

# IDTA 02014-1-0

## Functional safety for safety-relevant devices

18. November 2022

**SPECIFICATION**

Submodel Template of the  
Asset Administration Shell



Submodel Template

**IDTA** approved

- 100% AAS compliant
- Consistent & interoperable
- Released by the AAS experts

# Imprint

## **Publisher**

Industrial Digital Twin Association  
Lyoner Strasse 18  
60528 Frankfurt am Main  
Germany  
<https://www.industrialdigitaltwin.org/>

## Version history

<b>Date</b>	<b>Version</b>	<b>Comment</b>
18.11.2022	1.0	Release of the official Submodel template published by IDTA.

# Contents

1	General .....	6
1.1	About this document .....	6
1.2	Scope of the Submodels.....	6
1.3	Relevant standards for the Submodel template .....	7
1.4	Use cases, requirements, and design decisions .....	7
2	Submodel functional safety for safety-relevant devices .....	8
2.1	Approach.....	8
2.2	Attributes of the Submodel functional safety for safety-relevant devices.....	9
2.3	SubmodelElements of OperatingConditionsOfFunctionalSafetyCharacteristics.....	10
2.4	SubmodelElements of SafetyDeviceTypes .....	12
2.5	SubmodelElements of SafetySubsystem .....	13
2.6	SubmodelElements of ElectronicElement .....	15
2.7	SubmodelElements of ElectromechanicalElement.....	16
2.8	SubmodelElements of InherentlySafeSubsystem .....	17
Annex A.	Explanations on used table formats .....	19
1.	General .....	19
2.	Tables on Submodels and SubmodelElements.....	19
	Bibliography .....	20

# Figures

Figure 1: UML-Diagram for Submodel “functional safety for safety-relevant devices” ..... 8

# Tables

Table 1: Attributes of the Submodel FunctionalSafety .....	9
Table 2: SubmodelElements of OperatingConditionsOfFunctionalSafetyCharacteristics .....	10
Table 3: SubmodelElements of SafetyDeviceTypes .....	12
Table 4: SubmodelElements of SafetySubsystem .....	13
Table 5: SubmodelElements of ElectronicElement .....	15
Table 6: SubmodelElements of ElectromechanicalElement.....	16
Table 7: SubmodelElements of InherentlySafeSubsystem .....	17

# 1 General

## 1.1 About this document

This document is a part of a specification series. Each part specifies the contents of a Submodel template for the Asset Administration Shell (AAS). The AAS is described in [1], [2], [3] and [6]. First exemplary Submodel contents were described in [4], while the actual format of this document was derived by the "Administration Shell in Practice" [5]. The format aims to be very concise, giving only minimal necessary information for applying a Submodel template, while leaving deeper descriptions and specification of concepts, structures and mapping to the respective documents [1] to [6].

The target group of the specification are developers and editors of technical documentation and manufacturer information, which are describing assets in smart manufacturing by means of the Asset Administration Shell (AAS) and therefore need to create a Submodel instance with a hierarchy of SubmodelElements. This document especially details on the question, which SubmodelElements with which semantic identification shall be used for this purpose.

## 1.2 Scope of the Submodels

Engineering tools used for the design of safety control system of machinery and similar control systems need functional safety and reliability data.

The purpose of this Submodel is to define the structure of the engineering data model classes and properties for safety-relevant devices suitable for use in functional safety applications based on VDMA 66413:2012 and other applications.

The intended benefits of this Submodel are to:

- reduce the costs, time and efforts of mapping data for each customer request;
- optimize the workflow of information exchange with engineering tools;
- facilitate the selection of a product, especially regarding safety;
- give access to product data everywhere regardless of country, language and culture.

