SVENSK STANDARD
SS-EN ISO 19148:2021

Geografisk information – Linjära referenssystem (ISO 19148:2021)

Geographic information – Linear referencing (ISO 19148:2021)

Svenska Institutet för Standarder

Language: engelska/English

Edition: 2

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Fastställd: 2021-05-05
ICS: 07.040; 35.240.01; 35.240.30; 35.240.50; 35.240.60; 35.240.70; 35.240.99

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Europastandarden EN ISO 19148:2021 gäller som svensk standard. Detta dokument innehåller den officiella engelska versionen av EN ISO 19148:2021.

Denna standard ersätter SS-EN ISO 19148:2012, utgåva 1

The European Standard EN ISO 19148:2021 has the status of a Swedish Standard. This document contains the official version of EN ISO 19148:2021.

This standard supersedes the SS-EN ISO 19148:2012, edition 1

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A statement is an expression, in the content of a document, that conveys information. A statement can express permission, possibility or capability. Permission is expressed by the auxiliary may (its opposite being need not). Possibility and capability are expressed by the auxiliary can (its opposite being cannot).

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN ISO 19148

April 2021

ICS 35.240.70

Supersedes EN ISO 19148:2012

English Version

Geographic information - Linear referencing (ISO 19148:2021)

Information géographique - Référencement linéaire (ISO 19148:2021)

Geoinformation - Lineares Bezugssystem (ISO 19148:2021)

This European Standard was approved by CEN on 10 March 2021.

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This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

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CEN-CENELEC Management Centre: Avenue Marnix 17, B-1000 Brussels

Ref. No. EN ISO 19148:2021: E

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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

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

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

This second edition cancels and replaces the first edition (ISO 19148:2012), which has been technically revised.

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

— revision of the definition of the term linear element, removing a circular reference with the definition for the term linear referencing;

— introduction of the definition of the term referent;

— revision of the conceptual schema to meet current standards and harmonize with other ISO/TC 211 International Standards;

— refactoring of the core Linear Referencing System package, abstracting implementation classes into a new Application Schema package which is now presented as an example in Annex D;

— introduction of an approach addressing broken-chainage;

— introduction of an enumeration addressing directionality of measurements;

— introduction of an approach addressing Cross-Sectional Positioning (XSP) conventions;

— introduction of an approach addressing Measures with Uneven Distribution;

— refactoring of the Linearly Located Event package dropping the previous assumption that the Linear Element was always of a Feature type;

— introduction of simplifications of the conceptual schema;

— additional example illustrating Measures with Uneven Distribution in Annex C;

— introduction of information about some standards implementing the conceptual schema described in this document in Annex C;

— additional example illustrating Secondary Linear Referencing Systems in Annex E;

— the correction of minor errors;

— introduction of a detailed overview regarding changes and backwards compatibility in Annex F.

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

European foreword

This document (EN ISO 19148:2021) has been prepared by Technical Committee ISO/TC 211 "Geographic information/Geomatics" in collaboration with Technical Committee CEN/TC 287 “Geographic Information” the secretariat of which is held by BSI.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by October 2021, and conflicting national standards shall be withdrawn at the latest by October 2021.

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

This document supersedes EN ISO 19148:2012.

According to the CEN-CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Endorsement notice

The text of ISO 19148:2021 has been approved by CEN as EN ISO 19148:2021 without any modification.

Introduction

This document is a description of the data and operations required to support linear referencing. This includes Linear Referencing Systems, linearly located events and linear segments.

Linear Referencing Systems enable the specification of positions along linear objects. The approach is based upon the Generalized Model for Linear Referencing[12] first standardized within ISO 19133:2005. This document extends that which was included in ISO 19133, both in functionality and explanation.

ISO 19109 supports features representing discrete objects with attributes with values which apply to the entire feature. ISO 19123 allows the attribute value to vary, depending upon the location within a feature, but does not support the assignment of attribute values to a single point or length along a linear feature. Linearly located events provide the mechanism for specifying attribution of linear objects when the attribute value varies along the length of a linear feature. A Linear Referencing System is used to specify where along the linear object each attribute value applies. The same mechanism can be used to specify where along a linear object another object is located, such as guardrail or a traffic accident.

It is common practice to segment a linear object with linearly located events, based upon one or more of its attributes. The resultant linear segments are attributed with just the attributes used in the segmentation process, ensuring that the linear segments are homogeneous in value for these segmenting attributes.

