SIMOREG DC Master
6RA70 Series

Microprocessor-Based Converters from 6kW to 1900kW
for Variable-Speed DC Drives
NOTE

These applications do not purport to handle or take into account all of the equipment details or versions or to cover every conceivable operating situation or application. If you require more detailed information, or if special problems occur, which are not handled in enough detail in this document, please contact your local Siemens office.

The contents of these application are not part of an earlier or existing agreement or legal contract and neither do they change it. The actual purchase contract represents the complete liability of the A&D Variable-Speed Drives Group of Siemens AG. The warrant conditions, specified in the contract between the two parties, is the only warranty which will be accepted by the A&D Variable-Speed Drives Group. The warranty conditions specified in the contract are neither expanded nor changed by the information provided in the installation instructions.

WARNING

These converters contain hazardous voltages, hazardous rotating machinery (fans) and control rotating mechanical components (drives). Death, serious bodily injury or substantial property damage may occur if the instructions in the relevant operating manuals are not observed.

Only qualified personnel who are thoroughly familiar with all safety notices contained in the operating instructions as well as erection, installation, operating and maintenance instructions should be allowed to work on these devices.

The successful and safe operation of this equipment is dependent on careful transportation, proper storage and installation as well as correct operation and maintenance.
# Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>General</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>Functions</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>Description of functions</td>
<td>4</td>
</tr>
<tr>
<td>3.1</td>
<td>Direct tension control with tension measuring device</td>
<td>4</td>
</tr>
<tr>
<td>3.2</td>
<td>Indirect tension control without tension measuring device</td>
<td>5</td>
</tr>
<tr>
<td>3.3</td>
<td>Compensating (dancer) roll position control</td>
<td>5</td>
</tr>
<tr>
<td>3.4</td>
<td>Stop tension control</td>
<td>5</td>
</tr>
<tr>
<td>3.5</td>
<td>Slip core control</td>
<td>5</td>
</tr>
<tr>
<td>3.6</td>
<td>Variable web width</td>
<td>5</td>
</tr>
<tr>
<td>3.7</td>
<td>Variable material density</td>
<td>5</td>
</tr>
<tr>
<td>3.8</td>
<td>Calculator for the diameter</td>
<td>5</td>
</tr>
<tr>
<td>3.9</td>
<td>Gearbox stage</td>
<td>5</td>
</tr>
<tr>
<td>3.10</td>
<td>Web break recognition</td>
<td>6</td>
</tr>
<tr>
<td>3.11</td>
<td>Interfaces</td>
<td>6</td>
</tr>
<tr>
<td>3.11.1</td>
<td>Received data from top level control</td>
<td>6</td>
</tr>
<tr>
<td>3.11.2</td>
<td>Transmit data to top level control</td>
<td>7</td>
</tr>
<tr>
<td>3.11.3</td>
<td>Analog input</td>
<td>7</td>
</tr>
<tr>
<td>3.11.4</td>
<td>Analog output</td>
<td>7</td>
</tr>
<tr>
<td>3.11.5</td>
<td>Pulse generator input</td>
<td>7</td>
</tr>
<tr>
<td>4</td>
<td>Calculation of acceleration compensation</td>
<td>8</td>
</tr>
<tr>
<td>4.1</td>
<td>Determination of fixed value inertia</td>
<td>8</td>
</tr>
<tr>
<td>4.2</td>
<td>Determination of the variable moment of inertia</td>
<td>9</td>
</tr>
<tr>
<td>4.3</td>
<td>Formulas and dimensions</td>
<td>9</td>
</tr>
<tr>
<td>5</td>
<td>Commissioning notes</td>
<td>9</td>
</tr>
<tr>
<td>5.1</td>
<td>Speed feedback adjustment</td>
<td>9</td>
</tr>
<tr>
<td>5.2</td>
<td>Compensation of friction moment</td>
<td>10</td>
</tr>
<tr>
<td>5.3</td>
<td>Compensating moment of acceleration</td>
<td>10</td>
</tr>
<tr>
<td>5.3.1</td>
<td>Constant moment of inertia</td>
<td>10</td>
</tr>
<tr>
<td>5.3.2</td>
<td>Variable moment of inertia</td>
<td>10</td>
</tr>
<tr>
<td>5.4</td>
<td>Optimization of speed controller</td>
<td>11</td>
</tr>
<tr>
<td>5.5</td>
<td>Hints for setting Parameters</td>
<td>11</td>
</tr>
<tr>
<td>6</td>
<td>Appendix</td>
<td>12</td>
</tr>
<tr>
<td>6.1</td>
<td>List of freely assignable function Blocks used</td>
<td>12</td>
</tr>
<tr>
<td>6.2</td>
<td>List of settable fixed values used</td>
<td>13</td>
</tr>
<tr>
<td>6.3</td>
<td>Schematic diagram of control types</td>
<td>14</td>
</tr>
<tr>
<td>6.4</td>
<td>Detailed schematics</td>
<td>16</td>
</tr>
<tr>
<td>6.5</td>
<td>Parameter list</td>
<td>39</td>
</tr>
</tbody>
</table>
1 General

This application note shows how to implement a center winder using the freely assignable function blocks available through the option S00. The number and type of elements used, requires a software version of 1.83 or greater.

