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User Manual

EA Project Structure for Diagnostics Plant I&C

The purpose of this document is to precisely define EA project structure for documenting design of Diagnostics Plant I&C systems. This document covers "how" the design must be documented. The "what" part is covered in The Diagnostics Plant I&C methodology (ITER_D_JQLRRK).

Approval Process			
	Name	*Action*	*Affiliation*
Author	**Kalsi S.**	**20 Dec 2022:signed**	**IO/DG/SCOP/SCOD/CD/CCI**
Co-Authors	**Patil P.**	**26 Dec 2022:signed**	**IO/DG/SCOP/SCOD/CD/CCI**
Reviewers	**Leveque A.**	**24 Jan 2023:recommended**	**IO/DG/ENGN/EDD/PPD**
	Nagornyi N.	**24 Jan 2023:recommended**	**Project Center ITER (RF)**
	Neto A.	**22 Feb 2023:recommended**	**F4E (EU)**
	Perek P.	**30 Jan 2023:recommended**	**COSYLAB d.d. (EU)**
	Santos J.	**31 Jan 2023:recommended**	**IST / IPFN Instituto Superior Técni...**
	Solovev N.	**24 Jan 2023:recommended**	
	Stepanov D.	**10 Feb 2023:recommended**	**IO/DG/SCOP/SCOD/CD/DCS**
	Van Herck W.	**08 Feb 2023:recommended**	**IO/DG/SCOP/SCOD/CD/DCS**
Approver	**Simrock S.**	**22 Feb 2023:approved**	**IO/DG/SCOP/SCOD/CD/CCI**
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1 Introduction

1.1 Purpose

The purpose of this document is to precisely define EA project structure for documenting design of Diagnostics Plant I&C systems. This document covers "how" the design must be documented.

The "what" part is defined in a separate document [RD2]. This includes the various design elements like use cases, requirements, operation procedures, functions, variables, hardware architecture, state machine, etc. Note: In this document the following have been used interchangeably – operation procedure, procedure, activity.

1.2 Overview

This document describes what are the diagrams, elements, stereotypes, tagged values that must be used while developing the EA project.

At some locations in the document, there may be instances where references to "what" are mentioned alongside the "how" part for better understanding. Also, on request from Plant I&C developers references to user manuals of EA add-ins has been provided in the appropriate sections.

Note: This document does not intend to answer queries related to the contents of the different free format sections (artifacts). In most cases, the focus area of these sections will be clear from the name. For those where it is not, please refer examples of systems at good maturity level or else contact ea-support@iter.org.

1.3 Intended Audience

Table 1: Intended Audience

Audience	Description
Plant I&C Designer	Who shall use this document to populate EA Model for Plant I&C design
Plant I&C RO	Who shall use this document to review the EA Model

1.4 References

Table 2: References

Ref#	Document Name	IDM Ref
[RD1]	Plant Control Design Handbook (PCDH)	ITER_D_27LH2V
[RD2]	Diagnostics Plant I&C Design Process (SRS and SDS)	ITER_D_JQLRRK
[RD3]	Diagnostics Plant I&C variable Naming Guideline	ITER_D_X7R88V
[RD4]	ITER Control Breakdown Structure (CBS)	ITER_D_9TYFWC
[RD5]	Requirement Management Guideline	ITER_D_UNL5VW
[RD6]	Enterprise Architect Add-in user manuals	UL2FMF
[RD7]	List of Acceptance Criteria	ITER_D_6JL6ZQ
[RD8]	Signal and plant system I&C Variable Naming Convention	ITER_D_2UT8SH
[RD9]	Functional Breakdown for Diagnostics Plant I&C	ITER_D_ LAJF9S
[RD10]	Miscellaneous points related to Diagnostic Plant I&C Methodology	ITER_D_4ZKAE6
[RD11]	The CODAC - Plant System Interface	ITER_D_34V362
[RD12]	System Health Monitoring Variables	ITER_D_35XFCY
[RD13]	NDS v3 Core Library User Manual	ITER_D_S37HD2
[RD14]	NDS v3 EPICS Device Support User Manual	ITER_D_S977XP
[RD15]	List of Actors and Stakeholders	ITER_D_3W3WE4

1.5 Acronyms

Table 3: Acronyms

Acronyms	Description
CBS	Control Breakdown Structure
EA	Enterprise Architect
FAT	Factory Acceptance Test
HMI	Human Machine Interface
I&C	Instrumentation and Control
PBS	Plant Breakdown Structure
PCDH	Plant Control Design Handbook
PSOS	Plant System Operating States
RD	Reference Document
RO	Responsible Officer
SAT	Site Acceptance Test
UML	Unified Modeling Language

2 EA Project Structure

Note: All information entered in the EA project shall be in English only, and non-free text fields shall contain ASCII characters only. Also, all not applicable fields must be marked as “NA”.

2.1 Naming of EA Project

Each EA Project shall be named according to the Control Breakdown Structure (CBS). Following naming convention should be followed.

CBS1-CBS2 (example – D1-I2).

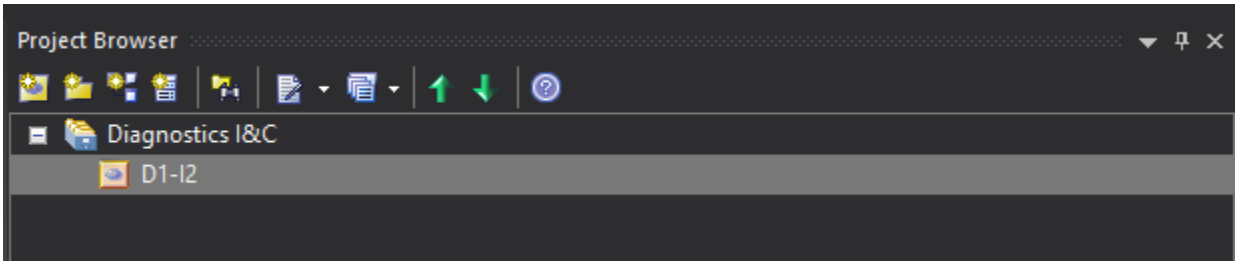


Figure 1: Plant I&C Project in EA Model

Detailed Plant I&C Control breakdown structure for Diagnostics (PBS 55) is available in [RD4].

2.2 Base Level Packages

This section describes the folder structure (Package Structure) in EA Project. Following table describes the package name and design information associated with each package. The naming of each high-level package shall be done as follows-

CBS1-CBS2 <Design Item> (Example D1-I2 Requirements)

Design Item	Package Name	Description
Plant I&C Requirements	CBS1-CBS2 Requirements	In this package Plant I&C requirements must be defined. This package shall include use cases, functional requirements, non-functional requirements, interlock, and safety requirements.
Operation Procedures	CBS1-CBS2 Operation Procedure	In this package various plant, I&C operation procedures must be defined.
Functional Analysis	CBS1-CBS2 Functional Analysis	In this package plant I&C functions and variables must be defined
Hardware Architecture	CBS1-CBS2 Hardware Architecture	In this package plant I&C hardware architecture, Signals and Components must be defined
I&C Cubicle Configuration	CBS1-CBS2 I&C Cubicle Configuration	In this package free format chapters on I&C cubicle configuration must be defined
Automation (PSOS)	CBS1-CBS2 Automation (PSOS)	In this package Plant I&C Automation (PSOS) must be defined
Software Environment	CBS1-CBS2 Software Environment	In this package plant I&C software environment must be defined
Test Scenarios	CBS1-CBS2 Test Scenarios	In this package free format chapters on Plant system test scenarios must be defined

Plant I&C Risk	CBS1-CBS2 Risks	In this package free format chapters on plant, I&C risks and issues must be defined
Users/Actors	CBS1-CBS2 User / Actor	In this package Plant system users and actors must be defined
Stakeholders	CBS1-CBS2 Stakeholders	In this package plant system stakeholders must be defined
Reference Documents	CBS1-CBS2 Reference Documents	In this package reference documents must be defined
Algorithms	CBS1-CBS2 Algorithms	In this package free format chapters on algorithms must be defined
CBS	<<CBS>> CBS1-CBS2 Control Breakdown Structure	In this package control breakdown structure must be defined
PBS	<<PBS>> CBS1-CBS2 Plant Breakdown Structure	In this package plant breakdown structure must be defined
Design Strategies	CBS1-CBS2 Design Strategies	In this package free format chapters on design strategies must be defined
Introduction	CBS1-CBS2 Introduction	In this package free format chapters on introduction must be defined
Overall Description	CBS1-CBS2 Overall Description	In this package free format chapters on overall description must be defined
Plant I&C Overview	CBS1-CBS2 Plant I&C Overview	In this package free format chapters on Plant, I&C Overview must be defined
Project Issues	CBS1-CBS2 Project Issues	In this package free format chapters on Project Issues must be defined
Test Plan	CBS1-CBS2 Test Plan	The contents of this package are yet to be defined
NDS Variables	CBS1-CBS2 NDS Variable	In this package NDS variables must be defined
Plant Automation	CBS1-CBS2 Plant Automation	In this package COS-PSOS mapping must be defined
Acceptance Criteria	CBS1-CBS2 Acceptance Criteria	In this package acceptance criteria must be defined

Note: Maturity assessment and Variable Attributes packages that are visible in the figure below, do not contain any design information, and hence not included in the table above.

Also, in the figure below you can also see COS, SYSM and User Interface packages. These are not required to be defined. If and when these will be required, this document will be updated.

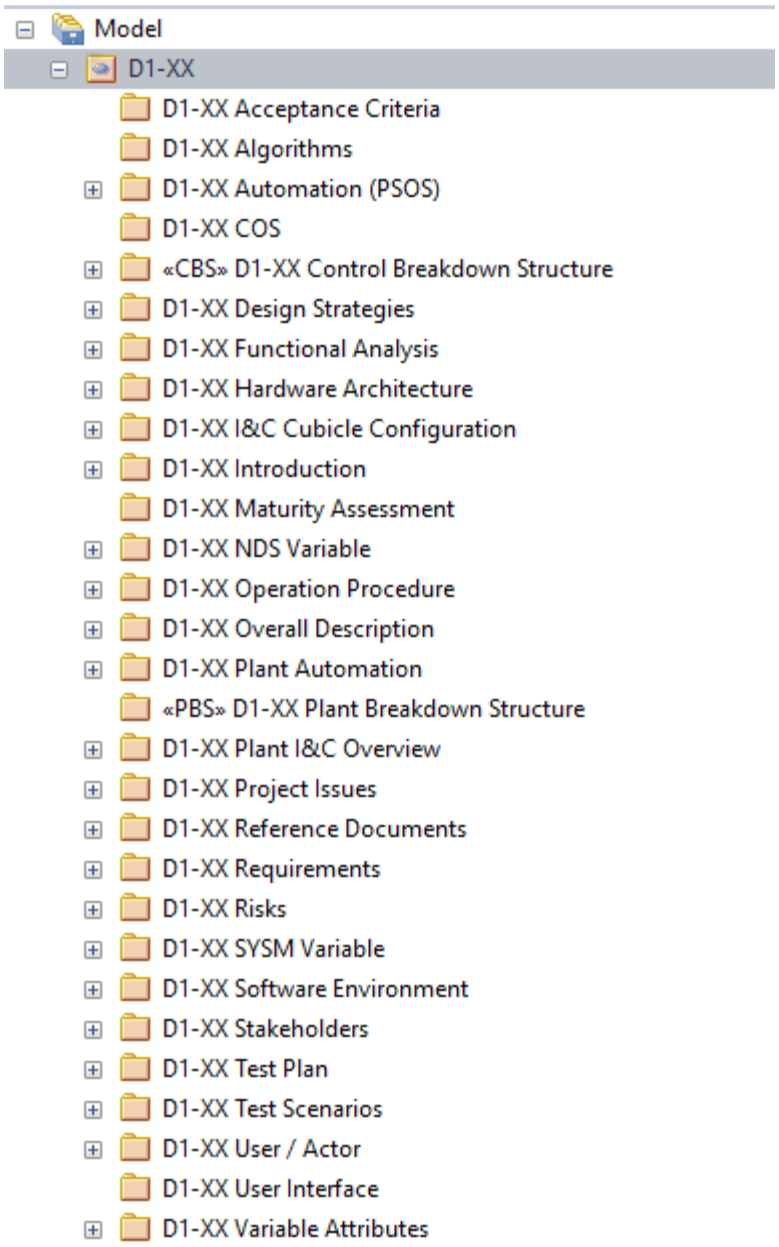


Figure 2: Folder Structure in EA

2.2.1 Link to Verification and Configuration Add-in for Initialization

Please refer [RD6] for the user manual.

2.3 Package Diagram of the EA Project

The figure below shows the organization of information into different packages.

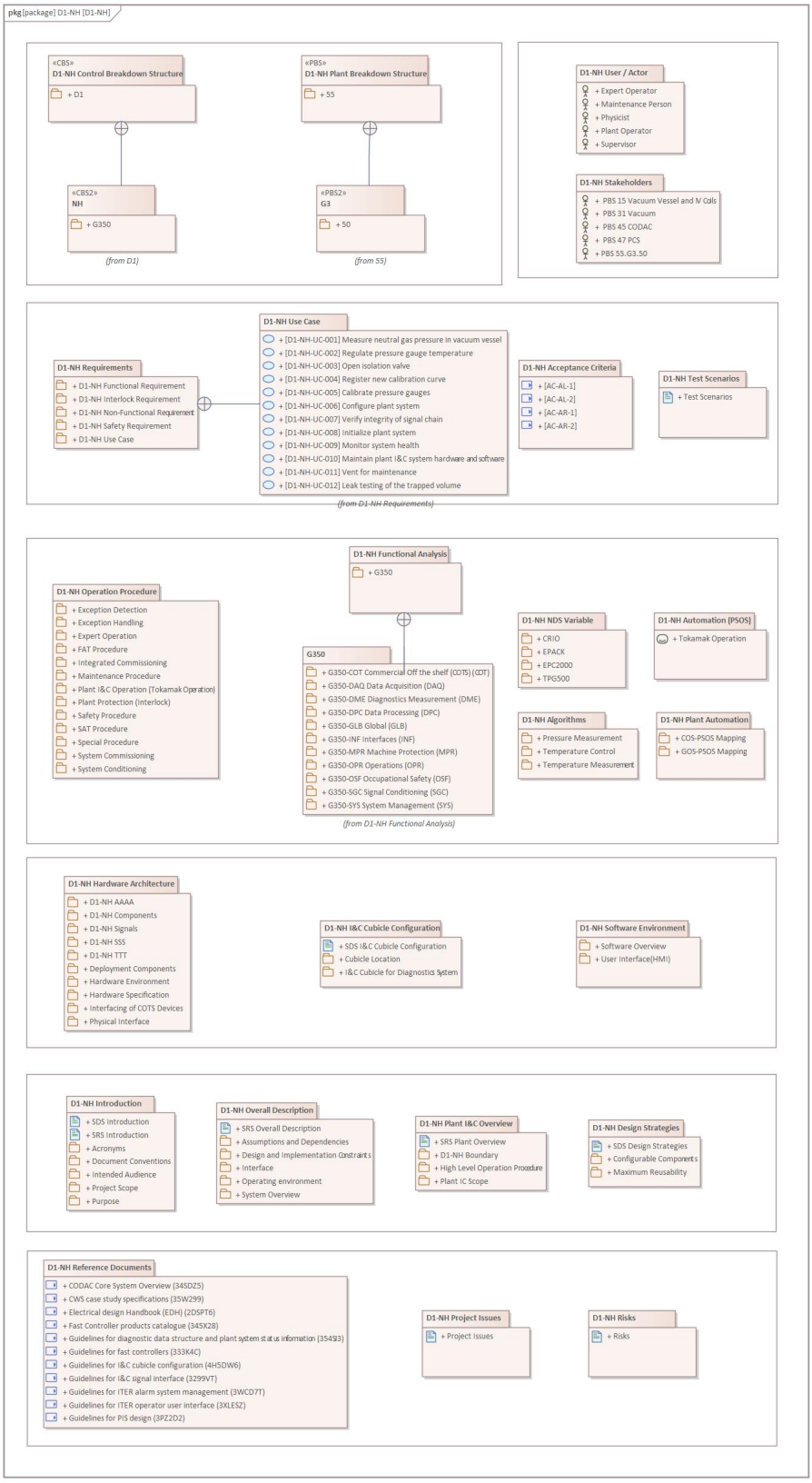


Figure 3: Package Diagram of EA project

2.4 Control Breakdown Structure

This section describes how to define Control Breakdown structure

Add package CBS1-CBS2 Control Breakdown Structure in EA Project (e.g., D2-Q0 Control Breakdown Structure). Provide Stereotype – CBS

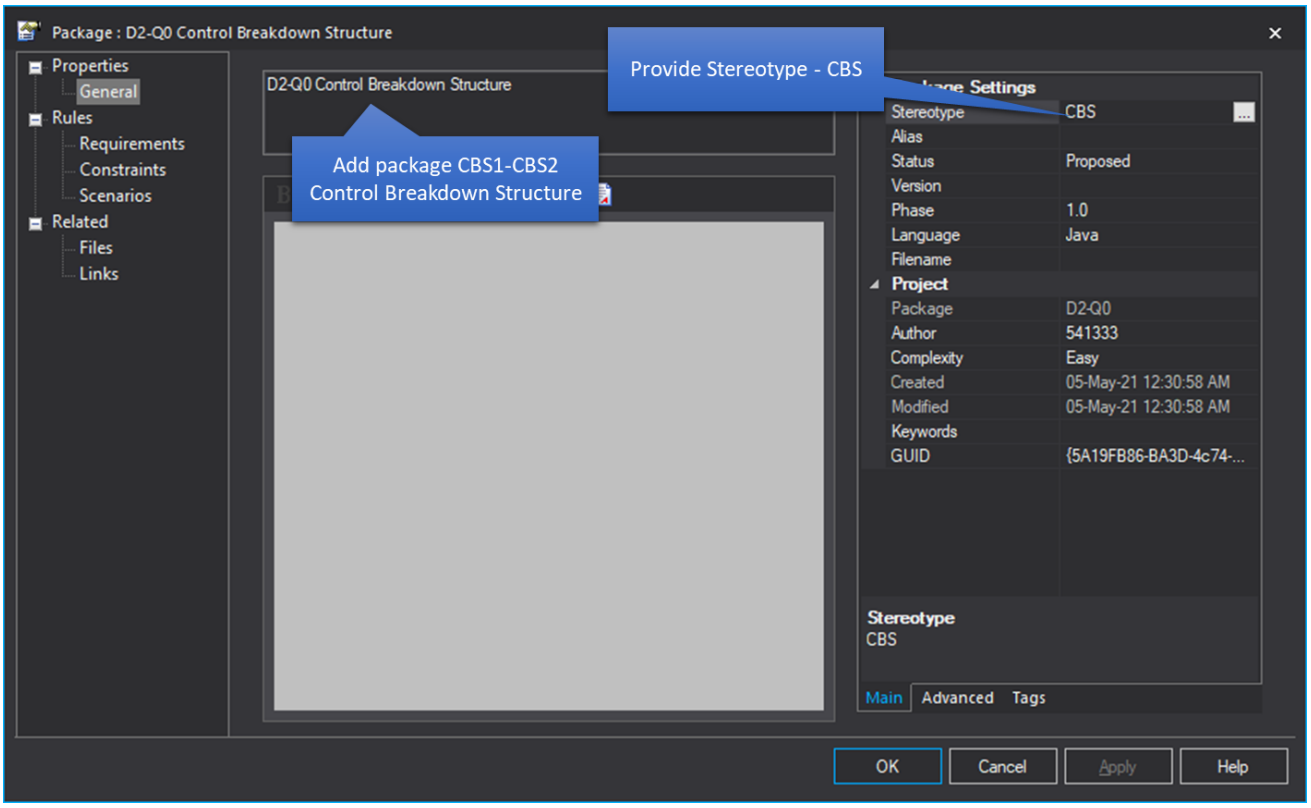


Figure 4: Add Package Control Breakdown Structure

2.4.1 Add CBS 1

Add Package CBS1 under CBS1-CBS2 Control Breakdown Structure. Provide the CBS Name and Stereotype – CBS1

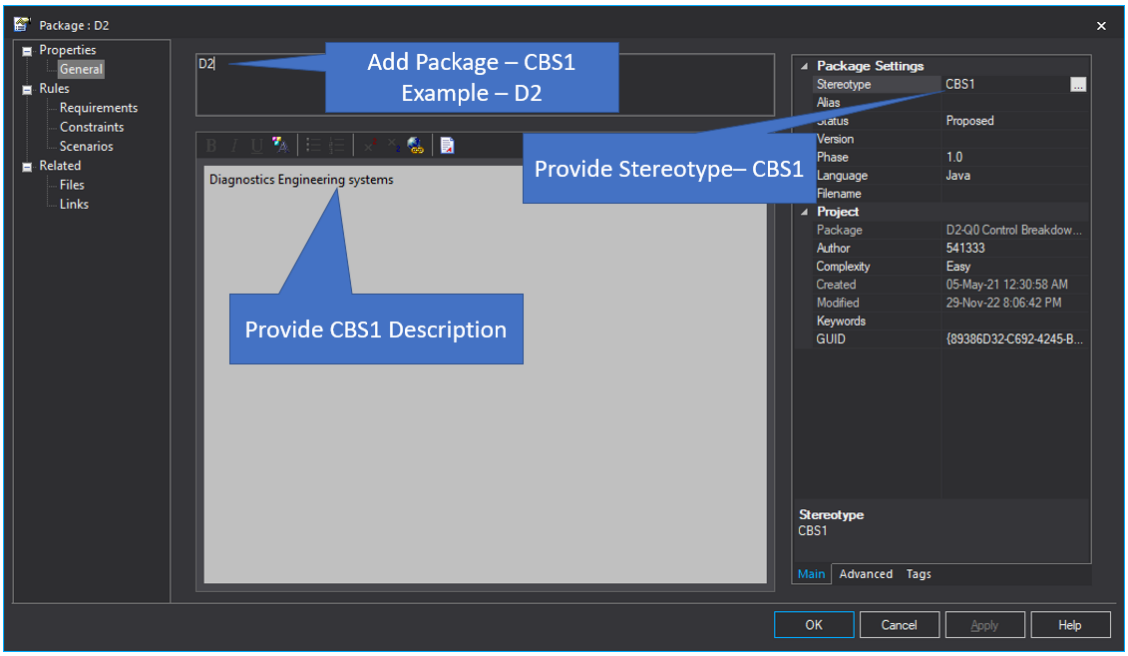


Figure 5: Add CBS 1

2.4.2 Add CBS 2

Add Package CBS2 under CBS1. Provide the CBS Name and Stereotype – CBS2

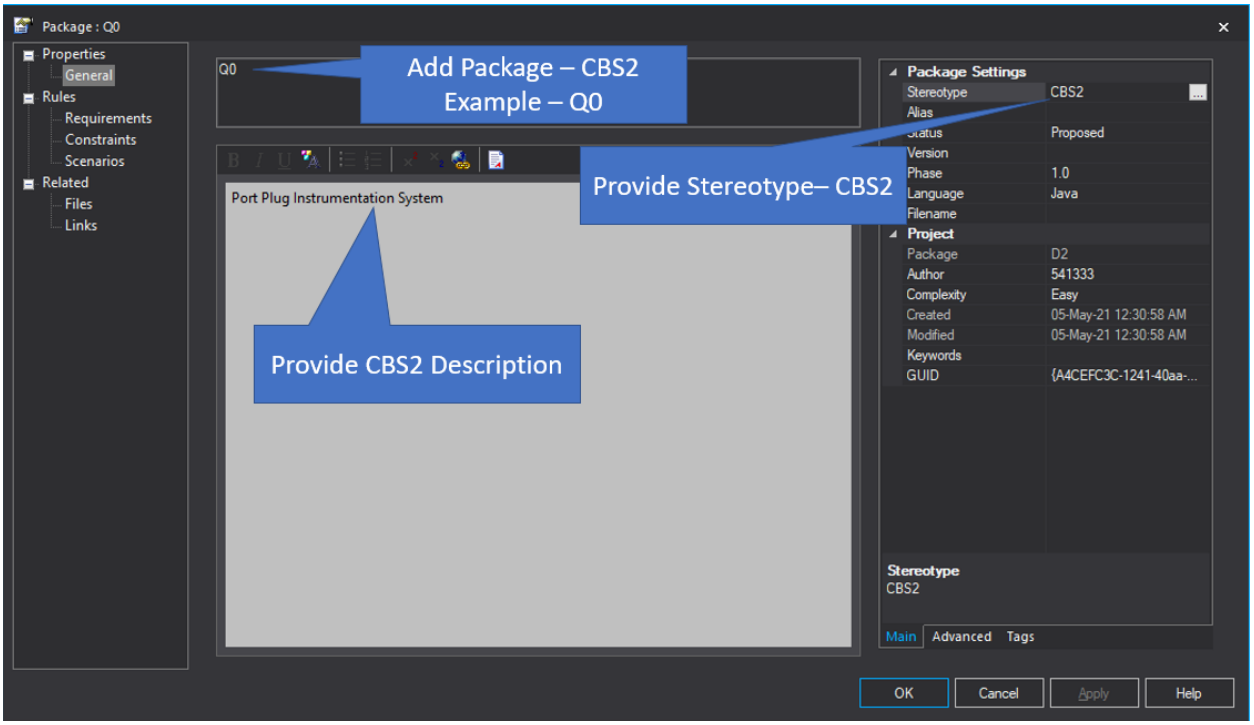


Figure 6: Add CBS 2

2.4.3 Add CBS 3

Add Package CBS3 under CBS2. Provide the CBS Name and Stereotype – CBS3

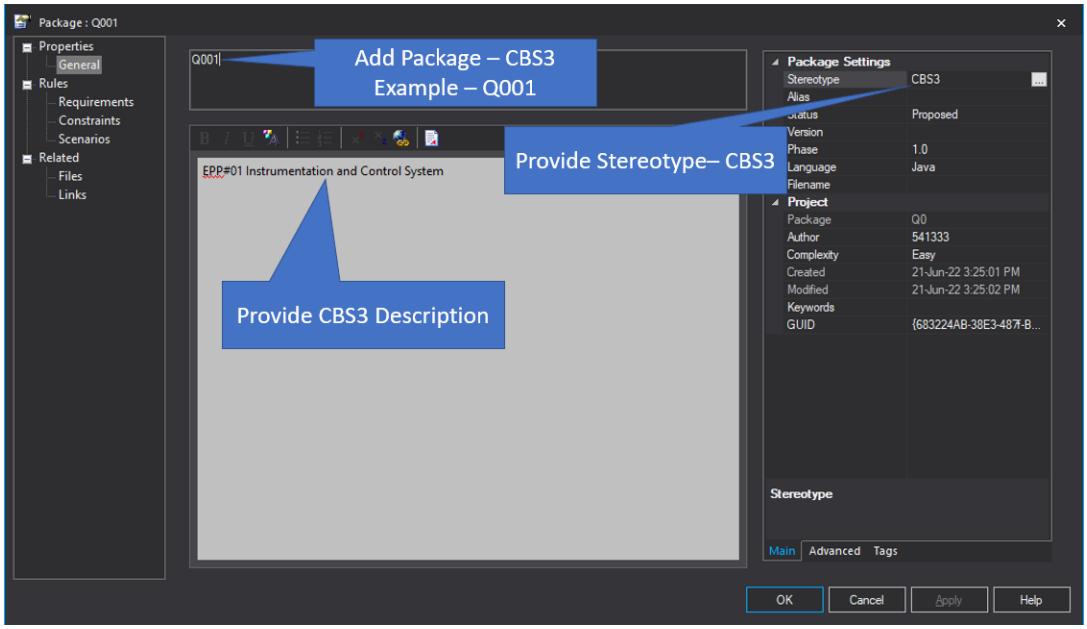


Figure 7: Add CBS 3

Follow above to add multiple CBS 3

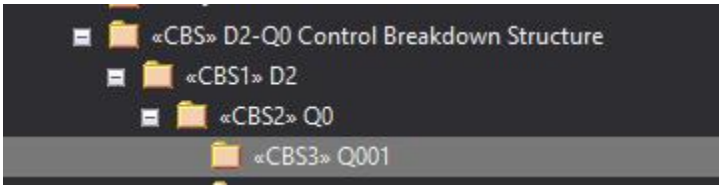


Figure 8: CBS structure in EA project

2.4.4 Add CBS Structure using Add-in

Refer Functional Analysis Add-in user manual to add Control Breakdown Structure. [RD6]

2.5 Plant Breakdown Structure

This section describes how to define Plant Breakdown structure.

Add package CBS1-CBS2 Plant Breakdown Structure in EA Project (e.g., D2-Q0 Plant Breakdown Structure). Provide stereotype – PBS

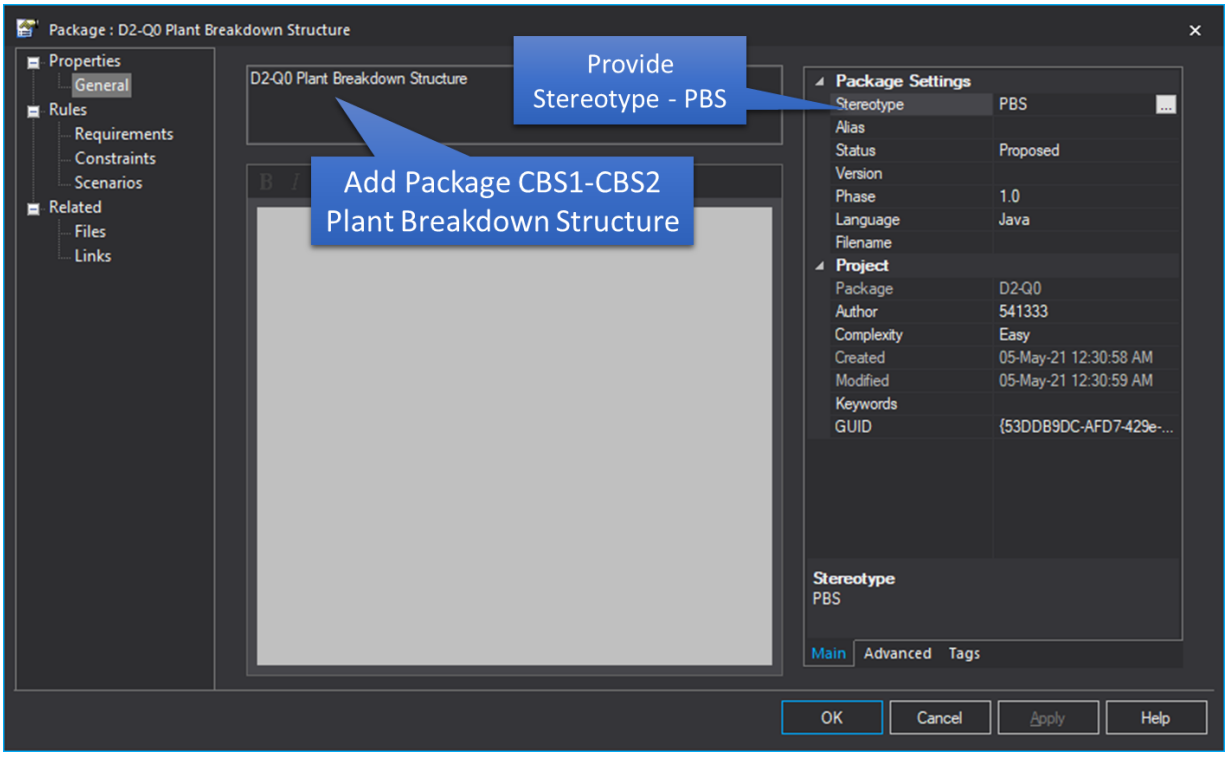


Figure 9: Add Package Plant Breakdown Structure

2.5.1 Add PBS 1

Add Package under CBS1-CBS2 Plant Breakdown Structure. Provide the PBS 1 Name (e.g. 55), as shown below. Also, provide the stereotype PBS1.

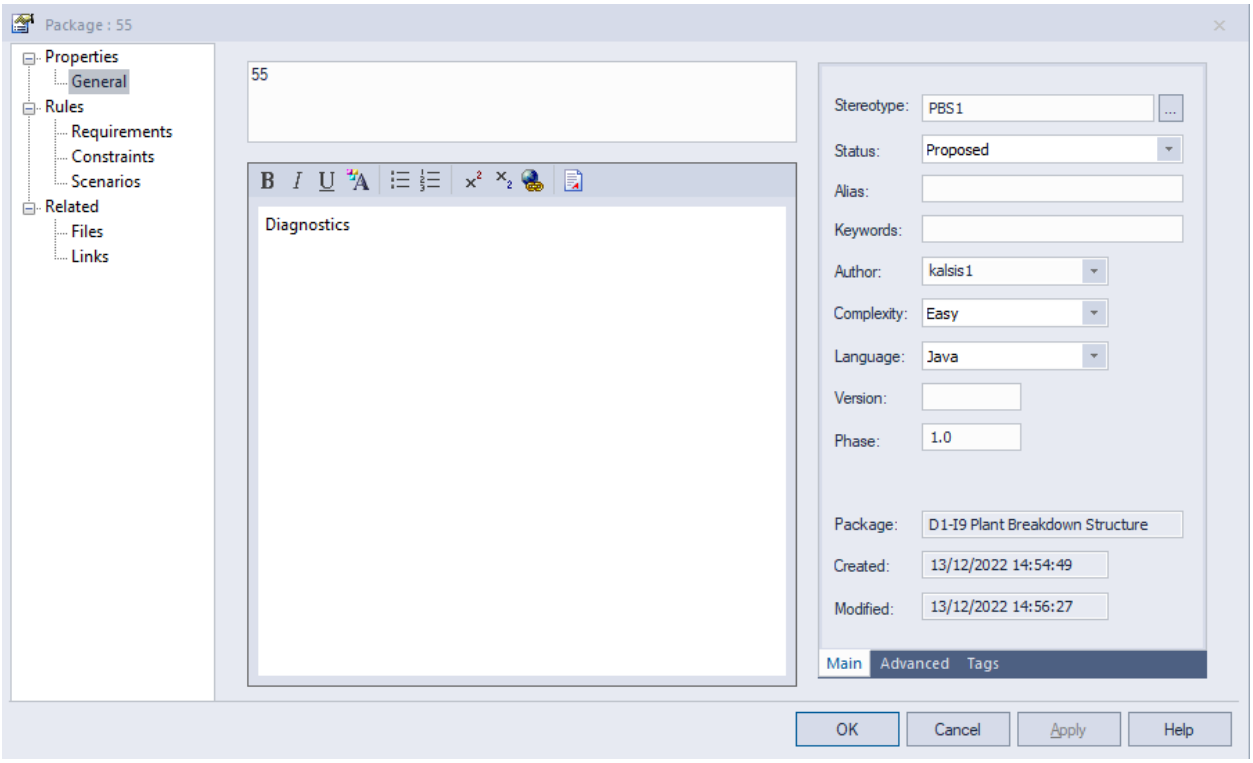


Figure 10: Add PBS 1

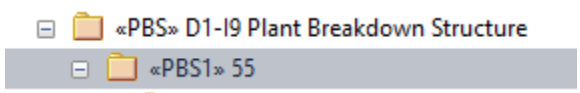


Figure 11: PBS 1 Added in Project

2.5.2 Add PBS 2

Add package under PBS 1 package. Provide the PBS 2 name, as shown below. Also, provide the stereotype PBS2.

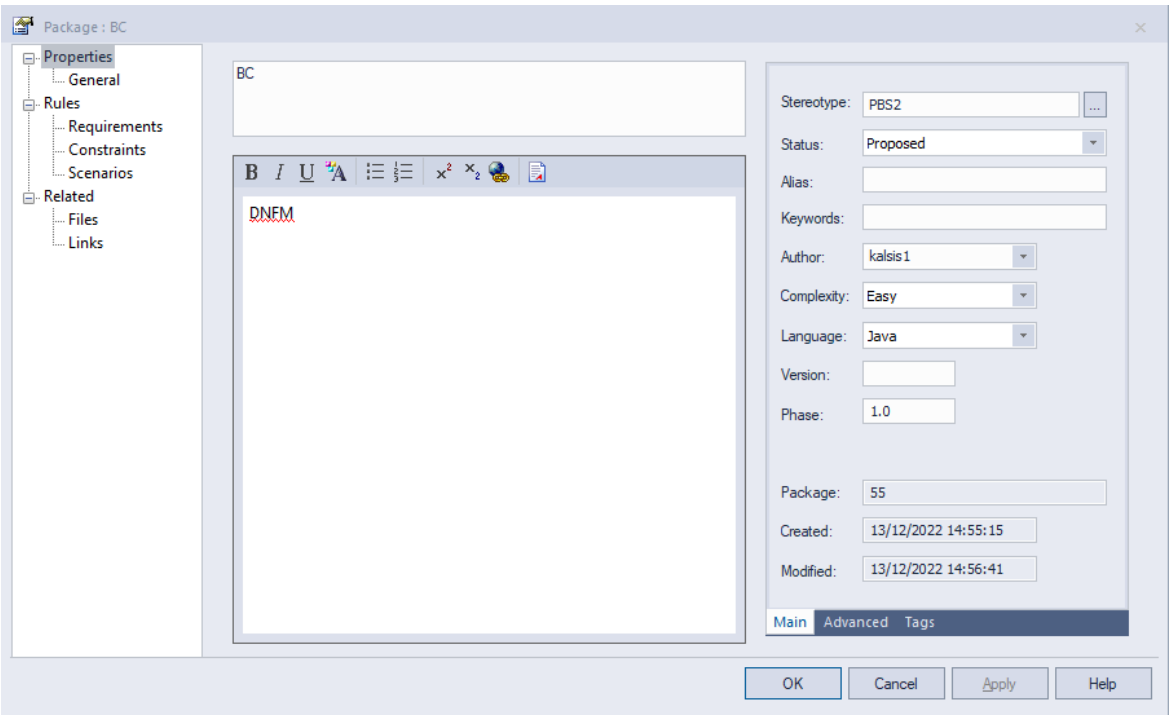


Figure 12: Add PBS 2

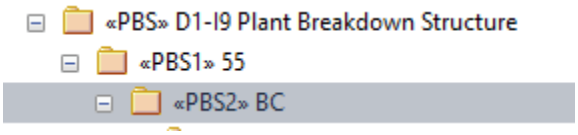


Figure 13: PBS 2 Added in Project

2.5.3 Add PBS 3

Add package under PBS 2 package. Provide the PBS 3 name, as shown below. Also, provide the stereotype PBS3.

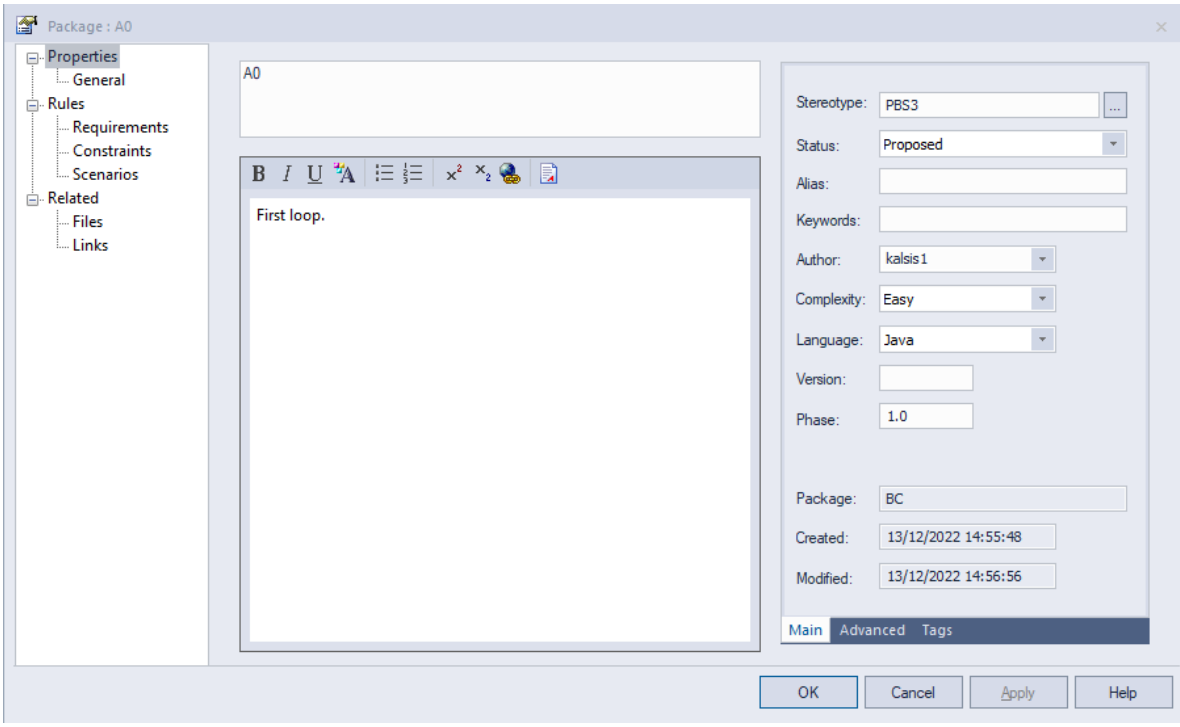


Figure 14: Add PBS 3

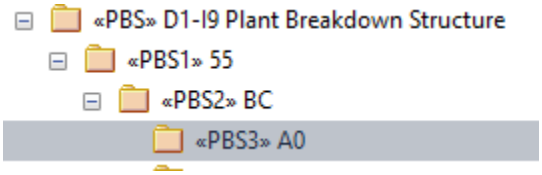
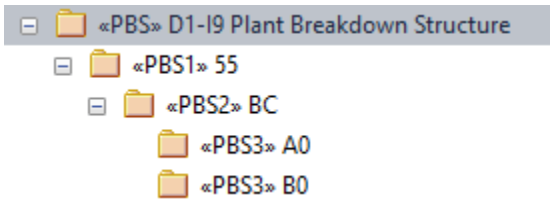


Figure 15: PBS 3 Added in the Project

Follow above steps to add multiple PBS 3.



2.5.4 Link to Signals and Component add-in

Please refer [RD6] for the user manual.

2.6 Plant I&C Boundary

1. Create Plant I&C Boundary package**.** To add Package right click on <CBS1-CBS2> Plant I&C Overview package (CBS1-CBS2 >> CBS1-CBS2 Plant I&C Overview), then select Add a Package. In the Name field, type **CBS1-CBS2 Boundary** and in Initial Content select Package only. Click OK.

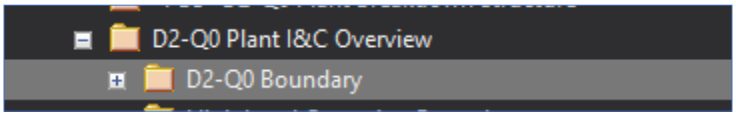


Figure 16: SRS Plant I&C Boundary Package in EA Project

2. Right click on CBS1-CBS2 Boundary package and select Add Diagram.
   New Diagram window will open. Select the diagram type as **Component.** Click **OK** to add Plant I&C Boundary Diagram.

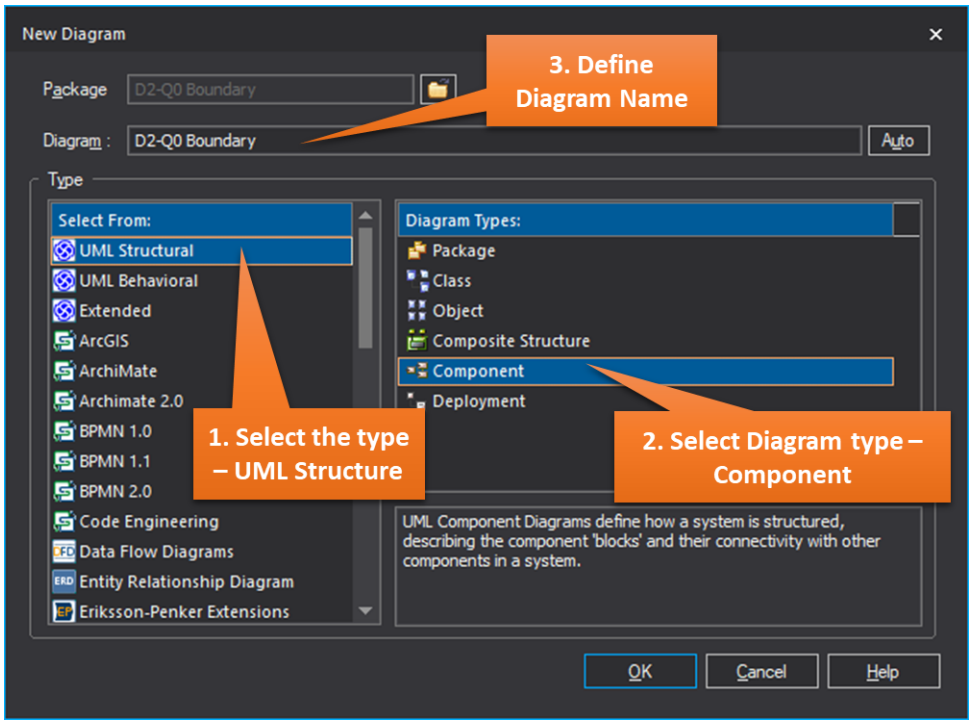


Figure 17: Create Component Diagram

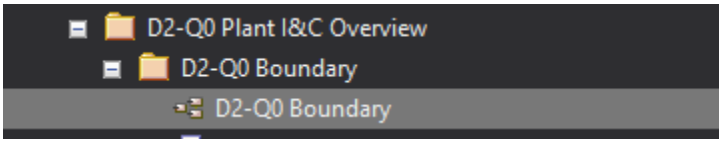


Figure 18: Plant I&C Boundary Diagram

3. Right click Diagram and select Properties or Press **F5** key or select from menu bar **Diagram >> Properties**. The property window will open. In the Property window, select Stereotype as **Boundary** and click **OK**.

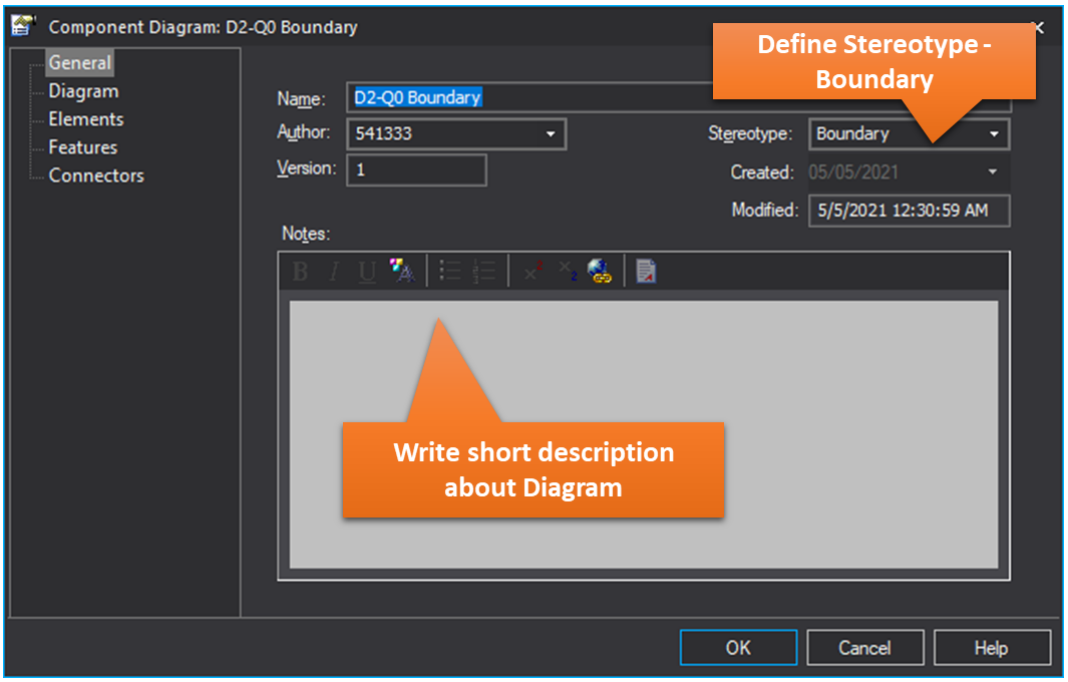


Figure 19: Stereotype for Plant I&C Boundary

4. Add Plant I&C Boundary Elements. Right click on the **Plant I&C Boundary** Package in Project Browser and select **Add Element**.
   Select toolset from Select Toolset as Component **(UML::Component)**. Select Type as **Component** from the drop-down list and Stereotype as **external** if it is external component else select **internal** if it is an internal component.

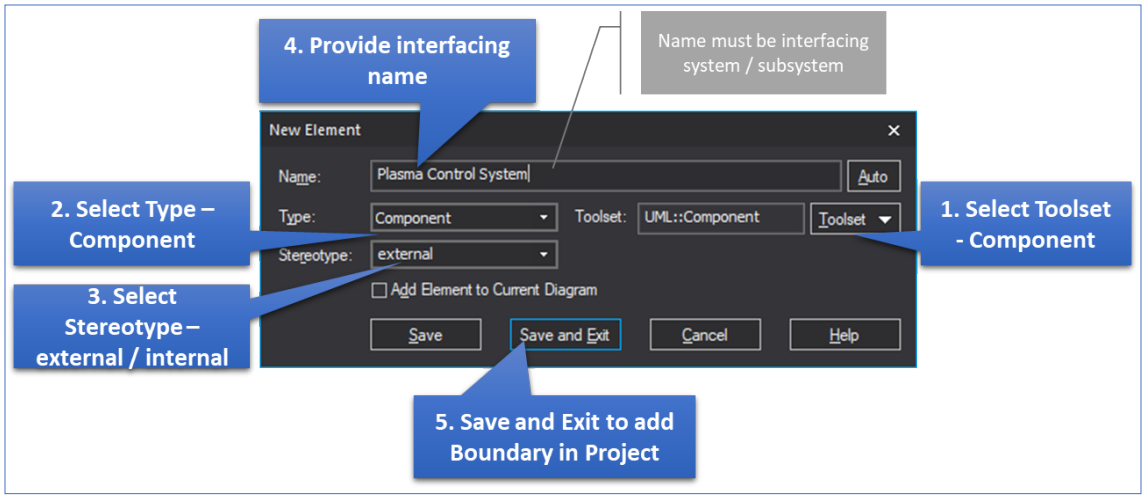


Figure 20: Plant I&C Boundary External Component

5. Double click the newly created component or Select component and press **Alt+Enter** or Right click on Element and select Properties. **Properties** window will open. Add description as shown in the following figure.

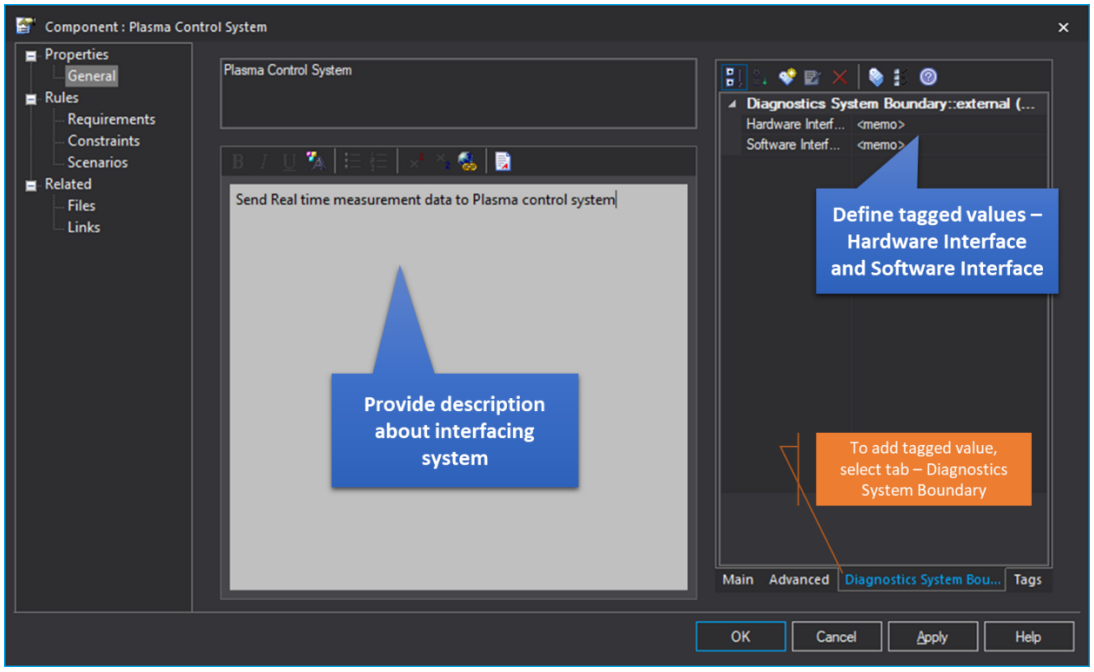


Figure 21: Add Boundary Component Description

6. Follow the above step to add multiple boundary components.

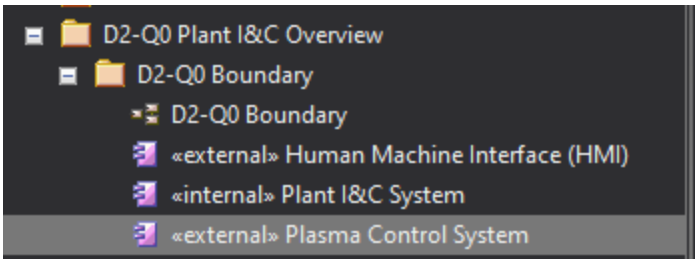
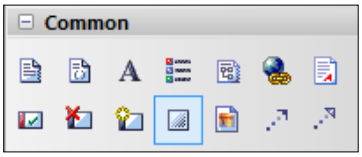


Figure 22: Plant I&C Boundary Components

7. After adding all component generate Plant I&C boundary Diagram. Use Associate (From Component Relationship)

and 

Boundary (From Common) to Prepare plant I&C Boundary.

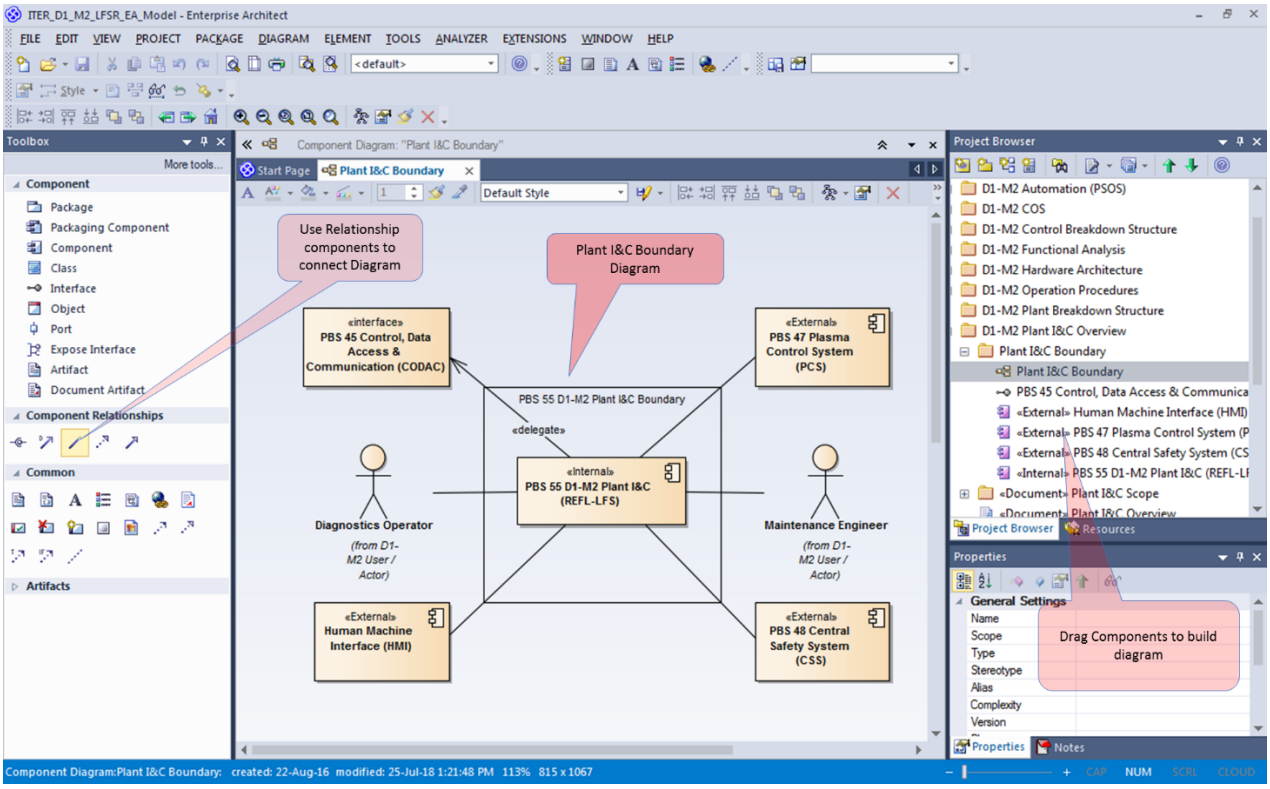


Figure 23: Plant I&C Boundary Diagram

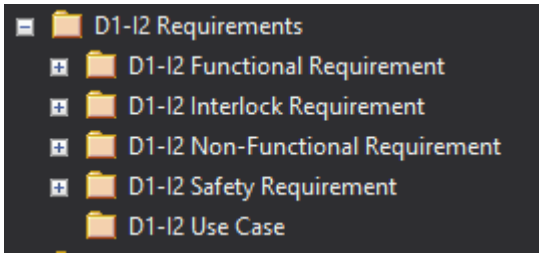
2.7 Plant I&C Requirements

[RD5] is the guideline for requirement management, which also explains the detailed breakdown of Plant I&C requirements. This section describes how to define Plant I&C Requirements in EA. This includes:

- Requirement sub-package structure
- Elements need to use for Plant I&C requirements and use cases
- Stereotypes to define use cases and requirements
- Tagged values used to define attributes and parameters for the use cases and requirements
- ID Format for use cases and requirements
- How to define Actors, stakeholders, and reference documents

2.7.1 Requirement Sub-Package Structure

The requirement package shall contain the 5 sub-packages and describe in the below table

Sub-package	Naming Format	Example
Use Cases	CBS1-CBS2 Use Case	
Functional Requirements	CBS1-CBS2 Functional Requirement	
Non-Functional Requirements	CBS1-CBS2 Non-Functional Requirement	
Interlock Requirements	CBS1-CBS2 Interlock Requirement	
Safety Requirements	CBS1-CBS2 Safety Requirement	

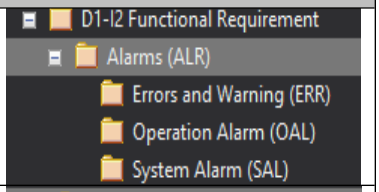
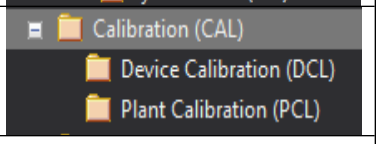
2.7.1.1 Use Cases

This sub-package will contain Plant I&C use cases. Section 2.7.2 describes more about use cases.

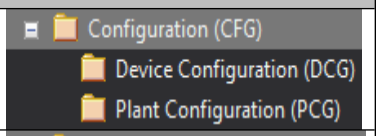
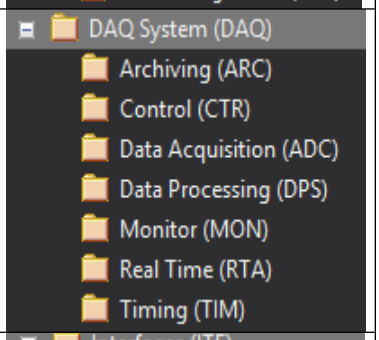
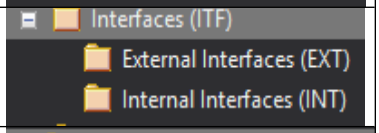
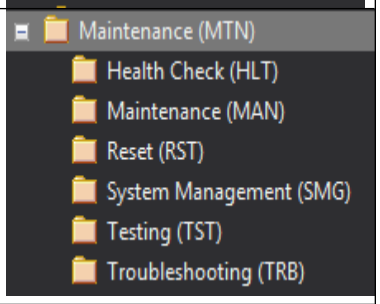
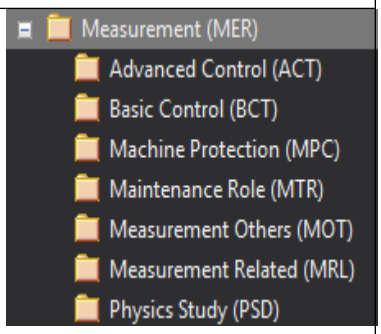
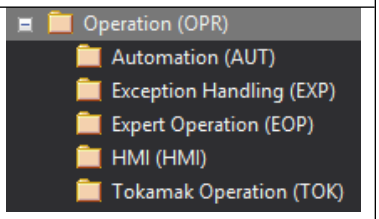
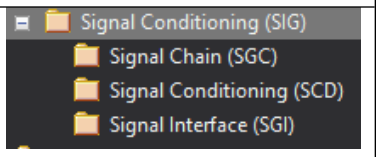
2.7.1.2 Functional Requirements

This sub-package will contain Plant I&C functional requirements. Below table describes the breakdown of functional requirements

Table 4: Sub-package structure for functional requirements

Requirement Category[1]	Requirement Type	Package Name	Example
Alarms		Alarms (ALR)	
	Errors and Warning	Errors and Warning (ERR)	
	Operation Alarm	Operation Alarm (OAL)	
	System Alarm	System Alarm (SAL)	
Calibration		Calibration (CAL)	
	Device Calibration	Device Calibration (DCL)	
	Plant Calibration	Plant Calibration (PCL)	
Configuration		Configuration (CFG)	
	Device Configuration	Device Configuration (DCG)	

[1] Refer [RD5] for more information about requirement category and requirement type

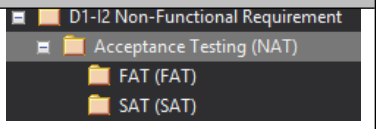
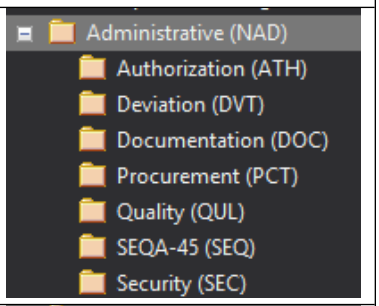
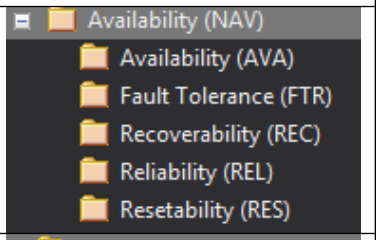
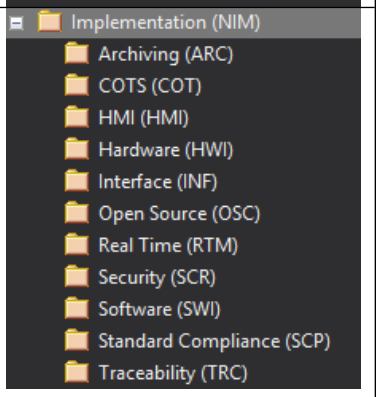
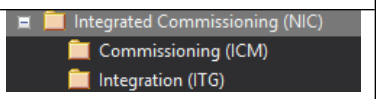
Requirement Category[1]	Requirement Type	Package Name	Example
	Plant Configuration	Plant Configuration (PCG)	
DAQ System		DAQ System (DAQ)	
	Archiving	Archiving (ARC)	
	Control	Control (CTR)	
	Data Acquisition	Data Acquisition (ADC)	
	Data Processing	Data Processing (DPS)	
	Monitor	Monitor (MON)	
	Real Time	Real Time (RTA)	
	Timing	Timing (TIM)	
Interfaces		Interfaces (ITF)	
	External Interfaces	External Interfaces (EXT)	
	Internal Interfaces	Internal Interfaces (INT)	
Maintenance		Maintenance (MTN)	
	Health Check	Health Check (HLT)	
	Maintenance	Maintenance (MAN)	
	Reset	Reset (RST)	
	System Management	System Management (SMG)	
	Testing	Testing (TST)	
	Troubleshooting	Troubleshooting (TRB)	
Measurement		Measurement (MER)	
	Advanced Control	Advanced Control (ACT)	
	Basic Control	Basic Control (BCT)	
	Machine Protection	Machine Protection (MPC)	
	Maintenance Role	Maintenance Role (MTR)	
	Measurement Others	Measurement Others (MOT)	
	Measurement Related	Measurement Related (MRL)	
	Physics Study	Physics Study (PSD)	
Operation		Operation (OPR)	
	Automation	Automation (AUT)	
	Exception Handling	Exception Handling (EXP)	
	Expert Operation	Expert Operation (EOP)	
	HMI	HMI (HMI)	
	Tokamak Operation	Tokamak Operation (TOK)	
Signal Conditioning		Signal Conditioning (SIG)	
	Signal Chain	Signal Chain (SGC)	
	Signal Conditioning	Signal Conditioning (SCD)	
	Signal Interface	Signal Interface (SGI)	

Requirement Category[1]	Requirement Type	Package Name	Example
Other		Other (OTH)	

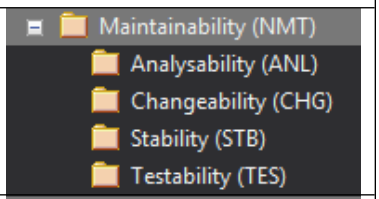
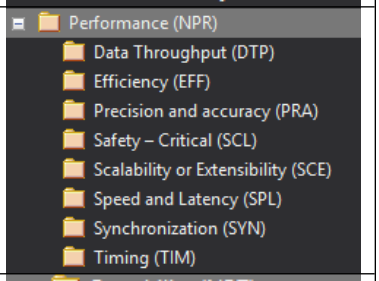
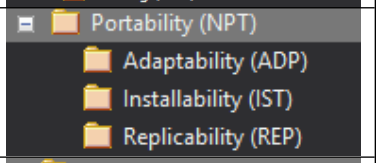
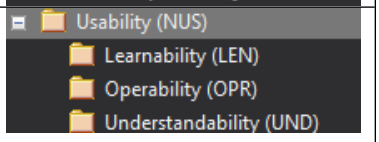
2.7.1.3 Non-Functional Requirements

This sub-package will contain Plant I&C functional requirements. Below table describes the breakdown of mom-functional requirements

Table 5: Sub-package structure for non-functional requirements

Requirement Category[2]	Requirement Type	Package Name	Example
Acceptance Testing		Acceptance Testing (NAT)	
	FAT	FAT (FAT)	
	SAT	SAT (SAT)	
Administrative		Administrative (NAD)	
	Authorization	Authorization (ATH)	
	Deviation	Deviation (DVT)	
	Documentation	Documentation (DOC)	
	Procurement	Procurement (PCT)	
	Quality	Quality (QUL)	
	SEQA-45	SEQA-45 (SEQ)	
	Security	Security (SEC)	
Availability		Availability (NAV)	
	Availability	Availability (AVA)	
	Fault Tolerance	Fault Tolerance (FTR)	
	Recoverability	Recoverability (REC)	
	Reliability	Reliability (REL)	
	Resetability	Resetability (RES)	
Implementation		Implementation (NIM)	
	Archiving	Archiving (ARC)	
	COTS	COTS (COT)	
	HMI	HMI (HMI)	
	Interface	Interface (INF)	
	Open Source	Open Source (OSC)	
	Real Time	Real Time (RTM)	
	Security	Security (SCR)	
	Standard Compliance	Standard Compliance (SCP)	
	Traceability	Traceability (TRC)	
Integrated Commissioning		Integrated Commissioning (NIC)	
	Commissioning	Commissioning (ICM)	

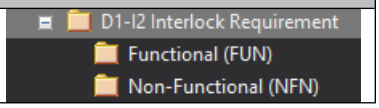
[2] Refer [RD5] for more information about requirement category and requirement type

Requirement Category[2]	Requirement Type	Package Name	Example
	Integration	Integration (ITG)	
Maintainability		Maintainability (NMT)	
	Analysability	Analysability (ANL)	
	Changeability	Changeability (CHG)	
	Stability	Stability (STB)	
	Testability	Testability (TES)	
Performance		Performance (NPR)	
	Data Throughput	Data Throughput (DTP)	
	Efficiency	Efficiency (EFF)	
	Safety – Critical	Safety – Critical (SCL)	
	Speed and Latency	Speed and Latency (SPL)	
	Synchronization	Synchronization (SYN)	
	Timing	Timing (TIM)	
Portability		Portability (NPT)	
	Adaptability	Adaptability (ADP)	
	Installability	Installability (IST)	
	Replicability	Replicability (REP)	
Usability		Usability (NUS)	
	Learnability	Learnability (LEN)	
	Operability	Operability (OPR)	
	Understandability	Understandability (UND)	
Environment		Environment (ENV)	
Other		Other (OTH)	

2.7.1.4 Interlock Requirements

This sub-package will contain Plant I&C Interlock (functional and non-functional) requirements. Below table describes the breakdown of interlock requirements

Table 6: Sub-package structure for Interlock requirements

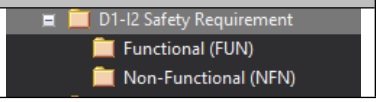
Requirement Category[3]	Requirement Type	Package Name	Example
Functional		Functional (FUN	
Non-Functional		Non-Functional (NFN)	

2.7.1.5 Safety Requirements

This sub-package will contain Plant I&C Safety (functional and non-functional) requirements. Below table describes the breakdown of safety requirements

[3] Refer [RD5] for more information about requirement category and requirement type

Table 7: Sub-package structure for Interlock requirements

Requirement Category	Requirement Type	Package Name	Example
Functional		Functional (FUN	
Non-Functional		Non-Functional (NFN)	

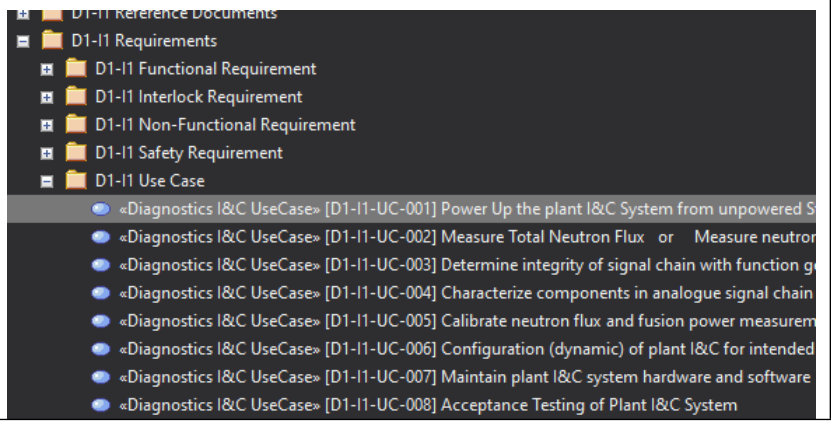
2.7.2 Define use cases

This section describes the element and diagram used to define use cases. It also describes the stereotypes and different tagged values need to define for the use cases

2.7.2.1 Use cases

A Use Case is a UML modeling element that describes how a user of the proposed system interacts with the system to perform a discrete unit of work.

