ASRM – Energy-efficient and power optimized motion profiles
Inspiring change in intralogistics
ASRM – value added topics

- Speed synchronism & Load distribution
  - Minimizing slippage and …
  - … maximizing acceleration

- Oscillation damping
  - Reduced mechanical stress and …
  - … increased throughput

- Safety
  - Optimization of the plant through …
  - … flexible safety concepts at all levels

- Bufferless storage
  - Through omission of mechanical buffers …
  - … more room, reduced costs

- Energy storage
  - Energy storage at the DC link …
  - … reduces size and costs for the electrical periphery

- Optimized motion profiles
  - Adaption of starting time or dynamic parameters …
  - … will help to reduce the required energy and the power peaks.
Agenda

• Introduction  3
• Strategies for optimizing  11
• Limitation of connection power  30
• Function block architecture  36
• Additional functions  40
Energy-efficient and power optimized motion profiles

Overview

Energy/power saving with optimized moving profiles

• Analysis of chassis (X) and hoist movement (Y)
• Time-critical movement will not be adapted -> performance is not reduced!
• Adaption of the non critical movement, e.g.:
  • Delayed start of the movement
  • Reduced acceleration and/or deceleration
  • Reduced positioning speed
• Software decides about the most effective measure regarding energy and power consumption
• Power peaks can be reduced up to 20% (depending on the specific machine)
• Additional potential for reduction by reducing the performance only for a small number of positions (e.g. 5%).

Energy-efficient and power optimized motion profiles

Concept

The LHD will only be in movement if chassis and hoist is in standstill. Compared with the hoist and the chassis the needed energy and power is low. Due to that this drive(s) are not taken into account for the optimization strategy.

The hoist drive lifts and lowers the load handling device (LHD) incl. Payload (Y axis)

The chassis drive moves the ASRM on the rail within the aisle (X axis)

Methods to reduce the power peaks and to increase the energy efficiency:

1. Energy-efficient and power optimized motion profiles
2. Limitation of maximum electrical connection power
3. Brake management for hoist drive
4. Energy saving mode
5. Asymmetrical acceleration/deceleration
Chassis unit
Kinetic energy and active power

Example: Traveling distance = 15m
Hoisting unit - Lifting
Kinetic energy and active power

Example: Height =15m

Deceleration

Constant movement

Acceleration

Lifting process – share of energy:

- Potential energy (depending on the height)
- Kinetic energy (during movement)
Hoisting unit - Lowering
Kinetic energy and active power

Example: Height = 15m

Lowering process – share of energy:
• Potential energy (depending on the height)
• Kinetic energy (during movement)
• Introduction 2
• Strategies for optimizing 11
• Limitation of connection power 30
• Function block architecture 36
• Additional functions 40
Shelf geometry
What movement is typically time-critical?

<table>
<thead>
<tr>
<th>Share of stockyard (inside the shelf)</th>
<th>white</th>
<th>red</th>
<th>grey</th>
</tr>
</thead>
<tbody>
<tr>
<td>30%</td>
<td></td>
<td>5%</td>
<td>65%</td>
</tr>
</tbody>
</table>

**Time-critical axis** (movement of this axis defines total positioning time)
- Hoisting unit
- Hoist and chassis
- Chassis

**Non-critical axis**: (movement of this axis takes less time)
- Chassis
- Hoisting unit
Goals and optimization strategies

1. **Avoid peak power**
   - Higher losses in areas with maximum active power
   - More costs for higher infeed power

2. **Use regenerative energy**
   - System is not always able to infeed regenerative energy back to the grid
     (for example: basic line module)
   - Improvement of the energy effectivity for the complete warehouse

3. **Prevent mechanics from damage**
   - Reduce wear and tear

Comparison of two different optimization strategies with the shown positioning task.

Chosen positioning task is 15 meters in X direction and 5 meters in Y direction
Initial state (before optimization)

Velocity and power

Simulation of mechanical power with no optimization.

