Application Guide for Predictive Maintenance Solutions
For Digital device production

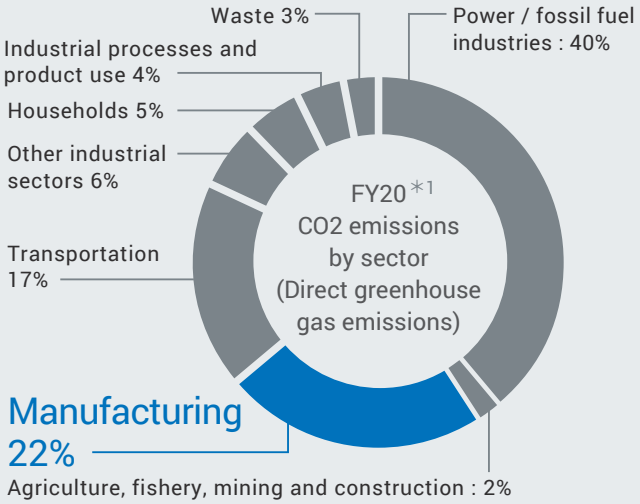
Solutions for Total Facility Condition and Trend Monitoring

Problems in Manufacturing Sector

Why the Manufacturing Sector Should Work Toward Carbon Neutrality

According to investigation by Japan's National Institute for Environmental Studies, manufacturing accounts for 22 % of the world's energy-related CO2 emissions.*1 This is a sizable share, indicating carbon neutrality efforts in the manufacturing sector can greatly impact total CO2 emission levels. Factories in particular, with their massive power consumption and industrial waste, are a major source of CO2 emissions, and in urgent need of improvement."Without initiatives taken to achieve carbon neutrality, there is a risk of corporate value being lost and negative impact on business. Therefore, achieving carbon neutrality is our corporate mission.

*1. Created based on the data from the Greenhouse Gas Inventory Office of Japan, National Institute for Environmental Studies



- Power / fossil fuel sector: Expand use of renewable energy
- Transportation sector: Use renewable energy, e.g. by using electric vehicles
- Manufacturing and building sectors: Implement rigorous energy conservation measures, use renewable energy

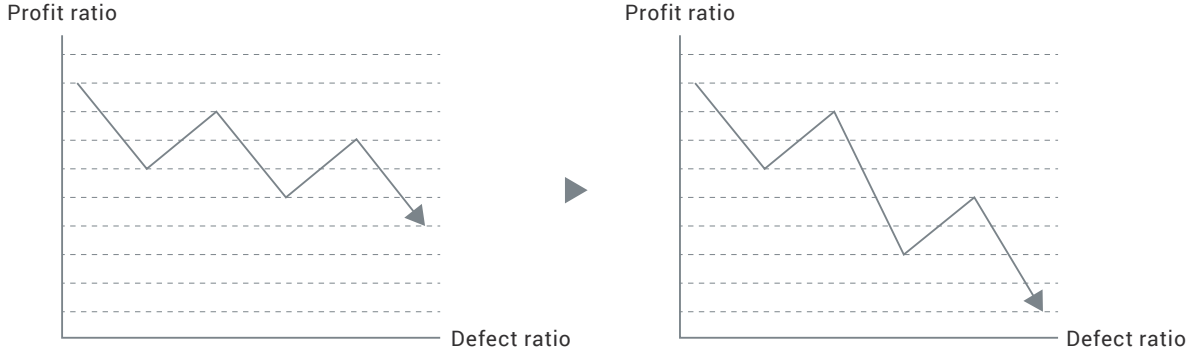
Conserving Energy Through Predictive Maintenance

Predictive maintenance allows you to effectively cut energy usage by reducing the frequency of failures and automating the equipment inspection process. According to "Economics of Manufacturing Machinery Maintenance" (June 2020) by Douglas S. Thomas and Brian A. Weiss, adopting predictive maintenance would be effective in reducing 0.8 billion USD of defects and 18.1 billion USD of downtime.*2 This improves machine throughput, profitability and reduces the impact on the environment

*2. References:NIST Advanced Manufacturing Series 100-34, Economics of Manufacturing Machinery Maintenance , Douglas S. Thomas, Brian A. Weiss, June 2020
https://www.nist.gov/el/applied-economics-office/manufacturing/topics-manufacturing/manufacturing-machinery-maintenance
https://nvlpubs.nist.gov/nistpubs/ams/NIST.AMS.100-34.pdf