The SIMOREG has to have 4Q functionality.

To use all functions, the control of the SIMOREG has to be done using a top level control system (for example SIMATIC S7), using an optional communication board (CB).

If you want to implement a hardware control, the extension board EB1 or EB2 has to be used, depending on your requirements. In this case, it is also required to alter the implementation of the freely assignable function blocks.

Mounting instructions for the optional boards can be found in the Users manual chapter 5.3 „mounting options”

2 Functions

The following functions have been implemented

♦ direct tension control with tension measuring device
♦ indirect tension control without tension measuring device using torque control
♦ dancer roll / compensating roll position control
♦ stop tension
♦ slip core control
♦ setting of a variable web width
♦ setting a variable material density
♦ calculator for diameter with monotone or not monotone change of diameter
♦ 2 gear box stages
♦ web break recognition

The selection of global settings such as
♦ control method
♦ direction of winding
♦ winder or unwinder
♦ gear box stage
♦ winding characteristic

is performed via the top level control system. Depending on the selection, the required changes are automatically performed by the SIMOREG. No changes to connector or binector connections have to be made.

In conjunction to the application, the characteristic curve, control settings and optimizations have to be applied.

In case a hardware control is implemented, the required changes can be done using OR function blocks (for details contact schematic 19).

3 Description of functions

3.1 Direct tension control with tension measuring device

This method works as current limitter. The pilot control value, derived from the tension set point, influences the limitter for the speed control output, taking the diameter, friction, moment of inertia and acceleration into account. A controller calculates a correction signal using the difference between tension set point and instantaneous value. The signal is added to the pilot control value. This process enables a more detailed guidance of the instantaneous tension value. To ensure the constance of the speed control output once it reaches the limit, a saturation factor has to be added.
3.2 Indirect tension control without tension measuring device
The function is similar to the function above (3.1). Since there is no instantaneous tension value, the limiter of the speed control is only influenced by pilot control.

3.3 Compensating (dancer) roll position control
The output of the position control equals a supplementary set point value for the speed control. The influence of the position control should be limited to 10 – 20 %. Sometimes it is necessary to implement the position control as proportional control with derivative portion in the actual value channel. If you want to use an external tension control to influence the compensating roll weight, the analog output 1 (X175, connector 14 & 15) delivers a tension control setpoint value with influence of the winding characteristic.

3.4 Stop tension control
The addition of the stop tension depends on the external control and the SIMOREG internal speed = 0 message. The stop tension is parameterized in percent in conjunction to the set operation state. If a constant stop tension is required, Parameter U151.01 has to be connected to K0001.

3.5 Slip core control
The coil hardness influences, in conjunction to the diameter, the tension set point according to an adjustable characteristic. The set points can be taken either from an internal characteristic block or externally from the bus. Depending on the application, 5 additional characteristics are available. It is reasonable to work without the slip core control if an unwinder is used. Switching between different characteristics is done via external control.

3.6 Variable web width
The selection of different web width’s is automatically taken into account for the calculation of the moment or inertia and therefore also for the resulting pre – control moment.

3.7 Variable material density
The selection of different material densities, is automatically taken into account for the calculation of the moment or inertia and therefore also for the resulting pre – control moment.

3.8 Calculator for the diameter
Using the web speed set point and winder speed, the calculator reckons the diameter. This calculation is only performed if there is a frictional connection to the continuos material, the tension controller is turned on and the system is in the run state. Since unwinder only reduce and winder increase the diameter, the calculation of the opposite direction is disabled. The calculator can be parameterized to enable processing of both directions.

3.9 Gearbox stage
The gear selection is taken into account for the calculation of the moment of inertia and therefore also the resulting pre – control moment.
3.10 Web break recognition

If the tension control is turned on, the web break recognition is enabled.

Direct tension control: Triggering results if current tension drops below minimum tension.
Indirect tension control: Triggering results if selectable moment variance is exceeded and moment drops below selectable minimum.
Compensating roll: Triggering results if instantaneous value exceeds selectable position value.

If web tear recognition is triggered, speed set point is set 0 and the calculation for the diameter is disabled. The unwinder turns backwards, the winder forward, both using their bias. If a compensating (dancer) roll control is used, the position controller reaches its limit, due to the missing instantaneous value. The bias results from the set intervention. After a selectable time, „Off 3“ is triggered.

3.11 Interfaces

3.11.1 Received data from top level control

Data exchange is done via the communication board (CB) 1. To ensure flawless operation, the settings in the following table have to be strictly followed.

