Gyro and Accelerometer Panel (GAP)

What is It and Why Support It

What Are Standards and Why Are They Important?

What is a Standard?

- An established norm or requirement
- Usually expressed as a formal document that establishes uniform engineering or technical criteria, methods, processes and practices
- Represents industry consensus
  - Balance between users, producers, academia, government and other interested parties
- If it didn't, it would not be accepted
- Consensus takes time to achieve
- Consensus requires openness, compromise and mutual respect between members

Why Important?

- Standards reduce confusion by establishing an accepted way to describe technology and products
- Standards create a common language that can be used by users, producers, academia, government and other interested parties
- Standards improve efficiency in development, production, test, and sales

Types of Standards

- Specification Format Guides
  - Provide manufacturers and users of inertial sensors and systems with recommendations relating to the preparation of a specification
  - Allow common ground to be established between manufacturers and users such that there will be no misunderstanding as to the meaning of a specified capability or performance requirement
- Test Procedures
  - Provide a compilation of recommended procedures for testing inertial sensors and systems.
  - Derived from those procedures presently used in the industry
  - Allow common ground to be established between manufacturers and users of inertial sensors and systems such that there will be no misunderstanding as to the method(s) used to test

Types of Standards

- Terminology
  - Provides consistent definitions that result in a common language for development, manufacture, test and use of inertial sensors and systems.
  - Serves as a basic reference for producers and users for preparing industry standards and for the interpretation of published technical reports
- Recommended Practices
  - Provide manufacturers and users of inertial sensors and systems with guidance on a particular aspect of the development, manufacture, test or use of inertial sensors and systems

What is the GAP?

GAP Charter & Makeup

Charter

The purpose of the Panel is to create standard terminology, specification formats, and test procedures for, and to promulgate understanding of components and systems for detection or measurement of linear or angular motion.

Makeup

The Panel is comprised of representatives of industry, government laboratories, educational institutions and professional societies who are knowledgeable of the characteristics, operating principles, sources of error, and areas of application of inertial sensors and systems.

Represented Companies

- 746 Test Squadron
- Acutronic
- AMRDEC
- Analog Devices
- Charles Stark Draper Laboratory
- Cleon Barker Consulting
- Ducommun Miltec
- Erickson Enterprises
- Honeywell
- Lockheed Martin Missiles & Fire Control
- Northrop Grumman
- Raytheon Missile Systems
- Sagem Defense Securite

GAP Organization

- Part of the IEEE Aerospace and Electronics Systems Society
  - Panel in existence for over 50 years (first meeting held in May 1962)
  - Two standing committees (Systems and Sensors)
  - Write and maintain inertial sensor and system standards
  - Yearly membership renewal required
- Bimonthly panel meetings
  - Meet 6 times a year for 2 days at a time
  - Hosted by companies or sometimes individuals
  - Alternate between East and West Coasts
  - Have also been held in Canada, France, Germany, and Russia
- Annually determine panel and committee objectives
  - Drives agenda for GAP meetings

IEEE Development Process

- Any interested party may attend the open meetings where standards are developed
  - Work consists of real time efforts plus homework submittals
  - New additions and changes are discussed and voted upon
  - Consensus is critical for standards to be adopted by industry
- Project authorization request (PAR)
  - Defines scope, purpose and need
  - Approved by IEEE Standards Association
- Work on documents takes place within appropriate committee
- Proposed standards, once developed, are sent out for industry survey, then panel ballot (75% affirmative vote required)

Published Standards

- Format Specification Guides & Test Procedures
  - Spinning wheel gyros
    - Single degree-of-freedom, spring restraint
    - Single degree-of-freedom, rate integrating
    - Dynamically tuned gyros (DTG)
  - Sagnac effect gyros
    - Ring laser gyros (RLG)
    - Fiber optic gyros (FOG)
  - Coriolis vibratory gyros (CVG)
  - Accelerometers
    - Angular accelerometers
    - Linear accelerometers
- Terminology
  - Inertial sensor terminology
  - Inertial systems terminology
- Recommended Practices
  - Precision centrifuge testing of linear accelerometers
  - Inertial Sensor Test Equipment, Instrumentation, Data Acquisition, and Analysis

Maintained Standards

Gyro and Accelerometer Panel

Sensors Committee

292 – 1969, 293 – 1969
Spring Restrained Gyro

517 – 1974, 529 – 1980
Rate Integrating Gyro

647 – 2006
Ring Laser Gyro

813 – 1988
Dynamically Tuned Gyro

952 – 1997
Fiber Optic Gyro

1431 – 2004
Coriolis Vibratory Gyro

671 – 1985
Nongyroscopic Angular Sensor

1293 – 1998
Nongyroscopic Linear Accelerometer

528 – 2001
Inertial Sensor Terminology

836 – 2009
Precision Centrifuge Testing of Linear Accelerometers

1554 – 2005
Inertial Sensor Test Equipment, Instrumentation, Data Acquisition, and Analysis

