TM490

Printing machine technology

PERFECTION IN AUTOMATION
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Prerequisites and requirements

Training modules	TM210 – Working with Automation Studio
Software	Automation Studio 3.0.90 Automation Runtime 3.08
Hardware	X20CP1485

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1 Introduction

Electronic media has made undeniable progress over the past two decades, in many cases replacing traditional printed media. Yet, we still interact with printed material every day. Not just magazines, newspapers and books, but also tickets, maps, wallpaper, textiles, all types of packaging – and these days even printed solar cells and "light paper". There's hardly a product out there that doesn't involve printing in one way or another.

The more you think about it, the more it becomes clear that printing technology is everywhere. Wikipedia defines printing technology as follows:

The general term "printing technology" covers a wide range of different techniques for reproducing text and images from a master or template, including letterpress, offset, gravure, flexographic and screen printing. Each technique uses a different process to transfer ink to the respective substrate.

Printed electronics use special electrically functional ink, yet the fundamental process remains the same.

Clearly, printing machine technology will continue to play an important role in automation technology long into the future.

This training module – TM490 – covers the topic of "Printing machine technology". It will present sample solutions programmed using the MTTension and MTRegister libraries. To improve comprehension, each control loop will be implemented and analyzed directly in Automation Studio.

Training module structure

The training module begins by explaining the most important terminology used in the field of industrial printing, which is important for understanding concepts that are explored later on. This is followed by a discussion of the various printing techniques, highlighting the advantages and disadvantages of each.

The next section explores the fundamental physical properties of a continuous production line. This type of machinery is widely used outside of printing as well, and warrants a closer look.

The next two sections are the main focus of this training module and cover the topics of tension control and registration control. Following a description of the libraries that are used and an explanation of how they work together, a number of "Solution Samples" are provided.

Finally, you will receive an overview of common types of registration marks and how they are detected.

Tip:

The Automation Studio help system contains a wealth of additional information and is highly recommended as a resource to help you get the most out of this training module.

1.1 Learning objectives

Participants should gain a general overview of the field of industrial printing technology. Building on this, they will develop a basic understanding of the fundamental concepts involved in printing technology.

The primary goal is to achieve a good understanding of the solutions offered by B&R.

- You will gain an overview of industrial printing technology, including terminology and trends.
- You will learn the basic physical properties of a production line with a continuous web.
- You will get to know the structure of the MTTension library and the tension control function blocks it offers.
- You will gain experience working with the "Multi Zone Tension Control" solution sample.
- You will get to know the structure of the MTRegister library and the registration control function blocks it offers.
- You will be prepared to commission a printing machine.
- You will get an overview of B&R's solutions for registration mark detection.

1.2 Safety notices and symbols

Unless otherwise specified, the descriptions of symbols and safety notices listed in "TM210 – Working with Automation Studio" apply.

2 Industrial printing technology

Industrial printing involves highly automated processes with high output volume. This is the only type of printing machine that is of interest from an automation standpoint and will be the only type addressed in this training module.

2.1 Basic printing terminology

There are a number of ways that one might classify printing machines and printing processes. The following is an overview of the main considerations involved.

Differentiating based on printing technique

Printing techniques can be defined by the type of printing form and impression form used:

- Flat-on-flat
- Cylinder-on-flat
- Cylinder-on-cylinder

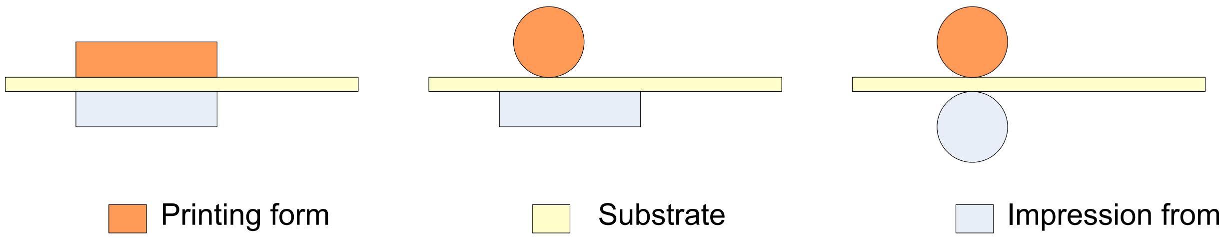


Figure 1: Printing techniques

Differentiating based on substrate

A defining feature of any printing process is the format in which the substrate is provided. It may come as a roll of continuous web or as individual sheets.

Another key feature is the type of substrate material used. Typical substrates include paper, cardboard packaging, various types of plastic and metal, or even textiles.

Differentiating based on printing process and printing form

The printing form is the object that transfers the content (text, images, etc.) to the substrate (paper, etc.). The shape of the printing surface and the material of the printing form depend on the printing process being used.

An important distinguishing feature is whether or not a printing form is used. Techniques that do not use a solid printing form are called non-impact printing, or NIP for short. Techniques that do use a printing form are referred to as "conventional".

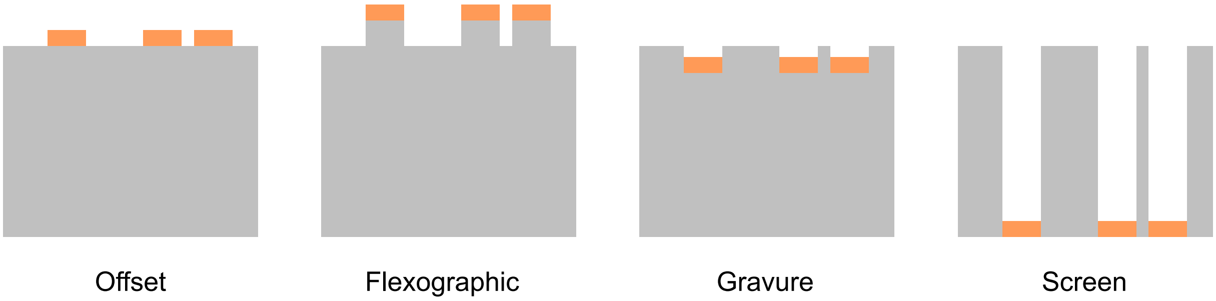


Figure 2: Conventional printing techniques (with printing form)

