SPECIFICATION

Submodel Safety Function

Version 1.1

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Submodel Template of the

Asset Adminstration Shell

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Version history

2023-November-28	V 1.1	Changes according to the Interopera Project Supervision Team
2023-August-31	V 1.0	Hand in of the specification for approval
2023-August-11	V 0.3	Draft Version for final discussion
2023-July-27	V 0.2	Internal Discussion Release of the Submodel template
2023-June-21	V 0.1	Initial Version

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Foreword

This is a submodel for the Asset Administration Shell. It concerns the technical description of safety functions of production machines and is supposed to support the reconfiguration of production resources during the entire period of use.

It was developed in the year 2023 by a group consisting of component vendors, researchers, and the Ferdinand-Steinbeis-Institute. This working group has discussed and created the results under guidance from the Interopera project group.

We would like to thank the people who participated in the working group and who contributed to the results that have been accomplished. The participants were:

- Philip Kleen, Fraunhofer IOSB-INA
- Prof. Dr. Busboom, Hochschule München
- Manuel Ungermann, PHOENIX CONTACT Deutschland GmbH
- Werner Steck, Ferdinand-Steinbeis-Institute

The project was supervised by Olga Mayer and Dachuan Shi of Fraunhofer IPA.

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 [1-3] 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 [1-6].

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 Submodel

This Submodel template aims at interoperable provision of information describing safety functions of production machines in regard to the asset of the respective Asset Administration Shell. Central element is the provision of properties [7], ideally interoperable by the means of dictionaries such as ECLASS and IEC CDD (Common Data Dictionary). The purpose of this document is to make selected specifications of Submodels in such manner that information about assets can be exchanged in a meaningful way between partners in a value creation network. It targets the technical description and documentation of required and available safety functions of a machine or component to enable machine reconfiguration along the life cycle.

The intended use-case is the provision of a standardized property structure for safety functions, which enables a common definition of the aforementioned properties and the reduction of search and transaction costs during reconfiguration. Also, it will provide the data basis for an automated risk assessment during reconfiguration of the shop floor.

This concept can serve as a basis for standardizing the respective Submodel. The conception is based on existing norms, studies of common practices at enterprises, directives, tools and standards so that a far-reaching acceptance can be achieved.

1.3 Relevant standards and sources of concepts for the Submodel template

According to [3], interoperable properties might be defined by standards, consortium specifications or manufacturer specifications. Useful standards providing sources of concepts are:

Table 1: List of examplary standards defining interoperable properties

IDTA Submodel „Functional Safety“	ECLASS
DIN EN ISO 12 100	DIN EN ISO 13 850
DIN EN ISO 14 119	DIN EN ISO 13 851

DIN EN ISO 13 128	DIN EN IEC 61508
DIN EN ISO 13 849	DIN EN IEC 62061

The safety functions are modelled according to the logic in SISTEMA.

So called property dictionaries are used identify information elements (see Terms and Definitions of [6]). Such property dictionaries include:

- ECLASS, see: https://www.eclasscontent.com/
- IEC CDD, see: https://cdd.iec.ch/cdd/iec61987/iec61987.nsf and https://cdd.iec.ch/cdd/iec62683/cdddev.nsf

In this document, properties are aimed to be described by ECLASS.

2 Information set for Submodel Contact Information

Use and economic relevance

Use Case Description according to DIN EN IEC 62559-2:

2.1.1 Name of Use Case

ID	01
Area	Reconfiguration of Machinery in Production Environments
Name	Asset Administration Shell (AAS) Template for the description of Safety Functions of a machine in a production environment

