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Standard representation of geographic point location by coordinates

Représentation normalisée de la localisation des points géographiques par coordonnées

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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 211, *Geographic information/Geomatics*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 287, *Geographic Information,* in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This third edition cancels and replaces the second edition (ISO 6709:2008), which has been technically revised. It also incorporates the Technical Corrigendum ISO 6709:2008/Cor. 1:2009.

The main changes are as follows:

— Harmonization with other recently revised ISO/TC 211 International Standards;

— Clarification of normative requirements to maintain rigid backwards compatibility when required;

— Correction of the issues contained in the Technical Corrigendum ISO 6709:2008/Cor. 1:2009;

— Correction of annexes that contained normative requirements but were labelled as informative;

— Deletion of annexes and concepts which have changed and were no longer suitable for the revised edition;

— Correction of instances where European numeric formatting conventions were incorrectly inserted. These conventions will no longer be recommended;

— Clarification of editorial issues.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

In accordance with the ISO/IEC Directives, Part 2, 2018, *Rules for the structure and drafting of International Standards*, in International Standards the decimal sign is a comma on the line. However, the General Conference on Weights and Measures (*Conférence Générale des Poids et Mesures*) at its meeting in 2003 passed unanimously the following resolution:

"The decimal marker shall be either a point on the line or a comma on the line."

In practice, the choice between these alternatives depends on customary use in the language concerned. In the technical areas of geodesy and geographic information it is customary for the decimal point always to be used, for all languages. That practice is used throughout this document.

Introduction

Geographic point location (GPL) is the description of a well-defined geographic place using a single coordinate tuple. Efficient interchange of GPL data requires formats which are universally interpretable and which allow the identification of points on, above and below the Earth's surface. Users in various disciplines 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. User applications can also require various levels of precision and can use latitude and longitude without height.

ISO 6709:1983 defined a specific format representation of latitude and longitude, and optionally altitude.

ISO 6709:2008 revised the format representation of the 1983 edition by:

— adding the ability to identify the coordinate reference system (CRS) to which coordinates are referenced, without which location is ambiguous, and

— expanding the use of altitude to allow for any ellipsoidal or gravity-related height or depth.

Since the first edition of this document in 1983, the field of geodesy has undergone significant technological advances, along with the continued development of other related geodesy and geomatics standards.

The aim of this edition is to address these new advances and standards and to revise the coordinate string suitable for digital representation (Clause 6) while continuing to support the requirements of the previous edition (Annex B).

Clause 7 defines a simpler structure for the unambiguous representation of GPL in a human-readable format.

In addition, a series of annexes are provided with the following content:

— Annex A (normative) defines the abstract test suite used for conformance testing;

— Annex B (normative) defines the representation of latitude and longitude coordinates that maintain backwards compatibility with ISO 6709:2008;

— Annex C (informative) presents a description and examples of how the position of coordinates can appear ambiguous without the use of a CRS;

— Annex D (informative) presents a table of mathematical precision values of resolution for latitude and longitude;

— Annex E (informative) describes the changes in this document compared to the previous edition of ISO 6709;

— Annex F (normative) specifies encodings for character strings and delimiters required in this document.

The following options are highlighted to users of this document:

a) For all cases where backwards compatibility is not required, this document recommends using the methods and rules specified in Clause 6, GPL representation, or Clause 7, human-readable GPL representation;

b) However, in systems and environments where backwards compatibility with ISO 6709:2008 is required, the methods and rules specified in Annex B can be used.

In addition, when using Annex B, it is recommended that suitable and comprehensive ancillary documentation, not defined within this document or in previous editions of this document, be prepared and accompany all instances of geographic point location text strings and human-readable representations claiming backwards compatibility.

The use of this document:

— establishes an expanded point representation string format supporting the current concepts and standards of geodesy and geographic information;

— when required, continues to support the needs of established user communities by maintaining backwards compatibility with the previous edition of this document (ISO 6709:2008);

— reduces the cost of interchange of data;

— reduces the delay in converting non-standard coding structures in preparation for interchange by providing advance knowledge of the standard interchange format; and

— provides flexible support for geographic point representation.

Standard representation of geographic point location by coordinates

1 Scope

This document specifies the representation of latitude and longitude and optionally height or depth compatible with previous editions of ISO 6709.

This document also supports the representations of other coordinate types and time that can be associated with those coordinates as defined through one or more coordinate reference systems (CRS).

This document describes a text string of coordinates, suitable for electronic data exchange, for one point, including reference system identification to ensure that the coordinates unambiguously represent the position of that point. Files containing multiple points with a single common reference system identification are out of scope. This document also describes a simpler text string structure for coordinate representation of a point location that is more suitable for human readability.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 8601-1, *Date and time — Representations for information interchange — Part 1: Basic rules*

ISO 8601-2, *Date and time — Representations for information interchange — Part 2: Extensions*

ISO/IEC 10646:2020, *Information technology — Universal coded character set (UCS)*

ISO 19111, *Geographic information — Referencing by coordinates*

ISO 19162, *Geographic information — Well-known text representation of coordinate reference systems*

3 Terms and definitions

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

ISO and IEC maintain terminological 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/

3.1
accuracy
closeness of agreement between a test result or measurement result and the true value

[SOURCE: ISO 3534-2:2006, 3.1.1, modified — Notes to entry have been removed.]

3.2
altitude
height where the chosen reference surface is mean sea level

3.3
compound coordinate reference system
coordinate reference system 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 19111:2019, 3.1.3]

3.4
coordinate
one of a sequence of numbers designating the position of a point

Note 1 to entry: In a spatial coordinate reference system, the coordinate numbers are qualified by units.

[SOURCE: ISO 19111:2019, 3.1.5]

3.5
coordinate reference system
coordinate system that is related to an object by a datum

Note 1 to entry: Geodetic and vertical datums are referred to as reference frames.

Note 2 to entry: For geodetic and vertical reference frames, the object will be the Earth. In planetary applications, geodetic and vertical reference frames may be applied to other celestial bodies.

[SOURCE: ISO 19111:2019, 3.1.9]

3.6
coordinate set
collection of coordinate tuples referenced to the same coordinate reference system and if that coordinate reference system is dynamic also to the same coordinate epoch

[SOURCE: ISO 19111:2019, 3.1.10]

3.7
coordinate system
set of mathematical rules for specifying how coordinates are to be assigned to points

[SOURCE: ISO 19111:2019, 3.1.11]

3.8
coordinate tuple
tuple composed of coordinates

Note 1 to entry: 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.

[SOURCE: ISO 19111:2019, 3.1.13]

3.9
datum
reference frame
parameter or set of parameters that realize the position of the origin, the scale, and the orientation of a coordinate system

[SOURCE: ISO 19111:2019, 3.1.15]

3.10
depth
distance of a point from a chosen vertical reference surface downward along a line that is perpendicular to that surface

Note 1 to entry: The line direction may be straight or be dependent on the Earth's gravity field or other physical phenomena.

Note 2 to entry: A depth above the vertical reference surface will have a negative value.

[SOURCE: ISO 19111:2019, 3.1.17]

3.11
ellipsoidal height
geodetic height
h
distance of a point from the reference ellipsoid along the perpendicular from the reference ellipsoid to this point, positive if upwards or outside of the reference ellipsoid

Note 1 to entry: Only used as part of a three-dimensional ellipsoidal coordinate system or as part of a three-dimensional Cartesian coordinate system in a three-dimensional projected coordinate reference system, but never on its own.

[SOURCE: ISO 19111:2019, 3.1.24]

3.12
geographic point location
well defined geographic place described by one coordinate tuple

[SOURCE: ISO 19145:2013, 4.1.11]

3.13
geographic point location representation
syntactic description of a geographic point location in a well known format

[SOURCE: ISO 19145:2013, 4.1.12]

3.14
gravity-related height
H
height that is dependent on the Earth's gravity field

Note 1 to entry: This refers to, amongst others, orthometric height and Normal height, which are both approximations of the distance of a point above the mean sea level, but also may include Normal-orthometric heights, dynamic heights or geopotential numbers.

Note 2 to entry: The distance from the reference surface may follow a curved line, not necessarily straight, as it is influenced by the direction of gravity.

[SOURCE: ISO 19111:2019, 3.1.37]

3.15
height
distance of a point from a chosen reference surface positive upward along a line perpendicular to that surface

Note 1 to entry: A height below the reference surface will have a negative value.

Note 2 to entry: Generalisation of ellipsoidal height (h) and gravity-related height (H).

[SOURCE: ISO 19111:2019, 3.1.38]

3.16
measurement precision
precision
closeness of agreement between indications or measured quantity values obtained by replicate measurements on the same or similar objects under specified conditions

Note 1 to entry: Measurement precision is usually expressed numerically by measures of imprecision, such as standard deviation, variance, or coefficient of variation under the specified conditions of measurement.

Note 2 to entry: The "specified conditions" can be, for example, repeatability conditions of measurement, intermediate precision conditions of measurement, or reproducibility conditions of measurement (see ISO 5725-1:1994).

