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User Manual

EA Add-in User Manual - Functional Analysis

EA Add-in User Manual - Functional Analysis

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	Name	*Action*	*Affiliation*
Author	**Patil P.**	**09 Dec 2022:signed**	**IO/DG/SCOP/SCOD/CD/CCI**
Co-Authors	**Kalsi S.**	**09 Dec 2022:signed**	**IO/DG/SCOP/SCOD/CD/CCI**
Reviewers			
Approver			
Document Security: Internal Use *RO: Simrock Stefan*			
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v1.0	Signed	17 Mar 2022	
v1.1	Signed	08 Jun 2022	Updated with additional information.
v1.2	Signed	14 Jun 2022	Holdback on the SYSM variable feature.
v1.3	Signed	09 Dec 2022	Updates regarding import/export of NDS variables and use of SYSM variables.

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1 Introduction

This document describes how to use the functional analysis add-in to define Functional Analysis in EA Project.

It can be developed in the following ways:

- By importing the excel file to the EA project, using add-in
- By using add-in's editor to develop the functional analysis

When we initialize our EA project using Verification and Configuration add-in, the base package required for functional analysis is created. But in case this initialization has not been done before, the functional analysis add-in will create the package.

Install functional analysis add-in from RD2.

2 References

Ref. #	Name	Link
RD1.	Functional Analysis Excel Template	ITER_D_3Z65F7
RD2.	EA Add-in – Functional Analysis	SharePoint
RD3.	Variable naming guideline	ITER_D_X7R88V
RD4.	Functional Breakdown Guideline	ITER_D_LAJF9S
RD5.	NDS Example and Template	ITER_D_7W6LA3

RD6.	SYSM Variables	ITER_D_35XFCY
RD7.	Functional Analysis and Device Support Explanations	ITER_D_7WDGKZ
RD8.	NDS v3 Core Library User Manual	ITER_D_S37HD2
RD9.	NDS v3 EPICS Device Support User Manual	ITER_D_S977XP

3 Add/Delete Control Breakdown Structure Level 3

It is mandatory to define CBS 3 structure in the EA project. This add-in can be used to add/delete CBS 3. Click on Control Breakdown Structure in the left menu. For adding CBS 3, click on CBS 2 in the tree, and then click “Add CBS”. After this, provide name and description and click “Update”. Deletion of CBS 3 is also intuitive.

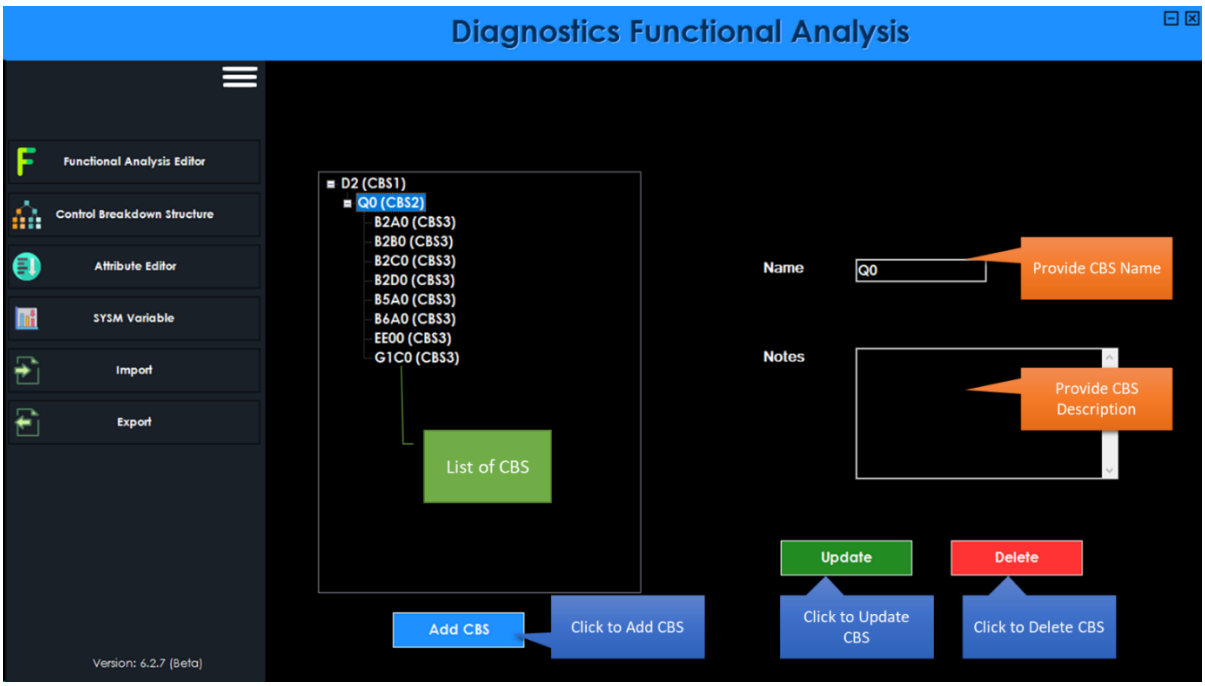


Figure 3-1: Edit Control Breakdown Structure

4 Use Excel file to Create Functional Analysis

4.1 Create Functional Analysis Excel file

Following is the template for the excel file. Download the latest template from RD1.

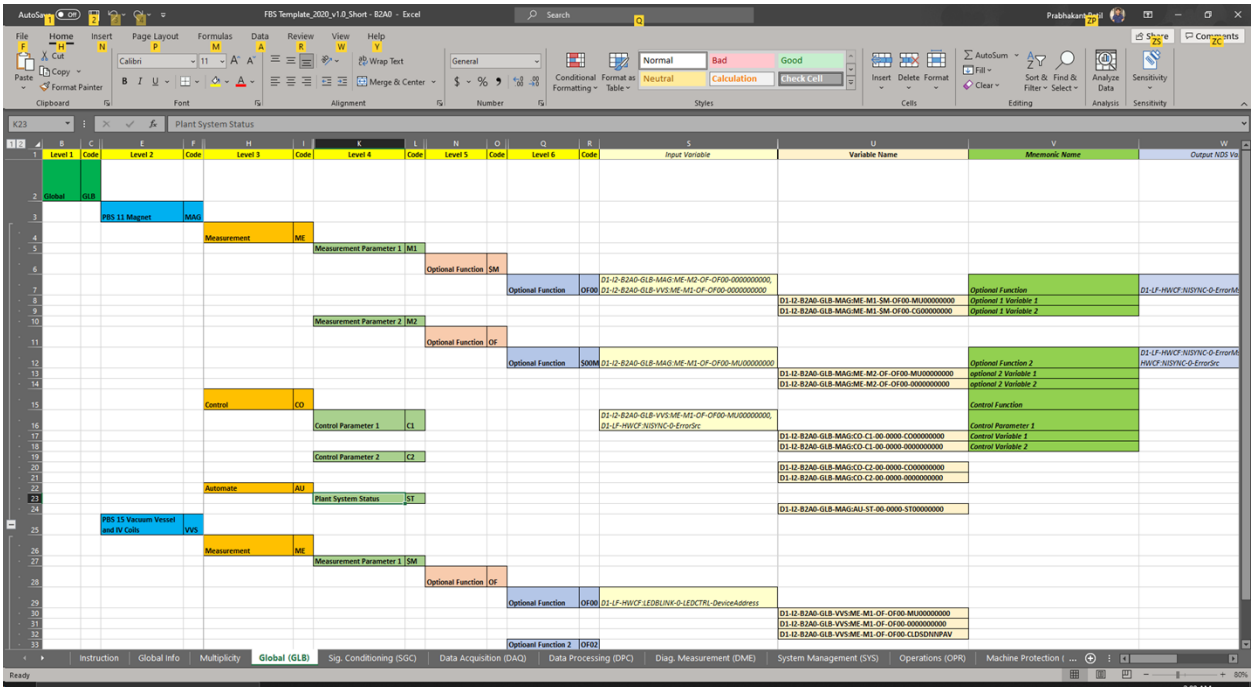


Figure 4-1: Excel template

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

4.1.1 Understanding the FBS excel file

1. Excel template has the different worksheets which represent FBS level 1 breakdown.
2. There is also a global info sheet which contains mainly the attributes 1..5 and their respective codes. It also contains the possible options for other fields, about which the detailed explanation will be provided at the relevant sections.
3. Then for each worksheet, we have FBS level 2 functions and their codes (both of which should be preferably the same as in the template).
4. The developer can define Level 3 onwards, both function names and their codes, as per his system design. Refer Figure 4-1: Excel template.

The ID columns in the worksheets (A, D, G, J, M, P) must be ignored, while developing the excel file.

The rationale behind the functional breakdown is explained in RD4. Additional guidance on how to use this guideline is discussed in RD7.

5. Important note 1 : The FBS excel file has functional breakdown up to level 6. For variables to be successfully imported to the EA project, please ensure that variables are defined for the functions at Level 4 and above and not below.
6. Important note 2 : In the current implementation, while defining functions (at the lowest level) in the FBS file, it is important to have at least one output Plant I&C variable.
7. The figure below is also important to understand.

Level 6	Code	*Input Variable*	ID	Variable Name	*Mnemonic Name*	*Output NDS Variable*	Description
Example	CU00	Input Var1, Input Var2, NDS Var1			Mnemonic name 1	NDS Var2	Descr 1
				D1-CD-AB00-DME-BCO:LC-P1-D0-CU00-CGRWPNCUSP	Mnemonic name 2		Descr 2
				D1-CD-AB00-DME-BCO:LC-P1-D0-CU00-CGREPNCUSP	Mnemonic name 3		Descr 3

- 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 output 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.

Figure 4-2: Example of a Plant I&C function

- Mnemonic names are an additional name space provided for naming the functions and variables.
- *For defining NDS variables refer section 5.*
- For a function, input variables are defined in column "Input Variable". The output variables are defined in two columns i.e. a) Column "Variable Name" for output Plant I&C variables b) Column "Output NDS Variable" for output NDS variables.
- Input variables (which can be Plant I&C, SYSM* or NDS variables) must be defined as comma separated or using new line characters. For eg. for function D1-CD-AB00-DME-BCO:LC-P1-D0-CU00, Input Var1, Input Var2, NDS Var1 are defined as input variables (note: the variable names here are put as examples only, and do not confirm to the variable naming rules).
  * SYSM variables cannot be defined as input variables in the Input Variable column. Refer section 6 for the reason behind this.

- Input variables for a function must be defined in the adjacent cell in the same row as shown above.
- More than one Plant I&C variables must be defined in different excel rows (not the same as function), as shown above.
- Mnemonic names must be defined in the same corresponding row. This provides another namespace for the variables and functions. It is an optional field.
- Output NDS variables must also be defined in the cell in the same row as comma separated or using new line characters.

8. The FBS excel file has also other columns. Attributes 1 .. 5 (column Z..AD). Refer RD3 to know about the attributes.
9. The next set of fields are:
    a. Archive – Mark whether the variable is to be archived or not. (Yes/No)
    b. Upper Limit – Upper limit of the variable
    c. Lower Limit – Lower limit of the variable
    d. Alarm – Mark whether the variable has an alarm associated with it or not (Yes/No)
    e. Alarm Low Limit – self explanatory
    f. Alarm Low Low Limit – self explanatory
    g. Alarm High Limit – self explanatory
    h. Alarm High High Limit – self explanatory
    i. Available on HMI – whether the variable is visible on the HMI (Yes/No)
    j. Unit - self explanatory
    k. Hardware Allocation – the hardware on which the variable resides. Please use the names of the hardware as per the PCDH component naming guideline (ITER_D_2UT8SH). Note: slow controller variables reside on the PSH.
    l. 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 ITER_D_2UT8SH).
    m. Status – Indicates the status of the variable/function (Proposed/Approved).
10. The fields *Alarm Type* and *Alarm Priority* in the template are deprecated, and must be ignored.
11. The fields *Data Type*, *Data Kind*, *Category* are implementation specific, and do not need to be considered for Design phase. More details about these fields in SDD user manual (ITER_D_32Z4W2).
12. *Priority* field is optional.
13. There is also support for multiplicity of channels in the FBS excel file. If you plan to use this feature, please read sections 4.1.2 and 4.1.3 before working on the excel file.

