**Module Design Document**

**For**

**CF14 PSA Torque Arbitrator**

**VERSION: 6.0**

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# Abbrevations And Acronyms

|  |  |
| --- | --- |
| Abbreviation | Description |
| DFD | Design functional diagram |
| MDD | Module design Document |
| FDD | Functional Design Document |
| CF | Customer Function |

# References

This section lists the title & version of all the documents that are referred for development of this document

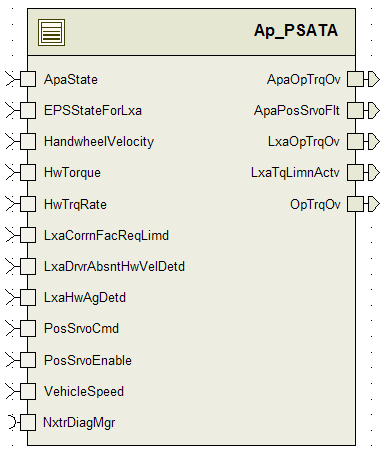
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| Sr. No. | Title | Version |
| 1 | MDD Guidelines | 01.04.00 |
| 2 | Software Naming Conventions | 2.0 |
| 3 | Software Design and Coding standards | 2.01 |
| 4 | CF14 PSA State handler FDD | 5.0.0 |

# PSA State Handler High-Level Description

*The PSA Torque Arbitrator will be equipped for EPS Systems with functions including Ramping and smoothing of PosServo command and Safety function. The safety function will monitor the PSA State Handler and PSA Torque Arbitrator.*

# Design details of software module

## Graphical representation of PSA Torque Arbitrator



## Data Flow Diagram

*Refer FDD*

## Module level DFD

*Refer FDD*

## Sub-Module level DFD

*Refer FDD*

## COMPONENT FLOW DIAGRAM

*Refer FDD*

# Variable Data Dictionary

## User defined typedef definition/declaration

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Typedef Name | Element Name | User Defined Type | Legal Range  (min) | Legal Range  (max) |
| None |  |  |  |  |

## Variable definition for enumerated types

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

# Constant Data Dictionary

## Program(fixed) Constants

## Embedded Constants

## Local

|  |  |  |  |
| --- | --- | --- | --- |
| Constant Name | Resolution | Units | Value |
| D\_POSSRVONTCENABLE\_MTRNM\_F32 | single preicision float | MTRNM | 0.0F |
| D\_FLTEPSILON\_ULS\_F32 | Single precision float | ULS | 0.0000001192092896F |

## Global

|  |
| --- |
| Constant Name |
| D\_ZERO\_CNT\_U8 |
| D\_ZERO\_ULS\_F32 |
| D\_TRUE\_CNT\_LGC |
| D\_2MS\_SEC\_F32 |
| D\_FALSE\_CNT\_LGC |
| D\_ONE\_ULS\_F32 |
| D\_MTRTRQCMDHILMT\_MTRNM\_F32 |
| D\_MTRTRQCMDLOLMT\_MTRNM\_F32 |

## Module specific Lookup Tables Constants

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

# Software Module Implementation

## Sub-Module Functions

## Initialization Functions

## Init: PSATA\_Init1

## Design Rationale

*Refer FDD*

## Module Outputs

None

## Module Internal

PSATA\_FilterdTrqSV\_HwNm\_M\_Str

PSATA\_LxaDiTranTi\_Sec\_M\_f32

## PERIODIC FUNCTIONS

## Per: PSATA\_per1

## Design Rationale

*Design follows implemenetation in FDD.*

## Store Module Inputs to Local copies

Refer FDD

## (Processing of function)………

*Refer to FDD (Block ‘PSATA\_Per1’)*

## Store Local copy of outputs into Module Outputs

Refer FDD.

## Interrupt Functions

*None*

## Serial Communication Functions

None

## Local Function/Macro Definitions

## LOCAL FUNCTION #1

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Function Name** | TrqArbn\_Fn | Type | Min | Max |
| **Arguments Passed** | PosSrvoCmd\_MtrNm\_T\_f32 | Float32 | -8.800000191 | 8.800000191 |
|  | EPSStateForLxa\_Cnt\_T\_enum | enum | 0 | 4 |
|  | ApaState\_Cnt\_T\_enum | enum | 0 | 3 |
| **Return Value** | N/A |  |  |  |

## Description

Implementation of ‘TorqueArbitration’ block in ‘PSATA\_Per1’. This function determines LxaPosServoCmd and APAPosSrvoCmd based on the current EPSStateForLxa and ApaState.

