The application SIMOTION Winder was developed with the objective to address many of the known winder applications using one application software.

If required, the application can be configured and/or also changed.

Using the SIMOTION control platform the application “SIMOTION Winder” allows winders and un-winders to be implemented in a wide range of applications, e.g. foil making machines, printing machines, coating machines...

Can be combined with other applications like:
SIMOTION Axis Function Block
SIMOTION Splice Control
SIMOTION Traversing Drive
SINAMICS DCC Load Sharing
Converting Toolbox

Benefits when using the Application

- Shorter engineering and service time (same look & feel)
- Can be used in all programming languages
- Industry standards are used (PLC open)
- Supported by Application Centers World Wide
- Regularly updated on Intranet
- Open source code so that you can adapt the functions to your requirements
- User Manuals in English and German
- Easy learning using pre-programmed application examples
- Free of Charge
Converting Toolbox
Contents of the Application

- PowerPoint presentation (English / German)
- Units / libraries (programming in ST or MCC)
- User Manuals (English and German)
- Example machine project for SIMOTION
Converting Toolbox
Scope of Functionality

Center Winder or Tandem center Winder
- Winds material around a core or mandrel
- The coil is driven by a motor
- The motor can be operated in torque or speed controlled mode
- Speed and torque are diameter dependent
- Dancers or load cells for tension control are optional

Turret winder
- Two or more center winds on a rotating axis
- Roll change on the fly
Converting Toolbox
Scope of Functionality

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Min Diameter $D_{\text{Min}}$
Max Diameter $D_{\text{Max}}$
Web Width $w$
Gear, Gear ratio $i$
Moment of Inertia $J_{\text{gear}}$

Material Velocity $V$
External Moment of Inertia $J_{\text{Core}}$
Motor Moment of Inertia $J_{\text{Motor}}$

Actual Diameter $D_{\text{act}}$
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Scope of Functionality

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Mf: Friction Torque
MP: Torque Precontrol
MT: Tension
n: winder speed
no: speed override
Converting Toolbox
Scope of Functionality – Process interfacing

The interfacing to the process is based on the sWinderConfig parameter toLineAxis. The following alternatives are implemented:

- **toLineAxis = TO#NIL:**
  There is no master axis specified. The coupling is based on the input variable lineAxisMotionVector.

- **toLineAxis = TO#driveAxis:**
  The master axis is a speed controlled axis. The reference diameter of the axis has to be specified. Optional position information has to be entered externally via I/O-structure.

- **toLineAxis = TO#posAxis:**
  The master axis is a positioning axis. Position information is available.

- **toLineAxis = TO#externalEncoderType:**
  The master axis is a machine encoder. Position information is available.
The winder axis can be operated

**speed controlled**

or

**position controlled**

The coupling to the process is always based on a speed setpoint.
### Converting Toolbox

**Scope of Functionality – System of units**

<table>
<thead>
<tr>
<th>Configuration data</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>sWinderConfig.sUnitConfig.eUnitLineAxis Velocity</td>
<td>M_MIN, MM_MIN, M_S, MM_S, FT_MIN, INCH_MIN, FT_S, INCH_S, DEG_S_PRINT</td>
</tr>
<tr>
<td>sWinderConfig.sUnitConfig.eUnitLineAxis Acceleration</td>
<td>M_S2, MM_S2, FT_S2, INCH_S2, DEG_S2_PRINT</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Configuration data</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>sLTCConfig.eUnitLTCAxisVelocity</td>
<td>RPM, RPS, DEG_MIN, DEG_S</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Measured variable</th>
<th>Unit</th>
<th>Metric</th>
<th>Anglo-American</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
<td>LU</td>
<td>e.g.: m (meter)</td>
<td>e.g.: ft (feet)</td>
</tr>
<tr>
<td>Length (base unit)</td>
<td>Lub</td>
<td>m (meter)</td>
<td>ft (feet)</td>
</tr>
<tr>
<td>Velocity</td>
<td>LU / TU</td>
<td>e.g.: m / min</td>
<td>e.g.: ft / min</td>
</tr>
<tr>
<td>Acceleration</td>
<td>LU / s²</td>
<td>e.g.: m / s²</td>
<td>e.g.: ft / s²</td>
</tr>
<tr>
<td>Speed</td>
<td>rpTU or ° / TU</td>
<td>e.g.: rpm</td>
<td>e.g.: rpm</td>
</tr>
<tr>
<td>Mass, Weight</td>
<td>m</td>
<td>kg</td>
<td>lb</td>
</tr>
<tr>
<td>Density</td>
<td>m / LUb³</td>
<td>kg / m³</td>
<td>lb / ft³</td>
</tr>
<tr>
<td>Inertia</td>
<td>J = mLUb²</td>
<td>kgm²</td>
<td>lbft²</td>
</tr>
<tr>
<td>Torque</td>
<td>M = mLUb²/s²</td>
<td>Nm= kgm² / s²</td>
<td>lbf ft = lbft² / s²</td>
</tr>
<tr>
<td>Force, Tension</td>
<td>Z = mLUb/s²</td>
<td>N = kg m /s²</td>
<td>lbf = lb ft / s²</td>
</tr>
</tbody>
</table>
The Winder Function Blocks cover the most common control modes. The open source code allows the implementation of individual know-how.

