this test:

Means of rotating/positioning the gyro about the OA with the OA horizontal,
Means of measuring the in-phase component of the gyro output.

4.18.1.3 Test Setup and Procedure. The gyro shall be oriented with the OA horizontal and north and the IRA west. Operate the gyro in accordance with the standard test conditions of paragraph 3.1. Position the gyro about the OA, recording the gyro output at the

IRA west, IRA up, IRA east, and IRA down positions, or continuously at a rate of rotation not exceeding _____ °/s.

4.18.1.4 Test Results. One-half the algebraic difference between the gyro outputs in the IRA east and the IRA west positions, divided by the gyro scale factor determined in paragraph 4.13.4.1, shall represent the acceleration-sensitive drift rate coefficient associated with acceleration along the SRA in (°/s)/g.

One-half the algebraic difference between the gyro outputs in the IRA up and the IRA down positions, divided by the gyro scale factor determined in paragraph 4.13.4.1, shall represent the acceleration-sensitive drift rate coefficient associated with acceleration along the IRA in (°/s)/g (correction may be made for earth's rate).

The acceleration-sensitive coefficient shall be computed as the square root of the sum of the squares of the IRA and the SRA coefficients. When using the continuous recording, the acceleration-sensitive coefficient shall be computed as one-half the peak-to-peak value divided by the gyro scale factor determined in paragraph 4.13.4.1.

The result shall conform to the requirement of paragraph _____.

4.18.2 Acceleration-Sensitive Coefficient, Centrifuge Method.

4.18.2.1 Purpose. The purpose of this test is to determine the acceleration-sensitive drift rate coefficient for accelerations greater than one g applied along each of the major gyro axes.

4.18.2.2 Test Equipment. The following test equipment from paragraph 3.2 is required for this test:

Centrifuge,
Means of measuring the in-phase component of the gyro output.

4.18.2.3 Test Setup and Procedure. Mount the gyro with the OA nominally vertical and the IRA nominally horizontal and directed along the centrifuge acceleration vector. For the second orientation, reposition the gyro so that the OA is nominally vertical and the SRA is nominally horizontal and directed along the centrifuge acceleration vector. With the gyro spin motor nonoperating, but with the gyro pickoff energized, operate the centrifuge in steps of _____ g up to a maximum of _____ g. Record the gyro output at each of the steps. Repeat for each orientation.

4.18.2.4 Test Results. Plot the pickoff output versus the acceleration input and obtain the slope. Divide by the gyro scale factor determined in paragraph 4.13.4.1. Repeat for each orientation. The acceleration-sensitive drift rate coefficient shall be computed as the square root of the sum of the squares of the two values obtained. The result shall conform to the requirement of paragraph _____.

4.18.3 Acceleration-Squared-Sensitive Coefficient, Vibration Method

4.18.3.1 Purpose. The purpose of this test is to determine the acceleration-squared-sensitive drift rate coefficient.

4.18.3.2 Test Equipment. The following test equipment from paragraph 3.2 is required for this test:

Means of measuring the in-phase component of the gyro output,
Vibration machine.

4.18.3.3 Test Setup and Procedure. The gyro shall be positioned on the vibration table so that the vibration vector is applied normal to the OA and at 45 degrees to the IRA. Operate the gyro in accordance with the standard test conditions of paragraph 3.1. Apply (sinusoidal, random) vibrations of the following magnitudes and frequencies _____, recording the gyro output before, during, and after the vibration input.

4.18.3.4 Test Results. Determine the change in the output during vibration from the average of the outputs before and after vibration. The acceleration-squared-sensitive coefficient is computed by dividing this value by the product of the square of the input root mean square g level and the gyro scale factor determined in paragraph 4.13.4.1. When more than one vibration level is employed, the acceleration-squared-sensitive coefficient is determined by a least squares fit to the data obtained in paragraph 4.18.3.3. The result shall conform to the requirement of paragraph _____.

4.18.4 Acceleration-Squared-Sensitive Coefficient, Centrifuge Method

4.18.4.1 Purpose. The purpose of this test is to determine the acceleration-squared-sensitive drift rate coefficient.

4.18.4.2 Test Equipment. The following test equipment from paragraph 3.2 is required for this test:

Means of measuring and recording the in-phase component of the gyro output,
Centrifuge with counterrotating satellite head.

