



moneo|SmartLimitWatcher

Intelligent dynamic threshold monitoring of critical process variables.





Introduction

The ongoing digitalisation of industries poses challenges for companies in monitoring and controlling their production processes.

One of the significant difficulties is the reliable monitoring of critical process parameters such as temperature, flow and vibration. In modern production plants, enormous amounts of sensor data are continuously generated through manual monitoring, which is not only time-consuming but also highly error-prone. Early detection of anomalies and undesirable process changes is crucial, as unplanned machine downtime can lead to massive financial losses.

Recent studies show that the world's 500 largest companies lose around 1.4 billion dollars a year due to unplanned downtime, which equates to 11% of their total revenue. In heavy industries, the cost per hour of downtime is around 59 million dollars - 1.6 times higher than in 2019¹.

Added to this is the increasing shortage of specialised maintenance personnel. Companies encounter the challenge of implementing complex monitoring systems that work reliably and can also be operated by less specialised employees. The loss of expert knowledge due to staff turnover also makes it necessary to use systems that can automatically recognise and evaluate anomalies without relying on years of experience.

These complex challenges require innovative solutions that are both technologically mature and user-friendly. In addition, it can also be smoothly integrated into existing production environments.

The moneo|SmartLimitWatcher is an intelligent tool that enables the automatic and early detection of anomalies in a critical process variable based on dependent sensor data and process parameters. By permanently monitoring the critical process variables in relation to production quality or system status, faults can be recognised at an early stage and the corresponding measures initiated.

¹ The true cost of downtime 2024: a comprehensive analysis, AEMT 2024
<https://www.theaemt.com/resource/the-true-cost-of-downtime-2024-a-comprehensive-analysis.html>

Your solution: moneo|SmartLimitWatcher

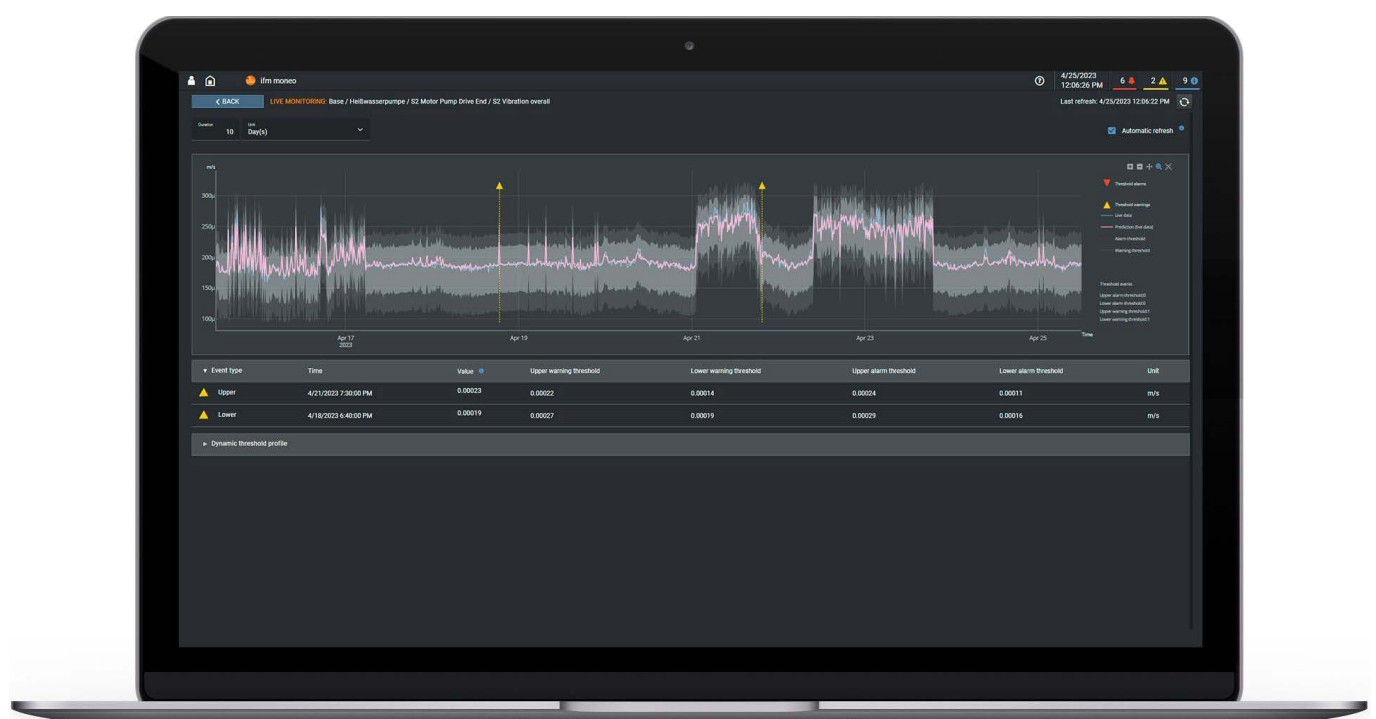
The moneo|SmartLimitWatcher is an innovative solution in the field of industrial process monitoring and was developed as an intelligent assistance system for monitoring dynamic values.

