# Module –

# High-Level Description

Non-AUTOSAR PWM driver required to perform EPS motor control PWM profiles.

# Figures

## Component Diagram

This diagram shows all data that is shared between functions within the module.

No data sharing

### Diagram – Function (Per1)

None (For more refer section 6)

# 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 (Global Variable Name) | Module Outputs (Global Variable Name) |
| CDD\_PhaseAdvFinal\_Cnt\_G\_u16[2] |  |
| CDD\_CommOffset\_Cnt\_G\_u16[2] | CDD\_PWMDutyCycleASum\_Cnt\_G\_u32[2] |
| CDD\_MtrPosElec\_Rev\_G\_u0p16[2] | CDD\_PWMDutyCycleBSum\_Cnt\_G\_u32[2] |
| CDD\_PwmDisable\_Cnt\_G\_lgc[2] | CDD\_PWMDutyCycleCSum\_Cnt\_G\_u32[2] |
|  | CDD\_PWMPeriodSum\_Cnt\_G\_u32[2] |
|  | CDD\_PhsReasA\_Cnt\_G\_u16[2] |
| CDD\_ModIdxFinal\_Uls\_G\_u16p16 | CDD\_PhsReasB\_Cnt\_G\_u16[2] |
| CDD\_CDDDataAccessBfr\_Cnt\_G\_u16 | CDD\_PhsReasC\_Cnt\_G\_u16[2] |
| CDD\_AppDataFwdPthAccessBfr\_Cnt\_G\_u16 | CDD\_DCPhsComp\_Cnt\_G\_u16[3] |
| CDD\_AppDataFbkPthAccessBfr\_Cnt\_G\_u16 | CDD\_PWMPeriod\_Cnt\_G\_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 |
| CDD\_SeedPWMDither\_Cnt\_M\_u16 | 1 | 0 | 65535 | PWMCDD\_START\_SEC\_VAR\_CLEARED\_16 |
| CDD\_DitherFlt1SV\_Cnt\_M\_u16 | 1 | 0 | 65535 | PWMCDD\_START\_SEC\_VAR\_CLEARED\_16 |
| CDD\_DitherFlt2SV\_Cnt\_M\_u16 | 1 | 0 | 65535 | PWMCDD\_START\_SEC\_VAR\_CLEARED\_16 |
| CDD\_PhaseOffset\_Rev\_M\_u0p16[3] | 2^-16 | 0 | 0.99998 | PWMCDD\_START\_SEC\_VAR\_CLEARED\_16 |
|  |  |  |  |  |
| PrevDCPhsAComp\_Cnt\_M\_u16p0 | 1 | 0 | 7150 | PWMCDD\_START\_SEC\_VAR\_CLEARED\_16 |
| PrevDCPhsBComp\_Cnt\_M\_u16p0 | 1 | 0 | 7150 | PWMCDD\_START\_SEC\_VAR\_CLEARED\_16 |
| PrevDCPhsCComp\_Cnt\_M\_u16p0 | 1 | 0 | 7150 | PWMCDD\_START\_SEC\_VAR\_CLEARED\_16 |
| DCPhsAComp\_Cnt\_M\_u16p0 | 1 | 0 | 7150 | PWMCDD\_START\_SEC\_VAR\_CLEARED\_16 |
| DCPhsBComp\_Cnt\_M\_u16p0 | 1 | 0 | 7150 | PWMCDD\_START\_SEC\_VAR\_CLEARED\_16 |
| DCPhsCComp\_Cnt\_M\_u16p0 | 1 | 0 | 7150 | PWMCDD\_START\_SEC\_VAR\_CLEARED\_16 |
| PrevPWMPeriod\_Cnt\_M\_u16 | 1 | 2950 | 7150 | PWMCDD\_START\_SEC\_VAR\_CLEARED\_16 |
| PWMPeriod\_Cnt\_M\_u16 | 1 | 2950 | 7150 | PWMCDD\_START\_SEC\_VAR\_CLEARED\_16 |
| PwmCdd\_PWMPrdMax\_Cnt\_M\_u16 | 1 | 4000 | 6667 | PWMCDD\_START\_SEC\_VAR\_CLEARED\_16 |
| PwmCdd\_PWMPrdMin\_Cnt\_M\_u16 | 1 | 3334 | 5000 | PWMCDD\_START\_SEC\_VAR\_CLEARED\_16 |
| PwmCdd\_PWMPrdRange\_Cnt\_M\_u16 | 1 | 666 | 1667 | PWMCDD\_START\_SEC\_VAR\_CLEARED\_16 |

