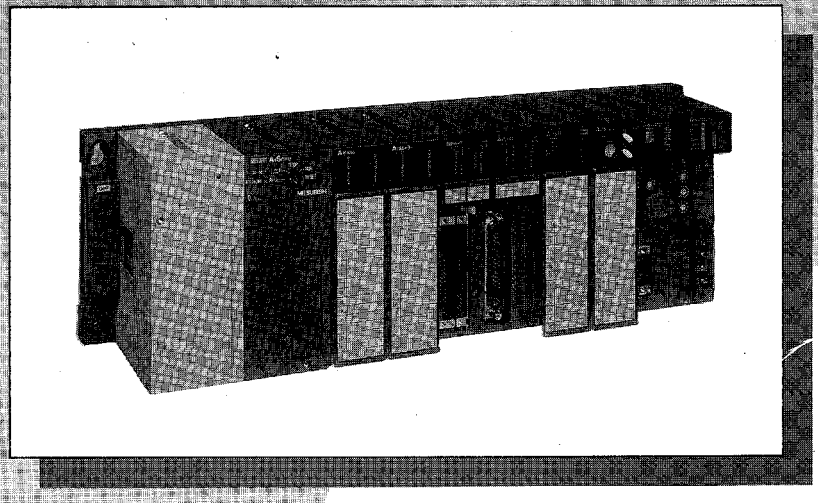
MITSUBISHI

PROGRAMMABLE CONTROLLERS

MELSEC-A

Handy Manual

MELSEC A1S SERIES



Handy Manual

MELSEC A1S SERIES

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Foreword

The A1S handy manual is designed as a learning aid for use with the MELSEC A1S programmable logic controller (PLC) and is aimed at the first time A1S user. Topics covered in this manual include unit selection, system configuration, installation, programming, and application examples.

It is hoped that after reading this, you will have a good understanding of the A1S PLC system, and be able to set up and use an A1S PLC system without the need of training or the study of individual manuals. However, please note that not all the details of the A1S PLC are contained in this handy manual and therefore where appropriate you should refer to the relevant user's or programming manual.

OVERVIEW

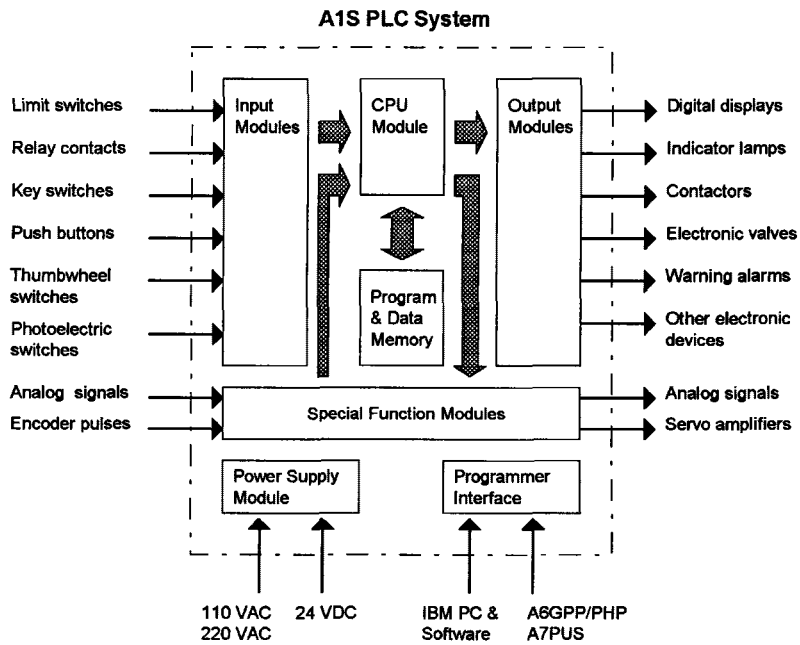
Chapter 1: Overview of the A1S PLC

What is the A1S ?

The Mitsubishi A1S programmable logic controller represents a low cost, high performance, compact micro modular PLC capable of solving almost all types of industrial control applications from simple relay replacement, to system control and networking.

How Does It Work ?

Similar to most PLCs available, the A1S operates by executing a sequential control program (sequence program) starting from the beginning of the program and finishing at the 'END' instruction contained within the sequence program. Depending on the results from each individual program section, the central processing unit (CPU module) will update the conditions of the inputs and outputs. The timing of the update depends upon the processing method that the CPU module is set to (dip switch setting), either refresh or direct mode. With the refresh mode the inputs and outputs are updated at the end of the program, and with the direct mode the inputs and outputs are updated as and when they are used within the sequence program. The sequence program itself is stored in a random access memory (RAM) within the CPU module which is battery backed to prevent program loss due to power failure to the PLC.

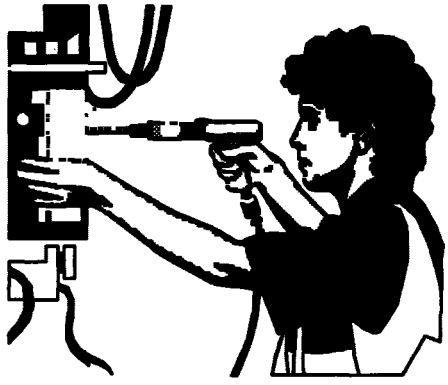


What Do I Choose ?

Understandably, when you look at the complete list of different types of input, output, and special function module available for the A1S, it can seem a difficult task to choose what you require for your application. But don't worry, the reason for all the different types of module is so the A1S can be used for all types of application. All you have to do is simply calculate the number of different types of input and output to be used in your application, and select the right type and number of modules from the list. The only other things to consider then are that you need a CPU module, power supply module, and base units to hold all of the modules you have selected. Also choose the programming device you want to use for the creation of your sequence program.

Where & How Do I Install It ?

The A1S PLC is primarily designed for installation inside electrical cabinets, however it can be installed in other places if adequate protection to dust, water, oil etc.. is made. Because of its micro modular design it takes up very little space and can be fixed on to DIN rail using the fixing attachments already installed on the back of the base units. Alternatively, the base units can be fixed in to place using the screw holes provided on each of its corners.



Is It Difficult To Program ?

Like all things that need programming, the A1S PLC may seem for the first time user to be a little difficult to program. However, the sequence programming language utilized, is designed to make it as easy as possible for you the user to create your own sequence programs without the need of specialized help. In fact, after a very short time you can become very proficient at writing programs which can perform the simple or complicated operations required to meet your application needs.

Two main types of program construction method are used, both of them using the MELSEC A dedicated sequence programming language, these are; instruction list (List mode) and relay ladder logic (Ladder mode). Each of them can perform the same tasks, the choice of which one to use is purely dependent on the user's preference. However the most commonly used method is relay ladder logic (Ladder mode) because of its graphical representation and simplicity.

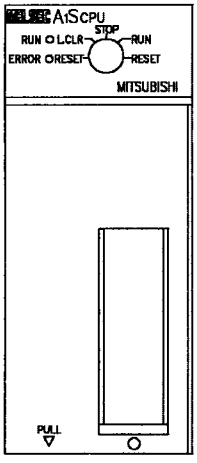
What Can I Use It For ?

The A1S is a true general purpose PLC which can be used for almost any type of control application. Example applications of where the A1S has been used are; data link control, positioning control, robot control, analog control, sequence control, data acquisition, and system monitoring. There are many other types of application in which the A1S has been used, so whatever your control application, the A1S can probably solve it in an easy to implement, cost effective way.

Chapter 2: A1S Module Descriptions

Central processing unit (CPU Module)

Model No. A1SCPU, A1SCPU-S1



The CPU module is the main part of the A1S PLC system, and can control up to 512 I/O points. It has a built-in battery backed RAM memory, real time clock function, programming port, operation mode LED's, and key switch control for operation mode. Mounted in the CPU slot of the CPU base unit, one CPU module is required per A1S system.

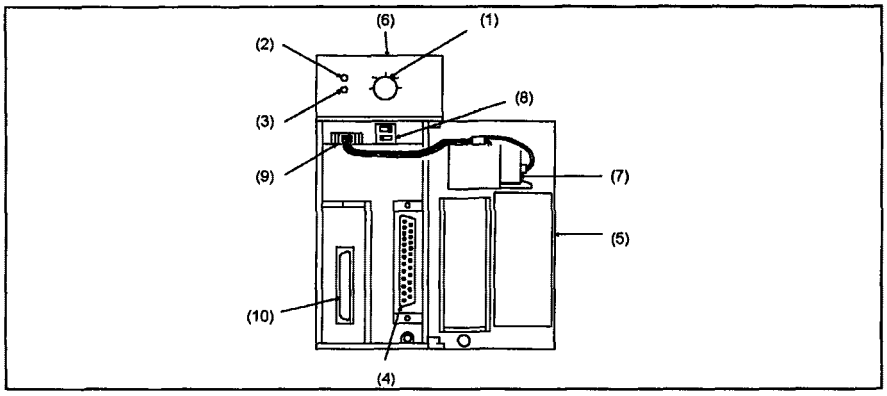
Item		A1SCPU	A1SCPU-S1
Control system		Repeated operation using stored program	
I/O control method		Refresh mode or direct mode (switch selectable)	
Programming language		Language dedicated to sequence control. Combined use of relay symbol type and logic symbolic type.	
No. of Instructions	Sequence instructions	26	
	Basic instructions	131	
	Application instructions	104	
Processing speed		Direct: 1.0 to 2.3 μsec	
(sequence instruction)		Refresh: 1.0	
I/O points		Max. 256 points	Max. 512 points
Watchdog timer (WDT)		10 to 2000 msec	
Memory capacity		32K bytes (RAM)	
Program capacity		Main sequence program + main computer program = 8K steps.	
		Internal microcomputer program can be set to 7K steps max.	
Internal relays (M)		1000 points (M0 to M999)	
Latch relays (L)		1048 points (L1000 to L2047)	
Step relays (S)		0 points (default value)	

MODULE DESCRIPTIONS

Link relays (B)		1024 points (B0 to B3FF)
Timers (T)	Number of points	256 points
	Specifications	100 msec timer: setting time 0.1 to 3276.7 sec (T0 to T199) 10 msec timer: setting time 0.01 to 327.67 sec (T200 to T255) 100 msec retentive timer: setting time 0.1 to 3276.7 sec (set in parameters)
Counters (C)	Number of points	256 points
	Specifications	Normal counter: setting range 1 to 32767 (C0 to C255) Interrupt counter: setting range 1 to 32767 (set in parameters)
Data registers (D)		1024 points (D0 to D1023)
Link registers (W)		1024 points (W0 to W1023)
Annunciators (F)		256 points (F0 to F255)
File registers (R)		Max. 4096 points (R0 to 4095)
Accumulator (A)		2 points (A0, A1)
Index registers (V, Z)		2 points (V, Z)
Pointers (P)		256 points (P0 to P255)
Interrupt pointers (I)		32 points (I0 to I31)
Special relays (M)		256 points (M9000 to M9255)
Special data registers (D)		256 points (D9000 to D9255)
Comments		Max. 1600 points (set in batches of 64 points)
Self diagnostic functions		Watchdog error, memory error detection, CPU error detection, I/O error detection, battery error detection, etc.
Operation mode at time of error		STOP/CONTINUE
STOP RUN output mode		Output data at time of STOP restored/data output after operation execution
Allowable momentary power failure		20 msec
Current consumption (5 VDC)		0.4 A
Weight		0.37 kg/0.81 lb.

Manual Reference No. IB(NA)-66320, A1SCPU User's Manual

Part identification and setting of A1SCPU



(1) RUN/STOP key switch
RUN/STOP: To start/stop running a sequence program
RESET: To reset hardware, and/or reset an error which has occurred during operation.
LATCH CLEAR: To clear devices in both the latch range and non-latch range which have been set in parameters.

(2) "RUN" LED
ON: A sequence program operation is being executed with the RUN/STOP key switch set in the RUN position.
OFF: The RUN LED is not lit if power is not supplied from the power supply module, the RUN/STOP key is in the STOP position, the remote STOP signal is input, or the remote PAUSE signal is input.
Flashing: The RUN LED flashes if an error causing the sequence operation to stop is detected by the self-diagnostic functions or the latch clear operation is executed.

(3) "ERROR" LED
ON: The self-diagnostic functions have detected an error.
OFF: No error has occurred.
Flashing: An annunciator (F) has been turned ON by the sequence program.

(4) RS422 connector
Used for program read/write, monitoring, or testing using a peripheral device.

(5) Cover
Protects the printed circuit board, memory module, connector, battery, etc.

(6) Module fixing screws
For fixing the module to the CPU base unit.

(7) Battery
For retaining stored data and programs during power failure.

(8) Dip switch
Used for switching the I/O control method and for setting the memory protect function.

(9) Battery connector
For connecting the battery.

(10) Memory module installation cover
For installing the optional EPROM and EEPROM memory modules.

MODULE DESCRIPTIONS

CPU Base Units

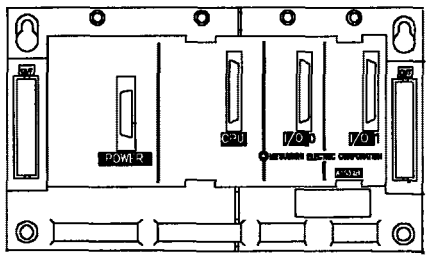
The CPU base units are for mounting the CPU module, 1 power supply module, and a number of I/O modules. The number of I/O modules that can be mounted on to the CPU base unit is dependent on the model number of the unit selected. Like the CPU module, each system requires one CPU base unit. Below is a list of the different CPU base unit models;

Model No. A1S32B

CPU base unit with spare I/O slots for 2 I/O modules.

External dimensions, 220 mm x 130 mm x 28 mm (8.66 in x 5.12 in x 1.10 in).

Manual Reference No. IB(NA) 66320, A1SCPU User's Manual

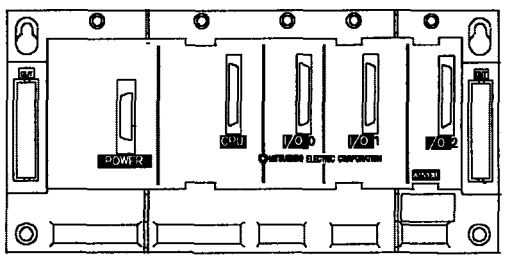


Model No. A1S33B

CPU base unit with spare I/O slots for 3 I/O modules.

External dimensions, 255 mm x 130 mm x 28 mm (10.04 in x 5.12 in x 1.10 in).

Manual Reference No. IB(NA) 66320, A1SCPU User's Manual

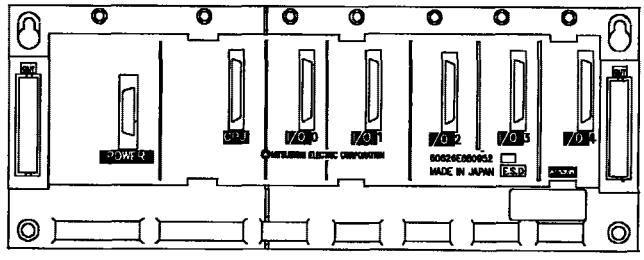


Model No. A1S35B

CPU base unit with spare I/O slots for 5 I/O modules.

External dimensions, 325 mm x 130 mm x 28 mm (12.80 in x 5.12 in x 1.10 in).

Manual Reference No. IB(NA) 66320, A1SCPU User's Manual

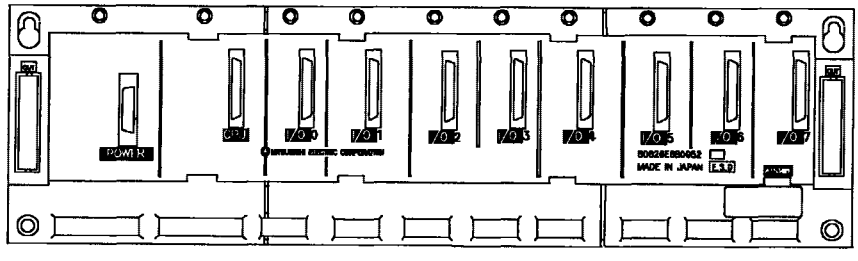


Model No. A1S38B

CPU base unit with spare I/O slots for 8 I/O modules.

External dimensions, 430 mm x 130 mm x 28 mm (16.93 in x 5.12 in x 1.10 in).

Manual Reference No. IB(NA) 66320, A1SCPU User's Manual



MODULE DESCRIPTIONS

Extension Base Units

The extension base units are for mounting an extra power supply module and/or extra I/O modules if required. The requirement for the extra I/O modules depends on the number of I/O modules you are using on your system, if it exceeds the number of I/O slots on the CPU base unit you have selected then one extension base unit is required. Connection of the extension base unit to the CPU base unit is made by an extension cable, one extension base unit can be used per system.

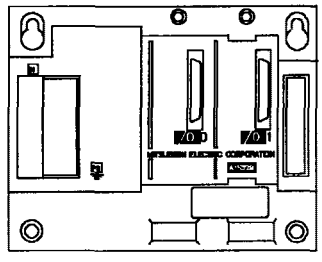
The requirement of an extra power supply module is dependent on the total 5 VDC current consumption of the complete A1S system, if one is required then an extension base with a power supply module slot should be selected. The number of I/O module slots and, if there is a power supply module slot, is dependent upon the extension base model number. A list of all different A1S extension base units is shown below;

Model No. A1S52B

Extension base unit with spare I/O slots for 2 I/O modules.

External dimensions, 135 mm x 130 mm x 28 mm (5.31 in x 5.12 in x 1.10 in)

Manual Reference No. IB(NA) 66320, A1SCPU User's Manual

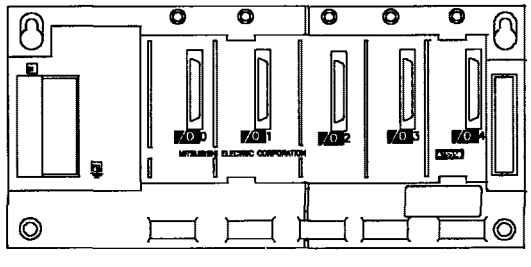


Model No. A1S55B

Extension base unit with spare I/O slots for 5 I/O modules.

External dimensions, 260 mm x 130 mm x 28 mm (10.24 in x 5.12 in x 1.10 in)

Manual Reference No. IB(NA) 66320, A1SCPU User's Manual

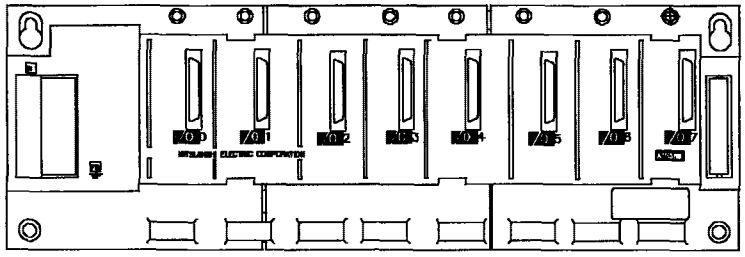


Model No. A1S58B

Extension base unit with spare I/O slots for 8 I/O modules.

External dimensions, 365 mm x 130 mm x 28 mm (14.37 in x 5.12 in x 1.10 in)

Manual Reference No. IB(NA) 66320, A1SCPU User's Manual

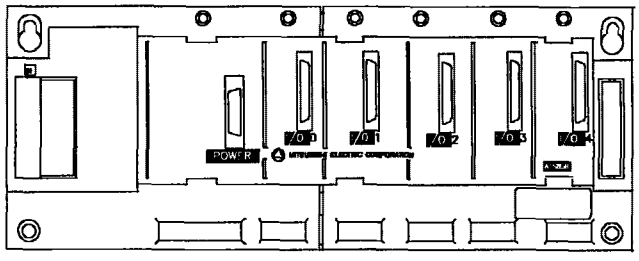


Model No. A1S65B

Extension base unit with spare I/O slots for 5 I/O modules and a power supply module slot.

External dimensions, 315 mm x 130 mm x 28 mm (12.40 in x 5.12 in x 1.10 in)

Manual Reference No. IB(NA) 66320, A1SCPU User's Manual

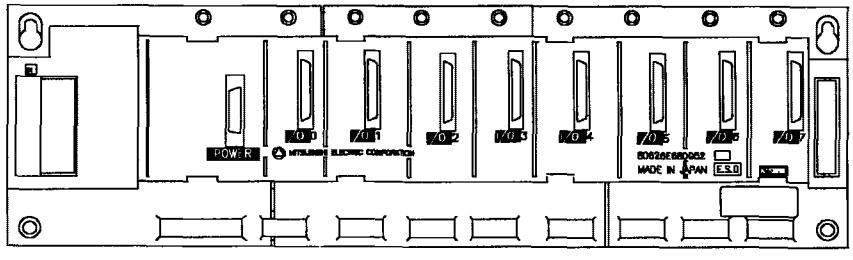


Model No. A1S68B

Extension base unit with spare I/O slots for 5 I/O modules and a power supply module slot.

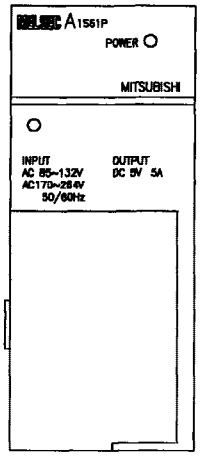
External dimensions, 420 mm x 130 mm x 28 mm (16.54 in x 5.12 in x 1.10 in)

Manual Reference No. IB(NA) 66320, A1SCPU User's Manual

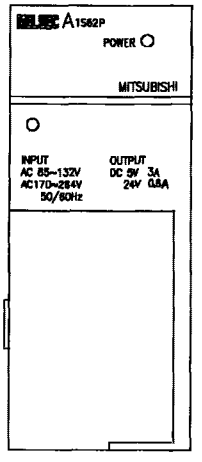


MODULE DESCRIPTIONS

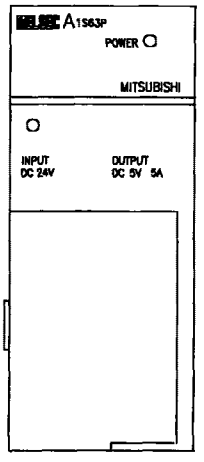
Power supply modules



A1S61P



A1S62P



A1S63P

The power supply modules provide the 5 VDC that is required by the CPU and I/O modules to function correctly. They are mounted on to the base units in the power supply module slot, and output the 5 VDC they generate to a power rail on the base unit. Input supply voltage to the power supply module is dependent on the model number selected, below is a list of all the A1S power supply modules available:

Model No. A1S61P

Power supply module with 110/230 VAC input, and 5 VDC 5 A output.

Manual Reference No. IB(NA) 66320, A1SCPU User's Manual

Model No. A1S62P

Power supply module with 110/230 VAC input, 5 VDC 3 A output, and 24 VDC 0.6 A output (can be used for powering relay output modules or input devices etc..)

Manual Reference No. IB(NA) 66320, A1SCPU User's Manual

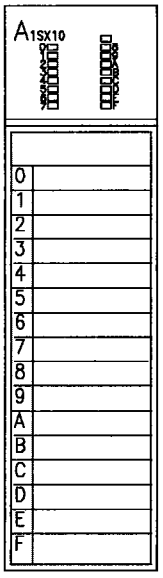
Model No. A1S63P

Power supply module with 24 VD input, and 5 VDC 5A output.

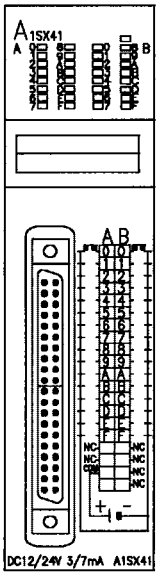
Manual Reference No. IB(NA) 66320, A1SCPU User's Manual

r supply module with 24 VDC input, and 5 VDC 5 A output.

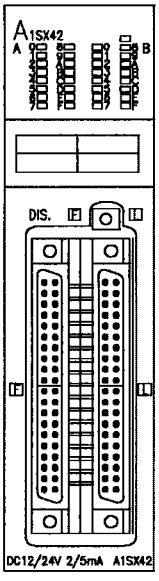
Input modules



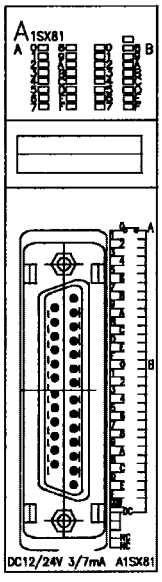
16 Point Terminal block



32 Point FCN Connector



64 Point FCN Connector



32 Point D-sub Connector

The input modules are the interface between the external input devices that are used on your application, such as limit switches, proximity switches, push buttons, auxiliary contacts etc., and the PLC. There are many types of input module, each of them with a differing input voltage specification and/or number of input points per module. A list of all the A1S input modules available is show below;

Model No. A1SX10

Input module with 16 x 110 VAC inputs, terminal block wiring.

Manual Reference No. IB(NA) 66320, A1SCPU User's Manual

Current consumption: 0.05A, 5 VDC

Model No. A1SX20

Input module with 16 x 240 VAC inputs, terminal block wiring.

Manual Reference No. IB(NA) 66320, A1SCPU User's Manual

Current consumption: 0.05A, 5 VDC

MODULE DESCRIPTIONS

Model No. A1SX30

Input module with 16 x 24 VAC or 24 VDC inputs, terminal block wiring.

Manual Reference No. IB(NA) 66320, A1SCPU User's Manual

Current consumption: 0.05A, 5 VDC

Model No. A1SX40

Input module with 16 x 12 or 24 VDC inputs (sink type), terminal block wiring.

Manual Reference No. IB(NA) 66320, A1SCPU User's Manual

Current consumption: 0.05A, 5 VDC

Model No. A1SX40-S1

Input module with 16 x 24 VDC high speed inputs (sink type), terminal block wiring.

Manual Reference No. IB(NA) 66320, A1SCPU User's Manual

Current consumption: 0.05A, 5 VDC

Model No. A1SX40-S2

Input module with 16 x 24 VDC inputs (sink type), terminal block wiring.

Manual Reference No. IB(NA) 66320, A1SCPU User's Manual

Current consumption: 0.05A, 5 VDC

Model No. A1SX41

Input module with 32 x 12 or 24 VDC inputs (sink type), FCN connector wiring.

Manual Reference No. IB(NA) 66320, A1SCPU User's Manual

Current consumption: 0.08A, 5 VDC

Model No. A1SX41-S2

Input module with 32 x 24 VDC inputs (sink type), FCN connector wiring.

Manual Reference No. IB(NA) 66320, A1SCPU User's Manual

Current consumption: 0.08A, 5 VDC

Model No. A1SX42

Input module with 64 x 12 or 24 VDC inputs (sink type), FCN connector wiring.

Manual Reference No. IB(NA) 66320, A1SCPU User's Manual

Current consumption: 0.09A, 5 VDC

Model No. A1SX42-S2

Input module with 64 x 24 VDC inputs (sink type), FCN connector wiring.

Manual Reference No. IB(NA) 66320, A1SCPU User's Manual

Current consumption: 0.09A, 5 VDC

Model No. A1SX71

Input module with 32 x 5 or 12 VDC inputs (sink or source type), FCN connector wiring.

Manual Reference No. IB(NA) 66320, A1SCPU User's Manual

Current consumption: 0.075A, 5 VDC

Model No. A1SX80

Input module with 16 x 12 or 24 VDC inputs (sink or source type), terminal block wiring.

Manual Reference No. IB(NA) 66320, A1SCPU User's Manual

Current consumption: 0.05A, 5 VDC

Model No. A1SX80-S1

Input module with 16 x 24 VDC high speed inputs (sink or source type), terminal block wiring.

Manual Reference No. IB(NA) 66320, A1SCPU User's Manual

Current consumption: 0.05A, 5 VDC

Model No. A1SX80-S2

Input module with 16 x 24 VDC inputs (sink or source type), terminal block wiring.

Manual Reference No. IB(NA) 66320, A1SCPU User's Manual

Current consumption: 0.05A, 5 VDC

MODULE DESCRIPTIONS

Model No. A1SX81

Input module with 32 x 12 or 24 VDC inputs (sink or source type), D-sub connector wiring.

Manual Reference No. IB(NA) 66320, A1SCPU User's Manual

Current consumption: 0.08A, 5 VDC

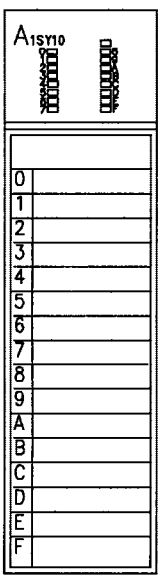
Model No. A1SX81-S2

Input module with 32 x 24 VDC inputs (sink or source type), D-sub connector wiring.

