Dokumentation
for the
Winding Controller BE 7

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Principle Function of Winding Control

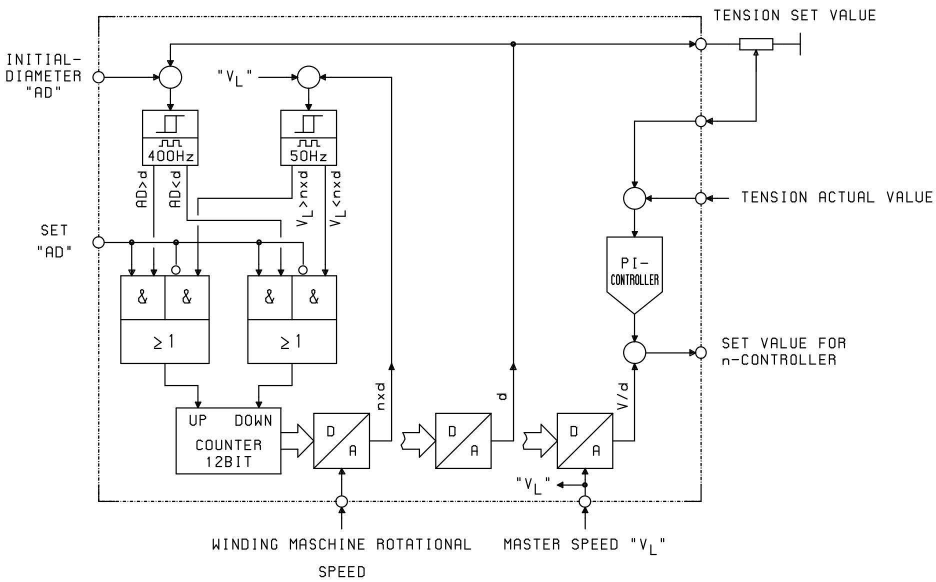
All of the current usual variable speed drives can be used as the drive concept.

Essentially these are:

- three-phase asynchronous motors with frequency converters
- three-phase asynchronous servomotors with inverters
- direct current motors with thyristor dc converters
- direct current servomotors with transistor controllers
- hydraulic motors with rate-proportioning control

The output of the winding controller represents the rotational speed or frequency set value for the subsequent control device.

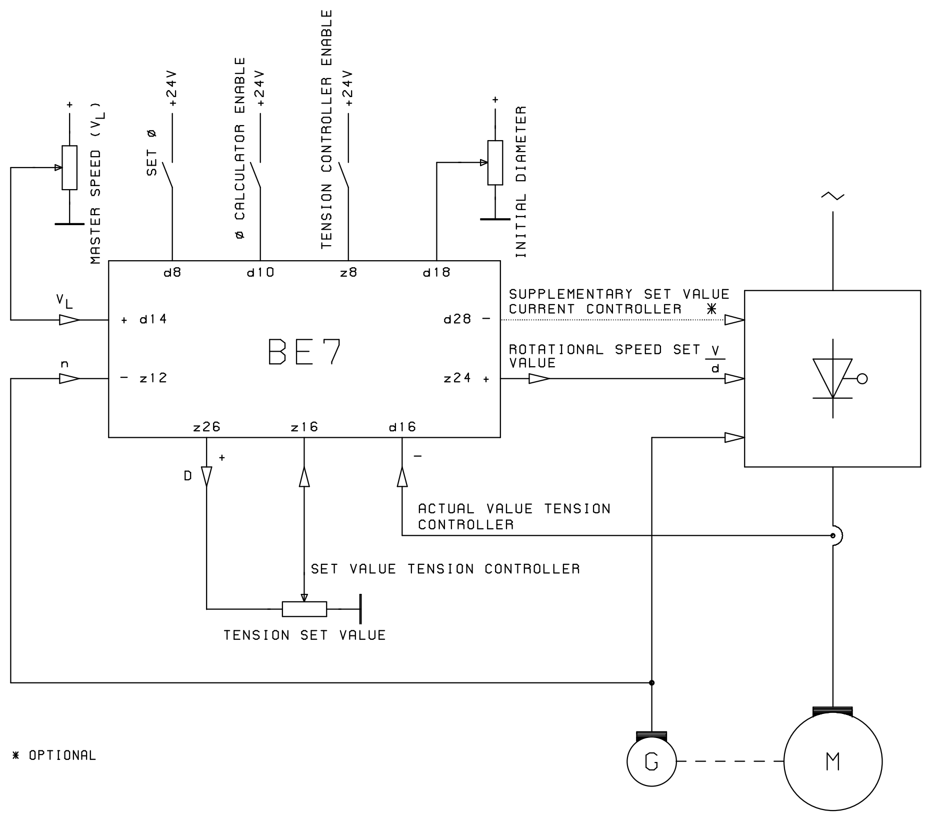
The rotational speed set value is calculated from the system's speed, divided by the winding diameter. The winding diameter is also calculated by means of the master speed (V_L) and winding rotational speed (n_{act}). In order to achieve a defined winding tension, the rotational speed set value is corrected through a superimposed PI-controller. This controller can be a current controller, compensator controller or tension controller depending on the system concept.



