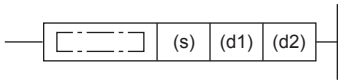
8.20 Initial State

Initial State

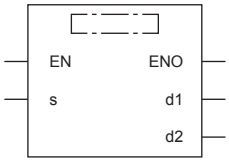
IST

FX5S FX5UJ FX5U FX5UC

Automatically controls the initial state and special relays in a step ladder program.

Ladder diagram	Structured text
	ENO:=IST(EN, s, d1, d2);

FBD/LD



Setting data

■Descriptions, ranges, and data types

Operand	Description	Range	Data type	Data type (label)
(s)	Head bit device number of the selector switch in the operation mode	—	Bit	ANYBIT_ARRAY (Number of elements: 8)
(d1)	Smallest state relay number of practical state relays in the automatic mode ((d1) < (d2))	—	Bit	ANY_BOOL
(d2)	Largest state relay number of practical state relays in the automatic mode ((d1) < (d2))	—	Bit	ANY_BOOL
EN	Execution condition	—	Bit	BOOL
ENO	Execution result	—	Bit	BOOL

■Applicable devices

Operand	Bit	Word			Double word		Indirect specification	Constant			Others
	X, Y, M, L, SM, F, B, SB, S	T, ST, C, D, W, SD, SW, R	U□\G□	Z	LC	LZ		K, H	E	$	
(s)	○*1	○*3	—	—	—	—	—	—	—	—	—
(d1)	○*2	—	—	—	—	—	—	—	—	—	—
(d2)	○*2	—	—	—	—	—	—	—	—	—	—

*1 S cannot be used.
*2 Only S can be used.
*3 T, ST, and C cannot be used.

Processing details

- Specify the head input in the operation mode in (s).
- Selector switches in the operation mode occupy eight devices from the head device.

- The switch functions shown in the table below are assigned to each of the devices specified for selector switches in the operation mode. When X20 is assigned, it is necessary to set X20 to X24 as rotary switches so that they do not turn ON at the same time. It is not necessary to wire unused switches, but they cannot be used for any other purpose because they are occupied by IST instruction.

Source	Device number (example)	Switch function	Descriptions
(s)	X20	Individual operation	Each load is turned ON and OFF by an individual pushbutton switch.
(s)+1	X21	Return to zero point	When the pushbutton switch for zero return is pressed, the machine automatically returns to the zero point.
(s)+2	X22	Stepping	Every time the start button is pressed, the machine performs one process.
(s)+3	X23	Cycle operation	When the start button is pressed while the machine is located at the zero point, the machine performs one cycle of automatic operation and stops at the zero point. If the stop button is pressed in the middle of one cycle, the machine stops immediately. When the start button is pressed after that, the machine performs the continuous operation from the last position, and automatically stops at the zero point.
(s)+4	X24	Continuous operation	When the start button is pressed while the machine is located at the zero point, the machine starts continuous operation. When the stop button is pressed, the machine finishes the current cycle until the zero point, and then stops at the zero point.
(s)+5	X25	Zero return start	Starts return to the zero point.
(s)+6	X26	Automatic start	Starts the stepping operation, cycle operation or continuous operation.
(s)+7	X27	Stop	Stops each operation.

- Specify the smallest device number of practical state relays in (d1) (for the automatic mode).
- Specify the largest device number of practical state relays in (d2) (for the automatic mode).

• While the command input is ON, the following devices are automatically switched and controlled. While the command input is OFF, the devices are not switched.

