SIEMENS

SINUMERIK

**SINUMERIK Edge
Analyze MyMachine /Condition**

Operating Manual

Valid for control system:
SINUMERIK 840D sl/ 840DE sl

Software
Analyze MyMachine /Condition, Version 2.1

09/2020
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Legal information

Warning notice system

This manual contains notices you have to observe in order to ensure your personal safety, as well as to prevent damage to property. The notices referring to your personal safety are highlighted in the manual by a safety alert symbol, notices referring only to property damage have no safety alert symbol. These notices shown below are graded according to the degree of danger.

> ⚠ **DANGER**
>
> indicates that death or severe personal injury **will** result if proper precautions are not taken.

> ⚠ **WARNING**
>
> indicates that death or severe personal injury **may** result if proper precautions are not taken.

> ⚠ **CAUTION**
>
> indicates that minor personal injury can result if proper precautions are not taken.

> **NOTICE**
>
> indicates that property damage can result if proper precautions are not taken.

If more than one degree of danger is present, the warning notice representing the highest degree of danger will be used. A notice warning of injury to persons with a safety alert symbol may also include a warning relating to property damage.

Qualified Personnel

The product/system described in this documentation may be operated only by **personnel qualified** for the specific task in accordance with the relevant documentation, in particular its warning notices and safety instructions. Qualified personnel are those who, based on their training and experience, are capable of identifying risks and avoiding potential hazards when working with these products/systems.

Proper use of Siemens products

Note the following:

> ⚠ **WARNING**
>
> Siemens products may only be used for the applications described in the catalog and in the relevant technical documentation. If products and components from other manufacturers are used, these must be recommended or approved by Siemens. Proper transport, storage, installation, assembly, commissioning, operation and maintenance are required to ensure that the products operate safely and without any problems. The permissible ambient conditions must be complied with. The information in the relevant documentation must be observed.

Trademarks

All names identified by ® are registered trademarks of Siemens AG. The remaining trademarks in this publication may be trademarks whose use by third parties for their own purposes could violate the rights of the owner.

Disclaimer of Liability

We have reviewed the contents of this publication to ensure consistency with the hardware and software described. Since variance cannot be precluded entirely, we cannot guarantee full consistency. However, the information in this publication is reviewed regularly and any necessary corrections are included in subsequent editions.

Preface

SINUMERIK documentation

The SINUMERIK documentation is organized into the following categories:

- General documentation/catalogs
- User documentation
- Manufacturer/service documentation

Additional information

You can find information on the following topics at the following address (https://support.industry.siemens.com/cs/de/en/view/108464614):

- Ordering documentation/overview of documentation
- Additional links to download documents
- Using documentation online (find and search in manuals/information)

If you have any questions regarding the technical documentation (e.g. suggestions, corrections), please send an e-mail to the following address (mailto:docu.motioncontrol@siemens.com).

mySupport/Documentation

At the following address (https://support.industry.siemens.com/My/ww/en/documentation), you can find information on how to create your own individual documentation based on Siemens' content, and adapt it for your own machine documentation.

Training

At the following address (http://www.siemens.com/sitrain), you can find information about SITRAIN (Siemens training on products, systems and solutions for automation and drives).

FAQs

You can find Frequently Asked Questions in the Service&Support pages under Product Support (https://support.industry.siemens.com/cs/de/en/ps/faq).

SINUMERIK

You can find information about SINUMERIK at the following address (http://www.siemens.com/sinumerik).

Target group

The operating manual is aimed at all machine tool users. The publication provides information required by the user to understand the Analyze MyMachine /Condition software.

Benefits

The operating manual allows the target group to get familiar with the software user interface. Based on the manual, the target group is capable of responding to problems and to take corrective action.

Standard scope

This documentation describes the functionality of the standard scope. Additions or revisions made by the machine manufacturer are documented by the machine manufacturer.

Other functions not described in this documentation might be executable in the control system. This does not, however, represent an obligation to supply such functions with a new control system or when servicing.

Furthermore, for the sake of clarity, this documentation does not contain all detailed information about all product types and cannot cover every conceivable case of installation, operation or maintenance.

Note regarding the General Data Protection Regulation

Siemens respects the principles of data privacy, in particular the data minimization rules (privacy by design). For this product, this means:

The products process the following personal data: User name, password, optionally name and first name. It does not involve data from the personal or private sphere. The above mentioned data is required for the access restriction function (login). The data saved is limited to the absolute minimum as this is absolutely necessary to make a differentiation between the access rights. The above-mentioned data cannot be saved with anonymity or with pseudo-anonymity as the objective of differentiating access rights would not be possible. Our products do not automatically delete the data mentioned above. If necessary, this data can be deleted in the corresponding user administration. If you have any questions, then please contact our customer support organization.

Technical Support

Country-specific telephone numbers for technical support are provided in the Internet at the following address (https://support.industry.siemens.com/sc/ww/en/sc/2090) in the "Contact" area.

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Fundamental safety instructions

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1.1 General safety instructions

> ⚠ **WARNING**
>
> **Danger to life if the safety instructions and residual risks are not observed**
>
> If the safety instructions and residual risks in the associated hardware documentation are not observed, accidents involving severe injuries or death can occur.
> * Observe the safety instructions given in the hardware documentation.
> * Consider the residual risks for the risk evaluation.

> ⚠ **WARNING**
>
> **Malfunctions of the machine as a result of incorrect or changed parameter settings**
>
> As a result of incorrect or changed parameterization, machines can malfunction, which in turn can lead to injuries or death.
> * Protect the parameterization against unauthorized access.
> * Handle possible malfunctions by taking suitable measures, e.g. emergency stop or emergency off.

1.2 Warranty and liability for application examples

Application examples are not binding and do not claim to be complete regarding configuration, equipment or any eventuality which may arise. Application examples do not represent specific customer solutions, but are only intended to provide support for typical tasks.

As the user you yourself are responsible for ensuring that the products described are operated correctly. Application examples do not relieve you of your responsibility for safe handling when using, installing, operating and maintaining the equipment.

1.3 Security information

Siemens provides products and solutions with industrial security functions that support the secure operation of plants, systems, machines and networks.

In order to protect plants, systems, machines and networks against cyber threats, it is necessary to implement – and continuously maintain – a holistic, state-of-the-art industrial security concept. Siemens' products and solutions constitute one element of such a concept.

Customers are responsible for preventing unauthorized access to their plants, systems, machines and networks. Such systems, machines and components should only be connected to an enterprise network or the internet if and to the extent such a connection is necessary and only when appropriate security measures (e.g. firewalls and/or network segmentation) are in place.

For additional information on industrial security measures that may be implemented, please visit
https://www.siemens.com/industrialsecurity (https://www.siemens.com/industrialsecurity).

Siemens' products and solutions undergo continuous development to make them more secure. Siemens strongly recommends that product updates are applied as soon as they are available and that the latest product versions are used. Use of product versions that are no longer supported, and failure to apply the latest updates may increase customer's exposure to cyber threats.

To stay informed about product updates, subscribe to the Siemens Industrial Security RSS Feed under
https://www.siemens.com/industrialsecurity (https://new.siemens.com/global/en/products/services/cert.html#Subscriptions).

Further information is provided on the Internet:

Industrial Security Configuration Manual (https://support.industry.siemens.com/cs/ww/en/view/108862708)

⚠ **WARNING**

Unsafe operating states resulting from software manipulation

Software manipulations, e.g. viruses, Trojans, or worms, can cause unsafe operating states in your system that may lead to death, serious injury, and property damage.

- Keep the software up to date.
- Incorporate the automation and drive components into a holistic, state-of-the-art industrial security concept for the installation or machine.
- Make sure that you include all installed products into the holistic industrial security concept.
- Protect files stored on exchangeable storage media from malicious software by with suitable protection measures, e.g. virus scanners.
- On completion of commissioning, check all security-related settings.

Overview

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2.1 Analyze MyMachine /Condition

Analyze MyMachine /Condition is an application that analyzes and tracks the status of your machine. For this purpose, specific mechatronic tests are used as well as data-analytic processes.