<table>
<thead>
<tr>
<th>Word</th>
<th>Connector</th>
<th>Bisector</th>
<th>Label</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>K3001</td>
<td>Control word 1</td>
<td>Control word 1 according to user manual</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>K3002</td>
<td>Control word 2</td>
<td>Control word 2 according to user manual</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>K3003</td>
<td>Control word 3</td>
<td>Control word 3 for coilers/ winders</td>
<td></td>
</tr>
<tr>
<td>B3300</td>
<td></td>
<td>Maneuver</td>
<td>1.....On</td>
<td></td>
</tr>
<tr>
<td>B3301</td>
<td></td>
<td>Set diameter</td>
<td>1.....Set</td>
<td></td>
</tr>
<tr>
<td>B3302</td>
<td></td>
<td>Stop diameter</td>
<td>1.....Stop</td>
<td></td>
</tr>
<tr>
<td>B3303</td>
<td>Wind/Coil from top/bottom</td>
<td>0.....top / 1......bottom</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B3304</td>
<td>Winder/Unwinder</td>
<td>0.....Winder / 1.....Unwinder</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B3305</td>
<td>Dancer roll control</td>
<td>If 1, the state of B3306 is not relevant</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B3306</td>
<td>Dir./Indir. Tension Control</td>
<td>0.....direct / 1.....indirect</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B3307</td>
<td>Gear box stage 1/2</td>
<td>0.....Stage1 / 1.....Stage 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B3308</td>
<td>Switch characteristic for coil hardness</td>
<td>The selected characteristic is the result of the combination of these three binectors (B3308,3309,3310)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B3309</td>
<td>Switch characteristic for coil hardness</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B3310</td>
<td>Switch characteristic for coil hardness</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B3311</td>
<td>Stop tension control</td>
<td>1.....On</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B3312</td>
<td>Tension control ON ext.</td>
<td>1.....On</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B3313</td>
<td>web break ext.</td>
<td>1.....On</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B3314</td>
<td>Reserved</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B3315</td>
<td>Reserved</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>K3004</td>
<td></td>
<td>system speed setpoint</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>K3005</td>
<td></td>
<td>Tension setpoint</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>K3006</td>
<td></td>
<td>Diameter set value</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>K3007</td>
<td></td>
<td>Ext. characteristic coil hardness</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>K3008</td>
<td></td>
<td>Web width If different materials are produced</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>K3009</td>
<td></td>
<td>Density If different materials are produced</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>K3010</td>
<td></td>
<td>Reserved</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>K3016</td>
<td></td>
<td>Reserved</td>
<td></td>
</tr>
</tbody>
</table>
3.11.2 Transmit data to top level control

Data exchange is done via the communication board 1 (CB1).

<table>
<thead>
<tr>
<th>Word</th>
<th>Parameter</th>
<th>Bit</th>
<th>Label</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 U734.01</td>
<td>Status word 1</td>
<td>0-15</td>
<td>Status word 1 according to user manual.</td>
<td></td>
</tr>
<tr>
<td>2 U734.02</td>
<td>Status word 2</td>
<td>0-15</td>
<td>Status word 2 according to user manual.</td>
<td></td>
</tr>
<tr>
<td>3 U734.03</td>
<td>Status word 3</td>
<td>0-15</td>
<td>Status word for winder/coiler status K9113</td>
<td></td>
</tr>
<tr>
<td>4 U734.04</td>
<td>Instantaneous speed value</td>
<td>0-15</td>
<td>K0179</td>
<td></td>
</tr>
<tr>
<td>5 U734.05</td>
<td>Instantaneous current value</td>
<td>0-15</td>
<td>K0109</td>
<td></td>
</tr>
<tr>
<td>6 U734.06</td>
<td>Instantaneous value of moment</td>
<td>0-15</td>
<td>K0142</td>
<td></td>
</tr>
<tr>
<td>7 U734.07</td>
<td>Current diameter</td>
<td>0-15</td>
<td>K9304</td>
<td></td>
</tr>
<tr>
<td>8 U734.08</td>
<td>Instantaneous tension value</td>
<td>0-15</td>
<td>K9240</td>
<td></td>
</tr>
<tr>
<td>9 U734.09</td>
<td>Output of tension control</td>
<td>0-15</td>
<td>K9249</td>
<td></td>
</tr>
<tr>
<td>10 U734.10</td>
<td>Reserved</td>
<td>0-15</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3.11.3 Analog input

Maneuver set point: analog input main set point X174: 4-5
value range: -10V......+10V
tension / position feedback value analog input 1 X174: 6-7
value range: tension feedback value: 0...........+10V
position feedback value: -10V......+10V

3.11.4 Analog output

Tension set point for compensating weight if compensating roll control is enabled: analog output 1 X175: 14-15

3.11.5 Pulse generator input

Input for digital pulse - generator corresponding to „User Manual“.
4 Calculation of acceleration compensation

In order to ensure a constant tension moment during acceleration and deceleration, the armature current should be pre controlled using the required moment. The moment of inertia is, due to the steady change of the diameter of the winder, never a constant value.