Note 3 to entry: Measurement precision is used to define measurement repeatability, intermediate measurement precision, and measurement reproducibility.

Note 4 to entry: Sometimes "measurement precision" is erroneously used to mean measurement accuracy.

[SOURCE: ISO/IEC Guide 99:2007, 2.15]

3.17
metadata
information about a resource

[SOURCE: ISO 19115-1:2014, 4.10]

3.18
resolution (of a coordinate)
unit associated with the least significant digit of a coordinate

Note 1 to entry: Coordinate resolution may have linear or angular units depending on the characteristics of the coordinate system.

3.19
sexagesimal degree
angle represented by a sequence of values in degrees, minutes, and seconds

Note 1 to entry: In the case of latitude or longitude, it may also include a character indicating hemisphere.

EXAMPLE 50.0795725 decimal degrees is represented as 50°04'46.461"

3.20
tuple
ordered list of values

Note 1 to entry: The number of values in a tuple is immutable.

[SOURCE: ISO 19136-1:2020, 3.1.60]

4 Abbreviated terms and character code notations

4.1 Abbreviated terms

CRS coordinate reference system

CRScsd coordinate reference system character string delimiter

EPSG EPSG geodetic parameter dataset

GML Geography Markup Language

GPL	geographic point location
HTML	HyperText Markup Language
ISOGR	ISO Geodetic Registry
JSON	JavaScript Object Notation
lat	latitude
lon	longitude
OGC	Open Geospatial Consortium
UCS	Universal Coded Character Set
URL	Uniform Resource Locator
WKT	well-known text
XML	eXtensible Markup Language

4.2 Character code notations

Character string delimiters required in this document are represented in accordance with notation from ISO/IEC 10646. Character names and code points are specified in Annex F, Table F.1.

5 Conformance

To conform to this document, representations of GPL shall satisfy the conditions specified in the abstract test suite (Annex A).

6 Geographic point location (GPL) representation

6.1 Overview

This edition of ISO 6709 revises and expands the representation of geographic point location (GPL), while maintaining an option (Annex B) for backwards compatibility with the previous edition (ISO 6709:2008).

ISO 19111 defines the elements required to describe a CRS. A coordinate tuple represents a location unambiguously only if the CRS to which it is referenced is identified and if that CRS is dynamic the epoch of the coordinates is also identified. Without this identification, uncertainty in position can result in the location being as much as several hundred metres distant (see Annex C).

In this document, CRS identifiers shall accompany all GPL representations. Identification may be through:

— a complete URL notation [6.5 a)],

— an abbreviated notation [6.5 b)] or

— a complete CRS definition as specified in ISO 19111, [6.5 c)].

ISO 19111 specifies several CRS types, of which the following are supported in this document. Any one, or a combination of these, shall accompany all GPL representations:

— geodetic CRS — three-dimensional,

— geographic CRS — two-dimensional or three-dimensional,

— projected CRS — two-dimensional, or sometimes three-dimensional,

— engineering CRS — two-dimensional, or sometimes one-dimensional or three-dimensional,

— parametric CRS — one-dimensional, with normally vertical orientation,

— vertical CRS — one-dimensional,

— temporal CRS — one-dimensional, and

— compound CRS.

NOTE For detailed information about each of these CRS types users can consult ISO 19111.

The text string representation format defined in 6.6 is used for single GPL instances. However, in practice, GPL instances with uniform representation formats are commonly grouped into coordinate sets that often provide a single CRS identification for the complete coordinate set. This single identification does not adhere to the specified representation requirements defined by this document. These types of coordinate sets are commonly formatted as files on digital storage, or structures in computer memory.

This document does not specify the format of these coordinate sets, and when coordinate sets are used, this document recommends that users provide suitable, clear and persistent documentation detailing the CRS identifiers of all elements in the GPL representation and character encoding used.

6.2 Component representation

This document specifies the representation of GPLs using the descriptive concept of a component. Each component is comprised of three required elements:

— a coordinate tuple (6.3),

— a character string delimiter (6.4), and

— a CRS identifier (6.5).

A series of components can then be combined to define a GPL representation.

The order of the components occurring in a GPL representation text string is not defined by this document and therefore enables any ordering of the components according to user or system requirements, provided a valid CRS identifier element accompanies each component. Parsing and identification of each component is possible by examining the character string delimiter.

The order and units of the coordinate tuples in each component are defined by the specific CRS. However, in a compound CRS, the CRS not only defines the required coordinate tuples but also the order of the components within the compound group.

6.3 Coordinate tuple

A coordinate tuple is an ordered list of values composed of coordinates. The coordinates within a coordinate tuple are mutually independent. The number of coordinates in a tuple is equal to the dimension of the coordinate system and the order of the coordinates in the coordinate tuple is identical to the order of the axes of the coordinate system. The order and units of the coordinate tuple are specified in the CRS definition associated with the component.

6.4 Character string delimiters and terminator notation

To differentiate GPL strings specified in this document from those represented using formats defined in the previous edition (ISO 6709:2008, Annex E.2), a new CRS character string delimiter (CRScsd) is defined.

For specific formatting requirements shown in this document, users should refer to the character encodings defined in Table E.1.

NOTE 1 Within this document, the notation *CRScsd* refers to a general CRS character string delimiter reference.

The format of the new CRScsd is composed of:

— the uppercase letters "CRS", immediately followed by;

— a single digit, either a 1, 2, 3 or 4, immediately followed by;

— a lowercase "d".

EXAMPLE 1 CRS2d is an example of a well-formed CRScsd.

The two characters immediately following the "CRS" together represent the dimension of the CRS and are referred to as the *suffix* of the CRS character string delimiter.

The following CRScsd strings represent the CRS types supported by this document:

a) CRS1d: one-dimensional spatial or temporal CRS.

EXAMPLE 2 Height, depth, pressure and time are examples of one-dimensional coordinate tuple elements.

b) CRS2d: two-dimensional single spatial CRS or two-dimensional compound CRS.

EXAMPLE 3 Lat/Lon, X/Y, Easting/Northing and polar coordinates are examples of two-dimensional coordinate tuple elements. A two-dimensional compound CRS identifier can define elements such as height and time.

c) CRS3d: three-dimensional single spatial CRS or three-dimensional compound CRS.

EXAMPLE 4 Lat/Lon/height, X/Y/Z and spherical coordinates are examples of three-dimensional coordinate tuple elements. A three-dimensional compound CRS identifier can define elements such as horizontal (Lat/Lon) plus time, where time can be the epoch of the coordinates.

d) CRS4d: four-dimensional single spatial CRS or four-dimensional compound CRS.

EXAMPLE 5 Lat/Lon/height/time and X/Y/Z/time are examples of four-dimensional coordinate tuple elements. A four-dimensional compound CRS identifier can define elements, such as X/Y/Z and time, where time can be an epoch of the coordinates.

Additionally, in each component of a GPL representation string, the following characters shall also act as delimiters:

e) the *plus sign* or *minus sign* [+/−] of the value acts as a delimiter between the coordinates of the tuple.

f) a *commercial at* [@] is used as a prefix delimiter of a coordinate epoch (ISO 19111:2019, B.4.3). The epoch refers to the coordinates and does not belong to the CRS and therefore does not modify the CRS definition in any way. When a coordinate epoch is used, the epoch prefix "@" and epoch value shall immediately precede the CRScsd and there shall be no spaces between the end digits of the coordinate and the epoch prefix.

g) *curly brackets* [{ }] are used to enclose a date/time string, in accordance with ISO 8601-1 or ISO 8601-2. The date/time string enclosed between curly brackets, without leading or trailing spaces, immediately precedes a CRS1d character string delimiter following the rules for CRS identifier structure (6.5).

h) *angle brackets* [< >] are used to enclose the CRS identifier and immediately follow the CRScsd according to the rules for CRS identifier structure (6.5).

NOTE 2 While the character names defined in Table F.1 are "LESS-THAN SIGN" and "GREATER-THAN SIGN", this document follows customary notation used in other ISO/TC 211 documents and collectively refers to these characters as "angle brackets".

i) a *solidus* [/] shall act as the terminator character and any GPL string shall always be terminated.

6.5 CRS identifier structure

Three methods exist for representing the CRS identifier structure. The complete URL notation [6.5 a)] provides an unambiguous reference to an authoritative CRS identifier, which is available in a registry and is suitable for implementation purposes, whereas the abbreviated notation [6.5 b)] uses various shortened descriptive references that represent a CRS identifier, but do not necessarily return an unambiguous reference to an authoritative CRS and are less useful for implementation purposes. The complete CRS definition as specified in ISO 19111 [6.5 c)] is used when the required CRS is not available in a registry, or when it is desirable to give the definition in full, despite there being a registry entry.

Any CRS identifier shall be enclosed within *angle brackets* < > immediately following the CRScsd.

NOTE 1 In the following structure definitions, the `CRScsd`, angle bracket delimiters and terminator character are shown in **`monospace bold regular`** type. The examples shown in this subclause are fragments of GPL representation strings and are designated as such by the "..." ellipsis at the start of each example.

