

Help

DCS800
DC Drives

Winder Application
Indirect Tension Control
Indirect Torque Control
Part 1
G563e Part 1

eLearning



© Copyright 1/19/2022 ABB. All rights reserved.
WINDER_INDIR_01R0101, page 1



Welcome to the winder application training module Winder application for the DCS800, one of the ABB DC Drives.

If you need help navigating this module, please click the Help button in the top right-hand corner. To view the presenter notes as text, please click the Notes button in the bottom right corner.

Objectives

After completing this module, you will know

- the key points of DCS800 winder application
- the winder structure diagram
- the tension reference handling
- how the diameter calculation works



After completing this module, you will know and be familiar with

- The key points of the winder application using it as indirect tension control.
- The winder structure diagram
- The tension reference handling
- How the diameter calculation works

Preconditions

You have advanced knowledge about

- Winder physics and Winder control structures (separate module)
- ABB DC converter DCS800 (separate course)



Before you continue this training, please note the prerequisite of this module.

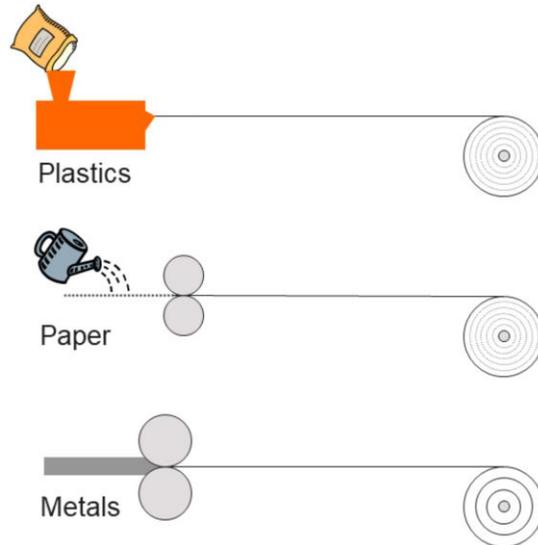
You have advanced knowledge about

- Winder physics and winder control structures. This topic has been covered in a separate module.
- ABB DC converter DCS800. This has also been discussed in a separate course!

You should also have completed training for the DCS800, so you should be familiar with the standard software structure and the available options of the DCS800.

Why is it reasonable to wind material?

Continuously produced materials will be wound and unwound during subsequent processes to finalize products.



Why is it reasonable to wind material?

Most materials produced continuously, like web or wire, can be better transported and can be better stored while wound.

During the subsequent processes it can be un- and rewound several times.

In the last stage of production, the material will be unwound to finalize the products.

