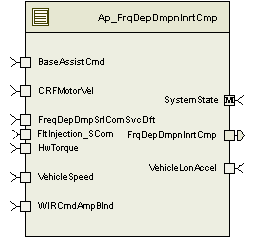
# Module -- Frequency Dependant Damping and Inertia Compensation

# High-Level Description

This MDD describes the methods to provide compensation that is dependent on filter of motor velocity which will compensate for motor inertia at low frequencies and provide damping acting at higher frequencies.

# Figures

## Diagram – Component



## Diagram – Function Data Sharing

N/A

### Diagram – FrqDepDmpnInrtCmp\_Per1

# Variable Data Dictionary

For details on module input / output variable, refer to the Data Dictionary for the application. Input / output variable names are listed here for reference.

(Note: Full variable names required in table.)

(Note: All global variables including End Of Line data used should be shown here)

|  |  |  |
| --- | --- | --- |
| Module Inputs | Module Outputs | |
| HwTorque\_HwNm\_f32 | | FrqDepDmpnInrtCmp\_MtrNm\_f32 |
| CRFMotorVel\_MtrRadpS\_f32 | |  |
| BaseAssistCmd\_MtrNm\_f32 | |  |
| VehicleSpeed\_Kph\_f32 | |  |
| WIRCmdAmpBlnd\_MtrNm\_f32 | |  |
| FreqDepDmpSrlComSvcDft\_Cnt\_lgc | |  |
| VehicleLonAccel\_KphpS\_T\_f32 | |  |

## Module Internal Variables

This section identifies the name, range and resolutions for module specific data created by this module. If there are no range restrictions on the variable, the term “FULL” is placed into the table for legal range.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable Name | Resolution | Legal Range  (min) | Legal Range  (max) | Software Segment |
| PrevTbarAng\_HwDeg\_M\_f32 | Single Precision Floating Point | -20 | 20 | FRQDEPDMPNINRTCMP\_START\_SEC\_VAR\_CLEARED\_32 |
| Prev1SclDrvVel\_RadpS\_M\_f32 | Single Precision Floating Point | -12917.3 | 12917.3 | FRQDEPDMPNINRTCMP\_START\_SEC\_VAR\_CLEARED\_32 |
| Prev2SclDrvVel\_RadpS\_M\_f32 | Single Precision Floating Point | -12917.3 | 12917.3 | FRQDEPDMPNINRTCMP\_START\_SEC\_VAR\_CLEARED\_32 |
| Prev1PreAttnComp\_MtrNm\_M\_f32 | Single Precision Floating Point | -8.8 | 8.8 | FRQDEPDMPNINRTCMP\_START\_SEC\_VAR\_CLEARED\_32 |
| Prev2PreAttnComp\_MtrNm\_M\_f32 | Single Precision Floating Point | -8.8 | 8.8 | FRQDEPDMPNINRTCMP\_START\_SEC\_VAR\_CLEARED\_32 |
| TbarVelFiltSv\_M\_str | N/A | N/A | N/A | FRQDEPDMPNINRTCMP\_START\_SEC\_VAR\_CLEARED\_UNSPECIFIED |
| TbarVelFiltSv\_M\_str.K\_ULS\_F32 | Single Precision Floating Point | 0.001255848 | 0.715390457 |  |
| TbarVelFiltSv\_M\_str.SV\_ULS\_F32 | Single Precision Floating Point | -6.6667 | 6.6667 | FRQDEPDMPNINRTCMP\_START\_SEC\_VAR\_CLEARED\_32 |
| PreDecelGain\_Uls\_M\_f32 | Single Precision Floating Point | 1 | FULL | FRQDEPDMPNINRTCMP\_START\_SEC\_VAR\_CLEARED\_32 |

