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(Revision of
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IEEE Standard for Inertial Sensor Terminology

IEEE Aerospace and Electronic Systems Society

Sponsored by the
Gyro and Accelerometer Panel



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**Gyro and Accelerometer Panel
of the
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Abstract: Terms and definitions relating to inertial sensors are presented in this standard. Usage as understood by the inertial sensor community is given preference over general technical usage of the terms herein. The criterion for inclusion of a term and its definition in this standard is usefulness as related to inertial sensor technology.

Keywords: inertial sensor technology, inertial sensor terminology

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Introduction

(This introduction is not a part of IEEE Std 528-2001, IEEE Standard for Inertial Sensor Terminology)

IEEE Std 528-2001 is a revision of IEEE Std 528-1994 and IEEE Std 528-1984. This standard is a listing of terms and definitions relating to inertial sensors. The criterion for inclusion of terms and definitions in this standard is their general usefulness as related to inertial sensor technology. This revision adds new terms associated with recent advancements in inertial sensor technology.

In this standard, the symbol g is used to denote a unit of acceleration equal in magnitude to the local value of gravity at a test site or the standard value 9.80665 m/s^2 . The symbol g is thus distinguished from g , which is the standard symbol for gram.

Participants

This standard 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 specialized sense, as applied to inertial sensors. In general, definitions that might be found in a standard textbook have not been included; for example, “damping ratio” and “orthogonality.”

This standard was prepared by the Gyro and Accelerometer Panel of the IEEE Aerospace Electronic Systems Society. This publication represents a group effort on a large scale. The major contributors to IEEE Std 528-1994 and to earlier versions were as follows:

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A total of 70 individuals attended 16 meetings of the Gyro and Accelerometer Panel during the preparation of this revised standard, IEEE Std 528-2001. The following individuals on the Gyro and Accelerometer Panel contributed to IEEE Std 528-2001:

Sid Bennett, <i>Chair</i>		
David R. Anderson	Yoshiaki Hirobe	Charles Pearce
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The following members of the balloting group voted on this revised standard. Balloters may have voted for approval, disapproval, or abstention.

Michael E. Ash	Kerry N. Green	Charles H. Pearce
Cleon H. Barker	Yoshiaki Hirobe	Rex B. Peters
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Yuri V. Filatov	Ralph B. Morrow, Jr.	Bruce R. Youmans
Thomas A. Fuhrman	Peter J. Palmer	

When the IEEE Standards Board approved this standard on 7 August 2001, it had the following membership:

Satish K. Aggarwal	James H. Gurney	James W. Moore
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1. Overview

This standard presents terms and definitions relating to inertial sensors. Usage as understood by the inertial sensor community is given preference over general technical usage of the terms herein. The criterion for inclusion of a term and its definition in this standard is usefulness as related to inertial sensor technology.

2. Definitions

2.1 acceleration-insensitive drift rate (gyro): The component of environmentally sensitive drift rate not correlated with acceleration.

NOTE—Acceleration-insensitive drift rate includes the effects of temperature, magnetic, and other external influences.

2.2 acceleration random walk (accelerometer): *See: random walk (acceleration random walk).*

2.3 acceleration-sensitive drift rate (gyro): The components of systematic drift rate correlated with the first power of a linear acceleration component, typically expressed in $(^{\circ}/h)/g$.

2.4 acceleration-squared-sensitive drift rate (gyro): The components of systematic drift rate correlated with either the second power of a linear acceleration component or the product of two linear acceleration components, typically expressed in $(^{\circ}/h)/g^2$.

2.5 accelerometer: An inertial sensor that measures linear or angular acceleration. Except where specifically stated, the term *accelerometer* refers to linear accelerometer. *See: angular accelerometer; linear accelerometer.*

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

2.7 activity dip (vibrating beam accelerometer): The phenomenon where, at certain frequencies, the resonator vibration amplitude decreases due to parasitic resonances within itself or with the surrounding structure.

2.8 alignment (gyro, accelerometer): *See: input-axis misalignment.*

2.9 Allan variance: A characterization of the noise and other processes in a time series of data as a function of averaging time. It is one half the mean value of the square of the difference of adjacent time averages from a time series as a function of averaging time.

2.10 angle random walk (gyro): *See:* **random walk (angle random walk).**

2.11 angular acceleration sensitivity: (1) (accelerometer). The change of output (divided by the scale factor) of a linear accelerometer that is produced per unit of angular acceleration input about a specified axis, excluding the response that is due to linear acceleration.

(2) (gyro). The ratio of drift rate due to angular acceleration about a gyro axis to 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.

2.12 angular accelerometer: An inertial sensor that measures the rate of change of inertial angular velocity about its input axis(es).

NOTE—An output signal is produced from the angular motion of a proof mass (rigid or fluid) relative to a case; or by differentiating the output of a strapdown gyroscope; or by differencing the outputs from an array of linear accelerometers.

2.13 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.**

2.14 angular velocity sensitivity (accelerometer): The change of output (divided by the scale factor and the square of angular rate or product of two angular rates) of a linear accelerometer that is produced per unit of angular velocity squared, when spun about a specified axis, excluding the response that is due to acceleration. *See:* **effective center-of-mass for angular velocity; rate-squared sensitivity.**

2.15 angular vibration sensitivity (gyro): The ratio of the change in output due to angular vibration about a sensor axis to the amplitude of the angular vibration causing it.

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

2.17 anisoinertia: (1) (accelerometer). A relationship among the principal axis moments of inertia of an accelerometer pendulum in which the moment of inertia about the output axis differs from the difference of the moments of inertia about the other two principal axes. This inequality causes the effective centers of mass for angular velocity and for angular acceleration to be physically separated. In a system in which the accelerometer is modeled as though it were located at the effective center of mass for angular acceleration, there will be an offset in accelerometer output proportional to the product of the angular rates about the input and pendulous axes. Anisoinertia may be expressed as the magnitude of the actual separation in units of length, or as a compensation term in units of $\mu\text{g}/(\text{rad/s})^2$. Anisoinertia, in this usage, differs from standard physical definitions, but it describes a real effect that is closely analogous to the effect of the same name in gyros. The effect is most easily described in a pendulous accelerometer, but it can also be seen in a nominally translational proof mass accelerometer that has sufficient angular elastic compliance to emulate a pendulous axis.

(2) (mechanical 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 that 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.

2.18 anti-lock means (laser gyro): Mitigation of lock-in effects by inducing a nonreciprocal phase (or frequency) shift between the counter-propagating beams.

NOTE—This can be accomplished by mechanical or magneto-optical means.