Systems Committee

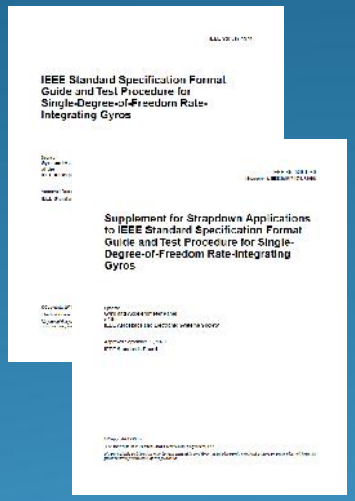
1559 – 2009
Inertial Systems Terminology

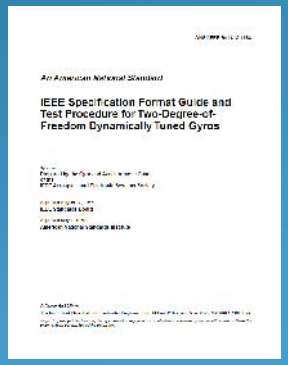
1780 – 201X *
Inertial Measurement Unit

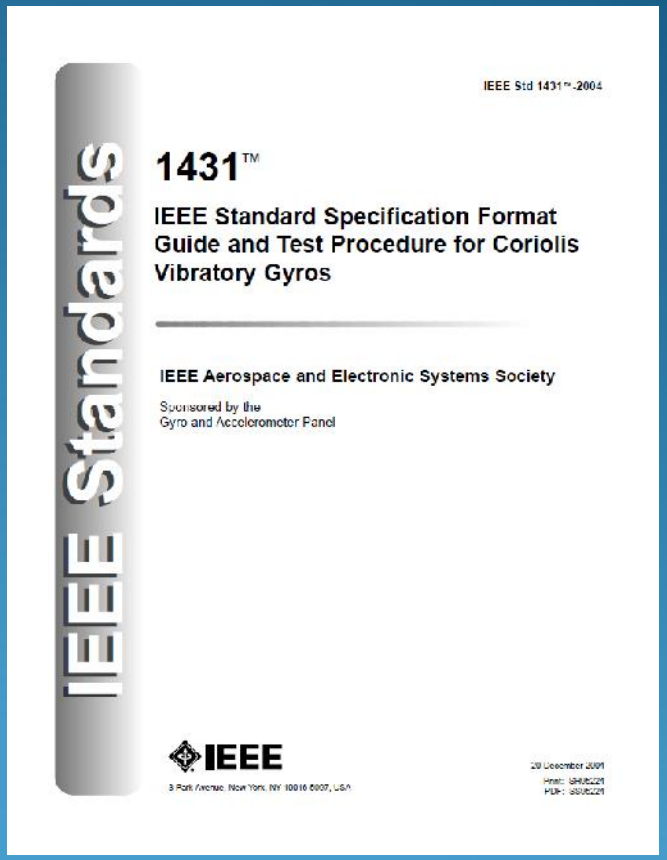
* Standard is in development

The numbers on this slide are the standard number followed by the year of publication

