Cat. No. W82-E1-1

OMRON USER'S MANUAL

Programmable Controller

Model SYSMAC-C120F

Flowchart Programming

RONICS CO.

Introduction

This user's manual provides all the information you need to install, operate, and maintain the OMRON SYSMAC-C120F Flowchart Programming Type Programmable Controller, which can be used for a wide range of industrial applications.

The C120F represents the cream of OMRON's control components technology which we used to respond to the demand for a low-cost, versatile industrial control system that can be quickly installed and easily operated by technicians with little or no experience with programmable controllers. Here are several of its many features.

Easy-to-understand programming technique
Unlike most of the existing programmable controllers, the C120F uses the Flowchart Programming technique developed with OMRON ingenuity. With this programming technique, even those who don't know or understand the circuit logic -- the programming technique required for other programmable controllers – can easily become good programmers. All that is required is to draw a flowchart representing the movement of the equipment to be controlled and then hit the keys on the programming console.

Automatic address management
The C120F adopts the "labeling concept" for automatic management of the address in memory. The addresses are automatically managed by designating a "label" when you have modified the program by adding or deleting instructions.

Parallel control of 32 systems
Another unique aspect of the C120F, or the flowchart programmable controller, is that it can readily control up to 32 systems at one time as though you have 32 independent programmable controllers in your control system. This capability is something difficult, if not impossible, to achieve with conventional ladder diagram type programmable controllers.

Ideal to configure small- and medium-scale control system
All functions for a small- and medium-scale control system are integrated in a single compact housing measuring only 100 mm in depth. The basic unit offers 48, 56, or 64 I/O points and the number of I/O points can be increased up to 256 in the full system configuration.

Compatibility among the SYSMAC-C series PCs
The instructions are fully compatible with the other versions in the flowchart type SYSMAC-C series. Therefore, the program you have written with the C120F can be executed by, say, a SYSMAC-C500F, the highest version of the flowchart type C series, or vice versa. Not only the instructions, but also all the peripheral devices are compatible among the flowchart type C series PCs.

Wide variations of I/O units
The terminal block of the I/O units can be removed for easy wiring. Besides, I/O units come in wide variations to enhance the capability of your control system. In addition to the general-purpose I/O units, for example, many special units are optionally available – the interrupt input unit, A/D conversion input unit, D/A conversion output unit, high-speed counter units – to name a few.

Optical fiber link system
When configuring a somewhat large control system, ensuring the reliability of the data transmitted within the system may be a headache. But you don't have to worry about it with a control system using the C120F because the optionally available remote I/O units employ fiber optics which provide superb noise immunity. Hence, the reliability of the data transmission is now raised almost to the upper limit.

About the manual

This manual was designed, written, and illustrated to be highly useful to people at all levels of understanding and experience with programmable controllers, including the first-time user. It has also been organized and indexed to allow easy access to specification information.

The only special knowledge you need is an understanding of flowcharts using familiar symbols in this computer age.

Here's what you will find in the following chapters and appendixes.

Chapter 1 and Chapter 2
Flowchart programmable controllers in general, and the C120F in particular, are introduced. Each part of the C120F is illustrated and explained.

Chapter 3
This chapter mainly covers the software aspect of the flowchart programmable controller and the concept of the flowchart programming technique is discussed in comparison with the ladder diagram programming technique. Brief descriptions of some of the C120F's unique instructions are also included.

Chapter 4 to Chapter 7
These three chapters discuss the hardware of the programmable controller. The discussion includes relay number assignment, installation, maintenance, and troubleshooting.

Appendixes

The many peripheral devices available to expand the C120F control system and provide valuable support services are introduced. Also covered are the basic and special instructions in programming, as well as product specifications. A comprehensive index is provided for easy reference.

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Chapter 1 Introduction to C120F

Overview

This introductory chapter explains why programmable controllers have become such a valuable part of modern factories. In this chapter, the SYSMAC-C120F is described, including its basic components and operating procedure.

PC basics

Programmable controllers, or PCs, evolved as industries sought economical ways to automate their production lines, particularly those involved in the manufacturing of equipment and other heavy industry products. The PCs took the place of relay-based control systems which were comparatively slower, less reliable, and which presented formidable wiring and maintenance requirements.

PCs operate by monitoring input signals from such sources as pushbuttons, sensors, and limit switches. When changes are detected in the signals, the controller system reacts, through user-programmed internal logic, to produce output signals. These signals operate the external loads of the controlled system, such as relays, monitor controls, indicator lights, and alarms.

This type of control system eliminates much of the wiring and rewiring that was necessary with the conventional relay-based system. Instead, the programmed logic provides the "wiring network" which can be changed as required by simply reprogramming the PC. Thus the automated processes of a production line can be controlled and modified at will, to achieve highly economical adaptability in a changing manufacturing environment.

A typical programmable controller has three basic components—an input/output section, a central processing unit (CPU), and a programming device.

Input/output section

This section consists of wiring and interfacing relays that connect the PC to the equipment being controlled.

Central processing unit

The CPU contains the control circuitry as well as the memory that stores the control plan that guides equipment operation. It is the heart of the PC and organizes all controller activity by scanning the control plan along with the status of the inputs and executes specified commands to specified outputs.

Programming device

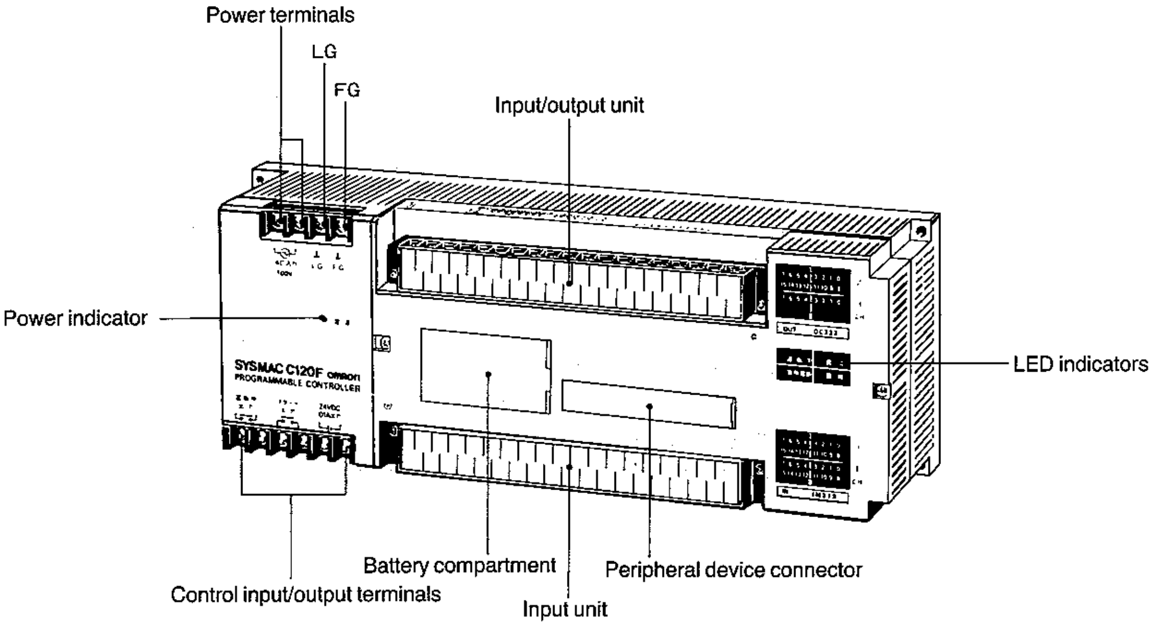
This device is used to enter the control plan into the CPU's memory. The user keys in the instructions are used to sequentially control the application process. There are several programming methods; in the case of the SYSMAC-C120F, it is flowchart programming, a unique programming technique described in detail in the next chapter.

C120F components

Due to its compact design, the C120F incorporates the detachable I/O terminals, microprocessor functions, and power supply in a single housing called the "CPU rack". The detachable programming console functions as the programming device. Additionally, various optional peripheral devices are available to support system expansion.

These components are explained and illustrated in the next several pages.

CPU rack



Power terminals

Connect commercial power source (100 to 120/200 to 240 VAC, 50/60 Hz) to the CPU rack from these terminals. Use M4 screw terminals or M4 solderless terminals for wiring the power source.

LG and FG terminals

These terminals are ground terminals and should be grounded at a resistance of 100 Ω or less to prevent electric shock.

Control input/output terminals

These three pairs of terminals are used to receive or produce control input/output signals. The RUN OUTPUT terminals are used to provide to an external device the output signal indicating the C120F's operation. The START INPUT terminals are used when you wish to start or stop the C120F by an external signal. The DC 24V 0.1A OUTPUT terminals output a signal rated at 24 VDC 0.1 A.

Input/output unit
To the input or output unit mounted here, connect the input device or load in your control system.

Battery compartment
When a RAM is mounted inside the CPU rack as the program memory, a battery must be also mounted to back up the memory. This compartment accommodates the backup battery.

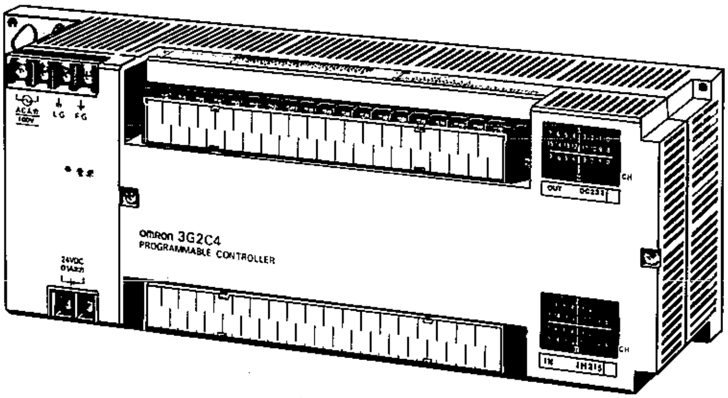
Input unit
The bottom slot of the CPU rack allows only an input unit to be mounted.

Peripheral device connector
Various peripheral devices, including the programming console, are connected to this connector either directly or via a connecting cable.

LED indicators (POWER, RUN, ERR/ALARM, OUT INH)
These indicators light up to indicate the operating status of the CPU.

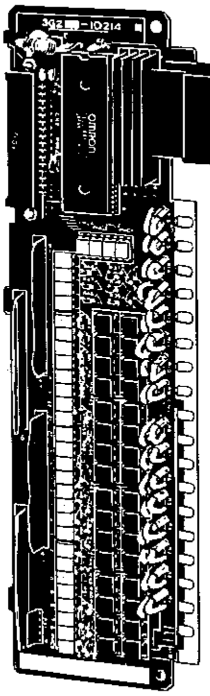
Expansion I/O rack

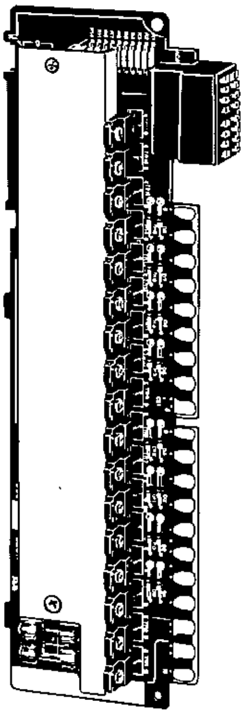
Aside from the input/output units mounted on the CPU rack, a module may be used to increase the number of I/O points per control system. This module is called "expansion I/O rack". A maximum of three expansion I/O racks can be connected per CPU rack of the C120F to thereby increase the total number of I/O points to 256 in the full system. Here is the appearance of the expansion I/O rack.



Input/output unit

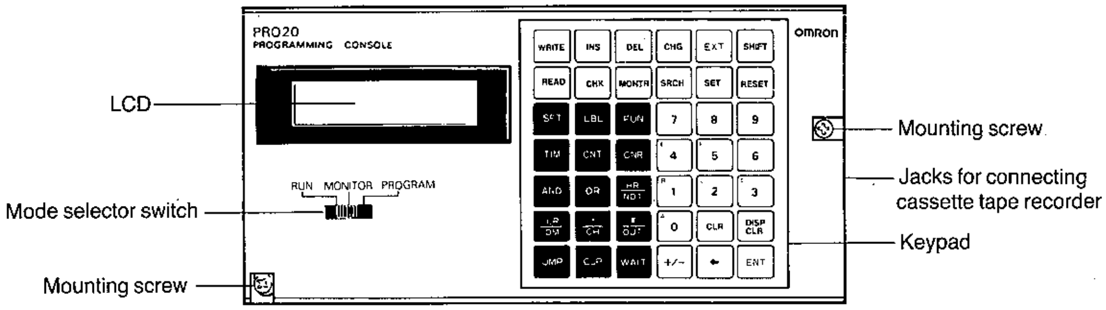
In both the CPU rack and expansion I/O rack, input/output units are mounted in the top and bottom slots. (Both the output unit and input unit can be mounted in the top slot of the CPU rack but only the input unit can be mounted in the bottom slot.) When pulled out from the slots, they look like this.





Programming console

This is the standard programming device used with the C120F. The program written by the programming console are stored in the memory of the CPU rack and executed. The operation of the programming console is explained in detail in its user's manual separately available.



Mounting screws
These two screws secure the detachable programming console to the CPU rack.

LCD
This displays the program as it is being written and is used for checking and monitoring program operation. It also displays error messages.

Keypad
The program is written in the CPU rack's memory with these keys.

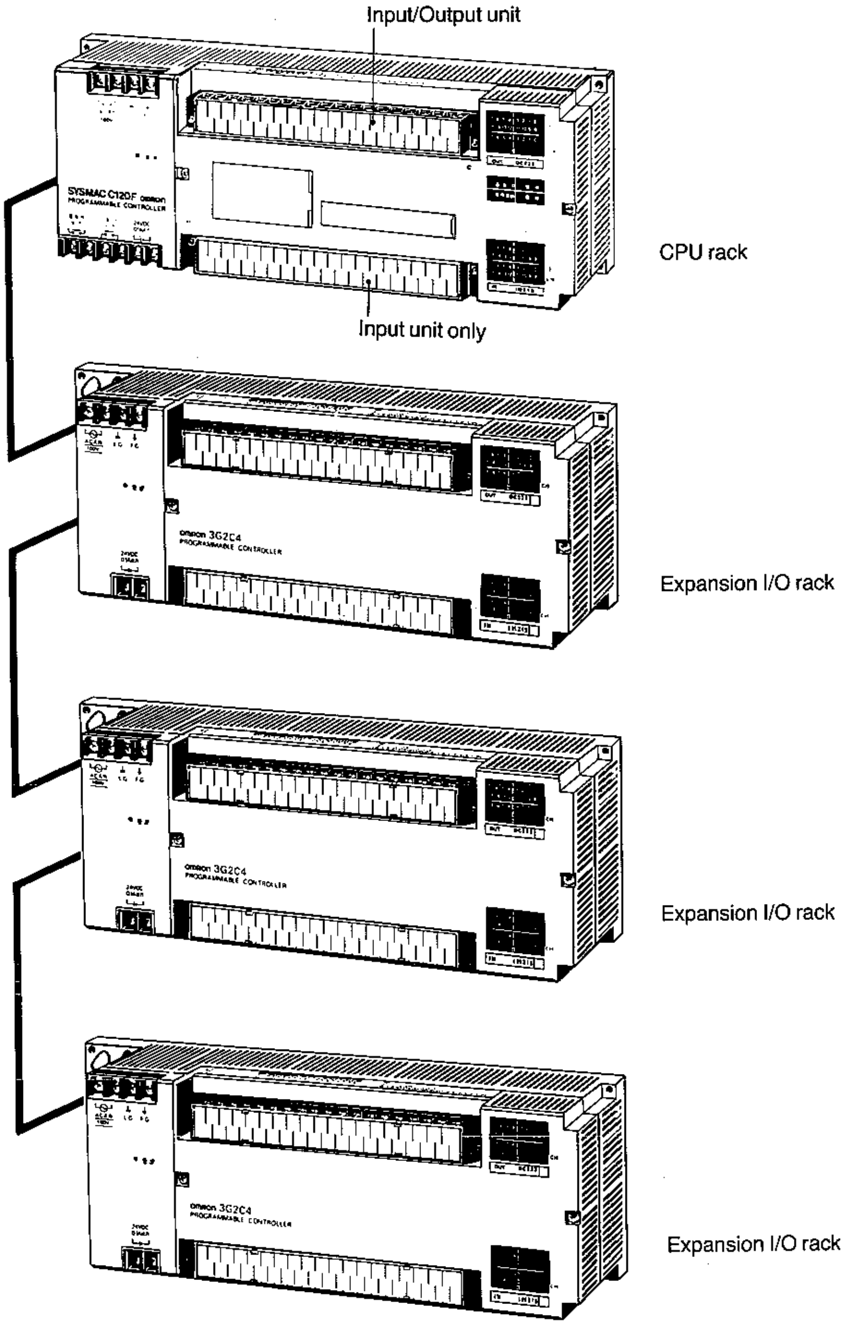
Mode selector switch
This three-position switch selects one of the three operation modes of the C120F: PROGRAM, MONITOR, and RUN.

Jacks for connecting cassette tape recorder
Programs may be saved to a standard cassette tape recorder connected to the output (MIC) jack. Previously written programs can also be supplied to the CPU rack's memory via the input (EAR) jack.

Introduction to C120F

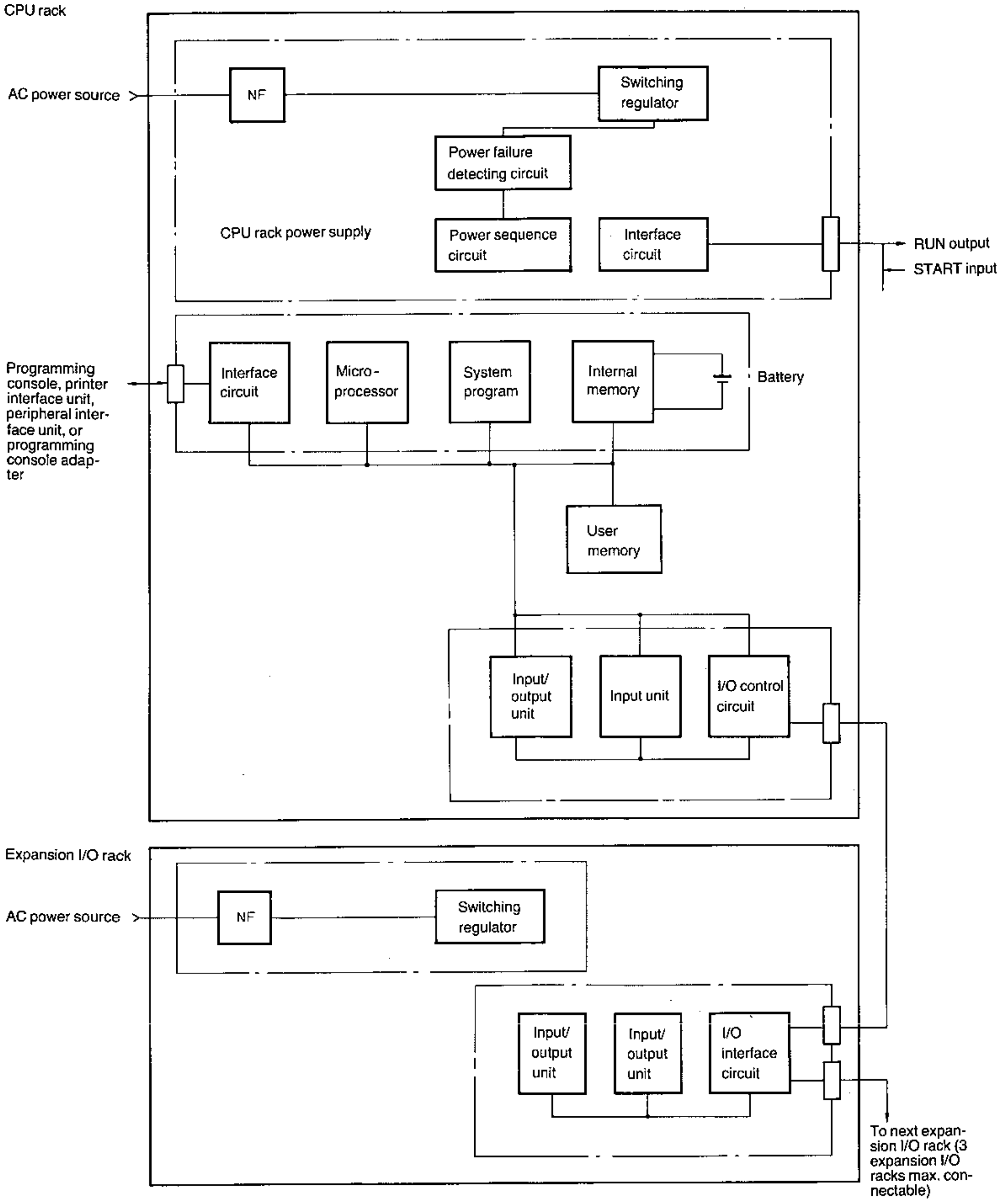
System configuration

This figure shows the full system possible with the C120F. Three expansion I/O racks are connected to a single CPU rack. With this system configuration, the maximum number of I/O points the C120F offers (i.e., 256 I/O points) can be obtained.
In the slots of each expansion I/O rack, any I/O units can be mounted.



Internal circuit configuration

The following diagram shows the internal circuit configurations of the CPU rack and expansion I/O rack.



Chapter 2 Operating procedure

The procedure for actually operating the C120F can be broadly divided into the following four steps.

1. Control system design

First, the equipment or system to be controlled must be decided. The ultimate purpose of the programmable controller is to control an external system. This "system to be controlled" can be a machine, equipment, or process and is often generically called the "controlled system".

The movement of the controlled system is constantly monitored by the devices that, when a given condition is satisfied, send a signal to the programmable controller. In response, the programmable controller outputs a signal to the device that actually controls the movement of the controlled system as required and thus achieves the intended control action.

2. I/O assignment

Second, the input/output devices to be connected to the programmable controller must be determined. The input devices can be various switches, sensors, etc. The output devices can be a solenoid, electromagnetic valve, or a motor, to name a few.

These input/output devices are in fact connected to the programmable controller. However, conceptually, they are "assigned" the numbers corresponding to the input/output relays with which the programmable controller is internally provided. Although the actual wiring of the input/output devices can be performed before or after programming, this assignment of "input/output numbers" must always be carried out before programming because the numbers are essential to programming.

3. Programming

Now, you can apply power to the C120F. If it is the first power application after the product has been delivered to you or since you changed the input/output configuration, you must perform an operation to register the input/output devices in the programmable controller's memory; in other words, generate the I/O table. This operation is easily accomplished by pressing some keys on the programming console in a fixed sequence (described in detail in the user's manual for the programming console).

After you have generated the "I/O table", you can write your program in the memory, using the programming console.

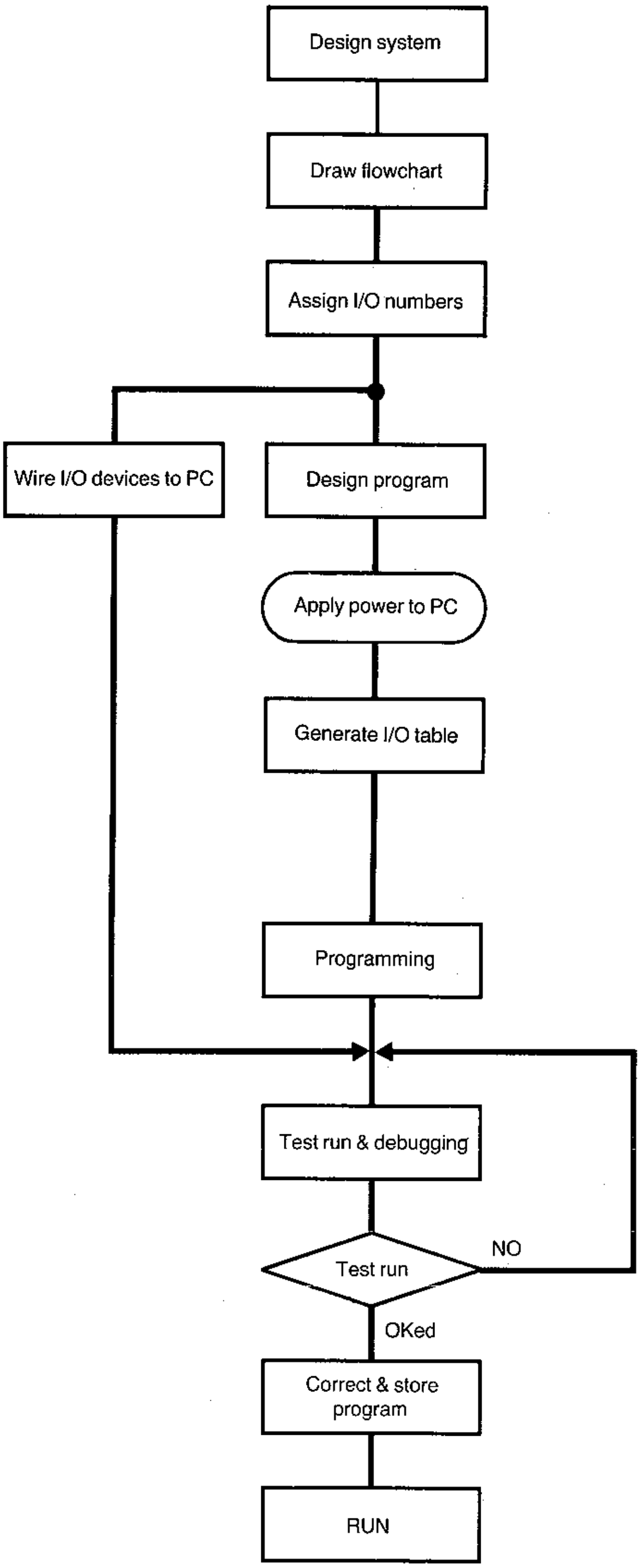
After you have written the program, it should be checked for errors by means of simulation or test run and corrected, if necessary. The completed program can be stored in a permanent storage device such as a cassette tape or PROM so that the program is protected from unauthorized access or inadvertent erasure. (The detailed discussion of programming may be found in Chapter 3.)

4. RUN operation

When the above three steps have been completed, the actual operation of the programmable controller can be started. This operation is called "RUN operation".

Operating procedure

The following flowchart summarizes the above discussion.

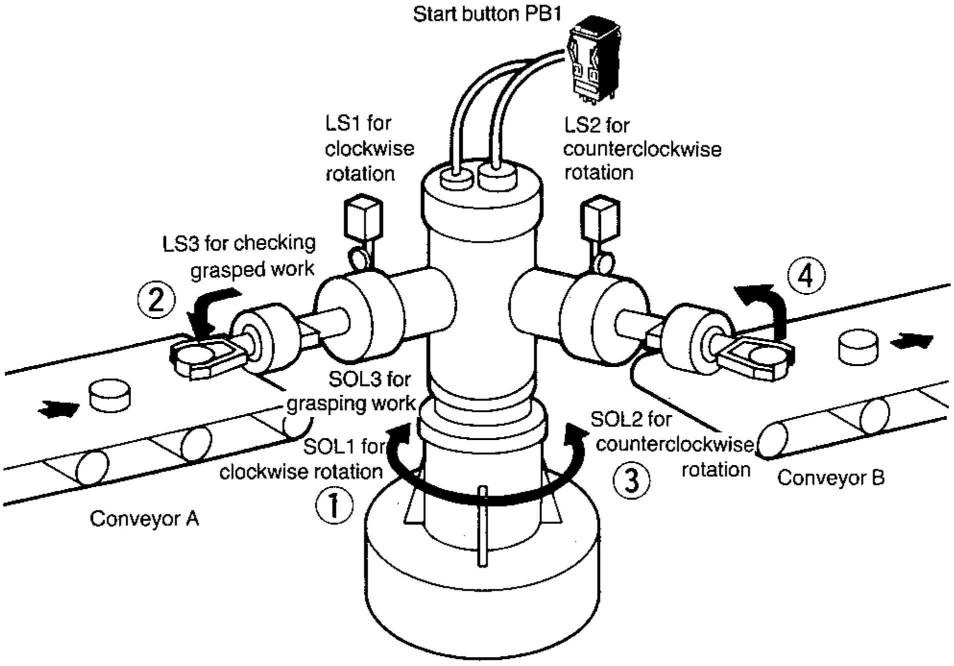


Now let's discuss each of the above steps in greater detail using a simple controlled system as an example. However, emphasis is placed on the first two steps in this chapter with the third step explained in the next chapter.

Control system design

As mentioned earlier, the control system created with the C120F must be first determined. However, since possible variations in application of the C120F are almost infinite, this section explains the control system design and I/O assignment procedures taking a specific example, to deepen your understanding of the programmable controller.

Suppose you wish to control the following robot's movement.



This kind of robot is seen in many automated factories. As is apparent from the figure, this robot picks up a work being carried on conveyor A, and places it on conveyor B.

Although seemingly simple, executing this series of operations with electric devices and circuitry is harder than realized.

Looking at the above figure closely will disclose that the robot performs one operation at a time when a given condition is met. Let's analyze these operations and conditions.

1. When the start button is pressed, the robot rotates its arm clockwise.
2. When the robot arm has moved to the position of the work on conveyor A, the arm grasps the work.
3. When the arm has grasped the work, it rotates counterclockwise.
4. When the arm has rotated to the position of conveyor B, it releases the work.

Since the programmable controller receives input signals and in response to which performs the intended control action by producing outputs, these conditions and operations can be considered as the input and output of the programmable controller, respectively. In other words, when conditions given to the programmable controller by input devices are satisifed, the controller causes the output device to operate to achieve the required control action. Now, let's look at what input and output devices are used in this example.

First, the movement of the robot is initiated by the human operator when he presses pushbutton switch PB1. As stated before, when this button is pressed, the arm rotates clockwise. This is because solenoid SOL1 for clockwise rotation operates. Therefore, in the first stage of the robot operation described above, PB1 serves as the input device and the SOL1 as the output device of the programmable controller.

Second, when the robot arm has rotated to a predetermined point, it stops and grasps the work on conveyor A. The arrival of the arm at the predetermined point must be detected. This is done by limit switch LS1 which inputs a signal to the programmable controller. In response, the programmable controller stops SOL1 and starts SOL3 that is used to make the arm grasp the work.

Third, when the arm has grasped the work, it rotates counterclockwise. But before letting the arm rotate, whether the arm has securely grasped the work must be checked. In this example, LS3 does this checking. When LS3 is turned ON, indicating that the arm has securely grasped the work, the programmable controller turns ON SOL2 which rotates the arm counterclockwise.

When the arm has rotated to the predetermined position on conveyor B, the arm is detected by LS2 (input). When LS2 is turned ON, SOL2 is turned OFF, thus the counterclockwise rotation of the arm is stopped. At the same time, SOL3 is also turned OFF to release the work from the robot arm.

Determining No. of I/O points

The input/output devices connected to the programmable controller is counted in units of "points". This point unit is also used to count the number of relays with which the programmable controller is provided internally. Therefore, all the input/output devices connected to the programmable controller is actually connected to each of the internal relays of the programmable controller.

The programmable controller should be able to accommodate about 10% more input/output (I/O) points than the existing number to provide for future expansion of the system. In other words, the programmable controller should have that number of internal relays.

Let's see how many I/O points are used in our example. For the input, four points of devices are used: one pushbutton and three limit switches (LS1 to LS3). For the output, three points of devices are used: SOL1 to SOL3. Therefore, the example system consists of seven I/O points in all and therefore, a programmable controller having more than 10 points can form this control system. In the case of the C120F, its CPU rack alone provides a maximum of 128 I/O points and the number of I/O points can be further increased up to 256 points by connecting a maximum of three expansion I/O racks to the CPU rack. Therefore, for the example system, even the number of I/O points the CPU rack itself has is more than enough.

The programmable controllers of the SYSMAC-C series all use the concept of I/O channels to identify individual I/O points. Each of these channels consists of 16 points and is expressed as four digits of decimal numbers.

The four-digit number used to identify an I/O point therefore can be broken down into the left two digits, which identify the channel, and the right two digits, which identify the point within the channel.

For example, "0000" identifies the first point of the first channel and "0104" identifies the fifth point of the second channel.

Now, all the input/output devices to be connected to the C120F are not actually connected to the programmable controller directly. Instead, they are connected via the input/output unit mounted on the C120F. As the I/O units for the C120F, 16-point, 32-point, and 64-point units are available. If a 32-point I/O unit is mounted on the C120F, for example, this means that the I/O unit occupies the 32 points (or two channels) of C120F's internal relays and that a maximum of 32 points of input/output devices can be connected to this I/O unit.

Determining memory capacity

When the number of I/O points is being determined, one important point to be noted is the capacity of the program memory. The program memory is used to store the user program and its capacity (the number of addresses) varies depending on the application of the programmable controller. The more complicated the control action performed by the programmable controller, the greater the memory capacity that is required. Generally, the memory capacity required for a particular application is calculated by multiplying the total number of required I/O points by 8 to 12. This is because the memory stores not only the user program but also the data for arithmetic operations.

Additionally, the memory should be ready for future modification in the specifications or expansion of the control system.

In our example, the total number of I/O points is seven. For convenience' sake, assuming that one I/O point requires eight addresses, multiply seven by, say, eight. The answer is 56, which means that a memory of more than 56-address capacity should be used for this example. (In reality, however, you can't calculate the memory capacity by such a simple procedure. There are many other factors to be considered and you may need an engineer's help to determine the memory capacity.)

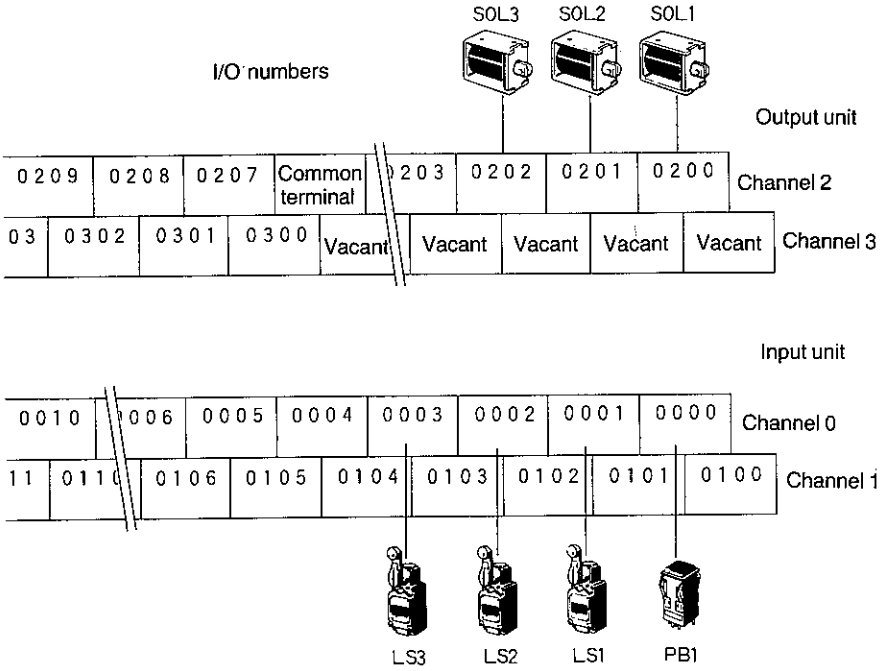
Usually, all SYSMAC-C series programmable controllers do not have a program memory when they are delivered. This is because, as easily seen from the above discussion, the required memory capacity varies depending on the user's intended application. The C120F is no exception and you should decide the memory capacity necessary for your control system and order the memory separately. Two types of memories are available. One is a random-access memory (RAM), whose data can be read or written as you like. The other is a read-only memory (ROM) which allows data to be read as many times as required but to be written only once. You cannot change or erase the data from a ROM once they have been written to the memory, unless you use a special device. For the C120F, Models ROM-H and RAM-H are available as a ROM and RAM, respectively.

I/O assignment

After you have determined the input/output devices, hence the number of I/O points required and the memory capacity, you should assign the I/O numbers to the I/O points. In our example, let's assign I/O numbers 0000 to 0003 to the four inputs, that is, 0000 to PB1, 0001 to LS1, 0002 to LS2, and 0003 to LS3. For the outputs, at least the channel number of the output points should be different from that of the input points. Therefore, let's assign output numbers 0200 to 0202 to the three output points, that is, 0200 to SOL1, 0201 to SOL2, and 0202 to SOL3.

These I/O numbers, as stated earlier, represent the I/O points, or more specifically, the I/O terminals of the I/O units mounted to the C120F. Therefore, by assigning of the I/O numbers to all the I/O devices, you can know which I/O device should be connected to which terminal of the I/O unit.

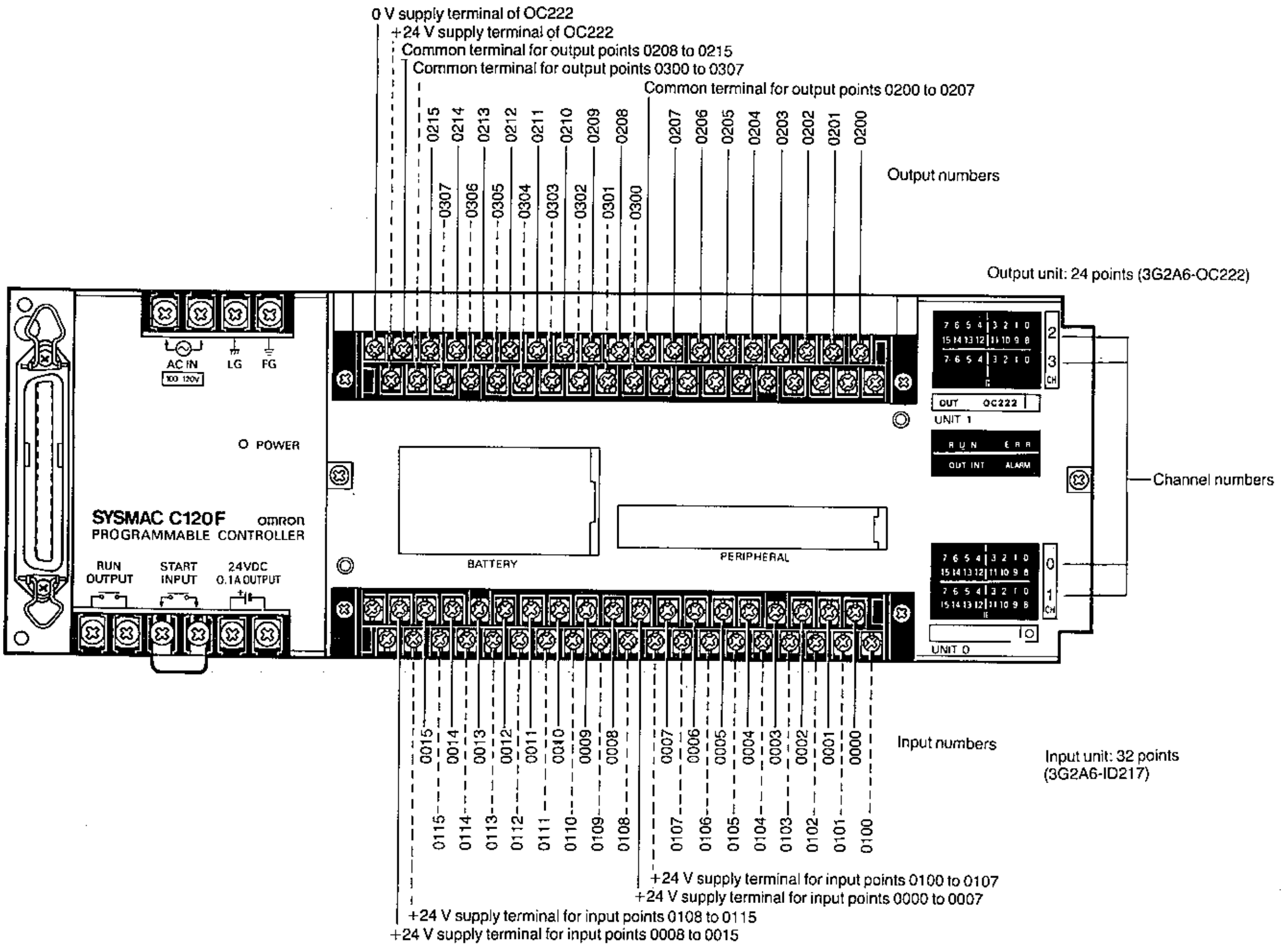
For example, when the input unit Type ID217 (32 points) and output unit Type OC222 (24 points) are mounted on the C120F, the I/O assignment, or actual wiring of the I/O devices can be as shown in the following figure.



I/O device wiring

When all the I/O numbers have been assigned, the input and output devices must be respectively connected to the input and output units. Although there are many I/O units available for connection to the C120F, let's continue to the already mentioned Type ID217 input unit and Type OC222 output unit.

The following figure shows the C120F to which the I/O units mentioned above are mounted. Note that an input unit must be always mounted in the bottom slot of the CPU rack. In the top slot, however, both an input and an output unit can be mounted.



Note that the terminal numbers (A0 to A18 and B0 to B18) inscribed on the terminal blocks of the input unit inversely correspond to the input numbers (0000 to 0018 and 0100 to 0115). For example, the input number 00 of channel 00 (i.e., 0000) corresponds to terminal number B18.

When connecting the input/output devices to the input/output units on the C120F, use wires having a conductor cross sectional area of 1.25 mm^2 and M3.5 solderless terminals. (For details on the wiring and relation information, refer to Chapter 6, Installation and mounting.)

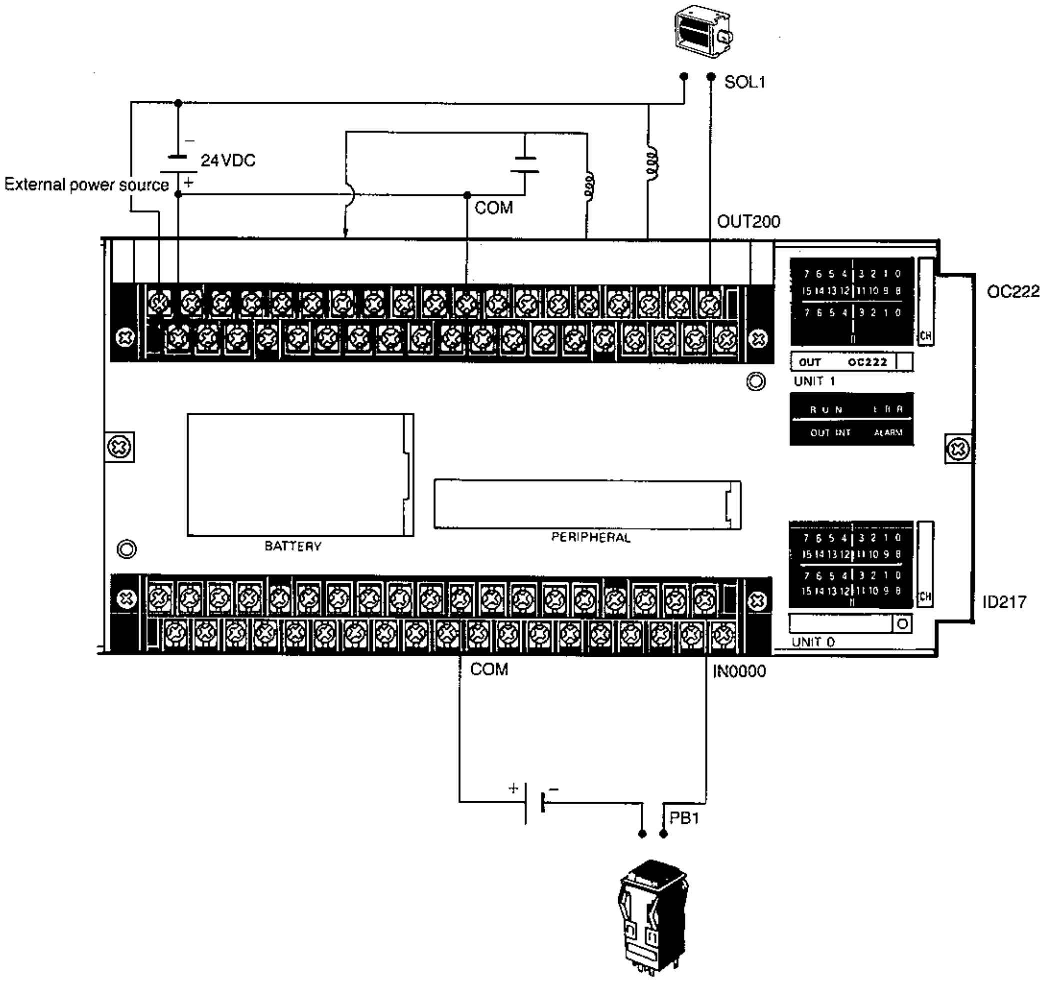
Operating procedure

External power supply

To each of the input and output units on the C120F, an external power source, by which the input or output device operates, must be connected. In the case of input unit ID217, connect the positive terminal of the external power source (24 VDC) to the common terminal of the input unit, terminal number B10. Connect the negative terminal of the power supply to one of the two lines of the input device. Connect the other line of the input device to the terminal having the terminal number assigned to that input device.

In the case of output unit, OC222, the positive line of the external power supply is branched with one of its two ends connected to terminal B18 of the output unit and the other end connected to terminal A8, which is the common terminal. The negative terminal of the power supply is connected to terminal A18. To this negative terminal of the power supply, one line of the output device is connected. The other line of the output device is connected to the terminal having the output number assigned to that output device.

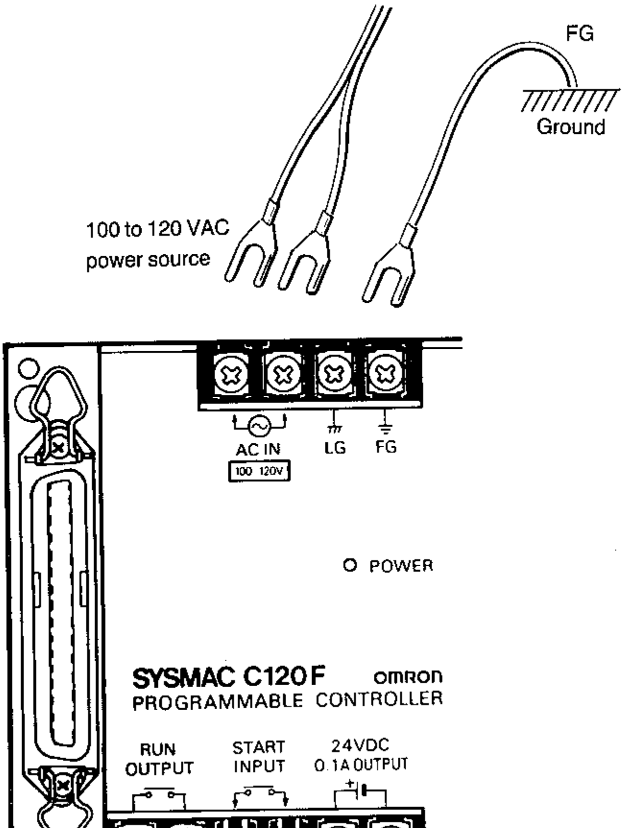
To visualize this discussion, look at the following figure. In this figure, as an example, one input device, PB1, and one output device, SOL1, are respectively connected to the input and output units.



Main power supply connection

Now the CPU rack power supply should be connected to the commercial power source. Connect a 100 to 120/200 to 240 VAC power source across the AC IN terminals of the power supply on the CPU rack. To make this connection, use a wire having a conductor cross sectional area of 2 mm^2 or more and M4 solderless terminals.

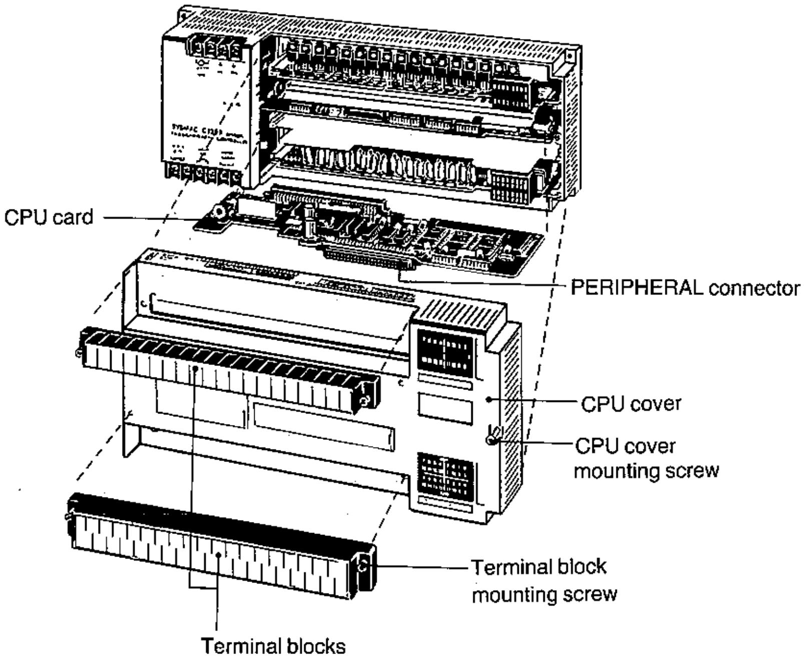
Also on the CPU rack power supply are two ground terminals: LG and FG. Although it is recommended to ground both the terminals, especially ground the FG terminal at a resistance of 100 Ω or less with a 2- mm^2 wire to prevent electric shock. (For more details, refer to Chapter 5, Installation.)



Memory mounting

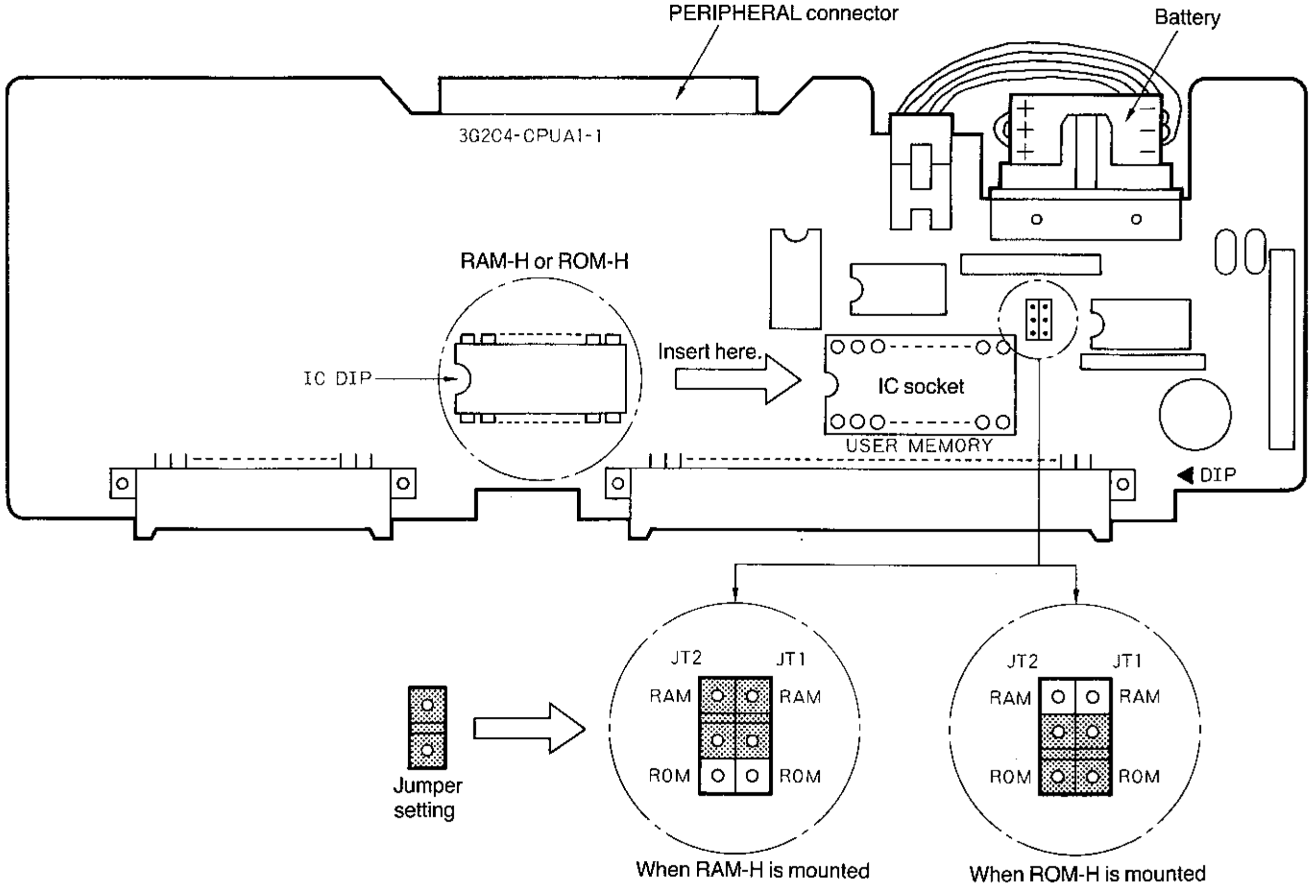
Earlier, we have decided the memory capacity necessary for our example and therefore, we should mount the memory in the programmable controller. In the case of C120F, two types of memories, RAM-H (equivalent to 6264) and ROM-H (equivalent to 2764) are available. Select the one suited to your application and then mount it observing the following procedure.

1. Remove the mounting screws from the terminal blocks to detach the terminal blocks from the CPU rack.
2. Remove the screws from the cover of the CPU rack to detach the cover.
3. Now several printed circuit boards are visible. The one having a battery connected to it is called the "CPU board" (3G2C4-CPUA1-1). Pull out this CPU card from the CPU rack.



4. On the CPU card, an IC socket is mounted as shown below. Mount the memory chip on this IC socket.
5. In the vicinity of the IC socket, there is a jumper. This jumper must be set according to whether the RAM-H or ROM-H is mounted. Short-circuit this jumper as illustrated.

Operating procedure



Chapter 3 Flowchart programming concept

Fundamentals

Language—SYSFLOW

The programming language is a set of characters and rules with which people can "tell" the programmable controller what to do and how to do it. As with computers, many types of programming languages have been developed for programmable controllers. Each language has merits and demerits and therefore is selected according to such factors as the controlled system, available hardware, and the experience and preference of the system designer.

Of all the programming languages for programmable controllers, ladder diagrams which use relay symbols are currently dominant. This is because ladder diagrams are easy to understand and use for circuit engineers who most of the time design the control system. One of the demerits of this programming language is that it is difficult to understand for laymen, namely, technicians, inspectors, etc., who work in the same factory as the designer but don't understand relay symbols. More often than not, only the designer can fully comprehend the movement of the control system.

However, in the course of designing, developing, inspecting, and maintaining a particular control system, there are some people with no knowledge of ladder diagrams and it takes too much time to explain the movement flow of the control system. For this reason, the demand for a programming language that is easy to understand for any one has grown in recent years.

To satisfy such a demand, languages that express the movement of a control system using an easily understood flowchart were developed by several manufacturers of programmable controllers. Of the flowchart programming languages developed by OMRON, the one provided to the C120F is the latest version and is named "SYSFLOW".

Programming procedure using SYSFLOW

The programming in SYSFLOW is carried out in four steps.

First, a flowchart illustrating what task the control system performs, and what role the programmable controller plays in that system, should be drawn. This flowchart, called a "process flowchart", is used to understand the movement of the entire control system in the designing stage.

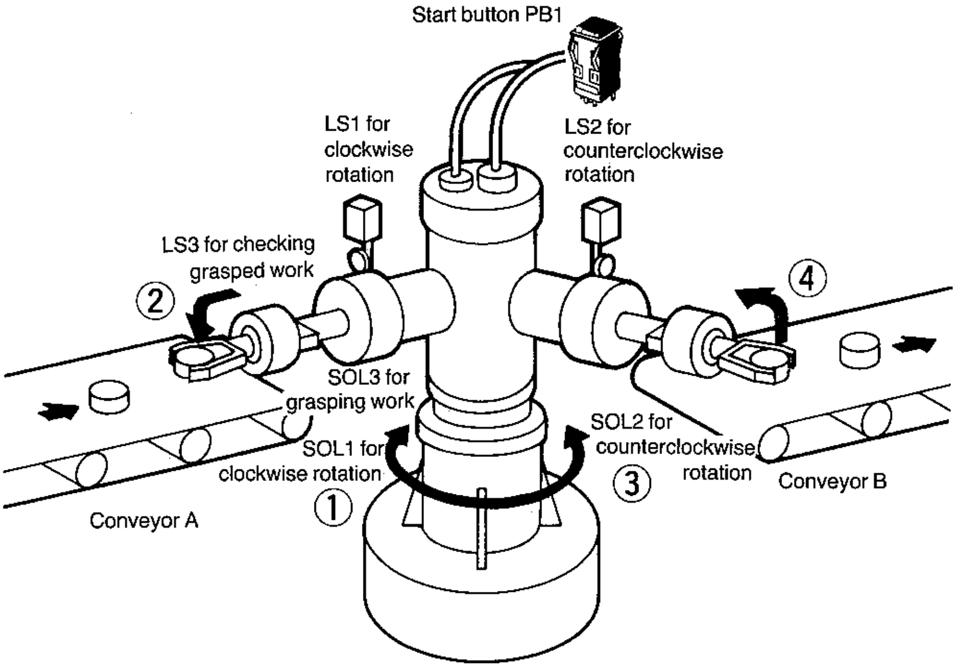
Second, a "general flowchart" must be drawn to express, as simply and clearly as possible, the sequence in which the program is to be executed and thus the control action is performed.

Third, a flowchart more detailed than the general flowchart should be drawn. This so-called "detailed flowchart" is the final flowchart which is then encoded into the instructions of the C120F.

Lastly, a coding sheet on which basis the detailed flowchart is encoded into the programmable controller's instructions must be created. This coding sheet is written in a table format and contains the instructions, and their addresses and data. When this coding sheet has been completed, the program can be written into the C120F's memory through the programming console.

Programming concept

Now we have understood the background and actual sequence of the flowchart programming technique, let's make a program using the example controlled system discussed in the preceding chapter. Remember the I/O assignment that was determined in Chapter 2? Using that I/O assignment, the following discussion is presented.



The control processes that can be realized by the flowchart programming technique can be broadly divided into three: step advanced process, parallel process, and flow processing. These processes can be respectively performed using the Wait, Branch, and Group instructions of the C120F. The control application example discussed in the preceding chapter can also be achieved by using these three instructions.

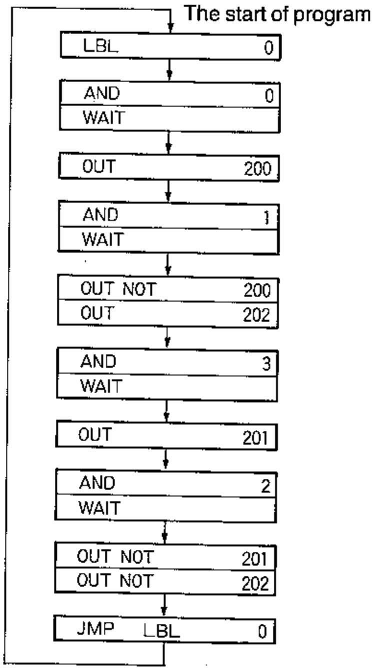
Wait instruction (step advanced processing)

In applications where the process must advance with time such as when controlling an assembly line, plating process, or water jet, the sequential control method by which the machinery is controlled on a step-by-step basis is required. In our example also, the robot's movement can be controlled sequentially. This type of control processing is called "step advanced processing" and can be realized by using the Wait instruction.

Flowchart programming concept

If the control action of the robot's movement is drawn as a flowchart, it will be like this.

Detailed flowchart



Program execution returns to the start of the program.

As you can see, this flowchart is written using only boxes. Notice the four-digit numbers in each box. These numbers are I/O numbers we have assigned to each input/output devices used in the robot. Let's review what I/O number was assigned to which I/O device.

Input number 0000 was assigned to pushbutton switch (PB1) and 0001 to 0003 were assigned to three limit switches (LS1 to LS3). Output numbers 0200 to 0202 were assigned to three solenoids (SOL1 to SOL3).

Now look at the second box. In addition to input number 0000, it has an AND instruction in it and immediately below the second box, a WAIT instruction follows. The WAIT instruction (and also the BRANCH instruction, for that matter) is often used in combination with another instruction and this is an example when it is used with the AND instruction. This combination of instructions causes program execution to wait until a given condition is satisfied. In this case, the condition means depression of the start switch PB1. Therefore, the program will neither be executed nor will it proceed to the next step until PB1 is pressed.

When PB1 is pressed, the program is executed and the next step is executed. Therefore, the OUT instruction is executed. When this OUT instruction is executed, the output device assigned the output number of the instruction operates. Therefore, SOL1, which causes the robot arm to rotate clockwise, operates.

At the next step, there is another combination of AND and WAIT instructions. This means that the program execution waits until the input 0000, which is a limit switch (LS1) to detect the clockwise rotation limit of the robot arm, is activated.

When LS1 is turned ON, it indicates that the robot arm has rotated to the position where it should stop rotating and pick up the work from conveyor A. In the next step of the flowchart, you see OUT NOT and OUT instructions. Note that the same output number as the OUT 0200 instruction in the third step is assigned to the OUT NOT instruction. This means that the output previously activated by the OUT 0200 instruction must be canceled. Therefore, SOL1, which has been activated by the OUT 0200 instruction, is now turned OFF by the OUT NOT 0200 instruction. Instead, OUT 0202 instruction is executed, activating SOL3 and causing the robot arm to pick up the work from the conveyor.

You can easily visualize how the other steps of the flowchart are executed except for the first and last steps.

In the last step of the flowchart, you see a character string "JMP LBL 0". This step has a Jump instruction (JMP) which causes the program execution to "jump" to the specified step of the flowchart. The destination is specified by "LBL 0". The "LBL" is a Label instruction which identifies the destination step to which the program execution is to jump.

Now look at the first step of the flowchart. There is another LBL instruction. The number 0 it has matches the number the LBL instruction in the JMP instruction has. Therefore, in this program, the execution jumps from the last step to the first step. Thus, the robot will not stop after it has performed one cycle of operation. Instead, it will repeat the operation as long as it is supplied with power.

After your program has been devised, it must be stored in the C120F's memory using the programming console. Storing the program of the step advanced processing like this is relatively easy. All you have to do is to create a coding sheet, on which each step of the flowchart is assigned a memory address, and press buttons on the programming console by referring to the coding sheet. Here is the coding sheet of the program discussed in this section.

Address	Instruction	Data
0000	LBL	0
0001	AND	0
0002	WAIT	
0003	OUT	200
0004	AND	1
0005	WAIT	
0006	OUT NOT	200
0007	OUT	202
0008	AND	3
0009	WAIT	
0010	OUT	201
0011	AND	2
0012	WAIT	
0013	OUT NOT	201
0014	OUT NOT	202
0015	JMP LBL	0

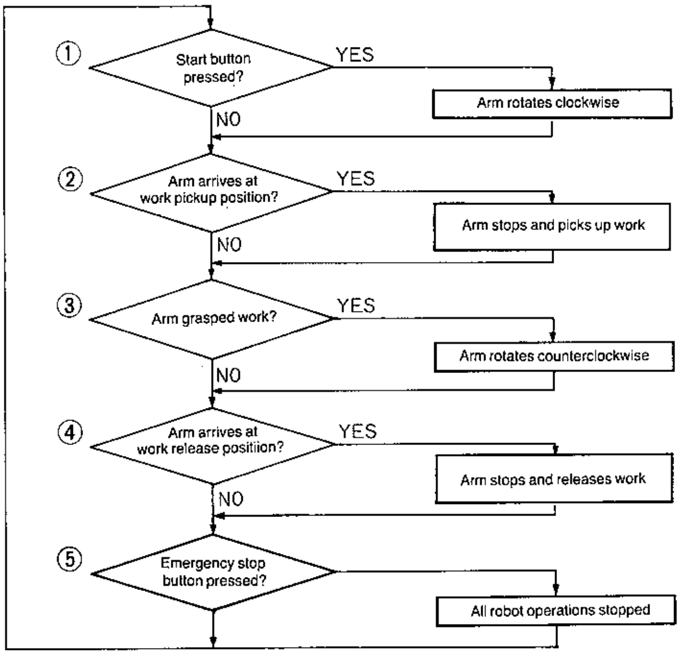
Branch instruction (flowchart processing)

Let's express the movement of the same robot using the Branch instruction of the C120F.

The Branch instruction causes the program execution to proceed to the next step of the flowchart when a given condition is not satisfied. If the condition is satisified, the program execution branches to the predetermined destination. Therefore, unlike the Wait instruction which causes the program execution to wait until a given condition is satisified, the Branch instruction does not stop the program execution.

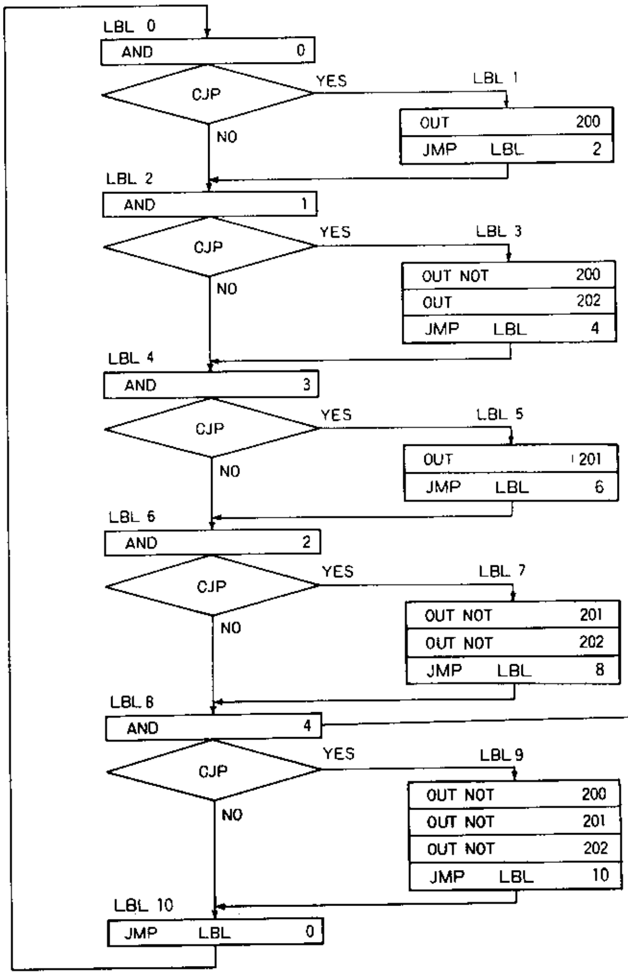
This instruction is used especially when satisfaction of a certain condition must be constantly checked. For example, suppose we add an emergency stop button to the example robot. Whenever this button is pressed, the movement of the robot should be stopped. To enable this kind of control action, this Branch instruction is useful.

The general flowchart of our example using the Branch instruction will be as follows:



Flowchart programming concept

Now, the detailed flowchart, from which the coding sheet is to be created, is as follows:



Input number 0004 is assigned to emergency stop button.

Immediately below the AND instruction at the first step, a diamond-shaped symbol appears. This symbol represents the Branch instruction. Like the Wait instruction, the Branch instruction is often used in combination with another instruction. In this case, the Branch instruction causes the program execution to proceed to the next step if PB1 is not pressed, contrary to the condition specified by the AND instruction. If the PB1 is pressed, the program execution branches to the OUT 0000 and JMP LBL 2 instructions. The other steps of this flowchart are similarly executed and the robot operates in exactly the same manner as when the program is written using Wait instructions only (i.e., without Branch instructions).

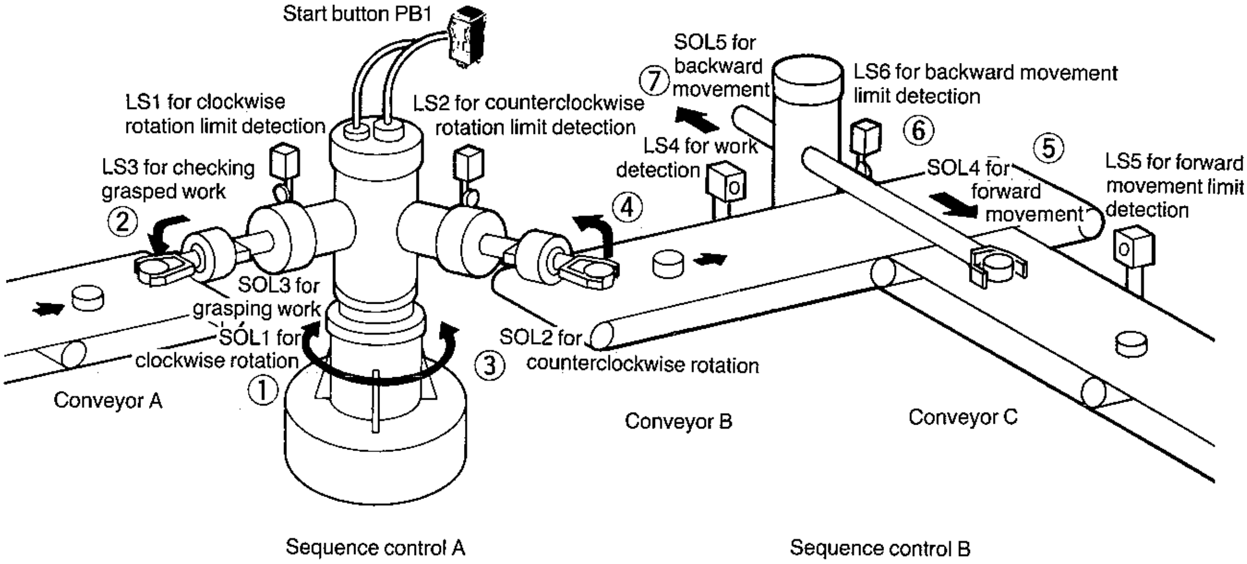
Flowchart programming concept

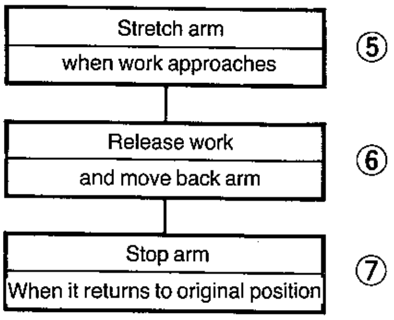
Writing a program using Branch instructions (or Group instruction to be explained next) to the C120F's memory is slightly more complicated than a program using Wait instructions only in that you have to write in all the NO conditions (that is, the left portion of the sample flowchart). Then, starting from the address next to the last one of the already written portion of the program, write in the YES conditions of the program (i.e., the right portion). Here is the coding sheet of the program we have discussed in this section.

0000	LBL	0
0001	AND	0
0002	CJP LBL	1
0004	AND	1
0005	CJP LBL	3
0006	LBL	4
0007	AND	3
0008	CJP LBL	5
0009	LBL	6
0010	AND	2
0011	CJP LBL	7
0012	LBL	8
0013	AND	4
0014	CJP LBL	9
0015	LBL	10
0016	JMP LBL	0
0017	LBL	1
0018	OUT	200
0019	JMP LBL	2
0020	LBL	3
0021	OUT NOT	200
0022	OUT	202
0023	JMP LBL	4
0024	LBL	5
0025	OUT	201
0026	JMP LBL	6
0027	LBL	7
0028	OUT NOT	201
0029	OUT NOT	202
0030	JMP LBL	8
0031	LBL	9
0032	OUT NOT	200
0033	OUT NOT	201
0034	OUT NOT	202
0035	JMP LBL	10

Group instruction (parallel processing)
The program comprising only Wait instructions can control only a single controlled system and thus is not capable of simultaneously controlling the operations of any other controlled system. To simultaneously control plural controlled systems of which each must be sequentially controlled, either several controllers or a controller capable of parallel processing is required. However, the Group instruction provided to the C120F enables more than one sequential control to be processed at the same time. The Group instruction of the C120F permits a maximum of 32 sequential control programs to be executed simultaneously. Therefore, using a single C120F, a powerful control system as though 32 programmable controllers were being used can be configured.

For example, if you wish to create a control system like the one shown below, in which two robots are controlled at the same time, at least two independent programs are required to control the respective robots. In such case, you can use the Group instruction.



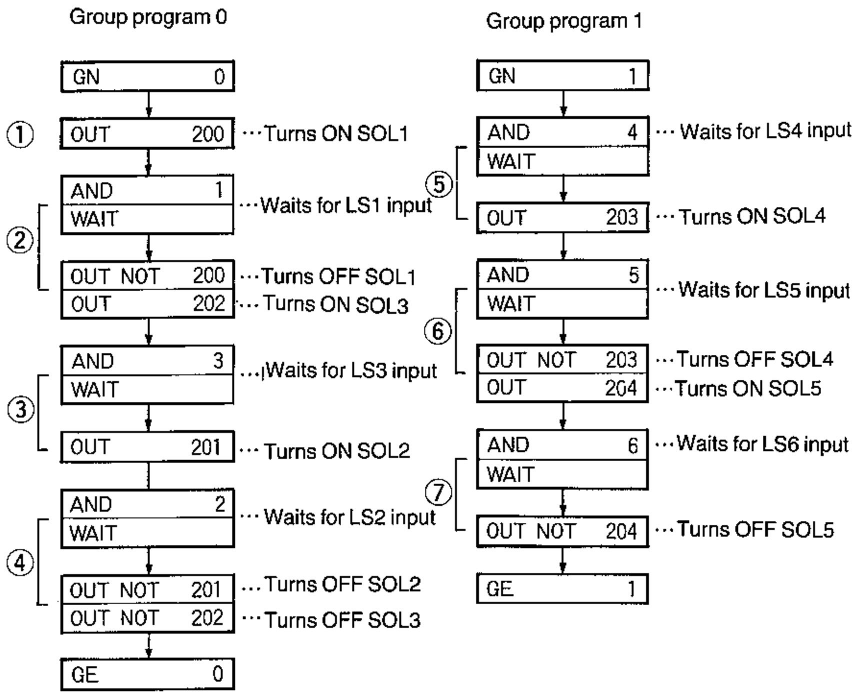


Programming the sequence control A in this figure has been already discussed in the preceding section. Therefore, our attention is focused on sequence control B. Here is its general flowchart.

In this manner, two programs for sequence control have been completed. However, both the programs represent only a part of the control system. Therefore, this type of program is called "group program". These group programs are placed under management of a program called "main program", to be discussed shortly.

For easy identification, let's assign number 0 to sequence control A and 1 to B. These identification numbers are used for the "GN" instructions of the respective group programs. The GN instruction indicates the start of a group program and should be always used in pairs with "GE" instruction, which indicates the end of the group program.

Now the I/O assignments and flowcharts of these two group programs are as follows:



- I/O assignment of group program 0

	I/O No.
LS1	0001
LS2	0002
LS3	0003
SOL1	0200
SOL2	0201
SOL3	0202

- I/O assignment of group program 1

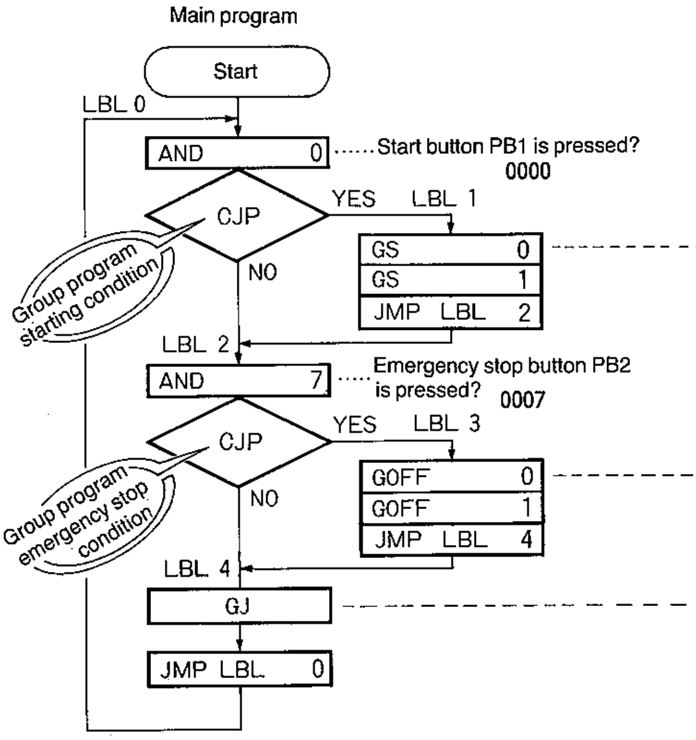
	I/O No.
LS4	0004
LS5	0005
LS6	0006
SOL4	0203
SOL5	0204

Execution of these group programs is initiated by the main program, which consists principally of Branch instructions and manages the starting, stopping, and restarting of each group program.

The I/O assignment and the flowchart of the main program that manages the two group programs will be as follows:

- I/O assignment

	I/O No.
PB1	0000
PB2	0007



Starts executing the group program. In the example, group programs 0 and 1 are executed on depression of PBI.

Turns OFF the outputs specified by the OUT instruction in the specified group program.

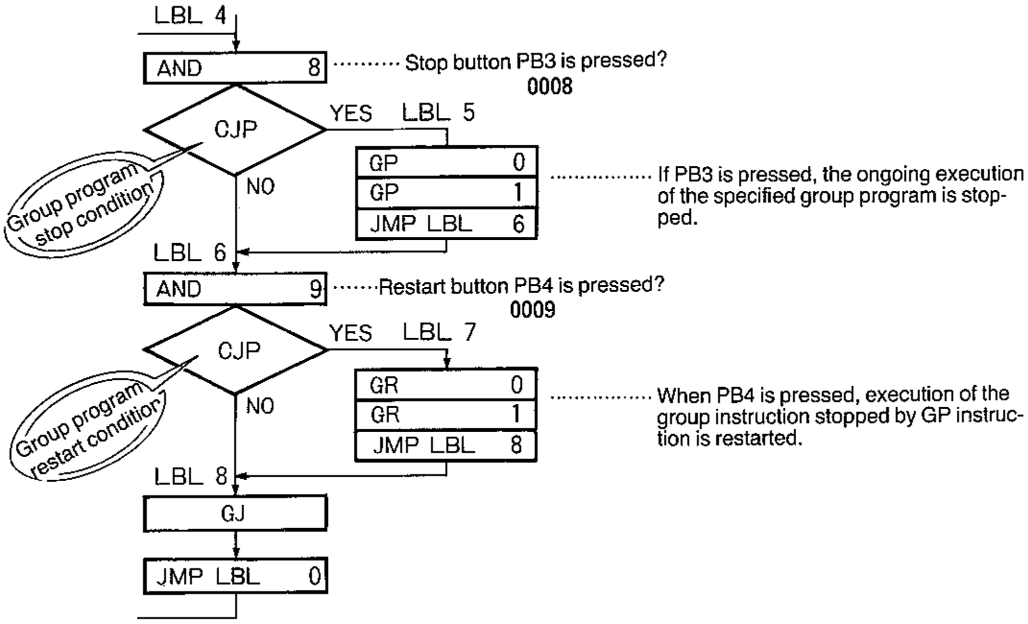
Program execution jumps to the specified group program when this instruction is executed.

In the step on the right of the main program flowchart, you see instructions named "GS". This stands for "Group Start" and the instruction starts executing the specified group program. For example, GS 0 instruction starts executing group program 0, and GS 1 instruction starts group program 1.

Below the Group start instructions are "GOFF" instructions, which turns OFF all the outputs specified by the OUT instructions in the specified group program. Therefore, for example, the GOFF 0 instruction, when executed, turns OFF all the outputs in group program 0.

The step immediately before the last step has a "GJ" instruction. It is when this instruction is executed that execution of the group programs is started.

To enable the operation of the sample control system to stop when PB3 (0008) is pressed and to restart when PB4 (0009) is pressed, this program is necessary.



Stop button PB3 is pressed? 0008

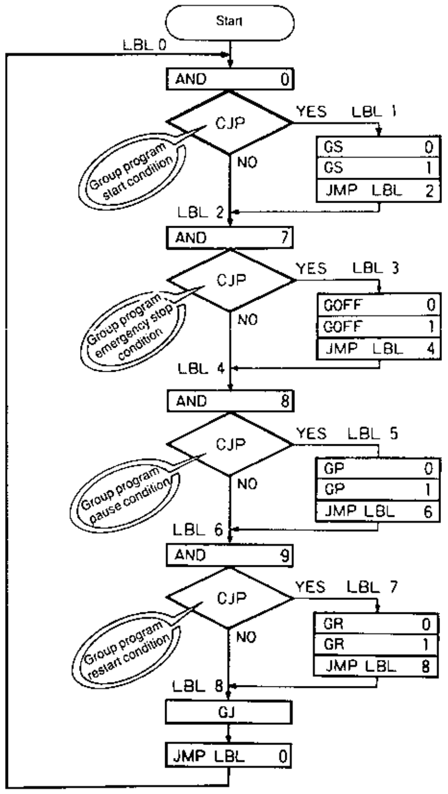
If PB3 is pressed, the ongoing execution of the specified group program is stopped.

Restart button PB4 is pressed? 0009

When PB4 is pressed, execution of the group instruction stopped by GP instruction is restarted.

In this program, two new Group instructions are used: GP and GR. The GP (Group Pause) instruction temporarily stops ongoing execution of the specified group program. In this case, for example, when PB3 is pressed, group programs 0 and 1, which are respectively specified by GP 0 and 1 instructions, are stopped. The GR (Group Restart) instruction restarts the group program whose execution has been temporarily stopped when a given condition (i.e., depression of PB4) is met.

Combining this program with the main program described earlier, we have the complete main program for the sample control system.

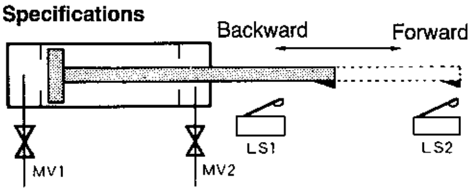


Programming examples

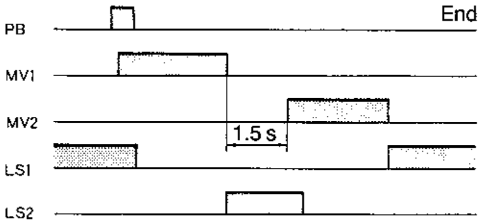
Now that you have already acquired a fair amount of knowledge as to how to program by reading up to here, this section provides you with more program examples to deepen your understanding.

