**Module Design Document**

**For**

**SysFricLrng**

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**Prepared For:**

**Software Engineering**

**Nexteer Automotive,**

**Saginaw, MI, USA**

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# Introduction

## Purpose

## Scope

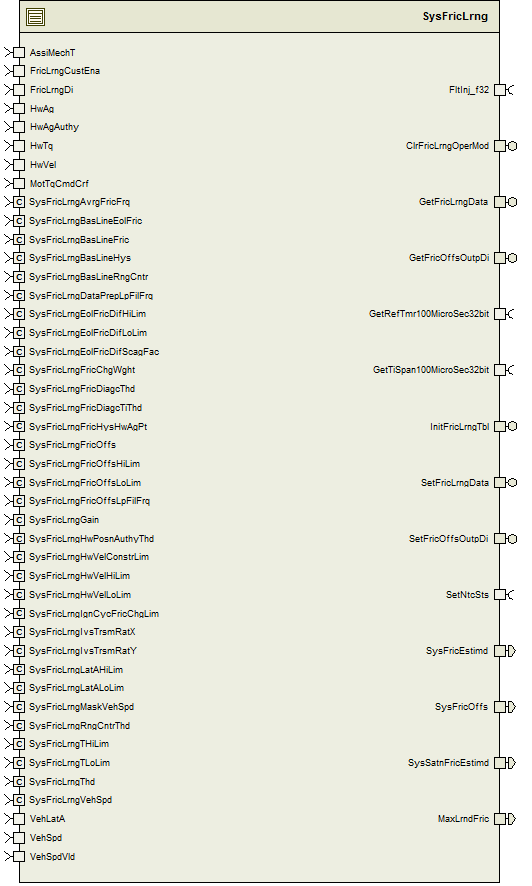
# SysFricLrng High-Level Description

*Refer FDD*

# Design details of software module

*Refer FDD*

## Graphical representation of SysFricLrng



## Data Flow Diagram

*Refer FDD*

### Component level DFD

*Refer FDD*

### Function level DFD

*Refer FDD*

# Constant Data Dictionary

## Program (fixed) Constants

### Embedded Constants

#### Local Constants

|  |  |  |  |
| --- | --- | --- | --- |
| Constant Name | Resolution | Units | Value |
| INDEX0\_CNT\_U08 | 1 | CNT | 0U |
| INDEX1\_CNT\_U08 | 1 | CNT | 1U |
| INDEX2\_CNT\_U08 | 1 | CNT | 2U |
| INDEX3\_CNT\_U08 | 1 | CNT | 3U |
| SYSSATNFRICESTIMDMIN\_HWNWMTR\_F32 | 1 | HwNwMtr | 0.0F |
| SYSSATNFRICESTIMDMAX\_HWNWMTR\_F32 2 | 1 | HwNwMtr | 20.0F |
| SYSFRICESTIMDMIN\_HWNWMTR\_F32 | 1 | HwNwMtr | 0.0F |
| SYSFRICESTIMDMAX\_HWNWMTR\_F32 | 1 | HwNwMtr | 20.0F |
| SYSFRICOFFSMIN\_HWNWMTR\_F32 | 1 | HwNwMtr | -5.0F |
| SYSFRICOFFSMAX\_HWNWMTR\_F32 | 1 | HwNwMtr | 5.0F |

For rest of the constants, please refer Data Dictionary

# Software Component Implementation

The detailed design of the function is provided in the FDD.

## Sub-Module Functions

## Init: SysFricLrngInit1

## Design Rationale

*In MDD, filters are initialized inside the for loop using switch case but in code filters are initialized one by one without any conditions.*

*In model, filters are initialized twice as it is not possible to use a variable for the filter initialization in the model. This is redundancy is not present in the code as variables are used for initializing the filters.*