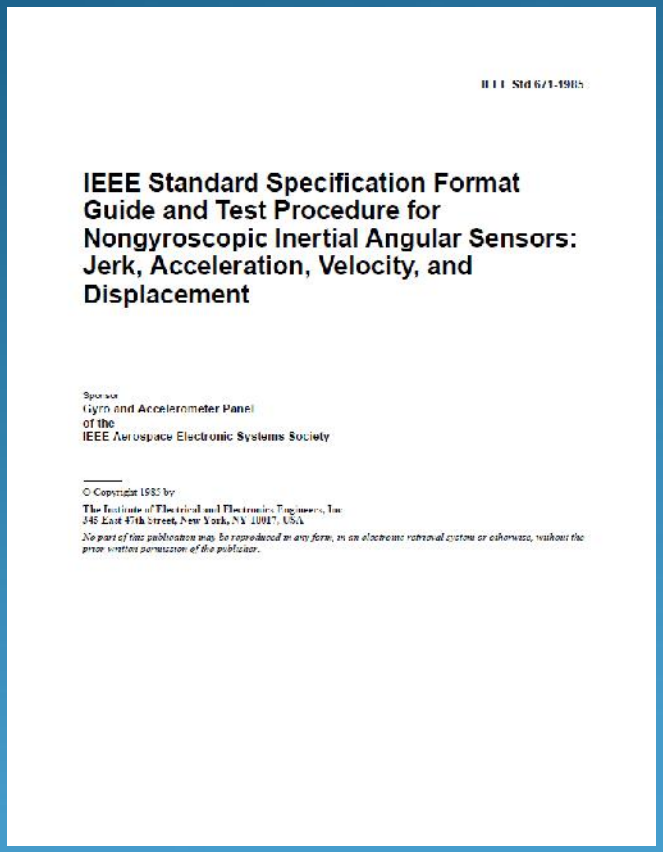
Gyro Standards







Accelerometer Standards



IEEE Std 671-1985

IEEE Standard Specification Format Guide and Test Procedure for Nongyroscopic Inertial Angular Sensors: Jerk, Acceleration, Velocity, and Displacement

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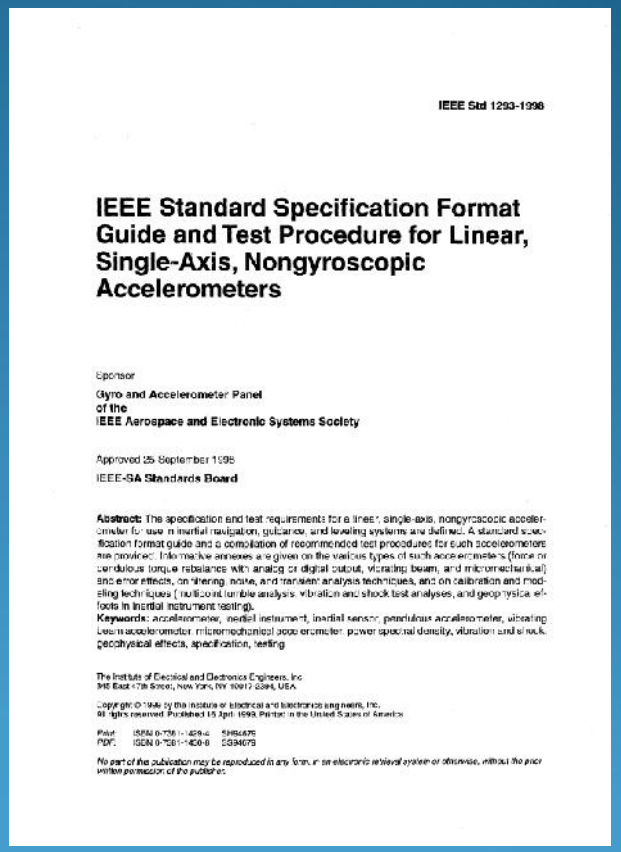

IEEE Std 1293-1998

IEEE Standard Specification Format Guide and Test Procedure for Linear, Single-Axis, Nongyroscopic Accelerometers

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of the
IEEE Aerospace and Electronic Systems Society

Approved 25 September 1998
IEEE-SA Standards Board

Abstract: The specification and test requirements for a linear, single-axis, nongyroscopic accelerometer for use in inertial navigation, guidance, and leveling systems are defined. A standard specification format guide and a compilation of recommended test procedures for such accelerometers are provided. Information is given on the various types of such accelerometers (force or pendulous torque rebalance with analog or digital output, vibrating beam, and micromechanical) and error effects, on filtering, noise, and transient analysis techniques, and on calibration and modeling techniques (nuisance tumble analysis, vibration and shock test analyses, and geophysical effects in inertial instrument testing).
Keywords: accelerometer, inertial instrument, inertial sensor, pendulous accelerometer, vibrating beam accelerometer, micromechanical accelerometer, power spectral density, vibration and shock, geophysical effects, specification, testing

