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Geographic information — Well known text for coordinate reference systems

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1. Preface

This draft is that submitted to ISO TC211 as a Committee Draft for ballot as a Draft International Standard (document N3596). The version incorporates deliberations by the OGC SWG during the first half of 2013. An OGC foreword will be added in a later revision of this document.

1. Submitting organizations

The following organizations submitted this Implementation Specification to the Open Geospatial Consortium Inc. as a Request For Comment (RFC):

1. International Association of Oil and Gas Producers (OGP)
2. Submission contact points

All questions regarding this submission should be directed to the editor or the submitters:

|  |  |
| --- | --- |
| CONTACT | COMPANY |
| Roger Lott | OGP |

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1. Changes to the OGC® Abstract Specification

The OGC® Abstract Specification does not require changes to accommodate this OGC® standard.

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Geographic information — Well known text for coordinate reference systems

*Information géographique — Représentation textuelle bien lisible de systèmes de référence 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.

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

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

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

ISO 19162 was prepared by Technical Committee ISO/TC 211, *Geographic information / Geomatics*, in close collaboration with the Open Geospatial Consortium (OGC).

This edition cancels and replaces ISO 19125-1:2004 sub-clause 6.4 which has been technically revised.

Introduction

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

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

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

# Scope

This International Standard defines the structure and content of a text string implementation of the abstract model for coordinate reference systems described in ISO 19111:2007. The string defines frequently needed types of coordinate reference systems and coordinate operations in a self-contained form that is easily readable by machines and by humans. The essence is its simplicity; as a consequence there are some constraints upon the more open content allowed in ISO 19111:2007. To retain simplicity in the well-known text description of coordinate reference systems, the scope of this International Standard excludes derived coordinate reference system capability other than for projected coordinate reference systems, parameter grouping and pass-through coordinate operations. Because it omits metadata about the source of the data and may omit metadata about the applicability of the information, the well-known text string is not suitable for the storage of definitions of coordinate reference systems or coordinate operations.

# Conformance requirements

This International Standard defines three classes of conformance:

1. Any well-known text string claiming conformance of coordinate reference system definition shall satisfy the requirements given in annex A.1.
2. Any well-known text string claiming conformance of coordinate operation definition shall satisfy the requirements given in annex A.2.
3. Any well-known text string claiming conformance for the definition of a coordinate transformation bound to a coordinate reference system definition shall satisfy the requirements given in annex A.3.

Any well-known text string claiming conformance to the whole of this Standard shall satisfy the requirements given in Annexes A.1, A.2 and A.3.

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

# Normative references

The following referenced documents are indispensible for the application of this document:

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

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

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

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

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

# Definitions and abbreviations

## Definitions

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

4.1.1

affine coordinate system

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

[SOURCE: ISO 19111:2007, 4.1]

4.1.2

bearing

horizontal angle at a point relative to a specified direction

NOTE The direction is usually specified to be north.

4.1.3

Cartesian coordinate system

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

NOTE *n* is 2 or 3 for the purposes of this International Standard.

4.1.4

compound coordinate reference system

coordinate reference system using at least two independent coordinate reference systems

NOTE Coordinate reference systems are independent of each other if coordinate values in one cannot be converted or transformed into coordinate values in the other.

[SOURCE: ISO 19111:2007, 4.3]

4.1.5

coordinate conversion

coordinate operation in which both coordinate reference systems are based on the same datum

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

NOTE A coordinate conversion uses parameters which have specified values that are not determined empirically.

[SOURCE: ISO 19111:2007, 4.6]

4.1.6

coordinate operation

change of coordinates, based on a one-to-one relationship, from one coordinate reference system to another

NOTE Supertype of coordinate transformation and coordinate conversion.

[SOURCE: ISO 19111:2007, 4.7]

4.1.7

coordinate reference system

coordinate system that is related to an object by a datum

NOTE For geodetic and vertical datums, the object will be the Earth.

[SOURCE: ISO 19111:2007, 4.8]

4.1.8

coordinate system

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

[SOURCE: ISO 19111:2007, 4.10]

4.1.9

coordinate transformation

coordinate operation in which the two coordinate reference systems are based on different datums

NOTE A coordinate transformation uses parameters which are derived empirically by a set of points with known coordinates in both coordinate reference systems.

[SOURCE: ISO 19111:2007, 4.11]

4.1.10

cylindrical coordinate system

three-dimensional coordinate system with two distance and one angular coordinates

[SOURCE: ISO 19111:2007, 4.13]

4.1.11

datum

parameter or set of parameters that define the position of the origin, the scale, and the orientation of a coordinate system

[SOURCE: ISO 19111:2007, 4.14]

4.1.12

ellipsoid

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

NOTE In this International Standard, ellipsoids are always oblate, meaning that the axis of rotation is always the minor axis.

[SOURCE: ISO 19111:2007, 4.17]

4.1.13

ellipsoidal coordinate system

geodetic coordinate system

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

[SOURCE: ISO 19111:2007, 4.18]

4.1.14

ellipsoidal height

geodetic height

*h*

distance of a point from the ellipsoid measured along the perpendicular from the ellipsoid to this point, positive if upwards or outside of the ellipsoid

NOTE Only used as part of a three-dimensional ellipsoidal coordinate system and never on its own.

[SOURCE: ISO 19111:2007, 4.19]

4.1.15

engineering coordinate reference system

coordinate reference system based on an engineering datum

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

[SOURCE: ISO 19111:2007, 4.20]

4.1.16

flattening

*f*

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

NOTE Sometimes inverse flattening 1/*f*= *a*/(*a − b*) is given instead; 1/*f* is also known as reciprocal flattening.

[SOURCE: ISO 19111:2007, 4.22]

4.1.17

geocentric coordinate reference system

ECEF Cartesian coordinate reference system

geodetic coordinate reference system including an earth-centred, earth-fixed, three-dimensional Cartesian coordinate system

4.1.18

geodetic coordinate reference system

coordinate reference system based on a geodetic datum

[SOURCE: ISO 19111:2007, 4.23]

4.1.19

geodetic datum

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

[SOURCE: ISO 19111:2007, 4.24]

4.1.20

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 19111:2007, 4.25]

4.1.21

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 19111:2007, 4.26]

4.1.22

geographic 2D coordinate reference system

ellipsoidal 2D coordinate reference system

geodetic coordinate reference system including a two-dimensional ellipsoidal coordinate system

4.1.23

geographic 3D coordinate reference system

ellipsoidal 3D coordinate reference system

geodetic coordinate reference system including a three-dimensional ellipsoidal coordinate system

4.1.24

image coordinate reference system

coordinate reference system based on an image datum

[SOURCE: ISO 19111:2007, 4.30]

4.1.25

linear coordinate system

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

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

[SOURCE: ISO 19111:2007, 4.32]

4.1.26

map projection

coordinate conversion from an ellipsoidal coordinate system to a plane

[SOURCE: ISO 19111:2007, 4.33]

4.1.27

parametric coordinate reference system

coordinate reference system based on a parametric datum

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

4.1.28

parametric coordinate system

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

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

4.1.29

polar coordinate system

two-dimensional coordinate system in which position is specified by distance and direction from the origin

NOTE For the three-dimensional case, see spherical coordinate system (4.1.35).

[SOURCE: ISO 19111:2007, 4.37]

4.1.30

prime meridian

zero meridian

meridian from which the longitudes of other meridians are quantified

[SOURCE: ISO 19111:2007, 4.38]

4.1.31

projected coordinate reference system

coordinate reference system derived from a two-dimensional geodetic coordinate reference system by applying a map projection

[SOURCE: ISO 19111:2007, 4.39]

4.1.32

semi-major axis

*a*

semi-diameter of the longest axis of an ellipsoid

NOTE This equates to the semi-diameter of the ellipsoid measured in its equatorial plane.

[SOURCE: ISO 19111:2007, 4.40]

4.1.33

semi-minor axis

*b*

semi-diameter of the shortest axis of an ellipsoid

NOTE The shortest axis coincides with the rotation axis of the ellipsoid and therefore contains both poles.

[SOURCE: ISO 19111:2007, 4.41]

4.1.34

spatio-parametric coordinate reference system

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

coordinate reference system and one is a spatial coordinate reference system

NOTE Normally the spatial component is “horizontal” and the parametric component is “vertical”.

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

4.1.35

spherical coordinate system

three-dimensional coordinate system with one distance measured from the origin and two angular coordinates, commonly associated with a geodetic coordinate reference system

NOTE Not to be confused with an ellipsoidal coordinate system based on an ellipsoid ‘degenerated’ into a sphere.

[SOURCE: ISO 19111:2007, 4.44]

4.1.36

spheroid

closed surface that differs only slightly from that of a sphere

4.1.37

vertical coordinate reference system

one-dimensional coordinate reference system based on a vertical datum

[SOURCE: ISO 19111:2007, 4.47]

4.1.38

vertical coordinate system

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

[SOURCE: ISO 19111:2007, 4.48]

4.1.39

white space

consecutive sequences of one or more characters that have no glyphs

[SOURCE: ISO/IEC 9075-2:2011, 3.1.6.48]

## Abbreviations

BNF Backus-Naur form

CRS coordinate reference system

CS coordinate system

EPSG International Association of Oil and Gas Producers' EPSG Geodetic Parameter Dataset,

[www.epsg-registry.org](http://www.epsg-registry.org)

OGC Open Geospatial Consortium, [www.opengeospatial.org](http://www.opengeospatial.org)

WKT well-known text

# Backus-Naur Form notation and syntax

The well-known text representation of coordinate reference systems and coordinate operations is defined in this International Standard using an extended version of Backus-Naur form (BNF) notation as defined in ISO/IEC 9075-1:2011, 6.2. The BNF provides the mechanism for generating a WKT string. The production rules in ISO/IEC 9075-1:2011, 6.2 apply.

In the version of BNF used in ISO/IEC 9075-1:2011, 6.2 and in this International Standard the following characters have the meaning described below:

* A character string enclosed in angle brackets "< >" is a syntactic element.
* A vertical bar "|" indicates alternatives.
* Braces "{ }" group elements.
* Square brackets “[ ]” denote optional elements.

NOTE: 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 multiple instances of that element. Ellipsis after braces "{ }…" applies the multiplicity to all elements within the braces. Ellipsis after square brackets "[ ]…" means that the content inside the square brackets may occur zero to many times.
* Double apostrophes "! !" 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 is significant.

# Well-known text string form

## Overview

The well-known text 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 given within delimiters. Some objects are composed of other objects so the result may be a nested structure. Nesting may continue to any depth. The delimiters are normally <left bracket> and <right bracket>. Implementations are free to substitute parentheses for brackets. Attributes are separated by commas.

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

Attributes may be text or numbers. 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.

A well-known text string contains no white space outside of double quotes. However padding with white space to improve human readability is permitted; the examples of well-known text 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.

## Encoding

All WKT strings are realized as a sequence of characters, or a character string. It is not the goal of this standard 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**:

1. A WKT string shall use one encoding throughout the entire string.
2. 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 ISO10646:2012.

## Structure

### Basic characters

|  |  |  |  |
| --- | --- | --- | --- |
| <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  *!! ISO/IEC 10646:2012 character identifiers U+0061 through U+007A* | |
| <digit> | ::= | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9  *!! ISO/IEC 10646:2012 character identifiers U+0030 through U+0039* | |
| <space> | ::= | SP | *!! ISO/IEC 10646:2012 character identifier U+0020* |
| <double quote> | ::= | " | *!! ISO/IEC 10646:2012 character identifier U+0022* |
| <percent> | ::= | % | *!! ISO/IEC 10646:2012 character identifier U+0025* |
| <ampersand> | ::= | & | *!! ISO/IEC 10646:2012 character identifier U+0026* |
| <quote> | ::= | ' | *!! ISO/IEC 10646:2012 character identifier U+0027* |
| <left paren> | ::= | ( | *!! ISO/IEC 10646:2012 character identifier U+0028* |
| <right paren> | ::= | ) | *!! ISO/IEC 10646:2012 character identifier U+0029* |
| <asterisk> | ::= | \* | *!! ISO/IEC 10646:2012 character identifier U+002A* |
| <plus sign> | ::= | + | *!! ISO/IEC 10646:2012 character identifier U+002B* |
| <comma> | ::= | , | *!! ISO/IEC 10646:2012 character identifier U+002C* |
| <minus sign> | ::= | - | *!! ISO/IEC 10646:2012 character identifier U+002D* |
| <period> | ::= | . | *!! ISO/IEC 10646:2012 character identifier U+002E* |
| <solidus> | ::= | / | *!! ISO/IEC 10646:2012 character identifier U+002F* |
| <colon> | ::= | : | *!! ISO/IEC 10646:2012 character identifier U+003A* |
| <semicolon> | ::= | ; | *!! ISO/IEC 10646:2012 character identifier U+003B* |
| <less than operator> | ::= | < | *!! ISO/IEC 10646:2012 character identifier U+003C* |
| <equals operator> | ::= | = | *!! ISO/IEC 10646:2012 character identifier U+003D* |
| <greater than operator> | ::= | > | *!! ISO/IEC 10646:2012 character identifier U+003E* |
| <question mark> | ::= | ? | *!! ISO/IEC 10646:2012 character identifier U+003F* |
| <left bracket> | ::= | [ | *!! ISO/IEC 10646:2012 character identifier U+005B* |
| <reverse solidus> | ::= | \ | *!! ISO/IEC 10646:2012 character identifier U+005C* |
| <right bracket> | ::= | ] | *!! ISO/IEC 10646:2012 character identifier U+005D* |
| <underscore> | ::= | \_ | *!! ISO/IEC 10646:2012 character identifier U+005F* |
| <left brace> | ::= | { | *!! ISO/IEC 10646:2012 character identifier U+007B* |
| <vertical bar> | ::= | | | *!! ISO/IEC 10646:2012 character identifier U+007C* |
| <right brace> | ::= | } | *!! ISO/IEC 10646:2012 character identifier U+007D* |
| <degree symbol> | ::= | ° | *!! ISO/IEC 10646:2012 character identifier U+00B0* |

### 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> |

This is taken directly from ISO 9075-2:2011, 5.1 and 5.3.

The integer and fractional parts of a number are separated by a <period>. No other separator is allowed. No other separator (e.g. for thousands or multiples thereof) is allowed.

### Well-known text characters

|  |  |  |
| --- | --- | --- |
| <wkt Unicode text character> | ::= | <nondoublequote character> | <doublequote symbol> |
| <nondoublequote character> | ::= | *!!* A <nondoublequote character> is any character of the source language character set other than a  <double quote>. |
| <doublequote symbol> | ::= | *"" !! two consecutive <double quote> characters* |
| <wkt Latin text character> | ::= | <simple Latin upper case letter> | <simple Latin lower case letter>  | <digit> | <underscore>  | <left bracket> | <right bracket> | <left paren> | <right paren>  | <space> | <percent> | <ampersand> | <quote> | <asterisk>  | <plus sign> | <comma> | <minus sign> | <period> | <solidus>  | <colon> | <semicolon> | <less than operator> | <equals operator>  | <greater than operator> | <question mark> | <left brace>  | <vertical bar> | <right brace> | <degree symbol>  | <doublequote symbol> |
| <quoted Latin text> | ::= | <double quote> { <wkt Latin text character> }… <double quote> |
| <quoted Unicode text> | ::= | <double quote> { <wkt Unicode text character> }… <double quote> |
| <wkt keyword character> | ::= | <simple Latin upper case letter> | <simple Latin lower case letter>  | <digit> | <underscore> |
| <delimiter> | ::= | <left delimiter> | <right delimiter> |
| <left delimiter> | ::= | <left bracket> | <left paren> |
| <right delimiter> | ::= | <right bracket> | <right paren> *!! See 6.3.6* |
| <wkt parameter separator> | ::= | <comma> |
| <datetime> | ::= | *!! See ISO 9075-2:2011* |

### Double quote

**Requirement:** If a double quote is required within a <quoted Latin text> or <quoted Unicode text> string, for example as the symbol for Sexagesimal seconds, then a <doublequote symbol> shall be used.

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

### Well-known text string

**Requirement:** The structure for a CRS well-known text string shall be:

|  |  |  |
| --- | --- | --- |
| <wkt token> | ::= | <wkt keyword> <left delimiter> <wkt content> <right delimiter> |
| <wkt keyword> | ::= | <wkt keyword character> [ <wkt keyword character> ]… |
| <wkt content> | ::= | <wkt parameter>  [ <wkt parameter separator> { <wkt parameter> | <wkt token> } ]… |
| <wkt parameter> | ::= | <number> | <quoted Latin text> | <quoted Unicode text> |

### Delimiter

**Requirement**: A CRS WKT string shall include only one of the two forms of delimiter, brackets or parentheses, allowed in 6.3.3.

In well-known text 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> must be used as the corresponding <right delimiter>; if <left paren> is used as a <left delimiter> then <right paren> must be used as the corresponding <right delimiter>. A nested token must use the same type of delimiter as the token in which it is nested.