- Axis start synchronous with their maximum dynamic parameters.
- Motoric power peaks overlay due to the acceleration of both axes.
Initial state (before optimization)

Electrical energy

Energy

\[ W = \int_{t_0}^{t_1} P(t) \cdot dt \]

Total electrical energy:
Diagram of total electrical energy including regenerative feedback

Absorbed energy:
Energy that is taken from the grid without regenerative feedback
Feedback to the grid is typically not paid by the energy provider
Optimization strategy 1 – Adapting dynamic parameters

Velocity and active power

Adapting the dynamic parameters:

- Speed or acceleration / deceleration of non time critical axis are reduced. Both axis reach the target position at the same time.
- Hoist: Reduction of the speed (see example)
- Chassis: Decrement of acceleration and deceleration

Compared with initial state the power peak is reduced by approx. 10% due to optimization.

45kW instead of 50kW at the same performance
Optimization strategy 1 – Adapting dynamic parameters

Electrical energy

**Energy**

\[ W = \int_{t_0}^{t_1} P(t) \cdot dt \]

Compared with the initial state the absorbed energy from the grid is reduced by approx. 14%.

60kWs instead of 70kWs at the same performance
Optimization strategy 2 – Adapting starting time
Velocity and active power

Adaption of starting time:

- Chassis is time critical:
  - A delay time before or after hoist movement avoids an overlap of the power peaks.
  - The chassis braking energy can be used for lifting
- Hoist is time critical -> Strategy 1 is used

Compared with the initial state the power peak is reduced by approx. 20%.
40kW instead of 50kW at the same performance
Optimization strategy 2 – Adapting starting time

Electrical energy

Energy

\[ W = \int_{t_0}^{t_1} P(t) \cdot dt \]

Compared with the initial state the absorbed energy from the grid is reduced by approx. 30%.

50kWs instead of 70kWs at the same performance.
## Comparison of strategies 1 and 2

<table>
<thead>
<tr>
<th></th>
<th>Initial state</th>
<th>Strategy 1 – Adapting dynamic parameters</th>
<th>Strategy 2 – Adapting starting time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motoric peak power [kW]</td>
<td>50</td>
<td>45</td>
<td>40</td>
</tr>
<tr>
<td>Savings in %</td>
<td>-</td>
<td>10 %</td>
<td>20 %</td>
</tr>
<tr>
<td>Energy absorbed [kWs]</td>
<td>70</td>
<td>60</td>
<td>50</td>
</tr>
<tr>
<td>Savings in %</td>
<td>-</td>
<td>14 %</td>
<td>30 %</td>
</tr>
</tbody>
</table>
Calculated power peaks for the entire shelf
Initial state

| Height [m] | 25.0 | 26.0 | 27.0 | 28.0 | 29.0 | 30.0 | 31.0 | 32.0 | 33.0 | 34.0 | 35.0 | 36.0 | 37.0 | 38.0 | 39.0 | 40.0 | 41.0 | 42.0 | 43.0 | 44.0 | 45.0 | 46.0 | 47.0 | 48.0 | 49.0 | 50.0 | 51.0 | 52.0 | 53.0 | 54.0 | 55.0 | 56.0 |
|------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| Width [m]  | 3.0  | 4.0  | 5.0  | 6.0  | 7.0  | 8.0  | 9.0  | 10.0 | 11.0 | 12.0 | 13.0 | 14.0 | 15.0 | 16.0 | 17.0 | 18.0 | 19.0 | 20.0 | 21.0 | 22.0 | 23.0 | 24.0 | 25.0 | 26.0 | 27.0 | 28.0 | 29.0 | 30.0 | 31.0 | 32.0 | 33.0 | 34.0 |
|            | < 49[kW] | 49[kW] ... 55[kW] | 55[kW] ... 59[kW] | > 59[kW] |

< 49[kW] | 49[kW] ... 55[kW] | 55[kW] ... 59[kW] | > 59[kW] |
Calculated power peaks for the entire shelf

