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Report *

Guideline for the implementation of Common Solutions for Piezo motor controller

This document contains an explanation of the common solution methodology and instructions on how to integrate common solutions into existing I&C projects.
This common solution covers the integration of a package for a Piezo Motor Controller into existing I&C projects.
This solution was initially prepared by the team working on the 55.E6 system.

This document explains how to use the other parts of this Common Solution package, and should be used together with them:
1. Guideline (this ...

Acceptance Process			
	Name	*Action*	*Affiliation*
Author	**Smirnov I.**	**09 Oct 2024:signed**	
Co-Authors			
Reviewers	**Ghate A.**	**04 Nov 2024:reviewed**	**IO/DG/CP/CIC/CCI**
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Change Log			
Guideline for the implementation of Common Solutions for Piezo motor controller (B5VVME)			
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Document Review Notice

DOCUMENT REVIEW NOTICE (DRN)
(This DRN takes precedence over any previous comments made on this version of the document).

[1] [Ghate Advait EXT] 1. Is this common solution applicable to all Pizeo motors or is it specific to Newport 8742 motor? Please clarify.
2. What does it mean by "Hardware Allocation"? Is it the same as hardware deployment of the pizeo motor NDS variables? If yes, then please change the name to Hardware deployment.
3. I didn't find the description of the tool to create EA functional analysis table realted to pizeo motor and to integrate the generated PVs and functions into the FBS. This functionality was given in the other common solution tools. Is it done delibrately
or there is no longer need to create FBS for this common solution?
4. It would be more value added if you explain the table in chapter 3.1.2 with an example exaplined in descripion field.
5. Please describe in details step-4 and step-6 of Option-1 in table 5. What are these columns after S and what modifications are quired in these columns.
6. Step -1 in table 6 is missing.
7. Please add a block diagram in section 3 showing development flow of the I&C project using common solution tools.Currently all common solution tools are exaplained independantly lacking the link between them in the context of the I&C project development.
Such diagram will give clarity on how these common solution tools will be used at different stages of the plant I&C project development.

LLC SZN

WESTERN EUROPE
ROSATOM

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IO/23/CT/4300002838.089	Guideline for the implementation of Common Solutions for Piezo motor controller	1.0

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IO/23/CT/4300002838.089	Guideline for the implementation of Common Solutions for Piezo motor controller	1.0

ACRONYMS AND ABBREVIATIONS

The following abbreviations and acronyms are used in this document.

Abbreviation	Meaning
ADC	Analog-to-digital converter
CBS	Control Breakdown Structure
COTS	Commercial Off-The-Shelf
CSS	Control System Studio
EA	Enterprise Architect
FBS	Functional Breakdown Structure
FPGA	Field-programmable gate array
GUI	Graphical User Interface
HMI	Human-Machine Interface
IDM	ITER Document Management
IOC	Input / Output Controller
I&C	Instrumentation & Control
MC	Mirror Cleaning
PBS	Plant Breakdown Structure
POC	Plant Other Controller
PSH	Plant System Host
PV	Process Variable
RF	Radio Frequency
SDD	Self-Description Data
µTCA	Micro Telecom Computing Architecture

IO/23/CT/4300002838.089	Guideline for the implementation of Common Solutions for Piezo motor controller	1.0

TABLE OF CONTENTS

IO/23/CT/4300002838.089	Guideline for the implementation of Common Solutions for Piezo motor controller	1.0

LIST OF FIGURES

LIST OF TABLES

IO/23/CT/4300002838.089	Guideline for the implementation of Common Solutions for Piezo motor controller	1.0

1. SCOPE

This common solution covers the integration of a package for a Piezo Motor Controller into existing I&C projects.

This solution was initially prepared by the team working on the 55.E6 system.

All the PVs Newport 8742 devices are deployed on PSH.

The source code can be found in [1]. The EA project can be found in [2].

2. GENERAL INFORMATION ABOUT COMMON SOLUTIONS

During the development of the I&C systems for diagnostic monitoring, it was observed that some parts of certain I&C projects could be implemented in other diagnostic-specific projects.

The following potential solutions were identified:

- Mirror Cleaning Operation Scheme;
- Temperature control through Baking Jacket;
- Thermocouple monitoring;
- Piezo motor controller;
- Imaging System;
- ADC with FPGA in µTCA form factor.

These components of the I&C projects are referred to as Common Solutions. Each of these systems can potentially be integrated into different diagnostic systems as needed.

Use case:

Team "A" is developing an I&C design for the diagnostic system “System 1”.

Team "B" has developed an I&C project for “System 2” that uses only a temperature monitoring system.

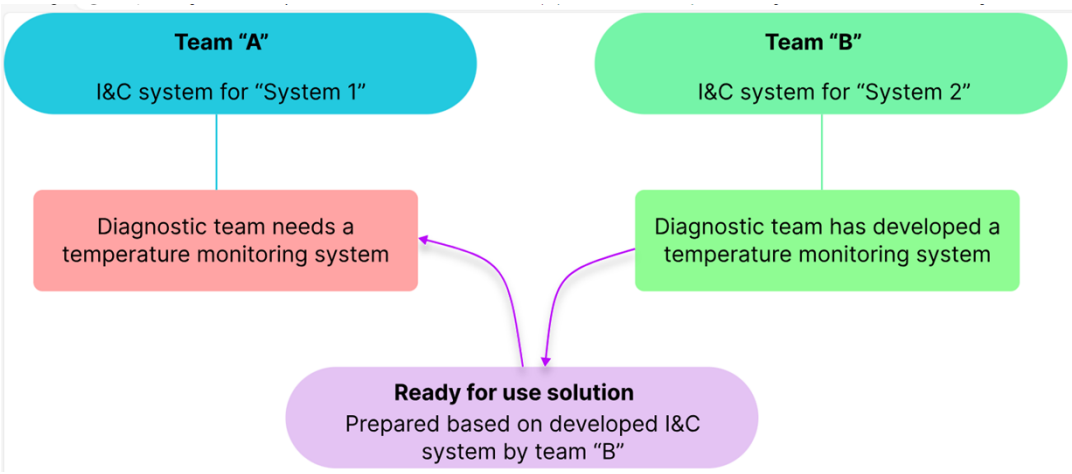


Figure 1 Representation of the teams

IO/23/CT/4300002838.089	Guideline for the implementation of Common Solutions for Piezo motor controller	1.0

During the development of the I&C system, team "A" recognized that there are thermocouples in "System 1", which means that a thermocouple monitoring system is needed. As a result, there are two different possibilities to integrate a temperature-monitoring system in the I&C project for "System 1":

1. *Independently develop a temperature monitoring system.*
2. *Integrate the temperature monitoring system developed by team "B".*

If team "A" selects the first option, development of the I&C project takes more time and more efforts from team "A"'s engineers. This is possible, but may be inefficient if there exists an off-the-shelf solution.

