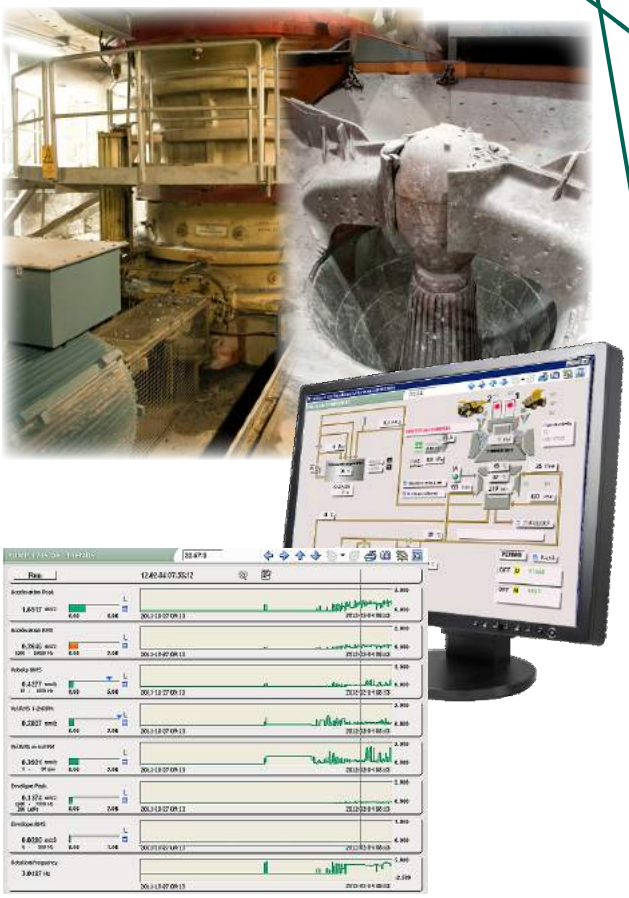
Metso DNA Machine Monitoring

Online condition monitoring system for the mining and construction industry

Metso DNA Machine Monitoring measures and analyzes the mechanical condition and performance of machines, based on vibration measurements and other machine parameters. DNA Machine Monitoring provides both protection and diagnostics tools for critical machinery, as well as condition monitoring and analyzing tools for predictive maintenance use. Online machine condition monitoring enables 24/7 monitoring, thus providing the fastest possible way to act on problems to secure plant availability, protect assets, provide information for maintenance planning and increase working environment safety.

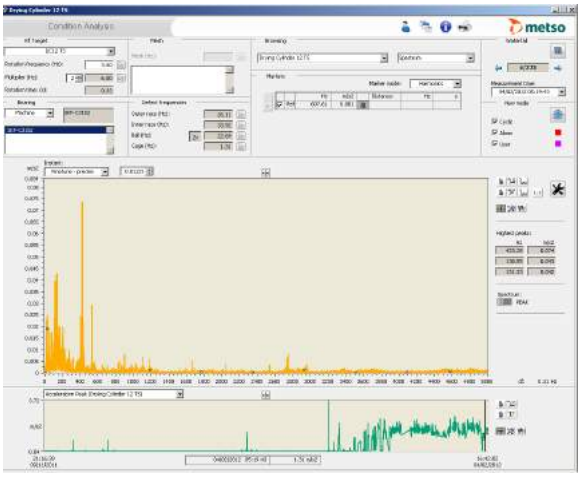
DNA Machine Monitoring can work as a fully integrated application in the Metso DNA automation platform or as a stand-alone system.



Online machine condition monitoring is based on fixed installed sensors on the machinery, cabled into I/O stations where measurement data is collected and analyzed. Alarms are generated when preset alarm limits are exceeded. Fault diagnostic is performed with comprehensive signal analyzing tools. Defect development is monitored by tracking history trends, thereby providing the tools for predictive maintenance for scheduling services and action planning.

Machine condition monitoring enables the detection of machines that do not perform properly or have mechanical faults, such as:

- bearing wear and instabilities
- lubrication problems
- unbalance
- misalignment
- thrust bearing wear
- shaft defects
- wear and looseness
- gear mesh problems
- resonances or impacts



Layered user interface from overall view into detailed analysis tools suits both for operator's and predictive maintenance person's use.

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Machine protection and condition monitoring

The applications provide alarm handling and analysis tools for fault diagnostics. Analysis tools include for example time signals, spectrums, enveloped acceleration signals and spectrums, orbit plots, history trends and Bode and Nyquist diagrams, depending on the type and construction of the machine being monitored.

The system can provide online machine protection in accordance with the API670 standard. For machine diagnostic it supports both online and cyclic measurement principle depending on the criticality of the machines.

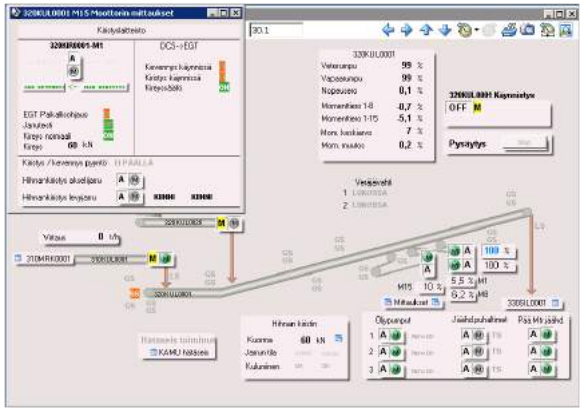
Both stand-alone and control system integrated

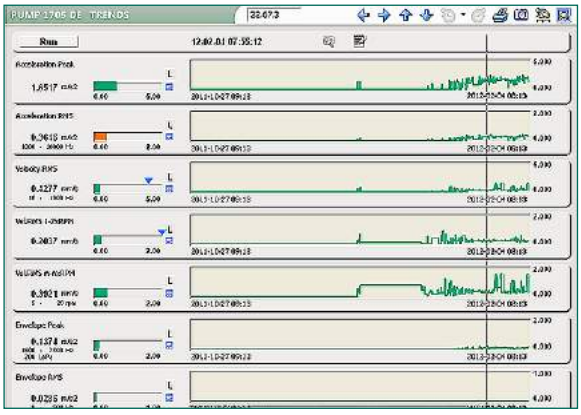
DNA Machine Monitoring can work as a dedicated stand-alone condition monitoring system, or it can be integrated as a part of the Metso DNA machine or plant control system. Utilizing networks sensors and I/O units can be distributed according to machine locations and plant layout. The operators and maintenance personnel can monitor rotating machinery condition data directly on their workstations, both in control rooms and in maintenance and production offices.

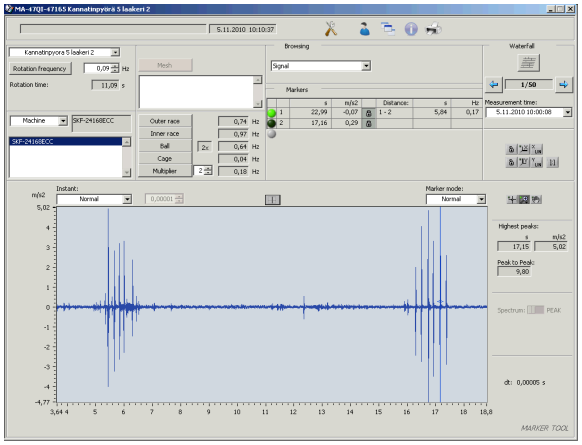
The most important vibration characteristic values are shown directly in the process pictures. Alarms will bring attention to the machinery in question. For the predictive maintenance tasks the system provides advanced tools for more detailed analysis of machine faults.

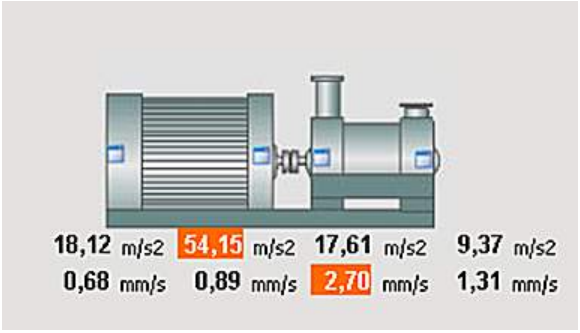
Remote diagnostics

The remote connection to the Metso DNA system ensures rapid support in problem situations. Specialized expert services are available for both mechanical condition monitoring and system maintenance.





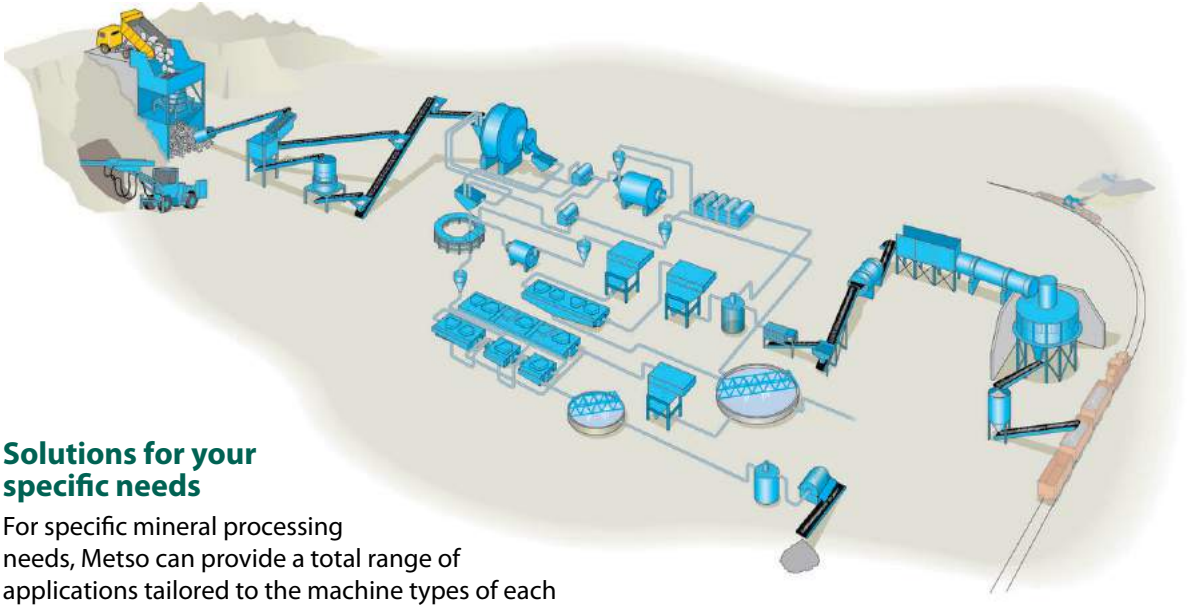




Alarming, trending and analyzing tools of the system enable proper maintenance planning to maximize plant availability.

One-stop supplier offers all the required component

Metso is a one-stop supplier for vibration-based condition monitoring, offering everything from sensors, system hardware, application software, engineering and start-up services to training, system maintenance and condition analysis and reporting services.



Solutions for your specific needs

For specific mineral processing needs, Metso can provide a total range of applications tailored to the machine types of each process. Applications cover monitoring of general machines like electric motors, pumps and gearboxes. And with the Metso background, being both a machine supplier and a condition monitoring supplier, we can provide you with customized industry-specific solutions. These include solutions for example for vibrating screens and feeders, vertimills, primary and secondary crushers, AG/SAG/ball mills and HPGRs.

DNA Machine Monitoring components

ACN processing units for both centralized and field installation

I/O groups and analog I/O units for vibration measurements, and digital units for trigger and status signal measurements

Vibration and process sensors

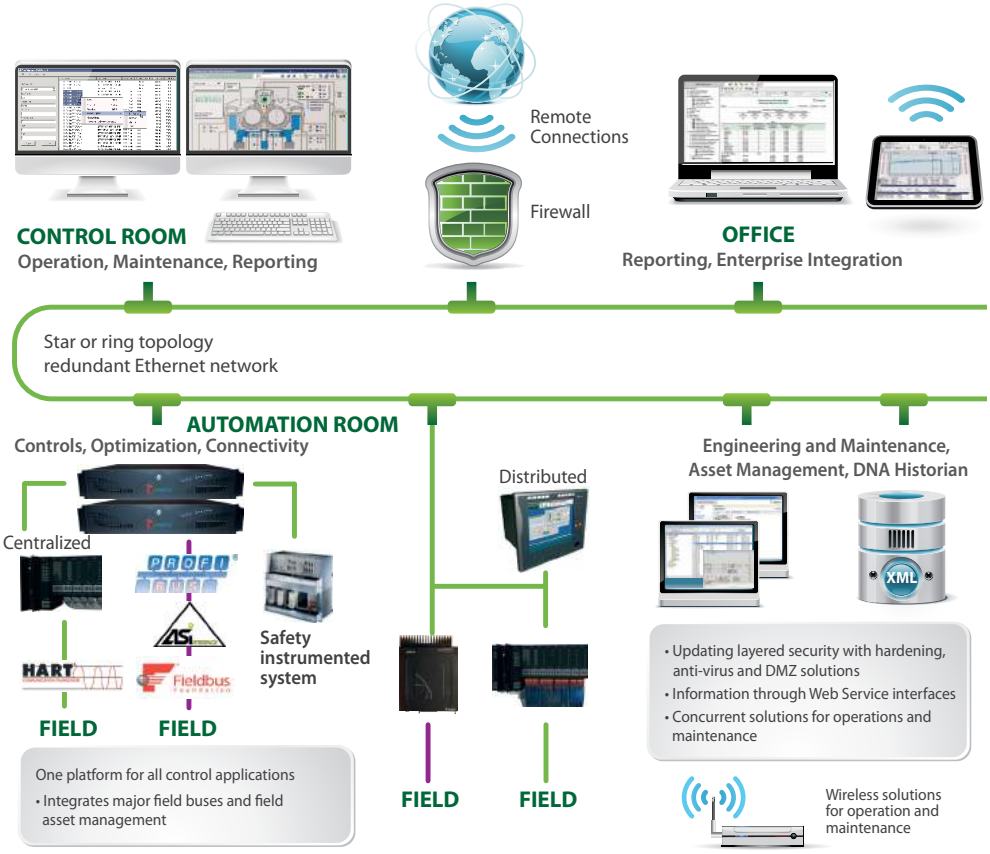
Reliability of the measurement data is ensured with sensors, connectors and cables designed for heavy and demanding industrial environments.

RVT105, acceleration sensor, low profile

RVT120, acceleration sensor, top exit

RTS-227, magnetic trigger sensor

Metso DNA minerals processing automation – total offering from Metso



System integration brings cost benefits

An integrated solution allows shared system resources to be utilized for control and condition monitoring applications. The same operator workstations, history databases, system networks and engineering tools can be used by all applications.

For more information, contact your local automation expert at Metso.

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ACN MR controller

High performance modular rail mounted controller

ACN MR is a multi-functional controller and member of Metso DNA's ACN controller family. The ACN MR controller is used in centralized, distributed and embedded applications. ACN MR can be also used in standalone applications with or without a connection to the Metso DNA system.

ACN MR is communication and application compatible with other ACN family controllers and VME controllers.

Key features

- Small size
- High processing power
- Advanced control features
- Fast control cycles, down to 5 ms
- No moving parts (fan or hard disk)
- One-to-one redundancy capability
- 5 x 100 Mbit/s Ethernet connections
- Removable SD card
- G3 environmental specification with optional lacquered models
- Operating temperature 0...+70°C
- Reliability due to the design and industrial components
- PROFIBUS DP interface unit (coming in 2013)
- Serial interface unit (coming in 2013)

ACN MR installed on a mounting base and ACN M120 I/Os

ACN MR installed on a mounting base and ACN M80 I/Os

ACN MR structure

The ACN MR controller is installed on the mounting base (MBMT120 or MBMT80, depending of the ACN I/O product family) together with the power supply unit (IPSP).

ACN MR mounting base can either be attached to the ACN I/O mounting bases with I/O units or ACN MR with power supply unit can be used as a separate controller.

ACN MR has a removable SD card containing the parameters needed when a node is starting. If a spare node is taken in use, the SD card is unplugged and changed to a spare node and the spare node will boot with the same configuration as the original one.

In the typical configuration the real-time operating system (RTOS), Process Controller software and the application are loaded from the Backup Server when the node is starting.

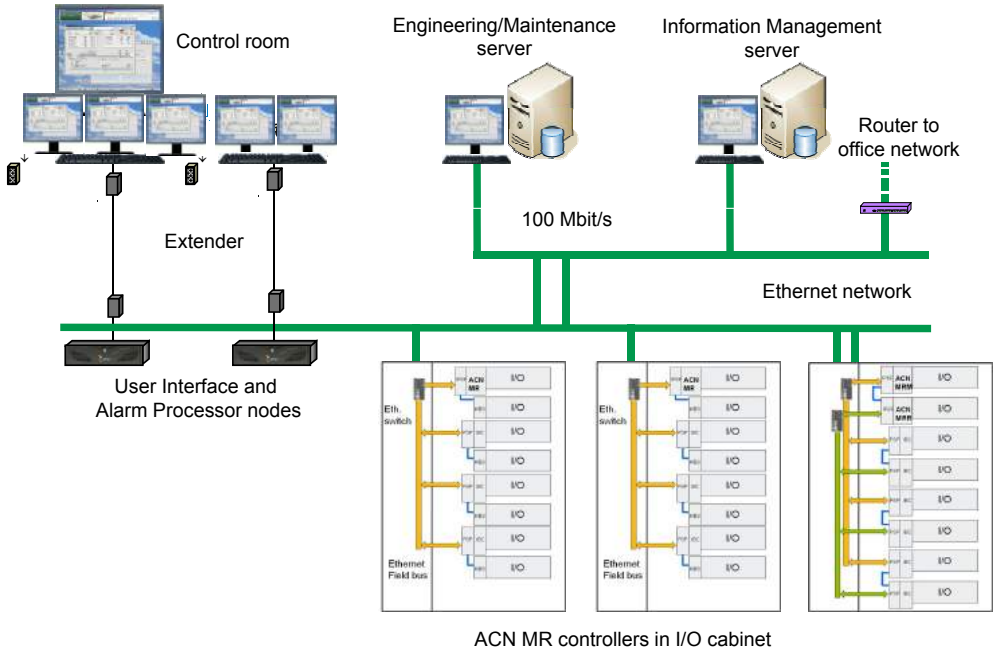
In standalone operation mode, software is loaded from local SD card. The SD card contains RTOS, Process Controller software and the application.

Architecture

The ACN MR controller is scalable from applications with few I/Os to applications with several thousand I/Os. Because of the small physical size, ACN MR can be installed in the same cabinet with ACN I/Os.

Medium size and large size applications

Below is an example of a system with about 2500 I/Os. The system consists of three ACN I/O cabinets and control room nodes. Each ACN I/O cabinet has the ACN MR controller located at the top of the cabinet.



Metso DNA with ACN MR controllers

Distributed and small applications

In distributed and small applications ACN MR controller is installed in the field cabinet with ACN I/O. Beside is a picture of a field cabinet with ACN MR and ACN I/O.

ACN MR process controllers and I/O in the field cabinet

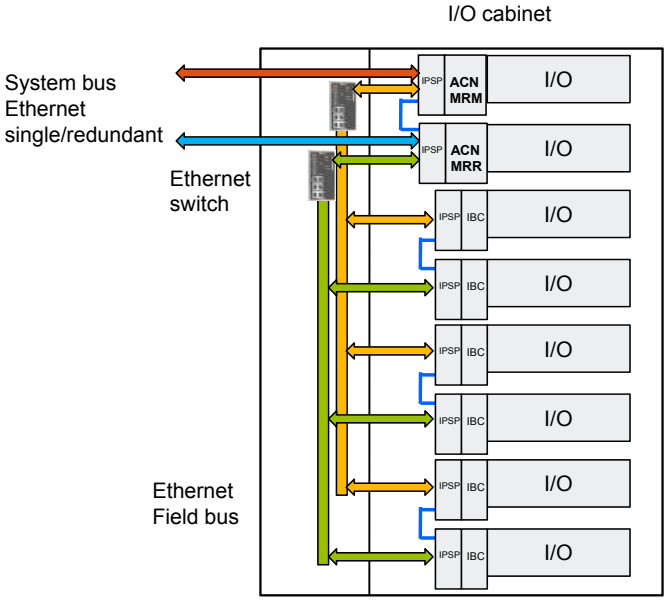
Interfaces

The interfaces available in ACN MR are:

- Four 10/100Base-T Ethernet ports on a CPU board for:
  - communication with Metso DNA nodes
  - ACN I/O communication
  - Ethernet protocols like Modbus/TCP
  - serial communication via an Ethernet-serial converter
- One 1000Base-T Ethernet port for redundant ACN MR
- Three channel PROFIBUS DP interface unit and two channel serial interface units are under development

Redundancy

ACN MR supports redundant Metso DNA Ethernet networks, redundant controllers (one-to-one redundancy) and redundant ACN I/O field buses and rack I/O.



