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South Africa	Circuit Breaker Industries LTD Private Bag 2016, Isando 1600, Johannesburg, South Africa	Tel : 27-11-928-2000 Fax : 27-11-392-2354
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China	Ryoden International Shanghai Ltd. 3F Block5 Building Automation Instrumentation Plaza 103 Cao Bao Rd. Shanghai 200233 China	Tel : 86-21-6475-3228 Fax : 86-21-6484-6996
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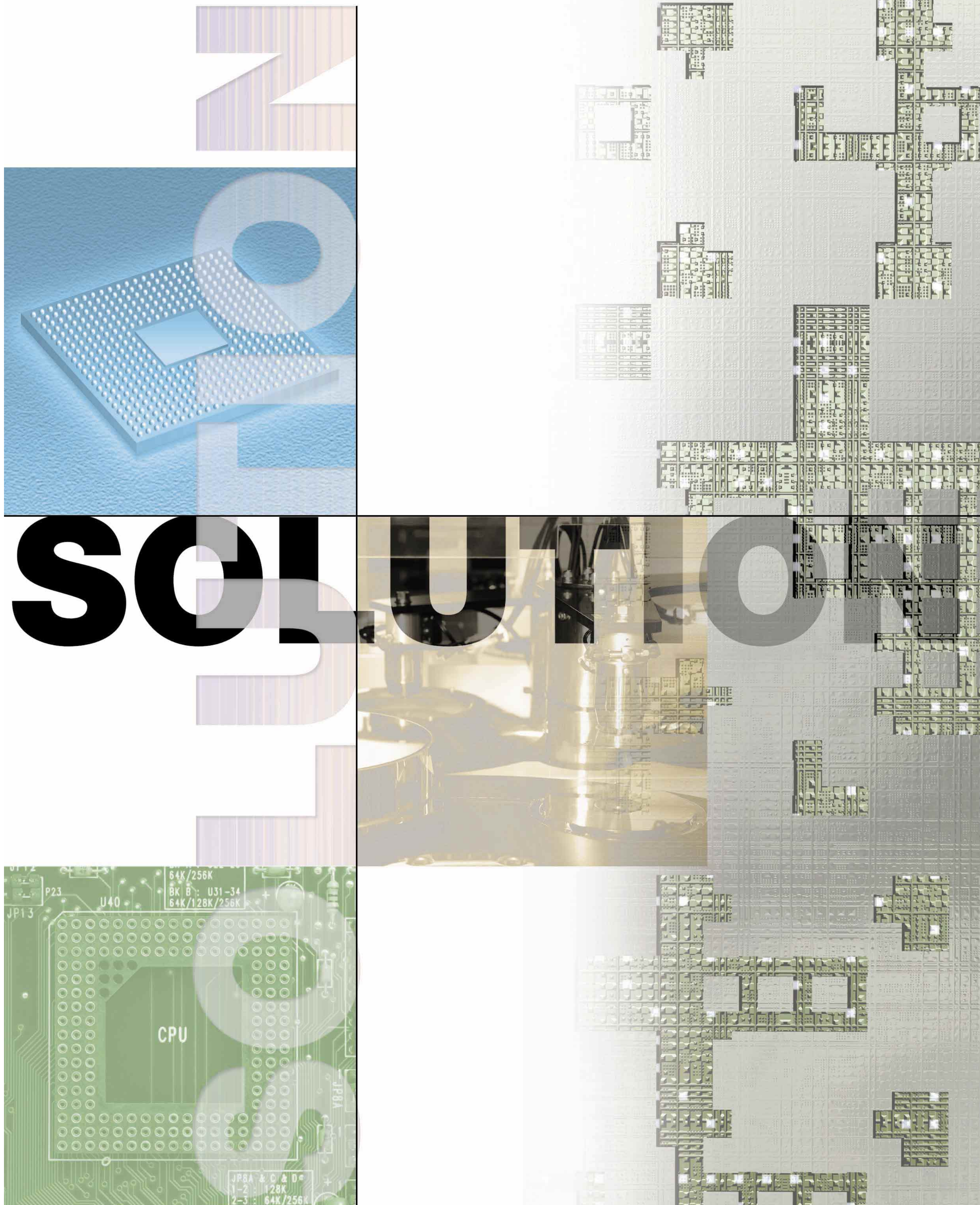
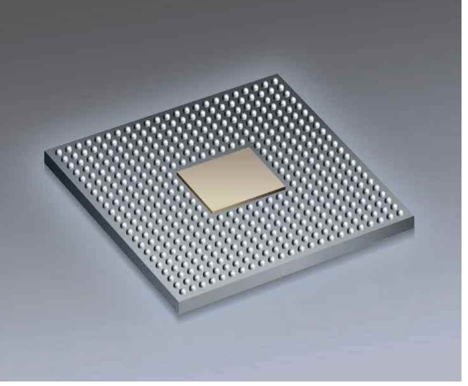
Solutions for Semiconductor Manufacturing Equipment





Needs and Challenges of Semiconductor Factories in the 21st century

- Factory automation in the 300 mm age and line/process management for single wafer process.
- Realizing stable, high-efficiency production (improving yield and reducing the RPT)
- Lean production of diversified products and shorten TAT in the age of SOC

RPT: Raw Process Time (equipment's actual production time) SOC: System On Chip (system LSI) TAT: Turn Around Time (time from order to delivery)

The Challenges of Semiconductor Manufacturing Equipment

1 Reduced footprint for 300mm

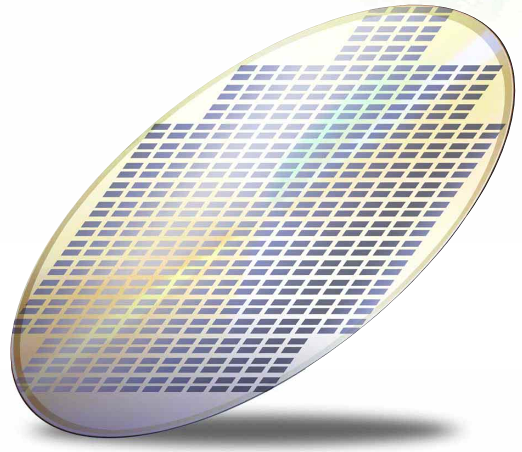
As well as being compatible with 300 mm wafers, it is necessary to reduce the size of the equipment so that space savings can be achieved in the cleanroom.

2 Improving throughput (improved performance of the equipment)

The single wafer processing, which processes and controls wafers one by one, will be the mainstream for the handling of 300 mm wafers. Therefore, high-performance equipment will be required in order to improve its throughput.

3 Maintaining the repeatability of the process results and reducing variations between machines, as well as among products (stabilized process)

Fine-tuning by the in-situ monitor is indispensable in order to eliminate problems of repeatability, in which the results do not match after processing with the same recipe, and problems of variation among equipment and products. (Support of in-situ process



4 Support of Advanced Process Control (APC) for high productivity (stabilized process)

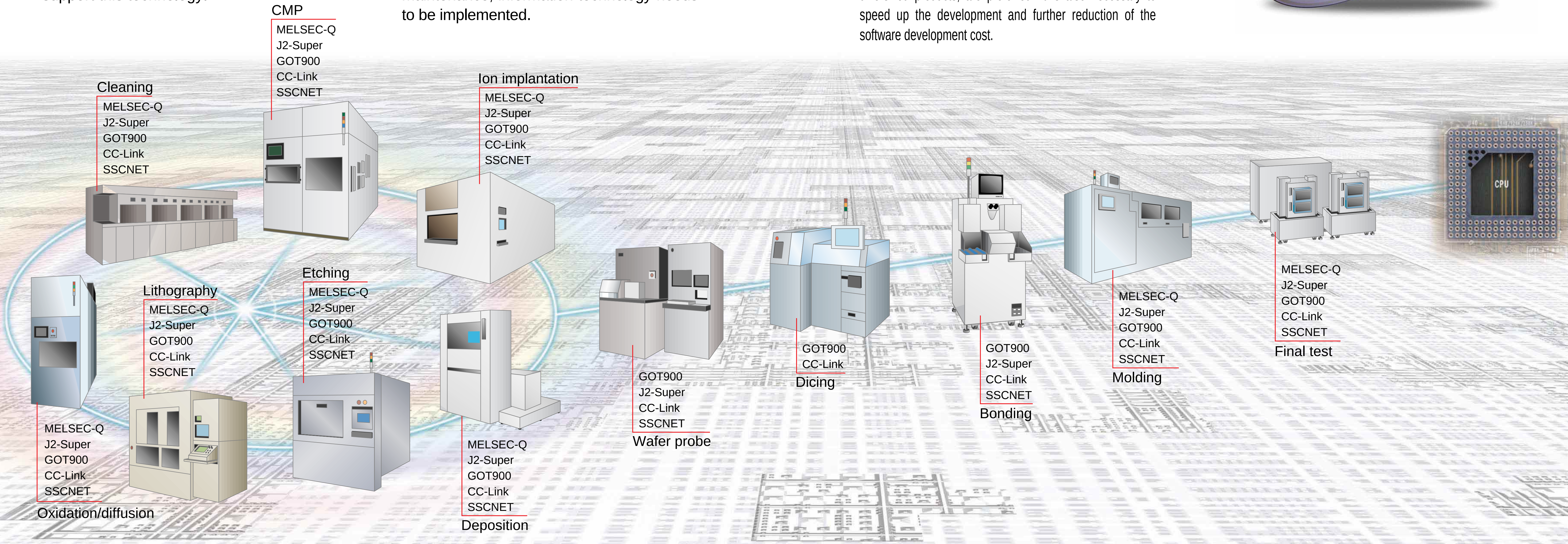
APC is getting attentions as a process control technology for achievement of high productivity. The equipment is required to support this technology.