Winder control structure

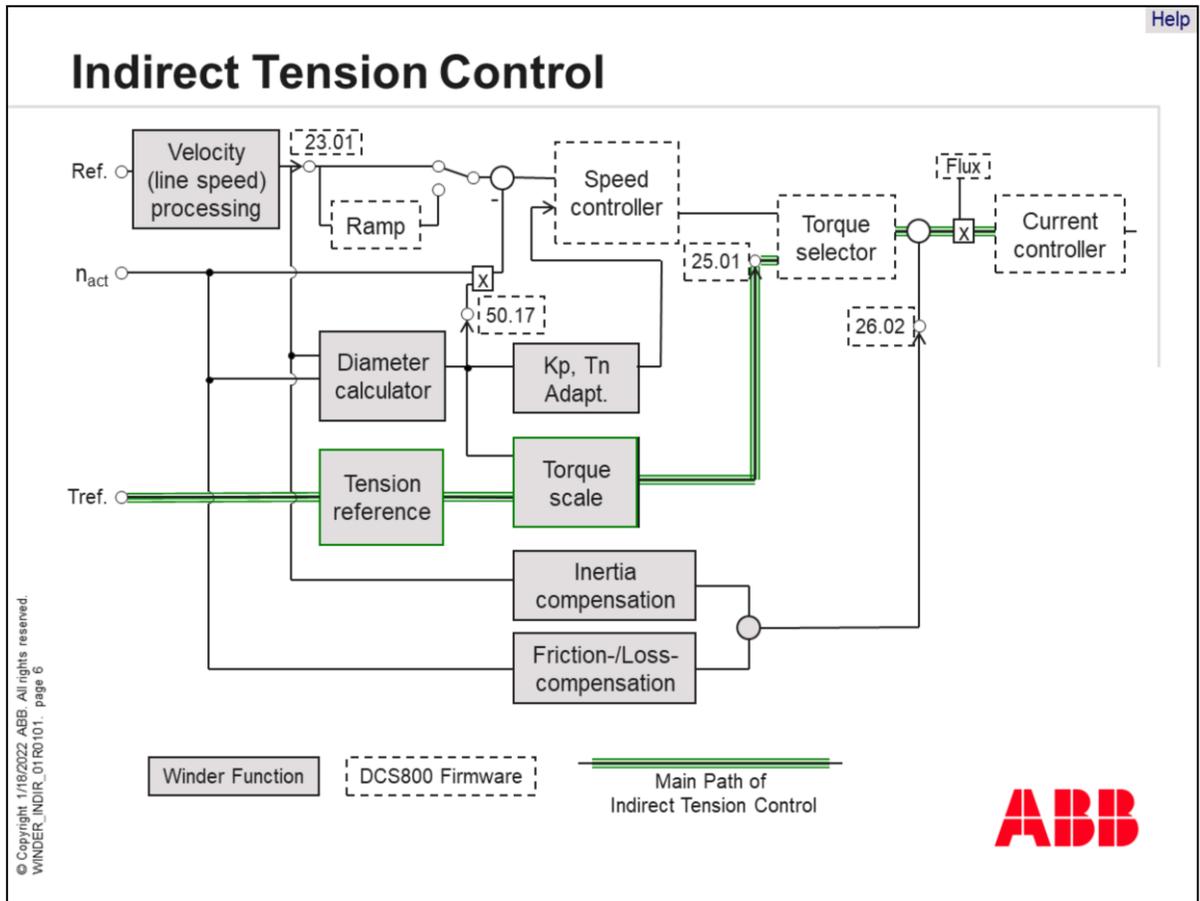
- The “Indirect tension control”, also called “Indirect torque control”, is one of the winder control structures.
- Features of the “indirect tension control”
 - Easy winding for easy requirements
 - Only a few values and signals needed from the production line
 - No measurement technique necessary, like load cell or dancer roll
 - Lead roll has to run in speed control mode
 - Stable operation with one controller



The indirect tension control is one of the winder control structures. Some people will know it as "indirect torque control".

The features of the "indirect tension control" are

- easy winding for easy requirements
- only a few values and signals are needed from the production line
- no measurement technique necessary, e.g. sensors like load cell or dancer roll
- the lead roll has to run in speed control mode, powered by a separate drive and
- stable operations with one controller, except for the field exciter circuit.



The diagram of the indirect tension control shows the main paths of the winding control structure.

The winder functions may be separated into the following parts: velocity processing (also called line speed), diameter calculation, tension reference handling and torque scaling, inertia compensation and friction- or loss-compensation.

