

An American National Standard

**IEEE Standard
Inertial Sensor Terminology**

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

Approved June 23, 1983
IEEE Standards Board

Approved May 31, 1985
American National Standards Institute

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Foreword

(This Foreword is not a part of IEEE Std 528-1984, IEEE Standard Inertial Sensor Terminology.)

This standard was prepared by the Gyro and Accelerometer Panel of the Aerospace Electronics Systems Society of the Institute of Electrical and Electronics Engineers.

This standard is a listing of terms and definitions relating to inertial sensors, and represents a consensus of manufacturers and users in industry, government agencies, and other interested groups.

When necessary, the needs of the inertial sensor community have been given preference over general technical usage. For example, degree-of-freedom, rotor angular momentum, and pendulosity are defined in a restricted sense, as applied to inertial sensors. In general, standard textbook definitions have not been included; for example, damping ratio and orthogonality.

The criterion for inclusion of terms or definitions in this standard is their general usefulness as related to inertial sensor technology.

The IEEE will maintain this standard current with the state of the technology. Comments are invited on this standard as are suggestions for additional material. These should be addressed to:

Secretary

IEEE Standards Board

The Institute of Electrical and Electronics Engineers, Inc

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This publication represents a group effort on a large scale. A total of 87 individuals attended 23 meetings of the Gyro and Accelerometer Panel while this standard was in preparation. The major contributors to this standard were the following:

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IEEE Standard Inertial Sensor Terminology

acceleration-insensitive drift rate (gyro). That component of systematic drift rate which has no correlation with acceleration.

acceleration-sensitive drift rate (gyro). Those components of systematic drift rates that are correlated with the first power of linear acceleration applied to the gyro case. The relationship of these components of drift rate to acceleration can be stated by means of coefficients having dimensions of angular displacement per unit time per unit acceleration for accelerations along each of the principal axes of the gyro (for example, drift rate caused by mass unbalance).

acceleration-squared-sensitive drift rate (gyro). Those components of systematic drift rates that are correlated with the second power or product of linear acceleration applied to the gyro case. The relationship of these components of drift having dimensions of angular displacement per unit time per unit acceleration squared for accelerations along each of the principal axes of the gyro and angular displacement per unit time per the product of accelerations along combinations of two principal axes of the gyro (for example, drift rate caused by anisoelectricity).

accelerometer. A device that senses the inertial reaction of a proof mass for the purpose of measuring linear or angular acceleration.

NOTE: In its simplest form, an accelerometer consists of a case-mounted spring and mass arrangement where displacement of the mass from its rest position, relative to the case, is proportional to the total nongravitational acceleration experienced along the instrument's sensitive axes.

activation time (gyro, accelerometer). *See:* turn-on time.

angular-acceleration sensitivity (accelerometer). The output (divided by the scale factor) of a linear accelerometer that is produced per unit of angular acceleration input about a specified axis.

angular-acceleration sensitivity (gyro). The ratio of drift rate due to angular acceleration

about a gyro axis divided by the angular acceleration causing it.

NOTE: In single-degree-of-freedom gyros, it is nominally equal to the effective moment of inertia of the gimbal assembly divided by the angular momentum.

angular accelerometer. A device that senses angular acceleration about an input axis. An output signal is produced by the reaction of the moment of inertia of a proof mass to an angular acceleration input. The output is usually an electrical signal proportional to applied angular acceleration.

angular-case-motion sensitivity (dynamically tuned gyro). The drift rate resulting from an oscillatory angular input about an axis normal to the spin axis at twice the rotor spin frequency. This effect is due to the single degree of freedom of the gimbal relative to the support shaft and is proportional to the input amplitude and phase relative to the flexure axes. *See:* two-N (2N) angular sensitivity.

angular-velocity sensitivity (accelerometer). The output (divided by the scale factor) of a linear accelerometer that is produced per unit of angular velocity input about a specified axis.

angular-vibration sensitivity (gyro, accelerometer). The ratio of the change in output due to angular vibration about a sensor axis divided by the amplitude of the angular vibration causing it.

anisoelectricity (gyro). The inequality of compliance of a structure in different directions. *See:* acceleration-squared-sensitive drift rate.

