



SIMOREG DC Master

6RA70 Series

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

Application
Center winder



NOTE

These application 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.

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**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.

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We have checked that the contents of this publication agree with the hardware and software described herein. Nonetheless, differences might exist and therefore we cannot guarantee that they are completely identical. The information given in this publication is reviewed at regular intervals and any corrections that might be necessary are made in the subsequent printings. Suggestions for improvement are welcome at all times.

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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 1.8 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 5.2 „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 limiter.

The pilot control value, derived from the tension set point, influences the limiter 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 continuous 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 it's 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.

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

3.11.2 Transmit data to top level control

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

Word	Parameter	Bit	Label	Note
1	U734.01		status word 1	Status word 1 according to user manual.
2	U734.02		status word 2	Status word 2 according to user manual.
3	U734.03		status word 3	Status word for winder/coiler status K9113
		0	Tension control is ON	1.....ON
		1	Tension control limit reached	1.....limit reached
		2	Web break	1.....Web break
		3	speed limit succeeded	1.....n>>
		4	Reserved	
		5	Reserved	
		6	Reserved	
		7	Reserved	
		8	Reserved	
		9	Reserved	
		10	Reserved	
		11	Reserved	
		12	Reserved	
		13	Reserved	
		14	Reserved	
		15	Reserved	
4	U734.04		Instantaneous speed value	K0179
5	U734.05		Instantaneous current value	K0109
6	U734.06		Instantaneous value of moment	K0142
7	U734.07		Current diameter	K9304
8	U734.08		Instantaneous tension value	K9240
9	U734.09		Output of tension control	K9249
10	U734.10		Reserved	
↓	↓	↓	↓	↓
16	U734.16		Reserved	

3.11.3 Analog input

Maneuver set point:

analog input main set point X174: 4-5

value range: -10V.....+10V

tension / position feedback value1

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:

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

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 winder's core mass is relatively small, or the gear ratio rather large, the moment of inertia can be considered irrelevant.

moment of inertia solid cylinder

$$J = \frac{\pi * \rho * b * D^4}{32} \quad [\text{kgm}^2] \quad \text{moment of inertia hollow cylinder}$$

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

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 %.

Requirement : $D = D_{core}$ and $t_b = t_n$

Determining the value for parameter P407

$$M_{bF} = \frac{J_F * n_N * i}{2,865 * D_{Core} * P_N} * \frac{\Delta V}{t_b} \quad [\%]$$

Determining the value for parameter P407

$$P407 = \frac{M_{bF} * t_h}{P542} * 100\%$$

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.

$$J_{v \max} = \frac{\Pi * \rho_{\max} * b_{\max} * (D_{\max}^4 - D_{\text{Core}}^4)}{32 * i^2} \text{ [kgm}^2\text{]}$$

Calculation of percental moment of acceleration corresponding to the related current in %
Requirements: D = D_{max}, t_b = t_h and J_F = 0

$$M_{bV} = \frac{b_{\max} * \rho_{\max} * (D_{\max}^4 - D_{\text{Core}}^4) * n_N}{29,18 * i * D_{\max} * P_N} * \frac{\Delta V}{t_b} \text{ [%]}$$

Determining the value for Parameter U529:

$$U529 = \frac{M_{bV} * t_h}{P542} * 100\%$$

4.3 Formulas and dimensions

b	web width [m]
D	diameter [m]
D _{max}	maximum diameter [m]
D _{Core}	diameter of winder - core [m]
i	gear ratio
J _F	constant moment of inertia (motor, Gear, winder - core) corresponding to shaft of motor [kgm ²]
J _v	variable moment of inertia result of windup material corresponding to shaft of motor [kgm ²]
M _{bF}	maximum moment of acceleration corresponding to J _F [% of MN]
M _{bV}	maximum moment of acceleration corresponding to J _{vmax} [% of MN]
M _N	rated moment of motor [Nm]
n _N	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]
Δv	speed difference [m/min]
ρ	specific weight (density) [kg/dm ³]

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: i₁=4, i₂=5.....→ 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 between
- ◆ 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

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

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

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

U261: Sets the integration time for the calculator of the diameter.
If fast diameter changes can occur (f.e. high system speed, small diameter, thick Materials), it might be required to reduce the value of U261.
The integration time has to be $\leq$ the maximal possible diameter reduction of the winder.

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

P406: Gear stage 2.
The value is calculated as follows: $i1/i2$.
f.e. $i1=4, i2=5 \rightarrow P406 = 4/5 = 80\%$

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:

$$U539.01 = \frac{188,5 * U537.01 * D_{Core}}{v_{max}} \quad [s]$$

D_{Core} Diameter of core [m]
 v_{max} Maximum system speed [m/min]

6 Appendix

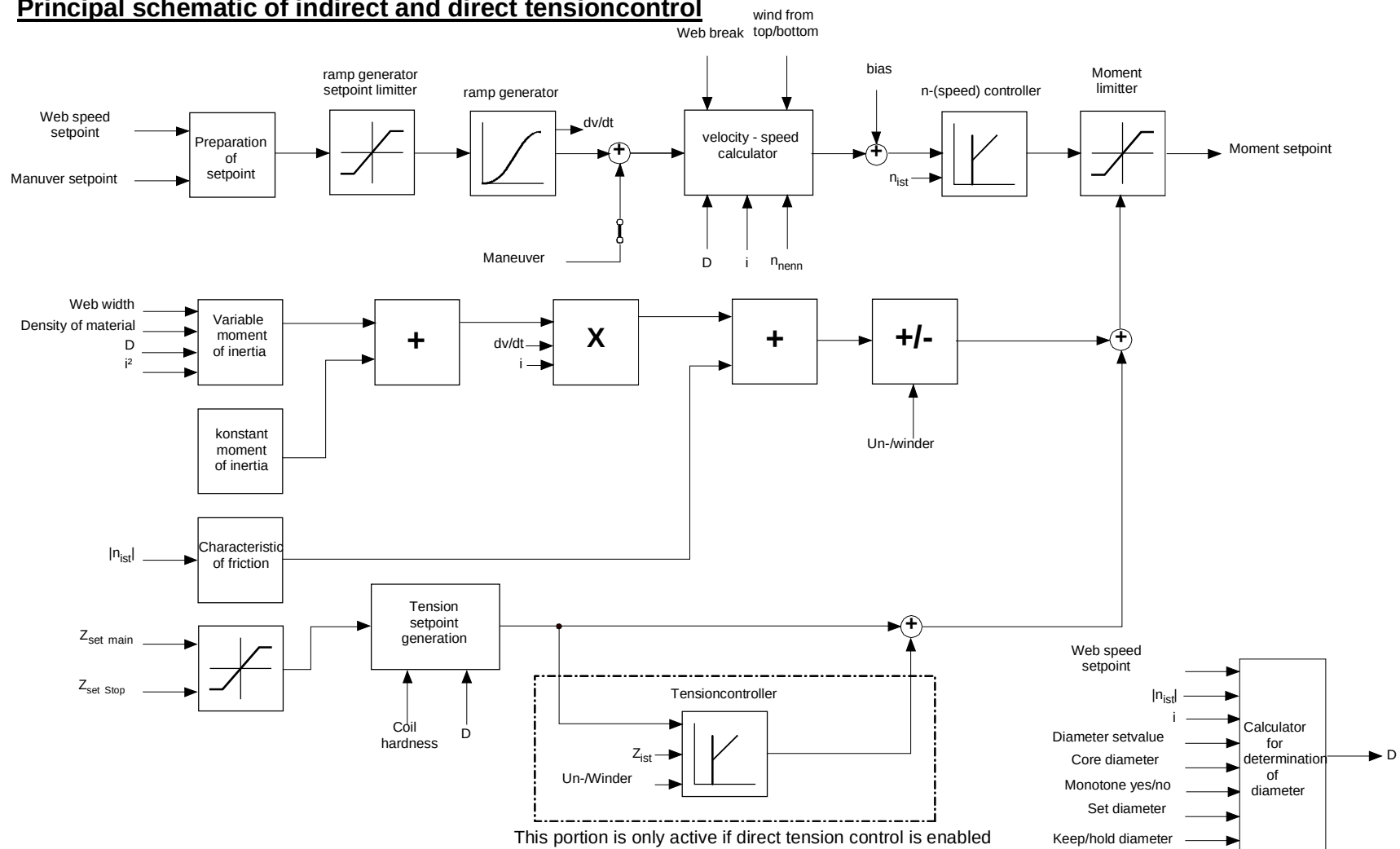
6.1 List of freely assignable function Blocks used

Block type	Blocknumber
Binector/connector converter	13
Average value during n cycles	16
Adders/Subtractors	20,21,22,23,24,25
Sign inverters	35,36
Switchable sign inverters	40,41
Dividers	45,46,47
Multipliers	50,51,52,53,290.....297
High resolution Multipliers/Dividers	55
Absolute value generators with filter	60,61
limiters	65
Limit-value monitors without filters	73,74
Tracking-/storage element	82
Analog signal selector switches	93.....99
Integrators	101
Characteristic Blocks	106,107,108
Simple ramp-function generator	113
Technology controller	114
Velocity-/speed controller	115
Variable moment of inertia	116
multiplexer	86,87
AND – elements	120.....129
OR – elements	150.....167
Inverters	180.....190
RS-flipflop	215
Timers	240.....245
Binary signal selector switch	250,251
PI-controller	260