Connection of the winding controller as an unwinder with indirect tension control (PI-controller as superimposed current controller)

The command set -∅ must take place as a pulse at least 100ms before the start of the winding machine.

The enabling of the tension controller takes place together with the start command. Thereafter, possibly a few seconds later, the enabling of the diameter calculator takes place.



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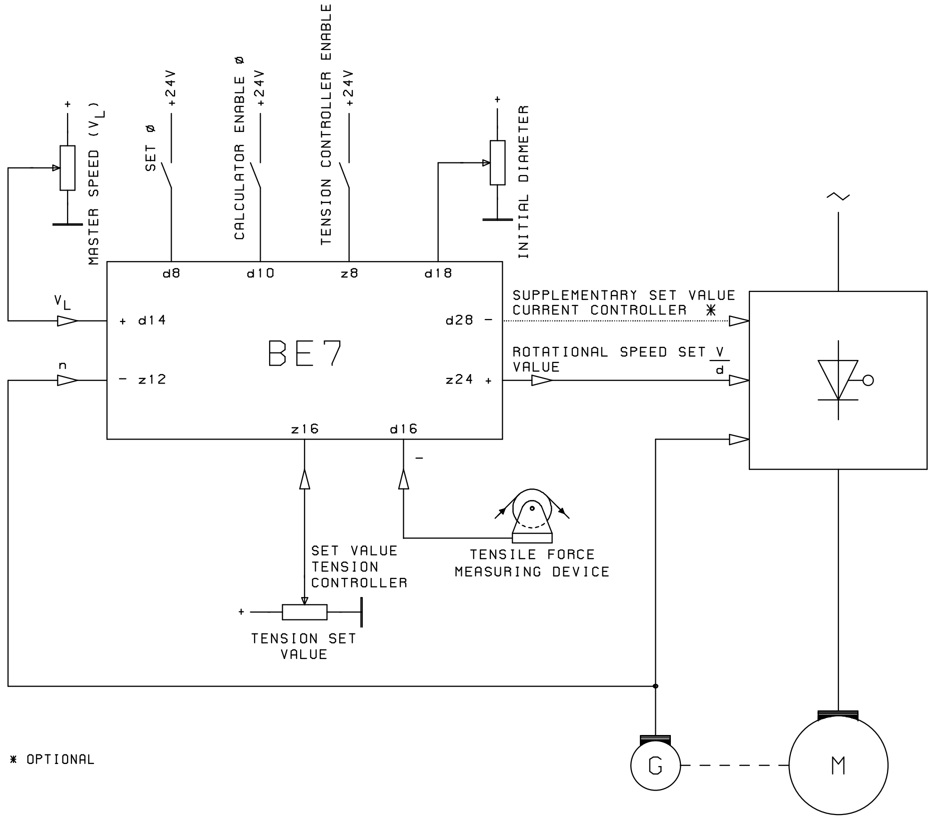

Connection of the winding controller as an unwinder with compensator control (PI controller as superimposed positioning controller)

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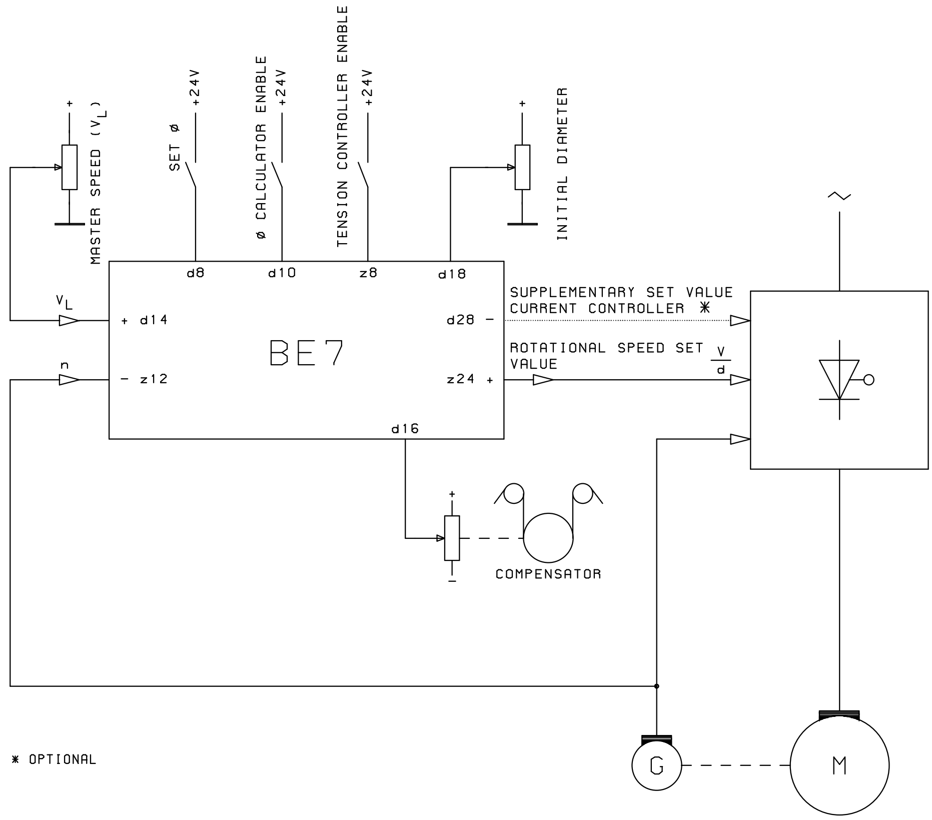

