Artificial Intelligence
Machine Automation Controller

NX701-Z00 / NY52-Z00

Machine learning and Optimization on the edge
Get your machine data out of the cloud
Manufacturing is rapidly advancing, and the world is facing a shrinking labor force and a shortage of skilled workers. Omron is helping to build a factory of the future where people and machines work in harmony by using AI and Machine Learning technologies at the Edge level and migrating tacit knowledge – such as the intuition of experienced operators – into explicit knowledge.

**Optimize your overall equipment effectiveness**

- Reduce equipment stops
- Maximize equipment performance
- Ensure product quality

The artificial intelligence machine automation controller (AI Controller) integrates state-of-the-art machine learning functionality into an Edge level industrial controller, allowing you to leverage machine level information in real time to prolong equipment life and improve product quality. The controller learns the data patterns of nominal machine behavior without being explicitly programmed, so that anomalies can be detected and acted upon immediately.

Leverage the expanding Sysmac Library available from Omron, based on data science and research, avoiding costly development of in-house analytics and optimization capabilities, as well as custom solutions.
Find the economic optimum point for machine maintenance

Make data-driven maintenance decisions

Each machine is unique and critical to production. The AI Controller learns from each machine to help move from scheduled and reactive maintenance toward status-based maintenance when it is truly necessary.

Current: Scheduled and reactive maintenance

Skilled engineers perform maintenance based on their intuition and experience regularly or after failure has occurred (time-based maintenance).

With AI Controller: Status-based maintenance

AI Controller monitors machine status using machine data. Maintenance is performed based on machine status when the data shows leading indicators through Anomaly Detection.

Benefits expected from status-based maintenance

1. Minimized downtime reduces production losses
2. Just-in-time maintenance reduces reactive costs
3. Replacing components only when necessary reduces stock of components
4. Error locations can be identified following leading indicators
5. Maintenance work can be standardized and skilled engineers can create new value
Predictive maintenance procedure using AI

Step 1  Generating a learning model
A learning model including a threshold value is generated from current machine data. (Nominal machine behavior is learned.)

Step 2  Monitoring the machine
Machine data is monitored based on the learning model. If the specific features exceed the threshold value, a notification is issued.

Step 3  Setting a new threshold value
The machine status is checked. If no error is found, a new threshold value is set.

Step 4  Maintenance performed
Programmatically determine what maintenance is required, including component replacement.

Step 5  Generating a learning model with new components
A new learning model including the threshold value is generated based on the previous error level after components are replaced. Repeating these steps makes status-based maintenance more reliable.
Detect machine anomalies quickly and accurately

By integrating the machine learning engine within the machine controller, the AI Controller enables the highest speed and security of data processing. Anomalies can be accurately detected in milliseconds.

Detection comparison between AI and conventional method
(time-series data such as voltage and current)

<table>
<thead>
<tr>
<th>Nominal machine behavior</th>
<th>Anomalous machine behavior</th>
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</thead>
<tbody>
<tr>
<td><strong>Threshold detection by program</strong></td>
<td><strong>Pattern detection by human eye</strong></td>
</tr>
<tr>
<td>Measured value</td>
<td>Measured value</td>
</tr>
<tr>
<td>Time</td>
<td>Time</td>
</tr>
<tr>
<td>Program Cannot detect changes that occur below the threshold value</td>
<td>Human eye Cannot detect minute changes that the human eye cannot distinguish</td>
</tr>
</tbody>
</table>

Functions to detect quickly and accurately

High-speed Time Series Database Function

Collection and storage of time-series data are fully synchronized with the control cycle. The periodically sampled data is used to understand machine behavior, enabling creation of accurate learning models and judgment. Moreover, data can optionally be saved to external Host, feeding enterprise level IoT systems and advanced analysis.
Machine learning for anomaly detection

Data collection
Time-series data collection, feature value creation

Data analysis
Mining, machine learning

Data utilization
Real-time monitoring and action

Features values are generated from data gathered from the real-world machine in production

Features with highest correlation to anomalies are extracted. A machine learning model is generated from the analysis results

The machine learning model is transferred to the AI controller. Machine status is monitored in real time.

Ultra-high-speed Machine Learning engine

The AI Machine Learning engine provides both speed and accuracy. Omron developed this unique technology based on the Isolation Forest machine learning engine, which is ideal for real-time processing, and fine-tuned it to increase detection accuracy. The algorithm is applicable to multimodal data and can be used for high-mix production lines where two or more operating modes are required.

Ultra-high-speed AI engine can calculate in several milliseconds

One machine learning model can discriminate multiple operating modes

Up to 16 feature dimensions
The AI Predictive Maintenance Library

Pre-made machine learning models
to detect anomalous machine behavior

The AI Predictive Maintenance Library, a collection of Omron developed Function Blocks specific to the AI Controller, calculates optimal feature values to judge real-world machine mechanism behavior.

