

# Modelling of Sensor Devices with <AutomationML />



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**BALLUFF**

 *innovating automation*

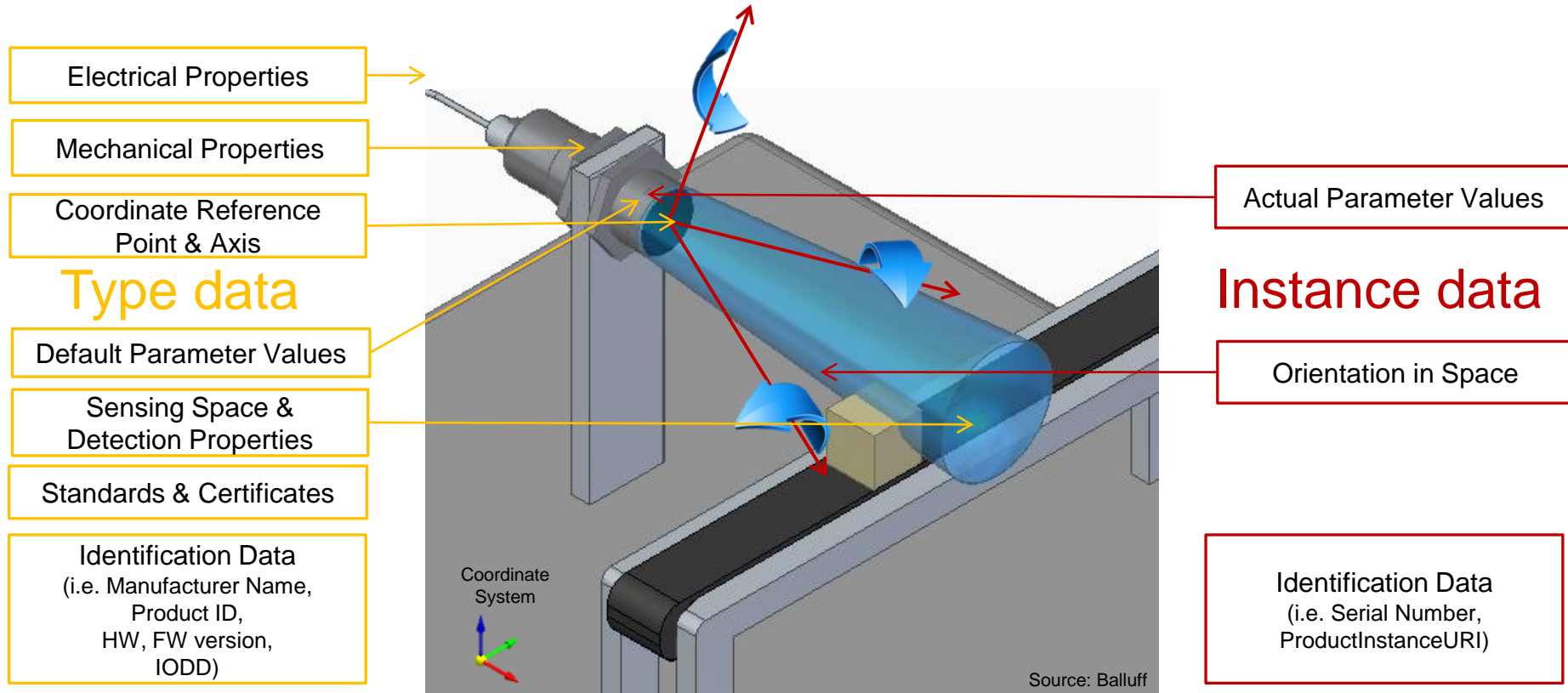
HS PF 

# AGENDA

- Sensor Model Properties
- ZVEI Working Group “Industrie 4.0 in der Sensorik“
- Sensor Standards
- Semantic Referencing with eCI@ss and IEC-CDD
- Why AutomationML
- AutomationML Library for Industrial Sensors