## LOCAL FUNCTION #2

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Function Name** | APASupervision\_Fn | Type | Min | Max |
| **Arguments Passed** | PosSrvoEnable\_Cnt\_T\_lgc | Boolean | FALSE | TRUE |
|  | HwTorque\_HwNm\_T\_f32 | Float32 | -10.0 | 10.0 |
|  | VehicleSpeed\_Kph\_T\_f32 | Float32 | 0 | 511 |
| **Return Value** | N/A |  |  |  |

## Description

Implementation of ‘APA Supervision’ block in ‘PSATA\_Per1’. This function determines the APA output torque overlay and monitors PosSrvo for errors.

## Local Function #3

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Function Name** | Cal\_ApaNTC | Type | Min | Max |
| **Arguments Passed** | PosSrvoEnable\_Cnt\_T\_lgc | Boolean | FALSE | TRUE |
|  | VehicleSpeed\_Kph\_T\_f32 | Float32 | 0 | 511 |
| **Return Value** | N/A |  |  |  |

## Description

This function monitors 'State Handler' and 'PosServo' for errors. Sets 'PosSrvoNTC\_Cnt\_lgc' signal accordingly.

Note: This implementation corresponds to lower half of APA NTC block.

## Local Function #4

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Function Name** | Cal\_PosServoSmoothingFactor | Type | Min | Max |
| **Arguments Passed** | HwTorque\_HwNm\_T\_f32 | Float32 | -10 | 10 |
|  | PosSrvoEnable\_Cnt\_T\_lgc | Boolean | FALSE | TRUE |
| **Return Value** | N/A |  |  |  |

## Description

Implementation of 'PosServoSmoothing' block. PosServoCmd changes instantly from zero when disabled to non-zero when enabled, and vice-versa. This routine calculates a scale factor for the PosServoCmd to smoothly ramp it in and out. First, it produces a linear scale factor, then feeds the linear factor into a lookup table to non-linearize it.This produces softer transitions when scale factor is near zero or near unity. The scale factor can decrease more rapidly when driver hand wheel torque is present.

## LOCAL FUNCTION #5

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Function Name** | LxaSupervision\_Fn | Type | Min | Max |
| **Arguments Passed** | VehicleSpeed\_Kph\_T\_f32 | Float32 | 0 | 511 |
|  | HwTorque\_HwNm\_T\_f32 | Float32 | -10.0 | 10.0 |
|  | PosSrvoEnable\_Cnt\_T\_lgc | Boolean | FALSE | TRUE |
|  | HandwheelVelocity\_HwRadpS\_T\_f32 | Float32 | -32.0 | 32.0 |
|  | LxaDrvrAbsntHwVelDetd\_Cnt\_T\_lgc | Boolean | FALSE | TRUE |
|  | LxaHwAgDetd\_Cnt\_T\_lgc | Boolean | FALSE | TRUE |
|  | HwTrqRate\_HwNmpS\_T\_f32 | Float32 | 0.0F | 200.0F |
|  | LxaCorrnFacReqLimd\_Uls\_T\_f32 | Float32 | 0.0 | 1.0 |
| **Return Value** | N/A |  |  |  |

## Description

Implementation of 'LxASupervision' block.

## LOCAL FUNCTION #6

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Function Name** | Cal\_LxaPosSrvoCmdLimit | Type | Min | Max |
| **Arguments Passed** | VehicleSpeed\_Kph\_T\_ u9p7 | u9p7 | 0 | 511 |
|  | LxaCorrnFacReqLimd\_Uls\_T\_f32 | Float32 | 0.0 | 1.0 |
| **Return Value** | N/A |  |  |  |

## Description

Implementation of ‘LxaPosSrvoCmdLimit’ block.

Calculates the limited Lxa PosServo command.

## LOCAL FUNCTION #7

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Function Name** | Cal\_LxaPosSrvoSmotngFactor | Type | Min | Max |
| **Arguments Passed** | PosSrvoEnable\_Cnt\_T\_lgc | Boolean | FALSE | TRUE |
| **Return Value** | N/A |  |  |  |

## Description

Implementation of 'LxaPosSrvoSmotngFactor' block.