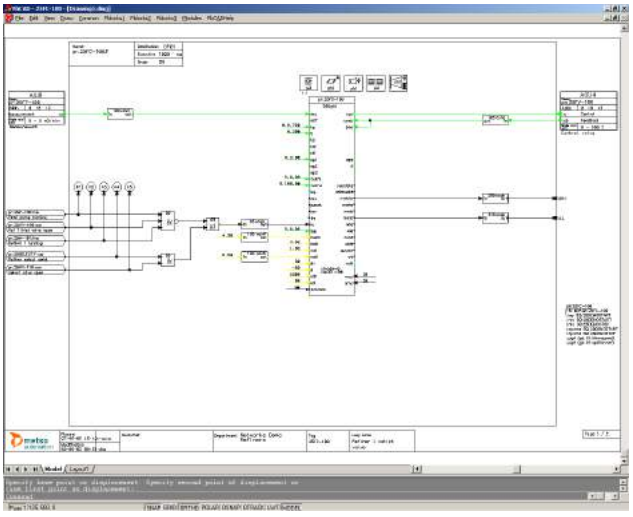
Redundant ACN MR controllers and I/Os

Engineering

The engineering library of the ACN controller provides function blocks for controls at all levels, including basic process control, advanced quality, drives, and optimization controls. Fuzzy, MPC, and programmable function blocks are available as a standard.

The Function Block CAD engineering tool is used for designing function block diagrams for process control loops, sequences, and interface applications.

Function block diagrams are saved in a common database located on the Engineering Server. At the same time, a function block diagram is a graphical document of an application, which is loaded in the runtime environment. This ensures that the documentation is always up-to-date.



Function block diagram

Performance

- The number of I/O channels per ACN MR is typically 250...2000 with control cycles of 100...1000 ms.
- The minimum control cycle is 5 ms and maximum control cycle is 64 s

Technical specification

- Compact rack mounted metal enclosure
- Fanless structure, cooling implemented with heat sinks

Dimensions [W x H x D] • ACN MR • MBMT mounting base	 40 x 125 x 95 mm 126 x 125 x 40 mm
Weight	1100 g
Protection	IP20
RAM memory	512 MB
Processor	Intel Atom 1.1 GHz
SD card	2 GB
Ethernet ports	5
USB ports	2
Drives	N/A
Expansion	N/A
Operating temperature	0°C... +70°C
Storage temperature	-20°C... +70°C
G3 environmental specification with optional lacquered units	
Power supply	18...36 VDC
Power consumption	10 W
Operating system	real-time operating system

Licenses and hardware

D201915	ACN MR Node
D201893	MBMT120 – ACN MR mounting base for ACN I/O M120
D202076	MBMT80 – ACN MR mounting base ACN I/O M80
D200989	Process controller and gateway base license, per node
D200990	Process Controller Capacity License / 100 I/Os

For more information, contact your local automation expert at Metso.

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ACN I/O M120

Metso DNA I/O units for demanding industrial applications

The ACN I/O is a modern I/O family used with ACN process controllers. ACN I/O combines the best features of a centralized and distributed I/O in one compact design. The ACN I/O is mounted on a DIN rail and therefore simplifies system design and cabinet assembly.

There are two series of the ACN I/O units: M80 and M120. M80 series includes units for a low current/voltage analog/digital applications. M120 series units are used when high voltage isolation between the channels is needed or when digital interface is needed for high DC/AC line voltages without external relays.

Key features

The advanced features and performance of ACN I/O M120 include:

- True hot swapping of I/O units.
  It is possible to change any number of I/O units during the operation of the system.
- Extensive channel-specific diagnostics.
- DIN rail installation simplifies system design, cabinet assembly and commissioning. ACN I/O M120 units can be easily installed in any kind of cabinets.
- Front I/O connections allow installation in wall-mounted cabinets with front access only.
- ACN I/O M120 has a high packing density. I/Os and cross connection boards are compact, thus saving rack-room space.
- Fast control response down to 20 ms.
- Transient protection designed for electrically noisy environments.
- 8-channel I/O units for fast dynamic measurements.

Technical features

- High resolution AI (16 bits) and AO (14 bits).
- 1 ms time stamping in digital inputs for true sequence of events collection.
- HART capable analog inputs and analog outputs with built-in one modem per channel.
- 1500/2200 VAC isolation
- 120/240 VAC digital I/O without intermediate relays
- Temperature rating 0 to +70 °C.
- Versatile cross connection and field wiring possibilities.
- Optional protective coating complying with G3 environmental specification.
- DNV approvals for marine applications
- Ethernet connection to the ACN process controller.

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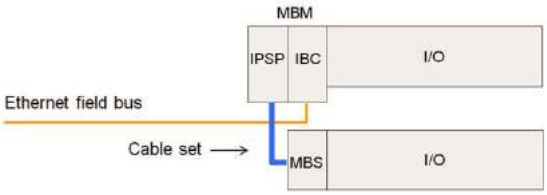
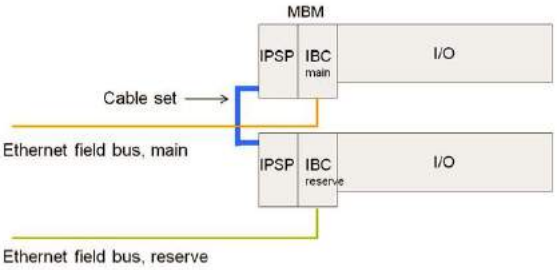
Structure


MBM
IPSP
IBC
I/O
Ethernet field bus
Cable set
MBS
I/O


MBM
IPSP
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main
I/O
Cable set
Ethernet field bus, main
IPSP
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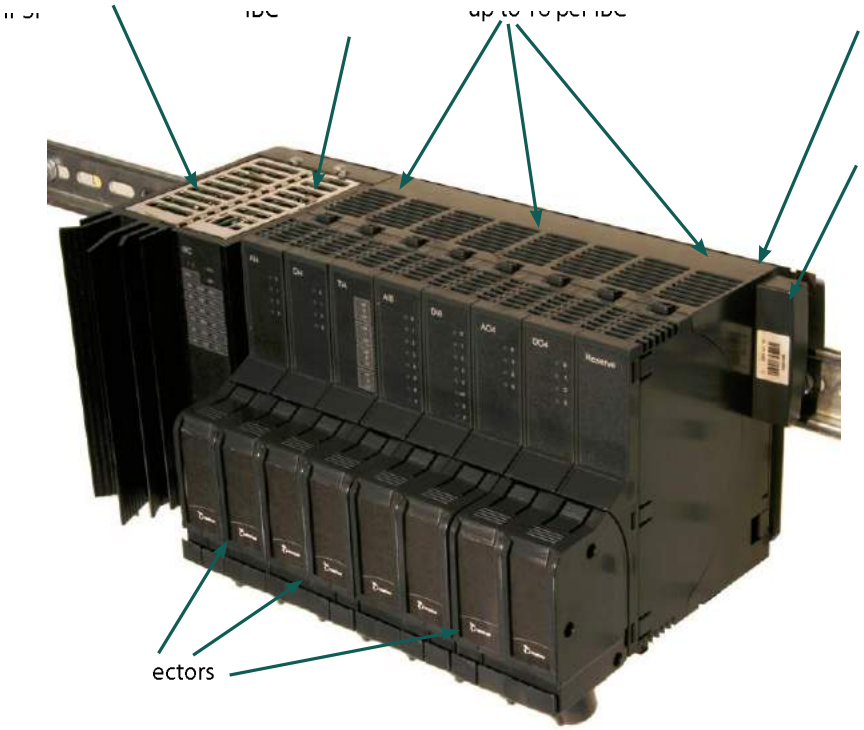
Ethernet field bus, reserve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Field bus architecture

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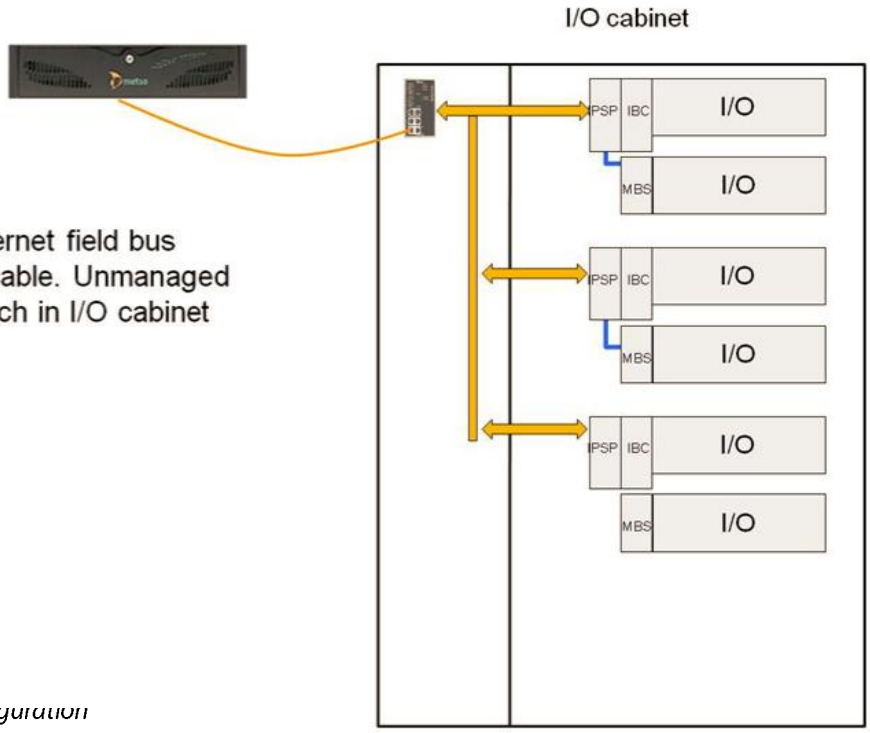
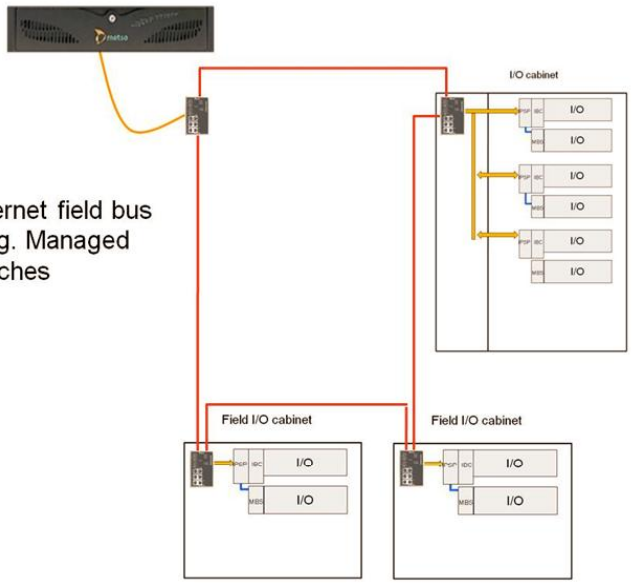


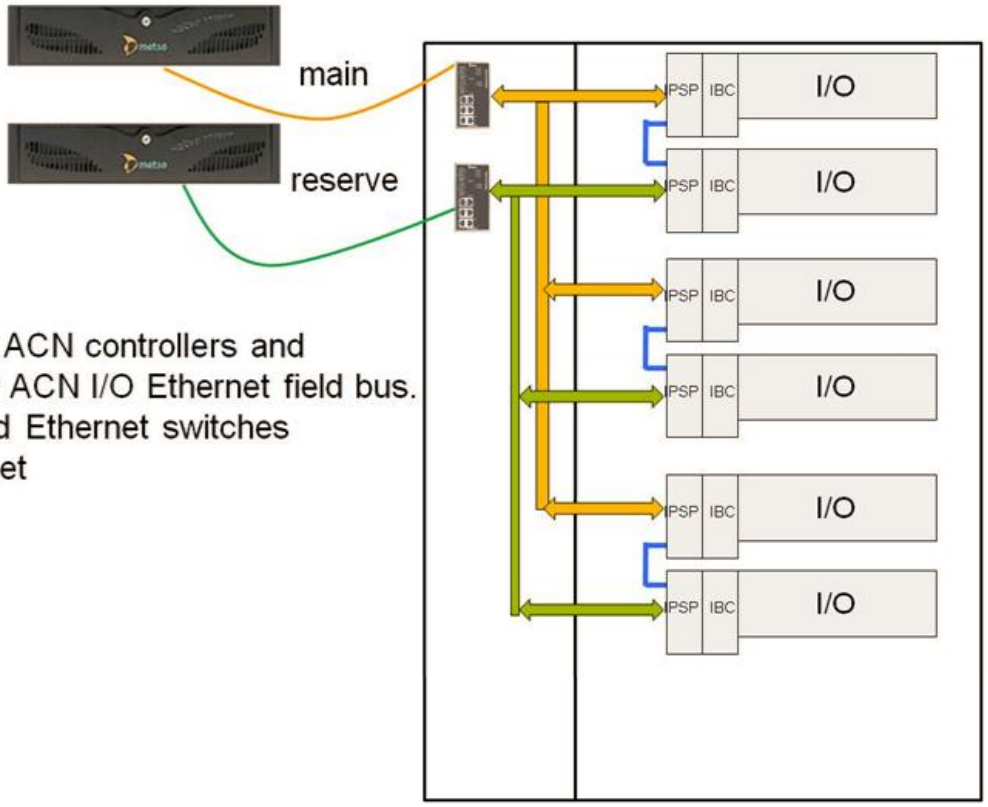
ACN I/O Ethernet field bus twisted pair cable. Unmanaged Ethernet switch in I/O cabinet

configuration



ACN I/O Ethernet field bus fiber optic ring. Managed Ethernet switches

Redundancy



Redundant ACN controllers and twisted pair ACN I/O Ethernet field bus. Unmanaged Ethernet switches in I/O cabinet

I/O redundancy

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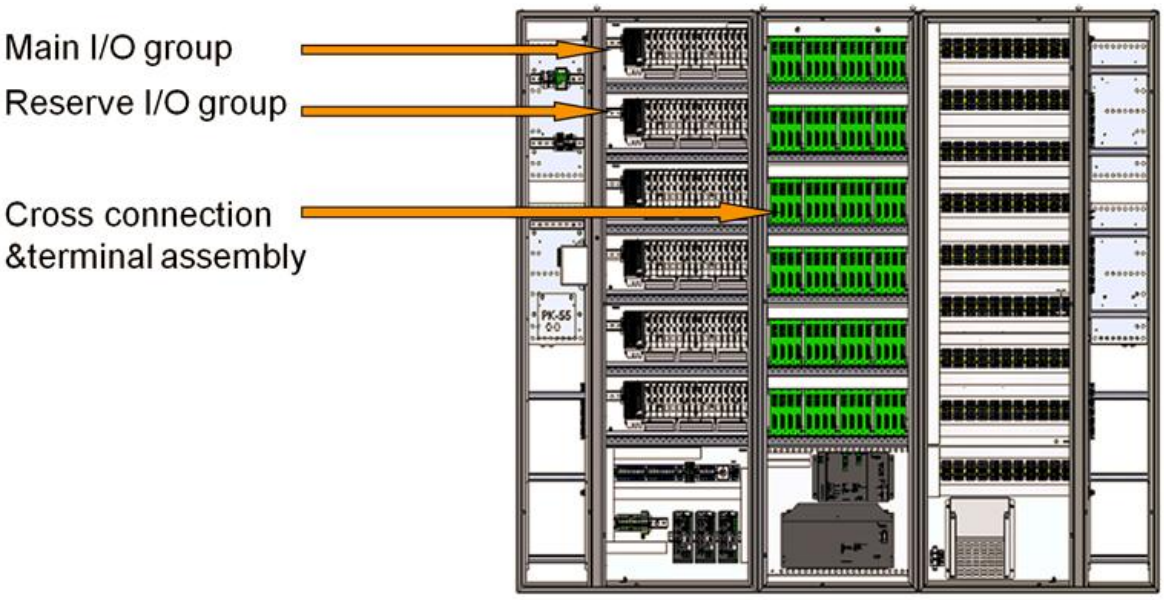

Cabinets

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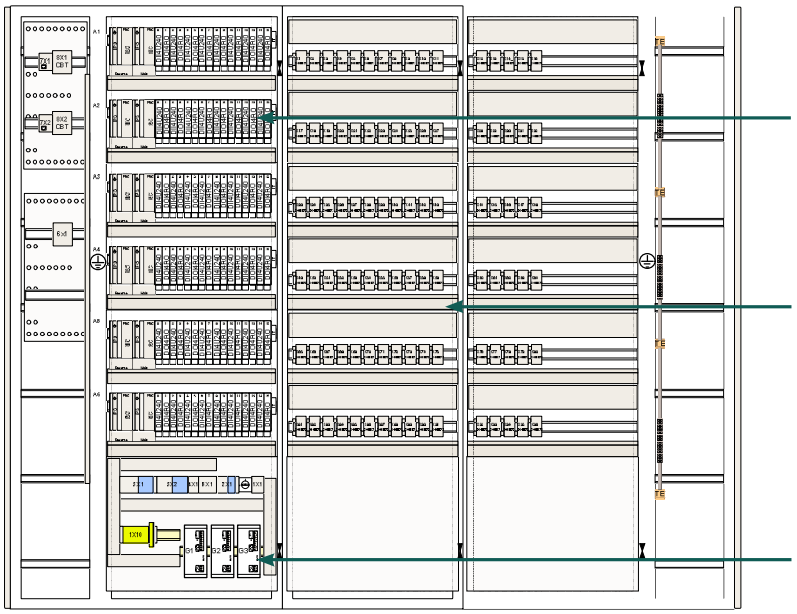

An example of centralized ACN I/O cabinet installation

Analog ACN I/O M120 units

Analog input and output units	AII8C/AII8CN	AII8V	AII4H	AOI4C	AOI4H
ɔn	8 -channel AI	8 -channel AI	4 ·	4	;O
Number of chann els	8 in	8 in	4 in	4 out	4 out
	0/4 to 20 mA	IC	0/4 t ith	0/4	vith
Load impedance				50 to 750 Ω	50 to 750 Ω
	16	16	16	14	14
Loop voltage source	nternal/ Extern l	External	Internal		
ation		1500 VAC	1500 VAC	1500 VAC	1500 VAC
Channel to system isol ition	1500 VAC	1500 VAC	1500 VAC	1500 VAC	1500 VAC

Temperature mea uring units	TCI8	TII4W3	TII4W4
Number of channels	8 in	4 in	4 in
Channel type			
Resolution (bits)	16	16	16
		Internal	Internal
Channel to channel isolation	1500 VAC	1500 VAC	1500 VAC
	1500 VAC	1500 VAC	1500 VAC

I/O units for mecha ical condition monitor g	AIF8V	AIF8T
	I 8 I tri	
Number of channels	8 in	8 in
Channel type		Tr
Resolution (bits)	16	16
Measuring interval	50 µs	50 µs
ation		
Channel to system isol tion	1500 VAC	1500 VAC

ACN I/O M120 units for turbine control

Servo output unit AOI3S

Servo outputs

- 3 analog output channels
- output range: -100...+100 mA
- settable range min and max
- settable dither:
  - frequency 50...500 Hz
  - amplitude 0...10 mA
- field loop diagnostics
- channel to channel isolation 1500 VAC
- channel to system isolation 1500 VAC
- 1 digital input channel
- field voltage supply 24 VDC
- current limit 40 mA
- shut-down function attachable to each AO channel individually
- reaction time 2 ms
- power load unbalance runback
- channel to channel isolation 1500 VAC
- channel to system isolation 1500 VAC

Valve position input units

AIT4L	AIT4C
• 4 LVDT input channels	• 4 input channels 0/4 – 20 mA
• input update interval 1 ms	• input update interval 1 ms
• settable measurement filter	• settable measurement filter
• 16-bit A/D converter	• 16-bit A/D converter
• ch. to ch. isolation 1500 VAC	• ch. to ch. isolation 1500 VAC
• ch. to system isolation 1500 VAC	• ch. to system isolation 1500 VAC

Machine protection and diagnostic units

AIF4E	AIF4V
• Fast eddy curent sensor measurement	• Fast vibration sensor measurement
• 4 input ch. with monitoring outputs	• 4 input ch. with monitoring outputs
• 50 µs sampling cycle	• 50 µs sampling cycle
• offset p-p and gap average calculations for machine protection	• peak and rms calculations for machine protection
• configurable filters for protection calculations	• configurable filters for protection calculations
• 4 output ch. 4...20 mA to protection system	• 4 output ch. 4...20 mA to protection system
• 1500 VAC to system and ch. to ch. isolation	• 1500 VAC to system and ch. to ch. isolation

Digital ACN I/O M120 units

voltages.

