# Module -- TrqCanc

# High-Level Description

# Figures

## Component Diagram

### 

# 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.

|  |  |  |
| --- | --- | --- |
| Module Inputs | Module Outputs | |
| EstKe\_VpRadpS\_f32 | |  |
| MRFMtrVel\_MtrRadpS\_f32 | |  |
| MtrCurrDaxRef\_Amp\_f32 | |  |
| MtrCurrQaxRef\_Amp\_f32 | |  |
| ElecPosDelayComp\_Rad\_f32 | | MtrCurrQaxRpl\_Amp\_T\_f32 |
| MtrElecPol\_Cnt\_s8 | | MtrCurrQaxCog\_Amp\_f32 |
| MtrPosElec\_Rev\_u0p16 | |  |
| EstKe\_VpRadpS\_f32 | |  |
| MtrCurrQax12Mag\_Amp\_f32 | |  |
| MtrCurrQax6Mag\_Amp\_f32 | |  |
| MtrCurrQax12Ph\_Rad\_f32 | |  |
| MtrCurrQax6Ph\_Rad\_f32 | |  |
| MtrCurrQax18Ph\_Rad\_f32 | |  |
| MtrCurrQax18Mag\_Amp\_f32 | |  |
| ActWriteAccBufIndex\_Cnt\_T\_u16 | |  |
| ReadBuffer\_Cnt\_M\_u16 | |  |