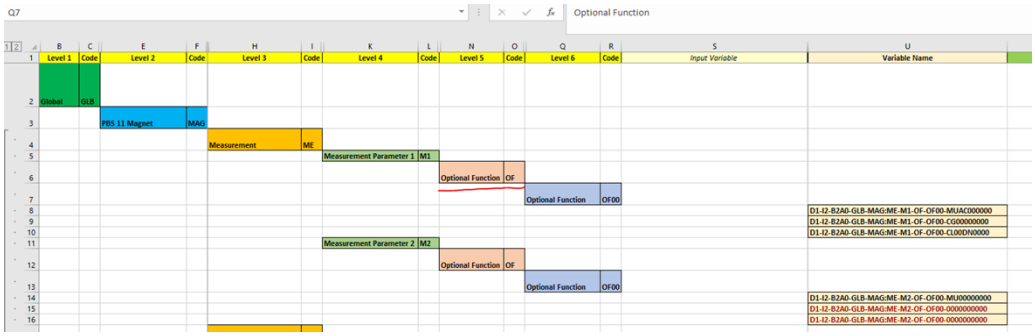
4.1.2 Working with the FBS excel file

1. First point to note is the coding convention of functions at each level. This is represented in the table below:

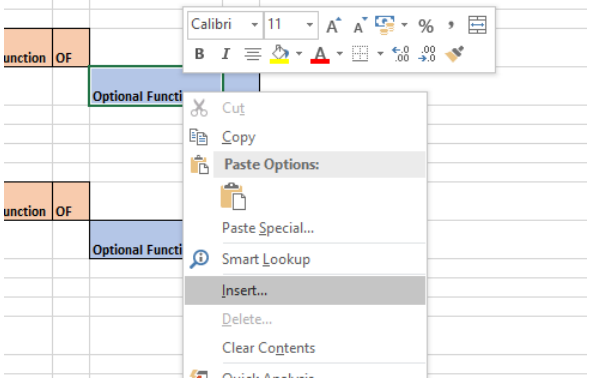
Function level	Code convention
FBS 1 (Column C)	3 characters (e.g. GLB)
FBS 2 (Column F)	3 characters (e.g. MAG)
FBS 3 (Column I)	2 characters (e.g. ME)
FBS 4 (Column L)	2 characters (e.g. M2)
FBS 5 (Column O)	2 characters (e.g. OF)

FBS 6 (Column R)	4 characters (e.g. OF00)

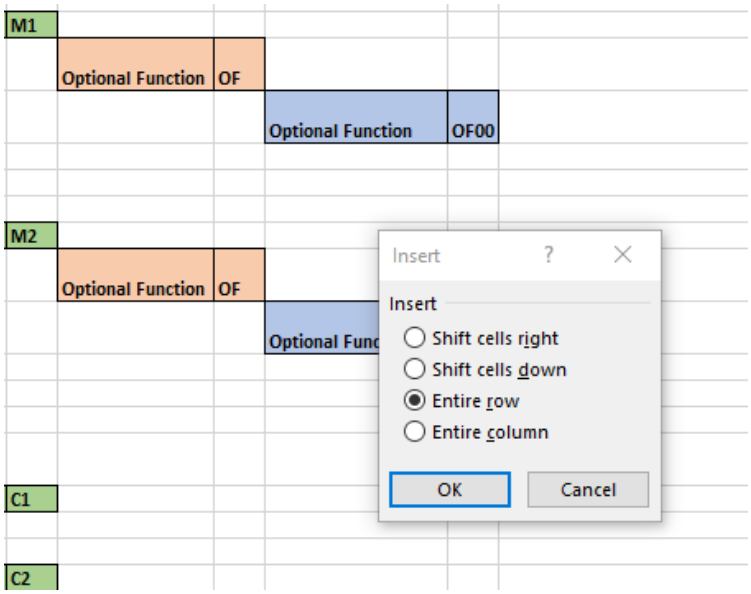
2. For creating a new function at any level, follow the steps below:
   a. Suppose a level 5 function needs to be created above the marked function in the figure below.



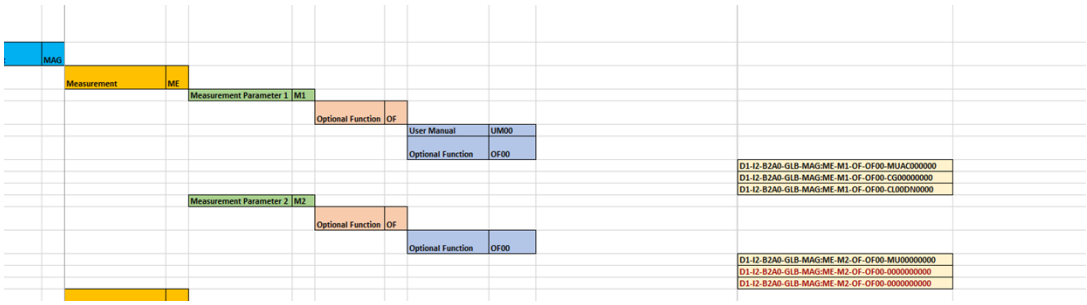
   b. Select cell Q7, and right click, and select Insert



   c. Then select Entire Row.

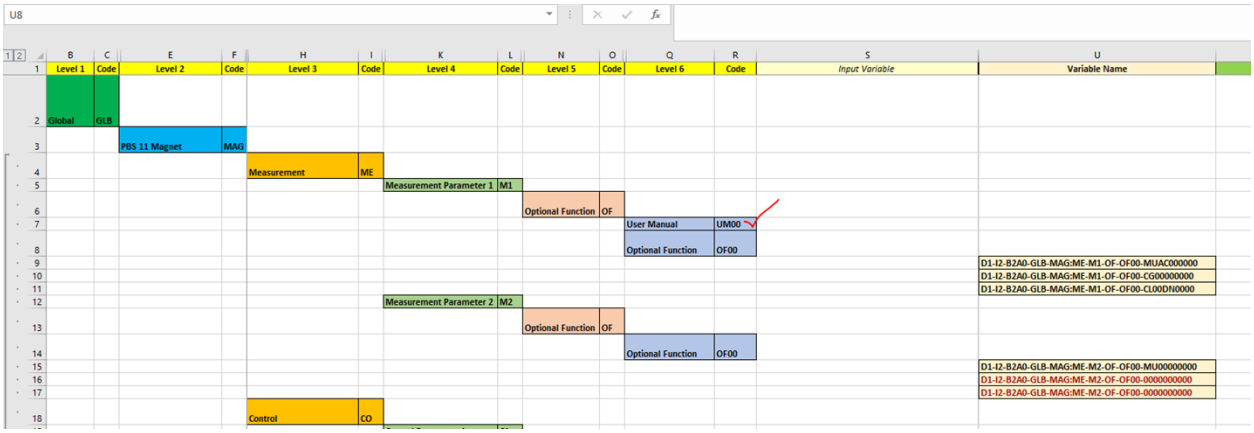


   d. An empty row gets created.
   e. Add the name of the new function and its code. The new function gets added.

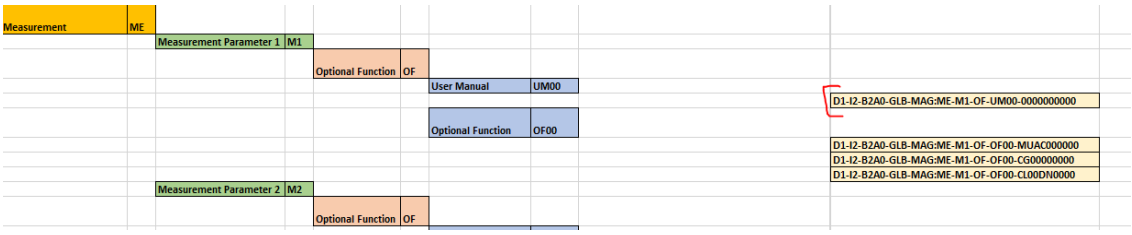


f. Note: Child functions should not have the same function code.

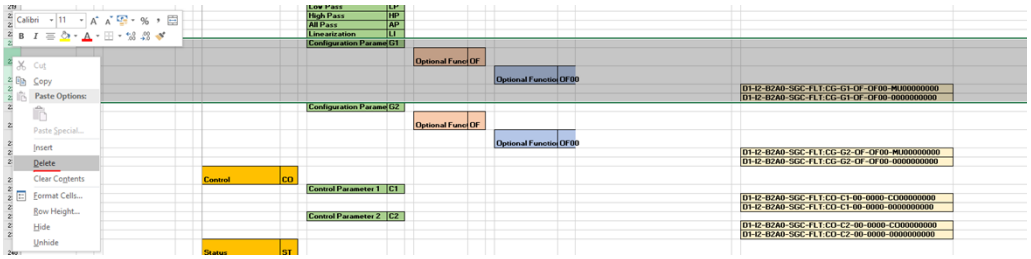
3. For creating variables, Insert a new row (Right click >> Insert. Select option Entire Row). The new variable will be added automatically. For example for creating the variable (Plant I&C Output Variable, to be specific) related to function "User Manual" as shown below



Right click on cell U8 (very important to note) (i.e. the cell where the variable should be formed), and then insert → new row. The variable gets created as shown below. In this same way, multiple variables can also be created (which must differ from one another in the name, through use of different attributes).



4. For deleting the functions or variables, please use the delete row functionality of excel. For example as shown below, for removing the function and variables under the function with code "G1", select the appropriate rows (5 in number, in example below) in the excel and then right click and click Delete.



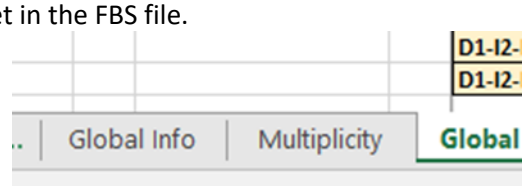
Note: Please be prudent while selecting the rows for deletion. This is because; the variables are named by using the codes of the functions at different levels. If some of the functions at different levels are deleted, the variable name does not get updated automatically.

5. After the variables have been defined, the attributes and fields related to the functions and variables must be completed. Refer section 4.1.1.
6. Note: For all the fields which are not yet known or not applicable, TBD or NA should be used respectively.

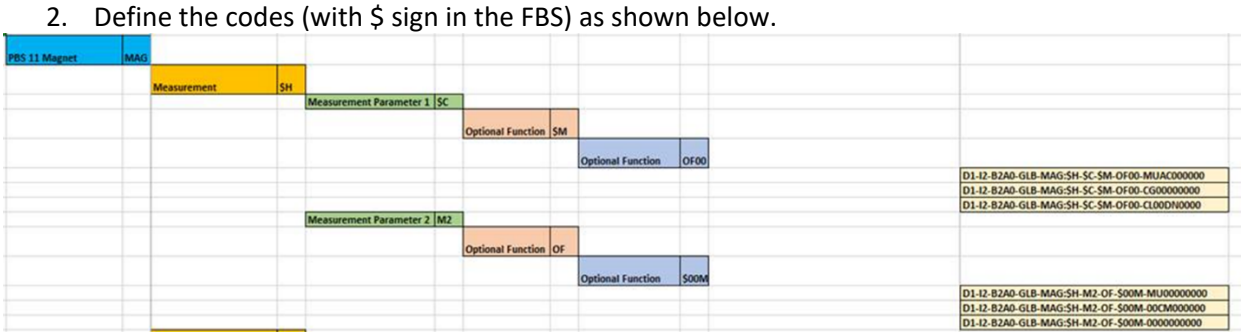
4.1.3 Multiplicity feature

Follow the steps below to use the multiplicity feature:

1. Add Multiplicity worksheet in the FBS file.



2. Define the codes (with $ sign in the FBS) as shown below.



3. Fill the multiplicity sheet as per the system design. So, as in the example below, $M will be replaced by M1…M4.

A	B	C	D	E	F
$M	M1	M2	M3	M4	
$C	CM	CD	CS	CF	
$00M	00M1	00M2	00M3		
$H	H9	H8			

4. Small example to demonstrate how multiplicity feature works, please refer the example here. The example has the source excel file and the EA project to which the file was imported.
5. Note: Special attention needs to be paid while designing the functions with multiplicity.

a. For functions which use the multiplicity feature, input variables and output NDS variables cannot be defined with variables, which themselves contain multiplicity. This is not foreseen. This need has been discussed for systems (55.E7 RXC and 55.GB ECH Detectors), and agreed that we do not need this mapping for all the channels.
b. For systems, which use the multiplicity feature, it is sufficient to demonstrate the input variables and output NDS variables, for only one representative channel of each type.
c. So, if you have a system with 95 similar channels. Then, you must define
    i. one channel of that type without multiplicity, which can be used to demonstrate the signal chain (input variables and output NDS variables) Eg. Channel 1
    ii. one channel of that type with multiplicity (where multiplicity values will run from 2..95)

4.2 Import Functional Analysis Excel file

Once the import file is fully completed, it should be imported to the EA project.