The hybrid application comprises a SINUMERIK Edge and a MindSphere application. Analyze MyMachine /Condition supports you for the following functions:

- Acquiring the current machine status based on mechanical parameters such as axis stiffness, backlash, friction values, signature and quadrant errors

- Identifying mechanical changes at the machine at an early stage as basis for condition-based maintenance

- Evaluating measurement results from one or several machines over a longer period of time using the MindSphere application

Functions

Analyze MyMachine /Condition contains the following functions.

SINUMERIK Edge application Analyze MyMachine /Condition

- User interface
    - Create tests
    - Execute tests
    - View results (simplified)
    - View results (experts)

- Calculating parameters referred to the axis
    - Equability
    - Stiffness
    - Friction dry/friction viscous
    - Friction distribution
    - Signature
    - Backlash
    - Quadrant error
    - Frequency response

- Results
  are displayed in tabular or graphical form

MindSphere application Analyze MyMachine /Condition

- Measurement configuration
  - Read access to all measurement configurations of the SINUMERIK Edge Assets linked with the tenant
  - Viewing individual measurement results
- Analysis of measurement results
  - Graphic representation and analysis of the measurement results over time

2.2   Measurement characteristics

Analyze MyMachine /Condition creates a mechanical fingerprint of your machine tool using the following measurement characteristics:

- Equability

- Friction

- Backlash

- Signature

- Quadrant error

- Stiffness

- Frequency response
  The frequency response can only be calculated if AST (Auto Servo Tuning) has been installed and configured on SINUMERIK Operate (Version 4.7.2).

Each characteristic value can be determined for each axis by executing a measurement program. However, if an axis has no direct measuring system, i.e. only one encoder is present, backlash and stiffness cannot be calculated. Two encoders are always required to calculate these characteristics.

Each measurement characteristic is described below. The causes of changes and possible effects on the characteristic values of your machine tool are also listed.

Equability

In the equability axis test, an axis is moved at constant velocity completely over the defined measurement path.
The alternating components of the load-side force with respect to the axis positions are determined from the measured motor torque:
The alternating components of the load-side force with respect to the axis positions are determined from the measured motor torque. The characteristic is the maximum force during travel in both directions.

Causes of changes

If the maximum force increases, the following causes are possible:

- Insufficient lubrication of the axis

- Mechanical damage to the axis

- Jammed cover segments

- Chip contamination

If the force curve is substantially changed compared with the reference point approach, this could be due to the following:

- Alignment or parallelism errors on the axis (e.g. as a result of a collision)

Possible effects

If the maximum force or force characteristic deviates too much, the following effects are possible:

- Reduced workpiece quality: length and surface defects on the workpiece

- Damage to the machine if the causes are not rectified in good time

Calculation

The axis is traversed at constant velocity along the defined measuring range.

Friction

The friction test supplies three different measurement results:

- Friction dry (stiction)

- Friction viscous (speed-dependent friction components)

- Friction distribution

The friction distribution provides information on how the axial friction is distributed between the spindle nut or the guidance. In this way it is possible to estimate which component of the drive train is responsible for the increase in friction as total friction increases. If the increased friction results in increased compression between the measuring systems, then the friction on the guide side has increased. Otherwise the friction has increased near the motor - at the spindle nut or upstream gear.

Causes of changes

- Increase in friction distribution - spindle nut

  - Mechanical defect in spindle nut

  - Insufficient lubrication of spindle nut / ball screw

- Increase in friction distribution - guidance

  - Mechanical defect on the guide carriage running surface

  - Insufficient lubrication of the guide

  - Insufficient lubrication of the cover

- Increase in the friction viscous/friction dry parameters: Insufficient lubrication

Possible effects on the machine

- Positioning errors caused by overshoot

Stiffness

Stiffness describes the overall stiffness of the drive train between the two measuring systems and can also be understood as the axial stiffness of the entire drive train of an axis. It results from a series connection of the individual stiffness values of the components. In drive trains with ball screw, the axial stiffness of the screw nut is usually the point with the lowest stiffness. Overall stiffness decreases as the distance from the locating bearing increases since the stiffness of the ball screw (tension/compression and rotation) decreases with increasing length.

Causes of changes

The stiffness of the axes of a machine tool can decrease over time. Stiffness does not normally increase. Possible causes are:

- Diminishing ball screw pre-tension
- Wear on the ball bearings in the guide
- Damage to bearing

Possible effects

If the stiffness diminishes too sharply, the following effects are possible:

- Reduced workpiece quality: length and surface defects on the workpiece
- Fall in the lowest natural frequency of the drive train, which can lead to stability problems in the position control loop

Calculation

The axis is accelerated at various positions. The individual, discrete measuring points are then described with polynomial interpolation.

Backlash

Backlash is a fault in positioning that occurs when the direction of force is reversed. It is caused by play and low levels of stiffness in the drive train. Backlash also affects bidirectional repeat accuracy.

Causes of changes

Backlash normally increases over time. Possible causes are:

- Wear in the guide grooves of the ball screw/spindle nut and thus increasing play
- Consequence of a collision: Ball bearings in the ball screw plastically deformed

Possible effects

If backlash increases too sharply, the following effects are possible:

- Positioning errors
- Surface defects (relief cutting during milling)
- Vibration of the machine during traversing movements with fast and frequent changes of direction

Calculation

Backlash is calculated from the difference between the two encoders after traversing with different µm-paths. Traversing is first in one direction at the measuring point and then in the opposite direction until the axis moves again. The backlash is determined in the middle between the upper and lower limits of the measuring range. For example, if a measuring range between 0 mm and 100 mm is specified, the backlash is determined at 50 mm.

Signature

The signature indicates periodic synchronous positioning errors due to location-dependent faults in the drive train. The signature is ascertained from the frequency ranges of several different constant speeds. If an order occurs in at least three different speeds, it can be excluded as a fault, e.g. due to an excited natural frequency. The order is adopted as a parameter.

The number of orders essentially indicates how often the motor must rotate until the periodic fault occurs again. Defective components in the drive train can be identified based on the signature. In such a case the comparison of the signature measurement with the reference measurement shows a new order, which was not present in the reference measurement.

Causes of changes

• Amplitude of one or more orders from the reference measurement increases

• New frequencies ("damage frequencies") suddenly become visible in comparison to the reference measurement

– Bearing damage

– Damage to the ball screw (e.g. plastic deformation in the guide grooves)

– Loss of tension in a toothed belt

Possible effects

• Surface defects caused by vibrations

• Positioning errors

Calculation

The signature is determined by order analysis during the equability test of an axis at three different constant speeds. The signature of Analyze MyMachine /Condition is only evaluated as a real order if an order is measured at three different speeds.

Quadrant error

A quadrant error can be regarded as a one-dimensional roundness test and refers to only one axis. A quadrant error occurs when the direction of the axis is reversed and is chiefly attributable to static friction effects of the axis.

Causes of changes

The quadrant error normally increases over time. Possible causes are:

• Change in the static friction of the drive train

• Incorrect setting of friction compensation

• Increased backlash

Possible effects

• Positioning errors

• Surface defects in mold making

Calculation

Quadrant errors are determined by a sine run and comparison with the ideal sine.

Frequency response

The standard measuring function of the SINUMERIK control calculates the mechanical behavior of the axis from the perspective of the drive in the frequency range. The result is displayed in the usual Bode diagram. The natural frequencies are determined automatically. The drive train is completely monitored by monitoring of high-frequency natural modes, such as couplings or belts whose effects are usually lost in the main stiffnesses.

Causes of changes

Possible causes are:

- Shifting natural frequencies due to wear in the drive train

- As a result of stiffness losses

Possible effects

- Possible incorrect parameterization of the existing controller settings, e.g. attenuation filters for resonance of the coupling, or parameterized gain factors no longer match the mechanical system

- Machine is no longer traversed with optimum controller parameters: Reduced traversing velocity or even quality defects on the workpiece

Calculation

The frequency response is determined using the "Auto Servo Tuning" (AST) measuring function of the SINUMERIK control. The measuring function is called via "AST from part program".

2.3 Managing users and rights

User groups

The system administrator creates user groups and users. He/she then assigns individual users to the corresponding user group.