6.2 List of settable fixed values used

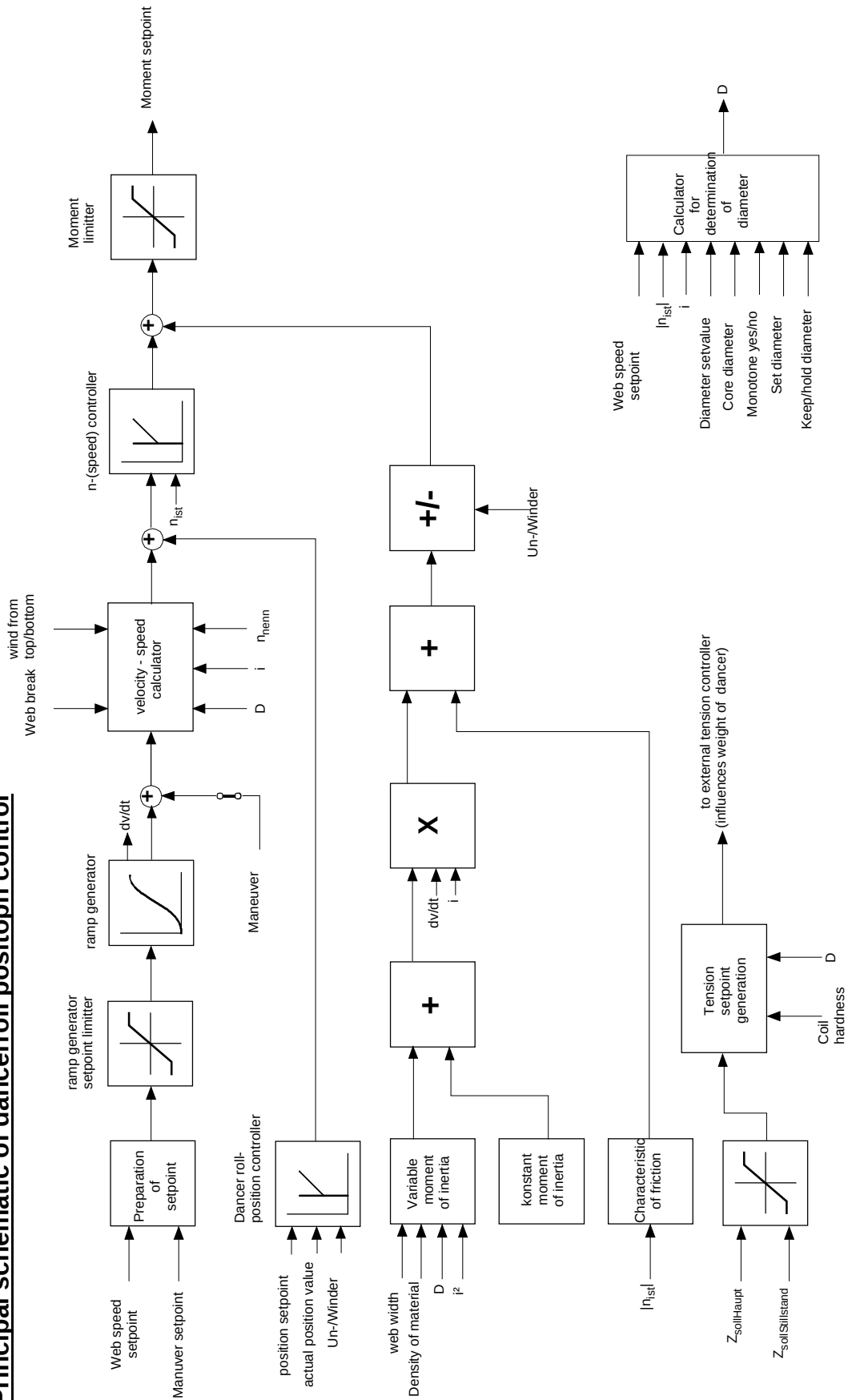
Parameter	Function
P401	Inching set point
P402	Adjustment of set point – actual value difference of moment for web break recognition
P403	Fine tuning of web (system) speed
P404	Diameter of core in % of D_{max}
P405	Bias for Speed controller in conjunction with direct and ind. tension cont.
P406	i gear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

6.3 Schematic diagram of control types

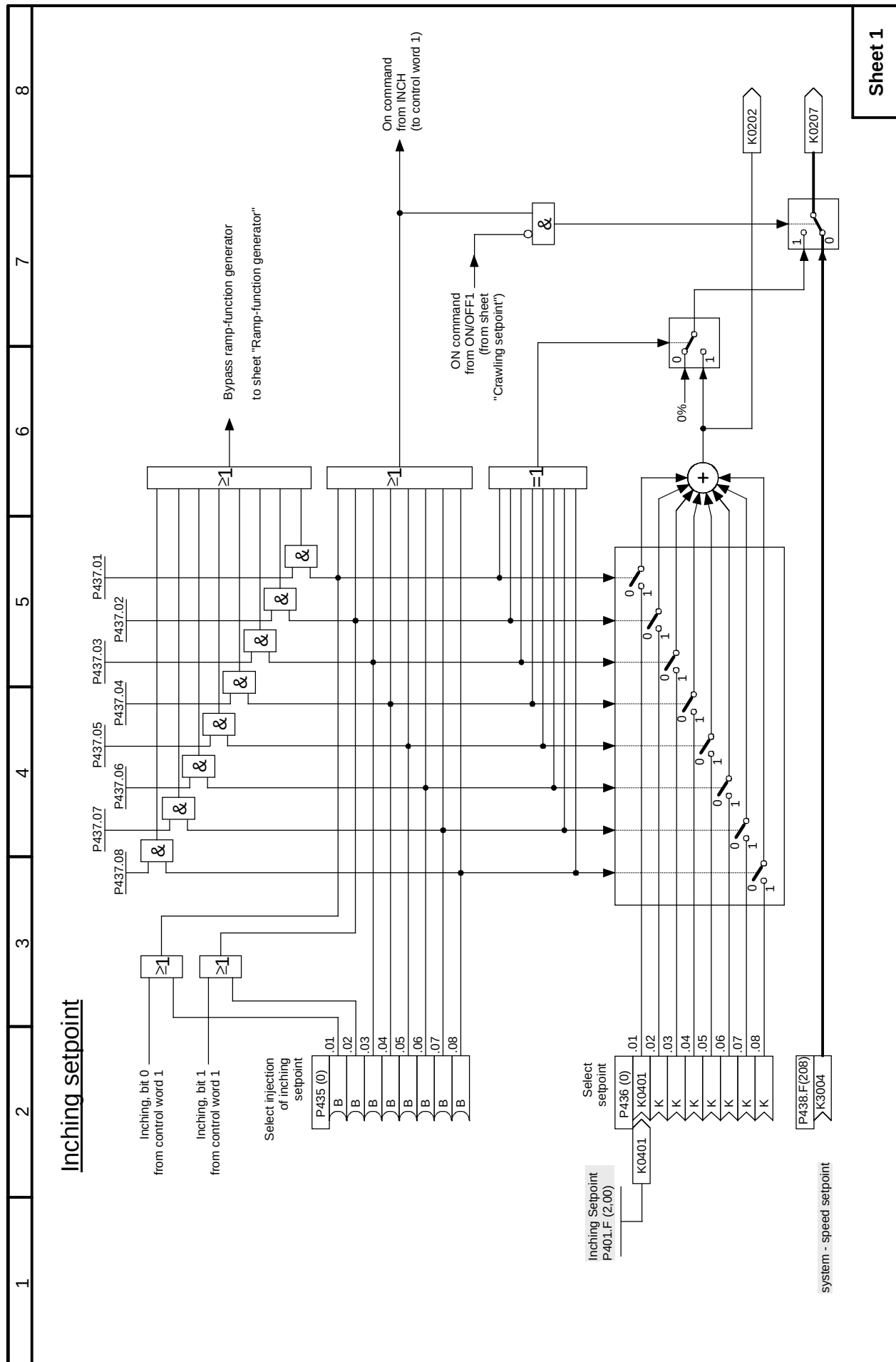
Principal schematic of indirect and direct tension control