## Reserved keywords

### Coordinate reference systems

The keywords defined in clauses 7 and 8 of this International Standard for coordinate reference systems, their component elements and their attributes are:

|  |  |  |
| --- | --- | --- |
| <datum anchor keyword> | ::= | ANCHOR |
| <angle unit keyword> | ::= | ANGUNIT | UNIT |
| <area description keyword> | ::= | AREA |
| <axis keyword> | ::= | AXIS |
| <base crs keyword> | ::= | BASECRS |
| <geographic bounding box keyword> | ::= | BBOX |
| <bearing keyword> | ::= | BEARING |
| <citation keyword> | ::= | CITATION |
| <compound crs keyword> | ::= | COMPOUNDCRS |
| <map projection keyword> | ::= | CONVERSION |
| <cs type keyword> | ::= | CS |
| <geodetic datum keyword> | ::= | DATUM |
| <ellipsoid keyword> | ::= | ELLIPSOID | SPHEROID |
| <engineering crs keyword> | ::= | ENGCRS |
| <geocentric crs keyword> | ::= | GCENCRS |
| <generic datum keyword> | ::= | GENDATUM |
| <geographic3d crs keyword> | ::= | GEOG3DCRS |
| <geographic2d crs keyword> | ::= | GEOGCRS |
| <identifier keyword> | ::= | ID |
| <image crs keyword> | ::= | IMAGECRS |
| <length unit keyword> | ::= | LENUNIT | UNIT |
| <meridian keyword> | ::= | MERIDIAN |
| <map projection method keyword> | ::= | METHOD | PROJECTION |
| <axis order keyword> | ::= | ORDER |
| <parametric crs keyword> | ::= | PARAMCRS |
| <param unit keyword> | ::= | PARAMUNIT | UNIT |
| <prime meridian keyword> | ::= | PRIMEM |
| <projected crs keyword> | ::= | PROJCRS |
| <remark keyword> | ::= | REMARK |
| <scale unit keyword> | ::= | SCALEUNIT | UNIT |
| <scope keyword> | ::= | SCOPE |
| <temporal crs keyword> | ::= | TIMECRS |
| <temporal extent keyword> | ::= | TIMEEXTENT |
| <time unit keyword> | ::= | TIMEUNIT | UNIT |
| <uri keyword> | ::= | URI |
| <vertical crs keyword> | ::= | VERTCRS |
| <vertical extent keyword> | ::= | VERTEXTENT |

Where alternatives are given the second is for backward compatibility.

### Coordinate operations

The keywords defined in clause 9 of this International Standard are:

|  |  |  |
| --- | --- | --- |
| <operation keyword> | ::= | COORDOP |
| <interpolation crs keyword> | ::= | INTERPCRS |
| <operation method keyword> | ::= | METHOD |
| <operation accuracy keyword> | ::= | OPACCURACY |
| <parameter file keyword> | ::= | PARAMETERFILE |
| <source crs keyword> | ::= | SOURCECRS |
| <target crs keyword> | ::= | TARGETCRS |

### Coordinate reference system and coordinate transformation couplets

The keywords defined in clause 10 of this International Standard are:

|  |  |  |
| --- | --- | --- |
| <abridged transformation keyword> | ::= | ABRTRANS |
| <bound crs keyword> | ::= | BOUNDCRS |

## Backward compatibility

This document makes several references to backward compatibility. Backward compatibility means that an implementation of this International Standard 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 International Standard. It also does not require an implementation of this International Standard to be able to output an object according to the old syntax. A mapping of older syntaxes to this International Standard is given in Annex C.

# Well-known text representation of common attributes

## Introduction

This clause defines the representation of attributes that are common to coordinate reference systems and coordinate operations, described in clauses 8 and 9 respectively.

## 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.

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 may result in duplication of name within the CRS WKT string.

**Requirement:** The well-known text representation of a <name> shall be:

|  |  |  |
| --- | --- | --- |
| <crs name> | ::= | <name> |
| <name> | ::= | <quoted Latin text> |

<quoted Latin text> is defined in 6.3.

## 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 boundCRS. It may also be utilised for components of these objects although this is not recommended except for coordinate operation methods (including map projections) and parameters. Multiple identifiers may be given for any object.

When an identifier is given for a coordinate reference system, coordinate operation or boundCRS, 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 well-known text description, the well-known text values shall prevail.

**Requirement:** The well-known text representation of an <identifier> shall be:

|  |  |  |
| --- | --- | --- |
| <identifier> | ::= | <identifier keyword> <left delimiter> <authority name> <comma> <authority unique identifier> [ <comma> <version> ] [ <comma> <authority citation> ] [ <comma> <id uri> ] <right delimiter> |
| <identifier keyword> | ::= | ID |
| <authority name> | ::= | <quoted Latin text> |
| <authority unique identifier> | ::= | <unsigned integer> | <signed numeric literal> | <quoted Latin text> |
| <version> | ::= | <unsigned integer> | <signed numeric literal> | <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 identifier in this International Standard. 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 8.3 and 9.3.

## Scope

Scope is an optional attribute which describes the purpose or purposes for which a CRS or a coordinate operation is applied.

**Requirement**: The well-known text 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."]

## Extent

### Introduction

Extent describes the spatial applicability of a CRS or a coordinate operation. This International Standard permits horizontal extent to be described by description or 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. Multiple extent attributes may be provided.

|  |  |  |
| --- | --- | --- |
| <extent> | ::= | <area description> | <geographic bounding box>  | <vertical extent> | <temporal extent> |

### Area description

**Requirement**: The well-known text 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."]

### Geographic bounding box

**Requirement**: The well-known text representation of a <geographic bounding box> shall be:

|  |  |  |
| --- | --- | --- |
| <geographic bounding box> | ::= | <geographic bounding box keyword> <left delimiter>  <lower left latitude> <comma> <lower left longitude>  <comma> <upper right latitude> <comma>  <upper right longitude> <right delimiter> |
| <geographic bounding box keyword> | ::= | BBOX |
| <lower left latitude> | ::= | <number> *!! See text* |
| <lower left longitude> | ::= | <number> *!! See text* |
| <upper right latitude> | ::= | <number> *!! See text* |
| <upper right longitude> | ::= | <number> *!! See text* |

EXAMPLE BBOX[51.43,2.54,55.77,6.40] for a geographic bounding box enveloping offshore Netherlands.

**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.

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.

### 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.

**Requirement**: The well-known text representation of a <vertical extent> shall be:

|  |  |  |
| --- | --- | --- |
| <vertical extent> | ::= | <vertical extent keyword> <left delimiter>  <vertical extent minimum height> <comma>  <vertical extent maximum height> [ <comma> <length unit> ]  <right delimiter> |
| <vertical extent keyword> | ::= | VERTEXTENT |
| <vertical extent minimum height> | ::= | <number> |
| <vertical extent minimum height> | ::= | <number> |

**Requirement**: If vertical extent units are not stated they shall be assumed to be metres.

EXAMPLE 1 VERTEXTENT[-1000,0,LENUNIT["metre",1.0]]

EXAMPLE 2 VERTEXTENT[-1000,0] where the heights are implicitly in metres.

### Temporal extent

Temporal extent is an optional attribute which describes a date or time range over which a CRS or coordinate operation is applicable. The format for date and time values is defined in ISO 9075-2. Start time is earlier than end time.

**Requirement**: The well-known text representation of a <temporal extent> shall be:

|  |  |  |
| --- | --- | --- |
| <temporal extent> | ::= | <temporal extent keyword> <left delimiter>  <temporal extent start> <comma>  <temporal extent end> <right delimiter> |
| <temporal extent keyword> | ::= | TIMEEXTENT |
| <temporal extent start> | ::= | <datetime> | <quoted Latin text> |
| <temporal extent end> | ::= | <datetime> | <quoted Latin text> |

EXAMPLE 1 TIMEEXTENT[2013-01-01,2013-12-31]

EXAMPLE 2 TIMEEXTENT["Jurassic","Quaternary"]

## 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 boundCRS as a whole. A <remark> cannot be included in the well-known text 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> may 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 well-known text 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,

LENUNIT["metre",1.0]]],

CS[ellipsoidal,2],

AXIS["latitude",north,ORDER[1]],

AXIS["longitude",east,ORDER[2]],

ANGUNIT["degree",0.0174532925199433],

REMARK["Система Геодеэических Координвт года 1995(СК-95)"]]

Further examples are included in 8.3 and 9.3.

## Unit and unit conversion factor

Some attributes of coordinate reference systems and coordinate operations are numbers which require the unit to be specified.

**Requirement**: The well-known text representation of a <unit> description shall be:

|  |  |  |
| --- | --- | --- |
| <unit> | ::= | { <angle unit> | <length unit> | <scale unit> | <time unit> | <param unit> |
| <angle unit> | ::= | { <angle unit keyword> <left bracket> <unit name> <comma>  <conversion factor> [ { <comma> <identifier> } ]… <right bracket> }  |  { <angle unit keyword> <left paren> <unit name> <comma>  <conversion factor> [ { <comma> <identifier> } ]… <right paren> } |
| <angle unit keyword> | ::= | ANGUNIT | UNIT  *!! In this International Standard the preferred keyword is ANGUNIT. UNIT is permitted for backward compatibility. Implementations should be able to read both forms.* |
| <length unit> | ::= | { <length unit keyword> <left bracket> <unit name> <comma>  <conversion factor> [ { <comma> <identifier> } ]… <right bracket> }  |  { <length unit keyword> <left paren> <unit name> <comma>  <conversion factor> [ { <comma> <identifier> } ]… <right paren> } |
| <length unit keyword> | ::= | LENUNIT | UNIT  *!! In this International Standard the preferred keyword is LENUNIT. UNIT is permitted for backward compatibility. Implementations should be able to read both forms.* |
| <scale unit> | ::= | { <scale unit keyword> <left bracket> <unit name> <comma>  <conversion factor> [ { <comma> <identifier> } ]… <right bracket> }  |  { <scale unit keyword> <left paren> <unit name> <comma>  <conversion factor> [ { <comma> <identifier> } ]… <right paren> } |
| <scale unit keyword> | ::= | SCALEUNIT | UNIT  *!! In this International Standard the preferred keyword is SCALEUNIT. UNIT is permitted for backward compatibility. Implementations should be able to read both forms.* |
| <time unit> | ::= | { <time unit keyword> <left bracket> <unit name> <comma>  <conversion factor> [ { <comma> <identifier> } ]… <right bracket> }  |  { <time unit keyword> <left paren> <unit name> <comma>  <conversion factor> [ { <comma> <identifier> } ]… <right paren> } |
| <time unit keyword> | ::= | TIMEUNIT |
| <param unit> | ::= | { <param unit keyword> <left bracket> <unit name> <comma>  <conversion factor> [ { <comma> <identifier> } ]… <right bracket> }  |  { <param unit keyword> <left paren> <unit name> <comma>  <conversion factor> [ { <comma> <identifier> } ]… <right paren> } |
| <param unit keyword> | ::= | PARAMUNIT |
| <unit name> | ::= | <name> *!! See 7.2* |
| <conversion factor> | ::= | <unsigned numeric literal> |

<**conversion factor**> is the number of SI standard units per unit.

**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 other unit types the appropriate SI standard unit shall be used. For scale, unity shall be used.

EXAMPLE 1 LENUNIT["metre",1]

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

EXAMPLE 3 ANGUNIT["degree",0.0174532925199433]

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

EXAMPLE 5 PARAMUNIT["hectopascal",100]

Further examples are included in 8.3 and 9.3.

# Well-known text representation of coordinate reference systems

## Coordinate reference systems

### CRS subtypes

This International Standard defines the representation of the several subtypes of coordinate reference systems used in spatial referencing that are defined in ISO 19111:2007 and ISO 19111-2:2009:

|  |  |  |
| --- | --- | --- |
| <coordinate reference system> | ::= | <geodetic crs> | <projected crs> | <vertical crs> |  <engineering crs> | <image crs> | <temporal crs> |  <parametric crs> | <compound crs> |

This International Standard subdivides the geodetic CRS subtype defined in ISO 19111:2007 into three further subtypes differentiated by their dimension and coordinate system:

|  |  |  |
| --- | --- | --- |
| <geodetic crs> | ::= | <geocentric crs> | <geographic3d crs> | <geographic2d crs> |

The subclauses of 8.1 that follow give a high-level definition of these subtypes. Definitions of the components of these CRS subtypes are given in 8.2. Examples are given in 8.3.

Definitions of name, identifier, scope, extent, remark and unit are given in clause 7.

### Geodetic (geocentric Cartesian) CRS

**Requirement**: The well-known text representation of a geocentric coordinate reference system shall be:

|  |  |  |
| --- | --- | --- |
| <geocentric crs> | ::= | <geocentric crs keyword> <left delimiter> <crs name>  <comma> <geodetic datum> <comma> <coordinate system>  [ <comma> <scope> ] [ { <comma> <extent> } ]...  [ { <comma> <identifier> } ]… [ <comma> <remark>] <right delimiter> |
| <geocentric crs keyword> | ::= | GCENCRS |

### Geodetic (geographic 3D) CRS

**Requirement**: The well-known text representation of a geographic 3D coordinate reference system shall be:

|  |  |  |
| --- | --- | --- |
| <geographic3d crs> | ::= | <geographic3d crs keyword> <left delimiter> <crs name>  <comma> <geodetic datum> <comma> <coordinate system>  [ <comma> <scope> ] [ { <comma> <extent> } ]...  [ { <comma> <identifier> } ]… [ <comma> <remark> ]  <right delimiter> |
| <geographic3d crs keyword> | ::= | GEOG3DCRS |

### Geodetic (geographic 2D) CRS

**Requirement**: The well-known text representation of a geographic 2D coordinate reference system shall be:

|  |  |  |
| --- | --- | --- |
| <geographic2d crs> | ::= | <geographic2d crs keyword> <left delimiter> <crs name>  <comma> <geodetic datum> <comma> <coordinate system>  [ <comma> <scope> ] [ { <comma> <extent> } ]...  [ { <comma> <identifier> } ]… [ <comma><remark> ] <right delimiter> |
| <geographic2d crs keyword> | ::= | GEOGCRS |

### Projected CRS

**Requirement**: The well-known text representation of a projected coordinate reference system shall be:

|  |  |  |
| --- | --- | --- |
| <projected crs> | ::= | <projected crs keyword> <left delimiter> <crs name>  <comma> <base crs>  <comma> <map projection> <comma> <coordinate system>  [ <comma> <scope> ] [ { <comma> <extent>} ]...  [ { <comma> <identifier> } ]… [ <comma> <remark> ] <right delimiter> |
| <projected crs keyword> | ::= | PROJCRS |
| <base crs> | ::= | <base crs keyword> <left delimiter> <base crs name> <comma>  <geodetic datum> [ <comma> <ellipsoidal cs unit> ] <right delimiter> |
| <base crs keyword> | ::= | BASECRS |
| <base crs name> | ::= | <name> *!! See 7.2* |
| <ellipsoidal cs unit> | ::= | <angle unit> |

<base crs> is the geodetic (geographic 2D) CRS from which the projected CRS has been derived excluding the axis details. Full axes definitions of the base CRS are not required within a projected CRS description.

**Requirement**: The base CRS <ellipsoidal cs unit> shall be that in which geodetic latitude and longitude would be quoted in the geodetic CRS. It is defined as an optional attribute for backward compatibility reasons but shall be included in WKT strings when the units of the map projection angular parameters are not explicitly included within those parameters (see 8.2.5).

### Vertical CRS

**Requirement**: The well-known text representation of a vertical coordinate reference system shall be:

|  |  |  |
| --- | --- | --- |
| <vertical crs> | ::= | <vertical crs keyword> <left delimiter> <crs name>  <comma> <vertical datum> <comma> <coordinate system>  [ <comma> <scope> ] [ { <comma> <extent> } ]...  [ { <comma> <identifier> } ]… [ <comma> <remark> ] <right delimiter> |
| <vertical crs keyword> | ::= | VERTCRS |

### Engineering CRS

**Requirement**: The well-known text representation of an engineering coordinate reference system shall be:

|  |  |  |
| --- | --- | --- |
| <engineering crs> | ::= | <engineering crs keyword> <left delimiter> <crs name>  <comma> <engineering datum> <comma> <coordinate system>  [ <comma> <scope> ] [ { <comma> <extent> } ]...  [ { <comma> <identifier> } ]… [ <comma> <remark> ] <right delimiter> |
| <engineering crs keyword> | ::= | ENGCRS |

### Image CRS

**Requirement**: The well-known text representation of an image coordinate reference system shall be:

|  |  |  |
| --- | --- | --- |
| <image crs> | ::= | <image crs keyword> <left delimiter> <crs name>  <comma> <image datum> <comma> <coordinate system>  [ <comma> <scope> ] [ { <comma> <extent> } ]...  [ { <comma> <identifier> } ]… [ <comma> <remark> ] <right delimiter> |
| <image crs keyword> | ::= | IMAGECRS |

### Temporal CRS

**Requirement**: The well-known text representation of a temporal coordinate reference system shall be:

|  |  |  |
| --- | --- | --- |
| <temporal crs> | ::= | <temporal crs keyword> <left delimiter> <crs name>  <comma> <temporal datum> <comma> <coordinate system>  [ <comma> <scope> ] [ { <comma> <extent> } ]...  [ { <comma> <identifier> } ]… [ <comma> <remark> ] <right delimiter> |
| <temporal crs keyword> | ::= | TIMECRS |

### Parametric CRS

**Requirement**: The well-known text representation of a parametric coordinate reference system shall be:

|  |  |  |
| --- | --- | --- |
| <parametric crs> | ::= | <parametric crs keyword> <left delimiter> <crs name>  <comma> <parametric datum> <comma> <coordinate system>  [ <comma> <scope> ] [ { <comma> <extent> } ]...  [ { <comma> <identifier> } ]… [ <comma> <remark> ] <right delimiter> |
| <parametric crs keyword> | ::= | PARAMCRS |

### Compound CRS

**Requirement**: The well-known text representation of a compound coordinate reference system shall be:

|  |  |  |
| --- | --- | --- |
| <compound crs> | ::= | <compound crs keyword> <left delimiter> <compound crs name> <comma> <horizontal crs> <comma>  <vertical crs> | <parametric crs> | <temporal crs> |  { <vertical crs> comma> <temporal crs> } |  { <parametric crs> comma> <temporal crs> }  [ <comma> <scope> ] [ { <comma> <extent> } ]...  [ { <comma> <identifier> } ]… [ <comma> <remark> ] <right delimiter> |
| <compound crs keyword> | ::= | COMPOUNDCRS |
| <compound crs name> | ::= | <name> *!! See 7.2* |
| <horizontal crs> | ::= | <geographic2D crs> | <projected crs> | <engineering crs> |

The representation of constituent CRSs is elaborated in the subclauses above.

