

ISO/TC 22/SC 31

Date: ~~2022-11-22~~2023-02

ISO/FDIS 23150:~~2022~~2023

ISO/TC 22/SC 31/WG 9

Secretariat: DIN

Road vehicles — Data communication between sensors and data fusion unit for automated driving functions — Logical interface

Véhicules routiers — Communication de données entre capteurs et unité de fusion de données pour les fonctions de conduite automatisée — Interface logique

iTeh STANDARD PREVIEW
(standards.iteh.ai)

ISO/FDIS 23150

<https://standards.iteh.ai/catalog/standards/sist/64eb6714-a8ac-473d-a03f-c4cf493a0737/iso-fdis-23150>

Edited DIS - MUST BE USED FOR FINAL DRAFT

COPYRIGHT PROTECTED DOCUMENT

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office

Ch. de Blandonnet 8 • CP 401

Tel. + 41 22 749 01 11

CH-1214 Vernier, Geneva, Switzerland

Fax + 41 22 749 09 47

copyright@iso.org

www.iso.org

iTeh STANDARD PREVIEW
(standards.iteh.ai)

ISO/FDIS 23150

<https://standards.iteh.ai/catalog/standards/sist/64eb6714-a8ac-473d-a03f-c4cf493a0737/iso-fdis-23150>