Sequence control programming example 1
In a cylinder in which a piston moves in two directions (back and forth), the solenoid valve MV1 for forwarding the piston turns on when the pushbutton switch (PB) is depressed, and the piston moves to the forward end. When the piston reaches the forward end, the limit switch LS2 turns on, causing the solenoid valve MV2 for reversing the piston to turn on after the lapse of the set time of a timer. When MV2 turns on, the piston moves back and stops at the reverse end (LS1).

Specifications



Here is the timing chart of this operation.



Normally, when writing a flowchart for programming, a general flowchart depicting the outline of the operations is first written.

Prepare an I/O No. assignment table and associate an I/O number with each operation written in the flowchart.

Prepare a detailed flowchart that can be written with the programming console of the SYSMAC-C120F.

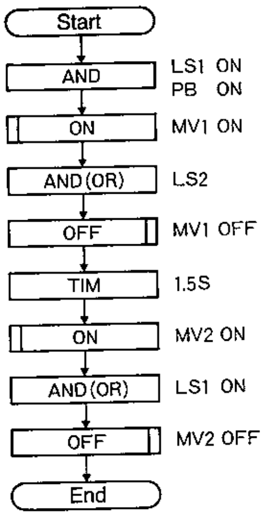
Use a JMP (Jump) instruction to repeat all the programmed operations from the beginning. A label number must be assigned to where the JMP instruction is used.

Write the program directly from the programming console.

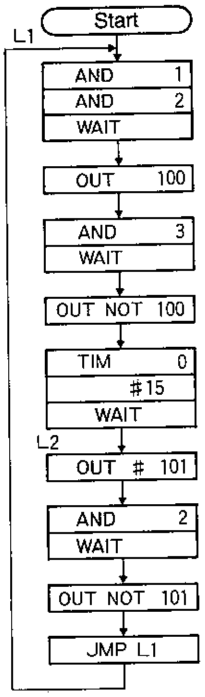
When the program needs to be executed from the specified step (e.g., L2 in "Detailed flowchart" below) for debugging, assign a label number to that step, irrespective of the JMP instruction, so that the step can be searched by the label number.

Flowchart programming concept

- **General flowchart**



- **Detailed flowchart**

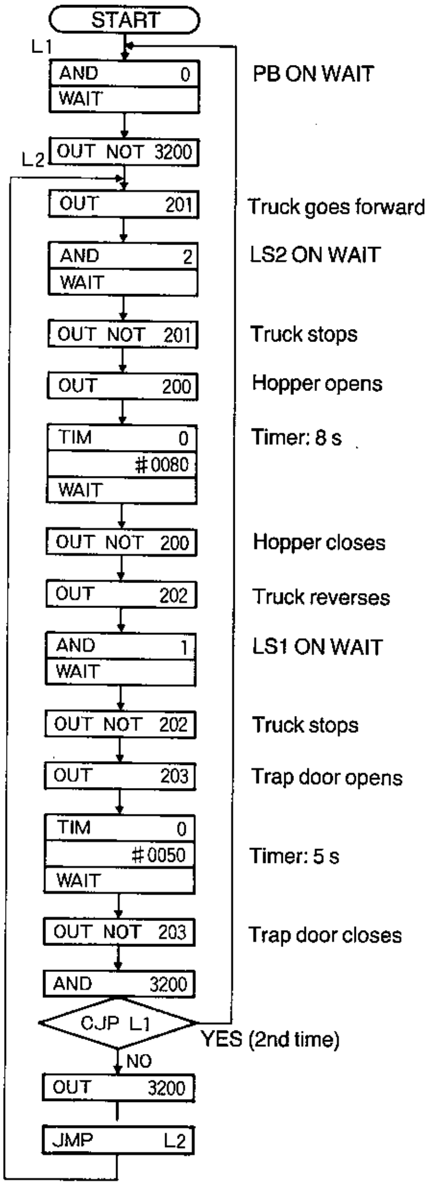


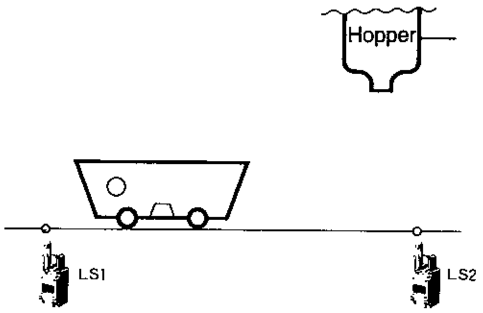
Instruction	I/O No.
PB	0001
LS1	0002
LS2	0003
MV1	0100
MV2	0101
TIM	0 (1.5 s)

To control the operation of the controlled system by using the program and addresses, write the addresses, instructions, and data on a coding sheet.

Address	Instruction	Data
0	LBL	1
1	AND	1
2	AND	2
3	WAIT	
4	OUT	100
5	AND	2
6	WAIT	
7	OUT NOT	100
8	TIM	0
9		#15
10	WAIT	
11	LBL	2
12	OUT	101
13	AND	2
14	WAIT	
15	OUT NOT	101
16	JMP	1
17		
18		

Sequence control programming example 2





	Symbol	I/O No.
Input	PB LS1 LS2	0 1 2
Output	Hopper	200
	Forward Backward Trap door	201 202 203
Timer	—	0

Internal auxiliary relay 3200 is used to record the operating status of the system when the control action has been once completed.

When pushbutton switch PB is depressed, the truck moves forward.

When limit switch LS2 is turned on, the truck stops and the hopper opens for 8 seconds.

After 8 seconds, the truck moves backward. Limit switch LS1 then turns on, and the truck stops to open its trap door for 5 seconds.

At the end of 5 seconds, the truck closes the trap door and one operation cycle is complete.

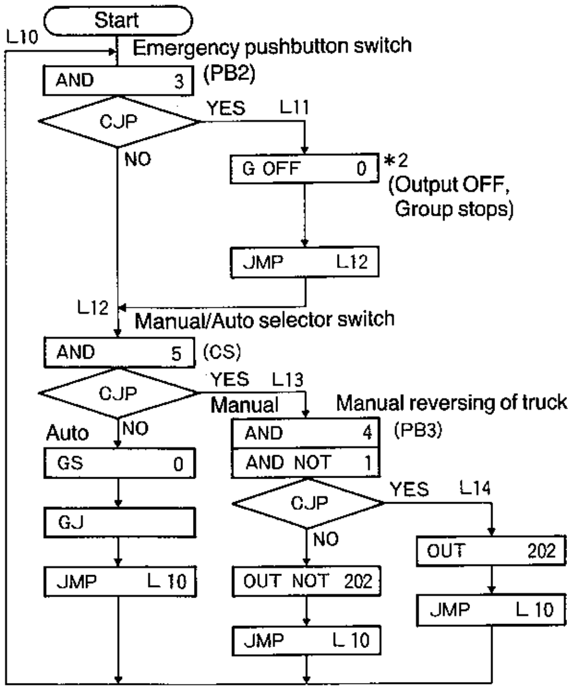
This cycle is repeated twice.

Parallel control programming example 1

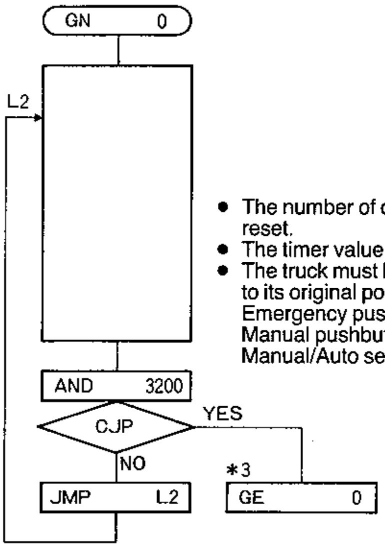
If an emergency stop signal is required in sequence control programming 2 described in earlier, a step to stop the truck during the operation can be programmed in this manner.

The emergency stop will be processed by the main program, and the group program 0 will be used for the normal truck operation.

Main program



Group program 0



- The number of operations will not be reset.
- The timer value will be reset.
- The truck must be returned manaully to its original position.

Emergency pushbutton switch PB2: 03
Manual pushbutton switch PB3: 04
Manual/Auto selector switch CS: 05

*1 Because the main program uses only Branch instructions and therefore forms a closed loop, the program execution cannot jump to another group program. For this reason, the GJ instruction is necessary to cause the program execution to forcibly jump to another group program. Within a group program, if a closed loop is formed as a result of using the Branch instruction, the GJ instruction must be used.

*2 When the GOFF instruction is executed, all the output relays specified by OUT instructions in a group program are caused to release. In this case, the present values of counters, shift registers, and the data memories will not be reset. To reset them, use the CNR instruction.

*3 When the GE instruction is executed, incrementing the step in a group program is stopped and reset, causing the program execution to return to its first step. For this reason, when the GS instruction is executed again, the group program is executed from its first step.

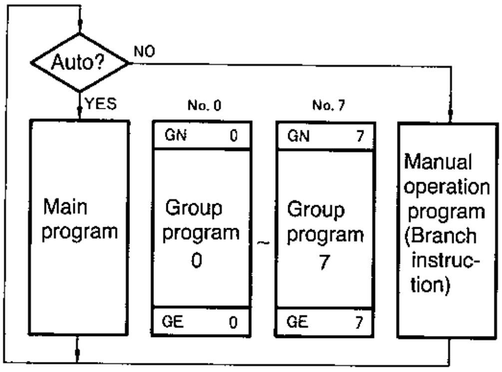
Operations such as the emergency stop of the truck which must take precedence over execution of the group program are processed by the main program. In the group program, the GOFF instruction is required to turn OFF the output relays, reset the present values of the timers/counters, and stop the execution of the group program.

Flowchart programming concept

Because the start of a group program must be specified by the main program, be sure to insert the GS instruction in the main program.

A group number must be written at the beginning of each group program, and the GE instruction must be written at the end of each program.

In this example, only a few manual operations are involved; thus the main program is sufficient to process those operations. In general, however, manual operations are programmed as shown below. With a manual operation program, pushbutton switches are depressed at random; and therefore, only the programs for sequential control cannot handle the randomly input signals. For this reason, Branch instructions are used. The GE instruction of each group should be also inserted at the beginning of the manual operation program. To change the mode between Automatic and Manual, a program to turn OFF the output relays is required.

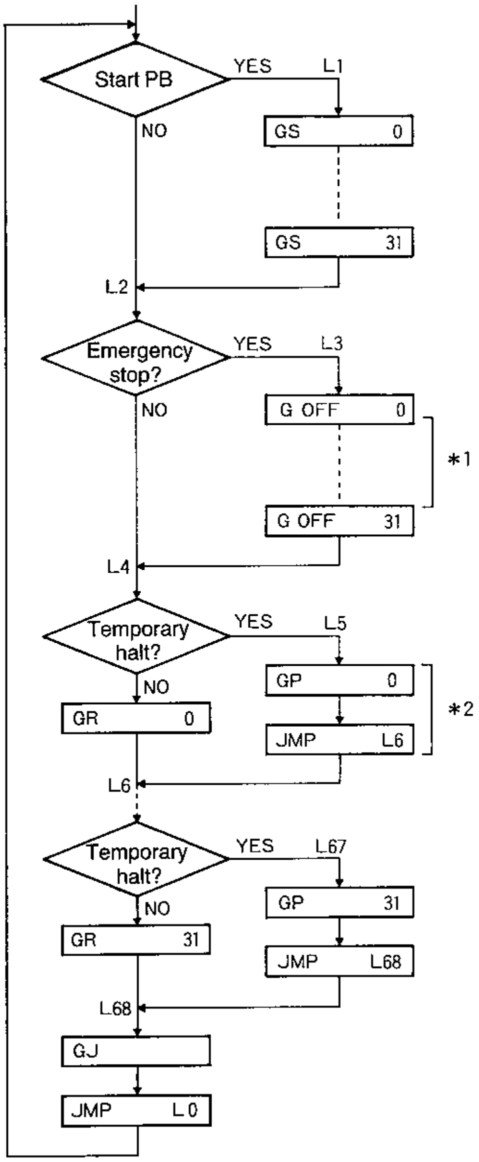


To control two or more trucks in the same manner as mentioned above, the same group programs and the main program are required and indicated by the above figures.

To interlock between the main program and a group program and between a group program and another, internal auxiliary relays are useful.

Parallel control programming example 2

The following program is used to temporarily stop a group program under execution and retain the operation steps of the group program.



*1 All the output relays specified by the OUT instructions in the group program specified by the GOFF instruction are released and the timers are reset.

However, the output relays specified by the other instructions including the SFT instruction are not turned OFF by the GOFF instruction. Use the CNR instruction to reset these output relays.

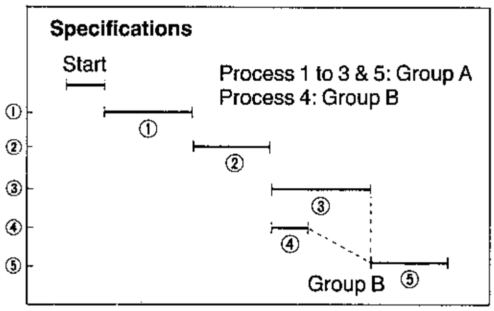
If this GOFF instruction is executed for an emergency stop, the states of the relays that have turned ON/OFF before the GOFF instruction execution are not retained.

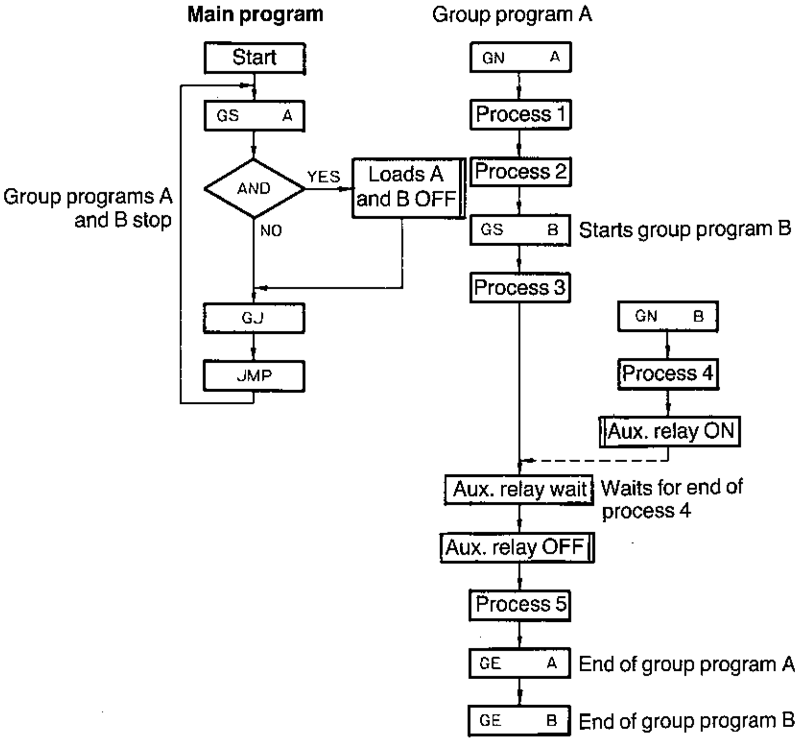
*2 When the GP instruction is executed, the execution of each group program halts at that point and both the steps and the states of the output relays before the execution are retained.

The execution of the GR instruction causes each group program to restart from where the group program has stopped. Even while the group program is in the halt state, the timer continues to operate.

Concept of parallel control during sequence control

In general, when controlling a single machine, sequence control may be initially performed, but parallel control will, in many instances, become necessary in the course of the sequence control. In this case the same principle of group program control can be applied, with the exception that Group program B in the following example must be started or stopped within the Group program A.



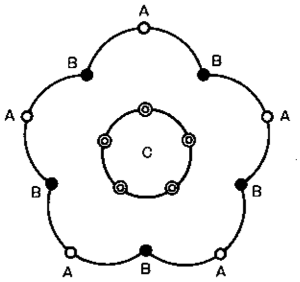


Another group program can be started or stopped within a group program.

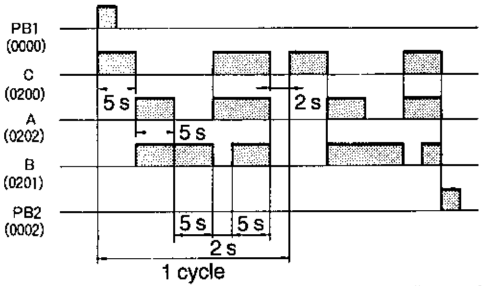
Internal auxiliary relays can be used to confirm the operation in progress between group programs and the end of each group.

Branch instructions can be used within a group program. If only Branch instructions are to be used, however, be sure to insert the GJ instruction in the program. For example, Branch instructions can be used in processes 1 through 5.

Example of water jet control programming



• Timing chart



(Timer: 0 is repeatedly used.)

1 When pushbutton switch PB1 is depressed, the water jets of group C turn ON.

2 The water jets of group C turn OFF after the lapse of 5 seconds, at which time the water jets of groups A and B turn ON.

3 The water jets of group A turn OFF after the lapse of 5 seconds; the water jets of group B turn OFF 5 seconds later.

4 As the water jets of group B turn OFF, the water jets of group C and A turn ON.

5 The water jets of group B turn ON after the lapse of 2 seconds. The water jets of all the groups are now ON.

6 The water jets of all the groups turn OFF after the lapse of 5 seconds.

7 The water jets of group C turn ON after the lapse of 2 seconds.

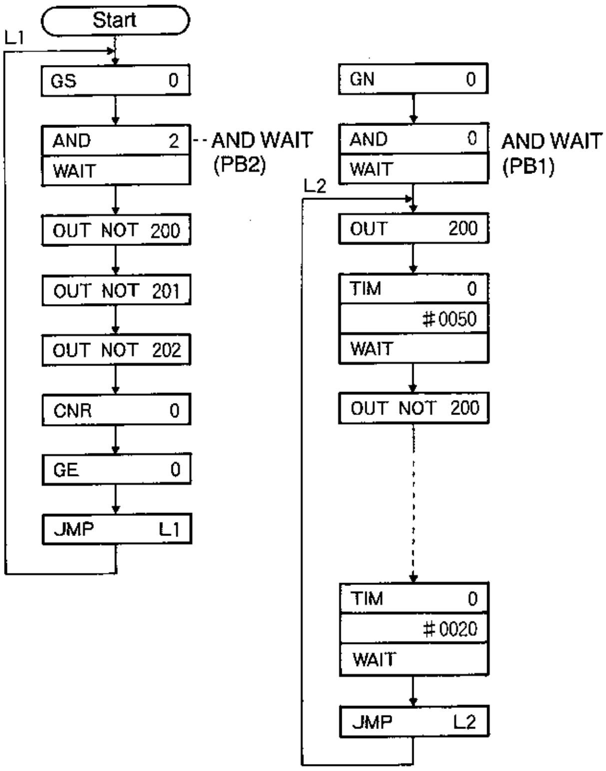
8 Steps 2 through 7 are repeated.

9 When pushbutton switch PB2 is depressed, the water jets of all the groups turn OFF. (PB2 is depressed at undefined intervals.)

The water jet control steps from 1 to 7 and the water jet stop step 9 must be programmed separately.

Flowchart programming concept

● Detailed flowchart



Address	Instruction	Data	Remarks
0	LBL	1	
1	GS	0	
2	AND	2	PB2
3	WAIT		
4	OUT NOT	200	
5	OUT NOT	201	
6	OUT NOT	202	
7	CNR	0	
8	GE	0	
9	JMP LBL	1	
10	GN	0	
11	AND	0	PB1
12	WAIT		
13	LBL	2	
14	OUT	200	
15	TIM	0	
16		#0050	5 s
17	WAIT		
41	TIM	0	
42		#0020	2 s
43	WAIT		
44	JMP	2	

Steps 1 through 7 are subject to sequence control and can be programmed easily with Wait instructions.

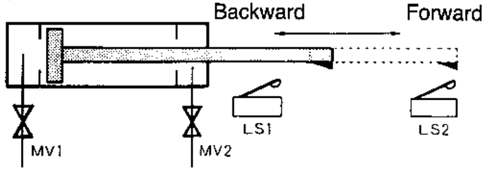
All the outputs of groups A, B, and C must be turned off and the water jet control program must be halted when Stop pushbutton switch PB2 is depressed.

The above two independent programs must be executed in parallel.

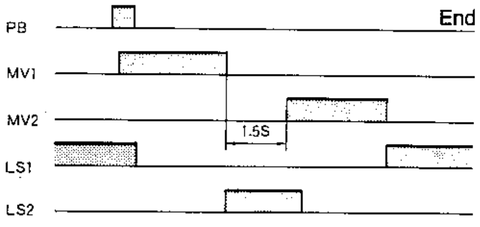
Programming example with branch instructions

In a cylinder in which a piston moves in two directions (backward and forward), the solenoid valve MV1 for forwarding the piston turns on when pushbutton switch PB is depressed and the piston moves to the forward end. When the piston reaches the forward end, the limit switch LS2 turns on, causing the solenoid valve MV2 for reversing the piston to turn on after the lapse of the set time. When MV2 turns on, the piston moves back and stops at the reverse end (LS1).

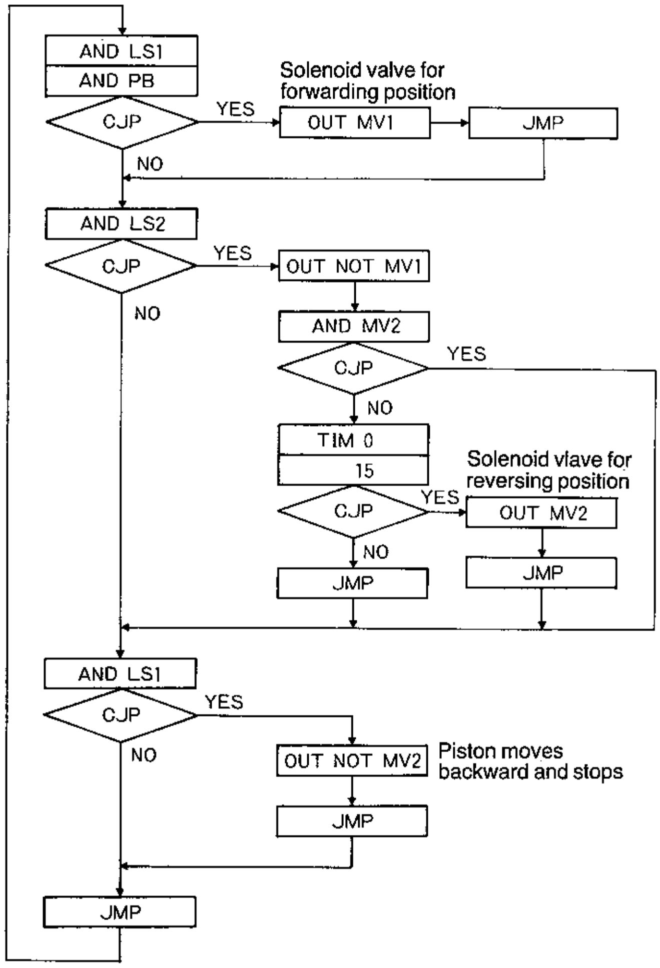
Specifications



Here is the timing chart of this operation.



Flowchart programming concept



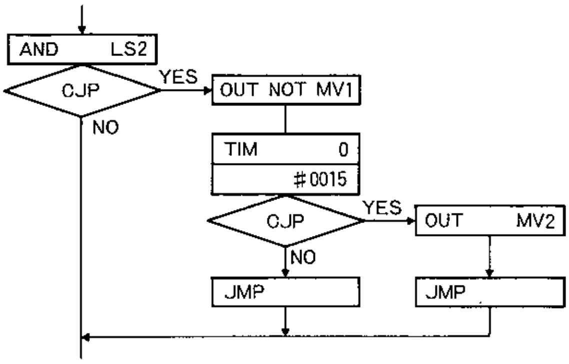
Instruction	I/O No.
PB	0001
LS1	0002
LS2	0003
MV1	0100
MV2	0101
TIM	0 (1.5 s)

Select the ON/OFF condition for each load.

- ON condition of MV1 ... AND of LS1 and PB
- OFF condition of MV1 ... LS2
- ON condition of MV2 ... TIM
- OFF condition of MV2 ... LS1

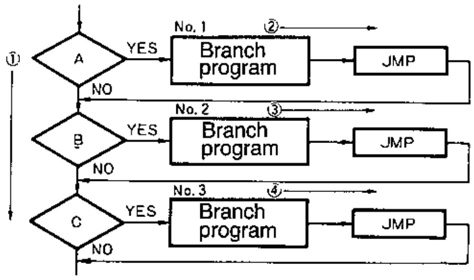
Based on these conditions, program as shown below using Branch instructions. In coding, attention must be paid to the timer program. If a timer is programmed on the vertical baseline of the flowchart, it will always operate. The timer must be programmed to operate only when MV2 is not operating and when a given condition is satisfied. If the timer is programmed as shown below, it operates again after the lapse of the set time until LS2 turns off.

Flowchart programming concept



The step numbers must be assigned in the direction of "NO" of each branch instruction (i.e., in vertical direction) and then to the steps in the direction of "YES" of the instruction (i.e., in horizontal direction). The JMP instruction must be added at the end of the program.

Assign step Nos. in the order of 1 to 4.



- The jump destination of A in the above figure is the first step of branch program No. 1.
- The number of steps required per Branch instruction is the number of Branch conditions 1.

Simulation, test run, program storage

On some occasions, the program does not cause the C120F to operate and thus to control the target equipment or system as you have envisioned. The abnormal operation of the controlled system can always be very dangerous and therefore, it is always good practice to thoroughly check your program before actually executing it to let the C120F operate.

The program can be checked in many ways. Under normal circumstances, you will first have to check and, if necessary, correct your program immediately after you have written it to the C120F memory. This process of program checking is known as "debugging" of the program. To debug the program, the C120F offers various methods, all of which are fully explained in the separately available user's manual for the programming console.

Since the main purpose of this manual is to explain the C120F's CPU rack, for information concerning the programming console, refer to its user's manual.

In this section, we focus our attention to the significance and procedure of simulation and test run, on the assumption that you have already written and debugged the program.

Simulation

The purpose of the simulation is to confirm whether the correct output signal is produced by the C120F in response to the correct input signal and thus the output device operates correctly. In case a mismatch of the input signal and output signal is found during the simulation, the cause of the mismatch must be discovered and corrected. The cause can be an error in designing the flowchart, misoperation of the programming console in writing the program, assignment of a wrong I/O number, or error in wiring the I/O devices.

To simulate the program execution, note the following points.

1 Turn off the power supply to the outputs so that none of the loads of the C120F operate even if the output signals are present on the output terminals of the C120F.
2 Connect a switch box to the input terminals for simulating the input signal of the C120F. Sometimes, however, it is easier to use the switches that have already been connected to the C120F's input terminals.
3 Apply power to the CPU rack and switch box. Using the mode selector switch on the programming console, set the C120F in the MONITOR or RUN mode. Then operate the switch box and confirm the relation between the input signals and output signals by observing the input and output LEDs on the right of the CPU rack.

Test run

After the simulation, supply power to the output devices. This time the movement of each of the output devices must be checked by actually inputting the signal that causes the corresponding output device to operate. When the output devices actually operate, they may make unexpected movements, which you could not find during debugging or simulation. If any abnormality is found as a result of the test run, discover its cause and correct it.

Program storage

After execution of all the checking and corrective actions for the program, your program is completed. The completed program can be stored to either a cassette tape or PROM chip. It is usually good practice to store the completed program in one of these storage devices to prevent its inadvertent erasure by misoperation of the C120F. Here, as an example, let's store the program in a PROM chip. (For details on how to store the program on a cassette tape, read the user's manual for the programming console.) To do so, you need a PROM writer (Type 3G2A5-PRW04) optionally available.

First, set the C120F in the PROGRAM mode and then remove the programming console from the CPU rack. Then mount the PROM writer on the CPU rack. On the PROM writer should be mounted a PROM chip, ROM-H.

Check the PROM chip to see whether its contents are completely erased. If not, use an ultraviolet-ray ROM eraser commercially available. Then write the contents of the C120F's memory to the PROM chip. (For details on the actual operation of the PROM writer, read the user's manual for Type 3G2A5-PRW04-E PROM writer).

Remove the PROM writer from the CPU rack. Mount the PROM chip to the CPU rack.

Mount the PROM chip to the CPU rack.

Chapter 4 Assignment of relay numbers

The SYSMAC-C120F is internally provided with many relays. The number of these relays that can be obtained from your control system varies depending on the system configuration. The full system configuration of the C120F offers 256 input/output relays, 459 internal auxiliary relays, 45 special auxiliary relays, 512 holding (retentive) relays, 128 timers/counters, and 512 channels of data memories. The list of each relay is provided in Appendix B. This chapter describes the functions of each internal relay and "free location concept", based on which the C120F automatically assigns the I/O numbers to its I/O channels.

Input/output relays

Relay Nos. 0000 to 1515

The full system of the C120F offers a maximum of 256 points of I/O relays. These relays are used to input signals from external sources to the C120F's CPU or output signals from the CPU to external devices.

Sixteen of input/output relays form one input/output channel, which is assigned a 2-digit number for identification. This identification number, or channel number is used by the CPU to manage the input and output channels. To the 2-digit channel number is appended another 2- digit number identifying a relay. Therefore, 4-digit input/output numbers are usually used to identify not only a relay but also the channel to which the relay belongs.

The channel numbers are automatically assigned to the input/output units according to the position on the CPU rack where the units are mounted. This automatic channel number assignment is described in detail later in this chapter.

Internal auxiliary relays

Relay Nos. 1600 to 6010

The 715 points of internal auxiliary relays provided to the C120F form an area where the program and data are processed. These relays cannot be used directly to control external (output) devices.

Holding relays

Relay Nos. HR0000 to 3115

These relays are also called "retentive relays". If a power failure occurs, they retain the present operating status during the power failure. A maximum of 512 points of holding relays are available from C120F.

Link relays

Relay Nos. LR0000 to 3115

Normally, these relays are used to link two or more programmable controllers. However, in the case of the C120F, they serve as internal auxiliary relays.

Timers/counters

Timer/counter Nos. TIM(S)/CNT000 to 127

The C120F is provided with 128 points of counters that can also function as timers. Therefore, the timers and counters are assigned the same identification numbers (000 to 127). This means that the same number cannot be assigned to both the timer and counter. For example, if counter number 000 is used, timer 000 cannot be used.

The maximum time that can be set for the timers assigned number TIM000 to 117 is 999.9 seconds, whereas the timers with numbers TIM118 to 127 can be set to 99.99 seconds maximum.

Data memories

Data memory Nos. DM000 to 511

A data memory consists of 16 bits and is used, in units of channels, to process data or perform arithmetic operation. The C120F is provided with 512 channels of data memories.

Special auxiliary relay functions

The C120F has 45 special auxiliary relays. Some operate or release according to internal conditions controlled by the hardware, regardless of the conditions of I/O devices. The operations of the others are controlled by the software (FAL instruction).

Relay No. 6011:

In case of a power failure, this relay must be turned ON to resume the instruction execution upon power restoration. It can be turned ON or OFF by the OUT instruction. When turning this relay ON, be sure to turn ON special auxiliary relay 6012 also.

Relay No. 6012:

This relay serves as a data retention flag that can be turned ON or OFF by an OUT instruction. If the flag is turned OFF, all the data in the I/O relay, internal auxiliary relay, link relay, and timer/counter areas are cleared on starting the RUN operation. When this flag is turned ON, the previous data in those relay areas are retained.

Note: When a power failure occurs, this flag will retain the data stored earlier.

Relay No. 6015

This relay serves as a LOAD OFF flag that can be turned ON or OFF by an OUT instruction. If this flag is turned OFF, the contents of the I/O relays are newly output to the output units. If the flag is turned ON, all output units are turned OFF, and the OUT INH indicator (LED) on the front panel of the CPU rack illuminates.

Note: When a power failure occurs, the LOAD OFF flag retains the data stored earlier.

Relay Nos. 6100 to 6107:

When Diagnostic (FAL, FALS) instruction is executed, a FAL No. (01 to 99) is output in BCD to this relay area.

6107	6106	6105	6104	6103	6102	6101	6101
$\times 10^1$				$\times 10^0$			

Further, the FAL No. is output to this area should an abnormal alarm output occur, such as one caused by battery failure.

In that event, the abnormal state will be reset through execution of the FAL 00 instruction or by means of the abnormal clear procedure, using the programming console.

Note: FAL No. 00 out to this area indicates the normal state.

Relay No. 6108:
This relay operates when a battery failure occurs and releases when the battery is returned to normal. To transmit the BATTERY FAILURE signal externally, prepare and program a circuit using the contacts of this relay.

Relay No. 6109:
This relay operates if the destination label of the indirect JMP instruction is undefined or if the label number is not specified in BCD.

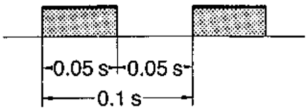
Relay No. 6110:
This relay operates when the number of I/O units actually mounted disagrees with those registered by means of a free-location concept.

Relay No. 6113:
This relay is normally ON.

Relay No. 6114:
This relay is normally OFF.

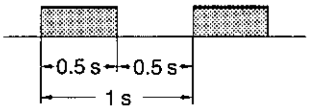
Relay No. 6115:
This relay operates if an error occurs in the channel number of a data memory (when expansion data memories are used.)

Relay No. 6300:
This relay is used to generate a 0.1-second clock. When used in conjunction with a counter, it functions as a timer for memory retention during a power failure.

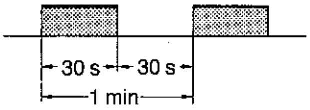


Note: The ON time of a 0.1-second clock is 50 ms. Therefore, if too long a time is required for program execution, the CPU may fail to read the clock.

Relay No. 6301:
This relay is used to generate a 1-second clock. When used in conjunction with a counter, it functions as a timer for memory retention during a power failure or as a long-time timer.



Relay No. 6302:
This relay is used to generate a 1-minute clock. When used in conjunction with a counter, it functions as a timer for memory retention during a power failure or as a long-time timer. The relay output can also be used as a cycle time signal.



Relay No. 6303:
This relay operates (ON) when the result of an arithmetic operation is not output in BCD, or when an address higher than 511 is specified in indirectly addressing the data memory.

Relay No. 6304:
This relay serves as a carry flag and operates or releases (ON or OFF) according to the result of an arithmetic operation. This relay is forcibly turned ON by an STC (Set Carry) instruction and OFF by a CLC (Clear Carry) instruction.

Relay No. 6305:
This relay operates if the result of a Compare operation (CMP instruction) executed is more than (>).

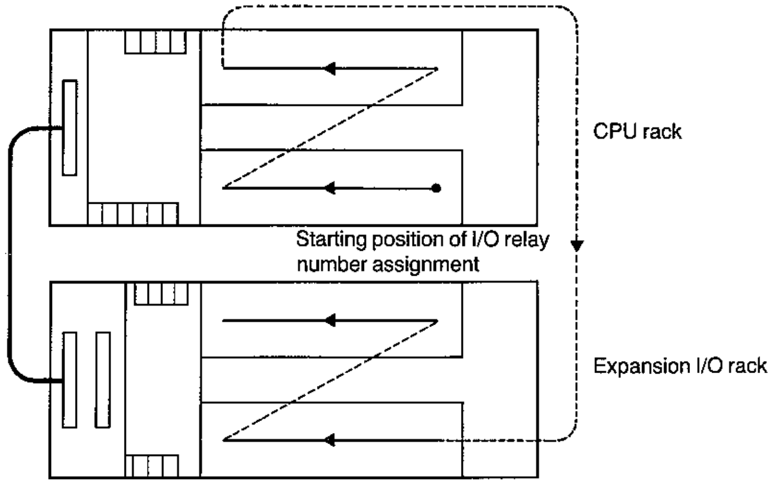
Relay No. 6306:
This relay operates if the result of a Compare operation (CMP instruction) executed is equal (=). The relay may operate if the result of an arithmetic operation is 0.

Relay No. 6307:
This relay operates if the result of a Compare operation (CMP instruction) executed is less than (<).

Relay Nos. 6308 to 6315:
These relays are normally OFF.

Free location concept

The C120F employs a free-location concept for I/O unit mounting. Any type of I/O unit can be mounted in any order to the CPU rack and the expansion I/O rack except for the bottom slot of the CPU rack, and I/O channel and relay numbers are assigned serially according to the mounting order of the I/O units. In the bottom slot of the CPU rack, only the input unit can be mounted.



The rightmost point (0000: channel 00, bit 00) of the I/O unit mounted on the lower I/O unit mounting position of the CPU rack is regarded as the starting point of the I/O assignment. The serial channel and relay numbers are assigned from the right to the left starting from this point. The assignment continues in the same manner from the lower to the upper I/O unit mounting position on the CPU rack. The I/O unit(s) mounted on an expansion I/O rack connected to the CPU rack is also assigned with serial I/O channel and relay numbers in exactly the same manner.

The I/O channel and relay numbers are determined by registering the mounted I/O unit in the CPU memory. This registration is initiated by using the programming console. For details, refer to I/O table generation operation described in the user's manual for the programming console.

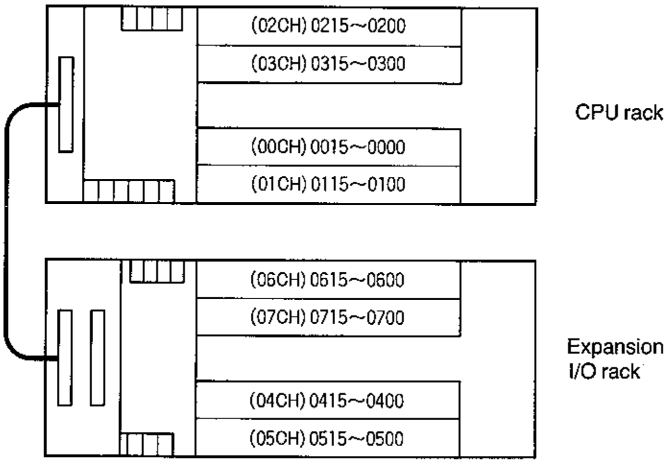
The vacant space is not registered as a channel.

If an I/O unit is later mounted additionally to a vacant position, the I/O unit location will disagree with the registered location and cause an I/O verify error to occur. If this happens, register the I/O unit location again.

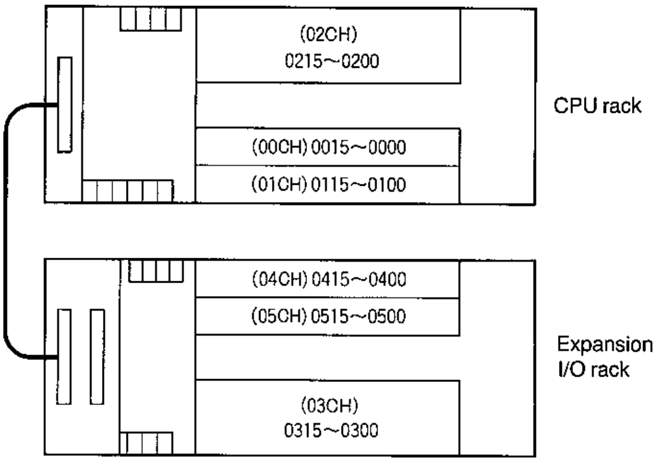
When the I/O table is generated, contents of channels 0 to 15 are cleared, regardless of whether the special auxiliary relay 6012 (data retention flag) is turned ON or OFF.

When I/O units are fully mounted in order

When only 32-point I/O units are mounted on the CPU rack and the expansion I/O rack, the relation between the I/O unit mounting positions and I/O channel and relay numbers is as follows:



When 16-point I/O units and 32-point I/O units are mounted on the CPU rack in combination, the relation among I/O unit locations, I/O channels, and relay numbers is as follows:



Further, the FAL No. is output to this area should an abnormal alarm output occur, such as one caused by battery failure.

In that event, the abnormal state will be reset through execution of the FAL 00 instruction or by means of the abnormal clear procedure, using the programming console.

Note: FAL No. 00 out to this area indicates the normal state.

Relay No. 6108:
This relay operates when a battery failure occurs and releases when the battery is returned to normal. To transmit the BATTERY FAILURE signal externally, prepare and program a circuit using the contacts of this relay.

Relay No. 6109:
This relay operates if the destination label of the indirect JMP instruction is undefined or if the label number is not specified in BCD.

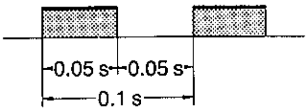
Relay No. 6110:
This relay operates when the number of I/O units actually mounted disagrees with those registered by means of a free-location concept.

Relay No. 6113:
This relay is normally ON.

Relay No. 6114:
This relay is normally OFF.

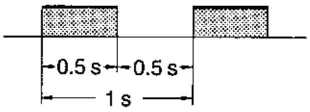
Relay No. 6115:
This relay operates if an error occurs in the channel number of a data memory (when expansion data memories are used.)

Relay No. 6300:
This relay is used to generate a 0.1-second clock. When used in conjunction with a counter, it functions as a timer for memory retention during a power failure.

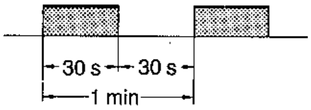


Note: The ON time of a 0.1-second clock is 50 ms. Therefore, if too long a time is required for program execution, the CPU may fail to read the clock.

Relay No. 6301:
This relay is used to generate a 1-second clock. When used in conjunction with a counter, it functions as a timer for memory retention during a power failure or as a long-time timer.



Relay No. 6302:
This relay is used to generate a 1-minute clock. When used in conjunction with a counter, it functions as a timer for memory retention during a power failure or as a long-time timer. The relay output can also be used as a cycle time signal.



Relay No. 6303:
This relay operates (ON) when the result of an arithmetic operation is not output in BCD, or when an address higher than 511 is specified in indirectly addressing the data memory.

Relay No. 6304:
This relay serves as a carry flag and operates or releases (ON or OFF) according to the result of an arithmetic operation. This relay is forcibly turned ON by an STC (Set Carry) instruction and OFF by a CLC (Clear Carry) instruction.

Relay No. 6305:
This relay operates if the result of a Compare operation (CMP instruction) executed is more than (>).

Relay No. 6306:
This relay operates if the result of a Compare operation (CMP instruction) executed is equal (=). The relay may operate if the result of an arithmetic operation is 0.

Relay No. 6307:
This relay operates if the result of a Compare operation (CMP instruction) executed is less than (<).

Relay Nos. 6308 to 6315:
These relays are normally OFF.

Further, the FAL No. is output to this area should an abnormal alarm output occur, such as one caused by battery failure.

In that event, the abnormal state will be reset through execution of the FAL 00 instruction or by means of the abnormal clear procedure, using the programming console.

Note: FAL No. 00 out to this area indicates the normal state.

Relay No. 6108:
This relay operates when a battery failure occurs and releases when the battery is returned to normal. To transmit the BATTERY FAILURE signal externally, prepare and program a circuit using the contacts of this relay.

Relay No. 6109:
This relay operates if the destination label of the indirect JMP instruction is undefined or if the label number is not specified in BCD.

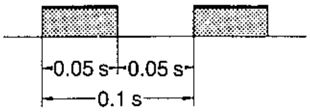
Relay No. 6110:
This relay operates when the number of I/O units actually mounted disagrees with those registered by means of a free-location concept.

Relay No. 6113:
This relay is normally ON.

Relay No. 6114:
This relay is normally OFF.

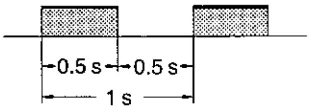
Relay No. 6115:
This relay operates if an error occurs in the channel number of a data memory (when expansion data memories are used.)

Relay No. 6300:
This relay is used to generate a 0.1-second clock. When used in conjunction with a counter, it functions as a timer for memory retention during a power failure.

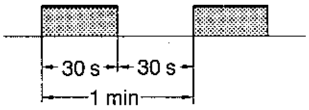


Note: The ON time of a 0.1-second clock is 50 ms. Therefore, if too long a time is required for program execution, the CPU may fail to read the clock.

Relay No. 6301:
This relay is used to generate a 1-second clock. When used in conjunction with a counter, it functions as a timer for memory retention during a power failure or as a long-time timer.



Relay No. 6302:
This relay is used to generate a 1-minute clock. When used in conjunction with a counter, it functions as a timer for memory retention during a power failure or as a long-time timer. The relay output can also be used as a cycle time signal.



Relay No. 6303:
This relay operates (ON) when the result of an arithmetic operation is not output in BCD, or when an address higher than 511 is specified in indirectly addressing the data memory.

Relay No. 6304:
This relay serves as a carry flag and operates or releases (ON or OFF) according to the result of an arithmetic operation. This relay is forcibly turned ON by an STC (Set Carry) instruction and OFF by a CLC (Clear Carry) instruction.

Relay No. 6305:
This relay operates if the result of a Compare operation (CMP instruction) executed is more than (>).

Relay No. 6306:
This relay operates if the result of a Compare operation (CMP instruction) executed is equal (=). The relay may operate if the result of an arithmetic operation is 0.

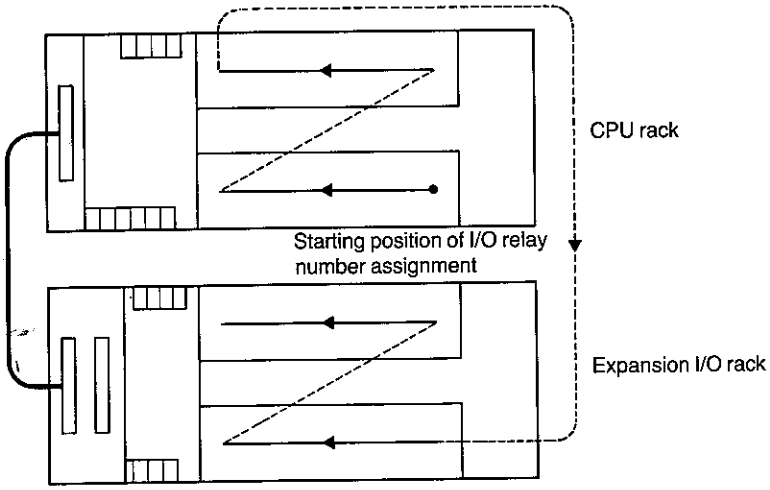
Relay No. 6307:
This relay operates if the result of a Compare operation (CMP instruction) executed is less than (<).

Relay Nos. 6308 to 6315:
These relays are normally OFF.

Assignment of relay numbers

Free location concept

The C120F employs a free-location concept for I/O unit mounting. Any type of I/O unit can be mounted in any order to the CPU rack and the expansion I/O rack except for the bottom slot of the CPU rack, and I/O channel and relay numbers are assigned serially according to the mounting order of the I/O units. In the bottom slot of the CPU rack, only the input unit can be mounted.



The rightmost point (0000: channel 00, bit 00) of the I/O unit mounted on the lower I/O unit mounting position of the CPU rack is regarded as the starting point of the I/O assignment. The serial channel and relay numbers are assigned from the right to the left starting from this point. The assignment continues in the same manner from the lower to the upper I/O unit mounting position on the CPU rack. The I/O unit(s) mounted on an expansion I/O rack connected to the CPU rack is also assigned with serial I/O channel and relay numbers in exactly the same manner.

The I/O channel and relay numbers are determined by registering the mounted I/O unit in the CPU memory. This registration is initiated by using the programming console. For details, refer to I/O table generation operation described in the user's manual for the programming console.

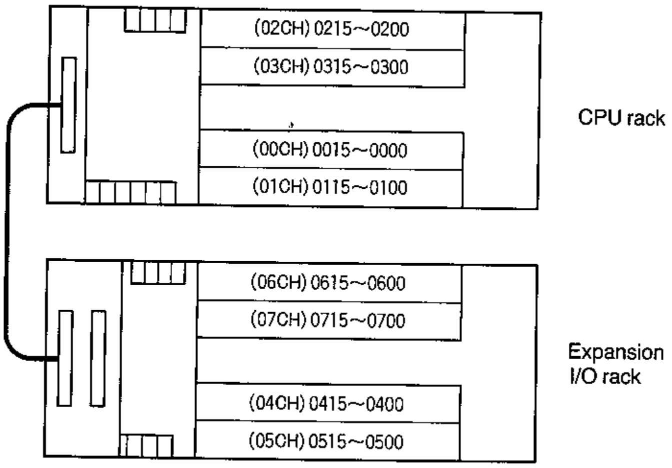
The vacant space is not registered as a channel.

If an I/O unit is later mounted additionally to a vacant position, the I/O unit location will disagree with the registered location and cause an I/O verify error to occur. If this happens, register the I/O unit location again.

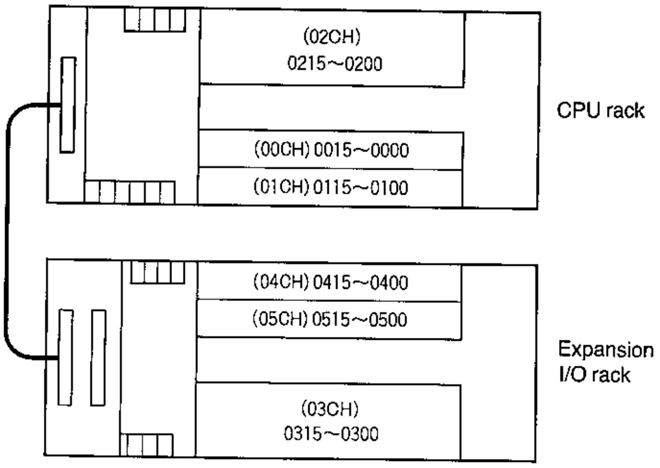
When the I/O table is generated, contents of channels 0 to 15 are cleared, regardless of whether the special auxiliary relay 6012 (data retention flag) is turned ON or OFF.

When I/O units are fully mounted in order

When only 32-point I/O units are mounted on the CPU rack and the expansion I/O rack, the relation between the I/O unit mounting positions and I/O channel and relay numbers is as follows:



When 16-point I/O units and 32-point I/O units are mounted on the CPU rack in combination, the relation among I/O unit locations, I/O channels, and relay numbers is as follows:



Assignment of relay numbers

If a mounted I/O unit is replaced with one having a different number of points, or if an additional I/O unit is mounted, the relay numbers assigned to the I/O unit already mounted to the channel higher than the new I/O unit will be reassigned in sequence. The same applies when a mounted I/O unit is removed from the CPU rack, resulting in a vacancy. The relay numbers will not be changed, however, if a new I/O unit is mounted to the channel next to the unit that has been mounted on the last position of the existing I/O unit row. After the replacement, addition, or removal of an I/O unit, the relay numbers will not be changed unless the mounted I/O units have been registered in the CPU memory. At this point, however, an I/O verify error or I/O setting error occurs.

If a vacant position(s) is required to mount additional I/O unit(s) in the future because of modifications in the design and specfications of the control system, use a dummy I/O unit(s) (3G2A6-DUM01) to reserve desired channels so that the program will not have to be changed.

Assignment of relay numbers

Assignment of relay numbers

If a mounted I/O unit is replaced with one having a different number of points, or if an additional I/O unit is mounted, the relay numbers assigned to the I/O unit already mounted to the channel higher than the new I/O unit will be reassigned in sequence. The same applies when a mounted I/O unit is removed from the CPU rack, resulting in a vacancy. The relay numbers will not be changed, however, if a new I/O unit is mounted to the channel next to the unit that has been mounted on the last position of the existing I/O unit row. After the replacement, addition, or removal of an I/O unit, the relay numbers will not be changed unless the mounted I/O units have been registered in the CPU memory. At this point, however, an I/O verify error or I/O setting error occurs.

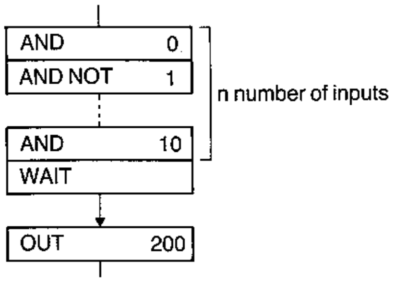
If a vacant position(s) is required to mount additional I/O unit(s) in the future because of modifications in the design and specfications of the control system, use a dummy I/O unit(s) (3G2A6-DUM01) to reserve desired channels so that the program will not have to be changed.

Chapter 5 Instructions

This chapter describes the instructions used by the C120F. The information includes the name, key input sequence, symbol, and function of each instruction along with a flowchart and coding chart.

AND WAIT

Flowchart



An AND WAIT instruction consists of a series of AND or AND NOT instructions for the specified number of input signals with a WAIT instruction written at the end of the series.

This instruction causes the program execution to wait until all the specified conditions for the input signals are satisfied, at which time the program execution proceeds to the next step.

Coding chart

Address	Instruction	Data
0100	AND	0
0101	AND NOT	1
⋮	⋮	⋮
0105	AND	10
0106	WAIT	⋮
0107	OUT	200
⋮	⋮	⋮

Use AND for NO contacts and AND NOT for NC contacts.

Contents of data

I/O relay, internal auxiliary relay	0 to 6315
Link relay	LR0 to 3115
Holding (retentive) relay	HR0 to 3115
Timer	TIM0 to 127

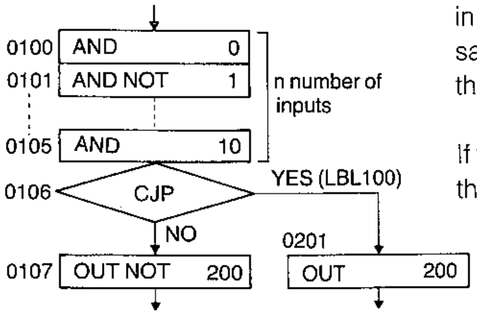
Because DM0 to DM511 are for channel data storage, the data in this area cannot be handled by an AND WAIT instruction.

CNT instructions cannot be used in combination with AND or OR instruction.

Label numbers for use with the CJP instruction are 0 to 1023 (decimal).

AND BRANCH

Flowchart



An AND BRANCH instruction consists of a series of AND or AND NOT instructions for the specified number of input signals with a CJP (Conditional Jump) instruction written at the end of the series.

This instruction causes the program execution to jump to the label specified in the CJP instruction if all the conditions for the specified input signals are satisfied (if YES). The program execution proceeds to the next step if any of these conditions is not satisfied (if NO).

If the label specified by the CJP instruction is not found in the program, all the output relays will be turned OFF and the CPU will halt.

Coding chart

Address	Instruction	Data
0100	AND	0
0101	AND NOT	1
⋮	⋮	⋮
0105	AND	10
0106	CJP LBL	100
0107	OUT NOT	200
⋮	⋮	⋮
0200	LBL	100
0201	OUT	200

Use AND for NO contacts and AND NOT for NC contacts.

Contents of data

I/O relay, internal auxiliary relay	0 to 6315
Link relay	LR0 to 3115
Holding relay	HR0 to 3115
Timer	TIM0 to 127

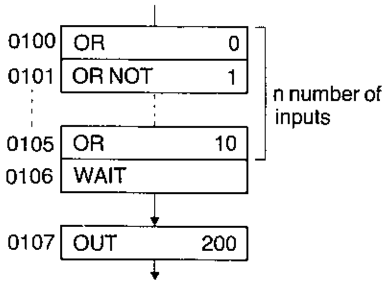
Because DM0 to DM511 are for channel data storage, the data in this area cannot be handled by an AND BRANCH instruction.

CNT instructions cannot be used in combination with AND or OR instruction.

Label numbers for use with the CJP instruction are 0 to 1023 (decimal).

OR WAIT

Flowchart



An OR WAIT instruction consists of a series of OR or OR NOT instructions for the specified number of input signals with a WAIT instruction written at the end of the series.

This instruction causes the program execution to wait until one or more of the conditions for the specified input signals are satisfied, at which time the program execution proceeds to the next step.

Coding chart

Address	Instruction	Data
0100	OR	0
0101	OR NOT	1
⋮	⋮	⋮
0105	OR	10
0106	WAIT	
0107	OUT	200

Use OR for NO contacts and OR NOT for NC contacts.

Contents of data

I/O relay, internal auxiliary relay	0 to 6315
Link relay	LR0 to 3115
Holding relay	HR0 to 3115
Timer	TIM0 to 127

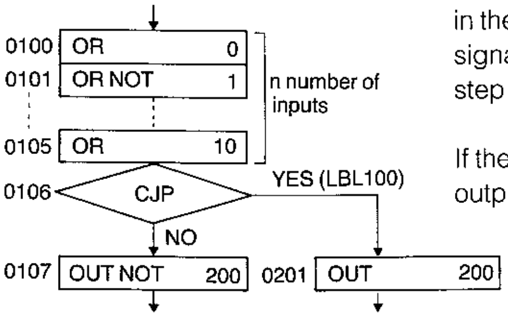
OR BRANCH

Flowchart

An OR BRANCH instruction consists of a series of OR or OR NOT instructions for the specified number of input signals with a CJP (Conditional Jump) instruction written at the end of the series.

This instruction causes the program execution to jump to the label specified in the CJP instruction if one or more the conditions for the specified input signals are satisfied (if YES). The program execution proceeds to the next step if all of these conditions are not satisfied (if NO).

If the label specified by the CJP instruction is not found in the program, all output relays are turned OFF and the CPU halts.



Coding chart

Address	Instruction	Data
0100	OR	0
0101	OR NOT	1
⋮	⋮	
0105	OR	10
0106	CJP LBL	100
0107	OUT NOT	200
⋮	⋮	⋮
0200	LBL	100
0201	OUT	200

Use OR for NO contacts and OR NOT for NC contacts.

Contents of data

I/O relay, internal auxiliary relay	0 to 6315
Link relay	LR0 to 3115
Holding relay	HR0 to 3115
Timer	TIM0 to 127

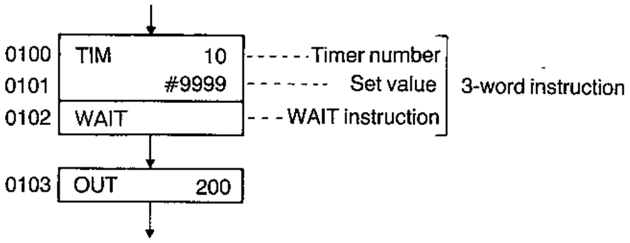
Label numbers for use with the CJP instruction are 0 to 1023 (decimal).

TIMER WAIT

TIM TIM (timer number) (set value)

where,
timer number: 0 to 127
set value: 0000 to 999.9/99.99 seconds

Flowchart



A TIM WAIT instruction consists of three words: a timer number, a set value, and a Wait instruction.

This instruction causes the specified value to be set in the specified timer. Program execution waits until the set value of the timer becomes 0. When the set value of the timer has elapsed, the time-up flag is set and the program execution proceeds to the next step.

The timers used in the SYSMAC-C120F are of a decrementing type. If the same timer is used again after the lapse of its set time, the original set value will be restored.

The timers having TIM numbers 0 to 117 can be set to a maximum of 999.9 seconds, whereas TIM118 to 127 can be set to 99.99 seconds maximum.

Coding chart

Address	Instruction	Data
0100	TIM	10
0101		#9999
0102	WAIT	
0103	OUT	200

Timer numbers are shared by the TMS and CNT instructions.

Contents of data

I/O relay, internal auxiliary relay	0 to 63
Link relay	LR0 to 31
Holding relay	HR0 to 31
Data memory	DM0 to 511
Constants	#0000 to 9999

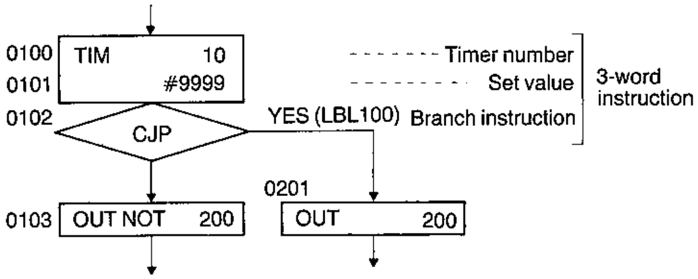
TIMER BRANCH

TIM (timer number)(set value)

where,
timer number: 0 to 127
set value: 0000 to 999.9/99.99 seconds

A TIM BRANCH instruction consists of three words: a timer number, a set value, and a CJP (Conditional Jump) instruction.

Flowchart



First execution of this instruction causes the specified value to be set in the timer. Program execution proceeds to the next step when the set time has not yet elapsed. When it has already elapsed, the program execution jumps to the label specified in the CJP instruction. If the specified label is not found in the program, all the output relays will be turned OFF and the CPU will halt.

Coding chart

Address	Instruction	Data
0100	TIM	10
0101		#9999
0102	CJP LBL	100
0103	OUT NOT	200
⋮	⋮	⋮
0200	LBL	100
0201	OUT	200

Timer numbers are shared by the TMS and CNT instructions.

Contents of data

I/O relay, internal auxiliary relay	0 to 63
Link relay	LR0 to 31
Holding relay	HR0 to 31
Data memory	DM0 to 511
Constant	#0000 to 9999

If a timer whose set time has not yet elapsed is used again, the decrementing operation of the timer starts with the present value.

Once a timer is set, it operates by itself while the CPU is scanning other programs. The timer operation stops on the lapse of the set time, and the time-up state is stored in the memory.

If a timer is specified by a CNR (Counter Reset) instruction, the timer will be reset on execution regardless of whether the timer is in operation or the set time of the timer has already elapsed.

If a power failure occurs, the present values of the timers will be reset. However, if the data retention flag (special auxiliary relay 6012) is turned ON, the present values of the timers are retained during the power failure. The timers will resume the operation from the retained value when the power is restored.

There are two types of timers whose values can be set by the TIM instruction. The value of one type (timers 0 to 117) is set in units of 0.1 second whereas that of the other (timers 118 to 127) can be set in units of 0.01 second.

Instruction	TIM10 #0128	TIM120 #0128
Time-up	128×0.1 s = 12.8 s	128×0.01 s = 1.28 s

Since the data in all the relay areas are retained when the data retention flag is turned ON, reset unnecessary relays by the CNR instruction.

Externally set timer data

Externally set timer data must be in four BCD digits, and the CPU checks whether it is or not. If it is not, special auxiliary relay 6303 is turned ON, indicating an error. In this case the program can still be executed, but the time-up operation may not be accurate.

External time setting

In this example, a value (i.e., 581.4 seconds) is set in timer 011 by an external time setting device connected to channel 01 of the input unit.

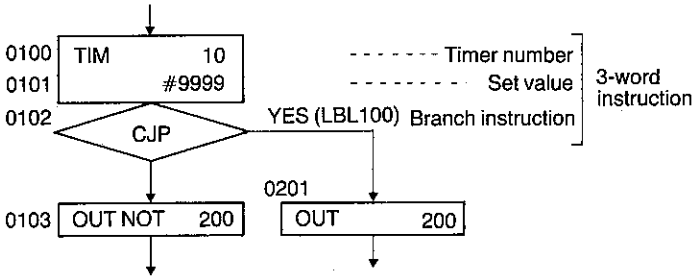
TIMER BRANCH

TIM (timer number)(set value)

where,
timer number: 0 to 127
set value: 0000 to 999.9/99.99 seconds

A TIM BRANCH instruction consists of three words: a timer number, a set value, and a CJP (Conditional Jump) instruction.

Flowchart



First execution of this instruction causes the specified value to be set in the timer. Program execution proceeds to the next step when the set time has not yet elapsed. When it has already elapsed, the program execution jumps to the label specified in the CJP instruction. If the specified label is not found in the program, all the output relays will be turned OFF and the CPU will halt.

Coding chart

Address	Instruction	Data
0100	TIM	10
0101		#9999
0102	CJP LBL	100
0103	OUT NOT	200
⋮	⋮	⋮
0200	LBL	100
0201	OUT	200

Timer numbers are shared by the TMS and CNT instructions.

Contents of data

I/O relay, internal auxiliary relay	0 to 63
Link relay	LR0 to 31
Holding relay	HR0 to 31
Data memory	DM0 to 511
Constant	#0000 to 9999

If a timer whose set time has not yet elapsed is used again, the decrementing operation of the timer starts with the present value.

Once a timer is set, it operates by itself while the CPU is scanning other programs. The timer operation stops on the lapse of the set time, and the time-up state is stored in the memory.

If a timer is specified by a CNR (Counter Reset) instruction, the timer will be reset on execution regardless of whether the timer is in operation or the set time of the timer has already elapsed.

If a power failure occurs, the present values of the timers will be reset. However, if the data retention flag (special auxiliary relay 6012) is turned ON, the present values of the timers are retained during the power failure. The timers will resume the operation from the retained value when the power is restored.

There are two types of timers whose values can be set by the TIM instruction. The value of one type (timers 0 to 117) is set in units of 0.1 second whereas that of the other (timers 118 to 127) can be set in units of 0.01 second.

Instruction	TIM10 #0128	TIM120 #0128
Time-up	128×0.1 s = 12.8 s	128×0.01 s = 1.28 s

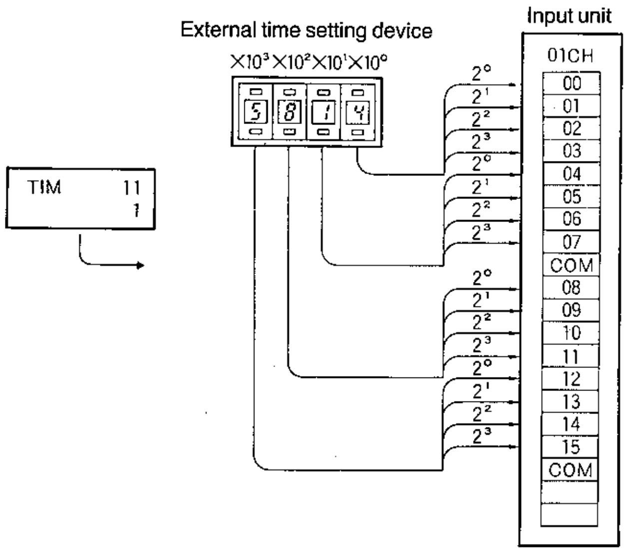
Since the data in all the relay areas are retained when the data retention flag is turned ON, reset unnecessary relays by the CNR instruction.

Externally set timer data

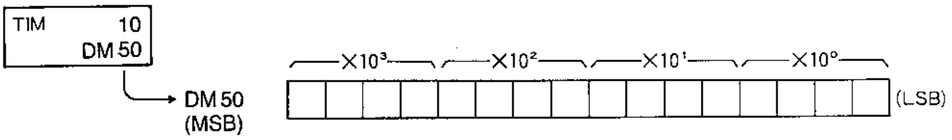
Externally set timer data must be in four BCD digits, and the CPU checks whether it is or not. If it is not, special auxiliary relay 6303 is turned ON, indicating an error. In this case the program can still be executed, but the time-up operation may not be accurate.

External time setting

In this example, a value (i.e., 581.4 seconds) is set in timer 011 by an external time setting device connected to channel 01 of the input unit.



If "DM0" is specified as the second word of a TIM instruction, the set time of the timer will be the content of the data memory.



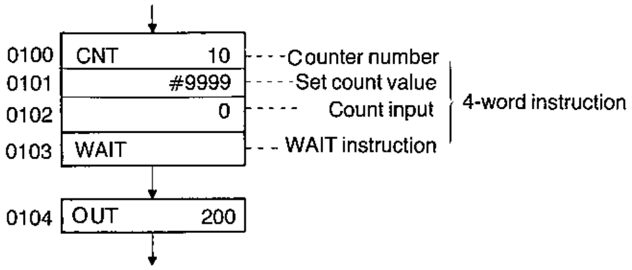
When the operation mode is changed by the mode selector switch of the programming console, the timers are reset and the present values are reset to the set values.

COUNTER WAIT

CNT (counter number)(set count value)(count input)

where,
counter number: 0 to 127
set count value: 0000 to 9999 counts
count input: 0 to 6315, LR0 to 3115, or HR0 to 3115

Flowchart



A CNT WAIT instruction consists of four words: a counter number, a set value, a count input, and a WAIT instruction.

This instruction causes the specified value to be set in the counter. The set value is decremented at the leading edge of each count input signal. The instruction causes the program execution to wait until the set value is decremented to 0. When the set count value is up, the count-up state is stored in the memory and the program execution proceeds to the next step.

Coding chart

Address	Instruction	Data
0100	CNT	10
0101		#9999
0102		0
0103	WAIT	
0104	OUT	200

Contents of data

I/O relay, internal auxiliary relay	0 to 63
Link relay	LR0 to 31
Holding relay	HR0 to 31
Data memory	DM0 to 511
Constant	#0000 to 9999

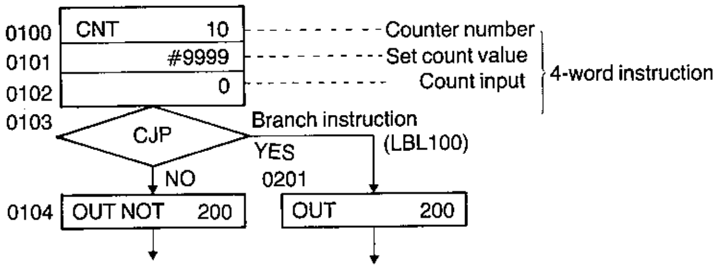
COUNTER BRANCH

The counters used in the SYSMAC-C120F are of a decrementing type. If the same counter is used again after its set count value is up, reset it once with a CNR instruction.

CNT (counter number)(set count value)(count input)

where,
counter number: 0 to 127
set count value: 0000 to 9999 counts
count input: 0 to 6315, LR0 to 3115, or HR0 to 3115

Flowchart



A CNT BRANCH instruction consists of four words: a counter number, a set value, a count input, and a CJP (Conditional Jump) instruction.

This instruction causes the specified count value to be set in the specified counter. The set value of the counter is decremented at the leading edge of each count input signal. When the set count is not yet up, the program execution proceeds to the next step. When the set count is up, the program execution jumps to the specified label in the CJP instruction.

If the label specified by the CJP instruction is not found in the program, all the output relays will be turned OFF and the CPU will halt.

Coding chart

Address	Instruction	Data
0100	CNT	10
0101		#9999
0102		0
0103	CJP LBL	100
0104	OUT NOT	200
⋮	⋮	⋮
0200	LBL	100
0201	OUT	200

Contents of data

I/O relay, internal auxiliary relay	0 to 63
Link relay	LR0 to 31
Holding relay	HR0 to 31
Data memory	DM0 to 511
Constant	#0000 to 9999

If a counter whose set count value has not been up is reused, the counter operation will start from the present value.

While the CPU is scanning other programs, it cannot control any input signals to the counter. The present value of the counter will therefore remain unchanged.

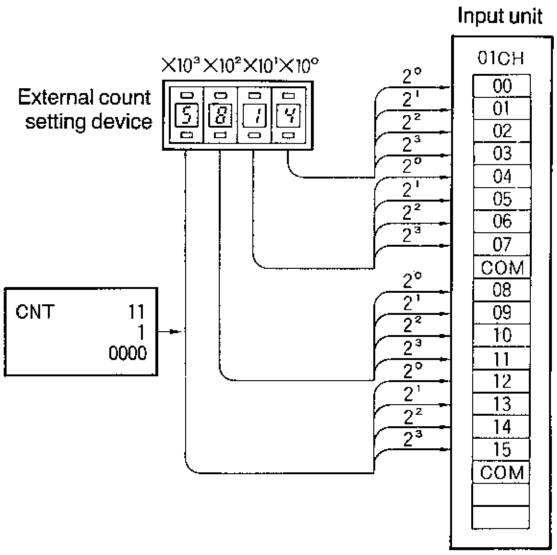
If the CNR (Counter Reset) instruction is executed, the specified counter will be reset regardless of whether the counter is in operation or its set count is up.

Externally set counter data

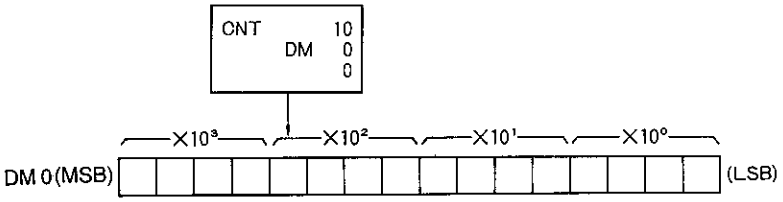
Externally set counter data must be in four BCD digits. The CPU checks whether the externally set counter data is in four BCD digits or not. If not in BCD digits, special auxiliary relay 6303 is turned ON, indicating an error.

External count setting

In this example, a value (i.e., 5,814 counts) is set in counter 011 by an external count setting device connected to channel 01 of the input unit.

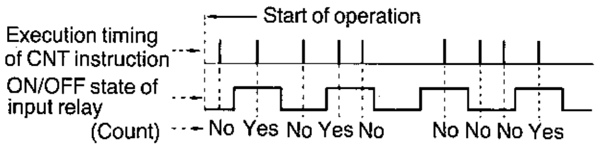


If a data memory number is specified as the second word of a CNT instruction, the set count value of the counter will be the contents of the data memory.



When a power failure occurs, the present count value of the counter is reset to 0 unless special auxiliary relays 6011 and 6012 are turned ON. If they are turned ON at the time of the power failure, the present value will be retained and the counting is resumed from the retained value upon power recovery.

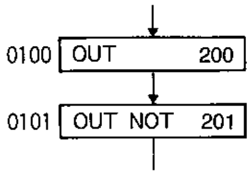
At the leading edge (i.e., from OFF to ON) of a count input signal, the counter decrements the count value by 1.



When the operation mode is changed by the mode selector switch of the programming console, the counters are reset and the present count values are reset to the set count value.

OUT/OUT NOT

Flowchart



The OUT instruction causes the specified relay to turn ON and the program execution to proceed to the next step.

The OUT NOT instruction causes the specified relay to turn OFF and the program execution to proceed to the next step.

Coding chart

Address	Instruction	Data
0100	OUT	200
0101	OUT NOT	201

Use the OUT instruction to turn ON an output relay and the OUT NOT instruction to turn it OFF.

These relays can be used as the data of the OUT or OUT NOT instruction. One point of the relays can be specified to turn ON or OFF by the OUT or OUT NOT instruction.

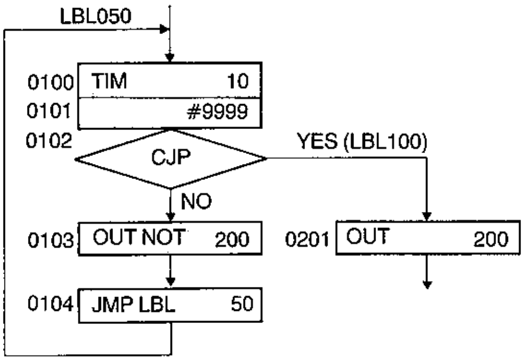
I/O relays, internal auxiliary relays: 0 to 6015, 6304
Link relays: LR0 to 3115
Holding relays: HR0 to 3115

When GOFF instruction is executed

In the group program specified by a GOFF instruction, all the output relays specified by OUT instructions will be turned OFF on execution of the GOFF instruction.

JUMP (JMP/CJP)

Flowchart



Direct jump

The JMP instruction causes the program execution to jump directly to a destination specified by a label.

Indirect jump

If "0" is specified to the JMP instruction, the CPU refers to the externally set label. If "DM0" is specified, the label will be the contents of the specified data memory.

Coding chart

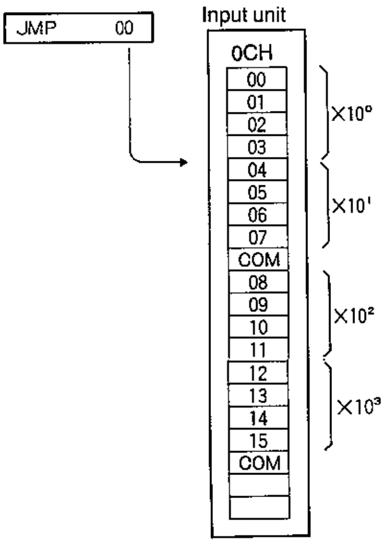
Address	Instruction	Data
0099	LBL	50
0100	TIM	10
0101		#9999
0102	CJP LBL	100
0103	OUT NOT	200
0104	JMP LBL	50
⋮	⋮	⋮
0200	LBL	100
0201	OUT	200

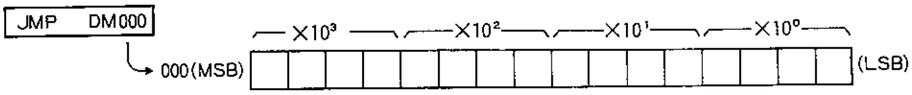
Contents of data

I/O relay, internal auxiliary relay	0 to 63
Link relay	LR0 to 31
Holding relay	HR0 to 31
Data memory	DM0 to 511
Label	LBL0 to 1023

Externally set value or the data memory contents must be specified in BCD. The CPU checks whether the externally set value or the data memory contents are specified in BCD. If an error is found during the BCD check, special auxiliary relays 6303 and 6109 are turned ON and the indirect jump instruction is treated as a NOP instruction.

If the specified label is not found in the program, the load is turned OFF and the CPU will halt.

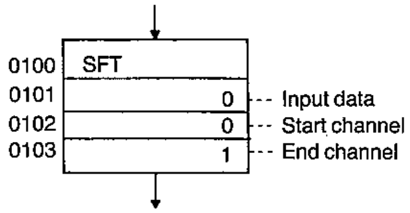




In case the label specified in the indirect jump instruction is not found in the program, special auxiliary relay 6109 is turned ON and the instruction is processed as NOP.

SHIFT REGISTER (SFT)

Flowchart



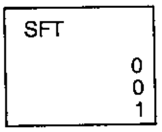
SFT (input data), (start channel), (end channel)

where,
input data: 0 to 6315, LR0 to 3115, or HR0 to 3115
start channel: 0 to 60, LR0 to 31, or HR0 to 31
end channel: 0 to 60, LR0 to 31, or HR0 to 31

This instruction can be used as a serial input shift register. Program the SFT instruction starting with input data, a start channel, and then an end channel.

Coding chart

Address	Instruction	Data
0100	SFT	—
0101		0
0102		0
0103		1



Each execution of this instruction causes the input data specified by an I/O relay number to shift by one bit from the specified start channel to the end channel.

In the above program, input relay 0 turns ON at the first, third, and fourth executions of the SFR instruction and OFF at the second execution. The contents of the channels are as shown below.
▨ shows the ON state and ☐ the OFF state.

Output unit (x2)

00CH	01CH
▨ 0000	0100
0001	0101
0002	0102
0003	0103
0004	0104
0005	0105
0006	0106
0007	0107
0008	0108
0009	0109
0010	0110
0011	0111
0012	0112
0013	0113
0014	0114
0015	0115

1st execution

→

00CH	01CH
0000	0100
▨ 0001	0101
0002	0102
0003	0103
0004	0104
0005	0105
0006	0106
0007	0107
0008	0108
0009	0109
0010	0110
0011	0111
0012	0112
0013	0113
0014	0114
0015	0115

2nd execution

→

00CH	01CH
▨ 0000	0100
0001	0101
▨ 0002	0102
0003	0103
0004	0104
0005	0105
0006	0106
0007	0107
0008	0108
0009	0109
0010	0110
0011	0111
0012	0112
0013	0113
0014	0114
0015	0115

3rd execution

→

00CH	01CH
▨ 0000	0100
▨ 0001	0101
0002	0102
▨ 0003	0103
0004	0104
0005	0105
0006	0106
0007	0107
0008	0108
0009	0109
0010	0110
0011	0111
0012	0112
0013	0113
0014	0114
0015	0115

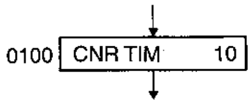
4th execution

Neither clock input nor reset input is used for the shift register. The register contents are shifted each time the SFT instruction is executed. To reset the shift register, use a CNR (Counter Reset) instruction.

Always specify the end channel number which is equal to or greater than the start channel number. Also, the start and end channels must be specified in the same relay area. For example, if an HR relay channel is specified as the start channel, the end channel must be also an HR relay channel.

COUNTER RESET (CNR)

Flowchart



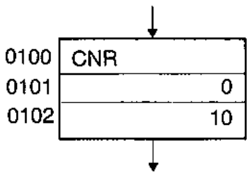
Although this instruction is used to reset the present count value of the specified counter, it can also reset the present value of the specified timer; the present state of the specified input/output relay channel, internal auxiliary relay channel, link relay channel, or holding relay channel; and the contents of the specified data memory. To allow the instruction to reset relay(s) other than the counter, use the TIM key on the programming console. The relay to be reset is also indicated by the message TIM displayed on the programming console.

Timer Reset (TIM0 to 127)

The CNR instruction causes the specified timer to return to its initial state.

Coding chart

Address	Instruction	Data
0100	CNR TIM	10
⋮	⋮	⋮



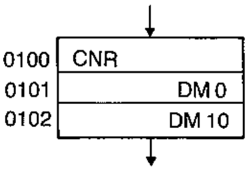
The CNR instruction causes the specified counter to return to its initial state.

Coding chart

Address	Instruction	Data
0100	CNR	
0101		0
0102		10

Resetting of I/O relay, internal auxiliary relay, link relay, and holding relay channels (0 to 60, LR0 to 31, HR0 to 31)

The CNR instruction is also used to reset the relays within the range specified by two relay channel numbers. It can also reset the data of the shift register.



Data memory reset (DM0 to 511)

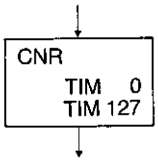
The CNR instruction is also used to reset the data memory contents within the range specified by two data memory channels.

Coding chart

Address	Instruction	Data
0100	CNR	
0101		DM 0
0102		DM 10

Contents of data

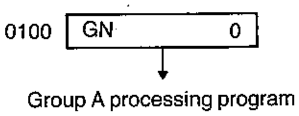
I/O relay, internal auxiliary relay	0 to 60
Link relay	LR0 to 31
Holding relay	HR0 to 31
Timer/counter	TIM/CNT0 to 127
Data memory	DM0 to 511



This instruction can also be used to reset the counters (or timers) in the specified range.

GROUP NUMBER (GN)

Flowchart



FUN B 1 A 0 (group number)

where,
group number: 0 to 31

This instruction is used to register a group number in memory and is written at the beginning of each group program. The registered group number will then be referenced by the group instructions explained in the following sections.