Table 8: Element use to define use case

Diagram Element	Example Image
Use Case	

The Use case element can be added from Toolbox. It can be added by drag and drop from toolbox to use case diagram

Figure 24: Use Case in Toolbox

2.7.2.1.1 Name, Description, and ID for the use case

The use case name shall be defined in below format

[ID] <Use Case Name>; e.g. [D1-I2-UC-001] Power Up the plant I&C System from unpowered State.

The same ID also need to define in the field call Alias. For detail illustration, refer below figure

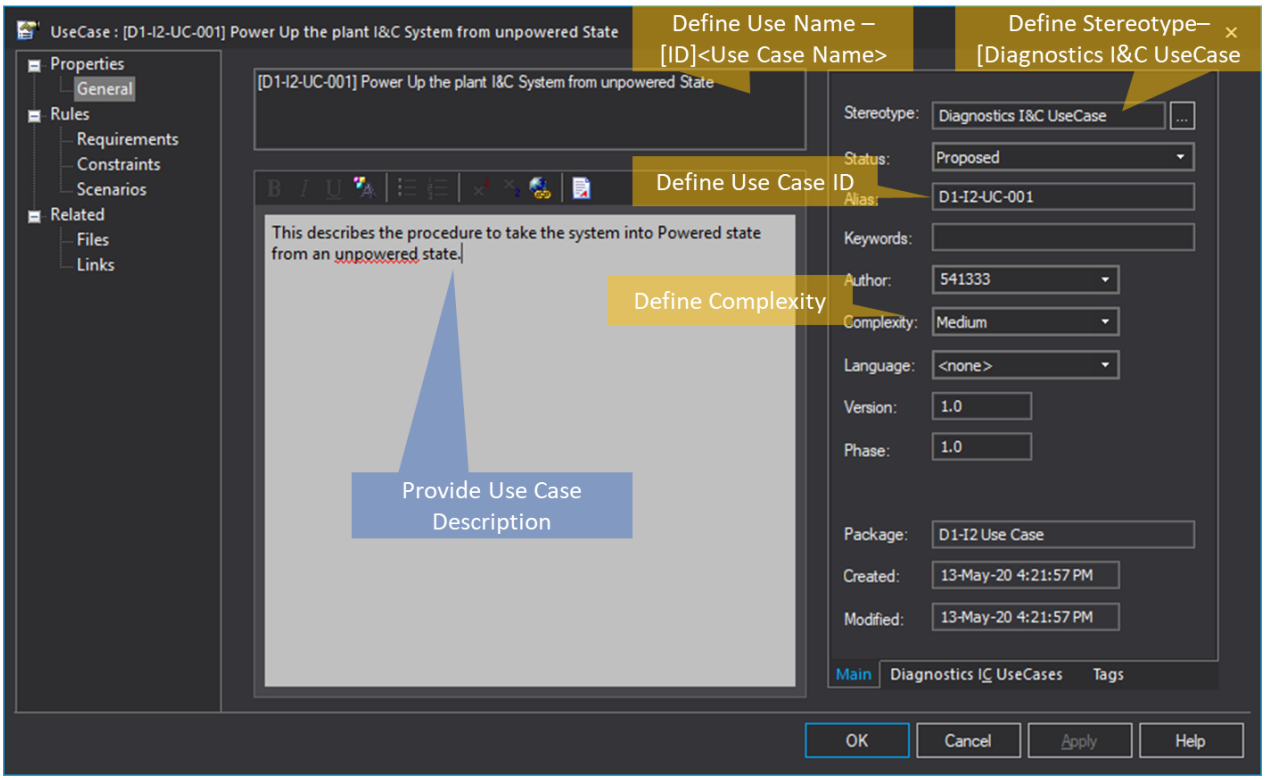


Figure 25: Use Case Name and ID

2.7.2.1.2 Stereotypes for Use Cases

Stereotype for use case is “Diagnostics I&C UseCase”.

2.7.2.1.3 Tagged values for Use cases

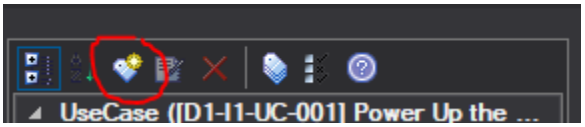
Table 9: Tagged Values for the use cases

Tagged Value name	Description
Assumption	Need to define assumptions of the use case.
Business Rules	Need to define business rules if any
Frequency of use	Need to define when to use this use case
Priority	Need to define Priority – High, Medium, and Low
Stakeholders	Need to define stakeholder for this use case. (Refer [RD15])
Actors	Need to define actors for this use case. (Refer [RD15])

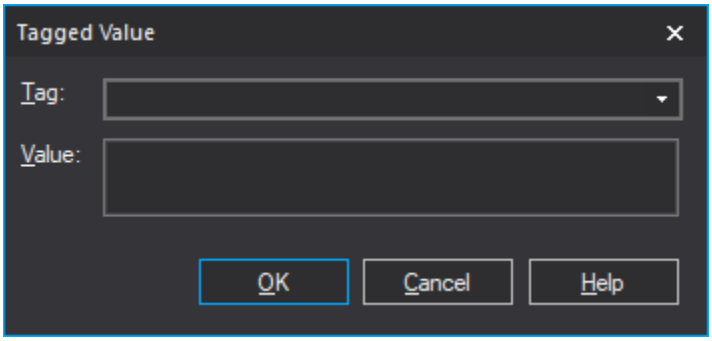
Note – This tagged value field has a 255-character limit. If the value is greater than 255 characters long, set the value to “<memo>” and insert the body of text in the Notes attribute (above).

How to define Memo

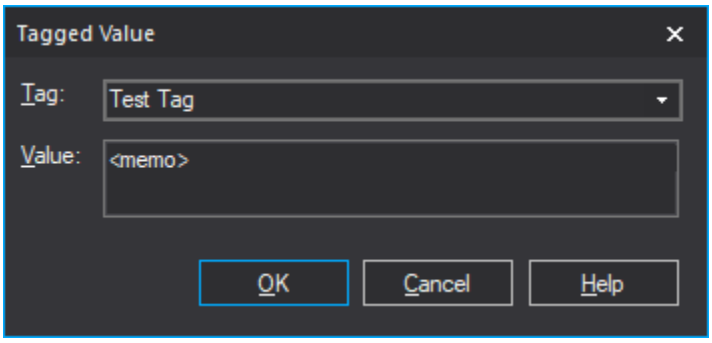
1. Click on New Tagged Value option from the Element Property



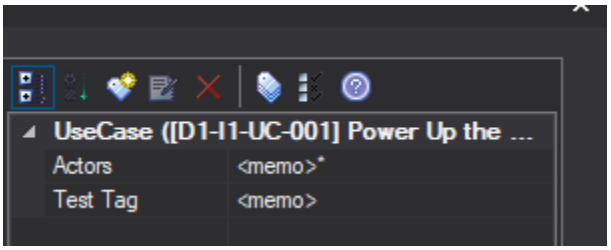
2. Tagged Value window will open



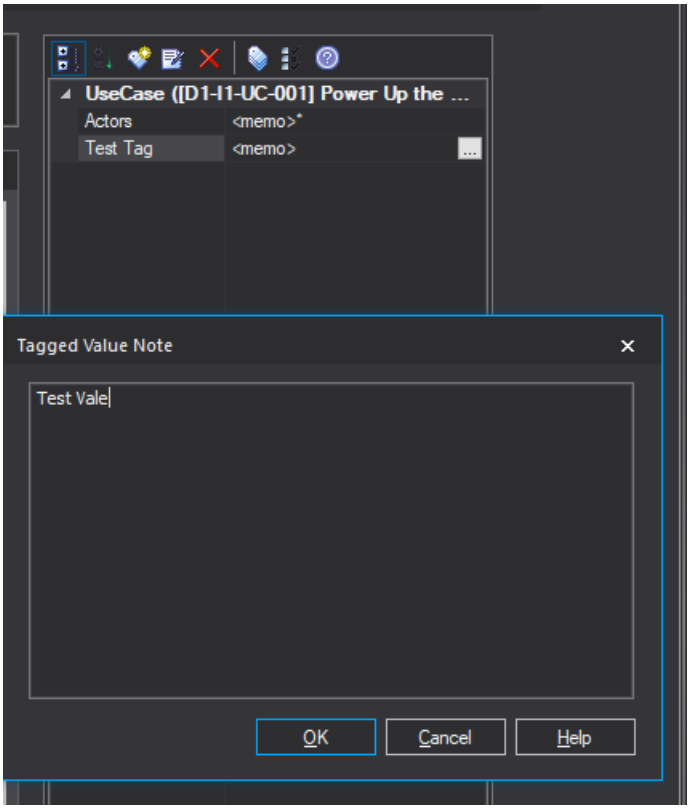
3. Define the tag name in Tag field and in Value field write <memo>



4. Click on OK button to define new tag with Memo option



5. To define value for new tag, click on memo, tag value note will open.



6. Click on OK to define Memo for tag.

2.7.2.1.4 Define Pre and Post conditions for use case

Typical constraints are **pre-** and **post-conditions**, which indicate things that must be true **before** execution of use case and things that must be true **after** execution of use case, or its action is complete. Pre and Post conditions can be defined under Rules>>Constraint Tab in Use case property window as shown in Figure 26

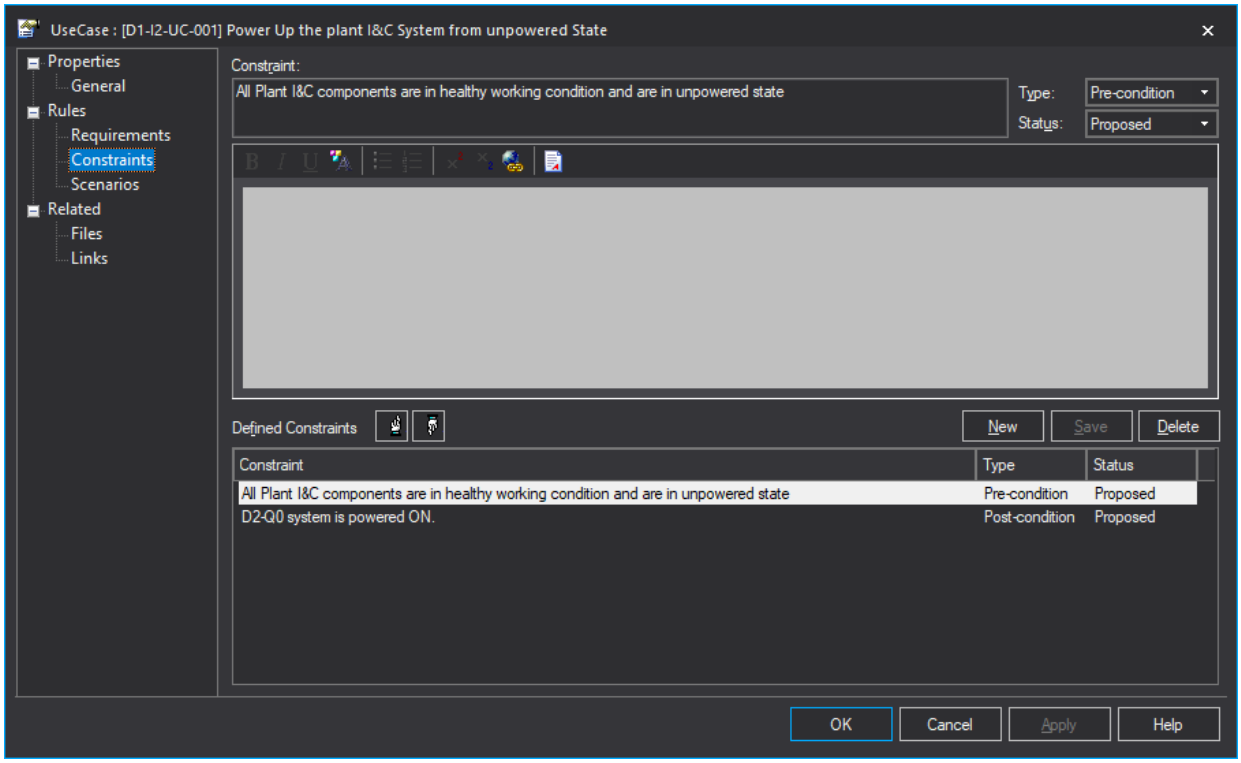


Figure 26: Pre and Post conditions for the use case

2.7.2.1.5 Define Limitation for use case

Limitations can be defined under Rules>>Constraint Tab in Use case property window as shown in Figure 27.

Mandatory Field value to define Limitations

Field	Value
Constraint	Write the limitation for the use case
Type	Invariant

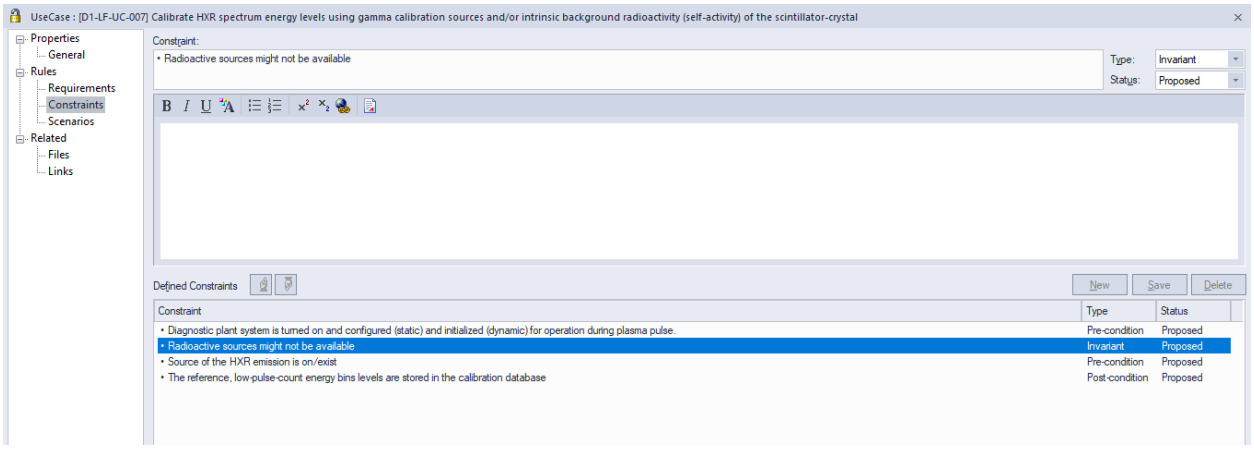


Figure 27: Limitation for the use case

2.7.2.1.6 Define Normal flow for the use cases

Normal flow indicates the steps through which the use case is executed. The normal flow can be defined under Rules>>Scenarios Tab in use case property window as shown in Figure 28

Mandatory Field value to define Normal flow

Field	Value
Scenario	Normal Flow
Type	Basic Path
Structure Specification Tab	Define normal flow here in the form of steps

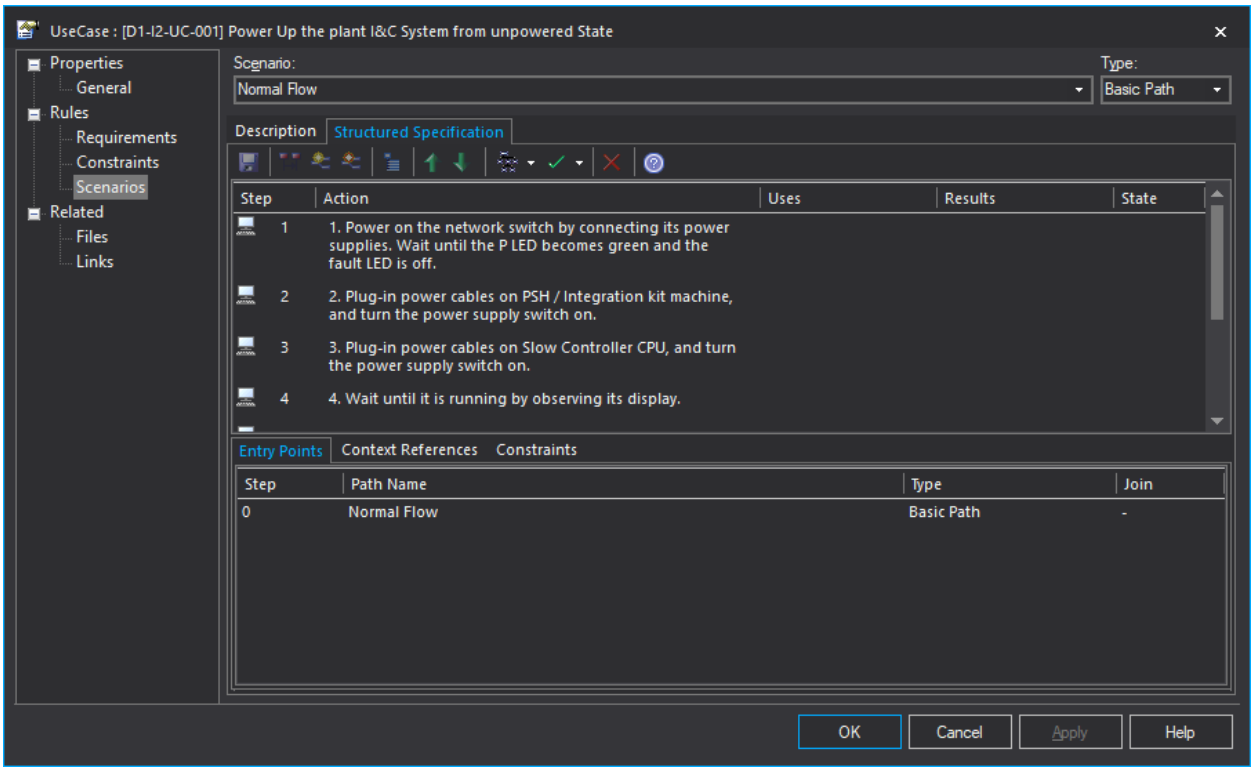


Figure 28: Define Normal flow

To Add Scenario: Properties>Scenarios or Properties Page | Scenarios

Using the Description tab

Field/Button	Action
Scenario	Defaults to the name **Normal Flow**. (You usually define the basic path of the scenario first.) If necessary, type in a different name for the scenario (to work on an existing scenario, click on the drop-down arrow and select the name from the list).
Type	Defaults to **Basic Path**; for the direct steps of the scenario. For subsequent scenarios, click on the drop-down arrow and select either: • **Alternate** – an alternative set of steps, in parallel with part of the basic path (Note – generally it is not used) • **Exception** – the path the scenario follows if a step of the basic path does not produce an appropriate result
Description	Record a textual description of how the user uses the current element. You can format the description text using the Notes toolbar at the top of the field.

	As well as applying the Notes window facilities, you can also generate a structured specification from the text in this field; highlight the text, right-click on it and select the Create Structure from Notes context menu option. The text is copied to the Structured Specification tab for the current scenario, either as a new specification or as the continuation of an existing specification, with a new step created at each carriage return. Subsequent changes to the text **on the Structured Specification** tab are not reflected on the Description tab.
New	Click on this button to clear the data fields so that you can enter data in them to create a new scenario.
Save	Click on this button to save a new scenario, or changes to an existing scenario.
Scenarios	This panel displays a list of the scenarios defined for this element, and the type of each scenario.
Delete	Click on this button to delete a scenario selected from the Scenarios panel.

2.7.2.1.7 Define Exceptions

Scenario to be executed if a step in normal flow does not produce appropriate result.

The exceptions can be defined under Rules>>Scenarios Tab in use case property window as shown in Figure 29

Mandatory field values to define exceptions for use case

Field	Value
Scenario	<Provide exception name>
Type	Exception
Structure Specification Tab	Define Exception flow (Optional)

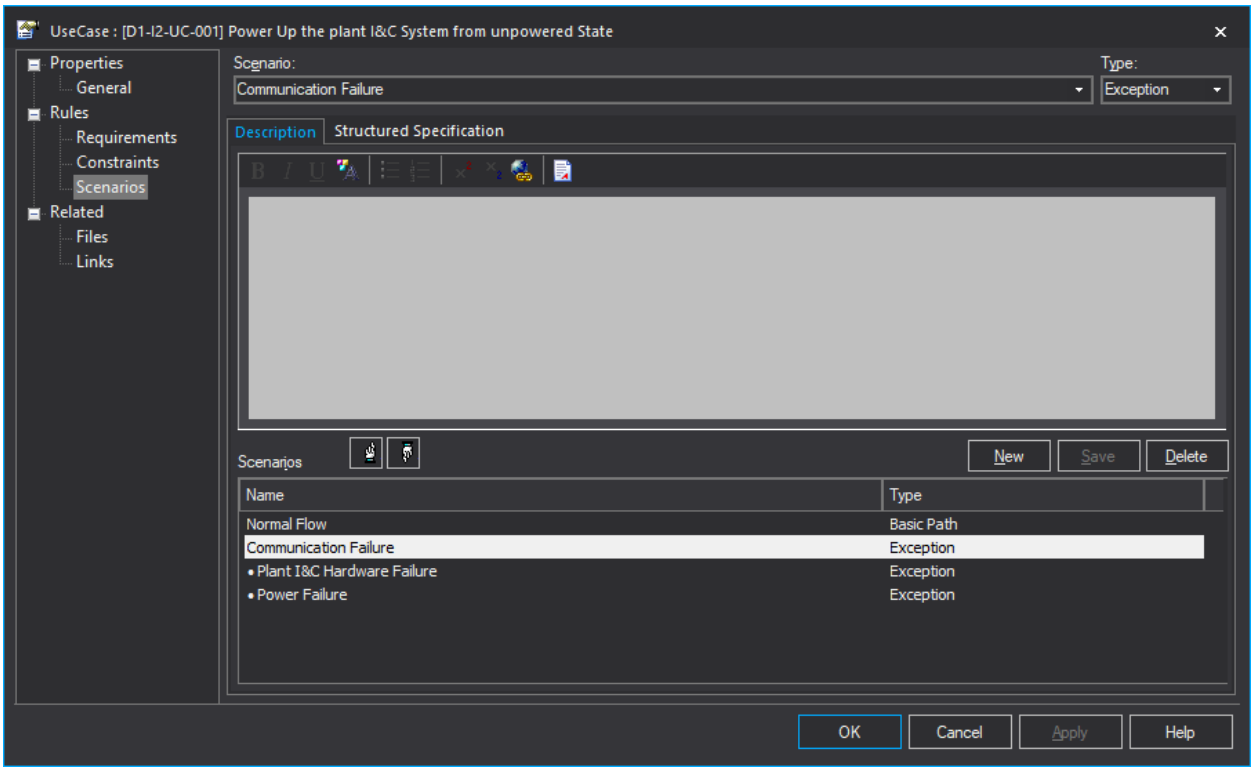


Figure 29: Define Exceptions

2.7.2.1.8 Use case model diagram (optional)

Use Case model diagrams capture Use Cases and the relationships between Actors and the subject (system). You can use them to:

- Describe the way outside things (Actors) interact at the system boundary
- Describe the response of the system

Stereotype for Use Case Model Diagram – UC_Model

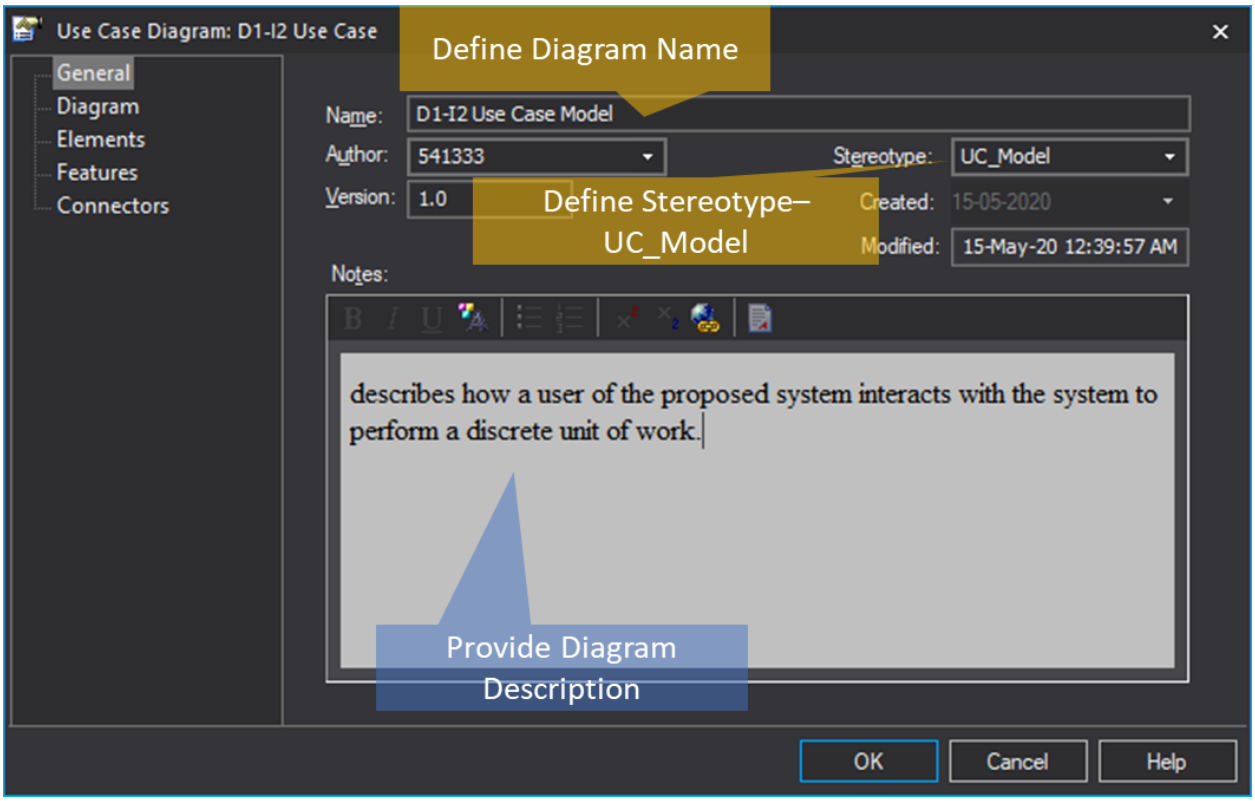


Figure 30: Use case model diagram Properties

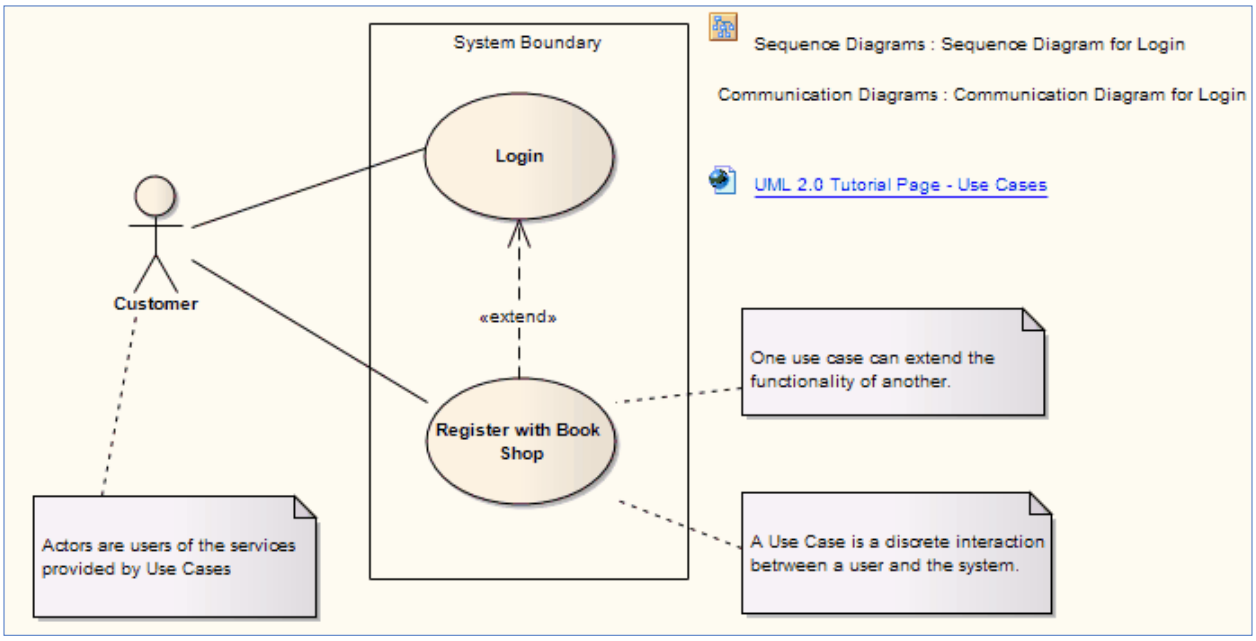


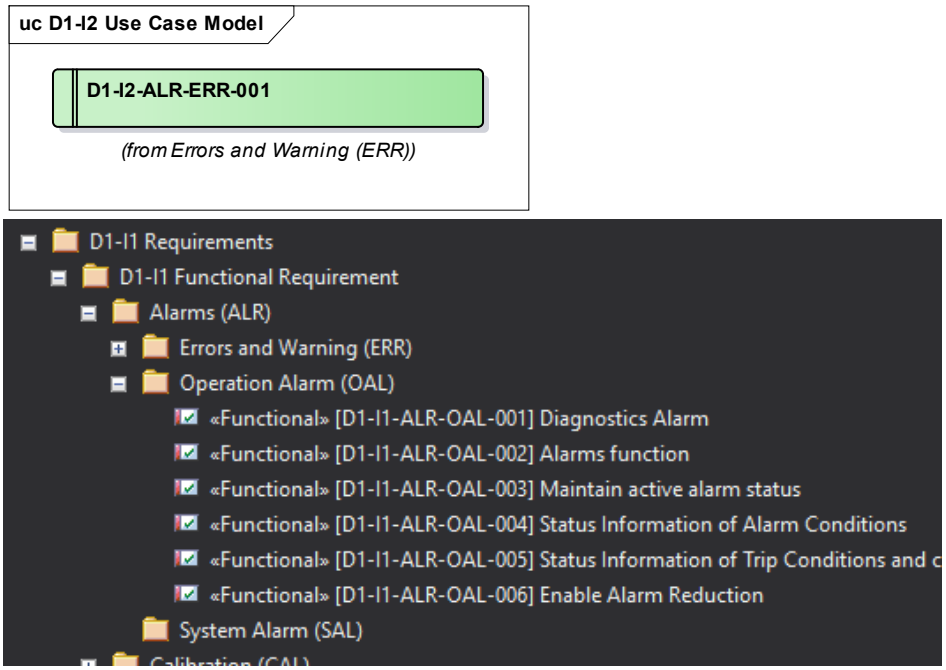
Figure 31: Example – Use case model diagram

2.7.3 Define Requirements

Breakdown for functional, non-functional requirements are defined in [RD5]. To define the sub-packages of requirements, refer section 2.7.1.

2.7.3.1 Elements need to use to define requirements

Below table describes the element need to use to define Plant I&C requirements

Diagram Element	Example Image
Requirement	

2.7.3.2 Name, Description, and ID for the requirements

Requirement name can be defined in below format

[ID]<Requirement Name> e.g. [D1-I2-ALR-ERR-001] Error and trace logging function

The same ID also need to define in the field call Alias. For detail illustration refer below figure

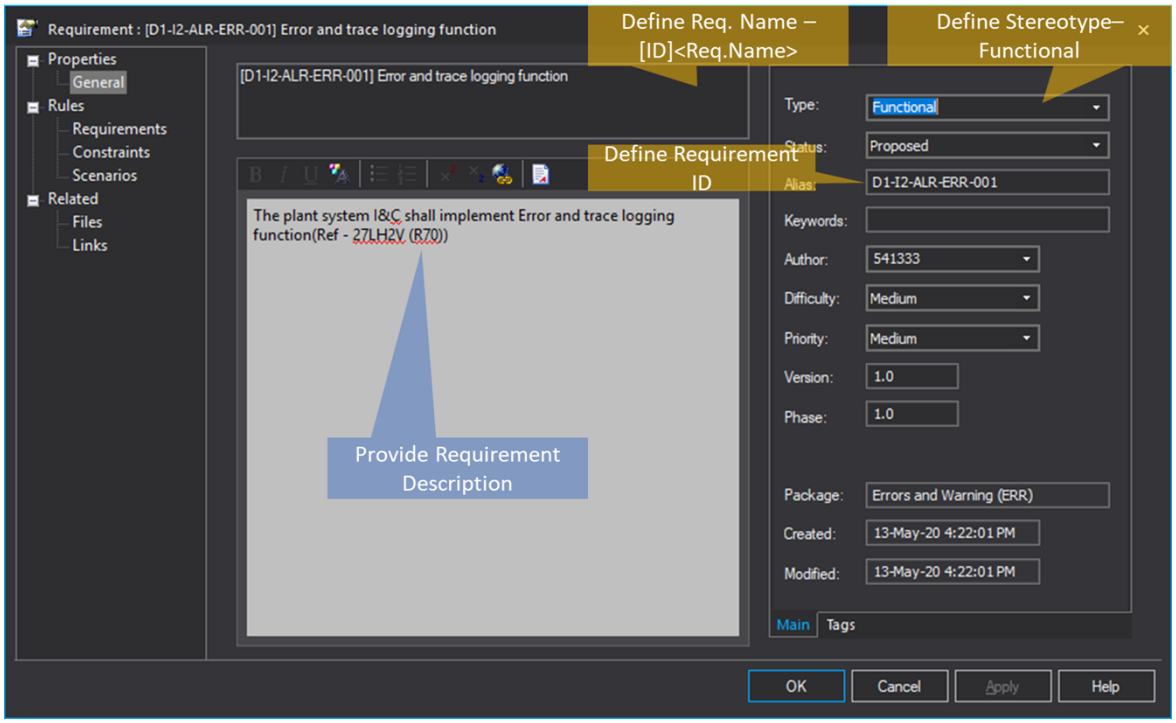


Figure 32: Requirement Name and ID

The ID format for Functional, Non-Functional, Interlock and Safety requirements are defined in [RD5].

2.7.3.3 Stereotypes for the requirements

Below table describes the Stereotype used for Plant I&C requirement category.

Note: As shown in Figure 32, Stereotype is defined in the *Type* field.

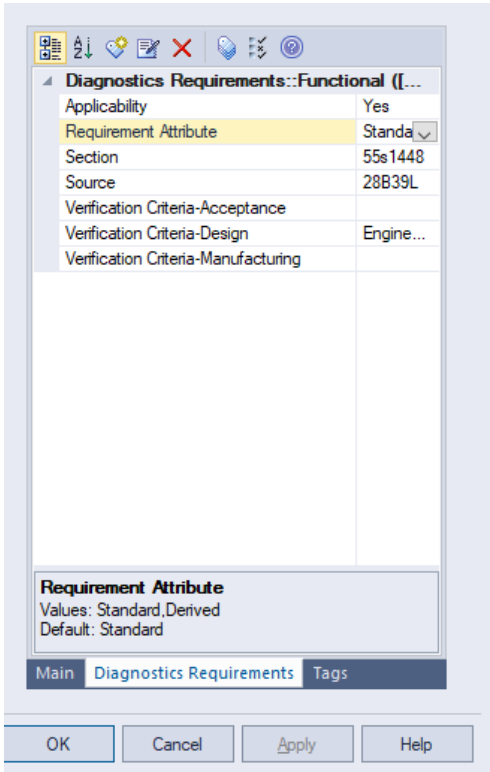
Stereotype	Description
Functional	This stereotype will be used for functional requirement
Non-Functional	This stereotype will be used for non-functional requirement

2.7.3.4 Tagged Values for the Requirements

Table 10: Tagged Values for the Requirements

Tagged Value name	Description
Applicability	Define the applicability **Yes** or **No** for the requirement
Requirement Attribute	Define requirement attribute either **Standard** or **Derived.** This field is optional (but strongly advised). The requirements coming from the handbooks i.e. PCDH (ITER_D_27LH2V) and its satellite documents, SRD 55 (ITER_D_28B39L), SRD 45 (ITER_D_28C2HL) and EDH 4 (ITER_D_4B523E) are Standard requirements. The other requirements coming

	from alternate sources like use cases, sub-SRD are Derived requirements.
Verification Criteria – Design	Need to define verification criteria for Life cycle phase (design) – Inspection, Analysis, Test, Engineering Review
Verification Criteria – Manufacturing	Need to define verification criteria for Life cycle phase (Manufacturing i.e. FAT) – Inspection, Analysis, Test, Engineering Review
Verification Criteria – Acceptance	Need to define verification criteria for Life cycle phase (Acceptance i.e. SAT and System Commissioning) – Inspection, Analysis, Test, Engineering Review
Source	Define the source document in IDM for the requirement
Section	Define the section in the source document in IDM for the requirement



2.7.3.5 Justification of the requirements

If applicability is 'No', then designer must provided justification for the non applicability.

For example see below figure.

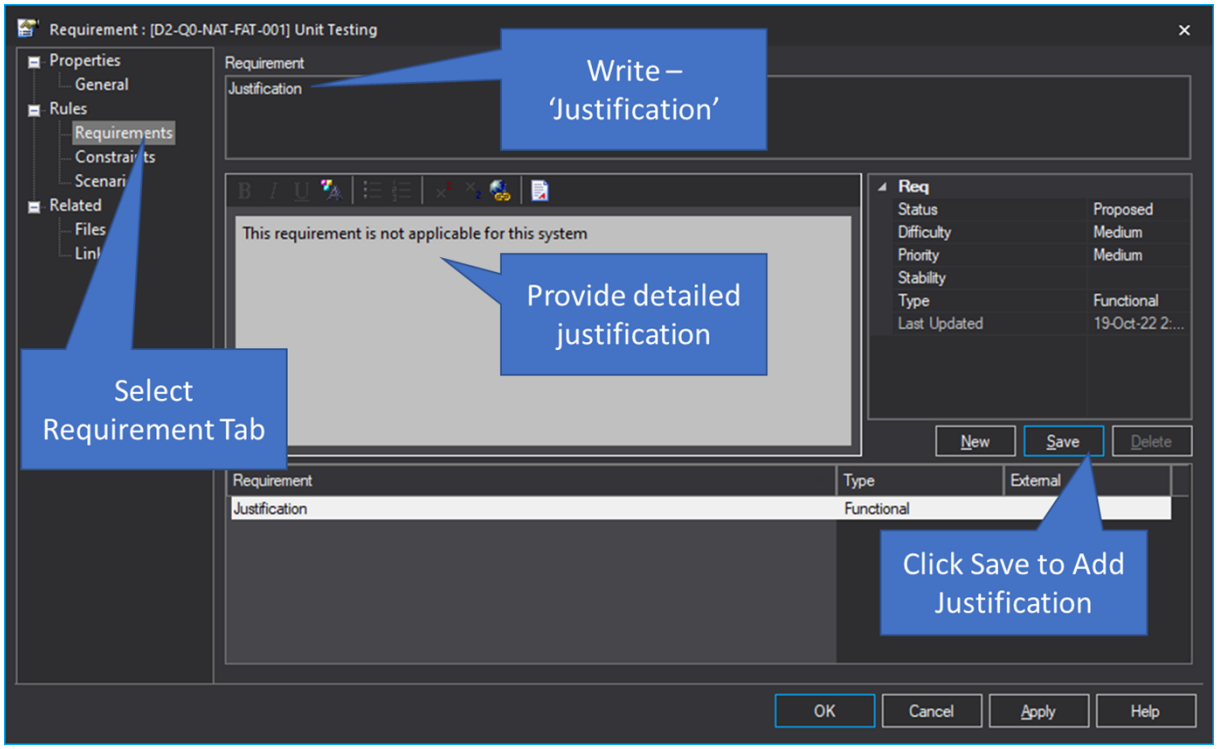


Figure 33: Provide Justification

Note – Ignore type of the requirement. Example *Functional* as shown in the above figure.

2.7.4 Define Actors / Users

An *Actor* is a user of the system; *user* can mean a human user, a machine, or even another system or subsystem in the model. Anything that interacts with the system from the outside of system boundary is termed an Actor

In EA Project an Actor can be added from use case toolbox. I&C designer must define Actor Name and its description. Below diagram shows example of Plant system actor.

In EA Project Actors need to be added under package CBS1-CBS2 User/Actor

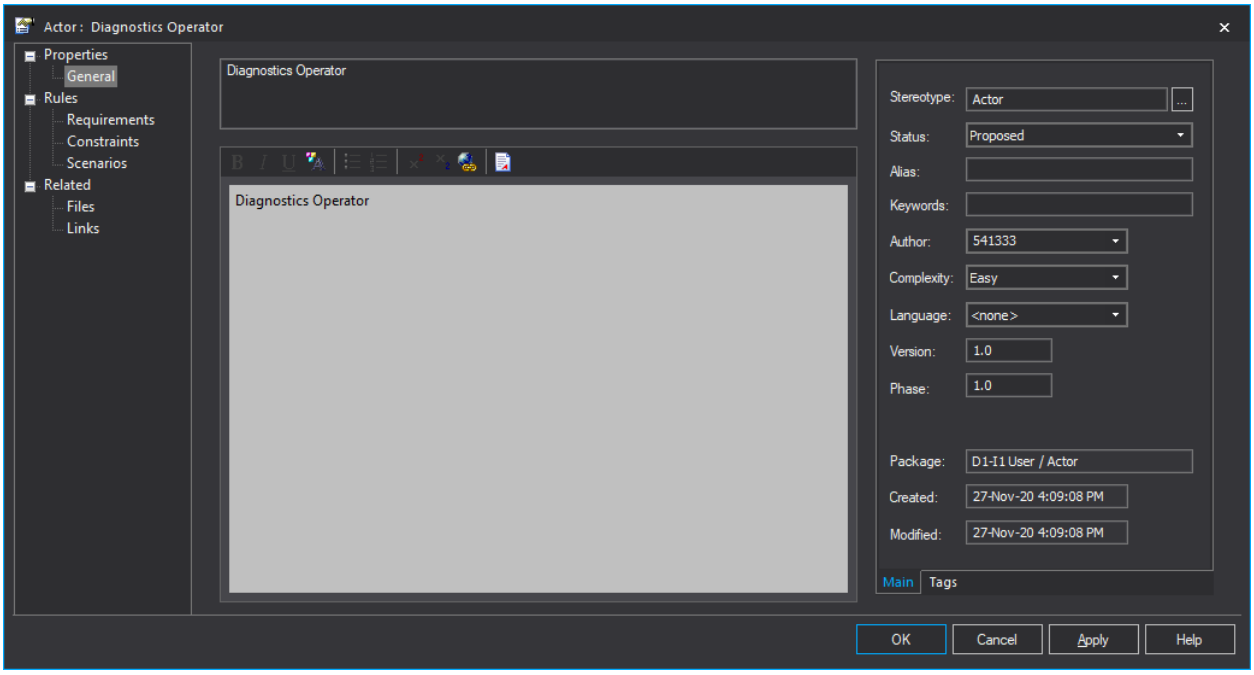


Figure 34: Plant System Actors.

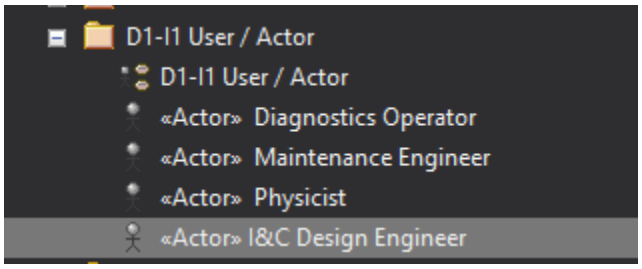


Figure 35: Actors in EA Project

Mandatory Field value to define Actors

Field	Value
Stereotype	Actor

Refer [RD15] for the list of actors.

2.7.5 Define Stakeholders

A Stakeholder is an Individual or organization or Plant system having a right, share, claim, or interest in a system or in its possession of characteristics that meet their needs and expectations

In EA Project Stakeholder can be defined under package CBS1-CBS2 Stakeholders.

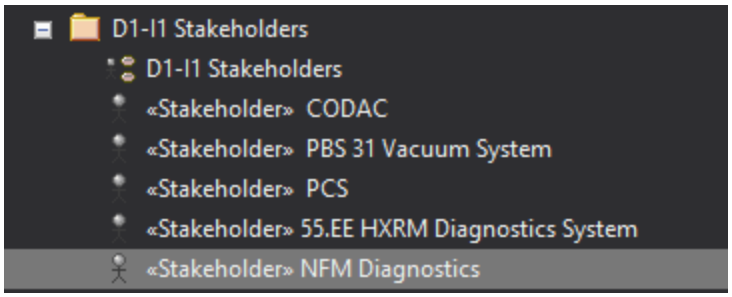


Figure 36: Stakeholders in EA Project

Type of element for stakeholder is Actor

Mandatory Field value to define Stakeholders

Field	Value
Stereotype	Stakeholder

Refer [RD15] for the list of stakeholders.

2.7.6 Define Reference Documents

Reference Documents can be defined using EA Element – Information Item.

Information Item can be added from Toolset Object as shown in below figure

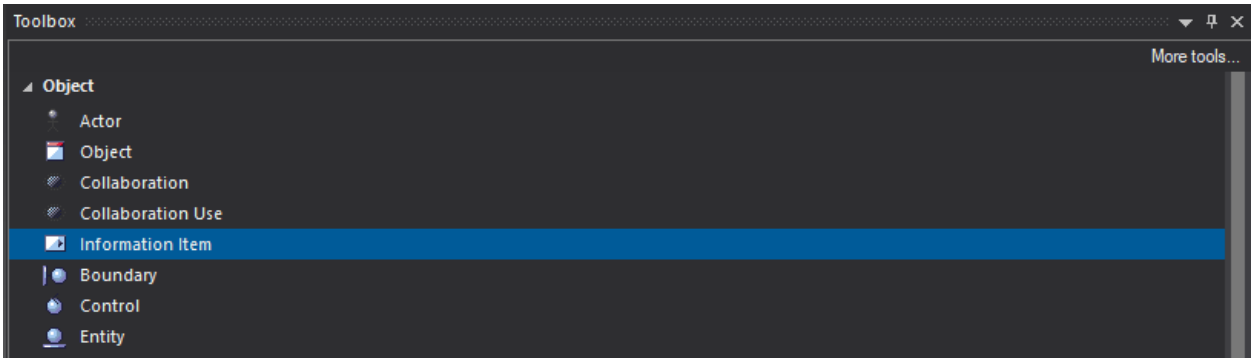


Figure 37: EA Element – Information Item for Reference Document

Below Diagram shows the fields to be filled in item properties to define reference documents.

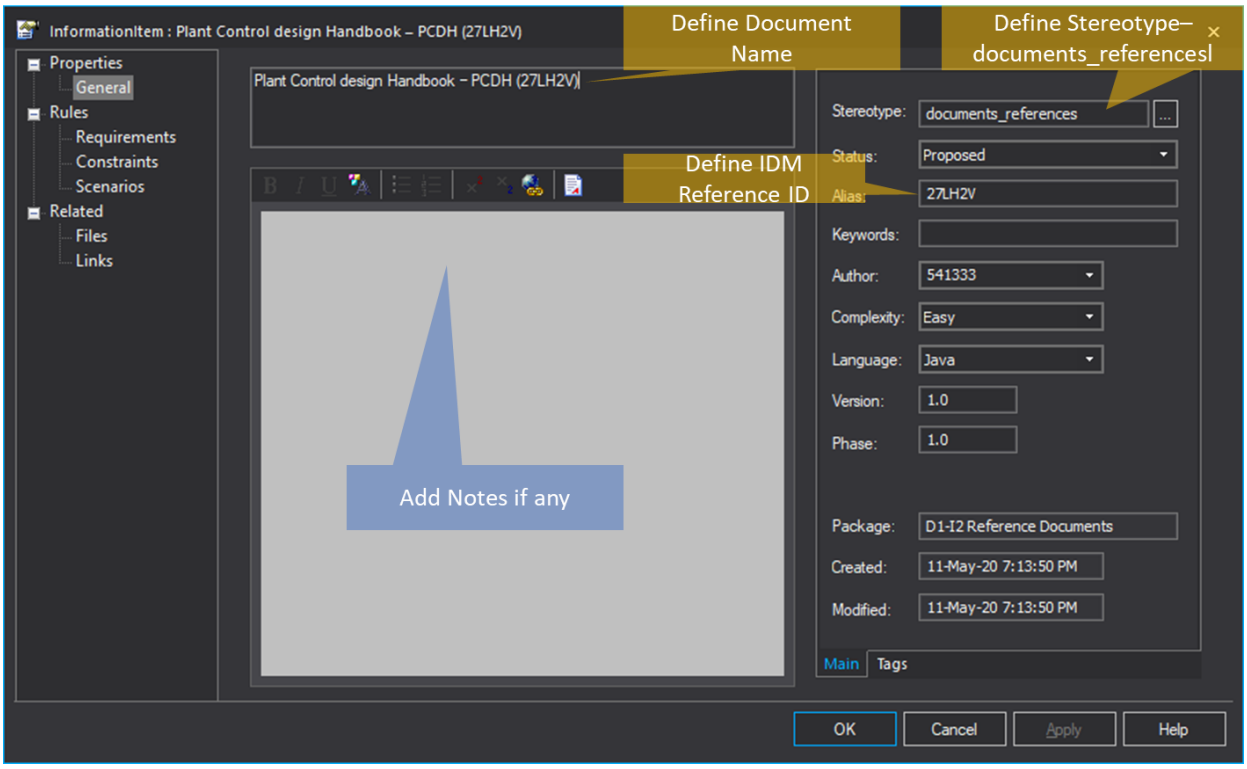


Figure 38: Define Reference documents

2.7.6.1 Stereotypes for the Reference Documents

Below table describes the Stereotype used for Reference Documents

Stereotype	Description
documents_references	This stereotype will be used to define reference documents

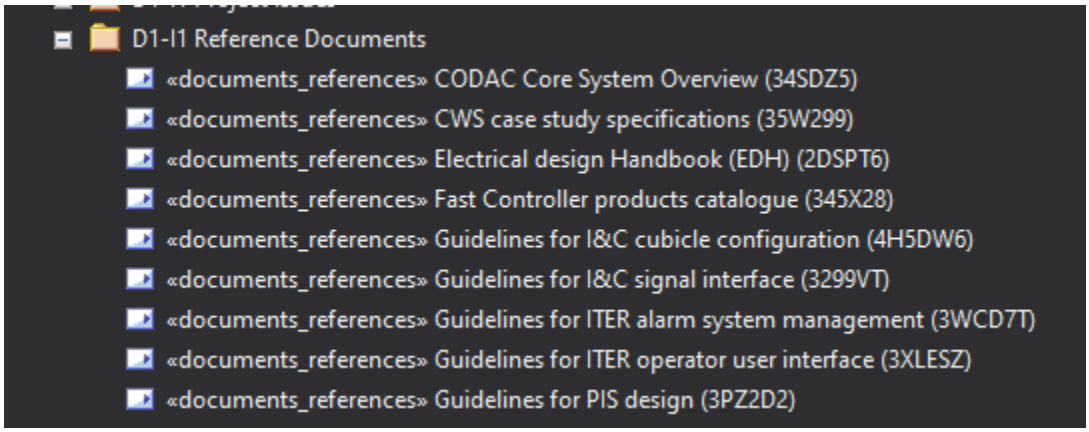


Figure 39: Reference documents in EA Project

2.7.7 Link to Requirement Management Add-in

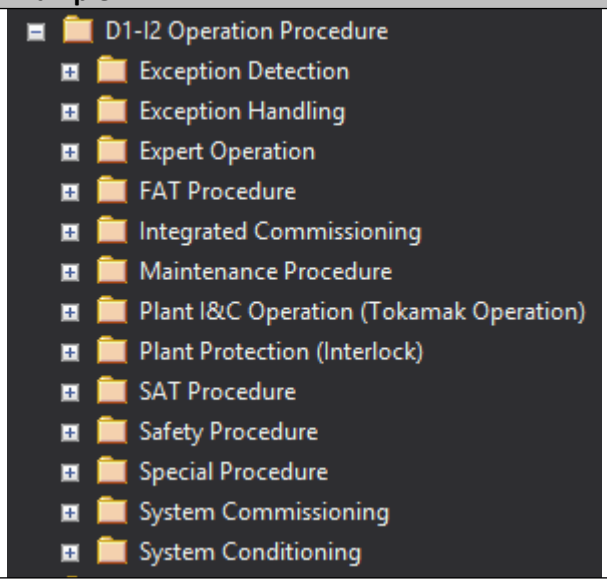
Please refer [RD6] for the user manual.

2.8 Operations Procedure

Refer section 4.3 to understand the essence of operation procedures. This section describes how to define operations procedures in EA (without using the add-in).

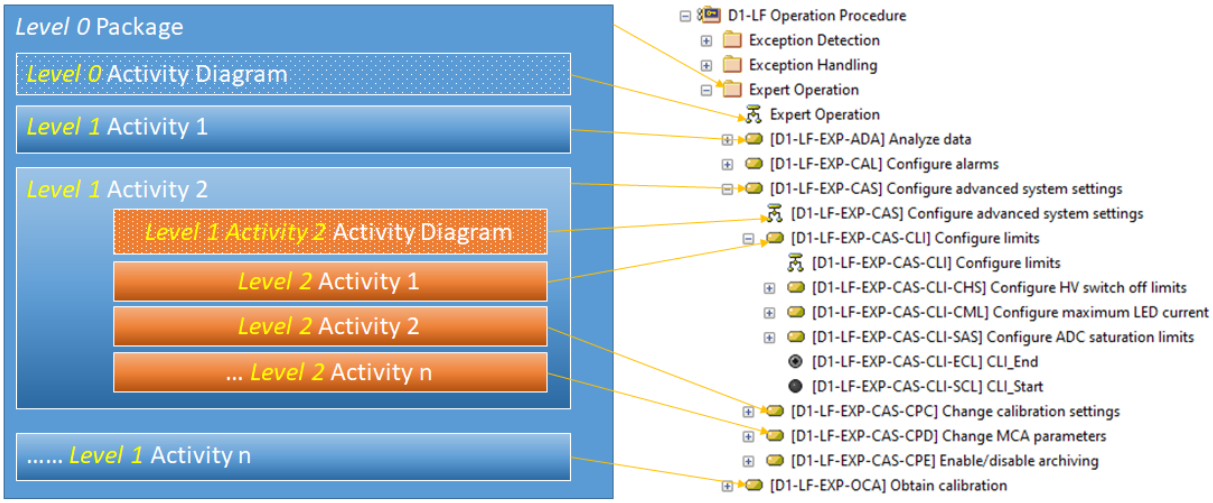
2.8.1 Operations Procedure Sub-Package Structure.

The Operations Procedure package shall contain the following 13 sub-packages:

Sub-package Naming Format	Example
Plant I&C Operation (Tokamak Operation)	
Expert Operation	
Exception Handling	
Exception Detection	
FAT Procedure	
SAT Procedure	
System Conditioning	
System Commissioning	
Integrated Commissioning	
Maintenance Procedure	
Plant Protection (Interlock)	
Safety Procedure	
Special Procedure	

2.8.2 Procedure Breakdown Hierarchy

The figure below explains the procedure breakdown hierarchy. The upcoming sections explain how to document them in the EA project.



Note: Activity ≙ Procedure
(They are equal by definition)

2.8.3 Concept of reference procedures

The concept of reference procedures was discussed in the 5th CODAC workshop on Diagnostics Plant I&C [RD10]. Video recording of the same are also available in the same folder.

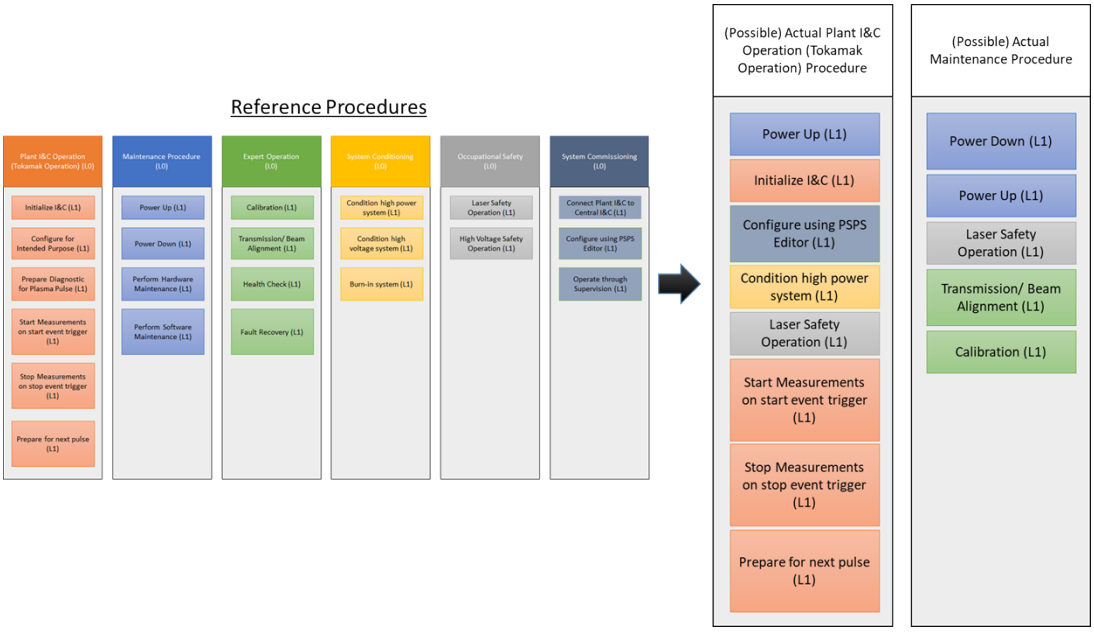


Figure 40. Concept of reference procedure

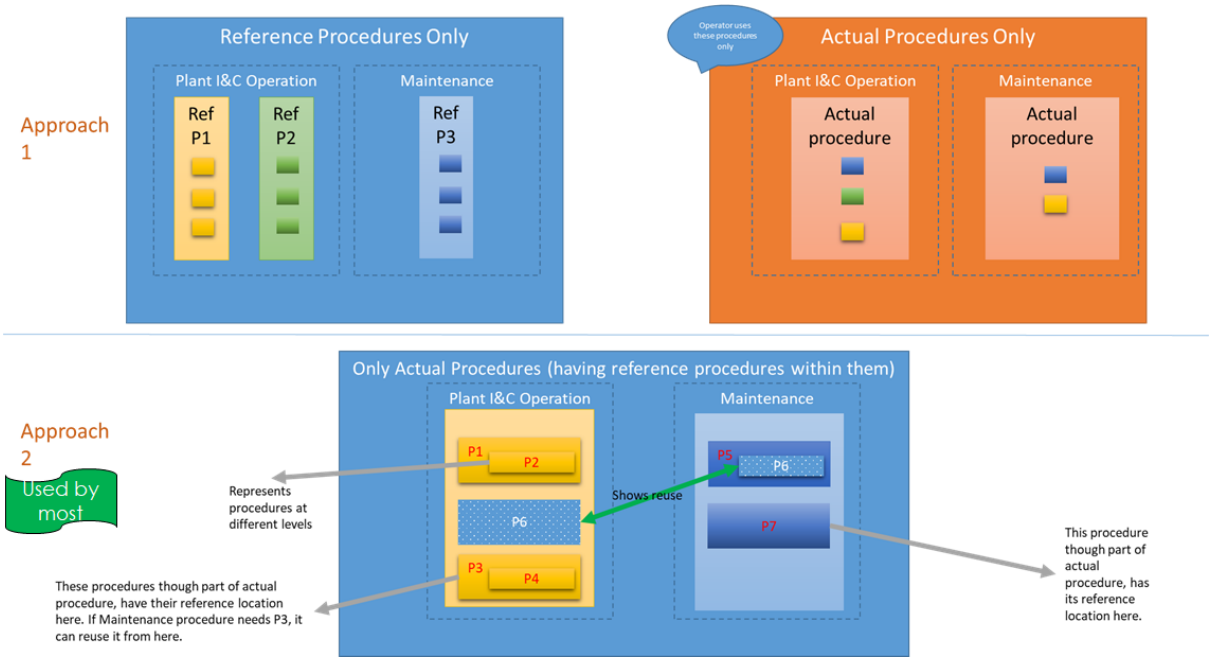


Figure 41. Approaches for documenting reference procedures

If you plan to use approach 1 for reference procedures, please contact ea-support@iter.org definition of relevant packages in EA.

The proposal for reference procedures is as shown below.

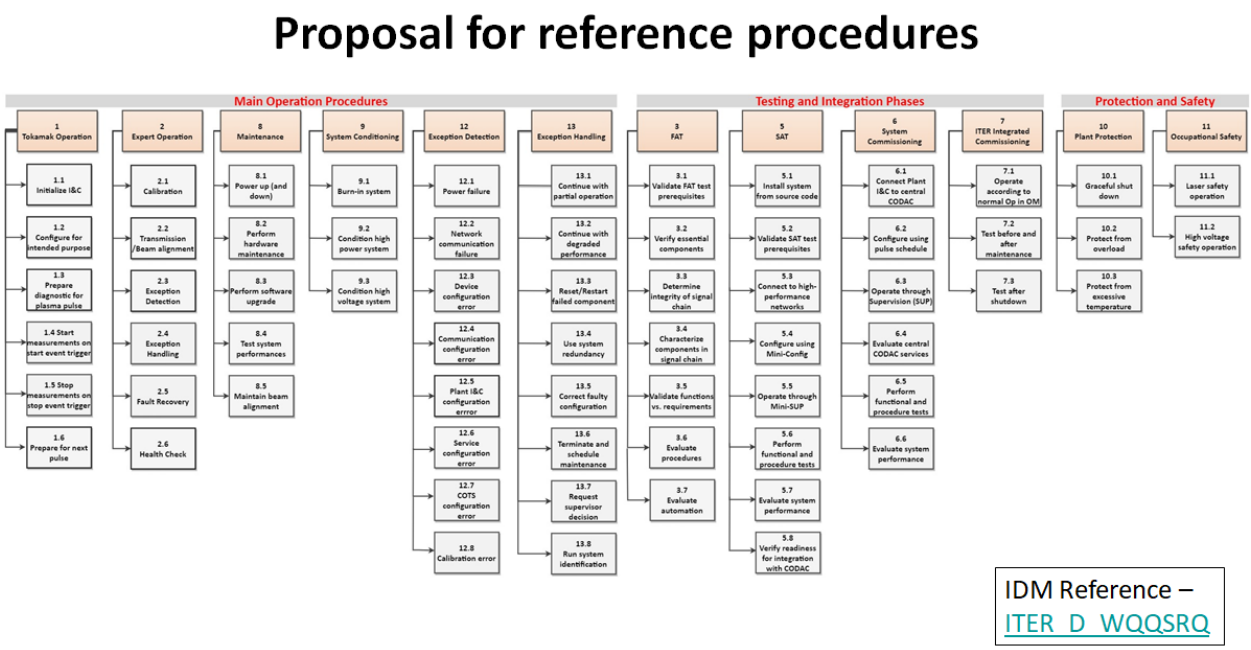


Figure 42. Proposal for reference procedures

2.8.4 Create Activity Diagram under Level 0 Package

1. Add new activity diagram under Level 0 operation procedure package

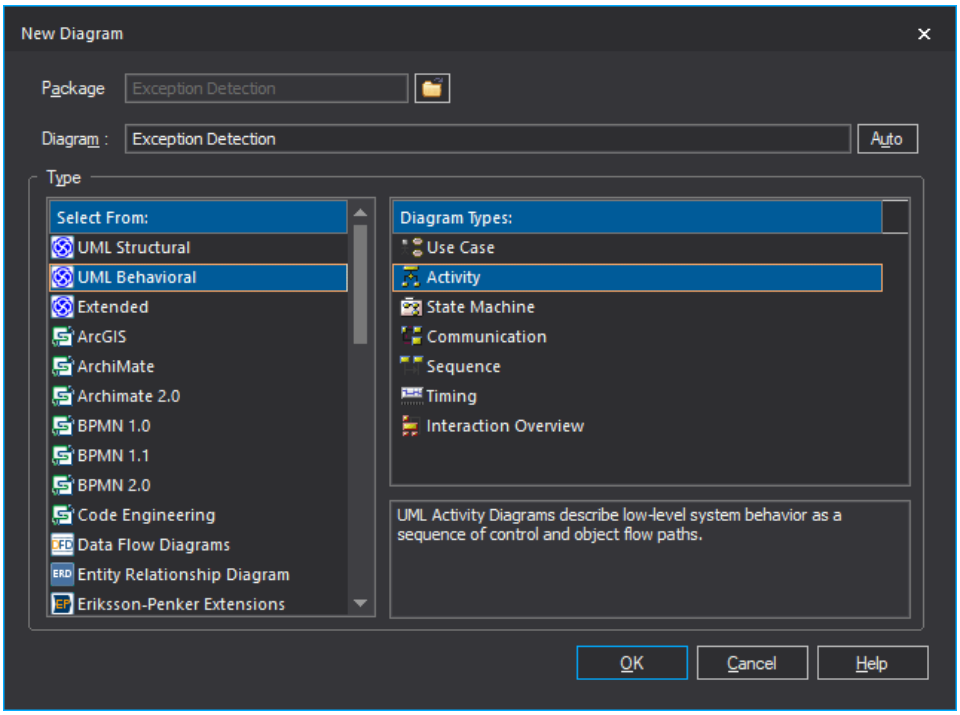


Figure 43: Add Activity Diagram

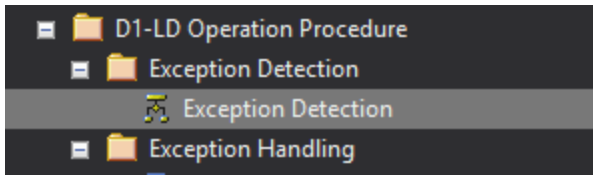
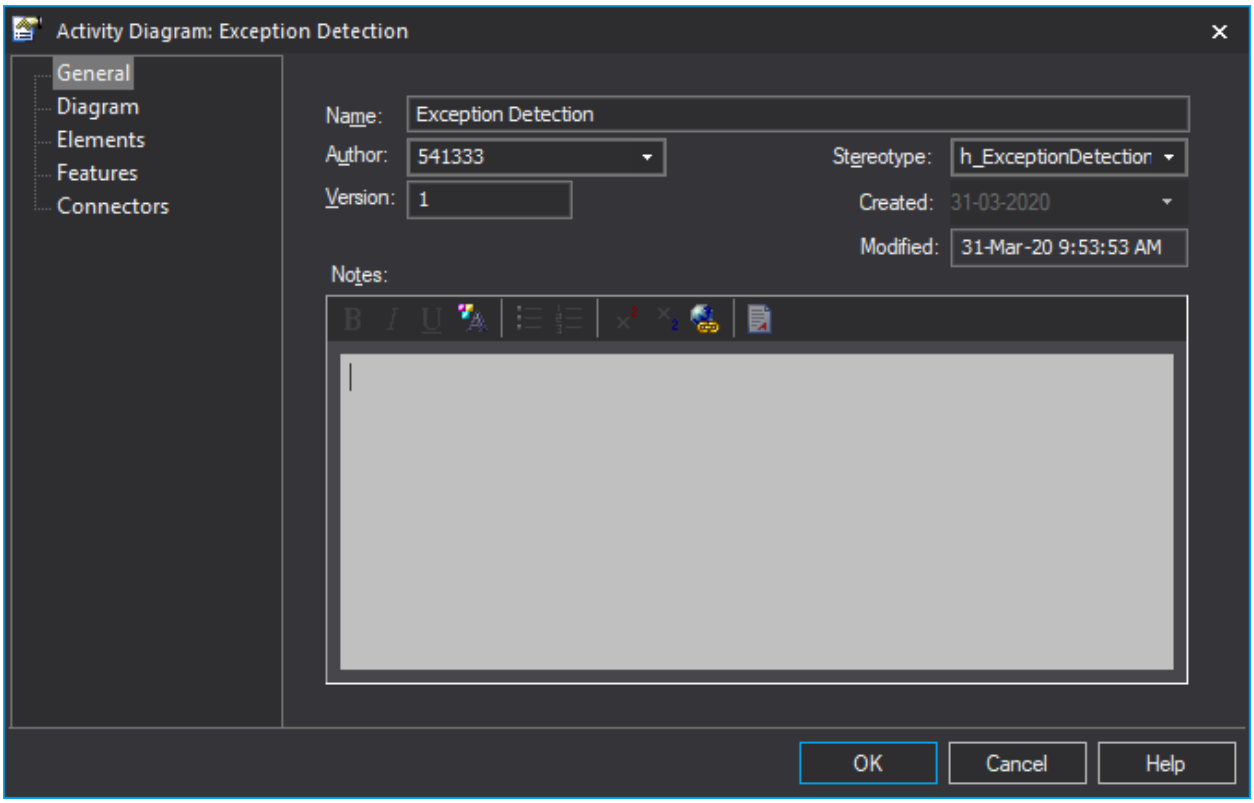


Figure 44: Activity Diagram Added

2. Define Stereotype for each level 0 activity diagram. Note: Stereotypes should be defined only for Level 0 Activity Diagrams.