### Module Display Variables

This section identifies the name, range and resolutions for data test points defined by the FDD. If there are no range restrictions on the variable, the term “FULL” is placed into the table for legal range.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable Name | Resolution | Legal Range  (min) | Legal Range  (max) | Software Segment |
| ADDCoef\_MtrNmSpRad\_D\_f32 | Single Precision Floating Point | FULL | FULL | FRQDEPDMPNINRTCMP\_START\_SEC\_VAR\_CLEARED\_UNSPECIFIED |
| DriverVelocity\_MtrRadpS\_D\_f32 | Single Precision Floating Point | FULL | FULL | FRQDEPDMPNINRTCMP\_START\_SEC\_VAR\_CLEARED\_UNSPECIFIED |
| FDDAttenOut\_MtrNm\_D\_f32 | Single Precision Floating Point | FULL | FULL | FRQDEPDMPNINRTCMP\_START\_SEC\_VAR\_CLEARED\_UNSPECIFIED |
| InertiaCompCalc\_MtrNm\_D\_f32 | Single Precision Floating Point | FULL | FULL | FRQDEPDMPNINRTCMP\_START\_SEC\_VAR\_CLEARED\_UNSPECIFIED |
| FiltFreqLUBlnd\_RadpS\_D\_f32 | Single Precision Floating Point | FULL | FULL | FRQDEPDMPNINRTCMP\_START\_SEC\_VAR\_CLEARED\_UNSPECIFIED |
| RawDecelGain\_Uls\_D\_f32 | Single Precision Floating Point | FULL | FULL | FRQDEPDMPNINRTCMP\_START\_SEC\_VAR\_CLEARED\_32 |
| TbarVelFiltVal\_HwDegpSec\_D\_f32 | Single Precision Floating Point | FULL | FULL | FRQDEPDMPNINRTCMP\_START\_SEC\_VAR\_CLEARED\_32 |

### User defined typedef definition/declaration

This section documents any user types uniquely used for the module.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Typedef Name | Element Name | User Defined Type | Legal Range  (min) | Legal Range  (max) |
| typedef struct filterCoef\_T | b0\_Uls\_f32 | Float32 | FULL | FULL |
|  | b1\_Uls\_f32 | Float32 | FULL | FULL |
|  | b2\_Uls\_f32 | Float32 | FULL | FULL |
|  | a0\_Uls\_f32 | Float32 | FULL | FULL |
|  | a1\_Uls\_f32 | Float32 | FULL | FULL |
|  | a2\_Uls\_f32 | Float32 | FULL | FULL |

# Constant Data Dictionary

## Calibration Constants

This section lists the calibrations used by the module. For details on calibration constants, refer to the Data Dictionary for the application.

|  |
| --- |
| Constant Name |
| k\_InrtCmp\_MtrInertia\_KgmSq\_f32 |
| t\_InrtCmp\_ScaleFactorTblY\_Uls\_u9p7[12] |
| k\_InrtCmp\_TBarVelLPFKn\_Hz\_f32 |
| t\_InrtCmp\_TBarVel\_ScaleFactorTblY\_Uls\_u9p7[12] |
| k\_InrtCmp\_MtrVel\_ScaleFactor\_Uls\_f32 |
| t\_FDD\_ADDStaticTblY\_MtrNmpRadpS\_um1p17[10] |
| t2\_FDD\_ADDRollingTblYM\_MtrNmpRadpS\_um1p17[2][10] |
| t\_FDD\_BlendTblY\_Uls\_u8p8[6] |
| t2\_FDD\_FreqTblYM\_Hz\_u12p4[2][12] |
| t\_FDD\_AttenTblX\_MtrRadpS\_u12p4[2] |
| t\_FDD\_AttenTblY\_Uls\_u8p8[2] |
| t\_WIRBlndTblX\_MtrNm\_u8p8[5] |
| t\_RIAstWIRBlndTblY\_Uls\_u2p14[5] |
| t\_DmpFiltKpWIRBlndY\_Uls\_u2p14[5] |
| t\_DmpDecelGainSlewY\_UlspS\_u13p3[6] |
| t\_DmpDecelGainSlewX\_MtrRadpS\_u11p5[6] |
| k\_DmpGainOnThresh\_KphpS\_f32 |
| k\_DmpDecelGain\_Uls\_f32 |
| k\_DmpDecelGainFSlew\_UlspS\_f32 |
| k\_DmpGainOffThresh\_KphpS\_f32 |
| t\_CmnVehSpd\_Kph\_u9p7[12] |
| t\_FddADDCoefTblX\_MtrNm\_u4p12[10] |
| k\_CmnTbarStiff\_NmpDeg\_f32 |
| k\_CmnSysKinRatio\_MtrDegpHwDeg\_f32 |

## Program(fixed) Constants

### Embedded Constants

All embedded constants whose values are provided in Eng units will be evaluated to the equivalent counts by using the FPM\_InitFixedPoint\_m() macro within the #define statement.

