

Rexroth IndraMotion MLC 12VRS Winder Function Application

R911333870
Edition 01

Application Manual



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1 About this Documentation

1.1 Validity of the Documentation

- Target group** This documentation is intended for users applying the winder technology functions.
- This documentation supports the user during the following phases:
- Engineering
 - Commissioning
 - Operation

1.2 Required and Supplementing Documentations

Documentation titles with type designation codes and parts numbers

IndraWorks		MLC	XLC
/36/	Rexroth IndraWorks 12VRS Software Installation DOK-IWORKS-SOFTINS*V12-COxx-EN-P, R911334396 This documentation describes the IndraWorks installation.	X	X
/5/	Rexroth IndraWorks 12VRS Engineering DOK-IWORKS-ENGINEE*V12-APxx-EN-P, R911334388 This documentation describes the application of IndraWorks in which the Rexroth Engineering tools are integrated. It includes instructions on how to work with IndraWorks and how to operate the oscilloscope function.	X	X
/20/	Rexroth IndraMotion MLC 12VRS Functional Description DOK-MLC***-FUNC****V12-APxx-EN-P, R911333848 This documentation describes wizards, context menus, dialogs, control commissioning, device configuration and functionalities of the IndraMotion MLC.	X	
/20/	Rexroth IndraLogic XLC 12VRS Functional Description DOK-XLC***-FUNC****V12-APxx-EN-P, R911333878 This documentation describes wizards, context menus, dialogs, control commissioning, device configuration and functionalities of the IndraLogic XLC.		X
/7/	Rexroth IndraWorks 12VRS CamBuilder DOK-IWORKS-CAMBUIL*V12-APxx-EN-P, R911333842 This documentation describes the basic principles and operation of the CamBuilder, the cam editing tool.	X	X
/37/	Rexroth IndraLogic XLC IndraMotion MLC 12VRS Automation Interface DOK-XLCMLC-AUT*INT*V12-APxx-EN-P, R911334178 This documentation describes the script-based access to IndraWorks project data via the interface of the Automation Interface.	X	X
/38/	Rexroth IndraWorks 12VRS FDT Container DOK-IWORKS-FDT*CON*V12-APxx-EN-P, R911334398 This documentation describes the IndraWorks FDT Container functionality. It includes the activation of the functionality in the project and working with DTMs.	X	X

About this Documentation

/29/	Rexroth IndraLogic XLC IndraMotion MLC 12VRS Project Conversion DOK-XLCMLC-PROCONV*V12-APxx-EN-P, R911334187 This documentation described the project conversion of IndraLogic 04VRS and IndraMotion MLC04VRS on IndraWorks Version 12 with IndraLogic 2G. It especially focuses on changes in the field of Motion and PLC.	X	X
/28/	Rexroth IndraMotion MLC 12VRS Commissioning DOK-MLC***-STARTUP*V12-COxx-EN-P, R911333858 This documentation describes the steps required for commissioning and performing service on the IndraMotion MLC system. It includes checklists for tasks to be frequently performed and a detailed description of the steps.	X	

Motion		MLC	XLC
/23/	Rexroth IndraLogic XLC IndraMotion MLC 12VRS PLCopen Libraries DOK-XLCMLC-FUNLIB**V12-LIxx-EN-P, R911334182 This documentation describes the function blocks, functions and data types of the RIL_CommonTypes, ML_Base and ML_PLCOpen libraries for the IndraLogic XLC/IndraMotion MLC. It also includes the error reactions of function blocks.	X	X
/27/	Rexroth IndraLogic XLC IndraMotion MLC 12VRS Generic Application Template DOK-XLCMLC-TF*GAT**V12-APxx-EN-P, R911334191 This documentation provides a structured template to the IndraLogic PLC programmer. This template can be used to add and edit the PLC programming code. It includes the template, the template wizard and example applications.	X	X
/31/	Rexroth IndraMotion MLC 12VRS RCL Programming Instruction DOK-MLC***-RCL*PRO*V12-APxx-EN-P, R911333852 This documentation provides information on the RobotControl. It is given most importance to the programming language RCL (RobotControl Language). The program structure, variables, functions, motion statements and the required system parameters are described.	X	
/21/	Rexroth IndraLogic XLC IndraMotion MLC 12VRS Parameters DOK-XLCMLC-PARAM***V12-RExx-EN-P, R911334176 This documentation describes the parameters of the XLC/MLC systems as well as the interaction between parameterization and programming. It includes the axis parameters, control parameters, kinematic parameters, touch probe parameters and programmable limit switch parameters.	X	X
/10/	Rexroth IndraDrive; Firmware for Drive Controllers MPH, MPB, MPD, MPC-07 DOK-INDRV*-MP*-07VRS**-FKxx-EN-P, R911328670		
/11/	Rexroth IndraDrive MPx-16 Functions DOK-INDRV*-MP*-16VRS**-APxx-EN-P, R911326767		

Field buses		MLC	XLC
/39/	Rexroth IndraMotion MLC 11VRS PLCopen Field Bus DOK-IM*ML*-PLCFBUS*V11-APxx-EN-P, R911333896 This documentation describes the creation of field bus drives in an IndraWorks project, function blocks, functions and data types of the libraries RIL_CommonTypes.library (excerpt for field bus drives), RMB_PLCOpenFieldBus.library, RIL_Utility.library (excerpt for field bus drives). It also includes the error reactions of function blocks.	X	X
/4/	Rexroth IndraLogic XLC IndraMotion MLC 12VRS Field Buses DOK-XLCMLC-FB*****V12-APxx-EN-P, R911334394 This documentation describes the supported field buses and their diagnostic function blocks.	X	X

About this Documentation

HMI		MLC	XLC
/8/	Rexroth IndraWorks 12VRS HMI DOK-IWORKS-HMI****V12-APxx-EN-P, R911334392 This documentation describes the functions, configuration and operation of the user interfaces IndraWorks HMI Engineering and IndraWorks HMI Operation.	X	X
/6/	Rexroth IndraWorks 12VRS WinStudio DOK-IWORKS-WINSTUD*V12-APxx-EN-P, R911333844 This documentation describes the installation of the software, working with WinStudio and the creation and operation of applications.	X	X
/50/	Rexroth IndraLogic XLC IndraMotion MLC 12VRS HMI Connection DOK-XLCMLC-HMI****V12-APxx-EN-P, R911334184 This documentation describes the visualization systems supported by the IndraLogic XLC and IndraMotion MLC and their connection.	X	X
PLC		MLC	XLC
/3/	Rexroth IndraWorks 12VRS IndraLogic 2G Programming Instruction DOK-IWORKS-IL2GPRO*V12-APxx-EN-P, R911334390 This documentation describes the PLC programming tool IndraLogic 2G and its usage. It includes the basic usage, first steps, visualization, menu items and editors.	X	X
/33/	Rexroth IndraWorks 12VRS, Basic Libraries, IndraLogic 2G DOK-IL*2G*-BASLIB**V12-LIxx-EN-P, R911333835 This documentation describes the system-comprehensive PLC libraries.	X	X
Technology			
/30/	Rexroth IndraMotion MLC 12VRS Technology Libraries DOK-MLC***-TF*LIB**V12-LIxx-EN-P, R911333868 This documentation describes the function blocks, functions and data types of the libraries "ML_TechInterface.library", "ML_TechMotion.library", "RMB_TechCam.library" and "ML_TechBase.library". It also includes libraries for the winder functionality, register controller functionality and CrossCutter functionality.	X	
/60/	Rexroth IndraMotion MLC 12VRS RegisterControl (Library) DOK-MLC***-REGI*CO*V12-LIxx-EN-P, R911333856 This documentation describes the inputs and outputs of the individual function blocks and provides notes on their usage.	X	
/62/	Rexroth IndraMotion MLC 12VRS RegisterControl (Application Manual) DOK-MLC***-REGI*CO*V12-APxx-EN-P, R911333854 This documentation describes the application of the integrated register control for a rotogravure printing machine. The components of the mark stream sensor, the HMI application and the error recovery options are described. This instruction provides information on how to operate the register control, react on errors and query diagnostics. This documentation is written for machine setters and machine operators.	X	
/49/	Rexroth IndraMotion MLC 12VRS Application of Winder Functions DOK-MLC***-TF*WIND*V12-APxx-EN-P, R911333870 This application-related system documentation describes the usage of the winder technology functions.	X	

About this Documentation

Hardware		MLC	XLC
/1/	Rexroth IndraControl L45/L65 DOK-CONTRL-IC*L45*L65*-PRxx-EN-P, R911324661	X	X
/2/	Rexroth IndraControl L25 DOK-CONTRL-IC*L25*****-PRxx-EN-P, R911328474	X	X
/24/	Rexroth IndraControl Lxx 12VRS Function Modules DOK-CONTRL-FM*LXX**V12-APxx-EN-P, R911333830 This documentation describes all function modules of the Lxx controls including engineering and diagnostics.	X	X
/12/	Rexroth IndraDrive Drive Controllers MPx-02 to MPx-07 DOK-INDRV*-GEN-**VRS**-PAxx-EN-P, R911297317		
/13/	Rexroth IndraDrive MPx-02 to MPx-07 and HMV DOK-INDRV*-GEN-**VRS**-WAxx-EN-P, R911297319		
/35/	Rexroth IndraDrive Drive Controller Control Sections CSB01, CSH01, CDB01 DOK-INDRV*-CSH*****-PR08-EN-P, R911295012		

Diagnostics and Service		MLC	XLC
/26/	Rexroth IndraMotion MLC/XLC 11VRS Service Tool DOK-IM*ML*-IMST***V11-RExx-EN-P, R911331940	X	X
/22/	Rexroth IndraLogic XLC IndraMotion MLC 12VRS Diagnostics DOK-XLCMLC-DIAG***V12-RExx-EN-P, R911334180 This documentation includes all control parameters implemented in the control systems IndraLogic XLC and IndraMotion MLC.	X	X

System Overview		MLC	XLC
/48/	Rexroth IndraMotion for Printing 12VRS System Overview DOK-IM*PR*-SYSTEM**V11-PRxx-EN-P, R911333840 This documentation describes the product IndraMotion for Packaging. It introduces the control systems, drive systems and I/O systems as well as the commissioning and programming.	X	
/48/	Rexroth IndraMotion for Packaging 12VRS System Overview DOK-IM*PA*-SYSTEM**V12-PRxx-EN-P, R911333838 This documentation describes the product IndraMotion for Packaging. It introduces the control systems, drive systems and I/O systems as well as the commissioning and programming.	X	
/9/	Rexroth IndraMotion MLC 12VRS System Overview DOK-MLC***-SYSTEM**V12-PRxx-EN-P, R911333860 This documentation provides an overview on the possible hardware/software components of the automation system IndraMotion MLC of the named version. It helps assembling a system.	X	
/9/	Rexroth IndraLogic XLC 12VRS System Overview DOK-XLC***-SYSTEM**V12-PRxx-EN-P, R911333880 This documentation provides an overview on the possible hardware/software components of the automation system IndraLogic XLC of the named version. It helps assembling a system.		X

About this Documentation

First Steps		MLC	XLC
/25/	Rexroth IndraMotion MLC 12VRS First Steps DOK-MLC***-F*STEP**V12-COxx-EN-P, R911333846 This documentation describes the first steps of the IndraMotion MLC and the RobotControl. It includes the hardware and software prerequisites as well as the creation of a project.	X	
/25/	Rexroth IndraLogic XLC 12VRS First Steps DOK-XLC***-F*STEP**V12-COxx-EN-P, R911333876 This documentation describes the first steps of the IndraLogic XLC. It includes the hardware and software prerequisites as well as the creation of a project.		X

xx Respective edition
Fig. 1-1: XCL/MLC documentation overview

1.3 Information Representation

1.3.1 Safety Instructions

The safety instructions available in the user documentations contain certain signal words (Danger, Warning, Caution, Notice) and if applicable, signal alert symbols (acc. to ANSI Z535.6-2006).

The signal word should direct the attention to the safety instructions. It indicates the severity of the hazard.

The signal alert symbol (warning triangle with exclamation mark) positioned in front of the signal words Danger, Warning and Caution indicates hazards for individuals.

DANGER

In case of non-compliance with this safety instruction, death or serious injury **will** occur.

WARNING

In case of non-compliance with this safety instruction, death or serious injury **could** occur.

CAUTION

In case of non-compliance with this safety instruction, minor or moderate injury could occur.

NOTICE

In case of non-compliance with this safety instruction, property damages can occur.

1.3.2 Symbols Used

Note Notes are represented as follows:



This is a note for the user.

Tip Tips are represented as follows:

About this Documentation



This is a tip for the user.

1.3.3 Names and Abbreviations

Term	Explanation
CANOpen	Field bus
DeviceNet	Field bus
Ethernet	Communication interface
IWE	IndraWorks Engineering
IWO	IndraWorks Operation
OWG	Optical waveguide
MLC	Motion Logic Control
MLD	Motion Logic Drive Control
NC	Numerical Control
OEM	Original Equipment Manufacturer
PROFIBUS-DP	Field bus
SERCOS	Field bus

Fig. 1-2: Terms and abbreviations used

2 Important Directions for Use

2.1 Appropriate Use

2.1.1 Introduction

Bosch Rexroth products represent state-of-the-art developments and manufacturing. They are tested prior to delivery to ensure operating safety and reliability.

WARNING

Personal injury and property damage caused by inappropriate use of the products!

The products may only be used in the manner that is defined as appropriate. If they are used in an inappropriate manner, then situations can develop that may lead to property damage or injury to personnel.



Bosch Rexroth, as manufacturer, is not liable for any damages resulting from inappropriate use. In such cases, the guarantee and the right to payment of damages resulting from inappropriate use are forfeited. The user alone carries all responsibility of the risks.

Before using Bosch Rexroth products, make sure that all the pre-requisites for appropriate use of the products are satisfied:

- Personnel that in any way, shape or form uses our products must first read and understand the relevant safety instructions and be familiar with appropriate use.
- If the product takes the form of hardware, then they must remain in their original state, in other words, no structural changes are permitted. It is not permitted to decompile software products or alter source codes.
- Do not mount damaged or faulty products or use them in operation.
- Make sure that the products have been installed in the manner described in the relevant documentation.

2.1.2 Areas of Use and Application

The IndraControl of Bosch Rexroth and its function modules are suitable for motion/logic applications.



The IndraControl and its function modules may only be used with the accessories and parts specified in this document. If a component has not been specifically named, then it may not be either mounted or connected. The same applies to cables and lines.

Operation is only permitted in the specified configurations and combinations of components using the software and firmware as specified in the relevant function descriptions.

IndraControl and its function modules have been developed for use in single or multiple-axis drives and control tasks.

To ensure an application-specific use, the machine operator and visualization panels are available with differing equipment and different interfaces.

Typical applications of IndraControl and its function modules are:

- [Handling and assembly systems]

Important Directions for Use

- [Packaging and foodstuff machines]
- [Printing and paper processing machines]
- [Machine tools]

IndraControl and its function modules may only be operated under the assembly, installation and ambient conditions as described here (temperature, system of protection, humidity, EMC requirements, etc.) and in the position specified.

2.2 Inappropriate Use

Using IndraControl and its function modules outside of the above-referenced areas of application or under operating conditions other than described in the document and the technical data specified is defined as "inappropriate use".

IndraControl and its function modules may not be used if

- they are subject to operating conditions that do not meet the above specified ambient conditions. This includes, for example, operation under water, in the case of extreme temperature fluctuations or extremely high maximum temperatures or if
- Bosch Rexroth has not specifically released them for that intended purpose. Please note the specifications outlined in the general safety instructions!

3 Project Planning and Configuration

3.1 General

The winder functions are described from the user point of view. For more details on the winder function blocks, the library description is required for the TechWinder library.

3.2 System Configuration

3.2.1 MLC Control

General The MLC control is a rack-based control connecting Motion and control functionality. The Motion functionality is mostly realized by a fix firmware. The control functionality is freely programmable with the Engineering Suite IndraWorks and the PLC programming environment IndraLogic 2.x.

- Hardware**
- IndraControl L25 (lower performance segment)
 - IndraControl L45 (medium performance segment)
 - IndraControl L65 (upper performance segment)

- Firmware**
- from FWA-CML25*-MLC-11VRS-D0
 - from FWA-CML45*-MLC-11VRS-D0
 - from FWA-CML65*-MLC-11VRS-D0



The control variant XLC cannot be used with the TechWinder library.

Software IndraWorks 12VRS for IndraMotion MLC

3.2.2 MLD Control

General The IndraMotion MLD is an "onboard" control integrated into the hardware of the IndraDrive control section. The PLC firmware is part of the drive firmware. In contrast to the IndraMotion MLC, the PLC engineering environment is the IndraLogic 1.x. (up to the drive firmware MPX08).

- Hardware**
- The control section CSH01.1 is required for the single-axis control MLD-S
 - The control section CSH01.3 is required for the multi-axis control MLD-M

- Firmware** Drive firmware from 07VRS:
- MPC firmware: Multi-axis MotionControl IndraMotion MLD-M for up to eight axes
 - MPH firmware: Single-axis control IndraMotion MLD-S for one axis

Function packages:

The drive firmware functionality is divided into several function packages. The function packages have to be ordered and licensed according to the application. The required function packages are then enabled.



The "IndraMotion MLD" function packages has to be enabled for the IndraMotion MLD.

The additional package "IndraMotion MLD Advanced" ("MA") has to be enabled for extended technology function blocks.

Project Planning and Configuration

Software
Special parameterization for the MLD control

The additional package "IndraMotion MLD Advanced" is only available for MPC firmware and MPH firmware (not for MPB firmware).

IndraWorks 12VRS for IndraMotion MLD

The "AxisData structure" of the drive has to be parameterized (P-0-1367 "PLC configuration", bit 6 is set or the dialog "PLC Configuration")

For the multi-axis control, set additionally in the PLC configuration that the PLC "permanently controls" (P-0-1367 "PLC configuration", bit 4 set or dialog for the "PLC Configuration") the drive.

For the MLD control, the virtual axis is realized using a master axis generator.

Configuring the virtual master axis generator:

The configuration of the virtual master axis generator comprises the following three parameterizations:

- Operation modes of the virtual master axis
Setting the positioning mode

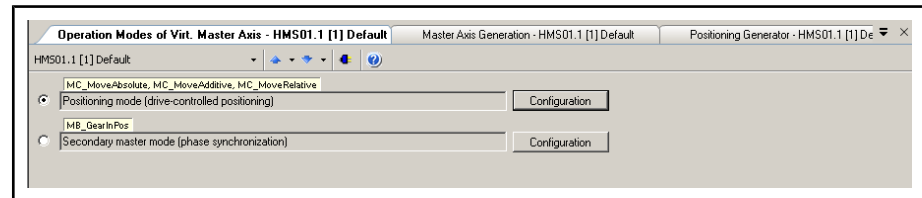


Fig.3-1: Operation modes of the virtual master axis

- Master axis generation
Entering the parameter P-0-0758 "Virtual master axis, actual position value"

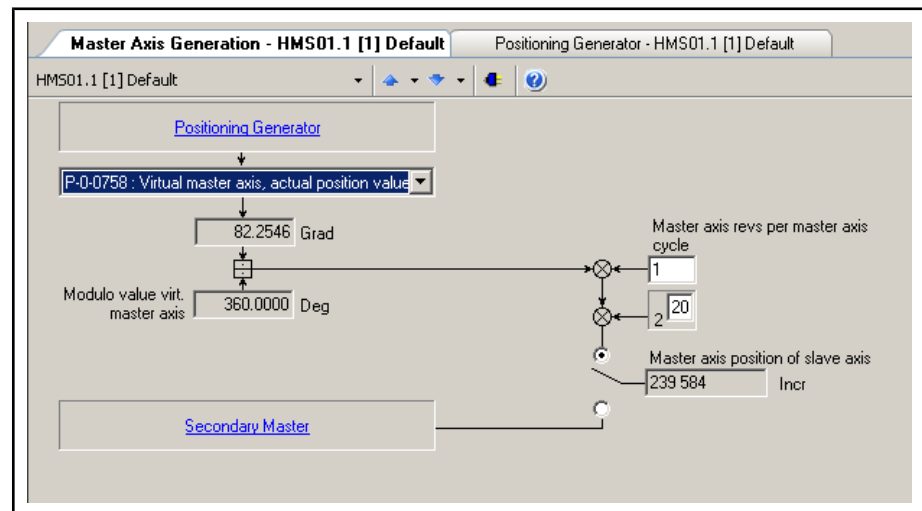


Fig.3-2: Master axis generation

- Positioning generator
Enabling position command value

Project Planning and Configuration

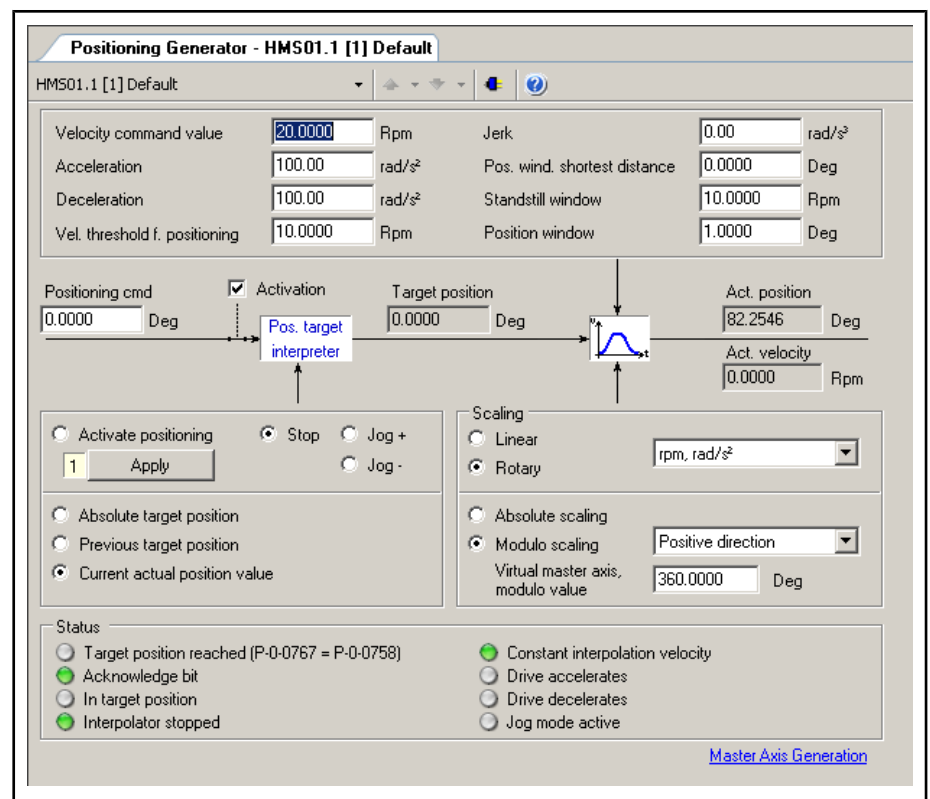


Fig. 3-3: Positioning generator

3.3 Ordering Information/Reference Lists

3.3.1 MLC Control

Description	Hardware type designation code	Firmware type designation codes
IndraMotion MLC based on IndraControl L25		
IndraControl CML25.1	CML25.1-3N-400-NN-NNC1-NW	FWA-CML25*-MLC-11VRS-D0
IndraMotion MLC based on IndraControl L45		
IndraControl CML45.1	CML45.1-3P-500-NA-NNNN-N	FWA-CML45*-MLC-11VRS-D0
IndraControl CML45.1 (with 8 MB S-RAM)	CML45.1-3P-504-NA-NNNN-N	
IndraMotion MLC based on IndraControl L65		
IndraControl CML65.1	CML65.1-3P-500-NA-NNNN-N	FWA-CML65*-MLC-11VRS-D0
IndraControl CML65.1 (with 8 MB S-RAM)	CML65.1-3P-504-NA-NNNN-N	