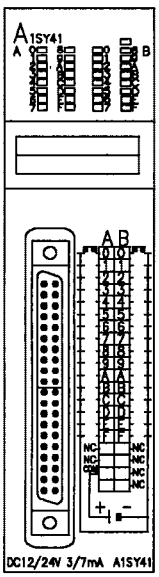
Manual Reference No. IB(NA) 66320, A1SCPU User's Manual

Current consumption: 0.05A, 5 VDC

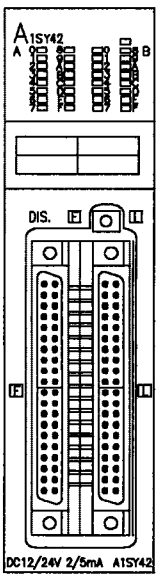
Output modules



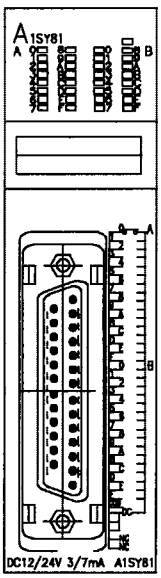
16 Point Terminal block



32 Point FCN Connector



64 Point FCN Connector



32 Point D-sub Connector

The output modules are the interface between the PLC and external output devices such as contactors, interposing relays, digital displays, lamps etc. There are many types of output module, each of them with a differing output switching voltage specification and/or number of output points per module. A list of all the A1S output modules available is show below;

Model No. A1SY10

Output module with 16 x relay contact outputs 24 VDC, 2 A or 240 VAC, 2 A switching voltage, terminal block wiring.

Manual Reference No. IB(NA) 66320, A1SCPU User's Manual

Current consumption: 0.12A, 5 VDC & 0.09, 24 VDC

MODULE DESCRIPTIONS

Model No. A1SY18A

Output module with 8 x independent relay contact outputs 24 VDC, 2 A or 240 VAC, 2 A switching voltage, terminal block wiring.

Manual Reference No. IB(NA) 66320, A1SCPU User's Manual

Current consumption: 0.24A, 5 VDC & 0.075A, 24 VDC

Model No. A1SY22

Output module with 16 x triac/SSR outputs 100-240 VAC, 0.6 A switching voltage, terminal block wiring.

Manual Reference No. IB(NA) 66320, A1SCPU User's Manual

Current consumption: 0.27A, 5 VDC & 0.004A, 200 VAC

Model No. A1SY28A

Output module with 8 x independent triac/SSR outputs 100-240 VAC, 1 A switching voltage, terminal block wiring.

Manual Reference No. IB(NA) 66320, A1SCPU User's Manual

Current consumption: 0.11A, 5 VDC

Model No. A1SY40

Output module with 16 x transistor outputs (sink type) 12 or 24 VDC, 0.1 A switching voltage, terminal block wiring.

Manual Reference No. IB(NA) 66320, A1SCPU User's Manual

Current consumption: 0.27A, 5 VDC & 0.016A, 24 VDC

Model No. A1SY41

Output module with 32 x transistor outputs (sink type) 12 or 24 VDC, 0.1 A switching voltage, FCN connector wiring.

Manual Reference No. IB(NA) 66320, A1SCPU User's Manual

Current consumption: 0.50A, 5 VDC & 0.016A, 24 VDC

Model No. A1SY42

Output module with 64 x transistor outputs (sink type) 12 or 24 VDC, 0.1 A switching voltage, FCN connector wiring.

Manual Reference No. IB(NA) 66320, A1SCPU User's Manual

Current consumption: 0.93A, 5 VDC & 0.016A, 24 VDC

Model No. A1SY50

Output module with 16 x transistor outputs (sink type) 12 or 24 VDC, 0.5 A switching voltage, terminal block wiring.

Manual Reference No. IB(NA) 66320, A1SCPU User's Manual

Current consumption: 0.12A, 5 VDC & 0.12A, 24 VDC

Model No. A1SY60

Output module with 16 x transistor outputs (sink type) 24 VDC, 2 A switching voltage, terminal block wiring.

Manual Reference No. IB(NA) 66320, A1SCPU User's Manual

Current consumption: 0.12A, 5 VDC & 0.015A, 24 VDC

Model No. A1SY60E

Output module with 16 x transistor outputs (source type) 5 or 12 or 24 VDC, 1 A switching voltage, terminal block wiring.

Manual Reference No. IB(NA) 66320, A1SCPU User's Manual

Current consumption: 0.20A, 5 VDC & 0.01A, 24 VDC

Model No. A1SY68A

Output module with 8 x independent transistor outputs (sink or source type) 5 or 12 or 24 or 48 VDC, 2 A switching voltage, terminal block wiring.

Manual Reference No. IB(NA) 66320, A1SCPU User's Manual

Current consumption: 0.13A, 5 VDC

MODULE DESCRIPTIONS

Model No. A1SY71

Output module with 32 x transistor outputs (sink type) 5 or 12 VDC, 16 mA switching voltage, FCN connector wiring.

Manual Reference No. IB(NA) 66320, A1SCPU User's Manual

Current consumption: 0.40A, 5 VDC & 0.15A, 24 VDC

Model No. A1SY80

Output module with 16 x transistor outputs (source type) 12 or 24 VDC, 0.8 A switching voltage, terminal block wiring.

Manual Reference No. IB(NA) 66320, A1SCPU User's Manual

Current consumption: 0.12A, 5 VDC & 0.04A, 24 VDC

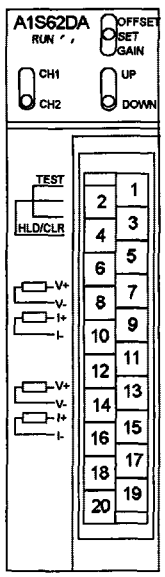
Model No. A1SY81

Output module with 32 x transistor outputs (source type) 12 or 24 VDC, 0.1 A switching voltage, D-sub connector wiring.

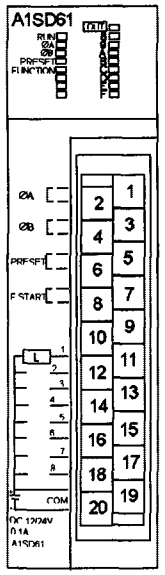
Manual Reference No. IB(NA) 66320, A1SCPU User's Manual

Current consumption: 0.50A, 5 VDC & 0.016A, 24 VDC

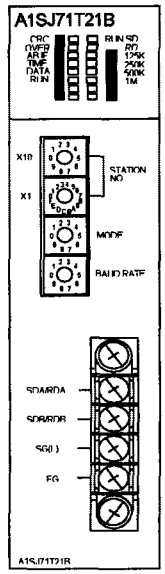
Special function modules



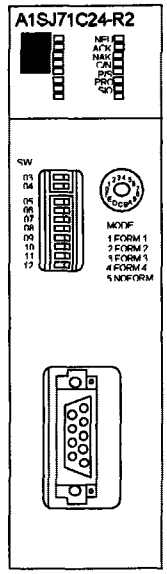
A1S62DA
Analog Output



A1SD61
High Speed Counter



A1SJ71T21B
MELSECNET/B



A1SJ71C24-R2
Computer Link

The special function modules are intelligent I/O modules which provide dedicated control for particular applications, such as position control, computer linking, networking etc.. They interpret or convert information between the PLC CPU and application specific devices, enabling complete PLC system integration. Each of the special function modules has its own particular function, below is a list of all the A1S special function modules;

Model No. A1S64AD

Analog to digital conversion module with 4 analog input channels, -10 to +10 VDC or -20 to +20 mA analog input signal. Digital output -12,288 to +12,287.

Manual Reference No.	IB(NA) 66336, A1S64AD User's Manual
Current consumption	0.4A, 5 VDC

MODULE DESCRIPTIONS

Model No. A1S62DA

Digital to analog conversion module with 2 analog output channels, -10 to +10 VDC or 0 to +20 mA analog output signal. Digital input -12,000 to +12,000.

Manual Reference No.	IB(NA) 66335, A1S62DA User's Manual
Current consumption	0.8A, 5 VDC

Model No. A1SJ71C24-R2

RS232C computer link module with 1 RS232C communication port. Full or half duplex transmission, 4 protocol modes, no-protocol mode, bi-directional mode, and protocol switching function.

Manual Reference No.	IB(NA) 66270, A1SJ71C24-R2/PRF User's Manual
Current consumption	0.1A, 5 VDC

Model No. A1SJ71C24-R4

RS422/485 computer link module with 1 RS422/485 communication port. Full or half duplex transmission, 4 protocol modes, no-protocol mode, bi-directional mode, protocol switching function, and multidrop capability.

Manual Reference No.	IB(NA) 66364, A1SJ71C24-R4 User's Manual
Current consumption	0.1A, 5 VDC

Model No. A1SJ71C24-PRF

RS232C printer module with 1 RS232C communication port. Full or half duplex transmission, 31 variable and 400 fixed message storage, with messages up to 80 characters long.

Manual Reference No.	IB(NA) 66270, A1SJ71C24-R2/PRF User's Manual
Current consumption	0.1A, 5 VDC

Model No. A1SD61

High speed counter module with 1 single or bi-phase input channel. Maximum count speed 50 KHz, 32 bit signed binary count range, 8 comparison transistor outputs, ring counter function, limit switch function, hold function, and sampling function.

Manual Reference No.	IB(NA) 66337, A1SD61 User's Manual
Current consumption	0.35A, 5 VDC

Model No. A1SI61

High speed interrupt module with 16 x 12 or 24 VDC high speed interrupt input points. Minimum input pulse length 0.5 ms, rising edge or falling edge interrupts.

Manual Reference No.	IB(NA) 66396, A1SI61 User's Manual
Current consumption	0.057A, 5 VDC

Model No. A1SJ71T21B

MELSECNET/B data link system interface module. Connects on to MELSECNET/B network linking up to 32 A1S PLCs, twisted pair cable connection, transmission speed up to 1 Mbaud, and 1K byte link points per station.

Manual Reference No.	IB(NA) 66339, A1SJ71T21B User's Manual
Current consumption	0.66A, 5 VDC

Model No. A1SJ71PT32-S3

MELSECNET/MINI-S3 remote I/O network master module. Controls up to 512 remote I/O points, twisted pair or plastic fiber optic connection, transmission speed 1.5 Mbaud, allows connection of F and FX series PLCs, A2C I/O modules, and Z series inverters.

Manual Reference No.	IB(NA) 66368, A1SJ71PT32-S3 User's Manual
Current consumption	0.0.35A, 5 VDC

MODULE DESCRIPTIONS

Model No. A1SD70

Single axis positioning module with one analog output channel. 32 bit signed binary positioning range, 1 to 400,000 PLS/Sec positioning speed, zeroing and jogging functions.

Manual Reference No.	IB(NA) 66367, A1SD70 User's Manual
Current consumption	0.3A, 5 VDC & 0.2A, +15 VDC & 0.02A -15 VDC

Model No. A1SD71-S2

Two axis positioning module with two pulse output channels. Positioning range 1 to 16,252,928. 10 to 200,000 PLS/Sec positioning speed, zeroing, M-code, backlash, compensation, and jogging functions.

Manual Reference No.	IB(NA) 66399, A1SD71-S2 User's Manual
Current consumption	0.8A, 5 VDC & 0.05A, 4.75 to 26.4 VDC

Model No. A1SP60

Pulse catch module with 16 x 24 VDC pulse input points. Pulse catch or normal input function, minimum pulse width 0.5 ms.

Manual Reference No.	IB(NA) 66398, A1SP60 User's Manual
Current consumption	0.055A, 5 VDC

Model No. A1SH42

Combined input and output module with 32 x 12 or 24 VDC input points, and 32 x transistor outputs (sink type) 12 or 24 VDC switching voltage. Inputs and outputs FCN connector wiring.

Manual Reference No.	IB(NA) 66320, A1SCPU User's Manual
Current consumption	0.5A, 5 VDC & 0.008, 24 VDC

Model No. A1S42X

Dynamic input module with 16 x 12 or 24 VDC input points. Input points can be automatically multiplexed for 16 or 32 or 48 or 64 points by switch selection.

Manual Reference No.	IB(NA) 66320, A1SCPU User's Manual
Current consumption	0.08A, 5 VDC

Model No. A1S42Y

Dynamic output module with 16 x transistor outputs (sink type) 12 or 24 VDC switching voltage. Output points can be automatically multiplexed for 16 or 32 or 48 or 64 points by switch selection.

Manual Reference No.	IB(NA) 66320, A1SCPU User's Manual
Current consumption	0.1A, 5 VDC & 0.008A 24 VDC

Model No. A1SG60

I/O slot blanking module for filling unused I/O slots on the base units.

Manual Reference No.	IB(NA) 66320, A1SCPU User's Manual
Current consumption	None

Model No. A1SG62

Dummy I/O point module for reservation of I/O points for future additions to the PLC system. 16 or 32 or 48 or 64 I/O points can be reserved by switch setting.

Manual Reference No.	IB(NA) 66320, A1SCPU User's Manual
Current consumption	None

Model No. A1S62RD3

3 wire temperature sensor input module with two sensor input channels. Compatible with 3 wire PT100 temperature sensors, 16 or 32 bit binary sensing value, and wire breakage detection.

Manual Reference No.	IB(NA) 66338, A1S62RD3/4 User's Manual
Current consumption	0.54A, 5 VDC

Model No. A1S62RD4

4 wire temperature sensor input module with two sensor input channels. Compatible with 4 wire PT100 temperature sensors, 16 or 32 bit binary sensing value, and wire breakage detection.

Manual Reference No.	IB(NA) 66338, A1S62RD3/4 User's Manual
Current consumption	0.44A, 5 VDC

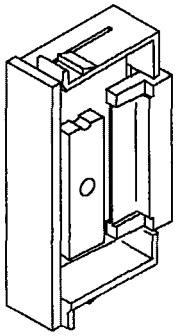
MODULE DESCRIPTIONS

Model No. A1ST60

Timer module with 8 analog timers. Timer range 0.1 to 600 seconds with a +/- 2% accuracy.

Manual Reference No.	IB(NA) 66397, A1ST60 User's Manual
Current consumption	0.055A, 5 VDC

Memory modules



The memory modules allow EEPROMs and EPROMs to be used for program storage, in addition to the RAM memory in the CPU module.

Model No. A1SMCA-2KE

EEPROM memory module with a capacity of 8k bytes (2k steps).

Manual Reference No. IB(NA) 66320, A1SCPU User's Manual

Model No. A1SMCA-8KE

EEPROM memory module with a capacity of 32k bytes (8k steps).

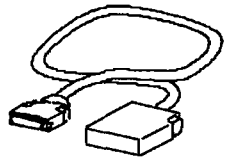
Manual Reference No. IB(NA) 66320, A1SCPU User's Manual

Model No. A1SMCA-8KP

EPROM memory module with a capacity of 8k bytes (2k steps).

Manual Reference No. IB(NA) 66320, A1SCPU User's Manual

Extension cables



The extension cables are for connecting the extension base units to the CPU base units. Different cable lengths are available according to the model number. A list of the A1S extension cables is shown below;

Model No. A1SC01B

Extension base to CPU base, 5.5 cm long.

Manual Reference No. IB(NA) 66320, A1SCPU User's Manual

Model No. A1SC03B

Extension base to CPU base, 33 cm long.

Manual Reference No. IB(NA) 66320, A1SCPU User's Manual

Model No. A1SC12B

Extension base to CPU base, 120 cm long.

Manual Reference No. IB(NA) 66320, A1SCPU User's Manual

Model No. A1SC30B

Extension base to CPU base, 300 cm long.

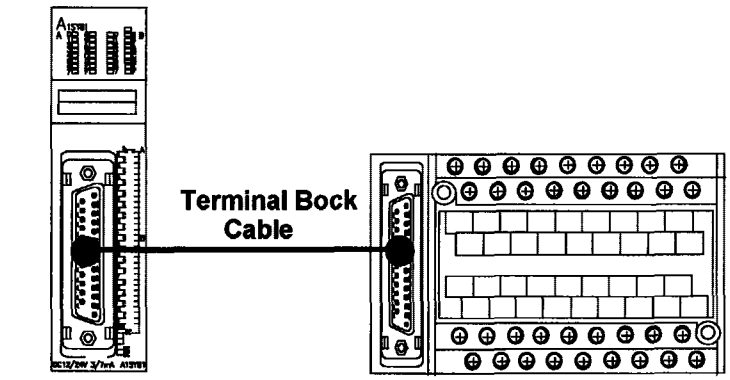
Manual Reference No. IB(NA) 66320, A1SCPU User's Manual

Model No. A1SC05NB

AnN extension base to A1S CPU base, 45 cm long.

Manual Reference No. IB(NA) 66320, A1SCPU User's Manual

Terminal block units and cables



Remote terminal block units for use with connector wiring type input and output modules. Connected to the I/O modules using a terminal block cable. There are many types of terminal block unit with a differing number of terminal points and/or compatible with different I/O modules.

There are two types of terminal block cable, one for use with sink type input/output modules, and the other for use with source type input/output modules. Below is a list of the A1S terminal block units and cables available

Model No. A6TBXY36

36 point terminal block unit for use with sink type input and output modules, A1SX41(S2), A1SX42(S2), A1SY41, A1SY42, or A1SH42.

Manual Reference No. No manual, specification sheet No. 88

Model No. A6TBXY54

54 point terminal block unit for use with sink type input and output modules, A1SX41(S2), A1SX42(S2), A1SY41, A1SY42, or A1SH42.

Manual Reference No. No manual, specification sheet No. 88

MODULE DESCRIPTIONS

Model No. A6TBX70

70 point terminal block unit for use with sink type input modules, A1SX41(S2), A1SX42(S2), or A1SH42.

Manual Reference No. No manual, specification sheet No. 88

Model No. A6TBX36-E

36 point terminal block unit for use with source type input module, A1SX81(S2).

Manual Reference No. No manual, specification sheet No. 88

Model No. A6TBY36-E

36 point terminal block unit for use with source type output module, A1SY81.

Manual Reference No. No manual, specification sheet No. 88

Model No. A6TBX54-E

54 point terminal block unit for use with source type input module, A1SX81(S2).

Manual Reference No. No manual, specification sheet No. 88

Model No. A6TBY54-E

54 point terminal block unit for use with source type output module, A1SY81.

Manual Reference No. No manual, specification sheet No. 88

Model No. A6TBX70-E

70 point terminal block unit for use with source type input module, A1SX81(S2).

Manual Reference No. No manual, specification sheet No. 88

Model No. AC05TB

Terminal block unit cable for use with sink type terminal block units and input/output modules, 0.5 m long.

Manual Reference No. No manual, specification sheet No. 88

Model No. AC10TB

Terminal block unit cable for use with sink type terminal block units and input/output modules, 1 m long.

Manual Reference No. No manual, specification sheet No. 88

Model No. AC20TB

Terminal block unit cable for use with sink type terminal block units and input/output modules, 2 m long.

Manual Reference No. No manual, specification sheet No.88

Model No. AC30TB

Terminal block unit cable for use with sink type terminal block units and input/output modules, 3 m long.

Manual Reference No. No manual, specification sheet No. 88

Model No. AC50TB

Terminal block unit cable for use with sink type terminal block units and input/output modules, 5 m long.

Manual Reference No. No manual, specification sheet No. 88

Model No. AC05TB-E

Terminal block unit cable for use with source type terminal block units and input/output modules, 0.5 m long.

Manual Reference No. No manual, specification sheet No. 88

Model No. AC10TB-E

Terminal block unit cable for use with source type terminal block units and input/output modules, 1 m long.

Manual Reference No. No manual, specification sheet No. 88

Model No. AC20TB-E

Terminal block unit cable for use with source type terminal block units and input/output modules, 2 m long.

Manual Reference No. No manual, specification sheet No. 88

Model No. AC30TB-E

Terminal block unit cable for use with source type terminal block units and input/output modules, 3 m long.

Manual Reference No. No manual, specification sheet No. 88

Model No. AC50TB-E

Terminal block unit cable for use with source type terminal block units and input/output modules, 5 m long.

Manual Reference No. No manual, specification sheet No. 88

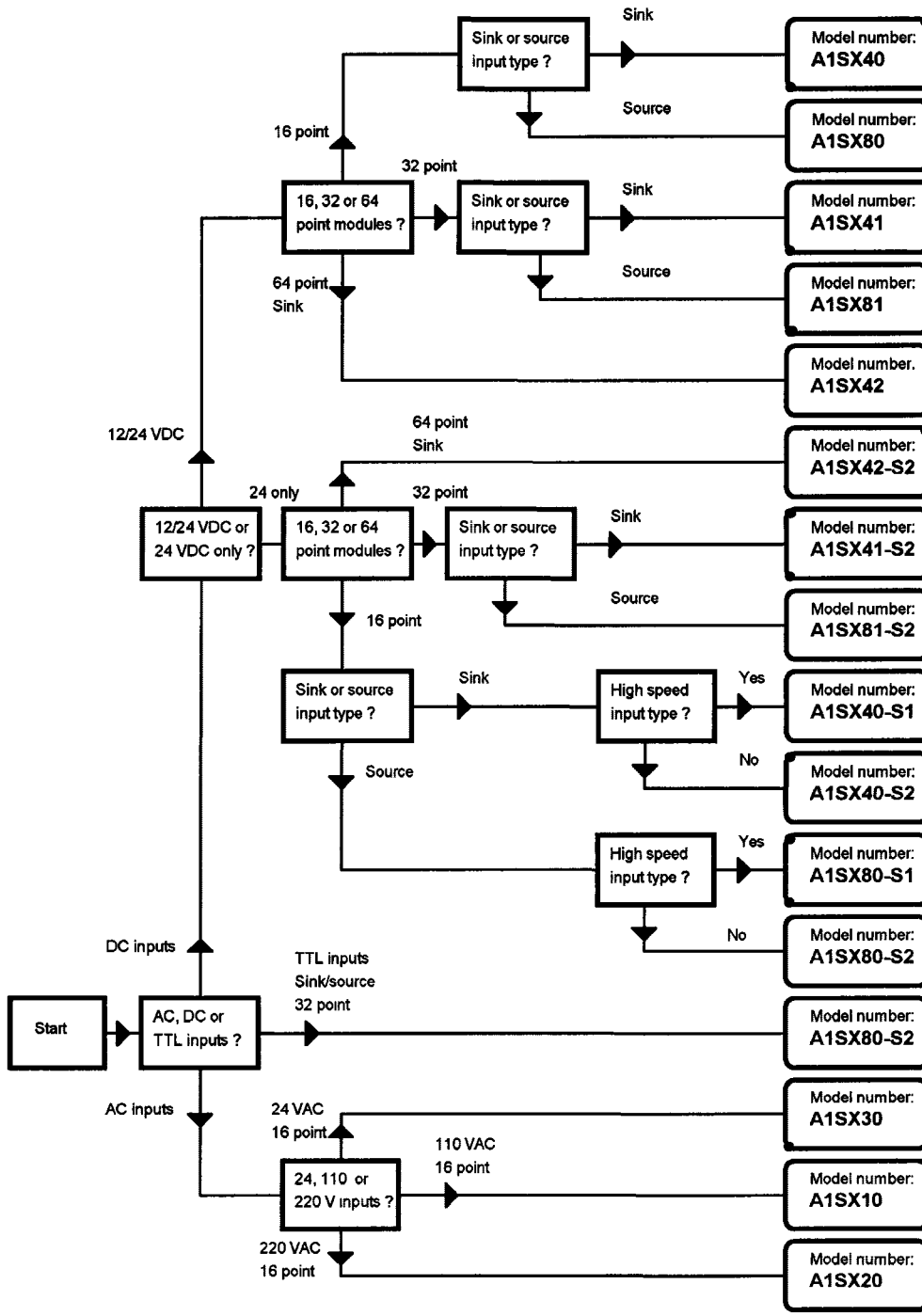
Chapter 3: System Selection and Configuration

System selection

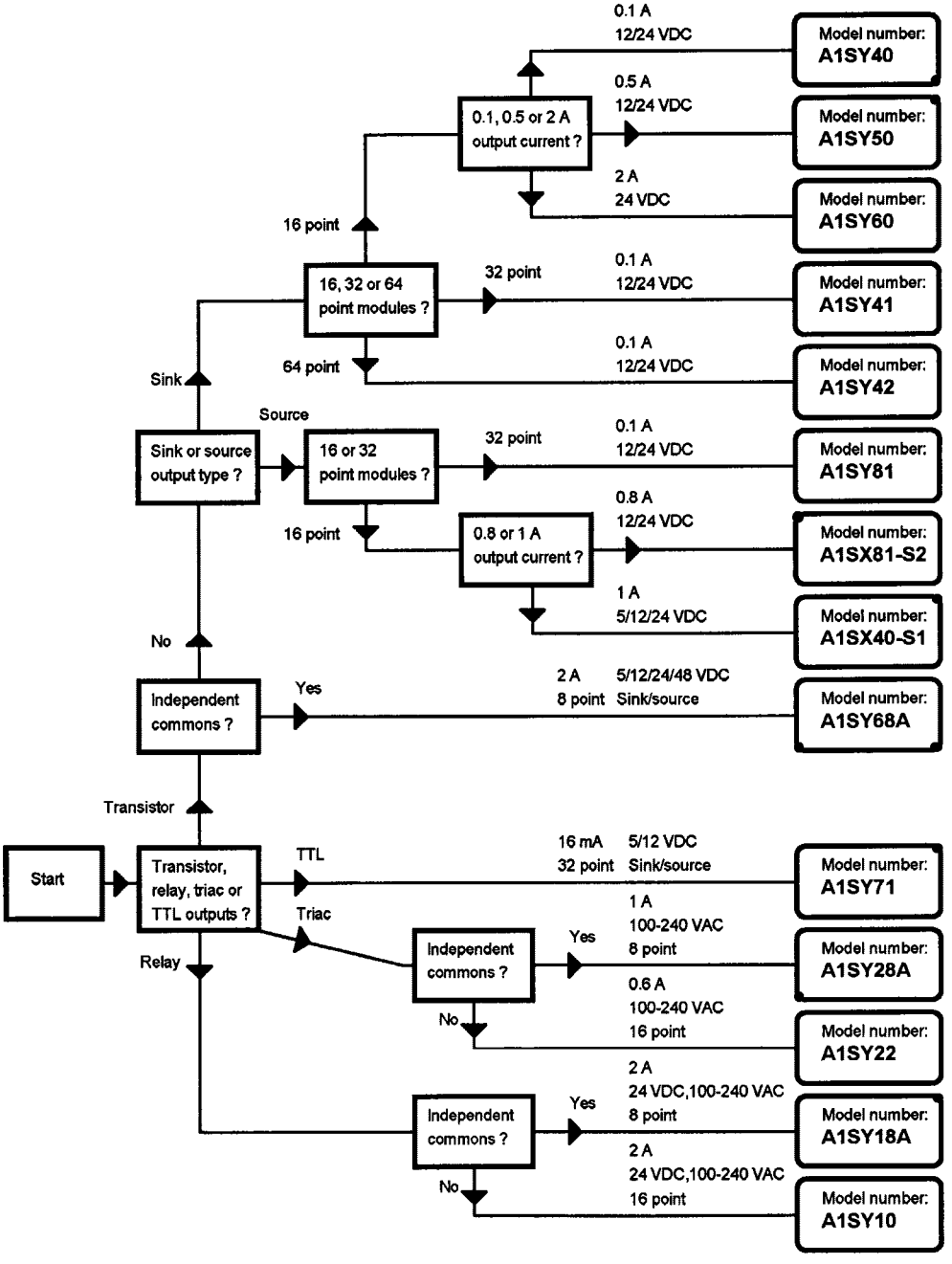
A1S system selection may seem to be a difficult task with so many different types of modules and accessories to choose from, as can be seen in chapter 2. However, it can be made easy by following the five steps outlined in this chapter. Follow them carefully and you will be able to match the A1S PLC system exactly to your application requirements.

