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EC-Z658

Easy-to-understand
Mechanism of Central HVAC Control

Central Air-Conditioning System

There are two types of building air-conditioning systems, i.e., the individual **air-conditioning system used for medium-scale buildings** (with a capacity of 10,000 m² or less) and the highly automated **central heating, ventilation, and air-conditioning system** (**central HVAC control system** for short) used for large-scale buildings (in excess of 10,000 m²).

This catalog explains installations that constitute the **central HVAC control system** and control devices that properly control the installations to create a comfortable living space.

Some products in this catalog are only available in Japanese market. Please contact us for further information.

MG CO., LTD.
www.mgco.jp
Make Greener automation

Introduction

Instrumentation devices developed for process automation (PA) have also been applied to factory automation (FA) and have greatly expanded the use of automation. They are now widely used for **building automation (BA)**, including central HVAC control systems.

We developed the **BA**-dedicated **Direct Digital Controller (DDC)** and solved common problems to a great extent in the general-purpose programmable logic controller (PLC).

Furthermore, we have prepared remote I/O modules specialized for building control and is convinced that its instrumentation devices have come to the point where they can serve well for the design labor saving of every **BA** system integrator (SI) and the systematic maintenance of BA.

We would like to recommend each SI to consider the adoption of our **open network DDC** and **remote I/O** products.

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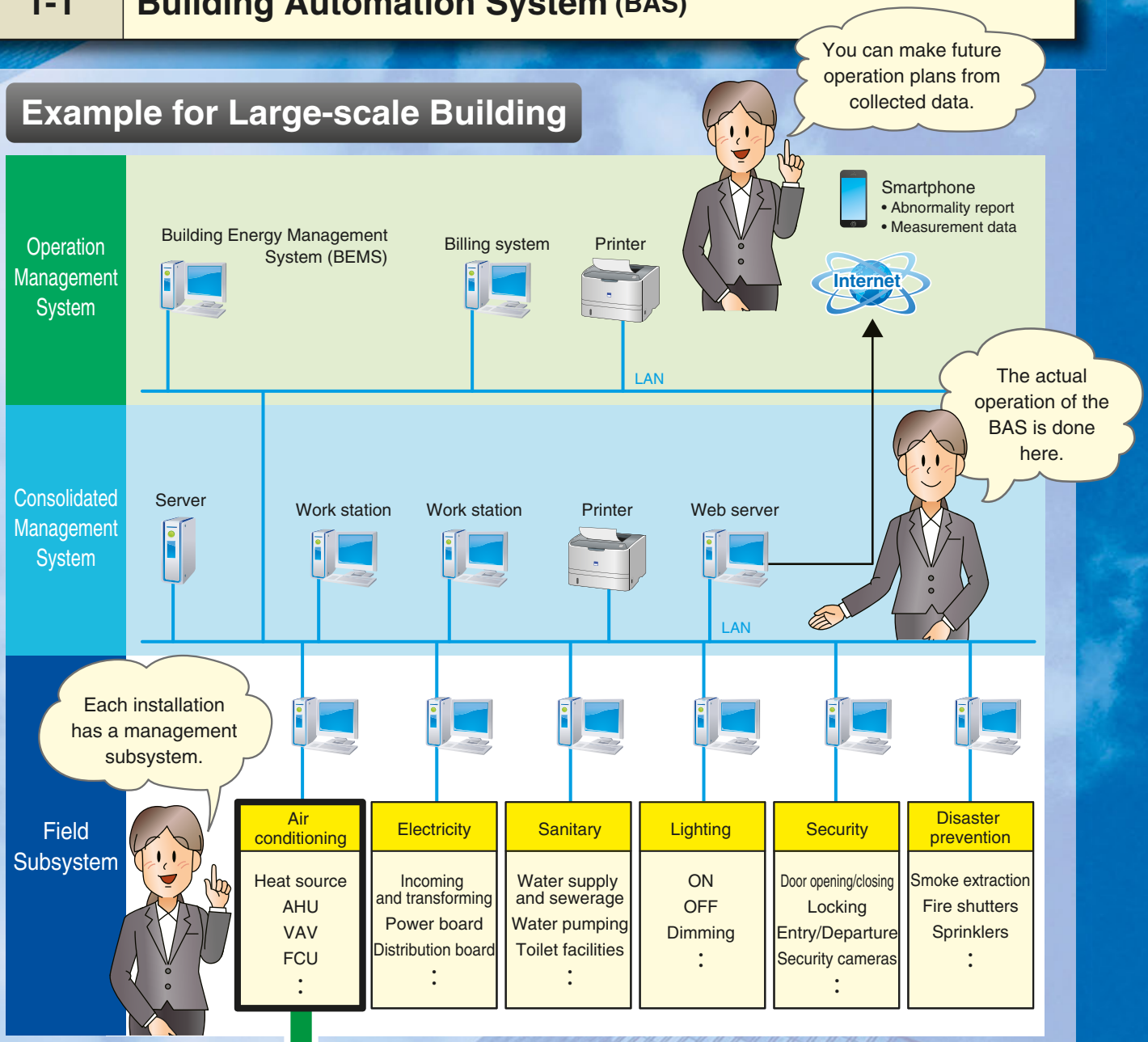
1-1 Building Automation System (BAS)

Example for Large-scale Building



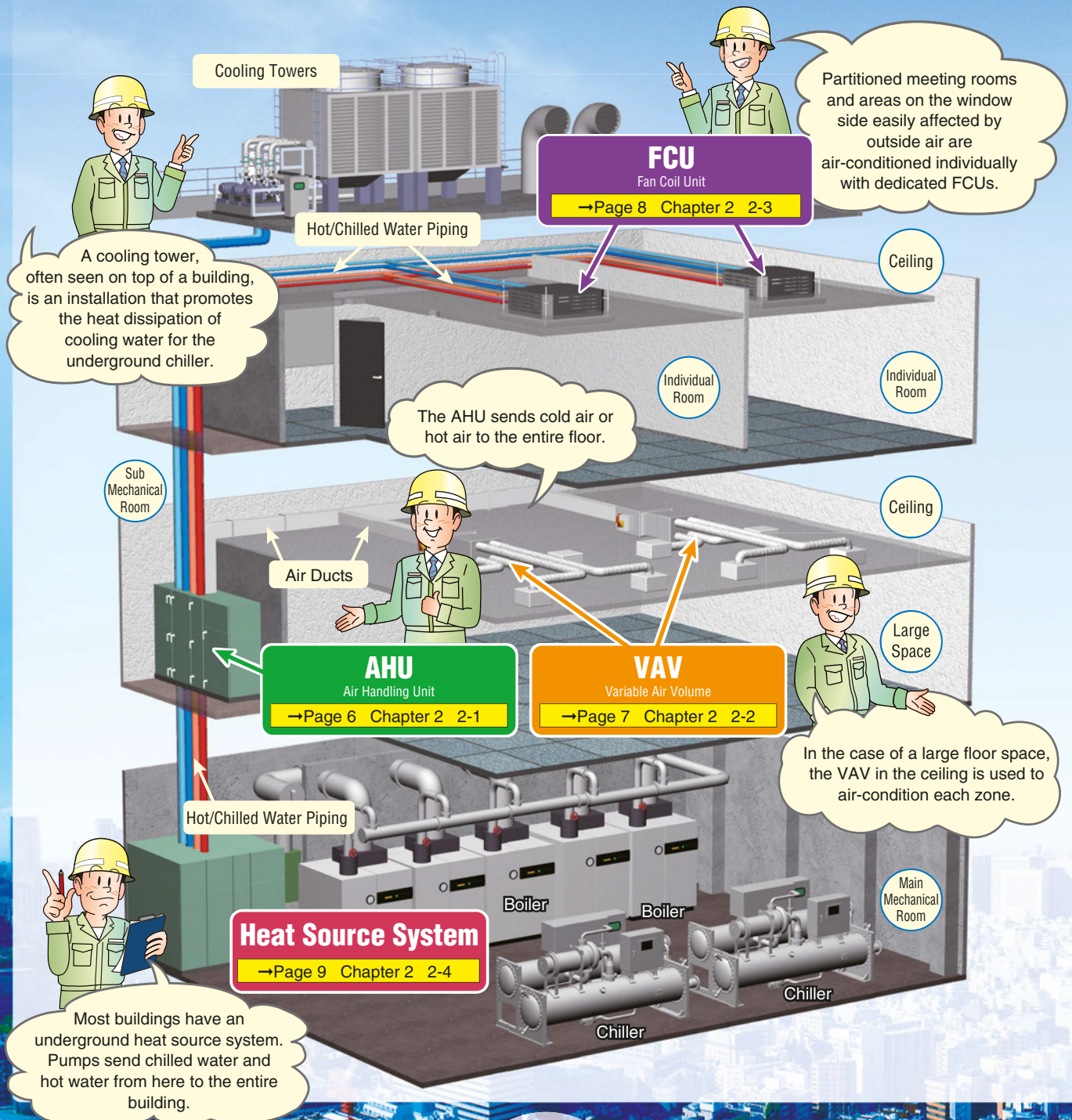
A subsystem is provided to each of the installations of a large-scale building, including the air-conditioning equipment, electric equipment, and sanitation equipment, and the consolidated management system is in control of all the subsystems of the entire building.

In the case of medium-scale or smaller buildings, it is common to use a system to control all the installations, including air-conditioning equipment, electric equipment, and sanitary equipment, grouped together.

Explanations about the central HVAC control system and the automatic control of it are provided from the following page.

1-2 Central HVAC Control System

The central HVAC control system is an air-conditioning system, in which a heat source system, including boilers, chillers, and conveying pumps concentrated in one place, produces and sends chilled water, hot water, or steam to the heat exchangers, e.g., air handling units and fan coil units (FCUs) on each floor, thus performing the cooling or heating of the entire building.
The central HVAC control system requires the initial cost and maintenance cost of the heat source system, and also requires an installation space (usually on a basement floor). Therefore, it is adopted for relatively large-scale office buildings, commercial facilities, hospitals, and hotels with a total floor area in excess of 10,000 m². In urban areas, the regional heating and cooling system is widely adopted as well, which receives chilled water, hot water, or steam from heat supply facilities (a district heating and cooling plant) and does not have heat source equipment in the buildings.
In this catalog, the air handling unit is referred to as the AHU, the fan coil unit is referred to as the FCU, and the variable air volume unit is referred to as the VAV, each of which is individually explained.



Basic Equipment for Central System

[Glossary]

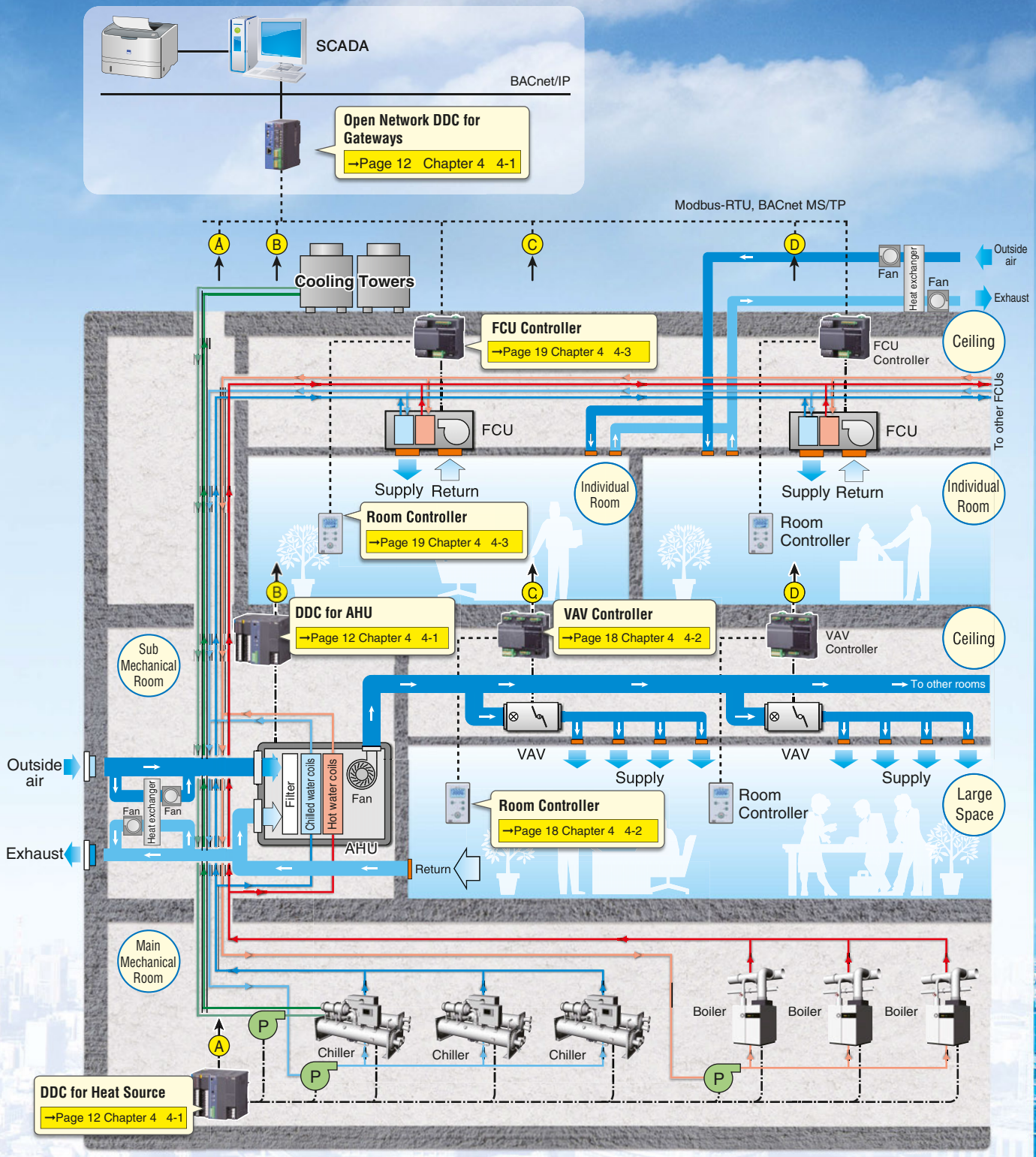
AHU : Air Handling Unit (i.e., Air conditioner) →Page 6 Chapter 2 2-1

VAV : Variable Air Volume (Variable air volume unit) →Page 7 Chapter 2 2-2

FCU : Fan Coil Unit →Page 8 Chapter 2 2-3

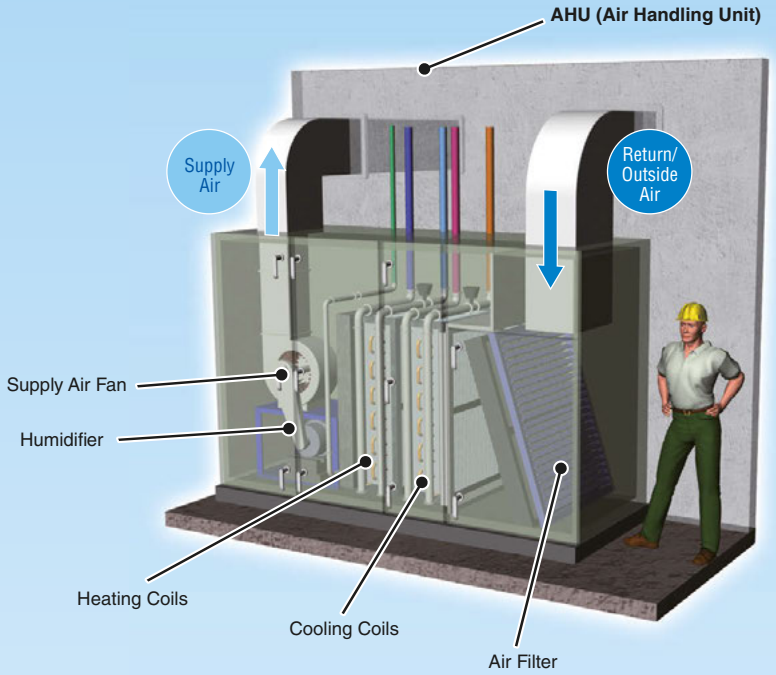
DDC : Direct Digital Controller →Page 12 Chapter 4 4-1

