3 Terms, definitions, symbols, and abbreviations

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at https://www.iso.org/obp
- IEC Electropedia: available at https://www.electropedia.org

Terms defined in the body of this International Standard are presented in italics at the point where they are defined. The Index of defined terms and concepts provides a directory of those terms.

3.1.1
Earth gravitational model
spherical harmonic expansion of the gravitational field potential

Note 1 to entry: Gravity includes rotational effects; however, such rotational effects are not included in this model.

3.1.2
ecliptic plane
plane defined by the orbit of a planet at a point in time

3.1.3
equatorial plane
plane through a designated centre of an object and perpendicular to the rotational axis of the object

3.1.4
geodetic datum
datum describing the relationship of a coordinate system to the Earth
[ISO 19111]

Note 1 to entry: In most cases, the geodetic datum includes an ellipsoid definition.

3.1.5
north pole
that pole of rotation that lies on the north side of the invariable plane of the solar system
[RIIC15]

Note 1 to entry: Some planets have retrograde rotation with respect to this definition.

Note 2 to entry: Map north (see 5.3.7.1) may be unrelated to this direction.

Note 3 to entry: The north side of the invariable plane of the solar system is the side facing in the direction of Polaris.

3.1.6
replete set
a connected subset of a Euclidean space with non-empty interior is replete if all of its points belong to either its interior or to the topological closure of its interior

Note 1 to entry: A replete set is a generalization of an open set that allows the inclusion of boundary points. Boundary points are important in the definitions of certain coordinate systems.

3.1.7
spatial object
physical or virtual object to which spatial information applies

3.1.8
spatial operation
mathematical function that re-expresses coordinates, directions, and/or orientations expressed in one spatial reference frame in terms of a different spatial reference frame; or mathematical function for distance or other geometric quantities within a single spatial reference frame

3.2 Notation, symbols and abbreviations

In this International Standard, dates that are included in an element of a concept instance specification shall conform to the notation and formats of ISO 8601.

Table 3.1 lists mathematical notation conventions commonly used in this document.

Table 3.1 — Mathematical notation

Style	Use	Examples
lower case, bold, italic	points, vectors	$\boldsymbol{x}, \boldsymbol{p}$
lower case, italic	variables, scalars, scalar-valued functions, axes of a linear coordinate system	a, b, f, x-axis
upper case, bold, italic	vector-valued functions, matrices, orthogonal frames	$\boldsymbol{F}, \boldsymbol{G}, \boldsymbol{M}$
upper case, italic	sets	S, T

Upper case italic letter symbols are also used for scalar-valued functions that are customarily capitalized.

Table 3.2 lists symbols commonly used throughout this document. Additional symbols used only in individual clauses are defined within those individual clauses.

Table 3.2 — Symbols

Symbol	Definition
SRF_S	source spatial reference frame
SRF_T	target spatial reference frame
ORM_S	object reference model of SRF_S
ORM_R	reference ORM for a given spatial object
CS_S	spatial coordinate system of SRF_S
$\mathbf{0}$	origin of an orthonormal frame
a	major semi-axis length of an oblate ellipsoid
b	minor semi-axis length of an oblate ellipsoid
$\boldsymbol{C}_i[\boldsymbol{G}]( )$	i-th coordinate-component curve at a point
$\boldsymbol{c}_S$	coordinate of a position in SRF_S
$d_E( )$	Euclidean distance function