Fig. 3-4: Firmware for the control hardware variants

3.3.2 IndraDrive Drive

The following firmware versions of the drives are supported by the MLC system:

- FWA-INDRV*-MPH-06VRS-D5-1-SNC-NN
- FWA-INDRV*-MPD-06VRS-D5-1-SNC-NN
- FWA-INDRV*-MPB-06VRS-D5-1-SNC-NN

Project Planning and Configuration

- FWA-INDRV*-MPC-06VRS-D5-1-SNC-NN
- FWA-INDRV*-MPH-07VRS-D5-1-SNC-NN
- FWA-INDRV*-MPD-07VRS-D5-1-SNC-NN
- FWA-INDRV*-MPB-07VRS-D5-1-SNC-NN
- FWA-INDRV*-MPC-07VRS-D5-1-SNC-NN
- FWA-INDRV*-MPH-08VRS-D5-1-SNC-NN
- FWA-INDRV*-MPD-08VRS-D5-1-SNC-NN
- FWA-INDRV*-MPB-08VRS-D5-1-SNC-NN
- FWA-INDRV*-MPC-08VRS-D5-1-SNC-NN
- FWA-INDRV*-MPB-17VRS-D5-1-SNC-NN
- FWA-INDRV*-MPM-17VRS-D5-1-SNC-NN
- FWA-INDRV*-MPC-17VRS-D5-1-SNC-NN

3.3.3 MLD Control

The multi-axis control MLD-M are supported for the following versions:

- FWA-INDRV*-MPC-07VRS-D5-1-SNC-NN
- FWA-INDRV*-MPC-08VRS-D5-1-SNC-NN
- FWA-INDRV*-MPC-17VRS-D5-1-SNC-NN

The single-axis control MLD-S are supported for the following versions:

- FWA-INDRV*-MPH-07VRS-D5-1-SNC-NN
- FWA-INDRV*-MPH-08VRS-D5-1-SNC-NN
- FWA-INDRV*-MPM-17VRS-D5-1-SNC-NN

4 Functional Description

4.1 Overview on Winding Functions

A winder application normally consists of a control, a winder drive, a material web and sensors if necessary. The web should be wound or unwound with a defined tension. The winding diameter changes continuously. The control calculates the current diameter using multiple system variables and controls the motor speed so that the web tension remains constant. If higher performance of tension accuracy or tension constancy are demanded, additional sensors such as a dancer roll or a tension load cell can be used.

The center-driven winder is the state-of-art today. That means a motor drives the central shaft of the winder. With regard to control technology, this is more difficult to be controlled than the so-called surface-driven winder (drive shaft at the circumference of the winder), but it is the more effective and mechanically the more simple variant.

There are different control methods for the center-driven winder:

1. Winder with closed-loop dancer position control and dancer roll
2. Winder with open-loop tensile stress control (without sensor)
3. Winder with closed-loop tensile stress control and torque limitation
4. Winder with closed-loop tensile stress control and speed correction

Each control method has advantages and disadvantages.

Criteria to select the suitable control concept

Control concept	Open-loop tensile stress control (without sensor)	Closed-loop tensile stress control and torque limitation	Closed-loop tensile stress control and speed correction	Closed-loop dancer position control with dancer roll
Note on the actual tensile value detection	No actual tensile value detection required	Sensitive to overload Does not interfere with the web characteristics	Sensitive to overload Does not interfere with the web characteristics	Does interfere with the web characteristics Material storing capacity
Winding ratio $D_{\max}/D_{\text{core}}$	Up to approx. 10:1 Good compensation of changes in velocity and friction required	Up to approx. 15:1 Good compensation of changes in velocity and friction required	Up to approx. 15:1	Up to approx. 15:1
Tension range $F_{\max}/F_{\min}$	Up to approx. 6:1 Good compensation of changes in velocity and friction required	Up to approx. 20:1	Up to approx. 20:1	Can only be changed via active force on the dancer roll
Winder ratio in the tension area $D_{\max}/D_{\text{core}} * F_{\max}/F_{\min}$	Up to approx. 40:1	Up to approx. 100:1 Depends mostly on the quality of the actual tension value signal	Up to approx. 100:1 Depends mostly on the quality of the actual tension value signal	Depends on the structure of the dancer Up to approx. 40:1

Functional Description

Control concept	Open-loop tensile stress control (without sensor)	Closed-loop tensile stress control and torque limitation	Closed-loop tensile stress control and speed correction	Closed-loop dancer position control with dancer roll
Web velocity	Up to 600 m/min At good compensation	Up to approx. 2000 m/min At good compensation of changes in velocity	Up to above 2000 m/min	Up to above 2000 m/min
Control procedure preferably used for:	Sheet metal, textile, paper	Paper, thin foils	Elastic, expandable material	Rubber, cable, wire, textile, foils, paper

Fig.4-1: Criteria to select the suitable control concept

4.2 Winder with Dancer Position Controller

4.2.1 Introduction and Overview

Introduction and Overview

The diameter calculator with dancer is used for center-driven winders. The tension is specified by a force which acts upon the movable part of the dancer. This force can be applied by a weight, a spring or a pneumatic element. The closed-loop control of the dancer position is performed in the dancer position controller. The actual value of the dancer position is recorded for example via an analog channel and is transferred to the closed-loop control.

The current winding diameter is calculated by an internally integrated diameter calculator. The velocity of the winding axis is adjusted with the help of the calculated winding diameter. Thus, the calculated winding diameter replaces an actual diameter recorded via a sensor system.

The diameter calculator with dancer thus represents a combination of a winder (represented by the winding axis and the diameter calculator) and a dancer position controller. The diameter calculator influences the gear fine adjustment and the dancer position controller influences the additive speed command value.

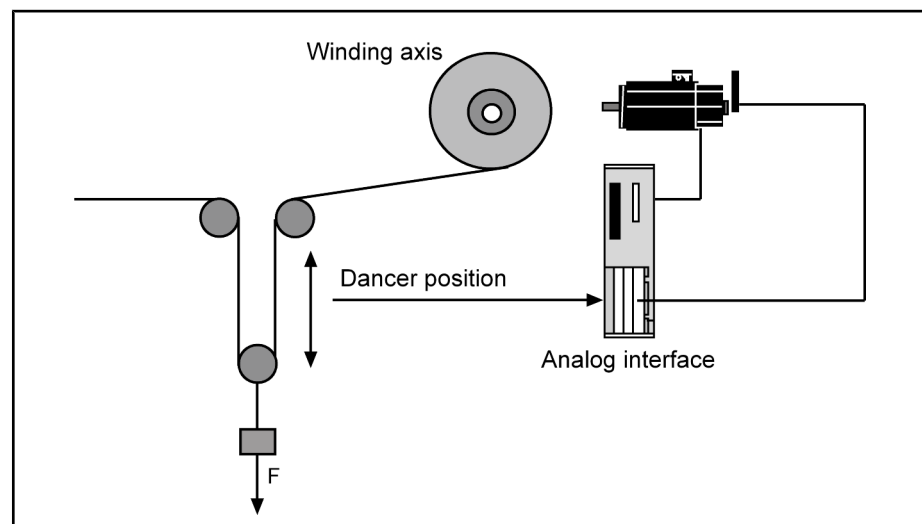


Fig.4-2: Principle of the diameter controller with dancer position controller

Functional Description

4.2.2 Interfaces of the Winder with Dancer

Interface Description

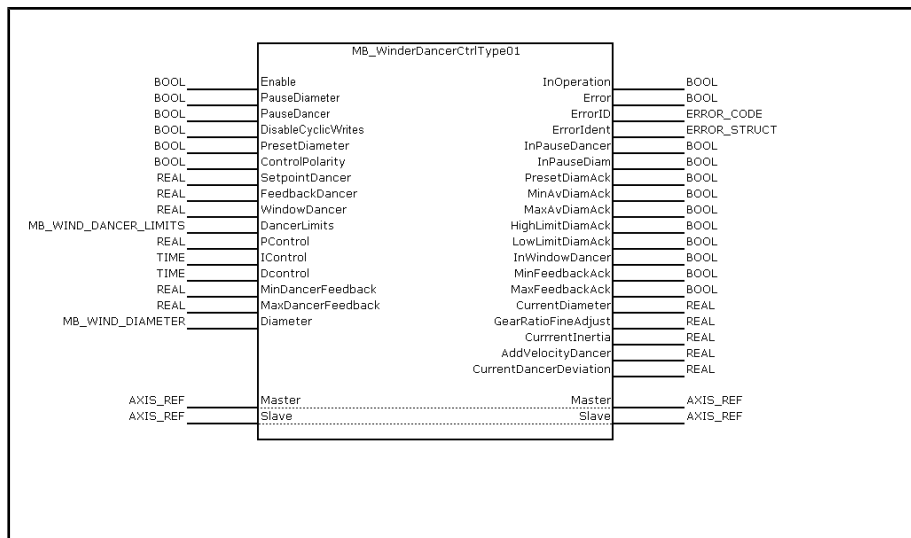


Fig.4-3: MB_WinderDancerCtrlType01 function block

I/O type	Name	Type	Comment
VAR_IN_OUT	Master	AXIS_REF	Reference to master axis
	Slave	AXIS_REF	Reference to the slave axis (winding axis)
VAR_INPUT	Enable	BOOL	Processing of function block enabled (level-controlled)
	PauseDiameter	BOOL	Diameter calculator paused; no further measurement of diameter and velocity adjustment (level-controlled)
	PauseDancer	BOOL	Dancer controller paused (level-controlled)
	DisableCyclicWrites	BOOL	If this input is set, the cyclic data is not written directly into the optional cyclic data container, but only displayed at the output
	PresetDiameter	BOOL	CurrentDiameter is set to PresetVal, GearRatioFineAdj is adjusted accordingly (edge-controlled)
	ControlPolarity	BOOL	Polarity of the closed-loop dancer control is inverted (applied in case of pos. edge at "Enable")
	SetpointDancer	REAL	Command value (setpoint) for closed-loop dancer control
	FeedbackDancer	REAL	Actual value (feedback) for dancer position
	WindowDancer	REAL	Window for monitoring the actual dancer position value [%] with regard to the command dancer position value. If the dancer position deviates from the command value by more than the given value, the function block reports this deviation by resetting the "InWindow" output
	DancerLimits	MB_WIND_DANCER_LIMITS	Structure for the automatic control variable limitation of the dancer
	PControl	REAL	Value for the Kp-gain of the closed-loop dancer control
	IControl	TIME	Value for the integral action time of the closed-loop dancer control

Functional Description

I/O type	Name	Type	Comment
	DControl	TIME	Value for the derivative time of the closed-loop dancer control
	MinDancerFeedback	REAL	Lower threshold for the actual dancer value (only for display with a binary output).
	MaxDancerFeedback	REAL	Upper threshold for the actual dancer value (only for display with a binary output).
	Diameter	MB_WIND_DIAMETER	Structure for the diameter calculator
VAR_OUTPUT	InOperation	BOOL	Function block is working
	Error	BOOL	Processing completed with error
	ErrorID	ERROR_CODE	Describing diagnostics in case of error
	ErrorIdent	ERROR_STRUCT	Detailed diagnostics
	InPauseDancer	BOOL	Dancer controller pausing
	InPauseDiam	BOOL	Diameter calculation paused
	PresetDiamAck	BOOL	Preset diameter is applied (is set providing "Preset" is pending)
	MinAvDiamAchieved	BOOL	Minimum diameter reached (based on the averaged diameter)
	MaxAvDiamAchieved	BOOL	Maximum diameter reached (based on the averaged diameter)
	HighLimitDiamActive	BOOL	Currently calculated diameter has reached the upper limit (Diameter value is discarded)
	LowLimitDiamActive	BOOL	Currently calculated diameter has reached the lower limit (diameter value is discarded)
	InWindowDancer	BOOL	Actual dancer value within dancer window
	MinFeedbackAchieved	BOOL	Actual value of the dancer position is below the input "MinDancerFeedback"
	MaxFeedbackAchieved	BOOL	Actual value of the dancer position is above the input "MaxDancerFeedback"
	CurrentDiameter	REAL	Current winding diameter
	GearRatioFineAdjust	REAL	Fine gear adjustment for speed adaptation of the drive [%]
	CurrentInertia	REAL	Current moment of inertia of the winding material + mechanics (based on the motor side) [kg m ²]
	AddVelocityDancer	REAL	Speed offset for the winding drive [rpm]
	CurrentDancerDeviation	REAL	Current control deviation of the dancer controller

Fig. 4-4: Interface variables of the MB_WinderDancerCtrlType01 function block
Functional diagram:

Functional Description

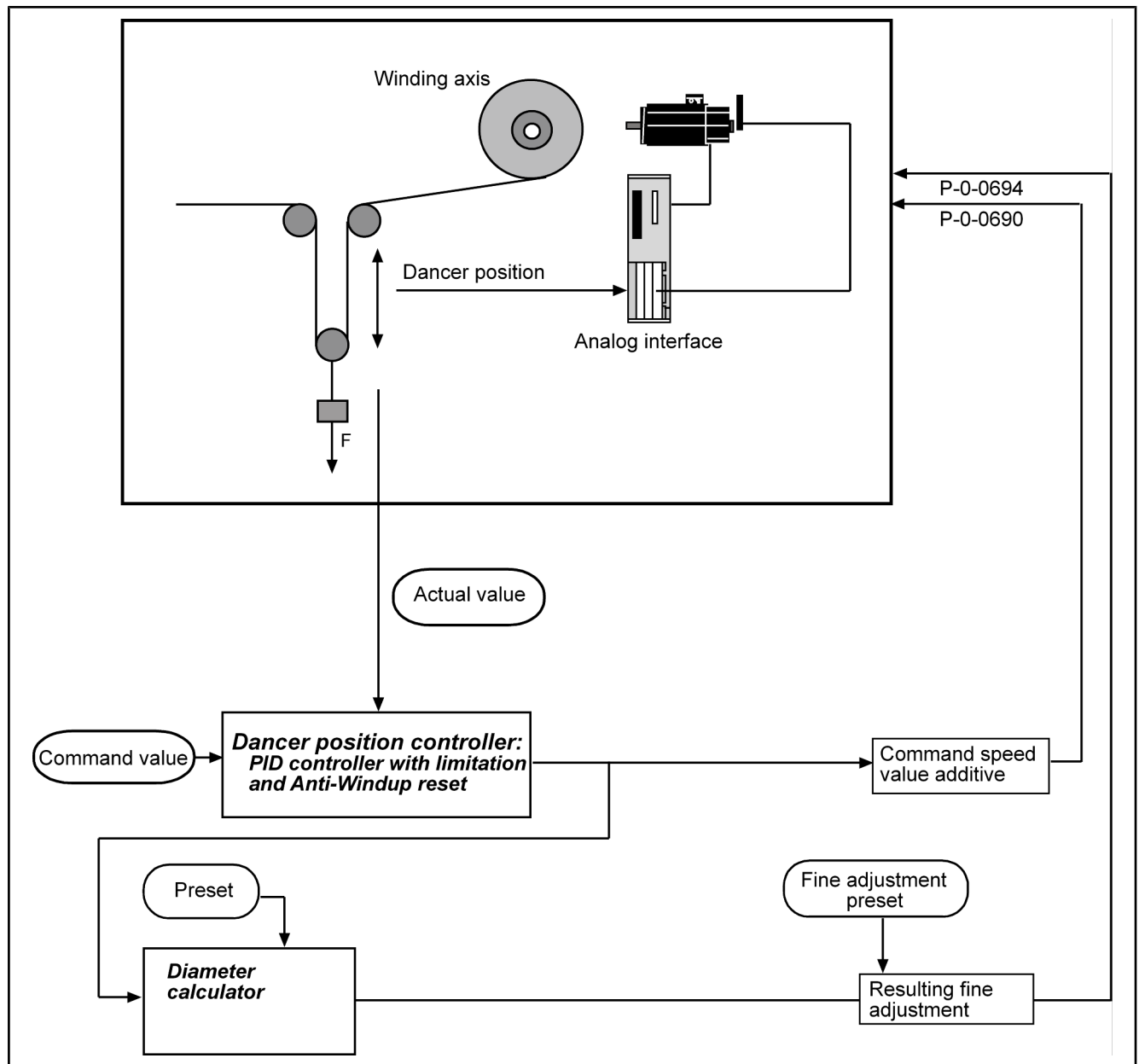


Fig. 4-5: Functional diagram of the diameter calculator with dancer

4.2.3 Commissioning of the Winder with Dancer

General Settings

Mechanical gear	An actual existing mechanical gear ratio from the drive axis to the winding axis has to be entered into the parameters S-0-0121 ("Input revolutions of load gear") and S-0-0122 ("Output revolutions of load gear").
Operation type of the winding drive (commanding)	The correct operation mode "Speed synchronization" of the drive and the drive enable of the drive have to be set for the winding axis. This can be carried out in two different ways as follows: - Set the "ModeSyncVel" operation mode by means of the AxisInterface (recommended) - Use the PLCopen "MC_Power", "MC_GearIn", "MC_Stop" function blocks to command the axis

Functional Description

Setting of the speed control loop

The electronic gear between master axis and winding axis is to be set to 1:1 for the winding axis (A-0-2720 "ELS, master axis gear, input revolutions" or P-0-0156 "Master drive gear input revolutions" and A-0-2721 "ELS, master axis gear, output revolutions" or P-0-0157 "Master drive gear output revolutions").

The following steps have to be made for an empty and full roll:

- Set Tn to 0 and let the winding axis rotate freely at low speed.
- Increase the parameter S-0-0100 "Velocity controller proportional gain" slowly starting from the default value until an oscillation of the velocity control deviation can be detected at the oscilloscope.
- If the oscillation frequency is significantly higher than 500Hz, the parameter P-0-0004 "Smoothing time constant - speed controller" is increased until the oscillation decreases again.

In general, the parameter P-0-0004 "Smoothing time constant - speed controller" has to be set to a value of 1000 at least.

- In this case, increase the parameter S-0-0100 "Velocity controller, proportional gain" until the control loop becomes instable again and then reduce it until the oscillation decays. Set the P-gain to the half of the last value set to be sufficiently far away from the stability limit.
- Decrease S-0-0101 "Velocity controller integral action time" starting from a relative high value (e.g. 1000 ms) until the control loop becomes instable and then increase it until the oscillation decreases. Enter twice the value as value for the parameter S-0-0101 "Velocity controller integral action time". The integral action time should not be lower than 150 ms.

The control loop setting of the drives selected has to ensure that both extreme cases (minimum diameter and maximum diameter) can be operated with stability.

Otherwise, these two values can be linearly adapted to each other depending on the current diameter (function block MB_WindSpeedAdaptionType01).

Determining the direction of rotation of the winding axis

The direction of rotation of the tensile axis or winding axis can be set using the axis parameter A-0-2798 "Polarity, master axis position" or the drive parameter P-0-0108 "Master drive polarity". If the winding axis does not rotate in the desired direction, the axis parameter A-0-2798 or the drive parameter P-0-0108 has to be reset accordingly.

When inverting the drive direction of rotation, the control direction ("ControlPolarity" input) is also to be inverted.

The following figure shows the principal relations between rewinders and unwinders.

Functional Description

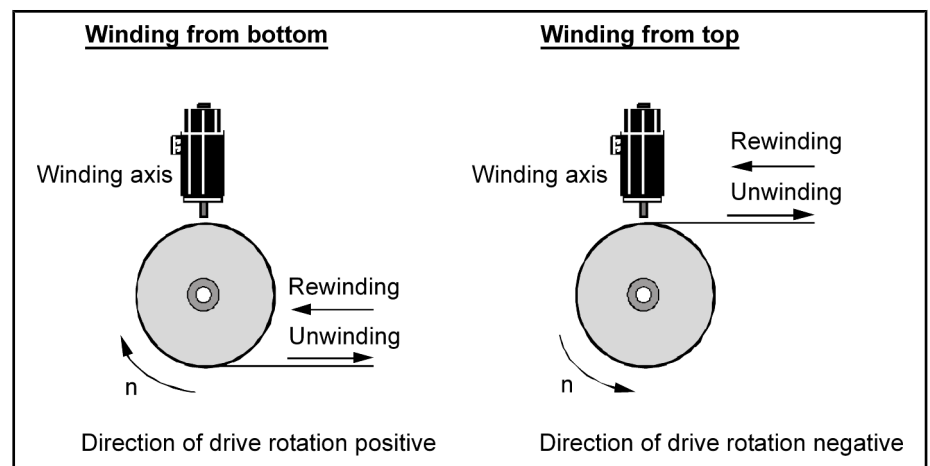


Fig. 4-6: Principles of rewinders and unwinders

Actual value detection of the dancer position

The dancer position is generally read in via an analog input. The analog input can either be read in at the drive (onboard analog input or via an MA1 extension card) or via an Inline analog input module of the control.

The actual value detection only processes positive actual values. If might be required to add an offset to the read value to ensure the mentioned over the complete range (e.g. offset is 0.1 volt). If the command value is specified in volts, a standardization factor is not required. If the command value is specified in mm, a standardization factor from volts to mm is required (e.g. 10 volts correspond to 200 mm; that is a standardization factor of 20 mm/V).