SELECTION AND CONFIGURATION

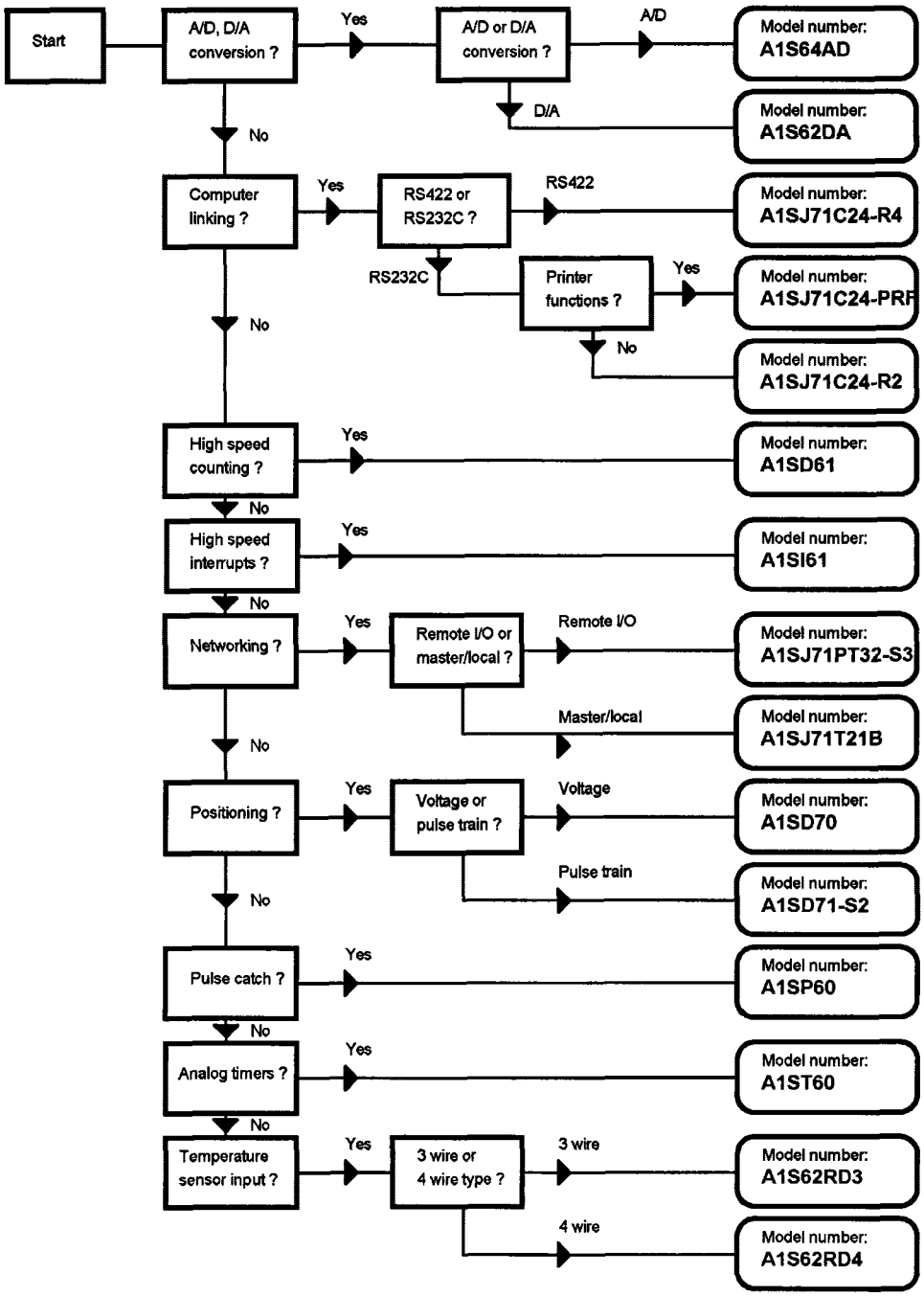
Step 1: Input module selection



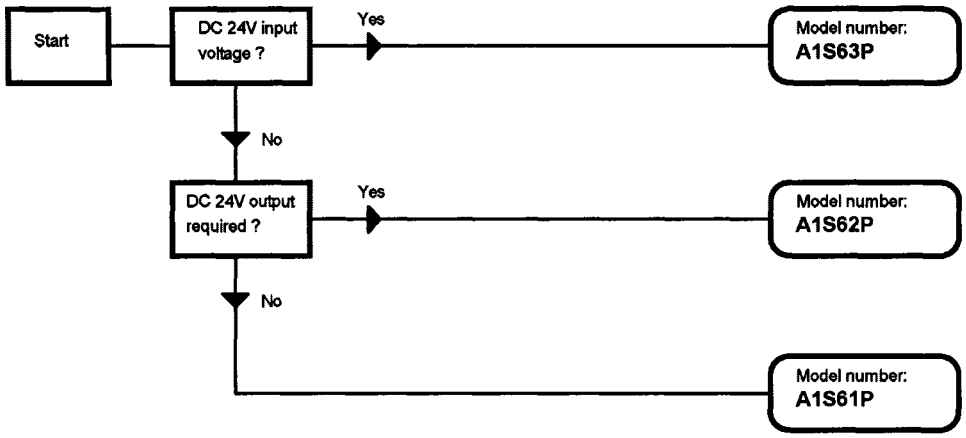
Step 2: Output module selection



Step 3: Special function module selection



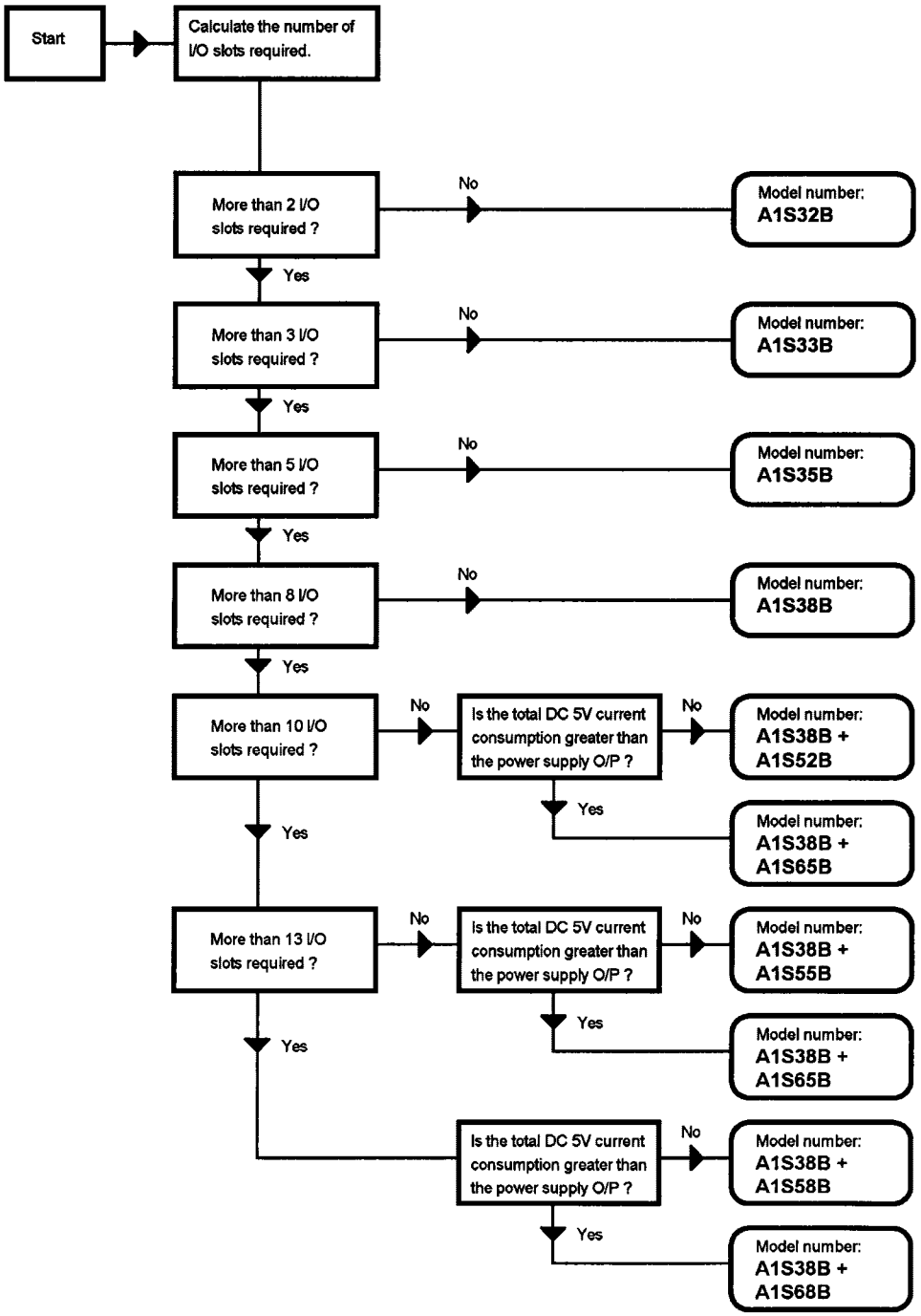
Step 4: Power supply module selection



Note:

1. If an A1S62P power supply unit has been selected, then ensure that the DC 5V current consumption of all the modules being powered by this power supply does not exceed 3A. If the current consumption is above 3A, then an A1S61P power supply module should be selected, and an external power supply should be used for the DC 24V that is required.
2. If an A1S65B or A1S68B extension base are used, then an additional power supply module is required.

Step 5: Base unit selection



System configuration

After selecting all of the components for your A1S system, it is then necessary to configure the system and assign input/output numbers for each of the modules you have chosen.

First of all each of the modules in your system must be allocated to an I/O slot on either the CPU or extension base unit. So write in the model numbers of the modules you have selected against the slot number where you want to locate them on the base units selected. A good idea when doing this is to keep all the input modules, output modules and special function modules together in groups, this makes it much easier when it comes to programming and installation later on.

When you have allocated an I/O slot for each of the modules, it is then necessary to assign numbers to all of the inputs and outputs in your system. The numbers range from 0 to FF, and are counted in hexadecimal i.e. 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F with the starting point for counting the module in slot 0 of the CPU base unit. From the module in slot 0 the numbers follow on consecutively through all the modules on the CPU base unit and then on to the modules in the extension base unit, if one is used. Please note when assigning the I/O numbers that single I/O slot special function modules occupy 32 points, two I/O slot special function modules occupy 48 points, and spare or vacant I/O slots occupy 16 points.

A1S System Examples

System Example 1

System requirements:

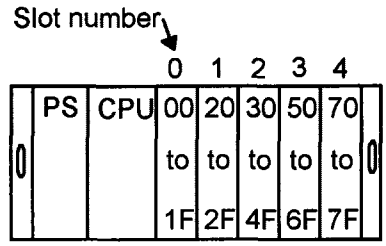
AC 240V input power supply

24 x DC 24V source type inputs

16 x relay contact outputs

2 x DC 0-10V analog inputs

1 x DC 0-10V analog output



Required modules:

CPU base unit	A1S35B
Power supply module	A1S61P
CPU module	A1SCPU
Slot 0	A1SX81
Slot 1	A1SY10
Slot 2	A1S64AD
Slot 3	A1S62DA
Slot 4	Vacant

Total number of I/O points used = 112

Total DC 5V current consumption = 1.8A

System Example 2

System requirements

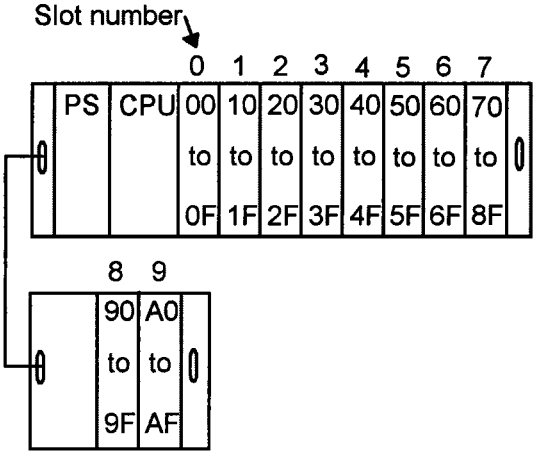
AC 240V input power supply

60 x AC 240V inputs

48 x triac/SSR outputs

16 x independent relay contact outputs

1 x RS232C computer link



Required modules

CPU base unit	A1S38B
Ext. base unit	A1S52B
Ext. cable	A1SC05B
Power supply	A1S61P
CPU module	A1SCPU
Slot 0 - 3	A1SX20
Slots 4 - 6	A1SY22
Slot 7	A1SJ71C24-R2
Slots 8 - 9	A1SY18A

Total number of I/O points used = 172

Total DC 5V current consumption = 1.36A

System Example 3

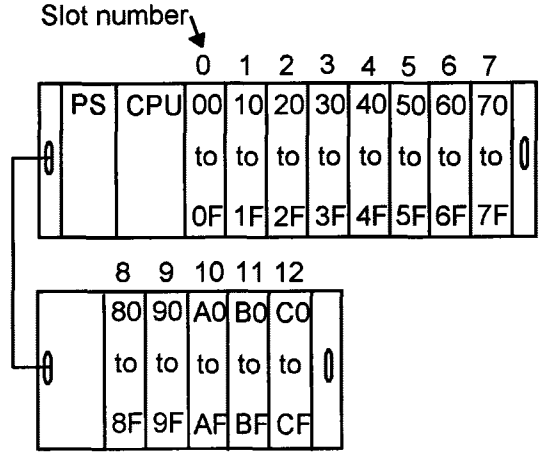
System requirements

DC 24V input power supply

100 x DC 24V source type inputs

80 x transistor source type outputs

Terminal block connections only



Required modules

CPU base unit	A1S38B
Ext. base unit	A1S55B
Ext. cable	A1SC05B
Power supply	A1S63P
CPU module	A1SCPU
Slots 0 - 6	A1SX80
Slots 7 - 11	A1SY80
Slot 12	Vacant

Total number of I/O points used = 180

Total DC 5V current consumption = 1.35A

System Example 4

System requirements

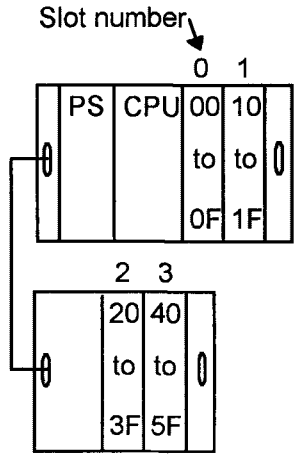
AC 110V input power supply

16 x DC 24V source type inputs

16 x relay contact outputs

1 x high speed counter input

1 x MELSECNET/B interface



Required modules

CPU base unit	A1S32B
Ext. base unit	A1S52B
Ext. cable	A1SC05B
Power supply	A1S61P
CPU module	A1SCPU
Slot 0	A1SX80
Slot 1	A1SY10
Slot 2	A1SD61
Slot 3	A1SJ71T21B

Total number of I/O points used = 96

Total DC 5V current consumption = 1.58A

Chapter 4: Installation

Installation environment

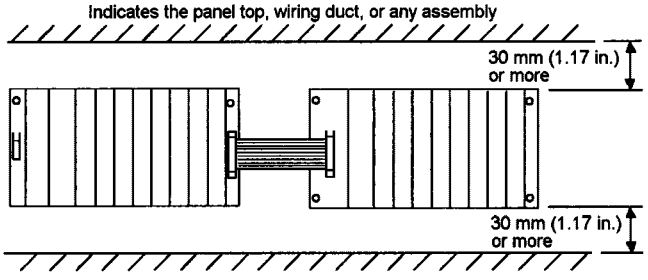
An A1S PLC system should not be installed in the following environments;

1. Locations where the ambient temperature is greater than 55 °C or less than 0 °C.
2. Locations where the ambient relative humidity is greater than 90% or less than 10%.
3. Locations where dew condensation occurs due to sudden changes in temperature.
4. Locations where there are corrosive and/or combustible gasses.
5. Locations where there is a high level of conductive powder, such as dust and iron filings, oil mist, salt, and organic solvents.
6. Locations exposed to the direct rays of the sun.
7. Locations where strong power and magnetic fields are generated.
8. Locations where vibration and shock are directly transmitted to the PLC system.

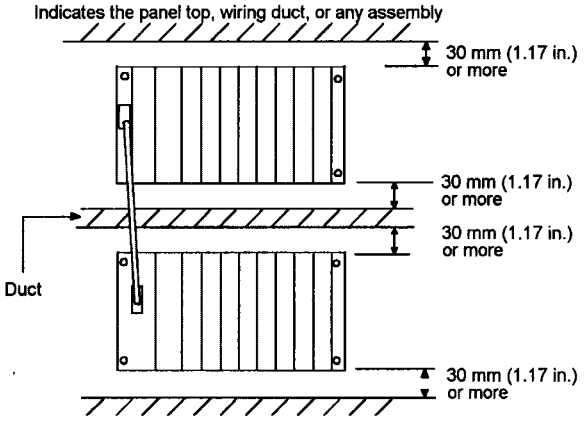
Base unit mounting instructions

The CPU and extension base units should be mounted in accordance with the following instructions;

1. To improve the ventilation of the PLC and to facilitate the addition or removal of any modules, allow a minimum 30 mm /1.18 in. clearance around the base unit.

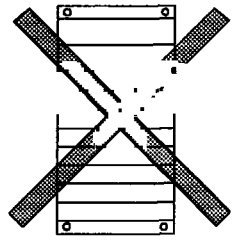


Parallel Mounting

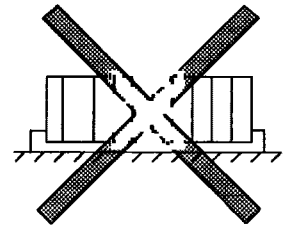


Serial Mounting

2. So as not to prevent correct ventilation, do not mount the base unit vertically or horizontally.



Vertical Mounting (Not allowed)

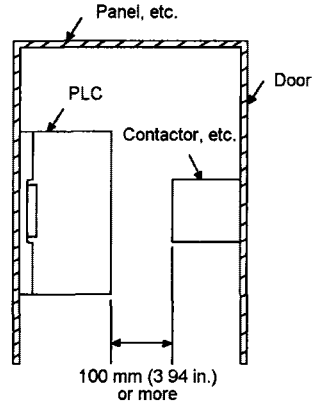


Horizontal Mounting (Not allowed)

3. The base unit should be mounted on a flat surface so as to prevent any strain to the printed circuit boards which could result in damage or incorrect operation.

4. Avoid mounting the base unit close to the source of any vibration, such as large magnetic contactors and/or large no-fuse breakers. If possible mount the base unit in a separate panel to the vibration source or mount it as far as possible from the vibration source.

5. If any equipment which generates noise or heat is positioned in front of the PLC system i.e. the equipment is mounted on the back of the panel door, allow a minimum clearance of 100 mm/3.94 in. between the front of the PLC system and such equipment.



Mounting the base units on DIN rail

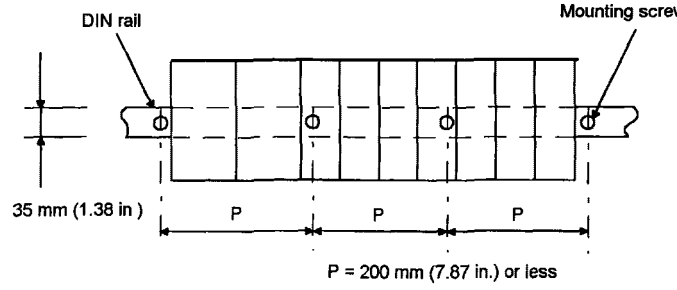
Both the CPU and extension base units can be fixed to DIN by the fixing hooks provided on the back of them. Below the method of installation is explained;

1. Applicable DIN rails:

TH35-7.5 Fe, TH35-7.5 Al, and TH35-15 Fe.

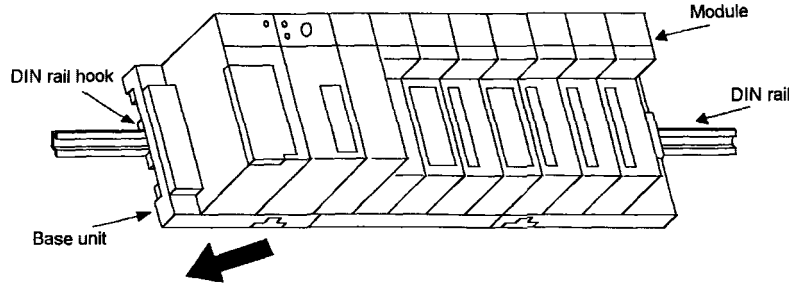
2. DIN rail fixing screw spacing:

When TH35-7.5 Fe or TH35-7.5 Al DIN rail is used for the mounting of the base unit, the space between the DIN rail fixing screws should be 200 mm/7.87 in. or less.



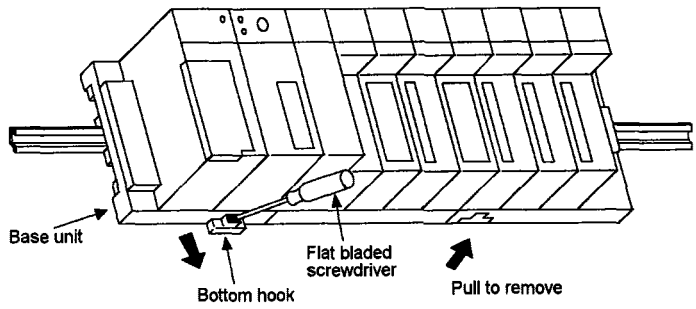
3. Mounting base unit onto DIN rail

First of all engage the DIN rail hook on the back of the base unit with the top of the DIN rail. Then push the base unit onto the rail and fix it in position.



4. Removing base unit from DIN rail

To remove the base unit from the DIN rail pull down the bottom DIN rail hook of the base unit using a flat bladed screwdriver. Then pull the base unit away from the DIN rail whilst still pulling down the DIN rail hook.

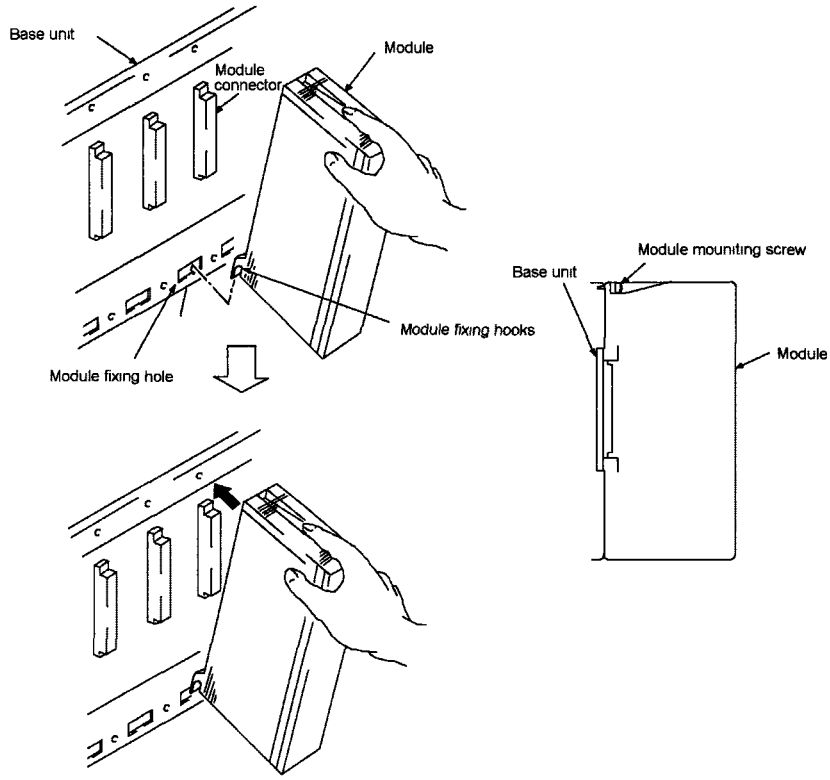


Installation and removal of A1S modules

This section explains how to install and remove the A1S onto and from the base unit. Please note that when installing or removing a module, always ensure that the power supply is turned OFF.

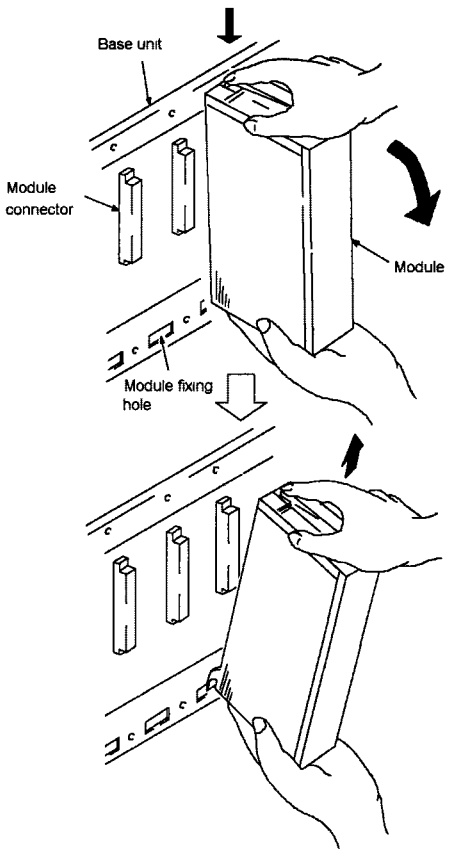
1. Installing a module onto the base unit

Insert the module fixing hooks on the bottom of the modules, into the module fixing holes of the base unit. Then push the module onto the base unit making sure that the module fixing hooks are firmly inserted in the fixing holes. After this, secure the module with the mounting screw at the top of the module.



2. Removing a module from the base unit

Remove the module mounting screw at the top of the module, then pull the module away and slightly down from the base unit. Lift the module upwards so as to remove the module fixing hooks from the fixing holes on the base unit.

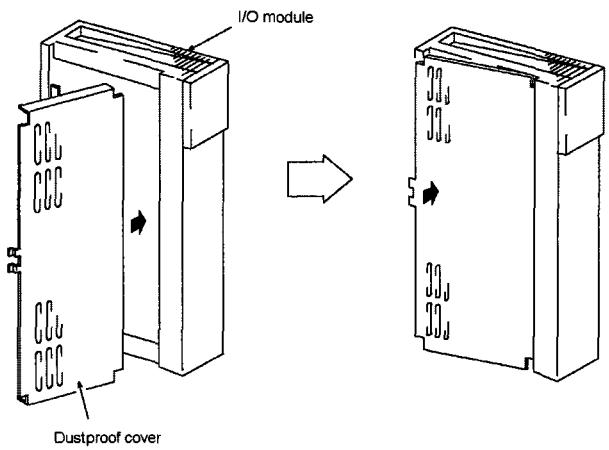


Installation and removal of dustproof cover

When an extension base unit which does not have a power supply module is used i.e. A1S52B, A1S55B, or A1S58B, it is necessary to install a dustproof cover which is supplied with the extension base unit on to the I/O module installed at the leftmost end of the base unit. This is to prevent any foreign matter from entering the I/O module which may cause malfunction of the I/O module itself.

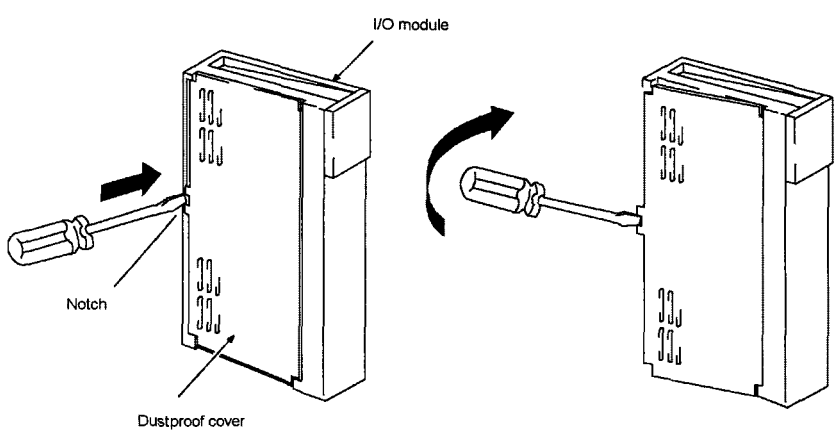
1. Installation

To insert the dustproof cover onto the I/O module, first insert the cover to the terminal/connector side and press the dustproof cover against the I/O module as shown below;



Removal

To remove the dustproof cover fit the tip of a flat bladed screwdriver in the notch on the left side of the dustproof cover. While keeping the tip of the screwdriver in the notch, gently move the screwdriver to the left (as shown below) until the cover snaps open.



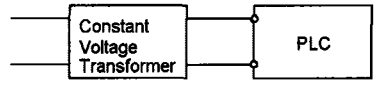
Chapter 5: Wiring

This chapter explains the wiring instructions for the A1S PLC system.

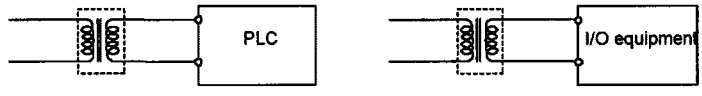
Wiring instructions for the power supply module

Below are the wiring instructions for the power supply modules of the A1S PLC.

1. If the fluctuations of the power supply modules incoming voltage are larger than permitted by the specification of the module, a constant voltage transformer should be used as shown below.



2. If the incoming power supply to the module generates noise outside the specifications of the power supply module, then an insulating transformer should be used as shown below.