## Coordinate reference system components

### Ellipsoid

The <ellipsoid> object is an attribute of <geodetic datum> (8.2.3.2). It is not used with other types of datum.

**Requirement**: The well-known text representation of an ellipsoid shall be:

|  |  |  |
| --- | --- | --- |
| <ellipsoid> | ::= | <ellipsoid keyword> <left delimiter> <ellipsoid name>  <comma> <semi-major axis> <comma> <inverse flattening>  [ <comma> <length unit> ] [ { <comma> <identifier> } ]…  <right delimiter> |
| <ellipsoid keyword> | ::= | ELLIPSOID | SPHEROID  *!! In this International Standard the preferred keyword is ELLIPSOID. SPHEROID is permitted for backward compatibility. Implementations shall be prepared to read both forms.* |
| <ellipsoid name> | ::= | <name> *!! See 7.2* |
| <semi-major axis> | ::= | <unsigned numeric literal> *!! See below for constraint* |
| <inverse flattening> | ::= | <unsigned numeric literal> *!! See below for constraint* |

ISO 19111:2007 allows an oblate ellipsoid to be defined through semi-major axis (a) and either semi-minor axis (b) or inverse flattening (1/f). If semi-minor axis is used as the second defining parameter the value for inverse flattening to be shown in the WKT string should be calculated from 1/f = a / (a – b).

ISO 19111:2007 also allows for the earth model to be a sphere, for which 1/f is infinite. In this International Standard if the earth model is a sphere <inverse flattening> shall be given an artificial value of zero.

**Requirement**: The well-known text representation of a sphere shall have an <inverse flattening> value of 0.

<length unit> is an optional attribute, optional for reasons of backward compatibility, but it is recommended that it is explicitly included in WKT strings. If it is omitted then the value for semi-major axis shall be given in metres. Conversely, if it is omitted then the value for the semi-major axis shall be assumed to be in metres. Its <conversion factor> shall be to metres and is the number of metres per unit. <length unit> is described in 7.7.

EXAMPLE 1 ELLIPSOID["GRS 1980",6378137,298.257222101,LENUNIT["metre",1.0]]

EXAMPLE 2 SPHEROID["GRS 1980",6378137.0,298.257222101]

EXAMPLE 3 ELLIPSOID["Clark 1866",20925832.164,294.97869821,

LENUNIT["US survey foot",0.304800609601219]]

EXAMPLE 4 ELLIPSOID["Sphere",6371000,0,LENUNIT["metre",1.0]]

The full requirements of planetary mapping are out of scope for ISO 19111. However a definition of WKT for a triaxial ellipsoid is given in informative Annex D.

### Prime meridian

The prime meridian is the meridian with a value of zero. The prime meridian is usually defined to be the international reference meridian which for the Earth passes through Greenwich, but this may not always be the case. The <prime meridian> object is conditional. For projected CRSs the prime meridian is inherited through the base CRS.

**Requirements**:

1. Prime meridian shall not be given for any type of datum and CRS other than geodetic.
2. It shall be given if the CRS type is geodetic and the prime meridian is not the international reference meridian. It may be given if the CRS type is geodetic and the prime meridian is the international reference meridian.
3. Conversely if the CRS type is geodetic and prime meridian is not given, the prime meridian shall be assumed to be the international reference meridian.
4. The well-known text representation of a prime meridian shall be:

|  |  |  |
| --- | --- | --- |
| <prime meridian> | ::= | <prime meridian keyword> <left delimiter> <prime meridian name> <comma> <irm longitude> [ <comma> <angle unit> ]  [ { <comma> <identifier> } ]… <right delimiter> |
| <prime meridian keyword> | ::= | PRIMEM |
| <prime meridian name> | ::= | <name> *!! See 7.2* |
| <irm longitude> | ::= | <signed numeric literal> [ <comma> <angle unit> ] |

<irm longitude> is the longitude of the prime meridian measured from the international reference meridian (Greenwich), positive eastward.

<angle unit> is an optional attribute, optional for reasons of backward compatibility, but it is recommended that it is included in WKT strings. If it is omitted then the value for <irm longitude> shall be taken from the geodetic CRS axis unit. If the subtype of the geodetic CRS to which the prime meridian is an attribute is geographic, the prime meridian's <irm longitude> value shall be given in the same angular units as those for the horizontal axes of the geographic CRS; if the geodetic CRS subtype is geocentric the prime meridian's <irm longitude> value shall be given in degrees. Its <conversion factor> shall be to radians and is the number of radians per unit. <angle unit> is described in 7.7.

EXAMPLE 1 PRIMEM["Ferro",-17.6666667] (taking the CRS axis unit of degrees)

EXAMPLE 2 PRIMEM["Paris",2.5969213] (taking the CRS axis unit of grads)

EXAMPLE 3 PRIMEM["Paris",2.5969213,[ANGUNIT,"grad",0.015707963267949]]

EXAMPLE 4 PRIMEM["Greenwich",0.0] (taking the CRS axis unit of degrees)

NOTE When the prime meridian name is "Greenwich" or the longitude of the IRM meridian in the geodetic CRS is zero, the inclusion of the prime meridian object in a WKT string is optional, so this example string should not normally be present. It is included here for backward compatibility reasons as the prime meridian object was mandatory in earlier CRS WKT specifications.

### Datum

#### Forms of datum

#### Two forms of datum are recognised, differentiated by their set of attributes:

|  |  |  |
| --- | --- | --- |
| <datum> | ::= | <geodetic datum> | <generic datum> |

#### Geodetic datum

**Requirement**: The well-known text representation of a geodetic datum shall be:

|  |  |  |
| --- | --- | --- |
| <geodetic datum> | ::= | <geodetic datum keyword> <left delimiter>  <geodetic datum name> <comma> <ellipsoid>  [ <comma> <datum anchor> ]  [ { <comma> <identifier> } ]… <right delimiter>  { <comma> <prime meridian> } |
| <geodetic datum keyword> | ::= | DATUM |
| <geodetic datum name> | ::= | <name> *!! See 7.2* |
| <datum anchor> | ::= | <datum anchor keyword> <left delimiter>  <quoted Latin text> <right delimiter> |
| <datum anchor keyword> | ::= | ANCHOR |

<geodetic datum> is used when the CRS type is geodetic (geographic or geocentric). For a projected CRS, the geodetic datum is included in the Base CRS.

<ellipsoid> is described in 8.2.1.

<prime meridian> is a conditional attribute; see 8.2.2. Following the data model of ISO 19111 it would be nested within the geodetic datum object. In this International Standard its nesting follows previous versions of CRS WKT.

EXAMPLE 1 DATUM["North American Datum 1983",

ELLIPSOID["GRS 1980",6378137,298.257222101,LENUNIT["metre",1.0]]]

EXAMPLE 2 DATUM["World Geodetic System 1984",

ELLIPSOID["WGS 84",6378388.0,298.257223563,LENUNIT["metre",1.0]]],

PRIMEM["Greenwich",0.0]

NOTE When the prime meridian name is "Greenwich" or the longitude of the IRM meridian in the geodetic CRS is zero, the inclusion of the prime meridian object in a WKT string is optional, so this example string may omit the prime meridian object, as shown in example 1.

EXAMPLE 3 DATUM["Tananarive 1925",

ELLIPSOID["International 1924",6378388.0,297.0,

LENUNIT["metre",1.0]],

ANCHOR["Tananarive observatory:21.0191667gS, 50.23849537gE (of Paris)"]],

PRIMEM["Paris",2.5969213,ANGUNIT["grad",0.015707963267949]]

#### Generic datum

Vertical, engineering, image, temporal and parametric datums all have the same set of attributes and can be described generically.

**Requirement**: The well-known text representation of a non-geodetic datum shall be:

|  |  |  |
| --- | --- | --- |
| <vertical datum> | ::= | <generic datum> |
| <engineering datum> | ::= | <generic datum> |
| <image datum> | ::= | <generic datum> |
| <temporal datum> | ::= | <generic datum> |
| <parametric datum> | ::= | <generic datum> |
| <generic datum> | ::= | <geodetic datum keyword> <left delimiter>  <generic datum name> [ <comma> <datum anchor> ]  [ { <comma> <identifier> } ]… <right delimiter> |
| <generic datum keyword> | ::= | GENDATUM |
| <generic datum name> | ::= | <name> *!! See 7.2* |
| <datum anchor> | ::= | <datum anchor keyword> <left delimiter>  <quoted Latin text> <right delimiter> |
| <datum anchor keyword> | ::= | ANCHOR |

EXAMPLE 1 GENDATUM["Newlyn"]

EXAMPLE 2 GENDATUM["Newlyn",ANCHOR["Mean Sea Level 1915 to 1921."]]

### Map projection

#### Introduction

Map projection is a specialised subset of coordinate conversion (see 9.1) in which the source and target CRSs are by definition the base geographic CRS and the projected CRS. In WKT strings, for reasons of backward compatibility map projection components (name, method and parameter) are nested differently from coordinate conversion components and parameter units may be implied.

**Requirement**: The well-known text representation of a map projection shall be:

|  |  |  |
| --- | --- | --- |
| <map projection> | ::= | <map projection conversion>  <comma> <map projection method >  { <comma> <map projection parameter> }… |
| <map projection conversion> | ::= | <map projection keyword> <left delimiter>  <map projection name>  [ { <comma> <identifier> } ]… <right delimiter> |
| <map projection keyword> | ::= | CONVERSION |
| <map projection name> | ::= | <name> *!! See 7.2* |
| <map projection method> | ::= | <map projection method keyword> <left delimiter>  <map projection method name>  [ { <comma> <identifier> } ]… <right delimiter> |
| <map projection method keyword> | ::= | METHOD | PROJECTION  *!! In this International Standard the preferred keyword is METHOD. PROJECTION is permitted for backward compatibility. Implementations shall be prepared to read both forms.* |
| <map projection method name> | ::= | <name> *!! See 7.2* |
| <map projection parameter> | ::= | <parameter keyword> <left delimiter> <parameter name>  <comma> <parameter value> [ <comma> <parameter unit> ]  [ { <comma> <identifier> } ]… <right delimiter> |
| <parameter keyword> | ::= | PARAMETER |
| <parameter name> | ::= | <name> *!! See 7.2* |
| <parameter value> | ::= | <signed numeric literal> |
| <parameter unit> | ::= | <unit> *!! See 8.2.4.4 for constraints* |

EXAMPLE 1 CONVERSION["UTM zone 10N"],

METHOD["Transverse Mercator",ID["EPSG",9807]],

PARAMETER["Latitude of natural origin",0,

ANGUNIT["degree",0.0174532925199433],

ID["EPSG",8801]],

PARAMETER["Longitude of natural origin",-123,

ANGUNIT["degree",0.0174532925199433],ID["EPSG",8802]],

PARAMETER["Scale factor at natural origin",0.9996,

SCALEUNIT["unity",1.0],ID["EPSG",8805]],

PARAMETER["False easting",500000,

LENUNIT["metre",1.0],ID["EPSG",8806]],

PARAMETER["False northing",0,LENUNIT["metre",1.0],ID["EPSG",8807]]

EXAMPLE 2 CONVERSION["UTM zone 10N",ID["EPSG",16010]],

METHOD["Transverse Mercator"],

PARAMETER["Latitude of natural origin",0,

ANGUNIT["degree",0.0174532925199433]],

PARAMETER["Longitude of natural origin",-123,

ANGUNIT["degree",0.0174532925199433]],

PARAMETER["Scale factor at natural origin",0.9996,

SCALEUNIT["unity",1.0]],

PARAMETER["False easting",500000,LENUNIT["metre",1.0]],

PARAMETER["False northing",0,LENUNIT["metre",1.0]]

#### Map projection name and identifier

Map projection (zone) encompasses the collection of method and parameter values. Its name is for human readability. Depending upon the naming convention in use it may also be included as part of the projected CRS name.

<identifier> is described in 7.3. It is an optional attribute. If an identifier is provided as an attribute within the <map projection conversion> object, because it is expected to describe a complete collection of zone name, method, parameters and parameter values, it shall override any identifiers given within the map projection method and map projection parameter objects.

#### Map projection method

Method name is for human readability. For interoperability it is the method formula that is critical in determining the equivalence of methods; this may be given through a map projection method <identifier>.

<identifier> is described in 7.3. It is an optional attribute. However if an identifier is included as an attribute within the <*map projection conversion>* object (8.2.4.2), that will take precedence over any identifier within the map projection method object.

If a map projection method <identifier> is not given, the WKT description is potentially ambiguous, relying on interpretation of method name. It is recommended that a map projection conversion identifier or a map projection method identifier is included in WKT strings. Identifiers for commonly encountered map projection methods are given in Annex E.2.

#### Map projection parameter

Parameter name is for human readability. For interoperability it is the method formula and its parameters that are critical in determining the equivalence of methods. See annex E. Identifiers for commonly encountered map projection methods are given in E.2; their parameters are listed in E.3.

The map projection parameters required are specific to the map projection method and will be listed sequentially. The order within the sequence is not significant but should be logical.

<parameter unit> is an optional attribute for reasons of backward compatibility. It is recommended that it is included explicitly in WKT strings. If omitted then:

**Requirements**: If <parameter unit> is omitted from the <map projection parameter>s a CRS WKT string then:

1. map projection parameter values that are lengths shall be given in the unit for the projected CRS axes.
2. map projection parameter values that are angles will be given in the unit for the base geographic CRS of the projected CRS; sexagesimal degree representations will be given as decimal values.
3. map projection parameters that are unitless (for example scale factor) will be given as a number which is close to or is unity (1.0).

The parameter type is included in E.3.

<identifier> is described in 7.3. It is an optional attribute. If an identifier is included as an attribute within the *map projection conversion* object (8.2.4.2) or *map projection method* object (8.2.4.3), that will take precedence over any identifier within the map projection parameter object.

### Coordinate system

#### Syntax

**Requirement**: The well-known text representation of a coordinate system shall be:

|  |  |  |
| --- | --- | --- |
| <coordinate system> | ::= | <cs type> { <comma> <axis> }… [ <comma> <cs unit> ] |
| <cs type> | ::= | <cs type keyword> <left delimiter> { affine | Cartesian | cylindrical | ellipsoidal | linear | parametric | polar | spherical | temporal | vertical } <comma> <dimension> [ { <comma> <identifier> } ]…  <right delimiter>  *!! See 8.2.5.2 for constraints* |
| <cs type keyword> | ::= | CS |
| <dimension> | ::= | <unsigned integer>  *!! Condition: cannot be 0. See 8.2.5.2 for constraints.* |
| <axis> | ::= | <axis keyword> <left delimiter> <axis nameAbbrev> <comma>  <axis direction> [ <comma> <axis order> ] [ <comma> <axis unit> ] [ { <comma> <identifier> } ]… <right delimiter>  *!! See 8.2.5.3, 8.2.5.4 and 8.2.5.5 for constraints* |
| <axis keyword> | ::= | AXIS |
| <axis order> | ::= | <axis order keyword> <left delimiter> <unsigned integer>  <right delimiter>  *!! See 8.2.5.3 for constraints* |
| <axis order keyword> | ::= | ORDER |
| <axis nameAbbrev> | ::= | <double quote> <axis name> | <axis abbreviation>  | { <axis name> <space> <axis abbreviation> } < double quote> |
| <axis name> | ::= | <name> |
| <axis abbreviation> | ::= | <left paren> <simple Latin letter>… <right paren> |
| <axis direction> | ::= | north [ <comma> <meridian> ] | northNorthEast | northEast | eastNorthEast | east | eastSouthEast | southEast | southSouthEast | south [ <comma> <meridian> ] | southWest | westSouthWest | west | westNorthWest | northWest | northNorthWest |  geocentricX | geocentricY | geocentricZ | up | down |  forward | aft | starboard | port | awayFrom | towards |  clockwise <comma> <bearing> | counterClockwise <comma> <bearing> | columnPositive | columnNegative | rowPositive | rowNegative | displayRight | displayLeft | displayUp | displayDown |  future | past | unspecified  *!! See 8.2.1.5 for constraints* |
| <meridian> | ::= | <meridian keyword> <left delimiter> <number>  <comma> <angle unit> <right delimiter>  *!! See 8.2.5.5 for constraints* |
| <meridian keyword> | ::= | MERIDIAN |
| <bearing> | ::= | <bearing keyword> <left delimiter> <number>  <comma> <angle unit> <right delimiter>  *!! See 8.2.5.5 for constraints* |
| <bearing keyword> | ::= | BEARING |
| <axis unit> | ::= | <unit> *!! See 7.7 and 8.2.5.6 for constraints* |
| <cs unit> | ::= | <unit> *!! See 7.7 and 8.2.5.6 for constraints* |

#### Coordinate system type

For various types of CRS the type of coordinate system that may be used is constrained, as is the permissible number of axes. These constraints are summarised in table 4 below.