## 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 |
| CogginTrqCancIndex\_D\_Cnt\_u16 | 1 | 0 | 511 | TRQCANC\_VAR\_CLEARED\_16 |
| CoggingTrqCanc\_MtrNm\_D\_f32 | Single precision float | -1 | 1 | TRQCANC\_VAR\_CLEARED\_32 |
| MtrCurrQax6thMag\_Amp\_D\_f32 | Single precision float | -220 | 220 | TRQCANC\_VAR\_CLEARED\_32 |
| MtrTrqRip6thPhs\_Rad\_D\_f32 | Single precision float | -2\*pi | 2\*pi | TRQCANC\_VAR\_CLEARED\_32 |
| MtrCurrQax18thMag\_Amp\_D\_f32 | Single precision float | -220 | 220 | TRQCANC\_VAR\_CLEARED\_32 |
| MtrTrqRip18thPhs\_Rad\_D\_f32 | Single precision float | -2\*pi | 2\*pi | TRQCANC\_VAR\_CLEARED\_32 |
| MtrCurrQax12thMag\_Amp\_D\_f32 | Single precision float | -220 | 220 | TRQCANC\_VAR\_CLEARED\_32 |
| MtrTrqRip12thPhs\_Rad\_D\_f32 | Single precision float | -2\*pi | 2\*pi | TRQCANC\_VAR\_CLEARED\_32 |
| MtrCurrQax6thMagFinal\_Amp\_D\_f32 | Single precision float | -220 | 220 | TRQCANC\_VAR\_CLEARED\_32 |
| MtrTrqRip6thPhsFinal\_Rev\_D\_f32 | Single precision float | 0 | 1 | TRQCANC\_VAR\_CLEARED\_32 |
| MtrCurrQax18thMagFinal\_Amp\_D\_f32 | Single precision float | -220 | 220 | TRQCANC\_VAR\_CLEARED\_32 |
| MtrTrqRip18thPhsFinal\_Rev\_D\_f32 | Single precision float | 0 | 1 | TRQCANC\_VAR\_CLEARED\_32 |
| MtrCurrQax12thMagFinal\_Amp\_D\_f32 | Single precision float | -220 | 220 | TRQCANC\_VAR\_CLEARED\_32 |
| MtrTrqRip12thPhsFinal\_Rad\_D\_f32 | Single precision float | -2\*pi | 2\*pi | TRQCANC\_VAR\_CLEARED\_32 |
| CoggingTrqMtrPosElec\_Rad\_D\_f32 | Single precision float | -2\*pi | 2\*pi | TRQCANC\_VAR\_CLEARED\_32 |
| MtrCurrQax12Mag\_Amp\_M\_ f32 | Single precision float | -220 | 220 | TRQCANC\_VAR\_CLEARED\_32 |
| MtrCurrQax12Ph\_Rad \_M\_ f32 | Single precision float | -2\*pi | 2\*pi | TRQCANC\_VAR\_CLEARED\_32 |
| MtrCurrQax6Mag\_Amp\_ M\_ f32 | Single precision float | -220 | 220 | TRQCANC\_VAR\_CLEARED\_32 |
| MtrCurrQax6Ph\_Rad\_ M\_ f32 | Single precision float | -2\*pi | 2\*pi | TRQCANC\_VAR\_CLEARED\_32 |
| MtrCurrQax18Mag\_Amp\_ M\_ f32 | Single precision float | -220 | 220 | TRQCANC\_VAR\_CLEARED\_32 |
| MtrCurrQax18Ph\_Rad\_ M\_ f32 | Single precision float | -2\*pi | 2\*pi | TRQCANC\_VAR\_CLEARED\_32 |
| TrqCanc\_MtrCurrQaxRpl6X\_Amp\_M\_s6p9[][] | 2^-9 | FULL | FULL | TRQCANC\_VAR\_CLEARED\_16 |
| TrqCanc\_MtrCurrQaxRpl6Y\_Amp\_M\_s6p9[][] | 2^-9 | FULL | FULL | TRQCANC\_VAR\_CLEARED\_16 |
| TrqCanc\_MtrCurrQaxRpl12X\_Amp\_M\_s6p9[][] | 2^-9 | FULL | FULL | TRQCANC\_VAR\_CLEARED\_16 |
| TrqCanc\_MtrCurrQaxRpl12Y\_Amp\_M\_s6p9[][] | 2^-9 | FULL | FULL | TRQCANC\_VAR\_CLEARED\_16 |
| TrqCanc\_MtrCurrQaxRpl18X\_Amp\_M\_s6p9[][] | 2^-9 | FULL | FULL | TRQCANC\_VAR\_CLEARED\_16 |
| TrqCanc\_MtrCurrQaxRpl18Y\_Amp\_M\_s6p9[][] | 2^-9 | FULL | FULL | TRQCANC\_VAR\_CLEARED\_16 |
| TrqCanc\_CorrecNomKe\_VpRadpS\_M\_f32 | Single precision float | .025 | 0.075 | TRQCANC\_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) |
| CoggingM\_Amp\_Str | CoggingMX\_Amp\_s6p9 | sint16 | FULL | FULL |
|  | CoggingMY\_Amp\_s6p9 | sint16 | FULL | FULL |
| CogTrqCalPtr | Rte\_Pim\_CogTrqCal()[512] | Uint16 | -1 | 1 |
| CogTrqCalRplCompPtr | Rte\_Pim\_CogTrqRplComp()[9] | Uint16 | -1 | 1 |

# 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\_Harmonic6thElec\_Uls\_f32 |
| k\_Harmonic12thElec\_Uls\_f32 |
| k\_Harmonic18thElec\_Uls\_f32 |
| t\_MtrCurrQaxRpl\_Amp\_u9p7[] |
| t\_MtrCurrDaxRpl\_Amp\_u9p7[] |
| t2\_MtrCurrQaxRpl6X\_Amp\_s6p9[] |
| t2\_MtrCurrQaxRpl6Y\_Amp\_s6p9[] |
| t2\_MtrCurrQaxRpl12X\_Amp\_s6p9[] |
| t2\_MtrCurrQaxRpl12Y\_Amp\_s6p9[] |
| t2\_MtrCurrQaxRpl18X\_Amp\_s6p9[] |
| t2\_MtrCurrQaxRpl18Y\_Amp\_s6p9[] |
| t\_MtrVelX\_MtrRadpS\_T\_u14p2[10] |
| t\_MtrTrqCancPIMagRP\_Uls\_u6p10[10] |
| t\_MtrTrqCancPIPhRP\_Rev\_u0p16[10] |
| t\_MtrCurrQaxRplPIY\_Amp\_u9p7[] |
| t2\_MtrTrqCancPIMagRP\_Uls\_u6p10[] |
| t2\_MtrTrqCancPIPhRP\_Rev\_u0p16[] |