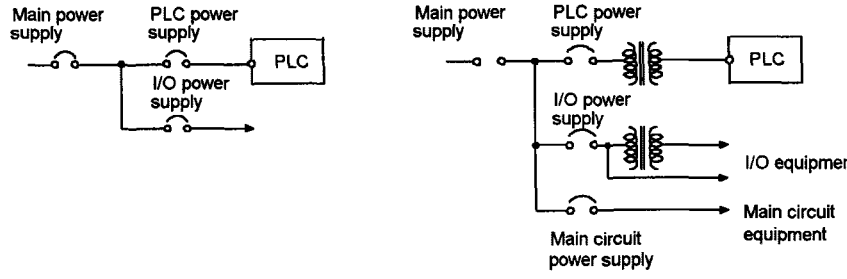


3. When a power transformer or insulating transformer is used to reduce the voltage from 200 VAC to 100 VAC, use one which has a capacity greater than shown in the table below.

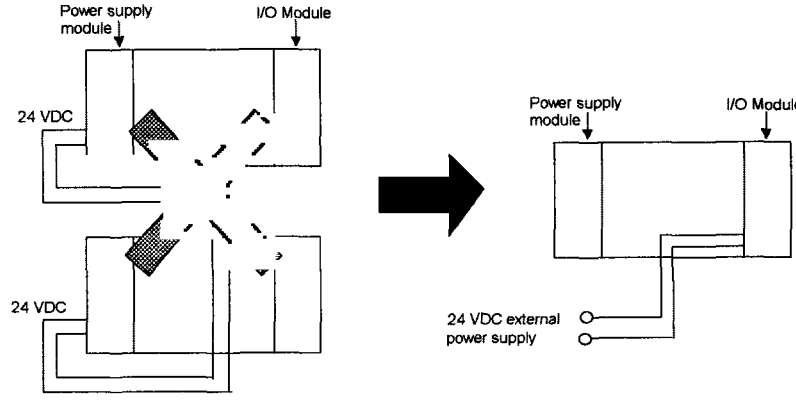
Power supply module	Transformer capacity
A1S61P	110 VA x n
A1S62P	110 VA x n

n = the number of power supply modules

4. When wiring, separate the PLC power supply from the input and output equipment power supply, and the main circuit supply



5. When using the 24 VDC output form the A1S62P power supply module, so as to protect the power supply modules do not supply one I/O module with 24 VDC from several power supply modules connected in parallel.

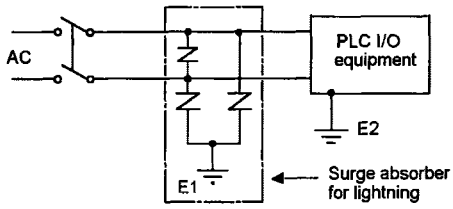


6. When using single wire cable, twist the 100 VAC, 200 VAC or 24 VDC input cables as closely as possible and connect the modules using the shortest possible cable lengths.

7. To minimize voltage drop, use the thickest (max. 2 mm² (14 AWG)) wires possible for the 100 VAC, 200 VAC or 24 VDC input cables.

8. Do not bundle or wire closely together the 100 VAC and 24 VDC with the main circuit wires or the I/O signal wires (high voltage or large current). if possible, provide at least 100 mm/3.94 in. distance between the cables and wires.

9. As a lightning protection measure, connect a surge absorber as shown below. Ensure that the surge absorber is grounded separately from the PLC and select an absorber making allowances for input power supply voltage rises.



Wiring of I/O equipment

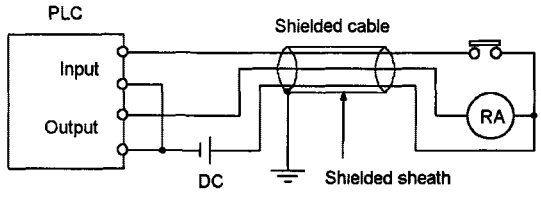
Below are wiring instructions for equipment connected to the input and output modules of the A1S system.

1. The applicable size of the terminal block connector is 0.75 mm² (AWG 18) to 1.5 mm² (AWG 14). However , it is recommended to use the smaller size cable as it is more convenient to use.

2. Separate the input and output lines.

3. I/O signal wires must be at least 100 mm/3.94 in. away from high voltage or high current main circuit wires.

4. When the I/O signal wires cannot be separated from the main circuit wires and power wires, ground the PLC side with batch shielded cables.



5. If wiring has been done using piping, then ground the piping.

6. Separate the 24 VDC I/O cables from the 100 VAC and 200 VAC I/O cables.

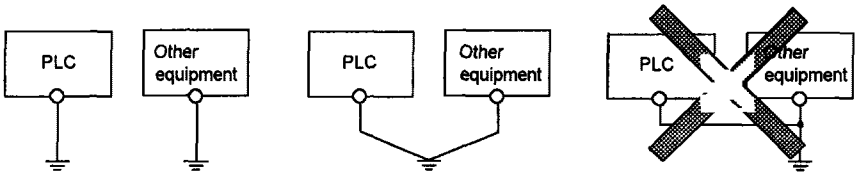
7. If wiring over distances longer than 200 mm/7.87 in., problems can sometimes occur due to leakage currents caused by line capacitance. In this case take corrective action as shown below.

Grounding

Grounding should be done according to the following.

1. Ground the PLC as independently as possible. Class 3 grounding should be used (grounding resistance 100 Ω or less).

2. When independent grounding is not possible, use the joint grounding method as shown below.



Class 3 grounding (Best)

Class 3 grounding (Goodt)

Joint grounding (Not allowed)

3. In the case of incorrect operation due to grounding, disconnect one or both of the LG. and FG terminals of the base units from the grounding.

Chapter 6: Programming

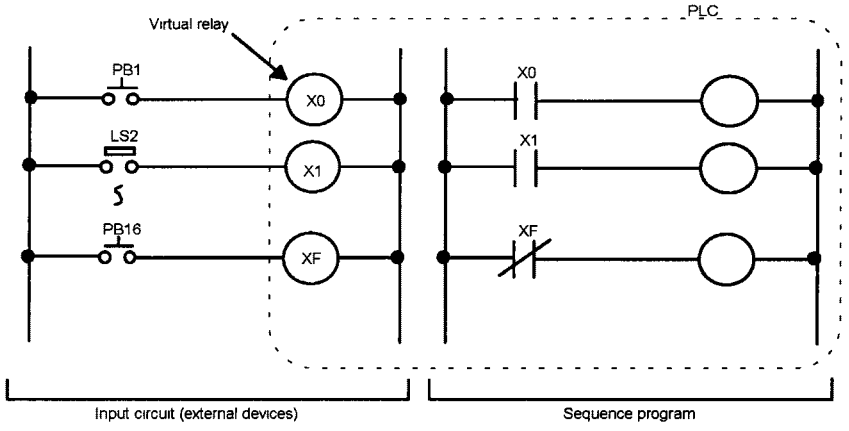
This chapter describes the language, instructions, method and equipment used for creating sequence programs for the A1S. It also describes the internal devices of the A1SCPU which can be used within the sequence program. These devices such as data registers, internal relays, timers, counters etc.. are all listed and explained in the first section of this chapter.

Description of internal devices

Inputs X

Using inputs, communication is made between the PLC and external equipment via the input modules off the PLC system. They are used to receive ON/OFF commands and data from external devices such as push buttons, select switches, digital switches etc.., for use within the sequence program.

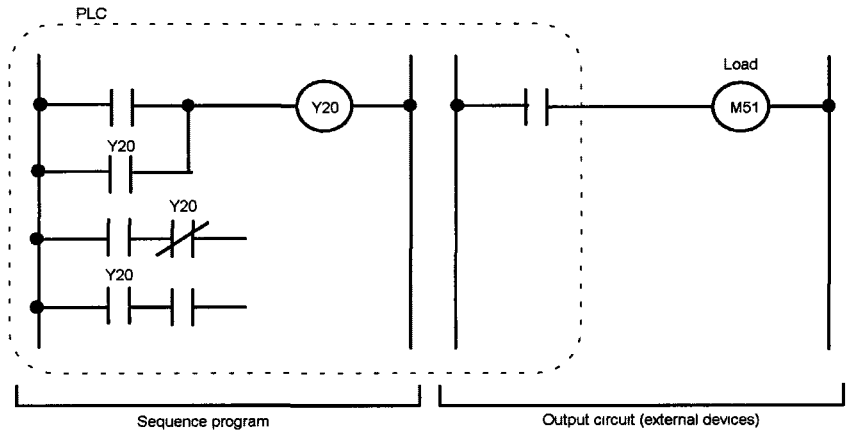
Assuming that one input point incorporates a virtual relay Xn within the PLC, the normally open contact (N/O) and normally closed contact (N/C) of that input point can then be used in the program. There is no restriction to the number of N/O contacts and N/C contacts used for that one input point.



Outputs Y

Like inputs, outputs enable communication between the PLC, via output modules in the PLC system, and external equipment. Outputs provide program control results to external devices such as solenoids, magnetic switches, signal lamps, digital indicators etc.

Assuming that one output point incorporates a virtual relay coil Yn within the PLC. The N/O contacts and N/C contacts of this coil can also be used within the program, with no restriction on the number of times they are used.



Auxiliary relays M, L, S

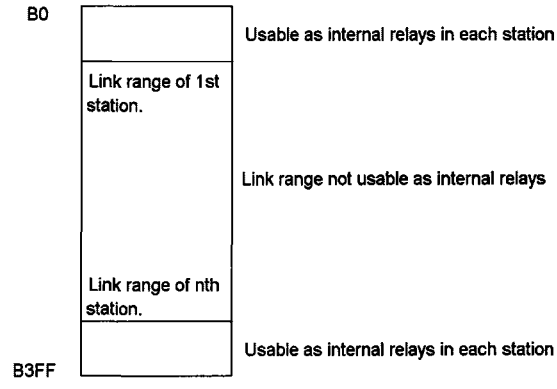
There are three types of auxiliary relays available for use in the PLC sequence program, internal relays (M), latch relays (L), and step relays (S). There is no limit to the number of N/O and N/C contacts used within a program.

The internal relays (M) and step relays (S) cannot be latched and therefore all of them are switched OFF, if the PLC is switched ON, reset or latch cleared. The latch relays are battery backed and therefore they retain the last operation state when the PLC is turned ON or reset. To switch OFF all of the latch relays, use the latch clear function of the PLC.

Link relays B

The link relays (B) are used as internal relays for the data link system. The ON/OFF data of the link relays used within the data link system can be read by switching them ON/OFF as output coils in the host or master station and used as contacts in all of the stations on the data link system. The link relays therefore allow ON/OFF data to be transferred between the master and local stations.

The range of link relays for use as coils in each station must be set in the parameters of the master station. Link relays which are not being used for the data link system can be used as internal relays. There is no restriction to the number of N/O contacts and N/C contacts of the link relays used in a sequence program.



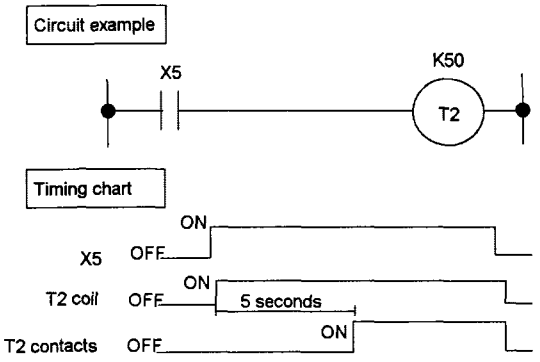
Annunciators F

Annunciators (F) are used for detecting faults or errors. By writing a fault detection part of your sequence program using annunciators, with each individual fault being represented by a corresponding annunciator being turned ON. The earliest annunciator number detected is automatically written to the special data register D9009. The annunciator numbers are then stored in special registers D9125 to D9132 in the order in which they occur on a first in first out basis. The value of special register D9124 is incremented by 1 each time any of the annunciators is turned ON and decremented by 1 each time they are reset using the RST instruction or the LED instruction is executed.

Timer T

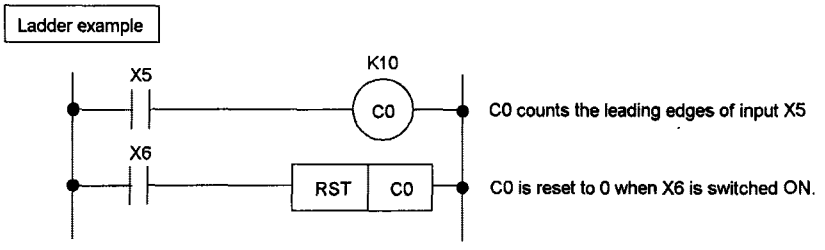
The timers used in the A1S PLC are up-timing timers which begin timing when the timer coil is switched ON, and times out when the present value reaches the set value. The timer contacts then close when the timer times out.

There are three types of timer available, 100 ms timers which are set in time divisions of 100 ms, 10 ms timers which are set in time divisions of 10 ms, and 100 ms retentive timers which are also set in time divisions of 100 ms. The retentive retain their current present value when the coil of the timer is turned OFF before timing out. With the other timers, the present value is reset to zero when this happens. To clear the present value of retentive time use the RST instruction.



Counter C

The counters used within the A1S PLC are up-counting which count out when the count value reaches the set value. The counter contacts then close when the counter counts out. The counters count the leading edges of pulses driving the counter coils, and counts once only when the coil is switched from OFF to NO. If the count coil is switched OFF, the count value is not lost, to clear a count value use the RST instruction.



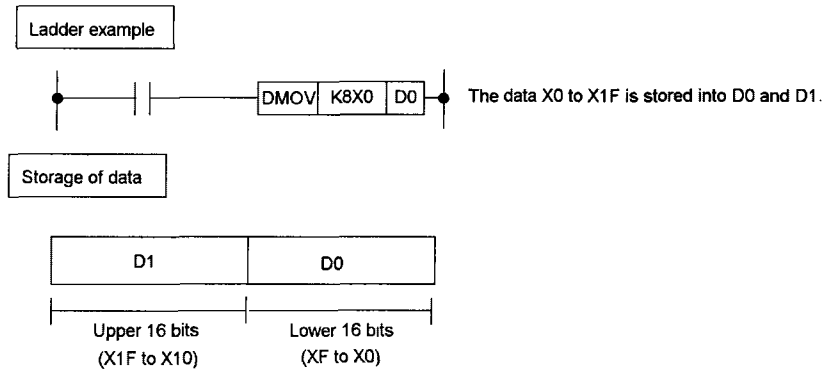
Interrupt counters C

The interrupt counter is for use within interrupt routines contained in the sequence program. When the counter coil is turned ON, the counter present value and contact status are updated after the execution of the IRET instruction at the end of the interrupt routine. Like the other counters it counts the leading edge of pulses driving its coil and counts only once when its input condition changes from OFF to ON.

Data register D

The data register (D) is a memory area in the PLC which stores data. A data register consists of 16 bits and allows read/write instructions requiring 16 bits, when 32 bit data is handled, two registers are used. The data register number specified by the 32 bit instruction contains the lower 16 bits and the specified data register number + 1 contains the upper 32 bits.

The data stored by the sequence program in the data register is retained until new data is written. To clear the data stored, turn OFF the power to the PLC or use the reset function of the PLC.



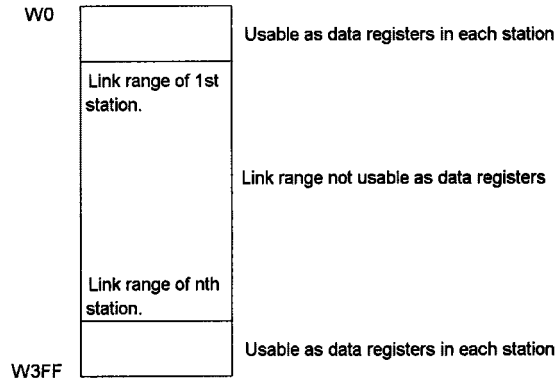
Link register W

Link registers (W) are data registers for use with the data link system. In the data link system, data is written to the link register by the host station and data read from the corresponding link registers by the other stations. Therefore link registers allow data to be transferred between the master and local stations on a data link system.

Before using the link registers, the link range must be set in the parameters of the master station. Link registers not be used for the data link system can be used as data registers at each station.

Like data registers, link registers consist of 16 bits and allow read/write operations requiring 16 bits. When 32 bit data is handled, two registers are used. The link register number specified by the 32 bit instruction contains the lower 16 bits and the specified link register number + 1 contains the upper 32 bits.

The data stored by the sequence program in the link register is retained until new data is written. To clear the data stored, turn OFF the power to the PLC or use the reset function of the PLC.



File registers R

File registers (R) are used a extra data registers which are located in the user memory area. They operate in the same way as data registers, with the exception of clearing the data, and can be used within the sequence program. To clear the data in a file register the FMOV(P) instruction should be used, if the power of the PLC is turned OFF or the PLC reset function is executed , the data in the file register will remain unchanged.

Accumulator A

The accumulator (A) is a data register which stores the operation results of some of the basic and application instructions, a list of which is shown below;

SER	RCRP
SERP	DRCR
SUM	DRCRP
SUMP	ROL
DSUM	ROLP
DSUMP	RCL
ROR	RCLP
RORP	DROL
DROR	DROLP
DRORP	DRCL
RCR	DRCLP

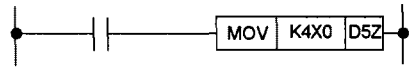
When an instruction other than those above is used, the accumulator can be used in the sequence program just like a data register.

Index registers Z, V

The index registers (Z, V) are used for the index qualification of devices such as X, Y, M, L, S, B, F, T, C, D, W, R, K, H, P. Note that when used with any bit device, the index register may only be used to specify the digit.

The index registers can be used in the sequence program like the data registers. They are 1 point and consist of 16 bits. Both read and write operations can be performed per 16 bits. For 32 bit operations the Z register is the lower 16 bits and the V register is the upper 16 bits, therefore V cannot be specified by a 32 bit instruction. Contents of the index registers is cleared in the same way as with the data registers.

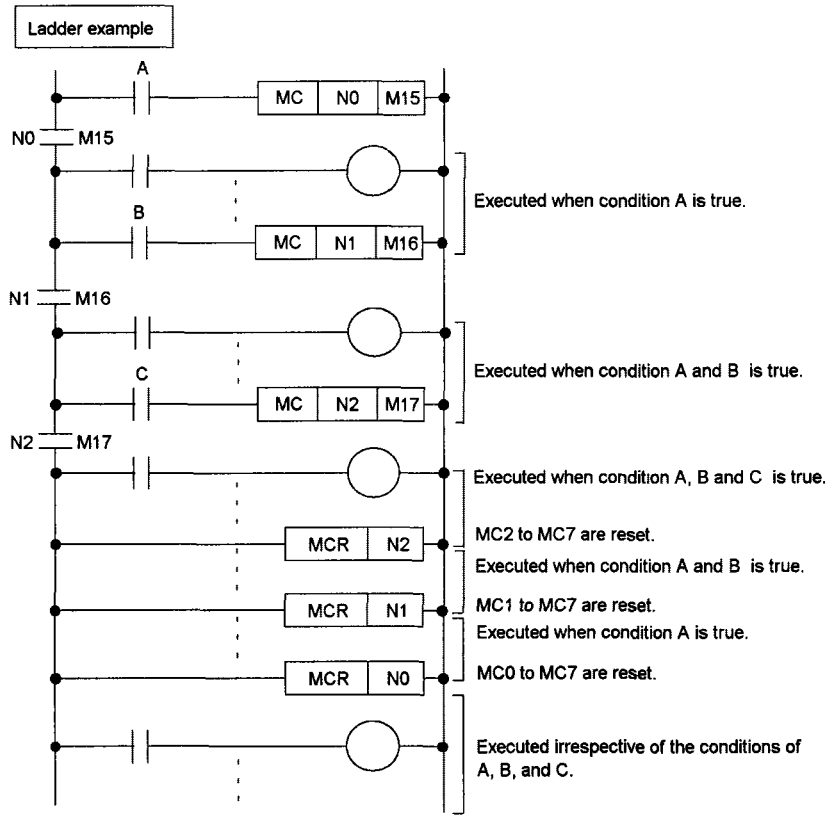
Ladder example



The data X0 to X1F is stored into D5+Z.

Nesting N

The use of nesting (N) allows a loop of master controls to several levels. Used with the MC and MCR instructions the nesting (N) numbers should written in serial order.



When the master control is OFF, the states of the timers and counters are as follows;

100 ms, 10 ms timers: timer count value returns to 0

100 ms retentive timers: timer count value remains at present value.

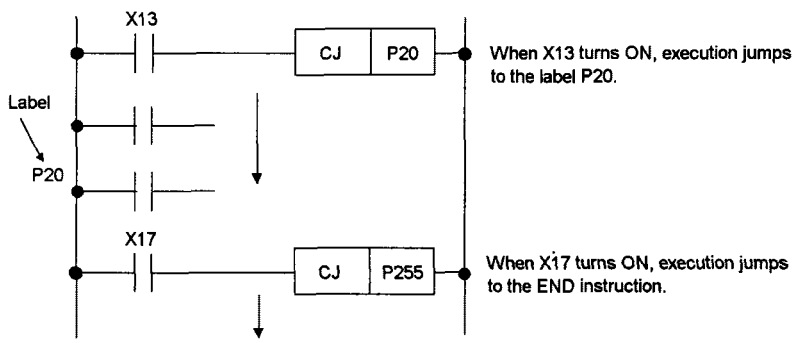
Counter: count value remains at present value.

OUT instruction: all are turned OFF

Pointer P

The pointer (P) indicates the jump destination for the branch instructions CJ, SCJ, CALL, JMP, and the pointer number attached to the beginning of the jump destination is referred to as a label. The same label cannot be used multiple times, in the case of multiple use an error will occur. The label 255 always indicates the END instruction of the sequence program and cannot be used as a label.

Ladder example



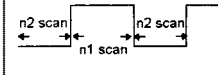
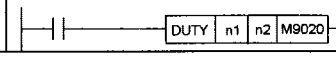
Interrupt pointer I

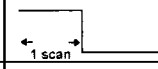
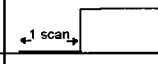
When an interrupt occurs, the interrupt pointer (I) indicates the jump destination of the corresponding interrupt program for that interrupt. Provide the same label as the interrupt pointer at the head of the interrupt program.

When interrupt pointers I29 to 31 are used in a sequence program, the jump is made to the corresponding interrupt program per interrupt time, every 10 msec, 20 msec or 40 msec.

Special relays M

The special relays (M) are internal relays which have a predefined function. They must not be switched ON/OFF in the sequence program, except for those indicated. A table of all the special relays and details of their functions is shown below.

Number	Name	Description	Details
*1M9000	Fuse blown	OFF: Normal condition ON: Presence of blown fuse output unit	Turned ON when there is one or more output units in which a fuse has blown. Remains ON if normal status is restored.
*1M9002	I/O unit verify error	OFF: Normal condition ON: Presence of error	Turned ON if the status of an I/O module is different from the status when power was turned ON. Remains ON if normal status is restored.
*1M9005	AC down detection	OFF: AC power good ON: AC power down	Turned ON if the power failure is greater than 10 ms. Is reset when power to PLC is turned from OFF to ON.
M9006	Battery low	OFF: Normal condition ON: Battery low	Turned ON when the battery voltage reduces to less than specified. Turned OFF when the battery voltage becomes normal.
*1M9007	Battery low latch	OFF: Normal condition ON: Battery low	Turned ON when the battery voltage reduces to less than specified Remains ON if the battery voltage becomes normal
*1M9008	Self diagnostic error	OFF: No error ON: Presence of error	Turned ON when an error is found as a result of self diagnosis
M9009	Annunciator detection	OFF: No detection ON: Detection present	Turned ON when OUT F or SET F instruction is executed Switched OFF when D9124 data is reset.
M9010	Operation error flag	OFF No error ON: Presence of error	Turned ON when an operation error occurs during the execution of an application instruction. Turned OFF when the error is eliminated.
*1M9011	Operation error flag	OFF: No error ON Presence of error	Turned ON when an operation error occurs during the execution of an application instruction. Remains ON if the error is eliminated.
M9012	Carry flag	OFF: Carry OFF ON: Carry ON	Carry flag used in application instructions
M9016	Data memory clear flag	OFF: No processing ON: Output clear	Clears the data memory including the latch range in remote RUN mode from computer , etc.. when turned ON.
M9017	Data memory clear flag	OFF: No processing ON Output clear	Clears the unlatched data memory in remote RUN mode from computer, etc. when turned ON
M9020 to M9024	User timing clocks		Relay which repeats On/OFF intervals of predetermined scan. When the power is turned ON or a reset is performed the clock starts with OFF Set the intervals of the ON/OFF by the DUTY instruction. 

*2M9025	Clock data set request	OFF: Ignore ON: Set requested	Writes the clock data from D9025-D9028 to the clock element after the END instruction is executed during the scan in which M9025 has changed from OFF to ON.
M9026	Clock data error	OFF: No error ON: Error	Switched ON by clock data (D9025-D9028) error.
*2M9028	Clock data read request	OFF: Ignore ON: Read request	Reads clock data D9025-D9028 in BCD when M9028 is ON.
M9030	0.1 second clock	OFF: 0.05 seconds ON: 0.05 seconds	Starts when power is turned ON or reset is performed.
M9031	0.2 second clock	OFF: 0.1 seconds ON: 0.1 seconds	
M9032	1 second clock	OFF: 0.5 seconds ON: 0.5 seconds	
M9033	2 second clock	OFF: 1 second ON: 1 second	
M9034	1 minute clock	OFF: 30 seconds ON: 30 seconds	
M9036	Normally ON	ON. Normal condition	Used as dummy contacts.
M9037	Normally OFF	OFF: Normal condition	
M9038	ON only for 1 scan after RUN		Switched ON/OFF in accordance with the RUN/STOP switch.
M9039	OFF only for 1 scan after RUN		
M9040	PAUSE enable coil	OFF: PAUSE disabled ON: PAUSE enabled	Enables PAUSE function if turned ON.
M9041	PAUSE status contact	OFF: Not during PAUSE ON: During PAUSE	Turned ON when PAUSE function is enabled and executed.
M9042	STOP status contact	OFF: Not during STOP ON: During STOP	Switched ON when the RUN/STOP switch is set to STOP.
M9043	Sampling trace completion	OFF: During sampling trace ON: Sampling trace completion	Turned ON upon completion of sampling trace performed the number of times preset by parameter after STRA instruction is executed. Reset when STRAR instruction is executed.
M9046	Sampling trace	OFF: No sampling ON: During sampling	Turned ON during sampling trace.
M9047	Sampling trace preparation	OFF: Sampling trace stop ON: Sampling trace start	Sampling trace is not executed until M9047 is turned ON. When OFF, sampling trace is stopped.
M9049	No. of characters output switching	OFF. Character up to NULL code output ON 16 characters output	When OFF, characters up to NULL (00H) code are output. When ON, ASCII codes for 16 characters are output.
*2M9052	SEG instruction switching	OFF: 7 SEG display ON I/O partial refresh	When OFF, serves as a 7 SEG display instruction. When ON, serves as a I/O partial refresh instruction.
*2M9053	EI/DI instruction switching	OFF: Sequence interrupt control ON. Link interrupt control	Turn ON to execute the link refresh enable, disable (EI, DI) instructions.
M9054	STEP RUN flag	OFF Not during STEP RUN ON: During STEP RUN	Turned ON when the RUN/STOP switch is set to STEP RUN.

M9055	Status latch completion flag	OFF: Uncompleted ON: Completed	Turned ON when the status latch is completed. Tuned OFF by the reset instruction.
*2M9084	Error check setting	OFF. Error checked ON· Error unchecked	Used to set whether or not the following error checks are made at the execution of the END instruction, fuse blown, I/O unit verify error and battery error.

All special relays are switched OFF by any of the power off, latch clear, and reset operations. The special relays remain unchanged when the RUN/STOP switch is set to STOP.

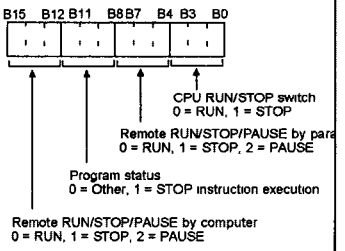
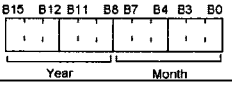
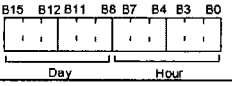
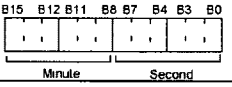
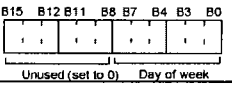
The relays in the table marked "*1" remain ON if normal status is restored. Therefore to turn them OFF either use the reset instruction in the sequence program, use a peripheral device to force them OFF, or execute the reset operation.

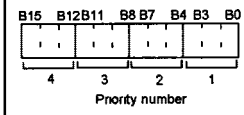
The relays in the table marked "*2" are switched ON/OFF in the sequence program.