### 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) |
| None |  |  |  |  |

# 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\_DitherLPFKn\_Cnt\_u16 |
| k\_PWMBaseFrequency\_Hz\_u16 |

## 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\_NhetFreq\_Hz\_Cnt\_u16 | 1 | u16 | 75000000UL |
|  |  |  |  |
| d\_HalfPrec16\_Cnt\_u16 | 1 | u16 | 32768UL |
| d\_Scaler1\_Cnt\_u16 | 1 | u16 | 1U |
|  |  |  |  |
| d\_Scaler16\_Cnt\_u16 | 1 | u16 | 16U |
| d\_SeedInitial\_Cnt\_u16 | 1 | u16 | 10U |
| d\_SeedMultiplier\_Cnt\_u16 | 1 | u16 | 57U |
| d\_SeedOffset\_Cnt\_u16 | 1 | u16 | 1U |
| d\_PWMFreqDither\_Hz\_u16 | 1 | u16 | 2000U |
| d\_FilterKdBits\_Cnt\_U16 | 1 | u16 | 5U |
| d\_MaxModIdx\_Uls\_u0p16 | 2-16 | u0p16 | (FPM\_InitFixedPoint\_m(0.9999847412109375,u0p16\_T)) |
| d\_MinModIdx\_Uls\_u0p16 | 2-16 | u0p16 | (FPM\_InitFixedPoint\_m(0.0,u0p16\_T)) |
| d\_120Deg\_Rev\_u0p16 | 2-16 | u0p16 | (FPM\_InitFixedPoint\_m(0.3333333333,u0p16\_T)) |
| d\_0Deg\_Rev\_u0p16 | 2-16 | u0p16 | (FPM\_InitFixedPoint\_m(0.0,u0p16\_T)) |
| d\_30Deg\_Rev\_u0p16 | 2-16 | u0p16 | (FPM\_InitFixedPoint\_m(0.0833333333,u0p16\_T)) |
| d\_60Deg\_Rev\_u0p16 | 2-16 | u0p16 | (FPM\_InitFixedPoint\_m(0.1666666666,u0p16\_T)) |
| d\_240Deg\_Rev\_u0p16 | 2-16 | u0p16 | (FPM\_InitFixedPoint\_m(0.6666666666,u0p16\_T)) |
| d\_180Deg\_Rev\_u0p16 | 2-16 | u0p16 | (FPM\_InitFixedPoint\_m(0.5,u0p16\_T)) |
| d\_PhaseAOffsetNrm\_Rev\_u0p16 | 2-16 | u0p16 | d\_0Deg\_Rev\_u0p16 |
| d\_PhaseBOffsetNrm\_Rev\_u0p16 | 2-16 | u0p16 | ((uint16)(d\_PhaseAOffsetNrm\_Rev\_u0p16-d\_120Deg\_Rev\_u0p16)) |
| d\_PhaseCOffsetNrm\_Rev\_u0p16 | 2-16 | u0p16 | (d\_PhaseAOffsetNrm\_Rev\_u0p16+d\_120Deg\_Rev\_u0p16) |
| d\_PhaseAOffsetInv\_Rev\_u0p16 | 2-16 | u0p16 | d\_60Deg\_Rev\_u0p16 |
| d\_PhaseBOffsetInv\_Rev\_u0p16 | 2-16 | u0p16 | (d\_PhaseAOffsetInv\_Rev\_u0p16+d\_120Deg\_Rev\_u0p16) |
| d\_PhaseCOffsetInv\_Rev\_u0p16 | 2-16 | u0p16 | ((uint16)(d\_PhaseAOffsetInv\_Rev\_u0p16-d\_120Deg\_Rev\_u0p16)) |
| d\_RevpCnt\_Uls\_u0p32 | 2-32 | u0p32 | 699051UL/\*(FPM\_InitFixedPoint\_m(1/d\_PACntspRev\_Uls\_u16p0,u0p32\_T))\*/ |
| d\_PACntspRev\_Uls\_u16p0 | 1 | u16p0 | 6144U |
| d\_SinePhsToGndTblSize\_Cnt\_u16 | 1 | u16 | 2049U |
| d\_MSBMask\_Cnt\_u16 | 1 | u16 | 0x8000U |
| D\_POSITIVEONE\_CNT\_S8 | 1 | s8 | 1 |
| D\_PHSAIDX\_CNT\_U16 | 1 | u16 | 0U |
| D\_PHSBIDX\_CNT\_ U16 | 1 | u16 | 1U |
| D\_PHSCIDX\_CNT\_ U16 | 1 | u16 | 2U |

