The Converting Toolbox
Converting Solutions from Siemens Industry
Converting Process and Control Requirements

**Unwind**
- Tension control
- Automatic splice

**Process**
- Register control
- Cut / Perf
- Position Based Web Control

**Rewind**
- Tension control
- Automatic splice
Siemens Answers with the Converting Toolbox
What can it do for you?

**Toolbox Features**
- Fully-supported product
- Detailed documentation
- Wide range of functionality
- Full applications and library functions
- Open source software
- Functional demo examples, with HMI screens

**Customer Benefits**
- Time saving during engineering and support
- Time-tested, reliable functions
- Worldwide Toolbox support
- Available without charge
- Solutions for all control architecture strategies
  - **PLC-based**
  - **Drive-based**
  - **Motion-based**
### Converting Toolbox

#### Standard function overview

<table>
<thead>
<tr>
<th>Winder</th>
<th>Splice Control</th>
<th>Tension Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diameter calculation, dancer-roll or load cell tension control, indirect tension control, taper tension, torque pre-control</td>
<td>Position-based calculation of switching signals, compensation of the rotary turret motion, no additional automation devices</td>
<td>Closed loop control (e.g. dancer control) and indirect tension control, torque limiting, torque pre-control (tension, acceleration)</td>
</tr>
<tr>
<td><strong>Web Accumulator</strong></td>
<td><strong>Rotary Knife</strong></td>
<td><strong>Flying Saw / Shear</strong></td>
</tr>
<tr>
<td>Control of accumulator storage drive, auto loading/unloading the accumulator, closed-loop tension control, calculation of fill-level</td>
<td>Motion profiles (constant acceleration, jerk limiting, polynomial, sinusoidal or combination), freely definable cutting profiles</td>
<td>Cut to length of moving material. Automatic operation, immediate cut, cut to length or to a print mark, virtual or real master, and more</td>
</tr>
<tr>
<td><strong>Traversing Axis</strong></td>
<td><strong>Integrated Register Control</strong></td>
<td><strong>Load Sharing</strong></td>
</tr>
<tr>
<td>Precise positioning of traverse wound material. parameters change on the fly, plausibility check of parameters, and more</td>
<td>The SIMOTION integrated register control, utilizes an innovative sensor technology directly connected to SIMOTION via PROFINET</td>
<td>Mechanically coupled axes are a common application. Consideration must be given to the coupling compliance</td>
</tr>
<tr>
<td><strong>Disturbance Compensation</strong></td>
<td><strong>Synchronized Drive Control</strong></td>
<td><strong>Converting Library</strong></td>
</tr>
<tr>
<td>Counter system related periodic disturbances, oscillations with independent compensation of up to three sinusoidal and periodic torque harmonics</td>
<td>The synchronous axis follows a leading axis or master. Multiple axes can be coupled to an individual master or groups of various masters</td>
<td>A library of commonly used converting functions, for converting applications, e.g. filters ramp gen., PID, dia calc, setpoint, and limit detect, etc.</td>
</tr>
</tbody>
</table>
Three Modules
A complete solution set

- **PLC Control**
  - STEP 7

- **Drive Control**
  - STARTER / DCC

- **Motion Control**
  - SCOUT
PLC-Based Solution
SIMATIC converting module

- SIMATIC PLC
- SIMATIC HMI
- SINAMICS S120 with safety integrated
- Synchronous Motors
- Asynchronous Motors
PLC-Based Solution
SIMATIC converting module

Features

- PLC ease of use and flexibility
- Open source code; structured text (PLC)
PLC-Based Solution
SIMATIC converting module example

Slitter Rewind
SIMATIC S7-1200

Unwinds, Turret Index & Splice
Main & Sectional Drives
Rewinds

Speed Coordination

Machine Web Control

SIMATIC converting module example
Drive-Based Solution
SINAMICS converting module

Architecture

SIMATIC PLC

SIMATIC HMI

SINAMICS S120
Control Unit

SINAMICS S120
with safety integrated

Synchronous Motors

Asynchronous Motors
Drive-Based Solution
SINAMICS (DCC) converting module

Features
• Drive-based performance
• Graphical programming editor (DCC)
Drive-Based Solution
SINAMICS converting module example

Coating / Laminating Line

- SIMATIC S7-1500
- Machine Control
- Speed Coordination
- Web Control, Unwind & Splice Control
- Web Control, Unwind & Splice Control
- Web & Tension Control
- Web & Tension Control
- Web & Tension Control
- Web & Tension Control
Motion-Based Solution
SIMOTION converting module