♦ Fixed inertia $J_F$ (adjustable using P407)
♦ variable moment of inertia $J_V$ (is calculated using building block 116, and is influenced by web width (K3008) and material density K3009)

Chapter 4 contains instructions on how to calculate the two moments using available system data.

4.1 Determination of fixed value inertia

The fixed moment of inertia is the sum of the following moment of inertia

♦ moment of inertia of motors
♦ moment of inertia of gear corresponding to the shaft of the motor
♦ moment of inertia of winder core corresponding to the motor shaft
♦ additional moment of inertia’s such as couplers

Formula:

$$J_F = J_{\text{Motor}} + J_{\text{Gear}} + \frac{J_{\text{Core}}}{i^2}$$

For motor or gear values please contact the datasheet or type plate. The inertia of the winder core has to be calculated. (Contact formula for the calculation of moment of inertia for solid cylinder or hollow cylinder.) If the winders core mass is relatively small, or the gear ratio rather large, the moment of inertia can be considered irrelevant.

moment of inertia solid cylinder

$$J = \frac{\pi \cdot \rho \cdot b \cdot D^4}{32} [\text{kgm}^2]$$

moment of inertia hollow cylinder

$$J = \frac{\pi \cdot \rho \cdot b \cdot (D^4 - D_{\text{Core}}^4)}{32} [\text{kgm}^2]$$

Calculation of percental moment of acceleration $M_{bF}$ using the fixed moment of inertia $J_F$ and the acceleration time $t_b$. The equation outputs a moment of inertia corresponding to the rated current in %.

Precondition: $D = D_{\text{core}}$, $t_b = t_{h}$ and $J_{\text{core}}$ is ignored

Determining the value for parameter $P407$

$$M_{bF} = \frac{J_F \cdot n_N \cdot i \cdot \Delta v}{2.865 \cdot D_{\text{Core}} \cdot P_N \cdot t_b} [%]$$

Determining the value for parameter $P407$

$$P407 = \frac{M_{bF} \cdot t_h}{P542} \times 100\%$$
4.2 Determination of the variable moment of inertia

The following equation outputs a value for the maximum variable moment of inertia using the maximum diameter, density and maximum width.

\[ J_{v,\text{max}} = \frac{\Pi \cdot \rho \cdot \max \cdot b \cdot \max \cdot (D_{\max}^4 - D_{\text{Core}}^4)}{32 \cdot i^2} \text{ [kgm}^2\text{]} \]

Calculation of percental moment of acceleration corresponding to the related current in %

Requirements: \( D = D_{\max}, \ t_b = \ t_h \) and \( J_F = 0 \)

\[ M_{b,V} = \frac{b_{\max} \cdot \rho_{\max} \cdot (D_{\max}^4 - D_{\text{Core}}^4) \cdot \pi \cdot nN}{29.18 \cdot i \cdot D_{\max} \cdot PN} \cdot \frac{\Delta V}{t_b} \text{ [%]} \]

Determining the value for Parameter U529:

\[ U529 = \frac{M_{b,V} \cdot t_h}{P542} \cdot 100\% \]

4.3 Formulas and dimensions

- \( b \): web width [m]
- \( D \): diameter [m]
- \( D_{\max} \): maximum diameter [m]
- \( D_{\text{Core}} \): diameter of winder - core [m]
- \( i \): gear ratio
- \( J_F \): constant moment of inertia (motor, Gear, winder - core) corresponding to shaft of motor [kgm²]
- \( J_V \): variable moment of inertia result of windup material corresponding to shaft of motor [kgm²]
- \( M_{b,F} \): maximum moment of acceleration corresponding to \( J_F \) [% of \( M_N \)]
- \( M_{b,V} \): maximum moment of acceleration corresponding to \( J_{v,\text{max}} \) [% of \( M_N \)]
- \( M_N \): rated moment of motor [Nm]
- \( nN \): rated motor speed [rpm]
- \( P_N \): rated motor power [kW]
- \( t_b \): time of acceleration [s]
- \( t_h \): ramp up time of web velocity; range 0 – \( V_{\max} \) [s]
- \( \Delta V \): speed difference [m/min]
- \( \rho \): specific weight (density) [kg/dm³]

5 Commissioning notes

5.1 Speed feedback adjustment

The following parameter have to be set:

- \( U518 \): minimum diameter of winder shaft in mm
- \( U519 \): gear ratio

If two gear box stages are used, the gear box with the smaller gear ratio has to be used for example: \( i_1 = 4, i_2 = 5 \ldots \Rightarrow U519 = 4 \)

\[ i = \frac{n_{\text{Motor}}}{n_{\text{winder}}} \]
U520 rated speed
The speed in rpm at maximum system speed and minimum winder diameter in min -1

U522 standardization of system speed in m/s at maximum set point

U523 standardization of diameter in mm. 100% = maximum diameter

5.2 Compensation of friction moment
In general, the friction depends on the speed of the winder. Gear warming can result in negative influence. After a few hours of operation there is the possibility a post optimization has to be performed.

