Bosch Rexroth Register Control

Integrated register control solution for maximum precision in printing

Sales Information

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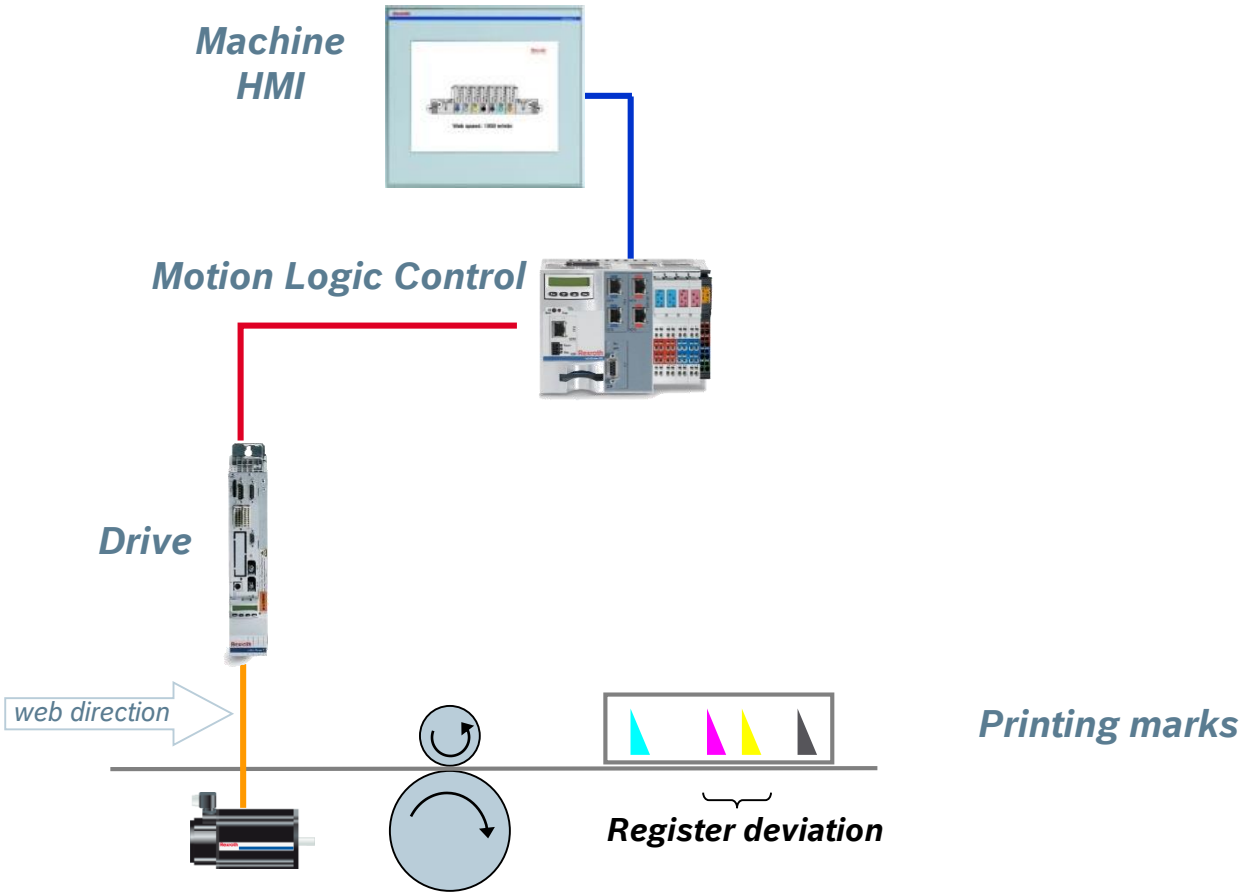
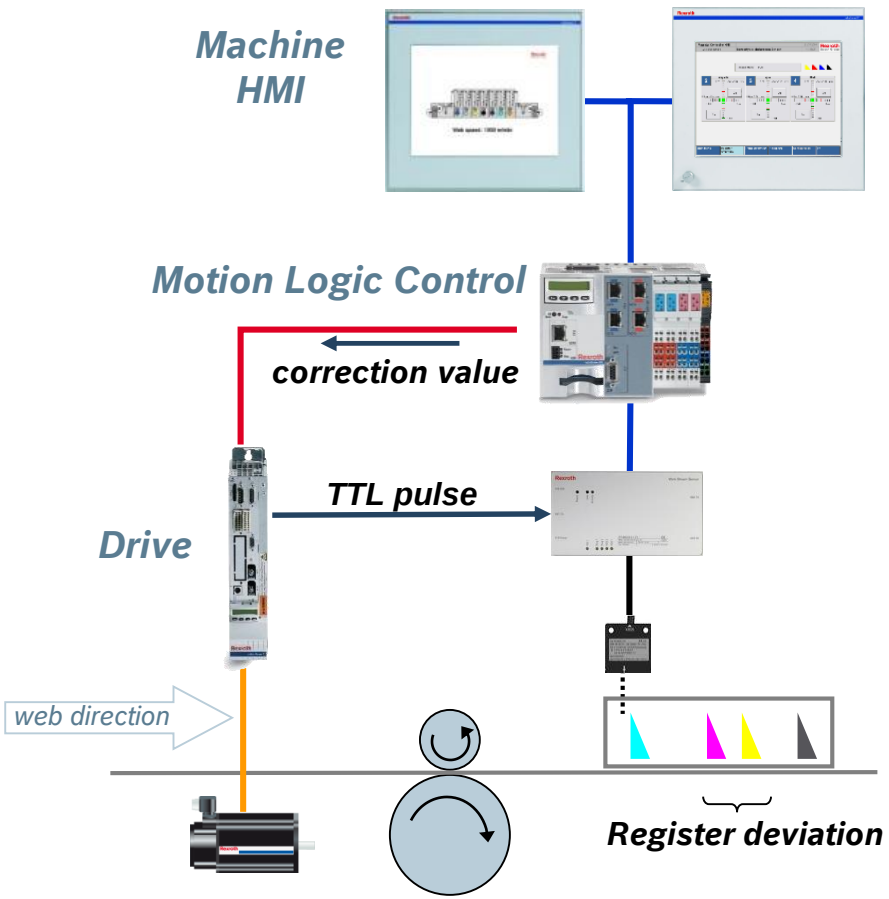
Principle – Axis Handling



Visualisation



Register control HMI
- *Ready made register control visualisation*

Ready made register control program
- *Sensor communication*
- *Calculation of register correction*

Sensor system
- *Electronic box*
- *Optical sensor head*

Printing marks

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Sensor system

Sensor electronic box

Fibre optic cable

Sensor optic

- Optical color sensor with highest scanning ability even on low contrast colors
- Auto-adjust of the sensitivity level
- Ambient light compensation
- Easy to integrate via Ethernet
- Also for explosion hazardous areas (ATEX certification)
- High temperature range sensor optic (up to 130°C / 265 °F)

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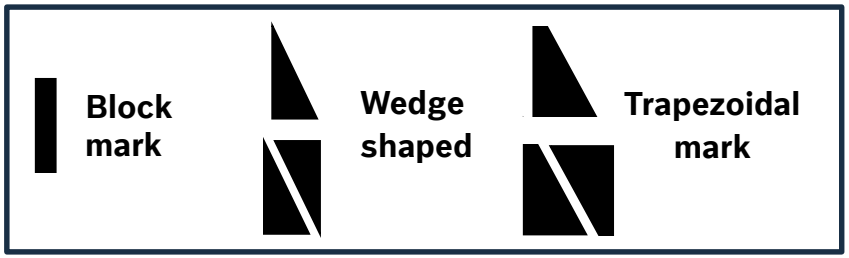
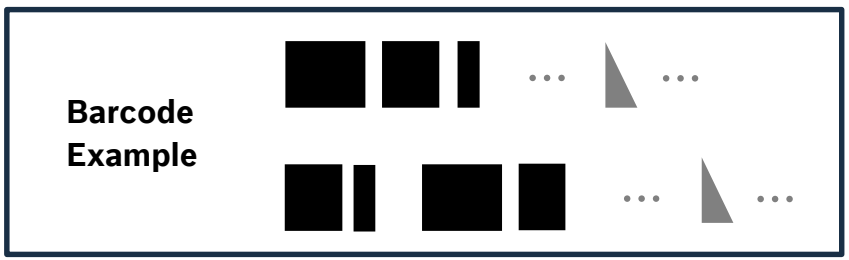
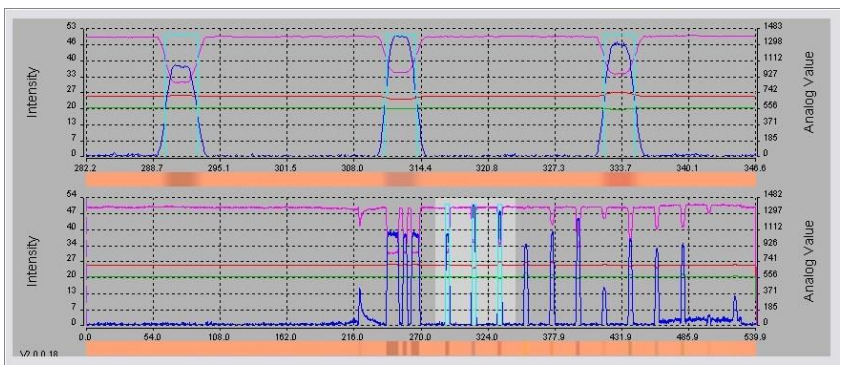
Basic features – Sensor system