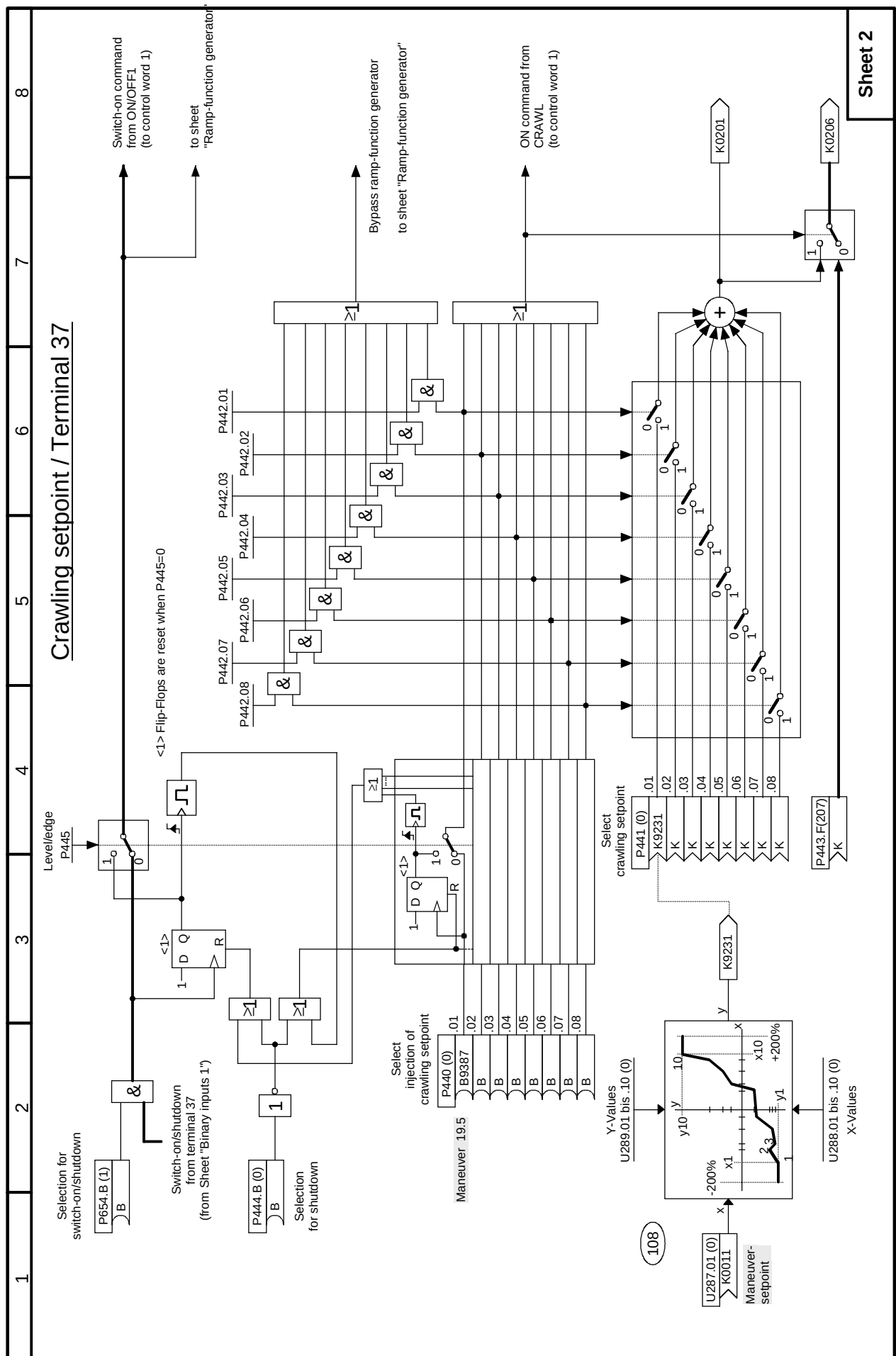
Sheet A

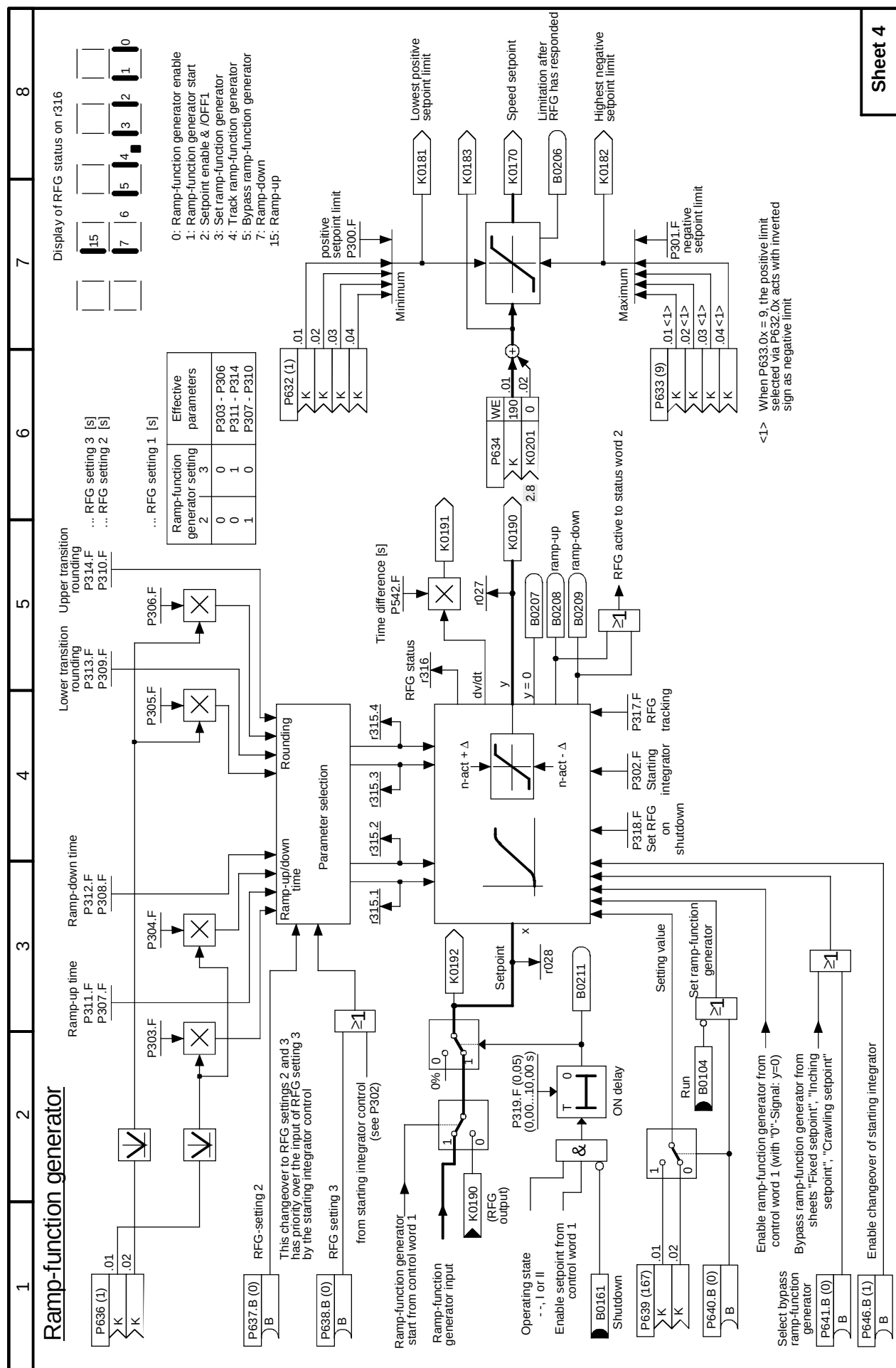
Principal schematic of dancerroll positopn control