4.18.4.3 Test Setup and Procedure. Mount the gyro with the OA nominally vertical and coincident with the satellite head rotation axis. The IRA and the SRA are nominally horizontal and in the same plane as the table acceleration. Adjust the satellite head position marker to provide a reference signal when the positive SRA is directed outward and parallel to the radius arm of the main table. Operate the gyro in accordance with the standard test conditions of paragraph 3.1. Operate the centrifuge in steps of _____ g up to a maximum of _____ g. Record the gyro pickoff voltage on the recording chart at each of the above steps.

4.18.4.4 Test Results. For this test the most significant error coefficients contributing to rate errors are included in the following equation:

$$X(\alpha) = D_0 + D_{1i}a_i + D_{1s}a_s + D_2a_ia_s$$

where

$X(\alpha)$ = output,
D_0 = acceleration-insensitive drift rate coefficient (zero offset),
D_{1i} = acceleration-sensitive drift rate coefficient associated with acceleration along the IA,
D_{1s} = acceleration-sensitive drift rate coefficient associated with acceleration along the SA,
D_2 = IA to SA acceleration-squared-sensitive drift rate coefficient,
a_i = acceleration vector along IRA,
a_s = acceleration vector along SRA.

The coordinate functions a_i and a_s are, in turn, functions of α where

α = angle between the SRA and the centrifuge acceleration vector,
$a_i = A_c \sin \alpha$,
$a_s = A_c \cos \alpha$,

where A_c = centrifuge acceleration vector magnitude. Substituting:

$$X(\alpha) = D_0 + D_{1i}A_c \sin \alpha + D_{1s}A_c \cos \alpha + \frac{D_2A_c^2}{2} \sin 2\alpha. \quad (1)$$

The above equation is of the form:

$$X(\alpha) = \frac{A_0}{2} + A_1 \sin \alpha + B_1 \cos \alpha + A_2 \sin 2\alpha \cdots \quad (2)$$

where A_0, A_1, B_1, $A_2 \cdots$, etc., are the Fourier coefficients. Correspondence of (1) and (2) reveals:

$$D_0 = \frac{A_0}{2}$$

$$D_{1i} = \frac{A_1}{A_c}$$

$$D_{1s} = \frac{B_1}{A_c}$$

$$D_2 = \frac{2A_2}{A_c^2}$$

Since the Fourier coefficients can be obtained from a Fourier analysis of the observed data, the coefficients D_0, D_{1i}, D_{1s}, and D_2 may be calculated.

If zero offset obtained from paragraph 4.13.4.4 is used as D_0, then an acceleration-squared coefficient D_2 may be obtained from the following equation:

$$D_2 = \frac{X(45°) + X(225°) - 2D_0}{A_c^2}$$

The result for D_2 shall conform to the acceleration-squared-sensitive drift rate requirement of paragraph _____.

Note: It may also be required that the results for D_0, D_{1i}, and D_{1s} conform to the requirements for zero offset and acceleration-sensitive drift rate.

4.19 Rate Sensitivity About the Spin Reference Axis Test

4.19.1 Condition 1: No Angular Rate About the IRA

4.19.1.1 Purpose. The purpose of this test is to determine the sensitivity of the gyro to angular rates about the SRA with no inputs about the IRA.

4.19.1.2 Test Equipment. The following test equipment from paragraph 3.2 is required for this test:

Single-axis rate table,
Means of measuring the in-phase component of the gyro output,
Means of measuring the table rate.

4.19.1.3 Test Setup and Procedure. Mount the gyro on the rate table with the SRA parallel to the table rotation axis within ± _____ degrees and nominally vertical. In the general case the SRA is not defined; therefore, this orientation is achieved by mounting the gyro with its IRA normal to the table rotation axis within the tolerance previously identified and nominally horizontal. Operate the gyro in accordance with the standard test conditions of paragraph 3.1.

With the table nonrotating, measure the in-phase component of the gyro signal. Rotate the gyro at the input-limit rate (or other suitable rate not to exceed the specified mechanical overload rate) in a CW direction. Measure the in-phase gyro signal. Reverse the direction of table rotation. Measure the in-phase gyro signal.

4.19.1.4 Test Results. Compute the rate sensitivity about the SRA as follows:

$$\frac{|A| + |B|}{2K\omega} \text{ (°/s)/(°/s)}$$

where A and B are the changes in the in-phase signal measured as a result of rotation in the positive and the negative direction about the SRA respectively, K is the gyro scale factor as determined in paragraph 4.13.4.1, and ω is the input-limit rate. This value shall conform to the requirement of paragraph _____.