The structure of the CRS identifier is defined for the following cases:

a) complete URL notation:

```
CRScsd<registryURL>/
```

where registryURL is a well-formed URL, without leading or trailing spaces, and returns the CRS identifier either as a human interface endpoint (e.g. HTML) or as service endpoint (e.g. XML, GML, WKT, JSON, etc.).

NOTE 2 The endpoint preference is based on the requirements of the user.

EXAMPLE 1

```
…CRS3d<https://geodetic.isotc211.org/register/geodetic/items/204>/
```

An HTML endpoint from the ISO Geodetic Registry (ISOGR) defining NAD 83 (HARN) CORRECTED – LatLonEHt, ID 204.

EXAMPLE 2

```
…CRS3d<https://epsg.org/def/crs/EPSG/0/4979/gml>/
```

An XML/GML endpoint from the EPSG Registry, defining geographic 3D WGS84 CRS - EPSG code 4979.

EXAMPLE 3

```
…CRS3d<https://registre.ign.fr/ign/IGNF/crs/IGNF/RGF93>/
```

An XML/GML endpoint from the IGNF (Institut Géographique National France) Registry defining a geocentric CRS representing *cartesiennes geocentriques,* ID RGF93.

b) abbreviated notation:

```
CRScsd<registryID:CRS-ID>/
```

where registry identifier (registryID) is a text string, without leading or trailing spaces, immediately followed by a single *colon* (:) then immediately followed by the CRS identifier (CRS-ID) from the registry.

Abbreviated notation can be:

— an authoritative identifier from a registry (Example 4),

— a "working identifier alias", used within a specific organization or domain, where the description and parameters of the CRS identifier are clearly understood by the members of the organization or domain (Example 5), or

— in the absence of an actual working registry, an authoritative source and document identifier can be provided (Example 6).

EXAMPLE 4

```
…CRS2d<EPSG:5345>/
```

Abbreviated notation of EPSG ID 5345, representing a projected 2D POSGAR 2007/Argentina Zone 3 CRS, defined online by: https://api.epsg.org/def/crs/EPSG/0/5345/gml or https://epsg.org/crs_5345/index.html

EXAMPLE 5

```
…CRS3d<OS-CRS:OSGB36 NG-ODN>/
```

To a specific group, the working notation of "OS-CRS:OSGB36 NG-ODN" is unambiguous within their group or organization. However, it is also identical to the CRS identifier EPSG 7405 as defined by: https://api.epsg.org/def/crs/EPSG/0/7405/gml or https://api.epsg.org/def/crs/EPSG/0/7405/wkt

NOTE 3 This document recommends that instances of "working" identifiers be clearly documented.

EXAMPLE 6

```
…CRS1d<ISO:8601-2 2019>/
```

This example shows an ISO document (ISO 8601-2:2019) used as a type of offline CRS registry. In the example, an ISO 8601-2 date/time string format is used and a specific document is required to interpret the format. Therefore, an abbreviated form of the International Standard name has been placed into the CRS identifier.

NOTE 4 As only one colon is defined in 6.5 b), the typical "colon notation" (document_number:publication_date) used in the ISO document title (8601-2:2019) has been replaced in Example 6 with a space.

c) complete CRS definition as specified in ISO 19111:

```
CRScsd<ISO_19111_complete_CRS_definition>/
```

where ISO_19111_complete_CRS_definition is represented using a WKT formatted string (ISO 19162), having no leading or trailing spaces, and surrounded by a pair of angle brackets (< >).

A complete CRS definition can be:

— used when online or official registry entries are not available,

— used when modifications to specific parameters are required (Example 7).

The full description is generally used only when reference to a description in a registry is not possible.

The full description shall be given through well-known text (WKT), conformant with ISO 19162.

EXAMPLE 7

```
...CRS2d<PROJCRS["JGD2011 / Modified UTM zone 54N",
BASEGEOGCRS["JGD2011",DATUM["Japanese Geodetic Datum 2011",
ELLIPSOID["GRS 1980",6378137,298.257222101,LENGTHUNIT
["metre",1.0]]]],CONVERSION["My map projection",METHOD["Transverse
Mercator",ID["EPSG",9807]],PARAMETER["Latitude of natural
origin",0,ANGLEUNIT["degree",0.01745329252]],PARAMETER
["Longitude of natural origin",144,ANGLEUNIT["degree",0.01745329252]],
PARAMETER["Scale factor at natural origin",0.9996,
SCALEUNIT["unity",1.0]],PARAMETER["False easting",500000,
LENGTHUNIT["metre",1.0]],PARAMETER["False northing",2000000,
LENGTHUNIT["metre",1.0]]],CS[cartesian,2],AXIS["easting
(E)",east,ORDER[1]],AXIS["northing (N)",north,ORDER[2]],
LENGTHUNIT["metre",1.0]]>/
```

This example shows a complete CRS definition, as specified by ISO 19111, in the form of a WKT string for a two-dimensional projected CRS using a user-defined map projection not found in a registry (the False northing is modified).

NOTE 5 When necessary, examples in this document use carriage returns to wrap the lines for readability and are not part of the specification.

6.6 Text string representation

6.6.1 Background

The GPL text string representation, defined in previous editions of this document, has been widely implemented in many information systems because of its simple representation, ease of understanding and relatively modest memory storage requirements.

While the GPL text string representation specified in this document maintains a similar approach to that of previous editions in terms of simplicity, understanding and storage requirements, the overall formatting rules defined in this document are closely aligned with the CRS identifier of each component.

To structure GPL text string representations conforming to this document, the rules in 6.6.2 and 6.6.3 shall apply.

6.6.2 Formatting rules for angular measures

6.6.2.1 Background

The required CRS identifier (6.5) in each component is used to interpret the format and values of the coordinate tuples within the specific component. Therefore, the order and units of measure (UoM), or simply, "units" of the coordinates, shall match the order and units defined in the CRS identifier. If the order and/or units are incompatible or different, the GPL representation is considered invalid and the unambiguous interpretation of the text string will fail.

Within a registry, it is expected that the CRS identifiers contain complete definitions for all attributes. However, some definitions allow the supplier to define specific representations, such as the format of latitude and longitude coordinates, where the units are not clearly defined.

The previous edition of this document recommended decimal degrees as the preferred format for text string representation in addition to supporting sexagesimal degree encodings. This document requires that the specific definitions contained in the CRS identifier be used for all GPL representation. For grads and radians, decimal numbers with no leading zeros are used. For degrees, or when representations for angular units are not provided by the CRS identifier, the formatting rules for latitude (6.6.2.2) and longitude (6.6.2.3) shall apply.

It is the responsibility of the user to ensure the order and units of the coordinates match those of the CRS and to provide accompanying documentation for any special cases.

In such cases where the use of accompanying documentation poses a risk for misinterpretation, this document recommends the registration of a new CRS identifier, in a registry, which clearly specifies definitions for all parameters.

6.6.2.2 Latitude

Latitude formatting rules are specified as:

a) latitude on or north of the equator shall be designated using a plus sign (+);

b) latitude south of the equator shall be designated using a minus sign (-);

c) 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.

The first two digits of the latitude shall represent degrees. Subsequent digits shall represent minutes, seconds, or decimal fractions. The number of digits after the decimal mark (full stop) is based on user requirements.

Latitude formatting examples:

EXAMPLE 1

Degrees and decimal degrees: `DD.DDDD`

EXAMPLE 2

Degrees, minutes and decimal minutes: `DDMM.MMMM`

EXAMPLE 3

Degrees, minutes, seconds and decimal seconds: `DDMMSS.SSSS`

6.6.2.3 Longitude

Longitude formatting rules are specified as:

a) longitude on or east of the prime meridian shall be designated using a plus sign (+);

b) longitude west of the prime meridian shall be designated using a minus sign (-);

c) 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.

The first three digits of the longitude shall represent degrees. Subsequent digits shall represent minutes, seconds, or decimal fractions. The number of digits after the decimal mark (full stop) is based on user requirements.

Longitude formatting examples:

EXAMPLE 1

Degrees and decimal degrees: `DDD.DDDD`

EXAMPLE 2

Degrees, minutes and decimal minutes: `DDDMM.MMMM`

EXAMPLE 3

Degrees, minutes, seconds and decimal seconds: `DDDMMSS.SSSS`

6.6.2.4 Coordinate resolution

Coordinates shall be given to a resolution commensurate with the position accuracy. The linear resolution equivalent to angular coordinates (latitude and longitude) is given in Annex D.

6.6.3 Component structure

In the component definitions and examples in this clause, the lines are wrapped, at specific points, for clarity and the following notation is used in the component definitions:

— elements of the components — *monospace underlined italic* type,

— character string delimiters and terminators — **monospace bold regular** type.