Therefore, selection of the second method reduces the time needed for development and integration of the temperature monitoring system in the I&C. Ready for use means that when team "A" integrates this solution into its monitoring system, all variables, functions, and other attributes conform to the naming conventions for "System 1".

In this case, team "A" only needs to specify the attributes regarding the "System 1" diagnostic and to integrate the ready-for-use solution into their existing I&C project.

The common solution consists of a set of ready-to-use parts of the I&C project:

- Enterprise Architect (EA) excel tables with a software tool for creation and integration of the attributes in existing EA tables for specific diagnostics.
- Parts of the software source code.
- Parts of the Wiring diagram related to the common solution.

These inputs can then be used to integrate the solution into existing I&C projects, taking account of the naming convention and specific attributes of the diagnostic, such as:

- PBS;
- CBS;
- Location of the diagnostic;
- Cubicle name etc.

A common solution can be considered a piece of the puzzle that will be fully integrated into the overall system to complement it, without negative impacts on the existing system.

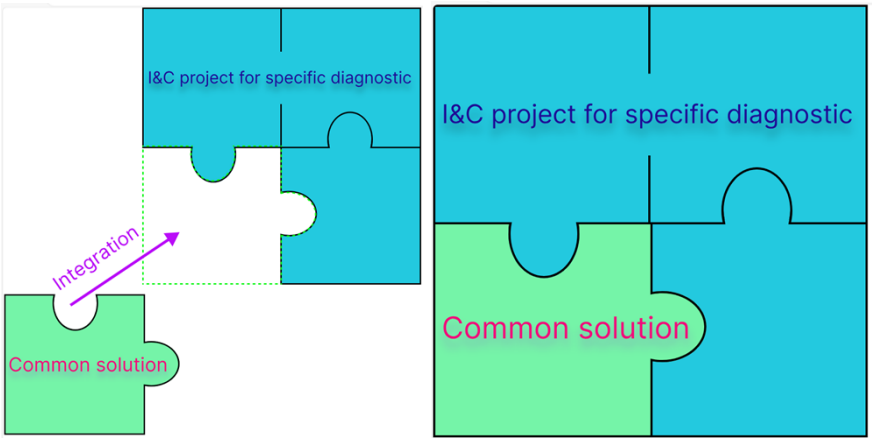


Figure 2 Common solution representation

IO/23/CT/4300002838.089	Guideline for the implementation of Common Solutions for Piezo motor controller	1.0

3. DETAILED DESCRIPTION OF THE COMMON SOLUTION PACKAGE

This section describes the package for integrating solutions into an existing I&C project:

- Tools for creating and integrating NDS variables into an existing project with NDS specifications.
- Package for partial software integration. Set of HMI objects to be integrated into an existing project.
- Description of the wiring diagram parts that are to be integrated into existing wiring diagram with BOM.

These packages provide convenient customization of the common solution to specific diagnostics based on input data prepared by developers, such as:

- PBS;
- CBS 1;
- CBS 2;
- Number of motors used;
- Hardware allocation.

After customization, the common solution can be integrated into the existing project.

The NDS tools and other useful items can be found on IDM as listed in Table 1.

Tool name	Purpose	IDM link
IO23CT4300002838.090_IA02_v1.0_NDS variables for Newport 8742 Piezo motor CS.xlsm	This document contains the tool for generation of NDS variables to be integrated into the existing EA project.	B5W2SP
IO23CT4300002838.091_IA02_v1.0_NDS specification and BOM for Piezo motor CS.xlsx	This document is to provide the information about the PVs reflected on HMI and necessary list of Hardware.	BGRNFX
HMI objects for piezo motor controller	This archive contains the set of .opi files needed to be integrated into existing CSS project.	*Attached to this document in IDM*
IO23CT4300002838.092_IA02_v1.0_SDD variables for Newport 8742	This tool can be used as an additional option for setting up the parameters of generated PVs for Newport 8742.	BGVRVZ
55E600-CU-5601_PICOMOTOR	Extract from the WIP diagram for 55.E6 to show the interface.	*Attached to this document in IDM*

IO/23/CT/4300002838.089	Guideline for the implementation of Common Solutions for Piezo motor controller	1.0

Table 1 List of tools and items for the common solution to be used

3.1. NDS generation tool

3.1.1. Description of the NDS generation tool

This tool generates the NDS variables for Newport 8742. This tool is available in IDM: B5W2SP. The “01_Main list” sheet be activated to start work with the tool, Figure 3.

