INTERNATIONAL STANDARD

ISO 6709

Second edition
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Standard representation of geographic point location by coordinates

Représentation normalisée des latitude, longitude et altitude pour la localisation des points géographiques

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established 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. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 6709 was prepared by Technical Committee ISO/TC 211, *Geographic information/Geomatics*.

This second edition cancels and replaces the first edition (ISO 6709:1983), which has been technically revised.

The first edition provided for the representation of latitude and longitude for geographic point locations. This second edition extends the use of the representation to applications requiring latitude or longitude values to be quoted separately, for example when quoting a difference in two meridian values. It also extends the representation of latitude and longitude to allow the values for each to be held in separate numeric fields.

This second edition additionally provides for the representation of horizontal point location by coordinates other than latitude and longitude, and makes provisions for a variable-length format which has the flexibility to cover these various requirements. It also includes provisions for heights and depths.

This second edition is primarily intended for data interchange between computer systems. Informative Annex D, which summarises the different requirements at the human interface, has been added.

The first edition used the term *altitude* to describe vertical position. This International Standard uses the more general term height and also allows for vertical location to be described as *depth*.

Introduction

Efficient interchange of geographic-point-location data requires formats which are universally interpretable and which allow identification of points on, above and below the earth's surface. Users in various disciplines may have different requirements. This is exemplified by the use of degrees and decimal degrees, as well as the traditional degrees, minutes and seconds, for recording latitude and longitude. Users may also require various levels of precision and may use latitude and longitude without height.

The use of this International Standard will

a) reduce the cost of interchange of data,

b) reduce the delay in converting non-standard coding structures in preparation for interchange by providing advance knowledge of the standard interchange format, and

c) provide flexible support for geographic point representation.

Standard representation of geographic point location by coordinates

1 Scope

This International Standard is applicable to the interchange of coordinates describing geographic point location. It specifies the representation of coordinates, including latitude and longitude, to be used in data interchange. It additionally specifies representation of horizontal point location using coordinate types other than latitude and longitude. It also specifies the representation of height and depth that may be associated with horizontal coordinates. Representation includes units of measure and coordinate order.

This International Standard is not applicable to the representation of information held within computer memories during processing and in their use in registers of geodetic codes and parameters.

This International Standard supports point location representation through the eXtensible Markup Language (XML) and, recognizing the need for compatibility with the previous version of this International Standard, ISO 6709:1983, allows for the use of a single alpha-numeric string to describe point locations.

For computer data interchange of latitude and longitude, this International Standard generally suggests that decimal degrees be used. It allows the use of sexagesimal notations: degrees, minutes and decimal minutes or degrees, minutes, seconds and decimal seconds.

This International Standard does not require special internal procedures, file-organization techniques, storage medium, languages, etc., to be used in its implementation.

2 Conformance

To conform to this International Standard, representations of point locations by coordinates shall satisfy all of the conditions specified in the abstract test suite (see Annex A).

3 Normative references

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

ISO/IEC 8859-1, *Information technology — 8-bit single-byte coded graphic character sets — Part 1: Latin alphabet No. 1*

ISO/TS 19103, *Geographic information — Conceptual schema language*

ISO 19107, *Geographic Information — Spatial schema*

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

ISO 19115:2003, *Geographic Information — Metadata*

ISO 19118, *Geographic information — Encoding*

ISO/TS 19127, *Geographic Information — Geodetic codes and parameters*

ISO 19133, *Geographic Information — Location based services — Tracking and navigation*

4 Terms and definitions

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

4.1
accuracy
closeness of agreement between a test result or measurement result and the true value

[ISO 3534-2:2006]

4.2
altitude
height where the chosen reference surface is mean sea level

4.3
coordinate
one of a sequence of n numbers designating the position of a point in n-dimensional space

NOTE In a coordinate reference system, the coordinate numbers are qualified by units.

[ISO 19111:2007]

4.4
coordinate set
collection of **coordinate tuples** related to the same coordinate reference system

[ISO 19111:2007]

4.5
coordinate tuple
tuple composed of a **sequence** of **coordinates**

NOTE The number of coordinates in the coordinate tuple equals the dimension of the coordinate system; the order of coordinates in the coordinate tuple is identical to the order of the axes of the coordinate system.

[ISO 19111:2007]

4.6
depth
distance of a point from a chosen reference surface measured downward along a line perpendicular to that surface

NOTE A depth above the reference surface will have a negative value.

[ISO 19111:2007]

4.7
height
h, H
distance of a point from a chosen reference surface measured upward along a line perpendicular to that surface

NOTE A height below the reference surface will have a negative value.