[Legend]
- BACnet/IP
- Modbus-RTU and BACnet MS/TP
- Individual wiring
- Chilled water supply pipe
- Chilled water return pipe
- Hot water supply pipe
- Hot water return pipe
- Cooling water supply pipe
- Cooling water return pipe

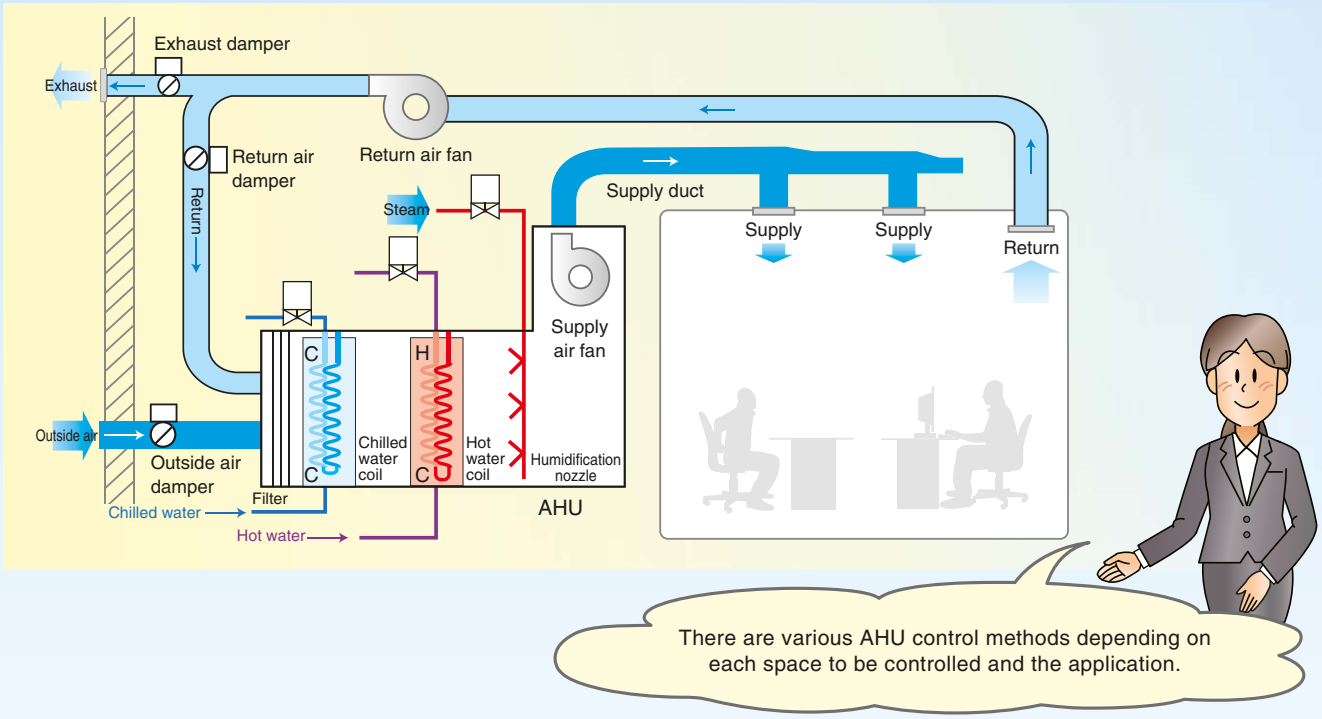


Chapter 2 **Main Units Comprising Central HVAC Control**

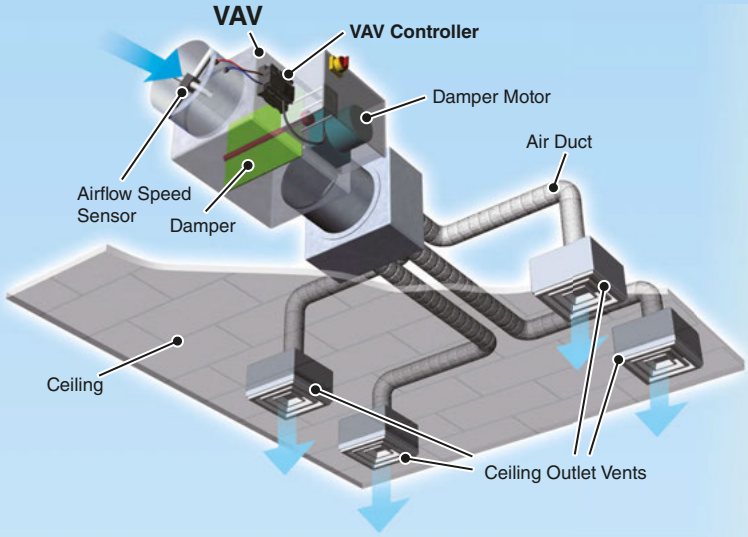
2-1 AHU (Air Handling Unit)

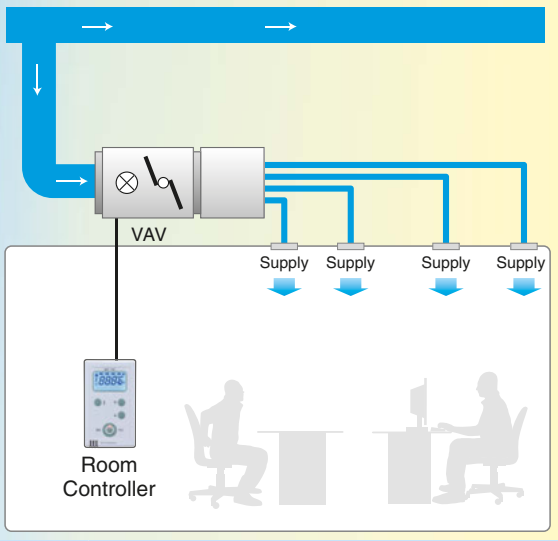


In order to create a comfortable living space that meets environmental standards, the AHU takes in outside air as well as air returning from each room, filters the air, performs heat treatment, and supplies treated air for the air conditioning to each room.
The AHU is of unit construction with an air filter, air heat exchanger, humidifier, and supply air fan in a metal casing, and is usually installed in a dedicated machine room.

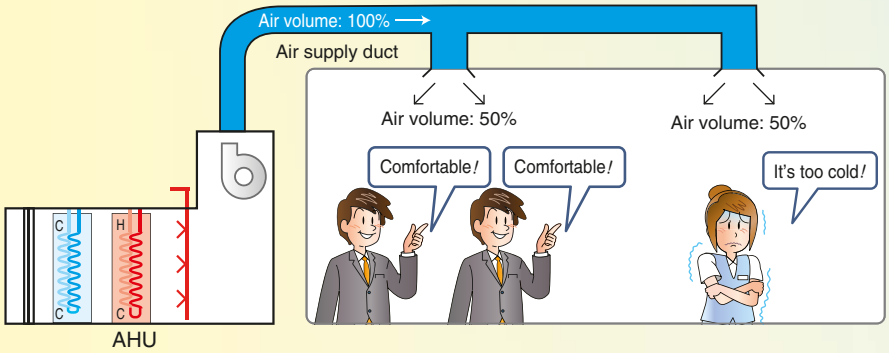


2-2 VAV (Variable Air Volume)

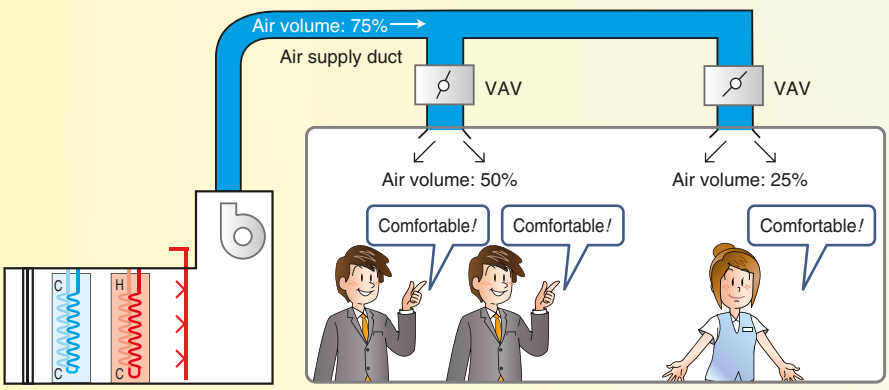




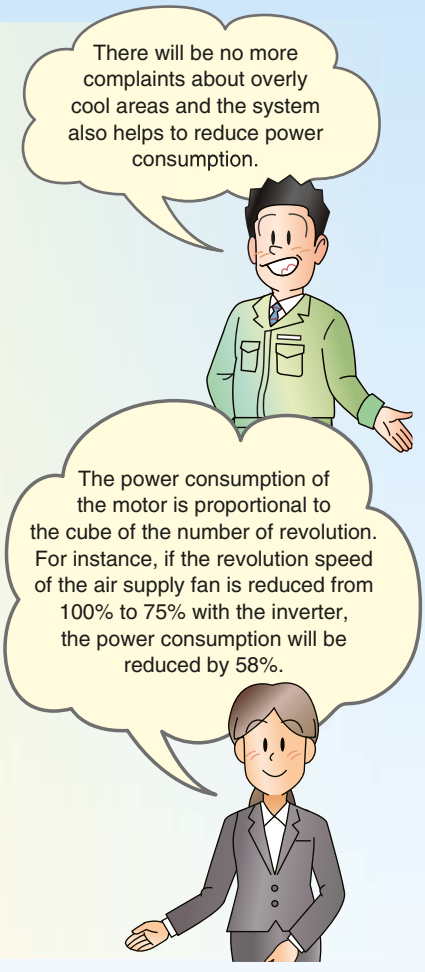
The VAV is used to control the temperature inside the room by varying the supply of air volume. It sends the required air volume that corresponds to the current room temperature to the AHU controller. The AHU controller calculates the total required air volume of each VAV unit and also controls the rotation speed of the air supply fan to minimize motive energy. The VAV is installed in the ceiling of the room. A single AHU usually requires anywhere from five to twenty VAVs.



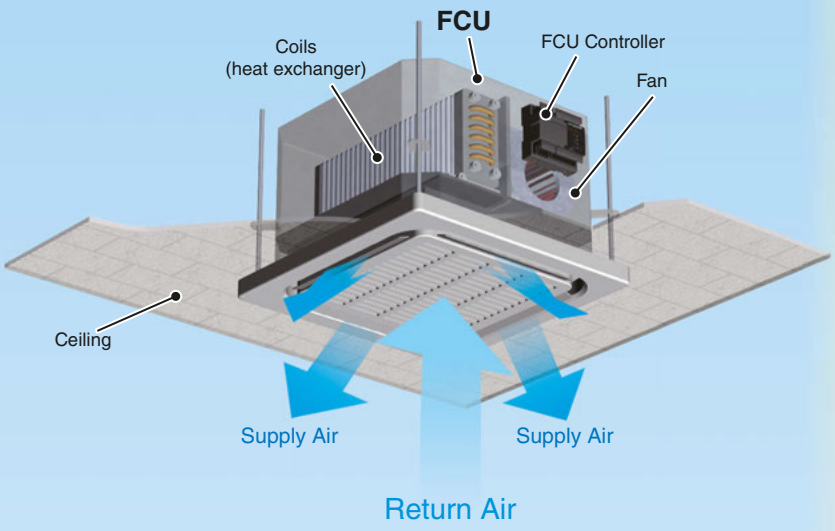
Fan rotation speed: 100% (Energy: 100%)

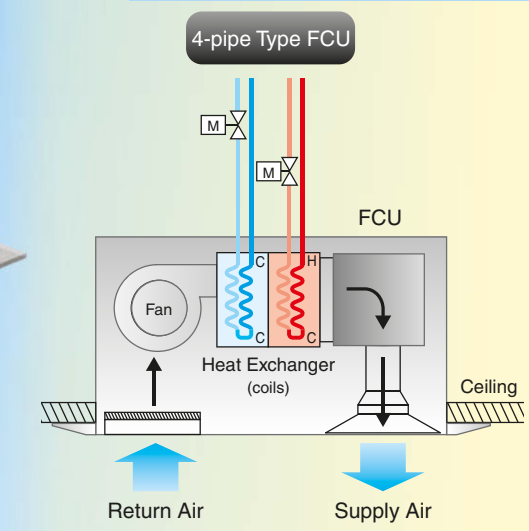


Fan rotation speed: 75% (Energy: 42%)



2-3 FCU (Fan Coil Unit)