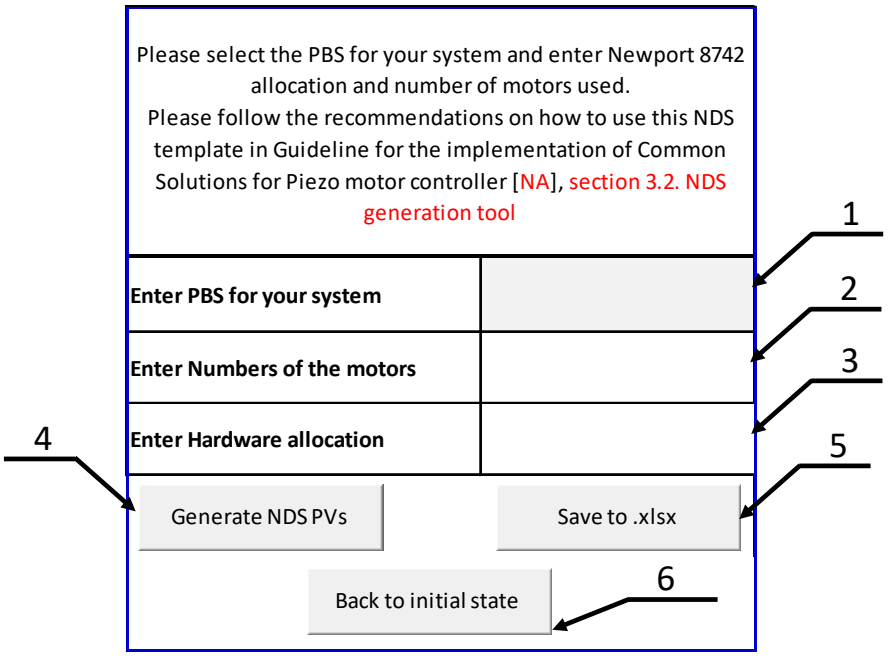


Figure 3 Control panel of NDS variables generation tool

A description of the NDS variables generator is presented in Table 2.

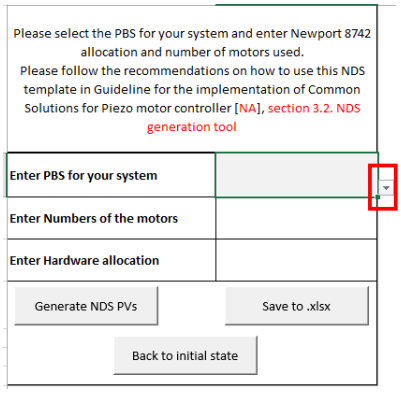
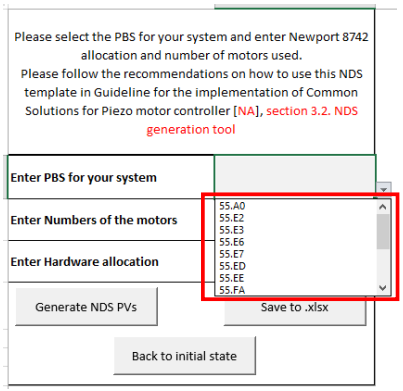
№	Name	Brief Description
1	Enter PBS for your system	This field contains a drop-down list with PBS of different systems. CBS 1 and CBS 2 are automatically selected after PBS selection.
2	Enter number of motors to be used	Enter the number of motors that are planned to be used in the plant I&C
3	Enter Hardware allocation Newport 8742	Enter the Newport 8742 allocation applicable for your system manually.
4	**Generate NDS PVs**	This button generates an NDS variables template
5	**Save to .xlsx**	This button saves the generated NDS PVs in .xlsx

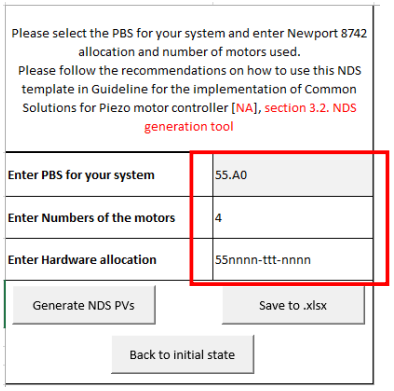
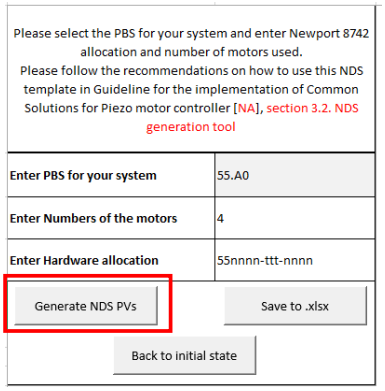
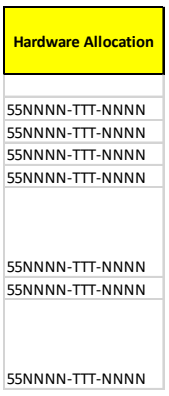
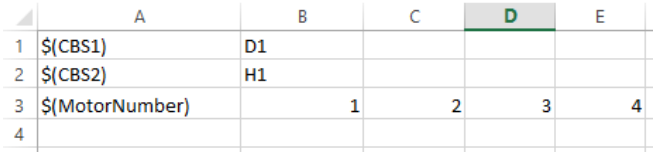
№	Name	Brief Description
6	**Back to initial state**	This button can be used if NDS PVs are generated with any mistakes. The NDS template returns to its original state when clicked.

Table 2 Description of the buttons and fields to be completed

3.1.2. How to generate NDS variables using the NDS variable generation tool

This section describes the sequence of steps to generate and save the NDS template, Table 3.

Steps	Description	Figure
Step 1	Click on the drop-down list to show the available PBS	
Step 2	Select the PBS applicable for your system using the drop-down list in the “Enter PBS for your system” field	

Steps	Description	Figure
Step 3	Manually enter the number of motors and Hardware allocation for Newport 8742 *Please note that you can enter your information in lower case. This tool automatically converts the entered text into the required case* ***Field "Enter Number of the motors" can be any different integer number***	
Step 4	Click the **Generate NDS PVs** button to generate the NDS variables template *A message confirming the generation of NDS variables will appear after the NDS variables have been generated*	
Step 5	The "Hardware allocation" fields on Newport 8742 sheet and fields $(CBS1) and $(CBS2), $(MotorNumber) on Newport 8742 _S are filled in after the **Generate NDS PVs** button is clicked	Newport 8742 sheet where the Column "Hardware allocation" is filled in  Newport 8742 _S sheet 

IO/23/CT/4300002838.089	Guideline for the implementation of Common Solutions for Piezo motor controller	1.0