Using the character string delimiters specified in 6.4 a) – i) the following structures are defined:

a) For one-dimensional spatial or temporal CRS identifiers (CRS1d), the structure is:

sign_One-dCoordinate_**CRS1d<**_CRS-identifier_**>/**

EXAMPLE 1

```
+100.5CRS1d<ISOGR:256>/
```

A GPL representation of an elevation value of +100.5 metres, based on a North American Vertical Datum of 1988 (NAVD88), CRS using abbreviated notation.

EXAMPLE 2

```
+329.72CRS1d<https://www.opengis.net/def/crs/EPSG/0/6360>/
```

A GPL representation of an elevation value of +329.72 in US survey feet, based on a North American Vertical Datum of 1988 (NAVD88) height (ftUS) CRS from the EPSG registry requested through the OGC definitions server.

b) For two-dimensional single spatial CRS identifiers, or two-dimensional compound CRS identifiers (CRS2d), the structure is:

sign_Two-dCoordinate1_**sign**_Two-dCoordinate2_**CRS2d<**_CRS-identifier_**>/**

EXAMPLE 3

```
+45.4293653-075.7016556CRS2d<https://api.epsg.org/def/crs/EPSG/0/4326/gml>/
```

A GPL representation of latitude +45.4293653 and longitude −075.7016556 in decimal degrees, based on the geographic 2D WGS84 CRS, defined through a link to an EPSG XML endpoint.

EXAMPLE 4

```
+452545.71-0754205.96CRS2d<https://api.epsg.org/def/crs/EPSG/0/4326/gml>/
```

A GPL representation of latitude +452545.71 and longitude -0754205.96 in sexagesimal degrees, based on the geographic 2D WGS84 CRS, defined through a link to an EPSG XML endpoint.

Example 3 and Example 4 use the same CRS identifier. However, the format of the coordinate tuples is different and is based on the rules specified in 6.6.2. It is the responsibility of the user to provide sufficient information in these cases.

EXAMPLE 5

```
-0754205.96+452545.71CRS2d<https://www.opengis.net/def/crs/OGC/1.3/CRS84>/
```

A GPL representation of longitude −0754205.96 and latitude +452545.71 in sexagesimal degrees. Here the CRS identifier, OGC WGS84 longitude-latitude, specifically defines the order of the coordinate tuples as longitude followed by latitude. It is important for the user to understand that unlike previous editions of this document, this example shows that in this edition, the order of the coordinate tuples within the component is solely defined by the CRS.

EXAMPLE 6

```
-2265.65+3303616.80CRS2d<https://api.epsg.org/def/crs/EPSG/0/2054/gml>/
```

A GPL representation of a pair of projected horizontal coordinates referenced to the Hartebeesthoek94 / Lo31 CRS, where EPSG 2054 and its parameters define that the values are a Westing (Y) of −2265.65 metres followed by a Southing (X) of +3303616.80 metres as EPSG 2054 uses a Cartesian CS (EPSG 6503) definition. This example further shows that the order of the coordinate tuples within the component is defined by the CRS. Therefore, it is imperative to understand the complete definition of the CRS identifier to interpret this GPL representation. The example coordinate tuple references the location of the Durban (DRBA) CORS base station, which is within the South African CORS network that is named TrigNet (http://www.trignet.co.za).

EXAMPLE 7

```
+50-1.5CRS2d<https://api.epsg.org/def/crs/EPSG/0/4807/gml>/
```

A GPL representation using units of grads/gons (g) defining a position 50gN, 1.5gW of Paris, using NTF(Paris) CRS or EPSG 4807.

EXAMPLE 8

```
+3775.51{2019-08-23T11:24:57}CRS2d<myGR:JGD2011(vertical)-OHt+Time>/
```

A GPL representation of height and time using a personally defined (fictitious) two-dimensional compound CRS [myGR: JGD2011(vertical)-OHt+Time] consisting of an orthometric height in metres (Mt. Fuji Japan) followed by an observation date/time string. The one-dimensional CRS is defined at: https://geodetic.isotc211.org/register/geodetic/items/428. It can be noted that the order of components and elements is changed based on the definition of the compound CRS.

c) For a three-dimensional single spatial CRS identifier, or a three-dimensional compound CRS identifier (CRS3d), the structure is:

sign_Three-dCoordinate1_**sign**_Three-dCoordinate2_
sign_Three-dCoordinate3_**CRS3d<**_CRS-identifier_**>/**

EXAMPLE 9

```
+1107356.4843-4344857.0942+4520991.4896CRS3d<ISOGR:372>/
```

A GPL representation of a three-dimensional geocentric Cartesian CRS with a static reference frame. In this example, coordinates representing X, Y, Z are in metres for the Canadian Coordinate Reference System based on NAD83 version 6, [NAD83(CSRS)v6 – XYZ] using abbreviated notation for the CRS identifier (ISOGR:372) and defined by: https://geodetic.isotc211.org/register/geodetic/items/372

EXAMPLE 10

```
-33.8559713+151.2062538+14.76CRS3d<ISOGR:329>/
```

A GPL representation of a three-dimensional geodetic ellipsoidal CRS with a static reference frame. In this example, coordinates representing latitude, longitude and ellipsoidal height in metres are based on the Geocentric Datum of Australia 2020 (GDA2020), using abbreviated notation for the

CRS identifier (ISOGR:329) and defined by: https://geodetic.isotc211.org/register/geodetic/items/329

EXAMPLE 11

```
+35.1666667+129.0833333+5.7CRS3d<myGR:Korea2000+Incheon_cmpnd_CRS>/
```

A GPL representation of Lat/Lon/Height using a personally defined (fictious) three-dimensional compound CRS (myGR:Korea2000:Incheon_cmpnd_CRS) consisting of Korea 2000 and Incheon height. The order of components is defined by the compound CRS. These CRS definitions exist separately as EPSG 5179 and EPSG 5193, respectively.

EXAMPLE 12

```
+5.7+129.0833333+35.1666667CRS3d<myGR:Incheon+Korea2000_H_Lon_Lat_cmpnd_CRS>/
```

A GPL representation modified from Example 11 of Height/Lon/Lat using a personally defined (fictious) three-dimensional compound CRS (myGR:Incheon+Korea2000_H_Lon_Lat_cmpnd_CRS) consisting of Incheon height followed by Korea 2000 Lon/Lat. It can be noted that the order of components and elements is changed based on the modified definition of the second compound CRS.

This document recommends defining a compound CRS to meet formatting requirements that maintains conformance to the rules specified in this document.

d) For a four-dimensional single spatial CRS identifier, or a four-dimensional compound CRS identifier (CRS4d), the structure is:

sign*Four-dCoordinate1***sign***Four-dCoordinate2*
sign*Four-dCoordinate3***sign***Four-dCoordinate4***CRS4d<***CRS-identifier***>/**

EXAMPLE 13

```
+385444.67-0770348.96+43.912{2010-05-25T09:31:25-07:00}CRS4d<myGR:GD3D_NAD83+T>/
```

A GPL representation of Lat/Lon/Height/time using a personally defined (fictitious) four-dimensional compound CRS (myGR: GD3D_NAD83+T) consisting of a three-dimensional geodetic ellipsoidal CRS and a one-dimensional temporal CRS (ISO 8601-1:2019).

EXAMPLE 14

```
-3957162.094+3310203.635+3737752.405{2019-12-23T11:24:57}CRS4d<myGR:ITRF2008+Time>/
```

A GPL representation of X/Y/Z/time using a personally defined (fictitious) four-dimensional compound CRS (myGR: ITRF2008+Time) consisting of a three-dimensional geocentric Cartesian CRS and a one-dimensional temporal CRS. It can be noted that the order of components and elements is changed based on the definition of the compound CRS.

e) For two- or three-dimensional single CRS identifiers with a dynamic reference frame requiring a coordinate epoch, the structures are respectively:

1) **sign***Two-dCoordinate1***sign***Two-dCoordinate2***@***epoch***CRS2d<***CRS-identifier***>/**

2) **sign***Three-dCoordinate1***sign***Three-dCoordinate2*

sign*Three-dCoordinate3***@***epoch***CRS3d<***CRS-identifier***>/**

NOTE The structure shown in e) 1) is for a two-dimensional dynamic reference frame with a coordinate epoch, while the structure shown in e) 2) is for a three-dimensional dynamic reference frame with a coordinate epoch.