This actual value can be filtered using a PT1-filter if the value varies a lot (e.g. 20 ms). If the analog input is read in at the drive, the filter in the drive is to be preferably used. For analog input 1, this is set in the parameter P-0-0217 "Analog input 1, time constant input filter". If the analog input is read in at the control, a PT1-filter function block can be used in the PLC library "LoopControl".

Basic Settings of the Function Block

Axis assignment

The axis reference (AXIS_REF) of the winding axis is connected at the "Slave" input.

The axis reference (AXIS_REF) of the master axis is connected at the "Master" input. This is the axis providing the web velocity of the machine.

The scaling type has to be identical for master axis and slave axis. Rotary scaling and preference scaling are recommended.

For the winding axis, the interpolation in the drive has to be enabled for the MLC control.

Setting rewinders or unwinders

There is no separate input to set rewinders and unwinders. It is switched between rewinders und unwinders via the "ControlPolarity" input. See also "Determining the direction of rotation".

Determining the dancer command value

The "SetpointDancer" input is specified in such a way that the dancer roll is located in the center position if the control deviation of the dancer "CurrentDancerDeviation" is approximately zero.

The unit of the dancer command value is identical to the actual dancer value. That means that if the actual value is read in in volts, the command value is also read in in volts. If the actual value is read in in mm, the command value is also read in in mm.

Settings for the diameter calculator

The settings for the diameter calculator are summarized in the "MB_WindDiameter" structure.

Functional Description

The variable "DiamSource" has to be set to "FALSE" for the diameter calculation. If "DiamSource" is set to "TRUE", the diameter is read in externally.

The core diameter of the winder (in mm) is entered into the variable "CoreDiameter".

The variable "RepeatLength" (in mm) has to be entered for the diameter calculation. This corresponds to the circumference of the master axis.

The limitations ("HighLimit", "LowLimit") can additionally be entered for the diameter calculation. This limits the diameter to a minimum (e.g. core diameter) and to a maximum value (e.g. maximum winding roll possible).

The standstill window of the master axis (parameter A-0-0222 "Standstill window" or S-0-0124 "Standstill window") has to be set to the lowest value possible (e.g. 0.1 rpm). When there is a standstill message of the master or the reference axis, the diameter calculator does not calculate!

Furthermore, the web width "WebWidth" (in mm) and the density "Density" (in kg/dm³) of the material web have to be entered.

The diameter calculations can be influenced with the calculation range "CalcRange" and an average value filter "AverageValue". At the beginning, there is a "CalcRange" of 360 degrees. Thus, **one calculation per winding axis revolution** and an "AverageValue" of 1 (an averaging) is not reasonable.

The diameter is only calculated if the material web is tensioned. That means that the binary output "DiameterEngaged" has to be set.



The ratio "RepeatLength"/"CoreDiameter" may not be greater than 25.

Otherwise, the gear adjustment via the gear fine adjustment is insufficient!

A relative motion of a dancer roll (applies only for winders with dancer) is considered when calculating the diameter using the "DancerConstant" variables. This dancer constant has to be determined once for a winder with dancer.

First, set the dancer constant "DancerConstant" to zero (default)

Set the "DancerConstant" value always to zero for the winders with open-loop and closed-loop tensile stress control.

Control variable limitation for the dancer position controller

To avoid higher deflection of the dancer roll (e.g. switch-on procedure of the dancer controller, chop at the flying splice), a velocity-dependent limitation has to be set for the dancer position controller.

The limitations are summarized in the MB_WIND_DIAMETER structure. A value for the lower limitation of the dancer controller output (e.g. 10 rpm) has to be entered into the variable "LowLimitControl". This value is decisive for the limitation of the switch-on process. A value for the upper limitation of the dancer controller output (e.g. 200 rpm) has to be entered into the variable "HighLimitControl". There is also a belonging master axis velocity "VelocityHighLimit" (e.g. setup velocity of the machine) for this value. There is linear interpolation between "LowLimitControl" and "HighLimitControl".

Functional Description

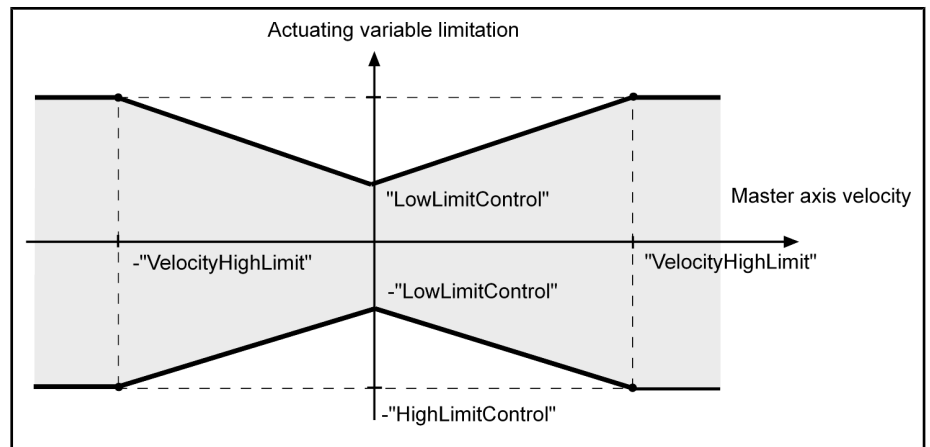


Fig. 4-7: Control variable limitation of the dancer position controller

This control variable limitation of the dancer position controller is dynamically adjusted according to the reference axis velocity and the diameter ratio [$\text{"RepeatLength"} / (\text{Pi} * \text{"CurrentDiameter"})$]. This means that at higher velocity, the limitation of the additive velocity of the dancer position controller is automatically higher than at lower velocity. Consideration of the diameter ratio results in an automatic adaptation of winding applications to a changing winding diameter.

Cyclic data channels for the winding drive

The parameter P-0-0694 ("Gear ratio fine adjustment, process controller") and the parameter P-0-0690 ("Additive velocity command value, process controller") have to be entered into the cyclic SERCOS channel of the corresponding drive ("UserCmdDataX"). The real axes are parameterized in IndraWorks in parameterization mode.

The function block automatically writes on these two drive parameters. If this is not desired, it can be switched off via the "DisableCyclicWrites" input. In this case, the outputs "GearRatioFineAdjust" and "AddVelocityDancer" have to be written manually to the drive parameters.

Final basic settings

Set the P-gain of the dancer position controller "PControl" to 1.0 for the initial commissioning.

Set the process variable window "WindowDancer" to 20% for example. If the actual dancer value is within the range of the dancer command value $\pm 20\%$, this is displayed at the "InWindowDancer" output.

Set the minimum and maximum thresholds "MinDancerFeedback" and "MaxDancerFeedback" to the values permitted for the dancer roll for the actual dancer value (absolute value in the unit of the dancer command value). Exceeding or falling below the actual dancer value is then displayed in the binary outputs "MinFeedbackAchieved" and "MaxFeedbackAchieved".

The moment of inertia of the mechanics and the winding shaft "MechanicInertia" can be set to 0 at the beginning.

Operating the Function Block

Initial startup of the winding axis

1. "Enable" of the function block for the winder with dancer. "Preset" of the diameter to the desired value (with the binary signal "PresetDiameter" and the value "Diameter.PresetVal").
2. Switch on the synchronous operation modes of all axes participating in the web process (for the winding axis "Speed synchronization" and "Mode-SyncVel").

Functional Description

3. The dancer roll has to move into the direction of the center position and the web has to be tensioned.
Otherwise, check the dancer command value "DancerSetpoint" and the input "ControlPolarity".
4. Synchronous run of the machine via specification of a velocity command value for the master axis (MoveVelocity for the master axis with 20 rpm for example). The web has to remain tensioned.
5. Check the calculated winding diameter after several winding axis revolutions.
If the calculated diameter deviates more than 5% from the actual diameter, check the mechanical gear and the "RepeatLength" of the master.
6. Stop the machine by setting the master axis command value to zero.

Setting the dancer control loop

1. "Enable" of the function block for the winder with dancer.
2. Switch on the synchronous operation modes of all axes participating in the web process (for the winding axis "Speed synchronization" and "Mode-SyncVel").
3. The dancer roll has to move into the direction of the center position and the web has to be tensioned.
4. **Open the dancer limitations**, that is "LowLimitControl" and "HighLimitControl" to 1000 rpm.
5. Increase the p-gain "PControl" of the dancer position controller until the dancer roll starts oscillating (excitation of the oscillation might be required). Then reduce the p-gain until the oscillation decays again. This critical "PControl" has to be reduced by approximately 50%. Then add command value jumps to the dancer command value "DancerSetpoint" and observe the oscillation behavior (recording with oscilloscope or trace if required). Optimize "PControl" accordingly later on if required.
Enter a lead time "DControl" if required. The minimum value is the cycle time for the MB_WinderDancerCtrlType01 function block. The higher the "DControl" value, the more powerful the controller.
Enter an integral action time "DControl" if required. A value within the range of seconds (e.g. one second).
Optimize these values later on if necessary using a jump response (command value jump) and an oscilloscope recording.
6. Enter these values again for the **dancer limitations**.
7. Check the values determined when the machine or master axis is rotating. Travel along the velocity profile of the master axis and correct the controller values if required.

Setting the dancer constant

1. Where there is deflection of the dancer from one end position to the other end position, determine the web distance (in mm).
2. Determine the difference between both the actual dancer values of the respective end position.
3. Calculate the quotient of both values.
4. Determine the sign of the dancer constant by conducting a practical test. For this purpose, the diameter calculation is observed at a slowly rotating winding axis and reference axis. Command value jumps to the dancer

Functional Description

command value should not have a significant influence on the calculation of the diameter if the sign is correct.

5. "Subsequently optimize" the calculated value for the dancer constant, as described in step 4 if required.

Basic sequence of a "flying splice"

A so-called "flying splice" is a change from a roll to a new roll when the material web is still moving and can be performed according to the following basic diagram:

(two winding axes and two winding function blocks are required).

1. Currently unwinding roll reaches critical diameter for chopping.
2. Switch on the respective winding function block the new roll and preset the diameter with the diameter of the new roll. Then set the "Pause" input.
3. Command the winding axis of the new roll and accelerate to the current web velocity.
4. Perform the material chopping (separating the unwinding roll from the web) and stick the new roll.
5. Remove the "Pause" input of the winding function block for the new roll.

The function block can be switched off for the old roll.

4.2.4 Diagnostics for the Winder with Dancer

The following error codes can occur for the winder with open-loop tensile stress control (without sensor):

ErrorID	Additional1	Additional2	Text
STATE_MACHINE_ERROR	16#1160	16#0020	Error in state machine
INPUT_RANGE_ERROR	16#1161	16#0002	HighLimit < LowLimit
		16#0003	FormatLength < 0.0
		16#0004	reference diameter < 0.0
		16#0005	process window < 0.0
		16#0006	High limit < 0.0
		16#0007	Low limit < 0.0
		16#0008	Velocity high limit < 0.0
		16#0009	p-gain < 0.0
		16#000A	setpoint < 0.0
		16#000B	Min feedback < 0.0
		16#000C	Max feedback < 0.0
		16#000D	Max feedback < Min feedback
		16#000E	Number of slave axis incorrect
		16#000F	Number of master axis incorrect
DEVICE_ERROR	16#1162	16#0001	Axis not in operating mode
RESSOURCE_ERROR	16#0004	16#0000	Incorrect drive firmware
RESSOURCE_ERROR	16#000F	16#0003	Drive function package "MA" not activated

Fig. 4-8: Error codes of the MB_DancerControlType03 function block

Functional Description

ErrorID	Additional1	Additional2	Text
STATE_MACHINE_ERROR	16#1100	16#0020	Error in state machine
INPUT_RANGE_ERROR	16#1101	16#0001	HighLimitDiameter < LowLimitDiameter
		16#0002	FormatLength < 0.0
		16#0003	WebWidth < 0.0
		16#0004	Density < 0.0
		16#0005	Core diameter < 0.0
		16#0006	DiamCalcRange < 0.0
		16#0007	Preset diameter < 0.0
		16#0008	Minimum diameter < 0.0
		16#0009	Maximum diameter < 0.0
		16#000A	HighLimitDiameter < 0.0
		16#000B	LowLimitDiameter < 0.0
		16#000C	DiamCalcMode invalid
		16#000D	Number of slave axis incorrect
		16#000E	Number of master axis incorrect
DEVICE_ERROR	16#1102	16#0001	No operating mode (no SERCOS phase 4)
RESSOURCE_ERROR	16#0004	16#0000	Incorrect drive firmware
RESSOURCE_ERROR	16#000F	16#0003	Drive function package "MA" not activated

Fig.4-9: Error codes of the MB_DiameterCalculatorType03 function block

4.3 Winders with Tensile Stress Control (Open-Loop, without Sensor)

4.3.1 Introduction and Overview

Diameter calculator with open-loop tensile stress control

The diameter calculator with open-loop tensile stress control is used on center-driven winders. The drive of the winding axis generally operates at its torque limit. The torque limit depends on the current winding diameter and the tension set.

The tensile stress is generated by adjusting the torque of the winding axis. Additional measuring elements are not required.

Functional Description

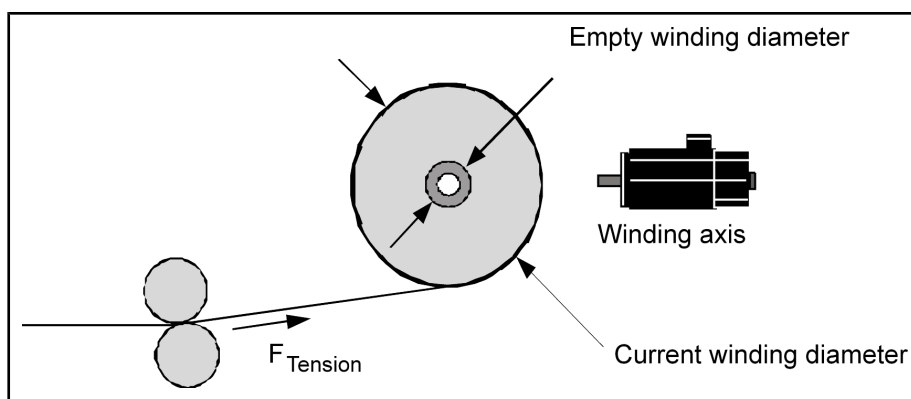


Fig. 4-10: Diameter calculator with tensile stress control (open-loop)

4.3.2 Interfaces of the Winder with Tensile Stress Control (Open-Loop, Without Sensor)

Interface Description

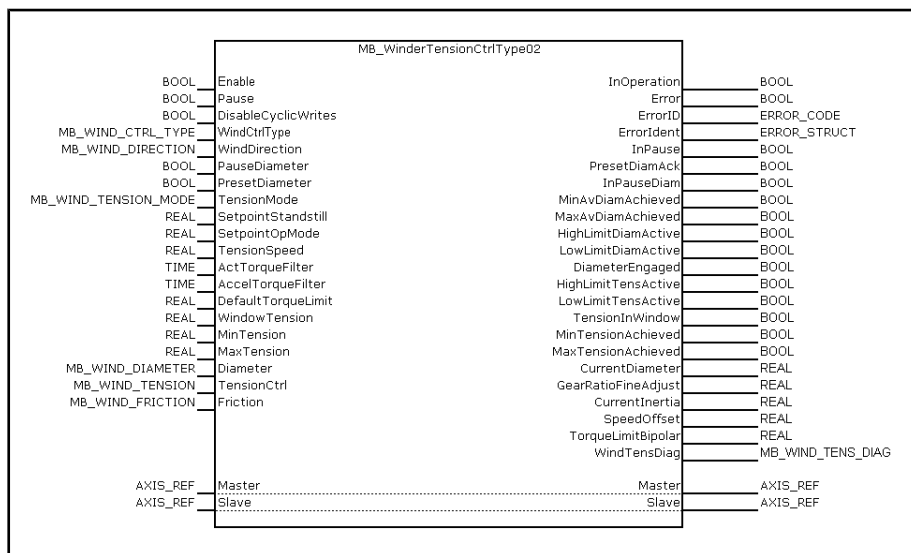


Fig. 4-11: MB_WinderTensionCtrlType02 function block

I/O type	Name	Type	Comment
VAR_IN_OUT	Master	AXIS_REF	Reference to master axis
	Slave	AXIS_REF	Reference to the slave axis (winding axis)
VAR_INPUT	Enable	BOOL	Processing of function block enabled (level-controlled)
	Pause	BOOL	Pausing the tension controller and the diameter calculator (values are frozen)
	DisableCyclicWrites	BOOL	If this input is set, the cyclic data is not written directly into the optional cyclic data container, but only displayed at the output
	WindCtrlType	MB_WIND_CTRL_TYPE	Winding structure Open-loop tension control (without sensor) OPEN_LOOP (16#0000) Closed-loop tension control (load cell) CLOSED_LOOP (16#0001)

Functional Description

I/O type	Name	Type	Comment
	WindDirection	MB_WIND_DIRECTION	Winding direction Rewinder REWIND (16#0000) Unwinder UNWIND (16#0001)
	PauseDiameter	BOOL	Pausing the diameter calculation Closed-loop/open-loop control of the torque limit remains active
	PresetDiameter	BOOL	CurrentDiameter is set to PresetVal, GearRatioFineAdj is adjusted accordingly (edge-controlled)
	TensionMode	MB_WIND_TENSION_MODE	Mode for tensioning the material web Tensioning with constant speed CONST_SPEED Tensioning at constant web velocity CONST_WEB_VEL
	SetpointStandstill	REAL	Specification of the standstill tension [N] (Changeover between standstill tension and operating tension by means of the standstill message from the drive).
	SetpointOpMode	REAL	Specifying the operating tension [N] (Changeover between standstill tension and operating tension by means of the standstill message from the drive).
	TensionSpeed	REAL	Tensioning speed in the case of an empty winder [min ⁻¹]
	ActTorqueFilter	TIME	Filter time constant for the actual torque S-0-0084 "Actual torque/force value"
	AccelTorqueFilter	TIME	Filter time constant for acceleration torque
	DefaultTorqueLimit	REAL	Value for the bipolar torque limit after deactivation of "Enable" [%]
	WindowTension	REAL	Window for the actual tension value [%] in relation to the command tensile stress value (output "TensionInWindow")
	MinTension	REAL	Lower threshold for the actual tension value (only for a display with the binary output "MinTensionAck")
	MaxTension	REAL	Upper threshold for the actual tension value (only for a display with binary output "MaxTensionAck")
	Diameter	MB_WIND_DIAMETER	Structure for the diameter calculator
	TensionCtrl	MB_WIND_TENSION	Structure for tension controller
	Friction	MB_WIND_FRICTION	Structure for the friction torque
VAR_OUTPUT	InOperation	BOOL	Function block is working
	Error	BOOL	Processing completed with error
	ErrorID	ERROR_CODE	Describing diagnostics in case of error
	ErrorIdent	ERROR_STRUCT	Detailed diagnostics
	InPause	BOOL	Tension controller and diameter calculator paused

Functional Description

I/O type	Name	Type	Comment
	PresetDiamAck	BOOL	Preset diameter was applied (is set as long as "Preset" is pending)
	InPauseDiam	BOOL	Diameter calculator paused
	MinAvDiamAchieved	BOOL	Minimum diameter reached (based on the averaged diameter)
	MaxAvDiamAchieved	BOOL	Maximum diameter reached (based on the averaged diameter)
	HighLimitDiamActive	BOOL	Currently calculated diameter has reached the upper limit (diameter value is discarded)
	LowLimitDiamActive	BOOL	Currently calculated diameter has reached the lower limit (diameter value is discarded)
	DiameterEngaged	BOOL	Diameter "engaged" TRUE: engaged FALSE: disengaged
	HighLimitTensActive	BOOL	Output of the tension controller has achieved the upper limit
	LowLimitTensActive	BOOL	Output of the tension controller has achieved the lower limit
	TensionInWindow	BOOL	Actual tension control value is within the tension control window
	MinTensionAchieved	BOOL	Tensile stress is below the "MinTension" input
	MaxTensionAchieved	BOOL	Tensile stress is above the input "MaxTension"
	CurrentDiameter	REAL	Currently calculated diameter [mm]
	GearRatioFineAdjust	REAL	Resulting fine adjustment of the gear for speed adaptation of the drive [%]
	CurrentInertia	REAL	Current moment of inertia of the winding material + mechanics (based on the motor side [kg m ²])
	SpeedOffset	REAL	Tensioning speed [rpm]
	TorqueLimitBipolar	REAL	Bipolar torque limit [%]
	WindTensDiag	MB_WIND_TENS_DIAG	Current control deviation of the dancer controller

Fig. 4-12: Interface variables of the MB_WinderTensionCtrlType02 function block
Functional diagram:

Functional Description

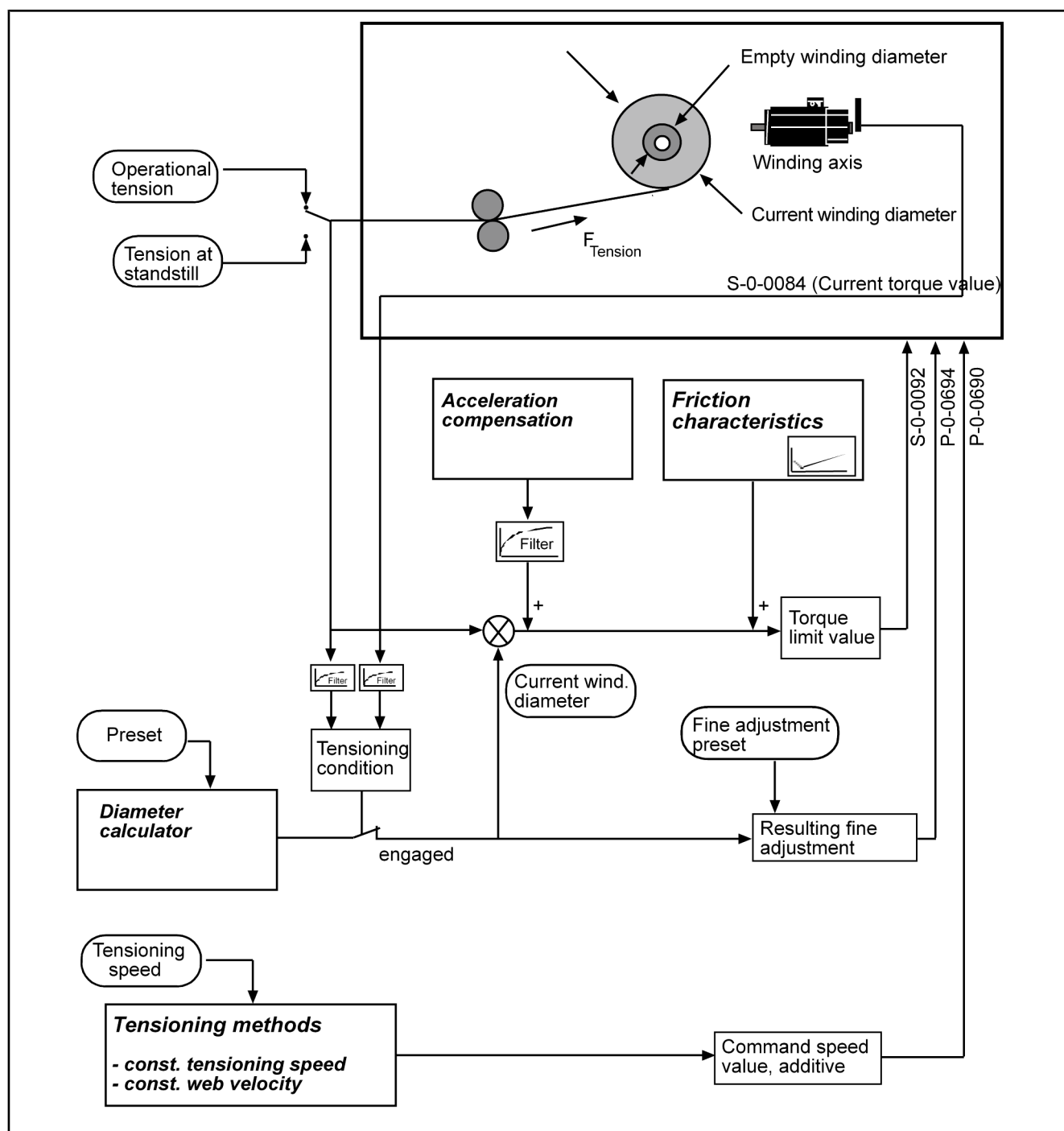


Fig.4-13: Functional diagram of the winder with tensile stress control (open-loop)

4.3.3 Commissioning the Winder with Tensile Stress (Open-Loop, Without Sensor)

General Settings

Mechanical gear An actually existing mechanical gear ratio from the drive axis to the winding axis has to be entered into the parameters S-0-0121 ("Input revolutions of load gear") and S-0-0122 ("Output revolutions of load gear").

