**Module Design Document**

**For**

**Torque Reasonableness Diagnostic**

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**Prepared For:**

**Software Engineering**

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|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Sl. No.** | **Description** | **Author** | **Version** | **Date** |
| 1 | Initial Version | Selva | 1.0 | 6-Nov-12 |
| 2 | Updated to version to SF-31 version 2 | Selva | 2.0 | 23-Feb-13 |
| 3 | Anomaly fix for A\_4644 | Srikanth | 3.0 | 25-Mar-13 |
| 4 | Fixes for Unit test findings | Srikanth | 4.0 | 15-Apr-13 |
| 5 | Anomaly fix for 4931 | OT | 5.0 | 30-Apr-13 |
| 6 | Updated for V3 SF31 (completely new) | Selva | 6.0 | 27-Nov-13 |
| 7 | Updated to SF-31 version 4 | VT | 7.0 | 08-Jan-14 |
| 8 | Updated to SF31 v5 | Selva | 8.0 | 23-Mar-15 |
| 9 | Updated to SF13A FDD version 6.0.0 and to new template | SB | 9.0 | 05-Aug-16 |

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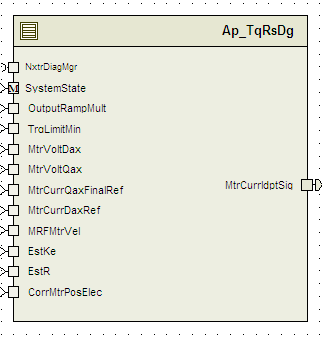
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# TqRsDg & High-Level Description

*The Torque Reasonableness Diagnostic compares the commanded electromagnetic motor torque (calculated from the commanded Iq and Id currents) to the measured electromagnetic torque (calculated from the measured Iq and Id currents) and sets a diagnostic flag when the error is outside of calibration boundaries for calibration time periods. This diagnostic is intended to trip due to a variety of possible errors within the closed loop control of the motor control, including but not exclusive to certain current measurement errors and output drive errors.*

# Design details of software module

## Graphical representation of TqRsDg



## Data Flow Diagram

### Module level DFD

N/A

### Sub-Module level DFD

N/A

## Component diagram

N/A

## Variable Data Dictionary

### User defined ‘typedef’ definition/declaration

N/A

### Variable definition for enumerated types

N/A

## Constant Data Dictionary

### Program Constants

#### Local Constants

Refer .m file

The filter constants were derived from the requirements in SF-09 in conjunction with the following filter analyses. Note that the upper frequency limits defined in the requirements for some values were not achievable. The data dictionary reflects the limits of both the requirements and the software limitations.

|  |  |  |  |
| --- | --- | --- | --- |
| Constant Name | Resolution | Units | Value |
| D\_BIT0\_ULS\_U8 | Uint8 | Cnt | 1 |
| D\_BIT1\_ULS\_U8 | Uint8 | Cnt | 2 |
| D\_SQRT3OVR2\_ULS\_F32 | Float32 | Uls | 0.866025403784 |

#### Global Constants

|  |
| --- |
| Constant Name |
| D\_ZERO\_CNT\_U8 |
| D\_2PI\_ULS\_F32 |
| D\_2MS\_SEC\_F32 |
| D\_ONE\_ULS\_F32 |
| D\_ZERO\_CNT\_U16 |
| D\_ZERO\_ULS\_F32 |
| D\_ONE\_CNT\_U8 |

### Module Specific Lookup Tables

None

## Software Module Implementation

<The detailed design of the function is provided in the FDD. The detail design shall only be add to the MDD when it is not provided in the FDD or the FDD is not adequate and clarification is needed.>

### Sub-Module Functions

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

##### **Design Rationale**

Init block is missing in the design. Filter initializations are done here.