**Control modes:**

- Indirect tension control
- Tension control with torque limiting
- Tension control with speed setpoint-adaption
- Dancer position control with speed setpoint-correction
- Dancer position control with torque limiting
- v-constant-Control

A change of the control mode can be done on the fly during the winding process.
Converting Toolbox
Scope of Functionality
Indirect Tension Control

- No tension feedback required
- Web speed is set via nip
- Tension torque pre-controlled via torque setpoint
- Good Inertia and friction torque compensation required
- Diameter ratio approx. 10:1
- Tension ratio approx. 6:1
- Winder torque ratio approx. 40:1
- Web speed up to approx. 600 m/min
- Material: foil, textile, paper
Converting Toolbox
Scope of Functionality
Indirect Tension Control

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Scope of Functionality
Tension control with torque limiting

- Tension measuring device required
- Web speed is set via nip
- Tension Torque pre-controlled via torque set point
- Good Inertia and friction torque compensation required
- Diameter ratio app. 15:1
- Tension ratio app. 20:1
- Winder torque app. 100:1
- Web velocity up to app. 2000 m/min
- Tension control via torque limitation
- Material: paper, thin film
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Scope of Functionality
Tension control with torque limiting

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Converting Toolbox
Scope of Functionality
Tension control with speed setpoint-adaption

- Tension measuring device required
- Web speed is set via nip
- Tension torque controlled via additional velocity setpoint
- Diameter ratio app. 15:1
- Tension ratio app. 20:1
- Winder torque app. 100:1
- Web velocity over 2000 m/min
- Material: Elastic, expandable material
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Scope of Functionality
Tension control with speed setpoint-adaption

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Dancer position control with speed setpoint-correction

- Dancer position measuring device required (e.g. potentiometer, encoder)
- Web speed is set via nip
- Web tension is controlled via additional speed setpoint
- Dancer influences the web path
- Diameter ratio up to app. 15:1
- Tension ratio controlled via dancer
- Winder torque ratio up to app. 40:1, depending on the dancer system
- Web speed up to app. 2000 m/min
- Material: rubber, cable, textile, film and paper
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Scope of Functionality
Dancer position control with speed setpoint-correction

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Winder is controlled to run with constant web speed (web speed command value)

- No tension control
- Web material tachometer required (for internal diameter calculation)
- No nip role necessary
- Diameter ratio up to app. 15:1
- Web speed: depending from mechanical construction
- Preferably for sorters
The diameter calculator is the most important element in a winder control. The precise diameter is required e.g. for the conversion of the machine speed into the winder speed as well as for the calculation of the required torque.

The diameter is calculated based on the relation between material and winder speed or is measured by an external device.

The following types of diameter calculation are implemented:

- External sensor
- Ratio between Web velocity and winder speed
- Integration of material thickness
- Integration of web velocity and winder speed (length and angle)
- Measurement of the web position and winder angle (length and angle)

A change of the diameter calculation can be done during the winding process.
Mode DIAM_CALC:
Diameter calculation based on ratio between web velocity and winder rotational speed. The diameter calculated in this mode during acceleration and deceleration phases is not reliable.

Mode DIAM_CALC_INTEGRAL:
Diameter calculation based on ratio between web length and winder angle. Web length and winder angle are determined by velocity and speed integration (no position feedback required). The integration length is parameterized by a multiplier of winder revolutions.

Mode DIAM_CALC_POSITION:
Diameter calculation based on ratio between web length and winder angle. For this calculation a direct position feedback is used. The measuring angle can be parameterized as multiples from winder revolutions.

Mode DIAM_THICKNESS_ADDITION:
Basis of the calculation is that the diameter change of every winder revolution is 2 * material thickness. The winder angle will be determined by winder speed integration. For this calculation mode the material thickness must be very accurate as well as the winder angle.

Mode DIAM_CALC_EXT:
The diameter is determined by an external measuring device or by winder speed characteristic.
Converting Toolbox
Scope of Functionality – Diameter calculation

The further processing of the calculated diameter value comprises a plausibility check and interpolation.