Special registers D

The special registers (D) are data registers which have a predefined function. They must not be written too in the sequence program, except for those indicated. A table of all the special registers and details of their functions is shown below.

Number	Name	Stored Data	Explanation
D9000	Fuse blown	Fuse blown module number	When a fuse blown module is detected, the lowest number of the detected unit is stored in hexadecimal. Cleared when all contents of D9100 are reset to 0.
D9002	I/O unit verify error	I/O unit verify error module number	If any I/O unit data is different from the data entered when power was turned ON, the first I/O number of the lowest number module among those detected is stored in hexadecimal. Cleared when all contents of D9100 are reset to 0.
*1 D9005	AC down counter	AC down time count	1 is added each time the input voltage becomes 80% or less of the rated voltage while the CPU is performing operations. The number is stored in binary.
*1 D9008	Self diagnostic error	Self diagnostic error number	When an error is detected as a result of self diagnosis, the error number is stored in binary.
D9009	Annunciator detection	F number at which the external failure has occurred.	When one or more annunciators are turned ON, the number of the earliest detected annunciator is stored in binary. D9009 can be cleared using the RST or LEDR instruction.
D9010	Error step	Step number at which the operation has occurred.	When an operation error occurs during the execution of an application instruction, the step number at which the error has occurred is stored in binary. Thereafter, each time an operation error occurs the contents of D9010 is renewed
D9011	Error step	Step number at which the operation has occurred.	When an operation error occurs during the execution of an application instruction, the step number at which the error has occurred is stored in binary. The contents cannot be renewed unless M9011 is reset and then turned ON again.
D9014	I/O control mode	I/O control mode number	The set mode is represented as below; 0 = Direct mode 3 = Refresh mode

D9015	CPU operating status	Operating status of the CPU	The operating status of the CPU is indicated as shown below: 
D9016	ROM/RAM setting	0: EPROM 1: RAM 2: EEPROM	Indicates the setting of the memory select switch. One value between 0 and 2 is stored in binary.
D9017	Scan time	Minimum scan time, increments of 10 ms	If the scan time is smaller than the contents of D9017, the new value is stored in binary after the END instruction execution
D9018	Scan time	Current scan time, increments of 10 ms.	The current scan time is stored in binary after each END instruction execution.
D9019	Scan time	Maximum scan time, increments of 10 ms	If the scan time is larger than the contents of D9019, the new value is stored in binary after the END instruction execution
*2D9020	Constant scan	Constant scan time, increments of 10 ms.	Set user program execution intervals in 10 ms increments.
*2D9025	Clock data	Clock data (year, month)	Stores the year and month in BCD 
*2D9026	Clock data	Clock data (day, hour)	Stores the day and hour in BCD 
*2D9027	Clock data	Clock data (minute, second)	Stores the minute and second in BCD 
*2D9028	Clock data	Clock data (,day of week)	Stores the day of the week in BCD 

*2D9038	LED priority display	Priority 1 to 4	Set the error item numbers for the LED display priorities 1 to 4  0: No display given 1: I/O verify and fuse blown 2: Special function module and link 3: CHK instruction 4: Annunciator F 6: Battery error
*2D9039	LED priority display	Priority 5 to 7	As above
*1D9100	Fuse blown module	Bit pattern in modules of 16 points of fuse blown modules	The output module numbers in units of 16 points, in which fuses have blown are entered as a bit pattern. A value of 1 in any of the bits indicates that the fuse has blown in the corresponding output point number.
*1D9116	I/O module verify error	Bit pattern in modules of 16 points of verify error modules.	When the I/O module data is different from those entered when power was turned ON, the I/O module numbers in units of 16 points are entered in a bit pattern. A value of 1 in any of the bits indicates that there is an I/O unit verify error.
D9124	Annunciator detection quantity	Annunciator detection quantity	When one of the annunciators F is turned ON, 1 is added to the contents of D9124. When one of the annunciators is reset, 1 is subtracted from the contents of D9124
D9125 D9126 D9127 D9128 D9129 D9130 D9131 D9132	Annunciator detection number	Annunciator detection number	When one of the annunciators is turned ON, the number of the annunciator turned ON is stored in to D9125 to D9132 in order. An annunciator which has been reset by the RST F instruction is cleared from the registers and the order is updated. If the LEDR F instruction is executed then the contents of D9125 to D9132 are shifted upward by one. When there are 8 annunciator detection's, the 9th one is not stored in to the data registers.

All special register data is cleared by any of the power off, latch clear, and reset operations. The data is retained when the RUN/STOP switch is set to STOP.

For the special registers in the table marked "*1", the contents of the register is not cleared if normal status is restored. Therefore to clear the contents either use the reset instruction in the sequence program, use a peripheral device to write a value of 0, or execute the reset operation.

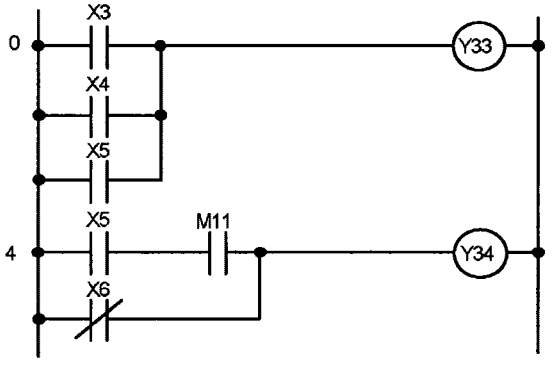
For the special registers in the table marked "*2". data is written by the sequence program.

Programming language

The A1S can be programmed in either a relay symbol language(a.k.a. ladder logic or ladder mode) or a logic symbolic language(a.k.a. instruction list or list mode). The relay symbol language is based on relay symbol representations and allows any ladder to be programmed a form which is very similar to relay control sequence ladder.

The logic symbolic language is based on the assembly language, one of the languages used to write microcomputer programs, and represents any program in the instruction, source, and destination parts.

Any program written in either language is stored into the memory of the PLC after it has been converted into the machine language. This conversion process is performed by the programming device used for programming the PLC.



Relay Symbolic Language

```
0 LD X3
1 OR X4
2 OR X5
3 OUT Y33
4 LD X5
5 AND M11
6 ORI X6
7 OUT Y34
8 END
```

Logic Symbolic Language

Numeric value and character representation

All numeric values and characters are processed in binary (BIN) by the PLC CPU with all data represented by two states, 0 and 1. The PLC CPU has conversion functions between binary and decimal (DEC), and also between binary and hexadecimal (HEX), therefore sequence programs can be written and operation results monitored in decimal or hexadecimal. The A1S CPU can process both 16 bit and 32 bit data,

Binary (BIN)

Binary represents numeric values as a series of 0's and 1's. After a 1, a carry occurs when using the BIN system. Below is an example of decimal values represented in binary, the shaded areas indicate where a carry has occurred.

BIN	0000	0001	0010	0011	0100	0101	0110	0111	1000	1001	1010
DEC	0	1	2	3	4	5	6	7	8	9	10

BIN bits correspond to DEC values as indicated below:

BIN bit	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
DEC value	1024	512	256	128	64	32	16	8	4	2	1

Example: BIN value, 1100101 = 64 + 32 + 4 + 1 = DEC value, 101

Binary coded decimal (BCD)

Binary coded decimal is a code for representing decimal numbers in a binary format. in the BCD system a carry occurs after 9. Examples of corresponding DEC, BIN, and BCD values are shown below

DEC	BIN	BCD
0	0	0
1	1	1
2	10	10
3	11	11
4	100	100

5	101		101
6	110		110
7	111		111
8	1000		1000
9	1001		1001
10	1010	1	0000
11	1011	1	0001
12	1100	1	0010

Hexadecimal (HEX)

In the hexadecimal system the number 9 is followed by A, B, C, D, E, and F. A carry occurs after F. Examples of corresponding DEC, HEX, and BIN values are shown below.

DEC	HEX	BIN
0	0	0
1	1	1
2	10	10
3	11	11

9	9	1001
10	A	1010
11	B	1011
12	C	1100
13	D	1101
14	E	1110
15	F	1111
16	10	10000
17	12	10001
---	---	
46	2E	101110
47	2F	101111

ASCII

ASCII codes correspond to alphanumeric characters and special symbols, they are used to communicate data between the PLC and external equipment. Examples of alphanumeric characters and their corresponding ASCII codes are shown below.

Alphanumeric Character	ASCII Code
0	30
1	31
2	32
A	41
B	42
C	43

Instructions

There are a total of 260 instructions for use with the A1S and they can be classified into the following groups, sequence instructions, basic instructions, and application instructions. In this section of the manual a list of all three groups of instruction is provided, plus a brief description of the processing operation each instruction performs. This is then followed by a detailed explanation of all the sequence instructions and some of the basic instructions. For more information on the instructions which are not covered in detail in this manual, please refer to the ACPU (Common Instructions) manual IB(NA)-66250.

Explanation of instruction lists

The instruction lists in this section are in the following format.

Classification	Unit	Instruction symbol	Symbol	Contents of processing	Execution condition	No. of steps
BIN 16 bit addition/subtraction	16 bits	+	+ Ⓢ Ⓓ	(D) + (S) ➔ (D)	⎍	5
		+P	+P Ⓢ Ⓓ		⎍↑	5
		+	+ Ⓢ1 Ⓢ2 Ⓓ	(S1) + (S2) ➔ (D)	⎍	7
		+P	+P Ⓢ1 Ⓢ2 Ⓓ		⎍↑	7
BIN 32 bit addition/subtraction	32 bits	D+	D+ Ⓢ Ⓓ	(D1,D) + (S+1,S)	⎍	9
		D+P	D+P Ⓢ Ⓓ	➔ (D+1,D)	⎍↑	9
		D+	D+ Ⓢ1 Ⓢ2 Ⓓ	(S1+1,S1) + (S2+1,S2)	⎍	11
		D+P	D+P Ⓢ1 Ⓢ2 Ⓓ	➔ (D+1,D)	⎍↑	11
⇧	⇧	⇧	⇧	⇧	⇧	⇧
(A)	(B)	(C)	(D)	(E)	(F)	(G)

(A) Classification

Classifies the instructions by applications

(B) Unit

Indicates the unit of processing at the execution of the instruction

Units of Processing	Device	Number of Points
16 bits	X, Y, M, L, S, F, B	Max. 16 points in units of 4 points
	T, C, D, W, R, A, Z, V	1 point
32 bits	X, Y, M, L, S, F, B	Max. 32 points in units of 4 points
	T, C, D, W, R, A, Z, V	2 points

(C) Instruction symbol

Indicates the instruction symbol used for the program. The instruction symbol is shown on a 16 bit instruction basis, the symbols of a 32 bit instruction and instructions which are only executed by a the rising edge from OFF to ON are indicated as below.

32 bit instruction

D is added to the head of the instruction

Example: + is a 16 bit instruction, D+ is a 32 bit instruction

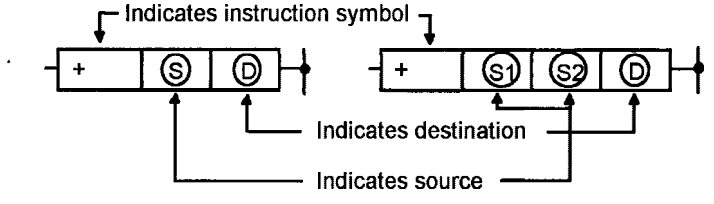
Instruction executed only at the rise from OFF to ON

P is added to the head of the instruction

Example: + is executed during ON, +P is executed only at the rise from OFF to ON

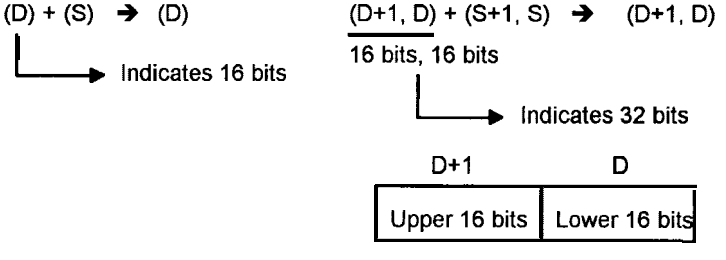
(D) Symbol

Indicates the symbol diagram in the circuit where the destination is where the data is to be stored after execution, and the source is where the data is stored before the execution.



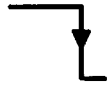
(E) Contents of processing

Indicates the processing of each instruction



(F) Execution condition

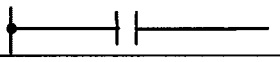
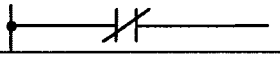
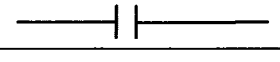
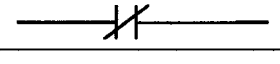
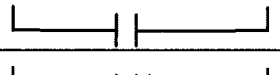
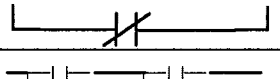
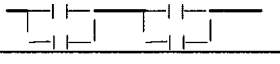
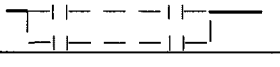
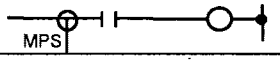
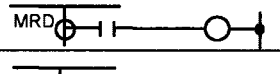
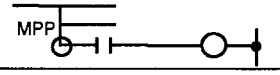
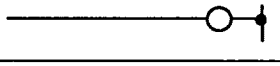
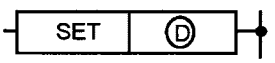
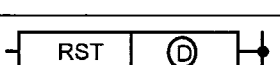
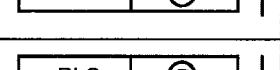
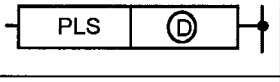
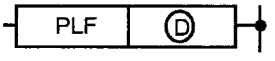
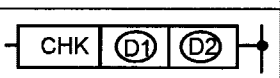
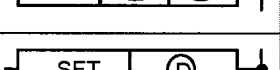
Indicates the execution condition of each instruction, details of which are shown below.

Symbol	Execution Condition
No entry	Instruction which is always executed
	Instruction which is executed during ON. Executes instruction only while the preceding condition of that instruction is ON. When the preceding condition is OFF, that instruction is not executed and not processed.
	Instruction which is executed once during OFF. Executes instruction only at the negative transition of the preceding condition of instruction, i.e. the condition changes from ON to OFF. Thereafter even if the condition is ON, that instruction is not executed and not processed.
	Instruction which is executed once during ON. Executes instruction only at the positive transition of the preceding condition of instruction, i.e. the condition changes from OFF to ON. Thereafter even if the condition is ON, that instruction is not executed and not processed.

(G) Number of steps

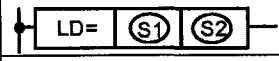
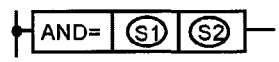
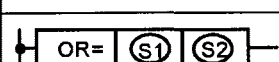
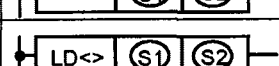
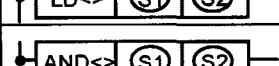
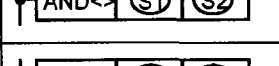
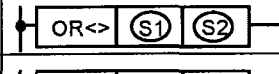
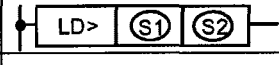
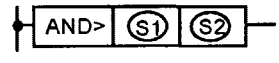
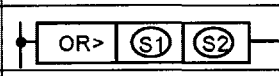
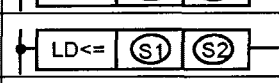
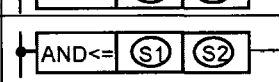
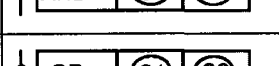
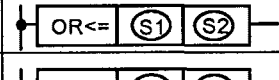
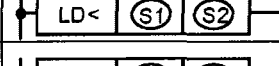
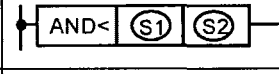
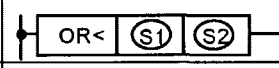
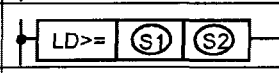
Indicates the number of program steps required for each instruction.

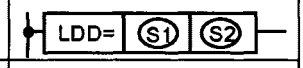
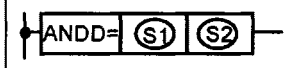
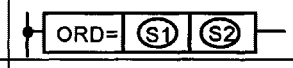
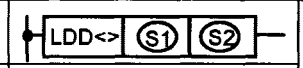
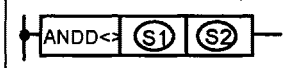
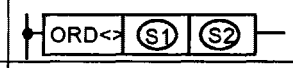
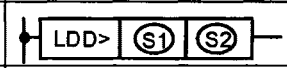
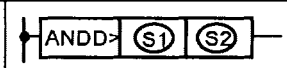
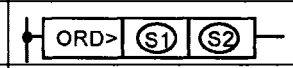
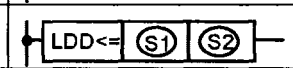
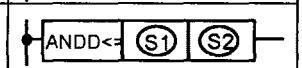
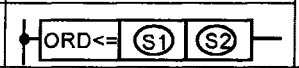
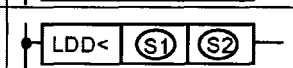
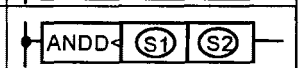
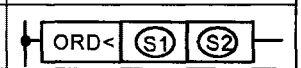
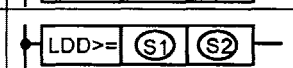
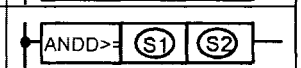
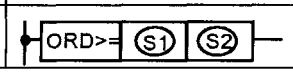
List of sequence instructions

Classification	Unit	Instruction symbol	Symbol	Contents of processing	Execution condition	No. of steps
Contact instructions		LD		Logical operation start (NO contact operation start)		1
		LDI		Logical NOT operation start (NC contact operation start)		1
		AND		Logical product (NO contact series connection)		1
		ANI		Logical product NOT (NC contact series connection)		1
		OR		Logical add (NO contact parallel connection)		1
		ORI		Logical add NOT (NC contact parallel connection)		1
Connection instructions		ANB		ANDs logical blocks (series connection of blocks)		1
		ORB		ORs logical blocks (parallel connection of blocks)		1
		MPS		Store the operation result		1
		MRD		Reads the operation result from MPS		1
		MPP		Reads the operation result from MPS and clears the result		1
Output Instructions		OUT		Device output		1 3
		SET		Device set		1 3
		RST		Device reset		1 3
		PLS		Generates one program cycle pulses on the leading edge of input signal.		3
		PLF		Generates one program cycle pulses on the trailing edge of input signal.		3
		CHK		Device output reverse Valid in I/O refresh mode		5
Shift Instructions		SFT		Shifts device 1 bit		3
		SFTP				3

Master Control Instructions		MC	MC n D	Master control start		5
		MCR	MCR n	Master control reset		3
Termination Instructions		FEND	FEND	Always used at the end of the main routine program to terminate processing		1
		END		Always used at the end of the sequence program to return to step 0		1
Other		STOP	STOP	Reset output after input condition is enabled, and stops the sequence program		1

List of basic instructions

Classification	Unit	Instruction symbol	Symbol	Contents of processing	Execution condition	No. of steps
Comparison Instructions	16 bits	LD=		Continuity when (S1) = (S2) Non-continuity when (S1) <> (S2)		5 7
		AND=				5 7
		OR=				5 7
		LD<>		Continuity when (S1) <> (S2) Non-continuity when (S1) = (S2)		5 7
		AND<>				5 7
		OR<>				5 7
		LD>		Continuity when (S1) > (S2) Non-continuity when (S1) <= (S2)		5 7
		AND>				5 7
		OR>				5 7
		LD<=		Continuity when (S1) <= (S2) Non-continuity when (S1) > (S2)		5 7
		AND<=				5 7
		OR<=				5 7
		LD<		Continuity when (S1) < (S2) Non-continuity when (S1) => (S2)		5 7
		AND<				5 7
		OR<				5 7
		LD>=		Continuity when (S1) >= (S2) Non-continuity when (S1) < (S2)		5 7
		AND>=				5 7
		OR>=				5 7

Classification	Unit	Instruction symbol	Symbol	Contents of processing	Execution condition	No. of steps
Comparison Instructions	32 bits	LDD=		Continuity when (S1+1,S1) = (S2+1,S2) Non-continuity when (S1+1,S1) <> (S2+1,S2)		11
		ANDD=				11
		ORD=				11
		LDD<>		Continuity when (S1+1,S1) <> (S2+1,S2) Non-continuity when (S1+1,S1) = (S2+1,S2)		11
		ANDD<>				11
		ORD<>				11
		LDD>		Continuity when (S1+1,S1) > (S2+1,S2) Non-continuity when (S1+1,S1) <= (S2+1,S2)		11
		ANDD>				11
		ORD>				11
		LDD<=		Continuity when (S1+1,S1) <= (S2+1,S2) Non-continuity when (S1+1,S1) > (S2+1,S2)		11
		ANDD<=				11
		ORD<=				11
		LDD<		Continuity when (S1+1,S1) < (S2+1,S2) Non-continuity when (S1+1,S1) >= (S2+1,S2)		11
		ANDD<				11
		ORD<				11
		LDD>=		Continuity when (S1+1,S1) >= (S2+1,S2) Non-continuity when (S1+1,S1) < (S2+1,S2)		11
		ANDD>=				11
		ORD>=				11

Classification	Unit	Instruction symbol	Symbol	Contents of processing	Execution condition	No. of steps
BIN Addition and Subtraction Instructions	16 bits	+	+ S D	(D) + (S) → (D)	⎍	5
		+P	+P S D		⎍↑	5
		+	+ S1 S2 D	(S1) + (S2) → (D)	⎍	7
		+P	+P S1 S2 D		⎍↑	7
		—	— S D	(D) - (S) → (D)	⎍	5
		—P	—P S D		⎍↑	5
		—	— S1 S2 D	(S1) - (S2) → (D)	⎍	7
		—P	—P S1 S2 D		⎍↑	7
BIN Addition and Subtractio Instructions	32 bits	D+	D+ S D	(D+1,D) + (S+1,S) → (D+1,D)	⎍	9
		D+P	D+P S D		⎍↑	9
		D+	D+ S1 S2 D	(S1+1,S1) + (S2+1,S2) → (D+1,D)	⎍	11
		D+P	D+P S1 S2 D		⎍↑	11
		D—	D— S D	(D+1,D) - (S+1,S) → (D+1,D)	⎍	9
		D—P	D—P S D		⎍↑	9
		D—	D— S1 S2 D	(S1+1,S1) - (S2+1,S2) → (D+1,D)	⎍	11
		D—P	D—P S1 S2 D		⎍↑	11

Classification	Unit	Instruction symbol	Symbol	Contents of processing	Execution condition	No. of steps
BIN Multiplication and Division Instructions	16 bits	*	* S1 S2 D	(S1) x (S2) → (D+1,D)	⎍	7
		* P	* P S1 S2 D		⎍↑	7
		/	/ S1 S2 D	(S1) ÷ (S2) → Quotient(D), Remainder(D+1)	⎍	7
		/P	/P S1 S2 D		⎍↑	7
BIN Multiplication and Division Instructions	32 bits	D*	D* S1 S2 D	(S1+1,S1) x (S2+1,S2) → (D+3,D+2,D+1,D)	⎍	11
		D* P	D*P S1 S2 D		⎍↑	11
		D/	D/ S1 S2 D	(S1+1,S1) ÷ (S2+1,S2) → Quotient(D+1,D), Remainder(D+3,D+2)	⎍	11
		D/P	D/P S1 S2 D		⎍↑	11
BCD Addition and Subtraction Instructions	4 digits	B+	B+ S D	(D) + (S) → (D)	⎍	7
		B+P	B+P S D		⎍↑	7
		B+	B+ S1 S2 D	(S1) + (S2) → (D)	⎍	9
		B+P	B+P S1 S2 D		⎍↑	9
		B—	B— S D	(D) - (S) → (D)	⎍	7
		B—P	B—P S D		⎍↑	7
		B—	B— S1 S2 D	(S1) - (S2) → (D)	⎍	9
		B—P	B—P S1 S2 D		⎍↑	9

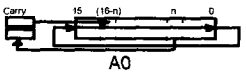
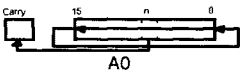
Classification	Unit	Instruction symbol	Symbol	Contents of processing	Execution condition	No. of steps
BCD Addition and Subtraction Instructions	digits	DB+	DB+ S D	(D+1,D) + (S+1,S) → (D+1,D)		9
		DB+P	DB+P S D			9
		DB+	DB+ S1 S2 D	(S1+1,S1) + (S2+1,S2) → (D+1,D)		11
		DB+P	DB+P S1 S2 D			11
		BD—	BD— S D	(D+1,D) - (S+1,S) → (D+1,D)		9
		BD—P	BD—P S D			9
		BD—	BD— S1 S2 D	(S1+1,S1) - (S2+1,S2) → (D+1,D)		11
		BD—P	BD—P S1 S2 D			11
BCD Multiplication and Division Instructions	4 digits	B*	B* S1 S2 D	(S1) x (S2) → (D+1,D)		9
		B*P	B*P S1 S2 D			9
		B/	B/ S1 S2 D	(S1) ÷ (S2) → Quotient(D), Remainder(D+1)		9
		B/P	B/P S1 S2 D			9
BCD Multiplication and Division Instructions	8 digits	BD*	BD* S1 S2 D	(S1+1,S1) x (S2+1,S2) → (D+3,D+2,D+1,D)		11
		BD* P	BD*P S1 S2 D			11
		BD/	BD/ S1 S2 D	(S1+1,S1) ÷ (S2+1,S2) → Quotient(D+1,D), Remainder(D+3,D+2)		11
		BD/P	BD/P S1 S2 D			11

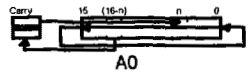
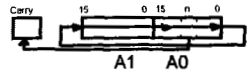
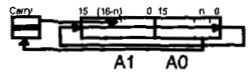
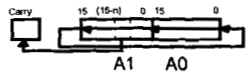
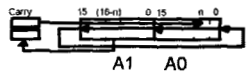
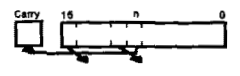
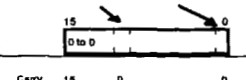
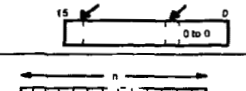
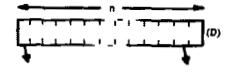
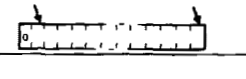
Classification	Unit	Instruction symbol	Symbol	Contents of processing	Execution condition	No. of steps
BIN data increment	16 bits	INC	INC Ⓓ	(D) + 1 → (D)		3
		INCP	INCP Ⓓ			3
	32 bits	DINC	DINC Ⓓ	(D+1,D) + 1 → (D+1,D)		3
		DINCP	DINCP Ⓓ			3
BIN data decrement	16 bits	DEC	DEC Ⓓ	(D) - 1 → (D)		3
		DECP	DECP Ⓓ			3
	32 bits	DDEC	DDEC Ⓓ	(D+1,D) - 1 → (D+1,D)		3
		DDECP	DDECP Ⓓ			3
BCD conversion	16 bits	BCD	BCD Ⓢ Ⓓ	BIN → BCD (S) → (D)		5
		BCDP	BCDP Ⓢ Ⓓ			5
	32 bits	DBCD	DBCD Ⓢ Ⓓ	BIN → BCD (S+1,S) → (D+1,D)		9
		DBCDP	DBCDP Ⓢ Ⓓ			9
BIN conversion	16 bits	BIN	BIN Ⓢ Ⓓ	BCD → BIN (S) → (D)		5
		BINP	BINP Ⓢ Ⓓ			5
	32 bits	DBIN	DBIN Ⓢ Ⓓ	BCD → BIN (S+1,S) → (D+1,D)		9
		DBINP	DBINP Ⓢ Ⓓ			9