Device number	Descriptions	ON/OFF condition	
SM8040	STL transfer disable	ON condition	Always remains ON in the individual operation. Always remains ON in the stepping operation except when the [START] button is pressed. Turns ON when the [STOP] button is pressed during return to the zero point and in the cycle operation.
		OFF condition	Turns OFF when the [START] button is pressed in the stepping operation. Turns OFF after the [STOP] button is pressed during return to the zero point and in the cycle operation.
SM8041	Transfer start	ON condition	Turns ON when the [START] button is pressed in the stepping operation and cycle operation. Turns ON after the [START] button is pressed in the cycle operation.
		OFF condition	Turns OFF when the operation mode is changed from RUN to STOP. Always remains OFF in the individual operation and during return to the zero point. Turns OFF after the [STOP] button is pressed in the continuous operation.
SM8042	Start pulse	ON condition	Instantaneously turns ON when the [START] button is pressed.
		OFF condition	Remains OFF except in the ON condition.
SM8043	Zero return complete	ON condition	Turns ON when return to the zero point is completed (in the user program).
		OFF condition	Turns OFF when the operation mode is changed from RUN to STOP. Remains OFF while return to the zero point is not completed.
SM8044	Zero return condition	ON condition	Turns ON when the zero point condition is established (in the user program).
		OFF condition	Turns OFF when the operation mode is changed from RUN to STOP. Remains OFF while return to the zero point is not completed.
SM8045	All output reset disable	ON condition	Turns ON when all-output reset is not executed (in the user program).
		OFF condition	Turns OFF when all-output reset is executed (in the user program).
SM8046	STL state ON	ON condition	Turns ON when SM8047 (Enable STL monitoring) is ON and either step relay (device S) is ON.
		OFF condition	Turns OFF when SM8047 (Enable STL monitoring) is OFF or when SM8047 (STL monitor enable) is ON and all step relays (device S) are OFF.
SM8047	Enable STL monitoring	ON condition	Turns ON when the IST instruction command is given.
		OFF condition	Turns OFF when the step ladder is finished (in the user program).

Device number	Descriptions	ON/OFF condition	
S0	Individual operation initial state	ON condition	when a individual operation mode is selected.
		OFF condition	Except a individual operation mode.
S1	Zero return initial state	ON condition	when a zero return operation mode is selected.
		OFF condition	Except a zero return operation mode.
S2	Automatic operation initial state	ON condition	when a automatic operation mode is selected.
		OFF condition	Except a automatic operation mode.

• Do not program the following state relays as general state relays;

Device number	Descriptions	ON/OFF condition	
S0 to S9	Occupied for the initial state • S0 to S2 are used for individual operation, zero return and automatic operation as shown above. • S3 to S9 can be used arbitrarily.	ON condition	Turns ON when a step relay (device S) is selected for the initial state.
		OFF condition	Turns OFF when no step relay (device S) is selected.
S10 to S19	Occupied for zero return	ON condition	Turns ON when a step relay (device S) is selected for return to the zero point.
		OFF condition	Turns OFF when no step relay (device S) is selected.