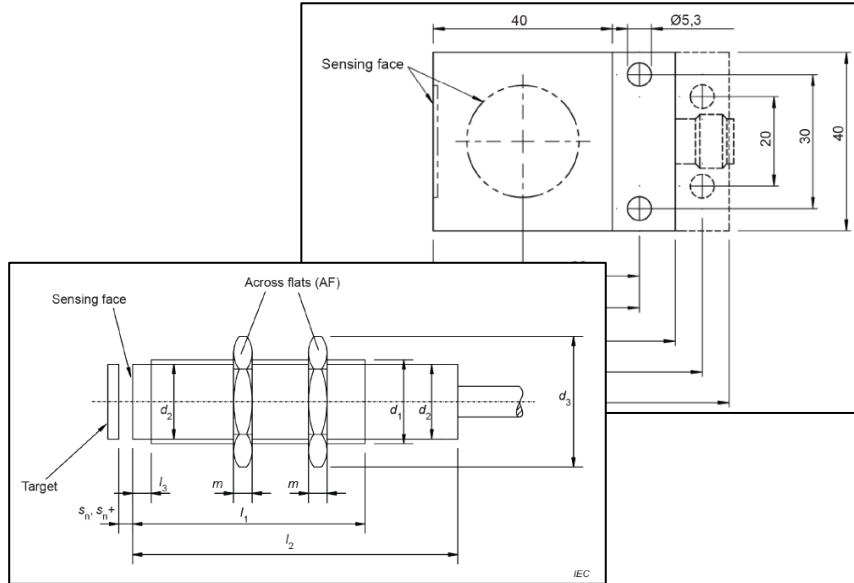


# TYPICAL SENSOR MODEL PROPERTIES



# SENSOR STANDARDS

The IEC 60947-5 standard series defines industrial proximity switches for different housing forms and detection technologies.



Source: <https://webstore.ansi.org/>

# IEC 60947-5-2: PROXIMITY SWITCHES

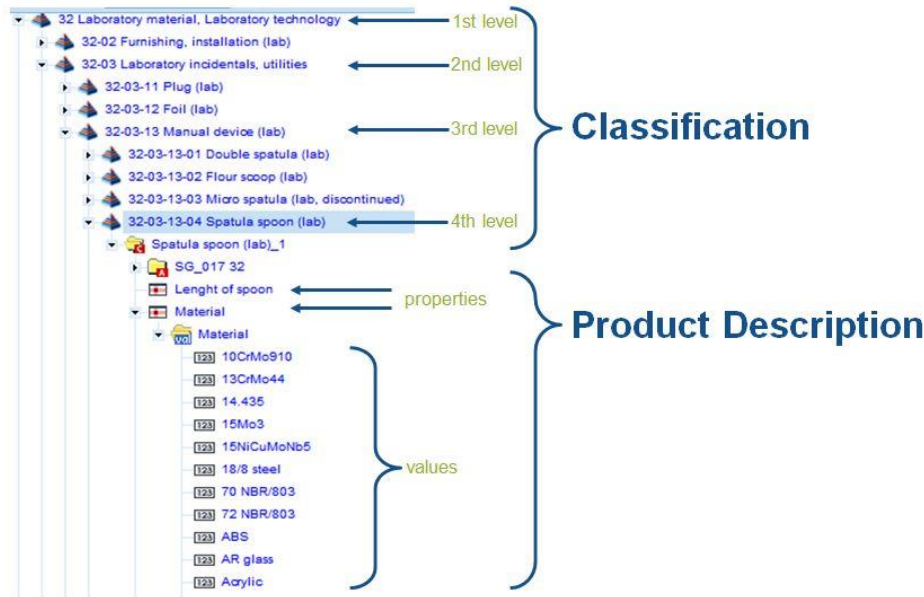
Table 1 – Classification of proximity switches

1 <sup>st</sup> pos./1 digit	2 <sup>nd</sup> pos./1 digit	3 <sup>rd</sup> pos./3 digits	4 <sup>th</sup> pos./1 digit	5 <sup>th</sup> pos./1 digit
SENSING MEANS	MECHANICAL INSTALLATION	CONSTRUCTION FORM AND SIZE	SWITCHING ELEMENT FUNCTION (OUTPUT)	TERMINALS
4.2	4.3	4.4		
I = inductive C = capacitive U = ultrasonic D = diffuse reflective photoelectric M = non-mechanical magnetic R = retroreflective photoelectric T = through-beam photoelectric	1 = embeddable 2 = non-embeddable 3 = either	FORM (1 capital letter) A = cylindrical threaded base B = cylindrical base C = cylindrical base (others) D = cylindrical base or side length	A = other other	integral leads 2 = plug-in 3 = screw 9 = other 4 terminal DC D = 2 terminal DC F = 2 terminal AC U = 2 terminal AC or DC S = other
		A30 Cylindrical threaded ∅ 30 mm	A NO (make) function	D 2 terminal DC Plug in

The IEC standards provide the reference data for the industries. But the documents are only available in PDF format, thus not really machine-readable for an Industry 4.0 engineering toolchain.