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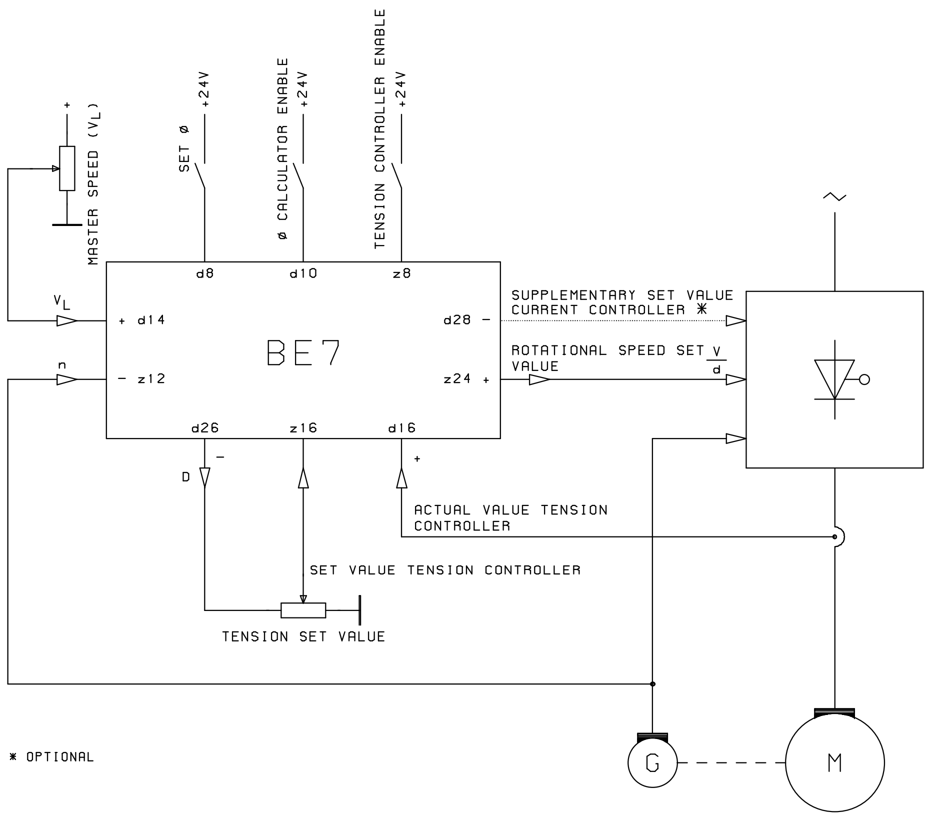

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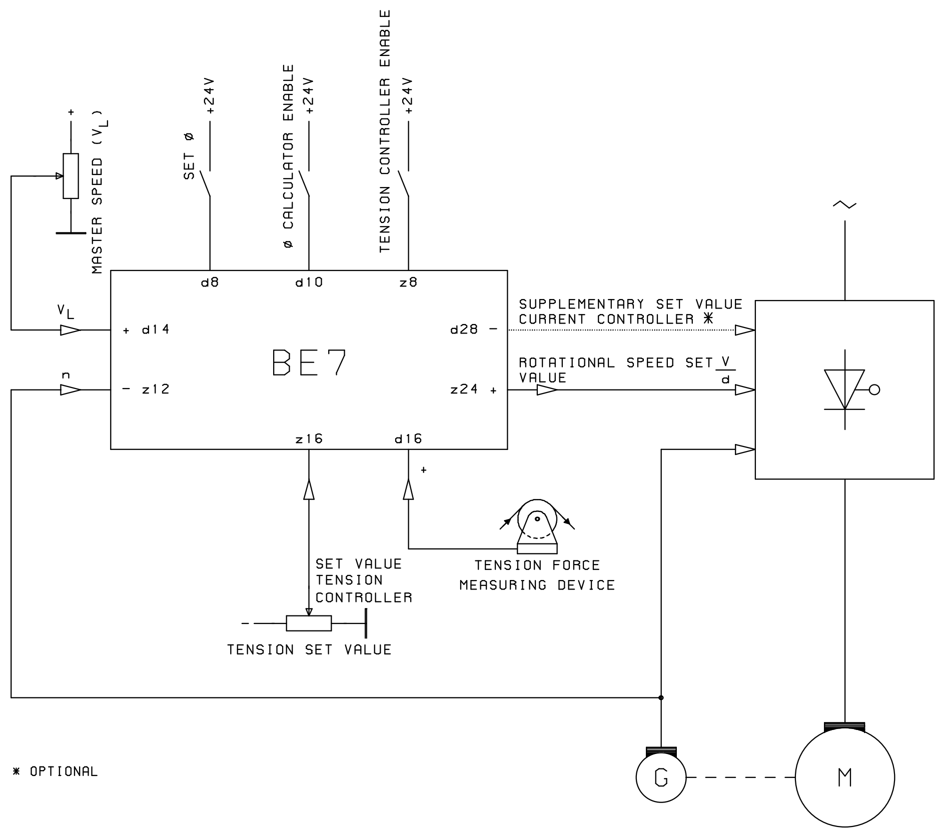

