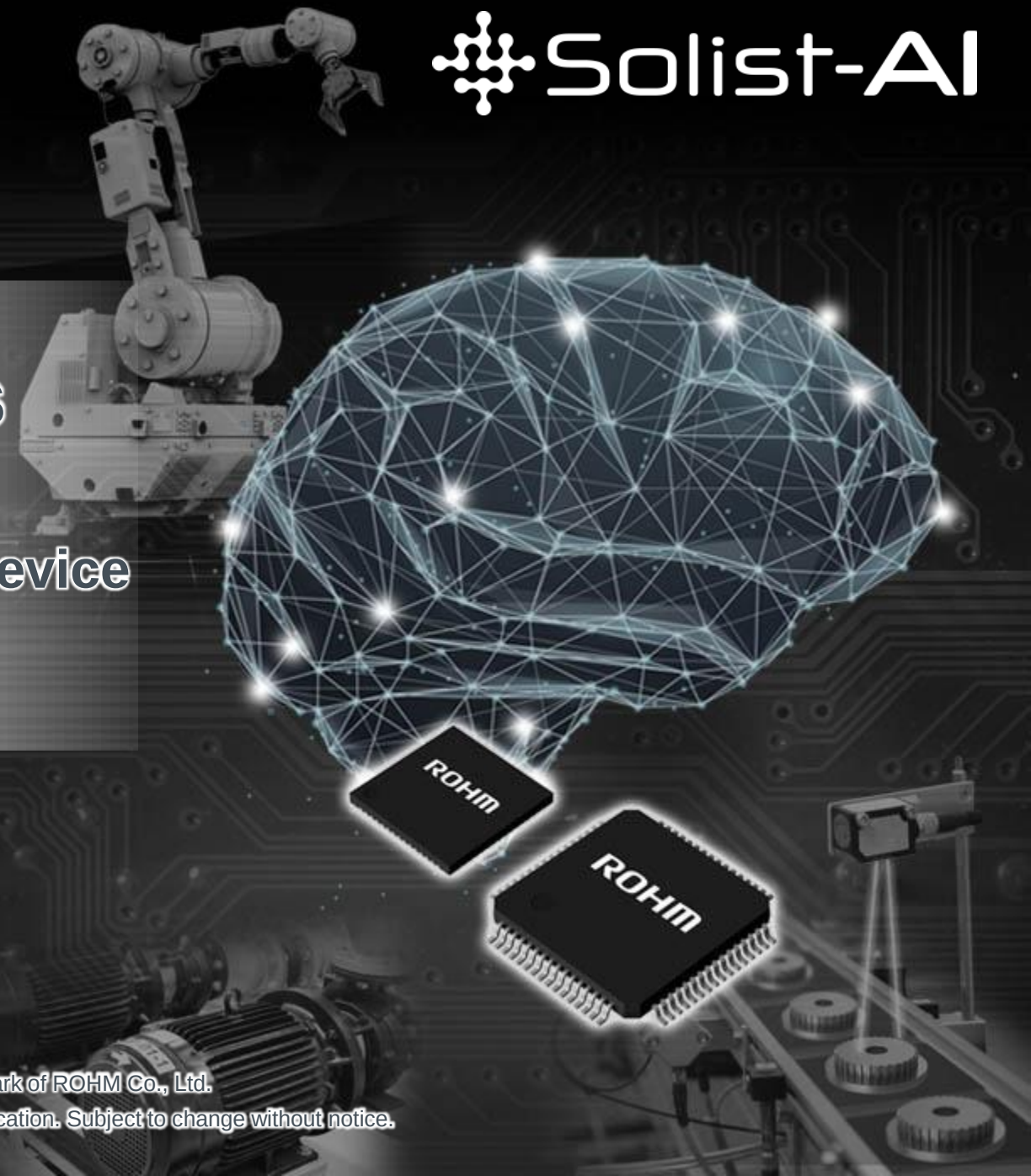
ROHM SEMICONDUCTOR

Electronics for the Future

Solist-AI

# ROHM’s AI-Equipped MCUs

## The industry's first* MCU capable of predicting equipment anomalies via on-device learning and inference without a network




June 4, 2025
ROHM Co., Ltd.
Marketing Communications Division.