Refer the table below for Stereotypes which are related to different Level 0 packages.

Table 11: Stereotype of Level 1 Activity Diagrams

Stereotype	Procedure Name	Level 0 Procedure Code
h_operationprocedure	Plant I&C Operation (Tokamak Operation)	OPR
h_FactoryAcceptance	FAT Procedure	FAT
h_SiteAcceptance	SAT Procedure	SAT
h_Maintenance	Maintenance Procedure	MTN
h_Commissioning	System Commissioning	SCM
h_Expertoperation	Expert Operation	EXP

h_Integrated	Integrated Commissioning	ICM
h_SystemCondition	System Conditioning	SCD
h_ExceptionDetection	Exception Detection	EPD
h_ExceptionHandling	Exception Handling	EPH
h_Protection	Plant Protection (Interlock)	PTC
h_Safety	Safety Procedure	SAF
h_specialprocedure	Special Procedure	SPL

2.8.5 Develop Activity Diagrams

To develop activity diagrams, use Activity Toolbox as shown in below diagram

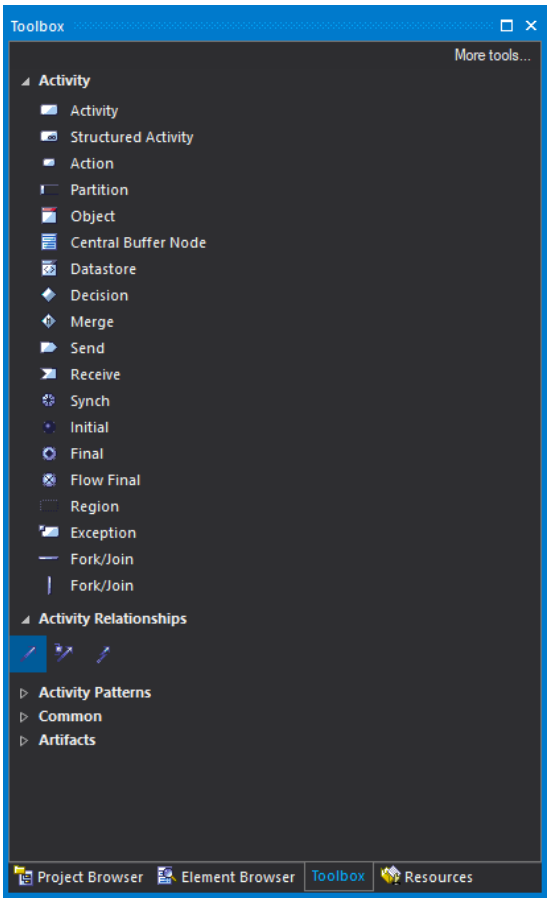


Figure 45: Activity Toolbox

The table below describes commonly used activity elements from Activity Toolbox. These elements are used in all levels of activity diagrams

Table 12: Activity Toolbox Elements

Element Name	Description
Activity	An Activity represents a functional behavior.
Structured Activity	Structured Activity elements are used in Activity diagrams. A Structured Activity is an activity node that can have subordinate nodes as an independent Activity Group.
Decision	Decision used to indicate a point of conditional progression: if a condition is true, then processing continues one way; if not, then another
Initial	It is used to define the start of the flow
Final	It is used to define the completion of flow
Control Flow	It is used to connect 2 elements
Fork/Join	The Fork/Join elements can be used to: • Fork or split the flow into a number of concurrent flows • Join the flow of a number of concurrent flows • Both join and split a number of incoming flows to a number of outgoing flows

Note: Activity diagrams at lower levels (i.e., Level 1, 2,) are automatically created when "Structured Activity" element names are used.

2.8.5.1 Define Level 1 Activities

Note: The steps below define how to develop Level 1 Activities, but the same steps should be used for developing activities at lower levels as well.

1. Open the Level 0 Activity Diagram**.**
2. Drag / Add Structured Activity from Activity tool pallet to activity diagram. Thereafter, Drag, select option as Other. For the activities at the lowest level, instead of structured activity, activity element must be used (since there are no activities lower than that level).

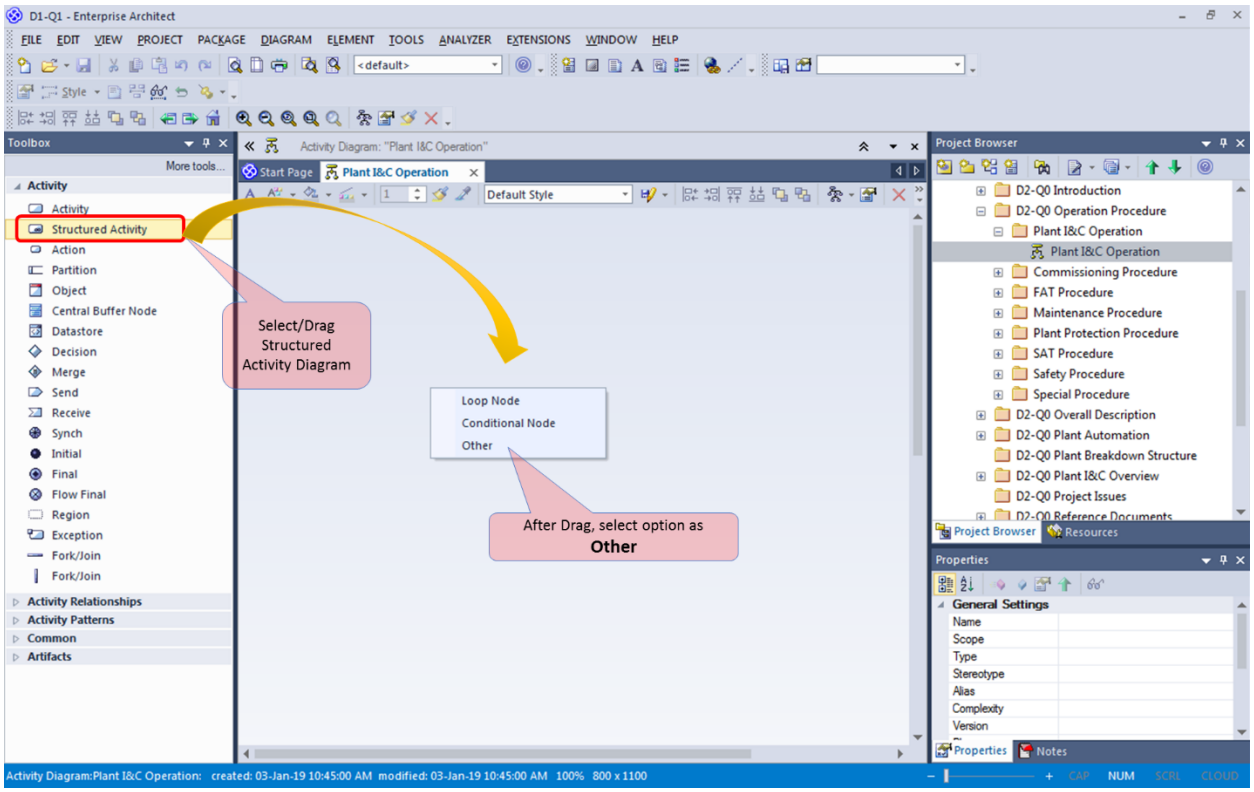


Figure 46: Select Structure Activity Diagram

3. A Popup window will open to select Activity Type. Select **Simple Composite** Activity and Click **OK.**

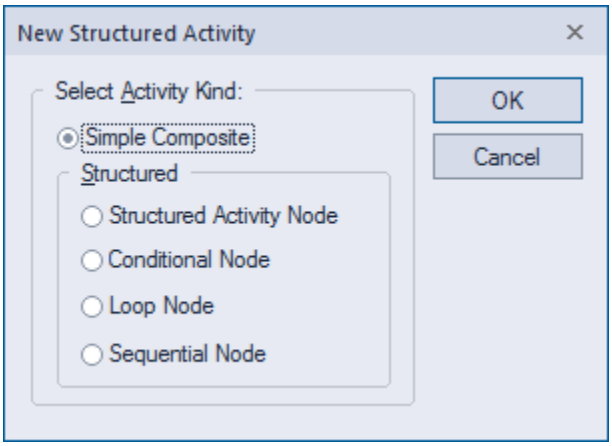


Figure 47: Select Activity Type

4. The property window will open.
5. Give Level 1 Activity name in the form of [Activity ID] <Activity Name>.

Activity ID - <CBS1>-<CBS2>-<Level 0 Code>-<Operation Procedure Code> (for example, D2-Q0-OPR-CFG) the example of activity name is [D2-Q0-OPR-CFG] for Configuration Procedure under Plant I&C Operation Procedure.

There are two types of ID formats supported. Please refer appendix 7 for the same.

6. Provide Activity ID in Alias. This should be same as mentioned in previous step within the brackets […] in the Name.
7. Provide Activity description in Notes.

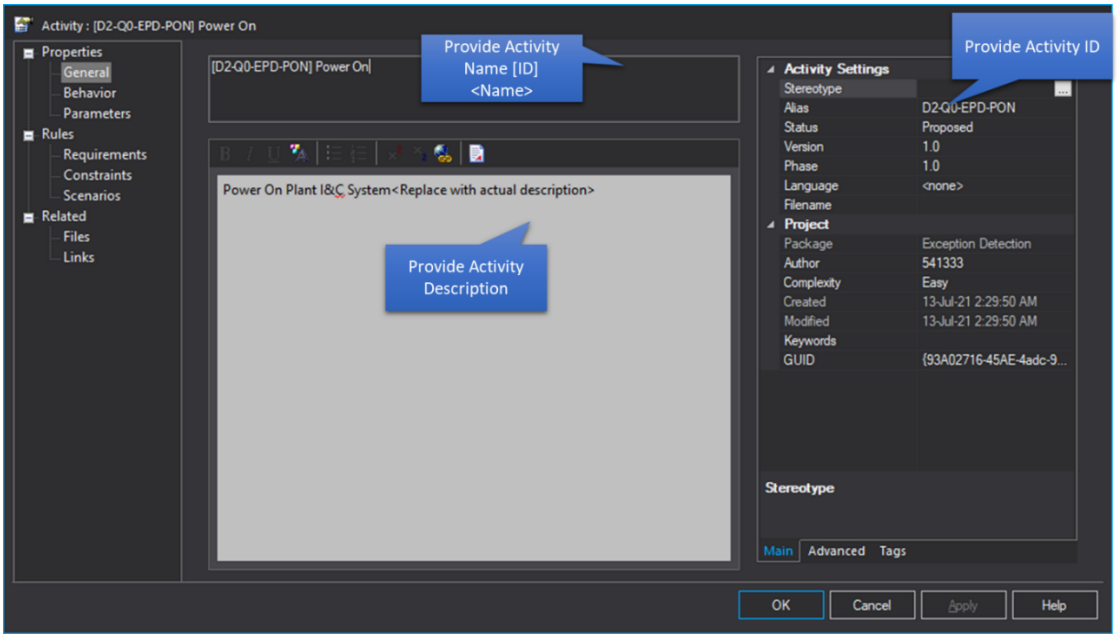


Figure 48: Level 1 Activity Details

8. Define tagged values for Actors, Stakeholders and Mnemonic name

Table 13: Tagged values for Activity Diagram

Tagged Name	Description
Actor[a]	Define Actors for the Procedure
Stakeholder[a]	Define Stakeholders for the Procedure

a -> Actors and Stakeholders should be defined for only Level 1 procedures (activities)

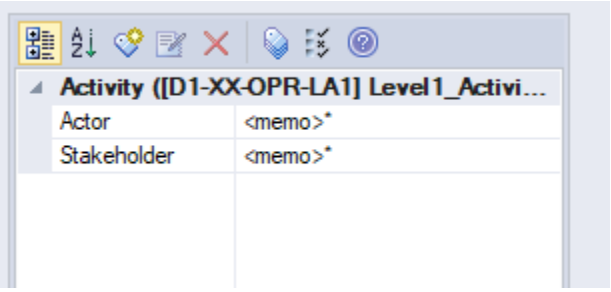


Figure 49: Define Tagged Values

9. To Add Pre-Conditions for Activity – Select Constraints type as Pre-conditions and write Pre-conditions in Constraint. Similar for Post-conditions. The pre-conditions and post-conditions are not needed for Level 1 and Level 2 procedures and are optionally advised for Level 3 and lower-level procedures.

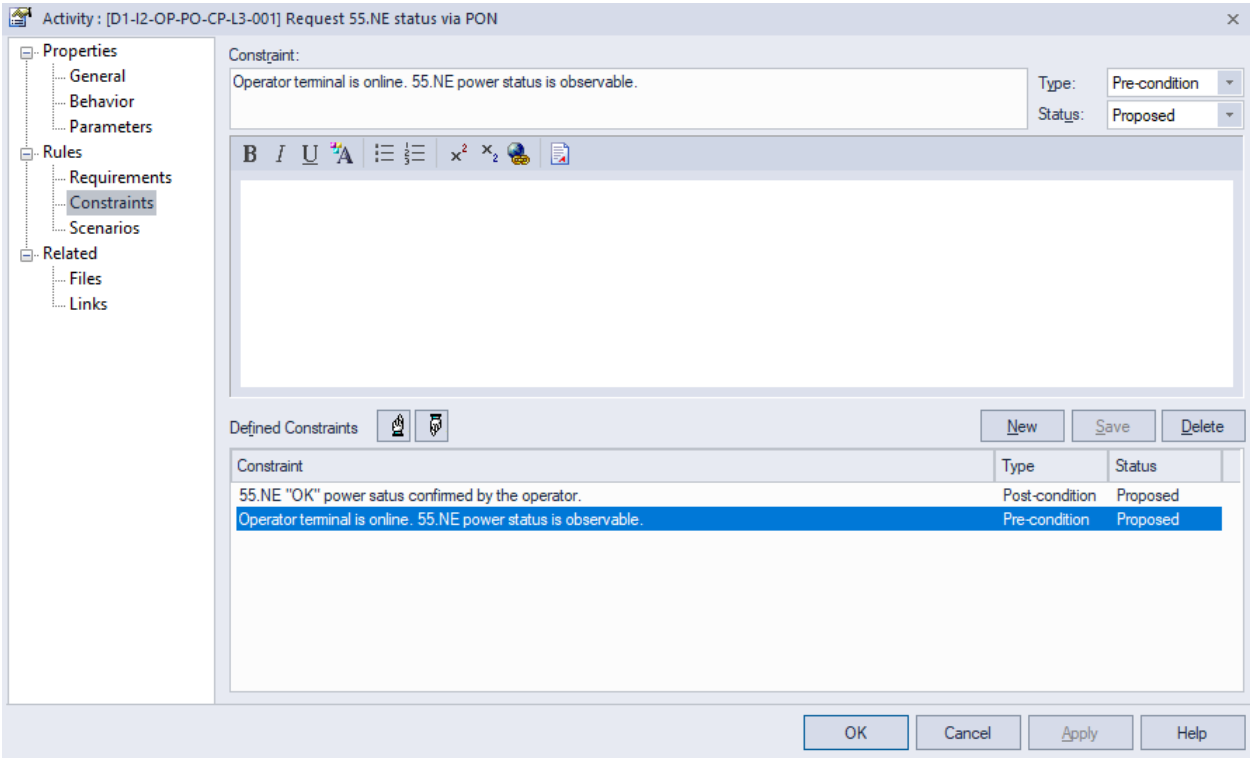


Figure 50: Define Pre-Conditions and Post-Conditions

10. Follow above steps to add multiple activities.

2.8.5.2 Connect Activities at Level 1

1. Use Control flow to connect activities at level 1

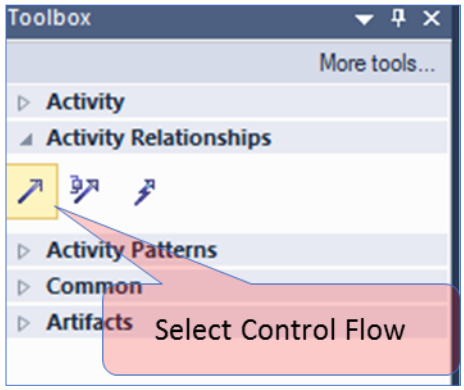


Figure 51: Control Flow in Activity tool pallet

2. After connection double click on Control Flow to give it a name.

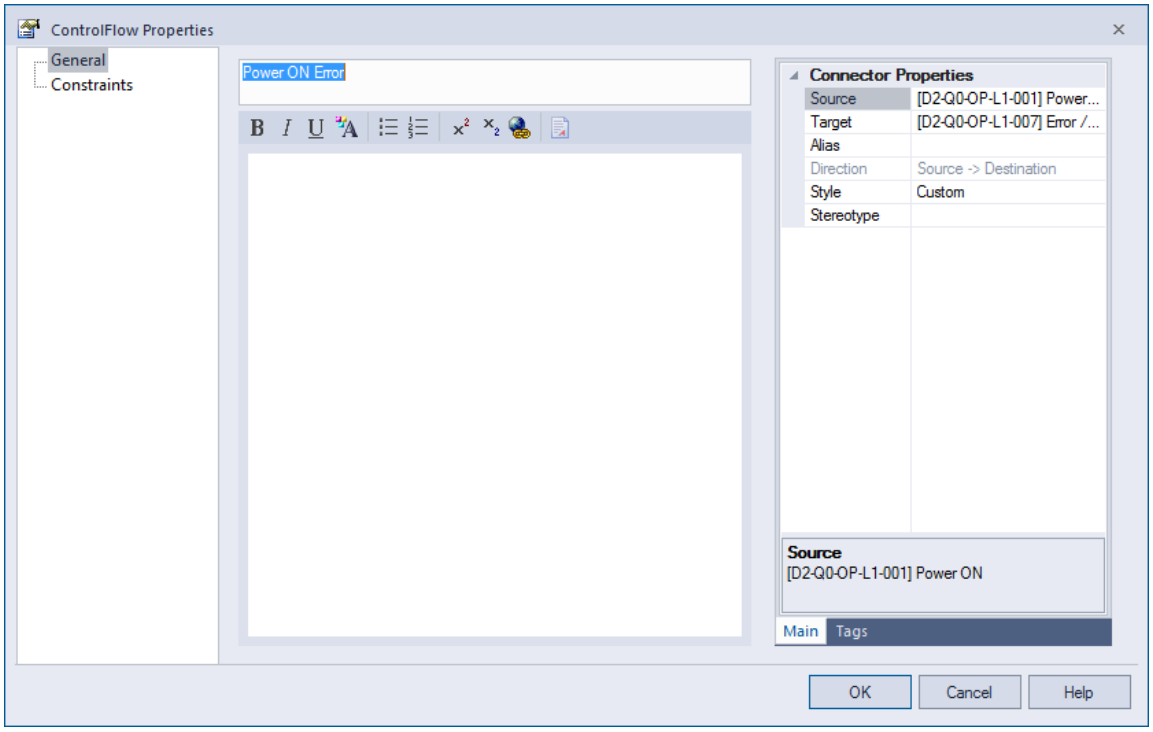


Figure 52: Control flow name

3. Use above steps to connect all activities.

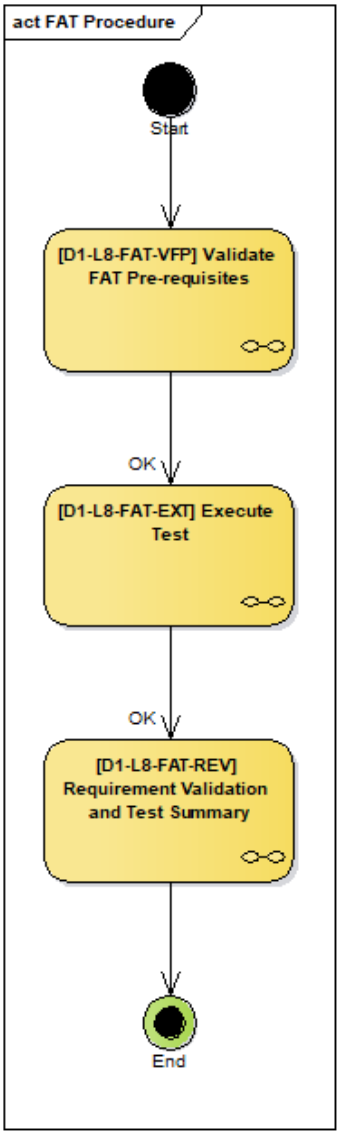


Figure 53: Example Level 1 Activity Diagram

Note: The same steps should be followed for connecting activities at lower levels.

2.8.6 Link to Operation Procedures add-in

Please refer [RD6] for the user manual.

2.9 Functional Analysis

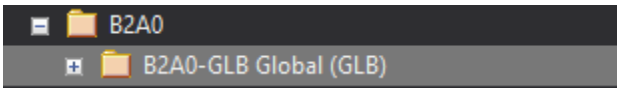
Refer section 4.2 for introduction to the functional analysis. Also, refer the guideline document [RD9].

This section describes the how to define functional analysis (Level 1 to Level 6) in EA. Plant I&C functions should be defined using Packages.

Functional analysis is to be defined under the package CBS1-CBS2 Functional Analysis. Under this package define the different CBS 3 packages. Under the CBS 3 packages, functional analysis packages must be defined. This is explained below.

2.9.1 Define Level 1 function

Level 1 function name shall be defined like CBS3-FBS1 Code <Function Name> (Function Code) e.g., B2A0-GLB Global (GLB)

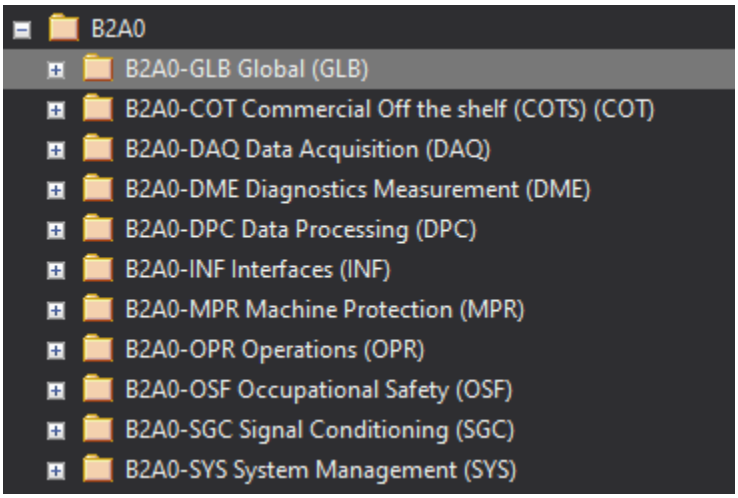


1. Following attributes need to define for each function

Field Name	Attribute	Description
Alias	Mnemonic Name	Need to define Mnemonic Name
Tagged Value	Code	Level 1 function code e.g., GLB
Tagged Value	ID	Level 1 function ID e.g., B2A0-GLB
Tagged Value	Priority	e.g., Low, Medium, High

Note: Alias (mnemonic name) and Priority are optional fields.

2. Need to follow above steps to define all level 1 functions



2.9.1.1 Add Package Diagram

For each level of function, it required to add package diagram. Following steps explain how to add package diagram

1. Right click on any level of function and select option Add Diagram. New Diagram window will open. From the list select diagram Type: Package Diagram as shown in below figure

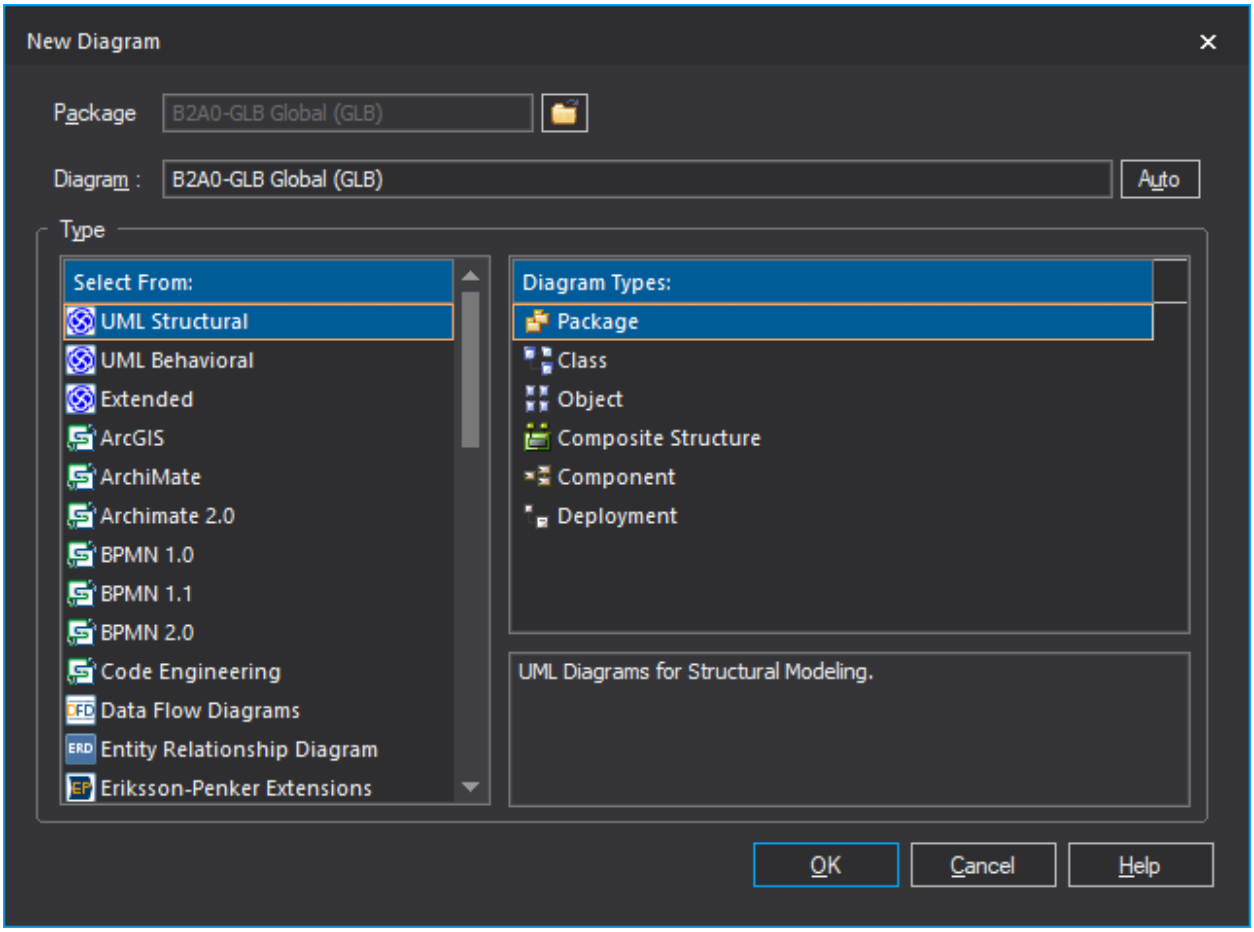
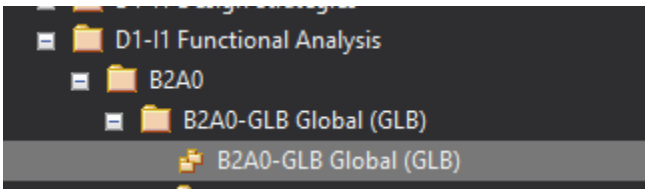
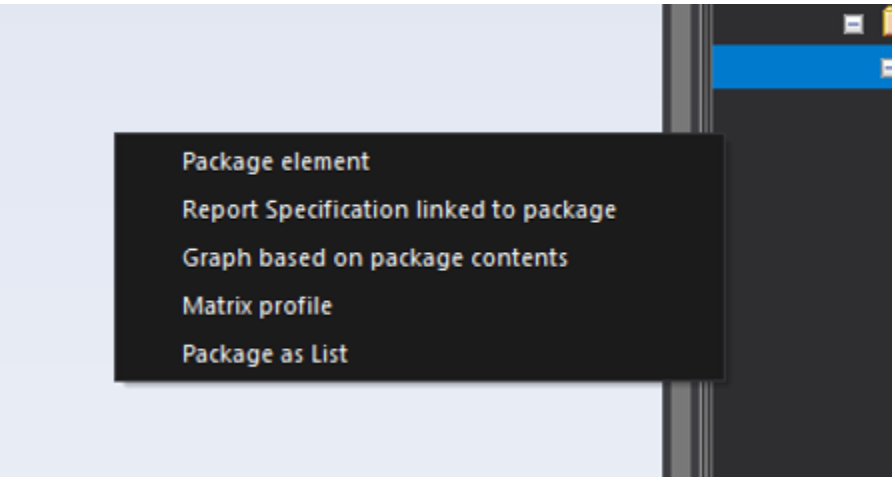


Figure 54: Add Package Diagram

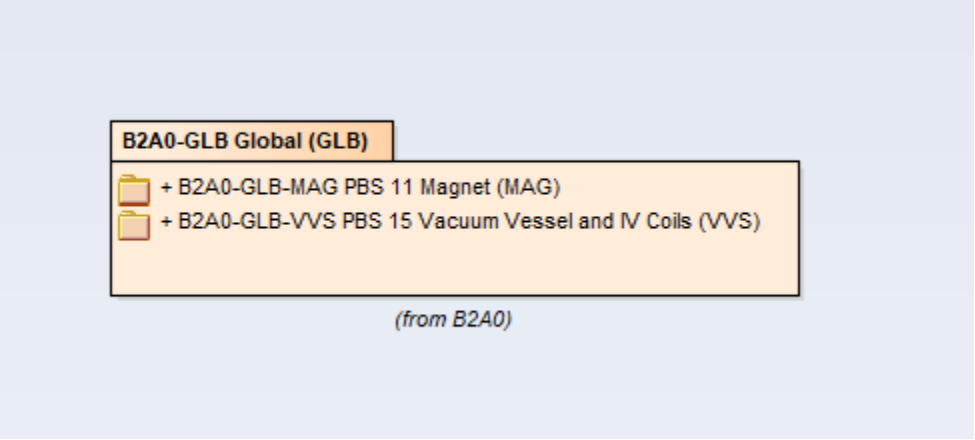
2. Click on OK button to add package diagram in EA Project



3. Open the diagram and drag level 1 function on the diagram. Popup will appear to select options.



4. Select package element from the option to create package diagram as shown in below figure.



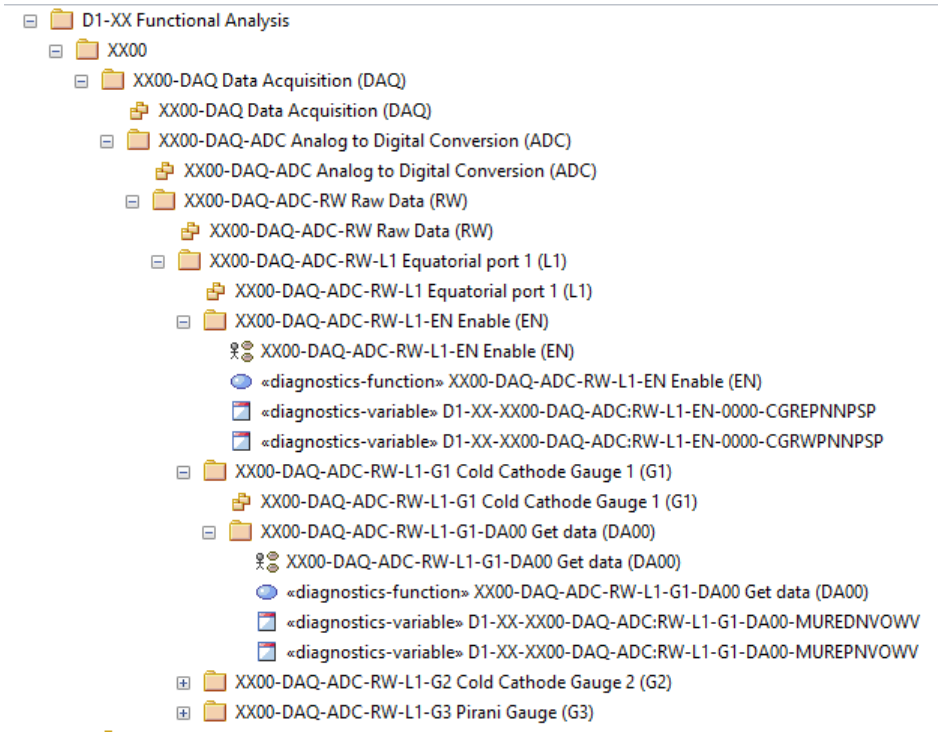
2.9.2 Subsequent Level functions

Similarly, following the steps defined in the previous section, function packages and their package diagrams for the lower level functions can be defined in the EA project.

For reference, the naming of functions are different levels is as below:

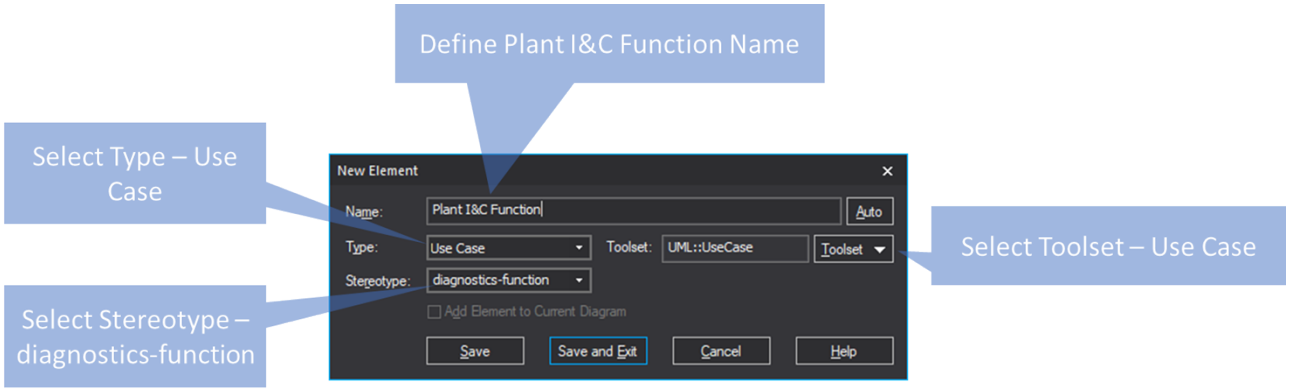
- Level 2 function name shall be defined like CBS3-FBS1 Code-FBS2 Code <Function Name> (Function Code>. E.g., B2A0-GLB-MAG PBS 11 Magnet (MAG)
- Level 3 function name shall be defined like CBS3-FBS1 Code-FBS2 Code-FBS3 Code <Function Name> (Function Code>. E.g., B2A0-GLB-MAG-ME Measurement (ME)
- Level 4 function name shall be defined like CBS3-FBS1 Code-FBS2 Code-FBS3 Code -FBS4 Code <Function Name> (Function Code>. E.g., B2A0-GLB-MAG-ME-M1 Measurement Parameter 1 (M1)
- Level 5 function name shall be defined like CBS3-FBS1 Code-FBS2 Code-FBS3 Code -FBS4 Code-FBS5 Code <Function Name> (Function Code). E.g., B2A0-GLB-MAG-ME-M1-M1 Optional Function (M1)
- Level 6 function name shall be defined like CBS3-FBS1 Code-FBS2 Code-FBS3 Code -FBS4 Code-FBS5 Code-FBS6 Code <Function Name> (Function Code). E.g., B2A0-GLB-MAG-ME-M1-M1-OF00 Optional Function (OF00)

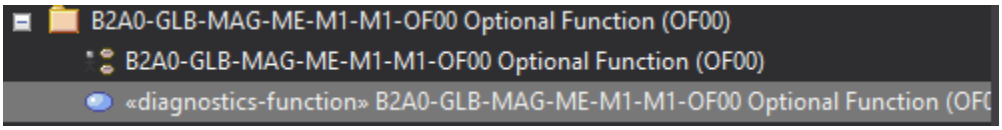
Note: The package which has the I&C function and associated variables, will not have a package diagram. It will rather have the function processing diagram. This is shown below.



2.9.3 Define Diagnostics Function

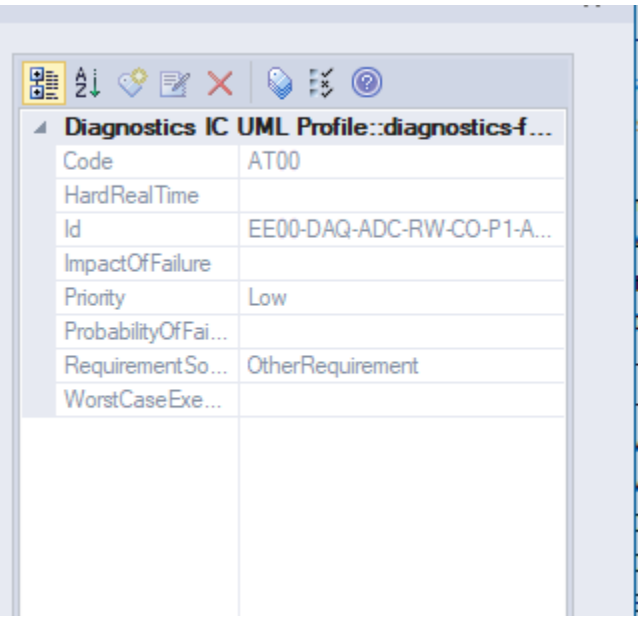
1. To add diagnostics function, it required to add use case element at last level package (Level 4 or Level 5 or Level 6)





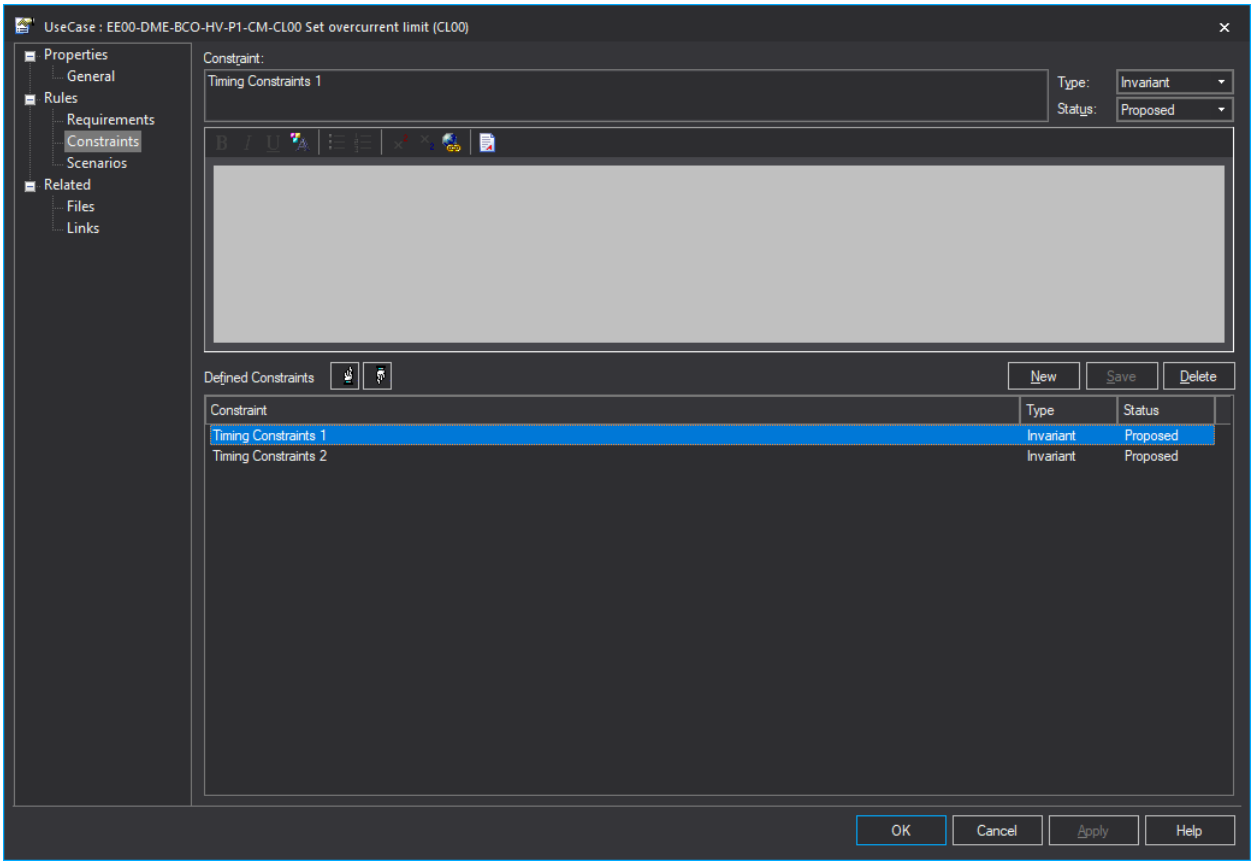
2. After adding diagnostics function it required to define attributes as shown in below table

Field Name	Attribute	Description
Tagged Value	Code	function code e.g., OF00
Tagged Value	ID	function ID e.g., B2A0-GLB-MAG-ME-M1-M1-OF00
Tagged Value	Priority	e.g., Low, Medium, High



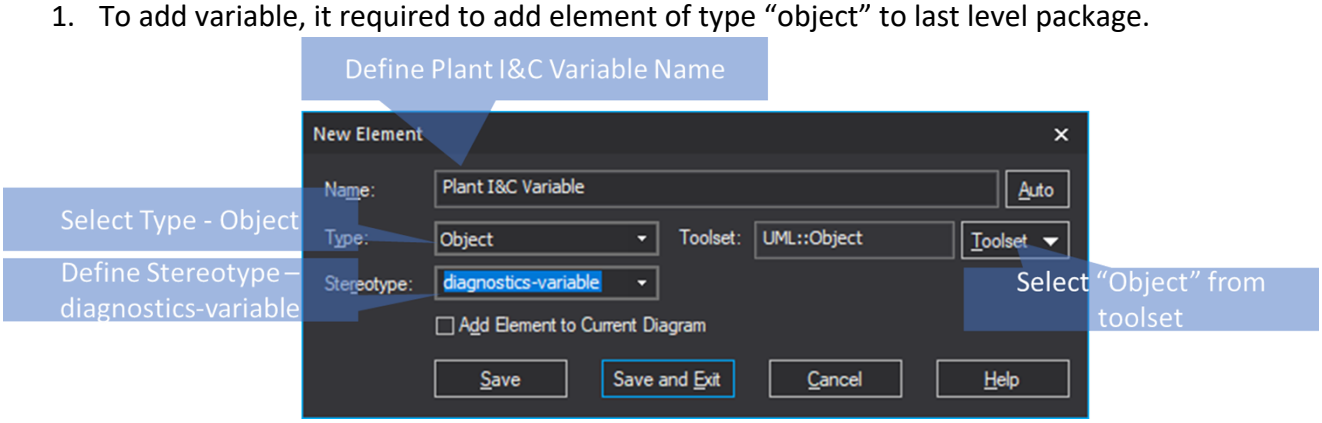
2.9.3.1 Define Timing Constraints

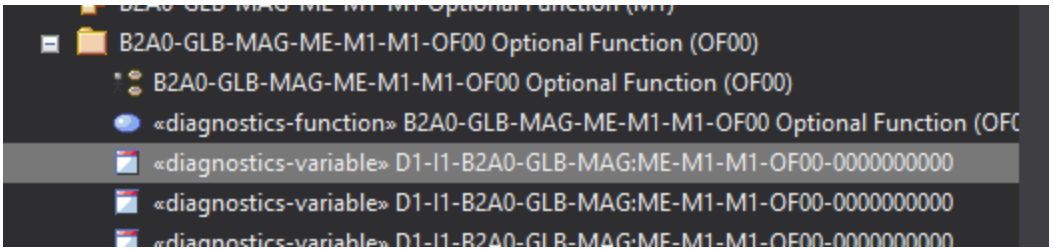
For diagnostics function, timing constraints shall be defined under constraint tab as shown below.



2.9.4 Define Plant I&C Variables

1. To add variable, it required to add element of type “object” to last level package.





2. After adding diagnostics Variable, it required to define attributes as shown in below table

Table 14 Tag values of a variable

Field Name	Attribute	Description (also refer the note below)
Tagged Value	Alias	Need to define Mnemonic Name
Tagged Value	Attribute 1	Need to define variable attribute 1 – Refer [RD3]
Tagged Value	Attribute 2	Need to define variable attribute 2 – Refer [RD3]
Tagged Value	Attribute 3	Need to define variable attribute 3 – Refer [RD3]
Tagged Value	Attribute 4	Need to define variable attribute 4 – Refer [RD3]
Tagged Value	Attribute 5	Need to define variable attribute 5 – Refer [RD3]. This attribute is optional.
Tagged Value	Archive	Yes/No
Tagged Value	Available on HMI	Yes/No
Tagged Value	Alarm	Yes/No
Tagged Value	Alarm Low Limit	self explanatory
Tagged Value	Alarm Low Low Limit	self explanatory
Tagged Value	Alarm High Limit	self explanatory
Tagged Value	Alarm High High Limit	self explanatory
Tagged Value	Lower Limit	Lower limit of the variable
Tagged Value	Upper Limit	Upper limit of the variable
Tagged Value	Category	Category is implementation specific and does not need to be considered for Design phase. More details about this field are in

		The CODAC - Plant System Interface ([RD11]). The possible options for this field are: State data Configuration data Simple command
Tagged Value	Data Kind	Data Kind is implementation specific and does not need to be considered for Design phase. More details about this field are in The CODAC - Plant System Interface ([RD11]). The possible options for this field are: Continuous. Type ≠ S. Two-state Multi-state String. Type is always S.
Tagged Value	Data Type	Data Type is implementation specific and does not need to be considered for Design phase. More details about this field are in The CODAC - Plant System Interface ([RD11]) The possible options for this field are : I8 I16 I32 U8 U16 U32 F32 F64 S
Tagged Value	Hardware Allocation	the hardware on which the variable resides. Please use the names of the hardware as per the PCDH component naming guideline ([RD8]). Note: slow controller variables reside on the PSH.
Tagged Value	Signal Name	Name of the signal which is associated with the variable. This field is only to be filled for those variables which represent direct conversion. (Refer figure 3 in ([RD8]).
Tagged Value	Unit	self explanatory. The name of the unit must be consistent from the list defined in https://psp.iter.org/PsProfile/page/reference/physicalunits.faces

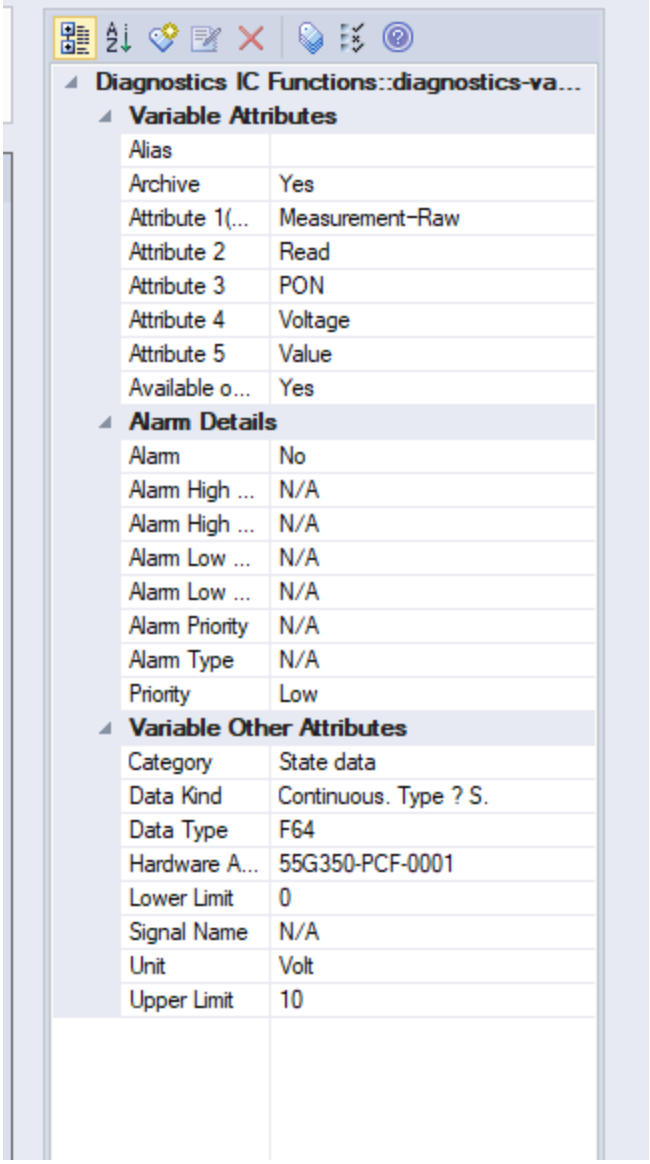


Figure 55: Tag values (attributes) of a variable

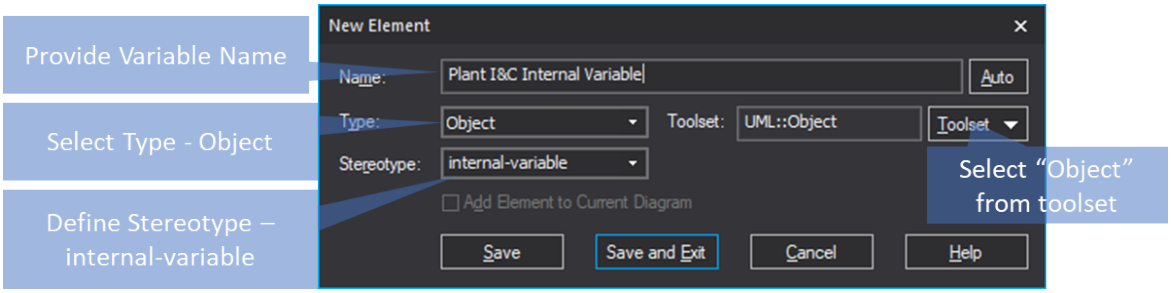
Note: In the figures above, please ignore the additional tag values which are not available in Table 14 Tag values of a variable.

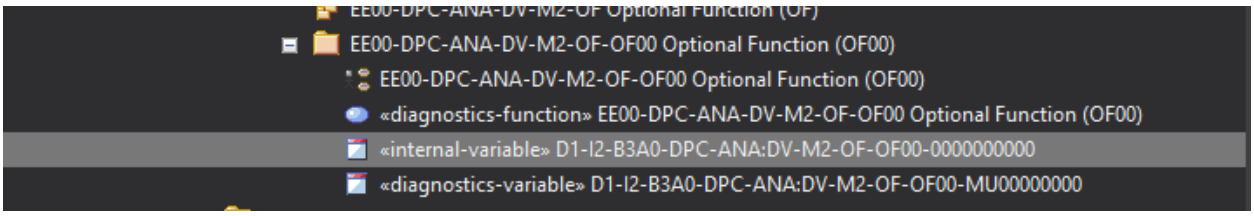
Note: It is highly recommended that variables are defined for functions at Level 4 or higher and not below.

2.9.5 Define Plant I&C Internal Variables

Concept of internal variable was discussed in slide 19 of [RD10].

To add internal variable, add element of type “object” to last level package.



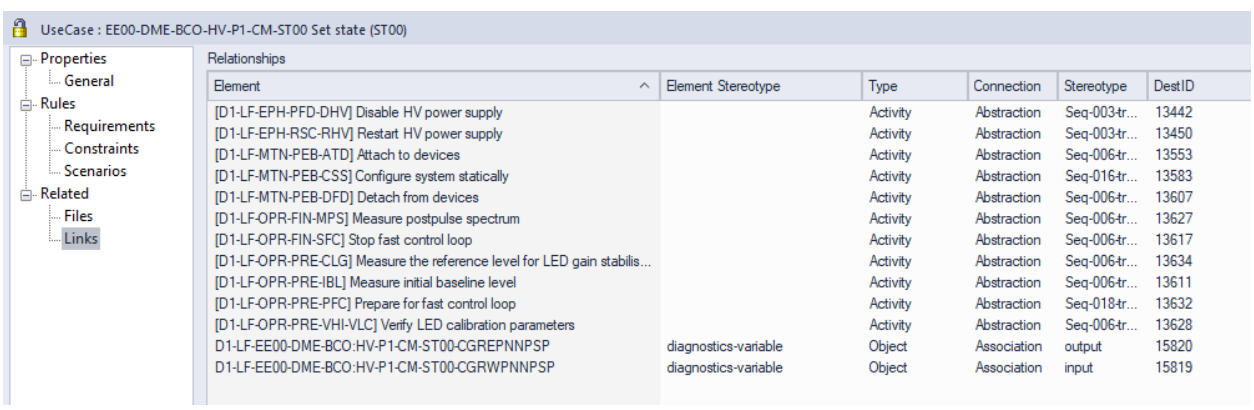


After adding internal variable, define tag values of the variable as explained in section 2.9.4.

2.9.6 Mapping variables to functions

The input and output variables for the functions should be defined as links. This is shown in the figure below. The connection type should be ***Association*** and Stereotype should be **'Input' or 'Output'** . The input variables can be Plant I&C, NDS variables; while the output variables can be Plant I&C, NDS variables.

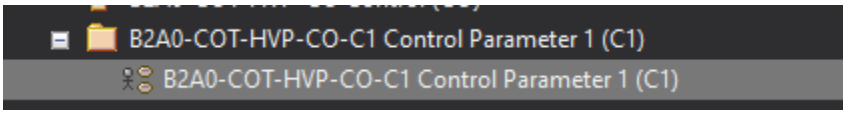
If a function uses SYSM variable as an input, it must be mentioned in the description of the function (refer section 2.13).



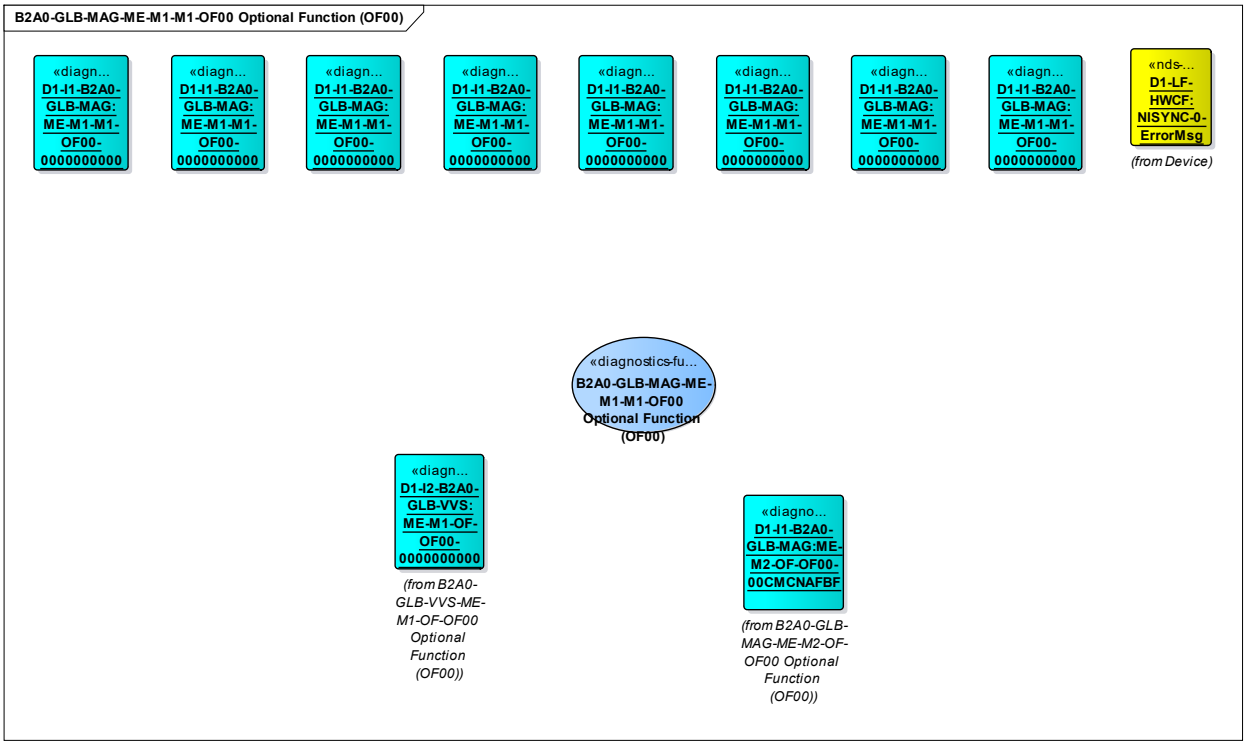
Element	Element Stereotype	Type	Connection	Stereotype	DestID
[D1-LF-EPH-PFD-DHV] Disable HV power supply		Activity	Abstraction	Seq-003-tr...	13442
[D1-LF-EPH-RSC-RHV] Restart HV power supply		Activity	Abstraction	Seq-003-tr...	13450
[D1-LF-MTN-PEB-ATD] Attach to devices		Activity	Abstraction	Seq-006-tr...	13553
[D1-LF-MTN-PEB-CSS] Configure system statically		Activity	Abstraction	Seq-016-tr...	13583
[D1-LF-MTN-PEB-DFD] Detach from devices		Activity	Abstraction	Seq-006-tr...	13607
[D1-LF-OPR-FIN-MPS] Measure postpulse spectrum		Activity	Abstraction	Seq-006-tr...	13627
[D1-LF-OPR-FIN-SFC] Stop fast control loop		Activity	Abstraction	Seq-006-tr...	13617
[D1-LF-OPR-PRE-CLG] Measure the reference level for LED gain stabilis...		Activity	Abstraction	Seq-006-tr...	13634
[D1-LF-OPR-PRE-IBL] Measure initial baseline level		Activity	Abstraction	Seq-006-tr...	13611
[D1-LF-OPR-PRE-PFC] Prepare for fast control loop		Activity	Abstraction	Seq-018-tr...	13632
[D1-LF-OPR-PRE-VHI-VLC] Verify LED calibration parameters		Activity	Abstraction	Seq-006-tr...	13628
D1-LF-EE00-DME-BCO:HV-P1-CM-ST00-CGREPNNPSP	diagnostics-variable	Object	Association	output	15820
D1-LF-EE00-DME-BCO:HV-P1-CM-ST00-CGRWPNNPSP	diagnostics-variable	Object	Association	input	15819

2.9.7 Define Process variable diagram

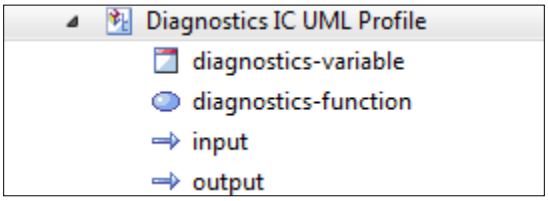
1. To create process variable diagram, Add use case diagram under last level I&C Function

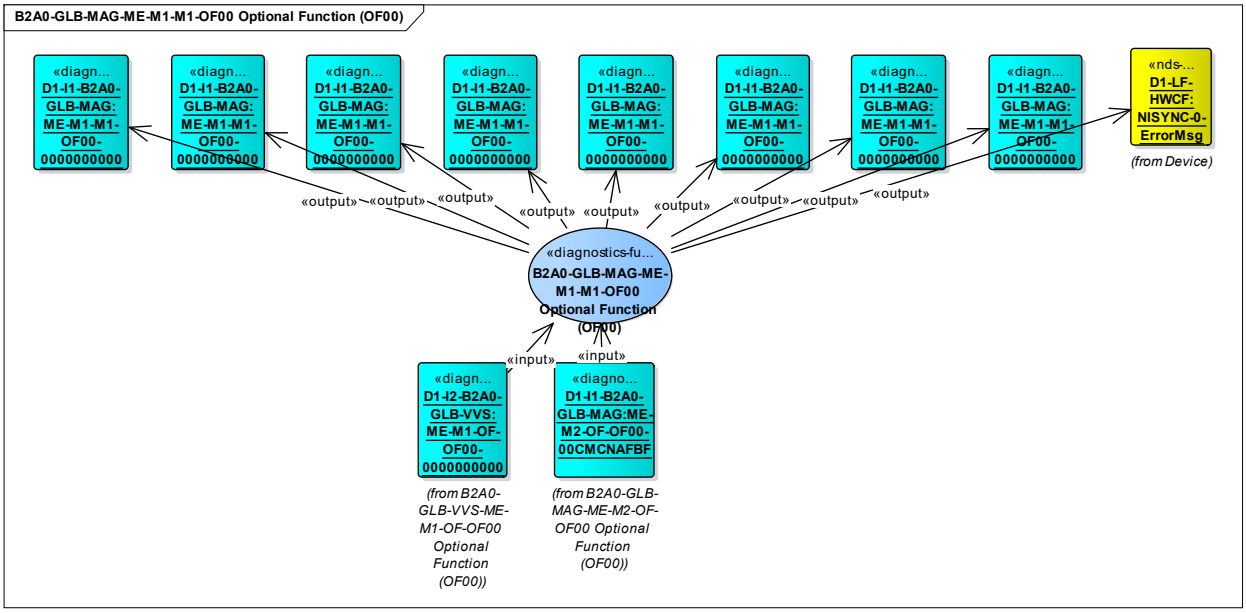


2. Drag all required Plant I&C functions and variables on the diagram



3. Use input and output connectors to prepare Process Variable Diagram. The connectors can be selected from the UML Profile.





2.9.8 Signal Chain

From mapping of variables, one can extract signal chains as shown below. Such diagrams are not required to be added to the EA project since these can be generated from the information present in the EA project.

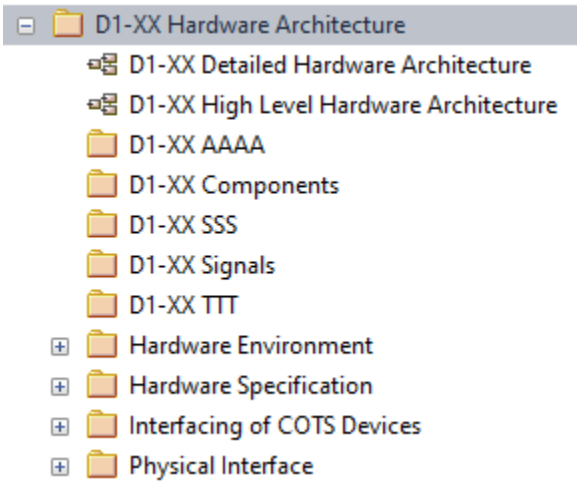
2.9.9 Link to Functional Analysis add-in

Please refer [RD6] for the user manual.

2.10 Hardware Architecture

This section describes how to define Hardware Architecture.

The folder structure (Package Structure) under the Hardware Architecture package (CBS1-CBS2 Hardware Architecture) is as below:



2.10.1 Define TTT Codes

Define TTT Codes used in the Plant I&C Components.

1. Create Package CBS1-CBS2 TTT (e.g., D2-Q0 TTT) under Package CBS1-CBS2 Hardware Architecture (e.g., D2-Q0 Hardware Architecture)
2. To define TTT code, it required to add TTT code element. Right click on CBS1-CBS2 TTT package, select option Add Element. (Note –Only Pre-defined TTT codes in PSP should be used.)

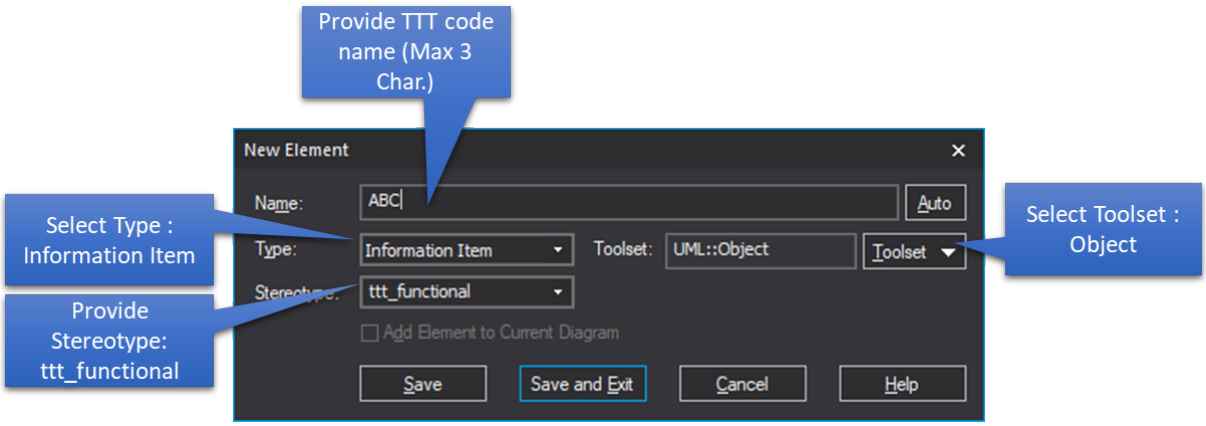
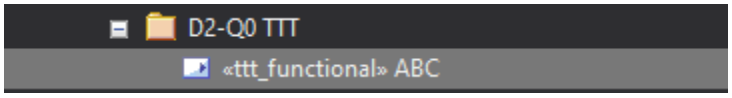


Figure 56: Add TTT Code

3. Click on Save or Save and Exit to add TTT code in EA Project



4. Select properties of the newly added TTT code and Provide description for the same as shown in below diagram

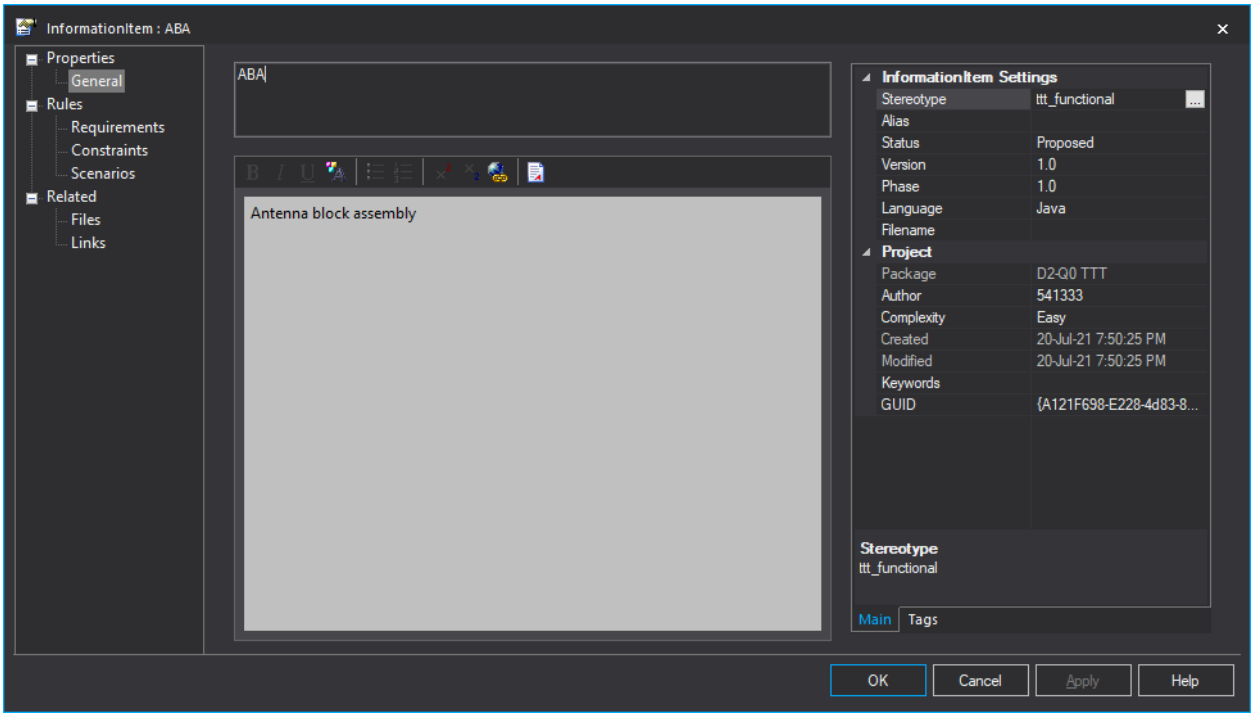


Figure 57: Provide TTT Code description

5. Follow above steps to add multiple TTT Codes

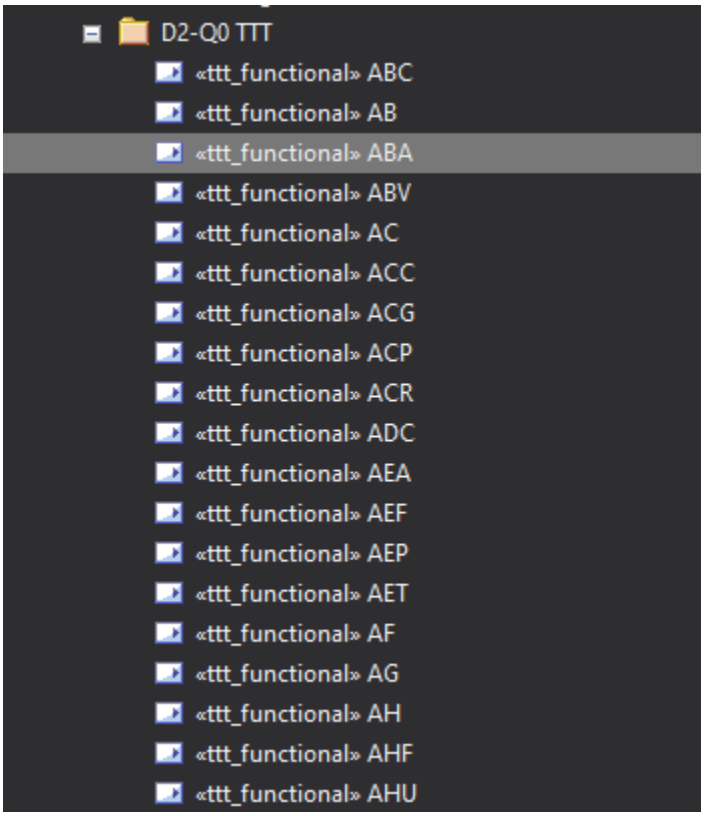


Figure 58: TTT Codes defined in EA Project

2.10.2 Define AAAA codes

Define AAAA Codes for all Plant I&C Signals used in Project.