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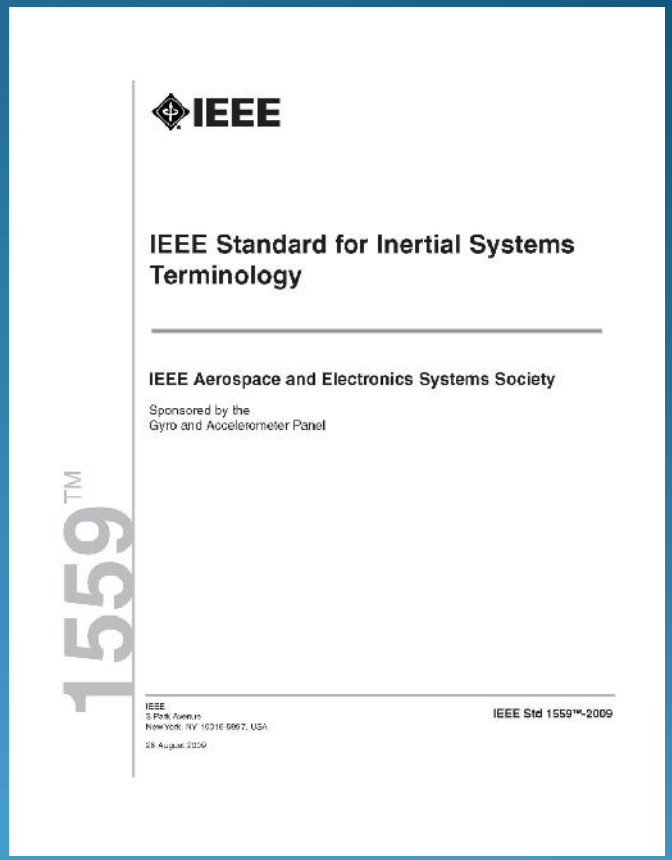
IEEE Std 528

- Standard for Inertial Sensor Terminology
  - 293 definitions, acronyms, abbreviations, and synonyms
  - Companion to IEEE Std 1559 " IEEE Standard for Inertial Systems Terminology"
- Published in 2001
- Alphabetical order
- Cross linked definitions
- Purpose
  - Compile and standardize terminology used in the development, manufacture, test, and use of inertial sensors
  - Serve as a basic reference for producers and users of inertial sensors

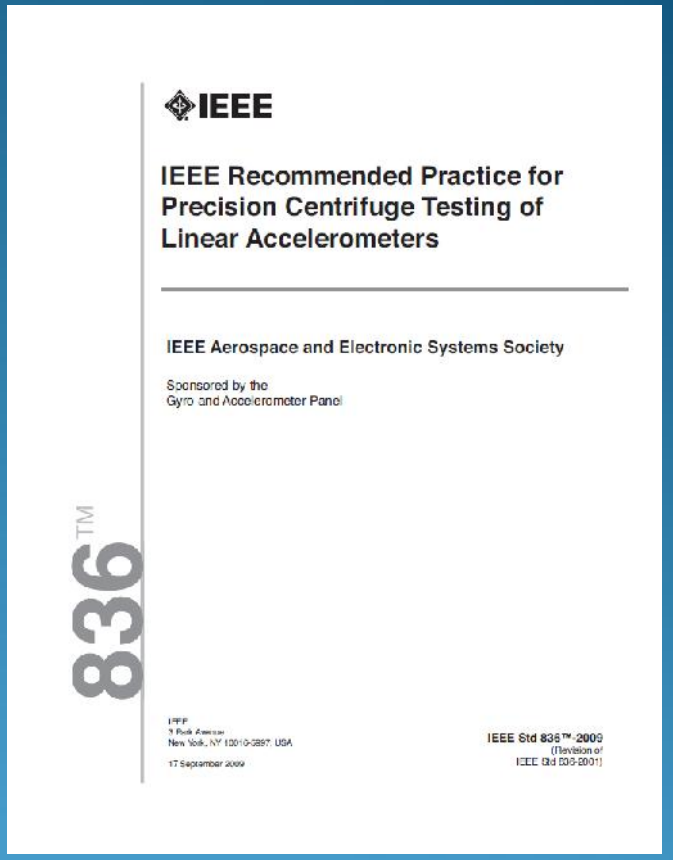
IEEE Std 1559

- Standard for Inertial Systems Terminology
  - 262 definitions, acronyms, abbreviations, and synonyms
  - Companion to IEEE Std 528 " IEEE Standard for Inertial Sensor Terminology"
- Published in 2009
- Alphabetical order
- Cross linked definitions
- Purpose
  - Compile and standardize terminology used in the development, manufacture, test, and use of inertial systems
  - Serve as a basic reference for producers and users of inertial systems