EXAMPLE 15

```
-4052052.645+4212836.005-2545104.721@2017.56CRS3d<ISOGR:425>/
```

A GPL representation of a three-dimensional geocentric Cartesian CRS with a dynamic reference frame [epoch 2017.56] formatted using the [@] delimiter specified in 6.4 f). In this example, coordinates representing X, Y, Z are in metres using ITRF2014 [ITRF2014-XYZ] using abbreviated notation for the CRS identifier (ISOGR:425) and defined by: http://geodetic.isotc211.org/register/geodetic/items/425

EXAMPLE 16

```
+452355.938292-0755520.139374@2010CRS2d<myGR:NAD83(CSRS)_v7>
```

A GPL representation of a two-dimensional geographic CRS with a dynamic reference frame formatted using the [@] delimiter specified in 6.4 f). In this example, the latitude and longitude coordinates at epoch 2010 are represented by a personally defined (fictitious) CRS (myGR: NAD83(CSRS)_v7). The coordinates represent the horizontal components of the three-dimensional Canadian Base Network station Bossler (BSLR), represented by the unique number: 833001, Ottawa, Canada and were obtained from: https://webapp.geod.nrcan.gc.ca/geod/data-donnees/station/report-rapport.php?id=833001

EXAMPLE 17

```
-4646624.918+2553843.245-3533201.936@2020.51CRS3d<myGR:ATRF2014-XYZ>/
```

A GPL representation of a three-dimensional geocentric CRS with a dynamic reference frame [epoch 2020.51] formatted using the [@] delimiter specified in 6.4 f). In this example coordinates representing X, Y, Z, are in metres with ATRF2014 as an abbreviated notation using a personally defined (fictious) CRS (myGR:ATRF2014-XYZ) identifier.

f) Additional examples showing how multiple components and CRSs with varying dimensions can be joined based on the structures in a) — e) to create GPL representation strings:

EXAMPLE 18

```
-85.5CRS1d<EPSG:5703>{2016-02-05T09:31:25-07:00}CRS1d<ISO:8601-1_2019>/
```

A GPL representation using two, one-dimensional components, the first representing an elevation value of −85.5 in metres from Badwater Basin, Death Valley, California USA, based on a North American Vertical Datum of 1988 (NAVD88) using an abbreviated CRS notation defined by EPSG: 5703. The second component, an observation date/time string is represented using an abbreviated CRS notation [ISO:8601-1_2019] defined by a published document (ISO:8601-1:2019).

EXAMPLE 19

```
{19850818}CRS1d<ISO:8601-1_2019>+1000.00+1500.52CRS2d<https://api.epsg.org/def/crs/
EPSG/0/6715/gml>/
```

A GPL representation using a one-dimensional component representing a date/time string using an abbreviated CRS notation defined by ISO:8601-1_2019, followed by a two-dimensional component, with the values +1000.00 E and 1500.52 N in metres based on an engineering CRS (Christmas Island Grid) defined by EPSG 6715.

EXAMPLE 20

```
+353929.1572+1394428.8869+60.74CRS3d<https://api.epsg.org/def/crs/EPSG/0/6667/gml>/
{H21.03.15T14:20:30}CRS1d<JIS:JISX0301_2002>/
```

A GPL representation of a three-dimensional geodetic ellipsoidal CRS with a static reference frame. In this example, latitude and longitude are defined by the angular coordinates in sexagesimal format, followed by the height as a meter value using JGD2011-LatLonEHt defined in EPSG 6667. An additional observation date/time string defined using abbreviated notation references Japan JIS X 0301:2002 as the CRS identifier.

7 Human-readable GPL representation

7.1 Overview of human-readable GPL representation

As in previous editions of this document, a human-readable GPL representation is essential for the representation of GPL.

The human-readable format is typically intended for situations in which communication of GPL representations is critical. The human-readable format shall not be a substitute for the GPL text string representation (6.6) when machine readable representations are required.

To maintain the unambiguous GPL representations defined in Clause 6, the human-readable format specified in Clause 7 defines additional formatting requirements, compared to the human-readable representation defined in previous editions of this document. The human-readable formatting requirements specified in this document always require a CRS identifier and follow the definitions of the specific CRS used. Therefore, when structuring a human-readable representation, understanding of the CRS is required. If a human-readable format is required in applications of digital display, the format shall be encoded using the characters specified in Table F.1.

7.2 General requirements of human-readable GPL representation

Coordinate values can be understood most easily when they are well laid out. User communities have their own specific requirements for representation. Documentation is recommended to accompany all human-readable GPL representations, especially for users outside of a specific community.

In the absence of a user community specification, the following formatting specifications shall be used.

All representations, where applicable, shall apply rules a) — d):

a) when multiple coordinates are present, each coordinate shall be separated by a *space*;

b) the order of the coordinates within the components shall be defined in the specific CRS;

c) CRS identifiers shall be listed at the end of the string, beginning after the last coordinate and separated by a *space*. Formatting of CRS identifiers shall follow rules c) 1) — c) 4):

 1) all CRS identifiers shall be placed within a pair of *angle brackets* [< >];

 2) each CRS identifier shall be formatted as a free-form string with no leading or trailing spaces;

 3) the sequence order of the CRS identifiers shall be identical to the sequence order of the associated coordinates in the human-readable text string;

 4) when multiple CRS identifiers are present, each shall be separated by a *space*.

d) the separator between the integer and fractional parts of a coordinate shall be a *full stop* (point) on the line (.);

Elements for axis abbreviation, axis direction and units of measure are defined in CoordinateSystemAxis class (ISO 19111:2019, Table 47) and used in the following rules.

For latitude and longitude coordinates the following rules e) — i) shall apply:

e) the units of measure for latitude and longitude coordinates shall follow the definition of the specific CRS;

f) when sexagesimal degree representation is specified the following rules f) 1) – f) 2) shall apply:

 1) where the minute or second value is less than 10, its value shall include a leading 0;

2) degree, minute and second units shall be identified with symbols:

i) the recommended symbols are:

— degrees — *degree sign* [°] ,

— minutes — *apostrophe* ['], and

— seconds — *quotation mark* ["].

ii) the symbols shall immediately follow their value;

iii) there shall be no spaces between degree, minute and second values.

g) latitude hemisphere north or south, shall follow the elements defined in the specific CRS:

1) there shall be no space between the latitude value and its hemisphere indicator;

2) if the elements are not defined, the latitude hemispheres north or south shall be indicated through the *Latin capital letters N* or *S*, respectively.

h) longitude hemisphere east or west, shall follow the elements defined in the specific CRS:

1) there shall be no space between the longitude value and its hemisphere indicator;

2) if the elements are not defined, the longitude hemisphere east or west shall be indicated through the *Latin capital letters E* or *W*, respectively.

i) axis abbreviations are recommended, and when present, shall be applied using the following rules:

1) when a hemisphere indicator is present, the axis abbreviation shall follow the hemisphere indicator separated by a *space*;

2) when there are no hemisphere indicators present, the axis abbreviation shall immediately follow the coordinate value (symbol) without any space.

For coordinate values representing heights or depths, the rules in j) shall apply:

j) direction and units of measure for height or depth are identified with a symbol, as specified by the elements defined in the specific CRS:

1) height or depth from the reference surface in the negative direction shall be designated using a *hyphen/minus* (-) immediately preceding the value;

2) the separator between the integer and fractional parts of the value shall be a *full stop* (point) on the line (.);

3) the unit symbol shall immediately follow the value;

4) there shall be no space between the value and its unit symbol;

5) to improve clarity the axis abbreviation shall immediately follow the unit symbol;

6) when no axis abbreviation is defined it shall be indicated through the *Latin capital letter H* and *Latin small letter t*, with no separating space (e.g. Ht).

For other coordinate types, the following rules k) — n) shall apply:

k) negative coordinate values shall be designated using a *hyphen/minus* (-) immediately preceding the value;

l) units of measure for the coordinate value shall be identified with a symbol, as specified by the elements defined in the specific CRS:

   1) the unit symbol should follow the value, and

   2) there should be no space between the value and its unit symbol.

m) axis abbreviations for the coordinate value shall be identified with a symbol, as specified by the elements defined in the specific CRS;

   1) the axis abbreviation symbol should follow the value, and

   2) there should be no space between the value and its axis abbreviation symbol.

n) when the axis abbreviations do not represent the directions, then the axis direction for the coordinate value shall be identified with a symbol, as specified by the elements defined in the specific CRS:

   1) the axis direction symbol shall follow the axis abbreviation, enclosed between left and right parenthesis "( )", and

   2) there shall be no space between the value and its axis direction symbol.

7.3 Formatted examples of human-readable text strings

The following are formatted examples of human-readable text strings:

EXAMPLE 1

```
40°26'27.00"N 105°45'17.00"W 3597.078mHt <NAD 1983>
```

This human-readable example depicts a lat/lon coordinate tuple with a height in metres. The CRS identifier text string contains a high level of ambiguity because the example assumes that the user community understands the meaning of Geographic NAD 1983. However, the CRS identifier is not clearly understood and the specific definition is not uniquely referable. Although this format is a valid human-readable string construction, a more descriptive CRS identifier is recommended, unless usage is restricted to a specific user community. Additionally, the axis-abbreviation for the height element is not defined and is represented using "Ht", as specified in 7.2 j) 6).

EXAMPLE 2

```
40°26'27.00"N 105°45'17.00"W 3597.078mHt <EPSG:5498>
```

As in Example 1, this human-readable example depicts the same lat/lon coordinate tuple and height. Here, the CRS identifier text string contains a moderate level of ambiguity because the CRS shown in the example assumes that the user community understands the meaning of EPSG 5498. With accompanying documentation, the CRS identifier is referable in certain situations.