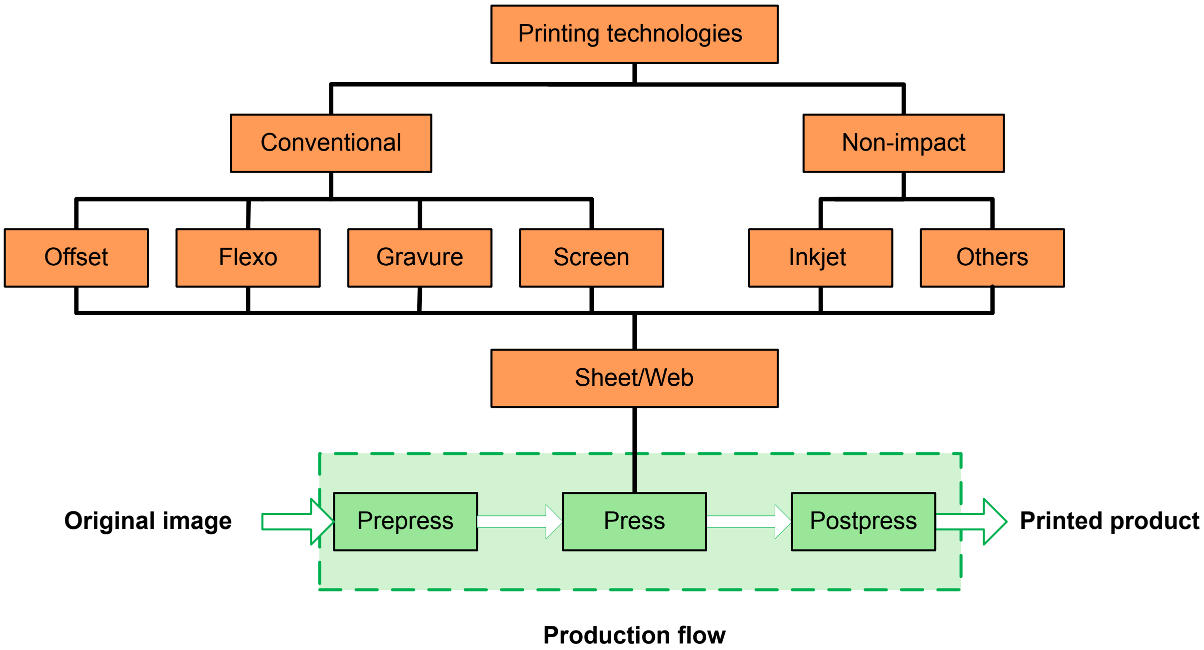


Figure 3: Printing process with production flow for multicolor printing

Color model

Multicolor printing usually uses the CMYK – Cyan, Magenta, Yellow, Key(black) – color model. These four colors can be combined to create a large portion of the colors that can be seen by humans. Colors that lie outside the CMYK color space – such as spot colors like gold and silver or reflective colors – require additional printing units. That's why modern printing machines sometimes feature more than ten printing units.

Figure 4: Multicolor printing

2.2 Trends and challenges in the printing industry

Times are changing for printing machine manufacturers

The turn of the millennium saw a fundamental restructuring of the media landscape that shifted the course of development for the printing industry. Traditional printed products like magazines, newspapers and books are instead being read on electronic devices. The growth of market volume has been further stunted by the increased productivity of modern, automated machinery. This development creates considerable excess capacity, particularly for web offset printing.

Even mass-circulated catalogs – the bread-and-butter of gravure printing – are in decline. Many mail-order companies have migrated to the Internet and taken the advertising money with them. Continued development of offset techniques has yielded improvements for short-run printing that are not profitable for gravure printing. Although offset printing itself is in decline, its ongoing development causes problems for gravure printers.

Long confined to office applications, digital printing has made its way into the industrial arena over the years and now competes virtually toe-to-toe with conventional printing techniques. With the trend toward ever smaller print runs – from advertisements and sales catalogs to custom photo books – demand for digital printing continues to grow. Nevertheless, the speed factor still presents an insurmountable obstacle for long run printing jobs. The ink costs are also much higher than with other techniques, such as web offset printing.

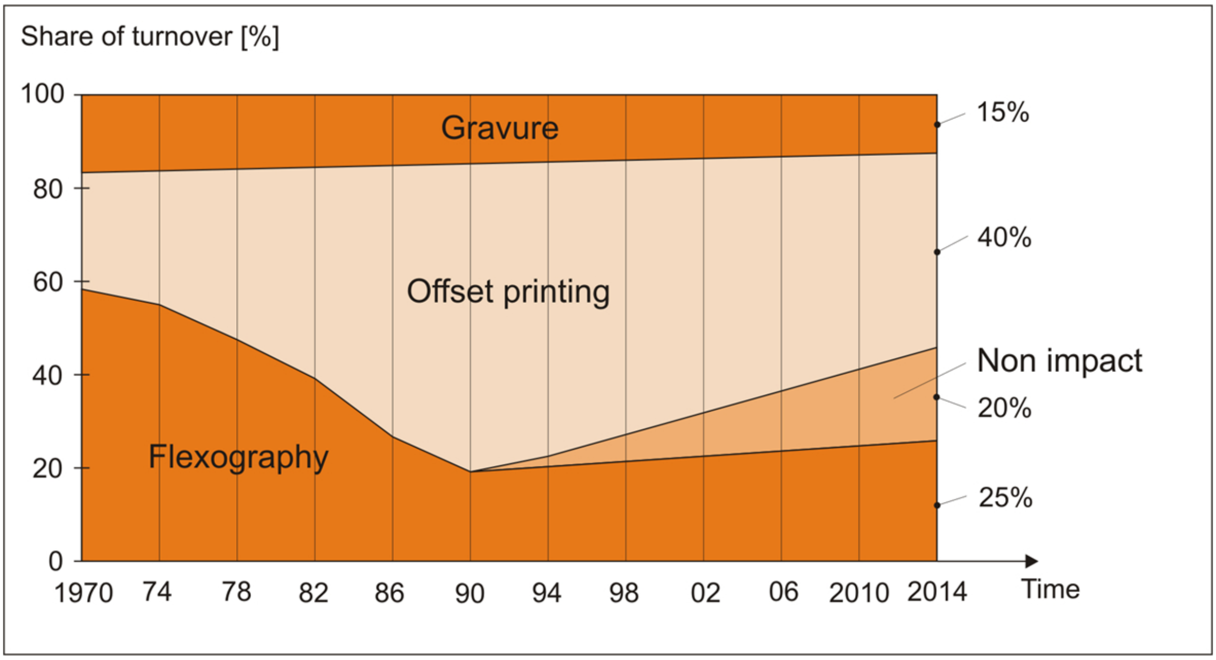


Figure 5: Market share in the printing industry

Potential growth markets for printing machine manufacturers

The trends toward digitalization and individualization will continue to increase the significance of non-impact processes. At the same time, manufacturers of traditional office printers continue to establish themselves as new players in this market.

Strong growth is projected for package printing, a segment that already comprises over a quarter of the world's total print output. Much of this growth is expected to occur in Asia. Print finishing is likely to increase in significance as producers attempt to catch customers' interest with packaging.

The potential for combining multiple printing techniques in a single machine is also very interesting. For example, offset and digital printing can be combined to allow individualized advertisements and packaging.

Printed electronics, where electrically functional inks are deposited on a substrate, is heralded as the technology with the greatest potential. The vast range of potential applications includes everything from intelligent products and packaging to computer displays and solar cells.

2.3 Overview of B&R technology for the printing industry

B&R offers a large portfolio of standardized solutions for printing applications.