## 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\_SQRT3OVR2\_ULS\_F32 | Single precision float | Unit less | 0.866025403784 |
| D\_6HARMONICNO\_F32 | Single precision float | Unit less | 6 |
| D\_12HARMONICNO\_F32 | Single precision float | Unit less | 12 |
| D\_COGGINGTBLRES\_F32 | Single precision float | Counts | 81.48733 |
| D\_MAXTBLVALUE\_CNT\_u16 | 1 | Counts | 511 |
| D\_SCALERADTOCNTS\_ULS\_F32 | Single precision float | Unit less | 10430.3783505 |
| D\_30DEGREES\_CNT\_U16 | 1 | Counts | 5461 |
| D\_DEG2RAD\_ULS\_F32 | Singles precision float | Unit less | 0.0174532925199 |
| D\_REVWITHROUND\_ULS\_F32 | Singles precision float | Unit less | 65536.5 |
| D\_ONEHALF\_ULS\_F32 | Singles precision float | Unit less | 0.5 |
| D\_POSITIVEONE\_CNT\_S8 | 1 | Counts | 1 |
| D\_COGTRQ\_LOOPLMT | 1 | Unit less | 128 |
| D\_DAXRPLTBLSZ\_CNT\_U8 | 1 | Counts | TableSize\_m(t\_MtrCurrDaxRpl\_Amp\_u9p7) |
| D\_QAXRPLTBLSZ\_CNT\_U8 | 1 | Counts | TableSize\_m(t\_MtrCurrQaxRpl\_Amp\_u9p7) |
| D\_COGTRQRPL\_LOOPLMT | 1 | Counts | 3U |
| D\_NOOFHARMONIC\_CNT\_U8 | 1 | Counts | 9U |
| D\_MINCOGRANGE\_NM\_S5P10 | S5P10\_T | Nm | -0.1 |
| D\_MINCOGRANGE\_NM\_S5P10 | S5P10\_T | Nm | 0.1 |

#### 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\_2PI\_ULS\_F32 |
| D\_ONE\_ULS\_F32 |
| D\_ZERO\_ULS\_F32 |

### 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 |
| t\_SinTbl\_Cnt\_u16 | Uint16 |  | TRQCANC\_START\_SEC\_CONST\_16 |

# 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\_s16\_m
2. FPM\_FloatToFixed\_m
3. TableSize\_m
4. FPM\_FixedToFloat\_m
5. IntplVarXY\_u16\_u16Xu16Y\_Cnt
6. BilinearXYM\_s16\_u16Xs16YM\_Cnt
7. sqrtf
8. atan2f
9. sinf
10. Rte\_Pim\_CogTrqCal
11. Rte\_Pim\_CogTrqRplComp

## Data Hiding Functions

MtrCntrl\_Read\_MtrElecPol\_Cnt\_s8

MtrCntrl\_Read\_MtrPosElec\_Rev\_u0p16

MtrCntrl\_Read\_ReadFwdPthAccessBfr\_Cnt\_u16

## Global Functions/Macros Defined by this Module

None

## Local Functions/Macros Used by this MDD only

# 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 |
| EstKe\_VpRadpS\_f32 | Rte\_IRead\_TrqCanc\_Init\_EstKe\_VpRadpS\_f32 |
|  |  |

## Initialization Functions

### Per: TrqCanc\_Init

#### Design Rationale

Update the lookup table for ripple’s

#### Processing



## Periodic Functions

### Per: TrqCanc\_Per1

#### Design Rationale

FastDataAccessBufIndex allows the buffer synchronization between data calculated on slower periodic loop time(2 milli seconds) and are read by faster periodic run time (ie 0.125ms)