#### Local

|  |  |  |  |
| --- | --- | --- | --- |
| Constant Name | Resolution | Units | Value |
| D\_FDDADDCOEFTBLSIZE\_ULS\_U8 | uint8 | Uls | 24U |
| D\_FLOATONE\_ULS\_F32 | Float32 | Uls | 1.0F |
| D\_FLOATEIGHT\_ULS\_F32 | Float32 | Uls | 8.0F |
| D\_FLOATFOUR\_ULS\_F32 | Float32 | Uls | 4.0F |
| D\_FLOATTWO\_ULS\_F32 | Float32 | Uls | 2.0F |
| D\_ATTENTBLMAXINPUT\_MTRRADPS\_F32 | Float32 | MtrRadpS | 4095.9375 |
| D\_ATTENTBLMININPUT\_MTRRADPS\_F32 | Float32 | MtrRadpS | 0.0 |

#### Global

This section lists the global constants used by the module. For details on global constants, refer to the Data Dictionary for the application.

|  |
| --- |
| Constant Name |
| D\_ONE\_ULS\_F32 |
| D\_PIOVR180\_ULS\_F32 |
| D\_2MS\_SEC\_F32 |
| D\_2PI\_ULS\_F32 |
| D\_MTRTRQCMDHILMT\_MTRNM\_F32 |
| BC\_FREQDEPDAMPING\_FAULTINJECTIONPOINT |
| FLTINJ\_INERTIACOMP |

### Module specific Lookup Tables Constants

(This is for lookup tables (arrays) with fixed values, same name as other tables)

|  |  |  |  |
| --- | --- | --- | --- |
| Constant Name | Resolution | Value | Software Segment |
|  |  |  |  |

# Functions/Macros used by the Sub-Modules

## Library Functions / Macros

The library and functions / Macros that are called by the various sub modules are identified below,

1. Abs\_f32\_m
2. FPM\_FloatToFixed\_m
3. TableSize\_m
4. FPM\_FixedToFloat\_m
5. LPF\_SvUpdate\_s16InFixKTrunc\_m
6. Limit\_m
7. FPM\_FloatToFixedWithRound\_m

## Data Hiding Functions

1. IntplVarXY\_u16\_u16Xu16Y\_Cnt

## Global Functions/Macros Defined by this Module

N/A

## Local Functions/Macros Used by this MDD only

### Calculate Driver Velocity

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Function Name** | DriverVelCalc | Type | Min | Max |
| **Arguments Passed** | HwTroque\_HwNm\_T\_f32 | float32 | -10 | 10 |
|  | CRFMotorVel\_MtrRadpS\_T\_f32 | float32 | -1118 | 1118 |
|  | VehicleSpeed\_Kph\_T\_f32 | float32 | 0 | 512 |
| **Return Value** | ScaledDriverVel\_MtrRadpS\_T\_f32 | float32 | -7226.652 | 7226.652 |

#### Description



### Calculate Gain

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Function Name** | DecelGain | Type | Min | Max |
| **Arguments Passed** | VehicleLonAccel\_KphpS\_T\_f32 | float32 | -10 | 10 |
|  | CRFMotorVel\_MtrRadpS\_T\_f32 | float32 | -1118 | 1118 |
|  |  |  |  |  |
| **Return Value** | DecelGain\_Uls\_T\_f32 | float32 | 1 | FULL |

#### Description



### Calculate ADD Coefficient

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Function Name** | ADDCoefCalc | Type | Min | Max |
| **Arguments Passed** | BaseAssistCmd\_MtrNm\_T\_f32 | float32 | -8.8 | 8.8 |
|  | WIRCmdAmpBlnd\_MtrNm\_T\_f32 | float32 | 0 | 8.8 |
|  | VehicleSpeed\_Kph\_T\_f32 | float32 | 0 | 512 |
| **Return Value** | ADDCoefCalc\_MtrNmSpRad\_T\_f32 | float32 | 0.0 | 0.041306 |

#### Description



### Calculate Filter Coefficients

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Function Name** | FilterCoefCalc | | Type | Min | Max |
| **Arguments Passed** | ADDCoef\_MtrNmSpRad\_T\_f32 | | float32 | 0.0 | 0.041306 |
|  | WIRCmdAmpBlnd\_MtrNm\_T\_f32 | | float32 | 0 | 8.8 |
|  | VehicleSpeed\_Kph\_T\_f32 | | float32 | 0 | 512 |
| **Return Value** | \*FilterCoefStr | b0\_Uls\_f32 | float32 | -2.74156205240179 | 0 |
|  |  | b1\_Uls\_f32 | float32 | 0.0 | 0.330448 |
|  |  | b2\_Uls\_f32 | float32 | -0.160083862455113 | 2.41111405240179 |
|  |  | a0\_Uls\_f32 | float32 | 0.5525885 | 3.9498924 |
|  |  | a1\_Uls\_f32 | float32 | -7.9996842 | -4.8417266 |
|  |  | a2\_Uls\_f32 | float32 | 4.0504234 | 10.6056849 |