Symbol	Definition
$d_G(\ )$	geodesic distance function
E	computational error
$\boldsymbol{E}$	embedded orthonormal frame
E_S	extended region of SRF_S
$\boldsymbol{E}(\ )$	embedding function
$(\boldsymbol{e_1}, \boldsymbol{e_2}, \boldsymbol{e_3})$	set of Cartesian basis vectors of an orthonormal frame
(e_0, e_1, e_2, e_3)	quaternion in 4-tuple form
$(e_0, \boldsymbol{e})$	quaternion in scalar vector form
f	flattening of an oblate ellipsoid
$\boldsymbol{G}$	generating function of a coordinate system
$\boldsymbol{G}_L$	generating function of a localized coordinate system
$\boldsymbol{G}_S$	spatial generating function of CS_S
$Dom(\boldsymbol{G}_S)$	domain of the generating function $\boldsymbol{G}_S$
$Rng(\boldsymbol{G}_S)$	range of the generating function $\boldsymbol{G}_S$
$\boldsymbol{H}_{F\leftarrow E}$	similarity transformation from frame $\boldsymbol{E}$ to frame $\boldsymbol{F}$
h	ellipsoidal height
h_0	ellipsoidal height at the CS origin
h_e	elevation with respect to the geoid
h_o	orthometric height
$\boldsymbol{I}$	identity matrix (or operator)
$\boldsymbol{I}_{F\leftarrow E}$	identity transformation from frame $\boldsymbol{E}$ to frame $\boldsymbol{F}$
k_0	central scale
k_{scaled}	point scale
k, m, n	number of dimensions, $1 \le k, m, n \le 3$
$k(\ )$	point distortion function
$\boldsymbol{L}$	localized orthonormal frame
$\boldsymbol{L}_{3D}$	localization operator (3D)
$\boldsymbol{M}_{F\leftarrow E}$	rotation matrix from frame $\boldsymbol{E}$ to frame $\boldsymbol{F}$
$\mathcal{M}(\varphi)$	radius of curvature in the meridian at latitude φ
$\mathcal{N}(\varphi)$	radius of curvature in the prime vertical at latitude φ
$\boldsymbol{n}_S$	direction vector in SRF_S
(n_1, n_2, n_3, θ)	rotation representation in terms of axis unit vector components and rotation angle
$\boldsymbol{O_E}$	origin of the embedded orthonormal frame $\boldsymbol{E}$
$\overrightarrow{\boldsymbol{O_E O_F}}$	vector from the origin of frame $\boldsymbol{E}$ to the origin of frame $\boldsymbol{F}$
$\overrightarrow{\boldsymbol{O_E p}}$	vector from the origin of frame $\boldsymbol{E}$ to the position $\boldsymbol{p}$