Procedure:
♦ Operate winder only with speed control, binector B3312 (tension control ON ext.) has to be 0
♦ Disable acceleration compensation f.e. by preventing the dv/dt Signal ( set P542 to 0,01 ).
♦ Take measurements at minimum diameter of winder; set minimal diameter; there may be no connection to material web.
♦ Start drive via internal ramp function generator, and increase the speed in steps (f.e 10% steps)
♦ After each speed increase, obtain the actual value of the current (monitoring parameter r019) and use it to set parameter U 283.01 - .10 (characteristic Nr. 106)
♦ Stop drive
♦ Select operation state „indirect tension control“ and set the bias P 405 = 0%, and binector B3302 (hold diameter value) to 1
♦ Start drive for winder and increase speed in 10 % steps. After each increase check connector K0160 (output of speed controller). The value should be in the range of +/-3%.

5.3 Compensating moment of acceleration
General procedure:
♦ No connection to material web, gear box stage 1 selected (changeover to gear box stage 2 is automatically taken in to account.
♦ Set ramp up time and ramp down time according to the application
♦ P542 is preset to 3s. If the ramp-up time or the ramp down-time is 30 s, the value of dv/dt equals 10 %. If ramp – up time and or ramp down time differ a lot from 30 s, P542 should be set so dv/dt reaches reasonable values.
♦ Select operating state „indirect tension control“ and set the bias P405 to 0 % and binector B3302 (hold diameter value) to 1.

5.3.1 Constant moment of inertia
♦ Take measurements at minimum coil diameter; set minimal diameter
♦ Prohibit influence of variable moment of inertia. fe. by setting the web width to 0% using K3008.
♦ Vary the speed of the winder between 10% - 90% and observe K0160 (output of speed controller) during acceleration and deceleration.
♦ Adjust P407 (effects dv/dt), so that K0160 has a maximum value of +/- 3%

5.3.2 Variable moment of inertia
♦ If possible insert a rather fully loaded coil with a large material width and density.
♦ Set values of actual diameter, density of material and web width
♦ Vary the speed of the winder between10% - 90% and observe K0160 (output of speed controller) during acceleration and deceleration.
♦ Adjust U529 (effects dv/dt ), so that K0160 has a maximum value of +/- 3%.

NOTE
If the web width and / or the density is always constant, Parameter U150.03 and / or U525.04 (density) have to be set to K0001 (100%)
5.4 Optimization of speed controller

Lift moment limits, for example by setting the signal “Compensating roll position control ON”. (P605 is set to 100%)
Set the adaptation of kp 2 using P559 and Tn 2 using P560. The value can be calculated using the following formula

\[ P559 = P560 = \frac{D_{\text{max}}^4 - D_{\text{Core}}^4}{D_{\text{max}}^4} \times U529 \times 100 \, [\%] \]

Requirement: Density and width of material have to be 100%, U529 calculated according to 5.3.2

5.4.1 Optimization at maximum diameter.
- Run system with fully loaded winder
- Perform optimization for speed controller according to the user manual (P051=26).
- Use value of P225 (kp) and P226 (Tn) to set P550 / P551 (equals upper values of kp-and Tn adaptation)

5.4.2 Optimization at minimal diameter
- Run system with empty winder
- Perform optimization for speed controller according to the user manual (P051=26).
- The set values in P225 and P226 equal the lower values of kp and Tn – adaptation

5.5 Hints for setting Parameters

P406: Gear stage 2.
The value is calculated as follows: \( i_1/i_2 \).
f.e. \( i_1=4, i_2=5 \Rightarrow P406 = 4/5 = 80\% \)

U198: Tension control: Value for required tension or moment for web break observation 10%.
Position control: Set Observation value for Compensating roll, f.e. 90%90%.

U282.01-.10: Characteristic of friction.
U283.01-.10: Only positive values allowed.

U285.01-.10: Characteristic for slip coil control
U286.01-.10: Only positive values allowed.

U288.01-.10: Characteristic (Building block 108).
U289.01-.10: Using this block, you can delinearize the influence of the potentiometer for maneuvering

U450: Delay web break recognition.
Is used to disable false triggering on short, sudden tension or moment drops.

U453: Time, during which the minimum tension (set using U198) has to be surpassed to activate the tension control.