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

“The decimal marker shall be either a point on the line or a comma on the line.” In practice, the choice between these alternatives depends on customary use in the language concerned. In the technical areas of geodesy and geographic information it is customary for the decimal point always to be used, for all languages. That practice is used throughout this document.

Geographic information — Linear referencing

1 Scope

This document specifies a conceptual schema for locations relative to a one-dimensional object as measurement along (and optionally offset from) that object. It defines a description of the data and operations required to use and support linear referencing.

This document is applicable to transportation, utilities, environmental protection, location-based services and other applications which define locations relative to linear objects. For ease of reading, most examples discussed in this document come from the transportation domain.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 19103, *Geographic information — Conceptual schema language*

ISO 19107, *Geographic information — Spatial schema*

ISO 19108, *Geographic information — Temporal schema*

ISO 19111, *Geographic information — Referencing by coordinates*

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
attribute event
value of an attribute of a *feature* (3.4) that can apply to only part of the feature

Note 1 to entry: An attribute event includes the *linearly referenced location* (3.16) where the attribute value applies along the *attributed feature* (3.2).

Note 2 to entry: An attribute event can be qualified by the *instant* (3.8) in which, or *period* (3.20) during which, the attribute value applied.

3.2
attributed feature
feature (3.4) along which an *attribute event* (3.1) applies

3.3
direct position
position (3.21) described by a single set of coordinates within a coordinate reference system

[SOURCE: ISO 19136-1:2020, 3.1.20]

3.4
feature
abstraction of real-world phenomena

[SOURCE: ISO 19101-1:2014, 4.1.11]

3.5
feature event
information about the occurrence of a *located feature* (3.17) along a *locating feature* (3.18)

Note 1 to entry: A feature event includes the *linearly referenced location* (3.16) of the located feature along the locating feature.

Note 2 to entry: A feature event can be qualified by the *instant* (3.8) in which, or *period* (3.20) during which, the feature event occurred.

3.6
geometric primitive
<geometry> geometric object representing a single, connected, homogeneous (isotropic) element of space

Note 1 to entry: Geometric primitives are non-decomposed objects that present information about geometric configuration. They include points, curves, surfaces and solids. Many geometric objects behave like primitives (supporting the same interfaces defined for geometric primitives) but are actually composites composed of some number of other primitives. General collections can be aggregates and incapable of acting like a primitive (such as the lines of a complex network, which is not connected and thus incapable of being traceable as a single line). By this definition, a geometric primitive is topological open, since the boundary points are not isotropic to the interior points. Geometry is assumed to be closed. For points, the boundary is empty.

[SOURCE: ISO 19107:2019, 3.50]

3.7
height
h, H
distance of a point from a chosen reference surface positive upward along a line perpendicular to that surface

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

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

[SOURCE: ISO 19111:2019, 3.1.38]

3.8
instant
0-dimensional *geometric primitive* (3.6) representing *position* (3.21) in time

Note 1 to entry: The geometry of time is discussed in ISO 19108:2002, 5.2.

[SOURCE: ISO 19108:2002, 4.1.17]

3.9
linear element
one-dimensional object that serves as the axis along which measurements are made

Note 1 to entry: Also known as curvilinear element.

EXAMPLE *Feature* (3.4), such as “road”; curve geometry; directed edge topological primitive.

3.10
linear referencing
specification of a *location* (3.19) relative to a *linear element* (3.9) as a measurement along (and optionally offset from) that element

Note 1 to entry: An alternative to specifying a location as a two- or three- dimensional *spatial position* (3.23).

3.11
linear referencing method
LRM
manner in which measurements are made along (and optionally offset from) a *linear element* (3.9)

3.12
linear referencing system
LRS
set of *linear referencing methods* (3.11) and the policies, records and procedures for implementing them

Note 1 to entry: Adapted from Reference [10].

3.13
linear segment
part of a linear *feature* (3.4) that is distinguished from the remainder of that feature by a subset of attributes, each having a single value for the entire part

Note 1 to entry: A linear segment is a one-dimensional object without explicit geometry.

Note 2 to entry: The implicit geometry of the linear segment can be derived from the geometry of the parent feature.

3.14
linearly located
located using a *linear referencing system* (3.12)

3.15
linearly located event
occurrence along a *feature* (3.4) of an attribute value or another feature

Note 1 to entry: The event *location* (3.19) is specified using *linearly referenced locations* (3.16).

Note 2 to entry: A linearly located event can be qualified by the *instant* (3.8) in which, or *period* (3.20) during which, the linearly located event occurred.

Note 3 to entry: ISO 19108 limits events to a single instant in time and does not include the specification of a location.