Digital input units	DII8P24	DII8P48	DII4U120	DII8U120	DII4U125
Operation			4 1		
Number of channels	8 in	8 in	4 in	8 in	4 in
				120 VAC	
Output load rating					
					Field voltage input
Circuit protection	Short circuit protected, Opto isolated	Short circuit protected, Opto isolated	Protected against transients	Protected against transients	Protected against transients
Channel to channel isolation	-	-	2200 VAC	-	2200 VAC
Isolation	1500 VAC	1500 VAC		1500 VAC	

Digital input units	DII4U240	DII8U240
Operation		
Number of channels	4 in	8 in
	240 VAC	
Output load rating		
	Field voltage input	
Circuit protection	Protected against transients	Protected against transients
Channel to channel isolation	2200 VAC	-
Isolation	1500 VAC	1500 VAC

Digital output and frequency units	DOI4RO	DOI8RO	FII4
Operation			
Number of channels	4 out	8 out	4 in
	Form	Form act	24 1
Output load rating	5 A / 120-240 VAC; 0.3 to 5 A / 24 to 125 VDC	1 A / 120-240 VAC; 0.3 to 3 A / 24 to 125 VDC	
Circuit protection			
			0
Channel to channel isolation	2200 VAC	-	1500 VAC
Isolation		1500 VAC	

Simulation

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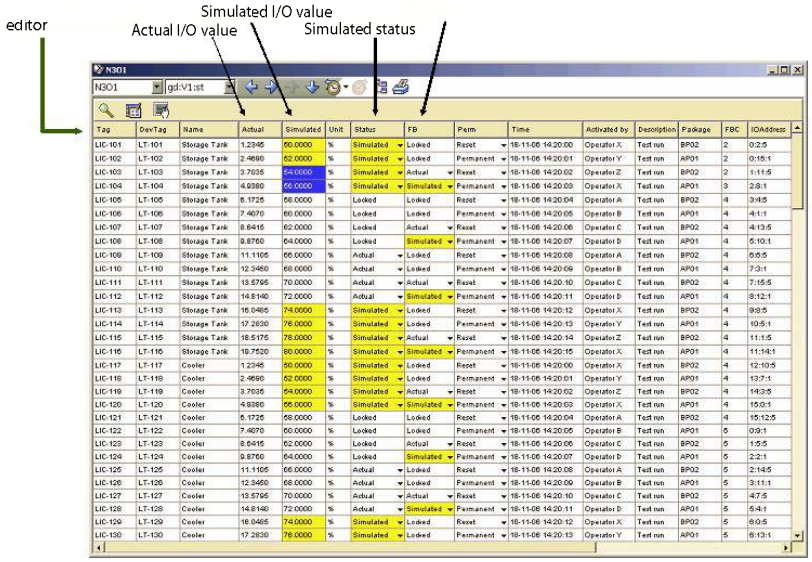

Simulation Event & Track Display IM_EVT_TRK

UTC Automatic scr

Time	Tag	Tag Description	Event	Operation Description
06-11-29 17:39:52:500	D08	Digital Output	SIMU UNLOCKED	
06-11-29 17:39:52:593	D08	Digital Output	SIMULATION OFF	
06-11-29 17:39:52:593	D08	Digital Output	SIMU UNLOCKED	
06-11-29 17:40:04:078	D09	Digital Output	SIMULATION ON	
06-11-29 17:40:12:078	D08	Digital Output	SIMULATION ON	
06-11-29 18:23:16:312	DI8	Digital Input	SIMULATION OFF	
06-11-29 18:23:20:312	DI8	Digital Input	SIMULATION ON	
06-11-29 18:23:25:166	DI8	Digital Input	SIMU VALUE	FALSE (TRUE)
06-11-29 18:23:37:166	AI8	Analog Input	SIMU VALUE	25.56 % (12.34)

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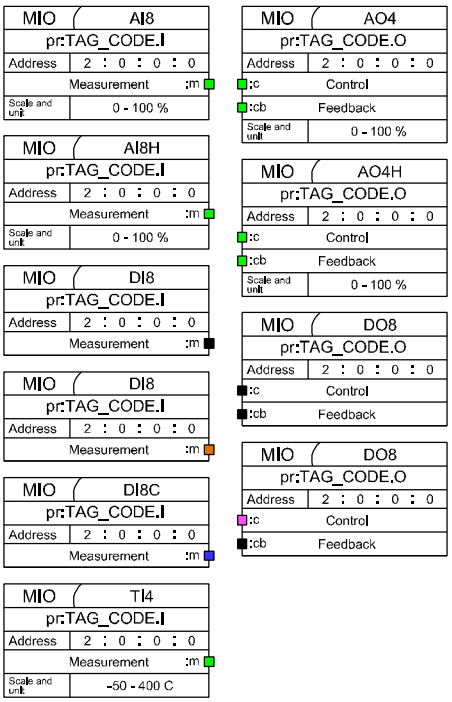
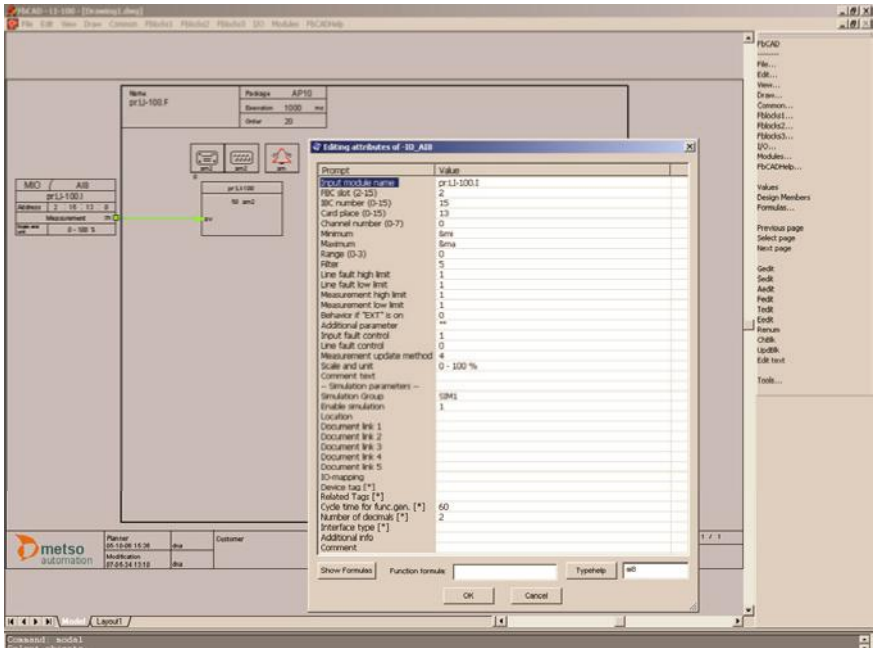
Engineering





ACN I/O engineering in Function Block CAD engineering tool

Hardware configuration

Diagnostics

ACN I/O has extensive channel-specific diagnostics. Diagnostics features are available without additional engineering.

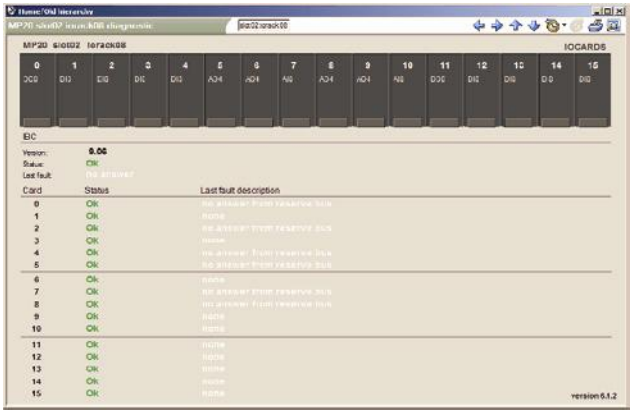
Standards and specifications

Degree of protection:	IP20
Electromagnetic compatibility:	
Electromagnetic immunity	EN 61000-6-2
Electromagnetic emission	EN 61000-6-4

Environmental requirements

These conditions are in accordance with the standard classes of IEC 60721-3-3K3.

Temperature:	
in horizontal installation	0...+70 °C
in other installation position	0...+40 °C
max. rate of change	0.5 °C / min
Relative humidity	5...90%, no condensation
Absolute humidity	1...25 g/m^3
Air pressure	70...106 kPa
Vibration:	IEC 60945
amplitude	1 mm (2...13 Hz)
acceleration	7 m/s^2 (13...100 Hz)
Shocks:	IEC 60721-3-3M1
acceleration	50 m/s^2
duration	11 ms
	half sine
Chemical conditions	IEC 60721-3-3C1
Chemical conditions (G3)	ISA-71.04
Biological conditions	IEC 60721-3-3B1
Erosion	IEC 60721-3-3S1



ACN I/O diagnostics picture on DNA Operate

Design rules for ACN I/O M120

General design rules:

- max. 3 Ethernet field buses / ACN controller, typically 1 or 2
- max. 8 I/O group pairs (16 I/O groups) / Ethernet field bus, typically 4-6

For more information, contact your local automation expert at Metso.

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13 AIF8 (FAST ANALOG INPUT UNIT)
AIF8V D201509
AIF8T D201510

13.1 USE

The AIF8 units are eight-channel analog input units used to measure analog current and voltage signals. The units are part of the ACN I/O M120 product family. The measuring channels of an AIF8 unit are galvanically connected but separated from the system per unit.

The AIF8 units can be used in Sensodec 6S and Metso DNA system for measurements in mechanical condition monitoring applications.

The AIF8V D201509 unit is for measuring 0...24 V voltage signals. The unit is equipped with a 4 mA constant current supply for acceleration sensors. The AIF8T D201510 unit is for measuring the rotation speed signals from the synchronization sensors (for example, RTS-226). The unit is equipped with a channel-specific current-limited operating voltage supply for the transmitter.

The measuring range can be selected and normalized programmatically. Analog RF and low-pass filtering as well as programmatic digital filtering are carried out on the incoming signals.

13.2 TECHNICAL SPECIFICATIONS

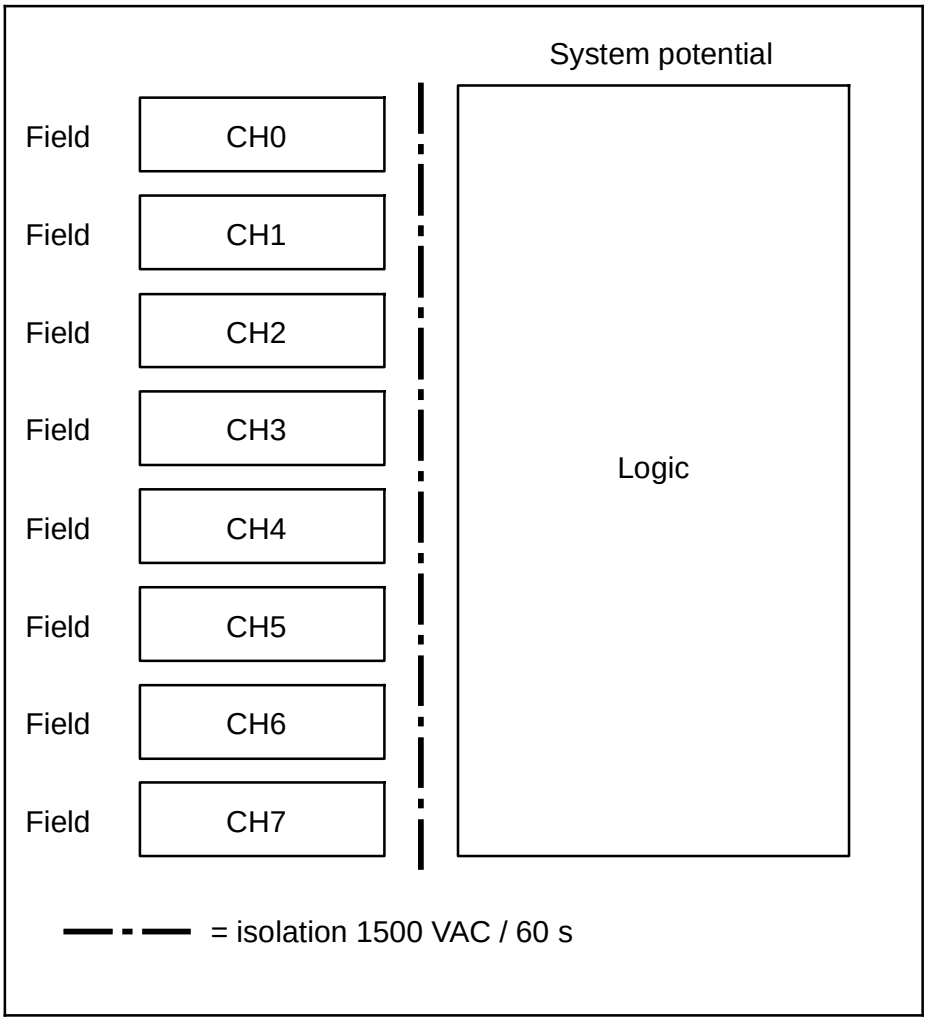
13.2.1 Structure

- the size of the casing: 130 mm x 24 mm x 95 mm [H x W x D]
- weight: 160 g

13.2.2 Field interfaces

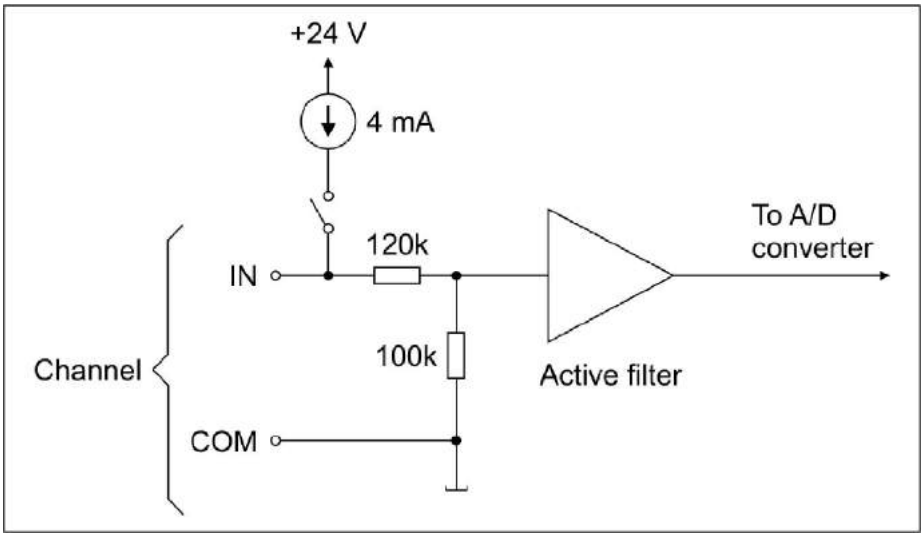
Inputs	**AIF8V D201509**	**AIF8T D201510**
Number of channels	8	
Measuring range	0...+24 VDC –5...+5 VAC	Trigger input, for example RTS–226
Input impedance	100 kΩ	249 Ω
Channel–specific current–limit	–	30 mA
Voltage supplies for transmitters [VS]	–	U_{NOM} = 24 VDC, U_{MIN} = 21 VDC
Constant current supplies for transmitters [IS]	4 mA ±0.1 %	---
Accuracy relative to the measuring range	0.05% @ 25 °C + 0.01%/10 °C	
AD resolution	16 bits	
Filtering	–3 dB, 9.1 kHz	
Measuring interval	50 μs (20 kHz)	
Isolation between channels and system	1500 VAC / 60 s	
Field circuit power supply	Operating voltage	

13.3 ISOLATION



13.4 INPUT CIRCUITS

13.4.1 AIF8V



For the field cable connector of an AIF8V unit, the connection order for signals is as follows:

Channel	AIF8V	Pin
0	COM (-)	1
0	IN / 4 mA (+)	2
1	COM (-)	3
1	IN / 4 mA (+)	4
2	COM (-)	5
2	IN / 4 mA (+)	6
3	COM (-)	7
3	IN / 4 mA (+)	8
4	COM (-)	9
4	IN / 4 mA (+)	10
5	COM (-)	11
5	IN / 4 mA (+)	12
6	COM (-)	13
6	IN / 4 mA (+)	14
7	COM (-)	15
7	IN / 4 mA (+)	16

For the cable connectors of an IXR16 cross connection board, the connection order for signals is as follows:

C = COM

Channel	7	7	6	6	5	5	4	4	3	3	2	2	1	1	0	0
AIF8V	IN	C	IN	C	IN	C	IN	C	IN	C	IN	C	IN	C	IN	C
IXR16	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1

Dual output acceleration and temperature sensor

RVT/TT-125 Code: 600-10026

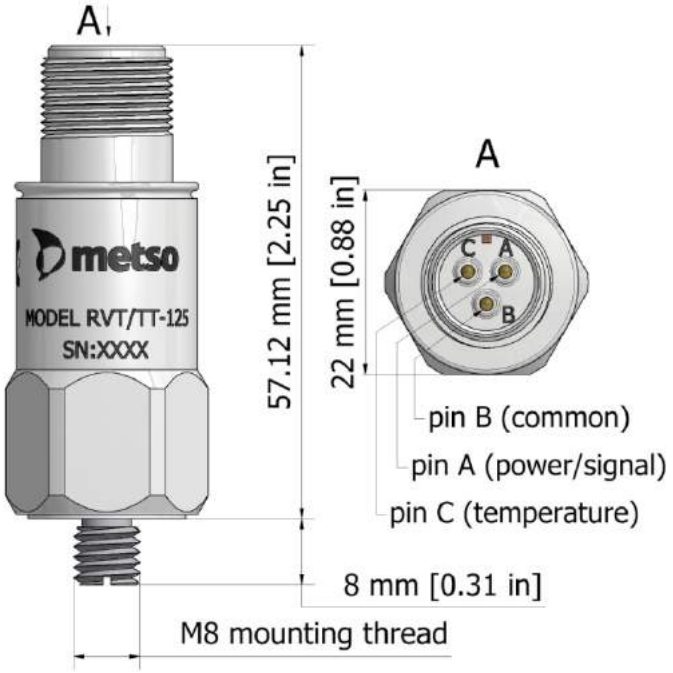
Key features

- Combined acceleration and temperature measurement
- Rugged design
- Corrosion resistant
- Hermetic seal
- ESD protection
- Reverse wiring protection
- Top exit connector

RVT/TT-125 is an industrial accelerometer with internal temperature sensor. Dual output sensor is an optimal solution for condition monitoring applications that utilize both vibration and temperature measurements.

RVT/TT-125 is suitable for machine monitoring in e.g. following industries:

- Pulp and Paper
- Mining and mineral industry
- Power generation
- Steel industry



metso

RVT/TT-125 specifications

Dynamic	Sensitivity, ±5%, 25 °C	100 mV/g
	Acceleration range	80 g peak
	Amplitude nonlinearity	1%
	Frequency response	
	±10%	1...7 000 Hz
	±3 dB	0.5...12 000 Hz
	Resonance frequency, mounted, min.	30 kHz
	Transverse sensitivity, max.	5% of axial
	Temperature response	±10% (-25...+120 °C)
Temperature	Sensitivity	10 mV/°C
	Temperature measurement range	+2... +120 °C
Electrical	Power requirement	
	Voltage source	18...30 VDC
	Bias current	2...10 mA
	Output impedance, max.	100 Ω
	Bias output voltage, nominal	12 VDC
	Grounding	Case isolated, internally shielded
Environmental	Temperature range	-50...+120 °C
	Vibration limit	500 g
	Shock limit, min.	5 000 g
	Sealing	Hermetic
Physical	Sensing element design	PZT ceramic, shear
	Weight	90 g
	Case material	316L stainless steel
	Mounting	M8 integral stud, (6 Nm max. Torque)
	Output connector	3 pin, MIL-C-5015 style
	Pin A	Accelerometer signal/power
	Pin B	Accelerometer and temperature sensor common
	Pin C	Temperature sensor signal

For more information, contact your local automation expert at Metso.

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Metso DNA

Machine Monitoring Operator Manual

Collection 2014 rev. 5
G2125_EN_05

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Expect results

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Table of Contents

1. Introduction 1

2. Condition Monitoring Process Diagram Window 2

3. Condition Monitoring Measuring Point Window 3

4. Runnability Monitoring Windows 4
4.1 Window of roll STA results 4
4.2 Felt analysis window 5
4.3 Metal Belt Monitoring 6

5. Lubrication Monitoring Windows 8

6. Analysis Tool 11
6.1 User Interface 12
6.2 Rotational frequency 13
6.3 Bearing information 13
6.4 Gearmesh frequency 14
6.5 Bearing defect frequency 14
6.6 Browsing 15
6.7 Marker functions 15
6.8 Scaling and zooming 16
6.9 Toolbar 17
6.10 Toolbox 17
6.11 Highest peak values 18
6.12 X-axis 19
6.13 Y-axis 19
6.14 Machine Structure Editor 20
6.15 View mode selection 22
6.16 Trend 23

7. Tuning Windows of Condition Monitoring and Runnability Monitoring Applications 24
7.1 Condition Monitoring Tuning Parameters for Analysis Group 24
7.2 Condition Monitoring Tuning Parameters for a Single Measuring Point 25

8. Intelligent Alarm Handling 28
8.1 Notice Curves 28
8.2 Parameter Groups 29
8.3 Parameters, "Recipe" 30
8.4 Running Notice Curves 32
8.5 Viewing and Editing Notice Curves 33
8.6 Viewing a notice curve 34
8.7 Editing a notice curve 34
8.8 Recommendations for Using Intelligent Alarm Handling 35

1. Introduction

Machine Monitoring supervises the state of mechanical equipment and observes running stability. Monitoring is based mainly on vibration measurements and vibration characteristics derived from them. Warnings and alarms are issued to the user when characteristics limit values are exceeded. Time history of the vibration values can be observed through history trends of the calculated characteristics.