Improvement of production time value with increased functional sophistication

As society changes drastically due to factors such as digitalization and the impact of the COVID-19 pandemic, the spread of digital equipment is accelerating. As miniaturization and sophistication continue to progress, there is greater demand at production sites than ever before for the realization of high-speed, high-precision controls for items that are difficult to manufacture, and stable operation to maintain production capacity is becoming even more important. In areas that have conventionally been handled with corrective maintenance or preventive maintenance, the increased sophistication of parts being produced brings increased added value, and there will be a shift to a structure that directly connects operation rate and yield rate to profit ratio. The realization of constantly operating equipment not only ensures profit for one's own company but is also an indicator of a supplier that is highly regarded by society as a whole, and the company will therefore likely receive more and more demand from clients.



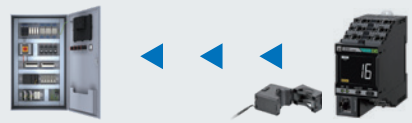
Defect ratio will come to have a greater impact on profit ratio

Omron's Predictive Maintenance Solutions

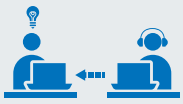
Implement preditive maintenance on existing equipment by easy retrofitting

All of our of production equipment is in an optimized state for manufacturing and ensures waste-free, consistent manufacturing. Adding functions to equipment takes a lot of time and expense due to remodeling and construction work, etc. There is also a risk that remodeling will affect conventional functionality, and the addition of predictive maintenance functions is not actively implemented. With OMRON's Predictive Maintenance solutions, these issues are tackled by means of retrofitting that takes into account the need for post-installation. This is not a case of simply adding retrofit functionality to existing equipment. Rather, it incorporates design tailored to the activities of the maintenance personnel who bear the responsibility for carrying out the important task of maintenance.

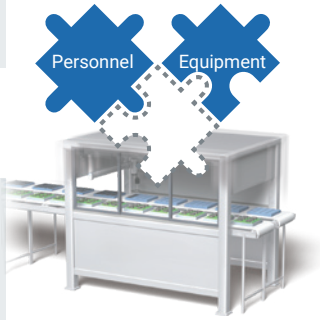
Setting Easy installation



Testing Easy verification



- Remote verification support
- Startup Guide
- Verification support video



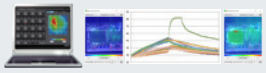
Design Quick design

Support for industry-standard networks

EtherNet/IP Modbus

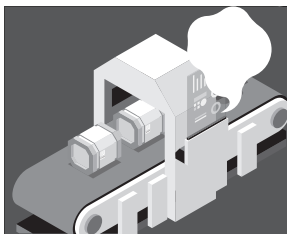
Operation Efficient operation

Monitoring tools and analysis software are also available



Improvements

BEFORE



Equipment is in a full operation state to meet market demands. Any sudden stoppage has a huge impact in terms of lost business opportunities and the trust of clients. Even when preventive maintenance is implemented, it is impossible to completely eliminate defects resulting from various factors, and there is always the risk of sudden stoppage.

AFTER

Without remodeling existing equipment, condition monitoring devices are easy to retrofit, enabling data collection, analysis and decisions to be made purely using on-site devices. Long halts can be avoided and stable operation can be implemented by using predictive maintenance to ascertain the condition of equipment degradation.

Amount of opportunity loss

As more and more sophisticated products are being manufactured, operating rate and yield rate will become more directly connected to profit ratio. Even a one-hour halt in production leads to huge opportunity loss.

Long halt (1 hour)
Approx. US$120,000 (per occasion)