## Module Outputs

*Refer FDD*

## Per: SysFricLrngPer1

## Design Rationale

*Refer FDD*

## Store Module Inputs to Local copies

*Refer FDD*

## (Processing of function)………

*Refer FDD*

## Store Local copy of outputs into Module Outputs

*Refer FDD*

## Server Runnables

## Server Runnable Name

*ClrFricLrngOperMod*

## Design Rationale

*Refer FDD*

## (Processing of function)………

*On server invocation call*

## Server Runnables

## Server Runnable Name

*GetFricLrngData*

## Design Rationale

*Refer FDD*

## (Processing of function)………

*On server invocation call*

## Server Runnable Name

*GetFricOffsOutpDi*

## Design Rationale

*Refer FDD*

## (Processing of function)………

*On server invocation call*

## Server Runnable Name

*InitFricLrngTbl*

## Design Rationale

*Refer FDD*

## (Processing of function)………

*On server invocation call*

## Server Runnable Name

*SetFricLrngDatal*

## Design Rationale

*Refer FDD*

## (Processing of function)………

*On server invocation call*

## Server Runnable Name

*SetFricOffsOutpDi*

## Design Rationale

*Refer FDD*

## (Processing of function)………

*On server invocation call*

## Interrupt Functions

*None*

## Interrupt Function Name

*None*

## Design Rationale

*NA*

## (Processing of the ISR function)…..

*NA*

## Module Internal (Local) Functions

## Local Function #1

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Function Name** | FricLearning | Type | Min | Max |
| **Arguments Passed** | SelHwAg\_HwDeg\_T\_f32 | Float32 | -1440.0 | 1440.0 |
| SelColTq\_HwNwtMtr\_T\_f32 | Float32 | -10 | 10 |
| VehSpdIdx\_Cnt\_T\_u16 | Uint16 | 0 | 3 |
| HwVelDir\_Cnt\_T\_u08 | Uint8 | 0 | 1 |
|  | LrngEna\_Cnt\_T\_Logl | Boolean | FALSE | TRUE |
| **Return Value** | NA | NA | NA | NA |

## Design Rationale

## Processing

Refer to ‘FricLearning’ subsystem in FDD.

Following per instance data is updated.

|  |
| --- |
| \*Rte\_Pim\_RawAvrg() (Min:0, Max:20) |
| Rte\_Pim\_SatnAvrgFric()[VehSpdIdx\_Cnt\_T\_u16] (Min:0, Max:20) |

Also writes the outputs SysFricEstimd and SysSatnFricEstimd

## Local Function #2

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Function Name** | RunningAndCalibrationModes | Type | Min | Max |
| **Arguments Passed** | \*FricOffs\_HwNwtMtr\_T\_f32 | Float32 | -5.0 | +5.0 |
|  | \*LrngEna\_Cnt\_T\_Logl | Boolean | FALSE | TRUE |
| **Return Value** | None | NA | NA | NA |

## Design Rationale

## Processing

Following PIMs are updated; refer to ‘RunningAndCalibrationModes’ subsystem in the FDD. FricOffs\_HwNwtMtr\_T\_f32 is the output of this function

|  |
| --- |
| Rte\_Pim\_FricLrngData()->FricOffs (Min:-5, Max:5) |
| \*Rte\_Pim\_RawAvrg() (Min:0, Max:20) |
| Rte\_Pim\_SatnAvrgFric()[VehSpdIdx\_Cnt\_T\_u16] (Min:0, Max:20) |

Also updates the input argument, \*FricOffs\_HwNwtMtr\_T\_f32.

## Local Function #3

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Function Name** | RawAvrgCalc | Type | Min | Max |
| **Arguments Passed** | VehSpdIdx\_Cnt\_T\_u16 | Uint16 | 0 | 5 |
| DeltaIdxOffsDec\_Cnt\_T\_u16 | Uint16 | 0 | 12 |
| DeltaIdxOffsInc\_Cnt\_T\_u16 | Uint16 | 0 | 13 |
| TotalCounter\_Cnt\_T\_u32 | Uint32 | 0 | 65535 |
|  | LrngEna\_Cnt\_T\_Logl | Boolean | FALSE | TRUE |
| **Return Value** | NA | NA | NA | NA |

## Design Rationale

## Processing

Refer to ‘Raw Average Calculation’ subsystem in FDD.