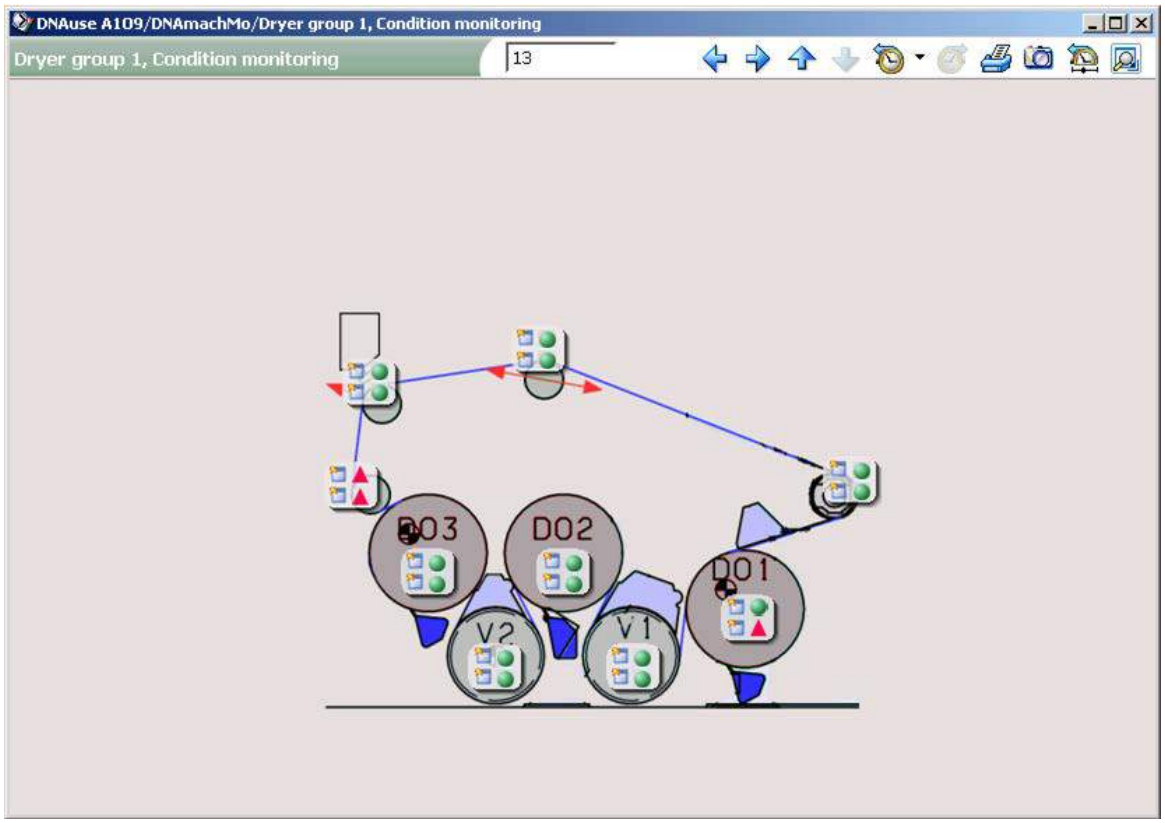
For a condition monitoring specialist, Machine Monitoring offers tools of analysis for investigating vibration signals and spectra as well as fault mechanisms. With the analysis tool, user can examine fault mechanisms and assess the severity of found mechanical faults.

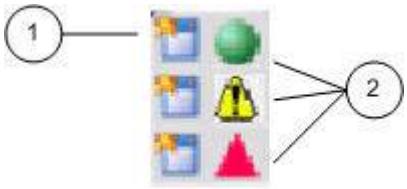
In addition to mechanical measurements, a lubrication monitoring application that measures the oil flow of the circular lubrication and issues upper limit, lower limit and zero flow alarms as needed can also be included in the system.

With the tuning windows of the condition monitoring, application parameters can be changed directly in the user interface. These include alarm limits, scaling of graphical presentations, operating parameters of analysis cycles and storing cycles as well as calculation parameters of signal analysis.

2. Condition Monitoring Process Diagram Window

Measuring points of the process part and their alarm statuses are visible in the diagram window of the respective process part. Alarm status (OK, warning or alarm) is indicated with symbols and colors. Next to each symbol indicating alarm status is a shortcut icon that opens a measuring point window when clicked. Characteristics calculated from that measuring point and their history trends are summarized in the measuring point window.

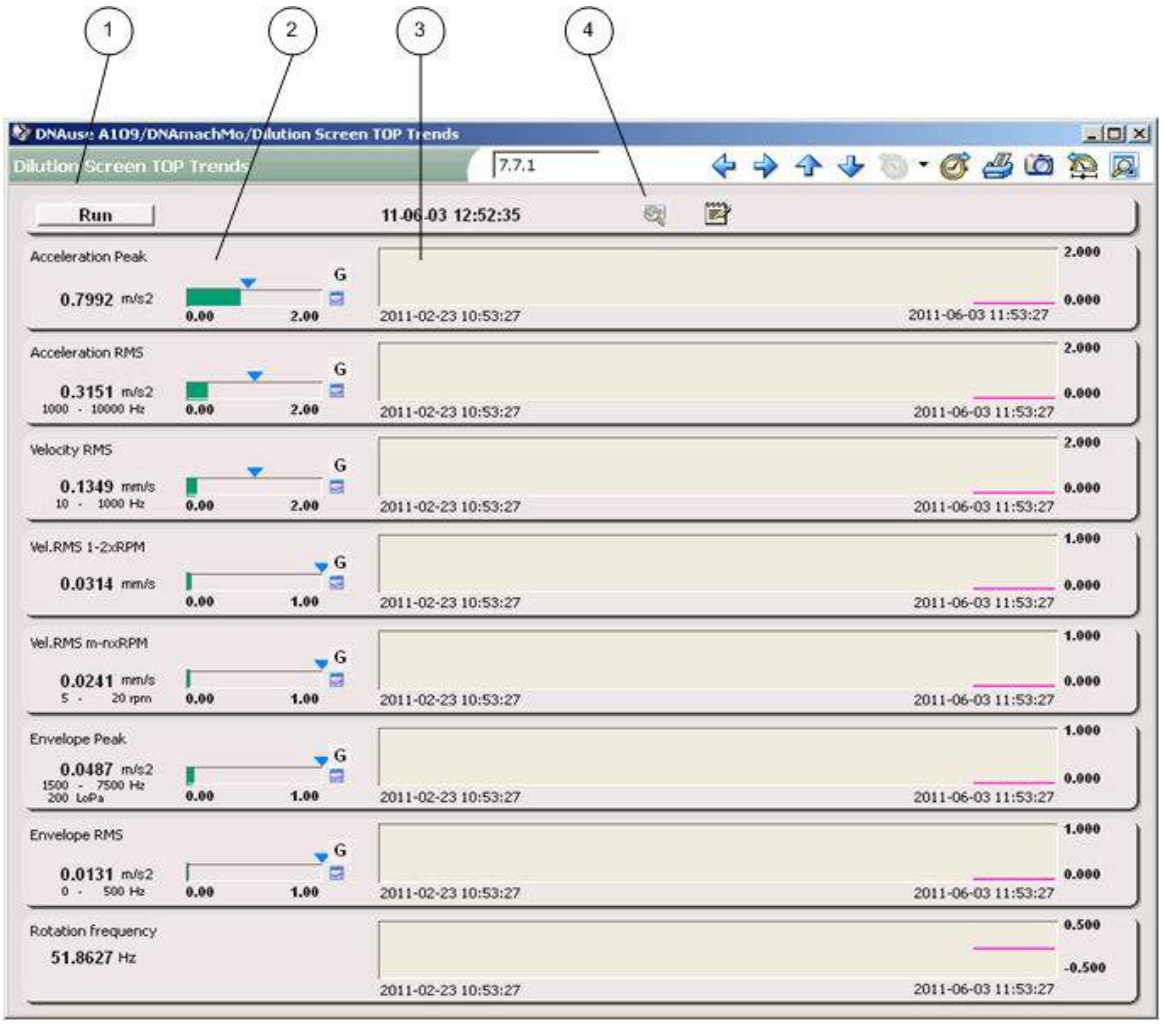




1. Shortcut to condition monitoring measuring point window
2. Alarm status of the characteristics calculated from the measuring point (green circle = no alarms, yellow triangle with an exclamation point = warning, red triangle = alarm)

3. Condition Monitoring Measuring Point Window

Characteristics values calculated on the basis of measuring point, alarm limits, alarm status and history trends are displayed in the measuring point window. The window also includes a button for opening the analysis tool which is used by condition monitoring specialists for observing signals and spectra.

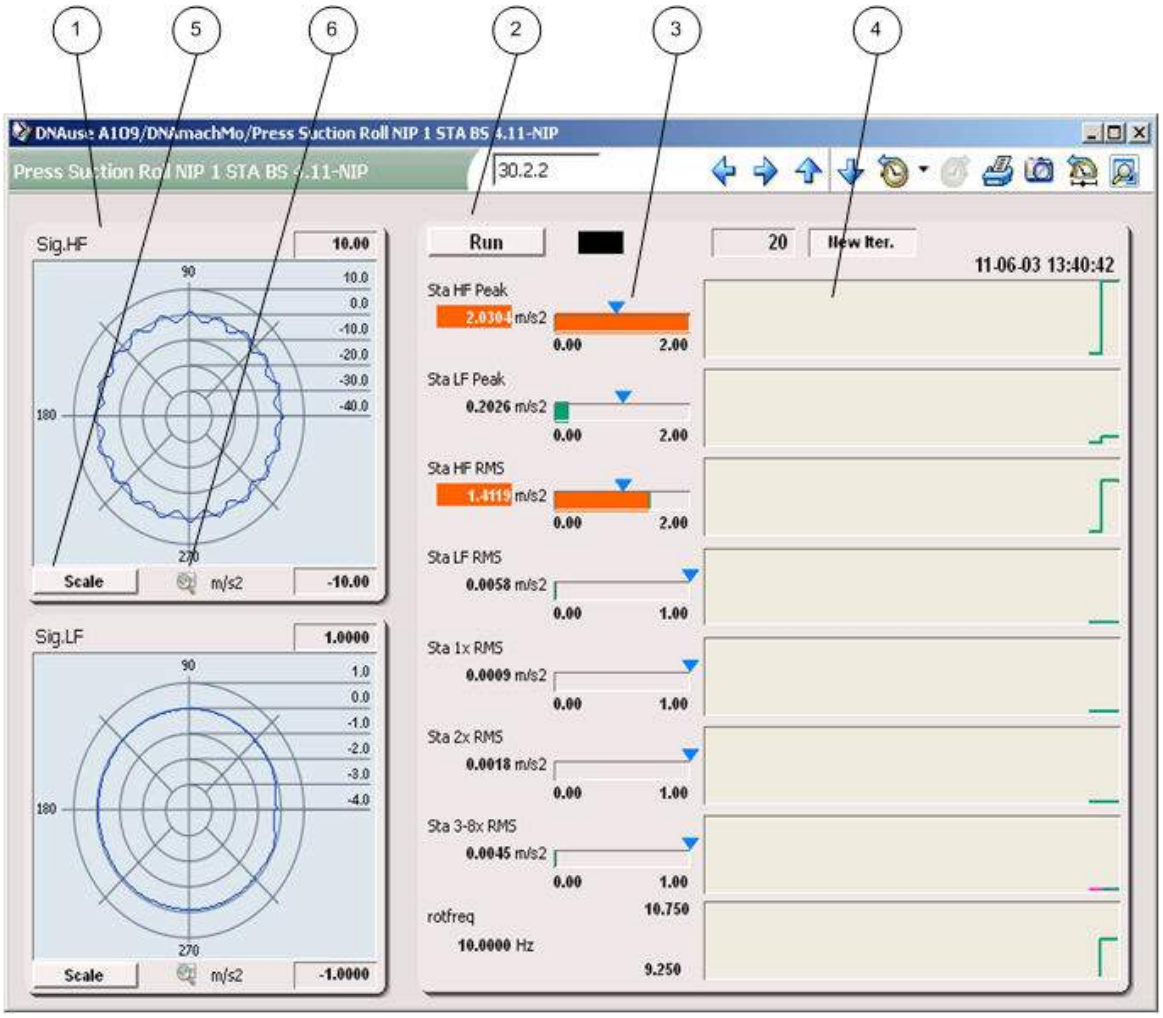


1. Starting analysis manually: performs measuring and updates results
2. Characteristics value as a number value and bar. Bar color indicates alarm status (green, yellow, orange). The triangle above the bar points to the alarm limit.
3. History trend of the characteristics
4. Opens the analysis tool and fetches the vibration signal of the respective measuring point.

4. Runnability Monitoring Windows

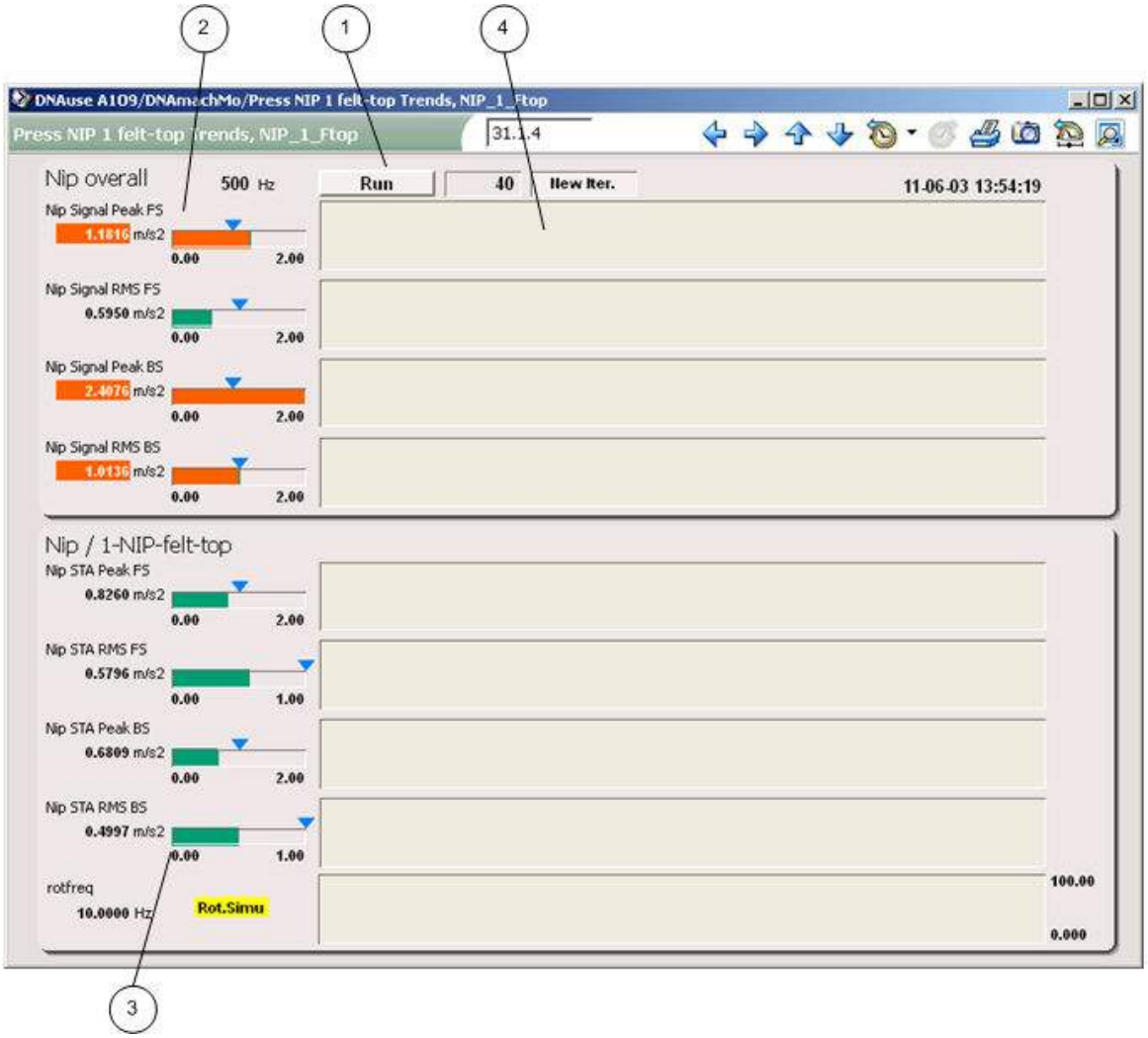
Synchronized Time Average (STA) is a method used in runnability monitoring. Results of the STA analysis are displayed in runnability monitoring windows. Structure of the windows is determined by analysis configuration.

4.1 Window of roll STA results



1. One-rotation-long STA vector in circle coordinates. High-frequency STA vector in the upper picture, low-frequency STA vector in the lower picture.
2. Starting analysis manually: performs measuring and updates results
3. Characteristics value calculated from STA diagram as a number value and bar. Bar color indicates alarm status (green, yellow, orange). The triangle above the bar points to the alarm limit.
4. Characteristics history trend
5. Automatic scaling
6. Opens the analysis tool and fetches the STA diagram of the respective measuring point.

4.2 Felt analysis window

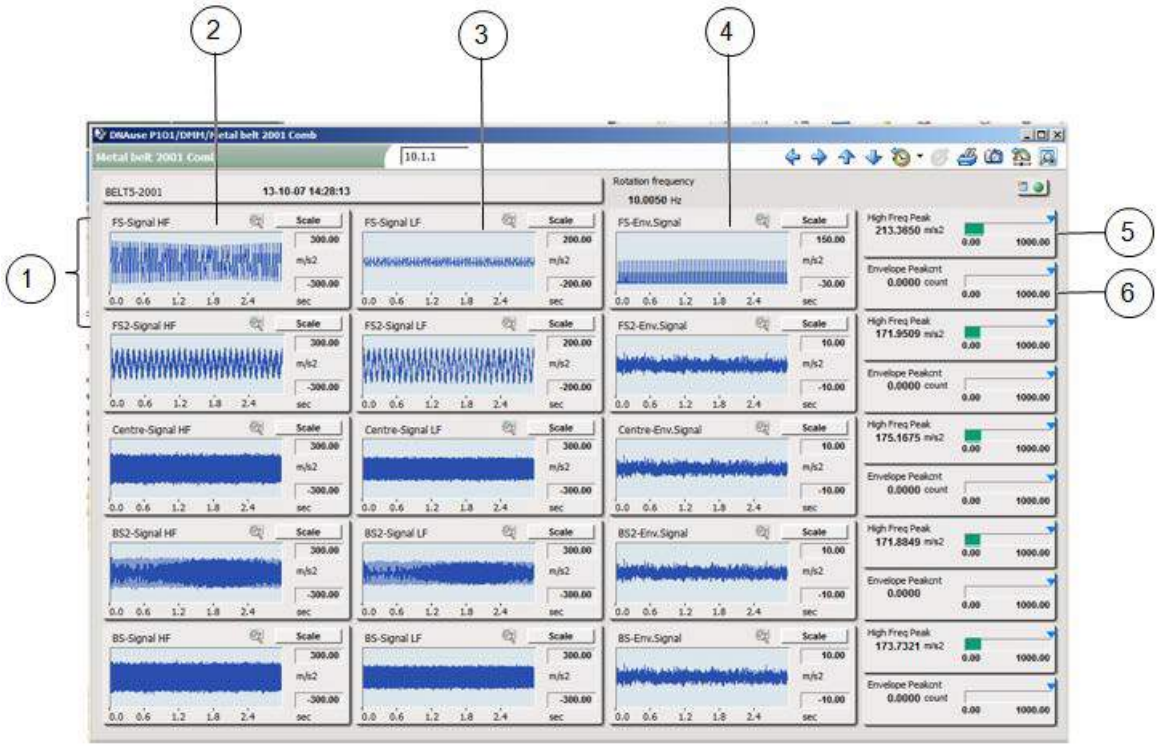


1. Starting analysis manually: performs measuring and updates results
2. Characteristics values calculated from nip vibration without synchronized average ("raw signal") as number values and bars at the front and back side of nip rolls. Bar color indicates alarm status (green, yellow, orange). The triangle above the bar points to alarm limit.
3. Nip vibration characteristics values calculated from STA diagram as number values and bars at the front and back side of nip rolls. Bar color indicates alarm status (green, yellow, orange). The triangle above the bar points to alarm limit.
4. Characteristics history trend

4.3 Metal Belt Monitoring

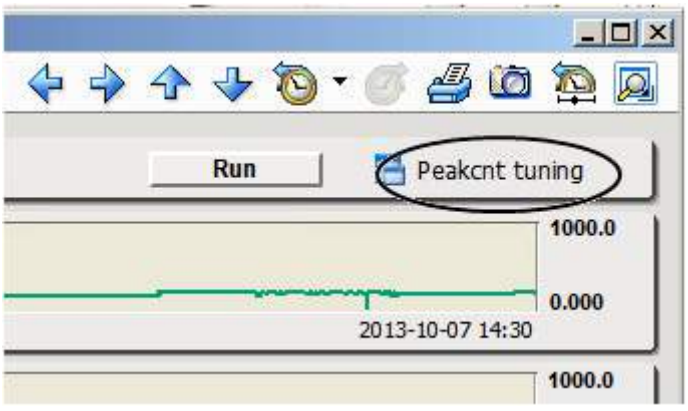
Metal belt monitoring aims at predicting changes in the metal belt condition (used e.g. in ValZone), such as emerging cracks. The most essential measurements and calculations for belt monitoring are collected to the summary window.