EXAMPLE 3

```
40°26'27.00"N 105°45'17.00"W 3597.078mHt <NAD83+NAVD88height/EPSG:5498/NGS:LL0764>
```

As in Examples 1 and 2, this human-readable example depicts the same lat/lon coordinate tuple and height in metres. Here the CRS identifier text string (NAD83+NAVD88 height EPSG:5498 NGS: LL0764) contains a low level of ambiguity and provides a significant amount of detail, with enough information that is referable to a very wide user community. It is probable that a wide range of users understand that the coordinates are NAD83-based horizontal with a NAVD88 orthometric height in metres, defined by EPSG registry code of 5498, a two-dimensional horizontal with a one-dimensional vertical compound CRS. This example point references the US National Geodetic Survey (NGS) Permanent Identifier (PID) LL0764, a vertical control mark (https://www.ngs.noaa.gov/cgi-bin/ds_mark.prl?PidBox=LL0764) in the Rocky Mountains, 16.7 km west of Estes Park, Colorado along Trail Ridge Road.

EXAMPLE 4

```
298412.15mE 9013860.88mN <Camacupa 1948 / UTM zone 33S>
```

This human-readable example depicts a pair of projected horizontal coordinates based on a Universal Transverse Mercator (UTM) projection. Here, the CRS identifier text string of Camacupa 1948 / UTM zone 33S is equivalent to the common name defined by EPSG 22033. The example coordinate tuple references a location in Luanda, Angola.

EXAMPLE 5

```
49126.26mY(west) 3758402.15mX(south) <EPSG:2048>
```

This human-readable example depicts a pair of projected horizontal coordinates referenced to the Hartebeesthoek94 / Lo19 CRS, which is a Gauss Conform Coordinate System that is based on a south-oriented Transverse Mercator projection. Here the axis direction (west or south) is shown. The order of the coordinates is defined by the CRS (EPSG:2048). The example coordinate tuple references the location of the Cape Town (CTWN) CORS base station, which is within the South African CORS network that is named TrigNet (http://www.trignet.co.za).

EXAMPLE 6

```
-35335.8mN -6119.2mE 2.9mH <JGD2011 / Japan Plane Rectangular CS
IX+JGD2011 (vertical) height>
```

This human-readable example depicts a pair of projected horizontal coordinates and a height in metres. The CRS identifier text string is based on a personally defined compound CRS comprised of a two-dimensional JGD2011/Japan Plane Rectangular CS IX projection (EPSG:6677) with an orthometric elevation in metres measured according to JGD2011 (vertical) (EPSG:6695). The CRS identifier text string is easily referable and has a low level of ambiguity. The point location references the historical terraced staircase entrance in front of Tokyo Station, Chiyoda-ku, Tokyo, Japan.

EXAMPLE 7

```
-35335.8mN -6119.2mE 2.9mH <JGD 2011/Japan Plane Rectangular CS IX>
<JGD2011 (vertical) height>
```

This human-readable example uses the same coordinates and elevation from Example 6, but depicts the horizontal coordinates and vertical height using multiple CRS identifier text strings, each of them formatted within a pair of angle brackets separated by a space, as specified in 7.2 c) 4).

EXAMPLE 8

```
-4052052.645mX +4212836.005mY -2545104.721mZ @2017.56 <ISOGR:425>
```

This human-readable representation depicts a three-dimensional geocentric Cartesian coordinate CRS with a dynamic reference frame [epoch 2017.56] formatted using the [@] delimiter 6.4 f). In this example, the coordinates representing X, Y, Z are in metres using ITRF2014 [ITRF2014-XYZ]. The CRS identifier text string uses abbreviated notation to describe ISOGR:425 and is specified by: https://geodetic.isotc211.org/register/geodetic/items/425

EXAMPLE 9

```
38°53'22.08257"N 77°02'06.86428"W 149.172mh {2018-11-27T10:31-05:00}
<NAD83(2011)+Time>
```

This human-readable representation depicts three-dimensional geodetic coordinates of lat/lon/ellipsoidal height with a temporal identifier using a personally defined (fictitious) compound CRS (NAD83(2011)+T). The personally defined compound CRS is composed of a three-dimensional geodetic ellipsoidal CRS defined by NAD 83 (2011) – epoch 2010 and a one-dimensional temporal CRS (ISO 8601-1:2019). The point location references the Washington Monument in Washington DC, USA, via a resurvey project as described in: https://www.ngs.noaa.gov/PUBS_LIB/NOAA_TR_NOS_NGS_51_2015_02_16.pdf and https://www.ngs.noaa.gov/surveys/ngs/wm2013/

Annex A
(normative)

Conformance and abstract test suite

A.1 General

To verify whether a representation of geographic point location by coordinates is in conformance with this document, check that it satisfies the requirements for the appropriate conformance class given in A.2 and A.3. Conformance shall be tested against the requirements specified in Clauses 6 and 7 and Annex B.

Conformance categories are shown in Table A.1.

Table A.1 — Categories of conformance

Category	Requirements in
Conformance for the representation of geographic point location for latitude and longitude or other coordinate types conforming to the requirements of a specific CRS used for that representation.	A.2
Conformance for the representation of latitude and longitude and optionally height or depth conforming to ISO 6709:2008.	A.3

A.2 Abstract test suite for conformance for geographic point location representation based on a specific CRS

A.2.1 Test case identifier: Components required for a geographic point location representation

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

b) Test method: Check the components described and confirm that each component is comprised of a coordinate tuple, a character string delimiter and a CRS identifier.

c) Reference: 6.2, 6.3, 6.4, 6.5.

d) Test type: Basic.

A.2.2 Test case identifier: Structure of a point location representation

a) Test purpose: Verify that a structure of a geographic point location is complete.

b) Test method: Check the requirements given in 6.6 and confirm that all of the necessary information is provided in the required format and sequence.

c) Reference: 6.6.2, 6.6.3.

d) Test type: Basic.

A.2.3 Test case identifier: Unambiguous human-readable representation

a) Test purpose: Verify that the unambiguous human-readable representation conforms to the requirements of this document.

b) Test method: Check the requirements given in Clause 7 and confirm that all of the necessary information is provided in the required format and sequence.

c) Reference: Clause 7.

d) Test type: Basic.

A.3 Abstract test suite for conformance for backwards compatible representation of geographic point location

A.3.1 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: B.2.

d) Test type: Basic.

A.3.2 Test case identifier: Representation of horizontal position

a) Test purpose: Verify that the representation of the horizontal position conforms to the elements described in B.3.1.

b) Test method: Check the requirements given in B.3.1 and confirm that all of the necessary information is provided in the required format and sequence.

c) Reference: B.3.1.

d) Test type: Basic.

A.3.3 Test case identifier: Representation of vertical position

a) Test purpose: Verify that the representation of the vertical position conforms to the elements described in B.3.2.

b) Test method: Check the requirements given in B.3.2 and confirm that all of the necessary information is provided in the required format and sequence.

c) Reference: B.3.2.

d) Test type: Basic.

A.3.4 Test case identifier: CRS identification

a) Test purpose: Verify that a CRS identifier is given for geographic point locations and that it covers both horizontal and vertical positions when geographic point locations include a vertical coordinate.

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

c) Reference: B.4.

d) Test type: Basic.

A.3.5 Test case identifier: Text string representation

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

b) Test method: Check the requirements given in B.5 and confirm that all of the necessary information is provided in the required format and sequence.

c) Reference: B.5.

d) Test type: Basic.

A.3.6 Test case identifier: Human-readable representation

a) Test purpose: Verify that the human-readable representation conforms to the requirements of this document.

b) Test method: Check the requirements given in B.6 and confirm that all of the necessary information is provided in the required format and sequence.

c) Reference: B.6.

d) Test type: Basic.

Annex B
(normative)

Backwards compatible representation of geographic point location

B.1 Overview

Annex B defines the structure and conforms to the requirements specified in ISO 6709:2008 with minimal editorial revisions.

ISO 6709:2008 defined geographic point location (GPL) for horizontal latitude and longitude coordinates, and optionally, height or depth.

In systems and environments where backwards compatibility with the previous edition of ISO 6709 is required the methods and formatting requirements defined in Annex B shall be applied.

In addition, when using the methods in Annex B, it is strongly recommended that suitable and comprehensive ancillary documentation, not defined within this document, or in previous editions of ISO 6709 be prepared and accompany all instances of geographic point location text strings and human-readable representations claiming backwards compatibility.

NOTE Further references to *geographic point location* in Annex B refer to *backwards compatible geographic point location* (ISO 6709:2008) and will not be restated as such.

B.2 Elements required for geographic point location

GPL shall be represented by the following elements:

a) coordinate representing horizontal position — latitude;

b) coordinate representing horizontal position — longitude;

c) optionally, for three-dimensional point locations, a value representing vertical position through either height or depth;

d) when unambiguous representation is required, or three-dimensional point locations are used, a single CRS identifier is required.

B.3 Representation of horizontal and vertical positions

B.3.1 Horizontal position

Horizontal position shall be described through a pair of coordinates. The directions of each coordinate axis, the order of the coordinates and their units shall be as described in the CRS identifier, 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, sexagesimal degrees may be used. Recommendations for display of latitude and longitude at the human interface are specified in B.6.