5 Intelligent equipment that supports factory automation

As the factories are automated and as the equipment is becoming intelligent, such as in the close link with the host and remote maintenance, information technology needs to be implemented.

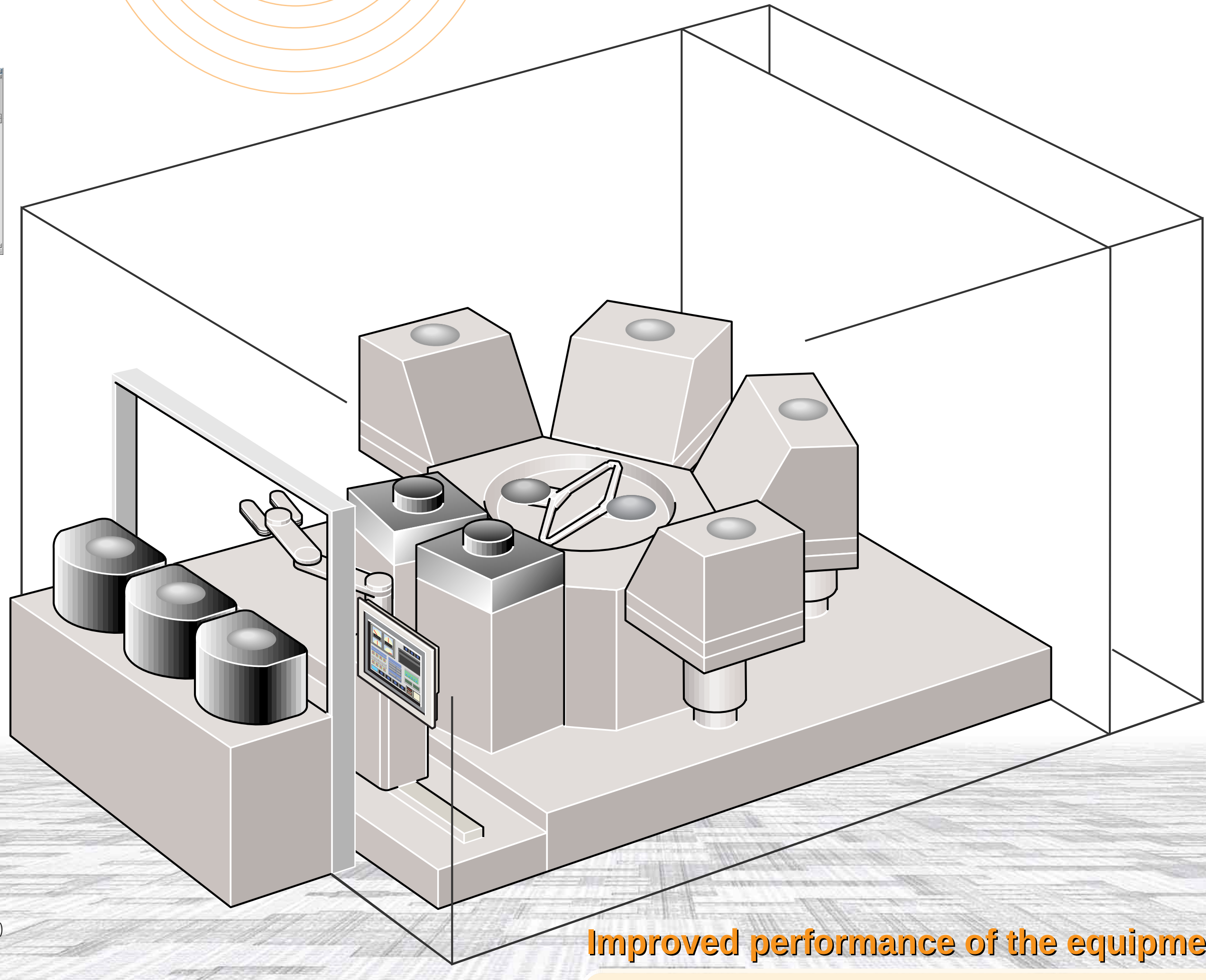
6 Shortening the construction period and reducing the cost of software development

In the age of SOC, a short installation period corresponding to the lifecycle of the device and multifunctional, small-size, and low-cost equipment suitable for lean production of diversified products, are preferred. It is also necessary to speed up the development and further reduction of the software development cost.



Mitsubishi Electric's control technology strongly supports the evolution of semiconductor manufacturing equipment.

Semiconductor manufacturing equipment

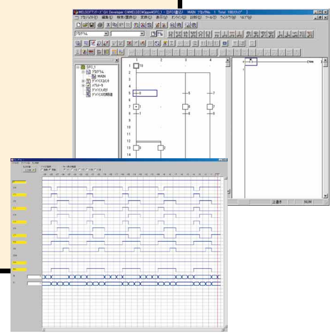


Shortening the installation period and reducing the cost of software development

Consolidated engineering environment

MELSOFT

■ It is easy to write control programs using the graphical language for the control program.
■ Debugging is possible by the simulation function, without real machine.
■ The program can be updated during execution, making it easy to revise the program and check the operation.
■ Creation of the operator interface screens (HMI screen) is similar to drawing. The screens can be created intuitively and visually.



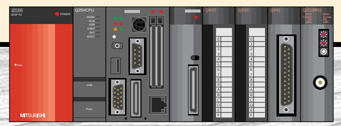
Improved performance of the equipment, stabilized process, adding intelligence to the equipment and reduced footprint

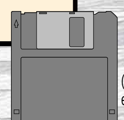
Multiple-CPU controller

MELSEC-Q Series

■ Palm-size, ultra-compact and super high-speed controller
■ High-speed, highly accurate control is achievable by real-time and deterministic control technology.
■ With multiple CPUs of the control CPU and PC CPU (Note1), the control system and information processing system are separated and integrated.
■ Internet technology and the database technology are utilized with the PC CPU.

Note 1: PC CPU is a product of CONTEC Co., Ltd.





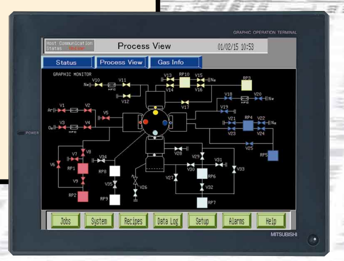
Adding intelligence to the equipment

HMI terminal

GOT900 Series

Graphic Operation Terminal 900 series

■ The invisible area inside the equipment can be monitored through a camera using the video display function.
■ Support for multiple languages by unicode (English, German, French, Chinese, Korean, Japanese, etc.)
■ Equipment alarms can be reviewed easily using the alarm history function.
■ The terminal is equipped with a VGA interface and can be used as a PC monitor, as well.



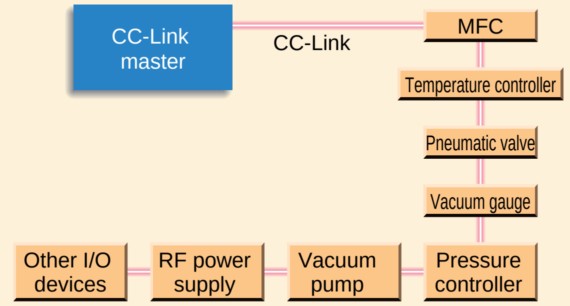
Improved performance of the equipment and stabilized process

High-speed SAN (Sensor Actuator Network)

CC-Link

SEMI Recognized

■ Open network
■ Stability and high-speed response is kept even with large number of nodes
■ Optimal network for in-situ control
■ Wiring cost reduction through reduced wiring

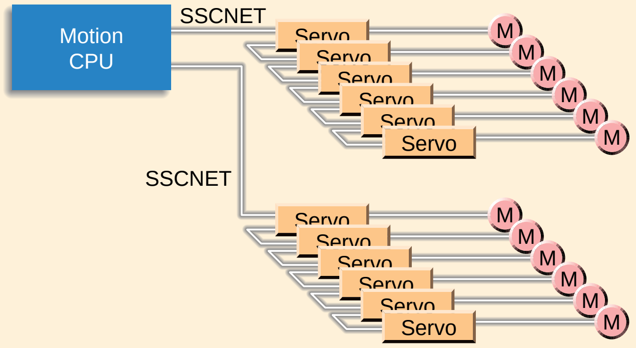


Improved performance of the equipment

High-speed servo network

SSCNET

■ High-speed, highly accurate positioning is possible (0.88 ms of high-speed command interval).
■ Easy configuration of the synchronized system and absolute system for servo motors
■ Wiring cost reduction through reduced wiring



Improved performance of the equipment

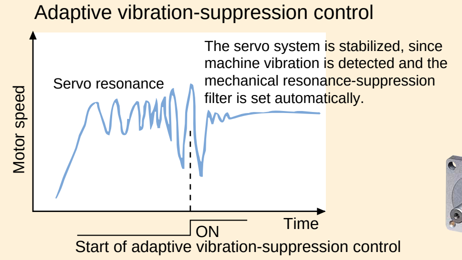
High-speed, high-performance AC servo

MR-J2-Super

J2-Super

■ A speed-loop frequency response of 550 Hz enables high-speed stabilization.
■ A high-resolution absolute encoder (131,072 p/rev) as standard achieves improved positioning accuracy and reduced rotation variation at low speeds.
■ Automatic suppression of machine vibration by adaptive mechanical vibration-suppression control

Adaptive vibration-suppression control



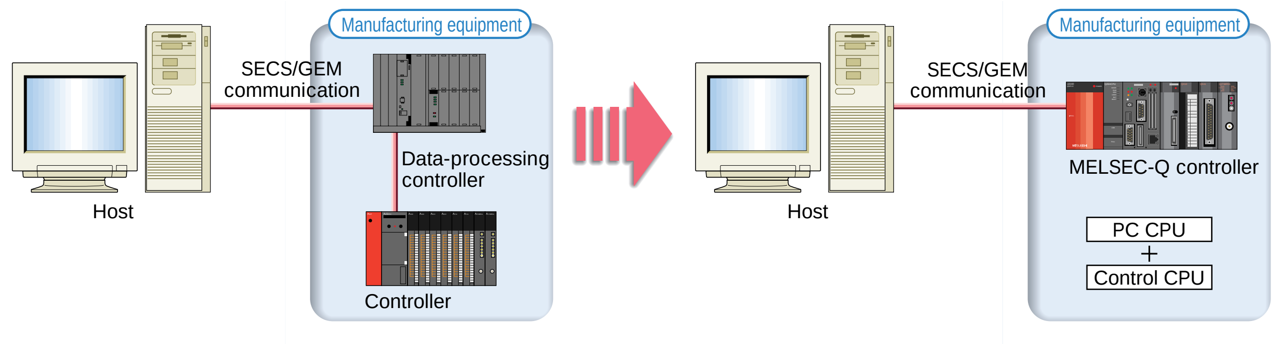
SOLUTION 1

Solution for reducing the footprint

Ultra-compact MELSEC-Q controllers and networks (CC-Link, SSCNET) strongly support equipment downsizing.