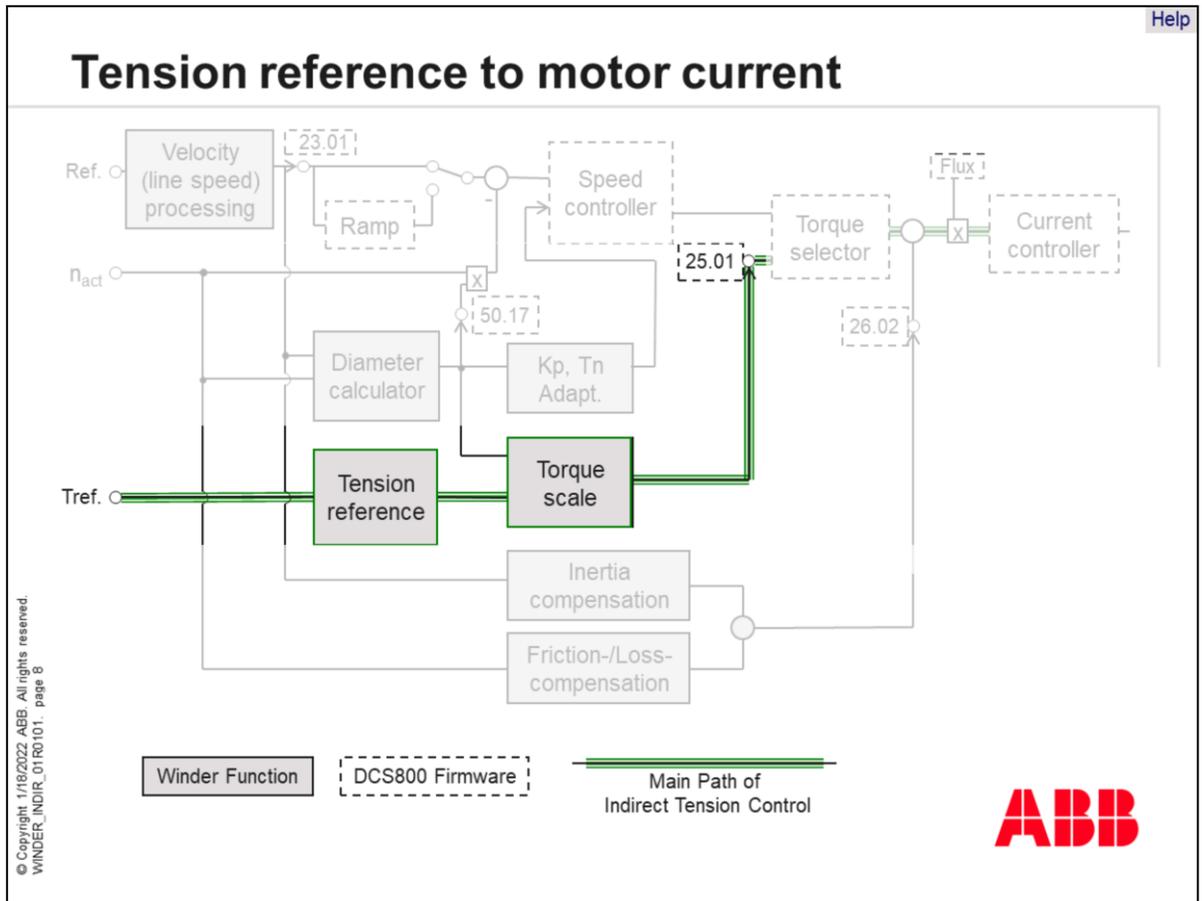
The green boxes are further functions in addition to basic firmware. The basic firmware functions are shown in dashed boxes.

Indirect Tension Control

- Diagram of indirect tension control
- Tension reference and motor current
- Diameter calculation
- Velocity or line speed control
- Friction and loss compensation
- Inertia
- Winder Logic Control
- Significant equations

This winder training is separated into the same parts as previously described.

Clicking on a chapter will take you to its first page.

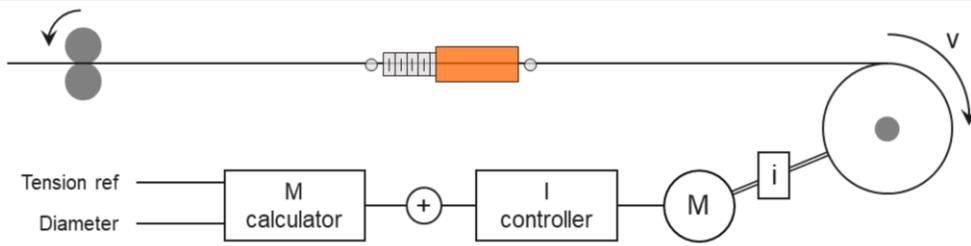


One of the main paths of indirect tension control is the path from tension reference to motor current.

The tension reference as a percentage value will be multiplied by the percentage value of the diameter and written to the torque reference parameter 25.01. This parameter is part of the DCS800 Firmware.

The other function blocks are part of the winder application which is located in the DCS800 Control Builder.