Overview of B&R solutions

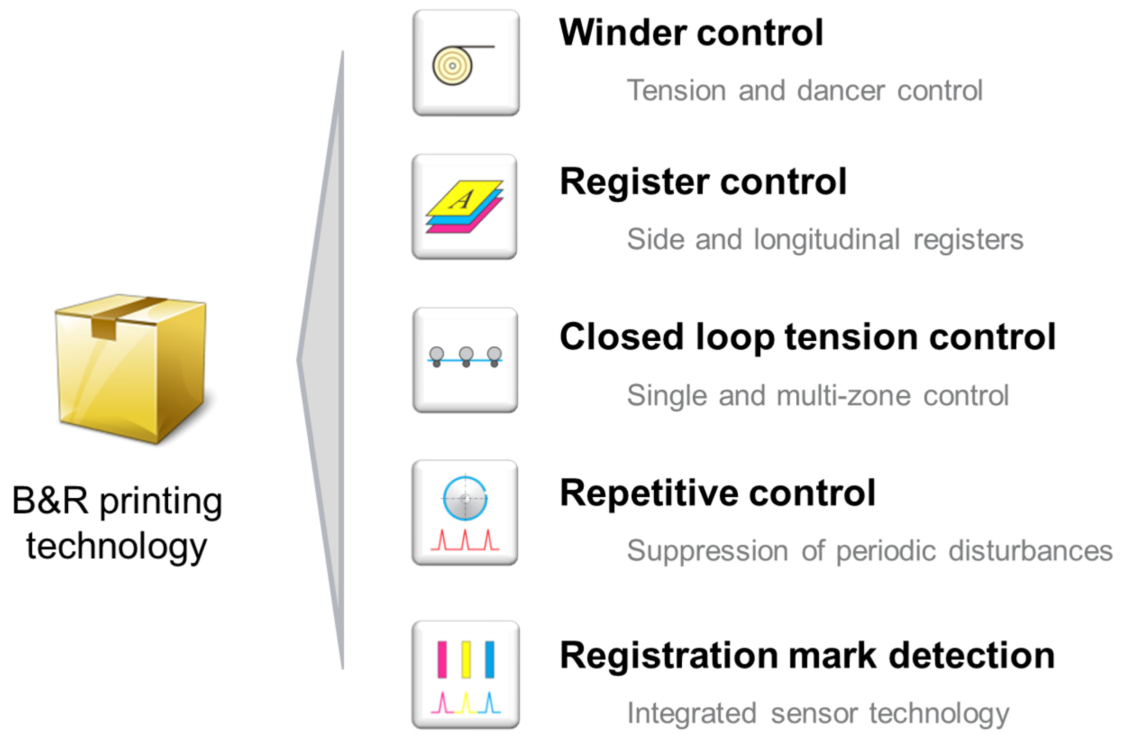


Figure 6: B&R technology for continuous web production lines

Solutions for printing processes

	Additional axis control	**Winder control**	**Register control**	**Tension control**
Task	**Rejection of periodic disturbances**	**Control of unwinder and rewinder axis**	**Position control of all printed images**	**Control of web tension in one or more zones**
Flexographic	Repetitive control	AsWndCon	MC_BR_Offset	MTTension
Rotogravure	---	AsWndCon	MTRegister	MTTension
Offset	---	AsWndCon	MTRegister	MTTension
Digital	---	AsWndCon	---	MTTension
Label	Repetitive control	AsWndCon	MC_BR_Offset	MTTension

3 Continuous production lines

Continuous production (also known as continuous web or reel-to-reel) is a production method with widespread applications in industries such as metalworking, textiles, paper and printing. Continuous production lines typically feature a series of driven and non-driven rollers that transport and guide the web.

3.1 Examples of continuous web production lines

Examples in the printing industry

- Flexographic printing
- Web offset printing
- Gravure printing
- Digital printing

Examples outside the printing industry

- Wire-drawing machines
- Roller mills

3.2 Basic physical properties of production lines

Describing the web is an important step in creating a mathematical model of the line. Keep in mind that the actual physical properties of a real web are much more complex than is shown here. Experience has shown, however, that relatively simple mathematical models can do a very good job of describing these properties.

The nips used to transport the web are also a decisive part of the model.

3.2.1 The web

The web is a three dimensional body, with different physical properties in each direction: longitudinal, sideways and perpendicular to the surface. Physical properties that are dependent on direction are called ansiotropic, while those that are independent of direction are called isotropic.

Every web also possesses elastic, viscoelastic and plastic characteristics. These characteristics are exhibited to different degrees depending on the type of material.

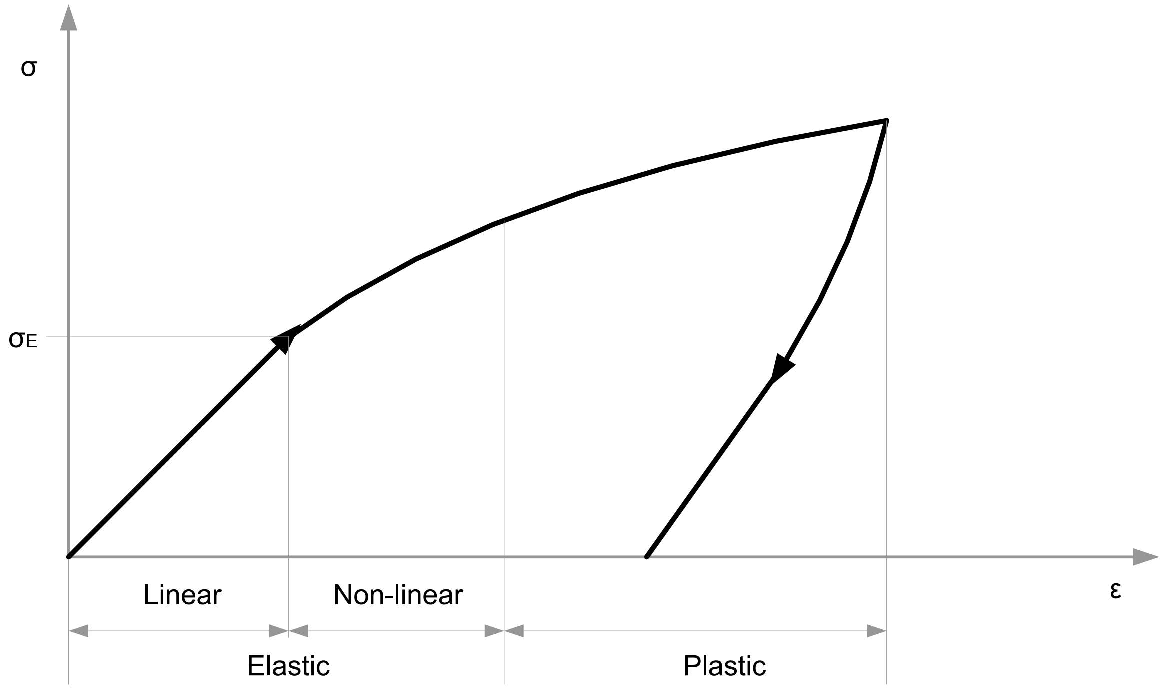


Figure 7: Stress-strain curve

For many industrial applications, despite the complexity of the actual physical properties, an elastic model is sufficient as a first approximation. The following applies for the strain (ε):

$$\varepsilon = \frac{\Delta L}{L_0}$$

If the thickness of the web is very small relative to its length and width, then the stress (σ) in the material can be described using Hooke's law with elastic modulus E and strain ε:

$$\sigma = E \cdot \varepsilon$$

If you factor in the cross-sectional area, you get the force necessary to achieve a specific amount of strain (ε).

$$F = E \cdot A \cdot \varepsilon$$

Typical values

Material	Elastic modulus
Paper	1.8 to 4.3 GPa
Plastic membrane	0.5 to 7 GPa

3.2.2 Exercise: Web

Determine the units:

1) What SI unit is used for force (F)?
2) What SI unit is used for area (A)?
3) What SI unit is used for stress (σ)?
4) What SI unit is used for strain (ε)?
5) What SI unit is used for elastic modulus (E)?

	SI unit	Comments
Force		
Area		
Stress		
Strain		
Elasticity module		

Calculations with stress, strain and force:

1) What is the value of the strain (ε) when a 1 meter long strip of paper is stretched by 1 mm?
2) What is the value of the stress (σ) when the elastic modulus is 2 GPa?
3) How much force (F) is required to achieve stress (σ) if the web has a cross-sectional area of A = 0.0001 m^2?

	Value	Note
Strain		
Stress		
Force		

3.2.3 Modeling web transport

The following is an analysis of how the web is transported in a continuous printing line. We will do so using a typical model of such a line. A very common design consists of three main sections: the infeed roll, the processing section and the outfeed roll. The web is supplied to the line from an infeed roll (unwinder).

In the next section the web is processed, and the finished product is then wound onto the outfeed roll (rewinder). Along the way, the web passes through a number of rollers and groups of rollers, which form nips where force is applied to the web in order to transport it – and often process it simultaneously.