Table  — Permitted coordinate system type and dimension by CRS

| **CRS type** | **Permitted CS type(s)** | **Dimension**  (number of axes) |
| --- | --- | --- |
| geocentric | Cartesian | 3 |
| geographic 3D | ellipsoidal  spherical | 3 |
| geographic 2D | ellipsoidal | 2 |
| projected | Cartesian | 2 |
| vertical | vertical | 1 |
| engineering | affine  Cartesian  cylindrical  linear  polar  spherical | 2 or 3  2 or 3  3  1  2  3 |
| image | affine  Cartesian | 2  2 |
| parametric | parametric | 1 |

#### Axis and axis order

Axis is repeated in a sequence. The number of axes in the sequence is the same as the dimensions of the coordinate system.

<axis order> identifies the order in which the coordinates of a point in a dataset are given and therefore is significant. In this International Standard it is defined in the BNF as an optional attribute to allow backward compatibility with OGC 01-009, however it is recommended that it should be explicitly included in a CRS WKT string.

**Requirement:** The following constraints shall apply:

1. When <axis order> is present in the WKT string <axis> descriptions shall be ordered according to the axis order sequence.
2. If <axis order> is omitted from the WKT string the sequence of <axis> descriptions shall imply the order of the axes and of coordinates referenced to the CRS.
3. For compound CRSs, the axes are described through the component CRS descriptions; the order of the compound axes shall be inferred from firstly the order of the component CRSs then secondly the order of axes within each component CRS.

EXAMPLE A compound CRS consists of a projected CRS with a vertical CRS, the component CRSs described in that order. The axes of the projected CRS are northing first, easting second. The axis of the vertical CRS is gravity-related height. The axis order for the compound CRS is northing first, easting second and gravity-related height third.

#### Axis name and abbreviation

ISO 19111 requires the name and abbreviation for each axis. In this International Standard, name and/or abbreviation is permitted. They are contained in a single quoted text string. If abbreviation is included in the text string it is given in parentheses.

EXAMPLE 1 "easting"

EXAMPLE 2 "(X)"

EXAMPLE 3 "easting (X)"

**Requirement:** The following constraints shall apply:

1. For geographic 2D CRSs, the two-dimensional ellipsoidal coordinate system axes are geodetic latitude, and geodetic longitude. In WKT strings the value of axis name shall be ‘latitude’ and ‘longitude’ respectively. Axis abbreviation may be omitted but if given and to be a single character then 'B' and 'L' respectively are recommended.

NOTE ISO 19111:2007 specifies the lower case Greek letters φ and λ as symbols for geodetic latitude and geodetic longitude. In this International Standard the abbreviations ‘B’ and ‘L’ from the Latin character set should be used in WKT strings. (B for Breite and L for Länge are the standard German abbreviations and used in academic texts worldwide).

1. For geographic 3D CRSs, the name and abbreviation of the horizontal axes in a WKT string shall follow the requirements in (a) above. The vertical axis name shall be 'ellipsoidal height'; the axis abbreviation shall be 'h' and should be included when abbreviations for the horizontal axes are included.
2. For geocentric CRSs, 'geocentric X' is the first axis of a right-handed earth-centred 3D Cartesian coordinate system. It lies in the equatorial plane such that a vector pointing in the direction of positive X passes through the intersection of the equator and the prime meridian. 'geocentric Y' is the second axis, in the equatorial plane such that a vector pointing in the direction of positive Y passes through the intersection of the equator and the meridian of 90°E. 'geocentric Z' is the third axis perpendicular to both X and Y such that it completes a right-handed coordinate system. The Z-axis is approximately parallel to the earth's rotation axis, positive towards the north pole. In WKT strings the axis names should be omitted (as they are given through the mandatory axis directions, see 8.2.5.5c) but the axes abbreviations, respectively ‘X’, 'Y' and ‘Z’, shall be given.
3. For projected CRSs, the two-dimensional Cartesian coordinate system axes names shall be ‘northing’ or 'southing' and 'easting' or ‘westing’ and shall be given when the axis directions and order are not east first, north second. Axis names may be omitted from WKT strings when the axis directions and order are east first, north second with abbreviations 'E' and 'N' respectively. Axis abbreviations shall be given; abbreviations should be in parentheses when the axis name is also given.
4. For vertical CRSs, the axis direction is up or down. In WKT strings the value of axis name shall be ‘gravity-related height’ and ‘depth’ respectively. Axis abbreviation may be omitted but if given for height it should be 'H'.
5. For engineering CRSs using polar coordinate systems where the lower case Greek letter θ is conventionally used as the symbol for direction, the letter ‘U’ from the Latin character set should be used as a one-character abbreviation in WKT strings.

#### Axis direction

Axis direction indicates the positive increment along an axis. The handedness of a 2- or 3-dimensional coordinate system may be derived from the directions.

**Requirement:** The following constraints shall apply:

1. For geographic 2D CRSs, the two-dimensional ellipsoidal coordinate system axes are geodetic latitude, positive northwards, and geodetic longitude, positive eastwards. Axis direction shall be 'north' and 'east' respectively.
2. For geographic 3D CRSs, the three-dimensional ellipsoidal coordinate system axes are geodetic latitude, positive northwards, geodetic longitude, positive eastwards, and ellipsoidal height, positive upwards. Axis direction shall be 'north', 'east' and 'up' respectively.
3. For geocentric CRSs, the axis direction shall be ‘geocentricX’, 'geocentricY' and ‘geocentricZ’ respectively.
4. For projected CRSs, except for coordinate systems centred on a pole, the axes' direction shall be north or south and east or west.

For coordinate systems centred on a pole the direction for both axes will be south (for the north pole case) or north (for the south pole case); the axes direction shall be supplemented with a <**meridian**> description. This is the value of the meridian that the axis follows from the pole. The prime meridian from which the meridian value is reckoned is given through the <prime meridian> object; if no <prime meridian> object is in the WKT string then the IRM or Greenwich meridian shall be assumed.

1. For vertical CRSs, the axis direction shall be ‘up’ or ‘down’.
2. For temporal CRSs, the axis direction shall be ‘future’ or ‘past’.
3. In engineering CRSs the horizontal directions are only approximate, the set of directions indicating whether the coordinate system is left-handed or right-handed when viewed from above the plane of the system. For engineering CRSs with polar coordinate systems the direction of the rotational axis shall be 'clockwise' or 'counterClockwise'. The specified direction from which the rotation is measured shall be given through the supplementary object <**bearing**> degrees. If <bearing> is not present in the WKT string the specified direction shall be taken to be north.

#### Axis unit and coordinate system unit

This International Standard provides two methods for specifying the coordinate system axis units. <axis unit> is an optional attribute which may be applied to each axis description and if applied shall describe the unit for that axis. <cs unit> is an optional attribute which if applied shall specify the unit for all axes of the coordinate system.

**Constraints**:

* + 1. a CRS WKT string shall include either <axis unit> for each axis or <cs unit> applying to all axes.
    2. <cs unit> shall not be used if the unit does not apply to all axes. In these cases <axis unit> shall be used.

EXAMPLE 1 A polar coordinate system requires one axis to be an angle and the other axis to be a length

EXAMPLE 2 A three-dimensional ellipsoidal coordinate system requires two axes (geodetic latitude and geodetic longitude) to be angles and the third axis (ellipsoidal height) to be a length.

For coordinate systems in which all axes have the same units, the use of <axis unit> leads to duplication of unit name and conversion factor. Duplication is avoided through the use of <cs unit>.

<axis unit> and <cs unit> are subsets of <unit> which is described in 7.7.

<axis unit> or <cs unit> may also specify the unit for implied map projection parameter values, as described in 8.2.4.

#### Examples of well-known text describing coordinate systems

##### CSs for geodetic CRSs:

EXAMPLE 1 CS[ellipsoidal,2],

AXIS["latitude",north],

AXIS["longitude",east],

ANGUNIT["degree",0.0174532925199433]

EXAMPLE 2 CS[ellipsoidal,3],

AXIS["latitude",north,ORDER[1],ANGUNIT["degree",0.0174532925199433]],

AXIS["longitude",east,ORDER[2],ANGUNIT["degree",0.0174532925199433]],

AXIS["ellipsoidal height (h)",up,ORDER[3],LENUNIT["metre",1.0]]

EXAMPLE 3 CS[Cartesian,3],

AXIS["X",geocentricX],AXIS["Y",geocentricY],AXIS["Z",geocentricZ],

LENUNIT["metre",1.0]

##### CSs for vertical CRSs:

EXAMPLE 1 CS[vertical,1],

AXIS["gravity-related height (H)",up],

LENUNIT["metre",1.0] (using <cs unit>)

EXAMPLE 2 CS[vertical,1],

AXIS["depth (D)",down,

LENUNIT["metre",1.0]] (using <axis unit>)

##### CSs for projected CRSs:

EXAMPLE 1 CS[Cartesian,2],

AXIS["E",east,ORDER[1],LENUNIT["metre",1.0]],

AXIS["N",north,ORDER[2],LENUNIT["metre",1.0]] (using <axis unit>)

EXAMPLE 2 CS[Cartesian,2],

AXIS["E",east],

AXIS["N",north],

LENUNIT["metre",1.0]] (using <cs unit>)

EXAMPLE 3 CS[Cartesian,2],

AXIS["northing (X)",north,ORDER[1]],

AXIS["easting (Y)",east,ORDER[2]],

LENUNIT["German legal metre",1.0000135965]

EXAMPLE 4 For an azimuthal projection centred on the north pole:

CS[Cartesian,2],

AXIS["easting (X)",south,

MERIDIAN[90,ANGUNIT["degree",0.0174532925199433]],

ORDER[1]],

AXIS["northing (Y)",south,

MERIDIAN[180,ANGUNIT["degree",0.0174532925199433]],

ORDER[2]],

LENUNIT["metre",1.0]

##### CSs for engineering CRSs:

EXAMPLE 1 CS[Cartesian,2],

AXIS["site north (x)",southeast,ORDER[1]],

AXIS["site east (y)",southwest,ORDER[2]],

LENUNIT["metre",1.0]

EXAMPLE 2 CS[polar,2],

AXIS["distance (r)",awayFrom,ORDER[1],LENUNIT["metre",1.0]],

AXIS["bearing (U)",clockwise,BEARING[234],ORDER[2],

ANGUNIT["degree",0.0174532925199433]]

EXAMPLE 3 CS[Cartesian,3],

AXIS["ahead (x)",forward,ORDER[1]],

AXIS["right (y)",starboard,ORDER[2}],

AXIS["down (z)",down,ORDER[3]],

LENUNIT["metre",1.0]]

##### CSs for temporal CRSs:

EXAMPLE CS[temporal,1],AXIS["time (t)",future],TIMEUNIT["second",1.0]

## Examples of well-known text describing coordinate reference systems

### Geodetic (geocentric Cartesian) CRS

EXAMPLE GCENCRS["JGD2000",

DATUM["Japanese Geodetic Datum 2000",

ELLIPSOID["GRS 1980",6378137,298.257222101]],

CS[Cartesian,3],

AXIS["X",geocentricX],

AXIS["Y",geocentricY],

AXIS["Z",geocentricZ],

LENUNIT["metre",1.0],

SCOPE["Geodesy, topographic mapping and cadastre"],

AREA["Japan"],BBOX[17.09,122.38,46.05,157.64],TIMEEXTENT[2002-04,2011-10-31],

ID["EPSG",4946,URI["urn:ogc:def:crs:EPSG::4946"]],

REMARK["注：JGD2000ジオセントリックは現在JGD2011に代わりました。"]]

### Geodetic (geographic 3D) CRS

EXAMPLE GEOG3DCRS["WGS 84",

DATUM["World Geodetic System 1984",

ELLIPSOID["WGS 84",6378137,298.257223563,LENUNIT["metre",1.0]]],

PRIMEM["Greenwich",0],

CS[ellipsoidal,3],

AXIS["latitude",north,ANGUNIT["degree",0.0174532925199433]],

AXIS["longitude",east,ANGUNIT["degree",0.0174532925199433]],

AXIS["ellipsoidal height (h)",up,LENUNIT["metre",1.0]],

ID["EPSG",4979]]

### Geodetic (geographic 2D) CRS

EXAMPLE 1 GEOGCRS["NAD83",

DATUM["North American Datum 1983",

ELLIPSOID["GRS 1980",6378137,298.257222101,LENUNIT["metre",1.0]]],

CS[ellipsoidal,2],

AXIS["latitude",north],

AXIS["longitude",east],

ANGUNIT["degree",0.017453292519943],

ID["EPSG",4269],

REMARK["1986 realisation"]]

EXAMPLE 2 GEOGCRS["NTF (Paris)",

DATUM["Nouvelle Triangulation Francaise",

ELLIPSOID["Clarke 1880 (IGN)",6378249.2,293.4660213]],

PRIMEM["Paris",2.5969213],

CS[ellipsoidal,2],

AXIS["latitude",north,ORDER[1]],

AXIS["longitude",east,ORDER[2]],

ANGUNIT["grad",0.015707963267949],

REMARK["Nouvelle Triangulation Française"]]

### Projected CRS

EXAMPLE 1 PROJCRS["NAD83 UTM 10",

BASECRS["NAD83(86)",

DATUM["North American Datum 1983",

ELLIPSOID["GRS 1980",6378137,298.257222101]], (default unit is metre)

ANGUNIT["degree",0.0174532925199433]],

CONVERSION["UTM zone 10N",ID["EPSG",16010]],

METHOD["Transverse Mercator"],

PARAMETER["Latitude of natural origin",0.0], (unit taken from base CRS)

PARAMETER["Longitude of natural origin",-123.0], (unit taken from base CRS)

PARAMETER["Scale factor",0.9996], (unit conversion is to unity)

PARAMETER["False easting",500000.0], (unit taken from CS axis)

PARAMETER["False northing",0.0], (unit taken from CS axis)

CS[Cartesian,2],

AXIS["E",east,ORDER[1]],

AXIS["N",north,ORDER[2]],

LENUNIT["metre",1.0],

SCOPE["Description of a purpose"],

AREA["An area description"],

REMARK["In this example units are implied. This is allowed for backward compatibility. It is recommended that units are explicitly given in the string."]]

EXAMPLE 2 PROJCRS["ETRS89 Lambert Azimuthal Equal Area CRS",

BASECRS["ETRS89",

DATUM["ETRS89",

ELLIPSOID["GRS 80",6378137,298.257222101,LENUNIT["metre",1.0]]]],

CONVERSION["LAEA"],

METHOD["Lambert Azimuthal Equal Area",ID["EPSG",9820]],

PARAMETER["Latitude of origin",52.0,

ANGUNIT["degree",0.0174532925199433]],

PARAMETER["Longitude of origin",10.0,

ANGUNIT["degree",0.0174532925199433]],

PARAMETER["False easting",4321000.0,LENUNIT["metre",1.0]],

PARAMETER["False northing",3210000.0,LENUNIT["metre",1.0]],

CS[Cartesian,2],

AXIS["Y",north,ORDER[1]],

AXIS["X",east,ORDER[2]],

LENUNIT["metre",1.0],

ID["EuroGeographics","ETRS-LAEA"]]

EXAMPLE 3 PROJCRS["NAD27 / Texas South Central",

BASECRS["NAD27",

DATUM["North American Datum 1927",

ELLIPSOID["Clarke 1866",20925832.164,294.97869821,

LENUNIT["US survey foot",0.304800609601219]]],

ANGUNIT["degree",0.0174532925199433]],

CONVERSION["Texas South Central SPCS27"],

METHOD["Lambert Conic Conformal (2SP)",ID["EPSG",9802]],

PARAMETER["Latitude of false origin",27.83333333333333,

ANGUNIT["degree",0.0174532925199433],ID["EPSG",8821]],

PARAMETER["Longitude of false origin",-99.0,

ANGUNIT["degree",0.0174532925199433],ID["EPSG",8822]],

PARAMETER["Latitude of 1st standard parallel",28.383333333333,

ANGUNIT["degree",0.0174532925199433],ID["EPSG",8823]],

PARAMETER["Latitude of 2nd standard parallel",30.283333333333,

ANGUNIT["degree",0.0174532925199433],ID["EPSG",8824]],

PARAMETER["Easting at false origin",2000000.0,

LENUNIT["US survey foot",0.304800609601219],ID["EPSG",8826]],

PARAMETER["Northing at false origin",0.0,

LENUNIT["US survey foot",0.304800609601219],ID["EPSG",8827]],

CS[Cartesian,2],

AXIS["X",east],

AXIS["Y",north],

LENUNIT["US survey foot",0.304800609601219],

REMARK["Fundamental point: Meade's Ranch KS, latitude 39°13'26.686""N, longitude 98°32'30.506""W."]]

