INTERNATIONAL STANDARD

# ISO 19162

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# Geographic information — Well-known text representation of coordinate reference systems

*Information géographique — Représentation textuelle bien lisible de systèmes de référence par coordonnées*



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# Foreword

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The committee responsible for this document is ISO/TC 211, jointly with the Open Geospatial Consortium (OGC).

# Introduction

Well-known Text (WKT) offers a compact machine- and human-readable representation of geometric objects. WKT may also be used for succinctly describing the critical elements of coordinate reference system (CRS) definitions.

WKT was described in the Open Geospatial Consortium implementation specifications 99-036 through 06-103r4 and International Standard ISO 19125-1:2004, “Geographic information – Simple feature access – Part 1: Common architecture”. The WKT representation of coordinate reference systems was subsequently extended in Open Geospatial Consortium implementation specification 01-009 "Coordinate Transformation Services" and this extension was later adopted in the Open Geospatial Consortium GeoAPI 3.0 implementation standard 09-083r3 and GeoPackage 1.0 implementation standard 12-128r10. The WKT representation of coordinate reference systems as defined in ISO 19125-1:2004 and OGC specification 01-009 is inconsistent with the terminology and technical provisions of ISO 19111:2007 and OGC Abstract Specification topic 2 (08-015r2), “Geographic information – Spatial referencing by coordinates”.

This International Standard provides an updated version of WKT representation of coordinate reference systems that follows the provisions of ISO 19111:2007 and ISO 19111-2:2009. It extends earlier WKT to allow for the description of coordinate operations. This International Standard defines the structure and content of well-known text strings. It does not prescribe how implementations should read or write these strings.



 

# Geographic information — Well-known text representation of coordinate reference systems

## 1 Scope

This International Standard defines the structure and content of a text string implementation of the abstract model for coordinate reference systems described in ISO 19111:2007 and ISO 19111-2:2009. The string defines frequently needed types of coordinate reference systems and coordinate operations in a self-contained form that is easily readable by machines and by humans. The essence is its simplicity; as a consequence there are some constraints upon the more open content allowed in ISO 19111:2007. To retain simplicity in the well-known text (WKT) description of coordinate reference systems and coordinate operations, the scope of this International Standard excludes parameter grouping and pass-through coordinate operations. The text string provides a means for humans and machines to correctly and unambiguously interpret and utilise a coordinate reference system definition with look-ups or cross references only to define coordinate operation mathematics. Because it omits metadata about the source of the data and may omit metadata about the applicability of the information, the WKT string is not suitable for the storage of definitions of coordinate reference systems or coordinate operations.



## 2 Conformance requirements



This International Standard defines eleven classes of conformance (see Annex A) in three groups:

1) Any WKT string claiming conformance of coordinate reference system definition shall satisfy the requirements in Annex A as shown in Table 1.

**Table 1 — Conformance requirements for coordinate reference systems**

| Coordinate reference system type | Conformance requirements given in |
|---|---|
| geodetic | A.1 |
| projected | A.2 |
| vertical | A.3 |
| engineering | A.4 |
| image | A.5 |
| parametric | A.6 |
| temporal | A.7 |
| derived geodetic<br>derived vertical<br>derived engineering<br>derived parametric<br>derived temporal | A.8 |
| compound | A.9 |

2) Any WKT string claiming conformance of coordinate operation definition shall satisfy the requirements given in A.10.

3) Any WKT string claiming conformance of coordinate transformation bound to a coordinate reference system definition shall satisfy the requirements given in A.11.

Conformance is applicable to the WKT string. Recommended practices for implementations writing or reading coordinate reference system WKT strings are given in Annex B.

## 3 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 8601:2004, *Data elements and interchange formats — Information interchange — Representation of dates and times*

ISO/IEC 9075-1:2011, *Information technology — Database languages — SQL — Part 1: Framework (SQL/Framework)*

ISO/IEC 9075-2:2011, *Information technology — Database languages — SQL — Part 2: Foundation (SQL/Foundation)*



ISO/IEC 10646:2012, *Information technology — Universal Coded Character Set (UCS)*

ISO 19111:2007, *Geographic information — Spatial referencing by coordinates*



ISO 19111-2:2009, *Geographic information — Spatial referencing by coordinates — Part 2: Extension for parametric values*

## 4 Definitions and abbreviations

### 4.1 Definitions

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

**4.1.1**
**affine coordinate system**
*coordinate system* (4.1.8) in Euclidean space with straight axes that are not necessarily mutually perpendicular

[SOURCE: ISO 19111:2007, 4.1]

**4.1.2**
**bearing**
horizontal angle at a point relative to a specified direction

Note 1 to entry: The direction is usually specified to be north. In some communities the term bearing refers specifically to grid north and directions relative to true north are then termed ‘azimuth’; in other communities a bearing refers specifically to true north. In this International Standard bearing is used for any specified reference direction. The angle may be reckoned positive clockwise or positive counter-clockwise depending upon the application.

 

**4.1.3**
**Cartesian coordinate system**
*coordinate system* (4.1.8) which gives the position of points relative to n mutually perpendicular axes that each has zero curvature

Note 1 to entry: *n* is 2 or 3 for the purposes of this International Standard.

