<AutomationML/>

The Glue for Seamless Automation Engineering

Whitepaper AutomationML

Part 2 – Role class libraries

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1 Introduction

1.1 Basics

The data exchange format defined in AutomationML whitepapers (Automation Markup Language, AML) is an XML schema based data format and has been developed in order to support the data exchange between engineering tools in a heterogeneous engineering tool landscape. Whitepaper part 1 gives an overview about the format.

The goal of AML is to interconnect engineering tools from the existing heterogeneous tool landscape in their different disciplines, e.g. mechanical plant engineering, electrical design, process engineering, process control engineering, HMI development, PLC programming, robot programming, etc.

AML stores engineering information following the object oriented paradigm and allows modelling of physical and logical plant components as data objects encapsulating different aspects. An object may consist of other sub-objects and may itself be part of a larger composition or aggregation. Typical objects in plant automation comprise information on topology, geometry, kinematics and logic, whereas logic comprises sequencing, behaviour and control.

AML combines existing industry data formats that are designed for the storage and exchange of different aspects of engineering information. These data formats are used on “as-is” basis within their own specifications and are not branched for AML needs.

The core of AML is the top-level data format CAEX that connects the different data formats. Therefore, AML has an inherent distributed document architecture.

Figure 1 illustrates the basic AML architecture and the distribution of topology, geometry, kinematic and logic information.

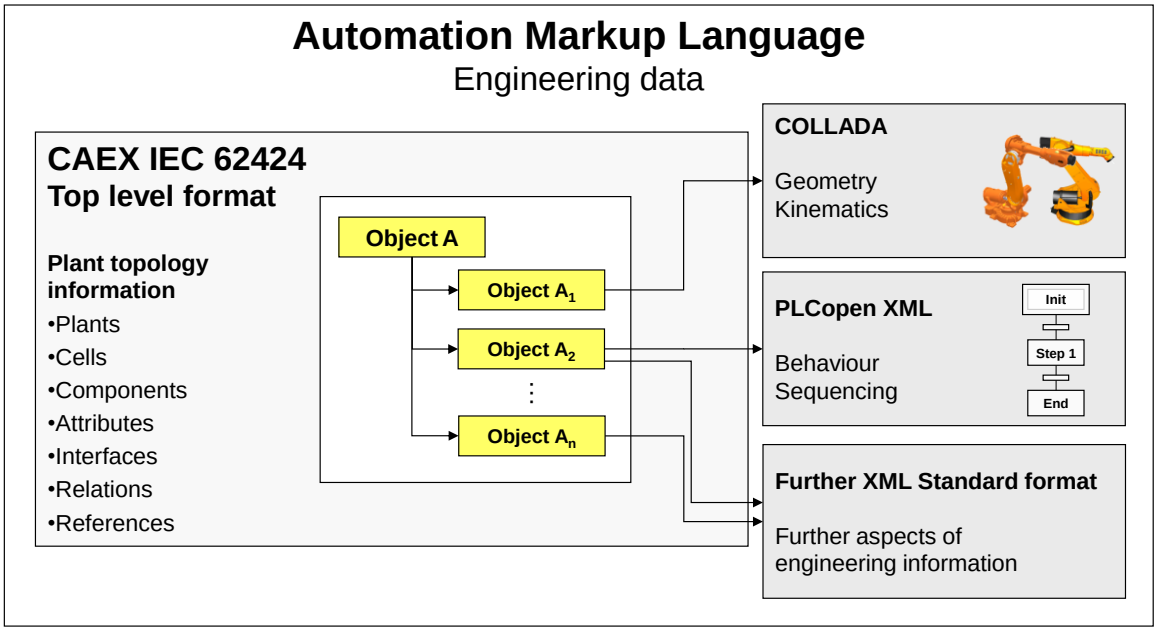


Figure 1 - Overview of the engineering data exchange format (AML)

Due to the different aspects of AML, AML whitepapers consist of different parts focussing on different aspects.

- Whitepaper part 1: Architecture and general requirements
  This part specifies the general AML architecture, the modelling of engineering data, classes, instances, relations, references, hierarchies, basic AML libraries and extended AML concepts.

- Whitepaper part 2: Role class libraries
  This part specifies additional AML libraries.

- Whitepaper part 3: Geometry and kinematics
  This part is intended to specify the modelling of geometry and kinematics information.

- Whitepaper part 4: Logic
  This part is intended to specify the modelling of logics, sequencing, behaviour and control related information.

Further parts may be added in the future in order to interconnect further data standards to AML.

Clause 5 describes normative role class libraries within AML.

Annex A describes the informative AML extended role class library.

Annex B gives an informative example for the usage of AML role classes.

Annex C shows some user-defined role class libraries of different origins.

Annex D gives an informative XML representation of the libraries defined in this whitepaper.

1.2 Scope

AML whitepapers specify an engineering data exchange format for use in industrial automation systems.

This whitepaper specifies normative as well as informative AML role class libraries for the modelling of engineering information for the exchange between engineering tools in the plant automation area by means of AML. Moreover, it presents additional user defined libraries as an example. Its provisions apply to the export/import applications of related tools.

This whitepaper does not define details of the data exchange procedure or implementation requirements for the import/export tools.

1.3 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

- IEC 62714-1:–, *Engineering data exchange format for use in industrial automation systems engineering – Automation Markup Language – Part 1: Architecture and general requirements*[1]

[1] Under consideration.

- IEC 61360-4-DB, *Standard data element types with associated classification scheme for electric components – Part 4: IEC reference collection of standard data element types and component classes*
- IEC 62264-1:2013, *Enterprise-control system integration – Part 1: Models and terminology*
- IEC 62424:2008, *Representation of process control engineering – Requests in P&I diagrams and data exchange between P&ID tools and PCE-CAE tools*
- Extensible Markup Language (XML) 1.0:2004, *W3C Recommendation (available at <http://www.w3.org/TR/2004/REC-xml-20040204/>)*

2 Terms, definitions and abbreviations

2.1 Terms and definitions

For the purposes of this document, the terms and definitions given in whitepaper part 1 as well as the following apply.

2.1.1 Robot

industrial robot
automatically controlled, reprogrammable, multipurpose manipulator, programmable in three or more axes, which can be either fixed in place or mobile for use in industrial automation applications

[SOURCE: ISO 8373:2012, 2.9, modified – the notes have been removed]

2.1.2 Sensor

unit that detects objects or obstacles in its monitoring range or that is affected by a measurand and which provides an electrical signal or data representing the detection or the measurement

EXAMPLE Limit switch, proximity sensor, pressure transmitter, vibration transducer, strain gauge, photo detector.

2.1.3 Measurand

particular quantity subject to measurement

[SOURCE: IEC 60050-311:2001, 311-01-03]

2.1.4 Actuator

functional unit that generates the manipulated variable, required to drive the final controlling element, from the output variable of the controlling element

[SOURCE: IEC 60050-351:2006, 351-49-07, modified – the notes, example, and figures have been removed]

EXAMPLE Contactor, variable speed drive.

2.2 Abbreviations

For the purposes of this document the abbreviations given in part 1 of the whitepapers:– as well as those given in Table 1 apply.

AGV	Automated guided vehicle
IPC	Industrial PC
NC	Numerical controller
PAC	Programmable automation controller
PC	Personal computer
RC	Robot controller

Table 1 – Abbreviations

3 AML role classes

3.1 Structure and references

Table ***2*** gives an overview about the AML related role class libraries specified in this whitepaper.

AutomationMLBaseRoleClassLib	Whitepaper part 1 – normative
AutomationMLDMIRoleClassLib AutomationMLCMIRoleClassLib AutomationMLBMIRoleClassLib AutomationMLCSRoleClassLib	Whitepaper part 2 – normative
AutomationMLExtendedRoleClassLib	Whitepaper part 2 – informative
UserDefinedRoleClassLib_RedBookVDMA UserDefinedRoleClassLibCompanySpecificStructure UserDefinedRoleClassLib_FoodAndBeverage UserDefinedRoleClassLibPandixPCE UserDefinedRoleClassLibPandixPPE	Whitepaper part 2 – informative, user-defined examples

Table 2 ***–*** *Structure of AML role class libraries*

NOTE 1 The concept of role class libraries, especially user-defined role class libraries is described in IEC62424:2008 and whitepaper part 1, 7.4.

NOTE 2 The role class tree (see Figure 2) does not necessarily reflect the inheritance relations between the classes, but only serves for better readability. The inheritance relation is depicted by the class referenced in curly brackets.

All role class libraries defined in this part are based on the AutomationMLBaseRoleClassLib defined in whitepaper part 1 which is shown in Figure 2.

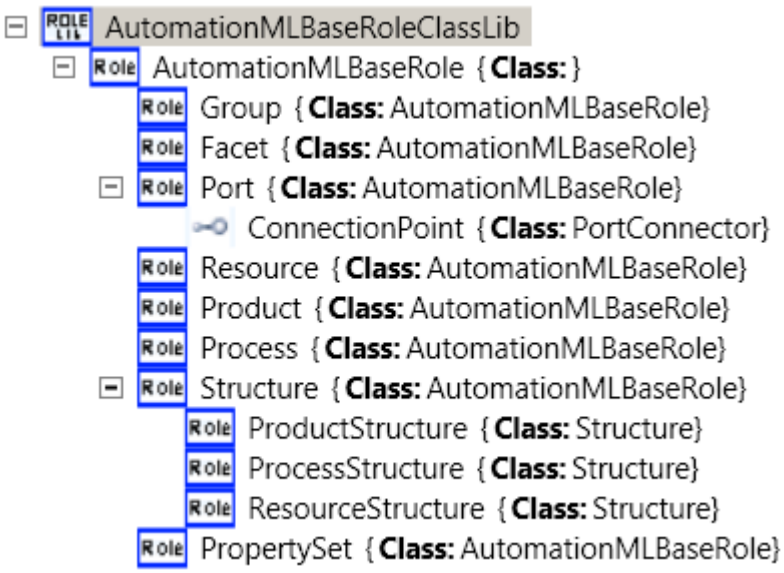


Figure 2 – AutomationMLBaseRoleClassLib defined in whitepaper part 1

Subclause 3.2 defines a normative AML role class library for the discrete manufacturing industry (AutomationMLDMIRoleClassLib).

NOTE The terms discrete, continuous, and batch manufacturing are used according to IEC 62264-1:2013.

Subclause 3.3 defines a normative AML role class library for the continuous manufacturing industry (AutomationMLCMIRoleClassLib).

Subclause 3.4 defines a normative AML role class library for the batch manufacturing industry (AutomationMLBMIRoleClassLib).

Subclause 3.5 defines a normative AML role class library for the control system (AutomationMLCSRoleClassLib).

Annex A shows an informative AML extended role class library (AutomationMLExtendedRoleClassLib).

Annex B shows an example for the usage of AML role classes.

Annex C shows some exemplary user-defined role class libraries.

As defined in whitepaper part 1, the version of AML is defined in the CAEX element “AdditionalInformation” as child of the CAEXFile root element. The AML version addressed in this document is “2.0”. Additionally, every role class library contains an individual library version which is defined in the CAEX element “Version” of the “RoleClassLib” element.

Role classes in AML can contain attributes according to the IEC 62424. The definition of the attribute shall be placed within the CAEX element “Description”. Attributes shall be defined by

1) referencing the Component Data Dictionary (IEC 61360-4-DB) or, if not possible,
2) referencing existing IEC standards or, if not possible,
3) user-defined textual explanations.

3.2 AML role class library for discrete manufacturing industry – AutomationMLDMIRoleClassLib

3.2.1 General

NOTE The version of this AML discrete manufacturing industry role class library is 2.4.0.

Figure 3, Figure 4, and Figure 5 present the normative AutomationMLDMIRoleClassLib as object tree. This library provides a set of basic discrete manufacturing industry related role classes. Details to each role class are given in 5.2.2 to 5.2.11.