Coding chart

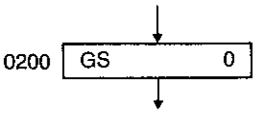
Address	Instruction	Data
0100	GN (10)	10
⋮	⋮	⋮

GROUP START (GS)

FUN **B 1** **B 1** (group number)

where,
group number: 0 to 31

Flowchart



This instruction places the specified group program in the ready-to- run state and causes the program execution to proceed to the next step. This instruction is also used to place in the ready-to-run state again the group program whose execution has been stopped by the GE instruction. If an attempt is made to execute the GS instruction for the group program that has already been executed, the CPU regards this instruction as a NOP instruction and executes nothing.

Coding chart

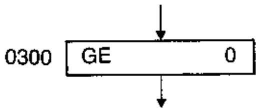
Address	Instruction	Data
⁝	⁝	⁝
0200	GS (11)	0
⁝	⁝	⁝

GROUP END (GE)

FUN **B 1** **C 2** (group number)

where,
group number: 0 to 31

Flowchart



This instruction is used to end the specified group program. On execution of this instruction, the program will not be executed. At the same time, the present states of I/O relays and the present values of counters in the executed group program are retained, and the timers continue to operate. To stop the timer operation, use the CNR instruction.

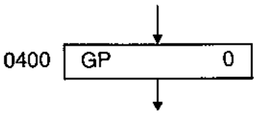
When execution of the group program is specified to end by the GE instruction written in the same program, the execution of the program is ended and then the program execution jumps to another group program. After the GE instruction specifying that group program has been executed, the program execution proceeds to the next step.

Coding chart

Address	Instruction	Data
⁝	⁝	⁝
0300	GE (12)	0
⁝	⁝	⁝

GROUP PAUSE (GP)

Flowchart



FUN B 1 D 3 (group number)

where,
group number: 0 to 31

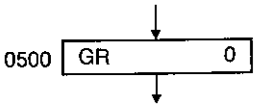
This instruction causes execution of the specified group program to be temporarily suspended. The execution will be resumed on execution of the GR (Group Restart) instruction. When the GP instruction is executed, the states of all the output relays are retained, and the timers continue to operate.

Coding chart

Address	Instruction	Data
¦	¦	¦
0400	GP (13)	0
¦	¦	¦

GROUP RESTART (GR)

Flowchart



FUN B 1 E 4 (group number)

where,
group number: 0 to 31

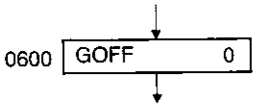
This instruction is used to start again the group program whose execution has been temporarily suspended by the GP instruction. If the GS or GP instruction has not been applied to the specified group the CPU regards the GR instruction as a NOP instruction and executes nothing.

Coding chart

Address	Instruction	Data
¦	¦	¦
0500	GR (14)	0
¦	¦	¦

GROUP OFF (GOFF)

Flowchart



FUN B 1 F 5 (group number)

where,
group number: 0 to 31

This instruction is used to reset the I/O and auxiliary relays specified by the OUT or OUT NOT instruction in the specified group program and to reset the present values of timers to the set values. When the GOFF instruction is executed, the relays and timers in the range from the beginning of the specified group program to the beginning of the next group program, to the SBN instruction, or to the GE instruction in the specified group are reset. The GOFF instruction also causes the execution of the specified group program to stop.

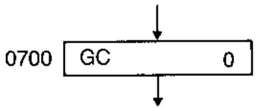
Coding chart

Address	Instruction	Data
⋮	⋮	⋮
0600	GOFF (15)	0
⋮	⋮	⋮

GROUP CONTINUE (GC)

FUN B 1 6 (group number)

Flowchart



where,
group number: 0 to 31

If a power failure occurs, this instruction causes the execution of the specified group program to be resumed upon recovery of the power failure, provided the data retention flags (special auxiliary relays 6011 and 6012) are turned ON before the power is applied to the SYSMAC-C120F again. In any other condition, the CPU regards this instruction as a NOP instruction and executes nothing.

The GC32 instruction is used to execute an interrupt servicing routine. When this instruction is executed, an interrupt servicing routine whose execution has been halted due to a power failure is resumed.

With special auxiliary relay 6011 turned ON, the timer does not start the timing operation even if the program execution is started. To start the timer, the GJ instruction explained next is used.

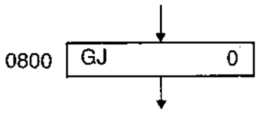
Coding chart

Address	Instruction	Data
⋮	⋮	⋮
0700	GC (16)	0
⋮	⋮	⋮

GROUP JUMP (GJ)

FUN B 1 7 (group number)

Flowchart



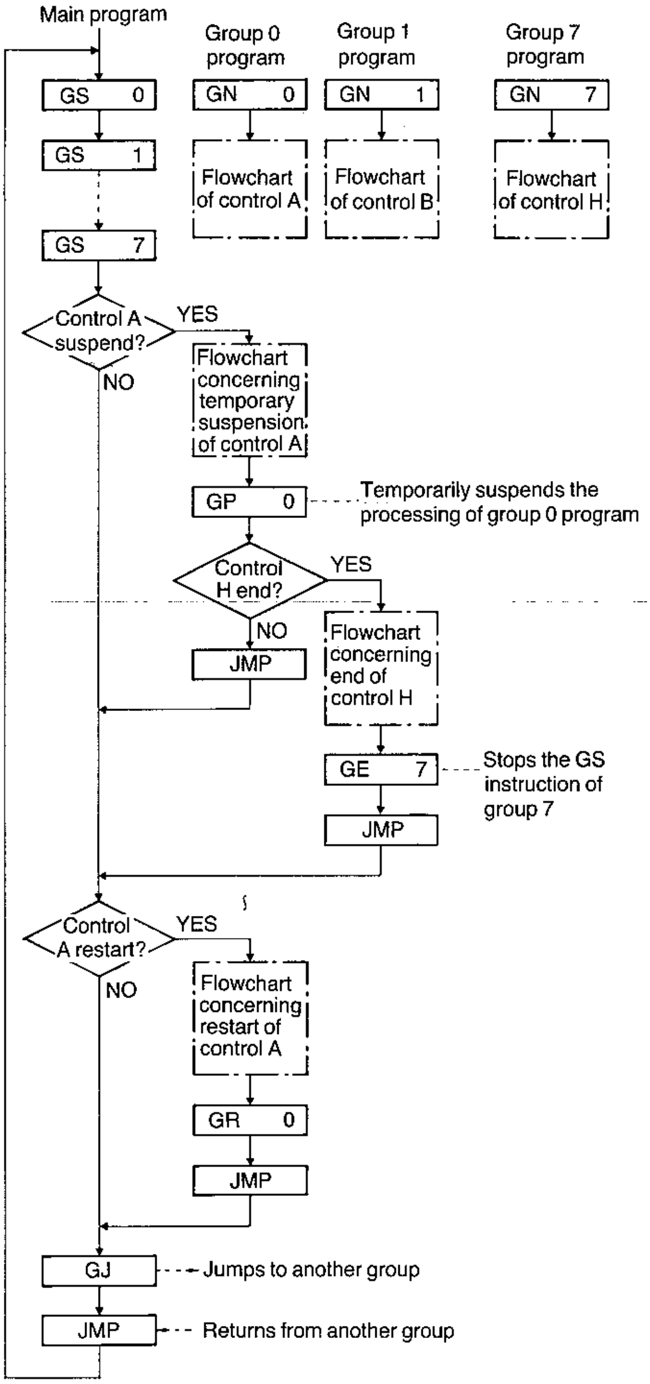
where,
group number: 0 to 31

This instruction causes the program execution to jump to the next group program that is in the ready-to-run state, or to the main program. When the program execution returns to the original group program, the step before which the program execution jumped is resumed.

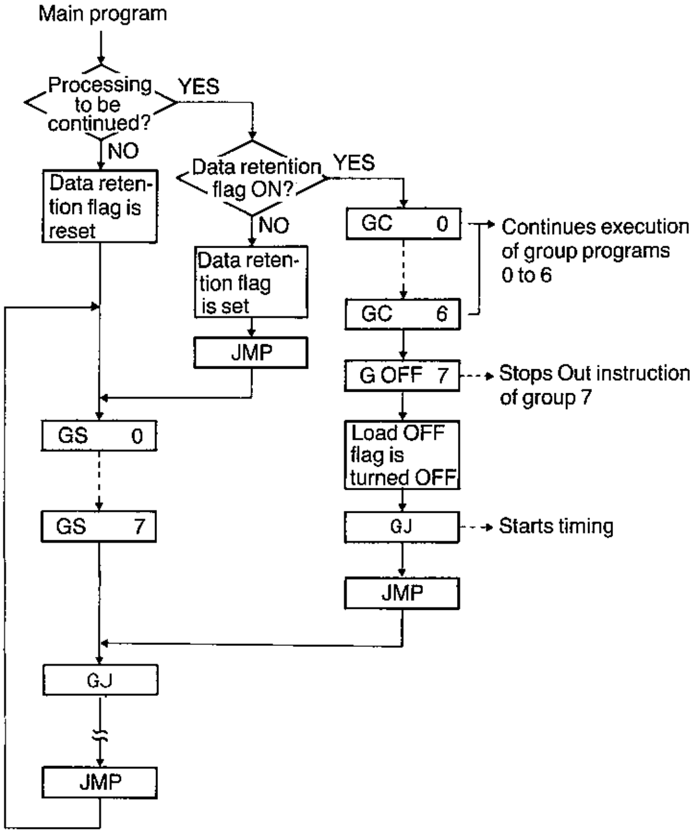
Coding chart

Address	Instruction	Data
⋮	⋮	⋮
0800	GJ (17)	0
⋮	⋮	⋮

Flowchart example of parallel processing



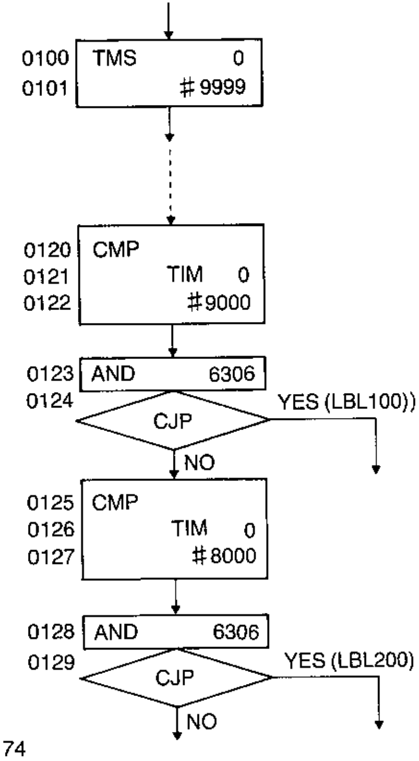
Flowchart example of power application



Note: If the data retention flag is turned ON, all the output relays are automatically turned off until the load-off flag is turned OFF on power application.

TIMER START (TMS)

Flowchart



FUN D 3 A 0 (timer number) (set value)

where,
timer number: 0 to 127
set value: 0000 to 999.9/99.99 s

This instruction is used to start timers and is shared by the TIM area. The concept of free location applies to this instruction.

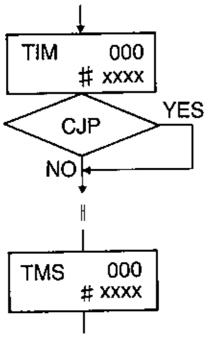
Coding chart

Address	Instruction	Data
0100	TMS (30)	10
0101		#9999
⋮	⋮	⋮
0120	CMP	
0121		TIM 0
0122		#9999
0123	AND	6306
0124	CJP LBL	100

Contents of data

I/O relay, internal auxiliary relay	0 to 63
Link relay	LR0 to 31
Holding relay	HR0 to 31
Data memory	DM0 to 511
Constant	#0000 to 9999

The TMS instruction is used to start a timer. This instruction functions as follows, the same as when the TIM BRANCH instruction is programmed:



Other than the above, the TMS instruction functions the same as the TIM instruction.

TMS numbers are shared by the TIM and CNT numbers.

There are two types of timers whose values can be set by the TMS instruction. The value of one type (timers 0 to 117) is set in units of 0.1 second whereas that of the other (timers 118 to 127) can be set in units of 0.01 second.

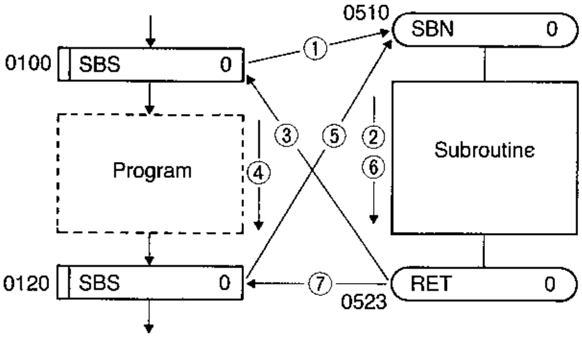
Instruction	TIM10 #0128	TIM120 #0128
Time-up	128×0.1 s = 12.8 s	128×0.01 s = 1.28 s

SUBROUTINE NUMBER (SBN) (SBS)

FUN D 3 B 1 (subroutine number)

where,
subroutine number: 0 to 31

Flowchart



Programs are executed in the order of 1, 2 ..... 7.

If the same sequence of instructions is used over and over again in a program, it may be placed between this instruction and the RET instruction to be explained later. This portion of the program between the two instructions is called a subroutine. A subroutine can be executed as many times as required by executing the SBS instruction (which is described next) the required number of times. A subroutine allows the number of words in the program to be reduced. A maximum of 32 subroutines can be registered.

The SBN instruction indicates the beginning of a subroutine and is written at the beginning of a program that is used frequently and thus should be used as a subroutine.

Coding chart

Address	Instruction	Data
0100	SBS (32)	0
	Program	
0120	SBS (32)	0
	Program	
0510	SBN (31)	0
	Subroutine	
0523	RET (33)	0

No.	0 to 31

RETURN (RET)

FUN D 3 C 2 (subroutine number)

where,
subroutine number: 0 to 31

This instruction indicates the end of a subroutine and is used in pairs with the SBS instruction.

SUBROUTINE START (SBS)

FUN D 3 D 3 (subroutine number)

This instruction causes the execution of the specified subroutine to start.

When the SBS instruction is executed, the CPU executes the subroutine registered using a subroutine number. When the execution continues up to the RET instruction, it returns to the step next to the SBS instruction in the original program.

If the specified subroutine number is not found in the program, the CPU regards the SBS instruction as a NOP instruction and executes nothing.

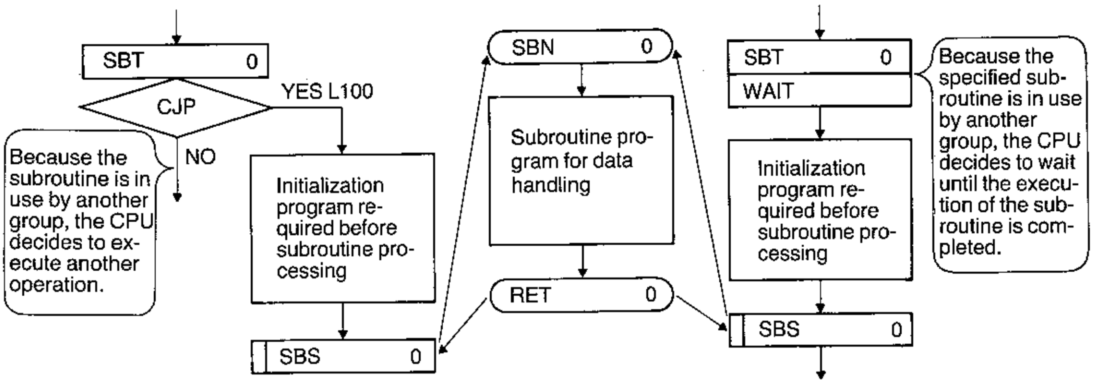
If the subroutine specified by the SBS instruction is under execution in the specified group program or another group program, the CPU will not execute the subroutine but instead will wait. If the execution of another group program has already been started when the CPU is in the wait state, the CPU will automatically execute that group program. In other words, the specified subroutine will be executed if it is not under execution by another group program.

SUBROUTINE TEST (SBT)

FUN D 3 E 4 (subroutine number) (label number)

where,
subroutine number: 0 to 31
label number: 0 to 1023

Flowchart



In the above example program, if WAIT instruction(s) and a program for arithmetic operations exist in the specified subroutine, both the programs share the data memories for the arithmetic operations. In this case, before executing the subroutine initialization program, the SBT instruction is used to examine whether the execution of the subroutine has already started. In this way, the subroutine can be used without erasing the contents of the data memories. The SBT instructions are divided into an SBT WAIT and an SBT BRANCH instruction.

Contents of data

No.	0 to 31
Label No.	0 to 1023

SBT WAIT instruction
This instruction consists of two words: SBT and WAIT.

If the subroutine specified by the SBT instruction is being executed by any other group, the CPU will not execute the subroutine in the specified program, but will wait until the execution of the subroutine has been completed. Then, the CPU executes the subroutine for the specified group program and proceeds to the next step.

SBT BRANCH instruction
This instruction consists of two words: SBT and CJP. If the subroutine specified by the SBT instruction is being executed by any other group, the CPU proceeds to the next step. If not, the CPU jumps to the destination whose label is specified by the CJP instruction.

Note: If the subroutine number specified by the SBT instruction is not found in the program, the CPU will perform the subroutine processing as if the jump condition were satisfied.

When arithmetic operations are to be performed using a subroutine, the data for arithmetic operations are usually initialized before the execution of the subroutine. If the subroutine for arithmetic operations is to be shared by more than one program, it is necessary to check whether the specified subroutine is not in use by any program other than those specified before executing the initialization program. The Subroutine Test (SBT) instructions inform the CPU whether the specified subroutine is under execution.

DIAGNOSTIC (FAL/FALS)

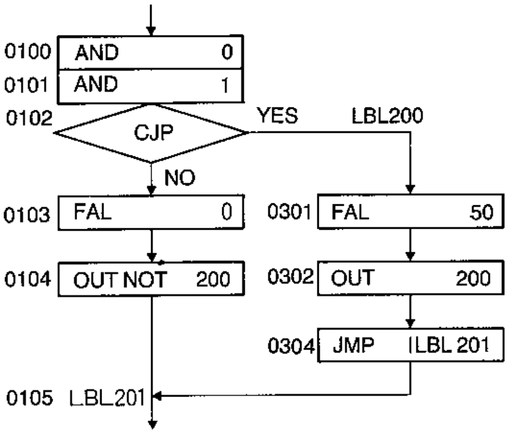
FUN | D 3 | F 5 | (number) [FAL]

where,
number: 0 to 99

FUN | D 3 | 6 | (number) [FALS]

where,
number: 1 to 99

Flowchart



The Diagnostic instructions are divided into a FAL instruction and a FALS instruction. These instructions are written in the portions of the program that especially must be monitored. If an error occurs in those portions, the instructions are executed, causing the CPU to output error codes.

The FAL instruction can be used to display the occurrence of a failure and is assigned with any numbers from 01 to 99 to identify a failure that has occurred. If a failure occurs and thus the FAL instruction is executed, the instruction can be reset by executing the FAL00 instruction.

Coding chart

Address	Instruction	Data
0100	AND	0
0101	AND	1
0102	CJP LBL	200
0103	FAL (35)	0
0104	OUT NOT	200
0105	LBL	201
⋮	⋮	⋮
0300	LBL	200
0301	FAL (35)	50
0302	OUT	200
0304	JMP LBL	201

Contents of data

No.	0 to 99 (FAL) 1 to 99 (FALS)

When the FAL instruction is executed, the corresponding FAL number is output to the FAL area (special auxiliary relays 6100 to 6107). The ALARM LED indicator on the front panel of the CPU rack lights up. The CPU continues its operation, however.

When FAL10 is output to the FAL area

6107	6106	6105	6104	6103	6102	6101	6100
"0"	"0"	"0"	"1"	"0"	"0"	"0"	"0"
2^3	2^2	2^1	2^0	2^3	2^2	2^1	2^0
x10				x1			

A maximum of two FAL errors can be stored in memory when another FAL error is detected before the first FAL error has been removed.

To reset the FAL area output, remove the cause of the FAL error and then execute the FAL0 instruction.

If the programming console is connected to the C120F, FAL area outputs can also be reset by performing the FAILURE READ operation.

Each time the FAL0 instruction is executed, the FAL area output is reset and another FAL error retained in the memory is output.

Note: Other alarms and failures, such as battery error and remote I/O error, are also output to the FAL area in addition to FAL and FALS instructions.

When the FALS instruction is executed, the corresponding FALS number is output to the FAL area and the ERROR indicator (LED) on the front panel of the CPU rack illuminates. The the CPU stops its operation.

To reset the FALS output, remove the cause of the FALS errors, and then perform a FAILURE READ operation using the programming console with the mode selector switch set to the PROGRAM position.

The FALS output can also be reset by restarting the C120F using the mode selector switch (RUN to PROGRAM to RUN) after removing the cause of the FALS error.

If a FALS error or any other error that causes the C120F to stop has occurred while a FAL error is being detected, that FALS or failure number is output in place of the FAL number.

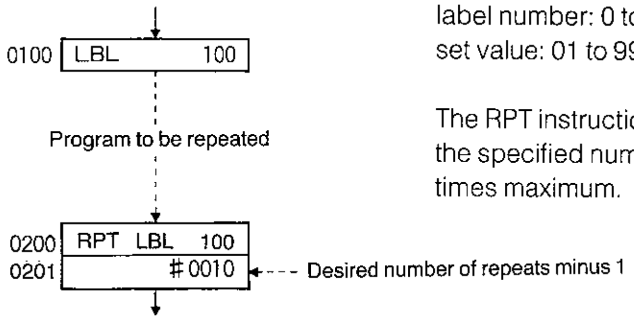
Priority of output:
The output of the FALS or the failures that cause the CPU to stop take precedence over the FAL or those that do not.

REPEAT (RPT)

FUN D 3 7 (label number) (set value)

where,
label number: 0 to 1023
set value: 01 to 99

Flowchart



The RPT instruction is used to repeat the execution of a specified program the specified number of times. The program execution can be repeated 99 times maximum.

Coding chart

Address	Instruction	Data
0100	LBL	100
⋮	⋮	⋮
0200	RPT(37) LBL	100
0201		#0010

Contents of data

Label No.	0 to 1023
Set value	#0001 to 0099

When this instruction is executed, the CPU repeats execution of the program the specified number of times. Then, the program execution proceeds to the next step.

If the specified label is not found in the program, all the output relays are turned OFF and the CPU stops.

Even if the program execution jumps from one group program to another during the execution of the RPT instruction and then returns to the initial group program, the program is executed the specified number of times.

Because the number of repetitions can be specified in each group, the specified number of repetitions will be performed in one group program even if a RPT instruction in another group program is executed.

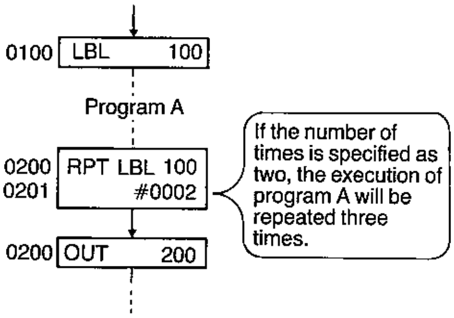
Even if the execution of a group program in which the RPT instruction is under execution is temporarily suspended by the GP instruction, the group program will be executed the specified number of times on restarting the program execution.

When a power failure occurs during the execution of the RPT instruction, the group program can be executed the specified number of times. To do this, special auxiliary relay 6012 must be turned ON before the power failure and the GC instruction must be executed after recovery of the power. The repetitious program execution is resumed. If the GS instruction is executed, however, the execution starts from the initially set value.

When the GE instruction is executed, the remaining number of repetitions (i.e., present value) returns to the initial value.

If another GS instruction is executed in the group program whose execution has already started, the CPU regards the second GS instruction as a NOP instruction and executes nothing. The number of repetitions therefore will not return to the initial value.

Totally, the program is executed once more than the specified number of times.



If the number of times is specified as two, the execution of program A will be repeated three times.

Before the first execution of the RPT instruction (Program A is executed for the first time)

↓

The CPU jumps to label 100 on execution of the RPT instruction.
Following the execution of Program A, the RPT instruction is executed for the first time, and the repeat counter is decremented to one. (Program A is executed for the second time.)

↓

The CPU again jumps to label 100 on execution of the RPT instruction. The RPT instruction is executed for the second time, following execution of program A, and the repeat counter is decremented to 0.
Then the program execution proceeds to the next step. (Program A is executed for the third time.)

↓

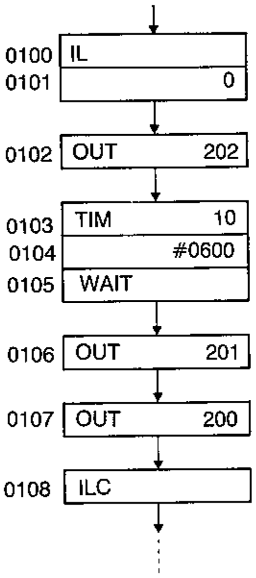
I/O relay No. 15 is turned ON.

INTERLOCK (IL)

FUN | D 3 | 8 | (relay number)

The IL instruction is always used in pairs with ILC (Interlock Clear) instruction, which is expained next, to turn OFF the output relays specified by the OUT instructions within a sequence of instructions in a program.

Flowchart



This instruction is executed while the specified I/O relay is turned OFF. When the IL instruction is executed, the I/O relays, internal auxiliary relays, and link relays specified by the OUT or OUT NOT instructions in the program between the IL and ILC instructions are reset and the present values of the timers are reset to the set value.

When the IL instruction is executed, the program execution does not jump to another group program and the present value of a counter and the states of the holding relay, data memory relay, and special internal auxiliary relay areas are retained. Moreover, the CPU regards the Subroutine Start (SBS) instruction as a NOP instruction and executes nothing.

When the specified I/O relay is turned ON, the CPU regards the IL instruction as a NOP instruction and executes nothing.

Coding chart

Address	Instruction	Data
0100	IL(38)	—
0101		0
0102	OUT	202
0103	TIM	10
0104		#0000
0105	WAIT	
0106	OUT	201
0107	OUT	200
0108	ICL(39)	—

Contents of data

Output relay, internal auxiliary relay	0 to 6315
Link relay	LR0 to 3115
Holding relay	HR0 to 3115

INTERLOCK CLEAR (ILC)

FUN D 3 9

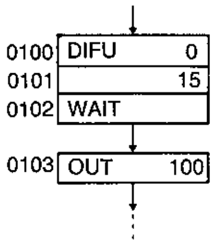
This instruction is used in combination with an IL instruction to determine the range within which the IL instruction can be executed.

DIFFERENTIATION UP (DIFU)/DIFFERENTIATION DOWN (DIFD) WAIT

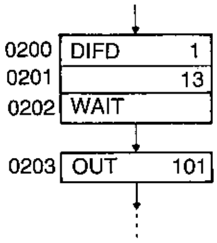
FUN E 4 A 0 (differentiation number) (relay number) [DIFU]

FUN E 4 B 1 (differentiation number) (relay number) [DIFD]

Flowchart for DIFU



Flowchart for DIFD



These instructions are used to execute the next step only once when a given condition is satisfied, and skip that step afterward.

When the DIFU or DIFD WAIT instruction is executed, the program execution is caused to wait until the leading or the trailing edge of the specified I/O relay. If the GS instruction is executed for another group program, however, the program execution will jump to that group program. The program execution proceeds to the next step at the leading or the trailing edge of the specified I/O relay.

Coding chart for DIFU

Address	Instruction	Data
0100	DIFU(40)	0
0101		15
0102	WAIT	
0103	OUT	100

Coding chart for DIFD

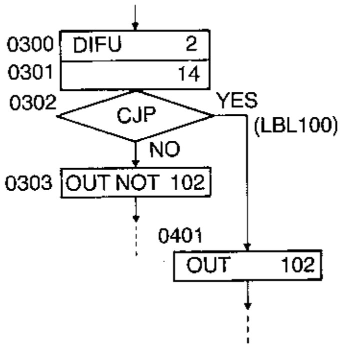
Address	Instruction	Data
0200	DIFD(41)	1
0201		13
0202	WAIT	
0203	OUT	101

Contents of data

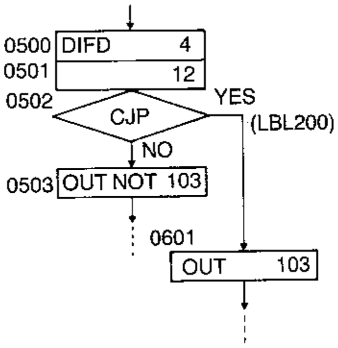
Output, relay, internal auxiliary relay	0 to 6315
Link relay	LR0 to 3115
Holding relay	HR0 to 3115

DIFU/DIFD BRANCH

Flowchart for DIFU BRANCH



Flowchart for DIFD BRANCH



When the DIFU or DIFD BRANCH instruction is executed, the program execution jumps to the destination specified by a label at the leading or the trailing edge of the specified I/O relay. If the state of the I/O relay remains unchanged, the program execution proceeds to the next step.

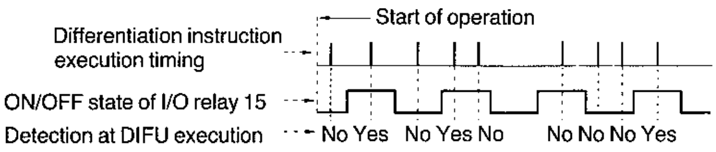
Coding chart for DIFU BRANCH

Address	Instruction	Data
0300	DIFU(40)	2
0301		14
0302	CJP LBL	100
0303	OUT NOT	102
⋮	⋮	⋮
0400	LBL	100
0401	OUT	102

Coding chart for DIFD BRANCH

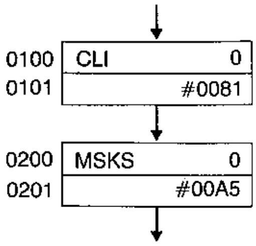
Address	Instruction	Data
0500	DIFD(41)	4
0501		12
0502	CJP LBL	200
0503	OUT NOT	103
⋮	⋮	⋮
0600	LBL	200
0601	OUT	103

A Differentiation instruction is detected at the leading or trailing edge of a specified I/O relay.



INTERRUPT MASK (MSKS)

Flowchart



FUN E 4 C 2 (interrupt unit number) (data)

The interrupt inputs via the interrupt input unit can be masked (disabled) in units of 1 point (bit). However, when a channel number is specified data, the most significant 8 bits are ignored.

Coding chart

Address	Instruction	Data
0100	MSKS(42)	0
0101		#0081
⋮	⋮	⋮
0200	CLI	0
0201	OUT	#0081

Contents of data

	Interrupt unit No.	Data
Constant	0 to 3	#00 to FF
I/O relay, internal auxiliary relay	—	0 to 63
Link relay	—	LR0 to 31
Holding relay	—	HR0 to 31
Data memory	—	DM0 to 511
Indirectly addressed	—	*DM0 to 511

This instruction is used to disable the interrupt inputs from an interrupt unit. The interrupt inputs are recorded, however.

The interrupt inputs can be disabled in units of 1 point.

In the above example, assuming interrupt unit 0 is mounted to channel 0 of the C120F, interrupt inputs for 0, 2, 5, and 7 are disabled, whereas those for 1, 3, 4, and 6 are enabled.

Interrupt input	7	6	5	4	3	2	1	0
Mask pattern	1	0	1	0	0	1	0	1
Interrupt disabled	YES	NO	YES	NO	NO	YES	NO	YES

CLEAR INTERRUPT (CLI)

FUN 4 3 (interrupt unit number) (data)

This instruction is used to clear the interrupt inputs internally recorded.

Whether the interrupt mask is cleared can be specified in units of 1 point.

In the above example, the interrupt inputs 0 and 7 that are internally recorded are cleared when the CLI instruction is executed.

When this instruction is executed, it clears all the internally registered interrupt inputs when power is applied to the C120F. However, the interrupt masks are not cleared.

Clearing the mask for the interrupt inputs and executing the CLI instruction must be performed by the program.

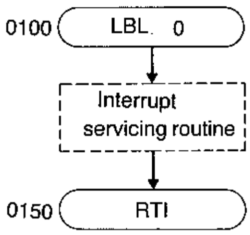
To clear the masking of the interrupt inputs 0 to 7 of interrupt input unit number 0 and the internally registered interrupt inputs when power is applied to the C120F, program as follows:

```
CLI        0
       #00FF
MSKS       0
       #0000
```

LABEL (LBL)

LBL (label number)

Flowchart



The LBL instructions are used to indicate the beginning of interrupt servicing routines. A maximum of 32 LBL instructions, namely, LBL0 to LBL31, are available which respectively correspond to a maximum of 32 interrupt inputs. These LBL instructions can be used as labels when no interrupt unit is mounted to the C120F.

Coding chart

Address	Instruction	Data
0100	LBL	0
⋮	⋮	⋮
0150	RTI (44)	⋮

When two interrupt units are mounted to channels 0 and 1 of the C120F, label numbers correspond to I/O numbers as follows:

CH	1CH
00	00
01	01
02	02
03	03
04	04
05	05
06	06
07	07
08	08
09	09
10	10
11	11
12	12
13	13
14	14
15	15

Label Nos. corresponding to I/O Nos.

CH	Bit	
0	00	→ LBL0
		∫
0	07	→ LBL7
2	00	→ LBL8
		∫
2	07	→ LBL15

Bits 8 to 15 of each interrupt unit can be used as internal auxiliary relays.

When the WAIT or CJP instruction is executed while an interrupt is being serviced, the program execution returns to the parallel processing of ordinary group programs. Therefore, the interrupt servicing will be delayed.

While an interrupt is serviced, the other interrupts are disabled.

RETURN (RTI)

FUN E 4 E 4

This instruction is used to indicate the end of an interrupt servicing and must be used in pairs with the LBL instruction. If the RTI instruction is executed for a purpose other than servicing interrupts, special auxiliary relay 6303 is turned ON causing all output relays to turn OFF and the CPU to halt.

The interrupt servicing routine executed when an interrupt input is generated from the interrupt unit is placed between the LBL and RTI instructions.

Since a maximum of 32 points of interrupt inputs can be used, LBL0 to LBL31 instructions are available, corresponding to the respective interrupts.

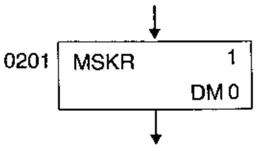
MASK READ (MSKR)

The interrupt masking state of the specified interrupt unit is output to the specified relay area.

FUN E 4 F 5 (interrupt unit number) (data)

This instruction is used to output in bit units the current interrupt masking state of the specified interrupt unit to the specified channel. Logical 1 of a bit indicates that the corresponding interrupt input is disabled whereas logical 0 of the bit indicates the enabled interrupt input. The most significant 8 bits of the channel are always logical 0, however.

Flowchart



Coding chart

Address	Instruction	Data
⋮	⋮	⋮
0200	MSKR (45)	1
0201		DM0
⋮	⋮	⋮

Contents of data

	Interrupt unit No.	Data
Constat	0 to 3	#00 to FF
I/O relay, internal auxiliary relay	—	0 to 60
Link relay	—	LR0 to 31
Holding relay	—	HR0 to 31
Data memory	—	DM0 to 511
Indirectly addressed data	—	*DM0 to 511

MOVE (MOV) and MOVE NOT (MVN)

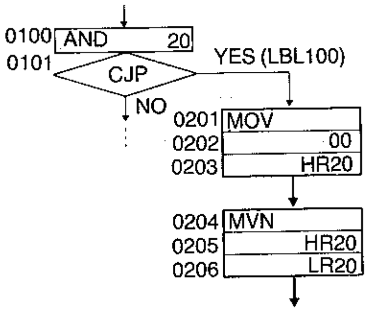
FUN F 5 A 0 (transfer data S)(destination channel D)[MOV]

FUN F 5 B 1 (transfer data S)(destination channel D)[MVN]

The MOV instruction is used to transfer 16-bit channel data or hexadecimal 4-digit (16-bit binary) constant to a specified channel.

If the transferred data are all 0, special auxiliary relay 6306 (= flag) turns ON.

Flowchart



Coding chart

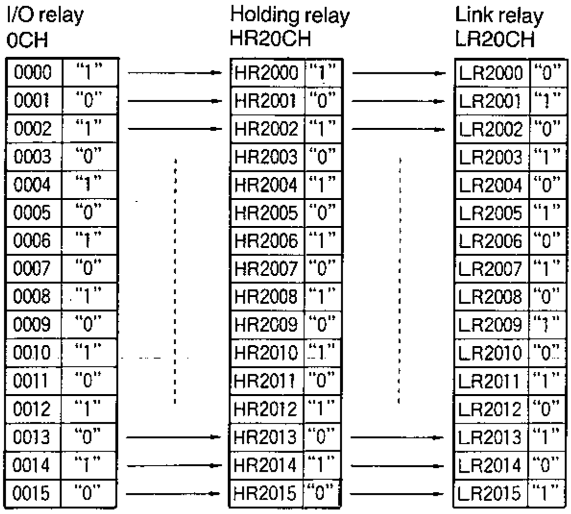
Address	Instruction	Data
0100	AND	20
0101	CJP LBL	100
⋮	⋮	⋮
0200	LBL	100
0201	MOV (50)	
0202		0
0203		HR20
0204	MVN (51)	—
0205		HR20
0206		LR20

Contents of data

	S	D
I/O relay, internal auxiliary relay	0 to 63	0 to 60
Link relay	LR0 to 31	
Holding relay	HR0 to 31	
Timer/counter	TIM/CNT0 to 127	—
Data memory	DM0 to 511	
Indirectly addressed data	*DM0 to 511	
Constant	#0 to FFFF	—

The MOV instruction is used to transfer data as is, whereas the MVN instruction is used to inverse and then transfer data.

When the above program is executed, the 16-bit data of 0CH (0000 to 0015) is transferred to HR20CH (HR2000 to HR2015), then inverted to be further transferred to LR20CH (LR2000 to LR2015).



I/O relay 0CH		Holding relay HR20CH		Link relay LR20CH	
0000	"1"	HR2000	"1"	LR2000	"0"
0001	"0"	HR2001	"0"	LR2001	"1"
0002	"1"	HR2002	"1"	LR2002	"0"
0003	"0"	HR2003	"0"	LR2003	"1"
0004	"1"	HR2004	"1"	LR2004	"0"
0005	"0"	HR2005	"0"	LR2005	"1"
0006	"1"	HR2006	"1"	LR2006	"0"
0007	"0"	HR2007	"0"	LR2007	"1"
0008	"1"	HR2008	"1"	LR2008	"0"
0009	"0"	HR2009	"0"	LR2009	"1"
0010	"1"	HR2010	"1"	LR2010	"0"
0011	"0"	HR2011	"0"	LR2011	"1"
0012	"1"	HR2012	"1"	LR2012	"0"
0013	"0"	HR2013	"0"	LR2013	"1"
0014	"1"	HR2014	"1"	LR2014	"0"
0015	"0"	HR2015	"0"	LR2015	"1"

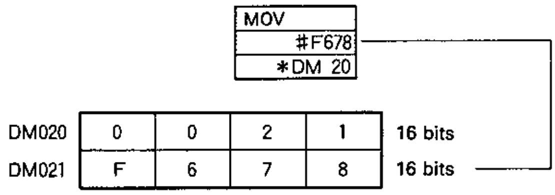
The result of the transfer will be:

when HR20CH = 0, 6306 = 1

when (LR20CH) ≠ 0, 6306 = 0

In constant designation, hexadecimal 4-digit (binary 16-bit) data is either transferred or inverted and then transferred.

The only channels that can be indirectly addressed are data memories DM0 to DM511. If the contents of the indirectly addressed area are not in BCD, or if they are greater than the maximum data memory channel, an error will occur; this will cause special auxiliary relay 6303 to turn ON, and the program will not be executed.



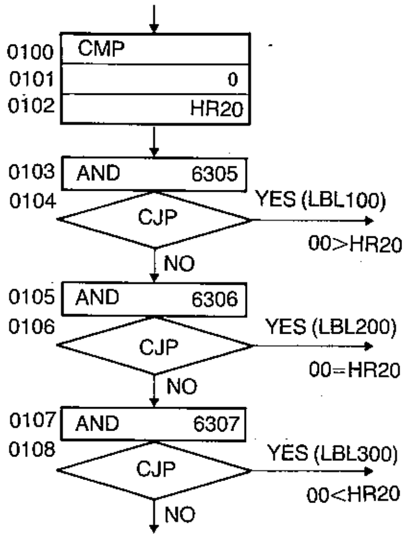
Because *DM20 is indirectly addressed, the data 21 (decimal) in DM20 specifies DM21, and a 4-digit constant (F678) is transferred to DM21. As a result, the contents of DM021 become F678. For details, refer to Compare instruction.

COMPARE (CMP)

FUN F 5 C 2 (comparing data) (compared data)

The CMP Instruction is used to compare a 16-bit channel data or a hexadecimal 4-digit (16-bit binary) constant against another 16-bit channel data. The result of the comparison is output to special auxiliary relay 6305, 6306, or 6307.

Flowchart



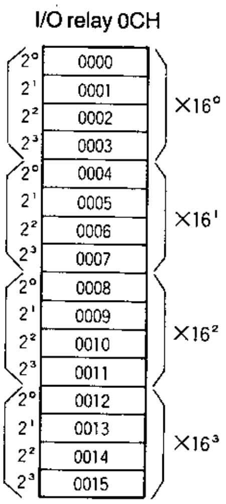
Coding

Address	Instruction	Data
0100	CMP (52)	
0101		0
0102		HR20
0103	AND	6305
0104	CJP LBL	100
0105	AND	6306
0106	CJP LBL	200
0107	AND	6307
0108	CJP LBL	300

Contents of data

I/O relay, internal auxiliary relay	0 to 63
Link relay	LR0 to 31
Holding relay	HR0 to 31
Timer/counter	TIM/CNT0 to 127
Data memory	DM0 to 511
Indirectly addressed data	*DM0 to 511
Constant	#0000 to 9999

When the above program is executed, the 16-bit data of 0CH (0000 to 0015) are compared against the 16-bit data of HR20CH (HR2000 to 2015), and the results are output to the result area of special auxiliary relays 6305 to 6307.



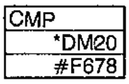
Result of comparison

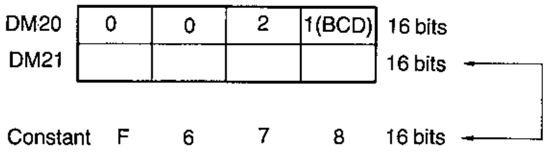
	6305	6306	6307
0CH>HR20CH	1	0	0
0CH=HR20CH	0	1	0
0CH<HR20CH	0	0	1

Constant is compared with the 4-digit hexadecimal (binary 16-bit) data.

The only channels that can be indirectly addressed are data memories DM0 to 511.

If the contents of the indirectly addressed data are not in BCD or if they are greater than the maximum data memory channel, an error will occur; this will cause special auxiliary relay 6303 to turn ON, and the program to be not executed.

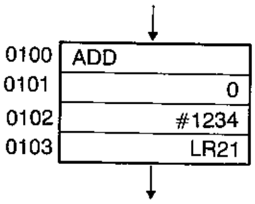




Because *DM20 is indirectly addressed, the data 21 (decimal) in DM20 specifies DM21, and the contents of DM21 are compared with the 4-digit constant F678 (16 bits).

ADD (ADD)

Flowchart



FUN F 5 D 3 (addend)(augend)(result channel)

The ADD instruction is used to execute the addition between two specified 4-digit BCD data.

When the Clear Carry (CLC) instruction is executed, the carry flag (special auxiliary relay 6304) is cleared.

Coding chart

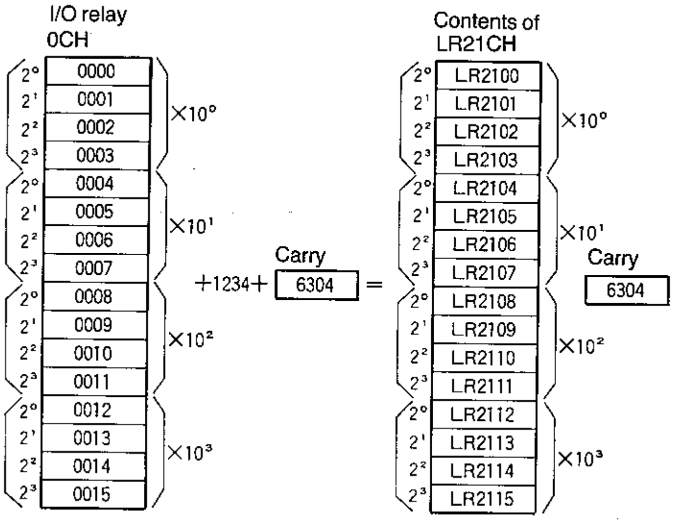
Address	Instruction	Data
0100	ADD(53)	
0101		0
0102		#1234
0103		LR21

Contents of data

	Addend/augend	Result CH
I/O relay, internal auxiliary relay	0 to 63	0 to 60
Link relay	LR0 to 31	
Holding relay	HR0 to 31	
Timer/counter	TIM/CNTO to 127	—
Data memory	DM0 to 511	
Indirectly addressed	*DM0 to 511	
Constant	#0000 to 9999	—

When the ADD instruction is executed, addition of a 4-digit BCD data to a 4-digit BCD data including a carry (6304) is performed. If the result of the addition is "0000", special auxiliary relay 6306 is turned ON, and if there is a carry in the result, 6304 is turned ON.

In the above program, the 16-bit contents of 0CH (0000 to 0015) are added in units of four BCD digits to the 16-bit contents of the 4-digit constant "1234", including a carry (6304), and the result of the addition is output to the 16-bit channel: LR21CH (LR2100 to LR2115). If there is a carry in the result, 6304 is turned ON, and if the result of the addition is "0000", 6306 is turned ON.



Before executing an ADD instruction, the carry register (6304) must always be cleared using a CLEAR CARRY (CLC) instruction. (Execution of CLC is omitted in multistage addition.)

The CPU checks whether the data for BCD addition are in four BCD digits. If not, an error will occur; this will cause special auxiliary relay 6303 to turn ON and the program to be not executed. The constant can be only specified in BCD.

The only channels that can be indirectly addressed are data memories DM0 to DM511.

If the contents of the indirectly addressed area are other than BCD data or greater than the maximum memory channel, an error will occur; this will cause special auxiliary relay 6303 to turn ON and the program to be not executed. The program shown above is executed when the NO contact of 0100 turns ON.

ADD
DM20
#1234
*DM22

DM20					16 bits
Constant	1	2	3	4	16 bits
DM22	0	2	0	0	16 bits
DM200					16 bits

Because *DM22 is indirectly addressed, the data 200 (decimal) in DM22 specifies DM200, and the result of addition of the contents of DM20 to the 4-digit constant 1234 is output to DM200. For details, refer to Compare instruction.

SUBTRACT (SUB)

FUN F 5 E 4 (subtrahend)(minuend)(result channel)

The SUB instruction is used to execute BCD subtraction between two specified 4-dibit data the CLC instruction is used to clear the carry flag (special auxiliary relay 6304).

Flowchart

0100	SUB
0101	0
0102	LR20
0103	HR21

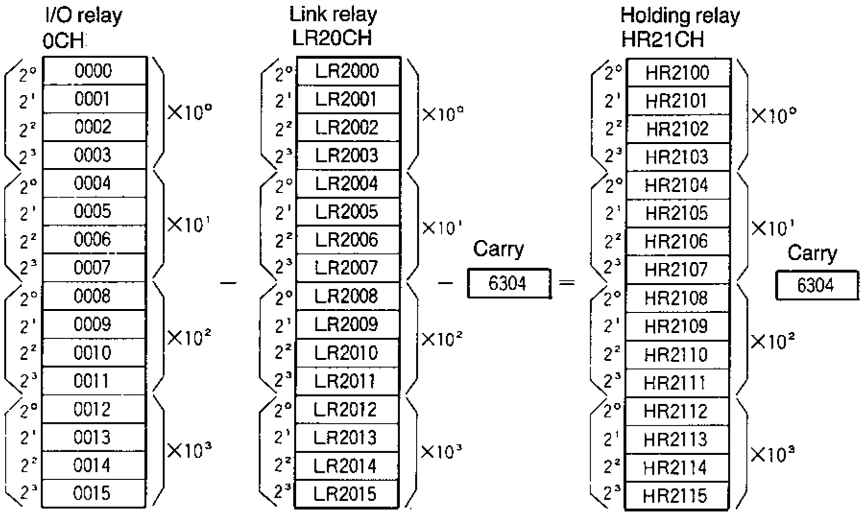
Coding chart

Address	Instruction	Data
0100	SUB(54)	—
0101		0
0102		LR20
0103		HR21

Contents of data

	Subtrahend/ minuend	Result CH
I/O relay, internal auxiliary relay	0 to 63	0 to 60
Link relay	LR0 to 31	
Holding relay	HR0 to 31	
Timer/counter	TIM/CNTO to 127	—
Data memory	DM0 to 511	
Indirectly addressed	*DM0 to 511	
Constant	#0000 to 9999	—

The SUB instruction is used to subtract 4-digit BCD data from another 4-digit BCD data including the carry flag (special auxiliary relay 6304). If the result of the subtraction is 0000, special auxiliary relay 6306 turns ON. If a carry is generated, special auxiliary relay 6304 turns ON. In the above program, the 16-bit contents of LR20CH (LR2000 to 2015) are subtracted from the 16-bit contents of 0CH (0000 to 0015) including the carry. The result of the subtraction is output to HR21CH (HR2100 to 2115). If a carry is generated, 6304 turns ON. If the result of the operation is 0000, 6306 turns ON.



Be sure to clear the carry flag by the Carry Clear (CLC) instruction prior to execution of the SUB instruction. However, clearing the carry flag is not necessary if multiple SUB Instructions are to be executed.

Since the subtract operation is performed using BCD data, the data are checked. If the data are not in BCD, an error occurs causing special auxiliary relay to turn ON and the instruction to be not executed. The constants can be designated by using BCD only.

The only channels that can be indirectly addressed are data memories DM0 to DM511.

If the contents of the indirectly addressed area are other than BCD data or greater than the maximum data memory channel, an error will occur; this will cause special auxiliary relay 6303 to turn ON and the program to be not executed. For details, refer to Compare instruction.

If the carry flag (6304) turns ON as a result of the operation, the data are output as tens complements. To obtain a true complement, subtract the tens complement from 0000.

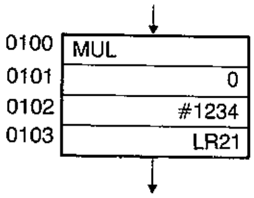
0000 –tens complement = true complement

MULTIPLY (MUL)

FUN 5 5 (multiplier)(multiplicand)(result channel)

The MUL instruction is used to execute BCD multiplication between two special 4-digit BCD data. This instruction uses two channels (16 bits x 2) for the result area of the arithmetic operation.

Flowchart



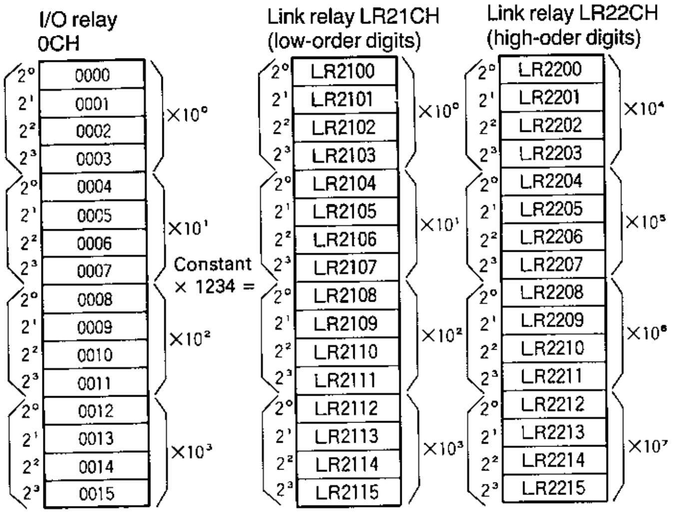
Coding chart

Address	Instruction	Data
0100	MUL(41)	
0101		0
0102		#1234
0103		LR21

Contents of data

	Multiplier/multiplicand	Result CH
I/O relay, internal auxiliary relay	0 to 63	0 to 59
Link relay	LR0 to 31	LR0 to 30
Holding relay	HR0 to 31	HR0 to 30
Timer/counter	TIM/CNT0 to 127	—
Data memory	DM0 to 511	DM0 to 510
Indirectly addressed	*DM0 to 511	*DM0 to 511
Constant	#0000 to 9999	—

When the MUL instruction is executed, multiplication of 4-digit BCD data by 4-digit BCD data is performed. Two channels are required for the result area of the arithmetic operation. In the above program, the 16-bit contents of 0CH (0 to 0015) are multiplied by the 16-bit contents of the 4-digit constant "1234" in units of four BCD digits; the result is output to the two 16-bit channels: LR21CH and LR22CH (LR2100 to LR2215). If the result of the multiplication is "00000000", special auxiliary relay 6306 is turned ON.

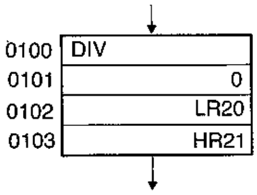


The CPU checks whether the data for BCD multiplication is in four BCD digits. If not, an error will occur; this will cause special auxiliary relay 6303 to turn ON and the program to be not executed.
The only channels that can be indirectly addressed are data memories DM0 to DM511.

If the contents of the indirectly addressed area are other than BCD data or greater than the maximum memory channel, an error will occur; this will cause special auxiliary relay 6303 to turn ON and the program to be not executed. For details, refer to the Compare instruction.

DIVIDE (DIV)

Flowchart



FUN F 5 6 (divisor)(dividend)(result channel)

The DIV instruction is used to execute BCD division between two specified 4-digit BCD data. This instruction uses two channels (16 bits×2) for the result area of the arithmetic operation.

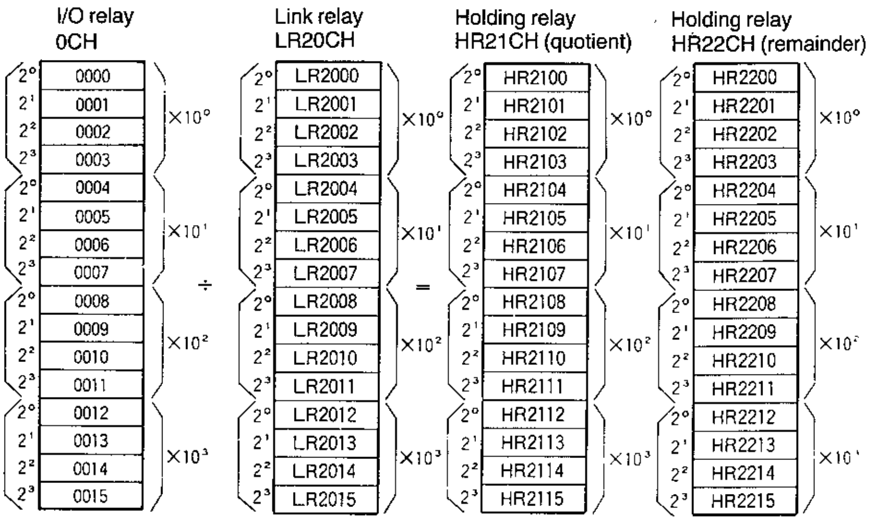
Coding chart

Address	Instruction	Data
0100	DIV(56)	—
0101		0
0102		LR20
0103		HR21

Contents of data

	Divisor/dividend	Result CH
I/O relay, internal auxiliary relay	0 to 63	0 to 59
Link relay	LR0 to 31	LR0 to 30
Holding relay	HR0 to 31	HR0 to 30
Timer/counter	TIM/CNT0 to 127	—
Data memory	DM0 to 511	DM0 to 510
Indirectly addressed	*DM0 to 511	
Constant	#0000 to 9999	—

When the DIV instruction is executed, 4-digit BCD division is performed. Two channels are required for the operation result area. In the above program, the 16-bit contents of 0CH (0 to 15) are divided by the 16-bits of LR20CH (LR2000 to LR2015) in units of four BCD digits, and the result of the division is output to the two 16-bit channels: HR21CH and HR22CH (HR2100 to HR2215). If the result of the division is "0000", special auxiliary relay 6306 is turned ON.



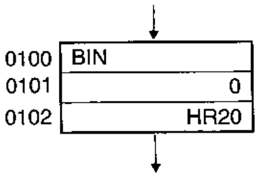
The CPU checks whether the data for BCD division are in four BCD digits. If not, an error will occur; this will cause special auxiliary relay 6303 to turn ON and the program to be not executed.

The only channels that can be indirectly addressed are data memories DM0 to DM511.

If the contents of the indirectly addressed area are other than BCD data or greater than maximum data memory channel, an error will occur; this will cause special auxiliary relay 6303 to turn ON, and the program not to be executed. For details, refer to Compare instruction.

BCD-TO-BIN CONVERSION (BIN)

Flowchart



FUN F 5 7 (channel to be converted)(destination channel)

The BIN instruction is used to convert 4-digit decimal data into 16-bit binary data and to output the converted data to the specified channel. If the converted data is "0000", special auxiliary relay 6306 is turned ON.

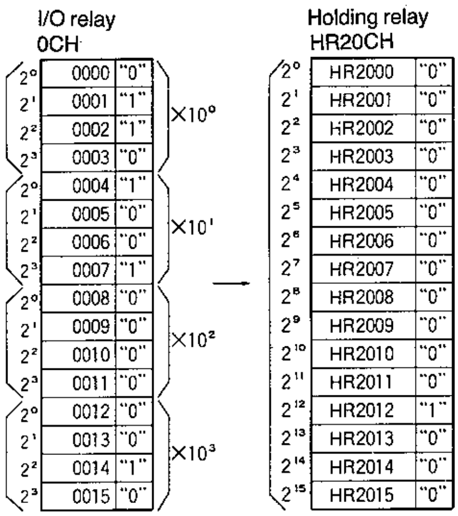
Coding chart

Address	Instruction	Data
0100	BIN(57)	—
0101		0
0102		HR20

Contents of data

	Converted CH	Destination CH
I/O relay, internal auxiliary relay	0 to 63	0 to 60
Link relay	LR0 to 31	
Holding relay	HR0 to 31	
Timer/counter	TIM/CNT0 to 127	—
Data memory	DM0 to 511	
Indirectly addressed	*DM0 to 511	

When the BIN instruction is executed, 4-digit decimal data in the specified channel is converted into 16-bit binary data. In the above program, the 16-bit contents of the 4-digit decimal data in 0CH (0 to 15) are converted into 16-bit binary data, then output to the 16 bits of HR20CH (HR2000 to HR2015).



The result of the conversion will be:

HR20CH = 0 → 6306 = 1
HR20CH ≠ 0 → 6306 = 0

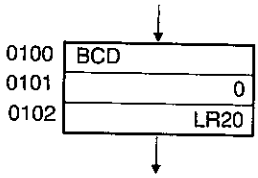
The CPU will check whether the data to be converted is in four-digit BCD. If not, an error will occur; this will cause special auxiliary relay 6303 to turn ON and the program to be not executed.

The only channels that can be indirectly addressed are data memories DM0 to DM511.

If the contents of the indirectly addressed area are greater than maximum data memory channel, an error will occur; this will cause special auxiliary relay 6303 to turn ON, and the program will not be executed. For details, refer to Compare instruction.

BIN-TO-BCD CONVERSION (BCD)

Flowchart



FUN | F 5 | 8 (channel to be converted)(destination channel)

The BCD instruction is used to convert 16-bit binary data into 4-digit decimal data and to output the converted data to the specified channel. When the converted data is "0000", special auxiliary relay 6306 (=) is turned ON.

Coding chart

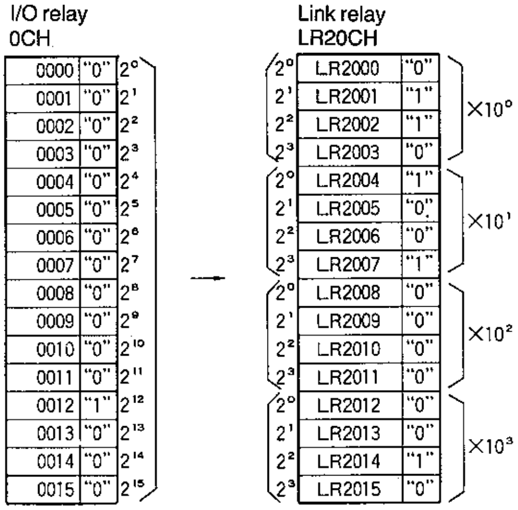
Address	Instruction	Data
0100	BCD(58)	—
0101		0
0102		LR20

Contents of data

	Converted CH	Destination CH
I/O relay, internal auxiliary relay	0 to 63	0 to 60
Link relay	LR0 to 31	
Holding relay	HR0 to 31	
Data memory	DM0 to 511	
Indirectly addressed	*DM0 to 511	

When the BCD instruction is executed, 16-bit binary data in the specified I/O channel is converted into 4-digit decimal data.

In the above program, the 16-bit binary data in 0CH (0 to 15) is converted into 4-digit decimal data and then output to the 16 bits of LR20CH (LR2000 to 2015).



I/O relay
0CH

0000	"0"	2^0
0001	"0"	2^1
0002	"0"	2^2
0003	"0"	2^3
0004	"0"	2^4
0005	"0"	2^5
0006	"0"	2^6
0007	"0"	2^7
0008	"0"	2^8
0009	"0"	2^9
0010	"0"	2^{10}
0011	"0"	2^{11}
0012	"1"	2^{12}
0013	"0"	2^{13}
0014	"0"	2^{14}
0015	"0"	2^{15}

→

Link relay
LR20CH

2^0	LR2000	"0"	×10°
2^1	LR2001	"1"	
2^2	LR2002	"1"	
2^3	LR2003	"0"	
2^0	LR2004	"1"	×10¹
2^1	LR2005	"0"	
2^2	LR2006	"0"	
2^3	LR2007	"1"	
2^0	LR2008	"0"	×10²
2^1	LR2009	"0"	
2^2	LR2010	"0"	
2^3	LR2011	"0"	
2^0	LR2012	"0"	×10³
2^1	LR2013	"0"	
2^2	LR2014	"1"	
2^3	LR2015	"0"	

The result of the conversion will be:

LR20CH = 0 → 6306 = 1
LR20CH ≠ 0 → 6306 = 0

If the converted decimal data exceeds 9999, an error will occur; this will cause special auxiliary relay 6303 to turn ON and the program to be not executed.

The only channels that can be indirectly addressed are data memories DM0 to DM511.

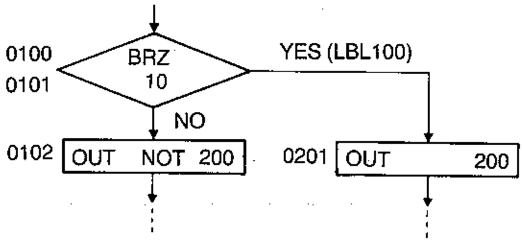
If the contents of the indirectly addressed area are other than BCD data or greater than maximum data memory channel, an error will occur; this will cause special auxiliary relay 6303 to turn ON and the program to be not executed. For details, refer to Compare instruction.

ZERO JUDGE (BRZ)

FUN F 5 9 (label no.)(channel)

These instructions cause the CPU to judge whether the contents of the specified channel are "0". If so, the program execution jumps to the destination specified by a label.

Flowchart



Coding chart

Address	Instruction	Data
0100	BRZ(59)	100
0101		10
0102	OUT NOT	200
⋮	⋮	⋮
0200	LBL	100
0201	OUT	200

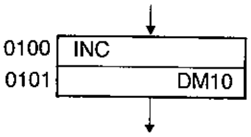
Contents of data

I/O relay, internal auxiliary relay	0 to 63
Link relay	LR0 to 31
Holding relay	HR0 to 31
Data memory	DM0 to 511

When the BRZ instruction is executed, the CPU judges whether the contents of the specified channel are 0. If so, the program execution jumps to the destination specified by a label; if not, it proceeds to the next step.

If the specified label number is not found in the program, special auxiliary relay 6303 is turned ON, causing all the output relays to turn OFF and the CPU to halt.

INCREMENT (INC)



FUN 6 $\overset{A}{0}$ (channel number)

The INC instruction is used to increment 4-digit BCD data by one.

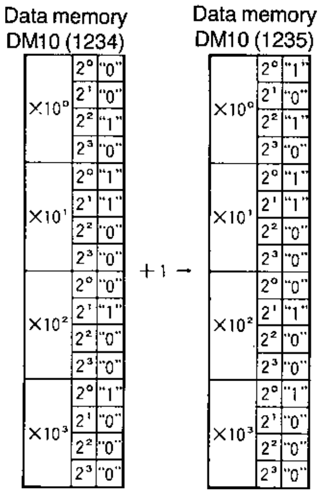
Coding chart

Address	Instruction	Data
0100	INC(60)	—
0101		DM10
⋮	⋮	⋮

Contents of data

I/O relay, internal auxiliary relay	0 to 60
Link relay	LR0 to 31
Holding relay	HR0 to 31
Data memory	DM0 to 511
Indirectly addressed data	*DM0 to 511

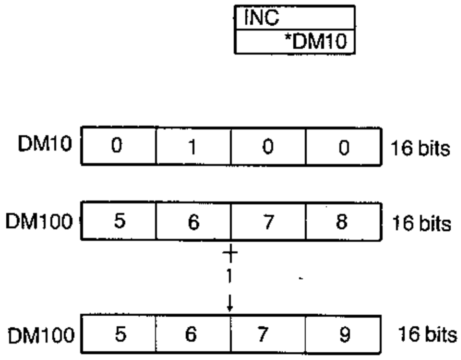
When the INC instruction is executed, the specified 4-digit BCD data is incremented by one. In the above program, the 16-bit contents of DM10 are incremented by one, and the result of the increment operation is stored in DM10. If the result of the operation is "0000", special auxiliary relay 6306 is turned ON.



The CPU checks whether the data to be incremented is 4-digit BCD. If not, an error will occur; this will cause special auxiliary relay 6303 to turn ON and the program to be not executed.

The only channels that can be indirectly addressed are data memories DM0 to DM511.

If the contents of the indirectly addressed area are other than BCD data or greater than maximum data memory channel, an error will occur; this will cause special auxiliary relay 6303 to turn ON and the program to be not executed. For details, refer to Compare instruction.



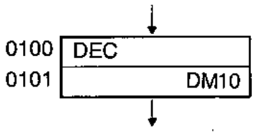
Because *DM10 is indirectly addressed, data 100 in DM10 specifies DM100, and the 16-bit contents of DM100 (5678) are incremented by one. The result of the increment operation (5679) is stored in DM100. For details, refer to Compare instruction.

DECREMENT (DEC)

FUN 6 B 1 (channel number)

The DEC instruction is used to decrement 4-digit BCD data by one.

Flowchart



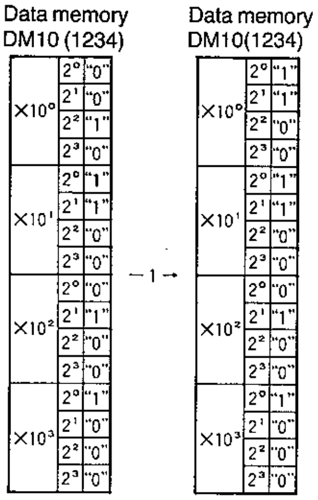
Coding chart

Address	Instruction	Data
0100	DEC(61)	—
0101		DM10

Contents of data

I/O relay, internal auxiliary relay	0 to 60
Link relay	LR0 to 31
Holding relay	HR0 to 31
Data memory	DM0 to 511
Indirectly addressed data	*DM0 to 511

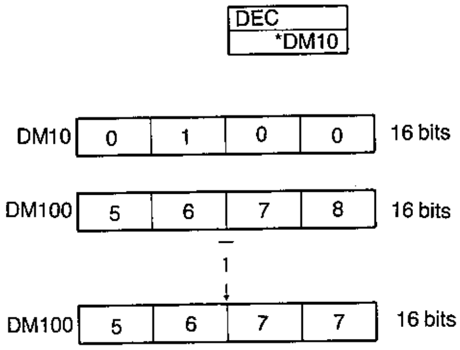
When the DEC instruction is executed, the specified 4-digit BCD data is decremented by one. In the above program, the 16-bit contents of DM10 are decremented by one, and the result of the decrement operation is stored in DM10. If the result of the operation is "0000", special auxiliary relay 6306 is turned ON.



The CPU checks whether the data to be decremented is 4-digit BCD. If not, an error will occur; this will cause special auxiliary relay 6303 to turn ON and the program to be not executed.

The only channels that can be indirectly addressed are data memories DM0 to DM511.

If the contents of the indirectly addressed area are other than BCD data or greater than maximum data memory channel, an error will occur; this will cause special auxiliary relay 6303 to turn ON and the program to be not executed.

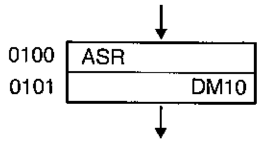


Because *DM10 is indirectly addressed, data 100 in DM10 specifies DM100, and the 16-bit contents of DM100 (5678) are decremented by one. The result of the decrement operation (5677) is stored in DM100. For details, refer to Compare instruction.

ARITHMETIC SHIFT RIGHT (ASR)

FUN 6 C 2 (channel number)

Flowchart



The ASR instruction is used to shift 16-bit data one bit to the right with carry. The ASR instruction requires two addresses for programming.

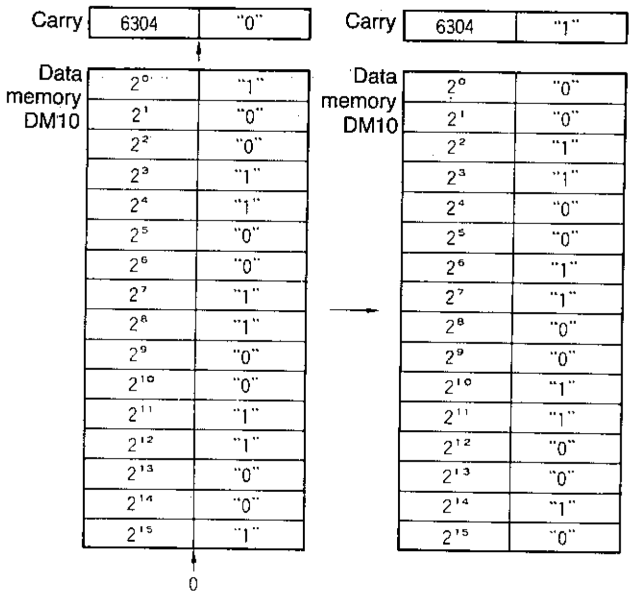
Coding chart

Address	Instruction	Data
0100	ASR(62)	—
0101		DM10

Contents of data

I/O relay, internal auxiliary relay	0 to 60
Link relay	LR0 to 31
Holding relay	HR0 to 31
Data memory	DM0 to 511
Indirectly addressed data	*DM0 to 511

When the ASR instruction is executed, 16-bit data is shifted one bit to the right with carry. In the above program all the 16-bit contents of DM10 are shifted one bit to the right with carry (6304). If the result of the operation is "0000", special auxiliary relay 6306 is turned ON.



Carry

6304	"0"

Data memory DM10

2^0	"1"
2^1	"0"
2^2	"0"
2^3	"1"
2^4	"1"
2^5	"0"
2^6	"0"
2^7	"1"
2^8	"1"
2^9	"0"
2^{10}	"0"
2^{11}	"1"
2^{12}	"1"
2^{13}	"0"
2^{14}	"0"
2^{15}	"1"

Carry

6304	"1"

Data memory DM10

2^0	"0"
2^1	"0"
2^2	"1"
2^3	"1"
2^4	"0"
2^5	"0"
2^6	"1"
2^7	"1"
2^8	"0"
2^9	"0"
2^{10}	"1"
2^{11}	"1"
2^{12}	"0"
2^{13}	"0"
2^{14}	"1"
2^{15}	"0"

The only channels that can be indirectly addressed are data memories DM0 to DM511.

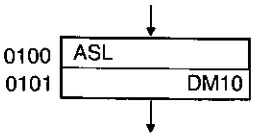
If the contents of the indirectly addressed area are other than BCD data or greater than the maximum data memory channel, an error will occur; this will cause special auxiliary relay 6303 to turn ON and the program to be not executed. For details, refer to Compare instruction.

ARITHMETIC SHIFT LEFT (ASL)

FUN 6 D 3 (channel data)

The ASL instruction is used to shift 16-bit data one bit to the left with carry. The ASL instruction requires two addresses for programming.

Flowchart



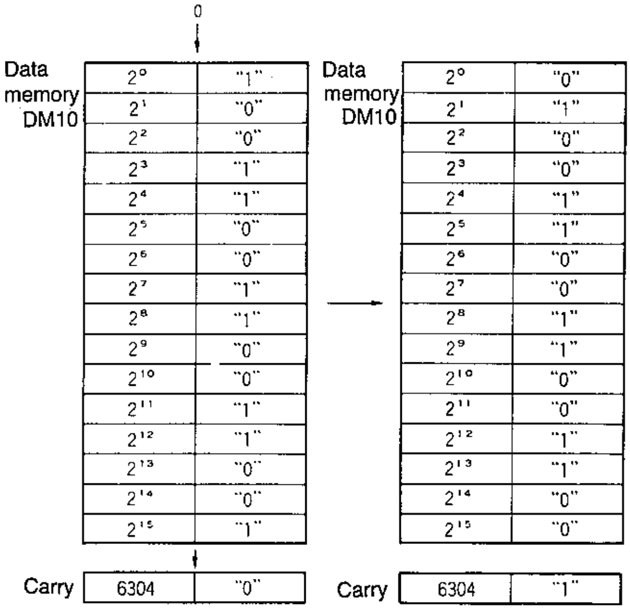
Coding chart

Address	Instruction	Data
0100	ASL(63)	—
0101		DM10
⋮	⋮	⋮

Contents of data

I/O relay, internal auxiliary relay	0 to 60
Link relay	LR0 to 31
Holding relay	HR0 to 31
Data memory	DM0 to 511
Indirectly addressed data	*DM0 to 511

When the ASL instruction is executed, 16-bit data is shifted one bit to the left with carry. In the above program, all the 16-bit contents of DM010 are shifted one bit to the left with carry (6304). If the result of the operation is "0000", special auxiliary relay 6306 is turned ON.



2^0	"1"
2^1	"0"
2^2	"0"
2^3	"1"
2^4	"1"
2^5	"0"
2^6	"0"
2^7	"1"
2^8	"1"
2^9	"0"
2^{10}	"0"
2^{11}	"1"
2^{12}	"1"
2^{13}	"0"
2^{14}	"0"
2^{15}	"1"
6304	"0"

2^0	"0"
2^1	"1"
2^2	"0"
2^3	"0"
2^4	"1"
2^5	"1"
2^6	"0"
2^7	"0"
2^8	"1"
2^9	"1"
2^{10}	"0"
2^{11}	"0"
2^{12}	"1"
2^{13}	"1"
2^{14}	"0"
2^{15}	"0"
6304	"1"

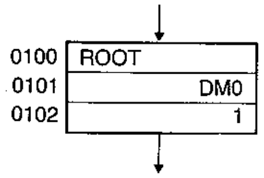
The only channels that can be indirectly addressed are data memories DM0 to DM511.

If the contents of the indirectly addressed area are other than BCD data or greater than the maximum data memory channel, an error will occur; this will cause special auxiliary relay 6303 to turn ON and the program to be not executed. For details, refer to Compare instruction.

SQUARE ROOT (ROOT)

FUN 6 E 4 (channel number)(result channel)

Flowchart



The ROOT instruction is used to compute the square root of an 8-digit BCD data. This instruction requires two channels (16 bits×2) as the arithmetic operation area.

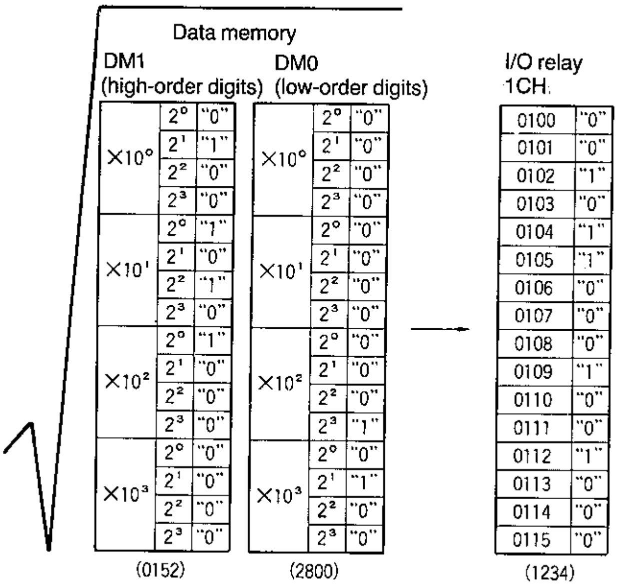
Coding chart

Address	Instruction	Data
0100	ROOT(64)	—
0101		DM 0
0102		1

Contents of data

	Converted CH	Destination CH
I/O relay, internal auxiliary relay	0 to 62	0 to 60
Link relay	LR0 to 30	LR0 to 31
Holding relay	HR0 to 30	HR0 to 31
Timer/counter	TIM to 127	—
Data memory	DM0 to 510	DM0 to 511
Indirectly addressed	*DM0 to 511	

When the ROOT instruction is executed, the square root of a BCD 8-digit integer is computed. In the above program, the square root of BCD data (16 bits×2) in DM0 and DM1 is computed, and the result (4-digit BCD integer) is output to 01CH (16 bits). If the result is 0000, special auxiliary relay 6306 turns ON. Only a 4-digit integer is output as a result data, and a fraction is rounded off at the decimal point.



The only channels that can be indirectly addressed are data memories DM0 to DM511.

If the contents of the indirectly addressed area are other than BCD data or greater than the maximum data memory channel, an error will occur; this will cause special auxiliary relay 6303 to turn ON and the program to be not executed. The CPU checks whether the data to be computed is 4-digit BCD. If not, an error will occur; this will cause special auxiliary relay 6303 to turn ON and the program to be not executed. For details, refer to Compare instruction.

AND WORD (ANDW)

FUN 6 F 5 (data 1)(data 2)(result channel)

The ANDW instruction is used to perform a logical AND operation between two specified data (16 bits each).

Flowchart

0100	ANDW
0101	0
0102	LR11
0103	DM12

Coding chart

Address	Instruction	Data
0100	ANDW(65)	—
0101		0
0102		LR11
0103		DM12

Contents of data

	Data 1 and 2	Result CH
I/O relay, internal auxiliary relay	0 to 63	0 to 60
Link relay	LR0 to 31	
Holding relay	HR0 to 31	
Timer/counter	TIM/CNT0 to 127	—
Data memory	DM0 to 511	
Indirectly addressed	*DM0 to 511	
Constant	#0000 to 9999	—

When the ANDW instruction is executed, a logical AND operation is performed between two 16-bit data. In the above program, the 16-bit contents of 0CH are ANDed with the 16-bit contents of LR11, and the result of the AND operation is stored in DM12. If the result of the operation is "0000", special auxiliary relay 6306 is turned ON.

I/O relay
0CH

0000	2^0	"1"
0001	2^1	"0"
0002	2^2	"0"
0003	2^3	"1"
0004	2^4	"1"
0005	2^5	"0"
0006	2^6	"0"
0007	2^7	"1"
0008	2^8	"1"
0009	2^9	"0"
0010	2^{10}	"0"
0011	2^{11}	"1"
0012	2^{12}	"1"
0013	2^{13}	"0"
0014	2^{14}	"0"
0015	2^{15}	"1"

Link relay
LR11CH

2^0	"1"
2^1	"0"
2^2	"1"
2^3	"0"
2^4	"1"
2^5	"0"
2^6	"1"
2^7	"0"
2^8	"1"
2^9	"0"
2^{10}	"1"
2^{11}	"0"
2^{12}	"1"
2^{13}	"0"
2^{14}	"1"
2^{15}	"0

Data memory
DM12

2^0	"1"
2^1	"0"
2^2	"0"
2^3	"0"
2^4	"1"
2^5	"0"
2^6	"0"
2^7	"0"
2^8	"1"
2^9	"0"
2^{10}	"0"
2^{11}	"0"
2^{12}	"1"
2^{13}	"0"
2^{14}	"0"
2^{15}	"0"

The only channels that can be indirectly addressed are data memories DM0 to DM511.

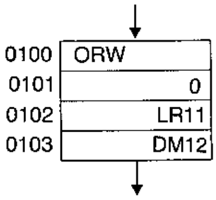
If the contents of the indirectly addressed area are other than BCD data or greater than the maximum data memory channel, an error will occur; this will cause special auxiliary relay 6303 to turn ON and the program to be not executed. For details, refer to Compare instruction.

OR WORD (ORW)

FUN 6 6 (data1)(data2)(result channel)

The ORW instruction is used to perform a logical OR operation between two specified data (16 bits each).

Flowchart



Coding chart

Address	Instruction	Data
0100	ORW(66)	—
0101		LR11
0102		DM12

Contents of data

	Data 1 and 2	Result CH
I/O relay, internal auxiliary relay	0 to 63	0 to 60
Link relay	LR0 to 31	
Holding relay	HR0 to 31	
Timer/counter	TIM/CNT0 to 127	—
Data memory	DM0 to 511	
Indirectly addressed	*DM0 to 511	
Constant	#0000 to FFFF	—

When the ORW instruction is executed, a logical OR operation is performed between two 16-bit data. In the above program, the 16-bit contents of 00CH are ORed with the 16-bit contents of LR11, and the result of the OR operation is stored in DM12. If the result of the operation is "0000", special auxiliary relay 6306 is turned ON.