Functional Description

Operation type of the winding drive (commanding)

The correct operation mode "Speed synchronization" of the drive and the drive enable of the drive have to be set for the winding axis. This can be carried out in two different ways as follows:

- Set the "ModeSyncVel" operation mode by means of the AxisInterface (recommended)
- Use the PLCopen "MC_Power", "MC_GearIn", "MC_Stop" function blocks to command the axis

The electronic gear between master axis and winding axis is to be set to 1:1 for the winding axis (A-0-2720 "ELS, master axis gear, input revolutions" or P-0-0156 "Master drive gear input revolutions" and A-0-2721 "ELS, master axis gear, output revolutions" or P-0-0157 "Master drive gear output revolutions").

Setting of the speed control loop

The following steps have to be made for an empty and full roll:

- Set Tn to 0 and let the winding axis rotate freely at low speed.
- Increase the parameter S-0-0100 "Velocity controller proportional gain" slowly starting from the default value until an oscillation of the velocity control deviation can be detected at the oscilloscope.
- If the oscillation frequency is significantly higher than 500Hz, the parameter P-0-0004 "Smoothing time constant - speed controller" is increased until the oscillation decreases again.

In general, the parameter P-0-0004 "Smoothing time constant - speed controller" has to be set to a value of 1000 at least.

- In this case, increase the parameter S-0-0100 "Velocity controller, proportional gain" until the control loop becomes instable again and then reduce it until the oscillation decays. Set the P-gain to the half of the last value set to be sufficiently far away from the stability limit.
- Decrease S-0-0101 "Velocity controller integral action time" starting from a relative high value (e.g. 1000 ms) until the control loop becomes instable and then increase it until the oscillation decreases. Enter twice the value as value for the parameter S-0-0101 "Velocity controller integral action time". The integral action time should not be lower than 150 ms.

The control loop setting of the drives selected has to ensure that both extreme cases (minimum diameter and maximum diameter) can be operated with stability.

Otherwise, these two values can be linearly adapted to each other depending on the current diameter (function block MB_WindSpeedAdaptionType01).

Determining the direction of rotation of the winding axis

The direction of rotation of the tensile axis or winding axis can be set using the axis parameter A-0-2798 "Polarity, master axis position" or the drive parameter P-0-0108 "Master drive polarity". If the winding axis does not rotate in the desired direction, the axis parameter A-0-2798 or the drive parameter P-0-0108 has to be reset accordingly.

The following figure shows the principal relations between rewinders and unwinders.

Functional Description

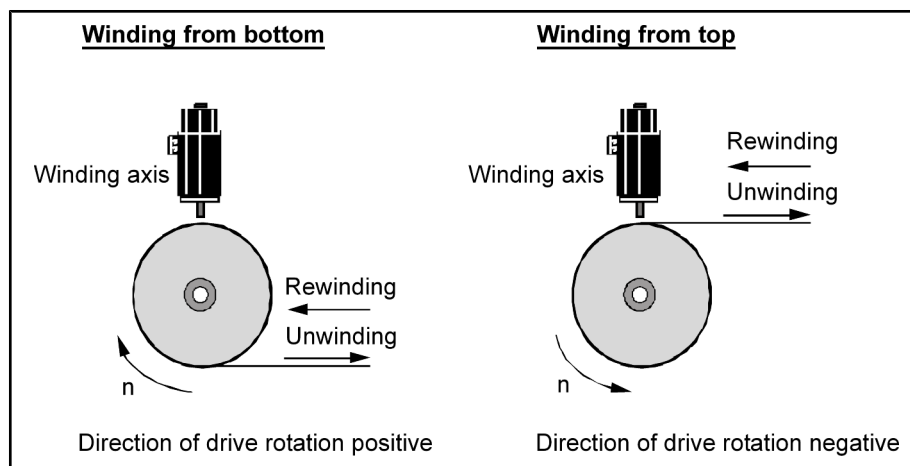


Fig.4-14: Principles of rewinders and unwinders

Actual tension value

The actual tension value is automatically calculated by the function block (when setting MB_WIND_CTRL_MODE with "OPEN_LOOP").

Additional leading and lagging of the winding axis

Additional leading or lagging via the gear fine adjustment (presetting gear fine adjustment "FineAdjust") can be set via the structure variable "qrAxisCtrl[Axis-Number].Admin.SyncMode.FineAdjust" of the "MB_AXIS_SYNCHRONISATION" data structure of the "ML_TechInterface" library. For a **rewinder**, a low **positive value** (e.g. 5 %) should be set. A low **negative value** should be set for an **unwinder**. This results in an improved startup behavior of the respective winding direction.

If the winding axis is not commanded with the AxisInterface, but with the PLCopen function blocks, the "MasterFineAdjust" input of the "MC_GearIn" function block has to be used.

Monitoring torque limit values

During the initial control startup, a drive warning "E2056 Torque limit value = 0" can occur if the winder function block is not yet enabled.

In order to prevent this, the value for the parameter S-0-0092 "Bipolar torque/force" can be written with a value unequal to zero such as 100% in the startup phase of the PLC program (e.g. warm start) of the corresponding cyclic data containers.

If the warning "E8260 Torque - force command value limit active" occurs when the function block is enabled, this warning can be eliminated by setting bit 4 of the parameter P-0-0556, "Axis controller configuration".

In some cases (e.g. multiple F8078 "Error in the speed control loop"), it can be necessary to disable the velocity controller monitoring (set bit 1 of the parameter P-0-0556 "Axis controller configuration").

Basic Settings of the Function Block**Axis assignment**

The axis reference (AXIS_REF) of the winding axis is connected at the "Slave" input.

The axis reference (AXIS_REF) of the master axis is connected at the "Master" input. This is the axis providing the web velocity of the machine.

The scaling type has to be identical for master axis and slave axis. Rotary scaling and preference scaling are recommended.

For the winding axis, the interpolation in the drive has to be enabled for the MLC control.

Setting the control method

The "WindCtrlType" input has to be set to the "OPEN_LOOP" mode using the enumeration MB_WIND_CTRL_MODE.

Functional Description

Setting rewinders or unwinders	It can be differentiated between rewinders and unwinders using the "WindDirection" input.
Determining the tension command values	There is one tension command value available for the standstill "SetpointStandstill" and one for the normal operation mode "SetpointOpMode". Switching between these two command values is automatically using the standstill message of the master axis. The standstill window of the master axis (parameter A-0-0222 "Standstill window" or S-0-0124 "Standstill window") has to be set to the lowest value possible (e.g. 0.1 rpm). The two tension values can be set to the same value for the initial commissioning.
Settings for the diameter calculator	The settings for the diameter calculator are summarized in the "MB_WindDiameter" structure. The variable "DiamSource" has to be set to "FALSE" for the diameter calculation. If "DiamSource" is set to "TRUE", the diameter is read in externally. The core diameter of the winder (in mm) is entered into the variable "CoreDiameter". The variable "RepeatLength" (in mm) has to be entered for the diameter calculation. This corresponds to the circumference of the master axis. The limitations ("HighLimit", "LowLimit") can additionally be entered for the diameter calculation. This limits the diameter to a minimum (e.g. core diameter) and to a maximum value (e.g. maximum winding roll possible). The standstill window of the master axis (parameter A-0-0222 "Standstill window" or S-0-0124 "Standstill window") has to be set to the lowest value possible (e.g. 0.1 rpm). When there is a standstill message of the master or the reference axis, the diameter calculator does not calculate! Furthermore, the web width "WebWidth" (in mm) and the density "Density" (in kg/dm³) of the material web have to be entered. The diameter calculations can be influenced with the calculation range "CalcRange" and an average value filter "AverageValue". At the beginning, there is a "CalcRange" of 360 degrees. Thus, one calculation per winding axis revolution and an "AverageValue" of 1 (an averaging) is not reasonable. The diameter is only calculated if the material web is tensioned. That means that the binary output "DiameterEngaged" has to be set.
	 The ratio "RepeatLength"/"CoreDiameter" may not be greater than 25. Otherwise, the gear adjustment via the gear fine adjustment is insufficient!
Tensioning method (TensionMode) and tensioning speed	A relative motion of a dancer roll (applies only for winders with dancer) is considered when calculating the diameter using the "DancerConstant" variables. This dancer constant has to be determined once for a winder with dancer. First, set the dancer constant "DancerConstant" to zero (default) Set the "DancerConstant" value always to zero for the winders with open-loop and closed-loop tensile stress control. A tensioning speed "TensionSpeed" has to be entered for the tensioning method at standstill (e.g. 10 rpm). Select between tensioning with constant tensioning speed ("TensionMode" input to "CONST_SPEED") and tensioning with constant web velocity ("TensionMode" input to "CONST_WEB_VEL").

Functional Description

	Enter the "TensionMode" input to "CONST_WEB_VEL" for the initial commissioning of the tensioning with constant web velocity.
Torque limit value, DefaultTorqueLimit	If the function block is enabled, the torque of the winding drive is limited to a calculated value. This calculated value corresponds to the torque required for the tension command value set. When disabling the function block, the torque is set to the value of the "DefaultTorqueLimit" input. Enter it at the "DefaultTorqueLimit" input (e.g. 100%).
Filtering the actual torque value	To determine whether the web is tensioned, the torque limit value S-0-0092 "Torque/force limit value, bipolar" and the actual torque value S-0-0084 "Actual torque/force value" are compared with each other. If the two values differ from each other more than 25%, the web is considered as untensioned (diameter calculator does not calculate anymore). At low tensions, an unfiltered actual torque value can cause the diameter calculator to engage. Thus, a filtering of this value can be set at the function block ("ActTorqueFilter" input) to achieve a constant tensioning condition "Diameter-Engaged". For this purpose, a value of 20 ms for example can be set at the "ActTorqueFilter" input.
Filtering the acceleration compensation	To compensate acceleration and deceleration processes, an additional acceleration torque is connected. This acceleration torque can be increased using a filter. For this purpose, enter a filter time (e.g. 20 ms) at the "AccelTorqueFilter" input.
Diagnostic settings	To monitor the tension, several binary diagnostic outputs can be evaluated. The "WindowTension" input (in %) is used to put a window around the tension command value. If the actual tension value is within the window, this is displayed at the "TensionInWindow" output (e.g. "TensionInWindow" 30%) To display the falling below or exceeding of the minimum and maximum threshold values, a "Min Tension" (in N) and "MaxTension" (in N) can be entered.
Determining the friction characteristic	Friction torque at standstill 1. The "standstill friction torque" ("StandstillTorque" variable in the data structure MB_WIND_TENSION) is determined when the master axis is at standstill and the winder is empty (core only). The winder function block is disabled. For the winding axis (slave axis), select the operation mode "Velocity control" (in the AxisInterface of the ML_TechInterface "MODE_VEL" library). The axis can also be controlled using the PLCopen function block MC_MoveVelocity. 10 rpm can be set as command value. 2. The value of the parameter P-0-0109 "Peak torque/force limit" is set to zero. The axis has to stop now. The value for this parameter is incremented until the drive starts to rotate. The last value corresponds to the friction torque at standstill. 3. The axis enable "MODE_VEL" is canceled (also by using the PLCopen function block "MC_Stop"). The parameter P-0-0109 "Peak torque/force limit" is reset to its previous value (e.g. 400%). The friction torque setting at standstill is thus completed. Friction torque at maximum speed: The "friction torque at maximum speed" ("MaxTorque" variable in the data structure MB_WIND_TENSION) is determined when the master axis is at standstill and with an empty winder (core only). The function block is disabled.

Functional Description

1. The operation mode "Velocity control" has to be selected for the winding axis (slave axis) (in the AxisInterface of the ML_TechInterface "MODE_VEL", also by using the PLCopen function block).

The command value for the selected operation mode has to be increased incrementally up to the value of the parameter S-0-0091 "Bipolar velocity limit value". The value for the parameter S-0-0091 "Bipolar velocity limit value" has to be entered according to application and motor data.

2. In the next step, the value of the parameter P-0-0109 "Peak torque/force limit" is decreased incrementally (e.g. from 100% towards 0%) until the drive speed also starts to decrease. The speed of the drive can be traced using the drive parameter S-0-0040 "Actual velocity value" or the axis parameter A-0-0102 "Actual velocity value". The last value of P-0-0109 "Peak torque/force limit" corresponds to the maximum friction torque at maximum speed.
3. The axis enable "MODE_VEL" is canceled (also by using the PLCopen function block "MC_Stop").

The parameter P-0-0109 "Peak torque/force limit" is reset to its previous value (e.g. 400%).

Setting the friction torque maximum speed "MaxTorque" is completed.

Determining of the minimum friction torque:

The minimum friction torque is determined using the deceleration test with an empty winder. The winding drive is decelerated from a constant velocity (e.g. 50 min⁻¹) to standstill (setting the operation mode "Mode_AH" of the AxisInterface or with the PLCopen function block "MC_Stop"). At the same time, the drive parameters P-0-0049 "Effective torque/force command value" (axis parameter A-0-0038 "Torque/force limit value, bipolar") and S-0-0040 "Actual velocity value" (axis parameter A-0-0102 "Actual velocity value") are recorded with an oscilloscope or with the trace function in IndraWorks.

The minimum value is read from the torque curve and can be transferred to the structure MB_WIND_FRICTION as "MinTorque". The corresponding speed is entered as "MinTorqueVelocity" in MB_WIND_FRICTION.

Cyclic data channels for the winding drive

The parameter P-0-0694 ("Gear ratio fine adjustment, process controller") and the parameter P-0-0690 ("Additive velocity command value, process controller") and S-0-0092 "Bipolar torque/force limit value" have to be entered in the cyclic SERCOS channel of the corresponding drive ("UserCmdDataX"). The real axes are parameterized in IndraWorks in parameterization mode.

The function block automatically writes on these drive parameters. If this is not desired, it can be switched off via the "DisableCyclicWrites" input. In this case, the outputs "GearRatioFineAdjust", "SpeedOffset" and "TorqueLimitBipolar" have to be written manually to the drive parameters.

Final basic settings

The moment of inertia of the mechanics and the winding shaft "MechanicInertia" can be set to 0 at the beginning.

Set the process variable window "WindowTension" to 30% for example. If the actual tension value is within the range of the tension command value +/- 30%, this is displayed at the "InWindowTension" output.

Set the minimum and maximum thresholds "MinTension" and "MaxTension" to the desired threshold values for the actual tension value (absolute values in the unit of the tension command value). Exceeding or falling below the actual tension value is then displayed in the binary outputs "MinTensionAchieved" and "MaxTensionAchieved".

Functional Description

Operating the Function Block

- Initial startup of the winding axis**
1. "Enable" of the function block for the winder with open-loop tensile stress control. "Preset" of the diameter to the desired value (with the binary signal "PresetDiameter" and the value "Diameter.PresetVal").
 2. Switch on the synchronous operation modes of all axes participating in the web process (for the winding axis "Speed synchronization" and "Mode-SyncVel").
 3. The winding axis has to tension the web.
If the winding axis rotates in the wrong direction, check the direction of rotation of the winding axis without winding function block and winder type (rewinder or unwinder).
 4. Synchronous run of the machine via specification of a velocity command value for the master axis (MoveVelocity for the master axis with 20 rpm for example). The web has to remain tensioned.
 5. Check the calculated winding diameter after several winding axis revolutions.
If the calculated diameter deviates more than 5% from the actual diameter, check the mechanical gear and the "RepeatLength" of the master.
 6. Stop the machine by setting the master axis command value to zero.

Specifics for a torque-limited unwinder

An unwinder should generally be operated with a generator, that means decelerating operation.

Since the actual torque is proportional to the current winding diameter r , of the desired tensile stress F , the mechanical friction M_{Friction} and the acceleration torque M_{accel} , the following dependencies result for the actual torque or the torque limit M_{Limit} :

$$M_{\text{Limit}} \sim F_{\text{Tension}} * r_{\text{Winder}} + M_{\text{accel}} + M_{\text{Friction}}$$

Fig.4-15: Torque limitation

Since the tension torque and the friction torque are opposite to each other while unwinding, the following condition results when leaving out the acceleration torque and the mechanical drive i (S-0-0121 "Load gear, input revolutions" / S-0-0122 "Load gear, output revolutions"):

$$M_{\text{Friction}} \leq \frac{F_{\text{Tension}} * r_{\text{winder}}}{i_{\text{mechanical}}}$$

Fig.4-16: Unwinder, condition for the friction torque

To obtain a value in percent, divide by S-0-0111 "Standstill current, motor" and the torque constant P-0-0051 "Torque/force constant".

$$M_{\text{Friction}} \leq \frac{F_{\text{Tension}} * r_{\text{Winder}}}{S-0-0111 * P-0-0051 * i_{\text{mechanical}}}$$

Fig.4-17: Unwinder, condition for the friction torque in percent

Functional Description



If the friction torque is higher than this condition (considering with minimum tension and minimum winding diameter!), the unwinder goes into motor operation.

This case is more difficult to control with regard to its process and should thus be avoided.

Basic sequence of a "flying splice"

A so-called "flying splice" is a change from a roll to a new roll when the material web is still moving and can be performed according to the following basic diagram:

(two winding axes and two winding function blocks are required).

1. Currently unwinding roll reaches critical diameter for chopping.
2. Switch on the respective winding function block the new roll and preset the diameter with the diameter of the new roll. Then set the "Pause" input.
3. Command the winding axis of the new roll and accelerate to the current web velocity.
4. Perform the material chopping (separating the unwinding roll from the web) and stick the new roll.
5. Remove the "Pause" input of the winding function block for the new roll.

The function block can be switched off for the old roll.