1. Right click Project root **<CBS1>-<CBS2>** (for example, D2-Q0) and select **Extensions >> Functional Analysis Add-in >> Functional Analysis Editor.**

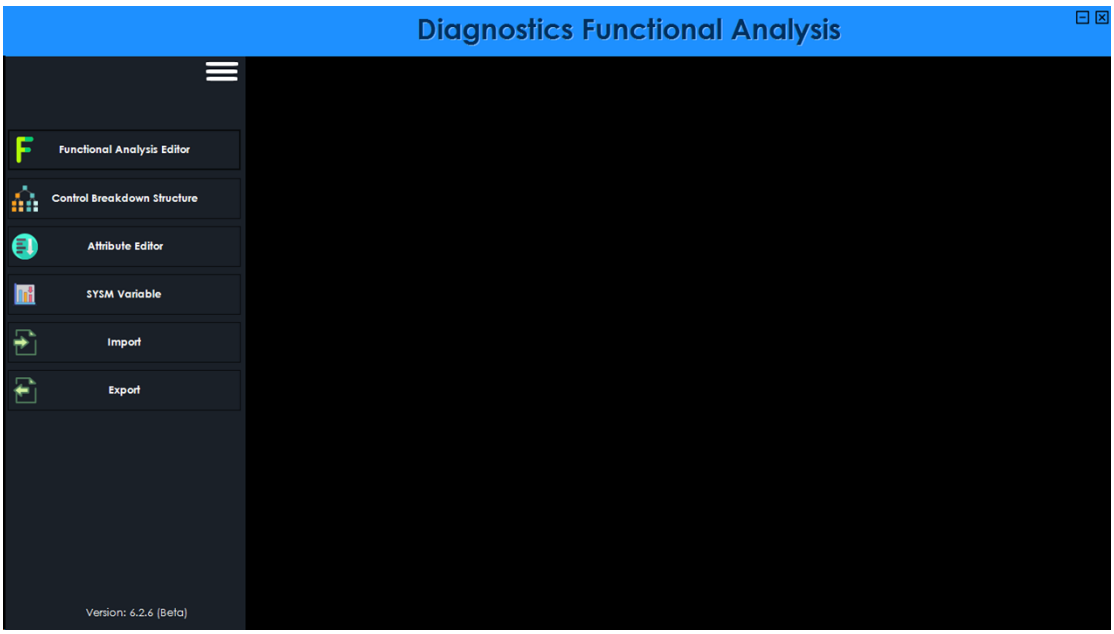


Figure 4-3:Functional Analysis Add-in

2. Click on Validate button to Validate Excel file.

Note: If the validation fails, then an error log will be generated.

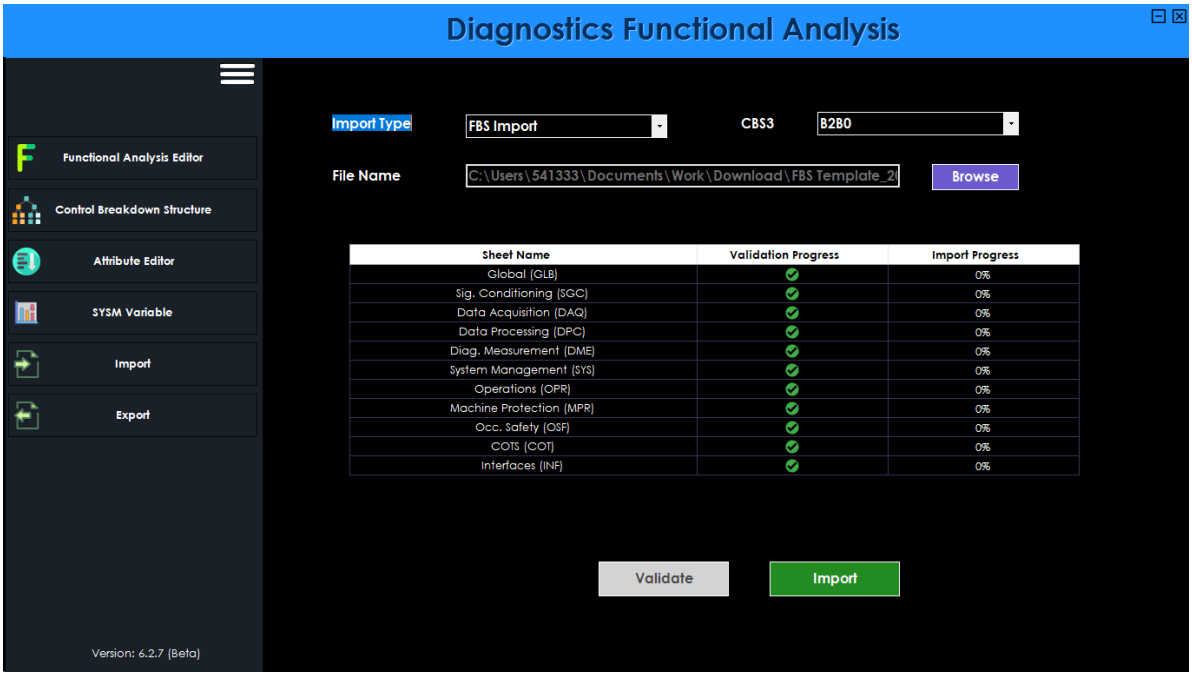


Figure 4-4: Validate Excel file

3. Click on Import Button to Import Functional Analysis.
   a. If there is no multiplicity and if the validation is successful, then the functional analysis file will be imported to the EA project.
   b. If the multiplicity exists in the imported sheet, then a message box as shown below appears. At this stage, the input excel file has been imported to the EA project, but with the $ placeholders. So, the user must replace these $ placeholders with the relevant codes. This process has been referred to as **cloning** henceforth.

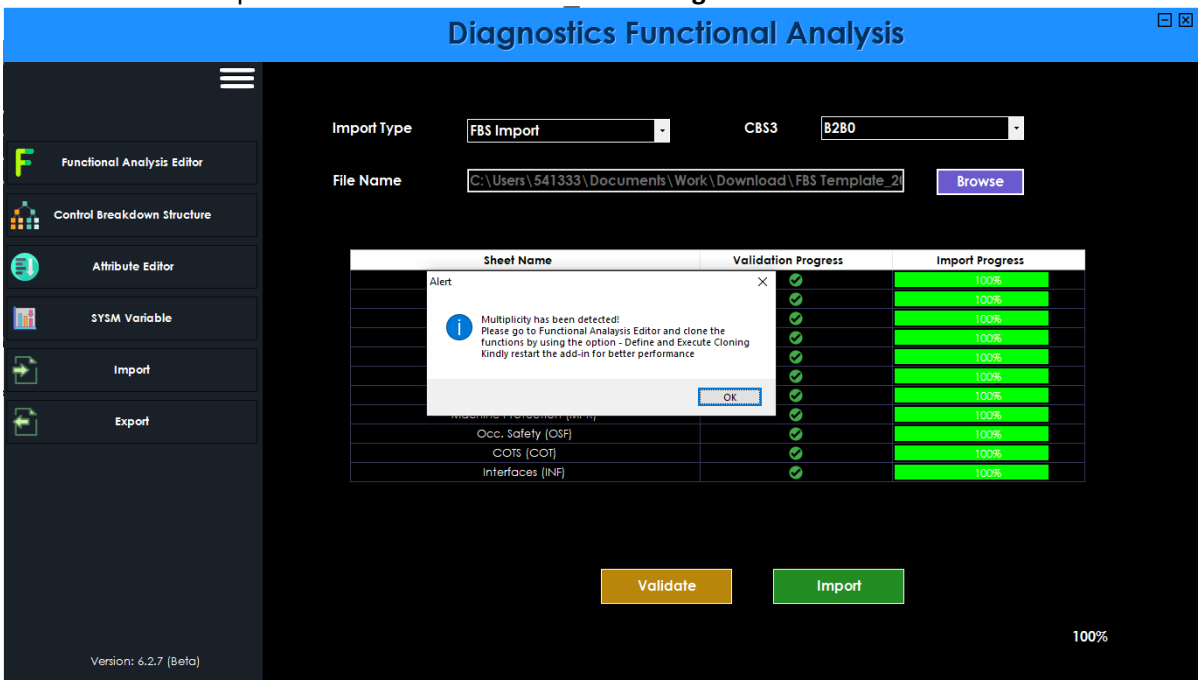


Figure 4-5: Functional Analysis Imported

4. With this message as shown above, you will need to restart the add-in. The user must now execute multiplicity, as explained in the following section.