#### 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 |
|  |
|  |

### Module specific Lookup Tables Constants

|  |  |  |  |
| --- | --- | --- | --- |
| Constant Name | Resolution | Value | Software Segment |
| t\_S\_SinePhsToGndTbl\_Cnt\_u0p16[2049] | 2-16 |  | None |

# 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,

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

1. FPM\_FloatToFixed\_m()
2. FPM\_FixedToFloat\_m()
3. Limit\_m()
4. Max\_m()
5. Min\_m()
6. CDD\_Read\_PhaseAdvanceFinal\_Rev\_u0p16()

## Data Hiding Functions

1. None

## Global Functions/Macros Defined by this Module

### Global Function #1

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Function Name** | CDD\_ApplyPWMMtrElecMechPol | Type | Min | Max | UTP Tol. |
| **Arguments Passed** | MtrElecMechPol\_Cnt\_s8 | Sint 8 | -1 | 1 |  |
|  |  |  |  |  |  |
| **Return Value** | CDD\_PhaseOffset\_Rev\_M\_u0p16 | Uint16 | 0 | 0.999987 |  |

#### Description

Applies the offsets needed for MtrElecMech Polarity Setting



### Global Function #2

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Function Name** | CDDPorts\_ClearPhsReasSum | Type | Min | Max | UTP Tol. |
| **Arguments Passed** | DataAccessBfr\_Cnt\_T\_u16 | Uint16 | 0 | 1 |  |
| **Return Value** | CDD\_PWMDutyCycleASum\_Cnt\_G\_u32 | Uint32 | 0 | 200000 | N/A |
|  | CDD\_PWMDutyCycleBSum\_Cnt\_G\_u32 | Uint32 | 0 | 200000 | N/A |
|  | CDD\_PWMDutyCycleCSum\_Cnt\_G\_u32 | Uint32 | 0 | 200000 | N/A |
|  | CDD\_PWMPeriodSum\_Cnt\_G\_u32 | Uint32 | 0 | 200000 | N/A |

#### Description

## 

## Local Functions/Macros Used by this MDD only

Local Macros are defined in PWMCDD\_Cfg.h file as the return values/calculation of return values are more project specific

### Local Function #1

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Function Name** | PwmPeriodDither\_u16 | Type | Min | Max | UTP Tol. |
| **Arguments Passed** | None |  |  |  |  |
|  |  |  |  |  |  |
| **Return Value** | PWMPeriod\_Cnt\_T\_u16 | Unit16 | 0 | 65535 |  |

#### Description

Generates the next PWM Period



### Local Function #3

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Function Name** | ModIndxPhase\_u0p16 | Type | Min | Max | UTP Tol. |
| **Arguments Passed** | PhaseIndex\_Rev\_T\_u0p16 | Uint16 | 0 | 0.999987 |  |
|  |  |  |  |  |  |
| **Return Value** | ModIdxPhs\_Cnt\_T\_u0p16 | Uint16 | 0 | 0.999987 |  |

#### Description

Calculates ModIndx for each phase



### Local Macro #1

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Function Name** | CDD\_Read\_PhaseAdvanceFinal\_Rev\_u0p16 | Type | Min | Max | UTP Tol. |
| **Arguments Passed** | &PhaseAdvFinal\_Rev\_T\_u0p16 | U0p16 | 0 | 1 |  |
|  |  |  |  |  |  |
| **Return Value** | none |  |  |  |  |