Contents

Page

Foreword..... vi

Introduction..... viii

1 Scope 1

2 Normative references 1

3 Terms and definitions..... 1

3.1 Architectural components..... 1

3.2 Terms for logical interface layers..... 2

3.3 Structure terms 3

3.4 Measurement terms..... 3

3.5 Requirement level terms 6

3.6 Road user relevant entity types 7

3.7 Axis and coordinate system terms 9

4 Abbreviated terms 15

5 Structure of the interface description..... 16

5.1 General 16

5.2 Signal 17

5.3 Interface 17

5.4 Specific signal grouping 18

5.5 Profile 19

6 Logical interface from a sensor as well as a sensor cluster to a fusion unit..... 19

6.1 General 19

6.2 Generic interface header 22

6.3 Generic interface entity..... 23

6.4 Profile: Uniqueness of interface versioning..... 23

7 Object level..... 24

7.1 General 24

7.2 Generic object level interface..... 24

7.2.1 Generic object level header 25

7.2.2 Generic object level entity..... 25

7.3 Potentially moving object interface..... 26

7.3.1 Potentially moving object header..... 35

7.3.2 Potentially moving object entity 36

7.3.3 Profile: Motion type 37

7.3.4 Profile: Motion state vector 38

7.4 Road object interface 39

7.4.1 Road object header 50

7.4.2 Road object entity..... 52

7.4.3 Profile: Colour model for RDOI..... 55

7.5 Static object interface..... 55

7.5.1 Static object header 84

7.5.2 Static object entity..... 86

7.5.3 Profile: Colour model for SOI..... 94

7.5.4 Profile: Detection references for 3D detections..... 94

7.6 Free space area object interface 97

7.6.1 Free space area object header 103

7.6.2 Free space area object entity..... 104

8	Feature level	105
8.1	General.....	105
8.2	Generic sensor cluster feature interface	106
8.2.1	Generic sensor cluster feature header	106
8.2.2	Generic sensor cluster feature entity	107
8.3	Camera feature interface.....	107
8.3.1	Camera feature header	111
8.3.2	Camera feature entity.....	112
8.3.3	Profile: Colour model for CFI	113
8.4	Ultrasonic feature interface	114
8.4.1	Ultrasonic feature header	117
8.4.2	Ultrasonic feature entity	118
9	Detection level.....	118
9.1	General.....	118
9.2	Generic sensor detection interface.....	119
9.2.1	Generic sensor detections header.....	119
9.2.2	Generic sensor detections entity	120
9.3	Radar detection interface	121
9.3.1	Radar detections header	123
9.3.2	Radar detections entity.....	125
9.3.3	Profile: Radar ambiguity.....	125
9.4	Lidar detection interface.....	125
9.4.1	Lidar detection header.....	128
9.4.2	Lidar detection entity	129
9.5	Camera detection interface	130
9.5.1	Camera detection header.....	134
9.5.2	Camera detection entity	135
9.5.3	Profile: Colour model for CDI.....	136
9.6	Ultrasonic detection interface.....	136
9.6.1	Ultrasonic detection header.....	139
9.6.2	Ultrasonic detection entity	140
9.6.3	Profile: Ultrasonic sensor cluster.....	142
10	Supportive sensor interfaces	144
10.1	General.....	144
10.2	Generic supportive sensor interface.....	145
10.2.1	Generic supportive sensor header.....	145
10.2.2	Generic supportive sensor entity.....	146
10.3	Sensor performance interface.....	146
10.3.1	Sensor performance header.....	150
10.3.2	Sensor performance entity.....	151
10.3.3	Profile: Uniqueness of interface versioning of SPIs.....	152
10.4	Sensor health information interface.....	152
10.4.1	Sensor health information header.....	155
10.4.2	Sensor health information entity.....	156
11	Sensor input interface	156
11.1	General.....	156
11.2	Generic sensor input interface.....	156
11.2.1	Generic sensor inputs header.....	156
11.2.2	Generic sensor inputs entity	157
11.2.3	Profile: Uniqueness of interface versioning of SII	157
11.3	Common sensor input interface	157
11.3.1	Common sensor input header	160
11.3.2	Common sensor input entity.....	161

ISO/FDIS 23150:~~2022~~2023(E)

Annex A (normative) Interface signals	162
Annex B (normative) Options and constraints.....	339
Bibliography	357

iTeh STANDARD PREVIEW
(standards.iteh.ai)

ISO/FDIS 23150

<https://standards.iteh.ai/catalog/standards/sist/64eb6714-a8ac-473d-a03f-c4cf493a0737/iso-fdis-23150>

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 22, *Road vehicles*, Subcommittee SC 31, *Data communication*.

This second edition cancels and replaces the first edition (ISO 23150:2021), which has been technically revised.

The main changes are as follows:

- extension of the potentially moving object interface at object level (extension of the logical signal group person);
- update of the road object interface at object level (extension of the road marking sign);
- extension of the static object interface at object level (extension of the entity type traffic sign; addition of new entity type traffic sign board);
- addition of new free space area interface at object level;
- extension of the camera detection interface at detection level (addition of new entity type point; update of existing entity type shape);
- addition of new interface level – sensor input interface (addition of new generic sensor input interface; addition of new common sensor input interface);

ISO/FDIS 23150:20222023(E)

- extension of the error model (addition of covariances, cross-covariances and time series as error model implementation);
- refinement of the terms, for example, value as measured-, tracked- and predicted quantity value;
- new measures to link signals with their origin, that means linking signals at object level with, for example, detection entities;
- harmonisation of the document, for example, to achieve a better readability;
- update and add figures for clarification.

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.

iTeh STANDARD PREVIEW
(standards.iteh.ai)

