EN

A member of the DVS Technology Group

Operating Manual

HRI® / HRIexpert® and HRI®analyze+

Issue date: April 2025

PRÄWEMA
Antriebstechnik GmbH
A member of the DVS Technology Group.

Hessenring 4
37269 Eschwege

Phone: +49 (0) 5651 / 8008-0
Telefax: +49 (0) 5651 / 12546
E-mail: vertrieb@praewema.de
Web: www.praewema.de

Foreword

These operating instructions refer to the HRI software program (Hybrid Reactive Index – Process Diagnostics) installed in the machine. The manual contains information about the menu windows dialogs, commands and buttons of the software program, and describes typical sequences and operator actions.

For information going beyond the contents of this manual, please contact the manufacturer or customer services.

When using the HRI software, not only these operating instructions but also the operating instructions of the machines involved must be followed without fail!

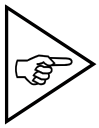
We have taken the greatest possible care in compiling the information contained in this documentation. Nonetheless, we may not exclude non-conformances, and reserve the right to make any technical change to the product without prior notice.

We do not assume any legal responsibility or liability for any damage or loss which may be caused thereby. Necessary changes will be incorporated in the following issue.

PRÄWEMA Antriebstechnik GmbH
Hessenring 4
37269 Eschwege, Germany
Phone: +49 (0) 5651 / 8008-0
Telefax: +49 (0) 5651 / 12546
Email: vertrieb@praewema.de
Internet: www.praewema.de

Table of Contents

Table of Illustrations



NOTE!
The illustrations used need not to be in exact accordance with delivered machine.

List of Tables

1 General Notes

1.1 Representation in the document

HRI® and **HRIexpert®** are registered trademarks. The registered trademark symbol is used in trademark law to identify registered trademarks. The registered trademark symbol ® is shown as a superscript R in a circle.

In the following text, for short only **HRI** is written.

The HRI software is designed for the PRÄWEMA **SynchroFine®** external honing machines and the PRÄWEMA **SynchroForm®** hob cutting and interior honing machines. In the following text, for simplicity only the short forms **SynchroFine** and **SynchroForm are** written.

1.2 Explanation of symbols used

In these operating instructions, concrete safety instructions are given to inform about the unavoidable residual risks when using the HRI software. These residual risks pose a danger to:

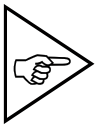
- People
- Product and machine
- Environment

Please heed these safety instructions at all times and the measures specified to avoid the dangers.

WARNING!
… indicates a possibly dangerous situation which **can lead to fatal or severe injuries** if not avoided.

CAUTION!
… indicates a possibly dangerous situation which **can result in minor or slight injuries** if it is not avoided.

NOTICE!
… indicates a possible hazardous situation that **can lead to damage of property** if it is not avoided.



NOTE!
… highlights useful tips and recommendations as well as information for efficient and fault-free operation.

INSTRUCTION
Handling instruction for executing a program step or making a program input.

SynchroFine
All data for SynchroFine are on a BLUE background and marked by a honing tool pictogram.

SynchroForm
All data for SynchroForm are on a RED background and marked by a milling tool pictogram.

1.3 List of abbreviations

Abbreviation	Meaning
BIN	Binary file
CNC	Computerized Numerical Control
CPU	Central Processor Unit
CSV	File format (Comma-Separated Values)
DDG	Diamond Dressing Gear (gearing dresser)
DDR	Diamond Dressing Ring (head dresser)
DMC	Data Matrix Code
ForceAvg	Average drive utilization in %
FFT	Frequency analysis
HMI	Human Machine Interface
HRI	Hybrid Reactive Index
HRIAvg	Average HRI value
HRILog	Logging file type, an HRILog file is generated daily.
HRIDebugLog	Logging file type, a file is generated for each workpiece.
HRIFFTLog	Logging file type with the recorded frequency ranges of the vibration sensors
HRIShockLog	Logging file type with the time signal of the vibration sensors
HRISurface	Integral of the HRI curve
IP	Internet protocol
IFM	Sensor-manufacturer
IEPE	Integrated Electronics Piezo Electric. Industry standard for piezoelectric sensors
LRQ	File for generating a license (License Request File)
MAC address	Media Access Control - Address
MAX	Maximal
MB	Megabyte
MIN	Minimal
mg	Milli G (thousandth of the acceleration due to gravity) g = 9.81 m/s^2
ms	Millisecond
MTX	MTX from Bosch Rexroth is a high-performance CNC system for controlling machine tools
MQTT	Message Queuing Telemetry Transport - open message protocol
NC	Numerical Control
NOK	NOK part (not in order)
OPC	Open Plattform Communications

OPCUA	OPC Unified Architecture
OCTAVIS	IFM Software
URL	Uniform Resource Locator
VSD	Vario Speed Dresser (Gearing dresser)
XML	File format (Extensible Markup Language)

Tab. 1 List of abbreviations

1.4 Glossary

Term	Meaning
Spark out	Dwell time at end axis distance without additional feed with oscillation.
Bandwidth	Characteristic value in the signal processing that specifies the width in the intervals in a frequency spectrum
Data-Matrix-Code	2-D codes for marking the workpieces, each workpiece is given an individual code
Feed Limiter	Active method for reducing the machining feed during the process
Frequency analysis	Targeted monitoring of specific orders to prevent quality failures in the workpieces
Limit curves	Limit curves can be shown graphically in the spectrum as colored lines.
Honing	Honing is a fine machining or hard fine machining process, and in the production is the last manufacturing a workpiece, gear wheel or similar.
Order analysis	In the order analysis, the noises or vibrations of rotating machines or vibrating components. The analysis is based on vibration and speed measurements, that require at least an acceleration sensor in order to evaluate the vibration of the test object. Additionally, the determined or estimated speed is required. In contrast to the frequency analysis the energy content of the noises or vibrations are not applied against the frequency, but against die order. In this connection, the order refers to the harmonic components of vibration signals.
Orders	Each order corresponds to a multiple of the basic speed of the rotor. This means that the first order corresponds to the speed of the rotor itself, the second order to the double speed, and so on. Each order stands for a harmonic component in the vibration signal.
Port	A port in a network is a software-defined number, this assigned to a network protocol, and communication for a specific service receives or transmits.
Nick	A nick is a fault measured with a hobbing test (chip or burr) on the tooth flank.
Offset	An offset (relative position) is a number, that is subtracted from all coordinates, so that only positive values remain.
1-Wire Bus	1-Wire is a digital, serial bus that only needs a data line and a ground line. Is used to record the spindle bearing temperature.
Temperature (HRI)	The temperature proportion of HRI is recorded in degrees Celsius. The temperature sensors of the spindle motors are used.
Current / Force (HRI)	The currents / forces is the percentage utilization of the individual motor and refers to the nominal current. Specification in percent.
Oscillations / vibrations (HRI)	The vibrations are recorded by sensors. The unit of vibrations is mg (thousandth of the acceleration due to gravity).

Gear Cutting / Power Skiving	Skiving is a soft machining process for manufacturing gearings.
Spectrum	The spectrum of a signal is composed of various frequencies.
Type	HRI variable for monitoring
Reaction	Fault response of the machine that is triggered when the value is exceeded
Status Value	Input status text number for display in the HMI.

Tab. 2 Glossary

1.5 Copyright

The copyright in this operating instructions remains with **PRÄWEMA Antriebstechnik GmbH**.

This operating instructions and all associated technical documents contain regulations and drawings of a technical nature. They must not be, in whole or in part, duplicated, distributed or used for purposes of competition or disclosed to third parties.

1.6 Training

As only thoroughly trained persons can operate a machine economically, as well as the training by PRÄWEMA Antriebstechnik GmbH Service Technicians on site, we also recommend specific training for HRI by PRÄWEMA Antriebstechnik GmbH in Eschwege. This manual serves as a complement to this training.

More detailed information about the training program is available from the sales representatives of PRÄWEMA Antriebstechnik GmbH.

1.7 Service

Address:	**PRÄWEMA Antriebstechnik GmbH**
	Hessenring 4
	37269 Eschwege, Germany
Sales and customer service	
Phone:	+49 (0) 5651 / 8008-0
Telefax:	+49 (0) 5651 / 12546
Sales e-mail address:	vertrieb@praewema.de
Customer Services e-mail address:	service@praewema.de
E-mail HRI Customer Services:	hrisupport@praewema.de
Internet:	www.praewema.com
	https://www.dvs-technology.com/praewema-antriebstechnik

2 Process Monitoring HRI

2.1 Functional description

Before using the operating instructions read them carefully from beginning to end to become familiar with the possible functions step-by-step.

The operating instructions are intended for qualified personnel and assumes corresponding specialist knowledge. Basic knowledge of the operation of software is assumed.

These operating instructions cover information about HRI monitoring which should enable the user to use the software consistently for its intended purpose and without operating errors.

The HRI software may only be operated by the Technical Customer Service of PRÄWEMA and authorized, trained and certified personal (for example machine setters)!

The document presents all the functions present in the system. Depending on the workplace and users rights the scope of available functions can vary.

The HRI software is pre-installed on all PRÄWEMA machines

2.2 What is HRI?

HRI means - **H**ybrid **R**eactive **I**ndex.

HRI reflects the process in a dimensionless value as a scalar variable.

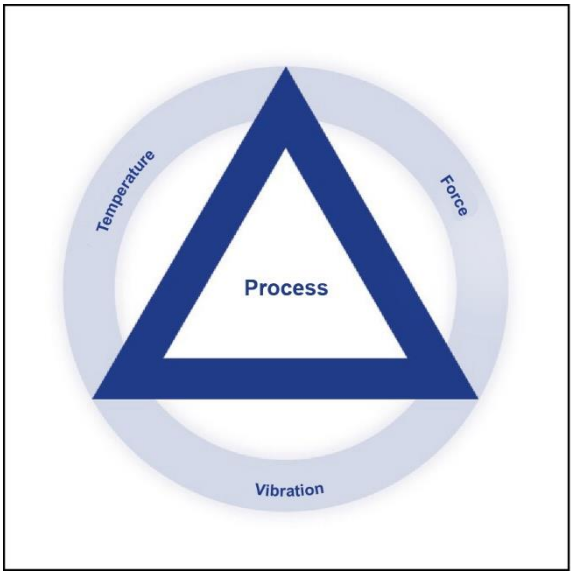


Fig. 1 HRI process parameters

HRI is an index which is created by the combination of three process parameters: temperature, force and vibration (oscillation), with the aid of a formula:

$$\mathbf{HRI = temperature_{HRI} + force_{HRI} + vibrations_{HRI}}$$

This index allows a unit-free representation of the process.

The HRI value reflects a characterization of the process.

The HRI software is a browser-based web application, which communicates via an interface. The application can be installed on all operating systems, e.g. on a Windows PC of the machine or on a separate Linux PC.

2.2.1 Added value with HRI

The HRI process monitoring system offers comprehensive control of every step of the machining process of a workpiece in the machine.

Separate limiting values can be defined for each process step, each axis and each sensor.

By implementing the extended status, limiting value breaches and fault responses are displayed in plain text on the HMI display.

Feed control allows precise process control.

There is also the option of recording component markings, e.g. by means of a data matrix code to ensure efficient tracking.

2.2.2 Goals of HRI

The goal of implementing HRI is to use only high-quality components (no raw or bad parts) in the assembly in order to ensure a trouble-free production process.

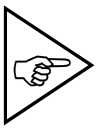
The HRI application also covers the early detection of tool breakages and the continuous monitoring of the process and input quality.

The implementation of preventive maintenance ensures that potential problems are dealt with proactively, and rectified.

2.2.3 HRI and HRIexpert

Functions	HRI	HRIexpert
Feed limitation by means of currents and vibrations	✓	✓
The measurement of the vibrations, currents / forces and the spindle temperature as a time signal	✓	✓
Individual limiting values for each sensor / each axis	✓	✓
Individual fault reaction for each sensor / each axis	✓	✓
Logging files with the minimum, average and maximum values for all sensor / axes	✓	✓
Feed limitation by orders	x	✓
Display of the orders on the machine and individual limiting values for the orders	x	✓
FFT and Shock Logging files for all sensors	x	✓

Tab. 3 Differences between HRI and HRIexpert



NOTE!
The installed and licensed software component is displayed in the *License management* menu. See section 3.6.6, item 6.

2.3 Range of applications of the HRI software

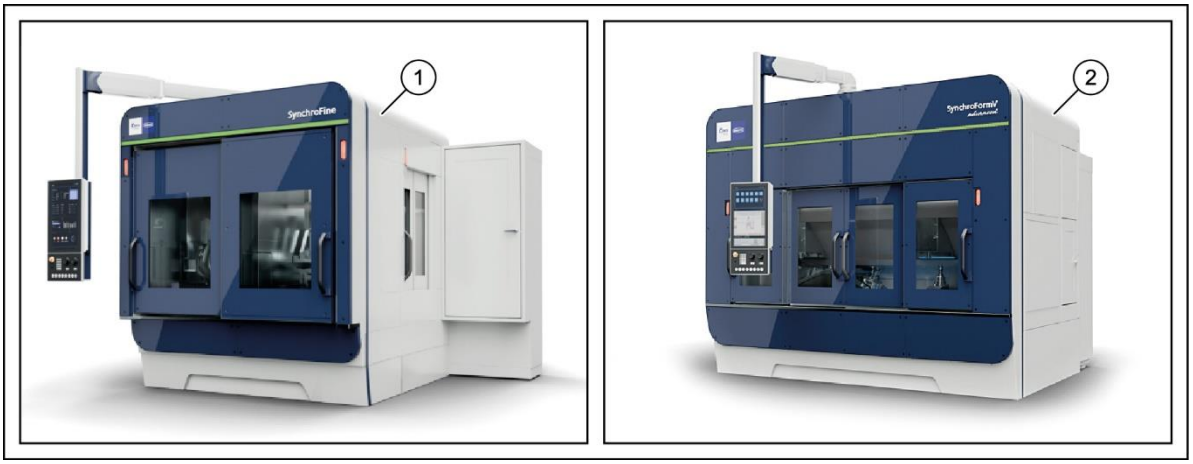


Fig. 2 Range of applications of the HRI software

1 External honing machine SynchroFine

2 Interior honing / skiving machine SynchroForm

The HRI software is pre-installed on all **SynchroFine** and **SynchroForm** machines from **PRÄWEMA** before delivery.

Fig. 3 HRI software components

In order to activate the HRI software, a license must be purchased. Depending on the license, you may be able to use the **HRI** component **HRIexpert** on the machine.

The **HRIexpert** component expands the range of **HRI** functions to include the frequency analysis (FFT) high-frequency data.

The **HRIanalyze+** component was developed to analyze the recorded HRI data. The program detects independently whether they are Log-, DebugLog-, FFTLog- or ShockLog files. For better readability and evaluation of the data, we also recommend that the component is installed on an external PC or laptop.

2.4 Parameter for calculating the HRI value

2.4.1 Temperature parameter

Changes to the temperatures of the tool and workpiece spindles have a negative effect on the quality of the workpieces.

The higher temperatures change the length and height of the spindle.

The temperature sensors are installed in the motors, and the individual values are set by the BOSCH Rexroth controller or the Siemens controller as available parameters.

The temperature can be individually monitored. If the set value is exceeded, a corresponding fault reply (response) is triggered. See chapter 3.2.1.2

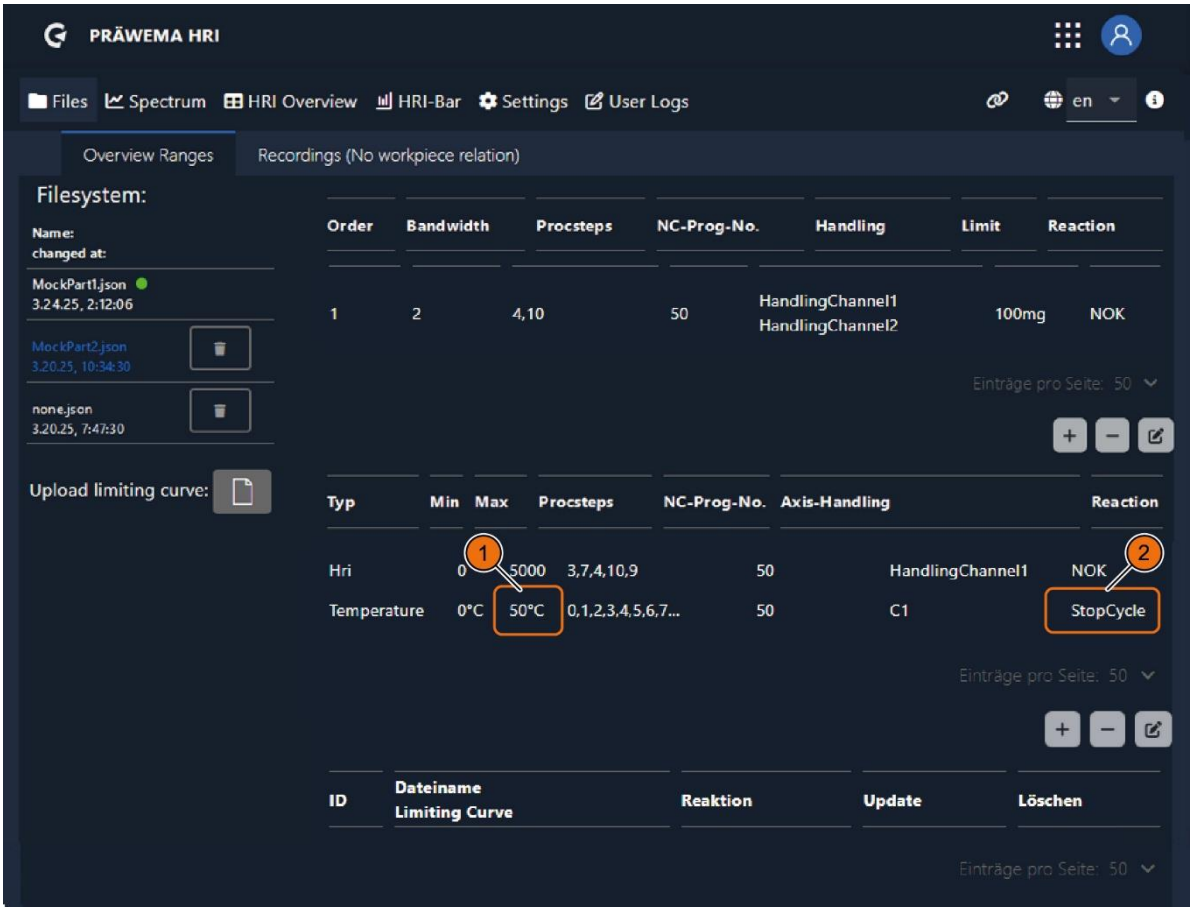


Fig. 4 Example of vibration parameters

1 Max. limiting value 2 Reaction

In the example, the machine with "StopCycle" is stopped if the limiting value of 50 °C is exceeded.

2.4.2 Parameter current / force

The current values of the axes involved in the process are recorded. These correspond to the process forces.

The current values are made available by the controller as parameters. The values are percentages of the **rated current**.

As well as recording the individual forces, the HRI also offers the opportunity of monitoring the average value of these forces. This average value is calculated at the end of the machining process, and enables the monitoring of a minimum and maximum range.

This monitoring is crucial in detecting deviations in the force behavior during the process, and for being able to respond at an early stage when required.

NOTICE!
At the beginning of the machining process, there must not be any direct contact between workpiece and tool. In this phase, an HRI monitoring on an absolute minimum value would not be appropriate, because this does not deliver useful information.
The absolute minimum value to start, is not different to the value that would occur after a tool breakage.

- Therefore activate the HRI monitoring for an average value.

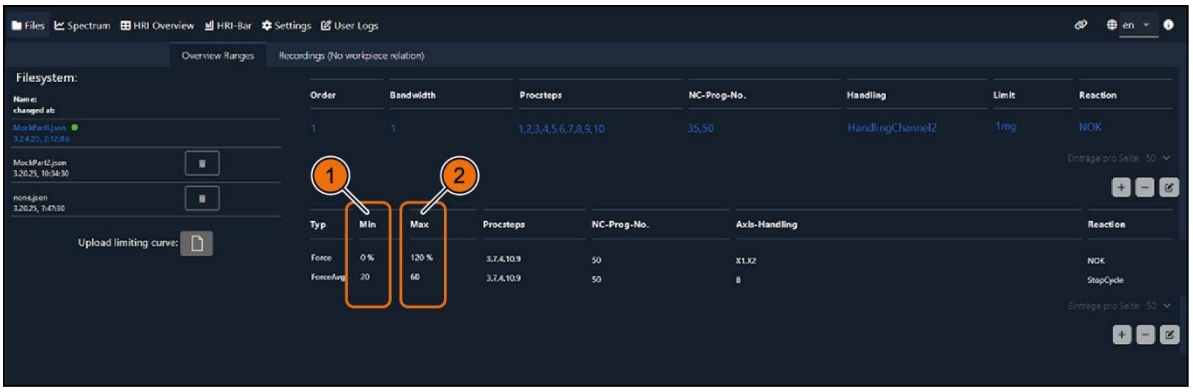


Fig. 5 Example current parameter

1 MIN limiting value 2 MAX limiting value

NOTE!
Depending on controller type and machine equipment, various overloadings of the individual axes can occur. See additional information in the attachment of the desired machine type

2.4.2.1 Parameter force - SynchroFine

The motors may be briefly overloaded, for example during the acceleration process. On Bosch Rexroth controllers, measured values of over 100% can occur.

The workpiece spindles can be overloaded by up to 350% and the linear axes up to 450%.

On SynchroFine machines with activated dollies, an offset of 30% is subtracted on the Z-axis. This adaptation takes into account the fact that the dolly and Z-axis work against each other. The utilization of the Z-axis with activated dolly on average some 30% higher in comparison to machines without an active dolly.

In the *Settings* menu, an offset can be adjusted. These are stored in the HRI data.

With no offset, the Z-axis is too heavily weighted in the calculation of the HRI index, changes in the other axes are not detected.

When calculating the current of the Z-axis, results less than zero are not accepted and written as zero.

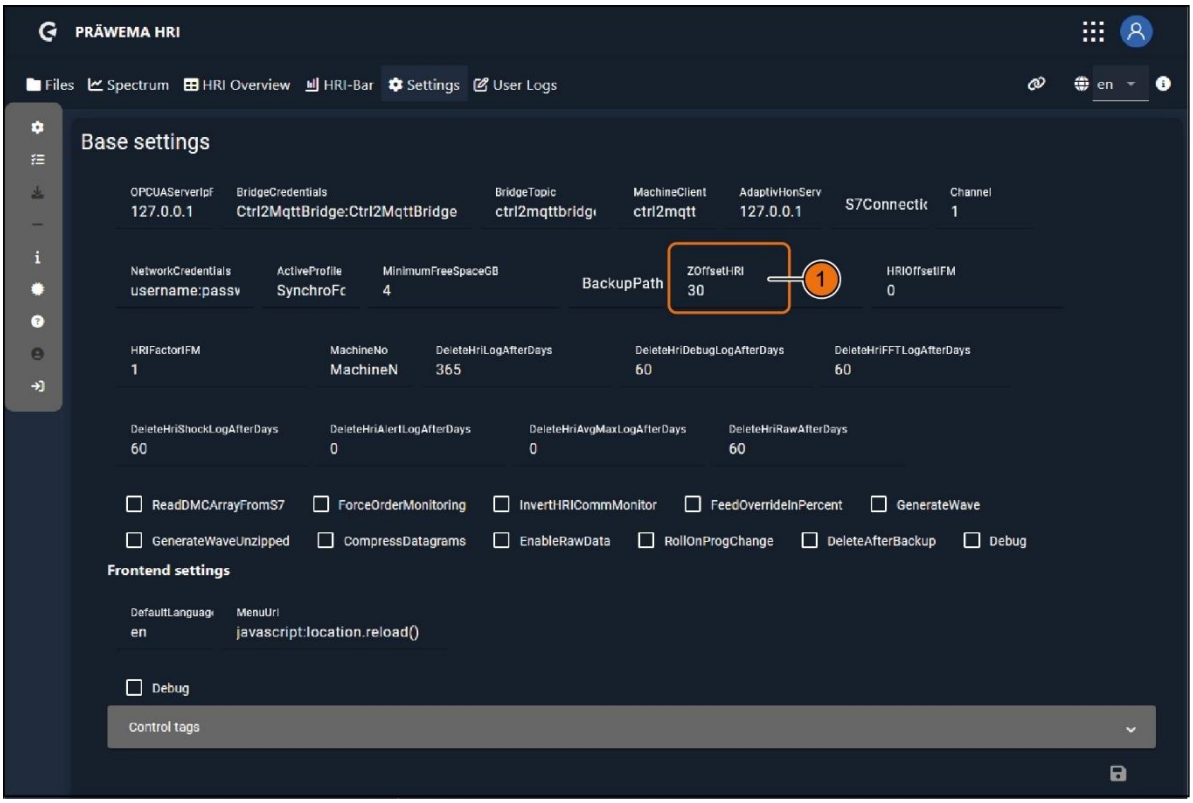


Fig. 6 Basic settings menu - example of setting of the offsets - SynchroFine

1 Input field ZOffsetHRI

Example of normal state for a SynchroFine machine:

F_{HRI} = 1,269.07

Example of shaft machining with a SynchroFine machine without offset:

F_{HRI} = 3,297.07

2.4.2.2 Parameter force - SynchroForm

The motors can be briefly overloaded, particularly during acceleration processes. The Siemens controllers do not record any measured values exceeding 100% of the rated current. No measured values over 100% are communicated to the HRI.

When specifying limiting values, ensure that on machines with a Siemens controller, no values higher than 100% are input. HRI would not trigger a fault response at limits over100% of the rated current.

2.4.3 Vibration parameter

To record the vibrations, various sensors and VSE evaluation units are installed in the PRÄWEMA machines. See chapter 6.5 and 7.5.

Vibration value

The data recorded by the individual vibration sensors are transferred raw data, whereby each sensor outputs its measured value in mg (one thousandth of the acceleration due to gravity).

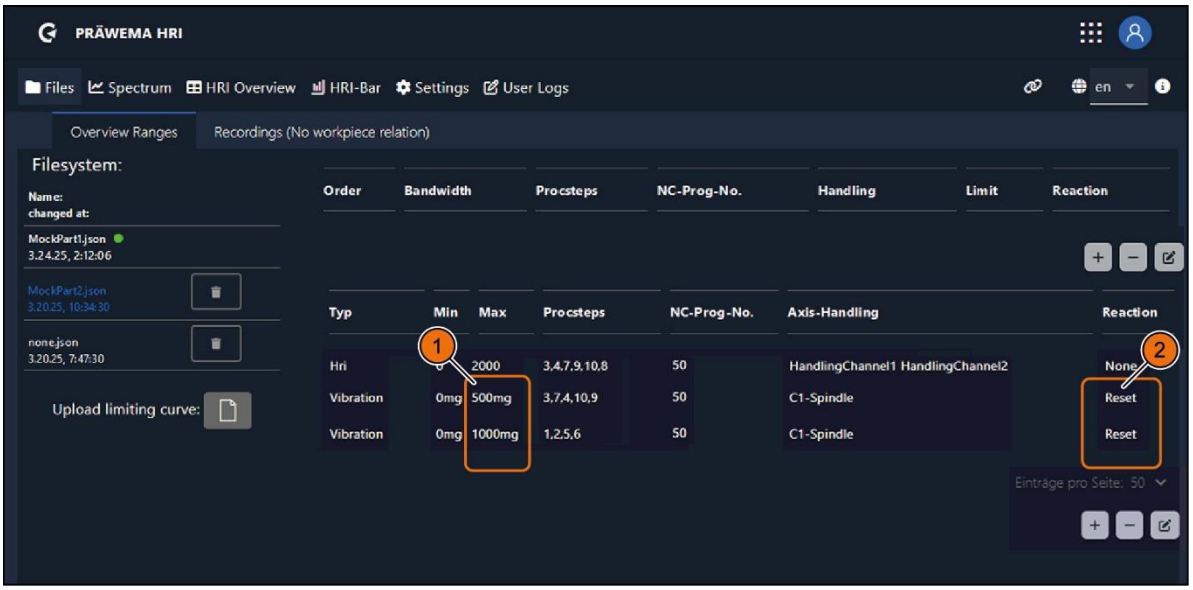


Fig. 7 Example of vibration parameters

1 Max. limiting value 2 Reaction

In the example, the machine is stopped with "reset" if the limiting value is exceeded.

3 Software component HRI®

3.1 The main HRI menu

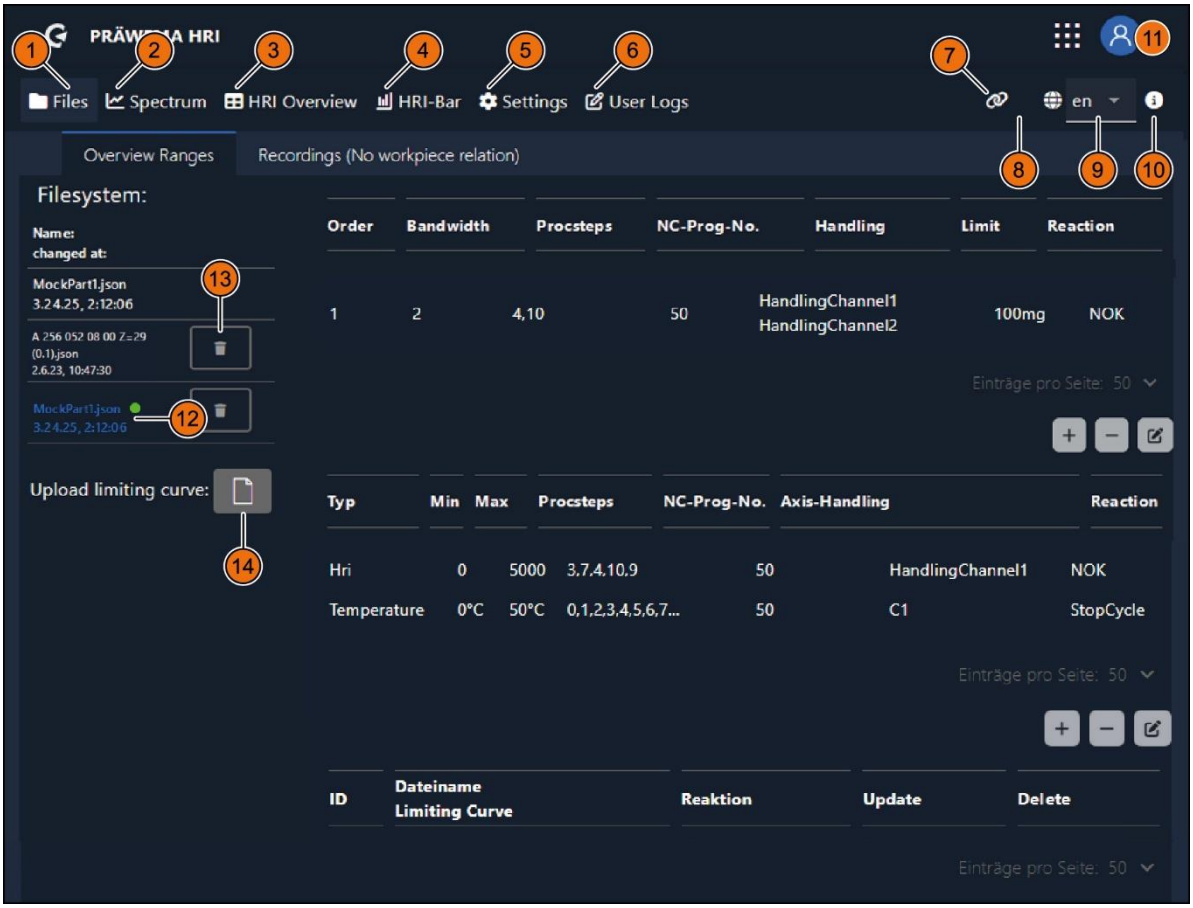
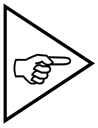


Fig. 8 Main menu HRI - data loaded

Item	Name	Function	Description
1	**Files**	Tabs	To the *file system* menu
2	**Spectrum** (only with HRIex-pert)	Tabs	To the *spectrum* menu Frequency objects as bar charts (See chapter 4.6)
3	**HRI overview**	Tabs	To the menu *HRI bar* HRI diagrams and HRI table
4	**HRI Bar**	Tabs	To the menu *HRI bar* shows the monitored variables (HRI, force, temperature, vibration)
5	**Settings**	Tabs	To the menu *Basic settings* All settings for communication between HRI and controller
6	**Documentation**	Tabs	To the *documentation* menu Creating a logbook
7	**System status**	Button	To *System status* menu window Display of the system status (connection to the backend, controller or sensors) Red = no connection yet, White = connection
8	**Side of the machine**	Selection field	Select left or right side of machine (only with **SynchroForm**)
9	**Language**	Selection field	*Select* language (en, cn, es)
10	**Information**	Button	To *Information* menu window Version display Frontend and Backend.
11	**Login**	Button	To *Login* menu window
12	**gear toothing**	Display field	Currently loaded gearings of the machine
13	**Deletion file**	Button	Delete gearings of the machine
14	**Upload limit curve**	Button	Only possible with the **HRIanalyze+** component See chapter 5.4.4.2

The programs in the *File system* of the machine HMI are loaded in the file system menu. The currently loaded gearing is preselected.



NOTE!
With a rollover over buttons or a symbol, for understanding, the text is displayed in the selected language.

3.1.1 Login menu window

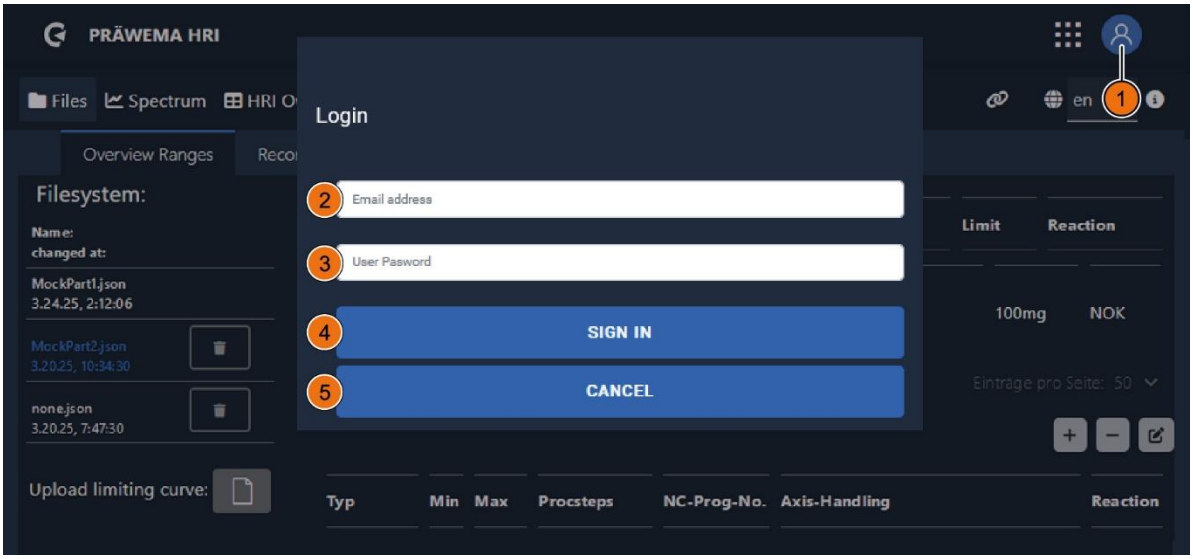


Fig. 9 Login menu window

Item	Name	Function	Description
1	**Login symbol**	Button	To open the login menu window
2	**Username**	Input field	Enter username
3	**Password**	Input field	Enter password
4	**LOGIN**	Button	Login after inputting the data
5	**STOP**	Button	Stop text input

INSTRUCTION
Proceed as follows to login to the HRI system:

1. Select the *Login* (1) button.
2. The *Login* menu window is opened.
3. Enter username (2) and your password (3),
4. Confirm *Login* (4) with button or *Cancel* (5).

3.1.2 Language menu window

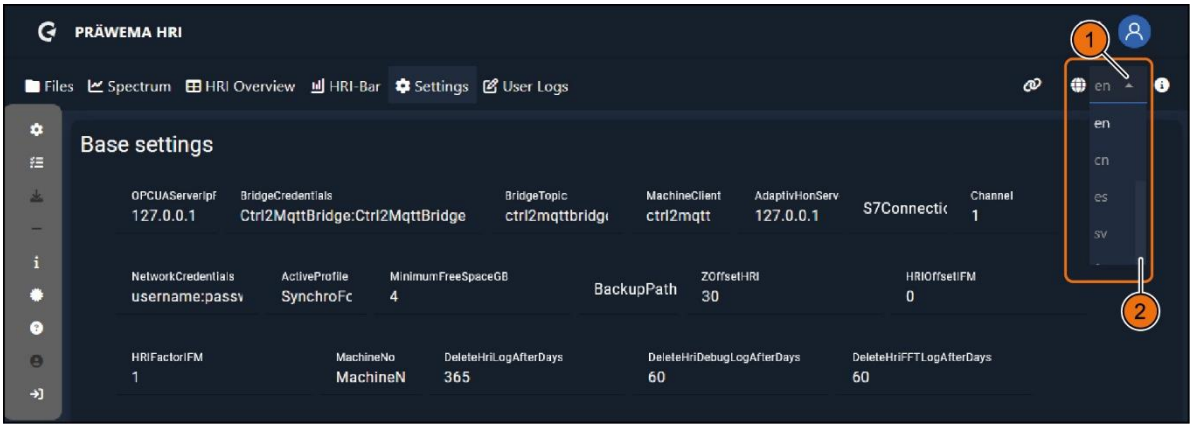


Fig. 10 Language menu window

Item	Name	Function	Description
1	**Language arrow**	Button	Currently selected language
2	**Language selection**	Drop-down menu	Select language

INSTRUCTION
To select a language, select the *Language* (1) button and the drop-down menu (2) opens, scroll down and select the desired language.

3.1.3 Information menu window

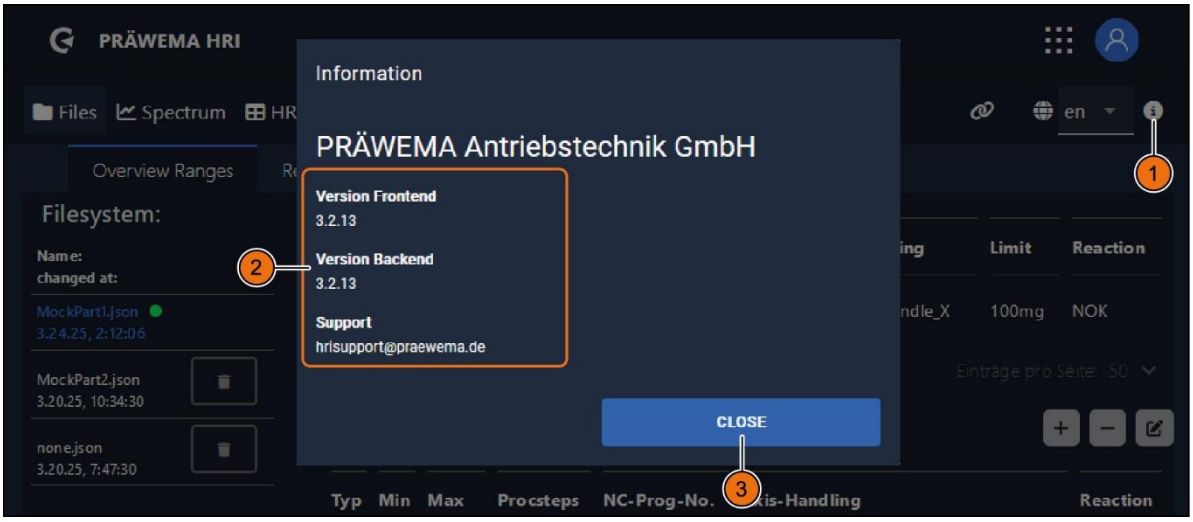


Fig. 11 Information menu window

Item	Name	Function	Description
1	**Symbol information**	Button	Open information menu window
2	**Menu window information**	Display field	Display Frontend, Backend and Support address
3	**CLOSE**	Button	Close information menu window

INSTRUCTION
Select the button (1) to open the *Information* menu window.
Select the CLOSE (3) button to close the *Information* menu window.

In the *Information* menu window, the Backend and Frontend versions and the support address are shown.

3.1.4 System status menu window

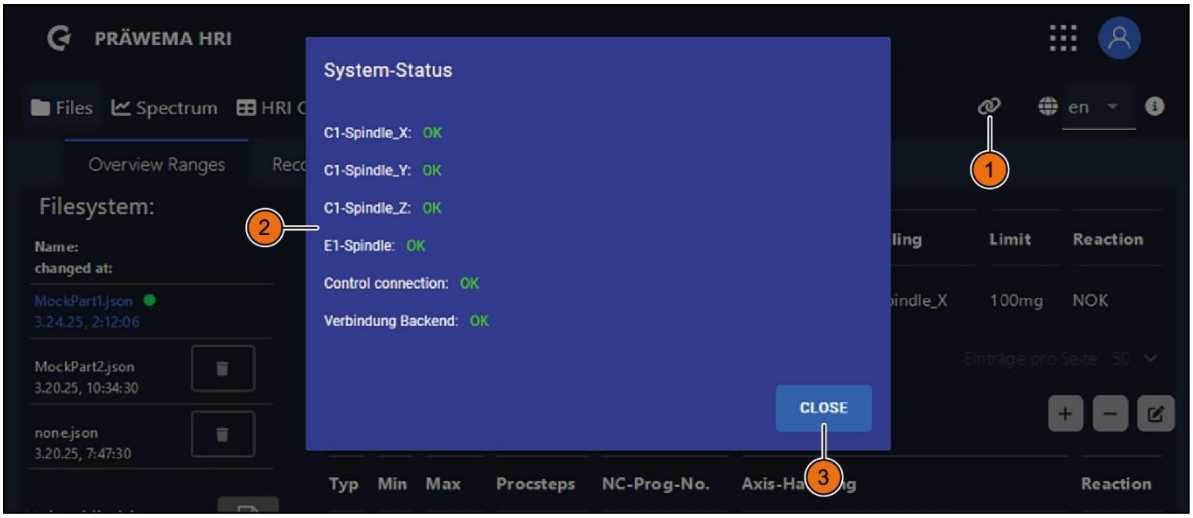


Fig. 12 System status menu window

Item	Name	Function	Description
1	**Symbol system status**	Button	Open system status menu window
2	**Menu window system status**	Display field	Status display of connections
3	**CLOSE**	Button	Close system status menu window

INSTRUCTION
Select the button (1) to open the *System status* menu window.
Select the CLOSE (3) button to close the *System status* menu window.

In the *System status* menu window are displayed the connections to the VSE, controller and Backend.

Display symbol of system status red = No connection yet
Display system status symbol white = HRI server connected

3.2 File system menu, overview of limiting values of diagnostic objects

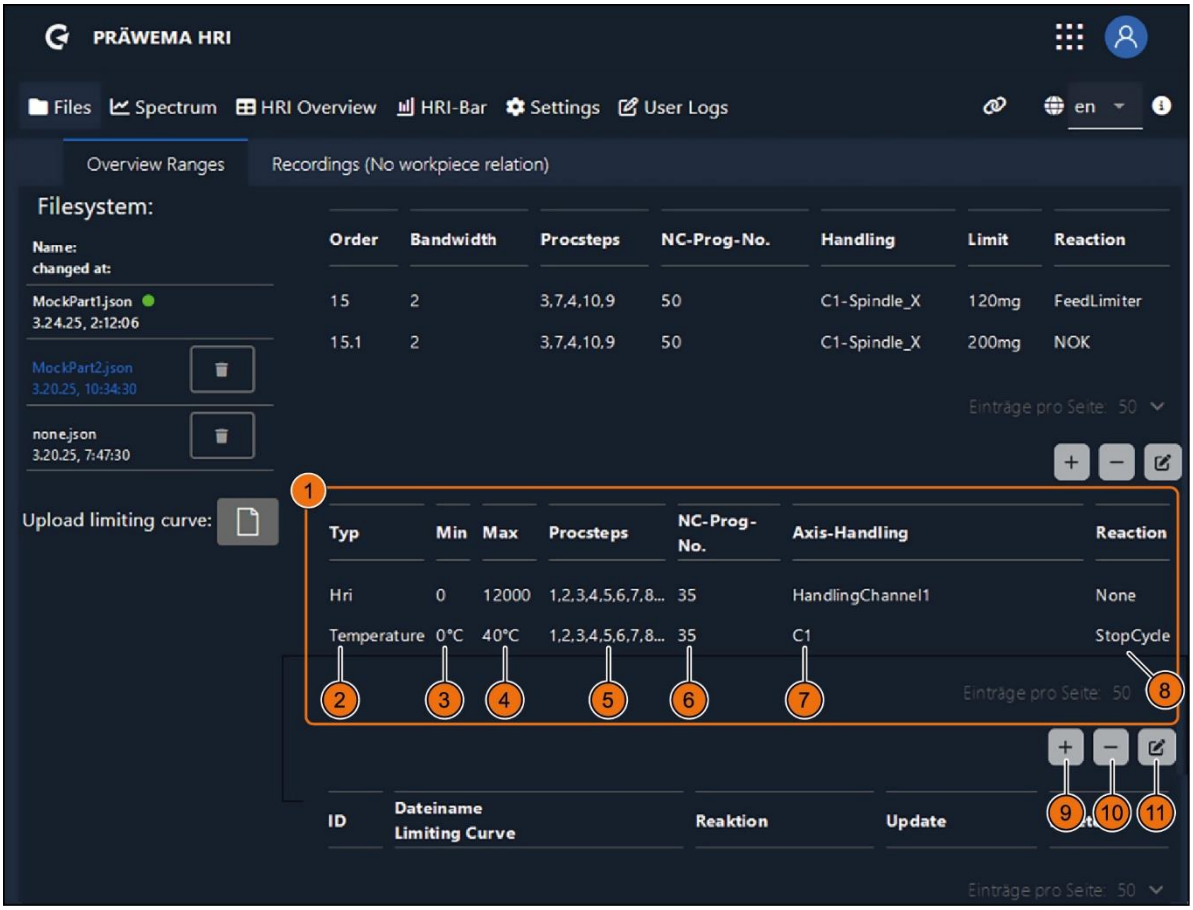


Fig. 13 File system menu - lower area, limiting values of diagnostic object

Item	Name	Function	Description
1	**HRI range**	Display range	All limiting values **diagnostic object**
2	**Type**	Display field	HRI variable for monitoring
3	**Min**	Display field	Limiting value that must be reached in the process step
4	**Max**	Display field	Limiting value that must not be exceeded in the process step
5	**Program steps**	Display field	Program steps of the machining processes that are monitored
6	**NC-program numbers**	Display field	NC subprograms that are monitored
7	**Axis handling**	Display field	The monitored axes and sensors.
8	**Reaction**	Display field	Fault response that is triggered by exceeding or not reaching the value.
9	**+**	Button	Open *New diagnostic object* menu
10	**-**	Button	Delete selected diagnostic object
11	**Edit**	Button	Open existing *Diagnostic object* menu

3.2.1 New diagnostic object menu - input menu for limiting values

An input menu for the *Diagnostic objects* is integrated into the software for easier configuration of the limiting values and to reduce the risk of incorrect inputs.

In this input menu, individual variables can be monitored and fault responses defined.

INSTRUCTION

To open the input menu, press the *Machining* (11) button in the *file system* menu.

To add an additional diagnostic object, select the "+" (9) button.

The *New diagnostic object* input menu is opened.

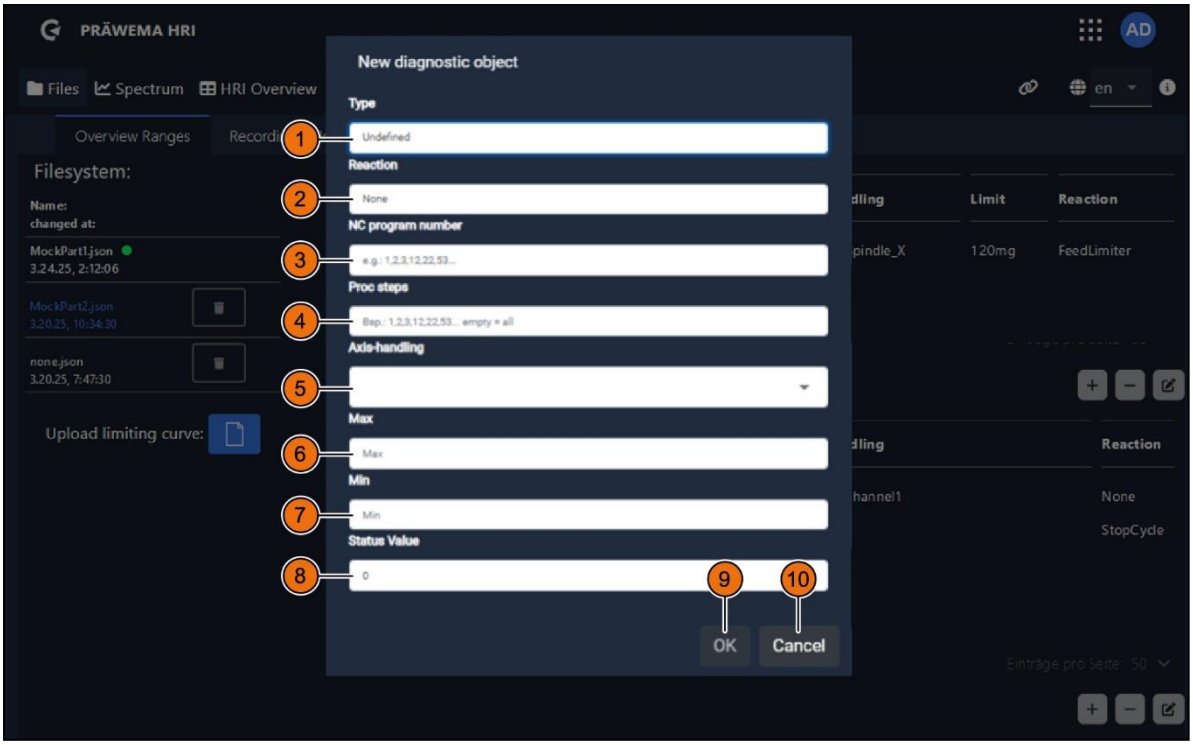


Fig. 14 New diagnostic object - input menu for limiting values

Item	Name	Function	Description
1	**Type**	List selection field	Select HRI variable for monitoring
2	**Reaction**	List selection field	Fault response that is triggered if the value is exceeded.
3	**NC-program numbers**	Input field	Various subprograms, select channel number
4	**Program steps**	Input field	Select program steps of the machining that should be monitored
5	**Axis handling**	Selection field	Select spindle or sensor which should be monitored
6	**Max**	Input field	Enter the limiting value that must not be exceeded in the process step
7	**Min**	Input field	Enter min. limiting value for fault response
8	**Status Value**	Input field	Input status text number for display in the HMI.

