**Module Design Document**

**For**

**VehDyn**

**March 08, 2018**

**Prepared For:**

**Software Engineering**

**Nexteer Automotive,**

**Saginaw, MI, USA**

**Prepared By:**

**SEPG,**

**Nexteer Automotive,**

**Saginaw, MI, USAChange History**

|  |  |  |  |
| --- | --- | --- | --- |
| **Description** | **Author** | **Version** | **Date** |
| Initial Version (SF-42 v001) | KMC | 1.0 | 19-Aug-13 |
| Local constant value and variable ranges/resolutions updated per FDD data dictionary updates. | KMC | 2.0 | 11-Sep-13 |
| Updated to SF-42 VCDMotPos version 002 | SB | 3.0 | 25-Aug-14 |
| Unit Test Findings Resolved | KPIT, SB | 4.0 | 4-Sep-14 |
| Updated to SF-42 VCDMotPos version 3 | SB | 5.0 | 31-Oct-14 |
| Updated to SF-42 VCDMotPos v004 | SB | 6.0 | 16-Jan-15 |
| Updated to SF-42 VCDMotPos rev 005 | SB | 7.0 | 02-Feb-15 |
| Added SCom function for force center position | JWJ | 8.0 | 27-Feb-15 |
| Updated to SF-42 VCDMotPos ver 006 | JK | 9.0 | 13-Aug-15 |
| Updated to SF-42A VehCentrDtmnByMotPosn v7 | SB | 10.0 | 30-Nov-15 |
| Updated to SF-42A VehCentrDtmnByMotPosn v7.1.0 | SB | 11.0 | 15-Dec-15 |
| Updated to SF-42A VehCentrDtmnByMotPosn v7.2.0 (changed max auth to 1) | OT | 12.0 | 7-Jan-15 |
| Updated to SF-42 FDD rev 7.3.0 (Fix for anomaly EA3#6247) | KK | 13.0 | 24-Feb-16 |
| Updated as per Unit Test Findings | KPIT | 14.0 | 06-Apr-2016 |
| Updated inputs/constants, changed cal name, added updated graph | ML | 15.0 | 24-May-17 |
| Updated to FDD rev 9.0.0, new template | Krzysztof Byrski | 16.0 | 08-Mar-2018 |

**Table of Contents**

[1 Introduction 4](#_Toc508276293)

[1.1 Purpose 4](#_Toc508276294)

[1.2 Scope 4](#_Toc508276295)

[2 VehDyn & High-Level Description 5](#_Toc508276296)

[3 Design details of software module 6](#_Toc508276297)

[3.1 Graphical representation of VehDyn 6](#_Toc508276298)

[3.2 Data Flow Diagram 6](#_Toc508276299)

[3.2.1 Module level DFD 6](#_Toc508276300)

[3.2.2 Sub-Module level DFD 6](#_Toc508276301)

[3.3 Component diagram 6](#_Toc508276302)

[3.4 Variable Data Dictionary 7](#_Toc508276303)

[3.4.1 User defined ‘typedef’ definition/declaration 7](#_Toc508276304)

[3.4.2 Variable definition for enumerated types 7](#_Toc508276305)

[3.5 Constant Data Dictionary 8](#_Toc508276306)

[3.5.1 Program Constants 8](#_Toc508276307)

[3.5.2 Module Specific Lookup Tables 8](#_Toc508276308)

[3.6 Software Module Implementation 9](#_Toc508276309)

[3.6.1 Sub-Module Functions 9](#_Toc508276310)

[3.6.2 Interrupt Service Routines 9](#_Toc508276311)

[3.6.3 \_SCOMM () Functions 9](#_Toc508276312)

[3.6.4 Module Internal (Local) Functions 10](#_Toc508276313)

[3.6.5 Transition Functions 12](#_Toc508276314)

[4 Known Limitations with Design 13](#_Toc508276315)

[5 UNIT TEST CONSIDERATION 14](#_Toc508276316)

[Appendix A Abbreviations and Acronyms 15](#_Toc508276317)

[Appendix B Glossary 16](#_Toc508276318)

[Appendix C References 17](#_Toc508276319)

# Introduction

## Purpose

Module Design Document for SF42 - VehDyn.