NOTE According to IEC62424:2008, user-defined attributes can be added.

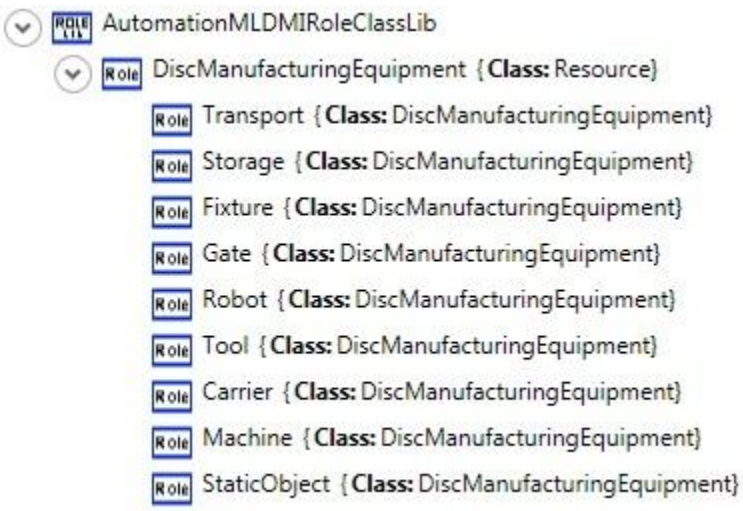


Figure 3 – AutomationMLDMIRoleClassLib

RoleClassLib

Name	AutomationMLDMIRoleClassLib
Description	AutomationML Discrete Manufacturing Industry Role Class Library
Version	2.3.3

RoleClass

Name	DiscManufacturingEquipment
RefBaseClassPa...	AutomationMLBaseRoleClassLib@AutomationMLBaseRoleClassLib/AutomationMLBaseRole/Resource

RoleClass (9)

	Name	RefBaseClassPath
1	Transport	DiscManufacturingEquipment
2	Storage	DiscManufacturingEquipment
3	Fixture	DiscManufacturingEquipment
4	Gate	DiscManufacturingEquipment
5	Robot	DiscManufacturingEquipment
6	Tool	DiscManufacturingEquipment
7	Carrier	DiscManufacturingEquipment
8	Machine	DiscManufacturingEquipment
9	StaticObject	DiscManufacturingEquipment

Figure 4 – XML grid of the AutomationMLDMIRoleClassLib

```
<RoleClassLib Name="AutomationMLDMIRoleClassLib">
  <Description>AutomationML Discrete Manufacturing Industry Role Class Library</Description>
  <Version>2.3.3</Version>
  <RoleClass Name="DiscManufacturingEquipment" RefBaseClassPath="AutomationMLBaseRoleClassLib@AutomationMLBaseRoleClassLib/AutomationMLBaseRole/Resource">
    <RoleClass Name="Transport" RefBaseClassPath="DiscManufacturingEquipment" />
    <RoleClass Name="Storage" RefBaseClassPath="DiscManufacturingEquipment" />
    <RoleClass Name="Fixture" RefBaseClassPath="DiscManufacturingEquipment" />
    <RoleClass Name="Gate" RefBaseClassPath="DiscManufacturingEquipment" />
    <RoleClass Name="Robot" RefBaseClassPath="DiscManufacturingEquipment" />
    <RoleClass Name="Tool" RefBaseClassPath="DiscManufacturingEquipment" />
    <RoleClass Name="Carrier" RefBaseClassPath="DiscManufacturingEquipment" />
    <RoleClass Name="Machine" RefBaseClassPath="DiscManufacturingEquipment" />
    <RoleClass Name="StaticObject" RefBaseClassPath="DiscManufacturingEquipment" />
  </RoleClass>
</RoleClassLib>
```

Figure 5 – XML text of the AutomationMLDMIRoleClassLib

3.2.2 RoleClass DiscManufacturingEquipment

Table ***3*** specifies the role class “DiscManufacturingEquipment”.

Class name	DiscManufacturingEquipment
Description	The role class “DiscManufacturingEquipment” shall be used for equipment related to discrete manufacturing industries.
Parent class	AutomationMLBaseRoleClassLib/AutomationMLBaseRole/Resource

Table 3 – RoleClass DiscManufacturingEquipment

3.2.3 RoleClass Transport

Table 4 specifies the role class “Transport”.

Class name	Transport
Description	The role class “Transport” shall be used for equipment that performs transport processes to transfer items.
Parent class	AutomationMLDMIRoleClassLib/DiscManufacturingEquipment

Table 4 – RoleClass Transport

EXAMPLE Conveyor, turntable, lift/lifter, AGV (automated guided vehicle), band conveyor, roll conveyor, rotating tower, lifting table, crane.

3.2.4 RoleClass Storage

Table ***5*** specifies the role class “Storage”.

Class name	Storage
Description	The role class “Storage” shall be used for equipment that is used to buffer products or material temporarily within the plant. It can also be used to feed products or materials into the production process or to export products or materials out of the production process.
Parent class	AutomationMLDMIRoleClassLib/DiscManufacturingEquipment

Table 5 ***–*** *RoleClass Storage*

EXAMPLE Buffer, LCA (low cost automation).

3.2.5 RoleClass Fixture

Table ***6*** specifies the role class “Fixture”.

Class name	Fixture
Description	The role class “Fixture” shall be used for equipment that reduces the degrees of freedom of an item.
Parent class	AutomationMLDMIRoleClassLib/DiscManufacturingEquipment

Table 6 ***–*** *RoleClass Fixture*

EXAMPLE Fixing element, clamp, restraint.

3.2.6 RoleClass Gate

Table 7 specifies the role class “Gate”.

Class name	Gate
Description	The role class “Gate” shall be used for equipment that can block or monitor an entrance, departure, or a passage way.
Parent class	AutomationMLDMIRoleClassLib/DiscManufacturingEquipment

Table 7 ***–*** *RoleClass Gate*

EXAMPLE Safety door, equipment that monitors or controls a transit area.

3.2.7 RoleClass Robot

Table 8 specifies the role class “Robot”.

Class name	Robot
Description	The role class “Robot” shall be used for robots.
Parent class	AutomationMLDMIRoleClassLib/DiscManufacturingEquipment

Table 8 – RoleClass Robot

3.2.8 RoleClass Tool

Table 9 specifies the role class “Tool”.

Class name	Tool
Description	The role class “Tool” shall be used for equipment used by resources that is necessary to or aids in the performance of an operation on the product.
Parent class	AutomationMLDMIRoleClassLib/DiscManufacturingEquipment

Table 9 – RoleClass Tool

EXAMPLE Manipulating, controlling, proofing or assembling tool, chisel, welding gun, milling tool.

3.2.9 RoleClass Carrier

Table 10 specifies the role class “Carrier”.

Class name	Carrier
Description	The role class “Carrier” shall be used for transport equipment that carries items.
Parent class	AutomationMLDMIRoleClassLib/DiscManufacturingEquipment

Table 10 – RoleClass Carrier

EXAMPLE Palette, container, handling aids, skid.

3.2.10 RoleClass Machine

*Table **11*** specifies the role class “Machine”.

Class name	Machine
Description	The role class “Machine” shall be used for mechanic or mechatronic equipment that creates added value on products and is designed expressly to perform specific tasks.
Parent class	AutomationMLDMIRoleClassLib/DiscManufacturingEquipment

Table 11 – RoleClass Machine

EXAMPLE Milling machine, welding machine, grinding machine.

3.2.11 RoleClass StaticObject

Table 12 specifies the role class “StaticObject”.

Class name	StaticObject
Description	The role class “StaticObject” shall be used for passive, static items positioned in the production environment.
Parent class	AutomationMLDMIRoleClassLib/DiscManufacturingEquipment

Table 12 – RoleClass StaticObject

EXAMPLE Fence, jamb.

3.3 AML role class library for continuous manufacturing industry – AutomationMLCMIRoleClassLib

3.3.1 General

NOTE The version of this AML continuous manufacturing industry role class library is 1.1.0.

Figure 6, Figure 7 and Figure 8 present the normative AutomationMLCMIRoleClassLib as object tree. Role classes of continuous manufacturing industry shall be derived directly or indirectly from an element of this library.

NOTE User-defined attributes can be added.

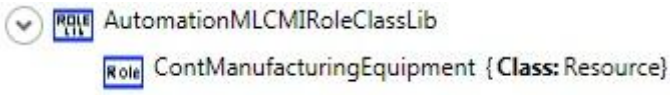


Figure 6 – AutomationMLCMIRoleClassLib

RoleClassLib		
	Name	AutomationMLCMIRoleClassLib
	Description	AutomationML Continuous Manufacturing Industry Role Class Library
	Version	1.0.0
	RoleClass	
		Name: ContManufacturingEquipment
		RefBaseClassPa...: AutomationMLBaseRoleClassLib@AutomationMLBaseRoleClassLib/AutomationMLBaseRole/Resource

Figure 7 – XML grid of the AutomationMLCMIRoleClassLib

```
<RoleClassLib Name="AutomationMLCMIRoleClassLib">
  <Description>AutomationML Continuous Manufacturing Industry Role Class Library</Description>
  <Version>1.0.0</Version>
  <RoleClass Name="ContManufacturingEquipment" RefBaseClassPath="AutomationMLBaseRoleClassLib@AutomationMLBaseRoleClassLib/AutomationMLBaseRole/Resource"/>
</RoleClassLib>
```

Figure 8 – XML text of the AutomationMLCMIRoleClassLib

3.3.2 RoleClass ContManufacturingEquipment

Table 13 specifies the role class “ContManufacturingEquipment”.

Class name	ContManufacturingEquipment
Description	The role class “ContManufacturingEquipment” shall be used for equipment related to continuous manufacturing.
Parent class	AutomationMLBaseRoleClassLib/AutomationMLBaseRole/Resource

Table 13 – RoleClass ContManufacturingEquipment

3.4 AML role class library for batch manufacturing industry – AutomationMLBMIRoleClassLib

3.4.1 General

NOTE The version of this AML batch manufacturing industry role class library is 1.0.0.

Figure 9, Figure 10 and Figure 11 present the normative AutomationMLBMIRoleClassLib as object tree. Role classes of batch manufacturing industry shall be derived directly or indirectly from an element of this library.

NOTE User-defined attributes can be added.

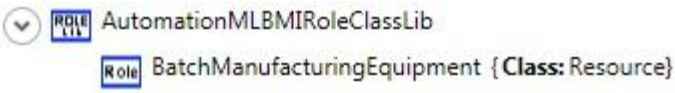


Figure 9 – AutomationMLBMIRoleClassLib

RoleClassLib		
	Name	AutomationMLBMIRoleClassLib
	Description	AutomationML Batch Manufacturing Industry Role Class Library
	Version	1.0.0
	RoleClass	
		Name: BatchManufacturingEquipment
		RefBaseClassPa...: AutomationMLBaseRoleClassLib@AutomationMLBaseRoleClassLib/AutomationMLBaseRole/Resource

Figure 10 – XML grid of the AutomationMLBMIRoleClassLib

```
<RoleClassLib Name="AutomationMLBMIRoleClassLib">
  <Description>AutomationML Batch Manufacturing Industry Role Class Library</Description>
  <Version>1.0.0</Version>
  <RoleClass Name="BatchManufacturingEquipment" RefBaseClassPath="AutomationMLBaseRoleClassLib@AutomationMLBaseRoleClassLib/AutomationMLBaseRole/Resource"/>
</RoleClassLib>
```

Figure 11 – XML text of the AutomationMLBMIRoleClassLib

3.4.2 RoleClass BatchManufacturingEquipment

Table 144 specifies the role class “BatchManufacturingEquipment”.

Class name	BatchManufacturingEquipment
Description	The role class “BatchManufacturingEquipment” shall be used for equipment related to batch manufacturing.
Parent class	AutomationMLBaseRoleClassLib/AutomationMLBaseRole/Resource

Table 14 – RoleClass BatchManufacturingEquipment

3.5 AML role class library for control systems – AutomationMLCSRoleClassLib

3.5.1 General

NOTE The version of this AML control system role class library is 2.3.0.