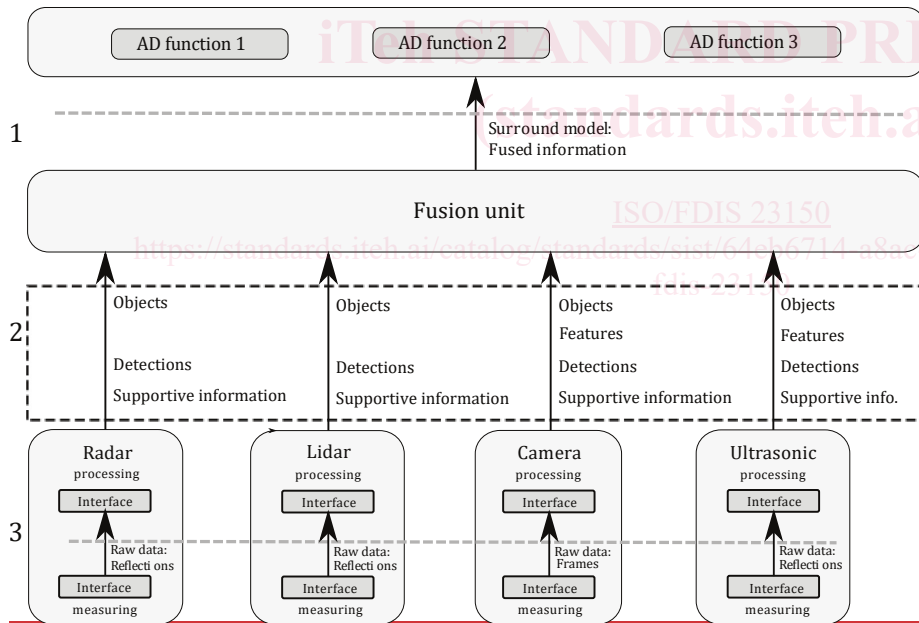
ISO/FDIS 23150

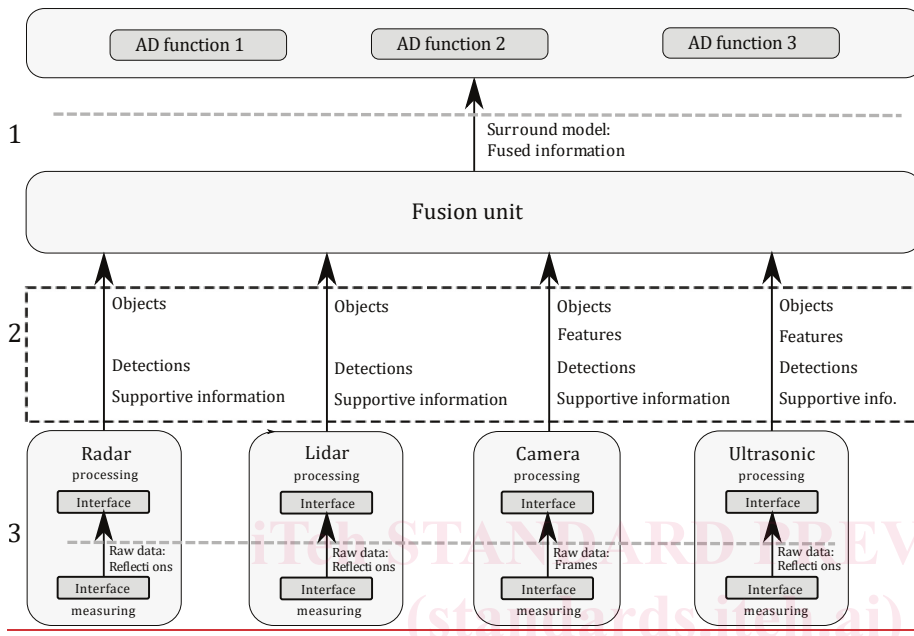
<https://standards.iteh.ai/catalog/standards/sist/64eb6714-a8ac-473d-a03f-c4cf493a0737/iso-fdis-23150>

Introduction

(Highly-)automated driving (AD) functions for road vehicles require a situation awareness of the surroundings of the vehicle and, preferably, a comprehensive scene understanding. For the fast and reliable recognition of real-world objects, a sensor suite is necessary to provide information for the fusion unit. Utilisation of different sensor technologies like radar, lidar, camera and ultrasonic with different detection capabilities is indispensable to ensure both complementary and redundant information. The fusion unit analyses and evaluates the different sensor signals and finally generates a dynamic surround model with sufficient scene understanding.

While current partly-automated functions utilise only particular objects (for example, vehicles, pedestrians, road markings) to generate a simple surround model, it is necessary for future highly-automated driving functions to merge not only the recognised objects but also to include other sensor-specific properties and characteristics of these objects for the generation of a coherent surround model of the surroundings. To minimise the development efforts for the sensors and the fusion unit and to maximise the reusability of development and validation efforts for the different functions on the sensor and fusion unit side, a standardised logical interface layer between the sensor suite and the fusion unit and a standardised logical interface layer to the sensor suite are worthwhile and beneficial for both the sensor supplier and the system supplier.