anisoinertia (gyro). The inequality of the moments of inertia about the gimbal principal axes. When the gyro is subjected to angular rates about the input and spin axes, and the moments of inertia about these axes are unequal, a torque is developed about the output axis which is proportional to the difference of the inertias about the input and spin axes multiplied by the product of the rates about these two axes. This torque results in a drift rate (anisoinertia drift) proportional to the product of the two input rates.

attitude storage (gyro). The transient deviation of the output of a rate integrating gyro from that of an ideal integrator when the gyro is subjected to an input rate. It is a function of the gyro characteristic time. (See Fig 1). *See:* float storage, torque command storage.

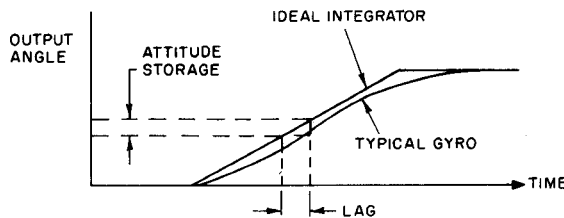


Fig 1
Attitude Storage

autoerection (gyro). The process by which gimbal axis friction causes the spin axis of a free gyro to tend to align with the axis about which the case is rotated. The resulting drift rate is a function of the angular displacement between the spin axis and the rotation axis.

automatic bias nulling (washout) (gyro, accelerometer). A circuit or system technique for setting the mean value of sensor output, averaged over a defined time period, to zero, or to some defined value.

axis-of-freedom (gyro). The axis about which a gimbal provides a degree-of-freedom.

bias (accelerometer). An accelerometer output when no acceleration is applied.

bias (gyro). *See:* acceleration-insensitive drift rate.

biasing (laser gyro). The action of intentionally imposing a real or artificial rate into the laser gyro to avoid the region in which lock-in occurs.

binary torquing (gyro, accelerometer). A torquing mechanization which uses only two torquer current levels, usually positive and negative of the same magnitude; no sustained zero current or off condition exists. The positive and negative current periods can be either discrete pulses or duration-modulated pulses. In the case of zero input (acceleration or angular rate), a discrete pulse system will produce an equal number of positive and negative pulses. A pulse-duration-modulated system will produce positive and negative current periods of equal duration for zero input. Binary torquing

delivers constant power to a sensor torquer (as compared to variable power ternary torquing) and results in stable thermal gradients for all inputs.

caging (gyro). The process of orienting and mechanically locking one or more gyro axes or gimbal axes to a reference position.

capturing (gyro, accelerometer). The use of a torquer (forcer) in a servo loop to restrain a gyro gimbal, rotor, or accelerometer proof mass to a specified reference position.

case (gyro, accelerometer). The structure which provides the mounting surfaces and establishes the reference axes.

characteristic time (gyro, accelerometer). The time required for the output to reach 63% of its final value for a step input.

NOTE: For a single-degree-of-freedom rate integrating gyro, it is numerically equal to the rate of the float moment of inertia to the damping coefficient about the output axis. For certain fluid filled sensors, the float moment of inertia may include other effects, such as that of transported fluid.

coast time (gyro). *See:* run-down time.

command rate (gyro). The input rate equivalent of a torquer command signal.

composite error (gyro, accelerometer). The maximum deviation of the output data from a specified output function. Composite error is due to the composite effects of hysteresis, resolution, nonlinearity, nonrepeatability, and other uncertainties in the output data. It is generally expressed as a percentage of half the output span. *See:* input-output characteristics.

coning effect (gyro). The apparent drift rate caused by motion of an input axis in a manner which generally describes a cone. This usually results from a combination of oscillatory motions about the gyro principal axes. The apparent drift rate is a function of the amplitudes and frequencies of oscillations present and the phase angles between them.

Coriolis acceleration (inertial sensor). Coriolis acceleration is that increment of acceleration relative to inertial space which arises from the velocity of a particle relative to a rotating coordinate system. Sometimes, the term Coriolis acceleration is also used to describe the apparent acceleration relative to a rotating coordinate system of a force-free moving particle.