

# Sysmac Automation Platform

One control, one connection, one software



EtherNet/IP

LOGIC MOTION VISION

SAFETY

EtherCAT

# One Machine Control

## Motion, Logic, Safety and Vision in one

One machine control through one connection and one software is how we define the new Sysmac automation platform. The new NJ machine automation controller integrates motion, logic sequencing, safety, vision and networking under one software: Sysmac Studio. This one software provides a true Integrated Development Environment (IDE) that includes a custom 3D motion simulation tool. The NJ controller comes standard with built-in EtherCAT and EtherNet/IP. The two networks with one connection purpose is the perfect match between fast real time machine control and data plant management.



**EtherCAT** 

**EtherNet/IP**

### One machine controller: NJ-Series

For complete control and management of your machine.  
Logic and advanced motion control in one

### One factory automation network : EtherNet/IP

For local or remote access to the complete machine



## One machine network: EtherCAT

For real time control of servo drive, inverter, safety, vision system and I/O



## One software: Sysmac Studio

For configuration, programming, simulation and monitoring

# One connection

## One machine network

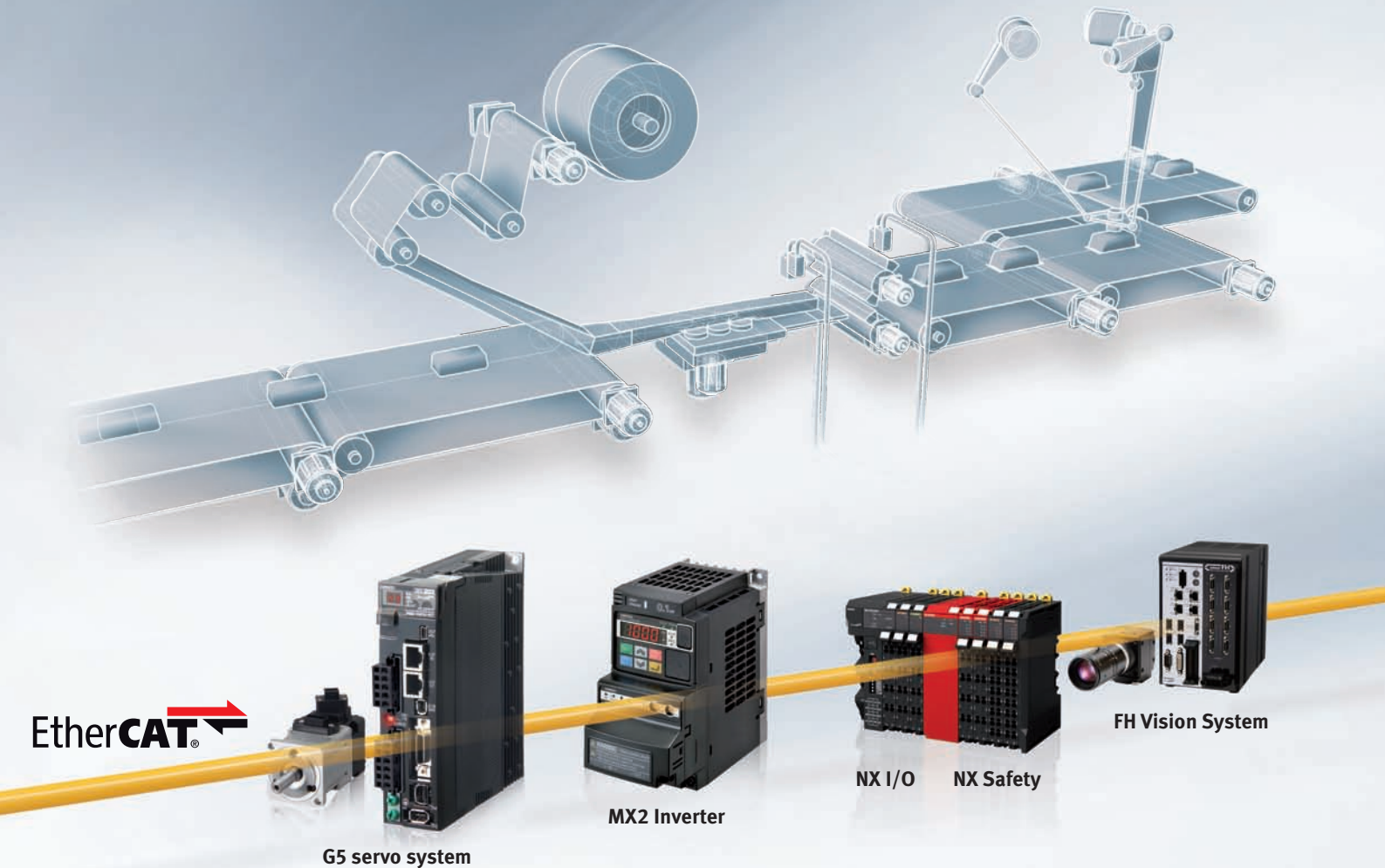
One connection via the NJ-Series controller allows seamless control and communication with both the machine and the factory. The new NJ-Series controllers join the world standard factory automation network, EtherNet/IP, with the best Ethernet-based machine control network, EtherCAT.



### **EtherNet/IP: the ONE factory automation network**

- » Peer-to-Peer controller communication
- » Interface with Sysmac Studio , NS HMI series or SCADA software
- » SQL Client
- » FTP server
- » Support MATLAB®/Simulink® simulation software





## EtherCAT: the ONE machine network

- » Up to 192 slaves
- » Fastest class machine network on the market
- » Noise immunity to stringent Omron standards
- » Embedded in Omron servo drive, inverter, safety, vision sensor and I/O
- » Uses standard STP Ethernet cable with RJ45 connectors

## Integrated safety into machine automation

- » FSoE – Safety over EtherCAT
- » Flexible system with distributed safety I/O
- » Conforms to IEC 61131-3 standard programming
- » PLCopen Function Blocks for Safety