### Vertical CRS

EXAMPLE VERTCRS["NAVD88",

GENDATUM["North American Vertical Datum 1988"],

CS[vertical,1],

AXIS["gravity-related height (H)",up],LENUNIT["metre",1.0]]

### Engineering CRS

EXAMPLE 1 ENGCRS["A construction site CRS",

GENDATUM["P1",ANCHOR["Peg in south corner"]],

CS[Cartesian,2],

AXIS["site east",southWest,ORDER[1]],

AXIS["site north",southEast,ORDER[2]],

LENUNIT["metre",1.0],

TIMEEXTENT["from time t1","to time t2"]]

EXAMPLE 2 ENGCRS["Astra Minas Grid",

GENDATUM["Astra Minas"],

CS[Cartesian,2],

AXIS["X",north,ORDER[1]],

AXIS["Y",west,ORDER[2]],

LENUNIT["metre",1.0],

ID["EPSG",5800]]

EXAMPLE 3 ENGCRS["A ship-centred CRS",

GENDATUM["Ship reference point",ANCHOR["Centre of buoyancy"]],

CS[Cartesian,3],

AXIS["x",forward],

AXIS["y",starboard],

AXIS["z",down],

LENUNIT["metre",1.0]]

### Temporal CRS

EXAMPLE TIMECRS["GPS Time",

GENDATUM["Time origin",ANCHOR["1980-01-01 00:00:00.0"]],

CS[temporal,1],AXIS["time",future],TIMEUNIT["day",86400.0]]

### Parametric CRS

EXAMPLE PARAMCRS["WMO standard atmosphere layer 0",

GENDATUM["Mean Sea Level",ANCHOR["1013.25 hPa at 15°C"]],

CS[parametric,1],

AXIS["pressure (hPa)",up],PARAMUNIT["HectoPascal",100.0]]

### Compound CRS

EXAMPLE 1 Spatial CRS

COMPOUNDCRS["NAD83 + NAVD88",

GEOGCRS["NAD83",

DATUM["North American Datum 1983",

ELLIPSOID["GRS 1980",6378137,298.257222101]],

PRIMEM["Greenwich",0],

CS[ellipsoidal,2],

AXIS["latitude",north,ORDER[1]],

AXIS["longitude",east,ORDER[2]],

ANGUNIT["degree”,0.0174532925199433]],

VERTCRS[“NAVD88”,

GENDATUM[“North American Vertical Datum 1983"],

CS[vertical,1],

AXIS["gravity-related height (H)",up],

LENUNIT["metre",1]]]

EXAMPLE 2 Spatio-temporal CRS

COMPOUNDCRS["GPS position and time",

GEOGCRS["WGS 84",

DATUM["World Geodetic System 1984",

ELLIPSOID["WGS 84",6378137,298.257223563]],

CS[ellipsoidal,2],

AXIS["latitude",north,ORDER[1]],

AXIS["longitude",east,ORDER[2]],

ANGUNIT["degree",0.0174532925199433]],

TIMECRS["GPS Time",

GENDATUM["Time origin",ANCHOR["1980-01-01"]],

CS[temporal,1],

AXIS["time" (T)",future],

TIMEUNIT["day",86400]]]

EXAMPLE 3 Spatio-parametric CRS

COMPOUNDCRS["ICAO layer 0",

GEOGCRS["WGS 84",

DATUM["World Geodetic System 1984",

ELLIPSOID["WGS 84",6378137,298.257223563]],

CS[ellipsoidal,2],

AXIS["latitude",north,ORDER[1]],

AXIS["longitude",east,ORDER[2]],

ANGUNIT["degree",0.0174532925199433]],

PARAMCRS["WMO standard atmosphere",

GENDATUM["Mean Sea Level",ANCHOR["Mean Sea Level = 1013.25 hPa"]],

CS[parametric,1],

AXIS["pressure" (P)",unspecified],

PARAMUNIT["day",86400]]]

# Well-known text representation of coordinate operations

## Coordinate operations

The WKT representation of a coordinate operation may be used for any coordinate operation (coordinate transformation or coordinate conversion) other than a map projection. Map projections are part of a projected CRS definition and are described in 8.2.4.

**Requirement**: The well-known text representation of a <coordinate operation> shall be:

|  |  |  |
| --- | --- | --- |
| <coordinate operation> | ::= | <operation keyword> <left delimiter> <operation name>  <comma> <source crs> <comma> <target crs>  <comma> <operation method>  { <comma> <operation parameter> | <operation parameter file> }…  [ <comma> <interpolation crs> ] [ <comma> <operation accuracy] [ <comma> <scope> ] [ { <comma> <extent> } ]...  [ { <comma> <identifier> } ]… [ <comma> <remark> ] <right delimiter> |
| <operation keyword> | ::= | COORDOP |
| <operation name> | ::= | <name> *!! See 7.2* |

## Coordinate operation components

### Source and target CRS

**Requirement**: The well-known text representation of a coordinate operation's source and target CRSs shall be:

|  |  |  |
| --- | --- | --- |
| <source crs> | ::= | <source crs keyword><left delimiter> <coordinate reference system>  <right delimiter> |
| <source crs keyword> | ::= | SOURCECRS |
| <target crs> | ::= | <target crs keyword><left delimiter> <coordinate reference system>  <right delimiter> |
| <target crs keyword> | ::= | TARGETCRS |

<coordinate reference system> is defined in clause 8.

### Coordinate operation name and identifier

Coordinate operation encompasses the collection of method and parameter values. Its name is for human readability.

<identifier> is described in 7.3. It is an optional attribute. If an identifier is provided as an attribute within the <coordinate operation> object, because it is expected to describe a complete collection of zone name, method, parameters and parameter values, it shall override any identifiers given within the coordinate operation method and coordinate operation parameter objects.

### Coordinate operation method

**Requirement**: The well-known text representation of a coordinate operation method shall be:

|  |  |  |
| --- | --- | --- |
| <operation method> | ::= | <operation method keyword> <left delimiter>  <operation method name>  [ { <comma> <identifier> } ]… <right delimiter> |
| <operation method keyword> | ::= | METHOD |
| <operation method name> | ::= | <name> *!! See 7.2* |

Method name is for human readability. For interoperability it is the method formula that is critical in determining the equivalence of methods; this may be given through an operation method <identifier>.

<identifier> is described in 7.3. It is an optional attribute. If an identifier is included as an attribute within the *coordinate operation* object (9.2.2), it shall take precedence over any identifier within the operation method object.

If an <identifier> is omitted for both coordinate operation and operation method, the WKT description is potentially ambiguous, relying on interpretation of method name. It is recommended that either a coordinate operation identifier or a coordinate operation method identifier is included in WKT strings. Identifiers for commonly encountered coordinate transformation methods are given in Annex E.4.

### Coordinate operation parameter

**Requirement**: The well-known text representation of a coordinate operation parameter shall be:

|  |  |  |
| --- | --- | --- |
| <operation parameter> | ::= | <parameter keyword> <left delimiter> <parameter name>  <comma><parameter value> <comma> <parameter unit>  [ { <comma> <identifier> } ]… <right delimiter> |
| <parameter keyword> | ::= | PARAMETER |
| <parameter name> | ::= | <name> *!! See 7.2* |
| <parameter value> | ::= | <signed numeric literal> |
| <parameter unit> | ::= | <length unit> | <angle unit> | <scale unit> | <time unit> | <paramunit> |

Units are described in 7.1.

Parameter name is for human readability. For interoperability it is the method formula and its parameters that are critical in determining the equivalence of methods. See Annex E. Identifiers for commonly encountered coordinate operation methods and their parameters are given in E.4; the parameters are listed in E.5. The coordinate operation parameters required are specific to the coordinate operation method and shall be listed sequentially. The order within the sequence is not significant but should be logical. Implementations should be prepared to read any order. For those methods included in Annex E the parameter order given in E.4 is recommended.

**Requirements**:

1. In coordinate operation WKT strings <parameter value>s shall be given in the sense <source crs> to <target crs>. If the transformation parameter 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. If the parameter is a scaling unit the conversion factor shall be to unity, for example parts per million (ppm) shall be given as 10-6. For commonly-encountered transformation parameters the parameter type is included in E.5.
2. <identifier> is described in 7.2. It is an optional attribute. If an identifier is included as an attribute within the *coordinate operation* object (9.2.2) or *coordinate operation method* object (9.2.3), it shall take precedence over any identifier within the coordinate operation parameter object.

### Coordinate operation parameter file

**Requirement**: The well-known text representation of a coordinate operation parameter file shall be:

|  |  |  |
| --- | --- | --- |
| <operation parameter file> | ::= | <parameter file keyword> <left delimiter> <parameter name> <comma> <parameter file name> [ { <comma> <identifier> } ]…  <right delimiter> |
| <parameter file keyword> | ::= | PARAMETERFILE |
| <parameter name> | ::= | <name> *!! See 7.2* |
| <parameter file name> | ::= | <quoted Latin text> |

For <parameter name> and <identifier> the requirements given in 9.2.4 shall apply.

### Interpolation CRS

Some coordinate operation methods require coordinates referenced to a CRS which is neither the source CRS or target CRS. For example, in a coordinate operation applying a vertical offset between two vertical CRSs using the either the vertical offset and slope method or a grid interpolation method such as VERTCON, horizontal coordinates are required. <interpolation crs> provides the mechanism for defining the CRS to which these coordinates are referenced.

**Requirement**: The well-known text representation of an <interpolation crs> shall be:

|  |  |  |
| --- | --- | --- |
| <interpolation crs> | ::= | <interpolation crs keyword> <left delimiter>  <coordinate reference system> <right delimiter> |
| <coordinate reference system> | ::= | INTERPCRS |

<coordinate reference system> is defined in clause 8.

### Operation accuracy

Operation accuracy is an optional attribute which indicates the typical error the application of a coordinate operation will introduce into errorless source CRS coordinates. It is an approximate figure for the area of applicability of the coordinate operation as a whole, given in metres.

**Requirement**: The well-known text representation of an <operation accuracy> shall be:

|  |  |  |
| --- | --- | --- |
| <operation accuracy> | ::= | <operation accuracy keyword> <left delimiter>  <accuracy> <right delimiter> |
| <operation accuracy keyword> | ::= | OPACCURACY |
| <accuracy> | ::= | <number> *!! <accuracy> is in metres* |

### Other coordinate operation attributes

<name> is described in 7.2.

<identifier> is described in 7.3. It is an optional attribute.

**Requirement:** If an identifier is provided as an attribute of a coordinate operation object, because it is expected to describe a complete collection of operation name, source and target CRSs, operation method, parameters and parameter values, it shall override any identifiers given within the component objects.

<scope> is described in 7.4 and <extent> in 7.5. These are optional attributes describing the applicability of the coordinate operation.

<remark> is described in 7.6.

## Examples of well-known text describing coordinate operations

Examples of coordinate transformations using WKT are shown below. In several of these examples the full source and target CRS definitions are omitted from the example so that the coordinate transformation elements are more clearly identified. Line feeds are included in these examples to aid clarity.

EXAMPLE 1

COORDOP["Tokyo to JGD2000 (GSI)",

SOURCECRS[

GCENCRS["Tokyo",

DATUM["Tokyo 1918",

ELLIPSOID["Bessel 1841",6377397.155,299.1528128]],

CS[Cartesian,3],

AXIS["X",geocentricX,ORDER[1]],

AXIS["Y",geocentricY,ORDER[2]],

AXIS["Z",geocentricZ,ORDER[3]],

LENUNIT["metre",1.0]]],

TARGETCRS[

GCENCRS["JGD2000",

DATUM["Japanese Geodetic Datum 2000",

ELLIPSOID["GRS 1980",6378137.0,298.257222101]],

CS[Cartesian,3],

AXIS["X",geocentricX],

AXIS["Y",geocentricY],

AXIS["Z",geocentricZ],

LENUNIT["metre",1.0]]],

METHOD["Geocentric translations"],

PARAMETER["X-axis translation",-146.414,

LENUNIT["metre",1.0],ID["EPSG",8605]],

PARAMETER["Y-axis translation",507.337,

LENUNIT["metre",1.0],ID["EPSG",8606]],

PARAMETER["Z-axis translation",680.507,

LENUNIT["metre",1.0],ID["EPSG",8607]]]

EXAMPLE 2

COORDOP["AGD84 to GDA94 Auslig 5m",

SOURCECRS[…*full CRS definition required here but omitted for brevity*…],

TARGETCRS[…*full CRS definition required here but omitted for brevity*…],

METHOD["Geocentric translations",ID["EPSG",1031]],

PARAMETER["X-axis translation",-128.5,LENUNIT["metre",1.0]],

PARAMETER["Y-axis translation",-53.0,LENUNIT["metre",1.0]],

PARAMETER["Z-axis translation",153.4,LENUNIT["metre",1.0]]

..OPACCURACY[5]

..AREA["Australia onshore"],BBOX[-43.7,112.85,-9.87,153.68]

..REMARK["Use NTv2 file for better accuracy"]]

EXAMPLE 3

COORDOP["Amersfoort to ETRS89 (3)",

SOURCECRS[…*full WKT definition required here but omitted for brevity*…],

TARGETCRS[…*full WKT definition required here but omitted for brevity*…],

METHOD["Coordinate Frame"],

PARAMETER["X-axis translation",565.2369,LENUNIT["metre",1.0]],

PARAMETER["Y-axis translation",50.0087,LENUNIT["metre",1.0]],

PARAMETER["Z-axis translation",465.658,LENUNIT["metre",1.0]],

PARAMETER["X-axis rotation",1.9725,ANGUNIT["microradian",1E-06]],

PARAMETER["Y-axis rotation",-1.7004,ANGUNIT["microradian",1E-06]],

PARAMETER["Z-axis rotation",9.0677,ANGUNIT["microradian",1E-06]],

PARAMETER["Scale difference",4.0812,SCALEUNIT["parts per million",1E-06]],

ID["EPSG",15739]]

EXAMPLE 4

COORDOP["NZGD49 to NZGD2000",

SOURCECRS[…*full WKT definition required here but omitted for brevity*…],

TARGETCRS[…*full WKT definition required here but omitted for brevity*…],

METHOD["NTv2",ID["EPSG",9615]],

PARAMETERFILE["Latitude and longitude difference file","nzgd2kgrid0005.gsb"],

ID["EPSG",15739,CITATION["LINZS25000"],

URI[<http://www.linz.govt.nz/geodetic/software-downloads/>]],

REMARK["Coordinate transformation accuracy 0.1-1.0m"]]

EXAMPLE 5

COORDOP["DHHN92 height to EVRF2007 height",

SOURCECRS[…*full WKT definition of DHHN92 required here but omitted for brevity*…],

TARGETCRS[…*full WKT definition of EVRF2007 required here but omitted for brevity*…],

METHOD["Vertical Offset and Slope",ID["EPSG",1046]],

PARAMETER["Inclination in latitude",-0.010,

ANGUNIT["arc-second",4.84813681109535E-06]],

PARAMETER["Inclination in longitude ",0.002,

ANGUNIT["arc-second",4.84813681109535E-06]],

PARAMETER["Vertical offset",0.015,LENUNIT["metre",1.0]],

PARAMETER["Ordinate 1 of evaluation point",51.05,

ANGUNIT["degree",0.0174532925199433]],

PARAMETER["Ordinate 2 of evaluation point",10.2166666666667,

ANGUNIT["degree",0.0174532925199433]],

..INTERPCRS["ETRS89"…*full WKT definition of ETRS89 required here but omitted for brevity*…],

..OPACCURACY[0.1],

..REMARK["Determined at 427 points. RMS residual 0.002m, maximum residual 0.007m"]]

# Well-known text representation of CRS and coordinate transformation couplets

## Bound CRS

The definition of a CRS is not dependent upon any relationship to an independent CRS. However in an implementation that merges datasets referenced to differing CRSs, it is sometimes useful to associate the definition of the transformation that has been used with the CRS definition. This facilitates the interrelationship of CRS by concatenating transformations via a common or hub CRS. This is sometimes referred to as ‘early-binding’. This International Standard permits the association of an abridged coordinate transformation description with a coordinate reference system description in a single text string. In a bound CRS the abridged coordinate transformation is applied to the source CRS with the target CRS being the common or hub system.