Tension reference to motor current



- The web tension is the result of

- tension set point (F)
- diameter (D)
- motor torque (T)
- gear ratio (i)

- Recap: physical formula

$$T = \frac{F \cdot D}{i \cdot 2}$$

$$i = \frac{\text{Motor}}{\text{Load}}$$

ABB

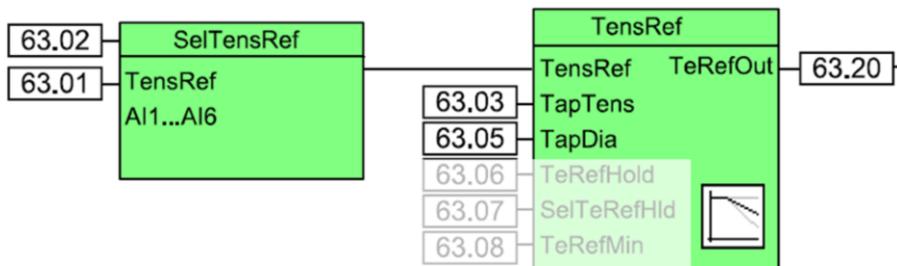
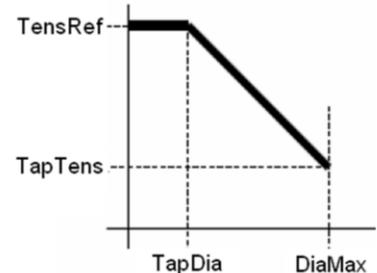
As an indirect tension controlled winder, without any tension feedback, the tension of a web is the **calculated** result of the tension set point, which is given as a tension reference, the diameter and the current-torque-characteristic of the DC motor. Also the gear ratio of the transmission influences the actual tension of the web.

The torque, which is responsible for the desired tension, is calculated from the tension set point, the gear transmission and the diameter.

Tension reference to motor current

- Tension is managed by the TensRef block (1)

- Selectable tension reference as TensRef input
- Taper tension with TapTens (63.03) and TapDia (63.05)



The tension set point, as tension reference, may be selected by the parameter 63.02 out of an internal parameter 63.01 or out of one of the analog inputs.

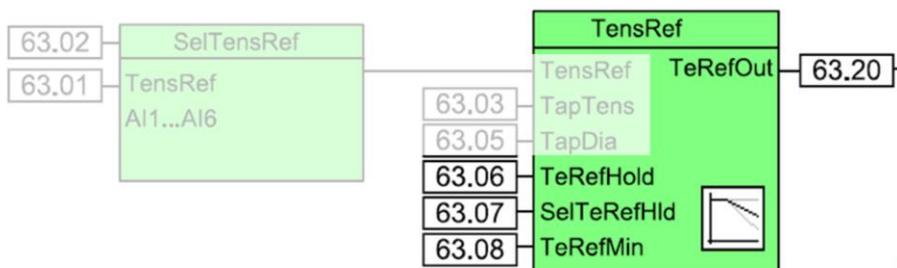
By using a field bus system the external set point has to be written to parameter 63.01.

Several web materials can be better wound with decreasing tension while the diameter increases. Therefore the taper tension TapTens (63.03) contains the percentage value, which reduces the tension reference at the maximal diameter. The reduction starts with the diameter of value TapDia (63.05).

Tension reference to motor current

- Tension is managed by the TensRef block (2)
 - Stand-still (or hold) tension TeRefHold (63.06), if activated via SelTeRefHld (63.07).
 - minimum tension reference, TeRefMin (63.08)
 - The result is shown in TeRefOut (63.20)

