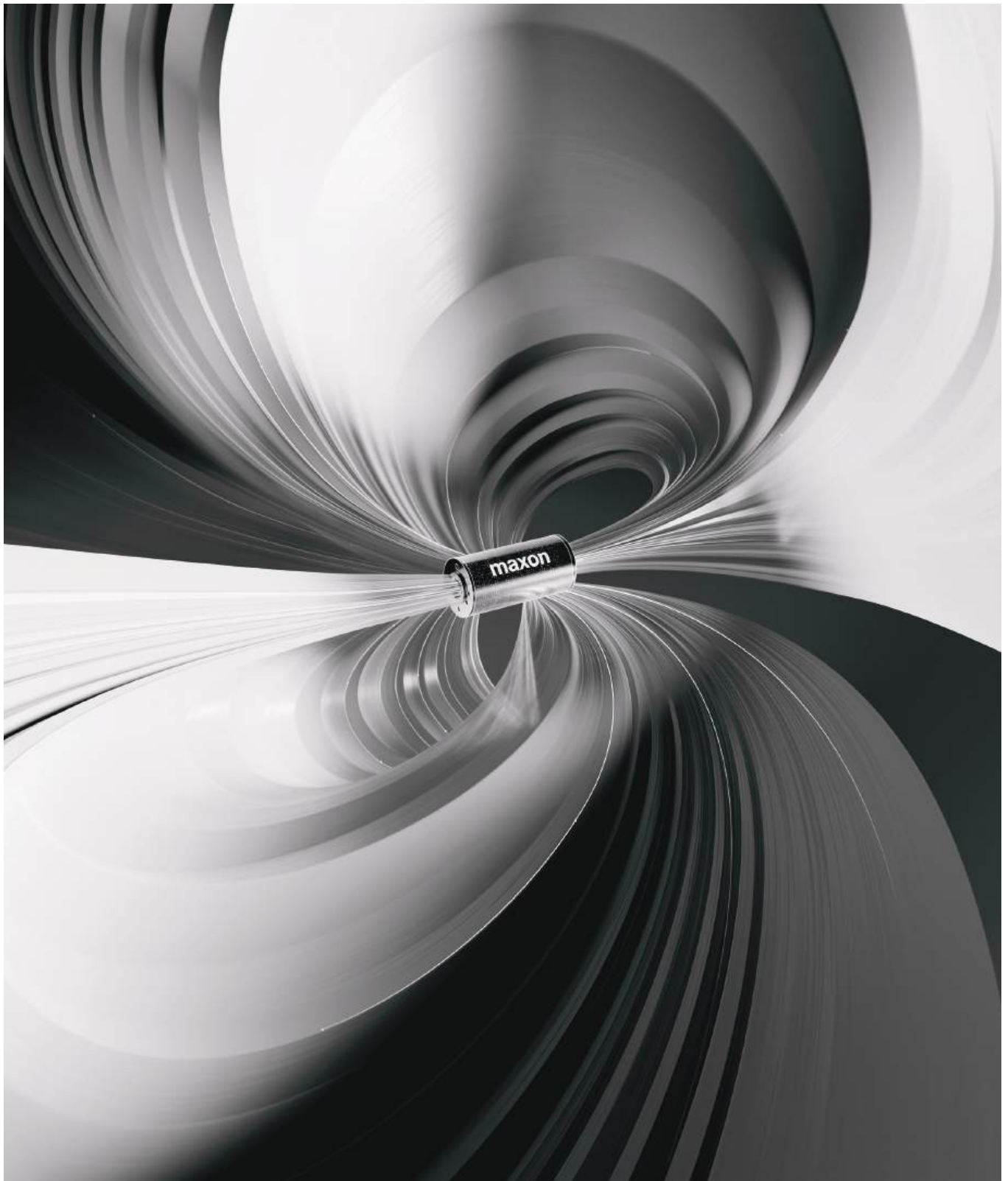# The motor
as a sensor

maxon MIND

motion insights and diagnostics

About maxon: The specialist for precision drive systems

maxon is a leading supplier of precision electric motors and drive systems, developing solutions tailored to the needs of customers in the medical, industrial automation, aerospace, mobility, and robotics sectors.