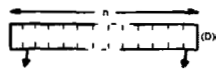
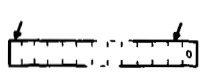
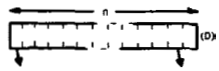
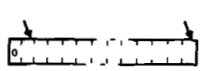
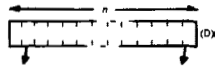
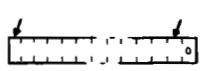
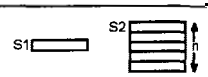
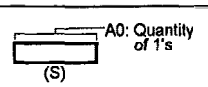
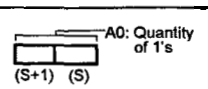
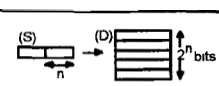
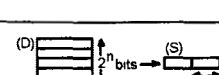
Classification	Unit	Instruction symbol	Symbol	Contents of processing	Execution condition	No. of steps
Transfer	16 bits	MOV	MOV (S) (D)	(S) → (D)		5
		MOVP	MOVP (S) (D)			5
	32 bits	DMOV	DMOV (S) (D)	(S+1,S) → (D+1,D)		7
		DMOVP	DMOVP (S) (D)			7
Negation transfer	16 bits	CML	CML (S) (D)	$\overline{(S)}$ → (D)		5
		CMLP	CMLP (S) (D)			5
	32 bits	DCML	DCML (S) (D)	$\overline{(S+1,S)}$ → (D+1,D)		7
		DCMLP	DCMLP (S) (D)			7
Block transfer	16 bits	BMOV	BMOV (S) (D) n	(S) → (D) | (S+n) → (D+n)		9
		BMOVP	BMOVP (S) (D) n			9
		FMOV	FMOV (S) (D) n	(S) → (D, D+1, ..., D+n)		9
		FMOVP	FMOVP (S) (D) n			9
Exchange	16 bits	XCH	XCH (D1) (D2)	(D1) ↔ (D2)		5
		XCHP	XCHP (D1) (D2)			5
	32 bits	DXCH	DXCH (D1) (D2)	(D1+1, D1) ↔ (D2+1, D2)		7
		DXCHP	DXCHP (D1) (D2)			7

List of application instructions

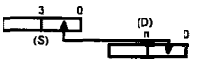
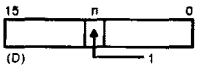
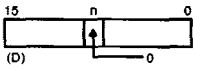
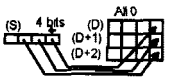
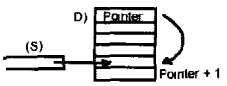
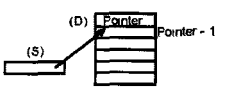
Classification	Unit	Instruction symbol	Symbol	Contents of processing	Execution condition	No. of steps
Logical product	16 bits	WAND	WAND (S) (D)	(D) AND (S) → (D)	⎍	5
		WANDP	WANDP (S) (D)		⎍↑	5
		WAND	WAND (S1) (S2) (D)	(S1) AND (S2) → (D)	⎍	7
		WANDP	WANDP (S1) (S2) (D)		⎍↑	7
	32 bits	DAND	DAND (S) (D)	(D+1, D) AND (S+1, S) → (D)	⎍	9
		DANDP	DANDP (S) (D)		⎍↑	9
Logical sum	16 bits	WOR	WOR (S) (D)	(D) OR (S) → (D)	⎍	5
		WORP	WORP (S) (D)		⎍↑	5
		WOR	WOR (S1) (S2) (D)	(S1) OR (S2) → (D)	⎍	7
		WORP	WORP (S1) (S2) (D)		⎍↑	7
	32 bits	DOR	DOR (S) (D)	(D+1, D) OR (S+1, S) → (D)	⎍	9
		DORP	DORP (S) (D)		⎍↑	9
Exclusive logical sum	16 bits	WXOR	WXOR (S) (D)	(D) XOR (S) → (D)	⎍	5
		WXORP	WXORP (S) (D)		⎍↑	5
		WXOR	WXOR (S1) (S2) (D)	(S1) XOR (S2) → (D)	⎍	7
		WXORP	WXORP (S1) (S2) (D)		⎍↑	7

Classification	Unit	Instruction symbol	Symbol	Contents of processing	Execution condition	No. of steps
Exclusive logical sum	32 bits	DXOR	DXOR (S) (D)	(D+1, D) XOR (S+1, S) → (D)		9
		DXORP	DXORP (S) (D)			9
NOT exclusive logical sum	16 bits	WXNR	WXNR (S) (D)	$\overline{(D) \text{ XOR } (S)}$ → (D)		5
		WXNRP	WXNRP (S) (D)			5
		WXNR	WXNR (S1) (S2) (D)	$\overline{(S1) \text{ XOR } (S2)}$ → (D)		7
		WXNRP	WXNRP (S1) (S2) (D)			7
	32 bits	DXNR	DXNR (S) (D)	$\overline{(D+1, D) \text{ XOR } (S+1, S)}$ → (D)		9
		DXNRP	DXNRP (S) (D)			9
2's complement	16 bits	NEG	NEG (D)	$\overline{(D)}$ +1 → (D)		3
		NEGP	NEGP (D)			3
Rightward rotation	16 bits	ROR	ROR (D)			3
		RORP	RORP (D)	"n" bit rotate to right		3
		RCR	RCR (D)			3
		RCRP	RCRP (D)	"n" bit rotate to right		3
Leftward rotation	16 bits	ROL	ROL (D)			3
		ROLP	ROLP (D)	"n" bit rotate to left		3

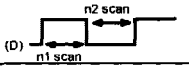
Classification	Unit	Instruction symbol	Symbol	Contents of processing	Execution condition	No. of steps
Leftward rotation	16 bits	RCL	RCL Ⓓ	 "n" bit rotate to left		3
		RCLP	RCLP Ⓓ			3
Rightward rotation	32 bits	DROR	DROR Ⓓ	 "n" bit rotate to right		3
		DRORP	DRORP Ⓓ			3
		DRCR	DRCR Ⓓ	 "n" bit rotate to right		3
		DRCRP	DRCRP Ⓓ			3
Leftward rotation	32 bits	DROL	DROL Ⓓ	 "n" bit rotate to left		3
		DROLP	DROLP Ⓓ			3
		DRCL	DRCL Ⓓ	 "n" bit rotate to left		3
		DRCLP	DRCLP Ⓓ			3
n bit shift	16 bits	SFR	SFR Ⓓ n			5
		SFRP	SFRP Ⓓ n			5
		SFL	SFL Ⓓ n			5
		SFLP	SFLP Ⓓ n			5
1 bit shift	n bit	BSFR	BSFR Ⓓ n			7
		BSFRP	BSFRP Ⓓ n			7

Classification	Unit	Instruction symbol	Symbol	Contents of processing	Execution condition	No. of steps
1 bit shift	n bit	BSFL	BSFL (D) n			7
		BSFLP	BSFLP (D) n			7
1 word shift	n word	DSFR	DSFR (D) n			7
		DSFRP	DSFRP (D) n			7
		DSFL	DSFL (D) n			7
		DSFLP	DSFLP (D) n			7
Data search	16 bits	SER	SER (S1) (S2) (D)			9
		SERP	SERP (S1) (S2) (D)	A0: Coinciding number A1: Coinciding quantity		9
		SUM	SUM (S)			3
		SUMP	SUMP (S)			3
		DSUM	DSUM (S)			3
		DSUMP	DSUMP (S)			3
		DECO	DECO (S) (D) n			9
		DECOP	DECOP (S) (D) n	8 → 256 Decode		9
		ENCO	ENCO (S) (D) n			9
		ENCOP	ENCOP (S) (D) n	256 → 8 Encode		9

PROGRAMMING

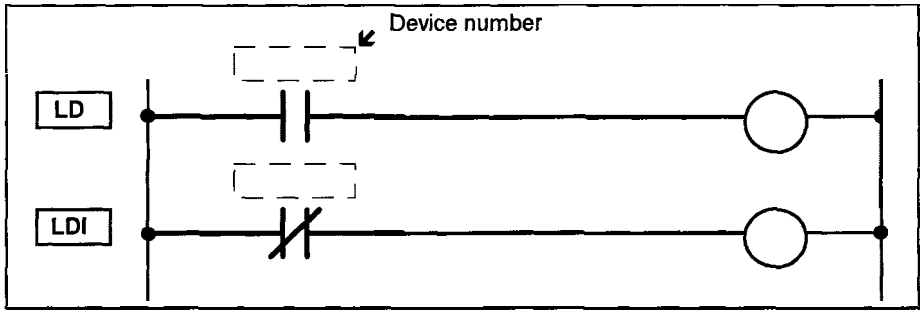
Classification	Unit	Instruction symbol	Symbol	Contents of processing	Execution condition	No. of steps
7 segment decode	16 bit	SEG	SEG (S) (D)			7
Bit set/reset	16 bits	BSET	BSET (D) n			7
		BSETP	BSETP (D) n			7
		BRST	BRST (D) n			7
		BRSTP	BRSTP (D) n			7
Association/ Dissociation	16 bits	DIS	DIS (S) (D) n	 When n=3		9
		DISP	DISP (S) (D) n			9
		UNI	UNI (S) (D) n	 When n=3		9
		UNIP	UNIP (S) (D) n			9
ASCII conversion	—	ASC	ASC Alphanumeric character (D)	Converts alphanumeric character into ASCII codes and stores into 4 points beginning with the device D		13
FIFO instructions	16 bits	FIFW	FIFW (S) (D)	 FIFO write		7
		FIFWP	FIFWP (S) (D)			7
		FIFR	FIFR (S) (D)	 FIFO read		7
		FIFRP	FIFRP (S) (D)			7
Buffer memory access	1 word	FROM	FROM (n1) (n2) (D) (n3)	Reads data from special function module		9
		FROMP	FROMP (n1) (n2) (D) (n3)			9

Classification	Unit	Instruction symbol	Symbol	Contents of processing	Execution condition	No. of steps
Buffer memory access	2 words	DFRO	DFRO (n1) (n2) (D) (n3)	Reads data from the special function modules		11
		DFROP	DFROP (n1) (n2) (D) (n3)			11
	1 word	TO	TO (n1) (n2) (D) (n3)	Writes data to the special function modules		9
		TOP	TOP (n1) (n2) (D) (n3)			9
	2 words	DTO	DTO (n1) (n2) (D) (n3)			11
		DTOP	DTOP (n1) (n2) (D) (n3)			11
Local station read/write	1 word	LRDP	LRDP (n1) (S) (D) (n2)	Reads data from local station		11
		LWTP	LWTP (n1) (D) (S) (n2)	Writes data to local station		11
Remote I/O station read/write		RFRP	RFRP (n1) (n2) (D) (n3)	Reads data from the special function module in remote I/O station		11
		RTOP	RTOP (n1) (n2) (D) (n3)	Writes data to special function module in remote I/O station		11
ASCII print	—	PR	PR (S) (D)	Outputs ASCII codes from the specified devices to the output module.		7
		PR	PR (S) (D)	Outputs ASCII codes sequentially from the specified devices to the output module until NULL (00H) is given		7
		PRC	PRC (S) (D)	Converts the comment in the specified device into ASCII code and outputs to the output module.		7
Display reset	—	LEDR	LEDR	Resets the display function		1
WDT reset	—	WDT	WDT	WDT is reset in sequence program		1
		WDTP	WDTP			1

Classification	Unit	Instruction symbol	Symbol	Contents of processing	Execution condition	No. of steps
Status latch	—	SLT	SLT	At the condition set by the parameter setting, data stored into memory for status latch		1
		SLTR	SLTR	Status latch is reset and SLT instruction is enabled		1
Sampling trace	—	STRA	STRA	At the condition set by the parameter setting, sampling data are stored into memory for status latch		1
		STRAR	STRAR	Sampling trace is resumed, STRA instruction is enabled		1
Carry	1 bit	STC	STC	Carry flag contact (M9012) is turned ON		1
		CLC	CLC	Carry flag contact (M9012) is turned OFF		1
Timing clock	1 bit	DUTY	DUTY n1 n2 D			7

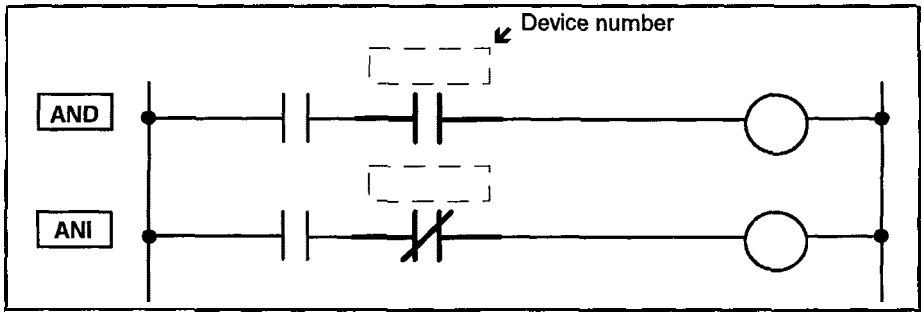
Sequence instruction description

Contact instructions
Operation start, series connection, parallel connection (LD, LDI, AND, ANI, OR, ORI)



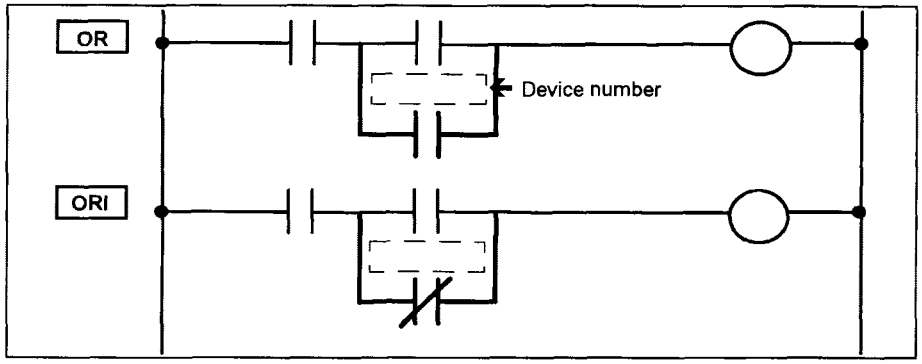
(a) LD, LDI

LD is a normally open contact start operation instruction and LDI is a normally closed start operation instruction. They use the ON/OFF data of the specified device and use this data as an operation result.



(b) AND, ANI

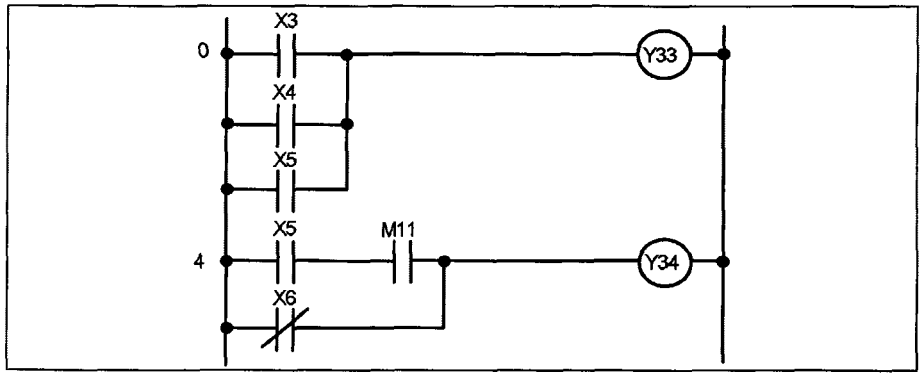
AND is a normally open contact series connection instruction and ANI is a normally closed contact series connection instruction. They use the ON/OFF data of the specified device, perform the AND/ANI operation using this data and the previous operation result. A new operation result is then produced.



(c) OR, ORI

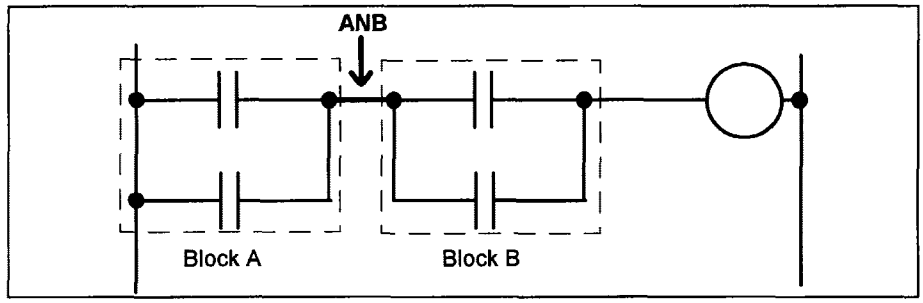
OR is a normally open contact parallel connection instruction and ORI is the normally closed contact parallel connection instruction. They use the ON/OFF data of the specified device, perform the OR/ORI operation using this data and the previous operation result. A new operation result is then produced.

Below is an example ladder logic program and its equivalent sequence instruction list using the instructions described in this section.



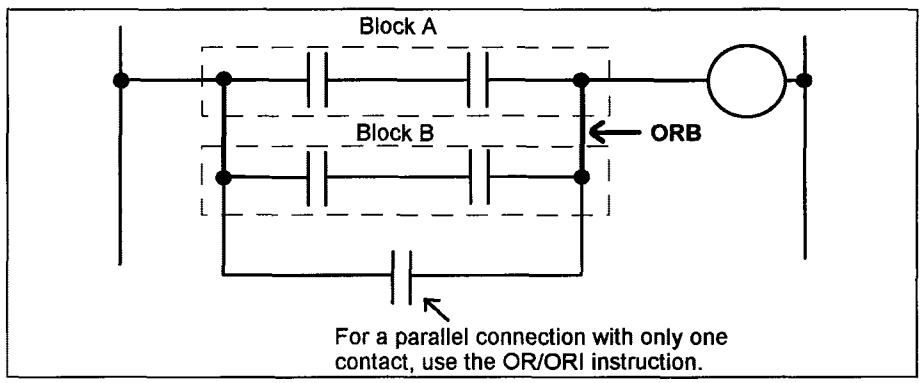
Step Number	Instruction	Device
0	LD	X3
1	OR	X4
2	OR	X5
3	OUT	Y33
4	LD	X5
5	AND	M11
6	ORI	X6
7	OUT	Y34
8	END	

Connection instructions
Ladder block series connection and parallel connection (ANB, ORB)



(a) ANB

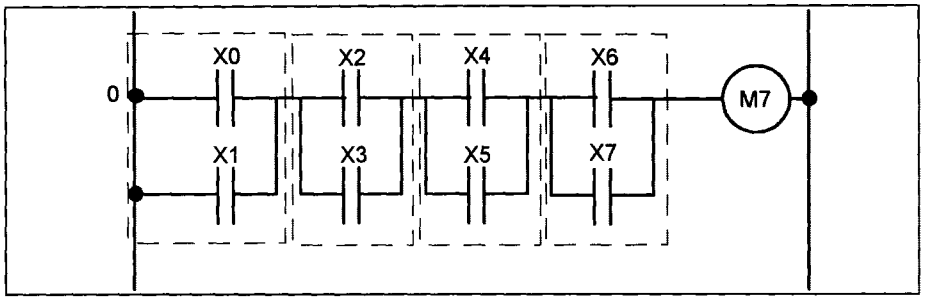
The ANB instruction performs an AND operation for blocks A and block B, and uses it as an operation result. The symbol of ANB is not a contact symbol but a connection symbol. A maximum of 7 ANB instructions can be written consecutively.



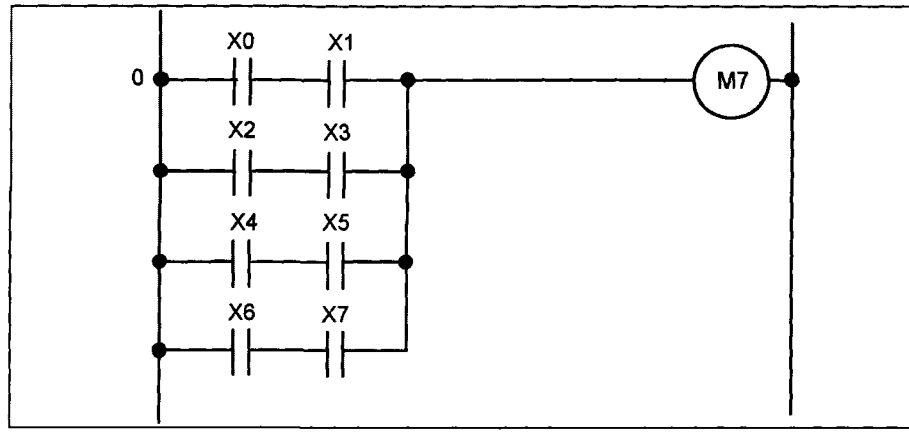
(b) ORB

The ORB instruction performs the OR operation of block A and block B, and uses it as an operation result. The ORB instruction only performs parallel connection of circuit blocks with two or more contacts. For parallel connection of circuit blocks with only one contact, the OR and ORI instructions should be used. The symbol of ORB is not a contact symbol but a connection symbol. A maximum of 7 ORB instructions can be written consecutively.

Below is examples of ladder logic programs and their equivalent sequence instruction lists using the instructions described in this section.

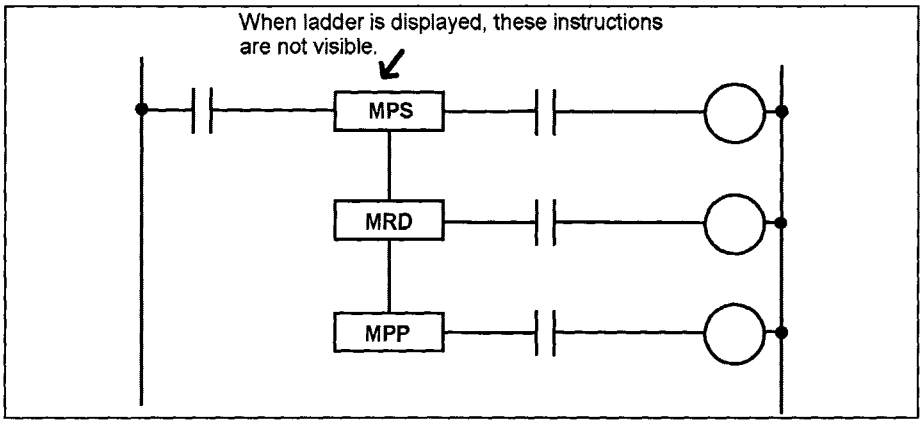


Step Number	Instruction	Device
0	LD	X0
1	OR	X1
2	LD	X2
3	OR	X3
4	ANB	
5	LD	X4
6	OR	X5
7	ANB	
8	LD	X6
9	OR	X7
10	ANB	
11	OUT	M7
12	END	



Step Number	Instruction	Device
0	LD	X0
1	AND	X1
2	LD	X2
3	AND	X3
4	ORB	
5	LD	X4
6	AND	X5
7	ORB	
8	LD	X6
9	AND	X7
10	ORB	
11	OUT	M7
12	END	

Operation result push, read, pop (MPS, MRD, MPP)



(a) MPS

The MPS instruction stores the operation result (ON/OFF) immediately preceding the MPS instruction. A maximum of 12 MPS instructions can be used consecutively, however if an MPP instruction is used in between the MPS instructions, the maximum number is reduced by 1.

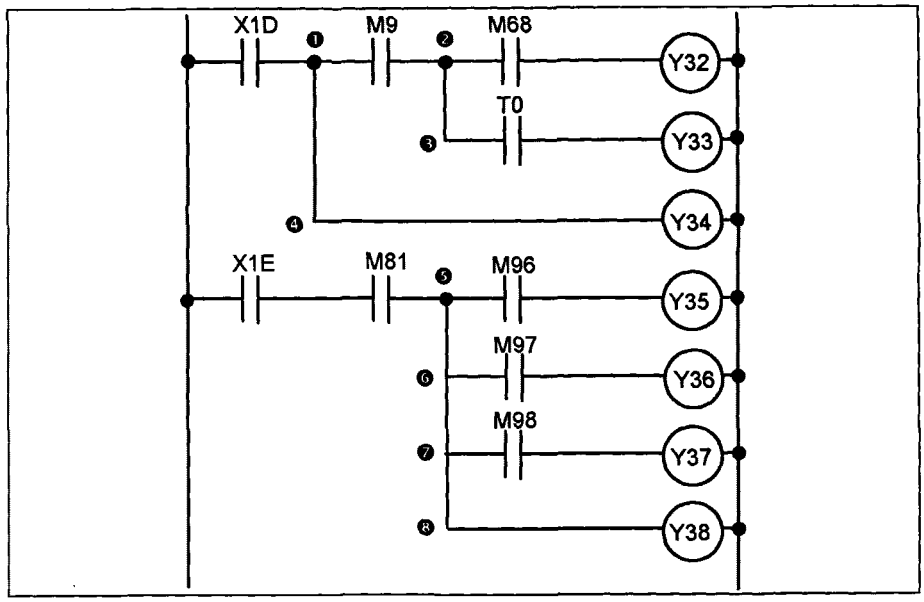
(b) MRD

The MRD instruction reads the operation result stored by the MPS instruction, and resumes the operation with that operation result, starting at the next step.

(c) MPP

The MPP instruction reads the operation result stored by the MPS instruction, and resumes the operation with that operation result, starting at the next step. The it clears the operation result stored by the MPS instruction.

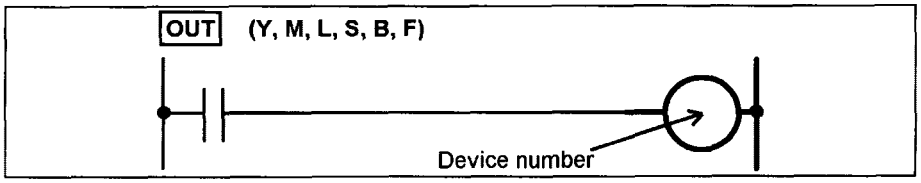
On the following page there is an example ladder logic program and its equivalent sequence instruction list using the instructions described in this section.



	Step Number	Instruction	Device
	0	LD	X1D
❶	1	MPS	
	2	AND	M9
❷	3	MPS	
	4	AND	M68
	5	OUT	Y32
❸	6	MPP	
	7	AND	T0
	8	OUT	Y33
❹	9	MPP	
	10	OUT	Y34
	11	LD	X1E
	12	AND	M81
❺	13	MPS	
	14	AND	M96

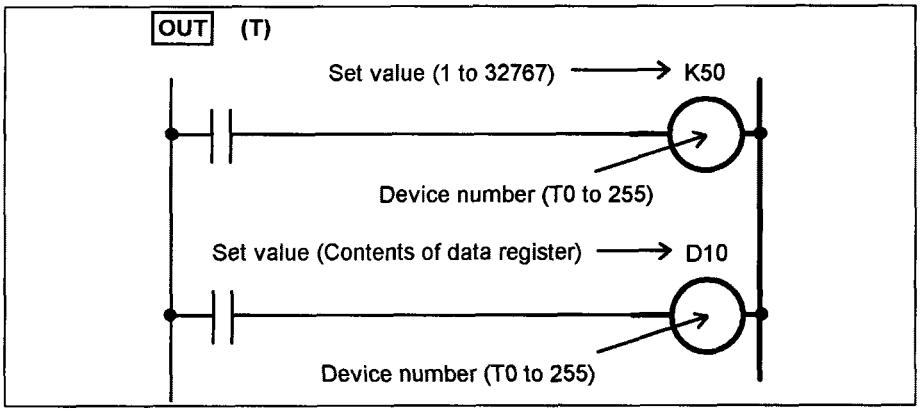
	15	OUT	Y35
❻	16	MRD	
	17	AND	M97
	18	OUT	Y36
❼	19	MRD	
	20	AND	M98
	21	OUT	Y37
❽	22	MPP	
	23	OUT	Y38
	24	END	

Output instructions
Bit device, timer, counter output (OUT)



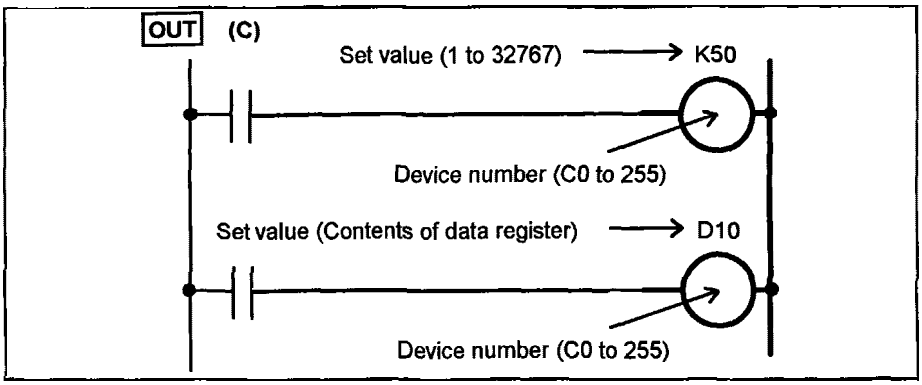
(a) OUT (Y, M, L, S, B, F)

This OUT instruction outputs the operation result for the instructions preceding the OUT instruction.