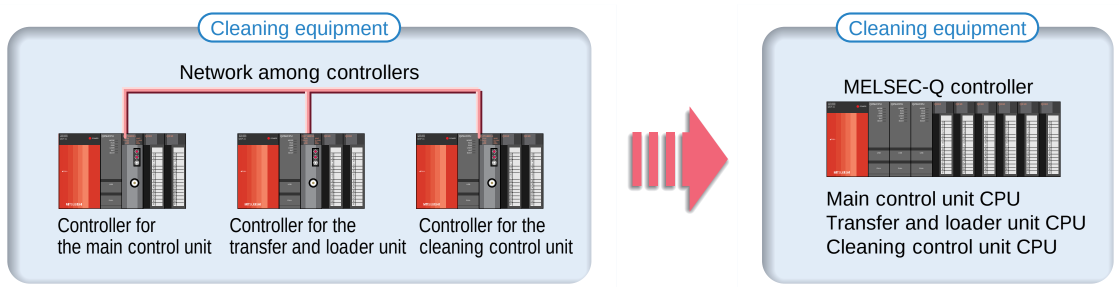
1) Space saving by integrating the PC functions

In the past, a data-processing controller such as a PC was necessary separately from a controller for data process functions such as host communications and process scheduling. Now, the PC CPU integrates those functions on a controller rack and, accordingly, space can be saved.



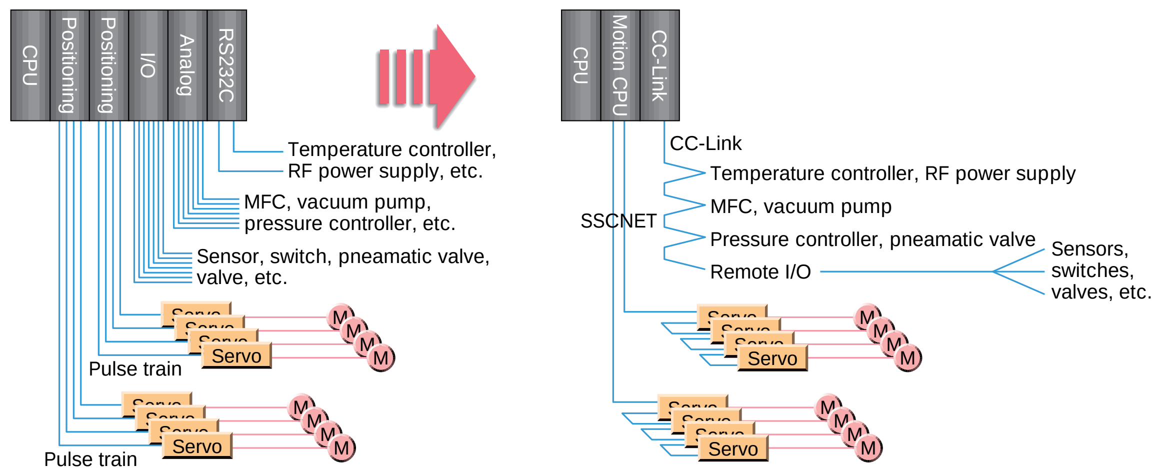
2) Space saving by integrating multiple controllers

In the past, each controller needed one CPU. Therefore, several controllers were needed for each distributed modularized function. Now, a multi-CPU system can integrate modularized CPUs on one controller so that the space can be saved. Additionally, power supplies, racks and communication interfaces can be reduced so that costs can also be saved by integrating CPUs.



3) Wiring and space saving by CC-Link and SSCNET

Connecting sensors and actuators by the network reduces cables in the equipment, wiring time and space.



SOLUTION 2

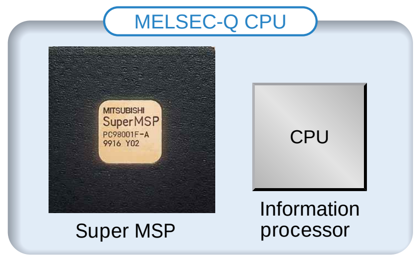
Solution for improved throughput

High-performance controllers, high-performance servos and high-performance networks strongly support the high performance of the equipment.

1) Increasing control speed by the MELSEC-Q Series high-performance multiple-CPU controller

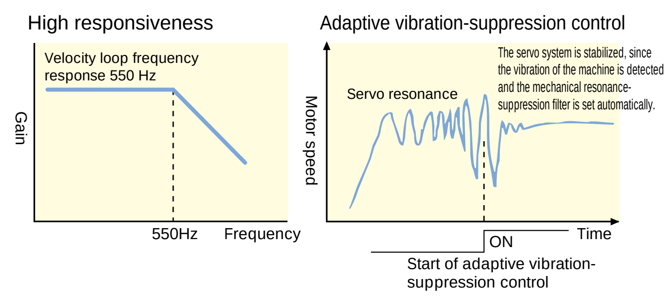
The multiple-CPU configuration with CPU modules of which execution speed for the basic instruction is 34ns does not only achieves higher performance, but also elevates the equipment potential to a higher degree with deterministic real-time control technology.

- High-speed processing speed; basic instruction = 34 ns (dedicated control processor: Super MSP on-board)
- Stable control performance is achieved with dual processors-Super MSP and the information processor eliminating affections to control performance by host computer accesses.
- Highly accurate closed-loop control is achieved by constant interval execution of 0.5 ms minimum interval.
- High-speed response is achieved by interrupt program execution. (A maximum of 256 interrupt factors can be set.)



2) Highly accurate, high-speed positioning by the MR-J2-Super high-performance servo

- 550Hz speed loop response servo achieves ultra-high speed stabilization for high speed positioning applications.
- A high-resolution absolute encoder, 131072 p/rev (17 bit), as standard provides stability and high responsiveness at low speeds.
- Machine vibrations can be reduced by applying optional mechanical resonance suppression filter upon real time and automatic detection of vibrations.
- Fully equipped with Mitsubishi's unique, state-of-the-art mechanisms such as the model adaptive control, real-time auto-tuning function, automatic motor identification function, etc.



3) High-performance motion control via SSCNET and motion CPU

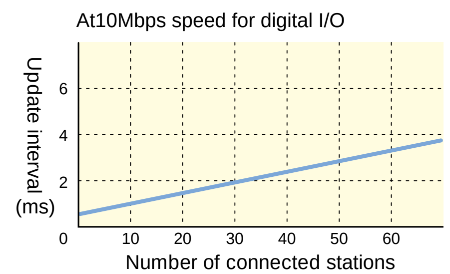
- Support of high-resolution encoders
  As responsiveness increases, encoders are evolving toward higher resolution (130,000 pulses or more).
  A 130,000-pulse encoder requires a command frequency equivalent of 9.3 Mpps at a speed of 5,000 r/min. However, motor speed cannot be increased because of the limitation of the command frequency (500 Kpps to 1 Mpps) in case of the pulse train command system.
  SSCNET is not constrained by frequency, so the performance of the servo can be fully utilized.
- SSCNET can synchronize servo axis to the clock of the controller, so that all axis are synchronized for controls such as interpolation
  Such synclonization cannot be executed by the pulse train command system.
- A high-speed command interval of 0.88 ms enables high-speed, highly accurate positioning.
- An absolute system, which does not require the machine to return to the origin after power on, can be configured easily.

4) High-speed I/O by CC-Link

In order to configure a stable, high-speed remote I/O control system, master module for the MELSEC-Q controller, master card for the PCI bus, various remote I/Os and analog I/Os are available. These modules are compatible with CC-Link, which is a high-speed SAN with a maximum transmission speed of 10 Mbps.

Features of CC-Link
- High-speed data refresh interval (4 ms with 64 remote I/O stations)
- Stable response that maintains the accurate timing of data transfer
- Distributed control is feasible via communication among several controllers.