U456: Time for reverse winding if web break occurs.
U539.01: Integration time - calculator for diameter
The following formula is used for calculation:

\[
U539.01 = \frac{188.5 \times U537.01 \times D_{\text{max}} \times L}{v_{\text{max}}} \quad [s]
\]

- \(D_{\text{max}}\) Maximum roller diameter \([\text{m}]\)
- \(L\) Number of layers on roller with maximum diameter
- \(v_{\text{max}}\) Maximum system speed \([\text{m/min}]\)

6 Appendix

6.1 List of freely assignable function Blocks used

<table>
<thead>
<tr>
<th>Block type</th>
<th>Blocknumber</th>
</tr>
</thead>
<tbody>
<tr>
<td>Binector/connector converter</td>
<td>13</td>
</tr>
<tr>
<td>Average value during n cycles</td>
<td>16</td>
</tr>
<tr>
<td>Adders/Subtractors</td>
<td>20, 21, 22, 23, 24, 25</td>
</tr>
<tr>
<td>Sign inverters</td>
<td>35, 36</td>
</tr>
<tr>
<td>Switchable sign inverters</td>
<td>40, 41</td>
</tr>
<tr>
<td>Dividers</td>
<td>45, 46, 47</td>
</tr>
<tr>
<td>Multipliers</td>
<td>50, 51, 52, 53, 290…297</td>
</tr>
<tr>
<td>High resolution Multipliers/Dividers</td>
<td>55</td>
</tr>
<tr>
<td>Absolute value generators with filter</td>
<td>60, 61</td>
</tr>
<tr>
<td>limiters</td>
<td>65</td>
</tr>
<tr>
<td>Limit-value monitors without filters</td>
<td>73, 74</td>
</tr>
<tr>
<td>Tracking-/storage element</td>
<td>82</td>
</tr>
<tr>
<td>Analog signal selector switches</td>
<td>90, 93…99</td>
</tr>
<tr>
<td>Integrators</td>
<td>101</td>
</tr>
<tr>
<td>Characteristic Blocks</td>
<td>106, 107, 108</td>
</tr>
<tr>
<td>Simple ramp-function generator</td>
<td>113</td>
</tr>
<tr>
<td>Technology controller</td>
<td>114</td>
</tr>
<tr>
<td>Velocity-/speed controller</td>
<td>115</td>
</tr>
<tr>
<td>Variable moment of inertia</td>
<td>116</td>
</tr>
<tr>
<td>multiplexer</td>
<td>86, 87</td>
</tr>
<tr>
<td>AND – elements</td>
<td>121…131</td>
</tr>
<tr>
<td>OR – elements</td>
<td>150…154, 156…167</td>
</tr>
<tr>
<td>Inverters</td>
<td>180…191</td>
</tr>
<tr>
<td>RS-flipflop</td>
<td>215</td>
</tr>
<tr>
<td>Timers</td>
<td>240…245</td>
</tr>
<tr>
<td>Binary signal selector switch</td>
<td>250, 251</td>
</tr>
<tr>
<td>PI-controller</td>
<td>260</td>
</tr>
</tbody>
</table>
### 6.2 List of settable fixed values used

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>P401</td>
<td>Inching set point</td>
</tr>
<tr>
<td>P402</td>
<td>Adjustment of set point – actual value difference of moment for web break recognition</td>
</tr>
<tr>
<td>P403</td>
<td>Fine tuning of web (system) speed</td>
</tr>
<tr>
<td>P404</td>
<td>Diameter of core in % of D_max</td>
</tr>
<tr>
<td>P405</td>
<td>Bias for Speed controller in conjunction with direct and ind. tension cont.</td>
</tr>
<tr>
<td>P406</td>
<td>i gear stage 2</td>
</tr>
<tr>
<td>P407</td>
<td>constant moment of inertia</td>
</tr>
<tr>
<td>P408</td>
<td>Scaling of tension setpoint</td>
</tr>
<tr>
<td>P409</td>
<td>Influence tension-/position controller</td>
</tr>
<tr>
<td>P410</td>
<td>Stop tension</td>
</tr>
<tr>
<td>P411</td>
<td>Position set point</td>
</tr>
<tr>
<td>P421</td>
<td>Change of diameter monotone  0.....no  1.....yes</td>
</tr>
</tbody>
</table>
Principal schematic of indirect and direct tension control

- Web speed setpoint
- Web break
- Web tension controller
- Web width
- Density of material
- Web thickness
- Characteristic of friction
- Un/Winder
- Web speed setpoint

Components:
- Preparation of setpoint
- Ramp generator
- Velocity-speed calculator
- Moment limiter

Calculators:
- Velocity-speed calculator
- Diameter set value
- Core diameter
- Monotone yes/no
- Set diameter
- Keep/hold diameter

This portion is only active if direct tension control is enabled.
6.4 Detailed schematics
Crawling setpoint / Terminal 37

Switch-on command from terminal 37
(0 control word 1)

Bypass ramp-function generator
to sheet "Ramp-function generator"

ON command from control word 1
to sheet "Ramp-function generator"