© Copyright 1/19/2022 ABB. All rights reserved.
WINDER_INDIR_01R0101, page 11



Further features of the TensRef block are

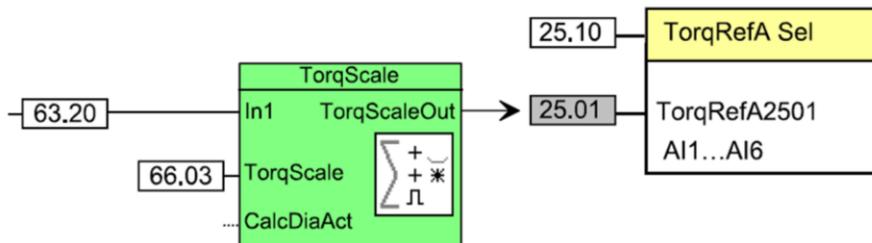
- Stand-still (or hold) tension. TeRefHold may be set in parameter (63.06)
- Setting the output to this value, if the command, selected via SelTeRefHld (63.07), is active.
- The value in parameter TeRefMin (63.08) may be set as minimum. The output of this block is limited to this value.
- The result of the tension reference is supported by parameter 63.20 as input for further processes.

Tension reference to motor current

- Final tension reference is calculated with the diameter.

$$Torque = Tension \bullet \frac{D}{D_{max}}$$

- The adjustment of calculated torque to the nominal relative motor torque is to be scaled using TorqScal (66.03).



The required torque target value is calculated with the tension reference value and the diameter.

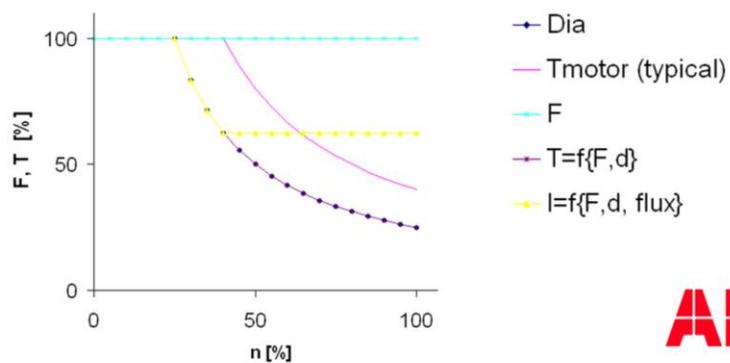
The calculated torque target value and the relative motor torque can be adapted by being scaled with parameter TorqScal (66.03).

Tension reference to motor current

- **Rule 1 of this application:**
„The maximum torque will be reached with a diameter of 100%.“
- Main TorqScale parameter 66.03

$$66.03 = \frac{(F \max \cdot D \max) / (2 \cdot i)}{T_{motor}} * 100\%$$

- Diagram



Rule 1 of this indirect tension application is:

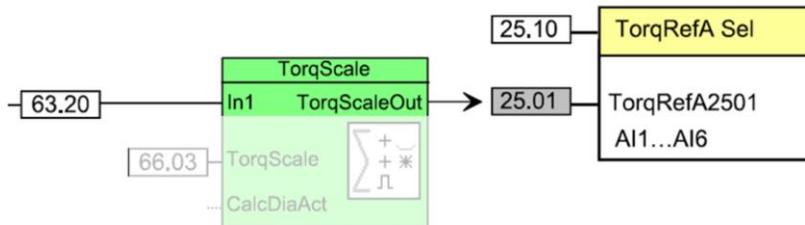
"The maximum torque will be reached with a diameter of 100%."

The TorqScale can be calculated by the maximum tension (F), the maximum diameter, the gear ratio and the nominal motor torque.