Optimization strategy 1 – Adapting dynamic parameters

| Height [m] | 23.0 | 24.0 | 25.0 | 26.0 | 27.0 | 28.0 | 29.0 | 30.0 | 31.0 | 32.0 | 33.0 | 34.0 | 35.0 | 36.0 | 37.0 | 38.0 | 39.0 | 40.0 | 41.0 | 42.0 | 43.0 | 44.0 | 45.0 | 46.0 | 47.0 | 48.0 | 49.0 | 50.0 | 51.0 | 52.0 | 53.0 | 54.0 | 55.0 | 56.0 | 57.0 | 58.0 | 59.0 | 60.0 | 61.0 | 62.0 | 63.0 | 64.0 | 65.0 | 66.0 | 67.0 | 68.0 | 69.0 | 70.0 | 71.0 | 72.0 | 73.0 | 74.0 | 75.0 | 76.0 | 77.0 | 78.0 | 79.0 | 80.0 | 81.0 | 82.0 | 83.0 | 84.0 | 85.0 | 86.0 | 87.0 | 88.0 | 89.0 | 90.0 | 91.0 | 92.0 | 93.0 | 94.0 | 95.0 | 96.0 | 97.0 | 98.0 | 99.0 | 100.0 |
|------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| Width [m]  | 1.0  | 2.0  | 3.0  | 4.0  | 5.0  | 6.0  | 7.0  | 8.0  | 9.0  | 10.0 | 11.0 | 12.0 | 13.0 | 14.0 | 15.0 | 16.0 | 17.0 | 18.0 | 19.0 | 20.0 | 21.0 | 22.0 | 23.0 | 24.0 | 25.0 | 26.0 | 27.0 | 28.0 | 29.0 | 30.0 | 31.0 | 32.0 | 33.0 | 34.0 | 35.0 | 36.0 | 37.0 | 38.0 | 39.0 | 40.0 | 41.0 | 42.0 | 43.0 | 44.0 | 45.0 | 46.0 | 47.0 | 48.0 | 49.0 | 50.0 | 51.0 | 52.0 | 53.0 | 54.0 | 55.0 | 56.0 | 57.0 | 58.0 | 59.0 | 60.0 | 61.0 | 62.0 | 63.0 | 64.0 | 65.0 | 66.0 | 67.0 | 68.0 | 69.0 | 70.0 | 71.0 | 72.0 | 73.0 | 74.0 | 75.0 | 76.0 | 77.0 | 78.0 | 79.0 | 80.0 | 81.0 | 82.0 | 83.0 | 84.0 | 85.0 | 86.0 | 87.0 | 88.0 | 89.0 | 90.0 | 91.0 | 92.0 | 93.0 | 94.0 | 95.0 | 96.0 | 97.0 | 98.0 | 99.0 | 100.0 |
Calculated power peaks for the entire shelf

Optimization strategy 2 – Adapting starting time

| Height [m] | 25.0 | 24.0 | 23.0 | 22.0 | 21.0 | 20.0 | 19.0 | 18.0 | 17.0 | 16.0 | 15.0 | 14.5 | 14.0 | 13.5 | 13.0 | 12.5 | 12.0 | 11.5 | 11.0 | 10.5 | 10.0 | 9.5 | 9.0 | 8.5 | 8.0 | 7.5 | 7.0 | 6.5 | 6.0 | 5.5 | 5.0 | 4.5 | 4.0 | 3.5 | 3.0 | 2.5 | 2.0 | 1.5 | 1.0 |
|------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| Width [m] | 10.0 | 9.0 | 8.0 | 7.0 | 6.0 | 5.0 | 4.0 | 3.0 | 2.0 | 1.0 | 10.0 | 9.0 | 8.0 | 7.0 | 6.0 | 5.0 | 4.0 | 3.0 | 2.0 | 1.0 | 10.0 | 9.0 | 8.0 | 7.0 | 6.0 | 5.0 | 4.0 | 3.0 | 2.0 | 1.0 | 10.0 | 9.0 | 8.0 | 7.0 | 6.0 | 5.0 | 4.0 | 3.0 | 2.0 | 1.0 | 10.0 | 9.0 | 8.0 | 7.0 | 6.0 | 5.0 | 4.0 | 3.0 | 2.0 | 1.0 | 10.0 | 9.0 | 8.0 | 7.0 | 6.0 | 5.0 | 4.0 | 3.0 | 2.0 | 1.0 | 10.0 | 9.0 | 8.0 | 7.0 | 6.0 | 5.0 | 4.0 | 3.0 | 2.0 | 1.0 |