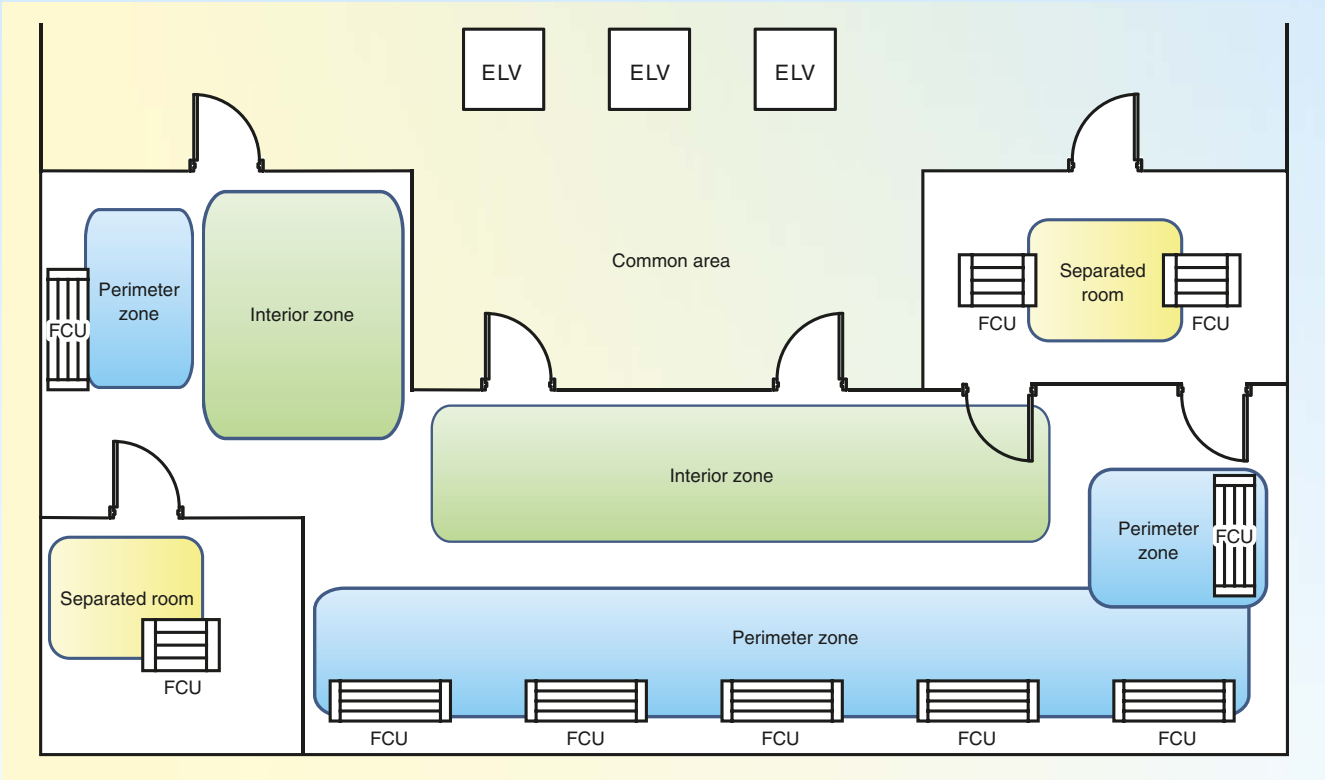




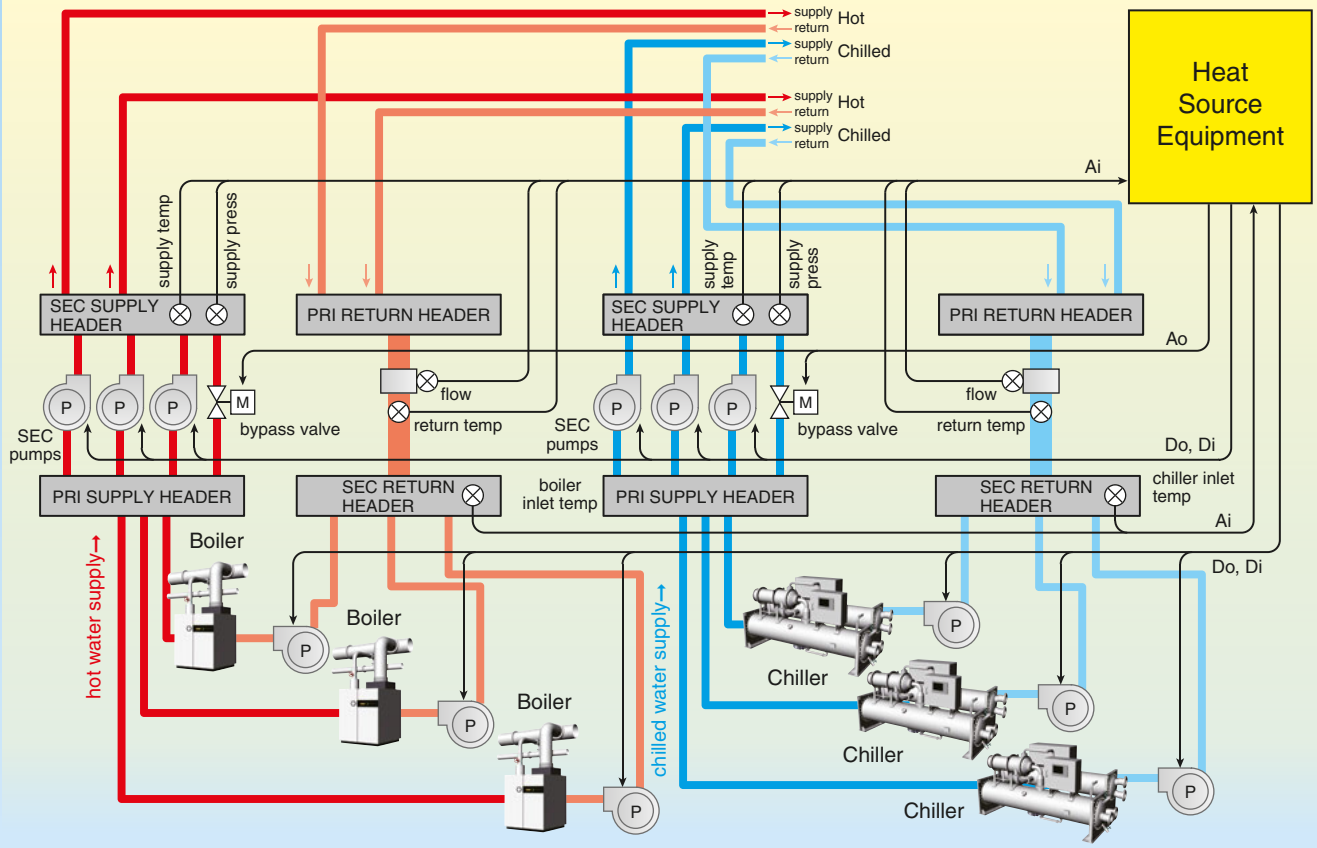
The FCU performs air conditioning in areas where temperature control is impossible only with the AHU, such as individually partitioned meeting rooms and areas on the window side easily affected by the outside air temperature. The FCU performs only temperature control and cannot perform humidity control. Furthermore, the FCU circulates only air. The AHU or an independent ventilator takes in fresh outdoor air.
There are two types of FCUs. One is a 4-pipe type that has independently a chilled water coil and hot water coil. The other is a 2-pipe type that has a coil that serves for both chilled water and hot water.

Perimeter Zone and Interior Zone

A floor with large square footage is divided into a perimeter zone on the window side susceptible to outside air and an interior zone barely affected by outside air.
In the perimeter zone, the air conditioning load differs between the south side exposed to sunlight and the north side not exposed to sunlight. The air-conditioning load also changes greatly in separated rooms, such as meeting rooms, depending on whether they are occupied or not. The FCU can control the temperature of each zone that cannot be done by an AHU only.

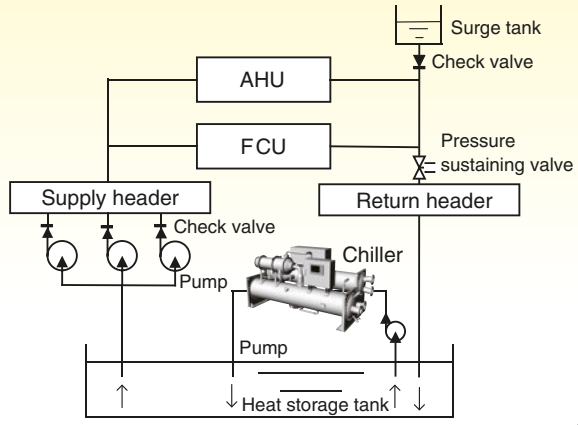


2-4 Heat Source System

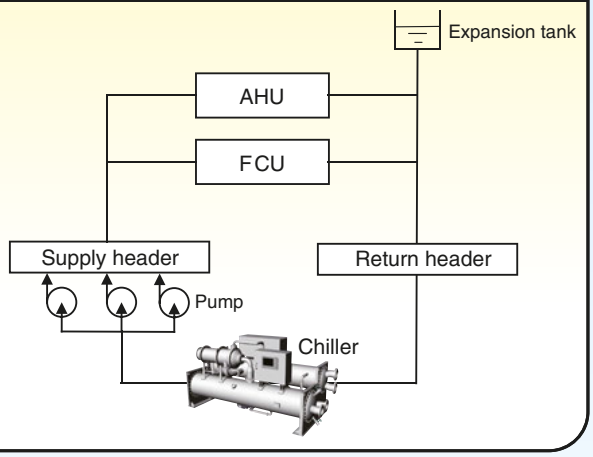


The central HVAC control system uses chilled water, hot water, or steam as a cooling or heating medium. The heat source system uses a chiller or boiler to provide chilled water or hot water to be transported to the AHUs and FCUs in the building (if the heat source is steam, it is sent to each AHU through piping after the steam pressure is adjusted with a pressure reducing valve. In this case, the steam is not sent to the FCUs because the FCUs do not use steam.). There are two types of air-conditioning water piping for building air conditioning. One is an open piping system and the other is a closed piping system (the above is an example of a closed piping system). The method of transporting chilled water or hot water varies with each piping system. Each system performs high energy-saving controls, including control of the number of heat source machines (e.g., chillers and boilers) and pumps, and the inverter-employed control of pump revolutions.

Open piping system



Closed piping system

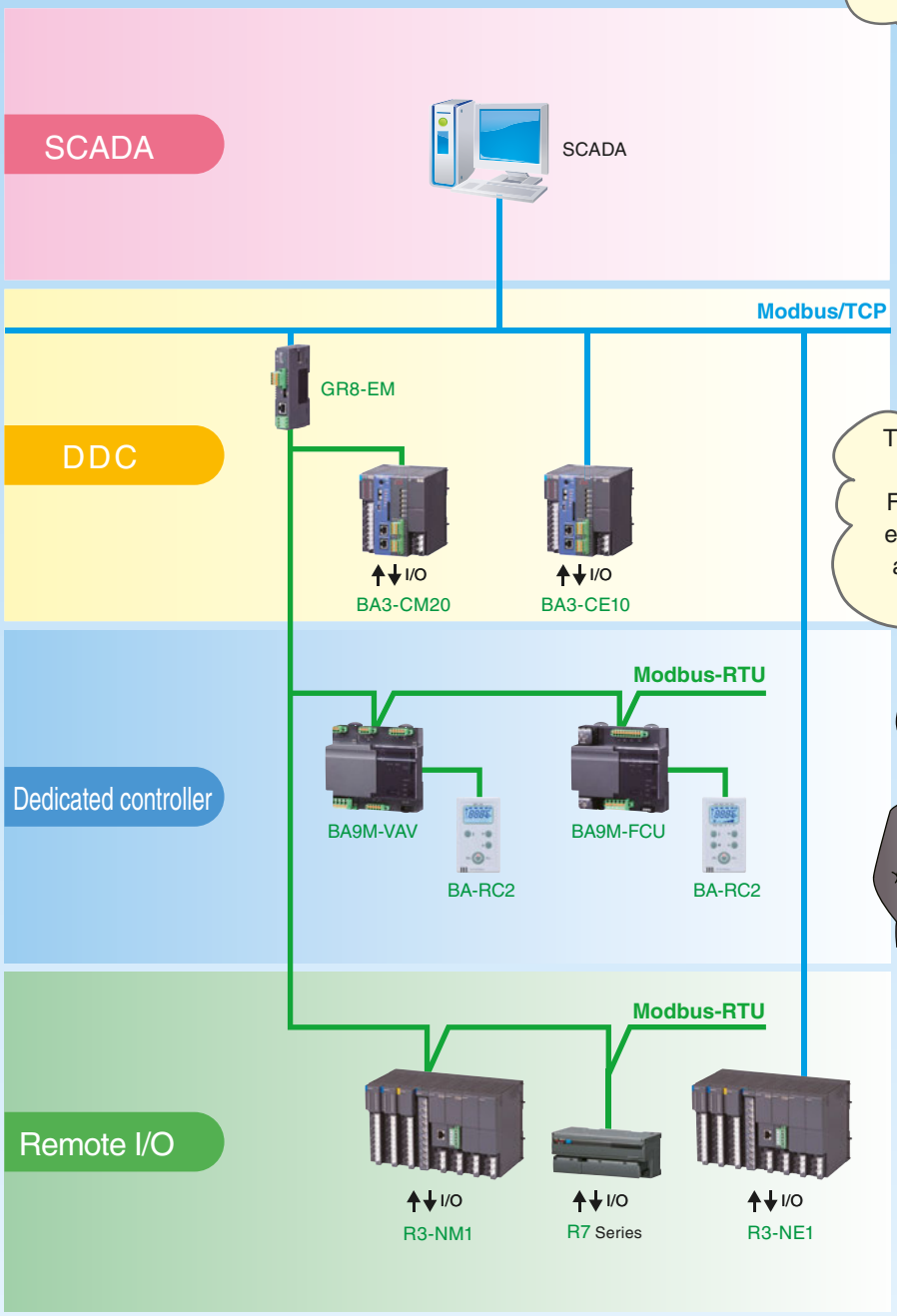


In the case of the open piping system, water drips from the piping if the pump system stops operating. In that case, the pressure sustaining valve is closed to prevent dripping. In the case of the closed piping system, water always remains in the piping, and no water drips with the system stopped.

Chapter 3 **Open Network for Air-conditioning Control System**

3-1 Modbus Network Configuration

Modbus is a simple protocol, and that is why Modbus can be applied to communication with various devices.



A general-purpose supervisory control and data acquisition (SCADA) can be used as a central monitoring device.

This DDC is dedicated to AHU control. Function blocks dedicated to air conditioning are available, which makes programming easier.

These controllers are dedicated to VAV and FCU control. They support various types of VAVs and FCUs.

We offer many types of I/O modules dedicated to BA.

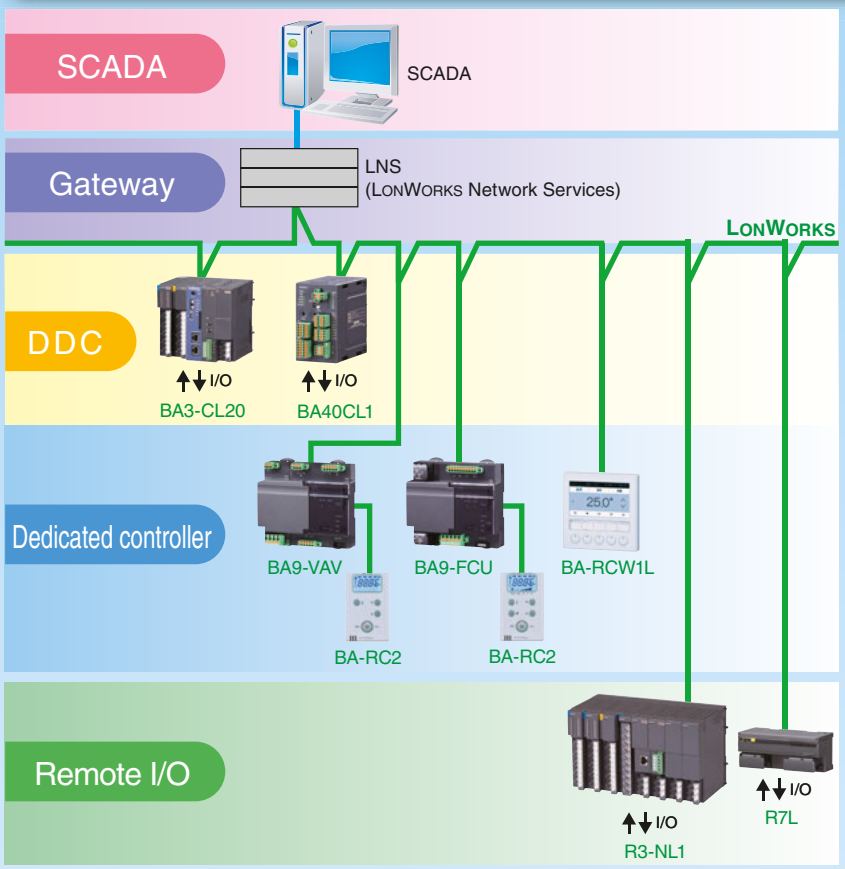
What is Modbus?

Modbus is a communication protocol developed by Modicon (now Schneider Automation International S.A.S.) for PLCs. The specifications of Modbus are open to the public (*1). Modbus only defines a communication protocol and does not specify physical layers, such as communication media. There are two Modbus communication methods, i.e., a method in RTU mode using binary data and the other method in ASCII mode using character data. RS-232 and RS-485 are used as the physical layers of these modes. In addition, there is another communication method (Modbus/TCP communication), which incorporates Modbus protocol messages on the Ethernet network.
Modbus is widely used in the fields of BA, FA, PA, etc. because its protocol specifications are open to the public and very simple.

(*1) For the protocol specification (PI-MBUS-300 Rev.J), refer to https://modbus.org/.