The system uses a combination of different AI algorithms that can recognise complex relationships between different process variables and use these to deduce dynamic thresholds for critical parameters. The dependencies between a target variable and several helpful variables are automatically identified and used for monitoring.

Particularly important is the no-code concept, which enables users without data science knowledge to implement and control complex monitoring systems with dynamic thresholds. This technology is based on advanced AI methods and continuously analyses the relationships between various process parameters in order to detect anomalies from the expected behaviour at an early stage.

Thanks to the intuitive user interface and the integrated 5-step wizard, users can put the system into practice quickly and easily without having to deal with complex programming or data analysis. The scalability of the system enables the monitoring of a wide range of process variables right up to complex process interrelationships. The self-learning algorithms automatically adapt the limit values to different operating states and ensure continuous 24/7 monitoring without manual interaction.

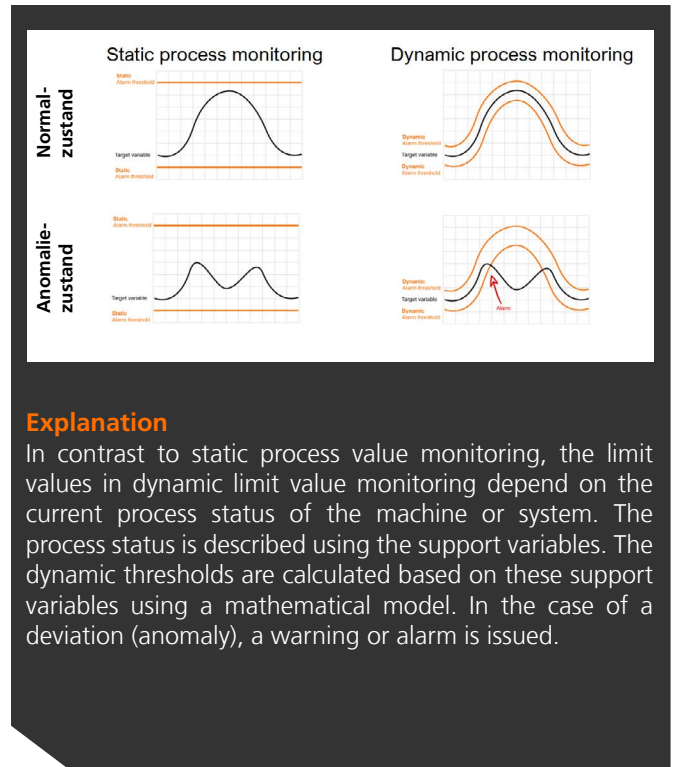
The intelligent calculation of dynamic expectation ranges and the automatic adaption of thresholds ensure a high level of reliability in anomaly detection. The flexible system architecture also allows integration into existing production environments. Also an easy expansion to include additional process variables into the system is possible, so that companies can gradually expand their monitoring systems.



Monitoring with dynamic thresholds

The moneo|SmartLimitWatcher is an intelligent tool that enables the automatic and early detection of anomalies in a critical process variable based on dependent sensor data and process parameters. It is used to continuously monitor this critical process variable (target variable/ support variable) about production quality or system status (e.g. temperature, flow rate, vibration, motor current).

AI methods are used to train a mathematical model from historical data, which is used for the continuous target-actual comparison between the measured and the predicted target variable. By additionally calculating dynamic expectation ranges (confidence bands) for the target variable, the behaviour of the target variable can be continuously evaluated and potential deviations automatically generate.



Possible applications

The AI of the moneo|SmartLimitWatcher can be used in different ways for process monitoring. It can be used for monitoring comparable machine components or for monitoring individual add-on parts or measured variables.

Horizontal use

Monitoring with the help of comparable machine components.

Requirement

The connected machine components are integrated in a process or in the same system and are physically dependent on each other. The advantage is that they only require a few sensors or measured values to recognise anomalies.