B.3.2 Vertical position

Vertical position shall be height or depth, as described by the CRS identifier. 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.

NOTE ISO 6709:1983 used the term "altitude" to describe vertical position. This document uses the more general term "height" and allows for vertical location to be described as "depth".

If height or depth is given:

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

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

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

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

B.4 Coordinate reference system identification

A CRS identifier shall be given for geographic point locations to be described unambiguously. When geographic point locations include a vertical coordinate, the specified single or compound CRS shall cover both horizontal and vertical positions. The definition of the CRS identifier shall match the order of the horizontal coordinates, meaning latitude followed by longitude.

It is recognized that, in the absence of a CRS identifier, a level of uncertainty in geographic point location is introduced. This geographic offset in position can be as much as 1 km from an actual point location as presented in Annex C.

Any CRS type as described by ISO 19111 that maintains the coordinate order of latitude followed by longitude, as specified by the backwards compatibility requirement, may be used.

B.5 Text string representation

B.5.1 General

For systems and environments requiring text string representation maintaining backwards compatibility with the previous edition of this document, the rules defined in the following subclauses shall be followed.

B.5.2 Angular formatting rules

Angular formatting rules are specified in the following subclauses:

— Angular formatting rules for latitude are specified in 6.6.2.2.

— Angular formatting rules for longitude are specified in 6.6.2.3.

B.5.3 Height or depth

The representation of height or depth is optional. However, if it is represented, it shall comply with the following rules:

a) if height or depth is expressed, a CRS identifier shall be supplied;

b) height or depth from the reference surface in the positive direction shall be designated using a *plus sign* (+);

c) height or depth from the reference surface in the negative direction shall be designated using a *minus sign* (-);

d) height or depth on the reference surface shall be designated using a *plus sign* (+);

e) the referenced CRS shall describe whether the value is a height or a depth;

f) direction and units for height and depth shall be defined through the referenced CRS.

B.5.4 Coordinate reference system identifier structure

To remove ambiguity of the coordinates, the use of a CRS identifier is recommended. When present, CRS identification shall be designated using the characters "CRS".

When required, the CRS identifier shall be enclosed within *angle brackets* [< >] immediately following the "CRS" characters.

NOTE 1 In the following structure definitions, the `CRS`, angle bracket delimiters and terminator character are shown in **`monospace bold regular`** type. The examples shown in this subclause are fragments of GPL representation strings and are designated as such by the "..." ellipsis in each example.

When represented, the structure of the CRS identifier shall conform to the following rules:

a) complete URL notation:

```
CRS<registryURL>/
```

where registryURL is a well-formed URL, without leading or trailing spaces, and returns the CRS identifier either as a human interface endpoint (e.g. HTML) or as service endpoint (e.g. XML, GML, WKT, JSON, etc.).

NOTE 2 The endpoint preference is based on the requirements of the user.

EXAMPLE 1

```
...CRS<https://api.epsg.org/def/crs/EPSG/0/4979/gml>/
```

An XML/GML endpoint from the EPSG Registry, defining geographic 3D WGS 84 CRS – EPSG code 4979.

b) abbreviated notation:

```
CRSregisterID:CRS-ID/
```

an abbreviated notation in which a registry identifier (registerID) is a text string, without leading or trailing spaces, immediately followed by a single *colon* (:) then immediately followed by the CRS identifier (CRS-ID) from the registry.

EXAMPLE 2

```
...CRSISOGR:204/
```

Defines ISO/TC211 Geodetic Registry ID 204 NAD 83 (HARN) CORRECTED – LatLonEHt referenced at: https://geodetic.isotc211.org/register/geodetic/items/204

B.5.5 Format

Elements defined in subclauses B.5.2 through B.5.4 shall be combined in a GPL formatted string using the following required sequence:

— latitude;

— longitude;

— height or depth, if represented;

— CRS identifier, when required.

In addition to the specified sequence of elements, the formatted string shall conform to the following rules:

— the number of digits for latitude, longitude and height (depth) shall indicate the precision of available data;

— there shall be no separator between the elements for latitude, longitude, height (depth) and the CRS identifier;

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.

— the GPL string shall be terminated and the terminator character shall be a *slash*, *stroke*, or *solidus* (/).

B.5.6 Formatted examples

Combined format text string representations are shown in the following examples.

a) examples of representation of latitude and longitude without height or depth:

EXAMPLE 1

```
+35.360628+138.727365/
```

In the preceding example, the position is ambiguous because no CRS is identified. Within a single user community there is a possibility this format can be clearly understood, but if used outside that community, the position can be ambiguous.

EXAMPLE 2

```
+452545.71-0754205.96CRS<https://api.epsg.org/def/crs/EPSG/0/4326/gml>/
```

A GPL representation of latitude +452545.71 and longitude -0754205.96 in sexagesimal degrees based on the geographic 2D WGS84 CRS defined through a link to an EPSG XML endpoint.

b) examples of representation of latitude and longitude with height or depth:

EXAMPLE 3

```
+35.360628+138.727365+3775.51CRSmyGR:JGD2011-LatLon+JGD2011-OHt/
```

This example shows the location of Mount Fuji, Japan using a personally defined (fictitious) registry (myGR) and a compound CRS composed of JDG2011-LatLon (ISOGR:416) and JGD2011-OHt (ISOGR: 428).

EXAMPLE 4

```
+36.250278-116.825833-83.357CRSEPSG:6319/
```

This example shows lat/lon/height at NGS-PID GS0240 for a position in Badwater Basin, Death Valley, California. The CRS is represented using a registry (EPSG) showing the CRS defined by code 6319 [NAD83(2011)].

B.6 Human-readable representation

B.6.1 Overview of human-readable representation

Decimal degrees are not always 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; and 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 those involved with emergency response, are accustomed to seeing latitude and longitude given in this order. If a height or depth is also given, it follows longitude. Presenting coordinate values in an unexpected order has life-safety implications.

B.6.2 General requirements of human-readable representation

Coordinate values can be understood most easily when they are well laid out. User communities are likely to have their own specific requirements for representation.

NOTE ISO 6709:2008 did not specify the use of a CRS for human-readable representation.

In the absence of a user community specification, and only when backwards compatibility with the previous edition of this document is required, the following formatting specifications shall be used:

a) each coordinate in a coordinate tuple shall be separated by a *space*;

b) latitude shall precede longitude;

c) latitude and longitude shall be given as sexagesimal degrees;

d) where the minute or second value is less than 10, its value shall include a leading 0;

e) degree, minute and second units shall be identified with symbols:

   1) the recommended symbols are:

      — degrees — *degree sign* [°],

      — minutes — *apostrophe* ['], and

      — seconds — *quotation mark* ["].

   2) the symbols shall immediately follow their value;

   3) there shall be no spaces between degree, minute and second values.

f) latitude hemisphere north or south shall be indicated through the letter *N* or *S* respectively;

   1) there shall be no space between the latitude value and its hemisphere indicator;

g) longitude hemisphere east or west shall be indicated through the letter *E* or *W* respectively;

   1) there shall be no space between the longitude value and its hemisphere indicator;

h) height or depth units are identified with a unit symbol:

   1) the unit symbol shall follow the value;

   2) there shall be no space between the value and its unit symbol;

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

B.6.3 Formatted examples of human-readable text strings

The following are formatted examples of human-readable text strings:

EXAMPLE 1

```
45°25'30.4910"N -75°42'00.4712"W
```

A human-readable example showing the lat/lon of the Canadian Parliament Building in Ottawa, Canada. The format is acceptable for backwards compatible uses in which heights or depths are not required.

EXAMPLE 2

```
35°42'36.2736"N 139°48'38.5200"E 2.00m
```

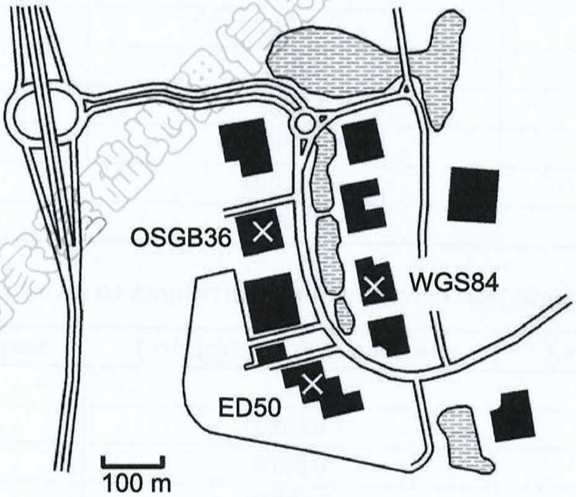
A human-readable example showing the lat/lon and height (elevation) at the base of the Tokyo Skytree Tower in Sumida-ku, Tokyo, Japan. The format is acceptable for backwards compatible uses in which heights or depths can be required.