Figure 12, Figure 13, and Figure 14 present the AutomationMLCSRoleClassLib as object tree, XML grid and XML text. Details to each role class are given in 5.5.2 to 5.5.15.

NOTE User-defined attributes can be added.

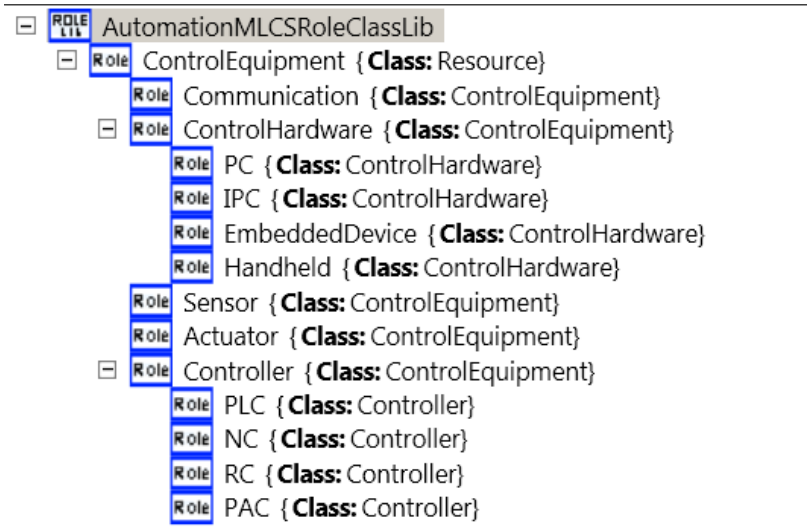


Figure 12 – AutomationMLCSRoleClassLib

RoleClassLib

Name	AutomationMLCSRoleClassLib
Description	AutomationML Control Industry Role Class Library
Version	2.2.1

RoleClass

Name	ControlEquipment
RefBaseClassPa...	AutomationMLBaseRoleClassLib@AutomationMLBaseRoleClassLib/AutomationMLBaseRole/Resource

RoleClass (5)

	Name	RefBaseClassPa...	RoleClass
1	Communication	ControlEquipment	
2	ControlHardware	ControlEquipment	RoleClass (4)
3	Sensor	ControlEquipment	
4	Actuator	ControlEquipment	
5	Controller	ControlEquipment	RoleClass (4)

RoleClass (4)

	Name	RefBaseClassPath
1	PC	ControlHardware
2	IPC	ControlHardware
3	EmbeddedDevice	ControlHardware
4	Handheld	ControlHardware

RoleClass (4)

	Name	RefBaseClassPath
1	PLC	Controller
2	NC	Controller
3	RC	Controller

Figure 13 – XML grid of the AutomationMLCSRoleClassLib

```
<RoleClassLib Name="AutomationMLCSRoleClassLib">
  <Description>AutomationML Control Industry Role Class Library</Description>
  <Version>2.2.1</Version>
  <RoleClass Name="ControlEquipment" RefBaseClassPath="AutomationMLBaseRoleClassLib@AutomationMLBaseRoleClassLib/AutomationMLBaseRole/Resource">
    <RoleClass Name="Communication" RefBaseClassPath="ControlEquipment" />
    <RoleClass Name="ControlHardware" RefBaseClassPath="ControlEquipment">
      <RoleClass Name="PC" RefBaseClassPath="ControlHardware" />
      <RoleClass Name="IPC" RefBaseClassPath="ControlHardware" />
      <RoleClass Name="EmbeddedDevice" RefBaseClassPath="ControlHardware" />
      <RoleClass Name="Handheld" RefBaseClassPath="ControlHardware" />
    </RoleClass>
    <RoleClass Name="Sensor" RefBaseClassPath="ControlEquipment" />
    <RoleClass Name="Actuator" RefBaseClassPath="ControlEquipment" />
    <RoleClass Name="Controller" RefBaseClassPath="ControlEquipment">
      <RoleClass Name="PLC" RefBaseClassPath="Controller" />
      <RoleClass Name="NC" RefBaseClassPath="Controller" />
      <RoleClass Name="RC" RefBaseClassPath="Controller" />
      <RoleClass Name="PAC" RefBaseClassPath="Controller" />
    </RoleClass>
  </RoleClass>
</RoleClassLib>
```

Figure 14 – XML text of the AutomationMLCSRoleClassLib

3.5.2 RoleClass ControlEquipment

Table 15 specifies the role class “ControlEquipment”.

Class name	ControlEquipment
Description	The role class “ControlEquipment” shall be used for equipment related to a control system. ControlEquipment can be used for every type of industry.
Parent class	AutomationMLBaseRoleClassLib/AutomationMLBaseRole/Resource

Table 15 – RoleClass ControlEquipment

3.5.3 RoleClass Communication

Table 16 specifies the role class “Communication”.

Class name	Communication
Description	The role class “Communication” shall be used for items dedicated to communication.
Parent class	AutomationMLCSRoleClassLib/ControlEquipment

Table 16 – RoleClass Communication

3.5.4 RoleClass ControlHardware

Table 17 specifies the role class “ControlHardware”.

Class name	ControlHardware
Description	The role class “ControlHardware” shall be used for hardware that provides runtime environments.
Parent class	AutomationMLCSRoleClassLib/ControlEquipment

Table 17 – RoleClass ControlHardware

3.5.5 RoleClass PC

Table 18 specifies the role class “PC”.

Class name	PC
Description	The role class “PC” shall be used for any general-purpose computer that provides runtime environments for software being executed on it.
Parent class	AutomationMLCSRoleClassLib/ControlEquipment/ControlHardware

Table 18 – RoleClass PC

3.5.6 RoleClass IPC

Table 19 specifies the role class “IPC”.

Class name	IPC
Description	The role class “IPC” shall be used for any PC-based computing platform for industrial applications that provides runtime environments for software being executed on it.
Parent class	AutomationMLCSRoleClassLib/ControlEquipment/ControlHardware

Table 19 – RoleClass IPC

3.5.7 RoleClass Handheld

Table 20 specifies the role class “Handheld”.

Class name	Handheld
Description	The role class “Handheld” shall be used for any portable, programmable, electronic device with an own power supply for particular applications.
Parent class	AutomationMLCSRoleClassLib/ControlEquipment/ControlHardware

Table 20 – RoleClass Handheld

3.5.8 RoleClass EmbeddedDevice

Table 21 specifies the role class “EmbeddedDevice”.

Class name	EmbeddedDevice
Description	The role class “EmbeddedDevice” shall be used for any device designed to perform one or a few dedicated software functions. It is embedded as part of another device often including hardware and mechanical parts.
Parent class	AutomationMLCSRoleClassLib/ControlEquipment/ControlHardware

Table 21 – RoleClass EmbeddedDevice

3.5.9 RoleClass Sensor

Table 22 specifies the role class “Sensor”.

Class name	Sensor
Description	The role class “Sensor” shall be used for sensors.
Parent class	AutomationMLCSRoleClassLib/ControlEquipment

Table 22 – RoleClass Sensor

3.5.10 RoleClass Actuator

Table 23 specifies the role class “Actuator”.

Class name	Actuator
Description	The role class “Actuator” shall be used for actuators.
Parent class	AutomationMLCSRoleClassLib/ControlEquipment

Table 23 – RoleClass Actuator

3.5.11 RoleClass Controller

Table 24 specifies the role class “Controller”.

Class name	Controller
Description	The role class “Controller” shall be used for self-acting functionalities that process signals according to a predefined logic and generate output signals in order to reach an intended behaviour of technical processes.
Parent class	AutomationMLCSRoleClassLib/ControlEquipment

Table 24 – RoleClass Controller

NOTE Controller functionalities can be realized by software or hardware.

3.5.12 RoleClass PLC

Table 25 specifies the role class “PLC”.

Class name	PLC
Description	The role class “PLC” shall be used for programmable control functionality focusing the processing of signals.
Parent class	AutomationMLCSRoleClassLib/ControlEquipment/Controller

Table 25 – RoleClass PLC

NOTE PLC functionality can be realized by software or hardware.

3.5.13 RoleClass NC

Table 26 specifies the role class “NC”.

Class name	NC
Description	The role class “NC” shall be used for programmable control functionality focusing the processing of numerical signals.
Parent class	AutomationMLCSRoleClassLib/ControlEquipment/Controller

Table 26 – RoleClass NC

NOTE NC functionality can be realized by software or hardware.

3.5.14 RoleClass RC

Table 27 specifies the role class “RC”.

Class name	RC
Description	The role class “RC” shall be used for programmable control functionality driving robots in order to reach an intended behaviour of the robot kinematic system and corresponding connected periphery.
Parent class	AutomationMLCSRoleClassLib/ControlEquipment/Controller

Table 27 – RoleClass RC

NOTE RC functionality can be realized by software or hardware.

3.5.15 RoleClass PAC

Table 28 specifies the role class “PAC”.

Class name	PAC
Description	The role class “PAC” shall be used for programmable automation functionality focusing on cross-domain functionality like binary, motion and continuous control.
Parent class	AutomationMLCSRoleClassLib/ControlEquipment/Controller

Table 28 – RoleClass PAC

NOTE PAC functionality can be realized by software or hardware.

Annex A – AML Extended Role Class Library

The AutomationMLExtendedRoleClassLibrary is a recommended extension of the AutomationMLBaseRoleClassLib and the AutomationMLDMIRoleClassLib and covers a wide area of typical roles of the discrete manufacturing industry.

Figure A.1 presents the AutomationMLExtendedRoleClassLib as object tree.

NOTE 1 The version of this AML extended role class library is 2.7.0.

NOTE 2 According to IEC62424:2008, user-defined attributes can be added.

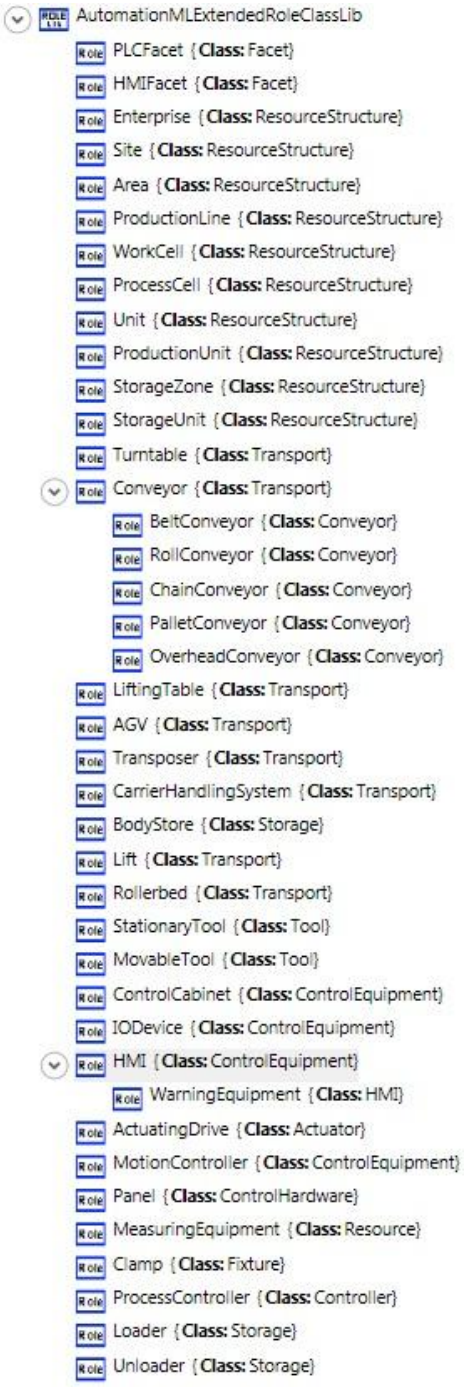


Figure A.1 – AutomationMLExtendedRoleClassLib

A.1 RoleClass PLCFacet

Table A.1 specifies the role class “PLCFacet”.