Vertical use

Detailed monitoring of a component with several measured values.

Note

The moneo|SmartLimitWatcher can be used to monitor coupled sensors as well as coupled systems.





Use Case: Monitoring the flow rate of a pump

Pumps are often operated in different speed ranges. This means that static monitoring of the limit values is only possible to a limited level, as these change depending on the speed.

The pump in our example is set up as follows:

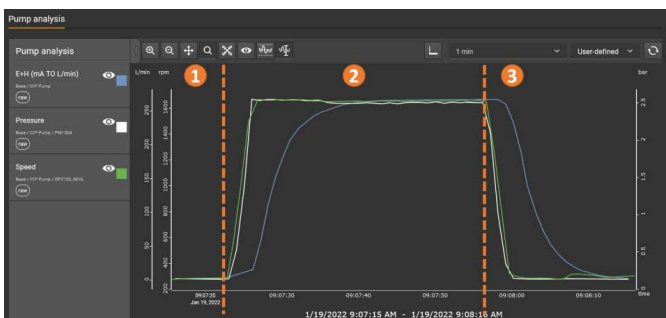
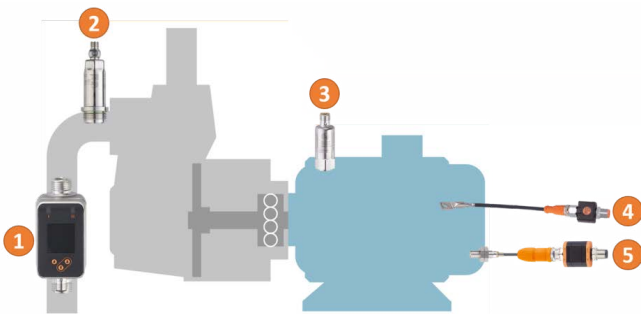
- flow rate at the pump outlet (1)
- pressure at the pump outlet (2)
- vibration at the pump (3)
- surface temperature of the motor (4)
- speed of the motor (5)

The target variable used here is the flow rate. This is an essential parameter for monitoring. Other sensors are used as support variables that describe the application (speed, vibration, pressure).

To check the qualification of the data, it should be analysed first. A typical characteristic profile for start-up, operation and run-down can look as follows. The dependence of flow rate and speed can be clearly seen due to their similar behaviour:

- start-up phase (1)
- operating phase (2)
- run-down phase (3)

As observed in the graph, there is a time shift between flow rate and speed. Therefore, a precise time resolution must be set later in the advanced settings (setup wizard step 1) of the moneo|SmartLimitWatcher.



Caption: **Blue: Flow rate / White: Pressure / Green: Speed**

The 5-Step Wizard of the moneo|SmartLimitWatcher

The moneo|SmartLimitWatcher tool can be opened via the “SmartLimitWatcher” icon on the home screen. In the topology, select the corresponding target variable and then start the setup wizard via “Start wizard”.

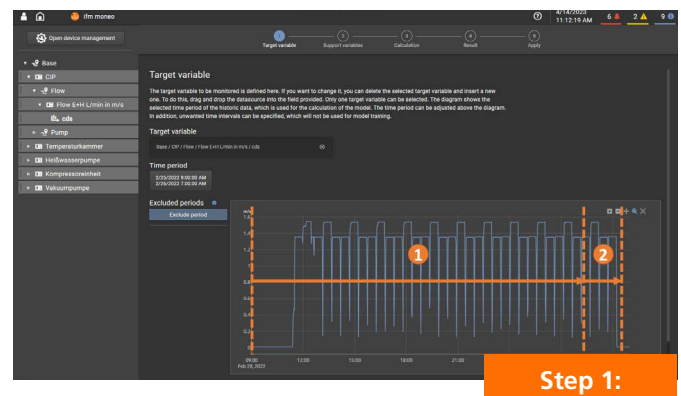
Step 1: Select data source

This first step involves:

- selecting a target variable to be monitored (e.g. temperature, flow rate, vibration)
- selecting one or more support variables that describe the process status
- defining the training period, which should include as many data points as possible

When calculating the model, the first 90% (1) of the data is used as training data, the last 10% (2) is used to test the model.

The selection is made conveniently by “drag & drop” from the existing sensor configuration. The system automatically checks the suitability of the selected variables for the AI-based analysis.