2.1.2 Scope of Application and Objectives

Scope of Application)	Safety features of machinery should be recordable in an Asset Admnistration Shell Template, which in the future could potentially simplify the reconfiguration of machinery in production by making data required for safe operation available in a standardized format.
Objectives	- Identification of possible safety features of machines and their components - Definition and selection of the safety features required for the use case - Development of an AAS (Asset Administration Shell) template to capture the safety features of machines and their components - Creation of a data basis for tools that support automated reconfiguration and risk assessment - Implementation of an example
Related Business Cases	- Process planning, production scheduling - Maintenance of machinery - Reconfiguration during relocation or replacement of plant components - Production - Engineering of production machinery

2.1.3 Description

Short Description
In the use case, the objective is to record the necessary information about the safety of a machine or machine component in an Asset Administration Shell (AAS) template, which is required in the event of a machine reconfiguration. This is to ensure the correct functioning of the required safety functions. A uniform definition in the standardized AAS later allows for the automated reading of information across different manufacturers and machines, thereby speeding up the assessment of current safety as well as the potential for recombination options.
Long Deskription
Contemporary productions in industrial companies often need to be adjusted to the current framework conditions. Over time, resources are altered and reconfigured to respond to changes in the goods being manufactured. It can occur that machines or machine components are reassembled for purposes and in combinations that were not originally envisaged by the manufacturer.

In the case of machine reconfiguration, a manual risk assessment must always be conducted, and it must be ensured that the new machine configurations do not pose a hazard to the employees.

Therefore, the goal of the project is to include details of the safety functions of machines and their components in an Asset Administration Shell Template, so that a data foundation is created that can be used for reconfiguration and risk assessment.

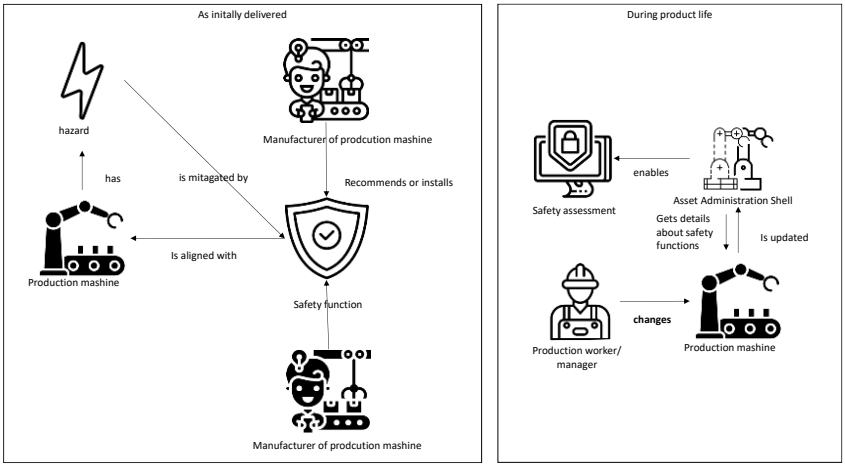

Figure 1: Depiction of Use Case „Safety Functions“

The figure shows how a machine is delivered by the manufacturer - with certain safety functions. On the right part, it can be seen how the AAS can be used as a basis for hazard assessment in the event of a change to the machine.

2.1.4 Stakeholders

Name of Stakeholder	**Type of Stakeholder**	**Description Stakeholder**	**Utility of the AAS within the Use Case**
Manufacturer of Machinery and Components	Enterprise/ Business	Industrial companies that manufacture machines or their components must create the AAS, populate it with data, and deliver it.	- Provision of additional information about the machine in the form of the AAS as a competitive advantage and unique selling point. - Later cross-selling or upselling is simplified for the manufacturer themselves. - Obligations for documentation are fulfilled. - In cases where a plant component can only be operated safely in conjunction with other components, this can be documented. - Reduction of efforts in the manufacturer's