3.16
linearly referenced location
location (3.19) whose *position* (3.21) is specified using *linear referencing* (3.10)

3.17
located feature
linearly located feature
feature (3.4) that is *linearly located* (3.14) along an associated (locating) feature

EXAMPLE A feature "bridge" can be a located feature along the feature "railway" [a *locating feature* (3.18)].

3.18
locating feature
linearly locating feature
feature (3.4) that is used to identify the *location* (3.19) of *linearly located* (3.14) features

EXAMPLE A feature "road" can be the locating feature for a feature "pedestrian crossing" [a *located feature* (3.17)].

3.19
location
particular place or *position* (3.21)

Note 1 to entry: A location identifies a geographic place.

Note 2 to entry: "Madrid", "California".

Note 3 to entry: Additionally, in this document, a location is represented by one of a set of data types that describe a *position* (3.21), along with metadata about that data, including coordinates (from a coordinate reference system), a measure (from a *linear referencing system* (3.12)), or an address (from an address system).

[SOURCE: ISO 19112:2019, 3.1.3]

3.20
period
one-dimensional *geometric primitive* (3.6) representing extent in time

Note 1 to entry: A period is bounded by two different *temporal positions* (3.24).

[SOURCE: ISO 19108:2002, 4.1.27]

3.21
position
data type that describes a point or geometry potentially occupied by an object or person

Note 1 to entry: A *direct position* (3.3) is a semantic subtype of position. Direct positions as described can define only a point and, therefore, not all positions can be represented by a direct position. That is consistent with the "is type of" relation. An ISO 19107 geometry is also a position, just not a direct position.

[SOURCE: ISO 19133:2005, 4.18]

3.22
referent
known *location* (3.19) along a *linear element* (3.9) from which relative measurements are made

EXAMPLE Milepost, kilopost or reference post.

3.23
spatial position
direct position (3.3) that is referenced to a two- or three-dimensional coordinate reference system

Note 1 to entry: An alternative to specifying a *location* (3.19) as a *linearly referenced location* (3.16).

3.24
temporal position
location (3.19) relative to a *temporal reference system* (3.25)

[SOURCE: ISO 19108:2002, 4.1.34]

3.25
temporal reference system
reference system against which time is measured

[SOURCE: ISO 19108:2002, 4.1.35]

3.26
valid time
time when a fact is true in the abstracted reality

[SOURCE: ISO 19108:2002, 4.1.39]

4 Abbreviated terms and UML notation

4.1 Abbreviated terms

CRS	coordinate reference system
GIS	geographic information systems
IFC	industry foundation classes
LandInfra	land and infrastructure conceptual model
NCHRP	national cooperative highway research program
RDF	resource description framework
REST	representational state transfer
SOAP	single object access protocol
SPARQL	SPARQL protocol and RDF query language
SQL	structured query language
UML	unified modelling language
XSP	cross-sectional positioning

4.2 UML notation

In this document, conceptual schemas are presented in the UML. ISO 19103 presents the specific profile of UML used in this document.

5 Conformance

5.1 Conformance overview

Clause 6 of this document uses the UML to present conceptual schemas for describing the constructs required for Linear Referencing. These schemas define conceptual classes that shall be used in application schemas, profiles and implementation specifications. This document concerns only externally visible interfaces and places no restriction on the underlying implementations other than what is required to satisfy the interface specifications in the actual situation, such as:

— interfaces to software services using techniques such as SOAP, REST and SPARQL end points;

— interfaces to databases using techniques such as SQL;

— data interchange using encoding as defined in ISO 19118.

Few applications require the full range of capabilities described by this conceptual schema. Clause 6, therefore, defines a set of conformance classes that support applications whose requirements range from the minimum necessary to define data structures to full object implementation. This flexibility is controlled by a set of UML concepts that can be implemented in a variety of manners. Implementations that define full object functionality shall implement all operations defined by the types of the chosen conformance class, as is common for UML designed object implementations. It is not necessary for implementations that choose to depend on external “free functions” for some or all operations, or forgo them altogether, to support all operations, but they shall always support a data type sufficient for recording the state of each of the chosen UML types as defined by its member variables. It is acceptable to use common names for concepts that are the same but have technically different implementations.

The UML model in this document defines abstract types, application schemas define conceptual classes, various software systems define implementation classes or data structures, and the XML from the encoding standard (ISO 19118) defines entity tags. All of these references the same information content. There is no difficulty in allowing the use of the same name to represent the same information content even though at a deeper level there are significant technical differences in the digital entities being implemented. This "allows" types defined in the UML model to be used directly in application schemas.