## 1.3 Relevant standards for the Submodel template

IEC 60947-1:2020, Low-voltage switchgear and controlgear - Part 1: General rules

IEC 61360-1:2017, Standard data element types with associated classification scheme – Part 1: Definitions – Principles and methods

IEC 62683-1 DB, Low-voltage switchgear and controlgear - Product data and properties for information exchange - Part 1: Catalogue data

IEC 61987 DB, Industrial-process measurement and control - Data structures and elements in process equipment catalogues

IEC 61508-2:2010, Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 2: Requirements for electrical/electronic/programmable electronic safety-related systems

IEC 62061:2021, Safety of machinery - Functional safety of safety-related control systems

ISO 13849-1:2015, Safety of machinery – Safety-related parts of control systems – Part 1: General principles for design

VDMA 66413:2012, Functional Safety - Universal data format for safety-related values of components or parts of control system

## 1.4 Use cases, requirements, and design decisions

Application of the relevant standards (1.3) requires the exchange of relevant data between all concerned: machine manufacturers, device manufacturers and calculation tools.

**Device manufacturers** create characteristic value libraries for their devices in “universal data format”. The device manufacturer is the person who manufactures devices and/or components and makes them available to the machine manufacturer or user in the spirit of the free movement of goods. As a result, the creator of a characteristic value library can and indeed may only be the device manufacturer.

**Calculation tool (suppliers)** provide a mechanism for importing characteristic value libraries in database format. The characteristic values are prepared for display and selection within the tool.

**Machine manufacturers** use the characteristic values library (file) provided by the device manufacturer to read and update the characteristic values (device data) within the calculation tool.

[source: VDMA 66413]

## 2 Submodel functional safety for safety-relevant devices

### 2.1 Approach

Figure 1 shows the UML-diagram defining the relevant properties which need to be set.

