



**Terms and symbols for flight dynamics —
Part I : aircraft motion relative to the air**

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FOREWORD

ISO (the International Organization for Standardization) is a worldwide federation of national standards institutes (ISO Member Bodies). The work of developing International Standards is carried out through ISO Technical Committees. Every Member Body interested in a subject for which a Technical Committee has been set up has the right to be represented on that Committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work.

Draft International Standards adopted by the Technical Committees are circulated to the Member Bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 1151 (originally draft No. 2117) was drawn up by Technical Committee ISO/TC 20, *Aircraft and space vehicles*.

It was approved in April 1971 by the Member Bodies of the following countries :

Austria	Greece	South Africa, Rep. of
Belgium	Israel	Spain
Czechoslovakia	Italy	Thailand
Egypt, Arab Rep. of	Japan	Turkey
France	Netherlands	United Kingdom
Germany	New Zealand	U.S.S.R.

No Member Body expressed disapproval of the document.

This International Standard cancels and replaces ISO Recommendation R1151-1969.

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International Standard ISO 1151, *Terms and symbols for flight dynamics — Part I : Aircraft motion relative to the air*, is the first in a series of International Standards, the purpose of which is to define the principal terms used in flight dynamics and to specify symbols for these terms.

Other International Standards in this series, which will be further extended in the future, are at present as follows :

ISO 1152, *Terms and symbols for flight dynamics — Part II : Motions of the aircraft and the atmosphere relative to the Earth*.¹⁾

ISO 1153, *Terms and symbols for flight dynamics — Part III : Derivatives of forces, moments and their coefficients*.

ISO 2764, *Terms and symbols for flight dynamics — Part IV : Parameters used in the study of aircraft stability and control*.²⁾

ISO 2765, *Terms and symbols for flight dynamics — Part V : Quantities used in measurements*.²⁾

In these International Standards, the term "aircraft" denotes an aerodyne having a fore-and-aft plane of symmetry. This plane is determined by the geometrical characteristics of the aircraft. When there are more than one fore-and-aft planes of symmetry, the reference plane of symmetry is arbitrary and it is necessary to indicate the choice made.

Angles of rotation, angular velocities and moments about any axis are positive clockwise when viewed in the positive direction of the axis.

All the axis systems used are three-dimensional, orthogonal and right-handed, which implies that a clockwise (positive) rotation through $\pi/2$ about the x-axis brings the y-axis into the position previously occupied by the z-axis.

Numbering of sections and clauses

Each of these International Standards represents a part of the whole study on terms and symbols for flight dynamics.

To permit easier reference to a section or a clause from one part to another, a decimal numbering has been adopted which begins in each International Standard with the number of the part it represents.

1) In course of transformation into an International Standard. (At present, ISO/R 1152.)

2) At present at the stage of draft.

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Terms and symbols for flight dynamics — Part I : aircraft motion relative to the air

1.0 INTRODUCTION

This International Standard deals with the motion of the aircraft in an atmosphere at rest or in uniform motion.

To fully account for the effects of aeroelasticity and of the Earth's curvature would necessitate more detailed consideration of certain aspects of the definitions given, although these have been framed in such a way that they can be more generally interpreted. The definitions of the axes apply as they stand when the Earth's surface is treated as a plane, that is, when the Earth's radius is taken as infinite, and, in the case of the body axes, when the aircraft is treated as rigid.

1.1 AXIS SYSTEMS

No.	Term	Definition	Symbol
1.1.1	Earth-fixed axis system	A system with both origin O_0 and axes fixed with respect to the Earth, chosen to suit the problem.	x_0, y_0, z_0
1.1.2	Normal earth-fixed axis system	An earth-fixed axis system (1.1.1) in which the z_0 -axis is vertically downward.	x_0, y_0, z_0 but x_g, y_g, z_g is an accepted alternative.
1.1.3	Aircraft-carried earth axis system	A system in which each axis has the same direction as the corresponding earth-fixed axis, with origin O , fixed in the aircraft, usually at the centre of gravity.	x_0, y_0, z_0
1.1.4	Aircraft-carried normal earth axis system	A system in which each axis has the same direction as the corresponding normal earth-fixed axis, with origin O , fixed in the aircraft, usually at the centre of gravity.	x_0, y_0, z_0 but x_g, y_g, z_g is an accepted alternative.
1.1.5	Body axis system	Axis system fixed in the aircraft with origin O , usually the centre of gravity, containing the longitudinal axis, the transverse axis and the normal axis according to the following definitions :	x, y, z
	Longitudinal axis	An axis in the plane of symmetry or, if the origin lies outside this, in a parallel plane through the origin, and in some suitable forward direction.	x
	Transverse axis	An axis normal to the plane of symmetry, and positive to starboard.	y
	Normal axis	An axis in the plane of symmetry or, if the origin lies outside this, in the parallel plane through the origin, normal to the longitudinal axis, positive in the ventral sense (when viewed from the origin O).	z
1.1.6	Air-path axis system	Axis system with aircraft fixed origin O , usually the centre of gravity, and containing the following axes :	x_a, y_a, z_a
	x_a -axis (air-path axis)	An axis in the direction of the aircraft velocity (1.3.1).	x_a
	y_a -axis	An axis normal to the air-path axis and the z_a -axis defined below. It is positive to starboard.	y_a
	z_a -axis	An axis in the plane of symmetry, or, if the origin lies outside this, in the parallel plane through the origin and normal to the air-path axis. In normal flight conditions it is therefore ventral (when viewed from the origin O).	z_a