### PROGRAMMING

### SIMULATION

### INFORMATION

Sysmac Studio

SQL-Database



# One connection

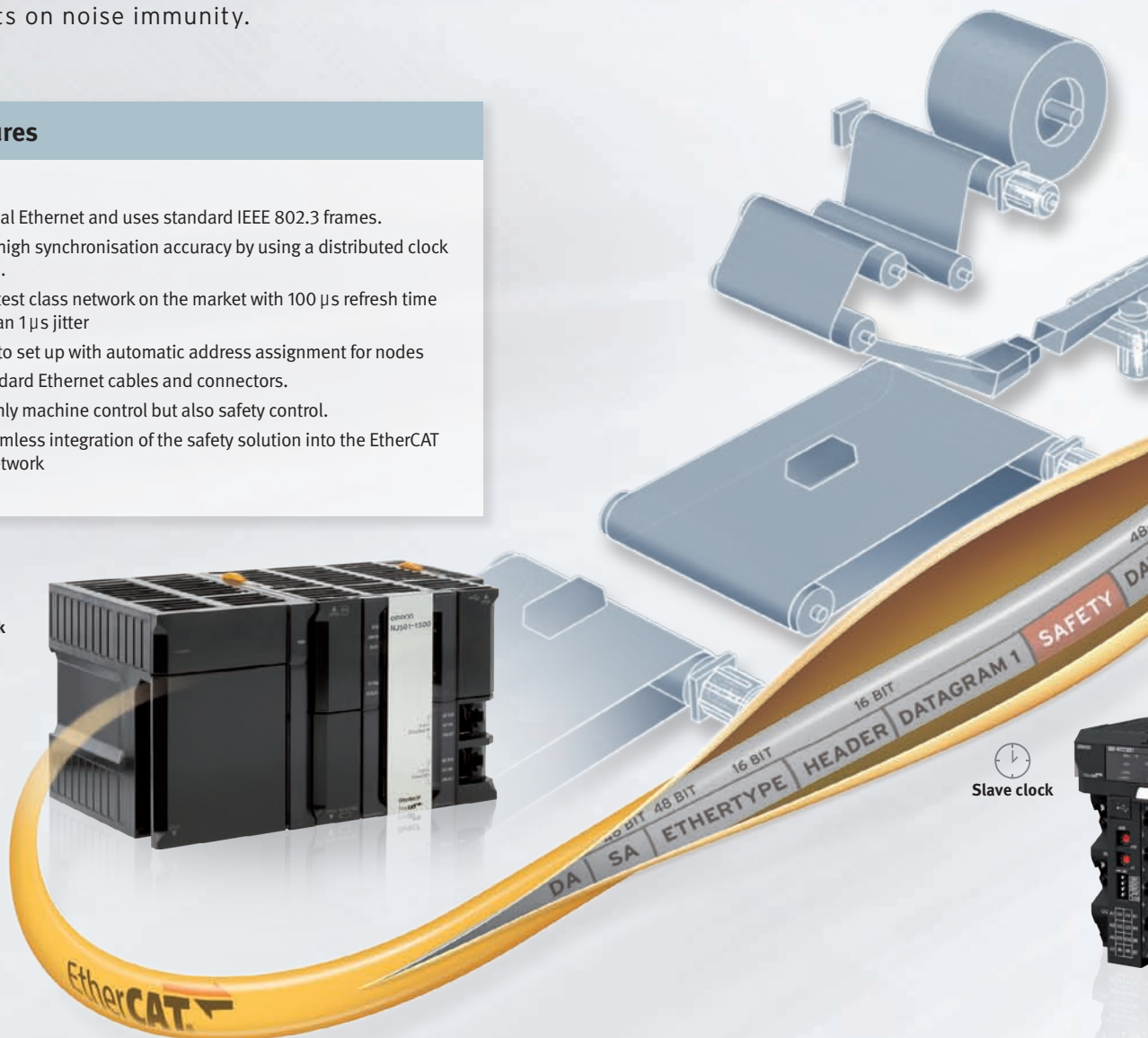
## EtherCAT the optimal machine network

EtherCAT is the fastest emerging network for machine automation. It is Omron's de-facto machine network for our wide range of field and motion devices. It is Ethernet based, fast, accurate and highly efficient in terms of data transmission. All our EtherCAT devices have been designed and tested to meet Omron's stringent requirements on noise immunity.

### Key features

- It is industrial Ethernet and uses standard IEEE 802.3 frames.
- It achieves high synchronisation accuracy by using a distributed clock mechanism.
- It is the Fastest class network on the market with 100  $\mu$ s refresh time and less than 1  $\mu$ s jitter
- It is simple to set up with automatic address assignment for nodes
- It uses standard Ethernet cables and connectors.
- It has not only machine control but also safety control.
- It offers seamless integration of the safety solution into the EtherCAT machine network

  
Master clock



### EtherCAT is Industrial Ethernet

The EtherCAT Telegram is contained in the Ethernet Data section of the IEEE 802.3 Ethernet frame. The frame travels through the media at 100 Mbps in full duplex mode.

### Safety over EtherCAT (FSoE)

Seamless integration of the safety into machine automation. The FSoE frame is included in the EtherCAT process data. This system provides a flexible solution with distributed safety I/O.





## "On-the-fly" data exchange

The slave devices extract and/or insert data on the fly. This method assures the highest possible throughput.

## Simple cabling: 100Base-TX

EtherCAT uses standard 100BASE-TX Ethernet communication very efficiently, over standard shielded Ethernet cables and connectors. No need for network switches. No need for network switches in line topology.

## Distributed clocks

The EtherCAT node slave measures the time difference between incoming and returning frame - timestamp-. With these timestamps the master can determine the propagation delay offset to the individual slave accurately. This mechanism ensures accurate synchronisation between devices with less than 1  $\mu$ s jitter.

