INTERNATIONAL STANDARD

ISO 6709

Second edition
2008-07-15

Standard representation of geographic point location by coordinates

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

Reference number
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ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

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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 50º04'46,461" 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.

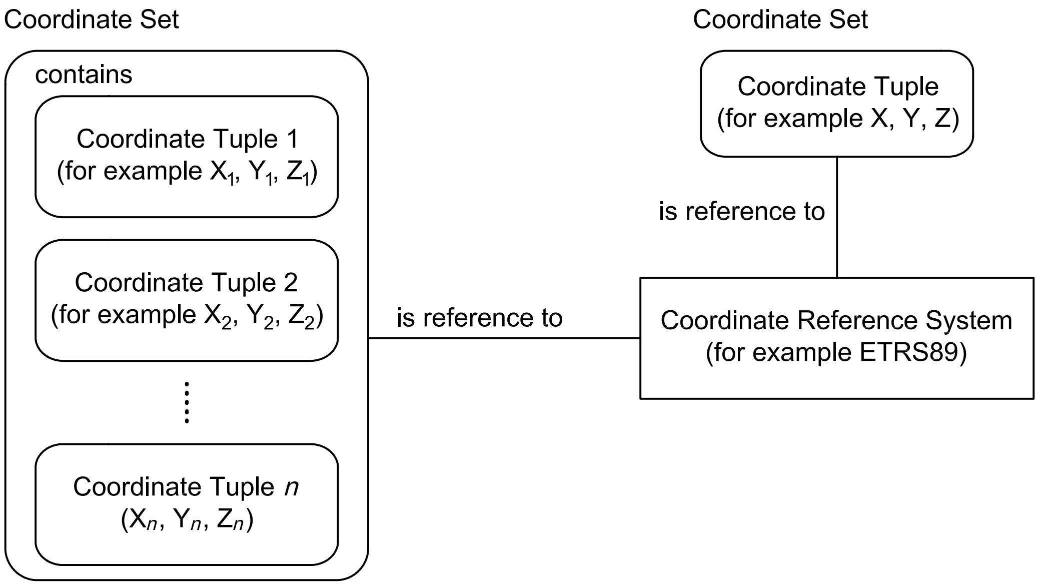


Figure 1 — Conceptual relationship of coordinates to a Coordinate Reference System (CRS)

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.

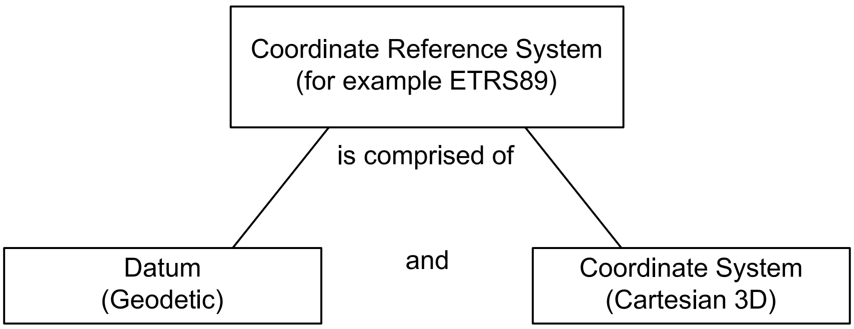


Figure 2 — Conceptual model of a Coordinate Reference System

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.

7.3 Text string representation

The representation of geographic point location by latitude, longitude and, optionally, height or depth through the text string defined in the first edition of this International Standard has, in this edition, been extended to include CRS identification. This optional text string representation to exchange geographic-point-location information, if used, shall be required to conform to the representation described in Annex H.

Annex A
(normative)

Conformance and abstract test suite

A.1 Conformance with this International Standard

A.1.1 Conformance requirement

Conformance requirement: Any geographic point location, expressed by coordinates, shall pass all the requirements described in the following abstract test suite.

A.1.2 Abstract test suite for conformance

A.1.2.1 Test Case Identifier: elements required for a geographic point location

a) Test purpose: Verify that all elements required for a geographic point location are complete.

b) Test method: Check the elements described and confirm that all required elements are present.

c) Reference: 6.2.

d) Test type: basic.

A.1.2.2 Test Case Identifier: Description of a CRS from a register

a) Test purpose: Verify that the description is complete and unambiguous.

b) Test method: Check the description given and confirm that it contains a sufficient definition of the CRS and that it is applicable to the point location.

c) Reference: 6.3 and ISO/TS 19127.

d) Test type: basic.

A.1.2.3 Test Case Identifier: definition of CRS

a) Test purpose: Verify that the full CRS definition conforms to the requirements of ISO 19111.

b) Test method: Check the definition given against the information required by ISO 19111 and confirm that all of the necessary information is provided in the necessary format and sequence

c) Reference: 6.3 and ISO 19111.

d) Test type: basic.

A.1.2.4 Test Case Identifier: representation of horizontal position

a) Test purpose: Verify that the representation of the horizontal position conforms to the elements described in 6.4.

b) Test method: Check the requirements given in 6.4 and confirm that all the necessary information is provided in the required format and sequence.

c) Reference: 6.4.

d) Test type: basic.