## Scope

The following definitions are used throughout this document:

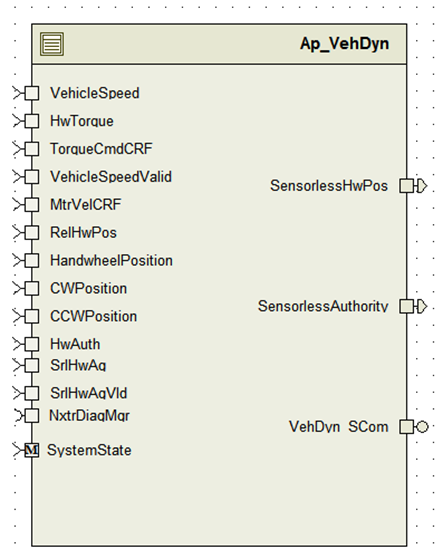
* **Shall**: indicates a mandatory requirement without exception in compliance.
* **Should**: indicates a mandatory requirement; exceptions allowed only with documented justification.
* **May**: indicates an optional action.

# VehDyn & High-Level Description

This module calculates HandWheel AutoCentering and determines the Vehicle Dynamics HandWheel Position and Vehicle Dynamics Authority.

# Design details of software module

## Graphical representation of VehDyn

**

## Data Flow Diagram

Refer FDD

### Module level DFD

Refer FDD

### Sub-Module level DFD

Refer FDD

## Component diagram

Refer FDD

## Variable Data Dictionary

### User defined ‘typedef’ definition/declaration

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Typedef Name | Element Name | User Defined Type | Legal Range  (min) | Legal Range  (max) |
| AUTOCNTRTYPE\_Str | MtrVel\_MtrRadpS\_f32 | float32 | 0 | 700 |
| VehSpd\_kph\_f32 | float32 | 0 | 255 |
| FiltPinTrq\_HwNm\_f32 | float32 | 0 | 20 |
| CntrWindow\_HwDeg\_f32 | float32 | 0 | 100 |
| Timer1Thresh\_mS\_u16 | uint16 | 0 | 60000 |
| Timer2Thresh\_mS\_u16 | uint16 | 0 | 60000 |
| Timer1\_mS\_u32 | uint32 | FULL | FULL |
| Timer2\_mS\_u32 | uint32 | FULL | FULL |
| RelHwPosFilt1SV\_HwDeg\_str | LPF32KSV\_Str | N/A | N/A |
| RelHwPosFilt1SV\_HwDeg\_str.SV\_Uls\_f32 | float32 | -3200 | 3200 |
| RelHwPosFilt1SV\_HwDeg\_str.K\_Uls\_f32 | float32 | 2.51327E-06 | 0.001255848 |
| RelHwPosFilt2SV\_HwDeg\_str | LPF32KSV\_Str | N/A | N/A |
| RelHwPosFilt2SV\_HwDeg\_str.SV\_Uls\_f32 | float32 | -3200 | 3200 |
| RelHwPosFilt2SV\_HwDeg\_str.K\_Uls\_f32 | float32 | 2.51327E-06 | 0.001255848 |
| Filter1Enable\_Cnt\_lgc | boolean | FALSE | TRUE |
| Filter2Enable\_Cnt\_lgc | boolean | FALSE | TRUE |
| Filter1Initialized\_Cnt\_lgc | boolean | FALSE | TRUE |
| Filter2Initialized\_Cnt\_lgc | boolean | FALSE | TRUE |

### Variable definition for enumerated types

|  |  |  |
| --- | --- | --- |
| Enum Name | Element Name | Value |
| None |  |  |

## Constant Data Dictionary

### Program Constants

#### Local Constants

|  |  |  |  |
| --- | --- | --- | --- |
| Constant Name | Resolution | Units | Value |
| D\_FCENTROFFSCON\_CNT\_U08 | 1 | Cnt | 1 |
| D\_HWPOSMAX\_HWDEG\_F32 | Single Precision Float | HwDeg | 1600 |
| D\_HWPOSMIN\_HWDEG\_F32 | Single Precision Float | HwDeg | -1600 |
| D\_LASTPOSNCON\_CNT\_U08 | 1 | Cnt | 5 |
| D\_MAXAUTHORITY\_ULS\_F32 | Single Precision Float | Uls | 1 |
| D\_NOAUTHORITY\_ULS\_F32 | Single Precision Float | Uls | 0 |
| D\_SRLCON\_CNT\_U08 | 1 | Cnt | 2 |
| D\_TRVLEXCLSNCON\_CNT\_U08 | 1 | Cnt | 4 |
| D\_VEHDYNCON\_CNT\_U08 | 1 | Cnt | 3 |