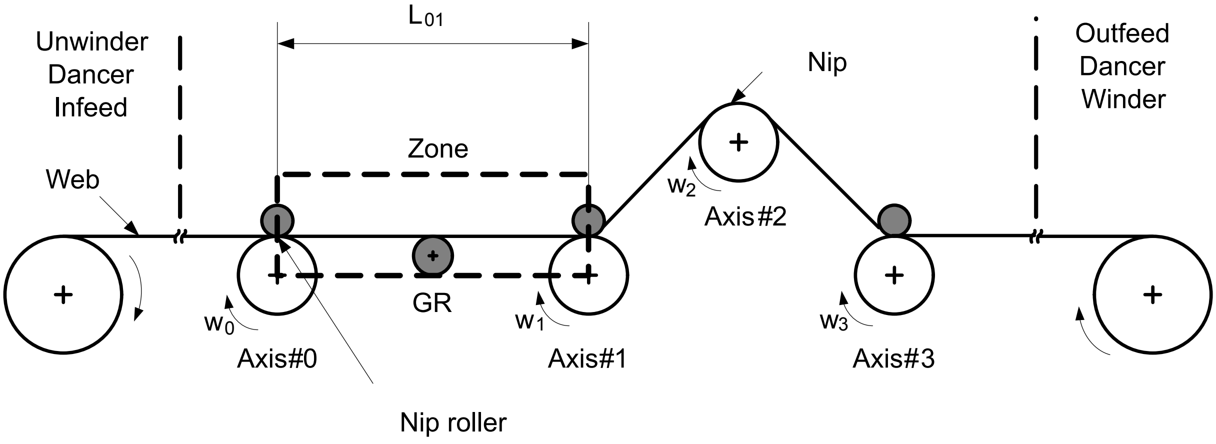


Figure 8: Diagram of a typical production line with a continuous web

Single zone

We will now focus our attention on a single zone. A zone refers to the area between two driven nip rollers. The web moves with linear speed u_d and is passed through nips #1 and #2.

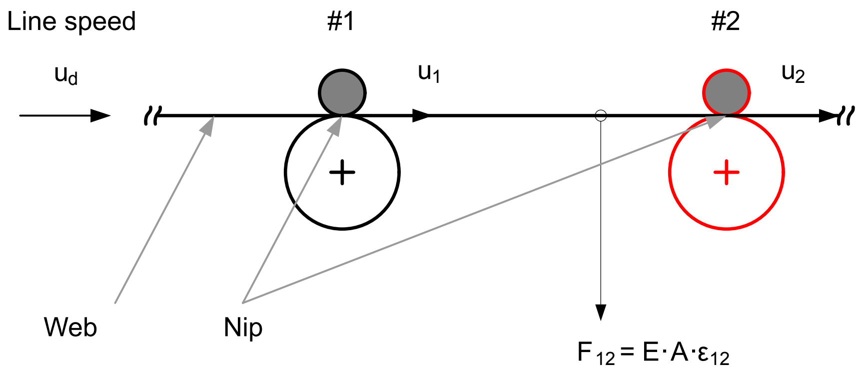


Figure 9: Diagram of a single zone

The following differential equation describes the dynamic strain properties around an operating point (u_d, ε_d):

$$\frac{d\Delta\varepsilon_{12}(t)}{dt} = \frac{1}{L_{12}}\left(u_d\left(\Delta\varepsilon_{01}(t) - \Delta\varepsilon_{12}(t)\right) + \left(\Delta u_2(t) - \Delta u_1(t)\right)\right)$$

The following applies:

$$u(t) = u_d + \Delta u(t)$$

$$\varepsilon(t) = \varepsilon_d + \Delta\varepsilon(t)$$

The change in strain over time in the zone depends on the difference between the strain in the infeed and the strain within the zone. It also depends on the difference between the speeds of the two axes.

Viewing the equation above as a transfer function results in:

$$\Delta\varepsilon_{12}(s) = \frac{u_d}{s \cdot L_{12} + u_d}\left(\Delta\varepsilon_{01}(s) + \frac{\Delta u_2(s) - \Delta u_1(s)}{u_d}\right)$$

We can see that the effect of changes takes the form of a PT1 element. Keep in mind, however, that we're only looking at one zone here.

Multizone analysis

Now we will expand our analysis to include multiple zones. The sequential nature of the zones causes coupling effects that are typical of this kind of production line. In other words, the web couples all of the axes to each other.

Increasing the speed of Axis 2 has an effect on the strain in the preceding zone as well as in all subsequent zones.

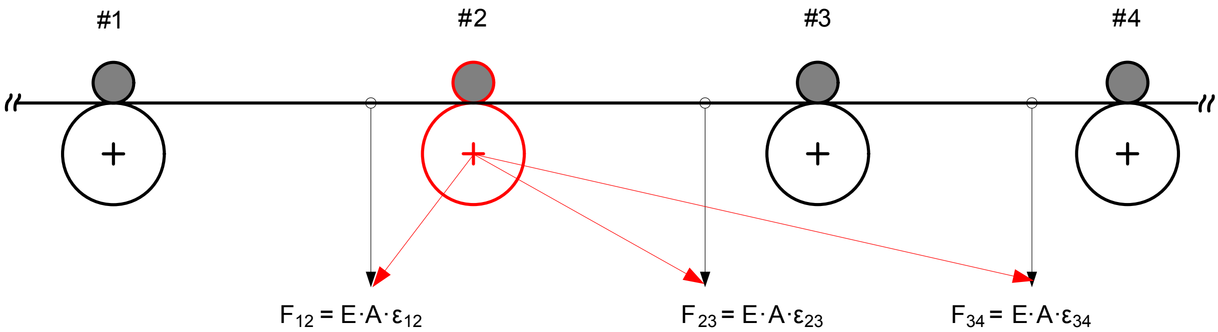


Figure 10: Diagram of coupled zones

The properties described above can now be modeled using the transfer functions:

$$\Delta\varepsilon_{12}(s) = \frac{1}{s L_{12} + u_d} \Delta u_2(s)$$

$$\Delta\varepsilon_{23}(s) = -\frac{1}{s L_{12} + u_d} \cdot \frac{s L_{12}}{s L_{23} + u_d} \Delta u_2(s)$$

$$\Delta\varepsilon_{34}(s) = -\frac{1}{s L_{12} + u_d} \cdot \frac{1}{s L_{23} + u_d} \cdot \frac{u_d s L_{12}}{s L_{34} + u_d} \Delta u_2(s)$$

The step response of u_2 is used to analyze the behavior.

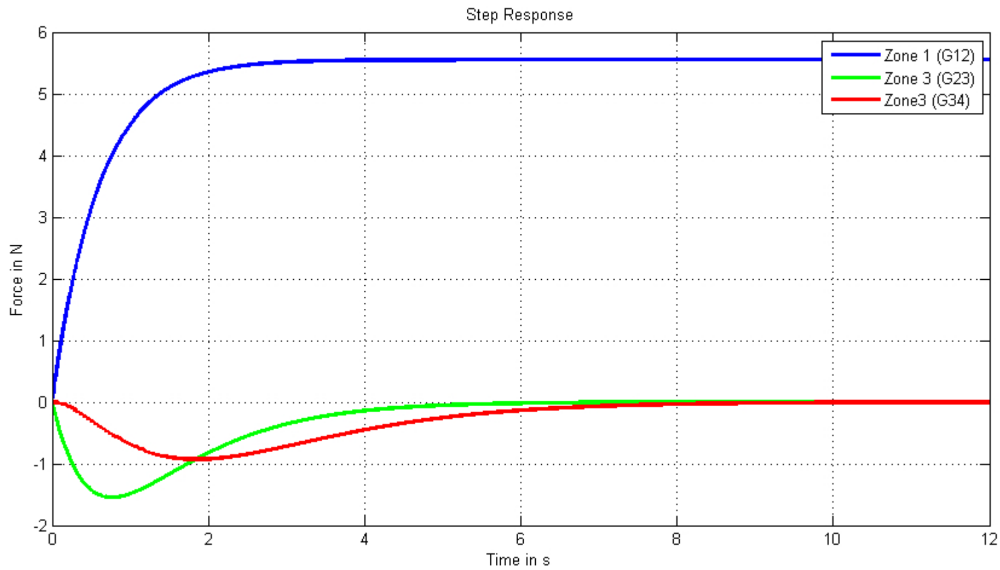


Figure 11: Step response

A change in the axis speed by Δu_2 therefore has a dynamic effect on the strain by $\Delta\varepsilon_{12}$, $\Delta\varepsilon_{23}$, $\Delta\varepsilon_{34}$ etc. Locally, the strain ε_{12} can only be influenced by the speed ratio of the subsequent drive.

