**Module Design Document**

**For**

**Sensor Offset Learning**

**Dec 7, 2016**

**Prepared By:**

**Shruthi Raghavan,**

**Nexteer Automotive,**

**Saginaw, MI, USAChange History**

|  |  |  |  |
| --- | --- | --- | --- |
| **Version** | **Description** | **Author** | **Date** |
| 1 | Initial Version | Selva Sengottaiyan | 07-Feb-2016 |
| 2 | Updated as per FDD v 1.2.0 | Krishna Anne | 07-Mar-2016 |
| 3 | Updated graphical representation | Nick Saxton | 17-Aug-2016 |
| 4 | Updated design limitations for FDD v1.5.0 | Shruthi Raghavan | 7-Dec-2016 |

Table of Contents[1 Introduction 6](#_Toc445196867)

[2 SnsrOffsLrng & High-Level Description 7](#_Toc445196868)

[3 Design details of software module 8](#_Toc445196869)

[3.1 Graphical representation of SnsrOffsLrng 9](#_Toc445196870)

[4 Constant Data Dictionary 11](#_Toc445196871)

[4.1 Program (fixed) Constants 11](#_Toc445196872)

[4.1.1 Embedded Constants 11](#_Toc445196873)

[5 Software Component Implementation 12](#_Toc445196874)

[5.1 Sub-Module Functions 12](#_Toc445196875)

[5.1.1 Init: SnsrOffsLrngInit1 12](#_Toc445196876)

[5.1.1.1 Design Rationale 12](#_Toc445196877)

[5.1.1.2 Module Outputs 12](#_Toc445196878)

[5.1.2 Per: SnsrOffsLrngPer1 12](#_Toc445196879)

[5.1.2.1 Design Rationale 12](#_Toc445196880)

[5.1.2.2 Store Module Inputs to Local copies 12](#_Toc445196881)

[5.1.2.3 (Processing of function)……… 12](#_Toc445196882)

[5.1.2.4 Store Local copy of outputs into Module Outputs 12](#_Toc445196883)

[5.1.1 Per: SnsrOffsLrngPer2 12](#_Toc445196884)

[5.1.1.1 Design Rationale 12](#_Toc445196885)

[5.1.1.2 Store Module Inputs to Local copies 12](#_Toc445196886)

[5.1.1.3 (Processing of function)……… 12](#_Toc445196887)

[5.1.1.4 Store Local copy of outputs into Module Outputs 12](#_Toc445196888)

[5.2 Server Runables 13](#_Toc445196889)

[5.2.1 SnsrOffsLrng\_RstHwTq 13](#_Toc445196890)

[5.2.1.1 Design Rationale 13](#_Toc445196891)

[5.2.1.2 Store Module Inputs to Local copies 13](#_Toc445196892)

[5.2.1.3 (Processing of function)……… 13](#_Toc445196893)

[5.2.1.4 Store Local copy of outputs into Module Outputs 13](#_Toc445196894)

[5.2.2 SnsrOffsLrng\_RstYawAndAg 13](#_Toc445196895)

[5.2.2.1 Design Rationale 13](#_Toc445196896)

[5.2.2.2 Store Module Inputs to Local copies 13](#_Toc445196897)

[5.2.2.3 (Processing of function)……… 13](#_Toc445196898)

[5.2.2.4 Store Local copy of outputs into Module Outputs 13](#_Toc445196899)

[5.2.3 SnsrOffsLrng\_SetHwAgOffs 13](#_Toc445196900)

[5.2.3.1 Design Rationale 13](#_Toc445196901)

[5.2.3.2 Store Module Inputs to Local copies 13](#_Toc445196902)

[5.2.3.3 (Processing of function)……… 13](#_Toc445196903)

[5.2.3.4 Store Local copy of outputs into Module Outputs 13](#_Toc445196904)

[5.2.4 SnsrOffsLrng\_GetHwAgOffs 14](#_Toc445196905)

[5.2.4.1 Design Rationale 14](#_Toc445196906)

[5.2.4.2 Store Module Inputs to Local copies 14](#_Toc445196907)

[5.2.4.3 (Processing of function)……… 14](#_Toc445196908)

[5.2.4.4 Store Local copy of outputs into Module Outputs 14](#_Toc445196909)

[5.2.5 SnsrOffsLrng\_SetHwTqOffs 14](#_Toc445196910)

[5.2.5.1 Design Rationale 14](#_Toc445196911)

[5.2.5.2 Store Module Inputs to Local copies 14](#_Toc445196912)

[5.2.5.3 (Processing of function)……… 14](#_Toc445196913)

[5.2.5.4 Store Local copy of outputs into Module Outputs 14](#_Toc445196914)

[5.2.6 SnsrOffsLrng\_GetHwTqOffs 14](#_Toc445196915)