## Flexible topology

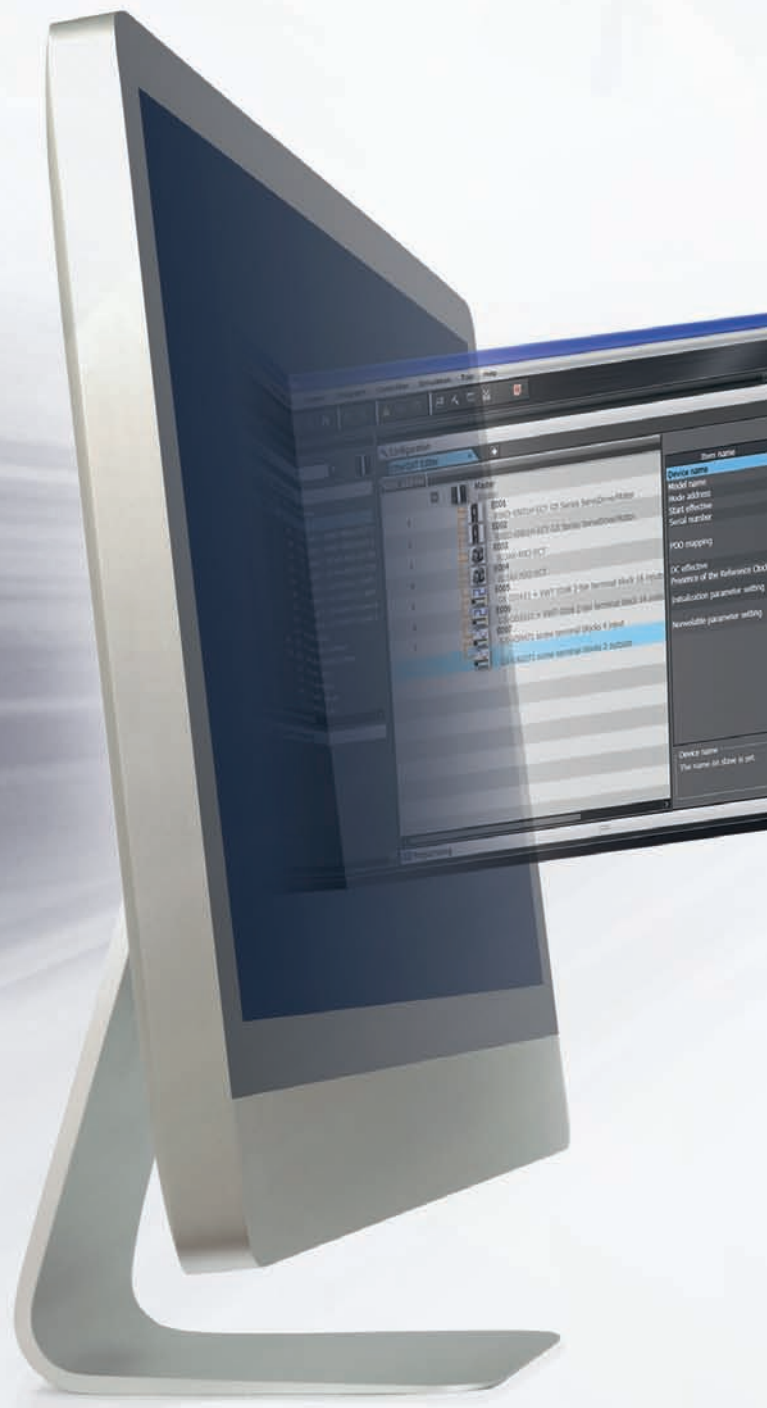
With two EtherCAT ports on all devices, no additional switches are required to create a linear network. EtherCAT junctions slaves can be used to build tree and star topologies, which provides section segregation isolation.

# One software

## Sysmac Studio for machine creators

Turning machine programmers into machine creators is the driving vision behind Sysmac Studio. Cutting programming, debugging and set-up time while maximising the functionality and performance of your machine is our ultimate goal. For this Sysmac Studio aims to offer ONE software for the complete machine. A software tool that only needs to be learned once, programmed, tested and tuned as one and secured as a whole.

Learn it **ONCE**  
Develop it **FAST**  
Test it as **ONE**  
Secure it **ALL**





## Learn it ONCE

- » One software for motion, safety, drives and vision
- » Fully compliant with open standard IEC 61131-3
- » One design and operation environment for configuration, programming and monitoring

## Develop it FAST

- » Supports Ladder, Structured Text and Function Block programming with a rich instruction set
- » CAM editor for easy programming of complex motion profiles
- » Intuitive editor with auto-complete assistance for Ladder and Structured Text programming
- » Support the Simulink environment for program code generation and simulation control systems

## Test it as ONE

- » One simulation tool for sequence and motion in a 3D environment
- » Complete or partial program can be simulated and debugged
- » Data trending for tuning and debugging

## Secure it ALL

- » Advanced security function with 32 digit security password.
- » Complete project or single Function Block can be protected
- » Machine cloning prevention



# One software

## Sysmac Studio to develop machines

Created to give you complete control over your automation system, Sysmac Studio integrates configuration, programming and monitoring. Graphics-oriented configuration allows quick set-up of the controller, field devices and networks while machine and motion programming based on IEC standard and PLCopen Function Blocks for Motion Control cuts programming time. Smart Editor with On-line debugging helps quick and error free programming. Advanced simulation of sequence and motion control, and data trace reduce machine tuning and set-up.

### Design and operability

Unified design environment is provided for programming, configuration and monitoring. It also offers intuitive navigation between control modes.

### Configuration and monitoring for servo system

Parameter setting, monitoring and data trace for servo drive and inverter.

### Motion control

The graphical CAM editor allows quick implementation of complex motion profiles. CAM tables can be modified on the fly. A PLCopen Function Blocks for the Motion Control library are available to implement general purpose motion control.