3.2.4 Registration error

In multicolor printing, subsequent printing units each press a different colored print image onto the web. The alignment of two overlapping points pressed in different colors that represent the same pixel in the master image file is called registration.

Misalignment, or registration error, is measured using registration marks that are printed along with each component image. Registration error can result from a large number of disturbance factors that may come from the unwinder or from the machine itself.

Longitudinal and side registration

The two basic types of registration are longitudinal (parallel to web movement) and side (perpendicular to web movement). Longitudinal registration is particularly sensitive to disturbances and must be corrected using registration control.

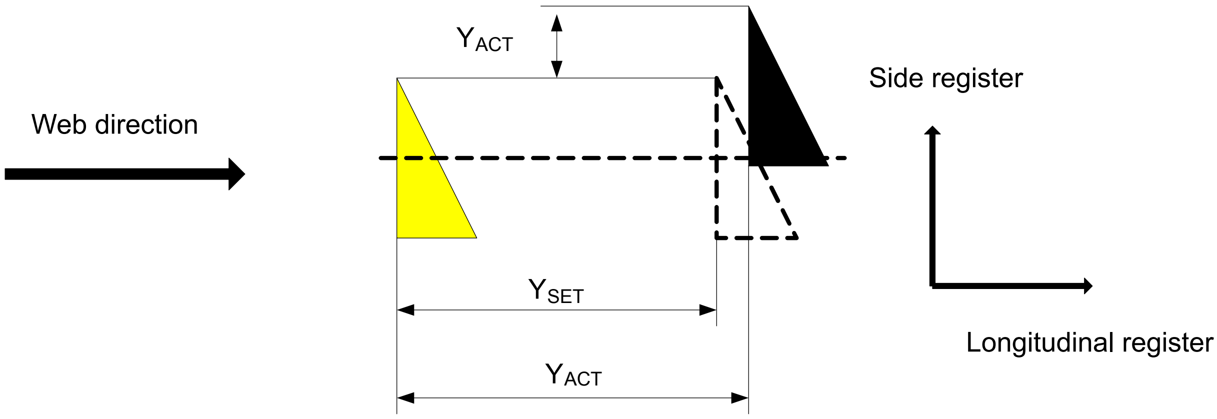
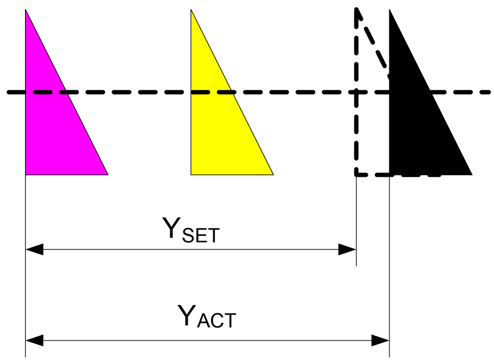


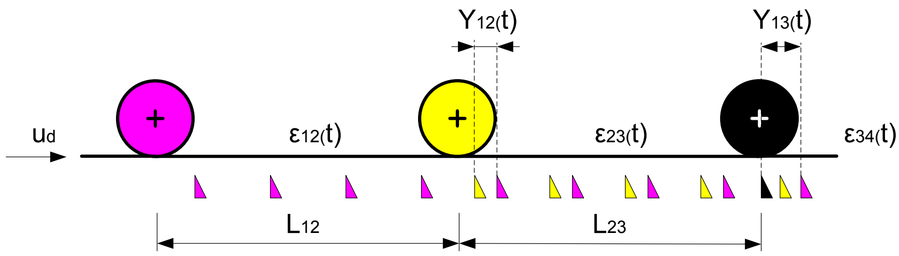
Figure 12: Longitudinal and side registration

Key color registration

The registration mark position is measured relative to the first registration mark.



The figure below shows a section of a web press. It shows three printing units and two zones.



The registration method shown above can be described using the following equations:

$$\Delta\varepsilon_{23}(s) = \frac{u_d}{s\,L_{23}+u_d}\left(\Delta\varepsilon_{12}(s) + \frac{\Delta u_3(s)-\Delta u_2(s)}{u_d}\right)$$

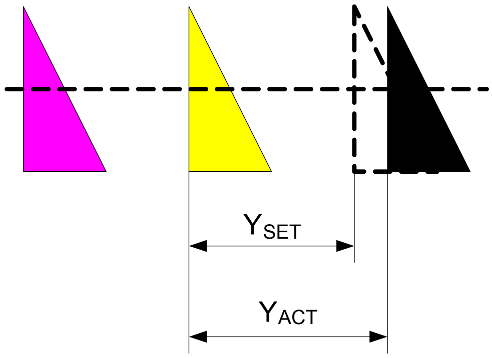
$$\Delta Y_{13}(s) = \frac{u_d}{s}\left(\Delta\varepsilon_{01}(s)e^{-s\,T_{13}} - \Delta\varepsilon_{23}(s)\right)$$

The time T_{13} is defined by:

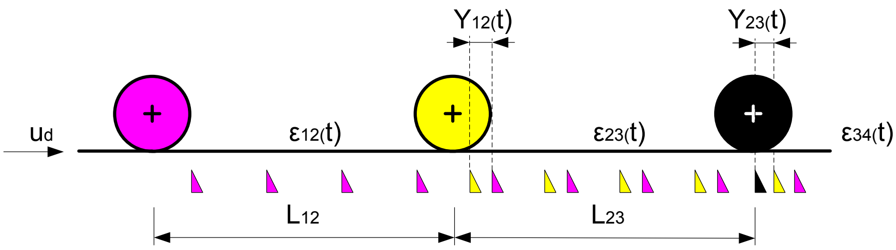
$$T_{13} = \frac{L_{13}}{u_d} = \frac{L_{12}+L_{13}}{u_d}$$

Sequential color registration

The registration mark position is measured relative to the preceding registration mark.



Instead of the key color registration marks being measured in the above method, here we are measuring the subsequent registration marks.



This registration method can be described using the following equations:

$$\Delta\varepsilon_{23}(s) = \frac{u_d}{s \cdot L_{23} + u_d}\left(\Delta\varepsilon_{12}(s) + \frac{\Delta u_3(s) - \Delta u_2(s)}{u_d}\right)$$

$$\Delta Y_{23}(s) = \frac{u_d}{s}\left(\Delta\varepsilon_{12}(s) e^{-s\,T_{23}} - \Delta\varepsilon_{23}(s)\right)$$

The time T_{23} is defined by:

$$T_{23} = \frac{L_{23}}{u_d}$$

4 Closed-loop tension control

Tension control for continuous production lines

Keeping this web stretching at a constant level is often a decisive factor in ensuring product quality. The goal of tension control is to manipulate the drives in a production line in such a way that their respective tension values converge at a stable, desired equilibrium. Due to the coupling effects caused by the web and demand for ever higher line speed and control quality, conventional single-variable controllers are not sufficient for these production lines.