I/O relay
0CH

0000	2^0	"1"
0001	2^1	"0"
0002	2^2	"0"
0003	2^3	"1"
0004	2^4	"1"
0005	2^5	"0"
0006	2^6	"0"
0007	2^7	"1".
0008	2^8	"1"
0009	2^9	"0"
0010	2^{10}	"0"
0011	2^{11}	"1"
0012	2^{12}	"1"
0013	2^{13}	"0"
0014	2^{14}	"0"
0015	2^{15}	"1"

Link relay
LR11CH

2^0	"1"
2^1	"0"
2^2	"1"
2^3	"0"
2^4	"1"
2^5	"0"
2^6	"1"
2^7	"0"
2^8	"1"
2^9	"0"
2^{10}	"1"
2^{11}	"0"
2^{12}	"1"
2^{13}	"0"
2^{14}	"1"
2^{15}	"0

Data memory
DM12

2^0	"1"
2^1	"0"
2^2	"1"
2^3	"1"
2^4	"1"
2^5	"0"
2^6	"1"
2^7	"1"
2^8	"1"
2^9	"0"
2^{10}	"1"
2^{11}	"1"
2^{12}	"1"
2^{13}	"0"
2^{14}	"1"
2^{15}	"1"

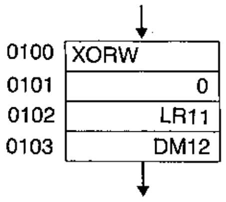
The only channels that can be indirectly addressed are data memories DM000 to DM511.

If the contents of the indirectly addressed area are other than BCD data or greater than the maximum data memory channel, an error will occur; this will cause special auxiliary relay 6303 to turn ON and the program to be not executed. For details, refer to Comparison of indirectly addressed data in 3.20, Compare instruction. The constant can be specified as 4-digit hexadecimal (binary 16-bit) data.

EXCLUSIVE OR WORD (XORW)

FUN 6 7 (data 1)(data 2)(result CH)

Flowchart



The XORW instruction is used to perform an exclusive logical OR operation between two specified data (16 bits each).

Coding chart

Address	Instruction	Data
0100	XORW (67)	—
0101		0
0102		LR11
0103	AND	DM12

Contents of data

	Data 1 and 2	Result CH
I/O relay, internal auxiliary relay	0 to 63	0 to 60
Link relay	LR0 to 31	
Holding relay	HR0 to 31	
Timer/counter	TIM/CNT0 to 127	—
Data memory	DM0 to 511	
Indirectly addressed data	*DM0 to 511	
Constant	#0000 to FFFF	—

When the XORW instruction is executed, an exclusive logical OR operation is performed between two 16-bit data. In the above program, the 16-bit contents of 0CH are exclusively ORed with the 16-bit contents of LR11, and the result of the OR operation is stored in DM12. If the result of the operation is “0000”, special auxiliary relay 6306 is turned ON.

I/O relay 0CH			Link relay LR11CH		Data memory DM12	
0000	2^{0}	“1”	2^{0}	“1”	2^{0}	“0”
0001	2^{1}	“0”	2^{1}	“0”	2^{1}	“0”
0002	2^{2}	“0”	2^{2}	“1”	2^{2}	“1”
0003	2^{3}	“1”	2^{3}	“0”	2^{3}	“1”
0004	2^{4}	“1”	2^{4}	“1”	2^{4}	“0”
0005	2^{5}	“0”	2^{5}	“0”	2^{5}	“0”
0006	2^{6}	“0”	2^{6}	“1”	2^{6}	“1”
0007	2^{7}	“1”	2^{7}	“0”	2^{7}	“1”
0008	2^{8}	“1”	2^{8}	“1”	2^{8}	“0”
0009	2^{9}	“0”	2^{9}	“0”	2^{9}	“0”
0010	2^{10}	“0”	2^{10}	“1”	2^{10}	“1”
0011	2^{11}	“1”	2^{11}	“0”	2^{11}	“1”
0012	2^{12}	“1”	2^{12}	“1”	2^{12}	“0”
0013	2^{13}	“0”	2^{13}	“0”	2^{13}	“0”
0014	2^{14}	“0”	2^{14}	“1”	2^{14}	“1”
0015	2^{15}	“1”	2^{15}	“0	2^{15}	“1”

The only channels that can be indirectly addressed are data memories DM0 to DM511.

If the contents of the indirectly addressed area are other than BCD data or greater than the maximum data memory channel, an error will occur; this will cause special auxiliary relay 6303 to turn ON and the program to be not executed. For details, refer to Compare instruction.

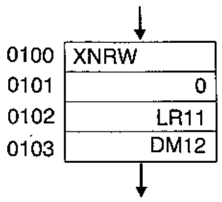
The constant can be specified as hexadecimal 4-digit (binary 16-bit) data.

EXCLUSIVE OR NOT WORD (XNRW)

FUN 6 8 (data 1)(data 2)(result channel)

The XNRW instruction is to perform an exclusive logical OR NOT operation between two specified data (16 bits each).

Flowchart



Coding chart

Address	Instruction	Data
0100	XNRW (68)	—
0101		0
0102		LR11
0103		DM12

Contents of data

	Data 1 and 2	Result CH
I/O relay, internal auxiliary relay	0 to 63	0 to 60
Link relay	LR0 to 31	
Holding relay	HR0 to 31	
Timer/counter	TIM/CNT0 to 127	—
Data memory	DM0 to 511	
Indirectly addressed data	*DM0 to 511	
Constant	#0000 to FFFF	—

When the XNRW instruction is executed, an exclusive logical OR NOT operation is performed between two 16-bit data.

In the above program, the 16-bit contents of 0CH are exclusively ORed with the 16-bit contents of LR11, and the result of the OR operation is inverted and then stored in DM12. If the result of the operation is "0000", special auxiliary relay 6306 is turned ON.

I/O relay
0CH

0000	2^0	"1"
0001	2^1	"0"
0002	2^2	"0"
0003	2^3	"1"
0004	2^4	"1"
0005	2^5	"0"
0006	2^6	"0"
0007	2^7	"1"
0008	2^8	"1"
0009	2^9	"0"
0010	2^{10}	"0"
0011	2^{11}	"1"
0012	2^{12}	"1"
0013	2^{13}	"0"
0014	2^{14}	"0"
0015	2^{15}	"1"

Link relay
LR11CH

2^0	"1"
2^1	"0"
2^2	"1"
2^3	"0"
2^4	"1"
2^5	"0"
2^6	"1"
2^7	"0"
2^8	"1"
2^9	"0"
2^{10}	"1"
2^{11}	"0"
2^{12}	"1"
2^{13}	"0"
2^{14}	"1"
2^{15}	"0

Data memory
DM12

2^0	"1"
2^1	"1"
2^2	"0"
2^3	"0"
2^4	"1"
2^5	"1"
2^6	"0"
2^7	"0"
2^8	"1"
2^9	"1"
2^{10}	"0"
2^{11}	"0"
2^{12}	"1"
2^{13}	"1"
2^{14}	"0"
2^{15}	"0"

The only channels that can be indirectly addressed are data memories DM0 to DM511.

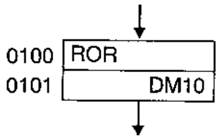
If the contents of the indirectly addressed area are other than BCD data or greater than the maximum data memory channel, an error will occur; this will cause special auxiliary relay 6306 to turn ON and the program to be not executed. For details, refer to Compare instruction.

The constant can be specified as hexadecimal 4-digit (binary 16-bit) data.

ROTATE RIGHT (ROR)

FUN 6 9 (channel number)

Flowchart



The ROR instruction is used to rotate 16-bit data one bit with carry. The ROR instruction requires two addresses for programming.

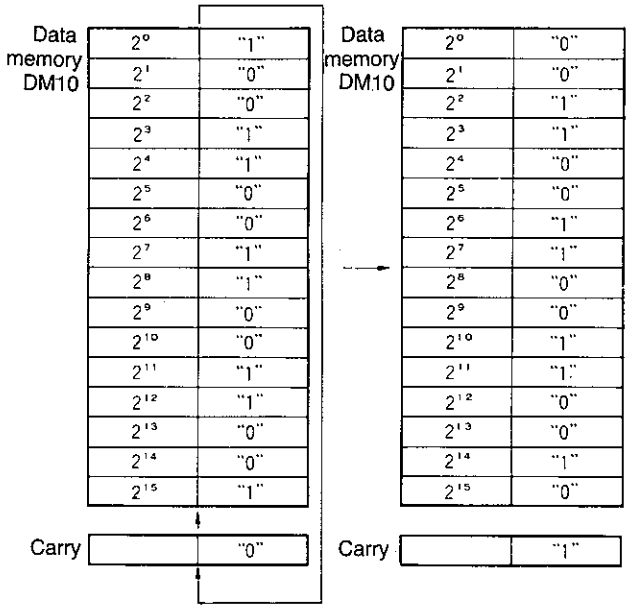
Coding chart

Address	Instruction	Data
0100	ROR (69)	—
0101		DM10
⋮	⋮	⋮

Contents of data

I/O relay, internal auxiliary relay	0 to 63
Link relay	LR0 to 31
Holding relay	HR0 to 31
Data memory	DM0 to 511
Indirectly addressed data	*DM0 to 511

When the ROR instruction is executed, 16-bit data, including a carry, is rotated one bit to the right with carry. In the above program, all the 16-bit contents of DM10 are rotated one bit to the right with carry (6304). If the result of the operation is "0000", special auxiliary relay 6306 is turned ON.

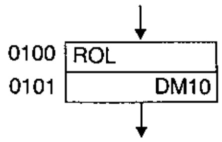


The only channels that can be indirectly addressed are data memories DM0 to DM511.

If the contents of the indirectly addressed area are other than BCD data or greater than the maximum data memory channel, an error will occur; this will cause special auxiliary relay 6303 to turn ON and the program to be not executed. For details, refer to Compare instruction.

ROTATE LEFT (ROL)

Flowchart



FUN 7 A 0 (channel number)

The ROL instruction is used to rotate 16-bit data one bit with carry. The ROL instruction requires two addresses for programming.

Coding chart

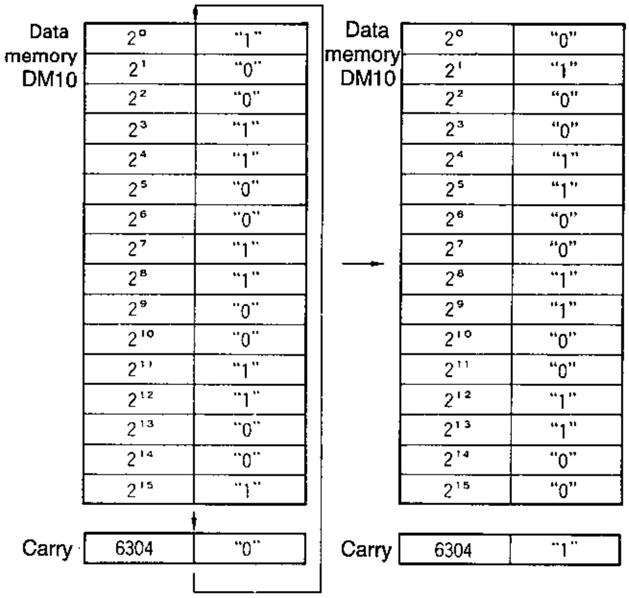
Address	Instruction	Data
0100	ROL (70)	—
0101		DM10

Contents of data

I/O relay, internal auxiliary relay	0 to 60
Link relay	LR0 to 31
Holding relay	HR0 to 31
Data memory	DM0 to 511
Indirectly addressed data	*DM0 to 511

When the ROL instruction is executed, 16-bit data is rotated one bit to the left with carry.

In the above program, all the 16-bit contents of DM10 are rotated one bit to the left with carry (6304). If the result of the operation is "0000", special auxiliary relay 6306 is turned ON.



Data memory DM10		
	2^0	"1"
	2^1	"0"
	2^2	"0"
	2^3	"1"
	2^4	"1"
	2^5	"0"
	2^6	"0"
	2^7	"1"
	2^8	"1"
	2^9	"0"
	2^{10}	"0"
	2^{11}	"1"
	2^{12}	"1"
	2^{13}	"0"
	2^{14}	"0"
	2^{15}	"1"
Carry	6304	"0"

Data memory DM10		
	2^0	"0"
	2^1	"1"
	2^2	"0"
	2^3	"0"
	2^4	"1"
	2^5	"1"
	2^6	"0"
	2^7	"0"
	2^8	"1"
	2^9	"1"
	2^{10}	"0"
	2^{11}	"0"
	2^{12}	"1"
	2^{13}	"1"
	2^{14}	"0"
	2^{15}	"0"
Carry	6304	"1"

The only channels that can be indirectly addressed are data memories DM0 to DM511.

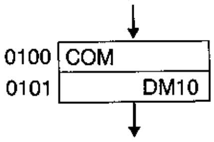
If the contents of the indirectly addressed area are other than BCD data or greater than the maximum data memory channel, an error will occur; this will cause special auxiliary relay 6303 to turn ON and the program to be not executed. For details, refer to Compare instruction.

COMPLEMENT (COM)

FUN 7 B 1 (channel number)

The COM instruction is used to invert 16-bit data. The COM instruction requires two addresses for programming.

Flowchart



Coding chart

Address	Instruction	Data
0100	CMP (71)	—
0101		DM10
⋮	⋮	⋮

Contents of data

I/O relay, internal auxiliary relay	0 to 60
Link relay	LR0 to 31
Holding relay	HR0 to 31
Data memory	DM0 to 511
Indirectly addressed data	*DM0 to 511

When the COM instruction is executed, the 16-bit data in the specified data memory is inverted. In the above program, the 16-bit contents of DM10 are inverted, and the result of the COMPLEMENT operation is stored in DM10. If the result of the operation is "0000", 6306 is turned ON.

Data memory DM10

2^0	"1"
2^1	"0"
2^2	"0"
2^3	"1"
2^4	"1"
2^5	"0"
2^6	"0"
2^7	"1"
2^8	"1"
2^9	"0"
2^{10}	"0"
2^{11}	"1"
2^{12}	"1"
2^{13}	"0"
2^{14}	"0"
2^{15}	"1"

→

Data memory DM10

2^0	"0"
2^1	"1"
2^2	"1"
2^3	"0"
2^4	"0"
2^5	"1"
2^6	"1"
2^7	"0"
2^8	"0"
2^9	"1"
2^{10}	"1"
2^{11}	"0"
2^{12}	"0"
2^{13}	"1"
2^{14}	"1"
2^{15}	"0"

The only channels that can be indirectly addressed are data memories DM0 to DM511.

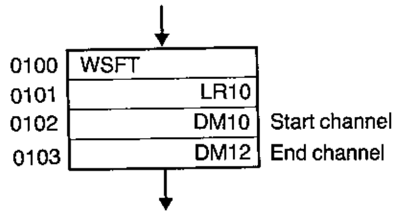
If the contents of the indirectly addressed area are other than BCD data or greater than the maximum data memory channel, an error will occur; this will cause special auxiliary relay 6303 to turn ON and the program to be not executed. For details, refer to Compare instruction.

WORD SHIFT (WSFT)

FUN | 9 | E 4 (data channel)(start channel)(end channel)

The WSFT instruction is used to shift data between the start and end channels in units of 16 bits.

Flowchart



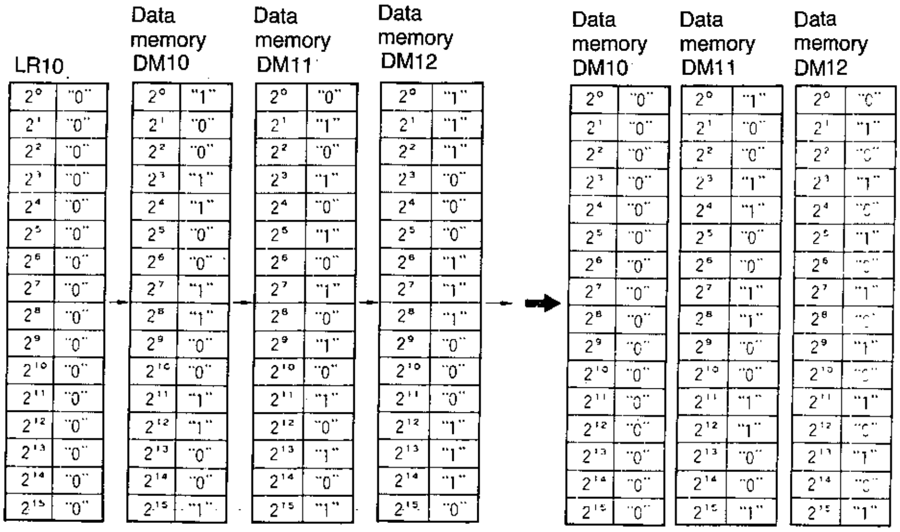
Coding chart

Address	Instruction	Data
0100	WSFT (94)	
0101		LR10
0102		DM10
0103		DM12

Contents of data

I/O relay, internal auxiliary relay	0 to 63
Link relay	LR0 to 31
Holding relay	HR0 to 31
Data memory	DM0 to 511
Indirectly addressed data	*DM0 to 511

When the WSFT instruction is executed, the data between the start and the end channels are shifted in units of 16 bits. In the above program, the 16-bit contents of DM10 to DM12 are shifted in units of 16 bits, and the contents of LR10 is input to the start channel.



	LR10	Data memory DM10	Data memory DM11	Data memory DM12	Data memory DM10	Data memory DM11	Data memory DM12
2^0	"0"	"1"	"0"	"1"	"0"	"1"	"0"
2^1	"0"	"0"	"1"	"1"	"0"	"0"	"1"
2^2	"0"	"0"	"0"	"1"	"0"	"0"	"0"
2^3	"0"	"1"	"1"	"0"	"0"	"1"	"1"
2^4	"0"	"1"	"0"	"0"	"0"	"1"	"0"
2^5	"0"	"0"	"1"	"0"	"0"	"0"	"1"
2^6	"0"	"0"	"0"	"1"	"0"	"0"	"0"
2^7	"0"	"1"	"1"	"1"	"0"	"1"	"1"
2^8	"0"	"1"	"0"	"1"	"0"	"1"	"0"
2^9	"0"	"0"	"1"	"0"	"0"	"0"	"1"
2^{10}	"0"	"0"	"0"	"0"	"0"	"0"	"0"
2^{11}	"0"	"1"	"1"	"0"	"0"	"1"	"1"
2^{12}	"0"	"1"	"0"	"1"	"0"	"1"	"0"
2^{13}	"0"	"0"	"1"	"1"	"0"	"0"	"1"
2^{14}	"0"	"0"	"0"	"1"	"0"	"0"	"0"
2^{15}	"0"	"1"	"1"	"0"	"0"	"1"	"1"

The data for the WSFT instruction contain a start channel number and an end channel number by which the range of word shifting can be specified. The start channel must be less than or equal to the end channel, and both the channel numbers must be within the same data area. Note that a WSFT instruction cannot be programmed, and special auxiliary relay 6303 turns ON if this condition is not satisfied.

The only channels that can be indirectly addressed are data memories DM0 to DM511.

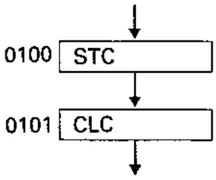
Use the data memory area for start and end channels when addressing relays indirectly. If the contents of the indirectly addressed area are not in BCD, if the abovementioned condition is not satisfied, or if a data memory number greater than the maximum data memory channel is addressed, an error will occur, causing special auxiliary relay 6303 to turn ON and the program to be not executed. For details, refer to Compare instruction.

SET CARRY (STC)/CLEAR CARRY (CLC)

FUN 9 5 [STC]

FUN 9 6 [CLC]

Flowchart



The STC instruction is used to set the carry flag (special auxiliary relay (6304) to 1, and the CLC instruction is used to reset the carry flag to 0.

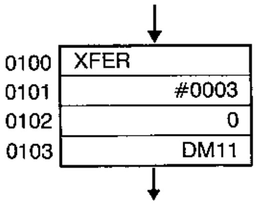
Coding chart

Address	Instruction	Data
0100	STC (95)	—
0101	CLC (96)	—

BLOCK MOVE (XFER)

FUN 7 2 (W)(S)(D)

Flowchart



where,
W: number of channels (words)
S: data transfer start channel number
D: destination channel start number

The XFER instruction is used to transfer channel data consecutively at one time.

Coding chart

Address	Instruction	Data
0100	XFER (72)	—
0101		#0003
0102		0
0103		DM11

Contents of data

	W	S	D
I/O relay, internal auxiliary relay	—	0 to 63	0 to 60
Link relay	—	LR0 to 31	
Holding relay	—	HR0 to 31	
Timer/counter	—	TIM/CNT0 to 127	
Data memory	—	DM0 to 511	
Indirectly addressed data	—	*DM0 to 511	
Constant	#0000 to 4095	—	

When the XFER instruction is executed, channel data are consecutively transferred at one time.

In the above program, data of 3 channels (48 bits), 0CH to 2CH (0 to 215), are consecutively transferred to DM11 to 13 by channel unit.

	I/O relay			Data memory
0CH	1 2 3 4	→	DM11	1 2 3 4
1CH	0 0 0 0	→	DM12	0 0 0 0
2CH	F F F F	→	DM13	F F F F

The transfer operation is consecutively executed from the start channel to a specified channel.

Note: Be sure not to specify the same block in duplicate, though both the channel from which data is to be transferred and the destination channel can be specified within the same area.

The only channels that can be indirectly addressed are data memories DM0 to DM511.

If the contents of the indirectly addressed area are other than BCD or greater than the maximum data memory channel, an error will occur, causing special auxiliary relay 6303 to turn ON and the program to be not executed. For details, refer to Compare instruction.

The data for the Block Move instruction that must be specified are the start channels of the source and destination of the transfer operation and the number of channels to be transferred. Any number of channels within the limitation of the hardware can be specified for transference, and the data must satisfy these conditions.

- Only BCD data are acceptable when specifying the number of channels.
- Block area must be within the same data area. (Start channel number + Number of channels − 1 ≤ Maximum channel number of data channel area).

BLOCK SET (BSET)

FUN 7 D 3 (S)(D1)(D2)

where,
S: set data
D1: set start channel number
D2: set end channel number

The BSET instruction is used to transfer the same data to all consecutive channels.

Flowchart

0100	BSET
0101	#1234
0102	DM0
0103	DM511

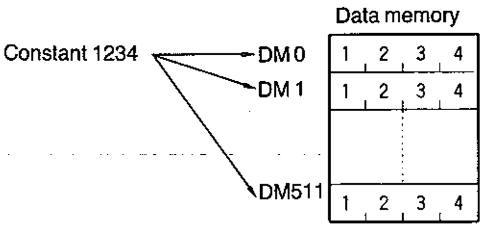
Coding chart

Address	Instruction	Data
0100	BSET(73)	—
0101		#1234
0102		DM 0
0103		DM511

Contents of data

	S	D1, D2
I/O relay, internal auxiliary relay	0 to 63	0 to 60
Link relay	LR0 to 31	
Holding relay	HR0 to 31	
Timer/counter	TIM/CNT0 to 127	
Data memory	DM0 to 511	
Indirectly addressed data	*DM0 to 511	
Constant	#0000 to 9999	—

When the BSET instruction is executed, the same data is transferred to all consecutive channels. In the above program, constant "1234" (16-bit data) is transferred to DM0 to 511.



The only data that can be indirectly addressed are data memories DM0 to DM511.

If the contents of the indirectly addressed area are other than BCD or greater than the maximum data memory channel, an error will occur; this will cause special auxiliary relay 6303 to turn ON and the program to be not executed. For details, refer to Compare instruction.

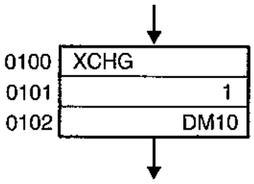
The data of a block settting instruction that must be specified are the start and end channels of the setting operation and the data to be set. Any number of channels within the limitation of the hardware can be specified for setting, and the data must satisfy these conditions.

Start channel number ≤ End channel number

Both channels must be within the same data area.

DATA EXCHANGE (XCHG)

Flowchart



If these data conditions are not satisfied, an error will occur; this will cause special auxiliary relay 6303 to turn ON and the program to be not executed. Any set data can be selected, and hexadecimal 4-digit (binary 16-bit) data can be specified for the constant.

FUN | 7 | E 4 | (channel number 1)(channel number 2)

The XCHG instruction is used to exchange one channel (16 bits) data with another.

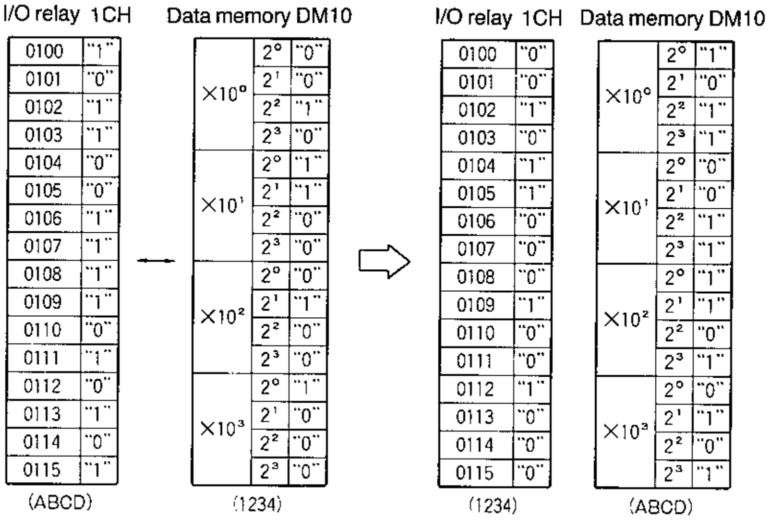
Coding chart

Address	Instruction	Data
0100	XCHG (74)	—
0101		1
0102		DM 10

Contents of data

I/O relay, internal auxiliary relay	0 to 60
Link relay	LR0 to 31
Holding relay	HR0 to 31
Timer/counter	TIM/CNT0 to 127
Data memory	DM0 to 511
Indirectly addressed data	*DM0 to 511

When the XCHG instruction is executed, 16-bit data of one channel is exchanged with another. In the above program, the contents of 1CH (0100 to 0115) are exchanged with the 16-bit contents of DM10.



I/O relay 1CH		Data memory DM10		
0100	"1"	×10⁰	2^0	"0"
0101	"0"		2^1	"0"
0102	"1"		2^2	"1"
0103	"1"		2^3	"0"
0104	"0"	×10¹	2^0	"1"
0105	"0"		2^1	"1"
0106	"1"		2^2	"0"
0107	"1"		2^3	"0"
0108	"1"	×10²	2^0	"0"
0109	"1"		2^1	"1"
0110	"0"		2^2	"0"
0111	"1"		2^3	"0"
0112	"0"	×10³	2^0	"1"
0113	"1"		2^1	"0"
0114	"0"		2^2	"0"
0115	"1"		2^3	"0"
(ABCD)		(1234)		

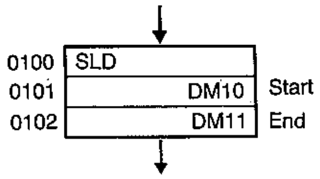
I/O relay 1CH		Data memory DM10		
0100	"0"	×10⁰	2^0	"1"
0101	"0"		2^1	"0"
0102	"1"		2^2	"1"
0103	"0"		2^3	"1"
0104	"1"	×10¹	2^0	"0"
0105	"1"		2^1	"0"
0106	"0"		2^2	"1"
0107	"0"		2^3	"1"
0108	"0"	×10²	2^0	"1"
0109	"1"		2^1	"1"
0110	"0"		2^2	"0"
0111	"0"		2^3	"1"
0112	"1"	×10³	2^0	"0"
0113	"0"		2^1	"1"
0114	"0"		2^2	"0"
0115	"0"		2^3	"1"
(1234)		(ABCD)		

The only channels that can be indirectly addressed are data memories DM0 to DM511.

If the contents of the indirectly addressed area are other than BCD data or more than the maximum data memory channel, an error will occur; this will cause special auxiliary relay 6303 to turn ON and the program to be not executed. For details, refer to Compare instruction.

ONE DIGIT SHIFT (SLD)

Flowchart



FUN 7 F 5 (start channel)(end channel)

The SLD instruction is used to shift data between the start and end channels by four bits to the left.

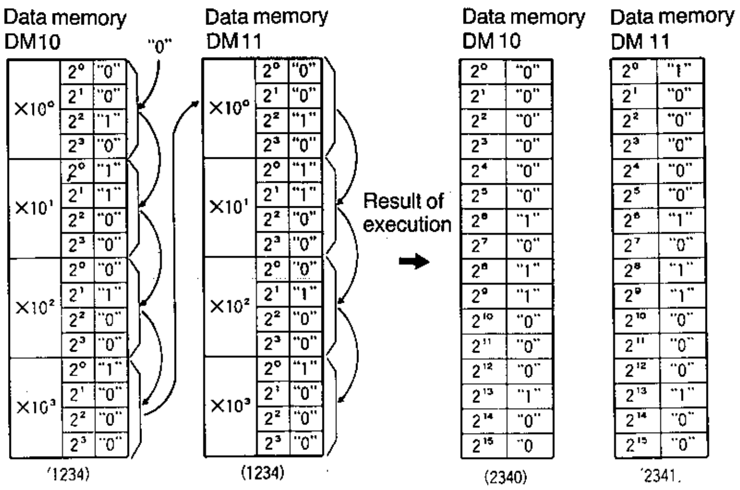
Coding chart

Address	Instruction	Data
0100	SLD (75)	—
0101		DM10
0102		DM11

Contents of data

I/O relay, internal auxiliary relay	0 to 60
Link relay	LR0 to 31
Holding relay	HR0 to 31
Data memory	DM0 to 511
Indirectly addressed data	*DM0 to 511

When the SLD instruction is executed, data between the start and end channels are shifted by 4 bits to the left. In the above program, the contents of DM10 to DM11 are shifted by 4 bits (1 bit×4 times) to the left. In this case "0" is inserted as the first digit of the start channel.



The data shifting takes place from the least significant digit of the start channel to the most significant digit of the end channel.

The data area for the SLD instruction is specified by a start channel number and an end channel number, both of which can be determined freely, provided these conditions are satisfied.

Start channel number ≤ End channel number

Both channels must be within the same data area.

If these data conditions are not satisfied, an error will occur; this will cause special auxiliary relay 6303 to turn ON and the program to be not executed.

The only channels that can be indirectly addressed are data memories DM0 to DM511. Use data memory area for the start and end channels.

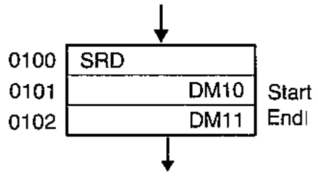
If the contents of the indirectly addressed area are other than BCD data or more than the maximum data memory channel, an error will occur; this will cause special auxiliary relay 6303 to turn ON, and the instruction to be processed as NOP. For details, refer to Compare instruction.

ONE DIGIT SHIFT RIGHT (SRD)

FUN 7 6 (start channel)(end channel)

The SRD instruction is used to shift data between the start and end channels by four bits to the right.

Flowchart



Coding chart

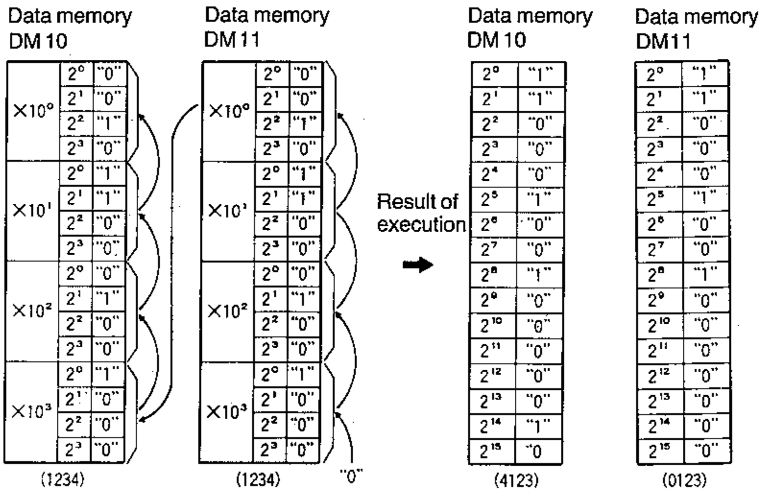
Address	Instruction	Data
0100	SRD (76)	—
0101		DM10
0102		DM11

Contents of data

I/O relay, internal auxiliary relay	0 to 60
Link relay	LR0 to 31
Holding relay	HR0 to 31
Data memory	DM0 to 511
Indirectly addressed data	*DM0 to 511

When the SRD instruction is executed, data between the start and end channels are shifted by four bits to the right.

In the above program, the contents of DM10 to DM11 are shifted by four bits (1 bit × 4 times) to the right. In this case, "0" is inserted as the last digit of the end channel.



The data shifting takes place from the most significant digit of the end channel to the least significant digit of the start channel.

The data area for the SLD instruction is specified by a start channel number and an end channel number, both of which can be determined freely, provided these conditions are satisfied.

Start channel number ≤ End channel number

Both channels must be within the same data area.

If these data conditions are not satisfied, an error will occur; causing special auxiliary relay 6303 to turn ON and the program to be not executed.

The only channels that can be indirectly addressed are data memories DM0 to DM511.

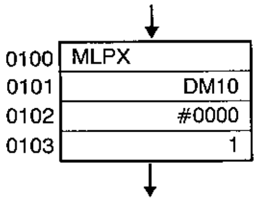
If the contents of the indirectly addressed area are other than BCD data or greater than the maximum data memory channel, an error will occur; this will cause special auxiliary relay 6303 to turn ON and the program to be not executed. For details, refer to Compare instruction.

4-TO-16 DECODER (MLPX)

FUN 7 7 (S)(K)(D)

where, S: conversion start channel number
K: digit designation
D: destination channel number

Flowchart



The MLPX instruction is used to decode 4-bit binary data of 16-bit data to 16-bit decimal data.

Coding chart

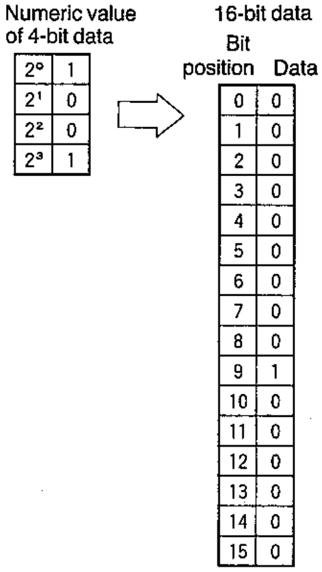
Address	Instruction	Data
0100	MLPX (77)	
0101		DM10
0102		#0000
0103		1

Contents of data

	S	D	K
I/O relay, internal auxiliary relay	0 to 63	0 to 60	
Link relay	LR0 to 31		
Holding relay	HR0 to 31		
Timer/counter	TIM/CNT0 to 127	—	TIM/CNT0 to 127
Data memory	DM511		
Indirectly addressed data	*DM511		
Constant	—		*

* The constant is determined according to the content of digit designation.

This instruction converts (decodes) a decimal numeric value represented by 4-bit data into 16-bit data whose bit at the bit position corresponding to the numeric value is 1 and then transfers the decoded data to a specified channel. All the other bits are 0.



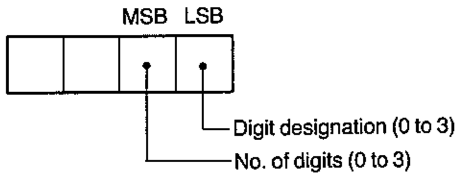
Numeric value of 4-bit data

2^0	1
2^1	0
2^2	0
2^3	1

16-bit data

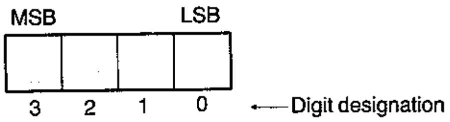
Bit position	Data
0	0
1	0
2	0
3	0
4	0
5	0
6	0
7	0
8	0
9	1
10	0
11	0
12	0
13	0
14	0
15	0

The digit designation data (K) is used to designate the position of the bit and the number of digits to be decoded.

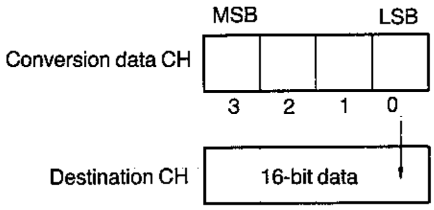


The actual number of digits to be decoded is the designated number of digits plus one digit.

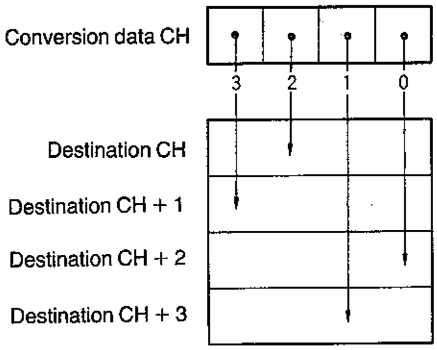
The designated digit specifies the digit from which the decoding starts.



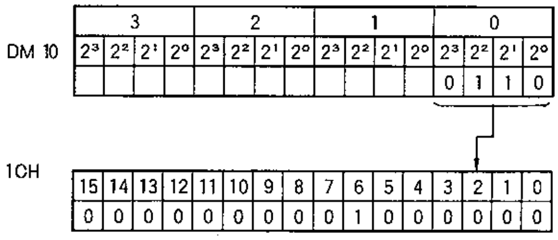
Example 1: When 0 is designated as both the digit and the number of digits



Example 2: When 2 is designated as the digit and 3 as the number of digits



With the initial program, the decoding will be performed as follows:

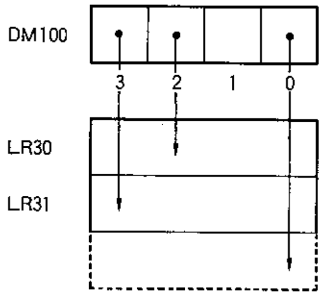


DM 10	3				2				1				0			
	2^3	2^2	2^1	2^0	2^3	2^2	2^1	2^0	2^3	2^2	2^1	2^0	2^3	2^2	2^1	2^0
													0	1	1	0

1CH	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0

The destination channel, to which the decoded data is to be transferred, must be within the same relay area as the channel at which the data conversion is performed. For example, if the MLPX instruction is programmed as follows, the channel that decodes and stores digit 0 does not exist. As a result, special auxiliary relay 6303 will turn ON and the MLPX instruction will be processed as NOP.

MLPX
DM100
#0022
LR 30



Should 4 or a higher number be specified as the digit or the number of digits, special auxiliary relay 6303 will turn ON and the instruction will be processed as NOP. Therefore, be careful not to exceed 4 when designating a channel as the digit designation data (K).

The only channels that can be indirectly addressed are data memories DM0 to 511.

If the contents of the indirectly addressed area are other than BCD data or more than the maximum data memory channel, an error will occur; this will cause special auxiliary relay 6303 to turn ON, and the instruction to be processed as NOP. For details, refer to Compare instruction.

16-TO-4 ENCODER (DMPX)

FUN 7 8 (S)(D)(K)

Flowchart

0100	DMPX
0101	1
0102	DM10
0103	#0021

where,
S: conversion start channel number
D: destination channel number
K: digit designation

The DMPX instruction is used to encode 16-bit decimal data into 4 bits of another 16-bit binary data.

Coding chart

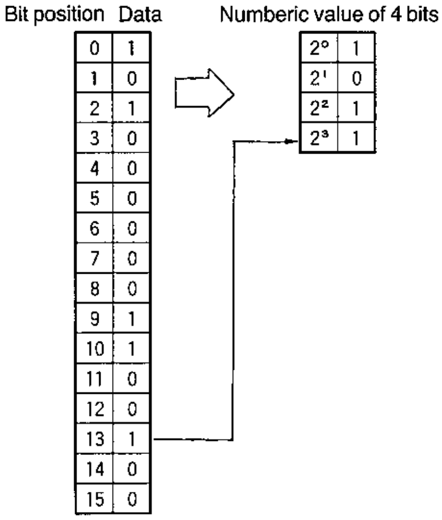
Address	Instruction	Data
0100	DMPX(78)	—
0101		1
0102		DM10
0103		#0021

Contents of data

	S	D	K
I/O relay, internal auxiliary relay	0 to 63	0 to 60	
Link relay	LR0 to 31		
Holding relay	HR0 to 31		
Timer/counter	TIM/CNT0 to 127	—	TIM/CNT0 to 127
Data memory	DM0 to 511		
Indirectly addressed data	*DM0 to 511		
Constant	—		*

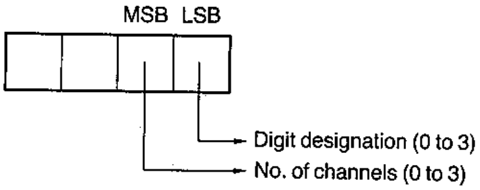
*The constant is determined according to the designated digit.

This instruction converts (encodes) the most significant bit (0 to 15) of the bits in 16-bit data that are logical 1 into a numeric value represented by 4-bit data, and then transfers the encoded data to the specified channel.



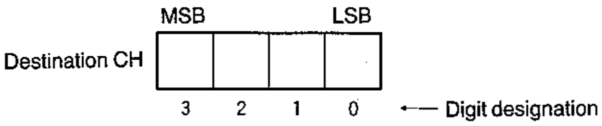
If the DMPX instruction is executed when there is more than one bit that is logical 1, the most significant bit of those bits takes precedence over the others. In the above example, bit 13 is given the priority. Bits 10, 9, 2, and 0 are ignored.

The digit designation (K) is used to designate the number of channels whose contents are to be encoded, and the digit position to which the data is to be stored.

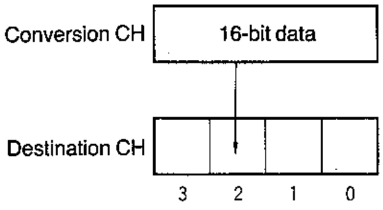


The actual number of channels whose contents are to be encoded is the designated number of channels plus one channel.

The designated digit specifies the digit to which the encoded data is to be stored.

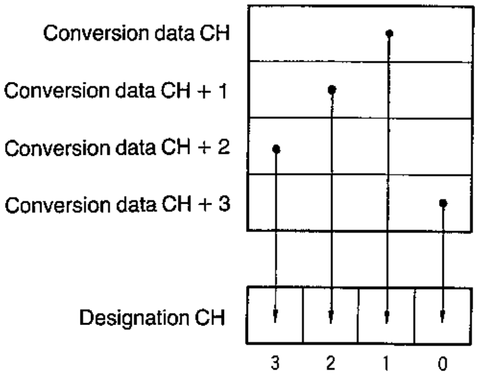


Example 1: When 2 is designated as the digit and 0, as the number of channels

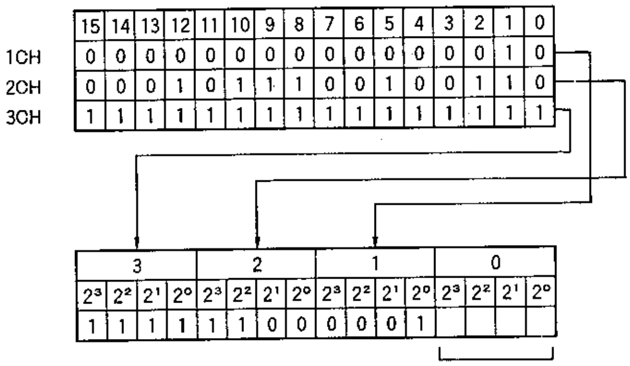


The bits of the digits other than that designated will remain unchanged.

Example 2: When 1 is designated as the digit and 3, as the number of channels



With the initial program, the data in the specified channel is encoded as follows:



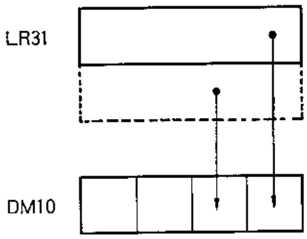
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
1CH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
2CH	0	0	0	1	0	1	1	1	0	0	1	0	0	1	1	0
3CH	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

3				2				1				0			
2^3	2^2	2^1	2^0	2^3	2^2	2^1	2^0	2^3	2^2	2^1	2^0	2^3	2^2	2^1	2^0
1	1	1	1	1	1	0	0	0	0	0	1				

This data remains unchanged.

The destination channel, to which the encoded data is to be transferred, must be within the same relay area as the channel at which the data conversion is performed. For example, if the DMPX instruction is programmed as follows, the channel from which encoded data is to be transferred does not exist. As a result, special auxiliary relay 6303 will turn ON and the DMPX instruction will be processed as NOP.

```
DMPX
          LR31
          DM10
          #0010
```



If 0 exists in the channel from which data is to be transferred, special auxiliary relay 6303 will turn ON and the instruction will be processed as NOP.

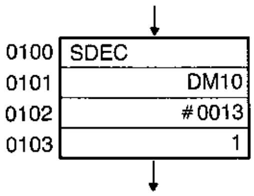
Should 4 or a higher number be specified as the digit or the number of channels, special auxiliary relay 6303 will turn ON and the instruction will be processed as NOP. Therefore, be careful not to exceed 3 when designating a channel as the digit designation data (K).

The only channels that can be indirectly addressed are data memories DM0 to DM511.

If the contents of the indirectly addressed area are other than BCD data or more than the maximum data memory channel, an error will occur; this will cause special auxiliary relay 6303 to turn ON, and the DMPX instruction to be processed as NOP. For details, refer to Compare instruction.

7-SEGMENT DECODER (SDEC)

Flowchart



FUN 7 9 (S)(K)(D)

where, S: conversion start channel
K: digit designation
D: destination channel

The SDEC instruction is used to convert 4 bits of 16-bit data into 8-bit data for 7-segment display.

Coding

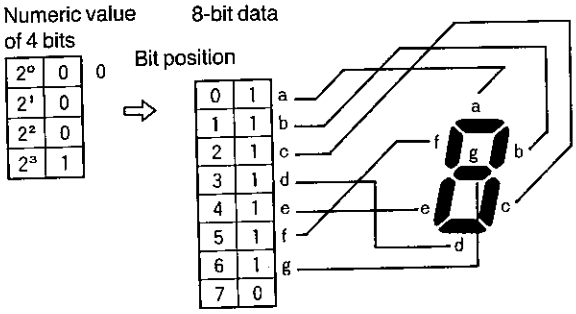
Address	Instruction	Data
0100	SDEC(79)	—
0101		DM 10
0102		#0013
0103		1

Contents of data

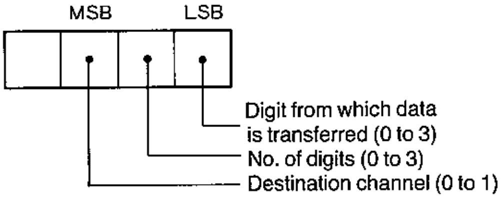
	S	D	K
I/O relay, internal auxiliary relay	0 to 63	0 to 60	
Link relay	LR0 to 31		
Holding relay	HR0 to 31		
Timer/counter	TIM/CNT0 to 127	—	TIM/CNT0 to 127
Data memory	DM0 to 511		
Indirectly addressed data	*DM0 to 511		
Constant	—		*

*The constant is determined according to the content of digit designation.

This instruction converts the specified 4-bit (1 digit) binary data in a channel into 8-bit data for 7-segment display and then transfers to the specified channel.

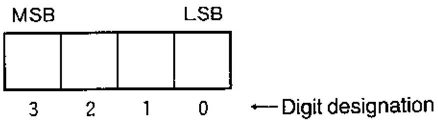


The digit designation data is used to specify the digit position at which the data to be converted exists, the number of digits to be converted, and the destination channel to which the converted data is to be transferred.

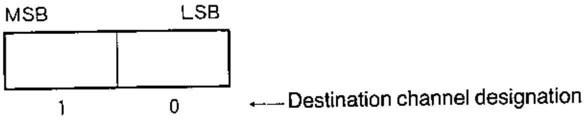


The actual number of digits whose data are to be converted is the designated number of digits plus one digit.

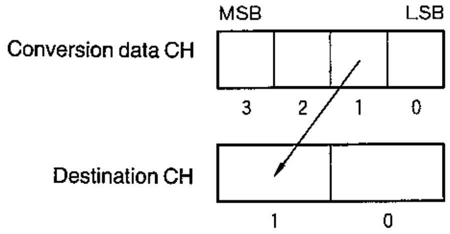
The designated digit from which the data is to be transferred specifies the digit from which the data conversion starts.



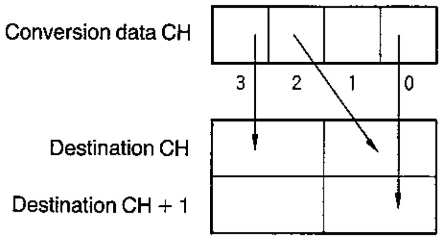
The designated destination channel specifies whether the converted 8-bit data is to be stored to the higher 8 bits or lower 8 bits of the specified channel.



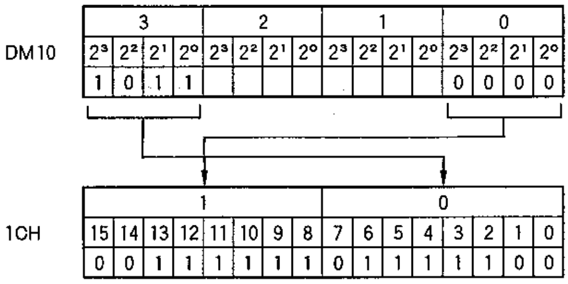
Example 1: When 1 is designated as the digit, 0 as the number of digits, and 1 as the destination channel



Example 2: When 2 is designated as the digit, 2 as the number of channels, and 0 as the destination channel



With the initial program, the specified binary data is converted as follows:



	3				2				1				0			
DM10	2^3	2^2	2^1	2^0	2^3	2^2	2^1	2^0	2^3	2^2	2^1	2^0	2^3	2^2	2^1	2^0
	1	0	1	1									0	0	0	0

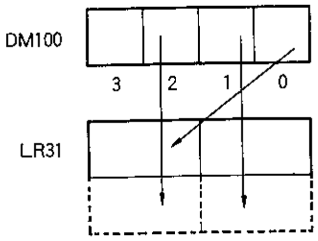
	1								0							
1CH	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	0	0	1	1	1	1	1	1	0	1	1	1	1	1	0	0

This table shows the relation between the input data and output data.

Input data for conversion	Converted output data	7-segment display
2^3 2^2 2^1 2^0(hexadecimal)	g f e d c b a	
0 0 0 0 (0)	0 0 1 1 1 1 1 1	0
0 0 0 1 (1)	0 0 0 0 0 1 1 0	1
0 0 1 0 (2)	0 1 0 1 1 0 1 1	2
0 0 1 1 (3)	0 1 0 0 1 1 1 1	3
0 1 0 0 (4)	0 1 1 0 0 1 1 0	4
0 1 0 1 (5)	0 1 1 0 1 1 0 1	5
0 1 1 0 (6)	0 1 1 1 1 1 0 1	6
0 1 1 1 (7)	0 0 1 0 0 1 1 1	7
1 0 0 0 (8)	0 1 1 1 1 1 1 1	8
1 0 0 1 (9)	0 1 1 0 1 1 1 1	9
1 0 1 0 (A)	0 1 1 1 0 1 1 1	A
1 0 1 1 (B)	0 1 1 1 1 1 0 0	b
1 1 0 0 (C)	0 0 1 1 1 0 0 1	c
1 1 0 1 (D)	0 1 0 1 1 1 1 0	d
1 1 1 0 (E)	0 1 1 1 1 0 0 1	E
1 1 1 1 (F)	0 1 1 1 0 0 0 1	F

The destination channel, to which the converted 8-bit data is to be transferred, must be within the same relay area as the channel at which the data conversion is performed. For example, if the SDEC instruction is programmed as follows, the channel that conveys and stores digit 1 does not exist. As a result, special auxiliary relay 6303 will turn ON and the SDEC instruction will be processed as NOP.

```
SDEC
          DM100
          #0120
          LR 31
```



Should 2 or a higher number be specified as the destination channel and 4 or a higher number, as the digit or the number of digits, special auxiliary relay will turn ON and the SDEC instruction will be processed as NOP. Therefore, be careful when specifying a channel as the digit designation data (K).

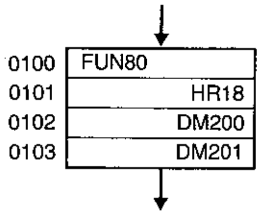
The only channels that can be indirectly addressed are data memories DM0 to DM511.

If the contents of the indirectly addressed area are other than BCD data or more than the maximum data memory channel, an error will occur; this will cause special auxiliary relay 6303 to turn ON and the SDEC instruction to be processed as NOP. For details, refer to Compare instruction.

MULTI-OUTPUT TIMER

FUN 8 0 (flag)(present value)(set value)

Flowchart



This instruction allows eight values to be set in a single timer. The range of the set values is from 0.1 second to 999.9 seconds.

Coding chart

Address	Instruction	Data
0100	FUN80	
0101		HR 18
0102		DM 200
0103		DM201

Contents of data

	Flag/present value	Set value
I/O relay, internal auxiliary relay	0 to 60	0 to 53
Link relay	LR0 to 31	LR0 to 24
Holding relay	HR0 to 31	HR0 to 24
Timer/counter	—	
Data memory	DM0 to 511	
Indirectly addressed	*DM0 to 511	
Constant	—	

This instruction can be used as an incrementing type timer whose timing operation can be controlled by controlling the corresponding flag. That is, when the flag is turned ON, the timing operation of the timer is started. The flag is turned OFF to stop the operation. Since eight values can be set in the timer, this instruction can function as if there were eight timers.

When the present value of the timer reaches or exceeds each of the set values (present value ≥ set value), the corresponding time-up flag in the specified channel becomes logical 1.

When this instruction is used for the timing control of external devices, the required number of timers can be significantly decreased, leading to reduction in the cost of the control system.

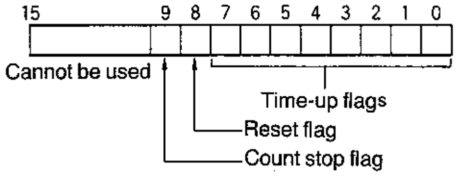
Description of operands

As the operands of the Multi-Output Timer instruction, a total of 10 channels for flags, present values, and set values are specified. The channels that can be specified as the operands are as shown in Contents of data.

Flag

One channel is required for the flags.

The following table illustrates the relation between the reset flag and count stop flag.



		Count stop flag	
		0	1
Reset flag	0	The present value, as it is being updated, is compared against the set values. When the present value coincideds with one of the set values, the corresponding time-up flag is turned ON.	NOP
	1	The present value and the time-up flags are cleared and the timer is stopped.	

Bits 10 to 15 in the flag channel are used as a system work area. If anything is written in this area by the user program, the normal operation of the Multi-Output Timer instruction cannot be performed.

To write data into the reset flag or count stop flag, use the OUT or OUT-NOT instruction. In a program in which a data memory is used as the flag channel, the OUT and OUT-NOT instruction cannot be used.

In this case, write the data into flags as illustrated in the following table.

Example

Example

	When "1" is written	When "0" is written
Reset flag	ORW #0100 Flag CH Flag CH	ANDW #FEFF Flag CH Flag CH
Count stop flag	ORW #0200 Flag CH Flag CH	ANDW #FDFF Flag CH Flag CH

Present value

One channel is required for the present value.

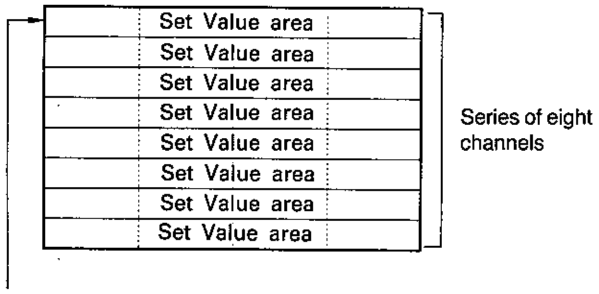
When the Multi-Output Timer instruction is executed, the timing operation is performed in units of 0.1 second. The operation can be continued to a maximum of 999.9 seconds depending on the set value.

If the cycle at which the user program executes the Multi-Output Timer instruction is 1.5 seconds or longer, the present value of the timer coincides with no set value. In this case, the timer stops its operation as is until the instruction is executed the next time, which likely causes an error in the operation. Therefore, be sure to program so that the Multi-Output Timer instruction is executed at a cycle of less than 1.5 seconds.

Set value

Eight channels are required for the set values.

The set values are assigned to a series of eight channels.



The first channel number is written in the user program as the operand "set value".

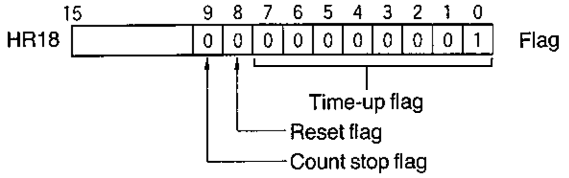
If "0000" is written as data in the set value area consisting of the eight channels, the subsequent data will be ignored.

The set value can be specified up to 999.9 seconds in units of 0.1 second. Therefore, to specify 15.5 seconds as the set value, for example, "155" is written.

Application

0100	FUN 80	
0101	HR18	······ Flag CH designation
0102	DM200	······ Present value CH designation
0103	DM201	······ Set value CH designation

When the Multi-Output Timer instruction is programmed as shown above, the relation between the flag channel and the channels (data memories) for the present and set values is as follows:

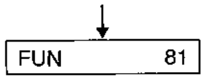


DM200	0	0	2	5	Present value
DM201	0	0	1	0	Set value area
DM202	0	0	3	5	
DM203	0	0	5	5	
DM204	0	0	8	0	
DM205	0	0	9	5	
DM206	0	1	1	0	
DM207	0	0	0	0	
DM208					

In this example, the contents of the data memories following DM207 are ignored.

Instructions for expansion

Flowchart



In case a total of 72 kinds of basic and special instructions provided to the C120F are not sufficient for a particular application, instructions that realize a special system program or new instructions that are expected to be standardized in updated versions of the programmable controller can be supplied upon your request.

Coding chart

Address	Instruction	Data
0100	FUN 81	—
		—
		—
		—

As the instructions for expansion, 17 instructions are available: FUN81 to 93 and FUN97 to 99.

If these instructions are used in the standard C120F, they are processed as NOP.

When you are ready to install the C120F, first give attention to the environmental conditions under which it will normally operate. The PC has been made for reliable use under tough conditions, but you still need to avoid using it in these areas.

Where the ambient temperature is below 0° or above 50°C.

Where abrupt temperature changes may cause condensation.

Where relative humidity is below 35% or above 85%.

Where corrosive or flammable gas may occur.

In extremely dusty conditions, or where subject to salt or iron particles.

Where subject to abnormal vibration or shock.

In direct sunlight.

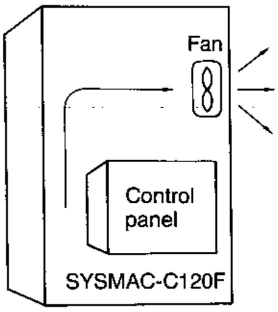
Where it can be splattered with water, oil, or chemical substances.

Control panel mounting

Two of the main considerations when mounting the PC in a control panel are how accessible it will be for operation and maintenance and whether the PC is properly protected against heat.

These are some of the things you should consider:

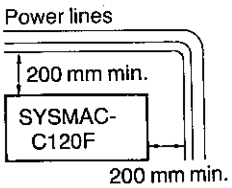
Provide the PC with adequate space for ventilation.



Avoid mounting the PC directly above any heat-generating source, such as a heater, transformer, or high-capacity resistor. Mount the PC as far away as possible from high-tension equipment or power devices for the sake of safety in maintenance and operation.

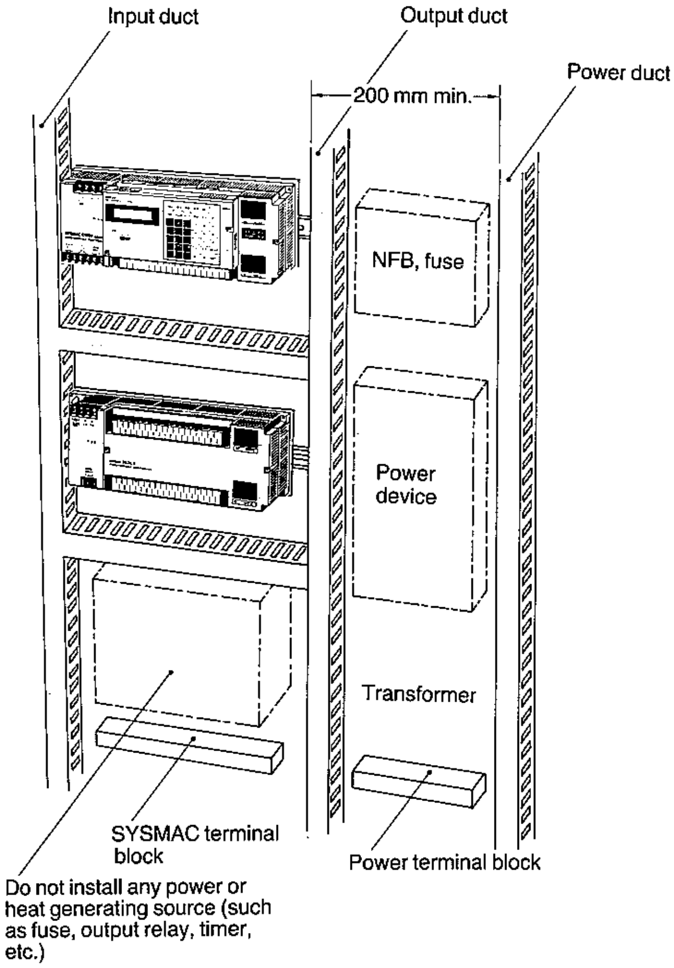
If the ambient temperature is above 50°C within the panel, you must install a fan for forced-air ventilation. However, the operating temperature range of the PC with the programming console mounted to it is from 0° to 45°C.

Avoid mounting the PC in a panel in which high-tension wiring or equipment is also installed.



Provide a distance of more than 200 mm between the high-tension equipment or power lines and the PC.

The C120F can be installed either directly to the mounting panel within a control panel or on a DIN rail. When connecting expansion I/O racks to the CPU rack for system expansion, avoid employment of more than three expansion I/O racks and use an expansion I/O rack connecting cable 2 m long in maximum.



When installing the C120F within a control panel, mount the programmable controller on a DIN rail or on an intermediate plate.

When mounting it on a DIN rail, secure the DIN rail attachment to the rear-sides of the C120F and expansion I/O racks.

Use Type PFP-100N2 DIN rail and Type 3G2A9-DIN01 DIN rail attachment.

Control panel wiring

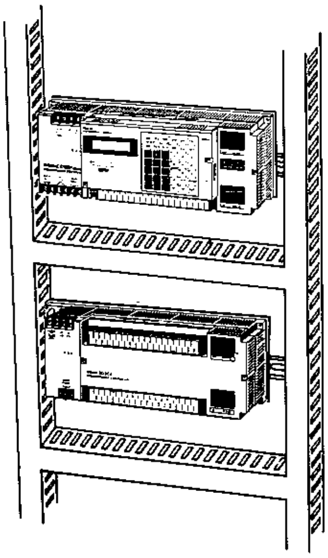
Pay attention to the following points for wiring within a control panel.

Provide a distance of 200 mm or more between high-tension lines or power lines and the C120F.

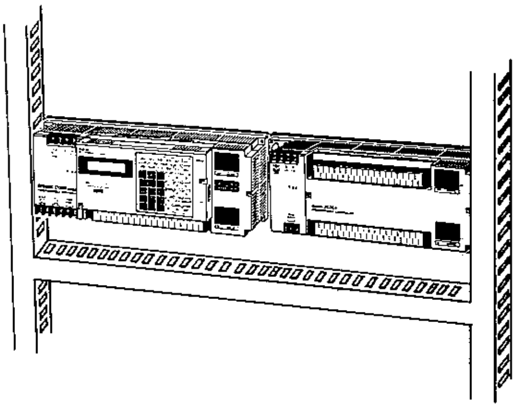
Avoid running the I/O connecting cable in the same duct as other wiring.

Arrange the wiring so that mounting and removing I/O units is not obstructed and that their operation indicators are easily visible.

Vertical mounting

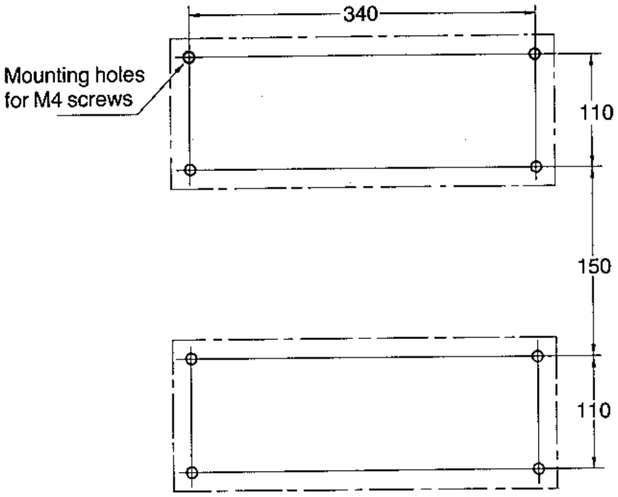


Horizontal mounting



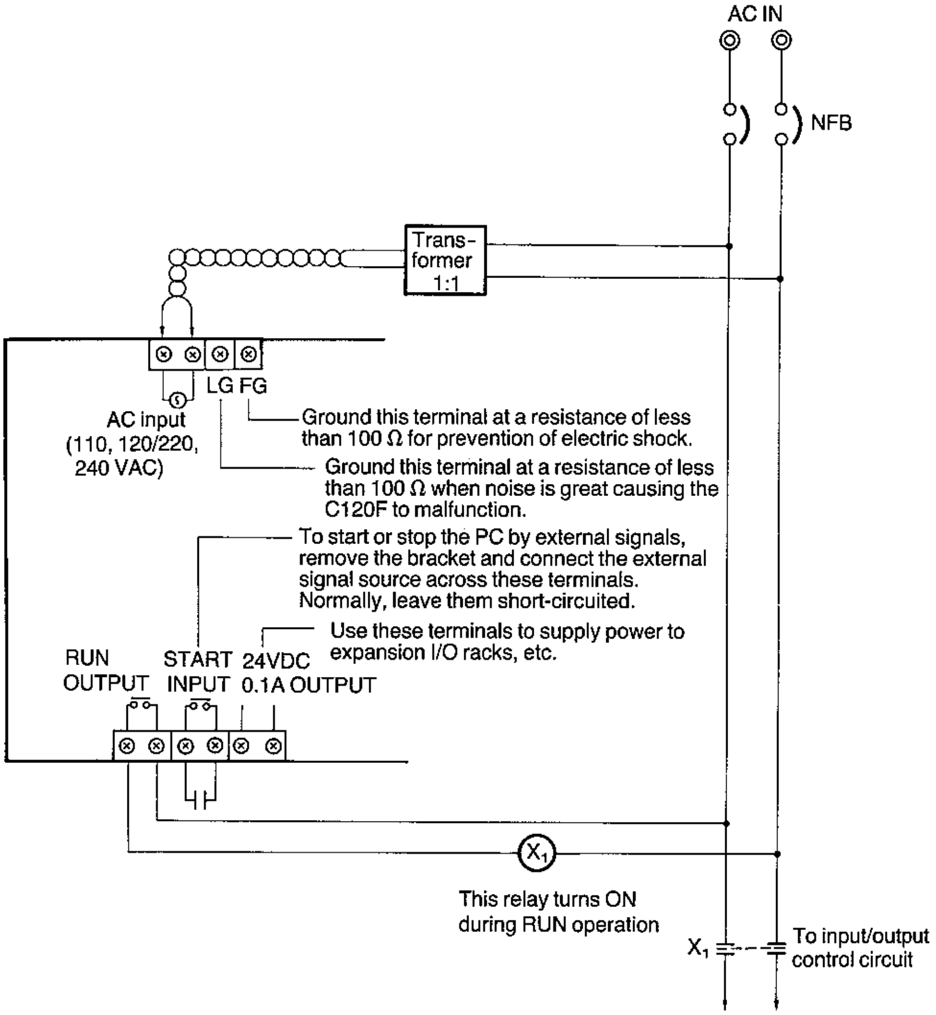
Mounting dimensions

The dimensions of the CPU rack and expansion I/O rack when they are mounted on the intermediate plate in a control panel are as follows:



Wiring of CPU rack power supply

Perform the wiring of the CPU rack power supply by referring to this diagram.



Ground this terminal at a resistance of less than 100 Ω for prevention of electric shock.

Ground this terminal at a resistance of less than 100 Ω when noise is great causing the C120F to malfunction.

To start or stop the PC by external signals, remove the bracket and connect the external signal source across these terminals. Normally, leave them short-circuited.

Use these terminals to supply power to expansion I/O racks, etc.

This relay turns ON during RUN operation

Power consumption

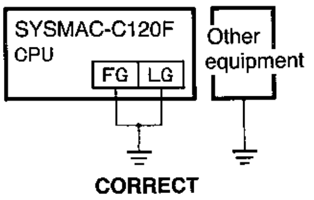
Power consumption of the maximum C120F system is 60 VA. However, upon power application, inrush current of about five times the steady-state current flows through the programmable controller.

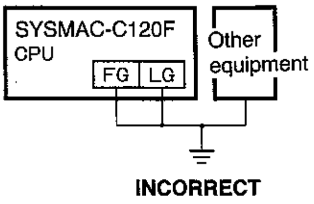
Power supply wiring

For the power line of the C120F, use a wire having a conductor cross sectional area of 2 mm^2 (AWG14) minimum to prevent voltage drop. Use twisted pair wires.

Noise

For general noise on the power line, the built-in noise suppressor in the C120F is sufficient. However, supplying power through a transformer with a voltage ratio of 1:1 helps to greatly reduce equipment-to-ground noise. Installation of such a transformer is recommended.





Grounding

Terminal FG is a ground terminal used for prevention of electric shock. Use a dedicated ground wire (having a conductor cross sectional area of 2 mm^{2}Ω (AWG14) min.) or grounding at a resistance of less than 100 Ω.

Terminal LG is a noise filter neutral terminal which does not normally require grounding. When electrical noise is a problem, however, short-circuit this terminal to terminal FG.

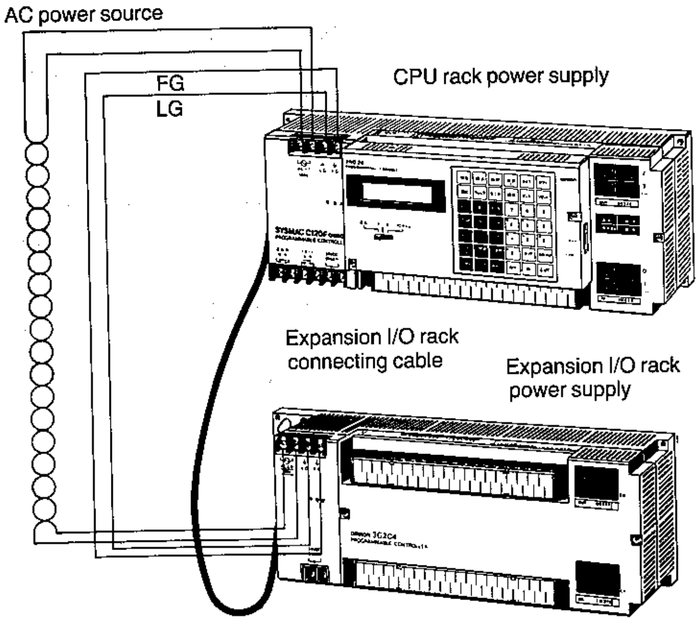
The PC may not operate correctly if its grounding wire is shared by other equipment or if grounding is attempted by attaching the grounding terminal to the metal superstructure of a building.

Do not use a grounding wire longer than 20 m. Care must be taken because ground resistance is affected by the nature of the ground, water content, season, and the amount of time that has elapsed since the wire was laid underground.

Wiring of expansion I/O rack

Use twisted pair wires having a conductor cross sectional area of 2 mm^2 (AWG14) for the expansion I/O rack wiring. Separate the power line from the I/O line.

Connect the ground lines of terminals LG and FG of the expansion I/O rack power supply to terminals LG and FG of the CPU rack with a line having a conductor cross sectional area of 2 mm^2 (AWG14).
Use Type 3G2A5-CN511 (50 cm) or 3G2A5-CN121 (1 m) connecting cable to connect the expansion I/O rack to the CPU rack.



Note: Avoid running the I/O connecting cable in the same duct as other wiring. Limit the cumulative length of the connecting cables to 2 m.

I/O unit wiring

Use lead wires having a conductor cross sectional area of 1.25 mm^2 or less for wiring the I/O unit.

Note: When an input device having operation indicators (neon lamps) is connected to the input unit, a certain amount of voltage is applied to the input unit via the indicators of the input device. Connect a bleeder resistor in parallel with the input signal line so that this voltage becomes equal to or less than the OFF voltage of the input unit.

When the triac output unit is used to drive a low-current load, the load may not be turned off due to leakage current. To prevent this, connect a bleeder resistor in parallel with the load.

Protection against power failure

Supply power to the C120F so that the supply voltage is within the rated operating voltage range.

A power sequence circuit is incorporated in the power supply for the C120F to prevent it from malfunctioning due to momentary power failure or supply voltage drop.

Supply voltage drop

If the supply voltage drops below 85% of the rated operating voltage, the C120F stops operating, causing the output relays to turn OFF.

Momentary power failure

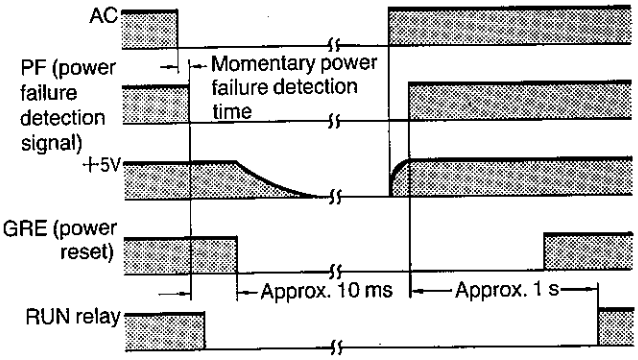
The C120F ignores a momentary power failure of less than 10 ms and the CPU continues to operate. A power failure of 10 ms or longer and shorter than 25 ms may or may not be detected.

If a power failure lasts longer than 25 ms, the CPU stops operating and its output relays are turned OFF.

Automatic recovery

The C120F automatically starts operating when 85% or more of the rated supply voltage is restored.

CPU run/stop timing chart



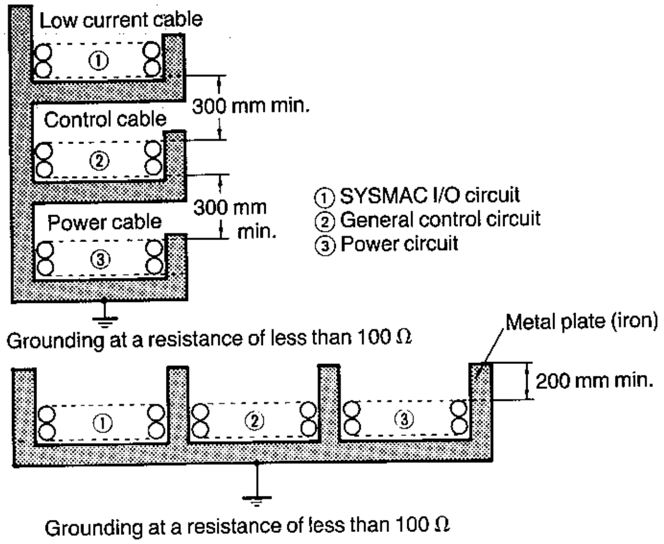
External wiring

Be sure to process the C120F I/O lines separately from other control lines. (Do not share the conductors of the I/O cable with the other cables.)

To lay the cables for the C120F with power cables rated at 400 V 10 A max., or 220 V 20 A max. pay attention to these points.

Provide a minimum distance of 300 mm between the cables when their racks are placed in parallel.

If two cables share the same duct at the end of cable processing, place a metal plate between the cables at the point at which they emerge from the duct.



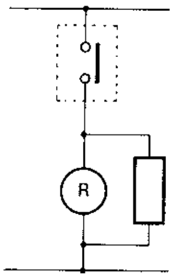
Notes on input/output

Noise-suppression measures

Be sure to take appropriate noise-suppression measures when any electrical device likely to produce noise is employed as a load of the PC.

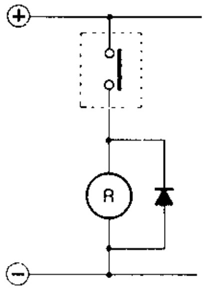
For example, electromagnetic relays and valves generating noise of more than 1,200 VAC require noise suppression.

For AC-operated noise sources, connect a surge suppressor in parallel with the coil of each device. For DC-operated noise sources, connect a diode in parallel with the coil of each device.



AC power source

C: 0.5 µF ±20% min.
Nonpolarity
Withstand voltage: 1,500 V min.
R: 50 Ω ±30%, 0.5 W



DC power source

Select a diode with breakdown voltage and current ratings according to the load.

Since the output elements of the C120F are packaged on a printed circuit board and connected to the terminal board, short-circuiting any of the loads connected to the output elements may damage the PC board. Fuses are thus recommended for protecting the output elements.

Maintenance and inspection

Regular inspections and appropriate maintenance of the PC are essential to ensure the full life of the PC and trouble-free operation of the controlled system. Safety measures to protect the system and minimize system downtime in the event of PC failure must also be taken. This chapter covers those topics in detail.

First, inspection items are presented in a table to be used for periodic check-off inspections. This is followed by a brief review of basic maintenance procedures. Using a flowchart format, a troubleshooting guide then presents actions that should be taken in the event of typical failures that might occur. At the end of the chapter, a list of programming console error messages is given, along with the corrective action to be taken in response.

Inspection

Inspection items

Nearly trouble-free semiconductor elements are employed as the main components of the C120F. Semiconductors are, however, subject to deterioration under rigorous environmental conditions and should be inspected periodically. The standard inspection cycle is 6 months to 1 year. More frequent inspections may be called for depending on factory conditions.

If the C120F is found to be outside the criteria shown in the following table, corrections should be made so that the criteria are met.

No.	Inspection item	Particulars of inspection	Criteria	Remarks
1	AC power source (1) Voltage (2) Fluctuation	(1) Is the rated voltage available when measured at the terminal block of the CPU rack?	Supply voltage must be within rated operating voltage range.	Voltmeter
		(2) Does a momentary power failure occur frequently or is there any sharp rise or drop in the supply voltage?	The supply voltage must be within the rated operating voltage range.	
2	Environmental conditions (1) Ambient temperature (2) Humidity (3) Vibration (4) Dust	Are the temperature and humidity within the required range? (When the PC is installed in a control panel, the temperature within the panel may be regarded as the ambient temperature of the PC.)	(1) 0° to +55°C (2) 35 to 85% RH (3) Must be free from vibration. (4) Must be free from dust.	Thermometers, hygrometers
3	I/O unit power source (1) Voltage (2) Fluctuation	Is the supply voltage, including its fluctuation, within the rated operating voltage range when measured at the terminal block of each I/O unit?	Must conform to the voltage specification of each I/O unit.	Voltmeter
4	Mounting conditions	(1) Are the CPU and I/O units attached firmly?	The mounting screws must not be loose.	Phillips screwdriver
		(2) Is each I/O unit fixed firmly?	The mounting screws must not be loose.	Phillips screwdriver
		(3) Is the I/O connecting cable connected firmly?	The connecting cable must not be loose.	Visual inspection
		(4) Is there a loose screw in the external wiring?	The terminal screws must not be loose.	Visual inspection
		(5) Is there a broken cable in the external wiring?	The external wiring must be free from any abnormalities in appearance.	Visual inspection
5	Service life	(1) Output relay	Electrically: 300×10^3 operations Mechanically: $20{,}000 \times 10^3$ operations	Refer to Model G6B relay catalog.
		Battery	4 years	Refer to the next page.

Caution: Be sure to turn off the power before replacing any unit of the SYSMAC-C120F.

Remember
If a defective unit is discovered and replaced, do another check to determine whether the replaced unit is abnormal.

When returning a defective unit to OMRON, please enclose a written description of the problem.

If the problem is faulty contact, wipe the PCB terminals with a clean all-cotton cloth moistened with industrial alcohol. Make certain there is no cloth fragments remaining on the terminals before plugging it in.

Tools and testing devices for maintenance
Screwdrivers (Phillips and flat-bladed)

VOM or digital voltmeter

Industrial alcohol and all-cotton cloth

Tools and testing devices for troubleshooting
Oscilloscope

Pen-recording oscilloscope

Thermometer, hygrometer

Maintenance parts
To ensure continuous operation of the controlled system in the event of failure, it is advisable to keep at least one spare I/O unit on hand.

Consumables
Fuse

For the CPU rack power supply and expansion I/O rack power supply: 3 A for AC power source

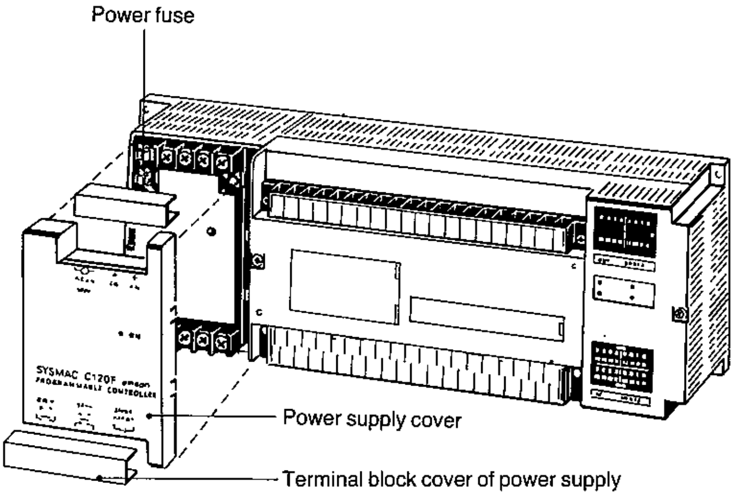
To replace the fuse, follow these three steps.

1) Turn off the power.

2) Remove the terminal blocks from the CPU rack power supply.

3) Remove the cover from the power supply.