**4.1.4**
**compound coordinate reference system**
*coordinate reference system* (4.1.7) using at least two independent coordinate reference systems

Note 1 to entry: Coordinate reference systems are independent of each other if coordinate values in one cannot be converted or transformed into coordinate values in the other.

[SOURCE: ISO 19111:2007, 4.3]

**4.1.5**
**coordinate conversion**
*coordinate operation* (4.1.6) in which both *coordinate reference systems* (4.1.7) are based on the same *datum* (4.1.11)

EXAMPLE Conversion from an ellipsoidal coordinate reference system based on the WGS 84 datum to a Cartesian coordinate reference system also based on the WGS 84 datum, or change of units such as from radians to degrees or feet to metres.

Note 1 to entry: A coordinate conversion uses parameters which have specified values that are not determined empirically.



[SOURCE: ISO 19111:2007, 4.6]



**4.1.6**
**coordinate operation**
change of coordinates, based on a one-to-one relationship from one *coordinate reference system* (4.1.7) to another

Note 1 to entry: Supertype of *coordinate transformation* (4.1.9) and *coordinate conversion* (4.1.5).

[SOURCE: ISO 19111:2007, 4.7]

**4.1.7**
**coordinate reference system**
*coordinate system* (4.1.8) that is related to an object by a *datum* (4.1.11)

Note 1 to entry: For *geodetic* and *vertical datums* (4.1.19, 4.1.39), the object will be the Earth.

[SOURCE: ISO 19111:2007, 4.8]

**4.1.8**
**coordinate system**
set of mathematical rules for specifying how coordinates are to be assigned to points

[SOURCE: ISO 19111:2007, 4.10]

**4.1.9**
**coordinate transformation**
*coordinate operation* (4.1.6) in which the two *coordinate reference systems* (4.1.7) are based on different *datums* (4.1.11)

Note 1 to entry: A coordinate transformation uses parameters which are derived empirically by a set of points with known coordinates in both coordinate reference systems.

[SOURCE: ISO 19111:2007, 4.11]

**4.1.10**
**cylindrical coordinate system**
three-dimensional *coordinate system* (4.1.8) with two distance and one angular coordinates

[SOURCE: ISO 19111:2007, 4.13]

**4.1.11**
**datum**
parameter or set of parameters that define the position of the origin, the scale, and the orientation of a *coordinate system* (4.1.8)

[SOURCE: ISO 19111:2007, 4.14]

**4.1.12**
**ellipsoid**
surface formed by the rotation of an ellipse about a main axis

Note 1 to entry: In this International Standard, ellipsoids are always oblate, meaning that the axis of rotation is always the minor axis.

[SOURCE: ISO 19111:2007, 4.17]



**4.1.13**
**ellipsoidal coordinate system**
geodetic coordinate system
*coordinate system* (4.1.8) in which position is specified by *geodetic latitude* (4.1.20), *geodetic longitude* (4.1.21) and (in the three-dimensional case) *ellipsoidal height* (4.1.14)



[SOURCE: ISO 19111:2007, 4.18]

**4.1.14**
**ellipsoidal height**
geodetic height
*h*
distance of a point from the *ellipsoid* (4.1.12) measured along the perpendicular from the ellipsoid to this point, positive if upwards or outside of the ellipsoid

Note 1 to entry: Only used as part of a three-dimensional *ellipsoidal coordinate system* (4.1.13) and never on its own.

[SOURCE: ISO 19111:2007, 4.19]

**4.1.15**
**engineering coordinate reference system**
*coordinate reference system* (4.1.7) based on an *engineering datum* (4.1.16)

EXAMPLES Local engineering and architectural grids; coordinate reference system local to a ship or an orbiting spacecraft.

[SOURCE: ISO 19111:2007, 4.20]

**4.1.16**
**engineering datum**
local datum
*datum* (4.1.11) describing the relationship of *a coordinate system* (4.1.8) to a local reference

 

Note 1 to entry: Engineering datum excludes both *geodetic* and *vertical datums* (4.1.19, 4.1.39).

EXAMPLE A system for identifying relative positions within a few kilometres of the reference point.

[SOURCE: ISO 19111:2007, 4.21]

**4.1.17**
**flattening**
*f*
ratio of the difference between the *semi-major axis* (*a*) (4.1.32) and *semi-minor axis* (*b*) (4.1.33) of an *ellipsoid* (4.1.12) to the semi-major axis; f = (a – b)/a

Note 1 to entry: Sometimes inverse flattening $1/f = a/(a-b)$ is given instead; $1/f$ is also known as reciprocal flattening.

[SOURCE: ISO 19111:2007, 4.22, modified – The first occurrence of the words “semi-major” have been expanded to “semi-major axis”.]