SINUMERIK Edge application

The following user groups are available for the SINUMERIK Edge application:

User group	Authorizations
OEMMachineCommissioningEngineer	• Viewing measurements and measurement groups • Creating measurements and measurement groups • Editing measurements and measurement groups • Deleting measurements and measurement groups
OEMServiceEngineer	• Viewing measurements and measurement groups This role does not have any authorization for editing measurements.

MindSphere application

The following roles are available:

- Standard users
  - ammcondition
- Administrator
  - ammcondition

You edit users and roles in the MindSphere application "MindSphere Settings".

Further information can be found at: MindSphere documentation (https://siemens.mindsphere.io/en/docs/mindaccess.html).

Access levels at the SINUMERIK control system

Authorizations are assigned via the access levels on the SINUMERIK control system.

Access levels can be changed by entering a password or adjusting the keyswitch position.

Access level	Authorization
0	Access level: SIEMENS
1	Access level: machine OEM
2	Access level: service
3	Access level: user
4	Access level: keyswitch position 3, programmer, machine tool builder
5	Access level: keyswitch position 2, qualified operator
6	Access level: keyswitch position 1, trained operator
7	Access level: keyswitch position 0, trainee operator

Access levels at the SINUMERIK user inter-face	Authorization
0, 1, 2	Access for commissioning engineers • Selecting and executing measurements that have not been referenced • Selecting referenced measurements
3, 4, 5, 6, 7	Access for machine operators • Selecting referenced measurements **Note**: If a measurement series is released on the control system that has not yet been referenced, then the machine operator cannot see this measurement series.

SINUMERIK Edge application

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3.1 Open Analyze MyMachine /Condition

Open the following applications on the Edge application home page:

- Configuring and analyzing measurements (Page 26)
- Configuring measurement group (Page 39)

Requirement

- SINUMERIK Edge is configured.
  Further information on the configuration is provided in the "Analyze MyMachine / Condition" Installation Manual.

Procedure

1. Enter the following address in the browser:
   `https://<ip-address-of-edgebox>:5443/analyzemymachineui`
   The home page opens.

2. Enter your Analyze MyMachine /Condition user name and password.
   Information on users and rights can be found in Chapter: Managing users and rights
   (Page 18).

3. Click the "Sign In" button.

4. The launch pad opens.
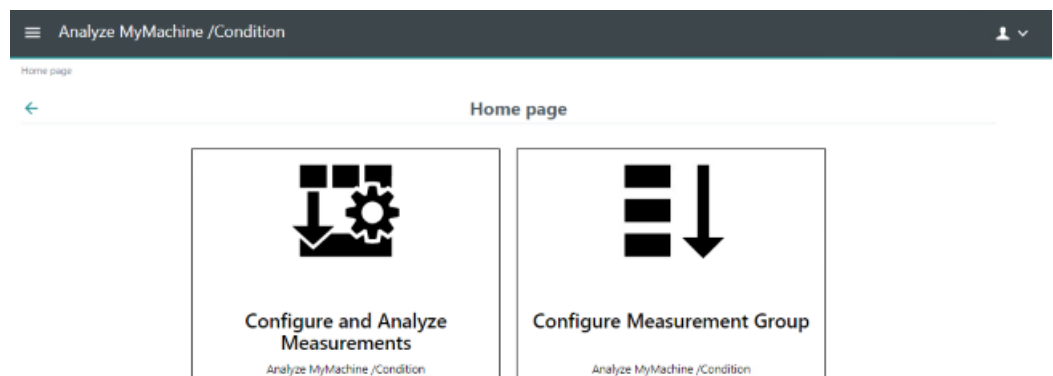
Sign out

1. Open the drop-down list at the top right in the title bar.

2. Select "Logoff".
   You are transferred to the SINUMERIK Edge administration page.

3. On the SINUMERIK Edge administration page, select "Logoff".

3.2 Defining parameters

For correct measurement results, the axis parameters must be set both in the SINUMERIK Edge application and on the SINUMERIK control.

Parameters

The following parameters are displayed in the SINUMERIK Edge application of Analyze MyMachine /Condition:

Parameters	Description
Channel name: axis	Displays channel name and axis identifier.
	Additionally it specifies whether it is a linear axis or axis of rotation.
JMot ([kg]/[kgm²])	Input field for drive parameters.
	For linear direct drives the value is specified in kg, otherwise in kgm².
Mechanical system	Selecting the mechanical axis type for linear axes. The following axis types are supported:
	• Ballscrew/linear motor
	• Rack-and-pinion drive
	This field is not displayed for rotary axes.
Micrometer step	Input field for the step width in micrometers for linear axes with rack-and-pinion drive. The default setting is 10 µm. The value can be changed in the range 1 µm to 100 µm.
	For linear axes with ball screw drive the default setting is 1 µm. This value cannot be changed.
	If the SINUMERIK control operates with values in inches, the corresponding inch values are displayed.
	This field is not displayed for rotary axes.
Gravity compensation	Check box for activating gravity compensation.
	For axes whose holding force/torque varies as a function of their position due to gravity (e.g. swivel axes). Vertical axes that have a constant holding force/torque do not require compensation.
	The compensation is deactivated by default.
Path of the AST strategy file	Input box for specifying the path to the strategy file.
	The strategy file is generated by the AST function in SINUMERIK Operate.

Requirement

Analyze MyMachine /Condition was started at the PC.

You are logged in with the "OEMMachineCommissioningEngineer" user role.

Procedure

1. Open the menu on the left in the title bar of Analyze MyMachine /Condition.

2. Select the entry "Axis settings".
   The application moves to the "Axis settings" page: `https://<ip-address-of-edgebox>:5443/analyzemymachineui/axissettings`
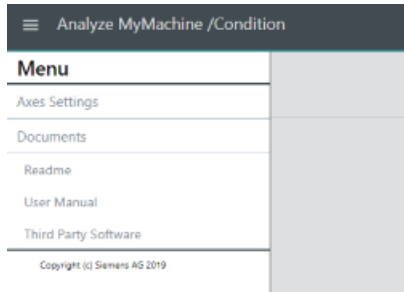
3. For the displayed axes, enter the corresponding "JMot" drive parameters.
   The axes are preassigned with the value 0.000001 [kgm^2, kg] and must be adapted.

4. For all linear axes, select the mechanical type of axis.

5. Enter the "micrometer step" for linear axes of the type "rack-and-pinion drive".

6. For axes that are affected by gravity over the distance, select the "Gravity compensation" check box.

7. If the axis is tested for frequency response, enter the path to the AST strategy file.

8. Make sure that the necessary information is entered on the "Axis Settings" page for all axes in all channels, otherwise you will obtain incorrect measurement results.
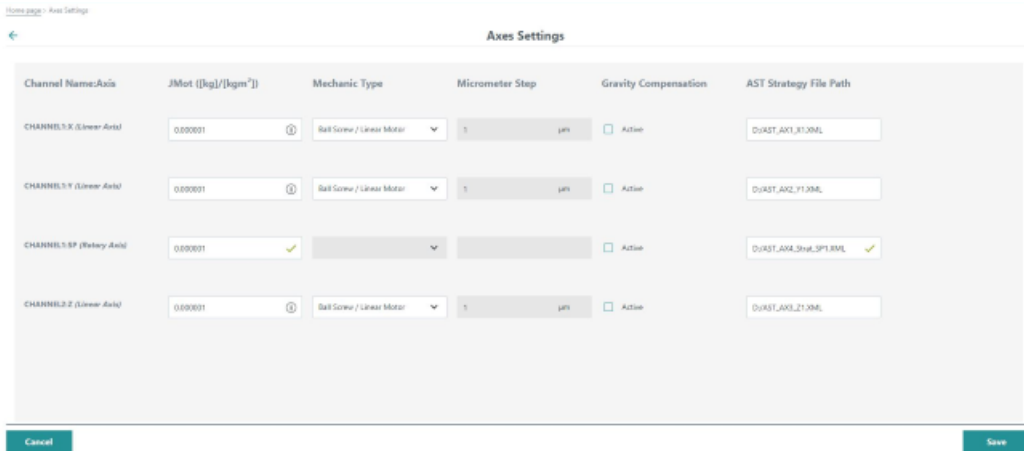
Drive parameters on the SINUMERIK control

1. In SINUMERIK Operate, press key <MENU SELECT> or <F10>.

2. Select the "Setup" operating area.

3. Press softkey "Mach. data".

4. Press softkey "Drive parameter".
   The list of parameters is displayed.

5. Search for parameter "p341" for your axis.

6. For each axis, set the corresponding parameter values in the "JMot" column.
   Use the "+" and "-" softkeys to navigate to the next or previous axis.