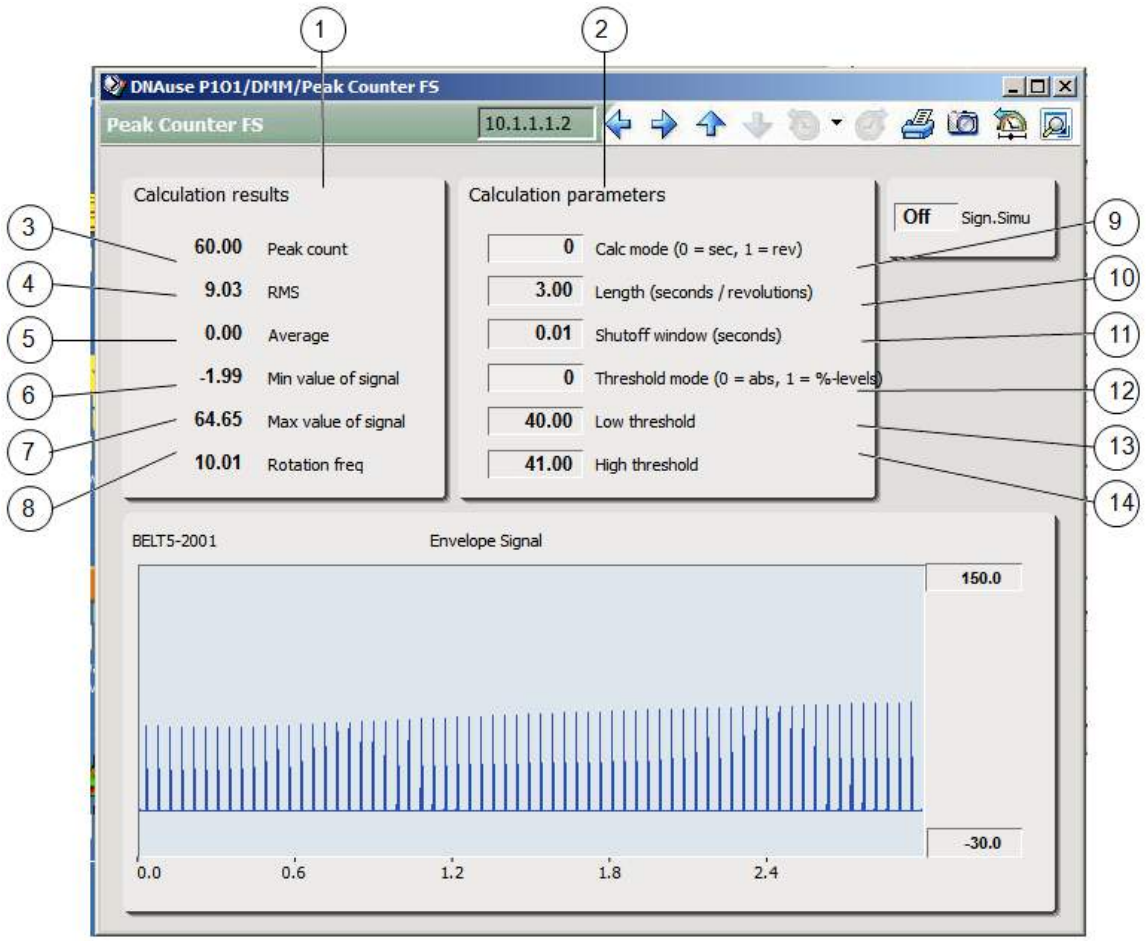
Summary window:



1. Most important results of all five channels are displayed on the same page one below another.
2. First column shows the high frequency signal of the channels.
3. Second column shows the low frequency signal of the channels.
4. Third column shows the envelope signal of the channels.
5. Peak value of acceleration is calculated from the high frequency signal.
6. Peak counter is calculated from the envelope signal.

Open **Peak Counter** window using the button in the top right corner of the trend window:



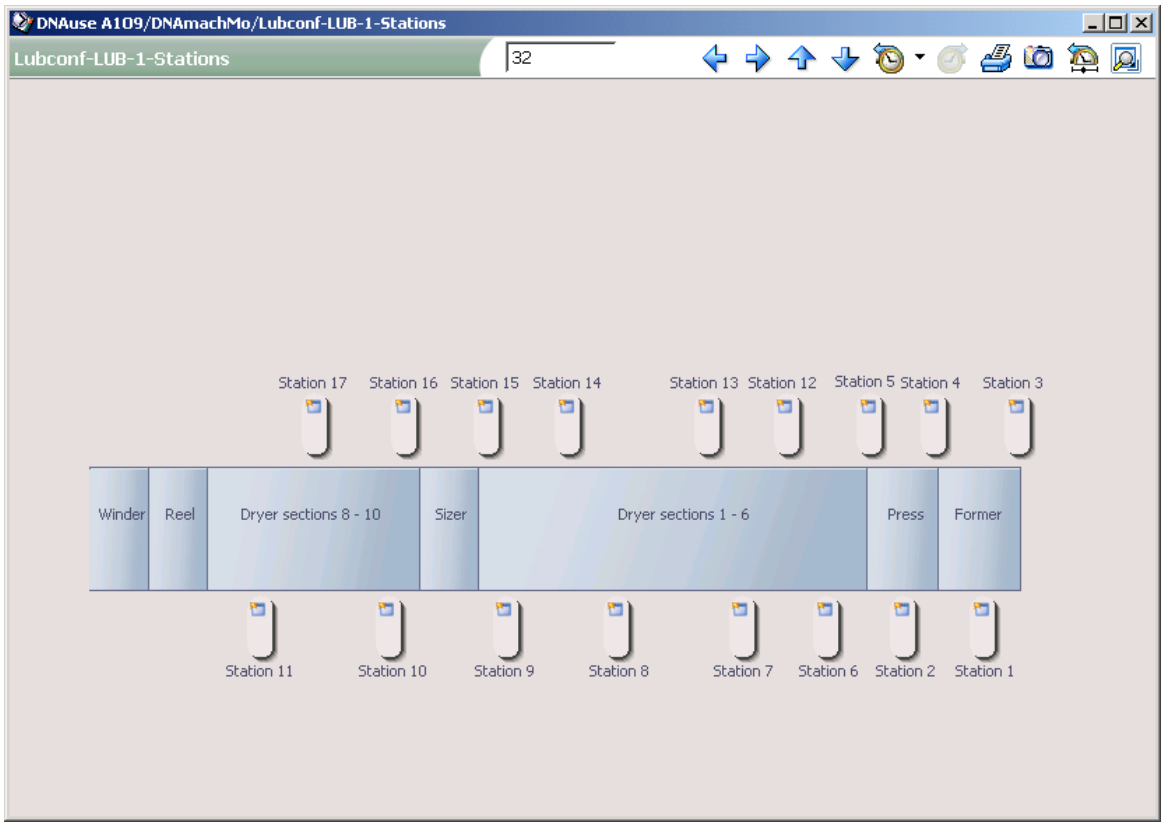


1. Results of internal calculations of the block used in PeakCount calculation.
2. Tuning parameters of calculation.
3. PeakCount value calculated using the parameters.
4. RMS value calculated from the envelope signal.
5. Average of the envelope signal
6. Minimum value of the envelope signal
7. Maximum value of the envelope signal
8. Rotation frequency of the belt
9. Selection of calculation mode. The length of the data set used in PeakCount calculation can be defined either as time or number of revolutions.
10. Length of calculation set (seconds/revolutions)
11. If two consecutive peaks are to be handled as a single peak, shutoff time can be used to determine the time during which new peaks are not accepted.
12. Values exceedind the threshold are interpreted as peaks. The threshold can be either an absolute acceleration value or a percentage of the RMS value of the envelope signal. (0 = absolute limits, 1 = percentage limits)
13. 14. Low and high threshold allow setting calculation of hysteresis value.

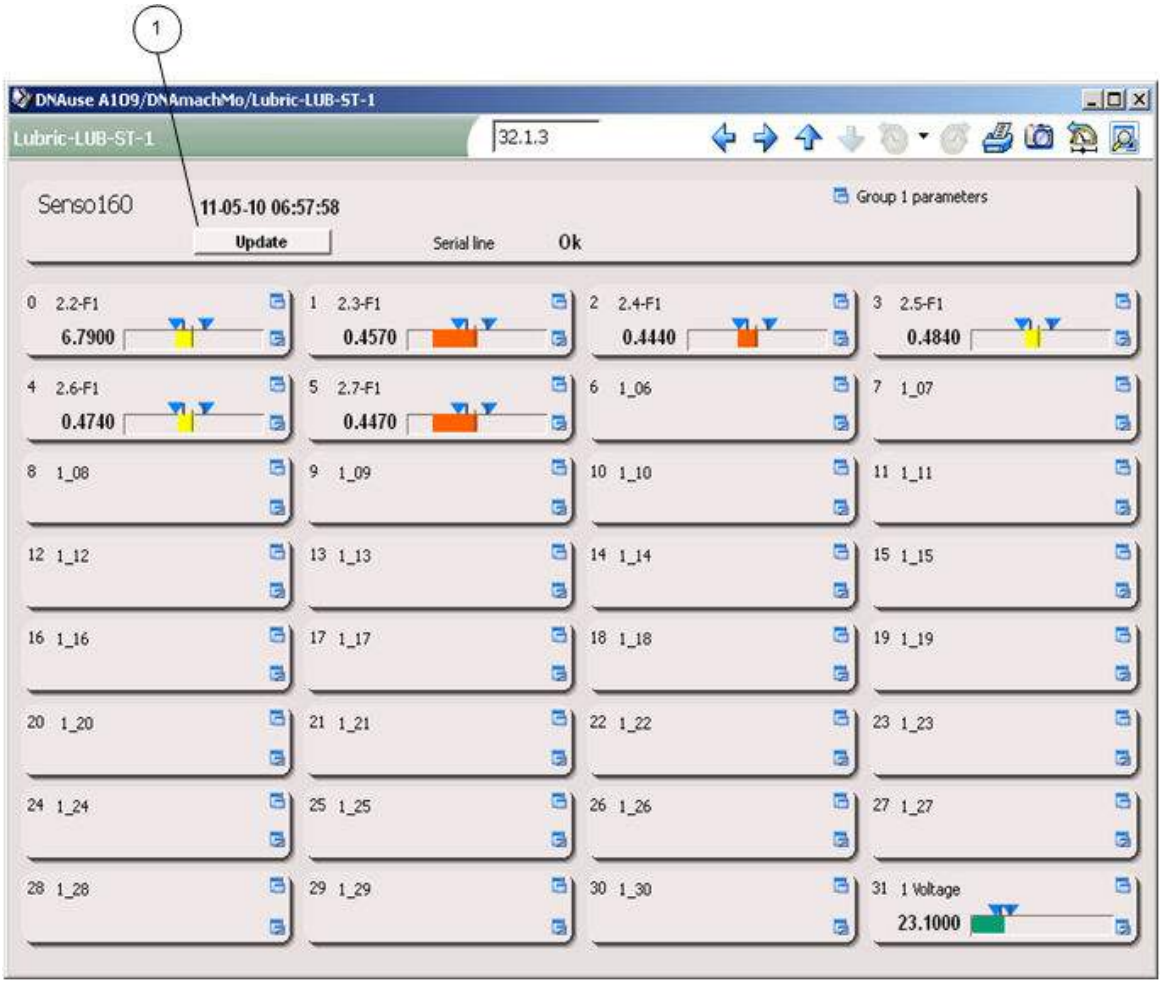
5. Lubrication Monitoring Windows

User Interface of lubrication monitoring displays measuring stations of lubrication flow. When a station-specific symbol is clicked, a window opens with lubrication information of that station.

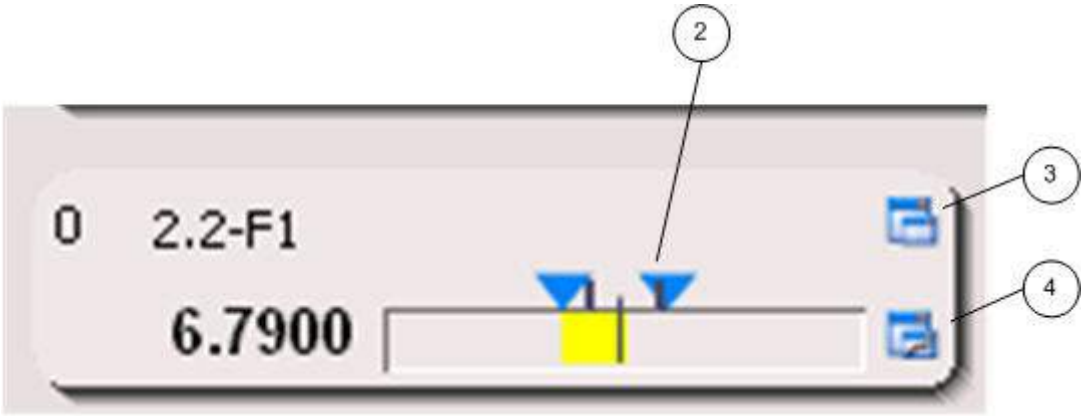
Lubrication monitoring user interface



Station-specific window



1. Manual update of station measuring results: reads station measurement values through a serial interface and updates results on screen.



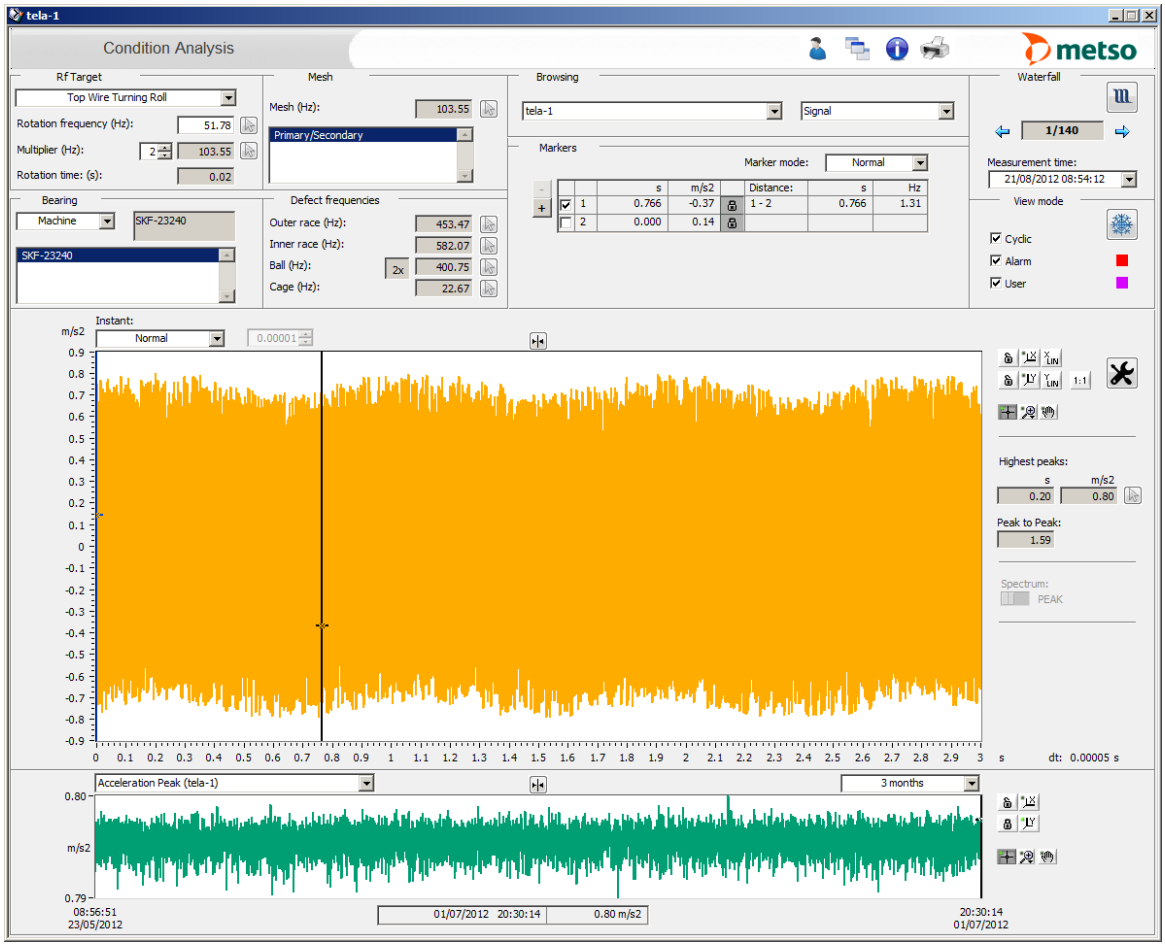
2. Lubrication channel measurement value as a number value and bar. The line in the middle of the bar indicates lubrication flow setting value. Bar color indicates alarm status (green: normal, yellow: warning, orange: alarm, red: zero flow alarm). The lines above the bar show warning limits and the triangles point to alarm limits (upper and lower limits).
3. Opens a channel-specific settings window where the channel's monitoring application parameters, such as alarm limits, can be set. Password protected.
4. Opens the trend window of the respective lubrication channel.

6. Analysis Tool

Machine Monitoring analysis tool is a versatile application designed for specialists for viewing closer spectra and time domain signals. The tool helps to identify developing mechanical faults, monitor machine function on a long term, and handle measured signals and spectra in many different ways.

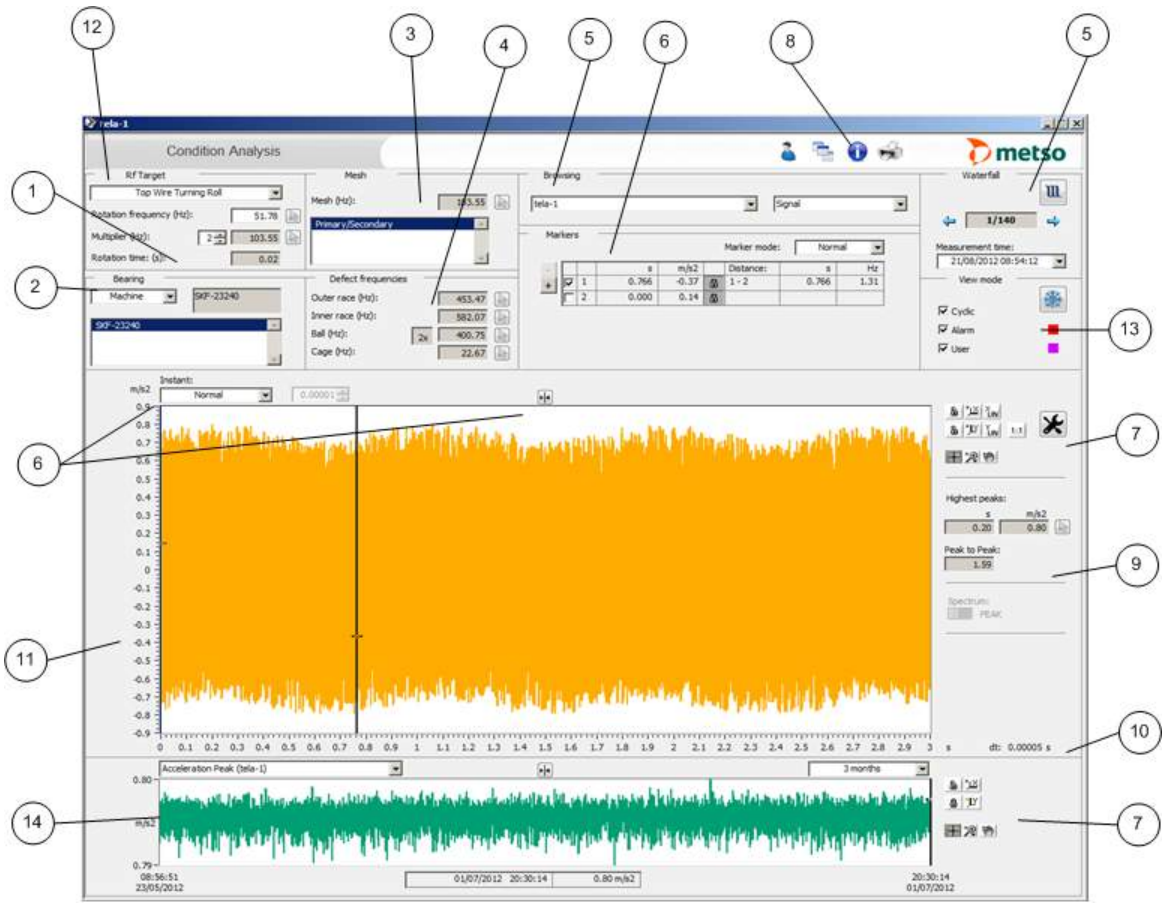
User is provided with a wide range of marking, zooming and browsing functions, as well as shortcuts to facilitate usage.

Additionally, with user-specific settings, each user can modify tool functions and appearance to make usage more efficient and fluent.