Class name	PLCFacet
Description	The role class “PLCFacet” should be used to model separate views concerning everything involved in PLC control code generators: PLC view on AML objects which points to information concerning PLC.
Parent class	AutomationMLBaseRoleClassLib/AutomationMLBaseRole/Facet

Table A.1 – RoleClass PLCFacet

A.2 RoleClass HMIFacet

Table A.2 specifies the role class “HMIFacet”.

Class name	HMIFacet
Description	The role class “HMIFacet” should be used to model separate views concerning everything involved in HMI: HMI view on AML objects which points to information concerning HMI.
Parent class	AutomationMLBaseRoleClassLib/AutomationMLBaseRole/Facet

Table A.2 – RoleClass HMIFacet

A.3 RoleClass Enterprise

Table A***.3*** specifies the role class “Enterprise”. Figure A.2 illustrates the structure defined in IEC 62264-1:2013.

Class name	Enterprise
Description	The role class “Enterprise” should be used for business structures. The definition of an “Enterprise” is given in IEC 62264-1:2013, 5.3.2: “An enterprise is a collection of sites and areas and represents the top level of a role-based equipment hierarchy. The enterprise is responsible for determining what products will be manufactured, at which sites they will be manufactured, and in general how they will be manufactured.”
Parent class	AutomationMLBaseRoleClassLib/AutomationMLBaseRole/Structure/ResourceStructure

Table A.3 – RoleClass Enterprise

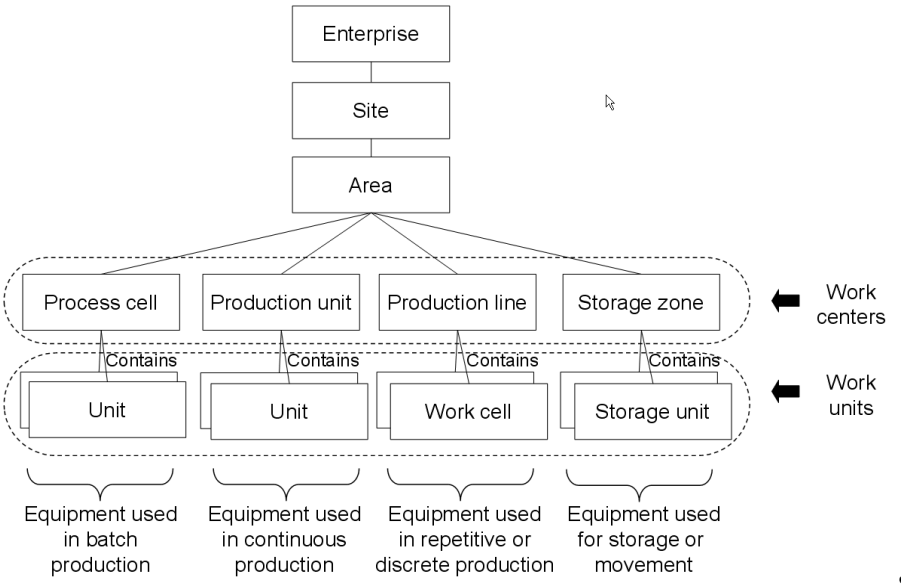


Figure A.2 - Resource structure [SOURCE: IEC 62264-1:2013]

A.4 RoleClass Site

Table A.4 specifies the role class “Site”.

Class name	Site
Description	The role class “Site” should be used for the position determination of a site. It is also used as element of a hierarchical organisation. The definition of a “Site” is given in IEC 62264-1:2013, 5.3.3: “A site is a physical, geographical, or logical grouping determined by the enterprise. It may contain areas, production lines, process cells, and production units.”
Parent class	AutomationMLBaseRoleClassLib/AutomationMLBaseRole/Structure/ResourceStructure

Table A.4 – RoleClass Site

EXAMPLE Plant, manufacturing facility.

A.5 RoleClass Area

Table A.5 specifies the role class “Area”.

Class name	Area
Description	The role class “Area” should be used for production buildings and their subdivisions (structure/hall). It is also used as element of a hierarchical organisation. The definition of an “Area” is given in IEC 62264-1:2013, 5.3.4: “An area is a physical, geographical, or logical grouping determined by the site. It may contain work centres such as process cells, production units, production lines, and storage zones.”
Parent class	AutomationMLBaseRoleClassLib/AutomationMLBaseRole/Structure/ResourceStructure

Table A.5 – RoleClass Area

EXAMPLE a hall.

A.6 RoleClass ProductionLine

Table A.6 specifies the role class “ProductionLine”.

Class name	ProductionLine
Description	The role class “ProductionLine” should be used for defining the role based equipment hierarchy defined in IEC 62264-1:2013, 5.3.7, for discrete manufacturing at the work cell level: “Production lines and work cells are the lowest levels of equipment … for discrete manufacturing processes. Work cells are usually only identified when there is flexibility in the routing of work within a production line. Production lines and work cells may be composed of lower-level elements…. The major processing activity often identifies the production line.”
Parent class	AutomationMLBaseRoleClassLib/AutomationMLBaseRole/Structure/ResourceStructure

Table A.6 – RoleClass ProductionLine

A.7 RoleClass WorkCell

Table A.7 specifies the role class “WorkCell”.

Class name	WorkCell
Description	The role class “WorkCell” should be used for defining the role based equipment hierarchy defined in IEC 62264-1:2013 at the work cell level: for sub units/sub production steps of units/production lines, stations, processes single components, cycle, location in which the production step takes place. It is used for hierarchization. The definition of a “WorkCell” is given in IEC 62264-1:2013, 5.3.7: “Production lines and work cells are the lowest levels of equipment … for discrete manufacturing processes. Work cells are usually only identified when there is flexibility in the routing of work within a production line. Production lines and work cells may be composed of lower-level elements…. The major processing activity often identifies the production line.”
Parent class	AutomationMLBaseRoleClassLib/AutomationMLBaseRole/Structure/ResourceStructure

Table A.7 – RoleClass WorkCell

NOTE For discrete manufacturing the role class ProductionLine should be used instead of role class WorkCell.

A.8 RoleClass ProcessCell

Table A.8 specifies the role class “ProcessCell”.

Class name	ProcessCell
Description	The role class “ProcessCell” should be used for sub units/sub production steps of units/production lines, station, processes single component, cycle, location in which the production step takes place. It is used for hierarchization. The definition of a “ProcessCell” is given in IEC 62264-1:2013, 5.3.8: “Process cells and units are the lowest level of … batch manufacturing processes. …. The major processing capability or family of products produced often identifies the process cell.”
Parent class	AutomationMLBaseRoleClassLib/AutomationMLBaseRole/Structure/ResourceStructure

Table A.8 – RoleClass ProcessCell

A.9 RoleClass Unit

Table A.9 specifies the role class “Unit”.

Class name	Unit
Description	The role class “Unit” should be used for linked chained production plants. It is used for hierarchization. The definition of a “Unit” is given in IEC 62264-1:2013, 5.3.8: “Process cells and units are the lowest level of equipment … for batch manufacturing processes. …. The major processing capability or family of products produced often identifies the process cell.”
Parent class	AutomationMLBaseRoleClassLib/AutomationMLBaseRole/Structure/ResourceStructure

Table A.9 – RoleClass Unit

A.10 RoleClass ProductionUnit

Table A.10 specifies the role class “ProductionUnit”.

Class name	ProductionUnit
Description	The role class “ProductionUnit” should be used for sub units/sub production steps of units/production lines, station, processes single component, cycle, location in which the production step takes place. It is used for hierarchization. The definition of a “ProductionUnit” is given in IEC 62264-1:2013, 5.3.6: “Production units and units are the lowest level of equipment … for continuous manufacturing processes. Production units are composed of units and units are composed lower level elements, such as equipment modules, sensors, and actuators…. A production unit generally encompasses all of the equipment required for a segment of continuous production that operates in a relatively autonomous manner. It generally converts, separates, or reacts one or more feed stocks to produce intermediate or final products. The major processing activity or product generated often identifies the production unit.”
Parent class	AutomationMLBaseRoleClassLib/AutomationMLBaseRole/Structure/ResourceStructure

Table A.10 – RoleClass ProductionUnit

A.11 RoleClass StorageZone

Table A.11 specifies the role class “StorageZone”.

Class name	StorageZone
Description	The role class “StorageZone” should be used defining the role based equipment hierarchy defined in IEC 62264-1:2013 at the storage zone level: The definition of an “StorageZone” is given in IEC 62264-1: 2013, 5.3.9: “Storage zones and storage units are the lowest level of material movement equipment … for discrete, batch and continuous manufacturing processes. A storage zone is a type of work centre and a storage unit is a type of work unit that is organized as elements within an area. These are the lower-level elements of an equipment hierarchy used in material storage and movement activities. A storage zone typically has the capability needed for the receipt, storage, retrieval, movement and shipment of materials. This may include the movement of materials from one work centre to another work centre within or between enterprises.”

Table A.11 – RoleClass StorageZone

A.12 RoleClass StorageUnit

Table A.12 specifies the role class “StorageUnit”.

Class name	StorageUnit
Description	The role class “StorageUnit” should be used defining the role based equipment hierarchy defined in IEC 62264-1:2013 at the storage unit level: The definition of an “StorageUnit” is given in IEC 62264-1: 2013, 5.3.9: “Storage zones and storage units are the lowest level of material movement equipment … for discrete, batch and continuous manufacturing processes. A storage zone is a type of work centre and a storage unit is a type of work unit that is organized as elements within an area. These are the lower-level elements of an equipment hierarchy used in material storage and movement activities. A storage zone typically has the capability needed for the receipt, storage, retrieval, movement and shipment of materials. This may include the movement of materials from one work centre to another work centre within or between enterprises.”
Parent class	AutomationMLBaseRoleClassLib/AutomationMLBaseRole/Structure/ResourceStructure

Table A.12 – RoleClass StorageUnit

EXAMPLE Rack, bin, slot, tank, pallet, barrel.

A.13 RoleClass Turntable

Table A.13 specifies the role class “Turntable”.

Class name	Turntable
Description	The role class “Turntable” should be used for rotating transport equipment which changes the horizontal transport direction of a product and/or carrier.
Parent class	AutomationMLDMIRoleClassLib/DiscManufacturingEquipment/Transport

Table A.13 – RoleClass Turntable

A.14 RoleClass Conveyor

Table A.14 specifies the role class “Conveyor”.

Class name	Conveyor
Description	The role class “Conveyor” should be used for generic equipment which performs linear transport.
Parent class	AutomationMLDMIRoleClassLib/DiscManufacturingEquipment/Transport

Table A.14 – RoleClass Conveyor

EXAMPLE Transport with start and stop points and without branching points.

A.15 RoleClass BeltConveyor

Table A.15 specifies the role class “BeltConveyor”.

Class name	BeltConveyor
Description	The role class “BeltConveyor” should be used for equipment which performs linear transport realized by one or more belts as transport platform.
Parent class	AutomationMLExtendedRoleClassLib/Conveyor

Table A.15 – RoleClass BeltConveyor

A.16 RoleClass RollConveyor

Table A.16 specifies the role class “RollConveyor”.

Class name	RollConveyor
Description	The role class “RollConveyor” should be used for equipment which performs linear transport realized by a sequence of rolls as transport platform.
Parent class	AutomationMLExtendedRoleClassLib/Conveyor

Table A.16 – RoleClass RollConveyor

A.17 RoleClass ChainConveyor

Table A.17specifies the role class “ChainConveyor”.

Class name	ChainConveyor
Description	The role class “ChainConveyor” should be used for equipment which performs linear transport driven by an endless chain as transport medium.
Parent class	AutomationMLExtendedRoleClassLib/Conveyor

Table A.17 – RoleClass ChainConveyor

A.18 RoleClass PalletConveyor

Table A.18 specifies the role class “PalletConveyor”.