3.3 Configuring and analyzing measurements

3.3.1 Creating a new measurement

Requirement

- SINUMERIK Operate (Version 4.7.2) is installed and configured.

- Option "AST CALL BY PART PROG" is set.

- An AST tuning strategy file must be created for every axis. You can use AST strategy template number 109 to do this.
  Additional information on how to use AST is provided in the AST Operating Manual.

- Link the tuning strategy file with AMM /C. Additional information is provided in Chapter: Defining parameters (Page 23).

  Additional information on configuring the Auto Servo Tuning (AST) is provided in the Analyze MyMachine /Condition Installation Manual

Elements in "Configuring and analyzing measurements"

Function	Description	
←	Navigates back to the previous page.	
Selection	☐	Empty: No measurement has been selected.
	☑	Activated: The measurement has been selected.
Name	Input field for the name of the measurement	
Characteristic Value	The following selection options are available: • Equability • Friction • Stiffness • Backlash • Quadrant error • Signature • Frequency response	
Channel name: Axis	Display of the channel name and the selected axis	
Lower limit measuring range	Displays the starting point of measurement travel	
Upper limit measuring range	Displays the end point of measurement travel	

Function	Description

Status	Display of the measurement status:
	
	• Created
	  The measurement was saved. However, you have still not entered all of the necessary data.
	
	• Defined
	  The measurement was saved with all of the necessary data.
	
	• Released
	  The measurement has been released. This means that on the SINUMERIK control in the Program Manager it is visible for the "OEMCommissioningEngineer" and "OEMServiceEngineer" roles.
	  The "MachOperator" role can select the measurement and execute a measurement after a measurement in "Referenced" status has become available.
	
	  – You have entered all the required data.
	
	  – You have stored the measurement.
	
	  – You have pressed the "Release measurements" button.
	    Further information on this topic is provided at: Releasing the measurement (Page 34).
	
	• Referenceable
	  You have at least one valid test result that you can use as reference.
	  Further information is provided at: Defining a measurement as a reference (Page 36).
	
	• Referenced
	  A test result was defined as reference.

Icons	🗑 Delete Deletes the corresponding measurement.
Add	This button is active for role "OEMMachineCommissioningEngineer". It adds a new measurement, and opens the "Configure Measurement" page with the "Basic Configuration" tab. **Further information** is provided at: Configure measurement (Page 28).
Transfer measurement to SINUMERIK	This button is displayed if the measurement is activated and is in the "Released" status. The measurement is made available to the SINUMERIK control. **Further information** is provided at: Releasing the measurement program (Page 35).

Procedure

1. On the home page, click on the "Configure and Analyze Measurements" button.

2. The "Configure and Analyze Measurements" page is opened. You can see the measurements that have been created so far.

   – Click on "Add".

3. The "Configure Measurement" page opens with the "Basic Configuration" tab.

3.3.2 Configure measurement

Notes on the distance

- The measuring program of an axis or measurement group should not exceed 45 min, as otherwise it is possible that invalid measurement results will be obtained.

- For frequency response tests, the traversing paths are used that have been defined in the AST configuration in SINUMERIK Operate. This means that the limit values specified on the "Basic Configuration" tab are not evaluated if you only select frequency response as the characteristic value.

- If you change the unit of measurement used on the SINUMERIK control, Analyze MyMachine / Condition is not adjusted immediately. It is very probable that the application will calculate values incorrectly. Restart Analyze MyMachine /Condition whenever the measurement unit on the SINUMERIK control is changed over.

Elements in the "Basic Configuration" tab

Function	Description
Name of the measurement	Input field for the unique name of the measurement
Channel name	Selection of the channel to be tested
Axis	Selection of the axis to be tested
Characteristic values to be calculated	Selection of the characteristic values that must be calculated for the measurements: • Equability • Friction • Stiffness • Backlash • Quadrant error • Signature • Frequency response • All features
Distance	
Lower limit measuring range	The starting point for measurement travel is defined here.
Upper limit measuring range	The end point of measurement travel is defined here.
Use software limit switch	Checkbox to activate the software limit switch of the particular axis
Diameter of circle	
Circle with high dynamic response	For measurements with a high dynamic response (r = 10 mm, F = 5000 mm/min)
Circle with medium dynamic response	For measurements with a medium dynamic response (r = 15 mm, F = 3000 mm/min)
Circle with low dynamic response	For measurements with a low dynamic response (r = 20 mm, F = 1000 mm/min) If the axis is configured as a rack & pinion axis, this option is preset as the default setting and cannot be changed.
Rotational stiffness of the coupling [Nm/rad]	Field to enter the rotational stiffness of the coupling
Inertia of the ball screw [kgm^2]	Field to enter the moment of inertia of the ball screw
Release measurement	The button sets the measurement to "Released" status. This button becomes visible when a measurement has been saved and all the required values have been defined.
Back	The small arrow at the top left of the title bar aborts the current processing and returns to the previous page.
Edit	This button opens an existing measurement for editing. This button becomes visible when a measurement has been saved.
Save	The button saves the changes. This button becomes visible when a measurement has been edited.
Cancel	This button is displayed when you create a new measurement. The button is not visible when you edit a measurement.

Procedure

1. Enter a unique name for the measurement in the "Measurement name" field.

2. Select the required channel from the "Channel name" drop-down list.
   Each channel has its own, unique list of axes.

3. Select the required axis from the "Axis" drop-down list.
   Each axis has a specified software limit that is checked.

   Note

   If you want to configure a measurement for a spindle, ensure that the selected spindle is configured as an axis.

   In addition, Analyze MyMachine /Condition supports the following axis types:
   - Master / slave: Only the master axis is measured.
   - Gantry: Only for the linear axes, whereby only the leading axis is measured.

   The axes of a newly configured channel in the SINUMERIK control are only offered for selection after Analyze MyMachine /Condition has been restarted.

   If two different channels of an axis have the same axis ID, then Analyze Mymachine / Condition displays the first axis on the configuration page.

4. Activate the appropriate checkbox to select the required characteristic values.

5. Enter the required limit values in the fields "Lower limit measuring range" and "Upper limit measuring range".
   - OR -
   Activate the checkbox "Set software limit switch" to accept the software limit switch related to an axis.
   The recommended setting is from lower to upper measurement range limit.
   If you enter a distance that is too small for calculation of the selected characteristic value, you will receive a warning.

6. If you have selected the "Quadrant error" characteristic value, specify the diameter of circle by activating the appropriate option button.

7. Enter the rotational stiffness of the coupling in Nm/rad in the corresponding input field.

8. Enter the moment of inertia of the ball screw in kgm^2 in the corresponding input field.

9. Click the "Save" button.
   The selection is saved. The new measurement is displayed in the list on the "Configure and Analyze Measurements" page.
   After being set up, the measurement has the status "Created" if not all of the necessary data has yet been entered.
   The measurement has the status "Defined" if all of the necessary data has been entered.
   - OR -
   Click the "Cancel" button to cancel the input.
   - OR -
   Click the small arrow on the left of the title bar to abort the current input and return to the previous page.

3.3.3   Creating secure positions

To avoid collisions, specify "Secure positions" when preparing the axes for the measurement. To avoid collisions during the measurement, axes not used for the measurement should be brought into a secure position.

Elements in the "Safe Positions"

Function	Description
Name of the measurement	The field in which the unique name of the measurement is displayed.
"Prolog" tab	
"Define prolog to ensure collision avoidance (recommended)" option	When activated, the entered NC code is accepted for the secure position.

Function	Description
"Prolog not necessary" option	When activated, the NC code is not used for the measurement program.
Input field	In this field, enter the NC code for the prolog. You can enter up to 2000 lines and up to 256 characters per line.
"Epilog" tab	
"Define epilog to ensure collision avoidance (recommended)" option	When activated, the entered NC code is accepted for the secure position.
"No epilog necessary" option	When activated, the NC code is not used for the measurement program.
Input field	In this field, enter the NC code for the epilog. You can enter up to 2000 lines and up to 256 characters per line.