[ISO 19111:2007]

4.8
metadata
data about data

[ISO 19115:2003]

4.9
precision
measure of the repeatability of a set of measurements

[ISO 19116:2004]

4.10
resolution
⟨coordinate⟩ unit associated with the least significant digit of a coordinate

NOTE Coordinate resolution may have linear or angular units depending on the characteristics of the coordinate system.

4.11
sexagesimal degree
angle represented by a sequence of values in degrees, minutes and seconds

NOTE In the case of latitude or longitude, it may also include a character indicating hemisphere.

EXAMPLE 50,079 572 5 degrees is represented as 50°04'46,461" sexagesimal degrees.

4.12
tuple
ordered list of values

[ISO 19136:2007]

5 Abbreviated terms

CRS Coordinate Reference System

GPL Geographic Point Location

GML Geography Markup Language

UML Unified Modelling Language

XML eXtensible Mark-up Language

6 Requirements for the representation of geographic point location

6.1 Conceptual model for geographic point locations

A *coordinate* is one of a sequence of numbers describing the position of a point. A *coordinate tuple* is composed of a sequence of coordinates describing one position.

EXAMPLE A coordinate tuple consisting of latitude, longitude and height represents a 3-dimensional geographic position.

A coordinate tuple represents a location unambiguously **only** if the coordinate reference system (CRS) to which it is referenced is identified. Without this identification, uncertainty in position may result in the location being as much as several hundred metres distant, see Annex B. ISO 19111 defines the elements required to describe a coordinate reference system.

A coordinate set is a collection of coordinate tuples. ISO 19111 requires that all coordinate tuples within a coordinate set should be referenced to the same coordinate reference system. If only one point is being described, the association between the coordinate tuple and coordinate reference system may be direct. For a coordinate set, one CRS identification or definition is associated with the coordinate set and all coordinate tuples in that coordinate inherit that association. The conceptual relationship between the coordinate tuple, coordinate set and coordinate reference system is illustrated in Figure 1 and is formally described in UML in Annex C.

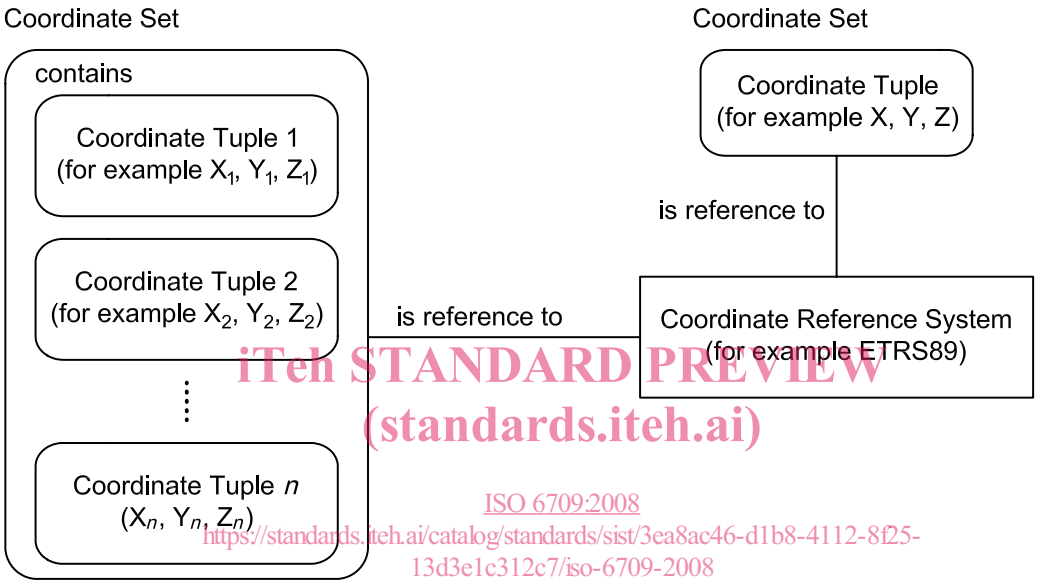

Figure 1 — Conceptual relationship of coordinates to a Coordinate Reference System (CRS)

Coordinates within a 2-dimensional CRS describe horizontal location. Given the importance of integrating the vertical dimension in modern systems, this International Standard also allows for the representation of coordinates describing a 3-dimensional position. A description of geographical point location in 3 dimensions can be made with reference to either a 3-dimensional CRS or a compound CRS consisting of a horizontal CRS and a vertical CRS. A coordinate reference system is comprised of one coordinate system and one datum as presented in Figure 2.