9	**OK**	Button	Confirmation of the inputs closure of the input menu
10	**Stop**	Button	Cancel the input and close the input menu

3.2.1.1 Types

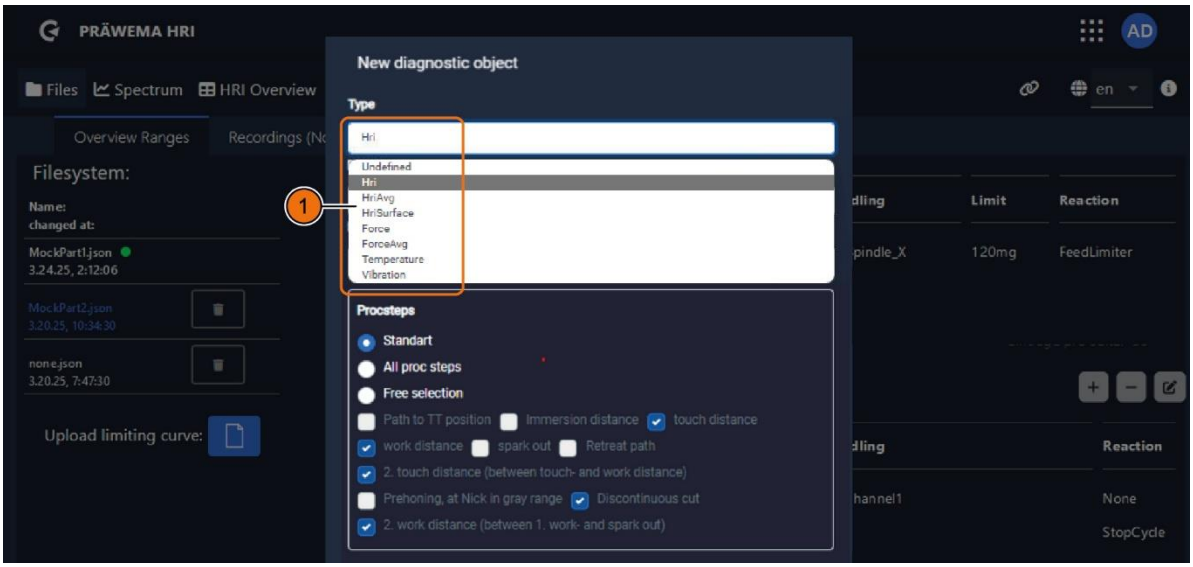


Fig. 15 New diagnostic object menu - selection list of types

Item	Types	Description
	Undefined	No info
1	**HRI**	Calculated HRI value
	HRIAvg	Average of the calculated HRI value
	HRISurface	Integral of the HRI curve
	Force	Force from the various axes
	ForceAvg	Average force from the various axes
	Temperature	Temperatures of the various spindles
	Vibration	Vibrations from the various sensors

The various HRI variables that are monitored are listed in the selection list *Types*.

INSTRUCTION
Click the *Types* selection field and select the HRI variable to be monitored.

3.2.1.2 Reactions

In the selection list, the fault responses are available for selection, which are triggered if certain values are exceeded or not reached.

These fault responses may cover various measures, such as stopping the process, triggering an alarm or displaying a warning message to indicate deviations or problems in the machining process.

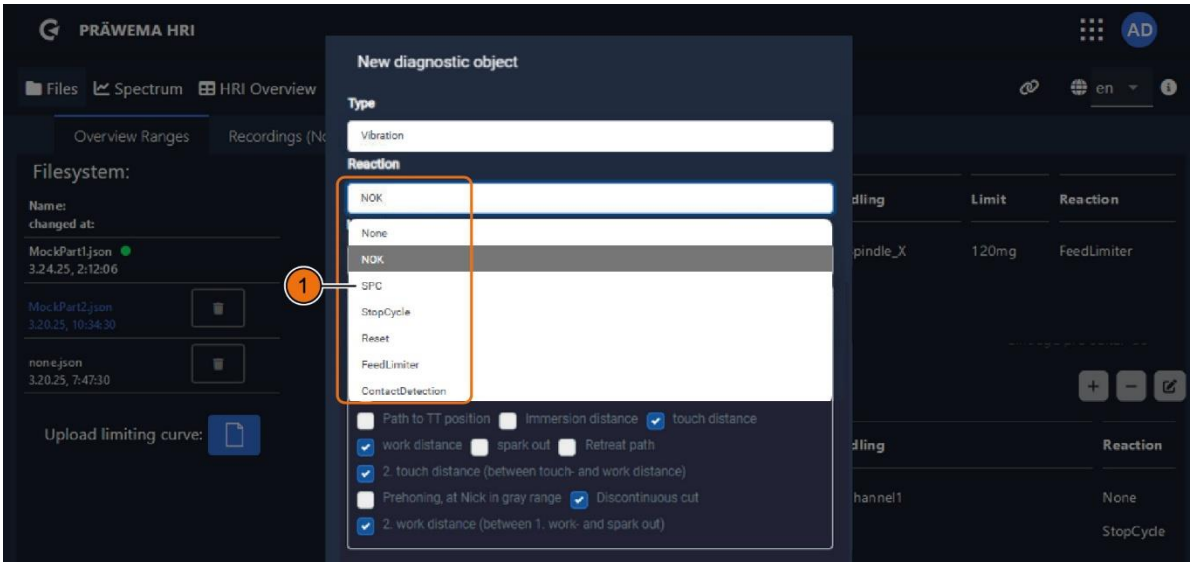


Fig. 16 New diagnostic object menu - selection list of Reactions

Item	Reaction	Description
1	**None**	No machine reaction
	NOK	The part is ejected as an NOK part
	SPC	The part is unloaded as an SPC part
	StopCycle	The machine stopped after the cycle.
	Reset	EMERGENCY STOP and retraction into X-0 position
	FeedLimiter	Feed limitation as from the infeed axis
	Contact detection	Contact detection from tool to workpiece.

Fault reaction MIN

If the average value of the machining is not reached, the HRI monitoring and the defined fault response are implemented. The **Minimal monitoring** should detect a tool breakage.

If there is no or little contact between the tool and the workpiece, this is detected and the fault response is triggered.

NOTE!
This fault response is only possible with HRIAvg, HRISurface and ForceAvg.

Fault reaction Max

If the value entered in the process is exceeded, the HRI monitoring responds and the defined fault response is implemented. High forces, vibrations or temperatures during the machining trips the fault reaction.

Fault reaction surface

The HRI monitoring reacts if the area under the HRI curve is smaller than the entered value. If the honing process is slowed by a manual intervention or a feed limitation, the maximum and minimum values are lower.

The integral under the curve of the HRI remains relatively stable. In this way, changes in the machine can be detected.

INSTRUCTION
Click on the *Reaction* selection field and select the corresponding reaction.

3.2.1.3 NC program numbers

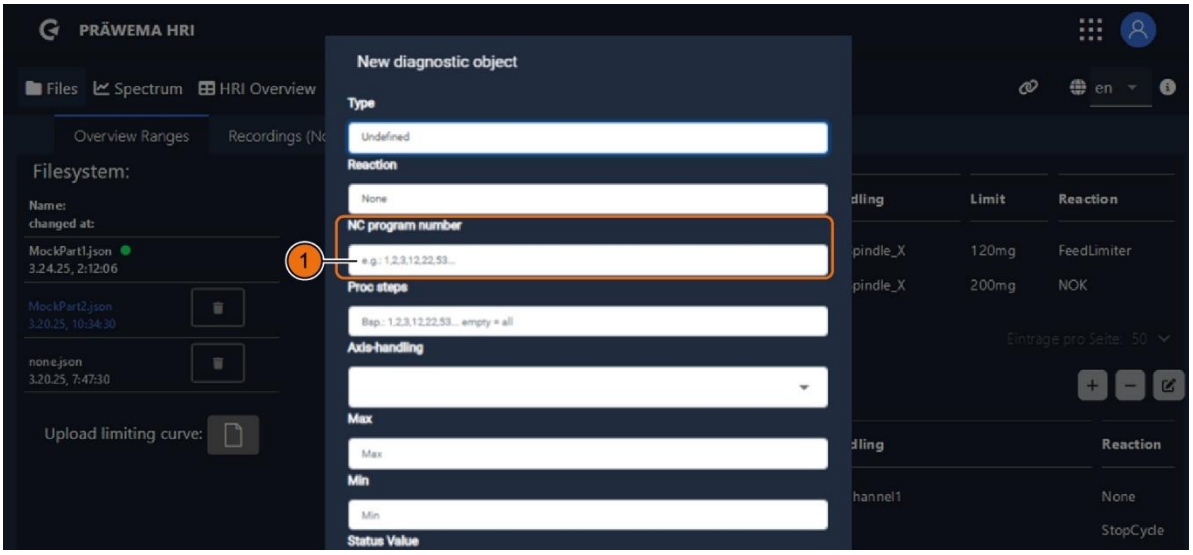


Fig. 17 New Diagnostic object menu - NC-program numbers

Item	Number	Description
1	**1**	Footprint / KM 0 measuring
	2-9	Additional programs (turning, drilling, ancillary processes, etc.)
	21	Honing ring measure head dresser
	22	Measure honing ring gearing dresser
	31	Profile head
	32	Profile gearing
	33	Preprofiling only with VSD
	34	Profiling only with VSD
	41	Workpiece measuring, left
	42	Workpiece measuring, right
	50	**Honing**
	51	Dress gearing with DDG
	52	Dressing head
	53	Dress with VSD
	60	Calibration

Tab. 4 NC-program numbers - for honing

Item	Channel	Description
1	35	Gear Cutting / Power Skiving

Tab. 5 NC program numbers - for skiving

In the *NC program numbers* input field, various program number are listed, that represent various subprograms. Each number represents a specific subprogram that performs a specific processing task, such as honing, form-truing, calibration or hobbing.

INSTRUCTION
Enter the corresponding NC program number in the input field (1) and separate with commas

3.2.1.4 Honing program steps

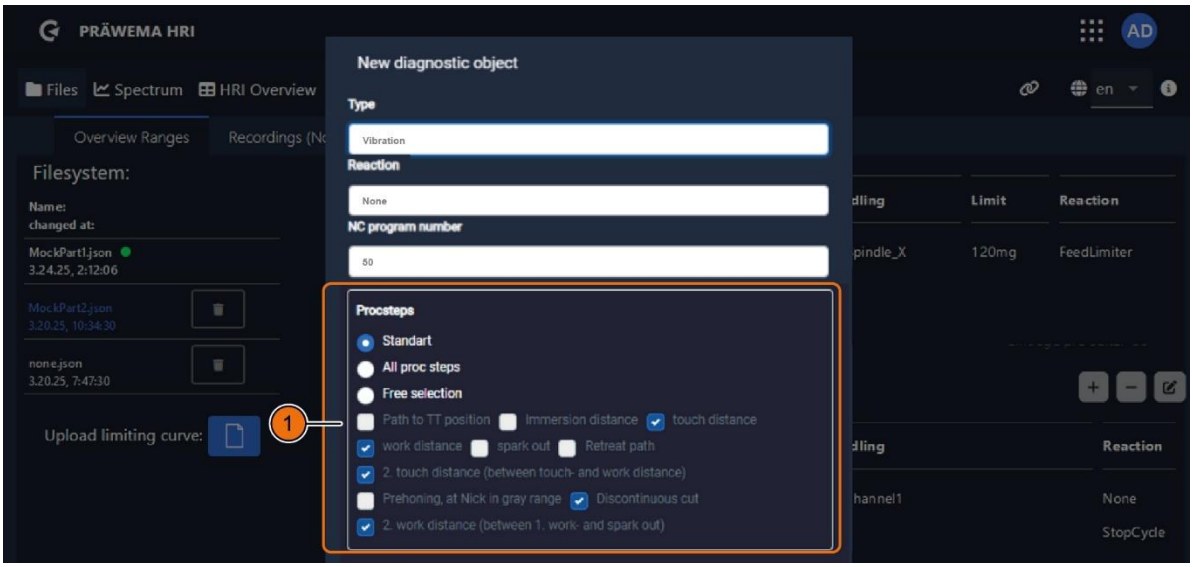


Fig. 18 New diagnostic object menu - program steps of honing

Item	Program step	Description
1		Standard
		All program steps
		Free selection
	1	Feed path from 0 to tooth-tooth position (ZZ)
	2	Insertion aid from tooth to tooth until scraping point (high feed ~1000 mm/min)
	3	1.
	4	1.
	5	Spark out (dwell time at end axis distance without additional feed with oscillation)
	6	Retraction path
	7	2. (optional)
	8	Pre-honing for nick in gray area (optional)
	9	Interrupted step (optional)
	10	2.
	25	VSD - steps without correction (dressing)
	26	VSD - steps without correction (dressing)

Tab. 6 Honing program steps

If NC program number **50** (honing) is activated, a selection can be made between the various process steps in plain text.

During the honing, various program steps are run through. Each of these steps, such as for example: Feed path, plunge path and work path, represent a specific process within the honing process.

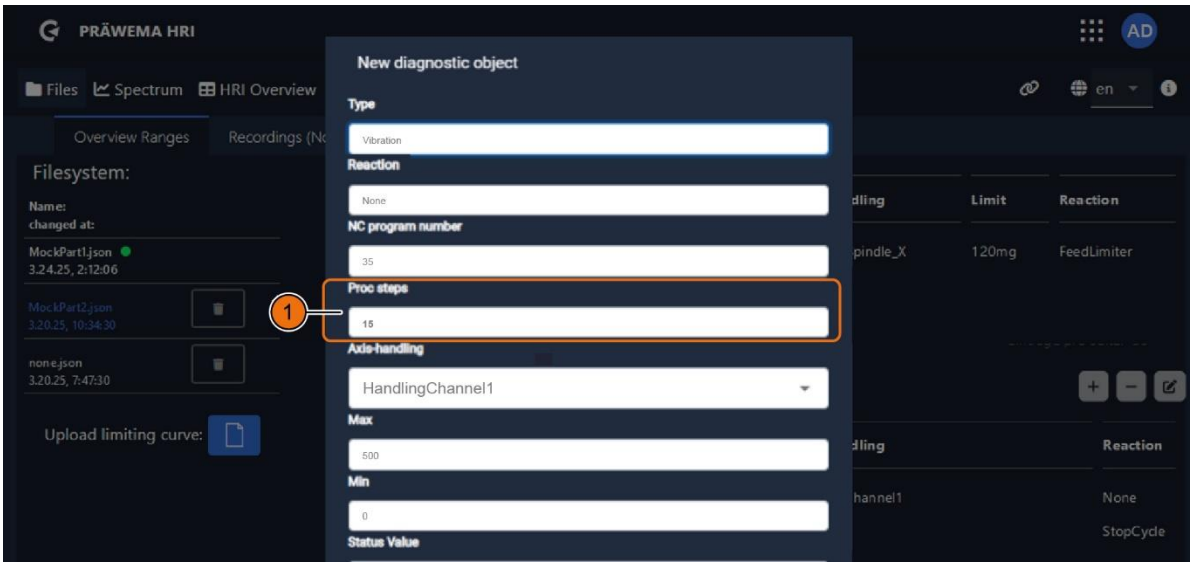


Fig. 19 New diagnostic object menu - program steps of hobbing

On skiving machines, each skiving stroke is considered as a separate process action. if, for example, a workpiece with 15 skiving strokes is to be processed, 15 corresponding process steps are recorded on the machine.

NOTE!
On other machines from the DVS Technology Group, the process steps are individually adapted to the processing of the machine.

INSTRUCTION
Enter the corresponding program steps in the input field (1) and separate with commas.

3.2.1.5 Axis handling

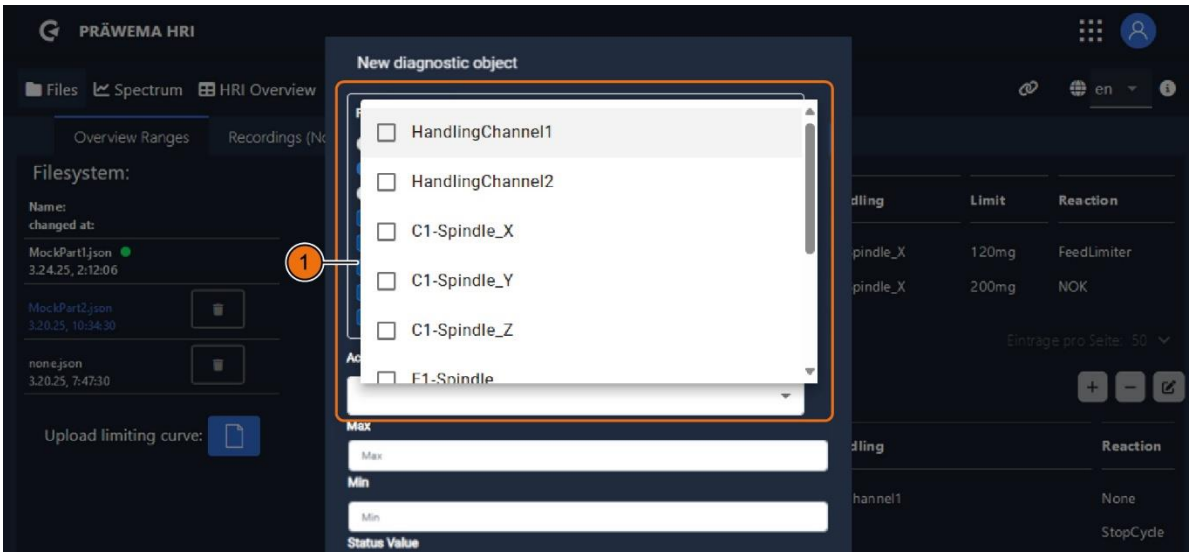


Fig. 20 New diagnostic object menu - axis handling

Item	Name of axis / handling	Description
1	Right-hand spindle	For HRI and vibration - all active sensors
	Left-hand spindle	For HRI and vibration - all active sensors
	X1 axis	For force and force AVG
	X2 axis	For force and force AVG
	Z1 axis	For force and force AVG
	Z2 axis	For force and force AVG
	C1 axis	For force and force AVG and temperature
	C2 axis	For force and force AVG and temperature
	B axis	For force and force AVG and temperature
	Individual vibration sensors	For vibration

Tab. 7 Axis handling

3.2.1.6 Status text display in the HMI menu machine status (example

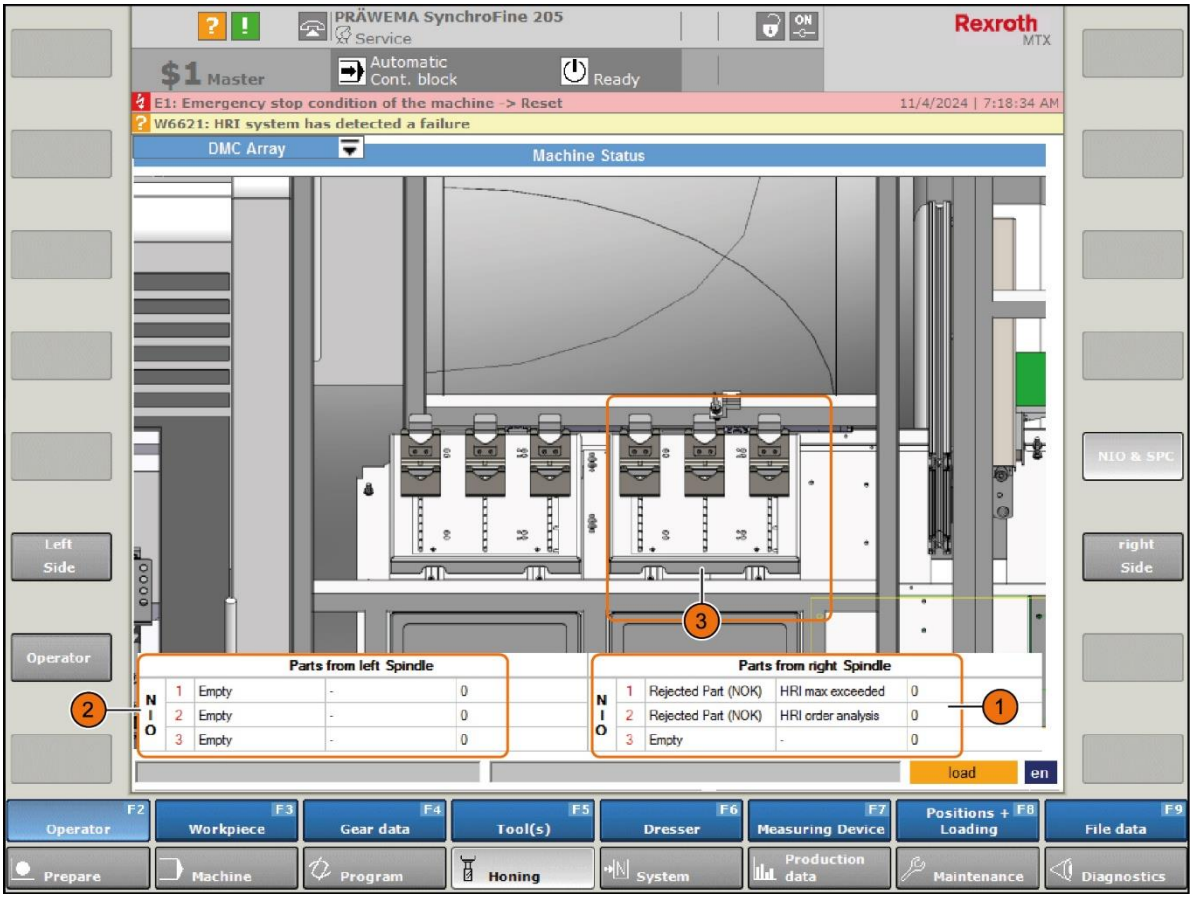


Fig. 21 Status text display in the *HMI menu machine* status (example)

1 Status text display for right-hand spindle
2 Status text display for left-hand spindle
3 NOK parts drawer right

The status value is sent to the honing HMI, and for the rejected workpieces displayed there in the HMI menu *machine* status. This enables the operator of the machine to determine the reason for ejecting the workpiece. The texts for the status value can be extended.

Item	Jam Value	Display text
1	18	HRI maximum exceeded
	19	HRI minimum not reached
	20	HRI maximum exceeded
	21	HRI Integral not achieved
	22	HRI order analysis
	23	HRI Reserve

NOTE!
The display depends on the installed component of the honing HMI.
The texts are displayed as from inspection 1839.

INSTRUCTION
Enter the corresponding status number in the *Diagnostic object* input menu.

3.2.2 Feed limitation menu - Current/Force and Vibration

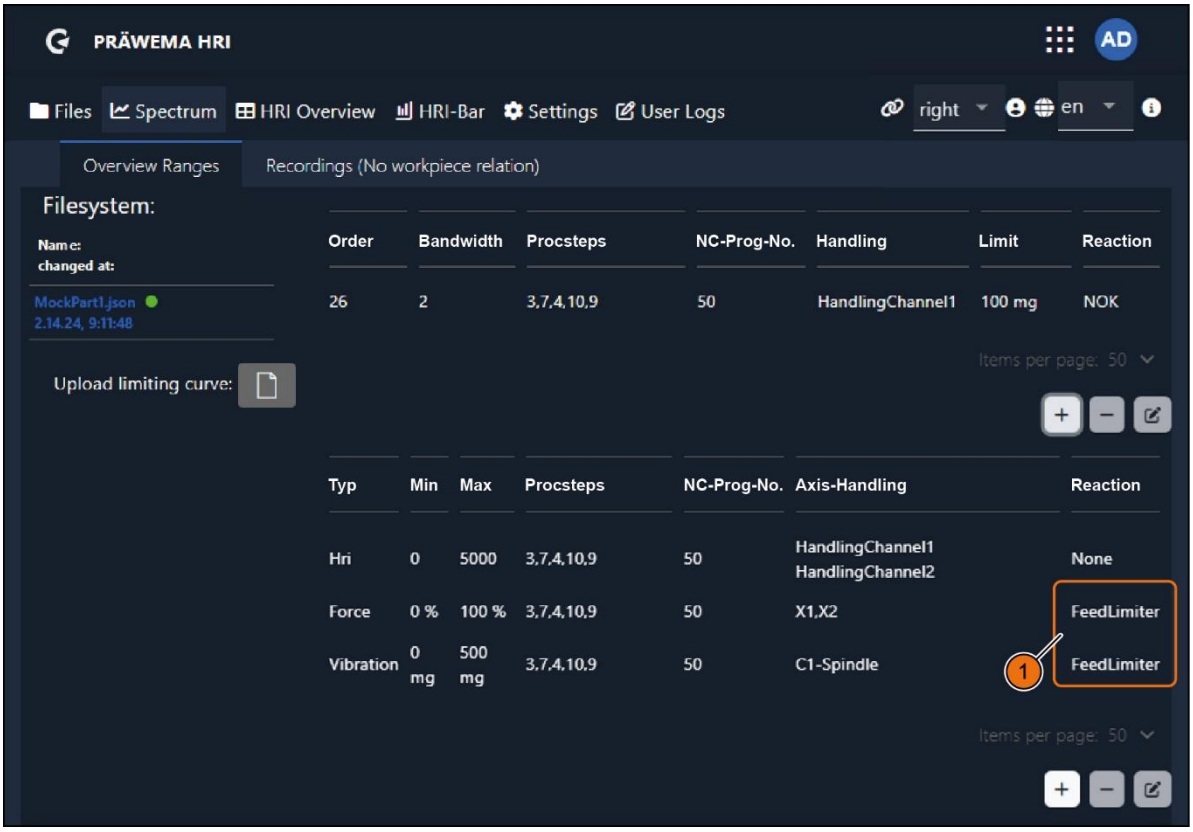


Fig. 22 Feed limitation menu - current/force and vibration

To make the process more stable, and to catch acceleration peaks, a feed limitation (Feed Limiter) (1) is integrated in the software. So that precise process control is possible,

The control of the machine feed can be done in the HRI component by specifying threshold values for **current/force** and vibration.

As soon as the specified threshold value is exceeded, there is the feed limitation.

First the feed is reduced in 10% steps. Exceeding 120% of the set limiting value, the Feed Limiter sets the value of the feed axis to 0%. An increase in the feed rate first starts when the measured value once again falls below the threshold value.

NOTE!
A limiting value for vibration monitoring is only available with the HRIexpert software component. See chapter 4.7.

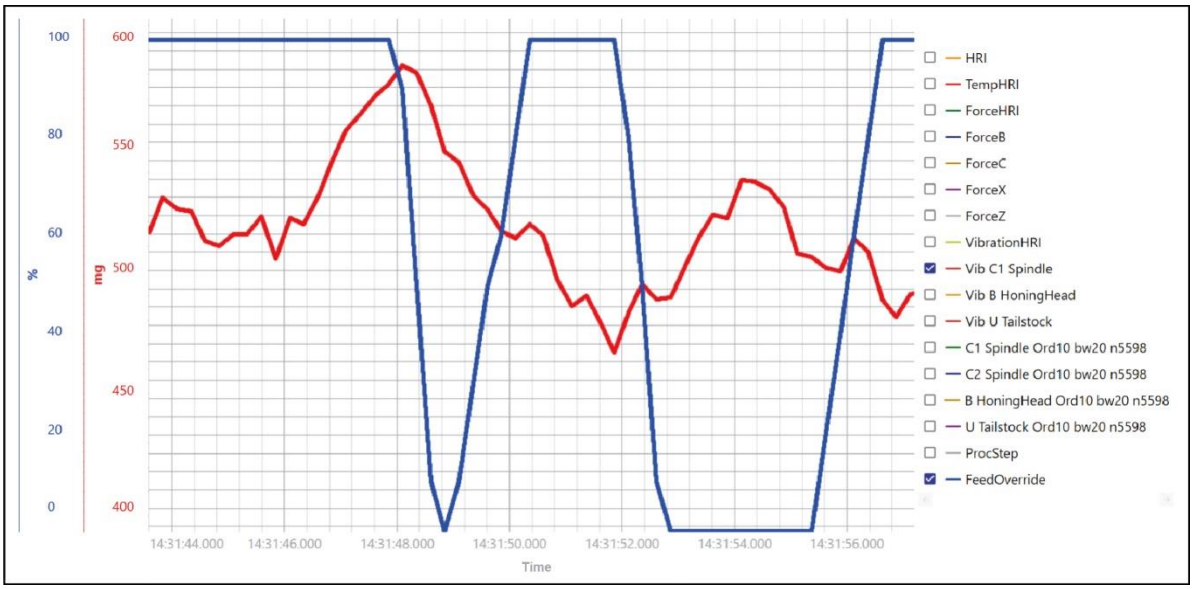


Fig. 23 Example of a feed limitation - feed limiter

The machine feed is limited by the vibrations of the C-axis.

First, the feed is reduced to 90%, and if this action is inadequate, the feed is reduced to 0%. When the vibrations fall below the limiting values again, the feed is increased again.

3.3 Spectrum menu

NOTE!
The Spectrum menu is only available in the HRIexpert software component. See chapter 3.7

3.4 HRI Menu overview

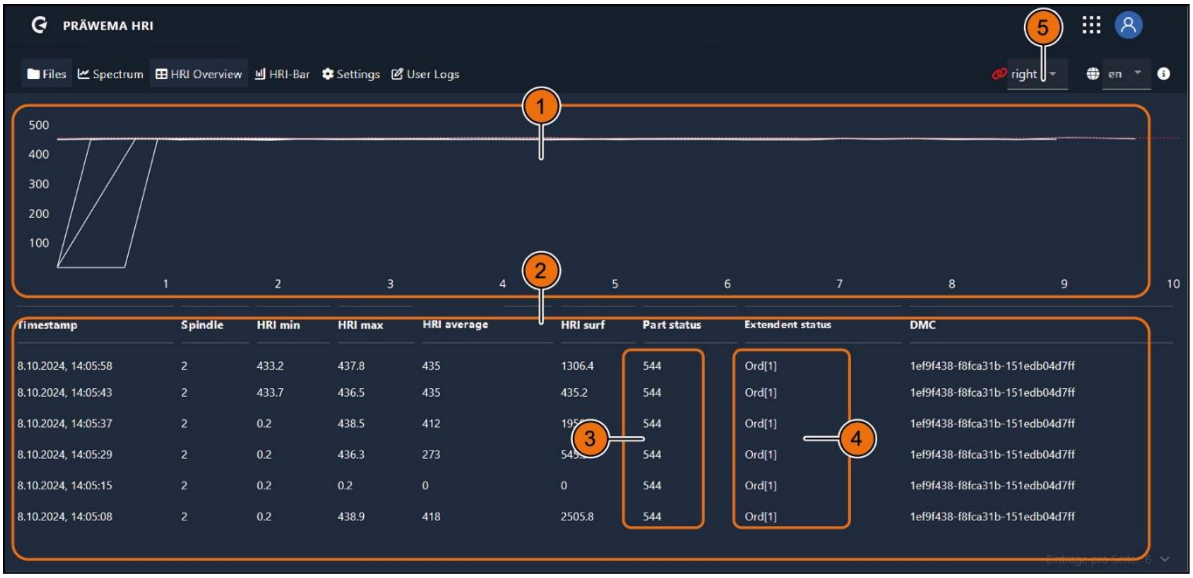


Fig. 24 HRI Menu overview (example)

1 HRI diagram
2 HRI table
3 Part status field
4 Extended status field
5 Select left / right side of the machine

In the menu, *HRI overview*, the machining of the last workpieces produced are shown as an HRI diagram (1) and HRI table (2). Machines in which processes can run in parallel, a distinction is made between the left and right sides of the machine (5).

The individual signals of the *Part status* (3) are bit values and can be combined with one another.

Significance of bit values:

Item	Bit value Part status	Description
3	**0/1**	Measuring is OK - limiting values were not exceeded
	2	During the processing, the limiting value was exceeded.
	4	During the machining, the average value was not reached
	8	During the machining, the surface is not reached.
	16	Fault message via HRI (vibrations, force or temperature)
	32	Fault message via HRIexpert (order object or limit curve)
	64	Stop after cycle end
	128	Eject workpiece (SPC)
	256	Reset - emergency retraction to X0 position
	512	Eject workpiece (NOK)

Example:
A triggering error message *"4 - During the machining is that the average value was not reached"*, with the error response *"64 - Stop after cycle end"* would be output as workpiece status *"68"*.

In the *Extended status* (4) field, the limiting value breaches are shown as plain text, with the set limiting values and the values that exceed or undershoot the values, and the set fault response.

3.5 To the menu HRI bar

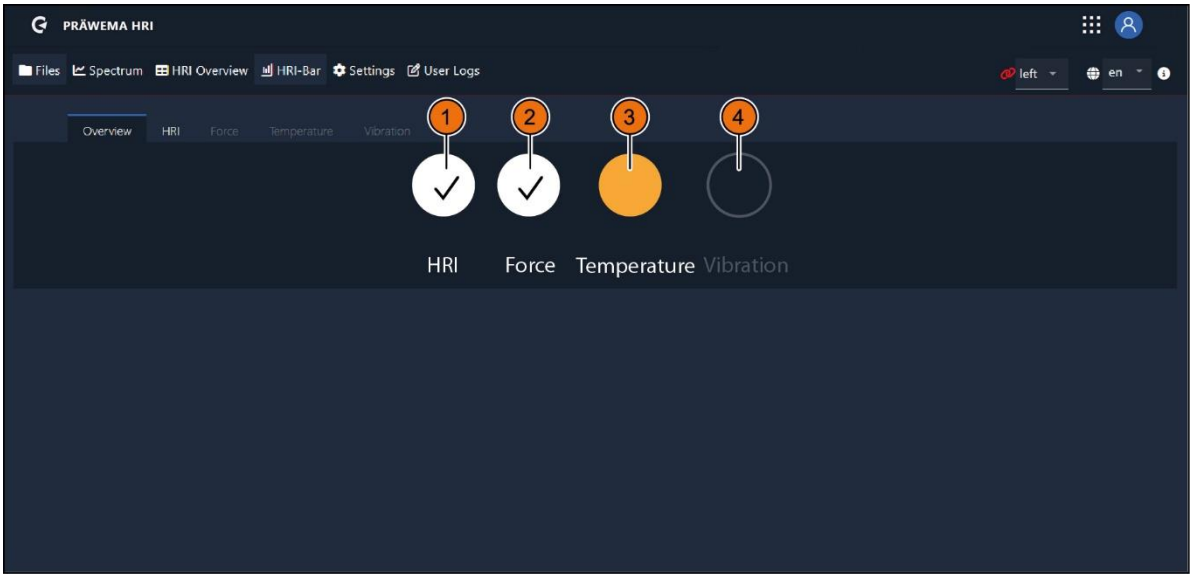


Fig. 25 HRI Bar (example)

1	HRI button	3	Temperature button
2	Force button	4	Vibrations button

The status messages of the process parameters are shown in the *HRI Bar* menu. As well as the *HRI value*, *force, temperature* and *vibrations* are also displayed for the parameters, whether the limiting values are observed.

During the creation of an HRI monitoring object, the associated buttons (1-4) are activated.

If the limiting value is less than 80% of the limiting value, the button is displayed with a white circle and a checkmark.

With limiting values of more than 80%, the button is orange, and in the event of exceeding this, it is shown in red.

If no diagnostic object has been created, the status message is colored gray (4).

INSTRUCTION
To display the individual HRI monitoring objects, click a button (1-4), and switch into the *HRI Bar single view* menu.

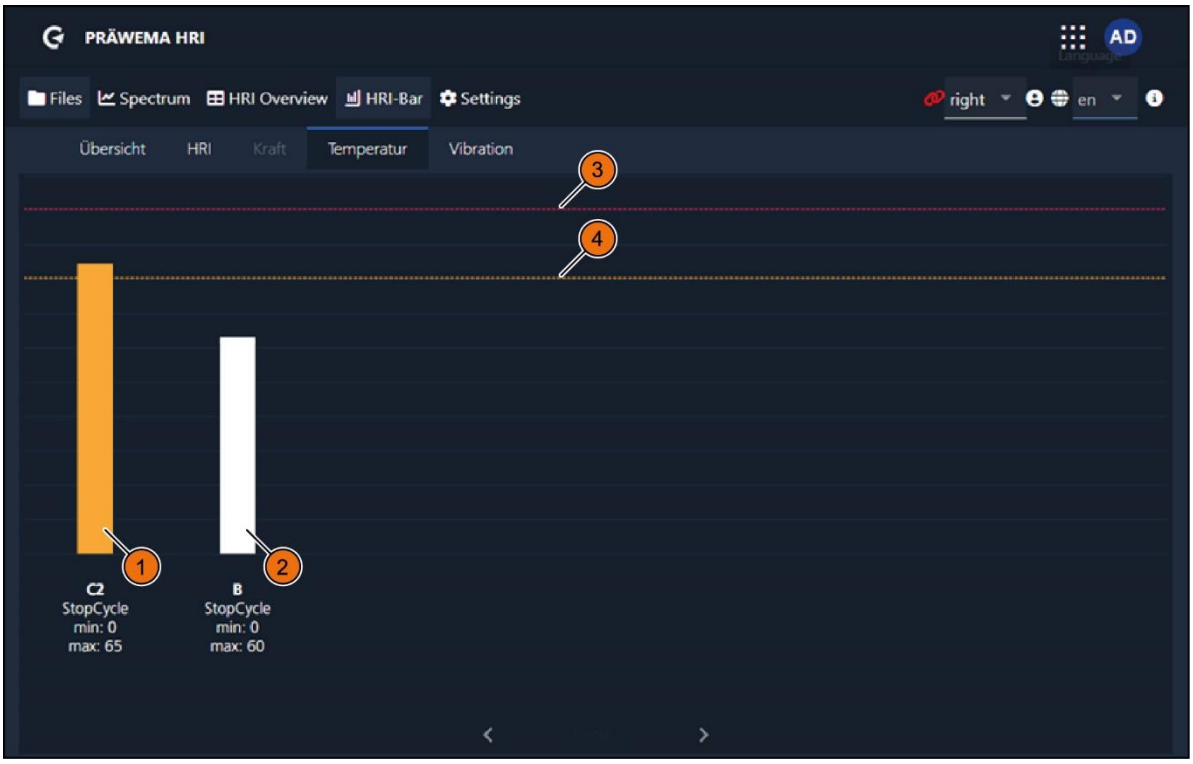


Fig. 26 HRI Bar single view (example)

1	Temperature of C2-axis	3	Red line
2	Temperature of B-Axis	4	Orange line

The *HRI Bar single view* menu opens.

NOTE!
Th HRI monitoring objects from HRIAvg, HRI Surface and ForceAvg are not displayed here. The values of these HRI monitoring objects are not calculated until the end of the process.

In the example, the orange line (4) is scaled to 80%, and the red line is the limiting value. Three HRI monitoring objects are created for the temperature.

On the C1-axis, the measured value lies between 80% and 99% of the set limiting values.

3.6 Settings menu

In the *Basic settings* menu, all the important settings for communication between HRI and the controller machines are set.

Furthermore, various additional options can be set here.

All entries in the Settings menu are stored in the *HRIData* directory on the PC

NOTE!
The basic settings are specified once during the commissioning by the PRÄWEMA service technician.
No additional settings are necessary, except in the case of faults or changes to the programming.
The changes can only be made with the authorization level administrator.

INSTRUCTION
To the extended view, click a symbol in the tool bar (1).
To close the extended view, click on a tool bar symbol again.

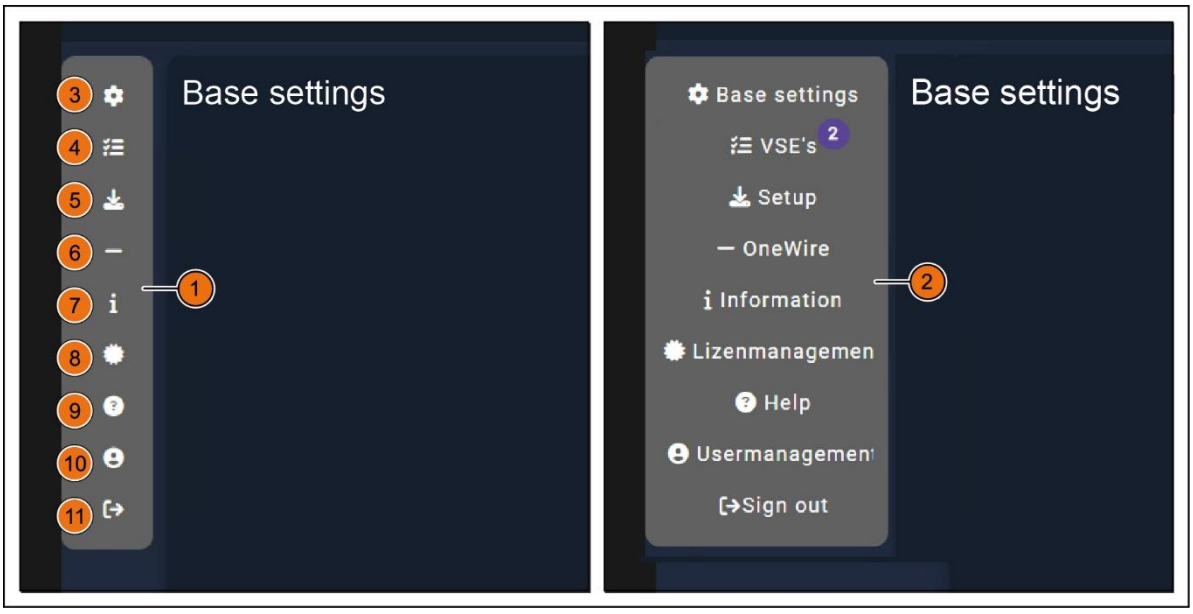


Fig. 27 Menu bar Basic settings closed and extended view

Item	Name	Description
1	**Menu bar**	Menu bar closed, only symbols
2	**Menu bar**	Extended view with text
3	**Basic settings**	To the *Documentation* menu Basic setting of all important settings for HRI and controller communication
4	**VSEs**	To the *VSE basic settings* menu Display of the VSE evaluation units for the vibration sensors
5	**Setup**	To the *Setup* menu Search for vibration sensors, Restart of HRI backend
6	**One Wire**	To the *OneWire* menu

		Input field for IP address of the controller
7	**Information**	To the *Information* menu Display of backend and frontend versions
8	**License management**	To the *License management* menu Display of installed licenses
9	**Help**	To the *Help* menu HRI and HRIexpert training documentation
10	**User management**	To the *User management* menu Creation of various users
11	**Login/Logout**	To *Login* menu window

3.6.1 Basic settings menu

3.6.1.1 Basic settings menu - Input fields

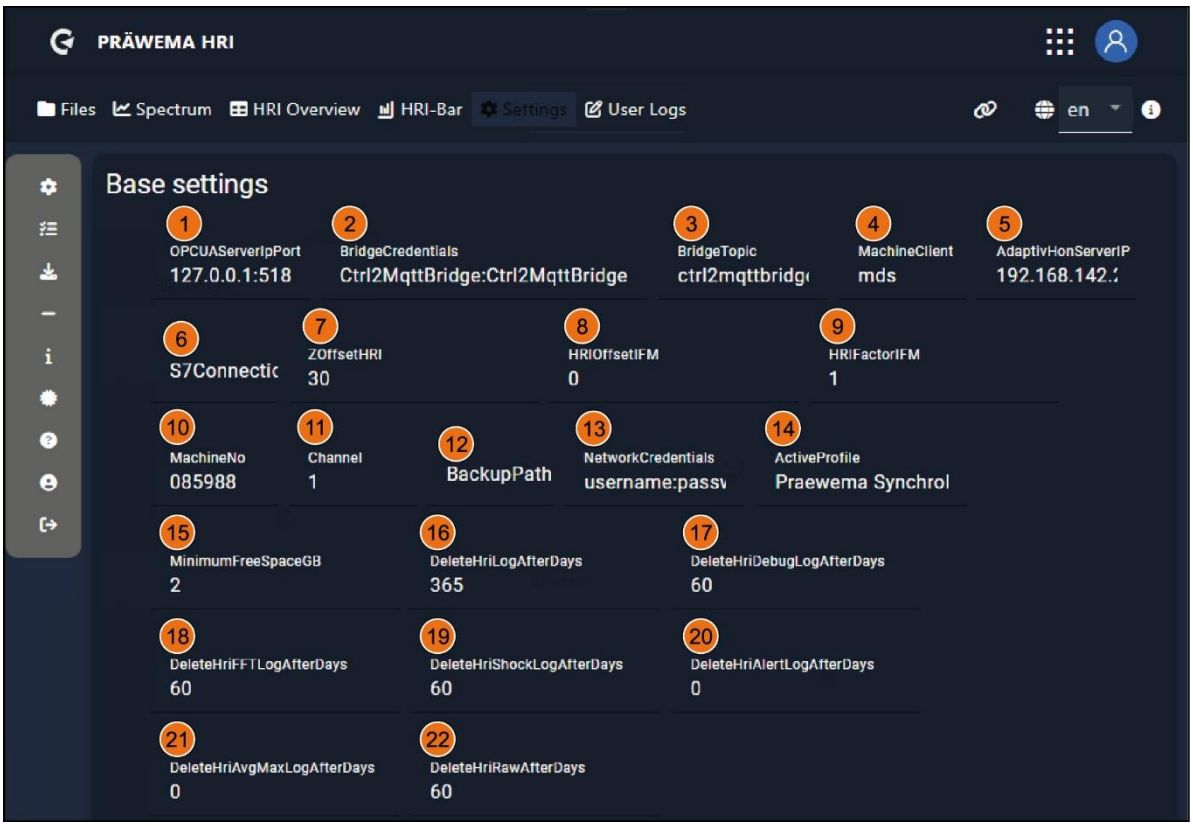


Fig. 28 Basic settings menu - upper range

Item	Name	Function	Description
1	**OPCUAServer-IpPort**	Input field	IP address of the controller with the OPC UA server port (from PRÄWEMA)
2	**Bridge Creden-tials**	Input field	User and password for the network bridge for DVS Edge (from PRÄWEMA)
3	**Bridge Topic**	Input field	For DVS Edge (from PRÄWEMA)
4	**Machine Client**	Input field	For DVS Edge (from PRÄWEMA)
5	**Adaptive Hon ServerIP**	Input field	IP address of the controller with the Adap-tiveHonServer (from PRÄWEMA)
6	**S7Connection IP**	Input field	IP address of the S7 CPU in the Profinet (from PRÄWEMA)
7	**ZOffsetHRI**	Input field	Only with SynchroFine - offset on the force of the Z-axis with activated tailstock
8	**HRIOffsetIFM**	Input field	Offset from the vibration proportion of the HRI calculation
9	**HRIFactorIFM**	Input field	Factor from the vibration proportion of the HRI calculation
10	**MachineNo**	Input field	Number of the machine
11	**Channel**	Input field	NC channel of the Siemens S7 Controller (from PRÄWEMA)

12	**BackupPath**	Input field	Storage location for the HRI backup on a server
13	**Network credentials**	Input field	Username and password for the backup server
14	**ActiveProfile**	Input field	Active profile - SynchroForm or SynchroFine (from PRÄWEMA)
15	**Minimum free space**	Input field	Minimum free hard disk space (in GB)
16	**Delete HRILog Data After Days**	Input field	Deletion of the Logging files after number of days on the machine
17	**DeleteHRIDebugLogAfterDays**	Input field	Deletion of the Debug Logging files after number of days on the machine
18	**DeleteHRIFFTLogAfterDays**	Input field	Deletion of the FFT Logging files after number of days on the machine
19	**DeleteHRI ShockLogAfter Days**	Input field	Deletion of the Shock Logging files after number of days on the machine
20	**DeleteHRIAlertLogAfterDays**	Input field	Deletion of the Alert Logging files after number of days on the machine
21	**DeleteHRIAvg MaxLogAfterDays**	Input field	Deletion of the Avg Max files after number of days on the machine
22	**DeleteHRIRaw AfterDays**	Input field	Deletion of the Raw files after number of days on the machine

3.6.1.2 Basic settings menu - checkboxes and control tags

Fig. 29 Basic settings menu - upper range

Item	Name	Function	Description (authorization)
1	**ReadDMC ArrayFromS7**	Checkbox	Read in data matrix code from Siemens S7 (from PRÄWEMA)
2	**Debug**	Checkbox	HRI recordings during standby and simulation
3	**PublishRaw DataViaMqtt**	Checkbox	Transmits raw data via MQTT (from PRÄWEMA)
4	**Enable raw data**	Checkbox	Record raw data
5	**ForceOrder Monitoring**	Checkbox	At least one order monitoring must be created (from PRÄWEMA)

6	**Generate LegacyCsvs**	Checkbox	Create standard CSV Log files
7	**LegacyCsv SaveAvgMax**	Checkbox	For OK workpieces only the average and maximum amplitudes of the vibrations are stored
8	**Generate Wave**	Checkbox	Generate a compressed WAVE file from the data of the vibration sensors
9	**Generate datagrams**	Checkbox	Generate datagrams for analyzing the workpieces
10	**Generate WaveUnzipped**	Checkbox	Generate an uncompressed WAVE file from the data of the vibration sensors
11	**CompressDatagrams**	Checkbox	Compress datagrams
12	**DeleteAfter Backup**	Checkbox	Delete the logging files on the machine if an external backup path is set up
13	**InvertHRI CommMonitor**	Checkbox	Communication monitoring inverted (by PRÄWEMA)
14	**FeedOverridelnPercent**	Checkbox	Feed limitation is written in percent on the PLC (from PRÄWEMA)
15	**Experimental**	Checkbox	Beta functions - Caution near production machines! (PRÄWEMA)
16	**RollOnProgChange**	Checkbox	Save new FFT/ShockLog files after dressing
17	**DefaultLanguage**	Input field	Standard language
18	**MenuUrl**	Input field	Function of the 9 points buttons in the header
19	**Debug**	Checkbox	HRI recordings during standby and simulation
20	**Control tags**	Drop-down menu	Set parameters for NC-communication
21	**Saving**	Button	Save last inputs

In the controller variables (Control tags) (20), the various parameters for the NC communication are set Values for recording in the HRILog files can be entered here.

INSTRUCTION
To open and close the *Control tags* drop-down menu, click on the (20).