*ROHM Wednesday, June 4, 2025 study

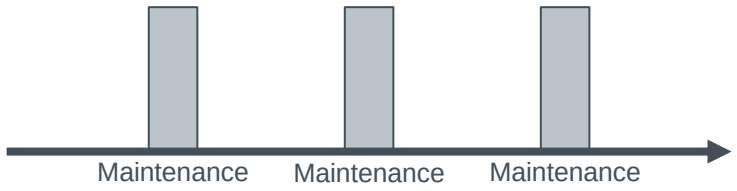
Development Background

# Enabling Efficient Operation of Industrial Equipment/Machinery

**Key challenges: Improving maintenance efficiency of machinery/equipment, reducing manpower due to labor shortages**
**Rising demand for fault prediction is accelerating the shift from 'preventive' maintenance to 'predictive' maintenance**

## Preventive Maintenance (Time-Based)

Regular inspections performed regardless of faults

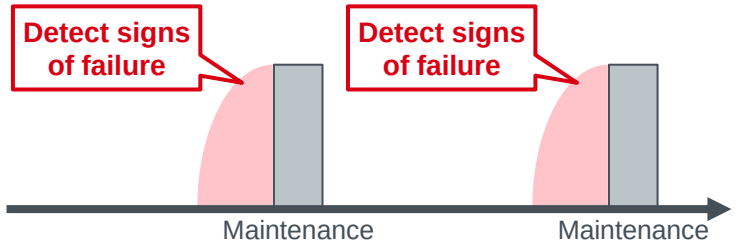



**Unnecessary maintenance increases burden and costs**

**Transitioning from 'preventive' to 'predictive'**

## Predictive Maintenance (Condition-Based)

**Inspections performed based on detected signs of failure**




**Optimizes maintenance frequency**
**Standardizes maintenance quality**
**(Reducing the risk of overlooking failures)**

**AI is effective for detecting early signs of equipment failure based on data from multiple sensors, enabling accurate real-time prediction of maintenance timing**

# Predictive Maintenance using AI MCUs

## AI Requirements for Fault Prediction and Conventional Challenges

| | | AI Requirements | Challenges with Conventional AI |
|---|---|---|---|
| 1 | Real-Time Capability + High-Accuracy Inference | Quickly and accurately detect anomalies while adapting to differences in equipment and installation environments | ● Requires a high-speed network to reduce latency caused by cloud-based processing<br>● Variations between devices make optimizing AI models labor-intensive |
| 2 | Network Security | Prevent equipment data leaks transmitted over networks | Requires data security measures |
| 3 | Optimal AI Model Construction | Efficiently develop AI tailored to specific devices and environments | Preparing training data is time-consuming |
| 4 | Low Power Consumption | The ability to reduce power consumption | AI processing necessitates a high-performance CPU, increasing power consumption |

**ROHM has developed innovative AI MCUs that enable AI learning and inference directly at the endpoint (device) without the need for the cloud**

Development Background

# Growing Demand for Endpoint AI

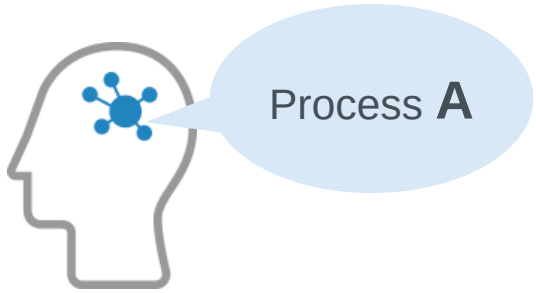
**Demand for AI processing at endpoints is growing due to the limitations of conventional AI implementation**

## Cloud-Based AI, Edge AI (General AI Chip)


AI: High-Performance Processing

Power Consumption:
Large (2W to 200W)