Founded in 1961, the Swiss company is owned by the Braun family and is headquartered in Sachseln (canton of Obwalden). The maxon Group employs around 3000 people at ten production sites worldwide and is represented in over 40 countries.

Briefly explained: This is maxon MIND

maxon MIND turns the motor into a sensor, making it a key component of innovative condition monitoring. Using machine learning, the system detects operational deviations at an early stage and provides precise condition analyses – for the entire drive system with its connected mechanical elements.

Customer benefits:

1. Early detection of wear and impending failures
2. On-demand condition analysis – with explainable insights
3. Simple, minimally invasive integration into existing systems
4. Low requirements for computing power and storage space
5. Integration with maxon Cloud via API

maxon MIND is easily scalable and works with standard components. The collected data remains anonymized and secure. maxon MIND is more than a product: it is a forward-looking service that makes a valuable contribution to predictive maintenance and efficient fleet management. On the following pages, we will introduce the system and explain how it works in more detail.

Table of contents

Contact

If you're interested in maxon MIND, feel free to contact our sales team at any time:
www.maxongroup.com/contact

maxon

maxon Group
Brünigstrasse 220, 6072 Sachseln
Switzerland
www.maxongroup.com

Imprint

maxon Newsroom
Corporate Marketing & Innovation

Overview

Benefits of maxon MIND

01

Real-time monitoring

maxon MIND enables regular real-time transparency of the operating condition of each connected drive system. Users can immediately assess drive data and detect deviations at the exact moment they occur, allowing for quick responses based on informed decisions.

02

Predictive alerts

maxon MIND provides early warnings about potential issues before they lead to critical failures. By detecting anomalies and wear trends at an early stage, maxon MIND supports proactive maintenance measures and helps prevent costly downtime.

03

Historical data & trend analyses

By accessing historical drive data, users can analyze long-term trends, identify recurring issues, and optimize system utilization. These continuous analyses support smarter maintenance planning and the ongoing improvement of operational strategies.

04

Fleet management

maxon MIND enables centralized management and monitoring of multiple drive systems at different locations through a unified integration layer with intuitive interfaces. Whether a few devices or a globally distributed fleet – users benefit from consistent system monitoring and centralized control.

05

Custom integration

maxon MIND can be individually integrated in various ways through the available interfaces. This ensures your application retains a consistent look and familiar user experience, while maxon MIND works for you in the background. Simple customization for any operational requirement.

Tailored solutions

No application is the same. That's why maxon MIND was developed with maximum flexibility. From the data acquisition process to model development, every element can be adapted to the specific use case.

Custom data models

The machine learning model is trained using the customer's relevant operational data. As a result, the predictions are based on the actual behavior of their systems – not on general assumptions. This leads to more precise, relevant, and immediately actionable insights.
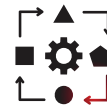
Individually adjustable parameters

maxon MIND adapts to your application: the machine learning models can be easily and seamlessly tailored to your requirements – ensuring that a condition warning truly is a warning. This creates a system that not only processes data but understands your reality. The result: precise responses to exactly what really matters in your applications.

Scalable system architecture

Whether you're monitoring a single device or an entire fleet – maxon MIND grows with your requirements. The system architecture can be flexibly configured for different levels of complexity.

Adaptation to the environment

For applications in demanding environments – such as cleanrooms, areas with strong vibrations, or temperature-sensitive zones – the sensitivity of maxon MIND can be precisely adjusted. And that's not all: maxon MIND can also intelligently map various influences on the same system. This ensures that maxon MIND operates reliably, safely, and precisely even under the highest demands.

How maxon MIND works

Software
The data is recorded on the
master controller. A small script ...