#### Description





### Generate Command

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Function Name** | GenFddIcCmd | | Type | Min | Max |
| **Arguments Passed** | ScaledDriverVel\_MtrRadpS\_T\_f32 | | float32 | -7226.652 | 7226.652 |
|  | \*FilterCoefStr | b0\_Uls\_f32 | float32 | -2.74156205240179 | 0 |
|  | b1\_Uls\_f32 | float32 | 0.0 | 0.330448 |
|  | b2\_Uls\_f32 | float32 | -0.166262133009164 | 2.41111405240179 |
|  | a0\_Uls\_f32 | float32 | 0.5525885 | 3.9498924 |
|  | a1\_Uls\_f32 | float32 | -7.9996842 | -4.8417266 |
|  | a2\_Uls\_f32 | float32 | 4.0504234 | 10.6056849 |
| **Return Value** | Compenstation\_MtrNm\_T\_f32 | | Float | -8.8 | 8.8 |

#### Description



# Software Module Implementation

## Runtime Environment (RTE) Initial Values

This section lists the initial values of data written by this module but controlled by the RTE. After RTE initialization, the data in this table will contain these values.

|  |  |
| --- | --- |
| Data | Value |
| Rte\_InitValue\_BaseAssistCmd\_MtrNm\_f32 | 0.0F |
| Rte\_InitValue\_CRFMotorVel\_MtrRadpS\_f32 | 0.0F |
| Rte\_InitValue\_FreqDepDmpSrlComSvcDft\_Cnt\_lgc | FALSE |
| Rte\_InitValue\_FrqDepDmpnInrtCmp\_MtrNm\_f32 | 0.0F |
| Rte\_InitValue\_HwTorque\_HwNm\_f32 | 0.0F |
| Rte\_InitValue\_VehicleSpeed\_Kph\_f32 | 0.0F |
| Rte\_InitValue\_WIRCmdAmpBlnd\_MtrNm\_f32 | 0.0F |
| Rte\_InitValue\_BaseAssistCmd\_MtrNm\_f32 | 0.0F |
| Rte\_InitValue\_CRFMotorVel\_MtrRadpS\_f32 | 0.0F |
| Rte\_ InitValue\_VehicleLonAccel\_KphpS\_f32 | 0.0F |

## Initialization Functions

### FrqDepDmpnInrtCmp\_Init



## Periodic Functions

### Per: \_Per1

#### Design Rationale

This periodic handles all location function calls to calculate the inertia and frequency dependant damping compensation.

#### Program Flow Start

Rte\_Call\_FrqDepDmpnInrtCmp\_Per1\_CP0\_CheckpointReached()

#### Store Module Inputs to Local copies

|  |  |
| --- | --- |
| Data | Value |
| HwTorque\_HwNm\_T\_f32 | Rte\_IRead\_FrqDepDmpnInrtCmp\_Per1\_HwTorque\_HwNm\_f32() |
| CRFMotorVel\_MtrRadpS\_T\_f32 | Rte\_IRead\_FrqDepDmpnInrtCmp\_Per1\_CRFMotorVel\_MtrRadpS\_f32() |
| BaseAssistCmd\_MtrNm\_T\_f32 | Rte\_IRead\_FrqDepDmpnInrtCmp\_Per1\_BaseAssistCmd\_MtrNm\_f32() |
| VehicleSpeed\_Kph\_T\_f32 | Rte\_IRead\_FrqDepDmpnInrtCmp\_Per1\_VehicleSpeed\_Kph\_f32() |
| WIRCmdAmpBlnd\_MtrNm\_T\_f32 | Rte\_IRead\_FrqDepDmpnInrtCmp\_Per1\_WIRCmdAmpBlnd\_MtrNm\_f32() |
| FDDDefSrvFlg\_Cnt\_T\_lgc | Rte\_IRead\_FrqDepDmpnInrtCmp\_Per1\_FreqDepDmpSrlComSvcDft\_Cnt\_lgc() |
| VehicleLonAccel\_KphpS\_T\_f32 | Rte\_IRead\_FrqDepDmpnInrtCmp\_Per1\_VehicleLonAccel\_KphpS\_f32() |

#### (Processing of function)………



#### Store Local copy of outputs into Module Outputs

|  |  |
| --- | --- |
| Data | Value |
| FrqDepDmpnInrtCmp\_MtrNm\_T\_f32 | Rte\_IWrite\_FrqDepDmpnInrtCmp\_Per1\_FrqDepDmpnInrtCmp\_MtrNm\_f32() |

#### Program Flow End

Rte\_Call\_FrqDepDmpnInrtCmp\_Per1\_CP1\_CheckpointReached();

## Fault Recovery Functions

N/A

## Shutdown Functions

N/A

## Interrupt Functions

N/A

## Serial Communication Functions

N/A

# Execution Requirements

## Execution Sequence of the Module

(Describe in words relevant details about the execution sequence of the different sub modules.)