## Endpoint AI (ROHM's AI MCU)

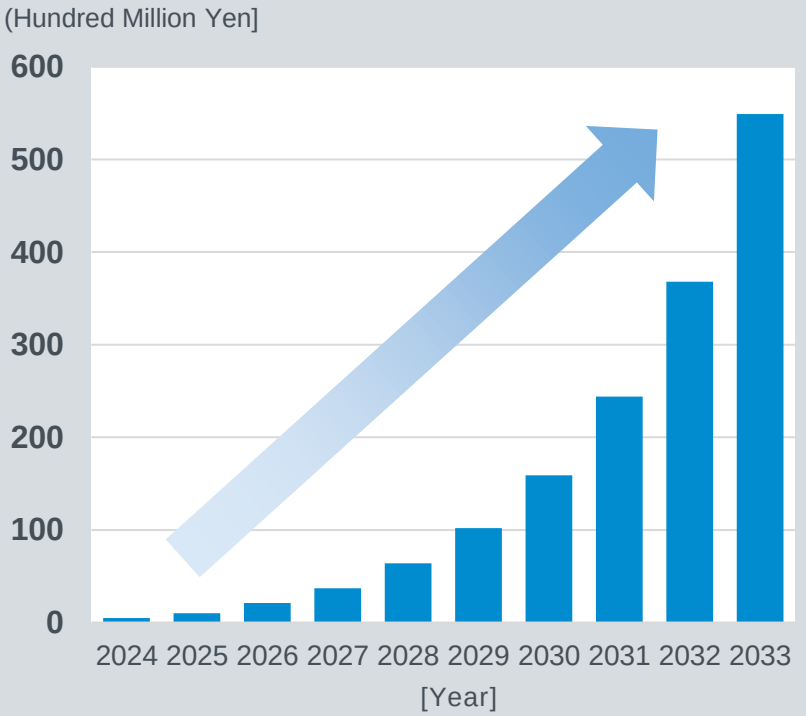



**AI: Optimized for specific processing to achieve high efficiency**

**Power Consumption: Small (approx. 40mW*)**

*Implementation value when operating a specific application

## Market Size of Endpoint AI CPUs




*ROHM June 4, 2025 study

**Addresses the issue of over-specification in cloud-based and edge AI (for predicting equipment failures)**

Supplement

# What is Solist-AI™?



## An on-device AI solution provided by ROHM for the edge computing field

### Solist-AI™ Brand

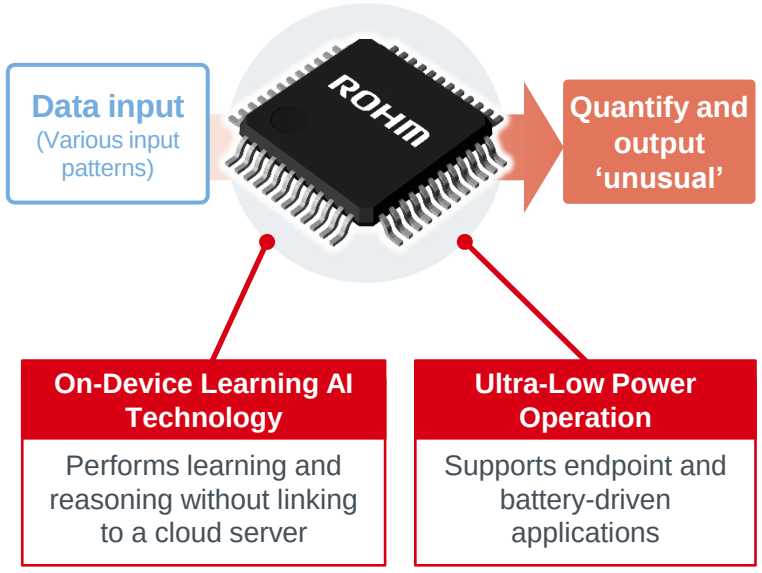
Solist-AI

Solution with On-device Learning Ic for STandalone-AI

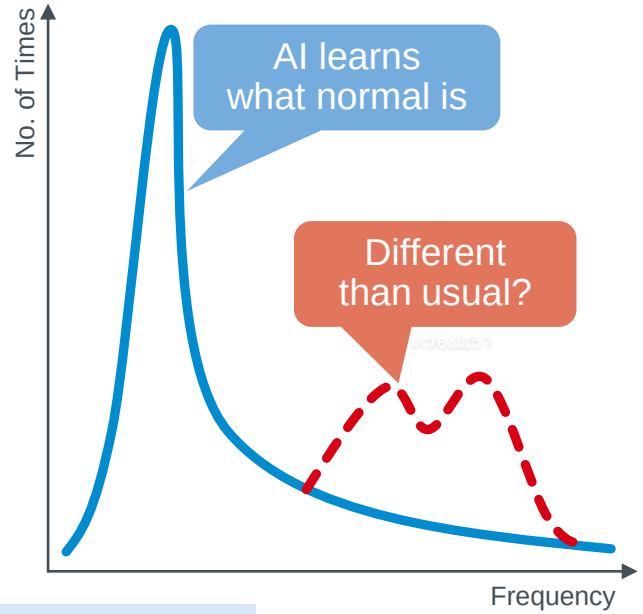
Solist-AI™ is ROHM's on-device AI solution designed for edge computing applications. Drawing inspiration from the musical term "Solist (Soloist)", which signifies solo performance, this innovative solution enables real-time learning and inference directly on standalone edge devices without relying on cloud servers. Powered by ROHM's proprietary on-device learning AI technology, Solist-AI™ is characterized by its compact design and low power consumption, contributing to the expansion of sustainable AI innovation.