A.1.2.5 Test Case Identifier: representation of vertical position

a) Test purpose: Verify that the representation of the horizontal position conforms to the elements described in 6.5.

b) Test method: Check the requirements given in 6.5 and confirm that all the necessary information is provided in the required format and sequence.

c) Reference: 6.5.

d) Test type: basic.

A.1.2.6 Test Case Identifier: text string representation

a) Test purpose: Verify that the text string representation conforms to the requirements of this International Standard.

b) Test method: Check the requirements given in Annex H and confirm that all the necessary information is provided in the required format and sequence.

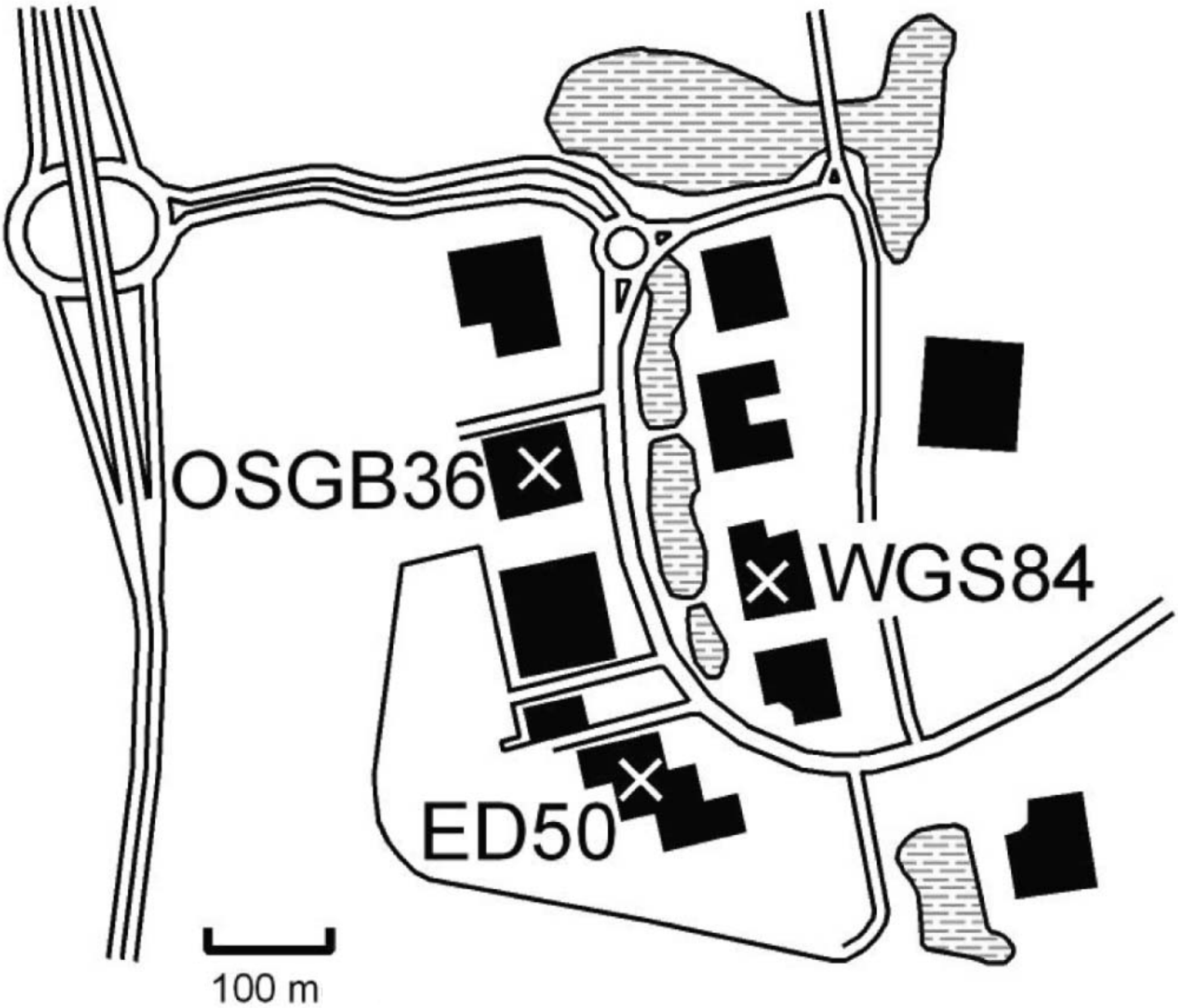
c) Reference: 7.3.

d) Test type: basic.

Annex B
(informative)

Latitude and longitude coordinates are not unique

Latitude and longitude are measurements on a model of the earth, normally an ellipsoid. Several hundred models have been defined and about forty different models remain in daily use. The selection of model, together with its position and orientation relative to the earth, is defined through a geodetic. If the model or its position or orientation is changed, that is, if the geodetic datum is changed, the values of latitude and longitude at a point will usually change. The same values of latitude and longitude referenced to different datums will refer to different locations (see Figure B.1). Conversely, for coordinate values to be unambiguous, the datum to which they are referenced must be identified.



NOTE “WGS 84”, “ED50” and “OSGB 1936” are the identifiers of Coordinate Reference Systems.

Figure B.1 — Locations with identical latitude and longitude values on three different datums

Projected coordinates are derived from geographic (latitude and longitude) coordinates. For the projected coordinates to be unambiguous, the datum for their source geographic coordinates must therefore also be identified.