1. Create Package CBS1-CBS2 AAAA (e.g., D2-Q0 AAAA) under Package CBS1-CBS2 Hardware Architecture (e.g., D2-Q0 Hardware Architecture)
2. To define AAAA code, it required to add AAAA code element. Right click on CBS1-CBS2 AAAA package, select option Add Element. (Note –Only Pre-defined TTT codes in PSP should be used.)

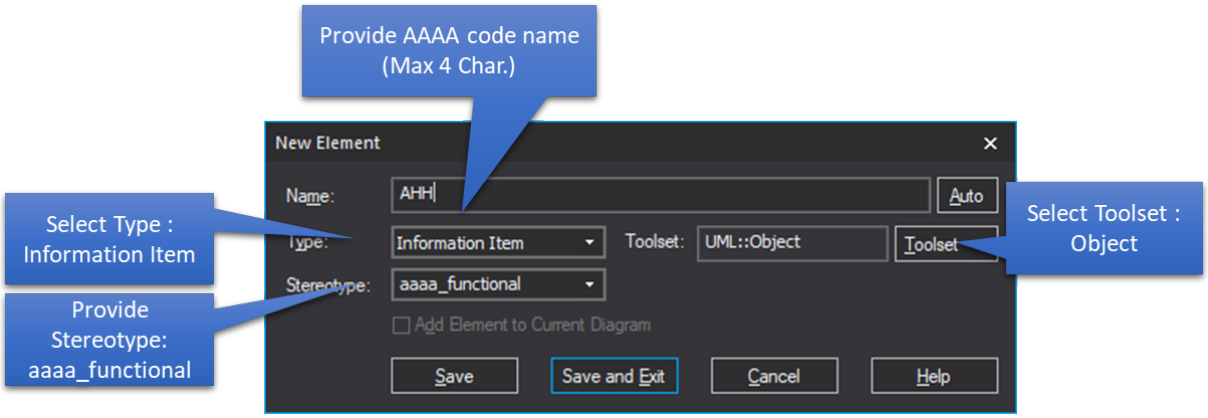
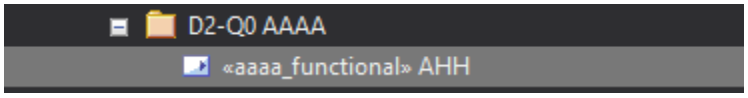


Figure 59: Add AAAA Code

3. Click on Save or Save and Exit to add AAAA code in EA Project



4. Select properties of the newly added AAAA code and Provide description for the same as shown in below diagram

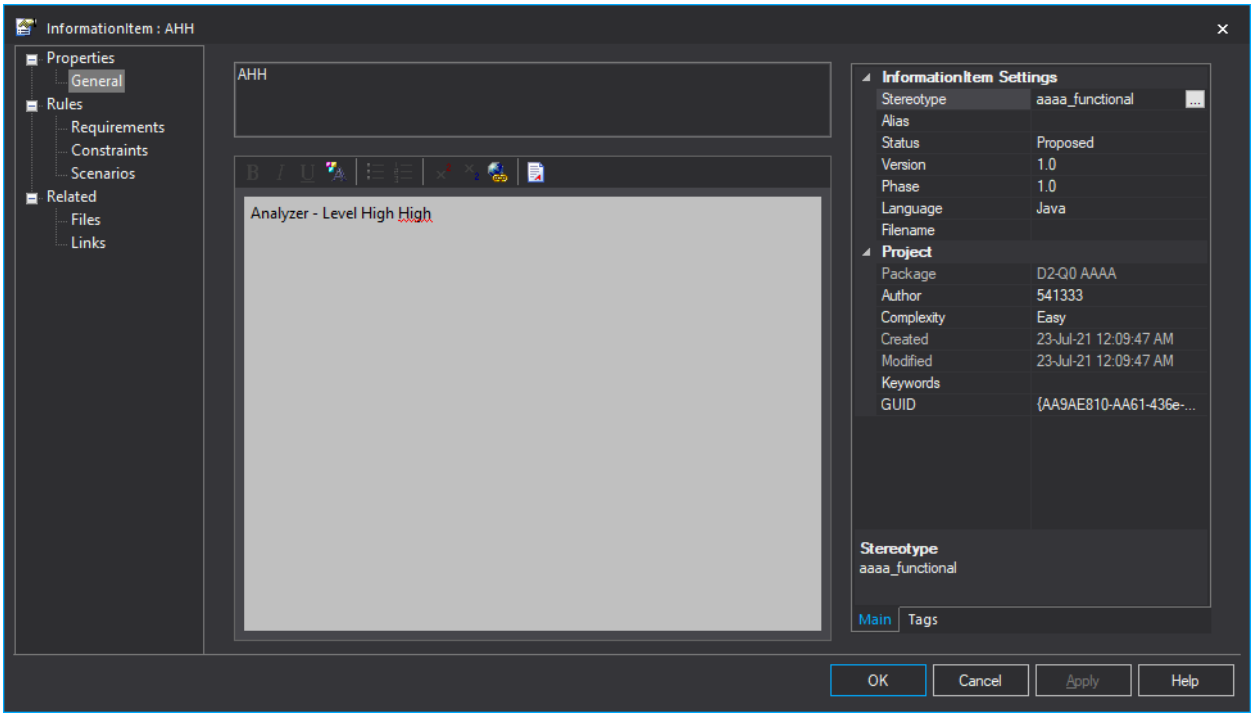


Figure 60: Provide AAAA Code description

5. Follow above steps to add multiple AAAA Codes

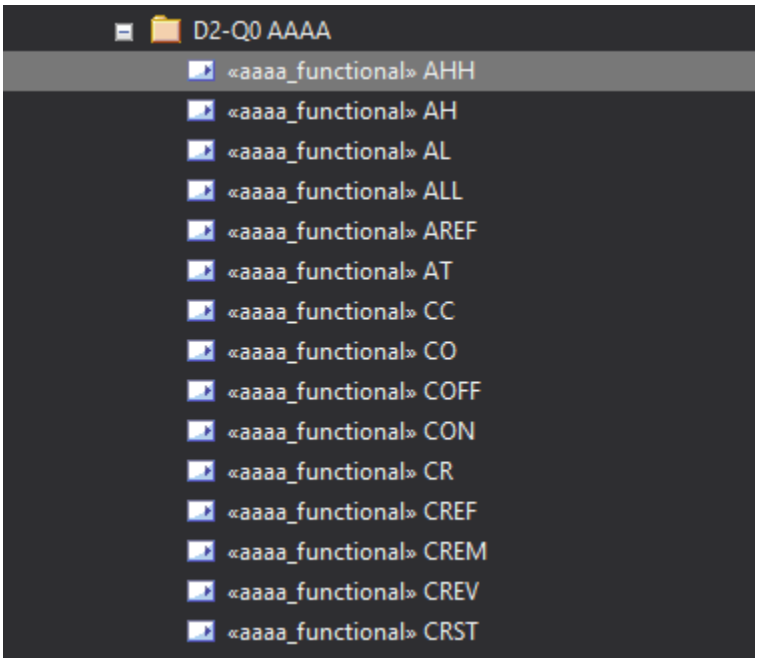


Figure 61: AAAA Codes defined in EA Project

2.10.3 Define SSS codes

Define SSS Codes for all Plant I&C Signals used in Project. SSS codes must be as per [RD8].

1. Create Package CBS1-CBS2 SSS (e.g., D2-Q0 SSS) under Package CBS1-CBS2 Hardware Architecture (e.g., D2-Q0 Hardware Architecture)
2. To define SSS code, it required to add SSS code element. Right click on CBS1-CBS2 SSS package, select option Add Element

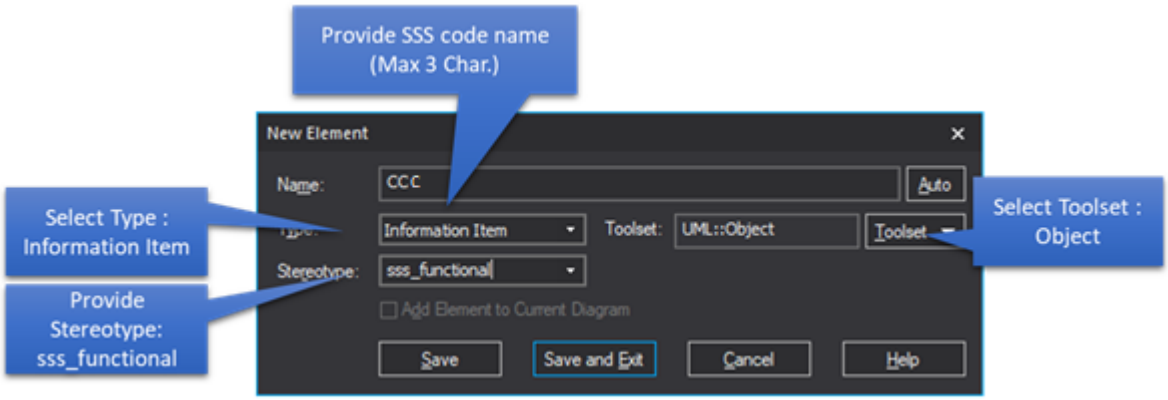
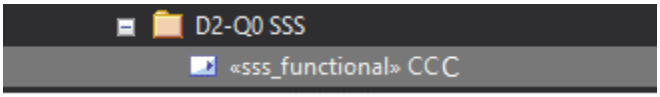


Figure 62: Add SSS Code

3. Click on Save or Save and Exit to add SSS code in EA Project



4. Select properties of the newly added SSS code and Provide description for the same as shown in below diagram

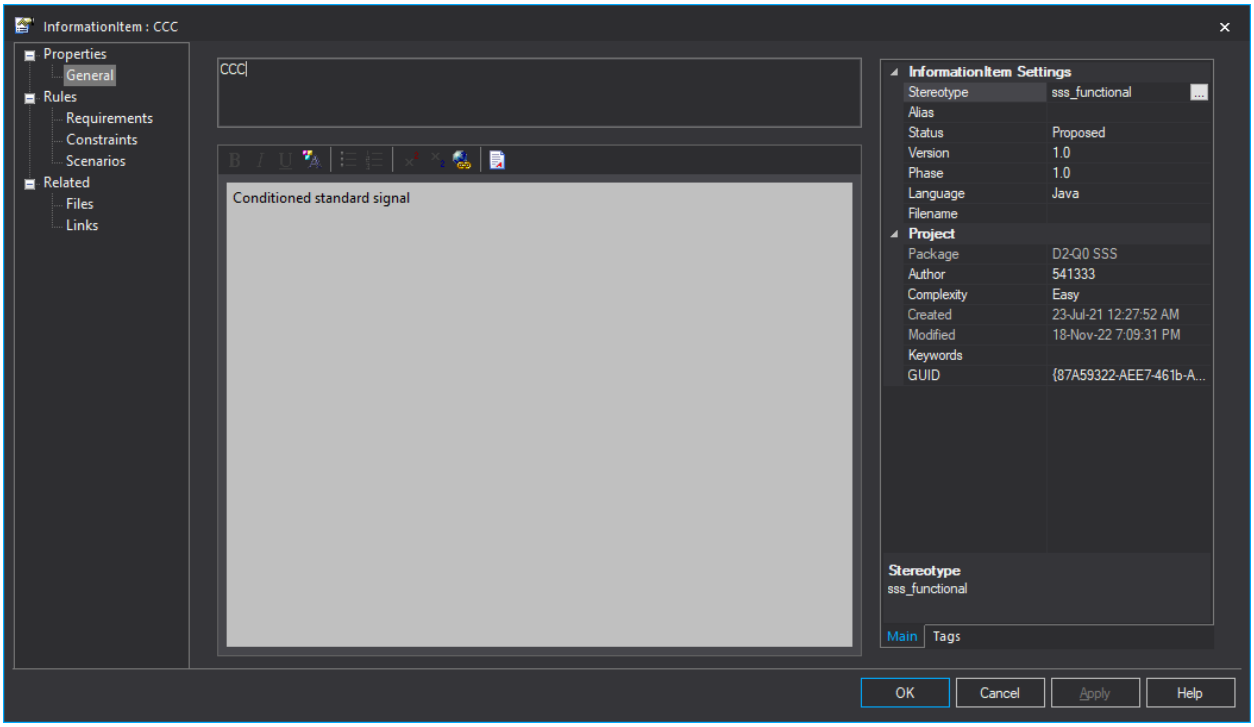


Figure 63: Provide SSS Code description

5. Follow above steps to add multiple SSS Codes

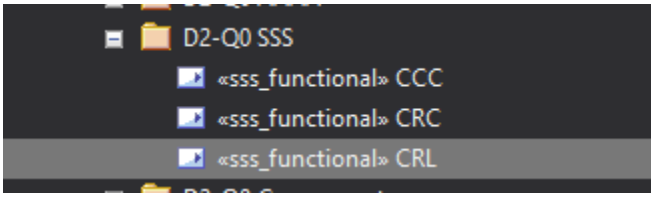


Figure 64: SSS Codes defined in EA Project

2.10.4 Define I&C Components

It requires to define Components used in Project.

1. Create Package CBS1-CBS2 Components (e.g., D1-LF Components) under Package CBS1-CBS2 Hardware Architecture (e.g., D1-LF Hardware Architecture)
2. To define Components, it required to add component element. Right click on CBS1-CBS2 Component package, select option Add Element

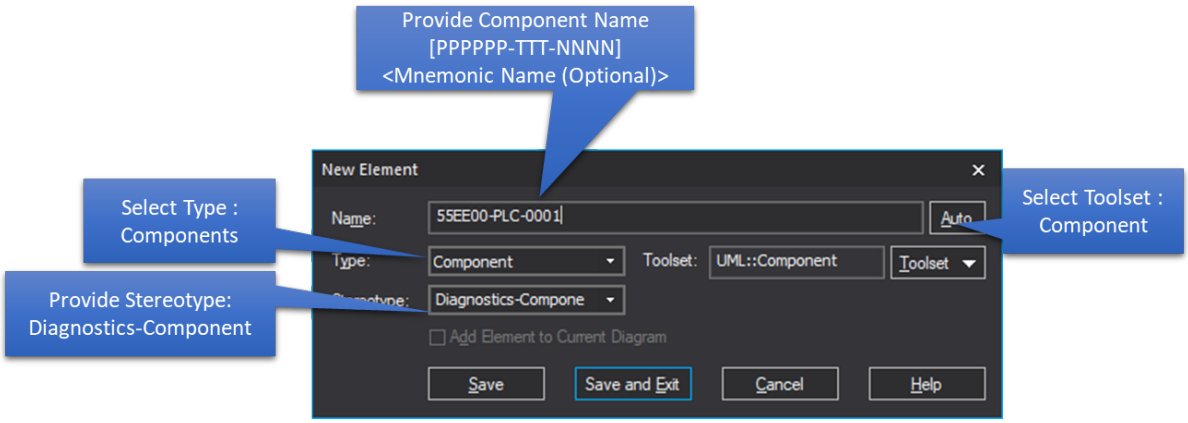
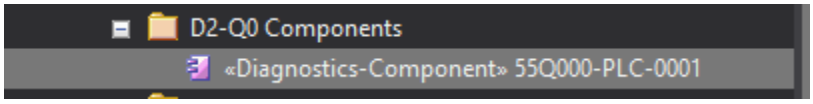


Figure 65: Add Components

Note: Component Name must be as per [RD8]. In Enterprise Architect Project, Component Name consist of Component Name + Mnemonic Name (Optional).

3. Click on Save or Save and Exit to add Components in EA Project



4. Select properties of the newly added Component and Provide description and attributes/tags for the same as shown in below diagram

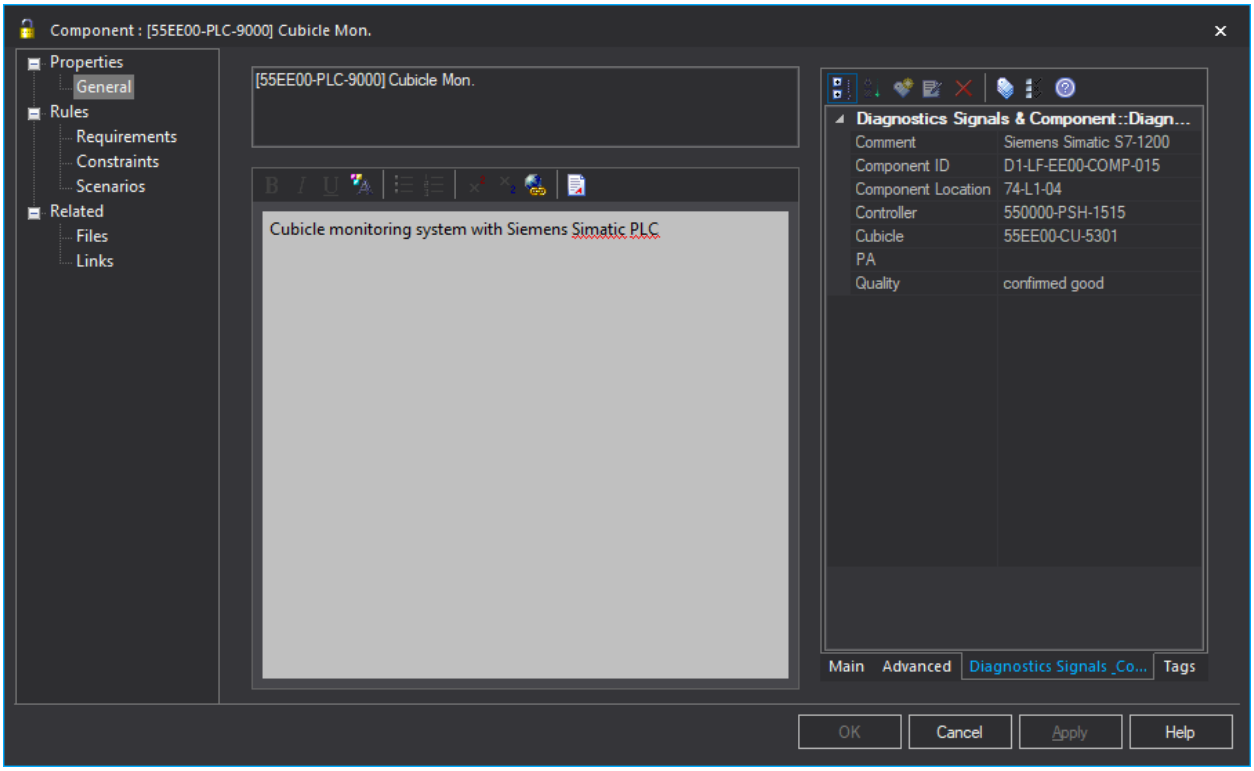


Figure 66: Provide descriptions and Tags

Tag Name	Definition
Comments	Provide comments if any for the component
Component ID	Provide Component ID CBS1-CBS2-CBS3-COMP-nnn (e.g., D1-LF-EE00-COMP-001) This ID is internal to EA Project
Component Location	Provide geographical location of the component. This location must be consistent with the location names present in https://psp.iter.org/PsProfile/page/reference/site.faces?idt=1
Controller Name	Provide controller name where component is linked
Cubicle	Provide the cubicle name with which the component is associated. The tagged value "Cubicle" should contain the location name for components that are not located in the cubicle
PA	Provide PA of the component
Quality	Provide Quality of the component – unconfirmed, confirmed good, confirmed bad, obsolete, deprecated, unknown, delete

5. Follow above steps to add multiple Components

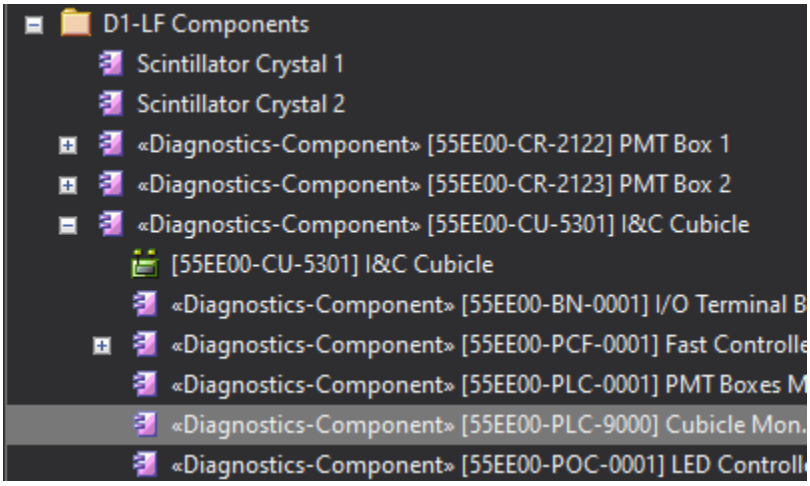


Figure 67: Components defined in EA Project

Note: CompositeStructure Diagrams can be created for components to create hierarchical component lists. This is shown in the above figure. These diagrams can then also be used for creating hardware architecture diagrams. Refer section 2.10.8.

2.10.5 Define I&C Signals

It requires to define I&C Signals used in Project.

1. Create Package CBS1-CBS2 Signals (e.g., D1-LF Signals) under Package CBS1-CBS2 Hardware Architecture (e.g., D1-LF Hardware Architecture)
2. To define Signals, it required to add Signal element. Right click on CBS1-CBS2 Signals package, select option Add Element

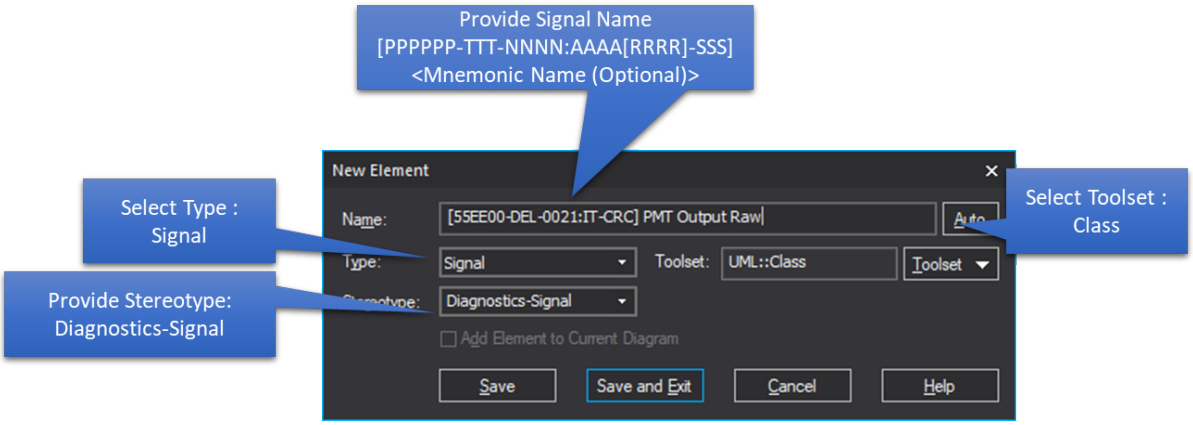
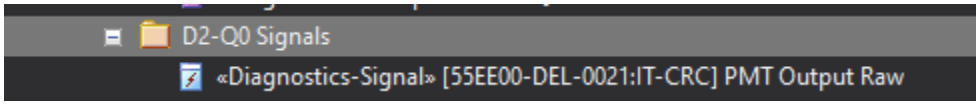


Figure 68: Add Signals

Note: Signal Name must be as per [RD8]. In Enterprise Architect Project, Signal Name consist of Signal Name + Mnemonic Name (Optional).

3. Click on Save or Save and Exit to add Signal in EA Project



4. Select properties of the newly added Signal and Provide description and attributes/tags for the same as shown in below diagram

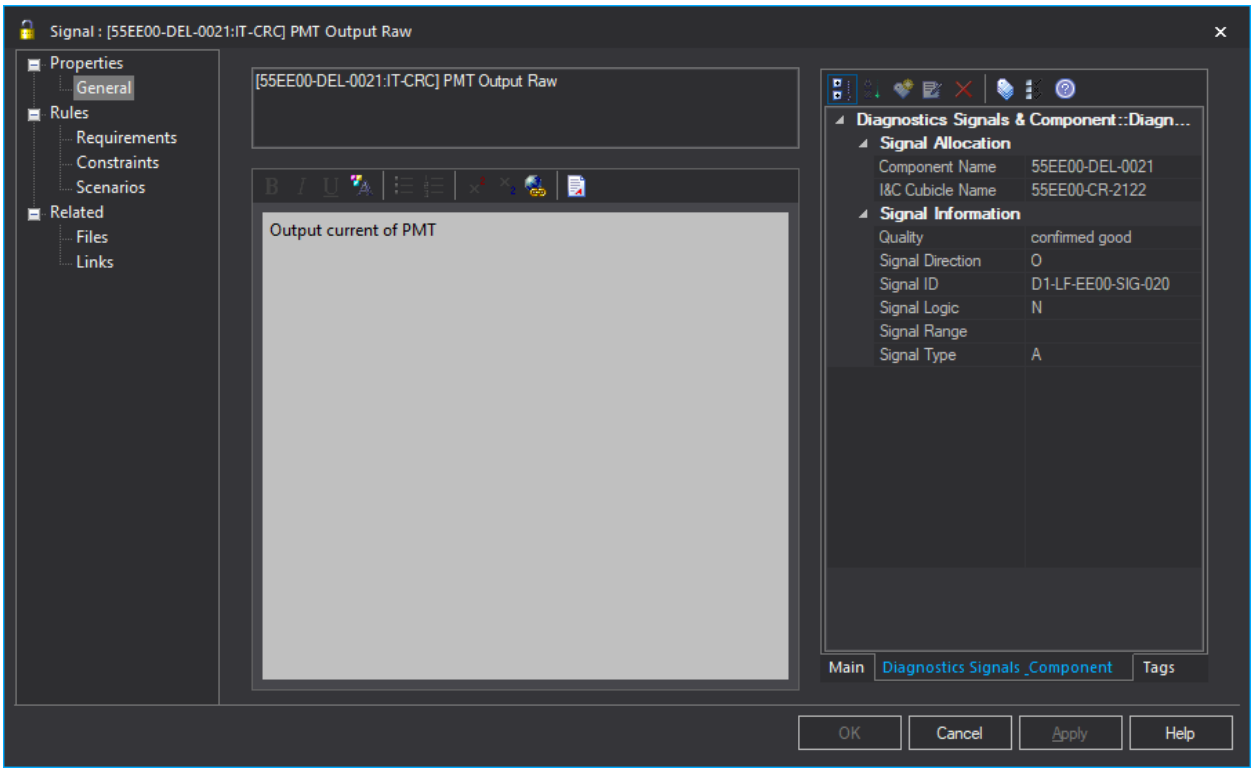


Figure 69: Provide descriptions and Tags

Signal Information Tag	Description	Comments
Signal ID	Signal ID must be in the form of **CBS1-CBS2-CBS3-SIG-nnn**	Example – D2-U0-UI00-SIG-001
Signal Name	Signal Name must be in the form of **PPPPPP-TTT-NNNN:AAAA[RRRR]-SSS**	
Component*	Component name must be in the form of **PPPPPP-TTT-NNNN**	
Description	Write description of the signal	
Type	Define Signal Type A or D	A – Analog, D – Digital
Direction	Define Direction I or O	I – Input, O – Output
Logic	Define Logic of the Signal P or N	P – Positive, N – Negative

Range	Define Range of the signal.	0 +10 V, -10 +10 V, -5 +5 V, 4 20 mA, PT 100, T/C Type K, T/C Type N, 24 V DC, Fieldbus In case the range is not suitable, please use "Custom"
I&C Cubicle	Define associated cubicle to the Signal	
Quality	Define the quality of the Signal – unconfirmed, confirmed good, confirmed bad, obsolete, deprecated, unknown, delete	

5. Follow above steps to add multiple Signals

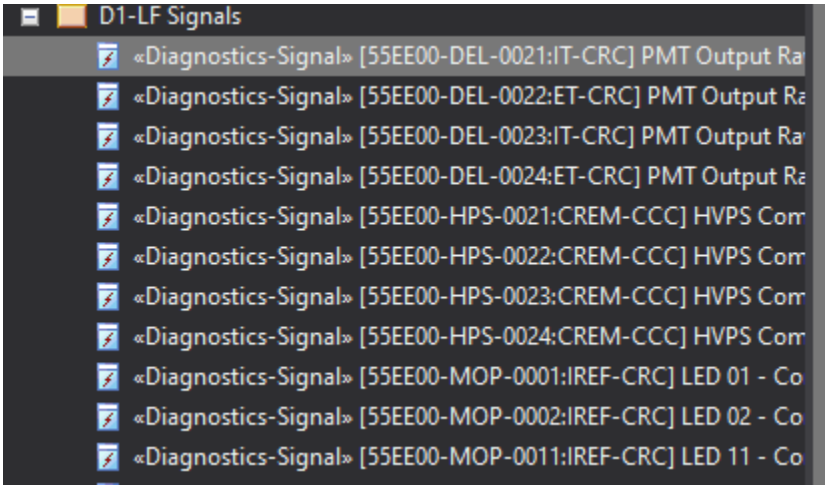


Figure 70: Signals defined in EA Project

2.10.6 Link Signals to Destination Component

This section describes how to link signal to its destination component. The information that this document wishes to convey is present in steps 4 and 5.

1. Right click **Signal** package (e.g. D2-Q0 Signal) and select Add Diagram.
2. New Diagram window will open. Select the diagram type as **Deployment.** Click **OK** to add Deployment Diagram.

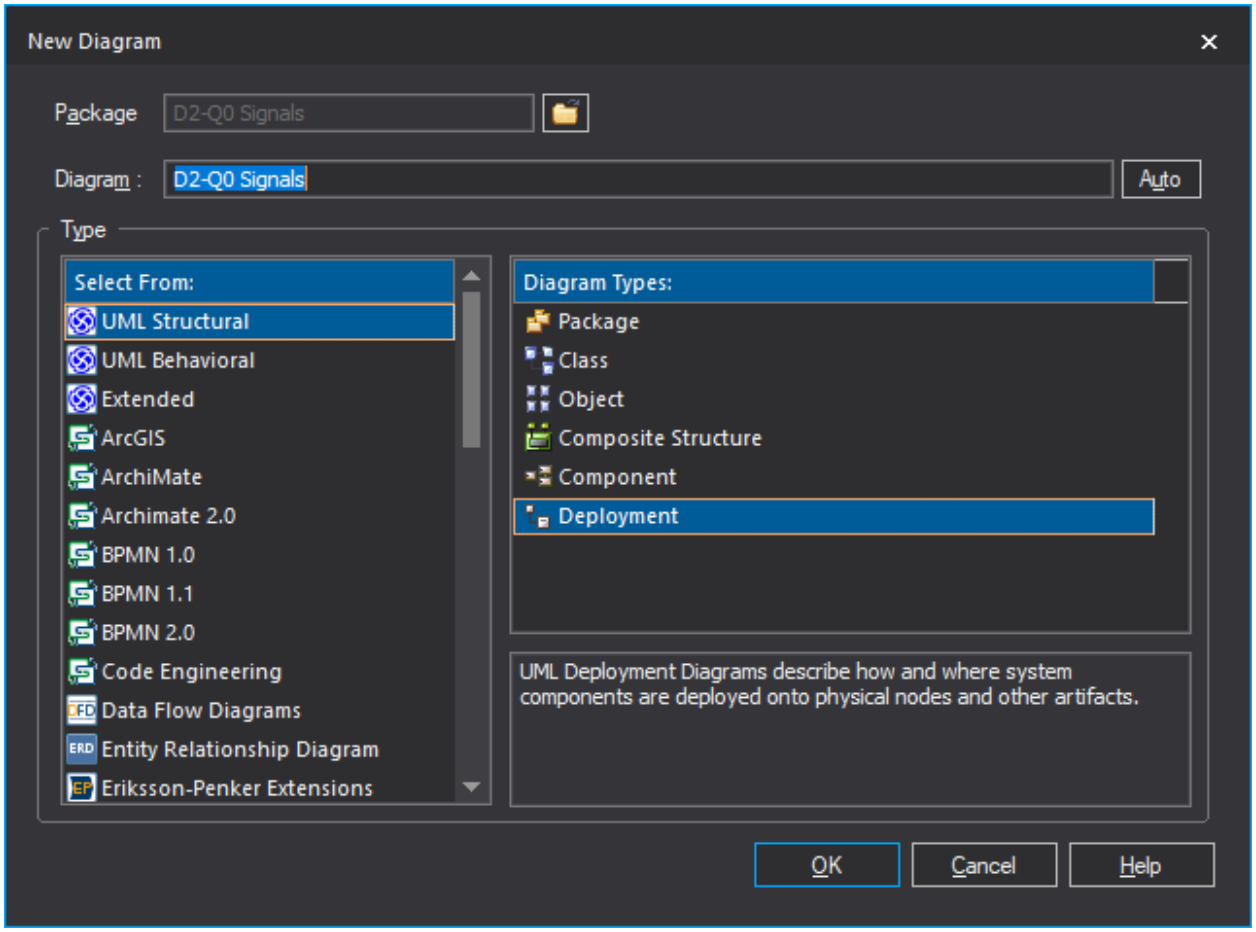
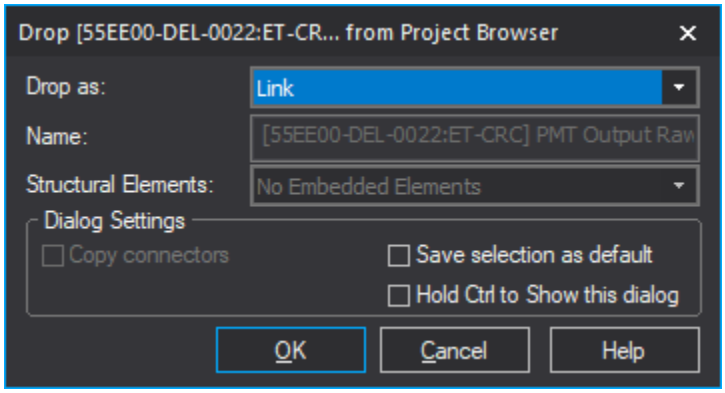


Figure 71: Create Deployment Diagram

3. Drag the signals and components which need to be linked on the diagram. Drop Signal or Components on diagram as link as shown in below figure.



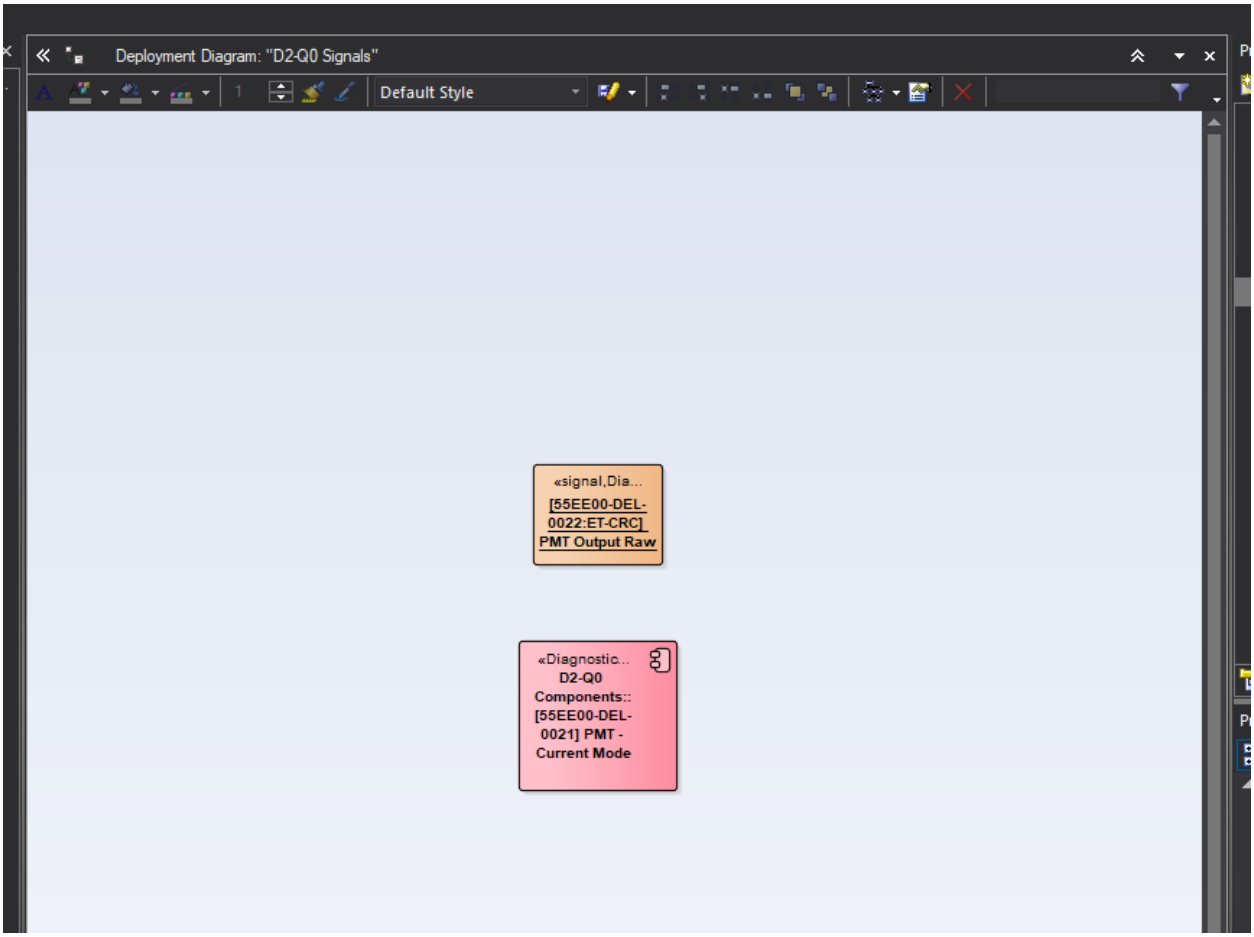


Figure 72: Signals and Components on Deployment Diagram

4. Select relationship – Communication Path from Toolbox to link between Signals and Components

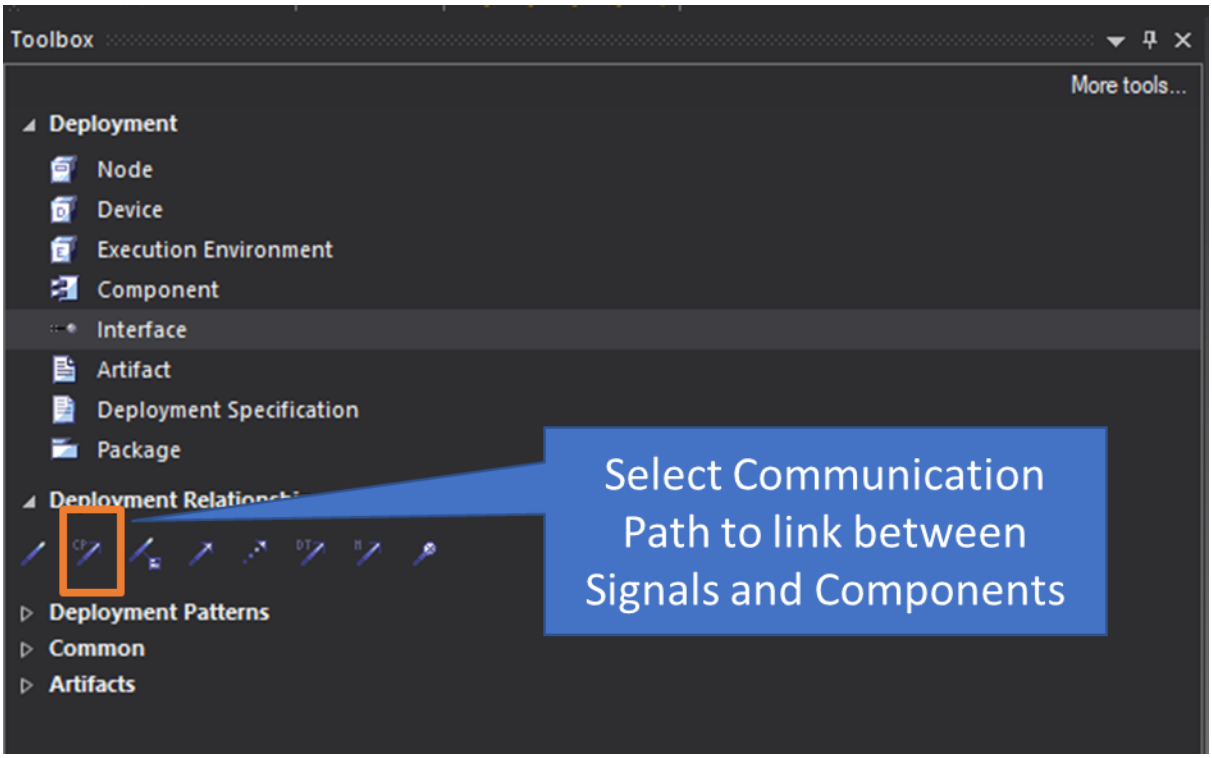


Figure 73: Select Link Communication Path

5. Connect Signals and Components

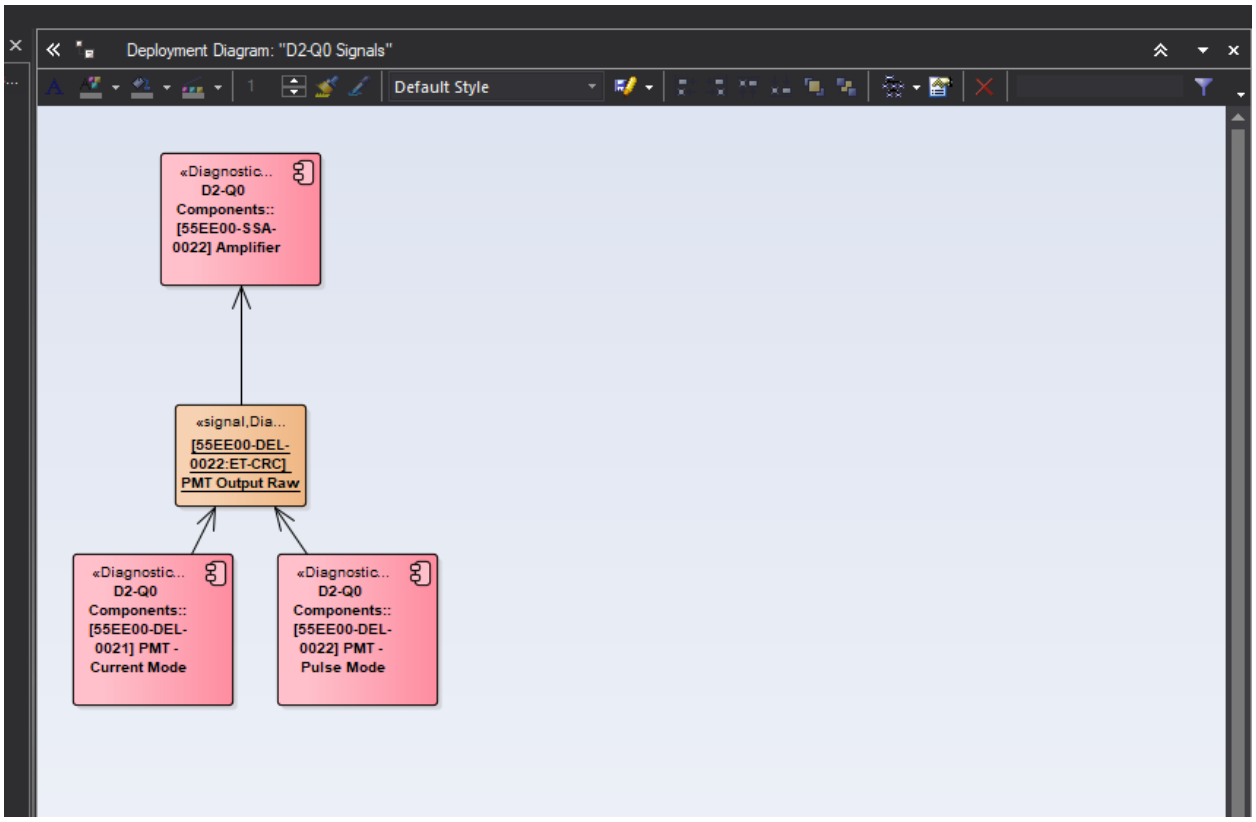


Figure 74: Link Between Signals and Components

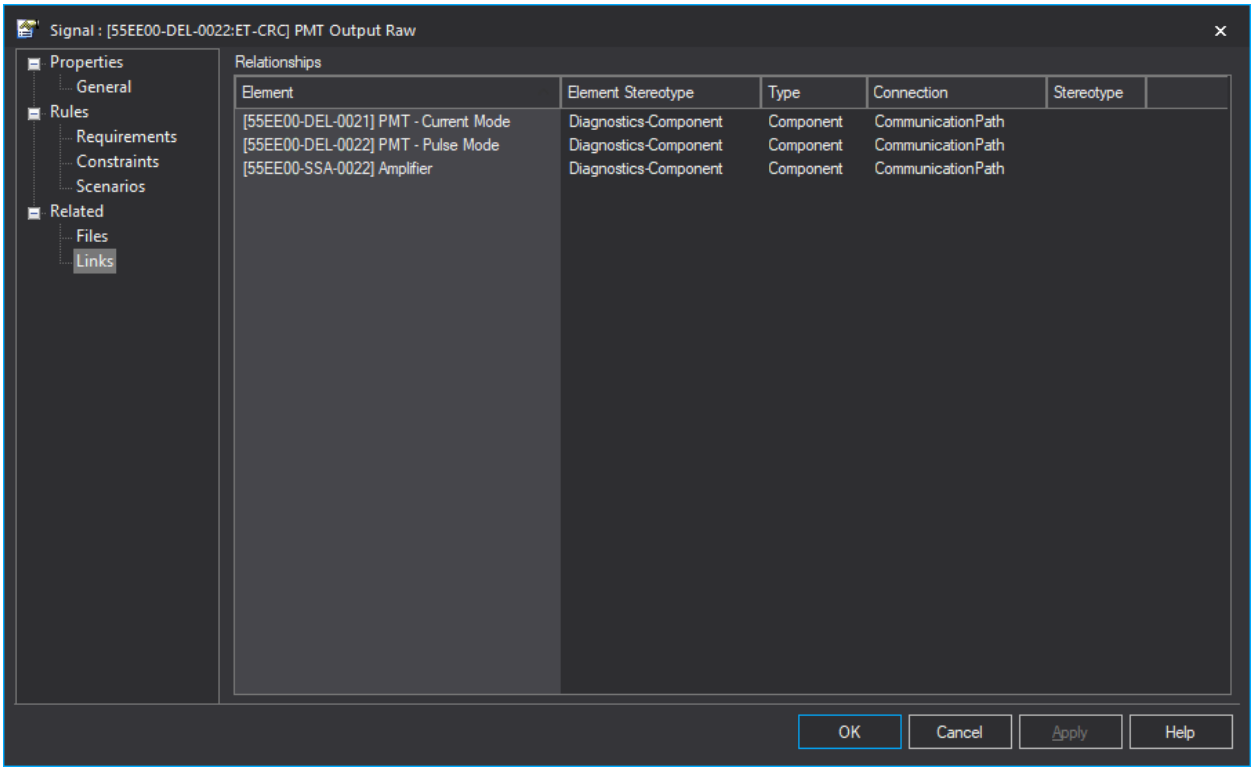


Figure 75: Link between Signal and Components

6. Follow above steps to establish link between multiple signals and components.

2.10.7 Link to Signals and Component add-in

Please refer [RD6] for the user manual.

2.10.8 Define Hardware Architecture diagram

2.10.8.1 High level hardware architecture diagram

In high level hardware architecture diagram, it is expected that the cubicles (along with their locations) of the plant I&C are depicted along with the CODAC CNP names. In this diagram it would be also helpful to show the location of the sensors/detectors, signal conditioning equipment as well.

1. To create High Level Hardware Architecture diagram, Add Component diagram under CBS1-CBS2 Hardware Architecture Package

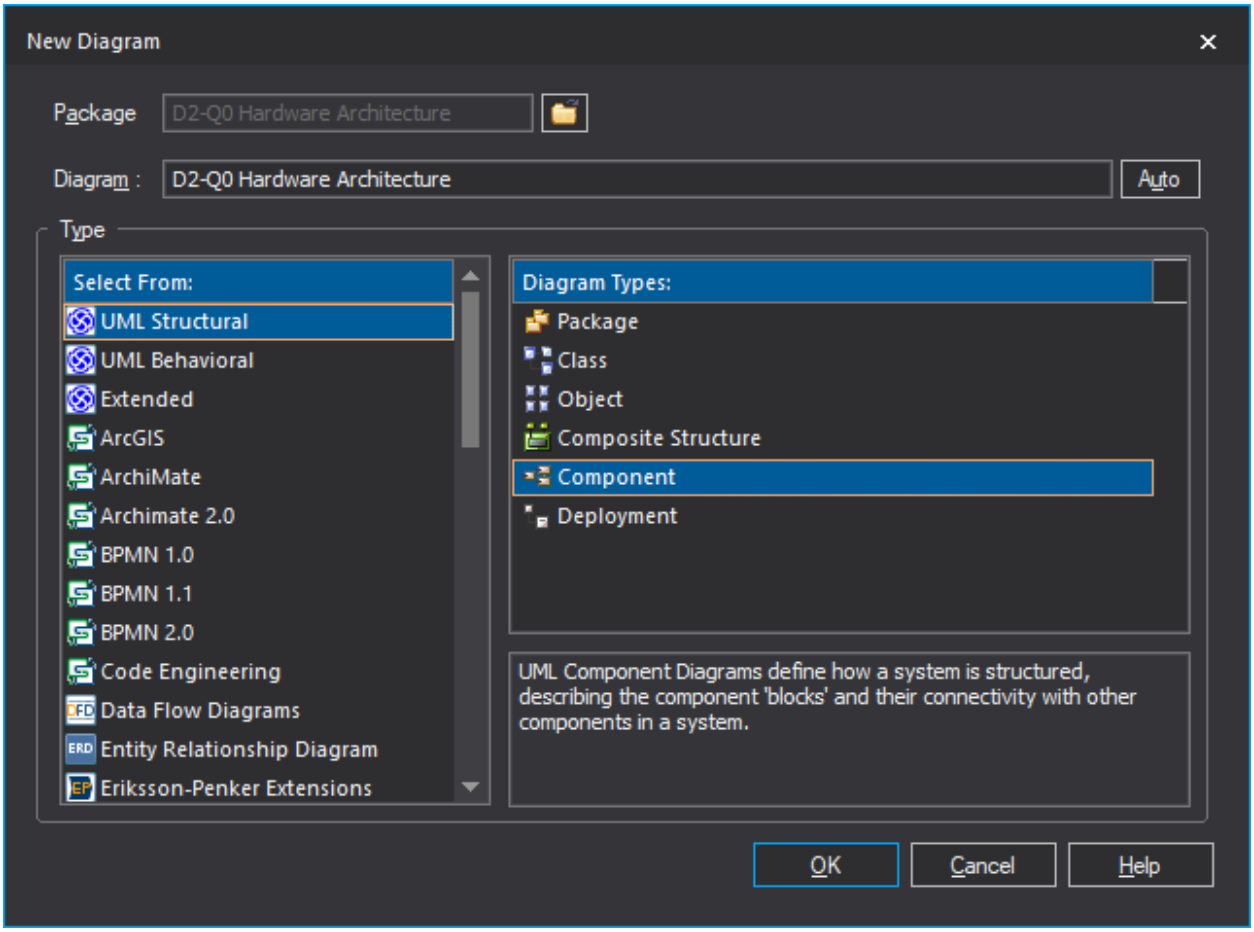
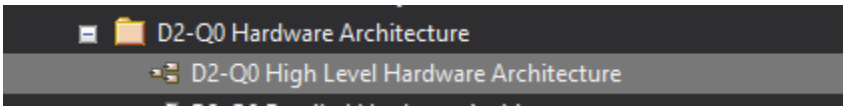


Figure 76: Select Diagram Type – Component



2. Open the Diagram Properties and Provide Diagram Description and Stereotype – **h_Hardware**
3. Drag all required Plant I&C Components diagram, and connect them. The connections can be made using the appropriate type of deployment diagram connectors like *Communication Path.*

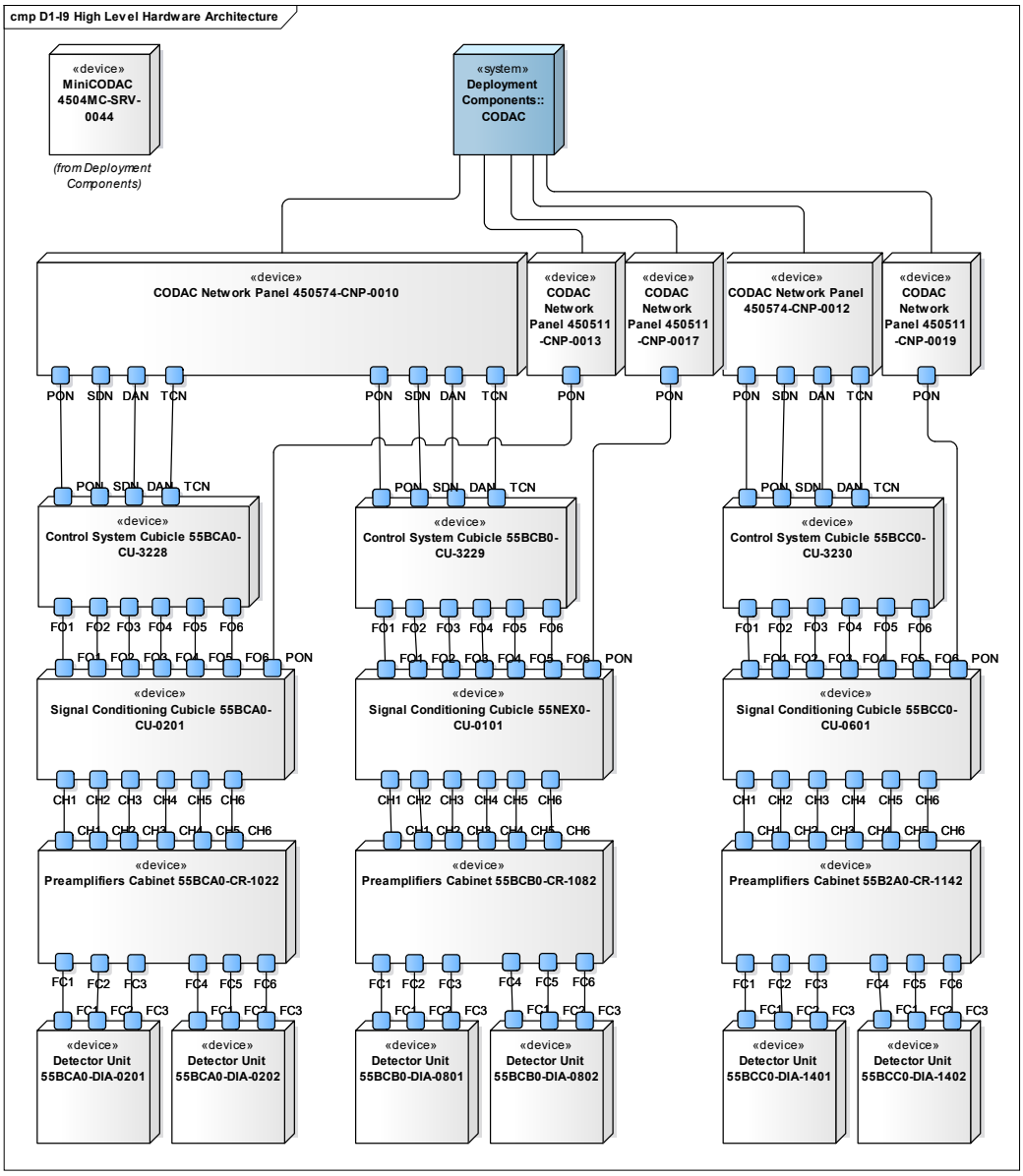


Figure 77: High-level Hardware Architecture Diagram – Example 1

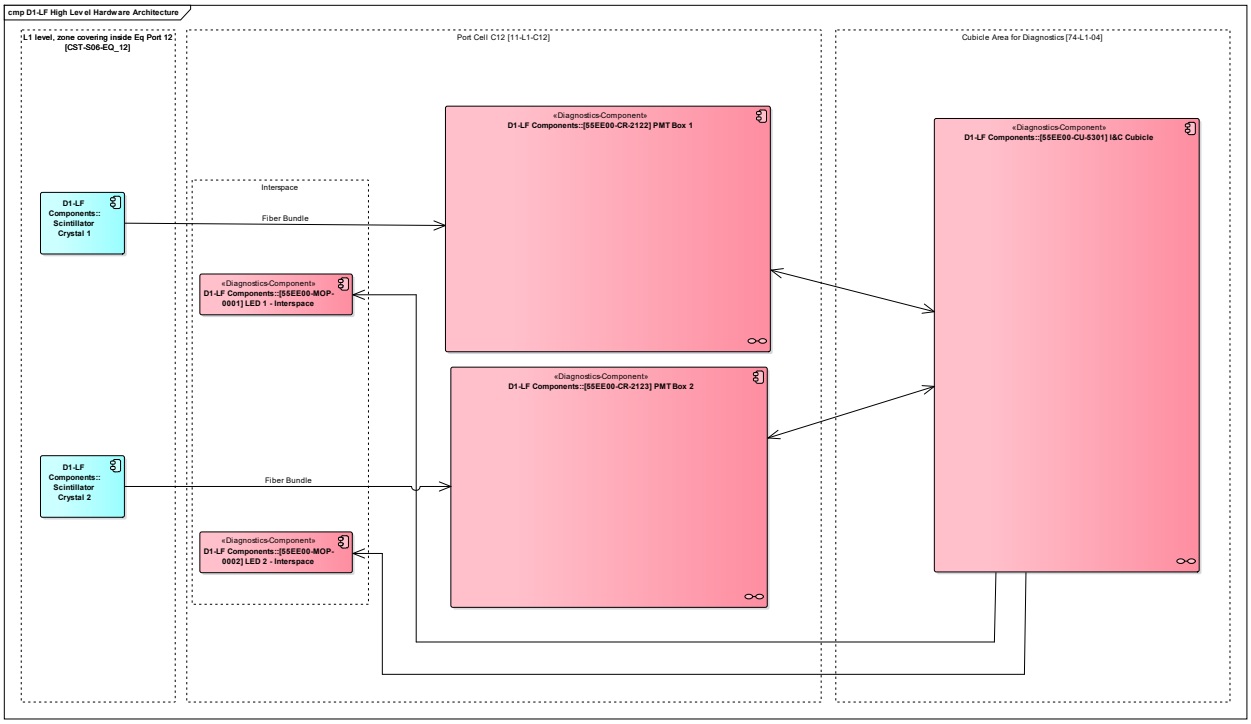
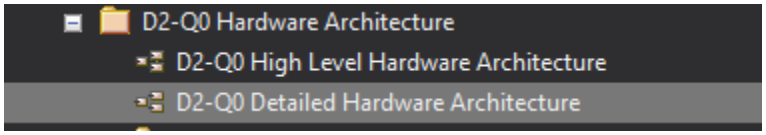


Figure 78: High-level Hardware Architecture Diagram Example 2

2.10.8.2 Detailed hardware architecture diagram

The detailed hardware architecture contains all plant I&C hardware components down to the device and boards level with correct component naming. The connectivity between these components is also shown.

1. To create Detailed Hardware Architecture diagram, Add Component diagram under CBS1-CBS2 Hardware Architecture Package



2. Open the Diagram Properties and Provide Diagram Description and Stereotype – **I_Hardware**
3. Drag all required Plant I&C Components on the diagram, and connect them. The connections can be made using the appropriate type of deployment diagram connectors like *Communication Path.*

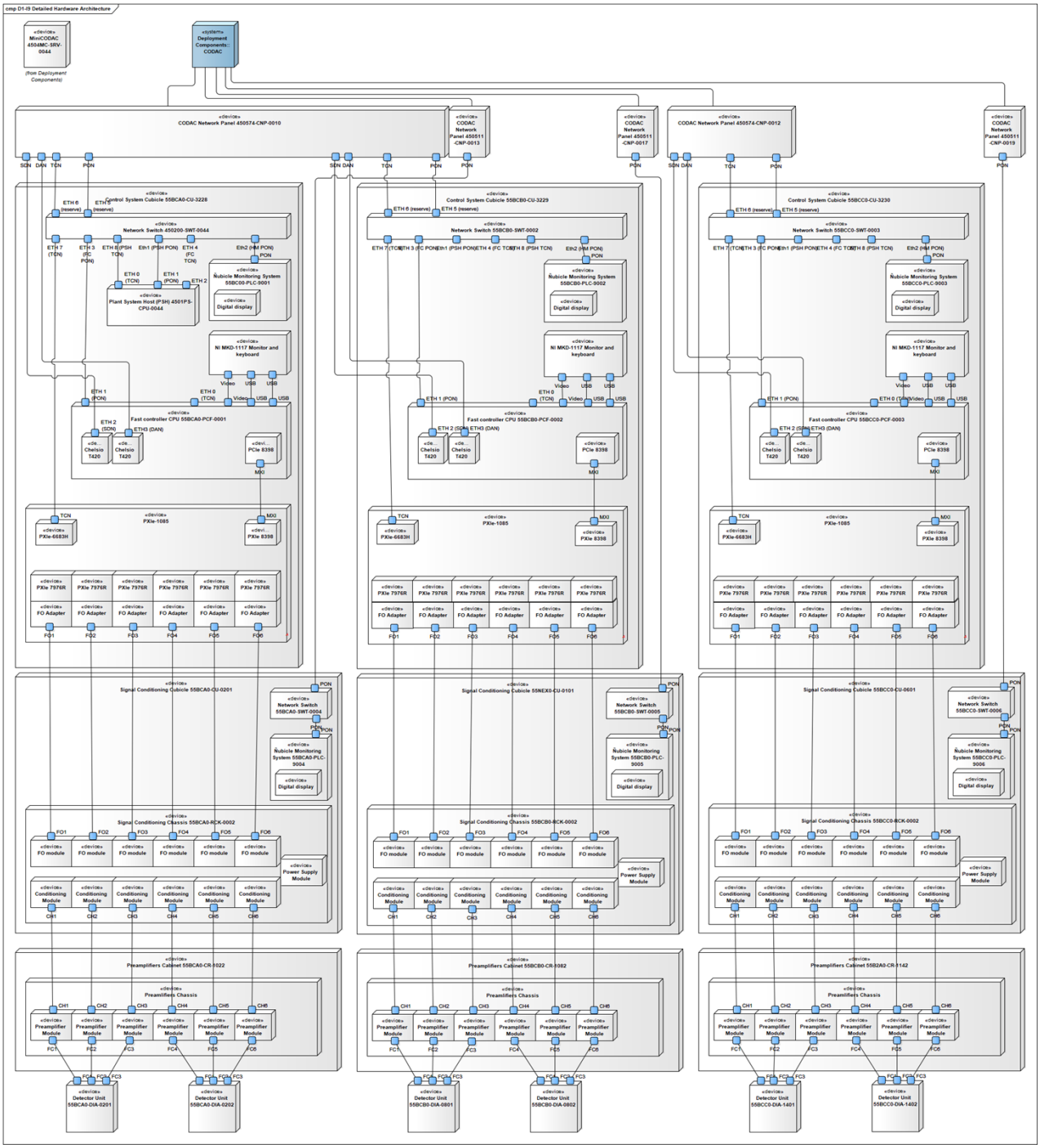


Figure 79: Detailed Hardware Architecture Diagram Example 1

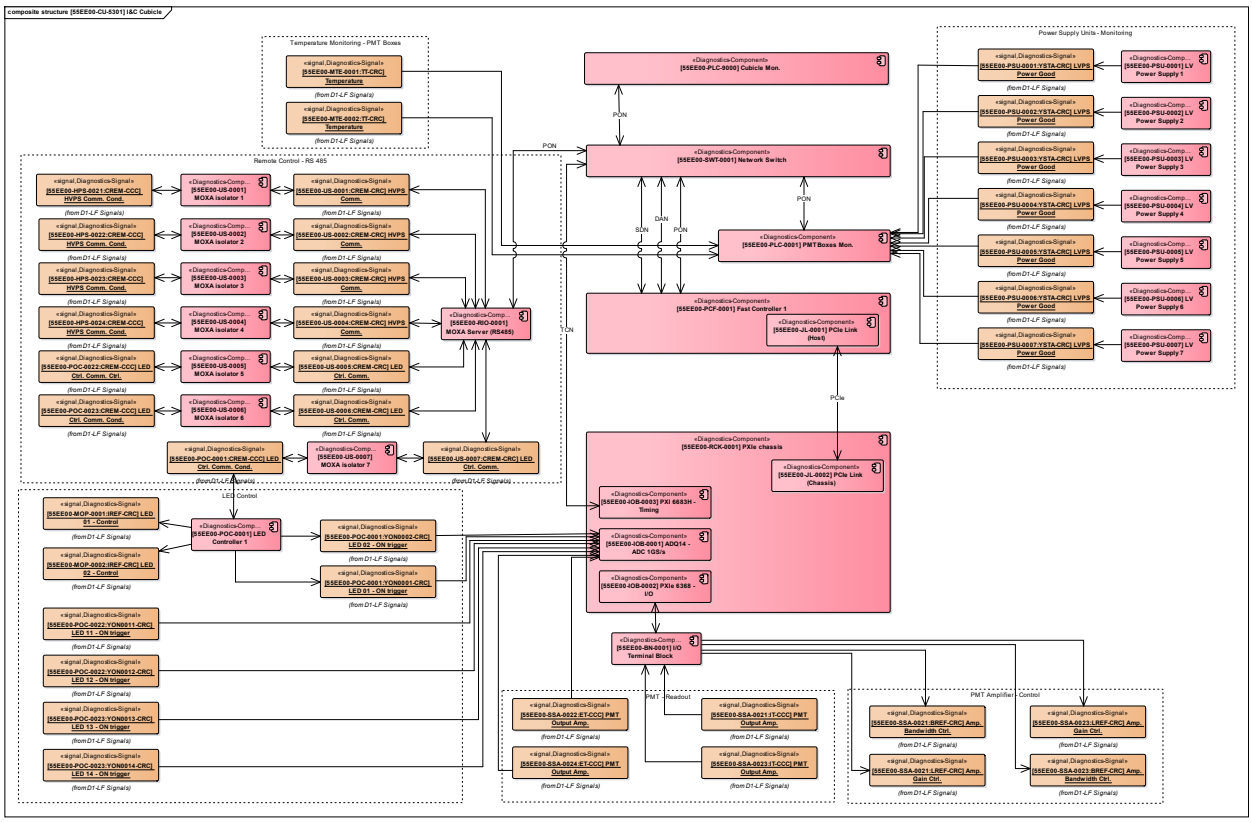


Figure 80: Detailed Hardware Architecture Example 2

Note 1: Figure 80 demonstrate the usage of CompositeStructure diagrams as mentioned in section 2.10.4.

Note 2: The design developer can also decide to represent signals from section 2.10.5 in the hardware architecture diagram. This is shown in Figure 80.

Note 3: The examples of high and detailed hardware architecture diagrams, serve to demonstrate a couple of the many possible ways of creating these diagrams. The diagram format is left at the designer's discretion (i.e. the hardware architecture diagrams are basically free-format, so long as the basic instructions currently present in this document are followed). The designer can present the diagram contents, element tree hierarchy, element connections, etc. as per the needs of the specific diagnostic.

2.10.9 Define Hardware Environment (SRS section 7.1)

1. Add package Hardware Environment under CBS1-CBS2 Hardware.
2. Under Hardware Environment Package add Document SRS Hardware Environment.

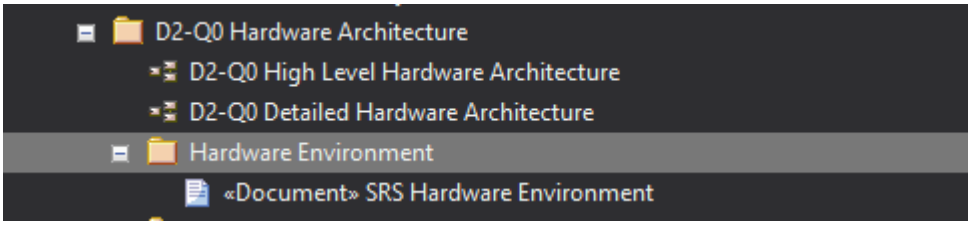


Figure 81: SRS Hardware Environment in EA Project

3. Right Click on Document and Select Properties and Provide
   a. Stereotype – **Document**
   b. Alias – SRS_HW_Env
4. Write the description, which will be printed in SRS document and save the same.

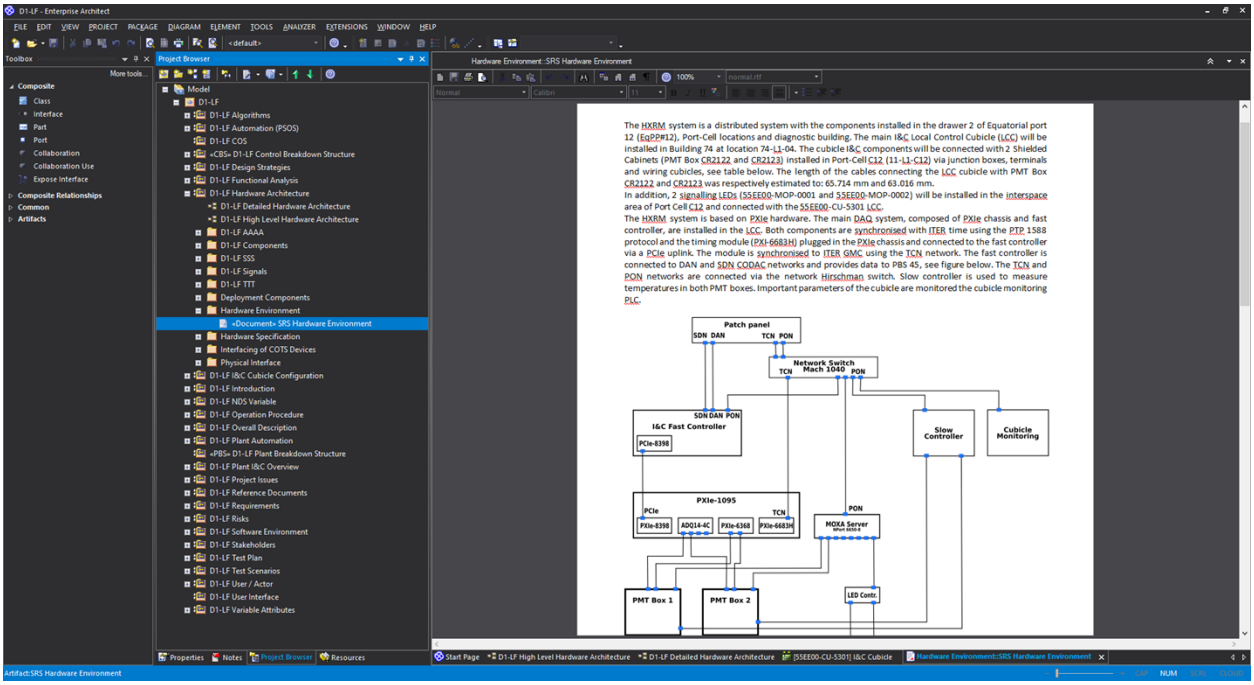


Figure 82: SRS Hardware Environment in EA

2.10.10 Define Hardware Specification (SDS section 7.3)

1. Add package Hardware Specification under CBS1-CBS2 Hardware Architecture
2. Under Hardware Specification Package add Document SDS Hardware Specification.