Architecture

SIMATIC PLC

SIMOTION D
Motion controller

SIMATIC HMI

SINAMICS S120 with safety integrated

Synchronous Motors
Asynchronous Motors

Unrestricted © Siemens Industry, Inc. 2015 All rights reserved.
Page 12 March 26, 2015
Motion-Based Solution
SIMOTION converting module

Features

- Highest level of performance
- Includes HMI application
- Can be demonstrated via SIMOTION demo
- Open source; structured text
Motion-Based Solution
SIMOTION converting module example

Diaper Machine

SIMATIC S7-1500

Speed Coordination

Machine Control

Web Control, Unwind & Splice Control

Web & Position Control
### Automation Architectures

**Solution / machine type**

<table>
<thead>
<tr>
<th>Toolbox Module</th>
<th>Networking</th>
<th>Application</th>
<th>Example Machine Types</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Web</td>
<td>Motion</td>
</tr>
<tr>
<td><strong>PLC SIMATIC</strong></td>
<td>• PROFIBUS • PROFINET</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Drive SINAMICS</strong></td>
<td>• PROFIBUS • PROFINET • EtherNet/IP</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Motion SIMOTION</strong></td>
<td>• ROFIBUS • PROFINET</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Converting Functions

Winder

An integral part of almost every converting machine
Toolbox winder application suitable for all common control modes
Eliminates several labor-intensive engineering steps

Converting Toolbox Highlights

Control techniques
• Dancer roll and/or tension control using velocity adaptation or torque limiting
• Indirect tension control using torque limiting, selectable via parameter

Diameter calculation
• By measuring or calculating – using the ratio between the material web velocity and the winder speed, or between material length and winding angle

Winding hardness characteristic
• Linear, table of interpolation points or hyperbole

Torque pre-control
Tension/dancer roll position and/or speed controller adaptation

Web break detection
Converting Functions

Accumulator

- Used for making flying roll changes while the machine is running
  - Suitable for lower machine speeds
- The wound roll is braked and the machine process supplied by either emptying (unwinder) or filling (winder)
- Accumulator is returned to the neutral position until the next roll change

Converting Toolbox Highlights

- May be used for winders and unwinders
- Control of the draw-off/feed
- Control of the accumulator storage drive
- Automatically loading and unloading the accumulator
- Brake control of the accumulator storage drive
- Closed-loop tension control in the accumulator
- Calculation of fill level
- Monitoring the accumulator position
- Web break monitoring
- Machine encoder may be used to determine the accumulator position (option)
Converting Functions
Splice control

To achieve the highest productivity, winders are often equipped with an automatic roll change function.

Splice control speeds up roll change and stabilizes machine process.

The roll is changed while the machine is operational by gluing and cutting the new material web.

The old roll is then moved to the change position for easy swap-out without having to interrupt the process.

Delay-free control of the knife and the contact roller by cams.

No additional components required.

Compensation.

Integrated monitoring of the splicing procedure.

Converting Toolbox Highlights

Position-based calculation of the switching signals for highest precision and repeatability for minimum overlap.
Converting Functions
Tension control

In addition to winding, tension control is the second most important function in a converting machine – to keep the material tension constant and when required, to control it.

- Avoids damaging the material web or even breaking it

Typically, the components involved in the control are part of a larger machine or system, which can include several tension zones and also winders.

Various open or closed control techniques for various measuring systems are implemented in the function – e.g. dancer roll systems or loadcell.

Converting Toolbox Highlights

Technique for closed control loops
- Tension control using torque limiting or velocity adaptation;
  dancer roll control using speed adaptation

Technique for open control loops
- Indirect tension control using torque limiting, draw control (velocity relationship)

Torque pre-control (tension, friction, acceleration)

Line operation without closed-loop control

Integrated controller with setpoint processing
Converting Functions
Traversing drive

Used in conjunction with winders for materials such as flat wire, shaped wire or foils, traversing drive units ensure that the material is wound as specified.

