# Module -- Generate Position Trajectory

# High-Level Description

Generate a position vs. time command from the current hand wheel position to a specified angle that does not exceed a specified maximum angular acceleration and velocity. Figure 1 illustrates an example of the output of this function.



Constant

Deceleration

Constant

Velocity

Constant

Acceleration

Initial

Position

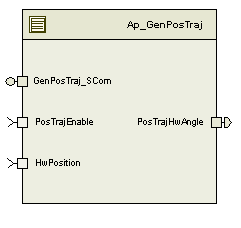
Commanded

Position

# Figures

## Diagram – Function Data Sharing

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



### Diagram – Function (Name)

This diagram describes the functional characteristics and data flow of a given function.

## Variable Data Dictionary

|  |  |  |
| --- | --- | --- |
| Module Inputs | Module Outputs | |
| HwPosition\_HwDeg\_f32 | | PosTrajHwAngle\_HwDeg\_f32 |
| PosTrajEnable\_Cnt\_lgc | |  |

## Module Internal Variables

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable Name | Resolution | Legal Range  (min) | Legal Range  (max) | Software Segment |
| GenPosTraj\_TargetAngle\_HwDeg\_M\_f32 | Single Precision Floating Point | -2000 | 2000 | GENPOSTRAJ\_START\_SEC\_VAR\_CLEARED\_32 |
| GenPosTraj\_TargetVelocity\_HwDegpSec\_M\_f32 | Single Precision Floating Point | 1 | 1000 | GENPOSTRAJ\_START\_SEC\_VAR\_CLEARED\_32 |
| GenPosTraj\_TargetAcceleration\_HwDegpSecSqr\_M\_f32 | Single Precision Floating Point | 0.125 | 10000 | GENPOSTRAJ\_START\_SEC\_VAR\_CLEARED\_32 |
| GenPosTraj\_TargetAngleInitial\_HwDeg\_M\_f32 | Single Precision Floating Point | -2000 | 2000 | GENPOSTRAJ\_START\_SEC\_VAR\_CLEARED\_32 |
| GenPosTraj\_TargetVelocityInitial\_HwDegpSec\_M\_f32 | Single Precision Floating Point | 0.125 | 10000 | GENPOSTRAJ\_START\_SEC\_VAR\_CLEARED\_32 |
| GenPosTraj\_TargetAccelerationInitial\_HwDegpSecSqr\_M\_f32 | Single Precision Floating Point | 1 | 1000 | GENPOSTRAJ\_START\_SEC\_VAR\_CLEARED\_32 |
| GenPosTraj\_HwPosInitial\_HwDeg\_M\_f32 | Single Precision Floating Point | -1440.11 | 1440.11 | GENPOSTRAJ\_START\_SEC\_VAR\_CLEARED\_32 |
| GenPosTraj\_CalculateFlag\_Cnt\_M\_lgc | n/a | 0 | 1 | GENPOSTRAJ\_START\_SEC\_VAR\_CLEARED\_ UNSPECIFIED |
| GenPosTraj\_HwAngleOffsetIn\_HwDeg\_M\_f32 | Single Precision Floating Point | 1440.11 | 1440.11 | GENPOSTRAJ\_START\_SEC\_VAR\_CLEARED\_32 |
| GenPosTraj\_StateTime\_Sec\_M\_f32 | Single Precision Floating Point | 0 | 128 | GENPOSTRAJ\_START\_SEC\_VAR\_CLEARED\_32 |

### User defined typedef definition/declaration

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Typedef Name | Element Name | User Defined Type | Legal Range  (min) | Legal Range  (max) |
| GenPosTraj\_CmdState\_Cnt\_M\_Enum | WAITING\_STATE = 0 ACCELERATION\_STATE = 1 CONSTANT\_VEL\_STATE = 2 DECELERATION\_STATE = 3  HOLD\_STATE = 4 | CMDSTATE\_Enum | n/a | n/a |

# Constant Data Dictionary

## Calibration Constants

|  |
| --- |
| Constant Name |
| k\_PosTrajMaxAngle\_HwDeg\_f32 |
| k\_PosTrajMaxVelocity\_HwDegpSec\_f32 |
| k\_PosTrajMaxAccel\_HwDegpSecSqr\_f32 |