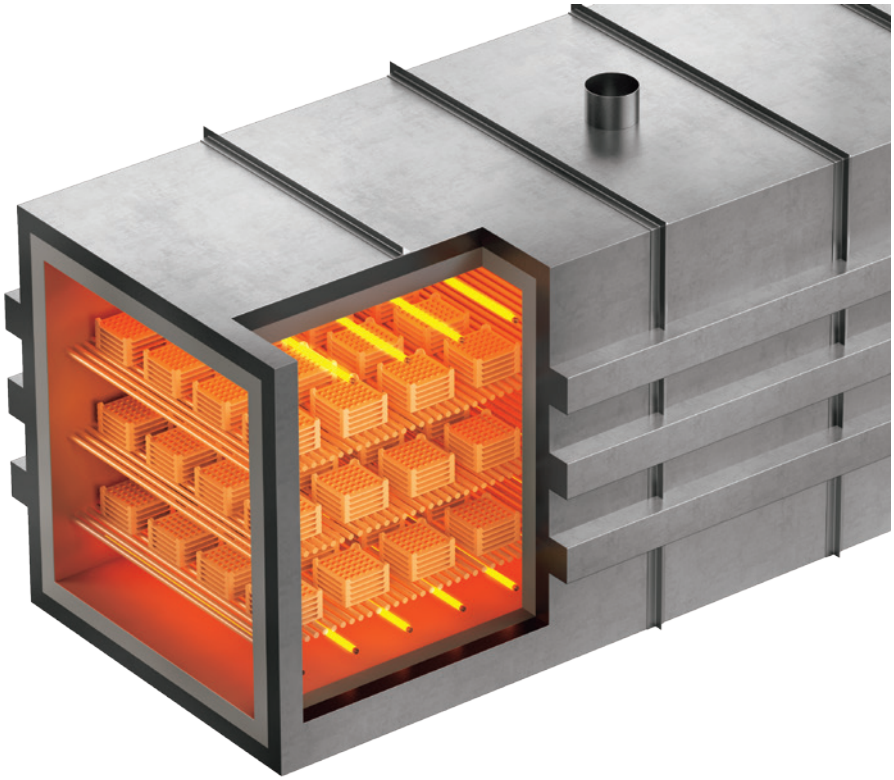
Basis of calculation
- Product unit price US$20
  production capacity 100 units/min.

*Excluding various expenses
*Not including cost of faulty parts and repairs, etc.

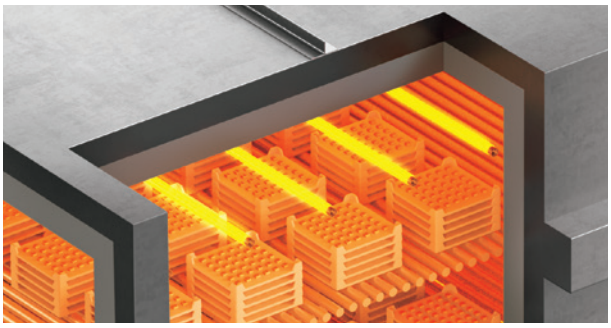
Total condition monitoring for firing equipment

In the manufacturing process of semiconductors and electronic parts, which requires great precision, quality management requires precise control of ambient temperature even in firing furnaces, transport speed, and other elements. There is also increasing need for equipment condition monitoring due to the lengthy downtime incurred when equipment defects occur.

Monitoring Target
Heater,
transport conveyor motor,
transport chain,
DC power supply,
control panel,
blower motor



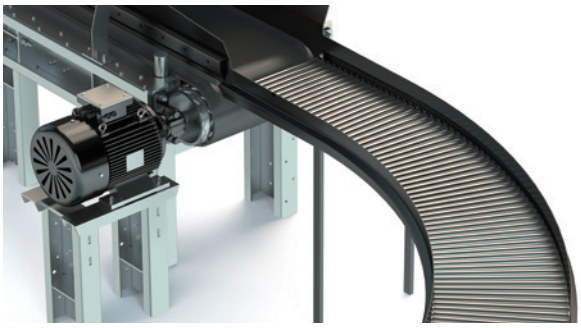
Monitoring for signs of heater burn-out



Heater Condition Monitoring Device
K7TM

Error Mode	Quality defects in electronic parts due to heater burn-out
Detection principle	Firing furnaces operate 24 hours a day, so the power supply can never be switched off. This means that heater degradation due to oxidization is accelerated and resistances values increase, which can be detected with heater condition monitoring devices
Implementation effects	Downtime resulting from sudden heater burn-out can be reduced. Also contributes to prevention of quality defects that may occur when furnace temperature profile changes due to heater burn-out

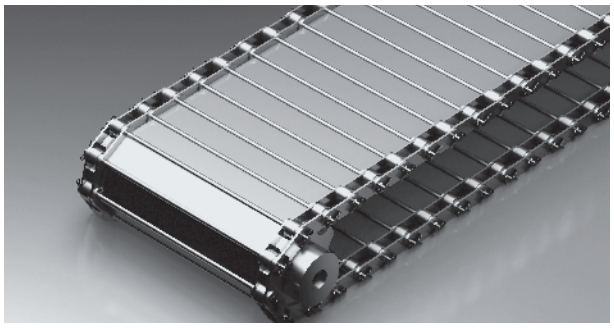
Transport conveyor motor insulation degradation monitoring