Source: IEC 60947-5-2

# SEMANTIC REFERENCING



Source: <http://wiki.eclass.eu>

Home > Issue 08/2016 > IEC World > Digital data exchange to be streamlined

## Digital data exchange to be streamlined

International Cooperation Agreement signed between the IEC and eCI@ss e. V.

By Janice Blondeau

The harmonization of standards in electrical engineering and electronics means a breakthrough for digital data exchange.



The agreement aims to facilitate the automatic transfer of shared content between the IEC Common Data Dictionaries (CDD) and eCI@ss dictionaries

Source: <https://iecetech.org/issue/2016-08/Digital-data-exchange-to-be-streamlined>

# WHY AUTOMATIONML ?

<b>Identification</b>	<b>0112/2///62683#ACC011</b>	
Global Trade Item Number (GTIN)	0112/2///62683#ACE101	0173-1#02-AAO663#003
manufacturer name	0112/2///62683#ACE102	0173-1#02-AAO677#002
manufacturer product number	0112/2///62683#ACE103	0173-1#02-AAO676#003
product family	0112/2///62683#ACE104	0173-1#02-AAU731#001
product name	0112/2///62683#ACE105	0173-1#02-AAW338#001
supplier name	0112/2///62683#ACE106	0173-1#02-AAO735#003
supplier product number	0112/2///62683#ACE107	0173-1#02-AAO736#004
product online information URL	0112/2///62683#ACE108	0173-1#02-AAQ326#002
customs tariff number	0112/2///62683#ACE109	0173-1#02-AAD931#005
<b>Installation, mounting and dimensions</b>	<b>0112/2///62683#ACG121</b>	
width of the device	0112/2///62683#ACE802	0173-1#02-BAD823#004
height of the device	0112/2///62683#ACE801	0173-1#02-BAD849#004
length of the device	0112/2///62683#ACE803	0173-1#02-BAD856#005
diameter of the device	0112/2///62683#ACE810	0173-1#02-BAD826#005
mounting position of the sensor	0112/2///62683#ACE811	0173-1#02-BAD866#007
housing construction	0112/2///62683#ACE813	0173-1#02-BAD840#007
<b>Connection facilities</b>	<b>0112/2///62683#ACG124</b>	
electrical connection of the sensor	0112/2///62683#ACE856	0173-1#02-BAD831#011
cable length	0112/2///62683#ACE857	0173-1#02-AAF309#003
rated cross-section	0112/2///62683#ACE862	
cable sheath material	0112/2///62683#ACE859	0173-1#02-AAD251#007

An Excel Sheet is not really suitable for modelling and data exchange on an industrial scale...

Some standardized exchange format is required that can transport this information

# SEMANTIC REFERENCING IN AUTOMATIONML

```

<Attribute Name=„Locally unique name" AttributeDataType="xs:anyType" Unit=„some text (optional)">
  <Description>Some descriptive text (optional)</Description>
  <DefaultValue>Some default value (optional)</DefaultValue>
  <Value>Some actual value (optional)</Value>
  <RefSemantic CorrespondingAttributePath=„Some semantic reference (optional)"/>
</Attribute>

```

## Examples:

```

<Attribute Name=„Degree of Protection" AttributeDataType="xs:string" Unit=„Code"
  <Value>IP67</Value>
  <RefSemantic CorrespondingAttributePath=„IRDI:0112/2///62683#AAH011" />
  <RefSemantic CorrespondingAttributePath=„IRDI:0173-1#02-BAG975#011" />
</Attribute>

```

IEC CDD

eCl@ss

```

<Attribute Name="Maximum operating ambient temperature" AttributeDataType="xs:integer" Unit="°C"
  <Value>55</Value>
  <RefSemantic CorrespondingAttributePath=„IRDI:0112/2///62683#ACE440" />
  <RefSemantic CorrespondingAttributePath=„IRDI:0173-1#02-AAS155#001" />
</Attribute>