- Mark shapes
  - Block mark
  - Wedge mark (single/double)
  - Trapezoidal mark (single/double)
- Barcode identification

  free definition of
  - block number
  - Block size
- Signal evaluation
  - Colour/contrast weighting
  - Auto adjust during Teach-in
- Markstream
  - Manual with oscilloscope function
  - Automatic with barcode detection

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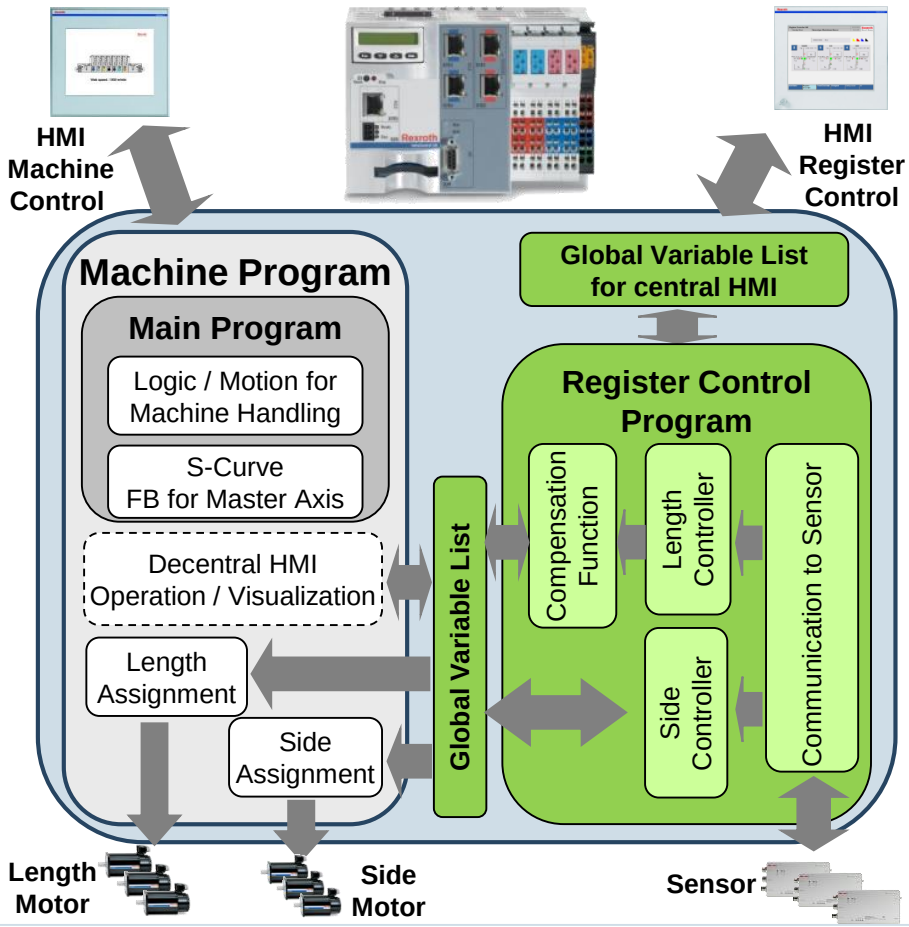
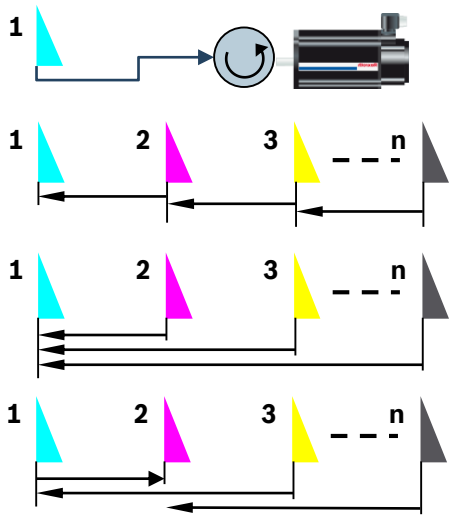
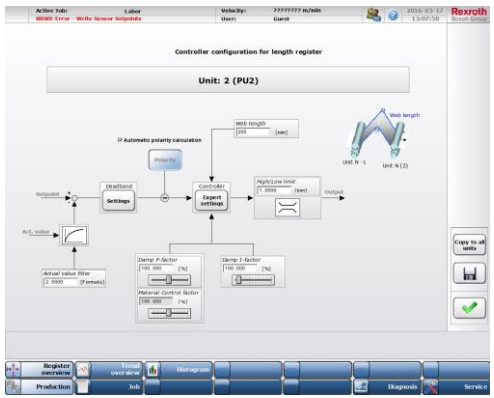
Motion Logic Control Overview



- Ready made register control program for fast /easy integration including:
  - Fixed interface to Register Control HMI
  - Communication to sensor system
  - Length control
  - Compensation functions
  - Interface to customer program
  - Side control
- Process improvement for customer program
  - optional FBs (S-Curve)
  - Decentral handling

Control - Basic features





- Length Register
  - Mark-Cylinder control
  - Mark-Mark control
    - Following Colour
    - Reference Colour
    - Freely configurable
- Side Register
  - Mark-Mark control
  - Different kind of actors possible
    - Position motors (adjust command position)
    - Stepper motors (adjust pos/neg-command)
- Format correction
  Insetting of preprinted material
- Automatic Control Settings
  - Dynamic calculation of PI loop settings
    (depending on speed, printing process, web length, ...)
  - Loop polarity definition depending on mark stream configuration

Ready made register control visualisations

- Main operation HMI
  - Relevant information at a glance
  - Intuitive operation
  - Online diagnosis
- Simple commissioning
  - Machine configuration dialogs
  - Job setting wizard
  - Job management
- Oscilloscope functionality
- User management
- Optional decentralized HMIs