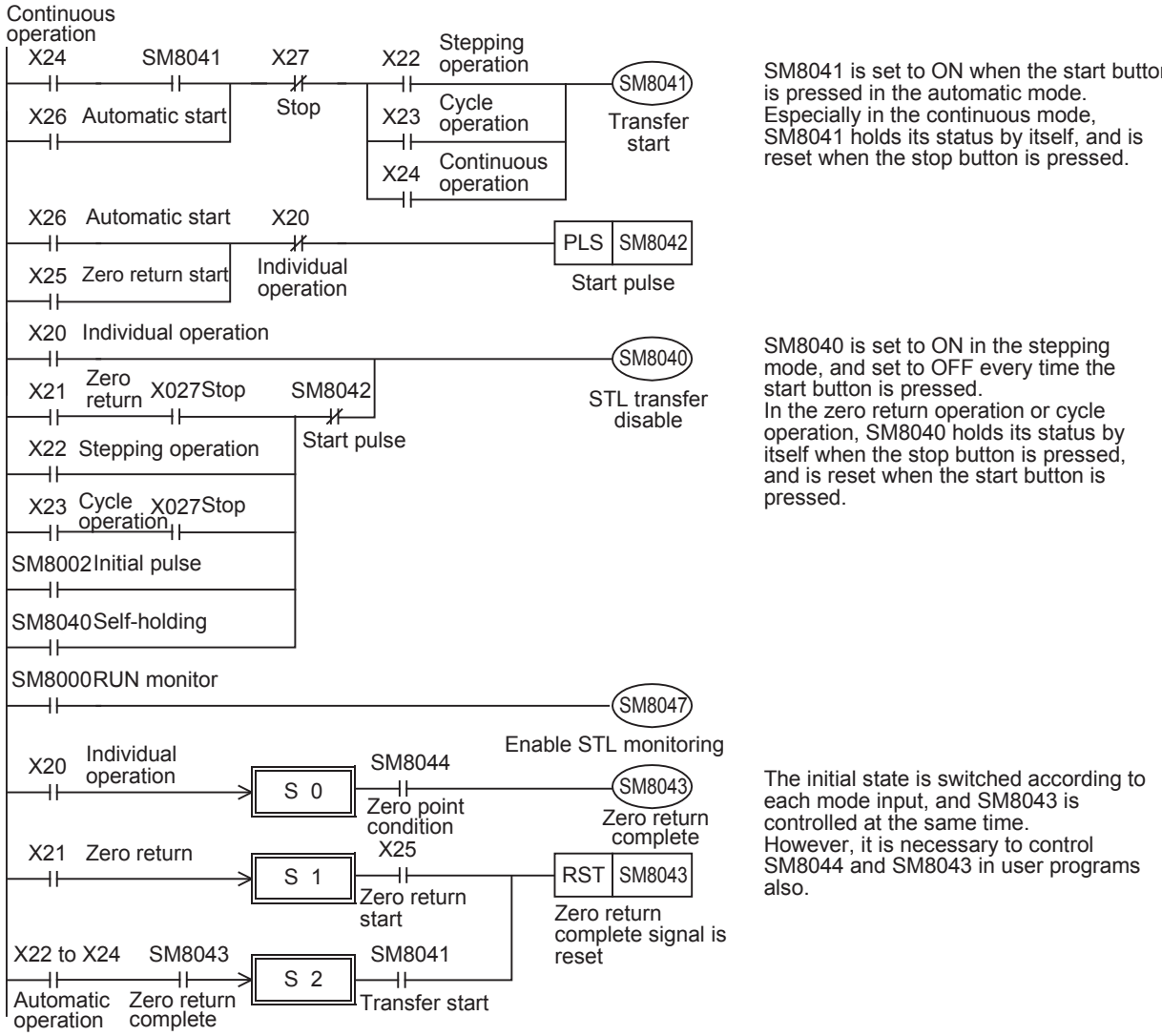
• If the devices are switched among individual operation (X20), zero return (X21) and automatic operation (X22, 23 and X24) while the zero return complete device (SM8043) is OFF, all outputs are set to OFF. Automatic operation can be started again after zero return is completed.

Precautions

- It is not necessary to use all switches for mode selection. When some switches are not used, leave the corresponding numbers in the unused status. Such numbers cannot be used for any other purpose.
- The IST instruction should be programmed earlier than a series of STL circuit such as state relays S0 to S2.
- Use the state relays S10 to S19 for the zero return operation. In the final state in the zero return operation, set SM8043 to ON, and then let it be reset to OFF by itself.
- The IST instruction can only be used once in a program.

■IST instruction equivalent circuit

- The details on special relays (SM) and initial state relays (S0 to S9) which are automatically controlled by the IST instruction is as shown in the equivalent circuit below. (Refer to the equivalent circuit below for reference.) This equivalent circuit cannot be programmed.

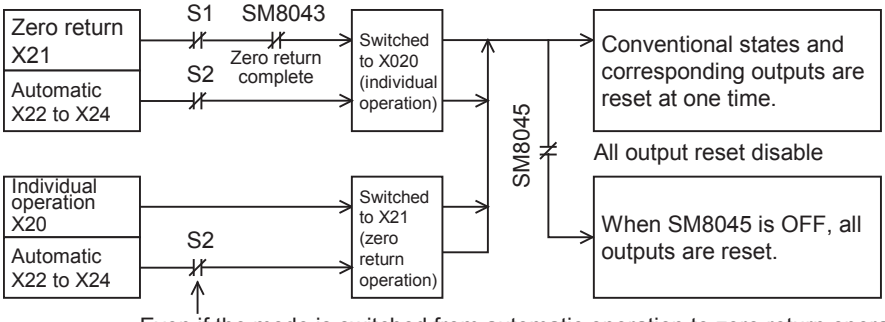


SM8041 is set to ON when the start button is pressed in the automatic mode. Especially in the continuous mode, SM8041 holds its status by itself, and is reset when the stop button is pressed.