- Green: < 49[kW]
- Yellow: 49[kW] ... 55[kW]
- Orange: 55[kW] ... 59[kW]
- Red: > 59[kW]
Calculated absorbed energy for the entire shelf

<table>
<thead>
<tr>
<th>Height [m]</th>
<th>Width [m]</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.0</td>
<td>&lt; 80[kWs]</td>
</tr>
<tr>
<td>6.0</td>
<td>80[kWs] ... 125[kWs]</td>
</tr>
<tr>
<td>12.0</td>
<td>125[kWs] ... 155[kWs]</td>
</tr>
<tr>
<td>13.0</td>
<td>&gt; 155[kWs]</td>
</tr>
</tbody>
</table>

Initial state

\[ 80 \text{[kWs]} \]

... 125 [kWs]

\[ 125 \text{[kWs]} \] ... 155 [kWs]

> 155[kWs]
Calculated absorbed energy for the entire shelf
Optimization strategy 1 – Adapting dynamic parameters

<table>
<thead>
<tr>
<th>Height [m]</th>
<th>Width [m]</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 0.2</td>
<td>0.2</td>
</tr>
<tr>
<td>0.2</td>
<td>0.3</td>
</tr>
<tr>
<td>0.3</td>
<td>0.4</td>
</tr>
<tr>
<td>0.4</td>
<td>0.5</td>
</tr>
<tr>
<td>0.5</td>
<td>0.6</td>
</tr>
<tr>
<td>0.6</td>
<td>0.7</td>
</tr>
<tr>
<td>0.7</td>
<td>0.8</td>
</tr>
<tr>
<td>0.8</td>
<td>0.9</td>
</tr>
<tr>
<td>0.9</td>
<td>1.0</td>
</tr>
</tbody>
</table>

Width [m] =>

- < 80[kWs]
- 80[kWs] ... 125[kWs]
- 125[kWs] ... 155[kWs]
- > 155[kWs]

\[ \text{Calculated absorbed energy for the entire shelf} \]
\[ \text{Optimization strategy 1 – Adapting dynamic parameters} \]

\[ \text{Height [m]} \rightarrow \\
\text{Width [m]} \\
\left\{ \begin{array}{c}
< 0.2 \\
0.2 \\
0.3 \\
0.4 \\
0.5 \\
0.6 \\
0.7 \\
0.8 \\
0.9 \\
1.0 \\
\end{array} \right. \\
\left\{ \begin{array}{c}
0.2 \\
0.3 \\
0.4 \\
0.5 \\
0.6 \\
0.7 \\
0.8 \\
0.9 \\
1.0 \\
\end{array} \right. \]
Calculated absorbed energy for the entire shelf
Optimization strategy 2 – Adapting starting time

<table>
<thead>
<tr>
<th>Height [m] =&gt;</th>
<th>Width [m] =&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>2,0</td>
<td>10, 2, 3</td>
</tr>
<tr>
<td>2,5</td>
<td>9, 2, 3, 7</td>
</tr>
<tr>
<td>3,0</td>
<td>8, 0, 2, 4</td>
</tr>
<tr>
<td>3,5</td>
<td>7, 2, 7, 8</td>
</tr>
<tr>
<td>4,0</td>
<td>6, 7, 7, 8</td>
</tr>
<tr>
<td>4,5</td>
<td>5, 7, 8, 9</td>
</tr>
<tr>
<td>5,0</td>
<td>4, 8, 9, 0</td>
</tr>
<tr>
<td>5,5</td>
<td>3, 9, 0, 0</td>
</tr>
<tr>
<td>6,0</td>
<td>2, 0, 0, 1</td>
</tr>
<tr>
<td>6,5</td>
<td>1, 0, 1, 1</td>
</tr>
<tr>
<td>7,0</td>
<td>0, 1, 1, 2</td>
</tr>
<tr>
<td>7,5</td>
<td>0, 2, 2, 2</td>
</tr>
<tr>
<td>8,0</td>
<td>0, 3, 3, 3</td>
</tr>
<tr>
<td>8,5</td>
<td>0, 4, 4, 4</td>
</tr>
<tr>
<td>9,0</td>
<td>0, 5, 5, 5</td>
</tr>
<tr>
<td>9,5</td>
<td>0, 6, 6, 6</td>
</tr>
<tr>
<td>10,0</td>
<td>0, 7, 7, 7</td>
</tr>
</tbody>
</table>