Flip-Flops are reset when P445=0

<1> Maneuver setpoint

Maneuver 19.5

X-Values

Y-Values

Select crawling setpoint

Selection for switch-on/shutdown

Selection for shutdown

Switch-on/shutdown from terminal 37 (from sheet "Binary inputs 1")

ON command from crawling setpoint (to control word 1)

Switch-on command from ON/OFF1 (to control word 1) to sheet "Ramp-function generator"

Bypass ramp-function generator to sheet "Ramp-function generator"

<1> Flip-Flops are reset when P445=0

Maneuver-setpoint
Setpoint processing

Main setpoint

Minimum

Maximum

Additional setpoint

K0195 U608.F (15.00%)

K0196

K0194

P643 (9)

K

K

K

K

P321.F (100.00)

(-300.00...300.00 %)

P322.F (1)

K

P642 (2)

K

K

K

K

K0198

K0197

Enable positive direction of rotation from control word 1

Enable negative direction of rotation from control word 1

When P643.0x=9, the limit selected via P642.0x acts with inverted sign as a negative limit

Normalization

U608.F (15.00%)

Minimum to ramp-function generator input

P645.F (0)

K

P333.F (1)

K

Sheet 3
Speed controller (1)

Adaptation of the P gain

- **P553.F (0)** (0.00 ... 100.00 %) Adap. point 1
- **P550.F (0.00)** (0.10 ... 200.00)% n contr. Kp1
- **P225.F (0.00)** (0.10 ... 200.00)% n contr. Kp2

Adaptation of the integration time

- **P554.F (0)** (0.00 ... 100.00 %) Adap. point 1
- **P551.F (0.650)** (0.010 ... 10,000) n contr. Tn1
- **P226.F (0.650)** (0.010 ... 10,000) n contr. Tn2

Droop (with adaptation)

- **P555.F (0)** (0.00 ... 10.00)% n contr. droop Kp1
- **P527.F (0.00)** (0.00 ... 10.00)% n contr. droop Kp2

Enable droop from control word 2

- **P630 (162)** I comp. n contr.

Adaptation of the P gain to Sheet Speed controller 2

- **P556.F (0.00)** (0.000 ... 100.000 %) Adap. point 1
- **P559.F (0.00)** (0.000 ... 100.000 %) Adap. point 2

Speed controller integration time to Sheet Speed controller 2

- **P560.F (0.00)** (0.000 ... 100.000 %) Adap. point 1
- **P563.F (100.00)** (-199.99 ... 0.00 %) Adap. point 2

Speed controller (1)
Compensation of friction  ATTENTION! Do N O T activate, contact sheet 11 for further information

Compensation of moment of inertia (dv/dt - Addition)

- dv/dt * P542
  vom Hochlautgeber
  K0191
  K0168
  P540.F
  K0150
  K0164
  P543.F
  P541.F
  K0152

(0...10000ms) P546.F. (0)
K0173
K0179
K0172
K0171

Sheet 7
Calculator for Diameter (2)

G(s) = \frac{1}{1 + sT1} \cdot Kp \cdot \frac{1}{1 + sTn}

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:

Transfer function:
Stop / Set diameter

Tension control: ON ext. 19.7
Durchm. halten ext. 19.5

Set diameter ext. 19.5
Tension control OFF 13.8

Power On Mode 1
⇒ y = x
⇒ freeze y

Priorität:
1. RESET
2. TRACK
3. STORE

Current diameter 18.7

On / Off delay

Impulsgenerator

1 = Reset

Delayed ON

Mode

Power On Imp.

Stop / Set diameter

Stop diameter

Sheet 9
Variable moment of inertia

\[ J_v = \frac{D^4 - D_{\text{Core}}^4}{D_{\text{max}}^4} \times K \]

- Current diameter: 8.7
- Core diameter: 8.5
- Density of material

Normalization of diameter
US26 (10000) (10...60000mm)
US25 (1)
K9304

Normalization of Core diameter
US27 (10000) (10...60000mm)
K9404

Normalization of max. diameter
US28 (10000) (10...60000mm)
K3003

US29 (1,00)
(0,10...100,00)

\( K \)
Compensation of acceleration and friction

Gear stage 1/2: 19.7

Web width
Var. moment of inertia: 10.7

Characteristic of friction

dv/dt: 4.6
i²: 11.3

Current diameter.
unw./ winder: 19.5
8a.7

Var. moment of inertia
fixed moment of inertia

100,00 %
P406.F (100;00)

P407.F (0.00)
Setpoint processing

- Ramp-up time: U302 (5.00)
- Ramp-down time: U403 (5.00)

Override ramp generator

- 0s: TH
- 0: TR

Current diameter:

1 = Enable simple ramp generator
0 = Set ramp generator to zero

Priority:
1. S (SET)
2. R (RESET)

Stop tension value
P410.F (0.00)

Stop tension value
U310 (0.01) U301 (0.00)

