Embedded PLC
Hard Logic Solver
Instruction Sets

User's Manual

FRECON Electric (Shenzhen) Co., Ltd.

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FOREWORD

Embedded PLC series bring the high performance, application flexibility and hardware compatibility to the Embedded PLC family of products. Ten contacts and abundant function blocks (also referred to as instructions) are provided for application control programs using the Embedded PLC series. In this manual, the usage for contacts and function blocks is described together with application examples.

Contact elements include:

(1) ┤ ├ (A normally open contact, usually referred to as: "A contact")
(2) ┤ / ├ (A normally closed contact, usually referred to as: "B contact")
(3) **-( )-** (A normal coil)
(4) **-(S)-** (A set coil)
(5) **-(R)-** (A reset coil)
(6) **-(↑)-** (A positive transitional coil)
(7) **-(↓)-** (A negative transitional coil)
(8) **-(M)-** (A holding coil during power loss)
(9) **-(SM)-** (A holding set coil during power loss)
(10) **-(RM)-** (A holding reset coil during power loss)

Function blocks instructions include:

(1) Timers and counters:
Timers: **T1.0, T0.1, T0.01,**
Counters: **UCTR, DCTR.**

(2) Mathematical blocks:
Adders: **ADD, ADDB, ADDL, ADBL, FADD,**
Subtracts**: SUB, SUBB, SUBL, SBBL, FSUB,**
Multipliers: **MUL, MULB, MULM, MUBM, MULL, MLBL, FMUL,**
Dividers: **DIV, DIVB, DIVM, DVBM, DIVL, DVBL, FDIV,**
Square root: **ISQR, FSQR.**

(3) Register, Table, Array instructions:
Move: **R->T, T->R, T->T, TXHG, BLKM, PACK,**
Rotate/Shift: **T_RS, BROT, ODSR,**
Modify: **MBIT,**
Compare**: T_CM, CMPR,**
Search: **T_SR,**
Logic: **AND, OR, XOR, COMP**
Stack: **PUSH, POP,**
Sense: **SENS,**

Encoder, Decoder: **ENCO, DECO, SSEG,**
Convert: **B->C, C->B, I->F, F->I.**

(4) Flow control instructions:
Main program: **EOP, SKIP, MCS, MSE, JMP, EOJ,**
Subroutine: **JSR, SBR, RET,**
Loop: **FOR, NEXT,**
Pointer: **INIP, INCP, DECP, PADD, PSUB.**

(5) System related instructions:
System date: **DGET, DSET, DCMP,**
System time: **TGET, TSET, TCMP,**
System status: **STAT.**

(6) Others:
CAM
CDMR (CDM read)
CDMW (CDM write)
MOVE

Users are advised to become familiar with the binary operation (which can be found in any Digital Design Textbook) and the characteristics for each contact element and function block before designing a control application program. Please also be advised that the data and illustrations in this manual are not binding. We reserve the right to modify our products in line with our policy of continuous product improvement. Information in this manual is subject to change without notice and should not be treated as a commitment by FRECON Electric (Shenzhen) Co., Ltd. FRECON assumes no responsibility for any errors that may appear in this manual.

CHAPTER 1: INTRODUCTION

The basic concept required to use this manual and the elements (contacts , function blocks, and instructions) in Embedded PLC is briefly described in this Chapter. In Section 1, the terminology and numerical representation are described. The constituents of a function block are described in Section 2 and the convention used to represent the function blocks is described in Section 3.

SECTION 1: Terminology and Numerical Representations:

BIT:

The basic unit of the binary system. The value of a bit is either 0 or 1. The abbreviation for bit is B, such as B0, B1, …...etc.

NIBBLE:

A nibble is composed of four bits such as B3~B0. It can be used to represent decimal values ranging from 0 to 9, or hexadecimal values ranging from 0~F. The abbreviation for nibble is NB, such as NB0, NB1, …… etc.

BYTE:

A byte is composed of eight bits (B7~B0) or two contiguous nibbles (NB1~NB0). It can be used to represent hexadecimal values ranging from 00~FF. The abbreviation for byte is BY, such as BY0, BY1, …… etc.