Class name	PalletConveyor
Description	The role class “PalletConveyor” should be used for equipment which is especially designed for linear transport of pallets.
Parent class	AutomationMLExtendedRoleClassLib/Conveyor

Table A.18 – RoleClass PalletConveyor

A.19 RoleClass OverheadConveyor

Table A.19 specifies the role class “OverheadConveyor”.

Class name	OverheadConveyor
Description	The role class “OverheadConveyor” should be used for equipment that performs overhead transport of hanging products or carriers.
Parent class	AutomationMLExtendedRoleClassLib/Conveyor

Table A.19 – RoleClass OverheadConveyor

A.20 RoleClass LiftingTable

Table A.20 specifies the role class “LiftingTable”.

Class name	LiftingTable
Description	The role class “LiftingTable” should be used for equipment that performs discrete vertical transport. The transport medium is also lifted. Normally used for minor heights.
Parent class	AutomationMLDMIRoleClassLib/DiscManufacturingEquipment/Transport

Table A.20 – RoleClass LiftingTable

A.21 RoleClass AGV

Table A.21 specifies the role class “AGV”.

Class name	AGV
Description	The role class “AGV” should be used for equipment that performs automated transportation of discrete units independent of other transport equipment.
Parent class	AutomationMLDMIRoleClassLib/DiscManufacturingEquipment/Transport

Table A.21 – RoleClass AGV

A.22 RoleClass Transposer

Table A.22 specifies the role class “Transposer”.

Class name	Transposer
Description	The role class “Transposer” should be used for transport equipment that performs the change of the transport medium. Changes the classification or relation of product to the carrier (one to another).
Parent class	AutomationMLDMIRoleClassLib/DiscManufacturingEquipment/Transport

Table A.22 – RoleClass Transposer

A.23 RoleClass CarrierHandlingSystem

Table A.23 specifies the role class “CarrierHandlingSystem”.

Class name	CarrierHandlingSystem
Description	The role class “CarrierHandlingSystem” should be used for equipment that performs an action to the carrier.
Parent class	AutomationMLDMIRoleClassLib/DiscManufacturingEquipment/Transport

Table A.23 – RoleClass CarrierHandlingSystem

EXAMPLE Forklift.

A.24 RoleClass BodyStore

Table A.24 specifies the role class “BodyStore”.

Class name	BodyStore
Description	The role class “BodyStore” should be used for buffering discrete products.
Parent class	AutomationMLDMIRoleClassLib/DiscManufacturingEquipment/Storage

Table A.24 – RoleClass BodyStore

EXAMPLE Body buffer.

A.25 RoleClass Lift

Table A.25 specifies the role class “Lift”.

Class name	Lift
Description	The role class “Lift” should be used for equipment that performs discrete vertical transport. Normally used for larger heights.
Parent class	AutomationMLDMIRoleClassLib/DiscManufacturingEquipment/Transport

Table A.25 – RoleClass Lift

EXAMPLE Lifter.

A.26 RoleClass Rollerbed

Table A.26 specifies the role class “Rollerbed”.

Class name	Rollerbed
Description	The role class “Rollerbed” should be used for a sequence of rolls. None of these rolls are driven.
Parent class	AutomationMLDMIRoleClassLib/DiscManufacturingEquipment/Transport

Table A.26 – RoleClass Rollerbed

A.27 RoleClass StationaryTool

Table A.27 specifies the role class “StationaryTool”.

Class name	StationaryTool
Description	The role class “StationaryTool” should be used for tools fixed at one place.
Parent class	AutomationMLDMIRoleClassLib/DiscManufacturingEquipment/Tool

Table A.27 – RoleClass StationaryTool

A.28 RoleClass MovableTool

Table A.28 specifies the role class “MovableTool”.

Class name	MovableTool
Description	The role class “MovableTool” should be used for tools which can be moved by equipment e.g. robots.
Parent class	AutomationMLDMIRoleClassLib/DiscManufacturingEquipment/Tool

Table A.28 – RoleClass MovableTool

A.29 RoleClass ControlCabinet

Table A.29 specifies the role class “ControlCabinet”.

Class name	ControlCabinet
Description	The role class “ControlCabinet” should be used for enclosed electrical and/or electronic assembly.
Parent class	AutomationMLCSRoleClassLib/ControlEquipment

Table A.29 – RoleClass ControlCabinet

EXAMPLE Switch cabinet, control box.

A.30 RoleClass IODevice

Table A.30 specifies the role class “IODevice”.

Class name	IODevice
Description	The role class “IODevice” should be used for devices providing the functionality to connect sensors or actuators with an automation system. IODevice can consist of different modules.
Parent class	AutomationMLCSRoleClassLib/ControlEquipment

Table A.30 – RoleClass IODevice

EXAMPLE Device consisting of analog/digital input/output modules.

A.31 RoleClass HMI

Table A.31 specifies the role class “HMI”.

Class name	HMI
Description	The role class “HMI” should be used for the functionality to visualize an industrial control and monitoring system for the effective operation and control of the machine by humans.
Parent class	AutomationMLCSRoleClassLib/ControlEquipment

Table A.31 – RoleClass HMI

A.32 RoleClass WarningEquipment

Table A.32 specifies the role class “WarningEquipment”.

Class name	WarningEquipment
Description	The role class “WarningEquipment” should be used for equipment providing warning functionality. NOTE The functionality can be realized in auditive, visual, haptic or other way.
Parent class	AutomationMLExtendedRoleClassLib/HMI

Table A.32 – RoleClass WarningEquipment

EXAMPLE Horn, signal light, vibration, siren, signal lamp.

A.33 RoleClass ActuatingDrive

Table A.33 specifies the role class “ActuatingDrive”.

Class name	ActuatingDrive
Description	The role class “ActuatingDrive” should be used for physical unit used for driving mechanically actuated final controlling elements.
Parent class	AutomationMLCSRoleClassLib/ControlEquipment/Actuator

Table A.33 – RoleClass ActuatingDrive

EXAMPLE Electric, hydraulic, pneumatic drive.

A.34 RoleClass MotionController

Table A.34 specifies the role class “MotionController”.

Class name	MotionController
Description	The role class “MotionController” should be used for logic to generate set points (the desired output or motion profile) and close a position or velocity feedback loop.
Parent class	AutomationMLCSRoleClassLib/ControlEquipment

Table A.34 – RoleClass MotionController

A.35 RoleClass Panel

Table A.35 specifies the role class “Panel”.

Class name	Panel
Description	The role class “Panel” should be used for physical objects providing one possibility for humans to interact with machines.
Parent class	AutomationMLCSRoleClassLib/ControlEquipment/ControlHardware

Table A.35 – RoleClass Panel

EXAMPLE Control panel, scanner, monitoring panel, key panel.

A.36 RoleClass MeasuringEquipment

Table A.36 specifies the role class “MeasuringEquipment”.

Class name	MeasuringEquipment
Description	The role class “MeasuringEquipment” should be used for defining equipment defined in IEC60050-311:2001, 311-03-05: “assembly of measuring instruments intended for specified measurement purposes”
Parent class	AutomationMLBaseRoleClassLib/AutomationMLBaseRole/Resource

Table A.36 – RoleClass MeasuringEquipment

EXAMPLE Surface measuring machine, paint thickness gauge.

A.37 RoleClass Clamp

Table A.37 specifies the role class “Clamp”.

Class name	Clamp
Description	The role class “Clamp” should be used for equipment that performs fixation processes to hold items at one specific point.
Parent class	AutomationMLDMIRoleClassLib/DiscManufacturingEquipment/Fixture

Table A.37 – RoleClass Clamp

A.38 RoleClass ProcessController

Table A.38 specifies the role class “ProcessController”.

Class name	ProcessController
Description	The role class “ProcessController” should be used for the control of a specific tool or machine that performs process steps on a product.
Parent class	AutomationMLCSRoleClassLib/ControlEquipment/Controller

Table A.38 – RoleClass ProcessController

EXAMPLE Welding control, technology control, glue control, combination of control and regulation of process.

A.39 RoleClass Loader

Table A.39 specifies the role class “Loader”.

Class name	Loader
Description	The role class “Loader” should be used for equipment to introduce products into the production process.
Parent class	AutomationMLDMIRoleClassLib/DiscManufacturingEquipment/Storage

Table A.39 – RoleClass Loader

EXAMPLE Magazine loader.

A.40 RoleClass Unloader

Table A.40 specifies the role class “Unloader”.

Class name	Unloader
Description	The role class “Unloader” should be used for equipment to export products out of the production process.
Parent class	AutomationMLDMIRoleClassLib/DiscManufacturingEquipment/Storage

Table A.40 – RoleClass Unloader

Annex B – Examples of usage of RoleClasses

B.1 General

RoleClasses are vendor independent and generic entities. They are used in order to assign a generic semantics to an object instance and to describe requirements of this object instance. Additionally, they can help in mapping data models of different engineering tools.

Figure B.1 explains this by means of an example: An object RB1 in the data model of Tool1 is modelled in AML as InternalElement which is derived from the SystemUnitClass Type_RB and additionally associated with the RoleClass Robot. Tool2 has an InstanceHierarchy with an InternalElement 3285_AB which is of type Rob and points to the same RoleClass Robot. A mapping between these two models can be derived by the RoleClass Robot (common to both InternalElements).

Tool1		
Instance (InternalElement)	Type (SystemUnitClass)	Role (RoleClass)
Station → RB1	Type_RB	Robot

Tool2		
Instance (InternalElement)	Type (SystemUnitClass)	Role (RoleClass)
3285_AB	Rob	Robot

Figure B.1 - Usage of roles in the mapping process

B.2 Example plant unit

The usage of RoleClasses will be explained by means of a simple example cell. The plant cell is depicted in Figure B.2. It consists of three plant components, a conveyor, a robot and a turntable. The robot places parts on the conveyor. The conveyor transports the parts to the turntable and the turntable forwards the parts to further plant cells.

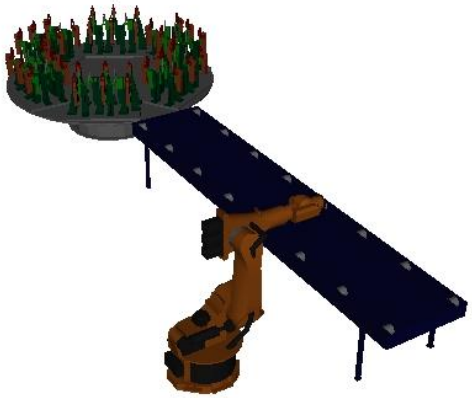


Figure B.2 – Example for usage of roles

The example (see Figure B.3) consists of the AML standard libraries (AutomationMLBaseRoleClassLib, AutomationMLDMIRoleClassLib, and AutomationMLExtendedRoleClassLib), the concrete plant within an InstanceHierarchy (RoleExample), and different plant component types within a SytemUnitClass library (ExampleSystemUnitClassLib). The RoleClassLibs and the contained RoleClasses are explained in whitepaper part 1, as well as Clause 3 and Annex A of this whitepaper.