Procedure

1. On the "Configuring and Analyzing Measurements" page, click on the underlined name of the measurement for which you want to set up secure positions
   The "Configure Measurement" page is then opened.

2. Open the "Secure positions" tab.

3. Click "Edit".

Defining the prolog

1. Activate the "Define prolog to ensure collision avoidance (recommended)" option

2. Enter the NC code in the input area.
   Example:
   ```
   ;Prolog_Code
   FFWON
   Y360 F5000
   Z360 F5000
   MSG("PROLOG EXECUTED")
   ```

Note

No syntax check

Ensure that you enter valid code at this point.

The system does not perform any syntax check.

3. Click the "Save" button.
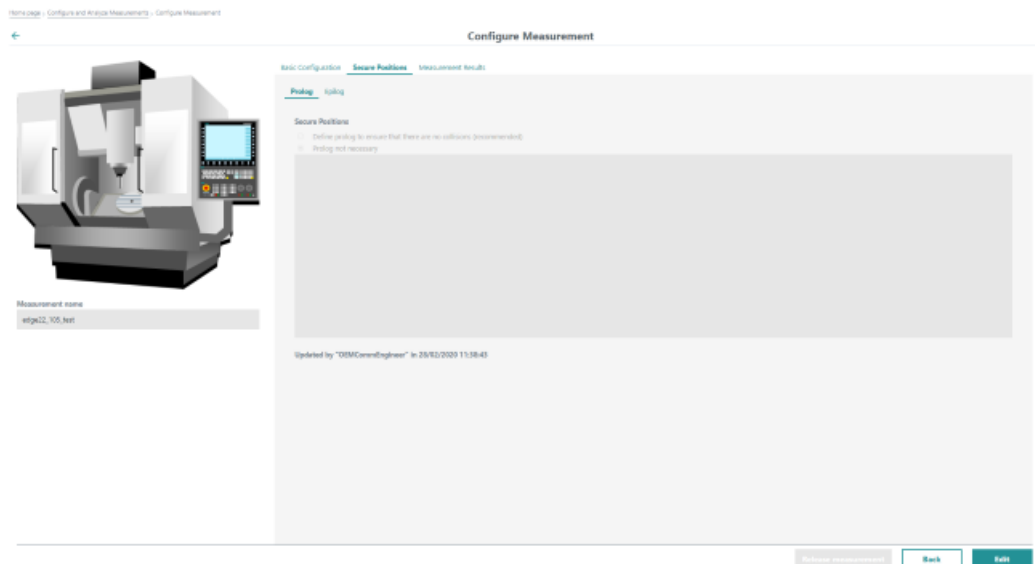
Defining the epilog

1. Activate the "Define epilog to ensure collision avoidance (recommended)" option

2. Enter the NC code in the input area.
   Example:
   ```
   ;Epilog_Code
   FFWON
   Y360 F5000
   Z360 F5000
   MSG("EPILOG EXECUTED")
   ```

   Note

   No syntax check

   Ensure that you enter valid code at this point.

   The system does not perform any syntax check.

3. Click the "Save" button.

3.3.4 Releasing the measurement

Requirement

The measurement must be in "Defined" status in order for it to be released.

Procedure

1. On the "Configuring and Analyzing Measurements" page, click on the underlined name of a measurement which has "Defined" status
   The "Configure Measurement" page is opened with the selected measurement.

2. Click on "Release Measurement".
   The measurement is assigned "Released" status.
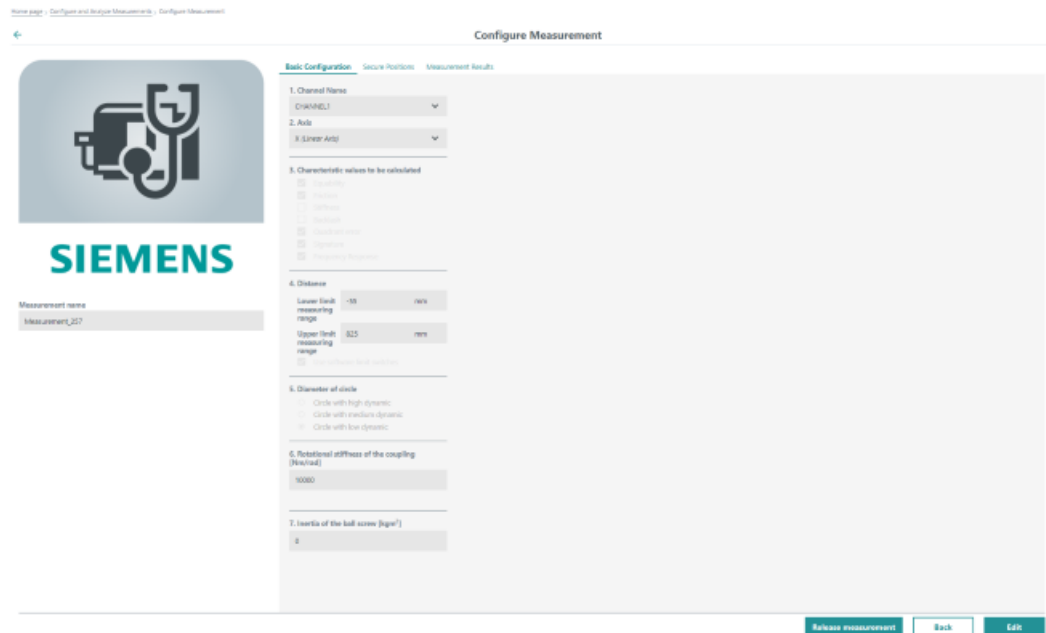
3.3.5 Releasing the measurement program

To use a measurement for NC programs, the corresponding measurement of the SINUMERIK control must be made available.

Only one measurement program can be released for the SINUMERIK control at any one time. The corresponding measurement program is color-highlighted in the list of measurements.

Requirement

To permit a release, the measurement must have one of the following states:

- Released

- Referenceable

- Referenced

Procedure

1. Open the "Configuring and Analyzing Measurements" page.

2. Activate the checkbox for the desired measurement.
   The "Transfer measurement to SINUMERIK" button is displayed.

3. Click on "Transfer measurement to SINUMERIK".
   The automatically generated NC program for the actual measurement is enabled in the SINUMERIK control under the name "<Axis name>_<9-11 characters of the name of the measurement>_<Time stamp>.MPF".
   You receive a message that the action was completed successfully.

4. Check the creation date in the network drive.
   The measurement program can be selected using the Program Manager on the SINUMERIK control.
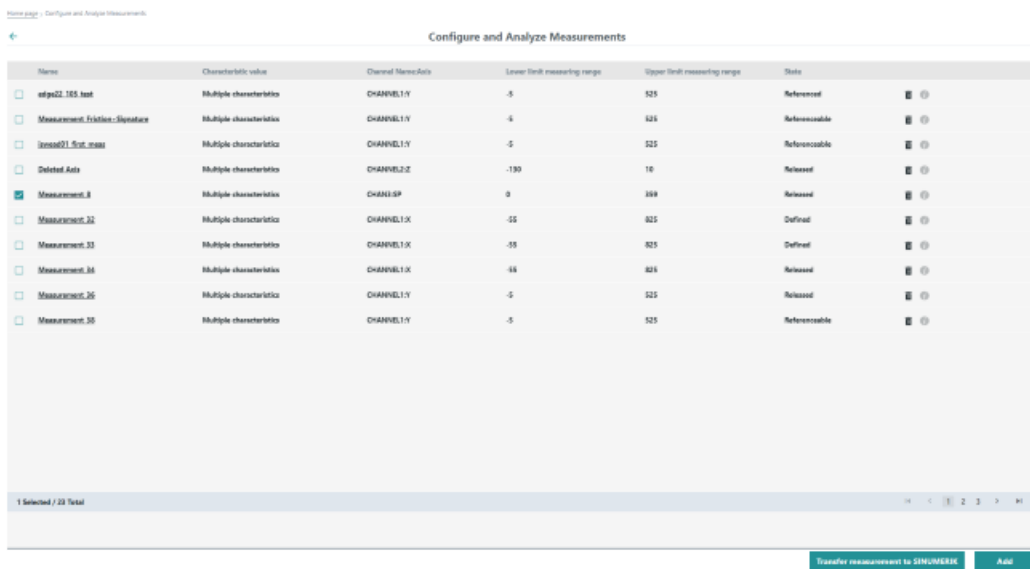
3.3.6 Defining a measurement as a reference

In a reference measurement, you create the threshold values for the following:

- Warning (warning threshold)
  If the value is exceeded, you receive a warning on the SINUMERIK control.