Step 1:

Step 2: Check data quality

The moneo|SmartLimitWatcher can perform a comprehensive quality check of the selected data:

- analysis of data availability and completeness
- checking the time resolution and sampling rate
- detection of anomalies and faults
- evaluation of the signal quality
- validation of the process correlations between the variables

The screenshot shows the 'Support variables' section. It contains a table with the following data:

Indicator	Path	Completeness	Actions
OK	Base / CIP / Pump / V0001 / ePeak	100.00 %	
OK	Base / CIP / Pump / V0001 / eRms	100.00 %	
OK	Base / CIP / Pump / V0001 / eRms	100.00 %	
OK	Base / CIP / Pump / V0001 / eRms	100.00 %	

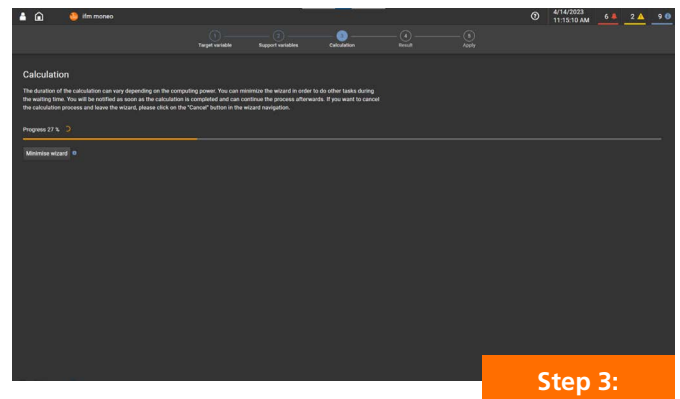
Step 2:

Step 3: Configure modelling

In this phase, the parameters for the AI model are defined:

- automatic selection of the optimal algorithm
- determination of relevant model parameters
- definition of the training periods
- definition of the update intervals
- configuration of the model adaptation

The system suggests optimum settings that can be adjusted as required.



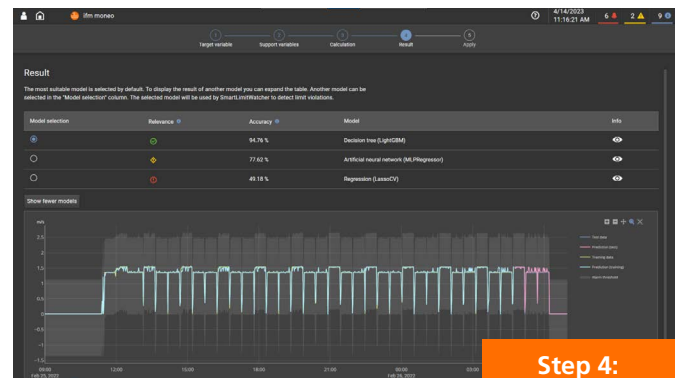
Step 3:

Step 4: Analyse model quality

After training, the system displays detailed information on model quality:

- accuracy of predictions
- reliability of the threshold calculation
- robustness against process fluctuations
- comparison of different model variants
- recommendation of the most favourable model

Interactive visualisations can be used to check the model quality for different operating states.



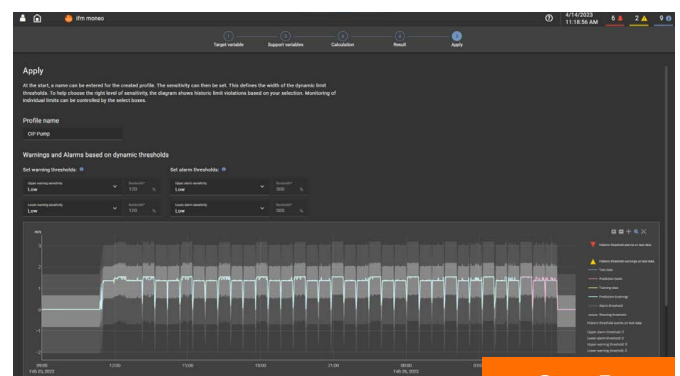
Step 4:

Step 5: Configure monitoring

In the last step, the parameters for running monitoring are defined:

- definition of warning and alarm thresholds
- setting the alarm delays
- configuration of the notifications
- defining the visualisation
- integration into existing dashboards

A preview shows the alarms to be expected under typical operating conditions. Once the configuration is complete, permanent monitoring starts automatically in the background.