4.3.4 Diagnostics for the Winder with Tensile Stress Control (Open-Loop, Without Sensor)

The following error codes can occur for the winder with open-loop tensile stress control (without sensor):

ErrorID	Additional1	Additional2	Text
STATE_MACHINE_ERROR	16#1100	16#0020	Error in state machine
INPUT_RANGE_ERROR	16#1101	16#0001	HighLimitDiameter < LowLimitDiameter
		16#0002	FormatLength < 0.0
		16#0003	WebWidth < 0.0
		16#0004	Density < 0.0
		16#0005	Core diameter < 0.0
		16#0006	DiamCalcRange < 0.0
		16#0007	Preset diameter < 0.0
		16#0008	Minimum diameter < 0.0
		16#0009	Maximum diameter < 0.0
		16#000A	HighLimitDiameter < 0.0
		16#000B	LowLimitDiameter < 0.0
		16#000C	DiamCalcMode invalid
		16#000D	Number of slave axis incorrect
		16#000E	Number of master axis incorrect
DEVICE_ERROR	16#1102	16#0001	No operating mode (no SERCOS phase 4)

Functional Description

ErrorID	Additional1	Additional2	Text
RESSOURCE_ERROR	16#0004	16#0000	Incorrect drive firmware
RESSOURCE_ERROR	16#000F	16#0003	Drive function package "MA" not activated

Fig.4-18: Error codes of the MB_DiameterCalculatorType03 function block

ErrorID	Additional1	Additional2	Text
STATE_MACHINE_ERROR	16#1180	16#0020	Error in state machine
INPUT_RANGE_ERROR	16#1181	16#0001	HighLimit < LowLimit
INPUT_RANGE_ERROR	16#1181	16#0002	FormatLength < 0.0
INPUT_RANGE_ERROR	16#1181	16#0003	WebWidth < 0.0
INPUT_RANGE_ERROR	16#1181	16#0004	Density < 0.0
INPUT_RANGE_ERROR	16#1181	16#0005	Core diameter < 0.0
INPUT_RANGE_ERROR	16#1181	16#0008	MinDiameter < 0.0
INPUT_RANGE_ERROR	16#1181	16#0009	MaxDiameter < 0.0
INPUT_RANGE_ERROR	16#1181	16#000A	High limit < 0.0
INPUT_RANGE_ERROR	16#1181	16#000B	Low limit < 0.0
INPUT_RANGE_ERROR	16#1181	16#000C	Slave axis number wrong
DEVICE_ERROR	16#1182	16#0001	No operating mode (no SERCOS phase 4)
RESSOURCE_ERROR	16#0004	16#0000	Incorrect drive firmware
RESSOURCE_ERROR	16#000F	16#0003	Drive function package "MA" not activated

Fig.4-19: Error codes of the MB_DiameterMeasurementType01 function block

ErrorID	Additional1	Additional2	Description
STATE_MACHINE_ERROR	16#11B0	16#20	Error in state machine
INPUT_RANGE_ERROR	16#11B1	16#01	Diameter.MechanicInertia < 0.0
INPUT_RANGE_ERROR	16#11B1	16#02	TensionCtrl.PreControlWeighting < 0.0
INPUT_RANGE_ERROR	16#11B1	16#03	MaxTension < 0.0
INPUT_RANGE_ERROR	16#11B1	16#04	MaxTension < MinTension
INPUT_RANGE_ERROR	16#11B1	16#05	Friction.StandstillTorque < 0.0
INPUT_RANGE_ERROR	16#11B1	16#06	Friction.MaxTorque < 0.0
INPUT_RANGE_ERROR	16#11B1	16#07	Friction.MinTorque < 0.0
INPUT_RANGE_ERROR	16#11B1	16#08	Friction.MinVelocity < 0.0
INPUT_RANGE_ERROR	16#11B1	16#09	WindowTension < 0.0
INPUT_RANGE_ERROR	16#11B1	16#0A	MinTension < 0.0
INPUT_RANGE_ERROR	16#11B1	16#0B	MaxTension < 0.0
INPUT_RANGE_ERROR	16#11B1	16#0C	Winding axis not in "BB"

ErrorID	Additional1	Additional2	Description
INPUT_RANGE_ERROR	16#11B1	16#0D	Incorrect torque scaling (A-0-0050) Scaling for the motor torque has to be based on the motor side
INPUT_RANGE_ERROR	16#11B1	16#0E	Axis number of the slave axis incorrect
INPUT_RANGE_ERROR	16#11B1	16#0F	Axis number of the master axis incorrect
RESSOURCE_ERROR	16#0004	16#0000	Incorrect drive firmware
RESSOURCE_ERROR	16#000F	16#0003	Drive function package "MA" not activated

Fig.4-20: Error codes of the MB_WinderTensionCtrlType01 function block

4.4 Winder with Tensile Stress Control (Closed-Loop)

4.4.1 Introduction and Overview

Diameter calculator with closed-loop tensile stress control

The diameter calculator with closed-loop tensile stress control is used on center-driven winders. The drive of the winding axis generally operates at its torque limit. The torque limit depends on the current winding diameter and the tension set. The torque limit corresponds to the value of the motor torque required to rotate the winder at the defined speed. It consists of load torque, friction torque and acceleration torque.

The tension controller is provided as PI-controller. It contains the function block "IL_PIDType01" from the "RIL_LoopControl" library. The control variable of the controller and the current winding diameter determine the torque limit value of the drive. The command value of the tension should also be scaled and transferred to the controller output ("PreControlWeighting" not equal to zero). When the scaling is not zero, the tension for the torque creation consists of the controller output variable added to the scaled command value. Scaling to zero means that only the tension controller is active. Thus, the tension controller should only be operated additively (e.g. with a scaling of 1.0).

The actual tension value is measured directly with the help of a load cell and transferred to the tension controller as actual value via an analog channel or field bus. With the web tensioned, the diameter calculator can calculate the current winding diameter.

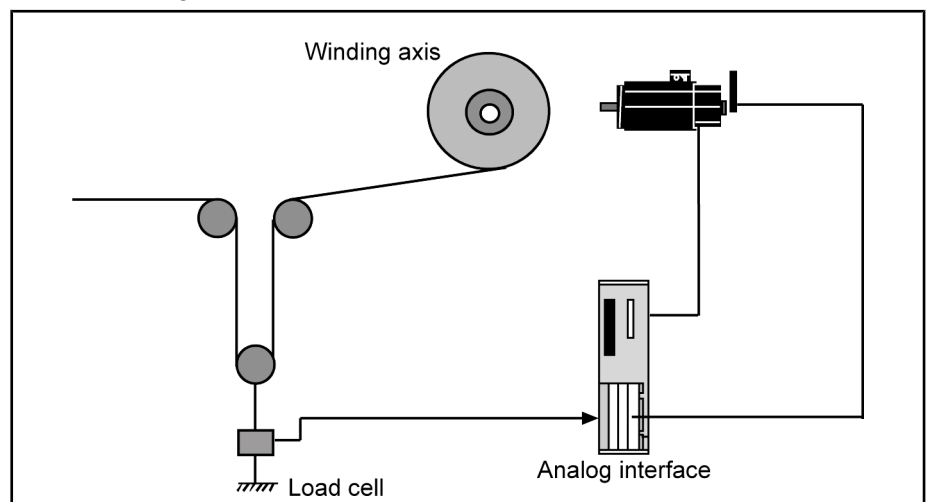


Fig.4-21: Diameter calculator with tensile stress control (closed-loop)

Functional Description

4.4.2 Interface of the Winder with Tensile Stress Control (Closed-Loop)

Interface Description

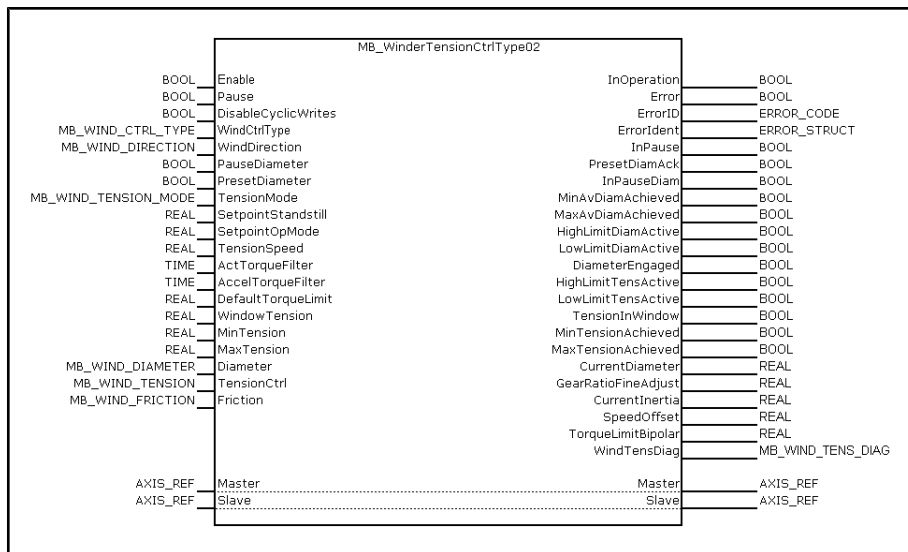


Fig.4-22: MB_WinderTensionCtrlType02 function block

I/O type	Name	Type	Comment
VAR_IN_OUT	Master	AXIS_REF	Reference to master axis
	Slave	AXIS_REF	Reference to the slave axis (winding axis)
VAR_INPUT	Enable	BOOL	Processing of function block enabled (level-controlled)
	Pause	BOOL	Pausing the tension controller and the diameter calculator (values are frozen)
	DisableCyclicWrites	BOOL	If this input is set, the cyclic data is not written directly into the optional cyclic data container, but only displayed at the output
	WindCtrlType	MB_WIND_CTRL_TYPE	Winding structure Open-loop tension control (without sensor) OPEN_LOOP (16#0000) Closed-loop tension control (load cell) CLOSED_LOOP (16#0001)
	WindDirection	MB_WIND_DIRECTION	Winding direction Rewinder REWIND (16#0000) Unwinder UNWIND (16#0001)
	PauseDiameter	BOOL	Pausing the diameter calculation Closed-loop/open-loop control of the torque limit remains active
	PresetDiameter	BOOL	CurrentDiameter is set to PresetVal, GearRatioFineAdj is adjusted accordingly (edge-controlled)
	TensionMode	MB_WIND_TENSION_MODE	Mode for tensioning the material web Tensioning with constant speed CONST_SPEED Tensioning at constant web velocity CONST_WEB_VEL

Functional Description

I/O type	Name	Type	Comment
	SetpointStandstill	REAL	Specification of the standstill tension [N] (Changeover between standstill tension and operating tension by means of the standstill message from the drive).
	SetpointOpMode	REAL	Specifying the operating tension [N] (Changeover between standstill tension and operating tension by means of the standstill message from the drive).
	TensionSpeed	REAL	Tensioning speed in the case of an empty winder [min ⁻¹]
	ActTorqueFilter	TIME	Filter time constant for the actual torque S-0-0084 "Actual torque/force value"
	AccelTorqueFilter	TIME	Filter time constant for acceleration torque
	DefaultTorqueLimit	REAL	Value for the bipolar torque limit after deactivation of "Enable" [%]
	WindowTension	REAL	Window for the actual tension value [%] in relation to the command tensile stress value (output "TensionInWindow")
	MinTension	REAL	Lower threshold for the actual tension value (only for a display with the binary output "MinTensionAck")
	MaxTension	REAL	Upper threshold for the actual tension value (only for a display with binary output "MaxTensionAck")
	Diameter	MB_WIND_DIAMETER	Structure for the diameter calculator
	TensionCtrl	MB_WIND_TENSION	Structure for tension controller
	Friction	MB_WIND_FRICTION	Structure for the friction torque
VAR_OUTPUT	InOperation	BOOL	Function block is working
	Error	BOOL	Processing completed with error
	ErrorID	ERROR_CODE	Describing diagnostics in case of error
	ErrorIdent	ERROR_STRUCT	Detailed diagnostics
	InPause	BOOL	Tension controller and diameter calculator paused
	PresetDiamAck	BOOL	Preset diameter was applied (is set as long as "Preset" is pending)
	InPauseDiam	BOOL	Diameter calculator paused
	MinAvDiamAchieved	BOOL	Minimum diameter reached (based on the averaged diameter)
	MaxAvDiamAchieved	BOOL	Maximum diameter reached (based on the averaged diameter)
	HighLimitDiamActive	BOOL	Currently calculated diameter has reached the upper limit (diameter value is discarded)
	LowLimitDiamActive	BOOL	Currently calculated diameter has reached the lower limit (diameter value is discarded)

Functional Description

I/O type	Name	Type	Comment
	DiameterEngaged	BOOL	Diameter "engaged" TRUE: engaged FALSE: disengaged
	HighLimitTensActive	BOOL	Output of the tension controller has achieved the upper limit
	LowLimitTensActive	BOOL	Output of the tension controller has achieved the lower limit
	TensionInWindow	BOOL	Actual tension control value is within the tension control window
	MinTensionAchieved	BOOL	Tensile stress is below the "MinTension" input
	MaxTensionAchieved	BOOL	Tensile stress is above the input "MaxTension"
	CurrentDiameter	REAL	Currently calculated diameter [mm]
	GearRatioFineAdjust	REAL	Resulting fine adjustment of the gear for speed adaptation of the drive [%]
	CurrentInertia	REAL	Current moment of inertia of the winding material + mechanics (based on the motor side [kg m ²])
	SpeedOffset	REAL	Tensioning speed [rpm]
	TorqueLimitBipolar	REAL	Bipolar torque limit [%]
	WindTensDiag	MB_WIND_TENS_DIAG	Current control deviation of the dancer controller

Fig.4-23: Interface variables of the MB_WinderTensionCtrlType02 function block
Functional diagram:

Functional Description

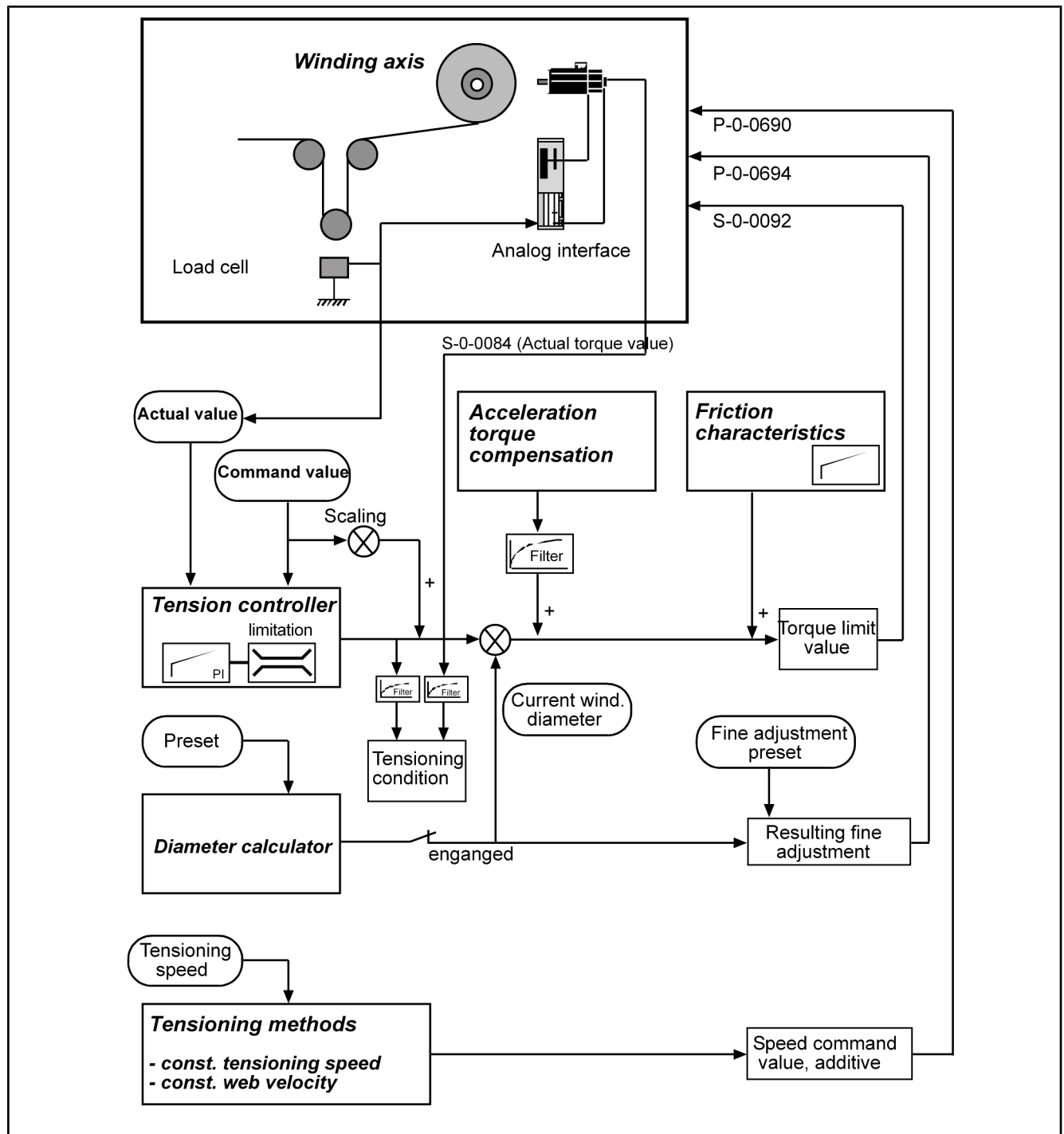


Fig. 4-24: Functional diagram of the winder with tensile stress control (closed-loop)

4.4.3 Commissioning the Winder with Tensile Stress Control (Closed-Loop)

General Settings

Mechanical gear An actually existing mechanical gear ratio from the drive axis to the winding axis has to be entered into the parameters S-0-0121 ("Input revolutions of load gear") and S-0-0122 ("Output revolutions of load gear").

Functional Description

Operation type of the winding drive (commanding)

The correct operation mode "Speed synchronization" of the drive and the drive enable of the drive have to be set for the winding axis. This can be carried out in two different ways as follows:

- Set the "ModeSyncVel" operation mode by means of the AxisInterface (recommended)
- Use the PLCopen "MC_Power", "MC_GearIn", "MC_Stop" function blocks to command the axis

The electronic gear between master axis and winding axis is to be set to 1:1 for the winding axis (A-0-2720 "ELS, master axis gear, input revolutions" or P-0-0156 "Electronic gear input revolutions" and A-0-2721 "ELS, master axis gear, output revolutions" or P-0-0157 "Electronic gear, output revolutions").

Setting of the speed control loop

The following steps have to be made for an empty and full roll:

- Set Tn to 0 and let the winding axis rotate freely at low speed.
- Increase the parameter S-0-0100 "Velocity controller proportional gain" slowly starting from the default value until an oscillation of the velocity control deviation can be detected at the oscilloscope.
- If the oscillation frequency is significantly higher than 500Hz, the parameter P-0-0004 "Smoothing time constant - speed controller" is increased until the oscillation decreases again.

In general, the parameter P-0-0004 "Smoothing time constant - speed controller" has to be set to a value of 1000 at least.

- In this case, increase the parameter S-0-0100 "Velocity controller, proportional gain" until the control loop becomes instable again and then reduce it until the oscillation decays. Set the P-gain to the half of the last value set to be sufficiently far away from the stability limit.
- Decrease S-0-0101 "Velocity controller integral action time" starting from a relative high value (e.g. 1000 ms) until the control loop becomes instable and then increase it until the oscillation decreases. Enter twice the value as value for the parameter S-0-0101 "Velocity controller integral action time". The integral action time should not be lower than 150 ms.

The control loop setting of the drives selected has to ensure that both extreme cases (minimum diameter and maximum diameter) can be operated with stability.

Otherwise, these two values can be linearly adapted to each other depending on the current diameter (function block MB_WindSpeedAdaptionType01).

Determining the direction of rotation of the winding axis

The direction of rotation of the tensile axis or winding axis can be set using the axis parameter A-0-2798 "Polarity, master axis position" or the drive parameter P-0-0108 "Master drive polarity". If the winding axis does not rotate in the desired direction, the axis parameter A-0-2798 or the drive parameter P-0-0108 has to be reset accordingly.

The following figure shows the general relations between rewinders and unwinders.

Functional Description

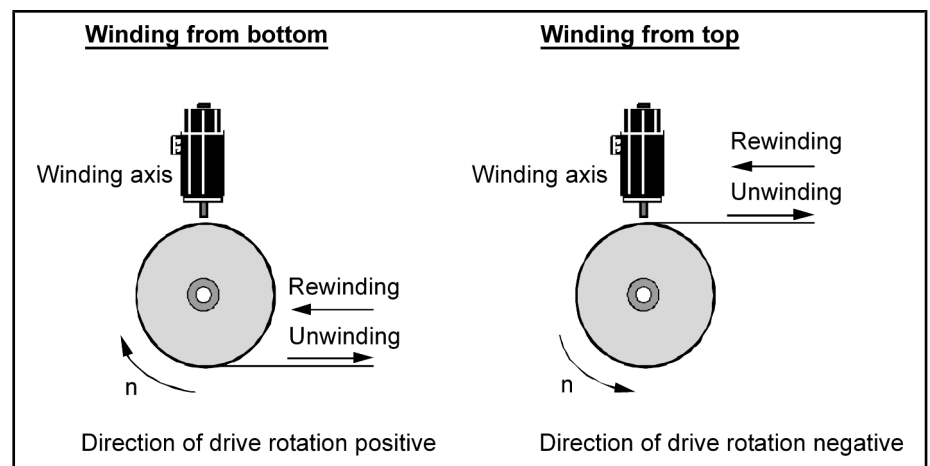


Fig. 4-25: Principles of rewinders and unwinders

Determining the actual tension value

The actual tension value is generally read in via an analog input. The analog input can either be read in at the drive (onboard analog input or via an MA1 extension card) or via an Inline analog input module of the control.

The actual value detection only processes positive actual values. If might be required to add an offset to the read value to ensure the mentioned over the complete range (e.g. offset is 0.1 volt).

If the actual tension value is read in in an analog voltage (volts), it has to be standardized to the unit Newton in the PLC using a a standardization factor (e.g. 10 volts correspond to 200 N, that is a standardization factor of 20 N/V).

This actual value can be filtered using a PT1-filter if this value varies a lot (e.g. 20 ms). If the analog input is read in at the drive, the filter in the drive is to be preferably used. For analog input 1, this is set in the parameter P-0-0217 "Analog input 1, time constant input filter". If the analog input is read in at the control, a PT1-filter function block can be used in the PLC library "LoopControl".

The actual value is connected to the "TensionCtrl.FeedbackVal" input.

Additional leading and lagging of the winding axis

Additional leading or lagging via the gear fine adjustment (presetting gear fine adjustment "FineAdjust") can be set via the structure variable "qrAxisCtrl[Axis-Number].Admin.SyncMode.FineAdjust" of the "MB_AXIS_SYNCHRONISATION" data structure of the "ML_TechInterface" library. For a **rewinder**, a low **positive value** (e.g. 5 %) should be set. A low **negative value** should be set for an **unwinder**. This results in an improved startup behavior of the respective winding direction.

If the winding axis is not commanded with the AxisInterface, but with the PLCopen function blocks, the "MasterFineAdjust" input of the "MC_GearIn" function block has to be used.

Monitoring torque limit values

During the initial control startup, a drive warning "E2056 Torque limit value = 0" can occur if the winder function block is not yet enabled.

In order to prevent this, the value for the parameter S-0-0092 "Bipolar torque/force" can be written with a value unequal to zero such as 100% in the startup phase of the PLC program (e.g. warm start) of the corresponding cyclic data containers.

If the warning "E8260 Torque - force command value limit active" occurs when the function block is enabled, this warning can be eliminated by setting bit 4 of the parameter P-0-0556, "Axis controller configuration".

In rare cases (e.g. multiple F8078 "Error in the speed control loop"), it can be necessary to disable the velocity controller monitoring (set bit 1 of the parameter P-0-0556 "Axis controller configuration").