SM8040 is set to ON in the stepping mode, and set to OFF every time the start button is pressed. In the zero return operation or cycle operation, SM8040 holds its status by itself when the stop button is pressed, and is reset when the start button is pressed.

The initial state is switched according to each mode input, and SM8043 is controlled at the same time. However, it is necessary to control SM8044 and SM8043 in user programs also.

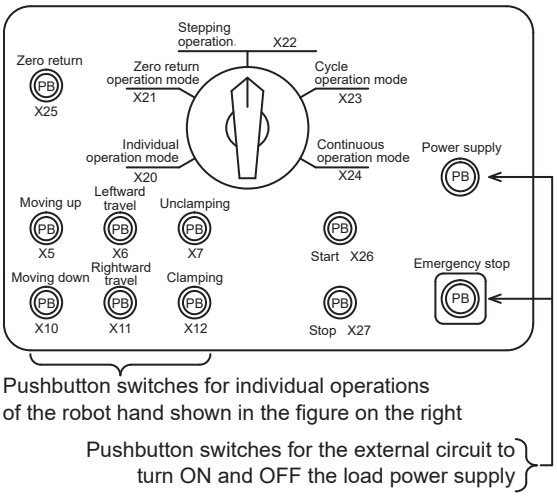
• When the operation mode is switched among the individual operation, zero return operation and automatic operation,all outputs and conventional states are reset at one time unless the machine is located in the zero point. (Reset of all outputs is not executed when SM8045 is driven.)



Even if the mode is switched from automatic operation to zero return operation while S2 is ON, state relays (except initial state relays) and outputs are not reset.

■Example of IST instruction introduction (example of workpiece transfer mechanism)

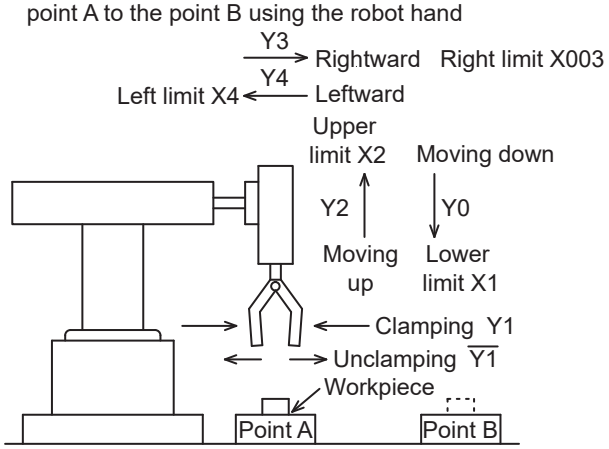
• Operation mode



Pushbutton switches for individual operations of the robot hand shown in the figure on the right

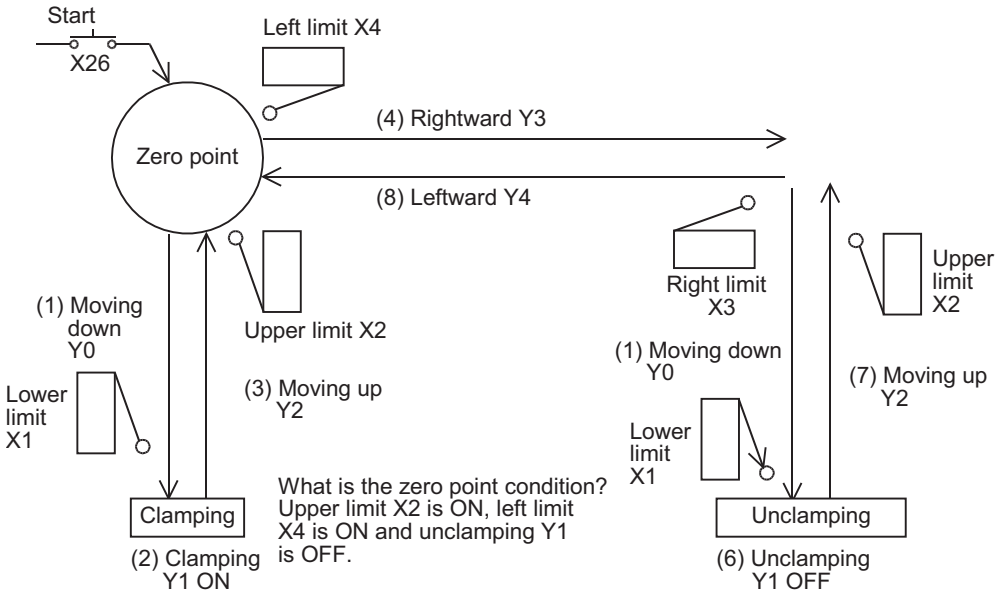
Pushbutton switches for the external circuit to turn ON and OFF the load power supply