The differences in coordinate values of a point caused by a change of geodetic datum are typically about 50 to 500 m but can be considerably more in extreme cases. When dealing with coordinates with an accuracy of approximately 1 km or worse, these differences are not significant. For applications requiring an accuracy of better than approximately 1 km, if coordinates are to be unambiguous, the identification of their datum is essential.

Annex C
(normative)

UML description for representation of geographic point locations

C.1 Introduction

This annex provides a formal description of a coordinate tuple and a coordinate set. These are two geometric constructs that are used in this International Standard and that have dependencies with other ISO geographic information standards. Dependencies are shown in Figure C.1. The geometric constructs are shown in detail in Figure C.2 in UML notation, which is documented in ISO/TS 19103.

The purpose of this UML description is to enable and support the representation of geographic point locations in various ways. The main classes of the UML diagram include the required functionality to transform geographic point locations and to identify coordinate representations.

C.2 UML package dependencies

The dependencies for the UML class diagram are shown in Figure C.2. Each dependency contains classes that are reused in this International Standard. These are as follows:

— ISO/TS 19103: Conceptual schema language;

— ISO 19107: Spatial schema;

— ISO 19111: Spatial referencing by coordinates;

— ISO 19115: Metadata;

— ISO 19133: Location based services — Tracking and navigation.