[5.2.6.1 Design Rationale 14](#_Toc445196916)

[5.2.6.2 Store Module Inputs to Local copies 14](#_Toc445196917)

[5.2.6.3 (Processing of function)……… 14](#_Toc445196918)

[5.2.6.4 Store Local copy of outputs into Module Outputs 14](#_Toc445196919)

[5.2.7 SnsrOffsLrng\_SetYawRateOffs 15](#_Toc445196920)

[5.2.7.1 Design Rationale 15](#_Toc445196921)

[5.2.7.2 Store Module Inputs to Local copies 15](#_Toc445196922)

[5.2.7.3 (Processing of function)……… 15](#_Toc445196923)

[5.2.7.4 Store Local copy of outputs into Module Outputs 15](#_Toc445196924)

[5.2.8 SnsrOffsLrng\_GetYawRateOffs 15](#_Toc445196925)

[5.2.8.1 Design Rationale 15](#_Toc445196926)

[5.2.8.2 Store Module Inputs to Local copies 15](#_Toc445196927)

[5.2.8.3 (Processing of function)……… 15](#_Toc445196928)

[5.2.8.4 Store Local copy of outputs into Module Outputs 15](#_Toc445196929)

[5.3 Module Internal (Local) Functions 15](#_Toc445196930)

[5.3.1 Module Internal (Local) Functions 15](#_Toc445196931)

[6 Known Limitations with Design 19](#_Toc445196932)

[7 UNIT TEST CONSIDERATION 20](#_Toc445196933)

[Appendix A Abbreviations and Acronyms 21](#_Toc445196934)

[Appendix B Glossary 22](#_Toc445196935)

[Appendix C References 23](#_Toc445196936)

# Introduction

Refer the Design Subproject.

# SnsrOffsLrng & High-Level Description

Refer the Design Subproject.

# Design details of software module

## Graphical representation of SnsrOffsLrng

**

# Constant Data Dictionary

## Program (fixed) Constants

### Embedded Constants

#### Local Constants

|  |  |  |  |
| --- | --- | --- | --- |
| Constant Name | Resolution | Units | Value |
| HWTQOFFSHILIM\_HWNWTMTR\_F32 | Single precision float | HwNwtMtr | 4 |
| HWTQOFFSLOLIM\_HWNWTMTR\_F32 | Single precision float | HwNwtMtr | -4 |
| VEHYAWRATEOFFSHILIM\_VEHDEGPERSEC\_F32 | Single precision float | VehDegPerSec | 20 |
| VEHYAWRATEOFFSLOLIM\_VEHDEGPERSEC\_F32 | Single precision float | VehDegPerSec | -20 |
| HWAGOFFSHILIM\_HWDEG\_F32 | Single precision float | HwDeg | -30 |
| HWAGOFFSLOLIM\_HWDEG\_F32 | Single precision float | HwDeg | -30 |
| MTRXSIZE\_CNT\_U08 | 1 | Cnt | 3 |