4.19.2 Condition 2: Angular Rate About Both the IRA and the SRA

4.19.2.1 Purpose. The purpose of this test is to determine the sensitivity of the gyro to angular rates about the SRA with inputs about the IRA.

4.19.2.2 Test Equipment. The following test equipment from paragraph 3.2 is required for this test:

Single-axis rate table,
Means of mounting the gyro with the IRA and the SRA at 45 degrees to the rate table axis of rotation,
Means of measuring the in-phase component of the gyro output,
Means of measuring the table rate.

4.19.2.3 Test Setup and Procedure. Mount the gyro on the rate table with the IRA and SRA at 45 ± _____ degrees from the table axis. Operate the gyro in accordance with the standard test conditions of paragraph 3.1. Rotate the table such that the component about the IRA is positive and at a suitable rate ω_1, not exceeding the positive-input limit of the gyro multiplied by $\sqrt{2}$. Measure the in-phase gyro signal.

Mount the gyro on the rate table with the IRA parallel to the table axis within _____ degrees. Operate the gyro in accordance with the standard test conditions of paragraph 3.1. Rotate the table in a positive direction about the IRA, adjusting the rate until the in-phase gyro signal equals that measured in the preceding paragraph within ± _____. Record this rate as ω_2.

The above test may be repeated with negative rates about the IRA.

4.19.2.4 Test Results. Compute the rate sensitivity about the SRA as follows:

$$\left|1 - \sqrt{2}\,\frac{\omega_2}{\omega_1}\right| \text{ (°/s)/(°/s)}$$

at $(\omega_1/\sqrt{2})$ °/s input to the IRA. The result shall conform to the requirement of paragraph _____.

If the test is repeated with negative input rates, the average of the two values obtained as above shall conform to the requirement of paragraph _____.

4.20 Rate Sensitivity About the Output Axis Test

4.20.1 Purpose. The purpose of this test is to determine the sensitivity of the gyro to angular rates about the OA.

4.20.2 Test Equipment. The following test equipment from paragraph 3.2 is required for this test:

Single-axis rate table,
Means of measuring the in-phase component of the gyro output,
Means of measuring the table rate.

4.20.3 Test Setup and Procedure. Mount the gyro with the SRA and the IRA perpendicular to the rate table axis within ± _____ degrees. In other respects operate the gyro in accordance with the standard test conditions of paragraph 3.1. Connect the gyro pickoff output to the output measurement equipment.

Operate the table at the following rates and record the output as shown:

*Input Rate**	*Direction*	*Record Output = R*
1. 1.5 nominal	CW	R_1 = _____
2. Nominal	CW	R_2 = _____
3. 0.5 nominal	CW	R_3 = _____
4. Nominal	CW	R_4 = _____
5. 1.5 nominal	CCW	R_5 = _____
6. Nominal	CCW	R_6 = _____
7. 0.5 nominal	CCW	R_7 = _____
8. Nominal	CCW	R_8 = _____

* Changes in the input rates must be accomplished without overshooting the next setting or the test must be restarted.

Nominal value should be selected to produce readable outputs and should also be less than one-half of the mechanical overload rate.

The test is limited by the threshold of the gyro in those cases where the alignment angle requirements are unusually tight.

4.20.4 Test Results. Compute the rate sensitivity about the output axis as follows:

$$\frac{R_2 + R_4 - (R_6 + R_8)}{4 \text{ (nominal input) (gyro scale factor)}}$$

The gyro scale factor shall be that determined in paragraph 4.13.4.1. The result shall conform to the requirement of paragraph _____.

4.21 Angular Acceleration Sensitivity About the Output Axis Test

4.21.1 Purpose. The purpose of this test is to determine the sensitivity of the gyro to angular acceleration about the OA.

4.21.2 Test Equipment. The following test equipment from paragraph 3.2 is required for this test:

Oscillating rate table (means for applying sinusoidal motion at controlled frequencies and amplitudes to the gyro),
Means of measuring the in-phase component of the gyro output.

4.21.3 Test Setup and Procedure

4.21.3.1 Test Setup. Mount the gyro on the oscillating table with the OA aligned parallel to the table axis within _____ degrees. Operate the gyro in accordance with the standard test condition of paragraph 3.1.