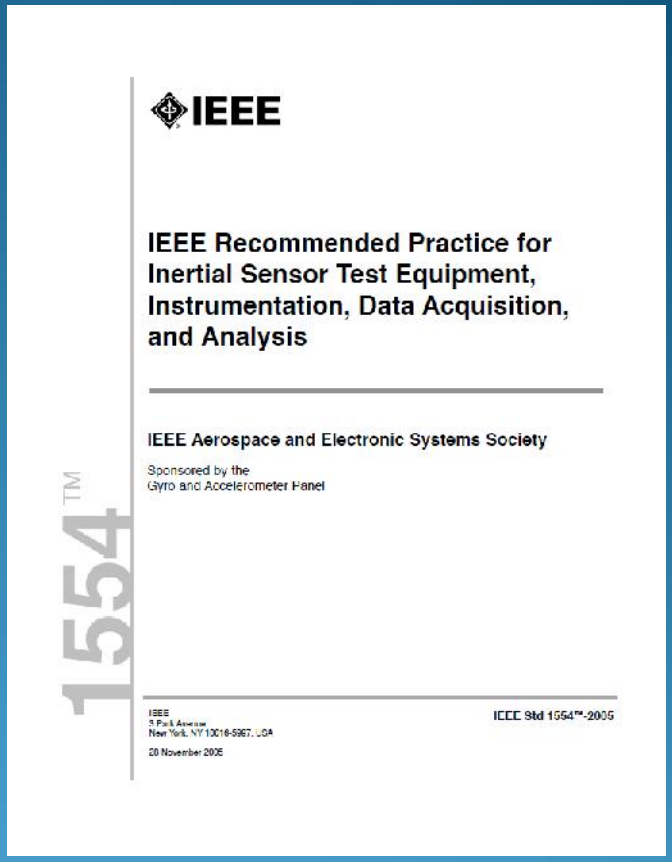
IEEE Std 836

- Recommended Practice for Precision Centrifuge Testing of Linear Accelerometers
- Published in 2009
- Addresses possible error sources
- Provides guidance for each phase of the testing
  - Beginning with planning
  - Ending with typical methods of data analysis
- Provides a detailed understanding of the various factors affecting accuracy of measurement
  - Those associated with the centrifuge
  - Those associated with the data collection process



IEEE Std 1554

- Recommended practice for carrying out gyro and accelerometer tests
- Published in 2005
- Inertial sensor test equipment
  - Fixtures, test tables, centrifuges, environmental chambers, and radiation test facilities
- General and inertial sensor specific electronics
  - Continuous counters, phase-locked loops, voltage-to-frequency converters, voltmeters and A/D converters, etc.
- Data acquisition computers and software
  - Including real-time digital filtering and automatic test equipment
- Data analysis techniques
  - Graphical, least squares, power spectral density (PSD), Allan variance



IMU Standard (In-Work)

- Scope
  - Provide guidelines for the preparation of an IMU specification document
- Purpose
  - Provide the specifications, typical units, format and terminology for manufacturers and users to specify inertial measurement units (IMU) in a manner that provides a common meeting ground
  - Allows each user to select which specifications are relevant to their particular application
  - The terminology is that which is commonly used by the inertial navigation community
- Need
  - To standardize both manufacturer and user specifications for inertial measurement units (IMU)
  - Establish common ground will be between manufacturers and users such that there will be no misunderstanding as to the meaning of a specified capability or performance requirement

Why Support the GAP?

Company Benefits

- Opportunity to influence the Inertial Community
- Opportunity to influence inertial standards
  - Ensure standard is compliant with your product or needs
  - Ensure that a standard is not adopted without your input
  - Ensure common terminology and practices so a user knows what they are getting
- Opportunity to know why a standard is the way it is and the context of it
  - Allows you to extrapolate
  - Allows you to apply the standard to another application
- Opportunity to enhance company image amongst the Inertial Community
- Opportunity to interact with customers to understand their needs
- Opportunity to promote new technologies

The GAP provides a non-threatening environment where a company's intellectual property is protected by focusing on common practices

Personnel Development

- Opportunity for employees to be in a leadership role
- Opportunity for employees to learn how to write inertial specifications
- Opportunity for employees to learn common terminology and practices
- Opportunity for employees to stay current with technology
- Opportunity for employees to interact with others that have different expertise levels and skill sets
- Opportunity for employees to learn how to negotiate
  - Reach mutual agreement
  - Develop character
  - Resolve conflict

The GAP provides opportunities for employees to learn and grow professionally

Personal Benefits

- Opportunity to be productive and give back to the Inertial Community
- Opportunity for Camaraderie
  - Change of pace
  - Interact with others in the inertial community
- Opportunity to get your name in the standards
- Opportunity to enhance your recognition and visibility in the inertial community
- Opportunity to distinguish yourself from your coworkers
- Opportunity for a leadership role
- Opportunity for exposure to a wide range of inertial technologies
- Opportunity to visit other inertial community organizations

The GAP provides opportunities for a wide range of personal benefits

GAP Website

- Public Page (http://ieee.grouper.org/groups/gap)
  - Charter
  - Bylaws
  - Objectives
  - Membership application form
  - Elected officers
  - Scheduled meetings
- Private Page (password protected)
  - Meeting Minutes
  - Drafts of standards
  - Membership lists