1.2 ANGLES

Orientation of the aircraft velocity with respect to the body axis system (see Figure 1).

No.	Term	Definition	Symbol
1.2.1	Angle of sideslip	The angle that the aircraft velocity (1.3.1) makes with the plane of symmetry of the aircraft. It is positive when the aircraft velocity component along the transverse axis (1.1.5) is positive. It has by convention the range $-\frac{\pi}{2} \leq \beta \leq \frac{\pi}{2}$	β
1.2.2	Angle of attack	The angle between the longitudinal axis (1.1.5) and the projection of the aircraft velocity (1.3.1) on the plane of symmetry. It is positive when the aircraft velocity component along the normal axis (1.1.5) is positive. It has by convention the range $-\pi < \alpha \leq \pi$	α

Transition from the aircraft-carried normal earth axis system to the body axis system is effected by the rotations Ψ, θ, ϕ defined below, taken in that order (see Figure 2).

NOTE — Analogous angles can be defined with respect to any aircraft-carried earth axis system. The same symbols Ψ, θ, ϕ , with appropriate suffixes as necessary, may then be used. On the other hand, the terms azimuth angle, inclination angle and bank angle refer only to the special case where the z_o -axis is vertical.

No.	Term	Definition	Symbol
1.2.3	Azimuth angle	The rotation (positive if clockwise) about the z_o (z_g)-axis which brings the x_o (x_g)-axis into coincidence with the projection of the longitudinal axis (1.1.5) on the horizontal plane through the origin O .	Ψ
1.2.4	Inclination angle (elevation)	The rotation in a vertical plane, following the rotation Ψ (1.2.3) and which brings the displaced x_o (x_g)-axis into coincidence with the longitudinal axis (1.1.5). It is positive when the x -axis lies above the horizontal plane through the origin O . It has by convention the range $-\frac{\pi}{2} \leq \theta \leq \frac{\pi}{2}$	θ
1.2.5	Bank angle	The rotation (positive if clockwise) about the longitudinal axis (1.1.5) which brings the displaced y_o (y_g)-axis into its final position y from the position it reached after rotation through Ψ (1.2.3).	ϕ

Transition from the aircraft-carried normal earth axis system to the air-path axis system is effected by the rotations χ_a , γ_a and μ_a defined below, taken in that order (see Figure 3).

No.	Term	Definition	Symbol
1.2.6	Air-path azimuth angle (air-path track angle)	The rotation (positive if clockwise) about the z_o (z_g)-axis which brings the x_o (x_g)-axis into coincidence with the projection of the air-path x_a -axis (1.1.6) on the horizontal plane through the origin O .	χ_a
1.2.7	Air-path inclination angle (air-path climb angle)	The rotation in a vertical plane, following the rotation χ_a (1.2.6) which brings the displaced x_o (x_g)-axis into coincidence with the air-path x_a -axis (1.1.6). It is positive when the x_a -axis lies above the horizontal plane through the origin O . It has by convention the range $-\frac{\pi}{2} \leq \gamma_a \leq \frac{\pi}{2}$	γ_a
1.2.8	Air-path bank angle	The rotation (positive if clockwise) about the air-path x_a -axis (1.1.6) which brings the displaced y_o (y_g)-axis into its final position y_a from the position it reached after rotation through χ_a (1.2.6).	μ_a

1.3 VELOCITIES AND ANGULAR VELOCITIES

No.	Term	Definition	Symbol
1.3.1	Aircraft velocity	The velocity of the origin O of the body axis system (1.1.5) (usually the centre of gravity) relative to the air unaffected by the aerodynamic field of the aircraft. The corresponding scalar quantity is the airspeed.	$\vec{V} (V)$
1.3.2	Speed of sound	The velocity of propagation of a sound wave in the ambient air unaffected by the aerodynamic field of the aircraft.	a
1.3.3	Mach number	The ratio of the airspeed (1.3.1) to the speed of sound (1.3.2). Equal to V/a	M is recommended. However the symbols Ma and $\mathcal{M}$ may be used if otherwise there would be a possibility of confusion.