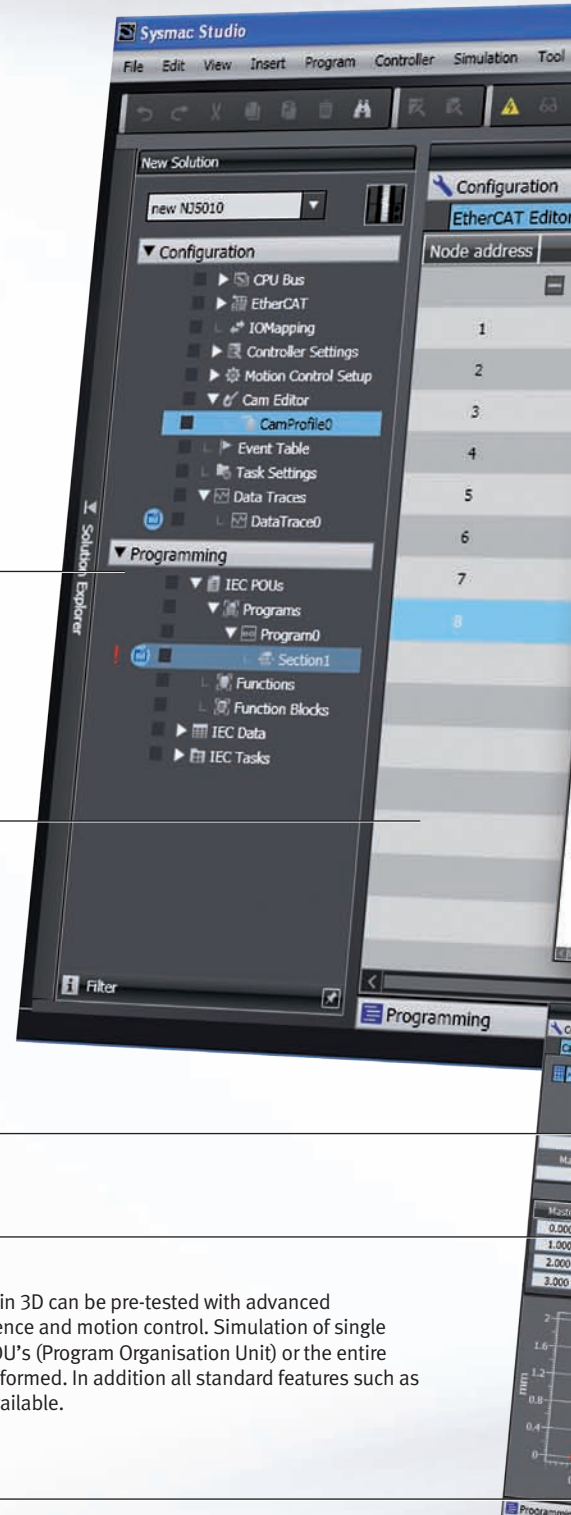


### Simulation

Motion trajectories in 3D can be pre-tested with advanced simulation of sequence and motion control. Simulation of single Function Blocks, POU's (Program Organisation Unit) or the entire program can be performed. In addition all standard features such as Break & Step are available.

### Data tracing

Easy system tuning thanks to integrated and synchronised data tracing of motion commands, position and speed feedback and I/O status and values.





## Programming

Multi-tasking and fully compliant to IEC 61131-3 standard. The program editor includes smart support functions such as syntax error check and clear colour segregation of variables and symbols. ST instructions can be directly written in Ladder programs thanks to in-line ST function.

## Integrated safety programming

The Function Block Diagram editor includes 79 safety FB/FUN. Conforms to IEC 61131-3 standard programming and PLCopen Function Blocks for Safety.



# NJ-Series Machine Automation Controller

## Complete and robust machine automation

The NJ-Series Machine Automation Controller is at the heart of the new Sysmac platform. One integrated machine controller that offers speed, flexibility and scalability of software centric architecture without compromising on the traditional reliability and robustness that you have come to expect from Omron PLCs. The NJ-Series is designed to meet extreme machine control requirements in terms of motion control speed and accuracy, communication, security and robust system. You just create...

### Motion control

- Up to 64 axis control
- Single axis moves and axes interpolation
- 32 axes / 500  $\mu$ s cycle time
- Electronic cams and gearboxes
- E-cam with on-the-fly change
- Full control of Axes Group Position
- Control of up to 8 Delta robots in 2 ms/ 4 Delta robots in 1 ms
- Integrated robotics FB library for Delta-3 control

### System robustness

- One event log for controller, field devices and networks
- Standard PLC system check: Watch-Dog Timer, memory check, network topology check, etc.

### NJ-Series controller features

- System cycle: 32 axes / 500  $\mu$ s
- Motion controller supporting up to 64 servo axes
- EtherNet/IP and EtherCAT ports embedded
- Up to 192 EtherCAT Slaves (64 axes)
- Standard IEC 61131-3 programming
- Certified PLCopen Function Blocks for Motion Control
- Linear and circular interpolation
- Linear and infinite axes management
- Electronic Gear and CAM synchronisation
- Global standards CE, cULus, NK, LR

### Machine control

- Complete integration of Logic, Motion, Safety and Vision
- Synchronous control of all machine network devices
- Multi-tasking programs
- In-line ST, Structured Text and Ladder mixed in one program
- I/O Capacity: 2,560 local points plus 192 EtherCAT slaves





### Hardware design

- Architecture based on new Intel® Atom™ Processor
- The most compact controller in its class
- Built-in USB port and SD card slot
- Fan-less cooling



### Standard Factory network

- Programming
- Other Machine controllers
- HMI / SCADA
- IT systems
- Standard Protocols and Services: TCP/IP, FTP, NTP, SNMP
- CIP protocol
- DB\_Connection FB's: SQL Client



### Standard Machine network

- Servos
- Inverters
- Robotics
- Vision systems
- Distributed I/O



### Unit type

CPU Unit	Unit type			Axes
NJ501	Standard	NJ Robotics	NJ with SQL Client	16, 32, 64
NJ301	Standard			4, 8

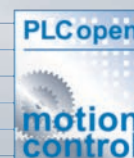
### Standard programming

- Fully conforms with IEC 61131-3 standards
- PLCopen Function Blocks for Motion Control



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# NX I/O

## Speed and accuracy for machine performance

Based on an internal high-speed bus running in synchronisation with the EtherCAT network and using the Time-Stamp function, the NX I/O can be controlled with microsecond accuracy and with nanosecond resolution. The I/O range consists of over 70 models including position interface, temperature inputs and integrated safety.

### EtherCAT®

#### EtherCAT connectivity

- Distributed clock to ensure I/O response with less than 1 µs jitter
- Safety over EtherCAT (FSoE)



#### EtherCAT coupler

- Up to 1024 byte input / 1024 byte output
- Automatic backup/restore of all I/O unit parameters. Except Safety Control unit and Safety I/O units

#### Digital I/O

- Units for 4, 8 or 16 points
- Standard, high-speed and Time-Stamp\* models

### NX I/O features

- NsynX technology provides deterministic I/O response with nanosecond resolution
- Digital I/O: high-speed and time-stamp models (NsynX)
- Analogue I/O: high performance models offer 10 µs conversion time per channel and 1:30000 resolution
- Detachable front connector with push-in type screwless terminals on all NX I/O units
- On/Offline configuration, simulation, and unified troubleshooting in the Sysmac Studio software