Mechanism for transferring a workpiece from the point A to the point B using the robot hand



Operation mode		Contents of operation
Manual mode	Individual operation mode:	Each load is turned ON and OFF by an individual pushbutton switch.
	Zero return operation mode:	When the pushbutton switch for zero return is pressed, the machine automatically returns to the zero point.
Automatic mode	Stepping operation mode:	Every time the start button is pressed, the machine performs one process.
	Cycle operation mode	When the start button is pressed while the machine is located at the zero point, the machine performs one cycle of automatic operation and stops at the zero point. If the stop button is pressed in the middle of one cycle, the machine stops immediately. When the start button is pressed after that, the machine performs the continuous operation from the last position, and automatically stops at the zero point.
	Continuous operation mode	When the start button is pressed while the machine is located at the zero point, the machine starts continuous operation. When the stop button is pressed, the machine finishes the current cycle until the zero point, and then stops at the zero point.

• Transfer mechanism

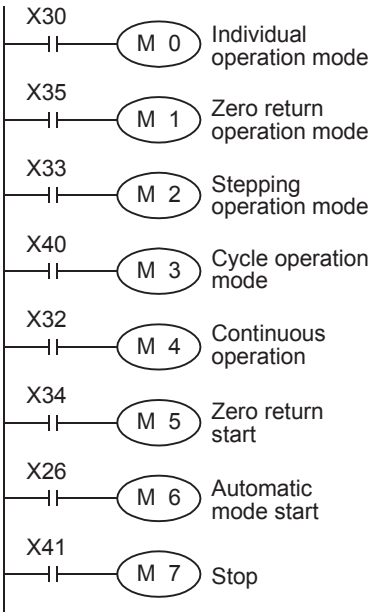


- For using IST instruction, it is necessary to assign inputs having consecutive device numbers as shown below for mode inputs. When using non-consecutive inputs or omitting some modes, change the layout by using an auxiliary relay as the head input for mode specification as shown in the figure below.

Input device	Assignment
X20	Individual operation mode
X21	Zero return operation mode
X22	Stepping operation mode
X23	Cycle operation mode
X24	Continuous operation mode
X25	Zero return start
X26	Automatic mode start
X27	Stop

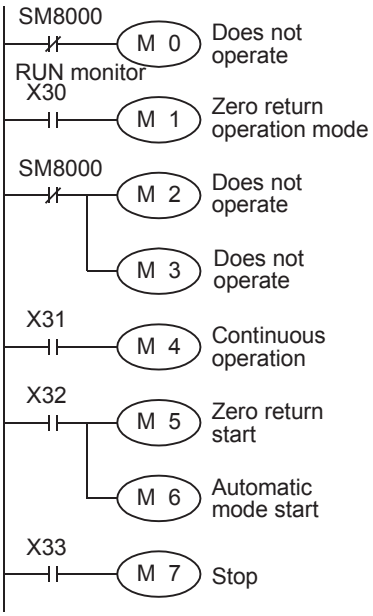
When inputs do not have consecutive device numbers

Example:
X30: Individual operation mode
X35: Zero return operation mode
X33: Stepping operation mode
X40: Cycle operation mode
X32: Continuous operation mode
X34: Zero return start
X26: Automatic mode start
X41: Stop