##### **Store Module Inputs to Local copies**

*None*

##### **(Processing of function)………**

*LPF\_Init\_f32\_m(D\_ZERO\_ULS\_F32, k\_CurrDiagPrimLPFKn\_Hz\_f32, D\_2MS\_SEC\_F32, &TqRsDg\_AlpaCurrDiagPrimLPF\_M\_Str)*

*LPF\_Init\_f32\_m(D\_ZERO\_ULS\_F32, k\_CurrDiagPrimLPFKn\_Hz\_f32, D\_2MS\_SEC\_F32, &TqRsDg\_BetaCurrDiagPrimLPF\_M\_Str)*

*LPF\_Init\_f32\_m(D\_ZERO\_ULS\_F32, k\_CurrDiagSecLPFKn\_Hz\_f32, D\_2MS\_SEC\_F32, &TqRsDg\_AlpaCurrDiagSecLPF\_M\_Str)*

*LPF\_Init\_f32\_m(D\_ZERO\_ULS\_F32, k\_CurrDiagSecLPFKn\_Hz\_f32, D\_2MS\_SEC\_F32, &TqRsDg\_BetaCurrDiagSecLPF\_M\_Str)*

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

*None*

#### Periodic sub-module TqRsDg\_Per1()

Refer ‘SF-31 Current Reasonableness Diagnostic’ block in the Simulink model.

##### **Design Rationale**

None

##### **Store Module Inputs to Local copies**

CorrMtrPosElec\_Rev\_T\_f32 = Rte\_IRead\_TqRsDg\_Per1\_CorrMtrPosElec\_Rev\_f32();

EstKe\_VpRadpS\_T\_f32 = Rte\_IRead\_TqRsDg\_Per1\_EstKe\_VpRadpS\_f32();

EstR\_Ohm\_T\_f32 = Rte\_IRead\_TqRsDg\_Per1\_EstR\_Ohm\_f32();

MRFMtrVel\_MtrRadpS\_T\_f32 = Rte\_IRead\_TqRsDg\_Per1\_MRFMtrVel\_MtrRadpS\_f32();

MtrCurrDaxRef\_Amp\_T\_f32 = Rte\_IRead\_TqRsDg\_Per1\_MtrCurrDaxRef\_Amp\_f32();

MtrCurrQaxFinalRef\_Amp\_T\_f32 = Rte\_IRead\_TqRsDg\_Per1\_MtrCurrQaxFinalRef\_Amp\_f32();

MtrVoltDax\_Volt\_T\_f32 = Rte\_IRead\_TqRsDg\_Per1\_MtrVoltDax\_Volt\_f32();

MtrVoltQax\_Volt\_T\_f32 = Rte\_IRead\_TqRsDg\_Per1\_MtrVoltQax\_Volt\_f32();

OutputRampMult\_Uls\_T\_f32 = Rte\_IRead\_TqRsDg\_Per1\_OutputRampMult\_Uls\_f32();

TrqLimitMin\_MtrNm\_T\_f32 = Rte\_IRead\_TqRsDg\_Per1\_TrqLimitMin\_MtrNm\_f32();

##### **(Processing of function)………**

Refer ‘SF-31 Current Reasonableness Diagnostic ‘ block in the Simulink model.

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

Rte\_IWrite\_TqRsDg\_Per1\_MtrCurrIdptSig\_Cnt\_u08(MtrCurrIdptSig\_Cnt\_T\_u08)

#### Non Periodic sub-module {\_NONPer()}

None

### Interrupt Service Routines

None

### \_SCOMM () Functions

None

### Module Internal (Local) Functions

None

### Transition Functions

None

# Known Limitations with Design

1. Init block is missing in the design.
2. Design need to be updated to use the latest filter blocks for KUpdate and OpUpdate functions.

# UNIT TEST CONSIDERATION

1. INLINE functions defined in “GlobalMacro.h” are not unit tested

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 | Process release 04.02.01 |
| 3 | [Software Naming Conventions.doc](http://misagweb01.nexteer.com/eRoomReq/Files/erooms8/NextGeneration/0_fc55f/Software%20Naming%20Conventions%2003x(In%20Work).doc) | Process release 04.02.01 |
| 4 | [Software Design and Coding Standards.doc](http://eroom1.nexteer.com/eRoomReq/Files/erooms8/NextGeneration/0_1a67a9/Software%20Design%20and%20Coding%20Standards.doc) | Process release 04.02.01 |
| 5 | FDD - SF31\_CurrentReasonablenessDiagnostic | 006 |