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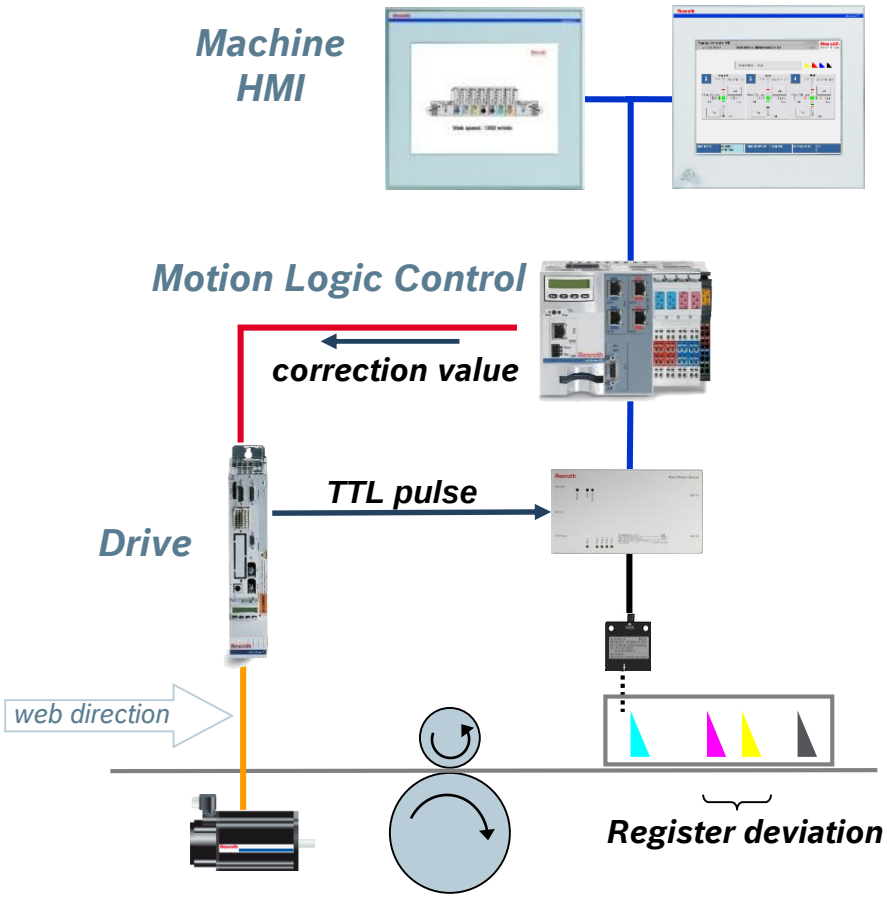
Principle - Visualisation



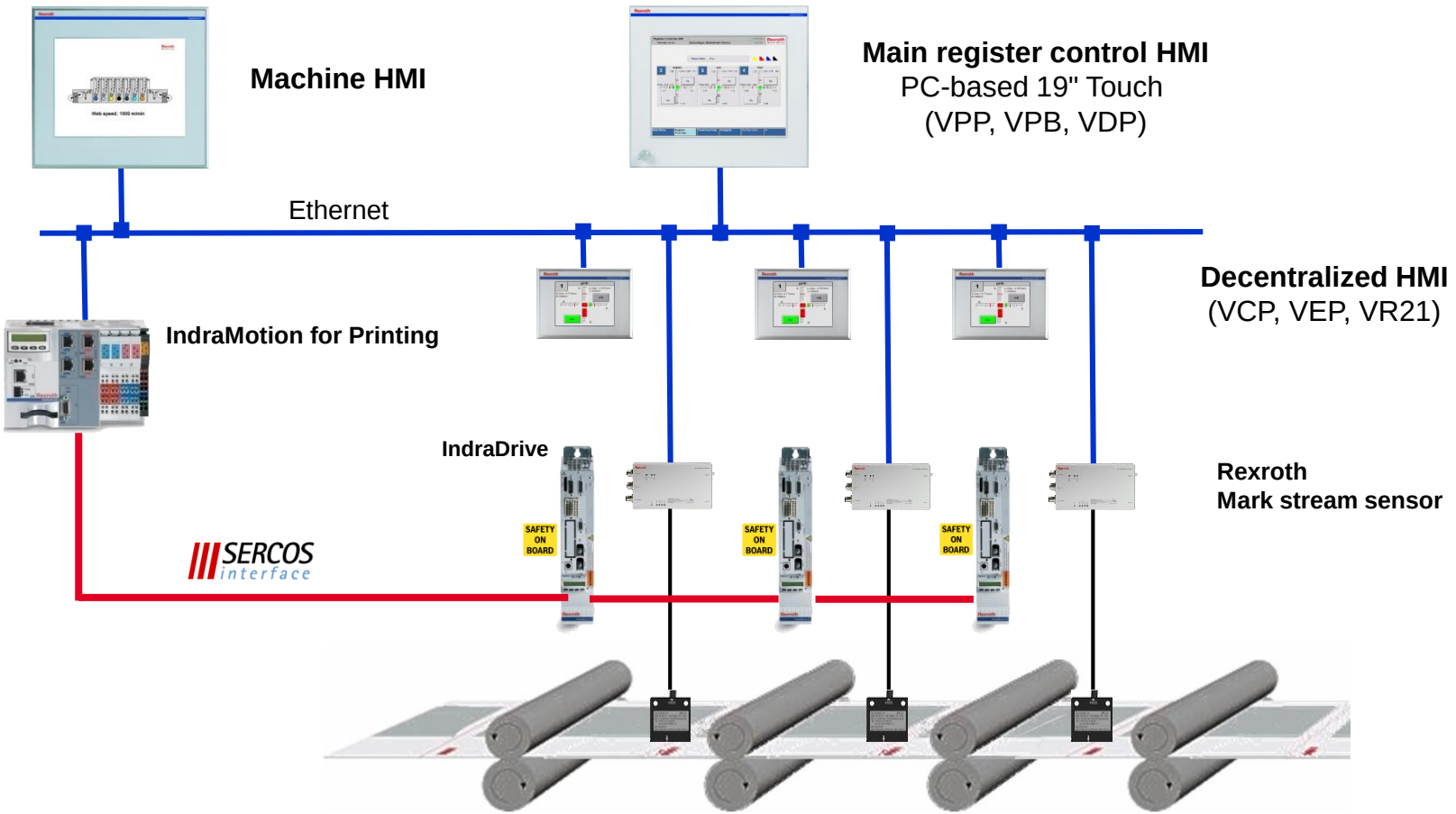
Register control HMI
- *Ready made register control visualisation*

Ready made register control program
- *Sensor communication*
- *Calculation of register correction*

Sensor system
- *Electronic box*
- *Optical sensor head*

Printing marks

General Automation Structure



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Summary

Sensor System

Max. web speed	1200 m/min (= 20m/s)
Sampling rate	250 kHz
Accuracy of measurement	<10 µm (with interpolation)
Format length	0,3 m – 1,5 m
Number of printing marks	Max. 12
Printing mark types	▪ Block mark ▪ Wedge-shaped (single/double) ▪ Trapezoidal mark (single/double) ▪ Barcode (i.e. as start code)
Printing mark detection	▪ Manually with oscilloscope function ▪ Automatically with barcode – within the printing layout ▪ Automatically when only marks are printed
Printing substrate	▪ Paper ▪ Plastic film (BOPP, PET, LDPE, …) transparent / non transparent ▪ Tinfoil ▪ Cardboard ▪ Compound ▪ Laminate
Interfaces	▪ Power supply 24 V ▪ Ethernet ▪ Encoder signals ▪ Optical interface

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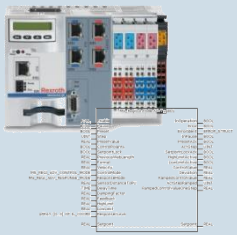
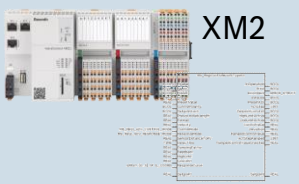
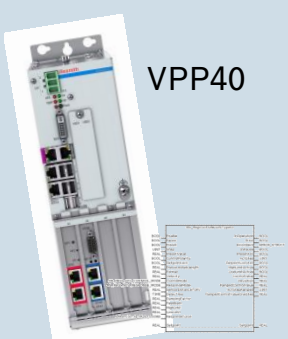
Register Control Program



XM2



VPP40



Software Package	RegisterControl Library and ready-made PLC-program • For 12 units • For 24 untis
Controller Hardware	IndraMotion MLC CML45/65/75 XM02 VPP40
Operation mode	▪ Mark – Mark (web to web) ▪ Mark – Pulse (web to cylinder)
Controller functions	▪ Longitudinal register ▪ Reference Color Control ▪ Previous Color Control ▪ Automatic calculation of loop settings depending on - webspeed - printing process - physical machine parameters ▪ Side register ▪ Insetting for preprinted material (format correction) ▪ face and back printing
Advanced Controller functions	▪ Auto pre-register ▪ Decoupling network ▪ Acceleration feedforward

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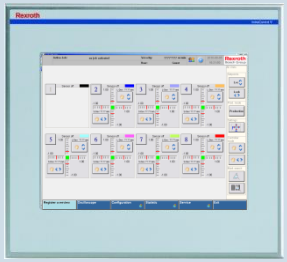
Visualisation