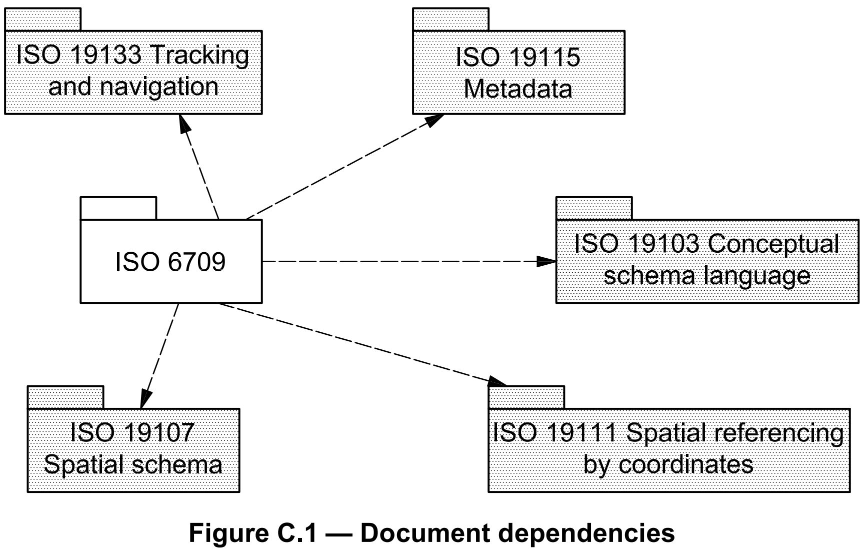


Figure C.1 — Document dependencies

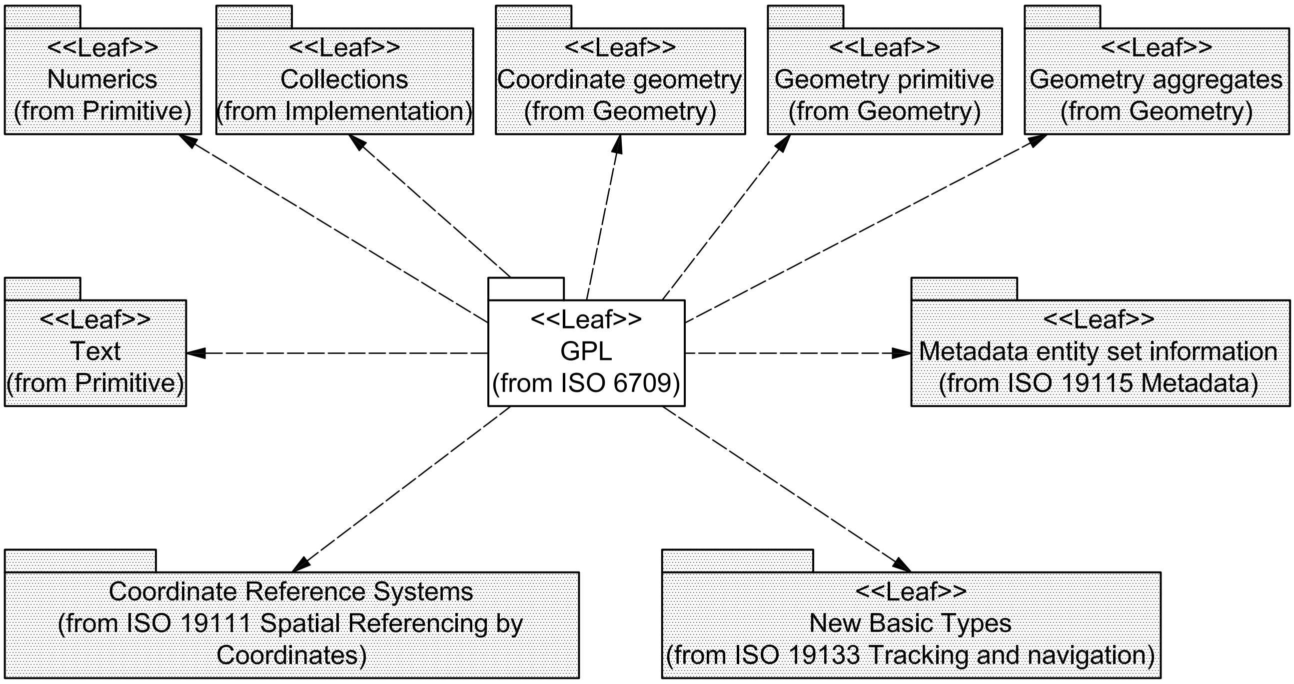


Figure C.2 — UML package dependencies

C.3 Description of the UML GPL package components

C.3.1 General

This subclause describes in detail the UML class diagram presented in Figure C.3. This class diagram has three classes to support multiple coordinate representations: GPL_CoordinateRepresentation, GPL_CoordinateTuple, GPL_CoordinateSet.

C.3.2 GPL_CoordinateRepresentation

A GPL_CoordinateRepresentation is a union data type consisting of either a CharacterString for text representation or BinaryData for binary number representation. Text representation includes, but is not limited to, the different flavour of extensible markup language (XML) representations.

```
GPL_CoordinateRepresentation::string [0,1] : CharacterString

GPL_CoordinateRepresentation::binary [0,1] : BinaryData
```

C.3.3 GPL_CoordinateTuple

C.3.3.1 General

A GPL_CoordinateTuple is a data type used for the representation of a geographic point location. It has one attribute to hold the coordinates and operations to perform the necessary transformations for the coordinate representation of one point.

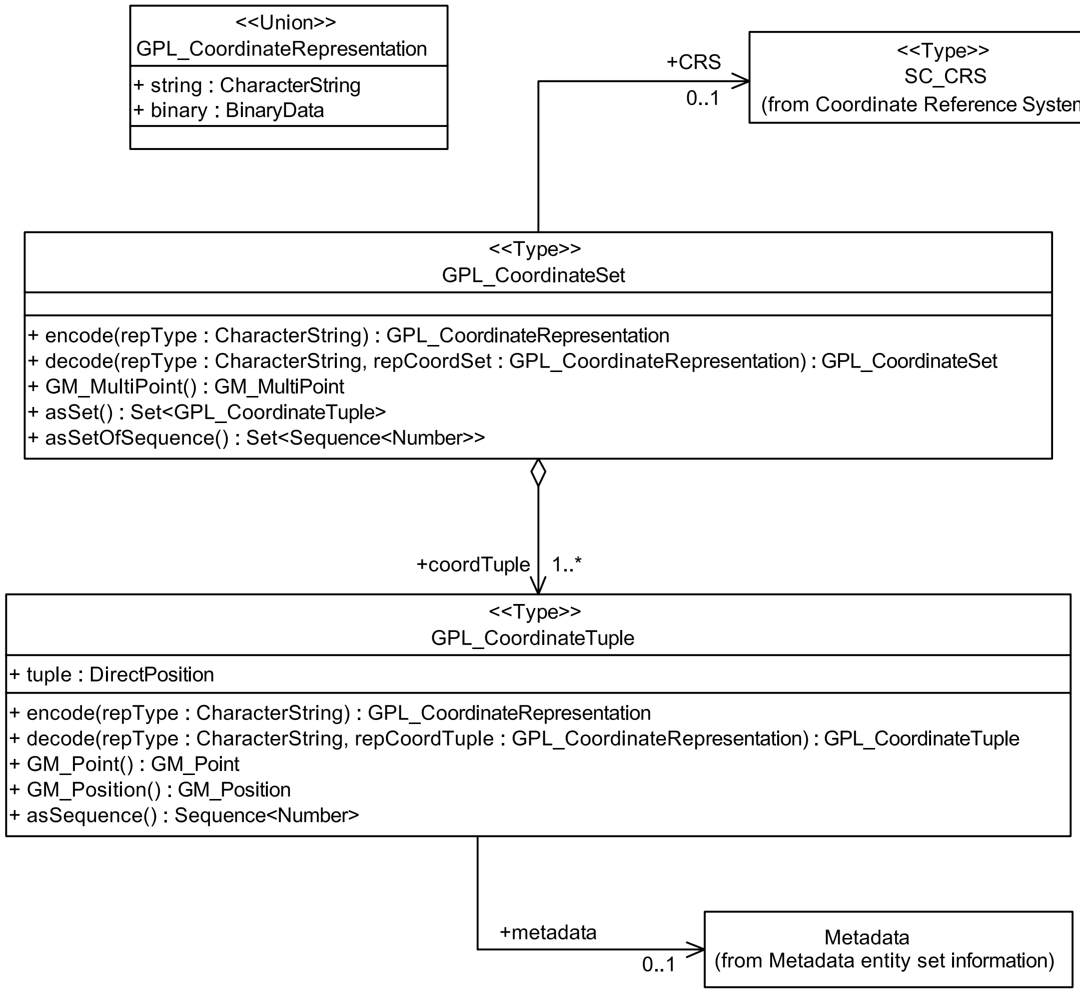


Figure C.3 — UML class diagram

C.3.3.2 tuple

Tuple is the attribute that holds the coordinates of this position in a DirectPosition data type. The DirectPosition, as described in ISO 19107, provides the mechanism to associate a coordinate reference system with this point.

```
GPL_CoordinateTuple::tuple : DirectPosition
```