### The first MCUs to implement Solist-AI™

#### AI MCU Concept




#### AI-Based Anomaly Detection




Click here for details: https://www.rohm.com/products/micon/solist-ai

**Ultra-low power MCUs capable of on-site on-device learning without a cloud server**

# Key Features of ROHM's On-Device AI Solution Solist-AI™



## Building an AI monitoring system directly on on-site devices enables real-time anomaly prediction and retrofitting to existing equipment

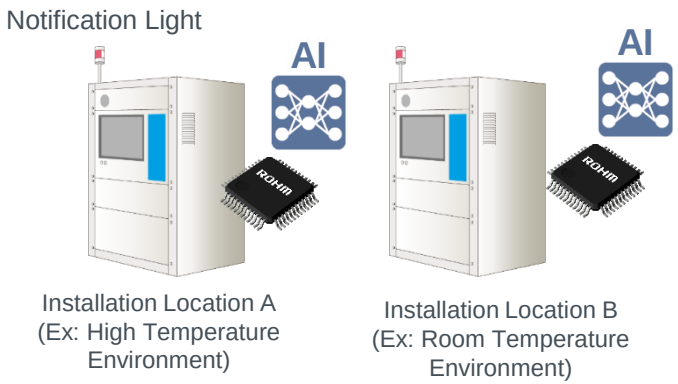
| AI Processing Model | | Cloud-Based AI | Edge AI | Endpoint AI | ROHM AI MCU |
|---|---|---|---|---|---|
| Cloud Computer (GPU) | | Training / Inference / AI<br>Data ↑ ↓ AI Model | Training / AI<br>Data ↑ ↓ AI Model | Training / AI<br>Only essential data ↑ | Not needed |
| Edge Computer (High-performance CPU) | | Data ↑ ↓ AI Results | Inference / AI<br>Data ↑ ↓ AI Results | Only essential data ↑ | |
| Endpoint (MCU) | | Sensor, Motor Control | Sensor, Motor Control | Inference<br>Sensor, Motor Control | AI / Additional training/Retraining / Training / Inference<br>Sensor, Motor Control |
| Network load | | Heavy | Medium | Light | None |
| AI Processing | Training | Cloud Required | Cloud Required | CPU Load: Heavy (software) | No Cloud Required (Learning On Device) |
| | Inference | Cloud Required | CPU Load: Heavy (software) | CPU Load: Heavy (software) | CPU Load: Light (hardware) |

**Learning and inference are carried out entirely at the endpoint without the relying on cloud/network connectivity**

**Hardware-based processing reduces the AI processing load, eliminating the need for a high-performance CPU**

# Advantages of AI MCUs

## Capable of learning at the point of installation (on-site)

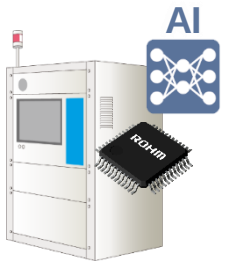



**Capable of inference in both high and room temperature environments**

- **Adapts to differences in installation environments**
  (e.g. noise, vibration, temperature, humidity)
- **Capable of compensating for variations even within the same equipment model**
- **No need to prepare training data**

## No cloud required

Can be retrofitted to existing standalone equipment

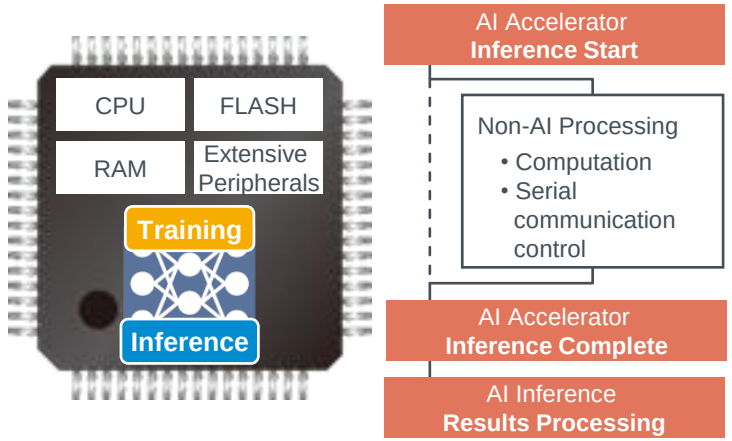



**AI MCU outputs results independently without connecting to a network**

- **No network setup required**
- **No security measures needed**
- **Zero network latency**

## High-speed hardware-based processing

Proprietary AI accelerator technology (AxlCORE-ODL)