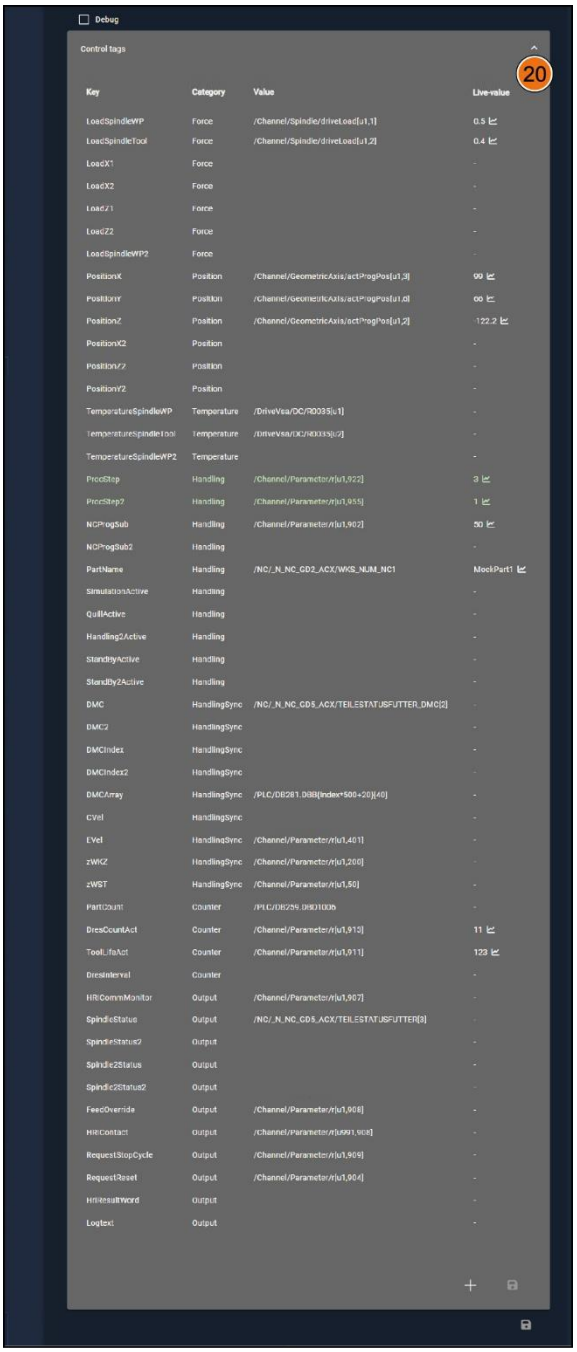


Fig. 30Menu Control tags opened

3.6.2 VSE basic settings menu - vibration sensor system

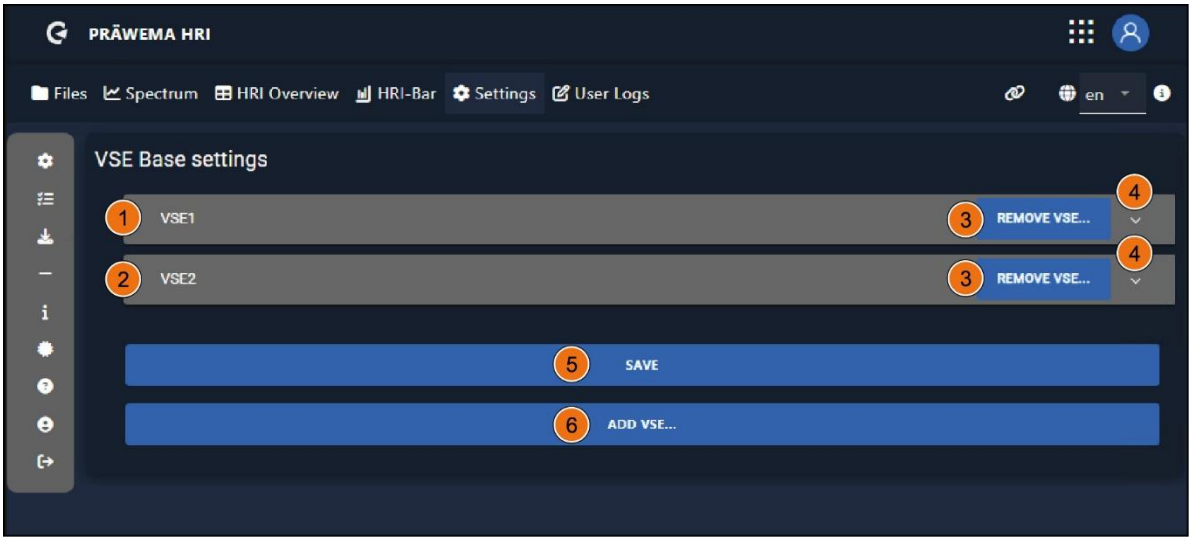


Fig. 31 Close VSE basic settings menu

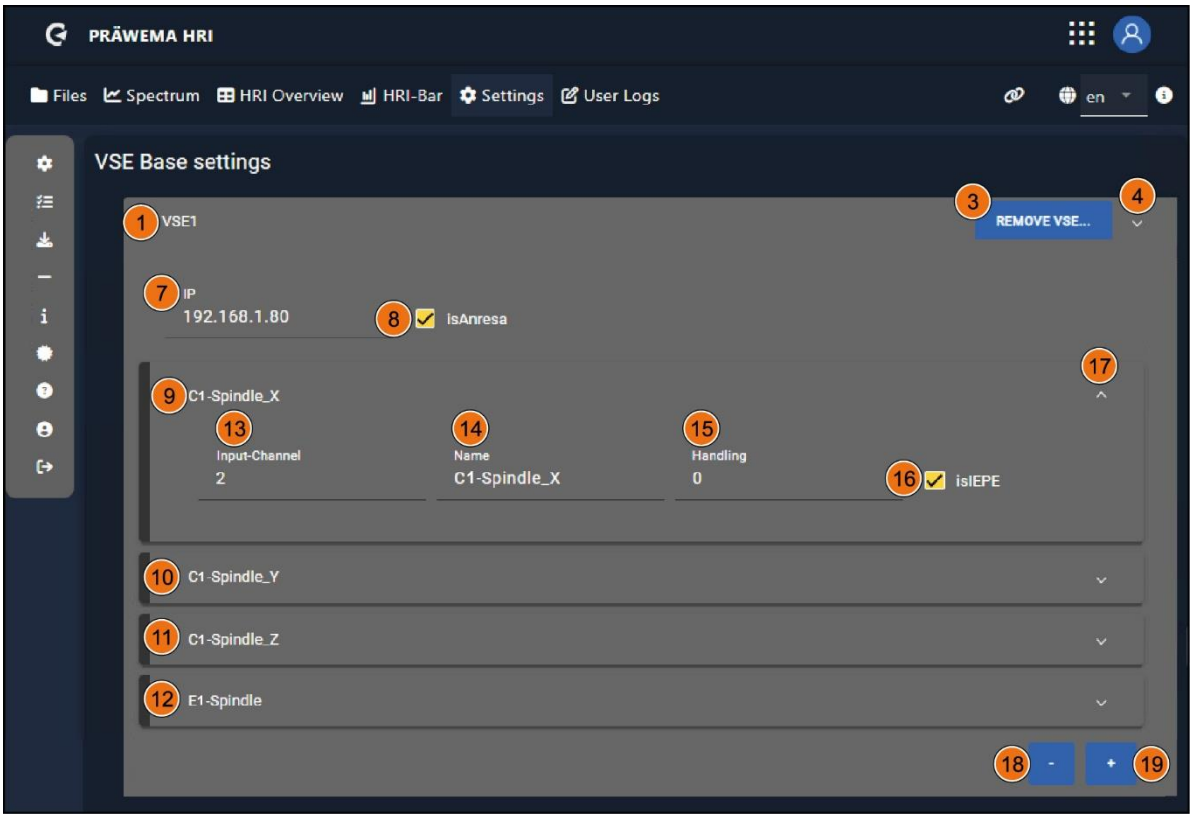


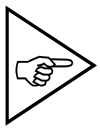
Fig. 32 Open VSE basic settings menu

Item	Name	Function	Description
1	**VSE1**	Display field	VSE no. 1
2	**VSE2**	Display field	VSE no. 2
3	**Remove VSE**	Button	Remove VSE
4	**Arrow**	Drop-down menu	Open / close VSE menu

5	**SAVE**	Button	Save input for the VSE basic settings
6	**ADD VSE**	Button	Add input for the VSE basic settings
7	**IP**	Input field	Display of IP address of VSE
8	**isAnresa**	Checkbox	Use of **ANRESA** firmware
9	**C1 spindle-X**	Drop-down menu	Input vibration sensor 1
10	**C1-Spindle_Y**	Drop-down menu	Input vibration sensor 2
11	**C1-Spindle_Z**	Drop-down menu	Input vibration sensor 3
12	**E1-Spindle**	Drop-down menu	Input vibration sensor 4
13	**Input channel**	Input field	Sensor input of VSE (1-4)
14	**Name**	Input field	Name of vibration sensor
15	**Handling**	Input field	Select processing side that should be monitored
16	**isIEPE**	Checkbox	IEPE sensor (current)
17	**Arrow**	Drop-down menu	Open the individual vibration sensors 1-4
18	**-**	Button	Deletion of a vibration sensor
19	**+**	Button	Addition if a vibration sensor

In the *VSE basic settings* menu, the individual VSE evaluation units of the manufacturer, IFM, are shown. Normally, one or two VSE evaluation units are used with the **ANRESA** firmware.

4 inputs (9-12) of the vibration sensors can be connected.to each VSE evaluation unit.



NOTE!
On older machines, a VSE evaluation unit is installed for each sensor.

Example (fig. 31**)**

In a SynchroForm machine, a single-axis sensor VSA001 (3) for the E1-spindle and a three-axis sensor VSM103 for the C1-spindle are connected.

The single-axis sensor VSA001 is connected to the sensor input 1 (3), and setup as an IFM standard vibration sensor.

The three-axis sensor VDM103 is connected to the inputs 2-4 (4-6), and set up as an IEPE sensor (current). Each axis of the sensor requires a separate input on the VSE evaluation unit.

INSTRUCTION
To open and close the drop-down menu, click on the arrow.

3.6.2.1 Settings for handling

Item	Handling number	Active sensor on the SynchroFine
15	**0**	One of the two spindle sensors is active
	1	Sensor on the C1 spindle is active
	2	Sensor on the C2 spindle is active

Item	Handling number	Active sensor on the SynchroForm
15	**1**	Sensor on the C1/E1 spindle is active
	2	Sensor on the C2/E2 spindle is active

INSTRUCTION
Depending on the sensor, enter the corresponding handling number in the input field (15).

3.6.3 Commissioning menu

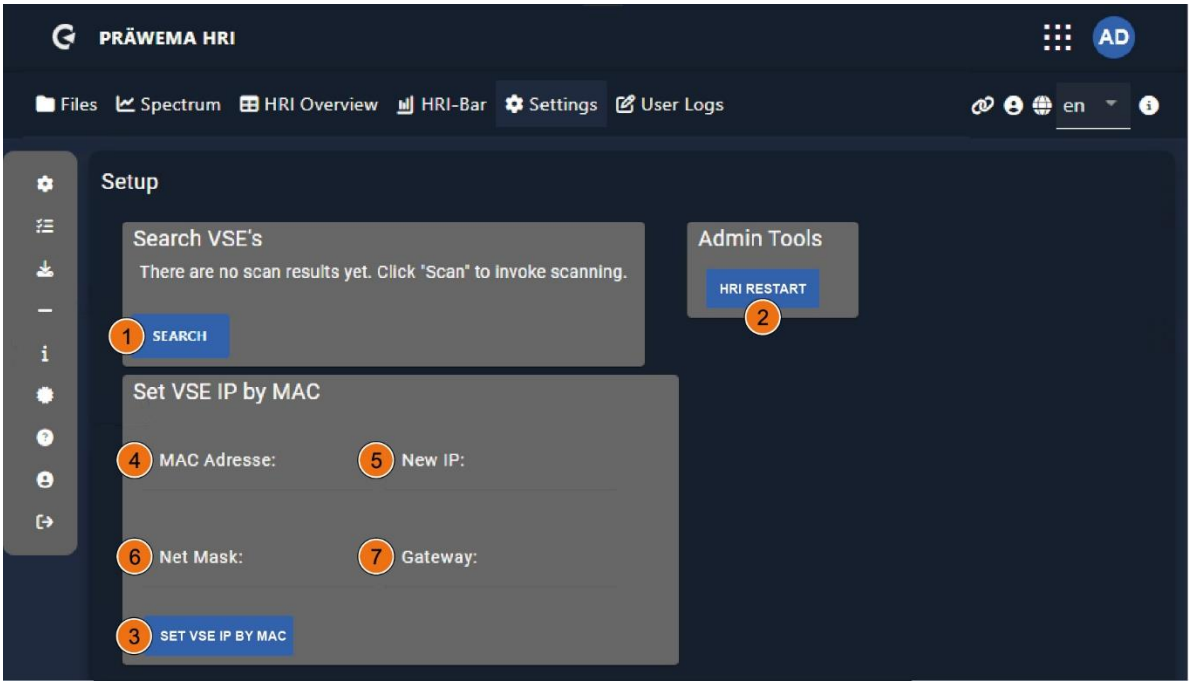


Fig. 33 Commissioning menu - search of VSE evaluation units

Item	Name	Function	Description
1	**FIND**	Button	Search for the evaluation units of the VSE vibration sensors
2	**RESTART HRI**	Button	Restart HRI backend
3	**SET VSE IP ON BASIS OF MAC**	Button	Set a new IP ADDRESS
4	**MAC address**	Input field	Enter MAC address of the VSE that should be given a new IP
5	**New IP**	Input field	Enter IP address that is to be assigned.
6	**Net Mask**	Input field	Enter subnet mask that is to be assigned.
7	**Gateway**	Input field	Enter gateway that is to be assigned

Fig. 34 Commissioning menu - open extended search input

Item	Name	Function	Description
8	**VSE no.**	Display field	VSE found

9	**IP**	Display field	IP address
10	**Port**	Display field	UDP port address
11	**Subnetmask**	Display field	Subnetmask
12	**Gateway**	Display field	Gateway
13	**MAC**	Display field	Media Access Control - Address
14	**Host name**	Display field	Host name
15	**Serial**	Display field	Serial number of device
16	**Firmware**	Display field	Software component
17	**Device type**	Display field	Hardware version
18	**Set new IP**	Input field	Enter new IP address
19	**Send new IP**	Button	Send new IP ADDRESS
20	**FLASH ANRESA**	Button	ANRESA firmware for the VSE evaluation units
21	**FLASH STANDARD**	Button	Standard firmware for the VSE evaluation units
22	**Arrow**	Drop-down menu	Open/close extended search input

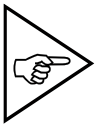
In the *Commissioning* menu, a search can be made for the VSE evaluations of the vibration sensors.

INSTRUCTION
To find a VSE evaluation unit, select the Search button (1).

After the search of a VSE evaluation unit, all relevant settings and information are shown in the extended search input. The IP address can be changed here.

INSTRUCTION
To change the IP address in the *Set New IP* input field (18) enter new IP address.

Furthermore, a selection can be made between the two firmware versions, **ANRESA** or **Standard**. Up to 4 sensors can be connected to the VSE evaluation units. These must be read out one after the other. With the ANRESA firmware, the channels can be read out in parallel.



NOTE!
The updating (flashing) of the ANRESA firmware is only possible as from hardware version 6 (16). If the installed hardware is older, the VSE evaluation unit must be exchanged to update the firmware.

INSTRUCTION
To select the firmware, select *the Flash* ANRESA (20) or *Flash Standard* (21) button.

If the search cannot find a VSE evaluation unit or the configuration of the IP address is not possible, the IP address can be set the aid of the MAC address.

Fig. 35 Adhesive label with MAC address on the VSE evaluation unit

The MAC address is on an adhesive label on the side of the VSE evaluation unit.

INSTRUCTION
To make the other configuration, proceed as follows:
- Enter the MAC address on the adhesive label in the input field (3),
- Enter the new IP address in the input field (18).
- Enter the gateway (12) in the input field,
- Enter the subnet mask in the input field (11),
- Select the *Set VSE IP by MAC* (7) button.

To accept the changes, the HRI Backend must be restarted.

INSTRUCTION
To restart the HRI Backend, select the button (2).

3.6.4 OneWire menu - temperature monitoring

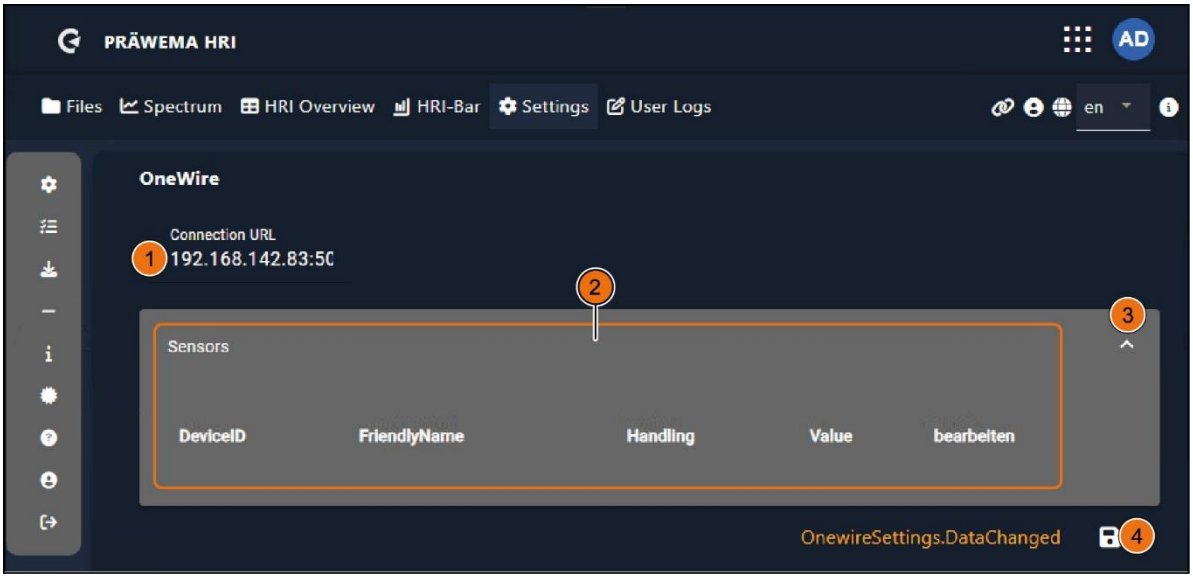


Fig. 36 OneWire menu - temperature monitoring

Item	Name	Function	Description
1	**Connection URL**	Input field	IP address of temperature controller
2	**Sensors**	Input field	Enter temperature sensor and display of the measured value
3	**Arrow**	Drop-down menu	Open/close temperature sensor data menu
4	**Saving**	Button	Save sensor data

In the *OneWire* menu, the HRI monitoring is connected to the controller.

Temperature sensors are mounted on the tool and workpiece spindles of the machine to monitor the bearing temperature. These sensors use the OneWire bus.

The IP address of the controller must be entered in the HRI. After successful connection to the controller, all connected sensors are automatically detected.

INSTRUCTION
Enter the IP address of the controller in the input field Connection *URL* (1).

The sensors are assigned to the particular installation locations by using the serial number of the OneWire sensors.

3.6.5 Information menu

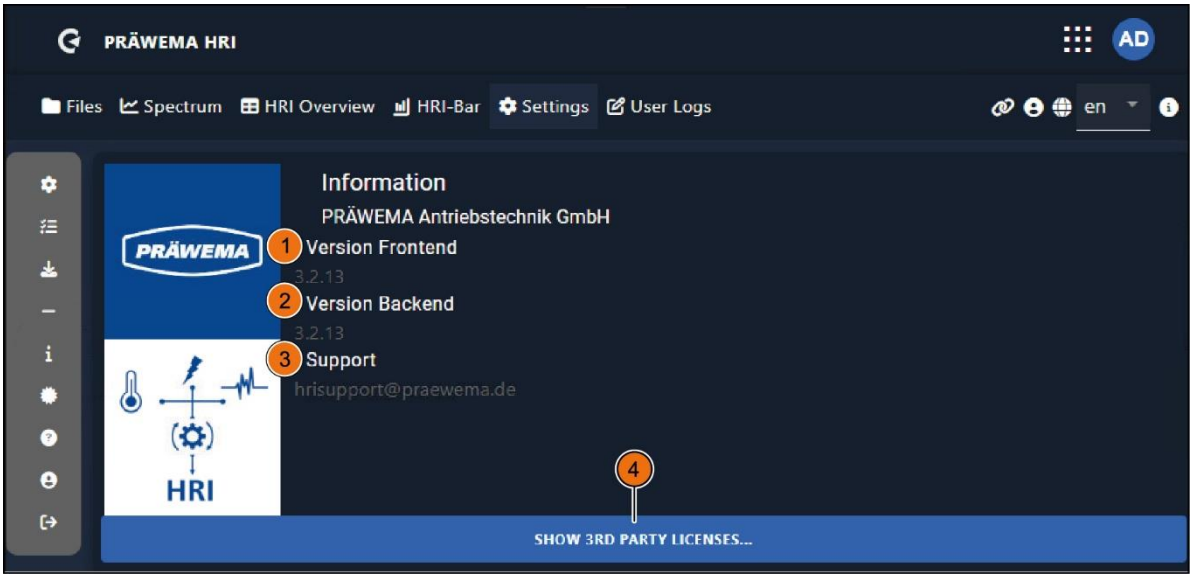


Fig. 37 Information menu

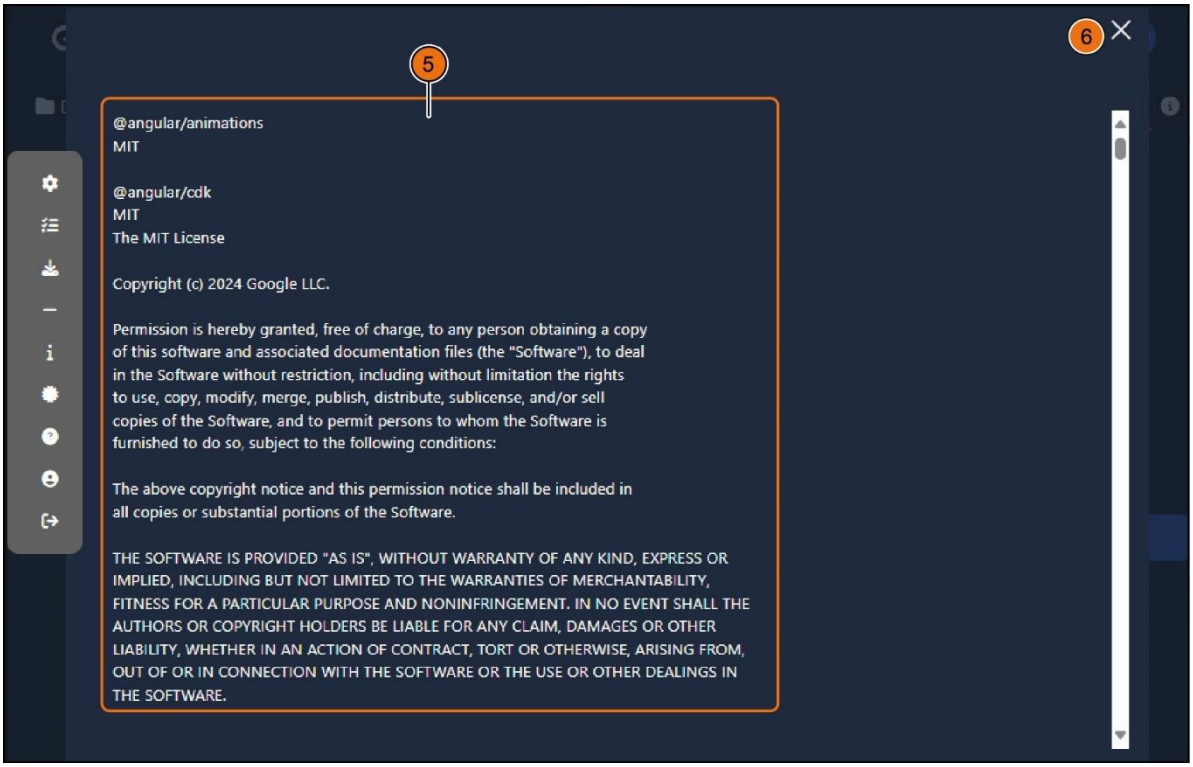


Fig. 38 Information menu - extended view

Item	Name	Function	Description
1	**Version Frontend**	Display field	Installed frontend version
2	**Version Backend**	Display field	Installed backend version
3	**Support**	Display field	Link to PRÄWEMA HRI Support
4	**SHOW 3RD PARTY LICENSES**	Button	Open extended view Display licenses from third parties

5	**Text field**	Display field	Licenses from third parties, scroll text field to read
6	**CLOSE**	Button	Close extended view

In the *Information* menu, the backend and frontend versions are shown.
When faults occur, always state the program version.

INSTRUCTION
To open the extended view, select the *SHOW 3RD PARTY-LICENSES* (4) button.

3.6.6 License management menu

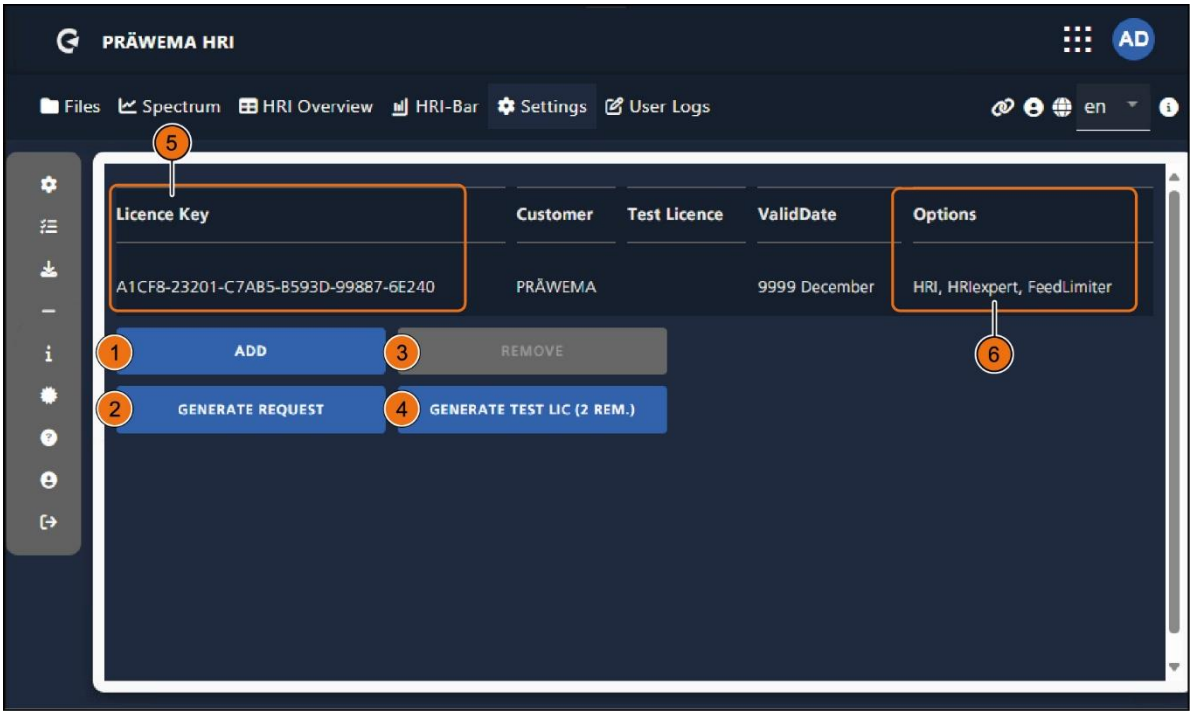


Fig. 39 License management menu

Item	Name	Function	Description
1	**ADD**	Button	Install additional licenses
2	**GENERATE REQUEST**	Button	Generate LRQ file
3	**REMOVE**	Button	Delete license
4	**GENERATE TEST LIC (2 REM)**	Button	Generate test license (2x possible)
5	**Lincence Key**	Display field	Display installed license keys
6	**Options**	Display field	Display of the licensed software component HRI / HRIexpert

In the *License management* menu, the installed licenses are shown.
The license key is generated by PRÄWEMA, and sent to the customer as a text file.

INSTRUCTION
To install additional licenses, select the *ADD* (1) button.

INSTRUCTION
To delete a license, select the *REMOVE* (3) button.

3.6.6.1 Generate permanent / provisional license

With the information from the License Request file a permanent or provisional license can be generated. A license file is generated. This License File must be installed in the HRI to activate all functions.

INSTRUCTION
To install additional licenses select the *ADD* button (fig. 39, pos. 1).

The Add a new license input window is opened.

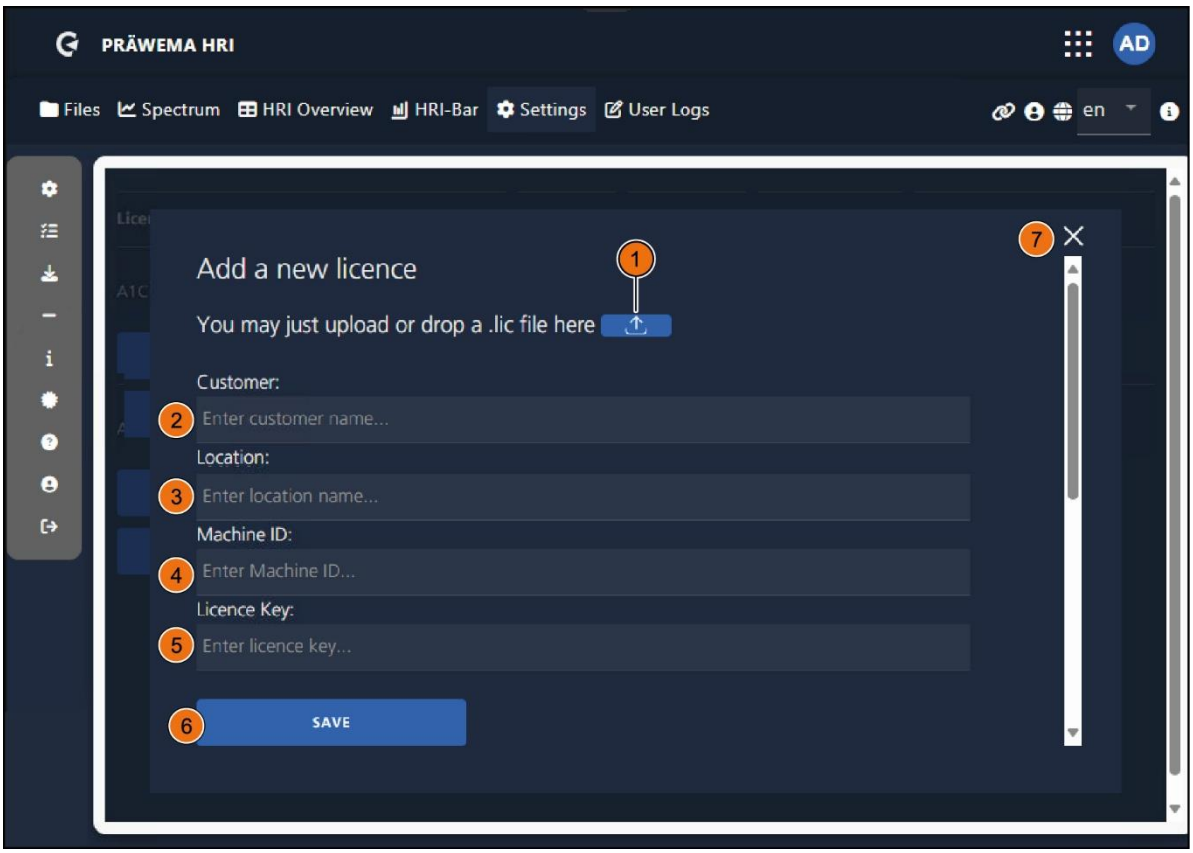


Fig. 40 License management menu - add a new licence input window

Item	Name	Function	Description
1	**IMPORT**	Button	Import LIC file
2	**Customer**	Input field	Enter customer name
3	**Location**	Input field	Enter location
4	**Machine ID**	Input field	Enter machine ID
5	**Licenses Key**	Input field	Input license key
6	**SAVE**	Button	Save all inputs
7	**CLOSE**	Button	Close input window

INSTRUCTION
To import the LIC file, select the blue button (1).

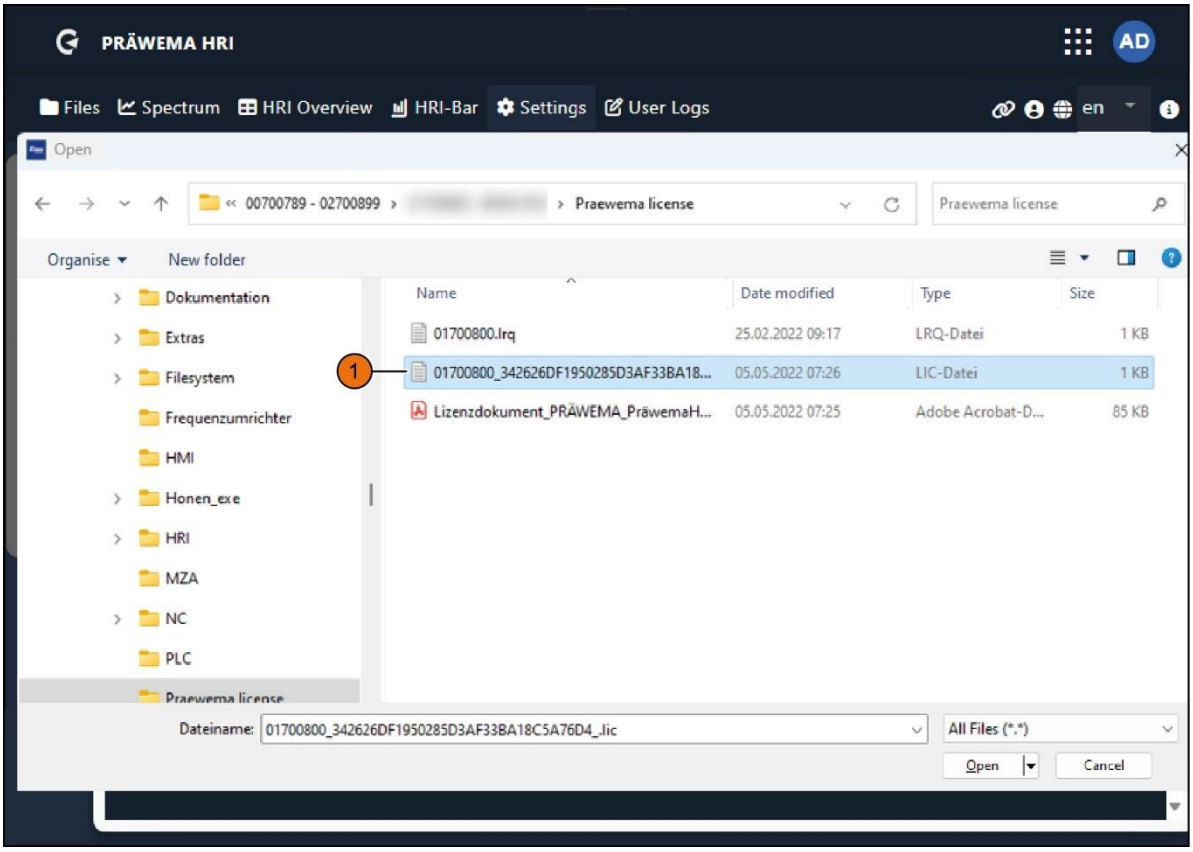


Fig. 41 License management menu - LIC file in the directory

INSTRUCTION
Select the LIC file (1) in the PC directory and import with *Open* button.

3.6.6.2 Generate permanent license

For a long-lasting license, an LRQ file must be generated.

INSTRUCTION
To create the LRQ file, select the *GENERATE REQUEST* button (fig. 39, pos. 2*).*

The *Generate License Request* input window is opened.

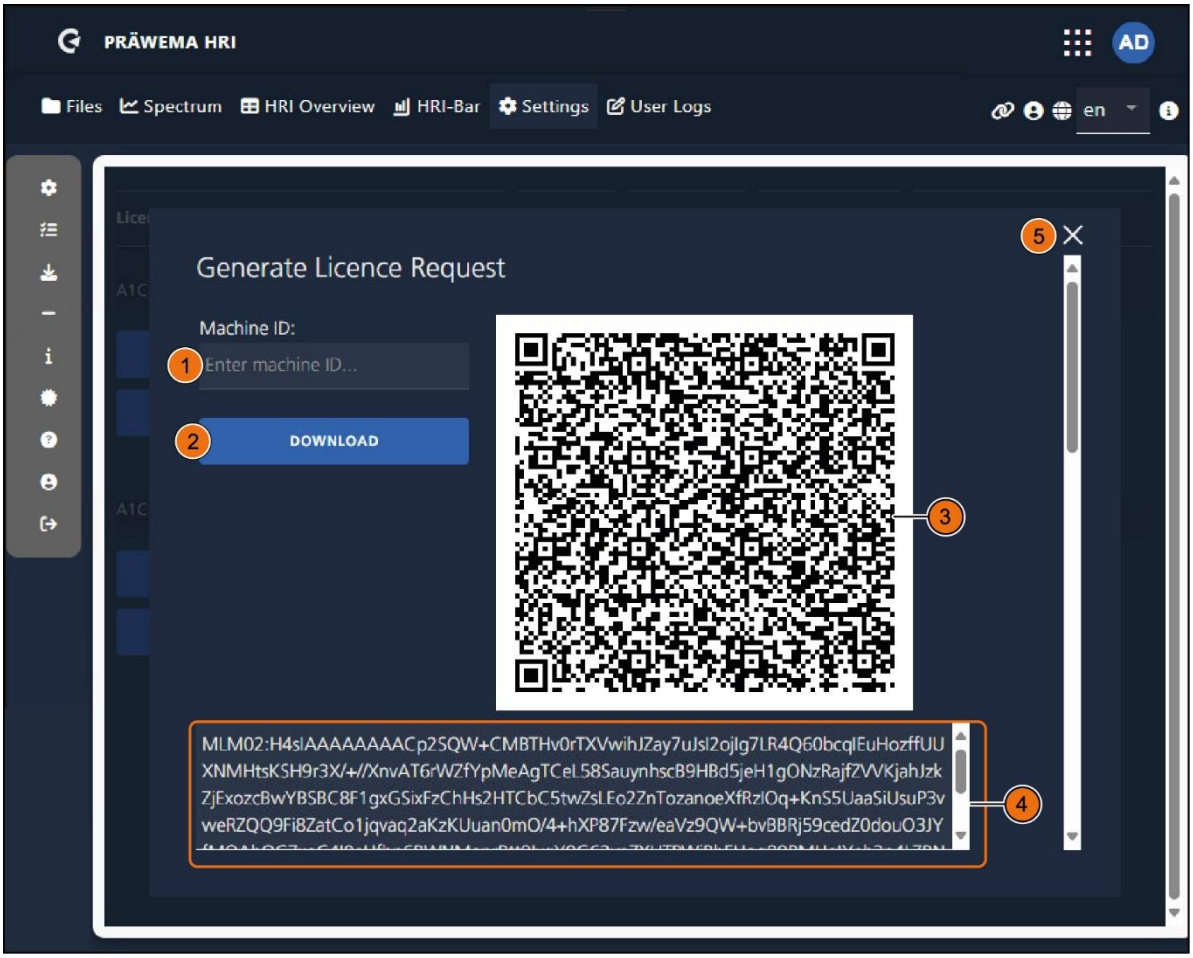


Fig. 42 License management menu - Generate License Request input window

Item	Name	Function	Description
1	**Machine ID**	Input field	Enter machine number
2	**DOWNLOAD**	Button	Save LRQ file
3	**QR-Code**	Display field	QR code graphic
4	**Text**	Display field	Text field with code
5	**CLOSE**	Button	Close input window

INSTRUCTION
To create the LRQ file:

1. Enter the machine number in the *Machine ID* (1) input field
2. To save the generated LRQ file in the Downloads folder, select the *Download* (2) button

3.6.6.3 Generate test license

A maximum of two test licenses can be generated. The test license works until the last day of the following month.

The license key is linked to a MAC address of the controller. If the controller is replaced, a new license must be generated. Test license can be used for the transition.

INSTRUCTION
To generate a test license, select the *GENERATE TEST LIC* (fig. 39, pos. 4).

The *Generate TEST LIC* input window is opened.

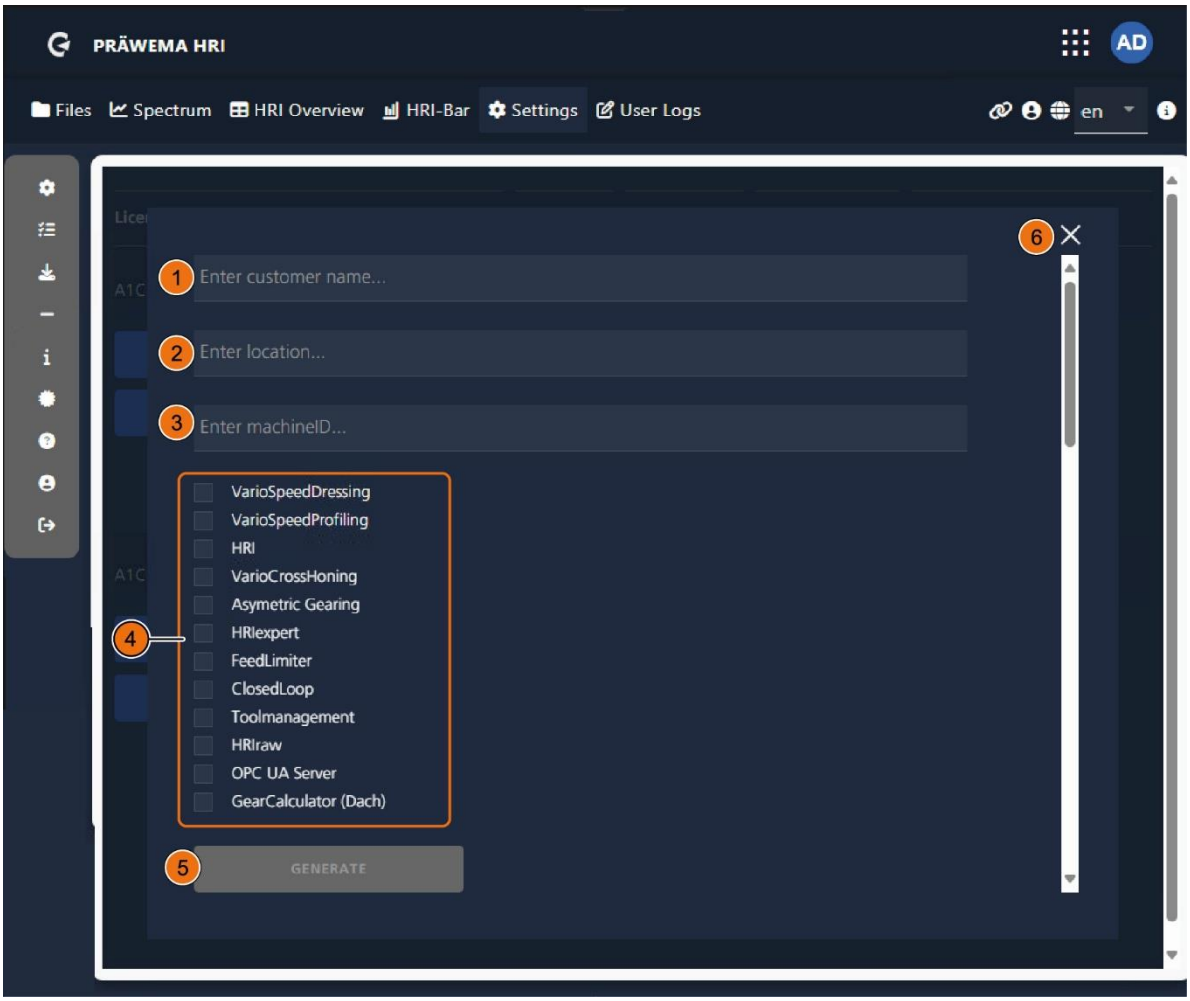


Fig. 43 License management menu - Generate Test license input window

Item	Name	Function	Description
1	**Customer name**	Input field	Enter customer name
2	**Location**	Input field	Enter location
3	**Machine ID**	Input field	Enter machine ID
4	**Variables**	Checkboxes	Select variable
5	**GENARATE**	Button	Create test license
6	**CLOSE**	Button	Close input window

3.6.7 Help menu

Fig. 44 Help menu

Item	Name	Function	Description
1	**Training document**	Display field	Training documentation for HRI and HRIexpert
2	**Navigation bar**	Button	Miniature view of the individual pages for navigating
3	**Page before**	Button	Scroll one page back
4	**Page no.**	Button	Enter the page nos., which should be opened
5	**Page back**	Input field	Scroll one page back
6	**Mag. lens**	Button	Open search function input field
7	**Enlarge +**	Button	Enlarge text
8	**Shrink -**	Button	Shrink text
9	**Scroll**	Button	Scroll in the document (across or vertically)

In the *Help* menu, the stored training documentation for HRI and HRIexpert are shown.

INSTRUCTION
To open the input field *Text search*, click the *Lens* button (6).

The input field *Text search* is opened for the search function.

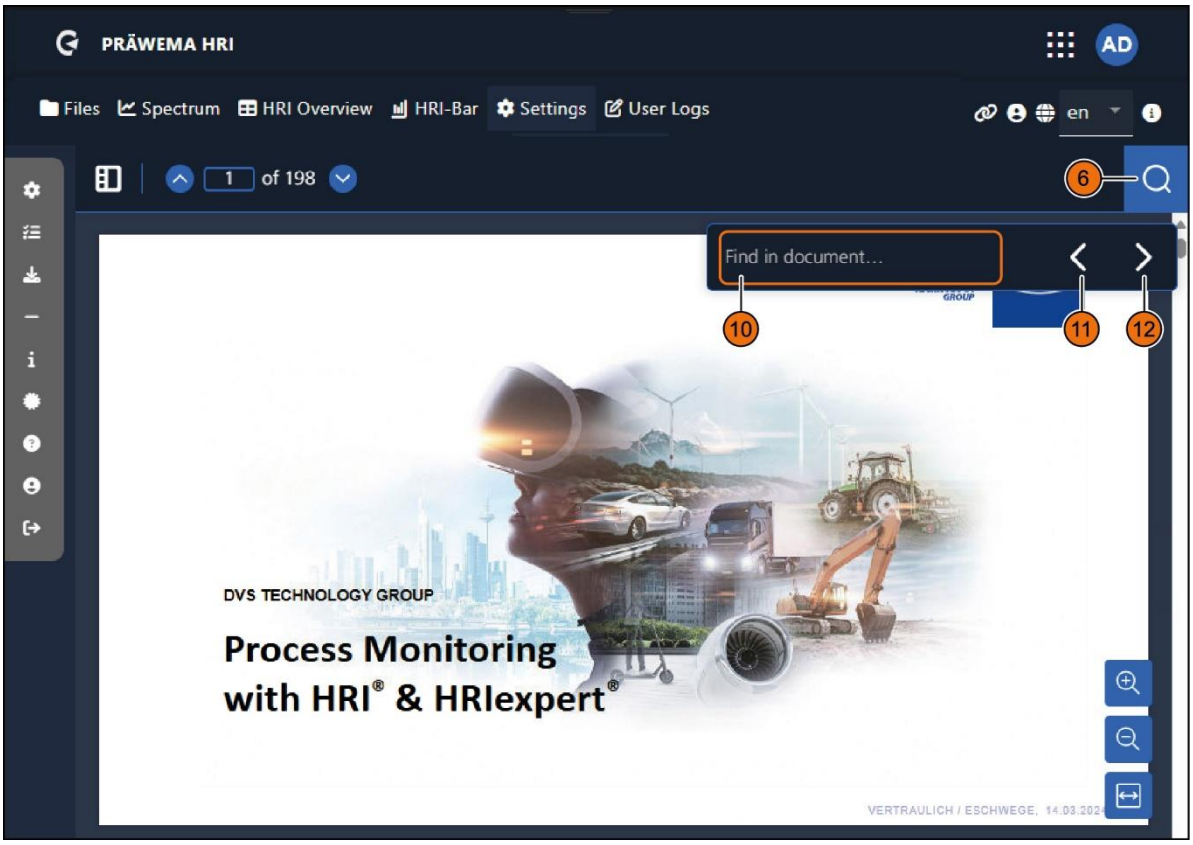


Fig. 45 Help menu - search open input field

Item	Name	Function	Description
10	**Search text field**	Input field	Enter text for search in the document
11	**Backwards**	Button	Jump to the previous hit in the training documentation.
12	**Forwards**	Button	Jump to the next hit in the training documentation.

INSTRUCTION
To close the input field *Text search* (10) click on the *Lens* button (6) again.

3.6.8 To the User management menu

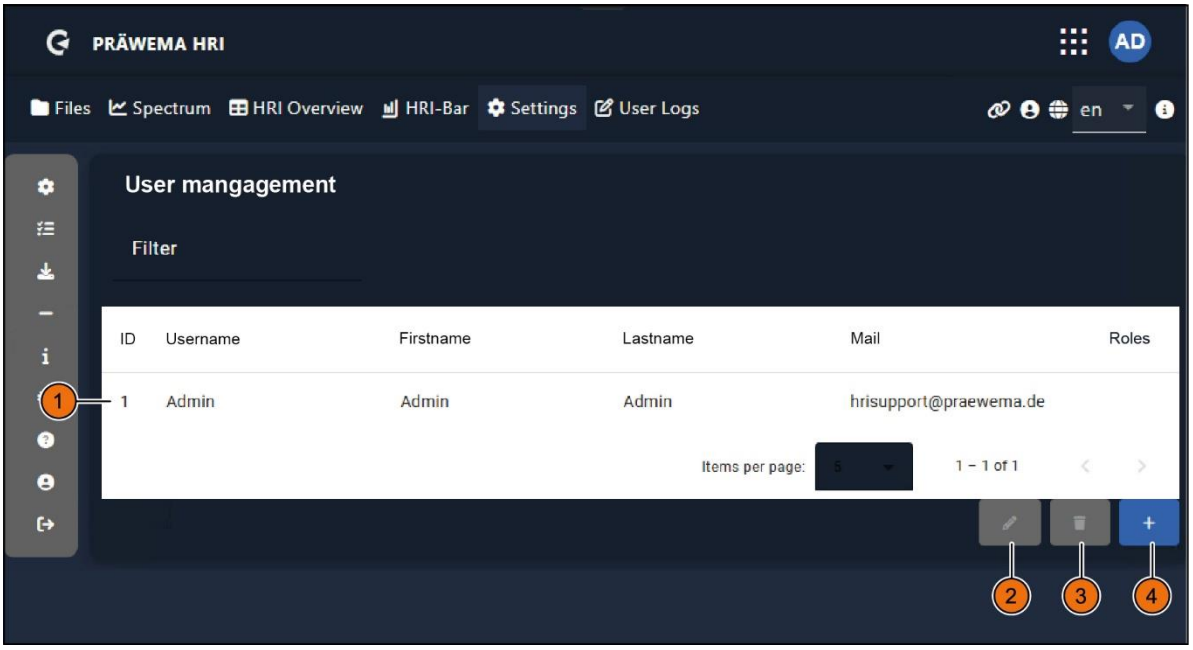


Fig. 46 To the user management menu

Item	Name	Function	Description
1	**User**	Display field	Registered user
2	**Edit**	Button	Process user data
3	**Delete**	Button	Delete user
4	**User Add (+)**	Button	Add new user

In the *User management* menu, various users can be created and edited. Authorization levels were introduced to prevent unauthorized inputs.