C.3.3.3 encode

The operation "encode" performs the representation of this GPL_CoordinateTuple in a GPL_CoordinateRepresentation.

```
GPL_CoordinateTuple::encode(repType : CharacterString) :
      GPL_CoordinateRepresentation
```

C.3.3.4 decode

The operation "decode" performs the decoding of a GPL_CoordinateRepresentation into a GPL_CoordinateTuple. If the GPL_CoordinateRepresentation includes more than one representation of a point, the operation will decode the first one only.

```
GPL_CoordinateTuple::decode(repType : CharacterString, repCoordTuple :
      GPL_CoordinateRepresentation) : GPL_CoordinateTuple
```

C.3.3.5 GM_Point

The operation “GM_Point” returns the GPL_CoordinateTuple as a GM_Point data type in conformance with ISO 19107.

```
GPL_CoordinateTuple::GM_Point() : GM_Point
```

C.3.3.6 GM_Position

The operation “GM_Position” returns the GPL_CoordinateTuple as a GM_Position data type in conformance with ISO 19107.

```
GPL_CoordinateTuple::GM_Position() : GM_Position
```

C.3.3.7 asSequence

The operation “asSequence” returns the GPL_CoordinateTuple as a sequence of numbers in conformance with ISO/TS 19103.

```
GPL_CoordinateTuple::asSequence() : Sequence<Number>
```

C.3.3.8 metadata

“metadata” is an association role to reference metadata elements as described in ISO 19115 to a GPL_CoordinateTuple.

```
GPL_CoordinateTuple::metadata [0,1] : ISO19115::MD_Metadata
```

C.3.4 GPL_CoordinateSet

C.3.4.1 General

A GPL_CoordinateSet is a data type that aggregates a number of GPL_CoordinateTuples. Similarly to the “CoordinateTuple”, CoordinateSet has operations to perform the necessary transformations for the coordinate representation of one or multiple points.

C.3.4.2 coordTuple

“coordTuple” is an association role that aggregates references of a number of GPL_CoordinateTuples.

```
GPL_CoordinateSet::coordTuple [1,n] : Reference<GPL_CoordinateTuple>
```

C.3.4.3 encode

The operation “encode” performs the representation of this GPL_CoordinateSet in a GPL_CoordinateRepresentation.

```
GPL_CoordinateSet::encode(repType : CharacterString) :
       GPL_CoordinateRepresentation
```

C.3.4.4 decode

The operation “decode” performs the decoding of a GPL_CoordinateRepresentation into a GPL_CoordinateSet. If the GPL_CoordinateRepresentation includes only one representation of a point, the operation will generate a GPL_CoordinateSet of only one GPL_CoordinateTuple.

```
GPL_CoordinateSet::decode(repType : CharacterString, repCoordTuple :
       GPL_CoordinateRepresentation) : GPL_CoordinateSet
```

C.3.4.5 GM_MultiPoint

The operation “GM_MultiPoint” returns a GM_MultiPoint representation in conformance with ISO 19107.

```
GPL_CoordinateSet::GM_MultiPoint() : GM_MultiPoint
```

C.3.4.6 asSet

The operation “asSet” returns the GPL_CoordinateSet as a set of GPL_CoordinateTuples.

```
GPL_CoordinateSet::asSet() : Set<GPL_CoordinateTuple>
```

C.3.4.7 asSetOfSequence

The operation “asSetOfSequence” returns the GPL_CoordinateSet as a set of sequence of numbers in conformance with ISO/TS 19103.

```
GPL_CoordinateSet::asSet() : Set<Sequence<Number>>
```

C.3.4.8 CRS

“CRS” is an association role that references the appropriate coordinate reference system to the CoordinateSet through its attribute “name” according to ISO 19111.

```
GPL_CoordinateSet::CRS [0,1] : ISO19111::SC_CRS
```


Annex D
(informative)

Representation of latitude and longitude at the human interface

It should not be assumed that decimal degrees are required at the human interface. Each user community has its own requirements for notations involving degrees, minutes and seconds, as well as various combinations of sexagesimal and decimal notations: degrees and decimal degrees; degrees, minutes and decimal minutes; degrees, minutes, seconds and decimal seconds.

The sequence of coordinates is critical. Historical conventional usage gives the latitude value before the longitude value. Users in the marine and air navigation fields, and involved with emergency response are used to seeing latitude and longitude given in this order. If a height or depth is also given, it follows longitude. Presenting coordinate values in another order has life-safety implications.