SEMI recognized

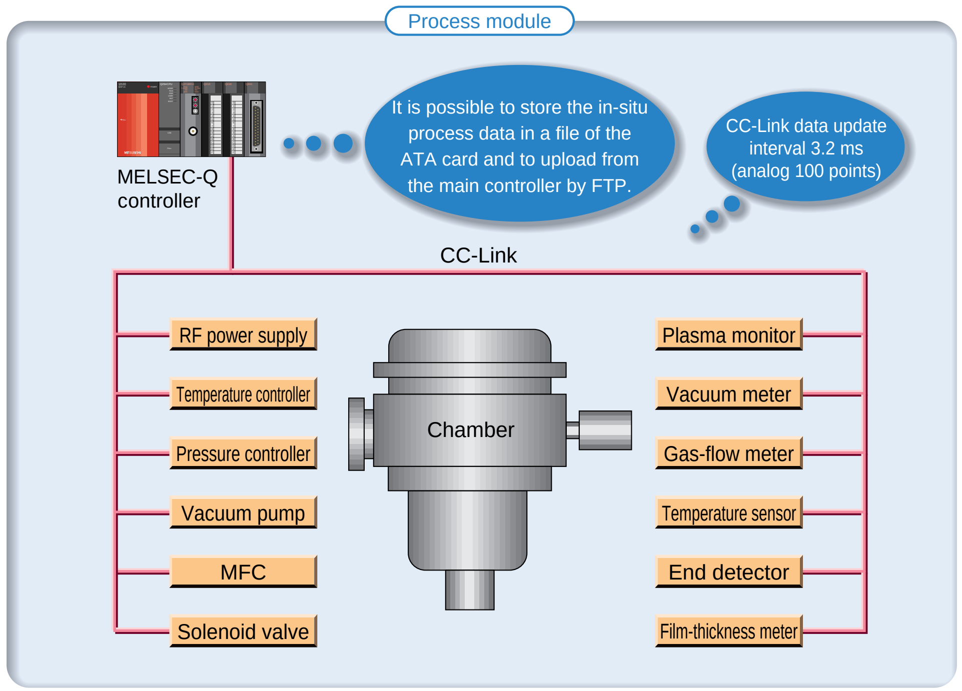


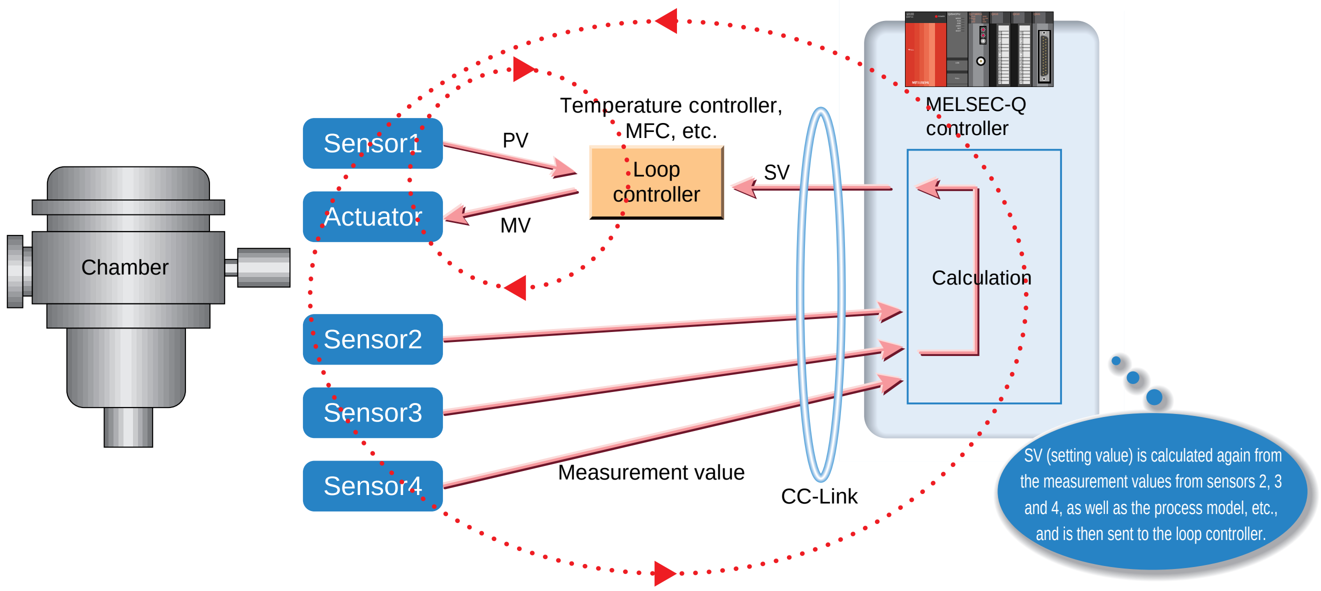
SOLUTION 3

Solution for maintaining the repeatability of the process results and for reducing variations between machines and among products

Capable of in-situ process control, which is essential to the solution for such problems, by the high-performance multiple-CPU controller MELSEC-Q and the high-speed SAN

There are problems of repeatability of processing results. Processing results of identical machines with same recipe are not same. Further, processing results of a machine with same recipe are always gradually drifted. In reality, differences of machines, wafers and processing timing cause variations.
Fine-tuning by the in-situ monitor is indispensable in order to eliminate such process instabilities.





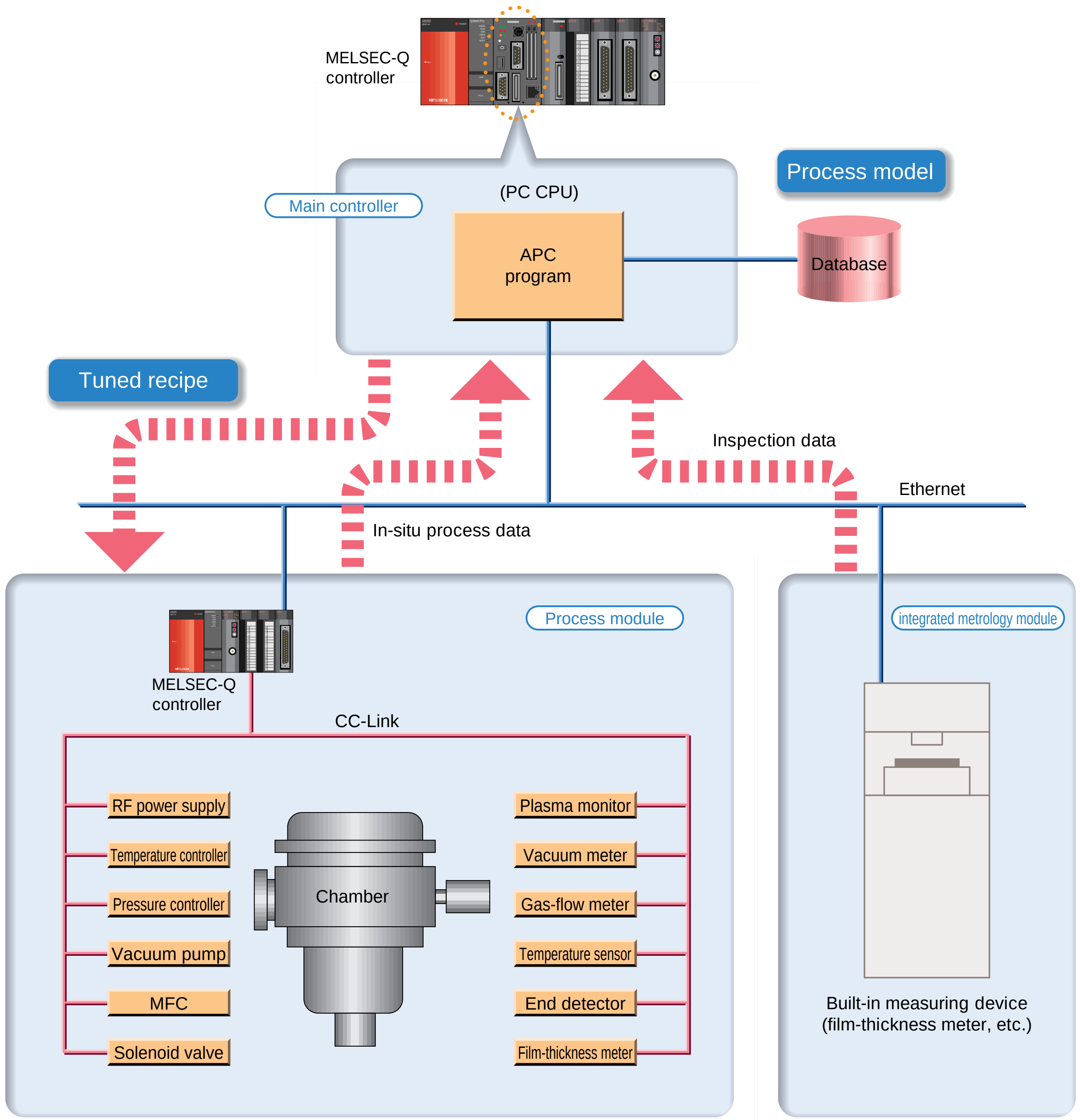
Example of real-time process control by the in-situ monitor

SOLUTION 4

Proposal of Advanced Process Control (APC) for high productivity

Ready for Advanced Process Control (APC) in the equipment by utilizing off-the-shelf Windows® software for the PC CPU

In APC, the process result data is collected from the processing equipment and the inspection measuring devices, then the recipe parameters are calculated based on the data and an appropriate process model. These new recipe parameters are used by the next process, Moreover, by executing APC in the equipment, some of the process parameters can be adjusted for each wafer instead of each lot. Therefore, additional effects such as improved yield and reduced scraps and reworks can be expected.



