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AxsGearInVel - Synchronizing to velocity

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Basics

GearInVel belongs to a group of synchronized Motion functions that behave like a gearbox. The GearInVel commands control the slave axis in the “Velocity" function on the drive and use the velocity of the master axis. As a result, the velocity of the slave axis (y) is proportional to the velocity of the master axis with the specified ratio. Note that the GearInVel commands can also calculate the position by integrating the calculated velocity, but this position is not controlled by the drive. The actual axis position may therefore deviate from this calculated position.

After the GearInVel command, the axis remains in the gearing function. To end the command, the command has to be canceled. For example, by a cancel command or by a new, non-buffered Motion command. A new command of the GearInVel command results in the axis not being synchronized when the command becomes active.

Functional description of GearInVel

GearInVel are Motion commands for axes that are based on the functionality of synchronized motion. GearInVel can be issued as a buffered command or as an unbuffered command. The commanded axis becomes a slave axis in relation to a specific master axis. This command sets the slave axis to the PLCopen state SYNCHRONIZED MOTION. While the command is ACTIVE, the velocity of the slave axis follows the velocity of the master axis.

The status of the synchronized Motion of the GearInVel commands always changes from NO_SYNC_MOTION to INITIAL_DYN_SYNCHRONIZING, as their calculation pipeline uses the derivation calculation step.

While the GearInVel command is active, the command ensures that the motion of the slave axis does not violate any restrictions for maximum velocity, maximum acceleration and maximum jerk. Due to these restrictions, it is possible that the slave axis cannot follow the master axis. For example, if the slave axis has to move faster than the maximum velocity specification allows. The violation of a constraint condition leads to a reaction defined by the configured dynamic synchronization error reaction, see ↘ “Error reaction”.

The following GearInVel commands are available:

- AxsGearInVelCmd
- AxsGearInVelCmdEx

Both commands have the following parameters:

GearInVel command parameters

Command parameters	Description
masterName	Master axis name

Command parameters		Description
syncSource		Master axis used for toothing, only the SYNC_SETPOINT option is supported. The command returns an error if another option is specified
Parameters	slaveVelOffset	Slave axis offset value
	ratioNumerator	Numerator of the transmission ratio as a rational number. The parameter can be negative in order to realize a counter-rotating gear
	ratioDenominator	Denominator of the transmission ratio as a rational number. The parameter can be negative in order to realize a counter-rotating gear
	fineAdjust	Percentage fine adjustment of the gear ratio as a rational number. The value causes an immediate change in the output of the calculation pipeline without interpolation or filtering
buffered		Flag: buffered or non-buffered command

The behavior of the GearInVel commands can be influenced by using parameters in the Data Layer RT of the axis. The standard indices for each Data Layer variable are listed in the following table.

Data Layer RT index values for GearInVel

Data Layer RT index	Parameter name	Description	Remarks
0	soiMasterOffsetDlIdx	Data Layer RT index for master axis, interpolated second order. If set to -1, the Data Layer RT input index 0 is used	Same index as GearInPos

Data Layer RT index	Parameter name	Description	Remarks
1	soiMasterOffsetVelIdx	Data Layer RT index for the master axis offset velocity constraint for second-order interpolation. If set to -1, the Data Layer RT input index 1 is used	Same index as GearInPos
2	soiMasterOffsetAccIdx	Data Layer RT index for the master axis offset acceleration limitation for second order interpolation. If set to -1, the Data Layer RT input index 2 is used	Same index as GearInPos
6	fofMasterOffsetDlIdx	Data Layer RT index for master axis offset, filtered first order. If set to -1, the Data Layer RT input index 6 is used	Same index as GearInPos
7	fofMasterOffsetTimeConstantDlIdx	Data Layer RT index for the master axis offset time constant for the change rate. If set to -1, the Data Layer RT input index 7 is used	Same index as GearInPos
10	fineAdjustDlIdx	Data Layer RT index for percentage fine adjustment. With a setting of -1, the Data Layer RT input index 10 is used	Same index as GearInPos
11	slaveVelOffsetDlIdx	Data Layer RT index for the slave axis. If set to -1, the Data Layer RT input index 11 is used	
12	foiSlaveOffsetDlIdx	Data Layer RT index for slave axis, interpolated first order. If set to -1, the Data Layer RT input index 12 is used	

Data Layer RT index	Parameter name	Description	Remarks
13	foiSlaveOffsetAccDlIdx	Data Layer RT index for the slave axis offset acceleration limitation for the first order interpolation. If set to -1, the Data Layer RT input index 13 is used	

Note that the standard input indices of the Data Layer RT start at 0 and continue without a gap in between. The meaning of the standard indices is different for the GearInPos and GearInVel commands.