#### Global Constants

|  |
| --- |
| Constant Name |
| D\_FALSE\_CNT\_LGC |
| D\_TRUE\_CNT\_LGC |
| D\_2MS\_SEC\_F32 |
| D\_ZERO\_ULS\_F32 |

### Module Specific Lookup Tables

|  |  |  |  |
| --- | --- | --- | --- |
| Constant Name | Resolution | Value | Software Segment |
| None |  |  |  |

## Software Module Implementation

Refer FDD

### Sub-Module Functions

#### Initialization sub-module VehDyn\_Init1()

Assignment of calibrations to Hi, Lo and Det speed dependant structures for use with vehicle dynamics is done here as the copy of calibrations only needs to be done once and there are variables internal to the structures that must also be initialized.

#### Periodic sub-module VehDyn\_Per1

Vehicle dynamics takes advantage of the fact that the conditions for determining use of the high speed algorithm follow the exact same procedure as in the common autocentering algorithm. Therefore, a third structure is used to determine the switch to high speed using a combination of cals defined for LoSpd AutoCentering, HiSpd Autocentering, and “HiSpdTimer4” in the FDD. Instead of using the output generated from this autocenterring algorithm, the Filter2Enable\_Cnt\_lgc flag is examined and when it becomes TRUE, high speed autocentering is allowed.

### Interrupt Service Routines

None

### \_SCOMM () Functions

#### VehDyn\_SCom\_ResetCenter

Refer FDD

#### VehDyn\_SCom\_ForceCenter

Refer FDD

### Module Internal (Local) Functions

#### Local Function SerialCommMethod

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Function Name** | SerialCommMethod | Type | Min | Max |
| **Arguments Passed** | SrlHwAg\_HwDeg\_T\_f32 | float32 | -1600 | 1600 |
|  | SrlHwAgVld\_Cnt\_T\_lgc | boolean | FALSE | TRUE |
|  | RelHwPos\_HwDeg\_T\_f32 | float32 | -1600 | 1600 |
|  | FildPinionTq\_HwNm\_T\_f32 | float32 | -890 | 890 |
|  | MtrVelCRF\_MtrRadpS\_T\_f32 | float32 | -1118 | 1118 |
|  | HwTorque\_HwNm\_T\_f32 | float32 | -10 | 10 |
| **Return Value** | Vld\_Cnt\_T\_lgc | boolean | FALSE | TRUE |
|  | HwAg\_HwDeg\_T\_f32 | float32 | -4800 | 4800 |

#### Local Function Autocenter\_f32

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Function Name** | Autocenter\_f32 | Type | Min | Max |
| **Arguments Passed** | FiltPinTrq\_HwNm\_T\_f32 | float32 | -18.8 | 18.8 |
|  | MtrVelCRF\_MtrRadpS\_T\_f32 | float32 | -1350 | 1350 |
|  | VehicleSpeed\_Kph\_T\_f32 | float32 | 0 | 512 |
|  | VehSpdValid\_Cnt\_T\_lgc | boolean | FALSE | TRUE |
|  | AutoCntr\_Cnt\_T\_str | AUTOCNTRTYPE\_Str\* | FULL | FULL |
|  | AutoCntr\_Cnt\_T\_str.MtrVel\_MtrRadpS\_f32 | AUTOCNTRTYPE\_Str\* | 0 | 700 |
|  | AutoCntr\_Cnt\_T\_str.VehSpd\_kph\_f32 | AUTOCNTRTYPE\_Str\* | 0 | 255 |
|  | AutoCntr\_Cnt\_T\_str.FiltPinTrq\_HwNm\_f32 | AUTOCNTRTYPE\_Str\* | 0 | 20 |
|  | AutoCntr\_Cnt\_T\_str.Timer1\_mS\_u32 | AUTOCNTRTYPE\_Str\* | 0 | 429496725 |
|  | AutoCntr\_Cnt\_T\_str.Timer1Thresh\_mS\_u16 | AUTOCNTRTYPE\_Str\* | 0 | 60000 |
|  | AutoCntr\_Cnt\_T\_str.RelHwPosFilt1SV\_HwDeg\_str.SV | AUTOCNTRTYPE\_Str\* | -3200 | 3200 |
|  | AutoCntr\_Cnt\_T\_str.RelHwPosFilt1SV\_HwDeg\_str.K | AUTOCNTRTYPE\_Str\* | 2.51327E-06 | 0.001255848 |
|  | AutoCntr\_Cnt\_T\_str.RelHwPosFilt2SV\_HwDeg\_str.SV | AUTOCNTRTYPE\_Str\* | -3200 | 3200 |
|  | AutoCntr\_Cnt\_T\_str.RelHwPosFilt2SV\_HwDeg\_str.K | AUTOCNTRTYPE\_Str\* | 2.51327E-06 | 0.001255848 |
|  | AutoCntr\_Cnt\_T\_str.CntrWindow\_HwDeg\_f32 | AUTOCNTRTYPE\_Str\* | 0 | 100 |
|  | AutoCntr\_Cnt\_T\_str.Timer2Thresh\_mS\_u16 | AUTOCNTRTYPE\_Str\* | 0 | 60000 |
|  | AutoCntr\_Cnt\_T\_str.Timer2\_mS\_u32 | AUTOCNTRTYPE\_Str\* | 0 | 4294967295 |
|  | AutoCntr\_Cnt\_T\_str.RelHwPosFilt1SV\_HwDeg\_str.SV | AUTOCNTRTYPE\_Str\* | -3200 | 3200 |
|  | AutoCntr\_Cnt\_T\_str.FiltPinTrq\_HwNm\_f32 | AUTOCNTRTYPE\_Str\* | 0 | 20 |
|  | OffsetRelHwPos\_HwDeg\_T\_f32 | float32 | -1600 | 1600 |
|  | RelHwPos\_HwDeg\_T\_f32 | float32 | -1600 | 1600 |
| **Return Value** | AutoCntrHwPos\_HwDeg\_T\_f32 | float32 | -3200 | 3200 |