Insulation Resistance Monitoring Device
K7GE-MG

Error Mode	Excessive heat treatment of work due to conveyor stoppage
Detection principle	When there is heat or environmental impact, motor insulation resistance values change, so this can be detected with insulation resistance monitoring devices
Implementation effects	Trend monitoring in insulation, which are difficult to ascertain purely by human intuition, can be monitored by periodically measuring motor insulation resistance values. Also contributes to preventing sudden equipment stoppage thanks to ability to make scheduled replacements

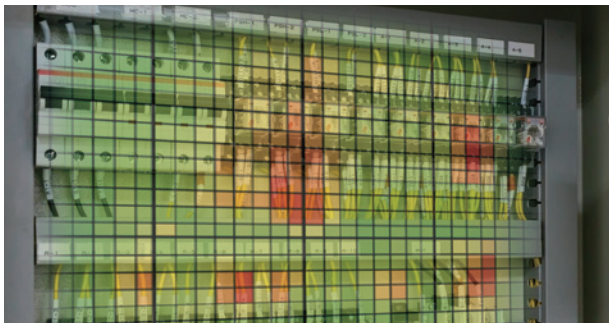
Transport chain conveyor abnormality monitoring



Advanced Motor Condition Monitoring Device
K7DD

Error Mode	Grease running out or presence of foreign matter in transport chain conveyor gears
Detection principle	Load changes fluctuate with the presence of foreign matter and grease running out. Multiple load change patterns for each motor can be detected with a single advanced motor condition monitoring device
Implementation effects	Even failure modes can be specified, so maintenance workload can be reduced. Also contributes to preventing sudden equipment stoppages, since scheduled maintenance can be performed in line with the condition of chain conveyor degradation

Firing furnace abnormal heat monitoring



Thermal Condition Monitoring Device
K6PM-TH

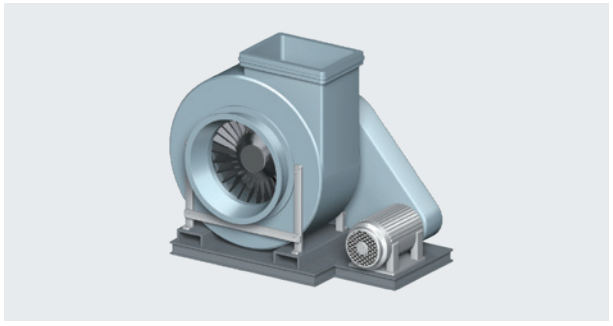
Error Mode	Fire due to abnormal heat generation of firing furnace panel transformer
Detection principle	Surface-wide temperature monitoring of abnormal heat generation of a device (transformer) inside the panel can be achieved using contact-free infrared sensors
Implementation effects	Frequency of inspections can be reduced by using a thermo viewer. Constant surface temperature monitoring contributes to reduced fire risk thanks to ability to take measures before abnormal heat generation occurs

Monitoring of replacement timing for sensors and control device DC power supplies

Switching Power Supply
S8VK-X

Error Mode	DC power supply failure due to age-related degradation
Detection principle	DC power supplies often reach the end of their life due to a decline in the capacity of internal condensers, and the speed of capacity decline changes significantly depending on the temperature of the usage environment. Timing for replacement can be detected by measuring internal condenser temperature and calculating capacity decline
Implementation effects	Output condition of power supply load can be ascertained, which makes it possible to reduce verification workload. Contributes to prevention of sudden equipment stoppage by enabling scheduled replacement with visualization of timing for replacement

Blower motor degradation monitoring



Motor Condition Monitoring Device
Vibration and Temperature type
K6CM-VB

Error Mode	Motor breakdown due to bearing failure (grease degradation or scratches)
Detection principle	When there is abnormal load applied on bearings, the orbital plane is separates, producing roughness, and smooth rotation is no longer possible, resulting in high-frequency oscillation. Since oscillation in the order of kHz can be measured, this can be detected with motor condition monitoring devices (oscillation and temperature monitoring devices)
Implementation effects	Scheduled maintenance is enabled by visualization of bearing degradation condition. Contributes to reduction of expenses for disposal of works inside firing furnaces thanks to ability to prevent sudden motor failure

Total condition monitoring for film formation equipment

Film formation processes increase due to process shrinking and increased lamination layers, which are key to improving semiconductor performance. In addition to the increased sophistication of film formation technology, there is also an increasing need for condition monitoring aimed at improving productivity and film formation quality.