Symbol	Definition
$\boldsymbol{P}$	generating projection
$\boldsymbol{P}_{\mathrm{S}}$	mapping equations for SRFs
$\boldsymbol{p}, \widetilde{\boldsymbol{p}}$	position vector
$\boldsymbol{p}_{\boldsymbol{E}}$	coordinate of position $\boldsymbol{p}$ expressed in terms of frame $\boldsymbol{E}$
$\left(p_x, p_y, p_z\right)_{\boldsymbol{E}}$	Coordinate-components of position $\boldsymbol{p}$ in terms of frame $\boldsymbol{E}$
$\boldsymbol{Q}$	inverse generating projection
$\boldsymbol{Q}_{\mathrm{S}}$	inverse mapping equations for SRFs
$\boldsymbol{q}, \boldsymbol{r}, \boldsymbol{s}, \boldsymbol{t}$	localization parameters
$\boldsymbol{R}$	rotation operator
$\mathbb{R}^{\boldsymbol{m}}$	vector space of m-tuples
$\boldsymbol{R}_{\boldsymbol{n}}\langle\theta\rangle$	rotation through angle θ about the axis $\boldsymbol{n}$
$[\boldsymbol{R}_{\boldsymbol{n}}\langle\theta\rangle]$	matrix representation of rotation operator $\boldsymbol{R}_{\boldsymbol{n}}\langle\theta\rangle$
$\boldsymbol{R}_{\boldsymbol{n},\boldsymbol{t}}\langle\theta\rangle$	non-origin-fixed rotation through angle θ about the directed axis $\{\boldsymbol{t}+\alpha\boldsymbol{n} \mid \alpha \in \mathbb{R}\}$ passing through the position vector $\boldsymbol{t}$ and parallel to the unit vector $\boldsymbol{n}$
$\boldsymbol{R}_{\boldsymbol{E}\rightarrow\boldsymbol{F}}$	orientation of frame $\boldsymbol{F}$ with respect to frame $\boldsymbol{E}$
$\boldsymbol{S}_i[\boldsymbol{G}]( )$	i-th coordinate-component surface at a point
$\boldsymbol{\mathcal{S}}(\varphi)$	meridional distance from latitude φ to the equator (see Table 5.6)
u_{F}	false easting
$[u, v]^{\mathrm{T}}$	2D position vector components
$[u, v, w]^{\mathrm{T}}$	3D position vector components
V_{S}	applicable region of SRFs
v_{F}	false northing
$\boldsymbol{v}_{\mathrm{S}}$	vector quantity in SRFs
$v( )$	vertical offset at a position
$\boldsymbol{W}$	world 3x3 transformation matrix
$[x, y]^{\mathrm{T}}$	2D position vector components
(x, y, z)	Cartesian coordinate tuple
$[x, y, z]^{\mathrm{T}}$	3D position vector components
$[x, y, z]_{\boldsymbol{E}}^{\mathrm{T}}$	3D position vector components with respect to the basis of frame $\boldsymbol{E}$
$\boldsymbol{x}$-$\boldsymbol{y}$-$\boldsymbol{z}$	Euler angle convention for sequence of body-fixed principal axis rotations
α	geodetic azimuth
α_0	geodetic azimuth of the secondary axis relative to local north
(α, ρ)	azimuthal coordinate tuple
(α, ρ, h)	azimuthal cylindrical coordinate tuple
(α, ρ, θ)	azimuthal spherical coordinate tuple

Symbol	Definition
γ	convergence of the meridian
Δs	scale difference from unity
$[\Delta x, \Delta y, \Delta z]^{\top}$	origin displacement vector components
$\vec{\Delta}_{F \leftarrow E}$	origin displacement vector from frame $\boldsymbol{E}$ to frame $\boldsymbol{F}$
ε	(first) eccentricity of an oblate ellipsoid
ε'	second eccentricity of an oblate ellipsoid
ε_{D}	directional error bound
ε_{P}	positional error bound
ε_{R}	ratio error bound
θ	spherical latitude, depression/elevation, cylindrical, polar, or rotation angle
$\Lambda_C(\lambda, \lambda_C)$	longitudinal centring function
λ	geodetic or planetodetic longitude
$\lambda_{\mathrm{origin}}$	origin longitude
(λ, φ)	surface geodetic coordinate tuple
(λ, θ, ρ)	equatorial spherical coordinate tuple
(λ, φ, h)	geodetic coordinate tuple
ρ	radius or range
(ρ, θ)	polar coordinate tuple
(ρ, θ, h)	cylindrical coordinate tuple
φ	geodetic latitude
$\varphi_{\mathrm{origin}}$	origin latitude
(φ, λ)	surface planetodetic coordinate tuple
(φ, λ, h)	planetodetic coordinate tuple
σ	scale factor, map scale
$\sigma_{F \leftarrow E}$	scale factor from frame $\boldsymbol{E}$ to frame $\boldsymbol{F}$
ω_i	i-th principal axis angle of rotation
$\boldsymbol{\Omega}_{F \leftarrow E}$	change of basis operator from frame $\boldsymbol{E}$ to frame $\boldsymbol{F}$
$[\boldsymbol{\Omega}_{\boldsymbol{E} \leftarrow \boldsymbol{F}}]$	matrix representation of change of basis operator $\boldsymbol{\Omega}_{F \leftarrow E}$

A shortened form of a word or phrase is commonly referred to as an abbreviation, an acronym, or an initialism. In this International Standard, all of these are collectively termed abbreviations. Table 3.3 lists the abbreviations used in this document, with two exceptions. Abbreviations used in the API (Clause 11) in the formation of enumerant and record data type element names are listed in Table 11.1. Abbreviations used in the construction of labels (see 13.2.2) are listed in Table F.1.