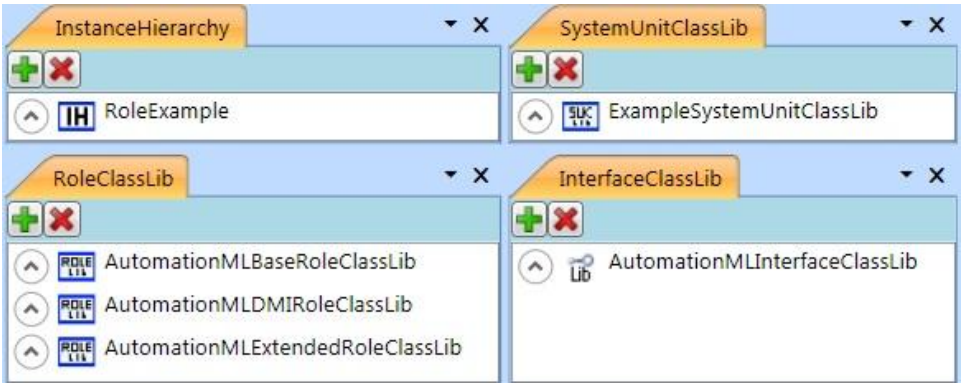


Figure B.3 – Example AML model

Figure B.4, Figure B.5, and Figure B.6 depict the InstanceHierarchy of the example called RoleExample. The example plant describes a cell which is indicated by the RoleClass WorkCell of the AutomationMLExtendedRoleClassLib. The reference to this role class means that the hierarchy element (InternalElement) describes a production line or a station in which the production step takes place. Additionally, the cell points to the RoleClass ResourceStructure of the AutomationMLBaseRoleClassLib. This means that the cell is a resource oriented object hierarchy.

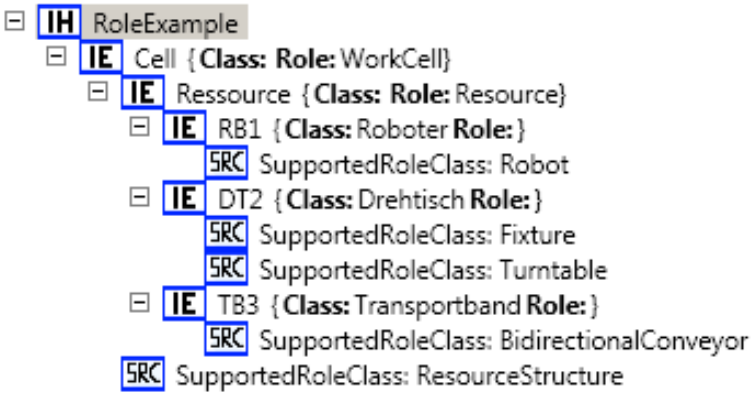


Figure B.4 – Example InstanceHierarchy for usage of roles

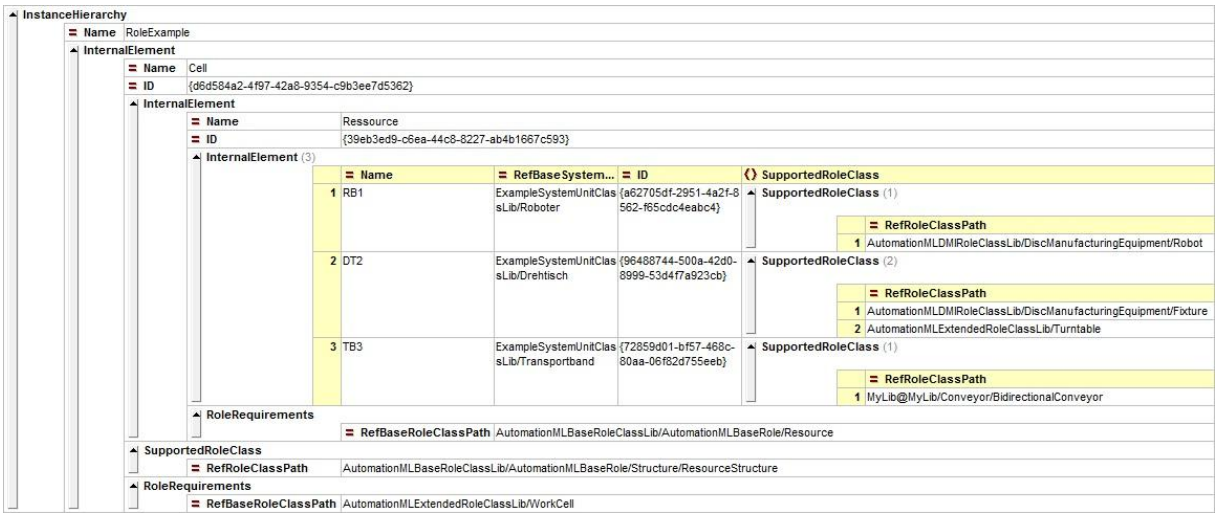


Figure B.5 – XML grid of the example InstanceHierarchy for usage of roles

```
<InstanceHierarchy Name="RoleExample">
  <InternalElement Name="Cell" ID="{d6d584a2-4f97-42a8-9354-c9b3ee7d5362}">
    <InternalElement Name="Ressource" ID="{39eb3ed9-c6ea-44c8-8227-ab4b1667c593}">
      <InternalElement Name="RB1" RefBaseSystemUnitPath="ExampleSystemUnitClassLib/Roboter" ID="{a62705df-2951-4a2f-8562-f65cdc4eabc4}">
        <SupportedRoleClass RefRoleClassPath="AutomationMLDMIRoleClassLib/DiscManufacturingEquipment/Robot"/>
      </InternalElement>
      <InternalElement Name="DT2" RefBaseSystemUnitPath="ExampleSystemUnitClassLib/Drehtisch" ID="{96488744-500a-42d0-8999-53d4f7a923cb}">
        <SupportedRoleClass RefRoleClassPath="AutomationMLDMIRoleClassLib/DiscManufacturingEquipment/Fixture"/>
        <SupportedRoleClass RefRoleClassPath="AutomationMLExtendedRoleClassLib/Turntable"/>
      </InternalElement>
      <InternalElement Name="TB3" RefBaseSystemUnitPath="ExampleSystemUnitClassLib/Transportband" ID="{72859d01-bf57-468c-80aa-06f82d755eeb}">
        <SupportedRoleClass RefRoleClassPath="MyLib@MyLib/Conveyor/BidirectionalConveyor"/>
      </InternalElement>
      <RoleRequirements RefBaseRoleClassPath="AutomationMLBaseRoleClassLib/AutomationMLBaseRole/Resource"/>
    </InternalElement>
    <SupportedRoleClass RefRoleClassPath="AutomationMLBaseRoleClassLib/AutomationMLBaseRole/Structure/ResourceStructure"/>
    <RoleRequirements RefBaseRoleClassPath="AutomationMLExtendedRoleClassLib/WorkCell"/>
  </InternalElement>
</InstanceHierarchy>
```

Figure B.6 – XML text of the example InstanceHierarchy for usage of roles

On the next hierarchy level, the InternalElement Cell gets an explicit InternalElement Ressource which references the RoleClass Resource of the AutomationMLBaseRoleClassLib.

The concept of division into resource, product and process is described in part 1 of the whitepapers: Resources describe plants, equipment or other production resources.

Below the InternalElement Ressource, there are three different plant components:

- The InternalElement RB1 which references the RoleClass Robot. This RoleClass is a standard AML RoleClass defined within the AutomationMLDMIRoleClassLib. This means that this InternalElement represents automatically controlled, reprogrammable, multipurpose manipulators, programmable in three or more axes, which can be either fixed in place or mobile for use in industrial automation applications. Furthermore, the technical implementation is given by the derivation from the SystemUnitClass Roboter described hereinafter.

- The InternalElement DT2 which references the RoleClass Turntable defined within the informative AutomationMLExtendedRoleClassLib. Furthermore, it possesses a reference to the standard RoleClass Fixture of the AutomationMLDMIRoleClassLib. This means that it represents rotating transport equipment which changes the horizontal transport direction of a product and/or carrier. But at the same time, the InternalElement is equipment that reduces the degrees of freedom of an item. Both RoleClasses are supported by this InternalElement. Furthermore, the technical implementation is given by the derivation from the SystemUnitClass Drehtisch described hereinafter.

- The InternalElement TB3 which references the RoleClass BidirectionalConveyor. This RoleClass is a user-defined RoleClass. The definition of the RoleClass can be found via the ExternalReference (see Figure B.7) which points to the file c://xyz_lib.aml on the localhost and is identified via the Alias MyLib. The RoleClass BidirectionalConveyor is referenced by means of the RefRoleClassPath element containing the string “MyLib@MyLib/Conveyor/BidirectionalConveyor" (see Figure B.8). This means that this InternalElement is a user-defined element which is because of restrictions of the AML specification derived directly or indirectly from the AutomationMLBaseRoleClass. Furthermore, the technical implementation is given by the derivation from the SystemUnitClass Transportband described hereinafter.

ExternalReference Path=../xyz_lib.aml Alias=MyLib

```
<ExternalReference Path="../xyz_lib.aml" Alias="MyLib"/>
```

Figure B.7 – External RoleClassLib reference

3	TB3	ExampleSystemUnitClassLib/Transportband	{72859d01-bf57-468c-80aa-06f82d755eeb}	**SupportedRoleClass** (1)

	RefRoleClassPath
1	MyLib@MyLib/Conveyor/BidirectionalConveyor

```
<InternalElement Name="TB3" RefBaseSystemUnitPath="ExampleSystemUnitClassLib/Transportband" ID="{72859d01-bf57-468c-80aa-06f82d755eeb}">
  <SupportedRoleClass RefRoleClassPath="MyLib@MyLib/Conveyor/BidirectionalConveyor"/>
</InternalElement>
```

Figure B.8 – Usage of external role class in example

Figure B.9, Figure B.10, and Figure B.11 depict the SystemUnitClass library of the example called ExampleSystemUnitClassLib. Within the library, three plant component types are modelled. These are:

- The class Roboter which points to the RoleClass Robot. This RoleClass is a standard AML RoleClass defined within the AutomationMLDMIRoleClassLib. This means that this SystemUnitClass represents automatically controlled, reprogrammable, multipurpose, manipulators programmable in three or more axes, which may be either fixed in place or mobile for use in industrial automation applications.

- The class Drehtisch which points to the RoleClass Turntable and Clamp defined within the informative AutomationMLExtendedRoleClassLib. This means that it represents rotating transport equipment which changes the horizontal transport direction of a product and/or carrier. But at the same time, the SystemUnitClass is able to perform fixation processes to hold items at one specific point. Both RoleClasses are supported by this SystemUnitClass.

- The class Transportband which points to the RoleClass Transport. This RoleClass is a standard AML RoleClass defined within the AutomationMLDMIRoleClassLib. This means that this SystemUnitClass is equipment that performs transport processes to transfer items from one location to another.

The SystemUnitClasses of this example describe the plant component types. This type can be system specific or language dependent. In the present case, the class names are in German. The roles make an independent understanding possible, even if German is not supported as a language.