The following library provides multiple-input control functions that account for the most significant coupling effects and compensate for them in the decoupling network.

4.1 Typical machine construction for tension control

Web stretching cannot be measured directly. However, a load cell can be used to measure the tension, so the tension will be our controlled variable.

4.2 MTTension library

This library is used to implement a multi-zone tension controller. It consists of three function blocks that can be used to simulate a closed control loop:

- MTTensionSimulation
- MTTensionDecoupling
- MTTensionController

With a dynamic simulation, you can perform many different tests without having to access the real process and risk damaging the line or wasting materials. This also shortens the time it takes to commission new lines.

4.2.1 MTTensionSimulation

This function block implements a simulation model for a continuous production line like the one shown in the following figure:

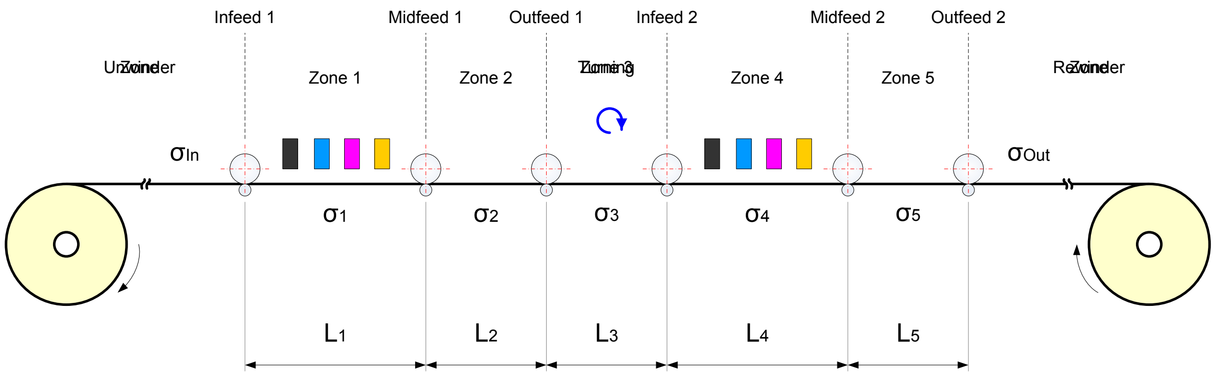


Figure 13: Schematic diagram of a printing machine with five zones

Assumptions made in the model

- No slippage at the nips. The material is held in place at the clamping points using friction or compression.
- Ideal speed control of power transmission system.
- The effects of factors such as temperature and humidity are ignored.

The MTTensionSimulation function block has the following interfaces:

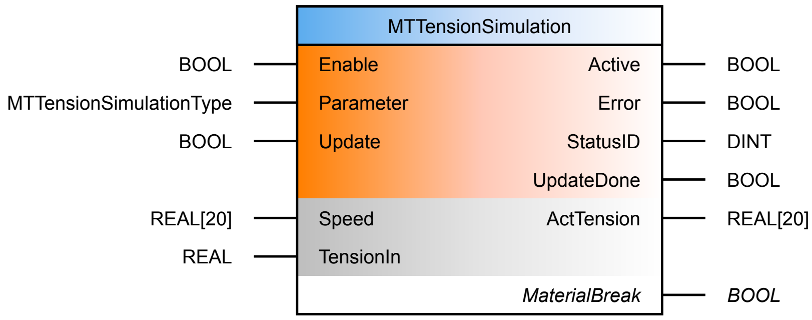


Figure 14: MTTensionSimulation - Interface description

4.2.2 Exercise: Simulation model

Analyzing the simulation model

1) *Create a new Automation Studio project.*

   Use ARsim as your target system. Add the MTTension library.

2) *Add the simulation model.*

   Add a new task to the project with the MTTensionSimulation function block. Use the sample code from the Automation Studio help system.

3) *Use the MTBasicsLimiter function block to generate the line speed profile.*

   Create a new global variable named gSetLineSpeed. Enter acceleration and deceleration values and generate a line speed. Connect the output of MTBasicsLimiter to the "Speed" inputs.

4) *Analyzing the simulation model*

   Create speed jumps at the "Speed" inputs and trace the configured "ActTension" outputs. Analyze the behavior of the model.

   How does it behave when the production line is stationary (u_d=0)?

   Can you explain the behavior based on the transfer functions?

4.2.3 MTTensionDecoupling

This function block implements a decoupling network for continuous production lines.

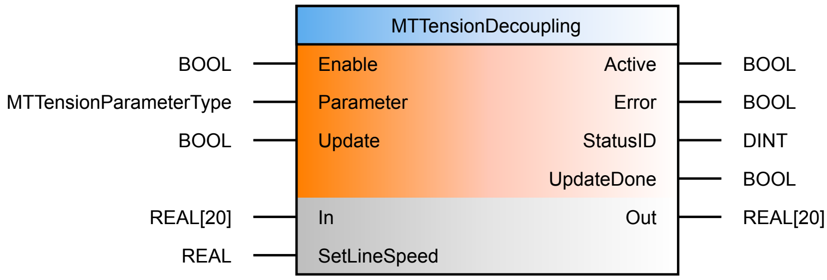


Figure 15: MTTensionDecoupling - Interface description

4.2.4 Exercise: Decoupling network

Analyzing the decoupling network

1) *Add the decoupling network "MTTensionDecoupling".*

   Add a new task with the "MTTensionDecoupling" function block.

2) *Analyze the input/output behavior.*

   Create jumps on the inputs "In[..]" and analyze the outputs "Out[..]" using Watch and Trace. What happens when $u_d = 0$ and $u_d > 0$?

3) *Connect the simulation model.*

   Do this using the PV mapping concept.

4) *Test the decoupling.*

   Create speed jumps in the decoupling network and analyze the outputs of the simulation model "ActTension[..]" using Trace.

4.2.5 MTTensionController

This function block implements a PID controller to provide tension control for continuous production lines.

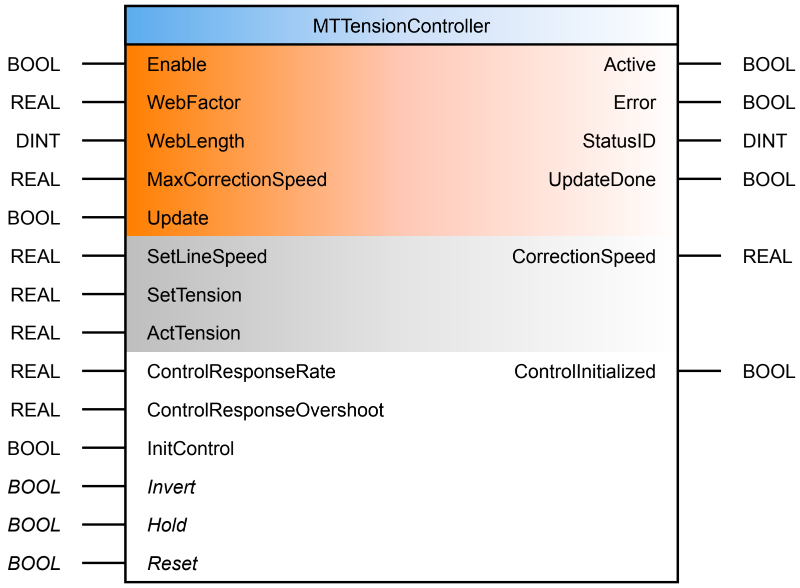


Figure 16: MTTensionController - Interface description

4.2.6 Exercise: Control loop

Analyzing the control loop

1) *Add the controller "MTTensionController".*

   Add a new task for the MTTensionController.

