

AS/NZS ISO 19162:2020
ISO 19162:2019



Australian/New Zealand Standard™

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



AS/NZS ISO 19162:2020

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Australian/New Zealand Standard™

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

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Preface

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee IT-004, Geographical Information/Geomatics, to supersede AS/NZS ISO 19162:2018.

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

This document is identical with, and has been reproduced from, ISO 19162:2019, *Geographic information — Well-known text representation of coordinate reference systems*.

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Australian or Australian/New Zealand Standards that are identical adoptions of international normative references may be used interchangeably. Refer to the online catalogue for information on specific Standards.

The terms “normative” and “informative” are used in Standards to define the application of the appendices or annexes to which they apply. A “normative” appendix or annex is an integral part of a Standard, whereas an “informative” appendix or annex is only for information and guidance.

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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 close collaboration with the Open Geospatial Consortium (OGC).

This second edition cancels and replaces the first edition (ISO 19162:2015), which has been technically revised.

The main changes compared to the previous edition are as follows:

- updates to reflect the changes made in ISO 19111:2019 from its previous edition ISO 19111:2007 to describe dynamic geodetic reference frames, three-dimensional projected coordinate reference systems, datum ensembles and coordinate metadata;
- remodelling of the descriptions of temporal coordinate reference systems, to reflect the changes made in ISO 19111:2019;
- the correction of minor errors.

Further details are given in [Annex D](#).

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.

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.

Introduction

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

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

The 2015 version of this document provided an updated version of WKT representation of coordinate reference systems that follows the provisions of ISO 19111:2007 and ISO 19111-2:2009. It extended earlier WKT to allow for the description of coordinate operations.

This document updates WKT for the extensions to ISO 19111 made through its 2019 revision:

- the description of dynamic geodetic and vertical coordinate reference systems;
- the change of coordinate values within a coordinate reference system due to point motion caused by tectonic deformation;
- the description of geoid-based vertical coordinate reference systems;
- the description of datum ensembles, groups of realizations of one terrestrial or vertical reference system that for low accuracy purposes may be merged ignoring coordinate transformation;
- a rigorous description of temporal coordinate reference systems;
- the removal (deprecation) of image coordinate reference systems; and
- the remodelling of scope and extent information.

This document defines the structure and content of well-known text strings. It does not prescribe how implementations should read or write these strings.

NOTES

Australian/New Zealand Standard

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

1 Scope

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

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

ISO 19111:2019, *Geographic information — Referencing by coordinates*

3 Terms, definitions and abbreviated terms

3.1 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 <http://www.electropedia.org/>

3.1.1

affine coordinate system

coordinate system in Euclidean space with straight axes that are not necessarily mutually perpendicular

[SOURCE: ISO 19111:2019, 3.1.1]

3.1.2

bearing

<geodesy> horizontal angle at a point relative to a specified direction

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

3.1.3

Cartesian coordinate system

coordinate system in Euclidean space which gives the position of points relative to n mutually perpendicular straight axes all having the same unit of measure

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

Note 2 to entry: A Cartesian coordinate system is a specialisation of an affine coordinate system.

[SOURCE: ISO 19111:2019, 3.1.2]

3.1.4

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]

3.1.5

coordinate conversion

coordinate operation that changes coordinates in a source coordinate reference system to coordinates in a target coordinate reference system in which both coordinate reference systems are based on the same datum

Note 1 to entry: A coordinate conversion uses parameters which have specified values.

EXAMPLE 1 A mapping of ellipsoidal coordinates to Cartesian coordinates using a map projection.

EXAMPLE 2 Change of units such as from radians to degrees or from feet to metres.

[SOURCE: ISO 19111:2019, 3.1.6]

3.1.6

coordinate epoch

epoch to which coordinates in a dynamic coordinate reference system are referenced

[SOURCE: ISO 19111:2019, 3.1.7]

3.1.7

coordinate operation

process using a mathematical model, based on a one-to-one relationship, that changes coordinates in a source coordinate reference system to coordinates in a target coordinate reference system, or that changes coordinates at a source coordinate epoch to coordinates at a target coordinate epoch within the same coordinate reference system

[SOURCE: ISO 19111:2019, 3.1.8]

3.1.8

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]

3.1.9

coordinate system

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

[SOURCE: ISO 19111:2019, 3.1.11]

3.1.10

coordinate transformation

coordinate operation that changes coordinates in a source coordinate reference system to coordinates in a target coordinate reference system in which the source and target coordinate reference systems are based on different datums

Note 1 to entry: A coordinate transformation uses parameters which are derived empirically. Any error in those coordinates will be embedded in the coordinate transformation and when the coordinate transformation is applied the embedded errors are transmitted to output coordinates.

Note 2 to entry: A coordinate transformation is colloquially sometimes referred to as a 'datum transformation'. This is erroneous. A coordinate transformation changes coordinate values. It does not change the definition of the datum. In this document coordinates are referenced to a coordinate reference system. A coordinate transformation operates between two coordinate reference systems, not between two datums.

[SOURCE: ISO 19111:2019, 3.1.12]

3.1.11

cylindrical coordinate system

three-dimensional coordinate system in Euclidean space in which position is specified by two linear coordinates and one angular coordinate

[SOURCE: ISO 19111:2019, 3.1.14]

3.1.12

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]

3.1.13

datum ensemble

group of multiple realizations of the same terrestrial or vertical reference system that, for approximate spatial referencing purposes, are not significantly different

Note 1 to entry: Datasets referenced to the different realizations within a datum ensemble may be merged without coordinate transformation.

Note 2 to entry: 'Approximate' is for users to define but typically is in the order of under 1 decimetre but may be up to 2 metres.

EXAMPLE "WGS 84" as an undifferentiated group of realizations including WGS 84 (TRANSIT), WGS 84 (G730), WGS 84 (G873), WGS 84 (G1150), WGS 84 (G1674) and WGS 84 (G1762). At the surface of the Earth these have changed on average by 0.7 m between the TRANSIT and G730 realizations, a further 0.2 m between G730 and G873, 0.06 m between G873 and G1150, 0.2 m between G1150 and G1674 and 0.02 m between G1674 and G1762.

[SOURCE: ISO 19111:2019, 3.1.16]

3.1.14**derived coordinate reference system**

coordinate reference system that is defined through the application of a specified coordinate conversion to the coordinates within a previously established coordinate reference system

Note 1 to entry: The previously established coordinate reference system is referred to as the base coordinate reference system.

Note 2 to entry: A derived coordinate reference system inherits its datum or reference frame from its base coordinate reference system.

Note 3 to entry: The coordinate conversion between the base and derived coordinate reference system is implemented using the parameters and formula(s) specified in the definition of the coordinate conversion.

[SOURCE: ISO 19111:2019, 3.1.8]

3.1.15**dynamic coordinate reference system**

coordinate reference system that has a dynamic reference frame

Note 1 to entry: Coordinates of points on or near the crust of the Earth that are referenced to a dynamic coordinate reference system may change with time, usually due to crustal deformations such as tectonic motion and glacial isostatic adjustment.

Note 2 to entry: Metadata for a dataset referenced to a dynamic coordinate reference system should include coordinate epoch information.

[SOURCE: ISO 19111:2019, 3.1.9]

3.1.16**dynamic reference frame**

dynamic datum reference frame in which the defining parameters include time evolution

Note 1 to entry: The defining parameters that have time evolution are usually a coordinate set.