(b) OUT (T)

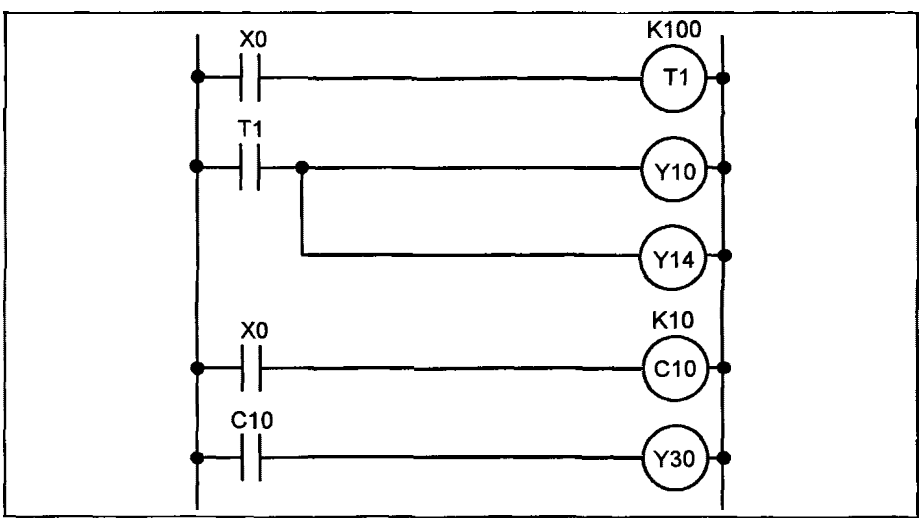
This OUT instruction uses the operation result for the instructions preceding the OUT instruction. If the operation result is ON, then the coil of the timer is turned ON and the timer counts up to its set value. When the operation result of the instructions preceding the OUT instruction changes from ON to OFF, the following occurs



(c) OUT (C)

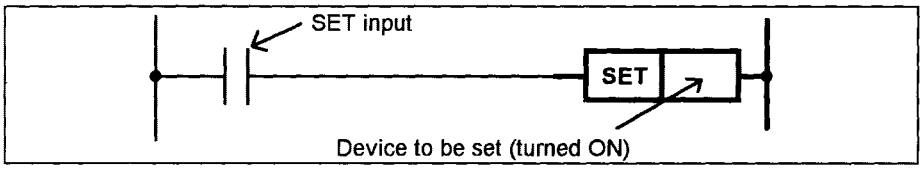
When the operation result from the instructions preceding the OUT instruction have changed from OFF to ON, 1 is added to the present value (count value). When the counter has counted out (count value = set value), the state counter contact is then turned ON for normally open contacts, and turned OFF for normally closed contacts. When the operation result of the instructions preceding the OUT instruction remain ON, counting is not performed (count inputs do not need to be converted to pulse inputs). After the counter has counted out, the count value and the status contact do not change until the RST instruction for the counter is executed.

An example program using all of the OUT instructions described in this section is shown below.



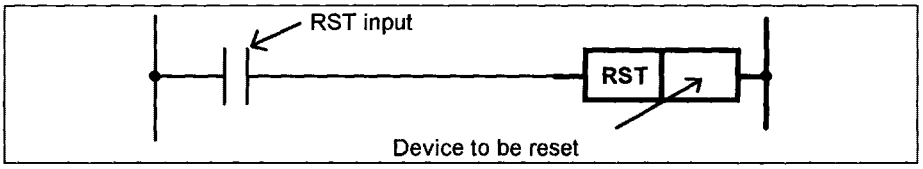
Step Number	Instruction	Device
0	LD	X0
1	OUT	T1 K100
2	LD	T1
3	OUT	Y10
4	OUT	Y14
5	LD	X0
6	OUT	C10 K10
7	LD	C10
8	OUT	Y30
9	END	

Bit device set, reset (SET, RST)



(a) SET

When the operation result from the instructions preceding the SET instruction is ON, the specified device is turned ON, The device which is turned ON, remains ON even if the operation result turns OFF. The devices can be turned OFF by the RST instruction.



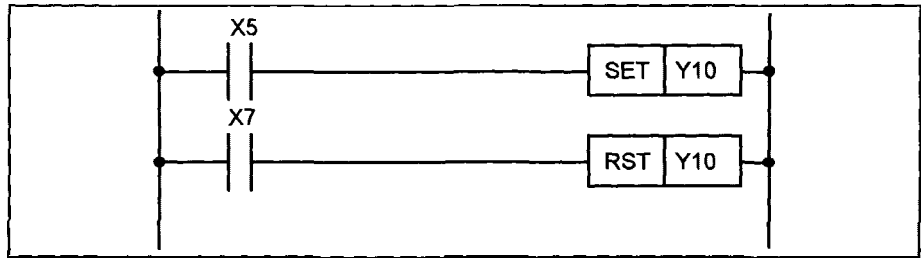
(b) RST

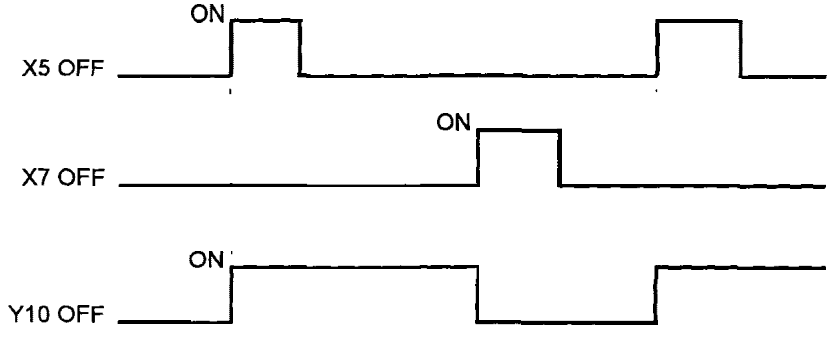
When the operation result from the instructions preceding the RST instruction is ON, the specified device changes according to the table below.

Device	Status
Y, M, L, S, B, F	Coil and contact are turned OFF.
T, C	Present value is set to 0, and coil and contact are turned OFF.
D, W, R, A0, A1, Z, V	Contents is set to 0

When the operation result is OFF, the status of the device does not change.

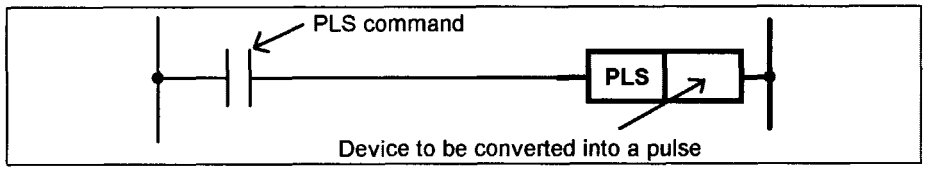
An example of a program containing the SET and RST instructions is shown on the following page, along with a timing chart explaining the operation of the program.





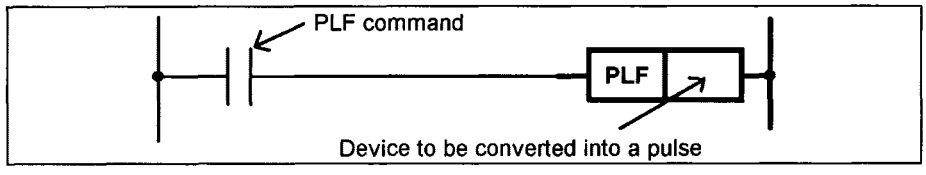
Step Number	Instruction	Device
0	LD	X5
1	SET	Y10
2	LD	X7
3	RST	Y10
	END	

Edge-triggered differential output (PLS, PLF)



(a) PLS

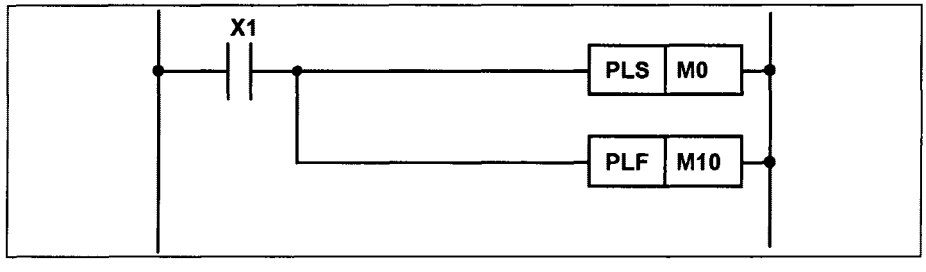
The PLS instruction turns the specified device ON for one scan of the sequence program when the operation result from the preceding instructions changes from OFF to ON. If the device is already in the ON state then the PLS instruction will turn the device OFF for one sequence program scan.

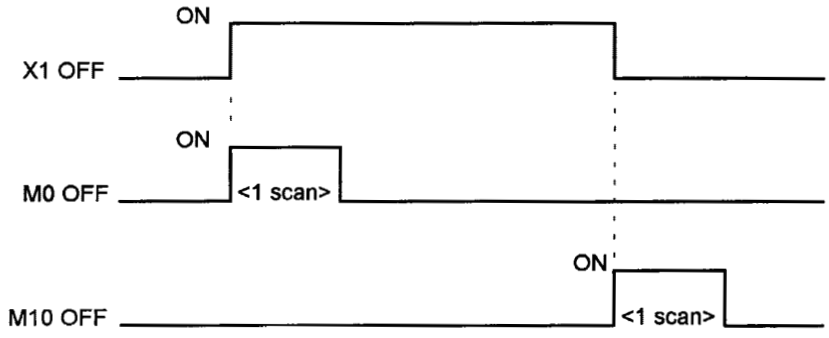


(b) PLF

The PLF instruction turns the specified device ON for one scan of the sequence program when the operation result from the instructions preceding the PLF instruction changes from ON to OFF. If the specified device status is already ON, then the PLF instruction turns the specified device OFF for one scan of the sequence program.

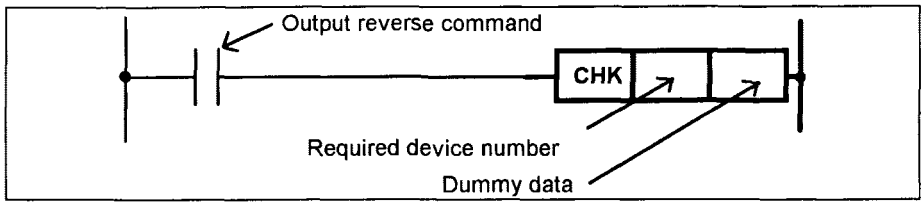
Examples of the PLS and PLF instruction are shown below





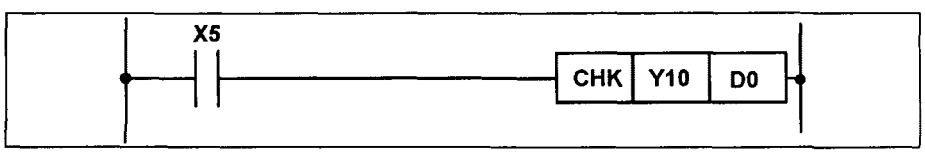
Step Number	Instruction	Device
0	LD	X1
1	PLS	M0
2	PLF	M10
3	END	

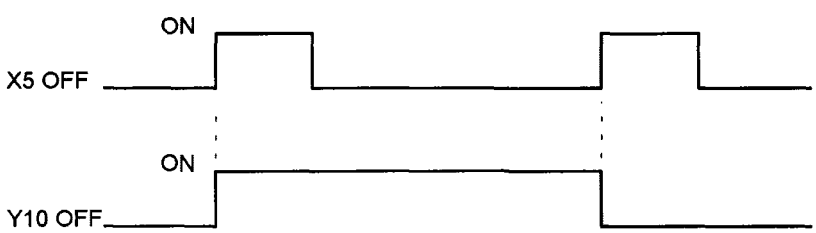
Bit device output reverse (CHK)



The CHK instruction has two functions, one which operates when the CPU is in refresh mode (default), and the other when the CPU is in direct mode. When the CPU is in refresh mode the specified device (D1), has its output status reversed when the operation result from the preceding devices turns from OFF to ON. Dummy data needs to be input for (D2), however the status of the device specified by (D2) is unchanged and can be used freely throughout the sequence program. When the CPU is in direct mode the CHK instruction carries out a 'failure check'. This function is classified as an application instruction and is described in the relevant section of the programming manual.

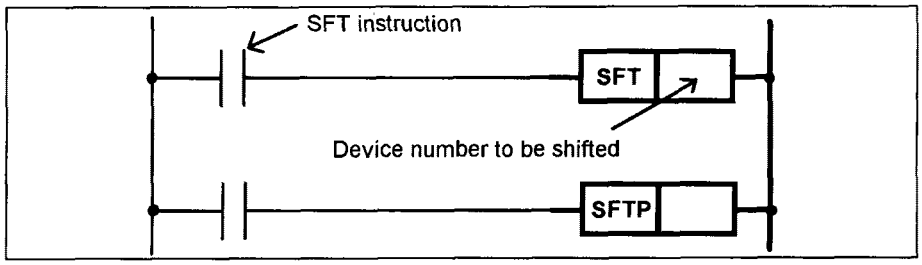
An example of the CHK instruction is shown below





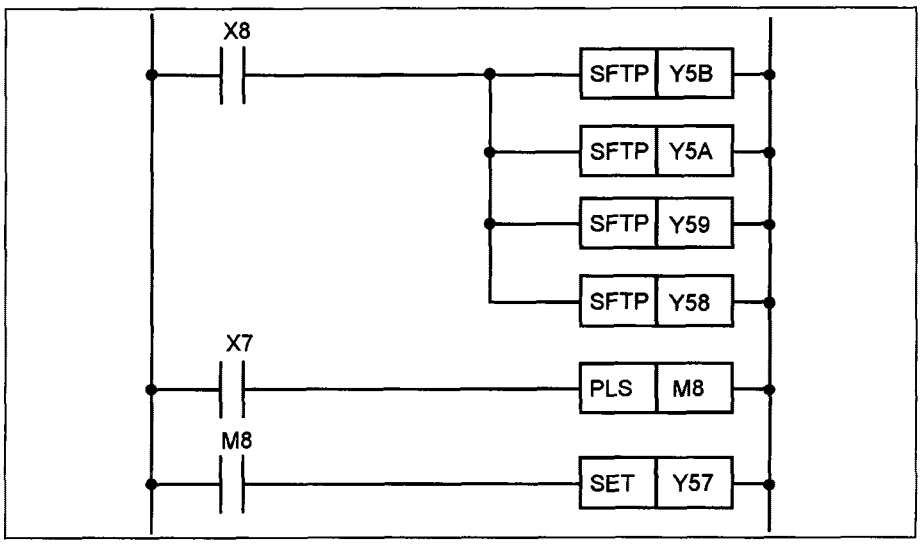
Step Number	Instruction	Device
0	LD	X1
1	CHK	Y10 D0
6	END	

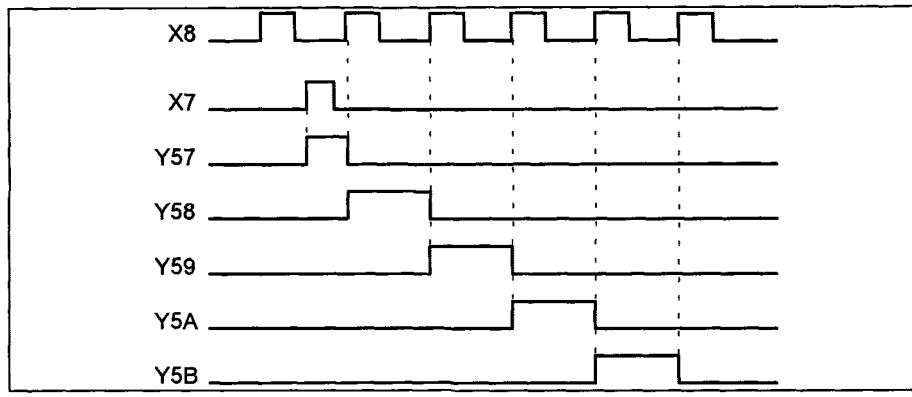
Shift instructions
Bit device shift (SFT, SFTP)



The SFT, SFTP instructions shift the ON/OFF status of the specified device number - 1, to the specified device number and turns OFF the device with the lower number. To turn ON the head device to be shifted, use the SET instruction. When the SFT of SFTP instruction is used consecutively, program the higher device numbers first so as not to overwrite the original data before shifting.

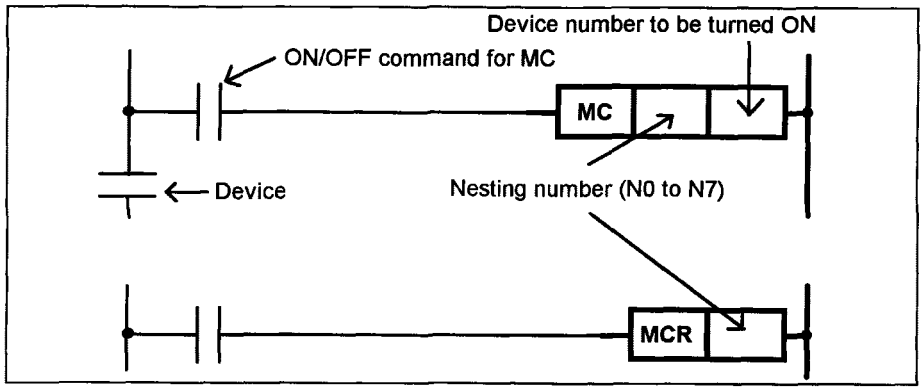
An example of the SFT/SFTP instruction is shown below





Step Number	Instruction	Device
0	LD	X8
1	SFTP	Y5B
4	SFTP	Y5A
7	SFTP	Y59
10	SFTP	Y58
13	LD	X7
14	PLS	M8
17	LD	M8
18	SET	Y57
19	END	

Master control instructions
Master control set, reset (MC, MCR)



MC

The MC instruction is used to allow the sequence program to perform efficient circuit switching by opening and closing the common bus circuits. MC is the master control start instruction, when the ON/OFF command for the MC is ON, operation results from MC to MCR remain unchanged. Scanning between the MC and MCR instructions is executed even when the ON/OFF command for the MC instruction is OFF. Scan time does not therefore become shorter. When the ON/OFF command for the MC instruction is OFF, the operation result of MC to MCR is as indicated below

100 ms, 10 ms timers	100 ms retentive timer and counter	OUT instruction	SET/RST and SFT
Time value is set to 0	Remains at present value	All turn OFF	Status is held

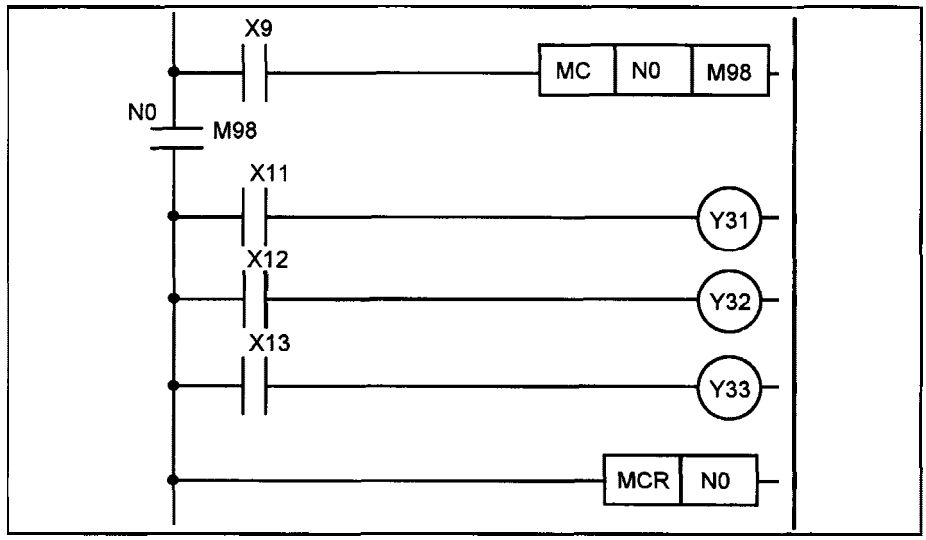
The MC instruction can use the same nesting N number repeatedly by changing the specified device number. When the MC instruction is ON, the coil of the specified device is turned ON. If a device is used twice for the OUT instruction, it is treated as a duplicated coil. To avoid this, do not use the specified device in other instructions.

MCR

The MCR instruction is a master control reset, and indicates the end of a master control range. Do not use a contact instruction before the MCR instruction

The MC instructions can be used by nesting. The range of each MC instruction is identified by a nesting number. Nesting numbers are used in the range of N0 to N7. Using nesting, circuits which sequentially restrict execution conditions of a program can be made.

An example of a program which uses the nesting of MC instructions is shown on the following page.



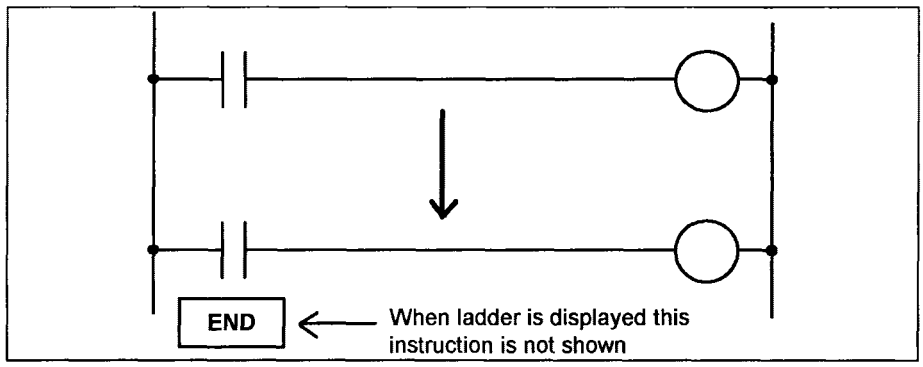
Step Number	Instruction	Device
0	LD	X9
1	MC	N0 M98
6	LD	X11
7	OUT	Y31
8	LD	X12
9	OUT	Y32
10	LD	X13
11	OUT	Y33
12	MCR	N0
15	END	

Termination instructions

Main routine program termination (FEND)

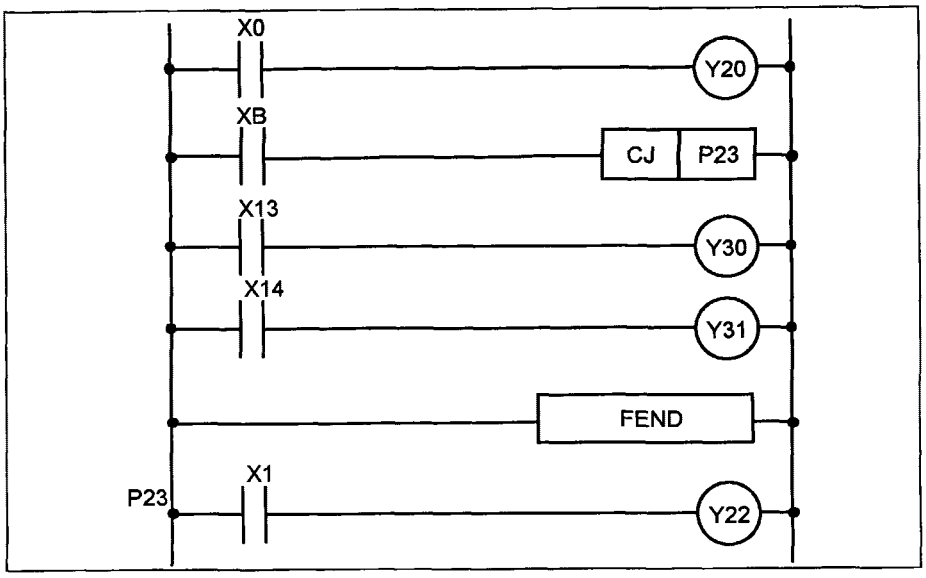
The FEND instruction terminates the main routine program. When the FEND instruction is executed, the PLC returns to step 0 after completion of the timer/counter processing, self diagnostic processing etc. and resumes operation from step 0. The sequence program located after the FEND instruction can be used for sub routines and interrupt programs which are called up from the main routine program.

An example of the FEND instruction used in conjunction with a conditional jump instruction is shown on the following page



Sequence program termination (END)

The END instruction indicates the end of program. At this step the scan returns to step 0. The END instruction cannot be used midway through a sequence program or sub sequence program. If END processing is necessary halfway through the program, use the FEND instruction. If the END instruction is not given in the program, operation error occurs and the PLC does not run.



Step Number	Instruction	Device
0	LD	X0
1	OUT	Y20
2	LD	XB
3	CJ	P23
6	LD	X13
7	OUT	Y30
8	LD	X14
9	OUT	Y31
10	FEND	
11	P23	
12	LD	X1
13	OUT	Y22
14	END	

Other instructions

Sequence program stop (STOP)

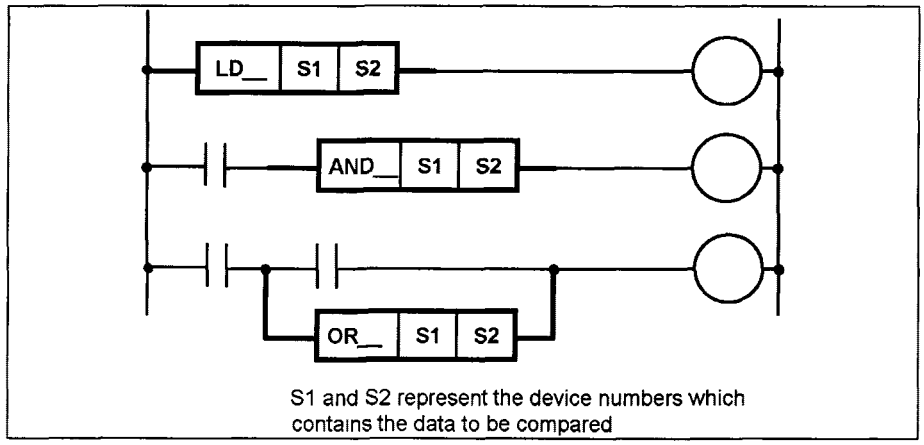
When the stop input turns ON, the outputs Y are reset and the operation of the PLC is stopped (the same function as when the RUN key switch on the CPU module is turned to the STOP position). When the STOP instruction is executed, bit 8 of the special register D9015 is set to 1. To resume operation of the PLC after execution of a STOP instruction, move the RUN key switch to the STOP position, and then back to the RUN position again. Do not use the STOP instruction in interrupt programs, subroutine or FOR/NEXT loops, else an operation error occurs.

Basic instruction descriptions.

The basic instructions are used for handling numeric data expressed in 16 bits or 32 bits, and they can be classified in to groups of instruction as shown below. A description of each of these groups, along with examples, can be found in the following pages of this section.

Comparison operation instructions, Arithmetic operation instructions, BCD/BIN conversion instructions, and Data transfer instructions.

Comparison operation instructions



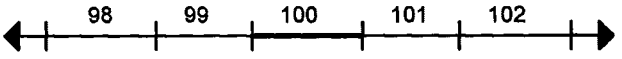
The comparison operation instructions make numerical magnitude comparisons (such as =, >>, << etc.) between two pieces of data. They are handled as a contact, and turn ON when the preceding condition is true. The application of comparison instructions is the same as that of a contact instruction for the corresponding sequence instruction as indicated below

LD, LDI (LD =, LDD =), AND, ANI (AND =, ANDD =), OR, ORI (OR =, ORD =)

There are 36 different types of comparison operation, combined in to 6 main groups.

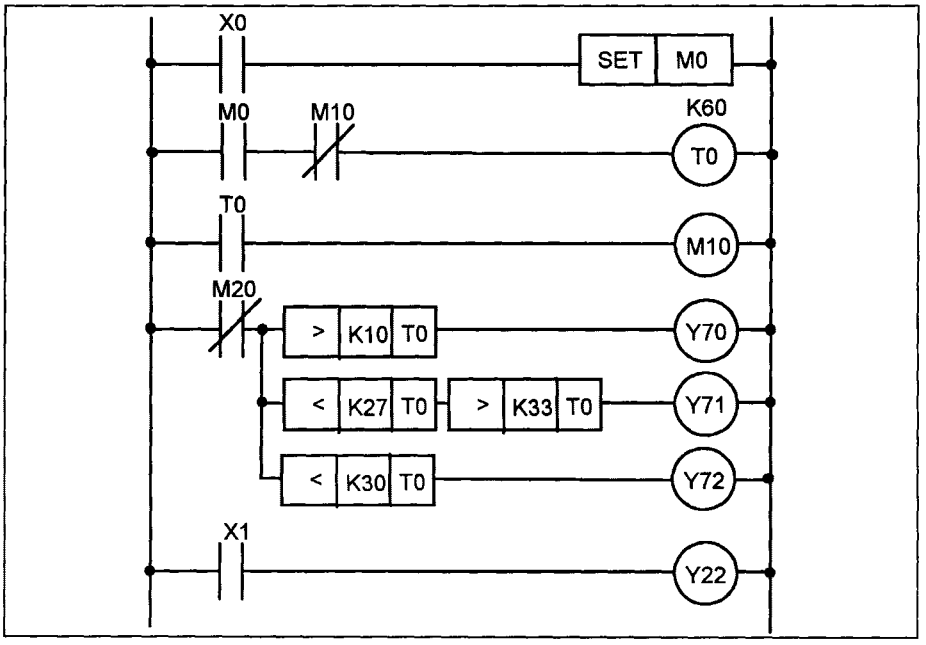
Group	Instruction Symbol	Group	Instruction Symbol	Group	Instruction Symbol
=	LD=	>	LD>	<	LD<
	AND=		AND>		AND<
	OR=		OR>		OR<
	LDD=		LDD>		LDD<
	ANDD=		ANDD>		ANDD<
	ORD=		ORD>		ORD<
<>	LD<>	<=	LD<=	>=	LD>=
	AND<>		AND<=		AND>=
	OR<>		OR<=		OR>=
	LDD<>		LDD<=		LDD>=
	ANDD<>		ANDD<=		ANDD>=
	ORD<>		ORD<=		ORD>=

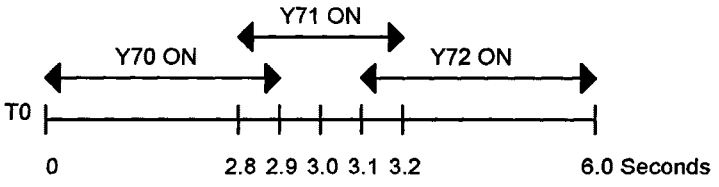
The conditions by which these groups of comparison instruction operate is shown below.