Following per instance data is updated.

|  |
| --- |
| \*Rte\_Pim\_RawAvrg() (Min:0, Max:20) |
| Rte\_Pim\_SatnAvrgFric()[VehSpdIdx\_Cnt\_T\_u16] (Min:0, Max:20) |

## Local Function #4

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Function Name** | PhiCalc | Type | Min | Max |
| **Arguments Passed** | SelHwAg\_HwDeg\_T\_f32 | Float32 | -1440 | 1440 |
| Gate\_Cnt\_T\_u16 | Uint16 | 0 | 65535 |
| DeltaIdxOffs\_Cnt\_T\_u16 | Uint16 | 0 | 10 |
| SelColTq\_HwNwtMtr\_T\_f32 | Float32 | -10 | 10 |
| **Return Value** | NA | NA | NA | NA |

## Design Rationale

## Processing

Refer to ‘Raw Average Calculation’ subsystem in FDD.

Following per instance data is updated.

|  |
| --- |
| Rte\_Pim\_FricLrngData()->Hys[DeltaIdxOffs\_Cnt\_T\_u16][Gate\_Cnt\_T\_u16 + 1U] (Min:-127, Max:127) |
| Rte\_Pim\_FricLrngData()->Hys[DeltaIdxOffs\_Cnt\_T\_u16][Gate\_Cnt\_T\_u16] (Min:-127, Max:127) |

## Local Function #5

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Function Name** | RangeCounterManager | Type | Min | Max |
| **Arguments Passed** | DeltaIdxOffs\_Cnt\_T\_u16 | Uint16 | 0 | 10 |
| DeltaIdxOffsDec\_Cnt\_T\_u16 | Uint16 | 0 | 12 |
| DeltaIdxOffsInc\_Cnt\_T\_u16 | Uint16 | 0 | 13 |
| Gate\_Cnt\_T\_u16 | Uint16 | 0 | 65535 |
| **Return Value** | NA | NA | NA | NA |

## Design Rationale

## Processing

Refer to ‘Range counter manager’ subsystem in FDD.

Following per instance data is updated.

|  |
| --- |
| \*Rte\_Pim\_ RngCntrThdExcdd() (Min:0, Max:1) |
| Rte\_Pim\_FricLrngData->RngCntr (:,:) (Min:0, Max:65535) |

## Local Function #6

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Function Name** | NTCSetReset | Type | Min | Max |
| **Arguments Passed** | MaxRawAvrgFric\_Cnt\_T\_f32 | Float32 | -127 | 254 |
| **Return Value** | NA | NA | NA | NA |

## Design Rationale

## Processing

Refer to ‘NTC\_Pass’ and ‘NTC\_Fail’ subsystem in FDD

Sets or resets the NTCNR\_0X0A2

## Local Function #7

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Function Name** | ClearingMode | Type | Min | Max |
| **Arguments Passed** | none | NA | NA | NA |
| **Return Value** | none | NA | NA | NA |

## Design Rationale

## Processing

Refer to ‘Clearing Mode’ subsystem in FDD.

Following per instance data is updated.

|  |
| --- |
| \*Rte\_Pim\_FricOffs()(Min:-5, Max:5) |

## Local Function #8

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Function Name** | ResettingMode | Type | Min | Max |
| **Arguments Passed** | \*FricOffs\_HwNwtMtr\_T\_f32 | NA | NA | NA |
| **Return Value** | None | NA | NA | NA |

## Design Rationale

## Processing

## 

Refer to ‘ResettingMode’ subsystem in FDD.