- High signal density; up to 16 I/O points in 12 mm width

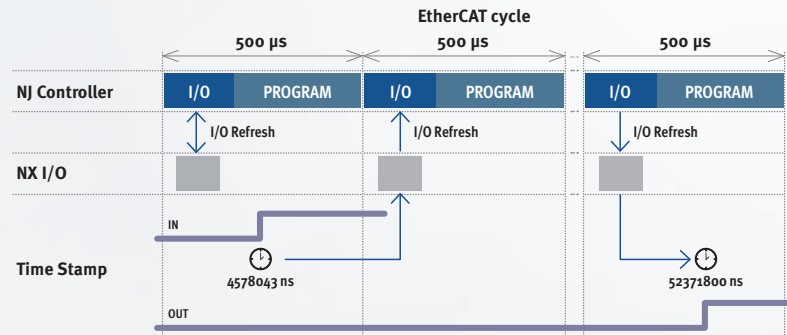


## NsynX technology

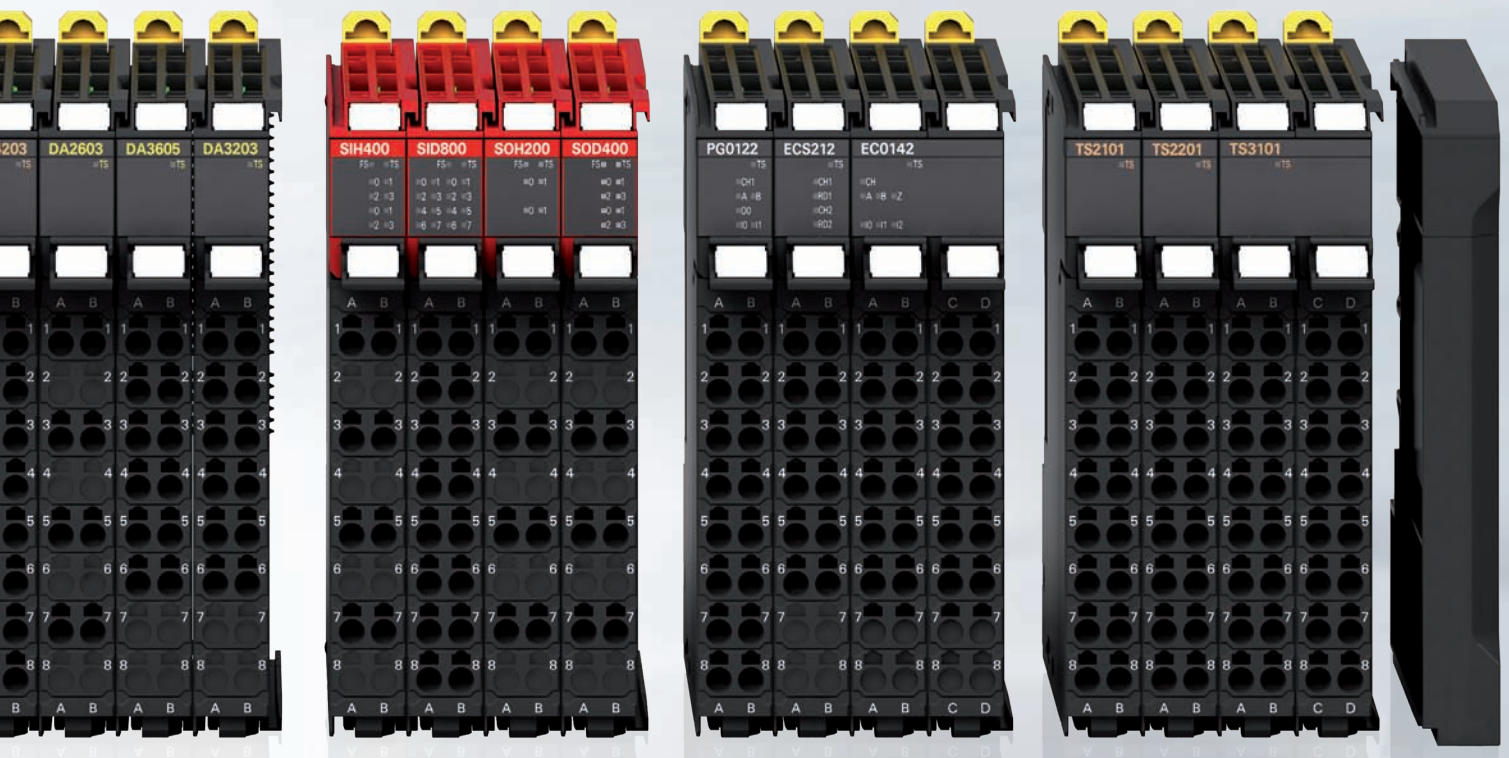
The NsynX technology is provided by the internal high-speed bus synchronised with the EtherCAT network. This technology is designed for machine control and includes:

- I/O units with distributed clock
- High-speed I/O units synchronised with the EtherCAT cycle
- I/O units with Time-Stamp function\* (accuracy < 1 µs)

### Time-Stamp\* sequence example



Accurate control of input events and perfect control of output with nanosecond resolution



#### Analogue I/O

- +/-10V voltage and 4-20 mA current signals
- 2, 4 or 8 channels per input unit
- 2 or 4 channels per output unit
- Standard and high-performance models

#### Safety I/O

- 4 or 8 points per Safety input unit
- 2 or 4 points per Safety output unit
- Freely allocation of the Safety I/O units on the internal high speed bus.

#### Position Interface

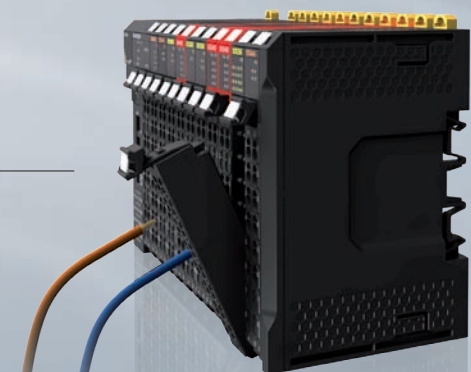
- Encoder input units for connection of external axes to the Sysmac system
- Incremental and absolute encoder support
- Positioning control unit with pulse train output

#### Temperature Inputs

- Thermocouple or RTD inputs, 2 or 4 per unit

#### End Cover

- Screwless clamping terminal block
- Fast and secure screwless push-in connections
- Removable I/O connectors for easy pre-wiring, testing and system maintenance



# NX Safety Control

## Integrated safety into machine automation

The Sysmac Automation platform integrates a safety solution within our one connection and one software concept. One connection is realised through the use of Safety over EtherCAT -FSoE- protocol. The One software is achieved by using the Sysmac Studio for configuration, programming and maintenance. The NX safety system consists of safety controller and safety I/O units. Both the safety controller and safety I/O can be freely distributed in an I/O rack throughout the network, mixing them in any combination with standard NX I/O.