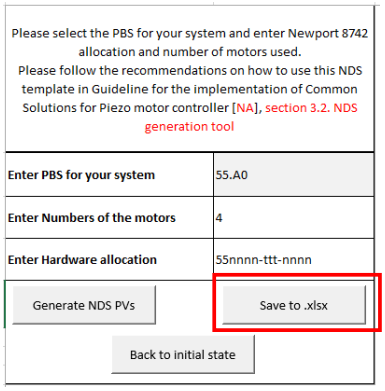
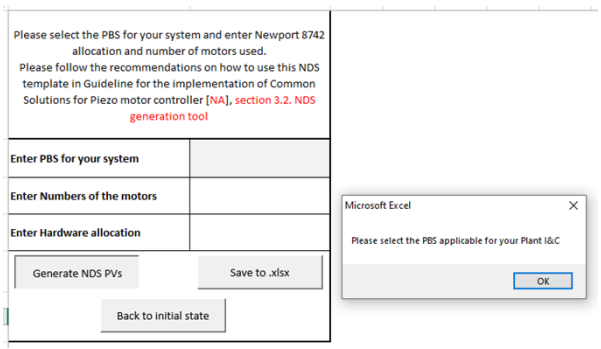
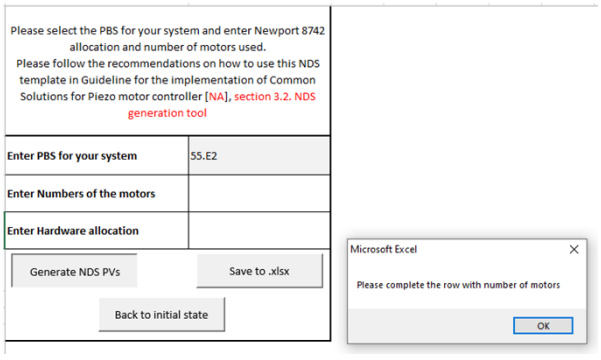
Steps	Description	Figure
	To save generated NDS variables template click the **Save to .xlsx** button *Once the file has been saved, a message will appear confirming that the NDS template has been successfully saved* *If you realize that the generated NDS template should not be saved after clicking Save to .xlsx button, press the **ESC** keyboard key*	

Table 3 How to generate and save NDS variables using NDS template generation tool

The information system was developed for the NDS template if some of the fields are not completed.

Description of the cases	Figure
PBS for the system is not selected	
Number of motors is not completed	

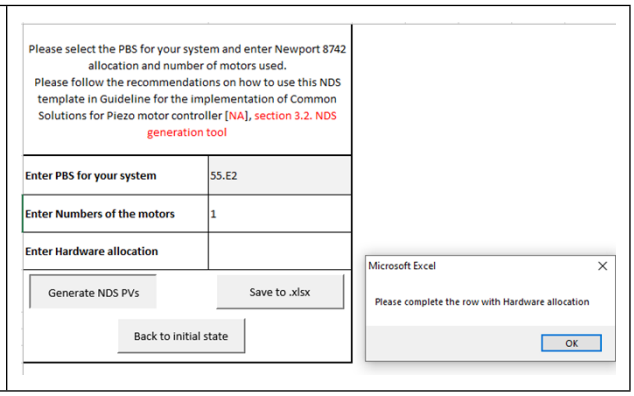
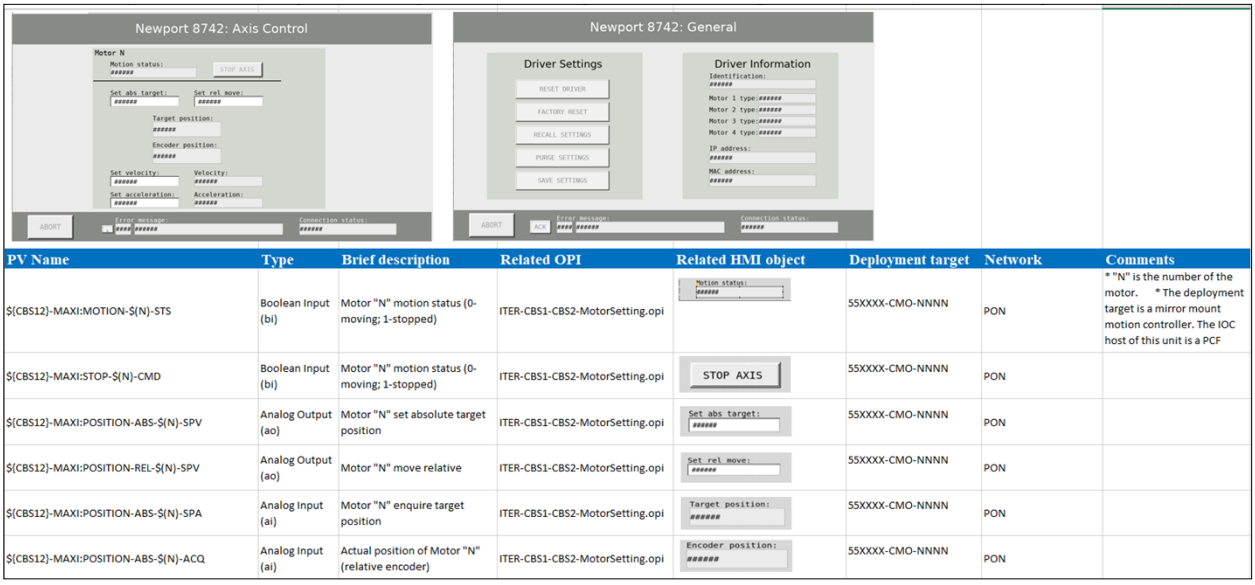
Hardware allocation is not completed	

Table 4 Information system for NDS template

3.2. How to understand process variables generated by NDS template

The NDS specification and BOM for Piezo motor Common Solution - BGRNFX is a document that consolidates the information about the process variables generated by NDS template.

This document reflects the variables, their purpose, deployment unit, network interface and related HMI object, Figure 4.