Functional Description

Basic Settings of the Function Block

Axis assignment	The axis reference (AXIS_REF) of the winding axis is connected at the "Slave" input. The axis reference (AXIS_REF) of the master axis is connected at the "Master" input. This is the axis providing the web velocity of the machine. The scaling type has to be identical for master axis and slave axis. Rotary scaling and preference scaling are recommended. "Interpolation" in the drive has to be enabled for the MLC control for the winding axis.
Setting the control method	The "WindCtrlType" input has to be set to the "CLOSED_LOOP" mode using the enumeration MB_WIND_CTRL_MODE.
Setting rewinders or unwinders	It can be differentiated between rewinders and unwinders using the "WindDirection" input.
Determining the tension command values	There is one tension command value available for the standstill "SetpointStandstill" and one for the normal operation mode "SetpointOpMode". Switching between these two command values is automatically using the standstill message of the master axis. The standstill window of the master axis (parameter A-0-0222 "Standstill window" or S-0-0124 "Standstill window") has to be set to the smallest value possible (e.g. 0.1 rpm). The two tension values can be set to the same value for the initial commissioning.
Settings for the diameter calculator	The settings for the diameter calculator are summarized in the "MB_WindDiameter" structure. The variable "DiamSource" has to be set to "FALSE" for the diameter calculation. If "DiamSource" is set to "TRUE", the diameter is read in externally. The core diameter of the winder (in mm) is entered into the variable "CoreDiameter". The variable "RepeatLength" (in mm) has to be entered for the diameter calculation. This corresponds to the circumference of the master axis. The limitations ("HighLimit", "LowLimit") can additionally be entered for the diameter calculation. This limits the diameter to a minimum (e.g. core diameter) and to a maximum value (e.g. maximum winding roll possible). The standstill window of the master axis (parameter A-0-0222 "Standstill window" or S-0-0124 "Standstill window") has to be set to the lowest value possible (e.g. 0.1 rpm). When there is a standstill message of the master or the reference axis, the diameter calculator does not calculate! Furthermore, the web width "WebWidth" (in mm) and the density "Density" (in kg/dm³) of the material web have to be entered. The diameter calculations can be influenced with the calculation range "CalcRange" and an average value filter "AverageValue". At the beginning, there is a "CalcRange" of 360 degrees. Thus, one calculation per winding axis revolution and an "AverageValue" of 1 (an averaging) is not reasonable. The diameter is only calculated if the material web is tensioned. That means that the binary output "DiameterEngaged" has to be set.

Functional Description



The ratio "RepeatLength"/"CoreDiameter" may not be greater than 25.

Otherwise, the gear adjustment via the gear fine adjustment is insufficient!

Tensioning method (TensionMode) and tensioning speed

A relative motion of a dancer roll (applies only for winders with dancer) is considered when calculating the diameter using the "DancerConstant" variables. This dancer constant has to be determined once for a winder with dancer.

First, set the dancer constant "DancerConstant" to zero (default)

Set the "DancerConstant" value always to zero for the winders with open-loop and closed-loop tensile stress control.

A tensioning speed "TensionSpeed" has to be entered for the tensioning method at standstill (e.g. 10 rpm).

Select between tensioning with constant tensioning speed ("TensionMode" input to "CONST_SPEED") and tensioning with constant web velocity ("TensionMode" input to "CONST_WEB_VEL").

Enter the "TensionMode" input to "CONST_WEB_VEL" for the initial commissioning of the tensioning with constant web velocity.

Torque limit value, DefaultTorqueLimit

If the function block is enabled, the torque of the winding drive is limited to a calculated value. This calculated value corresponds to the torque required for the tension command value set. When disabling the function block, the torque is set to the value of the "DefaultTorqueLimit" input.

Enter it at the "DefaultTorqueLimit" input (e.g. 100%).

Filtering the actual torque value

To determine whether the web is tensioned, the torque limit value S-0-0092 "Torque/force limit value, bipolar" and the actual torque value S-0-0084 "Actual torque/force value" are compared with each other. If the two values differ from each other more than 25%, the web is considered as untensioned (diameter calculator does not calculate anymore).

At low tensions, an unfiltered actual torque value can cause the diameter calculator to engage. Thus, a filtering of this value can be set at the function block ("ActTorqueFilter" input) to achieve a constant tensioning condition "Diameter-Engaged".

For this purpose, a value of 20 ms for example can be set at the "ActTorqueFilter" input.

Filtering the acceleration compensation

To compensate acceleration and deceleration processes, an additional acceleration torque is connected. This acceleration torque can be increased using a filter.

For this purpose, enter a filter time (e.g. 20 ms) at the "AccelTorqueFilter" input.

Diagnostic settings

To monitor the tension, several binary diagnostic outputs can be evaluated. The "WindowTension" input (in %) is used to put a window around the tension command value. If the actual tension value is within the window, this is displayed at the "TensionInWindow" output (e.g. "TensionInWindow" 30%)

To display the falling below or exceeding of the minimum and maximum threshold values, a "Min Tension" (in N) and "MaxTension" (in N) can be entered.

Determining the friction characteristic

Friction torque at standstill

1. The "standstill friction torque" ("StandstillTorque" variable in the data structure MB_WIND_TENSION) is determined when the master axis is at standstill and the winder is empty (core only). The winder function block is disabled. For the winding axis (slave axis), select the operation mode "Velocity control" (in the AxisInterface of the ML_TechInterface

Functional Description

"MODE_VEL" library). The axis can also be controlled using the PLCopen function block MC_MoveVelocity. 10 rpm can be set as command value.

2. The value of the parameter P-0-0109 "Peak torque/force limit" is set to zero. The axis has to stop now. The value for this parameter is incremented until the drive starts to rotate. The last value corresponds to the friction torque at standstill.
3. The axis enable "MODE_VEL" is canceled (also by using the PLCopen function block "MC_Stop").

The parameter P-0-0109 "Peak torque/force limit" is reset to its previous value (e.g. 400%).

The friction torque setting at standstill is thus completed.

Friction torque at maximum speed:

The "friction torque at maximum speed" ("MaxTorque" variable in the data structure MB_WIND_TENSION) is determined when the master axis is at standstill and with an empty winder (core only). The function block is disabled.

1. The operation mode "Velocity control" has to be selected for the winding axis (slave axis) (in the AxisInterface of the ML_TechInterface "MODE_VEL", also by using the PLCopen function block).

The command value for the selected operation mode has to be increased incrementally up to the value of the parameter S-0-0091 "Bipolar velocity limit value". The value for the parameter S-0-0091 "Bipolar velocity limit value" has to be entered according to application and motor data.

2. In the next step, the value of the parameter P-0-0109 "Peak torque/force limit" is decreased incrementally (e.g. from 100% towards 0%) until the drive speed also starts to decrease. The speed of the drive can be traced using the drive parameter S-0-0040 "Actual velocity value" or the axis parameter A-0-0102 "Actual velocity value". The last value of P-0-0109 "Peak torque/force limit" corresponds to the maximum friction torque at maximum speed.
3. The axis enable "MODE_VEL" is canceled (also by using the PLCopen function block "MC_Stop").

The parameter P-0-0109 "Peak torque/force limit" is reset to its previous value (e.g. 400%).

Setting the friction torque maximum speed "MaxTorque" is completed.

Determining of the minimum friction torque:

The minimum friction torque is determined using the deceleration test with an empty winder. The winding drive is decelerated from a constant velocity (e.g. 50 min⁻¹) to standstill (setting the operation mode "Mode_AH" of the AxisInterface or with the PLCopen function block "MC_Stop"). At the same time, the drive parameters P-0-0049 "Effective torque/force command value" (axis parameter A-0-0038 "Torque/force limit value, bipolar") and S-0-0040 "Actual velocity value" (axis parameter A-0-0102 "Actual velocity value") are recorded with an oscilloscope or with the trace function in IndraWorks.

The minimum value is read from the torque curve and can be transferred to the structure MB_WIND_FRICTION as "MinTorque". The corresponding speed is entered as "MinTorqueVelocity" in MB_WIND_FRICTION.

The parameter P-0-0694 ("Gear ratio fine adjustment, process controller") and the parameter P-0-0690 ("Additive velocity command value, process controller") and S-0-0092 "Bipolar torque/force limit value" have to be entered in the

Functional Description

cyclic SERCOS channel of the corresponding drive ("UserCmdDataX"). The real axes are parameterized in IndraWorks in parameterization mode.

The function block automatically writes on these drive parameters. If this is not desired, it can be switched off via the "DisableCyclicWrites" input. In this case, the outputs "GearRatioFineAdjust", "SpeedOffset" and "TorqueLimitBipolar" have to be written manually to the drive parameters.

Final basic settings

Set the P-gain of the tension controller "TensionCtrl.PControl" to 0.1 for the initial commissioning.

Set the command value precontrol "TensionCtrl.PreControlWeighting" to 1.0 (default).

Set the limitations "TensionCtrl.HighLimit" and "TensionCtrl.LowLimit" (e.g. five times the tension command value).

Set the process variable window "WindowTension" to 30% for example. If the actual tension value is within the range of the tension command value +/- 30%, this is displayed at the "InWindowTension" output.

Set the minimum and maximum thresholds "MinTension" and "MaxTension" to the desired threshold values for the actual tension value (absolute values in the unit of the tension command value). Exceeding or falling below the actual tension value is then displayed in the binary outputs "MinTensionAchieved" and "MaxTensionAchieved".

The moment of inertia of the mechanics and the winding shaft "MechanicInertia" can be set to 0 at the beginning.

Operating the Function Block

Initial startup of the winding axis

1. "Enable" of the function block for the winder with closed-loop tensile stress control. "Preset" of the diameter to the desired value (with the binary signal "PresetDiameter" and the value "Diameter.PresetVal").
2. Switch on the synchronous operation modes of all axes participating in the web process (for the winding axis "Speed synchronization" and "Mode-SyncVel").
3. The winding axis has to tension the web.
If the winding axis rotates in the wrong direction, the direction of rotation of the winding axis without winding function block and winder type (rewinder or unwinder).
4. Synchronous run of the machine via specification of a velocity command value for the master axis (MoveVelocity for the master axis with 20 rpm for example). The web has to remain tensioned.
5. Check the calculated winding diameter after several winding axis revolutions.
If the calculated diameter deviates more than 5% from the actual diameter, check the mechanical gear and the "RepeatLength" of the master.
6. Stop the machine by setting the master axis command value to zero.

Setting the tension control loop

1. "Enable" of the function block for the winder with closed-loop tensile stress control.
2. Switch on the synchronous operation modes of all axes participating in the web process (for the winding axis "Speed synchronization" and "Mode-SyncVel").
3. The winding axis has to move into this direction to tension the web.

Functional Description

4. **Open the limitations for the tension controller.** That means set "LowLimitControl" and "HighLimitControl" at least to a value twenty times as high as the tension command value (N).
5. Synchronous run of the machine via specification of a velocity command value for the master axis (MoveVelocity for the master axis with 20 rpm for example). The web has to remain tensioned.
Increase the Kp-gain "PControl" incrementally and oscillograph the actual tension value and the torque limit "TorqueLimitBipolar" until these signals are located in the desired accuracy range.
Determine the critical Kp-gain "PControl" alternatively (increase Kp-gain step by step until the actual tension value oscillates. Then decrease the Kp-gain until the oscillation decays and halves the Kp-gain.
Enter the integral action time "IControl". A value within the range of seconds (e.g. two seconds). (A significantly lower value can be entered for "IControl" at standstill). Increase the integral action time "IControl" step by step and oscillograph the actual tension value and the torque limit "TorqueLimitBipolar" until these signals are located in the desired accuracy range.
6. Enter the values again for the **limitations of the tension controller**.
7. Check the values determined at higher machine velocities or master axis velocities. If necessary, travel along the velocity profile of the master axis and correct controller values if required.

Specifics for a torque-limited unwinder

An unwinder should generally be operated with a generator, that means decelerating operation.

Since the actual torque is proportional to the current winding diameter r , of the desired tensile stress F , the mechanical friction M_{Friction} and the acceleration torque M_{accel} , the following dependencies result for the actual torque or the torque limit M_{Limit} :

$$M_{\text{Limit}} \sim F_{\text{Tension}} * r_{\text{Winder}} + M_{\text{accel}} + M_{\text{Friction}}$$

Fig.4-26: Torque limitation

Since the tension torque and the friction torque are opposite to each other while unwinding, the following condition results when leaving out the acceleration torque and the mechanical drive i (S-0-0121 "Load gear, input revolutions" / S-0-0122 "Load gear, output revolutions"):

$$M_{\text{Friction}} \leq \frac{F_{\text{Tension}} * r_{\text{winder}}}{i_{\text{mechanical}}}$$

Fig.4-27: Unwinder, condition for the friction torque

To obtain a value in percent, divide by S-0-0111 "Standstill current, motor" and the torque constant P-0-0051 "Torque/force constant".

$$M_{\text{Friction}} \leq \frac{F_{\text{Tension}} * r_{\text{Winder}}}{S-0-0111 * P-0-0051 * i_{\text{mechanical}}}$$

Fig.4-28: Unwinder, condition for the friction torque in percent

Functional Description



If the friction torque is higher than this condition (considering with minimum tension and minimum winding diameter!), the unwinder goes into motor operation.

This case is more difficult to control with regard to its process and should thus be avoided.

Basic sequence of a "flying splice"

A so-called "flying splice" is a change from a roll to a new roll when the material web is still moving and can be performed according to the following basic diagram:

(two winding axes and two winding function blocks are required).

1. Currently unwinding roll reaches critical diameter for chopping.
2. Switch on the respective winding function block the new roll and preset the diameter with the diameter of the new roll. Then set the "Pause" input.
3. Command the winding axis of the new roll and accelerate to the current web velocity.
4. Perform the material chopping (separating the unwinding roll from the web) and stick the new roll.
5. Remove the "Pause" input of the winding function block for the new roll.

The function block can be switched off for the old roll.

4.4.4 Diagnostics for the winder with Tensile Stress Control (Closed-Loop)

The following error codes can occur for the winder with closed-loop tensile stress control:

ErrorID	Additional1	Additional2	Text
STATE_MACHINE_ERROR	16#1100	16#0020	Error in state machine
INPUT_RANGE_ERROR	16#1101	16#0001	HighLimitDiameter < LowLimitDiameter
		16#0002	FormatLength < 0.0
		16#0003	WebWidth < 0.0
		16#0004	Density < 0.0
		16#0005	Core diameter < 0.0
		16#0006	DiamCalcRange < 0.0
		16#0007	Preset diameter < 0.0
		16#0008	Minimum diameter < 0.0
		16#0009	Maximum diameter < 0.0
		16#000A	HighLimitDiameter < 0.0
		16#000B	LowLimitDiameter < 0.0
		16#000C	DiamCalcMode invalid
		16#000D	Number of slave axis incorrect
		16#000E	Number of master axis incorrect
DEVICE_ERROR	16#1102	16#0001	No operating mode (no SERCOS phase 4)
RESSOURCE_ERROR	16#0004	16#0000	Incorrect drive firmware
RESSOURCE_ERROR	16#000F	16#0003	Drive function package "MA" not activated

Fig.4-29: Error codes of the MB_DiameterCalculatorType03 function block

Functional Description

ErrorID	Additional1	Additional2	Text
STATE_MACHINE_ERROR	16#1180	16#0020	Error in state machine
INPUT_RANGE_ERROR	16#1181	16#0001	HighLimit < LowLimit
INPUT_RANGE_ERROR	16#1181	16#0002	FormatLength < 0.0
INPUT_RANGE_ERROR	16#1181	16#0003	WebWidth < 0.0
INPUT_RANGE_ERROR	16#1181	16#0004	Density < 0.0
INPUT_RANGE_ERROR	16#1181	16#0005	Core diameter < 0.0
INPUT_RANGE_ERROR	16#1181	16#0008	MinDiameter < 0.0
INPUT_RANGE_ERROR	16#1181	16#0009	MaxDiameter < 0.0
INPUT_RANGE_ERROR	16#1181	16#000A	High limit < 0.0
INPUT_RANGE_ERROR	16#1181	16#000B	Low limit < 0.0
INPUT_RANGE_ERROR	16#1181	16#000C	Slave axis number wrong
DEVICE_ERROR	16#1182	16#0001	No operating mode (no SERCOS phase 4)
RESSOURCE_ERROR	16#0004	16#0000	Incorrect drive firmware
RESSOURCE_ERROR	16#000F	16#0003	Drive function package "MA" not activated

Fig. 4-30: Error codes of the MB_DiameterMeasurementType01 function block

ErrorID	Additional1	Additional2	Description
STATE_MACHINE_ERROR	16#11B0	16#20	Error in state machine
INPUT_RANGE_ERROR	16#11B1	16#01	Diameter.MechanicInertia < 0.0
INPUT_RANGE_ERROR	16#11B1	16#02	TensionCtrl.PreControlWeighting < 0.0
INPUT_RANGE_ERROR	16#11B1	16#03	MaxTension < 0.0
INPUT_RANGE_ERROR	16#11B1	16#04	MaxTension < MinTension
INPUT_RANGE_ERROR	16#11B1	16#05	Friction.StandstillTorque < 0.0
INPUT_RANGE_ERROR	16#11B1	16#06	Friction.MaxTorque < 0.0
INPUT_RANGE_ERROR	16#11B1	16#07	Friction.MinTorque < 0.0
INPUT_RANGE_ERROR	16#11B1	16#08	Friction.MinVelocity < 0.0
INPUT_RANGE_ERROR	16#11B1	16#09	WindowTension < 0.0
INPUT_RANGE_ERROR	16#11B1	16#0A	MinTension < 0.0
INPUT_RANGE_ERROR	16#11B1	16#0B	MaxTension < 0.0
INPUT_RANGE_ERROR	16#11B1	16#0C	Winding axis not in "BB"
INPUT_RANGE_ERROR	16#11B1	16#0D	Incorrect torque scaling (A-0-0050) Scaling for the motor torque has to be based on the motor side
INPUT_RANGE_ERROR	16#11B1	16#0E	Axis number of the slave axis incorrect
INPUT_RANGE_ERROR	16#11B1	16#0F	Axis number of the master axis incorrect

Functional Description

ErrorID	Additional1	Additional2	Description
RESSOURCE_ERROR	16#0004	16#0000	Incorrect drive firmware
RESSOURCE_ERROR	16#000F	16#0003	Drive function package "MA" not activated

Fig.4-31: Error codes of the MB_WinderTensionCtrlType01 function block

4.5 Winder with Tensile Stress Control (Closed-Loop) and Speed Correction

4.5.1 Introduction and Overview

The diameter calculator with closed-loop tensile stress control and speed correction is used on center-driven winders. The drive of the winding axis generally does NOT operate at its torque limit. Due to safety reasons, a torque limit is calculated that can additionally be set (the limit should be above the required motor torque and should not limit the drive in normal operation).

This winder is mainly used for elastic, expandable material.

The actual tension value is measured directly with the help of a load cell and transferred to the tension controller as actual value via an analog channel or field bus. With the web tensioned, the diameter calculator can calculate the current winding diameter.

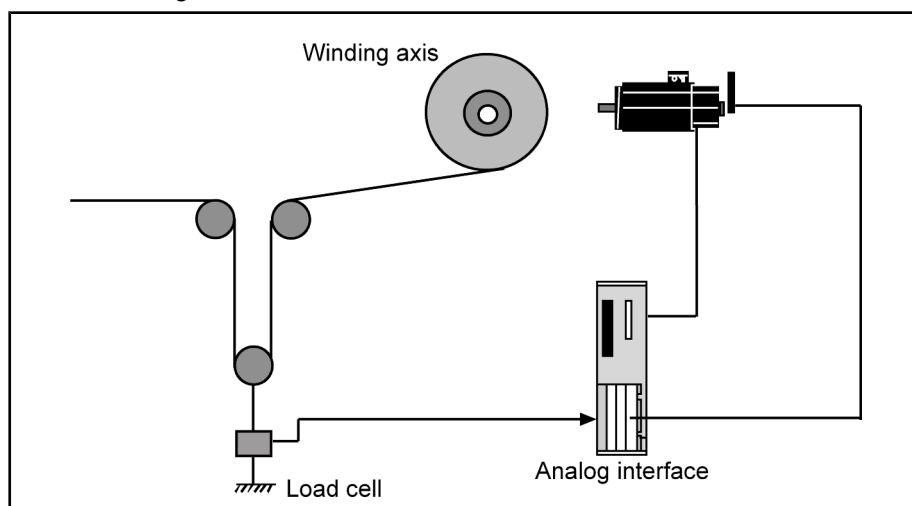


Fig.4-32: Diameter calculator with tensile stress control (closed-loop)

Functional Description

4.5.2 Interfaces of the Winder with Tensile Stress Control (Closed-Loop) and Speed Correction

Interface Description

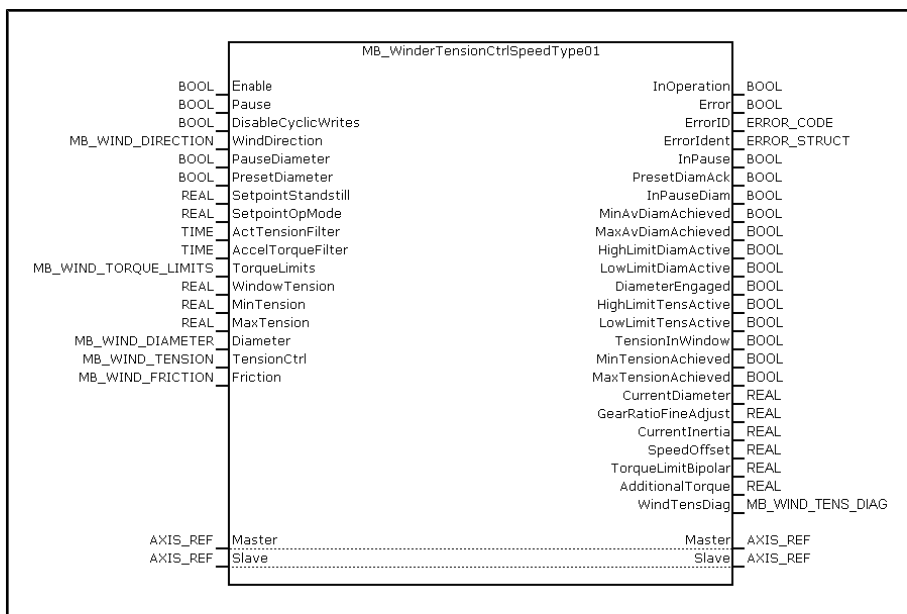


Fig.4-33: MB_WinderTensionCtrlSpeedType01 function block

I/O type	Name	Type	Comment
VAR_IN_OUT	Master	AXIS_REF	Reference to master axis
	Slave	AXIS_REF	Reference to the slave axis (winding axis)
VAR_INPUT	Enable	BOOL	Processing of function block enabled (level-controlled)
	Pause	BOOL	Pausing the tension controller and the diameter calculator (values are frozen)
	DisableCyclicWrites	BOOL	If this input is set, the cyclic data is not written directly into the optional cyclic data container, but only displayed at the output
	WindDirection	MB_WIND_DIRECTION	Winding direction Rewinder REWIND (16#0000) Unwinder UNWIND (16#0001)
	PauseDiameter	BOOL	Pausing the diameter calculation
	PresetDiameter	BOOL	CurrentDiameter is set to PresetVal, GearRatioFineAdjust is adjusted accordingly (edge-controlled)
	SetpointStandstill	REAL	Specification of the standstill tension [N] (Switching between standstill tension and operating tension by means of the standstill message of the drive)
	SetpointOpMode	REAL	Specifying the operating tension [N] (Changeover between standstill tension and operating tension by means of the standstill message from the drive).
	ActTensionFilter	TIME	Filter time constant for actual tension control
	AccelTorqueFilter	TIME	Filter time constant for acceleration torque