< 80[kWs]
80[kWs] ... 125[kWs]
125[kWs] ... 155[kWs]
> 155[kWs]

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### Comparison of strategies 1 and 2

#### Average values for the entire shelf

<table>
<thead>
<tr>
<th></th>
<th>Initial state</th>
<th>Strategy 1 – Adapting dynamic parameters</th>
<th>Strategy 2 – Adapting starting time</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Average value of motoric peak power [kW]</strong></td>
<td>53.7</td>
<td>44.6</td>
<td>41.2</td>
</tr>
<tr>
<td><strong>Savings in %</strong></td>
<td>-</td>
<td>17 %</td>
<td>23.3 %</td>
</tr>
<tr>
<td><strong>Average value of energy absorbed [kWs]</strong></td>
<td>108</td>
<td>100</td>
<td>95</td>
</tr>
<tr>
<td><strong>Savings in %</strong></td>
<td>-</td>
<td>7.4 %</td>
<td>12.1 %</td>
</tr>
</tbody>
</table>
Test reading at a real small parts ASRM

Absorbed energy

<table>
<thead>
<tr>
<th>Initial state</th>
<th>Strategy 1 – Adapting dynamic parameters</th>
<th>Strategy 2 – Adapting starting time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy absorbed [kWs]</td>
<td>116</td>
<td>115</td>
</tr>
<tr>
<td>Savings [kWs]</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>In %</td>
<td>-</td>
<td>0,9 %</td>
</tr>
</tbody>
</table>
Test reading at a real small parts ASRM

Electrical power

<table>
<thead>
<tr>
<th></th>
<th>Initial state</th>
<th>Strategy 1 – Adapting dynamic parameters</th>
<th>Strategy 2 – Adapting starting time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motoric / regenerative power [kW]</td>
<td>51 / 25</td>
<td>46 / 21</td>
<td>43 / 12</td>
</tr>
<tr>
<td>Savings in %</td>
<td>-</td>
<td>10% / 16%</td>
<td>16% / 52%</td>
</tr>
</tbody>
</table>
Agenda

- Introduction 3
- Strategies for optimizing 11
- Limitation of connection power 30
- Function block architecture 36
- Additional functions 40
Limitation of electrical power
Benefit and side effect

**+ Reduction of ASRMs maximum electrical connecting power (cost savings)**

- Possible usage of smaller infeed modules
- Smaller dimensioning of transformer and grid periphery possible
- Limitation of maximum power for ASRM depending on actual situation, e.g. at simultaneous start of several ASRMs

**- Reduced performance for some positions in the shelf (approx. 5 to 10%)**

- Dynamics of drives will be reduced if actual motion profile will exceed the power limitation → Increased cycle time for the actual motion profile
- Number of involved positions must be taken into account when defining the power limit
  Goal: max. 5 to 10% of positions with reduced performance
Limitation of electrical connection power  
Calculated power peaks for the entire shelf

- Limitation of ASRM maximum electrical power to 55kW (instead of 60kW)
- 20kW BLM infeed instead of 40kW can be used
- 10% of shelf positions with reduced performance (increased cycle time)
Limitation of electrical connection power
Calculated additional cycle time

- Power limitation of 55kW (20kW BLM)
- Start of movement at X=0 (chassis) and Y=0 (hoist)
- 0.5sec as maximum increase of cycle time
- Average increase of hoist movement 0.18%
- No increase of cycle time for chassis movement
Agenda

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- Additional functions 40
Function block “EffMcProfiles”
Overview input- and output signals
# Function block “EffMcProfiles”