3-2 LonWorks Network Configuration

LonWorks allows node-to-node communication freely without a master.



What is LonWorks?

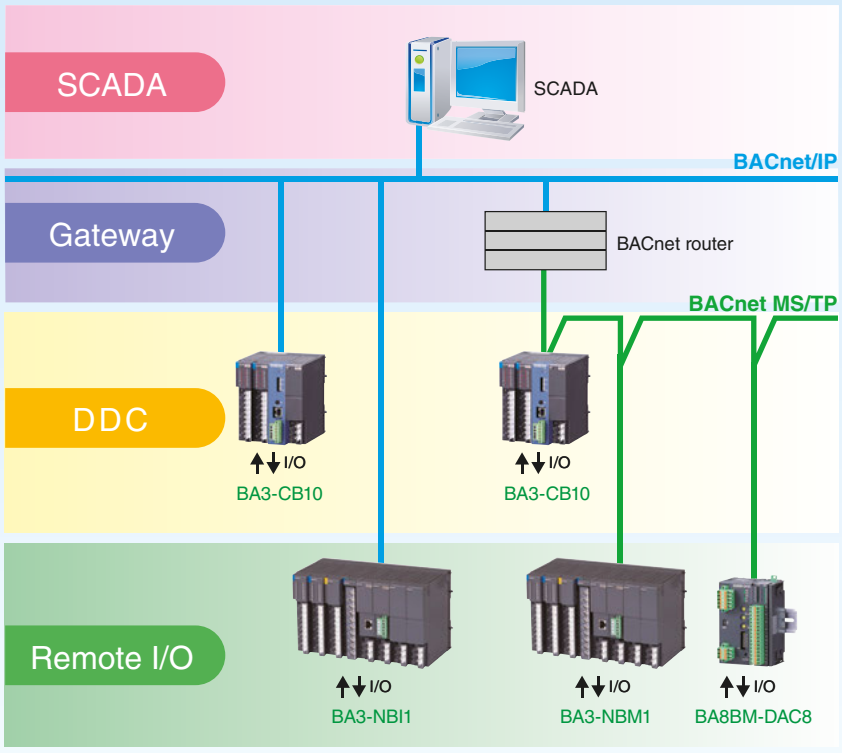
LonWorks is a networking platform for intelligent distributed network systems and developed by Echelon Corporation, an American company. It is used in a wide range of fields all over the world, including BA, FA, home control, and electric and gas monitoring.

LonWorks is characterized by distributed network systems. Network-connected nodes, such as sensors and actuators, have intelligence, and communicate with other nodes on the network and perform independent control. Therefore, each node incorporates an intelligent element called a neuron chip, where a control program is written.

The communication protocol of LonWorks is called LonTalk and it is defined for the physical layer through to the application layer. Various dedicated transceivers (Lon chips) are prepared for physical layer compatibility.

3-3 BACnet Network Configuration

BACnet is useful for building multi-vendor systems.



What is BACnet?

BACnet is an ANSI/ISO standard promoted by the American Society of Heating, Refrigerating, and Air conditioning Engineers (ASHRAE), and is widely used as an open communication protocol for BA (*2).

Two communications methods are available, i.e., BACnet LAN (a communication method using Ethernet, MS/TP, etc.) and BACnet/IP using Internet Protocol (IP), either of which is used according to the network layer to be used.

BACnet is characterized by physical devices (I/O devices) on the network and data that each device has, which are defined as objects (a set of abstracted data) and specifies services (standard procedures) that classify the purposes of accessing the objects. For this reason, manufacturers' own interfaces are unnecessary, and the interoperation of devices of different manufacturers becomes easy.

(*2) For the latest information on BACnet, refer to https://bacnet.org/.

Chapter 4 **BA Components**

4-1 Open Network DDC with Full of Useful Unique Functions Unavailable to General-purpose PLCs

The DDC is an autonomously distributed controller installed on site and communicates with the host SCADA and other control devices. Even if the network is shut down, the distributed controller will continue on-site control without being influenced.

Modbus-RTU DDC
BA Controller
Model: BA3-CM20

LonWorks DDC
BA Controller
Model: BA3-CL20

BACnet DDC
BA Controller
Model: BA3-CB10

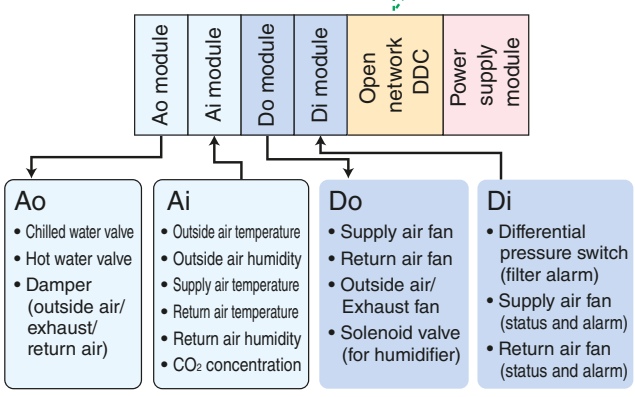
Main Functions and Features of Open Network DDC

- Mounted onto the base of the remote I/O **R3** Series to functions as a DDC exclusively for air conditioning.
- The Remote I/O **R3** Series handles many I/O points, with which a wide variety of I/O modules can be used.
  Analog input: Up to 256 points Analog output: Up to 256 points
  Discrete input: Up to 1024 points Discrete output: Up to 1024 points
- A programming language adopted conforms to international standard IEC 61131-3.
  Recommended: Function Block Diagram (FBD)
- Dedicated function blocks are available for air conditioning control.

Open Network DDC

Hardware configuration example using DDC

Modbus-RTU, Modbus/TCP, LonWorks, BACnet



A DDC model of I/O integrated type is also available.

LonWorks DDC
BA Controller
Model: BA40CL1

- Analog input
  - DC Voltage : 2 points
  - RTD (2-wire) : 2 points
- Discrete input : 4 points
- Analog output : 6 points
- Discrete output : 4 points

Feature 1 The Function Block system can be adopted as a programming language.

Can I create a Function Block?

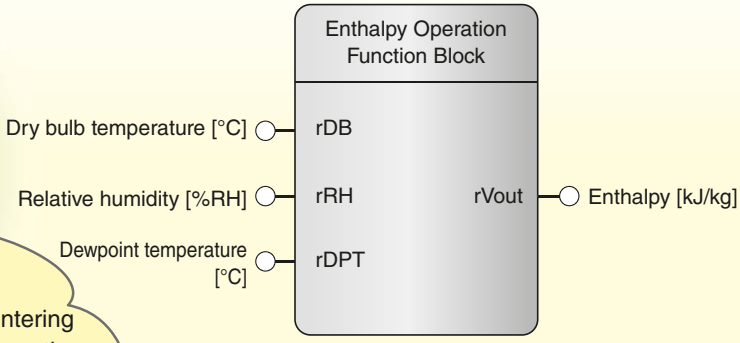
Anyone can easily make one.
We can prepare complicated Function Blocks, such as those for enthalpy operations and also PID operations.

What are Function Blocks?

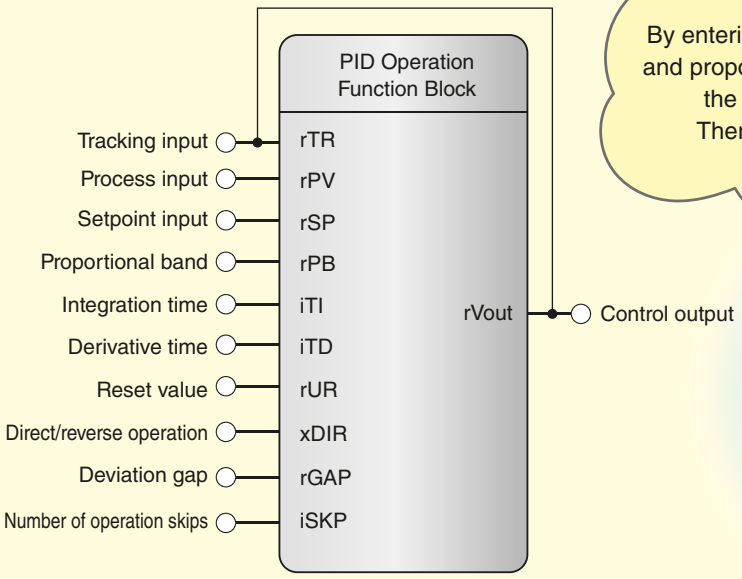
Contributing to efficiency improvements in the development of programs and the reduction of mistakes!

Function Blocks are repeatable programs that consist of blocks of frequently used logic and operations.
They contribute to efficiency improvements in the development of programs and the reduction of programming errors.

This is an example of an enthalpy operation block.
This block performs enthalpy operations by entering the dry bulb temperature and relative humidity or the dry bulb temperature and dew point temperature.
There is no need to enter complicated operation formulas.



This is a PID operation block.
By entering necessary parameters, such as set values and proportional band parameters, the block will output the operation result from the rVout terminal.
There is no need to write complicated control programs.



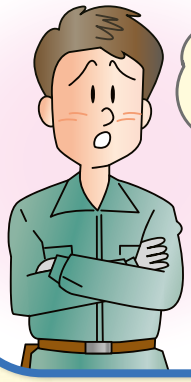
Advantages of Function Blocks

Function Blocks greatly reduce the number of steps necessary to write programs.

A ladder program requires a person to write many steps and takes time.

In the Function Block method, each block is used repeatedly, reducing concerns about bugs. Programming work can also be shared.

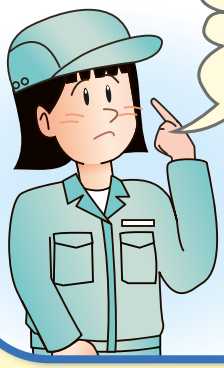
The program is easy to read for everyone.



I had to change an existing PLC ladder program for renovation work, but there was a problem. I could not figure out the program that someone else wrote.

A program written using the Function Block method consists of a combination of blocks that anyone can read.

Completed Function Blocks can be used repeatedly.

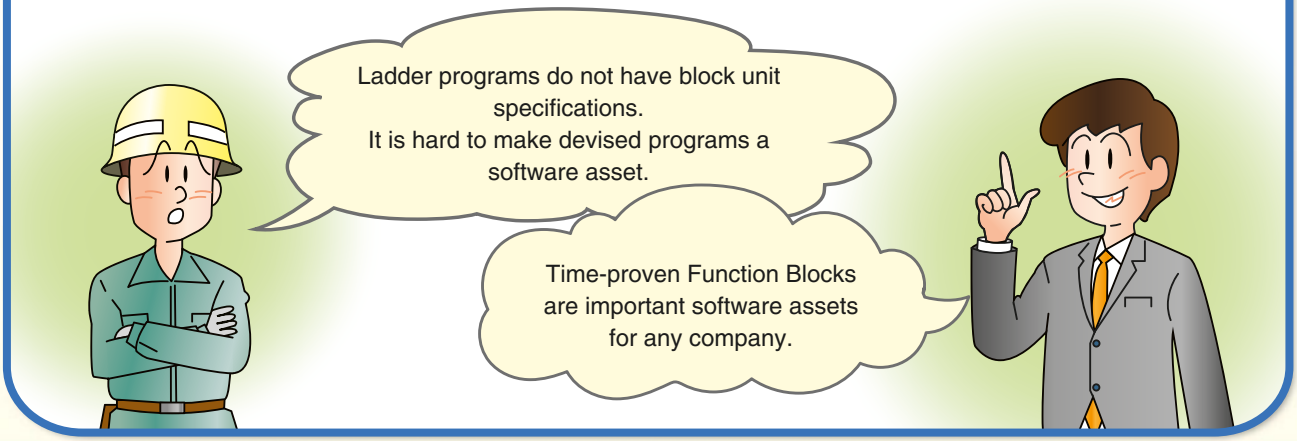


A ladder program is like a scroll, making it difficult to reuse the program that I took time to write.

I always make ladder programs from the beginning and they take time and cost money.

Time-proven Function Blocks do not need debugging. If engineers share blocks, they can reuse them for other projects.

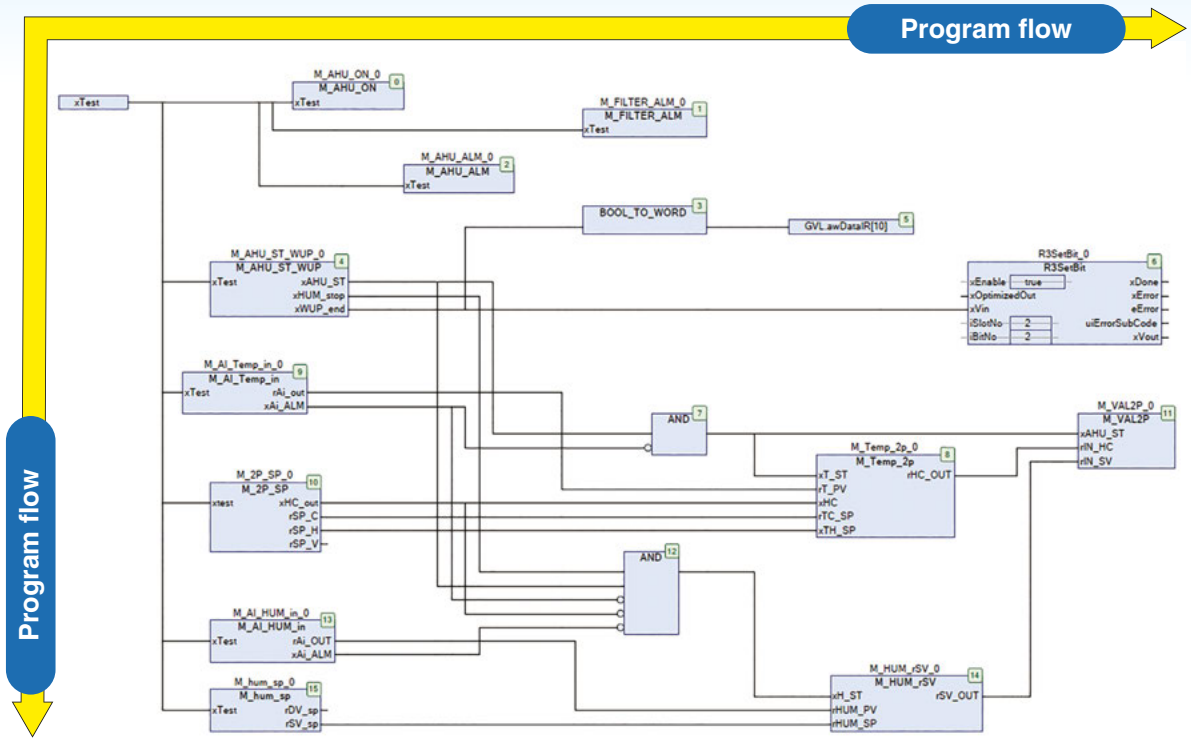
Software assets are accumulated.



How do they differ from ladder programs?

A program can be completed by simply connecting Function Blocks with lines.

A function block diagram is created by connecting each terminal of Functions and Function Blocks with wires.
A program flows from left to right and from top to bottom. It has a structure that anyone can understand at a glance.



Feature 2 Convenient function blocks are ready for use.

Example of a Function Block library for operation use

Open network DDC

	Function
1	Segment linearizer
2	Calorie calculation
3	System basic processing (system function)
4	Cyclic timer
5	Dual delay timer
6	Enthalpy operation
7	First order lag filter
8	Comparison with hysteresis
9	Supply air temperature optimization control
10	PID operation
11	Momentary output
12	Rate-of-change limit
13	Writing history records on variables
14	Pulse counter
15	Acquisition of current date and time
16	Weighted average

Many Function Blocks dedicated to air conditioning control are prepared. We have succeeded in drastically reducing the number of programming steps.