Dn=K100	OFF	ON	OFF
Dn<>K100	ON	OFF	ON
Dn>K100	OFF		ON
Dn<=K100	ON		OFF
Dn<K100	ON	OFF	
Dn>=K100	OFF	ON	

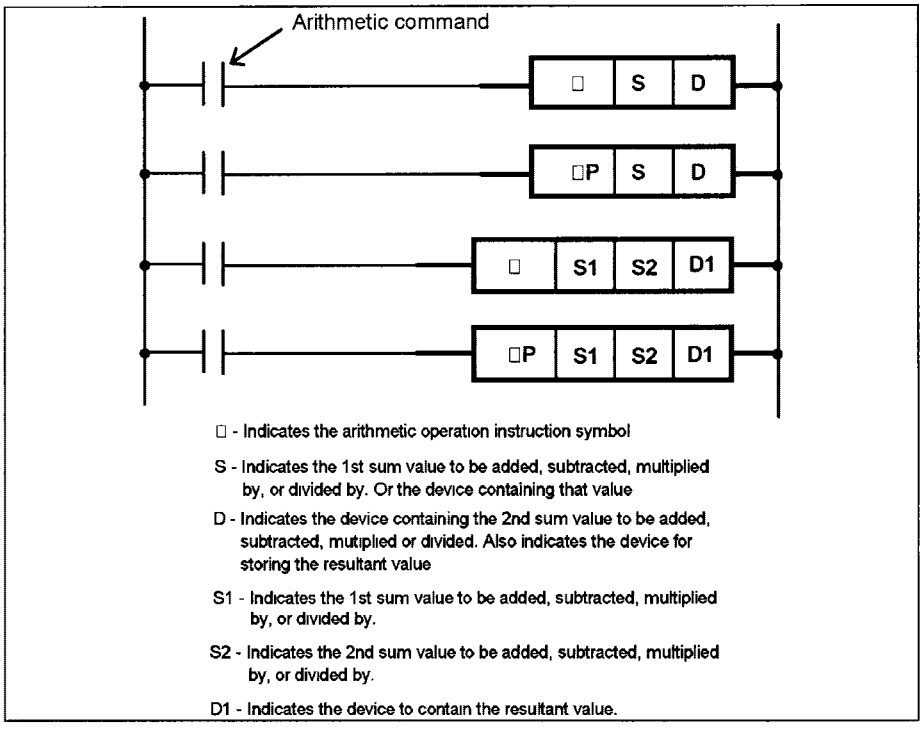
Below is an example program which uses some comparison instruction to indicate the current value the current value of the timer T0 by turning ON outputs Y070, Y071 and Y072 at three different settings.





Step Number	Instruction	Device
0	LD	X0
1	SET	M0
2	LD	M0
3	ANI	M10
4	OUT	T0 K60
5	LD	T0
6	OUT	M10
7	LDI	M20
8	AND>	K30 T0
13	OUT	Y70
14	AND<	K27 T0
19	AND>	K33 T0
24	OUT	Y71
25	AND<	K30 T0
30	OUT	Y72
31	LD	X1
32	RST	M0
33	END	

Arithmetic operation instructions

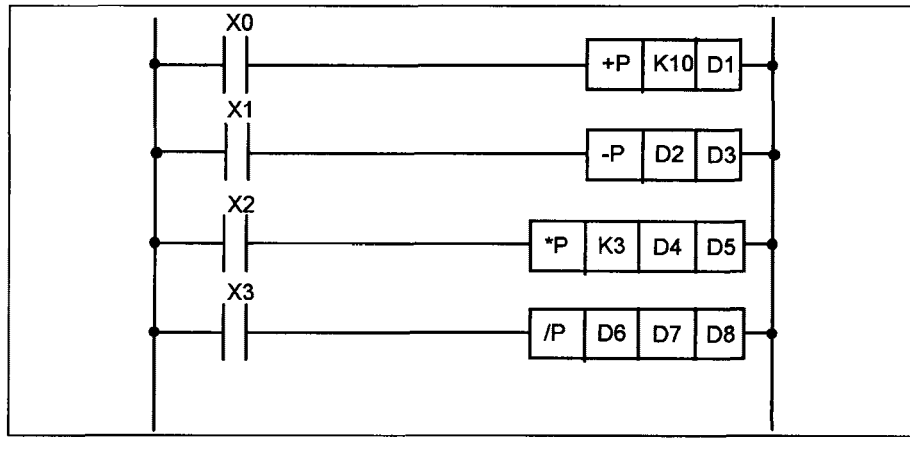


The arithmetic operation instructions are instructions which perform addition, subtraction, multiplication, and division of both BIN and/or BCD data. There are a total of 56 types of arithmetic operation as shown below.

Group	BIN Data Instruction Symbol	BCD Data Instruction Symbol
+	+	B+
	+P	B+P
	D+	DB+
	D+P	DB+P
-	-	B-
	-P	B-P
	D-	DB-
	D-P	DB-P

Group	BIN Data Instruction Symbol	BIN Data Instruction Symbol
*	*	B*
	*P	B*P
	D*	DB*
	D*P	DB*P
/	/	B/
	/P	B/P
	D/	DB/
	D/P	DB/P
+1 (Increment)	INC	
	INCP	
	DINC	
	DINCP	
-1 (Decrement)	DEC	
	DECP	
	DDEC	
	DDECP	

Below is an example of a program which uses some of the arithmetic instructions described in this section.



X0 ON: K10 + D1 = D1 (10 + 30 = 40)

X1 ON: D2 + D3 = D3 (40 - 20 = 20)

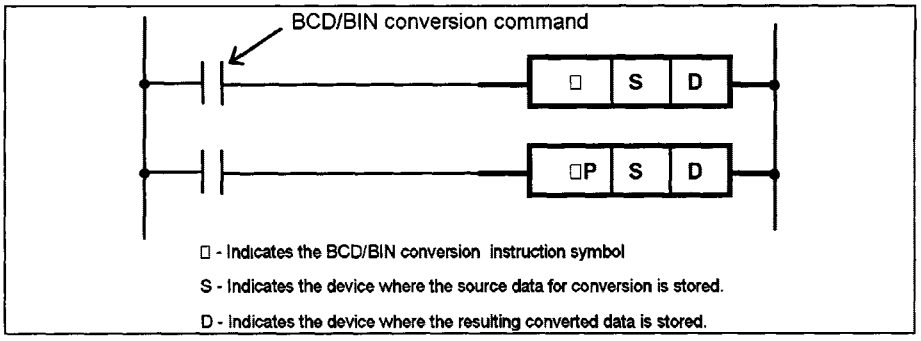
X2 ON: K3 x D4 = D5 (3 x 10 = 30)

X3 ON: D6 / D7 = D8 (80 / 20 = 4)

Step Number	Instruction	Device
0	LD	X0
1	+P	K10 D1
6	LD	X1
7	-P	D2 D3
12	LD	X2
13	*P	K3 D4 D5
20	LD	X3
21	/P	D5 D6 D7
28	END	

BCD/BIN conversion instructions

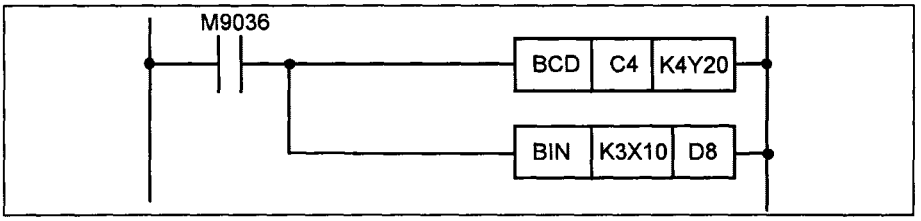
BCD BIN



There are 8 different types of BCD/BIN conversion instruction split in to two groups. One group which converts from BCD to BIN, and the other group which converts from BIN to BCD.

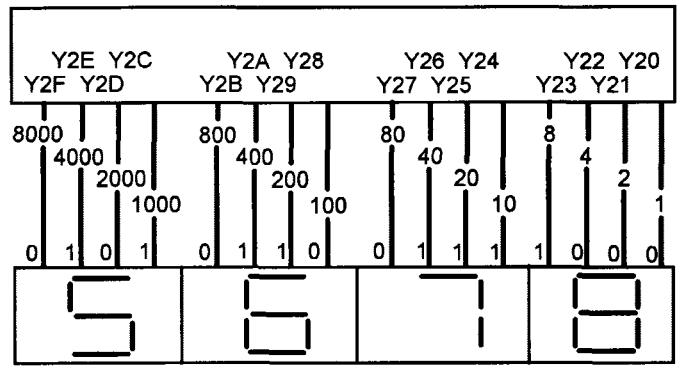
Group	Instruction Symbol	Group	Instruction Symbol
BCD	BCD	BIN	BIN
	BCDP		BINP
	DBCD		DBIN
	DBCDP		DBINP

Some examples of the BCD/BIN conversion instructions are shown below



PLC output module

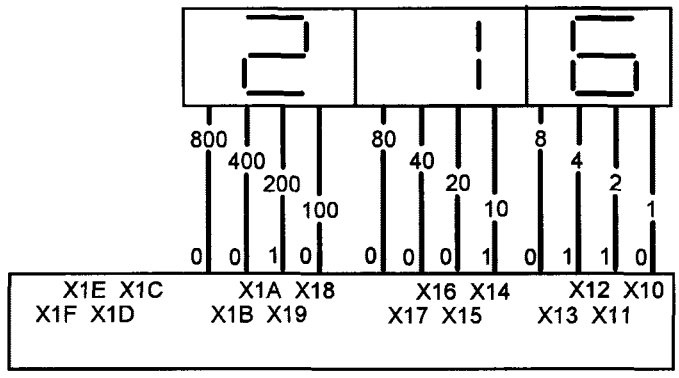
BCD



7 segment display

Digital switches (BCD)

BIN

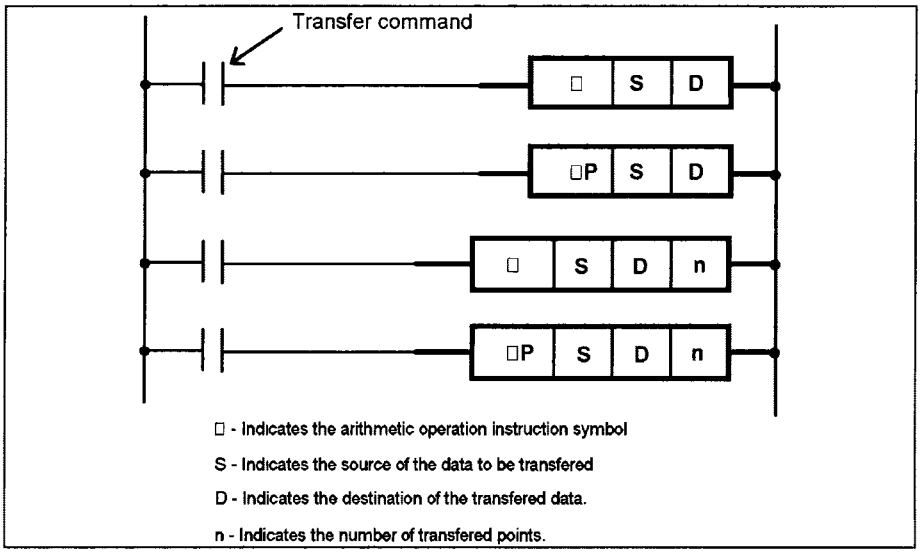


PLC input module

Step Number	Instruction	Device
0	LD	M9036
1	BCD	C2 K4Y20
6	BIN	K3X10 D8
11	END	

Data transfer instructions

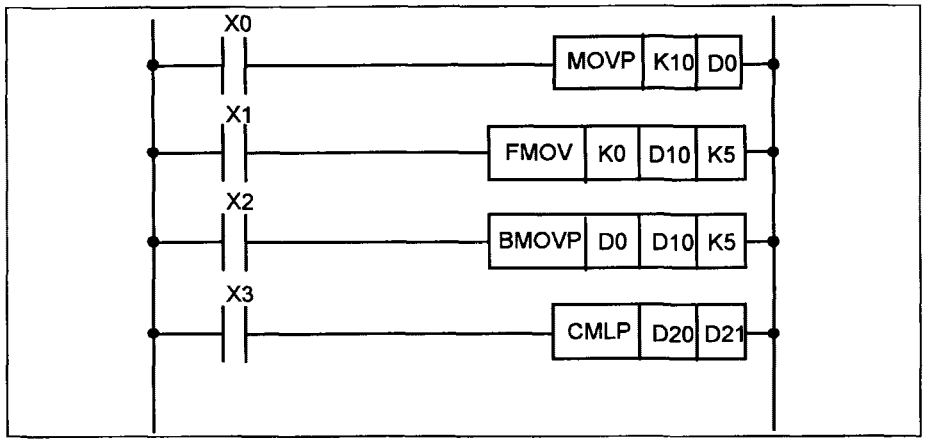
MOV CML BMOV FMOV XCH



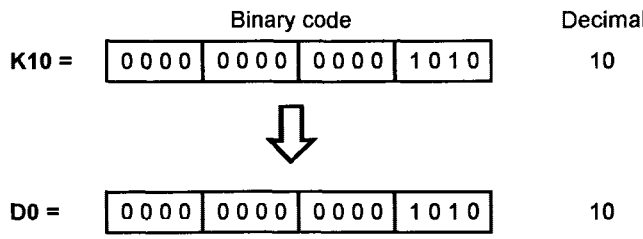
The data transfer instructions are instructions which perform data transfer, interchanging data, negative (reverse) data transfer, etc. There are a total 16 types of data transfer instruction as shown in the table below.

Group	Instruction Symbol	Group	Instruction Symbol
Transfer	MOV	Interchange	XCH
	MOVP		XCHP
	DMOV		DXCH
	DMOVP		DXCHP
Negative Transfer	CML	Block transfer	BMOV
	CMLP		BMOVP
	DCML	Same data block transfer	FMOV
	DCMLP		FMOVP

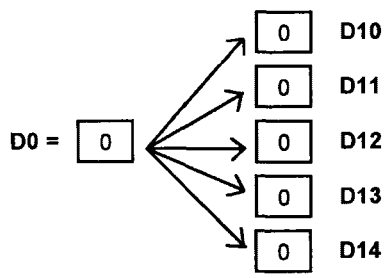
Below is an example of a program which uses some of the data transfer instructions.



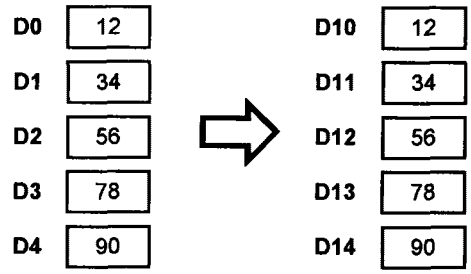
When X0 changes from OFF to ON the following *data transfer* occurs



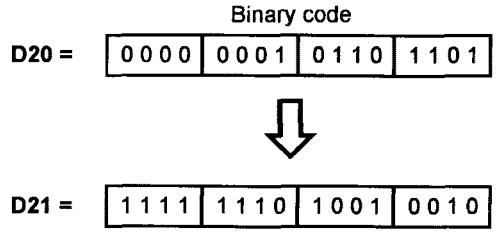
When X1 is turned ON the following data transfer occurs.



When X2 changes from OFF to ON the following data transfer occurs.



When X2 changes from OFF to ON the following data transfer occurs.



Step Number	Instruction	Device
0	LD	X0
1	MOVP	K10 D0
6	LD	X1
7	FMOV	K0 D10 K5
16	LD	X2
17	BMOVP	D0 D10 K5
26	LD	X3
27	CMLP	D20 D21
32	END	

Application instruction descriptions

Application instructions are used when special processing application processing is required. They can be classified in to 9 different groups as shown in the table below. Details and descriptions of all the application instructions can be found in the ACPU programming manual IB(NA)-66147-A.

Classification groups	Descriptions
Logical operation instructions	Logical operation such as logical add and logical product
Rotation instructions	Rotation of specified data
Shift instructions	Shift of specified data
Data processing instructions	Data processing such as 16-bit data search, decode, and encode
FIFO instructions	Read/write of FIFO table
Buffer memory access instructions	Read/write of buffer memory in special function modules
Local/Remote I/O access instructions	Read/write of data in local, remote I/O stations
Display instructions	Output of character code
Miscellaneous instructions	Instructions not classified in previous groups, such as WDT reset and carry flag set/reset

Chapter 7: A1S Application Examples

Building Management

MELSECNET/B data link control system application

Items controlled

Air conditioning (temperature, humidity), lighting

Overall aim

Air conditioning and lighting control for the complete building

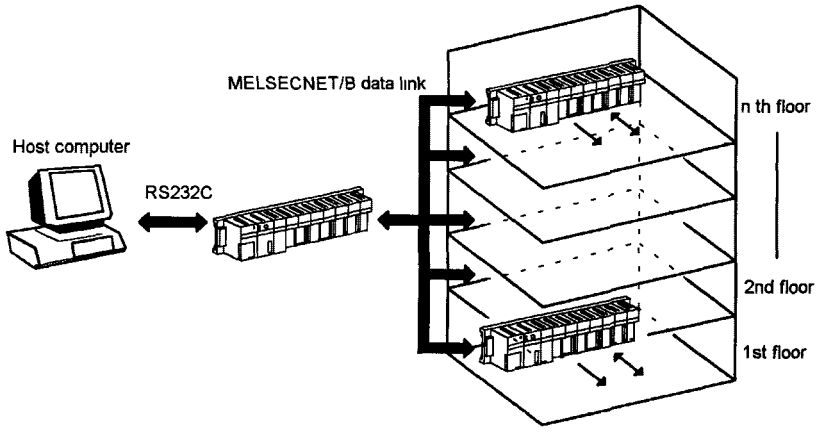
Advantages

The A1S PLCs are installed locally on each floor and connected to each other using economical twisted pair cabling, greatly reducing wiring costs.

Method of control description

Host computer:	Control and monitoring of the complete building
Master station PLC:	Linking data transfer between the host computer and the local station PLCs
Local station PLCs:	Air conditioning and lighting control, temperature and humidity monitoring

System configuration



PLC system requirements

Master station:	1 x A1SCPU	Local stations:	1 x A1SCPU
	1 x A1S61P		1 x A1S61P
	1 x A1S38B		1 x A1S38B
	1 x A1SJ71T21B		1 x A1SJ71T21B
	1 x A1SJ71C24-R2		1 x A1S62DA
	n x A1SX__		1 x A1S64AD
	n x A1SY__		n x A1SX__
			n x A1SY__

(A1SJ71T21B - MELSECNET/B interface module, see page 23)
(A1SJ71C24-R2 - RS232C computer lonk module, see page 22)

Milling Machine

Positioning control system application

Items controlled

Milling machine

Overall aim

The addition of a PLC controlled positioning unit to a general purpose manual milling machine to allow automatic positioning and the replacement of existing relay control panel.

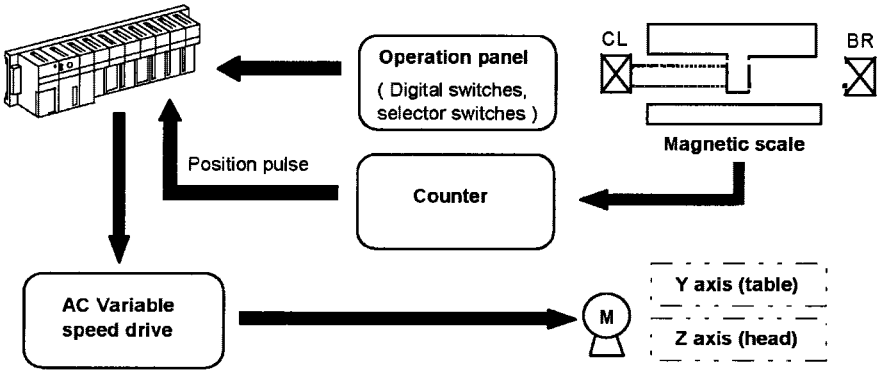
Advantages

Sequence control and positioning control are possible without the need for a specialized positioning system.

Method of control description

When the X and Y position data is set using a digital switch on the machines operation panel and a pattern is specified, the cutting pattern is calculated and the required positioning is performed. Since a three phase motor, and an AC variable speed drive are used for positioning in this application, smooth deceleration is achieved and stopping accuracy is obtained.

System configuration



PLC system requirements

1 x A1SCPU
1 x A1S61P
1 x A1S38B
1 x A1SD61
1 x A1S62DA
n x A1SX__
N x A1SY__

(A1SD61 - High speed counter module, see page 23)
(A1S62DA - Analog output module, see page 22)

APPLICATION EXAMPLES

Welding Robot

Robot control system application

Items controlled

Positioning mechanism, spot welder, welding gun and inverter

Overall aim

After the welding points are determined by teaching, automatic welding is done in a playback mode,

Advantages

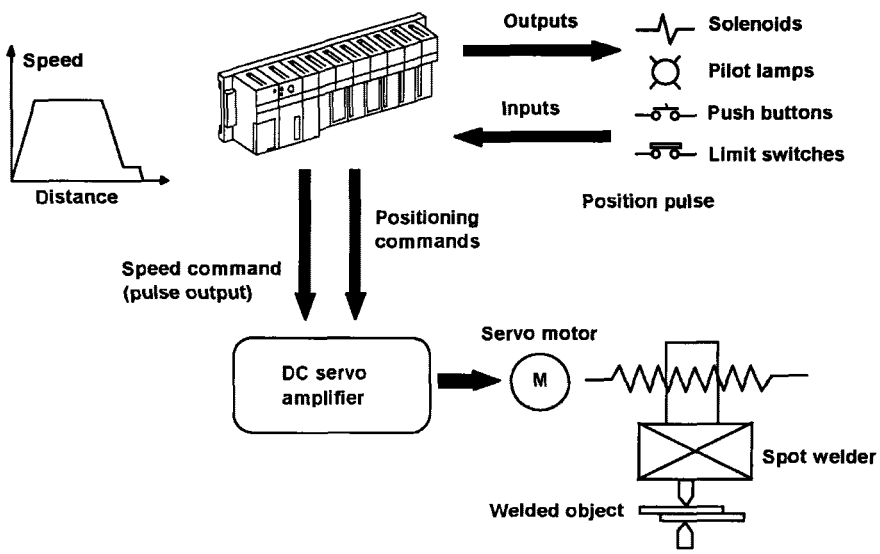
A low cost and simple welding robot is possible, without the need for a high cost specialized controller.

Method of control description

When the welding machine is manually operated in "teaching" mode, the position is detected by the position control module A1SD71-S2. At stop, the position is stored in a data register. Thereafter, only the welding points are taught.

In "playback" mode, position data is read out in the correct order and the welder is positioned and performs welding. During positioning the welder speed is controlled by the inverter. Stopping accuracy is approximately +/- 0.5 mm, and accumulative errors have been eliminated by the sequence program.

System configuration



PLC system requirements

1 x A1SCPU
1 x A1S61P
1 x A1S38B
1 x A1SD71-S2
n x A1SX__
N x A1SY__

(A1SD71-S2 - Position control module, see page 24)

Winding Machine

Analog control system application

Items controlled

DC motor

Overall aim

Constant surface speed control of the winding machine

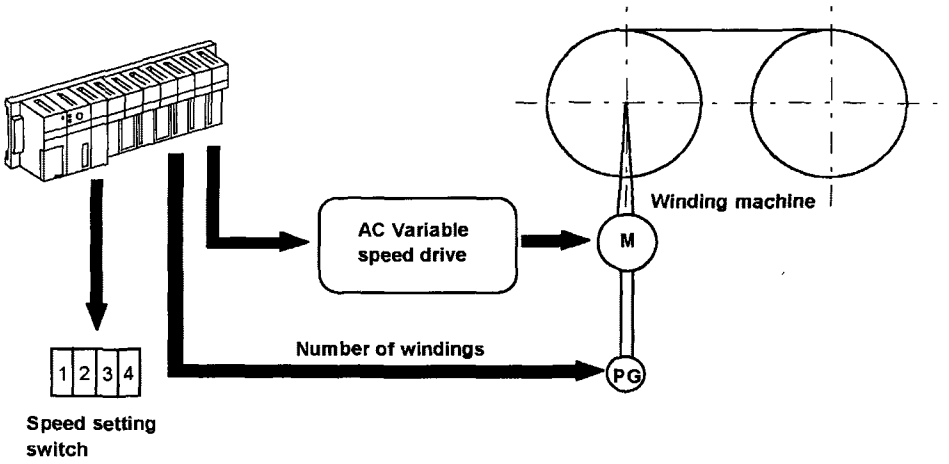
Advantages

Accurate numerical operation and analog output

Method of control description

The pulses of a pulse generator which is directly connected to a DC motor driving a winding machine, are counted by the high speed counter module A1SD61 to detect the number of present windings. The PLC calculates the speed through an arithmetic operation on the basis of the number of windings, depending on the type of the wound material to obtain a constant surface speed and gives a command to the variable speed controller of the DC motor using an analog output from the analog output module A1S62DA. Surface speed is set by an external digital switch.

System configuration



PLC system requirements

1 x A1SCPU
1 x A1S61P
1 x A1S38B
1 x A1SD61
1 x A1S62DA
n x A1SX__
n x A1SY__

(A1SD61 - High speed counter module, see page 23)
(A1S62DA - Analog output module, see page 22)

Energy Management of Compressor Station

Sequence control system application

Items controlled

Compressors

Overall aim

Energy saving operation of compressors.

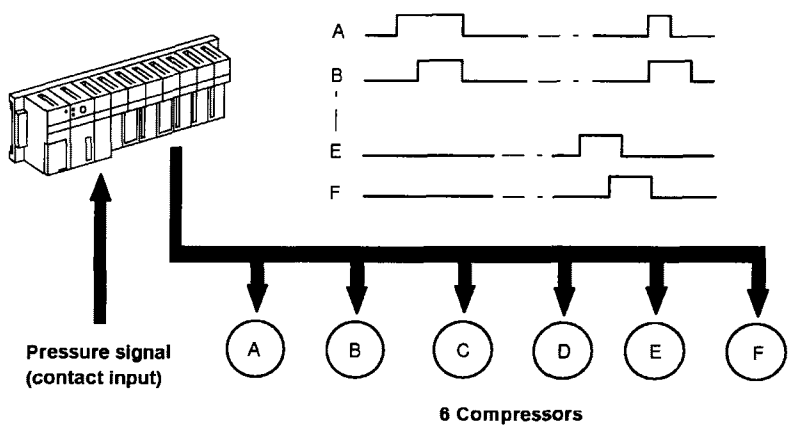
Advantages

Energy savings, provide reduced running and maintenance costs because of efficient use.

Method of control description

Independent and parallel operation of 6 compressors is controlled according to demand and air pressure. First-in, first-out control which stops in order of operation. In manual operation, any desired compressor can be turned on or off.

System configuration



PLC system requirements

1 x A1SCPU
1 x A1S61P
1 x A1S32B
n x A1SX__
n x A1SY__

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T

V

W

MELSEC A1S SERIES

MITSUBISHI ELECTRIC CORPORATION
HEAD OFFICE: MITSUBISHI DENKI BLDG MARUNOUCHI TOKYO 100 TELEX: J24532 CABLE MELCO TOKYO
NAGOYA WORKS: 1-14, YADA-MINAMI 5, HIGASHI-KU, NAGOYA, JAPAN

IB (NA) 66428-A (9304) MEE Printed in Japan