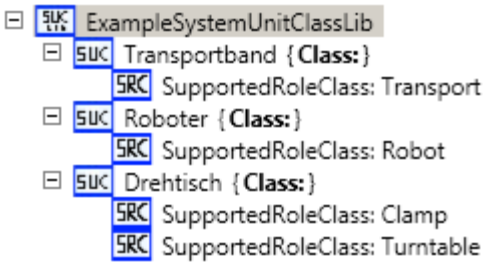
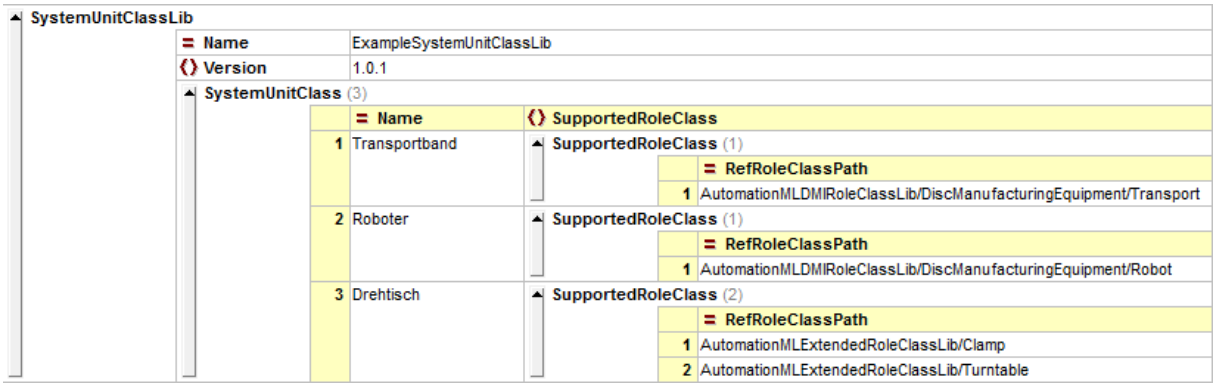


Figure B.9 – Example SystemUnitClass library for usage of roles



SystemUnitClassLib				
Name	ExampleSystemUnitClassLib			
Version	1.0.1			
SystemUnitClass (3)				
	Name	SupportedRoleClass		
1	Transportband	SupportedRoleClass (1)		
			RefRoleClassPath	
			1	AutomationMLDMIRoleClassLib/DiscManufacturingEquipment/Transport
2	Roboter	SupportedRoleClass (1)		
			RefRoleClassPath	
			1	AutomationMLDMIRoleClassLib/DiscManufacturingEquipment/Robot
3	Drehtisch	SupportedRoleClass (2)		
			RefRoleClassPath	
			1	AutomationMLExtendedRoleClassLib/Clamp
			2	AutomationMLExtendedRoleClassLib/Turntable

Figure B.10 – XML grid of the example SystemUnitClass library for usage of roles

```
<SystemUnitClassLib Name="ExampleSystemUnitClassLib">
  <Version>1.0.1</Version>
  <SystemUnitClass Name="Transportband">
    <SupportedRoleClass RefRoleClassPath="AutomationMLDMIRoleClassLib/DiscManufacturingEquipment/Transport"/>
  </SystemUnitClass>
  <SystemUnitClass Name="Roboter">
    <SupportedRoleClass RefRoleClassPath="AutomationMLDMIRoleClassLib/DiscManufacturingEquipment/Robot"/>
  </SystemUnitClass>
  <SystemUnitClass Name="Drehtisch">
    <SupportedRoleClass RefRoleClassPath="AutomationMLExtendedRoleClassLib/Clamp"/>
    <SupportedRoleClass RefRoleClassPath="AutomationMLExtendedRoleClassLib/Turntable"/>
  </SystemUnitClass>
</SystemUnitClassLib>
```

Figure B.11 – XML text of the example SystemUnitClass library for usage of roles

Annex C – User-defined RoleClass Libraries

C.1 General

Some existing user-defined libraries of different type and origin are listed here as an example. These consist of:

- UserDefinedRoleClassLibFoodAndBeverage.aml
  One industry-specific library in the context of food and beverage (see Figure C.1).

- UserDefinedRoleClassLibRedBookVDMA.aml
  One association-specific library from the VDMA (Verband Deutscher Maschinen- und Anlagenbau – German Engineering Federation) and VDW (Verein Deutscher Werkzeugmaschinenhersteller – German Machine Tool Manufacturers Union) – the RedBook: Every one of the different types of machines supplied by German machine tool manufacturers can be found in this directory.

- UserDefinedRoleClassLibCompanySpecificStructure.aml
  One company-specific library including structure related classes. This library is a concrete working example which shows how to build up such libraries in practice.

- UserDefinedRoleClassLibPandixPCE.aml and UserDefinedRoleClassLibPandixPPE.aml
  StandardLibraries related to the process industry according to the format PandIX. PandIX is a data model to describe the piping and instrumentation information of a process plant with focus on process automation aspects. It offers modelling guidelines for process control engineering data described in the P&ID (piping and instrumentation diagram) and hence formalized access to this data. For this it provides CAEX libraries especially designed for process automation.

These examples are not explained in detail within AML whitepapers. Further tool-specific libraries or libraries consisting of company standards are also possible.

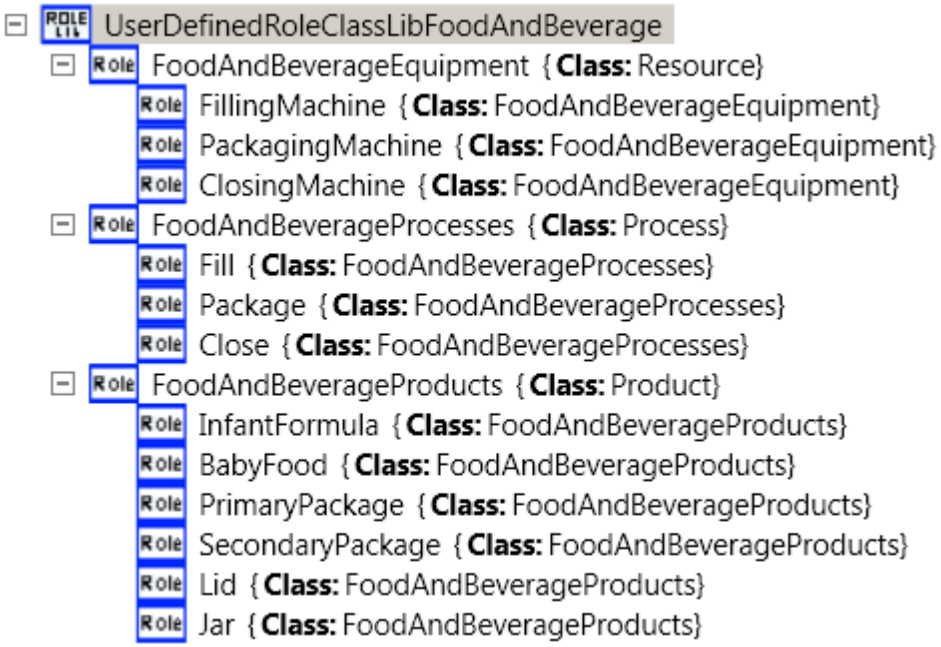
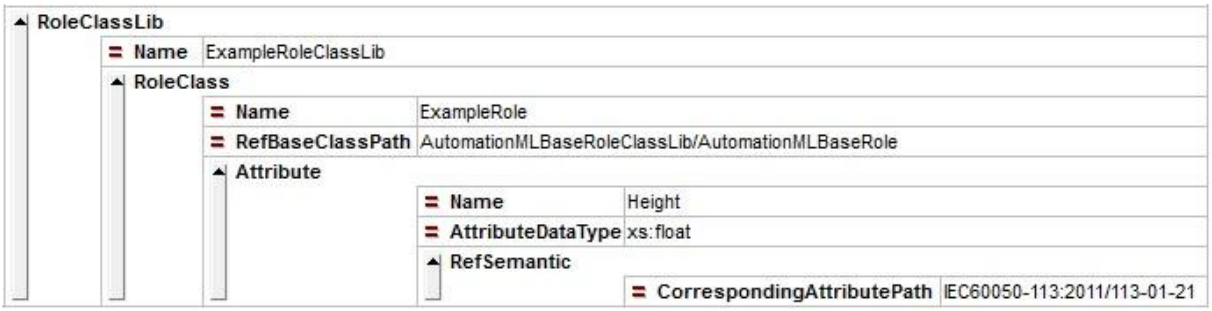


Figure C.1 – AML user-defined RoleClassLib FoodAndBeverage

C.2 External semantics of attributes

To include references to external definitions of attributes, the CAEX element “RefSemantic” can be used. This element enables referencing attribute semantics defined in other standards. In Figure C.2 the ExampleRole possesses an attribute Height. This attribute is defined in the IEC 60050-113:2011, 113-01-21, which is depicted by means of the CorrespondingAttributePath. This mechanism helps to reference externally defined attribute definitions.




```
<RoleClassLib Name="ExampleRoleClassLib">
  <RoleClass Name="ExampleRole" RefBaseClassPath="AutomationMLBaseRoleClassLib/AutomationMLBaseRole">
    <Attribute Name="Height" AttributeDataType="xs:float">
      <RefSemantic CorrespondingAttributePath="IEC60050-113:2011/113-01-21" />
    </Attribute>
  </RoleClass>
</RoleClassLib>
```

Figure C.2 – Example for external attribute semantics

Annex D – XML representation of AML libraries

D.1 AutomationMLDMIRoleClassLib

```
<?xml version="1.0" encoding="utf-8"?>
<CAEXFile FileName="AutomationMLDMIRoleClassLib.aml" SchemaVersion="2.15"
      xsi:noNamespaceSchemaLocation="CAEX_ClassModel_V2.15.xsd"
      xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">
 <AdditionalInformation AutomationMLVersion="2.0" />
 <AdditionalInformation>
  <WriterHeader>
   <WriterName>IEC SC65E WG 9</WriterName>
   <WriterID>IEC SC65E WG 9</WriterID>
   <WriterVendor>IEC</WriterVendor>
   <WriterVendorURL>www.iec.ch</WriterVendorURL>
   <WriterVersion>1.0</WriterVersion>
   <WriterRelease>1.0.0</WriterRelease>
   <LastWritingDateTime>2013-03-01</LastWritingDateTime>
   <WriterProjectTitle>Automation Markup Language Standard
     Libraries</WriterProjectTitle>
   <WriterProjectID>Automation Markup Language Standard
     Libraries</WriterProjectID>
  </WriterHeader>
 </AdditionalInformation>
<ExternalReference Path="AutomationMLBaseRoleClassLib.aml"
      Alias="AutomationMLBaseRoleClassLib" />
 <RoleClassLib Name="AutomationMLDMIRoleClassLib">
<Description>Automation Markup Language  Discrete Manufacturing Industry Role
      Class Library</Description>
  <Version>2.4.0</Version>
<RoleClass Name="DiscManufacturingEquipment"
      RefBaseClassPath="AutomationMLBaseRoleClassLib@AutomationMLBaseRoleClass
      Lib/AutomationMLBaseRole/Resource">
   <RoleClass Name="Transport" RefBaseClassPath="DiscManufacturingEquipment"
     />
   <RoleClass Name="Storage" RefBaseClassPath="DiscManufacturingEquipment" />
   <RoleClass Name="Fixture" RefBaseClassPath="DiscManufacturingEquipment" />
   <RoleClass Name="Gate" RefBaseClassPath="DiscManufacturingEquipment" />
   <RoleClass Name="Robot" RefBaseClassPath="DiscManufacturingEquipment" />
   <RoleClass Name="Tool" RefBaseClassPath="DiscManufacturingEquipment" />
   <RoleClass Name="Carrier" RefBaseClassPath="DiscManufacturingEquipment" />
   <RoleClass Name="Machine" RefBaseClassPath="DiscManufacturingEquipment" />
   <RoleClass Name="StaticObject"
     RefBaseClassPath="DiscManufacturingEquipment" />
  </RoleClass>
 </RoleClassLib>
</CAEXFile>
```

D.2 AutomationMLCMIRoleClassLib

```
<?xml version="1.0" encoding="utf-8"?>
<CAEXFile FileName="AutomationMLCMIRoleClassLib.aml" SchemaVersion="2.15"
      xsi:noNamespaceSchemaLocation="CAEX_ClassModel_V2.15.xsd"
      xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">
 <AdditionalInformation AutomationMLVersion="2.0" />
 <AdditionalInformation>
  <WriterHeader>
   <WriterName>IEC SC65E WG 9</WriterName>
   <WriterID>IEC SC65E WG 9</WriterID>
   <WriterVendor>IEC</WriterVendor>
   <WriterVendorURL>www.iec.ch</WriterVendorURL>
   <WriterVersion>1.0</WriterVersion>
   <WriterRelease>1.0.0</WriterRelease>
   <LastWritingDateTime>2013-03-01</LastWritingDateTime>
```

```
    <WriterProjectTitle>Automation Markup Language Standard
      Libraries</WriterProjectTitle>
    <WriterProjectID>Automation Markup Language Standard
      Libraries</WriterProjectID>
  </WriterHeader>
 </AdditionalInformation>
<ExternalReference Path="AutomationMLBaseRoleClassLib.aml"
      Alias="AutomationMLBaseRoleClassLib" />
 <RoleClassLib Name="AutomationMLCMIRoleClassLib">
<Description>Automation Markup Language Continuous Manufacturing Industry Role
      Class Library</Description>
  <Version>1.1.0</Version>
<RoleClass Name="ContManufacturingEquipment"
      RefBaseClassPath="AutomationMLBaseRoleClassLib@AutomationMLBaseRoleClass
      Lib/AutomationMLBaseRole/Resource" />
 </RoleClassLib>
</CAEXFile>
```