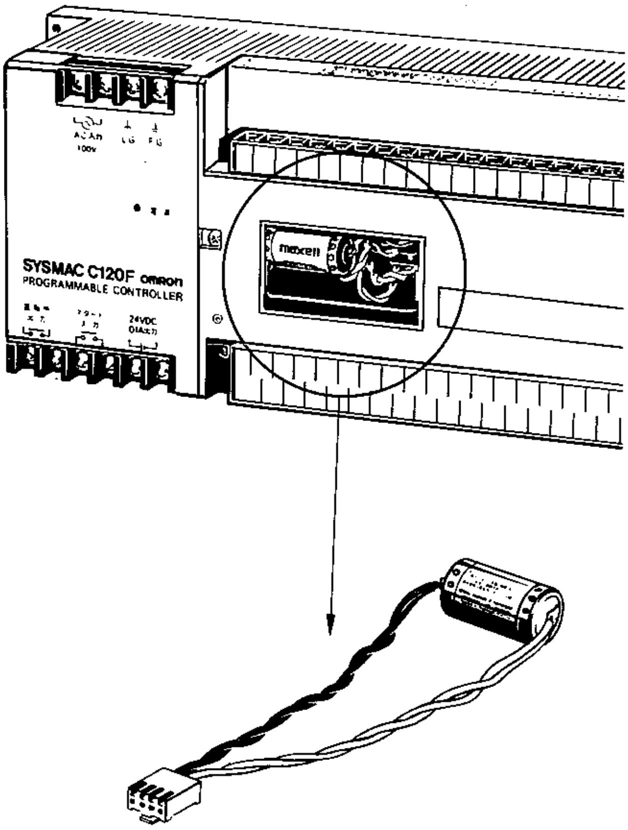
4) Replace the blown fuse with a new one.



Battery
Type 3G2A9-BAT08

The service life of the battery is approximately 5 years. Toward the end of this period, the message BATT LOW is displayed on the programming console. If this happens, replace the battery with a new one within a week.

Caution: Replace the battery within 3 minutes from turning the power off.



Note: When the AC power is not supplied to the C120F, apply the AC power for more than 10 seconds before replacing the battery; then turn it off.

I/O unit

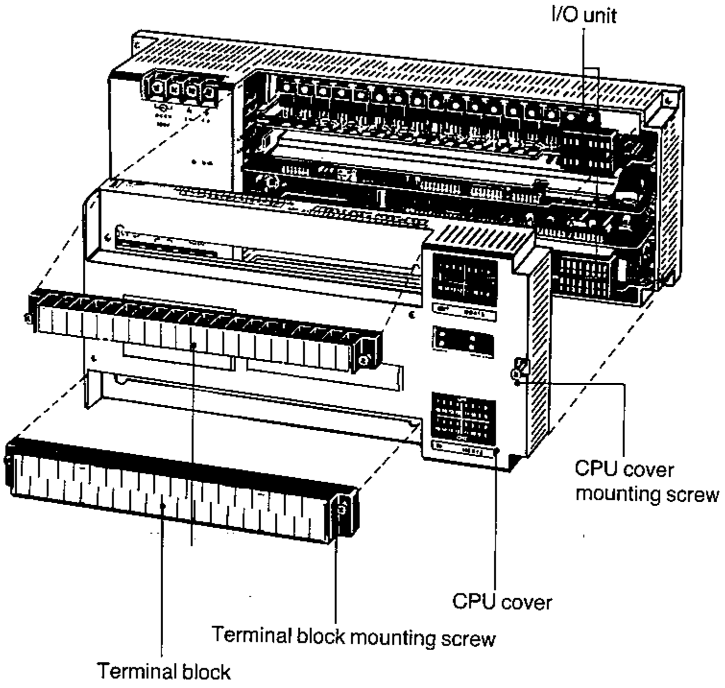
To replace the I/O unit, follow these steps.

1) Turn off the power.

2) Remove the mounting screws from the terminal blocks on the CPU rack. Remove the terminal blocks

3) Remove the mounting screws of the CPU rack cover. Remove the cover.

4) Pull out the I/O unit.



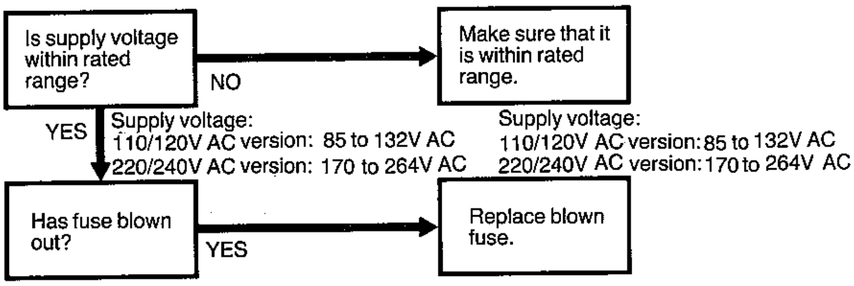
Note: Do not hold the LED section of the I/O unit.

Troubleshooting

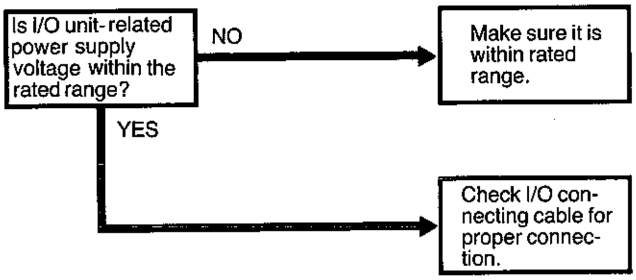
If any abnormality occurs in the C120F, thoroughly learn what the trouble is, check whether the symptom is reproducible or is caused through relationship with other equipment, then follow the troubleshooting flowcharts shown below.

Power supply checking

1. Check whether the AC power being supplied to the C120F is within the rated value.



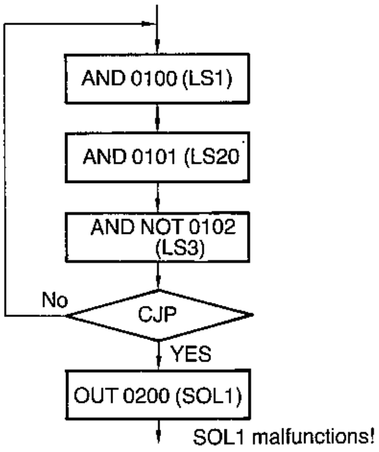
2. The power supply for loads is connected to the terminals of each I/O unit. Should any abnormality occur in this power supply, the I/O devices connected to the I/O unit will not operate. Check this power supply.

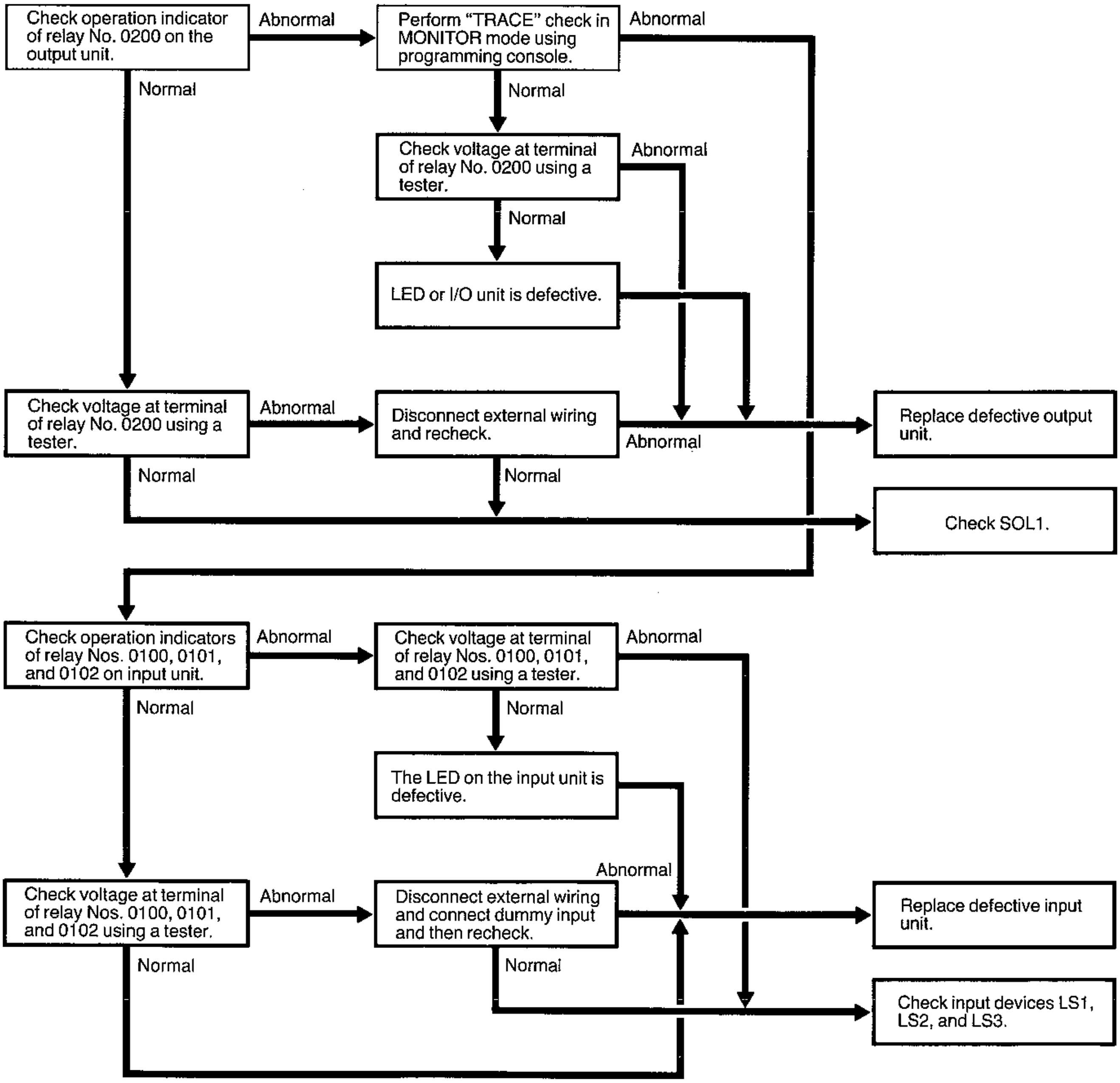


Input/output unit

The following flowchart is shown on the assumption that the user keeps the maintenance spare parts at hand. If no spare part is at hand, first check I/O devices thoroughly.

In the flowchart below, the description is based on the program example on the left.

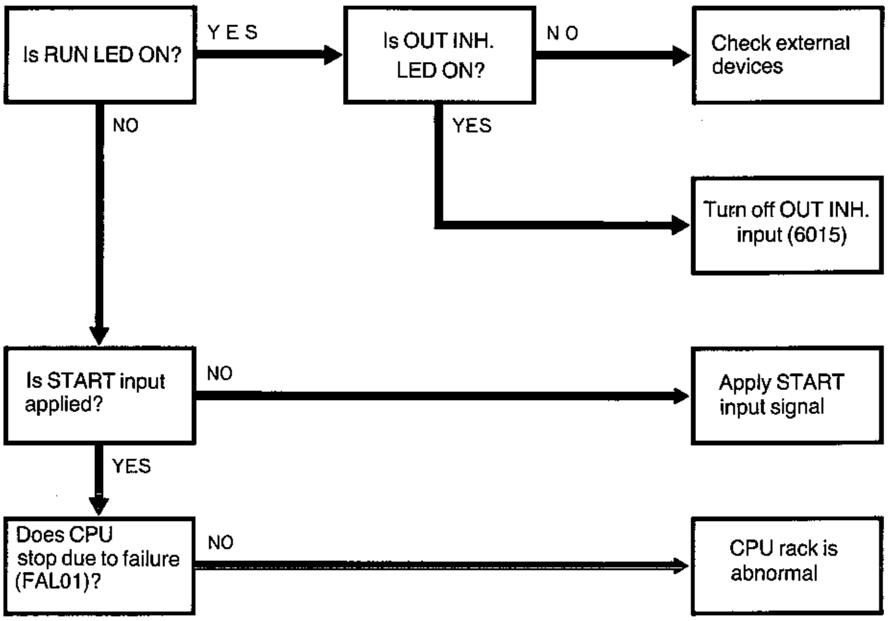




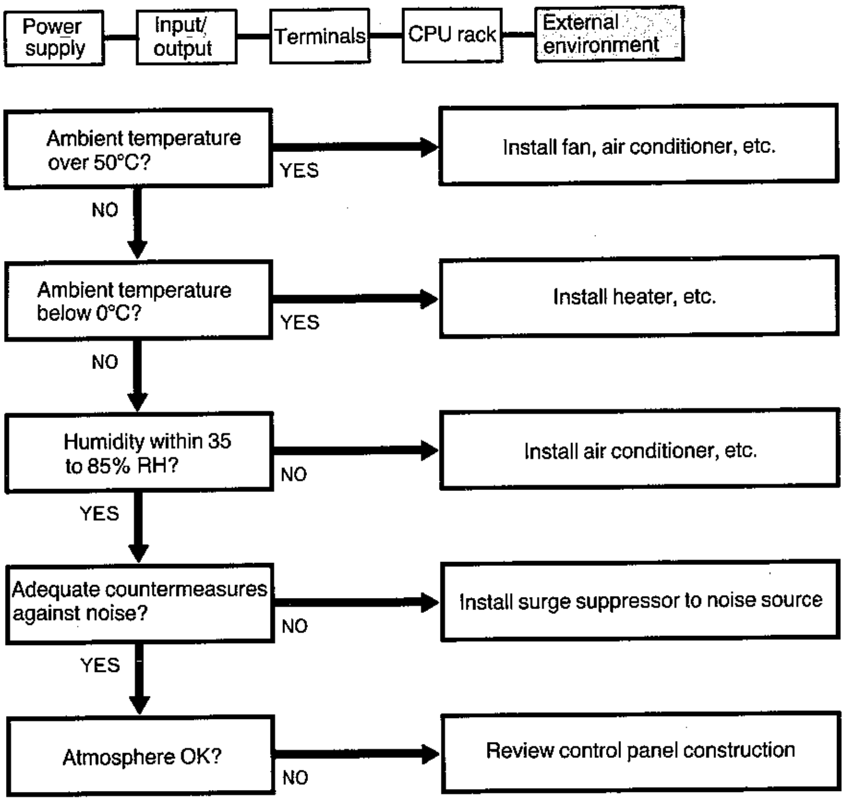
Terminal

1. Check each I/O unit for loose terminals.
2. Check the power supply terminals for loose connection.
3. Check each unit for loose mounting screws.
4. Check the I/O connecting cable for proper connection.

CPU rack



External environment



Self-diagnostic functions

The C120F's various diagnostic functions help to prevent and limit expensive system downtime caused by failures.

If an error occurs, it can be determined by the message and FAL number displayed on the programming console. In addition, the C120F has special auxiliary relays, some of which are used as a failure code output area. Therefore, the operation of the C120F can be continued or stopped by the user program as required, enabling flexible countermeasures to be taken against failures.

LIST OF ERROR MESSAGES AND ALARM OUTPUTS

Item		Description	LED indicators on CPU front panel					Message on programming console display
			POWER	RUN	CPU FAIL	ALARM	OUT INH	
–	Remote I/O unit power ON wait	Power not applied to remote I/O unit.	●	○	○	○	–	CPU WAITING
	Start input wait	START INPUT terminals are open.	●	○	○	○	–	CPU WAITING
A failure that causes the CPU to stop	Power failure	Power failure has occurred for 10ms or longer	○	○	○	○	○	
	CPU failure	Watchdog timer (120ms min.)	●	○	●	○	–	
	Memory error	Checksum error occurs or incorrect instruction exists.	●	○	●	○	–	MEMORY ERR
	I/O bus error	Error is detected during data transfer between CPU and I/O unit.	●	○	●	○	–	IO BUS ERR N
	I/O unit over error	The number of mounted I/O points exceeds that registered.	●	○	●	○	–	IO UNIT OVER
	I/O setting error	Input unit is replaced with output unit or vice versa.	●	○	●	○	–	IO SETTING ERR
	System failure	FALS instruction is executed by program.	●	○	●	○	–	FALS XX ERR
	JMP error	Destination label of JMP instruction is undefined.	●	○	●	○	–	JMP ERR
	Program error	User program exceeding memory capacity is executed.	●	○	●	○	–	PROGRAM ERR
	RTI error	RTI instruction is executed for purpose other than interrupt servicing.	●	○	●	○	–	RTI ERR
A failure that does not cause the CPU to stop	Remote I/O error	Error is detected during data transmission between CPU and remote I/O units.	●	●	○	●	–	RMTE IO ERR N
	I/O verify error	I/O units are removed.	●	●	○	●	–	IO VERIFY ERR
	System failure	FAL instruction is executed by program.	●	●	○	●	–	FAL XX ERR
	Battery error	Battery voltage is lower than that rated or no battery is inserted.	●	●	○	●	–	BATTERY ERR
	Host link error	Error is detected during data transmission between PC and host computer.	●	●	○	●	–	
	PC link error	Error is detected during data transmission between PC and the other PC.	●	●	○	●	–	
–	JMP destination error	Indirect JMP instruction is executed without destination label defined, or BCD error occurs in label.	●	●	○	●	–	JMP (IND) ERR
	DM number error	Data memory number or channel number exceeding maximum number is specified.	●	●	○	●	–	DM NUMBER ERR

● denotes that the indicator illuminates
○ denotes that the indicator goes off.
These examples of LED indicator are while the PC is in operation.

* 0 to 3 denote rack numbers.
** 0 to 3 denote remote I/O expansion cable numbers.

Special auxiliary relay	Failure code	Remedy
		Turn ON power of remote I/O.
		Short-circuit START input terminals.
		Apply power again.
		Set mode selector switch to PROGRAM position and turn off power. Check program.
	F1	Check RAM or ROM unit for correct mounting. Correct <????> in program. After correction, error reset operation must be performed.
	C0 to C3*	Check bus line between CPU and I/O unit. Confirm secure mounting of I/O unit or I/O before power application.
	E1	Confirm I/O channels by reading I/O table and then reassign I/O channels. After reassignment, generate I/O table.
	E0	Confirm I/O channels by performing I/O verify operation, and then reassign I/O channels. After reassignment, generate I/O table.
	1 to 99	Check program.
	F2	Check program.
	F3	Check program.
	F4	Check program.
6112 ON	B0 to B3**	Check transmission line between CPU and remote I/O slave unit. Check remote I/O slave station for normal operation.
6110 ON	E7	Confirm I/O channels by performing I/O verify operation, and then reassign I/O channels. After reassignment, generate I/O table.
	1 to 99	Check program.
6108 ON	F7	Check whether battery is correctly inserted in battery socket. Replace battery with new one.
6111 ON		Refer to user's manual for computer link unit.
		Refer to user's manual for PC link unit.
6109 ON	F9	Check program.
6113 ON	F8	Check program.

Abnormal symptom, possible cause, and corrective action

CPU rack

No.	Abnormal symptom	Possible cause	Corrective action	Remarks
1	Fuse blows repeatedly.	Circuit board is short-circuited or damaged by burning.	Replace CPU rack.	
2	Output DC voltage is abnormal.	Constant-voltage circuit is defective.	Replace CPU rack power supply.	
3	"RUN output" contact does not turn ON. (RUN indicator ON)	Power circuit is defective.	Replace CPU rack power supply.	
4	RUN indicator does not illuminate.	(1) DC voltage is not supplied. (2) Programming error (END instruction is missing.)	(1) Replace CPU rack power supply. (2) Correct program.	

Expansion I/O rack

No.	Abnormal symptom	Possible cause	Corrective action
1	Relays following particular relay number do not operate.	(1) Circuit board pattern is broken.	Check each bus line by buzzer.
		(2) Improper soldering	Resolder.
2	Abnormal relay numbers of expansion I/O rack are in units of 8.	(1) Cable wiring is broken.	Check each bus line by buzzer.
		(2) Improper soldering.	Resolder.
3	I/O of particular relay number erroneously turns on.	Improper soldering of connector.	Check each bus line by buzzer.
4	All relays of particular I/O unit do not operate.	Improper soldering of connector	Check each bus line by buzzer.

Input unit

No.	Abnormal symptom	Possible cause	Corrective action
1	All input units do not turn on.	• Operation indicators (LEDs) do not illuminate. External input voltage is not supplied or is low.	Supply power or raise supply voltage.
		• Operation indicators (LEDs) are illuminating. Signal level within unit is faulty.	Remove all I/O units being used and reinsert them one by one to find defective unit.
2	All relays of specific input unit do not turn on.	(1) Same as above	Same as above. Replace defective input unit.
		(2) Screws of terminal block are loose.	Retighten terminal screws.
3	All relays of specific input unit do not turn off.	Gate circuit is defective.	Replace defective input unit.
4	Input of particular relay number does not turn on.	(1) Gate circuit is defective.	Replace defective input unit.
		(2) Screws of terminal block are loose.	Retighten screw terminals.
		(3) ON time duration of external input is short.	Adjust external device.
		(4) Input circuit (photocoupler, for example) is defective.	Replace defective input unit.
		(5) Input relay number is incorrectly assigned to OUT instruction of program.	Correct program.
5	Input of particular relay number does not turn off.	(1) Faulty contact of jack	Clean contact with alcohol-moistened cloth.
		(2) Input circuit is defective.	Replace defective unit.
		(3) Input relay number is incorrectly assigned to OUT instruction of program.	Correct program.
6	Abnormal relay numbers are in units of 8 points.	(1) Data bus signal is faulty.	Remove all I/O units being used and reinsert them one by one to find defective unit.
		(2) IC-RAM of CPU is defective.	Replace CPU.
7	Inputs turn ON and OFF irregularly.	(1) External input voltage is low.	Raise external voltage.
		(2) Malfunction due to noise.	Countermeasures against noise. • Install surge suppressor. • Install insulating transformer. • Wire with shielded cable.
8	Input operation indicator does not illuminate. (Operation is normal.)	(1) LED indicator is defective.	Since this type of defect does not impede normal operation, repair it in your spare time or at the time of the next periodic inspection.

Output unit

No.	Abnormal symptom	Possible cause	Corrective action
1	All output units do not turn on.	(1) Supply voltage for load is not applied.	Apply voltage. (Raise voltage.)
		(2) Signal level within unit is defective.	Remove all I/O units being used and insert them one by one to find defective unit.
2	All relays of specific output unit do not turn on.	(1) Same as 1(1).	Same as above.
		(2) Screws of terminal block are loose.	Retighten screw terminals.
		(3) Faulty contact of jack.	Clean contact with alcohol-moistened cloth.
		(4) Fuse is blown.	Replace blown fuse.
		(5) Internal circuit is defective.	Replace defective unit.
3	All relays of specific output unit do not turn off.	(1) Faulty contact of jack and connector	Clean contact with alcohol-moistened cloth.
		(2) Gate circuit is defective.	Replace defective unit.
4	Output of specific relay number does not turn on.	• Operation indicator (LED) does not illuminate. (1) ON time duration of output is short.	Correct program.
		(2) Relay numbers of OUT instruction in program are used in duplicate.	Correct program.
		(3) Power circuit is defective.	Replace defective unit.
		• Operating indicator (LED) is illuminating. (1) Broken connection of external load.	Replace defective external load.
		(2) Screws of terminal block are loose.	Retighten screw terminals.
		(3) Pattern is broken.	Replace defective unit.
5	Output of specific relay number does not turn off.	• Operation indicator (LED) does not illuminate. (1) Contact does not release due to leakage current	Replace defective external load or add dummy resistor.
		(2) Relay numbers of OUT instruction in program are used in duplicate.	Correct program.
		(3) Power circuit is defective	Replace defective unit.
6	Abnormal relay number is in units of 8 points.	(1) Data bus signal is faulty.	Remove all I/O units being used and reinsert them one by one to find defective unit.
		(2) IC-RAM of CPU is defective.	Replace CPU.
7	Outputs turn on and off irregularly.	(1) Supply voltage for external load is low.	Raise external supply voltage.
		(2) Relay numbers of OUT instruction in program are used in duplicate.	Correct program.
		(3) Malfunction due to noise.	Countermeasures against noise • Install surge suppressor • Install insulating transformer • Wire with shielded cable
8	Output operation indicator does not illuminate. (Operation is normal.)	(1) LED indicator is defective.	Since this type of defect does not impede normal operation, repair it in your spare time or at the next periodic inspection.

Chapter 8 Special I/O units

Available types

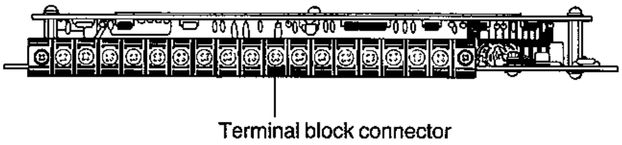
Classification		Specifications	Power supply voltage	Weight	Type
A/D conversion input unit	2-channel	+1 to +5 V, +4 to +20 mA	—	600g max.	3G2A6-AD001
		0 to +10 V	—	600 g max.	3G2A6-AD002
		0 to +5 V	—	600 g max.	3G2A6-AD003
		−10 to +10 V	—	600 g max.	3G2A6-AD004
		−5 to +5 V	—	600 g max.	3G2A6-AD005
	4-channel	+1 to +5 V, +4 to +20 mA	—	650 g max.	3G2A6-DA006
		0 to 10 V	—	650 g max.	3G2A6-DA007
D/A conversion output unit (assigned to two channels of PC)		+1 to +5 V, +4 to +20 mA	—	600 g max.	3G2A6-DA001
		0 to +10 V	—	600 g max.	3G2A6-DA002
		0 to +5 V	—	600 g max.	3G2A6-DA003
		−10 to +10 V	—	600 g max.	3G2A6-DA004
		−5 to +5 V	—	600 g max.	3G2A6-DA005
High-speed counter unit(assigned to four channels of PC)			—	700 g max.	3G2A6-CT001-E
Remote I/O master unit			—	500 g max.	3G2A6-RM001-E
Remote I/O slave unit	1:1	With one fiber optics connector for connecting only one slave unit to master unit	—	500 g max.	3G2A5-RT001-E
	1:2	With two fiber optics connectors for connecting two slave units to master unit	—	500 g max.	3G2A5-RT002-E
Optical transmitting I/O unit	Input unit	No-voltage contact, 10 mA, 8 points	110/120 VAC	580 g max.	3G5A2-ID001-E
			220/240 VAC	580 g max.	3G5A2-ID002-E
		12 to 24 VAC/VDC, 10 mA, 8 points	110/120 VAC	580 g max.	3G5A2-IM211-E
			220/240 VAC	580 g max.	3G5A2-IM212-E
		110/120 VAC, 10 mA, 8 points	110/120 VAC	580 g max.	3G5A2-IA121-E
		220/240 VAC, 10 mA, 8 points	110/120 VAC	600 g max.	3G5A2-IA221-E
			220/240 VAC	600 g max.	3G5A2-IA222-E
	Output unit	Relay contact, 250 VAC/24 VDC, 2 A, 8 points	110/120/220/ 240 VAC	600 g max.	3G5A2-OC221-E
		Triac, 85 to 250 VAC 1 A, 8 points		600 g max.	3G5A2-OA222-E
		Transistor, 12 to 48 VDC, 0.3 A, 8 points		600 g max.	3G5A2-OD411-E
Fiber optics cable		0.1 m-long with connector (used commonly for optical transmitting I/O unit)	—	20 g max.	3G5A2-OF011
		1 m-long with connector (used commonly for optical transmitting I/O unit)	—	40 g max.	3G5A2-OF101
		2 m-long with connector (used commonly for optical transmitting I/O unit)	—	60 g max.	3G5A2-OF201
		3 m-long with connector (used commonly for optical transmitting I/O unit)	—	80 g max.	3G5A2-OF301
		5 m-long with connector (used commonly for optical transmitting I/O unit)	—	120 g max.	3G5A2-OF501
		10 m-long with connector (used commonly for optical transmitting I/O unit)	—	220 g max.	3G5A2-OF111
		20 m-long with connector (used commonly for optical transmitting I/O unit)	—	420 g max.	3G5A2-OF211
		30 m-long with connector (used commonly for optical transmitting I/O unit)	—	620 g max.	3G5A2-OF311
		50 m-long with connector (used commonly for optical transmitting I/O unit)	—	1 kg max.	3G5A2-OF511

Mounting positions of I/O unit on CPU/expansion I/O rack

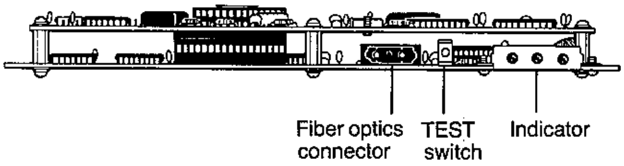
Rack	Mounting position	UNIT 0 position (lower position)	UNIT 1 position (upper position)
CPU rack	3G2C4-SC023-E 3G2C4-SC024-E 3G2C4-SC021-E 3G2C4-SC022-E	Basic input unit	Basic input unit Basic output unit
Expansion I/O rack	3G2C4-SI021 3G2C4-SI022	Basic input unit Basic output unit	Basic input unit Basic output unit
	3G2C4-SI023 3G2C4-SI024	Basic input unit Basic output unit	I/O link unit
	3G2C4-SI025 3G2C4-SI026	Basic input unit Basic output unit	A/D conversion input unit D/A conversion output unit High-speed counter unit
	3G2C4-SI027 3G2C4-SI028	Basic input unit Basic output unit	Remote I/O master unit

Names of parts

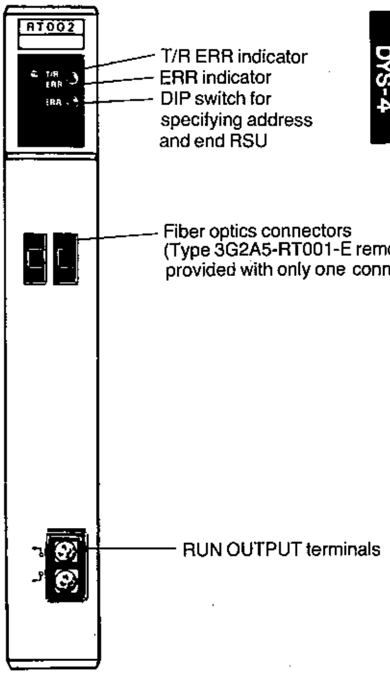
A/D conversion input unit (Type 3G2A6-AD00□)/D/A conversion output unit (Type 3G2A6-DA00□)/High-speed counter input unit (Type 3G2A6-CT001-E)

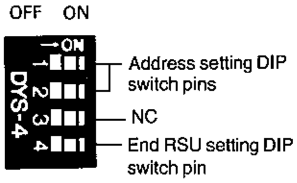


Remote I/O master unit (Type 3G2A6-RM001-E)



Remote I/O slave unit (Type 3G2A5-RT002-E/-RT001-E)





Indications

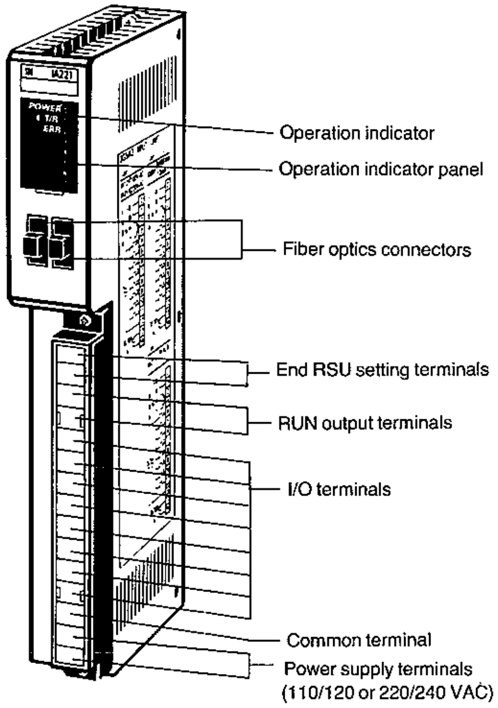
	Name of indicator	Function
Master/ slave unit	◐ T/R ● ERR	Blinks (◐) during normal data transmission and lights up (●) when a transmission error occurs.
Master unit	● TEST ○ OK	Lights up (●) if the transmission line is normal and does not (○) if it is abnormal when the transmission line is tested by using the TEST switch. This test can be repeatedly conducted while the TEST switch is being held down, but the TEST OK indicator goes out if a failure in the transmission line is detected.
	● END ○ RS CHK	Lights up (●) if no end RSU is found and does not (○) if the end RSU is found.
Slave unit	● I/O ERR	Lights up (●) when a failure occurs in the I/O bus of the slave unit or when the input or output to/from the slave unit is incorrectly recognized by the programmable controller.

Controls

	Name of parts	Function
Master unit	TEST switch	Tests the transmission for normal operation repeatedly while this switch is being held down when the programmable controller is in the PROGRAM mode.
Slave unit	Address/ END station setting DIP switch	Nos. 1 and 2 pins of this DIP switch specifies the address of the remote I/O slave unit. No. 4 pin specifies the end RSU. No. 3 pin is independent.
	RUN OUTPUT	Turns ON when no transmission error occurs with the programmable controller in the RUN or MONITOR mode and turns OFF under other condition (e.g., when the programmable controller is in the PROGRAM mode or when a transmission error occurs with the controller in the RUN or MONITOR mode).

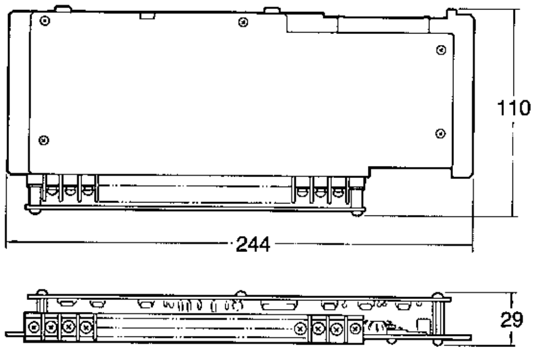
Optical transmitting I/O unit

3G5A2-ID00□-E/-IM21□-E/-IA□□□-E/-OC221-E/-OA221-E/-OD411-E



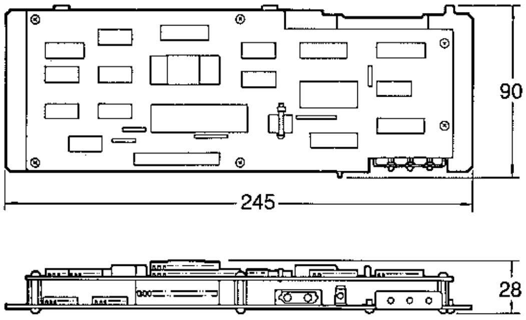
Dimensions

A/D conversion input unit (Type 3G2A6-AD00□)/D/A conversion output unit (Type 3G2A6-DA00□)/High-speed counter input unit (Type 3G2A6-CT001-E)

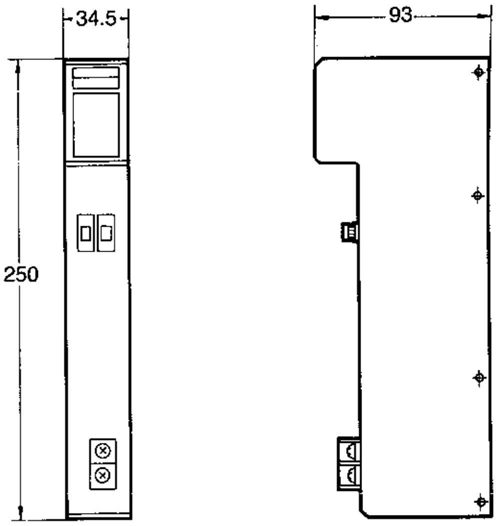


Remote I/O units

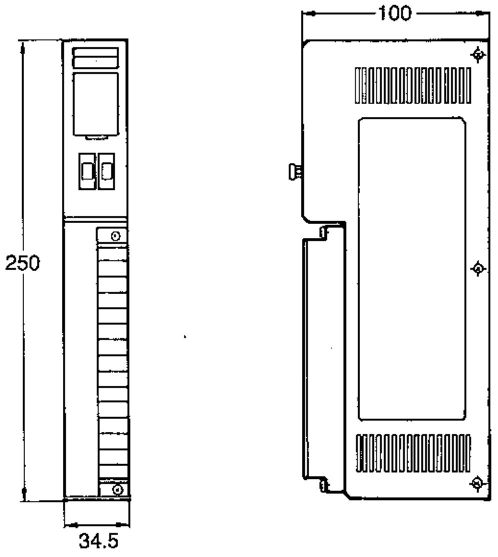
Remote I/O master unit (3G2A6-RM001-E)



Remote I/O slave unit (3G2A5-RT00□-E)



Optical transmitting I/O unit
(3G5A2-ID00□-E)/-IM21□-E/-IA□□□-E/-OC221-E/-O A221-E/-OD411-E



A/D conversion input unit

The A/D conversion input units available are broadly divided into two types by the number of channels: 2-channel type and 4-channel type.

The 2-channel type A/D conversion input unit is capable of converting an analog input signal into a 12-bit binary data. Various input signal ranges are available. For voltage input, the signal range can be 0 to +10 V, 0 to +5 V, +1 to +5 V, −5 to +5 V, or −10 to +10 V. For current input, a signal range of +4 to +20 mA is available.

This type of A/D conversion input unit has identical circuitry for each of the two channels (Line 1 and Line 2). The 4-channel type A/D conversion input unit converts an analog input signal into 10-bit binary data. For voltage input, the signal range can be 0 to +10 V or +1 to +5 V. For current input, the signal range is +4 to +20 mA.

This type of A/D conversion input unit has identical circuitry for each of the four channels (Lines 1 to 4).

Specifications

Input channel	2 channels	4 channels
External input range *1	Voltage input: 0 to +10 V 0 to +5 V +1 to +5 V −5 to +5 V −10 to +10 V	Voltage input: 0 to +10 V +1 to +5 V
	Current input: +4 to +20 mA	
External input impedance	Voltage input: 1 MΩ min.	
	Current: 250 Ω	
Resolution	1/4,095 of full scale	1/1,023
Output signal to SYSMAC-C Series *2	Binary 12 bits	Binary 10 bits
Linearity	±0.1% max.	±0.2% max.
Accuracy	±0.2% max of full scale (at 25°C)	
Temp. coefficient	±100PPM/°C of full scale	±150PPM/°C of full scale
Conversion time	2.5 ms/point max.	
Conversion cycle	5 ms max.	10 ms max.
Conversion mode	Sequential comparison	
Max. permissible external input	Voltage input: ±15 V max.	
	Current input: ±60 mA max.	
Terminal for external connection	Terminal block (cannot be dismounted)	
Internal power supply	+5 V, 300 mA max.	+5 V, 750 mA max.
Weight	600 g max.	650 g max.

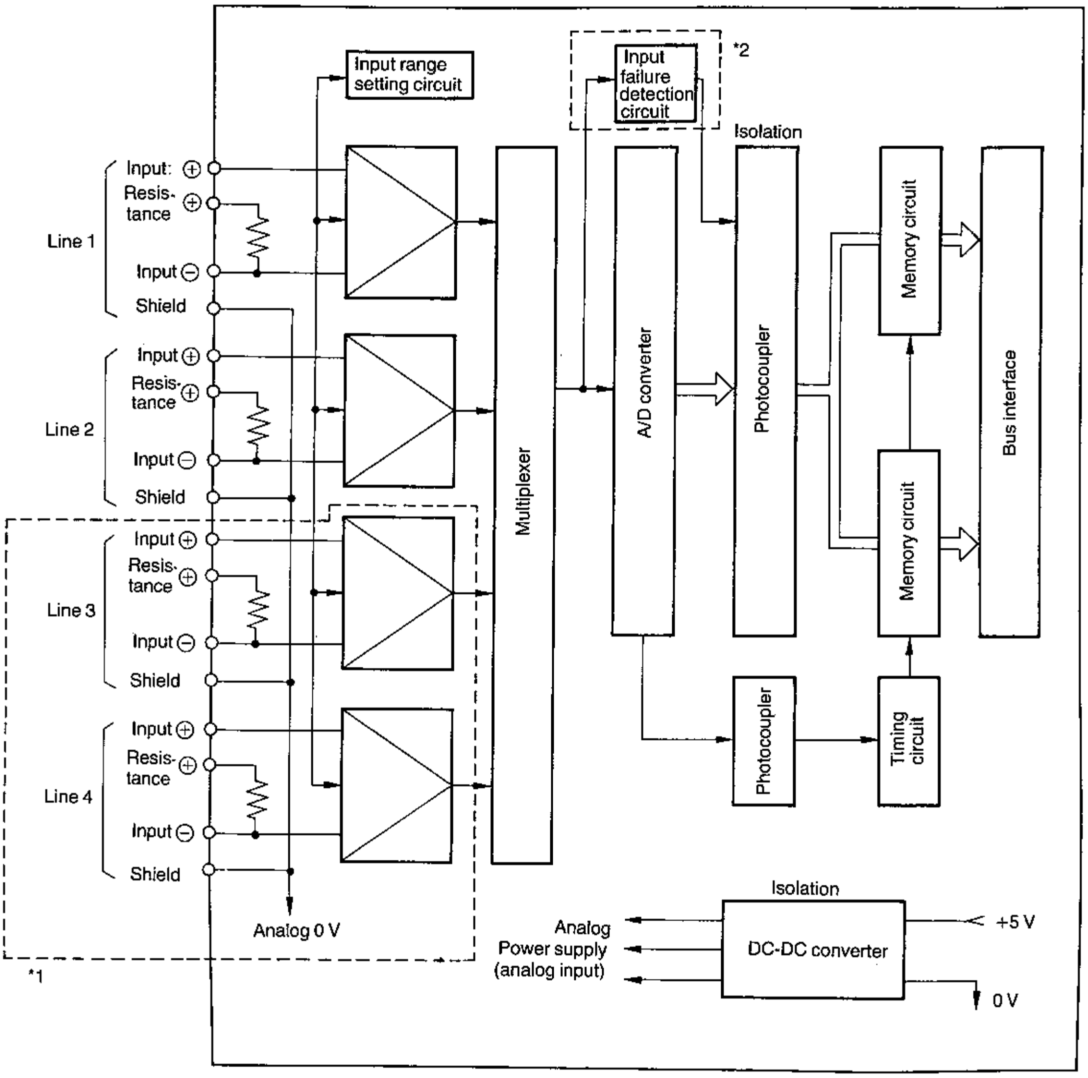
*1: Select and use the type with a desired input signal range by referring to Available types. The current input function is provided to only Types 3G2A6-AD001 and 3G2A6-AD006, whose voltage input ranges are both +1 to +5 V.

*2: An input analog signal is converted into a 12-bit binary data consisting of a sign bit and 11-bit data when the A/D conversion input unit (2-channel type only) with input signal range of −5 to +5 V or −10 to +10 V is used.

Note: Insert the A/D conversion input unit to the upper slot of an expansion I/O rack when mounting the unit to the SYSMAC-C120F.

To mount the unit to the SYSMAC-C120F, use Type 3G2C4-SI025 or 3G2C4-SI026.

Block diagram



*1 The circuitry for these two lines are not provided to the 2-channel type A/D conversion input unit.

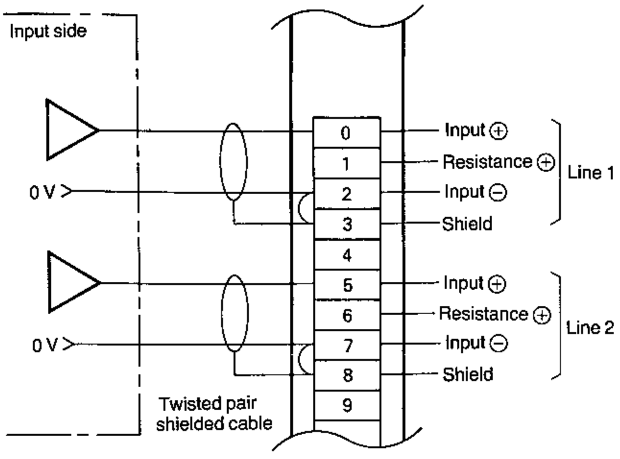
*2 The input failure detection circuit is not provided to the 4-channel type A/D conversion input unit.

Note: An input failure is detected by only Type 3G2A6-AD001 (+1 to +5 for voltage input or +4 to +20 mA for current input).

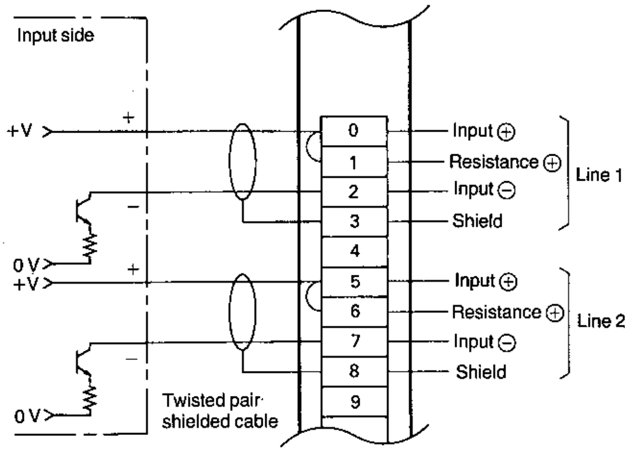
External connection diagram
2-channel type

Connection for voltage input

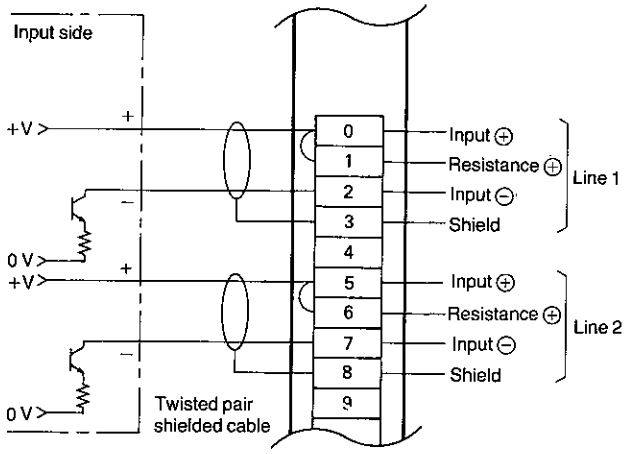
1. When the signal is a common mode input



2. When the signal is a differential output



Connection for current input

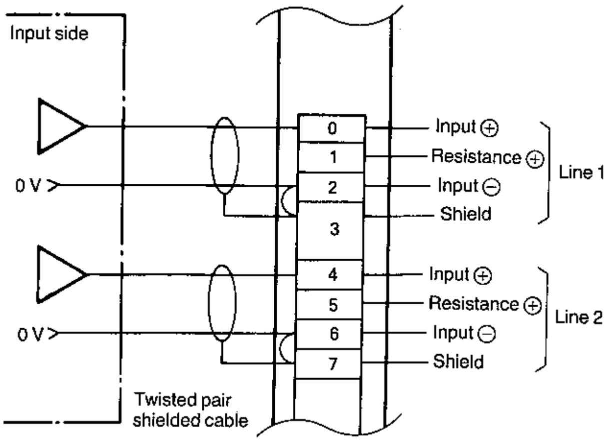


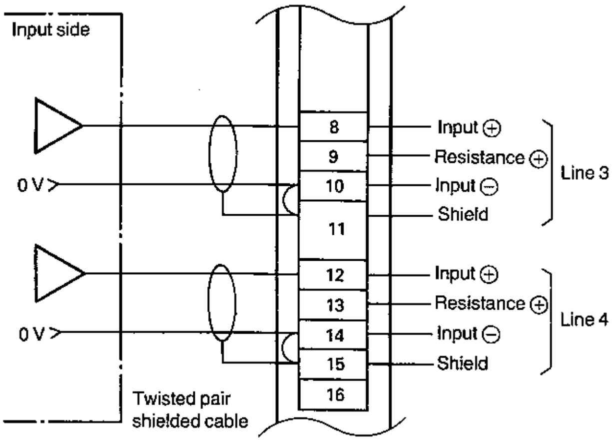
Note: Be sure to use a twisted pair shielded cable for input.

Short-circuit the Shield, Input ⊕, and Input ⊖ terminals of the circuit that is not used.

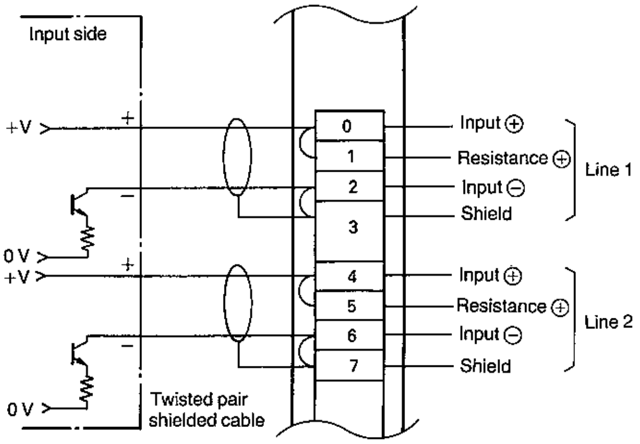
4-channel type

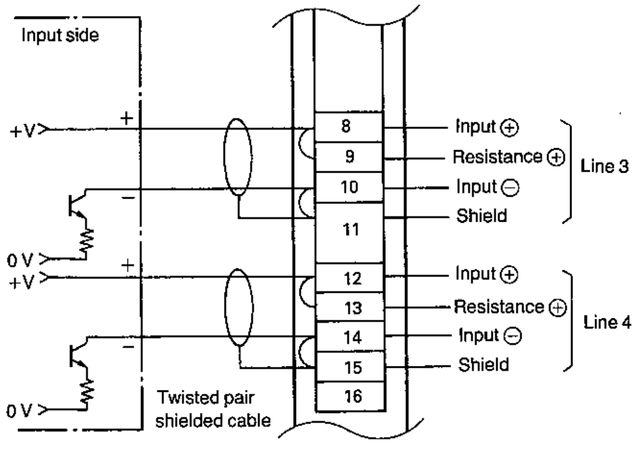
Connection for voltage input





Connection for current input





Note: Be sure to use a twisted pair shielded cable for input.

Short-circuit the Shield, Input ⊕, and Input ⊖ terminals of the circuit that is not used.

Assignment of relay number

(Output from A/D conversion input unit)

2-channel type

Channel No. / Bit No.	n CH	n+1 CH
0	A/D converted data 2^{0}	A/D converted data 2^{0}
1	A/D converted data 2^{1}	A/D converted data 2^{1}
2	A/D converted data 2^{2}	A/D converted data 2^{2}
3	A/D converted data 2^{3}	A/D converted data 2^{3}
4	A/D converted data 2^{4}	A/D converted data 2^{4}
5	A/D converted data 2^{5}	A/D converted data 2^{5}
6	A/D converted data 2^{6}	A/D converted data 2^{6}
7	A/D converted data 2^{7}	A/D converted data 2^{7}
8	A/D converted data 2^{8}	A/D converted data 2^{8}
9	A/D converted data 2^{9}	A/D converted data 2^{9}
10	A/D converted data 2^{10}	A/D converted data 2^{10}
11	A/D converted data 2^{11}	A/D converted data 2^{11}
12	0	0
13	0	0
14	0	0
15	0	0
	Line 1 input	Line 2 input

Note: Bit No. 11 is used as either A/D converted data or the sign bit. When used as the sign bit, the level of this bit becomes "1" when the level of the input signal is high and becomes "0" when the level of the input signal is low. Bit No. 15 of Type 3G2A6-AD001 A/D conversion input unit (+1 to +5 V for voltage input or +4 to +20 mA for current input) detects an input failure. The level of this bit becomes "1" when an input failure occurs and remains "0" during normal operation of the unit.
The signal level of bit No. 15 of other A/D conversion input units remains "0".

4-channel type

Channel No. / Bit No.	n CH	n+1 CH	n+2 CH	n+3 CH
0	A/D converted data 2^{0}	A/D converted data 2^{0}	A/D converted data 2^{0}	A/D converted data 2^{0}
1	A/D converted data 2^{1}	A/D converted data 2^{1}	A/D converted data 2^{1}	A/D converted data 2^{1}
2	A/D converted data 2^{2}	A/D converted data 2^{2}	A/D converted data 2^{2}	A/D converted data 2^{2}
3	A/D converted data 2^{3}	A/D converted data 2^{3}	A/D converted data 2^{3}	A/D converted data 2^{3}
4	A/D converted data 2^{4}	A/D converted data 2^{4}	A/D converted data 2^{4}	A/D converted data 2^{4}
5	A/D converted data 2^{5}	A/D converted data 2^{5}	A/D converted data 2^{5}	A/D converted data 2^{5}
6	A/D converted data 2^{6}	A/D converted data 2^{6}	A/D converted data 2^{6}	A/D converted data 2^{6}
7	A/D converted data 2^{7}	A/D converted data 2^{7}	A/D converted data 2^{7}	A/D converted data 2^{7}
8	A/D converted data 2^{8}	A/D converted data 2^{8}	A/D converted data 2^{8}	A/D converted data 2^{8}
9	A/D converted data 2^{9}	A/D converted data 2^{9}	A/D converted data 2^{9}	A/D converted data 2^{9}
10	0	0	0	0
11	0	0	0	0
12	0	0	0	0
13	0	0	0	0
14	0	0	0	0
15	0	0	0	0
	Line 1	Line 2	Line 3	Line 4

Input signal and converted data

The A/D conversion input unit is capable of converting an analog input signal into a digital data.

Note that five types of units are available and that their input signal ranges are different from each other.

In terms of input signal, two types of analog input signals are available; one is a unipolar signal input only to the + terminal of the unit, and the other is a bipolar signal input to both the + and − terminals. The resolution differs depending on which input signal range is employed.

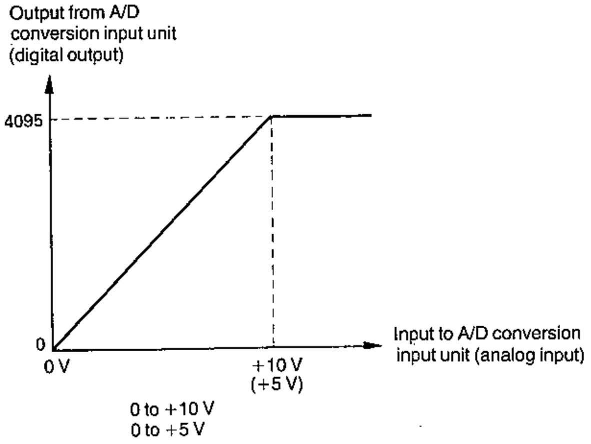
Unipolar input signal
Input range
2-channel type: 0 to +10 V, 0 to +5 V,
+1 to +5 V, or +4 to +20 mA
4-channel type: 0 to +10 V, +1 to +5 V,
or +4 to +20 mA

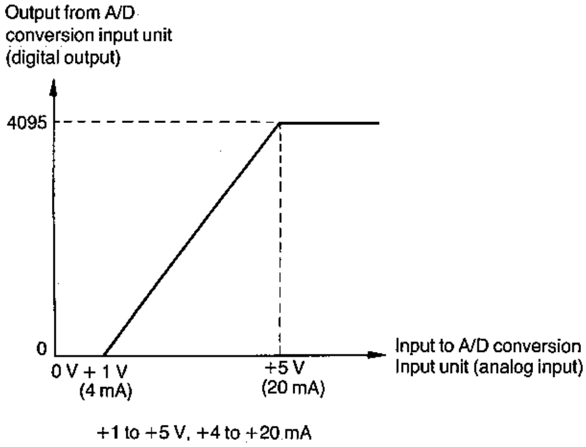
Converted output
2-channel type: A/D converted, 12-bit binary data
4-channel type: A/D converted, 10-bit binary data

Note: Bit No. 15 of Type 3G2A6-AD001 (+1 to +5 V for voltage output or +4 to +20 mA for current output) is an input failure detection bit. The level of this bit becomes "1" when an input failure occurs and becomes "0" during normal operation.

If the voltage input signal decreases below 0.5 V, or if the current input signal decreases below 2 mA, an input failure is detected and therefore, the level of bit No. 15 becomes "1".

Relation between analog input signal and A/D converted data

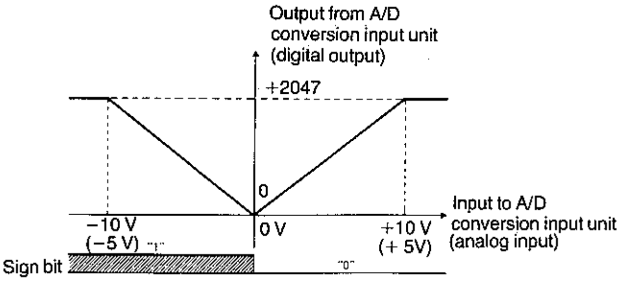




Bipolar input signal (only for 2-channel type)
Input range: −5 to +5 V or −10 to +10 V
Converted output: Sign bit (1 bit) and A/D converted, 11-bit binary data

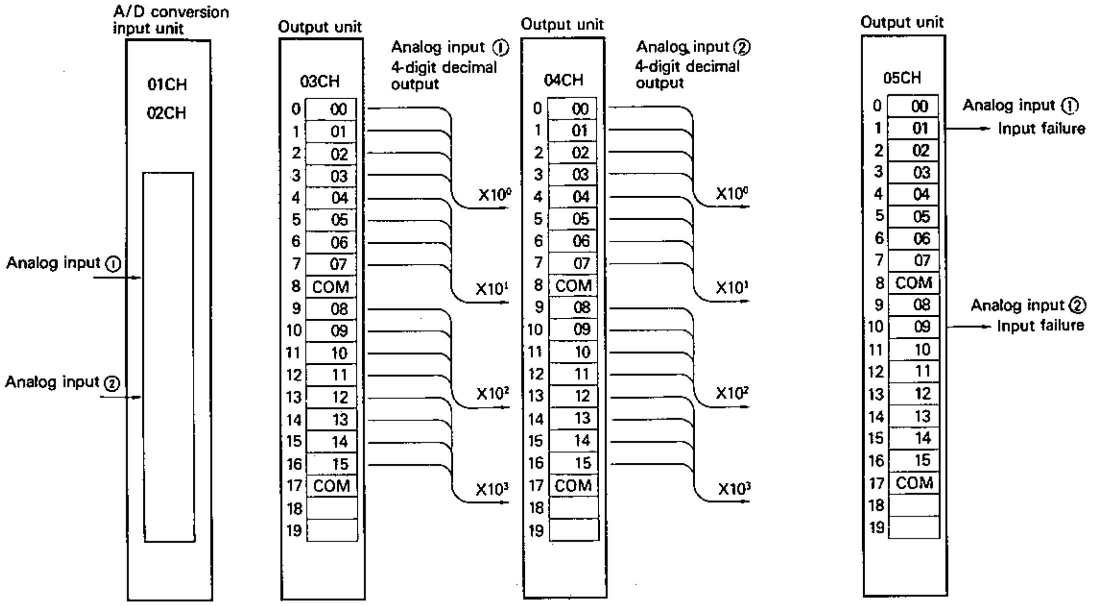
Note: Bit No. 11 is the sign bit. The level of this bit becomes "0" when the analog signal input to the A/D conversion input unit is positive and becomes "1" when a negative analog signal is input.
Conversion code: Sign magnitude method.

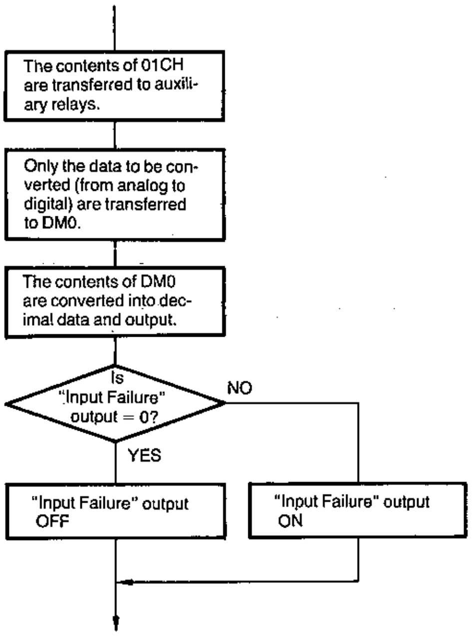
Relation between analog input signal and A/D converted data



Programming example

In this example, two types of analog signals are input to the A/D conversion input unit from external devices and are converted by the unit into decimal 4 digits (less than 4095).





```
  XFER
             # 0001 )  The contents of 1CH are transferred to
                 01 |  auxiliary relay 32CH.
                 32 )
  ANDW
                 32 )  Only the data to be converted (from analog
             # 0FFF |  to digital) are transferred to DM0.
             DM 000 )
  BCD
             DM 000 )  The contents of DM0 are converted into
                 03 )  decimal data and output to 03CH.
  AND          3215    "Input Failure" flag check
  CJP LBL       100
  OUT NOT       501    "Input Failure" output OFF
  JMP LBL       110
LBL             100
  OUT           501    "Input Failure" output ON
LBL             110
  XFER
             # 0001 )  The contents of 2CH are transferred to
                 02 |  auxiliary relay 32CH.
                 32 )
  ANDW
                 32 )  Only the data to be converted (from analog
             # 0FFF |  to digital) are transferred to DM1.
             DM 001 )
  BCD
             DM 001 )  The contents of DM1 are converted into
                 04 )  decimal data and output to 4CH.
  AND          3215    "Input Failure" flag check
  GJP LBL       200
  OUT NOT       509    "Input Failure" output OFF
  JMP LBL       210
LBL             200
  OUT           509    "Input Failure" output ON
LBL             210
```

Caution: Transfer data output from the A/D conversion unit to auxiliary relays by using the XFER instruction (FUN72) and then perform data processing by using the transferred data.

When using the A/D conversion unit to convert data in bit units as "Input Failure" flag, transfer data output from the unit to a relay in the internal auxiliary relay area.

D/A Conversion output unit

The D/A conversion output unit is capable of converting a 12-bit binary data from a SYSMAC-C Series programmable controller into an analog output signal. A wide variation of output signal ranges are available: 0 to +10 V, 0 to +5 V, +1 to +5 V, −10 to +10 V, −5 to +5 V for voltage output and +4 to +20 mA for current output. The D/A conversion output unit has an identical circuitry for each of the two channels (Line 1 and Line 2).

Specifications

No. of output points	2
External output range *1	Voltage output: 0 to +10 V 0 to +5 V +1 to +5 V −10 to +10 V −5 to +5 V
	Current output: +4 to +20 mA
External output impedance	Voltage output: 0.5 Ω max.
Max. current for external output	Voltage output: 15 mA
Permissible load resistance for external output	Current output: 550 Ω max.
Resolution	1/4,095 of full scale
Input signal from SYSMAC-C Series *2	Binary 12 bits
Lineartiy	±1/2 LSB max. at 25°C
Accuracy	±0.2% max. of full scale at 25°C
Temp. coefficient	±50 PPM/°C
Conversion time	5 ms max.
Conversion cycle	Program execution cycle of SYSMAC-C Series
Terminal for external connection	Terminal block (cannot be dismounted)
Internal power supply	+5 V, 550 mA max.
Weight	600 g max.

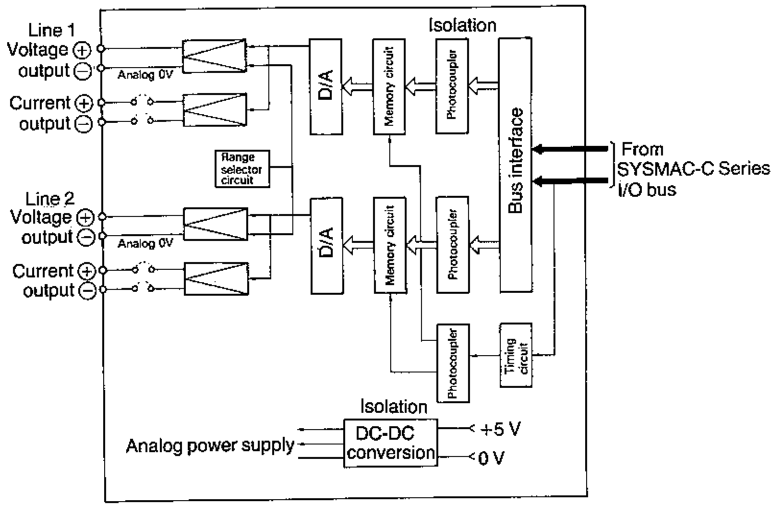
*1: Specify the external output range when placing your order (refer to Available types). Current output is available only in Type 3G2A6-DA001 whose voltage output range is +1 to +5 V.

*2: The binary code output from the types with the voltage output ranges consists of 1 sign bit and 11 bits.

Note: Insert the D/A conversion output unit to the upper slot of an expansion I/O rack when mounting the unit to the SYSMAC-C120F.

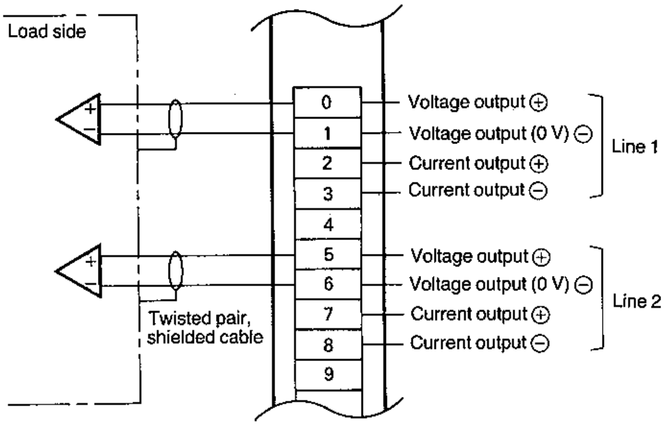
To mount the unit to the SYSMAC-C120F, use Type 3G2C4-SI025 or 3G2C4-SI026.

Block diagram

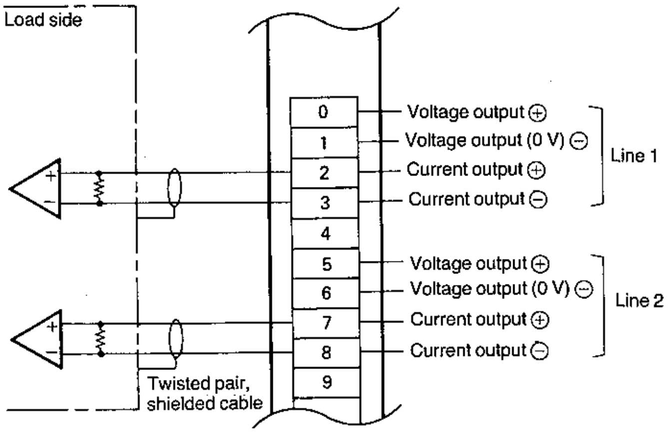


The current output (4 to 20 mA) is available only in the unit with the voltage output range +1 to +5 V. The terminal for the current output of the unit with the other voltage range is therefore opened.

Connection for voltage output



Connection for current output



Note: Be sure to use a twisted pair shielded cable for external output connection.

Use the shielded cable at the load side for both current and voltage outputs.

Assignment of relay number (inputs to D/A conversion output unit)

Channel No. / Bit No.	n CH	n+1 CH
0	D/A converted data 2^0	D/A converted data 2^0
1	D/A converted data 2^1	D/A converted data 2^1
2	D/A converted data 2^2	D/A converted data 2^2
3	D/A converted data 2^3	D/A converted data 2^3
4	D/A converted data 2^4	D/A converted data 2^4
5	D/A converted data 2^5	D/A converted data 2^5
6	D/A converted data 2^6	D/A converted data 2^6
7	D/A converted data 2^7	D/A converted data 2^7
8	D/A converted data 2^8	D/A converted data 2^8
9	D/A converted data 2^9	D/A converted data 2^9
10	D/A converted data 2^{10}	D/A converted data 2^{10}
11	D/A converted data 2^{11}	D/A converted data 2^{11}
12		
13		
14		
15		
	Line 1 input	Line 2 input

* During the D/A conversion, the contents of bits 12 to 15 are ignored. These bits can thus be used as internal auxiliary relays.

Note: The function bit 11 performs changes depending on whether the unit in use is designed for unipolar output or bipolar output. That is, bit 11 of a unipolar output type unit is a D/A converted data, and bit 11 of a bipolar output type serves as a sign bit. The level of the sign bit becomes 0 when the unit outputs a negative analog signal and becomes 1 when the unit outputs a positive analog signal.

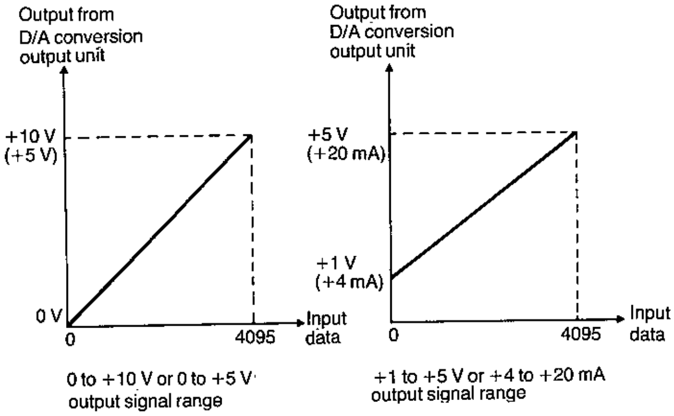
Operation

Converted data and output signal

The D/A conversion output unit converts an input digital data into an analog data. It converts a 12-bit binary data output from a SYSMAC-C Series programmable controller into a voltage or a current. Five types of units with different output signal ranges are available. Make a correct choice from these five types. The converted analog signal may be output from only a positive pole of the terminals or from both the positive and negative poles, depending on the signal range of the used unit. Note that the resolution of the signal also differs depending on this signal range.

Unipolar output signal
Output range: 0 to +10 V, 0 to +5 V, +1 to +5 V, +4 to +20 mA
D/A converted data: A 12-bit binary data is input to the unit.

Relation between input digital signal and output analog signal

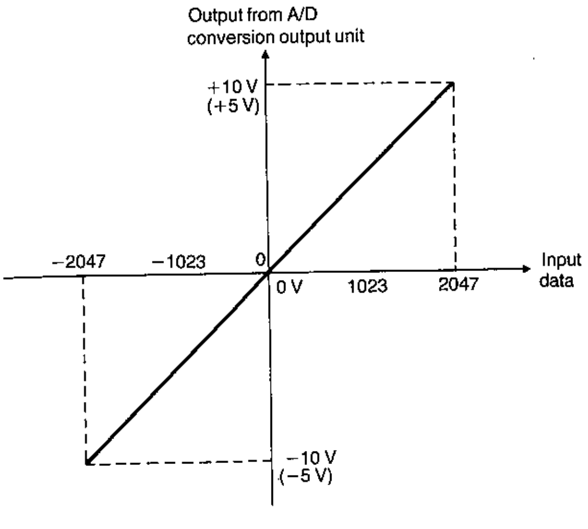


Note that an input binary data exceeding 12 bits (decimal 4095) cannot be converted into an analog signal.

Bipolar output signal
Output range: −10 to +10 V, −5 to +5 V
D/A converted data: A binary 11-bit data with one sign bit is input to the unit.

Note: Bit 11 is a sign bit. The level of this bit becomes "0" when the digital data input to the D/A conversion output unit is positive, and it becomes "1" when the input digital signal is negative.

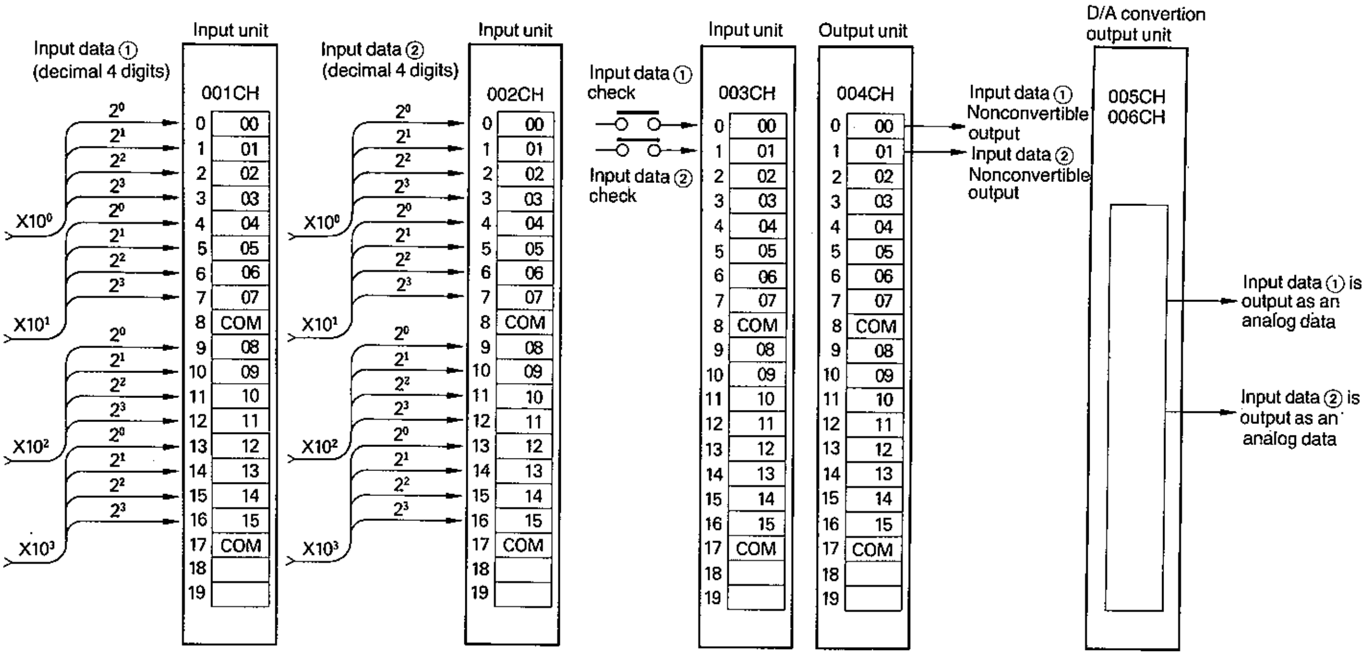
Relation between input digital and output analog signal The digital data input to the D/A conversion output unit; which exceeds decimal +2048 or is less than −2048, cannot be converted into an analog signal.

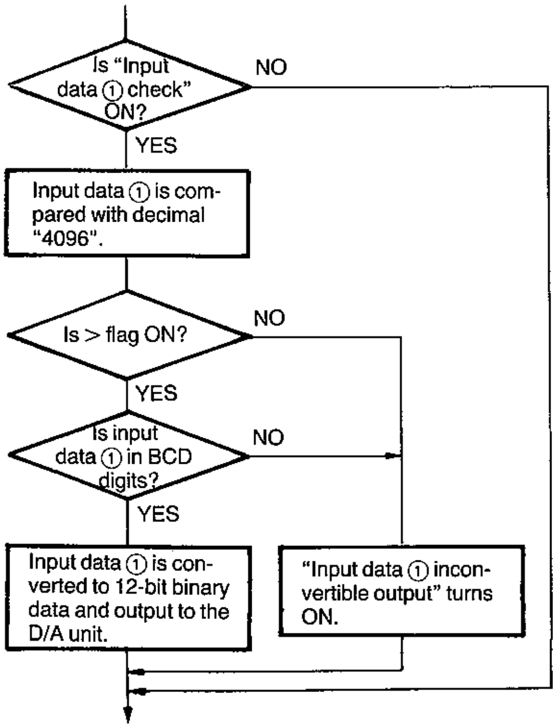


The digital data input to the D/A conversion output unit, which is in a range of decimal +2048 to +4095 (i.e., when the sign bit is 1), is treated as being in the range of decimal −1 to −2047. Therefore, the voltage output range in this case is 0 to −5 V or 0 to −10 V.

Programming examples

In this example, two types of 4-digit decimal data (less than 4095) are input to the D/A conversion output unit from external devices and are converted into an analog signal.





```
 AND        300
 CJP LBL    100
 JMP LBL    200      When input 300
                     is OFF
LBL         100
 MOV
                1
            DM  0
 CMP
            DM  0
            # 4096
 AND       6307      < flag
 CJP LBL    110
 JMP LBL    120
LBL         110
 BIN
            DM  0
                5
LBL         120
 AND       6306      =flag
 OR        6305      > flag
 OR         400      Self-holding
 OR        6303      Error flag
 CJP LBL    130
 JMP LBL    200
LBL         130
 OUT        400      Output impossible

LBL         200
 AND        301
 CJP LBL    210
 JMP LBL    300
```

```
LBL         210
 MOV
                2
            DM  0
 CMP
            DM  0
            # 4096
 AND       6307
 CJP LBL    220
 JMP LBL    230
LBL         220
 BIN
            DM  0
                6
LBL         230
 AND       6306
 OR        6305
 OR         401
 OR        6303
 CJP LBL    240
 JMP LBL    300
LBL         240
 OUT        401
LBL         300
```

Note: Special auxiliary relay No. 6303 of a SYSMAC-C120F programmable controller serves as an error flag. The level of this flag becomes "1" if an input data is not a BCD code.

High-speed counter unit

The high-speed counter unit is a 6-digit-BCD high-speed reversible counter that is connected to a SYSMAC-C Series programmable controller and sensor, such as a rotary encoder, and is capable of counting clock pulses at a rate of 50K counts per second. This unit is ideal for positioning control or high-speed measurement operations and can be connected with various sensors.

Specifications

Count input	Input signal *	Count input 1 Count input 2
	Voltage level of input signal	H: 6 to 12 V L: 0 to 4 V
	Input modes	• Command input 1/command input 2: UP/DOWN count command is to be executed by a program or count input 2 • Phase differential inputs: Specifies wheter UP/DOWN count command is to be executed by the phase difference between count inputs 1 and 2 as follows: UP: When count input 1 leads count input 2 by 90°. DOWN: When count input 1 lags count input 2 by 90°. (The above three modes are selectable by using the DIP switch in the unit.)
	Counting speed	Solid-state input: 50K cps max. (20K cps max. for phase differential input) Contact input: 30 cps max. (The above two counting speeds are selectble by using the DIP switch in the unit.)
Reset input	Voltage level of input signal	H: 6 to 12 V L: 0 to 4 V
	ON-delay time	1.5 ms max.
	OFF-delay time	2 ms max.
Output signals		• Output by hardware Coincidence signal: Relay contact output and transistor (open collector) output Present count value > set count value output signal: transistor (open collector) output
Internal power supply		+5 V 300 mA max.
Terminal for external connection		Terminal block (cannot be dismounted)
Power supply for sensor		12 VDC ±10% 100 mA (per point)
Power supply to outside circuit		24 VDC ±10% 500 mA
Weight		700 g max.

* Count input 1 can be connected to both the solid-state and contact inputs. Count input 2 can be connected to the solid-state input only.

Relay output specifications

Output switching capacity	Relay contact output (G6B) 250 VAC/2 A (p.f. = 1) 24 VDC/2 A
On-delay time	10 ms max.
OFF-delay time	15 ms max.
Service life	Electrically: 300×10^3 operations Mechanically: 20×10^6 operations

Open collector type transistor output specifications

Max. switching ability	24 VDC 200 mA
Leakage current	500 μA max.
Saturation voltage	1.3 V max.
ON-delay time	50 μs max.
OFF-delay time	50 μs max.

Note: Insert the high-speed counter unit to the upper slot of an expansion I/O rack when mounting the unit to the SYSMAC-C120F.

To mount the unit to the SYSMAC-C120F, use Type 3G2C4-SI025 or 3G2C4-SI026.

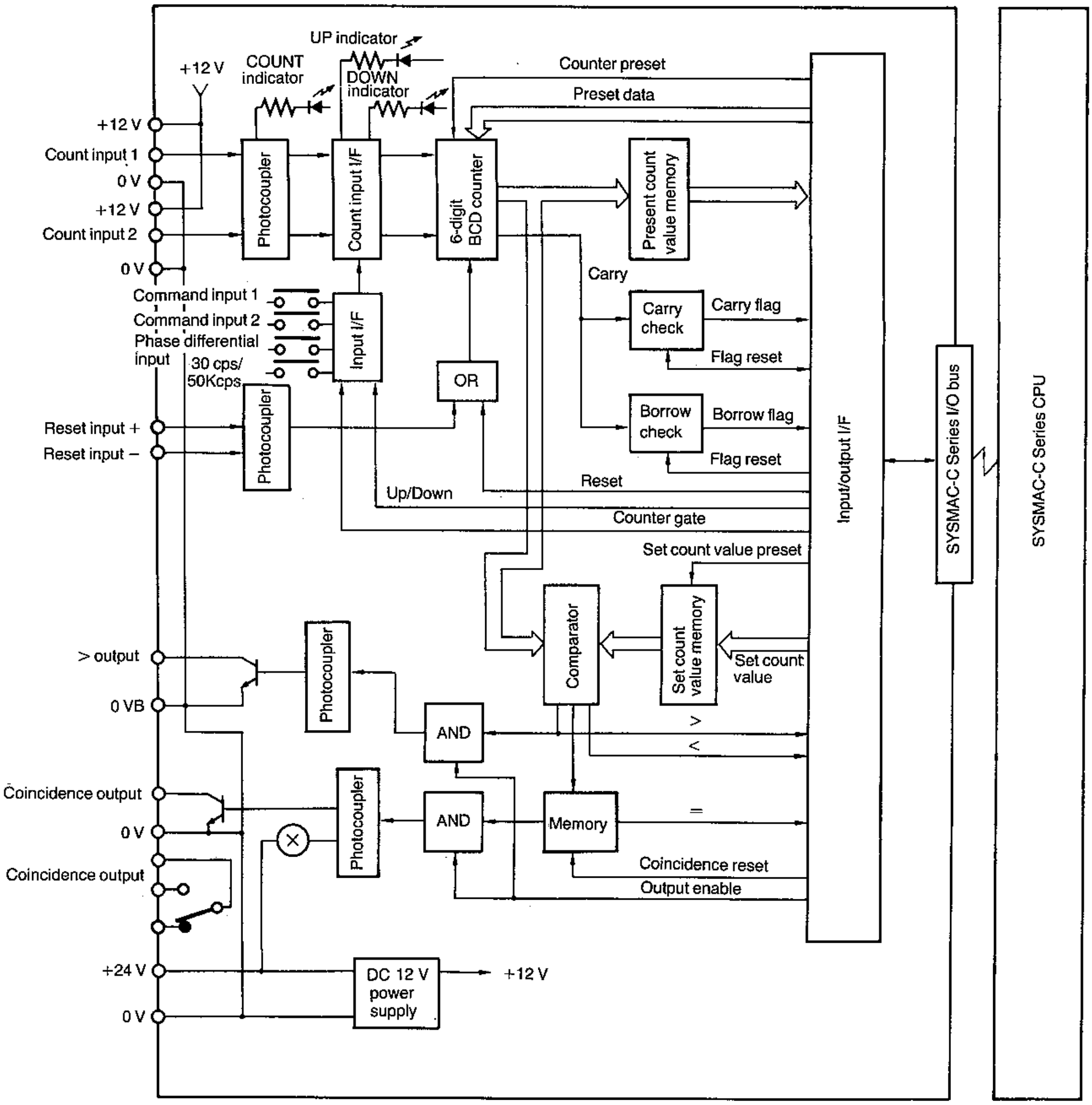
Indicators

Indicator		Function
✸ ○	COUNT	Lights up when count input 1 is L and goes out when count input 1 is H.
✸	UP	Lights up while the counter is performing an up-count operation.
✸	DOWN	Lights up while the counter is performing an up-count operation.
✸	PV > SV	Lights up when a present count value is greater than a set count value (present count value > set cout value).
✸	PV = SV	Lights up when a present count value is equal to a set count value (present count value = set count value). This indicator, however, unconditionally goes out when the "Output enable" relay is turned OFF.
✸	PV = SV	Lights up when a present count value is less than a set count value (present count value < set count value).
✸	+12 V	Lights up when the power supply for sensor is +12 V

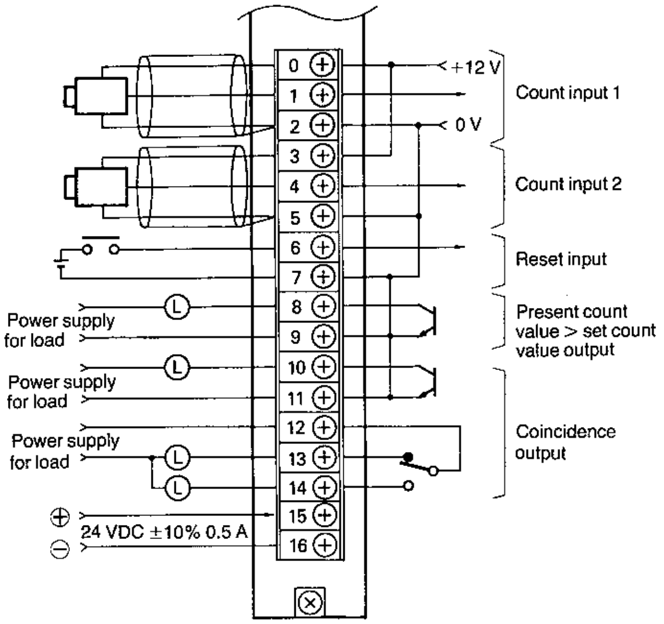
DIP switch for count input mode setting

Specifies the count input mode of the counter.

