The Winding Mode of the NANO-SV1 Module
from Version 1.05 onwards

Functioning Principle:

The coil spindle is driven by the axis of one NANO-SV1 module, the traverse is driven by the axis of another NANO-SV1. In two registers the transmission ratio, in two further registers the left and right edge of the coil have been defined. These edges can also be changed during the winding process. When the traversing axis has reached one of the edges, the turning direction of the traversing axis is reversed as quickly as possible, while a layer counter is being incremented. This process is repeated, until the number of windings defined in a register has been deposited.
The traversing axis has been coupled to the spindle by positioning values; this means its speed is adjusted to the speed of the spindle axis. If a speed ramp is run by the spindle axis, the ramp is proportionally taken over by the traversing axis, even during change of layers.
Both continuous and digital winding is possible.

Register Description:

As the winding function is not being handled by a controller, communication between the tow NANO-SV1 modules must be carried out via system bus. To start this communication, two register accesses are necessary:

Command 30: The Axis is the Spindle (Master)

(Register 1z101=30) By this command the spindle axis is given the information that its actual position is to be made available to other axes via system bus in fixed periods of time.

Register 1z143: Actual Position of the Spindle (Slave) is Received by the Axis

By writing a value unequal zero into this register of the traversing axis, the traversing axis is informed of which axis it is to receive the actual value. Thus, the axis number of the spindle axis which is carrying out the winding is written into the traversing axis.

Value range: 0, 21, 31, 41
Value after reset: 0

Important!

After writing into register 1z143 the busy bit of the status register (Bit 13, register 1z100) must be queried, before a new register or a new command is written onto axis z1 (see exemplary program).

The bus communication between the two axes is switched off again by **command 42** given to both axes. Here, the busy bit must be queried as well.

If communication is functioning properly, the position of the spindle can be read from register 1z195 of the traversing axis.

Register 1z101 (Traversing Axis) Command Register

four commands have been provided here:

command 66: switch on traversing function (*)
command 67: switch off traversing function
command 68: digital winding
command 69: continuous winding (*)

After reset, the functions marked by (*) are active.

Register 1z193 (Traversing Axis) Positive Edge

If the online nominal position of the traversing axis is greater than or equal to the value written in this register, the traversing axis is reversed.

Value range: ±8388607

Value after reset: 8388607

Register 1z194 (Traversing Axis) Negative Edge

If the online nominal position of the traversing axis is smaller than or equal to the value written in this register, the traversing axis is reversed.

Value range: ±8388607

Value after reset: -8388607

Edges Dependent on the Direction

The recognition of the edges is dependent on the direction. This means that if the traversing axis moving in positive direction, only the positive edge is recognised as well. The same applies to the negative edge. This way it is possible, to, for example, start the winding process from one position which is smaller than the negative edge.
When the position of the negative edge is exceeded, nothing will happen, because the axis is moving on to positive direction. Only after turning at the positive edge the negative edge will be considered again.

Register 1z156 (Traversing Axis) Driving Distance of the Traversing Axis During Spindle Rotation

During a rotation of the spindle by the number of increments written here in continuous winding mode, the traversing axis will move in a speed which is in relation to the positioning ratio (yet, it will never be

faster than the value written in register 1z103). In digital winding mode the axis will move by this value, if the rotation is ended in the speed written in register 1z103.
A positive value in register 1z156 means that the first layer is laid in counting direction of the spindle motion. Accordingly a negative value in register 1z156 means that the first layer is laid against counting direction of the spindle motion (provided the spindle is turning in positive direction - otherwise the driving direction of the traversing axis will just be the other way round).

Value range: ±32767

Value after reset: 1

It is also possible to change the traversing width (register 1z156) in one layer. For this purpose - at the same time, at which the layer width is to be changed - a *positive* value has to be written into register 1z156. In spite of the positive sign the traversing direction will be kept.
Before activating the winding mode the traversing width can be set for the first time. For this purpose the sign must be taken into consideration, in order to transfer the traversing direction.

Register 1z157 (both axes) Number of Increments of the Spindle Axis for a Spindle Rotation

In this register, both axes are informed of how many increments are covered by the spindle during one rotation.

Value range: 1 .. 32767

Value after reset: 1

Change Winding Gradient at the Edge of the Coil

Register 1z189 **(Traversing Axis) Winding Gradient to be taken over at the Next Edge**

Value range: 0 .. 8388607

Value after reset: 0

If during the winding process a value greater than 0 is written into this register, this value will be transferred at the next edge of the coil for the distance of the traversing axis during a spindle rotation. Register 1z156 is changed at the respective edge of a coil. Register 1z189 is reset to zero after the value transfer. Only positive values may be input. The calculation of the traversing direction is carried out automatically.

Higher Resolution of the Gradient Definition

To define the gradient in a higher resolution, register 1z179 of the traversing axis has been provided. Thus, the gradient will be calculated as follows:

Gradient = Register 1z156 (respectively 1z189) / (Register 1z157 * Register 1z179)

In the value written in register 1z157, the number of spindle increments per revolution must always be contained. The values to be input into registers 1z156 and 1z189 can now be higher by the value written in register 1z179 than the number of traverse axis increments per spindle rotation. This way, a non-integer gradient value can achieved.