Functional Description

I/O type	Name	Type	Comment
	TorqueLimits	MB_WIND_TORQUE_LIMITS	Structure for bipolar torque limit (S-0-0092)
	WindowTension	REAL	Window for the actual tension control value [%] in relation to the command tensile stress value ("TensionInWindow")
	MinTension	REAL	Lower threshold for the actual tension value (only for a display with the binary output "MinTensionAck")
	MaxTension	REAL	Upper threshold for the actual tension control value (only for a display with binary output "MaxTensionAck")
	Diameter	MB_WIND_DIAMETER	Structure for the diameter calculator
	TensionCtrl	MB_WIND_TENSION	Structure for tension controller
	Friction	MB_WIND_FRICTION	Structure for the friction torque
VAR_OUTPUT	InOperation	BOOL	Function block is working
	Error	BOOL	Processing completed with error
	ErrorID	ERROR_CODE	Describing diagnostics in case of error
	ErrorIdent	ERROR_STRUCT	Detailed diagnostics
	InPause	BOOL	Tension controller and diameter calculator paused
	PresetDiamAck	BOOL	Preset diameter was applied (is set as long as "Preset" is pending)
	InPauseDiam	BOOL	Diameter calculator paused
	MinAvDiamAck	BOOL	Minimum diameter achieved (relates to the averaged diameter)
	MaxAvDiamAck	BOOL	Maximum diameter achieved (relates to the averaged diameter)
	HighLimitDiamAck	BOOL	Currently calculated diameter has reached the upper limit (diameter value is discarded)
	LowLimitDiamAck	BOOL	Currently calculated diameter has reached the lower limit (diameter value is discarded)
	DiameterEngaged	BOOL	Diameter "engaged" TRUE: engaged FALSE: disengaged
	HighLimitTensActive	BOOL	Output of the tension controller has achieved the upper limit
	LowLimitTensActive	BOOL	Output of the tension controller has achieved the lower limit
	TensionInWindow	BOOL	Actual tension control value is within the tension control window
	MinTensionAchieved	BOOL	Tensile stress is below the "MinTension" input
	MaxTensionAchieved	BOOL	Tensile stress is above the input "MaxTension"
	CurrentDiameter	REAL	Currently calculated diameter [mm]

Functional Description

Operation type of the winding drive (commanding)	The correct operation mode "Speed synchronization" of the drive and the drive enable of the drive have to be set for the winding axis. This can be carried out in two different ways as follows: • Set the "ModeSyncVel" operation mode by means of the AxisInterface (recommended) • Use the PLCopen "MC_Power", "MC_GearIn", "MC_Stop" function blocks to command the axis
	The electronic gear between master axis and winding axis is to be set to 1:1 for the winding axis (A-0-2720 "ELS, master axis gear, input revolutions" or P-0-0156 "Electronic gear input revolutions" and A-0-2721 "ELS, master axis gear, output revolutions" or P-0-0157 "Electronic gear, output revolutions").
Setting of the speed control loop	The following steps have to be made for an empty and full roll: • Set Tn to 0 and let the winding axis rotate freely at low speed. • Increase the parameter S-0-0100 "Velocity controller proportional gain" slowly starting from the default value until an oscillation of the velocity control deviation can be detected at the oscilloscope. • If the oscillation frequency is significantly higher than 500Hz, the parameter P-0-0004 "Smoothing time constant - speed controller" is increased until the oscillation decreases again. In general, the parameter P-0-0004 "Smoothing time constant - speed controller" has to be set to a value of 1000 at least. • In this case, increase the parameter S-0-0100 "Velocity controller, proportional gain" until the control loop becomes instable again and then reduce it until the oscillation decays. Set the P-gain to the half of the last value set to be sufficiently far away from the stability limit. • Decrease S-0-0101 "Velocity controller integral action time" starting from a relative high value (e.g. 1000 ms) until the control loop becomes instable and then increase it until the oscillation decreases. Enter twice the value as value for the parameter S-0-0101 "Velocity controller integral action time". The integral action time should not be lower than 150 ms.
Determining the direction of rotation of the winding axis	The control loop setting of the drives selected has to ensure that both extreme cases (minimum diameter and maximum diameter) can be operated with stability. Otherwise, these two values can be linearly adapted to each other depending on the current diameter (function block MB_WindSpeedAdaptionType01). The direction of rotation of the tensile axis or winding axis can be set using the axis parameter A-0-2798 "Polarity, master axis position" or the drive parameter P-0-0108 "Master drive polarity". If the winding axis does not rotate in the desired direction, the axis parameter A-0-2798 or the drive parameter P-0-0108 has to be reset accordingly. The following figure shows the general relations between rewinders and unwinders.

Functional Description

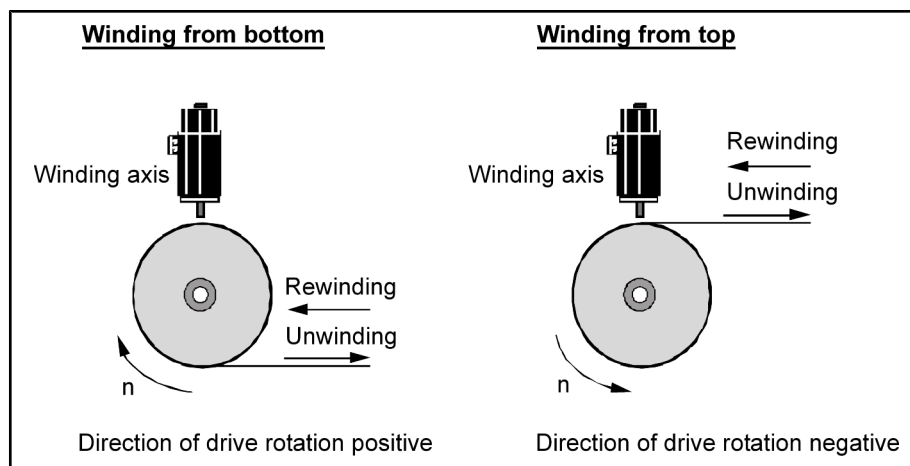


Fig.4-36: Principles of rewinders and unwinders

Detecting the actual tension value

The actual tension value is generally read in via an analog input. The analog input can either be read in at the drive (onboard analog input or via an MA1 extension card) or via an Inline analog input module of the control.

The actual value detection only processes positive actual values. If might be required to add an offset to the read value to ensure the mentioned over the complete range (e.g. offset is 0.1 volt).

If the actual tension value is read in in an analog voltage (volts), it has to be standardized to the unit Newton in the PLC using a a standardization factor (e.g. 10 volts correspond to 200 N, that is a standardization factor of 20 N/V).

This actual value can be filtered using a PT1-filter if the value varies a lot (e.g. 20 ms). If the analog input is read in at the drive, the filter in the drive is to be preferably used. For analog input 1, this is set in the parameter P-0-0217 "Analog input 1, time constant input filter". If the analog input is read in at the control, a PT1-filter function block can be used in the PLC library "LoopControl".

The actual value is connected to the "TensionCtrl.FeedbackVal" input.

Monitoring torque limit values

During the initial control startup, a drive warning "E2056 Torque limit value = 0" can occur if the winder function block is not yet enabled.

In order to prevent this, the value for the parameter S-0-0092 "Bipolar torque/force" can be written with a value unequal to zero such as 100% in the startup phase of the PLC program (e.g. warm start) of the corresponding cyclic data containers.

If the warning "E8260 Torque - force command value limit active" occurs when the function block is enabled, this warning can be eliminated by setting bit 4 of the parameter P-0-0556, "Axis controller configuration".

In rare cases (e.g. multiple F8078 "Error in the speed control loop"), it can be necessary to disable the velocity controller monitoring (set bit 1 of the parameter P-0-0556 "Axis controller configuration").

Basic Settings of the Function Block**Axis assignment**

The axis reference (AXIS_REF) of the winding axis is connected at the "Slave" input.

The axis reference (AXIS_REF) of the master axis is connected at the "Master" input. This is the axis providing the web velocity of the machine.

The scaling type has to be identical for master axis and slave axis. Rotary scaling and preference scaling are recommended.

For the winding axis, the interpolation in the drive has to be enabled for the MLC control.

Functional Description

Setting rewinders or unwinders	It can be differentiated between rewinders and unwinders using the "WindDirection" input.
Determining the tension command values	There is one tension command value available for the standstill "SetpointStandstill" and one for the normal operation mode "SetpointOpMode". Switching between these two command values is automatically using the standstill message of the master axis. The standstill window of the master axis (parameter A-0-0222 "Standstill window" or S-0-0124 "Standstill window") has to be set to the smallest value possible (e.g. 0.1 rpm). The two tension values can be set to the same value for the initial commissioning.
Settings for the diameter calculator	The settings for the diameter calculator are summarized in the "MB_WindDiameter" structure. The variable "DiamSource" has to be set to "FALSE" for the diameter calculation. If "DiamSource" is set to "TRUE", the diameter is read in externally. The core diameter of the winder (in mm) is entered into the variable "CoreDiameter". The variable "RepeatLength" (in mm) has to be entered for the diameter calculation. This corresponds to the circumference of the master axis. The limitations ("HighLimit", "LowLimit") can additionally be entered for the diameter calculation. This limits the diameter to a minimum (e.g. core diameter) and to a maximum value (e.g. maximum winding roll possible). The standstill window of the master axis (parameter A-0-0222 "Standstill window" or S-0-0124 "Standstill window") has to be set to the lowest value possible (e.g. 0.1 rpm). When there is a standstill message of the master or the reference axis, the diameter calculator does not calculate! Furthermore, the web width "WebWidth" (in mm) and the density "Density" (in kg/dm³) of the material web have to be entered. The diameter calculations can be influenced with the calculation range "CalcRange" and an average value filter "AverageValue". At the beginning, there is a "CalcRange" of 360 degrees. Thus, one calculation per winding axis revolution and an "AverageValue" of 1 (an averaging) is not reasonable. The diameter is only calculated if the material web is tensioned. That means that the binary output "DiameterEngaged" has to be set.
	 The ratio "RepeatLength"/"CoreDiameter" may not be greater than 25. Otherwise, the gear adjustment via the gear fine adjustment is insufficient!
Torque limit value, precontrol, DefaultTorqueLimit	A relative motion of a dancer roll (applies only for winders with dancer) is considered when calculating the diameter using the "DancerConstant" variables. This dancer constant has to be determined once for a winder with dancer. First, set the dancer constant "DancerConstant" to zero (default) Set the "DancerConstant" value always to zero for the winders with open-loop and closed-loop tensile stress control. The drive of the winding axis generally DOES NOT operates at its torque limit. The drive of the winding axis generally does NOT operate at its torque limit. Due to safety reasons, a calculated torque with a settable additive value is set for the torque limit. (this value should be above the required motor torque and not limit the drive in normal mode).

Functional Description

A torque limit proportional to the tension and the respective winder diameter is calculated cyclically.

$$M_{Limit} \sim F_{Tension} * r_{Winder} + M_{Accel.} + M_{Friction}$$

Fig.4-37: Torque limit

This cyclic value for the torque limit is precontrolled as additive torque command value.

Furthermore, this value can be increased by a proportional ratio (TorqueLimitFactor) and an additive ratio (MinTorqueLimit) so that the torque limit does not become active during normal winder operation.

$$M_{ResLimit} \sim M_{Limit} * (1 + TorqueLimitFactor) + MinTorqueLimit$$

Fig.4-38: Resulting torque limit

Set the "TorqueLimits.TorqueLimitFactor" input to approximately 20%.

Set the "TorqueLimits.MinTorqueLimit" input to approximately 10%.

When switching off the function block, the torque is set to the value of the "TorqueLimits.DefaultTorqueLimit" input.

Enter a value (e.g. 100%) at the "DefaultTorqueLimit" input.

Filtering the actual tension value

To determine whether the web is tensioned, the tension command value and the actual tension value are compared with each other. If the two values differ from each other more than 25%, the web is considered as untensioned (diameter calculator does not calculate anymore).

At low tensions, an unfiltered actual tension value can cause the diameter calculator to engage. Thus, a filtering of this value can be set at the function block ("ActTensionFilter" input) to achieve a constant tensioning condition "DiameterEngaged".

For this purpose, a value of 20 ms can be set for example at the "ActTensionFilter" input.

Filtering the acceleration compensation

To compensate acceleration and deceleration processes, an additional acceleration torque is connected. This acceleration torque can be increased using a filter.

For this purpose, enter a filter time (e.g. 20 ms) at the "AccelTorqueFilter" input.

Diagnostic settings

To monitor the tension, several binary diagnostic outputs can be evaluated. The "WindowTension" input (in %) is used to put a window around the tension command value. If the actual tension value moves within the window, this is displayed at the "TensionInWindow" output (e.g. "TensionInWindow" 30%).

To display the falling below or exceeding of minimum and maximum threshold values, a "MinTension" (in N) and "MaxTension" (in N) can be entered.

Determining the friction characteristic

Friction torque at standstill

1. The "standstill friction torque" ("StandstillTorque" variable in the data structure MB_WIND_TENSION) is determined when the master axis is at standstill and the winder is empty (core only). The winder function block is disabled. For the winding axis (slave axis), select the operation mode "Velocity control" (in the AxisInterface of the ML_TechInterface "MODE_VEL" library). The axis can also be controlled using the PLCopen function block MC_MoveVelocity. 10 rpm can be set as command value.
2. The value of the parameter P-0-0109 "Peak torque/force limit" is set to zero. The axis has to stop now. The value for this parameter is incremen-

Functional Description

ted until the drive starts to rotate. The last value corresponds to the friction torque at standstill.

3. The axis enable "MODE_VEL" is canceled (also by using the PLCopen function block "MC_Stop").

The parameter P-0-0109 "Peak torque/force limit" is reset to its previous value (e.g. 400%).

The friction torque setting at standstill is thus completed.

Friction torque at maximum speed:

The "friction torque at maximum speed" ("MaxTorque" variable in the data structure MB_WIND_TENSION) is determined when the master axis is at standstill and with an empty winder (core only). The function block is disabled.

1. The operation mode "Velocity control" has to be selected for the winding axis (slave axis) (in the AxisInterface of the ML_TechInterface "MODE_VEL", also by using the PLCopen function block).

The command value for the selected operation mode has to be increased incrementally up to the value of the parameter S-0-0091 "Bipolar velocity limit value". The value for the parameter S-0-0091 "Bipolar velocity limit value" has to be entered according to application and motor data.

2. In the next step, the value of the parameter P-0-0109 "Peak torque/force limit" is decreased incrementally (e.g. from 100% towards 0%) until the drive speed also starts to decrease. The speed of the drive can be traced using the drive parameter S-0-0040 "Actual velocity value" or the axis parameter A-0-0102 "Actual velocity value". The last value of P-0-0109 "Peak torque/force limit" corresponds to the maximum friction torque at maximum speed.
3. The axis enable "MODE_VEL" is canceled (also by using the PLCopen function block "MC_Stop").

The parameter P-0-0109 "Peak torque/force limit" is reset to its previous value (e.g. 400%).

Setting the friction torque maximum speed "MaxTorque" is completed.

Determining of the minimum friction torque:

The minimum friction torque is determined using the deceleration test with an empty winder. The winding drive is decelerated from a constant velocity (e.g. 50 min⁻¹) to standstill (setting the operation mode "Mode_AH" of the AxisInterface or with the PLCopen function block "MC_Stop"). At the same time, the drive parameters P-0-0049 "Effective torque/force command value" (axis parameter A-0-0038 "Torque/force limit value, bipolar") and S-0-0040 "Actual velocity value" (axis parameter A-0-0102 "Actual velocity value") are recorded with an oscilloscope or with the trace function in IndraWorks.

The minimum value is read from the torque curve and can be transferred to the structure MB_WIND_FRICTION as "MinTorque". The corresponding speed is entered as "MinTorqueVelocity" in MB_WIND_FRICTION.

Cyclic data channels for the winding drive

The parameter P-0-0694 ("Gear ratio fine adjustment, process controller") and the parameter P-0-0690 ("Additive velocity command value, process controller") and S-0-0092 "Bipolar torque/force limit value" have to be entered into the cyclic SERCOS channel of the corresponding drive ("UserCmdDataX"). The real axes are parameterized in IndraWorks in parameterization mode.

The function block automatically writes on these drive parameters. If this is not desired, it can be switched off via the "DisableCyclicWrites" input. In this case,

Functional Description

Final basic settings

the outputs "GearRatioFineAdjust", "SpeedOffset" and "TorqueLimitBipolar" and "AdditionalTorque" have to be written manually to the drive parameters.

Set the P-gain of the tension controller "TensionCtrl.PControl" to 0.1 for the initial commissioning.

Set the command value precontrol "TensionCtrl.PreControlWeighting" to 1.0 (default).

Set the limitations "TensionCtrl.HighLimit" and "TensionCtrl.LowLimit" (e.g. five times the tension command value).

Set the process variable window "WindowTension" to 30% for example. If the actual tension value is within the range of the tension command value +/- 30%, this is displayed at the "InWindowTension" output.

Set the minimum and maximum thresholds "MinTension" and "MaxTension" to the desired threshold values for the actual tension value (absolute values in the unit of the tension command value). Exceeding or falling below the actual tension value is then displayed in the binary outputs "MinTensionAchieved" and "MaxTensionAchieved".

The moment of inertia of the mechanics and the winding shaft "MechanicInertia" can be set to 0 at the beginning.

Operating the Function Block**Initial startup of the winding axis**

1. "Enable" of the function block for the winder with open-loop tensile stress control. "Preset" of the diameter to the desired value.
(with the binary signal "PresetDiameter" and the value "Diameter.PresetVal").
2. Switch on the synchronous operation modes of all axes participating in the web process (for the winding axis "Speed synchronization" and "Mode-SyncVel").
3. The winding axis has to tension the web.
If the winding axis rotates in the wrong direction, check the direction of rotation of the winding axis without winding function block and winder type (rewinder or unwinder).
4. Synchronous run of the machine via specification of a velocity command value for the master axis (MoveVelocity for the master axis with 20 rpm for example). The web has to remain tensioned.
5. Check the calculated winding diameter after several winding axis revolutions.
If the calculated diameter deviates more than 5% from the actual diameter, check the mechanical gear and the "RepeatLength" of the master.
6. Stop the machine by setting the master axis command value to zero.

Setting the tension control loop

1. "Enable" of the function block for the winder with closed-loop tensile stress control.
2. Switch on the synchronous operation modes of all axes participating in the web process (for the winding axis "Speed synchronization" and "Mode-SyncVel").
3. The winding axis has to move into this direction to tension the web.
4. **Open the limitations for the tension controller.** That means set "LowLimitControl" and "HighLimitControl" at least to a value twenty times as high as the tension command value (N).

Functional Description

5. Synchronous run of the machine via specification of a velocity command value for the master axis (MoveVelocity for the master axis with 20 rpm for example). The web has to remain tensioned.

Increase the Kp-gain "PControl" incrementally and oscillograph the actual tension value and the torque limit "TorqueLimitBipolar" until these signals are located in the desired accuracy range.

Determine the critical Kp-gain "PControl" alternatively (increase Kp-gain step by step until the actual tension value oscillates. Then decrease the Kp-gain until the oscillation decays and halves the Kp-gain.

Enter the integral action time "IControl". A value within the range of seconds (e.g. two seconds) is recommended (a significantly lower value can be entered for "IControl" at standstill). Increase the integral action time "IControl" step by step and oscillograph the actual tension value and the torque limit "TorqueLimitBipolar" until these signals are located in the desired accuracy range.

6. Enter the values again for the **limitations of the tension controller**.
7. Check the values determined at higher machine velocities or master axis velocities. If necessary, travel along the velocity profile of the master axis and correct controller values if required.

Specifics features for the winder with closed-loop tensile stress control and speed correction

Setting the tension controller:

The Kp-gain value for the tension controller ("PControl") depends on the material of the web. The following generally applies: The stiffer the material to be wound, the lower the Kp-gain of the tension controller. If different materials are wound, the Kp-gain has to be adjusted to the material.

Basic sequence of a "flying splice"

A so-called "flying splice" is a change from a roll to a new roll when the material web is still moving and can be performed according to the following basic diagram:

(two winding axes and two winding function blocks are required).

1. Currently unwinding roll reaches critical diameter for chopping.
2. Switch on the respective winding function block the new roll and preset the diameter with the diameter of the new roll. Then set the "Pause" input.
3. Command the winding axis of the new roll and accelerate to the current web velocity.
4. Perform the material chopping (separating the unwinding roll from the web) and stick the new roll.
5. Remove the "Pause" input of the winding function block for the new roll.

The function block can be switched off for the old roll.