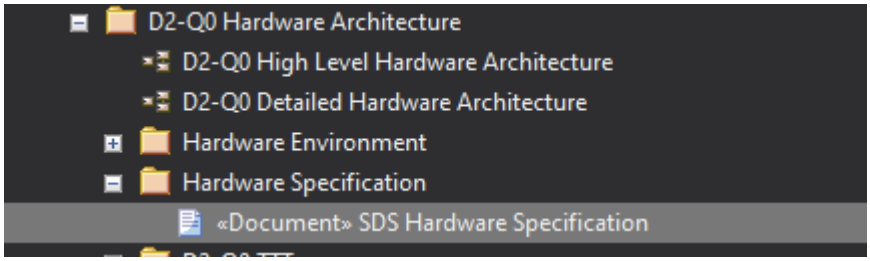


Figure 83: SDS Hardware Specification in EA Project

3. Right Click on Document and Select Properties and Provide
    a. Stereotype – **Document**
    b. Alias – SDS_HW_Spec
4. Write the description, which will be printed in SDS document and save the same.

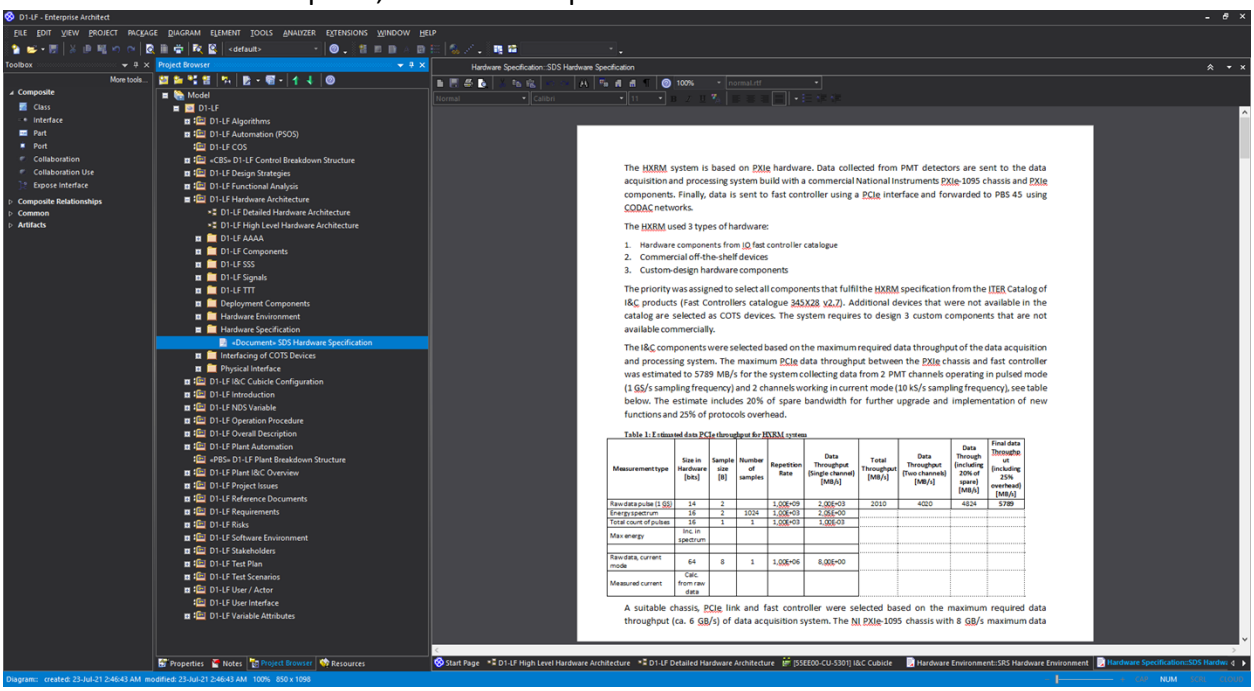


Figure 84: SDS Hardware Specification in EA

2.10.11 Interfacing of COTS Devices (SDS section 7.5)

1. Add package Interfacing COTS Devices under CBS1-CBS2 Hardware Architecture
2. Under Interfacing COTS Devices Package add Document SDS Interfacing of COTS Devices.

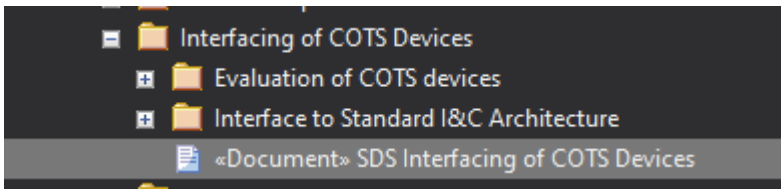


Figure 85: SDS Interfacing of COTS Devices in EA Project

3. Right Click on Document and Select Properties and Provide
    a. Stereotype – **Document**
    b. Alias – SDS_COTS_Interface
4. Write the description, which will be printed in SDS document and save the same.

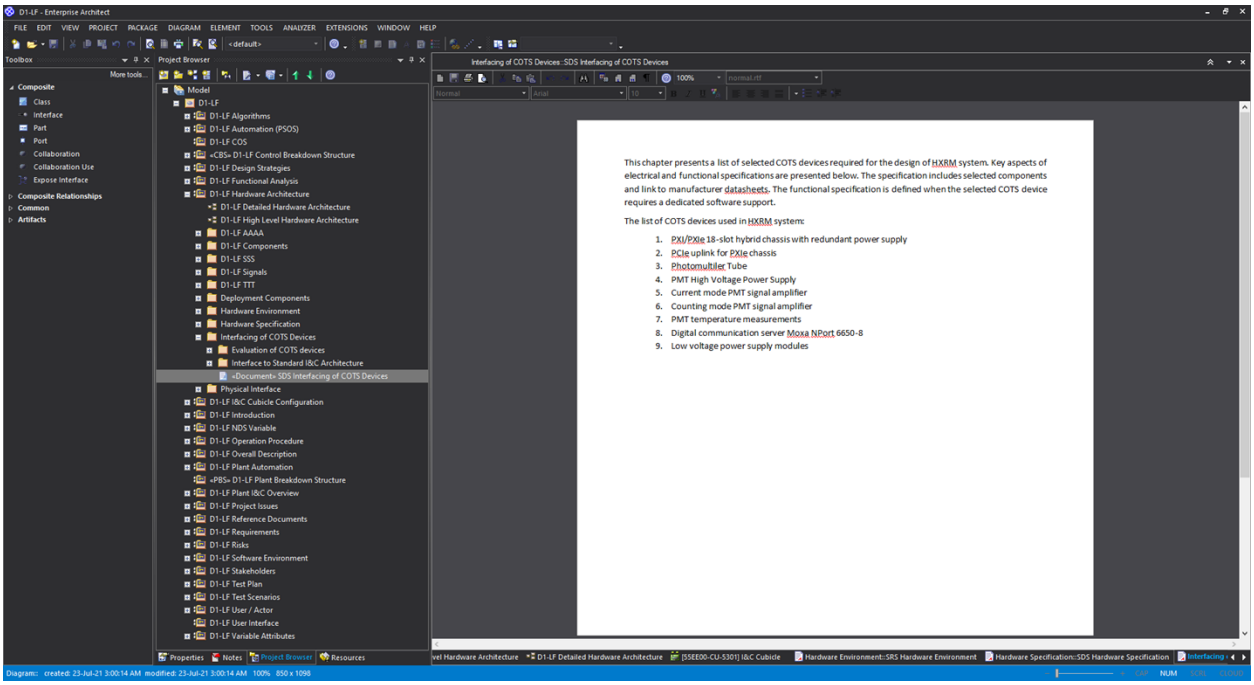


Figure 86: SDS COTS Interfacing Description

2.10.11.1 Evaluation of COTS Devices (SDS section 7.5.1)

1. Add package Evaluation of COTS devices under Interfacing COTS Devices
2. Under Evaluation of COTS devices Package add Document SDS Evaluation of COTS devices.

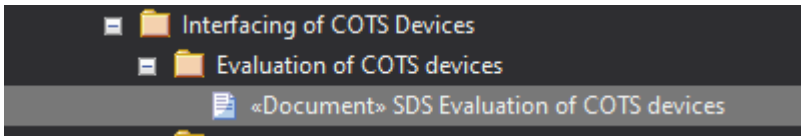
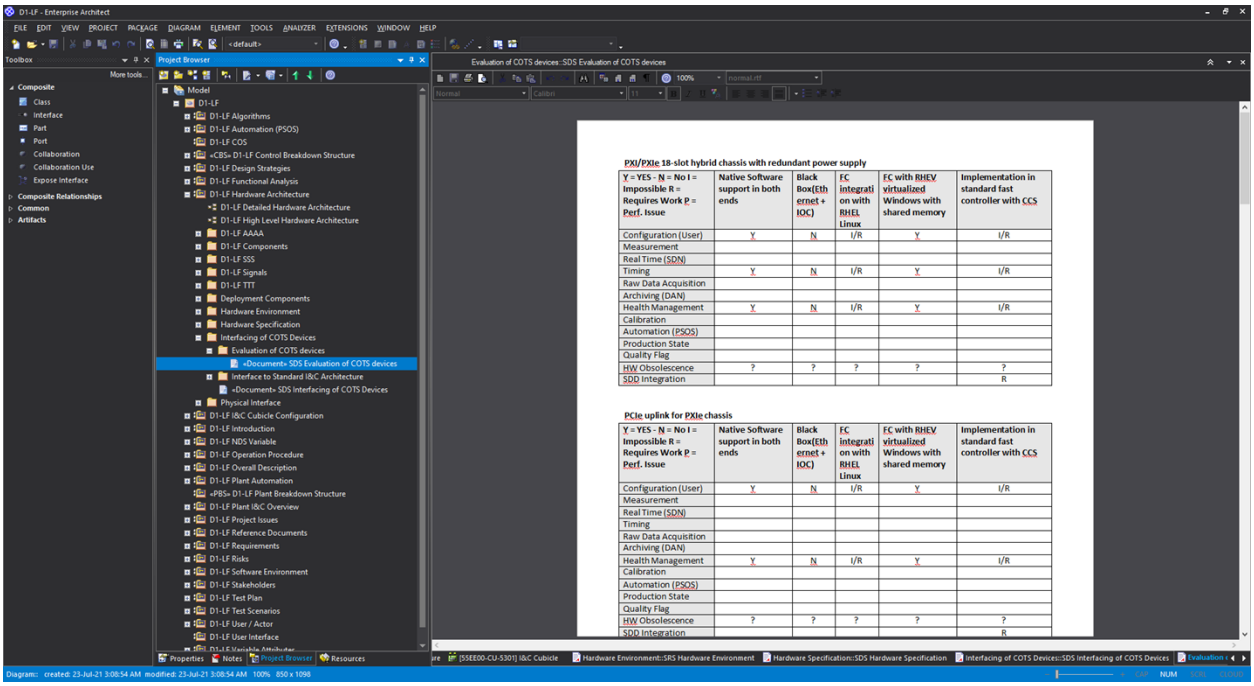


Figure 87: SDS Evaluation of COTS devices in EA Project

3. Right Click on Document and Select Properties and Provide
   a. Stereotype – **Document**
   b. Alias – SDS_COTS_Eval
4. Write the description, which will be printed in SDS document and save the same.



PXI/PXIe 18-slot hybrid chassis with redundant power supply

Y = YES - N = No I = Impossible R = Requires Work P = Perf. Issue	Native Software support in both ends	Black Box(Ethernet + IOC)	FC integration with RHEL Linux	FC with RHEV virtualized Windows with shared memory	Implementation in standard fast controller with CCS
Configuration (User)	Y	N	I/R	Y	I/R
Measurement					
Real Time (SDN)					
Timing	Y	N	I/R	Y	I/R
Raw Data Acquisition					
Archiving (DAN)					
Health Management	Y	N	I/R	Y	I/R
Calibration					
Automation (PSOS)					
Production State					
Quality Flag					
HW Obsolescence	?	?	?	?	?
SDD Integration					R

PCIe uplink for PXIe chassis

Y = YES - N = No I = Impossible R = Requires Work P = Perf. Issue	Native Software support in both ends	Black Box(Ethernet + IOC)	FC integration with RHEL Linux	FC with RHEV virtualized Windows with shared memory	Implementation in standard fast controller with CCS
Configuration (User)	Y	N	I/R	Y	I/R
Measurement					
Real Time (SDN)					
Timing					
Raw Data Acquisition					
Archiving (DAN)					
Health Management	Y	N	I/R	Y	I/R
Calibration					
Automation (PSOS)					
Production State					
Quality Flag					
HW Obsolescence	?	?	?	?	?
SDD Integration					R

Figure 88: SDS Evaluation of COTS devices Description

Interface to Standard I&C Architecture

2.10.11.2 Interface to Standard I&C Architecture (SDS section 7.5.2)

1. Add Interface to Standard I&C Architecture under Interfacing COTS Devices
2. Under Evaluation of COTS devices Package add Document SDS Interface to Standard I&C Architecture.

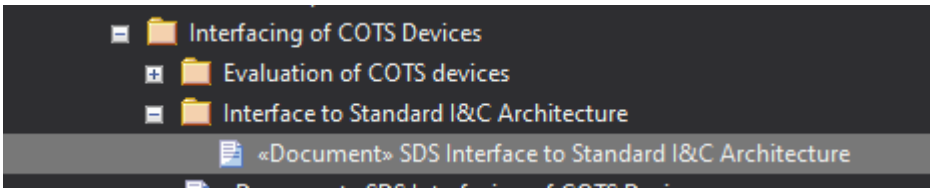


Figure 89: SDS Interface to Standard I&C Architecture in EA Project

3. Right Click on Document and Select Properties and Provide
   a. Stereotype – **Document**
   b. Alias – SDS_COTS_Interface_I_C
4. Write the description, which will be printed in SDS document and save the same.

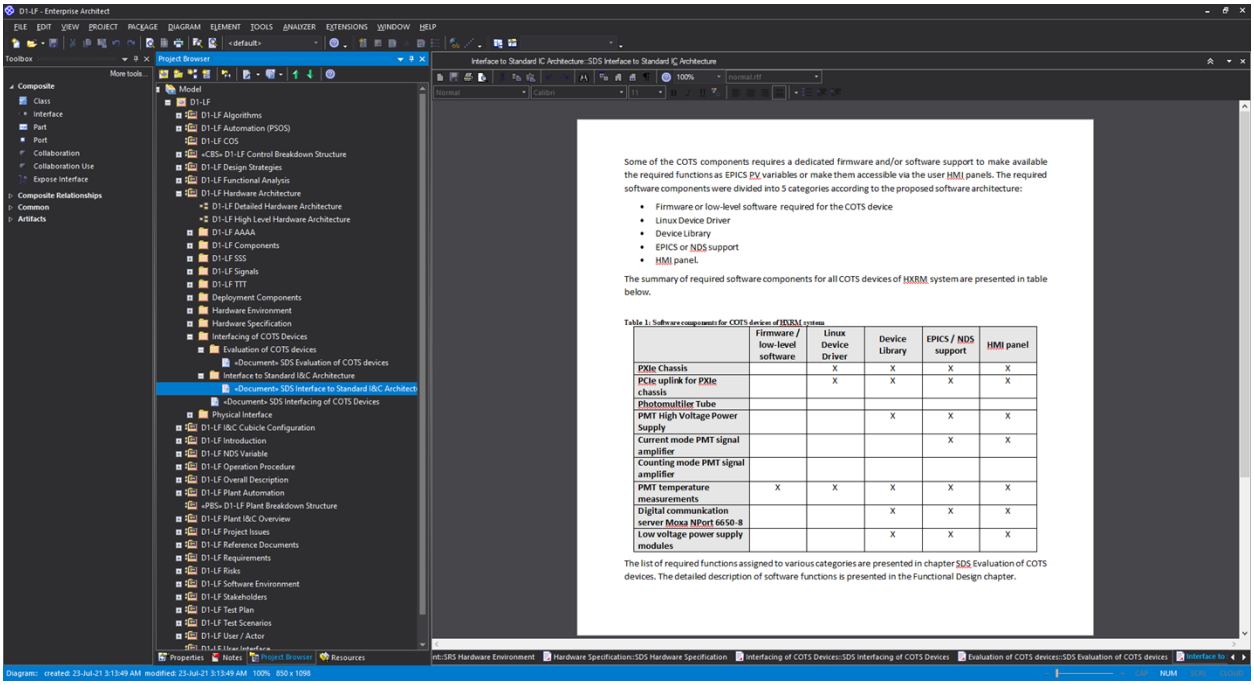


Figure 90: SDS Interface to Standard I&C Architecture Description

2.10.12 Define Physical Interface (SDS section 7.4)

1. Add package Physical Interface under CBS1-CBS2 Hardware Architecture
2. Under Physical Interface Package add Document SDS Physical Interface.

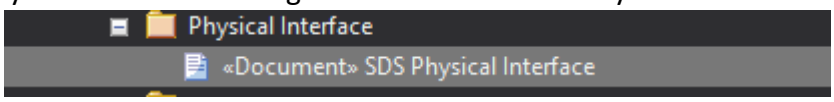


Figure 91: SDS Physical Interface in EA Project

3. Right Click on Document and Select Properties and Provide
    a. Stereotype – **Document**
    b. Alias – SDS_Physical_Intf
4. Write the description, which will be printed in SDS document and save the same.

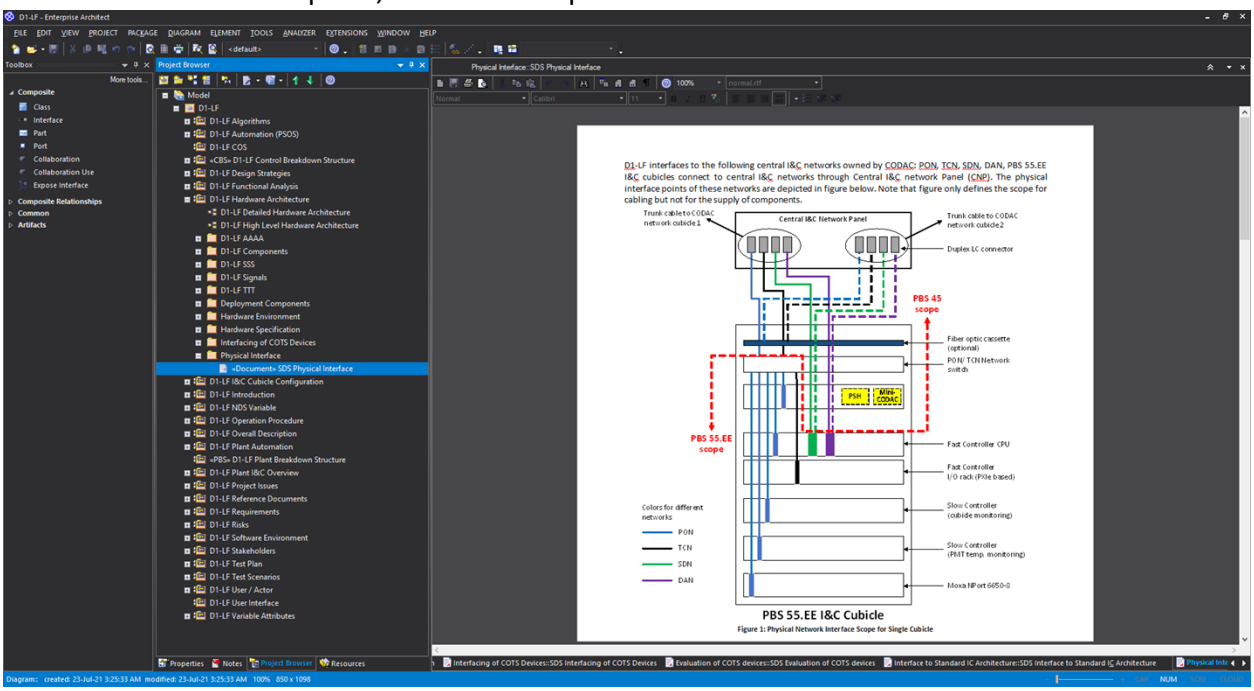


Figure 92: SDS Physical Interface in EA

2.11 Software Architecture

2.11.1 Software Overview (SDS section 8.1)

1. Add Document CBS1-CBS2 Software Environment-> Software Overview -> SDS Software Overview.
2. Provide Alias – SDS_SW_Overview
3. Open document and provide Software Environment details for the Project

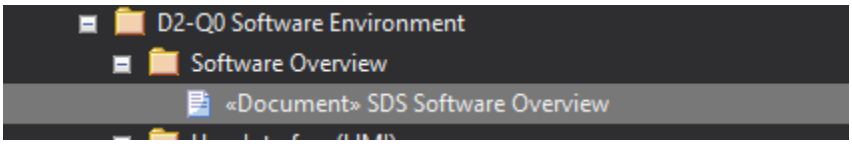


Figure 93: I&C Software Overview in EA Project

2.11.2 Software Environment (SDS section 8.2)

Following steps guide to development the software environment (~software architecture) diagram.

1. Right click **<CBS1>-<CBS2> Software Environment** (for example, D2-Q0 Software Environment) package and select Add Diagram.
2. New Diagram window will open. Select diagram type **Component** and click **OK.**
3. Right click on the newly created diagram and Select **Properties**.
4. Add **Stereotype** as **h_SWEnvironment.** Provide **Notes** if any description need to be given. Click **OK** when done.

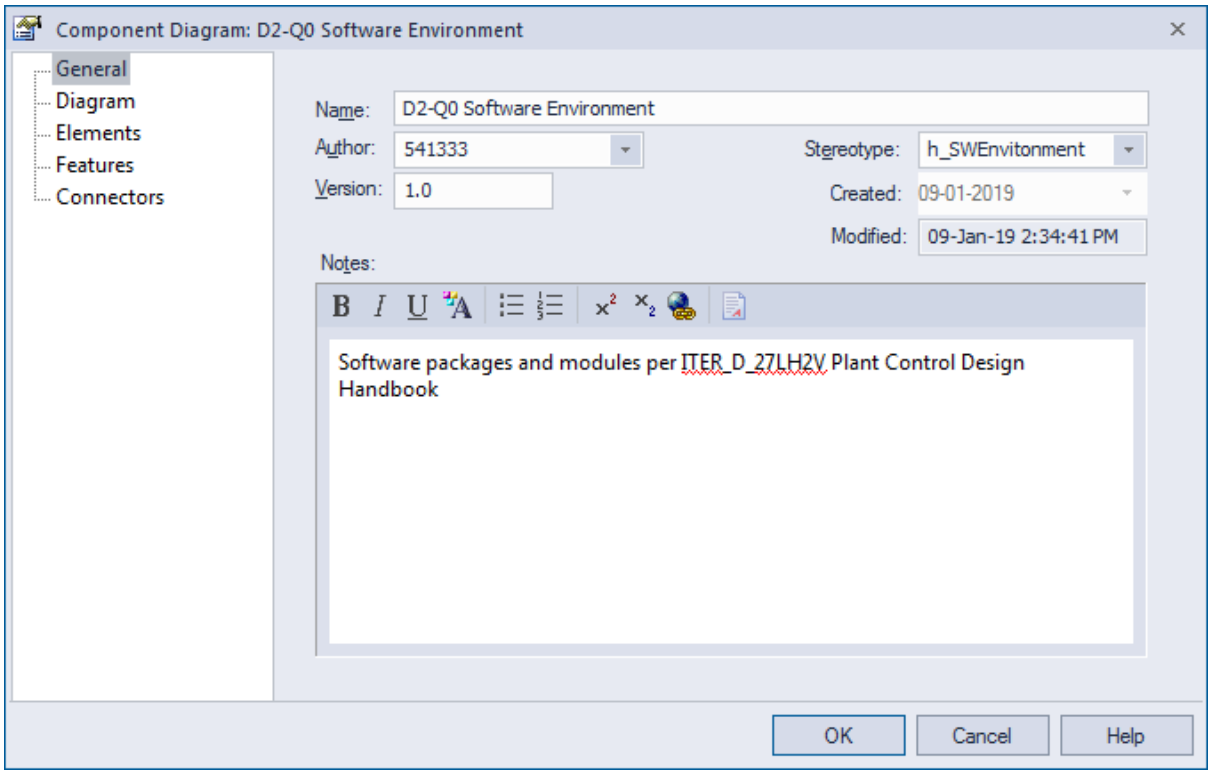


Figure 2-94: Software Environment

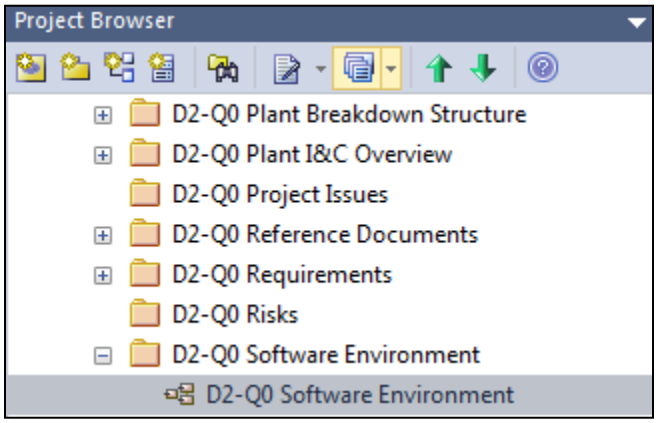


Figure 2-95: Software Environment Diagram

5. Open the diagram and draw software architecture. For drawing the diagram, software environment modules can be created. The steps for doing the same is described in section 2.11.2.1.

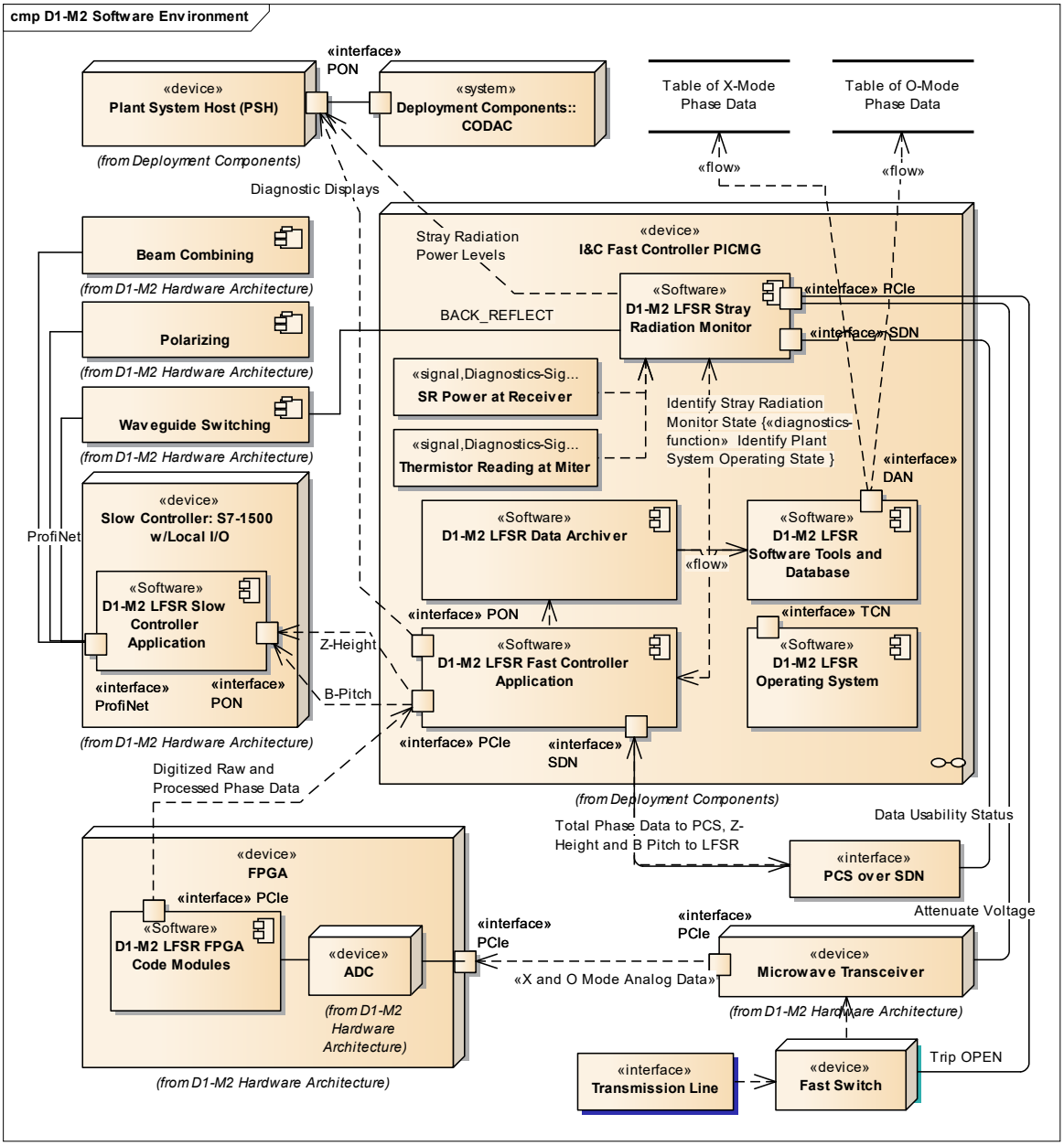


Figure 2-96: Software Environment Example 1

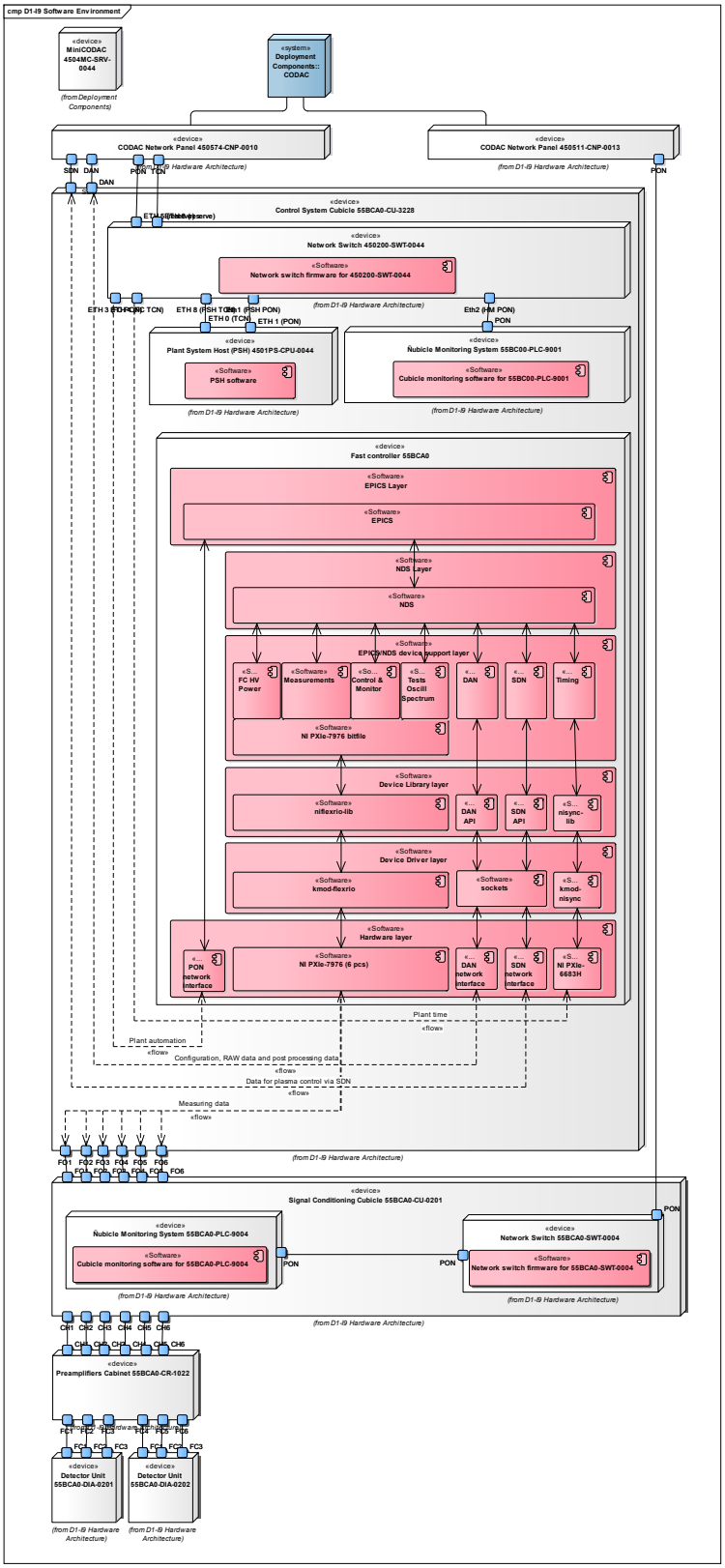


Figure 2-97: Software Environment Example 2

2.11.2.1 Software Environment Modules (SDS section 8.3)

1. Right click the **<CBS1>-<CBS2> Software Environment** Package in Project Browser and select **Add Element**.
2. Select the toolset from **Select Toolset >> UML >> Component**. Select Type as **Component** from the drop down list and Stereotype as **Software**.

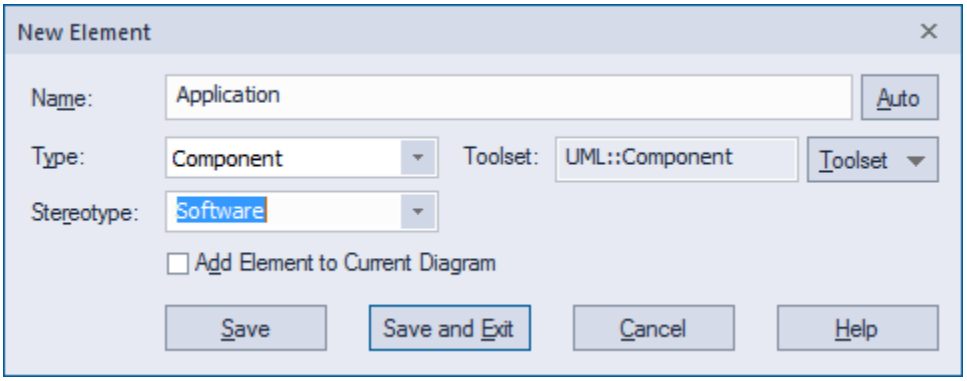


Figure 2-98: Adding Software Packages and Modules

3. Double click the newly created component and provide description in the **Notes** section.

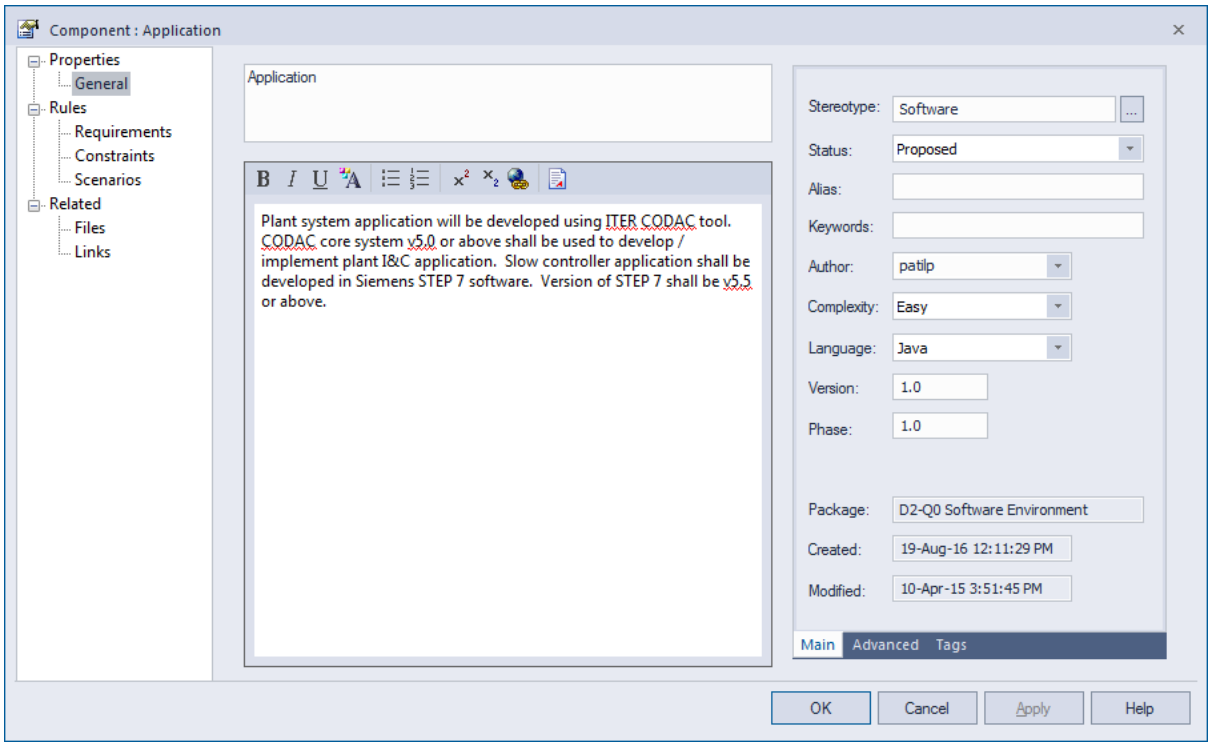


Figure 2-99: Description of Software Component

4. Follow the above steps to add various software modules. The Figure 2-101 shows the software environment modules corresponding to Figure 2-97.

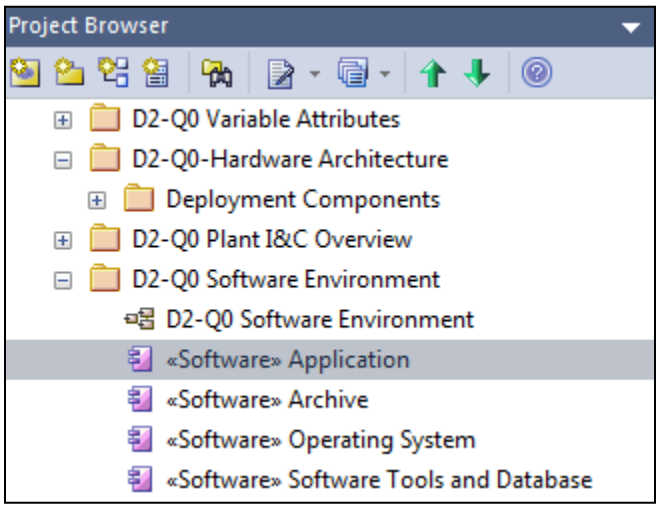


Figure 2-100: Software Modules in EA Example 1

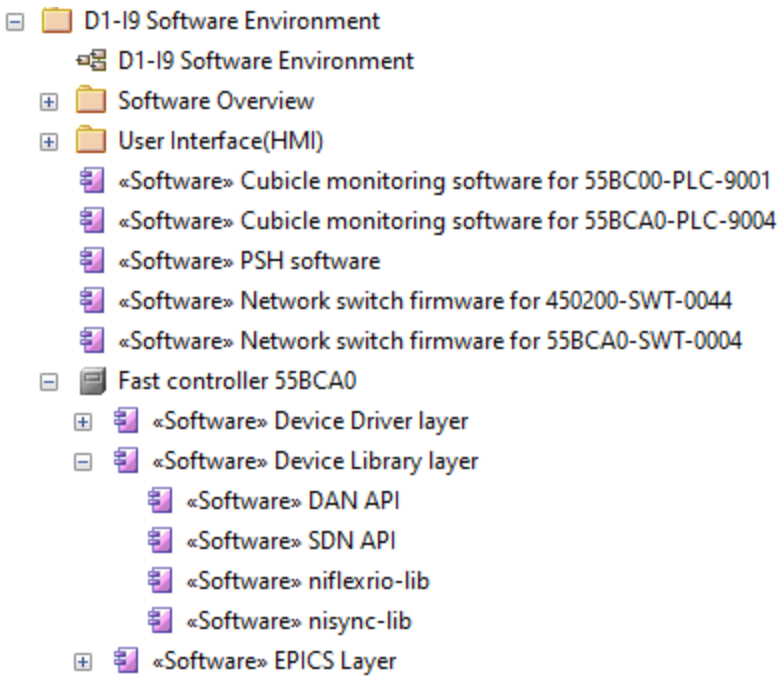


Figure 2-101: Software Modules in EA Example 2

2.11.3 User Interface (HMI) (SDS Section 8.2*)

1. Add Document CBS1-CBS2 Software Environment-> User Interface (HMI)-> SDS User Interface (HMI).
2. Provide Alias – SDS_User_Interface
3. Open document and provide User Interface details for the Project

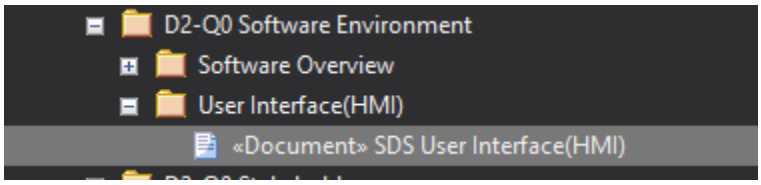


Figure 102: User Interface in EA Project

* - Note that the designer can decide to not draw the Software Environment diagram in EA, and use the free format chapter (section 2.11.1) for it. In that case the section number of this chapter will 8.2 in SDS.

2.12 NDS Variable

This section describes how to add NDS Variables in EA Project

1. Create package CBS1-CBS2 NDS Variable in EA Project like shown in below figure

2. Under CBS1-CNS2 NDS Variable package, add package for each NDS Device used in the Project

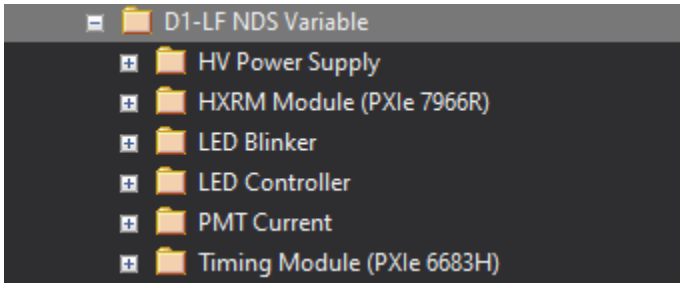


Figure 103: NDS Device Packages in EA Project

3. Under each device Package, Add NDS Function packages. These functions are the nodes as discussed in [RD13].

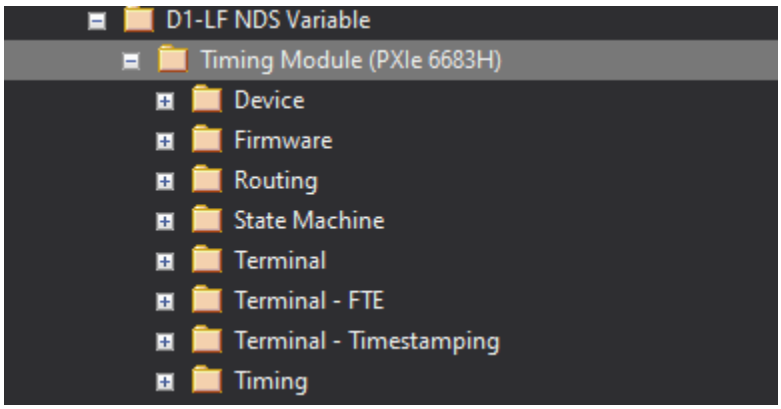


Figure 104: Example NDS Function Packages for Timing Module

4. Under each NDS function, add associated NDS Variable. The NDS variables are named as per [RD14].
5. To add NDS Variable, right click on the NDS Function and select Add Element.

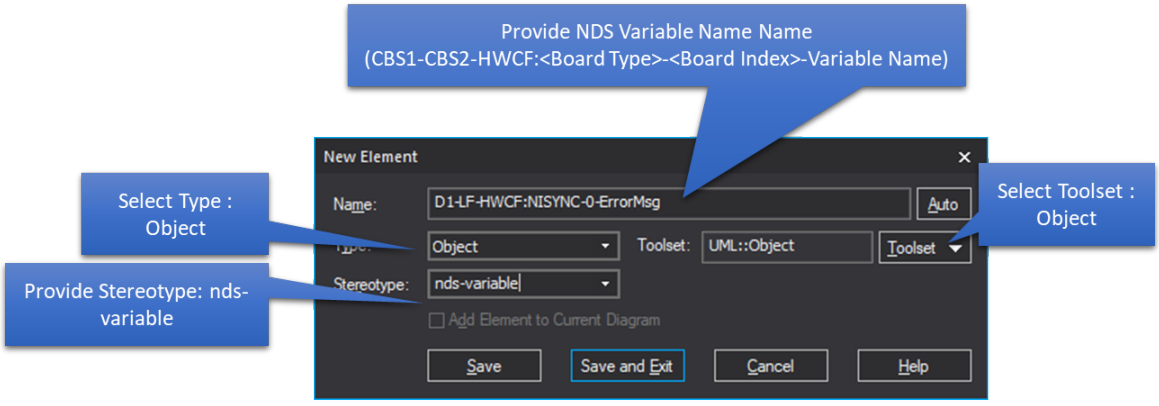
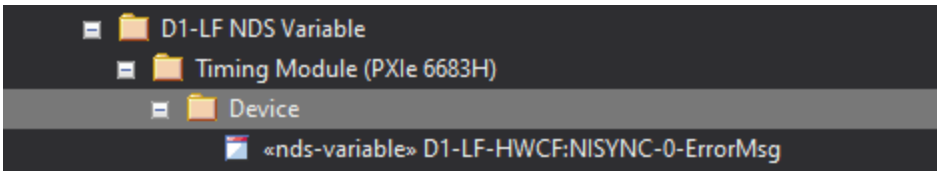


Figure 105: Add NDS Variable

6. Click on Save or Save and Exit to add variable in project



7. Open the properties for newly added variable, and provide description of the variable and Attribute/Tag of for the variable

Tag Name	Description
In/Out	Provide Variable flow direction Input (In from Device) or Output (Out to device). Value – In, Out Note – be careful about the direction of NDS variable
Hardware Allocation	Provide the name of the controller where the variable will be hosted (in EPICS IOC).

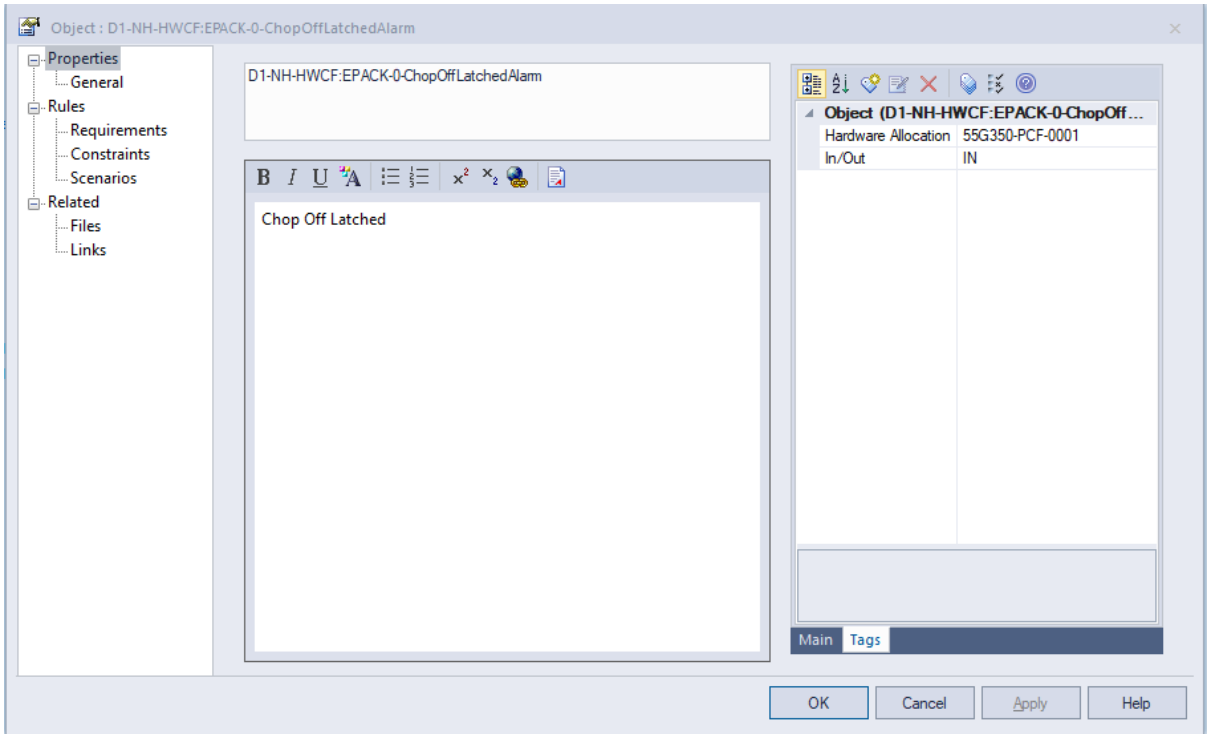


Figure 106: NDS Variable description

8. Follow above steps to add multiple NDS Functions and Variables

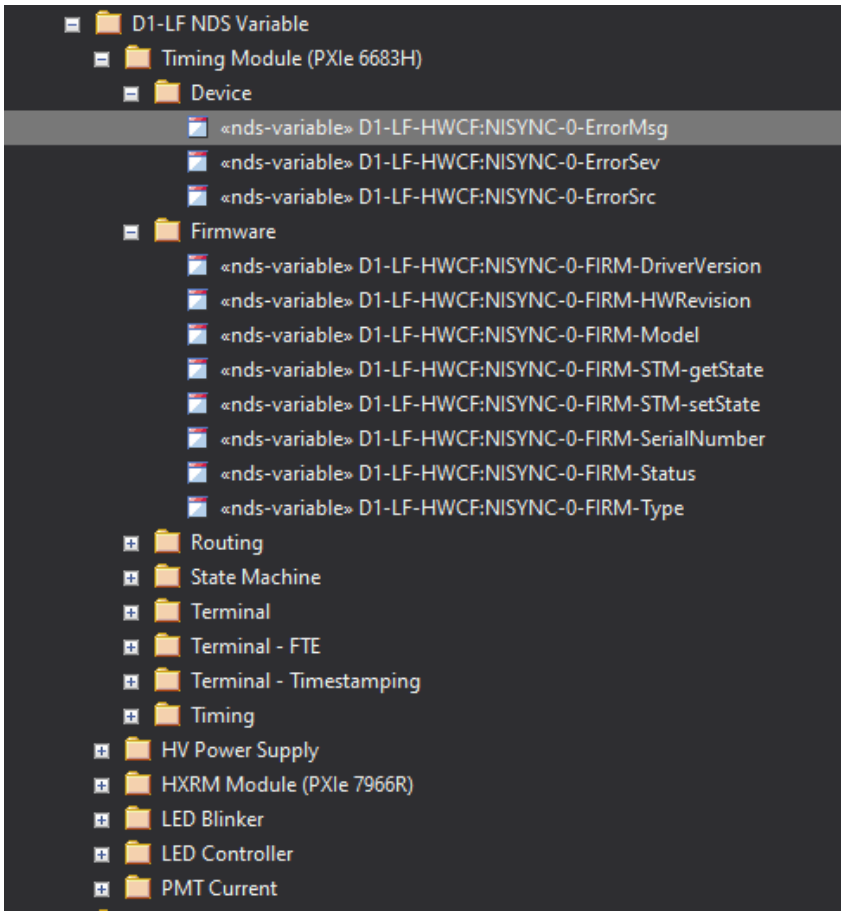


Figure 107: NDS Devices, Functions and Variables in EA Project

2.12.1 Link to Functional Analysis add-in

Please refer [RD6] for the user manual.

2.13 SYSM Variables

The naming format of the SYSM variables is described in [RD12]. It is not foreseen to define SYSM variables separately in the EA project. SYSM should be seen as standardized CODAC service which is injected to every component concerned during implementation.

If a function uses SYSM variable as an input, it must be mentioned in the description of the function.

2.14 Automation – State Machine

This section will describe how to define state machine.

1. Create package CBS1-CBS2 Automation (PSOS) (e.g., D2-Q0 Automation (PSOS)) in EA Project
2. To add state machine right click on the package and select add element.

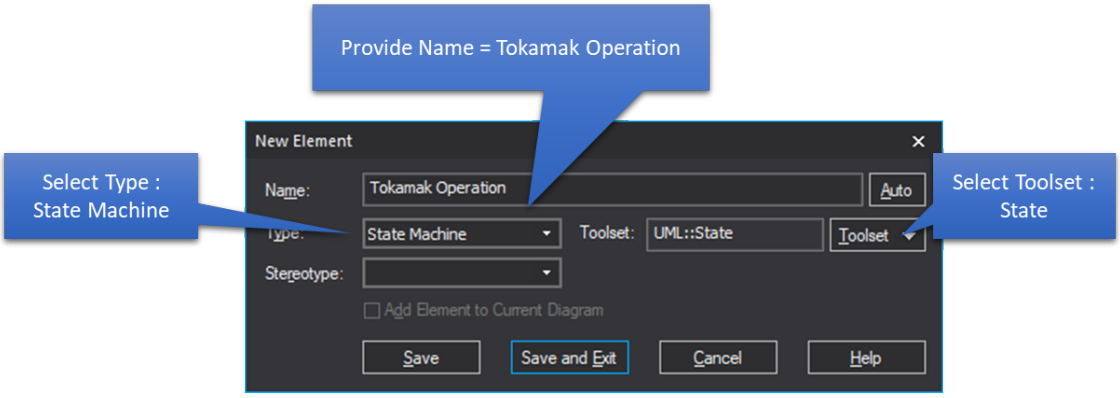
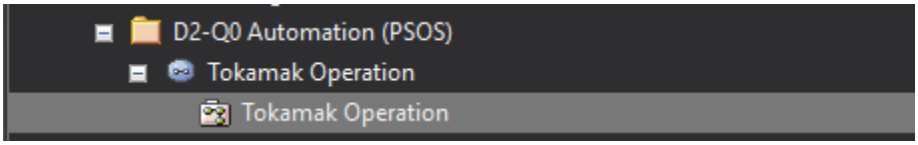


Figure 108: Add State Machine

3. Click on Save or Save and Exit to add variable in project



4. Open the Diagram – Tokamak Operation

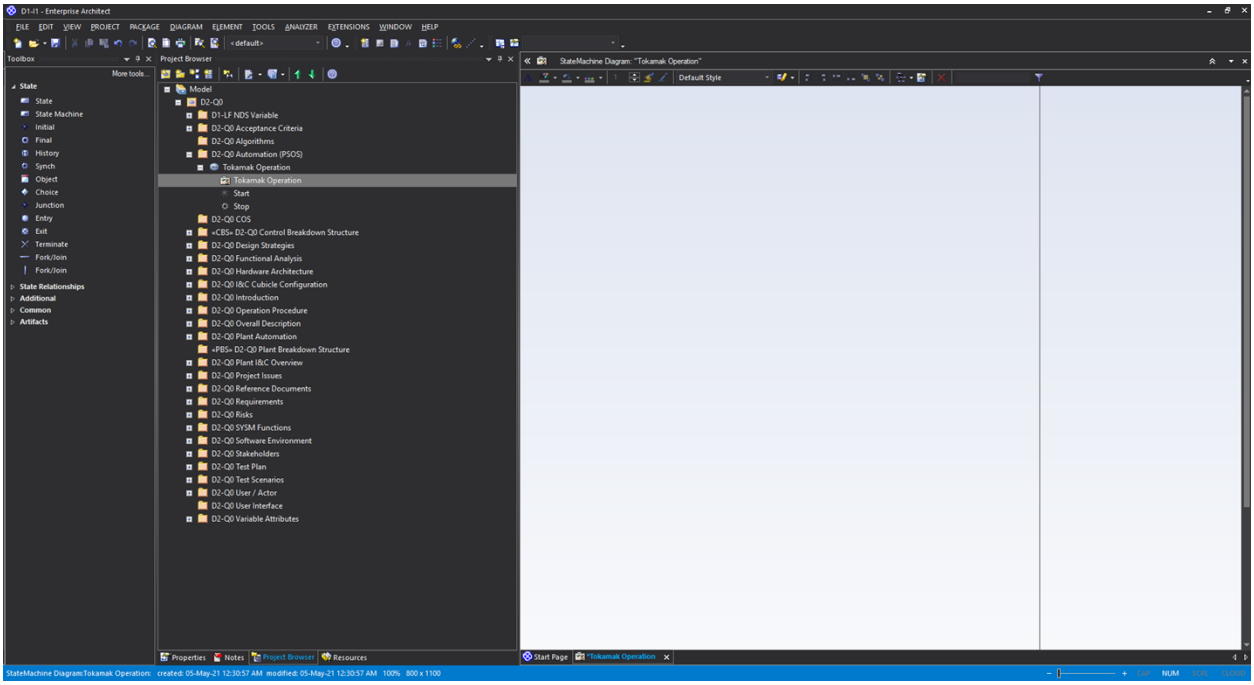


Figure 109: State Machine Diagram

2.14.1 Add States to State Machine

This section defines how to add states to state machine

1. Right click anywhere on state machine diagram and select option New Element or Connector. From the listed option select State

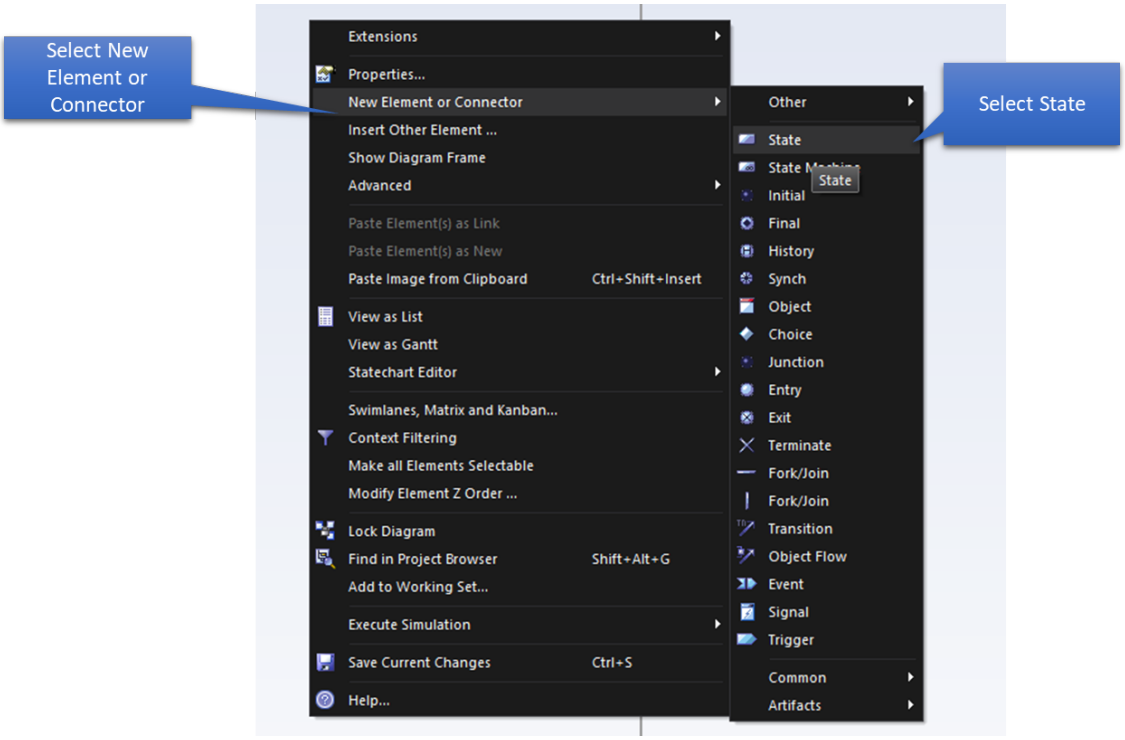


Figure 110: Select State Option

2. Or User can Drag State from Toolbox

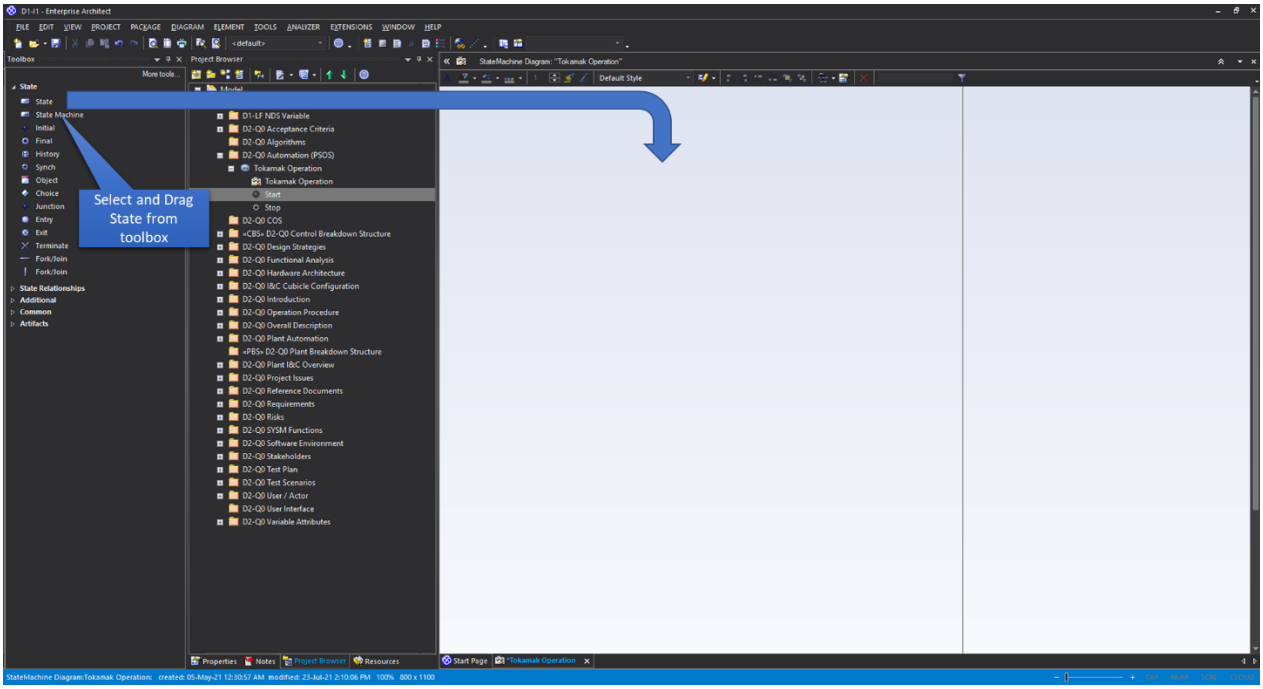


Figure 111: Drag State from Toolbox

3. After add-in state element on the diagram, it will open Properties of the Element. Provide Name, Description and Alias of the state

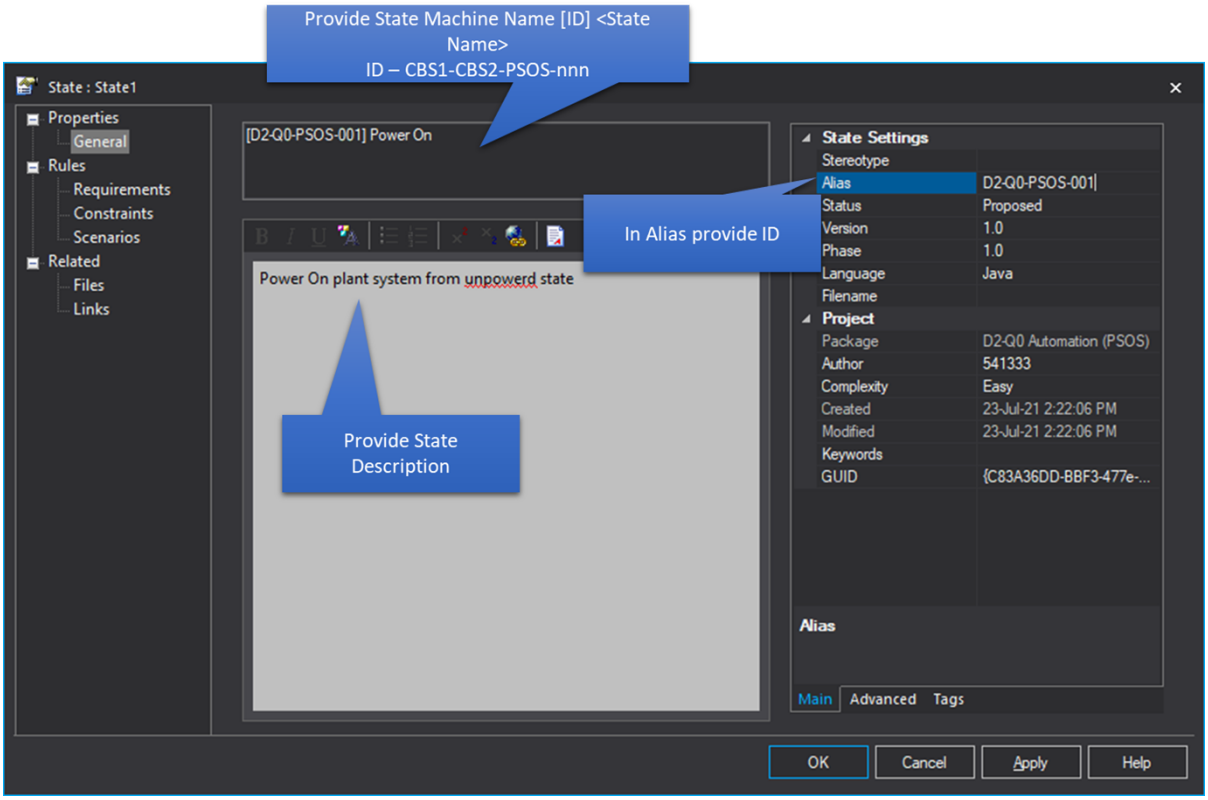


Figure 112: Provide State Name and Description

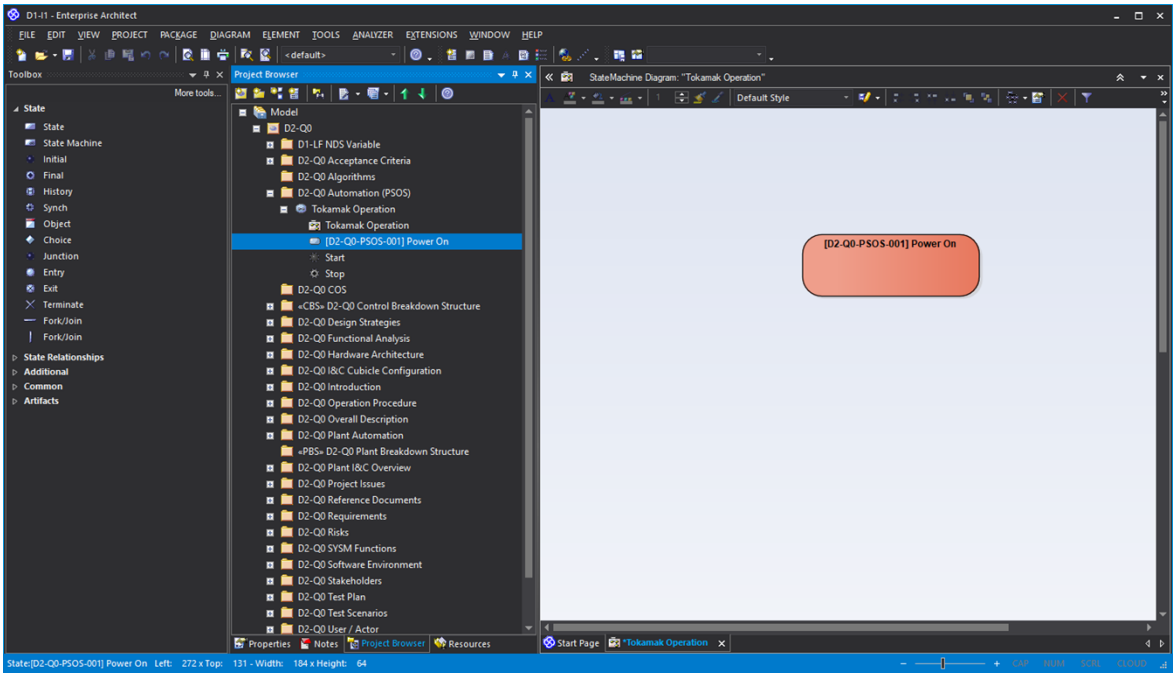


Figure 113: State Added on the Diagram

4. If user wants to draw hierarchical state machine, then, -> Right click on State and Select **New Child Diagram** >> **Composite Structure Diagram**
5. Follow above steps to add multiple States

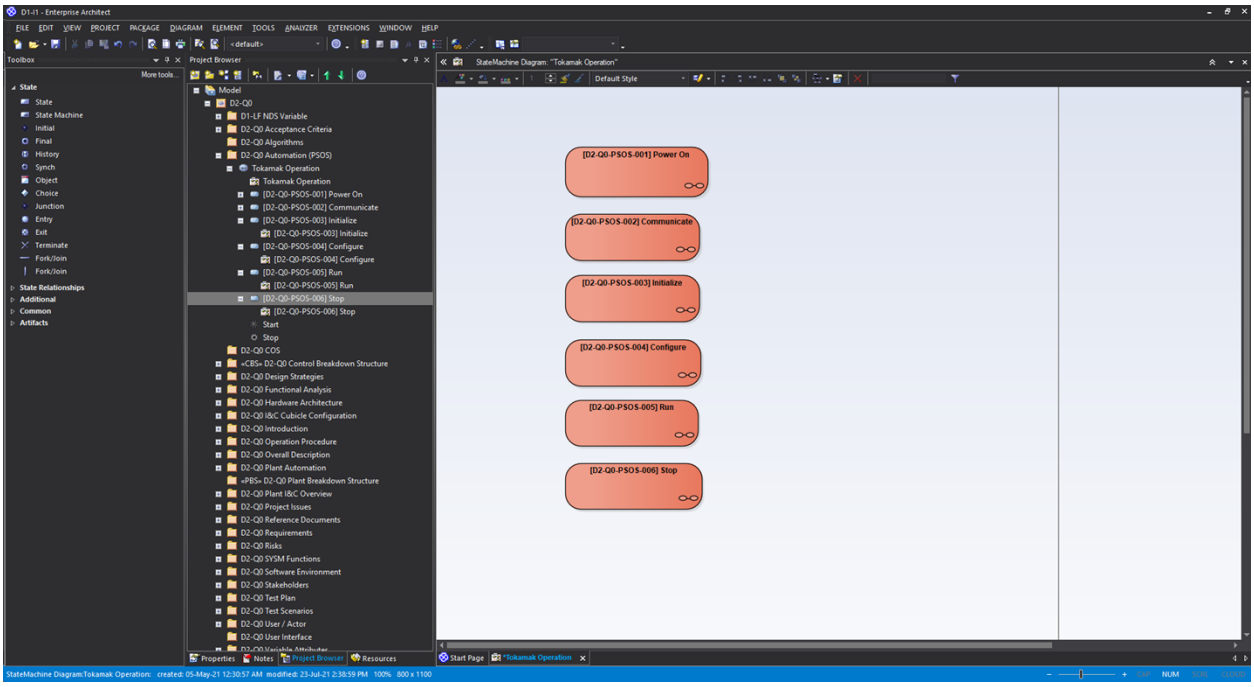
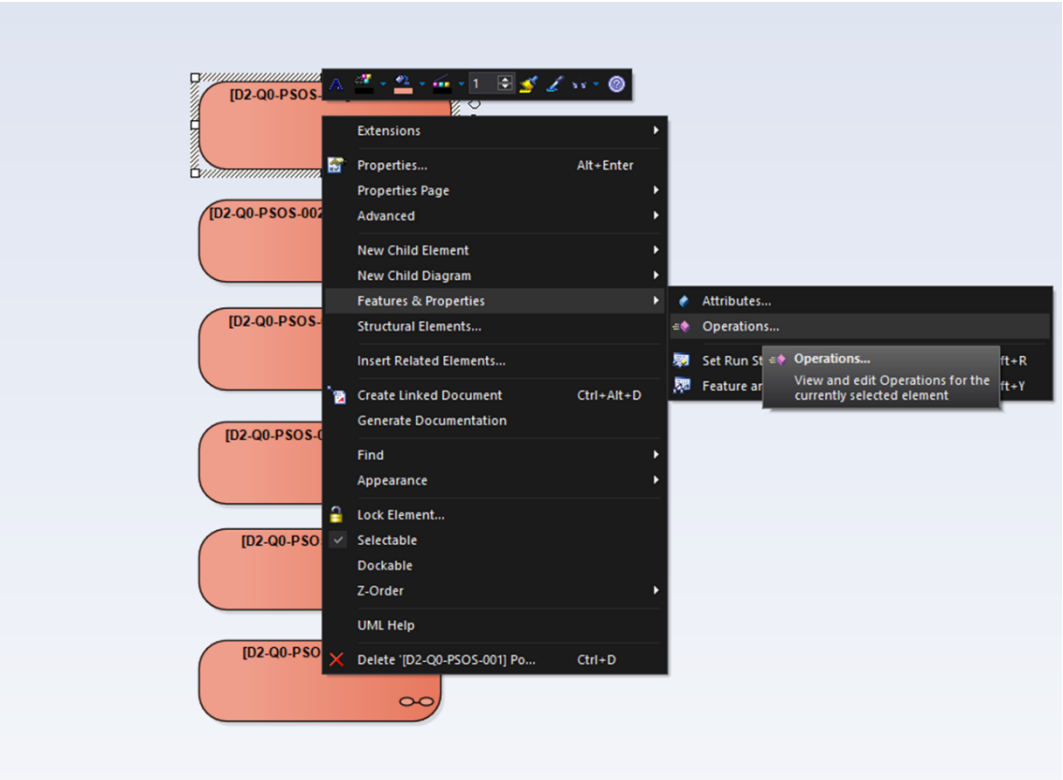


Figure 114: States added to state machine

2.14.2 Add Entry, Do and Exit Procedures

This section describes to add Entry, Do and Exit Procedures

1. Right click State and select Features and Properties >> Operations



2. This will open window to define Entry, Do and Exit Procedure

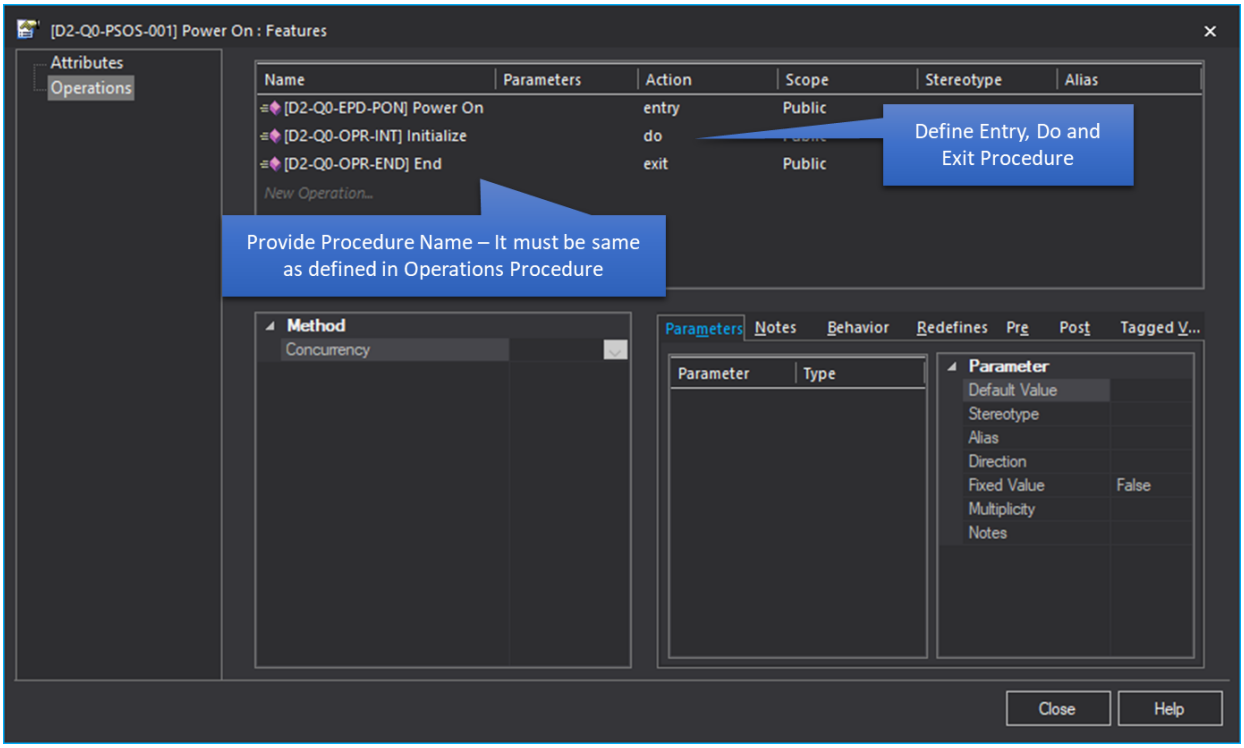
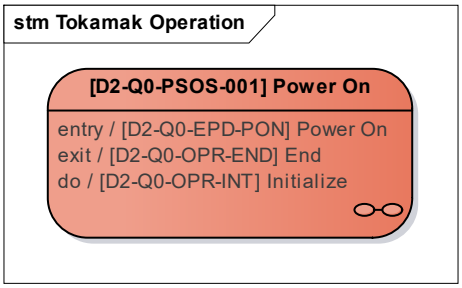


Figure 115: Define Entry, Do and Exit Procedures



3. Follow above steps to add Entry, Do and Exit Procedures for all States. Note – these procedures are the procedures which have already defined under the package Operation Procedure

2.14.3 Add Conditions to State

This section describes to add conditions to state

1. Right click State and select Features and Properties >> Attributes. Attribute window will open.
2. Here Conditions can be defined for a State. Condition name must be the variable name defined under functional analysis.