[SOURCE: ISO 19111:2019, 3.1.20]

3.1.17**ellipsoid****reference ellipsoid**

<geodesy> geometric reference surface embedded in 3D Euclidean space formed by an ellipse that is rotated about a main axis

Note 1 to entry: For the Earth the ellipsoid is bi-axial with rotation about the polar axis. This results in an oblate ellipsoid with the midpoint of the foci located at the nominal centre of the Earth.

[SOURCE: ISO 19111:2019, 3.1.22]

3.1.18**ellipsoidal coordinate system****geodetic coordinate system**

coordinate system in which position is specified by geodetic latitude, geodetic longitude and (in the three-dimensional case) ellipsoidal height

[SOURCE: ISO 19111:2019, 3.1.23]

3.1.19
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]

3.1.20
engineering coordinate reference system
 coordinate reference system based on an engineering datum

EXAMPLE 1 System for identifying relative positions within a few kilometres of the reference point, such as a building or construction site.

EXAMPLE 2 Coordinate reference system local to a moving object such as a ship or an orbiting spacecraft.

EXAMPLE 3 Internal coordinate reference system for an image. This has continuous axes. It may be the foundation for a grid.

[SOURCE: ISO 19111:2019, 3.1.25]

3.1.21
engineering datum
local datum
 datum describing the relationship of a coordinate system to a local reference

Note 1 to entry: Engineering datum excludes both geodetic and vertical reference frames.

[SOURCE: ISO 19111:2019, 3.1.26]

3.1.22
epoch
 <geodesy> point in time

Note 1 to entry: In this document an epoch is expressed in the Gregorian calendar as a decimal year.

EXAMPLE 2017-03-25 in the Gregorian calendar is epoch 2017,23.

[SOURCE: ISO 19111:2019, 3.1.27]

3.1.23
flattening
f

ratio of the difference between the semi-major axis (*a*) and semi-minor axis (*b*) of an ellipsoid to the semi-major axis: $f = (a - b)/a$

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

[SOURCE: ISO 19111:2019, 3.1.28]

3.1.24**frame reference epoch**

epoch of coordinates that define a dynamic reference frame

[SOURCE: ISO 19111:2019, 3.1.29]

3.1.25**geodetic coordinate reference system**

three-dimensional coordinate reference system based on a geodetic reference frame and having either a three-dimensional Cartesian or a spherical coordinate system

Note 1 to entry: In this document a coordinate reference system based on a geodetic reference frame and having an ellipsoidal coordinate system is geographic.

[SOURCE: ISO 19111:2019, 3.1.31]

3.1.26**geodetic latitude****ellipsoidal latitude**

φ

angle from the equatorial plane to the perpendicular to the ellipsoid through a given point, northwards treated as positive

[SOURCE: ISO 19111:2019, 3.1.32]

3.1.27**geodetic longitude****ellipsoidal longitude**

λ

angle from the prime meridian plane to the meridian plane of a given point, eastward treated as positive

[SOURCE: ISO 19111:2019, 3.1.33]

3.1.28**geodetic reference frame**

reference frame or datum describing the relationship of a two- or three-dimensional coordinate system to the Earth

Note 1 to entry: In the data model described in this document, the UML class GeodeticReferenceFrame includes both modern terrestrial reference frames and classical geodetic datums.

[SOURCE: ISO 19111:2019, 3.1.34]

3.1.29**geographic coordinate reference system**

coordinate reference system that has a geodetic reference frame and an ellipsoidal coordinate system

[SOURCE: ISO 19111:2019, 3.1.35]

3.1.30**linear coordinate system**

one-dimensional coordinate system in which a linear feature forms the axis

EXAMPLE 1 Distances along a pipeline.

EXAMPLE 2 Depths down a deviated oil well bore.

[SOURCE: ISO 19111:2019, 3.1.39]

3.1.31**map projection**

coordinate conversion from an ellipsoidal coordinate system to a plane

[SOURCE: ISO 19111:2019, 3.1.40]

3.1.32**parametric coordinate reference system**

coordinate reference system based on a parametric datum

[SOURCE: ISO 19111:2019, 3.1.45]

3.1.33**parametric coordinate system**

one-dimensional coordinate system where the axis units are parameter values which are not inherently spatial

[SOURCE: ISO 19111:2019, 3.1.46]

3.1.34**parametric datum**

datum describing the relationship of a parametric coordinate system to an object

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

[SOURCE: ISO 19111:2019, 3.1.47]

3.1.35**point motion operation**

coordinate operation that changes coordinates within one coordinate reference system due to the motion of the point

Note 1 to entry: The change of coordinates is from those at an initial epoch to those at another epoch.

Note 2 to entry: In this document the point motion is due to tectonic motion or crustal deformation.

[SOURCE: ISO 19111:2019, 3.1.48]

3.1.36**polar coordinate system**

two-dimensional coordinate system in Euclidean space in which position is specified by one distance coordinate and one angular coordinate

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

[SOURCE: ISO 19111:2019, 3.1.49]

3.1.37**prime meridian**

meridian from which the longitudes of other meridians are quantified

[SOURCE: ISO 19111:2019, 3.1.50]

3.1.38**projected coordinate reference system**

coordinate reference system derived from a geographic coordinate reference system by applying a map projection

Note 1 to entry: May be two- or three-dimensional, the dimension being equal to that of the geographic coordinate reference system from which it is derived.

Note 2 to entry: In the three-dimensional case the horizontal coordinates (geodetic latitude and geodetic longitude coordinates) are projected to northing and easting and the ellipsoidal height is unchanged.

[SOURCE: ISO 19111:2019, 3.1.51]

3.1.39

reference frame

datum

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, 3.1.52]

3.1.40

semi-major axis

a

semi-diameter of the longest axis of an ellipsoid

[SOURCE: ISO 19111:2019, 3.1.53]

3.1.41

semi-minor axis

b

semi-diameter of the shortest axis of an ellipsoid

[SOURCE: ISO 19111:2019, 3.1.54]

3.1.42

spatio-parametric coordinate reference system

compound coordinate reference system in which one constituent coordinate reference system is a spatial coordinate reference system and one is a parametric coordinate reference system

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

[SOURCE: ISO 19111:2019, 3.1.57]

3.1.43

spatio-parametric-temporal coordinate reference system

compound coordinate reference system comprised of spatial, parametric and temporal coordinate reference systems

[SOURCE: ISO 19111:2019, 3.1.58]

3.1.44

spatio-temporal coordinate reference system

compound coordinate reference system in which one constituent coordinate reference system is a spatial coordinate reference system and one is a temporal coordinate reference system

[SOURCE: ISO 19111:2019, 3.1.59]

3.1.45

spherical coordinate system

three-dimensional coordinate system in Euclidean space in which position is specified by one distance coordinate and two angular coordinates

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

[SOURCE: ISO 19111:2019, 3.1.60]

3.1.46

spheroid

closed surface that differs only slightly from that of a sphere

3.1.47**static coordinate reference system**

coordinate reference system that has a static reference frame

Note 1 to entry: Coordinates of points on or near the crust of the Earth that are referenced to a static coordinate reference system do not change with time.

Note 2 to entry: Metadata for a dataset referenced to a static coordinate reference system does not require coordinate epoch information.