```



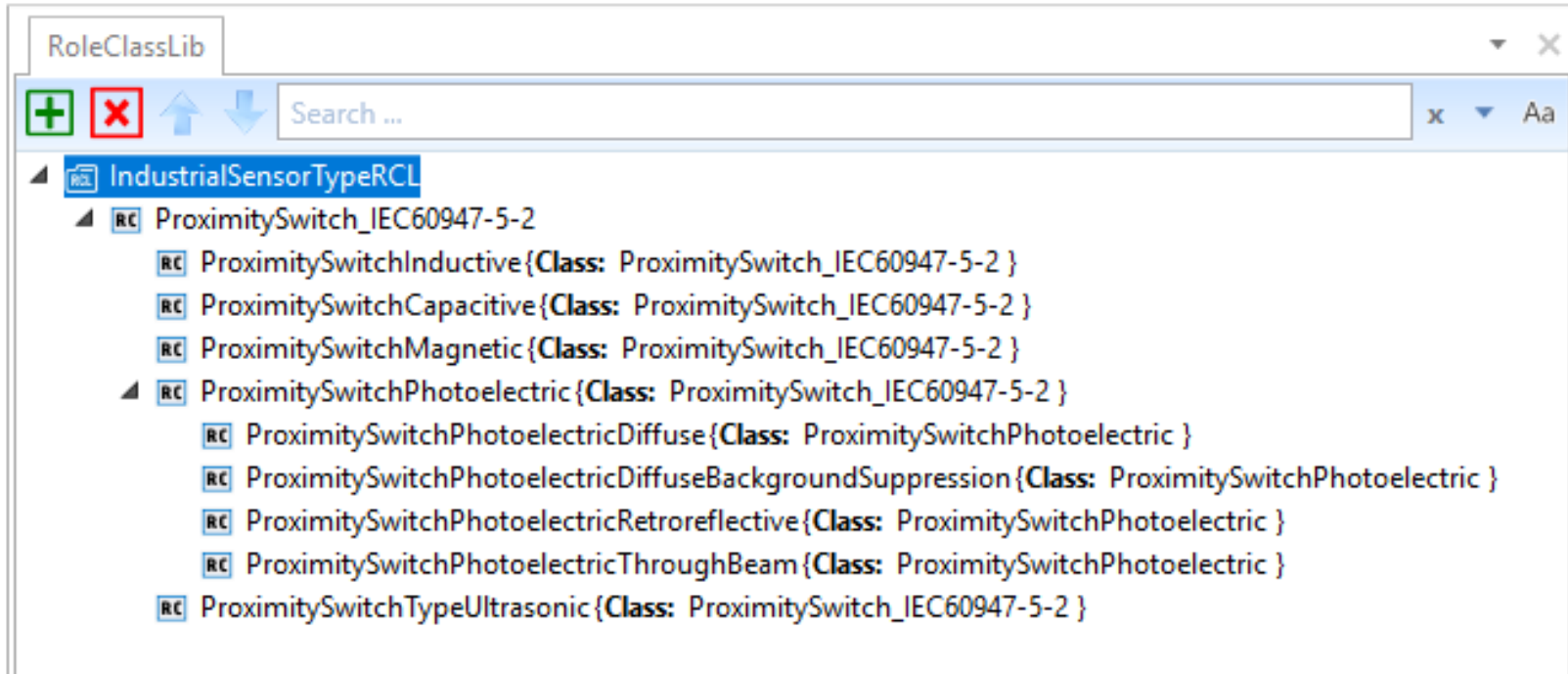
# INDUSTRIAL SENSOR LIBRARY IN AUTOMATIONML

```

<RoleClass Name="ProximitySwitch_IEC60947-5-2" RefBaseClassPath="AutomationMLBaseRoleClassLib/AutomationMLBaseRole">
  <Description>This role class provides standard classification attributes for proximity switches according to IEC
  60947-5-2, which applies to inductive and capacitive proximity switches that sense the presence of metallic
  and/or non-metallic objects, ultrasonic proximity switches that sense the presence of metallic objects,
  photoelectric proximity switches that sense the presence of objects with a magnetic field, and magnetic
  switches that sense the presence of objects with a magnetic field.
  </Description>
  <Attribute Name="SemanticSystems" AttributeDataType="xs:string" ListType="List">
    <Description>Defines the semantic systems in use.</Description>
    <RefSemantic CorrespondingAttributePath="ListType" />
  </Attribute>
  <Attribute Name="IEC62683" AttributeDataType="xs:string">
    <Description>IEC 62683 - SC 3D / SC 17B - Common Data Dictionary</Description>
    <Value>IEC 62683 - SC 3D / SC 17B - Common Data Dictionary</Value>
  </Attribute>
  <Attribute Name="Version" AttributeDataType="xs:string">
    <Value>2.0014.0016</Value>
  </Attribute>
  <Attribute Name="RefSemanticPrefix" AttributeDataType="xs:string">
    <Value>IRDI:0112/2///62683#</Value>
  </Attribute>
  <Attribute Name="URL" AttributeDataType="xs:string">
    <Value>https://cdd.iec.ch/cdd/iec62683/iec62683.nsf</Value>
  </Attribute>
  <Attribute Name="eClass" AttributeDataType="xs:string">
    <Description>IEC 62683 - SC 3D / SC 17B - Common Data Dictionary</Description>
    <RefSemantic CorrespondingAttributePath="ListType" />
  </Attribute>
  <Attribute Name="Version" AttributeDataType="xs:string">
    <Value>10.1</Value>
  </Attribute>
  <Attribute Name="RefSemanticPrefix" AttributeDataType="xs:string">
    <Value>IRDI:0173</Value>
  </Attribute>
  <Attribute Name="URL" AttributeDataType="xs:string">
    <Value>https://www.eclasscontent.com</Value>
  </Attribute>
  </Attribute>
  <Attribute Name="Identification" AttributeDataType="xs:string">
    <Description>Information necessary for unambiguous identification of the device</Description>
  </Attribute>
  <Attribute Name="GTIN" AttributeDataType="xs:string">
    <Description>Global Trade Item Number (GTIN). International unique and universal item
    number for products and services used by trade and industry (formerly EAN)</Description>
  </Attribute>
  <Attribute Name="Manufacturer" AttributeDataType="xs:string">
    <Description>Name of the Manufacturer (person, company or organisation)</Description>
  </Attribute>
  <Attribute Name="DeviceClass" AttributeDataType="xs:string">
    <Description>Product family name of the manufacturer, characterization may be based on its
    usage, operation principle, and its fabricated form</Description>
  </Attribute>
  <Attribute Name="Model" AttributeDataType="xs:string">
    <Description>Product name or model code of the manufacturer</Description>
  </Attribute>
  <Attribute Name="ProductCode" AttributeDataType="xs:string">
    <Description>Unique product identifier given by the manufacturer</Description>
  </Attribute>
  <Attribute Name="ProductURI" AttributeDataType="xs:string">
    <Description>Online information URL to the product data.</Description>
  </Attribute>