- ... triggers a diagnostic cycle
- ... generates relevant reference cycles
- ... records the motor signals
- ... enriches them with contextual data
- ... prepares them for analysis

Master Controller

Controller

Encoder

Gear

Motor

Initial situation
A machine equipped with a maxon drive system (motor,
gearbox, encoder, controller). The machine has a master
controller.

maxon MIND
motion insights and diagnostics

Step 3:
maxon MIND platform

Data processing
The data is transmitted to the cloud via a secure internet connection. In the cloud, the machine learning model analyzes the data and compares it with the reference state. This allows any deviation or anomaly to be immediately detected and flagged with a warning.

Step 4:
Integration

The collected data, condition analysis, and historical trends are accessed via an interface. This allows maxon MIND to integrate seamlessly into your dashboards and fleet management systems, offering full flexibility for integration and customization to meet your specific needs.

"The motor is the best sensor in the machine"

maxon MIND is a new offering from maxon. Claude Jaquemet, Business Development Manager Digital Business, provides insights here into the development and functionality of the system.

maxon MIND is an in-house innovation. How was the system developed internally?

Claude Jaquemet: Behind every advancement is a strong, interdisciplinary team, in this case consisting of people from Switzerland, Germany, and Australia. I took on the role of program lead, and together with our AI specialists we designed the technical solution. The project is the result of years of work.

What is the core idea behind maxon MIND?

Claude Jaquemet: The core principle is: the motor is the best sensor in the machine. The signals we read from the controller reflect the condition of the entire drive system and its environment. Therefore, maxon MIND plays a central role in diagnostics and condition-based maintenance of drive systems.

What use cases do you see for maxon MIND?

Claude Jaquemet: There are numerous possible applications for maxon MIND. During operation, condition monitoring is essential: it detects deviations and wear at an early stage, before they become problems. This can drastically reduce unplanned downtime and high consequential costs. Additionally, the system provides added value in service operations for applications where the actual device condition is crucial for maintenance planning.

What is the technical foundation of maxon MIND?

Claude Jaquemet: maxon MIND is based on explainable AI, which means every diagnosis and prediction is transparent and traceable. In safety-critical and highly regulated industries, this is not only desirable but essential. The machine learning model we developed requires only a small amount of data, runs on simple hardware, and integrates minimally into existing systems. This means fast implementation, low training effort, and no need for expensive GPU infrastructure. It enables cost-efficient new developments and straightforward retrofits — for a smart future without compromise.
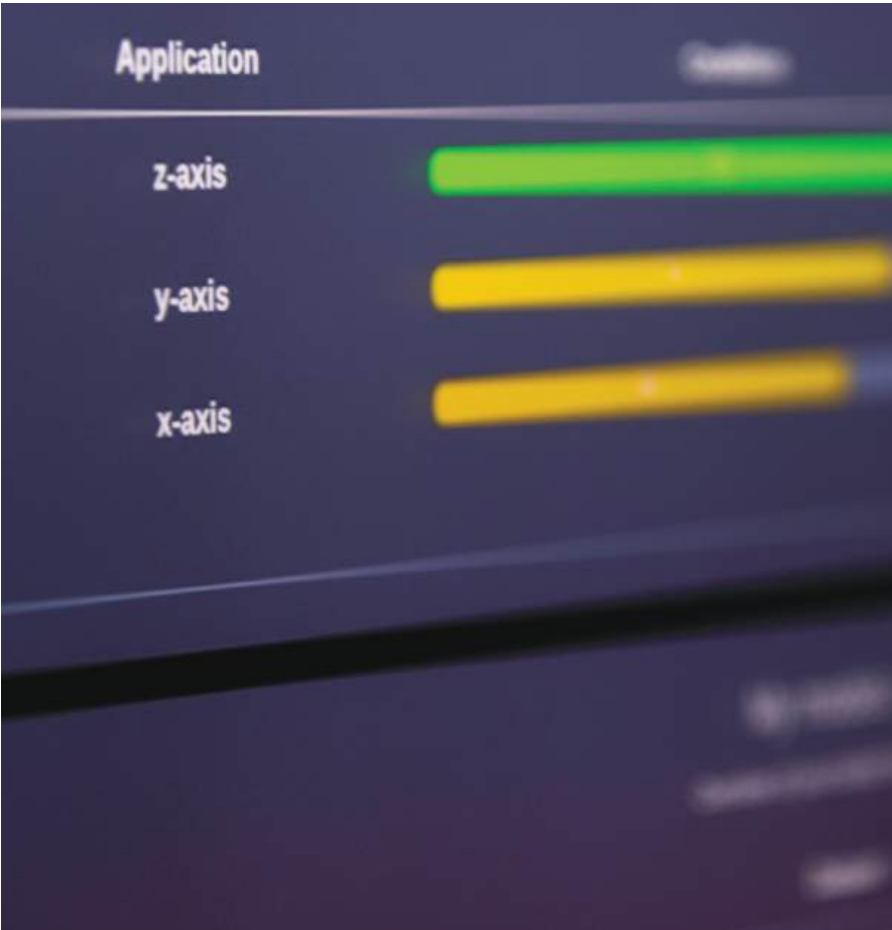
Why is maxon using machine learning here?