Monitoring Target
Vacuum pump motors, coolant circulation pump motors, heaters, DC power supplies, control panels, transport conveyors

Vacuum pump motor wear monitoring device

Advanced Motor Condition Monitoring Device
K7DD

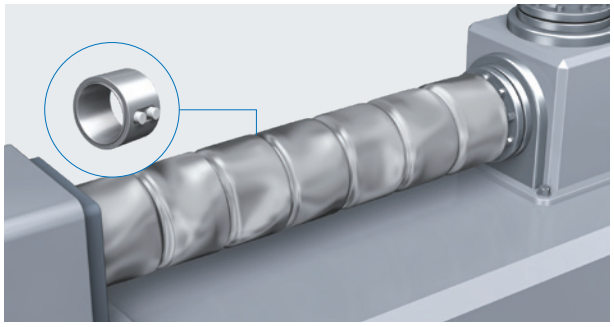
Error Mode	Pump operation stoppage due to meshing of vacuum pump gears
Detection principle	Load fluctuation of pump gear meshing due to accumulation of foreign matter can be ascertained, so this can be detected with advanced motor condition monitoring devices
Implementation effects	Contributes to prevention of film formation quality defects, since scheduled maintenance can be performed by ascertaining the condition of degradation caused by accumulation of foreign matter in vacuum pump gears

Vacuum pump insulation degradation monitoring

Insulation Resistance Monitoring Device
K7GE-MG

Error Mode	Equipment stoppage due to pump motor insulation degradation
Detection principle	When there is heat or environmental impact, motor insulation resistance values change, so this can be detected with insulation resistance monitoring devices
Implementation effects	Trend monitoring in insulation, which are difficult to ascertain purely by human intuition, can be monitored by periodically measuring motor insulation resistance values. Contributes to reduced person-hours thanks to automation of periodic inspections using insulation tester

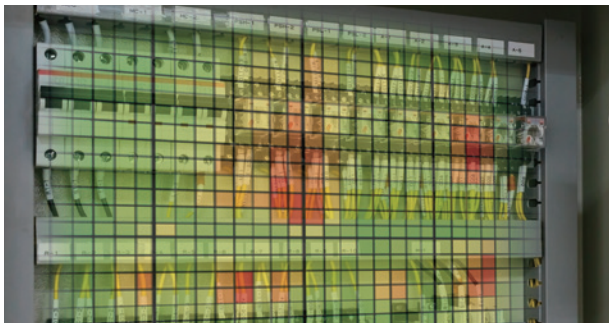
Monitoring for signs of heater burn-out



Heater Condition Monitoring Device
K7TM

Error Mode	Work desiccation defects due to heater burn-out
Detection principle	When a resistance heating-type heater is used for many years, oxidization progresses and fragility ensues, leading to increased resistance values, so this can be detected with heater condition monitoring devices
Implementation effects	Scheduled maintenance is enabled by visualization of heater degradation condition. Therefore, downtime resulting from sudden heater burn-out can be reduced. Also contributes to prevention of work quality defects resulting from uneven drying caused by heater burn-out

Firing furnace abnormal heat monitoring



Thermal Condition Monitoring Device
K6PM-TH

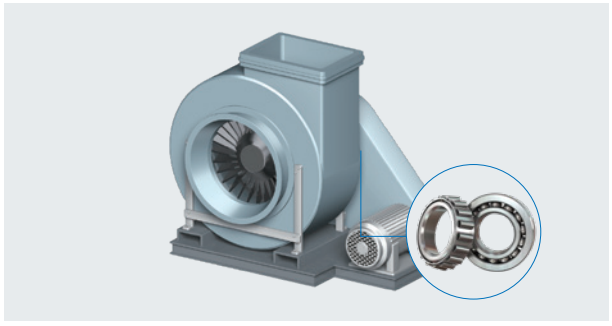
Error Mode	Fire due to abnormal heat generation of firing furnace panel transformer
Detection principle	Surface-wide temperature monitoring of abnormal heat generation of a device (transformer) inside the panel can be achieved using contact-free infrared sensors
Implementation effects	Frequency of inspections can be reduced by using a thermo viewer. Constant surface temperature monitoring contributes to reduced fire risk thanks to ability to take measures before abnormal heat generation occurs

Monitoring of replacement timing for sensors and control device DC power supplies