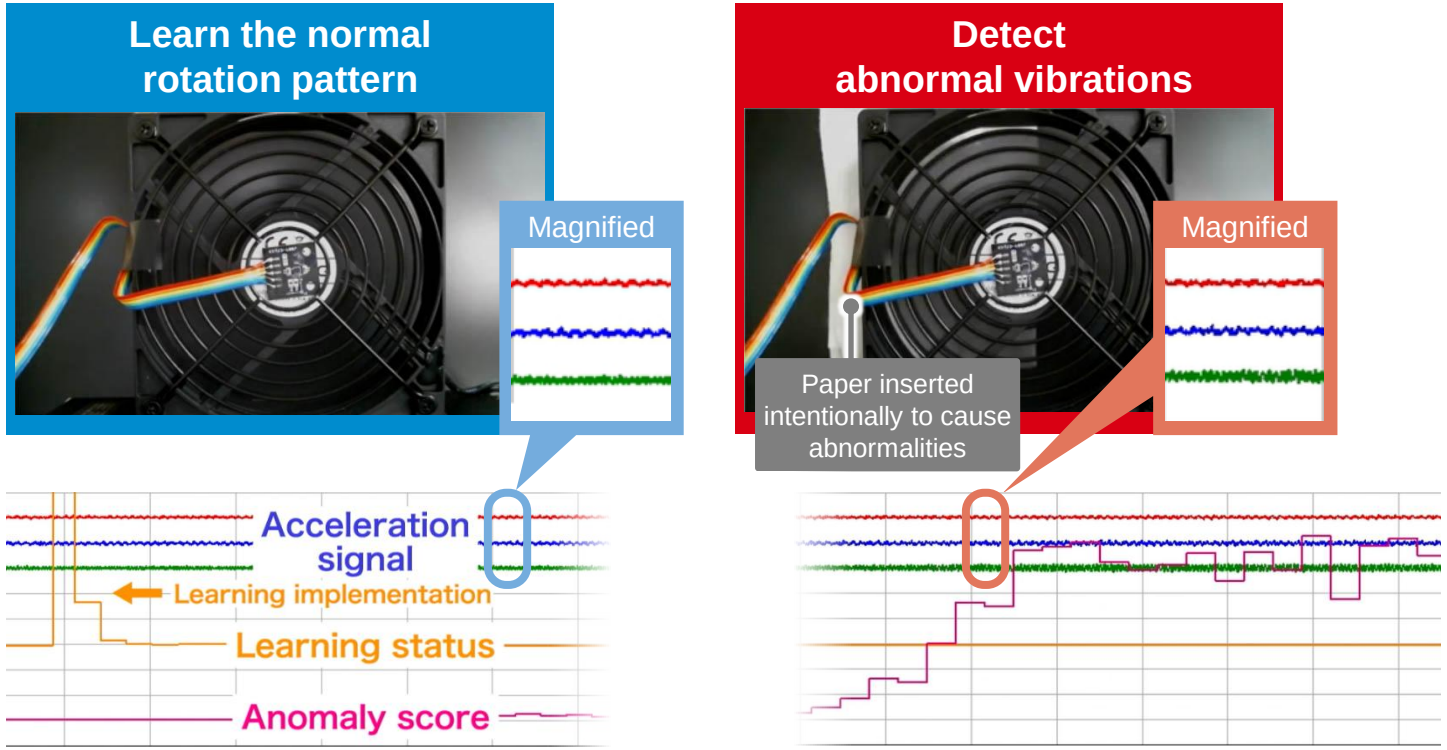

- **Minimal software load**
  (AI can be executed by simply configuring operational parameters)
- **High-speed processing possible**
  (Approximately 1,000 times faster AI processing*)
- **Easy optimization of AI models**

*Compared to ROHM's MCUs using software-based methods (condition: 12MHz operation)

# Use Cases of AI MCUs

## Predicts signs of component degradation or damage based on the severity of anomalies, reducing maintenance costs along with the risk of production line downtime

### [Example] Detecting Abnormal Vibrations in a Fan Motor




**Detects vibrations using a 3-axis accelerometer in the X, Y, and Z directions → Inserting paper increases the load, triggering the detection of abnormal vibrations**

### Other Use Cases

**FA Sensor + AI MCU**

Leverage data such as light, temperature, flow rate, and sound to monitor equipment conditions and identify anomalies

**Motor + AI MCU**

Track motor current, temperature, and rotational speed to monitor for load irregularities and bearing damage

**Residential Facilities / Home Appliances + AI MCU**

Utilize data from existing sensors to detect equipment anomalies at an early stage