4.21.3.2 Test Procedure. Operate the table at a frequency not over 1/10 of the natural frequency as determined by tests described in paragraph 4.22. Set the amplitude of oscillations to impress the following angular accelerations and record output as shown.

*Input Acceleration**	*Output*
1.	R_1 = _____
2.	R_2 = _____

* Input 1 should be at least twice that required to produce a measurable output. Input 2 should be at least twice input 1.

4.21.4 Test Results. Compute the angular acceleration sensitivity about the OA as follows:

$$\frac{R_2 - R_1}{(\text{input 2} - \text{input 1})\ (\text{gyro scale factor})}$$

The gyro scale factor shall be that determined in paragraph 4.13.4.1. The result shall conform to the requirement of paragraph _____.

4.22 Dynamic Response Test Series

4.22.1 Oscillating Rate Input Method

4.22.1.1 Purpose. The purpose of this test is to determine the natural frequency and the damping ratio of the gyro by measuring its response to an oscillating rate input.

4.22.1.2 Test Equipment. The following test equipment from paragraph 3.2 is required for this test:

(a) Phase measurement method,

Means of measuring the phase relation between the gyro output and the input rate;

(b) Amplitude measurement method,

Means of measuring the peak amplitude of the input rate,
Means of measuring the in-phase component of the gyro output.

4.22.1.3 Test Setup and Procedure

4.22.1.3.1 Test Setup. Mount the gyro on the oscillating rate table with the gyro IRA aligned parallel to the axis of the table and nominally vertical. Operate the gyro in accordance with the standard test conditions of paragraph 3.1. Connect the gyro pickoff output and the table rate output to the phase measuring device.

4.22.1.3.2 Test Procedure

4.22.1.3.2.1 Natural Frequency. Apply a sinusoidal input of _____ ± _____ °/s peak. Determine the input frequency f_n at which the gyro output lags the input rate by 90 ± _____ degrees.

4.22.1.3.2.2 Damping Ratio. Apply a sinusoidal input rate of _____ ± _____ °/s peak at frequencies of f_n/a, f_n/b, $\cdots$, ± _____ hertz where a, b, etc., are determined by the user's requirements. Measure the phase relation between the gyro input and output or measure the peak amplitude of the gyro output.

4.22.1.4 Test Results

4.22.1.4.1 Natural Frequency. The natural frequency f_n measured in paragraph 4.22.1.3.2.1 shall conform to the requirement of paragraph _____.

4.22.1.4.2 Damping Ratio. The damping ratio is calculated from the data obtained in paragraph 4.22.1.3.2.2 by comparing the measured phase relationships with a phase angle-frequency plot for a damped second-order system or by comparing the measured amplitude ratios with an amplitude-frequency plot for a damped second-order system. The damping ratio shall conform to the requirement of paragraph _____.

4.22.2 Step Input Method

4.22.2.1 Purpose. The purpose of this test is to determine the natural frequency and the damping ratio of the gyro by measuring its response to a step input.

4.22.2.2 Test Equipment. The following test equipment from paragraph 3.2 is required for this test:

Means of applying a step rate input to the gyro,
Means of recording the gyro response to a step rate input.

4.22.2.3 Test Setup and Procedure. Mount the gyro on the step rate table with the gyro IRA aligned parallel to the axis of the table and nominally vertical. Operate the gyro in accordance with the standard test conditions of paragraph 3.1.

Connect the gyro pickoff output and the table motion output to the recorder. Apply a change of rate from _____ °/s to _____ ± _____ °/s during a period not to exceed _____ seconds. Record the gyro and the table motion outputs.

4.22.2.4 Test Results. The gyro natural frequency and damping ratio are determined by comparing the recorded response with the step response of a damped second-order system. The natural frequency shall conform to the requirement of paragraph _____, and the damping ratio shall conform to the requirement of paragraph _____.

4.23 Warm-Up Time Test

4.23.1 Purpose. The purpose of this test is to determine the time interval required for the gyro to reach specified performance from the instant that it is energized under specified operating conditions.

4.23.2 Test Equipment. The following test equipment from paragraph 3.2 is required for this test:

Oscillating rate table (means of applying a sinusoidal rate to the gyro at a controlled frequency and amplitude),
Means of measuring the in-phase component of the gyro output,
Means of measuring the elapsed time.