- Service (service thresholds)
  If the value is reached, you receive a note on the SINUMERIK control that maintenance must be performed.

The reference measurement is always displayed, color-highlighted at the top in the measurement results table.

Requirement

- You have executed a measurement program.

- A valid measurement result is available.

- You have the "OEMCommissioningEngineer" role.

Procedure

1. On the "Configuring and Analyzing Measurements" page, click on the required measurement. The "Configure Measurement" page is then opened.

2. Open the "Measurement Results" tab.
   The table of measurement results is displayed.

3. Click the "Edit" icon in the icon list on the right-hand side.
   The "Define <timestamp> as reference measurement" dialog opens.

4. Enter the required threshold values for the following characteristic values:

   – Equability

   – Stiffness

   – Friction

   – Backlash

   – Quadrant error

   – Signature

   – Frequency response

   Note

   Threshold values for equability, quadrant errors and signature

   The threshold values for equability, quadrant errors and signature are absolute values for the deviation.

   Example: If the threshold value for quadrant errors is defined to be 50 µm, and the measured value is 53 µm, then the threshold value has been exceeded.

   - OR -
   Select the checkbox "Set default thresholds" if you want to use default threshold values.

5. To save the values as reference, click the "Save" button.
   - OR -
   To cancel the operation, click the "Abort" button.

Define measurement 11/08/2020 - 13:41:13 as reference measurement

Setting thresholds:

	Friction	Signature
Warning thresholds:	10 %	5 µm
Service thresholds:	20 %	10 µm

☐ Set default thresholds

| Abort | Remove reference | Save |

Removing a reference

1. On the "Configure Measurement" page, open the "Measurement Results" tab.

2. Open the reference measurement. The reference measurement is always displayed, color-highlighted at the top.

3. Click the "Remove Reference" button.

3.4 Configuring measurement group

Executing measurement groups provides the option of measuring more than one axis within an automated measurement operation.

You combine several measurements to create a group. This measurement group is transformed into a corresponding NC program on the SINUMERIK control.

Requirement

The following preconditions must be fulfilled in order to set up measurement groups:

- On the SINUMERIK Edge application: "OEMCommissioningEngineer" role

- On the SINUMERIK control: Access level 0, 1 or 2

- At least one of the measurements that is to be automated is in "Referenced" status

Procedure

1. On the home page, click on the "Configuring Measurement Group" button.
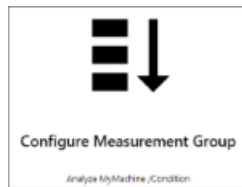
2. The "Configuring Measurement Group" page opens.
   Click on the "Add" button.

3. Enter a name for the new measurement group in the "Measurement group name" field.

4. Click the "Add" button.
   The "Available Measurement" dialog is opened.

5. Activate the checkboxes of the measurements that you want to add to the measurement group.

   Note

   All selected measurements must be assigned to the same channel.

6. Click the "Save" button in the "Available Measurement" dialog.
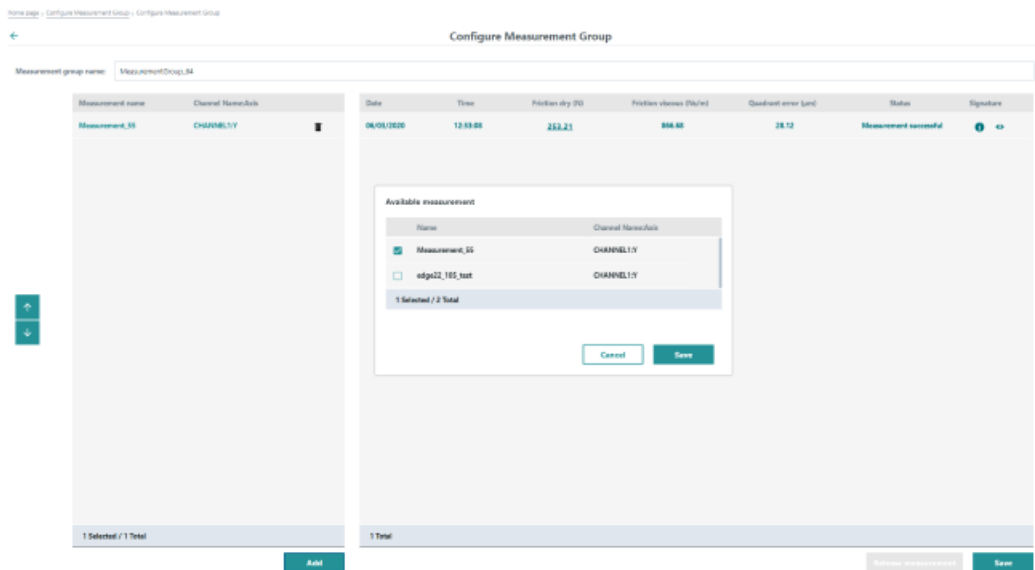
7. Use the vertical arrows to the left to define the sequence of measurements during execution of the measurement program.

8. Click the "Save" button.

9. Click the "Release Measurement" button.
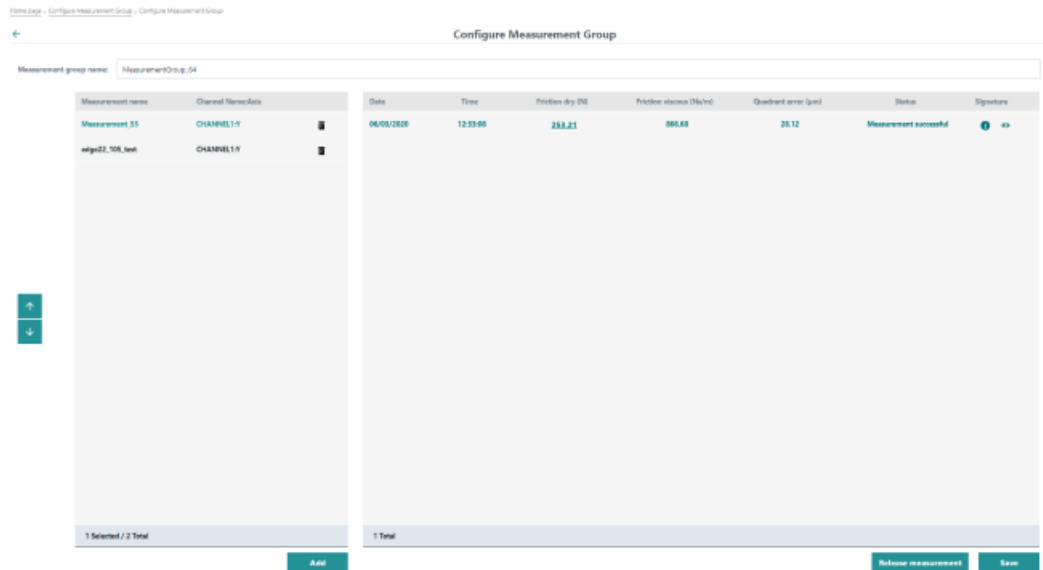
Note

Editing the measurement series

You can no longer edit the measurement group once the measurement group has been released.

10. Click on "Transfer Measurement Group Program to SINUMERIK".
The automatically generated NC program for the current measurement group is now released on the SINUMERIK control under the name "<mconfig-name><timestamp>.MPF". You receive a message that the action was completed successfully.

The measurement are executed when you activate the measurement group. The results are saved under the respective measurements.

You can navigate between the measurements and view individual results.

Delete measurement group

1. Click on the "Recycle bin" icon of the corresponding measurement group.
   The following confirmation prompt is displayed.