4.2.1 Execute Multiplicity

1. Right clicking on the function, which needs to be cloned, will give an option of “Define and Execute Cloning”.

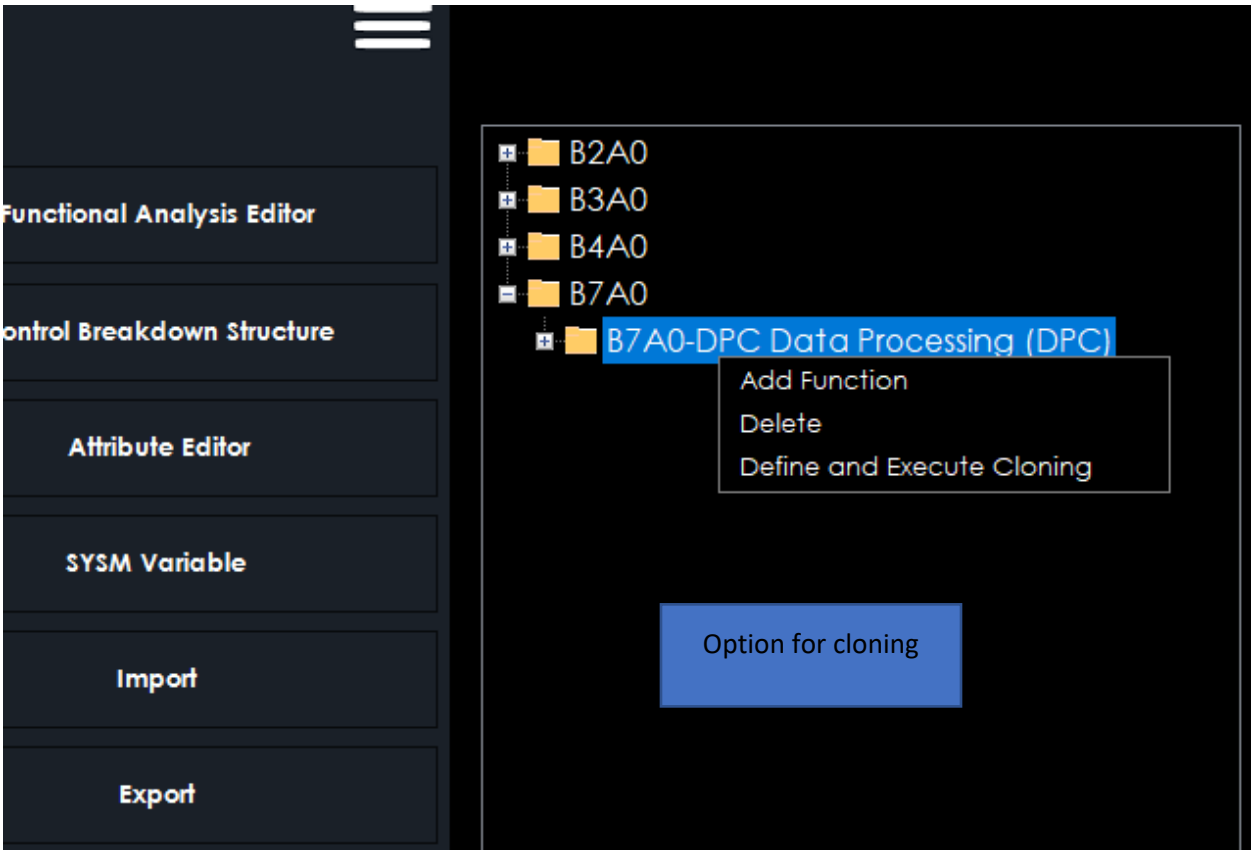


Figure 4-6: Functional Analysis Editor – Cloning Option

2. Clicking on the option will open the Cloning Form for the function.

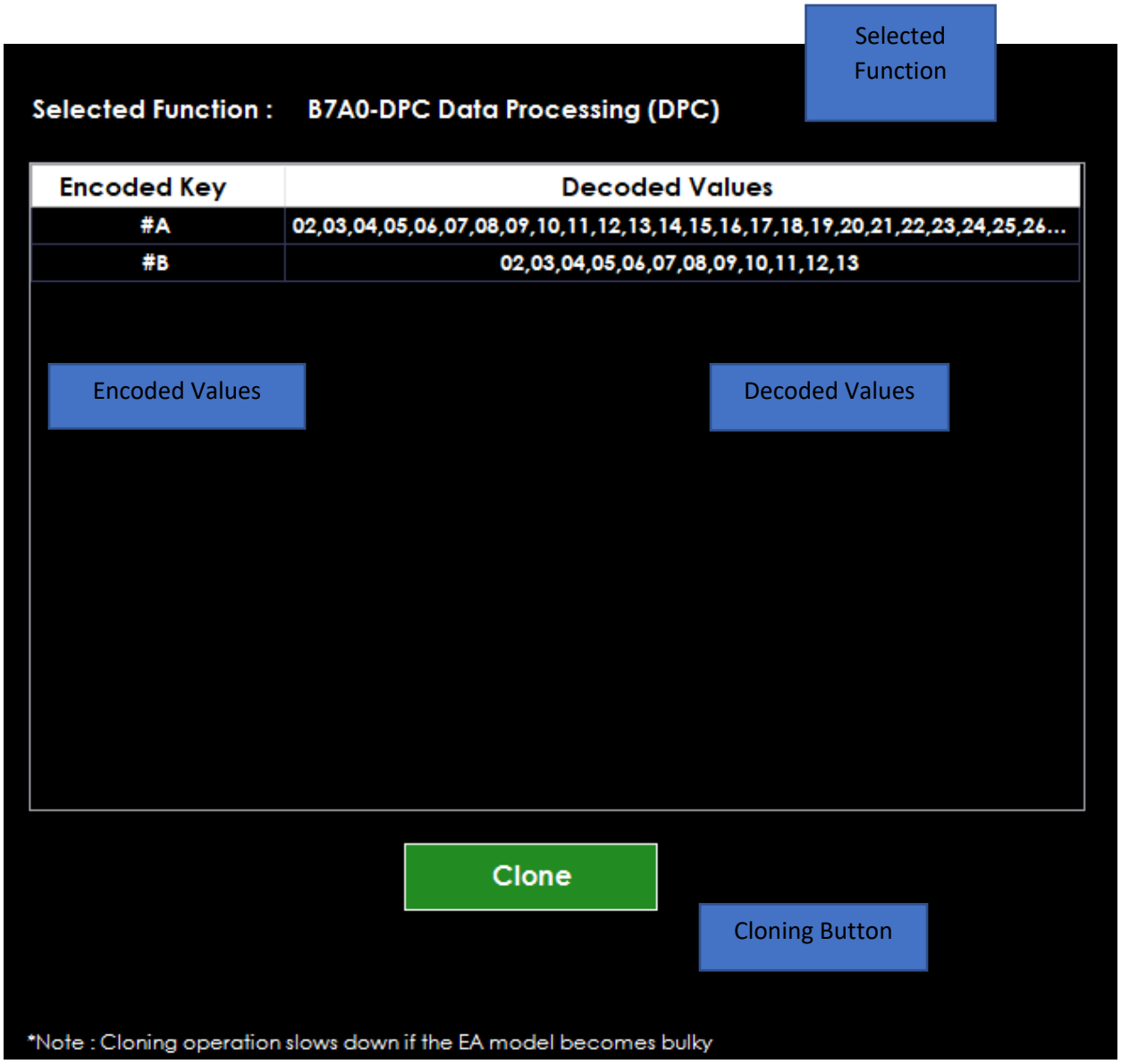


Figure 4-7: Cloning Screen

3. Clicking on the “Clone” button will start the cloning operation.
4. Note: If the count of the functions to be cloned is more than 300, which is an EA limitation, a popup message will appear asking to clone from a level lower than existing. See figure below.

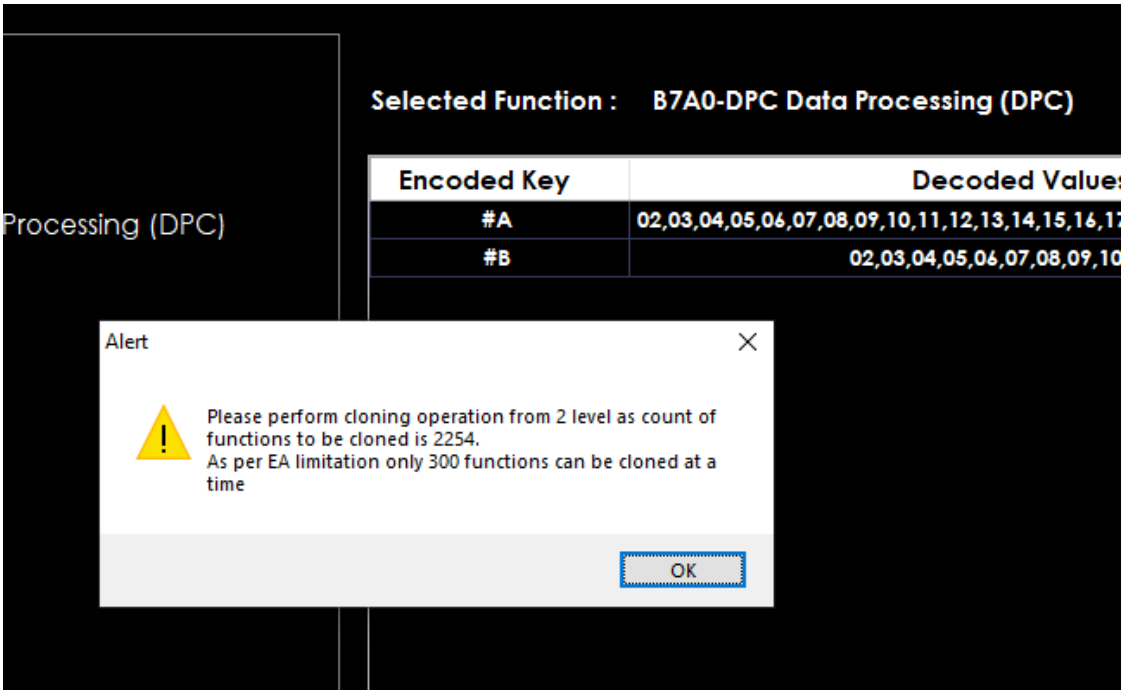


Figure 4-8: Count exceeds message

5. At this moment user must go to lower level and repeat the same steps.

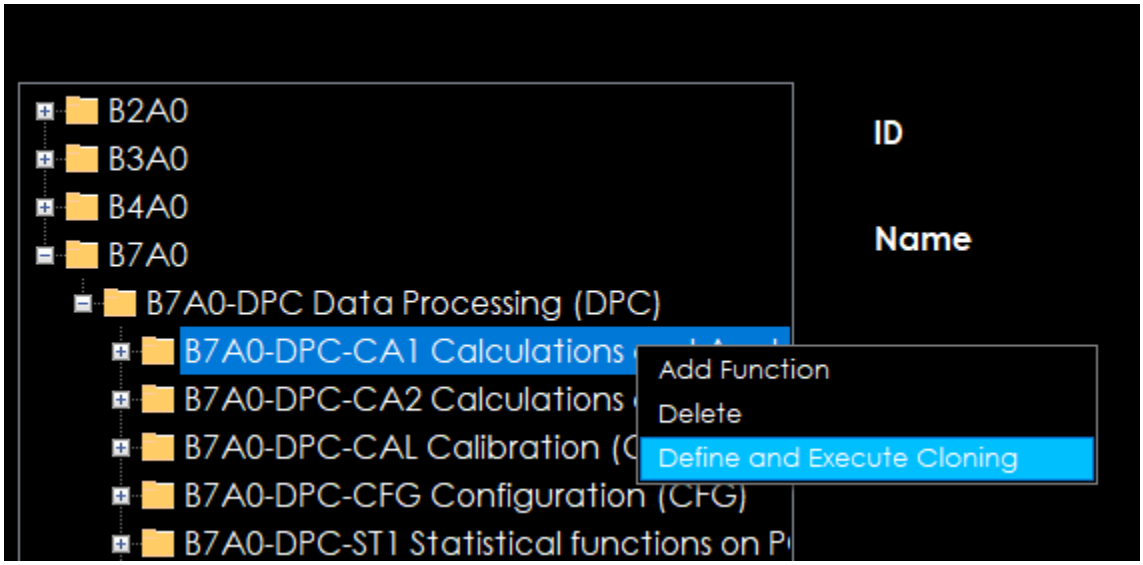


Figure 4-9: Cloning Operation from Second Level

6. In case, lower level also shows the same kind of message, then user will have to go to lower level again and perform the same steps. This iteration can at maximum go up to third level. For reference B7A0-DPC-CA1 is level 2.

7. After the cloning operation starts, progress bar will show the count of the function which are cloned / total function that need to be cloned, in that particular instance of cloning. This is shown below.