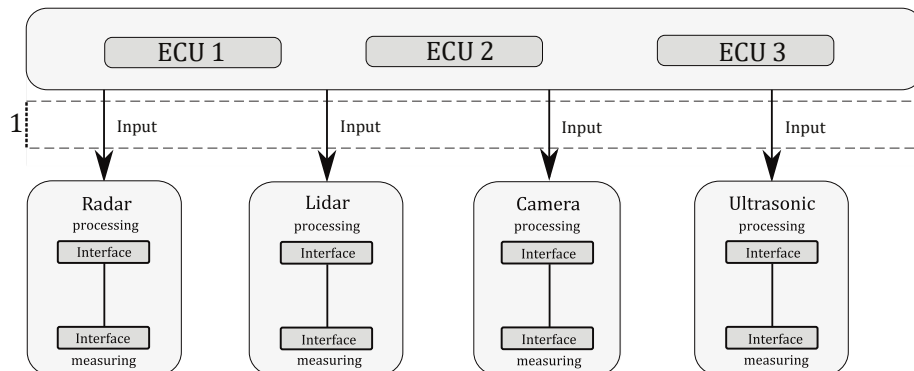


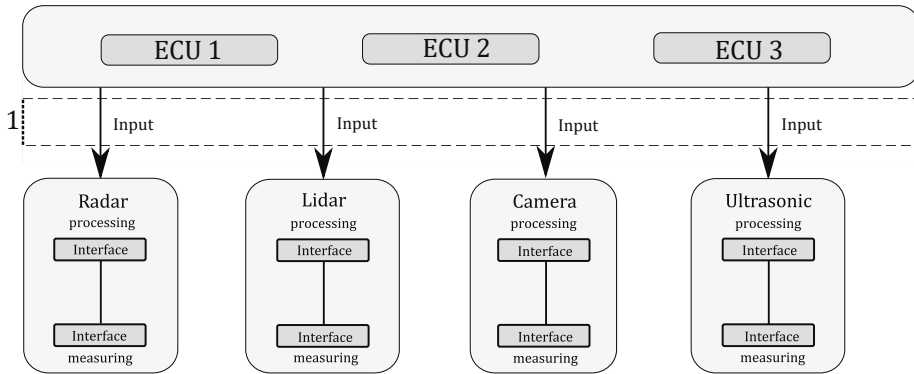
Key

- 1 logical interface layer between the fusion unit and AD functions
- 2 logical interface layer between a single sensor as well as a single sensor cluster and the fusion unit
- 3 interface layer on raw data level of a sensor's sensing element(s) and its processing

Figure 1 — Architecture: sensors/sensor clusters - fusion unit - AD functions

The logical interface layer between a single sensor as well as a single sensor cluster and the fusion unit (see Figure 1, key 2) addresses the encapsulation of technical complexity as well as objects including free space areas, features and detections to enable object-level, feature-level and detection-level fusion. Additional supportive information of the sensor as well as the sensor cluster will supplement the data for the fusion unit.





Key
1 logical interface layer between other in-vehicle electronic control units (ECUs) (for example, odometry) and a single sensor or a single sensor cluster

Figure 2 — Architecture: ECUs' sensor input – sensors/sensor clusters

The logical interface layer between an electronic control unit and a single sensor as well as a single sensor cluster (see Figure 2_key 1) addresses the input of a single sensor as well as a single sensor cluster.

ISO/FDIS 23150

<https://standards.iteh.ai/catalog/standards/sist/64eb6714-a8ac-473d-a03f-c4cf493a0737/iso-fdis-23150>

Road vehicles — Data communication between sensors and data fusion unit for automated driving functions — Logical interface

1 Scope

This document is applicable to road vehicles with automated driving functions. The document specifies the logical interface between in-vehicle environmental perception sensors (for example, radar, lidar, camera, ultrasonic) and the fusion unit which generates a surround model and interprets the scene around the vehicle based on the sensor data. The interface is described in a modular and semantic representation and provides information on object level (for example, potentially moving objects, road objects, static objects) as well as information on feature and detection levels based on sensor technology specific information. Further supportive information is available.