Coordinate values can be understood most easily when they are well laid out. User communities will have their own specific requirements for representation. In the absence of a user community specification, it is suggested that:

a) each coordinate in a coordinate tuple should be separated by a space;

b) the separator between the integer and fractional parts of a value shall normally be set in the user's operating system;

c) each coordinate tuple should be on a separate line of display;

d) latitude and longitude should be given as sexagesimal degrees;

e) where minute or second value is less than 10, its value should include the leading 0;

f) degree, minute and second units should be identified with symbols:

   — the recommended symbols are ° ' and " (ISO/IEC 8859-1, codes 1100, 0600, and 1008 Hex, respectively);

   — the symbols should follow their value;

   — there should be no spaces between degree, minute and second values;

g) latitude hemisphere north or south should be indicated with the letter N or S, respectively (ISO/IEC 8859-1, codes 0314 and 0503 Hex, respectively);

   — there should be no space between the latitude value and its hemisphere indicator;

h) longitude hemisphere east or west should be indicated with the letter E or W, respectively (ISO/IEC 8859-1; codes 0405 and 0507 Hex, respectively);

   — there should be no space between the longitude value and its hemisphere indicator;

i) height or depth units are identified with a symbol:

   — the symbol should follow the value, and

   — there should be no space between the value and its unit symbol;

j) height or depth from the reference surface in the negative direction shall be designated using a minus sign (–).

EXAMPLE 1 50°40'46,461"N 95°48'26,533"W 1 123,45m.

EXAMPLE 2 50°03'46,461"S 125°48'26,533"E 978,90m.

Annex E
(informative)

Latitude and longitude resolution

It is recommended that coordinates be quoted to a resolution commensurate with their accuracy. The resolution of coordinates is only an indication of their accuracy; the accuracy of coordinates or of a position should be given in metadata in accordance with ISO 19115.

This resolution should be maintained if coordinates are subjected to a transformation or conversion, for example, if plane rectangular coordinates are converted to geographical coordinates. For the earth, at the equator 1° of latitude or longitude is equivalent to approximately 110 km; 1′ equivalent to approximately 1 nautical mile (1 852 m) and 1″ equivalent to approximately 30 m.

Tables E.1 and E.2 give recommended resolutions to which latitude and longitude should be given for various equivalent linear resolutions. Table E.1 converts round numbers in linear units to approximate angular equivalents. Table E.2 converts sexagesimal degrees to approximate linear equivalents.

Table E.1 — Approximate angular resolution equivalents to exact linear units

Linear resolution (exact)	Decimal degrees (approx.)	Sexagesimal degrees (approx.)
100 km	1	1°
1 km	0,01	30″
100 m	0,001	3″
10 m	0,000 1	0,3″
1 m	0,000 01	0,03″
10 cm	0,000 001	0,003″
1 cm	0,000 000 1	0,000 3″

Table E.2 — Approximate linear resolution equivalents to exact sexagesimal degrees

Linear resolution (approx)	Decimal degrees (approx.)	Sexagesimal degrees (exact)
100 km	1	1°
1 nautical mile	0,016 7	1′
30 m	0,000 3	1″
3 m	0,000 03	0,1″
0,3 m	0,000 003	0,01″
0,03 m	0,000 000 3	0,001″
0,003 m	0,000 000 03	0,000 1″

Annex F
(informative)

Utilization of Geographic Point Locations

The examples in this annex illustrate the importance of geographic point location for localized features and related characteristics (properties). It shows how geographic-point-location representations can be used within an application schema.

EXAMPLE 1 Inter-modal Transport & Logistics Operations.

In the Inter-modal Transport & Logistics Operations, geographic point location and related characteristics (properties) are very important. In this example, there are two classes: Factory and Gate. Factories deliver parts to other factories and this is represented by the "deliver" association. Factory is described by a name, a location, and has gates to which parts are delivered. The gates are also described by a name with a specific location in the factory (see Figure F.1).

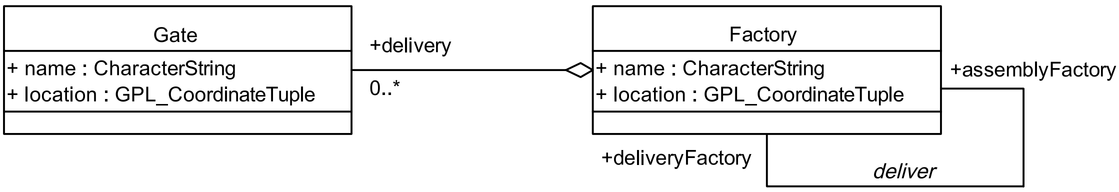


Figure F.1 — Example of UML class diagram of Inter-modal Transport & Logistics Operations

Example of GML encoding of Inter-modal Transport & Logistics Operations:

The namespace http://www.isotc211.org/2006/gpl is used as the namespace of the GML application schema encoding the conceptual model specified in Annex C.

```
<Features xmlns="http://www.someorg.org/example1"
xmlns:gpl="http://www.isotc211.org/2006/gpl"
xmlns:gml=http://www.opengis.net/gml/3.2
schemaLocation="http://www.someorg.org/example1.xsd">
   <member>
      <Factory gml:id="factoryA">
         <name>Factory A</name>
         <location>
            <gpl:GPL_CoordinateTuple>
               <gpl:tuple srsName="urn:ogc:def:crs:EPSG:6.6:4326">
                  35.89421911 139.94637467
               </gpl:tuple>
            </gpl:GPL_CoordinateTuple>
         </location>
         <deliveryGate xlink:href="#gate1"/>
         <deliveryGate xlink:href="#gate2"/>
      </Factory>
   </member>
   <member>
      <Gate gml:id="gate1">
         <name>Delivery Gate 1</name>
         <location>
            <gpl:GPL_CoordinateTuple>
```



```
                <gpl:tuple srsName="urn:ogc:def:crs:EPSG:6.6:4326">
                    35.89367744 139.94313278
                </gpl:tuple>
            </gpl:GPL_CoordinateTuple>
        </location>
    </Gate>
</member>
<member>
    <Gate gml:id="gate2">
        <name>Delivery Gate 2</name>
        <location>
            <gpl:GPL_CoordinateTuple>
                <gpl:tuple srsName="urn:ogc:def:crs:EPSG:6.6:4326">
                    35.896583 139.952425</gpl:tuple>
            </gpl:GPL_CoordinateTuple>
        </location>
    </Gate>
</member>
</Features>
```