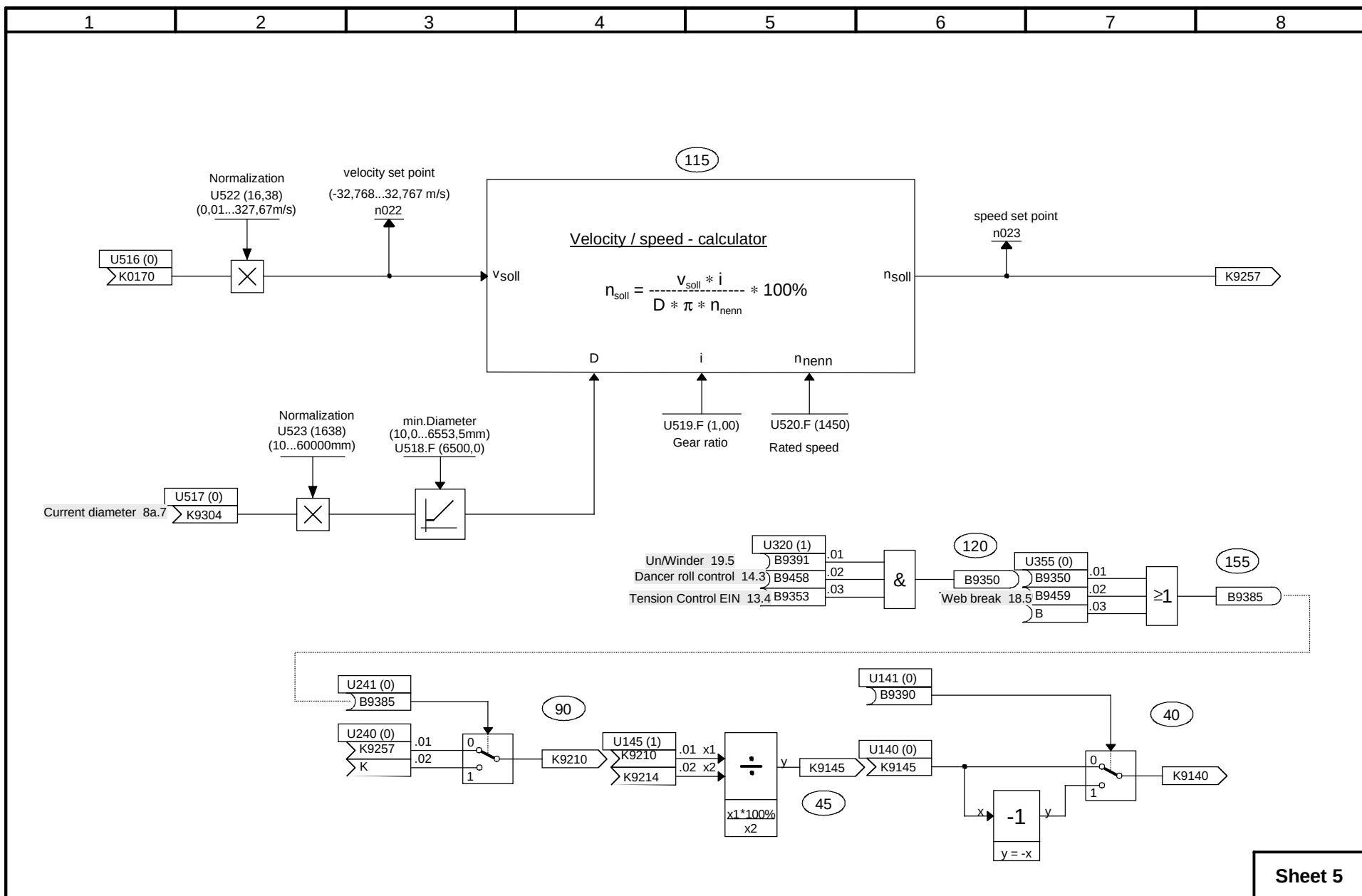


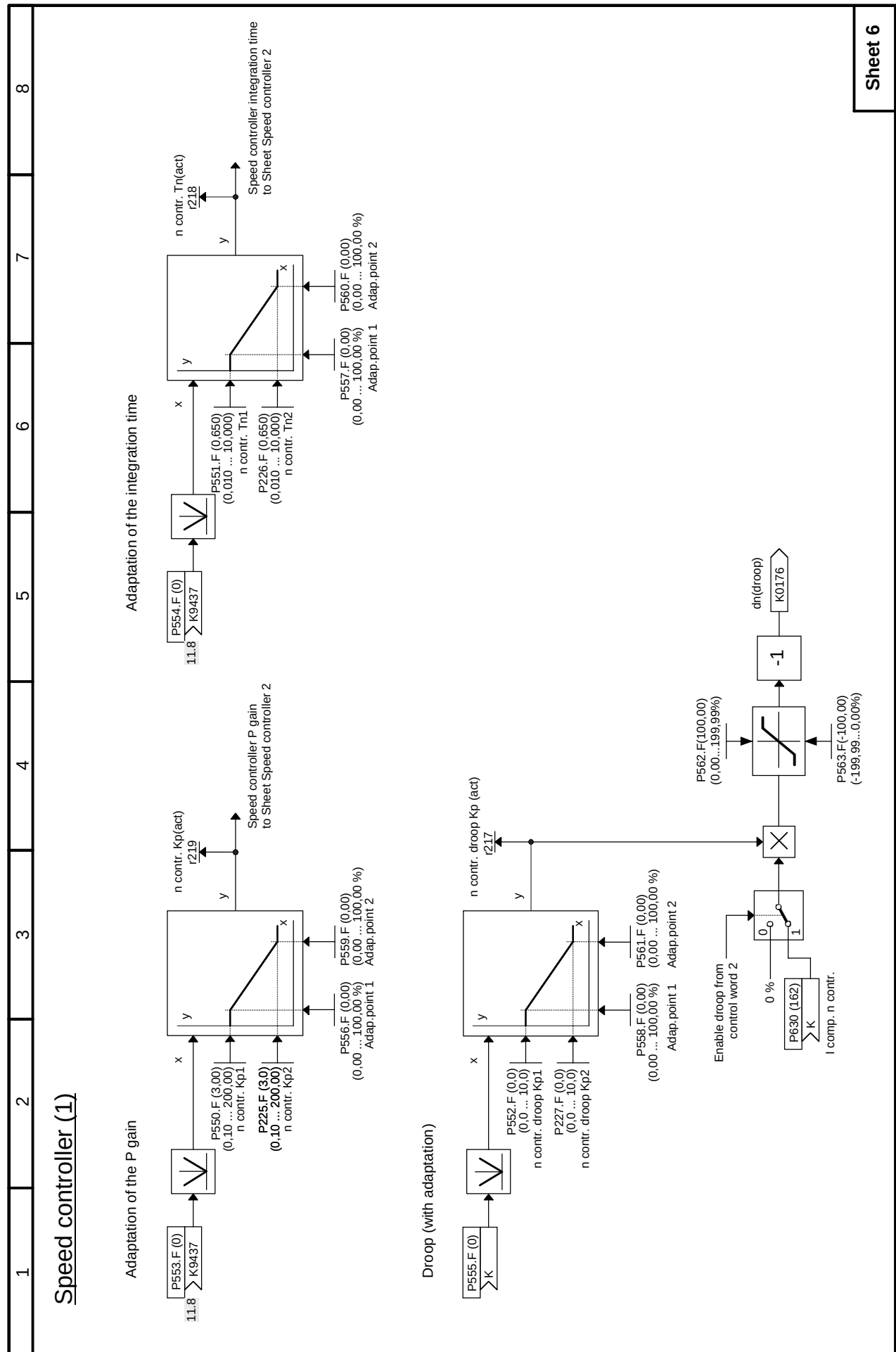
6.4 Detailed schematics











1

2

3

4

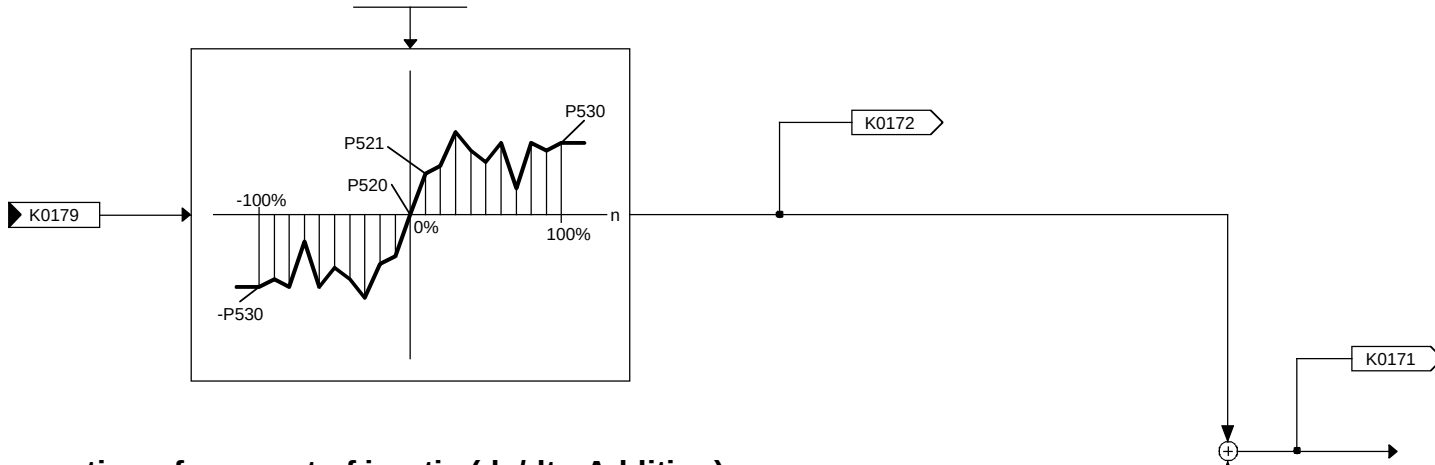
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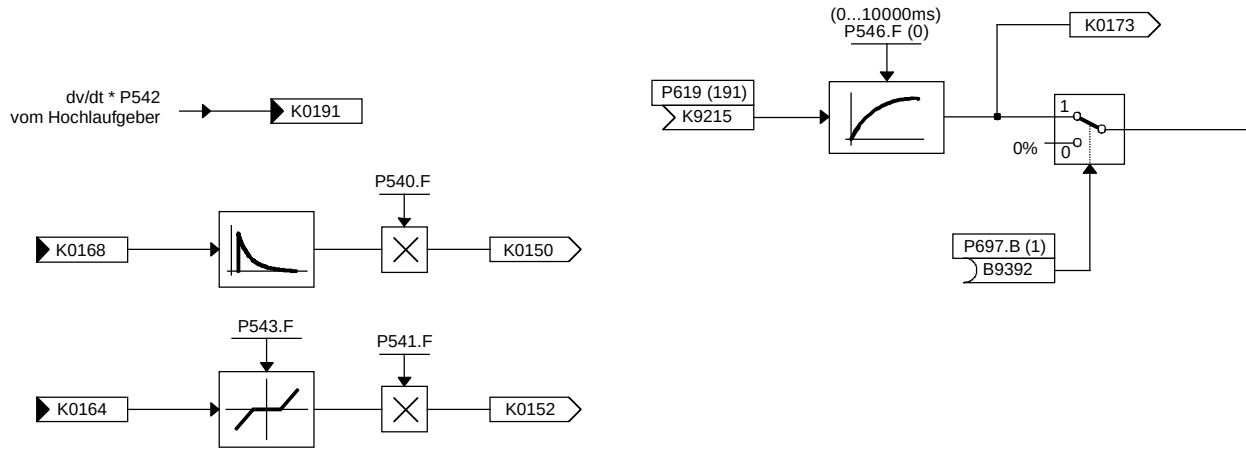
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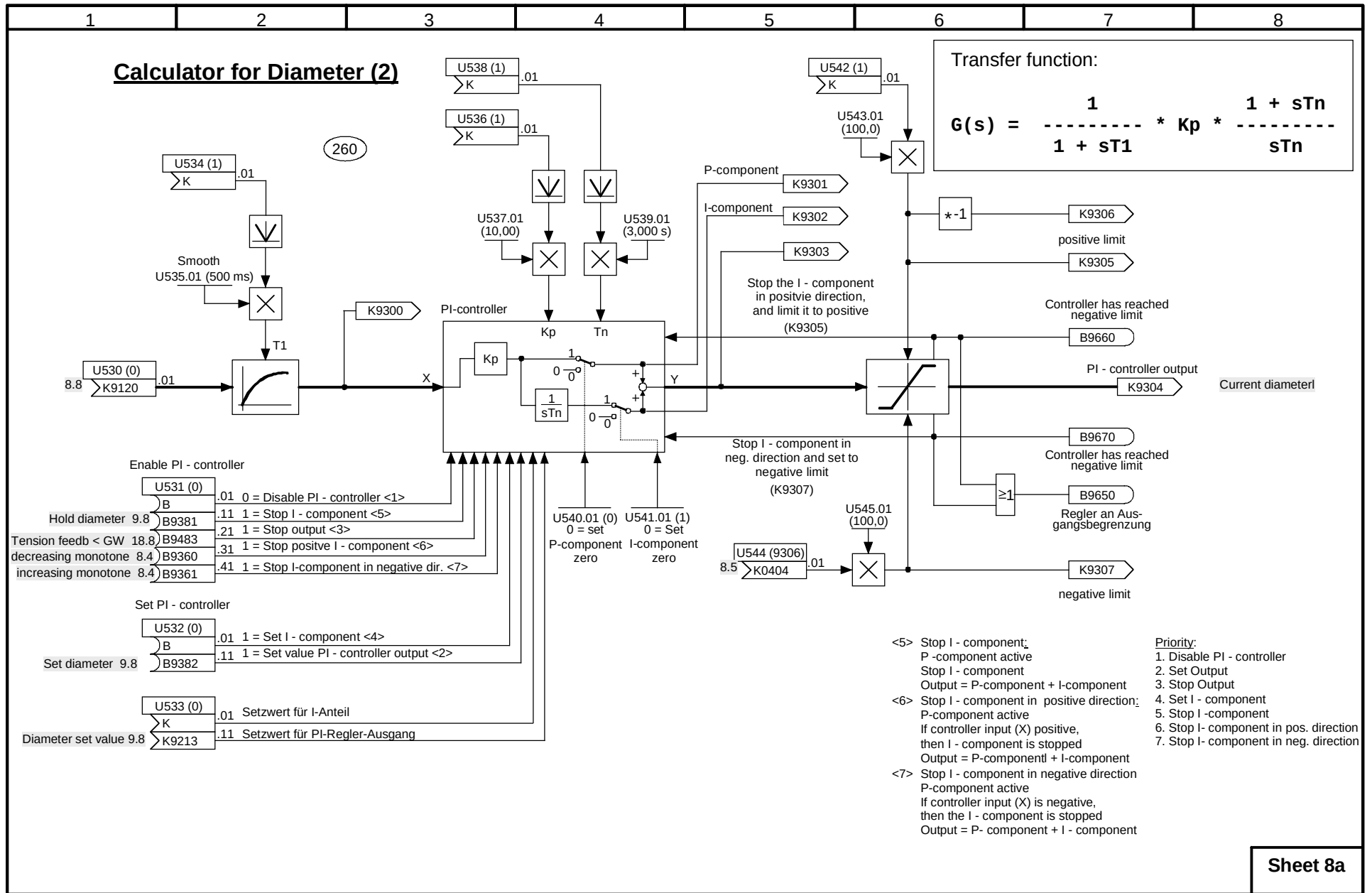
8