			customer service when inquiries about safety functions occur, since these can be answered by themselves or more quickly with the uniform data storage. - Image benefit, as the company's commitment to safety and innovation strength becomes apparent.
Production Management	Enterprise/ Business	Industrial companies that want to recombine their machines will use the information from the AAS (Asset Administration Shell).	- Finding relevant information is simplified (no need to search for documentation). - Information about the machine is always located in the same place - time-stable and long-term. - Possible to refer to the manufacturer's specifications when considering reconfiguration. - Can be supported by software tools that build on the data stored in the AAS.
Production Worker/ Employee	Person/ Individual	The production employees are to be protected by the safety functions. Operation and maintenance should be safe for them.	- In situations of uncertainty, production employees can also obtain information on the safety functions, which increases their perceived safety. - For maintenance, knowledge and modification of safety functions (e.g., during maintenance) can be vital.
Solution Provider)	Business/ Enterprise	Solution providers will offer software solutions based on the data from the AAS that enable automatic	- Standardized data foundation for the software solutions.

		reconfiguration of machines or automatic hazard assessment.	- Data foundation is digitally available. - History can be useful to guide users better through the process.

2.2 Relationship to the existing IDTA Submodel „Functional Safety“

The existing submodel “functional safety” is dealing with the performance of single components, focusing for example on the reliability of parts of a machine. This submodel instead looks at how different machines need to work together to ensure the required safety. It focuses on documenting different states over time, which will represent the current configuration of any machine at a given point in time.

3 Submodel and Collections

3.1 Overview of the Submodel “SafetyFunction”

The figure below shows the UML-diagram defining the relevant properties which need to be set. Figure 1 describes the details of the Submodel structure combined with examples.