EtherCAT®



EtherCAT telegram



Safety over  
EtherCAT®

### NX Safety controller

- The safety controller variables are part of the NJ controller project
- Flexibility and reusability of the programming code

### NX Safety features

- The safety controller meets PLe according to the ISO 13849-1 and SIL3 according to IEC 61508
- Flexible system lets you freely mix safety controller and safety I/O units with standard NX I/O
- Integration in One software, Sysmac Studio
- Certified programs can be reused, which reduces the amount of verification work



ISO 13849-1, PLe

IEC 61508, SIL3

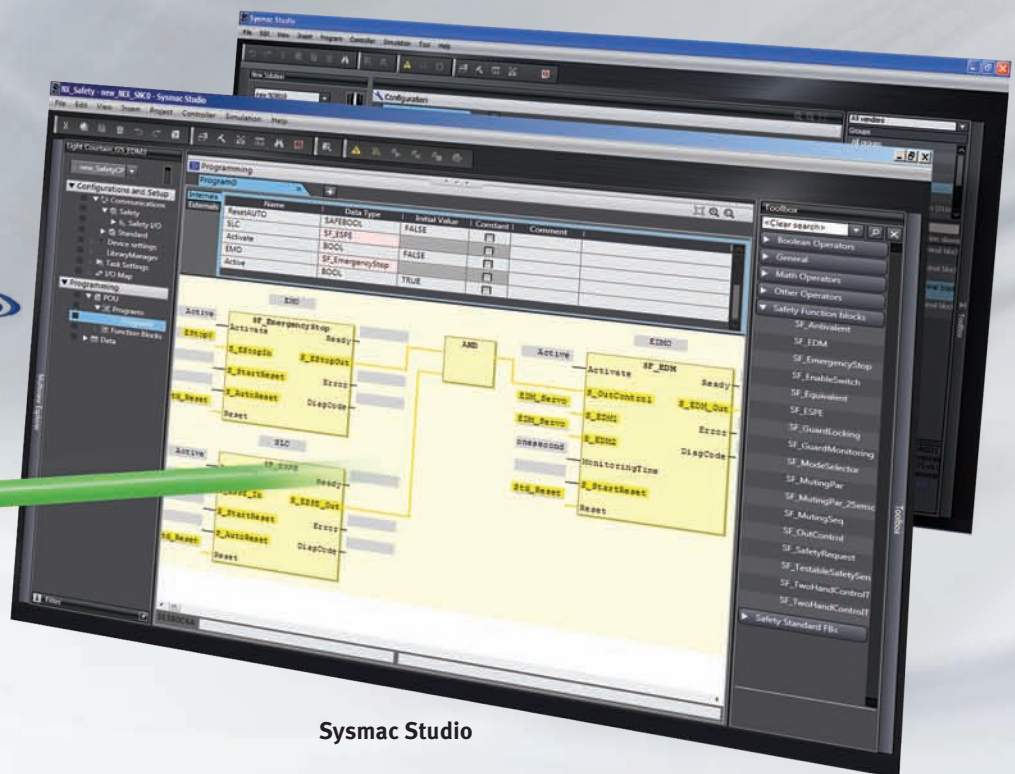


## Safety integration in One software

- Integrated Development Environment in Sysmac Studio provides one common software for hardware configuration, programming and maintenance of the Sysmac platform
- 79 safety FB/FUN conforming to IEC 61131-3 standard programming
- PLCopen Function Blocks for safety



NJ Controller



Sysmac Studio

## Safety over EtherCAT frame



### NX Safety I/O

- 4 or 8 points per Safety input unit  
The 4 points input type can connect OMRON special safety device directly
- 2 or 4 points per Safety output unit  
The 2 points output type is characterized by large output breaking current of 2.0A

# G5 Servo system

## At the heart of every great machine

Great machines are born from a perfect match between control and mechanics. G5 gives you that extra edge to build more accurate, faster, smaller and safer machines.



### EtherCAT connectivity

- Compliant with CoE -CIA402 Drive profile-
- Cyclic Synchronous Position, Velocity and Torque modes
- Embedded Gear Ratio, Homing and Profile Position mode
- Distributed clock to ensure high precision synchronisation



### Safety conformance

- PL-d according ISO13849-1
- STO: IEC61800-5-2
- SIL2 according to EN61508

### G5 servo system features

- Compact size servo drives with EtherCAT connectivity built-in
- High-response frequency of 2 kHz
- Load vibration suppression
- Embedded Safety conforming ISO13849-1 Performance Level d
- Advanced tuning algorithms (Anti-vibration function, torque feedforward, disturbance observer)
- Wide range of linear and rotary servo motors





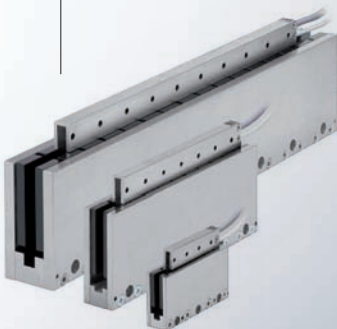
### Improved rotary motors

- Low cogging torque servo motors
- High accuracy provided by 20 bit encoder
- IP67 for all motors and connectors
- Large range of motors from 0.16 Nm up to 96 Nm nominal torque (224 Nm peak)



### Ironless linear motors

- Compact, efficient design
- Excellent force-to-weight ratio
- No latching force



### Iron-core linear motors

- Compact, flat design
- Optimum ratio between force and volume
- Weight-optimized magnetic track



# MX2 V1 and RX V1 Inverter

## Fast response inverter for Machine Control

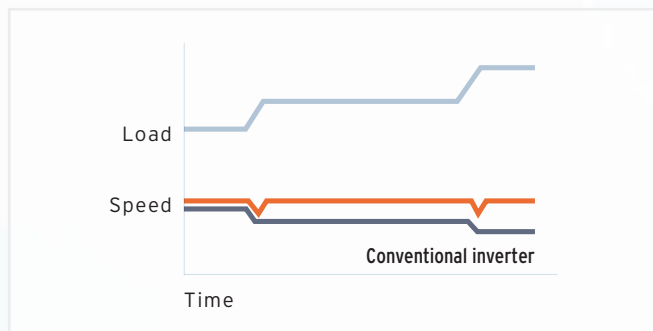
Thanks to its advanced design and algorithms, the MX2 inverter provides smooth control down to zero speed, plus precise operation for cyclic operations and torque control capability in open loop. The RX series combines high performance, application functionality and customisation to match the precise requirements. Both, the MX2 and RX inverter series are fully integrated within the Omron Sysmac automation platform.