```

# INDUSTRIAL SENSOR LIBRARY IN AUTOMATIONML



The screenshot shows the RoleClassLib application window. The title bar reads "RoleClassLib". Below the title bar is a toolbar with icons for adding (+), deleting (X), and navigating (up/down arrows), along with a search bar containing the text "Search ...". The main area displays a tree view of the class hierarchy:

- IndustrialSensorTypeRCL
  - ProximitySwitch\_IEC60947-5-2
    - ProximitySwitchInductive{Class: ProximitySwitch\_IEC60947-5-2 }
    - ProximitySwitchCapacitive{Class: ProximitySwitch\_IEC60947-5-2 }
    - ProximitySwitchMagnetic{Class: ProximitySwitch\_IEC60947-5-2 }
  - ProximitySwitchPhotoelectric{Class: ProximitySwitch\_IEC60947-5-2 }
    - ProximitySwitchPhotoelectricDiffuse{Class: ProximitySwitchPhotoelectric }
    - ProximitySwitchPhotoelectricDiffuseBackgroundSuppression{Class: ProximitySwitchPhotoelectric }
    - ProximitySwitchPhotoelectricRetroreflective{Class: ProximitySwitchPhotoelectric }
    - ProximitySwitchPhotoelectricThroughBeam{Class: ProximitySwitchPhotoelectric }
  - ProximitySwitchTypeUltrasonic{Class: ProximitySwitch\_IEC60947-5-2 }

Published at [automationml.org](http://automationml.org)