#### Program Flow Start

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

#### Store Module Inputs to Local copies

MRFMtrVel\_MtrRadpS\_T\_f32=Rte\_IRead\_TrqCanc\_Per1\_MRFMtrVel\_MtrRadpS\_f32

DaxRef\_Amp\_T\_f32=Rte\_IRead\_TrqCanc\_Per1\_MtrCurrDaxRef\_Amp\_f32

QaxRef\_Amp\_T\_f32 =Rte\_IRead\_TrqCanc\_Per1\_MtrCurrQaxRef\_Amp\_f32

WriteAccessBufIndex\_Cnt\_T\_u16= (FastDataAccessBufIndex\_Cnt\_M\_u16&1)^1;





  


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

#### Program Flow End

Rte\_Call\_TrqCanc\_Per1\_CP1\_CheckpointReached()

## Periodic Functions

### Per: TrqCogCancRefPer1

#### Design Rationale

FastDataAccessBufIndex allows the buffer synchronization between data calculated on slower periodic loop time(2 milli seconds) and are read by faster periodic run time. SlowDataAccessBufIndex allows the buffer synchronization between data calculated on faster periodic loop time(125 micro seconds) and are read by slower periodic run time (ie 2ms)

#### Program Flow Start

N/A

#### Store Module Inputs to Local copies

DataAccessBfr\_Cnt\_T\_u16 =FastDataAccessBufIndex\_Cnt\_M\_u16

MtrCntrl\_Read\_MtrElecPol\_Cnt\_s8(&MtrElecPol\_Cnt\_T\_s8)

MtrCntrl\_Read\_MtrPosElec\_Rev\_u0p16(&MtrPosElec\_Rev\_T\_u0p16)

MtrPosComputDelay\_Rad\_T\_f32=MtrPosComputationDelay\_Rad\_M\_f32[DataAccessBfr\_Cnt\_T\_u16]

EstKe\_VpRadpS\_T\_f32= MtrEstKe\_VpRadpS\_M\_f32[DataAccessBfr\_Cnt\_T\_u16]

MtrCurrQax6Mag\_Amp\_T\_f32 =MtrCurrQax6Mag\_Amp\_M\_f32[DataAccessBfr\_Cnt\_T\_u16] MtrCurrQax12Mag\_Amp\_T\_f32=MtrCurrQax12Mag\_Amp\_M\_f32[DataAccessBfr\_Cnt\_T\_u16] MtrCurrQax6Ph\_Rad\_T\_f32 =MtrCurrQax6Ph\_Rad\_M\_f32[DataAccessBfr\_Cnt\_T\_u16] MtrCurrQax12Ph\_Rad\_T\_f32 =MtrCurrQax12Ph\_Rad\_M\_f32[DataAccessBfr\_Cnt\_T\_u16]

MtrCurrQax18Mag\_Amp\_T\_f32=MtrCurrQax18Mag\_Amp\_M\_f32[DataAccessBfr\_Cnt\_T\_u16] MtrCurrQax18Ph\_Rad\_T\_f32 =MtrCurrQax18Ph\_Rad\_M\_f32[DataAccessBfr\_Cnt\_T\_u16]





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

None

#### Program Flow End

None

## Fault Recovery Functions

None

## Shutdown Functions

None

## Interrupt Functions

None

## Serial Communication Functions

### SComm: TrqCanc\_Scom\_ReadCogTrqCal

#### Design Rationale

#ifdef RTE\_PTR2ARRAYBASETYPE\_PASSING

FUNC(void, RTE\_AP\_TRQCANC\_APPL\_CODE) TrqCanc\_Scom\_ReadCogTrqCal(P2VAR(UInt16, AUTOMATIC, RTE\_AP\_TRQCANC\_APPL\_VAR) CogTrqCalPtr, UInt16 ID)

#else

FUNC(void, RTE\_AP\_TRQCANC\_APPL\_CODE) TrqCanc\_Scom\_ReadCogTrqCal(P2VAR(CoggingCancTrq, AUTOMATIC, RTE\_AP\_TRQCANC\_APPL\_VAR) CogTrqCalPtr, UInt16 ID)