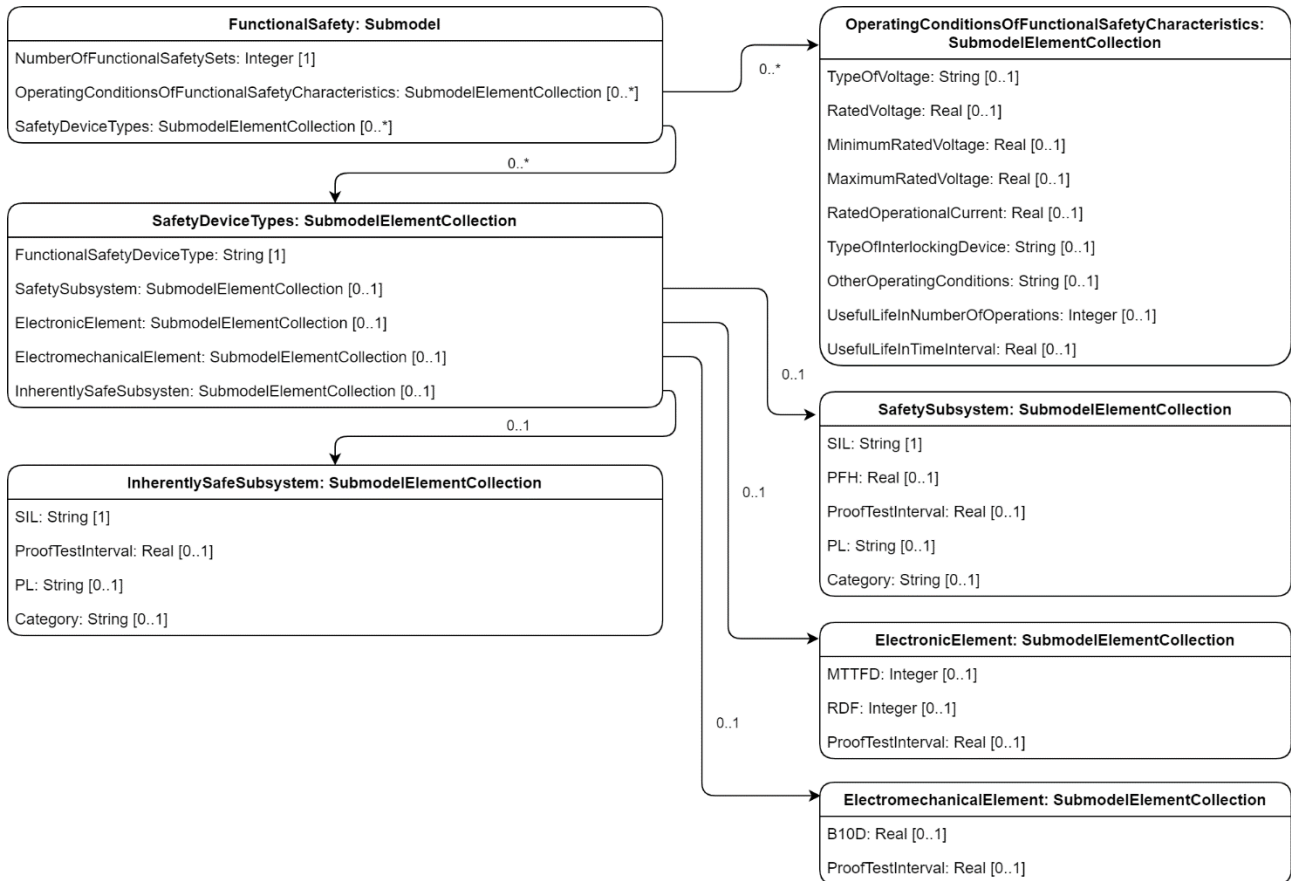


Figure 1: UML-Diagram for Submodel "functional safety for safety-relevant devices"



## 2.2 Attributes of the Submodel functional safety for safety-relevant devices

**Table 1: Attributes of the Submodel FunctionalSafety**

<b>idShort:</b>	FunctionalSafety		
<b>Class:</b>	Submodel (SM)		
<b>semanticId:</b>	[IRDI] 0112/2///62683#ACC007#001		
<b>Parent:</b>	Asset Administration Shell, to which the documents shall be associated to		
<b>Explanation:</b>	The Submodel defines a functional safety data model for devices to be used by engineering tools for the design of safety related control systems according to IEC 62061, IEC 61508-2 or ISO 13849-1 or for dependability analysis of electrotechnical systems. This Submodel is used to facilitate the exchange between computers of data characterizing safety relevant devices in particular. The data models described in this document is based on the definition in the IEC/CDD 62683-1 DB.		
<b>[SME type]</b>	<b>semanticId = [idType]value</b>	<b>[valueType]</b>	<b>card.</b>
<b>idShort</b>	<b>Description@en</b>	<b>example</b>	
[Property]	[IRDI] 0112/2///62683#ACE005#001	[integer]	1
NumberOfFunctionalSafetySets	cardinality property for the number of sets of characteristics of a product for use in functional safety assessment.	1	
[SMC]	[IRDI] 0112/2///62683#ACG057#001	n/a	0..*
OperatingConditionsOfFunctionalSafetyCharacteristics	operating condition limits for which the functional safety characteristics are valid		
[SMC]	[IRDI] 0112/2///62683#ACG070#001	n/a	0..*
SafetyDeviceTypes	selected device type depending on its safety related characteristics and its capability as subsystem or subsystem element		