Item	Authorization levels	Rights
1	**Operator**	No authorization to change limiting values.
	Setter	The limiting values can be changed
	Administrator	The limiting values and settings can be changed

INSTRUCTION
To add a new user, select the "+" (4) button.

The *Add user* input window is opened.

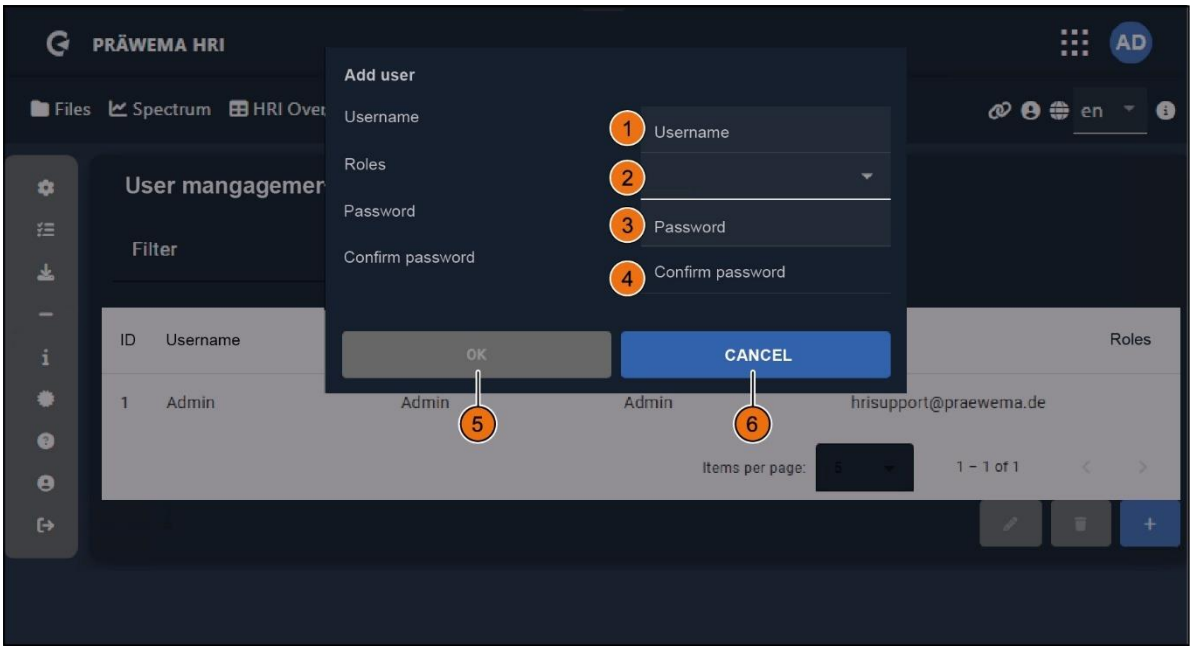


Fig. 47 User management menu, add user input window

Item	Name	Function	Description
1	**Username**	Input field	Enter username
2	**Role**	Selection field	Select user level
3	**Password**	Input field	Enter password
4	**Repeat password**	Input field	Repeat password
5	**OK**	Button	Confirm input
6	**STOP**	Button	Delete input

INSTRUCTION
To create a new user or to edit an existing user:

1. Enter username (1),
2. Select user level (2),
3. Specify password (3+4),
4. Confirm all entries with the *OK* (5) button.

3.7 Documentation menu

Fig. 48 Documentation menu

Item	Name	Function	Description
1	**Sequence**	Display field	Stored notices with date and clock time
2	**Delete**	Button	Delete sequence input
3	**NEW ENTRY**	Button	Create new logbook entry
4	**EXPORT**	Button	Export course as JSON file

In the *Documentation menu*, a logbook for the machine can be created.

Notices about changes and adjustments can be entered here. So, it can be documented why HRI objects were changed and what effects this has.

INSTRUCTION
To add a new entry, select the *NEW ENTRY* (3) button.

INSTRUCTION
To save the entry as a JSON file, select the *EXPORT* (4) button.

The *New logbook entry* input window is opened.

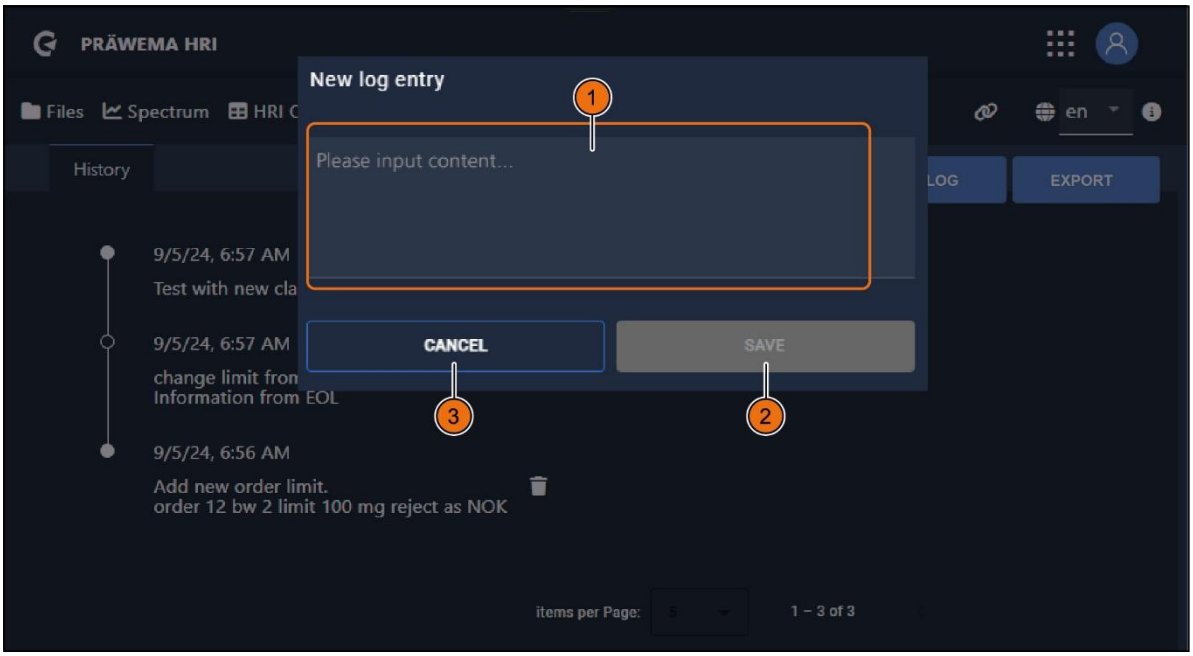


Fig. 49 Documentation menu - New logbook entry input window

Item	Name	Function	Description
1	**New Logbook entry**	Input field	Write new entry with date and clock time
2	**SAVE**	Button	Save new entry in the logbook
3	**STOP**	Button	Stop text input

4 HRI®expert software component

4.1 What is HRIexpert?

The **HRIexpert** software component expands the range of **HRI** functions to include the frequency analysis (FFT) high-frequency data.

This function facilitates the targeted monitoring of specific orders, to effectively prevent quality failures in the workpieces produced, and detect them before the next process.

In HRIexpert, limiting values can be defined individually and in detail, and extended to orders or even limit curves.

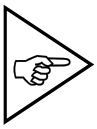
The saving of the frequency courses creates the basis for a workpiece-related detailed analysis.

4.1.1 Added value with HRIexpert

The order analysis and monitoring are essential functions that require expert knowledge for parameterizing.

Extended logging functions enable a detailed recording of various machining processes.

With the HRIexpert component, CSV files can be generated that are compatible with third party systems. This ensures seamless integration in various platforms.



NOTE!
Each order corresponds to a multiple of the basic speed of the rotor.
This means that the first order corresponds to the speed of the rotor itself, the second order to the double speed, and so on.
Each order stands for a harmonic component in the vibration signal.

4.2 HRIexpert - visualization

4.3 File system menu - overview of limiting values of frequency object

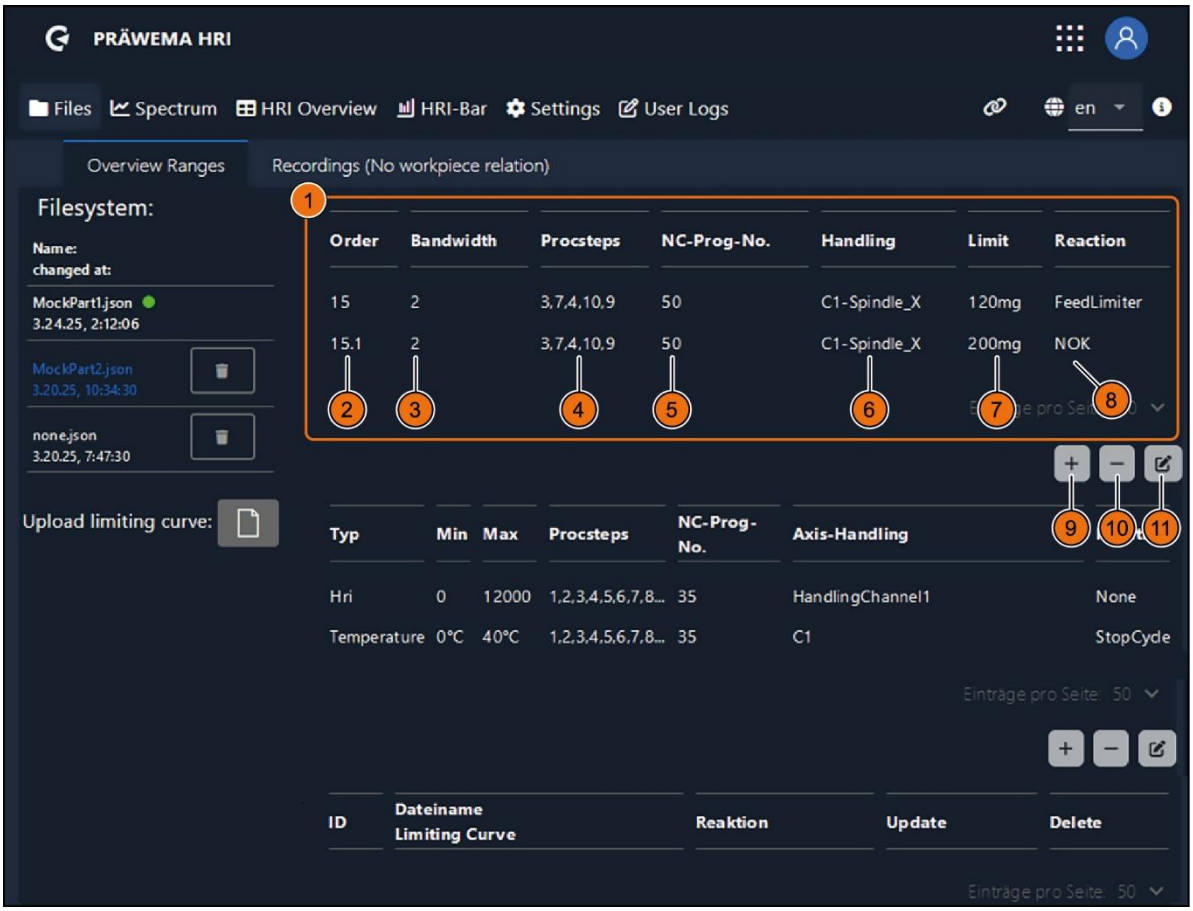


Fig. 50 File system menu - upper area - limiting values of frequency object

Item	Name	Function	Description
1	**Upper range**	Display range	All limiting values frequency object
2	**Order**	Display field	Orders that should be monitored (feedback required from the test bench)
3	**Bandwidth**	Display field	Bandwidth of orders
4	**Program steps**	Display field	Program steps of the machining that are monitored
5	**NC-program numbers**	Display field	NC subprograms that are monitored
6	**Handling**	Display field	Select which spindle or which sensor should be monitored
7	**Limiting value**	Display field	Limit value in mg which triggers the fault response when exceeded
8	**Reaction**	Display field	Fault response that is triggered if the value is exceeded.

9	**+**	Button	Create new frequency object
10	**-**	Button	Delete selected frequency object
11	**Edit**	Button	Open existing *frequency object* menu

4.3.1 New frequency object menu - input menu for limiting values

An input menu for the *Frequency objects* is integrated into the software for easier configuration of the limiting values and to reduce the risk of incorrect inputs.

In this input menu, individual variables can be monitored and fault responses defined.

INSTRUCTION

To open the input menu, press the *Machining* (11) button in the *file system* menu.

The *New frequency object* input menu is opened.

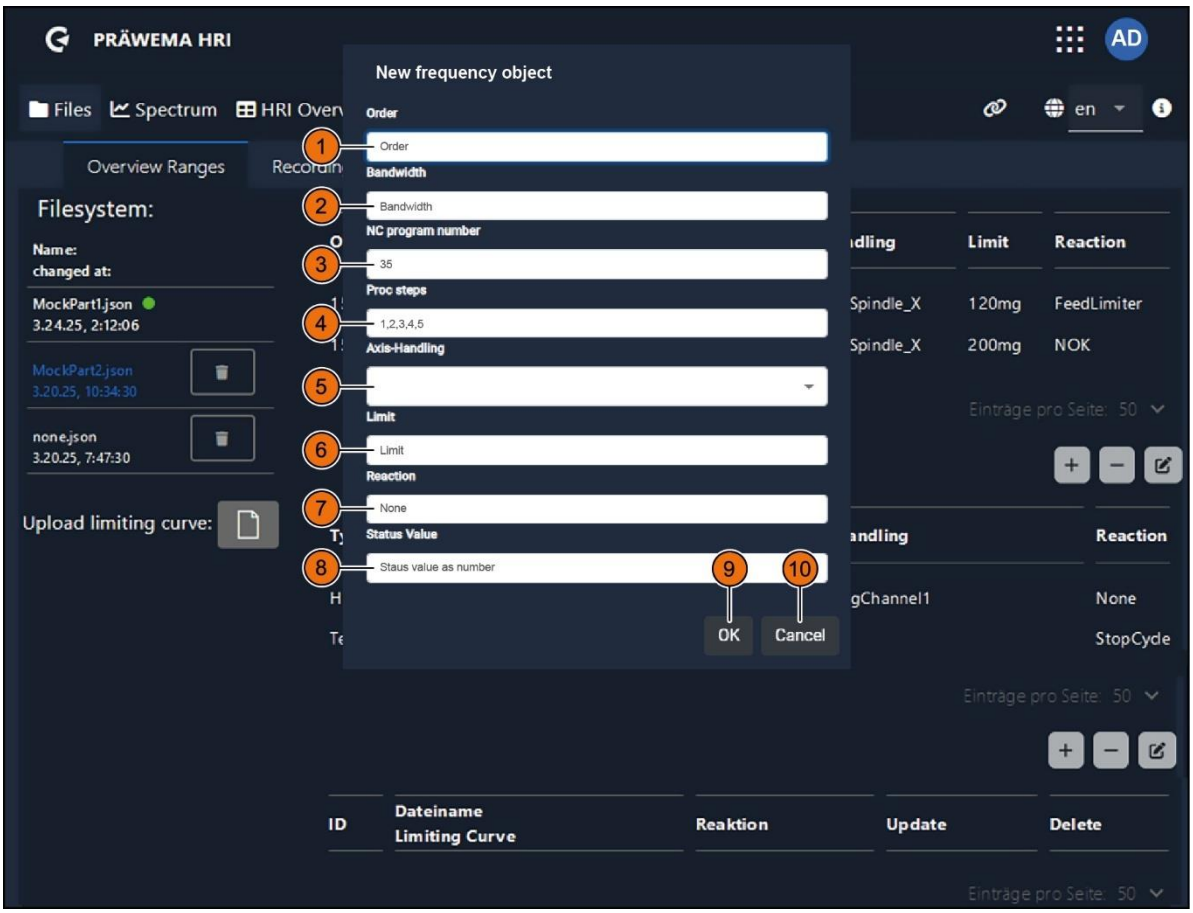


Fig. 51 Input menu: new frequency object

Item	Name	Function	Description
1	**Order**	Input field	Enter which orders should be monitored.
2	**Bandwidth**	Input field	Enter the bandwidth of the orders.
3	**NC program numbers**	Input field	Various subprograms, enter channel-number, See chapter 3.2.1.3
4	**Program steps**	Selection field	Select program steps of the machining that are monitored, See chapter 3.2.1.4
5	**Axis handling**	List selection field	Select spindle or sensor which should be monitored, See chapter 3.2.1.5

6	**Limiting value**	Input field	Enter the limiting value in mg which triggers the fault response when exceeded
7	**Reaction**	List selection field	Fault response that is triggered if the value is exceeded.
8	**Status Value**	Input field	Input status text number for display in the HMI.
9	**OK**	Button	close
10	**Stop**	Button	close

4.3.1.1 Responses of the machine

In the selection list, the fault responses are available for selection, which are triggered if certain values are exceeded or not reached.

These fault responses may cover various measures, such as stopping the process, triggering an alarm or displaying a warning message to indicate deviations or problems in the machining process.

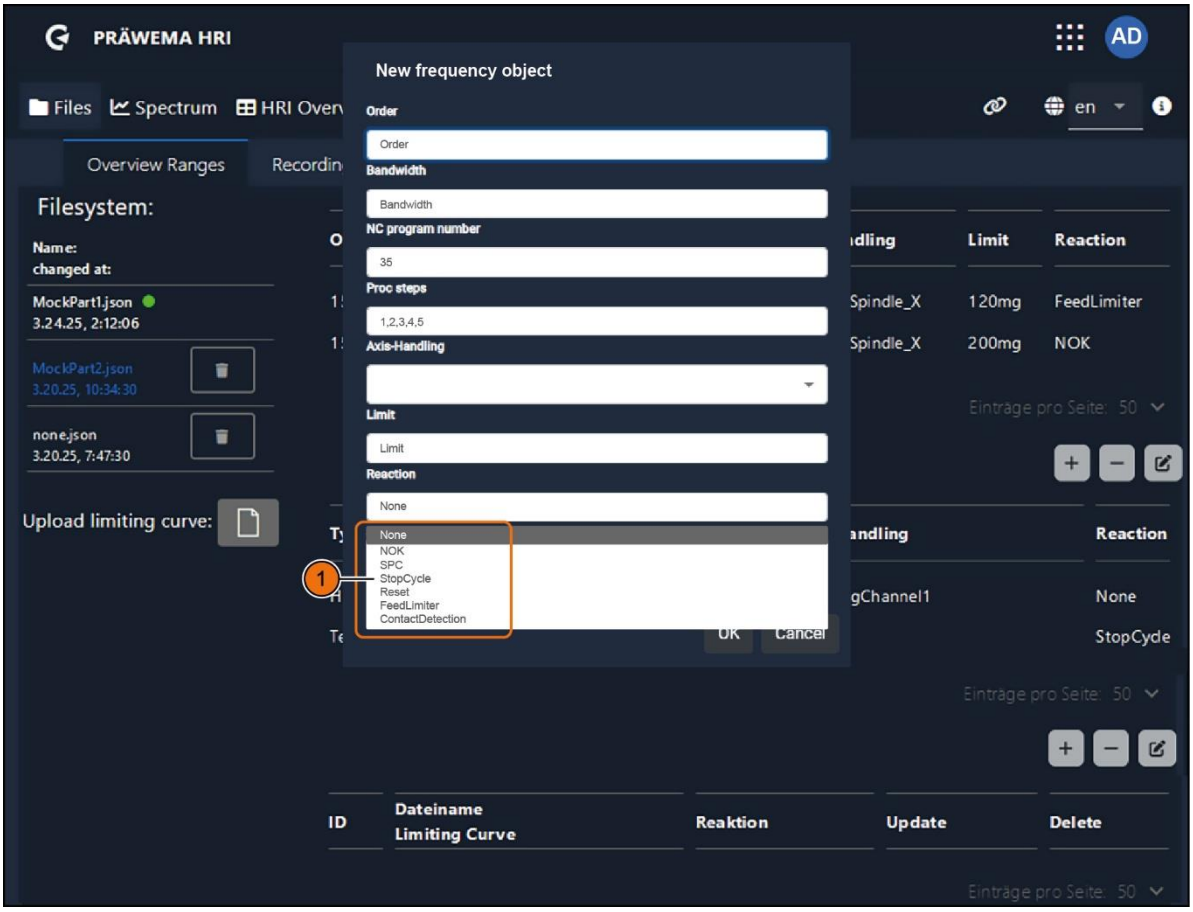


Fig. 52 New frequency object menu - selection list reactions

Item	Reaction	Description
1	**None**	No machine reaction
	NOK	The part is ejected as an NOK part
	SPC	The part is unloaded as an SPC part
	StopCycle	The machine stopped after the cycle.
	Reset	EMERGENCY STOP and retraction into X-0 position
	Feed control FeedLimiter	Feed limitation as from the infeed axis
	Contact detection	Contact detection from tool to workpiece.

4.3.1.2 Example of an order analysis

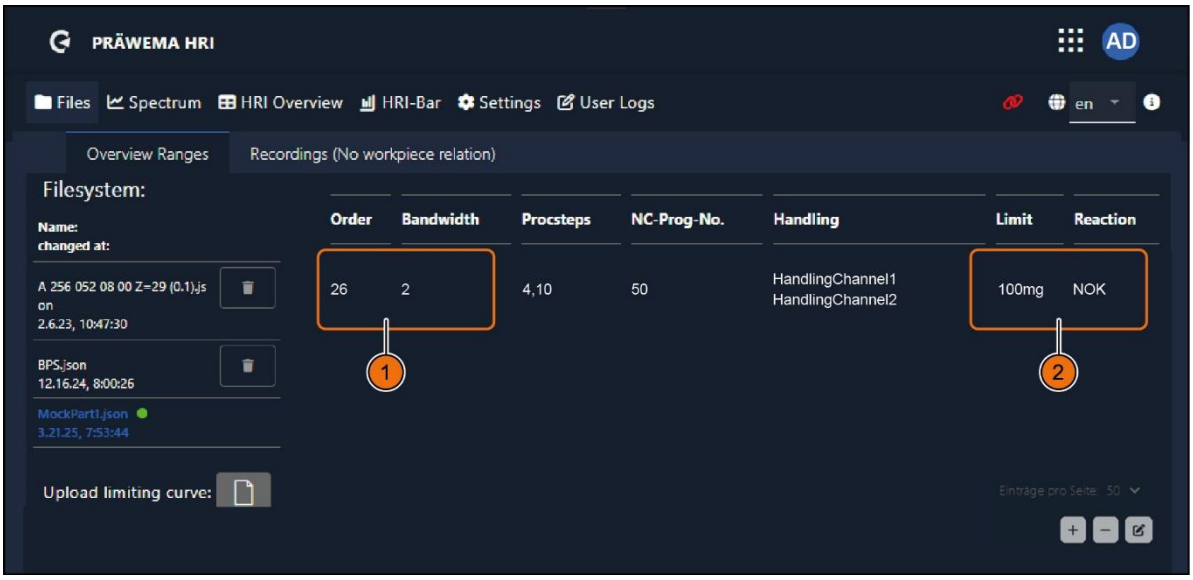


Fig. 53 Files menu - Order analysis

In this example the 26th order (1) is monitored with a Bandwidth of two orders.

Workpieces that exceed the limiting value of 100 mg are marked as NOK (2), and ejected from the production process.

This monitoring ensures a high product quality and minimizes exclusion in the assembly.

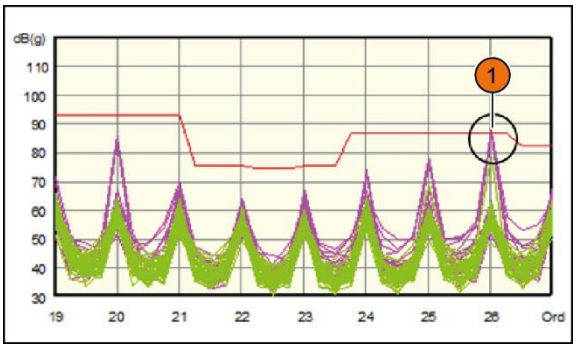


Fig. 54 Result of acoustic test stand

4.4 Upload limit curve

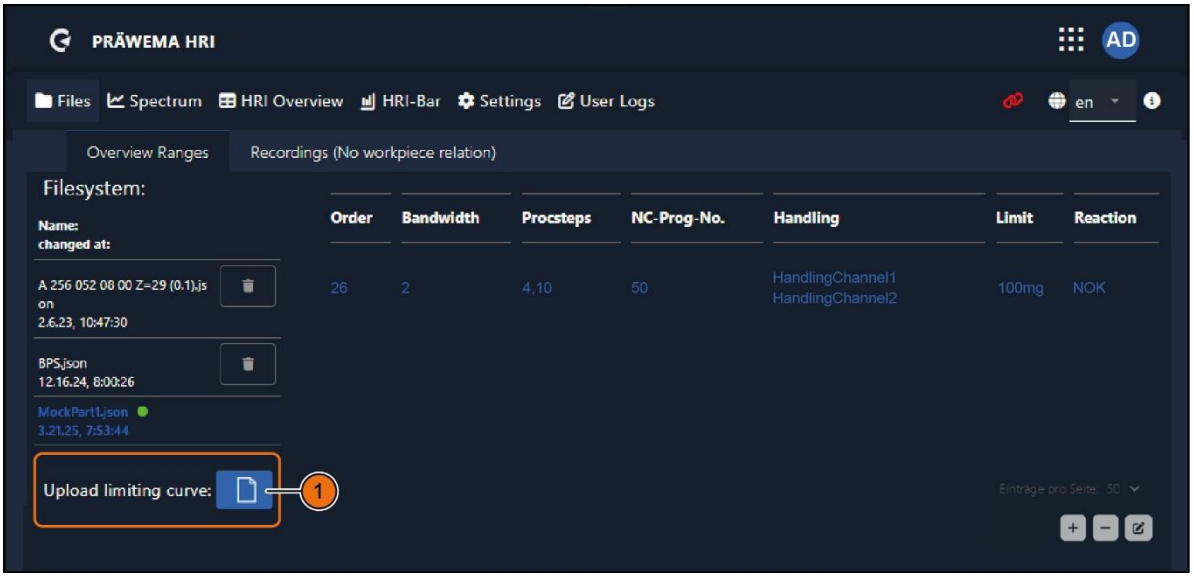


Fig. 55 Files menu - Upload limit curve

With the HRIanalyze+ software component, a limit curve can be created and saved as a JSON file. See chapter 5.4.4.2.

This limit curve can be read in and visualized with the HRIexpert.

INSTRUCTION
To upload the limit curve, select the button (1) in the menu file system.

The *Upload file* menu window file is opened .

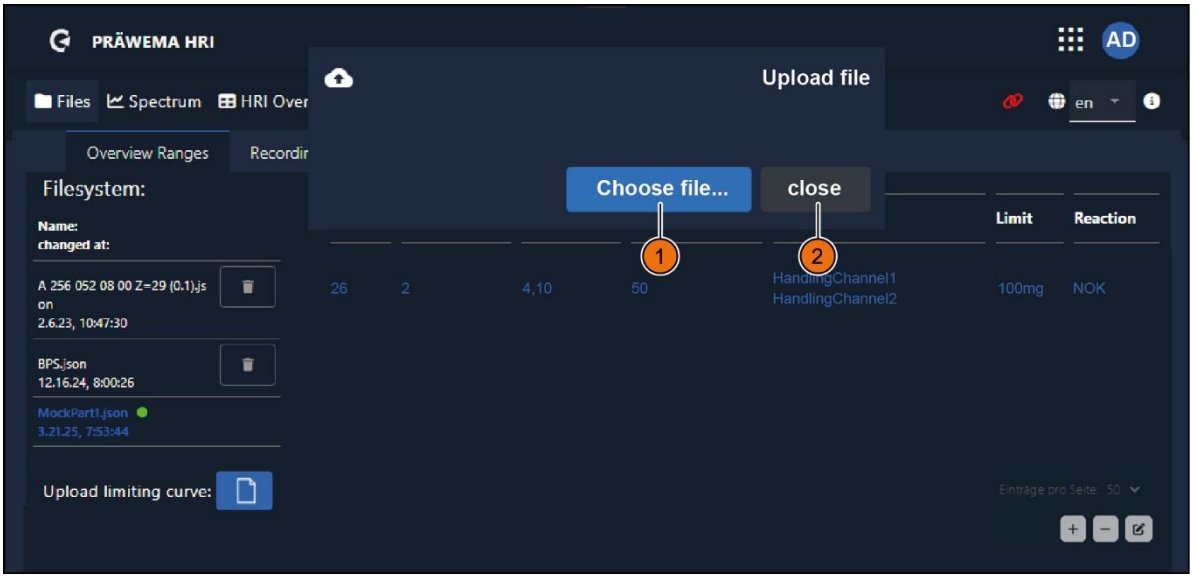
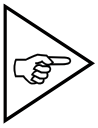


Fig. 56 Files menu - upload limit curve menu window

Item	Name	Function	Description
1	**Select file**	Button	Select file in the PC directory
2	**Close**	Button	Close menu window

INSTRUCTION
To upload the limit curve:

1. *Select the file* (1) button in the menu window.
2. A browser window is opened. Select the desired file on the PC and confirm with the *Open* button.
3. After the upload, the loading bar changes color.



NOTE!
The file name of the limit curve and the file name of the workpiece, for which the limit curve should apply, must be identical, otherwise the HRI monitoring (HRIexpert) cannot assign the limit curve!

INSTRUCTION
To check whether the limit curve has been uploaded, switch to the *Spectrum* menu. See chapter 4.6.3.

4.5 File system menu - Recordings

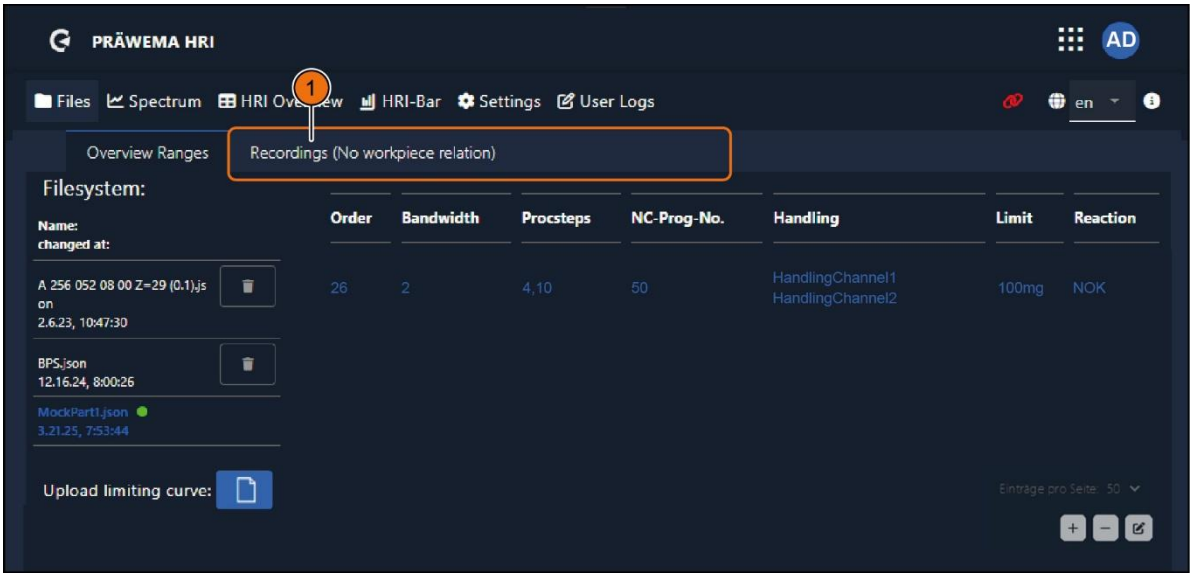


Fig. 57 Files menu - Register recordings - recording function of the spectrum

INSTRUCTION
In the *File system* menu, click register *Recordings* (1).

Register *Recordings* is opened in the Files menu.

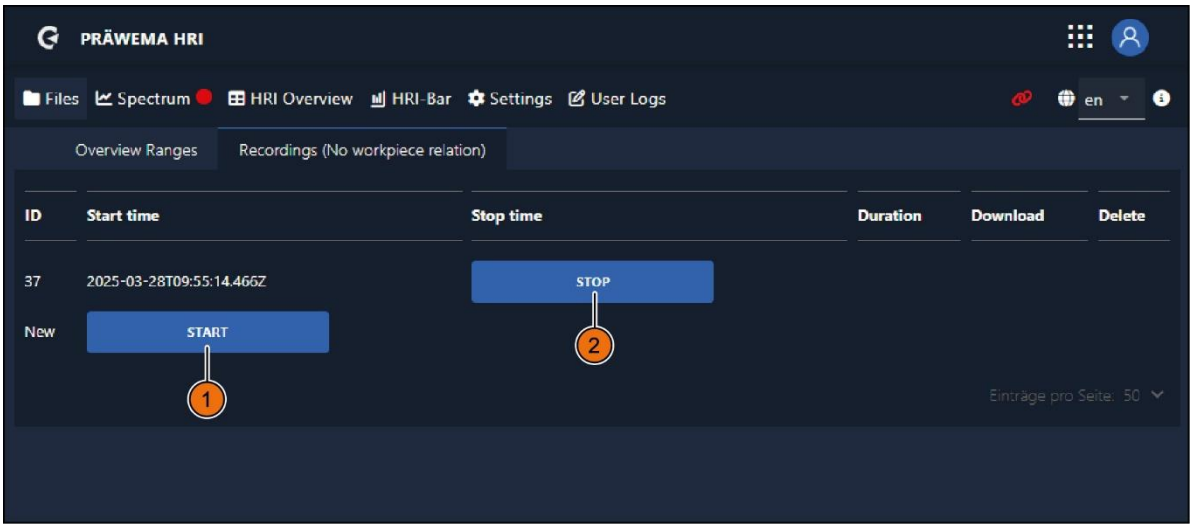


Fig. 58 Files menu - Register Recordings

Item	Name	Function	Description
1	**START**	Button	Start recording
2	**STOP**	Button	Stop recording

In register *Recordings*, a manual recording function of the vibration spectra can be started. Here the recording can also be stopped and the recording saved.

INSTRUCTION
To start the recording, click the *START* (1) button.
To stop the recording select the *STOP* (2) button.

The recording is stored as a BIN file. The recording can be opened and analyzed with the software component HRIanalyze+.

INSTRUCTION
To monitor the recording, open the *Spectrum* menu.

Activating the recording function shows an additional field in the *Spectrum* menu.

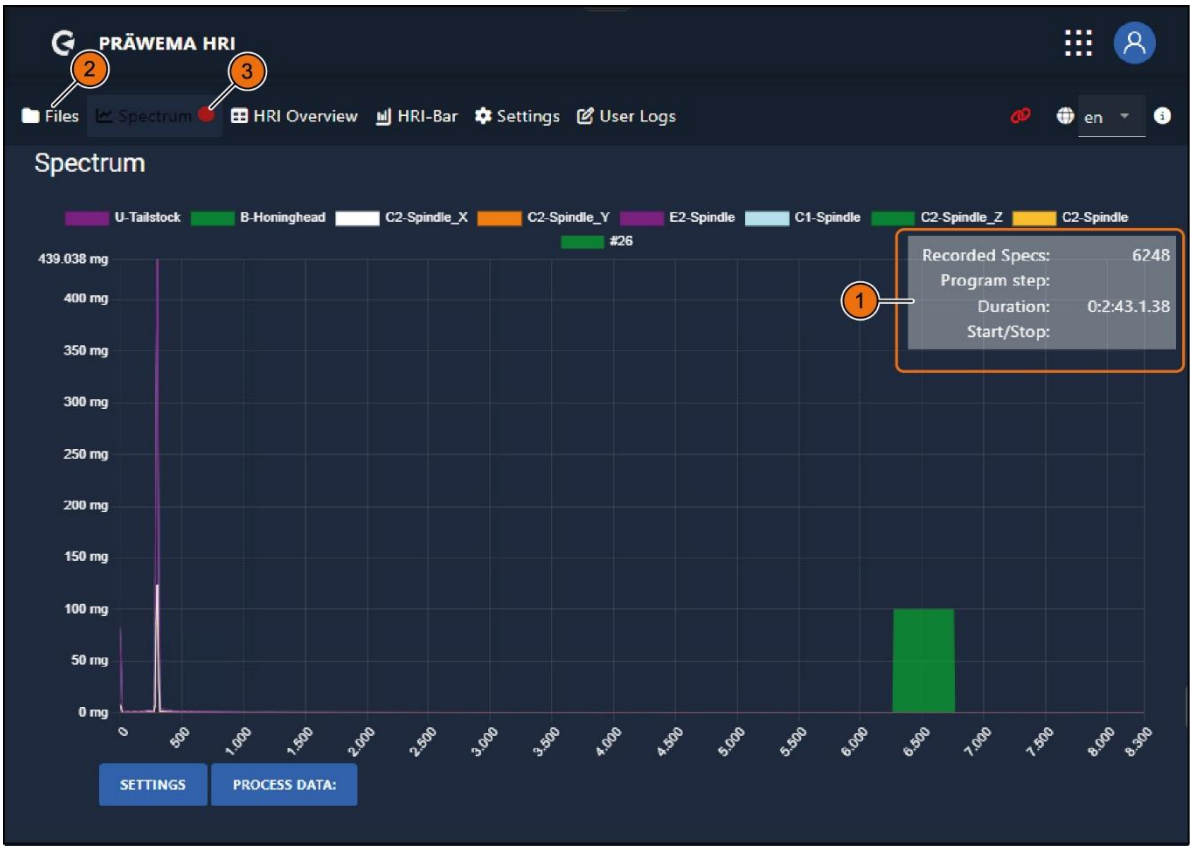


Fig. 59 Spectrum menu - Register recordings

Item	Name	Function	Description
1	**Infos Record**	Display field	Info on the running recording are shown
2	**FILES**	Button	To the *Files* menu
3	**Red point**	Display flashes	Recording running

INSTRUCTION
To stop the recording, select the STOP button in the *Files* menu.

4.6 Spectrum menu

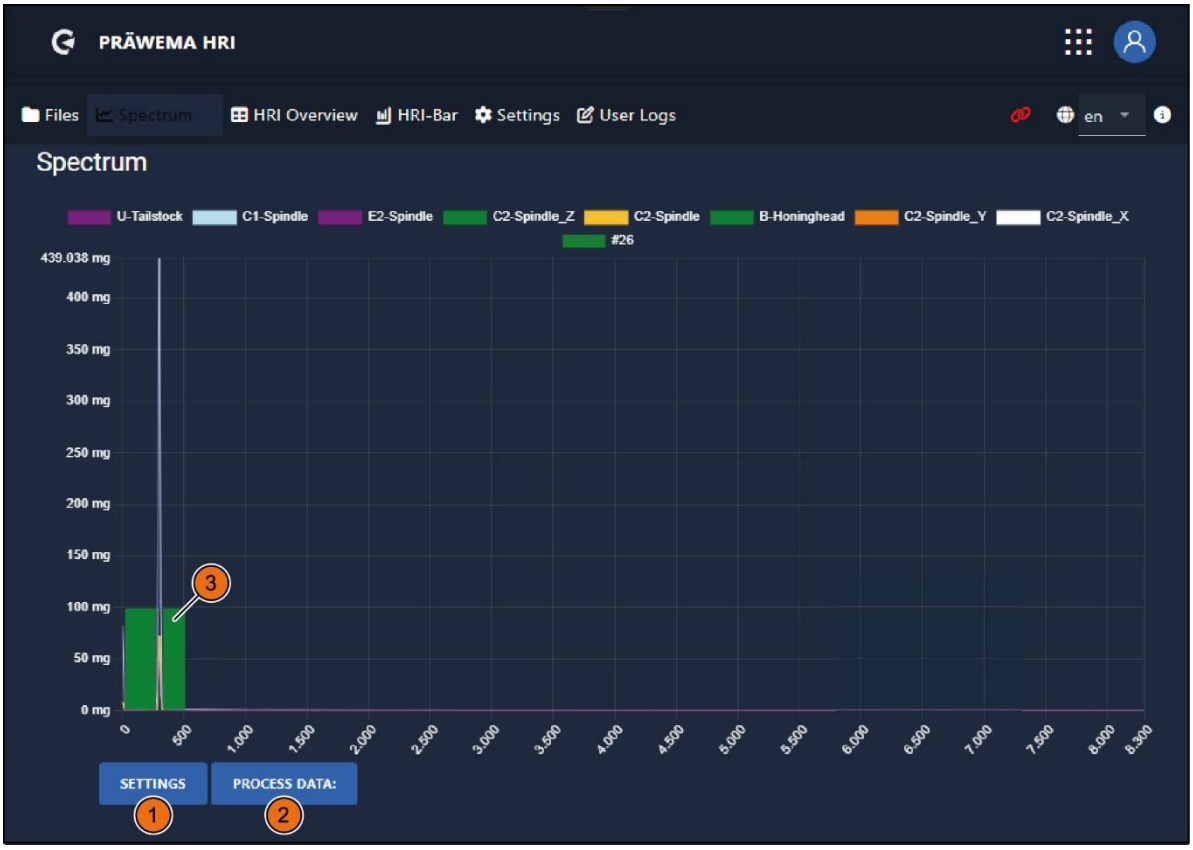


Fig. 60 Spectrum menu

Item	Name	Function	Description
1	**SETTINGS**	Button	Open the *Settings* menu window (orders / frequencies)
2	**PROCESS-DATA**	Button	Open *Process data* menu window
3	**Bar charts**	Indication	Frequency objects as bar charts

In the Spectrum menu, The order objects are shown as bar charts. If the process step is not active, the bar chart (3) is light blue. If the process step is active, the bar chart is green. If the limiting values are exceeded, the bar chart (3) is red.

INSTRUCTION
To open the *SETTINGS* menu window, select the button (1).

INSTRUCTION
To open the *PROCESS DATA* menu window, select the button (2).

4.6.1 Settings frequency / order)

The *SETTINGS* menu window is opened for order or frequency (1).

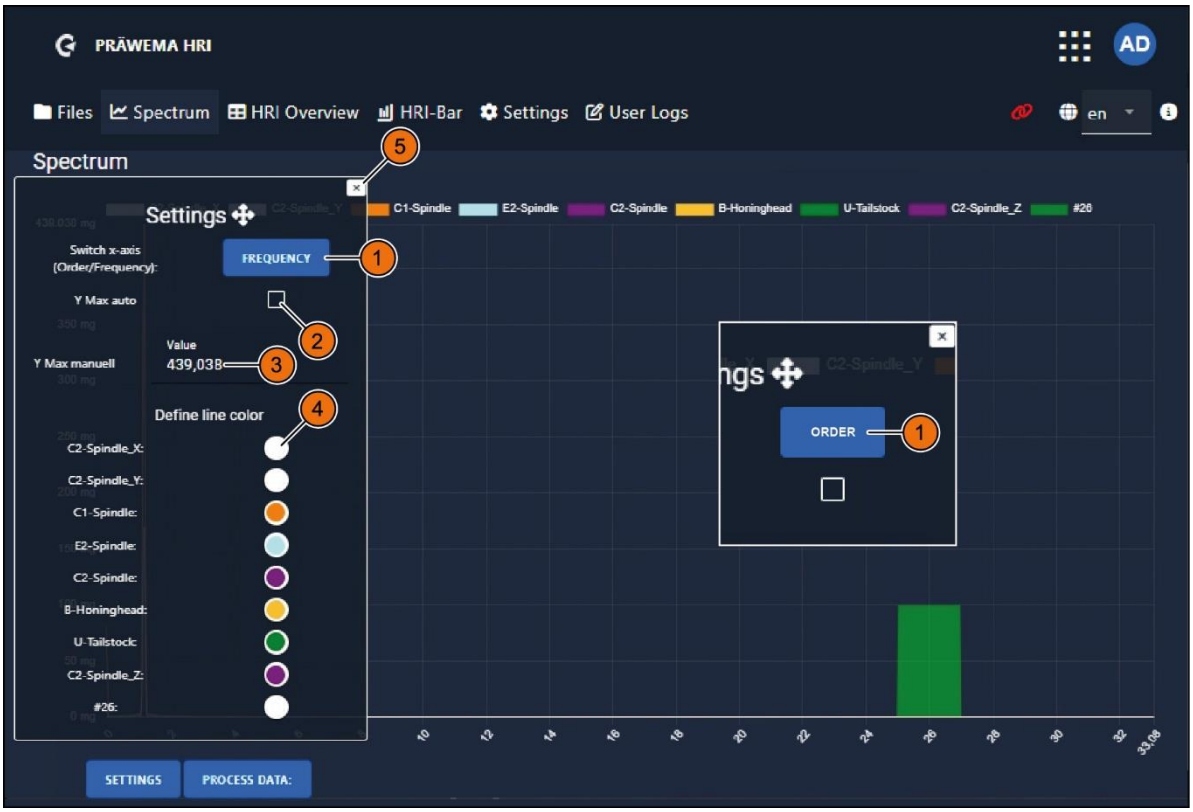


Fig. 61 Spectrum menu - Settings menu window - Adapt frequency or order

Item	Name	Function	Description
1	**FREQUENCY / ORDER**	Button	The X-axis of the diagram is shown as a FREQUENCY or ORDER.
2	**Y max automatic**	Checkbox	Adapt value automatically
3	**Y max manual**	Input field	Enter fixed value
4	**Line colors**	Buttons	Adjust line color
5	**Close**	Button	Save and close the Settings menu window

In the menu window *SETTINGS*, the X-axis can be switched between the frequency and the orders in relation to the speed of the workpiece spindle.

INSTRUCTION
Select the button (1) to change between the order or frequency settings.

INSTRUCTION
Set the Y-axis to either a fixed value (3) or to automatically adjusted (2).

The colors of the individual lines can be individually specified.

INSTRUCTION
To adapt the colors, select the desired *Line color* (4) button.

The *Adapt line colors* menu window is open.

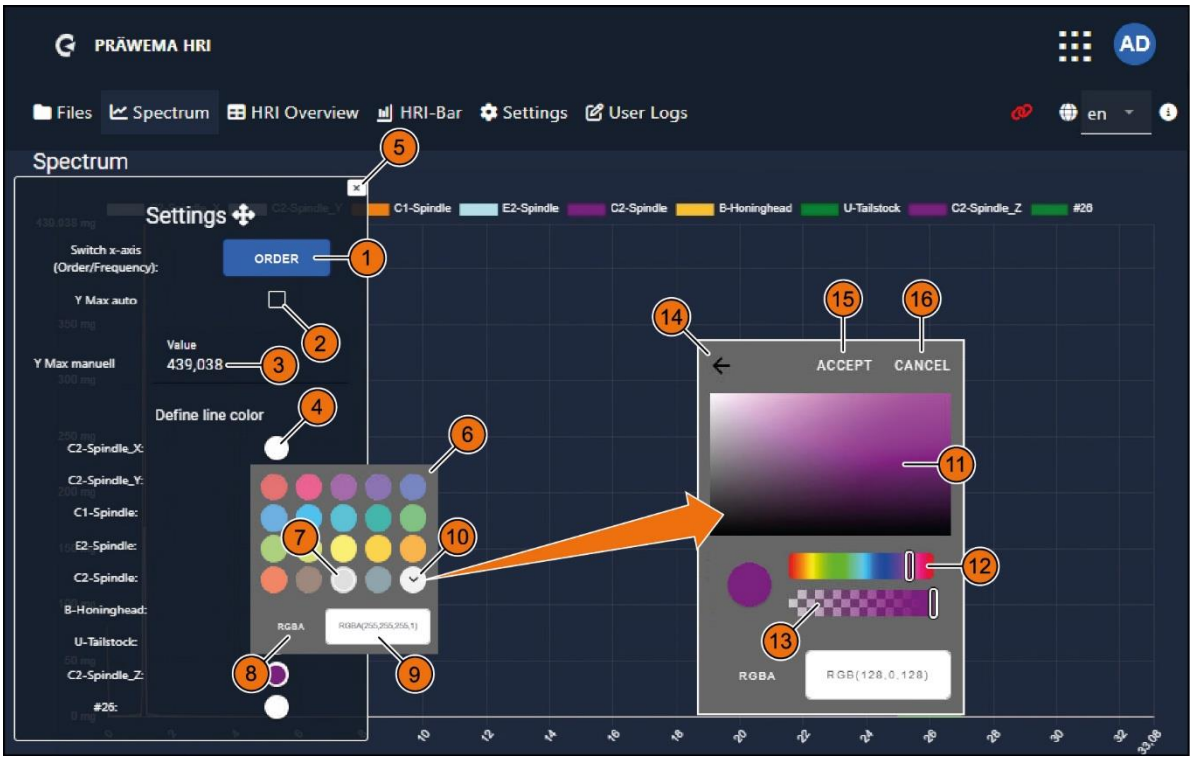


Fig. 62 Spectrum menu - Settings menu window - Adapt line colors

Item	Name	Function	Description
1	**FREQUENCY / ORDER**	Button	The X-axis of the diagram is shown as a FREQUENCY or ORDER.
2	**Y max automatic**	Checkbox	Adapt value automatically
3	**Y max manual**	Input field	Enter fixed value
4	**Defined line colors**	Buttons	Set line color
5	**Close**	Button	Close setting menu window
6	**Color selector**	Menu window	Select colors for the lines
7	**Current color**	Selection	Currently selected color (indicated by a white circle.
8	**Color model**	Button	Switch between the color models RGBA / HSLA / CMYK / HEX
9	**Color model Values**	Input field	Enter color values manually (numerical value)
10	**Color field**	Input field	Open color field menu window

11	**Extended color field window**	Selection field	Select color
12	**Color selector**	Slider	Select color
13	**Transparency**	Slider	Select transparency
14	**ACCEPT**	Button	Accept selected color
15	**CANCEL**	Button	Close menu window

INSTRUCTION
Select the button (10) to open the *Extended color* field menu window.
In the *Extended color* field (11) menu window, set a color and save with the *ACCEPT* (15) button.

In the color field of the color selector, various color components can be set in the color models RGBA, HSLA, CMYK or HEX.
All settings made are stored and are available the next time the page is called.