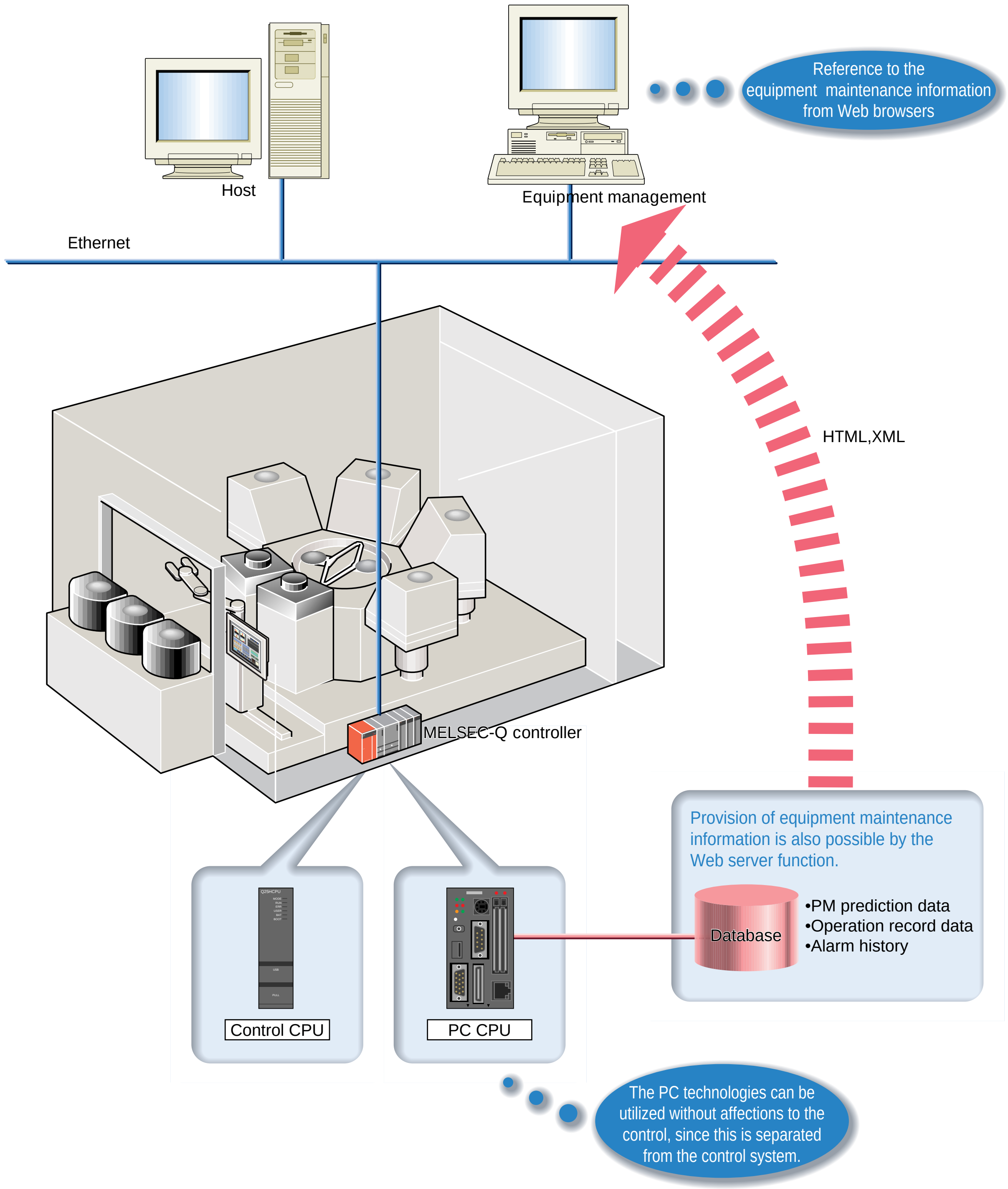
* Microsoft® Windows® is a registered trademark of US Microsoft Corporation in the United States and other countries.

SOLUTION 5

Support for the growing intelligence of equipment (incorpoartion with information technology)

It is possible to add intelligence to the equipment by utilizing the PC technologies (Internet technology, database, etc.) on the PC CPU.

Since separate and independent CPUs of the information processing system and control system are integrated as one controller, the PC technologies (network, Web, database) can be safely utilized without affecting control performance, and the information processing system and control system can be merged seamlessly.



SOLUTION 6

Solution for shortening the commissioning period and reducing the cost of software development

MELSOFT consolidated engineering environment

- ◆The graphical languages make it easy to write control applications.
- ◆The simulation function allows debugging without an actual machine.
- ◆The program can be modified during operations, making it easy to change the program and check the operations.
- ◆HMI (operator interface) can be developed without programming.

Shorter development period of the equipment application and reduced process steps

●Graphical languages for describing the control system

Top-down design and modularization are supported so that visible and easy-to-maintain programs can be written for complicated control systems.

Sequential Function Chart (SFC)

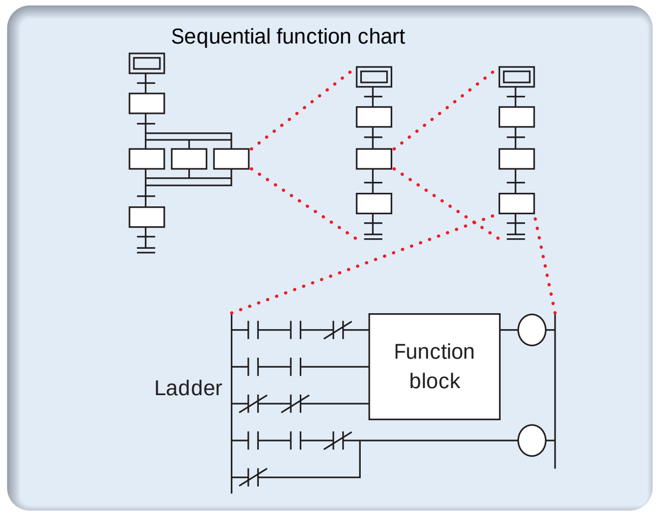
Suitable for describing changes of status that occurs sequentially, and a hierarchical approach, from macro to micro, is possible. (Top-down design support)

Function Block (FB)

FB is a reusable program element where the processing procedure can be packaged . Like electrical circuit design, the function block diagram (FBD) is also planned in order to describe the signal flow using lines to interconnect modularized FBs. (Bottom-up design support)

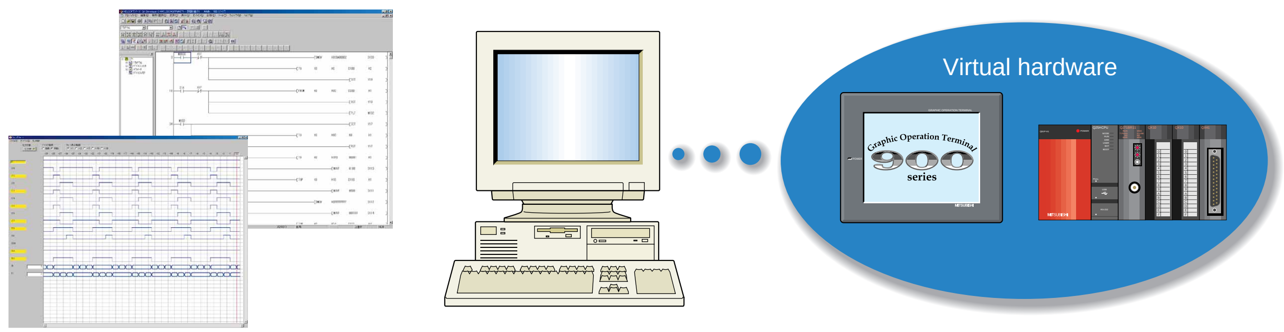
Ladder (LD)

This is best suited for describing the ON/OFF logics, and is applicable to event-driven programming.



●Simulation function

Without the target hardware, this function allows debugging of the created control program and HMI screen by executing a virtual controller and a virtual HMI terminal on the PC. It is possible to develop application programs in advance and test the majority of the programs at the initial stage of the development cycle until the hardware becomes ready.



Proposals for the Cleaning Equipment

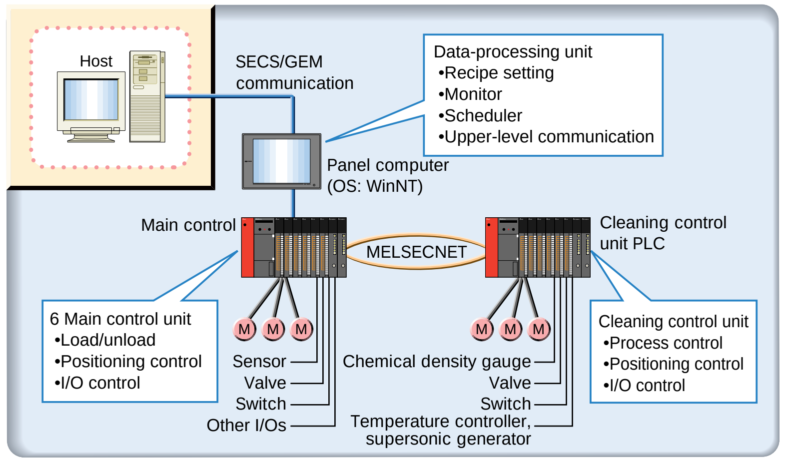
Configuration Example of a Conventional System

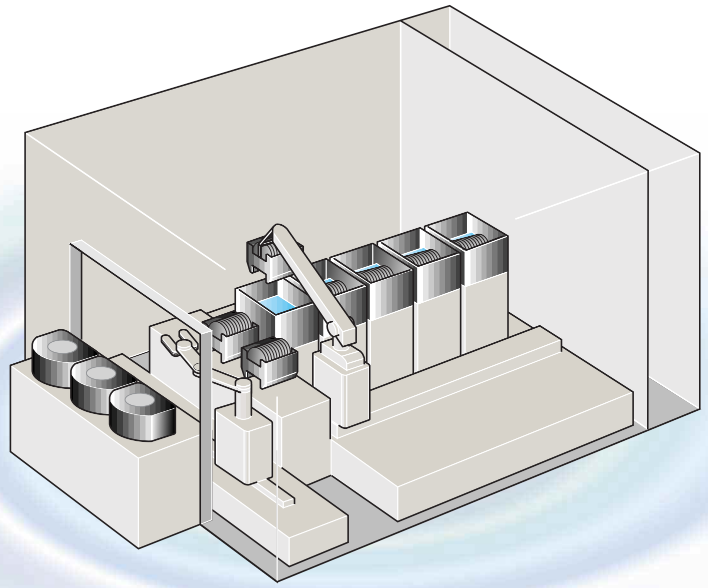
1) The controller's functions are divided into main control unit, the cleaning control unit and the data-processing unit including HMI, and are distributed over the network.
(Distribution method over the network was the only choice for function distribution and modularization.)
PLCs are often used for the controllers.