EXAMPLE 2 Tracking in Location Based Services (LBS) Applications.

Tracking is commonly used by a client in order to monitor the location of a target. The geographic point location (latitude and longitude) of the mobile subscriber and a property which identifies the target are sent to the client.

For instance, a mobile-subscriber sends its current location and property (name and cellular number) to the client by his request of tracking, and the mobile-subscriber returns a sequence of tracking locations. Figure F.2 gives an example of the UML class diagram of Tracking in Location Based Services (LBS) Applications.

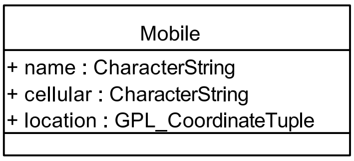


Figure F.2 — Example of UML class diagram of Tracking in Location Based Services (LBS) Applications

Example of GML encoding of Tracking in Location Based Services (LBS) applications:

Again, the namespace http://www.isotc211.org/2006/gpl is used as the namespace of the GML application schema encoding the conceptual model specified in Annex C.

```
<Features xmlns="http://www.someorg.org/example2"
xmlns:gpl="http://www.isotc211.org/2006/gpl"
xmlns:gml="http://www.opengis.net/gml/3.2"
schemaLocation="http://www.someorg.org/example2.xsd">
    <member>
        <Mobiler gml:id="mobiler1">
            <name>Ichiro Suzuki</name>
            <cellular>090-XXXX-XXXX</cellular>
            <location>
                <gpl:GPL_CoordinateTuple>
                    <gpl:tuple srsName="urn:ogc:def:crs:EPSG:6.6:4326">
                        35.68497219 139.75321667
                    </gpl:tuple>
```

```
            </gpl:GPL_CoordinateTuple>
         </location>
      </Mobiler>
   </member>
</Features>
```

Annex G
(informative)

Examples of XML representation

XML (eXtensible Markup Language) is a flexible way to create common information formats and share both the format and the data on the World Wide Web, intranets, and elsewhere. XML can be used by any individual or group of individuals or companies that wants to share information in a consistent way.

Geography Markup Language (GML) is an XML grammar written in XML schema for the description of application schemas, as well as for the transport and storage of geographic information. It is defined in ISO 19136. The key concepts used by Geography Markup Language (GML) to model the world are drawn from the geographic information series of International Standards and the OpenGIS Abstract Specification. Thus, GML specifies XML encodings, conforming with ISO 19118, of several of the conceptual classes defined in the ISO geographic information series of International Standards and the OpenGIS Abstract Specification.

This annex offers examples of XML and GML representations that have been developed for the exchange of geographic point locations. The first four examples are based on the conceptual model specified in Annex C, and the namespace "http://www.isotc211.org/2006/gpl" is used as the namespace of a GML application schema encoding that conceptual model. The fifth example is an XML representation based on the text string representation as documented in Annex H.

EXAMPLE 1 GML representation of Decimal degrees (DD.DD) with CRS identification from an offline register.

```
<gpl:GPL_CoordinateTuple>
   gpl:tuple srsName="...URI reference to CRS with lat/lon...">
      50.42 -22.59
   </gpl:tuple>
</gpl:GPL_CoordinateTuple>
```

EXAMPLE 2 GML representation of Decimal degrees (DD.DD) and depth from an offline geodetic register.

```
<gpl:GPL_CoordinateTuple>
   <gpl:tuple srsName="...URI reference to CRS with lat/lon/depth...">
      50.42 -22.59 543.43
   </gpl:tuple>
</gpl:GPL_CoordinateTuple>
```

EXAMPLE 3 GML representation of grid coordinates.

```
<gpl:GPL_CoordinateTuple>
   <gpl:tuple srsName="...URI reference to CRS with northing/easting...">
      1259753 18503245
   </gpl:tuple>
</gpl:GPL_CoordinateTuple>
```

EXAMPLE 4 GML representation of grid coordinates with height.

```
<gpl:GPL_CoordinateTuple>
   <gpl:tuple srsName="...URI reference to CRS with northing/easting/height...">
      503245.81 125906.56 43.43
   </gpl:tuple>
```

```
</gpl:GPL_CoordinateTuple>
```

EXAMPLE 5 Degrees and decimal degrees (alpha-numerical representation) with CRS = Coordinate Reference System.

```
<point>
   +50.42-022.59-543.43CRSWGS84/
</point>
```

Annex H
(informative)

Text string representation of point location

H.1 General

The single text string representation of ISO 6709:1983 has been used in many information systems because of its simple representation, ease of understanding, and relatively modest memory storage requirements. In this edition of this International Standard, the ISO 6709:1983 format has been extended to allow for depths as well as heights, and to include coordinate reference system identification.