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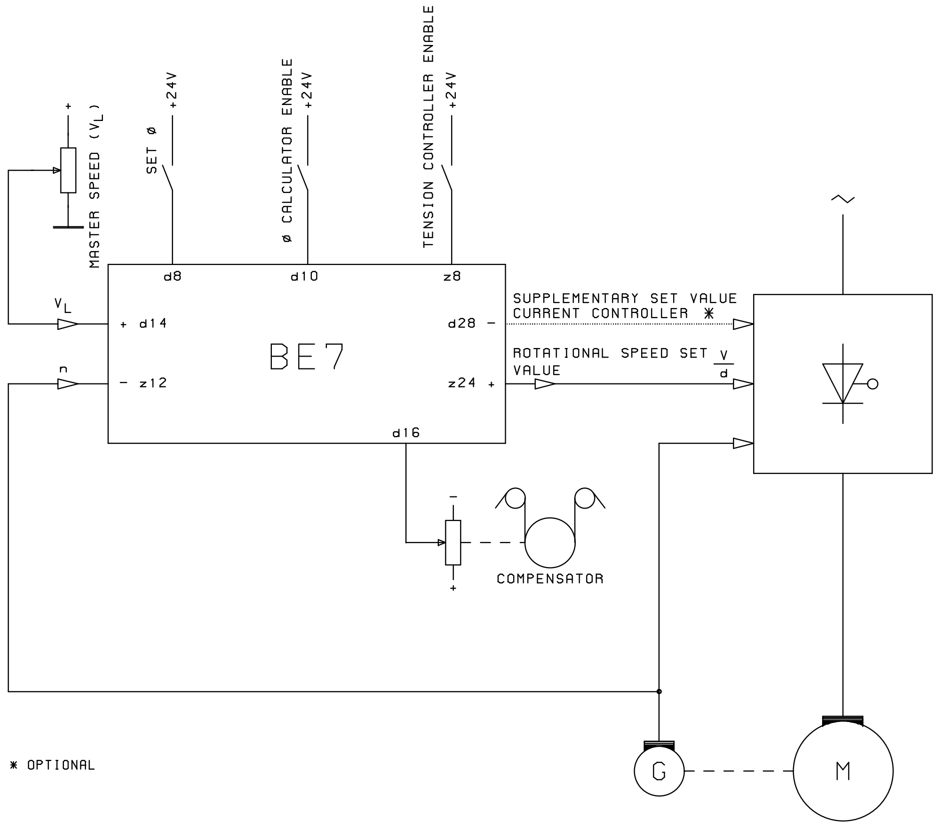


Function of the Winding Controller BE7

Supposition: Winder, indirect tension control with dc motor, i.e. the superimposed PI-controller is used as current controller.

a) **Setting the diameter:**

When the winding controller is switched on, the counter for the diameter calculator stands at any figure, the voltage +d at the summing amplifier N3 is therefore incorrect. The voltage that corresponds to the core diameter of the winder is now set using the potentiometer AD or externally. 10V thereby represents the largest possible winding diameter.

Example: Largest winding diameter 1,800mm, core diameter 450mm.

$$\frac{450\text{ mm x }10\text{ V}}{1{,}800\text{ mm}} = 2.5\text{ V}$$

The potentiometer AD or the external voltage at d18 is therefore set to 2,5V.

If external voltage is used, then the potentiometer AD is to be set to the value of the smallest core diameter.

The memory D1 is set through a pulse and thereby the output of N3 is laid via N4 to the multivibrators K1 and K2.

Assuming that the value +d is larger than +AD, then the output voltage at N4 is positive, the multivibrator K2 switches the counting pulse over the AND-gate D5 to the downwards input of the counter. If the counting content is so small that the voltage +d has the same value as +AD, the output voltage N4 = 0, the multivibrators K1 and K2 are also 0, the gate D5 is blocked and the memory D1 is reset.

The automatic calibration to AD is ended.

b) Diameter calculation in Winding mode:

The output V<> n * d is compensated to 0 V with the potentiometers V_L and n_{act} when the machine is running with the constant command „Set - ∅“.
The precondition for this is that the circumferential speed of the empty winder mandrel is synchronized with the speed of the system through rotational speed compensation on the thyristor-controller.

When the memory D1 is reset and the ∅-calculator is enabled, the summing amplifier N is switched to the multivibrators K1 and K2.