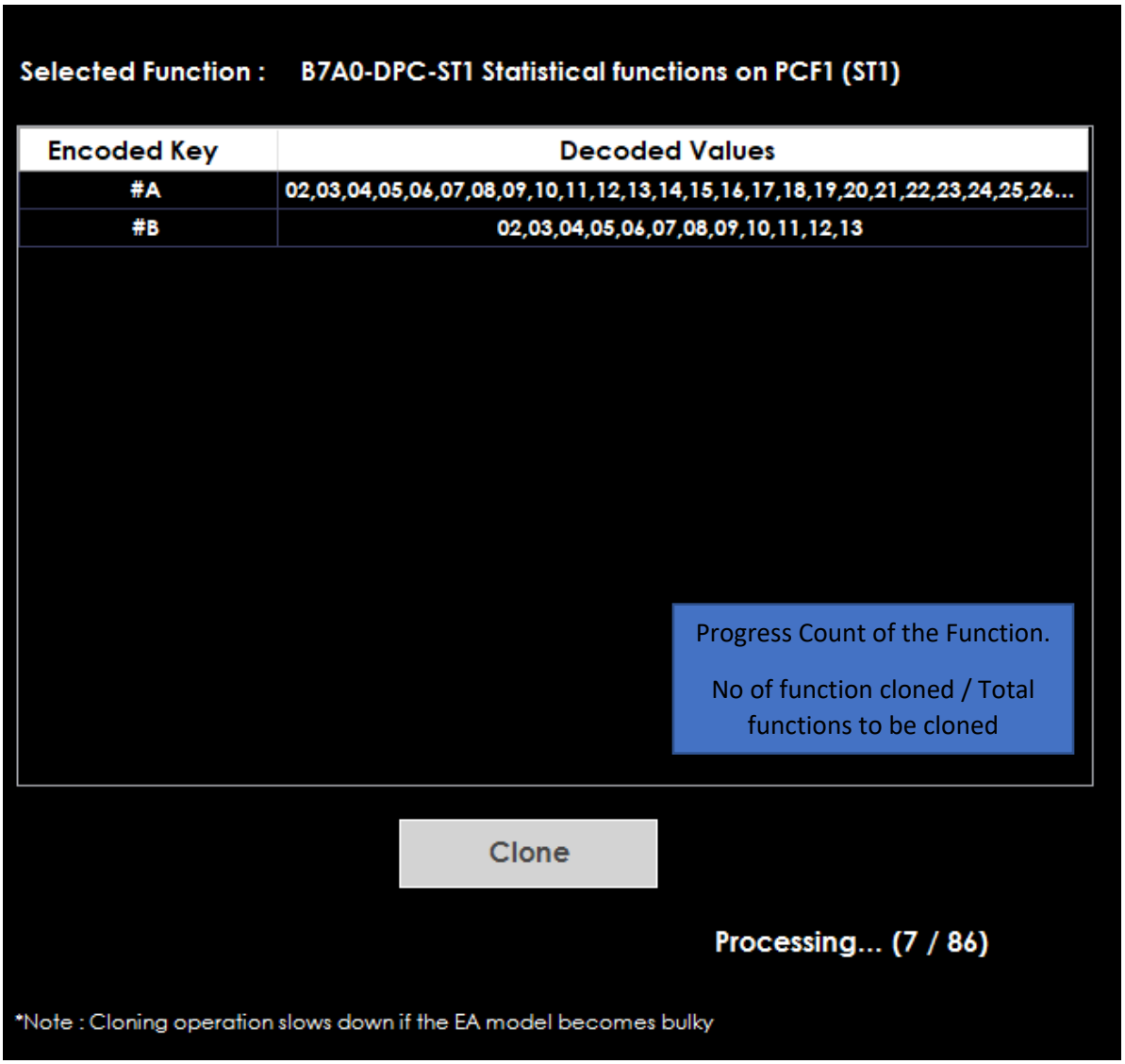


Figure 4-10: Cloning Progress Count

8. After the operation completes user will get a successful popup message.
9. Note: Clicking on a function, which has already been cloned, gives the below message.

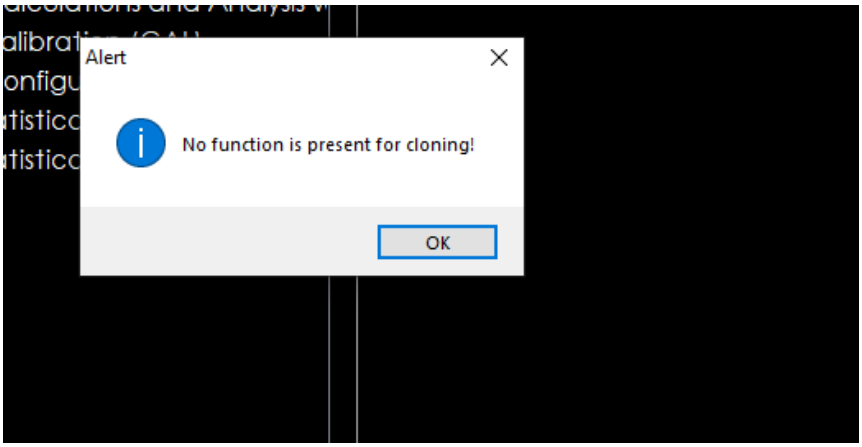


Figure 4-11: No encoded Value Message

4.2.2 Case of re-import of FBS excel file

Please refer the flowchart below, to understand the implications of reimporting the FB excel file.

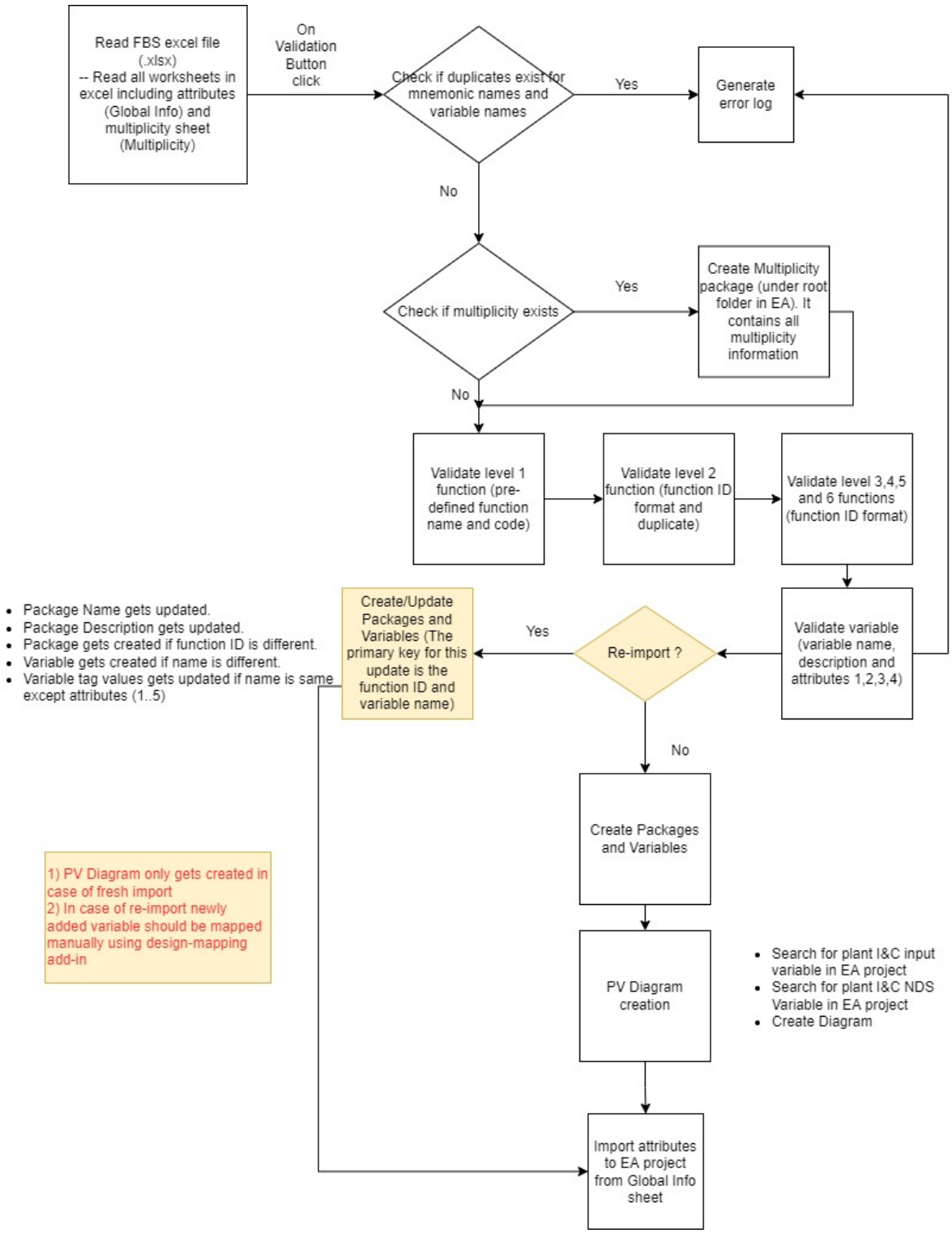


Figure 4-12: FBS reimport process

4.3 Export Functional Analysis

Click on Export Button to Export Functional Analysis. Note: The exported FBS excel file will always be without the elements of multiplicity, even though the import file had multiplicity within it.