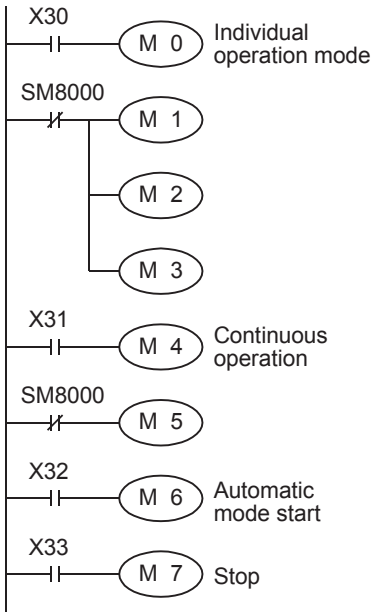
When only the continuous operation mode and zero return operation mode are used

Example:
X30: Zero return operation mode
X31: Continuous operation mode
X32: Automatic mode start zero return start
X33: Stop

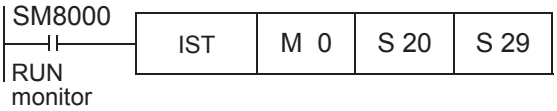


When only the continuous operation mode and individual operation mode are used

Example:
X30: Individual operation mode
X31: Continuous operation mode
X32: Automatic mode start
X33: Stop



In this example, M0 is used as the head input for mode specification.

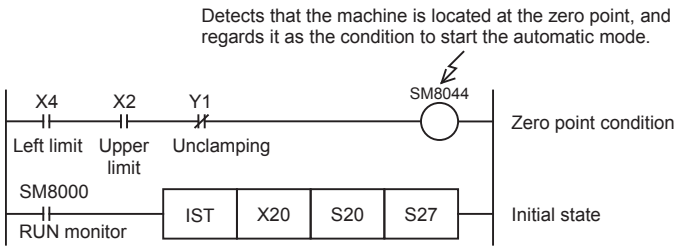


- Special relay (SM) used in the IST instruction are classified into two types. Some special relays are automatically controlled by the IST instruction itself according to the situation. Other special relays should be controlled by a program for preparation of operation or for purpose of control.

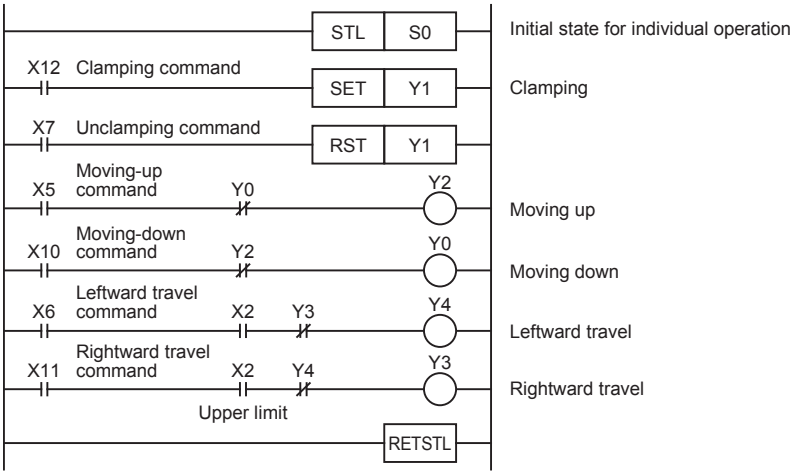
Special relay	Description	Remarks
SM8040 (STL transfer disable)	When this special relay turns ON, transfer of every state is disabled. Individual operation mode: SM8040 is always effective. Zero return operation mode and cycle operation mode: When the stop button is pressed, the operation is held until the start button is pressed. Stepping operation mode: SM8040 is always effective except when the start button is pressed. When the start button is pressed, SM8040 is not effective and transfer of states is allowed. Others: The operation is latched when the PLC mode switches from STOP to RUN, and reset when the start button is pressed. Even in the transfer disabled status, the operation is held for outputs in the states.	Special relays automatically controlled by the IST instruction
SM8041 (Transfer start)	This special relay allows transfer from the initial state S2 to the next state. Individual operation mode and zero return operation mode: SM8041 is not effective. Stepping operation mode and cycle operation mode: SM8041 is effective only while the start button is pressed and held. Continuous operation mode: The operation is latched when the start button is pressed, and cleared when the stop button is pressed.	
SM8042 (Start pulse)	SM8042 is activated instantaneously only when the start button is pressed.	
SM8047 (Enable STL monitoring)	When IST instruction is executed, SM8047 is set to ON. When the SM8047 turns ON, STL monitoring becomes valid, and state relay numbers (S0 to S899) in the ON status are stored in turn in the ascending order of device number to the special register SD8040 to SD8047. Up to eight state relay numbers in the ON status can be monitored. If either state relay is ON, the special auxiliary relay SM8046 is set to ON.	
SM8043 (Zero return complete)	Set this special relay (SM) to ON by a user program when the machine returns to the zero point in the zero return operation mode.	Special relays controlled by a sequence program
SM8044 (Zero point condition)	Detect the zero point condition of the machine, and drive this special relay. This signal is effective in every mode.	
SM8045 (All output reset disable)	When the mode is switched among individual operation mode, zero return operation mode and automatic mode, all outputs and operation state relays are reset if the machine is not located at the zero point. If SM8045 has been set to ON in advance, however, only operation state relays are reset.	