## 2.3 SubmodelElements of OperatingConditionsOfFunctionalSafetyCharacteristics

**Table 2: SubmodelElements of OperatingConditionsOfFunctionalSafetyCharacteristics**

<b>idShort:</b>	OperatingConditionsOfFunctionalSafetyCharacteristics		
<b>Class:</b>	SubmodelElementCollection (SMC)		
<b>semanticId:</b>	[IRDI] 0112/2///62683#ACG057#001		
<b>Parent:</b>	Submodel FunctionalSafety		
<b>Explanation:</b>	This SubmodelElementCollection contains information on operating condition limits for which the functional safety characteristics are valid.		
<b>[SME type]</b>	<b>semanticId = [idType]value</b>	<b>[valueType]</b>	<b>card.</b>
<b>idShort</b>	<b>Description@en</b>	<b>example</b>	
[Property] TypeOfVoltage	[IRDI] 0112/2///61987#ABA969#007 classification of a power supply according to the time behaviour of the voltage  enumeration: AC (AC, 0112/2///61987#ABL837#001), DC (DC, 0112/2///61987#ABL838#001), others (others, 0112/2///61987#ABI407#004)	[string]  DC	0..1
[Property] RatedVoltage	[IRDI] 0112/2///61987#ABA588#004 operating voltage of the device as defined by the manufacturer and to which certain device properties are referenced	[real]  24 [V]	0..1
[Property] MinimumRatedVoltage	[IRDI] 0112/2///61987#ABD461#004 lowest operating voltage of the device as defined by the manufacturer	[real]  15 [V]	0..1
[Property] MaximumRatedVoltage	[IRDI] 0112/2///61987#ABD462#004 highest operating voltage of the device as defined by the manufacturer	[real]  30 [V]	0..1
[Property] RatedOperationalCurrent	[IRI] <a href="https://admin-shell.io/idta/FunctionalSafety/RatedOperationalCurrent/1/0">https://admin-shell.io/idta/FunctionalSafety/RatedOperationalCurrent/1/0</a> current combined with a rated operational voltage intended to be switched by the device under specified conditions	[real]  300 [mA]	0..1
[Property] TypeOfInterlockingDevice	[IRDI] 0112/2///62683#ACE053#001 classification of device which prevent the hazardous operation of machine, depending on the technology of their actuating means and their output system  enumeration: TYPE1 (type 1, 0112/2///62683#ACH673#001), TYPE2 (type 2, 0112/2///62683#ACH674#001), TYPE3 (type 3, 0112/2///62683#ACH675#001), TYPE4 (type 4, 0112/2///62683#ACH676#001)	[string]  TYPE1	0..1

[Property] OtherOperating Conditions	[IRDI] 0112/2///62683#ACE070#001 other limits of operation related to functional safety characteristics	[string] Duty in number of operations per hour, 50% of normal current	0..1
[Property] UsefulLifeInNum berOfOperations	[IRDI] 0112/2///62683#ACE055#001 under given conditions, the number of operations for which the failure rate becomes unacceptable	[integer] 50,000	0..1
[Property] UsefulLifeInTime Interval	[IRDI] 0112/2///62683#ACE054#001 under given conditions, the time interval beginning at a given instant of time, and ending when the failure rate becomes unacceptable	[real] 10 [y]	0..1

## 2.4 SubmodelElements of SafetyDeviceTypes

**Table 3: SubmodelElements of SafetyDeviceTypes**

<b>idShort:</b>	SafetyDeviceTypes		
<b>Class:</b>	SubmodelElementCollection (SMC)		
<b>semanticId:</b>	[IRDI] 0112/2///62683#ACG070#001		
<b>Parent:</b>	Submodel FunctionalSafety		
<b>Explanation:</b>	This SubmodelElementCollection contains information on the selected device type depending on its safety related characteristics and its capability as subsystem or subsystem element		
<b>[SME type]</b>	<b>semanticId = [idType]value</b>	<b>[valueType]</b>	<b>card.</b>
<b>idShort</b>	<b>Description@en</b>	<b>example</b>	
[Property]	[IRDI] 0112/2///62683#ACE071#001	[string]	1
FunctionalSafety DeviceType	classification of device depending on their safety related characteristics and their capability as subsystem or subsystem element  enumeration: SUBST (safety subsystem, 0112/2///62683#ACH687#001), ELECTROEL (electronic element, 0112/2///62683#ACH688#001), ELECMECEL (electromechanical element, 0112/2///62683#ACH689#001), INTSUBST (inherently safe subsystem, 0112/2///62683#ACH690#001)	INTSUBST	
[SMC]	[IRDI] 0112/2///62683#ACG065#001	n/a	0..1
SafetySubsystem	entity of the top-level architectural design of a safety-related system where a dangerous failure of the subsystem results in dangerous failure of a safety function		
[SMC]	[IRDI] 0112/2///62683#ACG066#001	n/a	0..1
ElectronicElement	selected device type depending on its safety related characteristics and its capability as subsystem or subsystem element		
[SMC]	[IRDI] 0112/2///62683#ACG067#001	n/a	0..1
ElectromechanicalElement	electromechanical element subject to wearing provided with functional safety characteristics		
[SMC]	[IRDI] 0112/2///62683#ACG069#001	n/a	0..1
InherentlySafeSubsystem	subsystem without dangerous failure mode		