Calculates the Lxa PosSrvo Smoothing Factor.

## LOCAL FUNCTION #8

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Function Name** | Cal\_LxaPosSrvoSmotng | Type | Min | Max |
| **Arguments Passed** | PosSrvoEnable\_Cnt\_T\_lgc | Boolean | FALSE | TRUE |
| **Return Value** | N/A |  |  |  |

## Description

Implementation of LxaPosSrvoSmotng’ block.

Calculates the Lxa PosSrvo Smoothed Command.

## LOCAL FUNCTION #9

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Function Name** | LxaNTC | Type | Min | Max |
| **Arguments Passed** | VehicleSpeed\_Kph\_T\_ u9p7 | u9p7 | 0 | 511 |
|  | HwTorque\_HwNm\_T\_f32 | Float32 | -10.0 | 10.0 |
|  | HandwheelVelocity\_HwRadpS\_T\_f32 | Float32 | -32.0 | 32.0 |
|  | HwTrqRate\_HwNmpS\_T\_f32 | Float32 | 0.0F | 200.0F |
| **Return Value** | N/A |  |  |  |

## Description

Implementation of 'LxaNTC' block.Performs Lxa fault diagnostics.

## LOCAL FUNCTION #10

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Function Name** | Cal\_LxaPosSrvoSftySmotngFactor | Type | Min | Max |
| **Arguments Passed** | VehicleSpeed\_Kph\_T\_u9p7 | u9p7 | 0 | 511 |
|  | LxaDrvrAbsntHwVelDetd\_Cnt\_T\_lgc | Boolean | FALSE | TRUE |
|  | LxaHwAgDetd\_Cnt\_T\_lgc | Boolean | FALSE | TRUE |
| **Return Value** | N/A |  |  |  |

## Description

Implementation of 'LxaPosSrvoSftySmotngFactor' block.

Calculates LxaPosSrvoSftySmotngFactor.

## LOCAL FUNCTION #11

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Function Name** | Cal\_LxaOpTrqOv | Type | Min | Max |
| **Arguments Passed** | LxaDrvrAbsntHwVelDetd\_Cnt\_T\_lgc | Boolean | FALSE | TRUE |
|  | LxaHwAgDetd\_Cnt\_T\_lgc | Boolean | FALSE | TRUE |
| **Return Value** | N/A |  |  |  |

## Description

Implementation of 'LxaPosSrvoSftySmotng' block.

Calculates LxaOpTrqOv.

## LOCAL FUNCTION #12

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Function Name** | Cal\_OpTrqOv | Type | Min | Max |
| **Arguments Passed** | EPSStateForLxa\_Cnt\_T\_enum | enum | 0 | 4 |
|  | VehicleSpeed\_Kph\_T\_f32 | Float32 | 0 | 511 |
|  | ApaState\_Cnt\_T\_enum | enum | 0 | 3 |
| **Return Value** | OpTrqOv\_MtrNm\_T\_f32 | Float32 | -8.8 | 8.8 |

## Description

Implementation of 'SafetyTorqueArbitration' block.

Calculates OpTrqOv.

## LOCAL FUNCTION #13

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Function Name** | NTCDiagc\_Fn | Type | Min | Max |
| **Arguments Passed** | DiagcCdn\_Cnt\_T\_lgc | boolean | FALSE | TRUE |
|  | \*PNAccum\_Cnt\_T\_u16 | uint16 | 0 | 65535 |
|  | FltMode\_Cnt\_T\_str | struct | - | - |
|  | NTC\_Num\_T\_u16 | uint16 | 1 | 511 |
|  | \*Flt\_Cnt\_T\_lgc | boolean | FALSE | TRUE |
| **Return Value** | N/A |  |  |  |

## Description

Re-usable function for NTC diagnostics used in Supervision submodule.

Updates PN counter and sets NTC if necessary.

## GLObAL Function/Macro Definitions

None

## Tranisition FUNCTIONS

None

# Known Limitations With Design

# UNIT TEST CONSIDERATION

1.

FDD describes functionality and structural breakdown of this component. Data dictionary contains all attributes of varibales and calibrations used.

# Appendix