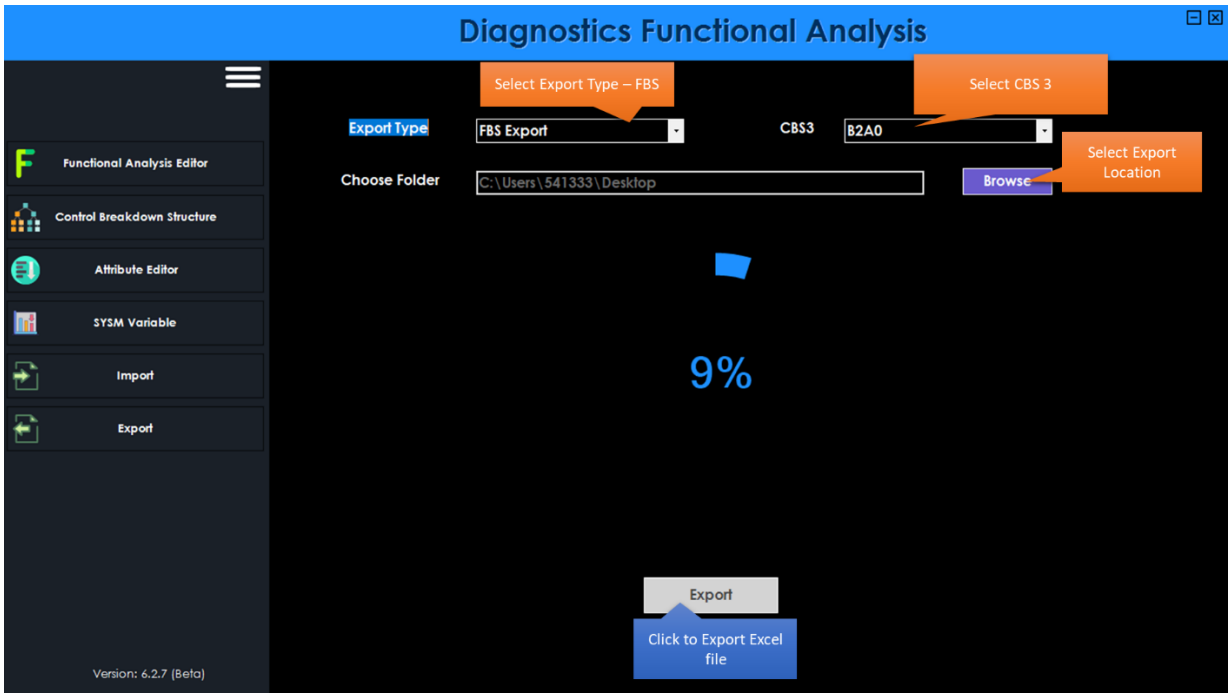


Figure 4-13: Export Functional Analysis

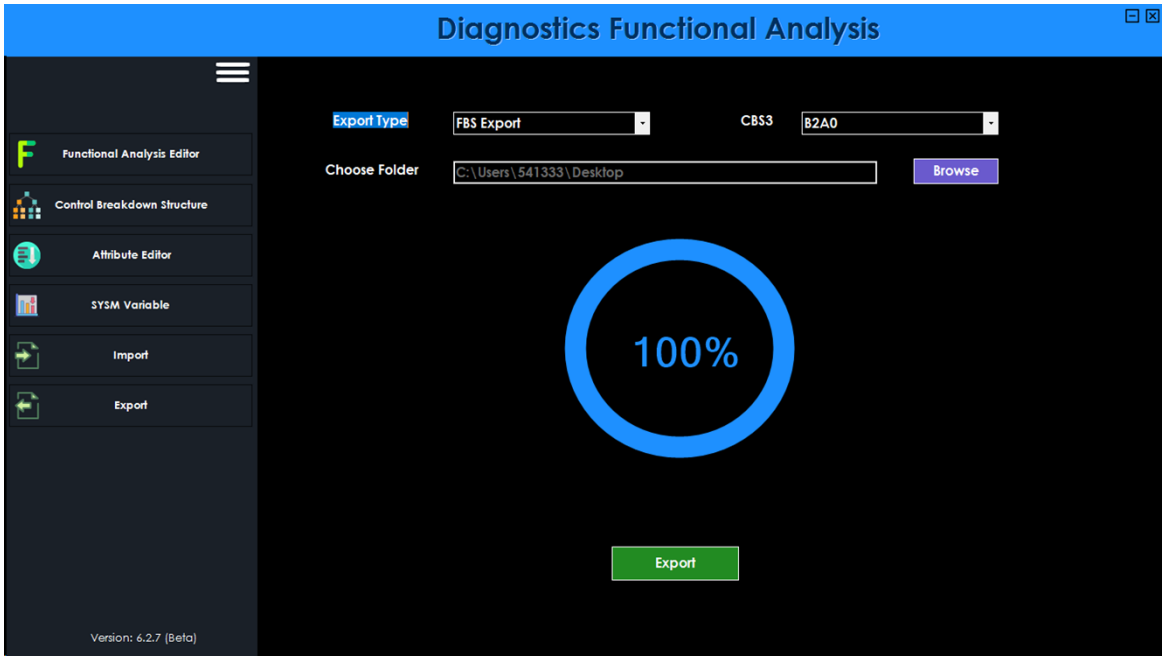


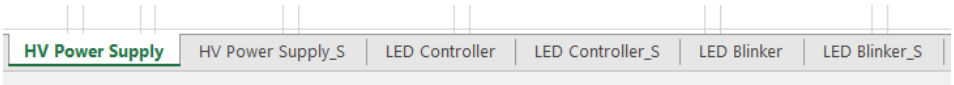
Figure 4-14: Export Successful

5 Import NDS Variables

RD5 is the template and example for defining the NDS variables.

The steps below, explain how to prepare the NDS import file.

1. The different NDS devices can be segregated into different worksheets as shown below.



2. For understanding, the functions of HV Power Supply are shown below.

| Variable name | | |

5. In this template file, the concept of placeholders (or macros) has been used to facilitate dealing with multiple channels. This is similar to multiplicity feature of FBS.

   A placeholder (or macro) is distinguished by a $ sign as shown in the figure below.

   $(CBS1) - $(CBS2) - HWCF : $(BOARDTYPE) - $(BOARDTYPEIDX) - Voltage_RBV

6. How this placeholder (or macro) needs to be replaced, is defined in the adjacent worksheet. This worksheet is named with a _S in the end.

   LED Controller | LED Controller_S

7. The contents of the _S sheet are as shown below

$(CBS1)	D1			
$(CBS2)	LF			
$(BOARDTYPE)	HVPS			
$(BOARDTYPEIDX)	0	1	2	3

8. After the import file has been prepared, import the NDS excel file into the EA project. Click on Import Button (in the left menu) and then select the Import Type as "NDS Variable Import" to Import NDS Variables. See figure below.

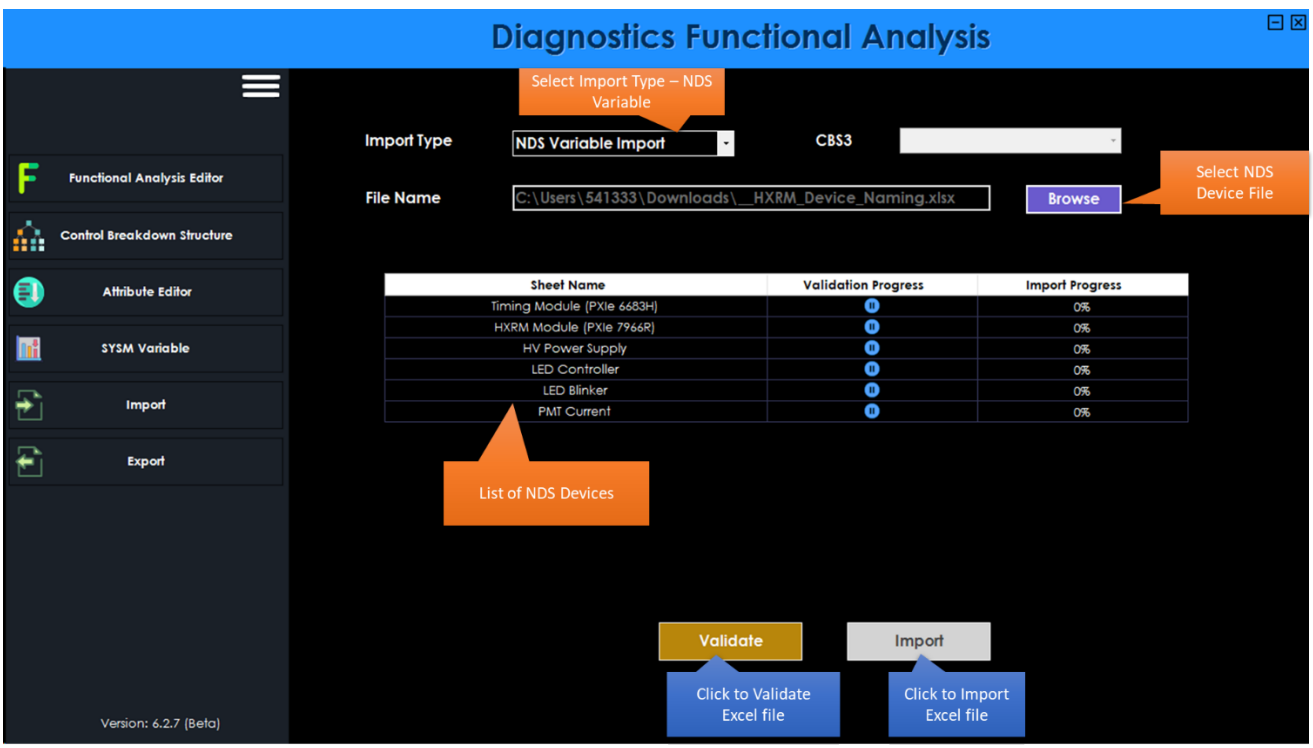


Figure 5-1: Select NDS Variable Excel File

9. Click on Validate button to Validate Excel file. In the validation, the only thing that is checked is that whether for every device worksheet there is a corresponding sheet detailing the placeholder values (i.e. _S worksheets).

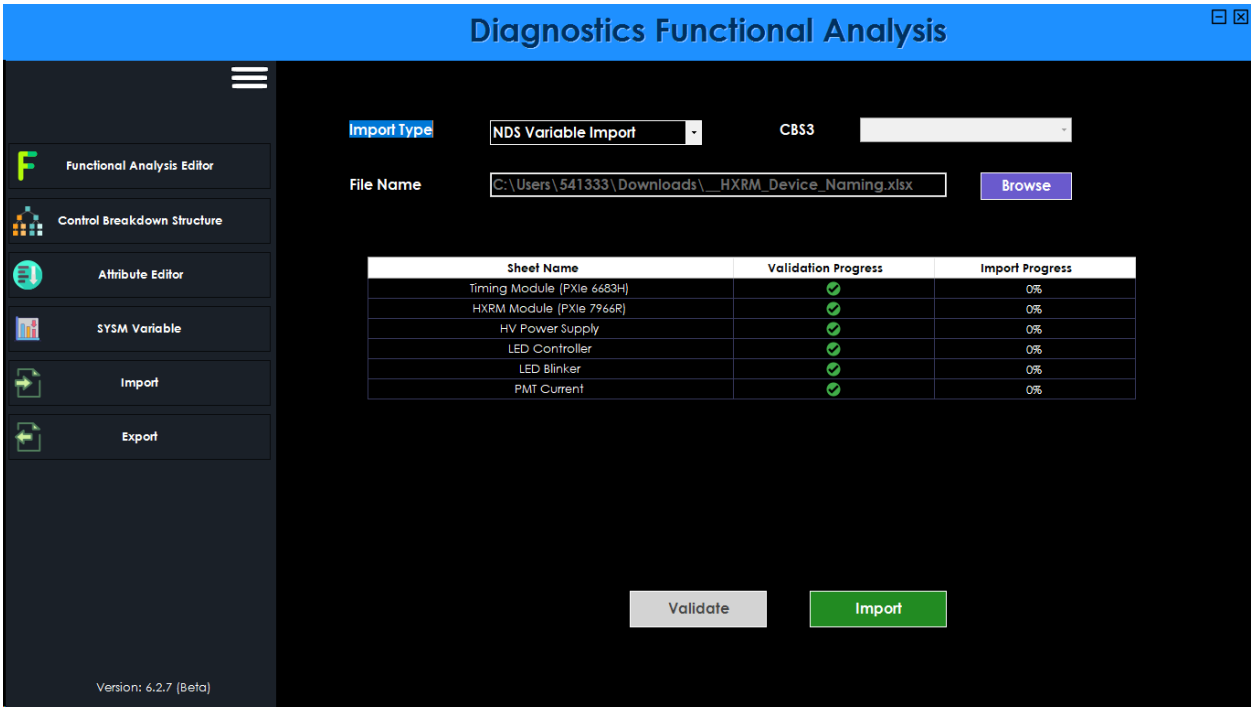


Figure 5-2: Validate Excel file

10. Click on Import button to Import NDS Variables. The variables will be imported to the EA project, as shown below.

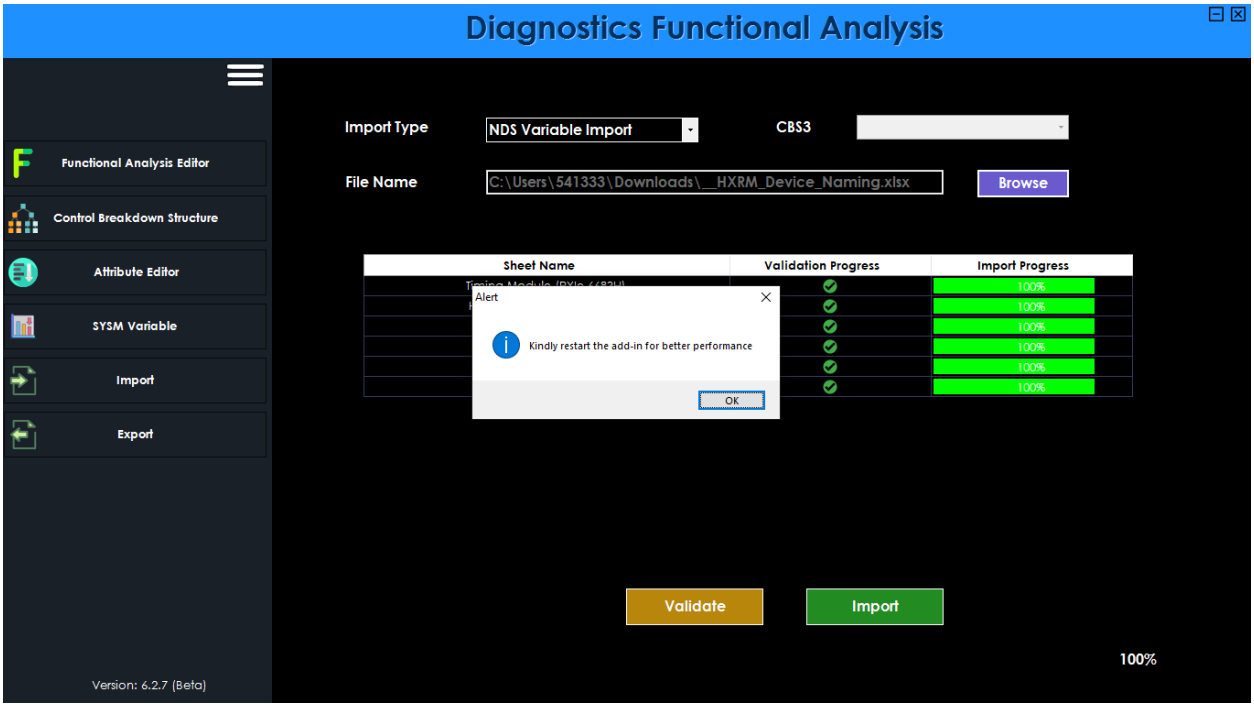
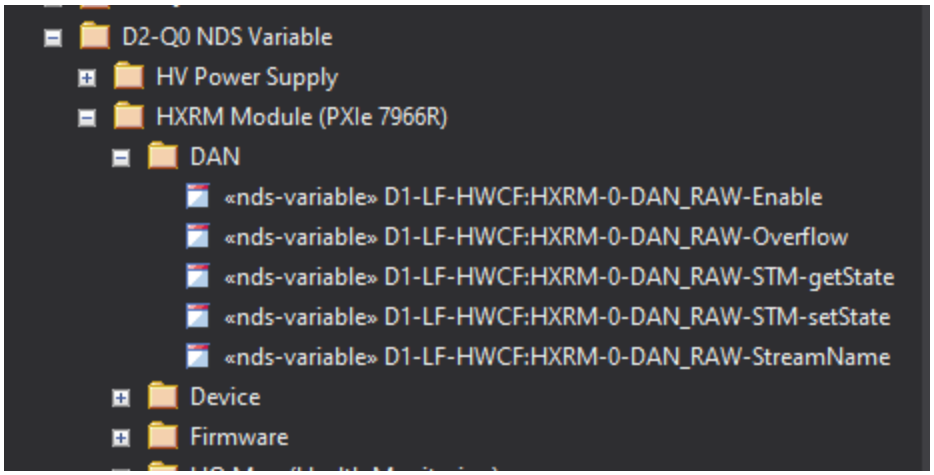