4.6.2 Process data

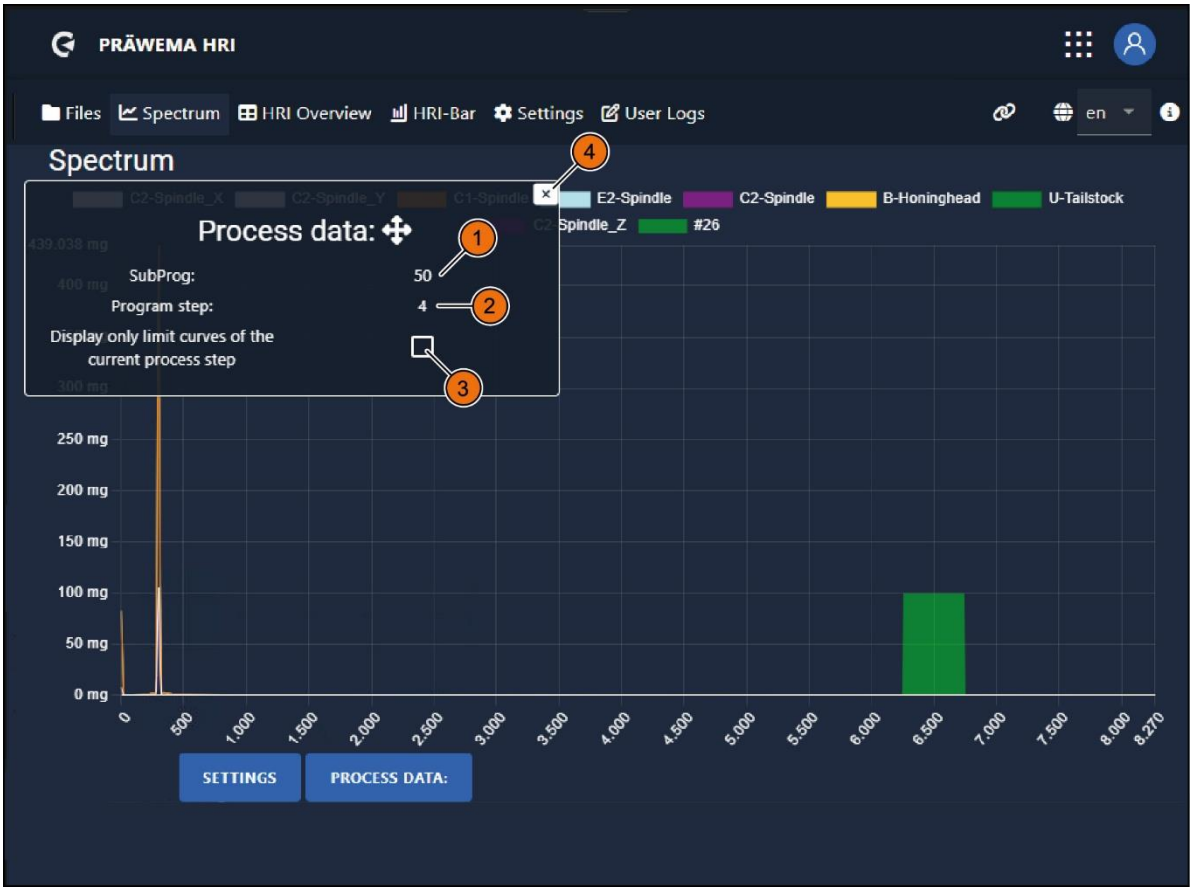


Fig. 63 Spectrum menu - adapt line colors menu window

Item	Name	Function	Description
1	**SubProg**	Display field	Display the current NC program
2	**Program step**	Display field	Display the active program step.
3	**Display only limit curves of the current process step**	Checkbox	Only display limit curves in the current process step
4	**Close**	Button	Close process data menu window

INSTRUCTION
To close the *Process data* menu window, click the button (4).

Under process data, the active NC program and the active process step are displayed. This controls the work step in which the machine processes the workpiece.

By means of a button, the limit curves are inly displayed in the current process step.

4.6.3 Check limit curve

After successful uploading of a limit curve (see chapter 4.4), a check can be made in the *Spectrum* menu whether or not the limit curve was taken over.

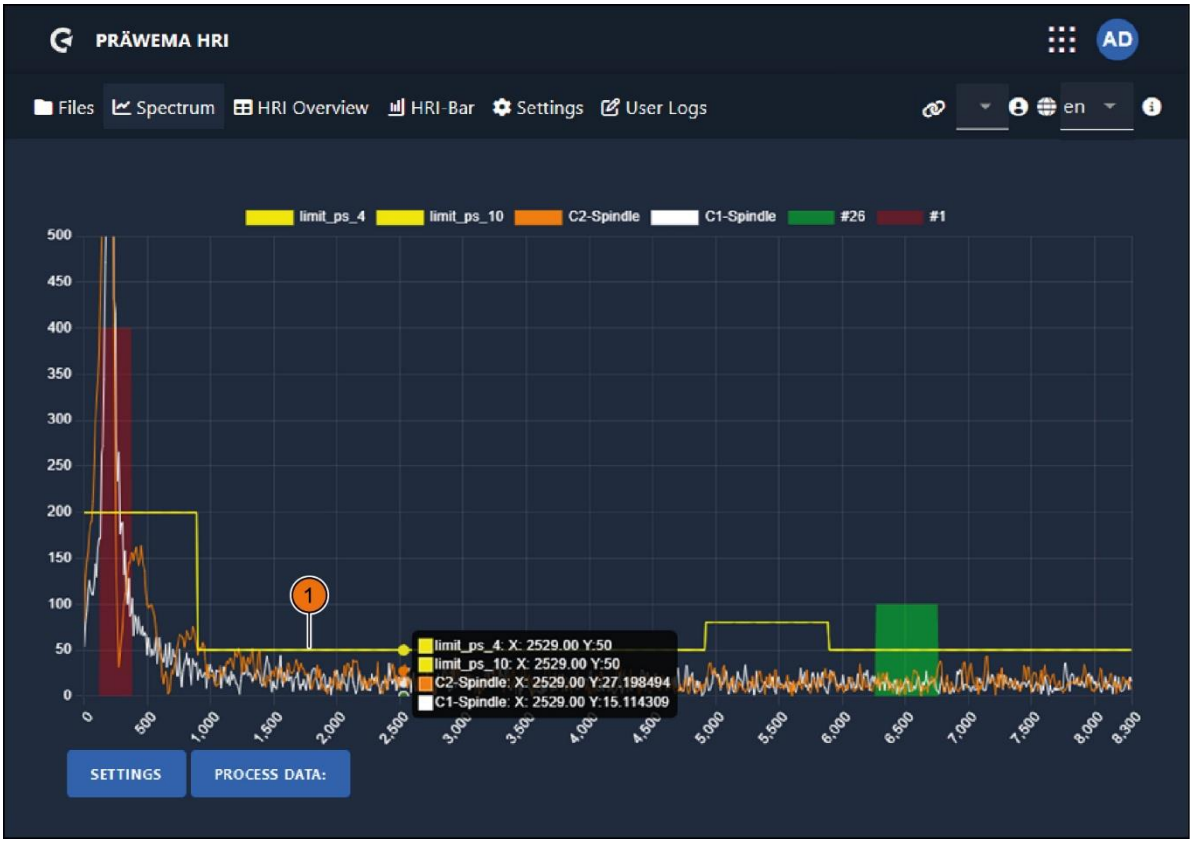


Fig. 64 Spectrum menu - checking the limit curve

The limit curve is shown in the *Spectrum* menu spectrum as a yellow limit line (1). Each active process step has been given its own limit curve.

4.7 Feed limitation menu - orders

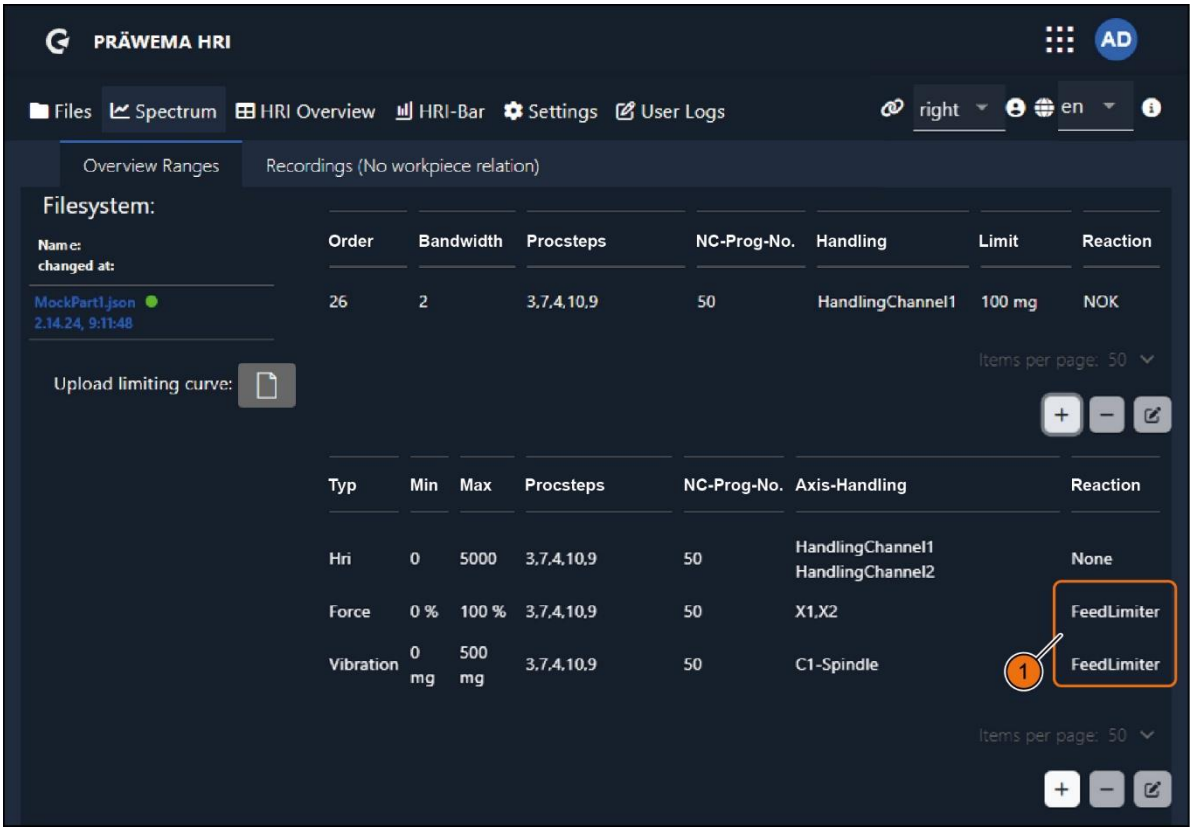


Fig. 65 Feed limitation menu - orders

To make the process stable, and to catch acceleration peaks, a feed limitation (Feed Limiter) was integrated in the software. So that precise process control is possible,

In the HRIexpert version, the control of the machine feed can be done by specifying threshold values for orders.

A limiting value for monitoring vibrations is programmed In the HRIexpert software component.

As soon as the specified threshold value is exceeded, there is the feed limitation.

The Feed Limiter was added to select the fault reaction (1).

If 100% of the set limiting values is exceeded, the feed is reduced by 10% steps until the vibrations stabilize. If the vibrations fall below the 100% limit, the feed is increased step by step.

In the event of exceeding the limiting value by 120%, the feed is reduced to 0%. If the vibrations fall below 100% of the limiting value, the feed is increased to 100% again in steps of 10%.

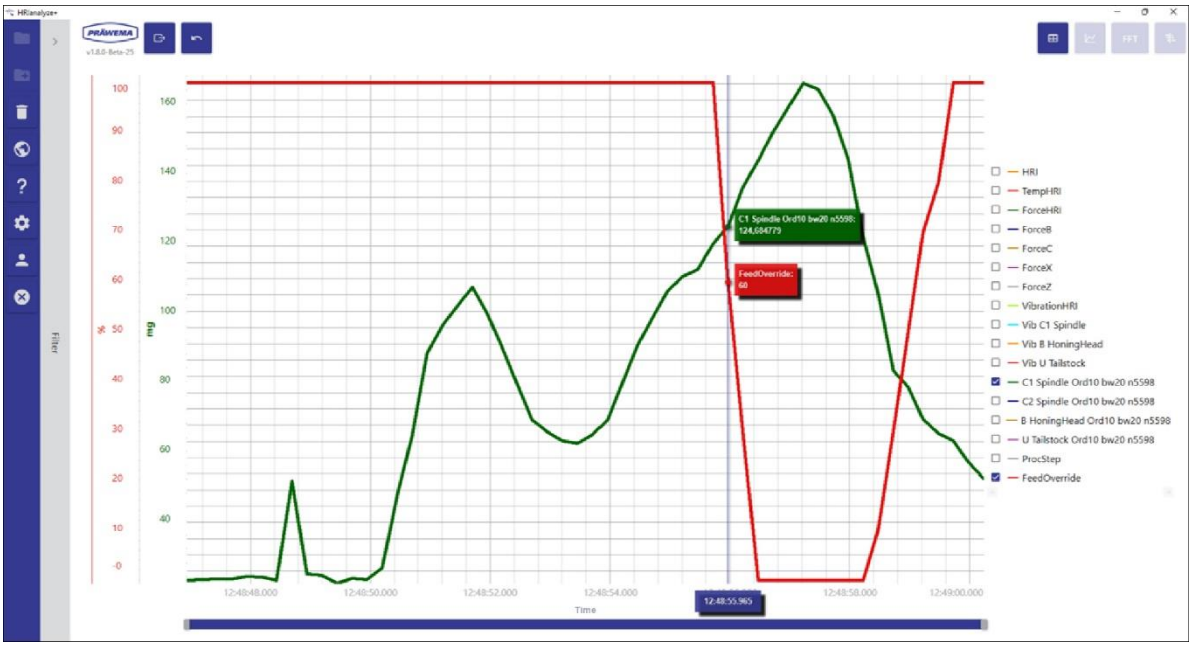


Fig. 66 Feed limitation menu - example in HRIanalyze+

The spindle "Vibration C1 spindle" (for the first 20 orders, value in mg) and FeedOverride (feed limitation) are shown in this example.

If the limiting value of 120 mg is exceeded, the feed limitation becomes active and reduces the feed of the X-axis.

5 HRI®analyze+ software component

5.1 What is HRIanalyze+?

The **HRIanalyze+** software component was developed to analyze the recorded HRI data. The program automatically detects the following file formats from the software components HRI and HRIexpert:

- HRILog
- HRIDebugLog
- HRIFFTLog
- HRIShockLog

The values in diagrams can be displayed in order to obtain an overview of the production and the part quality as quickly as possible.

For a better overview, certain parameters are preselected.

Furthermore, the following file-formats can be read in:

- XML files from Siemens Servo Trace,
- CSV files from the drive oscilloscope from Bosch Rexroth

From these read-in data, an FFT diagram can then be calculated.

5.2 HRIanalyze+ - visualization

INSTRUCTION
Proceed as follows to start the HRIanalyze+ software.

1. Open the *HRIanalyze+* file in the PC directory *HRIAnalyze+2.1.2* .
   The main HRIanalyze+ menu is opened.

5.3 Main menu HRI analyze+

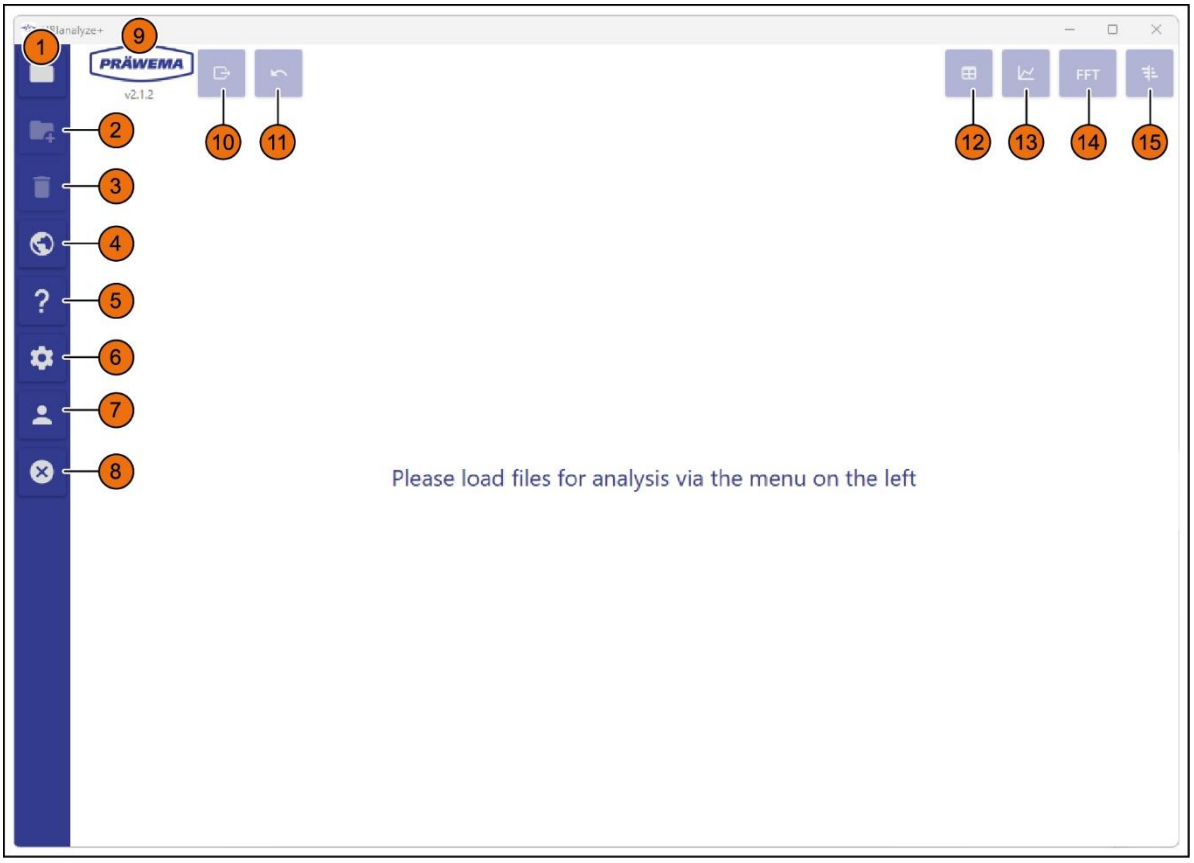


Fig. 67 Main menu HRIanalyze+

Item	Name	Function	Description
1	**Import**	Button	Open the *Import file* menu window
2	**Add files**	Button	Open the *Add files* menu window
3	**Unloading of files**	Button	Delete files
4	**Language selection**	Button	Open *Language selection* menu window
5	**Request support**	Button	Open the *Request support* menu window
6	**Settings**	Button	Open the *Settings* menu window
7	**Account**	Button	Open the *Current licenses* menu window.

8	**Exit**	Button	End HRIanalyze+ program
9	**v.2.1.2**	Display field	Current program version
10	**Export**	Button	Export current view of a diagram
11	**Back**	Button	One work step back
12	**Display table**	Button	Display values as table
13	**Line diagram**	Button	Display values as line diagrams
14	**FFT**	Button	Display values as FFT diagrams
15	**Display Campbell diagrams**	Button	Display values as Campbell diagrams

5.3.1 Import a file

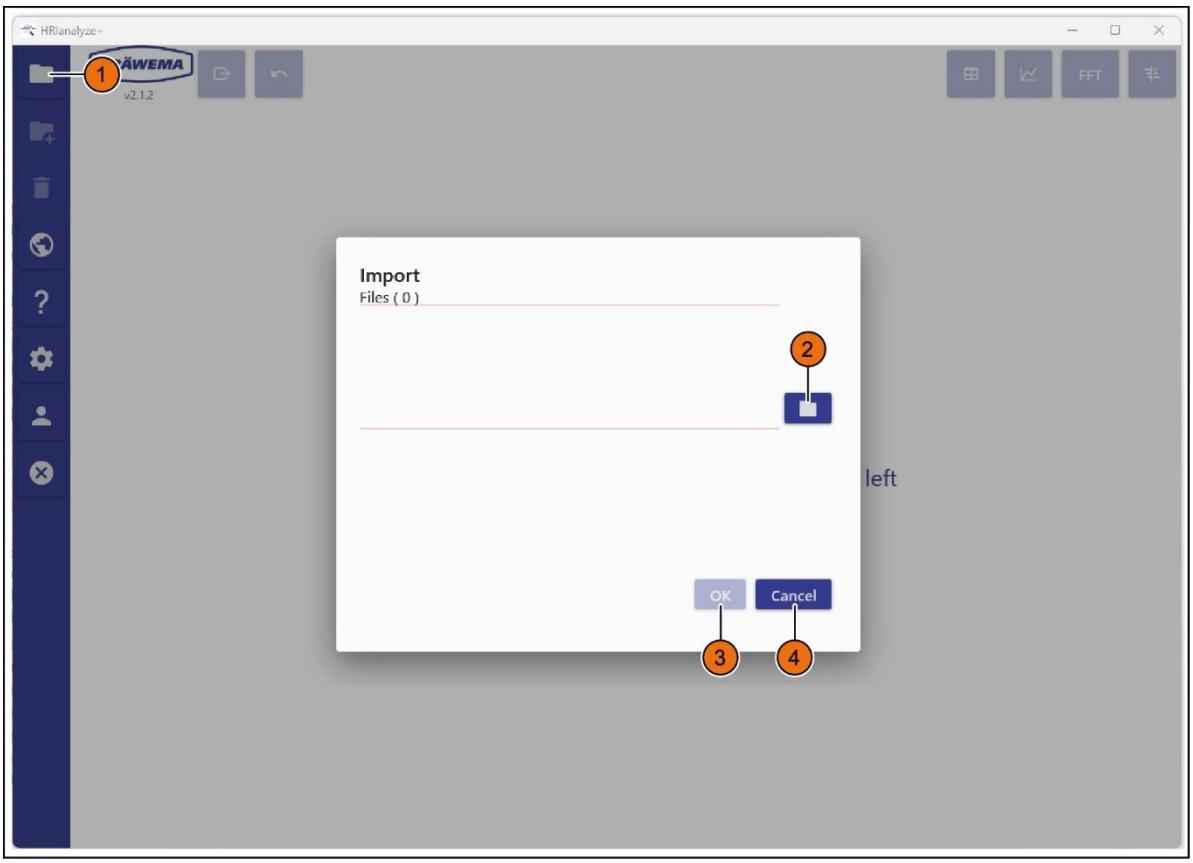


Fig. 68 Import menu window

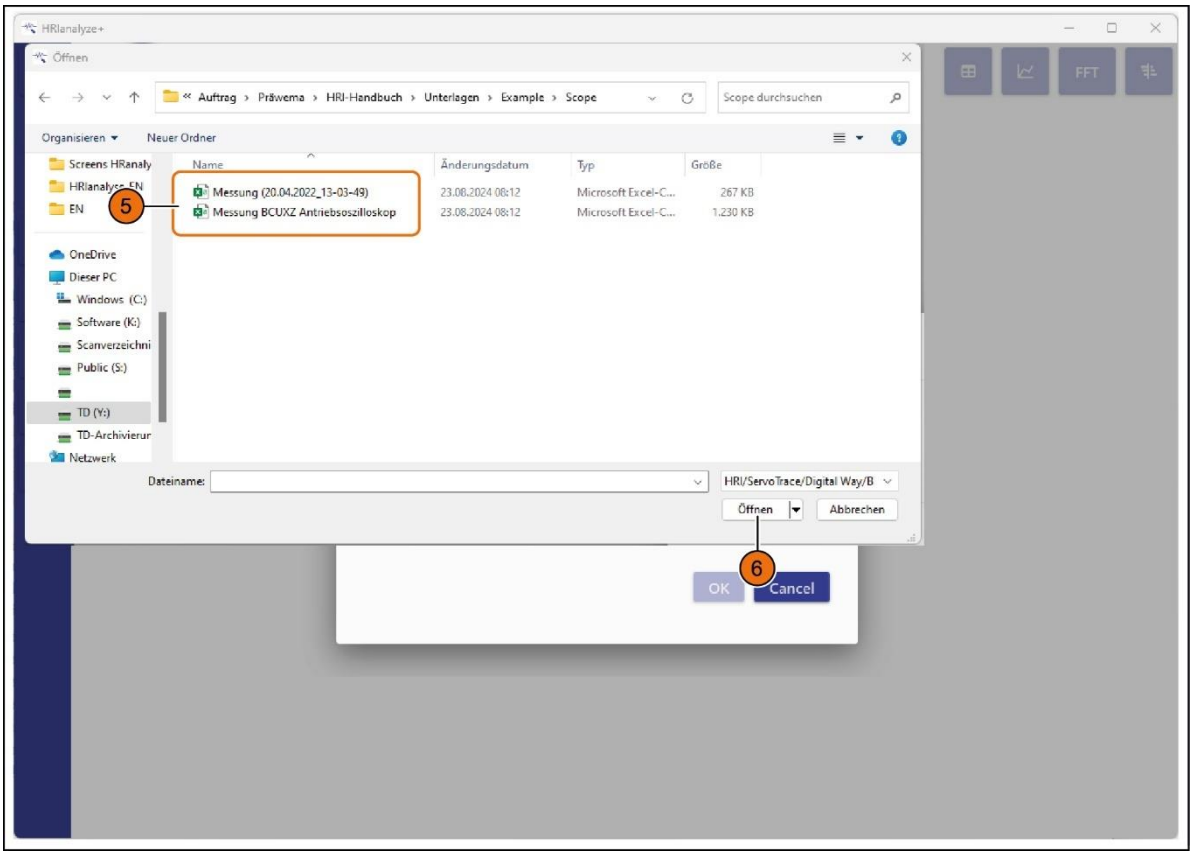


Fig. 69 Import menu window - data directory in the PC

Item	Name	Function	Description
1	**Import**	Button	Open the *Import file* menu window
2	**Directory**	Button	Select directory in the PC, and open file
3	**OK**	Button	Confirm the selected file and close the menu window.
4	**Stop**	Button	Stop the file import stop and close the menu window
5	**File**	File name	Select file in the PC directory
6	**Open**	Button	Confirm the selected file

INSTRUCTION
To import a file:

1. Select the *Import* button (1).
2. Select the *Directory* button (2).
3. Select the corresponding *File* (5) in the PC directory, and confirm with *Open* button (6),
4. Press the *OK* button (3). The menu window closes.

The following file types that were generated with HRI and HRIexpert can be loaded:

- HRILog
- HRIDebugLog
- HRIFFTLog
- HRIShockLog

HRIanalyze+ automatically detects the file type. Furthermore, the measurements from the spectrum display can be loaded.

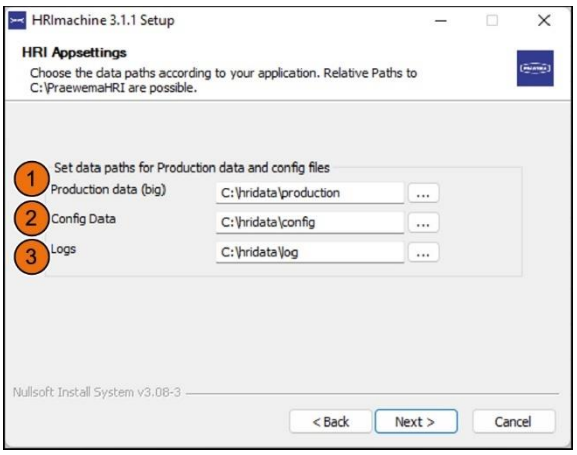
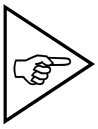


Fig. 70 Storage path in PC directory

NOTE!
When installing the HRI, a storage path for the HRI data is sought. Later, this setting can no longer be changed!

Production data (1)
The HRI files concerning the Production are stored in the *Production data* folder in the PC directory as HRILog, HRIDebugLog, HRIFFTLog, or HRIShockLog files.

Config Data (2)
The settings part programs and limit curves are stored under *Config Data*.



NOTE!
We recommend backing up this folder with the IndraWorks project:

Logs (3)
The logging files are stored in the *Logs* folder for error analysis.

The files are stored in the following folder:
(C/D):\hridata\production\(left\right)HRILog

The file name is built as follows:

Filetype_NCProgSubNr_Componentname_Date_Index
hrilog_50_Component_name_20210114_1

If monitoring objects are added or changed, a new file with an ascending index is created.

NC program numbers - see section 3.2.1.3.

5.3.2 Language selection

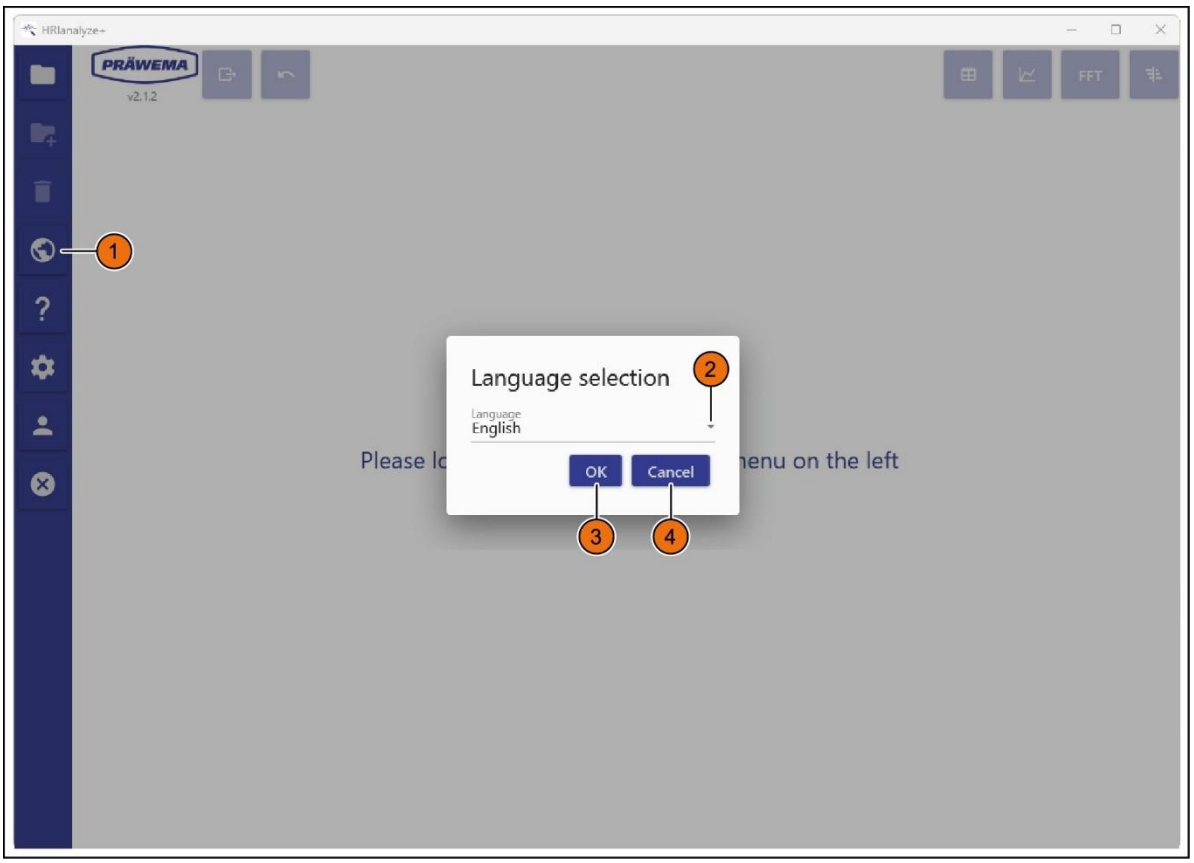


Fig. 71 Language selection menu window

Item	Name	Function	Description
1	**Language selection**	Button	Open *Language selection* menu window
2	**Language selection**	Drop-down menu	select a language
3	**OK**	Button	Confirm the selected language and close the menu window.
4	**Stop**	Button	Stop the language selection and close the menu window.

INSTRUCTION
To select a language

1. Select the *Language selection* (1) button.
2. Open the drop-down menu (2), and select the corresponding language,
3. Press the *OK* (3) button. The menu window closes.

5.3.3 Current licenses

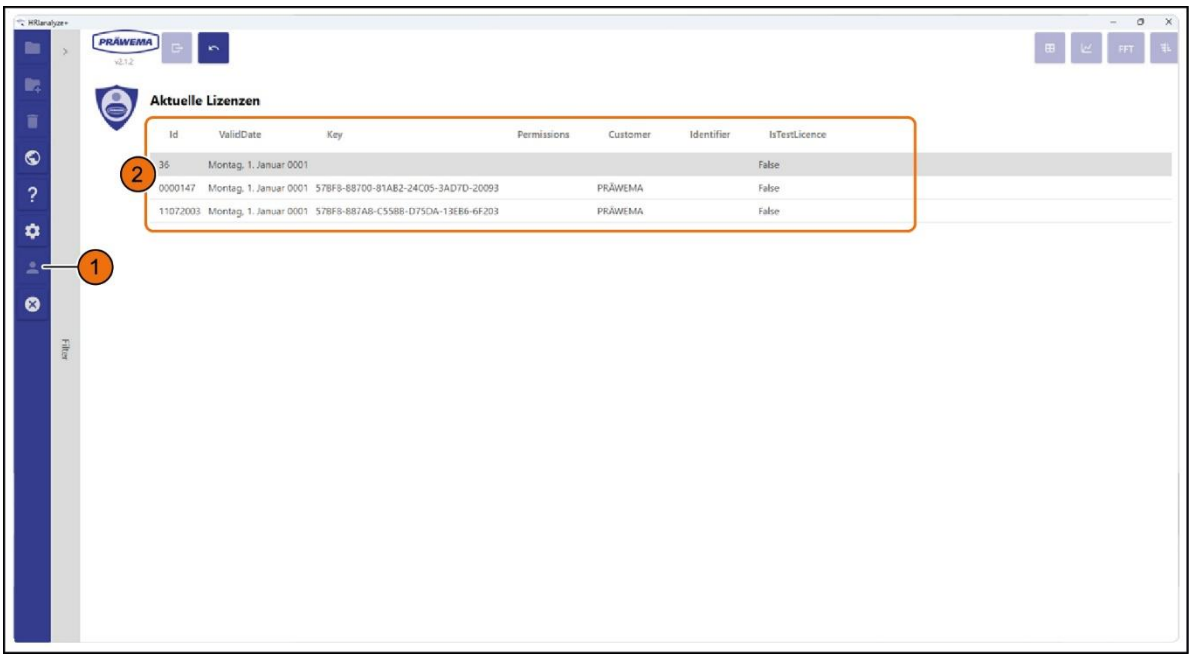


Fig. 72 Current licenses menu window

Item	Name	Function	Description
1	**Account**	Button	Open the *Current licenses* menu window.
2	**Current licenses**	Indication	Display data for licenses

INSTRUCTION
To display the current licenses:

1. Select the *Account* (1) button.
2. The *Current licenses* menu is open.

5.3.4 Export a screenshot

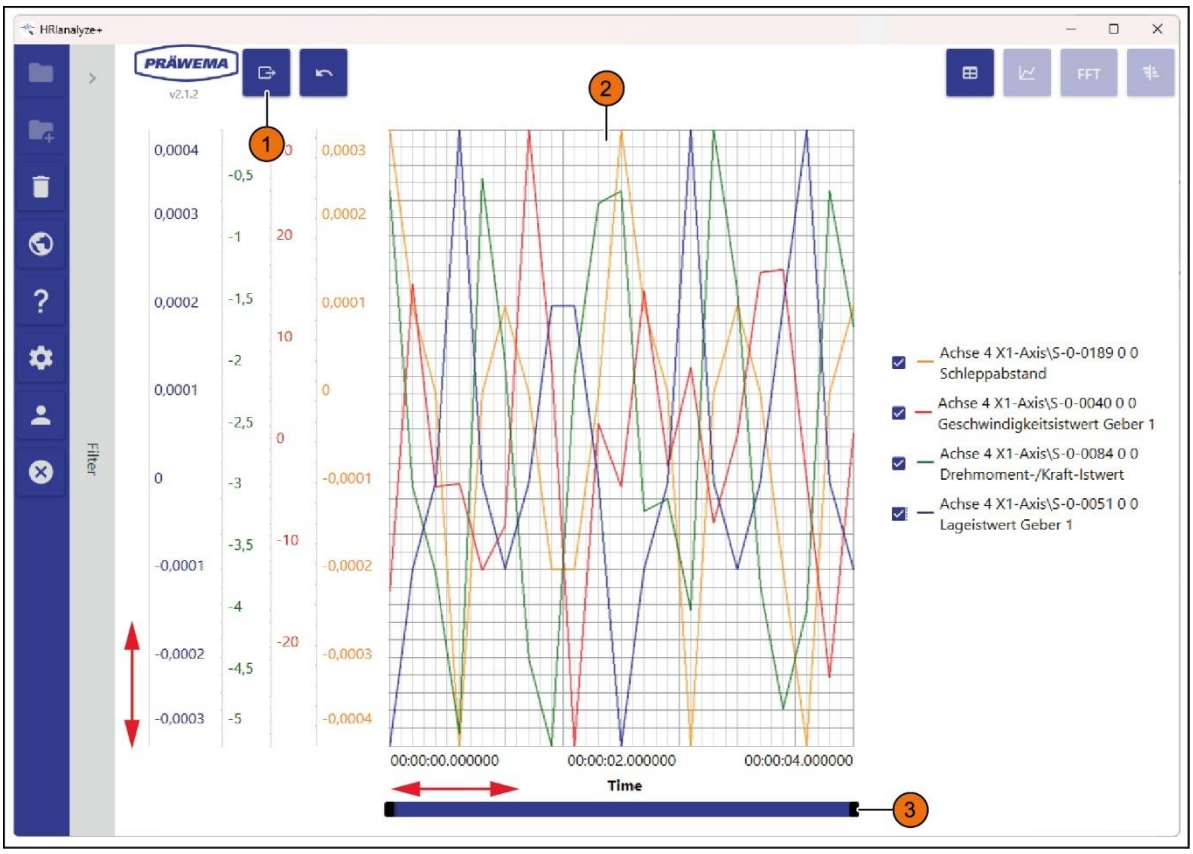


Fig. 73 Export a screenshot

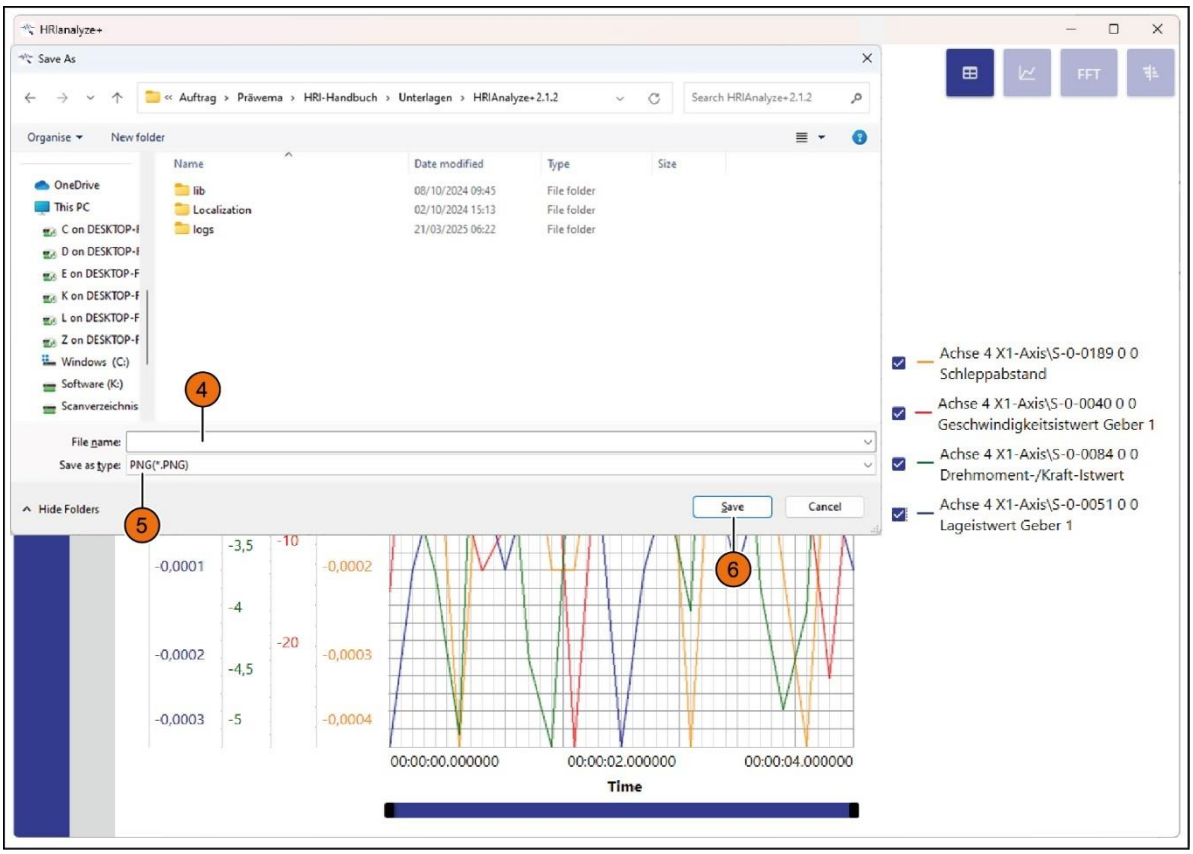


Fig. 74 Export a screenshot into the PC directory

Item	Name	Function	Description
1	**Export**	Button	Export current data
2	**Diagram**	Indication	Graphic representation of the parameters
3	**Scroll bar**	Scroll bar	Shift the chronological area
4	**File name**	Input field	Enter file name in the PC directory
5	**File type**	Selection list	Select format for saving
6	**Saving**	Button	Save file and close menu window.

The export of a screenshot is done in the current view, and is possible in the following formats:

- PNG
- JPG
- BMP
- PDF

INSTRUCTION
For the e of a screenshot:

1. Select the *Export* (1) button.
2. Enter the desired *File names* (4) and select the *File type* (5) in the open PC directory.
3. Confirm the input with the *Save* (6) button.
   The directory window closes.

5.4 Analyze HRI files

5.4.1 Analysis of HRIlog files

The files are stored in the following folder:
(C/D):\hridata\production\(left\right)HRILog

The file name is built as follows:

Filetype_NCProgSubNr_Componentname_Date_Index
hrilog_50_Component_name_20210114_1

If monitoring objects are added or changed, a new file with an ascending index is created.

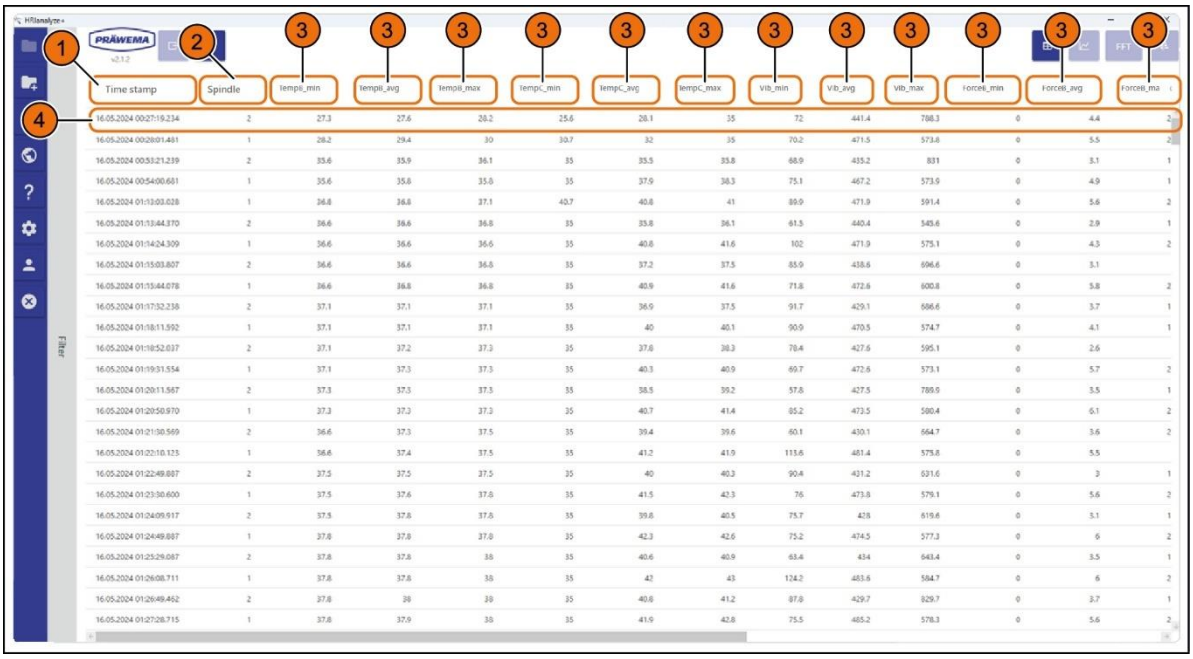


Fig. 75 Imported HRILog file - table view

Item	Name	Description
1	**Time stamp**	Date and clock time
2	**HRI**	HRI value
3	**Columns**	All other parameters of sensors (temperature, current/force, vibrations, axes)
4	**Lines**	Values for each machined workpiece.

The imported file is shown as a table. Each line (4) in the table stands for a machined workpiece. Each column (3) of the table represents the values for a measured parameter or sensor.

HRI creates a file for each day, for each workpiece that is processed on the machine.

All relevant information is stored as a **HRILog** file. For order objects, a shown as bar is created for each sensor.

Some columns are not shown in the HRIanalyze+. These columns are columns with text information. These HRILog files must then be opened with a text editor or a table program.

Workpieces that, for example, were read in though a DMC, this information is stored in the HRI, HRIFFTLog and HRIShockLog.

This enables workpieces to be traced from the honing process to the installation.

Fundamentally, the workpiece counter is stored in all log files.

If the machine works in simulation or standby mode, or the processing of a workpiece was stopped, the workpiece counter does not count it. This can lead to double part numbers and DMC. The simulation and standby is not recorded as from Backend version. 3.1.X.

NOTE!
If the processing is stopped by an EMERGENCY STOP (reset), there is a current peak, and so a high HRI value. Such workpieces must be considered separately via HRIDebugLog files.

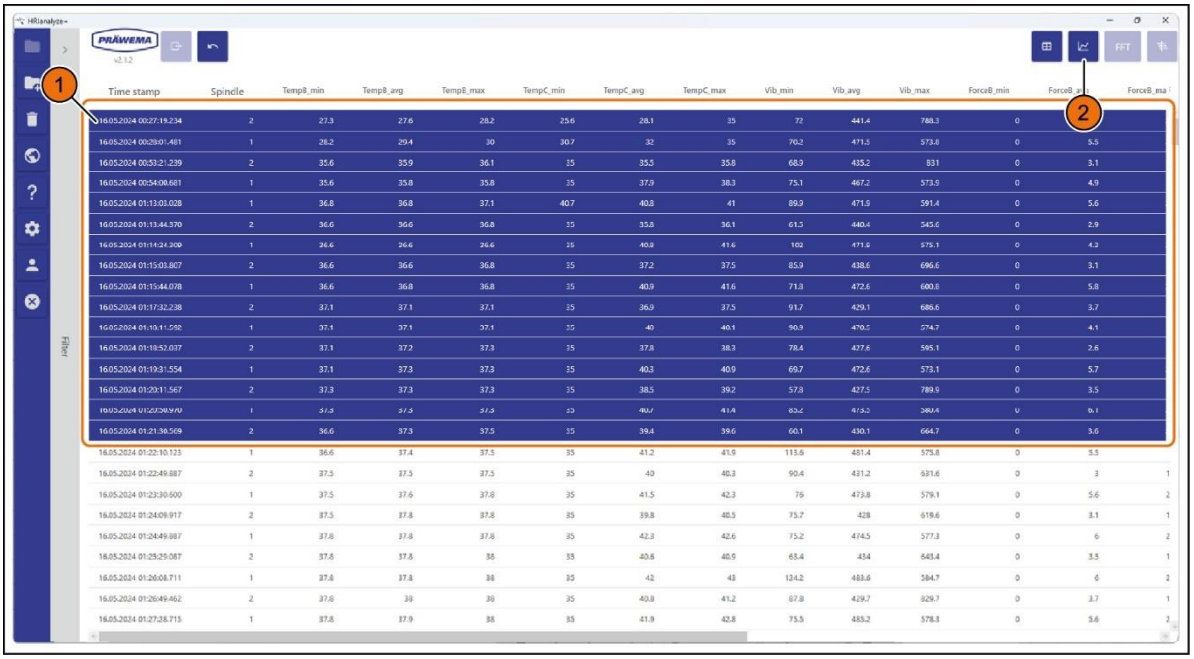


Fig. 76 Imported file - selected table cells

Item	Name	Function	Description
1	**Table**	Indication	Select table cells for calculation
2	**Line diagram**	Button	Display values as line diagrams

INSTRUCTION
To the representation of the table as a line diagram:

1. Select the desired table cells with the Shift key.
2. The *Display line diagram* (2) button.

NOTE!
We recommend always to just select some workpieces, and let them be displayed in the line diagram. The calculation of the minimal, average and maximum values requires a lot of processing power and can take a very long time for many workpieces,

The line diagram is created from the selected data in the table.

