

# 9 STEP LADDER INSTRUCTIONS

9

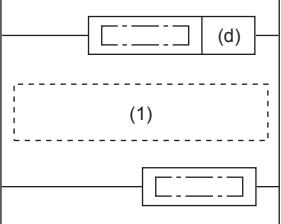
## 9.1 Starts/Ends Step Ladder

### STL, RETSTL

FX5S FX5UJ FX5U FX5UC

STL: This instruction starts step ladder.

RETSTL: This instruction ends step ladder.

| Ladder diagram                                                                                                | Structured text <sup>*1</sup> |
|---------------------------------------------------------------------------------------------------------------|-------------------------------|
| <br>(1): Step ladder program | STL(d);<br>RETSTL();          |
| <b>FBD/LD<sup>*1</sup></b>                                                                                    |                               |
|                            |                               |

\*1 For supported version, refer to  Page 1452 Added and Changed Functions.

### Setting data

#### ■ Descriptions, ranges, and data types

| Operand | Description                                   | Range     | Data type | Data type (label) |
|---------|-----------------------------------------------|-----------|-----------|-------------------|
| (d)     | The step relay number which assigns the State | 0 to 4095 | Bit       | ANY_BOOL          |

#### ■ Applicable devices

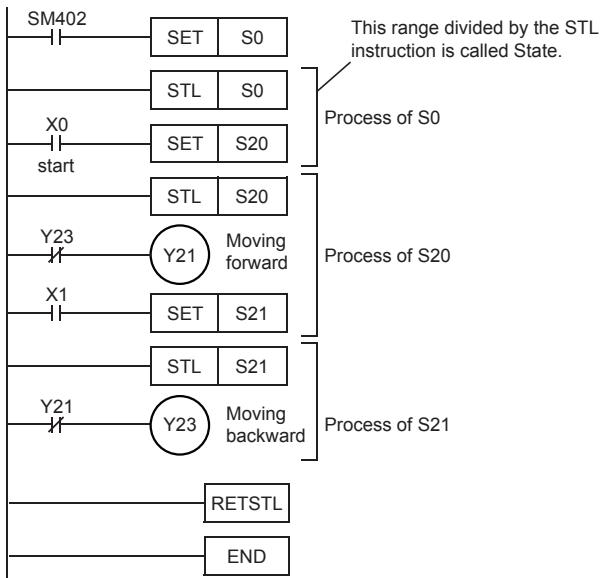
| Operand | Bit             | Word                        |                           |       | Double word |    | Indirect specification | Constant |   |    | Others |
|---------|-----------------|-----------------------------|---------------------------|-------|-------------|----|------------------------|----------|---|----|--------|
|         |                 | X, Y, M, L, SM, F, B, SB, S | T, ST, C, D, W, SD, SW, R | U□\G□ | Z           | LC |                        | K, H     | E | \$ |        |
| (d)     | ○ <sup>*1</sup> | —                           | —                         | —     | —           | —  | —                      | —        | — | —  | —      |

\*1 Only S can be used.

## Processing details

- In programs using step ladder instructions, a step relay S is assigned to each process based on machine operations, and sequences of input condition and output control are programmed as circuits connected to contacts (STL contacts) of state relays.
- In a step ladder program, a step relay S is regarded as one control process, and a sequence of input conditions and output controls are programmed in a state relay. Because the preceding process is stopped when the program execution proceeds to the next process, a machine can be controlled using simple sequences for each process.
- The step relay number specified by STL instruction is assigned to the State. The start and completion of the State use SET instruction, OUT instruction, RST instruction, and ZRST instruction.
- Program a step ladder program starting from the initial state relay in the order of state relay ON status transfer. Make sure to put the RETSTL instruction at the end of a step ladder program. The RETSTL instruction is omissionable anywhere other than the last Step Ladder.

The actual step ladder program is as follows.



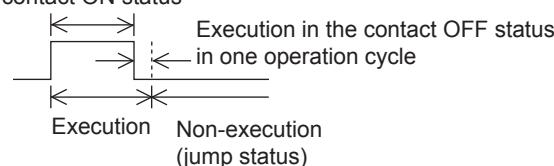
- A step ladder program is expressed as a relay ladder, but it can be created according to the machine control flow using state relays. A state relay consists of a drive coil and contact (STL contact) in the same way as other relays. Use SET or OUT instructions to drive a coil, and use STL instructions for a contact.
- The table below shows operations of internal circuits connected to the state relays,

#### Internal circuit diagram operation

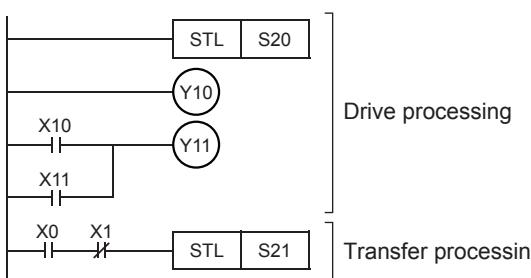
|                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|---------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Execution in the contact ON status                            | When a state relay turns ON, a connected circuit (internal circuit) is activated with a STL contact.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Execution in the contact OFF status (for one operation cycle) | When a condition (transfer condition) provided between state relays is satisfied, the next state relay turns ON, and the state relay which was been ON before hand turns OFF (transfer operation). In the state relay ON status transfer process, both state relays are ON for one operation cycle.<br>In the next operation cycle after the ON status is transferred to the next state relay, the former state relay is reset to OFF. A drive instruction connected to the bus line of the reset state relay is executed in the contact OFF status for one operation cycle regardless of the actual contact status before the drive instruction.<br>When the transfer state relay is used in a contact instruction, however, the contact image is executed in the OFF status immediately after the transfer condition is satisfied. |
| Non-execution                                                 | An instruction is not executed in the contact OFF status after the operation cycle where the instruction was executed in the contact OFF status (jump status).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |

- The figure below shows the timing chart of the state relay (internal circuit) activation status.