A GearInVel command does not actively initialize the Data Layer RT. The commands do not write any data to the Data Layer RT. The user of the system is responsible for setting values in the Data Layer RT.

AxsGearInVelCmdEx offers more flexibility than AxsGearInVelCmd. Both commands use the Data Layer RT for all variables of the Data Layer RT. However, AxsGearInVelCmd does not offer the option of specifying indices for the Data Layer RT variables, but uses AxsGearInVelCmdEx with a value of -1 for each Data Layer index. The value -1 is interpreted by AxsGearInVelCmdEx as the default index for each of the parameters specified with the value -1. The first 15 elements in the Data Layer RT are reserved for Motion.sync commands and are partly used for the GearInVel commands. Data Layer RT path: motion®admin®axs®{axis-name}®cfg®realtime-inputs®double-array-size.

PLC:

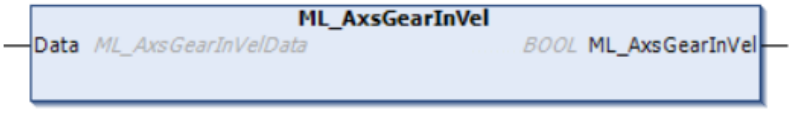

Fig. 148: ML_AxsGearInVel und ML_AxsGearInVelEx

ML_AxsGearInVel

STRUCT ML_AxsGearInVelData

Name	Data type	Inherited from	Address	Initial value	Comment

STRUCT ML_AxsGearInVelData

In	ML_iAxsGearInVel	Input: Command data of the command
Out	ML_oCmdResult	Output: Command parameters

STRUCT ML_AxsGearInVelExData

Name	Data type	Inherited from	Address	Initial value	Comment
In	ML_iAxsGearInVelEx				Input: Command data of the command
Out	ML_oCmdResult				Output: Command parameters

ENUM ML_SyncSource

Name	Data type	Inherited from	Address	Initial value	Comment
SYNC_SETPOINT	INT				
SYNC_ACTUAL	INT				

STRUCT ML_iAxsGearInVelParameters

Name	Data type	Inherited from	Address	Initial value	Comment
SlaveVelOffset	LREAL				Slave axis offset
RatioNumerator	DINT				Numerator of the ratio

STRUCT ML_iAxsGearInVelParameters

RatioDenominator	DINT				Denominator of the ratio
FineAdjust	LREAL				

STRUCT ML_iAxsGearInVelDlParameters

Name	Data type	Inherited from	Address	Initial value	Comment
SoiMasterOffsetDlIdx	DINT			-1	Master axis Data Layer index used for second-order offset
SoiMasterOffsetVelDlIdx	DINT			-1	Master axis offset velocity Data Layer index used for second-order offset
SoiMasterOffsetAccDlIdx	DINT			-1	Master axis offset acceleration Data Layer index for second-order offset
FofMasterOffsetDlIdx	DINT			-1	Master axis Data Layer index used for filtered first-order offset
FofMasterOffsetTimeConstantDlIdx	DINT			-1	Master axis Time constant Data Layer index for filtered first-order offset

STRUCT ML_iAxsGearInVelDlParameters				
FineAdjustDlIdx	DINT		-1	Fine adjustment Data Layer index for fine adjustment of the transmission ratio
SlaveVelOffsetDlIdx	DINT		-1	Slave axis offset speed Data Layer Index
FoiSlaveOffsetDlIdx	DINT		-1	Slave axis Data Layer index used for the first-order interpolated offset
FoiSlaveOffsetAccDlIdx	DINT		-1	Slave axis offset acceleration Data Layer index used for first-order interpolated offset

STRUCT ML_iAxsGearInVel EXTENDS ML_iAxsCmdBase					
Name	Data type	Inherited from	Address	Initial value	Comment
MasterName	STRING(15)				Name of the master axis that is being followed
SyncSource	ML_SyncSource				Synchronization source
Parameters	ML_iAxsGearInVelParameters				Parameters for the GearInVel command