## 2.5 SubmodelElements of SafetySubsystem

**Table 4: SubmodelElements of SafetySubsystem**

<b>idShort:</b>	SafetySubsystem		
<b>Class:</b>	SubmodelElementCollection (SMC)		
<b>semanticId:</b>	[IRDI] 0112/2///62683#ACG065#001		
<b>Parent:</b>	SubmodelElementCollection of SafetyDeviceType with FunctionalSafetyDeviceType = SUBST		
<b>Explanation:</b>	This SubmodelElementCollection contains information on safety subsystems, the entity of the top-level architectural design of a safety-related system where a dangerous failure of the subsystem results in dangerous failure of a safety function.		
<b>[SME type]</b>	<b>semanticId = [idType]value</b>	<b>[valueType]</b>	<b>card.</b>
<b>idShort</b>	<b>Description@en</b>	<b>example</b>	
[Property] SIL	[IRDI] 0112/2///62683#ACE051#001  safety integrity level: discrete level (one out of a possible three) for describing the capability to perform a safety function where safety integrity level three has the highest level of safety integrity and safety integrity level one has the lowest  enumeration: SIL1 (SIL 1, 0112/2///62683#ACH670#001), SIL2 (SIL 2, 0112/2///62683#ACH671#001), SIL3 (SIL 3, 0112/2///62683#ACH672#001)	[string]  SIL1	1
[Property] PFH	[IRDI] 0112/2///62683#ACE052#001  probability of dangerous failure within one hour: average frequency of dangerous failure of an SCS to perform a specified safety function over a given period of time  Note 1: Both terms PFH and PFHD correspond to the probability of dangerous failures per hour.  Note 2: The term “average probability of dangerous failure per hour” is not used in this edition anymore but the acronym PFH has been retained but when it is used it means “average frequency of dangerous failure [h]”.	[real]  1.0 x 10 <sup>-8</sup> [1/h]	0..1
[Property] ProofTestInterval	[IRDI] 0112/2///62683#ACE058#001  time interval between test performed to detect dangerous hidden failures in a safety-related system  NOTE The assumption is made that the useful lifetime corresponds to the mission time and proof test interval.	[real]  1.0 [y]	0..1

<p>[Property]</p> <p>PL</p>	<p>[IRDI] 0112/2///62683#ACE060#001</p> <p>performance level: discrete level used to specify the ability of safety-related parts of control systems to perform a safety function under foreseeable conditions</p> <p>enumeration:          PLA (PL a, 0112/2///62683#ACH677#001),          PLB (PL b, 0112/2///62683#ACH678#001),          PLC (PL c, 0112/2///62683#ACH679#001),          PLD (PL d, 0112/2///62683#ACH680#001),          PLE (PL e, 0112/2///62683#ACH681#001)</p>	<p>[string]</p> <p>PLA</p>	<p>0..1</p>
<p>[Property]</p> <p>Category</p>	<p>[IRDI] 0112/2///62683#ACE063#001</p> <p>classification of the safety-related parts of a control system in respect of their resistance to faults and their subsequent behaviour in the fault condition, and which is achieved by the structural arrangement of the parts, fault detection and/or by their reliability</p> <p>enumeration:          CATB (category B, 0112/2///62683#ACH682#001),          CAT1 (category 1, 0112/2///62683#ACH683#001),          CAT2 (category 2, 0112/2///62683#ACH684#001),          CAT3 (category 3, 0112/2///62683#ACH685#001),          CAT4 (category 4, 0112/2///62683#ACH686#001)</p>	<p>[string]</p> <p>CAT1</p>	<p>0..1</p>