# Software Component Implementation

## Sub-Module Functions

### Init: SnsrOffsLrngInit1

## Design Rationale

*Refer the Design.*

## Module Outputs

*Refer the Design.*

### Per: SnsrOffsLrngPer1

## Design Rationale

*Refer the Design.*

## Store Module Inputs to Local copies

*Refer the Design.*

## (Processing of function)………

*Refer the Design.*

## Store Local copy of outputs into Module Outputs

*Refer the Design.*

### Per: SnsrOffsLrngPer2

## Design Rationale

*Refer the Design.*

## Store Module Inputs to Local copies

*Refer the Design.*

## (Processing of function)………

*Refer the Design.*

## Store Local copy of outputs into Module Outputs

*Refer the Design.*

## Server Runables

### SnsrOffsLrng\_RstHwTq

## Design Rationale

*Refer the Design.*

## Store Module Inputs to Local copies

*Refer the Design.*

## (Processing of function)………

*Refer the Design.*

## Store Local copy of outputs into Module Outputs

*Refer the Design.*

### SnsrOffsLrng\_RstYawAndAg

## Design Rationale

*Refer the Design.*

## Store Module Inputs to Local copies

*Refer the Design.*

## (Processing of function)………

*Refer the Design.*

## Store Local copy of outputs into Module Outputs

*Refer the Design.*

### SnsrOffsLrng\_SetHwAgOffs

## Design Rationale

*Refer the Design.*

## Store Module Inputs to Local copies

*Refer the Design.*

## (Processing of function)………

*Refer the Design.*

## Store Local copy of outputs into Module Outputs

*Refer the Design.*

### SnsrOffsLrng\_GetHwAgOffs

## Design Rationale

*Refer the Design.*

## Store Module Inputs to Local copies

*Refer the Design.*

## (Processing of function)………

*Refer the Design.*

## Store Local copy of outputs into Module Outputs

*Refer the Design.*

### SnsrOffsLrng\_SetHwTqOffs

## Design Rationale

*Refer the Design.*

## Store Module Inputs to Local copies

*Refer the Design.*

## (Processing of function)………

*Refer the Design.*

## Store Local copy of outputs into Module Outputs

*Refer the Design.*

### SnsrOffsLrng\_GetHwTqOffs

## Design Rationale

*Refer the Design.*

## Store Module Inputs to Local copies

*Refer the Design.*

## (Processing of function)………

*Refer the Design.*

## Store Local copy of outputs into Module Outputs

*Refer the Design.*

### SnsrOffsLrng\_SetYawRateOffs

## Design Rationale

*Refer the Design.*

## Store Module Inputs to Local copies

*Refer the Design.*

## (Processing of function)………

*Refer the Design.*

## Store Local copy of outputs into Module Outputs

*Refer the Design.*

### SnsrOffsLrng\_GetYawRateOffs

## Design Rationale

*Refer the Design.*

## Store Module Inputs to Local copies

*Refer the Design.*

## (Processing of function)………

*Refer the Design.*

## Store Local copy of outputs into Module Outputs

*Refer the Design.*

## Module Internal (Local) Functions

### Module Internal (Local) Functions

##### Calculate **LearnHwAg**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Function Name** | LearnHwAg | Type | Min | Max | UTP Tol. |
| **Arguments Passed** | HwAgLrngLrngCdnVld\_Cnt\_T\_logl | Boolean | FALSE | TRUE |  |
|  | HwAgLrngEna\_Cnt\_T\_logl | Boolean | FALSE | TRUE |  |
|  | SysTqFild\_HwNm\_T\_f32 | float32 | -8.8 | 8.8 |  |
|  | HandwheelPosition\_HwDeg\_T\_f32 | float32 | -1440 | 1440 |  |
| **Return Value** | None |  |  |  |  |

#### Description

No flowchart added. For Unit test FDD should provide the information needed regarding function processing

##### Calculate **SOaCHierarchyManager**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Function Name** | SOaCHierarchyManager | Type | Min | Max | UTP Tol. |
| **Arguments Passed** | \*EnableYOC\_Cnt\_T\_logl | Boolean | FALSE | TRUE |  |
|  | \*HwAgLrngEna\_Cnt\_T\_logl | Boolean | FALSE | TRUE |  |
|  | \*HwAgLrngRst\_Cnt\_T\_logl | Boolean | FALSE | TRUE |  |
| **Return Value** |  |  |  |  |  |

#### Description

No flowchart added. For Unit test FDD should provide the information needed regarding function processing

##### Calculate **Perform\_TqInpDetn**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Function Name** | Perform\_TqInpDetn | Type | Min | Max | UTP Tol. |
| **Arguments Passed** | None |  |  |  |  |
|  |  |  |  |  |  |
| **Return Value** |  |  |  |  |  |

#### Description

No flowchart added. For Unit test FDD should provide the information needed regarding function processing

##### Calculate **EnableLearning**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Function Name** | **EnableLearning** | Type | Min | Max | UTP Tol. |
| **Arguments Passed** |  |  |  |  |  |
|  |  |  |  |  |  |
| **Return Value** | HwTqLrngEna\_Cnt\_T\_logl | Boolean | FALSE | TRUE |  |

#### Description

No flowchart added. For Unit test FDD should provide the information needed regarding function processing

##### Calculate CalculateKVector

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Function Name** | CalculateKVector | Type | Min | Max | UTP Tol. |
| **Arguments Passed** | TqMdlXAry\_HwRadpS\_T\_f32[3] | float32 | -42 | 42 |  |
|  | KVect\_Uls\_T\_f32[3] | float32 | -42 | 42 |  |
| **Return Value** |  |  |  |  |  |

#### Description

No flowchart added. For Unit test FDD should provide the information needed regarding function processing

##### Calculate **EnablePreProcessing**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Function Name** | **EnablePreProcessing** | Type | Min | Max | UTP Tol. |
| **Arguments Passed** | HwTqPreproc\_dB\_T\_f32 | float32 | -100 | 30 |  |
|  | SampleCntrLim\_Cnt\_T\_u16 | Uint16 | 1 | 65535 |  |
|  | TqInpPrsntVld\_Cnt\_T\_logl | Boolean | FALSE | TRUE |  |
|  | TqInpPrsnt\_Cnt\_T\_logl | Boolean | FALSE | TRUE |  |
| **Return Value** |  |  |  |  |  |

#### Description

No flowchart added. For Unit test FDD should provide the information needed regarding function processing

##### Calculate **UpdateCovarianceMatrix**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Function Name** | UpdateCovarianceMatrix | Type | Min | Max | UTP Tol. |
| **Arguments Passed** | TqMdlXAry\_HwRadpS\_T\_f32[3] | float32 | -42 | 42 |  |
|  | KVect\_Uls\_T\_f32[3] | float32 | -42 | 42 |  |
| **Return Value** |  |  |  |  |  |

#### Description

No flowchart added. For Unit test FDD should provide the information needed regarding function processing

TblSize\_Cnt\_T\_u16 is size of the single dimension of TqMdlAryKVect\_Uls\_T\_f32.