The following methods are implemented:

- No interpolation
- Interpolation with ramp-function generator based on the material thickness
- Interpolation with ramp-function generator (only position based diameter calculation)
- Interpolation without ramp-function generator (only position based diameter calculation)
Converting Toolbox
Scope of Functionality – Diameter calculation
Converting Toolbox
Scope of Functionality – Taper characteristic

Optional for rewrites, if the tension is reduced with an increasing diameter.

- Taper characteristic depends on the actual diameter
- The following characteristics are implemented:
  - Hyperbolic characteristic, max. tension reduction at infinite diameter
  - Hyperbolic characteristic, max. tension reduction at specified diameter
  - Linear characteristic, max. tension reduction at specified diameter
  - Breakpoint table with linear interpolation
Converting Toolbox
Scope of Functionality – Controller adaption

• Controller gain of the tension/position controller is adaptable based on the actual diameter
  → higher gain at higher diameter

• Controller gain of the speed controller is adaptable based on the moment of inertia or the diameter of the roll
  → higher controller performance with high load conditions
Converting Toolbox
Scope of Functionality – Torque pre-control

The torque for the winding process is calculated from three components:

1. **Acceleration / Deceleration torque**
   During acceleration or deceleration of the material an additional torque component is switched on the drive for more dynamic reaction and to prevent tension fluctuations.

   The acceleration compensation is based on the diameter, the web width, the gear ratio and the material density.

2. **Friction compensation**
   Compensation of mechanical losses for precise adjustments of the tension

3. **Tension pre-control**
   Adjustment of the tension, especially in the control mode indirect tension control

Using the torque pre-control, the technology data block is mandatory.
Converting Toolbox
Scope of Functionality – Tension mode (web mode)

- Tension operation can only be enabled if the control is in operation and web break detection is not signaling an error
- It is recommended to only enable tension operation in machine stand still
- Tension or position setpoint will be enabled using adaptable ramp functions
- If tension operation is not active, the diameter computer and the speed override are disabled
The technology controller based on the functionality of a PID-controller for the usage in e.g. a dancer-position- or tension-controller.

- Setpoint ramp function generator with settable input
- PID-controller
- RFG as controller output for smooth transitions
- Kp-Adaption
- Optional D-portion in the actual value channel
Residual length calculation – FCRLC (LConLib)

- The residual length of a roll can be calculated by entering the following parameters:
  - Web thickness
  - Actual diameter
  - Target diameter

- Output either the length of the material on the roll or the length of the material still to be wound
The Converting Library is available as:
- Library export (SIMOTION Converting Library)
- Sample project (SIMOTION Winder)

The Converting Library consists of **five** Units:

<table>
<thead>
<tr>
<th>Unit name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>aVersion</td>
<td>Changelog</td>
</tr>
<tr>
<td>fConvTools</td>
<td>General Drive-related functionality (closed loop control function blocks, System handling)</td>
</tr>
<tr>
<td>fWinderTools</td>
<td>Winder related function blocks (diameter calculator, technology controller, taper characteristic etc.)</td>
</tr>
<tr>
<td>fWinder</td>
<td>Winder function block (FBWinder)</td>
</tr>
<tr>
<td>fSplice</td>
<td>Function blocks to control flying splices</td>
</tr>
</tbody>
</table>
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Example Configuration

Example Configuration:
(stand alone / low Performance)

- SIMOTION D410-2 DP/PN
- SINAMICS S120 AC/AC
- Breaking Resistor (optional)
- TM31 (optional)
- Drive-Cliq Hub (optional)
- e.g. 1PH8 Motor

Standards:
SIMOTION Winder
SIMOTION Axis Function Block

Benefits:
- Modular solution based on standard products
- Higher hardware integration (no external traversing controller required)
- Fast and scalable control
- Onboard I/O and onboard Machine Encoder Interface
Converting Toolbox
Example Configuration

Example Configuration: (Machine control)

- SIMOTION D4x5-2
- SINAMICS S120 DC/AC
- Infeed (ALM / SLM / BLM)
- TB30/TM31 (optional)
- 1PH8 Motor

Standards:
SIMOTION Winder
SIMOTION Axis Function Block

Benefits:
- Time saver at engineering, test and commissioning
- Higher hardware integration (no extra Winder PLC)
- Modular and scalable solution based on standard products
Converting Toolbox Tools – Sizing: SIZER

SIZER WEB ENGINEERING

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Converting module for Project Generator

- Assisted configuration
- Generation of a machine project incl. control sequence

SIMOTION Project Generator

https://support.industry.siemens.com/cs/de/en/view/51339107
Thank you for your attention!

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