PV Name	Type	Brief description	Related OPI	Related HMI object	Deployment target	Network	Comments
$(CBS12)-MAXI:MOTION-$(N)-STS	Boolean Input (bi)	Motor "N" motion status (0-moving; 1-stopped)	ITER-CBS1-CBS2-MotorSetting.opi	Motion status:	55XXXX-CMO-NNNN	PON	* "N" is the number of the motor. * The deployment target is a mirror mount motion controller. The IOC host of this unit is a PCF
$(CBS12)-MAXI:STOP-$(N)-CMD	Boolean Input (bi)	Motor "N" motion status (0-moving; 1-stopped)	ITER-CBS1-CBS2-MotorSetting.opi	STOP AXIS	55XXXX-CMO-NNNN	PON	
$(CBS12)-MAXI:POSITION-ABS-$(N)-SPV	Analog Output (ao)	Motor "N" set absolute target position	ITER-CBS1-CBS2-MotorSetting.opi	Set abs target:	55XXXX-CMO-NNNN	PON	
$(CBS12)-MAXI:POSITION-REL-$(N)-SPV	Analog Output (ao)	Motor "N" move relative	ITER-CBS1-CBS2-MotorSetting.opi	Set rel move:	55XXXX-CMO-NNNN	PON	
$(CBS12)-MAXI:POSITION-ABS-$(N)-SPA	Analog Input (ai)	Motor "N" enquire target position	ITER-CBS1-CBS2-MotorSetting.opi	Target position:	55XXXX-CMO-NNNN	PON	
$(CBS12)-MAXI:POSITION-ABS-$(N)-ACQ	Analog Input (ai)	Actual position of Motor "N" (relative encoder)	ITER-CBS1-CBS2-MotorSetting.opi	Encoder position:	55XXXX-CMO-NNNN	PON	

Figure 4 Example of information about process variables generated by NDS template

In order to understand what Hardware devices should be used in the common solution the “Hardware specification” sheet is created, Figure 5.

Hardware	Manufacturer and model	Catalogue number	Quantity	Comments
PSH	Ecrin/Trenton OPALE-2 PICMG 1.3		1	The PSH is connected to the POC (In this case the Piezo motor controller) and acts as the PON for the POC
Piezo motor controller (POC)	Newport 8742		1	To one Newport 8742 controller 4 piezo motors could be connected
Piezo actuator	Newport 8302		1	This piezo actuator is connected to piezo motor via ethernet cabel (RJ-22 connector) in accordance with
Piezo controller PSU	Newport 8745-PS		1	This power supply is connected to Newport 8742

Figure 5 Common solution Hardware specification

3.3. Preparation of the EA project ready to import into SDD editor

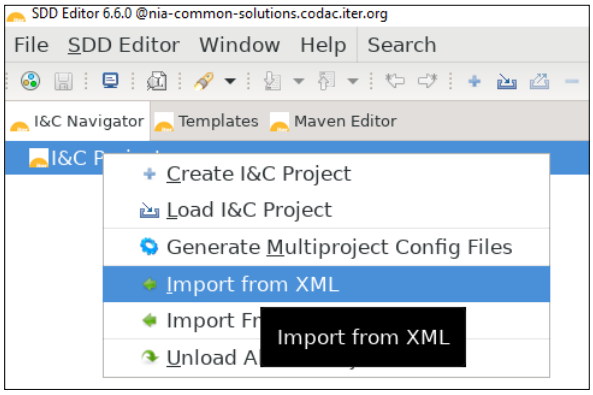
When the NDS variables template has been prepared, open EA project and import the NDS template using EA Functional analysis Add-in [3].

The next step is preparation of an .xml file using the EA2SDD script [4].

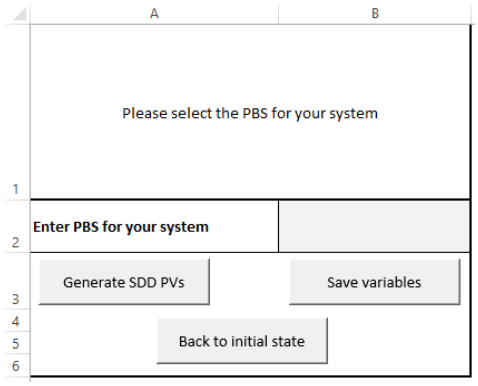
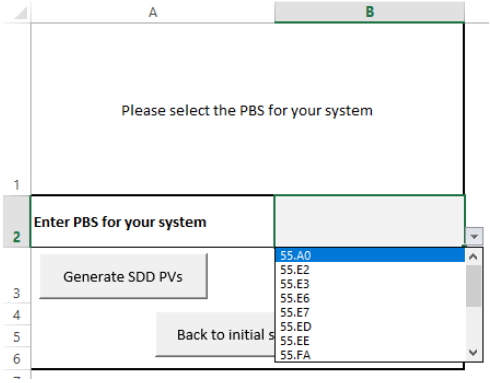
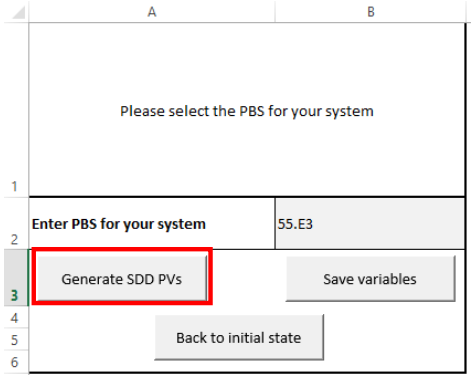
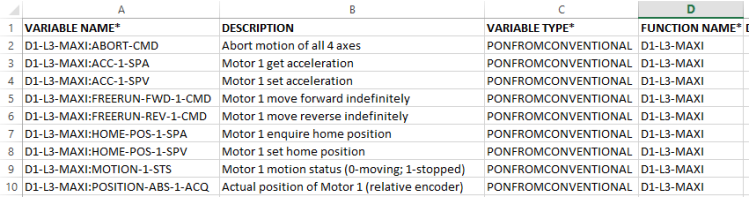
3.4. Package for partial software integration

Prerequisite: before integrating the HMI into the existing project please download the HMI objects archive attached to this document in IDM and extract the .opi files to the project's directory.