## Program(fixed) Constants

### Embedded Constants

#### Local

|  |  |  |  |
| --- | --- | --- | --- |
| Constant Name | Resolution | Units | Value |
| D\_MINTRGTACCEL\_HWDEGPSECSQR\_F32 | Single Precision Floating Point | HWDEGPSECSQR | 0.125 |
| D\_HWANGLECMD\_HWDEG\_F32 | Single Precision Floating Point | HWDEG | 1440.11 |

#### Global

|  |
| --- |
| Constant Name |
| D\_2MS\_SEC\_F32 |
| D\_ZERO\_ULS\_F32  D\_ONE\_ULS\_F32 |

### Module specific Lookup Tables Constants

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

1. Limit\_m
2. Abs\_f32\_m
3. Sign\_f32\_m

## Data Hiding Functions

1. <None>

## Global Functions/Macros Defined by this Module

### Global Function #1

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Function Name** | (Exact name used) | Type | Min | Max |
| **Arguments Passed** | (if none, write None) |  |  |  |
|  | (Insert more rows for additional passed arguments) |  |  |  |
| **Return Value** | (if no value returned, write N/A) |  |  |  |

#### Description

(Place flowchart/design for local function)

## Local Functions/Macros Used by this MDD only

### Initialize Variables

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Function Name** | InitializeVariables | Type | Min | Max | UT Tolerance |
| **Arguments Passed** | pHwPosOffset\_HwDeg\_T\_f32 | float32 pointer | -1440.11 | 1440.11 | 4.40E-02 |
|  | pSignDeltaTrgtAngle\_Cnt\_T\_f32 | float32 pointer | -1, 1 | |  |
|  | pDeltaAccel\_Sec\_T\_f32 | float32 pointer | 0.005 | 128 | 5.00E-04 |
|  | pDeltaVelocity\_Sec\_T\_f32 | float32 pointer | 0 | 128 | 5.00E-04 |
|  | pMaxAccel\_HwDegpSecSqr\_T\_f32 | float32 pointer | 0.125 | 10000 | 5.00E-04 |
|  | pMaxVelocity\_HwDegpSec\_T\_f32 | float32 pointer | 0.125 | 1000 | 5.00E-04 |
| **Return Value** | N/A |  |  |  |  |

#### Description

### Generate Signal

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Function Name** | GenerateSignal | Type | Min | Max | UT Tolerance |
| **Arguments Passed** | HwPosOffset\_HwDeg\_T\_f32 | float32 | -1440.11 | 1440.11 |  |
|  | SignDeltaTrgtAngle\_Cnt\_T\_f32 | float32 | -1, 1 | |  |
|  | DeltaAccel\_Sec\_T\_f32 | float32 | 0.005 | 128 |  |
|  | DeltaVelocity\_Sec\_T\_f32 | float32 | 0 | 128 |  |
|  | MaxAccel\_HwDegpSecSqr\_T\_f32 | float32 | 0.125 | 10000 |  |
|  | MaxVelocity\_HwDegpSec\_T\_f32 | float32 | 0.125 | 1000 |  |
|  | HwPosition\_HwDeg\_T\_f32 | float32 | -1440.11 | 1440.11 |  |
|  | CalculateFlag\_Cnt\_T\_lgc | boolean | 0 | 1 |  |
| **Return Value** | HwAngleCmd\_HwDeg\_T\_f32 | float32 | -1440.11 | 1440.11 | 4.40E-02 |

#### Description



# Software Module Implementation

## Runtime Environment (RTE) Initial Values

|  |  |
| --- | --- |
| Data | Value |
| PosTrajEnable\_Cnt\_lgc | FALSE |
| PosServHwAngle\_HwDeg\_f32 | 0.0 |
| HwPosition\_HwDeg\_f32 | 0.0 |

## Initialization Functions

None

## Periodic Functions

### Per: GenPosTraj\_Per1

#### Design Rationale

None

#### Program Flow Start

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

#### Store Module Inputs to Local copies

HwPosition\_HwDeg\_T\_f32 = Rte\_IRead\_GenPosTraj\_Per1\_HwPosition\_HwDeg\_f32()