When n * d deviates from V_L, depending on the direction of the counter, counting upwards or downwards takes place until the product n * d is again equal to V_L.

c) Calculation of the rotational speed set value

The third D/A converter divides the system’s speed by the actual diameter and thereby calculates the necessary rotational speed for the thyristor controller.

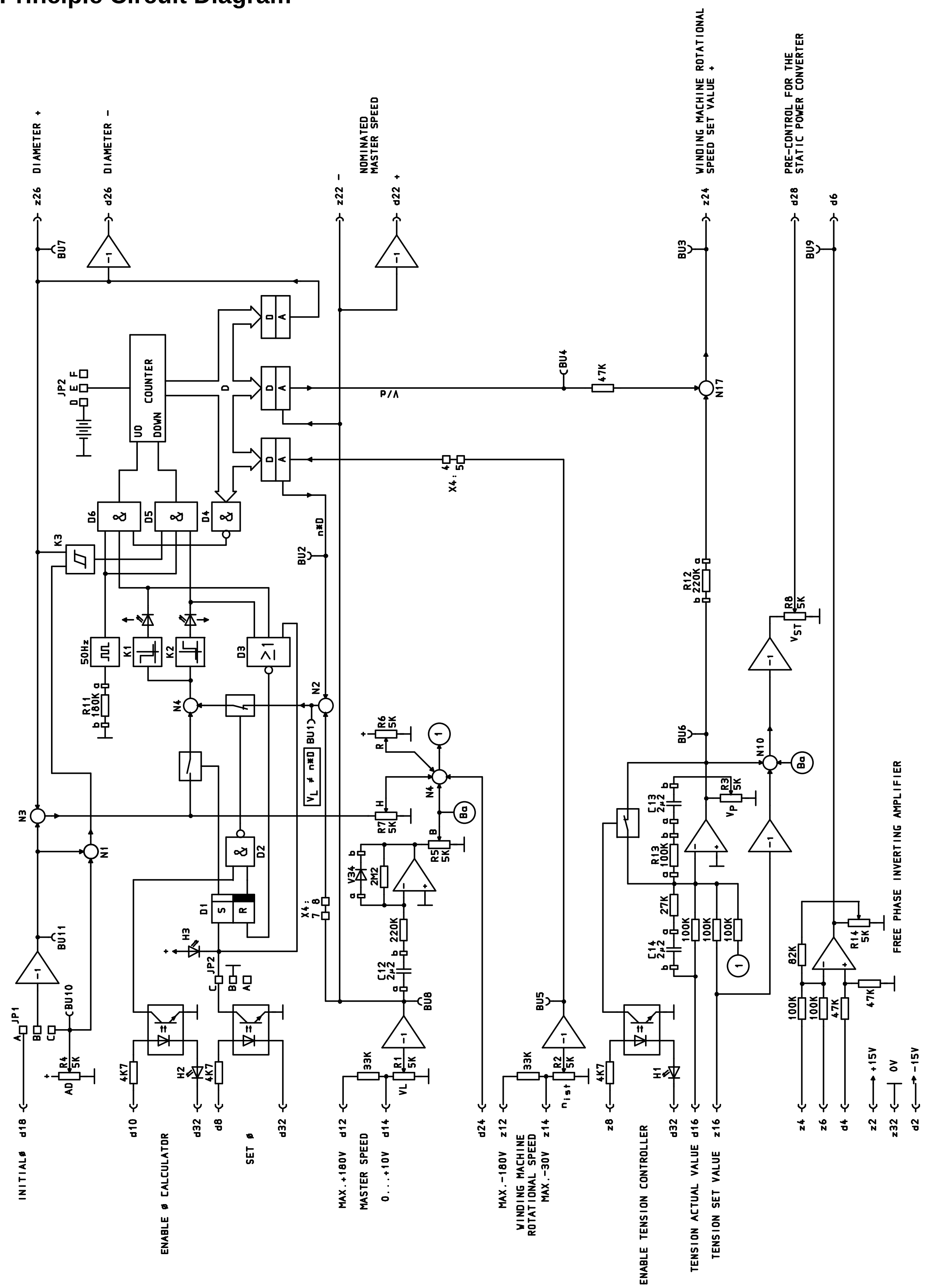
If the supply voltage fails, the content of the counter is saved for some months by means of an accumulator. During winding operations, it is not sufficient to merely offer the thyristor controller the calculated rotational speed set value. The difference between the desired and the actual tension must be compensated via the current controller. Therefore with indirect tension control, the voltage –d is laid via a Tension Set Value potentiometer to the Set Value Input of the PI-controller.

The armature current is fed as positive voltage, 0 to 10V, to the Actual Value Input and the controller is then enabled.

In order to raise the dynamic behaviour of the winding control, the additional options : Output PI-Controller, Tension Set Value and Acceleration Add-on can be connected directly to the current controller of the thyristor controller.

This pre-control relieves the control circuit, particularly during dynamic changes in the winding operation.