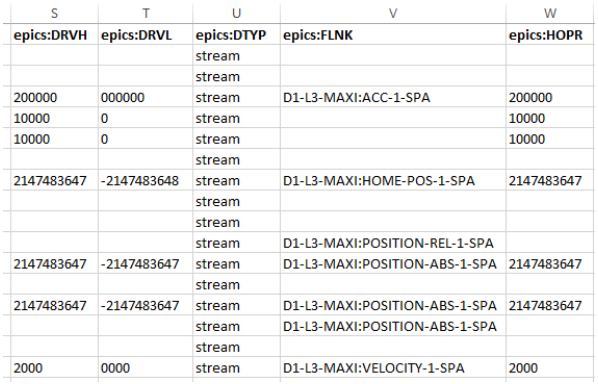
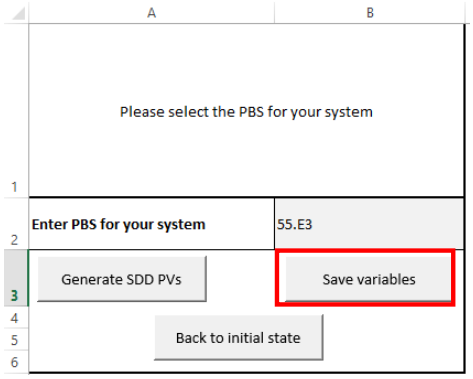
Table 5 contains the steps to set up the parameters for Newport 8742 variables.

Steps	Description	Figure
Step 1	Import the .xml file into the SDD editor obtained after exporting EA project using EA2SDD	
There are two options to parameter settings		
Option 1 – Using the tool for creating SDD PVs		
Step 1	Open the **IO23CT4300002838.088_IA02_v1.0_SDD variables for Newport 8742.xlsm** file [BGVRVZ]	Main page of the tool

IO/23/CT/4300002838.089	Guideline for the implementation of Common Solutions for Piezo motor controller	1.0

Steps	Description	Figure
		
Step 2	Select PBS	
Step 3	Click **Generate SDD PVs** button	
Step 4	Check that generation was performed correctly Modify the parameters of PVs starting from the “S” column	Example of generated SDD PVs  Parameters of PVs

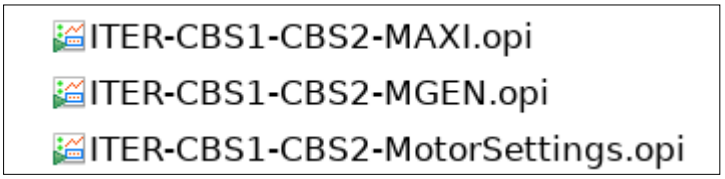
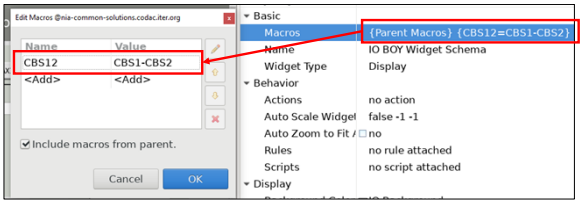
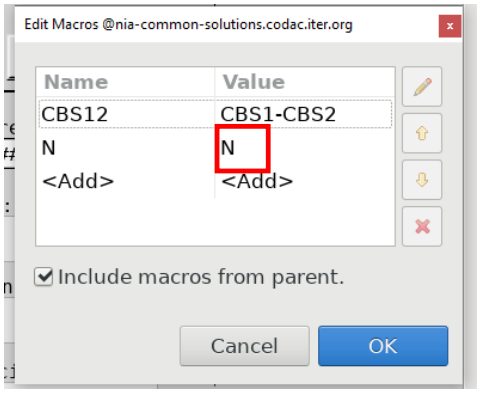
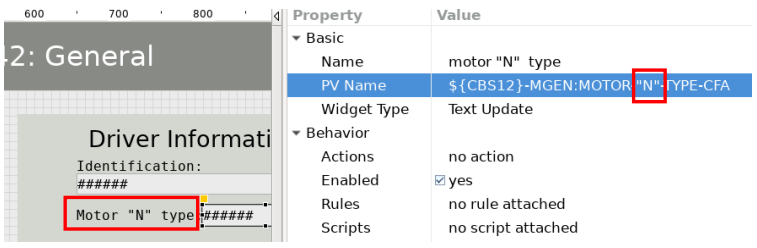
	A	B	C	D
1	VARIABLE NAME*	DESCRIPTION	VARIABLE TYPE*	FUNCTION NAME*
2	D1-L3-MAXI:ABORT-CMD	Abort motion of all 4 axes	PONFROMCONVENTIONAL	D1-L3-MAXI
3	D1-L3-MAXI:ACC-1-SPA	Motor 1 get acceleration	PONFROMCONVENTIONAL	D1-L3-MAXI
4	D1-L3-MAXI:ACC-1-SPV	Motor 1 set acceleration	PONFROMCONVENTIONAL	D1-L3-MAXI
5	D1-L3-MAXI:FREERUN-FWD-1-CMD	Motor 1 move forward indefinitely	PONFROMCONVENTIONAL	D1-L3-MAXI
6	D1-L3-MAXI:FREERUN-REV-1-CMD	Motor 1 move reverse indefinitely	PONFROMCONVENTIONAL	D1-L3-MAXI
7	D1-L3-MAXI:HOME-POS-1-SPA	Motor 1 enquire home position	PONFROMCONVENTIONAL	D1-L3-MAXI
8	D1-L3-MAXI:HOME-POS-1-SPV	Motor 1 set home position	PONFROMCONVENTIONAL	D1-L3-MAXI
9	D1-L3-MAXI:MOTION-1-STS	Motor 1 motion status (0-moving; 1-stopped)	PONFROMCONVENTIONAL	D1-L3-MAXI
10	D1-L3-MAXI:POSITION-ABS-1-ACQ	Actual position of Motor 1 (relative encoder)	PONFROMCONVENTIONAL	D1-L3-MAXI

Steps	Description	Figure
		
Step 5	Click **Save variables**	
Step 6	Select the folder and enter the Name of files First file is Variables_MAXI Second file if Variables_MGEN Third file is Variables_MSTS	
Step 7	Import the files with variables into the SDD editor	

