Technical Information
12.06.02

Flying Shear Function

NANO-SV Module, CAN-DIMA

This is a provisional information. Changes are reserved.

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IMPORTANT

Differences between Flying Shear function of Mikro and Nano:
The Nano Flying Shear function is:

- more flexible:
  - Slave axis can be started in every position in between the work range. Mikro had to start always at position 0
  - More influencing control of the user during disengagement phase by using a normal positioning command.
- more accurate:
  - More registers to adjust master slave relation more accurate
  - Calculations in the Flying Shear function / Follower function are more accurate than with the Mikro
  - Synchronization ramp is calculated more accurate and the master speed will be considered in the ramp calculation during the whole ramp. Mikro did consider the master speed not during the ramp, only before the movement.
- faster:
  - The control loop of the slave axis is 3 to 4 times faster than with the Mikro, that means: faster applications are possible.
- easier:
  Synchronization ramp handling is much easier:
  - Only the wanted start ramp has to be set and the function will calculate and process the synchronization ramp and will engage accurately.
  - No time consuming adjustments of the prepositioning like with the Mikro with Register 1132 and 1133

Other differences:

- Nano Flying Shear function will always start with prepositioning.

Both the N-SV1 module and the CAN-DIMA can use the Flying Shear function. To use it it’s necessary to have the N-SV1 OS file version 1.24 and for the CAN-DIMA OS file version 1.18

Use only the Modules as a master which are described in chapter 2.3.4 Master - slave communication

1 Introduction

The slave operation range is between -8 388 608 to + 8 388 607 increments. The start position of the slave can be everywhere between this range, also at a negative position. But the master needs to move always in POSITIV direction. Also the slave has to be in standstill before each flying shear cycle.

To use the Flying Shear function the master - slave parameter has to be setup like as using the follower mode. This parameter are the communication between master and slave (don’t forget the overflow position for endless positioning taken from master register 1x185), the transmission ratio and the encoder line number adaptation.

The Flying Shear function includes three phases: First the synchronization phase - the flying shear (slave axis) accelerates to the master speed - , second the slave axis follows the master axis - which is the follower mode - , third the disengaging and moving back to slave axis starting position to finish the flying shear cycle.

1.1 Synchronization phase

The N-SV1 or CAN-DIMA module calculates several values necessary for the start and initiates the synchronization ramp for the slave axis and at crossing point it switches to the second phase the follower mode.

The slave axis always starts the synchronization ramp before the master axis reaches the crossing point. This is called prepositioning. This optimizes the cycle time and results in a smooth transition into the synchronization or follower mode.

The slave axis calculates the start master position. If the master reaches this position the slave axis will start its synchronization ramp. This start master position depends on the actual position of the slave axis, the master speed and on the chosen start ramp time (Register 1xy05). Note: The start ramp time is set for reaching the maximal speed which is to be set in register 1xy18. The start master position is calculated in the way that the slave axis will accelerates to fulfill the start ramp time condition.

If the master position is >= the start master position the slave axis starts the synchronization ramp. During the synchronization ramp changes in the master speed are recognized and will change the steepness of the synchronization ramp. In fact the start ramp time conditions cannot be fulfilled if the master speed will change.

There are two conditions that are checked to switch into the next phase the follower mode:
A: master position in the slave is >= the slave axis position
B: master position in the slave is >= synchronization position
In case B it can happen (if the slave could not follow the master) that the synchronization occurs not without a jerk.

1.2 Follower phase

In the follower mode the nominal position and the nominal speed is given by the master axis. The follower mode works like the command 44. See Table 1 for information about P-amplification and tracking error.

1.3 Disengaging phase

To disengage the slave axis from the follower mode it is necessary to perform a position command by a POS - statement or by a REGISTER_LOAD - statement to register 1x102 through Sympas or the Setup Mode. It is in the decision of the User in which way he uses the position command to disengage the slave axis. For example he could disengage with a faster speed to avoid inhibition of the shear blade with the cutting material or to separate the cut material. After disengaging the user has the full control over the slave axis. But also the user is in charge to move the slave axis back to the starting position for another flying shear cycle which he starts by giving the flying shear start command again.