[SOURCE: ISO 19111:2019, 3.1.61]

3.1.48**static reference frame****static datum**

reference frame in which the defining parameters exclude time evolution

[SOURCE: ISO 19111:2019, 3.1.62]

3.1.49**temporal coordinate reference system**

coordinate reference system based on a temporal datum

[SOURCE: ISO 19111:2019, 3.1.63]

3.1.50**temporal coordinate system**

<geodesy> one-dimensional coordinate system where the axis is time

[SOURCE: ISO 19111:2019, 3.1.64]

3.1.51**temporal datum**

datum describing the relationship of a temporal coordinate system to an object

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

[SOURCE: ISO 19111:2019, 3.1.65]

3.1.52**vertical coordinate reference system**

one-dimensional coordinate reference system based on a vertical reference frame

[SOURCE: ISO 19111:2019, 3.1.70]

3.1.53**vertical coordinate system**

one-dimensional coordinate system used for gravity-related height or depth measurements

[SOURCE: ISO 19111:2019, 3.1.71]

3.1.54**vertical reference frame****vertical datum**

reference frame describing the relation of gravity-related heights or depths to the Earth

Note 1 to entry: In most cases, the vertical reference frame will be related to mean sea level. Vertical datums include sounding datums (used for hydrographic purposes), in which case the heights may be negative heights or depths.

Note 2 to entry: Ellipsoidal heights are related to a three-dimensional ellipsoidal coordinate system referenced to a geodetic reference frame.

[SOURCE: ISO 19111:2019, 3.1.72]

3.1.55

white space

sequence of one or more characters that have no glyphs

[SOURCE: ISO/IEC 9075-2:2016, 3.1.6.77]

3.2 Abbreviated terms

BNF	Backus-Naur form
CRS	coordinate reference system
CS	coordinate system
EPSG	European Petroleum Survey Group (geodetic parameter dataset now maintained at www.epsg-registry.org by the International Association of Oil and Gas Producers)
IRM	international reference meridian
OGC	Open Geospatial Consortium, www.opengeospatial.org
TRF	Terrestrial Reference Frame
UTC	Coordinated Universal Time
VRF	Vertical Reference Frame
WKT	Well-known text

4 Conformance requirements

This document defines eighteen classes of conformance (see [Annex A](#)):

- a) Any WKT string claiming conformance of a coordinate reference system definition shall satisfy the requirements in [Annex A](#) as shown in [Table 1](#).

Table 1 — Conformance requirements for coordinate reference systems

Coordinate reference system type	Conformance requirements given in
geodetic	A.1
geographic	A.2
projected	A.3
vertical	A.4
engineering	A.5
parametric	A.6
temporal	A.7
derived geodetic	A.8
derived geographic	A.9
derived projected	A.10
derived vertical	A.11
derived engineering	
derived parametric	

Table 1 (continued)

Coordinate reference system type	Conformance requirements given in
derived temporal	A.12
compound	A.13

- b) Any WKT string claiming conformance of coordinate metadata shall satisfy the requirements given in [A.14](#).
- c) Any WKT string claiming conformance of a coordinate operation definition shall satisfy the requirements in [Annex A](#) as shown in [Table 2](#).

Table 2 — Conformance requirements for coordinate operations

Coordinate operation type	Conformance requirements given in
coordinate transformation coordinate conversion other than a deriving conversion	A.15
deriving conversion	Within derived CRS in A.2 and A.7 to A.12
point motion operation	A.16
concatenated coordinate operation	A.17

- d) Any WKT string claiming conformance of coordinate transformation bound to a coordinate reference system definition shall satisfy the requirements given in [A.18](#).

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

5 Backus-Naur Form notation and syntax

The WKT representation of coordinate reference systems and coordinate operations is defined in this document using the extended version of Backus-Naur form (BNF) notation that is defined in ISO/IEC 9075-1:2016, 6.2. The BNF provides the mechanism for generating a WKT string. The production rules in ISO/IEC 9075-1:2016, 6.2 apply.

In this extended version of BNF the characters have the meaning:

- A character string enclosed in angle brackets "< >" is a syntactic element.
- A vertical bar "|" indicates alternatives.
- Braces "{}" define a group of elements.
- Square brackets "["]" denote optional elements. This use of square brackets within BNF notation should not be confused with the use of square brackets as delimiters in WKT strings.
- Ellipsis after an element "< >..." allows the use of one or multiple instances of that element.
- Ellipsis after braces "{}..." allows the use of one or multiple instances of of the group of elements.
- Ellipsis after square brackets "["]..." means that the content inside the square brackets may occur zero to many times.
- Double exclamation marks "!!" introduce normal English text. This is used when the definition of a syntactic element is supplemented by constraints not in the BNF definition but given later in the text.

In the BNF notation spaces are used to separate syntactic elements. Multiple spaces and line breaks are treated as a single space. These spaces do not form part of the resulting WKT string. All other characters in the BNF stand for themselves. The order of syntactic elements in the BNF is significant; it defines the format of the WKT string.

6 WKT string form

6.1 Overview

The WKT string is a representation of the definition of a CRS or coordinate operation. A string describes one CRS or coordinate operation object. Each object is represented by a token comprised of a keyword followed by a set of attributes of the object, the set enclosed by delimiters. Some objects are composed of other objects so the result may be a nested structure. Nesting may continue to any depth.

EXAMPLE KEYWORD1 [attribute1, KEYWORD2 [attribute2, attribute3]]

Keywords are case-insensitive. Where human readability of the string is important, as in this document, keywords are normally in upper case.

The delimiters are normally <left bracket> and <right bracket>. Implementations are free to substitute parentheses for brackets.

Attributes may be from an enumeration, may be numbers or may be text. Text is enclosed in double quotes. Two forms of text are defined, one restricted to the Latin1 character set and the other permitting any Unicode character set. Attributes are separated by a comma.

A WKT string contains no white space outside of double quotes. However, padding with white space to improve human readability is permitted; the examples of WKT that are included in this document have spaces and line feeds inserted to improve clarity. Any padding is stripped out or ignored by parsers, refer to [Annex B](#).

6.2 Encoding

All WKT strings are realized as a sequence of characters, or a character string. It is not the goal of this document to specify any encoding used in a given implementation. The only restriction is that the same encoding shall be used throughout the entire WKT definition.

Requirements:

- A WKT string shall use one encoding throughout the entire string. UTF-8 shall be used if no encoding is specified in the carrier.
- The characters used in a WKT string shall be wholly contained within the domain of a specific character set. This character set shall exist as a subset of the repertoire of the Universal Character Set specified by ISO/IEC 10646.

6.3 Characters used in WKT

6.3.1 Basic characters

The basic characters in a CRS WKT string are taken directly from ISO/IEC 9075-2:2016, 5.1 and 5.3.

```
<simple Latin upper case letter> ::= A | B | C | D | E | F | G | H | I | J | K | L | M |
                                   N | O | P | Q | R | S | T | U | V | W | X | Y | Z
                                   !! ISO/IEC 10646:2012 character identifiers U+0041
                                   through U+005A
```