2) *Connect to the decoupling network.*

   Do this using PV mapping.

3) *Test the closed control loop.*

   Perform setpoint step-changes on the closed control loop and analyze the behavior.

   Change the controller's "ControlResponseRate" and "ControlResponseOvershoot" parameters and analyze the behavior again.

4.3 MTTension Solution Sample

4.3.1 Exercise: Multi-zone tension control

1) *Create a new Automation Studio project.*

   Use ARsim as your target system.

2) *Add the "Multi Zone Tension Control" solution sample.*

   Do this using "Add Object". Activate the correct configuration and create a new CompactFlash.

3) *Connect to the visualization application.*

Use a VNC Viewer to connect to the visualization application.

4) *Analyze the behavior of the tension controller.*

Do so using only the visualization application.

5 Register control

A printed image generally consists of multiple colors. Each printing unit in a line only applies a single color. Ideally, these single-color images perfectly overlap to create the final product. In practice, however, a number of disturbance factors can cause them to be misaligned, or "out of register".

Causes of registration error

- Changes in feed tension
- Changes to the web's cross-section, the elastic modulus, the temperature or the humidity
- Change the line speed (acceleration and deceleration procedures).
- Check the inertia and friction values of the guide rollers.

The goal of registration control is to manipulate the drives in a printing machine in such a way that the registration error converges at a stable, desired equilibrium.

5.1 Direct and indirect registration control

Direct register control

With this machine construction, it is possible to correct a registration error directly with a position shift. The main requirement is low pressure at the contact point between substrate and printing plate. This allows the slippage to be used for repositioning.

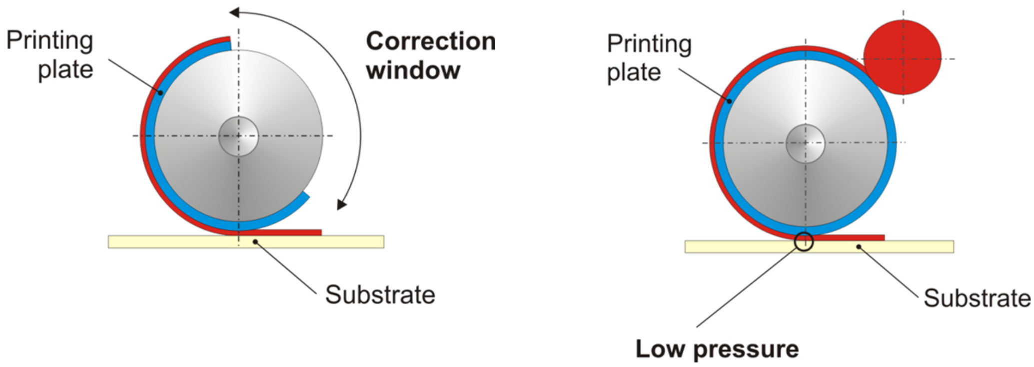


Figure 17: Machines with little to no pressure (no nip)

Indirect register control

With this machine construction, there is very high pressure between the plate cylinder and the impression cylinder. As a result, the substrate is clamped firmly between them (nip). Under these conditions, registration errors occur indirectly due to changes in web stretching. The coupling effects found on machines with nips make indirect registration control considerably more difficult to implement.

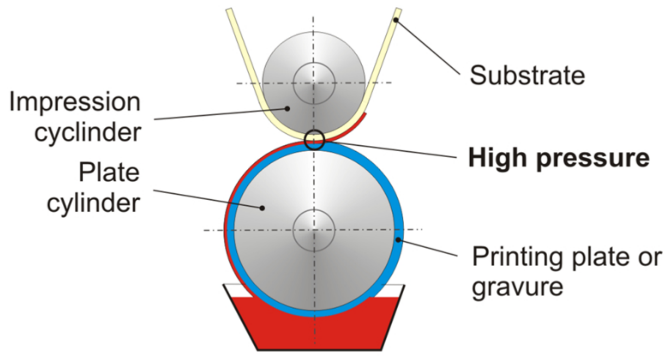


Figure 18: Machines with high pressure (nip)

5.2 Typical machine construction for indirect registration control

Registration error is measured using registration mark sensors (contrast sensors). The first printing unit does not have a sensor. Each subsequent unit is followed by a sensor for measuring registration error.

5.3 MTRegister library

This library is used to implement indirect registration control. It consists of three function blocks:

- MTRegisterSimulation
- MTRegisterDecoupling
- MTRegisterController

They can be used to simulate a closed control loop in order to test and optimize it before commissioning. The simulation model also makes it possible to study the behavior of a gravure printing machine.

5.3.1 MTRegisterSimulation

This function block implements a simulation model for a gravure printing machine with registration error.

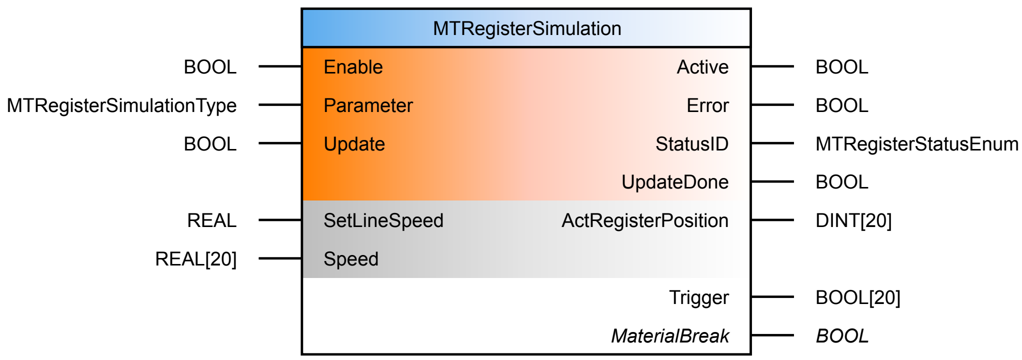


Figure 19: MTRegisterSimulation - Interface description

5.3.2 Exercise: MTRegisterSimulation

Analyzing the simulation model

1) *Create a new Automation Studio project.*

   Use ARsim as your target system. Add the MTRegister library.

2) *Add the simulation model.*

   Add a new task to the project with the MTRegisterSimulation function block. Use the sample code from the Automation Studio help system.

3) *Use the MTBasicsLimiter function block to generate the line speed profile.*

   Create a new global variable named gSetLineSpeed. Enter acceleration and deceleration values and generate a line speed. Connect the output of MTBasicsLimiter to the "Speed" inputs.

4) *Analyzing the simulation model*

   Create speed jumps at the input and trace the outputs. Analyze the behavior of the model. Test both modes "mtKEY_COLOR" and "mtSEQUENTIAL_COLOR".

5.3.3 MTRegisterDecoupling

This function block implements a decoupling network for gravure printing machinery.

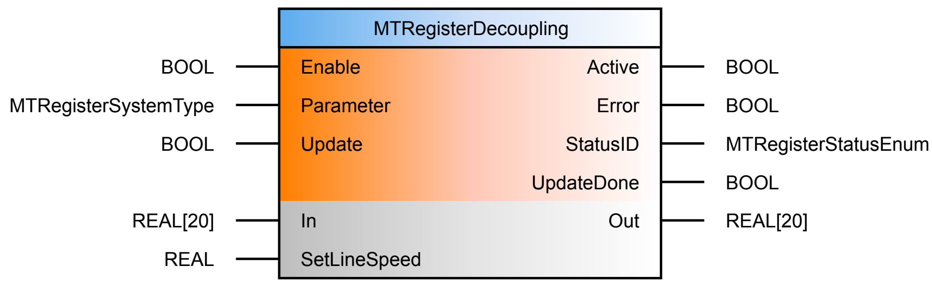


Figure 20: MTRegisterDecoupling - Interface description

5.3.4 Exercise: MTRegisterDecoupling

Analyzing the decoupling network

1) *Add the decoupling network "MTRegisterDecoupling".*

   Add a new task with the "MTRegisterDecoupling" function block.