Feature 3 The Open Network DDC can use a wealth of I/O points of Remote I/O R3 Series.

Not many analog I/O types are available to the PLC. A preprocessing converter is always required, which results in a cost increase.

The open network DDC can use a wealth of I/O points of the Remote I/O **R3** Series. Furthermore, modules for BA, including the Calorie meter and the Valve positioner module, are also available.

Multi-channel, Scalable Remote I/O

R3 Series

DC mV, V, mA Input	24 models
Sensor Input	19 models
Power I/O	16 models
Analog Output	7 models
Pulse I/O	13 models
Alarm	7 models
Discrete I/O	22 models
BA Control	9 models
BCD Code I/O	2 models
Temperature Control	1 model

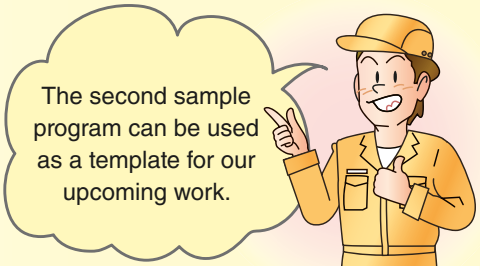
An amazingly wide variety of models are available.

For details of the Remote I/O **R3** Series, see 4-4 in Chapter 4 on page 20 .

Feature 4 Sample programs (*3) for standard AHU control are available.

Sample Programs

Seven sample programs for standard AHU control are available.
Using similar instrumentation patterns as templates will reduce engineering efforts at the time of initial installation and facility remodeling.



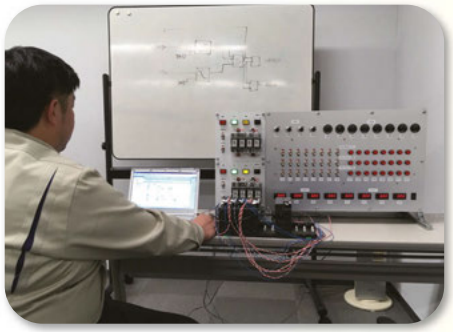
No.	Equipment configuration	Control contents
1	Chilled water and hot water (2-coil) system + Total heat exchanger	Indoor temperature control, indoor humidity control, outside air cooling control, CO_2 control, etc.
2	Chilled water and hot water (2-coil) system + Total heat exchanger + VAV	Supply air temperature control, return air humidity control, air volume variable control, outside air cooling control, CO_2 control, etc.
3	Chilled water and hot water (2-coil) system	Indoor temperature control, indoor humidity control, etc.
4	Chilled water and hot water (2-coil) system + Outside air damper	Indoor temperature control, indoor humidity control, outside air damper control, etc.
5	Chilled water and hot water (1-coil) system + Total heat exchanger	Indoor temperature control, indoor humidity control, outside air cooling control, CO_2 control, etc.
6	Chilled water and hot water (1-coil) system	Indoor temperature control, indoor humidity control, outside air cooling control, CO_2 control, etc.
7	Chilled water and hot water (2-coil) system + Outside air damper	Indoor temperature control, indoor humidity control, outside air damper control, etc.

(*3) When using a sample program, be sure to check the specifications, and perform check work, including debugging. Contact us for sample programs.

Feature 5 Debugging program simulators are available.

Debugging program simulators

The debugging of a developed program on the desk will reduce on-site work and person-hours.
A simulator is available with four RTD output points, a digital/analog I/O simulator with 24 discrete I/O points and 8 analog I/O points, and a power start/stop simulator.
Our special staff will support you. Please contact Customer Center for details.


Debugging work using a simulator


Power start/stop simulator


Digital/Analog I/O simulator

4-2 VAV-dedicated Open Network Controller (Model: BA9x-VAV)

The BA9x-VAV is a VAV-dedicated controller that varies the damper opening and changes the airflow volume, thus controlling the indoor temperature. The BA9x-VAV communicates with the AHU-dedicated open network DDC over the communications network and performs indoor temperature control in linking with the AHU. The BA9x-VAV is a compact size controller attached to the VAV in the ceiling.

Modbus

Model: BA9M-VAV

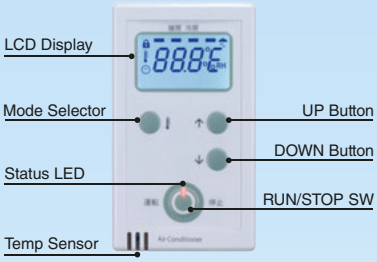
Modbus

Model: BA9M-VAVA

The BA9M-VAVA is premised to be used in combination with a VAV unit that can perform air volume control. Use the BA9M-VAV in the case of a VAV unit that needs Controller-employed air volume control.

LonWorks

Model: BA9-VAV



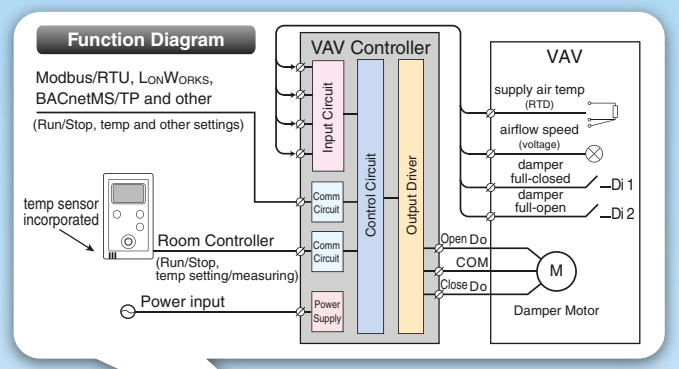
Room Controller

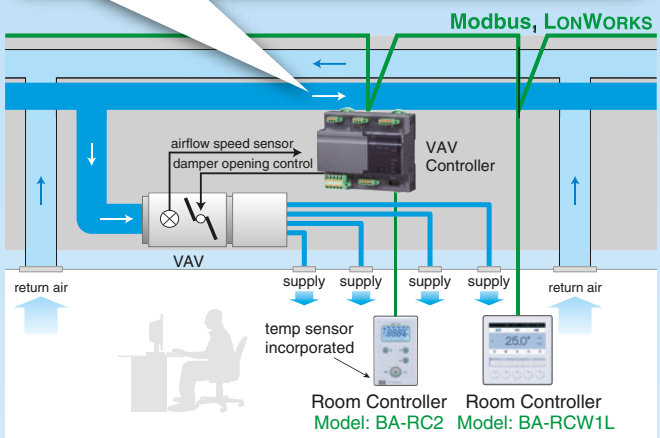
Model: BA-RC2

LonWorks Room Controller

Model: BA-RCW1L

For max. 4 zones





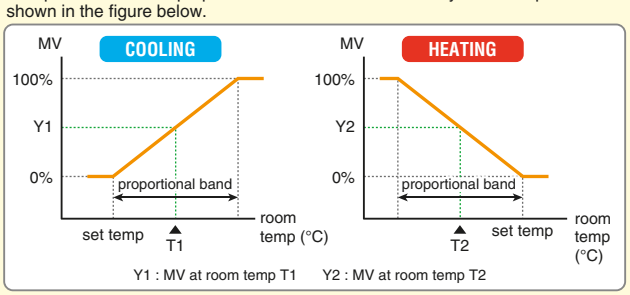
1 Temperature Control

The VAV Controller calculates airflow volume demand to adjust room temperature toward a setpoint.
The demand is then used for airflow volume control as explained below.

$$\text{DEMAND} = \frac{\text{(Proportional Control Output + Integral Control Output)}}{100\%} \times \text{(Preset Max Volume – Preset Min Volume)} + \text{Preset Min Volume}$$

● Proportional Control

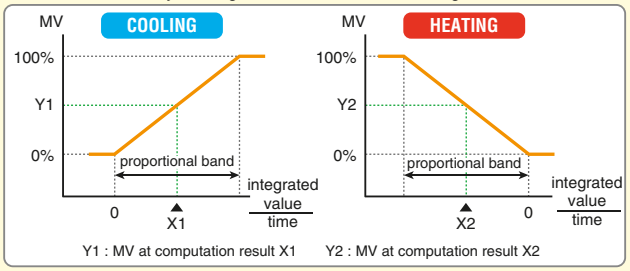
Manipulated value for proportional control is determined by room temperature as shown in the figure below.



Y1 : MV at room temp T1 Y2 : MV at room temp T2

● Integral Control

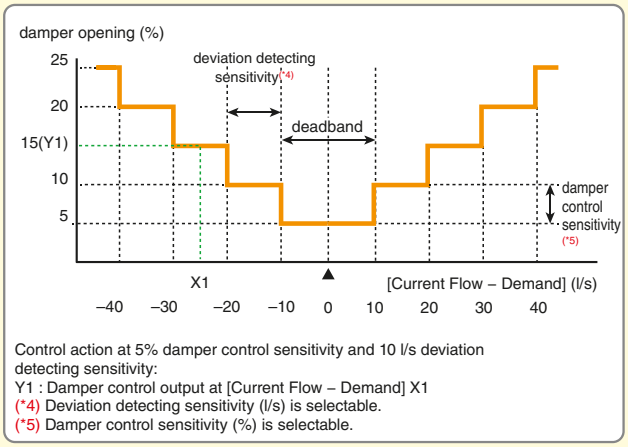
Difference between setpoint and room temperature is calculated every second and accumulated. Manipulated value for integral control is determined by dividing the accumulated value by its integration time as shown in the figure below.



Y1 : MV at computation result X1 Y2 : MV at computation result X2

2 Airflow Volume Control

The VAV Controller calculates current airflow volume using a speed sensor signal and manipulates damper opening to minimize airflow volume difference from the demand.
The damper opening is manipulated in five positions.



Control action at 5% damper control sensitivity and 10 l/s deviation detecting sensitivity:
Y1 : Damper control output at [Current Flow – Demand] X1
(*4) Deviation detecting sensitivity (l/s) is selectable.
(*5) Damper control sensitivity (%) is selectable.

● Damper Opening and Operating Time

The damper opening is controlled in proportion to a contact closure time provided by the VAV Controller for each of Open and Close directions. When the power supply is turned on, the Controller runs the damper from the full-open position to the full-closed position to measure its full span time and calculate opening change by time unit. The damper can be then set to a desired opening position in reference to the full-closed position by the contact closure.

4-3 FCU-dedicated Open Network Controller (Model: BA9x-FCU)

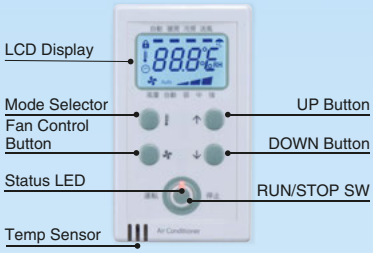
The BA9x-FCU is an FCU-dedicated controller that adjusts the room temperature with the starting and stopping of the FCU fan, the high-, medium-, and low-speed control of the fan, and the opening control of the chilled and hot water valves. The BA9x-FCU communicates with the host SCADA unit over the communications network. The BA9x-FCU is a compact controller mounted on the FCU.

Modbus

Model: BA9M-FCU

LonWorks

Model: BA9-FCU



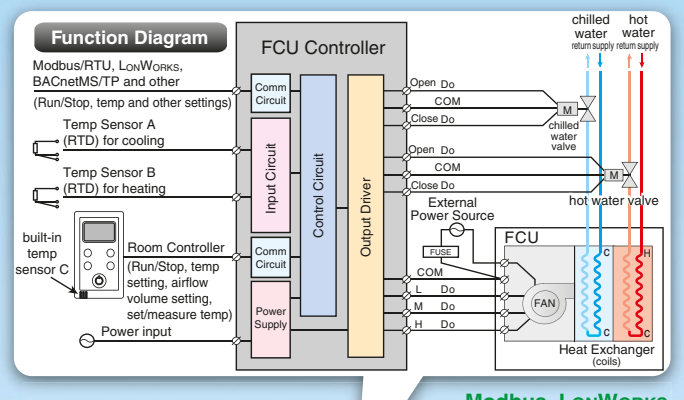
Room Controller

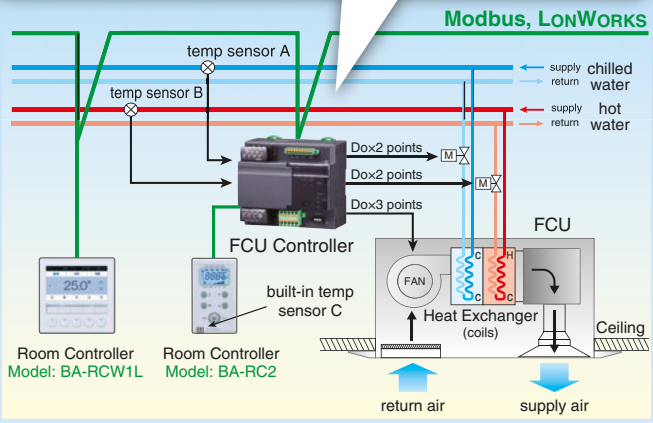
Model: BA-RC2

LonWorks Room Controller

Model: BA-RCW1L

For max. 4 zones

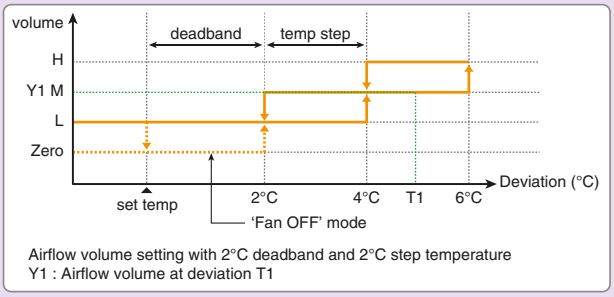




1 Airflow Volume Control

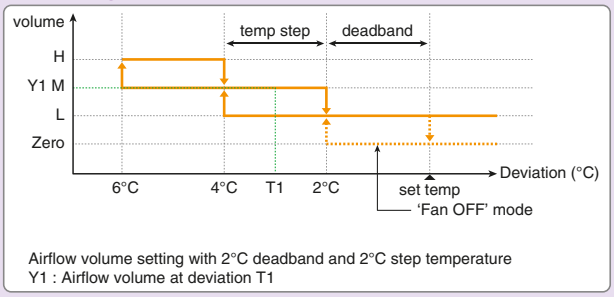
High, Medium, Low volume settings and Auto mode are available.
High, Medium or Low is manually switched.
In the Auto mode, the FCU adjusts airflow volume automatically in response to the deviation of measured room temperature(*6) from setpoint. 'Fan OFF' mode, in which the airflow is turned off when the deviation is within a preset deadband, is also selectable during automatic control.

● Cooling Mode



Airflow volume setting with 2°C deadband and 2°C step temperature
Y1 : Airflow volume at deviation T1

● Heating Mode



Airflow volume setting with 2°C deadband and 2°C step temperature
Y1 : Airflow volume at deviation T1

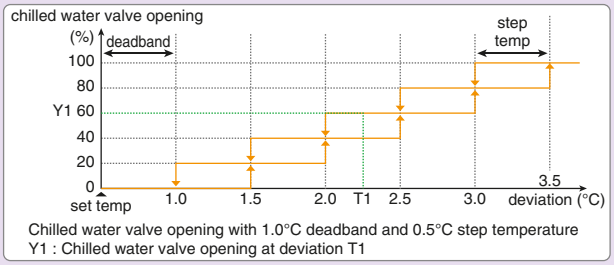
(*6) Measured by temperature sensor of the remote controller

2 Valve Opening Control

The FCU Controller manipulates chilled/hot water valves according to the deviation of measured room temperature from setpoint.
Either proportional or ON-OFF control strategy is selectable.