2 User interface

2.1 Effect of P-amplification and tracking error

The following table shows in which phase the P-amplification (Register 1x110) and the tracking error (Register 1x119 and Register 1x100, Bit 3 and Bit 23) have effect:

Phase	P-amplification	Tracking error
Synchronization-	NO	NO
Follower-	YES	YES
Disengaging-	YES (if mode 2 or 3)	YES (if mode 2 or 3)

Table 1

2.2 Error handling

2.2.1 Synchronization ramp error

A synchronization ramp error is recognized if the master position is already greater than the start master position after given command 80.

Possible reasons:

- Master speed to high
- Flying shear cycle time to high
- Length of material to long

Error-handling of the system:
Bit 3 of second status register 1x500 is set immediately after given command 80. And flying shear cycle is aborted.

Error-handling by user:

- Slow down master
- Set another start ramp time to accelerate slave axis
- Speed up the flying shear cycle

and

- give command 80 to reduce the master increments by the length of the material until the error disappears (shear will not cut until error disappears).

Or

- Start from the scratch

2.2.2 Stop slave during synchronization phase

There are two possibilities to stop the slave while it is in accelerating in synchronization phase.

- Command 82 stops the axis immediately (prepares a AXARR command)
- A POS command or write to register 1x102 starts a absolute positioning from the position and speed the axis has at the moment the command is given. With help of this the axis can be stopped with a ramp.

2.3 User-Registers

To use the Flying Shear function the following register has to be used to set the appropriate parameters.

The registers or commands marked with a star are new registers/commands implemented mostly for the Flying Shear function. Registers for P-amplification and tracking errors are already discussed in Table 1.

2.3.1 Status register

Register 1x500: Second status register

Read	Actual status
Write	Not allowed
Range	23-bit signed integer
Value after Reset	0

Flying shear status	
Bit 2:	Slave axis is synchronized with master axis: This bit is set if the slave axis is in the second phase, the follower phase. Bit is reset if slave axis is in disengaging phase.
Bit 3:	Synchronization ramp error: This bit is set immediately after the command 80 is given and the master position is already greater than the start master position. Bit is reset after another given command 80 if the master position is now less or equal than the start master position.
Bit 4:	Slave axis is in the synchronization ramp (Synchronization phase). Bit is set if slave axis is started and is performing a synchronization ramp. Bit is reset after the transition in the follower phase.

2.3.2 Command register

Register 1x101: Command register

New Commands	
80:	Charge flying shear: This command has to be given for every new cycle, it starts the first phase, the synchronization phase. If the synchronization phase is done the flying shear axis will automatically enter the follower phase. To escape the follower phase a positioning command has to be executed, like previously explained. The axis has to be in standstill before this command can be given.
81:	Set master position register to absolute value: This command clears the master position register 1xy95 in the slave from every occurred overflow and sets the register back to the actual absolute master position. This command has to be given if the flying shear function is started the first time or when the whole flying shear process or application was stopped through an error or emergency stop and a new start up has to be performed. The flying shear has to be in standstill before this command can be given.
82:	Stop flying shear: This command will stop the flying shear axis immediately by performing a AXARR without stop ramp This command is for emergency use. It can be given in any flying shear cycle. To start up properly after giving this command, command 81 should be

used.

2.3.3 Start- stop-ramp

Register 1x105: Start ramp
Sets the start ramp for the **synchronization-** and the **disengaging-** phase. In the synchronization phase the ram is always a linear ramp not a sine squared one.

Register 1x106: Stop ramp
Sets the stop ramp for the **disengaging-** phase.

2.3.4 Master - slave communication

The master axis can be a CAN-DIMA-, N-SV1-, SM2- or a SM1D-Module.

Register 1x143: Actual position is received by the axis (slave)
Register 1x144: Overflow position for endless positioning taken from master register 1x185

2.3.5 Master - slave transmission ratio

Register 1x156: Factor between master and slave
Register 1x157: Devisor between master and slave
Register 1x152: Encoder adaptation in the follower
Register 1x139: Offset between master position in slave and slave position

2.3.6 Master and slave encoder line value

Register 1x117: Encoder Line Count (Can-Dima = Always 1024 Counts)

2.3.7 Flying shear registers

The cutting length is assembled with the length of cut material and the width of the cutting tool. The cutting length can be split up into register 1x505 and register 1x506. The reference point of the cutting tool has to be set on this side of the cutting tool where the material comes from.