2) *Analyze the input/output behavior.*

   Create jumps on the inputs and analyze the outputs using Watch and Trace. Test both modes "mtKEY_COLOR" and "mtSEQUENTIAL_COLOR".

3) *Connect the simulation model.*

   Do this using the PV mapping concept.

4) *Test the decoupling.*

Create speed jumps in the decoupling network and analyze the outputs of the simulation model using Trace.

5.3.5 MTRegisterController

This function block implements a PID controller to provide registration control for gravure printing machinery.

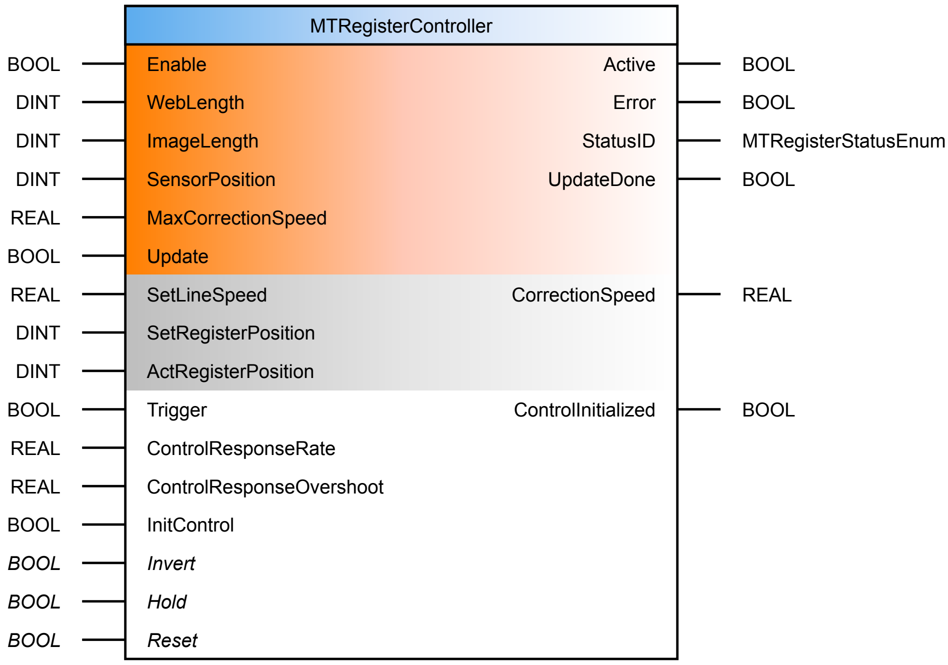


Figure 21: MTRegisterController - Interface description

5.3.6 Exercise: MTRegisterController

Analyzing the control loop

1) *Add the controller "MTRegisterController".*

Add a new task for the MTRegisterController.

2) *Connect to the decoupling network.*

Do this using PV mapping.

3) *Test the closed control loop.*

Perform setpoint step-changes on the closed control loop and analyze the behavior.

Change the controller's "ControlResponseRate" and "ControlResponseOvershoot" parameters and analyze the behavior again.

6 Registration mark detection

Registration marks are used for various purposes such as verifying the color, positioning and quality of a printed product. Each printing unit creates marks on the edge of the substrate in its respective color. A key requirement for high-quality registration control is reliable detection of registration marks.

6.1 Types of registration marks

The following figure shows some common types of registration marks. A key difference between them is whether or not they allow both the longitudinal and side registration to be measured in a single reading. Block marks only allow the longitudinal registration to be measured. Arrow marks, double-arrow marks and dot marks allow measurement of both the longitudinal and side registration.

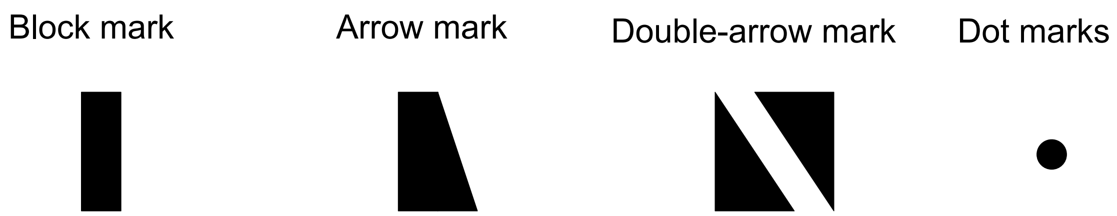


Figure 22: Common types of registration marks

6.2 B&R solutions for registration mark detection

	X20DS4389 module + digital contrast sensor	**X67BC8591 module + analog contrast sensor**	**SICK RS25 optical contrast sensor**
			
Functions	Longitudinal registration Cutoff registration	Longitudinal/side registration Cutoff registration	Longitudinal/side registration Cutoff registration "End of Press" measurement
Measurement methods	Mark to cylinder	Mark to cylinder Mark to mark	Mark to cylinder Mark to mark
Types of registration marks	Single marks	Key code Single marks Double marks	Key code Single marks Double marks
Area of application	1D registration marks	2D registration marks	2D registration marks
Line speed	up to 250 m/min	up to 600 m/min	up to 1000 m/min
Precision	+/- 30 µm	+/- 30 µm	+/- 20 µm
Suitable for use in potentially explosive environments	No	No	Yes

7 Summary

Automation Studio and the range of B&R hardware products offer comprehensive functionality for implementing closed loop controls for printing machinery. Many different types of printing machines can be implemented using standard motion control libraries.

Some machines, particularly those that have nips, require more complex control strategies to ensure the desired level of product quality. For these cases, there are special mechatronic libraries for certain types of printing machines.

The solutions presented here can easily be implemented on a PLC in place of costly external controllers.

In order to successfully implement control solutions for printing applications, it is important to have a good understanding of motion control in general. This topic is covered extensively in the respective training modules (TM400 and TM460).

The solution samples provided offer a quick and easy starting point for developing an application. They contain the logic, a configuration and a visualization application, as well as the necessary application code.

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SEM540 – Safe motion control***

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TM246 – Structured Text (ST)
TM250 – Memory Management and Data Storage

TM400 – Introduction to Motion Control
TM410 – Working with Integrated Motion Control
TM440 – Motion Control: Basic Functions
TM441 – Motion Control: Multi-axis Functions
TM1110 – Integrated Motion Control (Axis Groups)
TM1111 – Integrated Motion Control (Path Controlled Movements)
TM450 – Motion Control Concept and Configuration
TM460 – Initial Commissioning of Motors

TM500 – Introduction to Integrated Safety
TM510 – Working with SafeDESIGNER
TM540 – Integrated Safe Motion Control

TM600 – Introduction to Visualization
TM610 – Working with Integrated Visualization
TM630 – Visualization Programming Guide
TM640 – Alarm System, Trends and Diagnostics
TM670 – Advanced Visual Components

TM920 – Diagnostics and service
TM923 – Diagnostics and Service with Automation Studio
TM950 – POWERLINK Configuration and Diagnostics

TM261 – Closed-loop Control with LOOPCONR
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* SEM210 - Basics is a prerequisite for this seminar.
** SEM410 - Integrated motion control is a prerequisite for this seminar.
*** SEM410 - Integrated motion control and SEM510 - Integrated safety technology are prerequisites for this seminar.
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