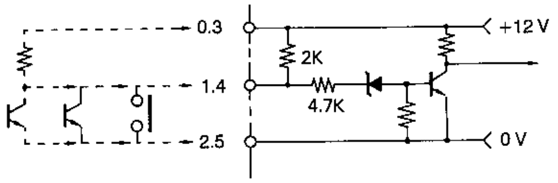
Block diagram



External connections

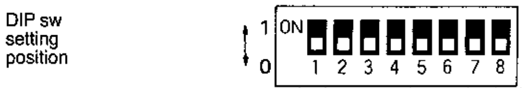


Count input signal



Note: Because the high-speed counter unit performs its operation at a counting speed of 50K counts per second, avoid connecting loads and wirings that may generate much noise to the coincidence output terminals.

Setting DIP switch for count input mode

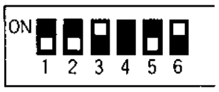


			1	2	3	4	5	6	7	8
INPUT MODE	COMMAND INPUT	1	1	0	0					
		2	0	1	1					
	PHASE DIFFERENTIAL INPUT		0	0	1					
	NO VOLTAGE CONTACT INPUT					1				
	WHEN PHASE DIFFERENTIAL INPUT						1	0		
	WHEN NOT PHASE DIFFERENTIAL INPUT						0	1		
IN 1	WHEN NOT EMITTER FOLLOWER SENSOR CONNECTION								1	
IN 2	WHEN NOT EMITTER FOLLOWER SENSOR CONNECTION									1

Setting of count input mode

Command input 1 mode:
This mode is used to specify UP/DOWN count command signal by a program.

Command input 2 mode:
This mode is used to specify UP/DOWN count command signal by count input 2.



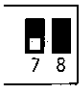
Phase differential input mode:
This mode is used to identify whether up-count or down-count operation is to be performed by the phase difference between count input 1 and 2.

Setting of frequency response

30 cps
(contact input):
With the pin set in the "ON" position, the counter unit can be operated in command input 1 mode only, and the response frequency of count input 1 is set to 30 cps.

50K cps (Solid-state input):
With this pin set in the "OFF" position, the counter unit can be operated in all input modes, and the response frequency of both count inputs, 1 and 2, is set to 50K cps.

Setting of sensor output



Set this pin in the "OFF" position when the output from the sensor that is connected to count input 1 is of the emitter follower type. Otherwise, set the pin in the "ON" position.

Set this pin in the "OFF" position when the output from the sensor that is connected to count input 2 is of the emitter follower type. Otherwise set the pin in the "ON" position.

Assignment of relay numbers

I/O of SYSMAC-C	OUT				IN			
Channel / Bit	nth CH		nth+1 CH		nth+2 CH		nth+3 CH	
0	Counter preset		Preset data 1	×10²	Carry		Present count data 1	×10²
1	Set count value preset		Preset data 2		Borrow		Present count data 2	
2	Count gate		Preset data 4		Present count value > set count value		Present count data 4	
3	UP/DOWN count command		Preset data 8		Present count value = set count value		Present count data 8	
4	Carry reset		Preset data 1	×10³	Present count value < set count value		Present count data 1	×10³
5	Borrow reset		Preset data 2		Normally ON		Present count data 2	
6	Coincidence reset		Preset data 4		Normally ON		Present count data 4	
7	Output enable		Preset data 8		Normally ON		Present count data 8	
8	Preset data 1	×10⁰	Preset data 1	×10⁴	Present count data 1	×10⁰	Present count data 1	×10⁴
9	Preset data 2		Preset data 2		Present count data 2		Present count data 2	
10	Preset data 4		Preset data 4		Present count data 4		Present count data 4	
11	Preset data 8		Preset data 8		Present count data 8		Present count data 8	
12	Preset data 1	×10¹	Preset data 1	×10⁵	Present count data 1	×10¹	Present count data 1	×10⁵
13	Preset data 2		Preset data 2		Present count data 2		Present count data 2	
14	Preset data 4		Preset data 4		Present count data 4		Present count data 4	
15	Preset data 8		Preset data 8		Present count data 8		Present count data 8	

Note: The term “set count value” is synonymous with “preset data”.

Function of relays

The following signals are input to the high-speed counter unit from the programmable controller.

Name of relay	Function
Counter preset	Presets the data set as a preset data to the counter; in other words, modifies a currently set value.
Set count value preset	Presets data set as a preset data to the set count value memory.
Count gate	Controls starting and stopping the counter. When this relay is turned ON, the counting operation starts, and when it is turned OFF, the counting operation stops. On power application, the count gate relay specifies that the counting operation is stopped.
UP/DOWN count command	Specifies the up-count or down-count operation by the user program when the high-speed counter unit is in the command input 1 mode. When this relay is turned ON, the down-count operation is specified. When it is OFF, the up-count operation is specified. On power application, the up-count command is given.
Carry reset	Resets the Carry signal of the counter. Once the Carry signal has been reset, it will not be set again until the count gate relay is turned ON and a counting operation is performed.
Borrow reset	Resets the Borrow signal of the counter. Once the Borrow signal is reset, it will not be set again until the counter gate relay is turned ON and a counting operation is performed.
Coincidence reset	Resets the present count value = set count value signal of the counter. Once the present count value = set count value signal has been reset, it will not be set again until the counter gate relay is turned ON and a counting operation is performed. If this relay is turned ON while the present count value coincides with the set count value, the present count value = set count value relay (i.e., bit No. 3 of n+2 CH) will not be turned ON.
Output enable	Enables the external output signals (coincidence output and present count value > set count value output) to be output. On power application, the output is disabled, and therefore, both the contact and transistor outputs are turned OFF.
Preset data (10^5 through 10^0)	Represent the preset data of the counter or the set count value memory. If these relays represent the data of the counter, those data are the present count value. The value of the data can be 000000 to 999999. On power application, the data are 000000.

The following signals are input to the programmable controller from the high-speed counter unit.

Carry	Turns ON when the present count value changes from 999999 to 000000 during the Add operation. This relay is turned OFF by the carry reset relay or an external reset signal.
Borrow	Turns ON when the present count value changes from 000000 to 999999. This relay is turned OFF by the borrow reset relay of an external reset signal.
Present count value > set count value	Turns ON when the present count value is greater than the set count value.
Present count value = set count value	Turns ON when the present count value coincides with the set count value. This relay is turned OFF by the coincidence reset relay or an external reset signal.
Present count value < set count value	Turns ON when the present count value is less than the set count value.
Present count value data	Present count value (000000 to 999999)

Note: On power application, all the relays are turned OFF.

Assignment of relay numbers

I/O of SYSMAC-C	OUT				IN			
Channel / Bit	nth CH		nth+1 CH		nth+2 CH		nth+3 CH	
0	Counter preset		Preset data 1	×10²	Carry		Present count data 1	×10²
1	Set count value preset		Preset data 2		Borrow		Present count data 2	
2	Count gate		Preset data 4		Present count value > set count value		Present count data 4	
3	UP/DOWN count command		Preset data 8		Present count value = set count value		Present count data 8	
4	Carry reset		Preset data 1	×10³	Present count value < set count value		Present count data 1	×10³
5	Borrow reset		Preset data 2		Normally ON		Present count data 2	
6	Coincidence reset		Preset data 4		Normally ON		Present count data 4	
7	Output enable		Preset data 8		Normally ON		Present count data 8	
8	Preset data 1	×10⁰	Preset data 1	×10⁴	Present count data 1	×10⁰	Present count data 1	×10⁴
9	Preset data 2		Preset data 2		Present count data 2		Present count data 2	
10	Preset data 4		Preset data 4		Present count data 4		Present count data 4	
11	Preset data 8		Preset data 8		Present count data 8		Present count data 8	
12	Preset data 1	×10¹	Preset data 1	×10⁵	Present count data 1	×10¹	Present count data 1	×10⁵
13	Preset data 2		Preset data 2		Present count data 2		Present count data 2	
14	Preset data 4		Preset data 4		Present count data 4		Present count data 4	
15	Preset data 8		Preset data 8		Present count data 8		Present count data 8	

Note: The term "set count value" is synonymous with "preset data".

Function of relays

The following signals are input to the high-speed counter unit from the programmable controller.

Name of relay	Function
Counter preset	Presets the data set as a preset data to the counter; in other words, modifies a currently set value.
Set count value preset	Presets data set as a preset data to the set count value memory.
Count gate	Controls starting and stopping the counter. When this relay is turned ON, the counting operation starts, and when it is turned OFF, the counting operation stops. On power application, the count gate relay specifies that the counting operation is stopped.
UP/DOWN count command	Specifies the up-count or down-count operation by the user program when the high-speed counter unit is in the command input 1 mode. When this relay is turned ON, the down-count operation is specified. When it is OFF, the up-count operation is specified. On power application, the up-count command is given.
Carry reset	Resets the Carry signal of the counter. Once the Carry signal has been reset, it will not be set again until the count gate relay is turned ON and a counting operation is performed.
Borrow reset	Resets the Borrow signal of the counter. Once the Borrow signal is reset, it will not be set again until the counter gate relay is turned ON and a counting operation is performed.
Coincidence reset	Resets the present count value = set count value signal of the counter. Once the present count value = set count value signal has been reset, it will not be set again until the counter gate relay is turned ON and a counting operation is performed. If this relay is turned ON while the present count value coincides with the set count value, the present count value = set count value relay (i.e., bit No. 3 of n+2 CH) will not be turned ON.
Output enable	Enables the external output signals (coincidence output and present count value > set count value output) to be output. On power application, the output is disabled, and therefore, both the contact and transistor outputs are turned OFF.
Preset data (10^5 through 10^0)	Represent the preset data of the counter or the set count value memory. If these relays represent the data of the counter, those data are the present count value. The value of the data can be 000000 to 999999. On power application, the data are 000000.

The following signals are input to the programmable controller from the high-speed counter unit.

Carry	Turns ON when the present count value changes from 999999 to 000000 during the Add operation. This relay is turned OFF by the carry reset relay or an external reset signal.
Borrow	Turns ON when the present count value changes from 000000 to 999999. This relay is turned OFF by the borrow reset relay of an external reset signal.
Present count value > set count value	Turns ON when the present count value is greater than the set count value.
Present count value = set count value	Turns ON when the present count value coincides with the set count value. This relay is turned OFF by the coincidence reset relay or an external reset signal.
Present count value < set count value	Turns ON when the present count value is less than the set count value.
Present count value data	Present count value (000000 to 999999)

Note: On power application, all the relays are turned OFF.

Assignment of relay numbers

I/O of SYSMAC-C	OUT				IN			
Bit \ Channel	nth CH		nth+1 CH		nth+2 CH		nth+3 CH	
0	Counter preset		Preset data 1	$\times 10^{2}$	Carry		Present count data 1	$\times 10^{2}$
1	Set count value preset		Preset data 2		Borrow		Present count data 2	
2	Count gate		Preset data 4		Present count value > set count value		Present count data 4	
3	UP/DOWN count command		Preset data 8		Present count value = set count value		Present count data 8	
4	Carry reset		Preset data 1	$\times 10^{3}$	Present count value < set count value		Present count data 1	$\times 10^{3}$
5	Borrow reset		Preset data 2		Normally ON		Present count data 2	
6	Coincidence reset		Preset data 4		Normally ON		Present count data 4	
7	Output enable		Preset data 8		Normally ON		Present count data 8	
8	Preset data 1	$\times 10^{0}$	Preset data 1	$\times 10^{4}$	Present count data 1	$\times 10^{0}$	Present count data 1	$\times 10^{4}$
9	Preset data 2		Preset data 2		Present count data 2		Present count data 2	
10	Preset data 4		Preset data 4		Present count data 4		Present count data 4	
11	Preset data 8		Preset data 8		Present count data 8		Present count data 8	
12	Preset data 1	$\times 10^{1}$	Preset data 1	$\times 10^{5}$	Present count data 1	$\times 10^{1}$	Present count data 1	$\times 10^{5}$
13	Preset data 2		Preset data 2		Present count data 2		Present count data 2	
14	Preset data 4		Preset data 4		Present count data 4		Present count data 4	
15	Preset data 8		Preset data 8		Present count data 8		Present count data 8	

Note: The term "set count value" is synonymous with "preset data".

Function of relays

The following signals are input to the high-speed counter unit from the programmable controller.

Name of relay	Function
Counter preset	Presets the data set as a preset data to the counter; in other words, modifies a currently set value.
Set count value preset	Presets data set as a preset data to the set count value memory.
Count gate	Controls starting and stopping the counter. When this relay is turned ON, the counting operation starts, and when it is turned OFF, the counting operation stops. On power application, the count gate relay specifies that the counting operation is stopped.
UP/DOWN count command	Specifies the up-count or down-count operation by the user program when the high-speed counter unit is in the command input 1 mode. When this relay is turned ON, the down-count operation is specified. When it is OFF, the up-count operation is specified. On power application, the up-count command is given.
Carry reset	Resets the Carry signal of the counter. Once the Carry signal has been reset, it will not be set again until the count gate relay is turned ON and a counting operation is performed.
Borrow reset	Resets the Borrow signal of the counter. Once the Borrow signal is reset, it will not be set again until the counter gate relay is turned ON and a counting operation is performed.
Coincidence reset	Resets the present count value = set count value signal of the counter. Once the present count value = set count value signal has been reset, it will not be set again until the counter gate relay is turned ON and a counting operation is performed. If this relay is turned ON while the present count value coincides with the set count value, the present count value = set count value relay (i.e., bit No. 3 of n+2 CH) will not be turned ON.
Output enable	Enables the external output signals (coincidence output and present count value > set count value output) to be output. On power application, the output is disabled, and therefore, both the contact and transistor outputs are turned OFF.
Preset data (10^5 through 10^0)	Represent the preset data of the counter or the set count value memory. If these relays represent the data of the counter, those data are the present count value. The value of the data can be 000000 to 999999. On power application, the data are 000000.

The following signals are input to the programmable controller from the high-speed counter unit.

Carry	Turns ON when the present count value changes from 999999 to 000000 during the Add operation. This relay is turned OFF by the carry reset relay or an external reset signal.
Borrow	Turns ON when the present count value changes from 000000 to 999999. This relay is turned OFF by the borrow reset relay of an external reset signal.
Present count value > set count value	Turns ON when the present count value is greater than the set count value.
Present count value = set count value	Turns ON when the present count value coincides with the set count value. This relay is turned OFF by the coincidence reset relay or an external reset signal.
Present count value < set count value	Turns ON when the present count value is less than the set count value.
Present count value data	Present count value (000000 to 999999)

Note: On power application, all the relays are turned OFF.

Assignment of relay numbers

I/O of SYSMAC-C	OUT				IN			
Channel / Bit	nth CH		nth+1 CH		nth+2 CH		nth+3 CH	
0	Counter preset		Preset data 1	×10²	Carry		Present count data 1	×10²
1	Set count value preset		Preset data 2		Borrow		Present count data 2	
2	Count gate		Preset data 4		Present count value > set count value		Present count data 4	
3	UP/DOWN count command		Preset data 8		Present count value = set count value		Present count data 8	
4	Carry reset		Preset data 1	×10³	Present count value < set count value		Present count data 1	×10³
5	Borrow reset		Preset data 2		Normally ON		Present count data 2	
6	Coincidence reset		Preset data 4		Normally ON		Present count data 4	
7	Output enable		Preset data 8		Normally ON		Present count data 8	
8	Preset data 1	×10⁰	Preset data 1	×10⁴	Present count data 1	×10⁰	Present count data 1	×10⁴
9	Preset data 2		Preset data 2		Present count data 2		Present count data 2	
10	Preset data 4		Preset data 4		Present count data 4		Present count data 4	
11	Preset data 8		Preset data 8		Present count data 8		Present count data 8	
12	Preset data 1	×10¹	Preset data 1	×10⁵	Present count data 1	×10¹	Present count data 1	×10⁵
13	Preset data 2		Preset data 2		Present count data 2		Present count data 2	
14	Preset data 4		Preset data 4		Present count data 4		Present count data 4	
15	Preset data 8		Preset data 8		Present count data 8		Present count data 8	

Note: The term “set count value” is synonymous with “preset data”.

Function of relays

The following signals are input to the high-speed counter unit from the programmable controller.

Name of relay	Function
Counter preset	Presets the data set as a preset data to the counter; in other words, modifies a currently set value.
Set count value preset	Presets data set as a preset data to the set count value memory.
Count gate	Controls starting and stopping the counter. When this relay is turned ON, the counting operation starts, and when it is turned OFF, the counting operation stops. On power application, the count gate relay specifies that the counting operation is stopped.
UP/DOWN count command	Specifies the up-count or down-count operation by the user program when the high-speed counter unit is in the command input 1 mode. When this relay is turned ON, the down-count operation is specified. When it is OFF, the up-count operation is specified. On power application, the up-count command is given.
Carry reset	Resets the Carry signal of the counter. Once the Carry signal has been reset, it will not be set again until the count gate relay is turned ON and a counting operation is performed.
Borrow reset	Resets the Borrow signal of the counter. Once the Borrow signal is reset, it will not be set again until the counter gate relay is turned ON and a counting operation is performed.
Coincidence reset	Resets the present count value = set count value signal of the counter. Once the present count value = set count value signal has been reset, it will not be set again until the counter gate relay is turned ON and a counting operation is performed. If this relay is turned ON while the present count value coincides with the set count value, the present count value = set count value relay (i.e., bit No. 3 of n+2 CH) will not be turned ON.
Output enable	Enables the external output signals (coincidence output and present count value > set count value output) to be output. On power application, the output is disabled, and therefore, both the contact and transistor outputs are turned OFF.
Preset data (10^5 through 10^0)	Represent the preset data of the counter or the set count value memory. If these relays represent the data of the counter, those data are the present count value. The value of the data can be 000000 to 999999. On power application, the data are 000000.

The following signals are input to the programmable controller from the high-speed counter unit.

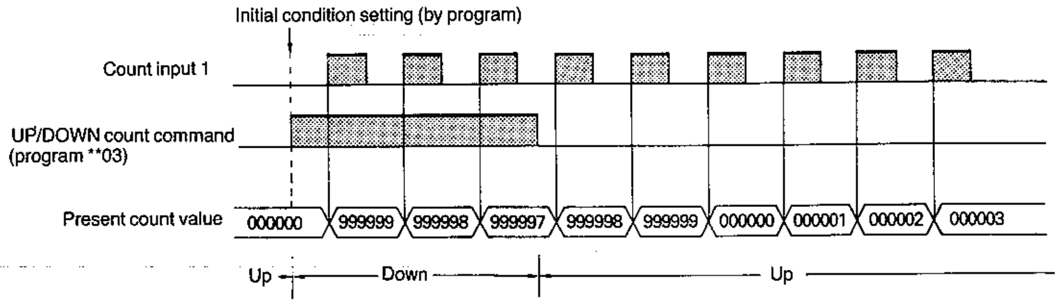
Carry	Turns ON when the present count value changes from 999999 to 000000 during the Add operation. This relay is turned OFF by the carry reset relay or an external reset signal.
Borrow	Turns ON when the present count value changes from 000000 to 999999. This relay is turned OFF by the borrow reset relay of an external reset signal.
Present count value > set count value	Turns ON when the present count value is greater than the set count value.
Present count value = set count value	Turns ON when the present count value coincides with the set count value. This relay is turned OFF by the coincidence reset relay or an external reset signal.
Present count value < set count value	Turns ON when the present count value is less than the set count value.
Present count value data	Present count value (000000 to 999999)

Note: On power application, all the relays are turned OFF.

Operation

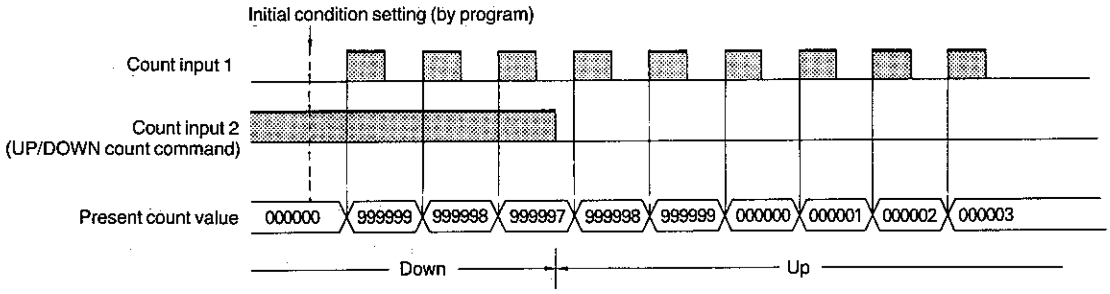
Timing charts of count mode

Command input mode 1



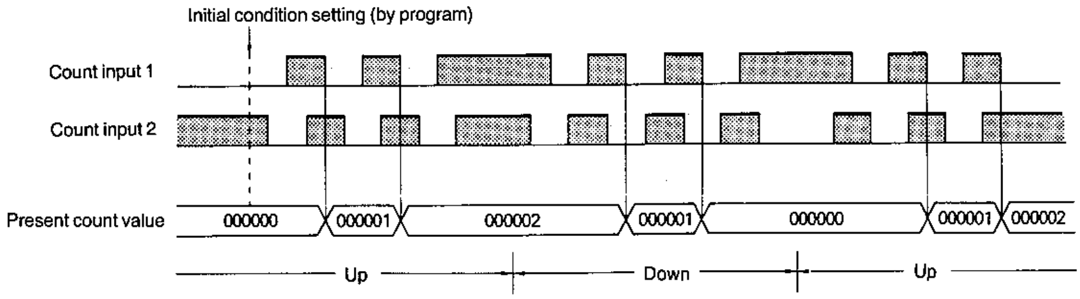
In this mode, the counter counts each leading edge of count input 1. The user program specifies either the UP or DOWN operation. The signal of count input 2 is ignored.

Command input mode 2



In this mode, the counter counts each leading edge of count input 1. Count input 2 specifies either the UP or DOWN operation. That is, the UP operation is performed when the input level of count input 2 is high, and if it is low, the DOWN operation is specified.

Phase differential input mode



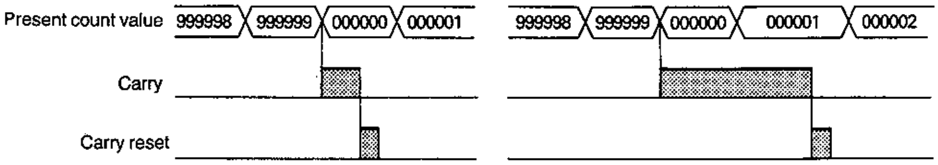
In this mode, whether the UP or DOWN operation is performed is specified by the phase difference between count inputs 1 and 2.

When count input 1 leads count input 2 by 90° at the leading edge of count input 1, the UP operation is specified at the trailing edge of count input 1. The DOWN operation, on the other hand, is specified when count input 1 lags count input 2 by 90° at the leading edge of count input 1.

Permissible phase differential error range is 90°±45°.

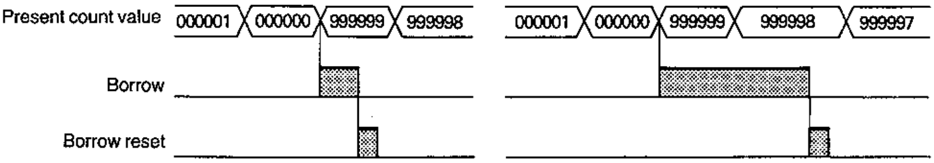
Timing charts of carry, borrow, and coincidence signals

Carry signal



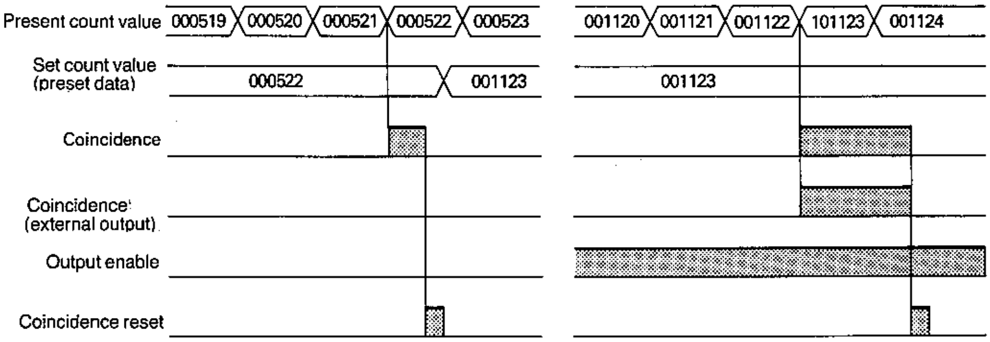
The level of the carry signal becomes high when the present count value of the counter changes from 999999 to 000000. This high level will be retained until the level of the carry reset or external reset signal becomes high.

Borrow signal



The level of the borrow signal becomes high when the present count value of the counter changes from 000000 to 999999. This high level will be retained until the level of the borrow reset or external reset signal becomes high.

Coincidence signal

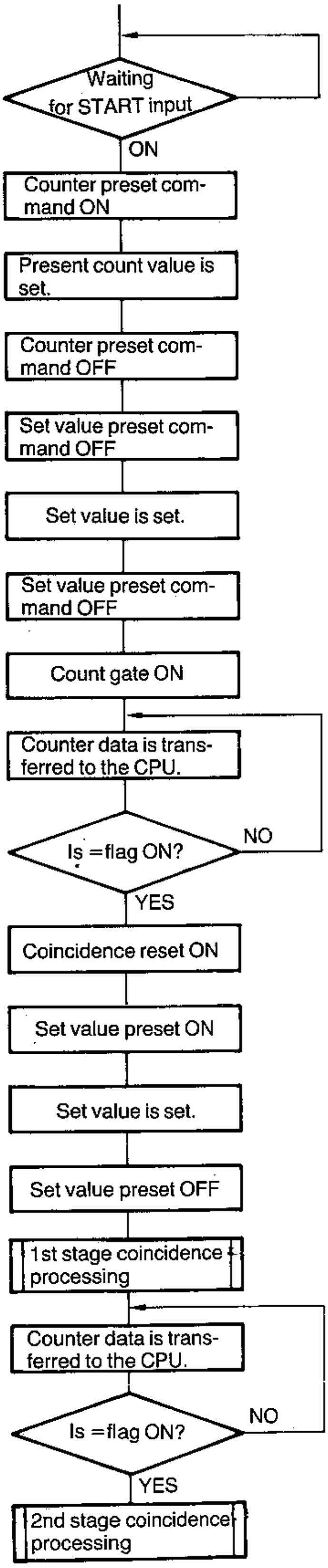


The level of the coincidence signal becomes high when the present count value of the counter coincides with the set count value. This high level will be retained until the level of the coincidence reset or external reset signal becomes high. The coincidence signal is not output until the level of the output enable signal becomes high.

Programming examples

Double preset counter

In this example, two count values "052200" and "112300" are processed with a double preset counter. (The counter unit is assigned to Channel Nos. 2 to 5 of the CPU. Channel No. 34 is an auxiliary relay.)



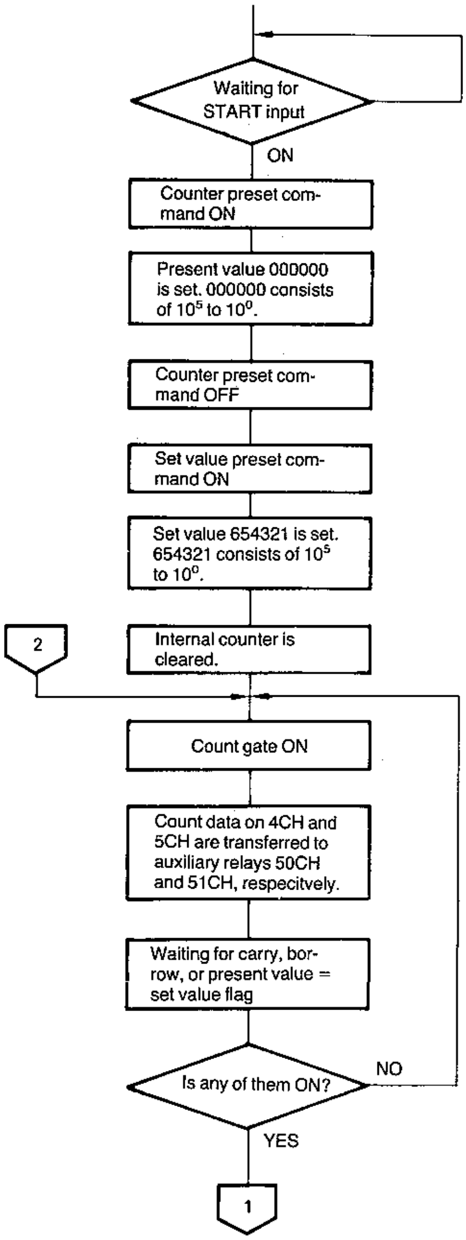
```
 AND        START input
 WAIT
 MOV                       Carry, borrow, coincidence reset, and count-
          # 0071           er preset commands are turned ON and
                2          present count value 00 is preset.
 MOV
          # 0000           Present count value 0000 is set. 0000
                3          consists of 10^5 to 10^2.
 OUT NOT     200
 OUT         201           Set value preset command ON
 MOV
          # 0522           Set value 0522 is set. 0522 consists of 10^5 to
                3          10^2.
 MOV                       Set value preset, carry, borrow, and coinci-
          # 0004           dence reset commands are turned OFF and
                2          count gate is turned ON.
LBL          100
 XFER                      Data of the counter unit on 4CH and 5CH are
          # 0002           transferred to auxiliary relays 34CH and
                4          35CH, respectively.
               34
 AND NOT    3403           Present value = Set value flag is checked.
 CJP LBL     100
 OUT         206
 OUT         201
 MOV
          # 1123           Set value 1122 is set. 1122 consists of 10^5
                3          and 10^2.
 OUT NOT     201
 OUT NOT     206
|1st stage coincidence processing|

LBL          200
 XFER
          # 0002           Data of the counter unit are transferred to
                4          the CPU.
               34
 AND NOT    3403           Present value = Set value flag is checked.
 CJP LBL     200
|2nd stage coincidence processing|
```

Multidigit preset UP counter (more than 6 digits)

In this example, count value "87654321" is processed with a multidigit preset UP counter.

- The counter unit is assigned to Channel Nos. 2 to 5 of the CPU rack.
- DM10 is used for internal counter.
- Auxiliary relays 50CH, 51CH, and No. 5207 are used.



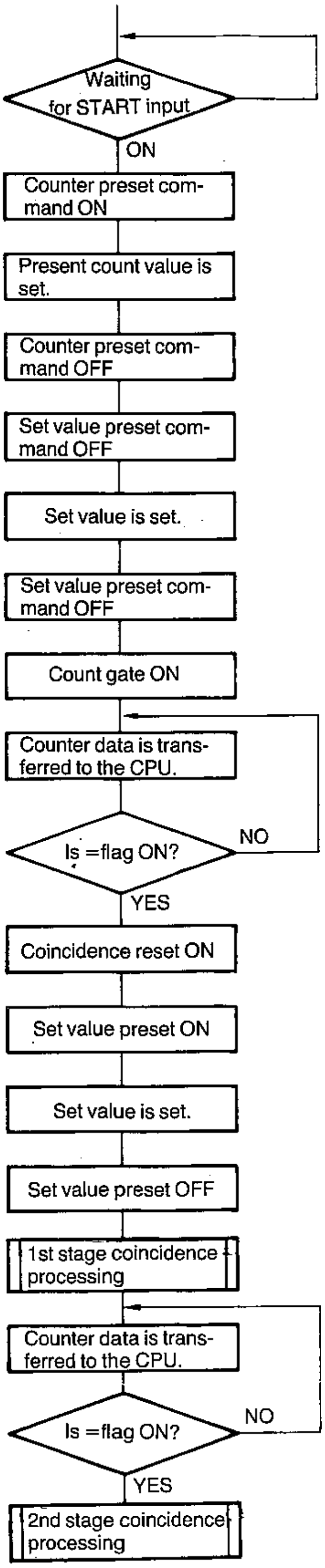
(Continued on next page)

AND	START input	
WAIT		
MOV	# 0071 2	Carry reset, borrow reset, and coincidence reset commands are turned ON. Counter preset command is turned ON and preset value 0 is set to 10^1 and 10^0.
MOV	# 0000 3	Present value 0000 is set. 0000 consists of 10^5 to 10^2.
MOV	# 2102 2	Counter preset command is turned OFF and set value present command is turned ON. Set value 21 is set. 21 consists of 10^1 and 10^0.
MOV	# 6543 3	Set value 6543 is set. 6543 consists of 10^5 to 10^2.
MOV	# 0000 DM 10	DM10 is cleared to 0.
OUT NOT	5207	
MOV	# 0004 2	Set value preset command is turned OFF and count gate is turned ON.
LBL	100	
XFER	# 0002 4 50	Counter unit inputs CH4 and CH5 are transferred to auxiliary relays CH50 and CH51, respectively.
OR	5000	Carry
OR	5001	Borrow
OR	5003	Present value = Set value
CJP LBL	101	
JMP LBL	100	

Programming examples

Double preset counter

In this example, two count values "052200" and "112300" are processed with a double preset counter. (The counter unit is assigned to Channel Nos. 2 to 5 of the CPU. Channel No. 34 is an auxiliary relay.)

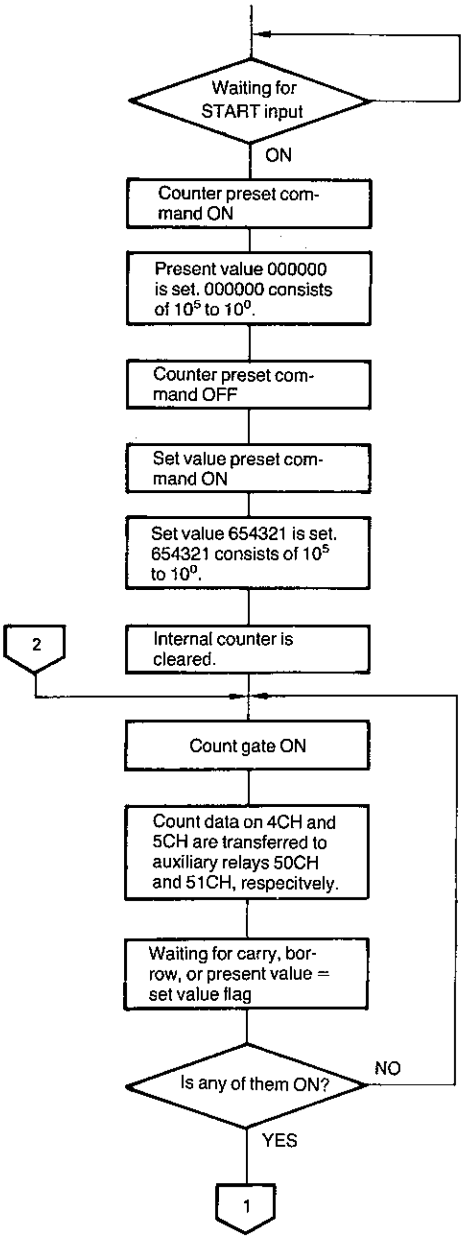


AND	START input	
WAIT		
MOV	# 0071 2	Carry, borrow, coincidence reset, and counter preset commands are turned ON and present count value 00 is preset.
MOV	# 0000 3	Present count value 0000 is set. 0000 consists of 10^5 to 10^2.
OUT NOT	200	
OUT	201	Set value preset command ON
MOV	# 0522 3	Set value 0522 is set. 0522 consists of 10^5 to 10^2.
MOV	# 0004 2	Set value preset, carry, borrow, and coincidence reset commands are turned OFF and count gate is turned ON.
LBL	100	
XFER	# 0002 4 34	Data of the counter unit on 4CH and 5CH are transferred to auxiliary relays 34CH and 35CH, respectively.
AND NOT CJP LBL	3403 100	Present value = Set value flag is checked.
OUT	206	
OUT	201	
MOV	# 1123 3	Set value 1122 is set. 1122 consists of 10^5 and 10^2.
OUT NOT	201	
OUT NOT	206	
1st stage coincidence processing		
LBL	200	
XFER	# 0002 4 34	Data of the counter unit are transferred to the CPU.
AND NOT	3403	Present value = Set value flag is checked.
CJP LBL	200	
2nd stage coincidence processing		

Multidigit preset UP counter (more than 6 digits)

In this example, count value "87654321" is processed with a multidigit preset UP counter.

- The counter unit is assigned to Channel Nos. 2 to 5 of the CPU rack.
- DM10 is used for internal counter.
- Auxiliary relays 50CH, 51CH, and No. 5207 are used.



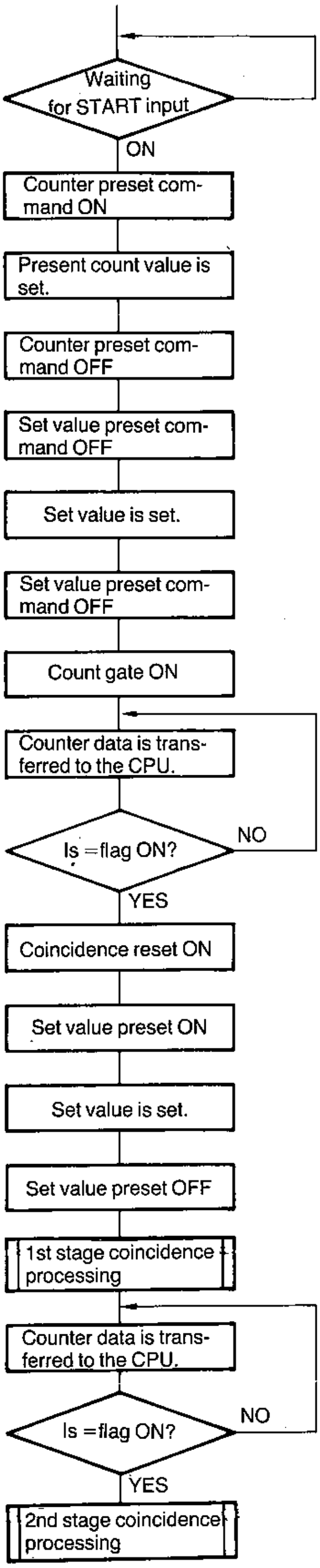
(Continued on next page)

```
  AND        START input
  WAIT                   Carry reset, borrow reset, and coincidence
  MOV                 \  reset commands are turned ON.
             #  0071  |  Counter preset command is turned ON and
                   2  /  preset value 0 is set to 10^1 and 10^0.
  MOV                 \
             #  0000  |  Present value 0000 is set. 0000 consists of
                   3  /  10^5 to 10^2.
  MOV                 \  Counter preset command is turned OFF and
             #  2102  |  set value present command is turned ON.
                   2  /  Set value 21 is set. 21 consists of 10^1 and
                      \  10^0.
  MOV                 |
             #  6543  |  Set value 6543 is set. 6543 consists of 10^5 to
                   3  /  10^2.
  MOV                 \
             #  0000  |  DM10 is cleared to 0.
            DM    10  /
  OUT NOT       5207
  MOV                 \
             #  0004  |  Set value preset command is turned OFF
                   2  /  and count gate is turned ON.
LBL              100
  XFER                \
             #  0002  |  Counter unit inputs CH4 and CH5 are
                   4  |  transferred to auxiliary relays CH50 and
                  50  /  CH51, respectively.
  OR            5000     Carry
  OR            5001     Borrow
  OR            5003     Present value = Set value
  CJP LBL        101
  JMP LBL        100
```

Programming examples

Double preset counter

In this example, two count values "052200" and "112300" are processed with a double preset counter. (The counter unit is assigned to Channel Nos. 2 to 5 of the CPU. Channel No. 34 is an auxiliary relay.)



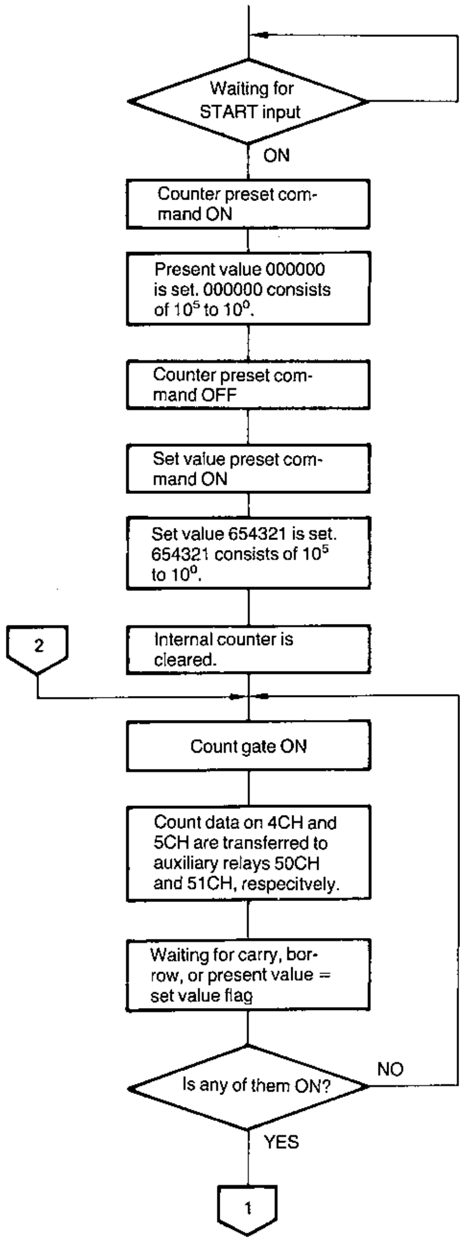
```
 AND       START input
 WAIT
 MOV             )  Carry, borrow, coincidence reset, and count-
         # 0071  |  er preset commands are turned ON and
              2  )  present count value 00 is preset.
 MOV             )
         # 0000  |  Present count value 0000 is set. 0000
              3  )  consists of 10^5 to 10^2.
 OUT NOT    200
 OUT        201     Set value preset command ON
 MOV             )
         # 0522  |  Set value 0522 is set. 0522 consists of 10^5 to
              3  )  10^2.
 MOV             )  Set value preset, carry, borrow, and coinci-
         # 0004  |  dence reset commands are turned OFF and
              2  )  count gate is turned ON.
LBL         100
 XFER            )
         # 0002  |  Data of the counter unit on 4CH and 5CH are
              4  |  transferred to auxiliary relays 34CH and
             34  )  35CH, respectively.
 AND NOT   3403  )  Present value = Set value flag is checked.
 CJP LBL    100  )
 OUT        206
 OUT        201
 MOV             )
         # 1123  |  Set value 1122 is set. 1122 consists of 10^5
              3  )  and 10^2.
 OUT NOT    201
 OUT NOT    206
|1st stage coincidence |
|processing            |

LBL         200
 XFER            )
         # 0002  |  Data of the counter unit are transferred to
              4  |  the CPU.
             34  )
 AND NOT   3403     Present value = Set value flag is checked.
 CJP LBL    200
|2nd stage coincidence |
|processing            |
```

Multidigit preset UP counter (more than 6 digits)

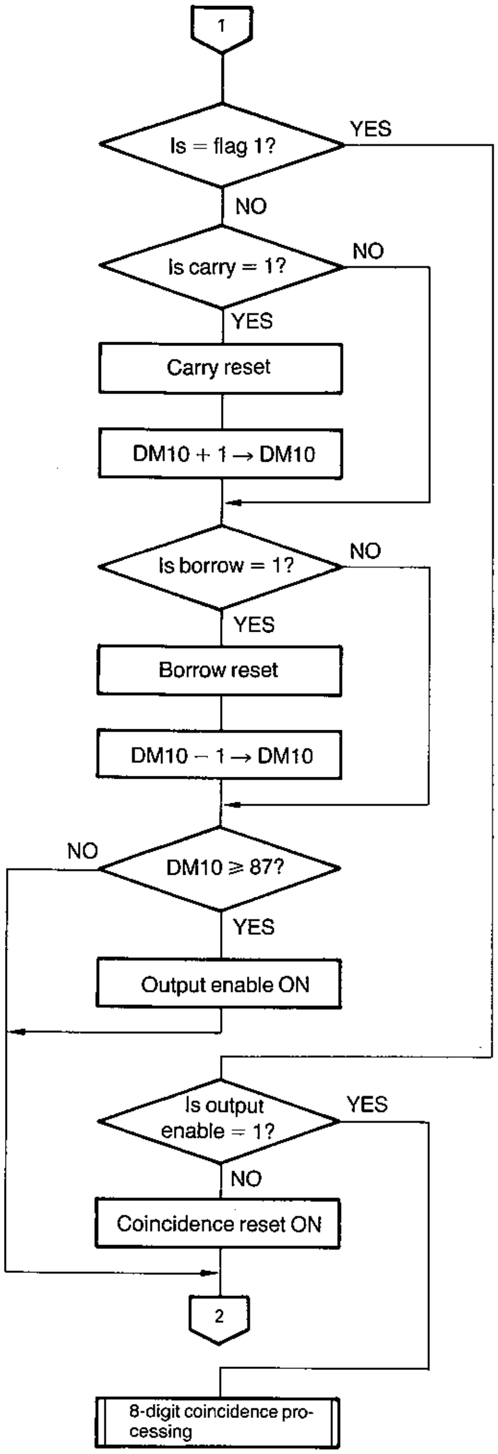
In this example, count value "87654321" is processed with a multidigit preset UP counter.

- The counter unit is assigned to Channel Nos. 2 to 5 of the CPU rack.
- DM10 is used for internal counter.
- Auxiliary relays 50CH, 51CH, and No. 5207 are used.



(Continued on next page)

```
 AND       START input
 WAIT                    Carry reset, borrow reset, and coincidence
 MOV                     reset commands are turned ON.
           # 0071        Counter preset command is turned ON and
                2        preset value 0 is set to 10^1 and 10^0.
 MOV
           # 0000        Present value 0000 is set. 0000 consists of
                3        10^5 to 10^2.
 MOV                     Counter preset command is turned OFF and
           # 2102        set value present command is turned ON.
                2        Set value 21 is set. 21 consists of 10^1 and
                         10^0.
 MOV
           # 6543        Set value 6543 is set. 6543 consists of 10^5 to
                3        10^2.
 MOV
           # 0000        DM10 is cleared to 0.
           DM  10
 OUT NOT     5207
 MOV                     Set value preset command is turned OFF
           # 0004        and count gate is turned ON.
                2
LBL           100
 XFER                    Counter unit inputs CH4 and CH5 are
           # 0002        transferred to auxiliary relays CH50 and
                4        CH51, respectively.
               50
 OR          5000        Carry
 OR          5001        Borrow
 OR          5003        Present value = Set value
 CJP LBL      101
 JMP LBL      100
```



```
LBL          101
  AND        5003    = flag
  CJP LBL     130
  AND NOT    5000    Carry flag
  CJP LBL     110
  OUT         204
  OUT NOT     204
  INC                Contents of DM10 is incremented by 1.
           DM  10
LBL           110
  AND NOT    5001    Borrow flag
  CJP LBL     120
  OUT         205
  OUT NOT     205
  DEC                Contents of DM10 is decremented by 1.
           DM  10
LBL           120
  CMP      DM  10
           # 0087
  AND        6307    DM10 < 87
  CJP LBL     100
  OUT         207    Output enable
  OUT        5207    Auxiliary data of output enable e
  JMP LBL     100
LBL           130
  AND        5207    Output enable
  CJP LBL     200
  OUT         206    Coincidence reset ON
  OUT NOT     206
  JMP LBL     100
LBL           200
```

8-digit coincidence processing

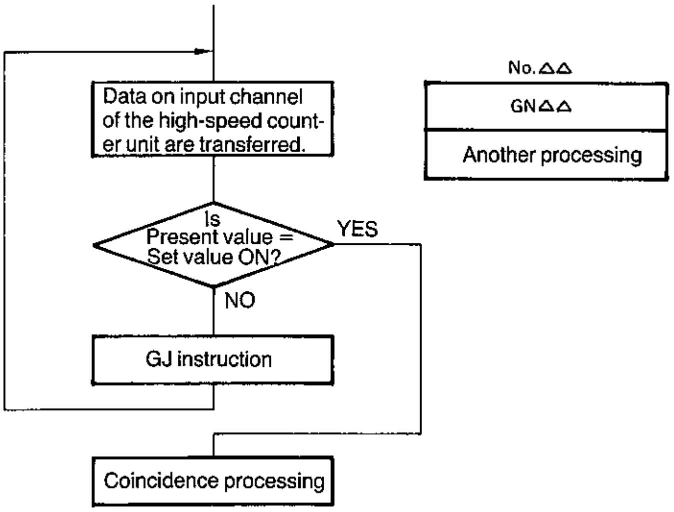
Precautions on using high-speed counter

To read data on an input channel (carry, borrow, present value > set value, present value = set value, present value < set value, and present value data) of the counter unit, transfer the necessary data to the internal auxiliary relay(s) by using the XFER instruction (FUN72) and use the transferred data.

XFER #0002	Number of channels whose data are transferred	Input 0002 to specify the number of channels
4	Starting channel (source) from which data are transferred	Starting channel of input data in the high-speed counter
50	Starting channel (destination) to which data are transferred	Auxiliary relay
AND 5003		Present value = Set value bit

- To process input signals such as carry, borrow, present value > set value, present value = set value, and present value < set value in bit units by using instructions such as AND and OR, transfer the data to the internal auxiliary relay(s).

- To perform in parallel another processing while the count value reaches the set value, use the GJ instruction.



(Example)

```
LBL          100
 XFER
            #0002
               4      Starting channel of input data
              50
 AND        5003      Present value = Set value
 CJP LBL     110
 GJ
 JMP LBL     100
LBL          110
   Coincidence processing
```

To preset a present value (or set value), turn ON the counter preset command (or set value preset command) prior to or simultaneously with a preset data.

While presetting a preset value or set value, carry, borrow or preset value = set value bit may turn ON depending on the data value. For this reason, create a program so that the output enable bit turns ON after completing the preset.

Do not use an instruction by which data are read from an output channel of the high-speed counter unit.

● (Incorrect example)
The counter unit is assigned to Channel Nos. 2 to 5.

● AND 202
● MOV
2
50

● When data from an output channel are required in the program, provide a subarea for the output channel in the internal auxiliary relay area and use the data transferred to the specified auxiliary relay(s).
(Example)
In the programming example of multidigit preset counter (more than 6 digits), auxiliary relay No. 5027 is used as a dummy of the output enable flag (207).

When using the counter unit with a remote I/O slave unit, take into account a delay of 20 ms min. for ON or OFF of preset and reset outputs.

Remote I/O unit

Two remote I/O units are used to control I/O units remotely situated from a SYSMAC-C Series programmable controller; the one serving as a master station (Type 3G2A5-RM001-E or 3G2A6-RM001-E) is called the remote master unit (RMU), and the other serving as a slave station (Type 3G2A5-RT002-E or 3G2A5-RT001-E) is the remote slave unit (RSU). The two stations are connected with SYSBUS (a pair of fiber optics cables) and can optically transmit data to each other at a high speed.

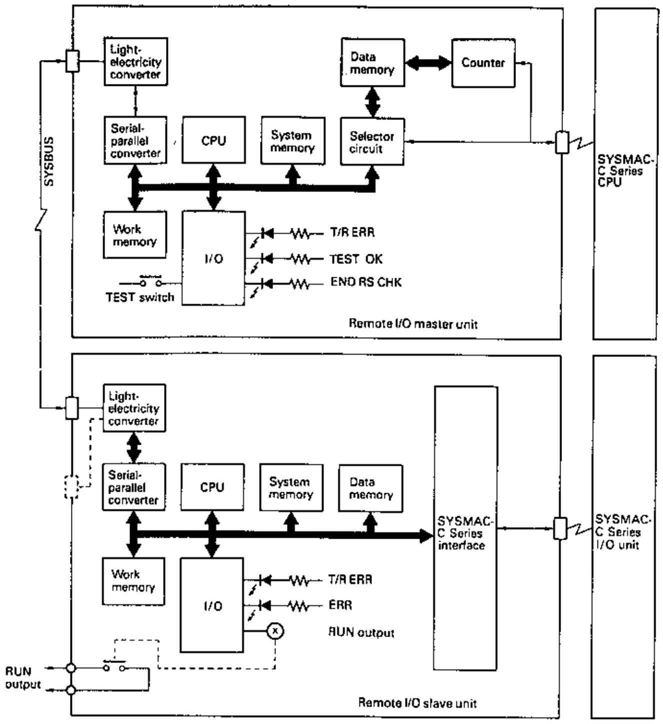
Because the remote I/O master unit can be used as a primary station of the remote I/O slave unit and an optical transmitting I/O unit (Type 3G5A2-XXX-E) as well, a variety of system configurations are possible by using the master unit, such as connecting the master unit to the optical transmitting I/O unit(s) only or to a combination of the remote I/O slave *unit* and optical transmitting I/O unit(s).

The remote I/O master and slave units are capable of transmitting a *maximum* of 2,048 I/O points at a transmission speed of 128 points per 16ms.

Specifications

Item	Master unit	Slave unit
Transmission system	Time-division multiplexing cyclic system	
Communication method	4-wire, half duplex system	
Transmisson speed	187.5K bps	
Transmission delay	128 points per 16 ms	
Transmission line	Polymer-clad quartz core fiber optics	
Line distance	800 m max.	
No. of I/Os that can be *transmitted*	2048 I/O points max. including special I/O unit	
External RUN output	—	G6B SPST-NO relay *contact* (closed during RUN mode) *Contact capacity:* 250 VAC 2 A (p.f.=1) 24 VDC 2A
Internal power supply	+5 V, 750 mA max.	+5 V, 550 mA max.
Weight	500 g max.	500 g max.

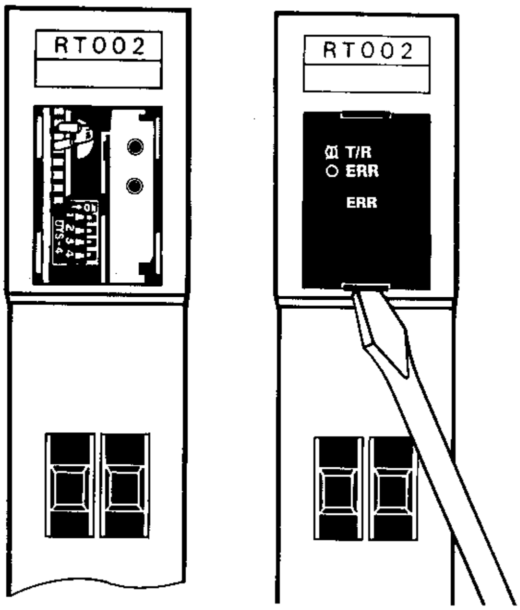
Configuration



Setting address and end RSU

Setting address and end RSU of remote I/O slave unit

Remove the indication panel from the remote I/O slave unit with a flat-blade screwdriver, and a 4-pin DIP switch will be found on a PC board. Set the DIP switch by referring to the following figure and table.



DIP switch	Function
Address/End RSU setting DIP switch 	 To specify No. 0 sub unit as the end RSU
	 To specify sub unit other than No. 0 as the end RSU
	 To specify No. 1 sub unit as the end RSU
	 To specify sub unit other than No. 1 as the end RSU

Note: A protective cap is attached as an accessory. Put it on the unused fiber optics connector of the remote I/O slave unit specified as the end RSU to prevent a malfunction of the unit from external interference light.

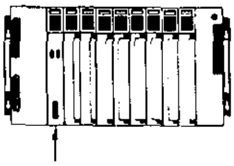
Although Type 3G2A5-RT001-E is exclusively used as the end RSU, perform the setting for the end RSU in the same manner as the other remote I/O slave units.

Caution: Be sure to perform the setting with the power turned OFF.

If the same address is specified to plural remote I/O slave units in duplication (e.g., two slave units are assigned address 0), data will compete for the SYSBUS, causing a transmission error to occur. Therefore, never specify the address in duplication.

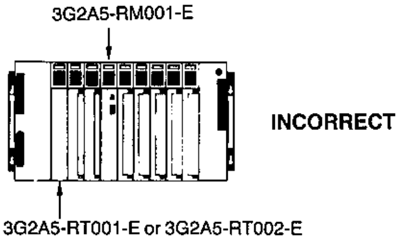
Hints on correct use

A maximum of four remote I/O master units can be connected to the CPU or the expansion I/O rack of the SYSMAC-C500F and three to the expansion I/O rack of the SYSMAC-C120F. The remote I/O slave unit must be inserted to the leftmost slot of the expansion I/O rack of the SYSMAC-C500F.

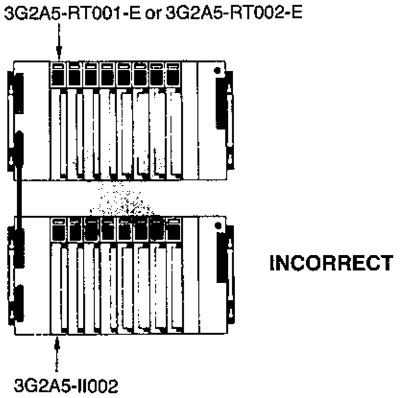


3G2A5-RT001-E or 3G2A5-RT002-E

The remote I/O master unit must not be mounted to the SYSMAC-C500F to which a remote I/O slave unit is already mounted.



The expansion I/O rack of the SYSMAC-C500F must not be connected for the purpose of system expansion to the SYSMAC-C500F to which a remote I/O slave unit is already mounted.



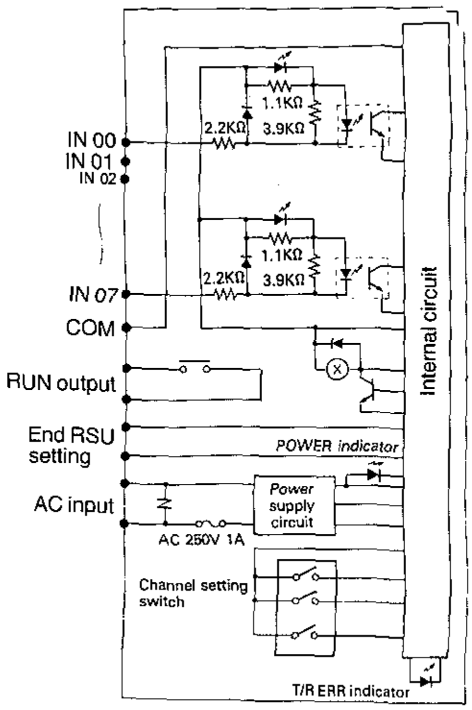
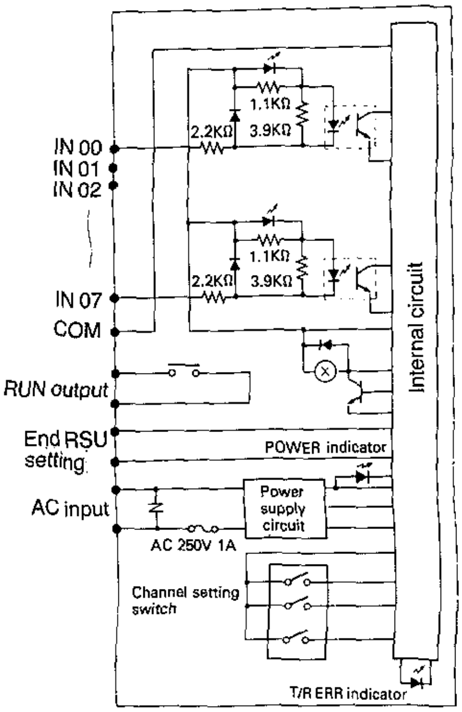
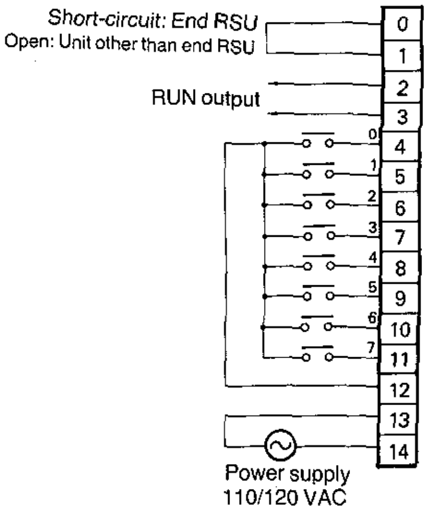
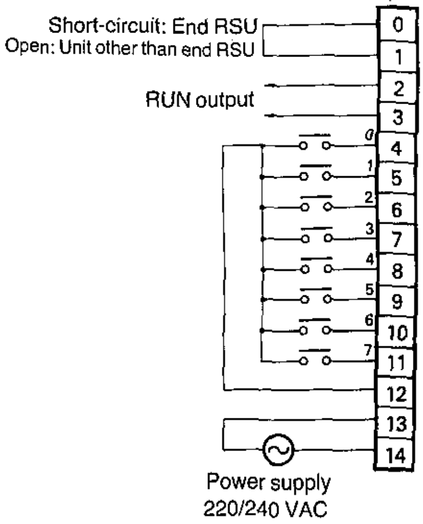
Optical transmitting I/O unit

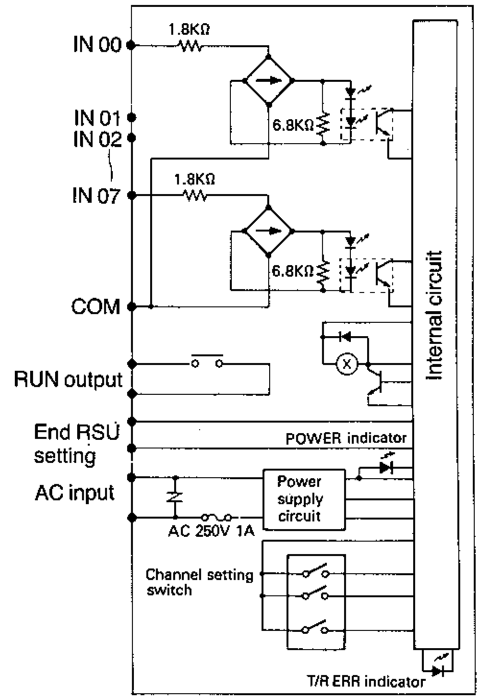
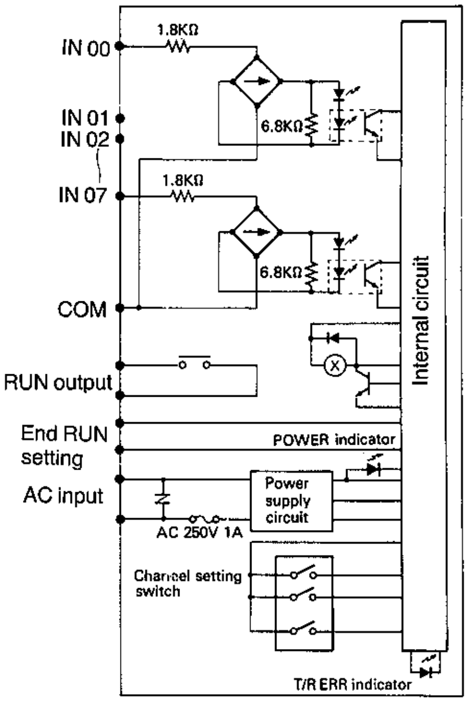
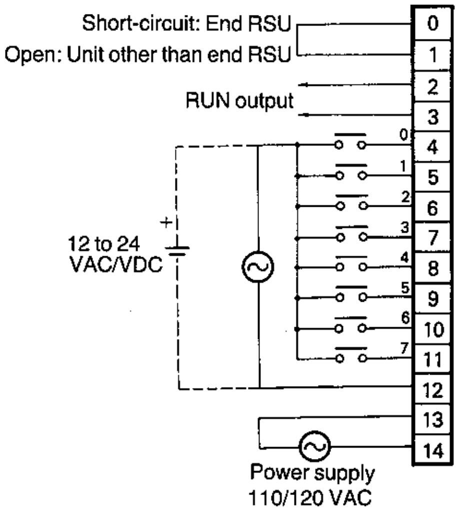
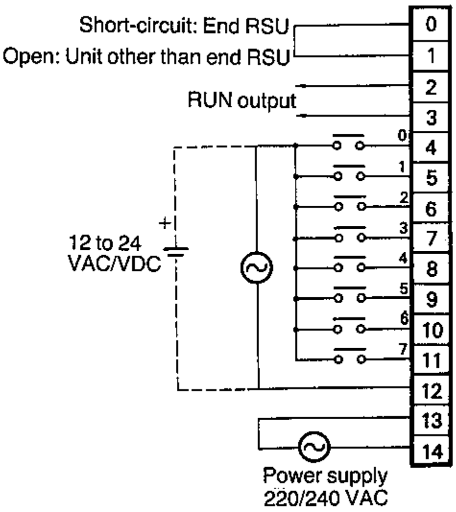
By connecting the optical I/O transmitting unit to the remote I/O master unit with a fiber optics cable, high-speed optical data transmission can be performed. The remote I/O master unit, which serves as the primary station of a data transmission system configured thereby, can be connected to plural optical I/O transmitting units only, or to a combination of the remote I/O slave unit and optical I/O transmitting units.

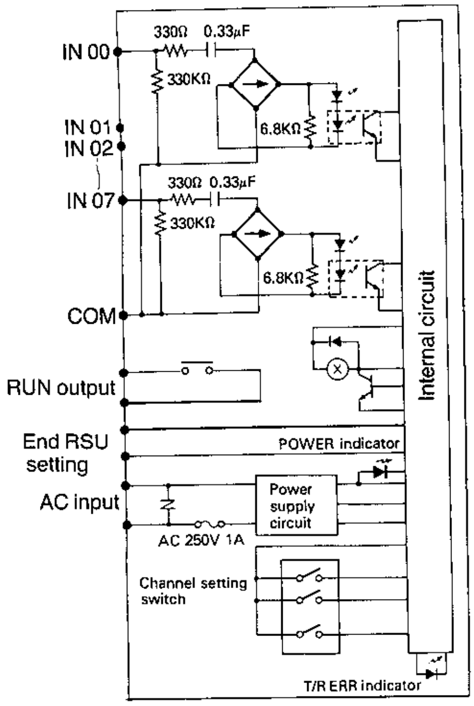
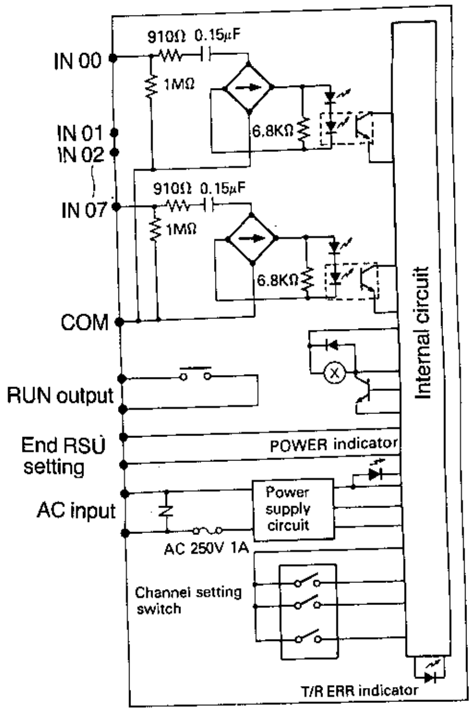
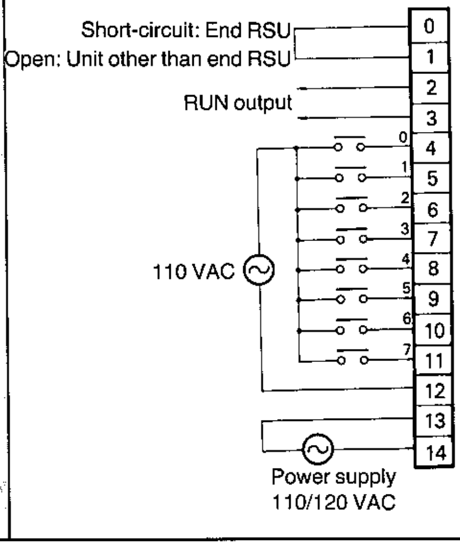
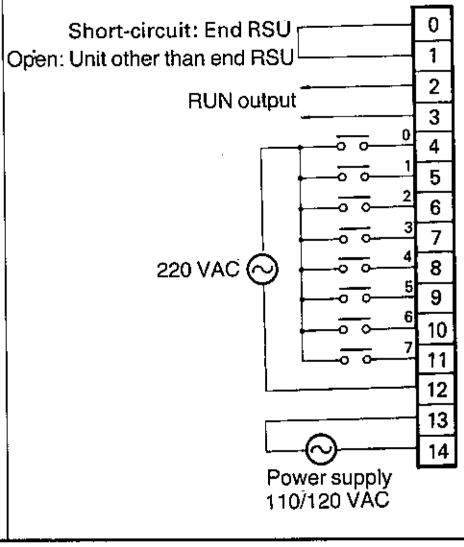
Since the number of I/O points per optical I/O transmitting unit is 8, a maximum of 64 optical I/O transmitting units can be connected per remote I/O master unit when the SYSMAC-C500F, which possesses 512 points of input/output relays, is used. However, the maximum number of units connectable to the SYSMAC-C120F is 32 because this programmable controller has 256 I/O points.

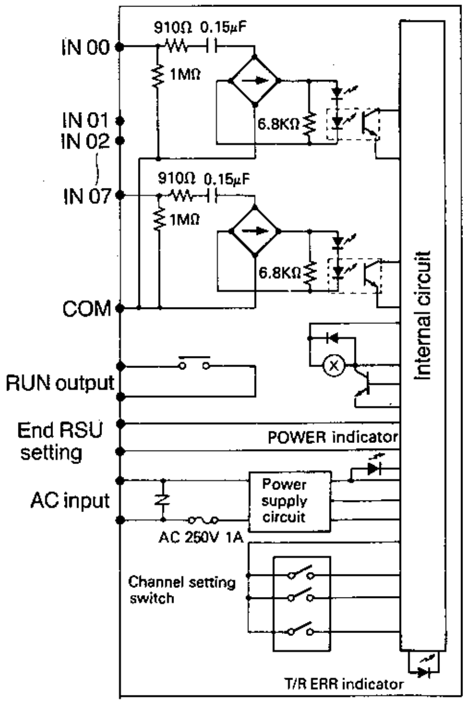
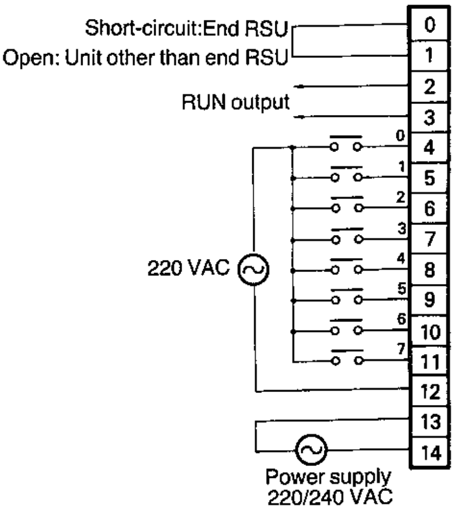
Specifications

Optical transmitting input unit

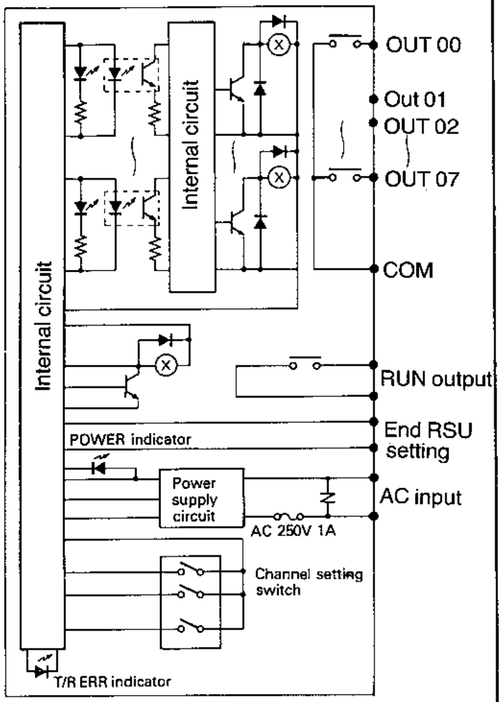
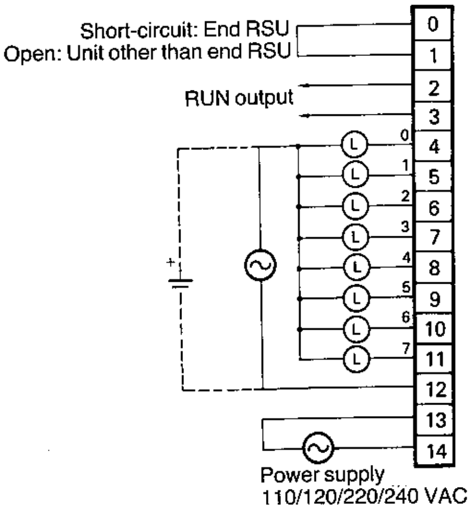
Type / Item	No-voltage contact input unit	
	3G5A2-ID001-E	3G5A2-ID002-E
Input voltage	*No-voltage contact*	No-voltage contact
Input impedance	—	—
Input current	10 mA typ.	10 mA type
ON-delay time	*10 ms max.*	*10 ms max.*
OFF-delay time	15 ms max.	15 ms max.
Number of circuits	8(8 points/common)	8(8 points/common)
ON voltage	—	—
OFF voltage	—	—
Supply voltage	110/120 VAC, 50/60 Hz	220/240 VAC, 50/60 Hz
Power consumption	20 VA max.	20 VA max.
Weight	580 g max.	580 g max.
Circuit configuration		
Terminal connection	 Power supply 110/120 VAC	 Power supply 220/240 VAC

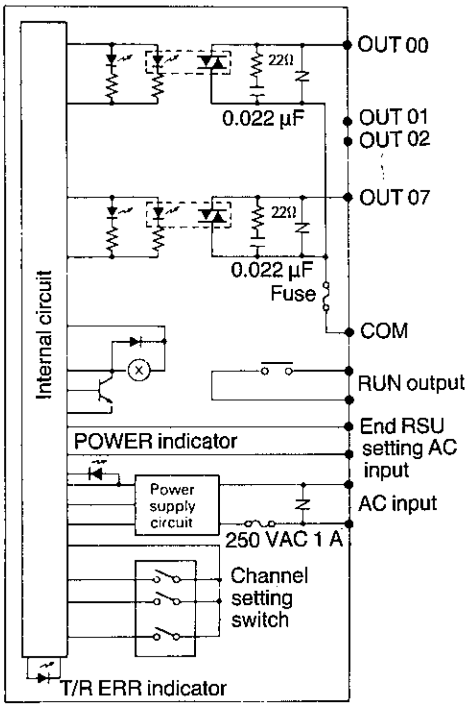
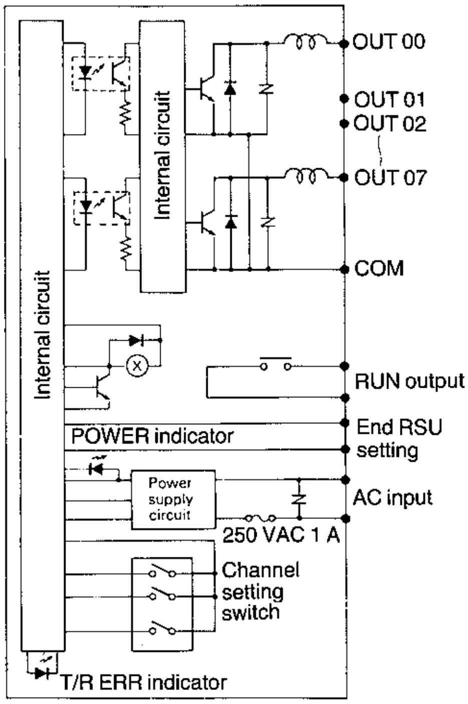
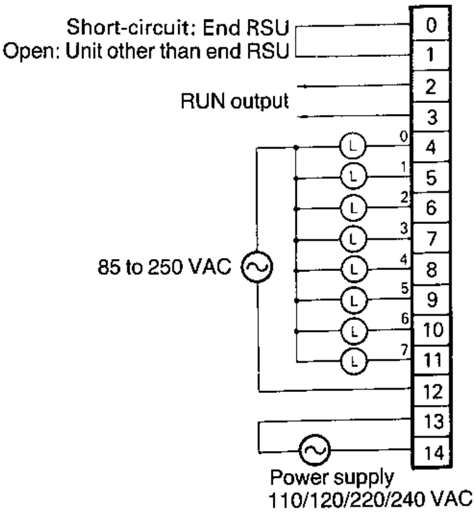
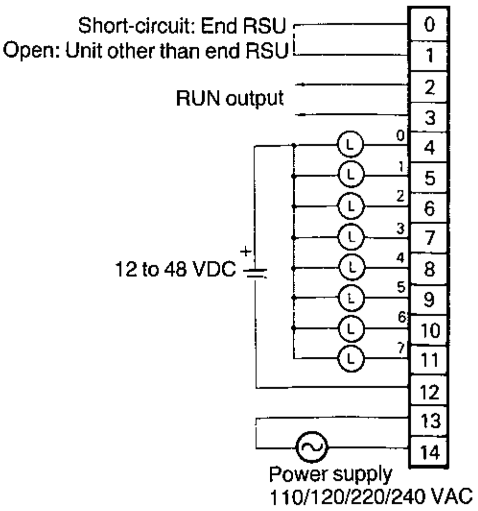
Type Item	AC/DC input unit 3G5A2-IM211-E	AC/DC input unit 3G5A2-IM212-E
Input voltage	12 to 24 VAC/VDC +10%, −15%	12 to 24 VAC/VDC +10%, −15%
Input impedance	1.8 kΩ	1.8 kΩ
Input current	10 mA typ. (24 VDC)	10 mA typ. (24 VDC)
ON-delay time	10 ms max.	10 ms max.
OFF-delay time	15 ms max.	15 ms max.
Number of circuits	8(8 points/common)	8(8 points/common)
ON voltage	10.2 V max.	10.2 V max.
OFF voltage	3.0 V min.	3.0 V min.
Supply voltage	110/120 VAC 50/60 Hz	220/240 VAC 50/60 Hz
Power consumption	20 VA max.	20 VA max.
Weight	580 g max.	580 g max.
Circuit configuration		
Terminal connection		

Item \ Type	AC input unit	
	3G5A2-IA121-E	3G5A2-IA221-E
Input voltage	110 VAC +10%, −15% 50/60 Hz	220 VAC +10%, −15% 50/60 Hz
Input impedance	9.7 kΩ(50 Hz), 8 kΩ(60 Hz)	22 kΩ(50 Hz), 18 kΩ(60 Hz)
Input current	10 mA typ. (100 VAC)	10 mA typ. (200 VAC)
ON-delay time	10 ms max.	10 ms max.
OFF-delay time	15 ms max.	15 ms max.
Number of circuits	8(8 points/common)	8(8 points/common)
ON voltage	60 VAC max.	120 VAC max.
OFF voltage	20 VAC min.	40 VAC min.
Power supply	110/120 VAC, 50/60 Hz	110/120 VAC, 50/60 Hz
Power consumption	20 VA max.	20 VA max.
Weight	580 g max.	600 g max.
Circuit configuration		
Terminal connection		

Item \ Type	AC input unit
	3G5A2-IA222-E
Input voltage	220 VAC +10%, −15% 50/60 Hz
Input impedance	22 kΩ (50 Hz), 18 kΩ (60 Hz)
Input current	10 mA typ. (200 VAC)
ON-delay time	10 ms max.
OFF-delay time	15 ms max.
Number of circuits	8(8 points/common)
ON voltage	120 VAC max.
OFF voltage	40 VAC min.
Power supply	220/240 VAC, 50/60 Hz
Power consumption	20 VA max.
Weight	600 g max.
Circuit configuration	
Terminal connection	

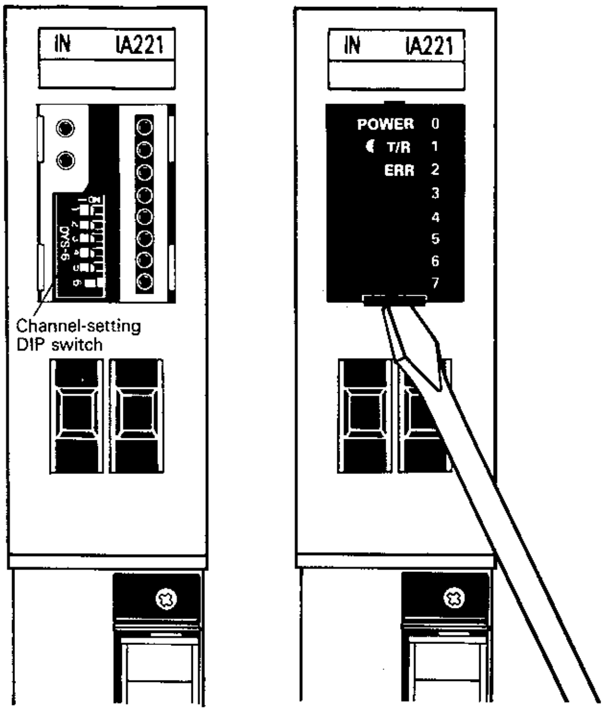
Optical transmitting output unit

Type	Contact output unit
Item	3G5A2-OC221-E
Max. switching capacity	250 VAC/2 A (p.f.=1), 24 VDC/2 A (8 A/common)
Min. Switching capacity	5 VDC 100 mA
ON-delay time	15 ms max.
OFF-delay time	15 ms max.
Number of circuits	8(8 points/common)
Service life	Electrical: 300,000 operations Mechanical: 50,000,000 operations
Power supply	110/120/220/240 VAC, 50/60 Hz
Power consumption	20 VA max.
Weight	600 g max.
Circuit configuration	
Terminal connection	

Type	Triac output unit	Transistor output unit
Item	3G5A2-OA222-E	3G5A2-OD411-E
Max. switching capacity	85 to 250 VAC +10%, −15% 1 A, 50/60 Hz	12 to 48 VDC +10%, −15% 0.3 A
Min. switching capacity	10 mA/100 VAC	—
Leakage current	3 mA max./100 VAC 6 mA max./200 VAC	100 µA max.
Saturation voltage	1.2 V max.	1.5 V max.
ON-delay time	1 ms max.	0.2 ms max
OFF-delay time	1/2 load frequency max.	0.3 ms max.
Number of circuits	8(8 points/common)	8(8 points/common)
Fuse capacity	5 A/8 points	No fuse is provided.
Supply voltage	110/120/220/240 VAC, 50/60 Hz	110/120/220/240 VAC, 50/60 Hz
Power consumption	20 VA max.	20 VA max.
Weight	600 g max.	600 g max.
Circuit configuration		
Terminal connection		

Channel and end RSU settings

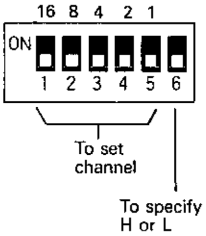
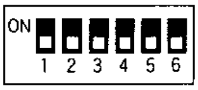
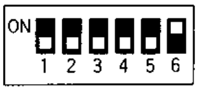
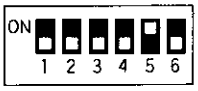
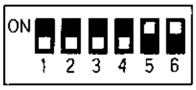
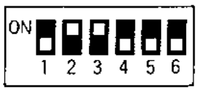
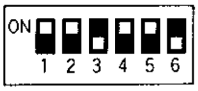
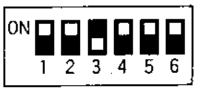
Channel setting



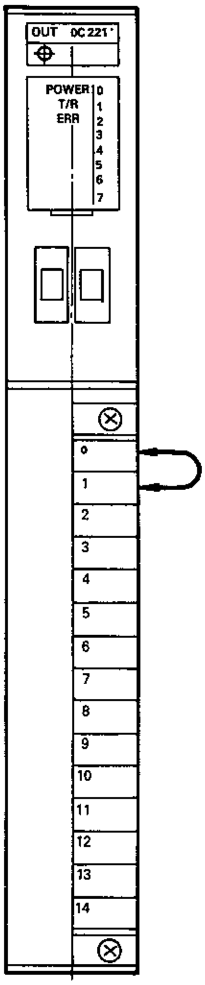
Remove the operation indicator panel of the optical transmitting I/O unit with a flat-blade screwdriver. Set the channel by using the 6-pin DIP switch mounted on the PC board. The channel number is set as a binary number. Set the channel by referring to the examples shown on the right.