Register zzy79: **(Traversing Axis) Additional Divisor for Calculating the Gradient)**

Value range: 0 .. 8388607

Value after Reset: 1

Register 1z190 (Traversing Axis) Counter of Layers

This register is incremented at each change of layers. Yet, it is not reset by the operating system software (except for reset). Thus, it can, respectively must, be preoccupied by the user program.

Value range: ±8388607

Value after reset: 0

Register 1z191 (Traversing Axis) Coils Covered up to This Time

In this register, the number of coils covered during winding in process has been written.
It must be preoccupied by the user himself.

Value range: ±8388607

Value after reset: 0

Register 1z192 (Spindle Axis) Number of Coils

With the help of this register a winding process can be started. (It can also be started by any other positioning start, e.g. POS instruction, writing into register 1z102, etc.).
This register value is in **relation** to the position headed last. This means, that the number of coils written into the register is headed for starting from the present position.
For the maximum value, the following relation must be fulfilled:

Register zzy92(sp) * Register zzy57(ve) + latest nominal position < 2147483647.

(Thus, the same value as has been written into register 1z157 of the traversing axis must be written into register 1z157 of the spindle axis, if the spindle is to be positioned via register 1z192.)
After writing into register 1z192 with the defined start ramp, the spindle axis will start; then it will drive on with the speed defined in register 1z103

and, after reaching the defined number of windings, will stop with the set stop ramp.

When pre-positioning of the spindle onto its starting position, please be careful to only turn it in winding direction, as for its edge recognition the former turning direction of the spindle axis is used. If thus a wrong turning direction is recognised, an edge might already be reported at switching on, which would lead to wrong positioning of the traversing axis.

Value range: ±8388607 (note restriction)

Value after reset: 0

Special Functions

"Void Increments"

So-called **"void increments"** can be inserted at the edge. The traverse axis will then stand still at the edge, until the spindle has covered the number of increments defined in **register 1z188 (of the traverse),** The increments will be calculated starting from the edge. If the traverse axis is not to be delayed, register 1z188 musdt not be written into after the start, unless the spindle has covered the number of increments that is to be written into the register.

Value after reset: 0
Value range: 0 ... 8.3 Mio

Limit Switch Function

The limit switch function (soft- and hardware limit switch) is also active during the winding process. When a limit switch is active, the winding mode will be left automatically and switched to the position control mode that has been defined in register 1z198. This limit switch recognition will not be recognised by the spindle axis, though.

Tracking Error Correction

If tracking error correction by speed pre-control has been activated, register 1z152 of the traverse axis is to be considered, if the number of encoder lines (NEL) of the two axes, referred to the motor revolution, have not got the same values.
During digital winding the tracking error correction must be deactivated (set bit 23 in register zzy00 of the traverse axis).

(Register 1z152 = 1000 * NEL (traverse axis) / NEL (spindle axis))

NEL = Number of Encoder Lines)

Exemplary Program:

Axis 21 is the spindle, axis 31 is the traverse axis

```
LABEL 40
     WHEN
          FLAG 1
     THEN
          POS [axis=31, Pos=R(startpos_trav), v=50]
          REGISTER_LOAD [12103 with 10]     ;ref. speed
          REGISTER_LOAD [12101 with 9]      ;ref. run
     WHEN
          AXARR axis=31
          BIT_SET [Reg=12100, Bit=0]        ;ref.
                                            ;completed
     THEN
          POS [axis=21, Pos=R(startpos_spin), v=50]
     WHEN
          AXARR axis=21
     THEN
          REGISTER_LOAD [13103 with 1000]   ;full
                                            ;traversing
                                            ;speed
     THEN
          REGISTER_LOAD [13157 with INCperREV_spin]
          REGISTER_LOAD [12157 with INCperREV_spin]
          REGISTER_LOAD [13156 with R(i_factor)]
          REGISTER_LOAD [13189 with 0]
          REGISTER_LOAD [13143 with 21]     ;spindle is
                                            ;axis 2
          REGISTER_LOAD [12101 with 30]     ;sending ON
```

```
    WHEN
        BIT_CLEAR [reg=13100, bit=13]
    THEN
        REGISTER_LOAD [13101 with 66]     ;traversing
                                          ;ON
        REGZERO Counter_of_Layers     ;reg 13190
        REGZERO Counter_of_Coils          ;reg 13191
        REGISTER_LOAD [12105 with 2000]   ;start ramp
        REGISTER_LOAD [12106 with 5000]   ;stop ramp
        REGISTER_LOAD [12103 with R(winding speed)]
        REG 12102
        =
        REG nom_coils
        *
        INCperREV_spin
        +
        REG startpos_spin
        (or REGISTER_LOAD [12192 with R(nom_coils))
    ;spread the layer deposited last
    WHEN
        REG counter_of_layers
        =
        REG layers_integer_1
    THEN
        REGISTER_LOAD [13189 with R(i_factorNEW)]
    WHEN
        AXARR axis=21                     ;spin. has
                                          ;arrived
    THEN
        REGISTER_LOAD [13101 with 67]     ;trav. OFF
        REGISTER_LOAD [12101 with 42]     ;send. OFF*
        REGISTER_LOAD [13101 with 42]     ;rec. OFF*
(*sending and receiving OFF are only necessary, if
there is no further winding carried out.)
    WHEN
        BIT_CLEAR [reg=12100, bit=13]     ;wait,
                                          ;until

        BIT_CLEAR [reg=13100, bit 13]     ;command is
                                          ;completed
    THEN
        GOTO 40
```