In the specification of an abbreviation, the letters in the word or phrase used to form the abbreviation are underlined.

Table 3.3 — Abbreviations

Abbreviation	Word or phrase
1D	one-Dimensional
2D	two-Dimensional
3D	three-Dimensional
AFWA	Air Force Weather Agency
API	Application Program Interface
BIPM	Bureau International des Poids et Mesures (International Bureau of Weights and Measures)
CAD/CAM	Computer-Aided Design/Computer-Aided Manufacturing
CFR	Coordinate Frame Rotation
CH1903	CH 1903 ("CH" is the ISO 3166-1 country code for Switzerland)
CS	Coordinate System
COAMPS	Coupled Ocean/Atmospheric Mesoscale Prediction System
COM	Convergence of the Meridian
D73	Datum 1973
DHDN	Deutschen Hauptdreiecksnetzes
DOS	Directorate of Overseas Surveys
DRAM	Dynamic Random Access Memory
DSS	Designated Spatial Surface
E	East
ENU	East-North-Up
ERM	Earth Reference Model
ESA	European Space Agency
ETRF	European Terrestrial Reference Frame
ETRS89	European Terrestrial Reference System 1989
FRG	Federal Republic of Germany
GCS	Global Coordinate System
GDA	Geocentric Datum of Australia
GGRS	Greek Geodetic Reference System
GPS	Global Positioning System
GRS	Geodetic Reference System
GTRS	Geo Tile Reference System
IAG	International Association of Geodesy
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers

Abbreviation	Word or phrase
IERS	International Earth Rotation and Reference Systems Service
IGLD	International Great Lakes Datum
IGN	Institut Géographique National (France)
IGRF	International Geomagnetic Reference Field
ISO	International Organization for Standardization
JTC	Joint Technical Committee
KKJ	Kartastokoordinaattijarjestelma
MGI	Militärgeographisches Institut
MM5	Mesoscale (weather) Model 5
MODTRAN	Moderate resolution Transmittance (atmospheric radiation transfer)
MP	Map Projection
MSL	Mean Sea Level
N	North
NASA	National Aeronautics and Space Administration
NAVD	North American Vertical Datum
NED	North-East-Down
NGO	Norges Geografiske Oppmåling
NOGAPS	Navy Operational Global Atmospheric Prediction System (United States)
NT	unknown
NTF	Nouvelle Triangulation Français (France)
OBRS	Object Binding Rule Set
ORM	Object Reference Model
ORMT	Object Reference Model Template
OSGM	Ordinance Survey Geoid Model
PVR	Position Vector Rotation
RD	Reference Datum
RT	Reference Transformation
RT90	Rikets Triangelnät 1990
S	South
S-JTSK	System - Jednotné Trigonometrické Síti Katastrální (Czechoslovakia)
SI	Système International d'unités (International System of Units)
SIRGAS	Sistema de Referencia Geocéntrico para las Américas (The Americas)
SO(3)	Special Orthogonal Group of degree 3
SRF	Spatial Reference Frame
SRFT	Spatial Reference Frame Template

Abbreviation	Word or phrase
SRM	Spatial Reference Model
SSM	SRF Set Member
STT	Similarity Transformation Template
TAI	Temps Atomique International (International Atomic Time)
UK	United Kingdom
UPS	Universal Polar Stereographic
US	United States
USGS	United States Geological Survey
UT0	Universal Time observed
UT1	Universal Time polar motion corrected
UT2	Universal Time Earth rotation corrected
UTC	Coordinated Universal Time
UTM	Universal Transverse Mercator
VOS	Vertical Offset Surface
W	West
WGS	World Geodetic System
WMM	World Magnetic Model