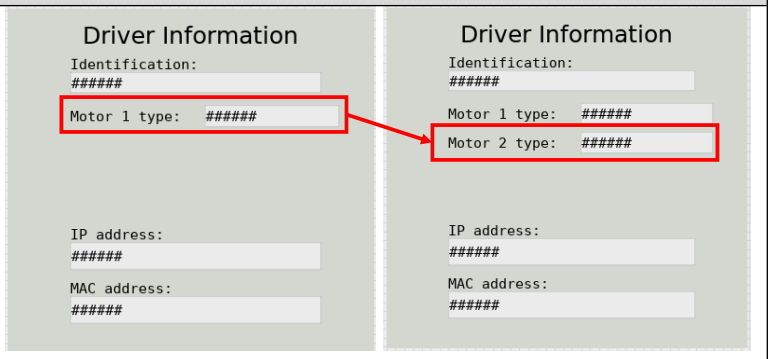
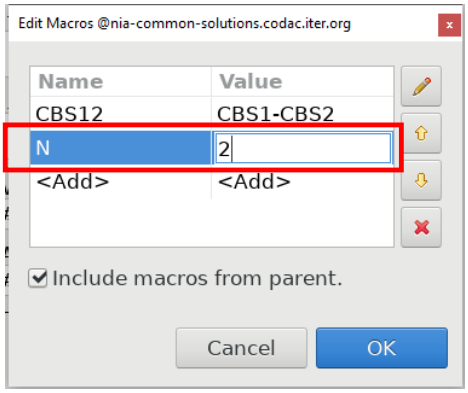
This option could be convenient for the user to set up the parameters of variables and to automatically import PVs into the existing I&C project.

The second option is to modify the parameters of PVs manually in SDD Editor. Please find the table with variables and parameters could be modified.

This section describes the steps for partial Software integration in CS-Studio, Table 6.

Steps	Description	Figure
Step 2	Open CSS Studio and import the following .opi objects: • ITER-CBS1-CBS2-MAXI.opi • ITER-CBS1-CBS2-MGEN.opi • ITER-CBS1-CBS2-MotorSettings.opi	
Step 3	For each file, please fill in the Parent macros with relevant CBS1, CBS2 and number of motor ***Example:*** ***CBS12 = D1-L2*** ***N = 1***	 **ITER-CBS1-CBS2-MotorSettings.opi where the motor number should be identified** 
Step 4	Open **ITER-CBS1-CBS2-MGEN.opi file** and change “N” to the number of the piezo motor in text label and in the PV name Please note that if there are more than 1 piezo motor used in your Plant I&C, the fields with labels and PV representation should be copied and	 **Adding the piezo motor**

IO/23/CT/4300002838.089	Guideline for the implementation of Common Solutions for Piezo motor controller	1.0

Steps	Description	Figure
	pasted in the “Driver information” field. And also, please change the number of the piezo motor in PV name	
Step 5	If there is more than one piezo motor, it is necessary to add new piezo motors in the **ITER-CBS1-CBS2-MAXI.opi** file	
Step 5.1	Create new file **ITER-CBS1-CBS2-MotorSettings.opi** inside the relevant folder. It can be done by copy + paste operation	
Step 5.2	For new file change the “N” macros to the number of piezo motor	

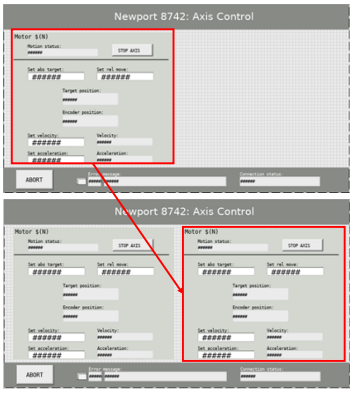
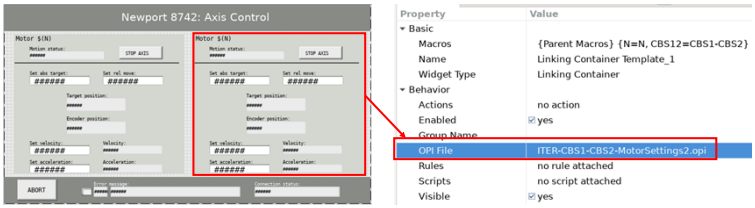
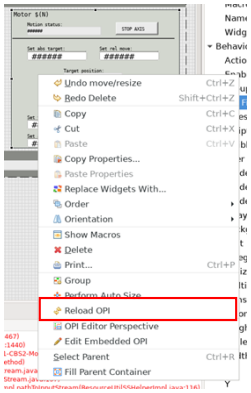
Steps	Description	Figure
Step 5.3	Open **ITER-CBS1-CBS2-MAXI.opi** file and copy + paste the file with motor settings	
Step 5.4	Change the Opi file for the new field with motor settings: 1. Click on new window and open the properties of this field. 2. Find the “OPI file” option 3. Select the file for the piezo motor that was created on step 5.1 4. Reload OPI in order to refresh the linked opi file.	Selection of the linked Opi file for the new window with motor settings  Reloading the window after selecting relevant Opi file for new window with motor settings 
Step 6	**Check that macros for all the .opi files are correctly completed with relevant CBS and numbers of piezo motors.**	

Table 6 Partial software integration

3.5. Package for partial wiring diagram integration

The first step is to import the partial motor Wiring Diagram (attached to this document in IDM), Figure 6. This page is extracted from the work-in-progress 55.E6 diagram.