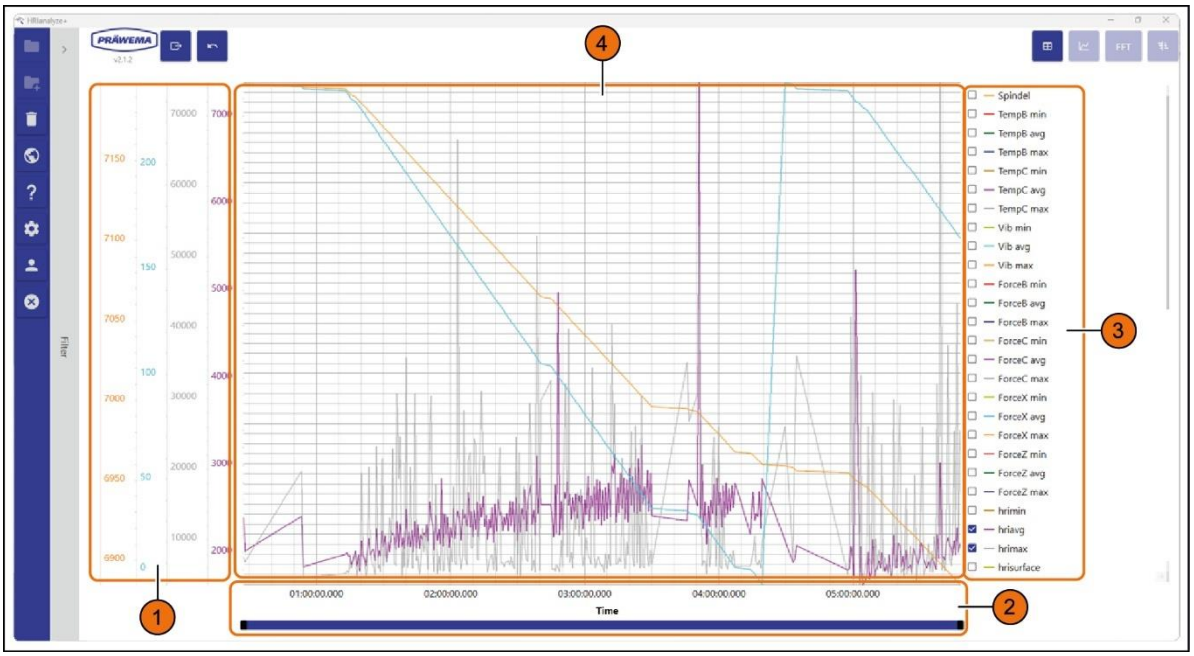


Fig. 77 View of the data as a line diagram - example

Item	Name	Function	Description
1	**Y axis**	Indication	Representation of the parameter values such as in the table
2	**X axis**	Indication	Representation of the time axis
3	**Parameter**	Checkboxes	Select parameters (columns from the table)
4	**Line diagram**	Indication	Display line diagram of the values

On the right-hand side of the line diagram, the displayed parameters can be selected or the selection can be canceled.

Information about the curve values and be shown by moving the mouse over the diagram.

INSTRUCTION
To select parameters in the line diagram, click the corresponding checkbox (3).

In the example, a preselection is made for the parameters HRImax, HRIavg, Partcount Dress and Lifetime Wheel.

A separate Y-axis is calculated for each column. Therefore, there can be prolonged waiting times for many order and diagnostic objects, when the diagram is calculated.

With the right mouse button, a dialog field can be opened and the information shown or hidden.

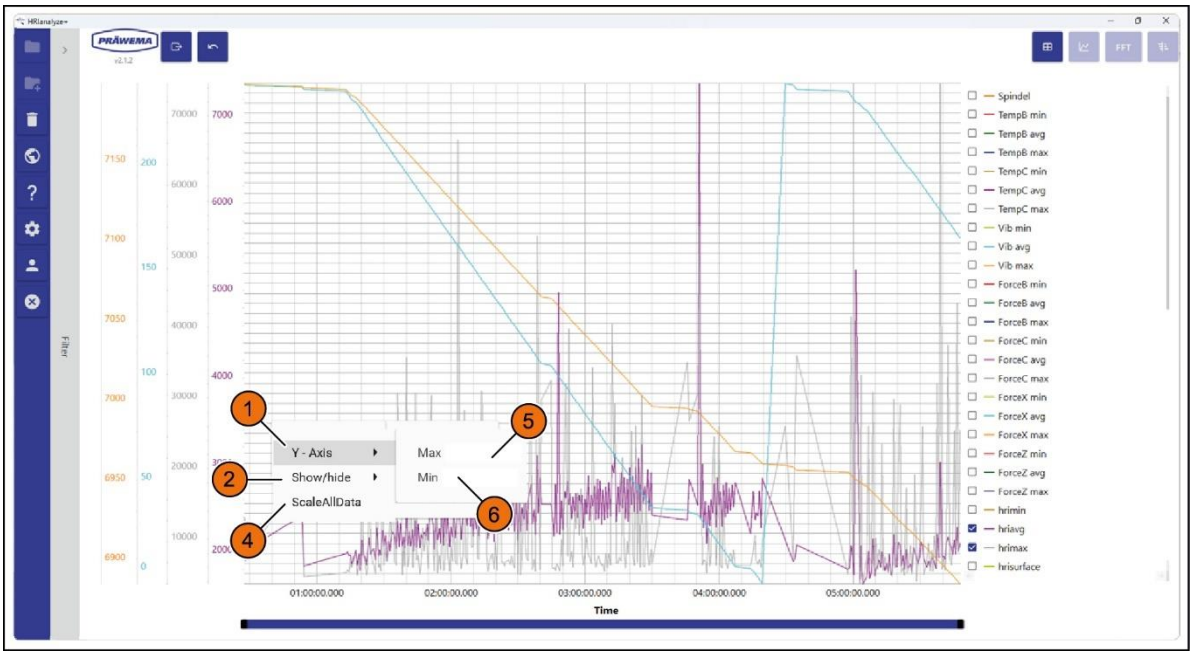


Fig. 78 Dialog field in the line diagram - line 1

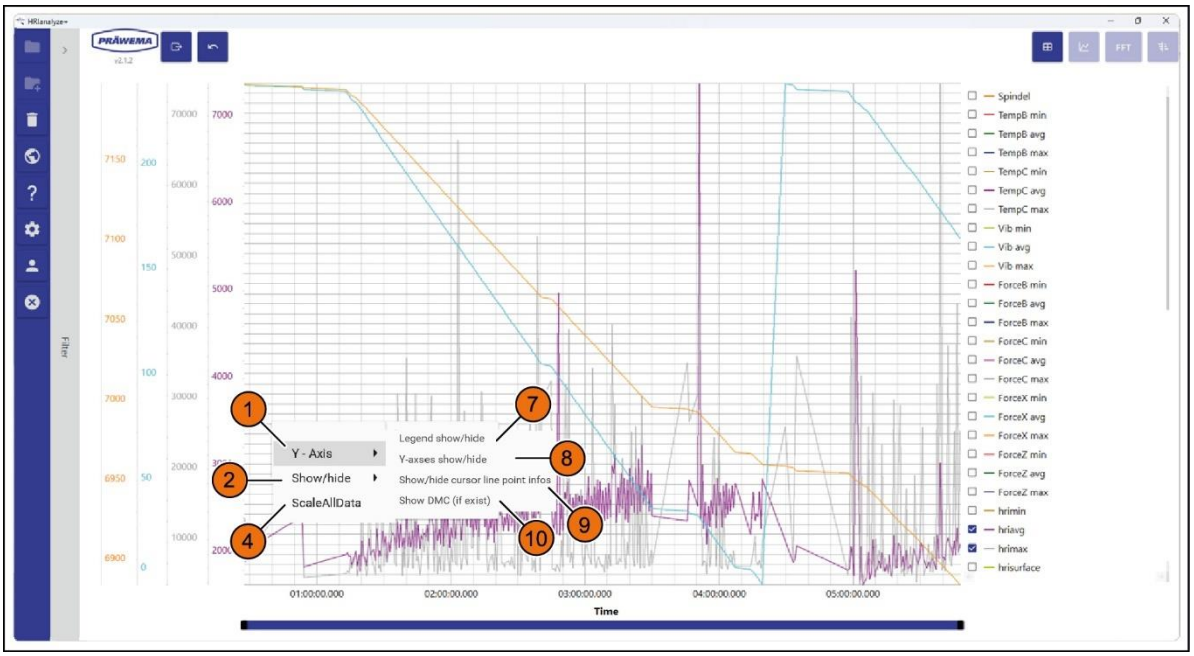


Fig. 79 Dialog field in the line diagram - line 2

Item	Name	Function	Description
1	**Y axis**	Drop-down menu	Input window, show min./max. of the Y-axis.
2	**Show/hide**	Drop-down menu	Input window for item show 6, 7, 8 and 9
3	**Markings**	Drop-down menu	
4	**ScaleAllData**	Button	Scaling of the Y-axis to the highest value
5	**Max**	Input field	Enter the maximum value of the Y-axis 6
6	**Min**	Input field	Enter the minimum value of the Y-axis 5

7	**Legend Show/hide**	Button	Parameters, right side show or hide
8	**Y-axes Show/hide**	Button	Show or hide all Y-axes
9	**Mouse pointer information**	Button	Show or hide mouse pointer information
10	**Display DMC**	Button	Display DMC, if present

5.4.2 Set and delete filter

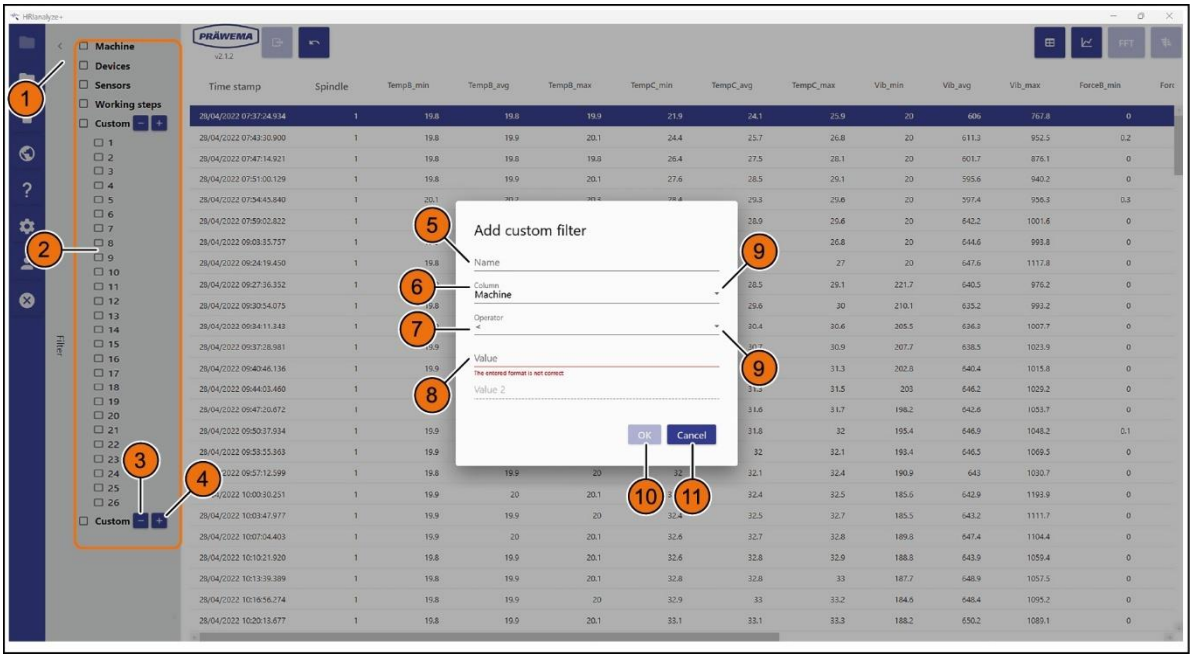


Fig. 80 Filter function - add filter menu window

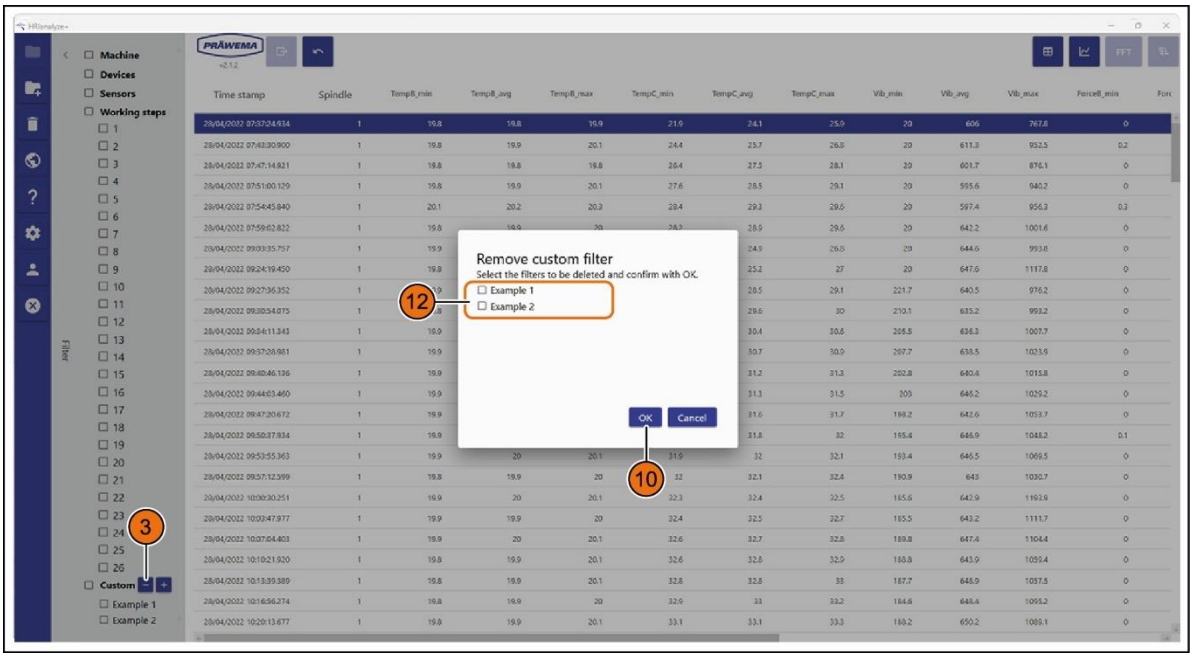


Fig. 81 Filter function - delete filter menu window

Item	Name	Function	Description
1	**Arrow**	Drop-down menu	Open and close Filter menu
2	**Filter**	Checkboxes	Select or deselect desired filter
3	**-**	Button	Open *Delete user-defined filter* menu window
4	**+**	Button	Open *Add user-defined filter* menu window
5	**Name**	Input field	Enter filter name

6	**Column**	Drop-down menu	Which variable should be filtered
7	**Operator**	Drop-down menu	Should be filtered with which operator
8	**Value**	Input field	Enter value
9	**Arrow**	Drop-down menu	Open and close drop-down menu
10	**OK**	Button	Confirm all inputs and close menu window
11	**Stop**	Button	Stop all inputs and close menu window
12	**User-defined filter**	Checkbox	Select user-defined filter to delete

After the import of a file, user-defined filters can be specified.

A filter can be set to better analyze the HRIFFTLog and the HRIShockLog files,

As well as filters on sensors and work steps, user-defined filters are also possible.

Specific frequency ranges can also be filtered. With the display, only these frequency ranges can be displayed in the lines or Campbell diagram

INSTRUCTION

To add a user-defined filter:

1. Click on the *Arrow* (1) in the *Filter drop-down* menu,
2. Select the + (4) button. The *Add filter* menu window is open,
3. Enter a name for the filter in the *Name* (5) input field,
4. Select a designation in the Column (6) drop-down menu,
5. Select a symbol in the *Operator* (7) drop-down menu,
6. Enter a value in the *Value* (8) input field,
7. With the *OK* (10) button confirm all inputs and close the input window.

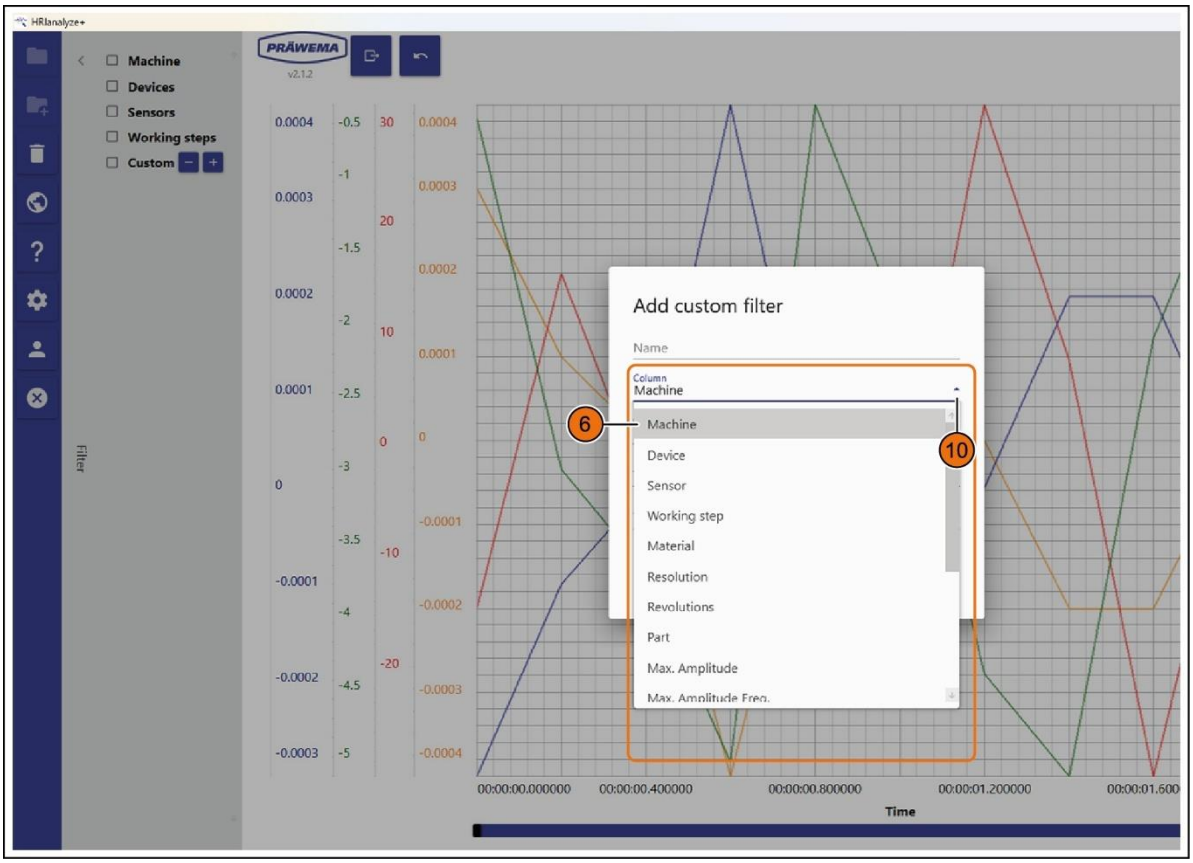


Fig. 82 Add user-defined filter - drop-down menu column

Item	Column	Description
6	**Machine**	Machine number
	Control system	Name of vibration sensor
	Sensor	Number of the inputs of the vibration sensor
	Step	Number of process step
	Material	Designation of the gearing / of the workpiece
	Resolution	Sampling rate of the vibration sensors
	Speed	Workpiece spindle speed
	Part	Part counter
	Max.	Maximum amplitude in mg
	Max. Amplitude freq.	Frequency with which the maximum amplitude was measured
	DMC	Serial number of workpiece
	Impact	Maximum level of the vibration sensor
	RMS	RMS value of the maximum level
	Spindle	Filter by spindle number

	Frequency range	Filter by a specific frequency range

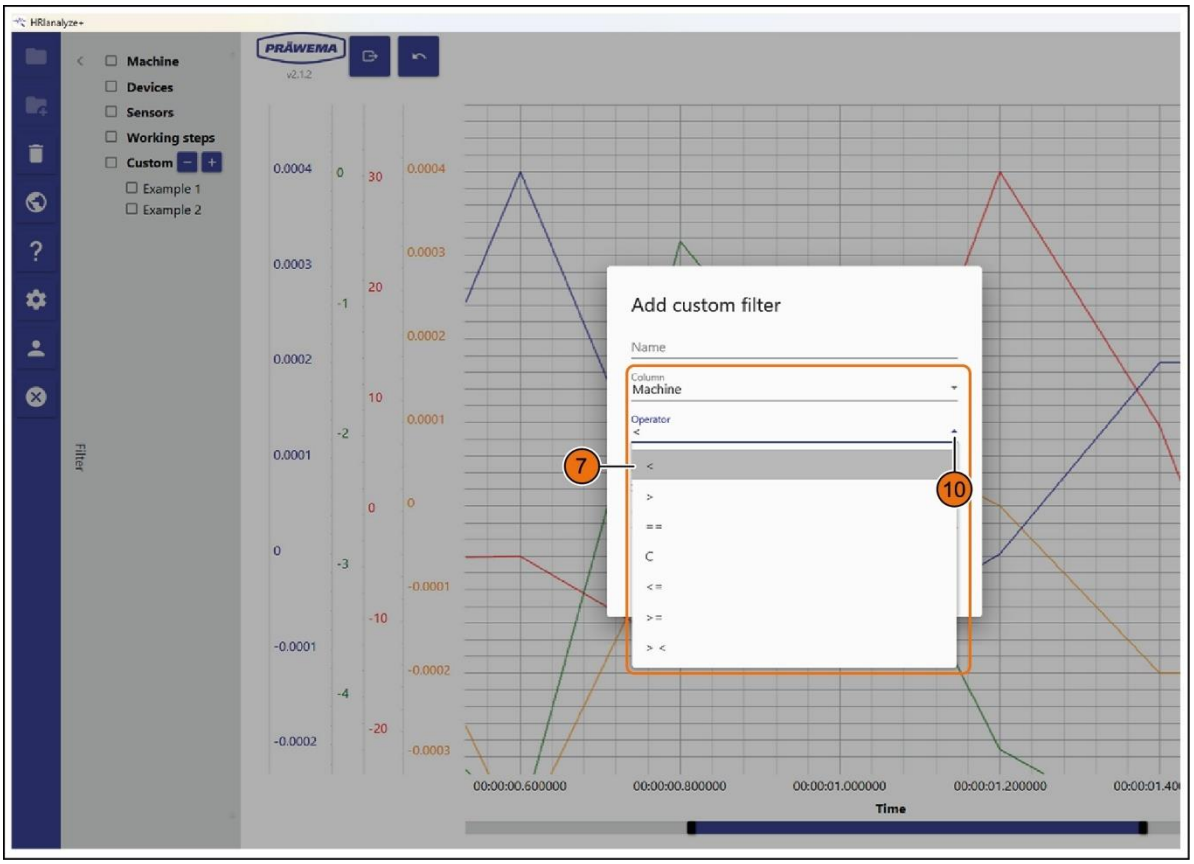


Fig. 83 Add filter - operator drop-down menu

Item	Operator	Description
7	**<**	Larger
	>	Smaller
	= =	Equal to (exact correspondence)
	C	Contains
	< =	Greater than or equal to
	> =	Less than or equal to
	> <	Values between

5.4.3 Analysis of HRIDebugLog files

HRI creates a debug file for each part.

With these files it is possible to check the course of the temperature, the forces and the vibrations during the machining process.

SynchroFine
SynchroFine machines record the positions of the linear axes X and Z are charted, and the position of the W-axis is recorded.

SynchroForm
SynchroForm machines record the positions of the linear axes X, Y and Z.

The files are stored in the following folder:
(C/D):\hridata\production\(left\right)HRIDebugLog

The file name is built as follows:

Filetype_Date_Time_NC-subprogram
hri_data_debug_2020-09-21T11-30-36_50_470

The components can be clearly assigned on the basis of the total number of parts.

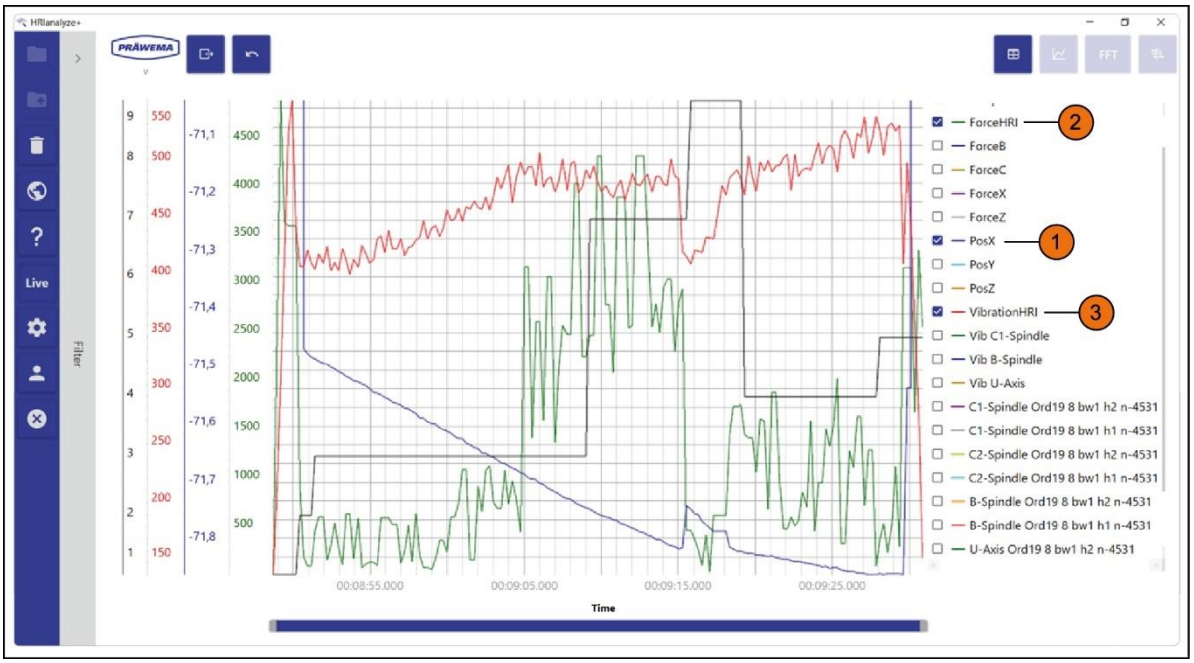


Fig. 84 Example HRIDebugLog file line diagram - SynchroFine

SynchroFine
This example shows the honing of a workpiece.

The blue line is the position of the X-axis (1). During work step 9 (interrupted cut), the X-axis is briefly retracted.

The force component (2) and the vibration component (3) on the HRI are reduced considerably during the stroke section.

After the tool comes into contact with the workpiece again, the forces are lower than before the interrupted step.

5.4.4 Analysis of HRIFFTLog files

The vibration spectra are stored in the HRIFFTLog files.

A complete spectrum is stored from each sensor every 120 ms. Each line in the table contains a frequency spectrum for a workpiece.

The spectra can be visualized with HRIanalyze+ as a line diagram or as a Campbell diagram.

The files are stored in the following folder:

(C/D):\hridata\production\(left\right)HRIFFTLog

The file name is built as follows:

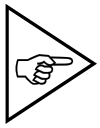
Channel_Date_Hour_Componentname_Sensorname_Processstep_FFT
34_2020090208_component_name_B_honinghead_26_FFT

To divide the quantity of data, every two hours a new FFT and shock file is generated. The quantity of data for one day can exceed one gigabyte in the case if a processing machine with 4 sensors.

This quantity of data must be completely loaded to analyze the vibrations. Therefore, the data is divided.

On the left-hand side of the overview, filters for the files HRIFFTLog and HRIShockLog are specified. See chapter 5.4.2.

The name of the sensors is shown in the text.



NOTE!
We recommend always to just select some workpieces, and let them be displayed in the line diagram. The calculation of the minimal, average and maximum values requires a lot of processing power and can take a very long time for many workpieces,

5.4.4.1 Campbell diagram

If a Campbell diagram is to be created, a menu window is opened.

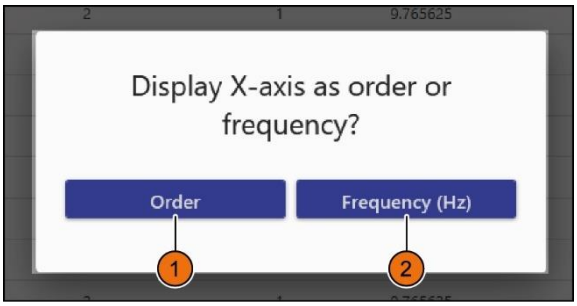


Fig. 85 Menu window query Campbell diagram

INSTRUCTION

To represent the X-axis in the diagram:

1. Select either the *Orders* (1) buttons or
2. Select the *Frequency* (2) button.

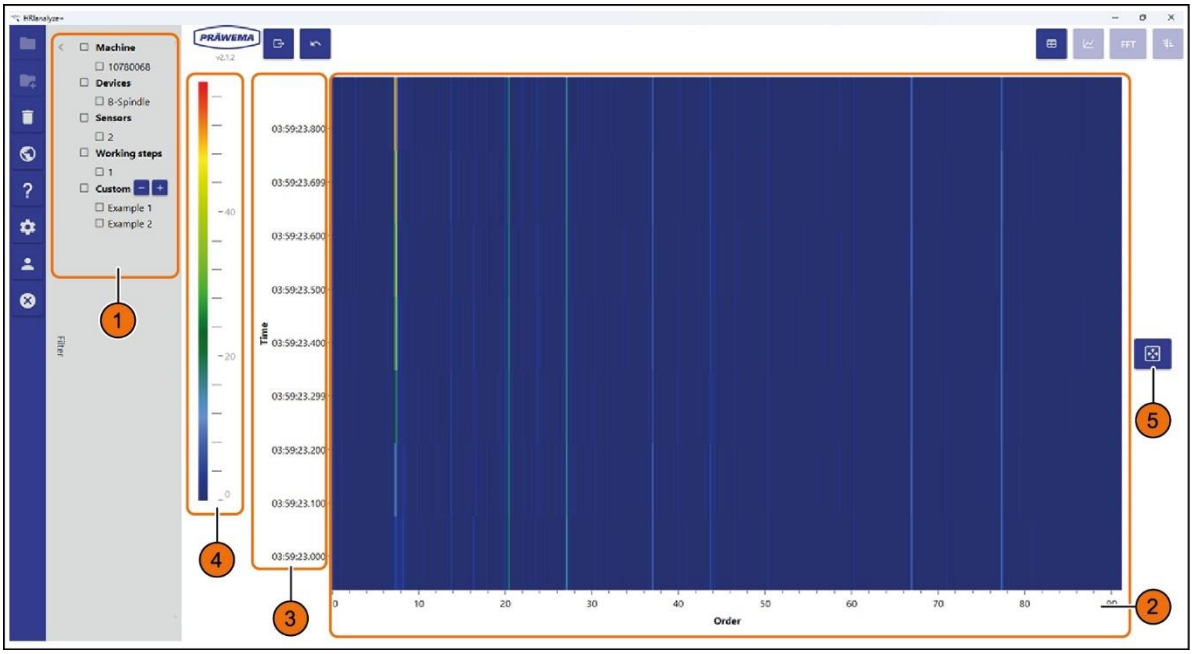


Fig. 86 Campbell diagram - display of the orders (example)

Item	Name	Function	Description
1	**Filter**	Drop-down menu	Open and close Filter menu
2	**X axis**	Indication	Representation of the orders (or frequencies)
3	**Y axis**	Indication	Representation of time in ms
4	**Color scale**	Indication	Adaptation of the color scale
5	**Draw anew**	Button	Reset zoom

NOTE!
When creating a Campbell diagram ensure that only one sensor is selected in the filter (1). Otherwise the creation is canceled with an error message.

In the Campbell diagrams menu, the meshing frequency and rotation frequency can be shown in the dialog menu.

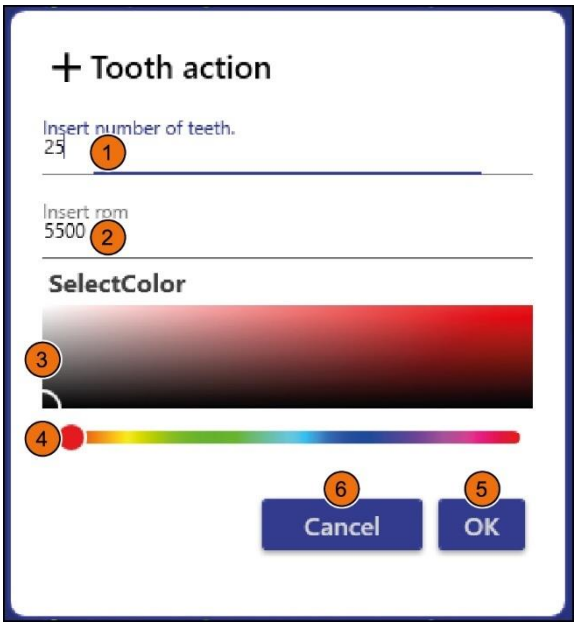


Fig. 87 Campbell diagram - display of the orders

Item	Name	Function	Description
1	**Number of teeth** program-mable	Input field	Enter the number of teeth
2	**Speed**	Input field	Enter speed
3	**Color field**	Selection field	Select color
4	**Color selector**	Slider	Select color
5	**OK**	Button	Confirm the inputs and close the menu window.
6	**Stop**	Button	Stop the input and close the menu window.

With the right mouse button, a pop-up-menu can be opened, and targeted markings added, and the color of the marking set.

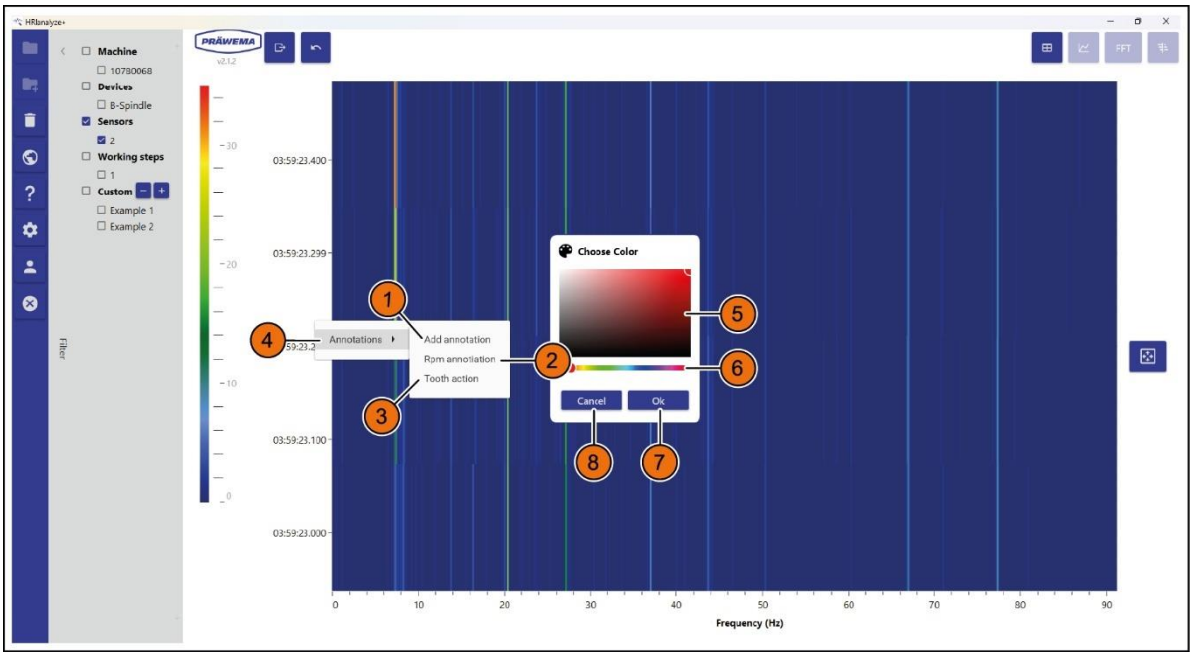


Fig. 88 Dialog field in the Campbell diagram - set marking

Item	Name	Function	Description
1	**Add marking**	Button	Add a marking
2	**Mark rotation frequency**	Button	Add a rotation frequency
3	**Meshing frequency**	Button	Add a meshing frequency
4	**Markings**	Drop-down menu	Open color window
5	**Color field**	Selection field	Select color
6	**Color selector**	Slider	Select color
7	**OK**	Button	Confirm the inputs and close the menu window.
8	**Stop**	Button	Stop the input and close the menu window.

INSTRUCTION

To show the pop-up menu *Markings*:

1. Click in the graphic with the right mouse button.
2. Set the desired color in the *Select color* menu and confirm with OK.

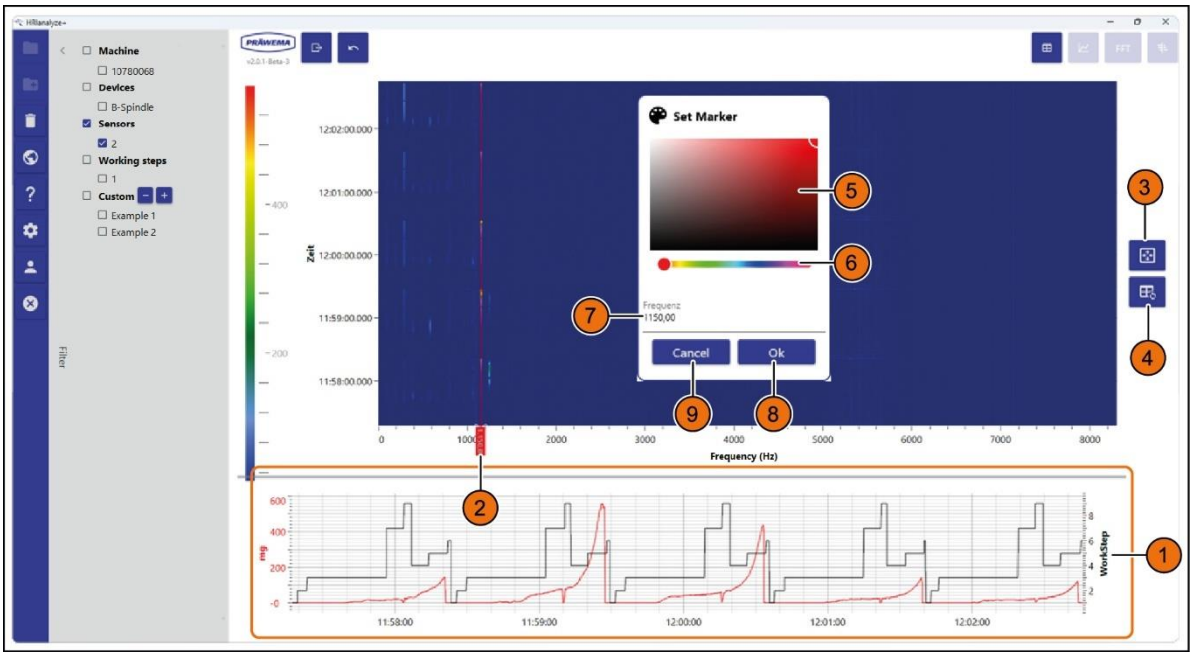


Fig. 89 Dialog field in the Campbell diagram - with line diagram

Item	Name	Function	Description
1	**Line diagram**	Indication	Line diagram is displayed
2	**Marking**	Indication	Set marking for a specific frequency.
3	**Draw anew**	Button	Reset zoom
4	**Synchronization**	Button	Synchronization between diagrams
5	**Color field**	Selection field	Select color
6	**Color selector**	Slider	Select color
7	**Frequency/ Order**	Input field	Enter frequency or order
8	**OK**	Button	Confirm the inputs and close the menu window.
9	**Stop**	Button	Stop the input and close the menu window.

Another line diagram (1) appears under the Campbell diagram.

In this, the chronological course of a specific frequency or order is shown. Apart from that, the individual work steps appear. This enables a differentiation of the workpieces. Furthermore, one sees how long a workpiece was processed.

INSTRUCTION
To adapt the line diagram under the Campbell diagram:

1. Shift the marking (2) on the desired frequency or order in the Campbell diagram or
2. Open the pop-up menu with a double click on the frequency or order input.
3. Enter the *Frequency* or *Order* (7) directly here,
4. Adapt the color (5+6) if necessary,
5. Use the *OK button* (8) to confirm the input and close the pop-up menu.

5.4.4.2 Limit curve

With a menu window, a limit curve can be created in the FFT line diagram.

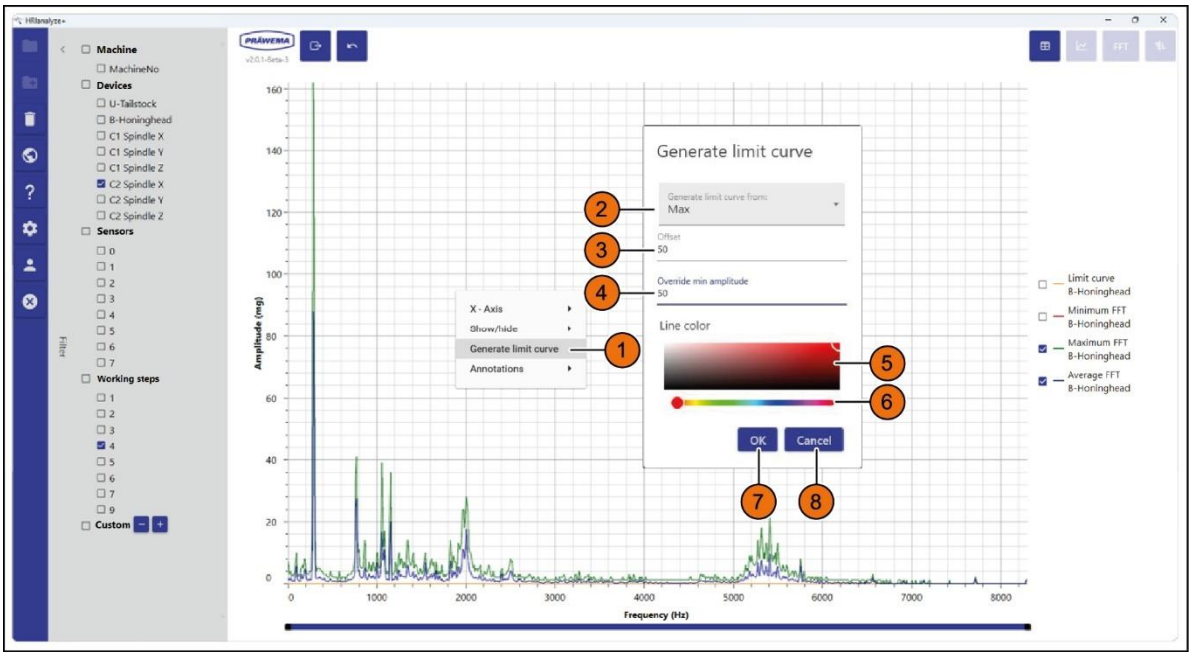


Fig. 90 FFT line diagram - create limit curve

Item	Name	Function	Description
1	**Create limit curve**	Button	Open *Create limite curve* menu window
2	**Create a limit curve from the**	Drop-down menu	Create limit curve of min. average or maximum
3	**Offset**	Input field	Specify offset
4	**Overwrite the minimum ampli-tude**	Input field	Specify the minimum limit for the limit curve
5	**Color field**	Selection field	Select color
6	**Color selector**	Slider	Select color
7	**OK**	Button	Confirm the inputs and close the menu window.
8	**Stop**	Button	Stop the input and close the menu win-dow.

INSTRUCTION

To show the dialog field *Create limit curve*:

1. Click in the graphic with the right mouse button,
2. *Create the limit curve* in the menu window, select the spectrum from which the limit curve is created,
3. Enter the value for the offset (3),
4. Enter the minimum limit (4) for the limit curve,
5. Set the desired line color (5+6) and confirm all entries with *OK* (7).

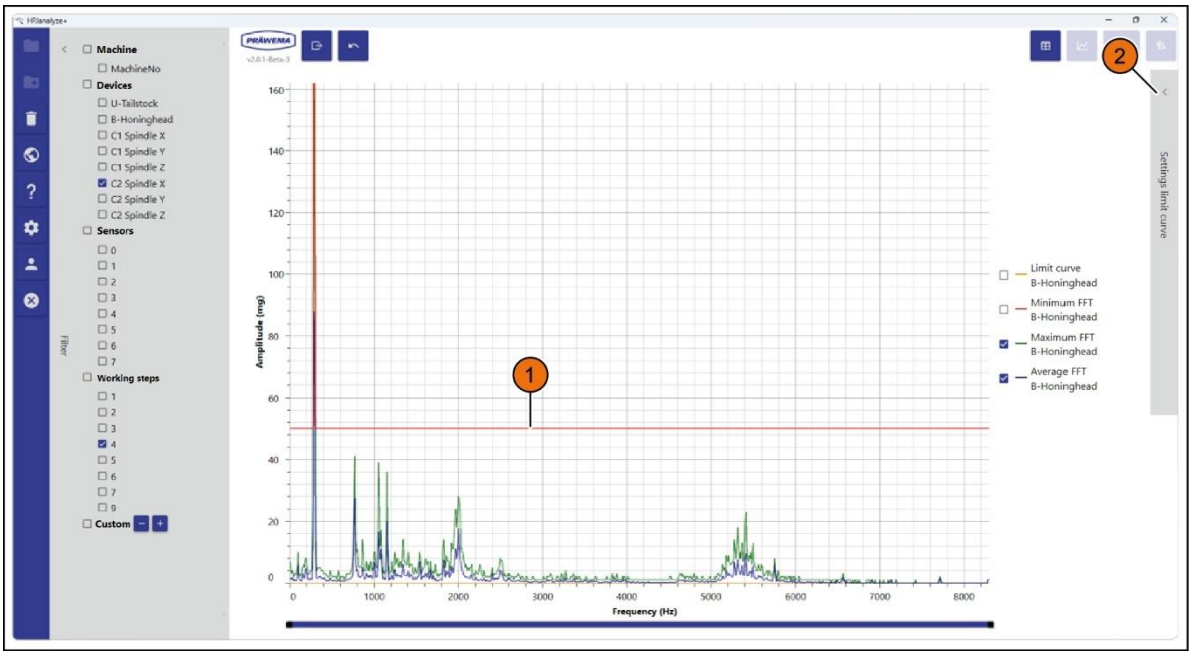


Fig. 91 Example of limit curve

In the example, the limit curve (1) was created with the following settings:

- Create limit curve of: **Max**
- Offset: **100**
- Overwrite the minimum amplitude: **50**
- Line color: **Red**

INSTRUCTION
For the fine adjustment of the limit curve, select the drop-down menu *Adjusting limit curve* (2).

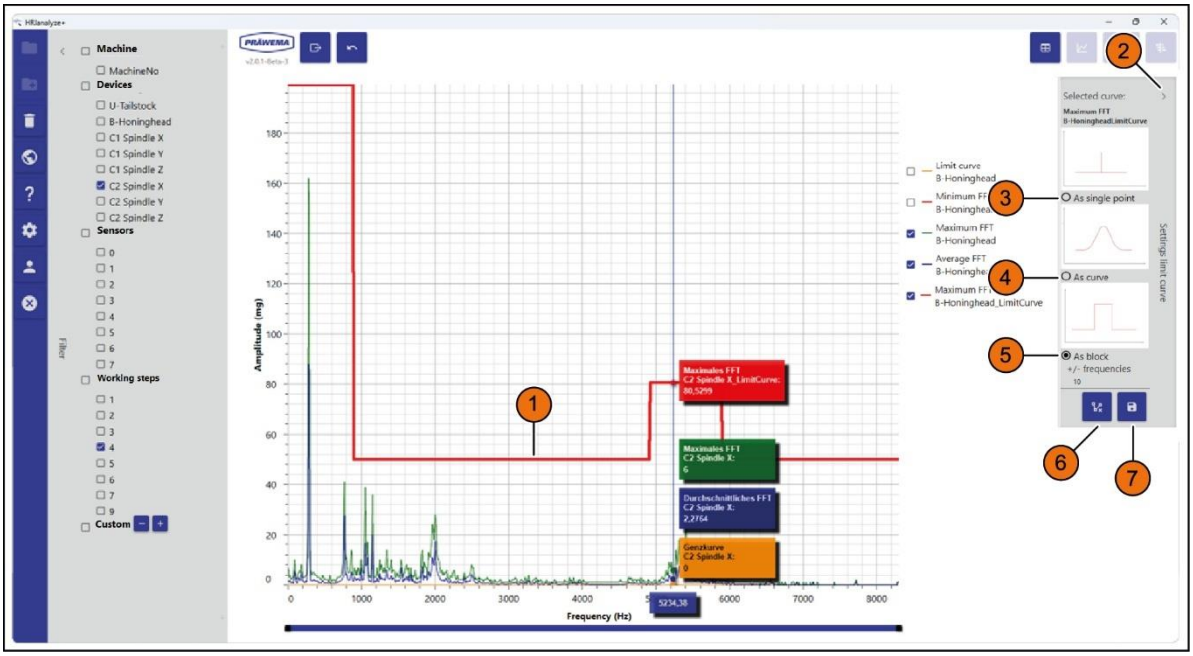


Fig. 92 Fine adjustment of limit curve

Item	Name	Function	Description
1	**Limit curve**	Indication	Chow the course of the limit curve
2	**Settings of the limit curve**	Drop-down menu	Open and close the limit curve settings menu
3	**Single point**	Option field	Edit limit curve as single point
4	**As curve**	Option field	Edit limit curve as curve
5	**As block**	Option field	Edit limit curve as block
6	**Delete**	Button	Delete limit curve
7	**Diskette symbol**	Button	Open the *Save limit curve* dialog window

After the fine adjustment of the limit curve, the limit curve can be saved in the *Limit curve settings* drop-down menu.

INSTRUCTION
Select the button (7) to save the limit curve.

The *Save limit curve* menu window is opened.

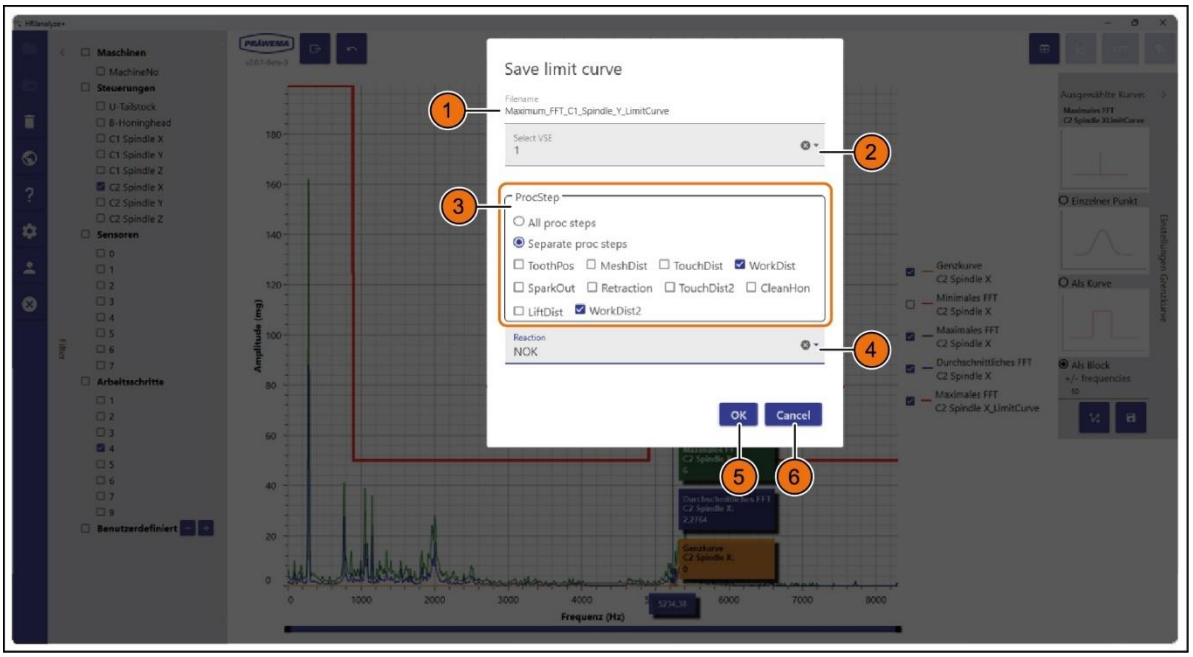


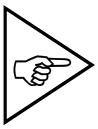
Fig. 93 Menu window save the limit curve

Item	Name	Function	Description
1	**File name**	Input menu	Assign the file name for the limit curve. This must agree with the name of the gearing!
2	**Select VSE**	Drop-down menu	Select VSE

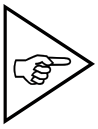
3	**Program steps**	Option field	Select program steps
4	**Reaction**	Drop-down menu	Select fault reaction
5	**OK**	Button	Confirm all inputs. A JSON file is saved. Close the menu window.
6	**Stop**	Button	Stop all inputs and close menu window

INSTRUCTION
In the save menu window, *Save the limit curve* as follows:

1. Enter file name (1),
2. Select the desired VSE in the drop-down menu (2),
3. Select the program steps (3),
4. Select the reaction in the drop-down menu (4),
5. With the OK button, confirm all inputs and close the menu window.