## Input signals

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
<th>Data type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enable</td>
<td>Enabling of the function block (edge-triggered)</td>
<td>Bool</td>
</tr>
<tr>
<td>Execute</td>
<td>Start of calculation</td>
<td>Bool</td>
</tr>
<tr>
<td>DynamicAxis</td>
<td>Dynamic parameters of the axis</td>
<td>PLC data type</td>
</tr>
<tr>
<td>OptStrategy</td>
<td>Selection of optimization strategy – default setting: strategy 2</td>
<td>Integer</td>
</tr>
<tr>
<td>MotionType</td>
<td>Selection if ASRM motion is done by TOs (PLC based) of by EPOS in S120</td>
<td>Integer</td>
</tr>
<tr>
<td>MaxPowerLimitation</td>
<td>Maximum electrical power limitation</td>
<td>Real</td>
</tr>
<tr>
<td>ActualPositionAxis</td>
<td>Actual position of X/Y axis (new initialized after Execute command)</td>
<td>Real</td>
</tr>
<tr>
<td>AxisTargetPos</td>
<td>Target position of X/Y axis</td>
<td>Real</td>
</tr>
<tr>
<td>TargetPosReached</td>
<td>Target position reached</td>
<td>Bool</td>
</tr>
<tr>
<td>OverridesAxisActive</td>
<td>Selection of overrides should be used</td>
<td>Bool</td>
</tr>
<tr>
<td>AxisOverrides</td>
<td>Overrides for dynamic parameters of X/Y axis</td>
<td>Integer</td>
</tr>
</tbody>
</table>
## Function block “EffMcProfiles”
### Output signals

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
<th>Data type</th>
</tr>
</thead>
<tbody>
<tr>
<td>XAxisExecute</td>
<td>Start movement X axis</td>
<td>Bool</td>
</tr>
<tr>
<td>YAxisExecute</td>
<td>Start movement Y axis</td>
<td>Bool</td>
</tr>
<tr>
<td>YAxisEnable</td>
<td>Pulse enabling for Y axis (only used for brake management)</td>
<td>Bool</td>
</tr>
<tr>
<td>OpDynamics</td>
<td>Output of optimized parameters</td>
<td>PLC data type</td>
</tr>
</tbody>
</table>
| PowerAxis     | Output of 14 points for power values of X/Y axis and total power in combination with the time stamp
                | Use case: e.g. condition monitoring or external power calculation           | PLC data type                  |
Agenda

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Additional functions
Brake management

At standstill of hoist drive most power is needed for holding the LHD incl. payload.

- With closed brake no electrical energy is needed.
- Potential of energy saving at e.g. long chassis movements and rest periods
- Time for opening and closing break is taken into account
- To avoid sagging of the load the electrical hold function will stay active during opening and closing time of the brake
- Goal: No losses in performance

Example:
- Power to hold the load electrically 0.8kW
  ⇒ Brake is closed for 2 seconds = savings of 1.6kWs of energy
- A minimum rest time can be defined below that time a brake will not be closed
Additional functions
Driving into buffer

Management of chassis movement in the buffer area
Inside buffer area the speed must be reduced to avoid a damage of the buffer

• More storage space available when buffer area can be used
Additional functions
Energy saving mode for ASRM

Activation of energy saving mode depending on the actual level of capacity
User definable override values for each axis (X and Y)
  • Acceleration
  • Deceleration
  • Speed

Possible use cases:
  • Energy and power efficient operation mode at times with lower workload
  • Adaption to environmental conditions e.g. to save energy for cooling the cabinet during summer time or to save cooling energy in deep freeze applications
  • Less electrical losses due to operation of motors at best degree of efficiency
  • Reduction of electrical and mechanical losses
  • Reduction of mechanical wear
Additional functions
Asymmetrical motion profiles

Asymmetrical motion profiles
- In some cases asymmetrical motion profiles have higher saving potentials
- Acceleration can be different from deceleration
Additional functions
Power calculation and time based motion optimization

Power calculation

• Before starting the movement the needed power of X/Y axis can be calculated
• Two different modes available
  • Simple power calculation
    Only one value for electrical and mechanical efficiency is used
  • Extended power calculation with additional functions:
    • Calculation of needed energy for the ASRM
    • More exact results that can be used e.g. for condition monitoring
      or a comparison of different ASRMs or plants

Time based optimization

• Space time selection (default value 0 seconds)
  Target position of optimized axis will be reached with that space time
• Use case: Reducing the waiting time before LHD can exchange load with the shelf
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