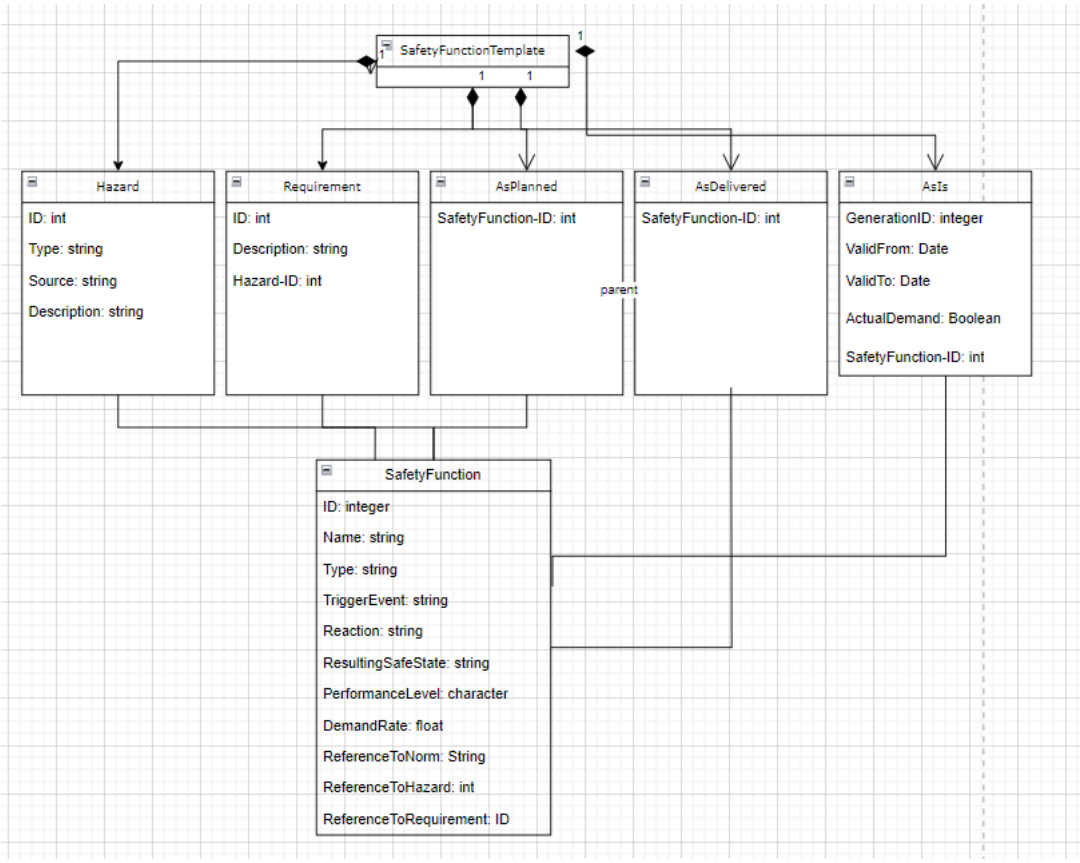

Figure 1: UML-Diagram for Submodel "SafetyFunction" - Overview

Table 2: Properties of Submodel “SafetyFunction"

idShort	SafetyFunctionTemplate *Note: the above idShort shall always be as stated.*		
Class	Submodel		
semanticId	---		
Parent	---		
Explanation	The Submodel “SafetyFunction” is the collection for various properties of safety functions of production machines, including the requirements, different states, and dependencies.		
[SME type]	**semanticId = [idType]value**	**[valueType]**	**card.**
idShort	**Description@en**	**example**	

3.2 Properties of the SMC “Hazard”

The following table describes the details of the SMC structure combined with examples.

idShort	SafetyFunctionTemplate.Hazard *Note: the above idShort shall always be as stated.*		
Class	SubmodelElementCollection		
semanticId	--		
isCaseOf	--		
AllowDuplicates	False		
Parent	SafetyFunctionTemplate		
Explanation	The Submodel Collection “Hazard” is the collection for various hazards that could occur while using a machine.		
[SME type]	**semanticity = [idType]value**	**[valueType]**	**card.**
idShort	**Description@en**	**example**	
ID [integer]	Unique identifier for the hazard	1	1:n
Type [string]	Hazard Type	Electrical	1:n
Source [string]	Source of the hazard	Energized parts	1:n
Description [string]	Textual description of the hazard	Electrical shock	1:n

3.3 Properties of the SMC “Requirement”

The following table describes the details of the SMC structure combined with examples.

Table 3: Properties of SMC "Requirement"

idShort	SafetyFunctionTemplate.Requirement *Note: the above idShort shall always be as stated.*
Class	SubmodelElementCollection
semanticId	--
isCaseOf	--
AllowDuplicates	False
Parent	SafetyFunctionTemplate

Explanation	The Submodel Collection “Requirement” is the collection for various requirements that need to be fulfilled to address the hazards.		
[SME type]	**semanticity = [idType]value**	**[valueType]**	**card.**
idShort	**Description@en**	**example**	
ID [integer]	ID of the requirement to enhance safety	1	1:n
Description [string]	Textual description of the requirement	In order to address hazard of hurting people, the machine needs to stop within 0.1 ms as soon as it detects the missing pressure on the control button.	1:n
HazardID [integer]	Foreign key that links to the ID of the hazard	5	

3.4 Properties of the SMC “AsPlanned”

The figure below shows the UML-diagram defining the relevant properties which need to be set. The table below describes the details of the submodel structure combined with examples.

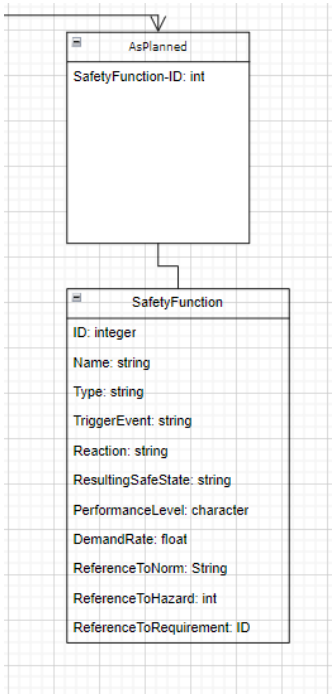

Figure 2: UML-Diagram for SMC "AsPlanned"