## 2.6 SubmodelElements of ElectronicElement

**Table 5: SubmodelElements of ElectronicElement**

<b>idShort:</b>	ElectronicElement		
<b>Class:</b>	SubmodelElementCollection (SMC)		
<b>semanticId:</b>	[IRDI] 0112/2///62683#ACG066#001		
<b>Parent:</b>	SubmodelElementCollection of SafetyDeviceType with FunctionalSafetyDeviceType = ELECTROEL		
<b>Explanation:</b>	This SubmodelElementCollection contains information on electronic elements, elements of electronic technology non evaluated according to a functional safety standard, provided with reliability data and which needs to be integrated specifically into a subsystem.		
<b>[SME type]</b>	<b>semanticId = [idType]value</b>	<b>[valueType]</b>	<b>card.</b>
<b>idShort</b>	<b>Description@en</b>	<b>example</b>	
[Property] MTTFD	[IRDI] 0112/2///62683#ACE057#001 mean time to dangerous failure: expectation of the mean time to dangerous failure	[integer] 10 [y]	0..1
[Property] RDF	[IRI] <a href="https://admin-shell.io/idta/FunctionalSafety/RDF/1/0">https://admin-shell.io/idta/FunctionalSafety/RDF/1/0</a> ratio of the overall failure rate of a device that can lead to a dangerous failure of the safety function	[integer] 50 [%]	0..1
[Property] ProofTestInterval	[IRDI] 0112/2///62683#ACE058#001 time interval between test performed to detect dangerous hidden failures in a safety-related system  NOTE The assumption is made that the useful lifetime corresponds to the mission time and proof test interval.	[real] 1.0 [y]	0..1

## 2.7 SubmodelElements of ElectromechanicalElement

**Table 6: SubmodelElements of ElectromechanicalElement**

<b>idShort:</b>	ElectromechanicalElement		
<b>Class:</b>	SubmodelElementCollection (SMC)		
<b>semanticId:</b>	[[IRDI] 0112/2///62683#ACG067#001		
<b>Parent:</b>	SubmodelElementCollection of SafetyDeviceType with FunctionalSafetyDeviceType = ELECMECEL		
<b>Explanation:</b>	This SubmodelElementCollection contains information on electromechanical elements, electromechanical elements subject to wearing provided with functional safety characteristics.		
<b>[SME type]</b>	<b>semanticId = [idType]value</b>	<b>[valueType]</b>	<b>card.</b>
<b>idShort</b>	<b>Description@en</b>	<b>example</b>	
B10D	[[IRDI] 0112/2///62683#ACE056#001 number of operations until ten percent dangerous failure: mean number of operating cycles at which ten percent of the components fail dangerously	[real] 2.0 x 10 <sup>6</sup>	0..1
[Property] ProofTestInterval	[[IRDI] 0112/2///62683#ACE058#001 time interval between test performed to detect dangerous hidden failures in a safety-related system  NOTE The assumption is made that the useful lifetime corresponds to the mission time and proof test interval.	[real] 1.0 [y]	0..1