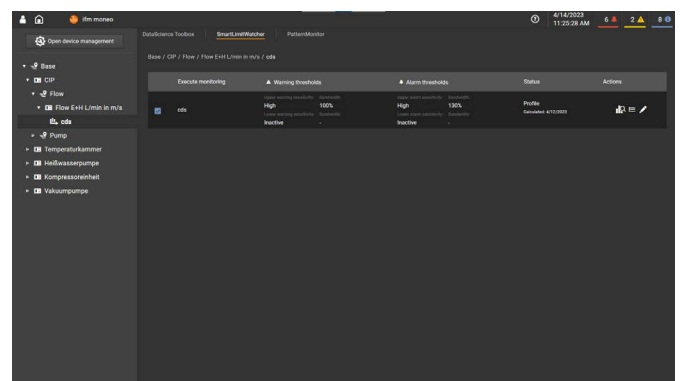
Step 5:

Live monitoring of the moneo|SmartLimitWatcher

To switch to live monitoring of the moneo|SmartLimitWatcher profile, the topology tree must first be opened. There are two options here via the main menu:

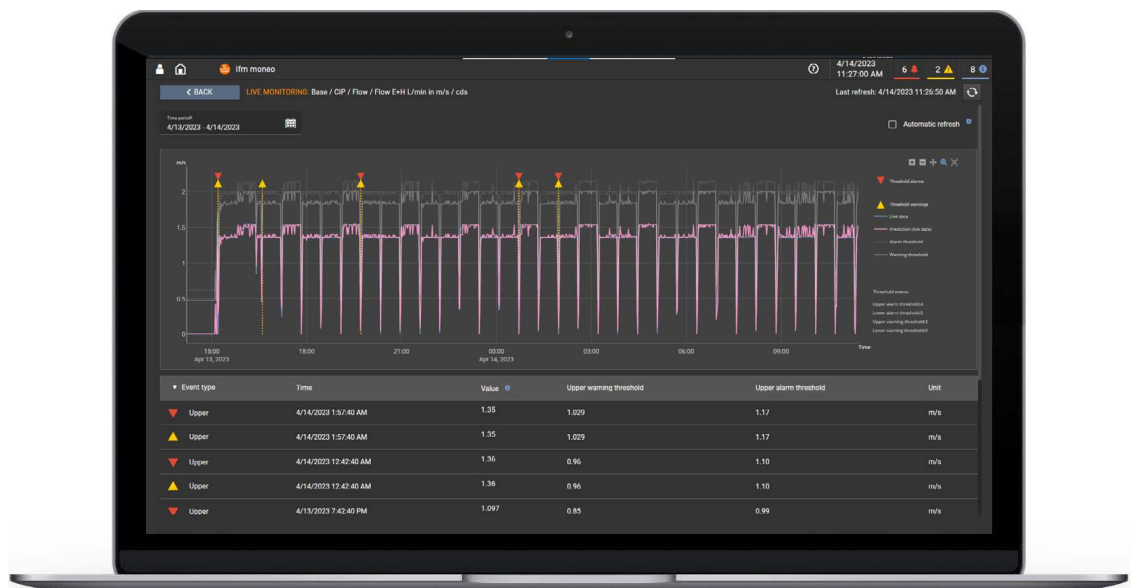
- via the Industrial AI Assistant button and then selecting 'Created profiles' under the moneo|SmartLimitWatcher section
- direct access by selecting the 'SmartLimitWatcher' button

To open the live monitoring of a process value, select the desired node in the topology tree and select the data source. Live monitoring, profile overview, or profile settings can now be opened via the 'Actions' tab.



To validate the selected settings, it is advisable to call up live monitoring and check the behaviour of the moneo|SmartLimitWatcher in live operation.

Warnings (yellow) and alarms (red) are displayed directly in the diagram. In this example, the thresholds are too sensitive and the settings need to be adjusted. The process knowledge shows that there is a false alarm in this example.



Further tools of the moneo|Industrial AI Assistant

The moneo|Industrial AI Assistant is an integral part of the moneo|IIoT Insights software add-on and therefore also of the moneo|IIoT Core. The Industrial AI Assistant currently includes the AI software solutions moneo|SmartLimitWatcher, moneo|PatternMonitor and moneo|LifetimeEstimator, which are used for anomaly detection and in the field of predictive maintenance.

			
Features	moneo SmartLimitWatcher	moneo PatternMonitor	moneo LifetimeEstimator
Anomaly detection	✓	✓	X
Predictive analysis	X	X	✓
Usage of one measured value	X	✓	✓
Usage of several measured values	✓	X	X
Pattern identification	X	✓	X
Dynamic alarm and warning thresholds	✓	X	X
Prediction of the remaining useful life	X	X	✓
AI/ML technology	✓	✓	✓