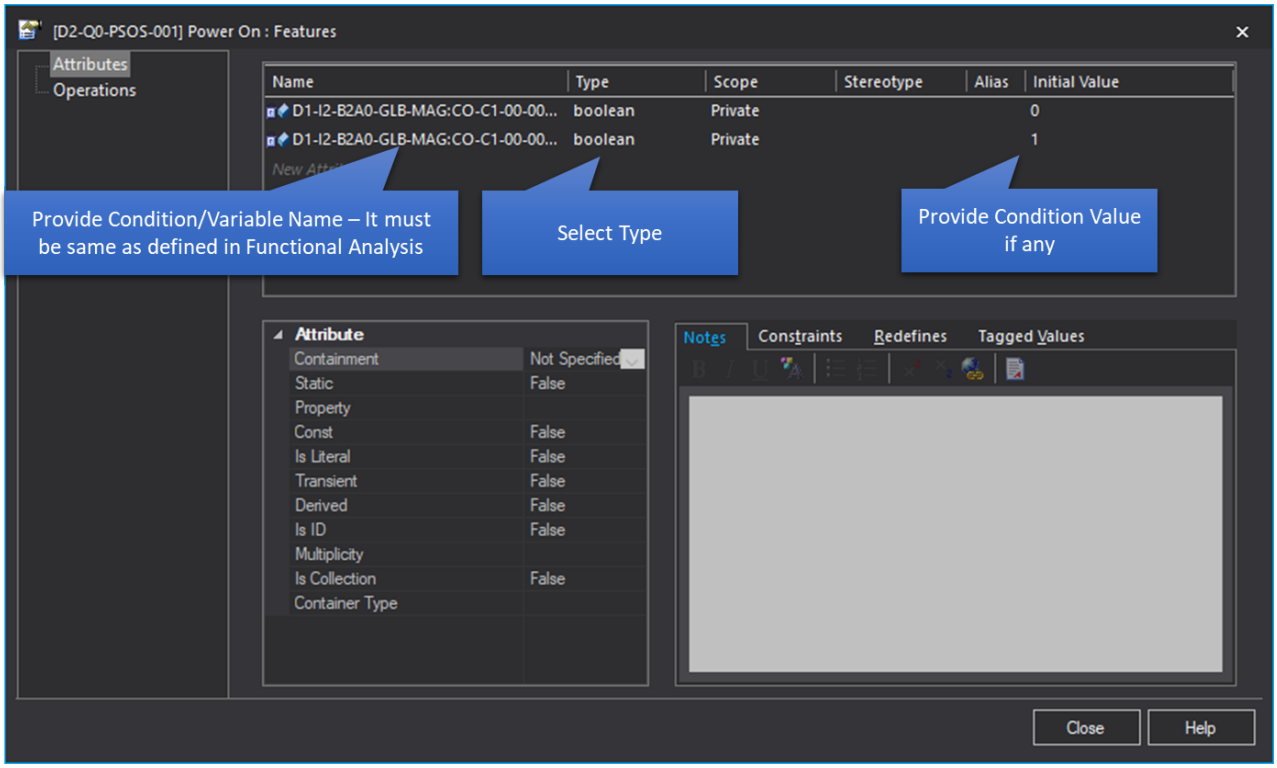
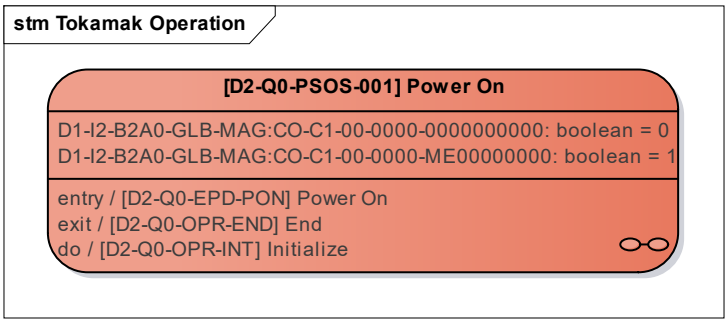


Figure 116: Define Conditions for the State

Note: In the figure above, the scope of the variable does not matter.



3. Follow above steps to add Conditions for each state

2.14.4 Transitions between states

This section describes how to define Transitions between states

1. Use the Transition from State Relationship tool to connect between States

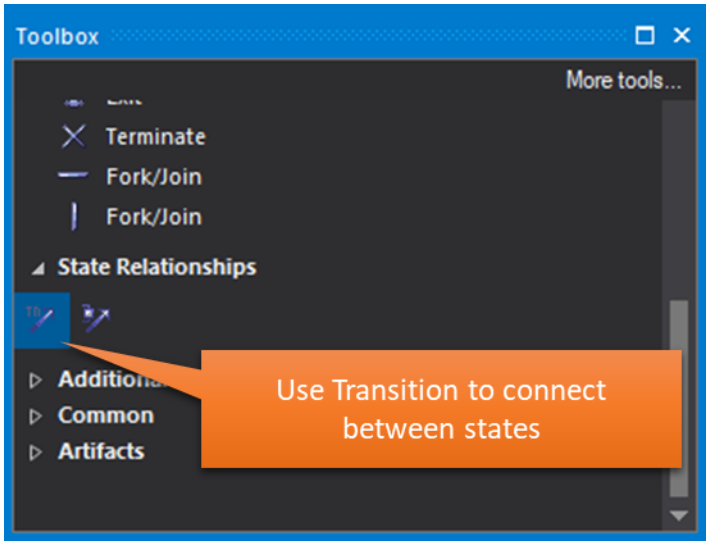


Figure 117: Use Transition from Toolbox

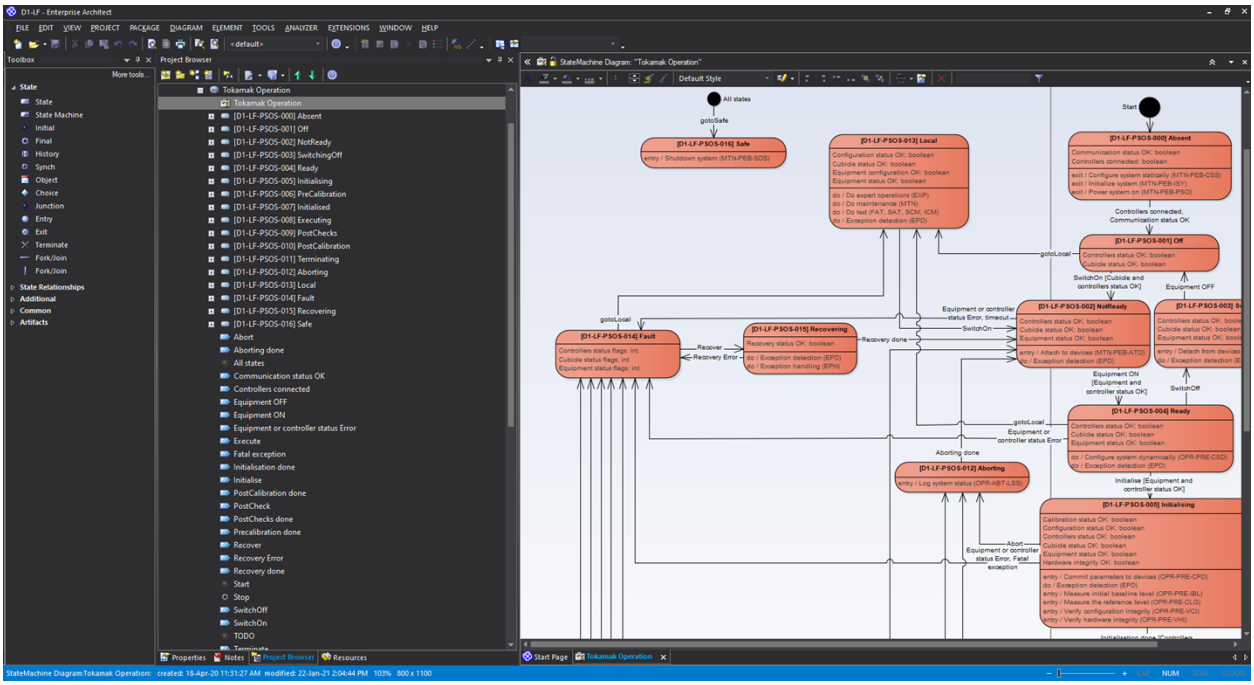


Figure 118: Transition Between States

2. Double click the Transitions to Add Trigger and Guard conditions (if applicable)

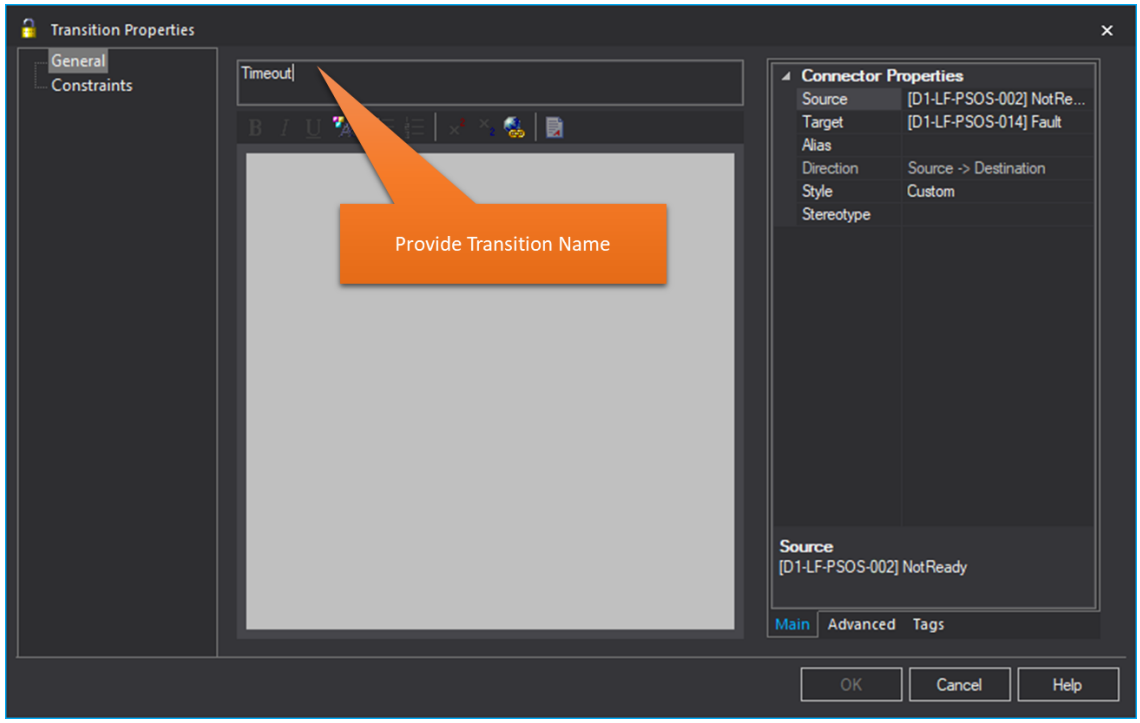


Figure 119: Provide Transition Name

3. Select Constraints to Add Trigger and Guard Conditions (if applicable)

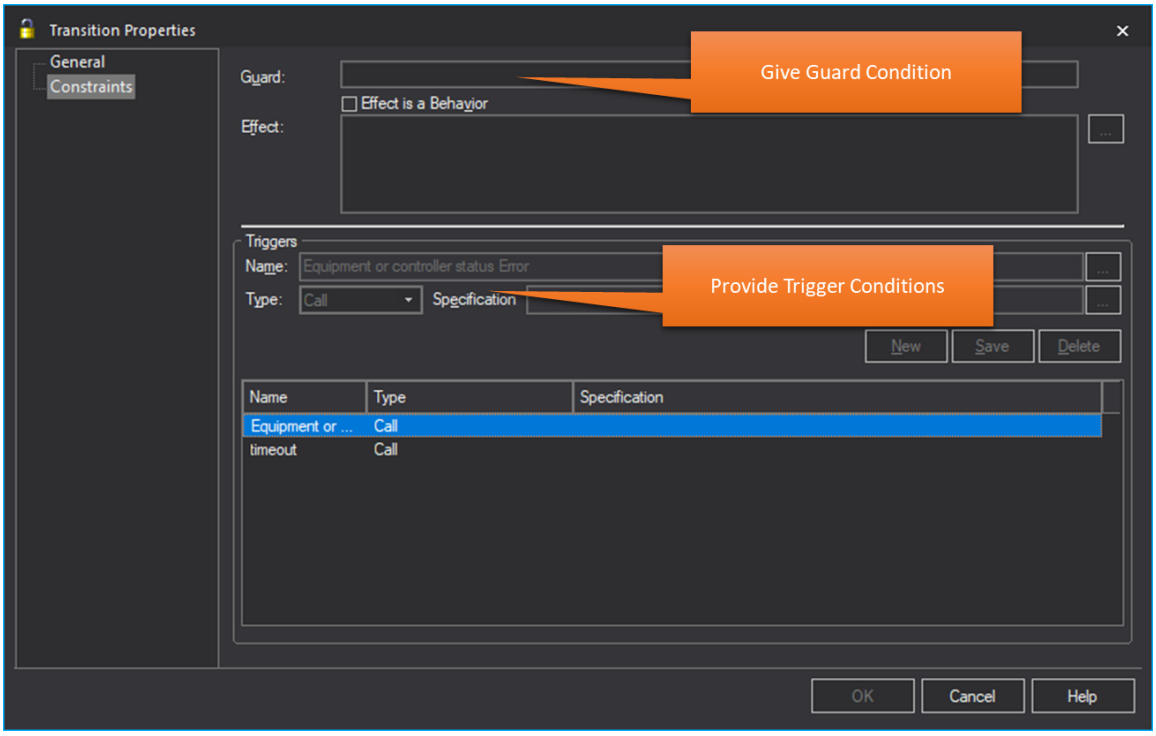


Figure 120: Provide Guard and Trigger

4. Follow above steps to add Transitions for all states. Also all guard and triggers if applicable.

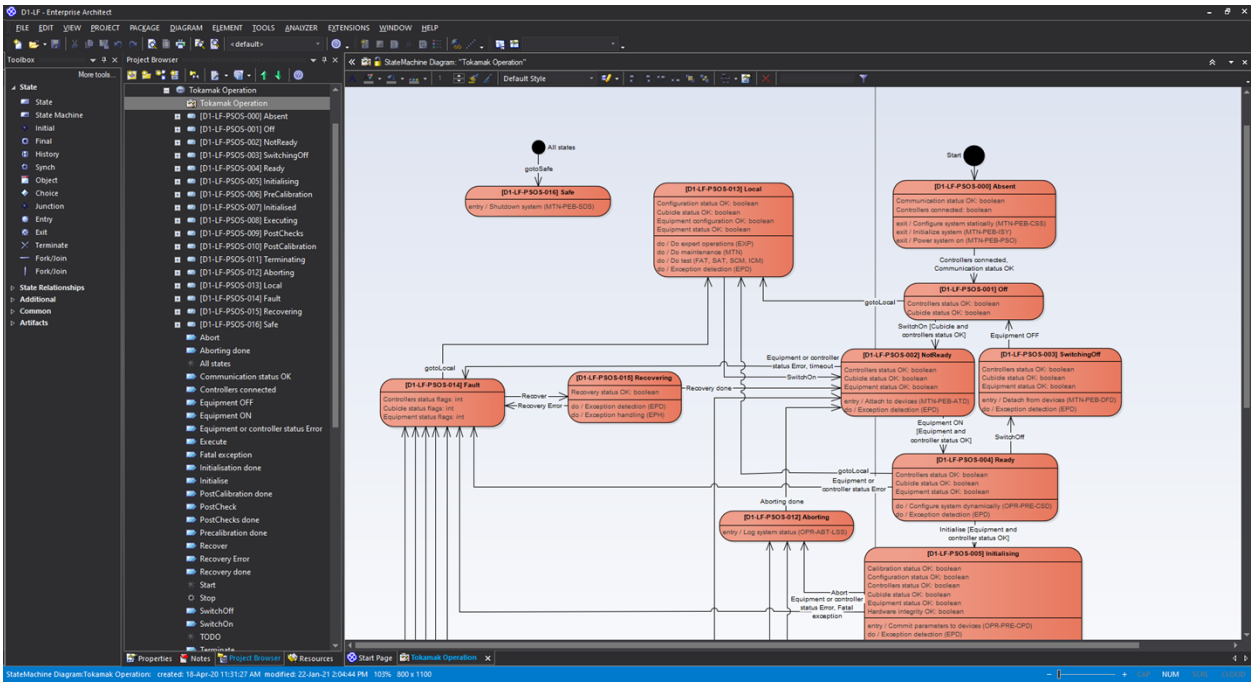


Figure 121: State Machine in EA Project

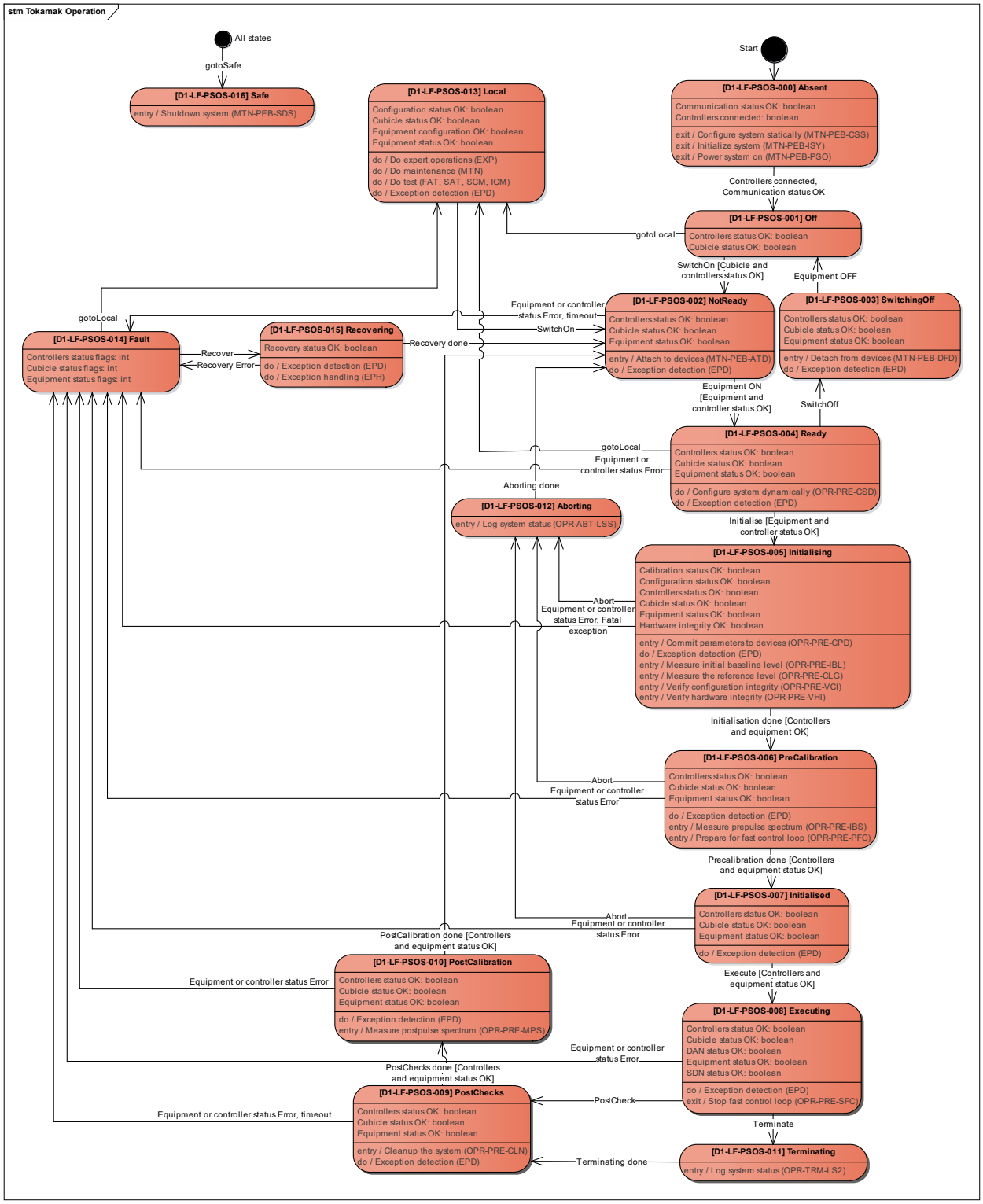


Figure 122: State Machine

Note: The state machine presented in this figure above is only for illustration. Please also refer section 4.4.

2.14.5 Link to Design Mapping add-in

Please refer [RD6] for the user manual.

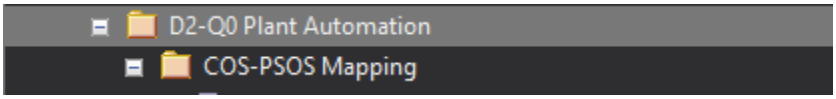
2.15 Plant Automation

This section describes how to define COS-PSOS and GOS-PSOS mapping in EA Project.

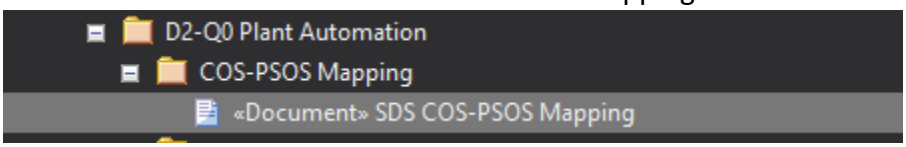
Create CBS1-CBS2 Automation Package in EA Project e.g., D2-Q0 Automation

2.15.1 COS-PSOS Mapping (SDS Section 6.2)

1. Create package COS-PSOS Mapping under Plant Automation



2. Add Document Name SDS COS-PSOS Mapping under Plant Automation



3. Select Document Property and provide Alias – SDS_COS_PSOS

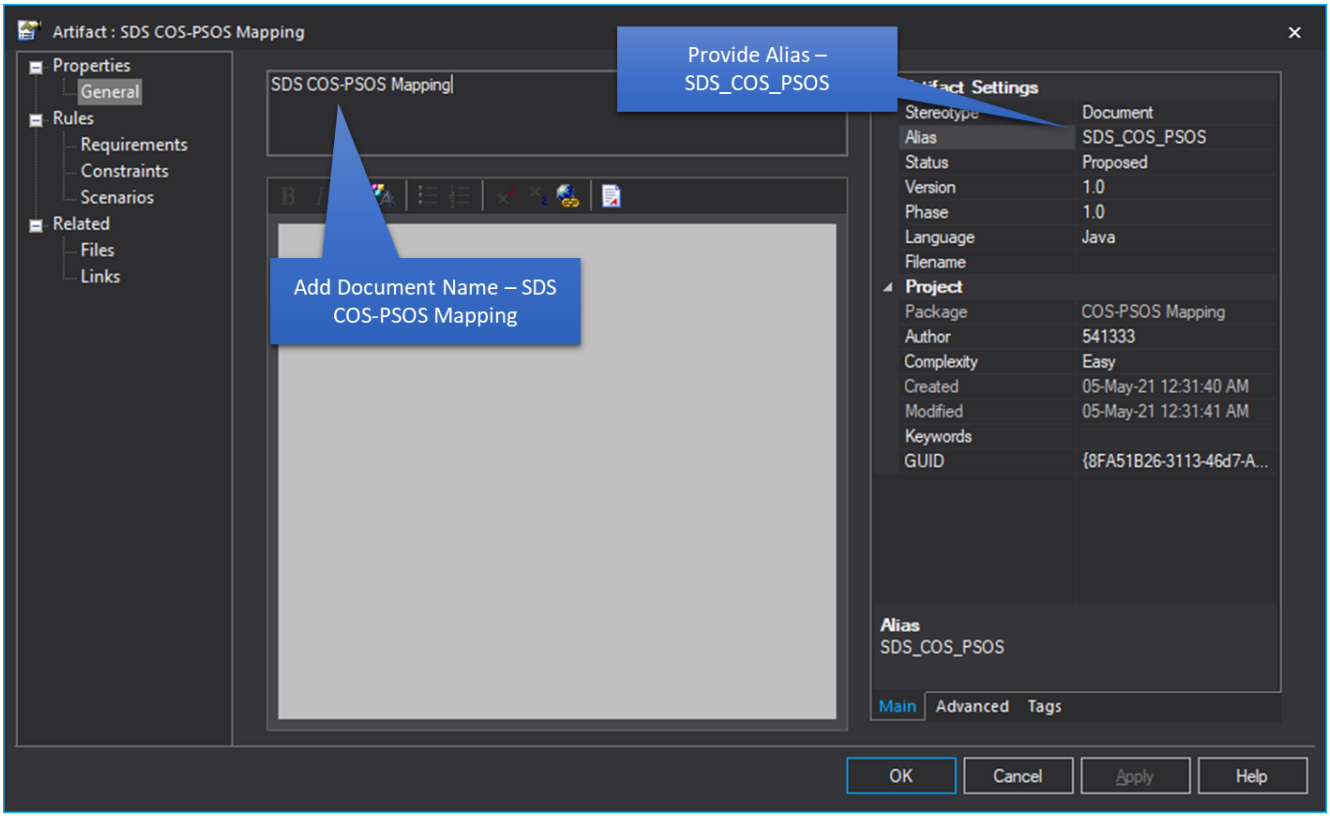
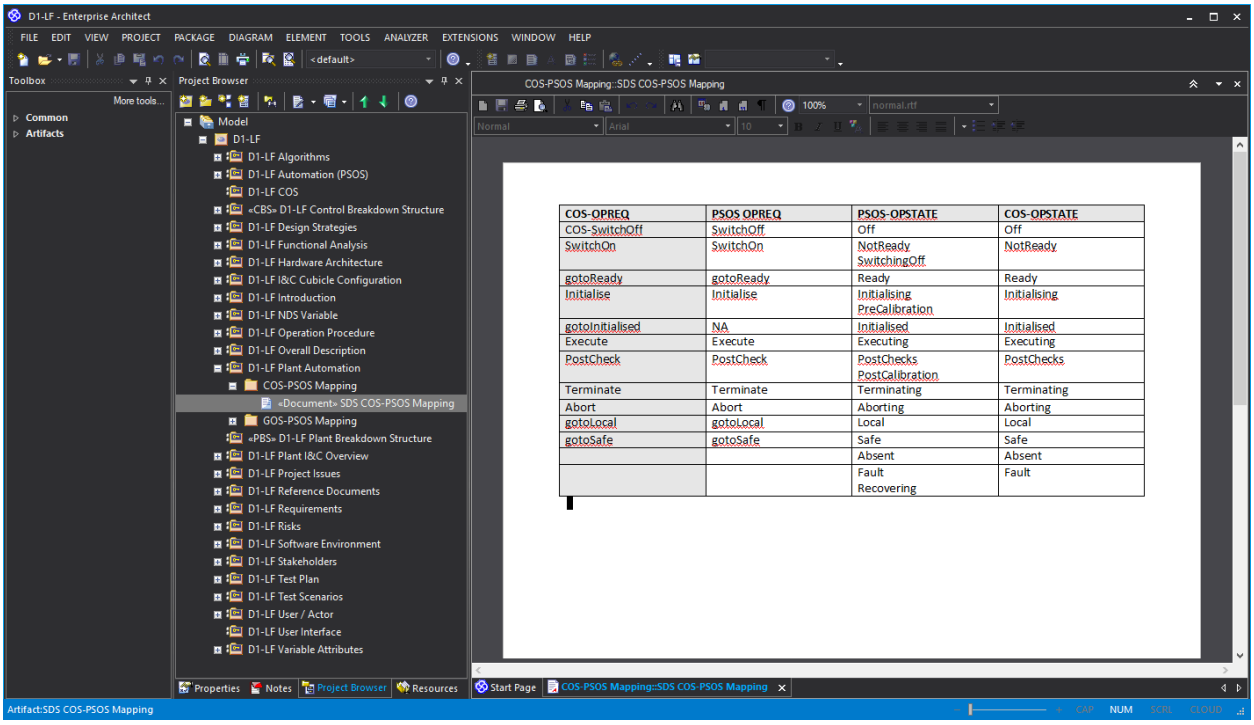


Figure 123: SDS COS-PSOS Mapping Properties

4. Open document and provide COS-PSOS Mapping.

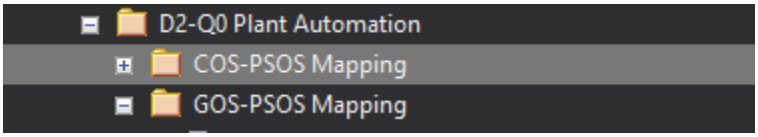


COS-OPREQ	PSOS OPREQ	PSOS-OPSTATE	COS-OPSTATE
COS-SwitchOff	SwitchOff	Off	Off
SwitchOn	SwitchOn	NotReady SwitchingOff	NotReady
gotoReady	gotoReady	Ready	Ready
Initialise	Initialise	Initialising PreCalibration	Initialising
gotoInitialised	NA	Initialised	Initialised
Execute	Execute	Executing	Executing
PostCheck	PostCheck	PostChecks PostCalibration	PostChecks
Terminate	Terminate	Terminating	Terminating
Abort	Abort	Aborting	Aborting
gotoLocal	gotoLocal	Local	Local
gotoSafe	gotoSafe	Safe	Safe
		Absent	Absent
		Fault Recovering	Fault

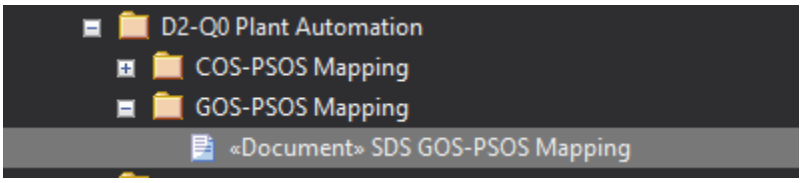
Figure 124: COS-PSOS Mapping in EA

2.15.2 GOS-PSOS Mapping (SDS Section 6.3)

1. Create package GOS-PSOS Mapping



2. Add Document Name SDS GOS-PSOS Mapping



3. Select Document Property and provide Alias – SDS_GOS_PSOS

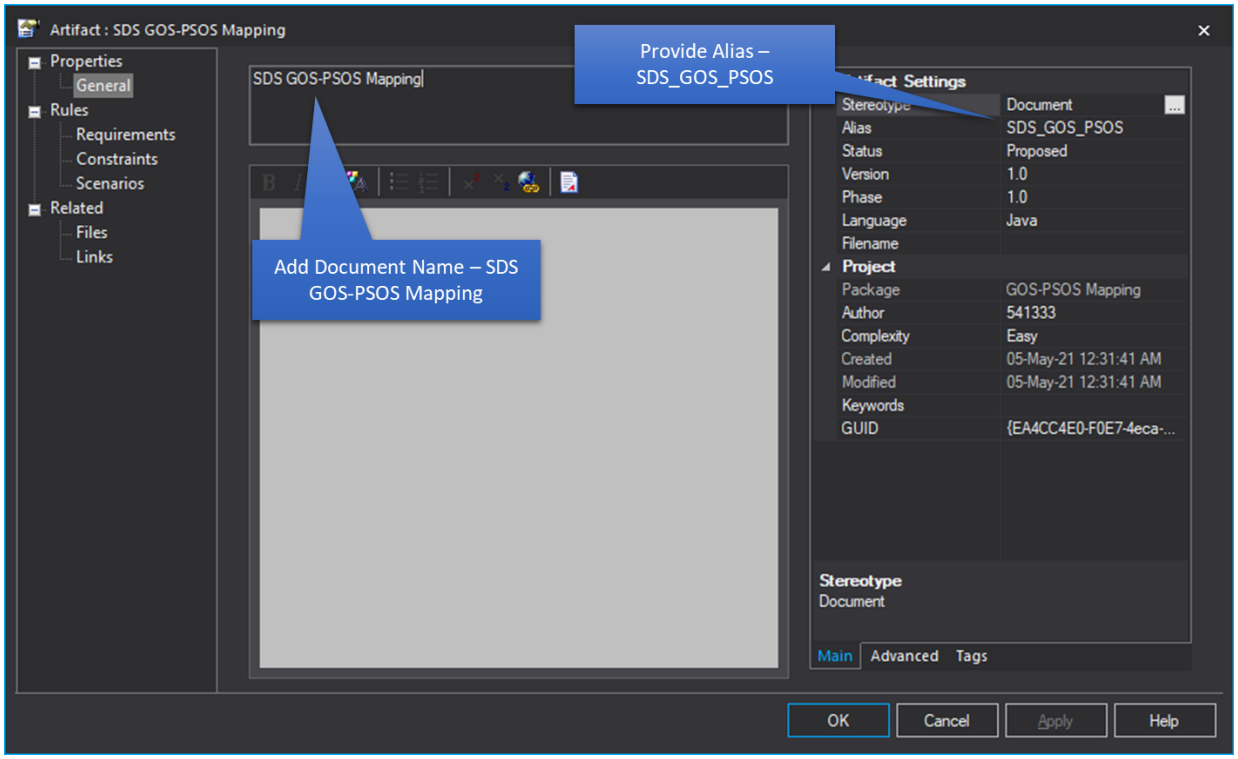


Figure 125: SDS GOS-PSOS Mapping Properties

4. Open document and provide GOS-PSOS Mapping.

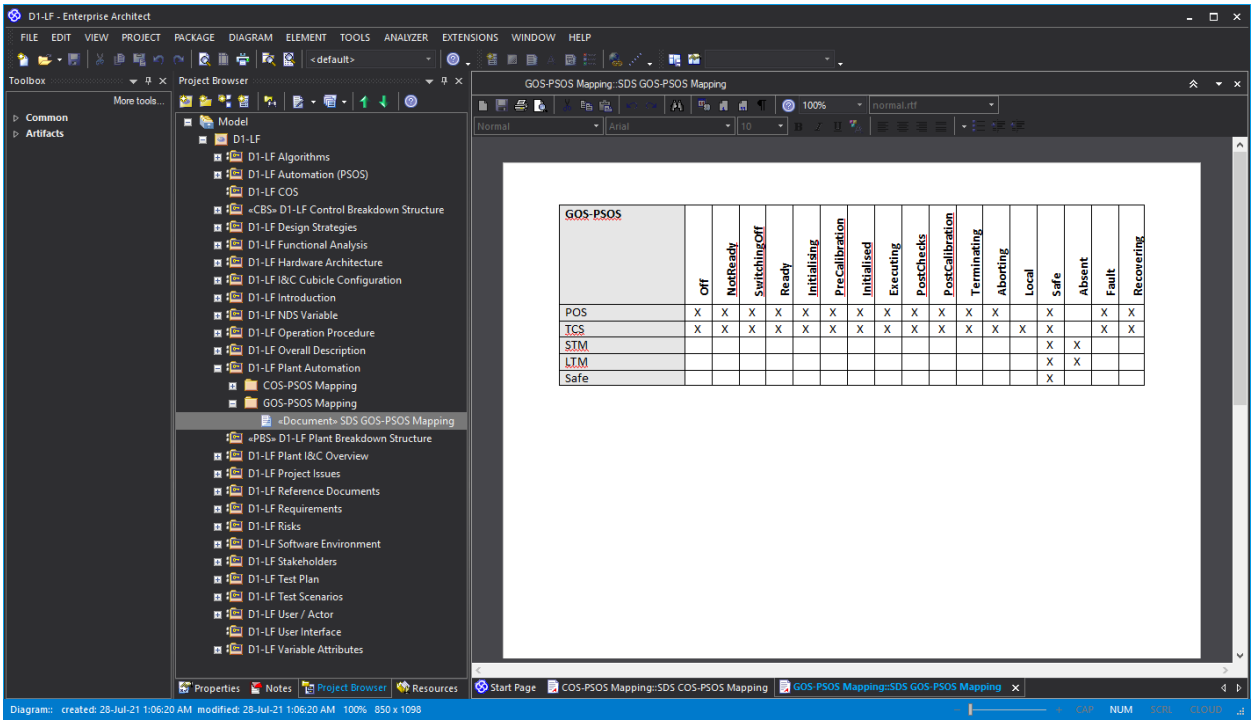


Figure 126: GOS-PSOS Mapping in EA

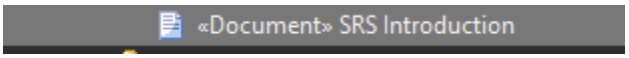
2.16 Free Format Chapters

In the below sections, the alias prefix tells us about the document which they are related.

2.16.1 Introduction Chapter – SRS Section 1

This section will describe the introduction chapter in the SRS document.

1. Crate Package CBS1-CBS2 Introduction e.g., D2-Q0 Introduction and sub package Purpose.
2. Add Document Name SRS Introduction



3. Select Document Property and provide Alias – SRS_Introduction
4. Define SRS Introduction in the document

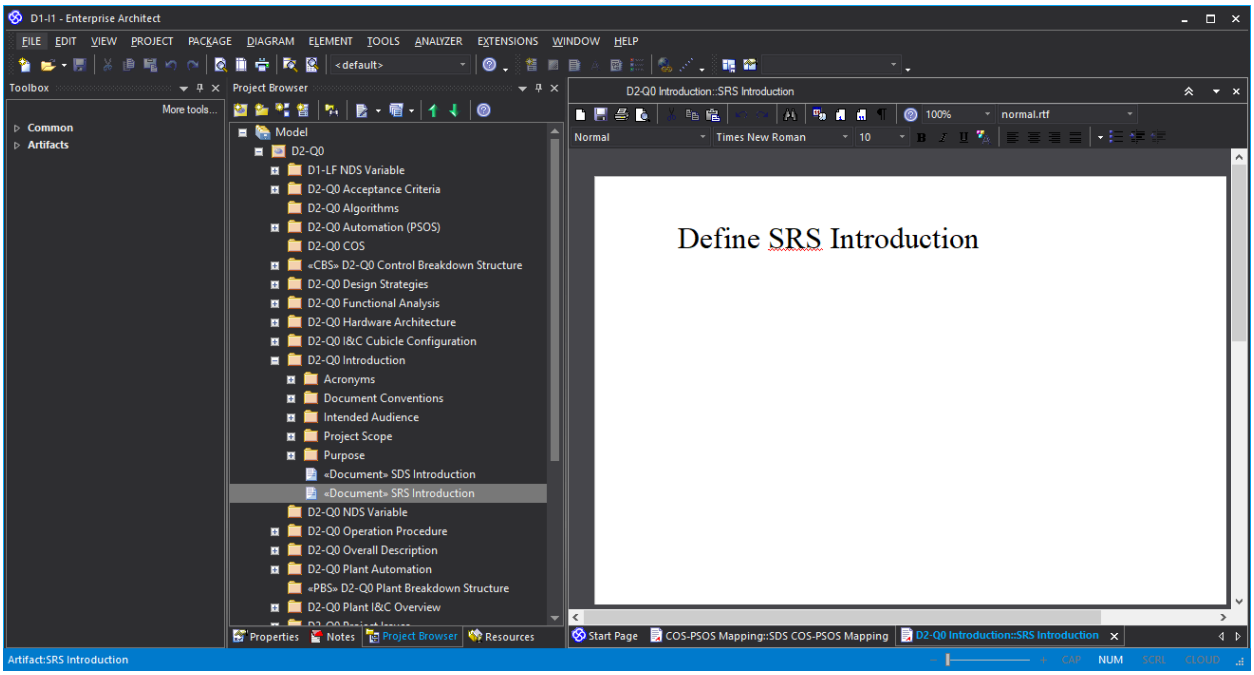


Figure 127: SRS Introduction

2.16.1.1 SRS Section – Purpose (Section 1.1 in SRS Document)

This section will describe the Purpose section in SRS document.

1. Add Document under Introduction->Purpose ->SRS Purpose.
2. Provide Alias – SRS_Purpose

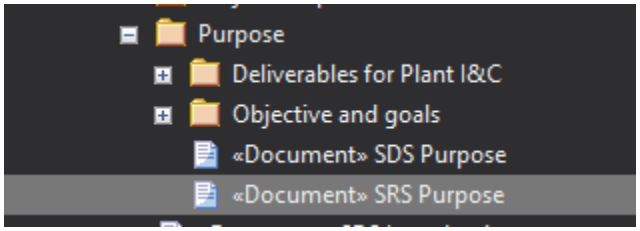


Figure 128: SRS Purpose in EA Project

3. Open document and provide Purpose

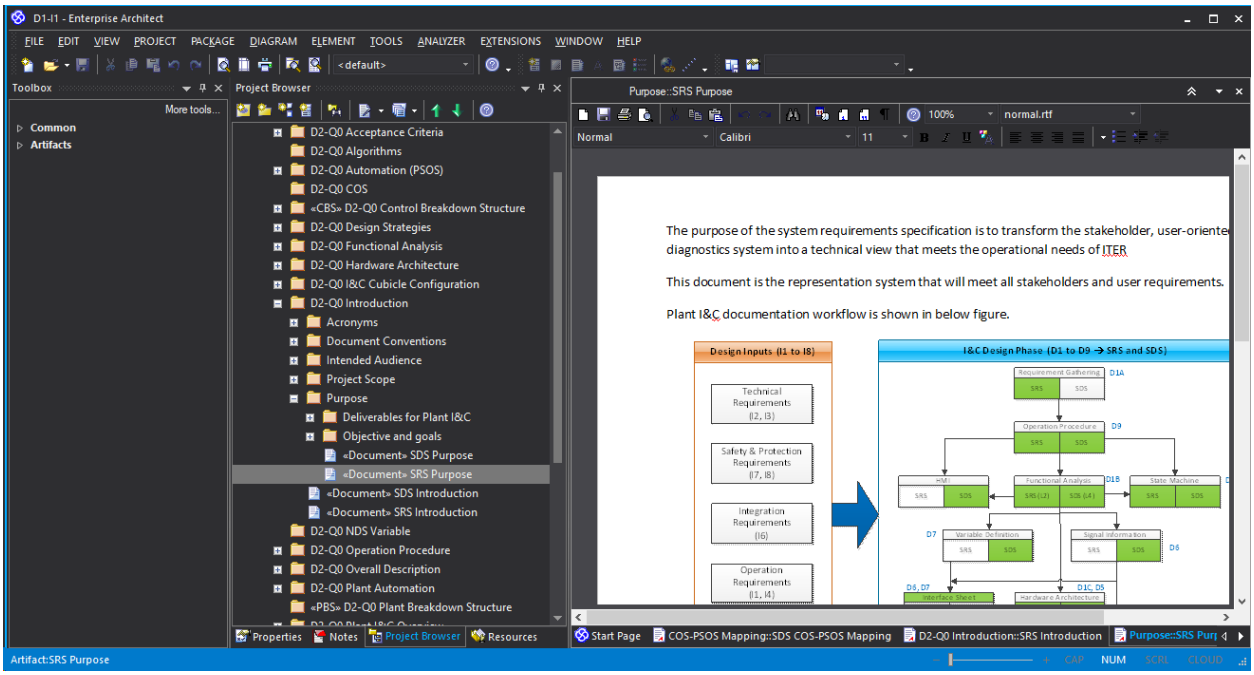


Figure 129: SRS Purpose in EA

2.16.1.2 SRS Section – Objective (Section 1.1.1)

This section will describe the Objective section in SRS document.

1. Add Document Introduction->Purpose->Objective and goals->SRS Objective and goals.
2. Provide Alias – SRS_Objective

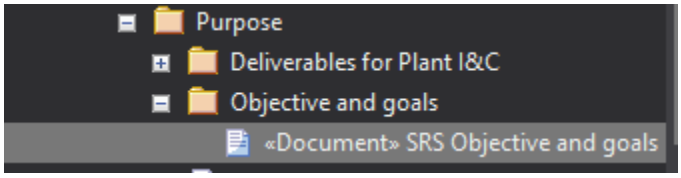


Figure 130: SRS Objective in EA

3. Open document and provide Objectives

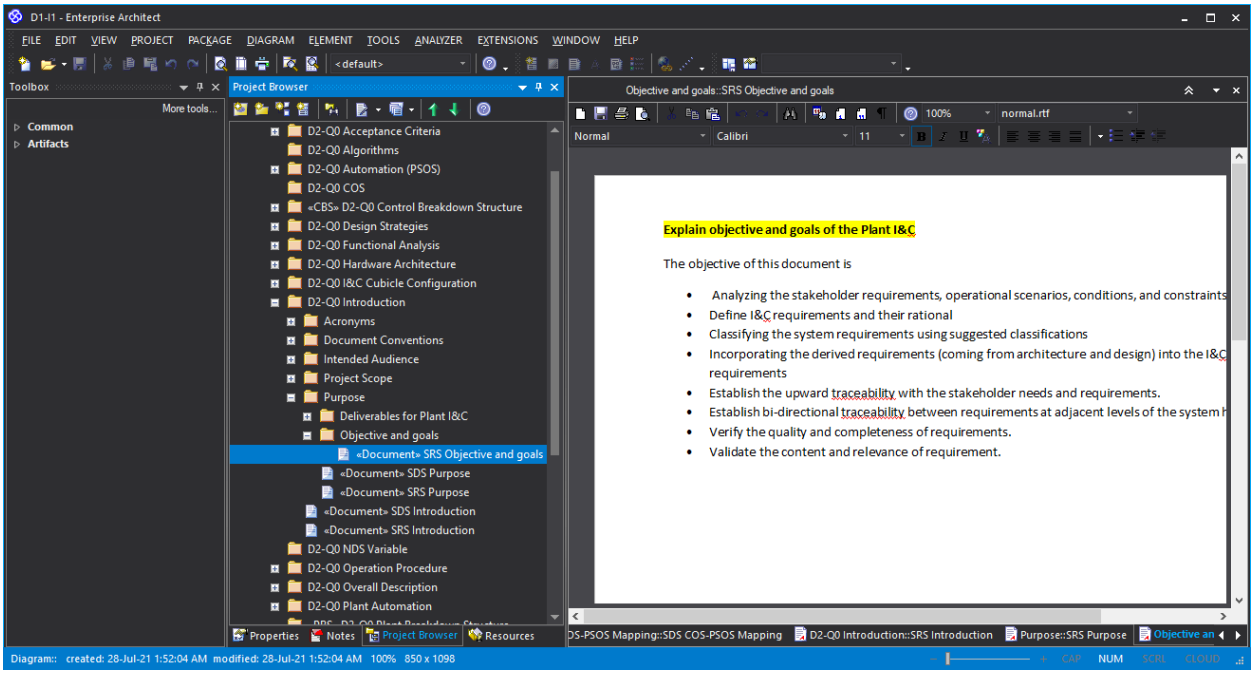


Figure 131: SRS Objective in EA

2.16.1.3 SRS Section – Deliverables for Plant I&C (Section 1.1.2)

This section will describe the Plant I&C deliverables section in SRS document.

1. Add Document Introduction->Purpose->Deliverables for Plant I&C->SRS Deliverables for Plant I&C.
2. Provide Alias – SRS_Deliverables

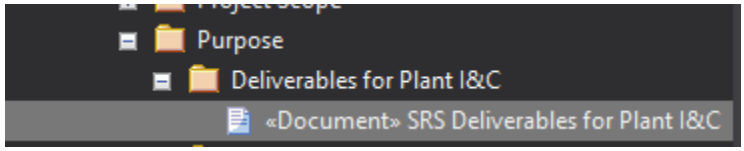


Figure 132: SRS I&C Deliverables in EA Project

3. Open document and provide Project Deliverables

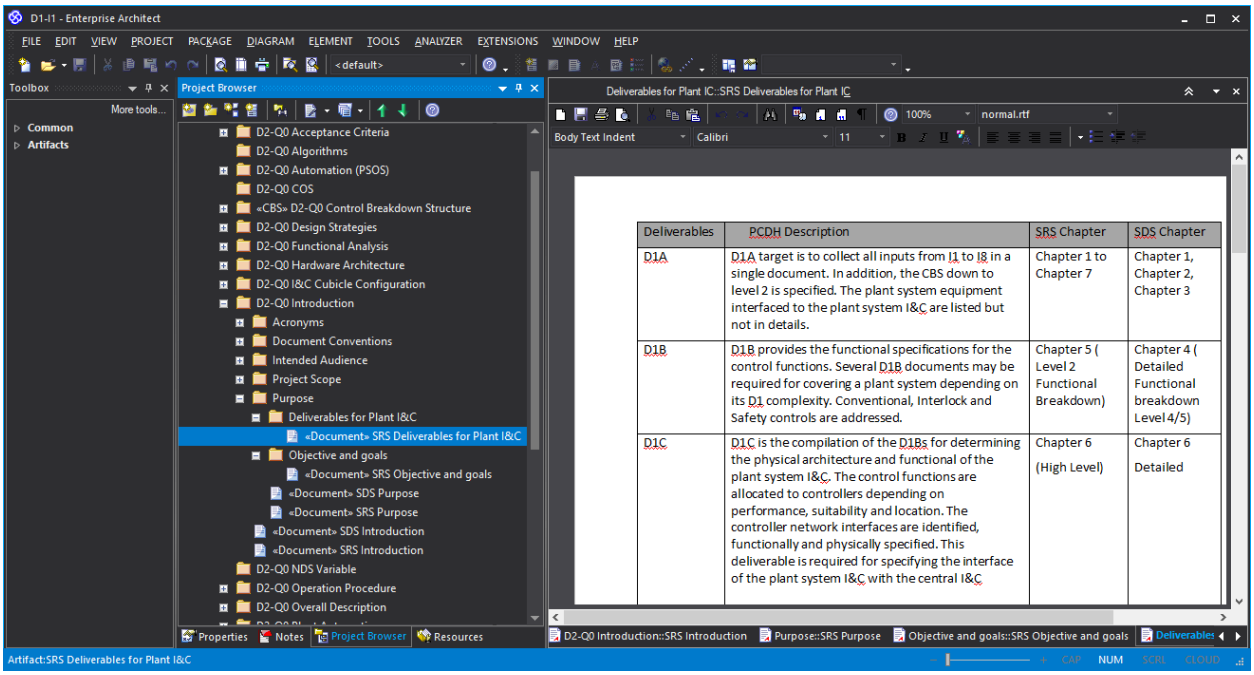


Figure 133: SRS I&C Deliverables in EA

2.16.1.4 SRS Section – Document Convention (Section 1.2)

This section will describe the Document Convention section in SRS document.

1. Add Document Introduction->Document Conventions->SRS Document Conventions.
2. Provide Alias – SRS_Doc_Conv

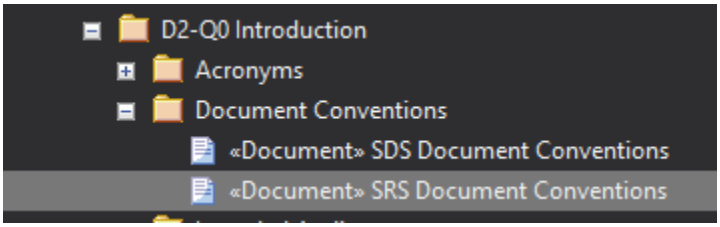


Figure 134: SRS Document Convention in EA Project

3. Open document and provide Document Conventions

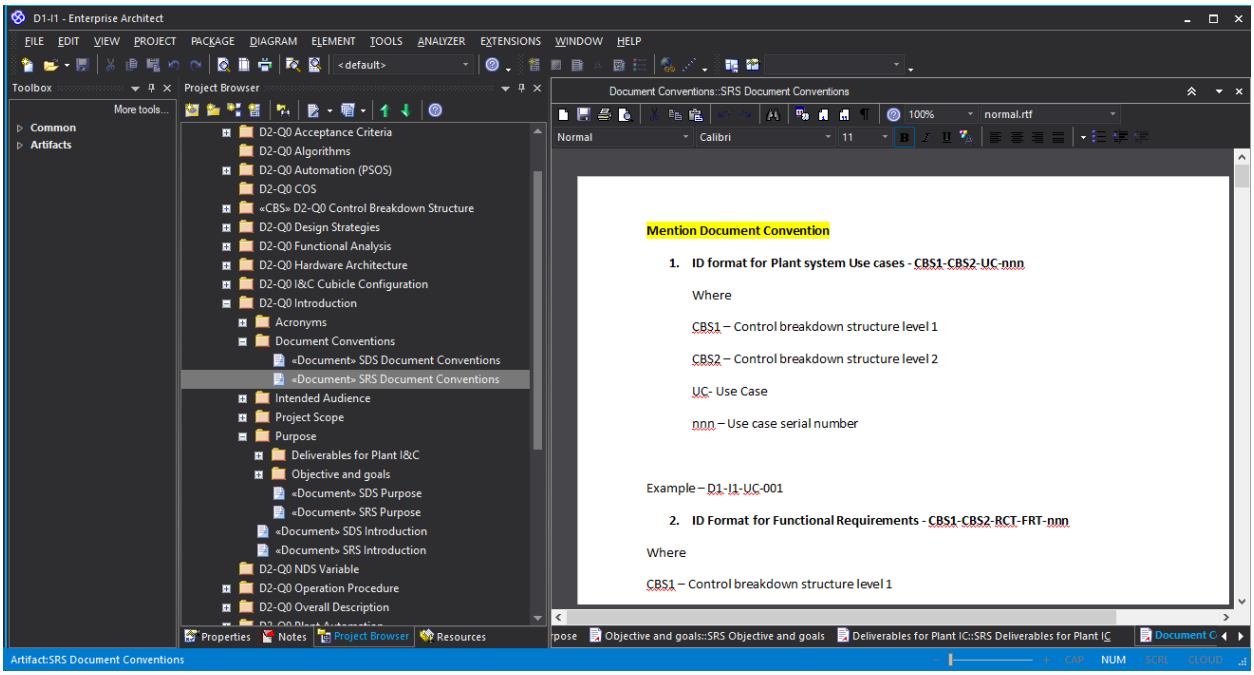


Figure 135: SRS Document Convention in EA

2.16.1.5 SRS Section – Intended Audience (Section 1.3)

This section will describe the Document Convention section in the SRS document.

1. Add Document Introduction->Intended Audience->SRS Intended Audience.
2. Provide Alias – SRS_Audience

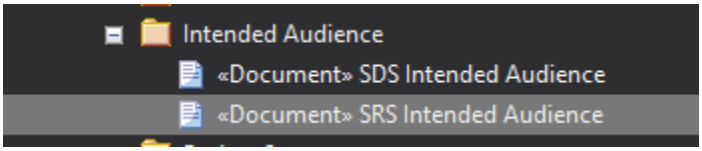


Figure 136: SRS Intended Audience in EA Project

3. Open document and provide intended audience details

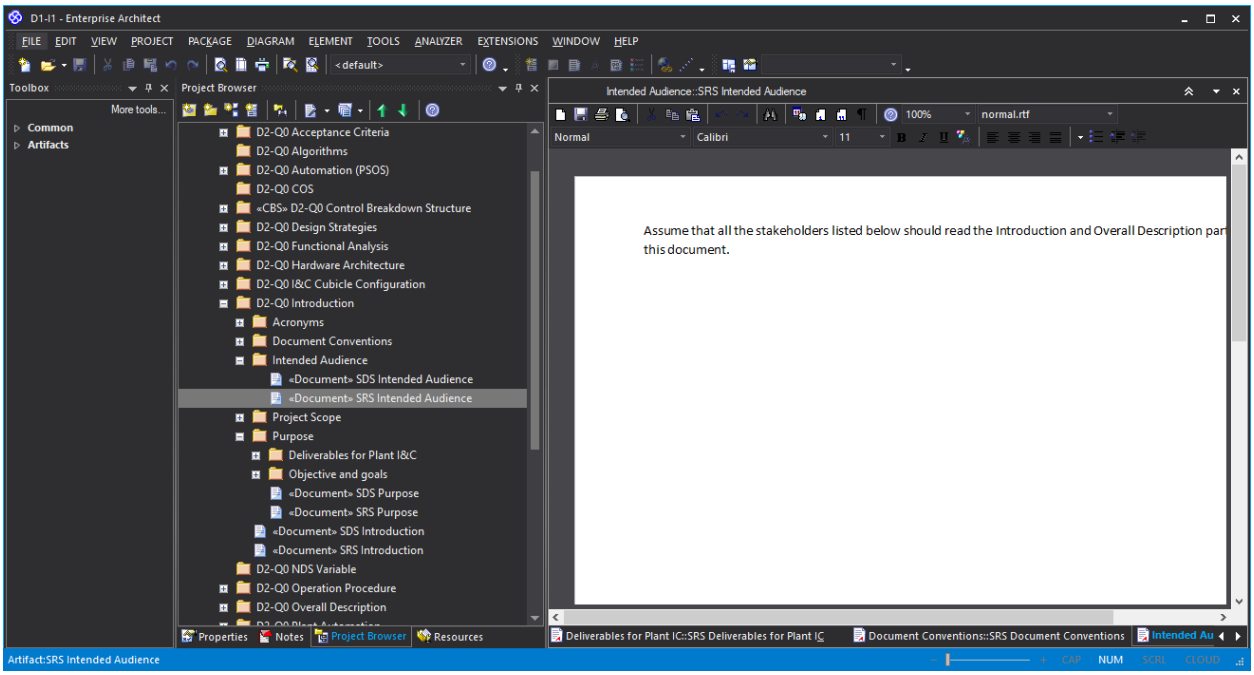


Figure 137: SRS Intended Audience in EA

2.16.1.6 SRS Section – Acronyms (Section 1.4)

This section will describe the Acronyms section in the SRS document.

1. Add Document Introduction->Acronyms->SRS Acronyms.
2. Provide Alias – Acronyms

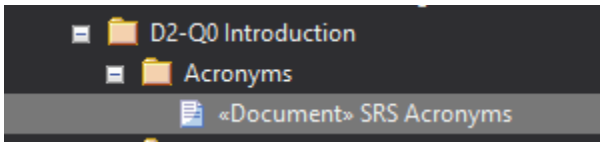


Figure 138: SRS Acronyms in EA Project

3. Open document and provide Acronyms

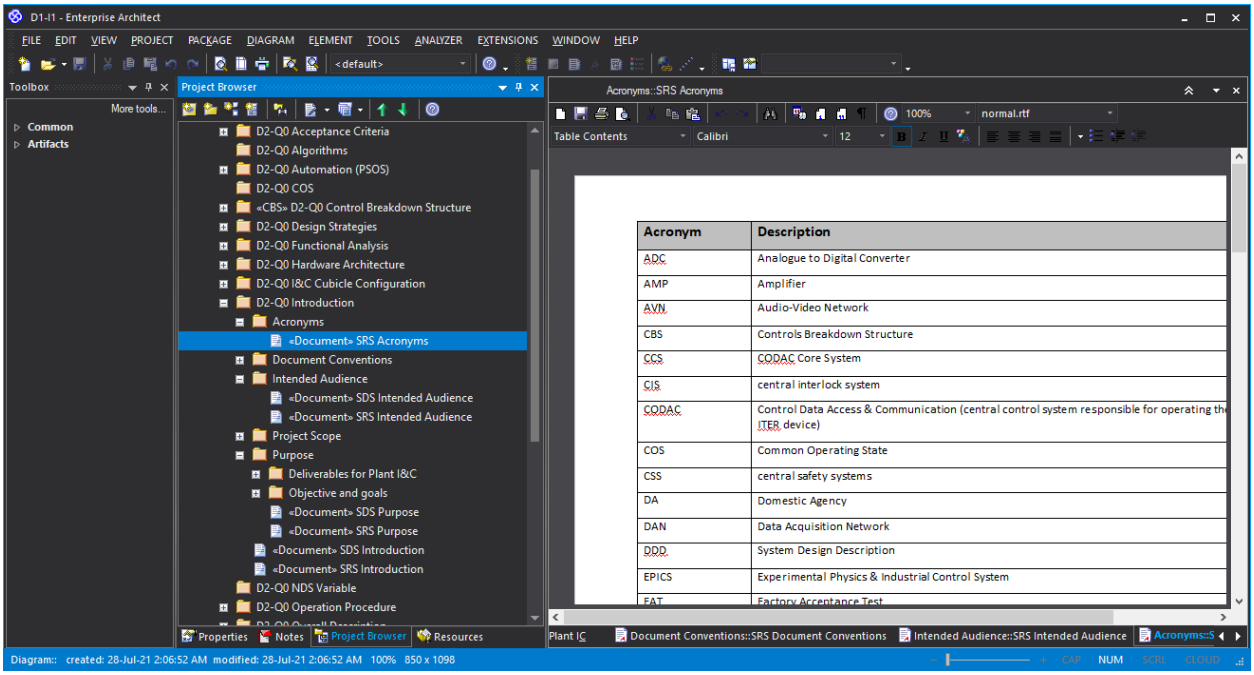


Figure 139: Acronyms in EA

2.16.2 Introduction Chapter – SDS

This section will describe the introduction chapter in the SDS document. The steps to be performed are the same as explained for SRS.