STRUCT ML_iAxsGearInVel EXTENDS ML_iAxsCmdBase		
Buffered	BOOL	TRUE, if the command is to be executed as buffered command, otherwise FALSE

STRUCT ML_iAxsGearInVelEx EXTENDS ML_iAxsCmdBase					
Name	Data type	Inherited from	Address	Initial value	Comment
MasterName	STRING(15)				Name of the master axis that is being followed
SyncSource	ML_SyncSource				Synchronization source
Parameters	ML_iAxsGearInVelParameters				Parameters for the GearInVel command
DlParameters	ML_iAxsGearInVelDlParameters				Data Layer parameters for the GearInVel command
Buffered	BOOL				TRUE, if the command is to be executed as buffered command, otherwise FALSE

Data Layer

Method: POST

URL: motion/axs/<axs_name>/cmd/gear-in-vel

Payload:

```
{
  "masterName": "X",
  "syncSource": "SYNC_SETPOINT",
  "parameters": {
    "slaveVelOffset": 0.0,
    "ratioNumerator": 1,
    "ratioDenominator": 1,
    "fineAdjust": 0.0
  },
  "buffered": true
}
```

Method: POST

URL: motion/axs/<axs_name>/cmd/gear-in-vel-ex

Payload:

```
{
  "masterName": "X",
  "syncSource": "SYNC_SETPOINT",
  "parameters": {
    "slaveVelOffset": 0.0,
    "ratioNumerator": 1,
    "ratioDenominator": 1,
    "fineAdjust": 0.0
  },
  "dlParameters": {
    "soiMasterOffsetDlIdx": -1,
    "soiMasterOffsetVelDlIdx": -1,
    "soiMasterOffsetAccDlIdx": -1,
    "fofMasterOffsetDlIdx": -1,
    "fofMasterOffsetTimeConstantDlIdx": -1,
    "slaveVelOffsetDlIdx": -1,
    "foiSlaveOffsetDlIdx": -1,
    "foiSlaveOffsetAccDlIdx": -1,
    "fineAdjustDlIdx": -1
  },
  "buffered": true
}
```

Python:

```
axs_cmd_gear_in_vel(axs: str, master: str, sync_source: int,
parameters: Dict[str, Union[float, int]], buffered: bool)
-> int:
```

```
"""Couple an axis to a master axis and synchronously follow
  using velocity control.

  Follow the velocity of the master axis with a specified
  gear ratio, fine adjust and velocity offset. The command
  uses the realtime Data Layer (at motion axis or system
  level), where the parameter locations in the realtime
  Data Layer are pre-defined.
  To explicitly define the locations of these parameters
  in the realtime Data Layer axs_cmd_gear_in_vel_ex can be
  used.

  Arguments:
    axs:            Name of the slave axis.
    master:         Name of the master axis.
    sync_source:    Sync source (Setpoint = 0, Actual = 1).
    parameters:     Parameters used for synchronized motion
                    with the following keys:
                    slave_vel_offset: (float):
                        Slave velocity offset value.
                    ratio_numerator (int):
                        Gear ratio numerator.
                    ratio_denominator (int):
                        Gear ratio denominator.
                    fine_adjustment (float):
                        Fine adjustment parameter.
    buffered:       True:  create this command as a
                      buffered command.
                    False: create this command as a
                      non-buffered command.

  Returns:
    The command id.
"""

axs_cmd_gear_in_vel_ex(axs: str, master: str, sync_source: int,
parameters: Dict[str, Union[float, int]],
dl_parameters: Dict[str, int], buffered: bool) -> int:

"""Couple an axis to a master axis and synchronously follow
  using velocity control.

  Follow the velocity of the master axis with a specified
  gear ratio, fine adjust and velocity offset. The realtime
  Data Layer indices for offsets and other parameters also
  have to be specified.
  If an index value is -1, the default index is selected.
  If an index value is < 1000, the specified index is used.
  If an index value is >= 1000, the system realtime Data
  Layer is referred.

  Arguments:
    axs:            Name of the slave axis.
    master:         Name of the master axis.
```

```
    sync_source:    Sync source (Setpoint = 0, Actual = 1).
    parameters:     Parameters used for synchronized motion
                    with the following keys:
                    slave_vel_offset: (float):
                      Slave velocity offset value.
                    ratio_numerator (int):
                      Gear ratio numerator.
                    ratio_denominator (int):
                      Gear ratio denominator.
                    fine_adjustment (float):
                      Fine adjustment parameter.
    dl_parameters:  soi_master_offset_dl_idx (int):
                      index of master offset target value,
                      second order interpolated.
                    soi_master_offset_vel_dl_idx (int):
                      index of master offset velocity
                      constraint for second order
                      interpolation.
                    soi_master_offset_acc_dl_idx (int):
                      index of master offset acceleration
                      constraint for second order
                      interpolation.
                    fof_master_offset_dl_idx (int):
                      index of second master offset,
                      first order filtered.
                    fof_master_offset_time_constant_dl_idx
                    (int):
                      index of time constant for change
                      rate of fofMasterOffset.
                    slave_vel_offset_dl_idx (int):
                      index of slave offset without
                      constraints.
                    foi_slave_offset_dl_idx (int):
                      index of slave offset constraint
                      for first order interpolation.
                    foi_slave_offset_acc_dl_idx (int):
                      index of slave offset acceleration
                      constraint for first order
                      interpolation.
                    fine_adjustment_dl_idx (int):
                      index of fine adjustment percentage
                      in addition to the commanded fine
                      adjustment.
    buffered:         True:  create this command as a
                        buffered command.
                    False: create this command as a
                        non-buffered command.

  Returns:
    The command id.
"""
```