2) The batch process scheduler function is implemented into a PC (panel computer) separated from the PLC. The scheduler's function is to determine the best timing for loading of a new batch by predicting the processing finish time of the wafers in each tank and the chemical change, with various parameters such as the lifecycle of the chemicals, usage, transfer time between tanks, etc.

3) Servo motor controls with the pulse train command method are used for wafer cassette transfer between tanks and for the positioning of the loader/unloader mechanism. Each servo amplifier is connected to the controller by the signal line.

4) I/O devices, such as sensors, valves and switches, are connected to the controller's I/O modules.



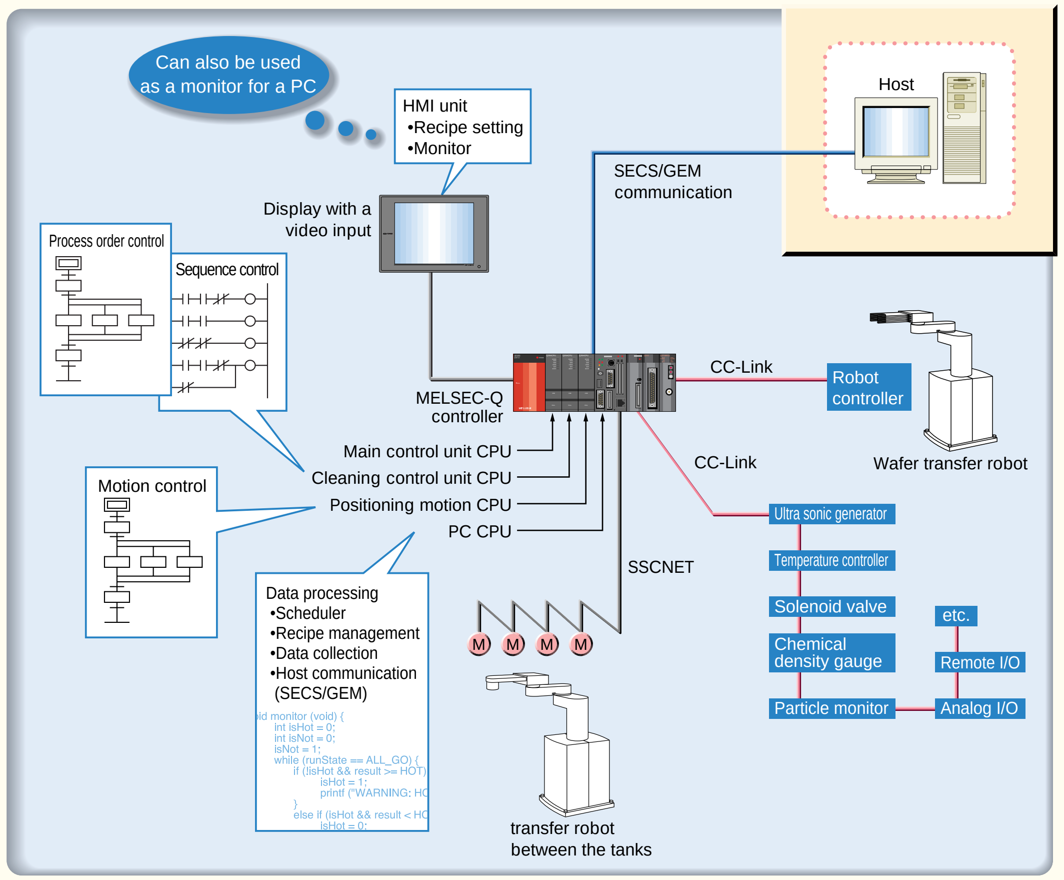


Challenges of the Equipment

1 Handling 300 mm wafers and reducing the footprint
2 Reducing the equipment cost and improving the cleaning capability
3 Supporting the automation (interface with the automatic transfer unit and standardization relating to the CIM framework)
4 Reducing the software development cost
5 Improving throughput (optimization of load timing, chemical change and transfer between tanks)
6 Improving the availability and yield of the equipment (prevention of over-dipping through optimized load timing)
7 Reducing the number of chemicals used and reducing the amounts of chemicals and pure water used
8 Flexibility for supporting the lean production of diversified products such as system LSI (handling multiple chemicals in the same tank)

Configuration Example of the Proposed System

SUGGESTION



Proposal 1 While maintaining function modularization and distribution, space saving and cost reduction are achievable by integrating the main control unit, the cleaning control unit and the data-processing units including HMI onto a single controller of multiple CPUs.

Proposal 2 An external PC (panel computer) becomes unnecessary by implementing the SECS/GEM communication and the batch loading scheduler function to the PC CPU.

Proposal 3 A complicated robot arm control for wafer cassette transfer between tanks and the positioning of the loader/unloader mechanism can be executed at high speed and high precision with improved throuput by the motion control CPU .

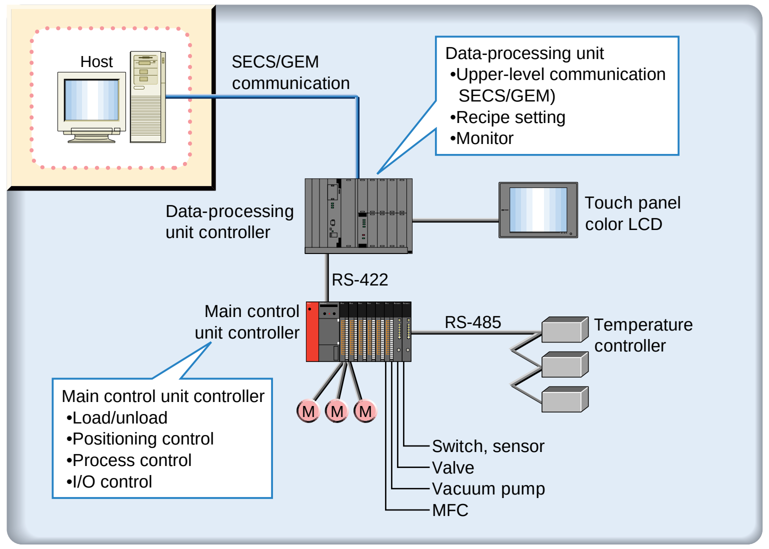
Proposal 4 Synchronized controls and absolute controls of the servo motors as well as wiring reduction can be configured easily, by using SSCNET network for connections between the motion CPU and servo amplifiers.

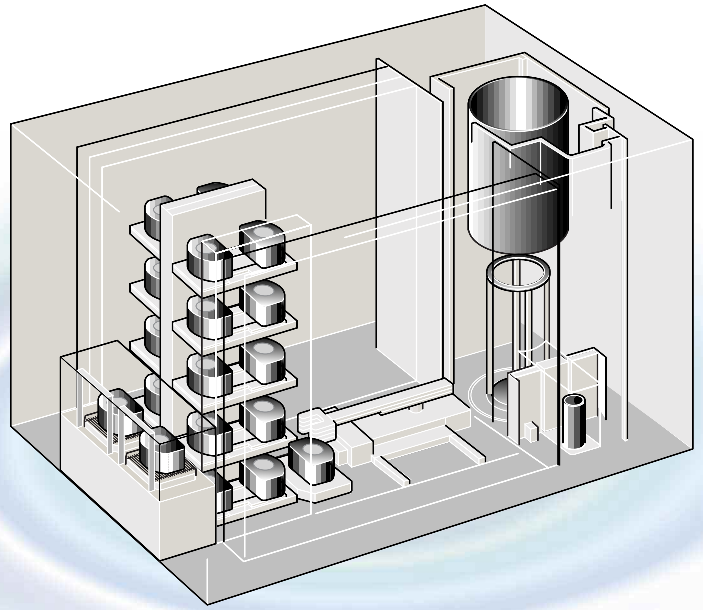
Proposal 5 Wiring can be reduced, without losing high-speed I/O performance, by using CC-Link for connections of temperature controllers and I/O modules connecting sensors, valves and switches.

Proposals for the Oxidation, Diffusion and Low-Pressure CVD Equipment

Configuration Example of a Conventional System

1) The controller is divided into the main control unit and the data-processing unit including HMI. And they are connected point-to-point via RS-422, etc.
2) Servo motor controls with the pulse train command method are used for wafer carrier transfer and for the positioning of the boat elevator mechanism. Each servo amplifier is connected to the controller by the signal lines.
3) I/O devices, such as sensors, valves and switches, as well as MFC, vacuum pump, etc., are connected to the controller's I/O module or serial interface module.
4) RS-485 is used for connection of the temperature controllers with proprietary protocol of the temperature controllers.