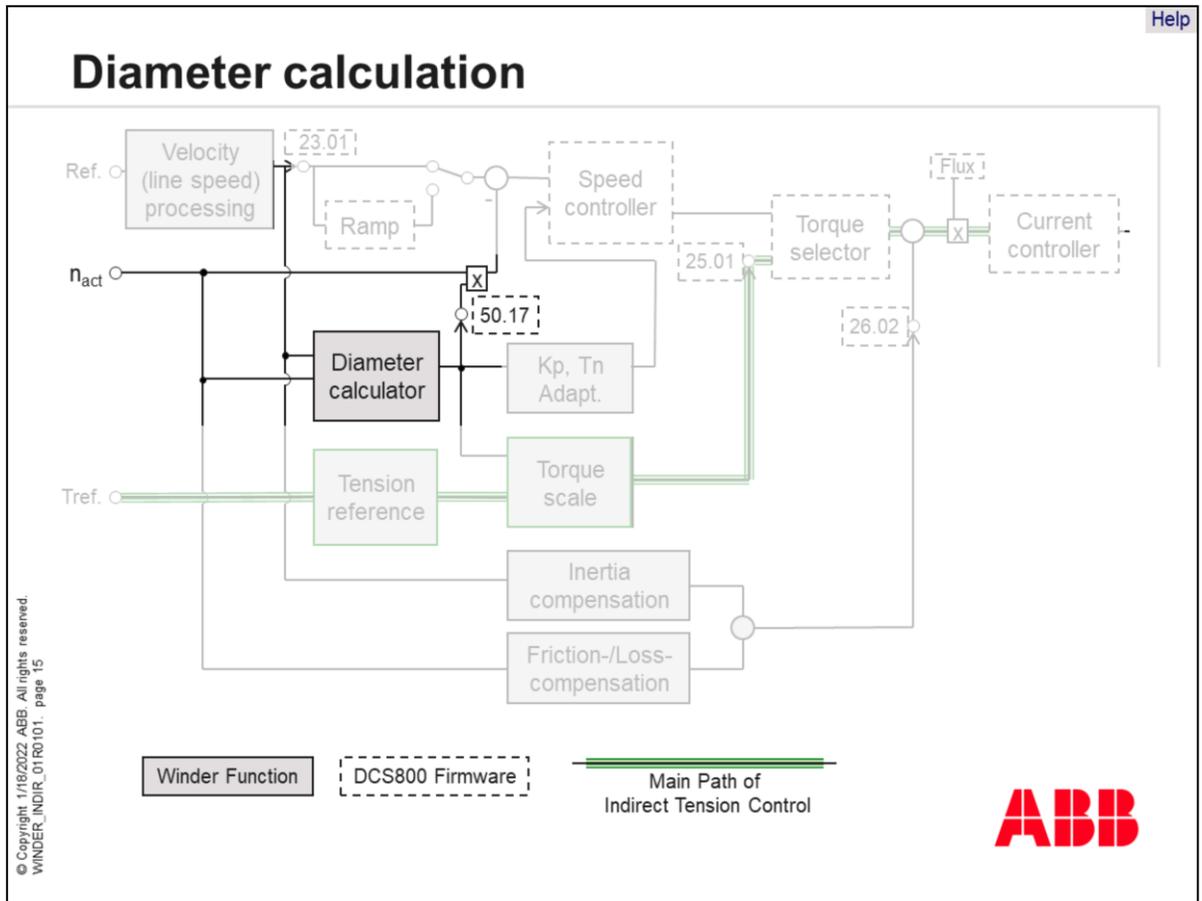
The simplified diagram shows the targeted torque value with 100% tension at different motor speeds, partly with field weakening. The minimum diameter is equivalent to maximum speed.

Tension reference to motor current

- Finally the scaled torque value is written to the torque reference input of the standard firmware DCS800.



Finally the scaled torque value is written to the torque reference input of the standard DCS800 firmware, parameter 25.01.

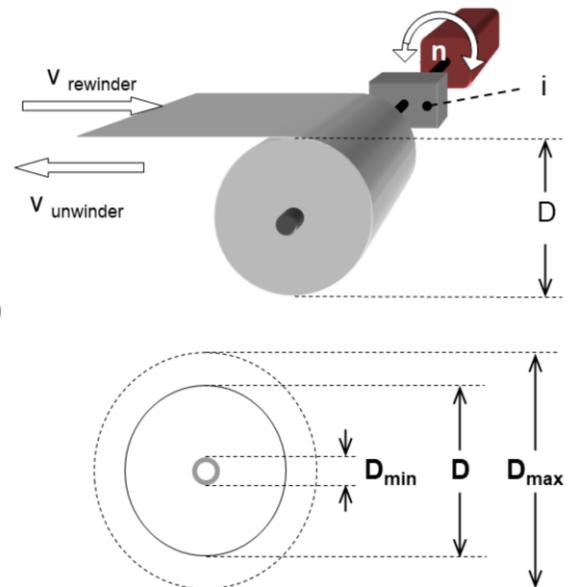


The diameter calculation is the most important part of the winder application. It is used to calculate the actual diameter with the actual line speed and the motor speed. This calculation is essential for the entire winder application because the calculated diameter value is used in several function blocks of the winder application.