Following per instance data is updated. Also updates the input argument ‘\*FricOffs\_HwNwtMtr\_T\_f32’.

|  |
| --- |
| Rte\_Pim\_FricLrngData()->RngCntr(;) |
| Rte\_Pim\_AvrgFricLpFil**X**()->FilSt (X: 1 to 4) |
| Rte\_Pim\_FricLrngData()->Hys(;) |
| Rte\_Pim\_FricOffs()(Min:-5, Max:5) |
| Rte\_Pim\_VehBasLineFric()[] (Min:-0, Max:127)  Rte\_Pim\_RawAvrgFric()[] (Min:--127, Max:254)  Rte\_Pim\_FilAvrgFric()[] (Min:--10 , Max: 10)  Rte\_Pim\_SatnAvrgFric()[](Min:--127, Max:254)  Rte\_Pim\_FricLrngData()->VehLrndFric[] (0-127) |

## Local Function #9

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Function Name** | HwAngConstraint | Type | Min | Max |
| **Arguments Passed** | FilHwAg\_HwDeg\_T\_f32 | Float32 | -1440 | 1440 |
|  | \*HwAgOK\_Cnt\_T\_Logl | boolean | 0 | 1 |
|  | \*SelHwAg\_HwDeg\_T\_f32 | Float32 | -1440 | 1440 |
| **Return Value** | NA | NA | NA | NA |

## Design Rationale

## Processing

Refer to ‘HwAngConstraint‘ subsystem in FDD. Updates the input arguments, \*HwAgOK\_Cnt\_T\_Logl and \*SelHwAg\_HwDeg\_T\_f32

## Local Function #10

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Function Name** | HwVelConstraint | Type | Min | Max |
| **Arguments Passed** | HwVel\_HwRadPerSec\_T\_f32 | Float32 | -42 | 42 |
| HwVelOK\_Cnt\_T\_Logl | Boolean | 0 | 1 |
| HwVelDir\_Cnt\_T\_u08 | Uint8 | 0 | 1 |
| **Return Value** | NA | NA | NA | NA |

## Design Rationale

## Processing

Refer to ‘HwVelConstraint’ subsystem in FDD.

## Local Function #11

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Function Name** | VehSpdConstraint | Type | Min | Max |
| **Arguments Passed** | VehSpd\_Kph\_T\_f32 | Float32 | 0 | 511 |
|  | \*VehSpdOK\_Cnt\_T\_Logl | Boolean | 0 | 1 |
| \*VehSpdIdx\_Cnt\_T\_u16 | Uint16 | 0 | 5 |
| **Return Value** | None | NA | NA | NA |

## Design Rationale

*Code is optimized due to limitation with the model; hence code completely won’t match the model. There won’t be any impact on the functionality.*

*In the model as it is not possible to break the for loop until the loop iterator reaches the configured constant threshold value, index corresponding to the position in ‘SysFricLrngVehSpd’ which breaches the conditions mentioned in ‘VehSpdIdxCalcn’ subsystem is calculated by successively adding the index value after multiplying it with either the condition true or false based on whether the vehicle speed value breaches the threshold mentioned in the FDD. In code as it is possible to exit the for loop as soon as a value in ‘VehSpdIdxCalcn’ breaches thresholds as mentioned in FDD, no such successive addition of loop counter is required.*

## Processing

Refer to ‘VehSpdConstraint’ subsystem in FDD.

## Local Function #12

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Function Name** | ColTqconstraint | Type | Min | Max |
| **Arguments Passed** | FilColTq\_HwNwtMtr\_T\_f32 | Float32 | -10 | 10 |
| \*SelColTq\_HwNwtMtr\_T\_f32 | Boolean | -10 | 10 |
| **Return Value** | NA | NA | NA | NA |

## Design Rationale

## Processing

Refer to ‘ColTqconstraint’ subsystem in FDD. Updates the \*SelColTq\_HwNwtMtr\_T\_f32.

## GLOBAL Function/Macro Definitions

NA

# Known Limitations with Design

None

# UNIT TEST CONSIDERATION

In model, one based indexing is used but in code 0 based indexing is used.

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)) | Process 4.02.01 |
| 2 | MDD Guideline | Process 4.02.01 |
| 3 | [Software Naming Conventions.doc](http://misagweb01.nexteer.com/eRoomReq/Files/erooms8/NextGeneration/0_fc55f/Software%20Naming%20Conventions%2003x(In%20Work).doc) | 2.0 |
| 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 | FDD- SF007A\_SysFricLrng\_Design | See Synergy sub project version |