Execution in the contact ON status

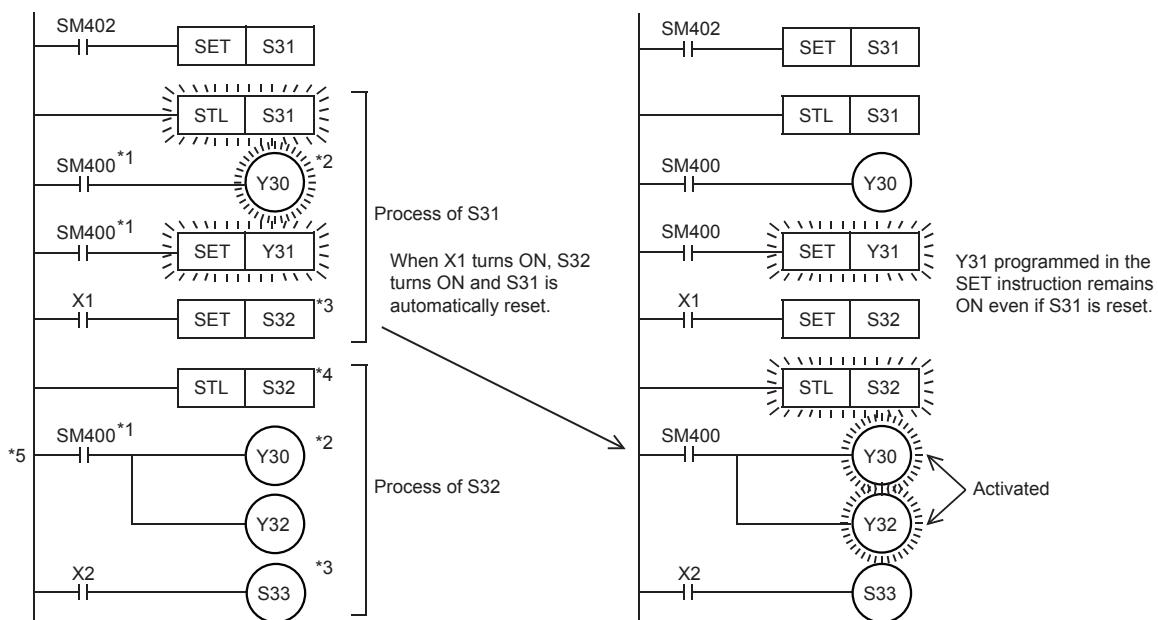


- Each state relay has three functions, driving a load, specifying a transfer destination and specifying a transfer condition. Such as the following program, driving a load and then transition processing. In a state relay without any load, the drive processing is not required.



## ■Operation of program

The step ladder program operates as follows.



\*1 It is always necessary to program to drive an output.

\*2 Output coils can be used again in different state relays.

\*3 Each OUT and SET instruction for step relays automatically resets the transfer source, and has the self-holding function.

\*4 One step relay number can only be used once.

\*5 It is not possible to place a pointer immediately after the STL instruction. If a pointer is placed, a program error (33E2H) occurs.

### Point

When the step relay is latched, the ON/OFF status is backed up by nonvolatile memory against power failure. Use this type of state relay if the operation should be restarted from the last point before power failure. These relays hold the operation status also at the time of RUN to STOP. If it RUN(s) again, the operation will be resumed from the State before STOP.

## ■Related devices

| Device           | Name                  | Description                                                                                                                                    |
|------------------|-----------------------|------------------------------------------------------------------------------------------------------------------------------------------------|
| SM8040           | STL transfer disable  | When SM8040 is set to ON, transfer of the ON status is disabled among all state relays.                                                        |
| SM8046           | STL state ON          | When the step relay turns on, SM8046 turns on automatically.                                                                                   |
| SM8047           | Enable STL monitoring | When SM8047 is turned on, it stores in SD8040 to SD8047 sequentially from the young number of the step relay which operates in the step relay. |
| SD8040 to SD8047 | ON step relay numbers | The turned-on step relay number is stored in SD8040 to SD8047 (Max. 8 points) sequentially from the smaller number.                            |

## Precautions

- When the step relay is not latched, step relay clears at power supply ON→OFF or RUN→STOP. If the State is valid and power supply ON→OFF or PLC RUN→STOP, operation can not be restarted from the last point before power-supply ON→OFF or RUN→STOP.
- The STL/RETSTL instruction cannot be used in a project including an SFC program.

## Operation error

| Error code (SD0/SD8067) | Description                                                                                                                                                                                                                  |
|-------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 33E3H                   | The STL instruction or RETSTL instruction is programmed between FOR-NEXT.                                                                                                                                                    |
| 33E5H                   | The STL instruction or RETSTL instruction is programmed in an interrupt program, subroutine program or function block.<br>The frequency of use of the STL instruction is not consistent with that of the RETSTL instruction. |
| 33F3H                   | Three or more STL instructions with the same step relay No. are programmed.                                                                                                                                                  |