4.23.3 Test Setup and Procedure. Mount the gyro on the oscillating rate table with the gyro IRA aligned parallel to the axis of the table and nominally vertical. Operate the gyro in accordance with the standard test conditions of paragraph 3.1 except that the thermal and mechanical starting conditions shall be _____ and the energizing sequence shall be _____.

TEST PARAGRAPH AND DESCRIPTION / GYRO PARAMETRIC TESTS / ENVIRONMENTAL TESTS		4.1 EXAMINATION OF PRODUCT	4.2 IMPEDANCE	4.3 DIELECTRIC	4.4 INSULATION RESISTANCE	4.5 LEAK	4.6 POLARITY	4.7 ELECTRICAL NULL	4.8 OUTPUT NOISE	4.9 RUN-UP TIME	4.10 ROTOR ROTATION DETECTOR	4.11 POWER CONSUMPTION AND CURRENT	4.12 RUN-DOWN TIME	4.13 GYRO SCALE FACTOR	4.13 COMPOSITE ERROR	4.13 HYSTERESIS ERROR	4.13 ZERO OFFSET	4.13 THRESHOLD	4.13 RESOLUTION	4.14 LIMIT STOPS
1	LOW TEMPERATURE	N	D N	N	N	N		D N	N	D N	D N	D N	D N	D N	D N	D N	D N	D N	N	N
2	HIGH TEMPERATURE	N	D N	N	N	N		D N	N	D N	D N	D N	D N	D N	D N	D N	D N	D N	N	N
3	EXCITATION VOLT.& FREQ. VARIATION							D		D		D		D	D	D	D			
4	MECHANICAL SHOCK	O N			O N	O N		O N	O N	O N	O N	O N	O N	O N	O N	O N	O N	O N	O N	O N
5	THERMAL SHOCK	O N	O N	O N	O N	O N		O N	O N	O N	O N	O N	O N	O N	O N	O N	O N	O N	O N	O N
6	HIGH ALTITUDE	N	N	N	N	N		N	N	N	N	N	N	N	N	N	N	N	N	N
7	VIBRATION	O N			O N	O N		O N	O N	O N	O S N	D O N	O N	O N	O N	O N	O N	O N	O N	O N
8	ACCELERATION	O N						O N	O N	O N	O N	O N	O N	O N	O N	O N	O N	O N	O N	O
9	MECHANICAL OVERLOAD									O	S	D O	O	O	O	O	O	O	O	O
10.1	LIFE, STORAGE	N	N	N	N	N		N	N	N	N	N	N	N	N	N	N	N	N	N
10.2	LIFE, OPERATING	D	O	O	O	O		D	D	D	O S	D	D	D	D	D	D	D	D	O
11	FUNGUS	N	N	N	N	N														
12	HUMIDITY	N	N	N	N	N														
13	SALT SPRAY	N	N	N	N	N														
14	ACOUSTICAL NOISE	O N			O N	O N		O N	O N	O N	O S N	D O N	O N	O N	O N	O N	O N	O N	O N	O N
15	THERMAL RADIATION	O N	O N							O N		D	O N	O N	O N	O N	O N	O N	O N	
16	AIR CURRENTS																			
17	HIGH PRESSURE	O N				N								O N	O N	O N	O N	O N	O N	
18	NUCLEAR RADIATION	S	O N	O N	O N	O N			O N	O N	S	D N	O N	O N	O N	O N	O N	O N	O N	
19	MAGNETIC FIELDS							D O	D O	D O	D O	O		D O	D O	D O	D O	D O	O	
20	RADIO NOISE							D	D		D			D	D	D	D	D	D	
21	SAND AND DUST	N	N	N	N	N														
22	SUNSHINE	N	N	N	N	N														
23	RAIN	N	N	N	N	N														