Claude Jaquemet: There are many different classes of machine learning — and we certainly didn't take the usual path here. Machine learning is essential for us because it can extract information from signals that often remain hidden. On the other hand, machine learning is often associated with massive data requirements, high computational demands, and expensive hardware. Our approach, however, builds models with fewer than 100 reference cycles, and diagnostics require fewer than 20 cycles. This means models can be created in less than 10 minutes, and condition diagnostics often in less than 1 minute. All of this is achieved without special hardware requirements in terms of computing power or memory.

Does the system learn from the motor in the customer's application?

Claude Jaquemet: Yes, it does. A

key feature of MIND is the integration of domain-specific expertise into the model. The physical relationships within a mechatronic system are directly incorporated into the modeling. This enables high prediction quality with minimal data requirements. The system also learns from the real-world application: at startup, an initial state is recorded that describes the motor in the context of its environment. During operation, new data is regularly fed in and compared with the model. The frequency of data acquisition is application-specific and agreed upon with the customer.

How important is the quality of the data?

Claude Jaquemet: Data quality plays a central role. To achieve valid results, the recorded signals must sufficiently represent the machine's operating condition. That's why maxon works closely with customers to define suitable measurement cycles. These may include standardized motion sequences that reflect typical load situations. This approach results in a model tailored to the customer's application — robust and capable of delivering reliable insights even under varying conditions.

How strong is customer interest in a system like maxon MIND?

Claude Jaquemet: Fortunately, interest is high — and it's coming from various directions. maxon MIND is especially in demand for applications where unexpected failures need to be detected early, such as to increase personal safety or minimize downtime. Our system also identifies issues that remain hidden in traditional testing. In production lines with multiple machines in sequence, maxon MIND can help detect even the smallest devia-

tions before they affect downstream processes.

maxon MIND collects condition data that is processed in the cloud. How is data privacy ensured?

Claude Jaquemet: Data privacy is a top priority for us. In addition to cloud safety and security services, we've integrated several privacy measures. When a machine sends data to the cloud, the customer can access and review it at any time via API. We also have access — but only to the data necessary for analysis. To uniquely identify the corresponding machine learning model, we require data that the customer can anonymize, except for the part number and serial number of the drive. This ensures that even after a machine configuration change, the underlying model continues to function reliably. We do not need sensitive or personal information. We don't need to know who the end customer is or what specific application is running. This keeps everything compliant with data protection and transparent.

How open is the maxon MIND platform for customers who want to create their own dashboards or integrate it into their own applications?

Claude Jaquemet: We planned for that from the beginning. We offer a dedicated API that allows customers to integrate the data into their own environment or ecosystem, such as for custom dashboards. This ensures that maxon MIND is not a closed solution, but one that integrates flexibly into existing systems.

What are the requirements for installing maxon MIND?

Claude Jaquemet: The platform is designed to be open. The solution is minimally invasive: existing motors, electronics, and controllers remain un-

Claude Jaquemet, Business Development Manager Digital Business.

changed. The only requirement is the installation of a software package on the master controller, which transmits the data — for example, using the MQTT protocol.