Figure 5-3: NDS Variables Imported Successfully.



5.1 Export NDS Variables

Click on Export Button (in the left menu) and then select the Export Type as "NDS Variable Export" to Export NDS Variables. See figure below.

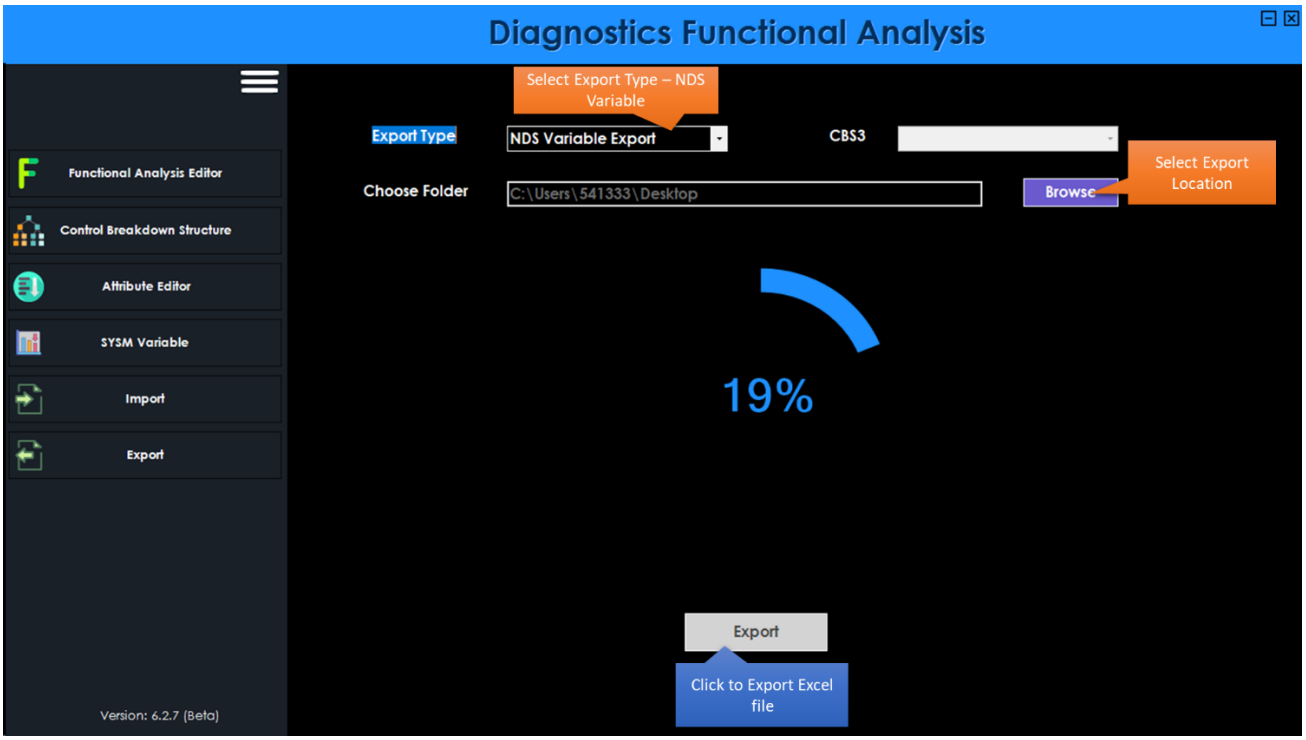


Figure 5-4: Export NDS Variables

6 Use SYSM variables

SYSM should be seen as standardized CODAC service which is injected to every component concerned during implementation. Hence, there is no provision to separately define SYSM variables in EA project. If SYSM variables are required to be used as input variables, then such information can be added to the description of the relevant function.

The naming of the SYSM variables is as per RD6, but it is not necessary to use exact variable names in the description of the function.

7 Other features of Functional Analysis Add-in

7.1 Add/Update/Delete Functions

1 Select function in the tree which has to be updated. Modify the information in the relevant fields and click Update.

2 Right click in the tree to Add/Delete functions. Note for adding functions: The right click must be done on a level higher than where the new function is desired.

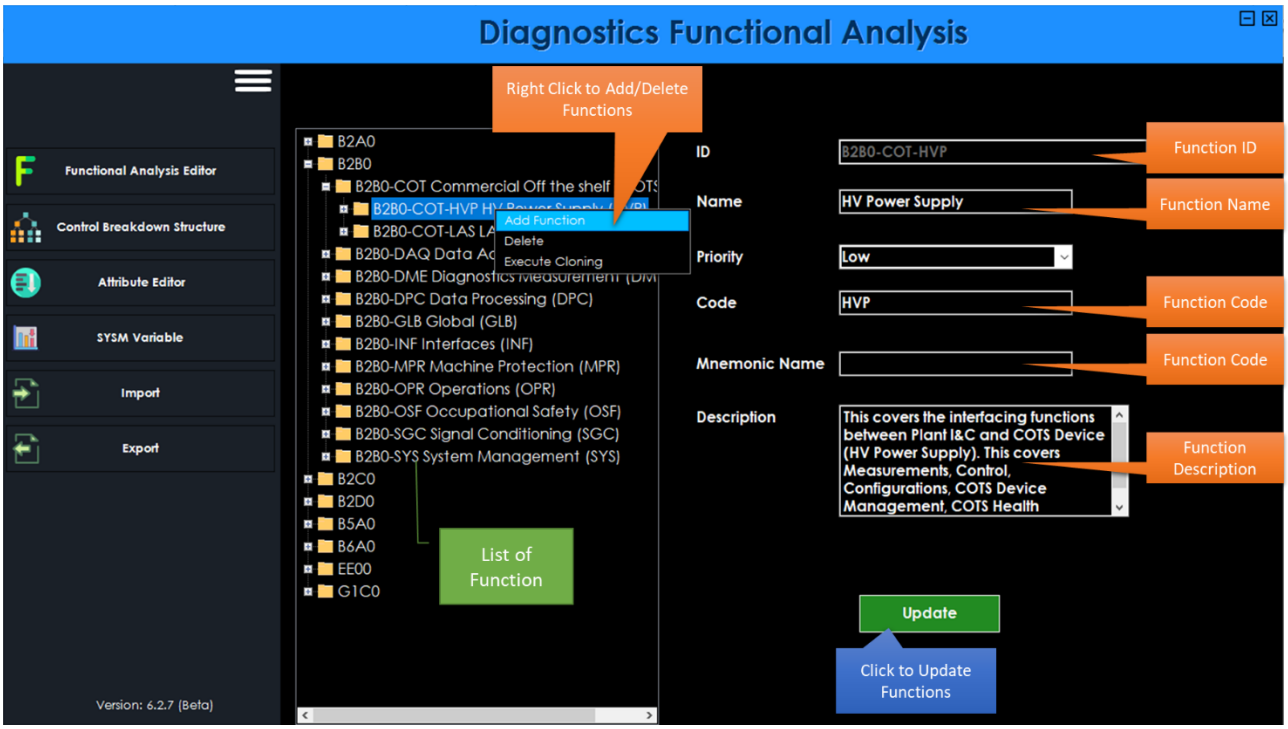


Figure 7-1: Update Function information.