#### Description

Converts phase advance final from count units to rev units. (Units type conversion)

### Local Macro #2

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Function Name** | CDD\_Read\_CorrectedMtrPos\_Rev\_u0p16 | Type | Min | Max | UTP Tol. |
| **Arguments Passed** | & CorrectedMtrPos\_Rev\_T\_u0p16 | U0p16 | 0 | 0.999984741 |  |
|  |  |  |  |  |  |
| **Return Value** | none |  |  |  |  |

#### Description

Reads the Motor position global variable and assign it to “CorrectedMtrPos\_Rev\_T\_u0p16”

### Local Macro #3

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Function Name** | CDD\_Read\_CommOffset\_Cnt\_u16 | Type | Min | Max | UTP Tol. |
| **Arguments Passed** | &CommOffset\_Cnt\_T\_u16 | U16 | 0 | 65535 |  |
|  |  |  |  |  |  |
| **Return Value** | none |  |  |  |  |

#### Description

Reads the Commutation offset and assign it global variable and assign it to “CommOffset\_Cnt\_T\_u16”

# 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 |
| None |  |

## Initialization Functions

### Init: PwmCdd\_Init

#### Design Rationale

None

#### Module Outputs

None

#### Module Internal

## Periodic Functions

### Per: \_Per1

#### Design Rationale

None

#### Program Flow Start

N/A

#### Store Module Inputs to Local copies

None

#### Processing of function



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

None

#### Program Flow End

N/A

## Fault Recovery Functions

None

## Shutdown Functions

None

## Interrupt Functions

None

## Serial Communication Functions

### SCom: ModuleName\_Scom\_

#### Design Rationale

None

#### Program Flow Start

N/A

#### Store Module Inputs to Local copies

None

#### Processing of function

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

None

#### Program Flow End

N/A

# Execution Requirements

## Execution Sequence of the Module

## 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 |
| PwmCdd\_Init | Once | EcuStartup |
| PwmCdd\_Per1 | Motor control ISR | All states |

## 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 |
| None |  |

## Local Functions

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

|  |  |
| --- | --- |
| Name of Sub Module | Software Segment |
| None |  |

# 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 Version | 17 Oct 2012 | Selva |
| 2 | 2.0 | Nhet specific names are changed to common names and project specific variables assignment are moved to configuration Macros to keep PWMCdd same across projects | 15-Feb-12 | Selva |
| 3 | 3.0 | Changed the Buffer index of CDD\_ModIdxFinal\_Uls\_G\_u16p16 from "CDD\_AppDataFwdPthAccessBfr\_Cnt\_G\_u16" to "CDD\_CDDDataAccessBfr\_Cnt\_G\_u16" | 19-Apr-13 | Selva |
| 4 | 4.0 | Updated for ranges for UTP | 1-July-13 | Selva |
| 5 | 5.0 | Deleted Dead time compensation and corrected the DCPhase calculation | 1-Nov -13 | Selva |
| 6 | 6.0 | Replaced d\_PWMFreqBase\_Hz\_u16Added with k\_PWMBaseFrequency\_Hz\_u16 d\_PwmPrdMax\_Cnt\_u16 with PwmCdd\_PWMPrdMax\_Cnt\_M\_u16 and d\_PwmPrdMin\_Cnt\_u16 with PwmCdd\_PWMPrdMin\_Cnt\_M\_u16 d\_PwmPrdRange\_Cnt\_u16 with PwmCdd\_PWMPrdRange\_Cnt\_M\_u16  removed d\_PwmPrdInitVal\_Cnt\_u16 which is not used. | 22-Jan-14 | LK |
| 7 | 7.0 | Module variable range updates | 27-Jan-14 | SR |
| 8 | 8.0 | Replaced CDD\_ModIdxFinal\_Uls\_G\_u16p16 with ModIdxFinal\_Uls\_T\_u16p16 for 83,3hz noise | 20-Aug-15 | Selva |

\