NOTE!
The file name (1) of the limit curve and the file name of the workpiece, for which the limit curve should apply, must be identical, otherwise the HRI monitoring (HRIexpert) cannot assign the limit curve!



NOTE!
The stored settings of the limit curve cannot be changed later on the machine!

The limit curve stored as a JSON file can be uploaded in the limit curve menu with HRIexpert, see chapter 4.4.

After successfully uploading a limit curve, a check can be made in the *Spectrum* menu whether the limit curve was taken over, see section 4.6.3.

5.4.5 Analysis of HRIShockLog files

The fourth type of log files are the HRIShockLog files.
With these files, a breakage of a tool can be detected.

The files are stored in the following folder:
(C/D):\hridata\production\(left\right)HRIShockLog

The file name is built as follows:

Channel_Date_Hour_Componentname_Sensorname_Processstep_Shock
50_2020090208_Componentname_B_HoningHead_2_Shock

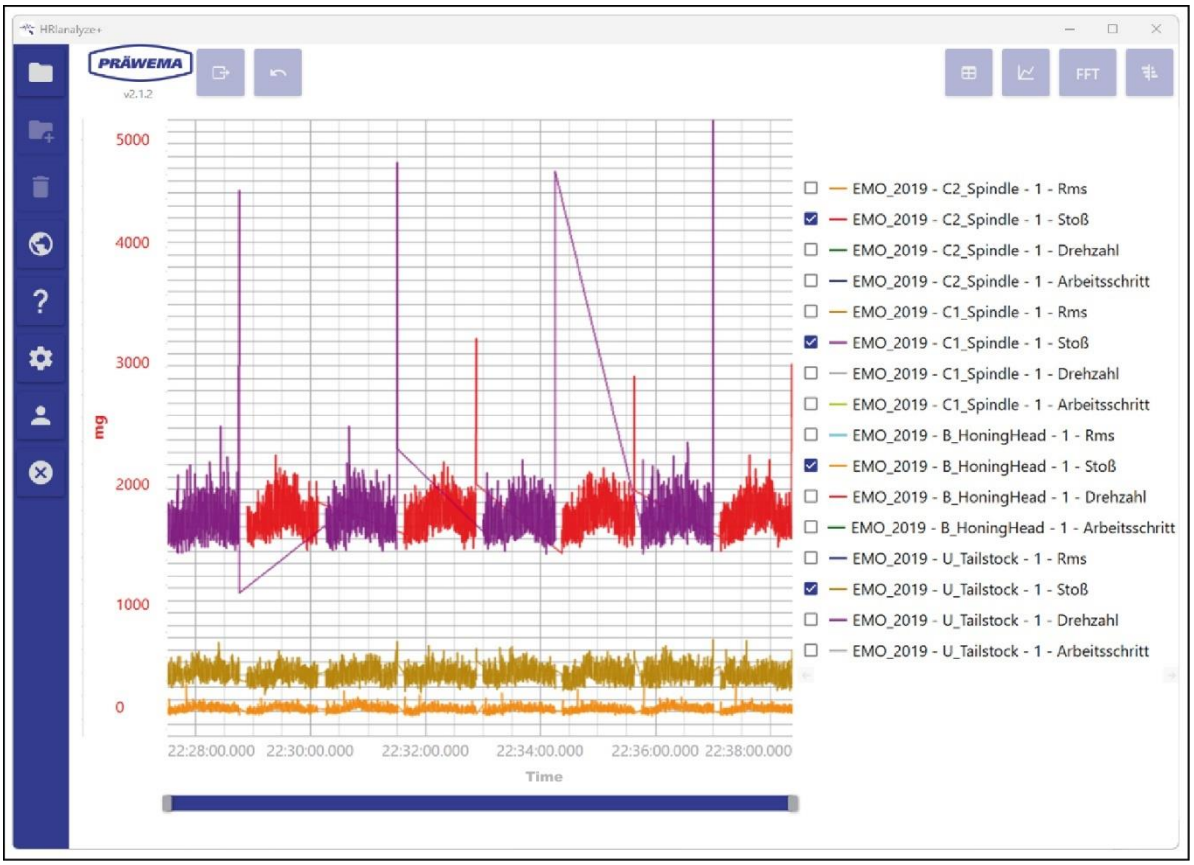


Fig. 94 Imported HRIShockLogFile - line diagram

The example of an HRIShockLog file shows a SynchroFine with two workpiece spindles. In each case of the processing, there is only one workpiece spindle in the grip.

For filter setting and deleting HRIShockLog files see section 5.4.2.

5.5 Analyzing other sources

With the software version HRIanalyze+, measuring files from other programs can also be opened.

Currently, measurements from the following sources can be opened:

- Siemens Trace
- Bosch Rexroth drive oscilloscope

NOTE!
Change the measurements from the Bosch Rexroth drive oscilloscope into a CSV format before reading them in.

5.5.1 Analyzing Siemens Trace

After opening the Siemens Trace measuring file, the measured signal are displayed.

NOTE!
Only applies to machines with Siemens controllers (here SynchroForm).

5.5.1.1 Line diagram

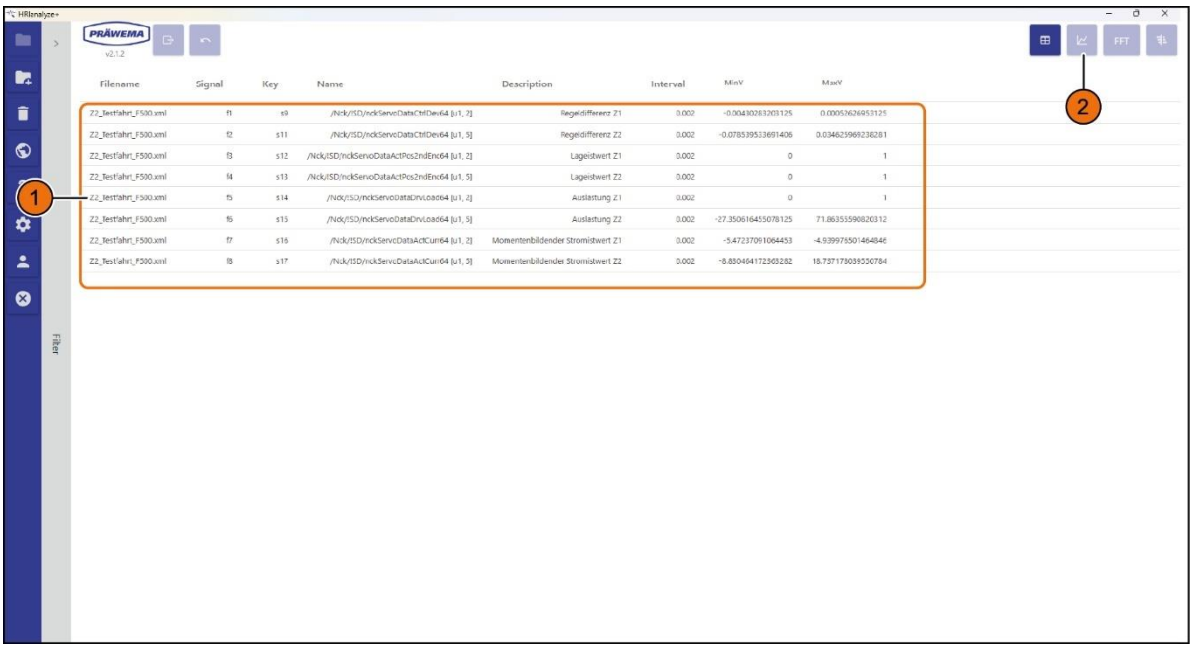


Fig. 95 Table view of Siemens Trace

INSTRUCTION
To represent the Siemens Trace measured values as line diagrams:

1. Import Siemens Trace measuring file,
2. Select the desired table cells (1) with the Shift key,
3. The *Display line diagram* (2) button.

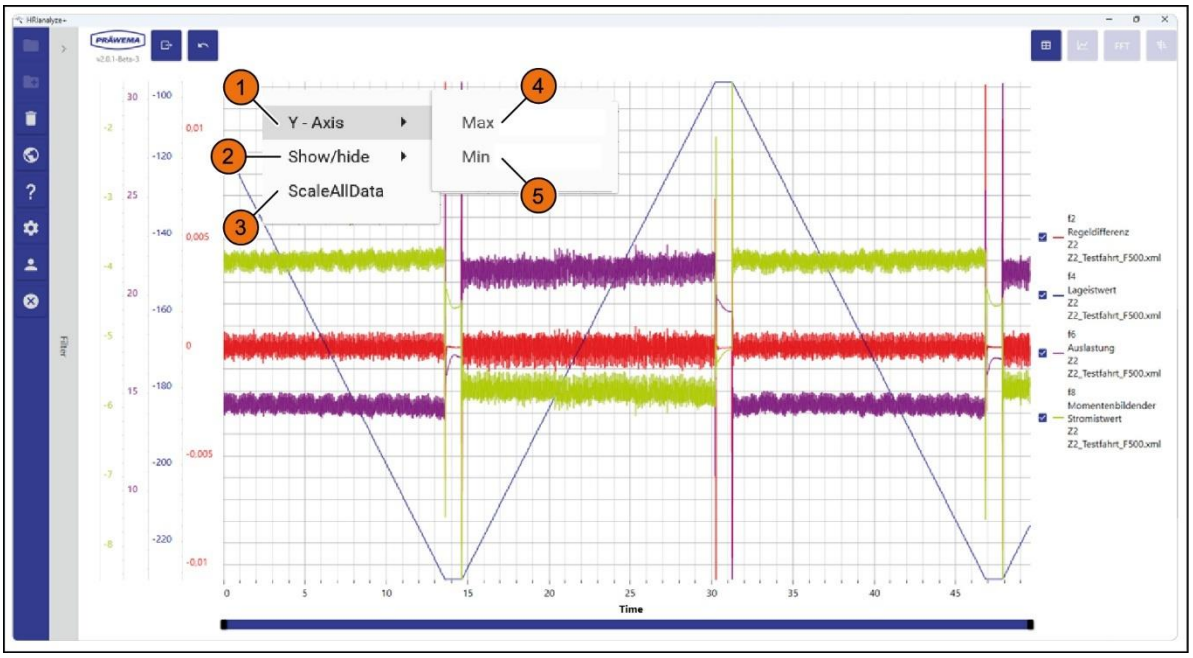


Fig. 96 Example of line diagram - Siemens Trace -

With the right mouse button, a dialog field can be opened in the line diagram, and the individual signals can be shown and hidden (1).

Item	Name	Function	Description
1	**Y axis**	Drop-down menu	Input window, show min./max. of the Y-axis.
2	**Show/hide**	Drop-down menu	Show and hide i
3	**ScaleAllData**	Button	Scale the curve to the maximum value
4	**Min**	Input field	Min.
5	**Max**	Input field	Max.

5.5.1.2 FFT diagram

From the signals of the Siemens Trace, spectra can also be calculated.

Before beginning the calculation, the period of time must be limited in the *FFT settings* menu window. The amplitudes of the vibrations and the frequencies change during the process. With the time limitation, specific anomalies can be targeted for investigation.

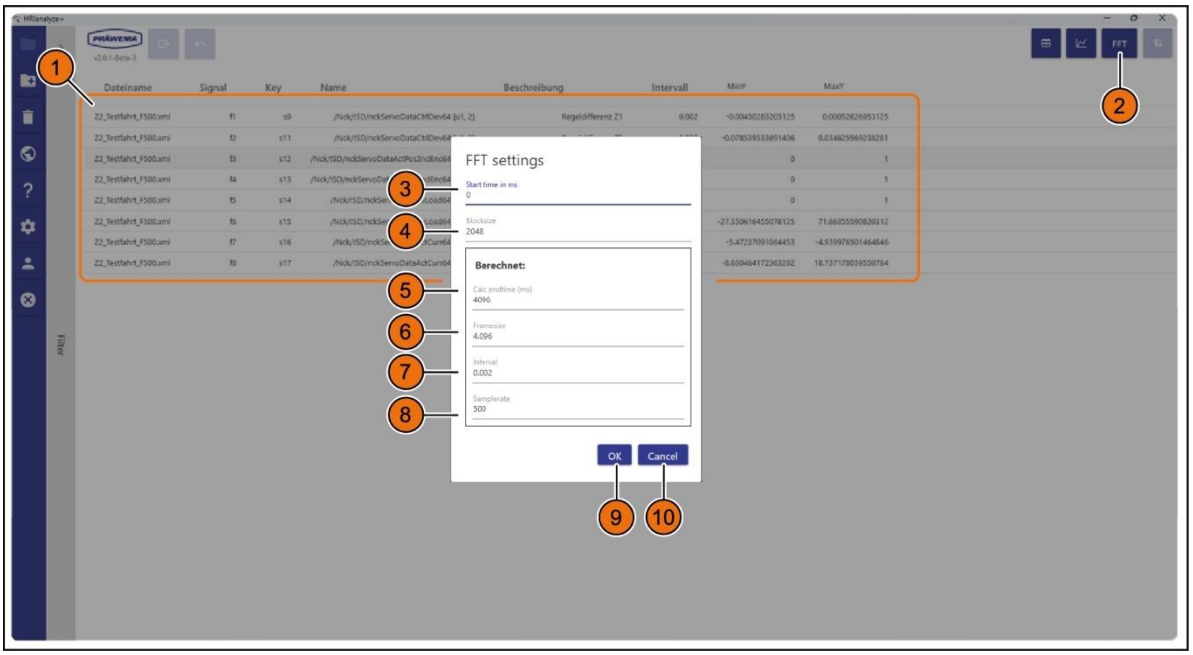


Fig. 97 FFT settings - Siemens Trace

Item	Name	Function	Description
1	**Table**	Indication	Select table cells
2	**FFT**	Button	Display values as FFT diagrams
3	**Start time in ms**	Input field	Enter start time
4	**Block length**	Input field	Enter block length
5	**Calculated end time (ms)**	Display field	End of FFT calculation
6	**FrameSize**	Display field	Number of values for FFT calculation
7	**Interval**	Display field	Time interval of recording in ms
8	**SampleRate**	Display field	Sample rate of the recording in Hz
9	**OK**	Button	Confirm the input entries and close the menu window.
10	**Stop**	Button	Stop the input and close the menu window.

INSTRUCTION
To represent the Siemens Trace measuring file as an FFT diagram:

1. Select the desired table cells (1) with the Shift key,
2. Select the *FFT* (2) button.
3. The *FFT settings* menu window is open,
   Enter *Start time* and *Block length* into the input fields (3+4),
4. Use the *OK* button (9) to confirm the input and close the menu window.

NOTE!
The block length (4) must be an exponent of 2.

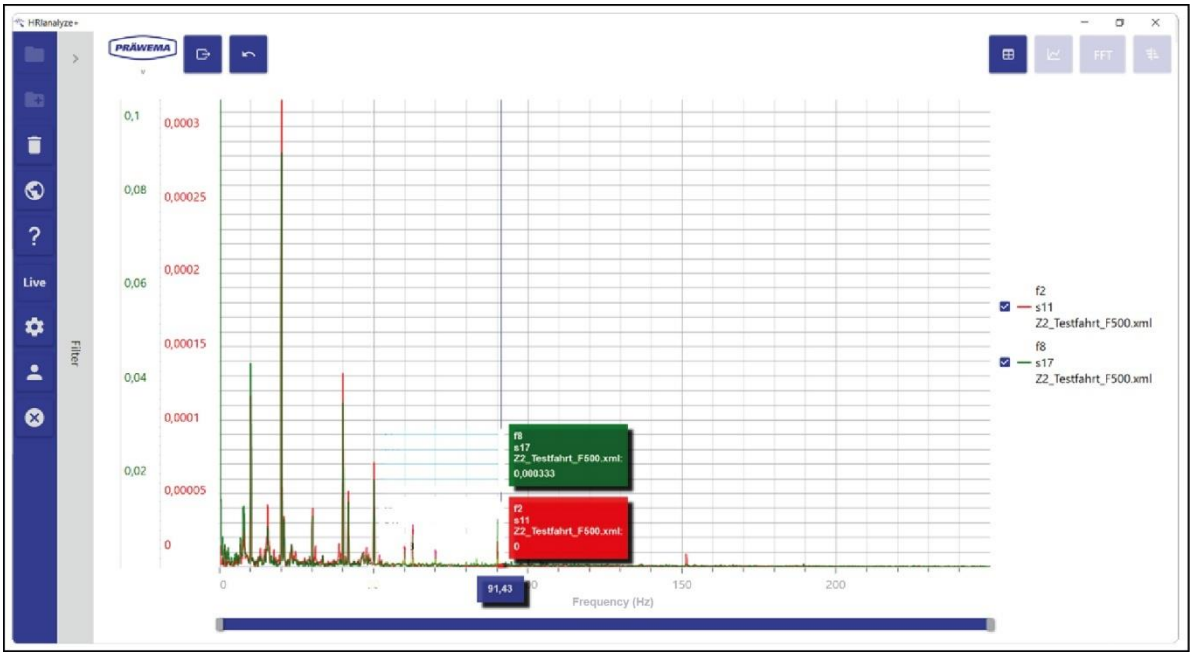


Fig. 98 Example FFT- line diagram - Siemens Trace

In this example, the travel to Z+ would be considered, with following settings:
Start time: 16,000 ms
Block length: 4096

5.5.2 Analyze Rexroth INDRA Works

When measuring in a SynchroFine, the honing ring is stopped just before the end of the machining.

At the position of the X-axis, it can be seen how the process gets out of control and leads to breakage (1) of the honing ring.

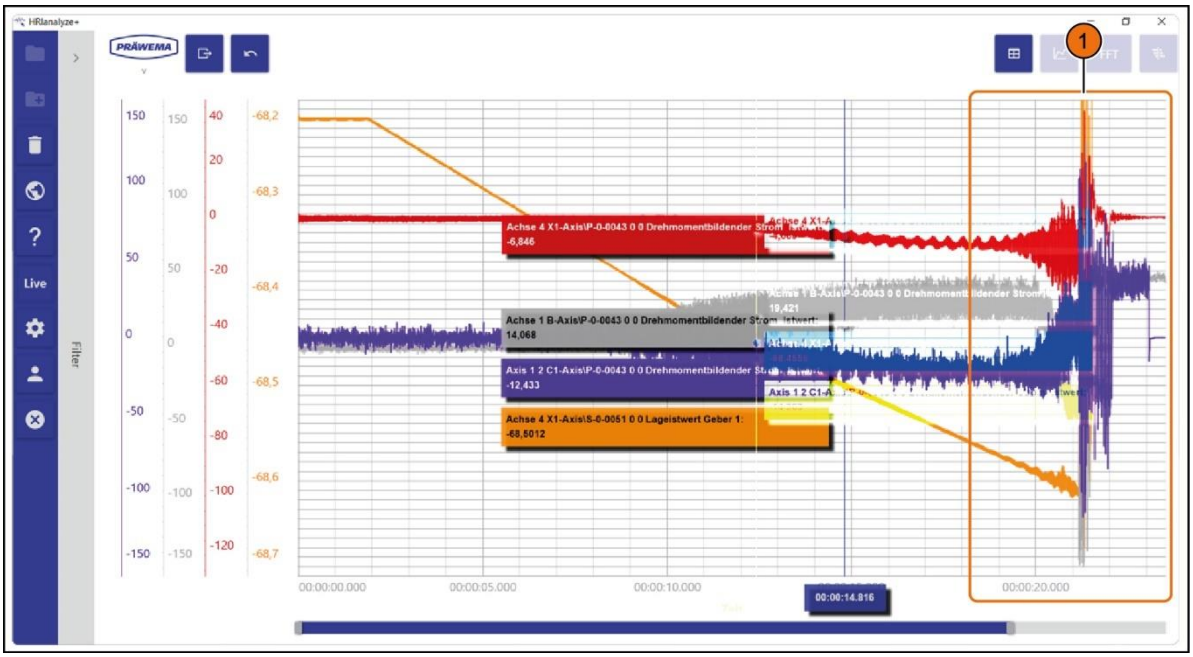


Fig. 99 Example: line diagram - REXROTH INDRA Works - tool breakage

6 HRI in SynchroFine machines.

6.1 SynchroFine process parameters

In SynchroFine machines, the following parameters are determined for the calculation of the HRI value:

- **Temperatures** of the B-axis and C-axis
- **Current / force** from the B-axis, C-axis, X-axis and Z-axis
- Values from the **Vibration sensors** of the B-axis, C-axis and U-axis

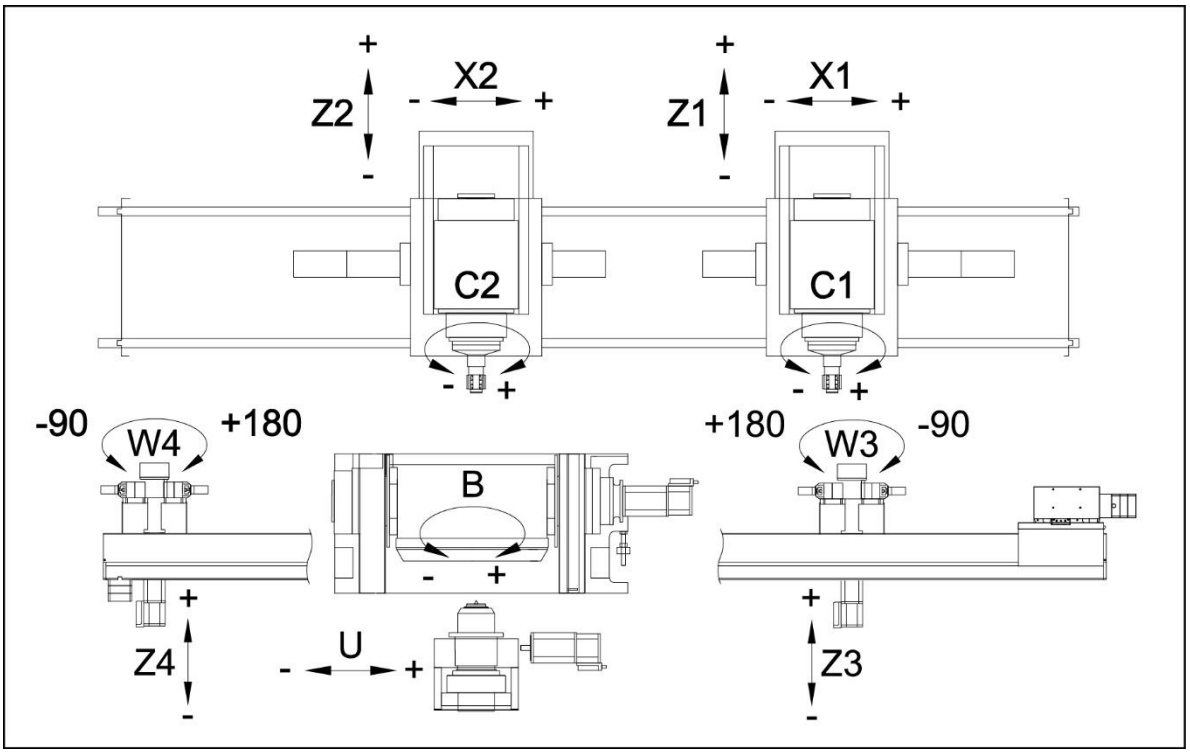


Fig. 100 Axes of a SynchroFine machine

B	Tool spindle, honing
C1	Workpiece spindle, right
C2	Workpiece spindle, left
U	Dolly cross slide
W3	Turret loader, right
W4	Turret loader, left
X1	Workpiece spindle cross slide, right
X2	Workpiece spindle cross slide, left
Z1	Workpiece spindle saddle slide, right
Z2	Workpiece spindle saddle slide, left
Z3	Turret loader saddle slide, right
Z4	Turret loader saddle slide, left

6.2 Machine description

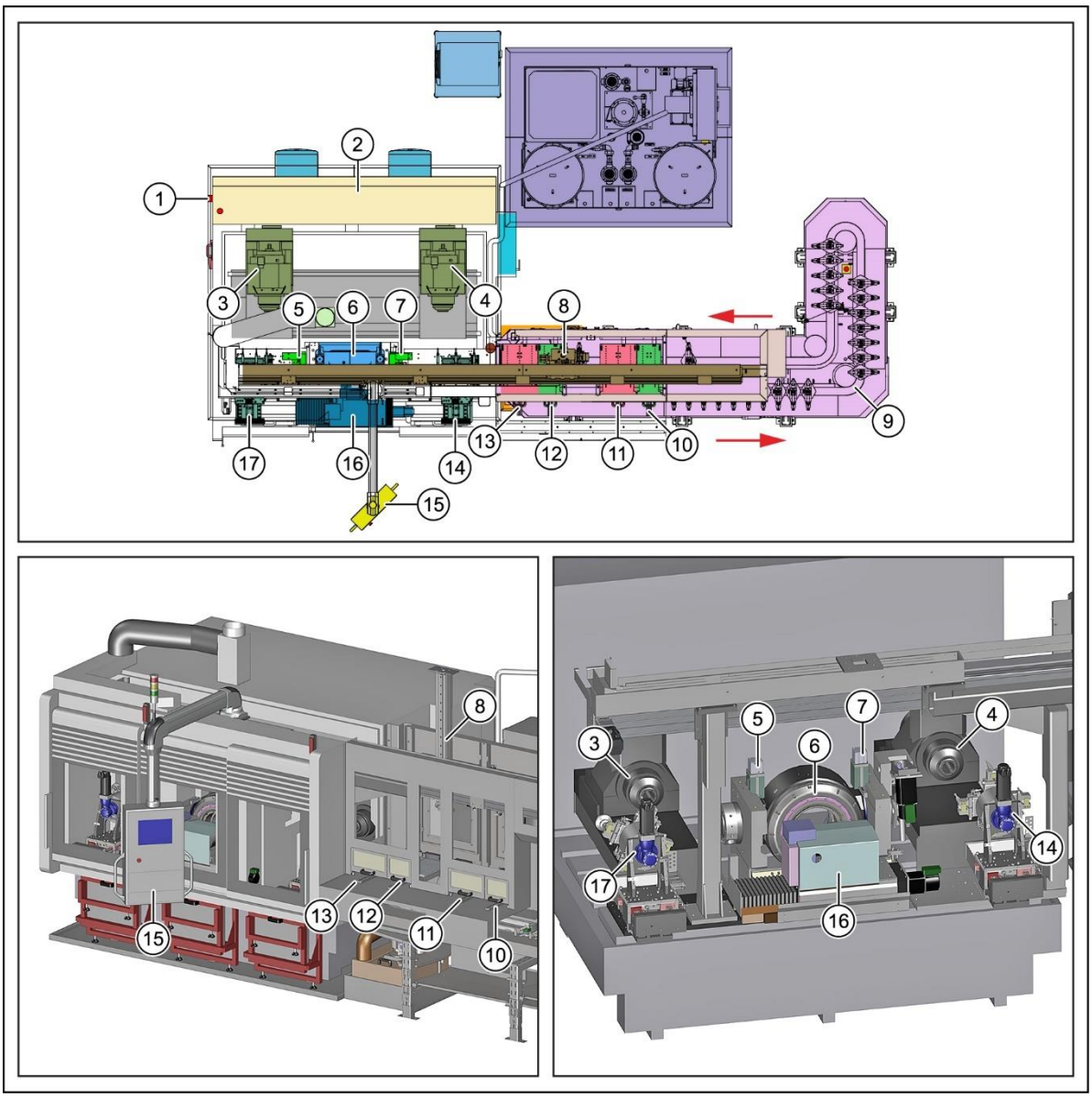


Fig. 101 Module overview, external honing machine SynchroFine (example)

1	Main switch	10	SPC parts drawer right
2	Control cabinet	11	NOK parts drawer right
3	Workpiece spindle C1	12	SPC parts drawer left
4	Tool spindle C2	13	NOK parts drawer left
5	Test station, left	14	Turret loader, right
6	Tool spindle - honing head	15	Control panel (HMI + HRI)
7	Test station, right	16	Pneumohydraulic / dolly
8	Loading gantry	17	Turret loader, left
9	Conveyor belt		

The **SynchroFine high performance gearing external honing machine** can be designed as a single spindle or as a double spindle machine (types HS-A-W or HSD-A-W).

The machine is a self-loading machine which picks up the workpiece with the clamping system, aligns it electronically, checks the tolerance range, and moves the workpiece into the machining station. The machine works using the hobbing method.

The machine is designed for machining wheels and shafts, and set up for automatic operation.

The X and Z axes are driven by an electric linear motor, and all the other CNC axes are equipped with wear-free, highly dynamic AC servomotors adapted to the requirements. All linear axes are monitored using a length measurement system.

By utilizing individual drives, the machine is excellently adapted to the requirements of tooth honing. The angular and linear adjustment possibilities allow the tool to be adjusted continuously to the workpiece.

To increase the total rigidity of the machine system the tool pivot W is pneumatically clamped. The individual drives of the position-controlled axes are equipped with suitable highly dynamic motors and controllers.

The feed rate of the workpiece axes is continuously adjustable, allowing it to be adapted optimally to the respective workpiece, the material thickness to be removed and the respective tolerance range of the toothing as well as to the material. The position and speed of the feed axes can be freely programmed by the user as an NC axis.

As standard, the machine is equipped with a CNC control made by Bosch Rexroth MTX as well as with a SERCOS interface. Error messages are displayed in plain text on the CNC monitor, and language can be selected.

The electronic control unit is divided according to power supply and control sectors and housed in two separate switch cabinets. The control cabinet is connected on the machine's rear side to the machine frame via the consoles.

The drive torques of tool and workpiece are designed for an operationally safe and high performance of the machine.

All movable machine guides and a large number of the adjustable guides are lubricated at settable intervals by a central lubricating unit. The usual monitoring devices and limit switches are available. The axis drives of the working axes are generally designed as continuously adjustable servomotors with incremental travel measurement, either as encoder or linear scale.

The machine has a comprehensive operator-guided fault diagnosis program to monitor the operational sequence in setup and automatic modes. This is displayed and can be observed on an operator console mounted next to the safety door of the machine. Interfaces to central computers are possible.

The safety cabin is equipped with door safeguards to exclude risks to the operating personnel to a major extent, even in the event of inattentiveness. The direct working area is enclosed separately and mechanically locked.

When machining long workpieces it is possible to use a dolly (16) It stabilizes the workpiece and permits oscillation of the Z axis without becoming loose from the workpiece.

6.3 Machining process

The honing process is based on a relative movement, subject to the axis angle of intersection between a spur-toothed or helical-toothed workpiece and a helical-toothed tool in the contact area.

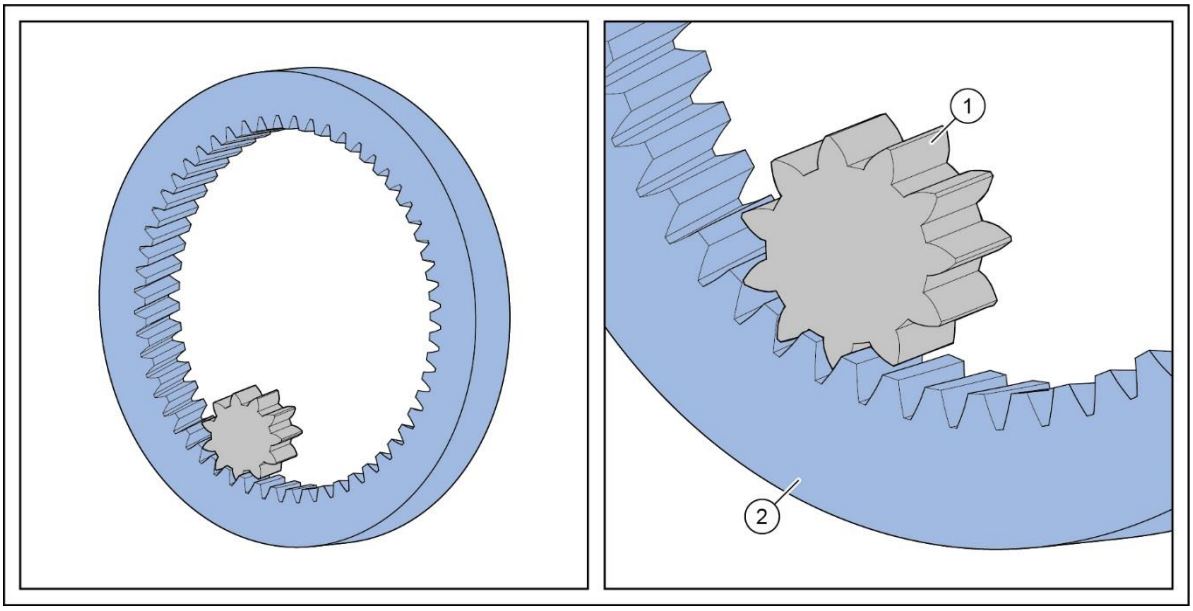


Fig. 102 Model of the honing technology - SynchroFine

1 Workpiece 2 Honing ring tool

The machine has the conventional monitoring installations and limit switches. The rotary speed of the tool and the workpiece are in the same ratio as their numbers of teeth.

The depth of cutting on both tooth flanks is specified precisely through a continuous, precisely defined rotational speed displacement in both positive and negative direction. The direction of rotation does not change during machining of the two tooth flanks. Workpieces whose tooth width exceeds the width of the honing tool can be machined over their whole width if an oscillation movement of the Z axis is also incorporated.

There is an extensive temperature stabilization system installed in the honing oil processing system. A balanced temperature of the tool, the workpiece on the chucking device and the flushing oil is an important precondition for safe machine operation.

The ideal working temperature is between 22°C and 26°C.

6.3.1 Hone tools

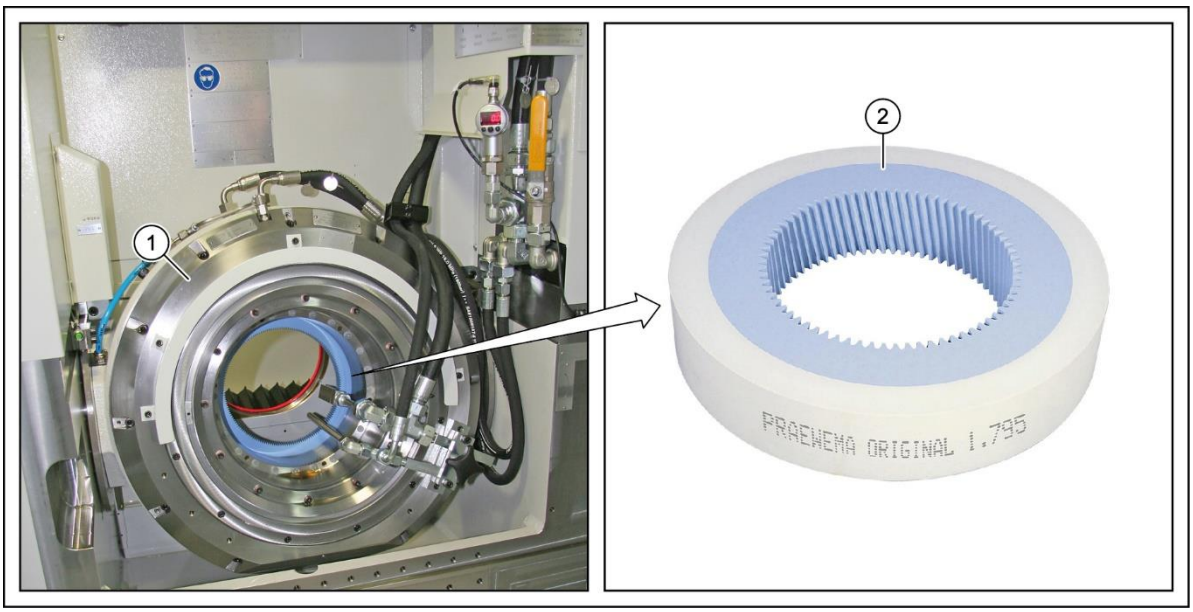


Fig. 103 Honing head with honing tool - SynchroFine

1 Honing head

2 Honing tool - Honing ring

The impact-sensitive honing tool (ceramic ring), the honing ring (2), is clamped in the honing head (1) by a hydraulic expansion chuck. During the honing process, the tool is flushed with honing oil via the flushing nozzles in order to remove the fine honing particles. Thus a continual honing result is guaranteed.

The honing head (1) can be swiveled by up to 90° and thus individually to the workpiece.

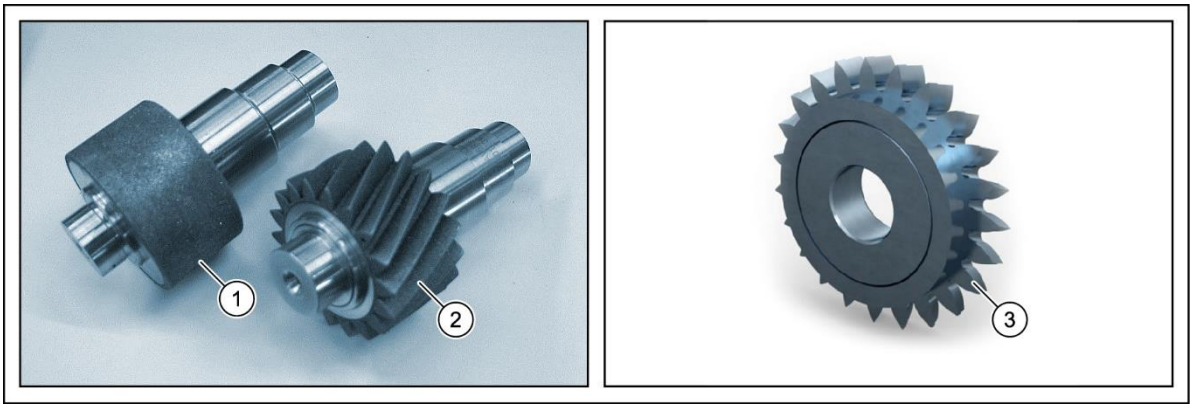


Fig. 104 Dressing tools - SynchroFine

1 Head dresser
Diamond Dressing Ring (DDR)

2 Gearing dresser
Diamond Dressing Gear (DDG)

3 Gearing dresser
Vario Speed Dresser (VSD)

There are two dressing tools in the turret loader for correcting tool wear on the honing ring. See chapter 6.3.

These tools are collected by the chucking device in separate intervals and fed into the honing tool. The tooth flanks and the head area of the tool are dressed separately.

Due to the tool wear, the final dimension of the honed parts changes continuously. The size of the tolerance range for the gearing defined in the drawing determines the dressing frequency.

This interval for a dressing procedure is stored in the automatic program, and is followed until the honing ring diameter has increased by approximately 5 mm (wear limit). The tool change is then indicated on the display.

Approx. 0.1 mm is worked off the tool per dressing cycle. This is automatically followed by a program correction of the axial distance.

6.4 Axes layout

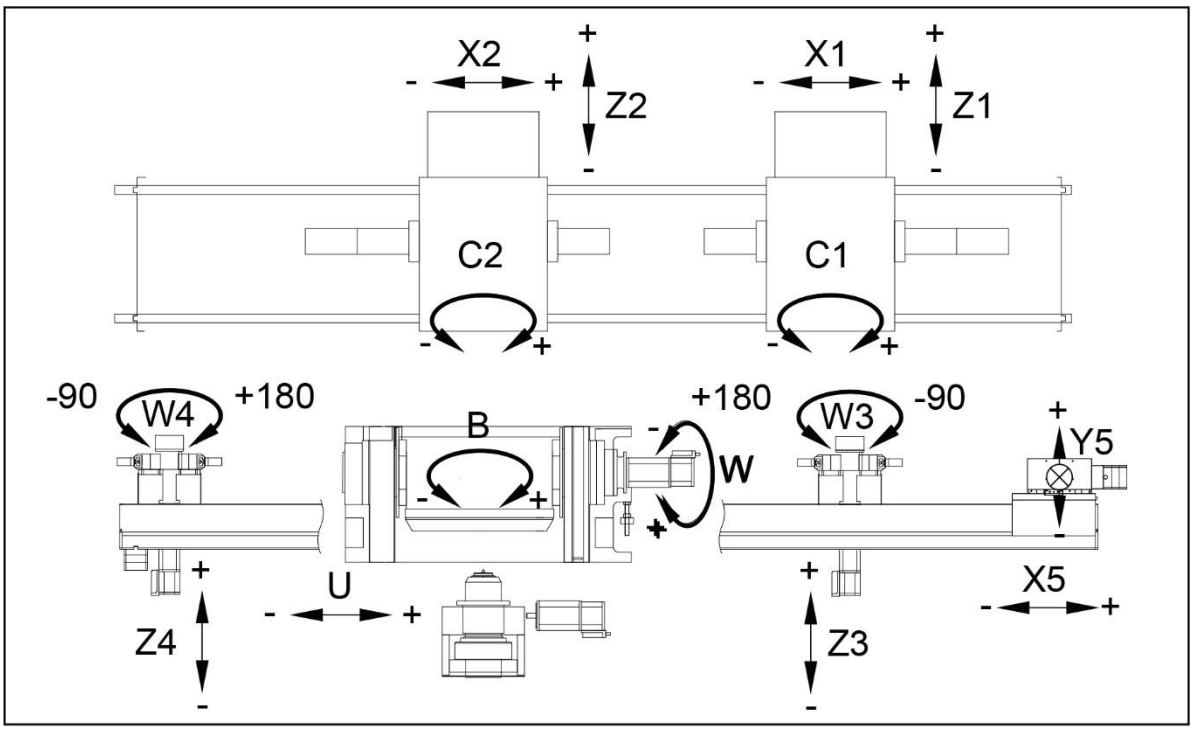


Fig. 105 CNC and positioning axes - SynchroFine

B	Tool spindle, honing
C1	Workpiece spindle, right
C2	Workpiece spindle, left
U	Dolly cross slide
W	Tool spindle swivel axle
W3	Turret loader, right
W4	Turret loader, left
X1	Workpiece spindle cross slide, right
X2	Workpiece spindle cross slide, left
X5	Loading gantry cross slide
Y5	Loading gantry load axis
Z1	Workpiece spindle saddle slide, right
Z2	Workpiece spindle saddle slide, left
Z3	Turret loader saddle slide, right
Z4	Turret loader saddle slide, left

6.5 Overview of vibration sensors

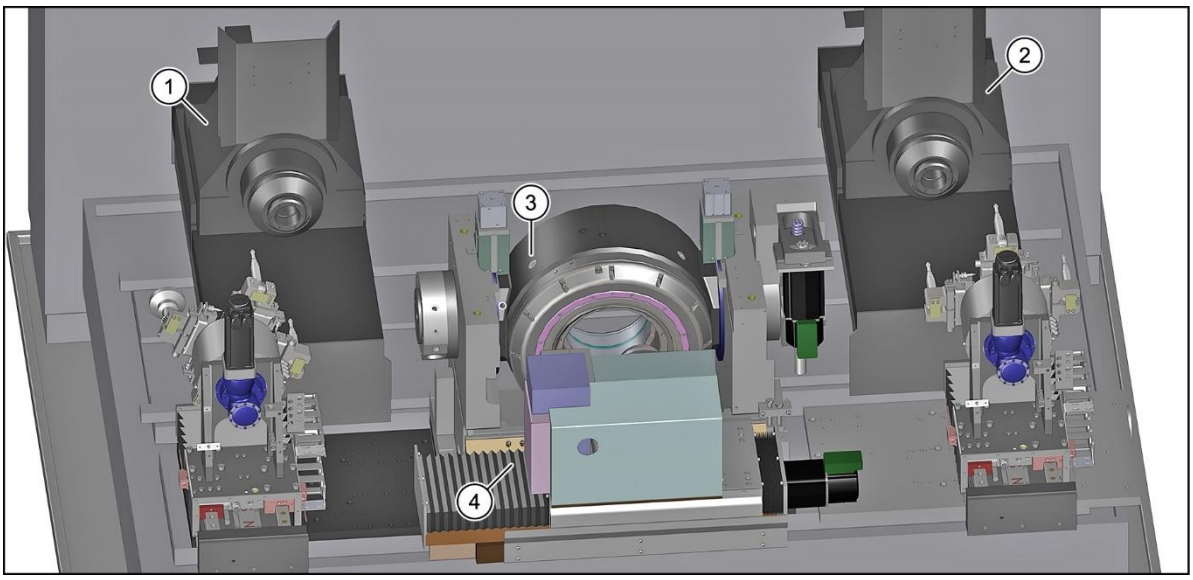


Fig. 106 Overview of vibration sensors on a SynchroFine external honing machine

1	Workpiece spindle sensor, left (C1-axis; XYZ-direction)	3	Sensor on the honing head (B-axis; XYZ-direction)
2	Workpiece spindle sensor, right (C2-axis; XYZ-direction)	4	Dolly sensor (U axis, X direction)

The recording of machine vibrations is integrated in the external honing machine sensors of the manufacturer IFM.

NOTE!
Heed the manufacturer's documentation

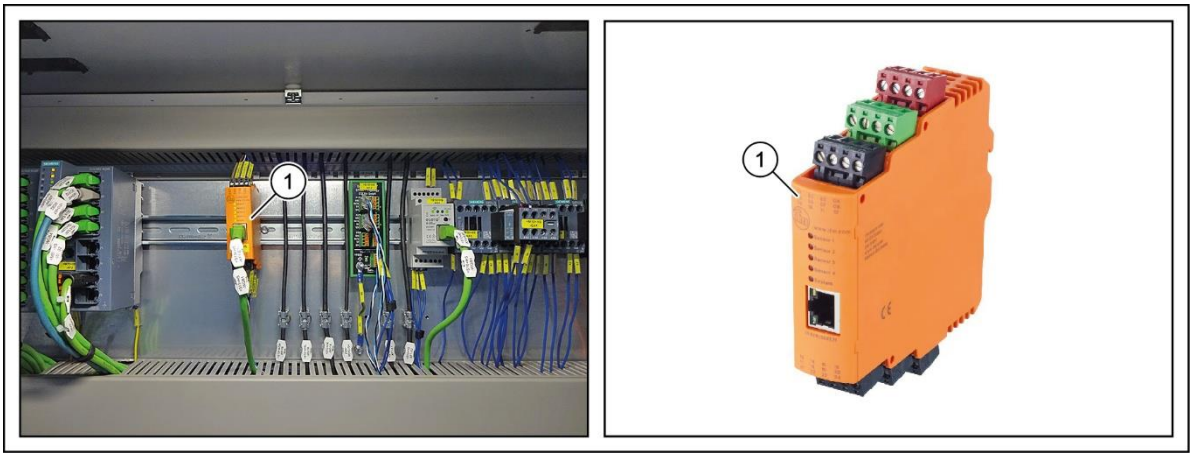


Fig. 107 VSE evaluation unit in the control cabinet

The appropriate evaluation units (1) are located in the control cabinet.

6.5.1 Vibration sensors on the workpiece spindles

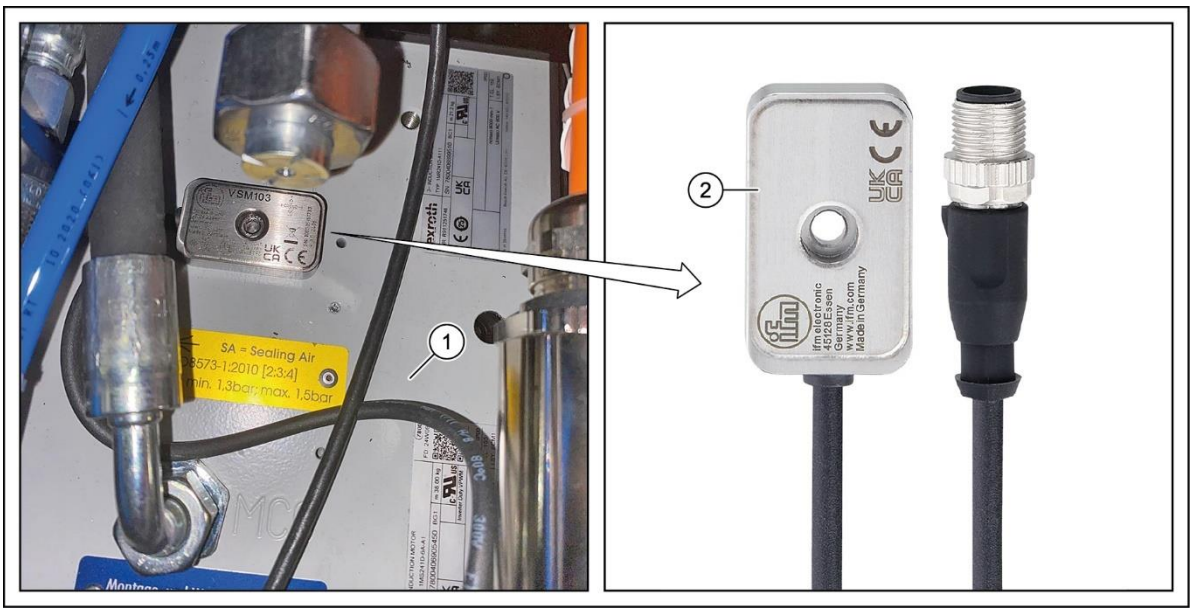


Fig. 108 Vibration sensors on the workpiece spindles - SynchroFine

1 Workpiece spindle C1/C2 2 Vibration sensor VSM103

Three-axis vibration sensors **VSM103** (2) made by IFM are installed as standard on the workpiece spindles (C-axis) (1).