Program example

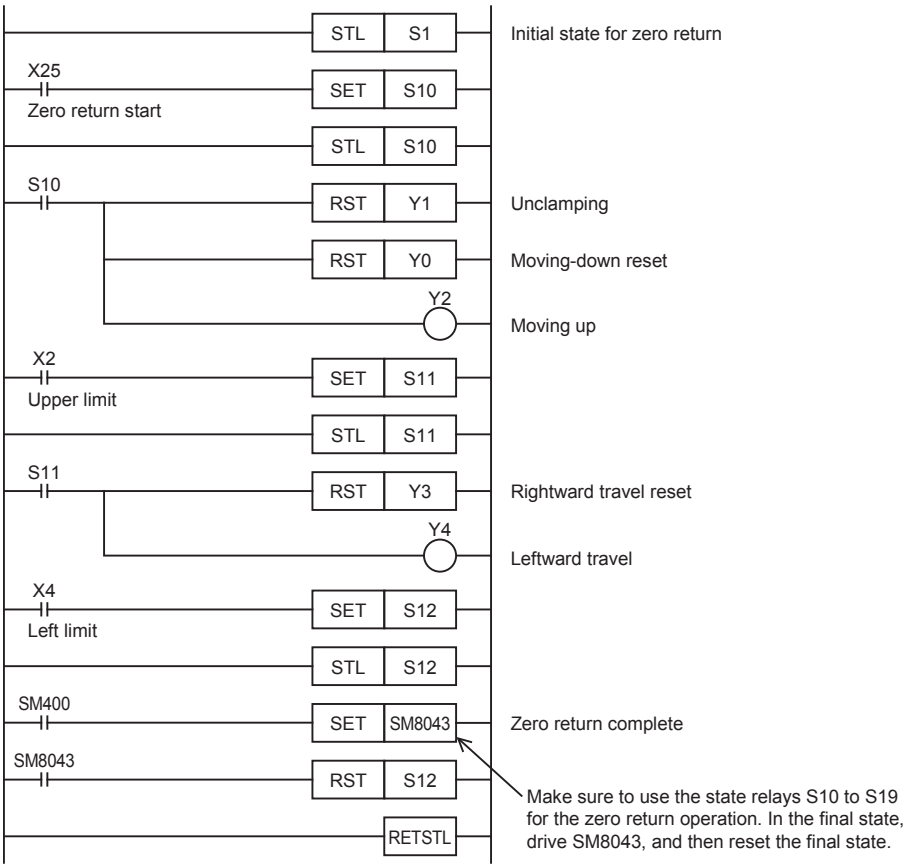
- While the machine is operating, the operation mode can be switched arbitrarily (among stepping operation, cycle operation and continuous operation) in the automatic mode. When the operation mode is switched between the individual operation mode, zero return operation mode and automatic mode while the machine is operating, all outputs are reset once to assure safety, after which the following mode becomes valid. (While SM8045 (All output reset disable) is ON, outputs are not reset at all.)