<simple Latin lower case letter>	::=	a b c d e f g h i j k l m n o p q r s t u v w x y z <i>!! ISO/IEC 10646:2012 character identifiers U+0061 through U+007A</i>
<digit>	::=	0 1 2 3 4 5 6 7 8 9 <i>!! ISO/IEC 10646:2012 character identifiers U+0030 through U+0039</i>
<space>	::=	SP <i>!! ISO/IEC 10646:2012 character identifier U+0020</i>
<double quote>	::=	" <i>!! ISO/IEC 10646:2012 character identifier U+0022</i>
<number sign>	::=	# <i>!! ISO/IEC 10646:2012 character identifier U+0023</i>
<percent>	::=	% <i>!! ISO/IEC 10646:2012 character identifier U+0025</i>
<ampersand>	::=	& <i>!! ISO/IEC 10646:2012 character identifier U+0026</i>
<quote>	::=	' <i>!! ISO/IEC 10646:2012 character identifier U+0027</i>
<left paren>	::=	(<i>!! ISO/IEC 10646:2012 character identifier U+0028</i>
<right paren>	::=	) <i>!! ISO/IEC 10646:2012 character identifier U+0029</i>
<asterisk>	::=	* <i>!! ISO/IEC 10646:2012 character identifier U+002A</i>
<plus sign>	::=	+ <i>!! ISO/IEC 10646:2012 character identifier U+002B</i>
<comma>	::=	, <i>!! ISO/IEC 10646:2012 character identifier U+002C</i>
<minus sign> ::- <hyphen>	::=	- <i>!! ISO/IEC 10646:2012 character identifier U+002D</i>
<period>	::=	. <i>!! ISO/IEC 10646:2012 character identifier U+002E</i>
<solidus>	::=	/ <i>!! ISO/IEC 10646:2012 character identifier U+002F</i>
<colon>	::=	: <i>!! ISO/IEC 10646:2012 character identifier U+003A</i>
<semicolon>	::=	; <i>!! ISO/IEC 10646:2012 character identifier U+003B</i>
<less than operator>	::=	< <i>!! ISO/IEC 10646:2012 character identifier U+003C</i>
<equals operator>	::=	= <i>!! ISO/IEC 10646:2012 character identifier U+003D</i>
<greater than operator>	::=	> <i>!! ISO/IEC 10646:2012 character identifier U+003E</i>
<question mark>	::=	? <i>!! ISO/IEC 10646:2012 character identifier U+003F</i>
<left bracket>	::=	[<i>!! ISO/IEC 10646:2012 character identifier U+005B</i>
<reverse solidus>	::=	\ <i>!! ISO/IEC 10646:2012 character identifier U+005C</i>
<right bracket>	::=	] <i>!! ISO/IEC 10646:2012 character identifier U+005D</i>
<circumflex>	::=	^ <i>!! ISO/IEC 10646:2012 character identifier U+005E</i>
<underscore>	::=	_ <i>!! ISO/IEC 10646:2012 character identifier U+005F</i>
<left brace>	::=	{ <i>!! ISO/IEC 10646:2012 character identifier U+007B</i>
<vertical bar>	::=	<i>!! ISO/IEC 10646:2012 character identifier U+007C</i>
<right brace>	::=	} <i>!! ISO/IEC 10646:2012 character identifier U+007D</i>
<degree symbol>	::=	° <i>!! ISO/IEC 10646:2012 character identifier U+00B0</i>

6.3.2 Numbers

<number>	::=	<signed numeric literal> <unsigned numeric literal>
<signed numeric literal>	::=	[<sign>] <unsigned numeric literal>
<unsigned numeric literal>	::=	<exact numeric literal> <approximate numeric literal>
<approximate numeric literal>	::=	<mantissa> E <exponent>
<mantissa>	::=	<exact numeric literal>
<exponent>	::=	<signed integer>
<signed integer>	::=	[<sign>] <unsigned integer>
<exact numeric literal>	::=	<unsigned integer> [<period> [<unsigned integer>]] <period> <unsigned integer>

<unsigned integer>	::=	<digit>...
<sign>	::=	<plus sign> <minus sign>

The integer and fractional parts of a number are separated by a <period>; a comma is not permitted. No other separator (e.g. for thousands or multiples thereof) is allowed.

6.3.3 Date and time

In this document calendar dates and times are restricted to the Gregorian calendar and the 24-hour clock as defined in ISO 8601-1. Only the ISO 8601-1 extended format (separators between date units and between sexagesimal time units) is permitted. Any precision is allowed. When time is included a UTC or local time zone designator is required. Other date formats such as geological eras or calendars other than Gregorian may be stated through a free format quoted text string.

<datetime>	::=	<Gregorian calendar datetime> <Gregorian ordinal datetime>
<Gregorian calendar datetime>	::=	<Gregorian calendar date> [<24 hour clock>]
<Gregorian calendar date>	::=	<year> [<hyphen> <month> [<hyphen> <day>]]
<year>	::=	<unsigned integer> <i>!! four digits</i>
<month>	::=	<unsigned integer> <i>!! two digits including leading zero if less than 10</i>
<day>	::=	<unsigned integer> <i>!! two digits including leading zero if less than 10</i>
<Gregorian ordinal datetime>	::=	<Gregorian ordinal date> [<24 hour clock>]
<Gregorian ordinal date>	::=	<year> [<hyphen> <ordinal day>]
<ordinal day>	::=	<unsigned integer> <i>!! three digits including leading zeroes if less than 100</i>
<24 hour clock>	::=	<time designator> <hour> [<colon> <minute> [<colon> <second>]] <time zone designator>
<time designator>	::=	T
<hour>	::=	<unsigned integer> <i>!! two digits including leading zero if less than 10</i>
<minute>	::=	<unsigned integer> <i>!! two digits including leading zero if less than 10</i>
<second>	::=	<seconds integer> [<period> [<seconds fraction>]] <i>!! In this document the separator between the integer and fractional parts of a second value shall be a period. The ISO 8601 preference for comma is not permitted.</i>
<seconds integer>	::=	<unsigned integer> <i>!! two digits including leading zero if less than 10</i>
<seconds fraction>	::=	<unsigned integer>
<time zone designator>	::=	<utc designator> <local time zone designator>
<utc designator>	::=	Z
<local time zone designator>	::=	{ <plus sign> <minus sign> } <hour> [<colon> <minute>]

In ISO 8601-1 time zone designator may be omitted, in which case local time is assumed but unspecified. In this document a time zone designator is mandatory.

EXAMPLE 1	2014	(Precision = year)
EXAMPLE 2	2014-01	(Calendar date, precision = month)

EXAMPLE 3	2014-03-01	(Calendar date, precision = day)
EXAMPLE 4	2014-060	(Ordinal date, precision = day)
EXAMPLE 5	2014-05-06T23Z	(Calendar date, precision = hour, UTC)
EXAMPLE 6	2014-157T23Z	(Ordinal date, precision = hour, UTC)
EXAMPLE 7	2014-07-12T16:00Z	(Precision = minute, UTC)
EXAMPLE 8	2014-07-12T17:00+01	(Precision = minute, local time one hour ahead of UTC)
EXAMPLE 9	2014-09-18T08:17:56-08	(Precision = second, local time eight hours behind UTC)
EXAMPLE 10	2014-11-23T00:34:56.789Z	(Precision = 1/1 000 second, UTC)

6.3.4 CRS WKT characters

The characters permitted in elements of a CRS WKT string formed from those in [6.3.1](#), [6.3.2](#) and [6.3.3](#) are:

<left delimiter>	::=	<left bracket> <left paren> <i>!! In this document the preferred left delimiter is <left bracket>. <left paren> is permitted for backward compatibility. Implementations shall be able to read both forms.</i>
<right delimiter>	::=	<right bracket> <right paren> <i>!! See 6.4.</i>
<wkt separator>	::=	<comma>
<quoted Latin text>	::=	<double quote> <wkt Latin text character>... <double quote>
<wkt Latin text character>	::=	<simple Latin upper case letter> <simple Latin lower case letter> <digit> <underscore> <left bracket> <right bracket> <left paren> <right paren> <left brace> <right brace> <less than operator> <equals operator> <greater than operator> <period> <comma> <colon> <semicolon> <plus sign> <minus sign> <space> <number sign> <percent> <ampersand> <quote> <asterisk> <circumflex> <solidus> <reverse solidus> <question mark> <vertical bar> <degree symbol> <doublequote symbol>
<quoted Unicode text>	::=	<double quote> { <wkt Unicode text character> }... <double quote>
<wkt Unicode text character>	::=	<nondoublequote character> <doublequote symbol>
<nondoublequote character>	::=	<i>!! A <nondoublequote character> is any character of the source language character set other than a <double quote>.</i>
<doublequote symbol>	::=	<i>"" !! two consecutive <double quote> characters</i>

6.3.5 Double quote

Requirement: If a double quote is required within a <quoted Latin text> or <quoted Unicode text> string, a <doublequote symbol> shall be used.