H.2 Latitude

H.2.1 Latitude on or north of the equator shall be designated using a plus sign (+), or (N). Latitude south of the equator shall be designated using a minus sign (–), or (S). The use of the Alpha designators (N) and (S) are preferable for the human interface.

H.2.2 The first two digits of the latitude string shall represent degrees. Subsequent digits shall represent minutes, seconds or decimal fractions according to the following convention in which the decimal mark (full stop or comma) indicates the transition from the sexagesimal system to the decimal system:

Degrees and decimal degrees:

DD.DD

Degrees, minutes and decimal minutes:

DDMM.MMM

Degrees, minutes, seconds and decimal seconds:

DDMMSS.SS

H.2.3 Leading zeros shall be inserted for a degree value less than 10, and zeros shall be embedded in proper positions when minutes or seconds are less than 10.

H.3 Longitude

H.3.1 Longitude on or east of the prime meridian shall be designated using a plus sign (+), or (E). Longitude west of the prime meridian shall be designated using a minus sign (–), or (W). The use of the Alpha designators (E) and (W) are preferable for the human interface.

H.3.2 The first three digits of the longitude string shall represent degrees. Subsequent digits shall represent minutes, seconds or decimal fractions, according to the following convention in which the decimal mark (full stop or comma) indicates the transition from the sexagesimal system to the decimal system:

Degrees and decimal degrees:

DDD.DD

Degrees, minutes and decimal minutes:

DDDMM.MMM

Degrees, minutes, seconds and decimal seconds:

DDDMMSS.SS

H.3.3 Leading zeros shall be inserted for degree values less than 100, and zeros shall be embedded in proper positions when minutes or seconds are less than 10.

H.4 Height or depth

H.4.1 The representation of height or depth is optional. If it is represented, it shall comply with H.4.2 through H.4.5

H.4.2 If height or depth is expressed, a CRS identifier shall be supplied.

H.4.3 Height or depth from the reference surface in the positive direction shall be designated using a plus sign (+). Height or depth from the reference surface in the negative direction shall be designated using a minus sign (–). Height or depth on the reference surface shall be designated using a plus sign (+).

H.4.4 The referenced CRS shall describe whether the value is a height or a depth.

H.4.5 Height and depth units shall be defined through the referenced CRS.

H.5 Coordinate Reference System identifier

H.5.1 CRS identification shall be designated by the use of the characters “CRS” preceding crsName.

H.5.2 The crsName shall be designated by the CRS unique identifier from the register according to the following description:

a) for an online register: “<url>” (url expression with brackets <>);

b) for a register which is not online: “registerID”:”register’s CRS ID”;

c) for a full CRS definition as defined in ISO 19111 (6.3 in this International Standard): the crsName shall be designated by “<CRS identifier (CRSID or CCRSID)>” in ISO 19111 (CRSID or CCRSID with bracket <>).

H.6 Format

H.6.1 Elements shall be combined in a point location string in the following sequence:

a) latitude;

b) longitude;

c) if represented, height or depth;

d) Coordinate Reference System identifier.

H.6.2 The number of digits for latitude, longitude and height (depth) shall indicate the precision of available data.

H.6.3 There shall be no separator between the elements for latitude, longitude, height (depth) and CRS.

NOTE The use of designators “+”, “–” and “CRS” preceding the value part of each element permits the recognition of the start of each element and the termination of the previous one.

H.6.4 The point location string shall be terminated. The terminator character shall be a solidus (/), unless otherwise specified in the documentation associated with interchange.

H.7 Examples

H.7.1 Examples of representation of latitude and longitude without height or depth:

a) Degrees `+40-075CRSWGS_84/`

b) Degrees `+40-075/`

NOTE The position is ambiguous because no CRS is identified.

a) Degrees and decimal degrees `+40.20361-75.00417CRSWGS_84/`

b) Degrees and minutes `+4012-07500CRSWGS_84/`

c) Degrees, minutes and decimal minutes `+4012.22-07500.25CRSWGS_84/`

d) Degrees, minutes and seconds `+401213-0750015CRSWGS_84/`

e) Degrees, minutes, seconds and decimal seconds `+401213.1-0750015.1CRSWGS_84/`

H.7.2 Examples of representation of latitude and longitude with height or depth:

a) Degrees +40-075+350CRSWGS_84/

b) Degrees and decimal degrees +40.20361-75.00417+350.517CRSWGS_84/

c) Degrees and minutes +4012-07500-169.2CRSWGS_84/

d) Degrees, minutes and decimal minutes +4012.22-07500.25-169.2CRSWGS_84/

e) Degrees, minutes and seconds +401213-0750015+2.79CRSWGS_84/

f) Degrees, minutes, seconds and decimal seconds +401213.1-0750015.1+2.79CRSWGS_84/

NOTE +2,79 is a height or depth as defined through the CRS.

Bibliography

[1] ISO 3534-2:2006, *Statistics — Vocabulary and symbols — Part 2: Applied statistics*

[2] ISO 19116:2004, *Geographic Information — Positioning services*

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