Diameter calculation

- **Diameter**
is mainly responsible for the aspired tension and for the aspired motor speed.
- **Physical quantities**
 - Line speed / velocity (**v**)
 - Diameter (**D**)
 - Gear ratio (**i**)
 - Motor speed (**n**)

$$D = \frac{v \cdot i}{n \cdot \pi}$$



ABB

One of the key parameters in winding technology is the diameter.

The diameter is mainly responsible for the aspired tension and for the aspired motor speed. With a correct diameter value the winder can run properly.

The diameter (D) is calculated from the line speed ($v =$ velocity), the motor speed (n), the gear ratio (i) and pi by using the equation shown.

The minimum and the maximum diameter of each application has to be known. These values are necessary for calculating the diameter ratio.

Help

Diameter calculation

- Relative

$$D = \frac{v(\%)}{n(\%)}$$
- **Min Core Diameter**
(diameter relation)

$$65.01 = \frac{D_{\min}}{D_{\max}} \cdot 100\%$$

DiaCalc

-----	In1 Velo	LimMin	-----
-----	In2 Nact	LimMax	-----
65.01	MinCoreDia	CalcDiaAct	65.20
65.04	TrampWDir	WinScale	-----
65.05	TrampWcDir		
65.06	RelVeloLev		
65.07	RelSpeedLev		
65.08	SelCmdDialnit		
-----	Init value		

- To prevent steps, the result will be shaped with a ramp:
 - Tramp WDir (65.04) **Time ramp winder direction**
 - Tramp WcDir (65.05) **Time ramp winder counter direction**

ABB

© Copyright 1/19/2022 ABB. All rights reserved.
 WINDER_INDIR_01R0101, page 17

The physical equation may be simplified to the value ratio out of line speed (v) and motor speed (n). Independent of the physical diameter, the maximum diameter is always 100% of a certain application.

The minimum diameter ratio has to be calculated as Min Core Diameter, which is equivalent to the diameter ratio of a certain application.

The value of parameter 65.01 is one of the important values of the winder application.

To prevent steps of the calculated diameter, the result will be shaped with a ramp. Two time ramps are prepared for this purpose.

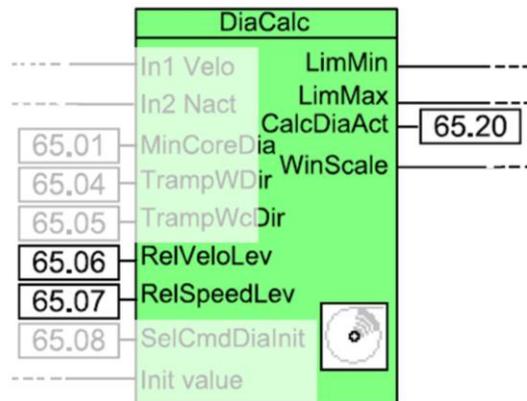
- Time "T ramp W Dir", parameter 65.04, is used to calculate the ramp for the normal winding direction. That means forwards with a rewinder and in reverse with an unwinder. Changing between these modes works automatically by using the winder logic.

- Time "T Ramp Wc Dir", parameter 65.05, is used to calculate the ramp for the opposite winding direction. That means in reverse with a rewinder and forwards with an unwinder. This time should be set to a larger value than the normal ramp time because it is only used for correcting the output if a wrong starting value has been used.

- It is necessary to type in time values for the largest diameter. These values will be reduced automatically if the diameter is decreasing.

Diameter calculation

- Released calculator with
 - Running drive
 - Command Winder On as „Indirect Tension Control“
 - Velocity value greater than **Release Velocity Level** (65.06)
 - Motor speed greater than **Release Speed Level** (65.07)



- The result CalcDiaAct is limited between MinCoreDia and 100%.