This document does not provide electrical and mechanical interface specifications. Raw data interfaces are also excluded.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

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

ISO and IEC maintain terminology 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 Architectural components

3.1.1

fusion

act of uniting *signals* (3.3.1) from two or more *sensors* (3.1.5) as well as *sensor clusters* (3.1.6) to create a *surround model* (3.1.7)

3.1.2

fusion unit

computing unit where the *fusion* (3.1.1) of *sensor* (3.1.5) data as well as a *sensor cluster* (3.1.6) data is performed

3.1.3

interface

shared boundary between two functional units, defined by various characteristics pertaining to the functions, physical interconnections, *signal* (3.3.1) exchanges and other characteristics of the units, as appropriate

[SOURCE: ISO/IEC 2382:2015, 2124351, modified — Notes to entry have been removed.]

3.1.4

logical interface

interface (3.1.3) between a *sensor* (3.1.5) as well as a *sensor cluster* (3.1.6) and the *fusion unit* (3.1.2), defined by logical characteristics

Note 1 to entry: Logical means a semantic description of the interface.

Note 2 to entry: Mechanical and electrical interfaces are excluded.

Note 3 to entry: This document uses the term interface as a shortcut for the term logical interfaces.

3.1.5

sensor

in-vehicle unit which detects entities external of the vehicle with pre-processing capabilities serving at least one *logical interface* (3.1.4)

Note 1 to entry: A sensor may use one or more sensing elements.

3.1.6

sensor cluster

group of *sensors* (3.1.5) of the same technology serving common *logical interfaces* (3.1.4)

Note 1 to entry: A sensor cluster can exceptionally consist of only one sensor.

EXAMPLE A stereo camera, a surround-view camera, an ultrasonic sensor array, a corner radar system.

3.1.7

surround model

representation of the real world adjacent to the ego-vehicle

3.1.8

in-vehicle communication

communication network used in vehicles to connect devices to exchange information

Note 1 to entry: A in-vehicle communication connects, for example, electric control units and *sensors* (3.1.5) with each other.

3.2 Terms for logical interface layers

3.2.1

detection

sensor technology specific entity represented in the *sensor coordinate system* (3.7.18) based on a single *measurement* (3.4.5) of a *sensor* (3.1.5)

Note 1 to entry: A small amount of history can be used for some detection *signals* (3.3.1), for example, model-free filtering may be used in track-before-detect algorithms.

3.2.2

detection level

set of *logical interfaces* (3.1.4) that provides *detections* (3.2.1)

3.2.3

feature

sensor technology specific entity represented in the *vehicle coordinate system* (3.7.16) based on multiple *measurements* (3.4.5)

Note 1 to entry: Multiple measurements can originate from a *sensor cluster* (3.1.6).

Note 2 to entry: Multiple measurements can originate from multiple *measurement cycles* (3.4.1).

Note 3 to entry: The term feature is used in this document not as function or group of functions as specified in ISO/SAE PAS 22736:2021.

3.2.4

feature level

set of *logical interfaces* (3.1.4) that provides *features* (3.2.3)

3.2.5

object

representation of a real-world entity with defined boundaries and characteristics in the *vehicle coordinate system* (3.7.16)

Note 1 to entry: The geometric description of the object is in the vehicle coordinate system.

Note 2 to entry: Object *signals* (3.3.1) are basically sensor technology independent. Sensor technology specific signals may extend the object signals.

EXAMPLE A *potentially moving object* (3.6.1), a *road object* (3.6.2), a *static object* (3.6.3), a *free space area object* (3.6.4).

3.2.6

object level

set of *logical interfaces* (3.1.4) that provides *objects* (3.2.5)

3.2.7

sensor input

data received by a *sensor* (3.1.5) or a *sensor cluster* (3.1.6) via the *in-vehicle communication* (3.1.8)

3.3 Structure terms

3.3.1

signal

entity consisting of one or more values and which is part of a *logical interface* (3.1.4)

3.3.2

logical signal group

grouping of *signals* (3.3.1) that has a logical relationship and a name for the grouping

3.3.3

classification

attribute-based differentiation

Note 1 to entry: An attribute is defined by a list of enumerators.

3.4 Measurement terms

3.4.1

measurement cycle

time period from the start of a data acquisition event to the start of the next data acquisition event

Note 1 to entry: A measurement cycle of one *sensor* (3.1.5) is a consistent view of an observed scene and not overlapping in time.