2. Acknowledge the confirmation prompt.
   The measurement group is deleted.

Note

Results of the measurements referenced with the group

The results of the measurements referenced with the group are still available.

3.5 Measurement results

3.5.1 Displaying the measurement results as table

Depending on the mechanical components of the machine, the following values are calculated after a successful measurement.

Mechanical system	Number of encoders	Equability	Stiffness	Friction dry	Friction distribution	Signature	Backlash	Quadrant error	Frequency response
Direct linear motor Direct torque motor	1	Yes	No	Yes	No	Yes	No	Yes	Yes
Ball screw	1	Yes	No	Yes	No	Yes	No	Yes	Yes
Ball screw Rack-and-pinion drive	2	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

If the measurement results exceed threshold values, the corresponding characteristic values are marked with a warning or service icon.

Elements in the "Measurement Results" tab

The "Measurement results" tab contains a table with the measurement results in relation to the selected characteristic values, as well as icons.

The table has the following columns:

- Date
- Time
- Equability (N)
- Stiffness (N/µm)
- Backlash (µm)
- Friction dry (N)
- Friction viscous (Ns/m)
- Quadrant error (µm)
- Friction distribution spindle nut (%)
- Friction distribution guidance (%)
- Frequency response (Hz)
- Status
- Signature

The following symbols are available:

Symbol	Function
ℹ	Displays the signature values.
👁	Graphically displays the signature values.
🗑	Deletes the measurement result.
✏	Opens dialog box "Define measurement as reference measurement".
⚠	Displays the alarm that the threshold values for the corresponding characteristic value have been exceeded.
🚫	Displays that the service organization must be contacted. Threshold values for this characteristic were exceeded.

Storage of the measurement results

The last 100 measurement results are stored in the database of Analyze MyMachine/Condition. If an additional measurement is performed, the oldest measurement result is automatically deleted.

Reference measurements are excluded from automatic deletion. However, if you define 100 measurement results as the reference, it is not possible to receive an additional measurement result. In such a case, delete some measurement results manually or remove the reference. **For more information** on reference measurements, see Chapter: Defining a measurement as a reference (Page 36)

Procedure

1. On the "Configure and Analyze Measurements" page, click on the required measurement. The "Configure Measurement" page is then opened.

2. Open the "Measurement Results" tab.
The measurement results for the selected machine are displayed in a table.
The measurement results for linear axes are always displayed metrically, even if the selected machine is operating with measurements in inches.
The actual measurement can be found at the start of the list or in the second row when a reference measurement is defined.

Note

If a new measurement result is generated while tab "Measurement Results" is open, then this result is only displayed after manually updating the web page (F5).

3.5.2 Graphically displaying measurement results

The following measurement results are also graphically displayed:

- Equability

- Stiffness

- Backlash

- Friction dry

- Signature

- Frequency response

Graphical display for "Signature"

1. On the "Configure Measurement" page, open the "Measurement Results" tab.
   The results are displayed as a table.

2. Click on the "Eye" icon for the desired measurement result.
   The measurement result is displayed as a diagram.

Graphical display of other characteristics

1. On the "Configure Measurement" page, open the "Measurement Results" tab.
   The results are displayed as a table. Results, that can be graphically displayed, are underlined.

2. Click on the appropriate measurement result.
   The measurement result is displayed as a curve.

Measurement series at the SINUMERIK control system

4

4.1 Open Analyze MyMachine /Condition on the SINUMERIK controller

Procedure

1. Press the "AMMC" softkey on the SINUMERIK control.

2. Depending on your particular access level, the "Traffic light view" window opens:
   - OEMCommissioningEngineer for measurements/measurement groups with "Released" status: Access level 0, 1 or 2
   - Machine operator for measurements/measurement groups with "Referenced" status: Access level 3

   More information about the access levels is provided in Chapter: Managing users and rights (Page 18).

4.2 Performing the measurement

Requirement

- The measurement has been created.
  Further information on this topic is provided at: Creating a new measurement (Page 26).

- The measurement has been made available to the SINUMERIK control.
  Further information on this topic is provided at: Releasing the measurement program (Page 35).

- If you have access level 3, 4, 5, 6 or 7: Ensure that the measurement has "Referenced" status.

Procedure

1. Open the Program Manager and switch to the "AMM/C" network drive.
2. Open directory "analyzemymachinecondition", and select the required measurement program.
3. Press the "Execute" softkey.
4. Ensure that the <FEED START> button is activated.

5. Set the override to 100 %.

   During the prolog and the lubrication process, the value can be changed if necessary. The override must be set to 100% no later than 3 s after the lubrication process. The override must remain at 100 % for the remaining measurement period.

6. Make sure that the axes can traverse the full distance.
7. Press the <CYCLE START> softkey on the SINUMERIK control.

   The measurement is started.

Cancel a measuring job

To cancel a measurement, press the <NC Reset> key on the SINUMERIK control.

The execution of the NC program is canceled.

Note

Press the <NC Stop> key or change the override <> 100 %

The measurement is not canceled; this leads to an invalid measurement result.

The "Status" and "Notes" measurement result columns indicate whether the results are valid or invalid. If an error message has been issued, the cause is displayed here.

Restarting the measurement series after canceling

1. Ensure that the override is set to 100 %.

2. Open the Program Manager and switch to the "AMM/C" network drive.

3. Open directory "analyzemymachinecondition", and select the "AMMC_TRIGGER_RESET" program.

4. Press the "Execute" softkey.

5. Press the <CYCLE START> softkey on the SINUMERIK control.

6. Restart the measurement.

4.3 View measurement results

Requirement

A measurement has been executed.

Procedure

Depending on the default thresholds set, you see the following colors displayed.

Color	Note
Green	Production with the machine can be continued without any further measures. The last measurement results lie within the specified tolerance.
Yellow	Contact the maintenance department. The last measurement results lie moderately outside specified tolerance. However, production with the machine can be continued.
Red	Immediately stop production with the machine and contact the maintenance department. The last measurements lie critically outside the tolerance limit.
Red	Contact the maintenance department. The last measurement was incorrect. However, production with the machine can be continued.

Examples

- The measurement was unsuccessful

- The measurement was successful

- The measurement indicates red and green results

MindSphere application

5

5.1 Opening Analyze MyMachine /Condition

You can open the MindSphere application Analyze MyMachine /Condition in the following ways:

- Sign in to MindSphere and start the application
- Directly enter the URL of the application into the Internet browser

Requirement

- SINUMERIK Edge has been configured.
  Further information on the configuration is provided in:
  "Analyze MyMachine /Condition" Installation Manual.

Signing in via MindSphere

1. Open the web site: https://<tenant-name>.eu1.mindsphere.io

2. The "Sign In" window opens.

   – Enter your email address and your password.

   – Click the "Sign In" button.

   – It is possible that additional entries are required if you use Multi Factor Authentication for your tenant.

3. Click on the "Analyze MyMachine /Condition" application.

4. The home page opens.
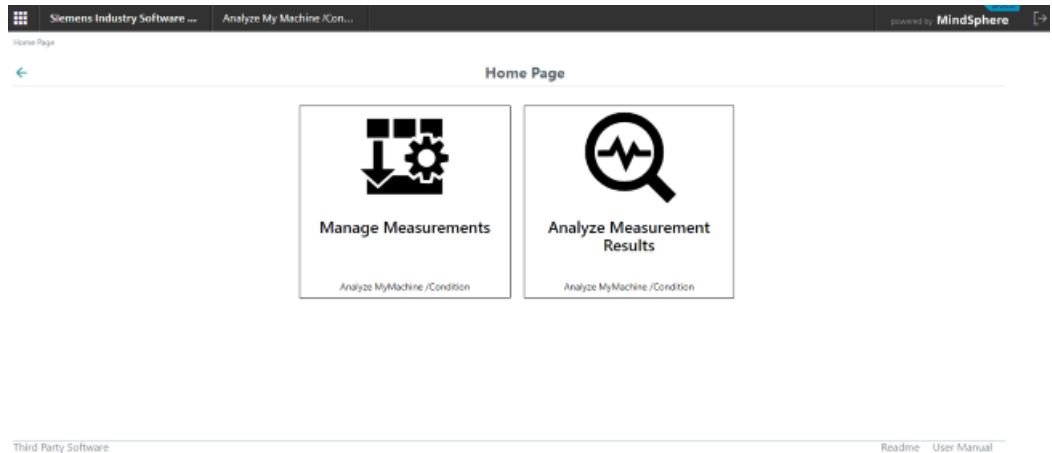
The following functions are available:

– Managing measurements

– Analyze Measurement Results

Sign in via URL

1. Enter the following address in the browser:
   `https://<iot-tenant>-ammcondition-<iot-tenant>.eu1.mindsphere.io`
   The Sign In window opens.