Compensation of friction ATTENTION! Do N O T activate, contact sheet 11 for further information

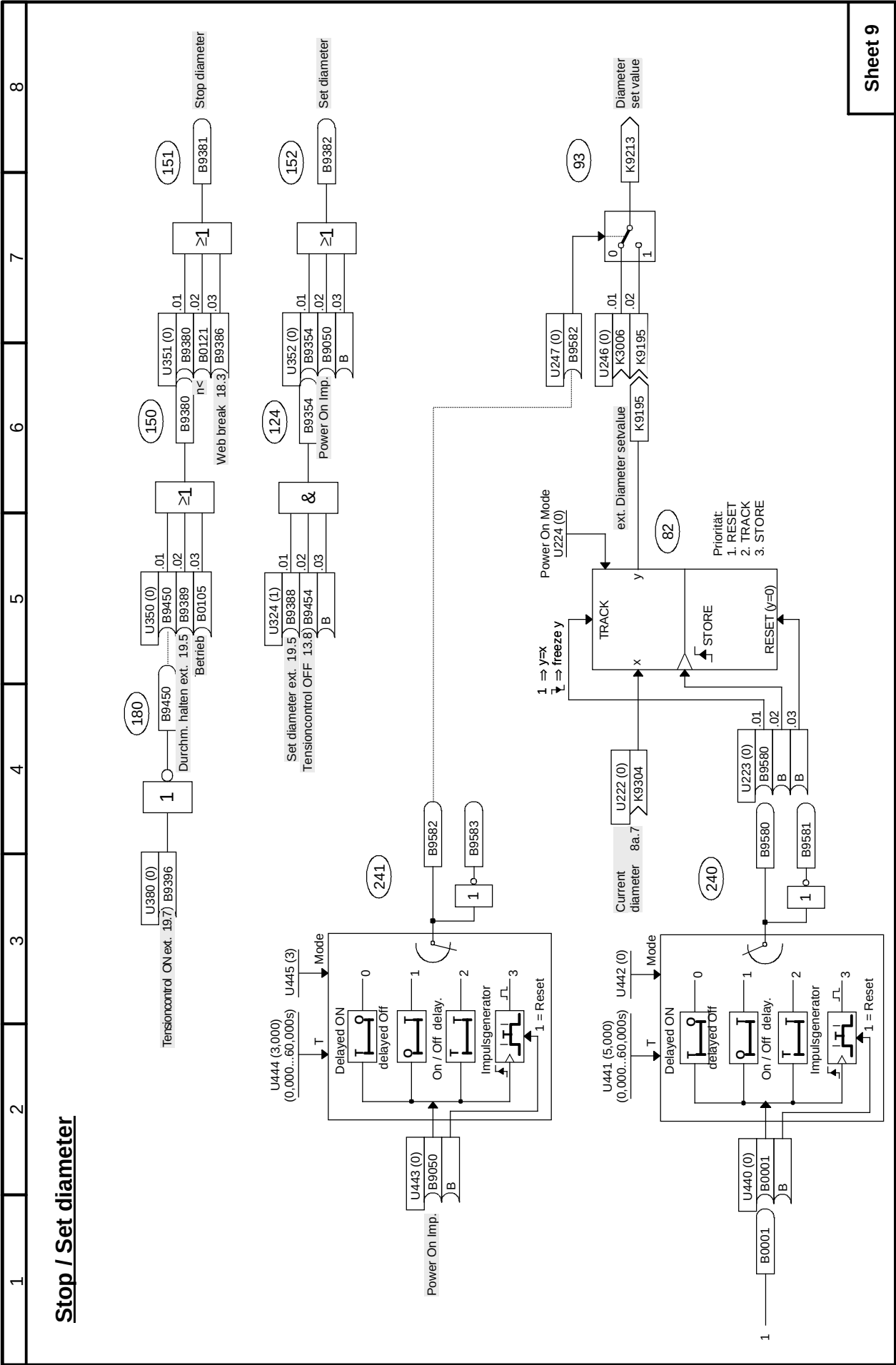


Compensation of moment of inertia (dv/dt - Addition)