## 2.8 SubmodelElements of InherentlySafeSubsystem

**Table 7: SubmodelElements of InherentlySafeSubsystem**

<b>idShort:</b>	InherentlySafeSubsystem		
<b>Class:</b>	SubmodelElementCollection (SMC)		
<b>semanticId:</b>	[IRDI] 0112/2///62683#ACG069#001		
<b>Parent:</b>	SubmodelElementCollection of SafetyDeviceType with FunctionalSafetyDeviceType = INTSUBST		
<b>Explanation:</b>	This SubmodelElementCollection contains information on inherently safe subsystems, subsystem without dangerous failure mode.		
<b>[SME type]</b>	<b>semanticId = [idType]value</b>	<b>[valueType]</b>	<b>card.</b>
<b>idShort</b>	<b>Description@en</b>	<b>example</b>	
[Property]	[IRDI] 0112/2///62683#ACE051#001	[string]	1
SIL	<p>safety integrity level: discrete level (one out of a possible three) for describing the capability to perform a safety function where safety integrity level three has the highest level of safety integrity and safety integrity level one has the lowest</p> <p>enumeration:            SIL1 (SIL 1, 0112/2///62683#ACH670#001),            SIL2 (SIL 2, 0112/2///62683#ACH671#001),            SIL3 (SIL 3, 0112/2///62683#ACH672#001)</p>	SIL1	
[Property]	[IRDI] 0112/2///62683#ACE058#001	[real]	0..1
ProofTestInterval	<p>time interval between test performed to detect dangerous hidden failures in a safety-related system</p> <p>NOTE The assumption is made that the useful lifetime corresponds to the mission time and proof test interval.</p>	1.0 [y]	
[Property]	[IRDI] 0112/2///62683#ACE060#001	[string]	0..1
PL	<p>performance level: discrete level used to specify the ability of safety-related parts of control systems to perform a safety function under foreseeable conditions</p> <p>enumeration:            PLA (PL a, 0112/2///62683#ACH677#001),            PLB (PL b, 0112/2///62683#ACH678#001),            PLC (PL c, 0112/2///62683#ACH679#001),            PLD (PL d, 0112/2///62683#ACH680#001),            PLE (PL e, 0112/2///62683#ACH681#001)</p>	PLA	

<p>[Property]</p> <p>Category</p>	<p>[IRDI] 0112/2///62683#ACE063#001</p> <p>classification of the safety-related parts of a control system in respect of their resistance to faults and their subsequent behaviour in the fault condition, and which is achieved by the structural arrangement of the parts, fault detection and/or by their reliability</p> <p>enumeration: CATB (category B, 0112/2///62683#ACH682#001), CAT1 (category 1, 0112/2///62683#ACH683#001), CAT2 (category 2, 0112/2///62683#ACH684#001), CAT3 (category 3, 0112/2///62683#ACH685#001), CAT4 (category 4, 0112/2///62683#ACH686#001)</p>	<p>[string]</p> <p>CAT1</p>	<p>0..1</p>
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# Annex A. Explanations on used table formats

## 1. General

The used tables in this document try to outline information as concise as possible. They do not convey all information on Submodels and SubmodelElements. For this purpose, the definitive definitions are given by a separate file in form of an AASX file of the Submodel template and its elements.

## 2. Tables on Submodels and SubmodelElements

For clarity and brevity, a set of rules is used for the tables for describing Submodels and SubmodelElements.

- The tables follow in principle the same conventions as in [5].
- The table heads abbreviate 'cardinality' with 'card'.
- The tables often place two information in different rows of the same table cell. In this case, the first information is marked out by sharp brackets [] from the second information. A special case are the semanticIds, which are marked out by the format: (type)(local)[idType]value.
- The types of SubmodelElements are abbreviated:

SME type	SubmodelElement type
Property	Property
MLP	MultiLanguageProperty
Range	Range
File	File
Blob	Blob
Ref	ReferenceElement
Rel	RelationshipElement
SMC	SubmodelElementCollection

- If an idShort ends with '{00}', this indicates a suffix of the respective length (here: 2) of decimal digits, in order to make the idShort unique. A different idShort might be chosen, as long as it is unique in the parent's context.
- The Keys of semanticId in the main section feature only idType and value, such as: [IRI]https://admin-shell.io/vdi/2770/1/0/DocumentId/Id. The attributes "type" and "local" (typically "ConceptDescription" and "(local)" or "GlobalReference" and (non-local)) need to be set accordingly; see [6].
- If a table does not contain a column with "parent" heading, all represented attributes share the same parent. This parent is denoted in the head of the table.
- Multi-language strings are represented by the text value, followed by '@'-character and the ISO 639 language code: example@EN.
- The [valueType] is only given for Properties.

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