2. Enter the user name and the password.

3. Click the "Sign In" button.
   The home page of the MindSphere application "Analyze MyMachine /Condition" opens.

Sign out

1. Open the home page of Analyze MyMachine /Condition.

2. Click on "Sign out".

In the MindSphere application, you only have read access rights to all measurement configurations of the SINUMERIK Edge assets connected with the tenant. All operating elements are deactivated.

Open the SINUMERIK Edge application (Page 21) to change the measurement configuration.

Elements in "Manage Measurement"

Function	Description
←	Navigates back to the previous page.
Asset Name	Input field to filter measurements according to Asset Names
Name	Displays the name of the measurement
Asset Name	Displays the asset name, which designates the Edge Box

Characteristic Value	The following entries are possible:
	• The name of the characteristic value is displayed if just one characteristic value is evaluated:
	  – Equability
	  – Friction
	  – Stiffness
	  – Backlash
	  – Signature
	  – Quadrant error
	  – Frequency response
	• "Several characteristic values" is displayed if several characteristic values are evaluated.
	• "All characteristic values" is displayed if all characteristic values are evaluated.

Channel name: Axis	Display of the channel name and the selected axis
Negative limit value (mm/inch/°)	Displays the starting point of measurement travel
Positive limit value (mm/inch/°)	Displays the end point of measurement travel
Status	Display of the measurement status: • Created The measurement was saved. However, you have still not entered all of the necessary data. • Defined The measurement was saved with all of the necessary data. • Released The measurement has been released. This means that on the SINUMERIK control in the Program Manager it is visible for the "OEMCommissioningEngineer" and "OEMServiceEngineer" roles. The "MachOperator" role can select the measurement and execute a measurement after a measurement in "Referenced" status has become available. • Referenceable You have at least one valid test result that you can use as reference. • Referenced A test result was defined as reference.

Procedure

1. On the home page, click on the "Manage Measurements" button.
   The "Manage Measurements" page opens. You can see the measurements that have been created so far.

2. Click the required measurement for more detailed information.
   The "Configure Measurement" page opens with the "Basic Configuration" tab. The display corresponds to the information in the SINUMERIK Edge application:

   – Configure measurement (Page 28)

   – Creating secure positions (Page 31)

   – Displaying the measurement results as table (Page 43)

   The Asset Name is also displayed.

5.2 Analyze Measurement Results

5.2.1 Selecting a measurement

Procedure

1. On the home page, click on "Analyze Measurement Results".
   The "Select Measurement" page opens.
   All of the available measurements are listed on the left.

2. Select the required measurement.

3. Click on the arrow pointing right to transfer the measurement to your selection.
   You can select up to 5 measurements.

4. Click on the arrow pointing left to remove a measurement from your selection.

5. Click on "Continue".
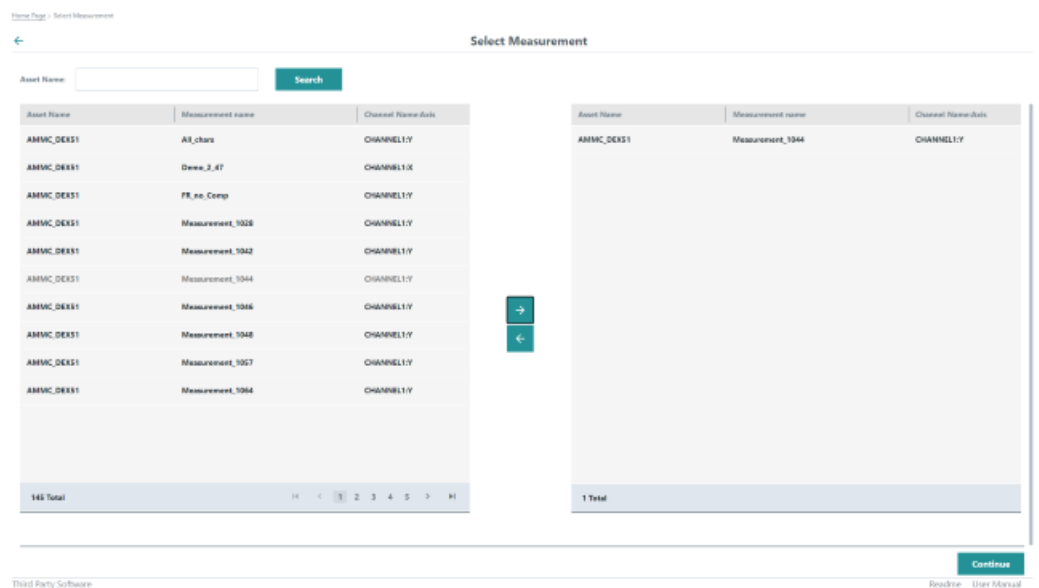
The "Analyze Measurement Results" page opens.

5.2.2 Analyzing measurement results

Procedure

On the "Analyze Measurement Results" page you can see the tree structure of the selected measurements on the left.

1. Activate the checkbox of the required parameter.
Each parameter is displayed in its own separate diagram.

2. Activate the checkbox under the diagram to display the threshold values.

Note

Displaying threshold values

Threshold values can only be displayed if the measurement has "Referenced" status. Otherwise, the checkbox will not be displayed.

Alarm, fault and system messages

<div style="text-align: right; font-size: 3em;">6</div>

6.1 Warning information

Warning notices for the machine operator

The following warning notices are displayed on the SINUMERIK controller.

NOTICE
No measuring program available on the SINUMERIK controller.
No measurement series has been configured.
Contact Maintenance.

NOTICE
No measurement results available.
The configuration of the measurements is incomplete.
Contact Maintenance.

NOTICE
No referenced measurement result available.
The configuration of the measurements is incomplete.
Contact Maintenance.

Warning notices for Maintenance

NOTICE
No measuring program available on the SINUMERIK controller.
No measurement series has been configured.
Release a measurement series for the SINUMERIK controller.

NOTICE
No measurement results available.
The configuration of the measurements is incomplete.
Perform a measurement on the SINUMERIK controller.

NOTICE
No referenced measurement result available.
The configuration of the measurements is incomplete.
Define a measurement result as a reference

Appendix

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A

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A.1 List of abbreviations

Admin	Administrator (user role)
AMM /C	Analyze MyMachine /Condition
AST	Auto Servo Tuning: Automatic servo tuning
CNC	Computerized Numerical Control:
COM	Communication
DIR	Directory:
FAQ	Frequently Asked Questions
h	Hour
HTTP	Hypertext Transfer Protocol
HTTPS	HyperText Transfer Protocol Secure,
IB	Commissioning engineer (user role)
ID	Identification number
IE	Internet Explorer
IFC	Interface Client
IoT	Internet of Things
IPC	Industrial PC
MB	Megabyte
MFA	Multi Factor Authentication
MLFB	Machine-Readable Product Code
MMM	Manage MyMachines
MMM /R	Manage MyMachines /Remote
MO	Machine operator
MSTT	Machine control panel
NC	Numerical Control: Numerical control
NCU	Numerical Control Unit: NC hardware unit
OEM	Original Equipment Manufacturer
OP	Operation Panel: Operating equipment
PC	Personal Computer
PCU	PC Unit: Computer unit
PLC	Programmable Logic Control: Programmable Logic Controller
SE	Service engineer
SI	SINUMERIK Integrate
SK	Softkey
SW	Software
TPM	Trusted Plattform Module: Chips for safety functions
URL	Uniform Resource Locator, einheitlicher Ressourcenzeiger

UTC	Universal Time Coordinated, coordinated global time
VNC	Virtual Network Computing

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