**Requirement**: The well-known text representation of a bound CRS shall be:

|  |  |  |
| --- | --- | --- |
| <bound crs> | ::= | <bound crs keyword> <left delimiter> <source crs> <comma> <target crs>  <comma> <abridged coordinate transformation>  [ { <comma> <identifier> } ]… [ <comma> <remark> ] <right delimiter> } |
| <bound crs keyword> | ::= | BOUNDCRS |

Examples are given in 10.3.

The source and target CRSs shall be defined through a full CRS description as described in clause 8. If the source CRS type is projected and the abridged coordinate transformation operates in the geodetic CRS domain, the transformation is deemed to operate on the projected CRS’s baseCRS but the projected CRS shall be described.

## Bound CRS components

### Abridged coordinate transformation

The well-known text representation of projected coordinate reference systems may use implication for the units of map projection parameters (see 8.2.4). In a similar way the abridged coordinate transformation also omits explicit identification of coordinate transformation parameter unit from the text string. It has several constraints.

**Requirements**:

1. The abridged form of coordinate transformation shall only be used as part of a bound CRS.
2. The abridged transformation shall be described in the sense from <source CRS> to <target CRS>.
3. The well-known text representation of an abridged coordinate transformation shall be:

|  |  |  |
| --- | --- | --- |
| <abridged coordinate transformation> | ::= | <abridged transformation keyword> <left delimiter> <operation name> <comma> <operation method > <comma>  { <abridged transformation parameter>… |  | <operation parameter file>… }  [ <comma> <scope> ] [ { <comma> <extent> } ]…  [ { <comma> <identifier> } ]… [ <comma> <remark> ]  <right delimiter> |
| <abridged transformation keyword> | ::= | ABRTRANS |

### Coordinate operation method in abridged coordinate transformations

In an abridged coordinate transformation description the format for operation method is identical to that defined in clause 9 but there are constraints:

**Constraint**: The only coordinate transformation methods that may be described in an abridged coordinate transformation shall be:

1. 3-, 7- and 10-parameter geocentric transformations (7-parameter methods include both Position Vector and Coordinate Frame methods);
2. Methods using interpolation of gridded data sets (NTv2, NADCON, geoid and height correction models).

### Abridged coordinate transformation parameter

**Requirement**: The well-known text representation of an abridged transformation parameter shall be:

|  |  |  |
| --- | --- | --- |
| <abridged transformation parameter> | ::= | <parameter keyword> <left delimiter>  <parameter name> <comma> <parameter value>  [ { <comma> <identifier> } ]… <right delimiter> |

The format for abridged transformation parameter is similar to that for coordinate operation parameter defined in 9.2.3 but there are constraints>.

**Requirements**:

1. The value of parameters which are linear shall be given in metres.
2. The value of parameters which are angular shall be given in arc-seconds (4.848136811095E-06 radian).
3. The value of parameters which are scale units shall be given as a number with respect to unity, for example 3.5 parts per million (ppm) shall be given as 1.0000035 and -3.5ppm shall be given as 0.9999965.
4. <unit> shall not be given.
5. Implementations are expected to identify the parameter value unit type from the parameter name.
6. The parameter values shall be described in the sense from source CRS to target CRS.

The parameters required are specific to the coordinate operation method and are listed sequentially. The order within the sequence is not significant but should be logical.

EXAMPLE ABRTRANS["Tokyo to JGD2000 (GSI)",

METHOD["Geocentric translations",ID["EPSG",1031]],

PARAMETER["X-axis translation",-146.414],

PARAMETER["Y-axis translation",507.337],

PARAMETER["Z-axis translation",680.507]]

### Coordinate operation parameter file

Operation parameter file is defined in 9.2.5.

## Examples of well-known text describing Bound CRSs

EXAMPLE 1

BOUNDCRS[

SOURCECRS[

GEOGCRS["NAD27",

DATUM["North American Datum 1927",

ELLIPSOID["Clarke 1866",6378206.4,294.978698213]],

CS[ellipsoidal,2],

AXIS["latitude",north],AXIS["longitude",east],

ANGUNIT["degree",0.0174532925199433]]],

TARGETCRS[

GEOGCRS["NAD83",

DATUM["North American Datum 1983",

ELLIPSOID["GRS 1980",6378137,298.2572221]],

CS[ellipsoidal,2],

AXIS["latitude",north],AXIS["longitude",east],

ANGUNIT["degree",0.0174532925199433]]],

ABRTRANS["NAD27 to NAD83 Alaska",

METHOD["NADCON",ID["EPSG",9613]],

PARAMETERFILE["Latitude difference file","alaska.las"],

PARAMETERFILE["Longitude difference file","alaska.los"]]]

EXAMPLE 2

BOUNDCRS[

SOURCECRS[…*full WKT definition required here but omitted for brevity*…],

TARGETCRS[…*full WKT definition required here but omitted for brevity*…],

ABRTRANS["NAD27 to NAD83(86) National",

METHOD["NTv2",ID["EPSG",9615]],

PARAMETERFILE["Latitude and longitude difference file","NTv2\_0.gsb"]]]

EXAMPLE 3

BOUNDCRS[

SOURCECRS[…*full WKT definition required here but omitted for brevity*…],

TARGETCRS[…*full WKT definition required here but omitted for brevity*…],

ABRTRANS["Amersfoort to ETRS89 (3)",

METHOD["Coordinate Frame",ID["EPSG",1032]],

PARAMETER["X-axis translation",565.2369,ID["EPSG",8605]],

PARAMETER["Y-axis translation",50.0087,ID["EPSG",8606]],

PARAMETER["Z-axis translation",465.658,ID["EPSG",8607]],

PARAMETER["X-axis rotation",0.407,ID["EPSG",8608]],

PARAMETER["Y-axis rotation",-0.351,ID["EPSG",8609]],

PARAMETER["Z-axis rotation",1.870,ID["EPSG",8610]],

PARAMETER["Scale difference",1.000004812,ID["EPSG",8611]]]]

NOTE Compare the rotation values (here in arc-seconds because in an abridged coordinate transformation) with those in the third example in 9.3

1. (normative)  
     
   Abstract test suite
   1. Conformance of a well-known text string describing a CRS
      1. Structure
2. Test purpose: to determine whether a text string representation of a coordinate reference system conforms to the characters and syntax required by this International Standard.
3. Test method: Verify that the BNF definition of the well-known text string conforms to the requirements of clause 5 and that text string syntax and content conform to the requirements of clause 6.
4. Reference: clauses 5 and 6.
5. Test type: capability.
   * 1. Content
6. Test purpose: to determine whether a text string representation of a coordinate reference system conforms to content required by this International Standard.
7. Test method: Verify that the text string describes one of the types of CRS supported, that it includes all of the elements specified for that type of CRS, and that these use the correct terminology and syntax.
8. Reference: clauses 7 and 8.
9. Test type: capability.
   1. Conformance of a well-known text string describing a coordinate operation
      1. Structure
10. Test purpose: to determine whether a text string representation of a coordinate operation conforms to the characters and syntax required by this International Standard.
11. Test method: Verify that the BNF definition of the well-known text string conforms to the requirements of clause 5 and that text string syntax and content conform to the requirements of clause 6.
12. Reference: clauses 5 and 6.
13. Test type: capability.
    * 1. Content
14. Test purpose: to determine whether a text string representation of a coordinate reference system conforms to content required by this International Standard.
15. Test method: Verify that the text string describes one of the types of CRS supported, that it includes all of the elements specified for that type of CRS, and that these use the correct terminology and syntax.
16. Reference: clauses 7, 8, and 9.
17. Test type: capability.
    1. Conformance of a well-known text string describing a BoundCRS
       1. Structure
18. Test purpose: to determine whether a text string representation of a BoundCRS conforms to the characters and syntax required by this International Standard.
19. Test method: Verify that the BNF definition of the well-known text string conforms to the requirements of clause 5 and that text string syntax and content conform to the requirements of clause 6.
20. Reference: clauses 5 and 6.
21. Test type: capability.
    * 1. Content
22. Test purpose: to determine whether a text string representation of a BoundCRS conforms to content required by this International Standard.
23. Test method: Verify that the text string describes one of the types of CRS supported, that it includes all of the elements specified for that type of CRS, and that these use the correct terminology and syntax.
24. Reference: clauses 7, 8, 9, and 10.
25. Test type: capability.
26. (informative)  
      
    Recommended practice
    1. Introduction

This International Standard defines the structure and content of well known text strings. It does not specifically address the requirements for implementations that write or read these strings. Some recommendations for such implementations are given below.

* 1. Keywords
     1. Keyword case sensitivity

Well-known text keywords by definition are case insensitive. KEYWORD is equivalent to keyword is equivalent to KeyWord and to kEYwORd. Where human readability is important (as in the examples in this International Standard) 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.

* + 1. Alternative keywords

Where two alternative keywords are defined, as a minimum, implementations should be able to write the first and to read both.

* + 1. Handling of unrecognised keywords

It is recognised that prior to the publication of this International Standard some tokens that are not included in this document have been produced. Parsers reading CRS WKT strings and encountering unrecognised keywords should ignore the token and its content. They should be able to continue parsing the string without throwing an exception.

* 1. Characters
     1. Handling of unrecognised characters

Implementations parsing WKT strings conformant with this International Standard are not required to be able to read non-LATIN1 character sets. But if they are unable to do so they should be able to continue reading the WKT string by ignoring the <remark> token (keyword and content) without throwing an exception.

* + 1. String length

The length of a well-known text string or of its components is not prescribed. However the following maximum lengths are recommended for implementations writing CRS WKT strings:

* The total length of a keyword should not exceed 24 characters.
* The total length of a <name> should not exceed 80 characters.
* The total length of a <quoted Latin text> string should not exceed 255 characters.
* The total length of a <quoted Unicode text> string should not exceed 255 characters.
* The total length of a CRS WKT string should not exceed 4096 characters.
  1. White space
     1. Insertion of white space

Outside of <quoted Latin text> and <quoted Unicode text> a well-known text string written to the requirements of this International Standard contains no white space. However to improve human readability implementations may insert spaces, tabs or line feeds before or after any element of the string. In the examples in this International Standard, line feeds and inset are included to aid clarity in reading this document.

Spaces should not be inserted within keywords or numbers.

* + 1. Parsing of white space outside of quoted text

Parsers reading CRS WKT strings should ignore white space outside of <quoted Latin text> or <quoted Unicode text>.

* + 1. Parsing of white space within quoted text

Parsers reading CRS WKT strings should ignore white space at the beginning or end of <quoted Latin text> or <quoted Unicode text>. Parsers may convert consecutive white space characters embedded within the quoted text string into a single <space>.

* 1. Identifiers
     1. Use of identifier

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

When an identifier is written into an object definition, all names, values and units for that object and its components which are given in the well-known text should be consistent with those given by the authority.

In the event of conflict in values given in the CRS WKT string and given by an authority through an object's name or an identifier, reading software should throw an exception or give users a warning message. The well-known text values should be assumed to prevail.

* + 1. Using names to interpret identity

If comparing the content of two <name> strings, implementations should ignore case, the characters <underscore> "\_", <minus sign> "-", <solidus> "/", <left paren> "(" and <right paren> ")".

EXAMPLE “Central\_Meridian” should be considered equal to “central-meridian", “Central meridian" and "centralMeridian".

* 1. Numbers
     1. Precision

Best practice is to preserve the original precision as specified by the information source. This may require maintaining 16 digits of precision.

* + 1. Defining parameters for a sphere

The well-known text representation of an ellipsoid requires the two defining parameters to be a and 1/f. For a sphere the value of 1/f is infinite. If the figure of the earth is a sphere it should have an artificial <inverse flattening> value of 0. Implementations should be prepared to read and handle this artificial value.

* + 1. Implied Units

Map projection <parameter unit> is an optional attribute for reasons of backward compatibility. It is recommended that it is included explicitly in WKT strings. If omitted then:

* map projection parameters that are lengths should be given in the unit for the projected CRS axes.
* map projection parameters that are angles should be given in the unit for the base geographic CRS of the projected CRS; sexagesimal degree representations should be given as decimal values.
* map projection parameters that are unitless (for example scale factor) should be given as a number which is close to or is unity (1.0).
  1. Attribute order

The order of elements in a well-known text string is dictated by the BNF in this document. Certain attributes notably map projection and coordinate operation parameters may be included multiple times. The parameters required are specific to the method and will be listed sequentially. The order within the sequence is not significant but should be logical. Implementations should be prepared to read any order. For those methods included in Annex E the parameter order as listed in E.2 for map projections and E.4 for coordinate operations is recommended.

1. (informative)  
     
   Mapping of concepts from previous versions of CRS WKT
   1. BNF

This annex describes differences between previous versions of CRS WKT defined in ISO 19125-1:2004 and OGC 01-009 and that defined in this International Standard. In this annex the syntax of BNF used follows that defined in clause 5. This differs from that used in both ISO 19125-1:2004 and OGC 01-009, given in table C.1 for reference.

Table C. — Mapping of BNF syntax.

| **19125-1:2004 and OGC CTS 01-009** | **This document** | **Comment** |
| --- | --- | --- |
| = | ::- | Production |
| < > | < > | Basic type |
| | | | | Alternative |
| { } | [ ] | Optionality |
| \* | ... | Multiplicity |
| ( ) | { } | Grouping |

Of more relevance is the backward compatibility of the WKT strings themselves; this is described in the following sub-clauses.

* 1. Backward compatibility of CRS common attributes
     1. Name

In both ISO 19125-1:2004 and OGC 01-009 the attribute <name> is, like in this International Standard, defined to be quoted text. However quoted text is not explicitly defined in these earlier specifications. As a consequence the name attribute in WKT strings written to the earlier specifications may contain characters and character sets not permitted by this International Standard. With this caveat, name attributes should be readable by implementations of this International Standard.

* + 1. ID (Authority)

This attribute is not defined in ISO 19125-1:2004. In OGC 01-009 the object AUTHORITY was defined. In this International Standard the following definition from OGC 01-009 has been deprecated but is included here for the purposes of documenting backward compatibility:

|  |  |  |
| --- | --- | --- |
| *<identifier>* | *::=* | *AUTHORITY <left delimiter> <authority name>*  *<comma> <authority unique identifier> <right delimiter>* |
| *<authority name>* | *::=* | *<quoted Latin text>* |
| *<authority unique identifier>* | *::=* | *<quoted Latin text>* |

The keyword AUTHORITY maps to the keyword ID in this International Standard. The attribute <authority unique identifier> in the BNF in this International Standard was called <code> in OGC 01-009 where it was defined to be quoted text, whereas <authority unique identifier> in this International Standard may be either a number (without quotes) or quoted text. For potential issues with quoted text in WKT strings written to earlier standards see C.2.1 above.

WKT descriptions of identifier (authority) written to the OGC 01-009 specification should be readable by implementations of this International Standard except when quoted text contains unsupported characters.

* 1. Backward compatibility of coordinate reference system components
     1. Ellipsoid

The WKT for describing an ellipsoid is defined in 8.2.1.

In this International Standard the following definition from ISO 19125-1:2004 has been deprecated but is included here for the purposes of documenting backward compatibility:

|  |  |  |
| --- | --- | --- |
| *<ellipsoid>* | *::=* | *ELLIPSOID <left delimiter> <ellipsoid name> <comma>*  *<semi-major axis> <comma> <inverse flattening> <right delimiter>* |

In this International Standard the following definition from OGC 01-009 has been deprecated but is included here for the purposes of documenting backward compatibility:

|  |  |  |
| --- | --- | --- |
| *<ellipsoid>* | *::=* | *SPHEROID <left delimiter> <ellipsoid name> <comma>*  *<semi-major axis> <comma> <inverse flattening> <right delimiter>* |

Both ISO 19125-1:2004 and OGC 01-009 required that the semi-major axis be given in metres. Neither ISO 19125-1:2004 nor OGC 01-009 allowed for a sphere to be defined (as inverse flattening is infinite).

WKT descriptions of ellipsoids defined in metres and written to the ISO 19125-1:2004 and OGC 01-009 specifications should be readable by implementations of this International Standard.

* + 1. Prime meridian

Prime meridian is defined in 8.2.2.

In this International Standard the following definition from both ISO 19125-1:2004 and OGC 01-009 has been deprecated but is included here for the purposes of documenting backward compatibility:

|  |  |  |
| --- | --- | --- |
| *<prime meridian>* | *::=* | *PRIMEM <left delimiter> <prime meridian name>*  *<comma> <irm longitude> <right delimiter>* |

In both ISO 19125-1:2004 and OGC 01-009 <prime meridian> was a mandatory attribute of geographic CRS. (In certain frequently-occurring conditions it may be omitted in this International Standard). The longitude unit was unstated in ISO 19125-1:2004; in OGC 01-009 it was taken to be the angular unit of the geographic CRS in which it was contained or for a geocentric CRS was in metres.

WKT descriptions of prime meridians written to the ISO 19125-1:2004 and OGC 01-009 specifications should be readable by implementations of this International Standard.