#### Local Function TrvlExclsn

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Function Name** | TrvlExclsn | Type | Min | Max |
| **Arguments Passed** | CwEOTPosition\_HwDeg\_T\_f32 | float32 | 360 | 1440.11 |
|  | CcwEOTPosition\_HwDeg\_T\_f32 | float32 | -1440.11 | -360 |
|  | RelHwPos\_HwDeg\_T\_f32 | float32 | -1600 | 1600 |
| **Return Value** | None |  |  |  |

#### Local Function Arbn\_f32

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Function Name** | Arbn\_f32 | Type | Min | Max |
| **Arguments Passed** | RelHwPos\_HwDeg\_T\_f32 | float32 | 360 | 1440.11 |
|  | SrlHwAgVldMdfy\_Cnt\_T\_lgc | Boolean | FALSE | TRUE |
|  | SrlHwAg\_HwDeg\_T\_f32 | float32 | -1600 | 1600 |
|  | VDHwPos\_HwDeg\_T\_f32 | Float32 | -3200 | 3200 |
|  | VDAuthority\_Uls\_T\_f32 | Float32 | -3200 | 3200 |
|  | RelSLPHwPos\_HwDeg\_T\_f32 | Float32 | -3200 | 3200 |
| **Return Value** | LearnedHwPos\_HwDeg\_T\_f32 | Float32 | -1600 | 1600 |

#### Local Function SmoothHwPos\_f32

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Function Name** | SmoothHwPos\_f32 | Type | Min | Max |
| **Arguments Passed** | LearnedHwPos\_HwDeg\_T\_f32 | Float32 | -1600 | 1600 |
| **Return Value** | SnsrlessHwPos\_HwDeg\_T\_f32 | Float32 | -1600 | 1600 |

### Transition Functions

#### VehDyn\_Trns1

This function implements the Power Off functions defined in the FDD model.

# Known Limitations with Design

1. INLINE functions defined in GlobalMacro.h are not unit tested.
2. Component name should be changed from “Vehicle Dynamics” or “VehDyn” to “Vehicle Center Determination by Motor Position” or VCDMotPos according to ICR 4616 and FDD rev 002.
3. VehDyn\_SCom\_ForceCenter function is required as a manufacturing service for C1XX program and Jared updated the same in v007 of source code (13191) and was supposed to be updated in the next revision of FDD. But in the latest version of FDD v006 released, it’s not implemented.

# UNIT TEST CONSIDERATION

None

1. Abbreviations and Acronyms

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

1. 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 |  |

1. 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 EA3 | 01.04.00 |
| 3 | Software Naming Conventions | 2.0 |
| 4 | Software Design and Coding Standards | 2.1 |
| 5 | SF042A\_VehCentrDtmnByMotPosn\_Design | 9.0.0 |