### Torque control in open loop

- Ideal for low to medium torque applications
- Can replace a flux vector inverter or servo drive in suitable systems

### Quick response to load fluctuation

- Stable control without decreasing machine speed improves quality and productivity



MX2 V1

EtherCAT®

### MX2 V1 features

- Power range up to 15 kW
- Torque control in open loop, ideal for low to medium torque applications
- 200% starting torque near stand-still operation (0.5 Hz)
- Double rating VT 120%/1 min and CT 150%/1 min
- IM and PM motor control
- Indexer functionality
- Drive Programming
- 24 VDC backup supply for control board and communications
- Built-in application functionality (i.e Brake control)



### Motor efficiency control

- Double rating VT 120%/1 min and CT 150%/1 min
- Energy saving function



RX V1

EtherCAT

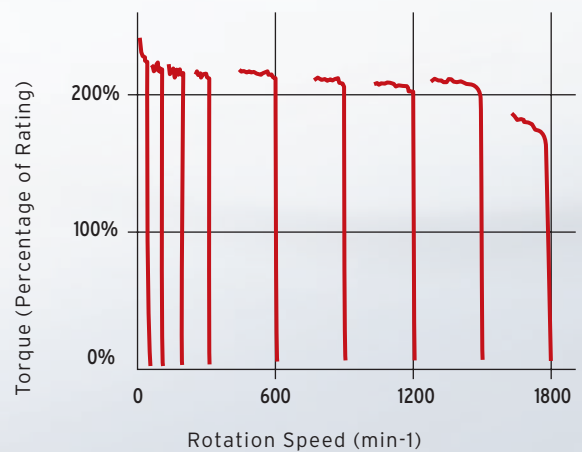
### RX V1 features

- Power range up to 132 kW
- Sensor-less and closed-loop vector control
- High starting torque in open-loop (200% at 0.3 Hz)
- Full torque at 0 Hz in closed-loop
- Double rating VT 120%/1 min and CT 150%/1 min
- Indexer functionality
- Drive Programming
- Built-in application functionality (i.e ELS - Electronic Line Shaft)

### 200% starting torque

- Near stand-still operation
- High starting torque in open loop
- Control of fast cyclic loads

(Example of Speed vs. Torque Characteristics:  
RX series V1 type)



# FH Vision System/FQ-M Smart Camera

## Image sensing checks conditions and flexibly changes machine action

Sensing devices play an important role in flexible machine control.

Performance that quickly and accurately moves the entire apparatus when embedded in a machine is incorporated into a compact image sensor.

### FH Vision System

#### High speed input/measurement/output

- All steps have been accelerated, with an image input speed of 3.3 ms, a high-speed image transfer bus, and 4-core complete parallel processing

#### High accuracy detection



- Incorporates Shape Search III for high-accuracy position detection that is not affected by focal shift or rotation
- Vision Master Calibration makes high-accuracy calibration easy

#### Easy to integrate in Machines

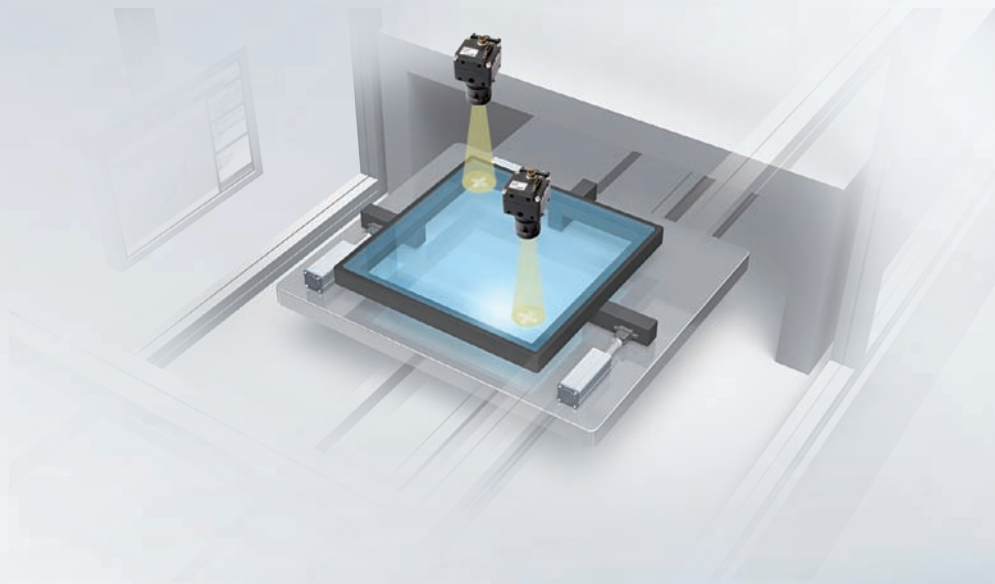
- .NET Control compatible for easy integration with a machine monitor
- Easy customization of original operation interfaces

#### FH features

- Lineup of controllers for 2/4/8 camera connection
- A total of 26 types of cameras can be connected from 300,000 pixels to 5 million pixels
- Almost 100 processes handle a wide variety of positioning and inspection tasks by means of a flow menu
- Supports .NET Control for easy integration with a machine monitor







## FQ-M Smart Camera



### Smart Camera

- Camera and image processing in one
- Standard C-mount lenses; choose the field of view and focus distance you need
- Variety of industrial connector types (angled, straight) for correct mounting

### Tracking applications

- Encoder input for tracking and calibration
- Fast and powerful object recognition
- Up to 5000 pieces per minute with 360 degree rotation

### FQ-M features

- Made specifically for tracking applications
- Fast and powerful object recognition
- Vision sensor with encoder input for tracking function
- Calibration function of the complete system



### High-speed output of measurement results

- EtherCAT port for high-speed motion control
- Ethernet port for advanced configuration and monitoring

# Service and Support



## PRESENCE

OMRON technical offices across the World



**Automation Center**  
Kusatsu (JPN), Shanghai (CHN),  
Barcelona (Spain), Fremont CA (USA)



**Tsunagi laboratory**  
Kusatsu (JPN), Shanghai (CHN),  
Den Bosch (NL)

Technical office

## COMPETENCE

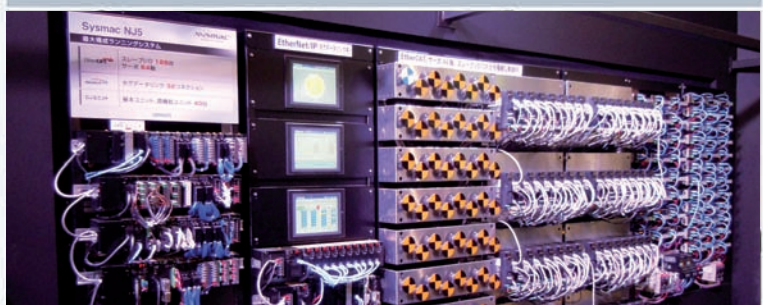
OMRON

### Design



Our wide network of machine automation specialists will help you to select the right automation architecture and products to meet your requirements. Our flat structure based on expert-to-expert contact ensures that you will have ONE accountable and responsible expert to deal with on your complete project.