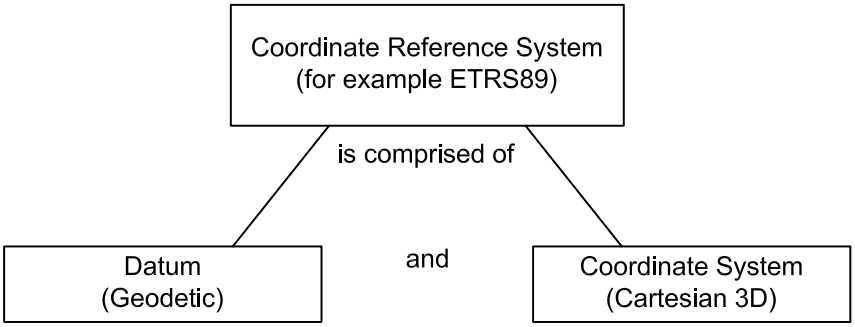

Figure 2 — Conceptual model of a Coordinate Reference System

6.2 Elements required for geographic point location

In this International Standard, geographic point location shall be represented by four elements:

— coordinate representing “x” horizontal position such as latitude;

— coordinate representing “y” horizontal position such as longitude;

— for 3-dimensional point locations, a value representing vertical position through either height or depth;

— a coordinate reference system identification.

6.3 Coordinate Reference System identification

A CRS identification shall be given for geographic point locations to be described unambiguously. For point location including the vertical position, a compound CRS identification shall be given; this compound CRS identification shall cover both horizontal and vertical positions. It is recognized that, in the absence of the CRS identification, a level of uncertainty in geographic point location is introduced. This geographic offset in position may be as much as 1 km from an actual point location as presented in Annex B.

A CRS description shall be through either

a) a reference to a definition in a register of geodetic codes and parameters conforming to the requirements of ISO/TS 19127, or

b) a full CRS definition, as defined in ISO 19111.

Methods a) and b) are alternative means of providing a full CRS definition. Method a) is recommended for simplicity but if the system definition is not available from a register it shall be given in full. In both methods, the CRS defines the order of coordinates in each coordinate tuple, units and representation of the values.

For some interchange purposes, it is sufficient to confirm the identity of the system without necessarily having the full system definition. When using method a), reference to a geodetic register, applications that only require to confirm the **identification** of a CRS can do so through the register citation and CRS unique identifier from that register. They do not need to retrieve the elements that constitute the CRS **definition** from the register, unless there is a need to quote these or to perform a coordinate operation on the coordinate set.

The syntax required for the CRS definition by geodetic register in method a) above shall be as follows:

1) for an online register:

   crsName=”url”

   EXAMPLE crsName=”http://www.xxxx.org#xxxx:1234”; or

2) for a register which is not online:

   crsName=[registerID]:[register’s CRS ID].

   EXAMPLE crsName=xxxx:1234.

6.4 Representation of horizontal position

Horizontal position shall be described through a pair of coordinates. Any coordinate reference system type as described in ISO 19111 may be used. The positive directions of each coordinate axis, the order of the coordinates and their units shall be as described in the coordinate reference system definition, when provided. When no CRS is provided, the following shall apply.

a) Within a coordinate tuple, the latitude value shall precede the longitude value.

b) Latitudes on or north of the equator shall be positive. Latitudes south of the equator shall be negative.

c) Longitudes on or east of the prime meridian shall be positive, longitudes west of the prime meridian shall be negative. The 180th meridian shall be negative. The prime meridian shall be Greenwich.

d) For digital data interchange, decimal degrees shall be the preferred representation. However, for backward compatibility with the first edition of this International Standard, sexagesimal degrees may be used. Recommendations for display of latitude and longitude at the human interface are given in Annex D.

6.5 Representation of vertical position

Vertical position shall be height or depth as described by the coordinate reference system definition. Heights measured upward from the origin shall be positive. Heights measured downward from the origin shall be negative. Depths measured downward from the origin shall be positive. Depths measured upward from the origin shall be negative.

If height or depth is given:

a) whether the value is a height or a depth, shall be defined in the CRS definition;

b) the position of the value in the coordinate tuple shall be given in the CRS definition;

c) the unit for the height or depth value shall be given in the CRS definition;

d) the origin for height or depth shall be defined in the CRS definition.

6.6 Coordinate resolution

Coordinates shall be given to a resolution commensurate with the position accuracy. Accuracy may be described through metadata as defined in ISO 19115. The linear equivalent for angular coordinates (latitude and longitude) is given in Annex E.

6.7 Utilization of geographic point locations

ISO 19115 gives details of ISO requirements for describing metadata for geospatial information. Examples of geographic point locations where coordinates and other attributes, such as date stamps or descriptive information associated with the geographic point location(s), are described in Annex F.

7 Representation of geographic point location

7.1 UML model

The UML model for the representation of geographic point location is described in Annex C.

7.2 XML representation

This International Standard supports GML, an XML grammar written in XML schema for the description of application schemas, as well as for the transport and storage of geographic information, but it also supports flexibility regarding geographic-point-location representations that will be addressed through a register. Examples of geographic point location through GML are given in Annex G.