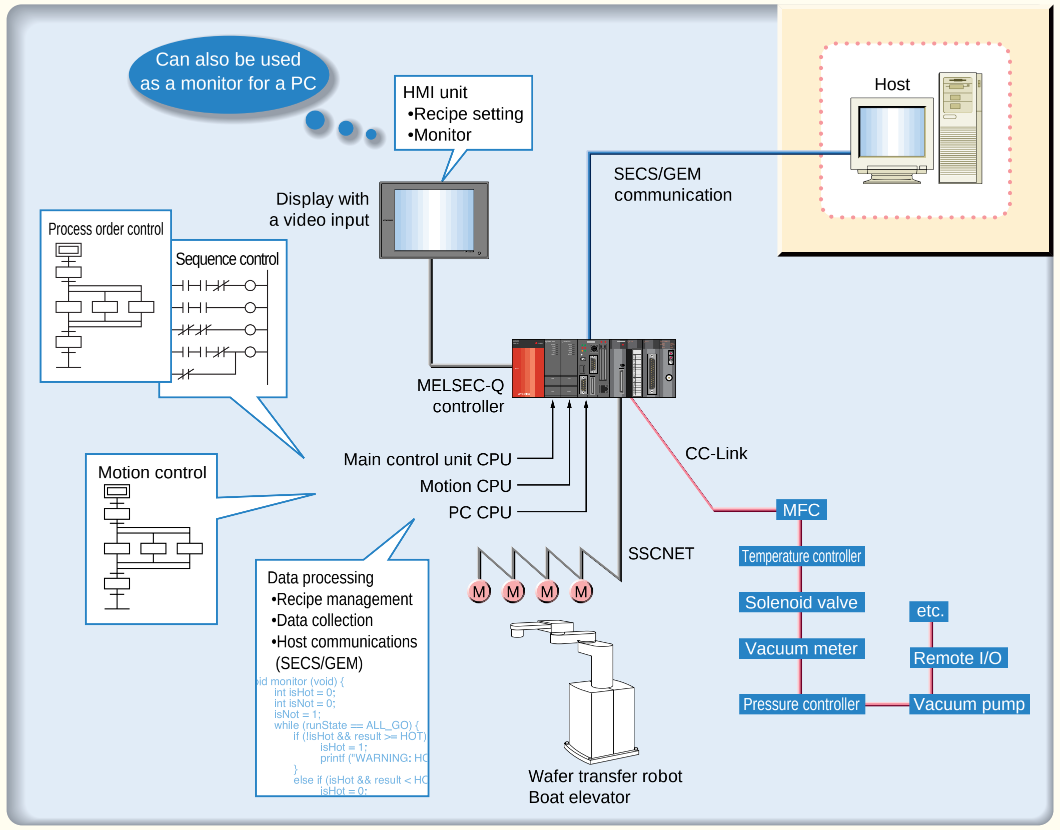




Challenges of the Equipment

1 Handling 300 mm wafers and reducing the footprint
2 Reducing the equipment cost and improving the process performance
3 Supporting the automation (interface with the automatic transfer unit and standardization relating to the CIM framework)
4 Reducing the software development cost
5 Reducing the number of wafers in a batch and reducing the cycle time
6 Improving the availability and yield of the equipment
7 Reducing the amount of dummy wafers used and reducing scraps

Configuration Example of the Proposed System



Proposal 1
While maintaining function modularization and distribution, space saving and cost reduction are achievable by integrating the main control unit and the data-processing units including HMI onto a single controller of multiple CPUs.

Proposal 2
The SECS/GEM communication function and Advanced Process Control (APC) function are implemented to the PC CPU with the off-the-shelf Windows-compatible SECS/GEM software and database software.

Proposal 3
The positioning control for wafer carrier transfer and the boat elevator mechanism can be executed at high speed and high precision with improved throuput by the motion control CPU.

Proposal 4
Synchronized controls and absolute controls of the servo motors as well as wiring reduction can be configured easily, by using SSCNET network for connections between the motion CPU and servo amplifiers.

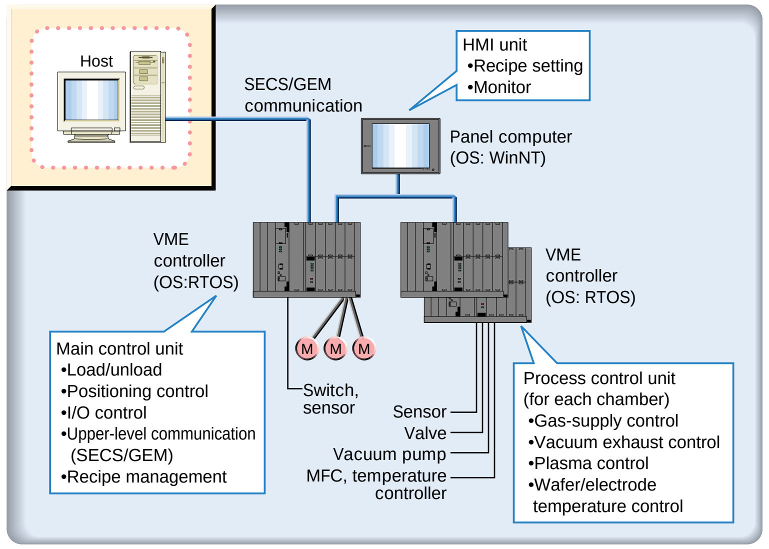
Proposal 5
Wiring can be reduced, without losing high-speed I/O performance, by using CC-Link for connections of temperature controllers and I/O modules connecting sensors, valves and switches.
As long as the temperature controllers are CC-Link compatible, there is no need to consider differences of application programs for temperature controllers from different manufacturers, because the profiles for the temperature controllers are standardized.

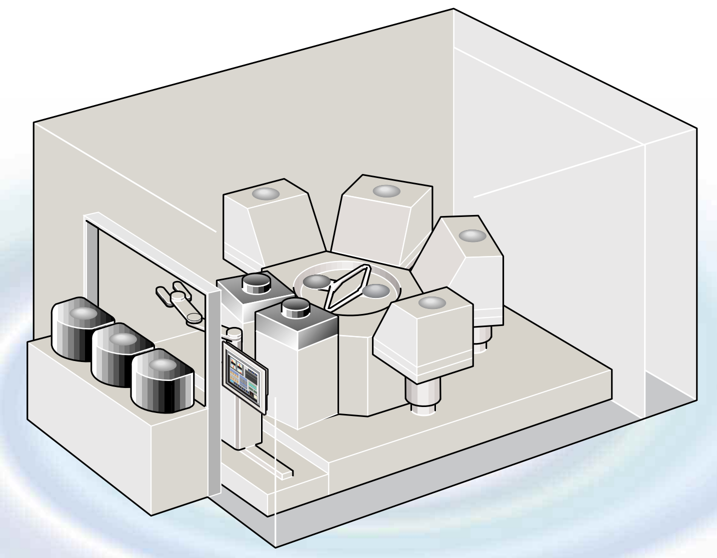
Proposals for the Multichamber Equipment

(Sputtering, dry etching, plasma CVD, etc.)

Configuration Example of a Conventional System

1) The controllers are modularized and distributed to each chamber.
   A VME bus compatible controller with real-time OS is often used for the controller.
2) Ethernet is often used as the network connecting controllers.
3) Servo motor controls with the pulse train command method are used for the positioning of the wafer transfer mechanism. And each servo amplifier is connected to the controller by the signal lines.
4) I/O devices, such as sensors, valves and switches, as well as MFC, temperature controller, RF power supply, pressure controller, vacuum pump, etc., are connected to the controller's I/O modules or serial interface modules.



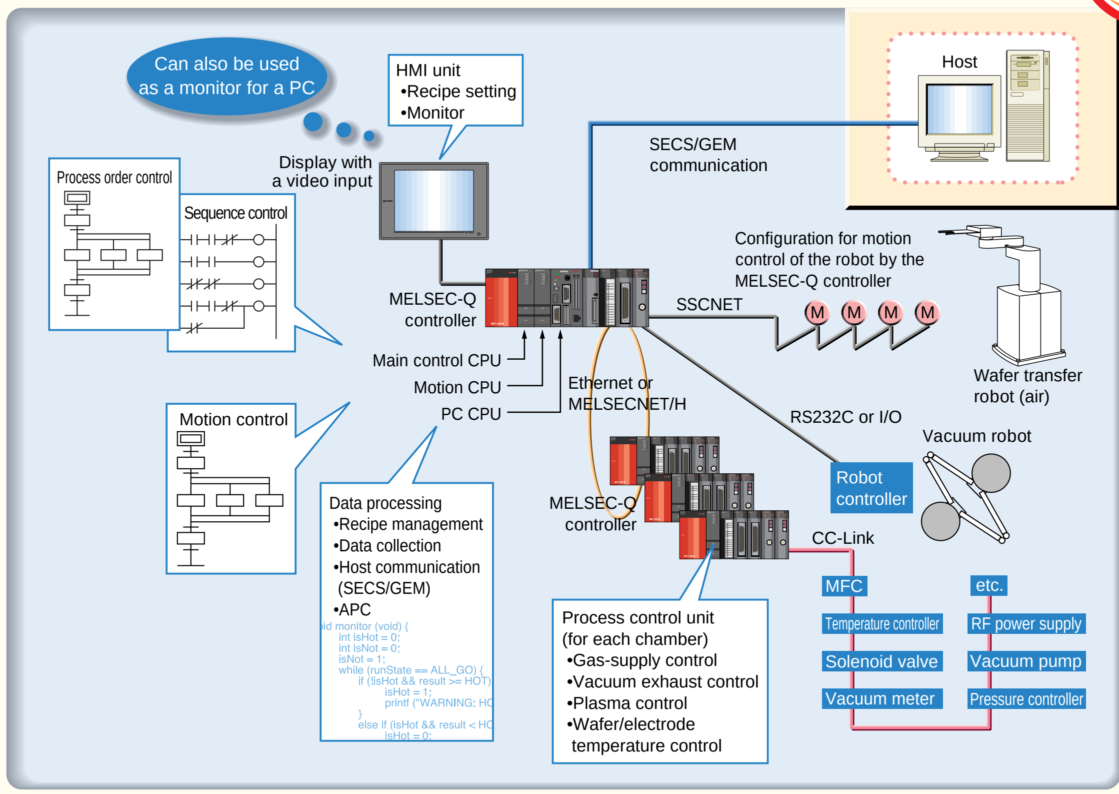


Challenges of the Equipment

1 Handling 300 mm wafers and reducing the footprint
2 Reducing the equipment cost and improving the equipment performance
3 Supporting the automation (interface with the automatic transfer unit and standardization relating to the CIM framework)
4 Reducing the software development cost
5 Maintaining process repeatability and reducing variations between machines and among products
6 Improving the availability and yield of the equipment

Configuration Example of the Proposed System

SUGGESTION



Proposal 1
The distributed control method, which allocates a controller for each modularized chamber, is same as the conventional system. However, the use of the MELSEC-Q controller achieves a smaller installation space requirement for the controller and reduced controller cost as against to the conventional VME system.