EXAMPLE "Datum origin is 30°25'20""N, 130°25'20""E."

6.4 Delimiter

In WKT strings the attributes for an item are included within a pair of left and right delimiters. The delimiters should normally be <left bracket> and <right bracket>. Implementations are free to substitute parentheses for brackets. If <left bracket> is used as a <left delimiter> then <right bracket> is required to be used as the corresponding <right delimiter>; if <left paren> is used as a <left delimiter> then <right paren> is required to be used as the corresponding <right delimiter>. A nested token is required to use the same type of delimiter as the token in which it is nested.

Requirement: A CRS WKT string shall include only one of the two forms of delimiter, brackets or parentheses, allowed in [6.3.4](#).

6.5 Case sensitivity

WKT keywords are case insensitive: KEYWORD, keyword, KeyWord and KEYwORd are all equivalent. Where human readability is important (as in the examples in this document) keywords should be written in only the <simple Latin upper case letter> set. KEYWORD is not equivalent to KEY_WORD; the underscore character is significant.

WKT enumerations are case insensitive. CARTESIAN is equivalent to cartesian is equivalent to Cartesian; NORTH is equivalent to north is equivalent to North.

Within quoted text, case is significant. “H” is not equivalent to “h”.

Requirement: Outside of quoted text, characters in a WKT string shall not be case sensitive.

6.6 Reserved keywords

The keywords defined in [Clauses 7](#) to [20](#) and [Annex E](#) of this document for coordinate reference systems, coordinate operations, their component elements and their attributes are summarised here. Those formed from multiple words or abbreviations are given in camel case to aid understanding; see [6.5](#) for implementation in a WKT string.

Keyword	BNF element	Clause in which defined
abridgedTransformation	<abridged transformation keyword>	20
anchor	<datum anchor keyword>	8 , 10 , 11 and 12
angleUnit	<angle unit keyword>	7
area	<area description keyword>	7
axis	<axis keyword>	7
baseEngCRS	<base engineering crs keyword>	14
baseGeodCRS	<base geodetic crs keyword>	9 and 14
baseGeogCRS	<base geographic crs keyword>	9 and 14
baseParamCRS	<base parametric crs keyword>	14
baseProjCRS	<base projected crs keyword>	14
baseTimeCRS	<base temporal crs keyword>	14
baseVertCRS	<base vertical crs keyword>	14
bBox	<geographic bounding box keyword>	7
bearing	<bearing keyword>	7
boundCRS	<bound crs keyword>	20
calendar	<calendar keyword>	13
citation	<citation keyword>	7
compoundCRS	<compound crs keyword>	15
concatenatedOperation	<concatenated operation keyword>	19

Keyword	BNF element	Clause in which defined
conversion	<map projection keyword>	9
coordEpoch	Alternative keyword for coordinate epoch	16
coordinateMetadata	<coordinate metadata keyword>	16
coordinateOperation	<operation keyword>	17
cs	<cs keyword> (coordinate system)	7
datum	<geodetic reference frame keyword>	8
derivedProjCRS	<derived projected crs keyword>	14
derivingConversion	<deriving conversion keyword>	14
dynamic	<dynamic crs keyword>	7
eDatum	<engineering datum keyword>	11
ellipsoid	<ellipsoid keyword>	8
engCRS	<engineering crs keyword>	11 and 14
engineeringCRS	Alternative keyword for engineering crs	11 and 14
engineeringDatum	Alternative keyword for engineering datum	11
ensemble	<datum ensemble keyword>	7
ensembleAccuracy	<datum ensemble accuracy keyword>	7
epoch	<coordinate epoch keyword>	16
frameEpoch	<frame reference epoch keyword>	7
geodCRS	<geodetic crs keyword>	8 and 14
geodeticCRS	Alternative keyword for geodetic crs	8 and 14
geodeticDatum	Alternative keyword for geodetic reference frame	8
geogCRS	<geographic crs keyword>	8 and 14
geographicCRS	Alternative keyword for geographic crs	8 and 14
geoidModel	<geoid model ID keyword>	10
id	<identifier keyword>	7
interpolationCRS	<interpolation crs keyword>	17
lengthUnit	<length unit keyword>	7
member	<datum ensemble member keyword>	7
meridian	<meridian keyword>	7
method	(i) <map projection method keyword>	9
	(ii) <operation method keyword>	14 , 17 and 18
model	<deformation model ID keyword>	7
operationAccuracy	<operation accuracy keyword>	17 and 18
order	<axis order keyword>	7
parameter	<parameter keyword>	9 , 14 , 17 and 18
parameterFile	<parameter file keyword>	14 , 17 and 18
parametricCRS	<parametric crs keyword>	12 and 14
parametricDatum	Alternative keyword for parametric datum	12
parametricUnit	<parametric unit keyword>	7
pDatum	<parametric datum keyword>	12
pointMotionOperation	<point motion operation keyword>	18
primeM	<prime meridian keyword>	8
primeMeridian	Alternative keyword for prime meridian	8
projCRS	<projected crs keyword>	9
projectedCRS	Alternative keyword for projected crs	9

Keyword	BNF element	Clause in which defined
projection	Alternative keyword for map projection method	9
remark	<remark keyword>	7
scaleUnit	<scale unit keyword>	7
scope	<scope keyword>	7
sourceCRS	<source crs keyword>	17 and 18
spheroid	Alternative keyword for ellipsoid	8
step	concatenated operation <step keyword>	19
targetCRS	<target crs keyword>	17
tDatum	<temporal datum keyword>	13
TRF	Alternative keyword for geodetic reference frame	8
temporalQuantity	Alternative keyword for time unit	7
timeCRS	<temporal crs keyword>	13 and 14
timeDatum	Alternative keyword for temporal datum	13
timeExtent	<temporal extent keyword>	7
timeOrigin	<temporal origin keyword>	13
timeUnit	<temporal unit keyword>	7
triaxial	<triaxial ellipsoid keyword>	Annex E
unit	Alternative keyword for all units	7
uri	<uri keyword>	7
usage	<usage keyword>	7
vDatum	<vertical reference frame keyword>	10
velocityGrid	Alternative keyword for deformation model ID	7
version	<operation version keyword>	17–20
vertCRS	<vertical crs keyword>	10 and 14
verticalCRS	Alternative keyword for vertical crs	10 and 14
verticalDatum	Alternative keyword for vertical reference frame	10
verticalExtent	<vertical extent keyword>	7
VRF	Alternative keyword for vertical reference frame	10

6.7 Backward compatibility

This document makes several references to backward compatibility. Backward compatibility means that an implementation of the text strings in this document would be able to read CRS WKT strings conforming to the old (ISO 19125-1:2004) syntax. It does not mean that a parser of a string compliant to ISO 19125-1:2004 could read WKT strings written in conformance with this document. It also does not require an implementation of the text strings in this document to be able to output an object according to the old syntax. [B.8](#) gives guidance on determining the version of a CRS WKT string. A mapping of older syntaxes to this document is given in [Annex C](#). Revisions to ISO 19162:2015 made in this document are described in [Annex D](#).