CalculateFlag\_Cnt\_T\_lgc = Rte\_IRead\_GenPosTraj\_Per1\_PosTrajEnable\_Cnt\_lgc()

#### Capture Inputs

If ((CalculateFlag\_Cnt\_M\_lgc) ==FALSE) AND (CalculateFlag\_Cnt\_T\_lgc ==TRUE) Then

GenPosTraj\_HwPosInitial\_HwDeg\_M\_f32 = HwPosition\_HwDeg\_T\_f32

GenPosTraj\_TargetAngleInitial\_HwDeg\_M\_f32 = GenPosTraj\_TargetAngle\_HwDeg\_M\_f32

GenPosTraj\_TargetVelocityInitial\_HwDegpSec\_M\_f32 = GenPosTraj\_TargetVelocity\_HwDegpSec\_M\_f32

GenPosTraj\_TargetAccelerationInitial\_HwDegpSecSqr\_M\_f32 = GenPosTraj\_TargetAcceleration\_HwDegpSecSqr\_M\_f32

End

#### Handle Subfunctions

InitializeVariables(&HwPosOffset\_HwDeg\_T\_f32, &SignDeltaTrgtAngle\_Cnt\_T\_f32, &DeltaAccel\_Sec\_T\_f32, &DeltaVelocity\_Sec\_T\_f32, &MaxAccel\_HwDegpSecSqr\_T\_f32, &MaxVelocity\_HwDegpSec\_T\_f32)

HwAngleCmd\_HwDeg\_T\_f32 = GenerateSignal(HwPosOffset\_HwDeg\_T\_f32, SignDeltaTrgtAngle\_Cnt\_T\_f32, DeltaAccel\_Sec\_T\_f32, DeltaVelocity\_Sec\_T\_f32, MaxAccel\_HwDegpSecSqr\_T\_f32, MaxVelocity\_HwDegpSec\_T\_f32, HwPosition\_HwDeg\_T\_f32, CalculateFlag\_Cnt\_T\_lgc)

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

GenPosTraj\_CalculateFlag\_Cnt\_M\_lgc = CalculateFlag\_Cnt\_T\_lgc

Rte\_IWrite\_GenPosTraj\_Per1\_PosTrajHwAngle\_HwDeg\_f32(HwAngleCmd\_HwDeg\_T\_f32)

#### Program Flow End

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

## Fault Recovery Functions

None

## Shutdown Functions

None

## Interrupt Functions

None

## Serial Communication Functions

### Scomm: GenPosTraj\_Scom\_SetInputParam

#### Design Rationale

The ranges of the SCom variables comes from the Nexteer Common Manufacturing Service (00F)

#### Program Flow Start

N/A

#### Description



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

None

#### Program Flow End

# 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

|  |  |  |
| --- | --- | --- |
| Function Name | Calling Frequency | System State(s) in which the function is called |
| GenPosTraj\_Per1 | 2 ms | ALL |

## Execution Requirements for Serial Communication Functions

|  |  |
| --- | --- |
| Function Name | Sub-Module called by (Serial Comm Function Name) |
| GenPosTraj\_Scom\_SetInputParam |  |

# Memory Map Definition Requirements

## Sub Modules (Functions)

|  |  |
| --- | --- |
| Name of Sub Module | Software Segment |
| GenPosTraj\_Per1 | RTE\_START\_SEC\_AP\_GENPOSTRAJ\_APPL\_CODE |

## Local Functions

|  |  |
| --- | --- |
| Name of Sub Module | Software Segment |
| InitializeVariables | RTE\_START\_SEC\_AP\_GENPOSTRAJ\_APPL\_CODE |
| GenerateSignal | RTE\_START\_SEC\_AP\_GENPOSTRAJ\_APPL\_CODE |

# 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 | Initial version | 13-Feb-12 | VK |
| 2 | 2 | Changes to the math while calculating angle command when in CONSTANT\_VEL\_STATE and changes to the ranges for the passed arguments | 21-Feb-12 | VK |
| 3 | 3 | Updated to ver2. Changed the names to Static Variables used inside the component. Updated the ranges | 17-Sep-13 | Selva |