● Cooling Mode (proportional control)

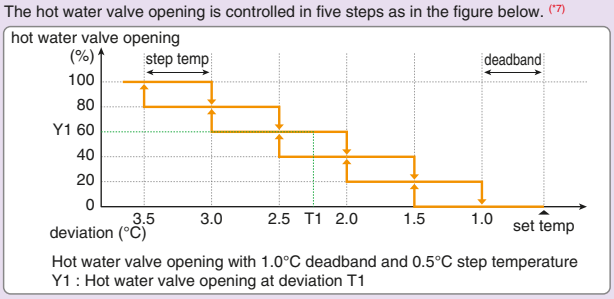
The chilled water valve opening is controlled in five steps as in the figure below. (*7)



Chilled water valve opening with 1.0°C deadband and 0.5°C step temperature
Y1 : Chilled water valve opening at deviation T1

● Heating Mode (proportional control)

The hot water valve opening is controlled in five steps as in the figure below. (*7)



Hot water valve opening with 1.0°C deadband and 0.5°C step temperature
Y1 : Hot water valve opening at deviation T1

(*7) Valve Opening and Operating Time
The valve opening is controlled in proportion to a contact closure time provided by the FCU Controller for each of Open and Close directions.
When the power supply is turned on, the Controller runs the valve from the full-open position to the full-closed position to measure its full span time and calculate opening change by time unit. The valve can be then set to a desired opening position in reference to the full-closed position by the contact closure.

4-4

I/O Modules Dedicated to BA are Available for Remote I/O R3 Series

The Remote I/O R3 Series handles many I/O points and is convenient and suitable for air-conditioning control.

Multi-channel, Scalable Remote I/O **R3 Series**

CE Varies with the model

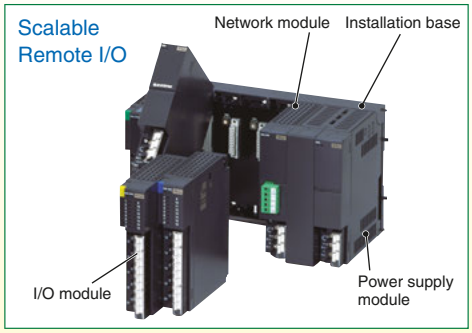
The **R3** Series is the most substantial remote I/O that responds to various types of networks and I/O modules.

Configuration

Size: H 130 (5.12) × D 120 (4.72) mm (inch)

- Supports many types of network protocols.
- I/O modules in a wide variety are available.

Each module handles many input or output points, thus making it possible to configure a high-density I/O system at a low cost.
The user can combine only the necessary modules, thus making it possible to build a system economically without waste.



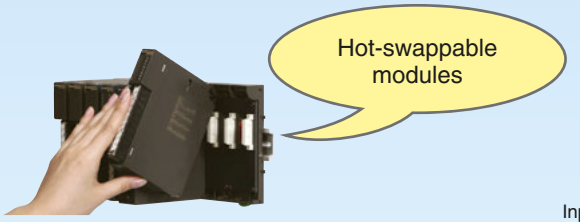
This is a modular type remote I/O system built with a flexible selection of power supply modules, network modules and input and output modules mounted on the base.

Base	2 slots - 16 slots
Base, free I/O address	4 slots - 16 slots

Power supply module	Continuous output current: 750 mA, single slot
	Continuous output current: 2 A, double slot

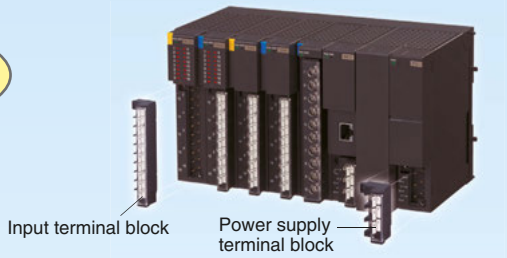
Easy and reliable snap-in mounting

Each I/O module and network module has a CPU and data is updated in serial communication with each other.
Therefore, if dual redundant communication system is used, no momentary interruption or bumping of analog output will occur even at the time of switching the system.
Exchanging I/O modules or network modules does not affect other modules.
The user can replace them with the power kept turned on.



Removable terminal blocks

Each **R3** Series terminal block is of detachable construction.
This is convenient when checking or changing the specifications of your system.



Supports many types of network protocols

Responds to 12 types of networks. (see below)

Economical I/O modules

Each remote I/O module has many input or output points, thus ensuring high cost performance per point.

A wide variety of special function modules.

A wide variety of special function modules are available, which include a multi-power monitor module for power calculations and a temperature controller module.

Three types of terminal blocks

Connector-type terminal blocks (18 types) and tension clamp terminal blocks (12 types), as well as screw terminal blocks, are available.

Supports dual redundant network and two independent networks

Improves the reliability of data communication.

Supports dual redundant power supply and two independent power sources

Possible to build a redundancy system with dual power supply or two power sources at 100 V AC, 200 V AC, and 24 V DC.

Types of communications networks

CC-Link CC-Link IE Field DeviceNet BACnet EtherNet/IP Modbus/TCP Modbus
MECHATROLINK LONWORKS T-Link FL-net PROFIBUS

Convenient I/O modules for BA are available, including a one-shot pulse module used to turn power on and off and a remote control relay module.

Model	I/O	Application	Monitoring/ control	Measurement	Power	Totalized pulse
R3-DA16	Discrete input, 16 ch.	Status monitoring, failure monitoring, and alarm monitoring	○	—	—	—
R3-DC16	Discrete output, 16 ch.	Season switching, status display, and interlocking	○	—	—	—
R3-DAC16	Discrete I/O (Di 8 ch., Do 8 ch.)	Power on/off control (one-shot pulse output)	○	—	—	—
R3-RR8	Remote control relay control, 8 ch.	Lighting control (remote control relay control)	○	—	—	—
R3-PA8	Totalized pulse input, 8 ch., 32 Bits	Pulse totalization (flow rate, power) (with preset function by host equipment)	—	—	—	○
R3-SV8 R3-SS8	DC voltage/DC current input, 8 ch.	Humidity, CO_2, pressure, flow rate, and others	—	○	—	—
R3-YV8 R3-YS4	DC voltage output, 8 ch. DC current output, 4 ch.	Controller, inverter, and others	○	—	—	—
R3-RS8	RTD input, 4 ch.	Temperature measurements (Pt, Ni, Cu)	—	○	—	—
R3-US4	Universal input, 4 ch.	Temperature, pressure, opening and others	—	○	—	—
R3-MS8	Potentiometer input, 8 ch.	Damper opening, and others	—	○	—	—
R3-CT8A	AC current input, 8 ch.	Current measurement on power equipment	—	—	○	—
R3-WTU	AC power input (1 system, 2 systems)	Active power, reactive power, power factor, demand, and others	—	—	○	—
R3-DS4A	4-20 mA input w/exc. (switch provided),(4 systems).	Power supply to 2-wire transmitters	—	○	—	—
R3-TS8	Thermocouple input, 8 ch.	Temperature measurement on pump bearings, and others	—	○	—	—
R3-MEX2	Actuator drive output (2 systems)	Direct driving of actuator (electric valve actuator and electric damper actuator)	○	—	—	—
R3S-CM2A	Temperature and flow rate (2 inputs)	Energy management	—	○	—	—

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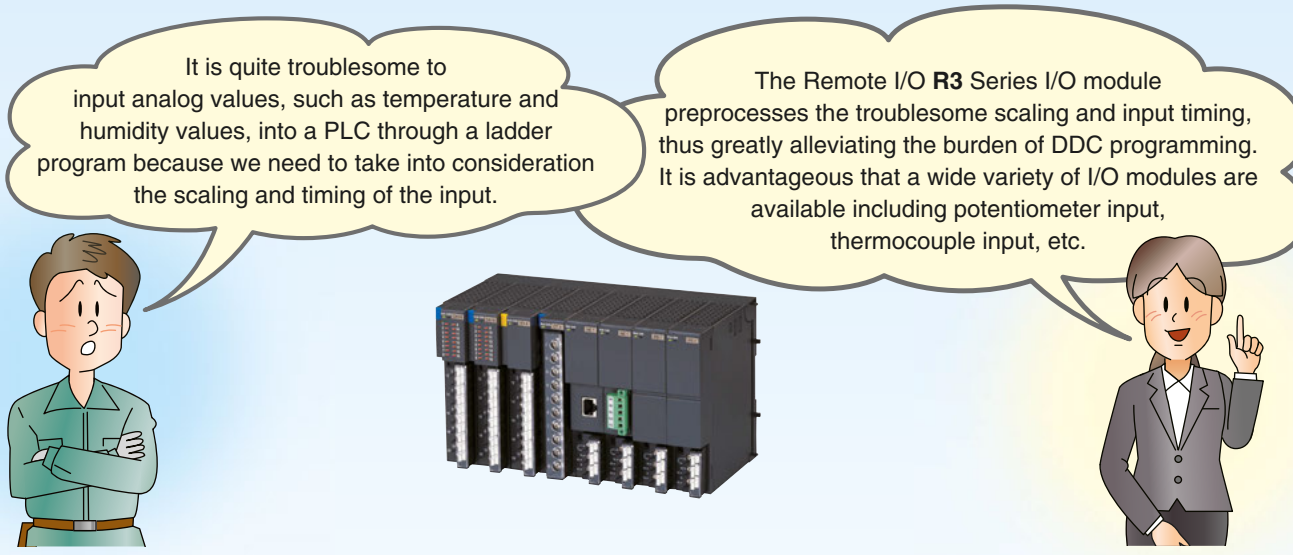
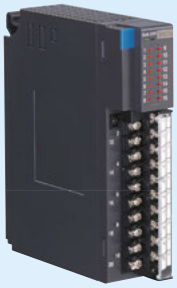
Guidance 2 ▶Page 22
Guidance 3 ▶Page 23
Guidance 4 ▶Page 23
Guidance 5 ▶Page 23

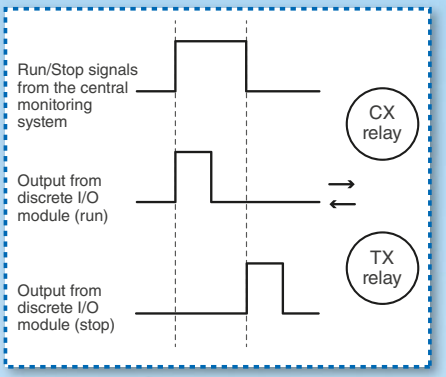


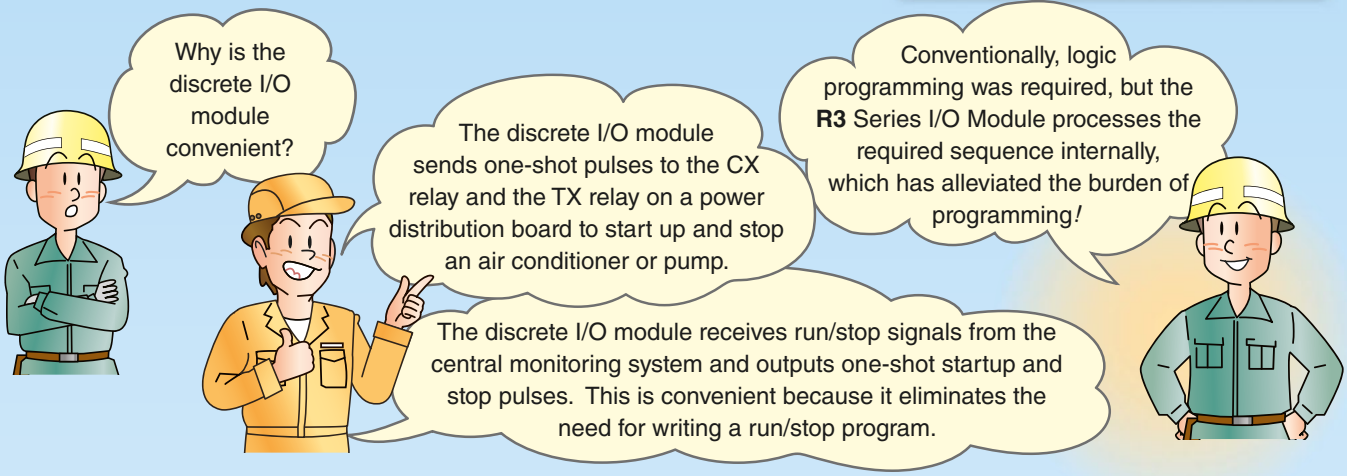
Guidance 1 Discrete I/O module



Model: R3-DAC16 Discrete I/O (Di 8 points, Do 8 points) CE
Model: R3-DAC16A Discrete I/O (Di 8 points, Do 8 points, internal power)

• Tension clamp terminal blocks are available as well. For details, see the specification sheet.

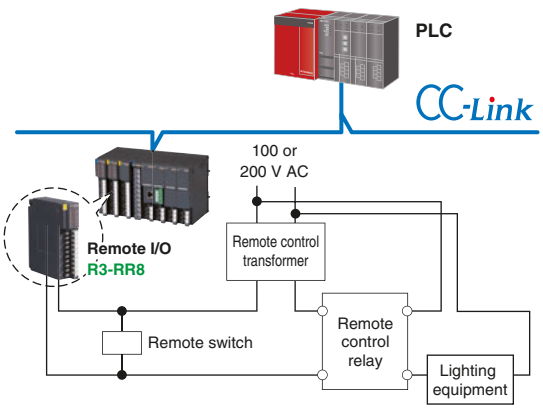




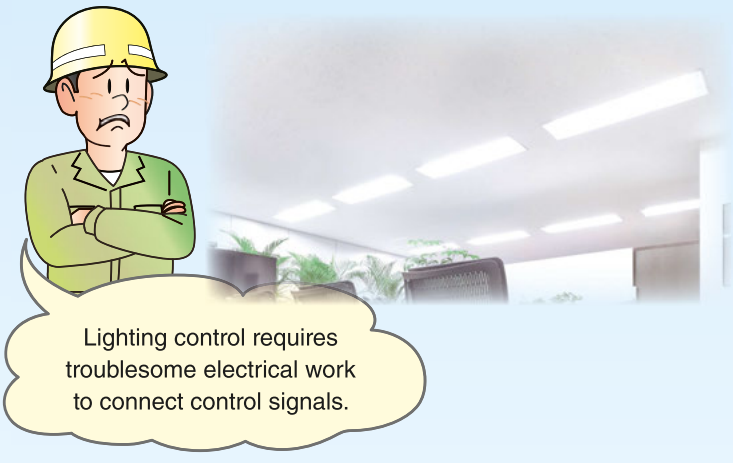
Guidance 2 Remote control relay control module

Model: R3-RR8 Do 8 points CE

• Tension clamp terminal blocks are available as well. For details, see the specification sheet.



The remote-control relay is a relay unit that is used to turn lighting equipment on and off remotely. You can turn the equipment on and off with low-voltage control signals (e.g., 24 V AC control signals) without directly turning the power supply to the equipment on and off. The **R3-RR8** can control remote control relays for eight circuits.



Guidance 3 Totalized pulse input module

Model: R3-PA8 Pi 8 points, 32 Bits CE

• Tension clamp terminal blocks are available as well.
For details, see the specification sheet.