##### Calculate **UpdateHwTqOffs**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Function Name** | **UpdateHwTqOffs** | Type | Min | Max | UTP Tol. |
| **Arguments Passed** | HwTqEstimnVld\_Cnt\_T\_logl | boolean | FALSE | TRUE |  |
|  | HwTqDriftEstimnOnCentr\_HwNm\_T\_f32 | float32 | -10 | 10 |  |
| **Return Value** | None |  |  |  |  |

#### Description

No flowchart added. For Unit test FDD should provide the information needed regarding function processing

##### Calculate **UpdateSampleCnt**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Function Name** | **UpdateSampleCnt** | Type | Min | Max | UTP Tol. |
| **Arguments Passed** | HwAgMeasd\_HwDeg\_T\_f32 | float32 | -1440 | 1440 |  |
|  |  |  |  |  |  |
| **Return Value** | None |  |  |  |  |

#### Description

No flowchart added. For Unit test FDD should provide the information needed regarding function processing

# Known Limitations with Design

The display variable dSnsrOffsLrngSysTqFild and PIM SysTqCdngFil structure have wrong ranges defined in the datadict.m file. The actual range according to developer is [-366, 366]. However, since the given range is larger and includes the correct range and because these variables are not affecting the downstream operations in a way that will fail the PIL, this is not changed in the interest of time (changing this would mean rerunning the robustness test and there wasn’t enough time for that before release).

The name of the NVM structure type SnsrLrndOffsRec2 is changed without any change to the name or datatype of the corresponding elements. The only difference between SnsrLrndOffsRec1 and SnsrLrndOffsRec2 is the ranges of the elements within the structure.

Since this is not the agreed process for EA4, the implementation deviates from FDD and uses the original structure in order to avoid a change to StdDef to only add a redundant datatype. For the next FDD revision we need to make a decision on whether to go back to SnsrLrndOffsRec1 in the FDD or change the StdDef and add SnsrLrndOffsRec2 type in it. Either way, once the new tool is officially rolled out for use, such deviations of type will be caught in the Polyspace as an error (necessitating manual fixes to work around such issues).

# UNIT TEST CONSIDERATION

The display variable dSnsrOffsLrngSysTqFild and PIM SysTqCdngFil structure have wrong ranges defined in the datadict.m file. The actual range according to developer is [-366, 366]. However, since the given range is larger and includes the correct range and because these variables are not affecting the downstream operations in a way that will fail the PIL, this is not changed in the interest of time (changing this would mean rerunning the robustness test and there wasn’t enough time for that before release).

Abbreviations and Acronyms

| **Abbreviation or Acronym** | **Description** |
| --- | --- |
|  |  |
|  |  |

Glossary

**Note**: Terms and definitions from the source “Nexteer Automotive” take precedence over all other definitions of the same term. Terms and definitions from the source “Nexteer Automotive” are formulated from multiple sources, including the following:

* ISO 9000
* ISO/IEC 12207
* ISO/IEC 15504
* Automotive SPICE® Process Reference Model (PRM)
* Automotive SPICE® Process Assessment Model (PAM)
* ISO/IEC 15288
* ISO 26262
* IEEE Standards
* SWEBOK
* PMBOK
* Existing Nexteer Automotive documentation

| **Term** | **Definition** | **Source** |
| --- | --- | --- |
| MDD | Module Design Document |  |
| DFD | Data Flow Diagram |  |

References

| **Ref. #** | **Title** | **Version** |
| --- | --- | --- |
| 1 | AUTOSAR Specification of Memory Mapping (Link:[AUTOSAR\_SWS\_MemoryMapping.pdf](http://www.autosar.org/download/R4.0/AUTOSAR_SWS_MemoryMapping.pdf)) | v1.3.0 R4.0 Rev 2 |
| 2 | MDD Guideline | EA4 01.00.01 |
| 3 | [Software Naming Conventions.doc](http://misagweb01.nexteer.com/eRoomReq/Files/erooms8/NextGeneration/0_fc55f/Software%20Naming%20Conventions%2003x(In%20Work).doc) | 1.0 |
| 4 | [Software Design and Coding Standards.doc](http://eroom1.nexteer.com/eRoomReq/Files/erooms8/NextGeneration/0_1a67a9/Software%20Design%20and%20Coding%20Standards.doc) | 2.1 |
| 5 | SF051A\_SnsrOffsLrng\_Design | See the synergy sub-project version included. |