7 WKT representation of common attributes

7.1 General

The WKT representation of attributes that are common to coordinate reference systems and coordinate operations — name, scope, extent, identifier and remarks — is described in [7.2](#) to [7.4](#). Coordinate system (a component of coordinate reference systems) is described in [7.5](#). Elements for a datum ensemble and a dynamic coordinate reference system are described in [7.6](#) and [7.7](#) respectively. Attributes specific to coordinate reference systems and to coordinate operations are described in [Clauses 8](#) to [19](#).

7.2 Name

From a computational perspective name is redundant information provided for human readability. For example, an ellipsoid is defined by the values of the semi-major axis and inverse flattening, and the ellipsoid name is redundant information. However, the name may be used to verify the defining values against those from an authoritative source. Comment on the comparison of text strings is given in [Annex B](#).

NOTE Name is a required attribute for the CRS object as well as for some component objects. Depending upon the convention adopted for CRS naming, this can result in duplication of name within the CRS WKT string.

7.3 Scope, extent, identifier and remark

7.3.1 General

The BNF element <scope extent identifier remark> is a collection of four optional attributes which may be applied to a coordinate reference system, a coordinate operation or a bound CRS. The <scope extent identifier remark> collection is to simplify the BNF through grouping. Usage (<scope> and <extent>) is described in [7.3.2](#), <identifier> in [7.3.3](#) and <remark> in [7.3.4](#).

Requirement: The WKT representation of a <scope extent identifier remark> element shall be:

```
<scope extent identifier remark> ::= [ { <wkt separator> <usage> } ]...
                                   [ { <wkt separator> <identifier> } ]...
                                   [ { <wkt separator> <remark> } ]
```

7.3.2 Usage (scope and extent)

7.3.2.1 Usage

Usage is an optional attribute which if included in a WKT string shall include both <scope> and <extent>. Multiple pairs of scope/extent may be used to describe the usage for different purposes over different extents. In this document the <scope> and <extent> elements may not be given alone but only as a pairing. Within each pairing, extent may consist of one or more of area textual description, area bounding box, vertical extent and/or temporal extent, see [7.3.2.3](#).

Requirement: The WKT representation of a <usage> element shall be:

```
<usage> ::= <usage keyword> <left delimiter>
          <scope> <wkt separator> <extent>
          <right delimiter>
<usage keyword> ::= USAGE
```

EXAMPLE 1 Structure of one scope-extent pairing
USAGE [<scope> , <extent>]

EXAMPLE 2 Structure of two scope-extent pairings
USAGE [scope1 , extent1] , USAGE [scope2 , extent2]

The individual <scope> and <extent> elements are described in the following subclauses. See [7.3.2.4](#) for further examples of scope and extent pairings.

7.3.2.2 Scope

Scope describes the purpose or purposes for which a CRS, datum, datum ensemble, coordinate operation or bound CRS is applied.

Requirement: The WKT representation of a <scope> shall be:

<scope>	::=	<scope keyword> <left delimiter> <scope text description> <right delimiter>
<scope keyword>	::=	SCOPE
<scope text description>	::=	<quoted Latin text>

EXAMPLE SCOPE["Large scale topographic mapping and cadastre."]

7.3.2.3 Extent

7.3.2.3.1 General

Extent describes the spatial and/or temporal applicability of a CRS, datum, datum ensemble, coordinate operation or bound CRS. Extent in this document uses the concepts described in ISO 19115-1. However, this document permits horizontal extent to be described by description and/or by geographic bounding box, but not by polygon because of string length considerations. It also allows for vertical and temporal extent. These extent attributes are all optional, although at least one shall be included in any Usage. Multiple extent attributes may be provided, but there is a constraint that within any one scope-extent pairing these shall be of different types.

Requirement: The WKT representation of an <extent> shall be:

<extent>	::=	<area description> <geographic bounding box> <vertical extent> <temporal extent> { <area description> <wkt separator> <geographic bounding box> } { <area description> <wkt separator> <vertical extent> } { <area description> <wkt separator> <temporal extent> } { <geographic bounding box> <wkt separator> <vertical extent> } { <geographic bounding box> <wkt separator> <temporal extent> } { <vertical extent> <wkt separator> <temporal extent> } { <area description> <wkt separator> <geographic bounding box> <wkt separator> <vertical extent> } { <area description> <wkt separator> <geographic bounding box> <wkt separator> <temporal extent> } { <area description> <wkt separator> <vertical extent> <wkt separator> <temporal extent> } { <geographic bounding box> <wkt separator> <vertical extent> <wkt separator> <temporal extent> } { <area description> <wkt separator> <geographic bounding box> <wkt separator> <vertical extent> <wkt separator> <temporal extent> }
----------	-----	---

7.3.2.3.2 Area description

Area description is an optional attribute which describes a geographic area over which a CRS or coordinate operation is applicable.

Requirement: The WKT representation of an <area description> shall be:

<area description>	::=	<area description keyword> <left delimiter> <area text description> <right delimiter>
<area description keyword>	::=	AREA
<area text description>	::=	<quoted Latin text>

EXAMPLE AREA["Netherlands offshore."]

7.3.2.3.3 Geographic bounding box

The geographic bounding box is an optional attribute which describes a "north up" area. Upper right latitude will be greater than the lower left latitude. Generally, the upper right longitude will be greater than the lower left longitude. However, when the area crosses the 180° meridian, the value of the lower left longitude will be greater than the value of the upper right longitude.

The geographic bounding box is an approximate description of location. For most purposes a coordinate precision of two decimal places of a degree is sufficient. At this resolution the identification of the geodetic CRS to which the bounding box coordinates are referenced is not required.

Requirement: The WKT representation of a <geographic bounding box> shall be:

<geographic bounding box>	::=	<geographic bounding box keyword> <left delimiter> <lower left latitude> <wkt separator> <lower left longitude> <wkt separator> <upper right latitude> <wkt separator> <upper right longitude> <right delimiter>
<geographic bounding box keyword>	::=	BBOX
<lower left latitude>	::=	<number> <i>!! See text</i>
<lower left longitude>	::=	<number> <i>!! See text</i>
<upper right latitude>	::=	<number> <i>!! See text</i>
<upper right longitude>	::=	<number> <i>!! See text</i>

Requirement: bounding box latitude coordinates shall be given in decimal degrees in the range -90 to +90, longitude coordinates shall be given in decimal degrees in the range -180 to +180 relative to the international reference meridian.

EXAMPLE 1 Geographic bounding box enveloping offshore Netherlands:
BBOX [51.43, 2.54, 55.77, 6.40]

EXAMPLE 2 Geographic bounding box enveloping offshore New Zealand and crossing the 180° meridian:
BBOX [-55.95, 160.60, -25.88, -171.20]

7.3.2.3.4 Vertical extent

Vertical extent is an optional attribute which describes a height range over which a CRS or coordinate operation is applicable. Depths have negative height values. Vertical extent is an approximate description of location; heights are relative to an unspecified mean sea level.

EXAMPLE 2 Two scope-extent pairings, the second of which has multiple extent attributes:

```
USAGE[SCOPE["Small scale topographic mapping."],
      AREA["Finland - onshore and offshore."]],
USAGE[SCOPE["Cadastre."],
      AREA["Finland - onshore between 26°30'E and 27°30'E."],
      BBOX[60.36,26.5,70.05,27.5]]
```

7.3.3 Identifier

Identifier is an optional attribute which references an external description of the object and which may be applied to a coordinate reference system, a coordinate operation or a bound CRS. It may also be utilised for components of these objects although this is recommended only for the following circumstances:

- coordinate operation methods and parameters;
- source and target CRSs when embedded within a coordinate transformation or a concatenated coordinate operation;
- source CRS when embedded within a point motion operation;
- individual coordinate operations embedded within a concatenated coordinate operation;
- base CRS when embedded within a derived CRS (including projected CRS);
- source CRS, target CRS and abridged transformation when embedded within a bound CRS;
- individual members of a datum ensemble.