3.4.2

measured quantity value

value of a quantity resulting from a *measurement* (3.4.5)

3.4.3

tracked quantity value

value of a quantity determined from observed sequential changes, using information related to the same characteristic

3.4.4

predicted quantity value

value of a quantity assessed before it is actually observable, using information related to the same characteristic

EXAMPLE Related information can be recent and previous *measured quantity values* (3.4.2), *tracked quantity values* (3.4.3) and state variables.

[SOURCE: IEV 192-13-02, modified — EXAMPLE has been added and the word "quantity" has been added to the term.]

3.4.5

measurement

processing result of a *measurement cycle* (3.4.1)

3.4.6

tracking

computation process used to calculate the *tracked quantity value* (3.4.3) of a quantity

3.4.7

prediction

computation process used to obtain the *predicted quantity value* (3.4.4) of a quantity

[SOURCE: IEV 192-11-01]

3.4.8

error

discrepancy between a *measured quantity value* (3.4.2), *tracked quantity value* (3.4.3) or *predicted quantity value* (3.4.4) or condition, and the true, specified or theoretically correct reference quantity value or condition

Note 1 to entry: An error within a system can be caused by failure of one or more of its components, or by the activation of a systematic fault.

[SOURCE: IEV 192-03-02, modified — "computed, observed or measured value" was modified to "measured quantity value, tracked quantity value or predicted quantity value", "value" was modified to "reference quantity value", Note 1 to entry has been adapted and Note 2 to entry was deleted.]

3.4.9

accuracy

closeness of agreement between a *measured quantity value* (3.4.2), *tracked quantity value* (3.4.3) or *predicted quantity value* (3.4.4) and a true quantity value

Note 1 to entry: The concept accuracy is not a quantity and is not given a numerical quantity value. A *measurement* (3.4.5), *tracking* (3.4.6) or *prediction* (3.4.7) is said to be more accurate when it offers a smaller *error* (3.4.8).

Note 2 to entry: The term *accuracy* should not be used for *trueness* (3.4.10) and the term *precision* (3.4.11) should not be used for accuracy, which, however, is related to both these concepts.

Note 3 to entry: Accuracy is sometimes understood as closeness of agreement between measured, tracked or predicted quantity values that are being attributed to the measurand.

[SOURCE: ISO/IEC Guide 99:2007, 2.13, modified — The terms "measurement accuracy" and "accuracy of measurement" were deleted, definition was extended for tracked or predicted quantity values and the Notes to entry have been adapted.]

3.4.10

trueness

closeness of agreement between the average of an infinite number of replicated *measured quantity values* (3.4.2), *tracked quantity values* (3.4.3) or *predicted quantity values* (3.4.4) and a reference quantity value

Note 1 to entry: Trueness is not a quantity and thus cannot be expressed numerically, but measures for closeness of agreement are given in the ISO 5725 series.

Note 2 to entry: Trueness is inversely related to systematic error but is not related to random error.

Note 3 to entry: The term *accuracy* (3.4.9) should not be used for trueness.

[SOURCE: ISO/IEC Guide 99:2007, 2.14, modified — The terms "measurement trueness" and "trueness of measurement" were deleted, definition was extended for tracked or predicted quantity values and the Notes to entry have been adapted.]

3.4.11

precision

closeness of agreement between indications or *measured quantity values* (3.4.2), *tracked quantity value* (3.4.3) or *predicted quantity values* (3.4.4) obtained by replicate *measurements* (3.4.5), *tracking* (3.4.6) or *prediction* (3.4.7) on the same or similar measurands under specified conditions

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

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

Note 3 to entry: Precision is used to define measurement, tracking or prediction repeatability, intermediate measurement or prediction precision and measurement, tracking or prediction reproducibility.

Note 4 to entry: Sometimes precision is erroneously used to mean *accuracy* (3.4.9).

Note 5 to entry: Precision is inversely related to random error but is not related to systematic error.

[SOURCE: ISO/IEC Guide 99:2007, 2.15, modified — The term "measurement precision" was deleted, the word "objects" was replaced by "measurands", definition was extended for tracked or predicted quantity values, the Notes to entry have been adapted and Note 5 to entry has been added.]

3.4.12

measurement error

measured quantity value (3.4.2) minus a reference quantity value