Typically through a position or velocity reference, they precisely position the material being wound on a core or similar:

- Such as to achieve a defined structure of the edge of a coil

The Siemens Converting Toolbox includes:

- Drive-based SINAMICS S120 solution for basic applications
- Motion-based SIMOTION solution for demanding applications

You can easily integrate the laying function of the Converting Toolbox into existing winder applications

All the data relevant to the laying device is specified via a precisely defined on-board interface.
Converting Functions
Traversing drive, cont’d

Converting Toolbox Highlights

All traversing parameters can be changed "on the fly"

Plausibility check of the parameters

Calculating motion equations and synchronous operation commands in the application

Compensation

Immediate direction reversal "on the fly"

Definition of the traversing profile using the winding step, waiting distance, acceleration angle

Define referencing, jogging and free positioning independently by axis commands

Available when using SIMOTION

- Offset angle control
- Independent and adaptable spikes
- Advance
- Angle-based high-precision coupling to the winding process
Converting Functions
Rotary knife

Rotary knives are used to cut or perforate continuous material webs (paper, metal, plastic, etc.), usually comprising one or several rotating rolls equipped with blades

• Must move synchronously with the material line in the cutting area

The motion profile of the rolls is subdivided into two ranges.

**In the synchronous range**
• The tool is synchronized with the material, in the simplest case this being synchronized speed

**In the format range**
• Equalization motion to adapt the cutting length takes place and the tool is not in use

The system can be optionally expanded to include energy management functions
Converting Functions
Rotary knife, cont’d

Converting Toolbox Highlights

Suitable for drum-type shears, multi-knife and eccentrics

Motion profiles can be selected via parameter
  • e.g. constant acceleration, jerk limiting, polynomial, sinusoidal, or a combination

Cutting profile: linear, overspeed or freely-definable using interpolation points
  • Such as for cosine correction

Operating mode manager: automatic operation, immediate cut, single cut, cutting program

Print mark correction with shift register

Polynomial cam disks can be changed "on the fly" during operation

Energy management
Format change of cross cutters via print marks using precise segment calculation of the cam disk
Coupling either through a machine encoder or internal synchronous operation coupling
  – Offset angle control
Adjustable rest position for the rotary knife
Converting Functions
Flying saw / flying shear

Used to cut endless material webs into sections
- Especially if the material being produced cannot be wound

Consists of a driven slide, which is synchronized to the material
- The saws or shears are moved with the same velocity as the material itself

After the cut has been made, the slides are moved back to the initial position

In addition to cutting, other operations are possible
- Such as drilling, embossing or die cutting

Converting Toolbox Highlights

- Operating mode manager
  - Automatic operation, immediate cut

- Cutting to length or to a print mark
- Inserting a gap
- Synchronizing to a precise position
- Coupling
  - Either through a machine encoder or internal synchronous operation coupling
Converting Functions
Load sharing

Coupled axes are used in a wide variety of applications
• Such as winder axes with several drive motors
The coupling can either be rigid (direct) or flexible (through the material web itself)
In cases such as these, the load must be distributed between the coupled drives

Converting Toolbox Highlights
Torque coupling
Overcontrol of the speed controller with torque limiting
Droop and compensation
Converting Functions
Integrated register control

SIMOTION integrated register control increases efficiency and precision

By Utilizing an innovative sensor technology directly connected to the SIMOTION control module via PROFINET, the drive controller calculates the register control algorithms and the conventional drive-related Motion Control functions.

The direct access to process data together with the virtually instantaneous transfer of control signals ensures exact and effective register control featuring superior control dynamics.

Converting Toolbox Highlights

- Register control is integrated into the Motion Control drive system, so no additional control cabinet is required.
- High control dynamic
- For use in rotogravure, offset, screen, and flexo printing
- Operation of the register control can be integrated into existing machine operating panel
- Adjustable print mark dimensions and print mark shapes
- Parameters for special productions can be stored and recalled
Converting Functions
Disturbance compensation

This application is used to counter system-related periodic disturbing oscillations to reduce the speed ripple

- To increase tension precision
- Especially at low speeds and low load levels

Converting Toolbox Highlights

Can be flexibly adapted to the particular machine

Independent compensation of up to three sinusoidal and periodic torque harmonics
Converting Functions
Synchronized drive control

In synchronous operation, an axis follows a leading axis or master
Multiple axes can be coupled to an individual master or groups of various masters

Converting Toolbox Highlights

Real leading axis
Virtual leading axis
Master value switchover
Catching up / stopping
Engaging / disengaging operation
Electronic gearing
Synchronization to master value (phasing)

Absolute and relative offset input
Print mark correction on leading and following axis side
Flying homing for following axis and real leading axis
Homing for following axis and real leading axis
Positioning for the real and virtual leading axis
Dead-time compensation
Converting Functions
Converting library

The Converting Library is a compilation of useful functions commonly used in converting applications

Functions Included

• Universal tools
• Logic functions
• Conversion functions
• Scaling functions
• Closed-loop functions
• Drive communication functions
• Sectional Drive
• Winder controls
The Converting Toolbox
Free reference CD

Email: mcs.converting.industry@siemens.com