1. SDS Section-Introduction (Section 1 in SDS)
    a. Create document Introduction->SDS Introduction
    b. Alias – SDS_Introduction
2. SDS Section-Purpose (Section 1.1 in SDS).
    a. Create document Introduction->Purpose->SDS Purpose
    b. Alias – SDS_Purpose
3. SDS Section-Document Convention (Section 1.2 in SDS).
    a. Create document Introduction->Document Conventions->SDS Document Conventions
    b. Alias – SDS_Doc_Conv
4. SDS Section-Intended Audience (Section 1.3 in SDS).
    a. Create document Introduction->Intended Audience->SDS Intended Audience
    b. Alias – SDS_Audience
5. SDS Section-Project Scope (Section 1.4 in SDS).
    a. Create document Introduction->Project Scope->SDS Project Scope
    b. Alias – SDS_Scope
6. SDS Section-Acronyms (Section 1.5 in SDS) - For SDS, the same document as for SRS will be used.

2.16.3 Overall Description – SRS Section 2

This section will describe the Overall Description chapter in the SRS document.

1. Add Document Overall Description->System Overview->SRS Overall Description.
2. Provide Alias – SRS_Overall_Desc

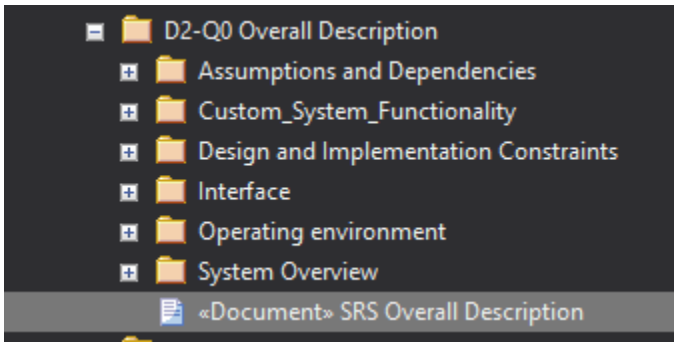


Figure 140: SRS Overall Description in EA Project

3. Open document and provide SRS Overall Description

2.16.3.1 SRS Section – System Overview (Section 2.1)

This section will describe the System Overview section in the SRS document.

1. Add Document System Overview->Locations->SRS System Overview.
2. Provide Alias – SRS_System_Overview
3. Open document and provide System Overview details

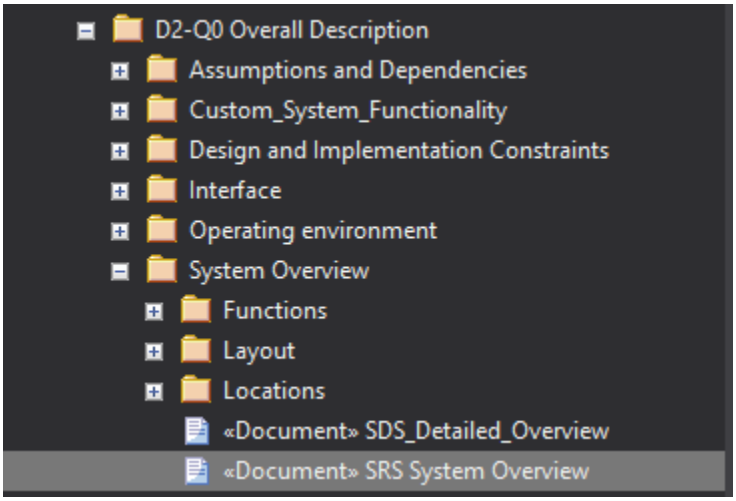


Figure 141: SRS System Overview in EA Project

2.16.3.2 SRS Section – Functions of 55.XX Diagnostics System (Section 2.1.1)

This section will describe the Functions of 55.XX diagnostics system section in SRS document.

1. Add Document System Overview->Functions-> SRS Functions.
2. Provide Alias – SRS_Functions
3. Open document and provide high level function details

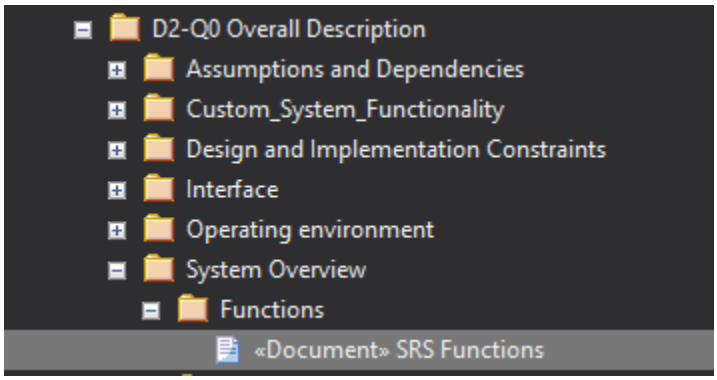


Figure 142: Plant System Functions in EA Project

2.16.3.3 SRS Section – Layout of 55.XX Diagnostics System (Section 2.1.2)

This section will describe the Layout of 55.XX diagnostics system section in SRS document.

1. Add Document System Overview->Layout-> SRS Layout.
2. Provide Alias – SRS_Layout
3. Open document and provide Layout Details

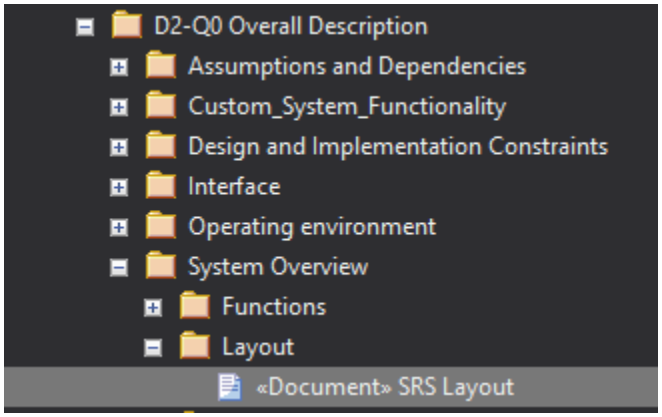


Figure 143: Plant System Layout in EA Project

2.16.3.4 SRS Section – Locations of 55.XX Diagnostics System (SRS Section 2.1.3)

This section will describe the Locations of 55.XX diagnostics system section in the SRS document.

1. Add Document System Overview->Location->SRS Locations.
2. Provide Alias – SRS_Locations
3. Open document and provide Location Details

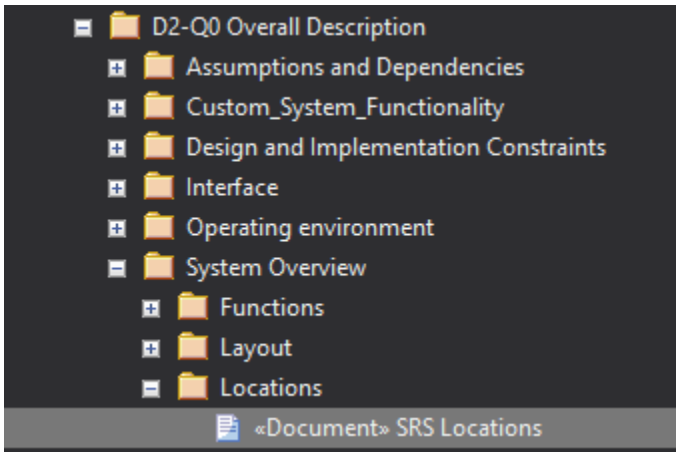


Figure 144: Plant System Locations in EA Project

2.16.3.5 SRS Section – Operating Environment (Section 2.2)

This section will describe the Operating Environment section in the SRS document.

1. Add Document Operating Environment->Modes of Operation->SRS Operating Environment.
2. Provide Alias – SRS_Op_Env
3. Open document and provide Operating Environment details

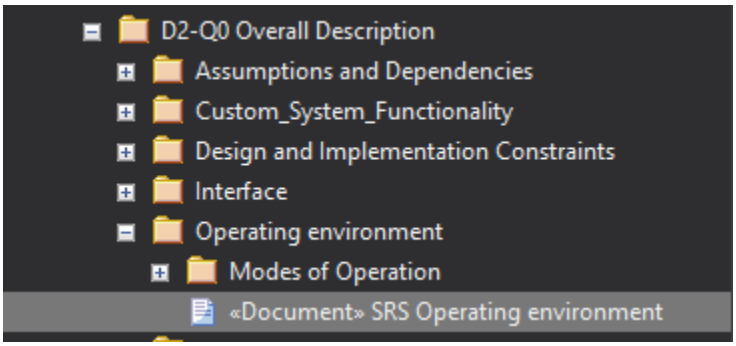


Figure 145: Plant System Operating Environment in EA Project

2.16.3.6 SRS Section – Modes of Operation (Section 2.2.1)

This section will describe the Modes of Operation section in the SRS document.

1. Add Document Operating Environment->Modes of Operation->SRS Modes of Operation.
2. Provide Alias – SRS_Modes_Operation
3. Open document and provide Modes of Operations Details

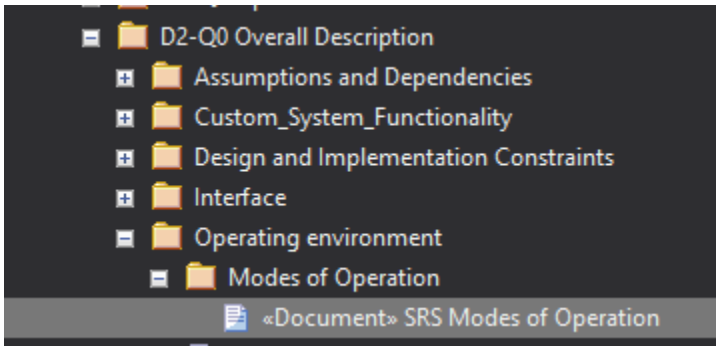


Figure 146: Plant Modes of Operation in EA Project

2.16.3.7 SRS Section – Interface to Other Plant System (Section 2.3)

This section will describe the physical and function Interface to other Plant system section in the SRS document.

1. Add Document Overall Description->Interface->SRS Interface.
2. Provide Alias – SRS_PS_Interfaces
3. Open document and provide physical and functional interface details

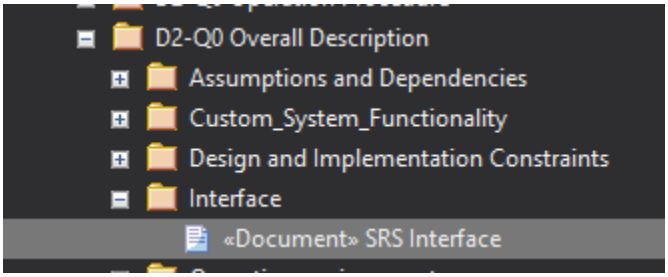


Figure 147: Plant Interfaces in EA Project

2.16.3.8 SRS Section – Design and Implementation Constraints (Section 2.4)

This section will describe the design and implementation constraints section in the SRS document.

1. Add Document Overall Description->Design and Implementation Constraints->SRS Design and Implementation Constraints.
2. Provide Alias – SRS_Design_Constraints
3. Open document and provide details

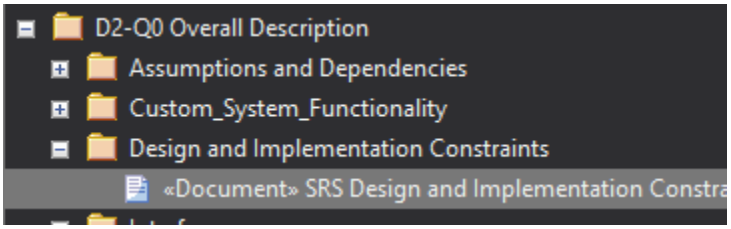


Figure 148: Design and Implementation Constraints in EA Project

2.16.3.9 SRS Section – Assumptions and dependencies (Section 2.5)

This section will describe the Assumptions and dependencies section in the SRS document.

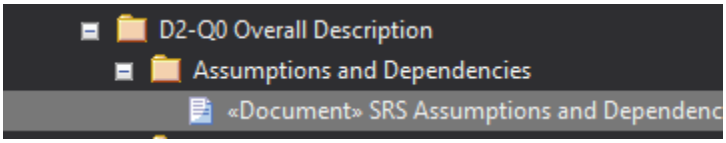
1. Add Document Overall Description->Assumption and Dependencies->SRS Assumption and Dependencies.
2. Provide Alias – SRS_Assump
3. Open document and provide Assumption Details
6. 

Figure 149: SRS Assumptions and Dependencies in EA Project

2.16.4 Design Strategies – SDS section 2

This section will describe the Design Strategies chapter in the SDS document.

1. Add Document CBS1-CBS2 Design Strategies-> SDS Design Strategies.
2. Provide Alias – SDS_Design_Strategies
3. Open document and provide details

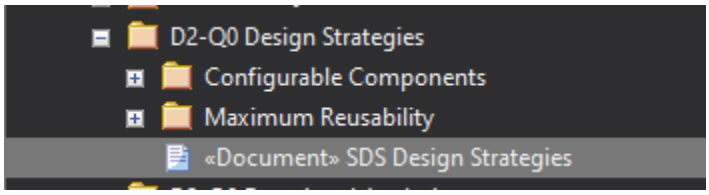


Figure 150: Design Strategies

2.16.4.1 SDS Section – Maximum Reusability (Section 2.1)

This section will describe the Maximum Reusability section in SDS document.

1. Add Document CBS1-CBS2 Design Strategies-> Maximum Reusability-> SDS Maximum Reusability.
2. Provide Alias – SDS_Max_Reuse
3. Open document and provide details

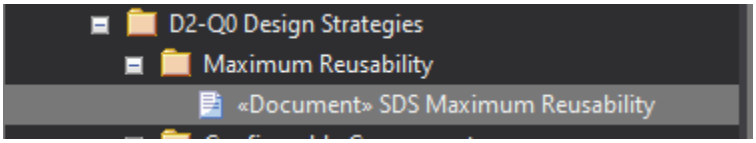


Figure 151: Maximum Reusability

2.16.4.2 SDS Section – Configurable Components (Section 2.2)

This section will describe the Configurable Component section in the SDS document.

1. Add Document CBS1-CBS2 Design Strategies-> Configurable Components-> SDS Configurable Components.
2. Provide Alias – SDS_Confg_Comp
3. Open document and provide details

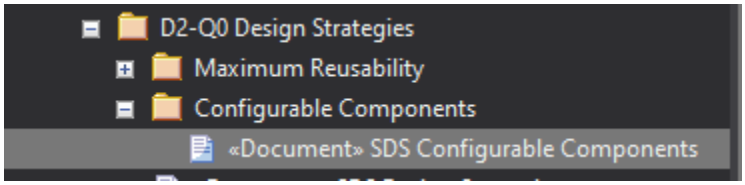


Figure 152: Configurable Components.

2.16.5 SRS Section - Plant I&C Overview (Section 3)

This section will describe the Plant I&C overview section in the SRS document.

1. Add Document Plant I & C Overview-> SRS Plant Overview.
2. Provide Alias – SRS_IC_Overview
3. Open document and provide details.

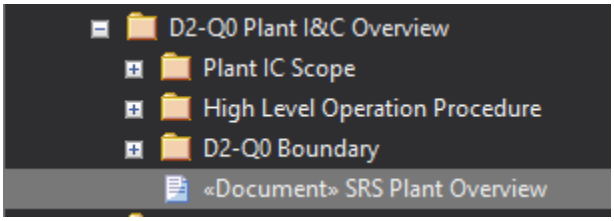


Figure 153: SRS Plant I&C overview in EA Project

2.16.6 Plant I&C Scope (SRS Section 3.1)

This section will describe the Plant I&C Scope section in the SRS document.

1. Add Document Plant I & C Overview->Plant IC Scope->SRS Plant IC Scope.
2. Provide Alias – SRS_IC_Scope
3. Open document and provide I&C Scope for the Project

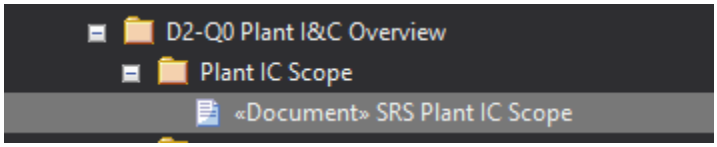


Figure 154: SRS Plant I&C Scope in EA Project

2.16.7 Plant I&C High Level Operation (SRS Section 3.4.1)

This section will describe the Plant I&C high-level operation section in the SRS document.

1. Add Document Plant I & C Overview->High Level Operation Procedure->SRS High Level Operation Procedure.
2. Provide Alias – SRS_High_Level_OP
3. Open document and provide high level operations details

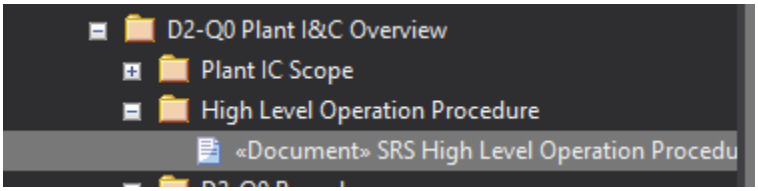


Figure 155: High Level Procedure in EA

2.16.8 Define Custom Chapters in EA

This section will describe how to define custom chapters in EA Project. Custom Chapters can be defined for both SRS and SDS documents. They can be defined under CBS1-CBS2 Overall Description and System Overview folder/package

2.16.8.1 Custom Chapter for SRS

2.16.8.1.1 Define custom chapter under System Overview.

1. Users need to add a Document(s) under System Overview Package/Folder. To add document right click on the package and select add element option.

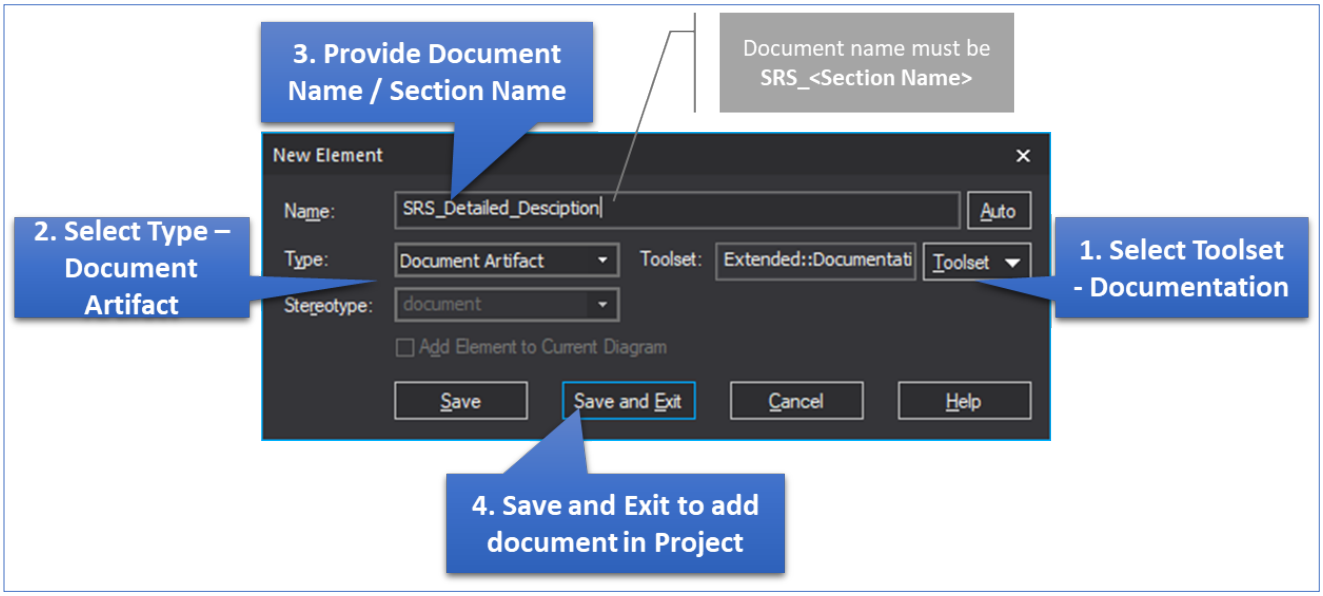
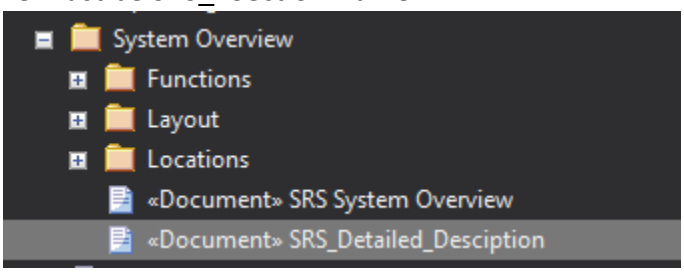


Figure 156: Add Custom Document

2. Document name must be SRS_<Section Name>



3. It requires to define the Alias; it must be same as document name.

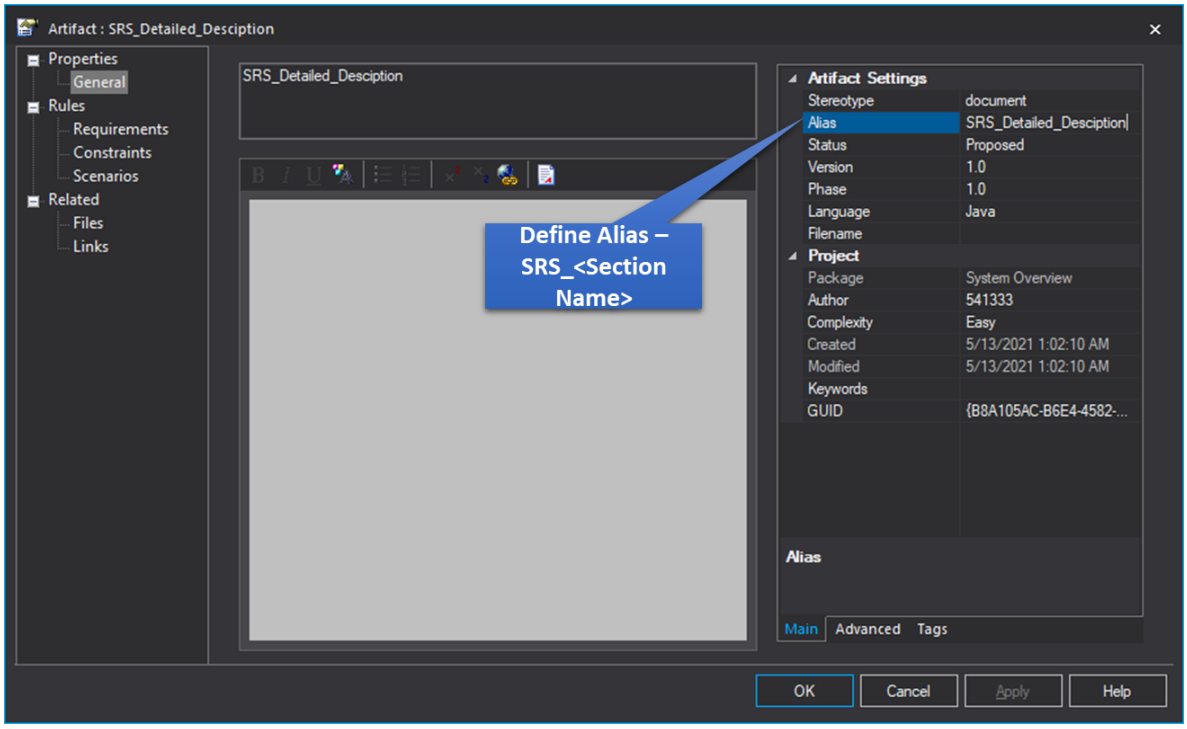


Figure 157: Define Alias for the document

4. Describe the custom section in created document.

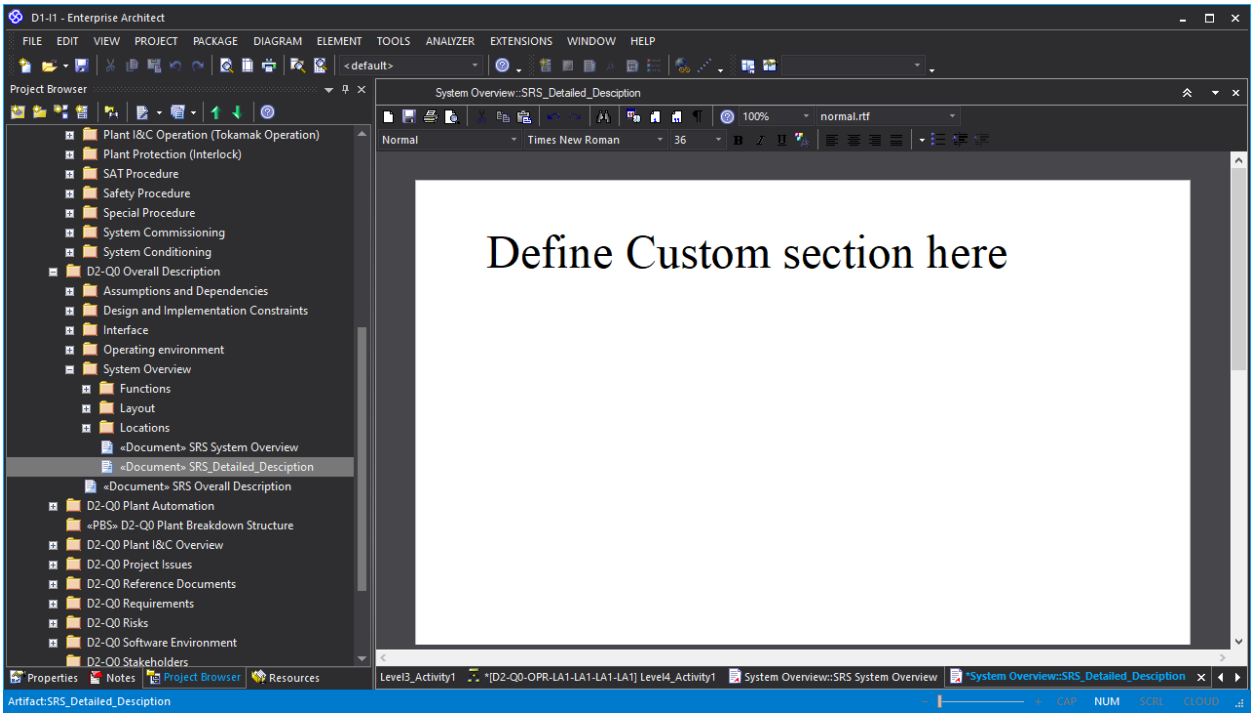
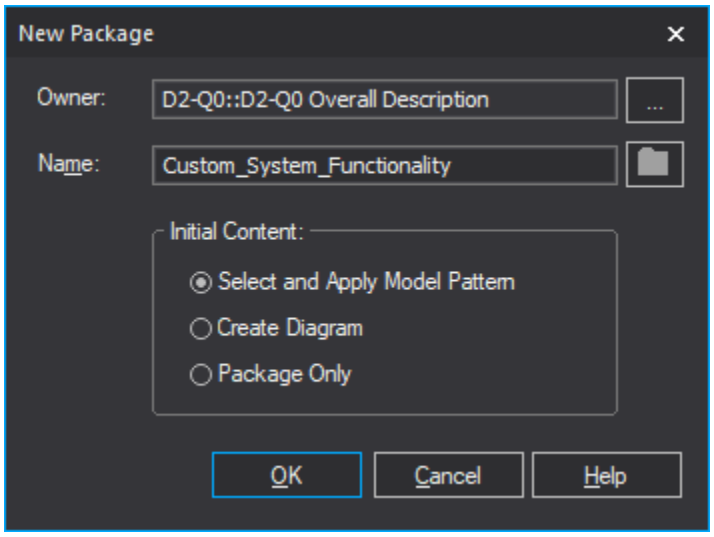


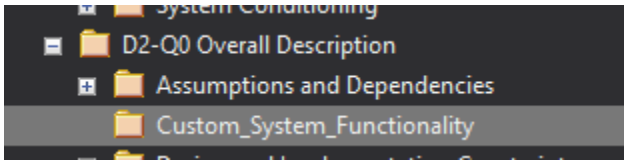
Figure 158: Describe custom section for SRS Document.

2.16.8.1.2 Define Custom Chapter under Overall Description.

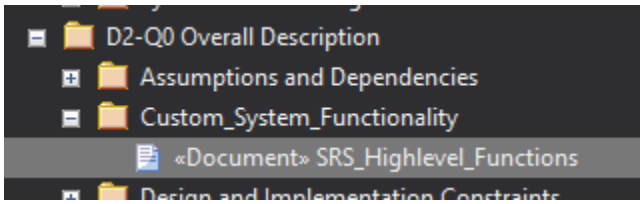
1. It required to add new Package / folder under Overall Description package/folder. The naming format must be “Custom_<Package_Name>” e.g., Custom_ System_Functionality



2. Click on OK to add custom package



3. Follow the steps defined in section 2.16.8.1.1 to custom SRS Chapter.



2.16.8.2 Custom Chapter for SDS

2.16.8.2.1 Define custom chapter under System Overview.

1. Users need to add a Document(s) under System Overview Package/Folder. To add document right click on the package and select add element option.

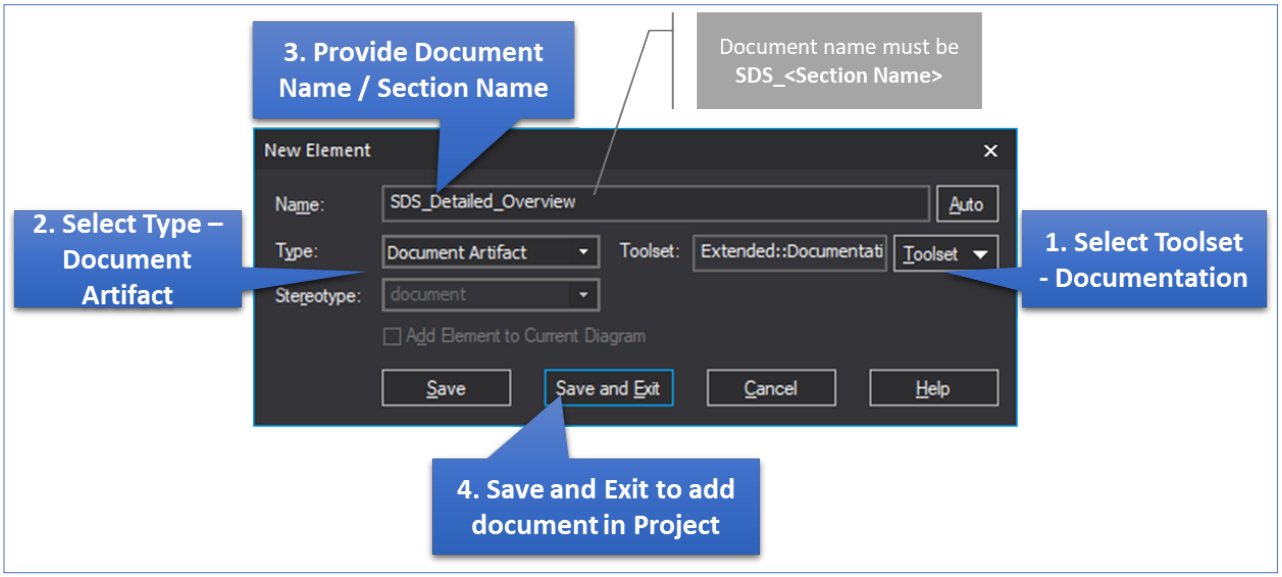
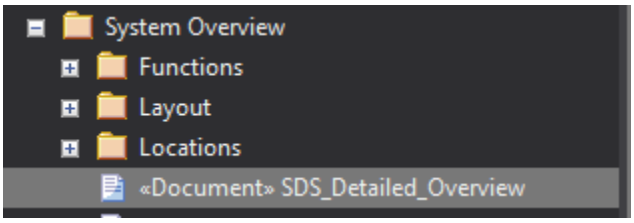


Figure 159: Add Custom Document

2. Document name must be SDS_<Section Name>



3. It requires to define the Alias; it must be same as document name.

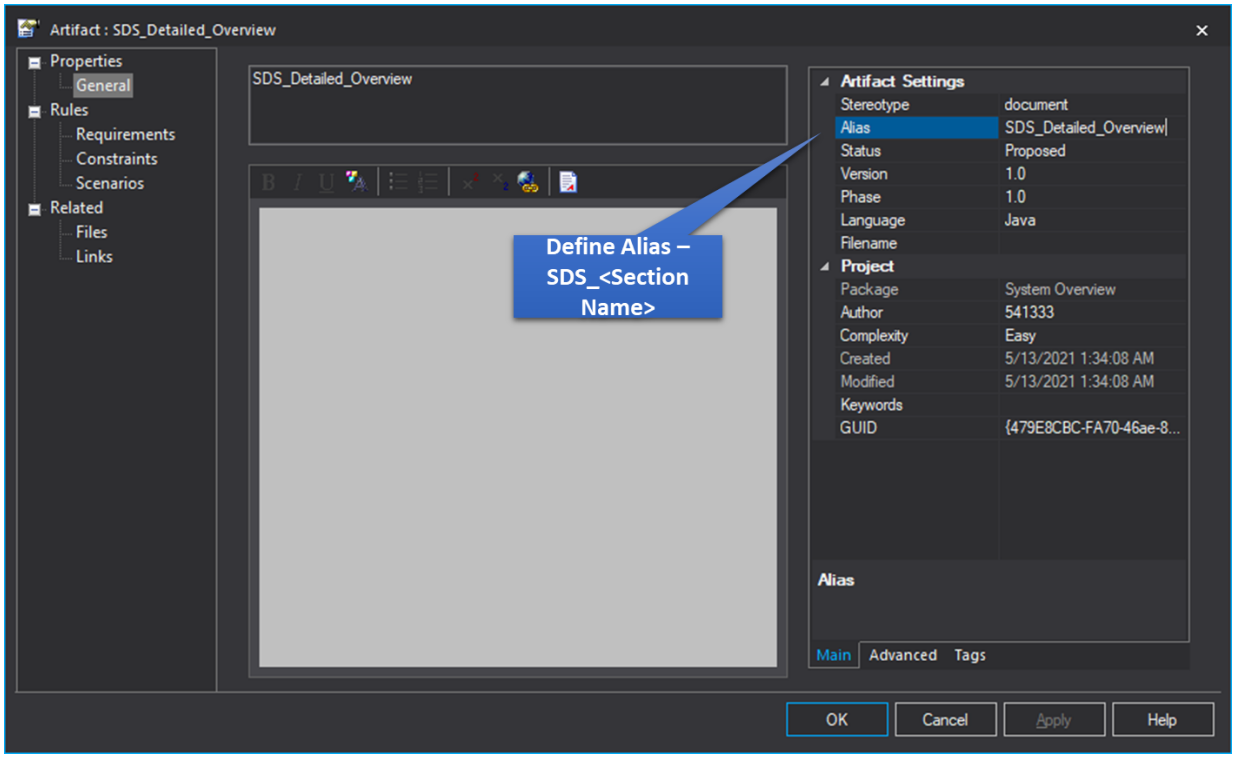


Figure 160: Define Alias for the document

4. Describe the custom section in created document.

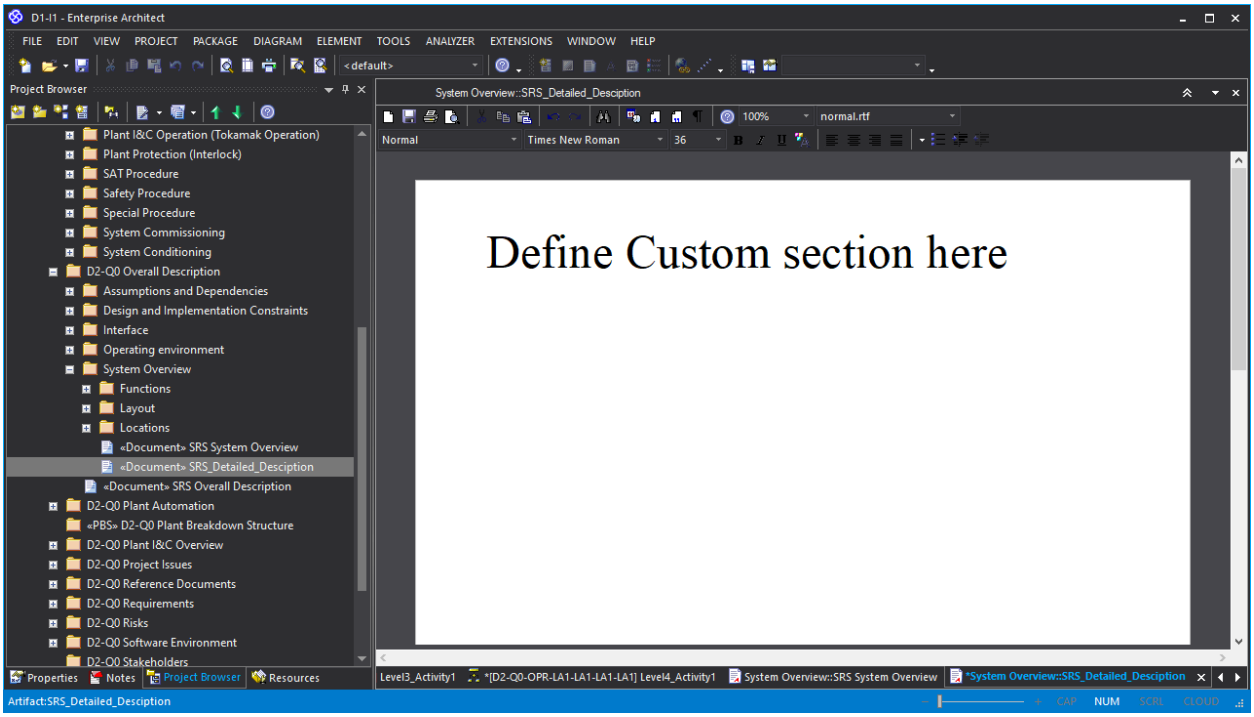
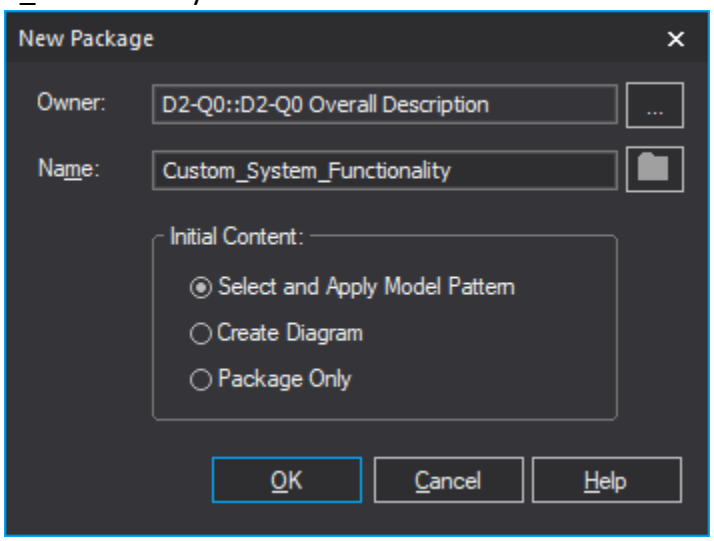


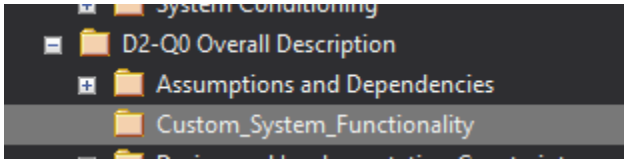
Figure 161: Describe custom section for SDS Document.

2.16.8.2.2 Define Custom Chapter under Overall Description.

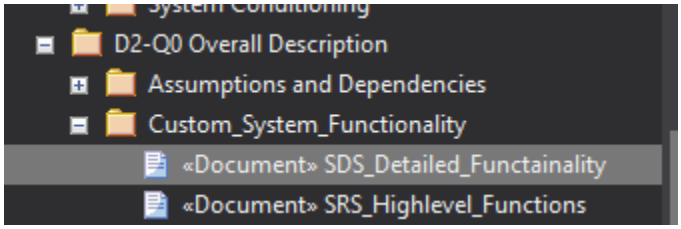
1. It required to add new Package / folder under Overall Description package/folder. The naming format must be "Custom_<Package_Name>" e.g., Custom_ System_Functionality



2. Click on OK to add custom package



3. Follow the steps defined in section 2.16.8.2.1 to custom SDS Chapter.



2.16.9 Project Issues

This section will describe the Project issue section in the SRS/SDS document. SRS section 8 and SDS section 11.

1. Add Document CBS1-CBS2 Project Issues-> Project Issues.
2. Provide Alias – Issues
3. Open document and provide Issues for the Project

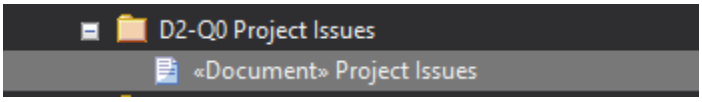


Figure 162: Project issues in EA Project

4. It required to define Project issues in following format

Issues	**Description**
Off-the-Shelf-Solutions	
Ready-made products	
Products that can be copied	
Reusable components	
New Problems	
Effects on current environment	
Effects on the installed systems	
Potentials user problems	
Limitations in the anticipated implementation environment that may inhibit the new product	
Follow-up problems	
Tasks	
Migration to the new product	
Requirements for migration to the new product	
Data that must be modified or translated for the new system	
Upgrade tools and procedures	

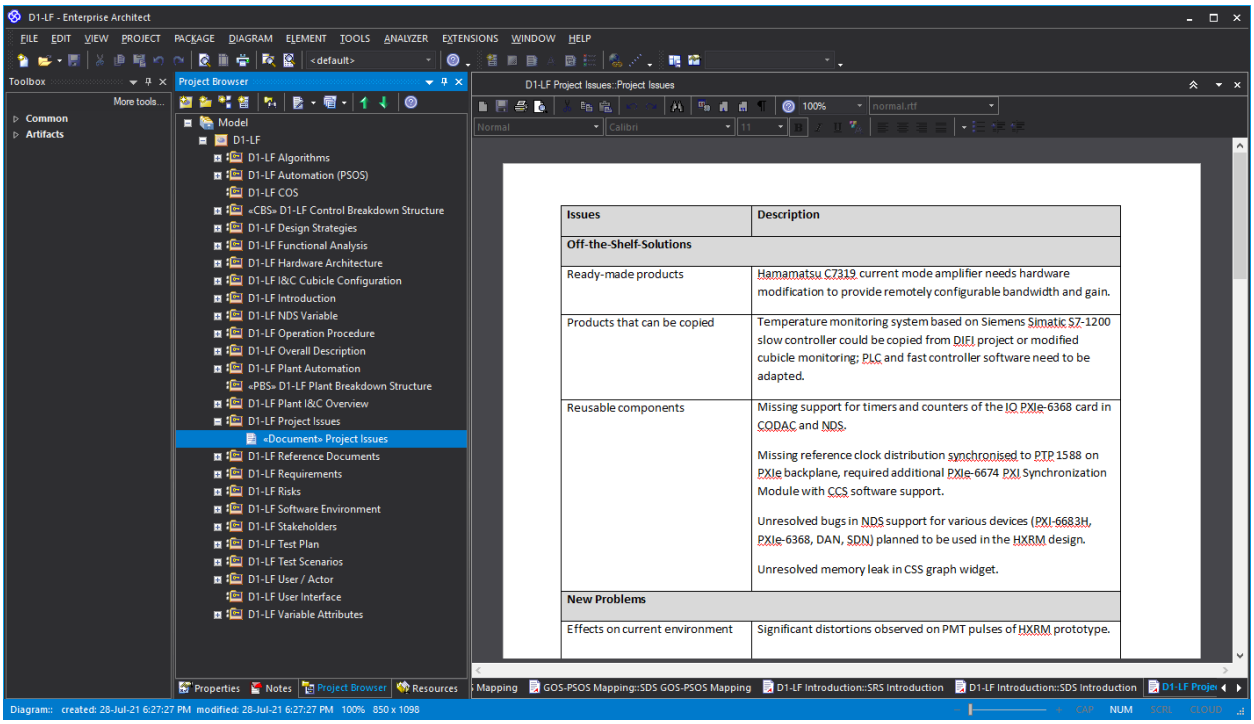


Figure 163: Project issues in EA

2.16.10 Risks

This section will describe the Project Risk section in the SRS/SDS document. SRS section 9 and SDS section 12.

1. Add Document CBS1-CBS2 Risks-> Risks.
2. Provide Alias – Risk
3. Open document and provide Risk for the Project

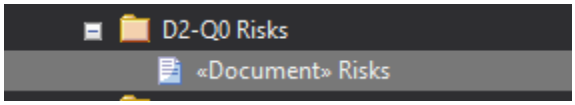


Figure 164: Risk in EA Project

4. It required to define Risks in following format

Ref ID	Risk	Likelihood	Severity	Mitigation
CBS1-CBS2-RK-001	Break of vacuum leak tightness	Low	High	Interspace vacuum monitoring

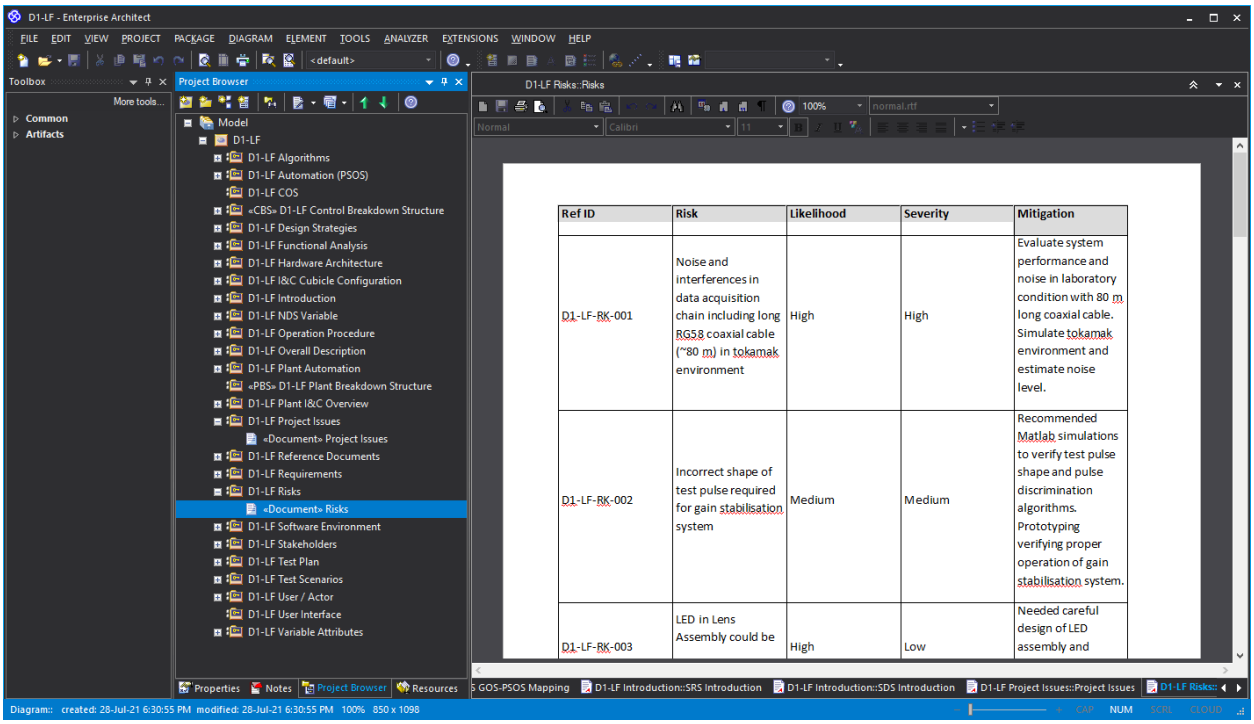


Figure 165: Risks in EA

2.16.11 I&C Cubicle Configuration (SDS section 9)

This section describes how to define I&C cubicle configuration in EA Project

1. Add Document CBS1-CBS2 I&C Cubicle Configuration-> SDS I&C Cubicle Configuration.
2. Provide Alias – SDS_Cubicle_Config
3. Open document and provide I&C Cubicle Configuration details for the Project

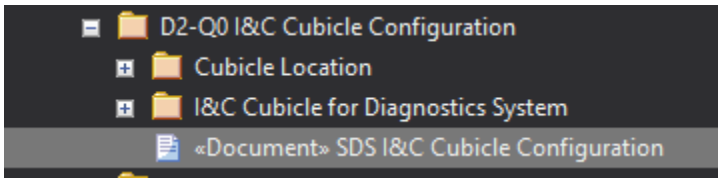


Figure 166: I&C Cubicle Configuration in EA Project

2.16.11.1 Cubicle Location (SDS section 9.2)

This section describes how to define I&C cubicle configuration in EA Project

1. Add Document CBS1-CBS2 I&C Cubicle Configuration-> Cubicle Location -> SDS Cubicle Location.
2. Provide Alias – SDS_Cubicle_Location
3. Open document and provide I&C Cubicle Location details for the Project

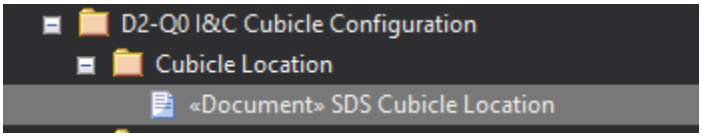


Figure 167: I&C Cubicle Location in EA Project

2.16.11.2 I&C Cubicle for Diagnostics System (SDS section 9.1)

This section describes how to define I&C cubicle for diagnostics system in EA Project

1. Add Document CBS1-CBS2 I&C Cubicle Configuration-> I&C Cubicle for Diagnostics System-> SDS I&C Cubicle for Diagnostics System.
2. Provide Alias – SDS_IC_Cubicle
3. Open document and provide I&C Cubicle details for the Project

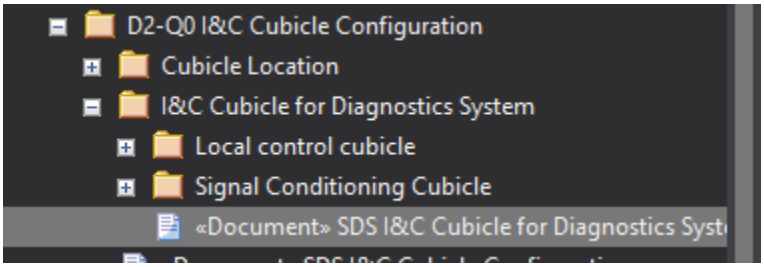


Figure 168: I&C Cubicle Details in EA Project

2.16.11.3 Local Control Cubicle (SDS section 9.1.1)

This section describes how to define Local Control cubicle for diagnostics system in EA Project

1. Add Document CBS1-CBS2 I&C Cubicle Configuration-> I&C Cubicle for Diagnostics System->Local Control Cubicle-> SDS Local Control Cubicle.
2. Provide Alias – SDS_LCC
3. Open document and provide LCC Cubicle details for the Project

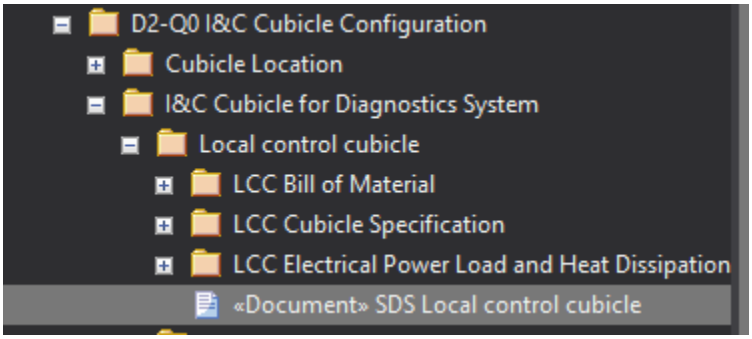


Figure 169: LCC Cubicle Details in EA Project

2.16.11.4 LCC Bill of Material (SDS section 9.1.1.3)

This section describes how to define LCC BOM in EA Project

1. Add Document CBS1-CBS2 I&C Cubicle Configuration-> I&C Cubicle for Diagnostics System->Local Control Cubicle-> LCC Bill of Material -> SDS LCC Bill of Material.
2. Provide Alias – SDS_LCC_BOM
3. Open document and provide LCC BOM details for the Project

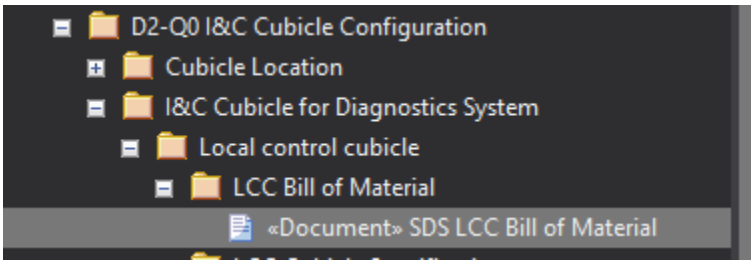


Figure 170: LCC Cubicle Details in EA Project

2.16.11.5 LCC Cubicle Specification (SDS section 9.1.1.1)

This section describes how to define LCC Cubicle Specification in EA Project

1. Add Document CBS1-CBS2 I&C Cubicle Configuration-> I&C Cubicle for Diagnostics System->Local Control Cubicle-> LCC Cubicle Specification-> SDS LCC Cubicle Specification.
2. Provide Alias – SDS_LCC_Spec
3. Open document and provide LCC Cubicle Specification details for the Project

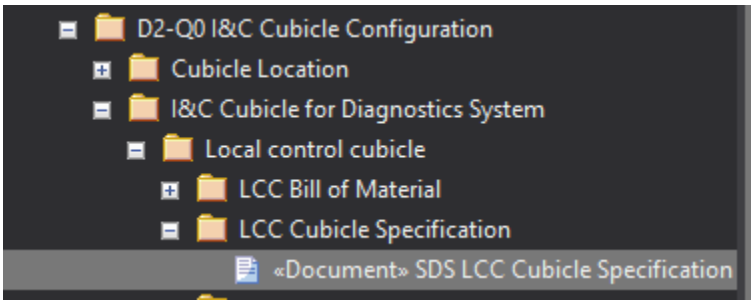


Figure 171: LCC Cubicle Specification Details in EA Project

2.16.11.6 LCC Electrical Power Load and Heat Dissipation (SDS section 9.1.1.2)

This section describes how to define LCC Electrical Power Load and Heat Dissipation in EA Project

1. Add Document CBS1-CBS2 I&C Cubicle Configuration-> I&C Cubicle for Diagnostics System->Local Control Cubicle-> LCC Electrical Power Load and Heat Dissipation-> SDS Electrical Power Load and Heat Dissipation.
2. Provide Alias – SDS_LCC_Power
3. Open document and provide LCC Electrical Power Load and Heat Dissipation details for the Project

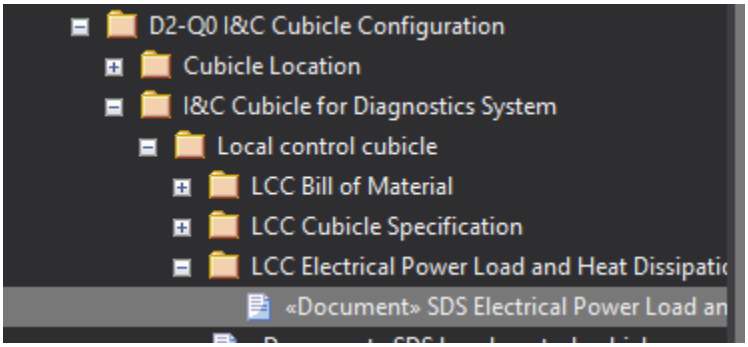


Figure 172: LCC Electrical Power Load and Heat Dissipation Details in EA Project

2.16.11.7 Signal Conditioning Cubicle (SDS section 9.1.2)

This section describes how to define Local Control cubicle for diagnostics system in EA Project

1. Add Document CBS1-CBS2 I&C Cubicle Configuration-> I&C Cubicle for Diagnostics System-> Signal Conditioning Cubicle-> SDS Signal Conditioning Cubicle.
2. Provide Alias – SDS_SCC
3. Open document and provide SCC Cubicle details for the Project

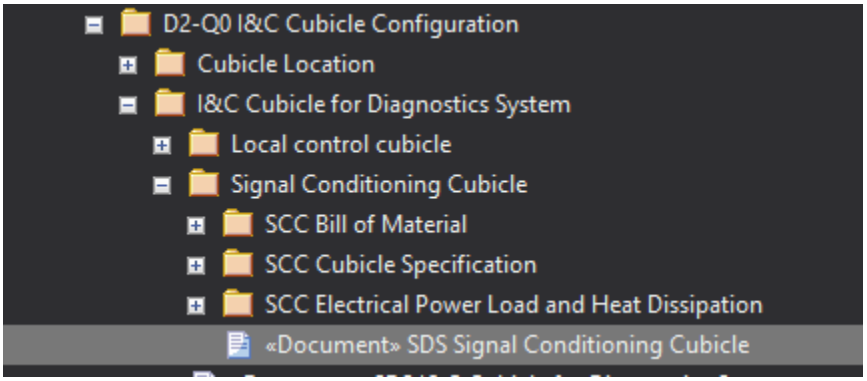


Figure 173: SCC Cubicle Details in EA Project

2.16.11.8 SCC Bill of Material (SDS section 9.1.2.3)

This section describes how to define SCC BOM in EA Project

1. Add Document CBS1-CBS2 I&C Cubicle Configuration-> I&C Cubicle for Diagnostics System->Local Control Cubicle-> SCC Bill of Material -> SDS SCC Bill of Material.
2. Provide Alias – SDS_SCC_BOM
3. Open document and provide SCC BOM details for the Project

2.16.11.9 SCC Cubicle Specification (SDS section 9.1.2.1)

This section describes how to define SCC Cubicle Specification in EA Project

1. Add Document CBS1-CBS2 I&C Cubicle Configuration-> I&C Cubicle for Diagnostics System->Local Control Cubicle-> SCC Cubicle Specification-> SDS SCC Cubicle Specification.
2. Provide Alias – SDS_SCC_Spec
3. Open document and provide SCC Cubicle Specification details for the Project

2.16.11.10 SCC Electrical Power Load and Heat Dissipation (SDS section 9.1.2.2)

This section describes how to define SCC Electrical Power Load and Heat Dissipation in EA Project

1. Add Document CBS1-CBS2 I&C Cubicle Configuration-> I&C Cubicle for Diagnostics System->Local Control Cubicle-> SCC Electrical Power Load and Heat Dissipation-> SDS Electrical Power Load and Heat Dissipation.
2. Provide Alias – SDS_SCC_Power
3. Open document and provide SCC Electrical Power Load and Heat Dissipation details for the Project

2.16.12 Algorithms

This Section Describes how to define Algorithms in EA

Cerate Package CBS1-CBS2 Algorithms in EA Project

To Add Algorithm for a Function: Create Package <Function Name> Under CBS1-CBS2 Algorithm Package

2.16.12.1 Add Algorithm Description

1. Add Document under Function Package. Provide Alias - – **SDS_whateverThePackageNameIncludingSpaces_Algorithms**

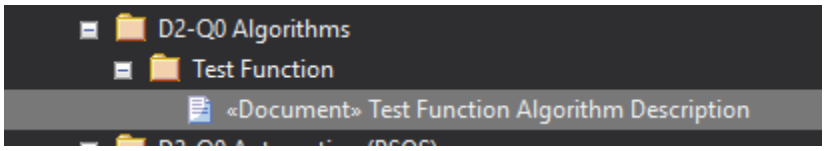


Figure 174: Algorithm Description

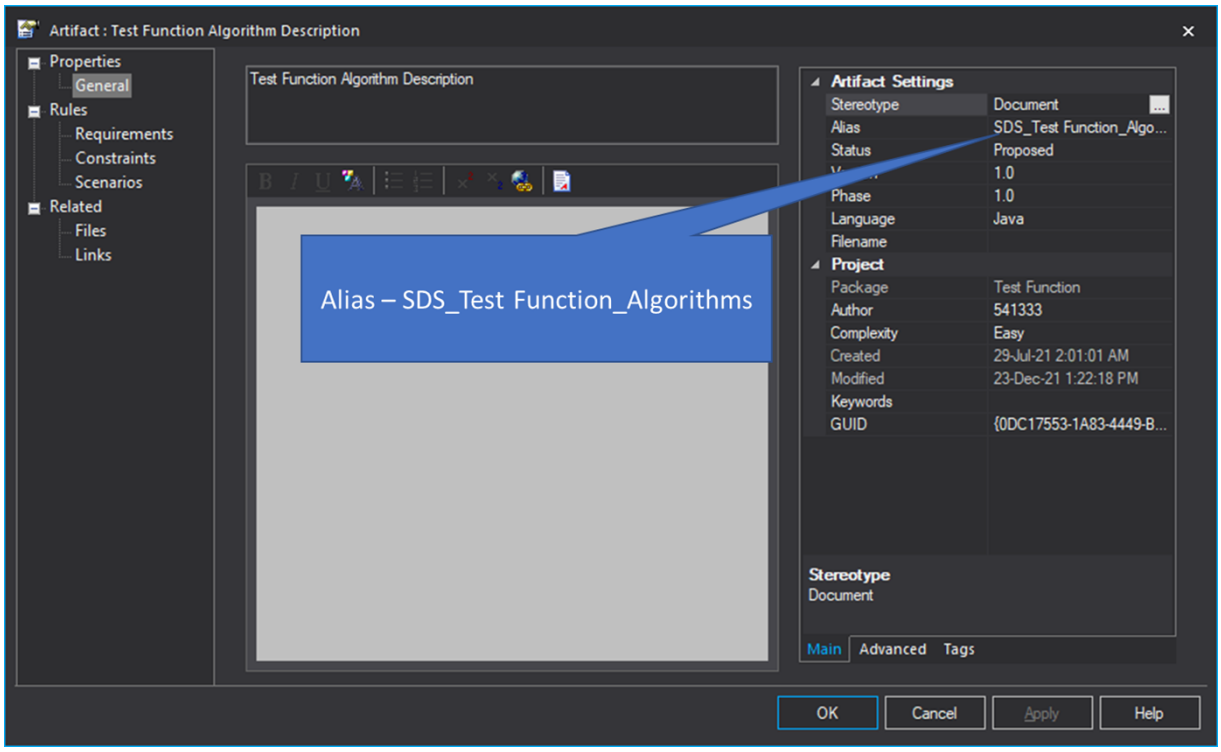


Figure 175: Alias Example

2. Open document and provide Algorithm Description

2.16.12.2 Add Algorithm Flow Chart

1. Add Activity Diagram to define Flow Chart
2. Provide Stereotype – Flow_Chart

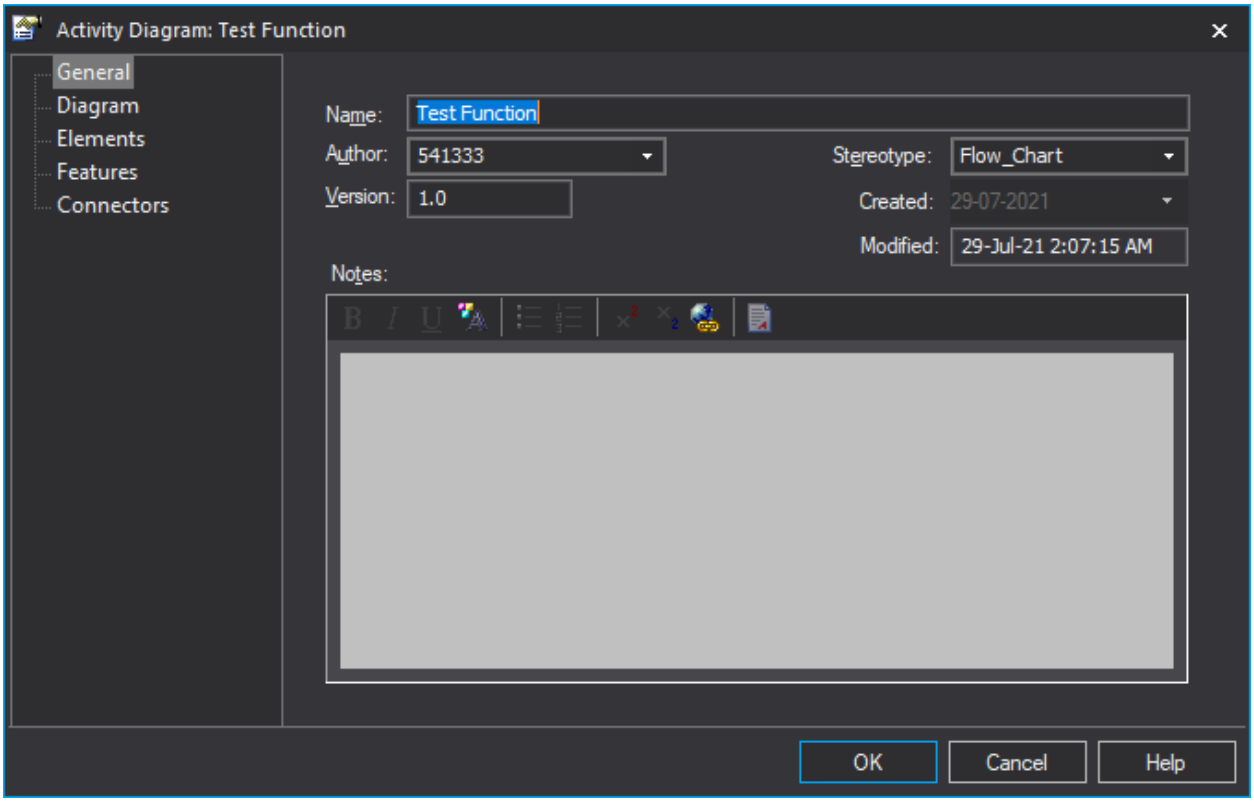


Figure 176: Activity Diagram to define Flow Chart

3. Open Diagram to describe algorithm in flow chart

2.16.12.3 Add Algorithm Sequence Diagram

1. Add Sequence Diagram to define Algorithm Sequence
2. Provide Stereotype – Sequence

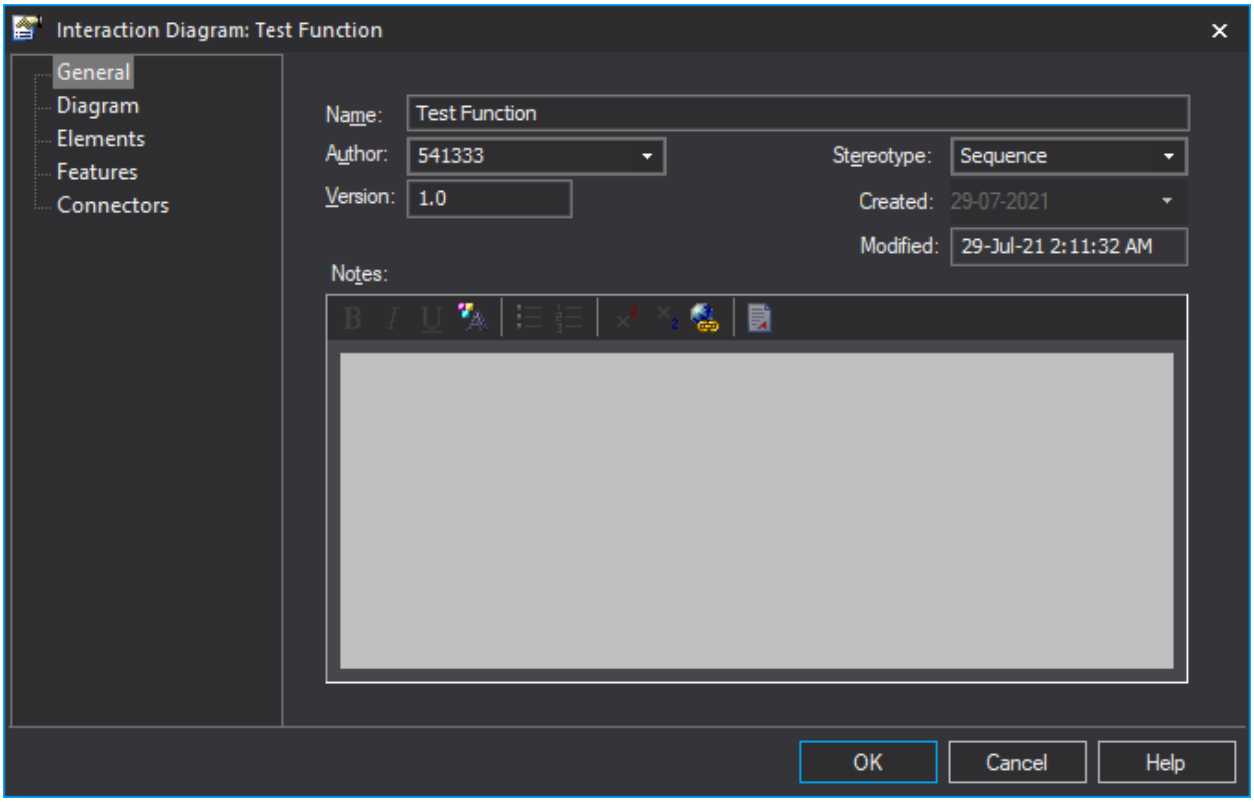


Figure 177: Sequence Diagram to define Algorithm

3. Open Diagram to describe algorithm in Sequence Diagram

2.16.12.4 Add Algorithm Timing Diagram

1. Add Timing Diagram to define Algorithm Sequence
2. Provide Stereotype – Timing

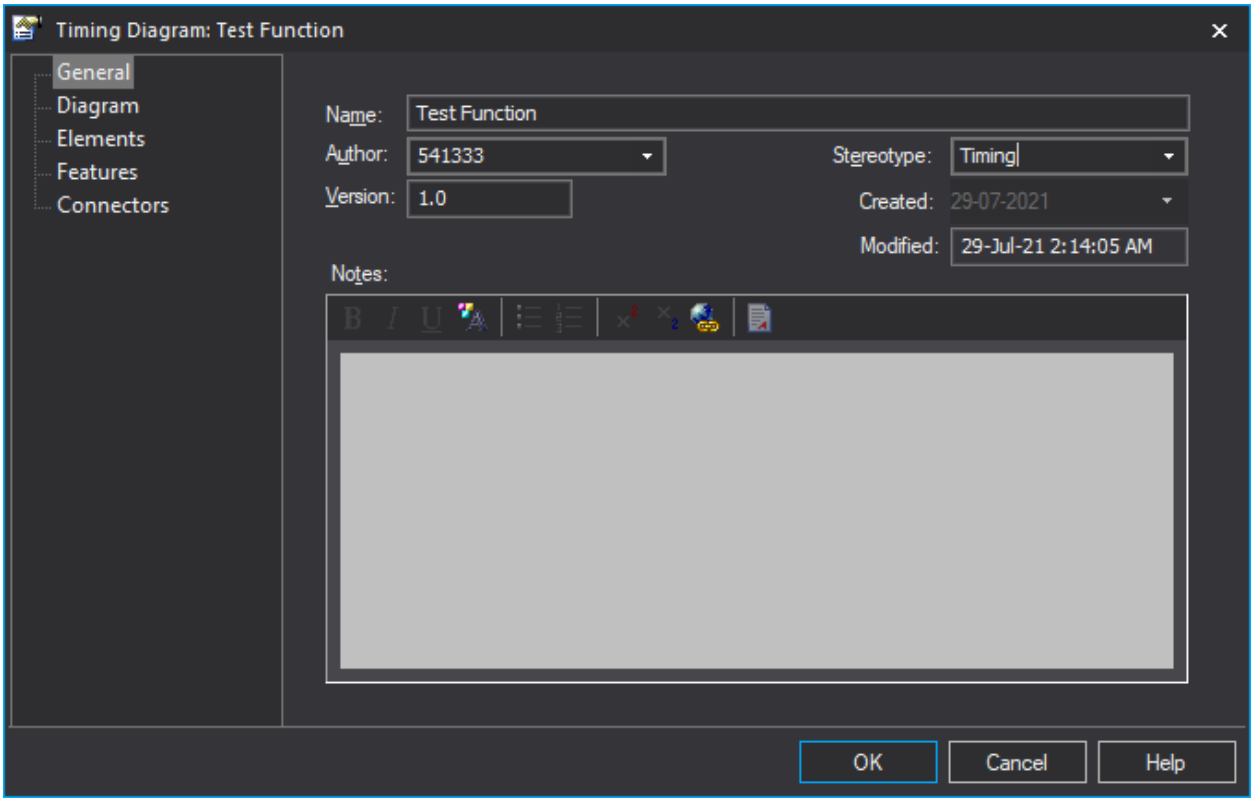


Figure 178: Timing Diagram to define Algorithm

3. Open Diagram to describe algorithm in Timing Diagram

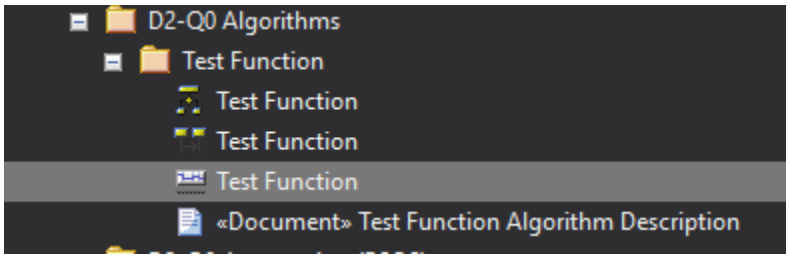


Figure 179: Algorithms in EA Project

Follow above steps to define Algorithms for multiple functions in EA Project.