Switching Power Supply
S8VK-X

Error Mode	DC power supply failure due to age-related degradation
Detection principle	DC power supplies often reach the end of their life due to a decline in the capacity of internal condensers, and the speed of capacity decline changes significantly depending on the temperature of the usage environment. Timing for replacement can be detected by measuring internal condenser temperature and calculating capacity decline
Implementation effects	Output condition of power supply load can be ascertained, which makes it possible to reduce verification workload. Contributes to prevention of sudden equipment stoppage by enabling scheduled replacement with visualization of timing for replacement

Gas exhaust blower motor degradation monitoring



Motor Condition Monitoring Device
Vibration and Temperature type
K6CM-VB

Error Mode	Motor breakdown due to bearing failure (grease degradation or scratches)
Detection principle	When there is abnormal load applied on bearings, the orbital plane is separates, producing roughness, and smooth rotation is no longer possible, resulting in high-frequency oscillation. Since oscillation in the order of kHz can be measured, this can be detected with motor condition monitoring devices (oscillation and temperature monitoring devices)
Implementation effects	The skills of maintenance personnel with a stethoscope rod an the like can be digitalized to enable simple trend monitoring. Contributes to prevention of sudden motor failure by enabling scheduled maintenance with the visualization of bearing degradation condition

Total condition monitoring for etching equipment

Etching is becoming ever more difficult and the need for etching equipment is increasing due to process shrinking and increased lamination layers, which are key to improving semiconductor performance. Therefore, equipment condition monitoring is essential for advanced etching technology and quality assurance.

Monitoring Target
Vacuum pump motors, coolant circulation pump motors, heaters, DC power supplies, control panels, transport conveyors

Vacuum pump motor wear monitoring device

Advanced Motor Condition Monitoring Device
K7DD

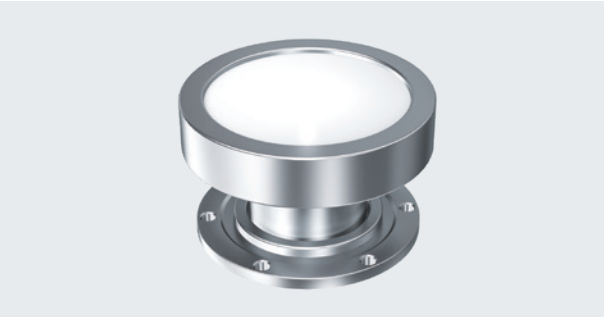
Error Mode	Pump operation stoppage due to meshing of vacuum pump gears
Detection principle	Load fluctuation of pump gear meshing due to accumulation of foreign matter can be ascertained, so this can be detected with advanced motor condition monitoring devices
Implementation effects	Contributes to prevention of film formation quality defects, since scheduled maintenance can be performed by ascertaining the condition of degradation caused by accumulation of foreign matter in vacuum pump gears

Vacuum pump insulation degradation monitoring

Insulation Resistance Monitoring Device
K7GE-MG

Error Mode	Equipment stoppage due to pump motor insulation degradation
Detection principle	When there is heat or environmental impact, motor insulation resistance values change, so this can be detected with insulation resistance monitoring devices
Implementation effects	Trend monitoring in insulation, which are difficult to ascertain purely by human intuition, can be monitored by periodically measuring motor insulation resistance values. Contributes to reduced person-hours thanks to automation of periodic inspections using insulation tester

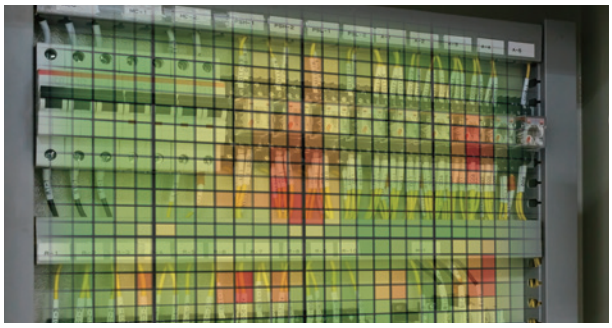
Monitoring for signs of stage heater burn-out



Heater Condition Monitoring Device
K7TM

Error Mode	Work desiccation defects due to heater burn-out
Detection principle	When a resistance heating-type heater is used for many years, oxidization progresses and fragility ensues, leading to increased resistance values, so this can be detected with heater condition monitoring devices
Implementation effects	Scheduled maintenance is enabled by visualization of heater degradation condition. Therefore, downtime resulting from sudden heater burn-out can be reduced. Also contributes to prevention of work quality defects resulting from uneven drying caused by heater burn-out