# ATTRIBUTE-GROUP: SEMANTIC SYSTEMS

- ▲ <A> 1 SemanticSystems
  - ▷ <A> IEC62683
    - ▷ <A> eCI@ss
  - ▷ <A> 1 Identification
  - ▷ <A> 1 InstallationMountingDimensions
  - ▷ <A> 1 GeneralTechnicalData
  - ▷ <A> 1 ControlAndAuxiliaryCircuits
  - ▷ <A> 1 ConnectionFacilities
  - ▷ <A> 1 ProductCertificatesAndStandards

Name	Semantic	Value
▲ SemanticSystems	ListType	
▲ IEC62683		
..... ClassificationSystem		IEC 62683 - SC 3D / SC 17B - Common Data Dictionary
..... Version		2.0014.0016
..... RefSemanticPrefix		IRD!0112/2///62683#
..... URL		<a href="https://cdd.iec.ch/cdd/iec62683/iec62683.nsf">https://cdd.iec.ch/cdd/iec62683/iec62683.nsf</a>
▲ eCI@ss		
..... ClassificationSystem		eCI@ss
..... Version		10.1
..... RefSemanticPrefix		IRD!0173
..... URL		<a href="https://www.eclasscontent.com">https://www.eclasscontent.com</a>

# ATTRIBUTE-GROUP: INSTALLATION & MOUNTING DIMENSIONS

- ▷ <A> SemanticSystems
- ▷ <A> Identification
- ▲ <A> **InstallationMountingDimensions**
  - <A> Height
  - <A> Width
  - <A> Length
  - <A> Diameter
  - <A> Mounting Position
  - <A> Housing Construction
- ▷ <A> GeneralTechnicalData
- ▷ <A> ControlAndAuxiliaryCircuits
- ▷ <A> ConnectionFacilities
- ▷ <A> ProductCertificatesAndStandards

InstallationMountingDimensions	IRDI:0112/2///62683#ACG121#001		Empty
..... Height	IRDI:0112/2///62683#ACE801#001	mm	xs:integer
	IRDI:0173-1#02-BAD849#004		
..... Width	IRDI:0112/2///62683#ACE802#001	mm	xs:integer
	IRDI:0173-1#02-BAD823#004		
..... Length	IRDI:0112/2///62683#ACE803#001	mm	xs:integer
	IRDI:0173-1#02-BAD856#005		
..... Diameter	IRDI:0112/2///62683#ACE810#001	mm	xs:integer
	IRDI:0173-1#02-BAD826#005		
..... Mounting Position	IRDI:0112/2///62683#ACE810#001	code	xs:string
	IRDI:0173-1#02-BAD866#007		
..... Housing Construction	IRDI:0112/2///62683#ACE813#001	code	xs:string
	IRDI:0173-1#02-BAD840#007		

# ATTRIBUTE-GROUP: GENERAL TECHNICAL DATA

- ▷ <A> SemanticSystems
- ▷ <A> Identification
- ▷ <A> InstallationMountingDimensions
- ▲ <A> **GeneralTechnicalData**
  - <A> Rated Operating Distance
  - <A> Effective Operating Distance
  - <A> Switching Element Function
  - <A> Switch Frequency
  - <A> Kind of Current
  - <A> Type of Sensor Output
  - <A> Number of Wiring Terminals
  - <A> IP Code
  - <A> Ambient Temperature
  - <A> Electric Shock Protection Class
  - <A> Housing Material
  - <A> Sensing Face Material
  - <A> Additional Functions
- ▷ <A> ControlAndAuxiliaryCircuits
- ▷ <A> ConnectionFacilities
- ▷ <A> ProductCertificatesAndStandards