Principle Circuit Diagram



Commissioning as an Unwinder

Supposition: Direct current motor with indirect tension control through the armature current.

a) Precondition:

Winding drive is stationary. Drive behind the unwinder (master drive) is running without material.

Potentiometers	R3 P-amplification tension controller	= left stop
	R5 Acceleration	= left stop
	R6 Friction compensation	= left stop
	R7 Winding strength	= left stop
	R8 Pre-control	= left stop

Control inputs „Set-∅“, „Enable ∅-calculator“, „Enable tension controller“ are not occupied!

Control input d8 „Set-∅“ (permanently trigger with 24V), or plug jumper JP2 from AB to BC.

Set the core diameter at socket 10 with the potentiometer AD.

For example:
Largest diameter = 1,600 mm (corresponds to 10V)
Core diameter = 400 mm. Set voltage at socket 10 to 2.5V.

$$\frac{400\text{ mm} \times 10\text{V}}{1{,}600\text{ mm}} = 2.5\text{ V}$$

c) Set the drive behind the unwinder to 100%. i.e. the master speed V_L on d12 or d14 is at maximum. Connect a voltmeter at socket 8 and set the voltage of the core diameter with the potentiometer R1 = V_L. In the example, therefore, -2.5V. Check the voltage at socket 3 (Winding machine rotational speed set value). It should be +10V.

d) Switch on the winding machine drive. Perform a calibration of the rotational speed on the thyristor control device. The circumferential speed of the empty mandrel must be equal to the circumferential speed of the subsequent draw-off equipment.

e) At 100% master speed, connect a voltmeter to socket 5 and with the potentiometer R2 = n_{act} compensate the voltage to 10V.

f) Check the Tension Set Value at input z16. It should be adjustable with the potentiometer Tension Set Value from 0 (left stop) to + 2.5 V. Check the Current Actual Value at input d16. For this operate the direct current motor at its current limit. (disconnect field). The current actual value should be 10V. This should only occur for a short time as the machine could otherwise be damaged.

g) The initial diameter is externally set at pin d18 and can be measured at socket 11. For this, plug jumper JP 1 from BC to AB.

Example:

Largest diameter = 1,600mm (corresponds to 10 V), current winding diameter = 1000mm. Voltage at socket 11 = 6.25V.

$$\frac{1{,}000\ \text{mm} \times 10\text{V}}{1{,}600\ \text{mm}} = 6.25\ \text{V}$$

h) Prepare the system for start-up. Set the Tension Set Value potentiometer to the desired tension. „Set-∅“ input, briefly activate. Start the system, enable the tension controller, enable the ∅-calculator. Run up the system as slowly as possible. During the winding operation, compare the calculated diameter at socket 7 with the actual diameter on the machine. +10V represents the maximum possible diameter.

i) Set additional options as required:

Friction:
At low speed and with a small diameter, set the Tension Set Value to 0 and using the potentiometer R6 (Friction) initiate the drive.

Acceleration:
Operate the winding machine with a low tension set value, so that the material is just taut. Increase the system speed and reduce it with maximum deceleration. Remove the resulting slackness in the material with R5 (acceleration add-on). The additional connection of the pre-control on the current controller of the thyristor controller could optimize this deceleration operation. Optimize with potentiometer R8 through several deceleration operations.
When in acceleration mode, the acceleration add-on can be masked-out through the diode V34, so that it is only effective during deceleration. The diode must be soldered-in from a to b in reverse direction for this.

Commissioning as a Winder

Supposition: Direct current motor with indirect tension control through the armature current.

a) Precondition:

Winding drive is stationary. Drive in front of the winder (master drive) is running without material.

Potentiometers	R3 P-amplification tension controller	= left stop
	R5 Acceleration	= left stop
	R6 Friction compensation	= left stop
	R7 Winding strength	= left stop
	R8 Pre-control	= left stop

Control inputs: „Set-∅“, „Enable ∅-calculator“, „Enable tension controller“ are not occupied!

b) Control input d8 „Set-∅“ (permanently trigger with 24V), or plug jumper JP2 from AB to BC.

Set the initial diameter at socket 10 with the potentiometer AD.

For example:
Largest diameter = 1,600mm (corresponds to 10V)
Core diameter = 400mm. Voltage at socket 10 = 2.5V.

$$\frac{400\text{ mm x }10\text{V}}{1{,}600\text{ mm}} = 2.5\text{ V}$$

Should the initial diameter be set externally, re-plug the bridge IP1 from BC to BA and lay the appropriate voltage to d18. The initial diameter is, however in all cases, to be set at potentiometer AD (socket 10).

c) Set the drive in front of the winder to 100%. i.e. the master speed V_L on d12 or d14 is at maximum. Connect a voltmeter at socket 8 and set the voltage of the core diameter with the potentiometer R1 = V_L. In the example, therefore, -2.5V. Check the voltage at socket 3 (Winding machine rotational speed set value). It should be +10V.

d) Switch on the winding machine drive. Perform a calibration of the rotational speed on the thyristor control device. The circumferential speed of the empty mandrel must be equal to the circumferential speed of the previous delivery device.