#endif

#### Program Flow Start

None

#### Store Module Inputs to Local copies

None

#### Processing



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

None

**Program Flow End**

None

### SComm: TrqCanc\_Scom\_SetCogTrqCal

#### Design Rationale

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Function Name** | CoggingTrqTableUpdate | Type | Min | Max | UTP Tol. |
| **Arguments Passed** | **\*CogTrqCalPtr** | Sint16 | -1 | 1 |  |
|  | **ID** | Unit16 | 0 | 4 |  |
| **Return Value** | None |  |  |  |  |

#### #ifdef RTE\_PTR2ARRAYBASETYPE\_PASSING

#### FUNC(void, RTE\_AP\_TRQCANC\_APPL\_CODE) TrqCanc\_Scom\_SetCogTrqCal(P2CONST(UInt16, AUTOMATIC, RTE\_AP\_TRQCANC\_APPL\_DATA) CogTrqCalPtr, UInt16 ID)

#### #else

#### FUNC(void, RTE\_AP\_TRQCANC\_APPL\_CODE) TrqCanc\_Scom\_SetCogTrqCal(P2CONST(CoggingCancTrq, AUTOMATIC, RTE\_AP\_TRQCANC\_APPL\_DATA) CogTrqCalPtr, UInt16 ID)

#endif

#### Program Flow Start

None

#### Store Module Inputs to Local copies

None

#### Processing



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

None

#### Program Flow End

None

## Local Function/Macro Definitions

### CoggingTrqTableUpdate#1

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Function Name** | CoggingTrqTableUpdate | Type | Min | Max | UTP Tol. |
| **Arguments Passed** | N/A | N/A | - | - |  |
| **Return Value** | N/A | N/A | N/A | N/A |  |

#### Description





### SinLookup #2

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Function Name** | SinLookup | Type | Min | Max | UTP Tol. |
| **Arguments Passed** | Theta\_Rad\_T\_f32 | Float32 | --2\*pi | 2\*pi |  |
| **Return Value** | Result\_Uls\_T\_f32 | Float32 | -1 | 1 |  |

#### Description



# 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 |
| TrqCanc\_Per1 | 2ms | ALL |
| TrqCogCancRefPer1 | 125us | ALL |
| TrqCanc\_Init | Init | At Startup |

## Execution Requirements for Serial Communication Functions

|  |  |
| --- | --- |
| Function Name | Sub-Module called by (Serial Comm Function Name) |
| TrqCanc\_Scom\_ReadCogTrqCal | EPS\_DiagSrvc |
| TrqCanc\_Scom\_SetCogTrqCal | EPS\_DiagSrvc |

# 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 |
| TrqCanc\_Per1 | RTE\_START\_SEC\_AP\_TRQCANC\_APPL\_CODE |
| TrqCanc\_Init | RTE\_START\_SEC\_AP\_TRQCANC\_APPL\_CODE |

## Local Functions

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

|  |  |
| --- | --- |
| Name of Sub Module | Software Segment |
| CoggingTrqTableUpdate | RTE\_START\_SEC\_AP\_TRQCANC\_APPL\_CODE |
| SinLookup | RTE\_START\_SEC\_AP\_TRQCANC\_APPL\_CODE |

# Known Issues / Limitations With Design

Note for UNIT TEST:

1. Rte\_Pim\_CogTrqCal and CogTrqRplComp is declared as unit16 with size of 521 with 512 values are used in the look up and 9 values are used in the harmonic table compensation.

Eventhough the values are read as uint16 it will be used as sint16 ( s5p10 preciously) with the range of -1 to 1 .

# Revision Control Log

|  |  |  |  |
| --- | --- | --- | --- |
| **Rev #** | **Change Description** | **Date** | **Author Initials** |
| 1.0 | Initial version (v8 FDD SF99B) | 23-Mar-13 | Selva |
| 2 | Updated to version 9 FDD SF99B | 5-June-13 | Selva |
| 3 | Updated to version 10 FDD SF99B | 21-Oct-13 | Selva |
| 4 | Updated to version 10 FDD SF99B | 23-Oct-13 | Selva |
| 5 | Updated to version 11 FDD SF99B | 7-Nov-13 | Selva |