Engineering	WinStudio based operator interface
Display and control panel	▪ IndraControl VR (Controller-based) ▪ IndraControl VEP (Embedded-PC-based) ▪ IndraControl VSx (Industrial PC-based)
Centralized	▪ Panel-PC 19" Touch (VPP60.3) ▪ Cabinet PC (VPB40.3) ▪ Operator display 19" Touch (VDP60.3)
Decentralized (Optional)	▪ Controller based terminal 3.5" Touch (VR 21) ▪ Embedded operator panel 12" Toch (VEP40.4)
Functions	▪ Register status and -adjustment ▪ Production parameter settings ▪ Job management ▪ User management ▪ Commissioning dialogs ▪ Machine configuration ▪ Sensor diagnostics ▪ Oscilloscope functionality ▪ Statistics (trend display and histogram) ▪ Log book ▪ Archive

Benefits of Integrated Solution

No additional hardware control devices

Realization of customer specific solutions

Fast and easy interface between machine control and register control

Modern machine operation concept for diagnosis and machine handling

Higher control dynamic because of fast data exchange

New efficient register control algorithms based on intelligent motion control technology

Increased control performance due to higher internal resolution

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References from customer machine

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Automation Examples

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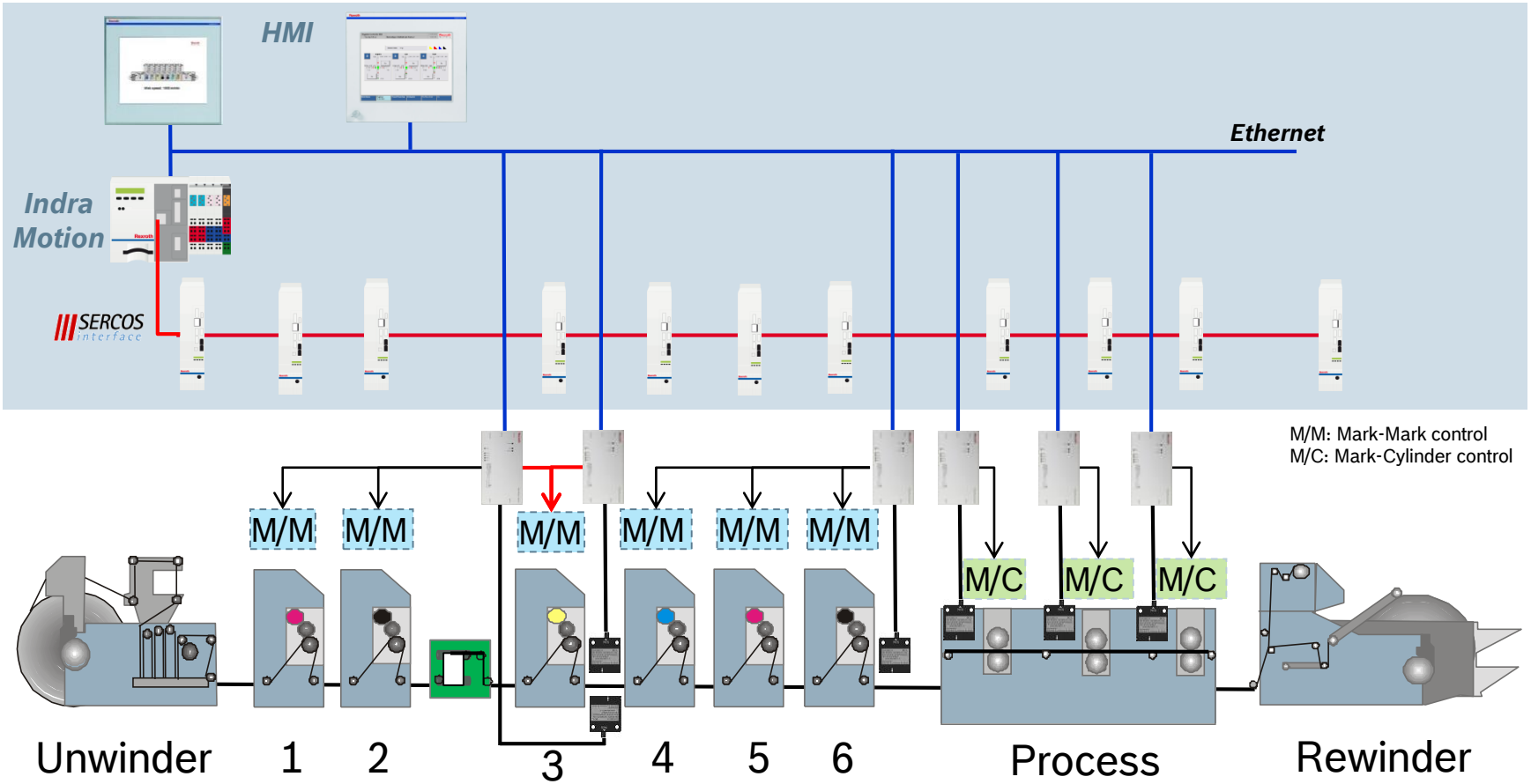
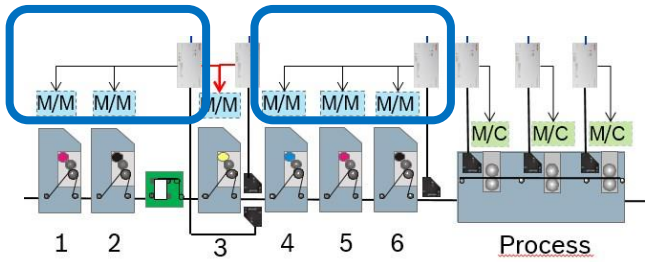
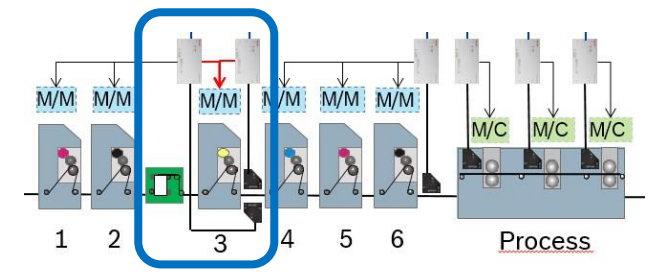
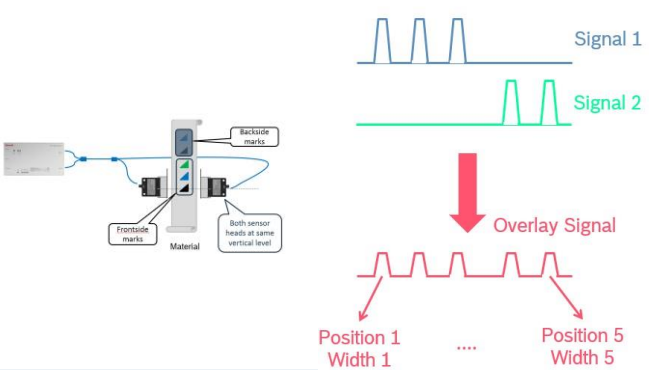
Narrow Web Overview



Narrow Web: Special register control functions







- Control several units with marks from one sensor
- Front- / backside control
  - Evaluation of two sensor systems
  - Two sensor heads connected at one sensor box
- Freely configurable reference unit