Stop tension value
U301 (0.01) U301 (0.01)

Stop tension value
U301 (0.01) U301 (0.01)

Stop tension value
U301 (0.01) U301 (0.01)

Stop tension value
U301 (0.01) U301 (0.01)

Stop tension value
U301 (0.01) U301 (0.01)

Stop tension value
U301 (0.01) U301 (0.01)

Stop tension value
U301 (0.01) U301 (0.01)

Stop tension value
U301 (0.01) U301 (0.01)

Stop tension value
U301 (0.01) U301 (0.01)

Stop tension value
U301 (0.01) U301 (0.01)

Stop tension value
U301 (0.01) U301 (0.01)

Stop tension value
U301 (0.01) U301 (0.01)

Stop tension value
U301 (0.01) U301 (0.01)

Stop tension value
U301 (0.01) U301 (0.01)

Stop tension value
U301 (0.01) U301 (0.01)

Stop tension value
U301 (0.01) U301 (0.01)

Stop tension value
U301 (0.01) U301 (0.01)

Stop tension value
U301 (0.01) U301 (0.01)

Stop tension value
U301 (0.01) U301 (0.01)

Stop tension value
U301 (0.01) U301 (0.01)

Stop tension value
U301 (0.01) U301 (0.01)

Stop tension value
U301 (0.01) U301 (0.01)
Tension Control Enable

- Tension feedback value < limit or actual position < 18.8
- Tension feedback value > limit

Tension Control ON

- Tension Control ON external
- Tension Control OFF

Tension Setpoint

- Tension setpoint after CH: 12.7
- Tension setpoint for external Tension Control

Smooth.

- Normalization: -200.0...+199.99V
  - P752 (10.00)

Offset

- -10.00...+10.00V
  - P754 (0.00)

D/A

- X175: 14

- X15: 15
Switching logic for Tension-/position control

Dancer control: 9.5
Un/Winder: 19.5
Ind. tension control: 19.5

Bias for speed controller:
if tension control is activated
P.405.F (10.00)

Tension/position control output: 15.8
Additional speed setpoint

Enable Tension/pos. cont.
Determination of moment setpoint if tension control is active

Output Tension/Pos. Contr. 13.8
Tension setpoint 12.7

Moment feedback value if tension control is active

Moment feedback value if tension control is active

Normalization of moment setpoint

Plant model F (100,00)

Normalization of moment setpoint

Sheet 16
Web break recognition (1)

Adjustment of moment setpoint - actual value diff.
P402.2 (100,00)

Hysteresis
0,00...199,99
U199 (0,00)

Minimum tension or dancer roll endposition

Hysteresis
0,00...199,99
U202 (0,00)

Maximal allowed moment deviation

Hysteresis
0,00...199,99
U199 (0,00)

Hysteresis
0,00...199,99
U199 (0,00)
Web break recognition (2)

Tension actual value < limit or position actual value > limit

Web break ext. 19

Tensioncontrol OFF delayed 13.8

U447 (5,000) (0,000...60,000s) U448 (0)

Delayed ON

Mode

U446 (0) B9190

B

U445 (1) B9483

B

U450 (2,000) (0,000...60,000s) U451 (0)

Delayed ON

Mode

U449 (0) B9352

B

Web break int.

U450 (2,000) (0,000...60,000s) U451 (0)

Delayed ON

Mode

U449 (0) B9352

B

Web break int.

U450 (2,000) (0,000...60,000s) U451 (0)

Delayed ON

Mode

U449 (0) B9352

B
Setting Controlword 3

- **157**: Maneuver
- **158**: Set diameter
- **159**: Hold diameter ext.
- **160**: Wickeln von oben/unten
- **161**: Unwinder/Winder
- **162**: Dancerollcontrol
- **163**: Dir./ind. tensioncontrol
- **164**: Gearstage 1/2
- **165**: Stop tension
- **166**: Tension Control ON ext.
- **167**: Web break ext.
Statusword 3

Tension control ON: 13.4
Tension controller operates in limit: 15.8
Web break: 18.3
Speed limit succeeded

Bitfield 4
Binector / Connector changer 1

Statusword 3
6.5 Parameter list

The Parameterlist can be found on the SIMOREG DC Master CD-ROM (Order.No.: 6RX1700-0AD64).
Directory: “Applikationen_d”
Filename: “achswickler.dnl”

After the installation of SIMOVIS, the file “achswickler.dnl” has to be copied to the following folder:

\SIMOVIS\PROJECTS\DRIVES\SIMOREG DC MASTER\n
The “achswickler.dnl” file can be printed or downloaded to 6RA70 memory. For more SIMOVIS specific information please contact the SIMOVIS manual.

After download file "achswickler.dnl" has been transferred, parameter U969 must be set to 4. This ensures that unconnected function blocks are deselected and any connected function blocks are selected (activated) if they are not selected already.