GeneralTechnicalData	IRDI:0112/2///62683#ACG122#001		Empty
Rated Operating Distance	IRDI:0112/2///62683#ACE251#001	mm	xs:float
	IRDI:0173-1#02-BAD815#006		
Effective Operating Distance	IRDI:0112/2///62683#ACE250#001	mm	xs:float
Switching Element Function	IRDI:0112/2///62683#ACE253#001	code	xs:string
Switch Frequency	IRDI:0173-1#02-BAD898#004	Hz	xs:float
Kind of Current	IRDI:0112/2///62683#ACE601#001	code	xs:string
Type of Sensor Output	IRDI:0112/2///62683#ACE254#001	code	xs:string
	IRDI:0173-1#02-BAD898#005		
Number of Wiring Terminals	IRDI:0112/2///62683#ACE877#001	code	xs:string
IP Code	IRDI:0112/2///62683#ACE218#001	code	xs:string
	IRDI:0173-1#02-BAG975#011		
Ambient Temperature	IRDI:0112/2///62683#ACE440#001	°C	xs:string
	IRDI:0173-1#02-BAS155#002		
	IRDI:0173-1#02-AAS180#002		
Electric Shock Protection Class	IRDI:0112/2///62683#ACE239#001	code	xs:string
	IRDI:0173-1#02-BAD781#006		
Housing Material	IRDI:0112/2///62683#ACE260#001	code	xs:string
	IRDI:0173-1#02-BAC461#012		
Sensing Face Material	IRDI:0112/2///62683#ACE261#001	code	xs:string
	IRDI:0173-1#02-BAD946#007		
Additional Functions	IRDI:0112/2///62683#ACE256#001		xs:string
	IRDI:0173-1#02-BAD816#002		

Attribute details: Type of Sensor Output

Information	
Description	Type of technology of the output interface of the sensor (i.e. NPN, PNP, NPNORPNP, PNP/PNP, NPN/NPN, PNP/NPN, OTHTEC, NAMUR, ASI, IOLINK, RELAY, REED, OPTO, TWOWIRE).
Identification	
Name	Type of Sensor Output
Value	
Value	
Default value	
Data Type	xs:string
Unit	code
Constraint	Constraint collection
Relations	
Semantic	Semantic collection
[0]	IRDI:0112/2///62683#ACE254#001
[1]	IRDI:0173-1#02-BAD898#005

# ATTRIBUTE-GROUP: CONNECTION FACILITIES

- ▷ <A> SemanticSystems
- ▷ <A> Identification
- ▷ <A> InstallationMountingDimensions
- ▷ <A> GeneralTechnicalData
- ▷ <A> ControlAndAuxiliaryCircuits
- ▲ <A> ConnectionFacilities
  - <A> **Electrical Connection**
  - <A> Cable Length
  - <A> Rated Cross-Section
  - <A> Cable Sheath Material
- ▲ <A> ProductCertificatesAndStandards
  - <A> CertificatesAndApprovals
  - <A> ProductStandards
  - <A> EnvironmentalDeclaration

Attribute details: Electrical Connection	
<b>Information</b> ⤴	
Description	Physical design of the electrical connection from the body of the sensor to the conductor suitable for the intended use (i.e. SPGCON, CABLE, CABLECON, SCREWCON, CON1/2, CON3/4, CON7/8, CONM5, CONM8, CONM12, OTHCON).
<b>Identification</b> ⤴	
Name	Electrical Connection
<b>Value</b> ⤴	
Value	<input type="text"/>
Default value	<input type="text"/>
Data Type	xs:string ▾
Unit	code ■
Constraint	Constraint collection <input type="checkbox"/> <input type="checkbox"/>
<b>Relations</b> ⤴	
↳ Semantic	Semantic collection <input type="checkbox"/> <input type="checkbox"/>
[0]	IRDI:0112/2///62683#ACE856#001 <input type="checkbox"/>
[1]	IRDI:0173-1#02-BAD831#011 <input type="checkbox"/>

# SUMMARY

- Electronic data models are the necessary foundation for both product catalogues (type models) and Digital Twins during operation (instance models)
- The industries have created standards for sensors like IEC 60947 that define a reference for both sensor manufacturers and operators. But this is basically paper, not further electronically processable.
- Semantic reference catalogues such as IEC-CDD and ECLASS aim to fill the gap and allow electronic referencing of the information described in these standards.
- But to create actual sensor models and process them in a vendor-independent tool chain, a data exchange format like AutomationML is required.
- These AutomationML specifications are then machine readable and can be checked for consistency and completeness.

## Typical Use Cases:

- Vendors can publish electronic data sheets for their sensor products that contain all necessary ECAD and MCAD information for Virtual Engineering and Commissioning.
- Customers can simplify the component selection process by checking the electronically readable properties against their requirements

THANK YOU FOR  
YOUR ATTENTION!

**If there are any questions,  
please feel free to contact me.**

Markus Rentschler

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