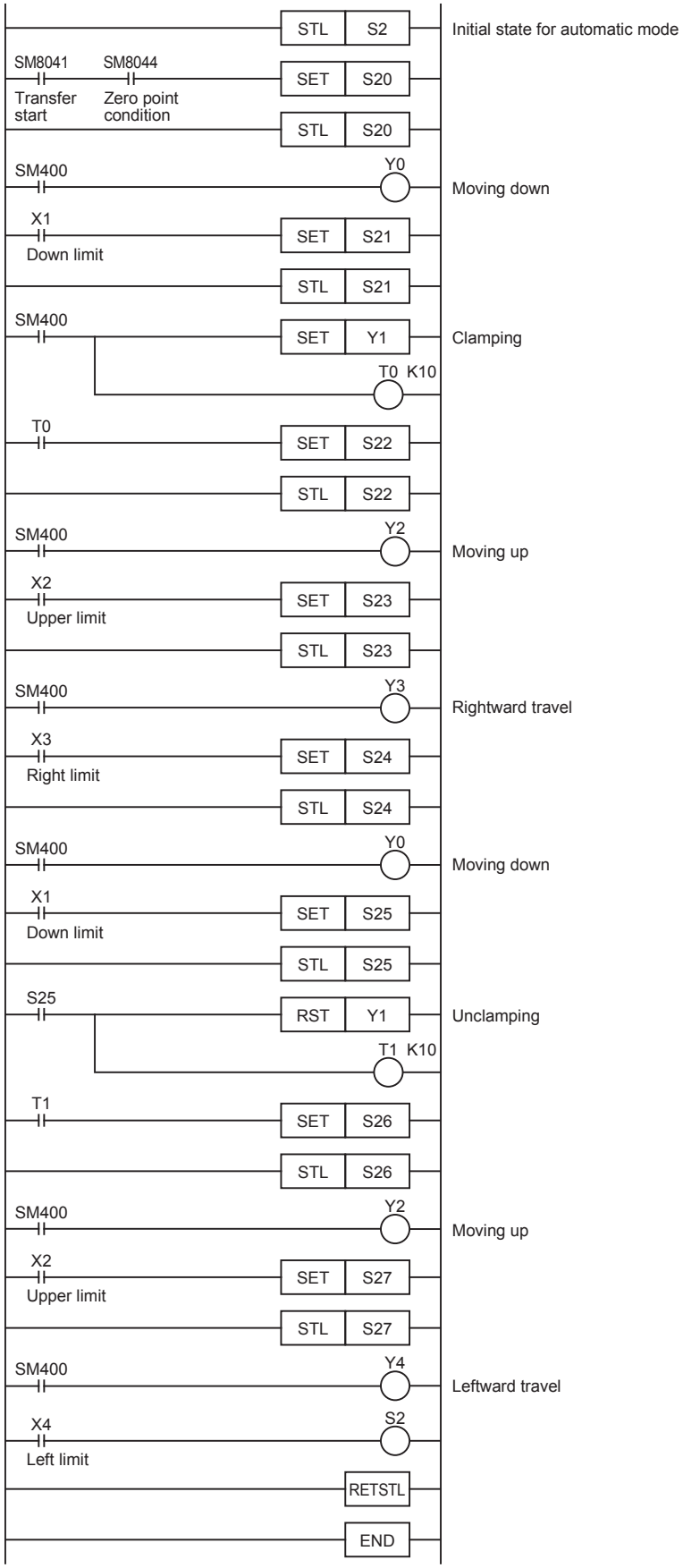
- Programming is not required when the individual operation mode is not provided.



- Programming is not required when the zero return operation mode is not provided. It is necessary to set SM8043 (zero return complete) to ON before starting the automatic mode.



• Automatic mode (stepping operation mode, cycle operation mode or continuous operation mode)



Operation error

Error code (SD0/SD8067)	Description
1811H	The number of times the IST instruction is simultaneously driven exceeds 1.
2820H	The device numbers specified in (d1) and (d2) show the following relationship: (d1) ≥ (d2)
	Eight points are not secured from the device specified in (s).
	An unavailable device is set in (s).
	An unavailable device is set in (d1).
	An unavailable device is set in (d2).