Annex C
(informative)

Uniqueness of latitude and longitude coordinates

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 approximately 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 concept that historically was called a geodetic datum, but for modern coordinate reference systems is known as a terrestrial reference frame. If the model or its position or orientation is changed, that is, if the CRS's geodetic reference frame or datum is changed, the values of latitude and longitude at a point usually changes. The same values of latitude and longitude referenced to different coordinate reference systems refer to different locations (Figure C.1). Conversely, for coordinate values to be unambiguous, it is necessary to identify the coordinate reference system to which they are referenced.

The differences in coordinate values of a point caused by a change of geographic coordinate reference system are typically about 50 m 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 CRS and its reference frame or datum is essential.



NOTE "WGS84", "ED50" and "OSGB36" are the identifiers of Coordinate Reference Systems.

Figure C.1 — Locations with identical latitude and longitude values referenced to three different CRSs

This concept of a change of model of the Earth, or a change in the position or orientation of the model with respect to the Earth, applies to other types of coordinates. Geocentric Cartesian, from which geodetic latitude, longitude and ellipsoid height are often derived, are only unambiguous when qualified by the identification of their CRS and its reference frame. Projected ('map grid') coordinates are derived from geographic (latitude and longitude) coordinates. For the projected coordinates to be unambiguous, it is therefore also necessary to identify the reference frame or datum for their base geographic coordinates.

Annex D
(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 19115-1.

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 (1852 m) and 1" equivalent to approximately 30 m.

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

Table D.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	0.0001	0.3"
1 m	0.00001	0.03"
10 cm	0.000001	0.003"
1 cm	0.0000001	0.0003"

Table D.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	0.0167	1'
30 m	0.0003	1"
3 m	0.00003	0.1"
0.3 m	0.000003	0.01"
0.03 m	0.0000003	0.001"
0.003 m	0.00000003	0.0001"

Annex E
(informative)

Changes compared to ISO 6709:2008

E.1 List of changes compared to ISO 6709:2008 (previous edition)

The main changes compared to ISO 6709:2008 are listed in the Foreword. Additional detail is provided in the following list:

a) In 2009, a Technical Corrigendum to ISO 6709:2008 was published. The corrigendum corrected errors and omissions in ISO 6709:2008, Annex D. In this document, ISO 6709:2008, Annex D and the revisions from the Technical Corrigendum have been verified, re-designated as normative and moved into Annex B. The Technical Corrigendum to ISO 6709:2008 has been cancelled.

b) At the time of publication, Annex D in ISO 6709:2008 was incorrectly designated as informative. In this document the content from ISO 6709:2008 Annex D was verified, re-designated as normative and formatted into Annex B.

c) Annex C in ISO 6709:2008 provided a UML description of geographic point location. The UML in that annex is no longer consistent with the current Harmonized Model (HM) of ISO/TC 211. During this revision, it was agreed by the project team that UML descriptions were not within the scope of this document, therefore ISO 6709:2008, Annex C and any UML notation elsewhere in ISO 6709:2008 were not carried through into this edition. Users wanting to model geographic point locations in UML should refer to ISO 19109 when used as a feature, or ISO 19107, when used as an attribute of a feature.

d) Annex F in ISO 6709:2008 contained UML and gave one example of how geographic point location representations could be used within an application schema. The concepts have since changed and during this revision it was agreed by the project team to remove Annex F.

e) Annex G in ISO 6709:2008 provided information and examples using the ISO 19136 series Geography Markup Language (GML), an eXtensible Markup Language (XML) grammar written in XML schema. Presently, these examples are no longer current because of conceptual changes and revisions to their reference standards. During the revision, it was agreed that these GML examples were not within the scope of this document and were inconsistent with current concepts and notation. Therefore, Annex G was removed. Users wanting to provide encodings of geographic point location using GML or XML should consult the ISO 19136 series.

f) ISO 6709:2008 extended ISO 6709:1983 to allow for depths as well as heights and to include coordinate reference system identification. These concepts have been clarified in this edition.

g) ISO 6709:2008, subclause 6.3 specified that "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." The syntax for a) was further defined in ISO 6709:2008, 6.3, items 1) and 2), each without the use of angle brackets. However, ISO 6709:2008 Annex H presented rules for formatting text string point locations and from that annex, H.5.2, items a) and c) specified the format of CRS identifiers with the use of angle brackets which was different from the statements in ISO 6709:2008, 6.3. Additionally, because there were no examples in ISO 6709:2008, Annex H to show the use of "online registries" or "full CRS definitions", this discrepancy could not be clarified. Therefore, in this document, the structure of the CRS identifier was clarified in B.5.4 a) as "complete URL notation" to use angle brackets. The structure in this document for "abbreviated notation" [B.5.4 b)] remains the same. Examples in this document (B.5.6) follow these formatting rules. The "full CRS definition" option was not added to this document (B.5.4) because there are no specific formatting rules or examples published in ISO 6709:2008.

h) Additionally, when ISO/TS 19127[1)] was updated and published in 2019, the content was no longer relevant to this document. Therefore, all references to ISO/TS 19127 have been removed.

i) ISO 6709:2008, Annex H contained normatively defined rules for the construction of text string representation of point location but was incorrectly designated as informative. This normative content was verified and moved into Annex B of this document.

j) Some numeric formatting in ISO 6709:2008 incorrectly followed localized/regionalized formatting conventions in which a "comma on the line" was used in place of a "point on the line". In addition, a space was used as a separator in place of a comma. In this edition, these conventions are considered incorrect and have been replaced. This is described in the Foreword and E.3.

E.2 Differentiation of GPL representations between editions

To differentiate between editions of GPL representation, humans and machine processes can quickly examine the CRScsd in a GPL representation using the following interpretation rules.

If the CRScsd in a GPL representation is:

— one of [CRS1d, CRS2d, CRS3d, or CRS4d], then the GPL representation is from the current edition, or

— one of [CRS], then the GPL representation is from the previous edition (ISO 6709:2008).

If no instance of [CRS1d, CRS2d, CRS3d, CRS4d, or CRS] is present, then one of the following scenarios is possible:

— the GPL representation is correctly formatted according to the previous edition (ISO 6709:2008), but the position of the point is ambiguous, or

— the GPL representation is incorrectly formatted.

E.3 Cultural and language adaptability

The previous edition of this document loosely supported cultural and language adaptability by allowing either a *full stop* (.) or *comma* (,) to be used as the "decimal mark." Users are required to understand these issues and consult all accompanying metadata and documentation. While the choice between these alternatives depends on customary use in the language (locale) concerned, it is preferred, in the technical areas of geodesy and geographic information that the decimal mark always be a full stop/decimal point (.) for all languages. This practice is required by this document.

1) Withdrawn. Replaced by ISO 19127:2009.

Annex F
(normative)

Character encodings

F.1 Character code notations

Universal Coded Character Set (UCS) values for character strings and delimiters required in this document are represented using notation based on ISO/IEC 10646:2020, 34.5 as specified in Table F.1.

Table F.1 — Character string delimiter names and UCS codes

ISO/IEC 10646 Name	Character	ISO/IEC 10646 UCS Code
SPACE		U+0020
QUOTATION MARK	"	U+0022
APOSTROPHE	'	U+0027
LEFT PARENTHESIS	(	U+0028
RIGHT PARENTHESIS	)	U+0029
PLUS SIGN	+	U+002B
HYPHEN-MINUS	-	U+002D
FULL STOP	.	U+002E
SOLIDUS	/	U+002F
DIGIT ONE	1	U+0031
DIGIT TWO	2	U+0032
DIGIT THREE	3	U+0033
DIGIT FOUR	4	U+0034
COLON	:	U+003A
LESS-THAN SIGN	<	U+003C
GREATER-THAN SIGN	>	U+003E
COMMERCIAL AT	@	U+0040
LATIN CAPITAL LETTER C	C	U+0043
LATIN CAPITAL LETTER E	E	U+0045
LATIN CAPITAL LETTER H	H	U+0048
LATIN CAPITAL LETTER N	N	U+004E
LATIN CAPITAL LETTER R	R	U+0052
LATIN CAPITAL LETTER S	S	U+0053
LATIN CAPITAL LETTER W	W	U+0057
LATIN SMALL LETTER D	d	U+0064
LATIN SMALL LETTER T	t	U+0074
LEFT CURLY BRACKET	{	U+007B
RIGHT CURLY BRACKET	}	U+007D
DEGREE SIGN	°	U+00B0

EXAMPLE "CRS" is represented by U+0043, U+0052 and U+0053 respectively.

NOTE While the character names for [<] and [>] in Table F.1 are "LESS-THAN SIGN" and "GREATER-THAN SIGN", this document follows customary notation used in other ISO/TC 211 documents and collectively refers to these characters as "angle brackets".

F.2 Encoding recommendations

This document does not specify a required character encoding for GPL string representation or human-readable notation. However, the use of a widely accepted character encoding such as that shown in ISO/IEC 10646 is recommended. When using ISO/IEC 10646, the encodings of the delimiters shall conform to the values specified in Table F.1. It is the responsibility of the user to clearly document any encodings used.

Bibliography

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