D.3 AutomationMLBMIRoleClassLib

```
<?xml version="1.0" encoding="utf-8"?>
<CAEXFile FileName="AutomationMLBMIRoleClassLib.aml" SchemaVersion="2.15"
      xsi:noNamespaceSchemaLocation="CAEX_ClassModel_V2.15.xsd"
      xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">
 <AdditionalInformation AutomationMLVersion="2.0" />
 <AdditionalInformation>
  <WriterHeader>
   <WriterName>IEC SC65E WG 9</WriterName>
   <WriterID>IEC SC65E WG 9</WriterID>
   <WriterVendor>IEC</WriterVendor>
   <WriterVendorURL>www.iec.ch</WriterVendorURL>
   <WriterVersion>1.0</WriterVersion>
   <WriterRelease>1.0.0</WriterRelease>
   <LastWritingDateTime>2013-03-01</LastWritingDateTime>
   <WriterProjectTitle>Automation Markup Language Standard
      Libraries</WriterProjectTitle>
   <WriterProjectID>Automation Markup Language Standard
      Libraries</WriterProjectID>
  </WriterHeader>
 </AdditionalInformation>
<ExternalReference Path="AutomationMLBaseRoleClassLib.aml"
      Alias="AutomationMLBaseRoleClassLib" />
 <RoleClassLib Name="AutomationMLBMIRoleClassLib">
<Description>Automation Markup Language Batch Manufacturing Industry Role
      Class Library</Description>
  <Version>1.1.0</Version>
<RoleClass Name="BatchManufacturingEquipment"
      RefBaseClassPath="AutomationMLBaseRoleClassLib@AutomationMLBaseRoleClass
      Lib/AutomationMLBaseRole/Resource" />
 </RoleClassLib>
</CAEXFile>
```

D.4 AutomationMLCSRoleClassLib

```
<?xml version="1.0" encoding="utf-8"?>
<CAEXFile FileName="AutomationMLCSRoleClassLib.aml" SchemaVersion="2.15"
      xsi:noNamespaceSchemaLocation="CAEX_ClassModel_V2.15.xsd"
      xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">
 <AdditionalInformation AutomationMLVersion="2.0" />
 <AdditionalInformation>
  <WriterHeader>
   <WriterName>IEC SC65E WG 9</WriterName>
   <WriterID>IEC SC65E WG 9</WriterID>
   <WriterVendor>IEC</WriterVendor>
   <WriterVendorURL>www.iec.ch</WriterVendorURL>
```

```
    <WriterVersion>1.0</WriterVersion>
    <WriterRelease>1.0.0</WriterRelease>
    <LastWritingDateTime>2013-03-01</LastWritingDateTime>
    <WriterProjectTitle>Automation Markup Language Standard
      Libraries</WriterProjectTitle>
    <WriterProjectID>Automation Markup Language Standard
      Libraries</WriterProjectID>
  </WriterHeader>
 </AdditionalInformation>
<ExternalReference Path="AutomationMLBaseRoleClassLib.aml"
      Alias="AutomationMLBaseRoleClassLib" />
 <RoleClassLib Name="AutomationMLCSRoleClassLib">
  <Description>Automation Markup Language Control Industry Role Class
      Library</Description>
  <Version>2.3.0</Version>
<RoleClass Name="ControlEquipment"
      RefBaseClassPath="AutomationMLBaseRoleClassLib@AutomationMLBaseRoleClass
      Lib/AutomationMLBaseRole/Resource">
    <RoleClass Name="Communication" RefBaseClassPath="ControlEquipment" />
    <RoleClass Name="ControlHardware" RefBaseClassPath="ControlEquipment">
      <RoleClass Name="PC" RefBaseClassPath="ControlHardware" />
      <RoleClass Name="IPC" RefBaseClassPath="ControlHardware" />
      <RoleClass Name="EmbeddedDevice" RefBaseClassPath="ControlHardware" />
      <RoleClass Name="Handheld" RefBaseClassPath="ControlHardware" />
    </RoleClass>
    <RoleClass Name="Sensor" RefBaseClassPath="ControlEquipment" />
    <RoleClass Name="Actuator" RefBaseClassPath="ControlEquipment" />
    <RoleClass Name="Controller" RefBaseClassPath="ControlEquipment">
      <RoleClass Name="PLC" RefBaseClassPath="Controller" />
      <RoleClass Name="NC" RefBaseClassPath="Controller" />
      <RoleClass Name="RC" RefBaseClassPath="Controller" />
      <RoleClass Name="PAC" RefBaseClassPath="Controller" />
    </RoleClass>
  </RoleClass>
 </RoleClassLib>
</CAEXFile>
```

D.5 AutomationMLExtendedRoleClassLib

```
<?xml version="1.0" encoding="utf-8"?>
<CAEXFile FileName="AutomationMLExtendedRoleClassLib.aml" SchemaVersion="2.15"
      xsi:noNamespaceSchemaLocation="CAEX_ClassModel_V2.15.xsd"
      xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">
 <AdditionalInformation AutomationMLVersion="2.0" />
 <AdditionalInformation>
  <WriterHeader>
    <WriterName>IEC SC65E WG 9</WriterName>
    <WriterID>IEC SC65E WG 9</WriterID>
    <WriterVendor>IEC</WriterVendor>
    <WriterVendorURL>www.iec.ch</WriterVendorURL>
    <WriterVersion>1.0</WriterVersion>
    <WriterRelease>1.0.0</WriterRelease>
    <LastWritingDateTime>2013-03-01</LastWritingDateTime>
    <WriterProjectTitle>Automation Markup Language Standard
      Libraries</WriterProjectTitle>
    <WriterProjectID>Automation Markup Language Standard
      Libraries</WriterProjectID>
  </WriterHeader>
 </AdditionalInformation>
<ExternalReference Path="AutomationMLBaseRoleClassLib.aml"
      Alias="AutomationMLBaseRoleClassLib" />
<ExternalReference Path="AutomationMLDMIRoleClassLib.aml"
      Alias="AutomationMLDMIRoleClassLib" />
<ExternalReference Path="AutomationMLCSRoleClassLib.aml"
      Alias="AutomationMLCSRoleClassLib" />
```

```
 <RoleClassLib Name="AutomationMLExtendedRoleClassLib">
  <Version>2.7.0</Version>
<RoleClass Name="PLCFacet"
      RefBaseClassPath="AutomationMLBaseRoleClassLib@AutomationMLBaseRoleClass
      Lib/AutomationMLBaseRole/Facet" />
<RoleClass Name="HMIFacet"
      RefBaseClassPath="AutomationMLBaseRoleClassLib@AutomationMLBaseRoleClass
      Lib/AutomationMLBaseRole/Facet" />
<RoleClass Name="Enterprise"
      RefBaseClassPath="AutomationMLBaseRoleClassLib@AutomationMLBaseRoleClass
      Lib/AutomationMLBaseRole/Structure/ResourceStructure" />
<RoleClass Name="Site"
      RefBaseClassPath="AutomationMLBaseRoleClassLib@AutomationMLBaseRoleClass
      Lib/AutomationMLBaseRole/Structure/ResourceStructure" />
<RoleClass Name="Area"
      RefBaseClassPath="AutomationMLBaseRoleClassLib@AutomationMLBaseRoleClass
      Lib/AutomationMLBaseRole/Structure/ResourceStructure" />
<RoleClass Name="ProductionLine"
      RefBaseClassPath="AutomationMLBaseRoleClassLib@AutomationMLBaseRoleClass
      Lib/AutomationMLBaseRole/Structure/ResourceStructure" />
<RoleClass Name="WorkCell"
      RefBaseClassPath="AutomationMLBaseRoleClassLib@AutomationMLBaseRoleClass
      Lib/AutomationMLBaseRole/Structure/ResourceStructure" />
<RoleClass Name="ProcessCell"
      RefBaseClassPath="AutomationMLBaseRoleClassLib@AutomationMLBaseRoleClass
      Lib/AutomationMLBaseRole/Structure/ResourceStructure" />
<RoleClass Name="Unit"
      RefBaseClassPath="AutomationMLBaseRoleClassLib@AutomationMLBaseRoleClass
      Lib/AutomationMLBaseRole/Structure/ResourceStructure" />
<RoleClass Name="ProductionUnit"
      RefBaseClassPath="AutomationMLBaseRoleClassLib@AutomationMLBaseRoleClass
      Lib/AutomationMLBaseRole/Structure/ResourceStructure" />
<RoleClass Name="StorageZone"
      RefBaseClassPath="AutomationMLBaseRoleClassLib@AutomationMLBaseRoleClass
      Lib/AutomationMLBaseRole/Structure/ResourceStructure" />
<RoleClass Name="StorageUnit"
      RefBaseClassPath="AutomationMLBaseRoleClassLib@AutomationMLBaseRoleClass
      Lib/AutomationMLBaseRole/Structure/ResourceStructure" />
<RoleClass Name="Turntable"
      RefBaseClassPath="AutomationMLDMIRoleClassLib@AutomationMLDMIRoleClassLi
      b/DiscManufacturingEquipment/Transport" />
<RoleClass Name="Conveyor"
      RefBaseClassPath="AutomationMLDMIRoleClassLib@AutomationMLDMIRoleClassLi
      b/DiscManufacturingEquipment/Transport">
    <RoleClass Name="BeltConveyor" RefBaseClassPath="Conveyor" />
    <RoleClass Name="RollConveyor" RefBaseClassPath="Conveyor" />
    <RoleClass Name="ChainConveyor" RefBaseClassPath="Conveyor" />
    <RoleClass Name="PalletConveyor" RefBaseClassPath="Conveyor" />
    <RoleClass Name="OverheadConveyor" RefBaseClassPath="Conveyor" />
  </RoleClass>
<RoleClass Name="LiftingTable"
      RefBaseClassPath="AutomationMLDMIRoleClassLib@AutomationMLDMIRoleClassLi
      b/DiscManufacturingEquipment/Transport" />
<RoleClass Name="AGV"
      RefBaseClassPath="AutomationMLDMIRoleClassLib@AutomationMLDMIRoleClassLi
      b/DiscManufacturingEquipment/Transport" />
<RoleClass Name="Transposer"
      RefBaseClassPath="AutomationMLDMIRoleClassLib@AutomationMLDMIRoleClassLi
      b/DiscManufacturingEquipment/Transport" />
<RoleClass Name="CarrierHandlingSystem"
      RefBaseClassPath="AutomationMLDMIRoleClassLib@AutomationMLDMIRoleClassLi
      b/DiscManufacturingEquipment/Transport" />
<RoleClass Name="BodyStore"
      RefBaseClassPath="AutomationMLDMIRoleClassLib@AutomationMLDMIRoleClassLi
      b/DiscManufacturingEquipment/Storage" />
```

```
<RoleClass Name="Lift"
      RefBaseClassPath="AutomationMLDMIRoleClassLib@AutomationMLDMIRoleClassLi
      b/DiscManufacturingEquipment/Transport" />
<RoleClass Name="Rollerbed"
      RefBaseClassPath="AutomationMLDMIRoleClassLib@AutomationMLDMIRoleClassLi
      b/DiscManufacturingEquipment/Transport" />
<RoleClass Name="StationaryTool"
      RefBaseClassPath="AutomationMLDMIRoleClassLib@AutomationMLDMIRoleClassLi
      b/DiscManufacturingEquipment/Tool" />
<RoleClass Name="MovableTool"
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