e) At 100 % master speed, connect a voltmeter to socket 5 and with the potentiometer R2 = n_{act} compensate the voltage to 10V.

f) Check the Tension Set Value at input z16. It should be adjustable with the potentiometer Tension Set Value from 0 (left stop) to - 2.5 V. (present voltage of the diameter). Check the Current Actual Value at input d16. For this, operate the direct current motor at its current limit. (disconnect field). The current actual value should be +10V. This should only occur for a short time as the machine could otherwise be damaged.

h) Prepare the system for start-up. Set the Tension Set Value potentiometer to the desired tension. „Set-∅“ input, briefly activate. Start the system, enable the tension controller, enable the ∅-calculator. Run up the system as slowly as possible. During the winding operation, compare the calculated diameter at socket 7 with the actual diameter on the machine. +10V represents the maximum possible diameter.

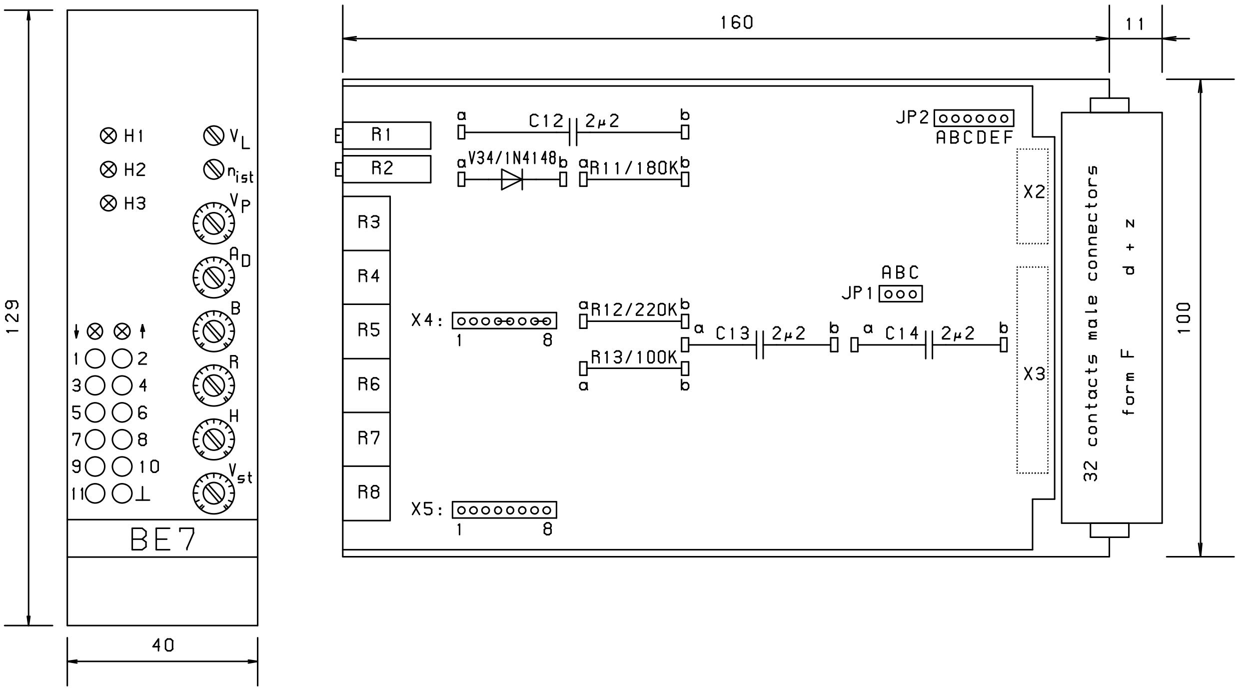
i) Set additional options as required:

Friction:
At the lowest speed and with a small diameter, set the tension set value to 0 and using the potentiometer R6 (Friction) initiate the drive.

Acceleration:
Operate the winding machine with a low tension set value, so that the material is just taut. Reduce the system speed and accelerate it with maximum acceleration. Remove the resulting slackness in the material with R5 (acceleration add-on). The additional connection of the pre-control on the current controller of the thyristor controller could optimize this acceleration operation. Optimize with potentiometer R8 through several acceleration operations.
When in deceleration mode, the acceleration add-on can be masked-out through the diode V34, so that it is only effective during starting-up. The diode must be soldered-in from a to b in forward direction for this.