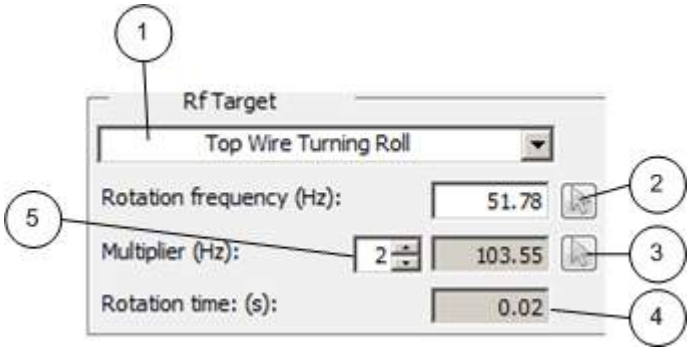
6.1 User Interface

The user interface of the analysis tool consists of the following sections:



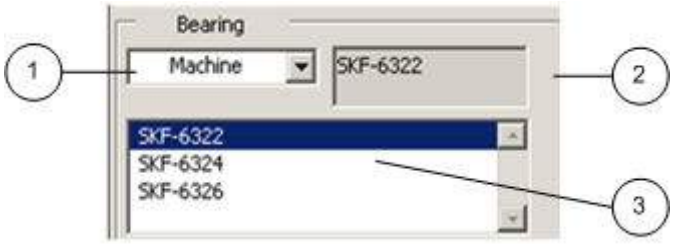
1. Rotational frequency
2. Bearing information
3. Gearmesh frequency
4. Bearing defect frequencies
5. Browsing
6. Marker functions
7. Scaling and zooming
8. Toolbar
9. Highest values
10. Resolution and frequency axis
11. Amplitude axis
12. Machine structure editor
13. View mode selection
14. Trend

6.2 Rotational frequency



1. Point selection of rotation frequency. Points can be inserted with the Machine Structure Editor that is accessed by selecting *Modify* from the drop-down list.
2. The first cursor will be set to the rotational frequency on the spectrum by pressing the cursor button. Respectively, second marker is set in the signal at the rotation frequency's distance from the first marker.
   The value in the field shows the rotational frequency at the measurement time. Value can be changed temporarily by typing a new value into the field.
3. Pressing the cursor button moves the cursor to the multiplier of the rotation frequency specified in the field.
4. Time elapsed in one rotation
5. Frequency multiplier

6.3 Bearing information

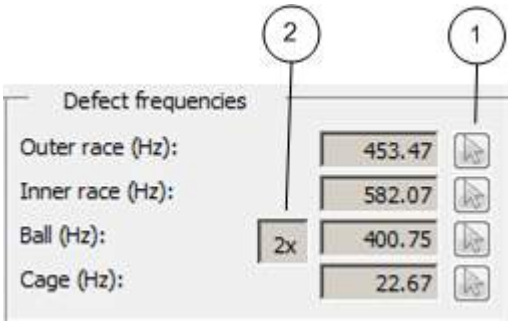


1. Bearing comparison. You can compare different bearing types by choosing either *Machine* or *All*. With the selection *Machine*, all bearings of the selected machine structure are displayed. With the *All* selection, all bearings in the component database are displayed.
2. Bearing type set to the measurement target. Bearing features are displayed when the mouse cursor is moved on top of the bearing type.
3. Bearings specified to the machine

6.4 Gearmesh frequency

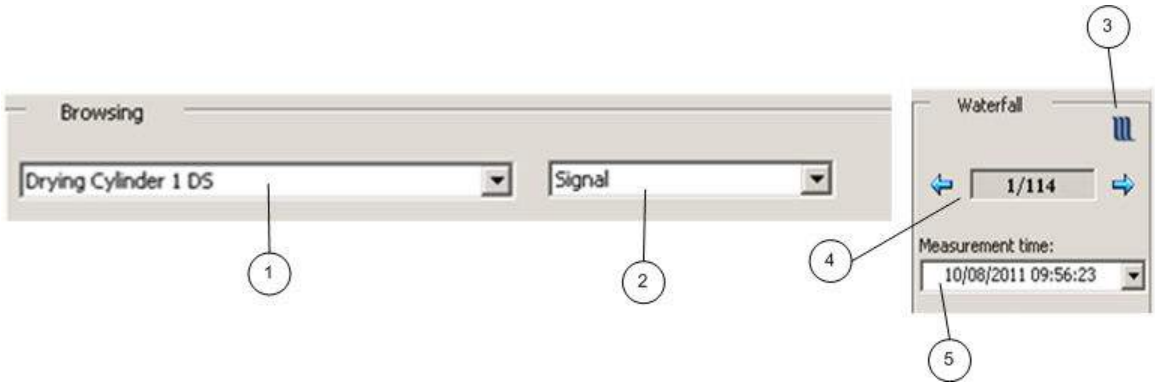
1. The first marker will be set to the gearmesh frequency on the spectrum by pressing the cursor button.
   The value in the field shows the frequency of the selected gearmesh in the measured rotational frequency.
2. Gearmeshes in the measured point. The gearmeshes can be inserted with the Machine Structure Editor.

6.5 Bearing defect frequency



1. The cursor can be moved to the frequency of bearing defect frequencies and frequency multiplier by pressing the cursor button.
   The values in the fields show bearing defect frequencies of the bearing type in the measured rotational frequency.
2. Ball spin frequency can be set to either base frequency or the second harmonic by clicking the button.

6.6 Browsing

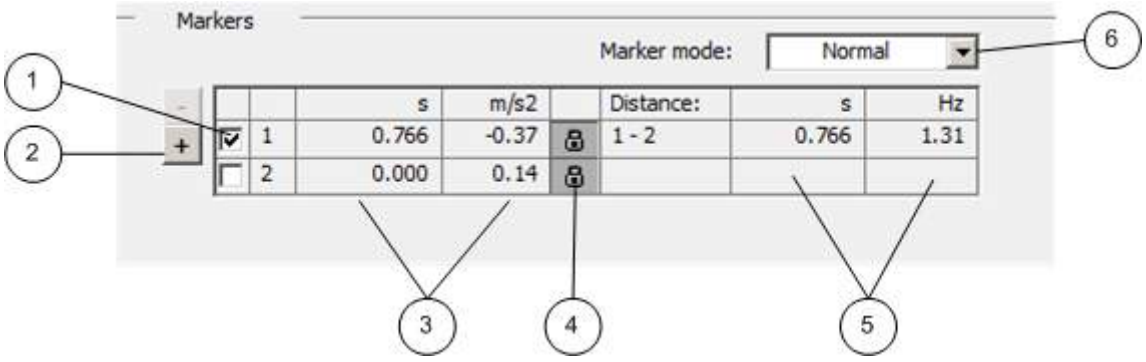


1. Position selection, for browsing through all the positions on selected Process area. For quick browsing, the user can press arrow up and arrow down keys.
2. Result type selection, for example, *Time level – Acceleration spectrum – Speed spectrum – Envelope time level – Envelope spectrum*.
3. Button for Waterfall functions.
4. Serial number of the spectrum / total number of the saved spectra. Number 1 is the most recent and 1052 is the oldest. Click on the arrow buttons to move to the next measurement - to the left for a newer and to the right for an older.
5. Time point of the selected measurement. When opening the tool, the time point of the latest measurement is displayed. Measurements can be browsed also by selecting them directly from the **Measurement time** list.

6.7 Marker functions

Marker functions are located in two sections in the user interface, as described below.

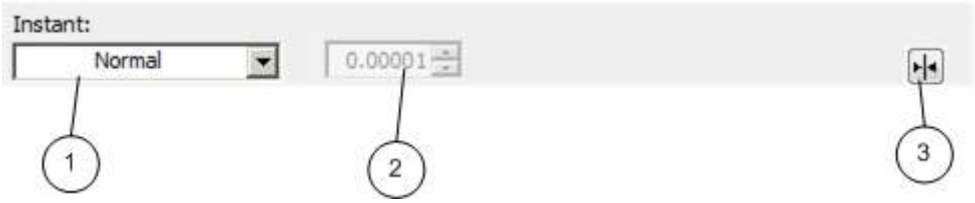
Marker box



1. Active marker can be moved either by dragging the marker or by arrow buttons one step at a time. You can activate the marker by selecting the cursor with mouse or by clicking the selection box.
2. You can add markers by clicking the "**+**" button.
3. Marker coordinates on X- and Y-axes.
4. If the marker has been locked to the data, cursor movement follows the curve points in steps according to the resolution. Opened lock means that movement of cursor is free and the steps for moving can be selected.
5. Frequency difference between two markers and time difference corresponding the frequency.

6. Marker modes: *Normal / Harmonics / Sideband*
    - *Harmonics*: sets harmonic markers in relation to the reference marker on screen
    - *Sideband*: If the point has a gearmesh, reference marker go to the gearmesh frequency and distance marker go to the distance of rotational frequency from the gearmesh.

Instant functions

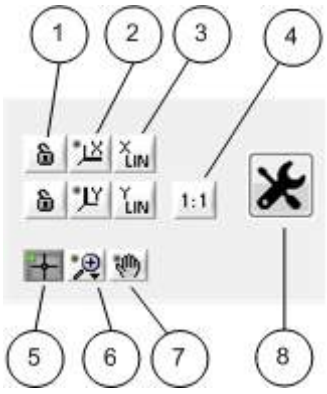


1. Shortcuts: *Normal / Finetuning - coarse / Finetuning - precise / Move cursors / Clear cursors*

    - *Normal*: cursor follows the curve points.
    - *Finetuning* cursor steps are as set in the *Finetuning* window (marker is unlocked).
    - *Move cursors*: activates two first cursors which can then be moved simultaneously with arrow buttons.
    - *Clear cursors*: Removes all other cursors from screen expect the first two (default cursors).

2. Cursor step distance. Becomes active in *Finetuning* mode.
3. Cursor centering in spectrum.

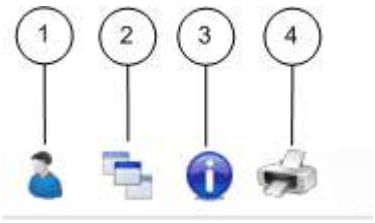
6.8 Scaling and zooming



1. Locking automatic scaling of X- and Y-axes.
2. Automatic scaling of X- and Y-axes.
3. Changing X- and Y-axes scaling to logarithmic. Default is linear scaling.
4. Restoring original scales.
5. Moving cursor by dragging with mouse.
6. Zooming options. Default is zooming in X-axis direction. Zooming can be activated via shortcut by right-clicking the mouse on top of the spectrum.
7. Moving spectrum by dragging with mouse. The pointer is shown as a hand.
8. Toolbox

6.9 Toolbar

Toolbar includes buttons for basic operations of Machine Monitoring.

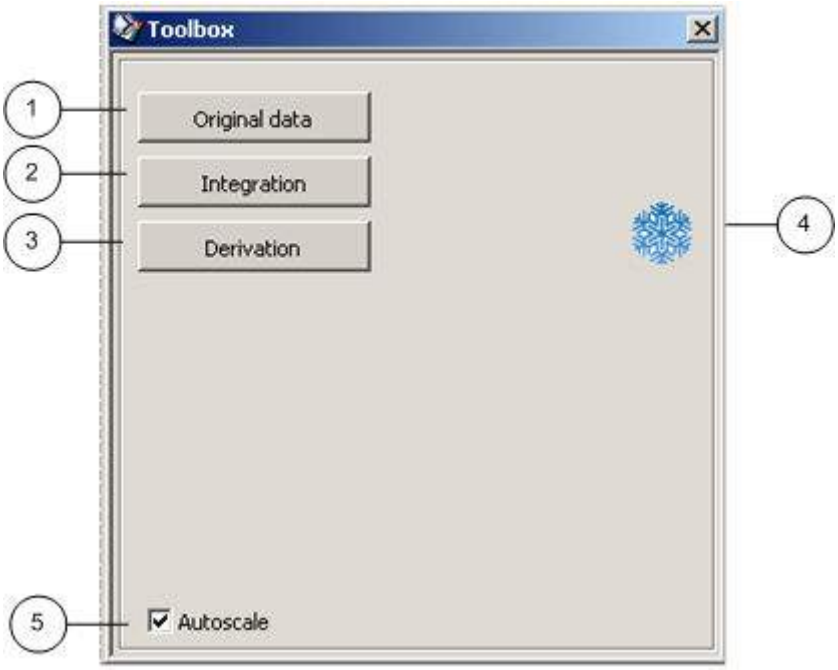


1. User settings
2. Move window to the back of the screen
3. Information
4. Print

6.10 Toolbox

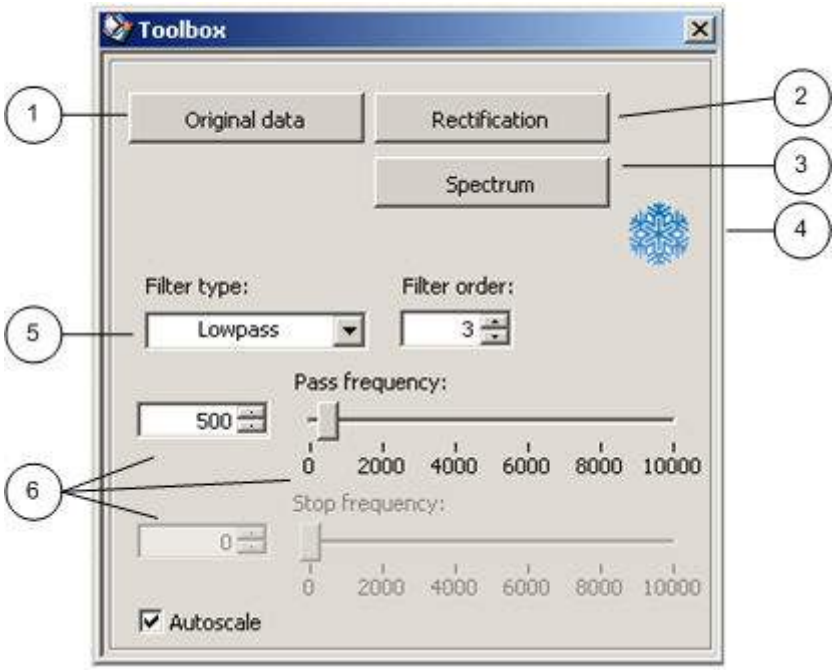
Toolbox is located in the right side of the Machine Monitoring user interface. Its functions depend on what is being examined. Options are *Spectrum* and *Signal*.

Spectrum



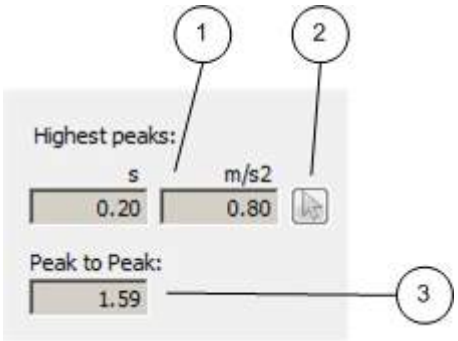
1. Restoring the original spectrum
2. Integration of the spectrum
3. Derivation of the spectrum
4. Freezing of the spectrum. If spectrum is not freezed after processing, it returns to its original state when the toolbox is closed.
5. Automatic scaling of X- and Y-axes

Signal



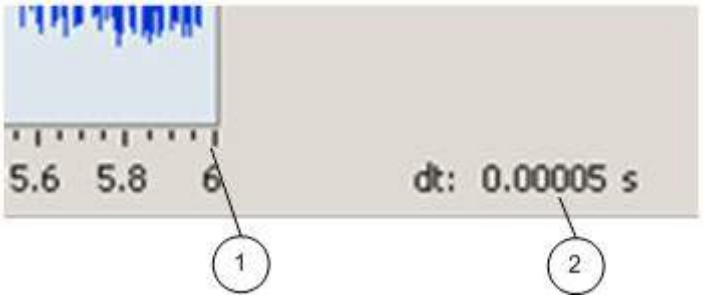
1. Restoring the original signal
2. Rectification of the signal
3. Creating spectrum of the signal
4. Freezing the curve. If the curve is not freezed after processing, it returns to its original state when the toolbox is closed.
5. Filter type selection (*Low-pass*, *High-pass* and *Band-pass*)
6. Cutoff frequency selection. Frequency can be changed by entering new values to the input fields or dragging the indicators with mouse. You can also type the cutoff frequency scales. Default value is always 0-10 000 Hz.

6.11 Highest peak values



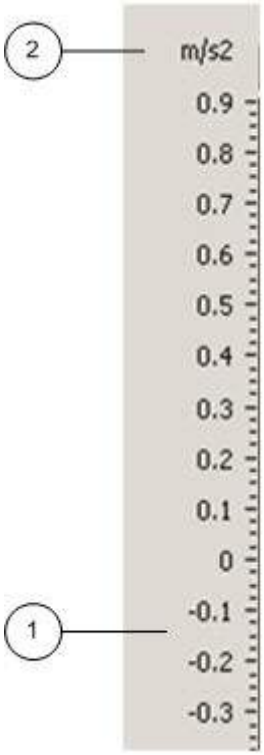
1. Highest value of the signal or three highest peaks of the spectrum.
2. The cursor will be set to the highest peak of the spectrum by pressing the cursor button.
3. Peak-to-Peak value of the signal.

6.12 X-axis



1. Scale of X-axis. Scaling can be changed by typing new values.
2. Resolution of X-axis.

6.13 Y-axis

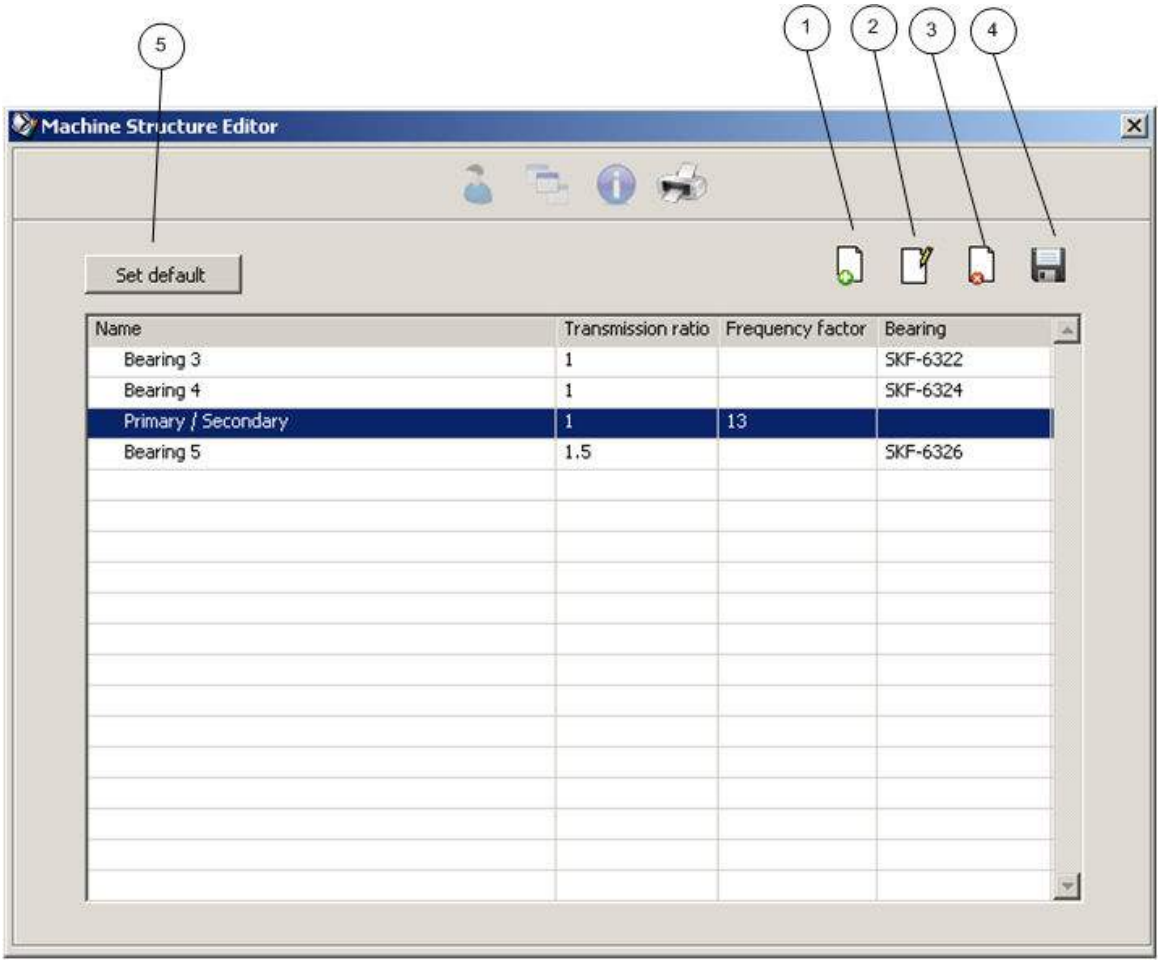


1. Scale of Y-axis. Scaling can be changed by typing new values.
2. Dimension of Y-axis.

6.14 Machine Structure Editor

Machine Structure Editor starts up when *Modify* is selected from the drop-down list above Machine Monitoring user interface *Rotational frequency* information.