Abnormal vibration detection - Demo video (Short clip, 55s)

Click here for the full video (04:29)

# Equipped with Arm® Cortex®-M0+ Core (48MHz Max. operating frequency) [ML63Q253x-NNNxx / ML63Q255x-NNNxx]

## Lineup

| Part No. | Memory: Code Flash [KB] | Memory: Date Flash [KB] | Memory: RAM [KB] | Operating Voltage [V] | Operating Temp. Ta [°C] | Timer | No. of Serial I/F: CAN FD | No. of Serial I/F: I²C | No. of Serial I/F: SPI | No. of Serial I/F: UART | A/D Converter | Package [mm] | Packaging Specification | Online Sales |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| New ML63Q2534-NNNTBZWAY | 128 | 8 | 16 | 2.3 to 5.5 | -40 to +105 | 16bit timer (independent operation) × 6, 16bit timer (timer/PWM/ Capture modes) × 2, 3-phase motor control × 3 (3-phase × pos./neg. = 6 outputs), Watchdog timer × 1, Real-time clock × 1, Time base counter × 2 | 1 | 1 | 2 | 4 | 12bit SA-ADC: 12ch 2 units Max. 1Msps | TQFP48 (9.0×9.0×1.2) | Tray | — |
| New ML63Q2534-NNNTBZWBY | | | | | | | | | | | | | Taping | In preparation |
| New ML63Q2537-NNNTBZWAY | 256 | | | | | | | | | | | | Tray | — |
| New ML63Q2537-NNNTBZWBY | | | | | | | | | | | | | Taping | YES |
| New ML63Q2554-NNNTBZWAY | 128 | | | | | | | | | | | TQFP64 (12.0×12.0×1.2) | Tray | — |
| New ML63Q2554-NNNTBZWBY | | | | | | | | | | | | | Taping | In preparation |
| New ML63Q2557-NNNTBZWAY | 256 | | | | | | | | | | | | Tray | — |
| New ML63Q2557-NNNTBZWBY | | | | | | | | | | | | | Taping | YES |
| ☆ ML63Q2534-NNNGDZW5AY | 128 | | | | | | | | | | | WQFN48 (7.0×7.0×0.8) | Tray | — |
| ☆ ML63Q2534-NNNGDZW5BY | | | | | | | | | | | | | Taping | — |
| ☆ ML63Q2537-NNNGDZW5AY | 256 | | | | | | | | | | | | Tray | — |
| ☆ ML63Q2537-NNNGDZW5BY | | | | | | | | | | | | | Taping | — |
| ☆ ML63Q2554-NNNGDZW5AY | 128 | | | | | | | | | | | WQFN64 (9.0×9.0×0.8) | Tray | — |
| ☆ ML63Q2554-NNNGDZW5BY | | | | | | | | | | | | | Taping | — |
| ☆ ML63Q2557-NNNGDZW5AY | 256 | | | | | | | | | | | | Tray | — |
| ☆ ML63Q2557-NNNGDZW5BY | | | | | | | | | | | | | Taping | — |

☆: Under Development

## Block Diagram

**ML63Q253x-NNNxx / ML63Q255x-NNNxx**

**32bit RISC CPU (Arm® Cortex®-M0+)**

| | | | |
|---|---|---|---|
| Flash ROM | Data Flash | SRAM | On-chip Debug |
| PLL 48 MHz | 3-Phase Motor Control PWM | Internal RC 32.768 kHz | **AI Accelerator** |
| CF, 16bit Timer, PWM Capture, TBC | I²C (M/S), SSIO (M/S), UART | 12bit SA ADC | CAN FD Controller |
| Voltage Level Supervisor | DMAC | Power Management | In-System Programming |

Operating voltage: 2.3V to 5.5V, Operating temp: -40C to +105C

## Features

- Equipped with AxlCORE-ODL that performs learning and inference using a 3-layer neural network
- Integrates dual-unit 12bit A/D converter
- Extensive I/F such as CAN FD
- Versatile timer functions, including 3-phase motor control PWM