* + 1. Datum

In this International Standard the following definition from ISO 19125-1:2004 has been deprecated but is included here for the purposes of documenting backward compatibility:

|  |  |  |
| --- | --- | --- |
| *<geodetic datum>* | *::=* | *<left delimiter> <datum name> <comma> <ellipsoid> <right delimiter>* |

where ellipsoid is as described in C.3.1. ISO 19125-1:2004 did not cater for any other datum type.

WKT descriptions of geodetic datums written to the ISO 19125-1:2004 specification should be readable by implementations of this International Standard.

In this International Standard the following definition from OGC 01-009has been deprecated but is included here for the purposes of documenting backward compatibility:

|  |  |  |
| --- | --- | --- |
| *<geodetic datum>* | *::=* | *DATUM <left delimiter> <datum name> <comma> <ellipsoid> [ <towgs84> ] <right delimiter>* |

where ellipsoid is as described in C.3.1.

TOWGS84 is a form of abridged coordinate transformation (see 10.2) but inappropriately modelled as part of a geodetic datum definition (a geodetic datum definition should not include a relationship to WGS 84). This International Standard has no backward compatibility with the TOWGS84 object.WKT descriptions of geodetic datums written to the OGC 01-009specification will be readable by implementations of this International Standard only if the optional TOWGS84 object is not contained.

|  |  |  |
| --- | --- | --- |
| *<vertical datum>* | *::=* | *VERT\_DATUM <left delimiter> <datum name> <comma>*  *<datum type> <right delimiter>* |
| *<engineering datum>* | *::=* | *LOCAL\_DATUM <left delimiter> <datum name> <comma>*  *<datum type> <right delimiter>* |

In OGC 01-009 datum type is a number but is otherwise not defined. This International Standard has no backward compatibility with the datum type object, and as a consequence has no backward compatibility with the keywords and objects VERT\_DATUM and LOCAL\_DATUM.

WKT descriptions of vertical and engineering datums written to the OGC 01-009specification are not readable by implementations of this International Standard.

* + 1. Map projection

Map projection is defined in 8.2.4.

In this International Standard the following definition from ISO 19125-1:2004 and OGC 01-009 has been deprecated but is included here for the purposes of documenting backward compatibility:

|  |  |  |
| --- | --- | --- |
| *<map projection>* | *::=* | *PROJECTION <left delimiter> <name> <right delimiter>*  *{ <comma> <projection parameter> }…* |
| *<map projection parameter>* | *::=* | *PARAMETER <left delimiter> < name> <comma> <parameter value> <right delimiter>* |
| *<parameter value>* | *::=* | *<number>* |

EXAMPLE 1 *PROJECTION["Transverse Mercator",*

*PARAMETER["Latitude of origin",0],*

*PARAMETER["Central meridian",-123],*

*PARAMETER["Scale factor",0.9996],*

*PARAMETER["False easting",500000],*

*PARAMETER["False northing",0]]*

EXAMPLE 2 *PROJECTION["UTM zone 10N",*

*PARAMETER["Latitude of natural origin",0],*

*PARAMETER["Longitude of natural origin",-123],*

*PARAMETER["Scale factor at natural origin",0.9996],*

*PARAMETER["FE",500000],*

*PARAMETER["FN",0]]*

WKT strings that used this definition exhibit the following ambiguities:

* + 1. in the name attribute there is no clear distinction between the projection (the collection of method plus its parameters) and projection method. In this International Standard the two concepts have separate keywords CONVERSION and METHOD respectively. Implementations of earlier specifications have differed in their interpretation of name, some giving the projection name (such as "UTM zone 10N") and others the method name (such as "Transverse Mercator").
    2. the method formula, which is critical for interoperability, is implied through the method name, and relies on the method and parameter name strings being interpreted by the receiving application with the same meaning as used in the producing application.
    3. the units for the parameter values are ambiguous.

WKT descriptions of map projections written to the ISO 19125-1:2004 and OGC 01-009 specifications should be readable by implementations but the string may not be interpretable by machine.

* + 1. Coordinate system

The WKT for describing a coordinate system is defined in 8.2.5.

NOTE Both ISO 19125-1:2004 and OGC 01-009 use the term coordinate system, but with a different meaning to this International Standard. The term coordinate system as used in those earlier specifications equates to coordinate *reference* system in this International Standard. Coordinate system as defined in ISO 19111 and used in this International Standard is a different, more limited, concept.

In this International Standard the following definition from ISO 19125-1:2004 has been deprecated but is included here for the purposes of documenting backward compatibility:

|  |  |  |
| --- | --- | --- |
| *<coordinate system>* | *::=* | *<cs unit>* |

EXAMPLE *UNIT["German legal metre",1.0000135965]*

WKT descriptions of coordinate systems written to the ISO 19125-1:2004 specification give a very incomplete description but should be readable by implementations of this International Standard. However the lack of definition of axis order may lead to ambiguity or serious error in interpretation of coordinates.

In this International Standard the following definition from OGC 01-009 has been deprecated but is included here for the purposes of documenting backward compatibility:

|  |  |  |
| --- | --- | --- |
| *<coordinate system>* | *::=* | *[ { <axis> <comma> } ]… <cs unit>* |
| *<axis>* | *::=* | *AXIS <left delimiter> <name> <comma>*  *{ north | east | south | west | up | down | other } <right delimiter>* |

EXAMPLE 1 *AXIS["northing",north]*

EXAMPLE 2 *AXIS["easting",east]*

EXAMPLE 3 *UNIT["German legal metre",1.0000135965]*

<axis> was an optional attribute. If omitted it was implied that there were two axes whose directions were east and north respectively.

In OGC 01-009 the options for axis directions were significantly reduced compared to those in this International Standard. They were sufficient for most but not all geographic and projected CRSs. Provision was made for describing axes for a geocentric CRS but the prescribed directions were incorrectly defined. The provision for describing axes for an engineering (local) CRS were incomplete and usable in only a minority of cases.

WKT descriptions of coordinate systems written to the OGC 01-009 specification may give an incomplete description but should be readable by implementations of this International Standard.

* 1. Backward compatibility of coordinate reference systems
     1. Geodetic CRS

Geocentric CRS is defined in 8.1.2, geographic 2D CRS in 8.1.4.In this International Standard the following definitions from ISO 19125-1:2004 and OGC 01-009 have been deprecated but are included here for the purposes of documenting backward compatibility:

|  |  |  |
| --- | --- | --- |
| *<geocentric crs>* | *::=* | *GEOCCS <left delimiter> <crs name> <comma> <datum>*  *<comma> <prime meridian>*  *[ { <comma> <axis> } ]… <comma> <axis unit> <right delimiter>* |
| *<geographic crs>* | *::=* | *GEOGCS <left delimiter> <crs name> <comma> <datum>*  *<comma> <prime meridian>*  *[ { <comma> <axis> } ]… <comma> <axis unit> <right delimiter>* |
| *<datum>* | *::=* | *DATUM <left delimiter> < name>*  *<comma> <spheroid> <right delimiter>* |
| *<spheroid>* | *::=* | *{ ELLIPSOID | SPHEROID } <left delimiter> <ellipsoid name> <comma> <semi-major axis> <comma> <inverse flattening>*  *<right delimiter>* |

In WKT strings that followed these definitions, the keyword omits the R in CRS. The inclusion of prime meridian is mandatory in the BNF (but not always included in WKT strings). The ellipsoid cannot be a sphere, and its semi-major axis must be given in metres. In ISO 19125-1:2004 the keyword is ELLIPSOID whilst in OGC 01-009 it is SPHEROID.

Axis name and direction are part of the OGC 01-009 definition but not included in ISO 19125-1:2004; coordinate system unit (called axis unit in the BNF in the older specifications) was required by both.

EXAMPLE 1 *GEOGCS["NAD83",*

*DATUM["North American Datum 1983",*

*ELLIPSOID["GRS 1980",6378137.0,298.257222101],*

*PRIMEM["Greenwich",0]],*

*UNIT["degree",0.0174532925199433]]*

EXAMPLE 2 *GEOGCS["NAD83",*

*DATUM["North American Datum 1983",*

*SPHEROID["GRS 1980",6378137.0,298.257222101],*

*PRIMEM["Greenwich",0]],*

*AXIS["latitude",NORTH],*

*AXIS["longitude",EAST],*

*UNIT["degree",0.0174532925199433]]*

If augmented to recognise the old keywords GEOCCS and GEOGCS as aliases of GCENCRS and GEOGCRS respectively, WKT descriptions of geocentric CRSs and geographic 2D CRSs written to the ISO 19125-1:2004 and OGC 01-009 specifications should be readable by implementations of this International Standard but may not be interpretable by machine.

The formal specifications of both ISO 19125-1:2004 and OGC 01-009 did not support WKT descriptions of geographic 3D CRSs.

* + 1. Projected CRS

Projected CRS is defined in 8.1.5.In this International Standard the following definitions from ISO 19125-1:2004 and OGC 01-009 have been deprecated but are included here for the purposes of documenting backward compatibility.

|  |  |  |
| --- | --- | --- |
| *<projected crs>* | *::=* | *PROJCS <left delimiter> <crs name> <comma> <geogcs>*  *<comma> <projection>*  *[ { <comma> <axis> } ]… <comma> <axis unit> <right delimiter>* |

<geogcs> and <projection> and their limitations are described in C.4.1 and C.3.4 respectively.

EXAMPLE 1 *PROJCS[NAD83 / UTM zone 10N,*

*GEOGCS["NAD83",*

*DATUM["North American Datum 1983",*

*SPHEROID["GRS 1980",6378137.0,298.257222101],*

*PRIMEM["Greenwich",0]],*

*AXIS["latitude",NORTH],*

*AXIS["longitude",EAST],*

*UNIT["degree",0.0174532925199433]]*

EXAMPLE 2 *PROJCS[NAD83 / UTM zone 10N,*

*GEOGCS["NAD83",*

*DATUM["North American Datum 1983",*

*ELLIPSOID["GRS 1980",6378137.0,298.257222101],*

*PRIMEM["Greenwich",0]],*

*AXIS["longitude",EAST],*

*PROJECTION["UTM zone 10N"*

*PARAMETER[*

*UNIT["metre",1.0]]*

If augmented to recognise the old keyword PROJCS as an alias of PROJCRS, WKT descriptions of projected CRSs written to the ISO 19125-1:2004 and OGC 01-009 specifications should be readable by implementations that read strings conformant to this International Standard but the string may not be interpretable by machine.

* + 1. Vertical CRS and engineering (local) CRS

ISO 19125-1:2004 did not support these CRS types. The OGC 01-009 specification did do so. In this International Standard the following definitions from OGC 01-009 have been deprecated but are included here for the purposes of documenting backward compatibility:

|  |  |  |
| --- | --- | --- |
| *<vertical CRS>* | *::=* | *VERT\_CS <left delimiter> <vertical CRS name>*  *<comma> <vertical datum> <comma> <length unit>*  *[ <comma> <axis> ] <right delimiter>* |
| *<engineering CRS>* | *::=* | *LOCAL\_CS <left delimiter> <engineering CRS name>*  *<comma> <engineering datum> <comma> <length unit>*  *[ <comma> <axis> ] <right delimiter>* |

As a consequence of the lack of backward compatibility with the component keywords and objects VERT\_DATUM and LOCAL\_DATUM objects as discussed in D.3.4, implementations reading strings conformant to this International Standard have no backward compatibility with the VERT\_CS or LOCAL\_CS objects.

* + 1. Compound CRS

ISO 19125-1:2004 did not support this CRS type. The OGC 01-009 specification did do so. In this International Standard the following definition from OGC 01-009 has been deprecated but is included here for the purposes of documenting backward compatibility:

|  |  |  |
| --- | --- | --- |
| *<compound CRS>* | *::=* | *COMPD\_CS <left delimiter> <compound CRS name>*  *<comma> <coordinate reference system>*  *<comma> <coordinate reference system> <right delimiter>* |

This definition allows any combination of CRS types, for example two horizontal CRSs. This International Standard constrains permissible combinations. In practice WKT strings written to the OGC 01-009 specification are likely to be a combination permitted by this International Standard, one of which will be vertical and one of which will probably be geographic 2D or projected but could be engineering (local). However as a consequence of the lack of backward compatibility with the keywords and objects VERT\_DATUM and LOCAL\_DATUM objects as discussed in D.3.4 and D.4.3, this International Standard has no backward compatibility with the COMPD\_CS object.

* + 1. Fitted CS

OGC 01-009 describes at FITTED\_CS object. This has no equivalent in ISO 19111. This International Standard has no backward compatibility with this object.

* 1. Backward compatibility of coordinate operations

OGC 01-009 defines a math transform object.

|  |  |  |
| --- | --- | --- |
| *<math transform>* | *::=* | *<param mt> | <concat mt> | <inv mt> | <passthrough mt>* |
| *<param mt>* | *::=* | *PARAM\_MT <left delimiter> <classification name>*  *{ <comma> <operation parameter }… <right delimiter>* |

The PARAM\_MT object requires a subset of the attributes for <coordinate operation> defined in 9.1. However as it is missing several other attributes mandatory in <coordinate operation> (source and target CRSs, clear distinction between operation and operation method), this implementations written to this International Standard have no backward compatibility with the math transform object.

* 1. Mapping of tokens and keywords from previous versions of CRS WKT to this International Standard

Table C. — Mapping of BNF tokens and keywords between previous versions of CRS WKT and this International Standard

| **19125-1:2004** | **OGC CTS 01-009** | **This document** | **Comment** |
| --- | --- | --- | --- |
| Coordinate Reference Systems | | | |
| <coordinate system> | <coordinate system> | <coordinate reference system> | ISO 19125-1:2004 uses the term SRS. SRS is a superset which includes CRS. But in ISO 19125-1 only CRS concepts are described.  Previous specifications of CRS WKT have used the term coordinate system for the ISO 19111 concept of coordinate reference system. In ISO 19111 and this International Standard, 'coordinate system' is used for a different concept, limited to describing the axes of a CRS. |
| <name> | <cs name> | <crs name> |  |
| Geocentric CRS | | | |
| <geocentric cs> | <geocentric cs> | <geocentric crs> |  |
| GEOCCS | GEOCCS | GCENCRS |  |
| Geographic 3D CRS | | | |
|  |  | <geographic 3D crs> |  |
| (see comment) | GEOG3DCRS | In OGC 06-103r4 this concept appears as an extension to GEOGCS where a third axis is optional |
| Geographic 2D CRS | | | |
| <geographic cs> | <geographic cs> | <geographic 2D crs> |  |
| GEOGCS | GEOGCS | GEOGCRS |  |
| Projected CRS | | | |
| <projected cs> | <projected cs> | <projected crs> |  |
| PROJCS | PROJCS | PROJCRS |  |
| <geogcs> | <geogcs> | <base crs> | There is a change in the attributes of base crs compared to geogcs to clarify the attributes to be provided. In ISO 19125-1 and OGC 01-009 the axes are omitted in the examples (and in many implementations) but the BNF specification does not permit this. |
| GEOGCS | GEOGCS | BASECRS |  |
| <name> | <cs name> | <base crs name> |  |
| Vertical CRS | | | |
|  | <vert cs> | <vertical crs> |  |
| VERT\_CS | VERTCRS |  |
| Engineering CRS | | | |
|  | <local cs> | <engineering crs> |  |
| LOCAL\_CS | ENGCRS | Conceptually equivalent to ISO 19111's engineering CRS. |
| Image CRS | | | |
|  |  | <image crs> | Not previously specified. |
| IMAGECRS |  |
| Temporal CRS | | | |
|  |  | <temporal crs> | Not previously specified. |
| TIMECRS |  |
| Parametric CRS | | | |
|  |  | <parametric crs> | Not previously specified. |
| PARAMCRS |  |
| Compound CRS | | | |
|  | <compd cs> | <compound crs> |  |
| COMPD\_CS | COMPOUNDCRS |  |
|  | <horz cs> | <horizontal crs> |  |
|  | <head cs> |  | This has no equivalent in ISO 19111 which constrains the types of CRS allowed to form compound CRSs. If <head cs> meets the ISO 19111 constraint of being either a geographic 2D or a projected CRS, it can be mapped through <horizontal crs> to <geogCRS> or <projCRS> respectively. |
|  | <tail cs> |  | This has no equivalent in ISO 19111 which constrains the types of CRS allowed to form compound CRSs. If <tail cs> meets the ISO 19111 constraint of being a vertical CRS it can be mapped to <vertical crs>. |
| Fitted CRS | | | |
|  | <fitted cs> |  | <fitted cs> has no equivalent in ISO 19111 or this International Standard as it combines the separate concepts of CRS and coordinate operation. |
| FITTED\_CS |
| <to base> |
| <base cs> |
| Datum | | | |
| <datum> | <datum> | <geodetic datum> |  |
| DATUM | DATUM | DATUM |  |
|  |  |  |  |
|  | <vert datum>  <local datum> | <generic datum> | In this document generic datum is used for a greater range of datum types than was the case in previous specifications. |
| VERT\_DATUM  LOCAL\_DATUM | GENDATUM | In this document GENDATUM is used by multiple CRS types. Maps to VERT\_DATUM and LOCAL\_DATUM in CTS 01-009. |
|  | <datum type> |  | Not clear from OGC 01-009 what this concept is. No equivalent in ISO 19111 or this International Standard. |
|  |  |  |  |
| <name> | <name> | <datum name> |  |
| Ellipsoid | | | |
| <ellipsoid> | <spheroid> | <ellipsoid> |  |
| ELLIPSOID | SPHEROID | ELLIPSOID |  |
| <name> | <name> | <ellipsoid name> |  |
| <semi-major axis> | <semi-major axis> | <semi-major axis> |  |
| <inverse flattening> | <inverse flattening> | <inverse flattening> |  |
| Prime meridian | | | |
| <prime meridian> | <prime meridian> | <prime meridian> |  |
| PRIMEM | PRIMEM | PRIMEM |  |
| <name> | <name> | <prime meridian name> |  |
| <longitude> | <longitude> | <irm longitude> |  |
| Map projection | | | |
| <projection> | <projection> | <coordinate operation> |  |
| PROJECTION | PROJECTION | CONVERSION | 19125-1 and CTS 01-009 are not clear whether PROJECTION is the coordinate operation or the coordinate operation method. Implementations have differed in their interpretation. (See comment below). |
| PROJECTION | PROJECTION | METHOD |
| <name> | <name> | <map projection name> |  |
| <projection> | <projection> | <map projection method> |  |
| <name> | <name> | <map projection method name> |  |
| <parameter> | <parameter> | <map projection parameter> |  |
| PARAMETER | PARAMETER | PARAMETER |  |
| <name> | <name> | <parameter name> |  |
| <value> | <value> | <parameter value> |  |
| <unit> | <unit> | <parameter unit> |  |
|  |  | <parameter file name> | Not previously specified. |
| PARAMETERFILE |
| Coordinate System | | | |
|  | <twin axes> | <coordinate system> |  |
| AXIS | AXIS |  |
|  | <axis order> |  |
| <name> | <axis name> | In this document axis name is constrained by CRS type and in turn axis name constrains axis direction. These constraints were not previously specified. |
|  | <axis abbreviation> |  |
| (axis direction) |  | Enumerated list in WKT1. |
| Unit | | | |
| <linear unit> | <linear unit> | <length unit> |  |
| UNIT | UNIT | LENUNIT |  |
| <angular unit> | <angular unit> | <angle unit> |  |
| UNIT | UNIT | ANGUNIT |  |
|  |  | <scale unit> |  |
| UNIT | UNIT | SCALEUNIT |  |
| <unit name> | <unit name> | <unit name> |  |
| <conversion factor> | <conversion factor> | <conversion factor> |  |
| Identifier | | | |
|  | <authority> | <identifier> |  |
| AUTHORITY | ID |  |
| <name> | <authority name> |  |
| <code> | <authority unique identifier> | The types permitted are expanded in this International Standard. |
|  | <version> |  |
| Remark | | |  |
|  |  | <remark> | New to this International Standard. |
| Bound CRS | | | |
|  |  | <bound CRS> |  |
|  | BOUNDCRS |  |
| <to WGS84> | <abridged coordinate transformation> |  |
| TOWGS84 | ABRTRANS | Similar concept but modelled completely differently. |
| <seven param> |  |  |
| <dx> | <parameter name> |  |
| <dy> | <parameter name> |  |
| <dz> | <parameter name> |  |
| <ex> | <parameter name> |  |
| <ey> | <parameter name> |  |
| <ez> | <parameter name> |  |
| <ppm> | <parameter name> |  |