Table 4: Properties of SMC “AsPlanned"

idShort	SafetyFunctionTemplate.AsPlanned *Note: the above idShort shall always be as stated.*		
Class	SubmodelElementCollection		
semanticId	AsPlanned		
Parent	SafetyFunctionTemplate		
Explanation	The Submodel Collection “AsPlanned” is the collection for the safety function properties that were planned by the manufacturer.		
[SME type]	**semanticId = [idType]value**	**[valueType]**	**card.**
idShort	**Description@en**	**example**	
[SMC] SafetyFunction	SubCollection for each safety funtion	Safety Function 3	1:n
Name [string]	Description of the safety function	Two-hand-control	1:1
ID [integer]	ID to identify the safety function	8	1:1
Type [string]	Type of safety function	Safe Stop	1:1
TriggerEvent [string]	What causes the safety function to activate?	One of the buttons that are supposed to be pressed by the user, is released during active usage.	1:1
Reaction [string]	Description of the expected reaction to the trigger event	Stop the actuator 123 of the saw	1:1
ResultingSafeState [String]	Description of the resulting safe state	Actuator 123 stopped	1:1
PerformanceLevel [Character]	Describes the Performance Level of the Safety Function according to the respective standard	a	1:1
DemandRate [float]	Demand Rate per hour	20	1:1
ReferenceToNorm [string]	Reference to the respective norm or standard	ISO 12100:2011-03	1:1
ReferenceToRequire-ments [integer]	Reference to the requirement that is adressed	7	1:1

ReferenceToHazard [integer]	Reference to the hazard that is adressed	5	1:1

3.5 Properties of the SMC “AsDelivered”

The figure below shows the UML-diagram defining the relevant properties which need to be set. Table 5**Fehler! Verweisquelle konnte nicht gefunden werden.** describes the details of the Submodel structure combined with examples.

Table 5: Properties of SMC “AsDelivered"

idShort	SafetyFunctionTemplate.AsDelivered *Note: the above idShort shall always be as stated.*		
Class	Submodel		
semanticId	AsDelivered		
Parent	SafetyFunctionTemplate		
Explanation	The Submodel Collection “AsDelivered” describes the safety functions of the asset at the state of delivery.		
[SME type]	**semanticId = [idType]value**	**[valueType]**	**card.**
idShort	**Description@en**	**example**	
See AsPlanned, identical structure.			

3.6 Properties of the SMC “AsIs”

The figure below shows the UML-diagram defining the relevant properties which need to be set. Table 6 describes the details of the Submodel structure combined with examples.

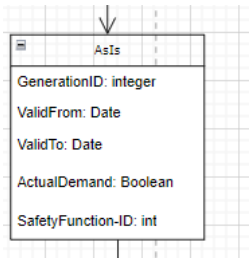

Figure 3: UML-Diagram for SMC "AsIs"

Table 6: Properties of SMC “AsIs"

idShort	SafetyFunctionTemplate.AsIs *Note: the above idShort shall always be as stated.*
Class	Submodel
semanticId	AsIs

Parent	SafetyFunctionTemplate		
Explanation	The Submodel Collection “AsIs” is the collection for the current safety functions.		
[SME type]	**semanticId = [idType]value**	**[valueType]**	**card.**
idShort	**Description@en**	**example**	
Identical to the structure in “AsPlanned”			
GenerationID [integer}	Identifies the generation of the configuration	1	1:n
ValidFrom [date]	Validity of the current information about the safety function	03/15/2023	1:n
ValidTo [date]	Validity of the current information about the safety function	08/30/2023	1:n
ActualDemand [boolean]	Current demand of the safety function – is it in use or not	True	1:n

Annex A: Explanations on used table formats

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.

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 informations in different rows of the same table cell. In this case, the first information is marked out by sharp brackets [] form 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

SME type Submodel	**Element 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 choosen, 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 (no-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@de.
- The [valueType] is only given for Properties.

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