Caution: Be sure to perform the setting with the power turned OFF.

When the same channels are specified in duplication for the input or output of an optical transmitting unit, the data will compete for the SYSBUS, causing a transmission error to occur. Therefore, never set the same channel in duplication.

DIP switch	Description
Setting example  	 0 channel "L"
	 0 channel "H"
	 1 channel "L"
	 1 channel "H"
	 12 channel "L"
	 12 channel "H"
	 27 channel "L"
	 27 channel "H"

End RSU setting



To specify an optical transmitting I/O unit as the end RSU, short-circuit terminal Nos. 0 and 1 as shown in the above figure.

Put the protective cap attached as an accessory on one of the fiber optics connectors to prevent a malfunction caused by an external interference light.

Operation, diagnostic functions, and failure detection of remote I/O unit and optical transmitting I/O unit

Address and channel setting and assignment of I/O channels

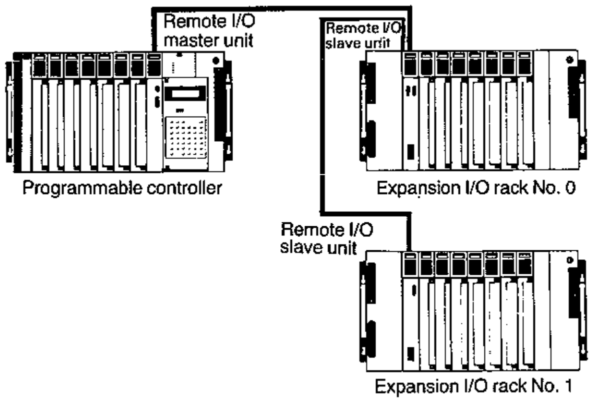
Significance of address setting

Up to two remote I/O slave units, each of which functions as a slave station, or 64 optical transmitting I/O units can be connected to a remote I/O master unit that serves as a master station.

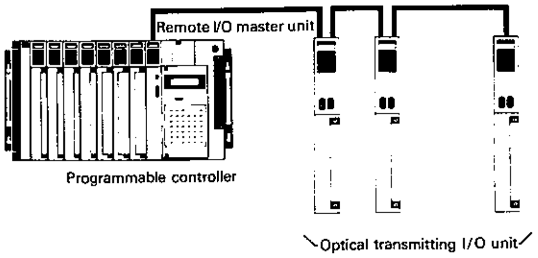
The maximum number of I/O points of the optical transmitting I/O units that can be connected to a SYSMAC-C120F programmable controller is 32 units (256 points). Because the remote I/O master unit must recognize the addresses and the channels of each I/O unit connected to the master unit, setting the addresses and channels of these I/O units is important to facilitate the managing of the connected I/O units by the master unit.

Address of remote I/O slave units

Two remote I/O slave units can be connected to a remote I/O master unit. Set the address of each connected remote I/O slave unit so that the remote I/O master unit identifies the address of each expansion I/O rack to which each I/O slave unit is mounted. For details on DIP switch setting of the remote I/O slave unit, refer to Setting address and end RSU (remote I/O slave unit).



Channel setting for optical transmitting I/O unit

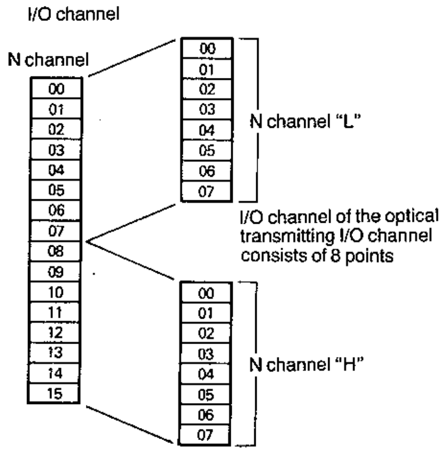


Special I/O units

An I/O channel of the SYSMAC-C Series programmable controller consists of 16 points, and that of an optical transmitting I/O unit, 8 points. When setting the I/O channel of an optical transmitting I/O unit, pay attention to these two items.

First, the I/O channel of the programmable controller to which the optical transmitting I/O unit is assigned must be determined. Unlike the remote I/O slave unit that is automatically assigned an I/O channel when it is mounted to the expansion I/O rack, the channel of each optical transmitting I/O unit must be set by using the DIP switch incorporated in the unit.

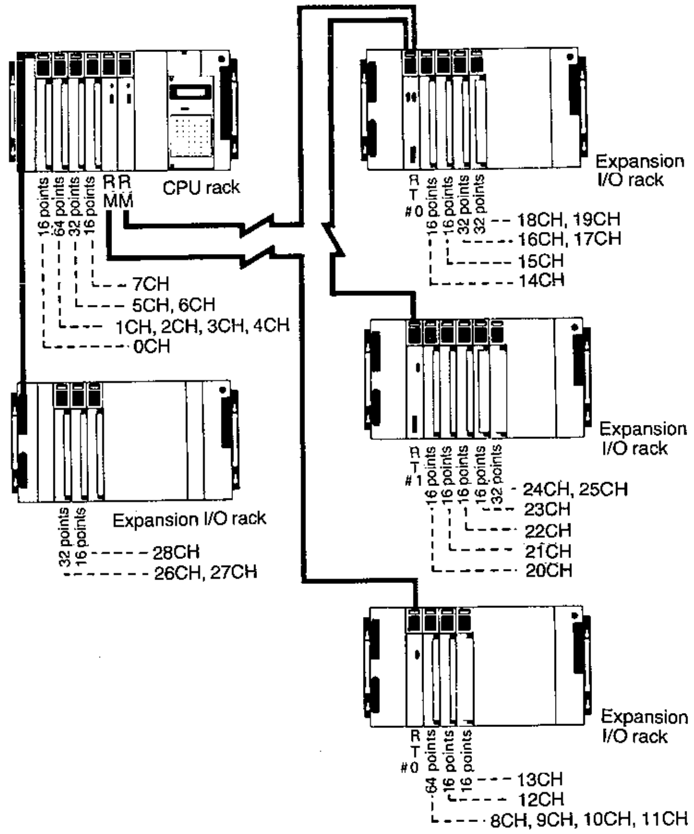
Second, as stated, an I/O channel of the SYSMAC-C Series programmable controller consists of 16 points, whereas that of an optical transmitting unit consists of 8 points. Therefore, relay numbers 00 to 07 of a specific I/O channel are regarded as lower-order (L) addresses, and relay numbers 08 to 15 are treated as higher-order (H) addresses, and an optical transmitting I/O unit is connected to each of the L and H addresses.



Note, however, that *an optical transmitting input and output unit must not be assigned to the L and H addresses of the same channel.* To set the DIP switch of the optical transmitting I/O unit, refer to Channel and end RSU settings of optical transmitting I/O unit.

Assignment of I/O channels

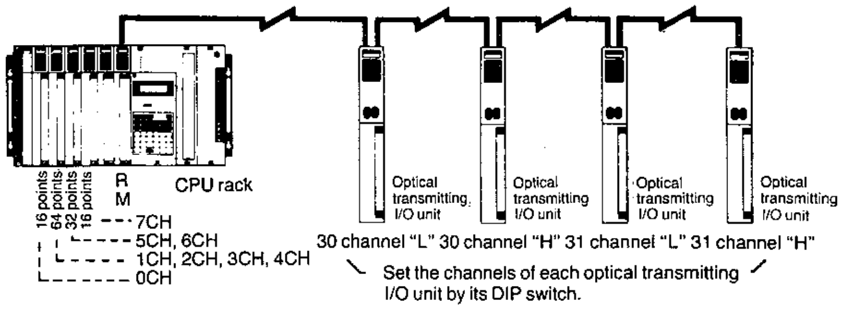
Example 1: Connection between SYSMAC-C500F and remote I/O units

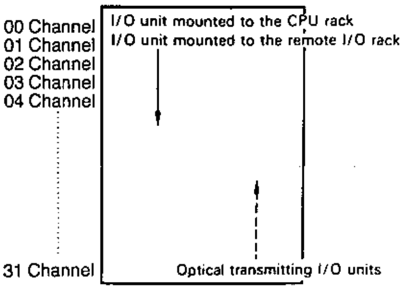


When an I/O unit is mounted to an expansion I/O rack mounting a remote I/O unit, the programmable controller automatically assigns a channel to the I/O unit. Refer to Free location concept in Chapter 4.

Special I/O units

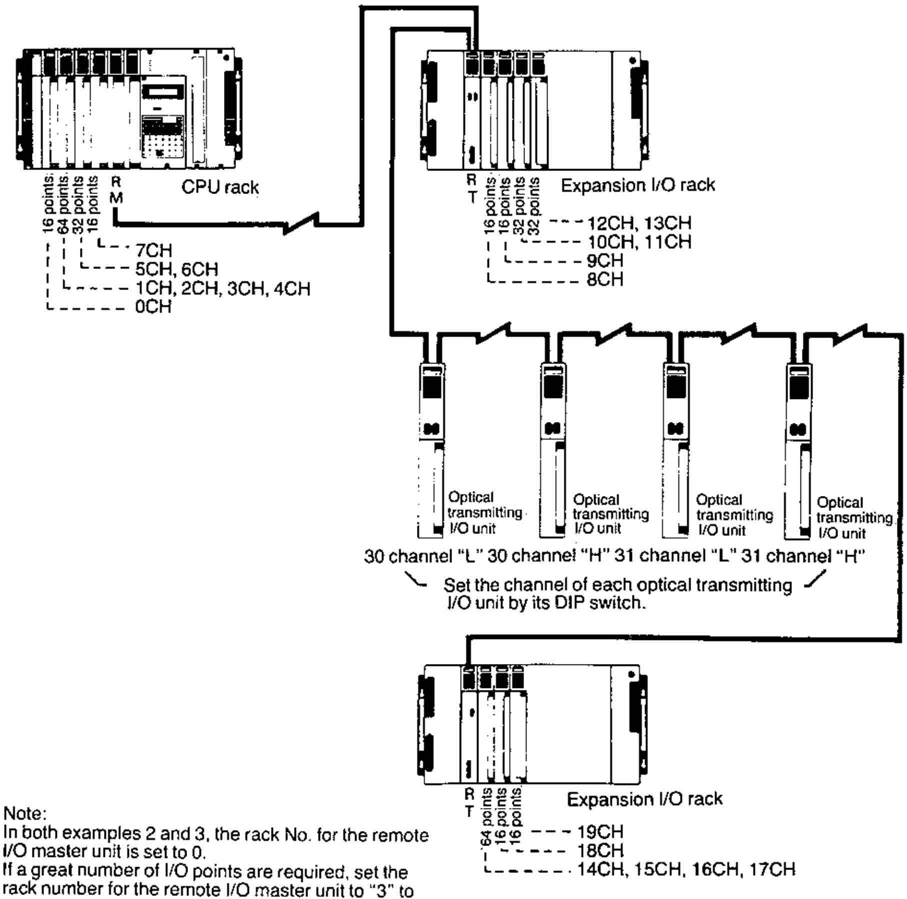
Example 2: Connection between SYSMAC-C500F and optical transmitting I/O unit





Because the channel is automatically assigned to the I/O unit(s) mounted to the CPU rack of the programmable controller or to the expansion I/O rack in sequence starting from channel 00, the channel to optical transmitting I/O unit(s) must be assigned in reverse sequence starting from channel 31. In so doing, pay special attention so that the I/O channels of the programmable controller and those of the optical transmitting I/O units do not overlap.

Example 3: Connecting between SYSMAC-C500F, remote I/O units, and optical transmitting I/O units



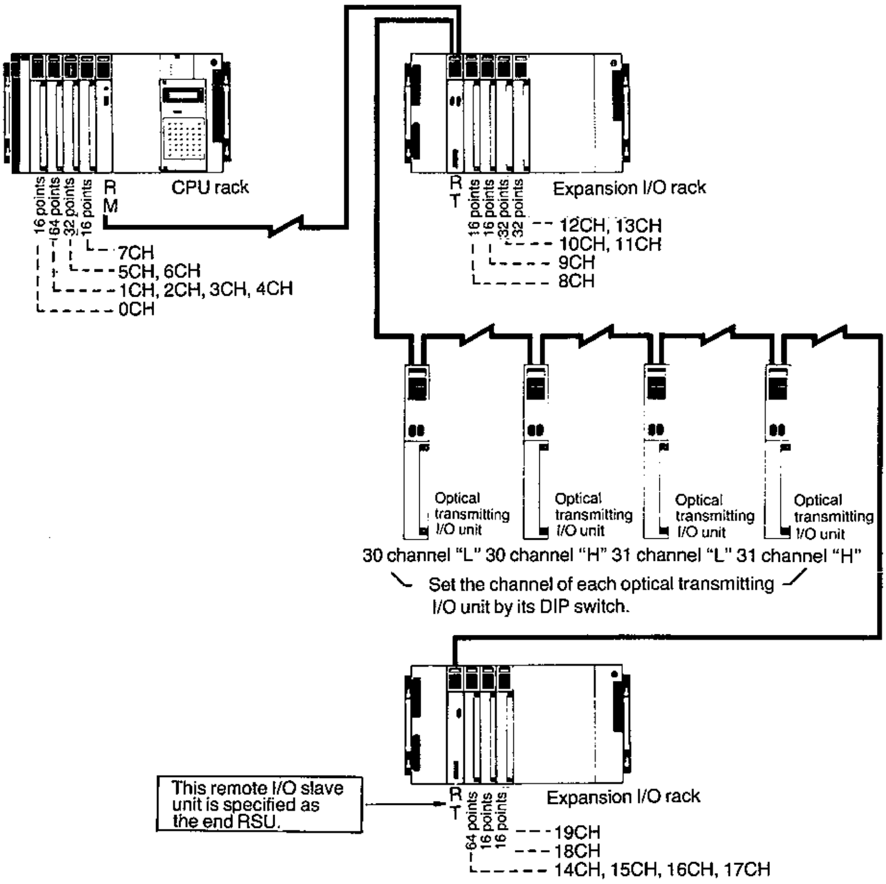
Note:
In both examples 2 and 3, the rack No. for the remote I/O master unit is set to 0.
If a great number of I/O points are required, set the rack number for the remote I/O master unit to "3" to prevent I/O channel numbers from overlapping. At this time, set the channel number of the optical I/O transmitting unit to 31 so that the I/O number becomes channel 127.

Meaning of end station

On power application, the remote I/O master unit checks whether a remote I/O slave unit or an optical transmitting I/O unit that is specified as the end RSU is connected to it. If an I/O unit specified as the END station exists, the remote I/O master unit recognizes the I/O units currently connected to the SYSBUS. The remote I/O slave unit transmits data to and from the I/O units connected to the SYSBUS. The I/O units not connected to the SYSBUS or the optical transmitting I/O units connected after the end RSU are consequently ignored by the remote I/O master unit. To prevent this, specify the I/O unit with the greatest I/O channel number as the end RSU.

Example 1

(When the rack No. for remote I/O master unit is set to "0")

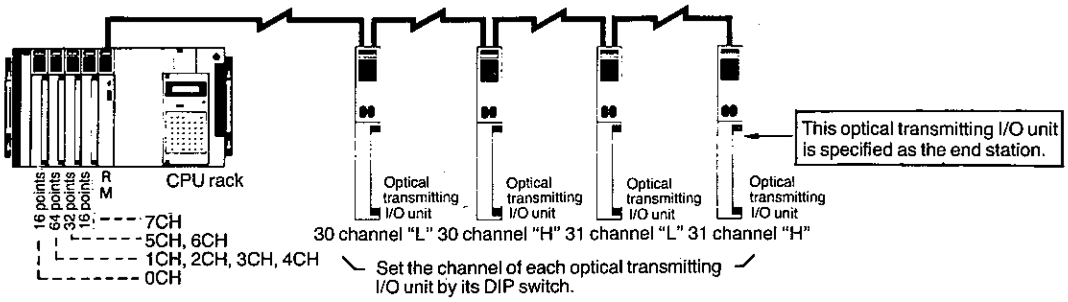


30 channel "L" 30 channel "H" 31 channel "L" 31 channel "H"

Set the channel of each optical transmitting I/O unit by its DIP switch.

This remote I/O slave unit is specified as the end RSU.

Example 2



This optical transmitting I/O unit is specified as the end station.

30 channel "L" 30 channel "H" 31 channel "L" 31 channel "H"

Set the channel of each optical transmitting I/O unit by its DIP switch.

Mounting procedures of remote I/O units and optical transmitting I/O units

Mounting remote I/O units and optical transmitting units

Observe the following procedures when newly mounting remote I/O unit(s) or optical transmitting I/O unit(s) to the CPU rack.

1. Check the I/O units currently mounted to the CPU rack for the last I/O channel number.
2. Set the address of the newly mounted remote I/O slave unit. Also set the channel of the newly mounted optical transmitting I/O unit. In so doing, pay particular attention that the set channel number does not overlap with the last channel number of the I/O unit mounted to the CPU rack. Note that the number of I/O points of the set channel must not exceed the maximum number of I/O relays provided to the PC. In case the number of the I/O points of the set channel exceeds the maximum number of the programmable controller's I/O relays, an I/O unit over error occurs.
3. Sequentially connect the fiber optics cables (SYSBUS) to the connector of each unit starting from the remote I/O master unit. Type 3G2A5-RT002-E remote I/O slave unit and the optical transmitting I/O unit have two fiber optics connectors. The fiber optics cable from the remote I/O master unit can be connected to either of them.
4. Specify the I/O unit that has been connected last to the SYSBUS as the END station. When doing so, confirm that any other I/O unit connected to the SYSBUS is not specified as the END station.
5. Turn on the power of each unit in the system. This may be done in any order.
6. After the END STA CHECK indicator of the remote I/O master unit goes out, generate an I/O table by using the programming console of the PC.
7. With the programming console, check whether the newly mounted remote I/O slave unit and optical transmitting I/O unit have been correctly registered to the CPU of the PC.

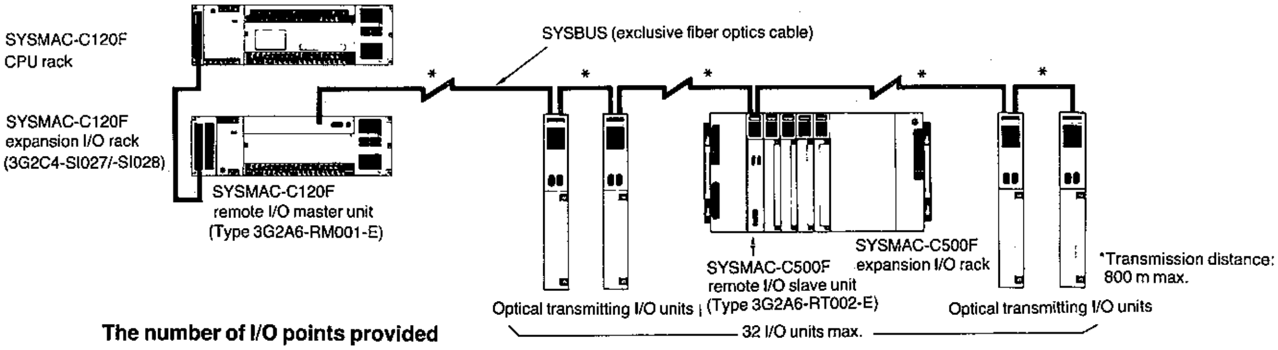
Note: Once the above procedures have been performed, the system is ready for operation on power application.

Should the system not operate normally after the above procedures have been correctly observed, refer to List of error messages and alarm output.

Generate or check the I/O table by using the programming console.

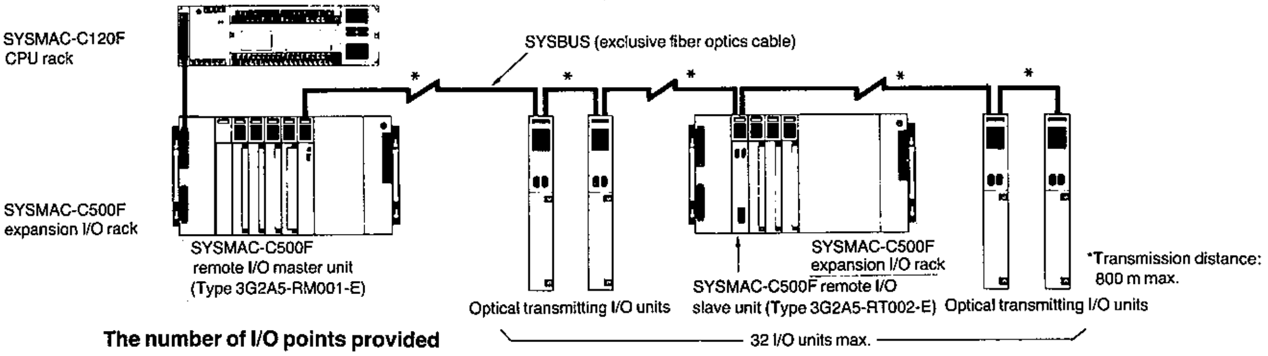
System configuration examples

When connecting remote I/O slave unit and optical transmitting I/O units to SYSMAC-C120F via remote I/O master unit:



The number of I/O points provided to the system: 256 max.

Count the number of I/O units on the remote I/O slave unit in units of 8 points in the same manner as the optical transmitting I/O unit. For example, a unit provided with 16 points is counted as two units.



The number of I/O points provided to the system: 256 max.

Count the number of I/O units on the remote I/O slave unit in units of 8 points in the same manner as the optical transmitting I/O unit. For example, a unit provided with 16 points is counted as two units.

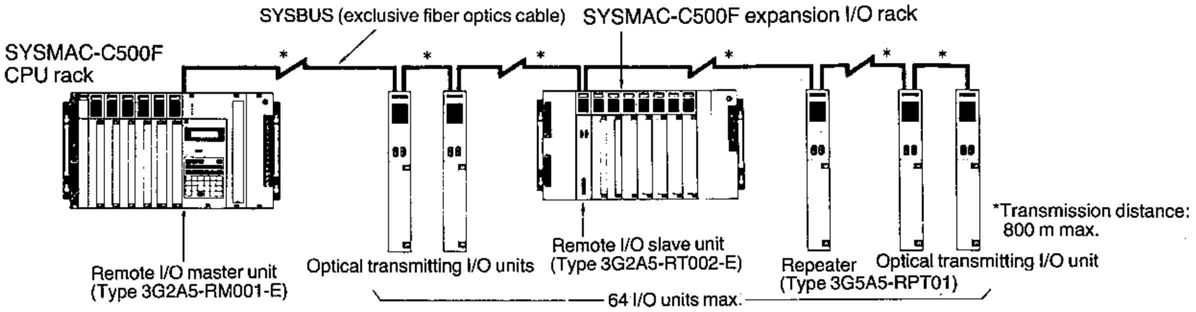
The remote I/O master unit can be inserted in the upper slot of the SYSMAC-C120F expansion I/O rack or in any I/O connector of the SYSMAC-C500F expansion I/O rack. It cannot, however, be directly connected to the SYSMAC-C120F rack.

Up to two remote I/O slave units or 64 optical transmitting I/O units can be connected to a remote I/O main unit. Note, however, that I/O units cannot be mounted to the SYSMAC-C120F exceeding 256 I/O points because the maximum number of I/O relays provided to the PC is 256.

In terms of the optical transmitting unit, the maximum number of units that can be connected to the SYSMAC-C120F is 32 because eight I/O points are provided per optical transmitting I/O unit.

When mounting Type 3G2A6-RM001-E remote I/O master unit to the SYSMAC-C120F expansion I/O rack, use Type 3G2C4-SI027/-SI028.

When connecting the remote I/O units and/or optical transmitting I/O units to the SYSMAC-C500F



Count the number of I/O units on the remote I/O slave unit in units of 8 I/O points in the same manner as the optical transmitting unit. For example, a unit provided with 16 points is counted as two units.

The number of I/O points provided to the system: 2,048 max.

The remote I/O master unit can be connected to any I/O connector on the SYSMAC-C500F CPU rack or to the SYSMAC-C500F expansion I/O rack.

Up to two remote I/O slave units or 64 optical transmitting I/O units can be connected to a remote I/O master unit. Note, however, that I/O units cannot be connected to the SYSMAC-C500F exceeding 512 I/O points because the maximum number of I/O relays provided to the PC is 256. In terms of optical transmitting I/O unit, the maximum number of units that can be connected to the SYSMAC-C500F is 64 because eight I/O points are provided per optical transmitting I/O unit.

If more than 32 units of the optical transmitting and remote I/O slave units are to be connected to the programmable controller, a repeater (Type 3G5A2-RPT01) must be connected as the 33rd unit. (In this case, disregarding the number of I/O points the remote I/O slave unit possesses, count it as one unit.)

Diagnostic functions

The SYSMAC-C Series programmable controller is manufactured with a consistent design philosophy supported by high technology for integration of components under the most advanced quality control system. As a result of these excellent manufacturing conditions, the PC is capable of minimizing time required for troubleshooting should a failure occur. This is because the PC is provided with various diagnostic functions.

Diagnostic functions for hardware
(Checks CPU, I/O unit bus, and SYSBUS)
System diagnosis
(Checks the remote I/O unit system for correct use)

These abnormal statuses can be monitored by messages and FAL numbers displayed on the LCD of the programming console.
In addition, the PC has the special auxiliary relays, each of which is assigned to output an abnormal status. These relays associated with the user program allow the PC to provide flexible countermeasures against failure because the decision can be made whether to continue or stop the operation of the system.

Special I/O units

List of failures and alarm outputs

	Item	Description	LED indicators on CPU					Message on programming console	LED indicators on remote I/O master unit		
			POWER	RUN	ERR	ALARM	OUT INHB.		T/R ERR	TEST OK	END RS CHK
A failure that occurs before the CPU operates	Remote power ON wait	• Power of expansion I/O rack is turned OFF. • Transmisison line (SYSBUS) is disconnected.	●	○	–	–	–	CPU WAITG	◐	–	●
		No END station is specified.									
		Transmisison error occurs on SYSBUS.***							●	–	–
		Failure has occurred in I/O bus of expansion I/O rack.							●		–
		Failure has occurred in remote I/O slave unit or optical transmitting I/O unit.							◐	–	–
		Failure has occurred in remote I/O master unit							○	○	○
		Wrong address has been set for remote I/O slave unit.							◐	–	–
A failure that does not cause the CPU to stop	Remote I/O error	• Transmission error occurs in SYSBUS.**** • SYSBUS is disconnected.	●	–	–	●	–	RMTE I/O ERR	●	–	–
		•iPower of remote I.O unit or optical transmitting I.O unit is turned OFF. • Failure has occurred in CPU.							●	–	–
		Failure has occurred in I/O bus of expansion I/O rack.							●	–	–
		Failure has occurred in remote I/O master unit.							○	○	○
	I/O verify error	• I/O unit or optical transmitting I/O unit is removed from or mounted to expansion I/O rack. • Channel number assigned to I/O unit of programmable controller and that assigned to optical transmitting I/O unit are overlapped.	●	–	–	●	–	I/O VER ERR	–	–	–
A failure that causes the CPU to stop	I/O setting error	Mounting positions of input and output units mounted to expansion I/O rack are exchanged.	●	○	●	–	–	I/O SET ERR	–	–	–
		Both optical transmitting input and output units are assigned to same channel.							–	–	–

Note:

● : illumination ○ : extinguished ◐ : flashing

* Failure codes B0 to B7 are assigned to remote I/O master units in sequence starting from the unit assigned with the lowest-order channel number.

** These numbers indicate the special auxiliary relay numbers of the PC.

LED indicators on remote I/O slave unit		LED indicators on optical transmitting I/O unit		Special auxiliary relay	Failure code	Remedy
T/R ERR	ERR	POWER	T/R ERR			
–	–	–	–	–		Turn on power of expansion I/O rack and optical transmitting I/O unit one after another.
–	–	–	–	6112 ON **		• Specify remote I/O slave unit or optical transmitting I/O unit assigned with the greatest channel number as end RSU. • For details on specifying end RSU, refer to identifying abnormal I/O unit when transmission error occurs in SYSBUS.
–	✱	–	–	–		Check remote I/O slave unit, I/O unit, and base unit mounted to expansion I/O rack.
○	○	✱	○			Replace faulty remote I/O slave unit or optical transmitting I/O unit with new one.
–	–	–	–			Replace faulty remote I/O master unit with new one.
–	–	✱	–			• Assign address either 0 or 1 to remote I/O slave unit. • If 2 or 3 is specified as address of remote I/O slave unit, this address will be ignored.
✱	–	✱	✱	6112 ON **	B0 to B7*	When cause of failure is removed, unit will recover from abnormal state automatically. If not, replace power supply of each unit or unit itself with new one. For details on this, refer to Identifying abnormal I/O unit when transmisison error occurs in SYSBUS.
○	○	–	○			
–	✱	–	–			Check remote I/O slave unit, I/O units, and expansion I/O rack.
–	–	–	–			Replace remote I/O master unit with new one.
–	–	–	–	6110 ON **	E7	After verifying I/O table by using programming console, assign channel number to each I/O unit correctly.
–	✱	–	–		E0	After verifying I/O table by using programming console: • Return input and output units to their original mounting positions. • Generate I/O table again.
–	–	–	–			

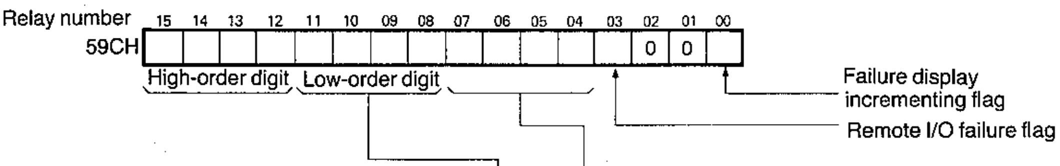
*** If the same address is assigned to two remote I/O slave units or the same channel is assigned to plural optical transmitting I/O units in duplication, the data will compete for the SYSBUS. Consequently, a transmission error will frequently occur. The transmission error also occurs because of influence of external interference light when no protective cap is put on the unused of the two fiber optics connectors on the end RSU.

Internal auxiliary relays and failure code

In case a failure listed in List of failures and alarm outputs occurs in any of the remote or optical transmitting I/o units connected to a SYSMAC-C120F programmable controller, the abnormal unit can be identified by monitoring the internal auxiliary relays of channel number 59 of the PC.

The following figure and table show the relation between how each relay of channel number 59 is used to identify the abnormal unit and what each failure code displayed on the programming console of the controller means.

Configuration of 59CH

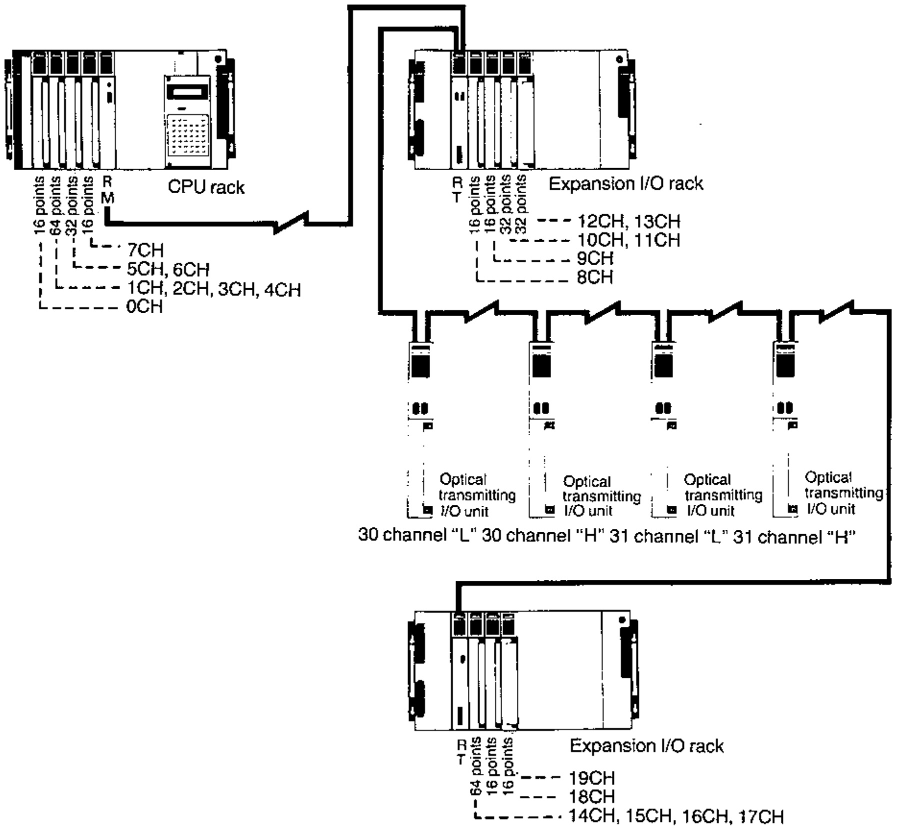


Location of failure	Meaning of failure code	Data of 59CH		Meaning of failure code
Remote I/O unit	The failure code B0 to B3 are sequentially assigned to the remote I/O master units mounted to the CPU rack of the PC or an expansion I/O rack starting from the unit assigned the lower-order channel number.	B0 to B3	8	Number 8 indicates that a failure has occurred in a remote I/O master unit.
			0	Number 0 indicates that a failure has occurred in the remote I/O slave unit mounted to the expansion I/O rack number 0.
			1	Number 1 indicates that a failure has occurred in the remote I/O slave unit mounted to the expansion I/O racknumber 1.
Optical transmitting I/O unit	Number 00 to 31 indicates the channel numbers assigned to the optical transmitting I/O unit in use.	00 to 31	0	Number 0 indicates that optical transmitting I/O unit specified as an L channel.
			1	Number 1 indicates the optical transmitting I/O unit specified as an H channel.

Failure display incrementing flag: When a failure has occurred in plural units, the displayed failure code can be incremented by turning this flag ON and OFF.

Remote I/O failure flag: This flag indicates that a failure has occurred in a remote I/O unit or an optical transmitting I/O unit.

Examples of identifying abnormal unit



1. In the above system, if a failure occurs in the optical transmitting I/O unit specified as channel number 31 with lower-order addresses (31CH "L"), the contents of number 251 channel will be as follows.

	15			0
59CH	0 0 1 1	0 0 0 1	0 0 0 0	1 0 0 0

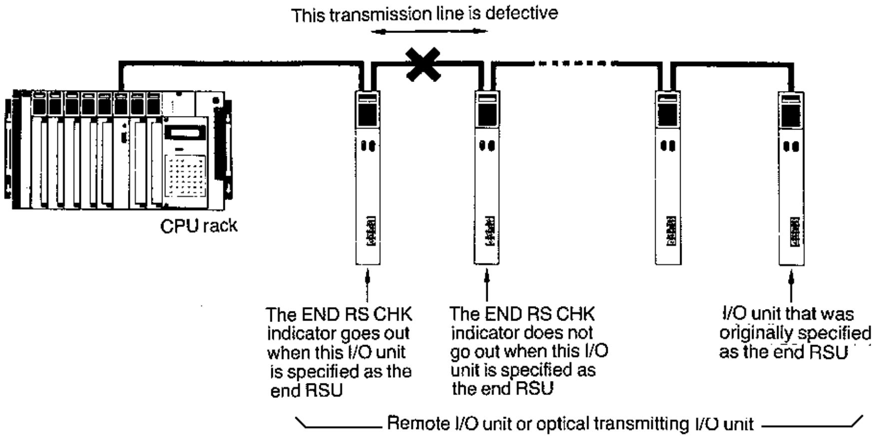
Identifying abnormal I/O unit when transmission error occurs in SYSBUS

Failure before remote I/O main unit recognizes end RSU

On some occasions, the T/R ERR indicator on the remote I/O master unit blinks while the END RS CHK indicator remains illuminated, even though the end RSU is specified. In such case, chances are that the transmission line (SYSBUS) may be disconnected, or the power of the expansion I/O rack or optical transmitting I/O unit may be turned OFF. To spot the location of the failure, observe the following procedures.

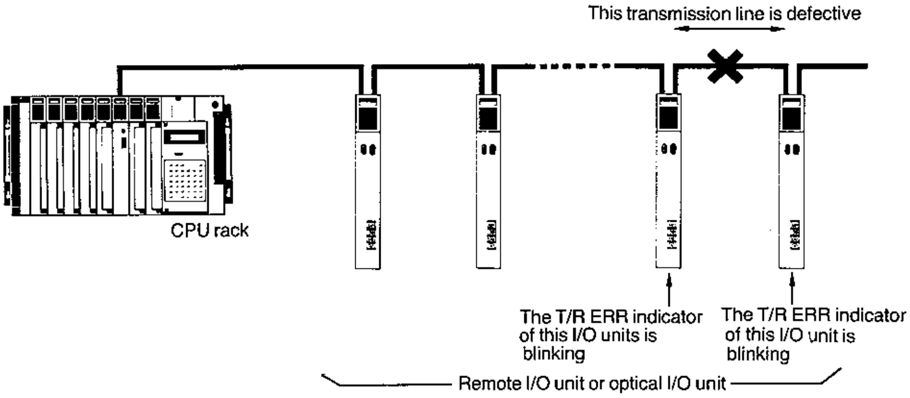
1. Specify I/O unit immediately before the one specified as the end RSU.
2. Check that the END RS CHK indicator on the remote I/O master unit extinguishes.

   Repeat this procedure until the END STA CHECK indicator goes out. When the END STA CHECK indicator extinguishes, it means that the failure occurred in the transmission line between the I/O unit being specified as the end RSU when the indicator goes out and the I/O unit that was specified as the end RSU immediately before.



After remote I/O main unit recognizes end RSU

Check the I/O units one after another. The failure has occurred between the I/O unit whose T/R ERR indicator is illuminating and the one whose T/R ERR indicator is blinking.



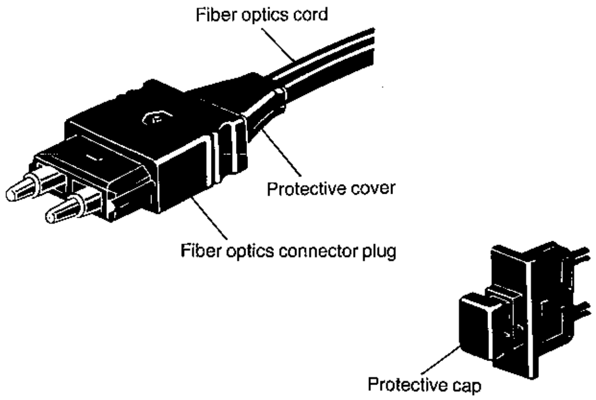
Handling of fiber optics cable

Although the fiber optics cable possesses adequate mechanical durability, be careful not to drop any heavy object on it. Connect or disconnect the fiber optics connector by holding its plug, and never by the fiber optics cable.

The fiber optics connector cannot be connected in the reverse direction, so confirm its direction when connecting it and be sure to insert the connector until it locks.

Be careful not to soil the connecting portion of the fiber optics connector. Place the protective cap, attached as an accessory, on the connector when not in use. Should the connector be soiled, wipe it off gently with absorbent cotton soaked with ethyl alcohol or a clean tissue paper.

Do not use an organic solvent other than ethyl alcohol.
The fiber optics capable is very flexible and has a minimum bending radius of 15 mm, but avoid using it with small bending radius.


Fiber optics cord
Protective cover
Fiber optics connector plug
Protective cap

Host computer linkage system configuration

The SYSMAC-C Sereis realizes an efficient as well as effective decentralized control of factory automation by linking a host computer to the PC.

Connecting plural programmable controllers to host computer (SYSWAY)
All internally controlled data of the programmable controller such as the SYSMAC-C120F or -C500F can be transmitted to/from the host computer such as a personal computer or minicomputer.

The data transmission rate is selectable from 300, 600, 1.2K, 2.4K, 4.8K, 9.6K, and 19.2K bps.

The RS-232C or RS-422 interface can be used to connect the host computer with the programmable controller.

For data transmission between the host computer and programmable controller, an exclusive synchronization is employed. Therefore, the data transmission rate of the host computer must be synchronized with that of the programmable controller.

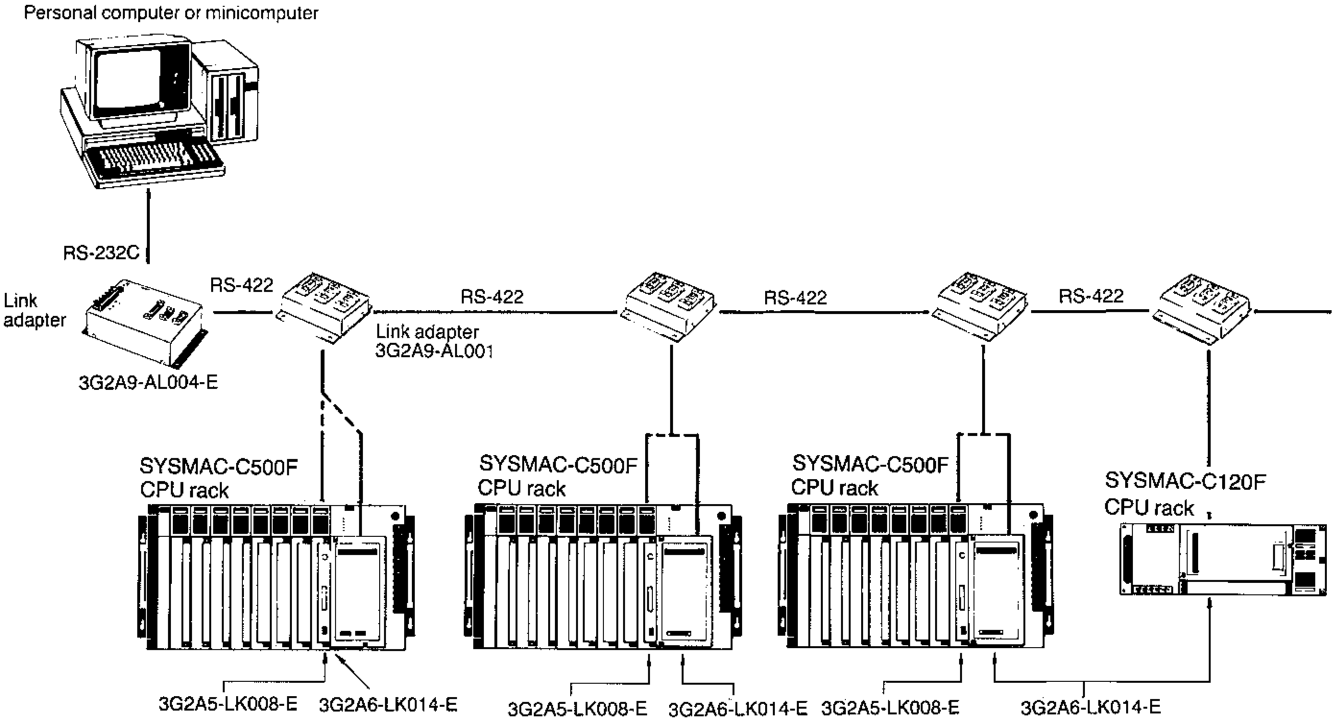
Type 3G2A5-LK008-E/3G2A6-LK012-E/-LK013-E/-LK014-E host link unit must be mounted to the programmable controller (SYSMAC-C500F and -C120F).

The number of Type 3G2A9-AL001 link adapters that serve as the distributor for the data transmission cables is determined by the number of pieces of equipment linked with the programmable controller. That is, where the number of those pieces of equipment is represented as n, n−1 link adapters are required.

The twisted pair, shielded cable of the RS-422 interface provides an extension of 500 m.

Systems configured of remote I/O, I/O, or PC link unit can be used in parallel with the system of the host computer linkage.

SYSWAY system
Communication method: 4-wire, half duplex system
Transmission format: multipoint (RS-422) or point-to-point (RS- 232C)
Transmission rate: 300, 600, 1.2K, 2.4K, 4.8K, 9.6K, or 19.2 K bps selectable
Synchronization system: Start-stop synchronization system, independent synchronization system
Transmission control procedure: Exclusive control procedure (multipoint) or OMRON original protocol (point-to-point)
Maximum No. of programmable controllers connectable: 32 (when the multipoint control procedure is used)
Transmission line: Twisted pair, shielded cable



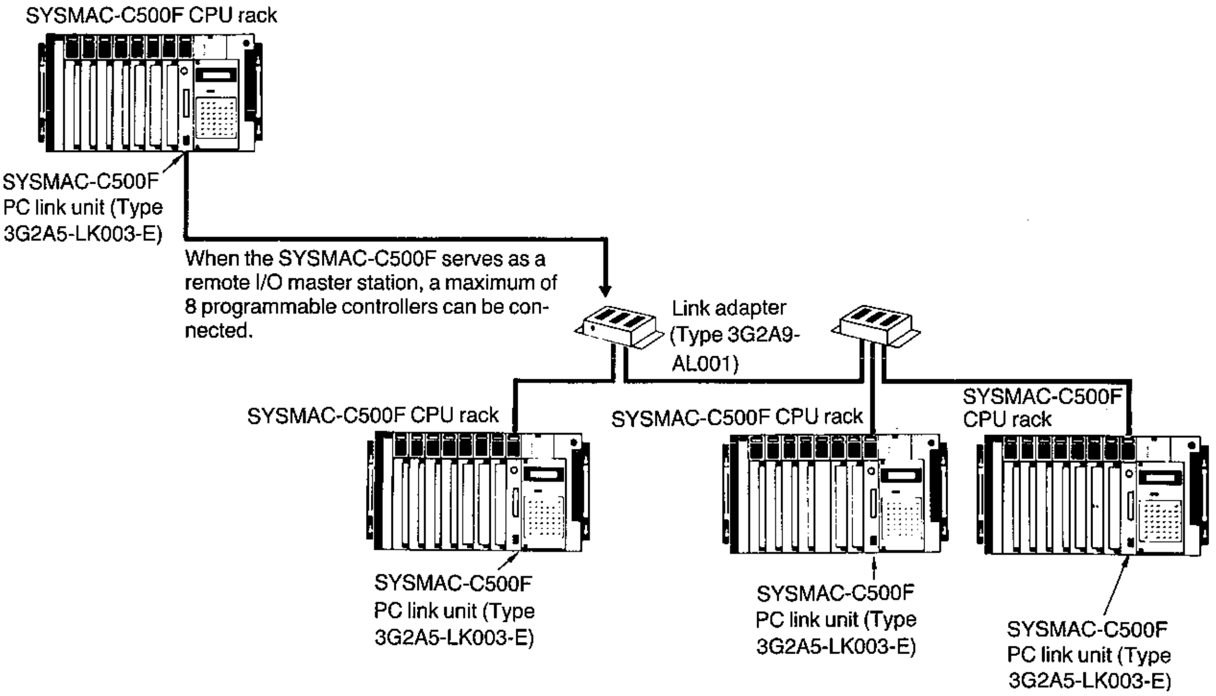
Programmable controller linkage system configuration

This system is designed for the purpose of decentralized control and allows data transmission between programmable controllers to be easily performed by using an exclusive relay area.

The wiring procedure has been simplified, thereby significantly reducing the installation cost.

Transmission speed	128K bps
Maximum no. of programmable controller connectable	8 (when SYSMAC-C500F serves as a master station)
Cable used	Twisted pair, shielded cable
Data transmission time	Approx. 25 ms (64 points × 8 programmable controllers)
Transmission distance (Total cable length)	500 m max. (branch cable: 10 m max.)
Diagnostic functions	CPU watchdog timer, transmission error check
Maximum no. of I/O points to be transmitted (when SYSMAC-C500F serves as a master station)	When 8 programmable controllers linked: 64 points/controller When 4 programmable controllers linked: 128 points/controller When 2 programmable controllers linked: 256 points/controller

Note: When the system is configured of SYSMAC-C series programmable controllers only, the number of controllers to be linked can be specified by using a selector switch.



I/O linkage system configuration

The employment of fiber optics cables has improved noise immunity of the PC resulting in higher reliability of the system.

The wiring procedure has been simplified, thereby significantly reducing the installation cost.

The maximum transmission distance between the PCs is 800 m.

By using the user program of the PC to which the remote I/O master unit is mounted and the user program of the controller to which an I/O link unit is connected, the data of the I/O base can be transmitted/received among a maximum of 16 PCs.

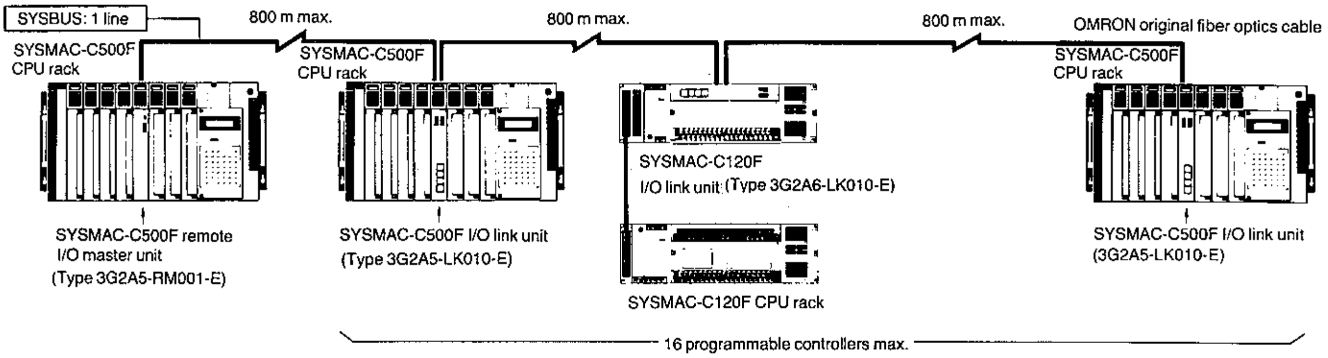
The PC to which the remote I/O master unit is connected functions as the primary station that controls the flow of data.

The PCs to which an I/O unit is connected functions as a secondary station that actually transmits and receives data.

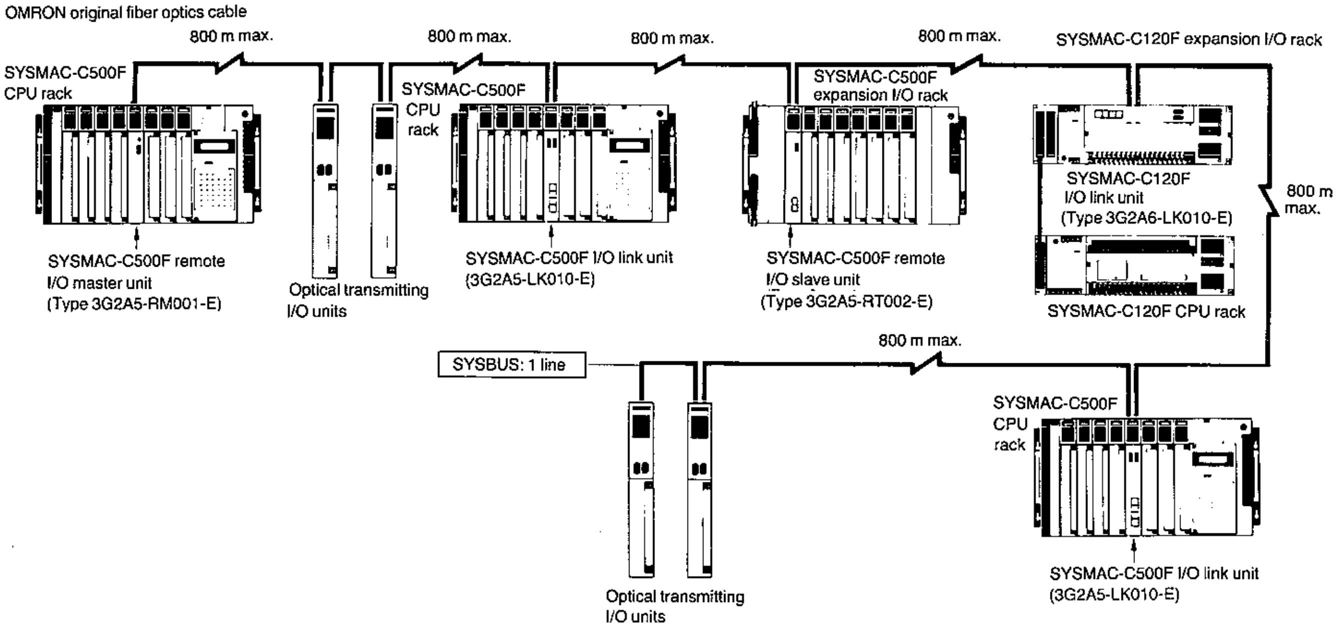
The maximum number of I/O link units that can be controlled by the remote I/O master unit differs depending on the maximum number of I/O points provided to the PC to which the remote I/O master unit is connected and the number of I/O points of each I/O link unit connected.

The number of the I/O link units is determined as follows:
The maximum number of I/O points of the programmable controller to which the remote I/O master unit is mounted ≥ the total number of I/O points of each I/O link unit connected

Connecting I/O link units only to remote I/O master unit (SYSBUS)



Connecting I/O link unit, optical transmitting I/O unit, and remote I/O slave unit to remote I/O master unit (SYSBUS)



SYSBUS system

Communication method: bidirectional, half-duplex
Transmission format: multipoint
Transmission rate: 187.5K bps
Transmission system: TDM (Time Division Multiplex system)
Synchronization: start-stop synchronization
Transmission control procedure: exclusive transmission (cyclic control system)
Maximum number of programmable controllers connectable: 64 (transmission capacity: 8 points/unit)
Transmission cable: 2-core fiber optics cable (quartz-polymer, 250 μm dia. core)

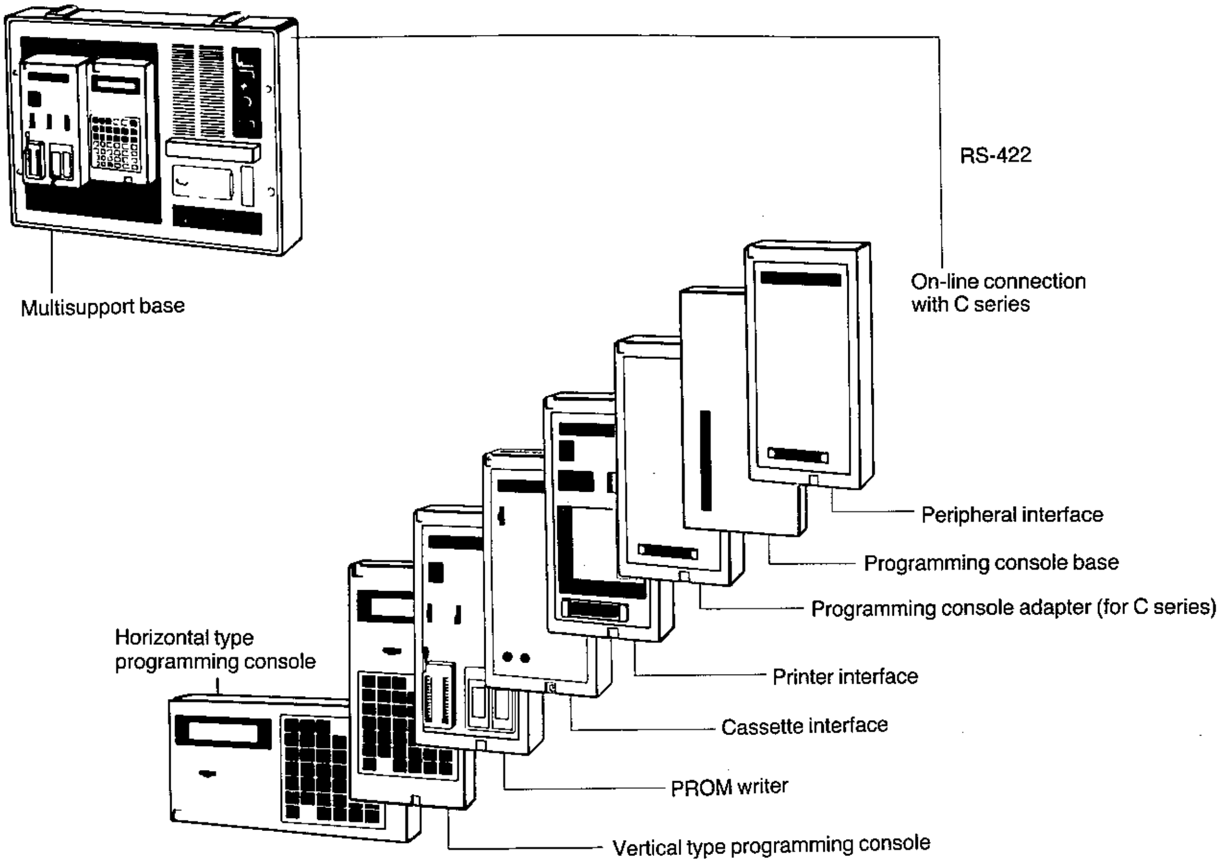
Chapter 10 Peripheral devices

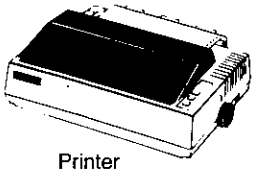
Available types

Product name	Specifications	Type	Weight (max.)
Programming console	Vertical type (for SYSMAC-C500F) • Current consumption: 260 mA max.	3G2A5-PRO19-E	400 g
	Horizontal type (for SYSMAC-C120F) • Current consumption: 260 mA max.	3G2A6-PRO20-E	400 g
Programming console adapter	Connct this adapter to the PC when the programming console is connected to the controller via a connecting cable	3G2A5-AP001-E	400 g
Programming console base	Mount this base to the programming console when the programming console is connected to the controller via a connecting cable	3G2A5-BP001	400 g
PROM writer	For PROM, ROM-GA (2732A), ROM-H (2764), ROM-I (27128) • Current consumption: 850 mA max.	3G2A5-PRW04-E	540 g
Printer interface	Interface for X-Y plotter or printer • Memory cassette (option) • Current consumption: 400 mA max.	3G2A5-PRT01-E	540 g max.
Peripheral interface	Interface between programmable controller and graphic programming console (CRT) or multisupport base (MSB)	3G2A5-IP004-E	400 g
Cassette interface	For SYSMAC-V8, −M1R, −M5R, P0R, and −S6 • Current consumption: 160 mA max.	3G2A5-CMT01-E	400 g
Multisupport base	• Supply voltage: 110/120 VAC • No. of connectable peripheral devices: 2 max. • Memory cassette (option)	3G2A5-MSB01-E	8 kg
	• Supply voltage: 220/240 VAC • No. of connectable peripheral devices: 2 max. • Programmable controller connectable • Memory cassette (option)	3G2A5-MSB02-E	8 kg
Programming console adapter	For SYSMAC-V8 programming console or MSB interface	3G2A5-AP002	400 g
Memory cassette for multi-support base	For flowchart programming type SYSMAC-C series	3G2A5-MP007-E	100 g
Memory cassette for printer interface unit	For flowchart programming type SYSMAC-C series	3G2A5-MP008-E	200 g
Programming console connecting cable	2 m (for programming console and multisupport base)	3G2A2-CN221	350 g
Printer connecting cable	2 m	SCY-CN201	220 g
Cassette deck connecting cord	1.5 m	SCYP0R-PLG01	500 g

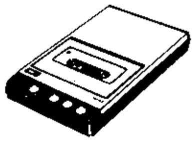
Peripheral devices

Appearance



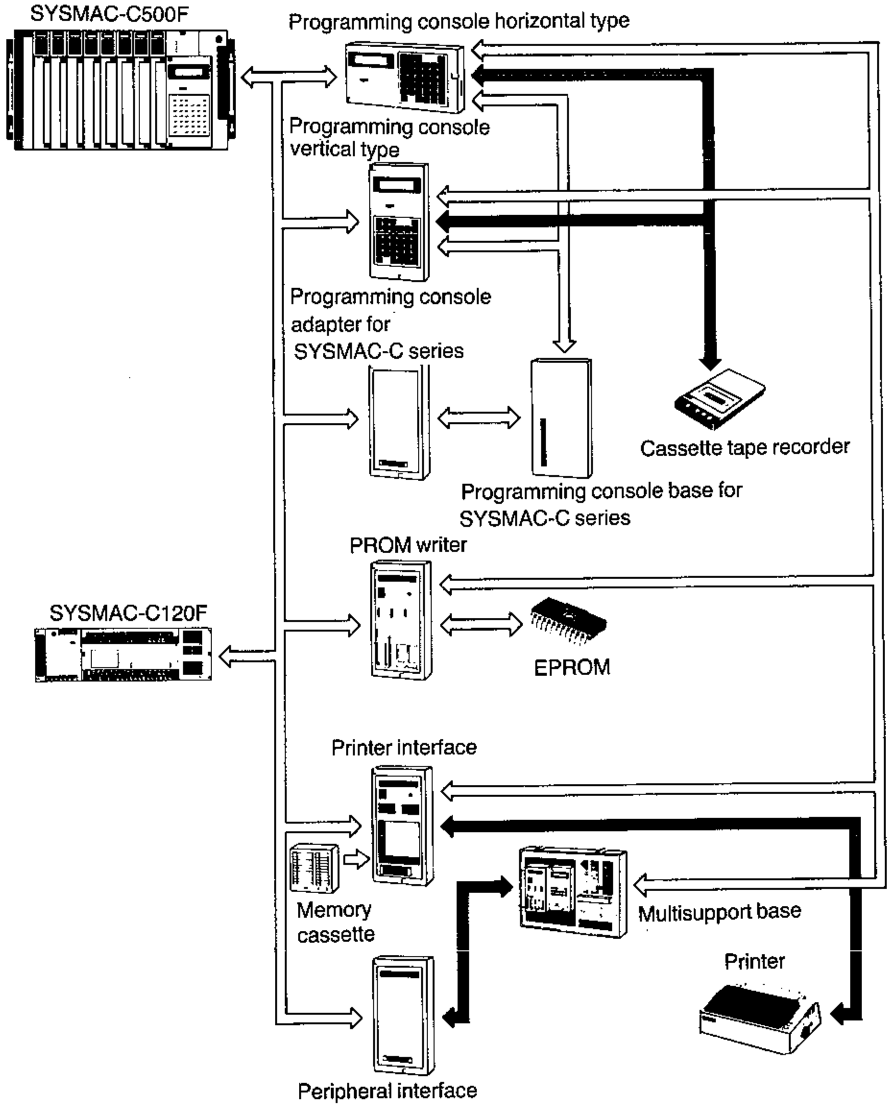


Printer



Cassette tape recorder

Connections



Ratings

Supply voltage	110, 120/220, 240 VAC, 50/60 Hz
Operating voltage range	85 to 110% of rated voltage*
Power consumption	CPU rack: 50 VA max. Expansion I/O rack: 35 VA max.
Insulation resistance	5 MΩ min. at 500 VDC (between external terminal and outer casing)
Dielectric strength	1,500 VAC, 50/60 Hz for 1 minute (between external terminal and outer casing)
Noise immunity	1,000 Vp-p Rise time: 1 ns; Pulse width: 100 ns to 1 µs
Vibration	16.7 Hz, 3mm double amplitude, (in X, Y, Z directions, respectively 30 min)
Shock	10 G (in X, Y, Z directions, respectively 3 times)
Ambient temperature	Operating: 0° to +50°C Storage: −20° to +65°C
Humidity	35 to 85% RH (without condensation)
Atmosphere	Must be free from corrosive gases
Degree of protection	IP30

Specifications

Characteristics

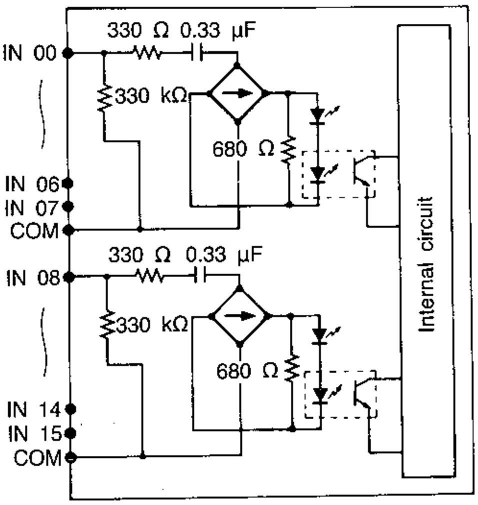
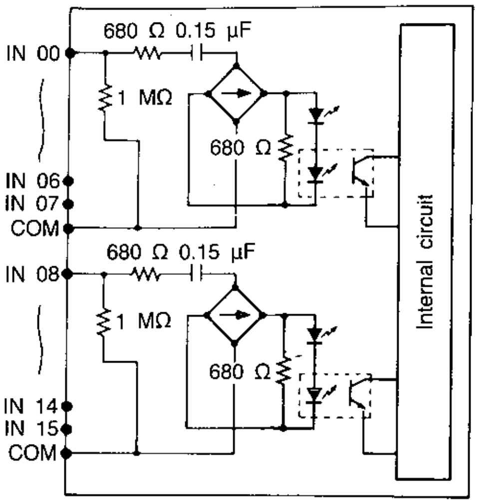
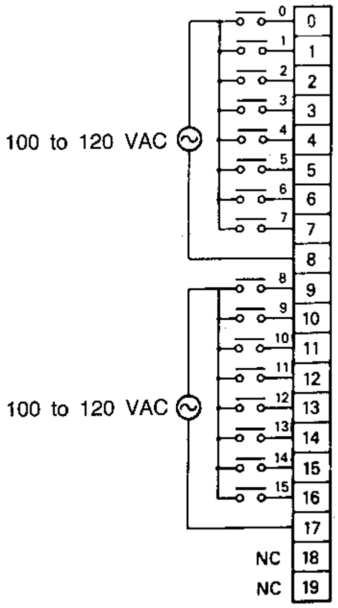
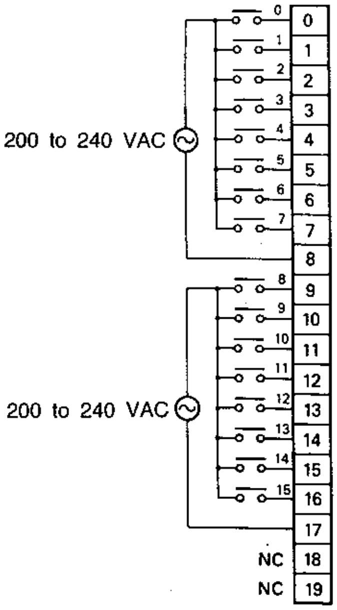
Control system	Stored program system
Main control element	MPU, CMOS, LS-TTL
Programming system	Flowchart
Instruction word length	16 bits/address (1 to 4 addresses/instruction)
Number of instructions	71 kinds
Execution time/address	50 µs (average of execution times for AND, OR, and OUT instructions) 5.8 ms (When parallel processing of 32 group programs is performed)
Programming capacity	4K address (RAM/ROM)
Program label capacity	1K words (0 to 1023)
Number of programs for parallel processing	Main program + 32 group programs (0 to 31)
Number of input/output relays	256 (Relay Nos. 0000 to 1515)
Number of internal auxiliary relays	459 (Relay Nos. 3200 to 6010)
Number of link relays	512 (Relay Nos. LR0000 to 3115) (Can be used as internal auxiliary relays)
Number of holding (retentive) relays	512 (Relay Nos. HR0000 to 3115)
Number of timers/counters	128 (Timer Nos. TIM000 to 127 and counter Nos. CNT000 to 127)
	Timer: 0 to 999.9 s (TIM000 to 117)/0 to 99.99 s (TIM118 to 127) Counter: 0 to 9999 counts
Number of special auxiliary relays	45 (Relay Nos. 6011 to 6315)*
Number of data memories	512 (DM000 to 511)
Expansion data memoris	Not provided
Control input signal	• START INPUT: In RUN mode, PC operates this when contact is closed and stops when it is opened.
Control output signal	• RUN OUTPUT: This contact is closed during PC operation.
DC power supply	24 VDC, 0.1 A (incorporated)
Memory protective function against power failure	Data in holding relays, timers/counters, and data memories before power failure are retained in the memory.
Battery	• Service life of built-in battery is about 5 years at a temperature of 25°C. If ambient temperature at which battery is to be used exceeds 25°C, battery life will be shortened. Replace battery within one week after message BATTERY ERR is displayed on programming console. Replace battery within approx. 5 minutes after turning off power switch.
Diagnostic functions **	• CPU failure (watchdog timer) • Battery failure • Memory failure • I/O bus failure
	Program check 1. Jump destination error check 2. Label number, group number, subroutine number, timer/counter number, and differentiation instruction duplication checks 3. Instruction error check 4. Label, group number, subroutine number, and timer/counter definition checks 5. IL-ILC and SBN-RET error checks 6. Syntax error check

* For details, refer to Special auxiliary relays in Chapter 4.

** For details, refer to List of error messages and alarm outputs in Chapter 7.

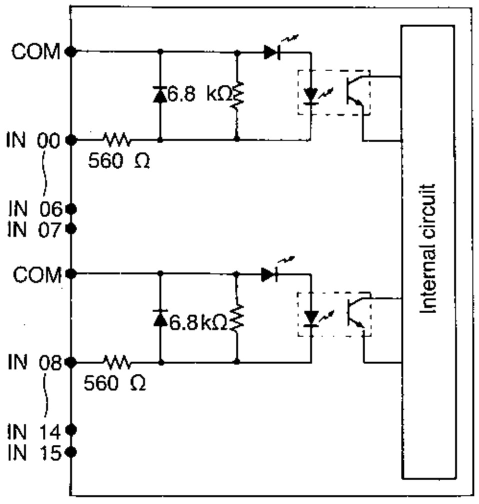
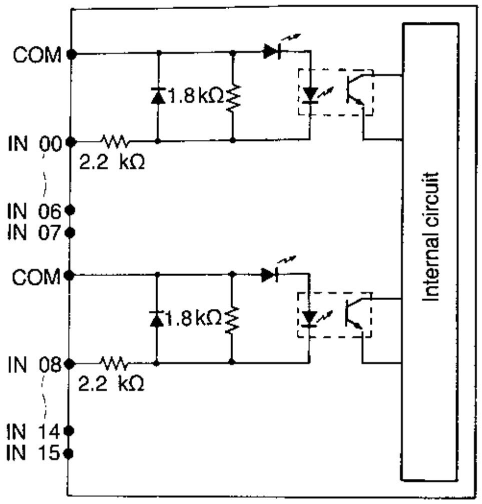
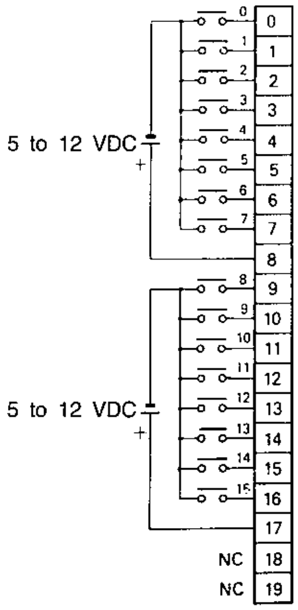
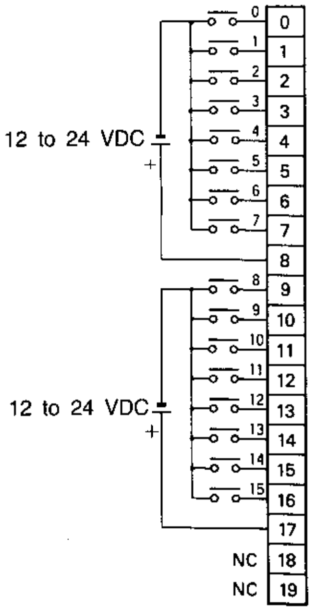
I/O unit specifications

Input unit specifications

Type Item	AC input unit	
	3G2A6-IA121	3G2A6-IA222
Input voltage	85 to 132 VAC 50/60 Hz	170 to 264 VAC 50/60 Hz
Input impedance	9.7 kΩ (50 Hz), 8 kΩ (60 Hz)	22 kΩ (50 Hz), 18 kΩ (60 Hz)
Input current	10 mA typ. (100 VAC)	10 mA typ. (200 VAC)
ON delay time	35 ms max.	35 ms max.
OFF delay time	55 ms max.	55 ms max.
Number of circuits	16 (8/common)	16 (8/common)
Weight	450 g max.	450 g max.
ON voltage	60 VAC max.	120 VAC max.
OFF voltage	20 VAC min.	40 VAC min.
Current consumption of internal constant-voltage circuit	5 VDC 10 mA max.	5 VDC 12 mA max.
Circuit configuration		
Terminal connections*		

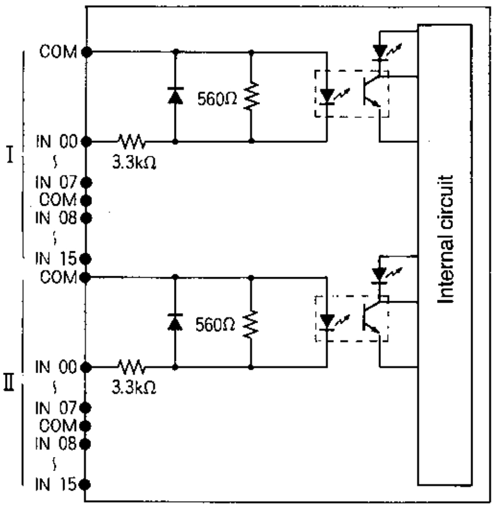
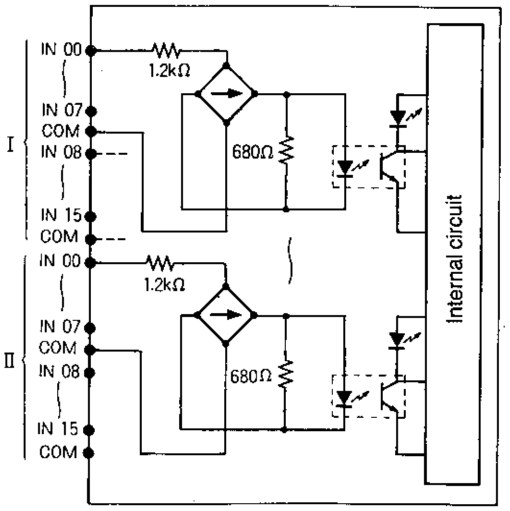
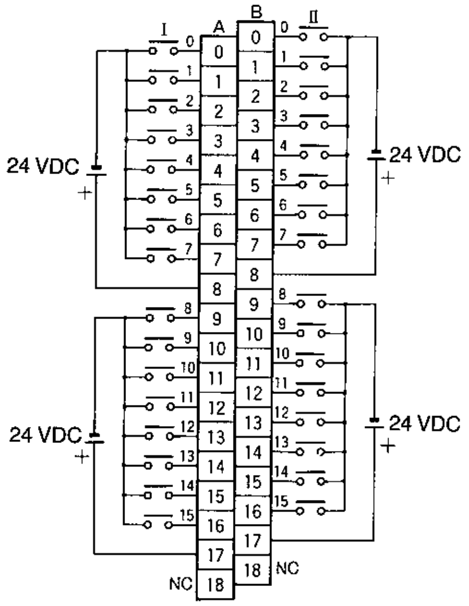
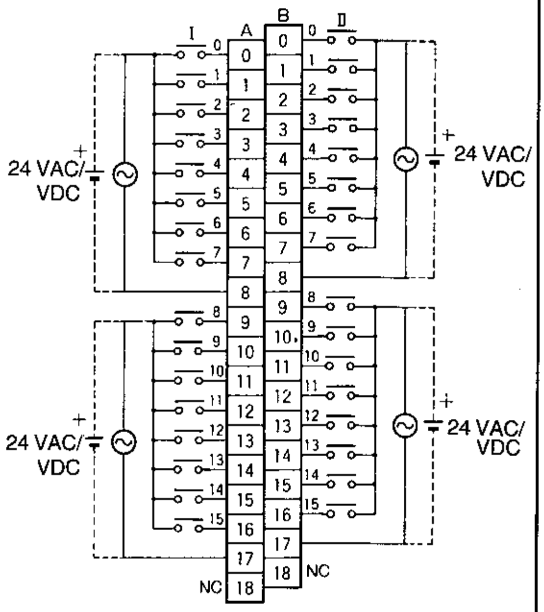
*The terminal numbers and I/O channel numbers of an I/O unit are changed according to the position on the CPU (or expansion I/O) rack on which the I/O unit is mounted. The terminal connections shown above are for when the I/O unit is mounted on the UNIT 1 position.