## Execution Rates for sub-modules called by the Scheduler

This table serves as reference for the Scheduler design

|  |  |  |
| --- | --- | --- |
| Function Name | Calling Frequency | System State(s) in which the function is called |
| FrqDepDmpnInrtCmp\_Per1 | 2ms | WarmInit, Operate ,Off |
| FrqDepDmpnInrtCmp\_Init | Once at startup | On Init |

## Execution Requirements for Serial Communication Functions

|  |  |
| --- | --- |
| Function Name | Sub-Module called by (Serial Comm Function Name) |
| None |  |

# Memory Map Definition Requirements

## Sub Modules (Functions)

This table identifies the software segments for functions identified in this module.

|  |  |
| --- | --- |
| Name of Sub Module | Software Segment |
| FrqDepDmpnInrtCmp\_Per1 | RTE\_START\_SEC\_AP\_FRQDEPDMPNINRTCMP\_APPL\_CODE |
| FrqDepDmpnInrtCmp\_Init | RTE\_START\_SEC\_AP\_FRQDEPDMPNINRTCMP\_APPL\_CODE |

## Local Functions

This table identifies the software segments for local functions identified in this module.

|  |  |
| --- | --- |
| Name of Sub Module | Software Segment |
| DriverVelCalc | AUTOMATIC |
| ADDCoefCalc | AUTOMATIC |
| FilterCoefCalc | AUTOMATIC |
| GenFddIcCmd | AUTOMATIC |
|  |  |

# Filter Analysis

|  |  |
| --- | --- |
| File | Description |
|  | Filter analysis for all the LPF filters called in this MDD. Analysis contains high/low cutoff frequencies with max output. |

# Known Issues / Limitations With Design

1. INLINE functions defined in globalmacro.h are not unit tested

# Revision Control Log

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Item #** | **Rev #** | **Change Description** | **Date** | **Author Initials** |
| 1 | 1.0 | Initial Release | 23-Nov-11 | KJS |
| 2 | 2.0 | Corrections made after initial compile of the component, also updated service defeat input for clarity | 29-Nov-11 | KJS |
| 3 | 3.0 | Corrections made to range of module variable PrevTbar, and overflow condition in GenFDDIcCmd function. | 21-Dec-11 | KJS |
| 4 | 4.0 | Updated attenuation table limits for unsigned value | 21-Dec-11 | KJS |
| 5 | 5.0 | Corrected anomaly 2787 | 10-Jan-12 | KJS |
| 6 | 6.0 | Corrected anomaly 2799, changes to section 5.4.1.1 | 13-Jan-12 | KJS |
| 7 | 7.0 | Updated diagrams for anomaly correction 2855, filter analysis in section 9 and UTP known issue comment in section 10. | 21-Jan-12 | KJS |
| 8 | 8.0 | Updated ranges on filter coefficients | 08-Feb-12 | KJS |
| 9 | 9.0 | Fixed Anom 3616 | 09-Aug-12 | NRAR |
| 10 | 10.0 | UTP fixes as per mismatch with SRC | 28-Aug-12 | NRAR |
| 11 | 11 | Check Points added | 20-sep-2012 | SSK |
| 12 | 12 | Updated to version 5 FDD SF-14 | 7-Feb-13, | Selva |
| 13 | 13 | Change in the calibration names | 8-Feb-12 | Selva |
| 14 | 14 | Fixed anomaly 4786 | 12-Apr-2013 | SP |
| 15 | 15 | Interpolation input signal resolution corrections, anomaly 4775 | 12-Apr-2013 | JJW |
| 16 | 17 | A6259 fix - Initialized the module level variable used for previous value of DecelGain to 1. | 27-Aug-14 | SB |
| 17 | 18 | Ranges for parameters added in the function” FilterCoefCalc”. And flowcharts updated | 16-Sep-14 | KPIT/SB |