Multiple identifiers may be given for any object.

When an identifier is given for a coordinate reference system, coordinate operation or bound CRS, it applies to the whole object including all of its components.

Should any attributes or values given in the cited identifier be in conflict with attributes or values given explicitly in the WKT description, the WKT values shall prevail.

Requirement: The WKT representation of an <identifier> shall be:

<identifier>	::=	<identifier keyword> <left delimiter> <authority name> <wkt separator> <authority unique identifier> [<wkt separator> <version>] [<wkt separator> <authority citation>] [<wkt separator> <id uri>] <right delimiter>
<identifier keyword>	::=	ID
<authority name>	::=	<quoted Latin text>
<authority unique identifier>	::=	<number> <quoted Latin text>
<version>	::=	<number> <quoted Latin text>
<authority citation>	::=	<citation keyword> <left delimiter> <citation> <right delimiter>
<citation keyword>	::=	CITATION
<citation>	::=	<quoted Latin text>
<id uri>	::=	<uri keyword> <left delimiter> <uri> <right delimiter>
<uri keyword>	::=	URI
<uri>	::=	<quoted Latin text>

Version is an optional attribute indicating the version of the repository or object that is cited. Citation is an optional attribute that may be used to give further details of the authority. URI is an optional attribute that may be used to give reference to an online resource.

NOTE In previous specifications the authority object was defined more narrowly than is the identifier object in this document. See [Annex C](#).

EXAMPLE 1 ID["Authority name", "Abcd_Ef", 7.1]

EXAMPLE 2 ID["EPSG", 4326]

EXAMPLE 3 ID["EPSG", 4326, URI["urn:ogc:def:crs:EPSG::4326"]]

EXAMPLE 4 ID["EuroGeographics", "ES_ED50 (BAL99) to ETRS89", "2001-04-20"]

Further examples are included in [Clauses 8 to 17](#).

7.3.4 Remark

<remark> is an optional attribute. Any information contained in a <remark> is informative. It does not modify the defining parameters of an object.

A <remark> may be applied to a coordinate reference system, coordinate operation or bound CRS as a whole. A <remark> should not be included in the WKT for components of a coordinate reference system or coordinate operation, but a remark in the coordinate reference system or coordinate operation object may include information about these components.

NOTE A <remark> can be included within the descriptions of source and target CRS embedded within a coordinate transformation as well as within the coordinate transformation itself.

Any character other than a <wkt Latin text character> that is to be contained in a CRS WKT string may be included only as part of <quoted Unicode text> within a <remark>.

Requirement: The WKT representation of a <remark> shall be:

```
<remark> ::= <remark keyword> <left delimiter> <quoted Unicode text>
               <right delimiter>
<remark keyword> ::= REMARK
```

EXAMPLE 1 REMARK["A remark in ASCII"]

EXAMPLE 2 REMARK["Замечание на русском языке"]

EXAMPLE 3

```
GEOGCRS["S-95",
  DATUM["Pulkovo 1995",
    ELLIPSOID["Krassowsky 1940",6378245,298.3,
      LENGTHUNIT["metre",1.0]]
  ],
  CS[ellipsoidal,2],
  AXIS["latitude",north,ORDER[1]],
  AXIS["longitude",east,ORDER[2]],
  ANGLEUNIT["degree",0.0174532925199433],
  REMARK["Система Геодезических Координат года 1995 (СК-95)"]
]
```

Further examples including remarks are given in [Clauses 8](#) to [19](#).

7.4 Unit and unit conversion factor

7.4.1 Unit description

Some attributes of coordinate system axes and coordinate operation parameters are numbers which require the unit to be specified. General aspects are described here. For additional aspects that are specific to ordinal and temporal coordinate system axes see [7.5.6](#).

Requirement: The WKT representation of a <unit> description shall be:

<unit>	::=	<spatial unit> <time unit>
<spatial unit>	::=	<angle unit> <length unit> <parametric unit> <scale unit>
<angle unit>	::=	<angle unit keyword> <left delimiter> <unit name> <wkt separator> <conversion factor> [{ <wkt separator> <identifier> }]... <right delimiter>
<length unit>	::=	<length unit keyword> <left delimiter> <unit name> <wkt separator> <conversion factor> [{ <wkt separator> <identifier> }]... <right delimiter>
<parametric unit>	::=	<parametric unit keyword> <left delimiter> <unit name> <wkt separator> <conversion factor> [{ <wkt separator> <identifier> }]... <right delimiter>
<scale unit>	::=	<scale unit keyword> <left delimiter> <unit name> <wkt separator> <conversion factor> [{ <wkt separator> <identifier> }]... <right delimiter>
<time unit>	::=	<time unit keyword> <left delimiter> <unit name> [<wkt separator> <conversion factor>] [{ <wkt separator> <identifier> }]... <right delimiter> <i>!! In this document when the <time unit> is applied to a temporal coordinate system axis the <conversion factor> is conditional: see 7.4.3.</i>
<angle unit keyword>	::=	ANGLEUNIT UNIT <i>!! In this document the preferred keyword is ANGLEUNIT. UNIT is permitted for backward compatibility. Implementations shall be able to read both forms.</i>
<length unit keyword>	::=	LENGTHUNIT UNIT <i>!! In this document the preferred keyword is LENGTHUNIT. UNIT is permitted for backward compatibility. Implementations shall be able to read both forms.</i>
<parametric unit keyword>	::=	PARAMETRICUNIT

<scale unit keyword>	::=	SCALEUNIT UNIT <i>!! In this document the preferred keyword is SCALEUNIT. UNIT is permitted for backward compatibility. Implementations shall be able to read both forms.</i>
<time unit keyword>	::=	TIMEUNIT TEMPORALQUANTITY <i>!! In this document the preferred keyword is TIMEUNIT. TEMPORALQUANTITY is permitted. Implementations shall be able to read both forms.</i>
<unit name>	::=	<quoted Latin text>
<conversion factor>	::=	<unsigned numeric literal> <i>!! <conversion factor> is the number of SI standard units per unit. See 7.4.2 and 7.4.3.</i>

NOTE <identifier> is described in [7.3.4](#).

7.4.2 Conversion factor — Spatial and parametric units

Requirements: If the unit is linear its conversion factor shall be to metres and is the number of metres per unit. If the unit is angular its conversion factor shall be to radians and is the number of radians per unit. For parametric units the appropriate SI standard unit shall be used. For scale, unity shall be used.

EXAMPLE 1 LENGTHUNIT["metre",1]

EXAMPLE 2 LENGTHUNIT["German legal metre",1.0000135965]

EXAMPLE 3 ANGLEUNIT["degree",0.0174532925199433]

EXAMPLE 4 SCALEUNIT["parts per million",1E-06]

EXAMPLE 5 PARAMETRICUNIT["hectopascal",100]

Further examples are included in [7.5](#) and [Clauses 8 to 17](#).