How long does the implementation phase take?

Claude Jaquemet: The preparation phase can vary depending on the customer's application. That's why we aim to fully understand the customer's use case. We clarify which use cases provide added value, what conditions need to be met, whether a specific API is required, and so on. This initial phase is crucial. Once everything is clarified, the actual implementation is quick: if the machine is already connected to the internet and the controller has the additional computing power needed for data acquisition, the system can be put into operation within a few days.

/01
Consulting and
requirements analysis

The integration begins with a detailed consultation to understand system architecture, operational goals, and data environment. Our experts work closely with your team to identify the relevant parameters for monitoring – such as load profiles, usage cycles, and environmental conditions. This ensures that maxon MIND is aligned with your real-world application from the very beginning.
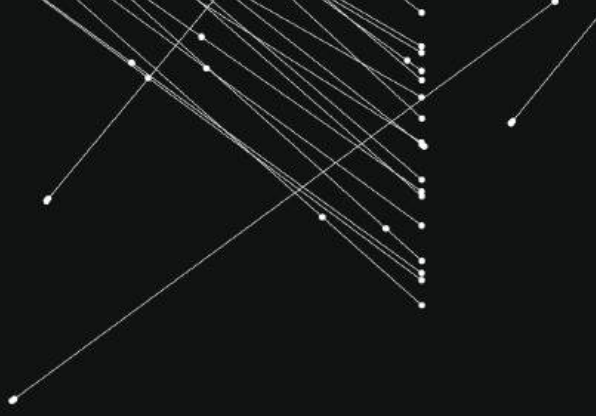
/02
Solution design
and prototyping

Based on your requirements, we ensure that the maxon MIND system is configured to capture the right data and support your desired outcomes. Whether you are integrating maxon MIND into an existing system or developing a new platform – we support rapid prototyping and early testing to ensure system compatibility and performance.

This is how maxon MIND is implemented at our customers

The integration of maxon MIND into your application follows maxon's customer-oriented and collaborative philosophy. We understand that every application has its own operational context. Our integration process is designed with this in mind – so that condition monitoring can be tailored to your specific requirements.

/03
System testing
and validation

After implementation, maxon MIND undergoes extensive testing to ensure it delivers precise and actionable insights. We support you in validating the system under real operating conditions, refining data acquisition strategies, and calibrating model behavior according to your specific application.

/04
Final implementation
and optimization

The final integration includes fine-tuning the system for optimal performance. This may involve adjusting model parameters or reference cycles. The result is a fully integrated, intelligent monitoring solution that increases reliability, reduces downtime, and evolves with your system over time.

Use cases for maxon MIND

Here we present possible applications for maxon MIND. These are examples – of course, our solution can also be used in other areas where maxon drive systems are in operation.

Medical devices

→ Ensuring operational readiness in life-critical systems: In medical technology, even brief interruptions can jeopardize patient safety. maxon MIND enables early detection of anomalies in drive systems used in surgical, diagnostic, and life-support devices.

→ Fleet-wide monitoring for increased safety: With maxon MIND, manufacturers and service teams can monitor entire fleets of medical devices in real time – for greater reliability, fewer emergency interventions, and improved compliance with regulatory requirements.

Industrial automation

→ Avoiding downtime on the production line: In high-throughput environments, the failure of a single motor can bring the entire operation to a halt. maxon MIND provides real-time insights that help detect wear early and prevent failures before they disrupt production.

→ Intelligent maintenance, lower costs: By predicting failures and optimizing maintenance intervals, maxon MIND helps reduce unplanned downtime, minimize spare parts consumption, and improve overall equipment effectiveness (OEE).

Laboratory automation

→ Protecting sensitive workflows: In automated laboratory systems, the reliability of the drives is crucial for sample integrity and throughput.

→ Data-driven optimization: With historical trend analysis and predictive alerts, laboratories can fine-tune system performance, reduce maintenance efforts, and ensure consistently high quality.

Precision Drive Systems

www.maxongroup.com