With Machine Structure Editor, you can insert the bearing and gearmesh information of the item. This information can be directly utilized when analyzing measurement data in the analysis window. Below the **Machine Structure Editor** window:

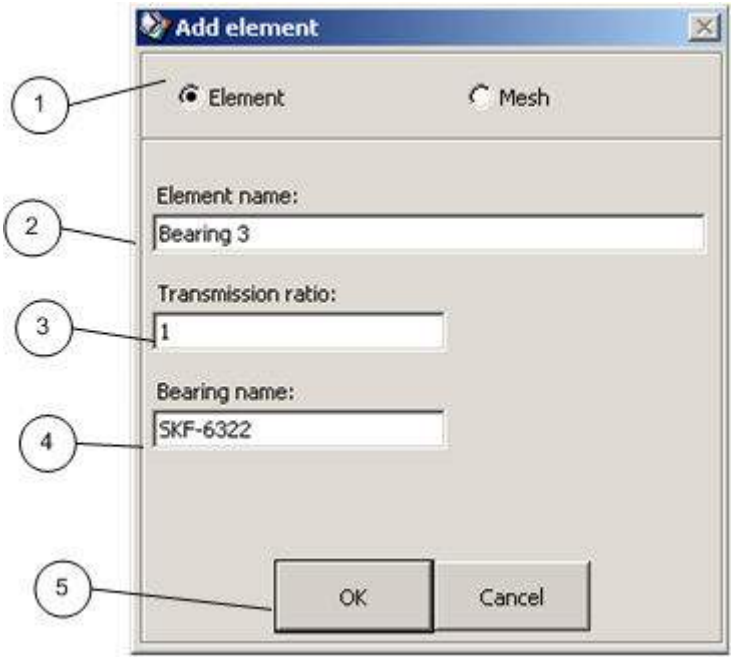


Machine structure editor buttons:

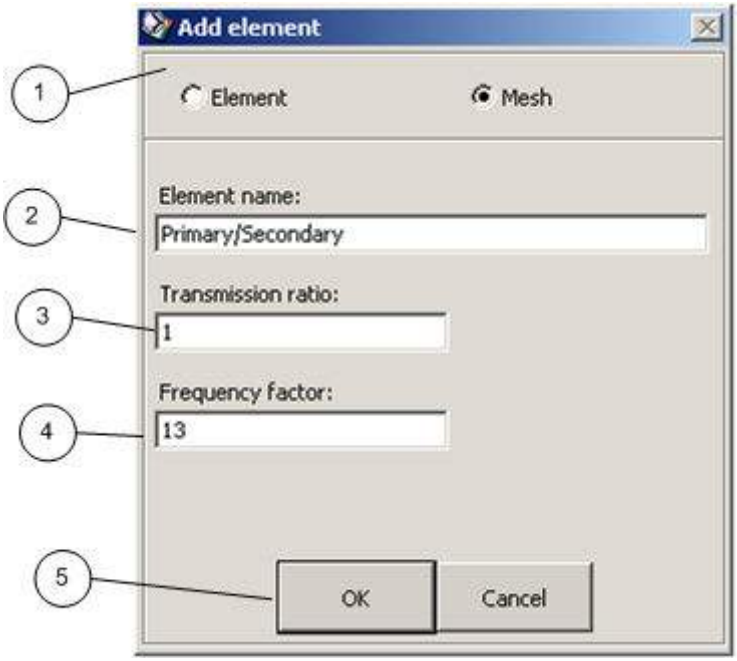
1. Add new row
2. Edit selected row
3. Remove selected row
4. Save data
5. Set default value. Select a row that is displayed in the analysis window by default when the tool is opened for this item.

Add new row

When you want to create a new row, click the **Add new row** button.

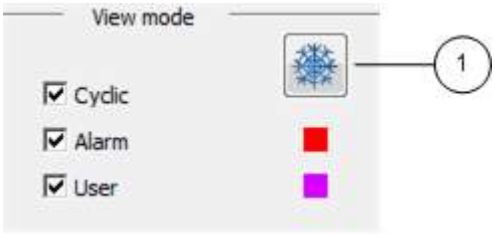


1. Element selection. Other fields are displayed according to this selection.
2. Element name (element)
3. Transmission ratio (element)
4. Bearing name (element)
5. Confirm (**OK**) or cancel



1. Element selection. Other fields are displayed according to this selection.
2. Element name (mesh)
3. Transmission ratio (mesh)
4. Frequency factor (mesh). Number of teeth.
5. Confirm (**OK**) or cancel

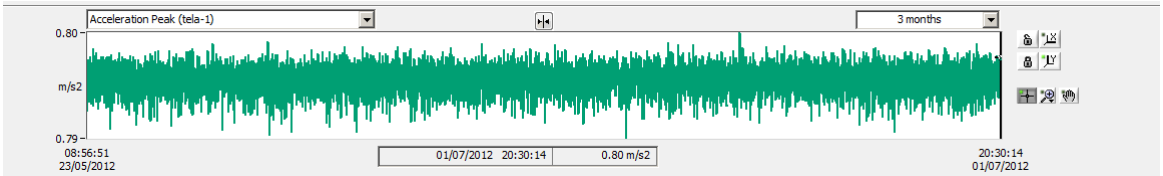
6.15 View mode selection



You can fetch needed waterfall (cyclic) curves, automatically saved alarm curves and curves you have stored yourself and display them all on screen. By default, waterfall curves are displayed when the analysis tool is launched.

1. Freezing the curve button.

6.16 Trend



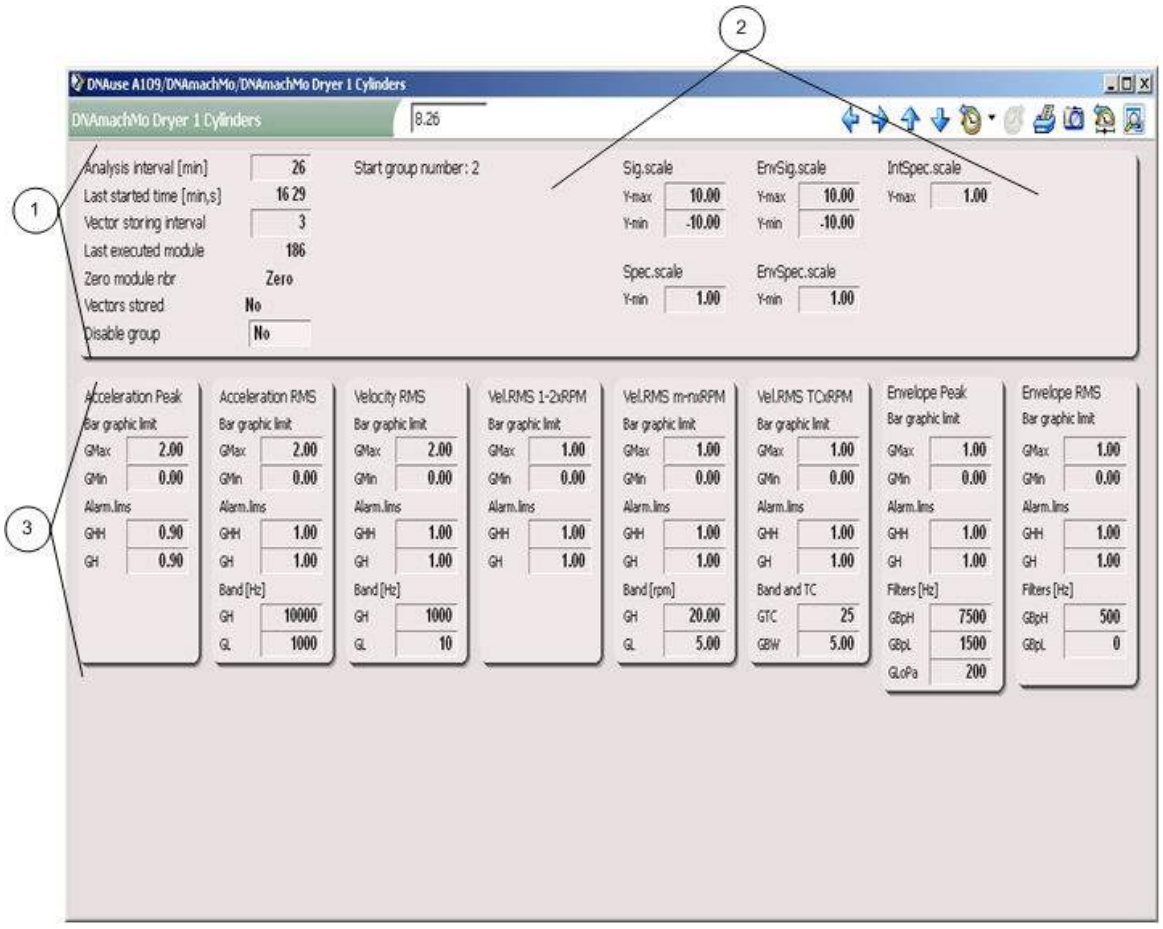
You can browse machine trends by selecting a trend from the drop-down list and fetch trend point curves by dragging the cursor in the trend view. The same scaling and zooming functions are available as in the spectrum window. You can also select the length of the trend from the drop-down list.

7. Tuning Windows of Condition Monitoring and Runnability Monitoring Applications

In tuning windows, parameters related to condition monitoring application can be altered, such as graphical presentation scaling, alarm and warning limits as well as analysis measurement parameters. Changes can be applied on two levels: either to the whole measuring point group or to a single measuring point. When applied to the whole measuring point group, the changes affect all measuring points that use the settings of that group.

7.1 Condition Monitoring Tuning Parameters for Analysis Group

Changing the group parameters affects all measuring points that use the settings of that parameter group:



1. General settings:

   - Analysis interval: operation cycle of the application
   - Vector storing interval: for example, when value is 3, every third vector in operating cycle is saved to the circular buffer of the waterfall storage.
   - Disable group: Passivating analysis

2. Diagram scaling settings:

    - Sig.scale: scaling of signal drawing
    - EnvSig.scale: scaling of envelope signal drawing
    - IntegSpec.scale: scaling of velocity spectrum drawing
    - Spec.scale: scaling of acceleration spectrum drawing
    - EnvSpec.scale: scaling of envelope spectrum drawing

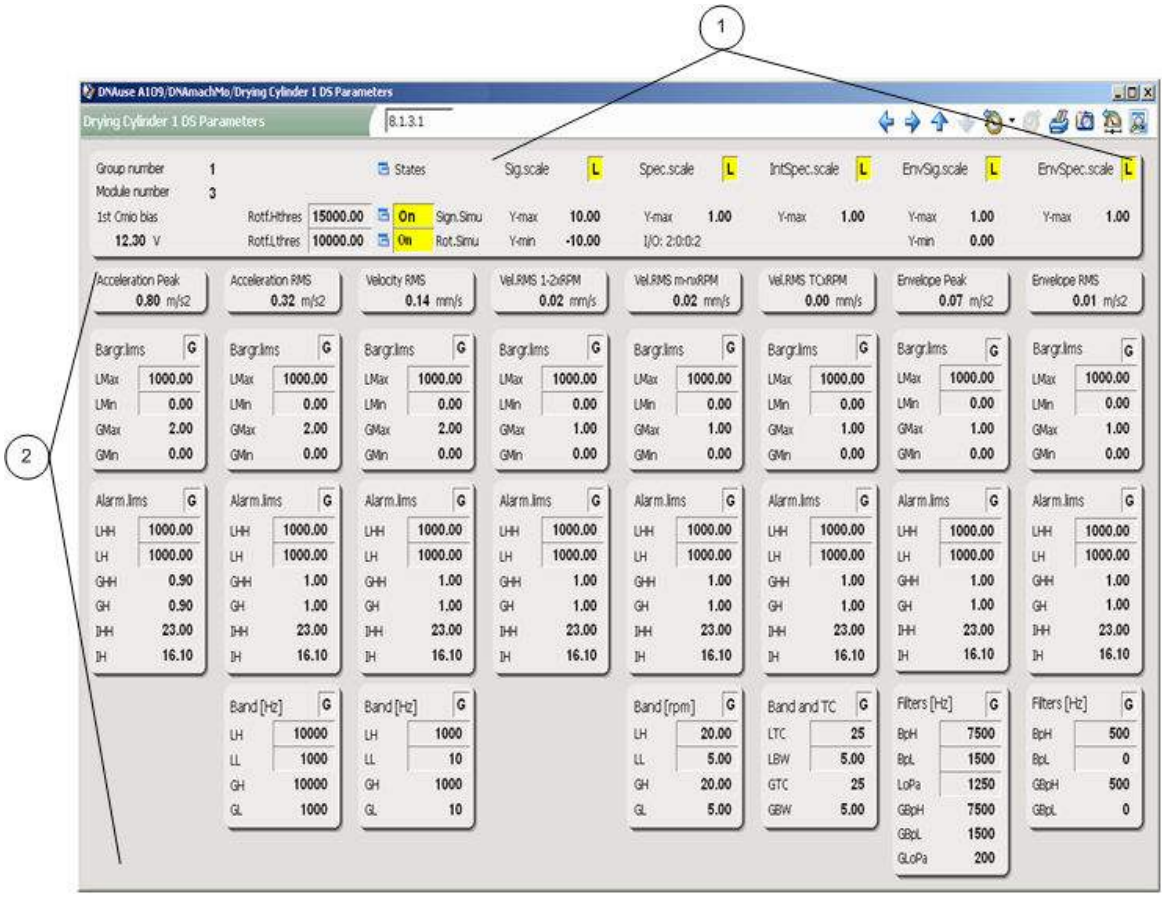
3. Characteristics-specific settings:

    - Bar graph limit: bar scale settings. Gmin, Gmax = minimum and maximum limits of drawing scaling.
    - Alarm limits: alarm and warning limit settings. GHH= alarm limit, GH= warning limit.
    - Acceleration RMS characteristics: Band (Hz): RMS characteristics frequency band. GH= upper limit frequency, GL=lower limit frequency
    - Velocity RMS characteristics: Band (Hz): RMS characteristics frequency band. GH= upper limit frequency, GL=lower limit frequency
    - Vel.RMS m-nxRPM: Band (rpm): Frequency band upper and lower limit of the velocity RMS value that is calculated in relation to rotational frequency (GH= upper limit, GL= lower limit) for example, GH=20 and GL=5 -> frequency band is 5xRPM-20xRPM
    - VelRMS TCxRPM: Band and TC: multiplier and bandwith parameters for velocity RMS value that is calculated in relation to rotational frequency. GTC= frequency multiplier, GBW= bandwidth around the monitored frequency. For example GTC= 25, GBW= 5 -> RMS value is calculated from a frequency band with center frequency of 25xRPM and bandwidth +/-5 percent of the center frequency.
    - Envelope Peak: Filters Hz: Limit frequency values of band-pass filter and low-pass filter used in envelope analysis. GBpH= upper limit frequency of band-pass filter, GBpL= lower limit frequency of band-pass filter, GLpH= limit frequency of low-pass filter.
    - Envelope RMS: Frequency band of RMS characteristics calculated from the envelope signal (GBpH= upper limit frequency, GBpL= lower limit frequency)

7.2 Condition Monitoring Tuning Parameters for a Single Measuring Point

Parameters of each measuring point can be set individually for that point, or parameters can be read from analysis group settings. The choice can be made for each parameter by selecting either **L** for individual setting of a measuring point or **G** for parameter group setting. If **L** is selected, group parameters do not affect that setting. If **G** is selected, local settings for that measuring point are not valid but group settings apply.

Tuning window for a single measuring point



1. Scaling settings of diagram drawing:

   - For each setting, selection is made either for L= individual settings of the respective point, or G= settings are read from group settings
   - Sig.scale: Scaling of signal drawing
   - EnvSig.scale: Scaling of envelope signal drawing
   - IntegSpec.scale: Scaling of velocity spectrum drawing
   - Spec.scale: Scaling of acceleration spectrum drawing
   - EnvSpec.scale: Scaling of envelope spectrum drawing

2. Characteristics-specific settings:

   - L/G choice determines for each parameter whether group settings or individual settings are used. L= local settings of the specific setting are valid. G= settings are read from group settings
   - Bar graph limit: bar scaling settings. Lmin, Lmax= lower and upper limits of an individual drawing; Gmin,Gmax= group limits; L/G selection determines whether group parameters or individual parameters are in use.
   - Alarm limits: alarm and warning limit settings. LHH= individual alarm limit, LH= individual warning limit; GHH= group alarm limit, GH= group warning limit, IHH= speed-dependent alarm limit (individual), IH= speed-dependent warning limit (individual).

- Acceleration RMS characteristics: Band (Hz): Frequency band of RMS characteristics. GH= group upper limit frequency, GL= group lower limit frequency, LH= individual upper limit frequency, LL= individual lower limit frequency. L/G selection determines whether group parameters or individual parameters are in use.
- Velocity RMS characteristics: Band (Hz): Frequency band of RMS characteristics. GH= group upper limit frequency, GL= group lower limit frequency, LH= individual upper limit frequency, LL= individual lower limit frequency. L/G selection determines whether group parameters or individual parameters are in use.
- Vel.RMS m-nxRPM: Band (rpm:) Upper and lower limit of RMS value frequency band calculated in relation to rotational frequency. GH= group upper limit, GL= group lower limit, LH= individual upper limit, LL= individual lower limit. L/G selection determines whether group parameters or individual parameters are in use. For example GH=20 and GL=5 -> frequency band is 5xRPM-20xRPM.
- VelRMS TCxRPM: Band and TC: multiplier and bandwidth parameters for velocity RMS value that is calculated in relation to rotational frequency. GTC= group frequency multiplier, GBW= group bandwidth around the monitored group frequency. LTC= individual rotational frequency multiplier, LBW= individual bandwidth around the monitored frequency. For example, LTC= 25, LBW= 5 -> RMS value is calculated from a frequency band withcenter frequency of 25xRPM and bandwidth +/-5 percent of the center frequency.
- Envelope Peak: Filters Hz: Limit frequency values of band-pass filter and low-pass filter used in envelope analysis. GBpH= upper limit frequency of group band-pass filter,GBpL= lower limit frequency of group band-pass filter, GLpH= limit frequency of group low-pass filter. BpH= upper limit frequency of individual band-pass filter, BpL= lower limit frequency of individual band-pass filter, LpH= limit frequency of individual low-pass filter. L/G selection determines whether group parameters or individual parameters are in use.
- Envelope RMS: Frequency band of RMS characteristics derived from envelope signal. GBpH= group upper limit frequency, GBpL= group lower limit frequency, BpH= individual upper limit frequency, BpL= individual lower limit frequency. selection determines whether group parameters or individual parameters are in use.

8. Intelligent Alarm Handling

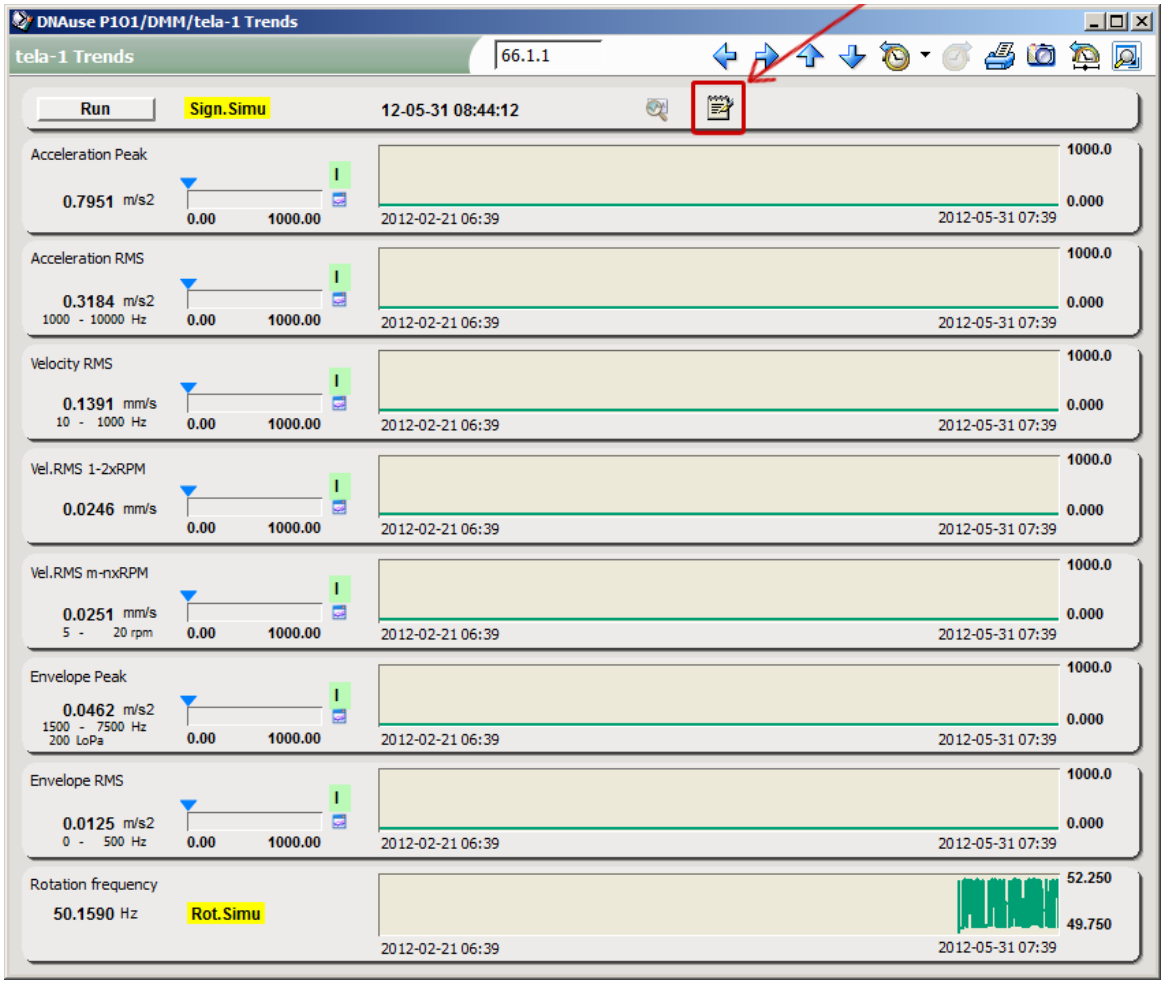
Using Intelligent Alarm Handling makes the alarm handling easier, especially in the machines, in which driving speeds change a lot and values of characteristics change by driving speed. In addition to driving speed, the changing variable can be also rotational frequency. IAH is based on use of notice curves, which can also be used for the targets, whose speed changes only a little. The becoming notice curve is in this case more simple than in targets whose speed changes more.

Setting and using the notice curves replaces the traditional alarm handling, which is based on groups and is handled by scaling tool. It is possible to set own alarm level for each speed zone by notice curves in characteristic-specific way.