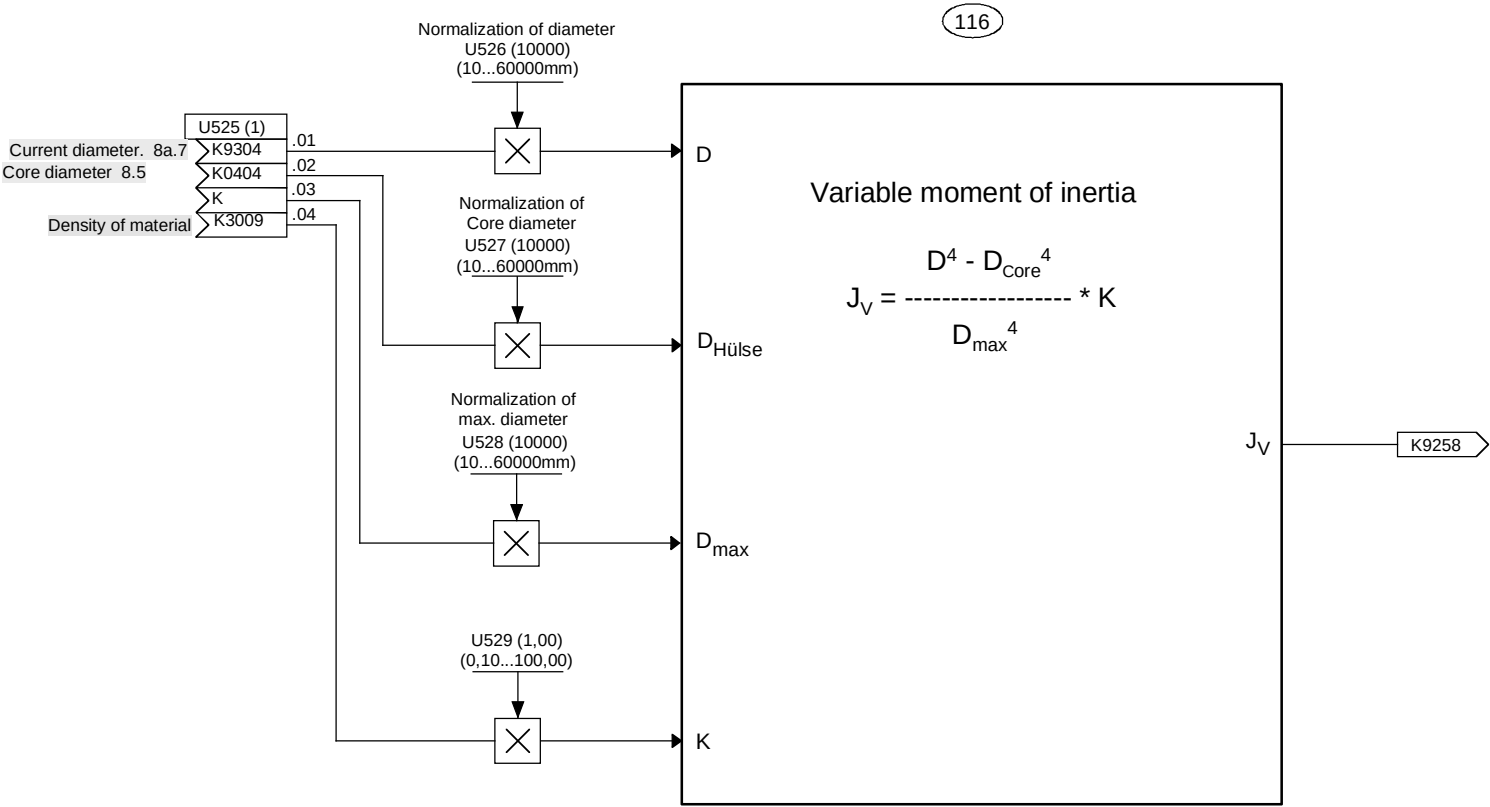


Sheet 8a

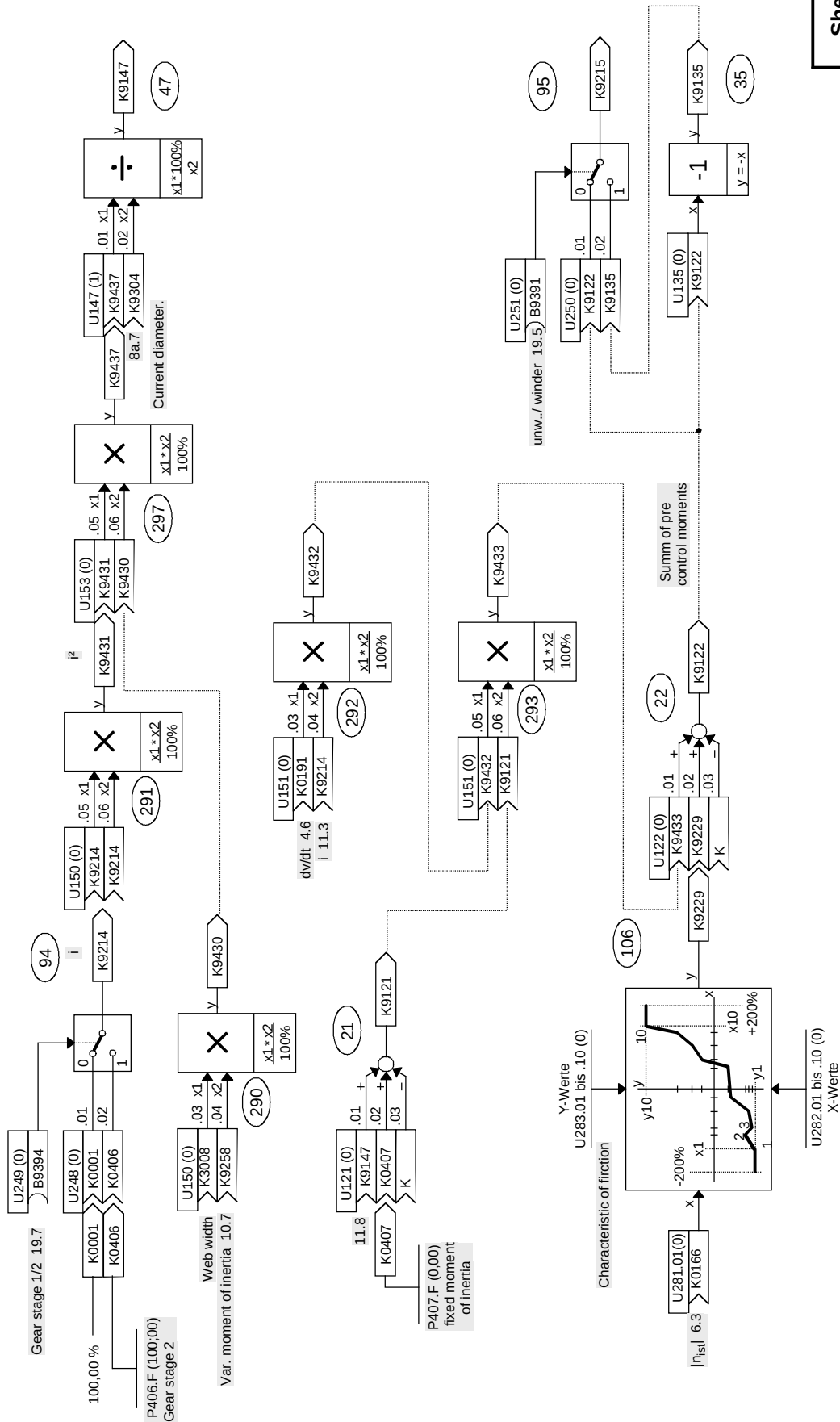


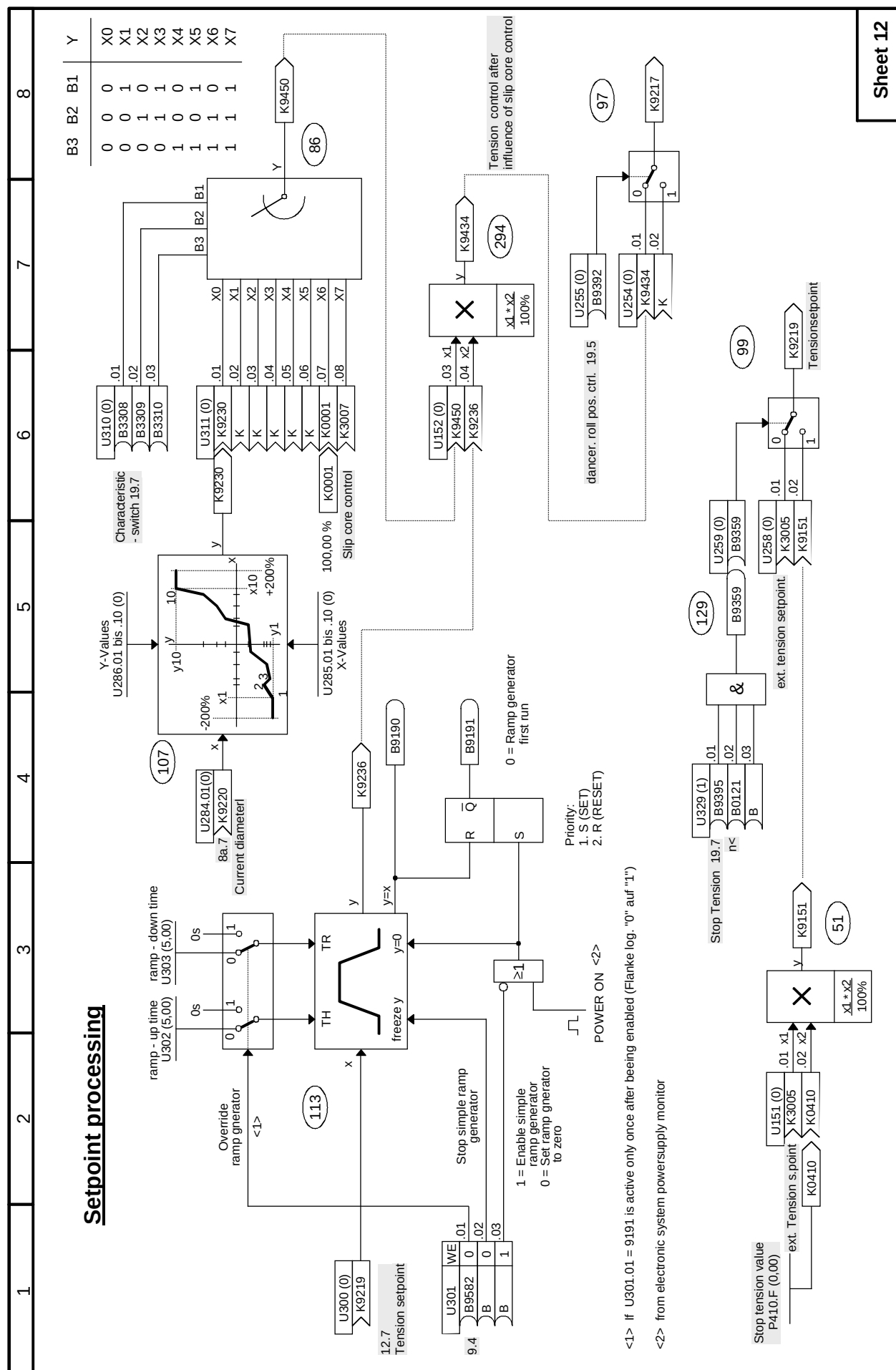
1 2 3 4 5 6 7 8

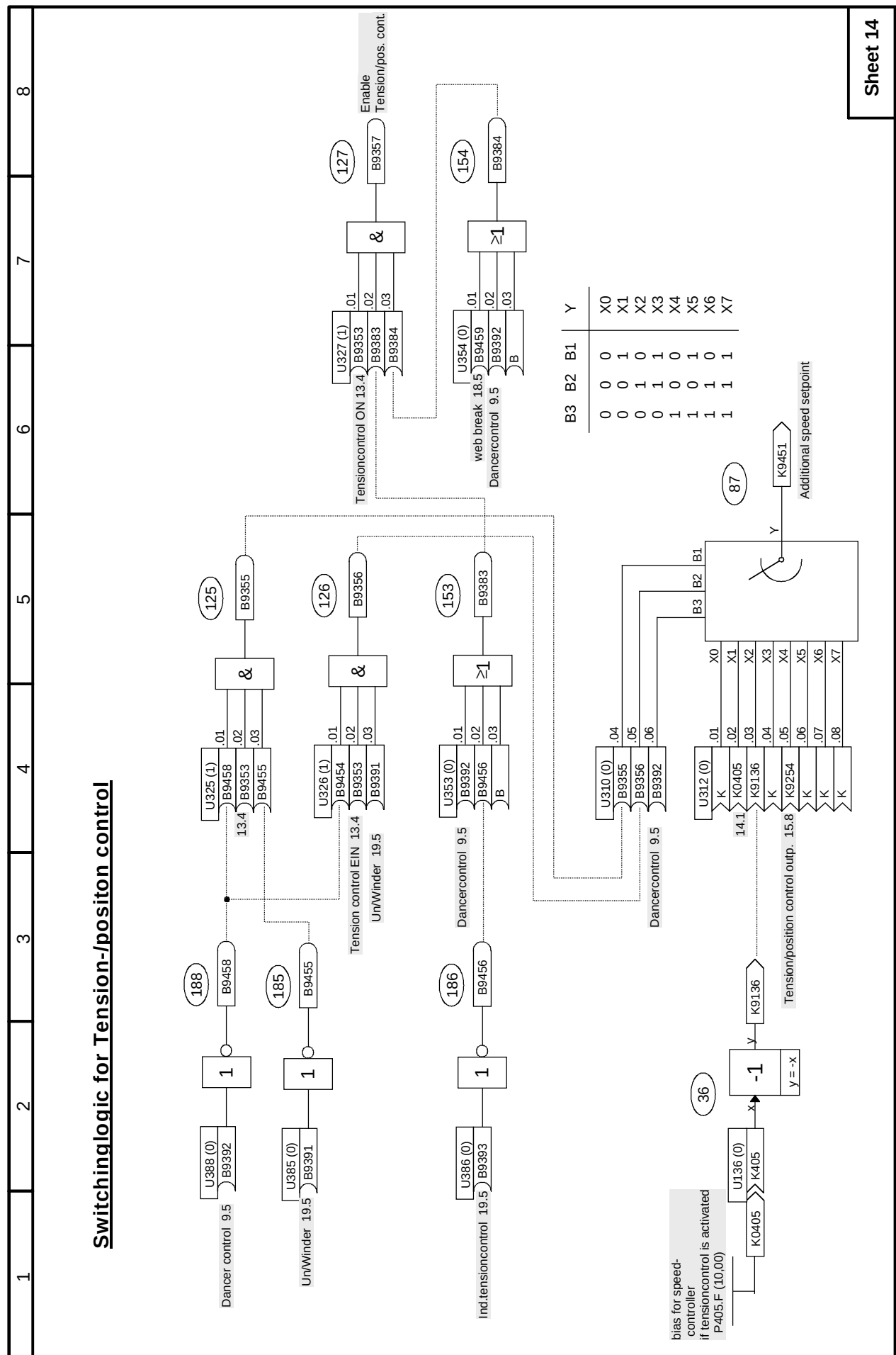
Variable moment of inertia



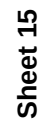
Compensation of acceleration and friction