### Proof of concept



As your project matures make use of our Automation centers to test and catch-up with technology trends in motion, robotics, networking, safety, quality control etc. Make use of our Tsunagi (connectivity) laboratory to interface, test and validate your complete system with our new machine network (EtherCAT) and factory network (EtherNet/IP).

We will assign a dedicated application engineer to assist with initial programming and proof testing of the critical aspects of your automation system. Our application engineers have in-depth expertise in and knowledge of networks, PLCs, motion, safety and HMIs when applied to machine automation.





## CONFIDENCE

### Development



During your prototyping phase you will need flexibility in technical support, product supply and exchange. We will assign an inside sales contact to help you source the correct products fast during your prototyping phase.

### Commissioning



With our world-wide network for service and support the export of your product is made simple, we will support you on-site with your customer, anywhere in the world. We can arrange a liaison sales engineer to facilitate training, spare parts supply or even machine commissioning. All this in a localised language with localised documentation – giving you complete peace of mind.

## ASSURANCE

### Serial production



As your production increases we will engage in supplying you within 24hrs and repairing within 3 days. All our products are global products meeting global standards - CE, cULus, NK, LR -

# Product overview

## Controller



NJ3 CPU units  
for 4 and 8 axes

NJ5 CPU units  
for 16, 32 and 64 axes

### NJ-Series

- Integration of Logic and Motion in one Intel CPU
- Scalable control: CPUs for 4, 8, 16, 32 and 64 axes
- New PLC Logic and Motion cores, 100% Omron quality
- IEC 61131-3 programming languages
- EtherCAT and EtherNet/IP ports embedded
- Certified PLCopen Function Blocks for Motion Control
- Reuse with most of the CJ-series I/O units



## I/O



NX I/O

### NX I/O

- Over 70 models of I/O units including position interface, temperature inputs and integrated safety
- High-speed I/O units synchronised with the EtherCAT cycle
- NsYNX technology provides deterministic I/O response with nanosecond resolution
- Automatic backup/restore of all I/O unit parameters
- Detachable front connector with push-in type screw-less terminals in all NX I/O units
- Slim design: up to 16 I/O points in just 12 mm width

## Safety



NX Safety

### NX Safety Control

- The safety controller meets Category 4, PLe according to the ISO 13849-1 and SIL3 according to IEC 61508
- Flexible system lets you freely mix safety controller and safety I/O units with standard NX I/O
- Up to 8 safety input points per unit
- Safety Function Blocks conforming to IEC 61131-3 standard programming
- PLCopen Function Blocks for safety

## Servo



### G5 servo drive

- High-response frequency of 2 kHz
- Built-in safety conforming ISO13849-1 Performance Level d
- High accuracy provided by 20 bit encoder
- Advanced vibration suppression functions



### G5 servo motor

- Power range from 50 W to 15 kW
- IP67 protection
- Low cogging torque



### Linear motor solutions

- Linear motor force range from 26.5 to 760 N
- Ironless and iron-core motor types available
- Wide range of over 100 standard linear motor axes



## Inverter



### MX2 V1

- Power range up to 15 kW
- Torque control in open loop
- 200% starting torque
- Double rating VT 120%/1 min and CT 150%/1 min
- Drive Programming



### RX V1

- Power range up to 132 kW
- Sensor-less and closed-loop vector control
- High starting torque in open-loop (200% at 0.3 Hz)
- Full torque at 0 Hz in closed-loop
- Double Rating VT 120%/1 min and CT 150%/1 min
- Drive Programming

## Vision and sensing



### FH series Vision System

- Fast processing of all steps, including image input, measuring, and output.
- Incorporates Shape Search III for high-accuracy position detection that is not affected by focal shift or rotation.

### FQ-M series Smart Camera

- Camera, vision and connectivity in one
- Designed for high speed pick and place
- Encoder tracking and smart calibration function



### ZW series displacement Sensor

- Compact and lightweight fiber displacement sensor
- Stable measurements for any material with same mounting position
- Robust sensor head structure



### N-Smart

#### E3NX-FA Fiber Sensors

- Auto adjustment to optimum light level with dynamic range of 40,000 times

#### E3NC-L Compact Laser Sensors

- 2 types of head are available for long distance and variable spot type and minute spot type

#### E3NC-S Ultra-compact CMOS Laser Sensors

- Stable detection from to glossy workpieces to black rubber with the industry's smallest body\*

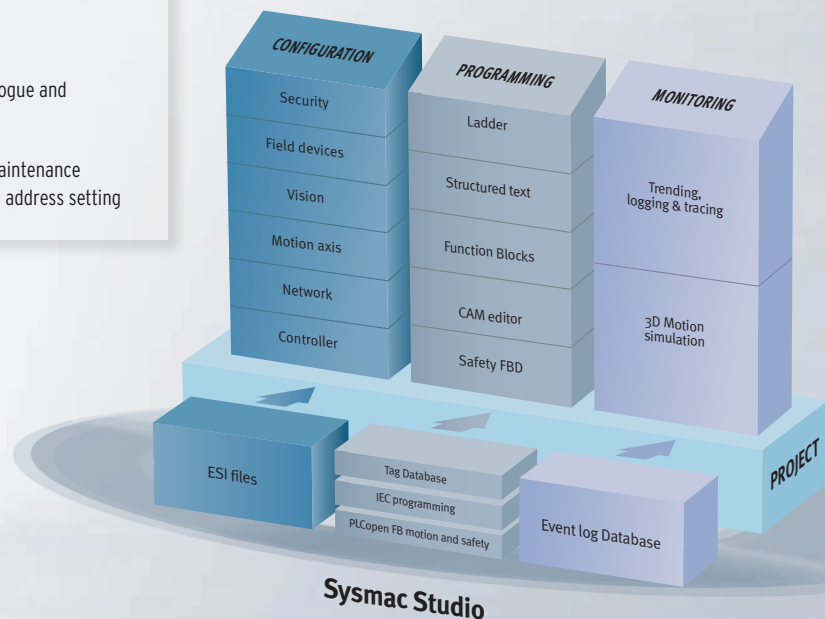
\*Based on February 2013 OMRON investigation

## Distributed I/O



### GX series

- Wide variety of lineup: digital, analogue and encoder I/O units
- High-speed input
- Removable I/O terminal for easy maintenance
- Easy set-up: automatic and manual address setting



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