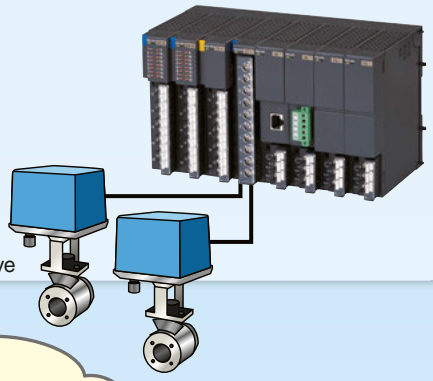
What advantage is expected from the function that allows the central monitoring system to preset the totalized count value?

The totalized count values of electricity, gas, and water supply are used for billing and indispensable to building management.
The law requires the replacement of billing meters at regular intervals, and it is necessary to match the reading value of each meter with the corresponding display value in the central monitoring system at the time of replacement. It is convenient to use the function that allows the central monitoring system to preset the integrated values.

Guidance 4 Valve positioner module

Model: R3-MEX2 for 2 systems, buit in SSR CE

• For details, see the specification sheet.

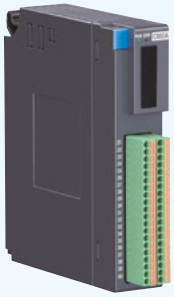


Electric control valve

We still want to use the existing valve actuator as it is.

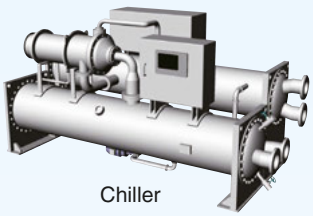
The Valve Positioner Module can directly drive existing motorized valves.

Guidance 5 Calorie meter



Model: R3S-CM2A 2 inputs, Tension clamp terminal block

• For details, see the specification sheet.



Chiller

This product is available for calorific value calculation for energy management and for the control of the number of heat sources.

Boiler

Many more convenient and easy-to-use features are available.

I/O circuits are all isolated.

The PLC's analog input is non-isolated. Isolators are always required on the input side. The cost of a system will increase for that reason.

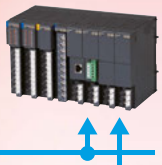
The input circuits of all Remote I/O **R3** Series products are insulated from the field side. The cost will be reduced accordingly.

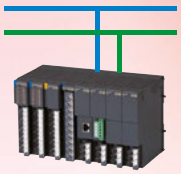
Dual redundancy for power supply and network is possible.

The heat source equipment of heat supply plants must not stop working. So, it needs to be absolutely reliable.

Two power sources

Two network lines





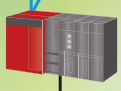
Commercial power source

Emergency power source

The **R3** Series supports dual power supply and network lines, which will increase the reliability of the system dramatically.

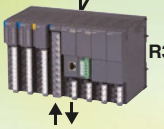
The R3 Series is an open network system that is ideal for adding I/O points to existing systems.

We want to add I/O points to an existing PLC system, but we wonder if there is a good way to do this.



Existing PLC

CC-Link/DeviceNet



R3 Series

I/O

R3 Series

I/O

The **R3** Series can be used as remote I/O for an existing PLC system. The cost performance will also be improved greatly.

The lineup of Remote I/O Series includes the R6, R7, R8, and R9 Series besides the R3 Series.

Furthermore, a variety of models, including those of subminiature type, block type with fewer channels, slice type, multi-channel type, are available so that customers can choose ones that are most suitable to their applications.

R6 Series - Ultra-Slim, Scalable Remote I/O

R6 Series

The R6 Series is an ultra-small combination remote I/O model that can make effective use of a small space as much as possible.

This is suitable for applications with relatively few I/O points where signal input and output coexist.
Three types of terminals—Euro, screw, and tension clamp terminals—are available so that customers can choose the most suitable one.
What is more, a wide variety of network modules and I/O modules are available.

Compact Remote I/O

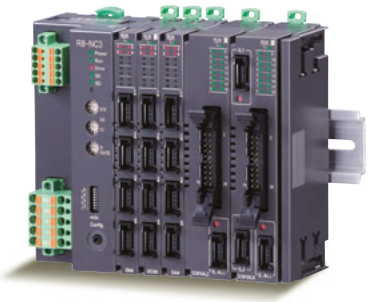
R7 Series

The R7 Series is a compact, all-in-one remote I/O model.

This economical palmtop remote I/O model of single block construction integrates a network, power supply, and I/O in one package.
A wide variety of extension modules for contact I/O points are available.
In the case of analog inputs, the R7 Series transmits 0% to 100% data in a resolution of 0 to 10000 of the full-scale range.

Slice Type, Scalable Remote I/O

R8 Series



The R8 Series is a remote I/O model created in response to customers' requests.

This is a remote I/O model with no mounting base that can flexibly combine a necessary number of ultra-thin I/O modules.
Modules with built-in interlocking functions are available. They turn all output signals OFF at once in response to contact input from a safety device, such as an emergency stop switch.
We will welcome customers' request to adopt different manufacturers' terminal blocks and connectors. Feel free to consult us.

Multi-channel All-in-one Remote I/O

R9 Series

This compact remote I/O model for power calculations is designed with economic efficiency.

This is a power measurement remote I/O model that calculates various power quantities, such as active power, reactive power, power factors, and apparent power, and communicates data via open network.
The model accepts a maximum of eight channels of current input from the same system. Therefore, the model is suitable for the power monitoring of multiple machines.
By mounting an SD card, the date-linked logging of power quantities, such as current and power values, is possible.

Convenient for building multi-vendor systems

This Remote I/O model is compatible with BACnet as a de facto standard communication protocol for building automation.

BTL certification

This product has BTL certification under a certification test service conducted by the BACnet Testing Laboratory (BTL).

Direct I/O compatible with BACnet

BA8 Series

Discrete input & Relay output module, 4 points each (BACnet MS/TP)

Model: BA8BM-DAC8 CE

Remote I/O compatible with BACnet

BA3 Series

BA Controller (BACnet MS/TP, BACnet/IP)

Model: BA3-CB10

Network Module (BACnet MS/TP)

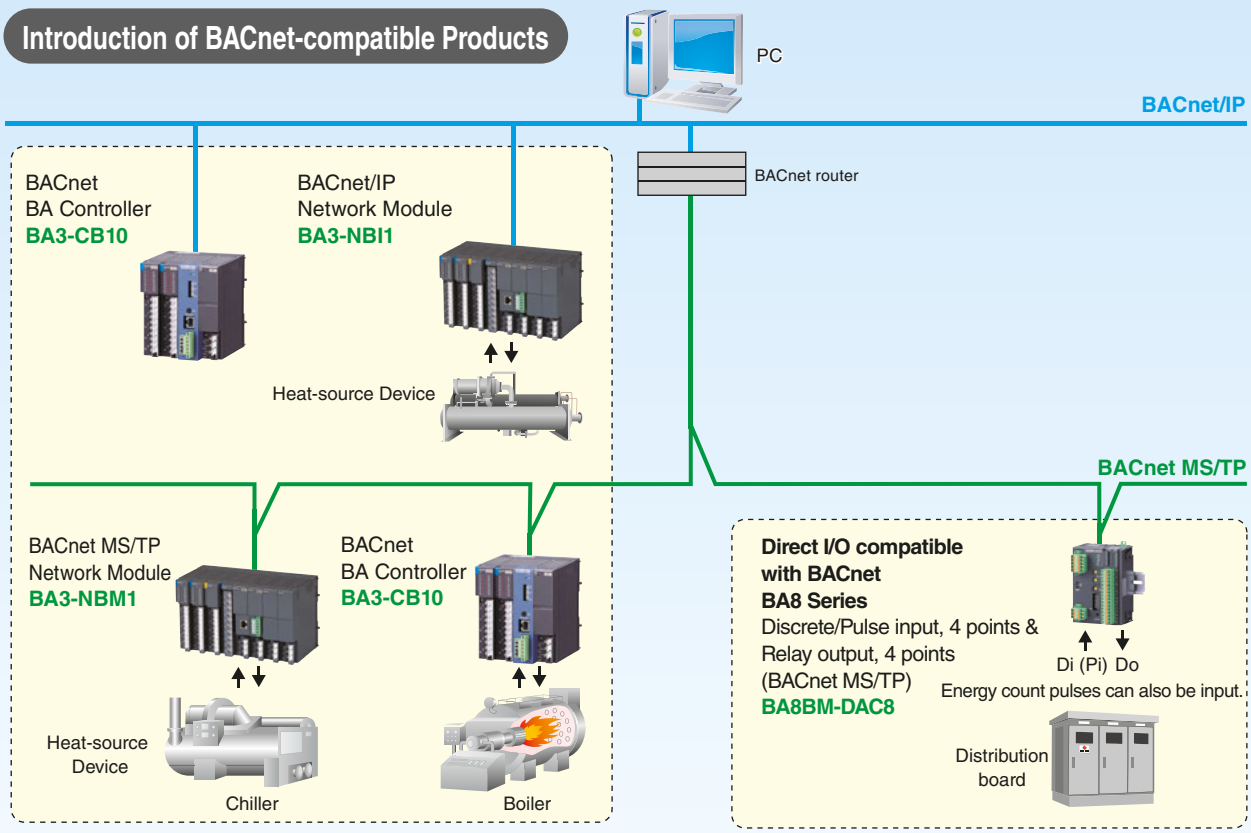
Model: BA3-NBM1

Network Module (BACnet/IP)

Model: BA3-NBI1

Users can select an optimum type of I/O module from a wide variety of Remote I/O R3 Series according to the application.

Introduction of BACnet-compatible Products



Process Controller of Touch Panel Type

Full-spec New-generation Programmable Controller

- Provided with a fine, full-dot large color LCD. (4.3-inch TFT with 256 colors, 480 × 272 dots)
- Equipped with advanced control and computing functions to support a wide range of user applications.
- Excellent maintainability supported by various engineering functions.

Multi-Function PID Controller

CE IP55

Basic model	SC100
Modbus/NestBus extension model	SC200

Multi-Function PID Controller with Manual Loader

CE IP55

Basic model	SC110
Modbus/NestBus extension model	SC210

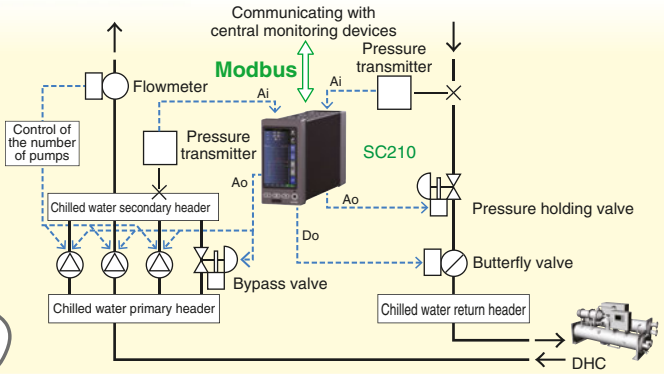
Multi-Function PID Controller with Pulse Width Output

CE IP55

SC200D

Example: Reciprocating pressure control of chilled water control

The SC series controller can control two loops. In this example, a controller performs the pressure control of the chilled water supply and return headers. By writing a sequence program in the controller, complicated sequence control will be possible for starting and stopping pumps.



We have a lot of experience in heat source receiving facilities from district heating and cooling plants.

Temperature Controller and Temperature Control Module

A general-purpose type temperature controller incorporating an easy-to-see display

- By allocating contact input, the user can switch banks and operation modes.
- The TC10EM can control two loops. The remote setpoint (SP) function is available in the case of single-loop control.
- Manipulated value (MV), process value (PV), and alarm output can be allocated as control outputs.

TC10EM

TC10NM

R3-TC2

R8-TC2

Temperature Controller

CE IP65

96 (3.8) × 96 (3.8) mm (inch)
TC10EM
48 (1.89) × 96 (3.8) mm (inch)
TC10NM

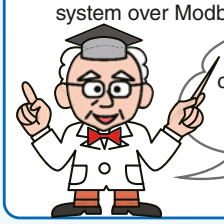
Temperature Control Module

CE (R8-TC2)

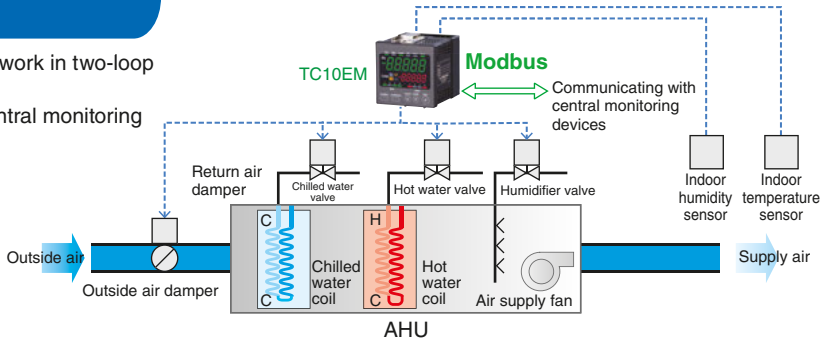
R3-TC2
R8-TC2

Example: Room temperature and humidity control

A single TC10EM temperature controller can work in two-loop control of temperature control and humidity. Furthermore, it can communicate with the central monitoring system over Modbus.



A temperature controller is enough for simple temperature and humidity control.



• For details, see the specification sheet.

High Resolution of 1/1000
Long Life Operation
Open Network Capable Actuator

LINEAR MOTION

CE UKCA IP66
Varies with the model

LINEAR MOTION | 2500 N 562 lbf MAX THRUST | 40 mm 1.57 in MAX STROKE | AC DC POWERED

Adopts a stepping motor.

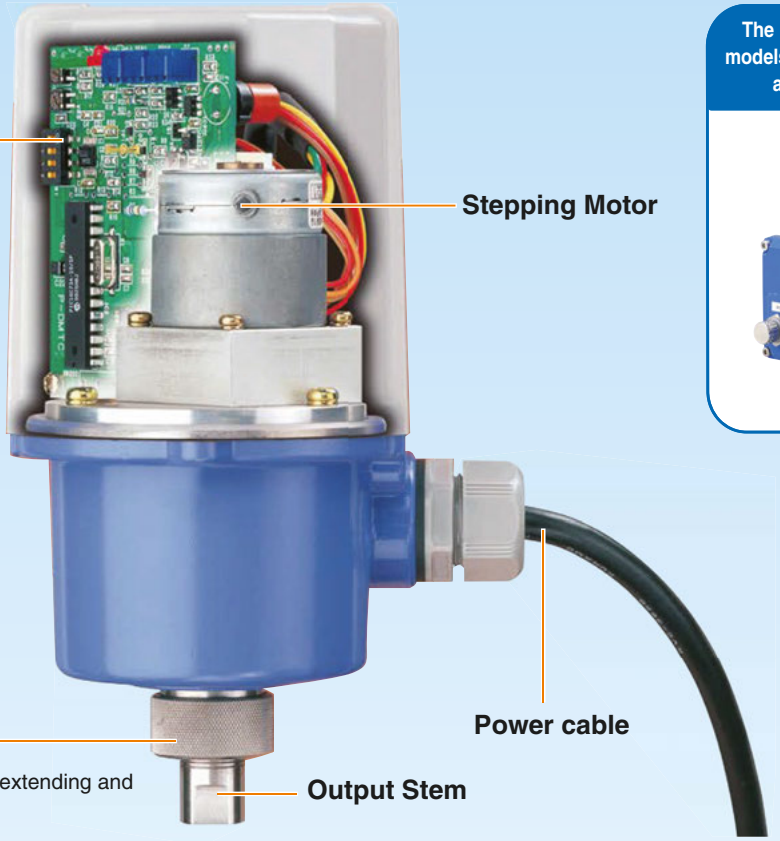
With the adoption of a stepping motor, the MSP Series has achieved a long life and a resolution of 1/1000 of the full stroke. Furthermore, the MSP Series supports various types of open network protocols.