1. (informative)  
     
   Triaxial ellipsoid

#### The reference ellipsoid for the Earth for which the WKT string is defined in 8.2.1 is an oblate ellipsoid of revolution. A triaxial ellipsoid (figure D.1) may be required for planetary mapping and other applications. Their full CRS description is outside the scope of this International Standard.

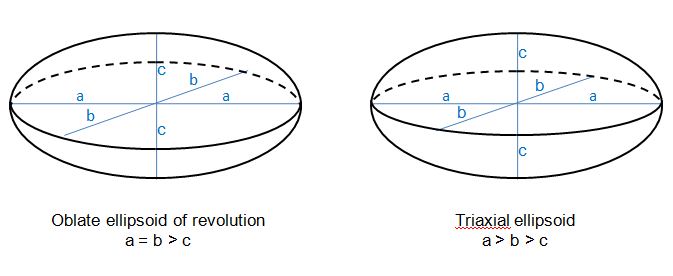


Figure D. — Oblate and triaxial ellipsoids

#### A WKT string definition for a triaxial ellipsoid is given below.

|  |  |  |
| --- | --- | --- |
| <triaxial ellipsoid> | ::= | TRIAXIAL <left delimiter> <ellipsoid name>  <comma> <semi-major axis> <comma> <semi-median axis> <comma><semi-minor axis> <comma> <triaxial ellipsoid unit>  [ <comma> <identifier> ]… <right delimiter> |
| <semi-major axis> | ::= | <unsigned numeric literal> |
| <semi-median axis> | ::= | <unsigned numeric literal> |
| <semi-minor axis> | ::= | <unsigned numeric literal> |
| <triaxial ellipsoid unit> | ::= | LENUNIT <left delimiter> <unit name> <comma> <conversion factor>  [ <comma> <identifier> ]… <right delimiter> |
| <unit name> | ::= | <quoted Latin text> |
| <conversion factor> | ::= | <signed numeric literal> |

The conversion factor shall be to metres and is the number of metres per unit.

EXAMPLE TRIAXIAL["Io 2009 IAU IAG",1829400,1819400,1815700,

LENUNIT["metre",1]]

NOTE 'Triaxial' is an example of a user-defined keyword not described in the normative requirements of this document. . Applications conformant to this International Standard may ignore unrecognised keywords and their attributes.

1. (informative)  
     
   Identifiers for coordinate operation methods and parameters
   1. Introduction

To facilitate interoperability, the sending and receiving applications need to have a common understanding of the semantics of coordinate operation methods and parameters. Previous CRS WKT specifications used name strings as identifiers as the basis for this understanding. Names are often not good enough. The same name, for example "Stereographic" [map projection], may be associated with different formulas, the formula differences being significant. Conversely one shared concept may have very different names which are not readily seen to be synonyms, for example the map projection parameter "longitude of origin" and "central meridian". A further difficulty has been the inconsistency in rendering of names.

The most commonly encountered coordinate operation methods, their formulas and their parameters have been codified in the EPSG Geodetic Parameter Dataset. The tables in the sub-clauses that follow summarise coordinate operation methods and their parameters that are frequently encountered in geographic information systems. The formulas are included within the EPSG Dataset. Additional less frequently used methods which may be locally important may also be found in the EPSG Dataset. Applications may use different formulas, but if these give equivalent results as those of EPSG then they are functionally the same.

NOTE Unless otherwise noted, all methods use ellipsoidal formulas

Method formula differ in their treatment of reversibility. Some methods use one formula for both forward and reverse computations, with the signs of some or all of the parameter values needing to be changed for the reverse case. Other methods include different forward and reverse formula both of which utilise the same parameters and parameter values; most map projections are in this category. Yet other methods are not reversible. Some are theoretically not exactly reversible but for earth sciences can be considered to be reversible in practice. Detailed documentation of method formula and parameter reversibility is beyond the scope of this annex. The EPSG Dataset documents the reversibility of the methods it describes. Table E.1 summarises the methods and parameters given in the remainder of this annex.

Method definition including formula, parameters used in that formula and an example as given in the EPSG Dataset may be obtained by substitution of the relevant method code in the hyperlink:

<http://www.epsg-registry.org/indicio/query?request=GetRepositoryItem&id=urn:ogc:def:method:EPSG::9802>

The EPSG Dataset defines the order in which parameters should be listed. It is recommended that this order be followed in WKT strings.

**Table E.1 — Coordinate operation methods and parameters**

|  |  |  |
| --- | --- | --- |
| **Table** | **Clause** | **Content** |
| E.2 | E.2 | Map projection methods |
| E.3 | E.3 | Map projection parameters |
| E.4 | E.4 | Coordinate operation (excluding map projection) methods |
| E.5 | E.5 | Coordinate operation (excluding map projection) parameters |

* 1. Map projection methods

**Table E.2 — Map projection methods**

| **Coordinate operation method name** | **Method name alias(es)** | **EPSG Method code** | **Codes of parameters used by this method**  (refer to E.3) |
| --- | --- | --- | --- |
| Albers Equal Area | *Albers* | 9822 | 8821, 8822, 8823. 8824, 8826, 8827 |
| American Polyconic | *Polyconic* | 9818 | 8801, 8802, 8806, 8807 |
| Cassini-Soldner | *Cassini* | 9806 | 8801, 8802, 8806, 8807 |
| Hotine Oblique Mercator (variant A) | *Rectified skew orthomorphic* | 9812 | 8811, 8812, 8813, 8814, 8815, 8806, 8807 |
| Hotine Oblique Mercator (variant B) | *Rectified skew orthomorphic* | 9815 | 8811, 8812, 8813, 8814, 8815, 8816, 8817 |
| Lambert Azimuthal Equal Area | *Lambert Equal Area*  *LAEA* | 9820 | 8801, 8802, 8806, 8807 |
| Lambert Conic Conformal (1SP) | *Lambert Conic Conformal*  *LCC* | 9801 | 8801, 8802, 8805, 8806, 8807 |
| Lambert Conic Conformal (2SP) | *Lambert Conic Conformal*  *LCC* | 9802 | 8821, 8822, 8823. 8824, 8826, 8827 |
| Mercator (variant A) | *Mercator* | 9804 | 8801, 8802, 8805, 8806, 8807 |
| Mercator (variant B) | *Mercator* | 9805 | 8823, 8802, 8806, 8807 |
| Oblique stereographic | *Double stereographic* | 9809 | 8801, 8802, 8805, 8806, 8807 |
| Transverse Mercator | *Gauss-Boaga*  *Gauss-Krüger*  *TM* | 9807 | 8801, 8802, 8805, 8806, 8807 |
| Transverse Mercator (South Orientated) | *Gauss-Conform* | 9808 | 8801, 8802, 8805, 8806, 8807 |

* 1. Map projection parameters

**Table E.3 — Map projection parameters**

| **Parameter code** | **Coordinate operation parameter name**  *(alias(es))* | **Parameter description** |
| --- | --- | --- |
| 8801 | latitude of natural origin  *(latitude of origin)* | geodetic latitude of the point from which the values of both the geographical coordinates on the ellipsoid and the grid coordinates on the projection are deemed to increment or decrement for computational purposes  Alternatively: geodetic latitude of the point which in the absence of application of false coordinates has grid coordinates of (0,0) |
| 8802 | longitude of natural origin  *(longitude of origin)*  *(central meridian)* | geodetic longitude of the point from which the values of both the geographical coordinates on the ellipsoid and the grid coordinates on the projection are deemed to increment or decrement for computational purposes. Alternatively: geodetic longitude of the point which in the absence of application of false coordinates has grid coordinates of (0,0) |
| 8805 | scale factor at natural origin  *(scale factor)* | factor by which the map grid is reduced or enlarged during the projection process, defined by its value at the natural origin |
| 8806 | false easting | value assigned to the abscissa (east or west) axis of the projection grid at the natural origin |
| 8807 | false northing | value assigned to the ordinate (north or south) axis of the projection grid at the natural origin |
| 8811 | latitude of projection centre | latitude of the point at which the azimuth of the central line for an oblique projection is defined |
| 8812 | longitude of projection centre | longitude of the point at which the azimuth of the central line for an oblique projection is defined |
| 8813 | azimuth of initial line | direction (north zero, east of north being positive) of the great circle which is the centre line of an oblique projection. The azimuth is given at the projection centre |
| 8814 | angle from rectified to skew grid | angle at the natural origin of an oblique projection through which the natural coordinate reference system is rotated to make the projection north axis parallel with true north |
| 8815 | scale factor on initial line | factor by which the map grid is reduced or enlarged during the projection process, defined by its value at the projection centre |
| 8816 | easting at projection centre  *(false easting)* | easting value assigned to the projection centre |
| 8817 | northing at projection centre  *(false northing)* | northing value assigned to the projection centre |
| 8821 | latitude of false origin  *(latitude of origin)* | geodetic latitude of the point which is not the natural origin and at which grid coordinate values false easting and false northing are defined |
| 8822 | longitude of false origin  *(longitude of origin)* | geodetic longitude of the point which is not the natural origin and at which grid coordinate values false easting and false northing are defined. |
| 8823 | latitude of 1st standard parallel | geodetic latitude of one of the parallels of intersection of the cone with the ellipsoid. It is normally but not necessarily that nearest to the pole. Scale is true along this parallel. |
| 8824 | latitude of 2nd standard parallel | geodetic latitude of one of the parallels at which the cone intersects with the ellipsoid. It is normally but not necessarily that nearest to the equator. Scale is true along this parallel. |
| 8826 | easting at false origin  *(false easting)* | easting value assigned to the false origin |
| 8827 | northing at false origin  *(false northing)* | northing value assigned to the false origin |

* 1. Coordinate transformation methods

**Table E.4 — Coordinate transformation methods**

| **Coordinate operation method name** | **Method name alias(es)** | **EPSG Method code** | **Codes of parameters used by this method**  (refer to E.5) |
| --- | --- | --- | --- |
| Geocentric translations (geocentric domain) | *Geocentric translations* | 1031 | 8605, 8606, 8607 |
| Position Vector transformation (geocentric domain) | *Position Vector 7-param. transformation*  *Bursa-Wolf*  *Helmert* | 1033 | 8605, 8606, 8607, 8608, 8609, 8610, 8611 |
| Coordinate Frame Rotation (geocentric domain) | *Coordinate Frame Rotation*  *Bursa-Wolf*  *Helmert* | 1032 | 8605, 8606, 8607, 8608, 8609, 8610, 8611 |
| Molodensky-Badekas (geocentric domain) | *Molodensky-Badekas* | 1034 | 8605, 8606, 8607, 8608, 8609, 8610, 8611, 8617, 8618, 8667 |
| NTv2 |  | 9615 | 8656 |
| NADCON |  | 9613 | 8657, 8658 |
| Vertical Offset |  | 9616 | 8603 |
| Longitude rotation |  | 9601 | 8602 |

* 1. Coordinate transformation parameters

**Table E.5 — Coordinate transformation parameters**

| **Parameter code** | **Coordinate operation parameter name**  *(alias(es))* | **Parameter description** |
| --- | --- | --- |
| 8603 | Vertical Offset  *(dH)* | difference between the height or depth values of a point in the target and source coordinate reference systems |
| 8605 | X-axis translation  *(dX)*  *(tX)* | difference between the X values of a point in the target and source coordinate reference systems |
| 8606 | Y-axis translation  *(dY)*  *(tY)* | difference between the Y values of a point in the target and source coordinate reference systems |
| 8607 | Z-axis translation  *(dZ)*  *(tZ)* | difference between the Z values of a point in the target and source coordinate reference systems |
| 8608 | X-axis rotation  *(rX)* | angular difference between the Y and Z axes directions of target and source coordinate reference systems. This is a rotation about the X axis as viewed from the origin looking along that axis. The particular method defines which direction is positive, and what is being rotated (point or axis). |
| 8609 | Y-axis rotation  *(rY)* | angular difference between the X and Z axes directions of target and source coordinate reference systems. This is a rotation about theY axis as viewed from the origin looking along that axis. The particular method defines which direction is positive, and what is being rotated (point or axis). |
| 8610 | Z-axis rotation  *(rZ)* | angular difference between the X and Y axes directions of target and source coordinate reference systems. This is a rotation about the Z axis as viewed from the origin looking along that axis. The particular method defines which direction is positive, and what is being rotated (point or axis). |
| 8611 | Scale difference  *(dS)* | the ratio of a length between two points in target and source coordinate reference systems.  If a distance of 100 km in the source coordinate reference system translates into a distance of 100.001 km in the target coordinate reference system, the scale difference is 1 ppm (the ratio being 1.000001). |
| 8617 | Ordinate 1 of evaluation point | value of the first ordinate of the evaluation point |
| 8618 | Ordinate 2 of evaluation point | value of the second ordinate of the evaluation point |
| 8656 | Latitude and longitude difference file | name of the [path and] file containing latitude and longitude differences |
| 8657 | Latitude difference file | name of the [path and] file containing latitude differences |
| 8658 | Longitude difference file | name of the [path and] file containing longitude differences |
| 8667 | Ordinate 3 of evaluation point | value of the third ordinate of the evaluation point |

Bibliography

[1] ISO 19125-1:2004, *Geographic information – Simple feature access — Part 1: Common architecture*.

[2] OGC OpenGIS Project Document 99-036, *OpenGIS Simple Features Specification for SQL, revision 1.1*.

[3] OGC OpenGIS Project Document 06-103r4, *Simple feature access — Part 1: Common architecture*.

[4] OGC OpenGIS Project Document 01-009, *Implementation Specification: Coordinate Transformation Services, revision 1.00*.

[5] OGC Project Document 09-083r3, *GeoAPI 3.0 Implementation Standard*.