BundleIF:

```
namespace motion::sync::cmd {
 enum class SyncSource : uint32_t
 {
  ///< use master ipo position (setpoint position)
  SYNC_SETPOINT,

  ///< use master actual position (encoder position)
  SYNC_ACTUAL,

  ///< use extrapolated master position
  SYNC_ACTUAL_EXTRAPOLATED,

  SYNC_LAST_ENTRY
 };

 struct GearInVelParameters
 {
  ///< slave velocity offset value
  double  slaveVelOffset {0.0};

  ///< numerator ratio value
  int32_t ratioNumerator {1};

  ///< denominator ratio value
  int32_t ratioDenominator {1};

  ///< fine adjust parameter
  double  fineAdjust {0.0};
 };

 struct GearInVelDlParameters
 {
  ///< Data Layer index of master offset
  int32_t soiMasterOffsetDlIdx {-1};

  ///< Data Layer index of master offset velocity
  int32_t soiMasterOffsetVelDlIdx {-1};

  ///< Data Layer index of master offset acceleration
  int32_t soiMasterOffsetAccDlIdx {-1};

  ///< Data Layer index of additional master offset
  int32_t fofMasterOffsetDlIdx {-1};

  ///< Data Layer index of additional master offset
  ///< time constant
  int32_t fofMasterOffsetTimeConstantDlIdx {-1};

  ///< Data Layer index of slave velocity offset
  int32_t slaveVelOffsetDlIdx {-1};

  ///< Data Layer index of additional slave offset
  int32_t fofSlaveOffsetDlIdx {-1};
```

```
    int32_t foiSlaveOffsetDlIdx {-1};

    ///< Data Layer index of additional slave offset
    ///< acceleration
    int32_t foiSlaveOffsetAccDlIdx {-1};

    ///< Data Layer index of additional fine adjust
    int32_t fineAdjustDlIdx {-1};
  };
}

::motion::core::MotionResult(*axsGearInVelCmd)
(void* handle,
 const ::motion::core::dia::CmdSourceInfo& sourceInfo,
 const char* slaveName,
 const char* masterName,
 ::motion::sync::cmd::SyncSource syncSource,
 const ::motion::sync::cmd::GearInVelParameters& parameters,
 bool buffered,
 uint64_t& cmdID);

::motion::core::MotionResult(*axsGearInVelCmdEx)
(void* handle,
 const ::motion::core::dia::CmdSourceInfo& sourceInfo,
 const char* slaveName,
 const char* masterName,
 ::motion::sync::cmd::SyncSource syncSource,
 const ::motion::sync::cmd::GearInVelParameters& parameters,
 const ::motion::sync::cmd::GearInVelDlParameters&
 dlParameters,
 bool buffered,
 uint64_t& cmdID);
```