A compact and lightweight electric actuator for control valves.

The high-thrust, compact, and lightweight MSP Series can be connected to a control valve located in a narrow space or at an elevated position. The MSP Series is driven by linear motion in which the output stem moves directly up and down. Therefore, unlike conventional electric actuators, the MSP Series does not need a link mechanism to convert the rotating movement to linear motion. The MSP Series incorporates zero and span adjustments, which enables stroke and tightening position adjustments with a control valve at the time of setup, thus greatly reducing on-site adjustment time.

Control Circuit

- Electronic limiter for full-open/-closed positions for easy calibration
- Overload protection functions



Seal-spring

- Spring mechanism for both extending and retracting directions
- Constant sealing pressure (MSP4 for single direction only)

The MSP Series lineup includes models that support open networks and auto-setup function.

External view	 IP66 CE UKCA	 IP66 CE UKCA	 IP66 CE UKCA
Model No.	MSP4	MSP5	MSP6
Operation Time (10 mm), Thrust	5 sec. / 150N 9 sec. / 300N 18 sec. / 700N	5 sec. / 150N 9 sec. / 300N 18 sec. / 700N	5 sec. / 600N 8 sec. / 1200N 15 sec. / 2500N
Stroke	5-10 mm, 8-15 mm	5-10 mm, 10-20 mm	10-20 mm, 20-40 mm

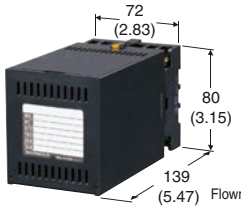
• For details, see the specification sheet.

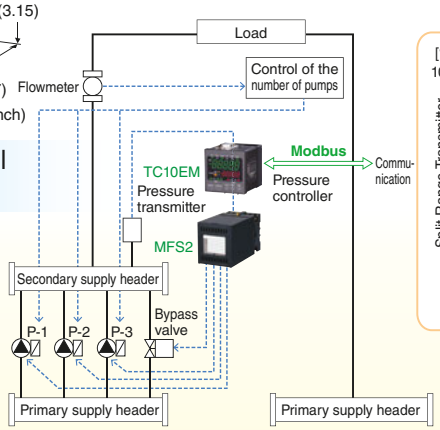
1 Splits a single input signal into four isolated output signals.

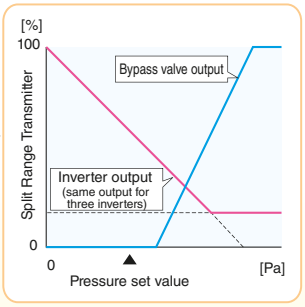
The MFS2 is very often used for air-conditioning control systems.

Isolated Four Outputs Split-Range Transmitter

Model: MFS2





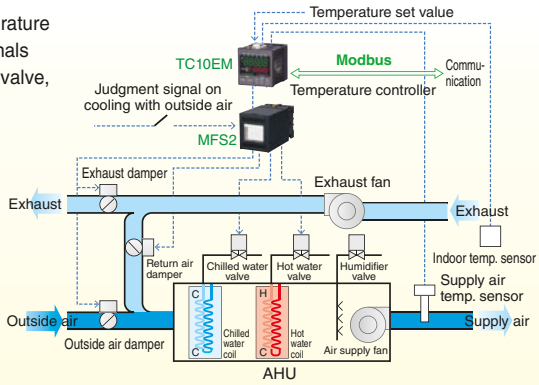


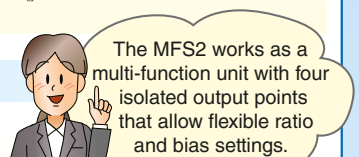
Example: Inverters and a bypass valve in control of the supply pressure of a chilled water header.

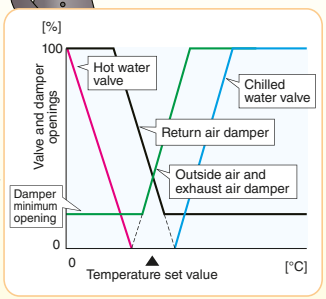
The control output from a pressure controller is split into inverter control signals for three chilled water pumps and a single control signal for a header bypass valve. Three chilled water pumps and a header bypass valve are split and set in the sequence as shown below. The MFS2 makes it easy to realize an energy-saving system that supplies chilled water to match the load of the chilled water.

Example: Instrumentation in control of an air conditioner cooling with outside air

The MFS2 splits the control output of the temperature controller and transmits four isolated output signals individually to the hot water valve, chilled water valve, outside air and exhaust dampers, and return air damper. Furthermore, the MFS2 inputs into the temperature controller a contact signal to activate the function of cooling with outside air. The chilled water valve and hot water valve operate in the sequence for cooling and heating as shown below. When cooling with outside air is possible, the outdoor air damper, exhaust damper, and return air damper will operate in the sequence shown and perform outside air cooling.







• For details, see the specification sheet.

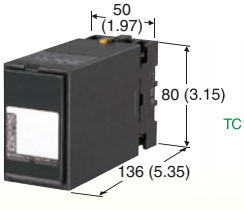
2 Splits a single input signal into two isolated output signals (non-isolated).

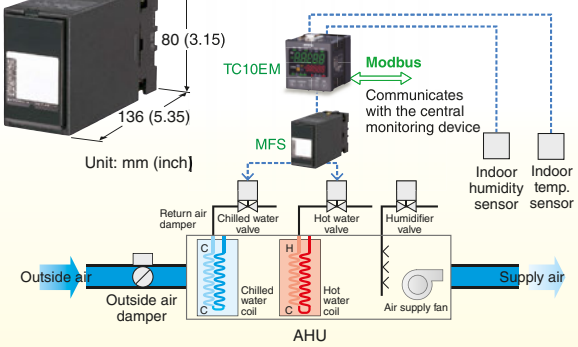
Chilled water valve and hot water valve control is possible with a single control output signal.

Split-Range Transmitter

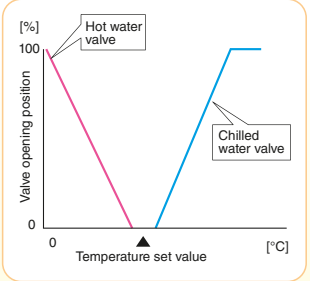
Model: MFS

The MFS receives the output signal of the temperature controller and splits the signal into two and outputs them. The MFS is used for the V-shaped split operation of the chilled water valves and hot water valves of AHUs and the split operation of large-sized and small-sized flow valves.





Control example of chilled water valve and hot water valve of AHU



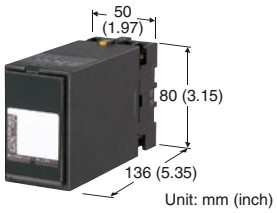
• For details, see the specification sheet.

3 Existing electric instrumentation using 135 Ω input can be retrofitted.

4-20 mA DC is converted into a resistance value such as 135 Ω.

Wide Variety of Resistance Ranges
DC/Potentiometer Converter

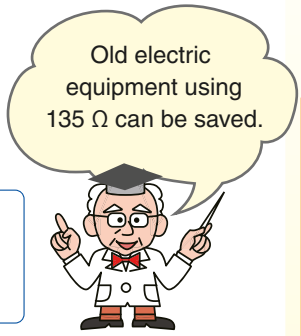
Model: CVR1

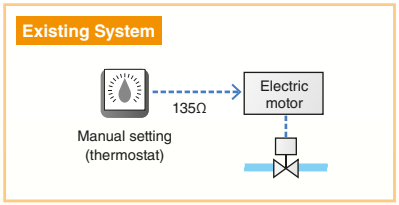


- Upgrading of manual-to-remote setting for inverters
- Remote control of electric actuators accepting 135 Ω input
- Automation and remote setting of equipment controlled manually with potentiometers

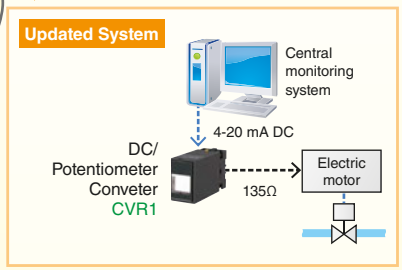
Wide Selection of Resistance Ranges

100 Ω	500 Ω	5 kΩ	50 kΩ
135 Ω	1 kΩ	10 kΩ	100 kΩ
200 Ω	2 kΩ	20 kΩ	





We want to control remotely while maintaining the existing electric actuator.



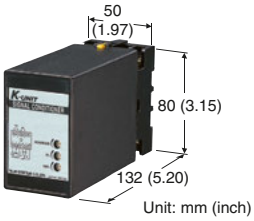
• For details, see the specification sheet.

4 I/I Positioners dedicated to electric valves and dampers for air conditioners, driven with 24 V AC

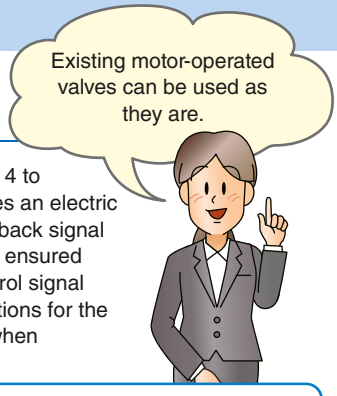
Position control is possible with a direct/reverse turn motor.

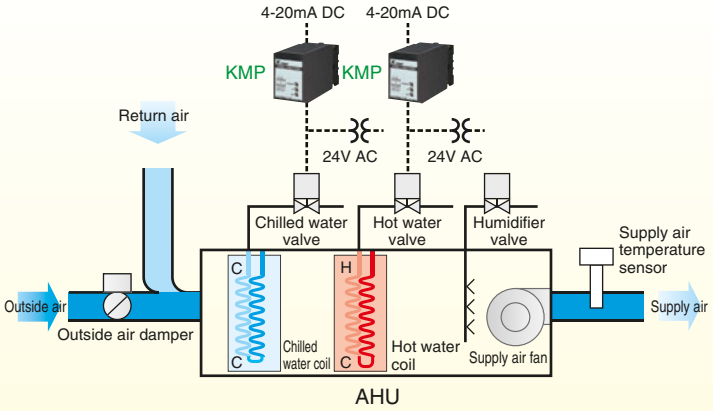
Valve Positioner (for 24 V AC motor)

Model: KMP



The KMP receives a control signal of 4 to 20 mA DC from a controller and drives an electric valve or damper that provides a feedback signal of 135 Ω. The long life of the KMP is ensured with semiconductor switches for control signal output. Users can select also the options for the split operation or reverse operation when ordering.





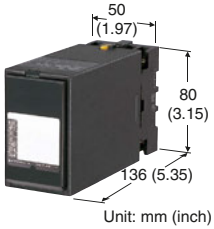
Network-capable Valve Positioners

Modbus, built-in SSR

Model: MEXM

LONWORKS, built-in SSR

Model: MEXL



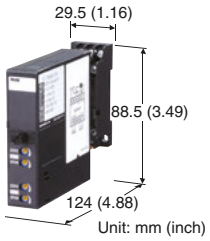
• For details, see the specification sheet.

5 Isolators accepting a single input signal, and providing two isolated output signals.

Two isolated output signals are convenient for the inverter control of air supply and exhaust fans.

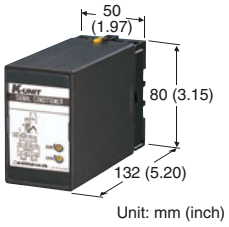
Plug-in Socket Mounted Signal Transmitter

Model: W2VS

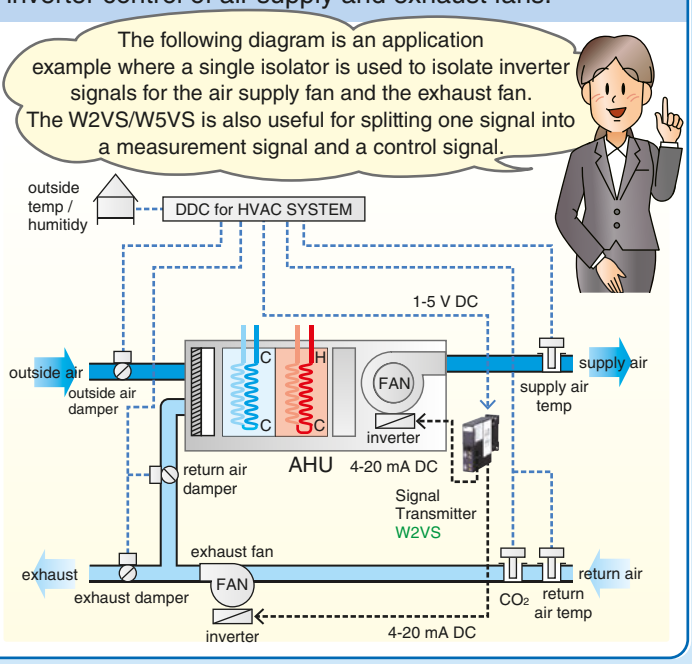


Built-in excitation, Two isolated outputs Pulse Isolator

Model: KWYPD



The following diagram is an application example where a single isolator is used to isolate inverter signals for the air supply fan and the exhaust fan. The W2VS/W5VS is also useful for splitting one signal into a measurement signal and a control signal.



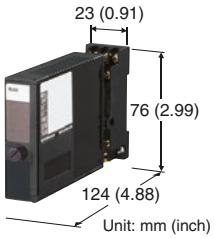
• For details, see the specification sheet.

6 Function modules generally used for BA

Easy ratio/bias setting with the control buttons with a help of digital display behind the front cover.

Output Bias Ratio/Bias Transmitter

Model: M2REB

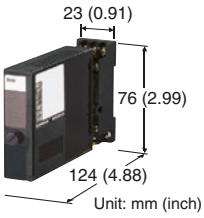


The Ratio/Bias Transmitter is an output bias type (ratio function $X_0=KX_1+B$) and you can set both ratio and bias setting with the control buttons with a help of digital display behind the front cover.

Addition or selection for two signals are performed.

High/Low Selector

Model: M2SES

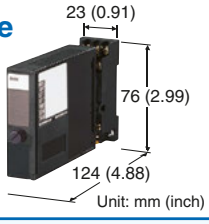


The M2SES outputs the larger or smaller one of two input values. This feature can be used for dehumidification control (for example, with a chilled water valve) by selecting either of a temperature control signal or a humidity control signal.

RTD transmitter programmable with a PC software tool

PC Programmable RTD Transmitter

Model: M2XR2



Various types of RTD sensors, e.g. JPt, Pt, Ni, Cu, are selectable.

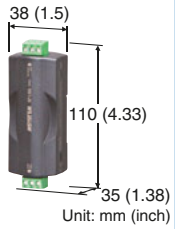
• For details, see the specification sheet.

7 Noise filter for LonWorks

Compatible to FTT-10A network.

LonWorks Noise Filter (FTT-10A)

Model: NF-LWA

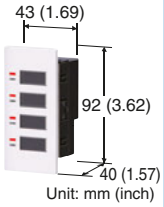


The NF-LWA satisfies the specifications of insulation choke for FTT-10A network recommended by Echelon.
Note: This unit is not applicable to LonWorks Link Power network.

8 Indoor switch for LonWorks

LonWorks Indoor Switch

Model: BA-RCL



The BA-RCL is an indoor switch for the LonWorks, which is used to perform the ON/OFF control of lighting.

Easy-to-understand Mechanism of Central HVAC Control

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