4.15 PICKOFF PHASE SHIFT	4.16 SWITCHING RATE	4.17 SELF-TEST TORQUER	4.18 ACCEL-SENSITIVE DRIFT RATE	4.19 RATE SENSITIVITY ABOUT SRA	4.20 RATE SENSITIVITY ABOUT OA	4.21 ANGULAR ACCELERATION SENSITIVITY ABOUT THE OA	4.22 NATURAL FREQUENCY	4.22 DAMPING RATIO	4.23 WARM-UP TIME	-MONITOR OUTPUT	COMMENTS
D N	D N	D N	D N	N	N	D N	D N	D N	D N		
D N	D N	D N	D N	N	N	D N	D N	D N	N		
D	D										
O N	O N	O N	O N	O N	O N	O N	O N	O N		D	
O N	O N	O N	O N	O N	O N	O N	O N	O N		D	
N	N	N	N	N	N	N	N	N	N		
O N	O N	O N	O N	O N	O N	O N	O N	O N		D	SPECIAL TEST MAY BE RUN TO DETERMINE IF MOTOR REMAINS IN SYNC.
O N	O N	O N	O D N	O N	O N	O N	O N	O N		D	CENTRIFUGE TESTS FOR ACCEL-SENS. DRIFT USUALLY RUN WITH SPIN MOTOR-OFF.
	O		O							D	SPECIAL TEST MAY BE RUN TO DETERMINE IF MOTOR REMAINS IN SYNC.
N	N	N	N	N	N	N	N	N	N		
D	D	O	O	O	O	D	D	D	D		SPECIAL TEST MAY BE RUN TO DETERMINE IF MOTOR REMAINS IN SYNC. PARAMETRIC TESTS TO BE PERFORMED AT INTERVALS TO BE SPECIFIED FOR EACH TEST.
O N	O N	O N	O N	O N	O N	O N	O N	O N		D •	SPECIAL TEST MAY BE RUN TO DETERMINE IF MOTOR REMAINS IN SYNC.
	O N					D O N	D O N	D O N		D	
						D	D	D	D	D	
	O N					D	D	D		D	
O N	O N	O N S				O N	O N	O N		D	SPECIAL TESTS MAY BE RUN TO DETERMINE IF MOTOR REMAINS IN SYNC. AND USING TORQUER TO DETERMINE RATE TRANSFER CHARACTERISTICS. THE HAZARDS OF POST-EXPOSURE HANDLING SHOULD BE CONSIDERED.
D O	D O	D O				D O	D O	D O		D	
D	D										

Apply a sinusoidal input rate of _____ ± _____ °/s peak at a frequency of _____ ± _____ hertz. Energize the gyro and simultaneously start the elapsed time recorder. Measure the peak amplitude of the gyro output. When this output reaches _____ ± _____ °/s, stop the elapsed time recorder.

4.23.4 Test Results. The elapsed time measured shall conform to the requirement of paragraph _____.

4.24 Environmental Test Series

Procedures for most environmental tests are well covered by existing industry, government, and military documents, an example of which is MIL-E-5272, "Environmental Testing, Aeronautical and Associated Equipment." Rather than duplicate samples of existing procedures, this Test Procedure provides assistance in selecting the gyro parameters that will be most important to measure in each environment. This selection is made based on the expected environmental sensitivities of the spring-restrained single-degree-of-freedom rate gyro and the cost effectiveness of the testing. The application of the gyro will determine which tests, or combinations of tests, are pertinent.

4.24.1 Purpose. The purpose of these tests is to verify that the gyro performs as specified during and/or after subjection to environments outside of the standard operating conditions, but within the specified environmental limits.

4.24.2 Test Equipment. The following test equipment from paragraph 3.2 is required for each environmental test:

Equipment for providing the specified environment,
Means of measurement of the environment and time,
Adaptation of the gyro to the environmental equipment such as special holding fixtures, cables, etc,
Equipment for the gyro test, chosen as indicated in paragraphs 4.1 through 4.22.

4.24.3 Test Procedure. Detail the procedure for the manipulation of the environment, including the tolerances and the rates of change, integrated with the procedure for the gyro test. Caution notes on overload limits on the environmental intensity applied to the gyro can be specified if required.

4.24.4 Test Results. Parametric test data shall include the additional notation of the environment in which it was obtained. Where required, the gyro data shall be plotted versus the environmental intensity in order to determine the sensitivity.

Table 1 is intended to be a guide for the selection of the gyro test that should be conducted in association with the environmental tests that are chosen dependent on the application of the gyro. The coding is as follows:

- D = The gyro parametric test is to be conducted while the gyro is operating or nonoperating as applicable, during the specified environment.
- O = The gyro is to be operated during the specified environment and the parametric test performed before and after.
- N = The gyro is to be nonoperating during the specified environment, and the parametric test performed before and after.
- S = A special test is recommended as described under Comments.

When Monitor Output is the requirement, further clarification is necessary as to how output variation is to be judged.