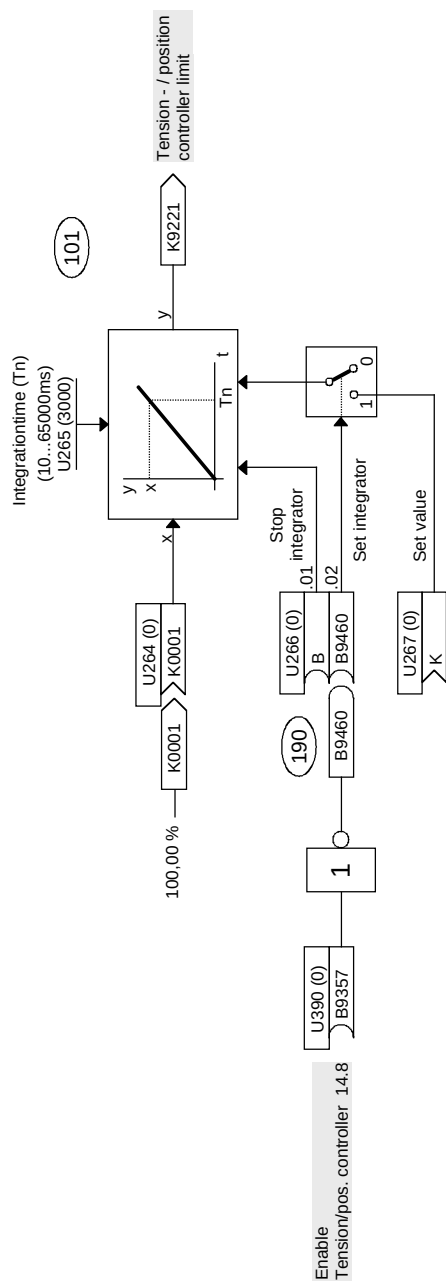


Sheet 14

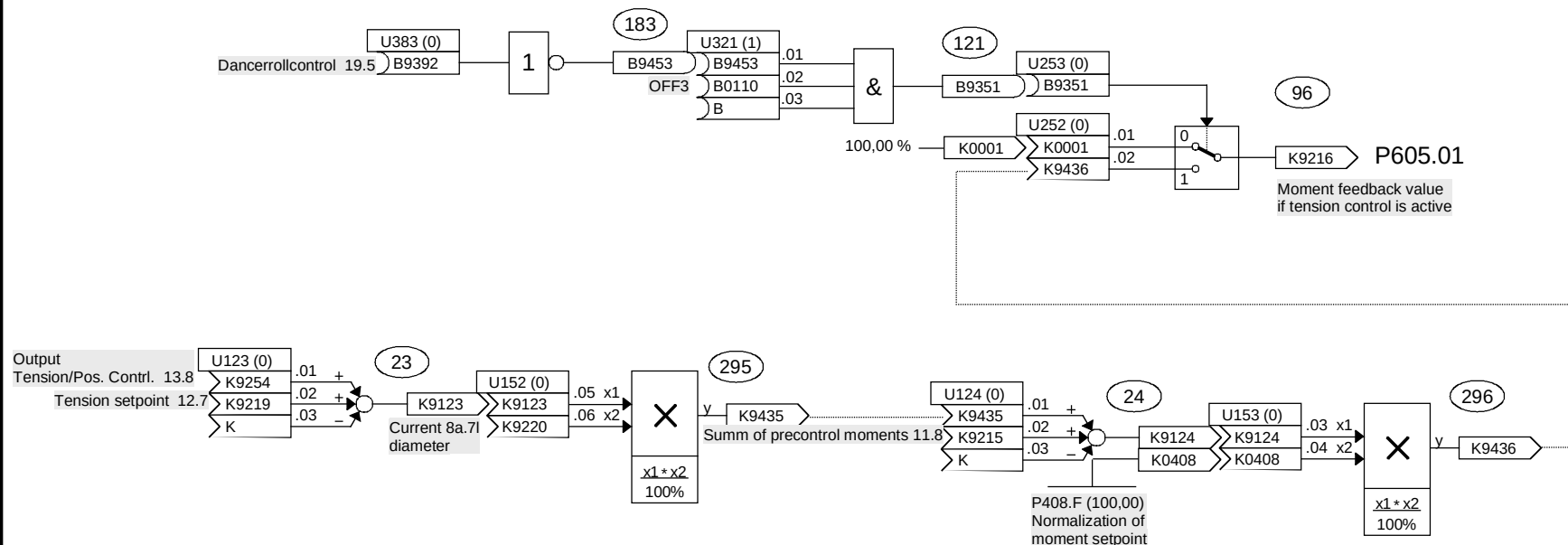


$<1> 0$ = D-component influences only the feedback channel
 1 = Normal PID-Regler: D-component is active for control deviation

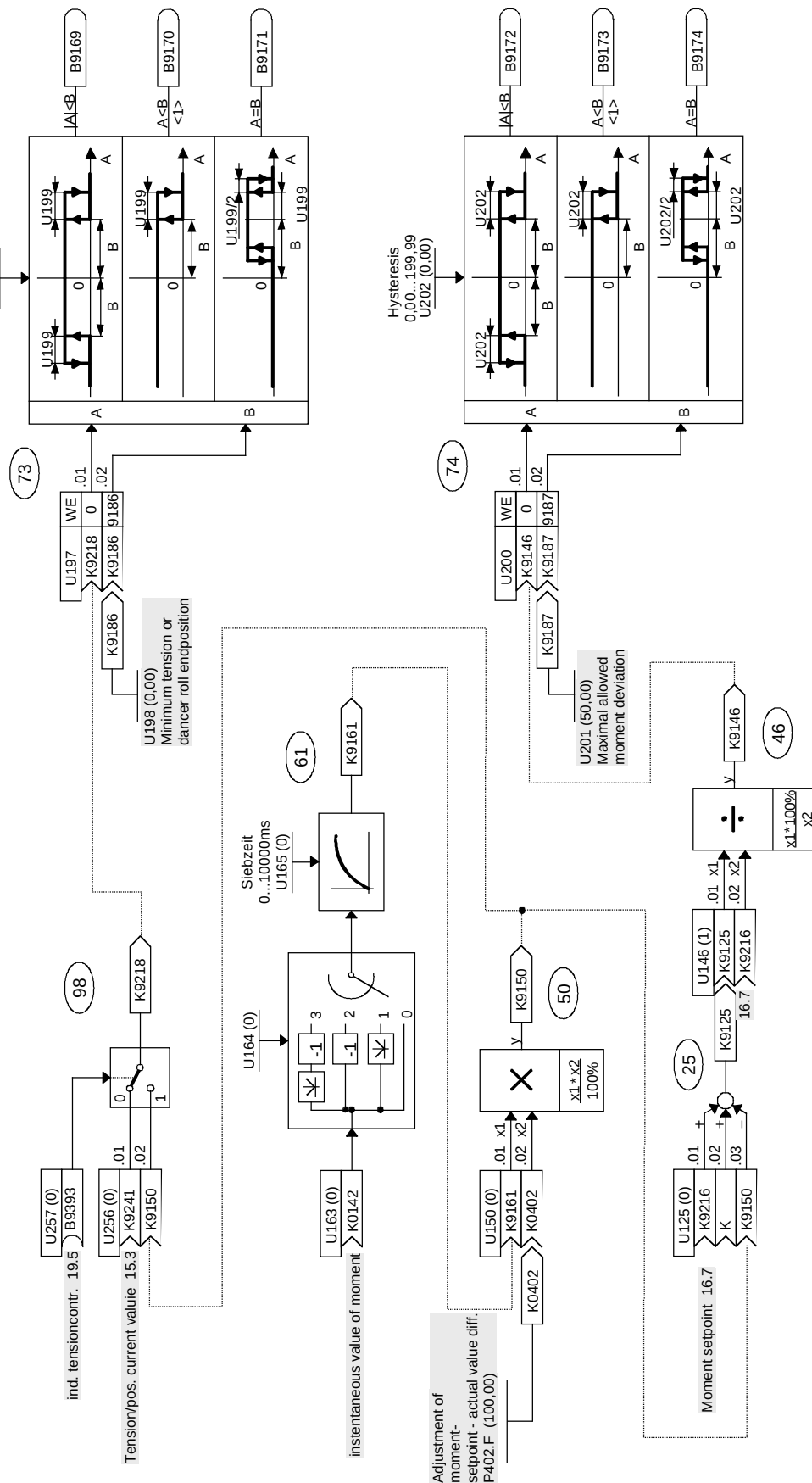
Tension-/position controller (2)