IO/23/CT/4300002838.089	Guideline for the implementation of Common Solutions for Piezo motor controller	1.0

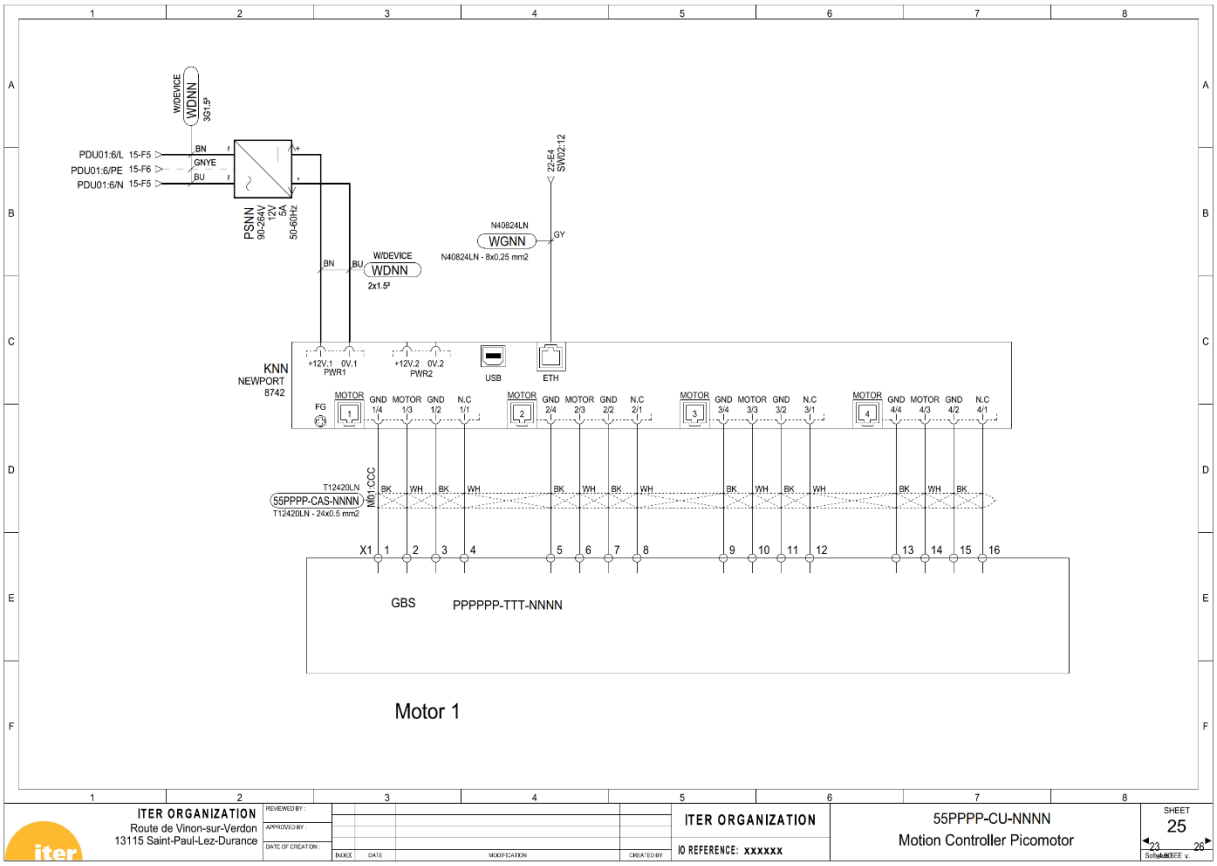
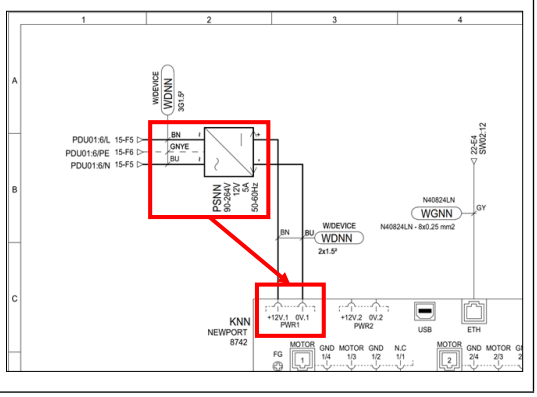


Figure 6 The wiring diagram page needing to be imported

For insertion of the partial wiring diagram with Newport 8742 into an existing wiring diagram, please follow the recommendations in Table 7.

Steps	Description	Figure
Step 1	Connect the Newport 8742 to power supply Newport 8745-PS with applicable electrical characteristics that are specified on wiring diagram	

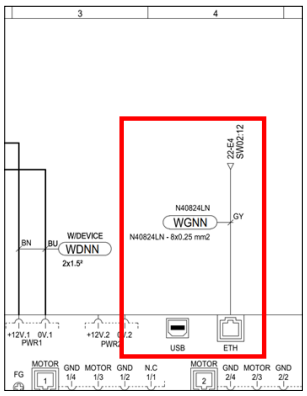
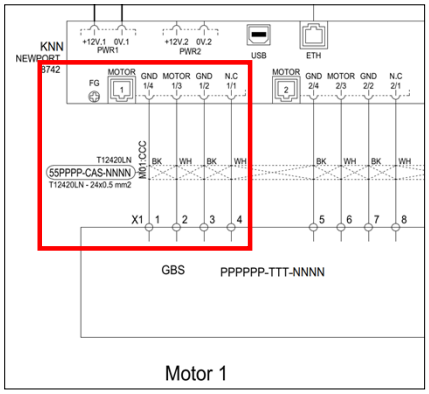
Steps	Description	Figure
Step 2	Connect the Newport 8742 to the Network Switch trough the Ethernet cable	
Step 3	Connect the Newport 8742 to the motor using the Piezo actuator Newport 8302	
Step 4	**Check that all the wires and cables have their numbers.**	

Table 7 How to integrate a partial wiring diagram into an existing project

All the details about controller Newport 8742, piezo actuator Newport 8302 and power supply Newport 8745-PS could be found in the reference documentation [6, 7, 8].

4. REFERENCES

№	Title of the document	IDM link	Version
1	Source code SVN repository	SVN	/
2	D1.4 - EA project file	9FW52V	1.0
3	EA Add-in User Manual - Functional Analysis	5ZZ55H	1.5
4	Enterprise Architect Project Exchange with SDD or PSP – Work Instruction	REFLY3	2.0

IO/23/CT/4300002838.089	Guideline for the implementation of Common Solutions for Piezo motor controller	1.0

№	Title of the document	IDM link	Version
5	Cubicle Wiring Diagram for 55.E6 (to be added once the diagram is published). For now, an extract of the WIP diagram is attached to this guideline in IDM.	*TBD*	*TBD*
6	Controller Newport 8742	User manual	/
7	Piezo actuator Newport 8302	FAQ	/
8	Power supply Newport 8745-PS	Official website	/