8.1 Notice Curves

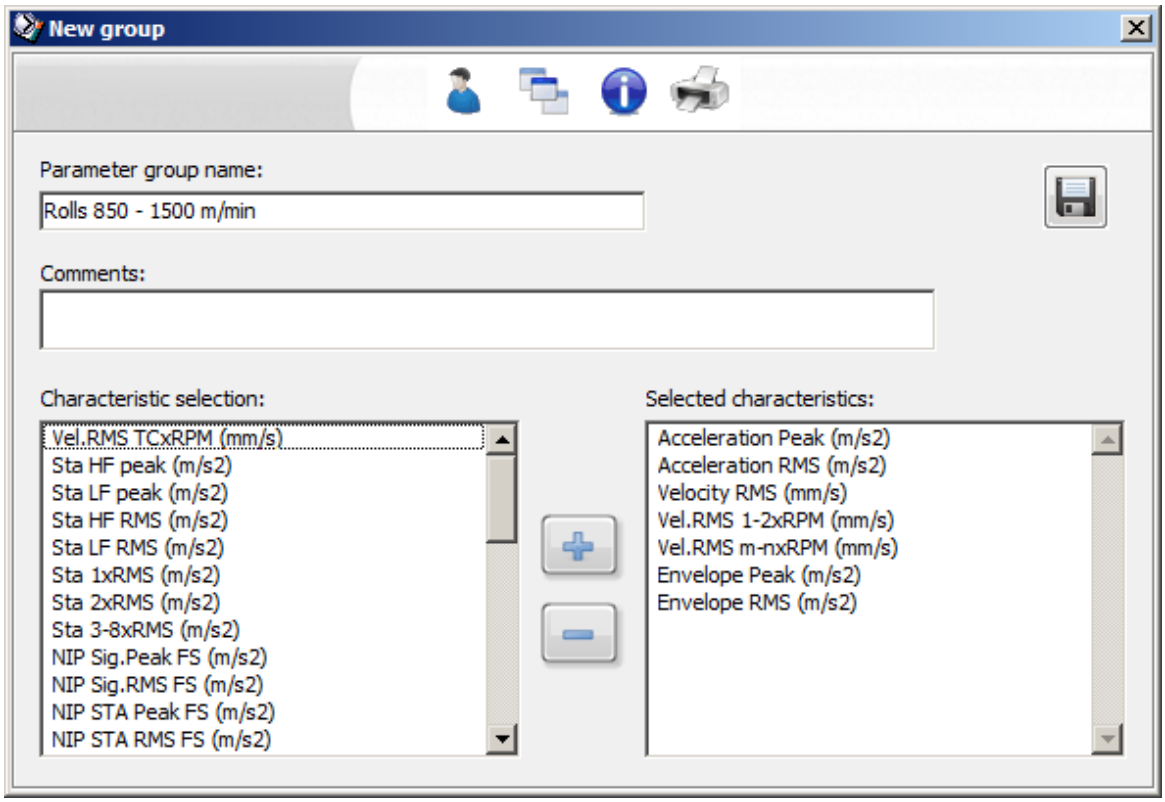
Functions dealing with notice curves are opened from the **Intelligent Alarm Handling** button in DNA Operate user interface. With these functions it is possible to:

- create parameter groups for running notice curves and create a "running recipe"
- choose the characteristics and targets for the curve run
- run the notice curves
- remove the notice curves



8.2 Parameter Groups

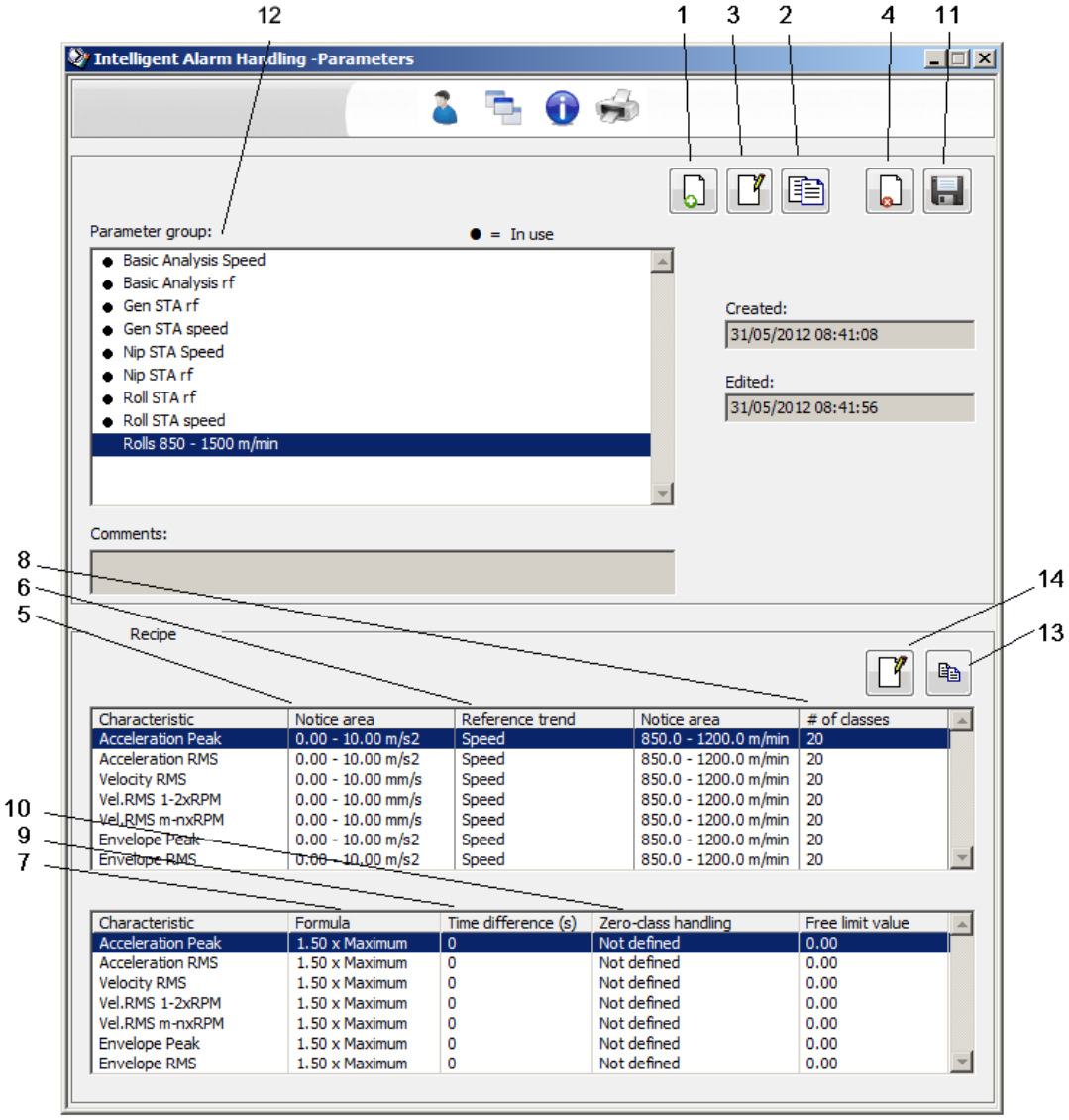
New parameter group is created or an existing group can be edited in **Edit group** window assuming that the group is not in use.



- Give a descriptive name to the new group.
- You can give more information about the parameter group in the **Comments** field.
- Select the characteristics needed for the group in the selection box on the left. Click the **+** button to add them.
- To remove characteristics from a group, select them in the box on the right and click the **-** button.
- Save the new group or changes made to a group by clicking the Save button in the upper right corner.

8.3 Parameters, "Recipe"

The parameters used in calculating notice curves can be viewed, edited, copied and deleted in the **Parameters** window. A new group is also created in the same window.

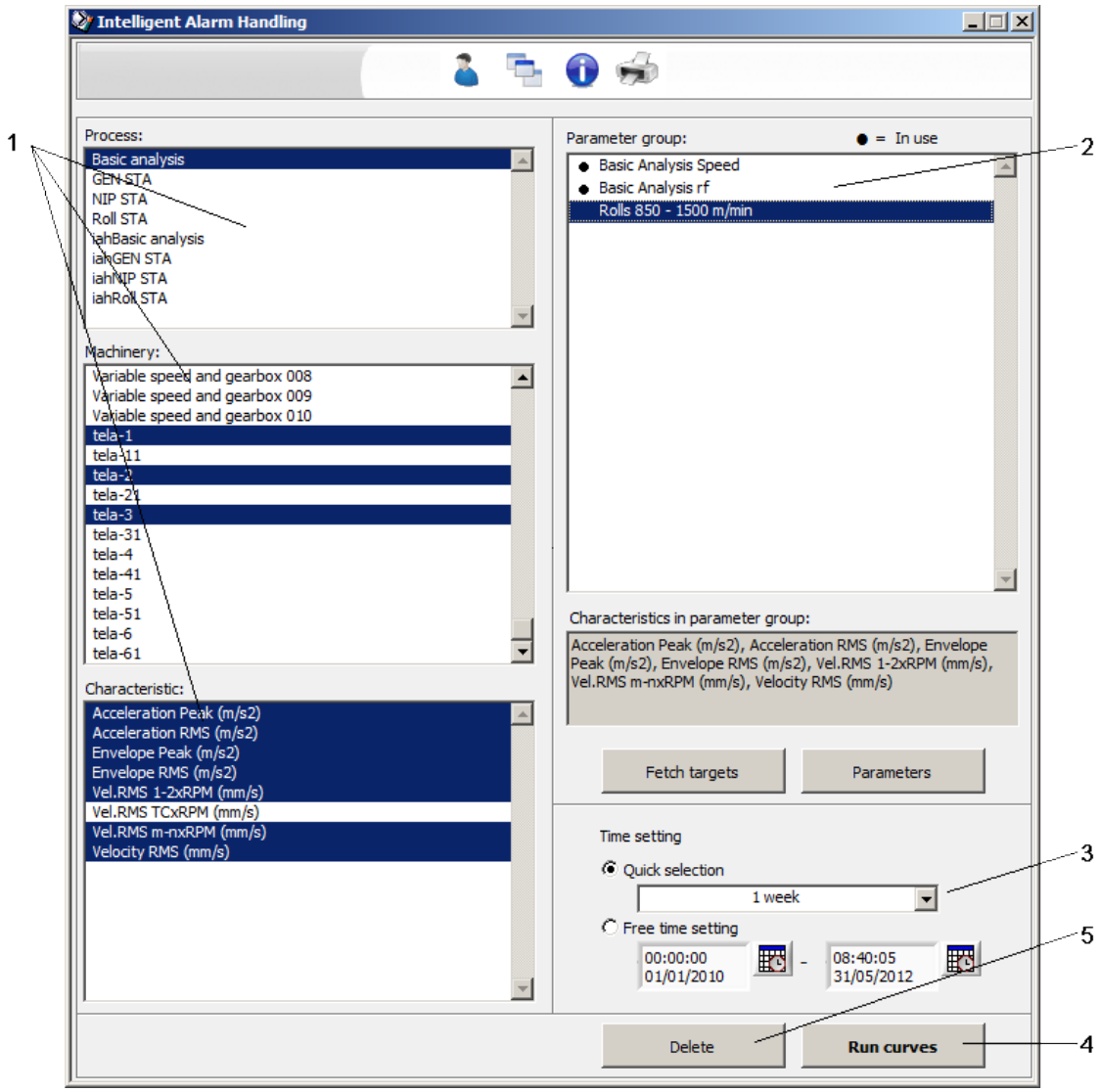


1. Start creating a new parameter group by clicking the New button.
   After saving the group, the name of the group can be found on the list and the dates show the time of saving.
2. You can also create a group by copying an existing group and saving it with a another name.
3. You can only edit a group which is not in use.
4. You can only remove a group which is not in use.
5. Characteristics of the parameter group and amplitude range taken into account while running notice curves.
   If there a several characteristics selected for the group, the range must be defined for each characteristic.
6. Reference trend can be either rotational frequency or machine speed.
   Notice area is the length of the x-axis of the notice curve.
7. Formula.

8. Number of classes in the notice curve.
   Number of classes defines how many zones calculated separately there are in the notice curve. For example in this case the notice area is 0...60 Hz and there are 20 classes. The notice curve is divided into 20 parts of 3 Hz.
9. The maximum allowed in time difference between trend points.
10. If the class does not have any trend points during the selected time frame, the value of the notice curve class can be defined.
11. Saving the parameter group.
12. The created parameter groups and the information on which groups are in use = notice curves have been run using the parameter groups.
13. Copying the characteristic-specific parameters to all the characteristics of the parameter group.
14. Editing the parameters.

8.4 Running Notice Curves

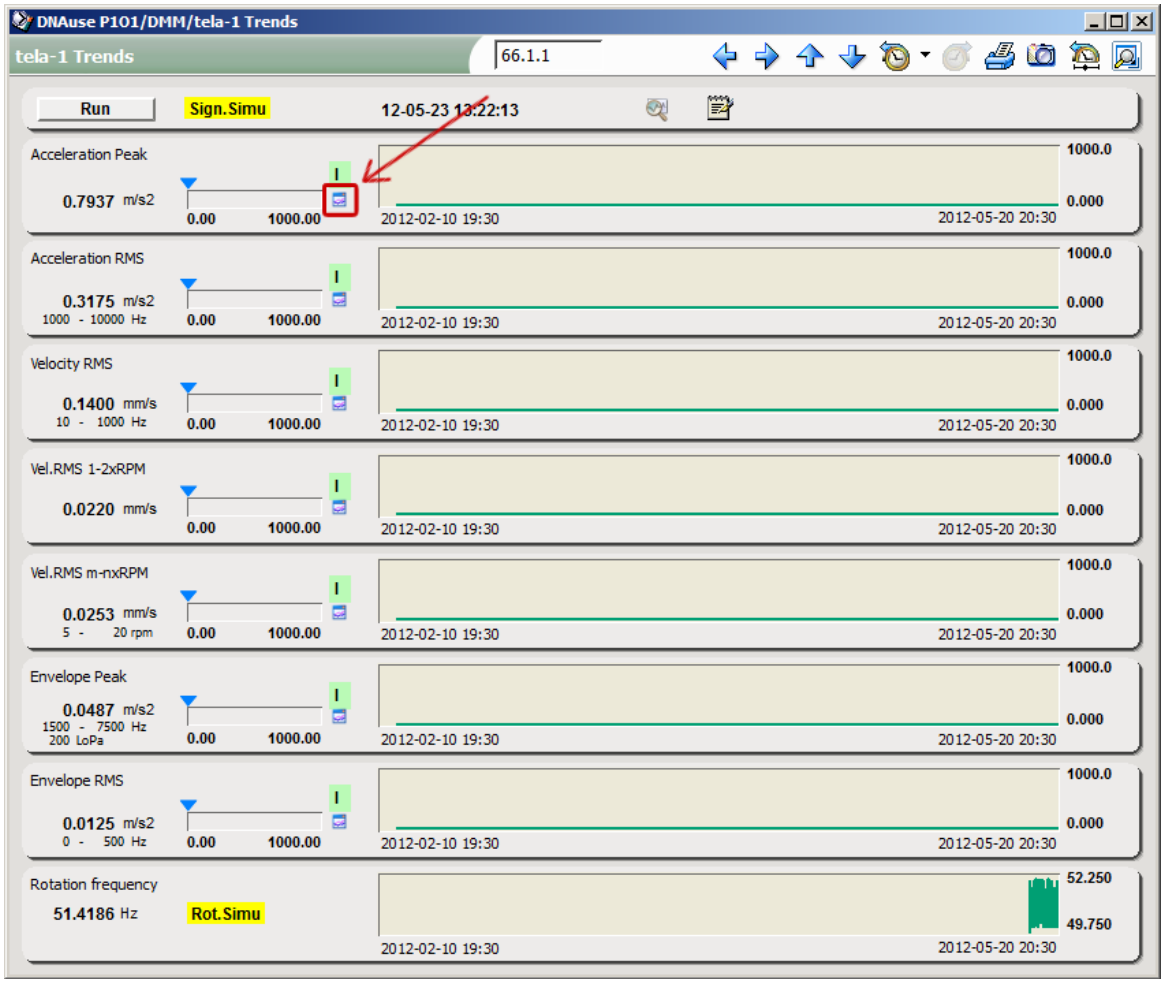
Targets and characteristics for the run of notice curves are selected in the **Running notice curves** window. Also the time frame from which the calculation data is used to create the notice curve is selected in this window.



1. Select the targets by first selecting the process, the machinery and characteristic in the selection boxes.
   You can select several items by holding the Ctrl or Shift button down while making the selection.
2. A parameter group contains the parameters needed for running the notice curves.
   To create a new group, click the **Parameters** button and give the group information in the window that opens.
3. You can set the length of the trends used in the calculation of notice curves either using the quick selection or freely.
4. Running the curves.
5. After deleting the notice curves the new results use normal alarm handling.

8.5 Viewing and Editing Notice Curves

Notice curves can be viewed and edited from the characteristic displays.

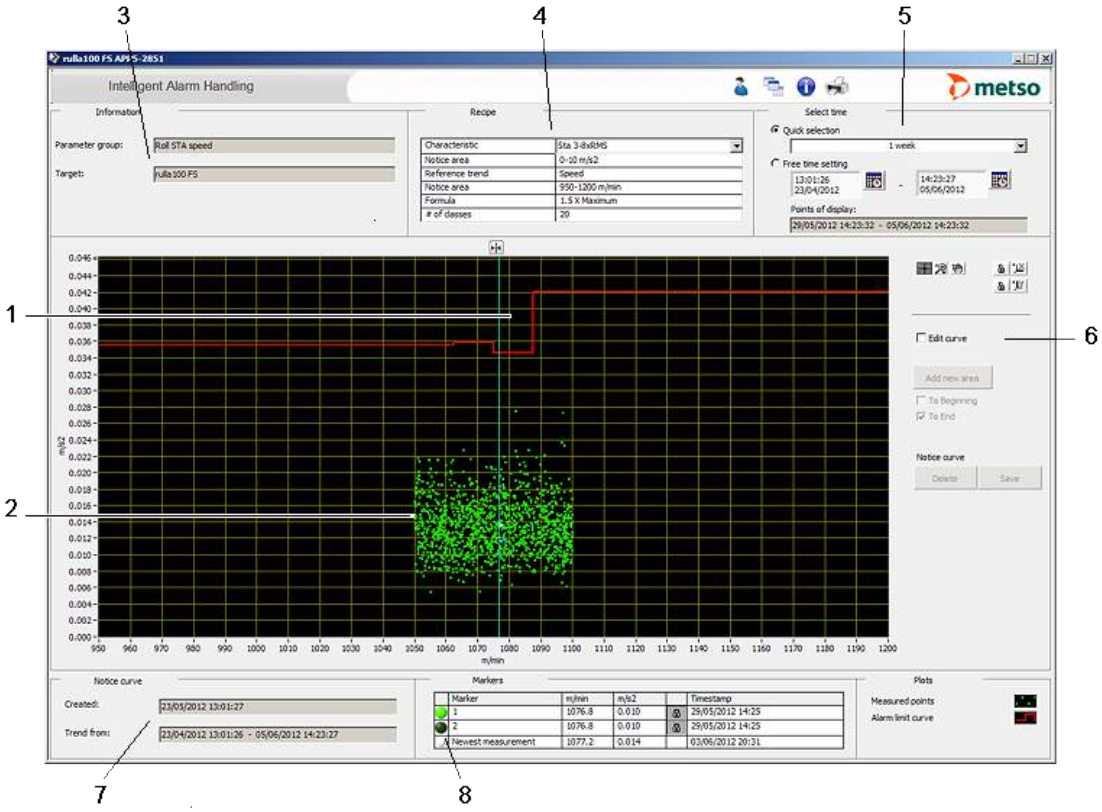


The "I" flag on the right side of the characteristic bar indicates that Intelligent Alarm Handling is in use in this characteristic.

You can view the notice curve by clicking the button under the "I" flag.

8.6 Viewing a notice curve

Notice curve created during the run can be viewed in the **Viewing a notice curve** window as a step-shaped curve and the measurement results as points.



1. Notice curve
2. Trend points
3. Used parameter group and the name of the target
4. Parameters
5. The time frame of the visible measurement results can be changed using the quick selection or freely.
6. Editing the curve
7. Information on the notice curve
8. Markers

8.7 Editing a notice curve

1. You can edit the value of a single zone by dragging on the handle with the mouse.
2. You can add a new class (zone) into the beginning or end of the area.
3. Saving the changes.
4. Deleting the notice curve.

8.8 Recommendations for Using Intelligent Alarm Handling

In order to get all the benefits of Intelligent Alarm Handling and to have reliable results, the application should be used as systematically as possible. One possible way to use it in the paper machine environment is presented below.

1. Intelligent alarm handling is used only for machines and devices in good condition. Machine condition is checked beforehand and if there are trend points from defect situations, the points are removed from notice curve run using trend definition.
2. A few parameter groups are created, for example three for different rotational frequency ranges: one for large rolls, one for small rolls and one for motors and primary shafts. Rotational frequency ranges are determined from the measurement results so that the minimum limit of notice curve run is 1 Hz below the lowest and maximum limit is 1 Hz above the highest running speed. The frequency range is divided into 10...15 classes. The idea of the division is that the notice curve opens to the screen in the right scale without scaling and the speed changes are considered in the notice curve with sufficient accuracy.
3. Amplitude range can be defined high enough for the groups, according to possible maximum. Each notice curve is individual and a more accurate estimate is therefore not necessary.
4. The most important characteristics are included in the parameter groups, for example high frequency signal peak value (PEAK-HF) and RMS value of velocity spectrum (RMS-LF). Later on, after more experience, new parameter groups can be created for other characteristics.
5. Notice curves are run in appropriate batches, for example one process section at a time.
6. Notice curves are checked and, if necessary, the zones are edited directly using the editing handles.