Control panel abnormal heat monitoring



Thermal Condition Monitoring Device
K6PM-TH

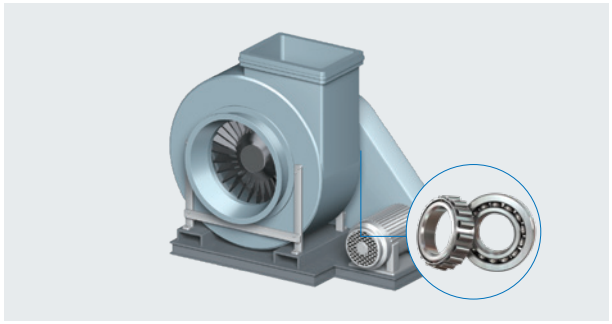
Error Mode	Fire due to abnormal heat generation of firing furnace panel transformer
Detection principle	Surface-wide temperature monitoring of abnormal heat generation of a device (transformer) inside the panel can be achieved using contact-free infrared sensors
Implementation effects	Frequency of inspections can be reduced by using a thermo viewer. Constant surface temperature monitoring contributes to reduced fire risk thanks to ability to take measures before abnormal heat generation occurs

Monitoring of replacement timing for sensors and control device DC power supplies

Switching Power Supply
S8VK-X

Error Mode	DC power supply failure due to age-related degradation
Detection principle	DC power supplies often reach the end of their life due to a decline in the capacity of internal condensers, and the speed of capacity decline changes significantly depending on the temperature of the usage environment. Timing for replacement can be detected by measuring internal condenser temperature and calculating capacity decline
Implementation effects	Output condition of power supply load can be ascertained, which makes it possible to reduce verification workload. Contributes to prevention of sudden equipment stoppage by enabling scheduled replacement with visualization of timing for replacement

Blower motor degradation monitoring



Motor Condition Monitoring Device
Vibration and Temperature type
K6CM-VB

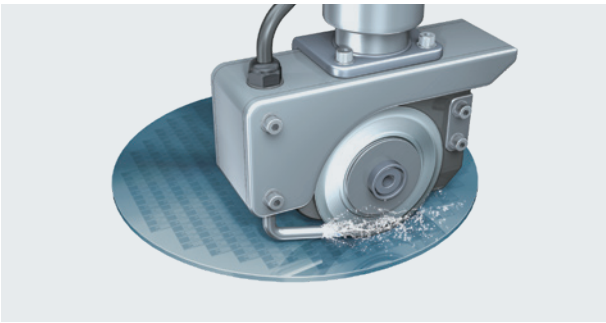
Error Mode	Motor breakdown due to bearing failure (grease degradation or scratches)
Detection principle	When there is abnormal load applied on bearings, the orbital plane is separates, producing roughness, and smooth rotation is no longer possible, resulting in high-frequency oscillation. Since oscillation in the order of kHz can be measured, this can be detected with motor condition monitoring devices (oscillation and temperature monitoring devices)
Implementation effects	Scheduled maintenance is enabled by visualization of bearing degradation condition. Contributes to reduction of expenses for disposal of works inside firing furnaces thanks to ability to prevent sudden motor failure

Total condition monitoring for dicing sew

Semiconductor wafers, which are essential for semiconductor manufacturing, are tending to adopt larger apertures. While cost is being reduced with the increase of chip yield per wafer, there is also increased impact in cases if disposal due to equipment failure, etc., so condition monitoring is important for stable production.

Monitoring Target
Dicing tools,
machining motor,
machining stage,
DC power supply,
lamination process,
oolant circulation pump

Dicing tool abnormal condition monitoring



Advanced Motor Condition
Monitoring Device
K7DD

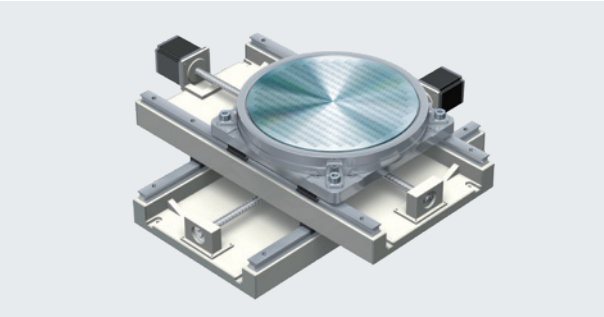
Error Mode	Wear and breakage of dicing tools causes quality of cut and processed goods to decline
Detection principle	Can be detected with advanced motor condition monitoring device by ascertaining patterns
Implementation effects	Contributes to reduced risk of work quality decline, since scheduled maintenance can be performed in line with condition of dicing tool degradation