5.2 Conformance classes

5.2.1 General

Conformance to this document shall consist of either data type conformance or both data type and operation conformance. The related tests are provided in the abstract test suite in Annex A.

5.2.2 Data type conformance

Data type conformance includes the usage of data types in application schemas or profiles that instantiate types in this document. In this context, "instantiate" means that there is a correspondence between the types in the appropriate part of this document, and the data types of the application schema or profile in such a way that each standard type can be considered as a supertype of the application schema data type. This means that an application schema or profile data type corresponding to a standard type contains sufficient data to recreate that standard type's information content.

Table 1 assigns conformance tests, detailed in Annex A, to each of the packages in Clause 6. Each row in the table represents one conformance class. A specification claiming data type conformance to a package in the first column of the table shall satisfy the requirements specified by the tests given in the remaining columns to the right.

Table 1 — Data type conformance tests

Package	Conformance test					
	A.1.1	A.1.2	A.1.3	A.1.4	A.1.5	A.1.6
Linear Referencing System	X	—	—	—	—	—
Linear Referencing Towards Referent	X	X	—	—	—	—
Linear Referencing Offset	X	—	X	—	—	—
Linear Referencing Offset Vector	X	—	X	X	—	—
Linearly Located Event	X	—	—	—	X	—
Linear Segmentation	X	—	—	—	X	X

5.2.3 Operation conformance

Operation conformance includes both the consistent use of operation interfaces and data type conformance for the parameters, and return values used by those operations. Operation conformance also includes get and set operations for attributes.

Table 2 assigns conformance tests, detailed in Annex A, to each of the packages in Clause 6. Each row in the table represents one conformance class. A specification claiming operation conformance to a package in the first column of the table shall satisfy the requirements specified by the tests given in the remaining columns to the right.

Table 2 — Operation conformance tests

Package	Conformance test					
	A.1.1 A.2.1	A.1.2 A.2.2	A.1.3 A.2.3	A.1.4 A.2.4	A.1.5 A.2.5	A.1.6 A.2.6
Linear Referencing System	X	—	—	—	—	—
Linear Referencing Towards Referent	X	X	—	—	—	—
Linear Referencing Offset	X	—	X	—	—	—
Linear Referencing Offset Vector	X	—	X	X	—	—
Linearly Located Event	X	—	—	—	X	—
Linear Segmentation	X	—	—	—	X	X

6 Linear referencing

6.1 Background

6.1.1 Linear referencing concepts

6.1.1.1 General

LRSs are in wide use in transportation but are also appropriate in other areas such as utilities. They allow for the specification of positions along linear elements by using measured distances along (and optionally offset from) the element. This is in contrast to using spatial positions that use two- or three-dimensional coordinates, consistent with a particular CRS.

Linearly referenced locations are significant for several reasons. First, a significant amount of information is currently held in huge databases from legacy systems that pre-date GISs. Many useful applications can and have been built on these data with no understanding of where on the earth's surface the data are located. Knowing where they are located relative to a linear element such as a roadway route or pipeline is sufficient to support these applications and can be used as a means of integrating data from multiple, disparate sources.

In some situations, having a linearly referenced location along a known linear element is more advantageous than knowing its spatial position. Consider a crash in need of emergency assistance. Knowing the linear element (e.g. Northbound I-95) and the approximate linear location is superior to having a potentially more precise spatial GPS location that is not of significant accuracy to determine whether it is northbound or southbound I-95, especially if an impassable barrier separates the two carriageways.

The linearly referenced location as specified in this document as a position expression, therefore, has many uses. It can be used to tie information about a linear facility to a specific location along that facility. It can also be used to find a position on the face of the earth by specifying how far along the position is (and optionally offset from) on a particular linear element.

This document proposes a consistent specification for describing linearly referenced locations that also enables translation between different referencing methods and/or linear elements. It also specifies how these position expressions can be used to specify how information that pertains to only a part of a linear element can be specified as linearly located events.

A LRS is a set of LRMs and the policies, records and procedures for implementing them. There are numerous, seemingly disparate, LRMs in use today. There is no single, best method, as each has advantages in certain situations. It is, therefore, unreasonable to propose a single standard LRM. The Generalized Model for Linear Referencing[12] has been developed which instead categorizes LRMs into a basic set of common concepts. The additional advantage of this approach is that it also enables a singular method for translating linearly referenced locations into locations specified by another method or along an alternative linear element. This translation method is both closed and transitive,