Robustness minimizes effects of environmental changes

Through research and data science, Omron machine learning models have been designed to minimize the effects of environmental change using specific feature values, helping to stabilize predictive maintenance activities.

※The above results were obtained under Omron’s test conditions. The same results are not guaranteed for all conditions.
System configuration

**AI Controller Software utilities**
- **Configuration tool**
- **Visualization tool**
- **AI Operator**
- **Visualization tool**
- **AI Viewer**

**NY Series**
- AI Controller software utilities are pre-installed in Windows on the NY Series
  - AI Operator
  - AI Viewer

**NX Series**
- Install the AI controller software utilities on the host computer
  - AI Operator
  - AI Viewer

**AI controller**
- Time Series Database Function
- Feature Value/Machine Learning Function
- WebAPI Connection Function

**AI Predictive Maintenance Library**

**EtherCAT slaves**

**Optimal web server connection for additional analysis**

- Web server
- Proxy server, DNS server, etc.
- Firewall

**EtherCAT/IP**
# Ordering Information

## NX-series AI Controller

<table>
<thead>
<tr>
<th>Product Name</th>
<th>Specifications</th>
<th>Current (Power) consumption</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>NX701 CPU Units with AI function</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NX701-Z700</td>
<td>80MB</td>
<td>40W (including SD Memory Card and End Cover)</td>
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<tr>
<td></td>
<td></td>
<td>4 MB: Retained during power interruption</td>
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<tr>
<td></td>
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<td>256 MB: Not retained during power interruption</td>
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</table>

## NY-series AI Controller

<table>
<thead>
<tr>
<th>Product Name</th>
<th>Operating system</th>
<th>CPU type</th>
<th>Number of motion axes</th>
<th>RAM memory (non-ECC type)</th>
<th>Storage size</th>
<th>Interface option</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industrial Box PC with AI function</td>
<td>Windows Embedded Standard 7 - 64bit</td>
<td>Intel® Core™ i7-4700EQ</td>
<td>64</td>
<td>16GB</td>
<td>128GB×2 SSD iMLC/pSLC</td>
<td>RS-232C</td>
<td>NYS12-Z500-1XX214T1X</td>
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<td>Industrial Panel PC with AI function</td>
<td>Windows Embedded Standard 7 - 64bit</td>
<td>Intel® Core™ i7-4700EQ</td>
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<td>16GB</td>
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AI Controller Services (Americas)

Services are required to allow customers to get best results from Sysmac AI Controller solution. These services are scheduled when the controls machinery is sufficiently ready to produce and establish a normal baseline. Startup Service will include any necessary AI Controller software utilities, licenses, and AI Predictive Maintenance Library files required for the application and expected user outcomes.

<table>
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<th>Service Part Numbers</th>
<th>Service Description</th>
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<td>AIC-STARTUPSUPPORT</td>
<td>Required multi-day Service includes group training on concepts, technology, and hands-on work to start data collection, feature extraction, model creation, AI Controller Predictive Maintenance Library installation, and utilization within machine controls program.</td>
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<tr>
<td>AIC-RELEARNINGSUPPORT</td>
<td>Optional Service for re-training additional members after initial Startup Service, as well as assistance with feature extraction, model creation, and threshold setting with the AI Controller software utilities provided during Startup.</td>
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Controllers & I/O
• Machine Automation Controllers (MAC) • Motion Controllers
• Programmable Logic Controllers (PLC) • Temperature Controllers • Remote I/O

Robotics
• Industrial Robots • Mobile Robots

Operator Interfaces
• Human Machine Interface (HMI)

Motion & Drives
• Machine Automation Controllers (MAC) • Motion Controllers • Servo Systems
• Frequency Inverters

Vision, Measurement & Identification
• Vision Sensors & Systems • Measurement Sensors • Auto Identification Systems

Sensing
• Photoelectric Sensors • Fiber-Optic Sensors • Proximity Sensors
• Rotary Encoders • Ultrasonic Sensors

Safety
• Safety Light Curtains • Safety Laser Scanners • Programmable Safety Systems
• Safety Mats and Edges • Safety Door Switches • Emergency Stop Devices
• Safety Switches & Operator Controls • Safety Monitoring/Force-guided Relays

Control Components
• Power Supplies • Timers • Counters • Programmable Relays
• Digital Panel Meters • Monitoring Products

Switches & Relays
• Limit Switches • Pushbutton Switches • Electromechanical Relays
• Solid State Relays

Software
• Programming & Configuration • Runtime