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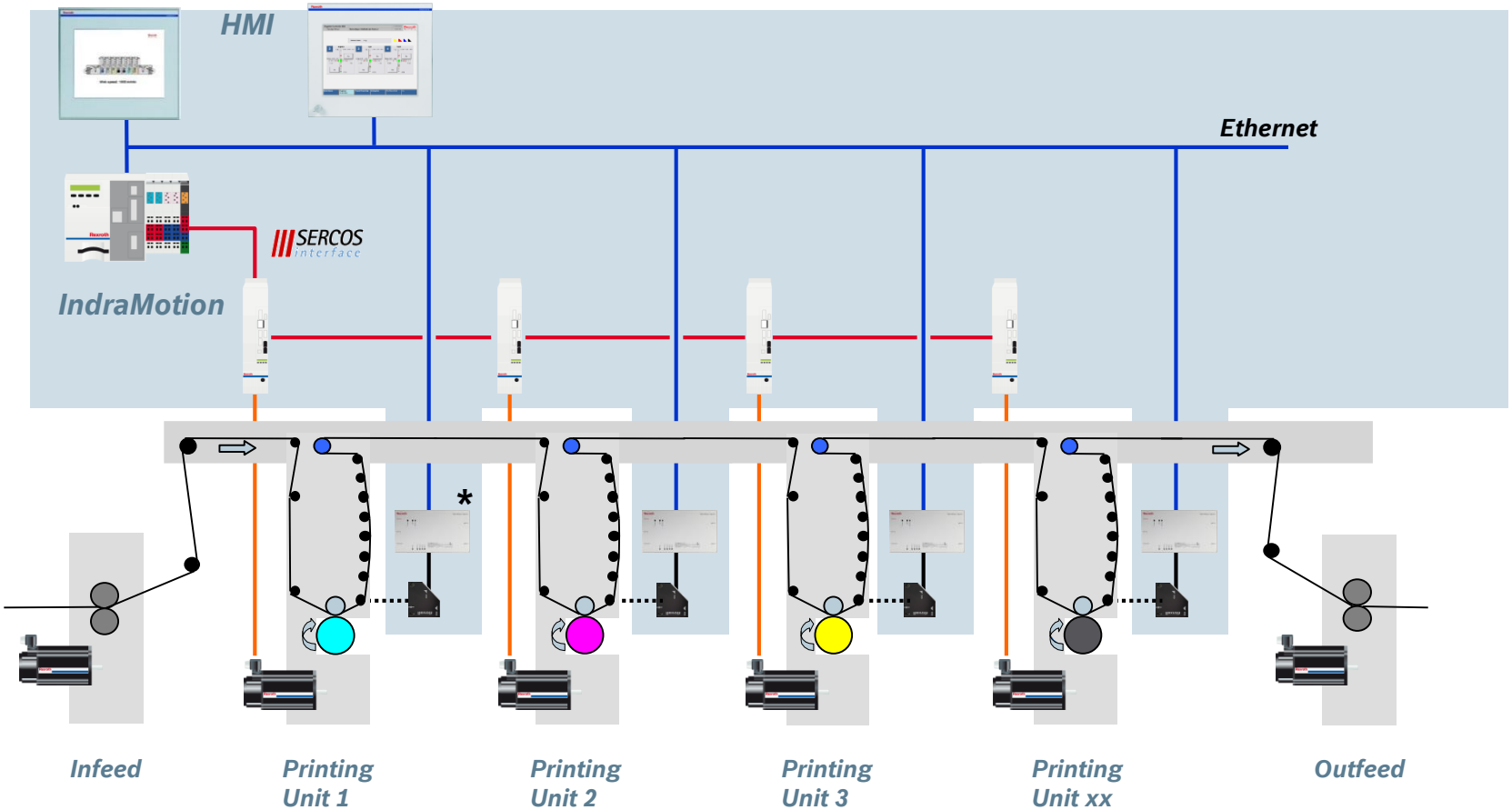
Rotogravure Press Overview



* sensor at PU1 optional - only for pre-printed material necessary

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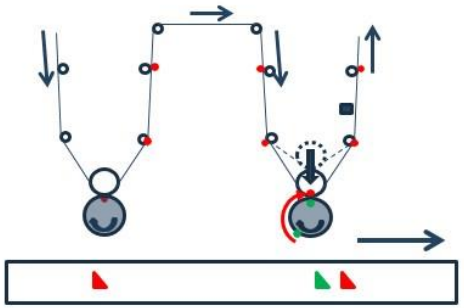
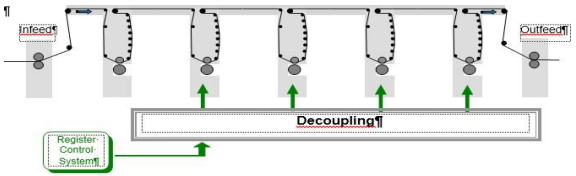
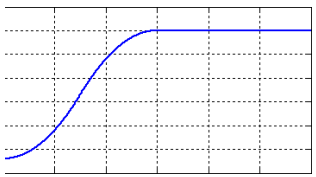
Rotogravure: Special register control functions

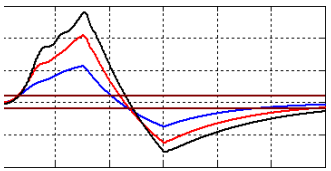




Acceleration



Register error



- Position pre-register

  Define phase offest before print ON, to start at nearly the correct register position.
  - Manual presetting of old saved value
  - Manual presetting of calculated values from machine program
  - Automatic Pre Register (APR)

- Rotogravure decoupling network
  - Cascading strategy to avoid interaction between different print units, caused by cylinder movements.

- Acceleration compensation
  - Reduce register error during acc/deceleration, caused by the inertia of the non driven rollers between the print cylinders

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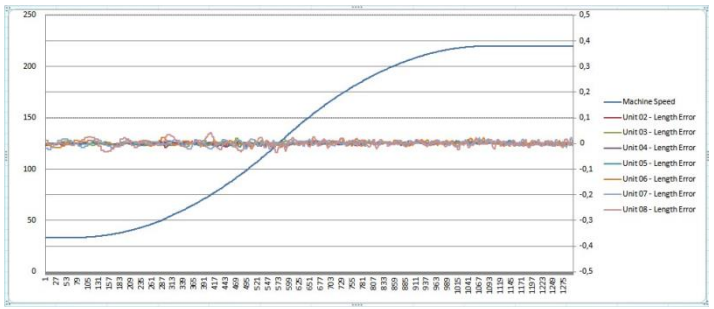
Customer example: 8 PU rotogravure machine

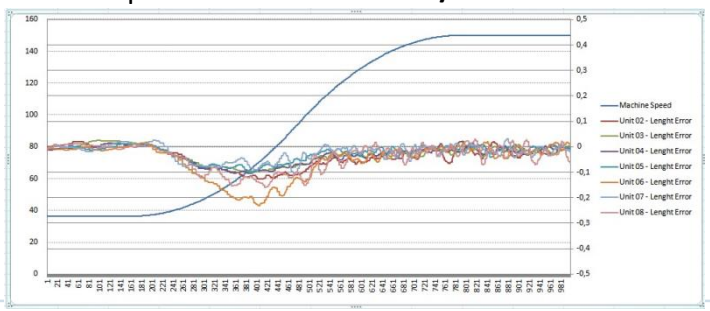
PET (8 Units)

constant speed	**< +/-0.05mm**
acceleration phase	**< +/-0.05mm**



PE 45µm (8 Units)

constant speed	**< +/-0.05mm**
acceleration phase	**< +/-0.2 mm**
Splice	**< +/-0.2mm**



- Rotogravure decoupling network
- Acceleration compensation
- same settings for PET + PE
- Unit 8 last unit -> long material way to outfeed -> higher deviation
- AccTime: 0-250m/min in 180sec
- Following mark control strategy
- Without cooling cylinder

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Advanced register control functions
Detailed description