Machining motor insulation degradation monitoring

Insulation Resistance
Monitoring Device
K7GE-MG

Error Mode	Electric shock accidents and fire caused by short circuit due to degradation of machining motor insulation
Detection principle	When coolant or sawdust penetrate the inside of a motor, the insulation resistance value of the motor changes, so it is possible to detect this with insulation resistance monitoring devices
Implementation effects	Trend monitoring in insulation, which are difficult to ascertain purely by human intuition, can be monitored by periodically measuring motor insulation resistance values. Also contributes to preventing sudden equipment stoppage thanks to ability to make scheduled replacements

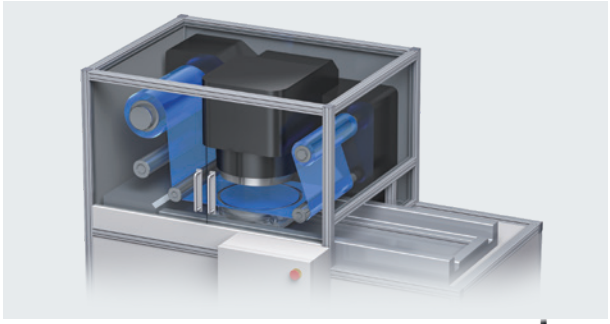
Detection of machining stage cut metal chip jamming



Advanced Motor Condition Monitoring Device
K7DD

Error Mode	Operational failure due to foreign matter in ball screws or grease running out
Detection principle	Load change varies depending on abnormality mode, such as foreign matter biting or grease running out, etc. By capturing these load change abnormalities, this can be detected with a single advanced motor condition monitoring device
Implementation effects	Even failure modes can be specified, so maintenance workload can be reduced. Also contributes to preventing occurrence of defective products, since stable operating condition of machining stage can be monitoredt

Lamination process monitoring



Motor Condition Monitoring Device
Vibration and Temperature type
K6CM-VB

Error Mode	Lamination quality defects due to drop in wafer temperature
Detection principle	Surface-wide temperature monitoring of wafer surface temperature can be achieved using contact-free infrared sensors
Implementation effects	Monitoring wafer surface temperature contributes to reduction of production loss in lamination processes

Monitoring of replacement timing for sensors and control device DC power supplies

Switching Power Supply
S8VK-X

Error Mode	DC power supply failure due to age-related degradation
Detection principle	DC power supplies often reach the end of their life due to a decline in the capacity of internal condensers, and the speed of capacity decline changes significantly depending on the temperature of the usage environment. Timing for replacement can be detected by measuring internal condenser temperature and calculating capacity decline
Implementation effects	Output condition of power supply load can be ascertained, which makes it possible to reduce verification workload. Contributes to prevention of sudden equipment stoppage by enabling scheduled replacement with visualization of timing for replacement

Blower motor degradation monitoring

Motor Condition Monitoring Device
Vibration and Temperature type
K6CM-VB

Error Mode	Motor breakdown due to bearing failure (grease degradation or scratches)
Detection principle	When there is abnormal load applied on bearings, the orbital plane is separates, producing roughness, and smooth rotation is no longer possible, resulting in high-frequency oscillation. Since oscillation in the order of kHz can be measured, this can be detected with motor condition monitoring devices (oscillation and temperature monitoring devices)
Implementation effects	Scheduled maintenance is enabled by visualization of bearing degradation condition. Contributes to reduction of expenses for disposal of works inside firing furnaces thanks to ability to prevent sudden motor failure

Product Lineup for Omron's Predictive Maintenance Solutions

Advanced Motor Condition Monitoring Device
K7DD

Cat. No.N235-E1

Motor Condition Monitoring Device
K6CM Series

Cat. No.N220-E1

Insulation Resistance Monitoring Device
K7GE

Cat. No.N226-E1

Thermal Condition Monitoring Device
K6PM

Cat. No.H232-E1

Heater Condition Monitoring Device
K7TM

Cat. No.N229-E1

Switching Power Supply
S8VK-X

Cat. No.T211-E1

Note: Do not use this document to operate the Unit.

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