6.5.2 Vibration sensor on the honing head

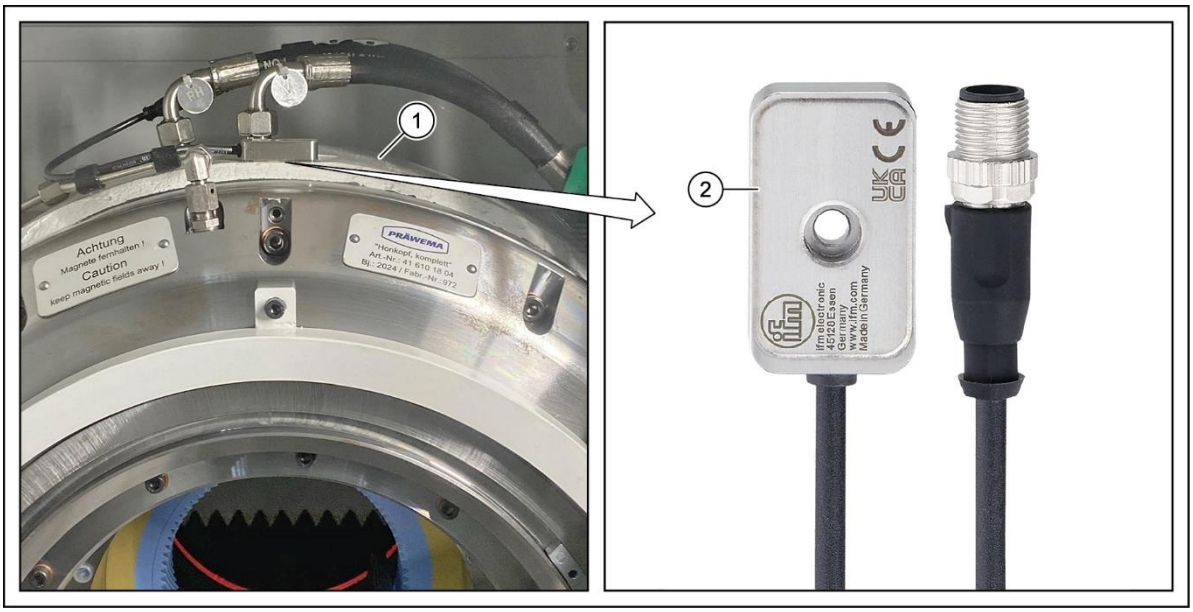


Fig. 109 Vibration sensor on the honing head - SynchroFine

1 Honing head 2 Vibration sensor VSM103

A three-axis vibration sensor **VSM103** (2) made by IFM is installed as standard on the honing head (B-axis) (1).

6.5.3 Vibration sensor on the dolly

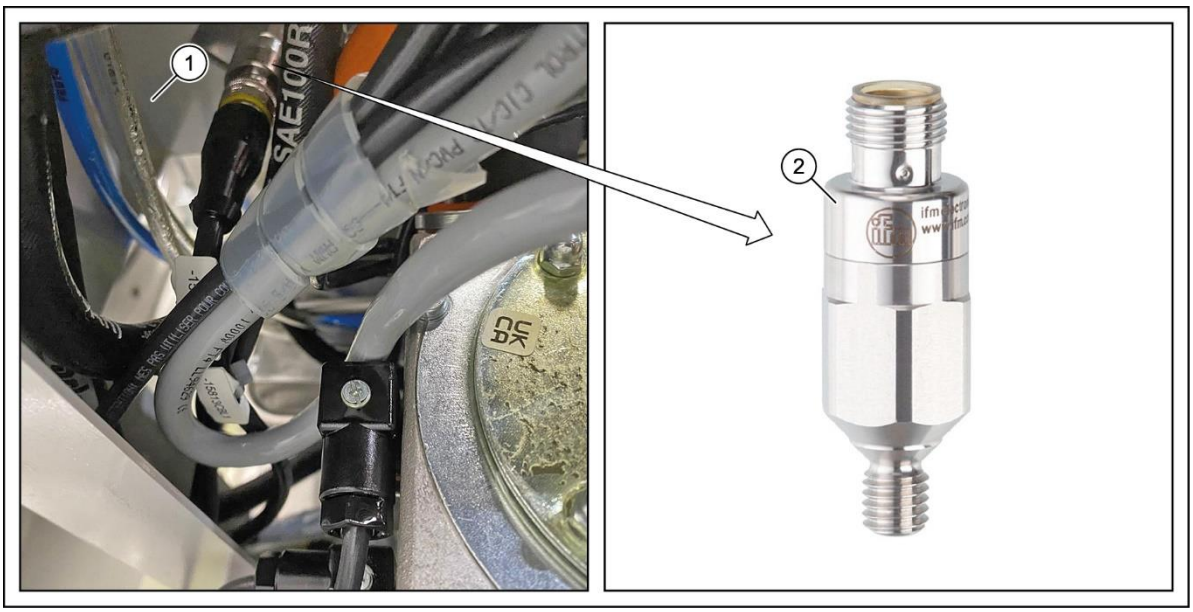


Fig. 110 Vibration sensor on the dolly - SynchroFine

1 U-axis dolly 2 Vibration sensor VSA001

A single-axis vibration sensor **VSA001** (2) made by IFM is installed on the dolly (U-axis) (1) as standard.

6.6 Starting the HRI software - SynchroFine

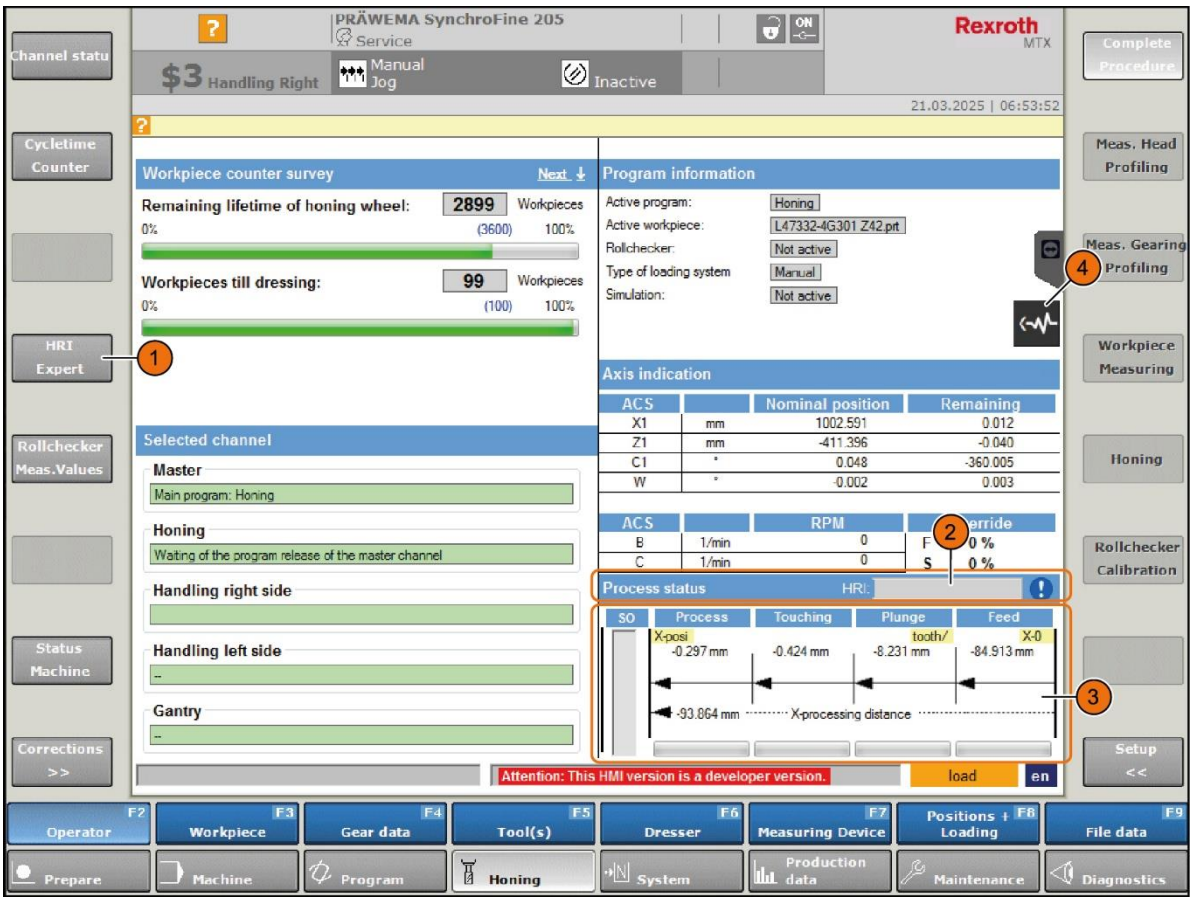


Fig. 111 HMI menu operator in the SynchroFine

1 HMI interface *HRI Expert*
2 Display of process status
3 Display of processing sequence HMI
4 Button for the HRI *Spectrum* menu

In the up-to-date HoningHMI software version (as from version 6.6.2.1033, of 25.01.2019), there is a change to the HRI software in the HMI *Operator* menu.

The current HRI value is displayed as a bar chart (2). The value is scaled to 110% of the maximum HRI value.

If the set value is exceeded, the color changes from blue to red.

INSTRUCTION

Proceed as follows to change to the HRI software:

5. In the HMI *Operator* menu of the machine, select the HRI-Expert (1) button,
6. The main HRI menu is opened, see section 3.1.
7. Select the *Login* button,
8. Enter your email and password in the open *Login* menu window, see Section 3.1.1,
9. Acknowledge with the *Login* button.

NOTE!

This function is currently only active for SynchroFine.

INSTRUCTION
Select the button (4) to display the HRI menu *Spectrum*.

6.7 Starting the HRI software in older SynchroFine machines

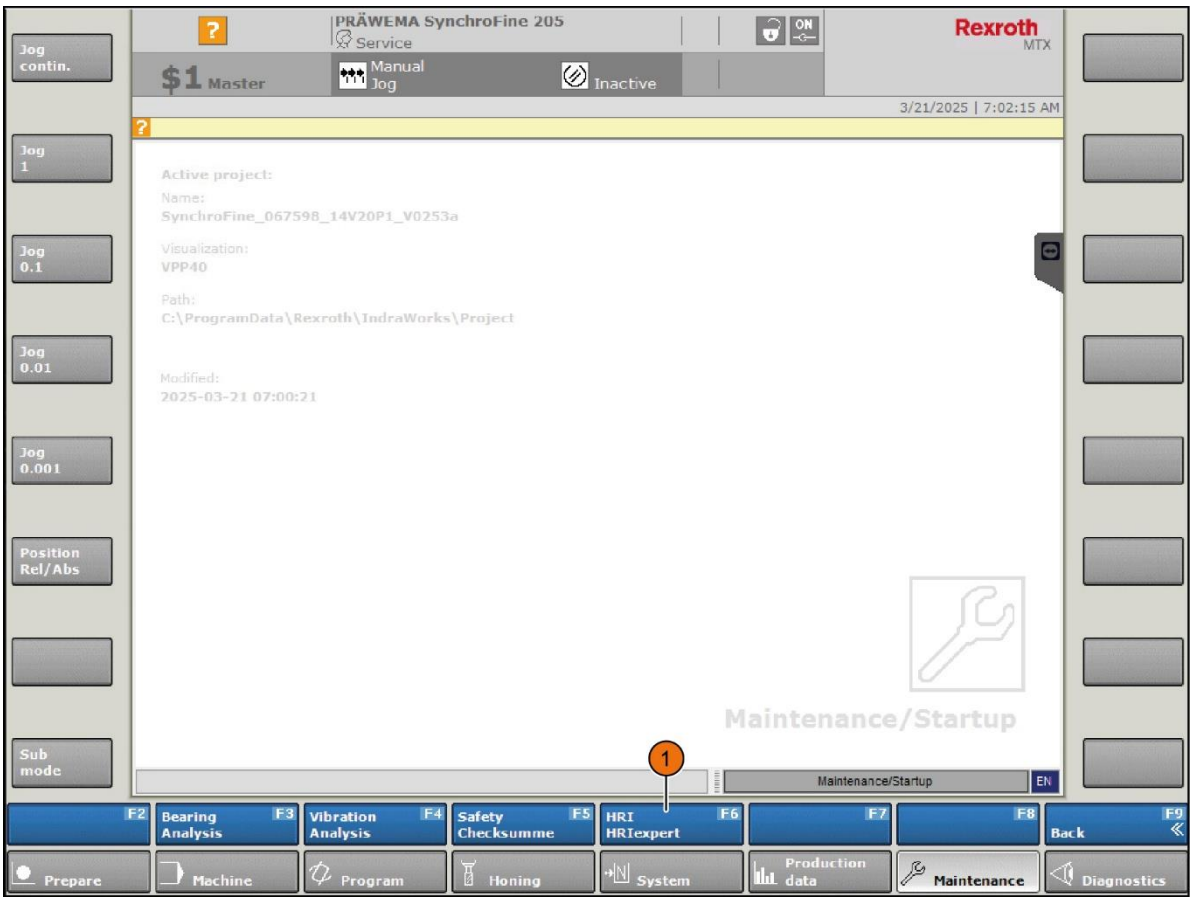


Fig. 112 HMI Operator menu in older SynchroFine machines

1 HMI interface HRI Expert

In older SynchroFine machines, the HRI-software is started in the HMI *maintenance* menu.

INSTRUCTION
Proceed as follows to change to the HRI software:

1. Select the HRI-Expert (1) button in the HMI *Maintenance* menu of the machine,
2. The main HRI menu is opened, see section 3.1.
3. Select the *Login* button,
4. Enter your email and password
   in the open *Login* menu window, see Section 3.1.1,
5. Acknowledge with the *Login* button.

6.8 Known SynchroFine phenomena

6.8.1 Problematic frequencies

If the machine displays peaks in the frequency ranges, this indicates a problem in the machine.

Main frequency	Resonance frequency	Description
Approx. 200 - 350 Hz		As resonance frequency of the cross slide, depending on the machine type
	240 Hz	On 204 HS without additional weights
	350 Hz	On 204 HS with additional weights
	240 - 300 Hz (nom. 280 Hz)	On 205 HS or 305 HS
Approx. 1.040 Hz		Resonance frequency of the spindle (housing)
Approx. 1.050 - 1.850 Hz		Resonance frequency of the clamping system incl. dolly
Approx. 3,000 - 4,000 Hz		Dolly

Tab. 8 Problematic frequencies - SynchroFine

6.8.2 Problematic products

If the machine displays high values in specific orders, this indicates a problem in the machine.

Order DE	Description
1. Order	Concentricity / imbalance (difficult to detect)
2. / 3. Order	Wobbling and/or incorrect position of the dolly
3. / 4. Order	Indication of worn guides of the X- or Z-axis

Tab. 9 Problematic products - SynchroFine

All order statements are based on the rotation frequency of the C-spindle.

6.8.3 Bearing arrangements of spindles

Honing head 205	Bearing arrangement
Outer ring	26,36
Inner ring	28,61
Roller	22,64

Tab. 10 Bearing arrangements honing head 205 - SynchroFine

Honing head 305	Bearing arrangement
Outer ring	30,65
Inner ring	32,43
Roller	15,73

Tab. 11 Bearing arrangements honing head 305 - SynchroFine

C-spindle ZX05-039-00K	Bearing front	Bearing rear
Outer ring	9,9	8,73
Inner ring	12,2	11,27
Roller	7,47	6,66

Tab. 12 Bearing arrangements C spindle ZN05-039-00K - SynchroFine

C-spindle ZX05-053-00K	Bearing front	Bearing rear
Outer ring	11,93	9,42
Inner ring	13,07	10,58
Roller	19,13	15,64

Tab. 13 Bearing arrangements C spindle ZN05-053-00K - SynchroFine

U-axis dolly	Bearing front	Bearing rear
Outer ring	8,08	8,0
Inner ring	8,92	11,98
Roller	17,7	3,95

Tab. 14 Bearing arrangements U-axis dolly - SynchroFine

6.8.4 Causes of current peaks

Axis	Cause
B-axis honing head	Higher currents in the B-axis are usually generated by outsize workpieces or by workpieces with hardening distortion. One-sided machining of the component generates current peaks during honing.
C axis workpiece spindle	Small break-outs in the honing stone or imprecise positioning
X-axis feed axis	Chips in tooth root
Z-axis oscillating axis	A burr on the flank of the tooth generates a current pulse in the Z-axis. If the pneumatic pressure of the dolly is too high, the Z-axis is constantly under higher load. A broken spring on the spatter guard flap leads to higher loading of the Z-axis.

Tab. 15 Causes of current peaks - SynchroFine

7 HRI in SynchroForm machines.

7.1 SynchroForm process parameters

On SynchroForm skiving machines the following parameters are determined for the calculation of the HRI value:

- **Temperatures** of the C-axis and E-axis
- **Current / force** from the C-axis and E-axis (X-axis, Y-axis (skiving) and Z-axis)
- Values from the **Vibration sensors** of the C-axis (tri-axis sensor) and the E-axis

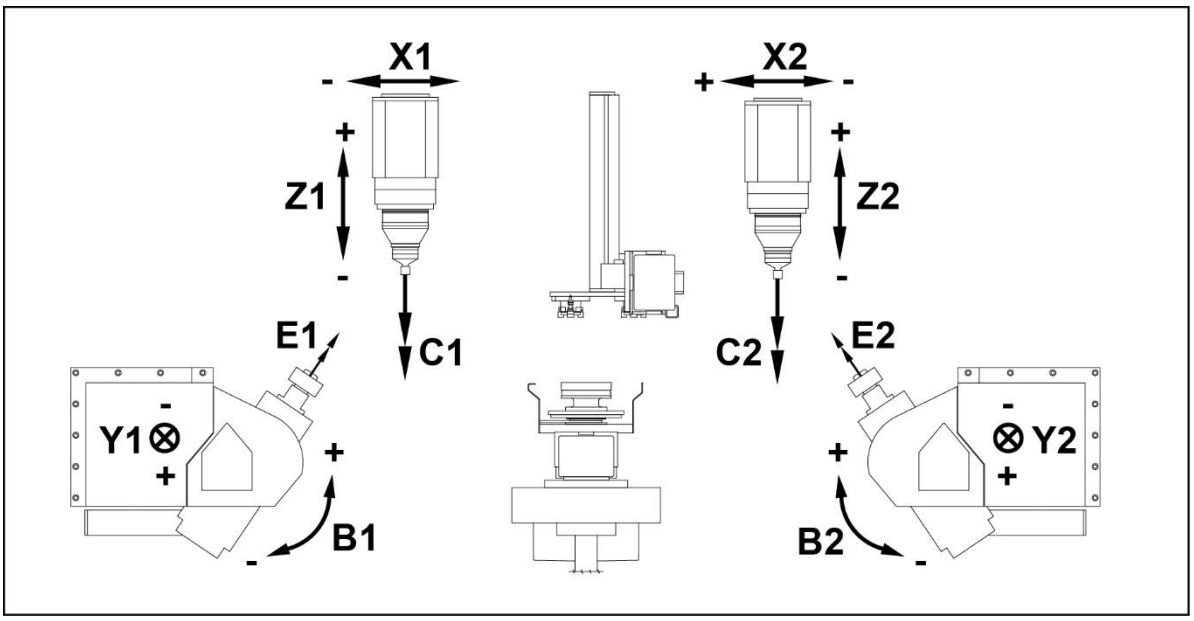


Fig. 113 Axes of a SynchroForm double spindle skiving machine

B1	Swivel axis tool spindle 1	X1	Workpiece spindle cross slide 1
B2	Swivel axis tool spindle 2	X2	Workpiece spindle cross slide 2
C1	Workpiece spindle 1, left	Y1	Infeed axis, tool spindle 1
C2	Workpiece spindle 2, right	Y2	Infeed axis, tool spindle 2
E1	Tool spindle 1 left (skiving)	Z1	Workpiece spindle vertical axis 1
E2	Tool spindle 2, right (skiving)	Z2	Workpiece spindle vertical axis 2

Particularly during acceleration processes, the motors can be briefly overloaded. It is important that the Siemens controls do not record any measured values exceeding 100% of the rated current. No measured values over 100% are communicated to the HRI.

NOTE!
When setting limiting values ensure that on machines with a Siemens controller, no values higher than 100% are input.
The HRI would not trigger a fault response to limiting values over 100% of the rated current.

7.2 Machine description

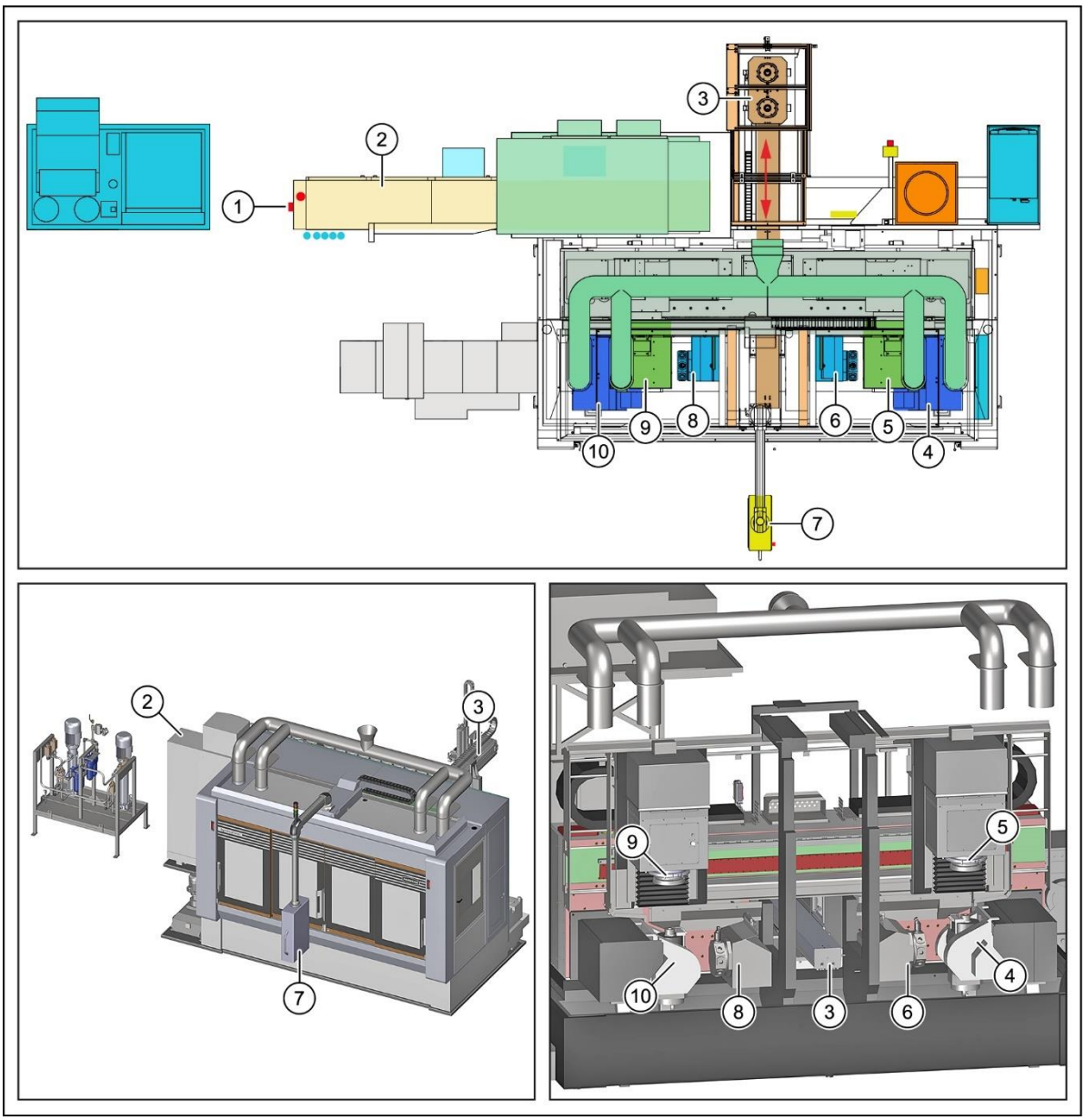


Fig. 114 Module overview of SynchroForm internal honing / skiving machine (example)

1	Main switch	6	Tool turret, right
2	Control cabinet	7	Control panel (HMI + HRI)
3	Shuttle with shuttle carriage	8	Tool turret, left
4	Tool spindle E2 (Power skiving module, right)	9	Workpiece spindle C1
5	Workpiece spindle C2	10	Tool spindle E1 (Power skiving module, left)

The **SynchroForm CNC gearing processing machine** can be designed as a single spindle or double spindle machine.

Various machining processes, such as skiving (soft machining) and interior honing (hard machining) can be **performed on the machine**.

The modular construction of the SynchroForm machine provides an optimal platform to complement further modules, key technologies, such as skiving, interior honing or pointing um additional modules.

In the example, the loading and unloading the machine is done with a shuttle (3). This is located centrally behind the machine.

The vertical power skiving modules (4+10) on the left and the right is used to cut the gearing on the workpieces. For deburring the workpieces, there is a tool turret with a deburring steel and roller deburring tool installed alongside each power skiving module. The workpiece spindles C1+C2 (5+9) are mounted vertically on the compound slide, and equipped with a highly dynamic drive. The workpiece spindles are equipped with an appropriate adapter flange in order to hold the chucking device.

The workpiece spindles are electronically coupled with the tool spindles. The gear ratios can be freely selected on the operator console.

Skiving of the gearing:

The shuttle (3), together with the shuttle carriage, is located centrally behind the machine.

The customer places the raw parts on the raw part rack on the Shuttle carriage.

The Shuttle carriage moves the raw part forward into the machining area.

The particular workpiece spindle C1+C2 (5+9) takes over the raw part, clamps it externally and moves to a positioning device. There, the gearing is centered on an initiator.

Then the gearing on the tool spindles is machined E1+E2 (10+4).

The workpiece is then deburred on the turrets (8+6).

After the processing, the relevant workpiece spindle takes the finished part back to the pick-up position, to the shuttle carriage, and transfers the finished part to the finished part rack.

The shuttle carriage moves out of the machine to the rear. There, the finished part is unloaded by the customer.

Internal honing of the internal gearing

In this place, a tool change in the tool spindles E1+E2 is necessary!

Before starting the internal honing, the newly used unprofiled grinding tool (honing wheel) must be dressed. To do this, the shuttle carriage (3) with the dressing tools travels forwards on the racks into the machining area of the machine.

The respective workpiece spindle picks up the dressing tool from the rack on the shuttle carriage and moves with it to the tool spindle E1+E2. The grinding tool is dressed for the first time. A toothing is worked into the grinding tool. After dressing, the dressing tool is returned to the rack on the shuttle carriage by the corresponding workpiece spindle.

The workpiece spindle C1+C2 (5+9) receives the hardened workpiece, clamps it externally and moves it to the positioning device. There, the gearing is centered on an initiator.

The workpiece spindle moves with the raw part to the testing station. Here the oversize of the raw part is checked on the rollchecker.

Internal honing of the internal gear on the tool spindles E1+E2 is carried out.

After the processing, the relevant workpiece spindle takes the finished part back to the pick-up position, to the shuttle carriage, and transfers the finished part to the finished part rack.

The shuttle carriage moves with the finished part out of the machine to the rear. The finished part is unloaded by the customer.

7.3 Power skiving modules - tools

Fig. 115 Tool spindle E1/E2 - skiving modules - SynchroForm (example)

1	Tool spindle E1/E2	4	Milling tool - skiving wheel
2	Tool holder	5	Internal honing tool - honing wheel
3	Servomotor		

The skiving machine is equipped with two adjustable vertical tool spindles E1 and E2 (1) for the skiving and interior honing of the gearing.

The tool spindles each have a swivel axis (B1/B2) and a linear axis (Y1/Y2).

To machine various workpieces, the tools (4+5) need to be changed.

7.4 Axes layout

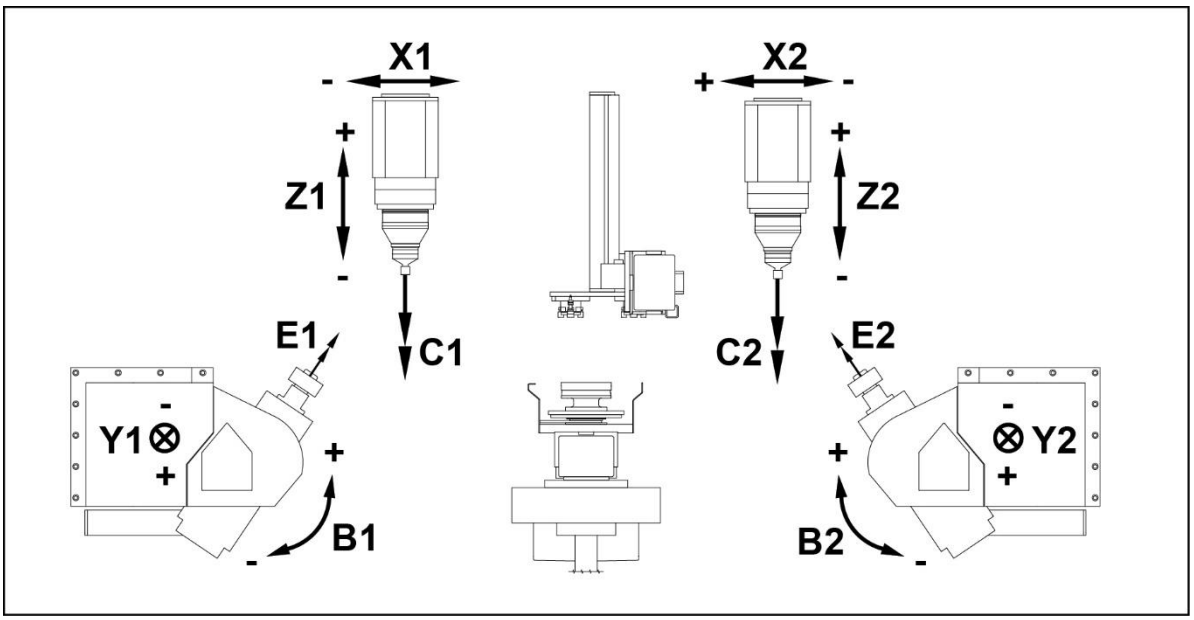


Fig. 116 Axes of the SynchroForm double spindle skiving machine - SynchroForm

B1	Swivel axis tool spindle 1	X1	Workpiece spindle cross slide 1
B2	Swivel axis tool spindle 2	X2	Workpiece spindle cross slide 2
C1	Workpiece spindle 1, left	Y1	Infeed axis, tool spindle 1
C2	Workpiece spindle 2, right	Y2	Infeed axis, tool spindle 2
E1	Tool spindle 1 left (skiving)	Z1	Workpiece spindle vertical axis 1
E2	Tool spindle 2, right (skiving)	Z2	Workpiece spindle vertical axis 2

7.5 Overview of sensors

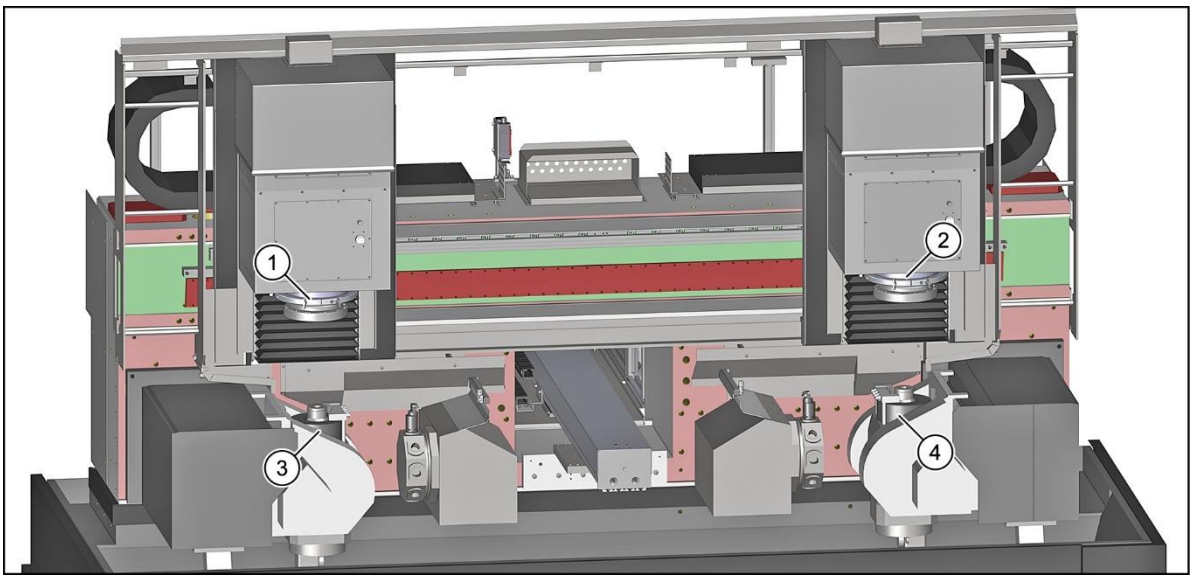


Fig. 117 Overview of vibration sensors skiving machine - SynchroForm

1	Workpiece spindle sensor, left (C1-axis; XYZ-direction)	3	Tool spindle sensor, left (E1-axis, X direction)
2	Workpiece spindle sensor, right (C2-axis; XYZ-direction)	4	Tool spindle sensor, right (E2 axis, X direction)

To record machine vibrations, sensors and evaluation units made by IFM are integrated into the skiving machine.

NOTE!
Heed the manufacturer's documentation!

7.5.1 Vibration sensors on the tool spindles

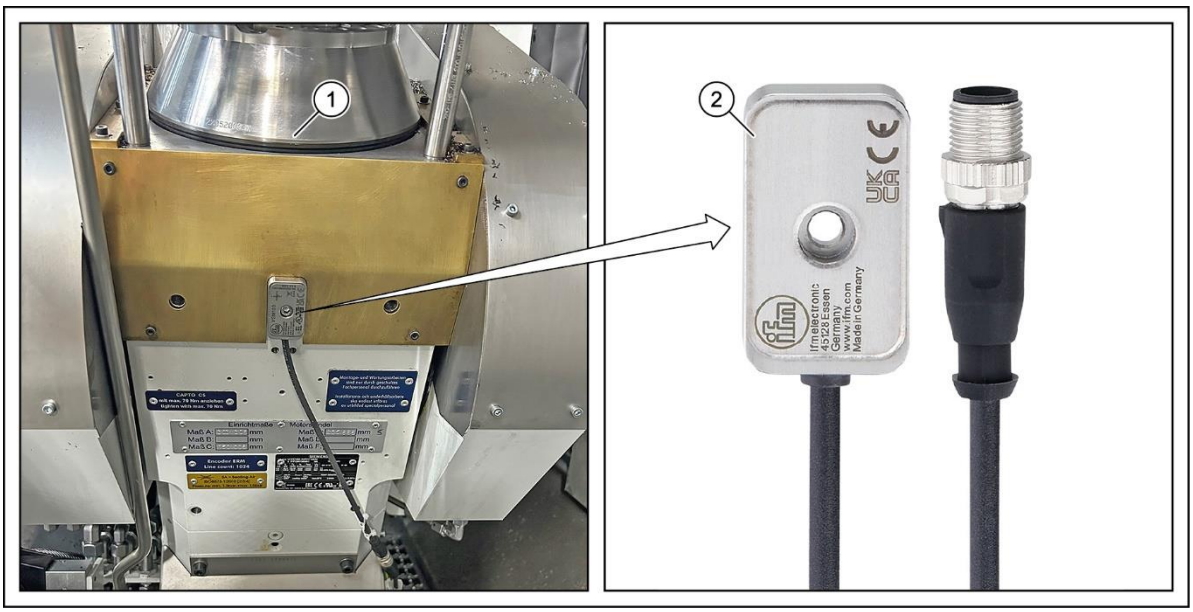


Fig. 118 Three-axis vibration sensor on the tool spindles - SynchroForm

1 Tool spindle E1/E2 2 Three-axis vibration sensor

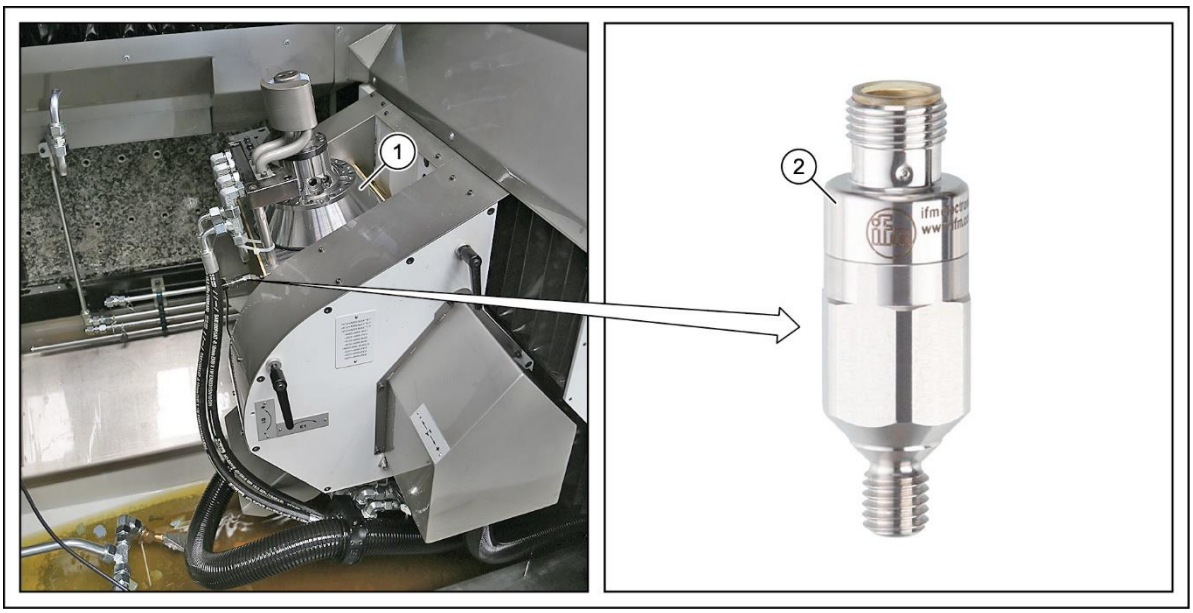


Fig. 119 A single-axis vibration sensor on the tool spindles - SynchroForm

1 Tool spindle E1/E2 2 Single-axis vibration sensor

Three-axis vibration sensors or single-axis vibration sensors can be installed on the tool spindles (1) (E-axis).

7.5.2 Vibration sensors on the workpiece spindles

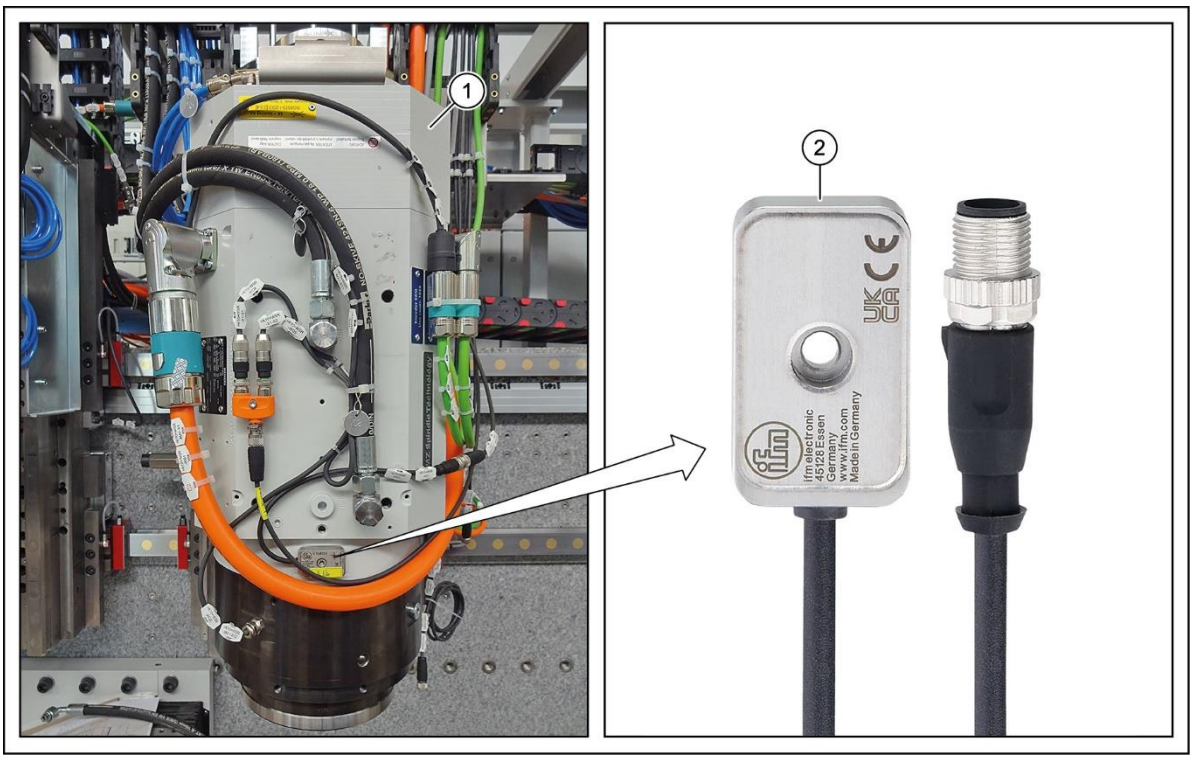


Fig. 120 Vibration sensors on the workpiece spindles - SynchroForm

1 Workpiece spindle C1/C2 2 Vibration sensor VSM103

Three-axis vibration sensors **VSM103** (2) made by IFM are installed as standard on the workpiece spindles (C-axis) (1).

7.5.3 Temperature sensors on the workpiece spindles

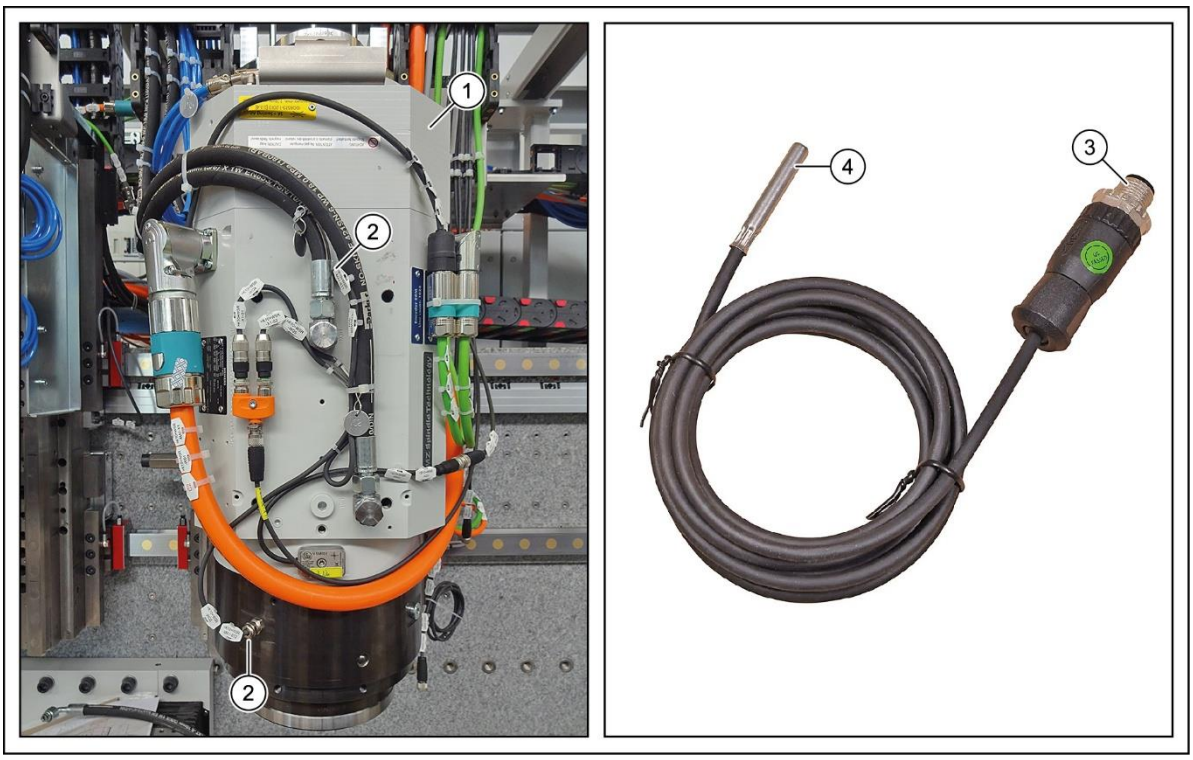


Fig. 121 Temperature sensors on the workpiece spindles - SynchroForm

1	Workpiece spindle C1/C2	3	Connection cable
2	Connection to the spindle	4	Temperature sensor

Temperature sensors (4) are installed as standard on the workpiece spindles (C-axis) (1) of the SynchroForm machines.

7.6 Starting the HRI software - SynchroForm

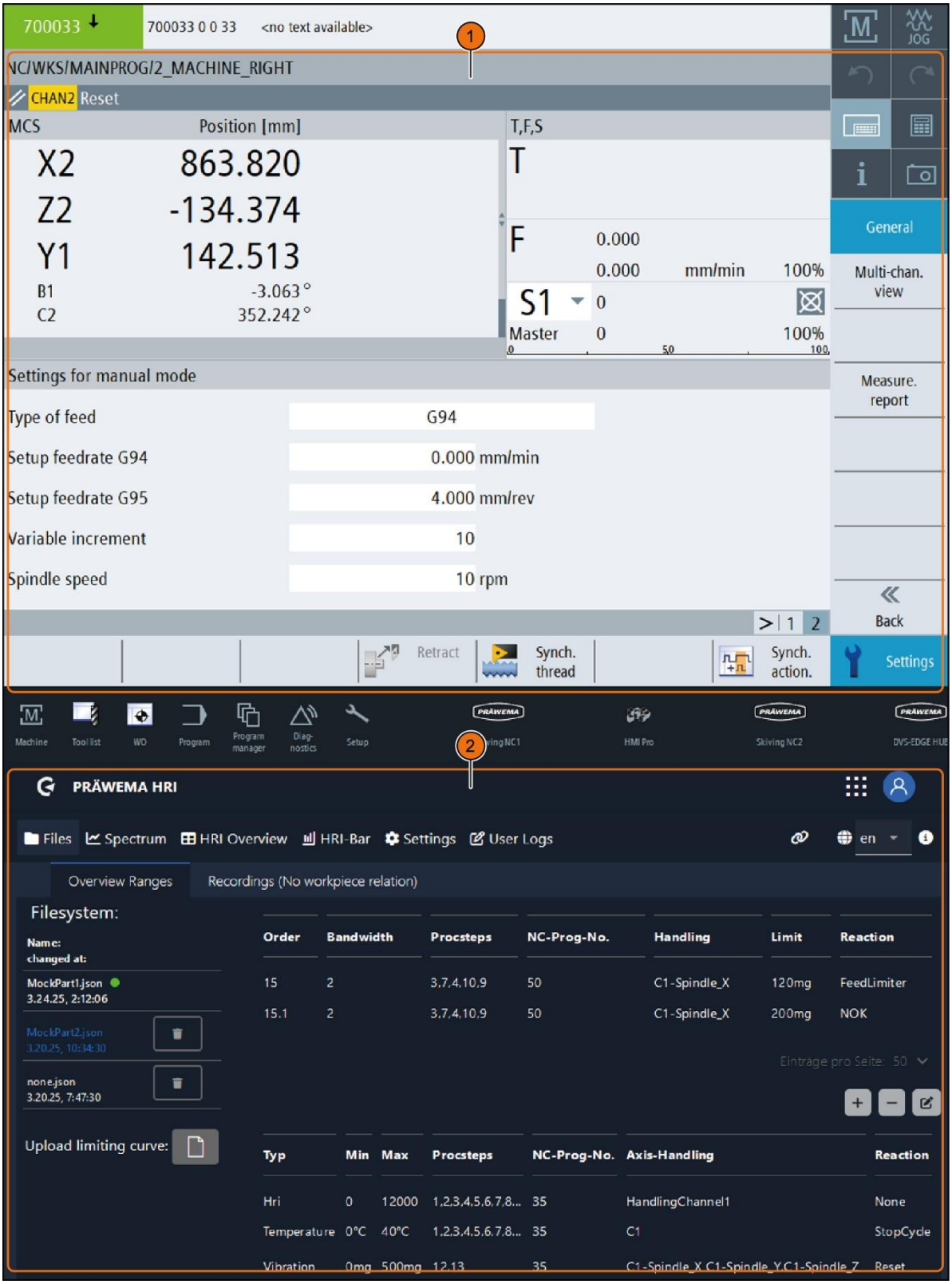


Fig. 122 Display HMI/HRI menu with SynchroForm machines with vertical display

1 HMI menu 2 HRI main menu

SynchroForm machines with a vertical display are permanently shown in the lower half of the HRI menu.

7.7 Known SynchroForm phenomena

7.7.1 Bearing arrangements of spindles

E-spindles ZZ05-078-00K + ZZ05-079-00K	Bearing front	Bearing rear
Outer ring	10,92	8,26
Inner ring	13,07	10,73
Roller	4,99	3,64

Tab. 16 Bearing arrangements E-spindles ZZ05-078-00K + ZZ05-079-00K - SynchroForm

Spindle ZX05-0180-0K + ZF05-098-00K	Bearing front	Bearing rear
Outer ring	9,79	9,23
Inner ring	12,2	11,76
Roller	4,09	3,93

Tab. 17 Bearing arrangements E-spindles ZZ05-0180-0K + ZZ05-098-00K - SynchroForm

Spindle ZX05-182-00K + ZX05-201-00K + ZX05-204-00K	Bearing front	Bearing rear
Outer ring	9,74	8,72
Inner ring	12,26	11,27
Roller	7,77	3,73

Tab. 18 Bearing arrangements E-spindles ZX05-182-00K+ZX05-201-00K+ZX05-204-00K - SynchroForm

Spindle ZX05-103-00K	Bearing front	Bearing rear
Outer ring	9,31	7,85
Inner ring	11,69	10,15
Roller	4,2	3,72

Tab. 19 Bearing arrangements spindle ZN05-103-00K - SynchroForm

Spindle ZX05-103-50K	Bearing front	Bearing rear
Outer ring	9,87	7,41
Inner ring	12,12	9,58
Roller	4,67	3,72

Tab. 20 Bearing arrangements spindle ZN05-103-50K - SynchroForm

Spindle ZX05-130-00K	Bearing front	Bearing rear
Outer ring	14,80	13,79
Inner ring	17,20	16,21
Roller	6,52	6,07
Bearing cage	0,46	0,46

Tab. 21 Bearing arrangements spindle ZN05-130-00K - SynchroForm

8 Conclusion

Dear Readers,

We thank you for the confidence which you have shown us by purchasing the license for the HRI software, and we hope that we are having a positive effect working processes.