7.4.3 Conversion factor — Temporal quantities

Unit uses the datatype of UnitOfMeasure. This is defined in ISO 19103. The class includes a note "conversion ToISOstandardUnit is not null only if the conversion is a simple scale". For many temporal cases, the unit is not a simple scale: the size of a month, a day or an hour vary at different locations in the calendar due to correction factors and alterations such as leap seconds, leap years, and seasonal time zone changes. Conversion of a temporal quantity (time unit) to the SI base unit for time, the second, therefore may or may not be ambiguous when compared to a calendar definition of that quantity. Examples are given in ISO 19111:2019, D.4. In these cases, UnitOfMeasure instances of temporalCount and temporalMeasure are described with no relation to the second.

NOTE In ISO 8601-1 the terms 'calendar day', 'calendar month' and 'calendar year' are used, with the note: often referred to as 'day', 'month' and 'year' respectively.

POSIX time is commonly used in software. It is dimensioned in seconds, but leap seconds are ignored (not applied)^[6]. A unit of measure "second" may be used to represent this, but it shall be defined independent of the SI second, not as a specific number of SI seconds. It may be thought of as a "calendar second".

Requirement: For temporal quantities, in this document called time units, the unit conversion factor shall be to seconds and is the number of seconds per unit, but the conversion factor is not to be given when it is not a simple scaling.

EXAMPLE 1 Simple scaling, so conversion factor is required.
`TIMEUNIT["millisecond", 0.001]`

EXAMPLE 2 Scaling not simple (number of seconds in a month varies), so conversion factor not required.
`TIMEUNIT["calendar month"]`

EXAMPLE 3 Using the POSIX formula^[6] which ignores leap seconds, so conversion factor not required.
`TIMEUNIT["calendar second"]`

NOTE The example given in ISO 19162:2015:
`TIMEUNIT["day", 86400.0]`

is deprecated. The number of seconds in a calendar day is not a simple scaling (because some days contain leap seconds) so conversion factor is not to be given.

7.4.4 Default unit

Recommended practice is for units to be explicitly described. However, for backward compatibility reasons, this document in places permits unit description to be implied. This may result in incomplete specification.

EXAMPLE Angular units cannot be inferred from a coordinate system with linear units, as in the angle unit for longitude of a prime meridian which cannot be inferred from a geodetic coordinate reference system having a Cartesian coordinate system.

Requirement: Where no implied unit can be inferred then in this document the default implied linear unit shall be metre, the default implied angular unit shall be degree.

7.5 Coordinate system

7.5.1 Syntax

Most coordinate system attributes are common to all subtypes of spatial and temporal coordinate systems. Exceptions are associated with the coordinate system axis unit attribute and its qualifier, the conversion factor to an SI base unit:

- When the coordinate system type is 'temporalCount' or 'temporalMeasure', the inclusion of the axis unit conversion factor in WKT is conditional, see [7.4.3](#).
- When the coordinate system type is 'ordinal' or 'temporalDateTime', the axis unit attribute and its conversion factor are not required in WKT, see [7.5.6](#) and [13.3](#).

The syntax for all coordinate systems is described here.

Requirement: The WKT representation of a coordinate system shall be:

```
<coordinate system> ::= <spatial cs>
                        | <temporalCountMeasure cs> | <ordinal-dateTime cs>
```

<spatial cs>	::=	<cs keyword> <left delimiter> <spatial cs type> <wkt separator> <dimension> [{ <wkt separator> <identifier> }]... <right delimiter> { <wkt separator> <spatial axis> }... [<wkt separator> <cs unit>] <i>!! Requires axis unit attributes including conversion factor.</i>
<temporalCountMeasure cs>	::=	<cs keyword> <left delimiter> <temporalCountMeasure cs type> <wkt separator> <dimension> [{ <wkt separator> <identifier> }]... <right delimiter> <wkt separator> <temporalCountMeasure axis> <i>!! Requires axis unit attributes, conversion factor is conditional. See 7.5.2.</i>
<ordinal-dateTime cs>	::=	<cs keyword> <left delimiter> <ordinal-dateTime cs type> <wkt separator> <dimension> [{ <wkt separator> <identifier> }]... <right delimiter> { <wkt separator> <ordinal-dateTime axis> }... <i>!! Axis unit is not required.</i>
<cs keyword>	::=	CS
<spatial cs type>	::=	affine Cartesian cylindrical ellipsoidal linear parametric polar spherical vertical <i>!! See 7.5.2 for constraints.</i>
<temporalCountMeasure cs type>	::=	temporalCount temporalMeasure <i>!! See 7.5.2 for constraints.</i>
<ordinal-dateTime cs type>	::=	ordinal temporalDateTime <i>!! See 7.5.2 for constraints.</i>
<dimension>	::=	1 2 3 <i>!! Unsigned integer. See 7.5.2 for constraints.</i>
<spatial axis>	::=	<axis keyword> <left delimiter> <axis nameAbbrev> <wkt separator> <axis direction> [<wkt separator> <axis order>] [<wkt separator> <spatial unit>] [{ <wkt separator> <identifier> }]... <right delimiter> <i>!! Axis unit and conversion factor mandatory. See 7.5.6.2.</i>
<temporalCountMeasure axis>	::=	<axis keyword> <left delimiter> <axis nameAbbrev> <wkt separator> <axis direction> [<wkt separator> <axis order>] [<wkt separator> <time unit>] [{ <wkt separator> <identifier> }]... <right delimiter> <i>!! Axis unit mandatory, conversion factor conditional. See 7.5.6.4.</i>

<ordinal-dateTime axis>	::=	<axis keyword> <left delimiter> <axis nameAbbrev> <wkt separator> <axis direction> [<wkt separator> <axis order>] [{ <wkt separator> <identifier> }]... <right delimiter> <i>!! The attribute 'axis unit' is not required for an ordinal coordinate system or for a temporal dateTime coordinate system. See 7.5.6.3.</i>
<axis keyword>	::=	AXIS
<axis nameAbbrev>	::=	<double quote> { <axis name> <axis abbreviation> <axis name and abbrev> } <double quote>
<axis name>	::=	<wkt Latin text character>...
<axis abbreviation>	::=	<left paren> <simple Latin letter>... <right paren>
<axis name and abbrev>	::=	<axis name> <space> <axis abbreviation> <i>!! See 7.5.3 for requirements for axis name and abbreviation.</i>
<axis direction>	::=	north [{ <wkt separator> <meridian> }] northNorthEast northEast eastNorthEast east eastSouthEast southEast southSouthEast south [{ <wkt separator> <meridian> }] southSouthWest southWest westSouthWest west westNorthWest northWest northNorthWest geocentricX geocentricY geocentricZ up down forward aft port starboard clockwise <wkt separator> <bearing> counterClockwise <wkt separator> <bearing> columnPositive columnNegative rowPositive rowNegative displayRight displayLeft displayUp displayDown future past towards awayFrom unspecified <i>!! See 7.5.4 for constraints.</i>
<meridian>	::=	<meridian keyword> <left delimiter> <number> <wkt separator> <angle unit> <right delimiter> <i>!! See 7.5.4 for constraints.</i>
<meridian keyword>	::=	MERIDIAN
<bearing>	::=	<bearing keyword> <left delimiter> <number> <right delimiter> <i>!! See 7.5.4 for constraints.</i>
<bearing keyword>	::=	BEARING
<axis order>	::=	<axis order keyword> <left delimiter> <unsigned integer> <right delimiter> <i>!! See 7.5.5 for constraints.</i>
<axis order keyword>	::=	ORDER
<cs unit>	::=	<unit> <i>!! See 7.4 and 7.5.6 for constraints.</i>
<spatial unit>		See 7.4 and 7.5.6 .
<time unit>		See 7.4 for time unit definition and 13.3 for application to coordinate systems.