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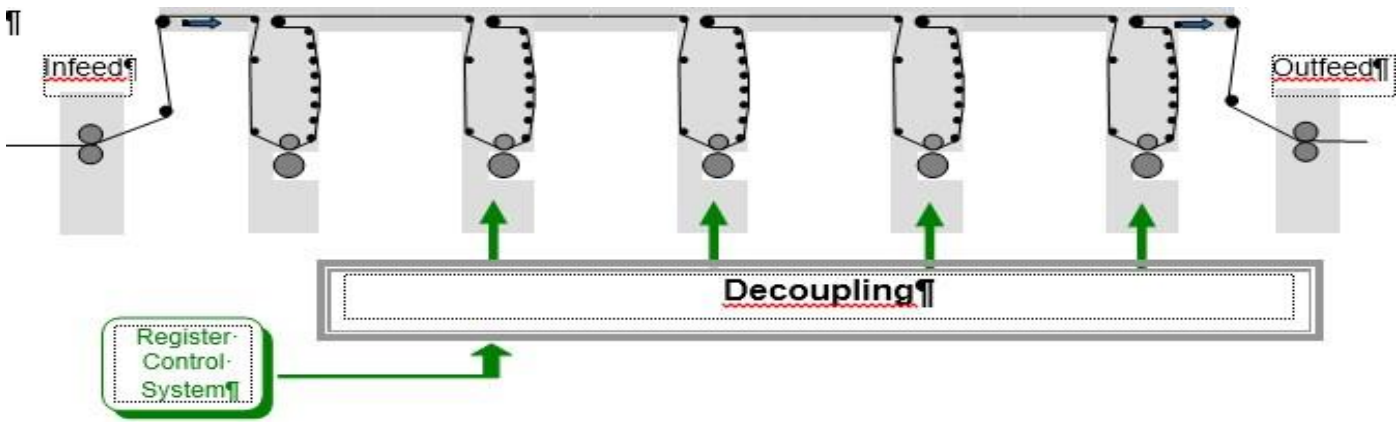
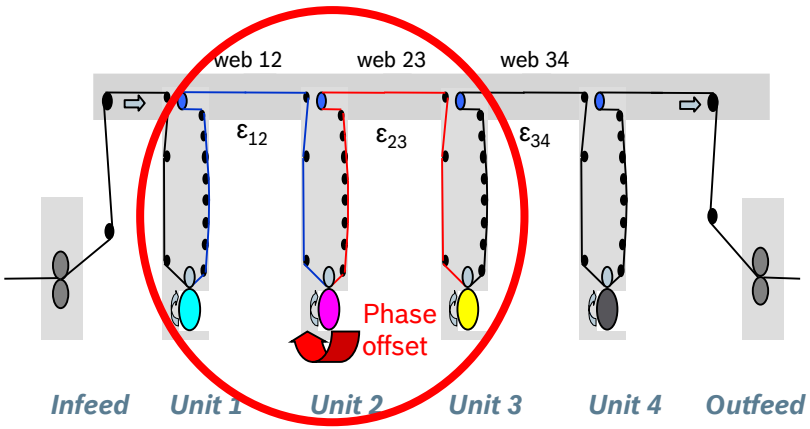
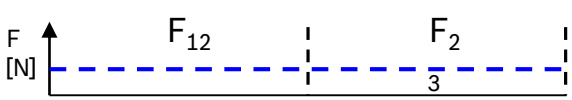
Rotogravure decoupling network

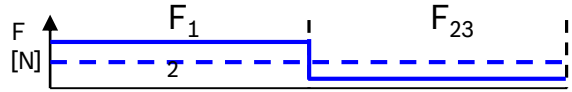


Decoupling network - Details





stationary state (prior to phase adjustment):



state directly after phase adjustment:

stationary state (after phase adjustment):

- Rotogravure machine process
  - Print cylinder like nip
  - Cylinder adjustment pull material back / forward
- Effect to material
  - Changed web tension in front / behind print cylinder
  - With balancing of the web tension the colour register is changed
- Problem
  - Slow reaction of register changing
  - Interaction to following print units
- Solution:
  - Dynamic compensation algorithm

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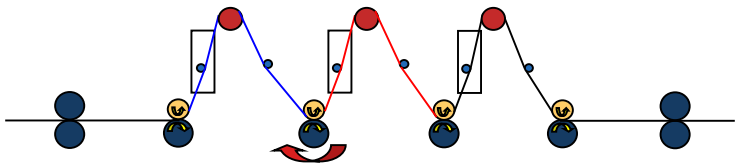
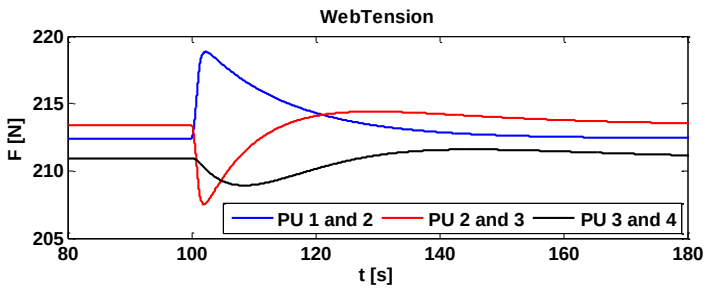
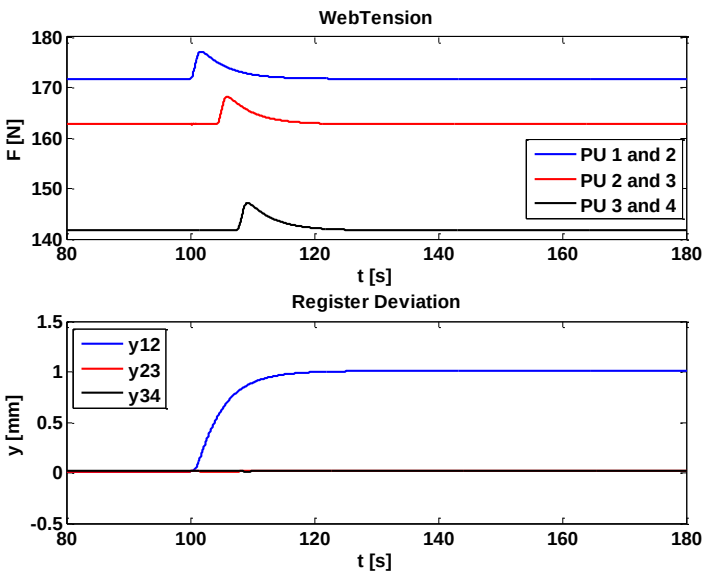
Bosch Rexroth decoupling compensation



Without compensation algorithm



With Bosch Rexroth compensation



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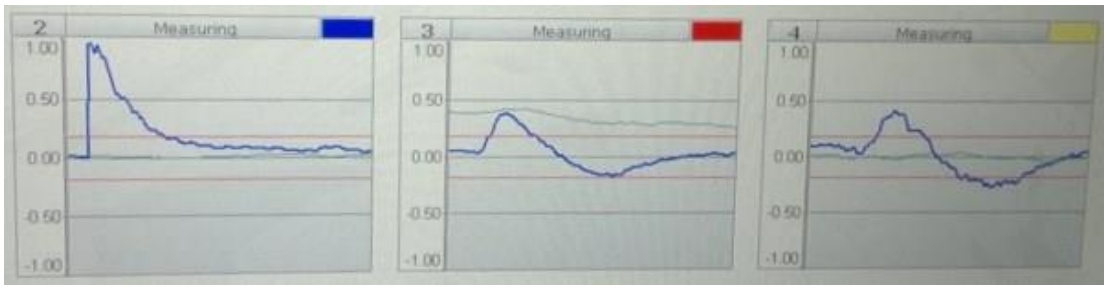
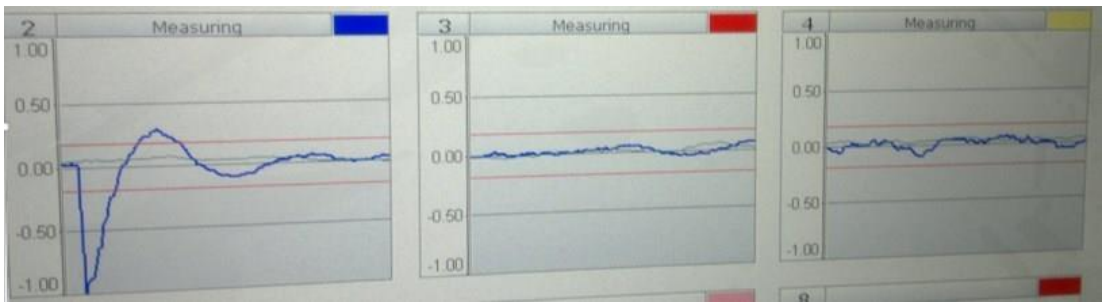
Decoupling effect at customer machine

- Machine speed = 30 m/min
- Register control ON
- Setpoint jump PU 2 of 1mm



Without compensation algorithm



With Bosch Rexroth compensation

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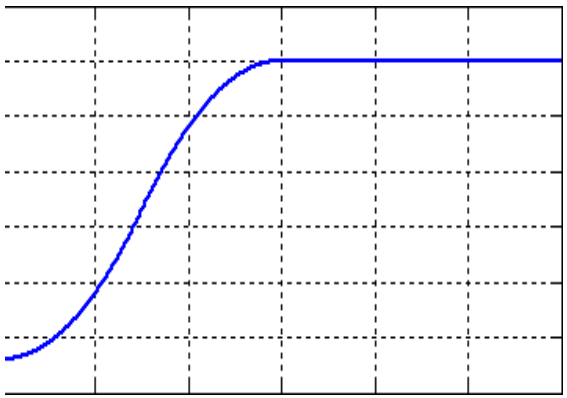
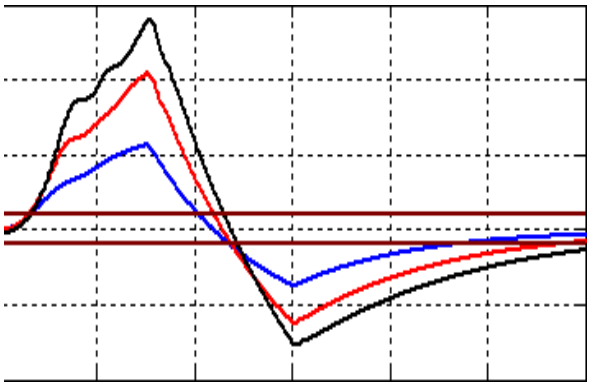
Acceleration compensation - Details