Specifications

Type Item	DC input unit	
	3G2A6-ID112	3G2A6-ID213
Input voltage	5 to 12 VDC +10, −5%	12 to 24 VDC +10%, −15%
Input impedance	560 Ω	2.2 kΩ
Input current	16 mA typ. (12 VDC)	10 mA typ. (24 VDC)
On-delay time	1.5 ms max.	1.5 ms max.
OFF-delay time	1.5 ms max.	1.5 ms max.
Number of circuits	16 points (8 points/common)	16 points (8 points/common)
Weight	450 g max.	450 g max.
On voltage	4.0 VDC max.	10.2 VDC max.
OFF voltage	1.5 VDC min.	3.0 VDC min.
Current consumption of internal constant-voltage circuit	5 VDC 10 mA max.	5 VDC 20 mA max.
Circuit configuration	 Two-wire sensors cannot be connected.	
Terminal connections*		

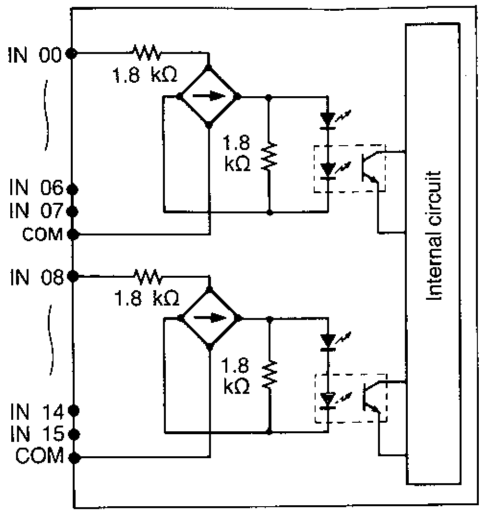
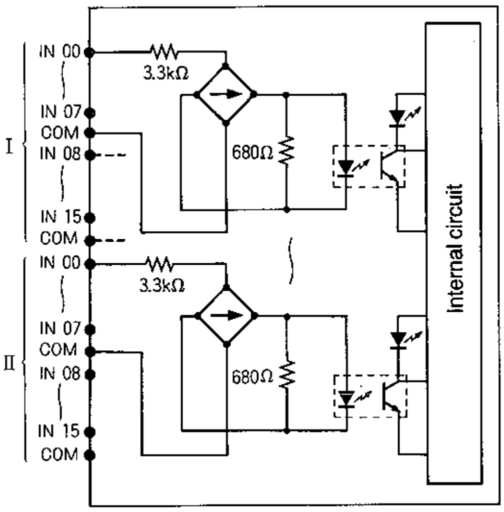
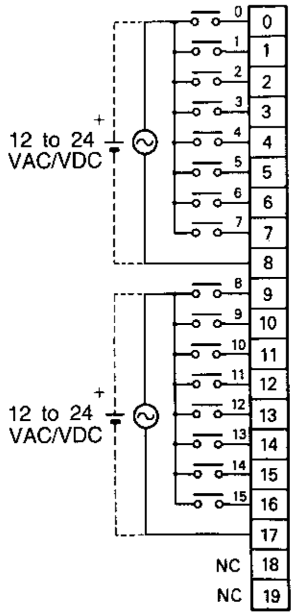
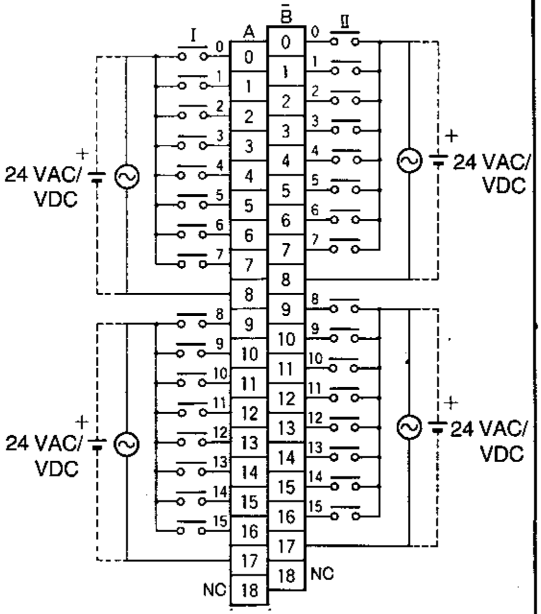
*The terminal numbers and I/O channel numbers of an I/O unit are changed according to the position on the CPU (or expansion I/O) rack on which the I/O unit is mounted. The terminal connections shown above are for when the I/O unit is mounted on the UNIT 1 position.

Specifications

Item \ Type	DC input unit 3G2A6-ID217	AC/DC input unit 3G2A6-IM111
Input voltage	24 VDC +10%, −15%	12 VAC/VDC +10%, −15%
Input impedance	3.3 kΩ	1.2 kΩ
Input current	7 mA typ. (24 VDC)	7 mA typ. (12 VDC)
ON delay time	1.5 ms max.	15 ms max.
OFF delay time	1.5 ms max.	15 ms max.
Number of circuits	32 points (8 points/common)	32 points (8 points/common)
Weight	500 g max.	500 g max.
ON voltage	16.0 V max.	8.0 V max.
OFF voltage	5.0 V max.	3.0 V max.
Current consumption of internal constant-voltage circuit	5 VDC 160 mA max.	5 VDC 200 mA max.
Circuit configuration		
Terminal connections*		

*The terminal numbers and I/O channel numbers of an I/O unit are changed according to the position on the CPU (or expansion I/O) rack on which the I/O unit is mounted. The terminal connections shown above are for when the I/O unit is mounted on the UNIT 1 position.

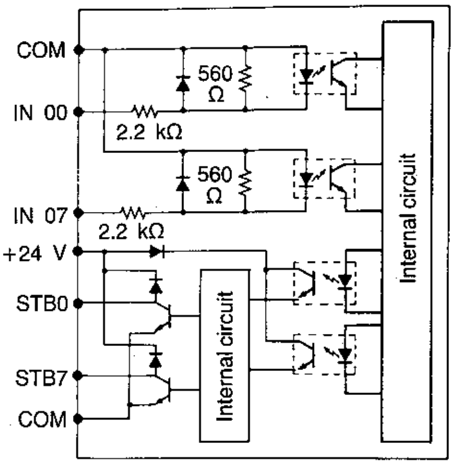
Specifications

Type / Item	AC/DC input unit	
	3G2A6-IM211	3G2A6-IM213
Input voltage	12 to 24 VAC/VDC +10%, −15%	24 VAC/VDC +10%, −15%
Input impedance	1.8 kΩ	2.2 kΩ
Input current	10 mA typ. (24 VDC)	7 mA typ. (24 VDC)
ON-delay time	15 ms max.	15 ms max.
OFF-delay time	15 ms max.	15 ms max.
Number of circuits	16 points (8 points/common)	32 points (8 points/common)
Weight	450 g max.	500 g max.
ON voltage	10.2 VDC max.	16.0 VDC max.
OFF voltage	3.0 VDC min.	3.0 VDC min.
Current consumption of internal constant-voltage circuit	5 VDC 10 mA max.	5 VDC 200 mA max.
Circuit configuration		
Terminal connections*		

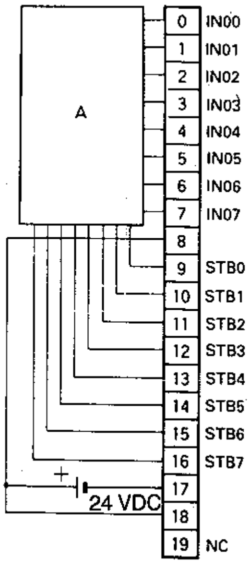
*The terminal numbers and I/O channel numbers of an I/O unit are changed according to the position on the CPU (or expansion I/O) rack on which the I/O unit is mounted. The terminal connections shown above are for when the I/O unit is mounted on the UNIT 1 position.

Type Item		DC input unit 3G2A6-ID212 (NPN)
Input specifications	Input voltage	24 VDC +10%, −15%
	Input impedance	2.2 kΩ
	Input current	10 mA typ. (24 VDC)
	ON delay time	1.5 ms max.
	OFF delay time	1.5 ms max.
	ON voltage	10.2 VDC max.
	OFF voltage	3.0 VDC min.
Output specifications	Max. switching capacity	24 VDC +10%, −15% 0.1 A
	Leakage current	100 μA max.
	Saturation voltage	1.5 V max.
	ON delay time	0.2 ms max.
	OFF delay time	3.0 ms max.
	Fuse capacity	No fuse is provided.
	Supply voltage to internal constant-voltage circuit	24 VDC +10%, −10%
Common specifications	Number of circuits	64
	Weight	450 g max.
	Current consumption of internal constant-voltage circuit	5 VDC 300 mA max.

Circuit configuration

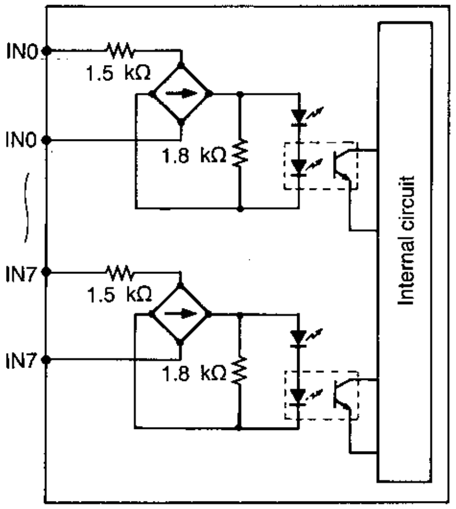
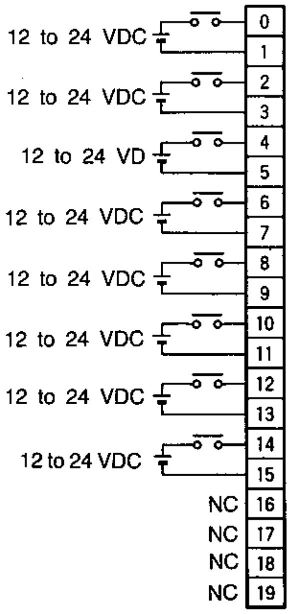


Terminal connections*



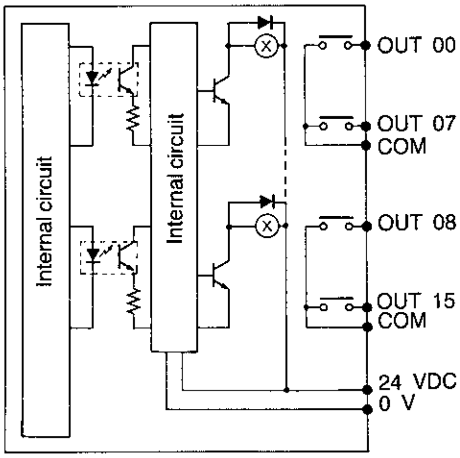
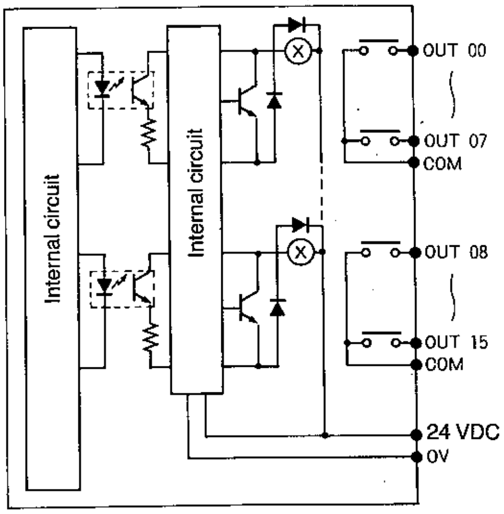
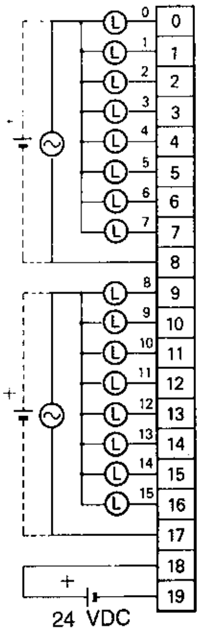
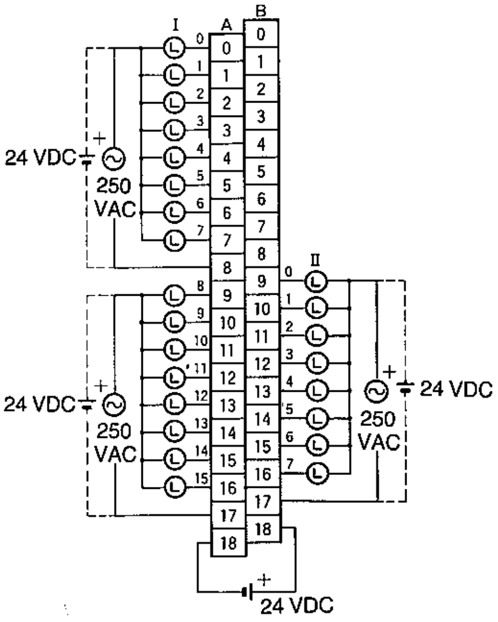
*The terminal numbers and I/O channel numbers of an I/O unit are changed according to the position on the CPU (or expansion I/O) rack on which the I/O unit is mounted. The terminal connections shown above are for when the I/O unit is mounted on the UNIT 1 position.

Specifications

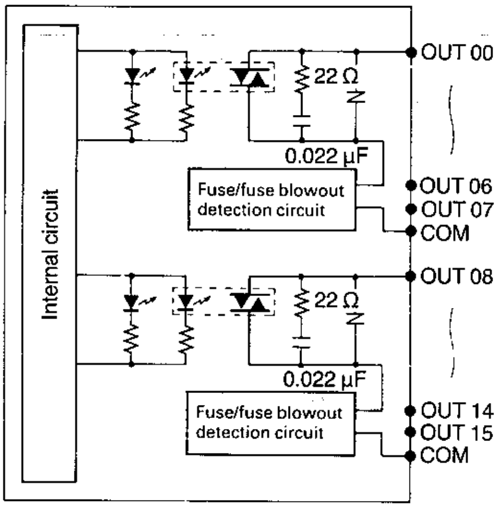
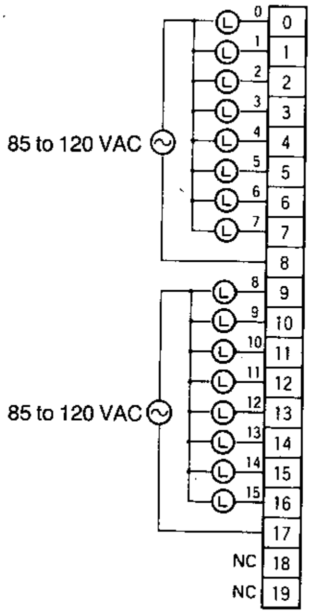
Item \ Type	Interrupt input unit 3G2A6-ID216
Input voltage	12 to 24 VDC +10%, −5% (nonpolar)
Input impedance	1.5 kΩ
Input current	13 mA typ. (24 VDC)
ON delay time	1 ms max.
OFF delay time	1.5 ms max.
Number of circuits	8 (independent common)
Weight	450 g max.
ON voltage	10.2 VDC max.
OFF voltage	3.0 VDC min.
Current consumption of internal constant-voltage circuit	5 VDC 200 mA max.
Circuit configuration	
Terminal connections*	

*The terminal numbers and I/O channel numbers of an I/O unit are changed according to the position on the CPU (or expansion I/O) rack on which the I/O unit is mounted. The terminal connections shown above are for when the I/O unit is mounted on the UNIT 1 position.

Output unit specifications

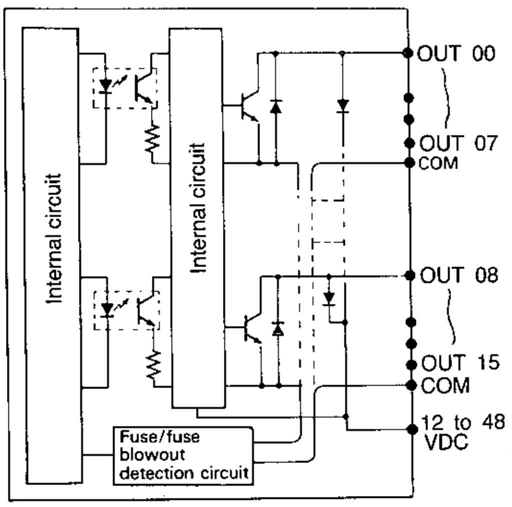
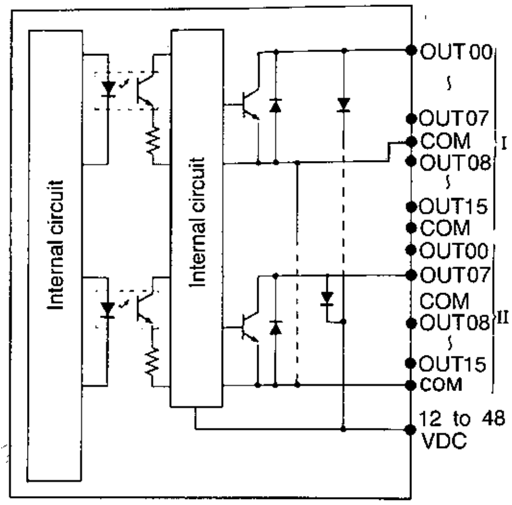
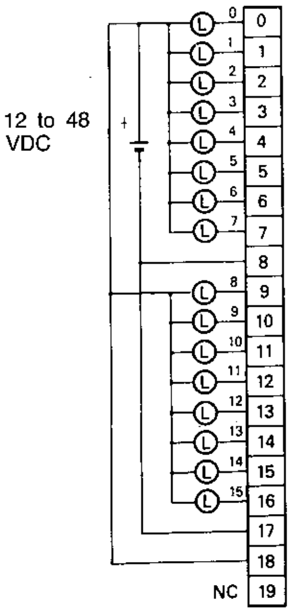
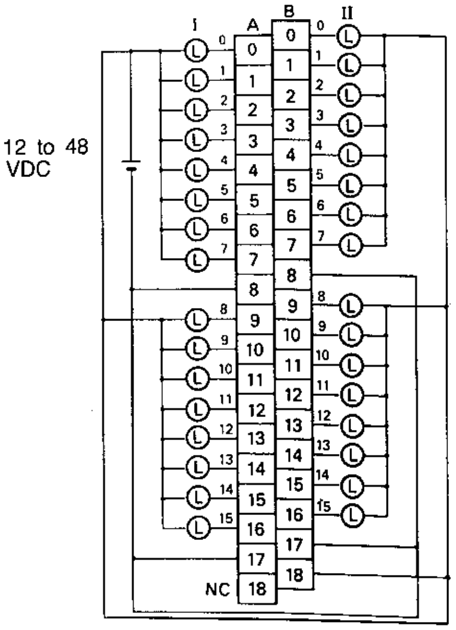
Type Item	Contact output unit	
	3G2A6-OC221	3G2A6-OC222
Max. switching capacity	250 VAC/2 A (p.f.=1), 24 VDC/2 A (8 A/common, 16 A/unit)	250 VAC/2 A (p.f.=1), 24 VDC/2 A (8 A/common, 24 A/unit)
Min. switching capacity	5 VDC 10 mA	5 VDC 10 mA
Supply voltage to internal constant-voltage circuit (for relay driving)	Voltage: 24 VDC +10%, −10% Current: 10 mA/point, 160 mA/unit	Voltage: 24 VDC +10%, −10% Current: 10 mA/point, 160 mA/unit
ON delay time	15 ms max.	15 ms max.
OFF delay time	15 ms max.	15 ms max.
Number of circuits	16 (8/common)	24 (8/common)
Weight	450 g max.	500 g max.
Current consumption of internal constant-voltage circuit	5 VDC +5%, −5%, 100 mA max./24 VDC +10%, −10%, 160 mA max.	5 VDC +5%, −5%, 180 mA max./24 VDC +10%, −10%, 240 mA max.
Service life	Electrically: 300,000 operations Mechanically: 20,000,000 operations (Type G6B-1114P)	Electrically: 300,000 operations Mechanically: 20,000,000 operations (Type G6B-1114P)
Circuit configuration	 Relays are mounted on sockets and are replaceable.	
Terminal connections*		

*The terminal numbers and I/O channel numbers of an I/O unit are changed according to the position on the CPU (or expansion I/O) rack on which the I/O unit is mounted. The terminal connections shown above are for when the I/O unit is mounted on the UNIT 1 position.

Item \ Type	Triac output unit 3G2A6-OA121
Max. switching capacity	85 to 120 VAC 1 A 50/60 Hz (4 A/common, 5 A/unit)
Min. switching capacity	10 mA/100 VAC
Leakage current	3 mA/100 VAC max.
Saturation voltage	1.2 V max.
ON delay time	1 ms max.
OFF delay time	1/2 of load frequency max.
Number of circuits	16 (8/common)
Weight	500 g max.
Current consumption of internal constant-voltage circuit	5 VDC 300 mA max.
Fuse capacity	5 A/8 points
Circuit configuration	
Terminal connections*	

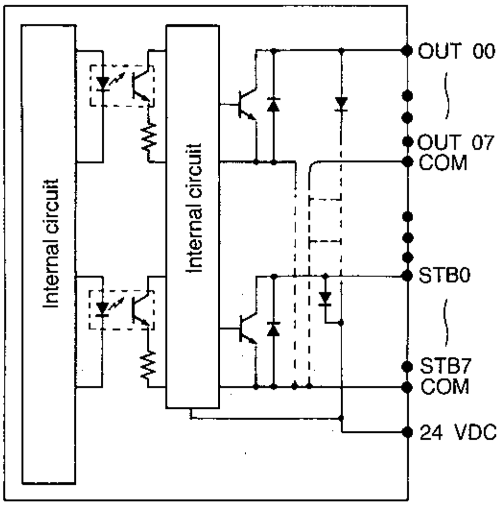
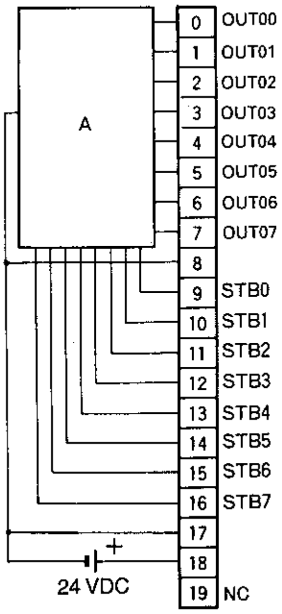
*The terminal numbers and I/O channel numbers of an I/O unit are changed according to the position on the CPU (or expansion I/O) rack on which the I/O unit is mounted. The terminal connections shown above are for when the I/O unit is mounted on the UNIT 1 position.

Specifications

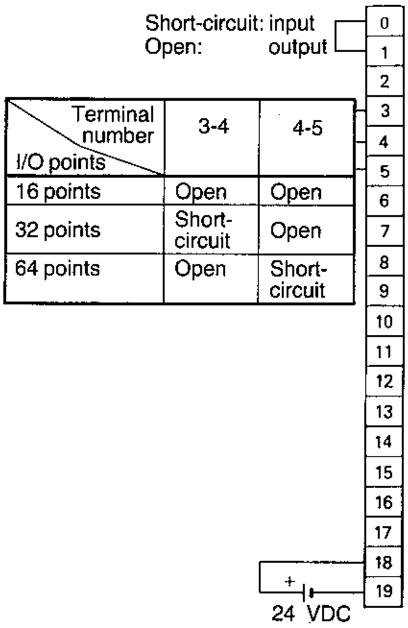
Item \ Type	Transistor output unit	
	3G2A6-OD411	3G2A6-OD412
Max. switching capacity	12 to 48 VDC +10%, −15% 1 A (4 A/common, 5 A/unit)	12 to 48 VDC +10%, −15% 0.3 A (4 A/common, 5 A/unit)
Leakage current	100 µA max.	100 µA max.
Saturation voltage	1.4 V max.	1.5 V max.
ON delay time	0.2 ms max.	0.2 ms max.
OFF delay time	0.3 ms max.	0.3 ms max.
Number of circuits	16 (8/common)	32 (8/common)
Weight	500 g max.	530 g max.
Current consumption of internal constant-voltage circuit	5 VDC 160 mA max.	5 VDC 230 mA max.
Fuse capacity	5 A/8 points	Fuse is not provided.
Supply voltage to internal constant-voltage circuit	12 to 48 VDC +10%, −10% 50 mA max.	12 to 48 VDC +10%, −10% 80 mA max.
Circuit configuration	 OUT: negative logic output	 OUT: negative logic output
Terminal connections*		

*The terminal numbers and I/O channel numbers of an I/O unit are changed according to the position on the CPU (or expansion I/O) rack on which the I/O unit is mounted. The terminal connections shown above are for when the I/O unit is mounted on the UNIT 1 position.

Specifications

Item \ Type	Transistor output unit 3G2A6-OD211
Max. switching capacity	24 VDC +10%, −15% 0.1 A
Leakage current	100 µA max.
Saturation voltage	1.5 V max.
ON delay time	0.2 ms max.
OFF delay time	0.3 ms max.
Number of circuits	64
Weight	450 g max.
Current consumption of internal constant-voltage circuit	5 VDC 300 mA max.
Fuse capacity	Fuse is not provided.
Supply voltage to internal constant-voltage circuit	24 VDC +10%, −10% 50 mA max.
Circuit configuration	 OUT: positive logic output STB: negative logic output
Terminal connections*	

*The terminal numbers and I/O channel numbers of an I/O unit are changed according to the position on the CPU (or expansion I/O) rack on which the I/O unit is mounted. The terminal connections shown above are for when the I/O unit is mounted on the UNIT 1 position.

Type / Item	Dummy I/O unit 3G2A6-DUM01	
Selection function	Unit designation	Input/output
	Point designation	16/32/64 points
Weight	450 g max.	
Current consumption of internal constant-voltage circuit	5 VDC 35 mA max.	
Supply voltage to internal constant-voltage circuit	24 VDC +10%, −10% 30 mA max.	
Circuit configuration		
Terminal connections*		

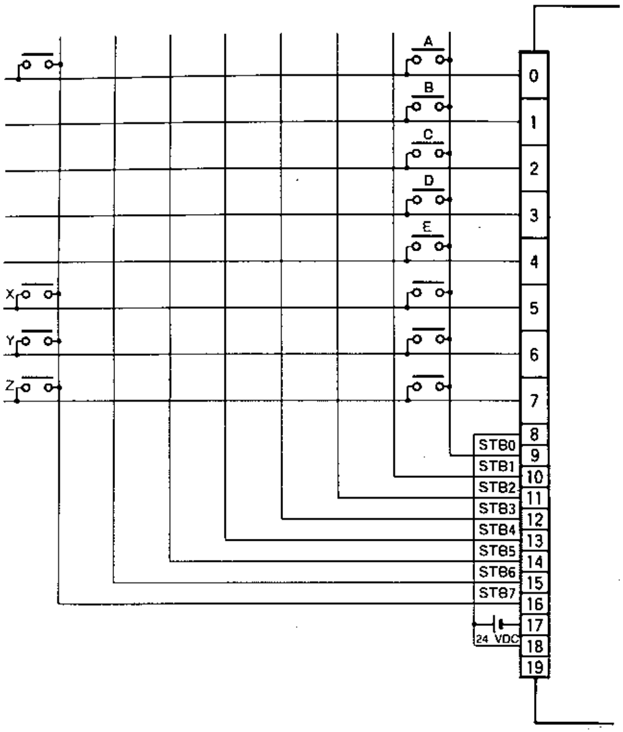
Terminal number / I/O points	3-4	4-5
16 points	Open	Open
32 points	Short-circuit	Open
64 points	Open	Short-circuit

*The terminal numbers and I/O channel numbers of an I/O unit are changed according to the position on the CPU (or expansion I/O) rack on which the I/O unit is mounted. The terminal connections shown above are for when the I/O unit is mounted on the UNIT 1 position.

DC input (64-point) unit

Since this unit is of dynamic input type, a maximum of 16 digits of data can be input to the programmable controller via this unit from thumbwheel switches or a keyboard with simplified wiring.

Connection example 1



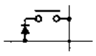
Relay number

	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
Channel n											…	E	D	C	B	A
Channel n+1																
Channel n+2																
Channel n+3	Z	Y	X	…												

When the key corresponding to "A" is depressed, relay 00 of channel n is turned on (i.e., becomes logical 1).

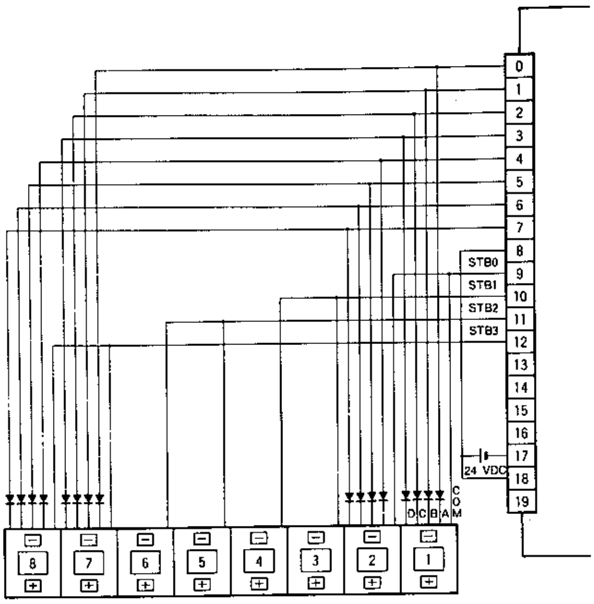
In this example, channel n is determined according to the sequence in which the DC input unit is mounted on the C120F. For details, refer to Free location concept in Chapter 4.

Insert a diode to each key as follows if more than one key is depressed at the same time.



Note: Since the DC input unit is operated on an extremely small current, provide adequate distance between the wires of the unit and high-tension equipment or power lines when performing wiring; otherwise, use shielded cables. Also, keep the length of the wires below 10 m.

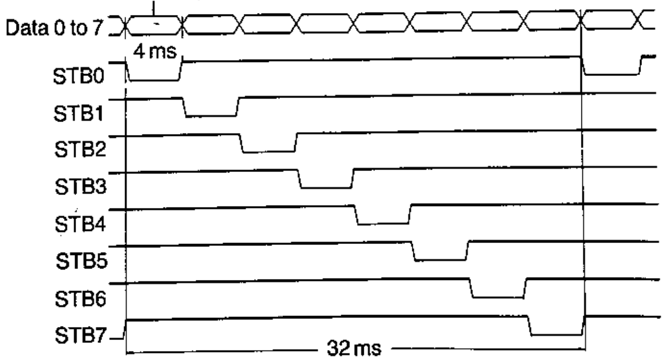
Connection example 2



Relay number

Channel n	0	1	0	0	0	0	1	1	0	0	1	0	0	0	0	1
Channel n+1	1	0	0	0	0	1	1	1	0	1	1	0	0	1	0	1
Channel n+2																
Channel n+3																

Timing

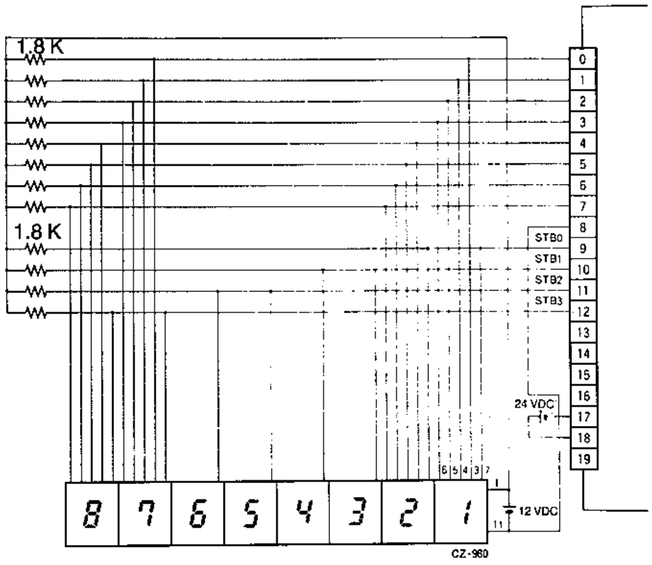

These pulses are input as data to contacts 0 to 7 of channel n.

DC output (64-point) unit

Since this unit is of dynamic output type, the wiring of a device to be connected to it (such as a numeric display device) can be simplified.

This unit outputs positive logic data. Therefore, when data is output, it is logical "1" and the terminal output becomes high level. The strobe output is negative logic. Therefore, when the strobe signal is output, the terminal output becomes low level.

Connection example



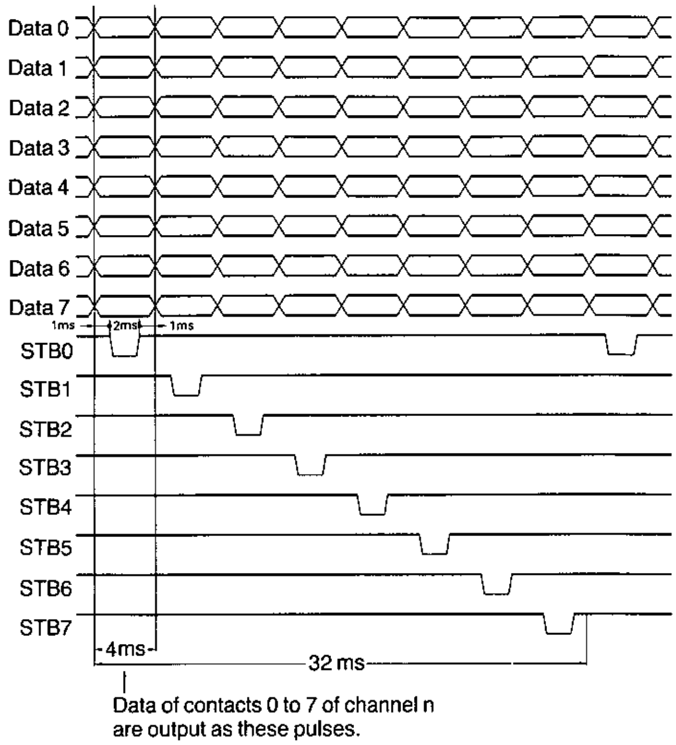
Relay number

	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
Channel n	0	1	0	0	0	0	1	1	0	0	1	0	0	0	0	1
Channel n+1	1	0	0	0	0	1	1	1	0	1	1	0	0	1	0	1
Channel n+2																
Channel n+3																

In this example, channel n is determined according to the sequence in which the DC input unit is mounted on the C120F. For details, refer to Free location concept in Chapter 4.

Note: Since the DC output unit is operated on an extremely small current, provide adequate distance between the wires of the unit and high-tension equipment or power lines when performing wiring; otherwise, use shielded cables. Also, keep the length of the wires below 10 m. In the above diagram, a voltage of 24 VDC must be applied at the same time or before applying a voltage of 12 VDC. The 24 VDC supply voltage must be turned off at the same time or after turning off the 12 VDC supply voltage.

Timing

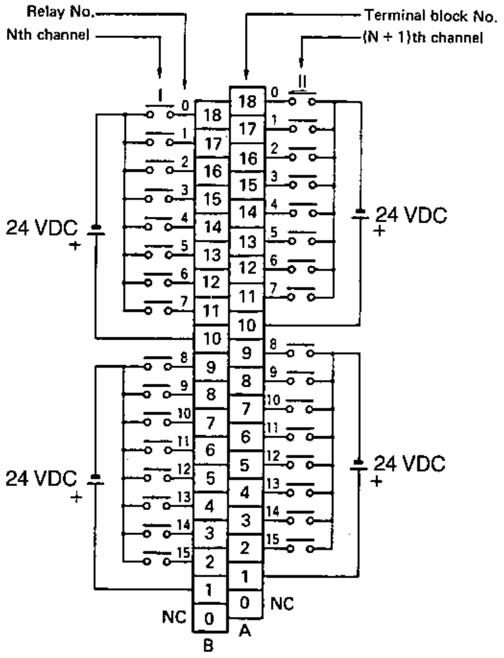

Data 0
Data 1
Data 2
Data 3
Data 4
Data 5
Data 6
Data 7
1ms
2ms
1ms
STB0
STB1
STB2
STB3
STB4
STB5
STB6
STB7
4ms
32 ms
Data of contacts 0 to 7 of channel n are output as these pulses.

I/O number assignment to terminals

The terminal connections shown in the preceding section, I/O unit specifications, are when the I/O unit is mounted on the UNIT 1 position (top slot) of the CPU or expansion I/O rack.
The terminal connections are as follows when the I/O unit is mounted on the UNIT 0 (bottom slot) position.

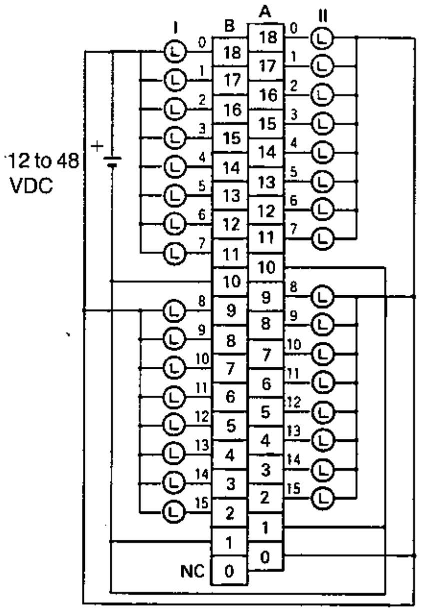
32-point input unit

3G2A6-ID217
3G2A6-IM111
3G2A6-IM213



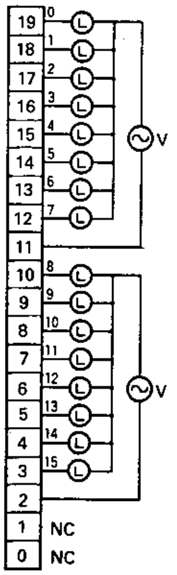
32-point output unit

3G2A6-OD412



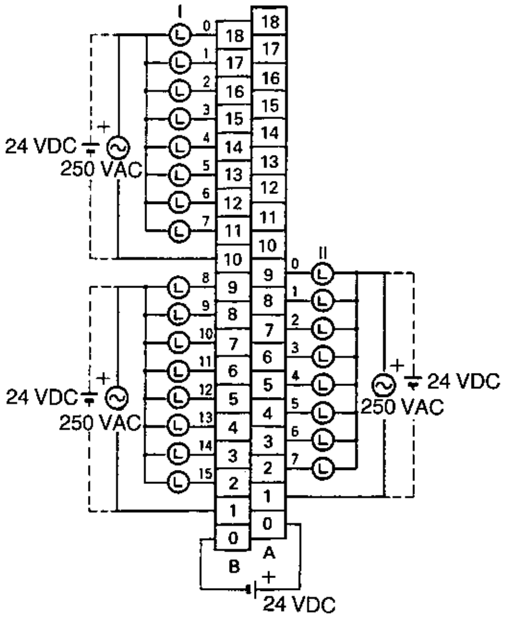
16-point I/O unit

3G2A6-IA121
3G2A6-IA222
3G2A6-ID112
3G2A6-ID213
3G2A6-IM211
3G2A6-OC221
3G2A6-OD411
3G2A6-OA222



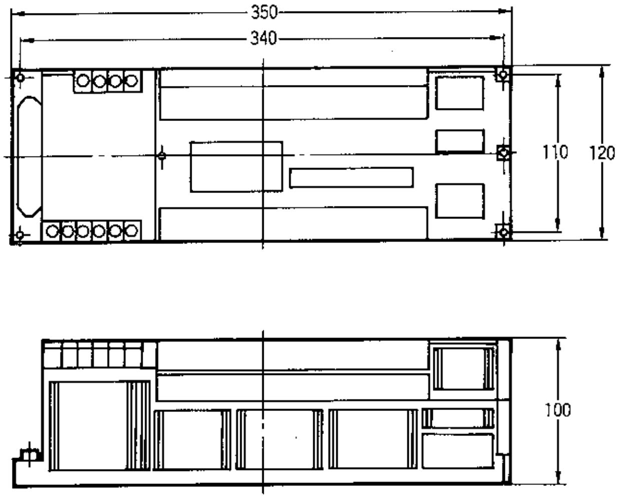
24-point output unit

3G2A6-OC222

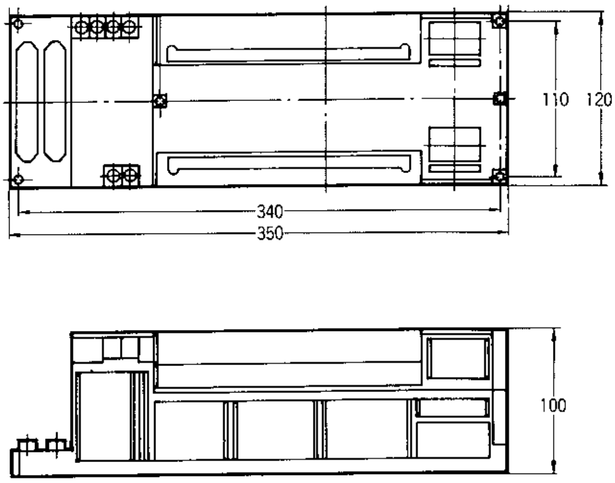


Dimensions

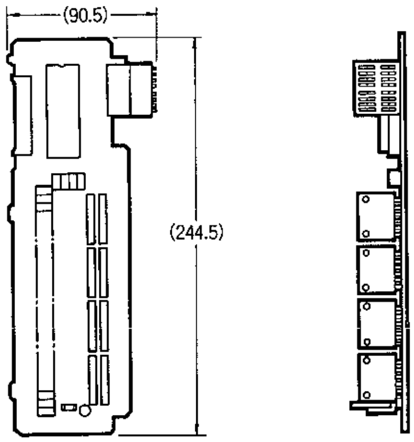
CPU rack

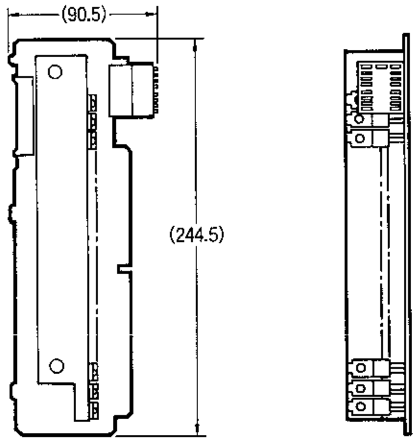


Expansion I/O rack



I/O unit





Appendix B List of relay numbers

Name	No. of points	Relay number															
Input/output relay	256 points	0000 to 3115															
		00CH	01CH	02CH	03CH	04CH	05CH	06CH	07CH	08CH	09CH	10CH	11CH	12CH	13CH	14CH	15CH
		00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
		01	01	01	01	01	01	01	01	01	01	01	01	01	01	01	01
		02	02	02	02	02	02	02	02	02	02	02	02	02	02	02	02
		03	03	03	03	03	03	03	03	03	03	03	03	03	03	03	03
		04	04	04	04	04	04	04	04	04	04	04	04	04	04	04	04
		05	05	05	05	05	05	05	05	05	05	05	05	05	05	05	05
		06	06	06	06	06	06	06	06	06	06	06	06	06	06	06	06
		07	07	07	07	07	07	07	07	07	07	07	07	07	07	07	07
		08	08	08	08	08	08	08	08	08	08	08	08	08	08	08	08
		09	09	09	09	09	09	09	09	09	09	09	09	09	09	09	09
		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
		11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
		12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
		13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13
		14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14
		15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15

Relay numbers 1600 (16CH) to 3115 (31CH) can be used as internal auxiliary relays.

List of relay numbers

Name	No. of points	Relay number															
Internal auxiliary relay	459 points	3200 to 6010															
		32CH	33CH	34CH	35CH	36CH	37CH	38CH	39CH	40CH	41CH	42CH	43CH	44CH	45CH	46CH	47CH
		00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
		01	01	01	01	01	01	01	01	01	01	01	01	01	01	01	01
		02	02	02	02	02	02	02	02	02	02	02	02	02	02	02	02
		03	03	03	03	03	03	03	03	03	03	03	03	03	03	03	03
		04	04	04	04	04	04	04	04	04	04	04	04	04	04	04	04
		05	05	05	05	05	05	05	05	05	05	05	05	05	05	05	05
		06	06	06	06	06	06	06	06	06	06	06	06	06	06	06	06
		07	07	07	07	07	07	07	07	07	07	07	07	07	07	07	07
		08	08	08	08	08	08	08	08	08	08	08	08	08	08	08	08
		09	09	09	09	09	09	09	09	09	09	09	09	09	09	09	09
		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
		11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
		12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
		13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13
		14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14
		15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
		48CH	49CH	50CH	51CH	52CH	53CH	54CH	55CH	56CH	57CH	58CH	59CH	60CH	61CH	62CH	63CH
		00	00	00	00	00	00	00	00	00	00	00	00	00			
		01	01	01	01	01	01	01	01	01	01	01	01	01			
		02	02	02	02	02	02	02	02	02	02	02	02	02			
		03	03	03	03	03	03	03	03	03	03	03	03	03			
		04	04	04	04	04	04	04	04	04	04	04	04	04			
		05	05	05	05	05	05	05	05	05	05	05	05	05			
		06	06	06	06	06	06	06	06	06	06	06	06	06			
		07	07	07	07	07	07	07	07	07	07	07	07	07			
		08	08	08	08	08	08	08	08	08	08	08	08	08	*3		
		09	09	09	09	09	09	09	09	09	09	09	09	09			
		10	10	10	10	10	10	10	10	10	10	10	10	10			
		11	11	11	11	11	11	11	11	11	11	11	11				
		12	12	12	12	12	12	12	12	12	12	12	12				
		13	13	13	13	13	13	13	13	13	13	13	13				
		14	14	14	14	14	14	14	14	14	14	14	14				
		15	15	15	15	15	15	15	15	15	15	15	15				

*2

List of relay numbers

Name	No. of points	Relay number															
Link relay	512 points	LR0000 to 3115															
		00CH	01CH	02CH	03CH	04CH	05CH	06CH	07CH	08CH	09CH	10CH	11CH	12CH	13CH	14CH	15CH
		00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
		01	01	01	01	01	01	01	01	01	01	01	01	01	01	01	01
		02	02	02	02	02	02	02	02	02	02	02	02	02	02	02	02
		03	03	03	03	03	03	03	03	03	03	03	03	03	03	03	03
		04	04	04	04	04	04	04	04	04	04	04	04	04	04	04	04
		05	05	05	05	05	05	05	05	05	05	05	05	05	05	05	05
		06	06	06	06	06	06	06	06	06	06	06	06	06	06	06	06
		07	07	07	07	07	07	07	07	07	07	07	07	07	07	07	07
		08	08	08	08	08	08	08	08	08	08	08	08	08	08	08	08
		09	09	09	09	09	09	09	09	09	09	09	09	09	09	09	09
		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
		11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
		12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
		13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13
		14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14
		15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
		16CH	17CH	18CH	19CH	20CH	21CH	22CH	23CH	24CH	25CH	26CH	27CH	28CH	29CH	30CH	31CH
		00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
		01	01	01	01	01	01	01	01	01	01	01	01	01	01	01	01
		02	02	02	02	02	02	02	02	02	02	02	02	02	02	02	02
		03	03	03	03	03	03	03	03	03	03	03	03	03	03	03	03
		04	04	04	04	04	04	04	04	04	04	04	04	04	04	04	04
		05	05	05	05	05	05	05	05	05	05	05	05	05	05	05	05
		06	06	06	06	06	06	06	06	06	06	06	06	06	06	06	06
		07	07	07	07	07	07	07	07	07	07	07	07	07	07	07	07
		08	08	08	08	08	08	08	08	08	08	08	08	08	08	08	08
		09	09	09	09	09	09	09	09	09	09	09	09	09	09	09	09
		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
		11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
		12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
		13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13
		14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14
		15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15

All the link relays of the C120F are used as internal auxiliary relays.

List of relay numbers

Name	No. of points	Relay number															
Holding relay (These relays retain the data during a power failure.)	512 points	HR0000 to 3115															
		00CH	01CH	02CH	03CH	04CH	05CH	06CH	07CH	08CH	09CH	10CH	11CH	12CH	13CH	14CH	15CH
		00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
		01	01	01	01	01	01	01	01	01	01	01	01	01	01	01	01
		02	02	02	02	02	02	02	02	02	02	02	02	02	02	02	02
		03	03	03	03	03	03	03	03	03	03	03	03	03	03	03	03
		04	04	04	04	04	04	04	04	04	04	04	04	04	04	04	04
		05	05	05	05	05	05	05	05	05	05	05	05	05	05	05	05
		06	06	06	06	06	06	06	06	06	06	06	06	06	06	06	06
		07	07	07	07	07	07	07	07	07	07	07	07	07	07	07	07
		08	08	08	08	08	08	08	08	08	08	08	08	08	08	08	08
		09	09	09	09	09	09	09	09	09	09	09	09	09	09	09	09
		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
		11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
		12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
		13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13
		14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14
		15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
		16CH	17CH	18CH	19CH	20CH	21CH	22CH	23CH	24CH	25CH	26CH	27CH	28CH	29CH	30CH	31CH
		00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
		01	01	01	01	01	01	01	01	01	01	01	01	01	01	01	01
		02	02	02	02	02	02	02	02	02	02	02	02	02	02	02	02
		03	03	03	03	03	03	03	03	03	03	03	03	03	03	03	03
		04	04	04	04	04	04	04	04	04	04	04	04	04	04	04	04
		05	05	05	05	05	05	05	05	05	05	05	05	05	05	05	05
		06	06	06	06	06	06	06	06	06	06	06	06	06	06	06	06
		07	07	07	07	07	07	07	07	07	07	07	07	07	07	07	07
		08	08	08	08	08	08	08	08	08	08	08	08	08	08	08	08
		09	09	09	09	09	09	09	09	09	09	09	09	09	09	09	09
		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
		11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
		12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
		13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13
		14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14
		15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15

Name	No. of points	Timer/Counter number												
Timer/Counter	128 points													
		000	010	020	030	040	050	060	070	080	090	100	110	120
		001	011	021	031	041	051	061	071	081	091	101	111	121
		002	012	022	032	042	052	062	072	082	092	102	112	122
		003	013	023	033	043	053	063	073	083	092	103	113	123
		004	014	024	034	044	054	064	074	084	094	104	114	124
		005	015	025	035	045	055	065	075	085	095	105	115	125
		006	016	026	036	046	056	066	076	086	096	106	116	126
		007	017	027	037	047	057	067	077	087	097	107	117	127
		008	018	028	038	048	058	068	078	088	098	108	118	
		009	019	029	039	049	059	069	079	089	099	109	119	

Because same timer or counter number is shared by the TIM, CNT, and TIMS instructions, no timer or counter number can be assigned to those instructions in duplicate. Therefore, do not program a circuit in which timers or counters having the same number may be simultaneously turned ON.

List of relay numbers

Name	No. of points	Data memory number															
		DM000 to 511															
Data memory (These data memories retain the data during a power failure.)	512 points x 16 bits	000	010	020	030	040	050	060	070	080	090	100	110	120	130	140	150
		001	011	021	031	041	051	061	071	081	091	101	111	121	131	141	151
		002	012	022	032	042	052	062	072	082	092	102	112	122	132	142	152
		003	013	023	033	043	053	063	073	083	092	103	113	123	133	143	153
		004	014	024	034	043	054	064	074	084	094	104	114	124	134	144	154
		005	015	025	035	045	055	065	075	085	095	105	115	125	135	145	155
		006	016	026	036	046	056	066	067	086	096	106	116	126	136	146	156
		007	017	027	037	047	057	067	077	087	097	107	117	127	137	147	157
		008	018	028	038	048	058	068	078	088	098	108	118	128	138	148	158
		009	019	029	039	049	059	069	079	089	099	109	119	129	139	149	159
		160	170	180	190	200	210	220	230	240	250	260	270	280	290	300	310
		161	171	181	191	201	211	221	231	241	251	261	271	281	291	301	311
		162	172	182	192	202	212	222	232	242	252	262	272	282	292	302	312
		163	173	183	193	203	213	223	233	243	253	263	273	283	293	303	313
		164	174	184	194	204	214	224	234	244	254	264	274	284	294	304	314
		165	175	185	195	205	215	225	235	245	255	265	275	285	295	305	315
		166	176	186	196	206	216	226	236	246	256	266	276	286	296	306	316
		167	177	187	197	207	217	227	237	247	257	267	277	287	297	307	317
		168	178	188	198	208	218	228	238	248	258	268	278	288	298	308	318
		169	179	189	199	209	219	229	239	249	259	269	279	289	299	309	319
		320	330	340	350	360	370	380	390	400	410	420	430	440	450	460	470
		321	331	341	351	361	371	381	391	401	411	421	431	441	451	461	471
		322	332	342	352	362	372	382	392	402	412	422	432	442	452	462	472
		323	333	343	353	363	373	383	393	403	413	423	433	443	453	463	473
		324	334	344	354	364	374	384	394	404	414	424	434	444	454	464	474
		325	335	345	355	365	375	385	395	405	415	425	435	445	455	465	475
		326	336	346	356	366	376	386	396	406	416	426	436	446	456	466	476
		327	337	347	357	367	377	387	397	407	417	427	437	447	457	467	477
		328	338	348	358	368	378	388	398	408	418	428	438	448	458	468	478
		329	339	349	359	369	379	389	399	409	419	429	439	449	459	469	479
		480	490	500	510												
		481	491	501	511												
		482	492	502													
		483	493	503													
		484	494	504													
		485	495	505													
		486	496	506													
		487	497	507													
		488	498	508													
		489	499	509													

16-bit configuration

Data memory area

000	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
001	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
002	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
003	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
510	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
511	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

Note: The data memories cannot be used with bit designation instructions (for example, AND, OR, OUT) or SFT instruction.

The data memories are specified by the DM instruction in units of 16 bits.

List of relay numbers

Name	No. of points	Relay number		Description	
Special auxiliary relay	45	60CH	6011	When a power failure occurs, this relay is used to resume instruction execution after power recovery.	Input/output
			6012	This relay serves as a data retention flag and is turned ON at the start of the RUN operation when the states of the I/O relays, internal auxiliary relays, link relays, and timers or counters are to be retained. If the states of those relays are to be cleared, this relay is turned OFF.	These relays are for both input and output and can be turned ON or OFF by the OUT instruction.
			6013	*4	
			6014	*3	
			6015	This relay serves as a load off flag. If it is turned ON, all outputs will be turned OFF, and if this flag is turned OFF, all outputs will continue.	
		61CH	6100 6101 6102 6103	1 2 4 8 ×10^0 When the FAL or FALS (diagnositc) instruction is executed, the FAL No. (01 to 99) is output in each of these relays.	Input only
			6104 6105 6106 6107	1 2 4 8 ×10^1	
			6108	This relay turns ON when the battery in the CPU rack is abnormal.	
			6109	This relay is turned ON when the destination label for the indirect JMP instruction is undefined or when a BCD error occurs in the label number.	
			6110	This relay turns ON when the number of I/O units mounted to the PC disagrees with that registered.	
			6111	Cannot be used.	
			6112	*2	
			6113	This relay is normally ON.	
			6114	This relay is normally OFF.	
			6115	This relay is turned ON when an error occurs in the channel number of the data memories.	
		62CH	6200 6201 6202 6203 6204 6205 6206 6207 6208 6209 6210 6211 6212 6213 6214 6215	Cannot be used.	
		63CH	6300	This relay is used to generate 0.1-second clock pulse.	
			6301	This relay is used to generate 1.0-second clock pulse.	
			6302	This relay is used to generate 1.0-minute clock pulse.	
			6303	This relay turns ON when the result of an arithmetic operation is not output in BCD or when an error is detected in indirectly addressed data (error flag).	
			6304	This relay turns ON if a carry exists in the result of an arithmetic operation (carry flag).	Input/output
			6305	This relay turns ON if the result when the Compare (CMP) instruction is executed is more than (> flag).	Input only
			6306	This relay turns ON if the result when the Compare (CMP) instruction is executed is equal or 0 (= flag).	
			6307	This relay turns ON if the result when the Compare (CMP) instruction is executed is less than (< flag).	
Normally OFF	8		6308	This relay is normally OFF.	
			6309	This relay is normally OFF.	
			⋮	⋮	
			6315	This relay is normally OFF.	

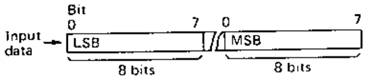
*1: The data retention can be performed only when the operation mode is changed from PROGRAM to MONITOR or RUN.

For the functions of the special auxiliary relays marked *2 to *4 and how to use them, refer to the following:

*2 – User's manual for remote I/O unit
*3 – User's manual for PC link unit
*4 – User's manual for host link unit

Appendix C List of instructions

Basic instructions

Instruction	Symbol	Mnemonic	Operand	Function	Remarks	Page
AND WAIT	AND	AND ⋮ WAIT	NOT RELAY NO. ⋮ ⋮	This instruction causes the program execution to wait until the specified number of AND conditions are satisfied.	RELAY NO. I/O relay and internal auxiliary relay: 0000 to 6315 Link relay: LR0000 to 3115 Holding relay: HR0000 to 3115 Timer: TIM000 to 127 LABEL NO. 0 to 1023 NOTE: 1. Because data memories DM000 to DM511 and expansion data memories are channels, the data in them cannot be used by these instructions. 2. CNT instructions cannot be used in combination with AND or OR instructions.	55
AND BRANCH	AND	AND ⋮ CJP	NOT RELAY NO. ⋮ ⋮ LABEL NO.	This instruction causes the program execution to jump to a specified label if the specified number of AND conditions are satisfied. If the conditions are not satisfied, the program execution proceeds to the next step.		55
OR WAIT	OR	OR ⋮ WAIT	NOT RELAY NO. ⋮ ⋮	This instruction causes the program execution to wait until one or more OR conditions are satisfied.		3-2
OR BRANCH	OR	OR ⋮ CJP	NOT RELAY NO. ⋮ ⋮ LABLE NO.	This program execution causes the program execution to jump to a specified label if one or more OR conditions are satisfied. If the conditions are not satisfied, the program execution proceeds to the next step.		57
TIM WAIT	TIM	TIM WAIT	TIMER NO. SET VALUE	This instruction causes a specified timer to set and the program execution to wait until the set time elapses.	TIMER NO. 0 to 127 SET VALUE Constant: 0 to 9999 Externally set: 00CH to 63CH LR00CH to 31CH HR00CH to 31CH DM000 to 511 LABEL NO. 0 to 1023 (DOWN timer)	58
TIM BRANCH	TIM	TIM CJP	TIMER NO. SET VALUE LABLE NO.	This instruction causes a specified timer to set and the program execution to proceed until the set time elapses. When the set time has elapsed, the time-up flag is set and the program execution jumps to a specified label.		59
CNT WAIT	CNT	CNT WAIT	COUNTER NO. SET VALUE INPUT RELAY	This instruction causes a specified counter to count in a descending order the inputs to a specified relay and the program execution to wait until the set value reaches 0.	COUNTER NO. Constant: 0 to 9999 Externally set: 00CH to 63CH LR00CH to 31CH HR00CH to 31CH DM000 to 511 INPUT RELAY 0000 to 6315 Link relay: LR0000 to 3115 Holding relay: HR0000 to 3115 LABEL NO. 0 to 1023 (DOWN counter)	61
CNT BRANCH	CNT	CNT CJP	COUNTER NO. SET VALUE INPUT RELAY LABLE NO.	This instruction causes a specified counter to count in a descending order the inputs to a specified relay and the program execution to proceed to the next step until the set value reaches 0. When the set value reaches 0, the count-up flag is set and the program execution jumps to a specified label.		62
OUT	OUT	OUT	NOT RELAY NO.	This instruction causes a specified relay to turn ON or OFF.	RELAY NO. 0000 to 6015 and 6304 Link relay: LR0000 to 3115 Holding relay: HR0000 to 3115	65
JMP	JMP	JMP	LABEL NO.	This is a direct jump instruction that causes the program execution to jump to any destination specified by a label.	LABEL NO. 0 to 1023 CH 00CH to 63CH LR00CH to 31CH HR00CH to 31CH DM000 to 511	65
		JMP	CH	This is an indirect jump instruction that causes the program execution to jump to a destination specified by using the contents of a specified channel or data memory as a label.		65
SFT	SFT	SFT	INPUT DATA LSB CH MSB CH	This instruction shifts data in two adjacent channels by 1 bit and places input data in the LSB. 	INPUT DATA 0000 to 6315 Link relay: LR0000 to 3115 Holding relay: HR0000 to 3115 CH 00 to 60 CH LR00 to 31 CH HR00 to 31 CH	67
CNR	CNR	CNR	RELAY NO.	This instruction causes the present value of a specified timer or counter to be reset while the timer or counter is in operation (i.e., to return to the initial value set by the program).	RELAY NO. TIM/CNT000 to 127 CH 00CH to 60CH LR00CH to 31CH HR00CH to 31CH TIM/CNT000 to 127 DM000 to 511	68
		CNR	CH CH	This instruction causes the data or present value in adjacent two areas (such as two CH, DM, TIM, or CNT areas) to be reset.		

List of instructions

Instruction	Symbol	Mnemonic	Operand	Function	Remarks	Page
WAIT	WAIT	WAIT		This instruction is used at the end of the AND, OR, TIM, CNT, DIFU, DIFD, or SBT instruction so that these instructions can be used as wait instructions.		–
CJP		CJP	LABEL NO.	This instruction is used at the end of the AND, OR, TIM, CNT, DIFU, DIFD, or SBT instruction so that these instructions can be used as branch instructions.	LABEL NO. 0 to 1023	–
LBL		LBL	LABEL NO.	This instruction is used to identify the beginning of the program specified by the JMP, CJP, BRZ, or RPT instruction, to which the program execution is to jump		
NOP		NOP		This is a no-operation instruction.		–

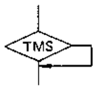
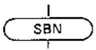
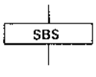
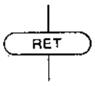
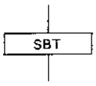
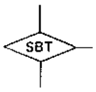
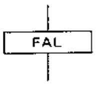
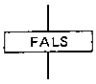
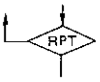
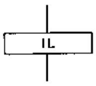
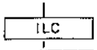
Auxiliary instructions

Instruction	Symbol	Mnemonic	Operand	Function	Remarks	Page
NOT	——		NOT	This instruction is used in pairs with the AND, OR, or OUT instruction to inverse the state of I/O relays.		–
*	——		* DM	This instruction is used to specify an indirectly addressed data.		–

Group instructions

Instruction	Symbol	Mnemonic	Operand	Function	Remarks	Page
GN (FUN10)	GN	GN	NO.	This instruction indicates the beginning of a group program.	NO. 0 to 31	69
GS (FUN11)	GS	GS	NO.	This instruction starts executing a specified group program from the beginning of the group. If the group program has been already under execution, this instruction is regarded as a no-operation instruction.		70
GE (FUN12)	GE	GE	NO.	This instruction is used to end and initialize the execution of a specified group program. If the subroutine in the group program is under execution when this instruction is executed, the subroutine is also initialized.		70
GP (FUN13)	GP	GP	NO.	This instruction is used to suspend the execution of a specified group program. If this instruction is executed while the subroutine in the group program is under execution, the subroutine execution is inhibited.		71
GR (FUN14)	GR	GR	NO.	This instruction resumes executing the group program from where the group program has been suspended by the GP instruction.		71
GOFF (FUN15)	GOFF	GOFF	NO.	When I/O relays and timers exist between a specified group and the next, or between a specified subroutine and the end address, this instruction resets the I/O relay state specified by the OUT instruction and the present value of the timer. The other instructions are regarded as NOP (no operation) instructions.		71
GC (FUN16)	GC	GC	NO.	This instruction allows the execution of a group program, which has been stopped by a power failure, to be resumed upon power recovery provided that the group program has turned ON the data retention flag before the power failure.		72
GJ (FUN17)	GJ	GJ		This instruction causes the program execution to jump to another group program. When the execution is returned to the original group program, the step before which the execution jumped is executed.		72

Special instructions

Instruction	Symbol	Mnemonic	Operand	Function	Remarks	Page
TMS (FUN30)		TMS	TIMER NO. SET VALUE	This instruction is used to start the timing operation of a specified timer. (Timer numbers are shared by the TIM and TMS instructions.)	TIMER NO. TIM000 to 127 SET VALUE Constant: 0 to 9999 Externally set: 00CH to 63CH LR00CH to 31CH HR00CH to 31CH DM000 to 511 + (DOWN timer)	74
SBN (FUN31)		SBN	NO.	This instruction is used to identify the beginning of a subroutine.	NO. 0 to 31	74
SBS (FUN32)		SBS	NO.	This instruction causes the program execution to jump to a specified subroutine and to proceed to the next step on completion of the subroutine.		
RET (FUN33)		RET	NO.	This program is used to identify the end of a specified subroutine and causes the program execution to return to the step of the original program before which the execution jumped to the subroutine.		76
SBT WAIT (FUN34)		SBT WAIT	NO.	This instruction is used to check whether a specified subroutine is being executed by another group program and causes the program execution to wait until completion of the ongoing subroutine execution.	NO. 0 to 31 LABEL NO. 0 to 1023	77
SBT BRANCH (FUN34)		STB CJP	NO. LABEL	This instruction causes the program execution to jump to a specified label if a specified subroutine is not executed by another group program. If the subroutine is under execution, the program execution proceeds to the next step.		
FAL (FUN35)		FAL	NO.	This is a failure processing instruction which allows the CPU to continue operating. When this instruction is executed, the FAL No. is output to the FAL output relay area and the FAL indicator on the CPU rack illuminates.	NO. 00 to 99 NOTE: FAL0 is an instruction to clear the FAL.	78
FALS (FUN36)		FALS	NO.	This is a failure processing instruction which causes the CPU to stop. When this instruction is executed, the FAL No. is output to the FAL output relay area and the FAL indicator on the CPU rack illuminates.	NO. 01 to 99	
RPT (FUN37)		RPT	LABEL NO. SET VALUE	This instruction causes the program execution to be repeated by the specified number of times and then to proceed to the next step.	LABEL NO. 0 to 1023 SET VALUE 01 to 99	80
IL (FUN38)		IL	RELAY NO.	This IL and ILC instructions are used in pairs. When the relay specified by the IL instruction is turned OFF, the states of the output relays specified by the OUT instruction and the present values of the timers or counters specified by the TIM or CNT instructions that exist between the IL and ILC instructions are reset. The instructions other than the OUT and TIM or CNT are treated as NOP instructions. When the relay specified by the IL instruction is turned ON, both the IL and ILC instructions are regarded as NOP instructions.	RELAY NO. 0000 to 6315 LR0000 to 3115 HR0000 to 3115	82
ILC (FUN39)		ILC				83

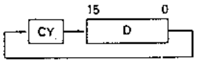
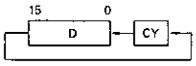
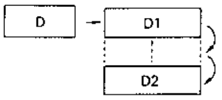
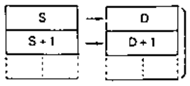
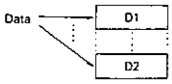
List of instructions

Instruction	Symbol	Mnemonic	Operand	Function	Remarks	Page
DIFU WAIT (FUN40)	DIFU			This instruction causes the program execution to wait until the input relay specified by the Differentiation instruction is turned ON.	DIF NO. 000 to 127 RELAY NO. 0000 to 6315 LR0000 to 3115 HR0000 to 3115	84
DIFU BRANCH (FUN40)	DIFU	DIFD CJP	DIF NO. RELAY NO. LABEL NO.	This instruction causes the program execution to jump to a specified label only when the input relay specified by the Differentiation instruction is turned ON; otherwise, the program execution proceeds to the next step.		85
DIFD WAIT (FUN41)	DIFD	DIFD WAIT	DIF NO. RELAY NO.	This instruction causes the program execution to wait until the input relay specified by the Differentiation instruction is turned OFF.		84
DIFD BRANCH (FUN41)	DIFD	DIFD CJP	DIF NO. RELAY NO. LABEL NO.	This instruction causes the program execution to jump to a specified label only when the input relay specified by the Differentiation instruction is turned OFF; otherwise the program execution proceeds to the next step.		85
MSKS (FUN42)	MSKS	MSKS	Interrupt unit No. D	This instruction is used to mask the interrupt on the lower 8 bits of the input from a specified interrupt input unit. The higher 8 bits of the input are ignored.	Interrupt unit No. 0 to 3 D 00CH to 63CH LR00CH to 31CH HR00CH to 31CH DM000 to 511 *DM000 to 511	85
CLI (FUN43)	CLI	CLI	Interrupt unit No. D	This instruction is used to clear the interrupt masks set on the lower 8 bits of the input by the MSKS instruction; the higher 8 bits of the input are ignored.		86
RTI (FUN44)	RTI	RTI		This instruction indicates the completion of the interrupt servicing and causes the interrupted program execution to be resumed.	———	87
MSKR (FUN45)	MSKR	MSKR	Interrupt unit No. D	This instruction is used to read the interrupt masking state of a specified interrupt unit to the lower 8 bits of an area specified by D. The higher 8 bits of D are always 0.	Interrupt unit No. 0 to 3 D 00CH to 63CH LR00CH to 31CH HR00CH to 31CH DM000 to 511 *DM000 to 511	
MOV (FUN50)	MOV	MOV	S D	This instruction is used to transfer (channel data or a constant to a specified channel. S → D	S S1 S2 00CH to 63CH LR00CH to 31CH HR00CH to 31CH TIM/CNT000 to 127 DM000 to 511 *DM000 to 511 Constant: 0000 to FFFF D 00CH to 63CH LR00CH to 31CH HR00CH to 31CH DM000 to 511 *DM000 to 511	88
MVN (FUN51)	MVN	MVN	S D	This instruction is used to transfer inversed channel data or a constant to a specified channel. S → D		
CMP (FUN52)	CMP	CMP	S1 S2	This instruction is used to compare two specified data (channel data or constants). $S_1 \lessgtr S_2$		90

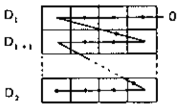
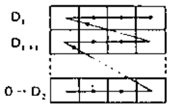
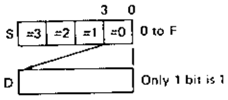
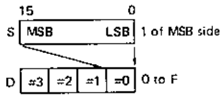
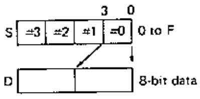
List of instructions

Instruction	Symbol	Mnemonic	Operand	Function	Remarks	Page
ADD (FUN53)	ADD	ADD	S1 S2 D	This instruction is used to perform BCD addition of channel data to another channel data or a constant. $S1 + S2 + \boxed{CY} = D, \boxed{CY}$	S1 S2 00CH to 63CH LR00CH to 31CH HR00CH to 31CH TIM/CNT000 to 127 DM000 to 511 *DM000 to 511 Constant: 000 to 9999 D Same as MOV	91
SUB (FUN54)	SUB	SUB	S1 S2 D	This instruction is used to perform BCD subtraction of channel data from another channel data or a constant. $S_1 - S_2 - \boxed{CY} = D, \boxed{CY}$		93
MUL (FUN55)	MUL	MUL	S1 S2 D	This instruction is used to perform BCD multiplication of channel data by another channel data or a constant. $S_1 + S_2 = D, \quad D+1$ (LSB) (MSB)	S1 S2 Same as ADD D 00CH to 59CH LR00CH to 30CH HR00CH to 30CH DM000 to 511 *DM000 to 511	95
DIV (FUN56)	DIV	DIV	S1 S2 D	This instruction is used to perform BCD division of channel data by another channel data or a constant. $S_1 \div S_2 = D$ Remainder D+1		96
BIN (FUN57)	BIN	BIN	S D	This instruction is used to convert BCD data into BIN data. S → D (BCD) (BIN)	S 00CH to 63CH LR00CH to 31H HR00CH to 31H TIM/CNT000 to 127 DM000 to 511 *DM000 to 511 ● Of these two instructions, only the BIN instruction can use the timers or counters. D Same as MOV	97
BCD (FUN58)	BCD	BCD	S D	This instruction is used to convert BIN data into BCD data. S D (BIN) (BCD)		99
BRZ (FUN59)	BRZ	BRZ	LABEL NO. CH	This instruction causes the program execution to jump to a specified label if the contents of a specified channel are 0.	CH 00CH to 63CH LR00CH to 31CH HR00CH to 31CH DM000 to 511	101
INC (FUN60)	INC	INC	D	This instruction is used to increment specified BCD channel data by one. D+1 → D	D 00CH to 60CH LR00CH to 31CH HR00CH to 31CH DM000 to 511 *DM000 to 511	102
DEC (FUN61)	DEC	DEC	D	This instruction is used to decrement specified BCD channel data by one. D−1 → D		103
ASR (FUN62)	ASR	ASR	D	This instruction is used to shift specified channel data to the right. 15 0 0→ D → CY		104
ASL (FUN63)	ASL	ASL	D	This instruction is used to shift specified channel data to the left. 15 0 CY ← D ← 0		105
ROOT (FUN64)	ROOT	ROOT	S D	This instruction is used to compute the square root of 8-digit BCD data. $\sqrt{S, \quad S+1} \rightarrow D$ (LSB) (MSB)	S 00CH to 62CH LR00CH to 30CH HR00CH to 31CH TIM/CNT000 to 126 DM000 to 510 *DM000 to 511 D Same as MOV	106

List of instructions

Instruction	Symbol	Mnemonic	Operand	Function	Remarks	Page
ANDW (FUN65)	ANDW	ANDW	S1 S2 D	This instruction is used to perform a logical AND operation in units of channels between specified channel data and another channel data or a constant. $S_1 \wedge S_2 \rightarrow D$	S1, S2 Same as MOV D Same as MOV	107
ORW (FUN66)	ORW	ORW	S1 S2 D	This instfuction is used to perform a logical OR operation in units of channels between specified channel data and another channel data or a constant. $S_1 \vee S_2 \rightarrow D$		108
XORW (FUN67)	XORW	XORW	S1 S2 D	This instruction is used to perform an exclusive logical OR operation in units of channels between specified channel data and another channel data or a constant. $S_1 \veebar S_2 \rightarrow D$		109
XNRW (FUN68)	XNRW	XNRW	S1 S2 D	This instruction is used to perform an exclusive logical NOR operation in units of channels between specified channel data and another channel data or a constant. $\overline{S_1 \veebar S_2} \rightarrow D$		110
ROR (FUN69)	ROR	ROR	D	This instruction is used to rotate to the right the bits of a specified channel including the carry. 		112
ROL (FUN70)	ROL	ROL	D	This instruction is used to rotate to the left the bits of a specified channel including the carry. 		113
COM (FUN71)	COM	COM	D	This instruction is used to invert the bits of a specified channel. $\overline{D} \rightarrow D$		114
WSFT (FUN94)	WSFT	WSFT	D D1 D2	This instruction is used to shift data in units of channels. 	D, D1, D2 Same as MOV ● Start channel ⩽ End channel ● The start and end channels must be within the same relay area.	115
STC (FUN95)	STC	STC		This instruction is used to set the carry to 1. 1 → $\boxed{CY}$	——	117
CLC (FUN96)	CLC	CLC		This instruction is used to reset the carry to 0. 0 → $\boxed{CY}$		
BLOCK TRANSFER (XFER) (FUN72)	XFER	XFER	No. of words S D	This instruction is used to transfer a series of specified channel data to specified channels.  No. of words	No. of words #0000 to #4095 S Same as BIN instruction	117
BLOCK SET (BSET) (FUN73)	BSET	BSET	Data D1 D2	This instruction is used to set the same data in a series of specified channels. 	Data Same as S of MOV instruction D, D1, D2 00 to 60, LR00 to 31 HR00 to 31, TIM/CNT000 to 127, DM000 to 511 *DM000 to 511	118

List of instructions

Instruction	Symbol	Mnemonic	Operand	Function	Remarks	Page
DATA EX-CHANGE (XCHG) (FUN74)	XCHG	XCHG	D1 D2	This instruction is used to exchange data between two specified channels. $D_1 \leftrightarrow D_2$	D1, D2 Same as XFER instruction	120
ONE DIGIT SHIFT LEFT (SLD) (FUN75)	SLD	SLD	D1 D2	This instruction is used to shift 1 digit (4 bits) to the left. 	S Same as BIN instruction D, D1, D2 Same as XFER instruction Digit designation #0000 to #0003	121
ONE DIGIT SHIFT RIGHT (SRD) (FUN76)	SRD	SRD	D1 D2	This instruction is used to shift 1 digit (4 bits) to the right. 		122
4-TO-16 DE-CODER (MLPX) (FUN77)	MLPX	MLPX	S Digit designation D	This instruction is used to convert (decode) 1-digit (4 bits) data into 16-bit channel data. 		123
16-TO-4 EN-CODER (DMPX) (FUN78)	DMPX	DMPX	S D Digit designation	This instruction is used to convert (encode) 16-bit channel data into 1-digit (4 bits) data. 		127
7-SEG-MENT DE-CODER (SDEC) (FUN79)	SDEC	SDEC	S Digit designation D	This instruction is used to convert 1-digit (4 bits) data of a specified channel into 8-bit data for 7-segment display. 		130
MULTI-OUTPUT TIMER (FUN80)	FUN80	FUN80	Flag Present time Set time	This instruction is used as an UP type timer to set eight values to a single timer. It compares the contents of the present value channel against the set value channel and sets a time-up flag in the flag channel when the present value is equal to or greater than the set value.	FLAG CHANNEL PRESENT VALUE Same as D of MOV instruction SET VALUE 00 to 53 LR00 to 24 MR00 to 24 DM000 to 511 *DM000 to 511	134
FUN81 to 93, 97 to 99	FUN No.	FUN No.	— — —	These are reserved instructions for expansion, including options, and processed as NOP in the standard SYSMAC-C120F.	No. 81 to 93 97 to 99	137

Relation between special auxiliary relays and instructions

		Special auxiliary relay				
Relay number		6307 (<)	6306 (=)	6305 (>)	6304 (CY)	6303 (ER)
Description		Turns ON if the result when the compare instruction is executed, is less than.	Turns ON if the result when the compare instruction is executed, is equal.	Turns ON if the result when the compare instruction is executed, is more than.	Turns ON if a carry exists in the result of an arithmetic operation.	Turns ON if the data is not in BCD or if an error occurs in indirect addressing or jump designation.
Instruction	FUN No.					
TIM						↕
TIMS	30					↕
CNT						↕
CNR TIM						↕
CNR CNT						↕
JMP						↕
CJP						↕
RPT	37					↕
MOV	50		↕			↕
MVN	51		↕			↕
CMP	52	↕	↕	↕		↕
ADD	53		↕		↕	↕
SUB	54		↕		↕	↕
MUL	55		↕			↕
DIV	56		↕			↕
BIN	57		↕			↕
BCD	58		↕			↕
INC	60		↕			↕
DEC	61		↕			↕
ASR	62		↕		↕	↕
ASL	63		↕		↕	↕
ROR	69		↕		↕	↕
ROL	70		↕		↕	↕
COM	71		↕			↕
WSFT	94					↕
ROOT	64		↕			↕
ANDW	65		↕			↕
ORW	66		↕			↕
XORW	67		↕			↕
XNRW	68		↕			↕
STC	95				1	
CLC	96				0	
BRZ	59		↕			
XFER	72					↕
BSET	73					↕
XCHG	74					↕
SLD	75					↕
SRD	76					↕
MLPX	77					↕
DMPX	78					↕
SDEC	79					↕

- When the present value of the TIM, TMS, or CNT instruction is reset, the set vâlue is checked for BCD.
- When special auxiliary relay 6303 (error flag) is turned ON, no instruction except the TIM, TMS, CNT, and CNR is executed.
- When special auxiliary relay 6303 is turned ON, the states of the other special auxiliary relays (6304 to 6307) are not changed.
- The states of the special auxiliary relays are not changed by the execution of instructions other than those listed above.

- ↕ : Changed

Vacant: Not changed

Appendix D Ordering information

The following products are available for configuring a SYSMAC-C120F system to meet your particular requirements. Use the following table to select and order the products desired.

Classification		Specifications	Weight (max.)	Type name
CPU rack		110/120 VAC ROM/RAM****	2.5 kg	3G2C4-SCA22-E
		220/240 VAC ROM/RAM****	2.5 kg	3G2C4-SCA24-E
Expansion I/O rack		110/120 VAC for mounting I/O unit	2.5 kg	3G2C4-SI021
		220/240 VAC for mounting I/O unit	2.5 kg	3G2C4-SI022
		110/120 VAC for mounting I/O link unit	2.5 kg	3G2C4-SI023
		220/240 VAC for mounting I/O link unit	2.5 kg	3G2C4-SI024
		110/120 VAC for mounting A/D conversion input, D/A conversion output, or high-speed counter unit	2.5 kg	3G2C4-SI025
		220/240 VAC for mounting A/D conversion input, D/A conversion output, or high-speed counter unit	2.5 kg	3G2C4-SI026
		110/120 VAC for mounting remote I/O unit	2.5 kg	3G2C4-SI027
		220/240 VAC for mounting remote I/O unit	2.5 kg	3G2C4-SI028
I/O connecting cable		Cable length: 50 cm	300 g	3G2A5-CN511
		Cable length: 100 cm	400 g	3G2A5-CN121
I/O unit	Input unit	100 to 120 VAC 10 mA, 16 points*	450 g	3G2A6-IA121
		200 to 240 VAC 10 mA, 16 points*	450 g	3G2A6-IA222
		12 to 24 VAC/VDC 10 mA, 16 points, PNP/NPN input**	450 g	3G2A6-IM211
		12 VAC/VDC 7 mA, 32 points, PNP/NPN input**	500 g	3G2A6-IM111
		24 VAC/VDC 7 mA, 32 points, PNP/NPN input**	450 g	3G2A6-IM213
		5 to 12 VDC 16 mA, 16 points, NPN input***	450 g	3G2A6-ID112
		12 to 24 VDC 10 mA, 16 points, NPN input***	450 g	3G2A6-ID213
		Interrupt input unit: 12 to 24 VDC, 8 points, PNP/NPN	450 g	3G2A6-ID216
		24 VDC 7 mA, 32 points, NPN input***	450 g	3G2A6-ID217
		24 VDC 10 mA, 64 points, dynamic scan method	450 g	3G2A6-ID212
	Output unit	Relay contact 250 VAC/24 VDC 2 A, 16 points (with relay socket)	450 g	3G2A6-OC221
		Relay contact 250 VAC/24 VDC 2 A, 24 points (without relay socket)	500 g	3G2A6-OC222
		Triac 85 to 250 VAC 1 A, 16 points	500 g	3G2A6-OA222
		Transistor 12 to 48 VDC 1 A, 16 points	500 g	3G2A6-OD411
		Transistor 12 to 48 VDC 0.3 A, 32 points	530 g	3G2A6-OD412
		Transistor 24 VDC 0.1 A, 64 points, dynamic scan method	450 g	3G2A6-OD211
	Dummy I/O unit	I/O 16, 32, 64 points (common)	450 g	3G2A6-DUM01
Optional products	EPROM chip	64 bits (2764)	50 g	ROM-H
	RAM chip	64 bits (6264)	50 g	RAM-H
	Battery		100 g	3G2A9-BAT08
	Cover plates	Covers vacant slot on C120F	50 g	3G2A6-COV01
	DIN rail attachment	For mounting C120F to DIN rail	500 g	3G2A9-DIN01

* ON-delay time: 35 ms, OFF-delay time: 55 ms
** ON-delay time: 15 ms, OFF-delay time: 15 ms
*** ON-delay time: 1.5 ms, OFF-delay time: 1.5 ms
**** The EPROM and RAM chips are optional.

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