**4.1.18**
**geodetic coordinate reference system**
*coordinate reference system* (4.1.7) based on a *geodetic datum* (4.1.19)

[SOURCE: ISO 19111:2007, 4.23]

**4.1.19**
**geodetic datum**
*datum* (4.1.11) describing the relationship of a two- or three-dimensional *coordinate system* (4.1.8) to the Earth



[SOURCE: ISO 19111:2007, 4.24]



**4.1.20**
**geodetic latitude**
ellipsoidal latitude
$\varphi$
angle from the equatorial plane to the perpendicular to the *ellipsoid* (4.1.12) through a given point, northwards treated as positive

[SOURCE: ISO 19111:2007, 4.25]

**4.1.21**
**geodetic longitude**
ellipsoidal longitude
$\lambda$
angle from the *prime meridian* (4.1.30) plane to the meridian plane of a given point, eastward treated as positive

[SOURCE: ISO 19111:2007, 4.26]

**4.1.22**
**image coordinate reference system**
*coordinate reference system* (4.1.7) based on an *image datum* (4.1.23)

[SOURCE: ISO 19111:2007, 4.30]

**4.1.23**
**image datum**
*engineering datum* (4.1.16) which defines the relationship of a *coordinate system* (4.1.8) to an image

[SOURCE: ISO 19111:2007, 4.31]

**4.1.24**
**linear coordinate system**
one-dimensional *coordinate system* (4.1.8) in which a linear feature forms the axis

EXAMPLES Distances along a pipeline; depths down a deviated oil well bore.

[SOURCE: ISO 19111:2007, 4.32]

**4.1.25**
**map projection**
*coordinate conversion* (4.1.4) from an *ellipsoidal coordinate system* (4.1.13) to a plane

[SOURCE: ISO 19111:2007, 4.33]

**4.1.26**
**parametric coordinate reference system**
*coordinate reference system* (4.1.7) based on a *parametric datum* (4.1.28)

[SOURCE: ISO 19111-2:2009, 4.2]

**4.1.27**
**parametric coordinate system**
one-dimensional *coordinate system* (4.1.8) where the axis units are parameter values which are not inherently spatial

[SOURCE: ISO 19111-2:2009, 4.1]



**4.1.28**
**parametric datum**
*datum* (4.1.11) describing the relationship of a *parametric coordinate system* (4.1.27) to an object



Note 1 to entry: The object is normally the Earth.

[SOURCE: ISO 19111-2:2009, 4.3]

**4.1.29**
**polar coordinate system**
two-dimensional *coordinate system* (4.1.8) in which position is specified by distance and direction from the origin

Note 1 to entry: For the three-dimensional case, see *spherical coordinate system* (4.1.35).

[SOURCE: ISO 19111:2007, 4.37]

**4.1.30**
**prime meridian**
zero meridian
meridian from which the longitudes of other meridians are quantified

[SOURCE: ISO 19111:2007, 4.38]

**4.1.31**
**projected coordinate reference system**
*coordinate reference system* (4.1.7) derived from a two-dimensional *geodetic coordinate reference system* (4.1.18) by applying a *map projection* (4.1.25)

[SOURCE: ISO 19111:2007, 4.39]

 

**4.1.32**
**semi-major axis**
*a*
semi-diameter of the longest axis of an *ellipsoid* (4.1.12)

Note 1 to entry: This equates to the semi-diameter of the ellipsoid measured in its equatorial plane.

[SOURCE: ISO 19111:2007, 4.40]

**4.1.33**
**semi-minor axis**
*b*
semi-diameter of the shortest axis of an *ellipsoid* (4.1.12)

Note 1 to entry: The shortest axis coincides with the rotation axis of the ellipsoid and therefore contains both poles.

[SOURCE: ISO 19111:2007, 4.41]

**4.1.34**
**spatio-parametric coordinate reference system**
*compound coordinate reference system* (4.1.4) in which one constituent *coordinate reference system* (4.1.7) is a *parametric coordinate reference system* (4.1.26) and one is a spatial coordinate reference system

Note 1 to entry: Normally the spatial component is “horizontal” and the parametric component is “vertical”.

[SOURCE: ISO 19111-2:2009, 4.4]



**4.1.35**
**spherical coordinate system**
three-dimensional *coordinate system* (4.1.8) with one distance measured from the origin and two angular coordinates, commonly associated with a *geodetic coordinate reference system* (4.1.18)



Note 1 to entry: Not to be confused with an *ellipsoidal coordinate system* (4.1.13) based on an *ellipsoid* (4.1.12) ‘degenerated’ into a sphere.

[SOURCE: ISO 19111:2007, 4.44]

**4.1.36**
**spheroid**
closed surface that differs only slightly from that of a sphere

**4.1.37**
**vertical coordinate reference system**
one-dimensional *coordinate reference system* (4.1.7) based on a *vertical datum* (4.1.39)

[SOURCE: ISO 19111:2007, 4.47]

**4.1.38**
**vertical coordinate system**
one-dimensional *coordinate system* (4.1.8) used for gravity-related height or depth measurements

[SOURCE: ISO 19111:2007, 4.48]

**4.1.39**
**vertical datum**
*datum* (4.1.11) describing the relation of gravity-related heights or depths to the Earth

Note 1 to entry: In most cases, the vertical datum will be related to mean sea level. *Ellipsoidal heights* (4.1.14) are treated as related to a three-dimensional *ellipsoidal coordinate system* (4.1.13) referenced to a *geodetic datum* (4.1.19).