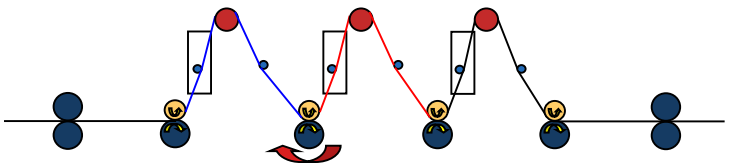
Acceleration

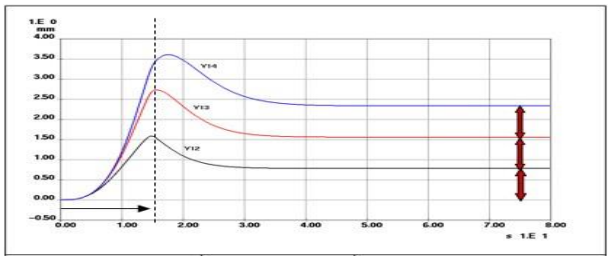


Register error

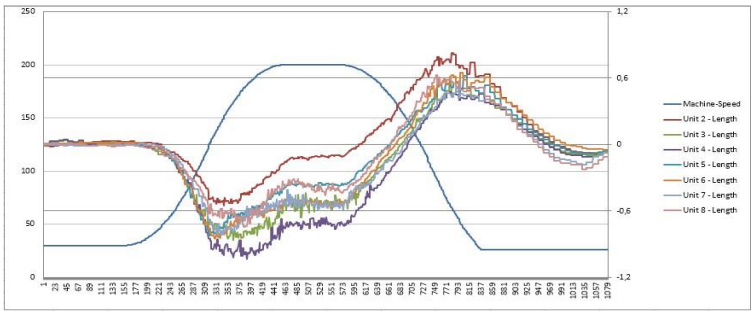


Acceleration compensation - Background





Simulation Acceleration Error



Register Error – 8 PU Machine – Material PE

- Situation at the machine
  - During acceleration shift of the print register
- Two kind of register error
  - Velocity error
  - Acceleration error
- Register error depends on
  - Length of material
  - Elasticity of material
  - Inertia of non-driven roller
  - Friction of non driven roller
  - Material effect of dryer
  - ....

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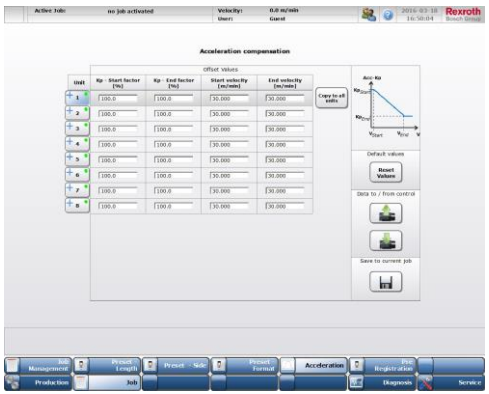
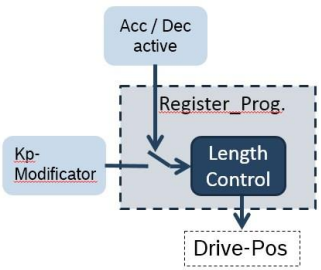
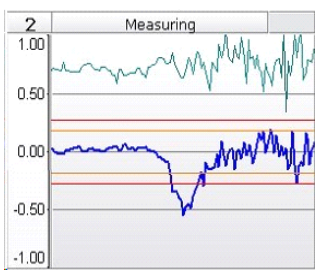
Acceleration compensation - Realization



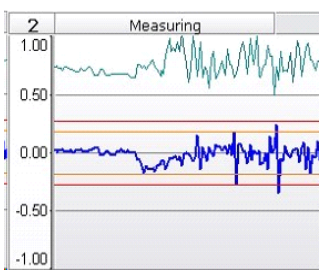


- Register control ON during acc-/ deceleration
  - Reducing of register error
  - Still deviation is too high (especially with PE material)
- Modification of control loop during acceleration
- Speed adaption to avoid instable control at higher speed
- Further reducing of register error

Laboratory test acceleration error

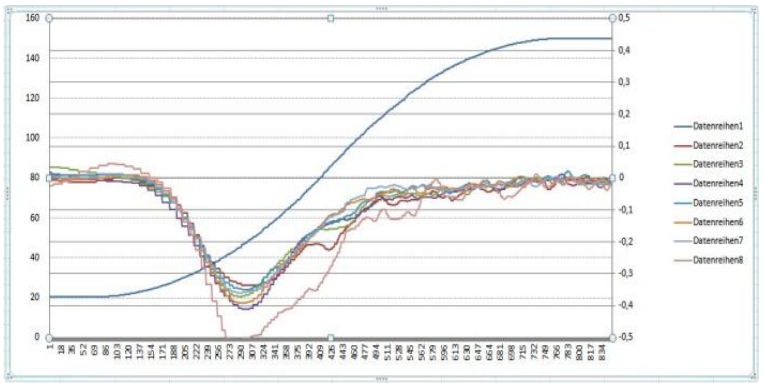


Laboratory test acceleration compensation

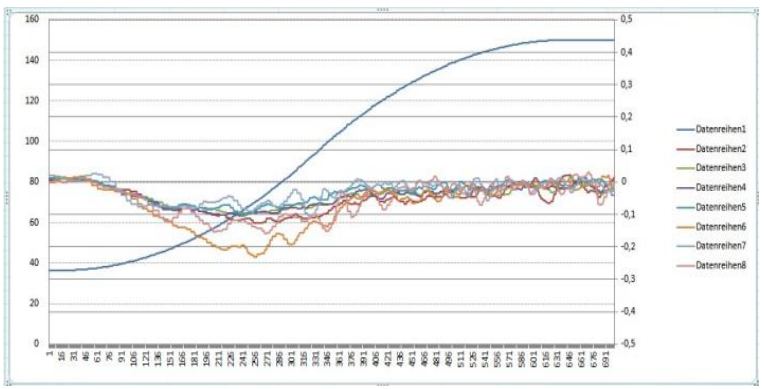


Effect acceleration compensation

No acceleration compensation



With acceleration compensation



- 8 print units
- Long material way unit 8 to outfeed -> higher deviation

- Acceleration with S-curve
- Acc time: 100m/min in 60sec

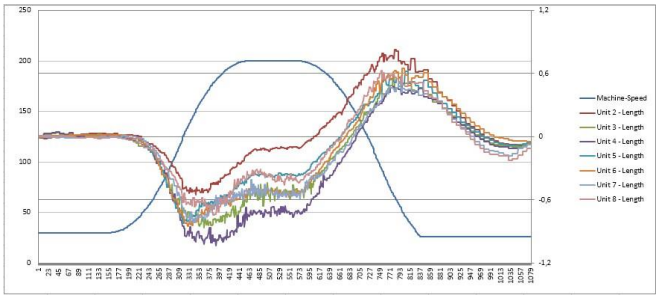
- Control ON
- Following mark strategy

- PE (45µm)