Proposal 2
By complete separation of the control system and data-processing system using multiple CPUs at the main control unit so that stable throughput can be maintained because of no affection of data processing load to the control performance.

Proposal 3
The SECS/GEM communication function and Advanced Process Control (APC) function are implemented to the PC CPU with the off-the-shelf Windows-compatible SECS/GEM software and database software.

Proposal 4
Ethernet can be used for large data transfer between controllers, while MELSECNET/H can be used for real-time data transfers between controllers. Therefore, suitable systems can be configured.

Proposal 5
The positioning control for wafer transfer robot can be executed at high speed and high precision with improved throuput by the motion control CPU.

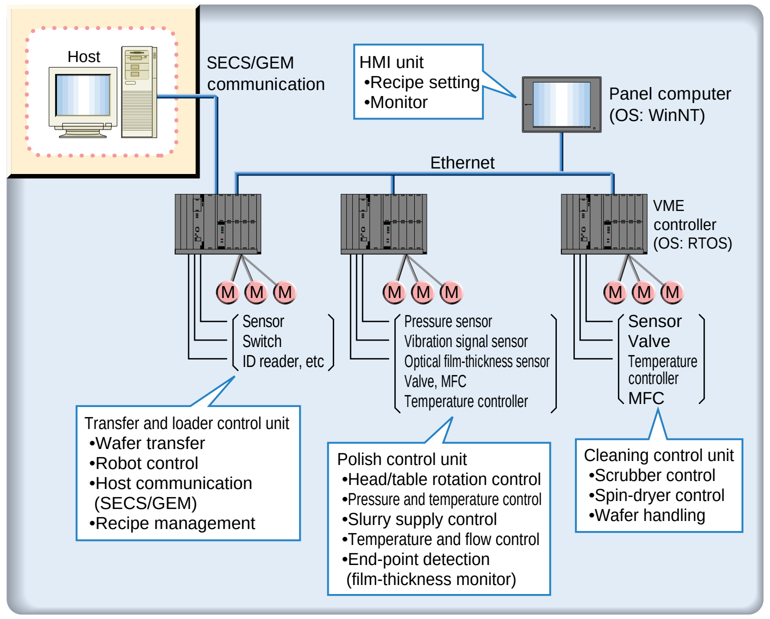
Proposal 6
Synchronized controls and absolute controls of the servo motors as well as wiring reduction can be configured easily, by using SSCNET network for connections between the motion CPU and servo amplifiers.

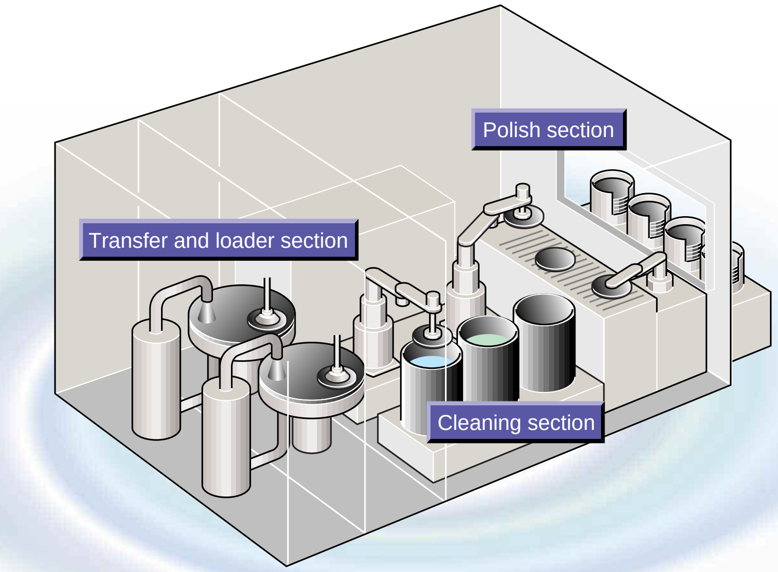
Proposal 7
Wiring can be reduced, without losing high-speed I/O performance, by using CC-Link for connections of temperature controllers and I/O modules connecting sensors, valves and switches.

Proposals for the CMP Equipment

Configuration Example of a Conventional System

1) The controller's functions are divided into the transfer and loader control unit, the polish control unit, the cleaning control unit and the HMI unit, and are distributed over the network. VME bus compatible controllers with real-time OS are often used for the controllers.
2) Ethernet is often used as the network connecting the controllers.
3) Servo motor controls with the pulse train command method are used for the positioning of the wafer transfer mechanism. And each servo amplifier is connected to the controller by the signal lines
4) I/O devices, such as sensors, valves and switches, as well as film-thickness sensor, temperature controller, etc, are connected to the controller's I/O card or serial interface card.



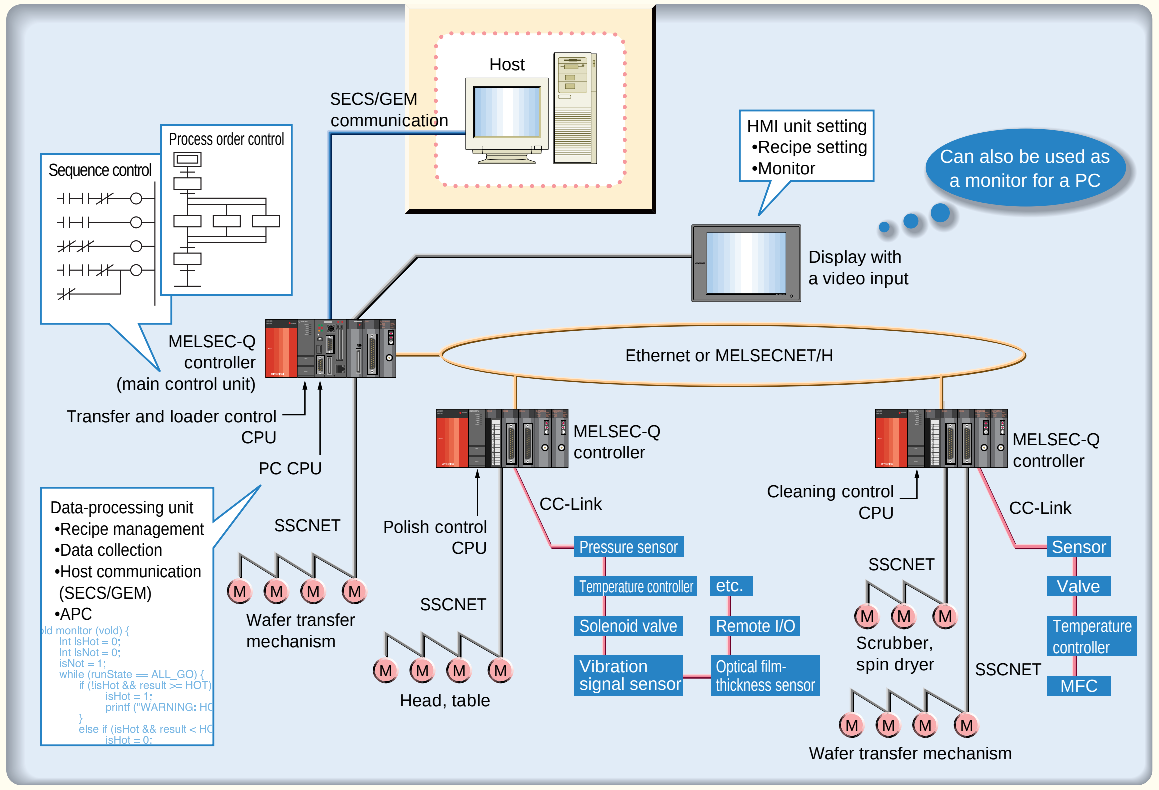


Challenges of the Equipment

1 Installation in the cleanroom (dry-in/dry-out)
2 Downsizing for reducing the space in order to install in the cleanroom (reduced footprint)
3 Reducing the equipment cost and improving throughput
4 Supporting the automation (interface with the automatic transfer unit and standardization relating to the CIM framework)
5 Reducing the software development cost
6 Modularizing the equipment
7 Improving wafer surface uniformity

SUGGESTION

Configuration Example of the Proposed System



Proposal 1 The controller's functions are divided into the transfer and loader control unit, the polish control unit and the cleaning control unit, and distributed over the network, is same as the conventional system. However, the use of the MELSEC-Q controller achieves a smaller installation space requirement for the controller and reduced controller cost as against to the conventional VME system.

Proposal 2 By complete separation of the control system and data-processing system using multiple CPUs at the main control unit so that stable throughput can be maintained because of no affection of data processing load to the control

Proposal 3 The SECS/GEM communication function and Advanced Process Control (APC) function are implemented to the PC CPU with the off-the-shelf Windows-compatible SECS/GEM software and database software.

Proposal 4 Ethernet can be used for large data transfer between controllers, while MELSECNET/H can be used for real-time data transfers between controllers. Therefore, suitable systems can be configured.

Proposal 5 By using SSCNET-compatible positioning modules and SSCNET for controlling the head table as well as the wafer transfer mechanism, high-speed, highly precise positioning as well as wiring reduction can be achieved inexpensively.

Proposal 6 Wiring can be reduced, without losing high-speed I/O performance, by using CC-Link for connections of temperature controllers and I/O modules connecting sensors, valves and switches.