**Capable of supporting control and data processing for industrial equipment and home appliances**

# Development Support Tools

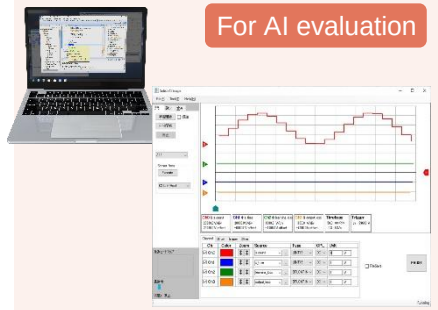


## Adopting an Arm® core enables compatibility with general-purpose tools and ROHM's integrated development environment

### AI MCU Development Environment

**5 Solist-AI™ Scope**

For AI evaluation



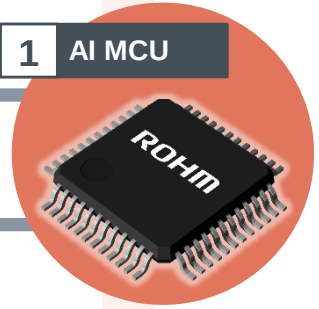
**2 MCU Evaluation Board**

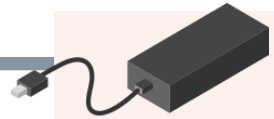

RB-D63Q2537TB48


RB-D63Q2557TB64

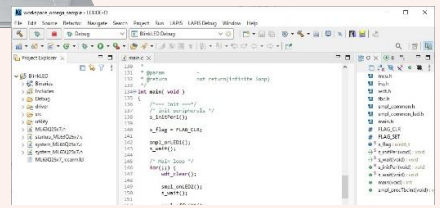
**9 USB-SPI Conversion Adapter**

**1 AI MCU**



**8 Arm® Debug Adapter**



**6 Integrated Development Environment LEXIDE-Ω**

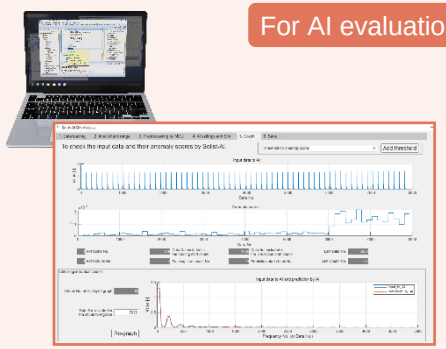
**10 Arm® Integrated Development Environment Keil® MDK**

For AI evaluation

**7 AI Evaluation Board** (Ecosystem partner)

### AI operation verification simulator

For AI evaluation



**4 Solist-AI™ Sim**

### Sample Program

**3 Reference Software**

**Online Distributors**

DigiKey MOUSER ELECTRONICS Farnell

| No. | Tool Name | Where to Obtain | Contents |
|---|---|---|---|
| 1 | AI MCU | ROHM | ML63Q253x-NNNxx<br>ML63Q255x-NNNxx |
| 2 | MCU Evaluation Board | | Board for standalone AI MCU evaluation/software development |
| 3 | Reference Software | ROHM (Web download) | Sample software for AI MCU |
| 4 | Solist-AI™ Sim | | AI operation verification simulator executable on a PC |
| 5 | Solist-AI™ Scope | | Real-time viewer for verifying AI effectiveness<br>(included with reference software) |
| 6 | Integrated Development Environment | | LEXIDE-Ω<br>(developed by ROHM) |
| 7 | AI Evaluation Board | Ecosystem partner | Sensor connectable board for real-world verification of AI effectiveness |
| 8 | Arm® Debug Adapter | Commercially available | Debugger for connecting a computer to the Arm® core |
| 9 | USB-Conversion Adapter | | Adapter for connecting AI MCU and Solist-AI™ Scope |
| 10 | Arm® Integrated Development Environment | | Arm® Keil® MDK |

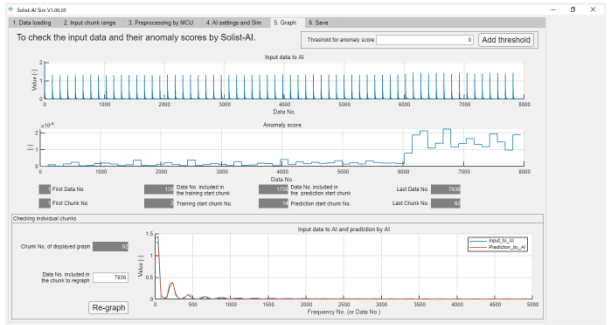
# Support Tools for Evaluating AI Functions



## AI simulator and real-time viewer available for evaluating learning and inference
## Sensor-connectable AI evaluation board also offered for real-world verification

### 4 Solist-AI™ Sim

AI operation verification simulator

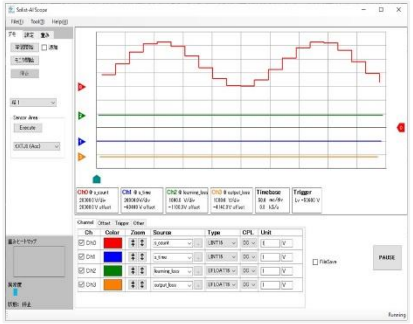



**Evaluate the effectiveness of learning and inference on a PC before AI MCU implementation**

- Input customer data to validate AI operation on a PC
- Output data can be directly used for training on the AI MCU