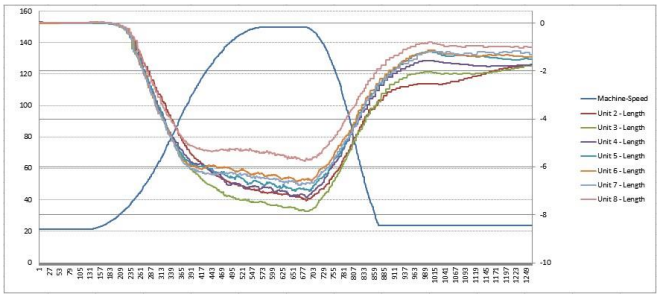
Rexroth
Bosch Group

Acceleration compensation at customer machine

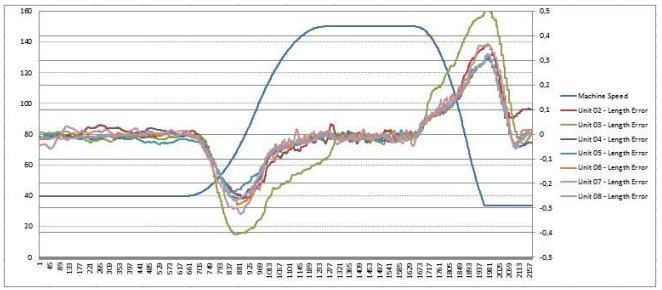
PET



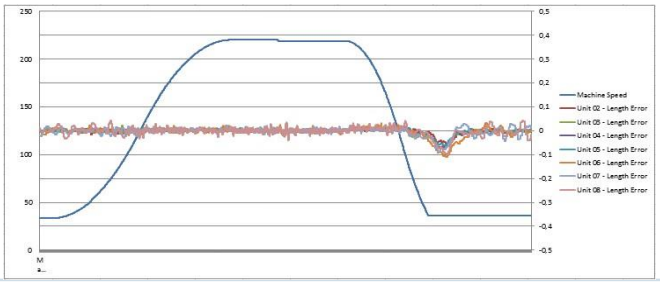
PE

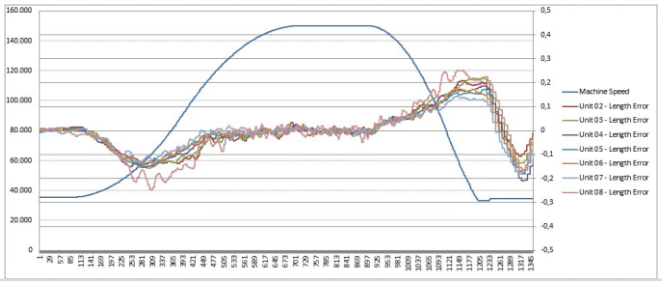


No control
No compensation



Control ON
No compensation

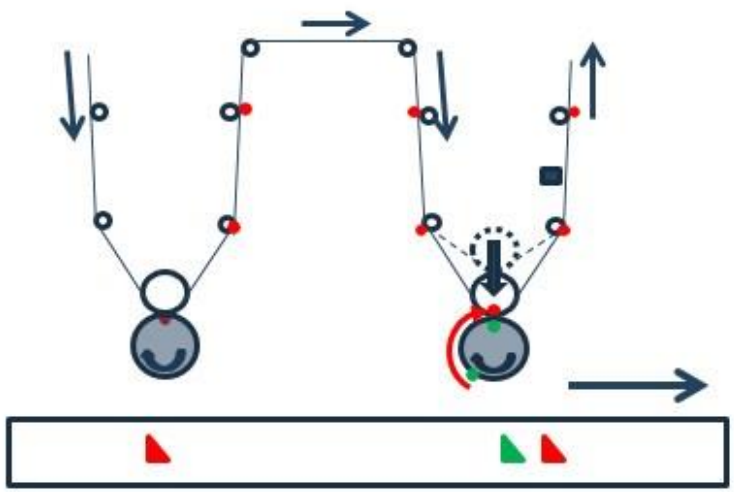




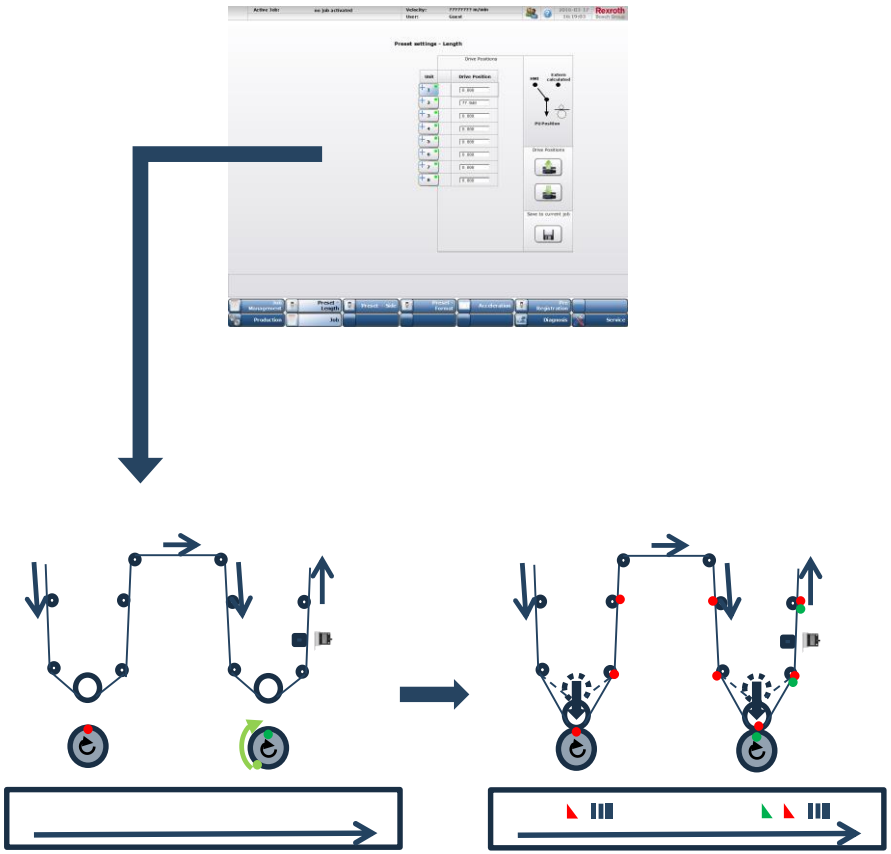
Control ON
Compensation ON

Rexroth
Bosch Group

Position pre-register

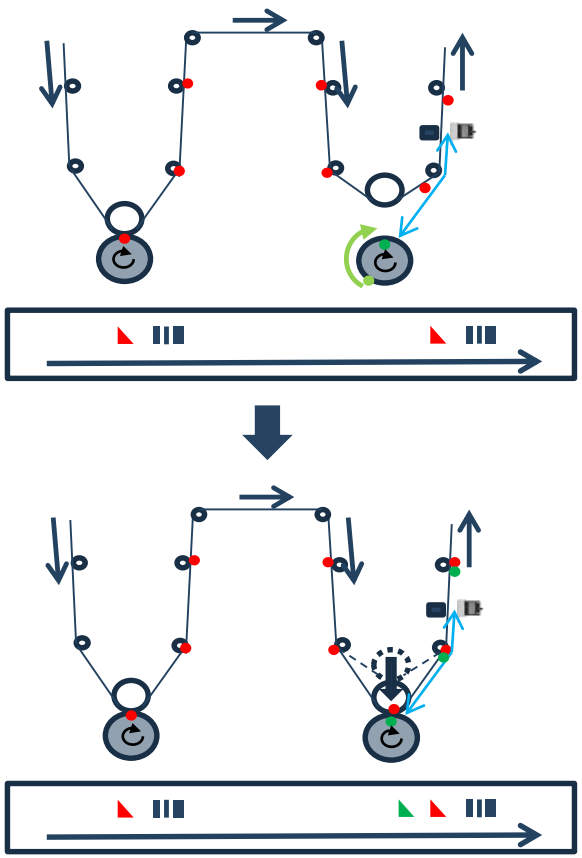


Manual pre-register – Details



- Positon offset value of a previous production are saved e.g. at register HMI.
- At the same or similar (identical format / material) production saved values can be loaded again
- Units start at correct print positions
- Optional position offsets can be calculated by machine program

Auto pre-register (APR) – Details



Automatically calculated print position

- Procedure:
  - First unit starts print of mark + barcode
  - Other units check the position of the barcode - coming to the sensor
  - Depending on the mech. dimension of the print unit, correct phase offset position is calculated and adjusted.
  - After offset adjustment -> Print On
  - The print starts immediately at the correct place

End