2.16.13 Test Scenarios (SDS section 10)

This section describes how to define Test Scenarios in EA Project

1. Add Document CBS1-CBS2 Test Scenarios-> Test Scenarios.
2. Provide Alias – Test_Scenarios
3. Open document and provide Test Scenarios details for the Project

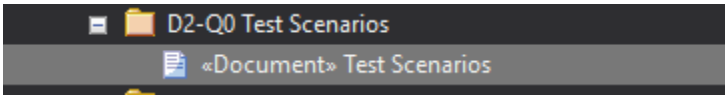


Figure 180: Test Scenarios in EA Project

4. Test Scenarios need to be defined in following format

Test Scenario Name	<Test Scenario Name>
ID	
Description	
Flow	
Validation criteria	

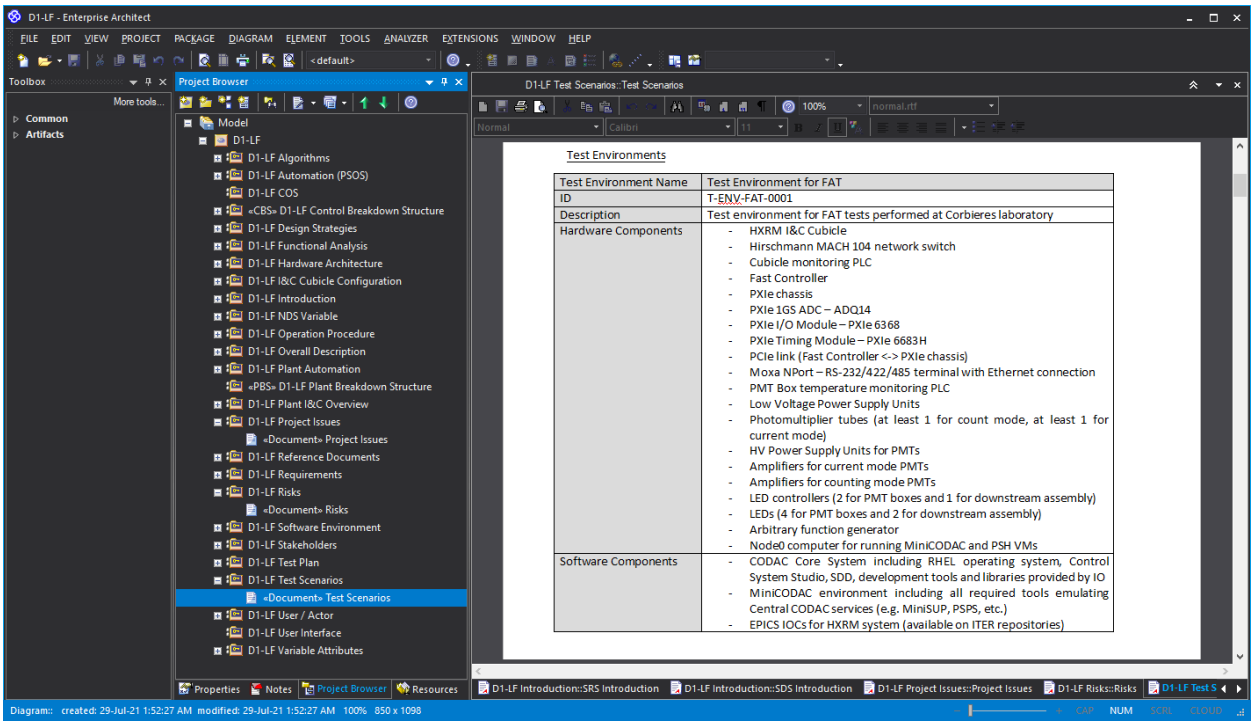


Figure 181: Test Scenario Example in EA

2.17 Acceptance Criteria

This section describes how to define Acceptance Criteria in EA Project

1. Create Package CBS1-CBS2 Acceptance Criteria (e.g., D2-Q0 Acceptance Criteria)
2. To define acceptance criteria, right click on package CBS1-CBS2 Acceptance, and select add Element .
3. Provide details as shown in below diagram. In the name field, the ID of the acceptance criteria needs to be provided. Name can be added optionally. Refer [RD7]. Stereotype to be provided is “acceptance”. Toolset should be selected as Object.

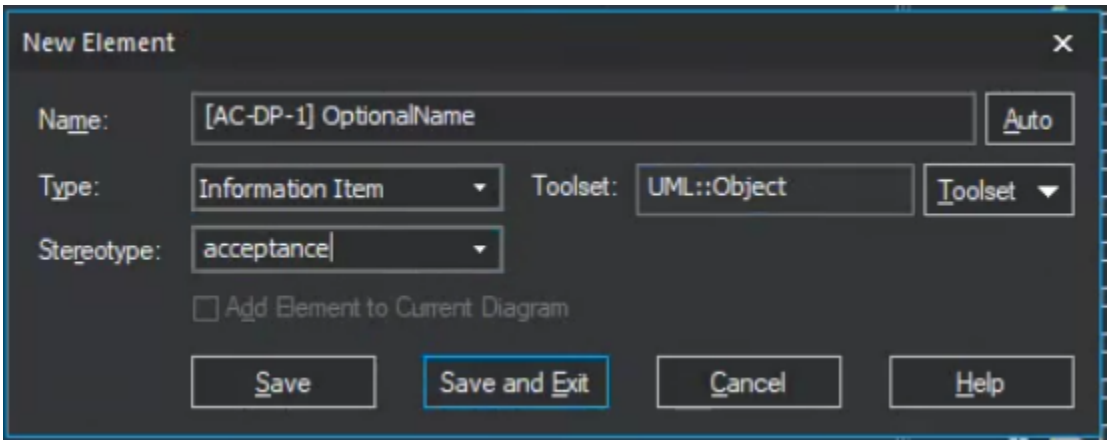


Figure 182: Add Acceptance Criteria

4. Click Save and Exit, to add acceptance criteria in EA Project.
5. Open Properties of Acceptance Criteria and provide description and tag values for the acceptance criteria. If the applicability is No, then the justification must be provided in the Notes tag (memo).

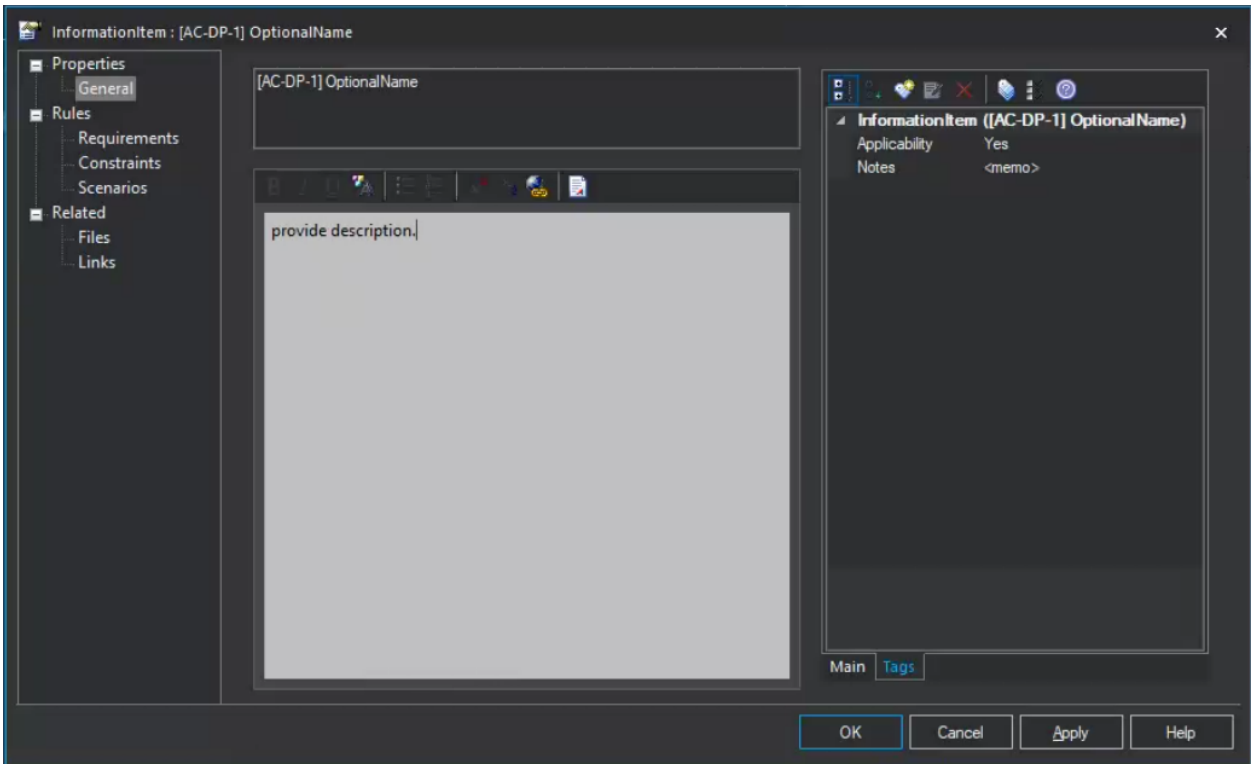


Figure 183: Acceptance Criteria Description and Tags

6. Also, add the ID of the acceptance criteria in the Alias field as shown below.

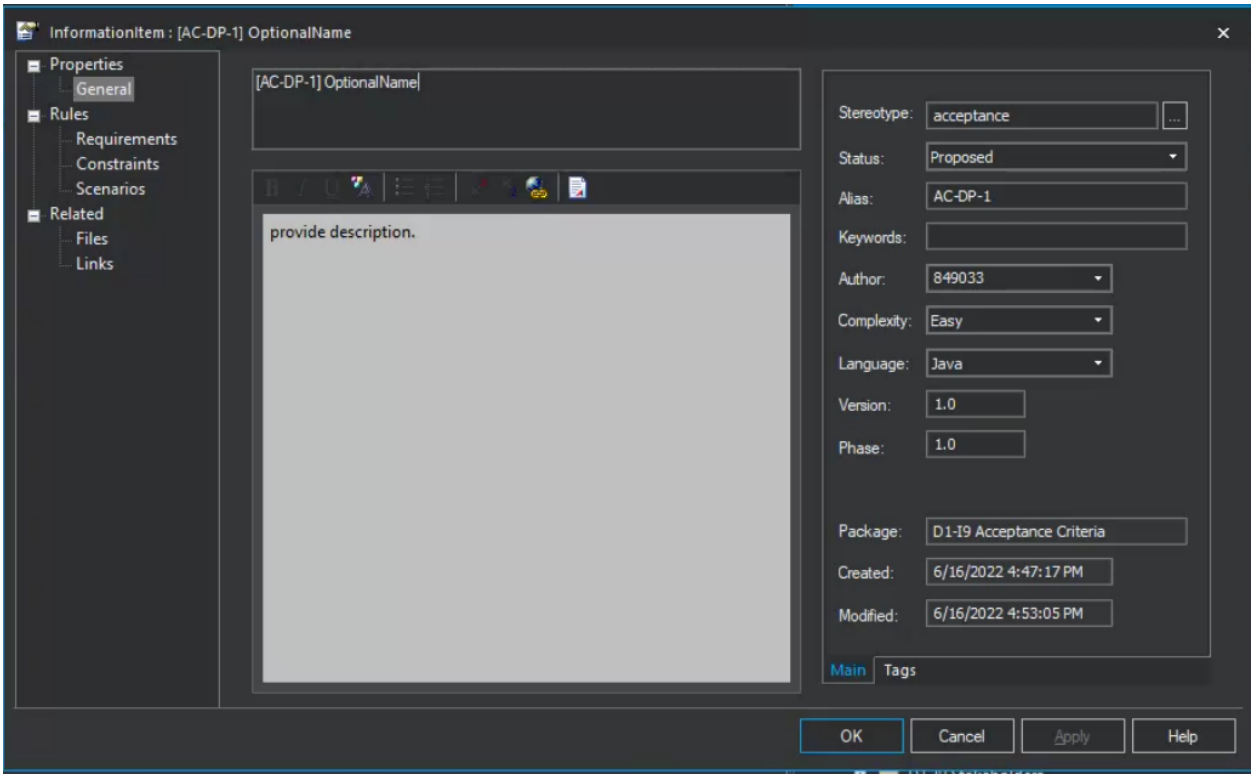


Figure 184: Acceptance Criteria Alias

7. Follow above steps to add multiple acceptance Criteria.

2.17.1 Link to Verification and Validation Add-in

Please refer [RD6] for the user manual.

2.18 Mappings

2.18.1 Function to requirement category mapping (Verification)

This section describes mapping between Requirement Categories and Plant I&C Functions (Level 1 to Level 6). Steps 1-3 only describe a method of creating this mapping. The information that this document wishes to convey is present in steps 4 and 6.

1. Add package diagram under selected requirement category

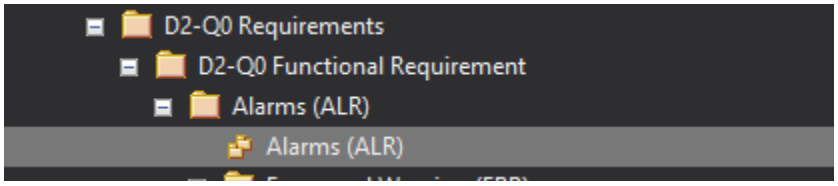


Figure 185: Add Package Diagram

2. Drag the requirement category package on the diagram.

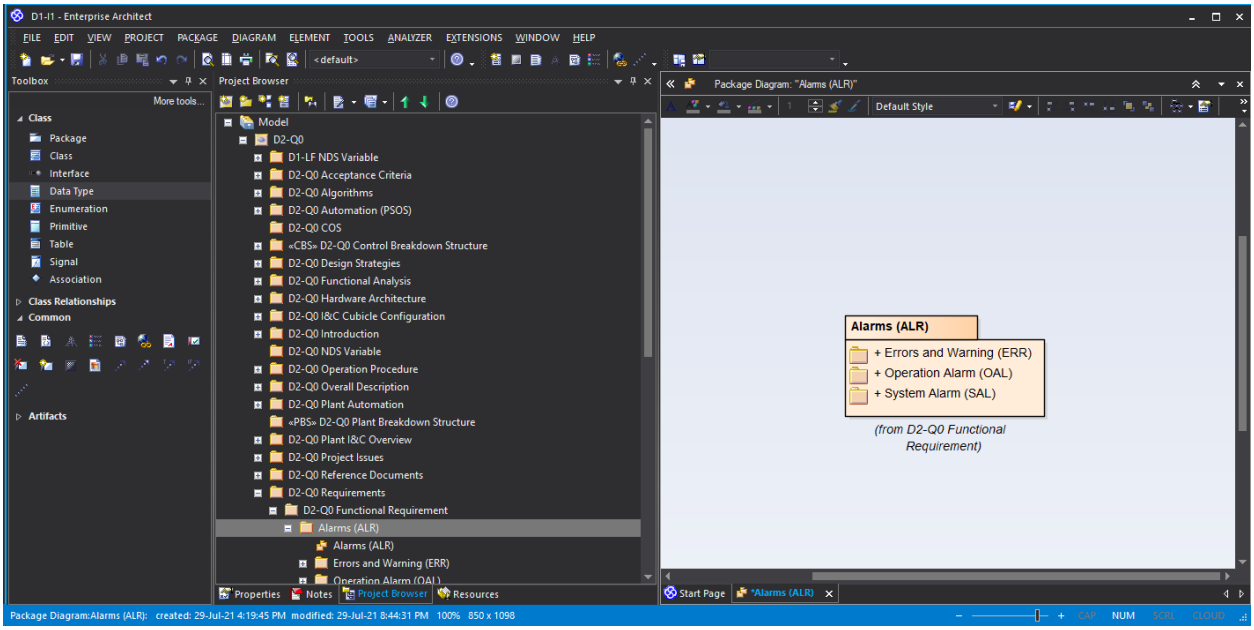


Figure 186: Add Requirement Category Package on Diagram

3. Drag the function package on the same diagram

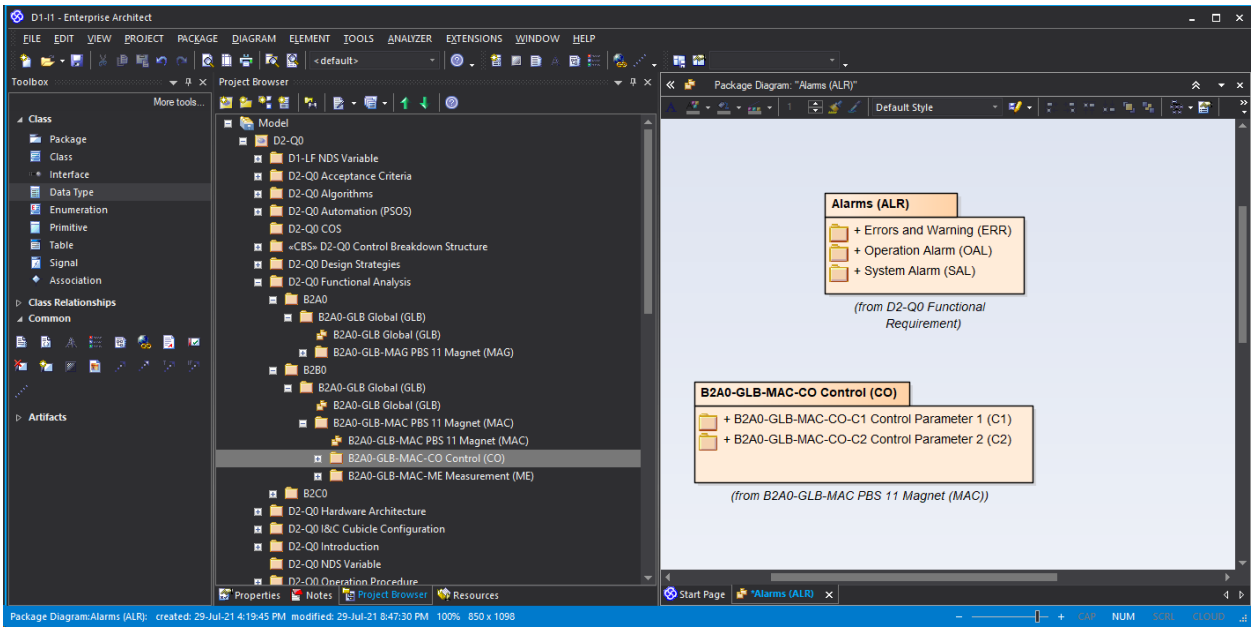


Figure 187: Add Function on Package Diagram

4. Use Trace to establish mapping between functions and requirements

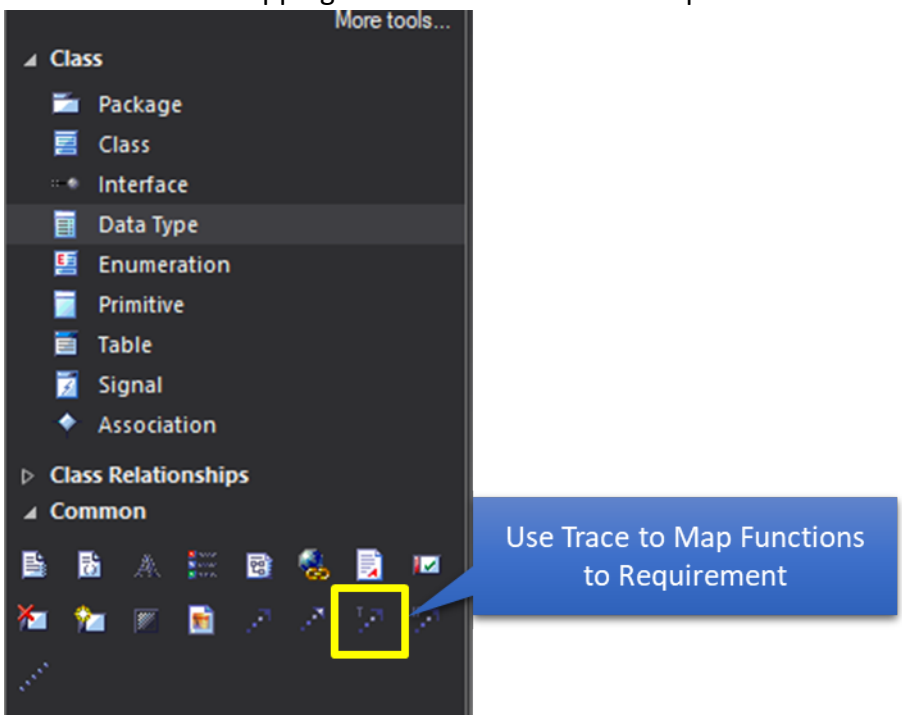


Figure 188: Use Trace to map functions to requirement categories

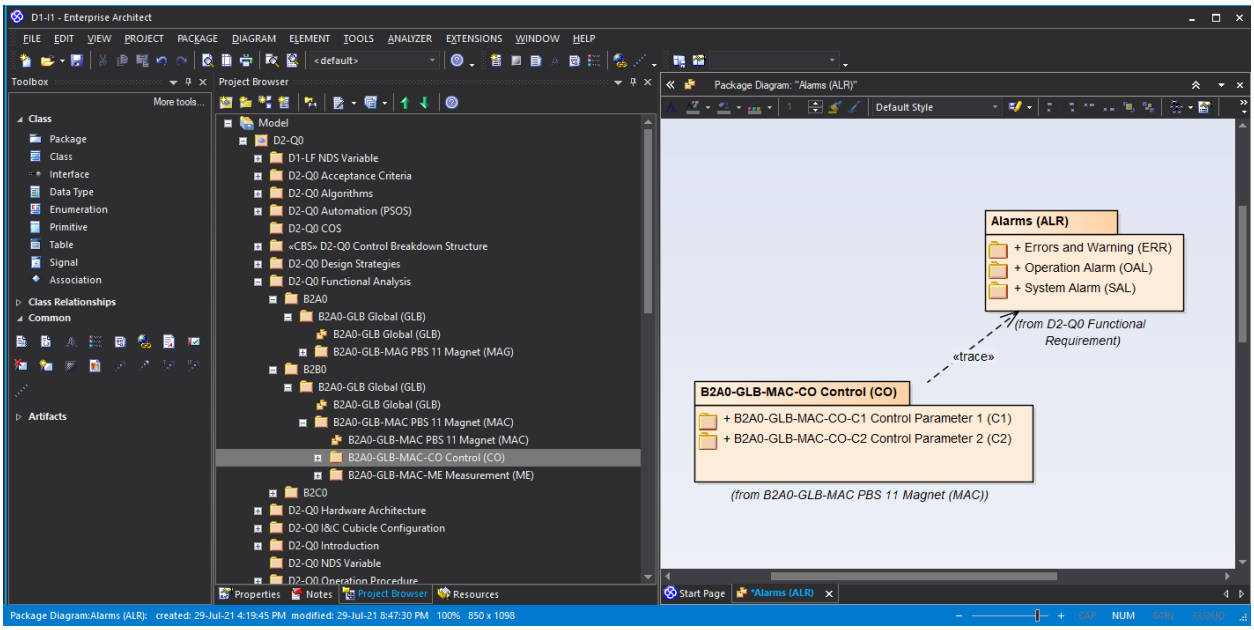


Figure 189: Trace between Functions and requirement categories

5. Double click on Trace and open Property window.
6. Provide Stereotype – trace_req_fun

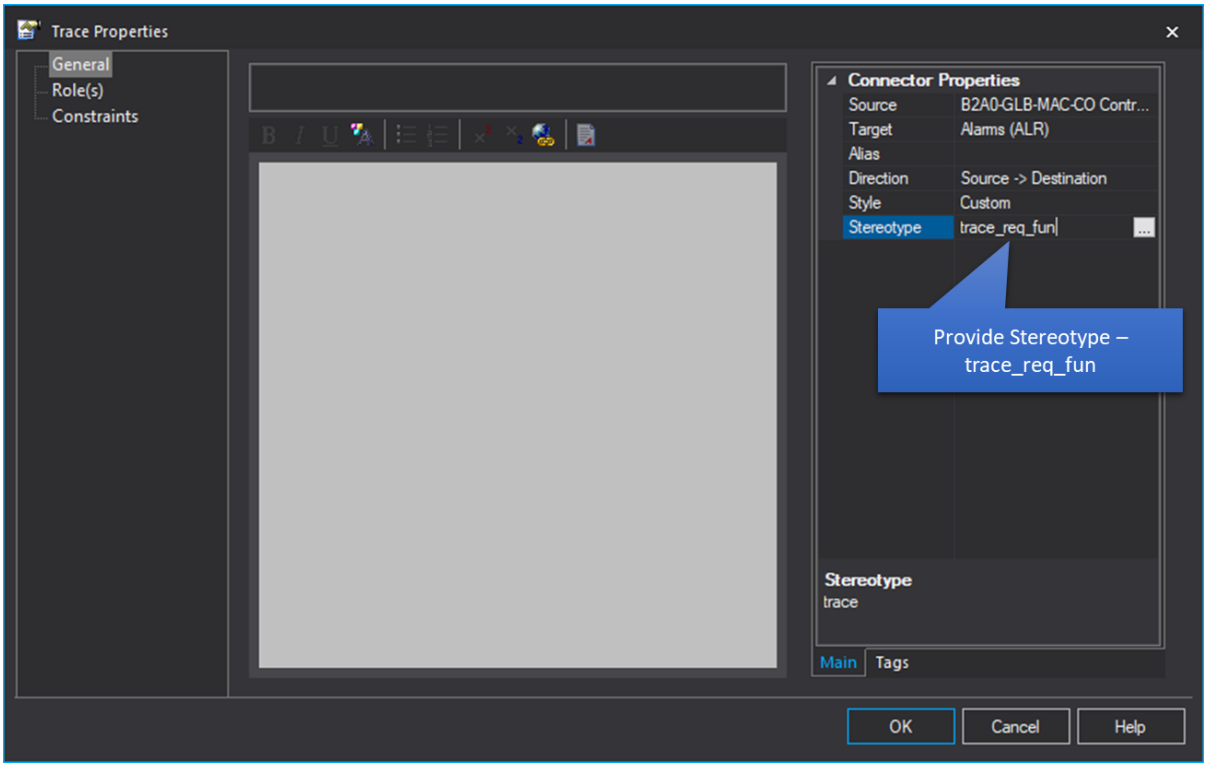


Figure 190: Define Stereotype for Trace between requirement categories and functions

7. Follow above steps to add multiple mapping between functions and requirement categories.

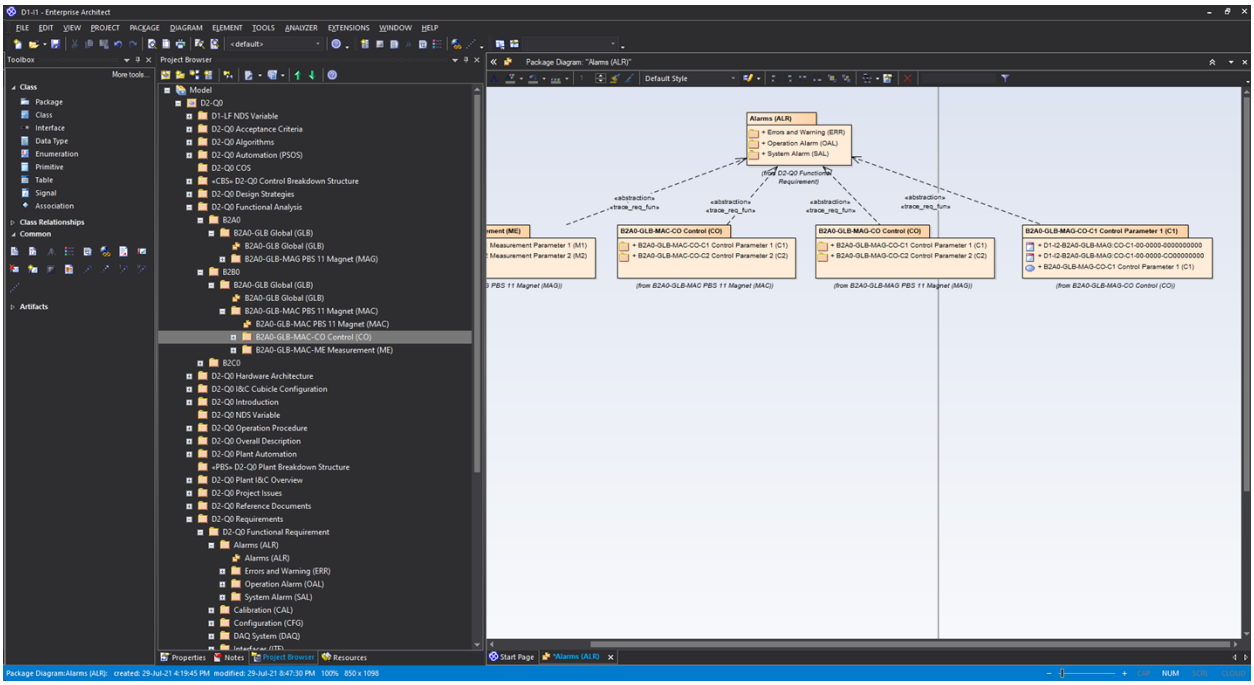


Figure 191: Function to Requirement category mapping in EA

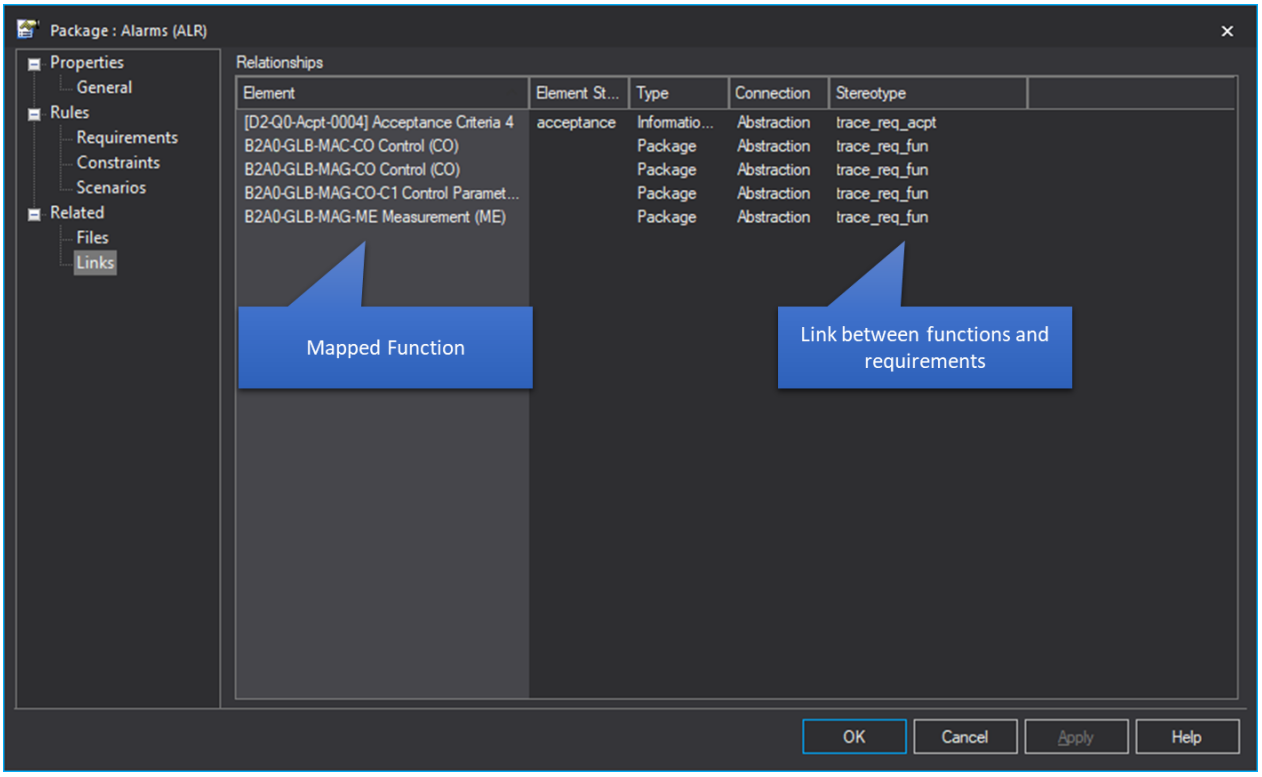


Figure 192: Link between Functions and Requirement categories

2.18.1.1 Link to Verification and Validation Add-in

Please refer [RD6] for the user manual.

2.18.2 Procedure to function mapping

This section describes how to map plant I&C functions to operation procedures. Steps 1-3 only describe a method of creating this mapping. The information that this document wishes to convey is present in steps 4 and 6.

1. Add use case diagram under procedure where function mapping is required.

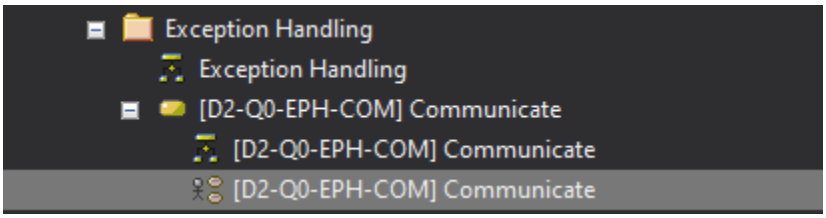


Figure 193: Add Use Case Diagram

2. Drag the activity element on the use case diagram.

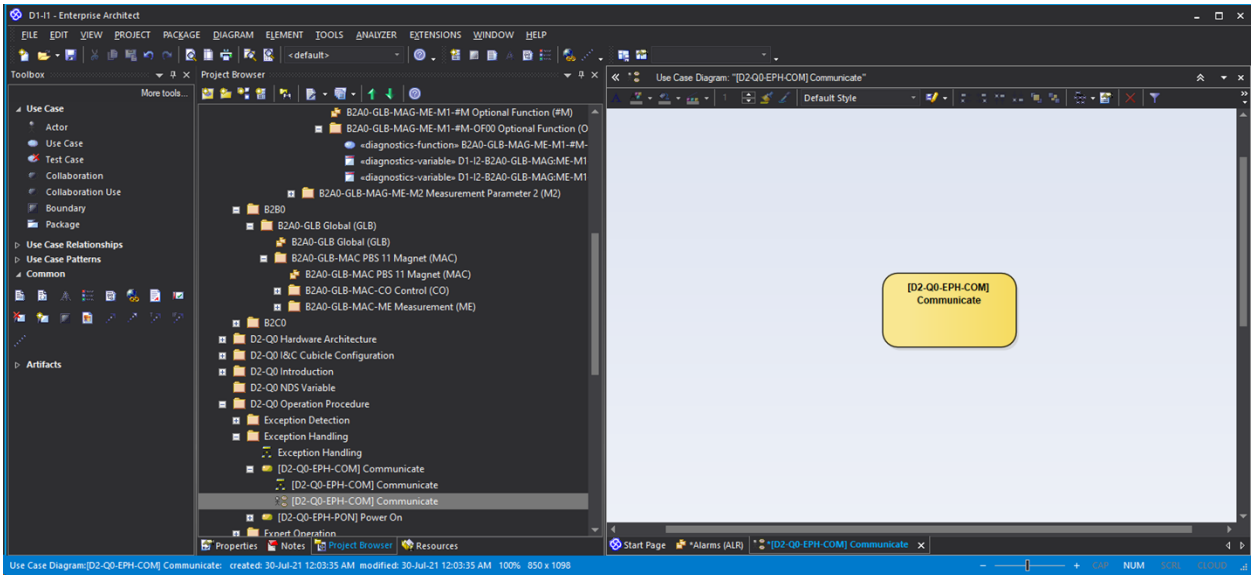
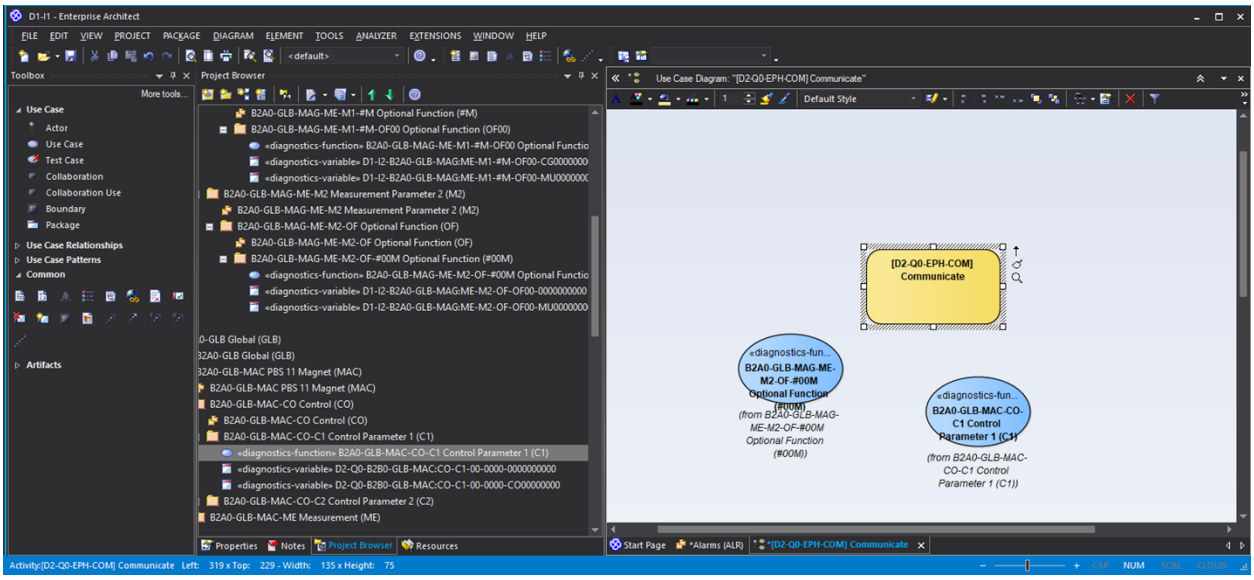


Figure 194: Add Activity element on use case diagram

3. Drag diagnostics functions which we want to map to activity on the same diagram.


D1-I1 - Enterprise Architect
FILE EDIT VIEW PROJECT PACKAGE DIAGRAM ELEMENT TOOLS ANALYZER EXTENSIONS WINDOW HELP
Toolbox
Project Browser
Use Case Diagram: "[D2-Q0-EPH-COM] Communicate"
Default Style
[D2-Q0-EPH-COM] Communicate
«diagnostics-fun... B2A0-GLB-MAG-ME-M2-OF-#00M Optional Function (#00M)
(from B2A0-GLB-MAG-ME-M2-OF-#00M Optional Function (#00M))
«diagnostics-fun... B2A0-GLB-MAC-CO-C1 Control Parameter 1 (C1)
(from B2A0-GLB-MAC-CO-C1 Control Parameter 1 (C1))
Start Page
*Alarms (ALR)
*[D2-Q0-EPH-COM] Communicate
Properties
Notes
Project Browser
Resources
Activity:[D2-Q0-EPH-COM] Communicate Left: 319 x Top: 229 - Width: 135 x Height: 75

4. Use Trace to establish mapping between functions and activity.

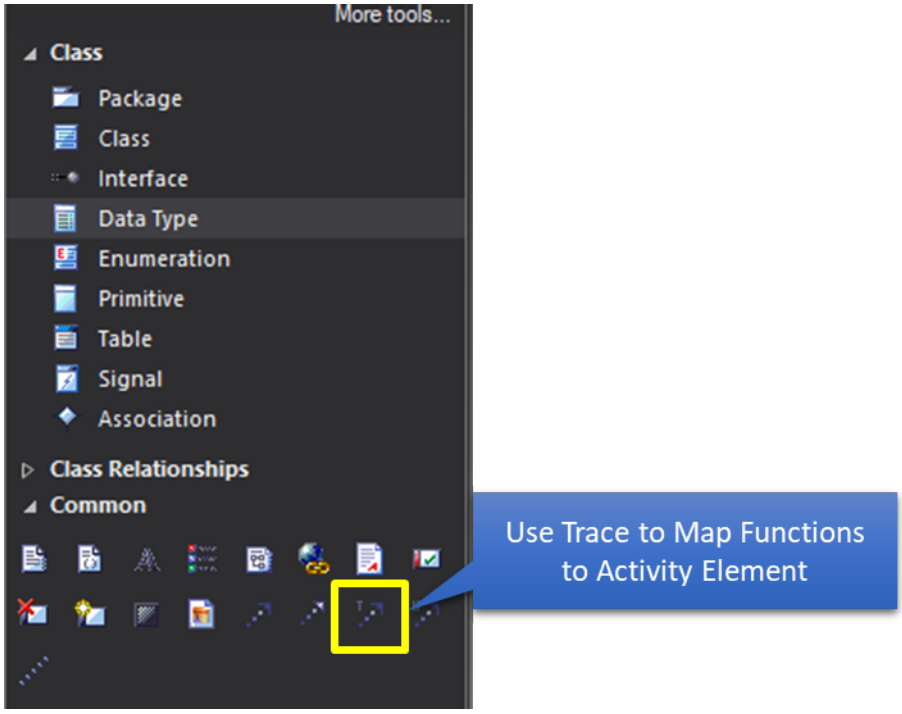


Figure 195: Use Trace to map functions to activity element

5. Double click on Trace and open Property window.
6. Provide Stereotype – Seq-001-trace (001 need to be replaced with sequential numbers for multiple functions). This number helps to define the sequence in which the functions are executed.

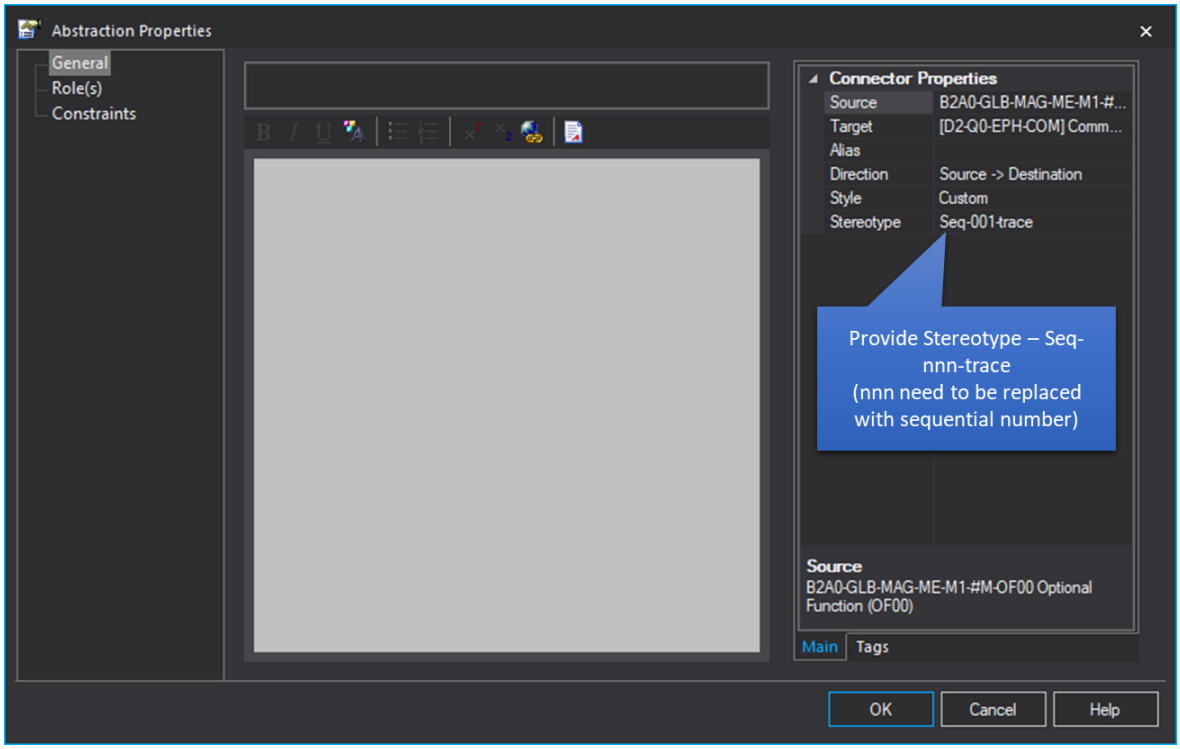


Figure 196: Define Stereotype for Trace between Activity and functions

7. Follow above steps to link multiple functions to Activity

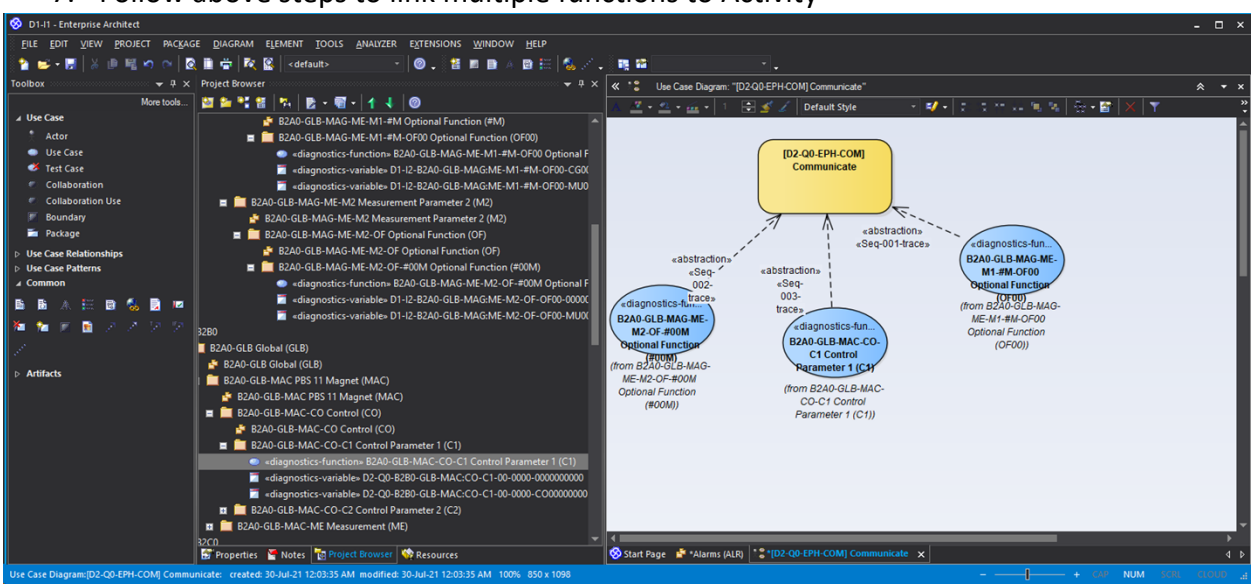


Figure 197: Link functions to Procedures

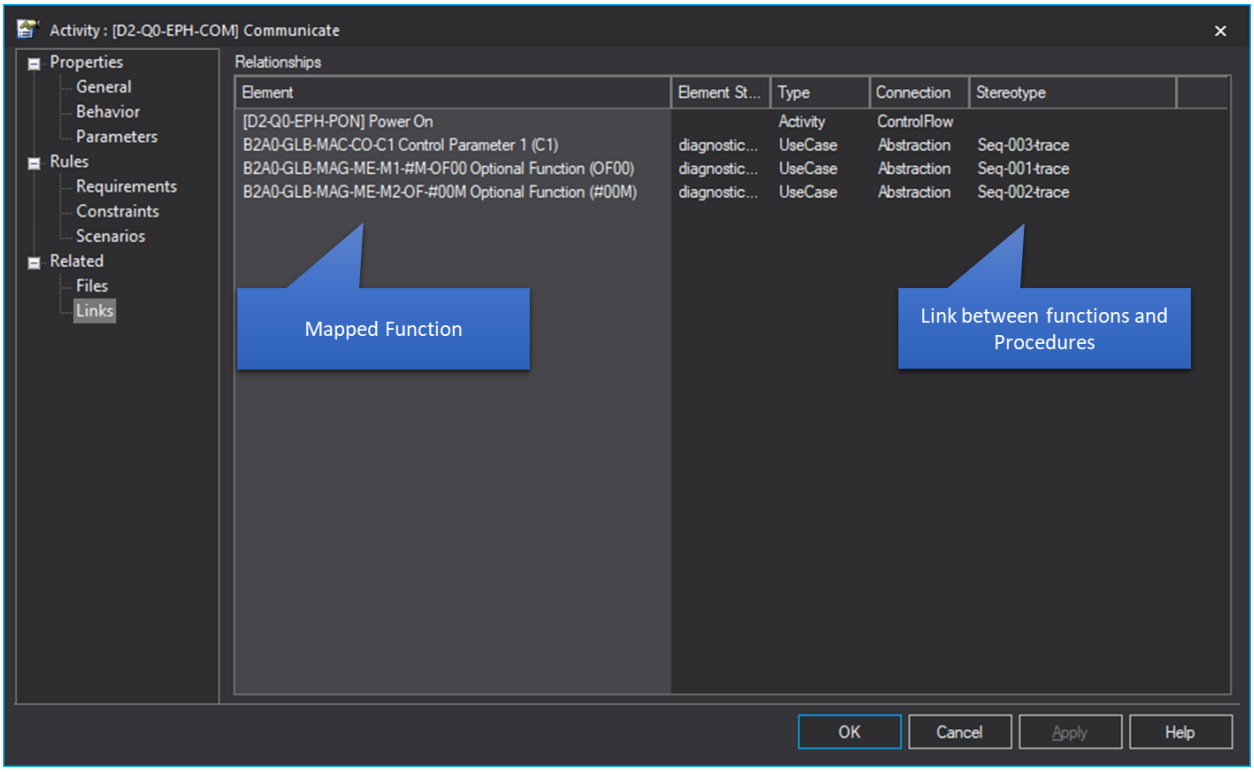


Figure 198: Link between Procedures and Functions

Note – Only functions from level 4,5 or 6 (whichever is last level function) must be mapped to the procedures. So, G350-GLB-P31-VP must not be mapped.

2.18.2.1 Link to Design Mapping Add-in

Please refer [RD6] for the user manual.

3 On Customizations

In addition to the design elements and structure explained in section 2, design developer is allowed to add custom diagrams, elements, stereotypes and tagged values.

The package structure (folder structure) can also have variations to subdivide a huge list of elements (required by the project structure to be located within a certain folder) into sub-folders for better readability. For example signals and components. Please contact ea-support@iter.org if you plan to alter the folder structure.

4 Additional Topics not related to EA Project Structure

These topics have been requested by Plant I&C designers to be included in this document. This section has overlap with [RD2], and will be removed from this document in future versions, once [RD2] is updated.

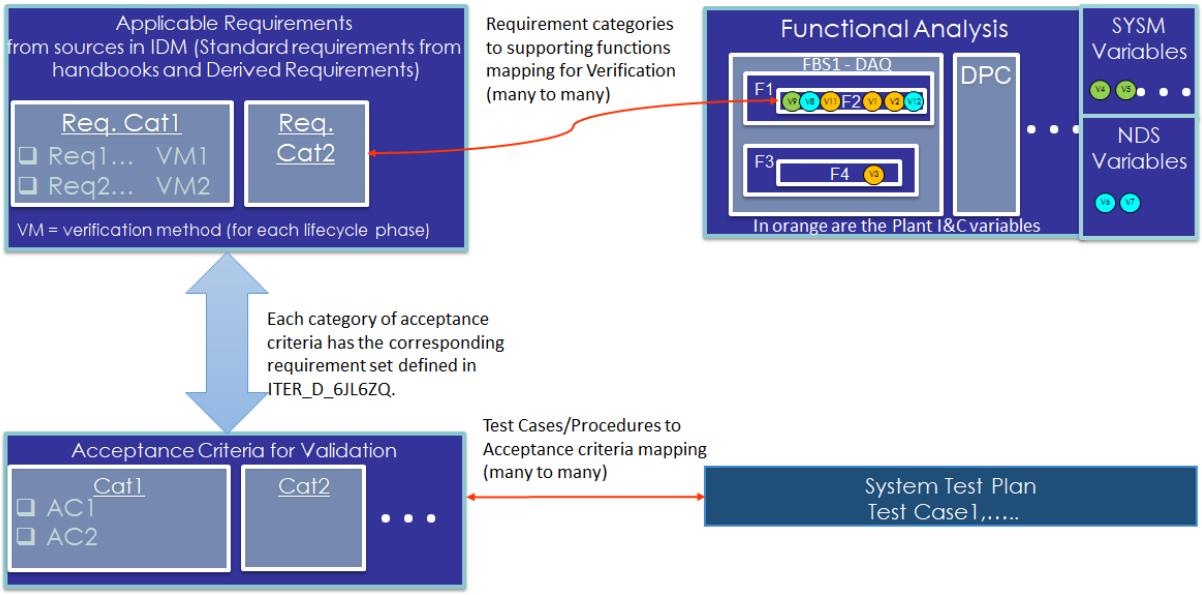
4.1 Requirement Traceability

Requirements must be verified and validation. This is explained in section 6 of [RD5] and ITER_D_4WDZXW slide 4.

Verification is demonstrated through mapping between requirement categories and functions. Refer ITER_D_4WDZXW slide 5-10.

Validation is through defining the acceptance criteria. Refer [RD7]. For each category of acceptance criteria, the corresponding requirement set is also included in this document. In the detailed test plan (STP), a mapping between the acceptance criteria and Test cases/procedures is required.

The two mappings for traceability are shown in the figure below (in red).



4.2 Functional Analysis

One of the major objectives while preparing this functional analysis file is to develop the variable names associated with the functions. The variables must be named as per [RD3].

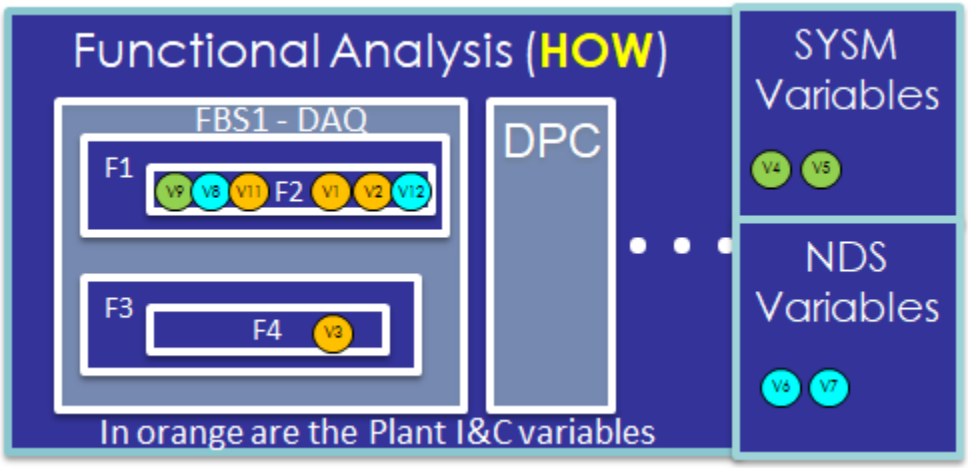
For easy reference, a snippet from the document is as below:

> In the diagnostic plant I&C context, the naming concept of diagnostics plant I&C variable is as below
>
> **CBS1-CBS2-CBS3-FBS1-FBS2:FBS3-FBS4-FBS5-FBS6-A1A2A3A4A5**
>
> Where A1 to A5 are attributes 1 to 5
>
> - For variable attributes refer Appendix III
> - For CBS1-CBS2-CBS3 refer Appendix I
> - For FBS1-FBS2 refer Appendix II
> - FBS3-FBS4-FBS5-FBS6 should be defined by the designer.
>
> Note- Control Function Identifier = CBS1-CBS2-CBS3-FBS1-FBS2 and Variable Identifier = FBS3-FBS4-FBS5-FBS6-A1A2A3A4A5

Variables can be of three types - Plant I&C, SYSM and NDS. The figure below shows a Plant I&C function with one input Plant I&C, NDS and SYSM variable each. This function has one out Plant I&C variable and one output NDS variable. Instead of only one, the number of each type of these variables can be more than one also. This example is only for illustration.

11.

12. The figure below shows the idea behind functional breakdown. This picture only shows the functional breakdown concept and does not accurately depict the recommendation "It is highly recommended that variables are defined for functions at Level 4 or higher and not below." from section 2.9.4.

13. 

4.3 Operation Procedures

As per the methodology, (operation) procedures are the Activity Diagrams (also called flowcharts) from SysML. They must be documented in a hierarchical structure. The Plant I&C procedures must cover all the steps needed to accomplish the objective.

The following steps could be executed:

- Manually by operator using I&C functions (moving optics using stepper motor)
- <u>Manually by operator without I&C</u> (no I&C function) (e.g. physically turning ON a power supply) (less preferred option)
- Through automation (to the extent possible). The procedures consisting of most steps using I&C, will have the option to be automated. Complete automation may not be possible, since operator will need to be in loop for some steps. Procedures can be automated using state machine or sequencer.

When designing the operation procedures, always design them as if, they are to be executed manually. Otherwise detailed design will never get documented. Automation can be introduced later.

For example, to perform the "obtain new calibration coefficients" task, all the related steps must be defined such as

1. Switch calibration light source on
2. Move optics to calibration position
3. Measure light in from calibration source
4. Measure light out from optical instruments
5. Calculate calibration maps for optical instruments
6. Save calibration maps to calibration database
7. Move optics back to measurement (resting) position
8. Switch off calibration light source

In the steps listed above, it is possible (if only I&C functions are used) that all the steps can be automated. But still the procedure defined in the design must list all these steps and not a single step only like “Click on button - obtain new calibration coefficients”.

4.4 Discussions on State Machine design with Operations

Please refer the document ITER_D_7RRHDZ for discussions held on this topic with IO-CT Operations teams.

5 Appendix – Stereotypes for EA Project Structure

Below table provides a list of stereotypes that need to be used in the EA project.

Table 15: Stereotypes list

Stereotype
aaaa_functional
acceptance
Actor
Boundary
CBS
CBS1
CBS2
CBS3
Diagnostics I&C UseCase
Diagnostics-Component
diagnostics-function
Diagnostics-Signal
diagnostics-variable
Document
documents_references
external
Flow_Chart
Functional
h_Commissioning
h_ExceptionDetection
h_ExceptionHandling

h_Expertoperation
h_FactoryAcceptance
h_Hardware
h_Integrated
h_Maintenance
h_operationprocedure
h_Protection
h_Safety
h_SiteAcceptance
h_specialprocedure
h_SystemCondition
h_SWEnvironment
Input
internal
Internal-variable
l_Hardware
nds-variable
Non-Functional
Output
PBS
PBS1
PBS2
PBS3
Seq-001-trace
Sequence
Software
sss_functional
Stakeholder
Timing
trace_req_fun
ttt_functional
UC_Model

6 Appendix - Alias for Free format chapters

Below table provides a list of alias that need to be used in the EA project.

Table 16: Alias list

Alias
Acronyms
Issues
Risk
SDS_Audience
SDS_Confg_Comp
SDS_COS_PSOS
SDS_COTS_Eval
SDS_COTS_Interface
SDS_COTS_Interface_I_C
SDS_Cubicle_Config
SDS_Cubicle_Location
SDS_Design_Strategies
SDS_Doc_Conv
SDS_GOS_PSOS
SDS_HW_Spec
SDS_IC_Cubicle
SDS_Introduction
SDS_LCC
SDS_LCC_BOM
SDS_LCC_Power
SDS_LCC_Spec
SDS_Max_Reuse
SDS_Physical_Intf
SDS_Purpose
SDS_SCC
SDS_SCC_BOM
SDS_SCC_Power
SDS_SCC_Spec
SDS_Scope
SDS_SW_Overview
SDS_User_Interface
SRS_Assump
SRS_Audience
SRS_Deliverables
SRS_Design_Constraints
SRS_Doc_Conv
SRS_Functions

SRS_High_Level_OP
SRS_HW_Env
SRS_IC_Scope
SRS_IC_Overview
SRS_Introduction
SRS_Layout
SRS_Locations
SRS_Modes_Operation
SRS_Objective
SRS_Op_Env
SRS_Overall_Desc
SRS_PS_Interfaces
SRS_Purpose
SRS_System_Overview
Test_Scenarios

7 Appendix - ID format for Operation Procedures

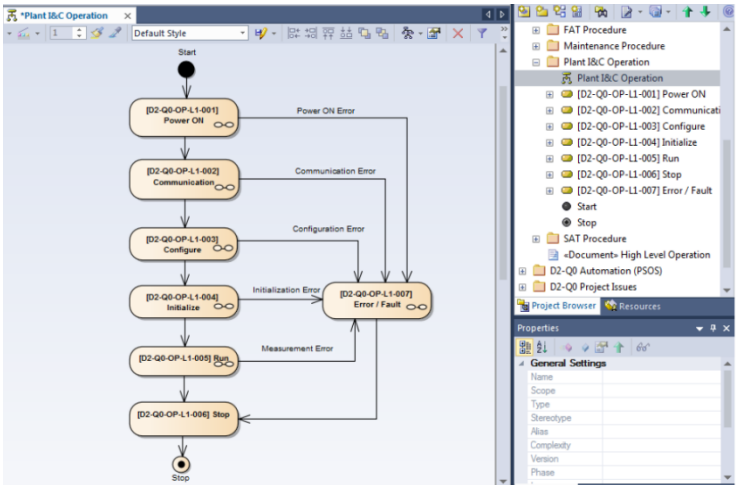
Two styles of ID format are supported. These are described below:

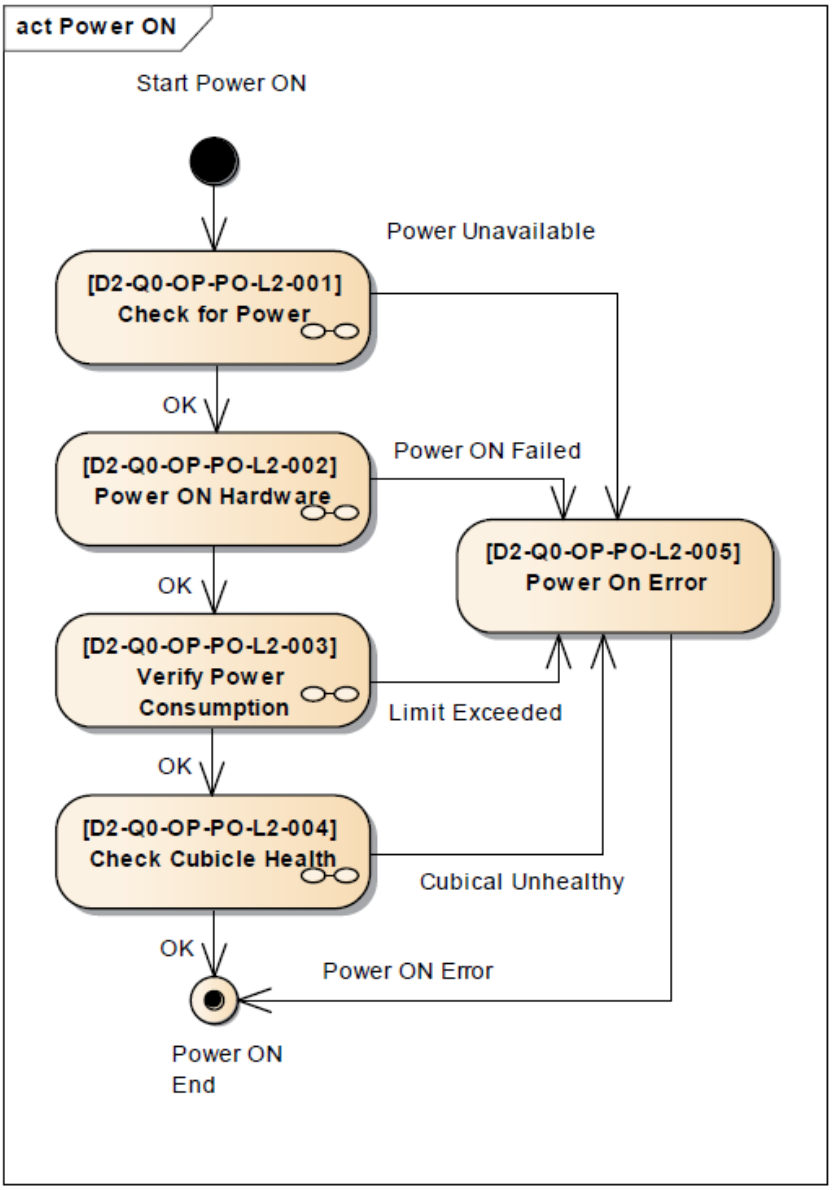
1) Procedure ID format used in excel file template. <u>This is also the preferred format.</u>

   Example for Level 1 operation procedure - <CBS1>-<CBS2>-<Level 0 Procedure Code>-<Level 1 Procedure Code>
   D2-Q0-OPR-CFG is for a Configuration Level 1 Procedure under Plant I&C Operation Level 0 Procedure.

   Example for Level 2 operation procedure - <CBS1>-<CBS2>-<Level 0 Procedure Code>-<Level 1 Procedure Code>-<Level 2 Procedure Code>
   D1-I9-OPR-INT-COM is for a Level 2 operation procedure whose code is COM and is present under Level 1 and Level 0 operation procedures whose codes are “INT” and “OPR” respectively.

2) This procedure ID format was used earlier but is still supported (but not with excel import). In this format the procedures codes are two characters only and end with a three digit number. This is shown below.


*Plant I&C Operation
Default Style
Start
[D2-Q0-OP-L1-001] Power ON
Power ON Error
[D2-Q0-OP-L1-002] Communication
Communication Error
[D2-Q0-OP-L1-003] Configure
Configuration Error
[D2-Q0-OP-L1-004] Initialize
Initialization Error
[D2-Q0-OP-L1-007] Error / Fault
[D2-Q0-OP-L1-005] Run
Measurement Error
[D2-Q0-OP-L1-006] Stop
Stop
FAT Procedure
Maintenance Procedure
Plant I&C Operation
Plant I&C Operation
[D2-Q0-OP-L1-001] Power ON
[D2-Q0-OP-L1-002] Communicati
[D2-Q0-OP-L1-003] Configure
[D2-Q0-OP-L1-004] Initialize
[D2-Q0-OP-L1-005] Run
[D2-Q0-OP-L1-006] Stop
[D2-Q0-OP-L1-007] Error / Fault
Start
Stop
SAT Procedure
«Document» High Level Operation
D2-Q0 Automation (PSOS)
D2-Q0 Project Issues
Project Browser
Resources
Properties
General Settings
Name
Scope
Type
Stereotype
Alias
Complexity
Version
Phase


act Power ON
Start Power ON
Power Unavailable
[D2-Q0-OP-PO-L2-001]
Check for Power
OK
Power ON Failed
[D2-Q0-OP-PO-L2-002]
Power ON Hardware
[D2-Q0-OP-PO-L2-005]
Power On Error
OK
[D2-Q0-OP-PO-L2-003]
Verify Power
Consumption
Limit Exceeded
OK
[D2-Q0-OP-PO-L2-004]
Check Cubicle Health
Cubical Unhealthy
OK
Power ON Error
Power ON
End

So here we can see that D2-Q0-OP-L1-001 is a Level 1 procedure under Plant I&C Operation Level 0 procedure. Similarly, D2-Q0-OP-PO-L2-001 is a Level 2 procedure under Power ON Level 1 procedures.