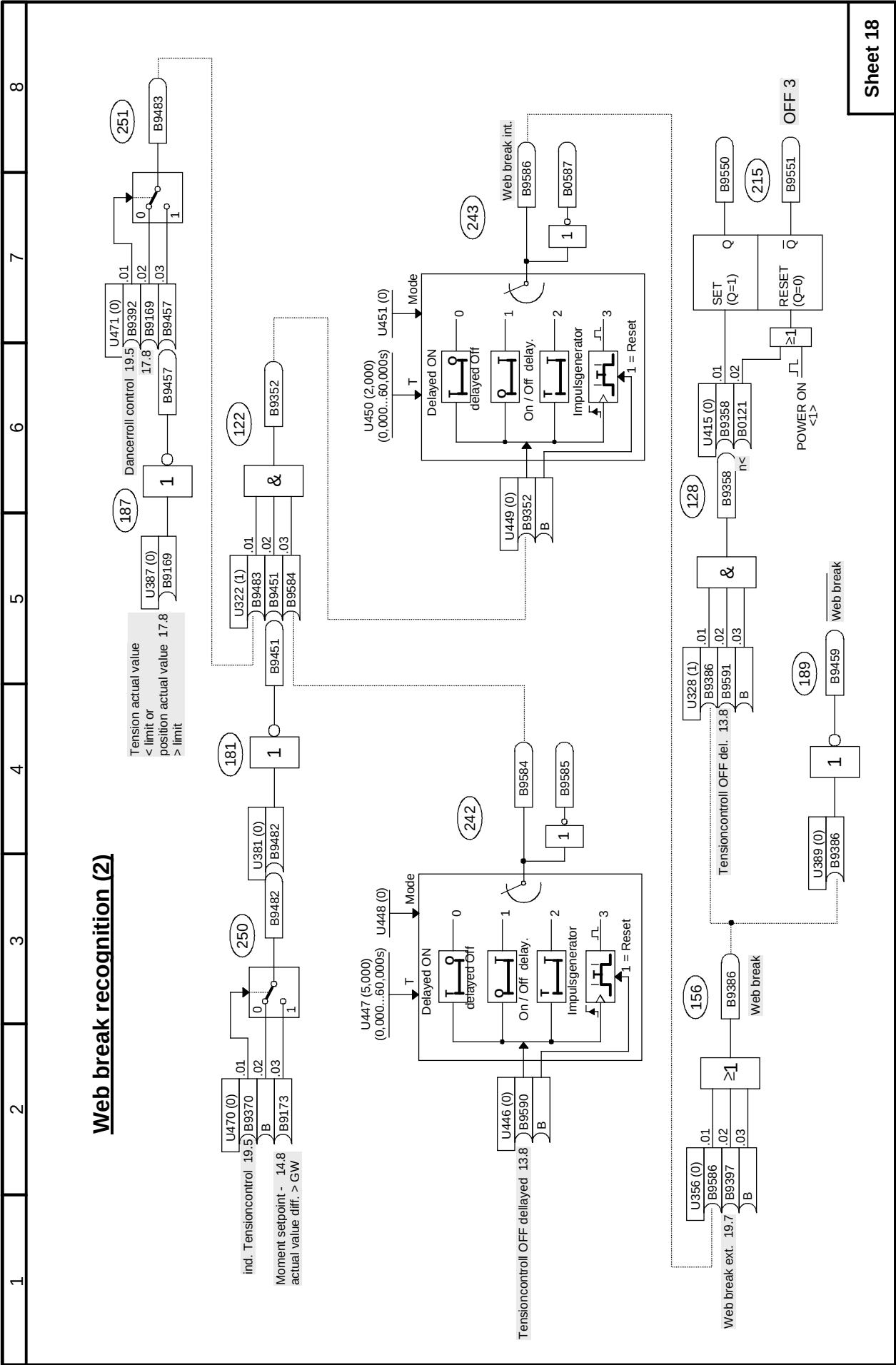


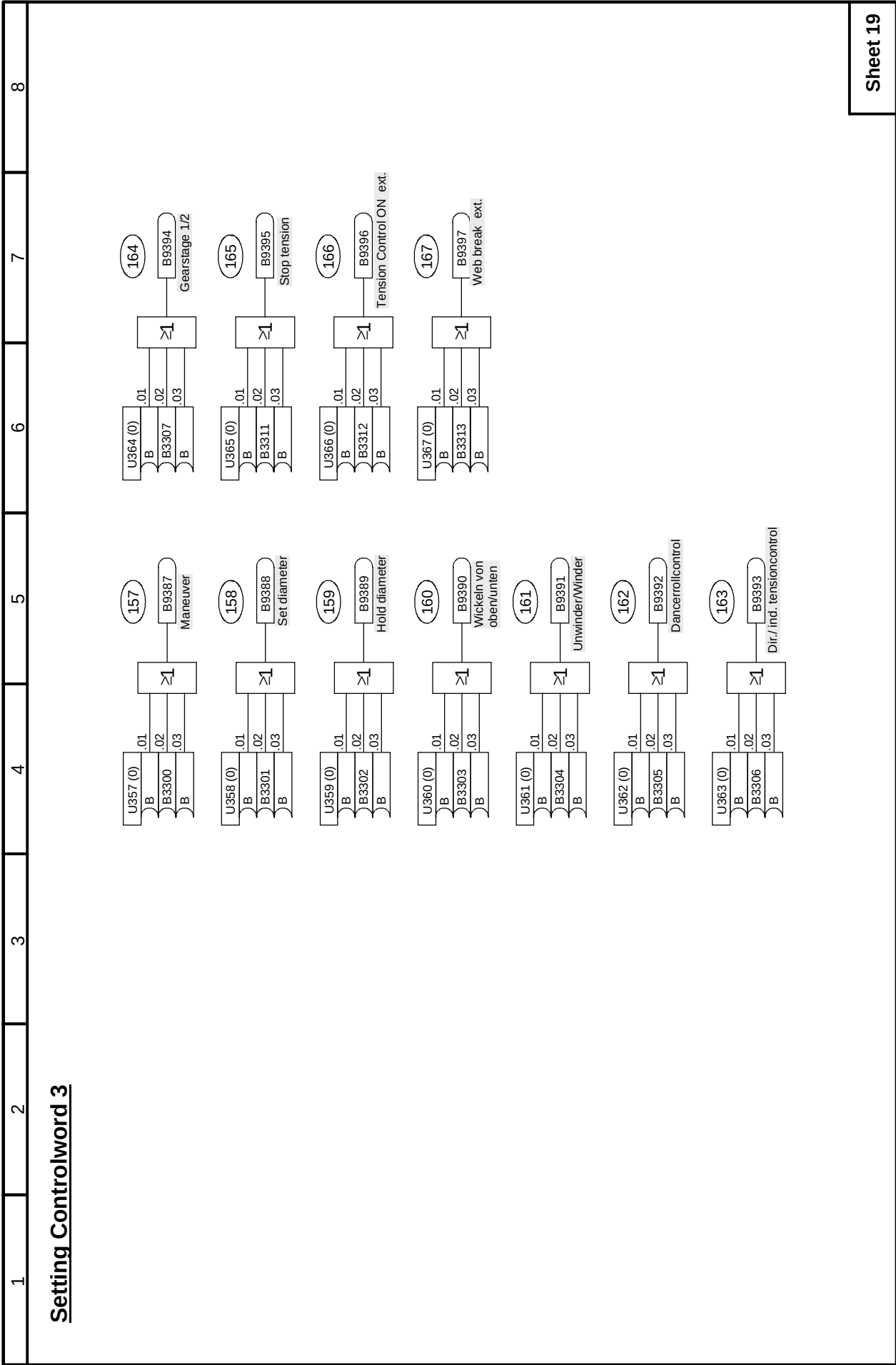
Determination of moment setpoint if tensioncontrol is active

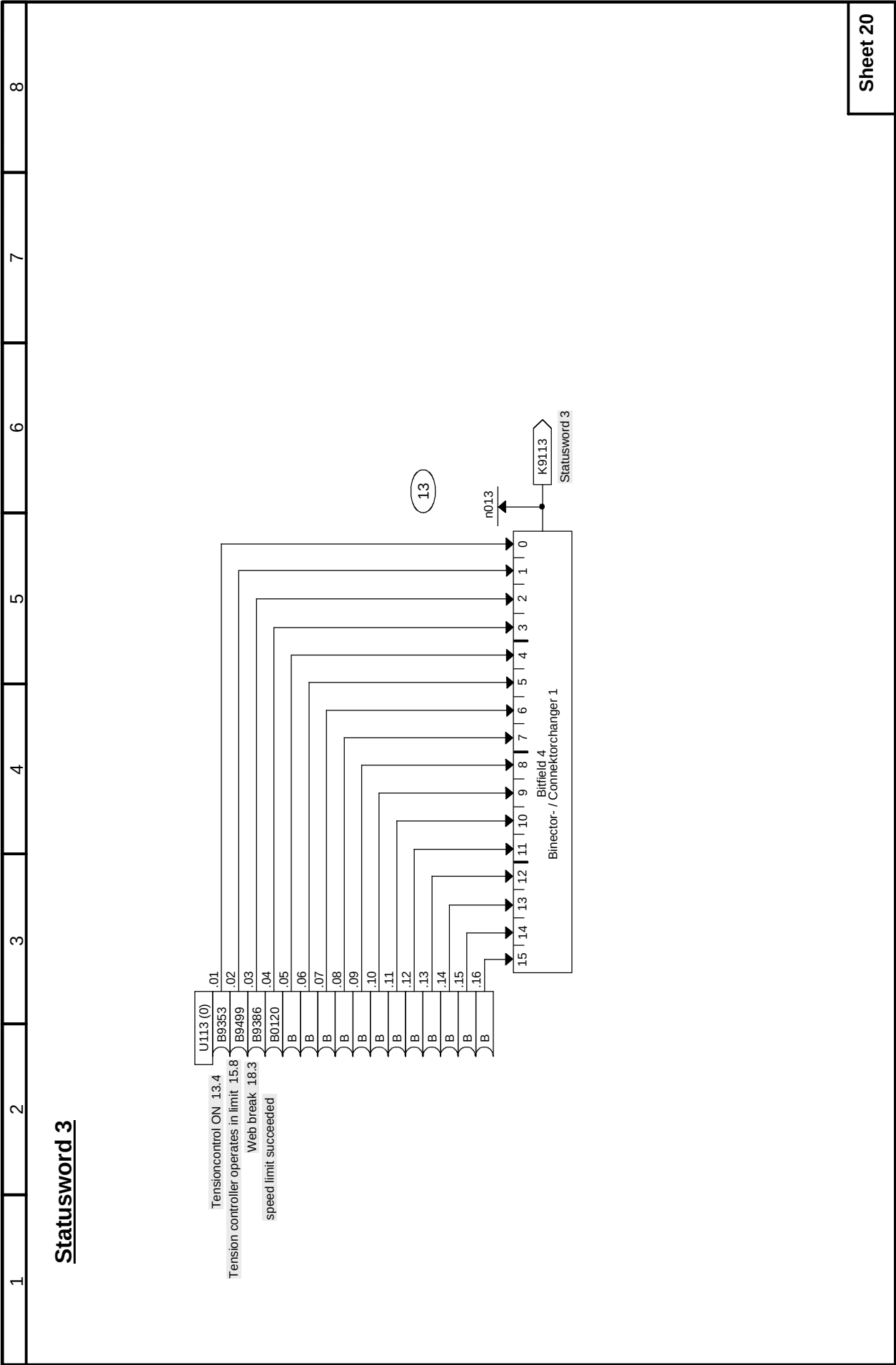


Web break recognition (1)









6.5 Parameter list

The Parameterlist can be found on the SIMOREG DC Master CD-ROM (Order.No.: 6RX1700-0AD64).

Directory: "SIMOVIS"

Filename: "achswickler_V1.8.dnl"

After the installation of SIMOVIS, the file "achswickler_V1.8.dnl" has to be copied to the following folder:

\SIMOVIS\PROJECTS\DRIVES\SIMOREG DC MASTER\

The "achswickler_V1.8.dnl" file can be printed or downloaded to 6RA70 memory. For more SIMOVIS specific information please contact the SIMOVIS manual.