4.5.4 Diagnostics for the Winder with Tensile Stress Control (Closed-Loop) and Speed Correction

The following error codes can occur for the winder with closed-loop tensile stress control:

Functional Description

ErrorID	Additional1	Additional2	Text
STATE_MACHINE_ERROR	16#1100	16#0020	Error in state machine
INPUT_RANGE_ERROR	16#1101	16#0001	HighLimitDiameter < LowLimitDiameter
		16#0002	FormatLength < 0.0
		16#0003	WebWidth < 0.0
		16#0004	Density < 0.0
		16#0005	Core diameter < 0.0
		16#0006	DiamCalcRange < 0.0
		16#0007	Preset diameter < 0.0
		16#0008	Minimum diameter < 0.0
		16#0009	Maximum diameter < 0.0
		16#000A	HighLimitDiameter < 0.0
		16#000B	LowLimitDiameter < 0.0
		16#000C	DiamCalcMode invalid
		16#000D	Number of slave axis incorrect
		16#000E	Number of master axis incorrect
DEVICE_ERROR	16#1102	16#0001	No operating mode (no SERCOS phase 4)
RESSOURCE_ERROR	16#0004	16#0000	Incorrect drive firmware
RESSOURCE_ERROR	16#000F	16#0003	Drive function package "MA" not activated

Fig.4-39: Error codes of the MB_DiameterCalculatorType03 function block

ErrorID	Additional1	Additional2	Text
STATE_MACHINE_ERROR	16#1180	16#0020	Error in state machine
INPUT_RANGE_ERROR	16#1181	16#0001	HighLimit < LowLimit
INPUT_RANGE_ERROR	16#1181	16#0002	FormatLength < 0.0
INPUT_RANGE_ERROR	16#1181	16#0003	WebWidth < 0.0
INPUT_RANGE_ERROR	16#1181	16#0004	Density < 0.0
INPUT_RANGE_ERROR	16#1181	16#0005	Core diameter < 0.0
INPUT_RANGE_ERROR	16#1181	16#0008	MinDiameter < 0.0
INPUT_RANGE_ERROR	16#1181	16#0009	MaxDiameter < 0.0
INPUT_RANGE_ERROR	16#1181	16#000A	High limit < 0.0
INPUT_RANGE_ERROR	16#1181	16#000B	Low limit < 0.0
INPUT_RANGE_ERROR	16#1181	16#000C	Slave axis number wrong
DEVICE_ERROR	16#1182	16#0001	No operating mode (no SERCOS phase 4)
RESSOURCE_ERROR	16#0004	16#0000	Incorrect drive firmware
RESSOURCE_ERROR	16#000F	16#0003	Drive function package "MA" not activated

Fig.4-40: Error codes of the MB_DiameterMeasurementType01 function block

Functional Description

ErrorID	Additional1	Additional2	Description
STATE_MACHINE_ERROR	16#1120	16#0020	Error in state machine
INPUT_RANGE_ERROR	16#1121	16#0001	Diameter.MechanicInertia < 0.0
INPUT_RANGE_ERROR	16#1121	16#0002	TensionCtrl.PreControlWeighting < 0.0
INPUT_RANGE_ERROR	16#1121	16#0003	MaxTension < 0.0
INPUT_RANGE_ERROR	16#1121	16#0004	MaxTension < MinTension
INPUT_RANGE_ERROR	16#1121	16#0005	Friction.StandstillTorque < 0.0
INPUT_RANGE_ERROR	16#1121	16#0006	Friction.MaxTorque < 0.0
INPUT_RANGE_ERROR	16#1121	16#0007	Friction.MinTorque < 0.0
INPUT_RANGE_ERROR	16#1121	16#0008	Friction.MinVelocity < 0.0
INPUT_RANGE_ERROR	16#1121	16#0009	WinderTension < 0.0
INPUT_RANGE_ERROR	16#1121	16#000A	MinTension < 0.0
INPUT_RANGE_ERROR	16#1121	16#000B	MaxTension < 0.0
INPUT_RANGE_ERROR	16#1121	16#000C	Incorrect torque scaling (A-0-0050 or S-0-0086), scaling for motor torque has to be on the motor side
INPUT_RANGE_ERROR	16#1121	16#000E	Axis number of the slave axis incorrect
INPUT_RANGE_ERROR	16#1121	16#000F	Axis number of the master axis incorrect
INPUT_RANGE_ERROR	16#1121	16#0010	SetpointStandstill < 0.0
INPUT_RANGE_ERROR	16#1121	16#0011	SetpointOpMode < 0.0
INPUT_RANGE_ERROR	16#1121	16#0012	Default torque limit < 0.0
INPUT_RANGE_ERROR	16#1121	16#0013	Minimum torque limit < 0.0
INPUT_RANGE_ERROR	16#1121	16#0014	Torque limit factor < 0.0
INPUT_RANGE_ERROR	16#1122	16#0001	Winding axis not in "BB"
RESSOURCE_ERROR	16#0004	16#0000	Incorrect drive firmware
RESSOURCE_ERROR	16#000F	16#0003	Drive function package "MA" not activated
RESSOURCE_ERROR	16#0012	16#00xx	AxisRef.CntrlNo incorrect

Fig. 4-41: Error codes of the MB_WinderTensionCtrlSpeedType01 function block

5 Visualization Dialogs

5.1 Introduction

The following visualization dialogs are provided for the MLC control in IndraWorks:

1. Winder with closed-loop dancer position control and dancer roll
2. Winder with open-loop tensile stress control (without sensor)
3. Winder with closed-loop tensile stress control and torque limitation

Visualization dialogs in IndraWorks

These are located in the project tree below the technology node.

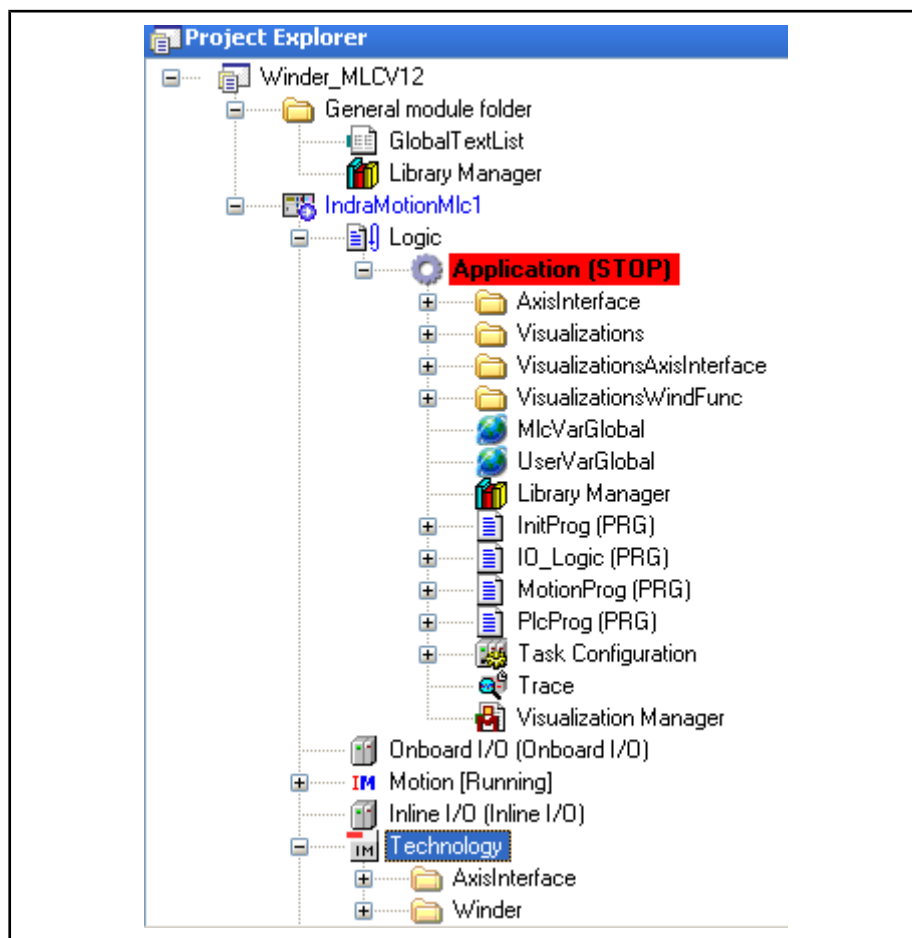


Fig. 5-1: Technology nodes in the project tree

These dialogs are provided in the project tree after the following conditions have been fulfilled:

- Usage of the respective function blocks in the PLC program
- Compilation of the PLC project
- "Online switching" with the control

Visualization Dialogs

5.2 Dialogs for Winders with Dancer Position Control (Closed-Loop)

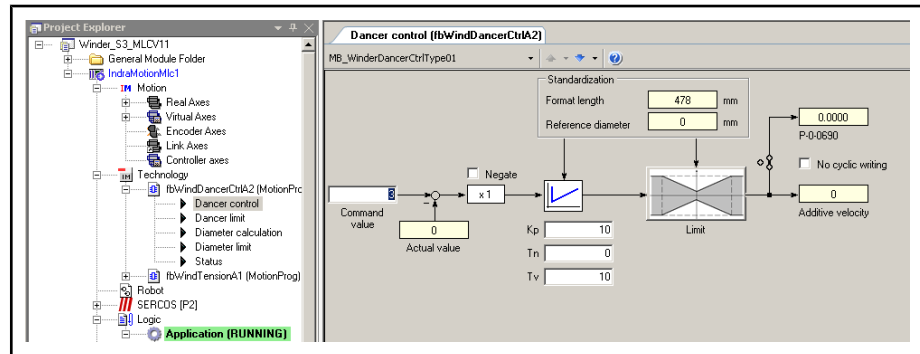


Fig.5-2: Dancer position control (closed-loop)

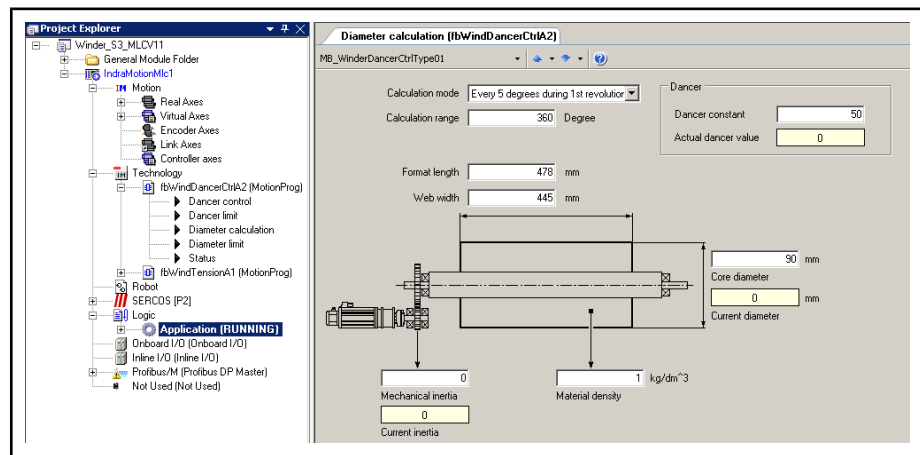


Fig.5-3: Diameter calculation

Visualization Dialogs

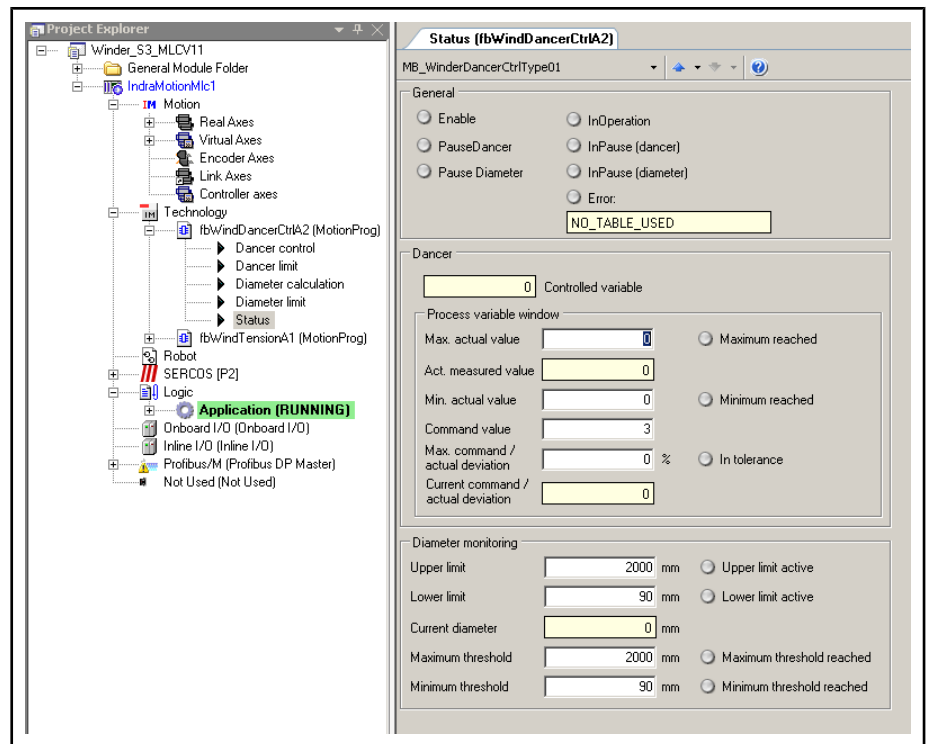


Fig.5-4: Winder with dancer, status

5.3 Dialogs for Winders with Tensile Stress Control (Open-Loop, Without Sensor)

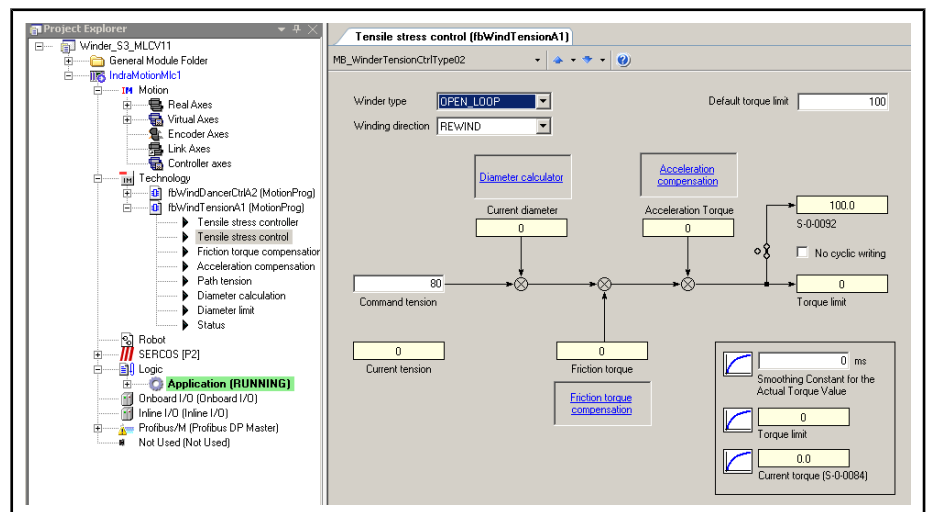


Fig.5-5: Winder with tensile stress control (open-loop)

Visualization Dialogs

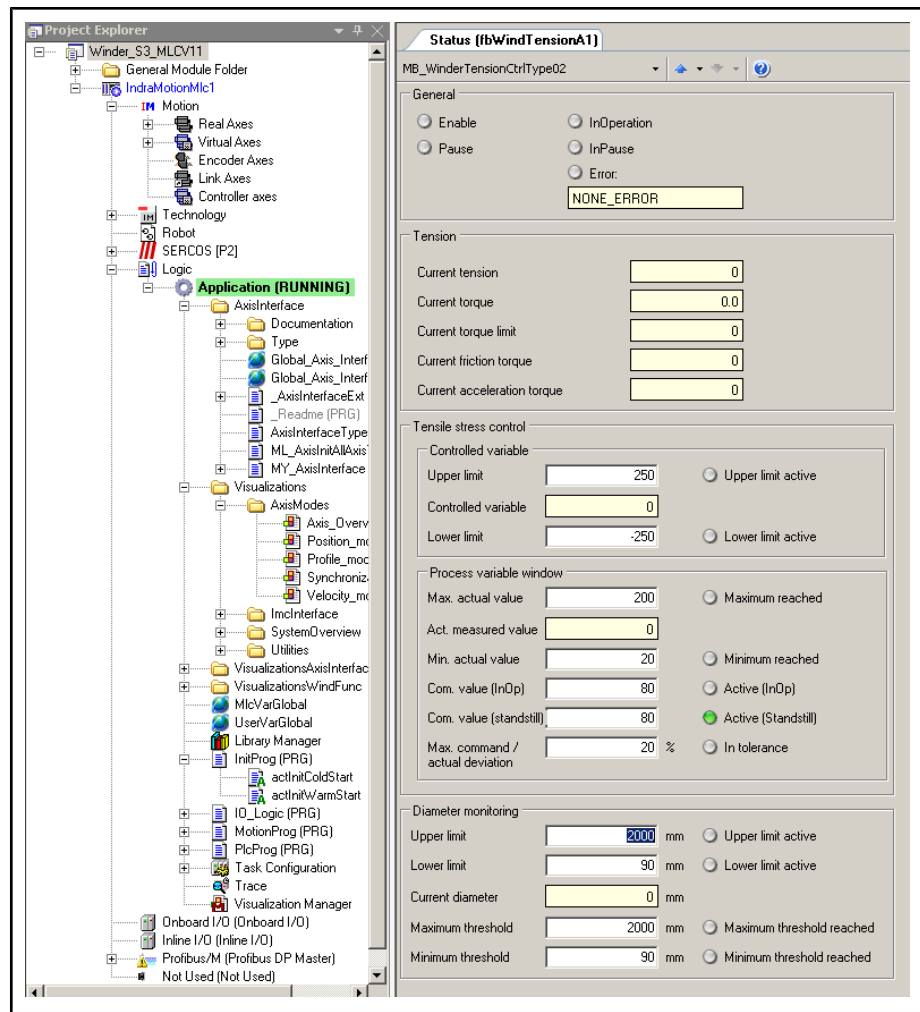


Fig.5-6: Winder with tensile stress control (open-loop), status

5.4 Dialogs for Winders with Tensile Stress Control (Closed-Loop)

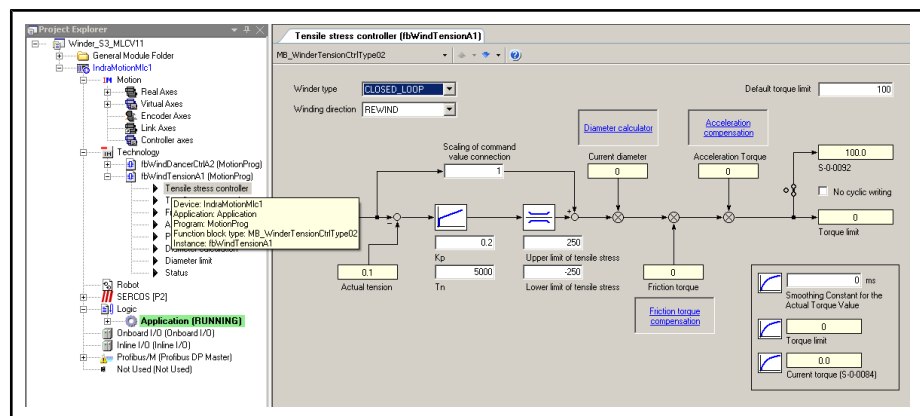


Fig.5-7: Winder with tensile stress control (closed-loop)

Visualization Dialogs

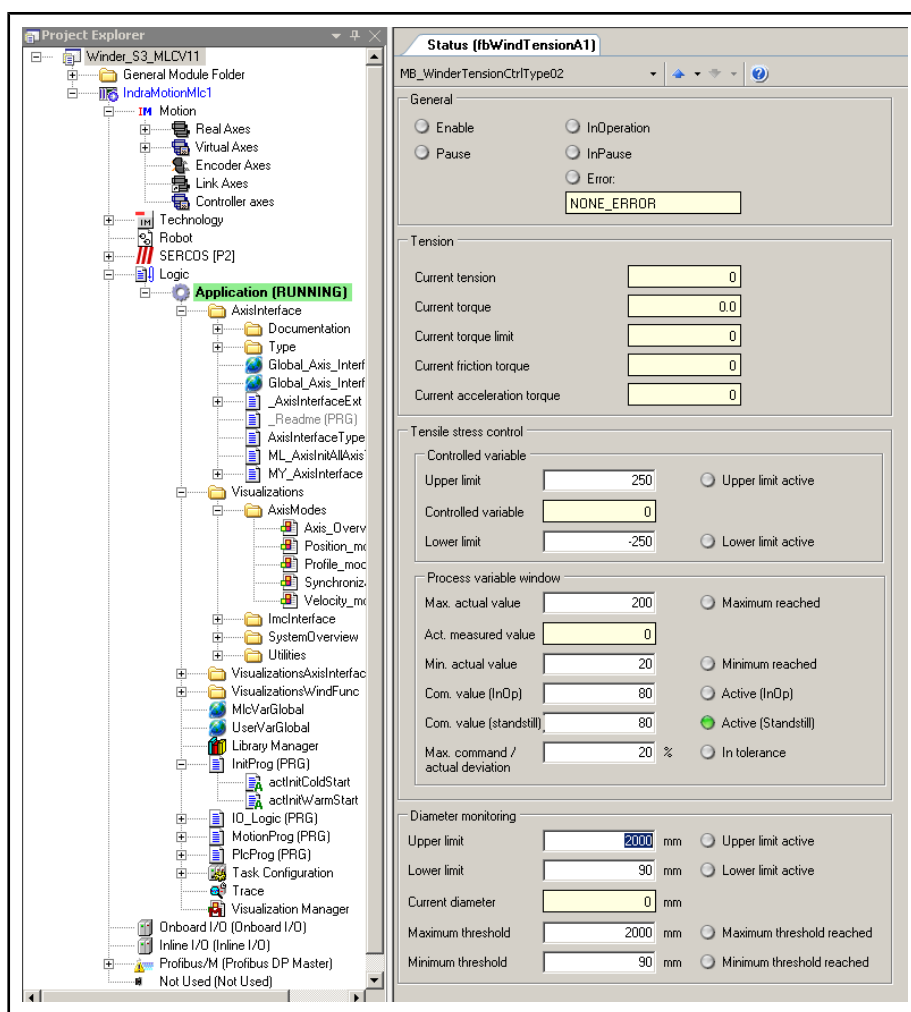


Fig. 5-8: Winder with tensile stress control (closed-loop), status

6 Service and Support

Our service helpdesk at our headquarters in Lohr, Germany and our worldwide service will assist you with all kinds of enquiries. You can reach us **around the clock - even on weekend and on holidays**.

	Helpdesk	Service Hotline Worldwide
Phone	+49 (0) 9352 40 50 60	Outwith Germany please contact our sales/service office in your area first.
Fax	+49 (0) 9352 40 49 41	
E-mail	service.svc@boschrexroth.de	For hotline numbers refer to the sales office addresses on the Internet.
Internet	http://www.boschrexroth.com You will also find additional notes regarding service, maintenance (e.g. delivery addresses) and training.	

Preparing Information

For quick and efficient help please have the following information ready:

- Detailed description of the fault and the circumstances
- Information on the type plate of the affected products, especially type codes and serial numbers
- Your phone, fax numbers and e-mail address so we can contact you in case of questions.

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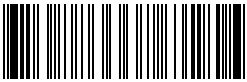
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