Register 1x505: Length of cut material

Read	Actual length
Write	New length. It is valid for a new flying shear cycle.
Range	0...8388607
Value after Reset	0 (Increments)

The length of cut material has to be measured in slave axis increments. The change of this value takes effect immediately after a given command 80.

Register 1x506: Width of cutting tool

Read	Actual width
Write	New width. It is valid for a new flying shear cycle.
Range	0...8388607
Value after Reset	0 (Increments)

The length of cut material has to be measured in slave axis increments. The change of this value takes effect immediately after a given command 80.

3 Example Program

This is an example where the axis 21 is a JX2-SV1 Module while the axis 31 is a CAN-DIMA.
Axis 21 is the master
Axis 31 is the slave

```
TASK 0
            -FLAG 1
            ; Part of Initialization
            REGISTER_LOAD (12198, 3)
            REGISTER_LOAD (13198, 3)
            REGISTER_LOAD (13105, 500)          ;start ramp
            ; Set master axis parameter  AXIS 21
            REGISTER_LOAD (12117, 2500)         ;line number ob encoder
            REGISTER_LOAD (12103, 500)
            REGISTER_LOAD (12101, 3)
            REGISTER_LOAD (12101, 1)
            ; Set slave parameter  AXIS 31 CAN-DIMA
            REGISTER_LOAD (13101, 3)
            REGISTER_LOAD (13101, 1)
            ; Set start position for slave
TASK 100
            ; flying shear Init
      WHEN
            FLAG 1
      THEN
            REGISTER_LOAD (13105, 500)          ;set for position to start position
            ;set reference point of master (can be made in a different way)
            REGISTER_LOAD (12171, -200000)
            ;calculate start position of slave. If offset is not need Reg 13139 can be
            ;ignored
            REG 120 = -100000 + REG 13139
            POS (31, @120, 1000)
      WHEN
            AXARR 31
      THEN
            ; set flying shear parameter
            REGISTER_LOAD (13101, 81)
            REGISTER_LOAD (13505, @505)         ;cutting length
            ; Set master slave parameter
            ; Set transmission ratio
            REGISTER_LOAD (13156, 1)
            REGISTER_LOAD (13157, 2)
            ; Set encoder line adaption IMPORTANT
            ; Master encoder lines: 2500
            ; Slave encoder lines: 1024
            REGISTER_LOAD (13152, 410)
```

```
        ; Set communication parameter
        REGISTER_LOAD (13144, @12185)
        REGISTER_LOAD (13143, 21)
        REGISTER_LOAD (12101, 30)
    WHEN
        ; Wait for clear busy bit to ensure
        ; communication is established
        BIT_CLEAR (13100, 13)
    THEN
        ; Start master in endless positioning
        REGISTER_LOAD (12101, 56)
        ; Wait until master reaches its max speed
        ; before starting flying shear
    WHEN
        LIMITS (13196, 400, 600)
    THEN

LABEL 101
        ;start flying shear cycle
        ;set (linear) synchronization ramp if different to start ramp in
        ;disengaging phase or back positioning
        REGISTER_LOAD (13105, @105)
        REGISTER_LOAD (13505, @505)          ;cutting length
        ;start calculating and waiting for master crosses start master position
        REGISTER_LOAD (13101, 80)
    WHEN
        BIT_SET (13500, 2)
    THEN
        ; When synchronized
        ; Simulate cutting time
        DELAY @110
        ; Prepare disengaging
        REGISTER_LOAD (13105, 500)           ;new start ramp
        ;calculate the way for stopping. Can be also a absolute position, far
        ;enough away from limit switch
        REG 100
        =
        50000
        +
        REG 13109
        ; Disengage to a further away position
        ; speed could be higher than slave speed while cutting to disconnect
the     ;cutting tool from cutting material
        POS (31, @100, 2000)
    WHEN
        AXARR 31
    THEN
        ; Move to start position again
        POS (31, @120, 3000)
    WHEN
        AXARR 31
```

```
    THEN
    IF
          FLAG 1
    THEN
          GOTO 101              ; go on to next cut
    ELSE
          REGISTER_LOAD (12101, 0) ; stop master and flying shear function
          GOTO 100
```