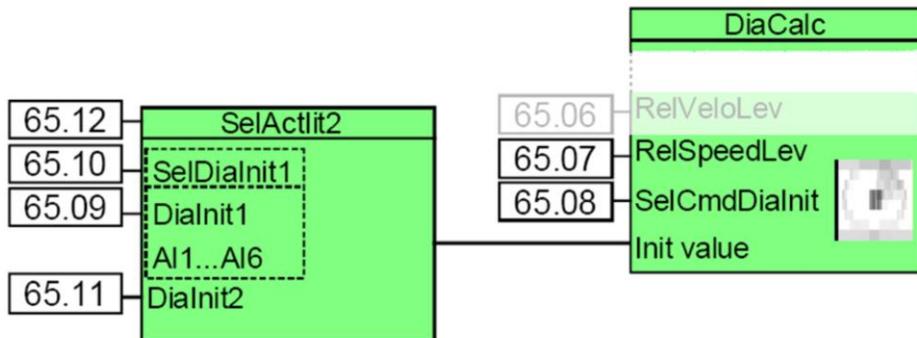
The diameter calculator is released, if the following conditions are fulfilled

- DCS800 is in running status
- The command "Winder On" has set the drive into tension controlled mode
- The velocity value is greater than the **Release Velocity Level**, set in parameter 65.06
- The motor speed is greater than the **Release Speed Level**, set in parameter 65.07

The result CalcDiaAct of the diameter calculation is limited between MinCoreDia, out of parameter 65.01 and 100%.

Diameter calculation

- Initial diameter setting
 - Command via SelCmdDialnit (65.08)
 - Two selectable values
 - of parameter 65.09 or an analogue input
 - of parameter 65.11



© Copyright 1/19/2022 ABB. All rights reserved.
WINDER_INDIR_01R0101, page 19

Setting the initial diameter is possible with function block "DiaCalc".

Before starting a winding process it is necessary to set the actual diameter. The reference of the set command can be selected by parameter 65.08, called "Sel Cmd Dia init". It is possible to select parameter "Diainit1" with parameter 65.09 and parameter "Dialnit2" with parameter 65.11. Command "Sel Act Init 2", parameter 65.12, changes between these values. It is also possible to overwrite parameter 65.09 and 65.11 with a PLC.

Instead of "Dia Init1", an analog input can be selected to connect external supplies like potentiometers or ultra sonic sensors. The output of the diameter calculator will be set to the selected value as long as the set command is active. The limitation of the output is active but the ramp is disabled.

Diameter calculation

- Output value CalcDiaAct is used in several winder function blocks
- Output value WinScale calculates the actual motor speed with the velocity feedback via „WinderScale“ (50.17) of standard software.
- **Rule 2 of this application:**
„The maximal motor speed will be reached with the minimum diameter and the maximum velocity (line speed).“

The output value CalcDiaAct is used in several winder function blocks. The output value WinScale calculates the actual motor speed with the velocity feedback via "WinderScale" (50.17) of standard software.

Rule 2 of this application:

"The maximum motor speed will be reached with the minimum diameter and the maximum velocity (line speed)."

Further description

- Please continue to the next module and the following subjects
 - Velocity reference
 - Calculation of losses
 - Winder Logic

Further information about the "Indirect Tension Control" can be found in part 2 of the winder module.

Please continue to the next module and the following subjects:

- Velocity reference
- Calculation of losses
- Winder Logic

Summary

Key points of this module

- Basics of “Indirect Tension Control”
- Winder structure diagram
- Tension reference handling
- Diameter calculation

Here are the key points of this module:

- Basics of "Indirect Tension Control"
- Winder Structure Diagram
- Tension reference handling
- Diameter calculation

Glossary

- **Dancer roll**
swinging roll for balancing
- **Lead rolls**
rolls to control the line speed
- **Load cell**
roll to measure the tension
- **Core**
metal shaft in the middle of the roll
- **Unwinder**
winding up
- **Rewinder**
winding
- **Acceleration torque**
motor torque to accelerate the plant
- **Torque losses**
speed dependent losses
cause of coupled mechanic (non linear)



Power and productivity
for a better world™