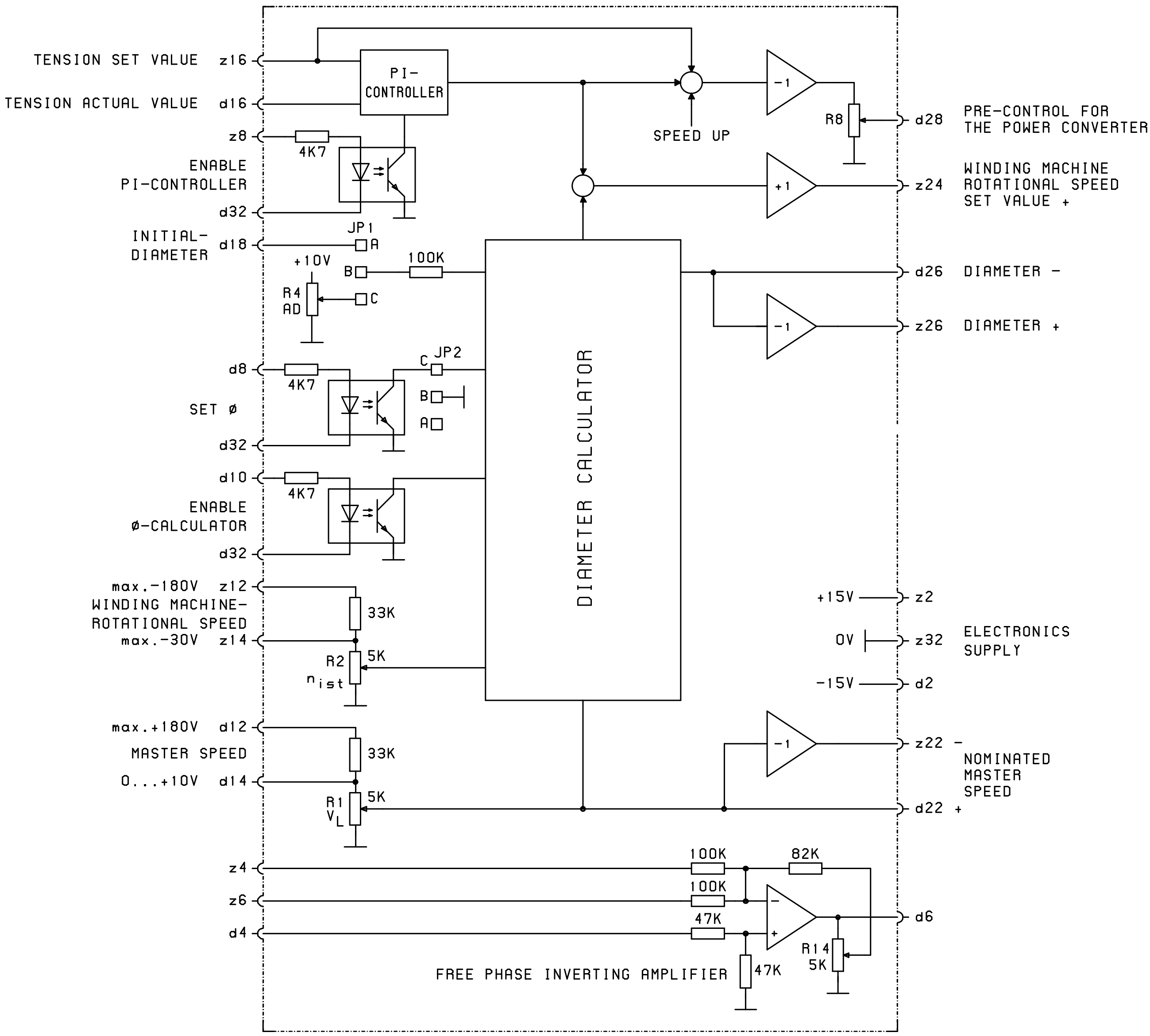
Winding strength:
Depending on requirements, the tension should lessen as the diameter increases. Adjust using potentiometer R7 (Winding strength).

Mechanical Set-Up



Connection Plan

CONNECTION PLAN FOR THE WINDING CONTROLLER BE7



BE 7 Technical Data

Voltage supply		:	± 14.5…15.5V
Current consumption		:	± 75 mA
Control inputs (Optical coupler)		:	15…30V / 4…9 mA
Storage of the diameter		:	digital (buffered by accumulator)

Analog Inputs:

Initial diameter	d18	:	± 0.1…+10V
Winding rotational speed	z12	:	max. –180V
Winding rotational speed	z14	:	max. –30V
Potentiometer range n_{act}	(R2)	:	1:10
Master speed	d12	:	max. +80V
Master speed	d14	:	max. +30V
Potentiometer range V_L	(R1)	:	1:10
Free summing amplifier		:	max. ±11 V / Rin = 100 kΩ

Analog Outputs:

Pre-control static power converter	d28	:	0…-10V / max. 5 mA
Rotational speed set value	z24	:	0…+10V / max. 5 mA
Diameter -	d26	:	0…-10V / max. 5 mA
Diameter +	z26	:	0…+10V / max. 5 mA
Nominated master speed +	d22	:	0…+10V / max. 5 mA
Nominated master speed -	z22	:	0…-10V / max. 5 mA

Error limits of the diameter calculator:

Possible diameter range	:	1/100
Possible master speed range	:	1/100
Entire rotational speed regulating range	:	1/500
Operating point diameter calculator	:	V/n*d > 15mV
Ambient temperature	:	0…50℃
Front panel	:	anodized aluminium 8TE/3HE
Printed circuit board	:	Euro card size 100 x 160mm
Blade connector strip	:	Type F32-pol (d+z)
Weight	:	270 g