### 5 Solist-AI™ Scope

AI operation real-time viewer



**Monitor AI operation in real time**

- Connect to the AI MCU and display real-time AI operation from the actual device on a PC
- Output data can be used as training data for Solist-AI™ Sim

### 7 AI Evaluation Board

Ecosystem partner

**Connect sensors to confirm AI effectiveness on the actual device**

- Built-in accelerometer
- AI inference results can be sent to a PC via USB

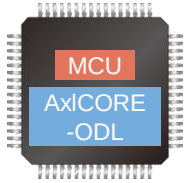
# Ecosystem



## Building an ecosystem in collaboration with partner companies to support customers with immediate use and implementation

### ROHM

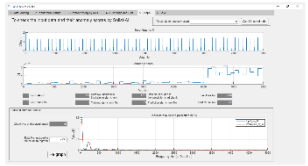
**Provide AI MCUs and utilities**




AI MCU

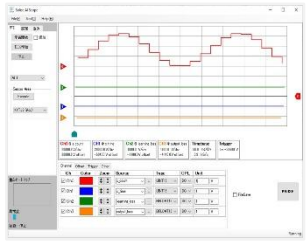
**Solist-AI™ Sim**

AI operation verification



**Solist-AI™ Scope**

AI effect real-time viewer



### Ecosystem Partners

Panasonic

SHINWA

DATATECNO

AIxtal

MECHATRAX

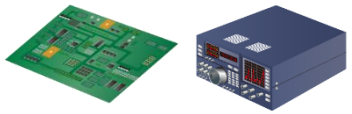
P板.COM

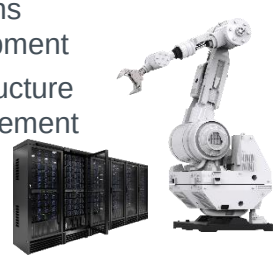
SEC Systems Engineering Consultants

KoyoDenshi Quest for Technology

*Companies shown are just examples. Listed in no particular order.

| Hardware development and sales | Develop software, provide services | Establish and provide a foundational platform |
|---|---|---|
| ● Modules<br>● Evaluation boards | ● Middleware/SDK<br>● Application software development<br>● AI utilization expertise | ● Solutions development<br>● Infrastructure enhancement |





### Customer

Leverage the AI expertise of ecosystem partners

Integrate AI modules into existing in-house products

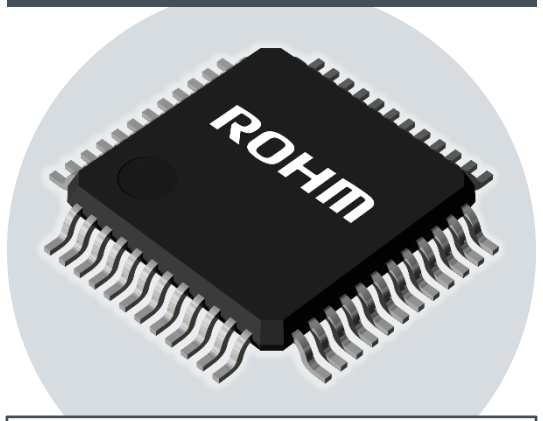
1. **Reduce AI implementation costs and risks**
2. **Provide a wide range of readily deployable options**
3. **Customize development based on cost and quantity**

# Future Development Roadmap

*Plan as of June 4, 2025

## Expanded lineup with the addition of ML63Q253x-NNNxx/ML63Q255x-NNNxx

**Replace main MCUs**



ML63Q253x-NNNxx
/ ML63Q255x-NNNxx

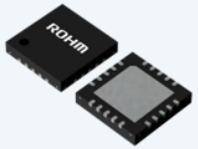
**Higher performance**

M3/M33 Core (100MHz)

**Replace high-performance main MCUs**

**Smaller・Fewer pins**

20/ 32 pins



**Add AI functionality to existing systems**

**Enhanced support for peripheral functions**

USB I/F, DAC

**Expand application scope**

### Applications

- Motors (AC servos/inverters)
- Large home appliances
- Robots

- FA sensors
- Batteries
- Motors (DC/steppers)
- Power tools
- Residential facilities / small home appliances


Electronics for the Future

ROHM Co.,Ltd.

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