7.2 Add/Delete/Update Plant I&C Variable

1 Right click on last level function to Add Plant I&C Variables.

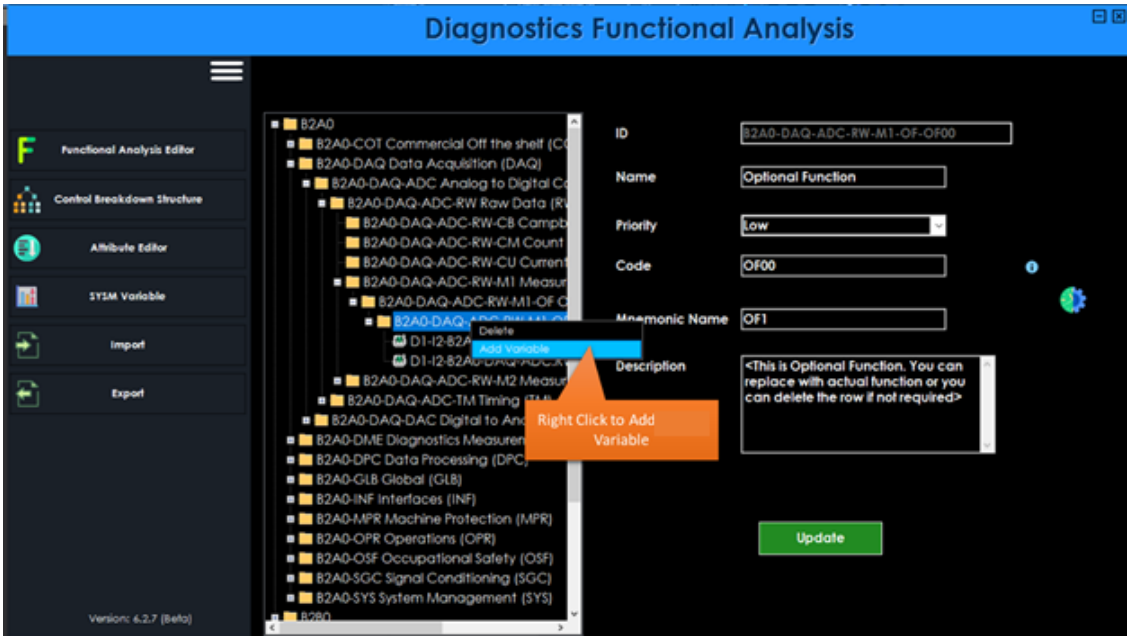


Figure 7-2: Add Plant I&C Variable

2 Provide all required variable information and click on Save Button to Add Variable.

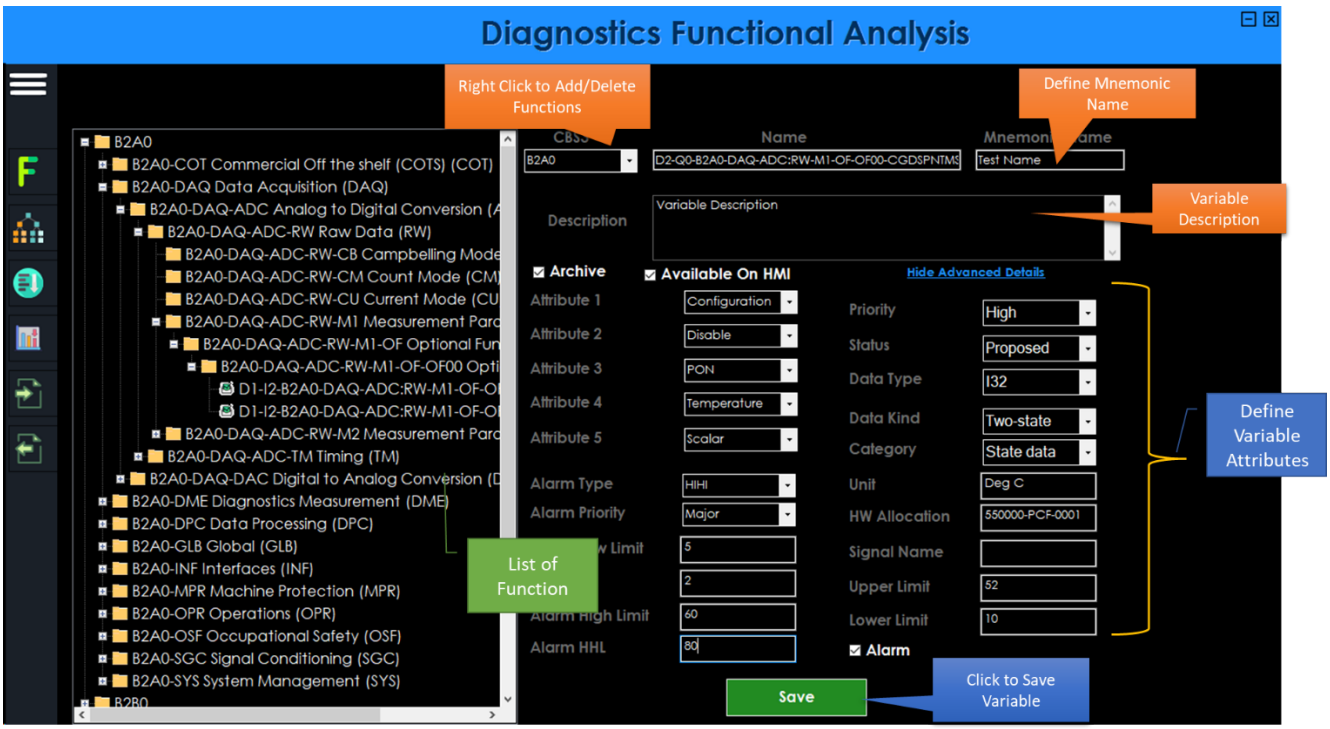


Figure 7-3: Add Variable Information

3 For deleting the variable, right click on the variable and click Delete. Also, note that if the function associated with a variable is deleted, then the variable also gets delete, which makes sense.

4 Updating the variable is same as updating a function, as explained in the section above.

5 =

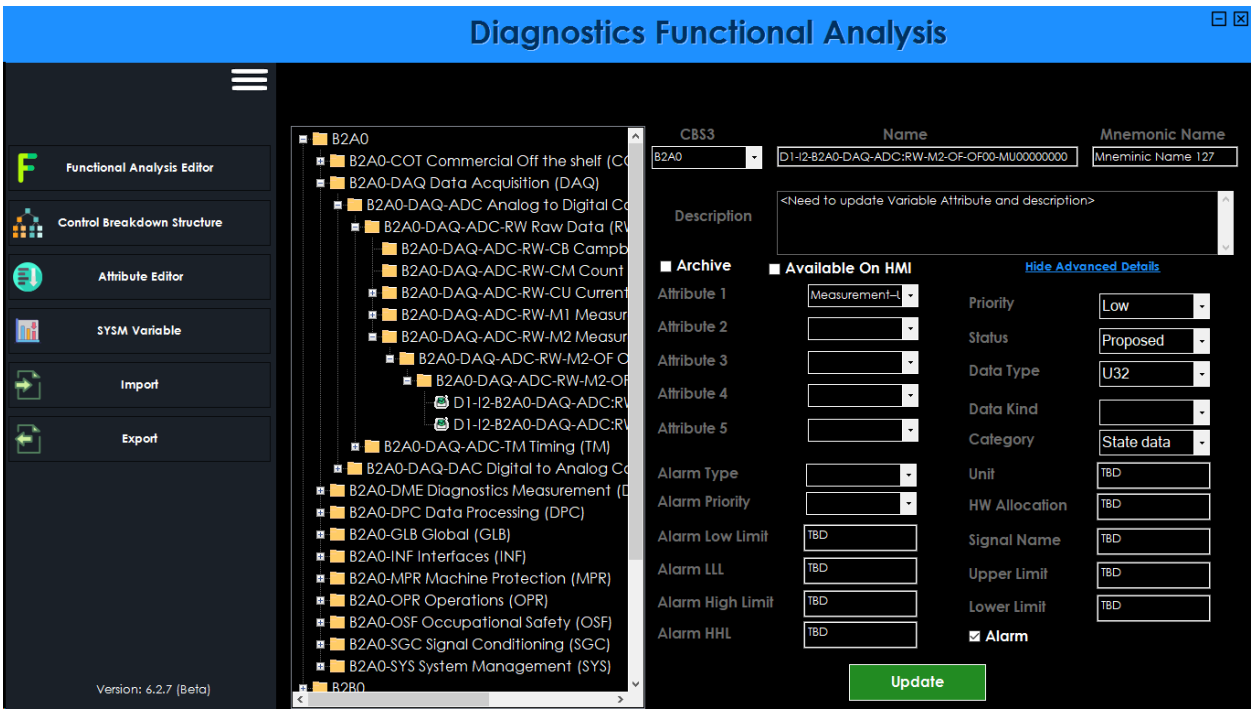
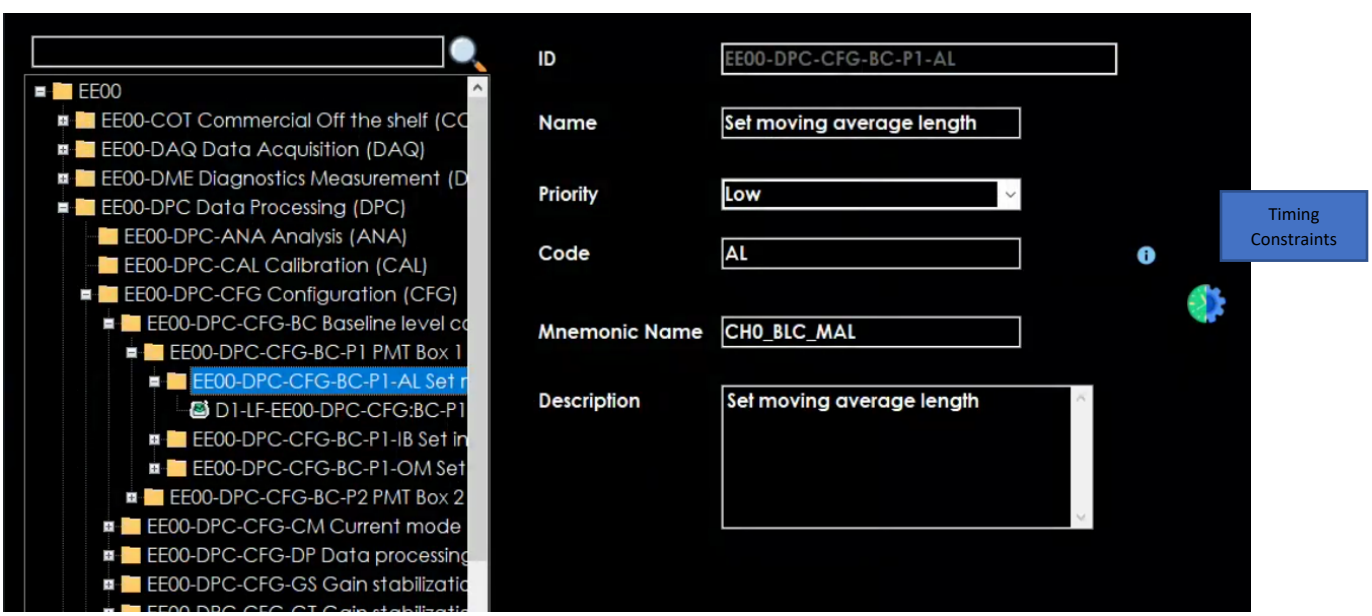


Figure 7-4: Update Variable Attributes and Information

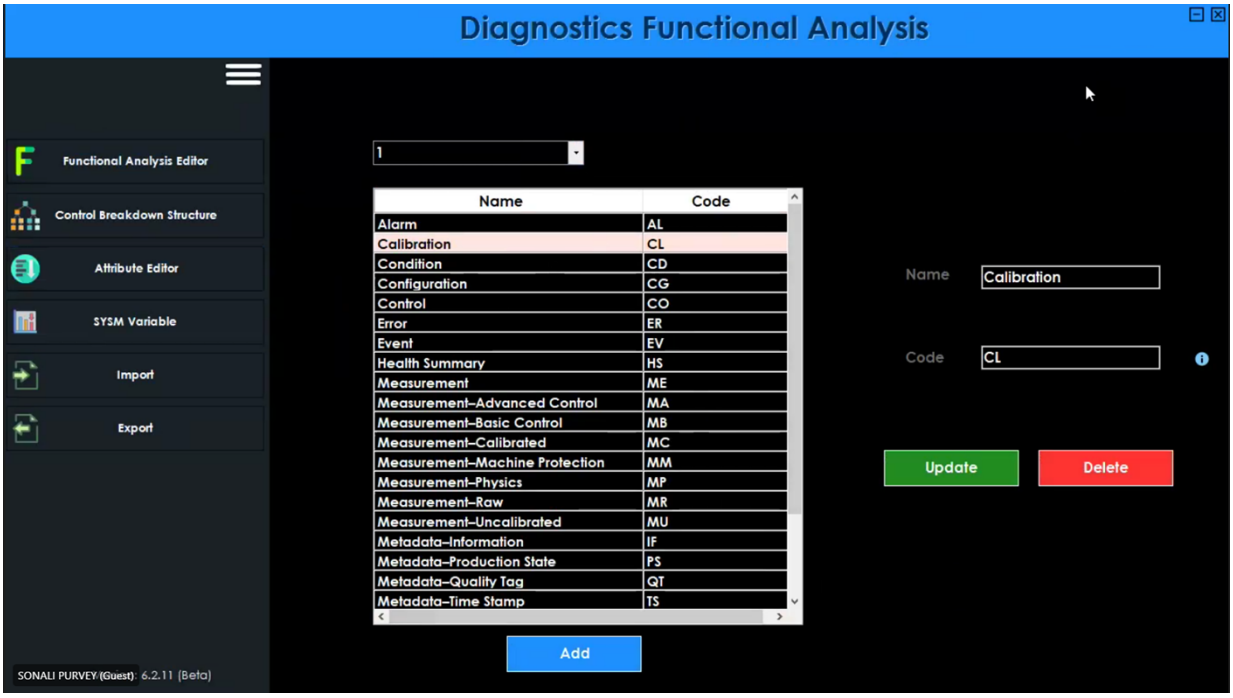
7.3 Timing Constraints

These need to be defined **only for** those functions, which have strict execution time constraints. Since, these need to be defined for only such functions, one way of add-in this information easily is using the add-in feature (update function) explained in section 7.1.

Note: These constraints are to be defined only for functions at the lowest level. Hence, this option is visible only for lowest level functions. See figure below.



There is also an option for importing/exporting timing constraints excel file. Please contact ea-support@iter.org , if you wish to use this feature.

7.4 Attribute Editor

Attributes can be added/deleted/modified from this page.