WORD:

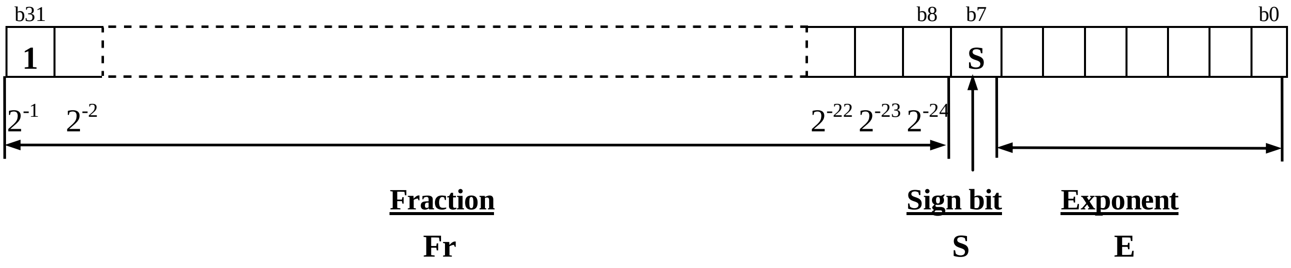
A word is composed of sixteen bits. It can be used to represent hexadecimal values ranging from 0000~FFFF or 0~65535 in the decimal system. The abbreviation for word is W, such as W0, W1, …… etc. Since Embedded PLC is based on 16-bit microcomputer architecture, a word occupies one register in the computer memory.

LONG WORD:

A long word is composed of two continuous words or 32 bits. It can be used to represent hexadecimal values ranging from 00000000~FFFFFFFF, floating point numbers through special convention, or decimal format ranging from 0~99999999. The abbreviation for long word is LW, such as LW0, LW1, …… etc. A long word occupies two continuous registers in the computer memory. The first register contains the most significant 16 bits (usually referred to as HIGH WORD), the second register contains the least significant 16 bits (usually referred to as LOW WORD). A long word is referenced by the address occupied by the High Word.

Floating Point Representation using a Long Word:

A long word (32 bits) can be used to represent a floating point number. The bit assignment is shown in the following figure:



Formula: $\mathbf{I = (-1)^{S} \times 2^{(E-64)} \times Fr}$

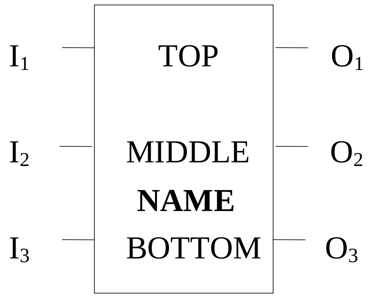
For example, assuming that the content of register 40130 is C000h and register 40131 is 0042h; then for an operation using floating point referencing register 40130 (40130 and 40131 actually), the value used is:

40130	40131
1100 0000 0000 0000	0000 0000 0100 0010

$\mathbf{I = (-1)^{0} \times 2^{(66-64)} \times (2^{-1}+2^{-2}) = 3}$

SECTION 2: Constituents of a Function Block

In Embedded PLC series, a function block is composed of four parts: Function Name, Input Control, Operand and Function Output as shown in the following figure:



Where:
1. I_1, I_2, I_3 are Input controls
2. O_1, O_2, O_3 are Function outputs.
3. TOP, MIDDLE, BOTTOM stand for Top node, middle node and bottom node. These three nodes are operands.
4. NAME is the name of the function block.

Function Name:

The function name is an abbreviation or acronym of the operation performed by the function block. Two to four characters are used to represent the function. A complete list of the function block names may be found in the FOREWORD of this manual.

Input Control:

There must be one input control for each function block. This input control (usually referred to as I_1) is used to determine whether to execute this function block or not. For some function blocks, there are two additional input controls (I_2 and I_3). They are used to determine the execution mode of the function block.

Function Output:

There must be a function output control for each function block. This output (usually referred to as O_1) is used to drive a coil or used as an input control for the next function block. For some function blocks, there are two additional output controls (O_2 and O_3), they are also used to represent the results of the execution.

Operands:

Operands, as the name implies, are the objects of operations. An operand whose content is not altered by the operation is called a SOURCE. An operand that is used to store the result of the operation is called a DESTINATION. Operands can be Input contact, Output coil or register in memory. For Embedded PLC, the designations of operands are listed in the following table:

Table 1.1: Operands

Initial	NAME	DESCRIPTION
0	Output Coil (Discrete output)	Use Output coil as an operand. Since 1 word = 16 bits, thus the number assignment of the operand must be a multiple of 16 plus 1. For example: 00001, 00017, 00033.
1	Input contact (Discrete input)	Use Input contact as an operand. The number assignment of the operand must be a multiple of 16 plus 1. For example: 10001, 10017, 10033.
3	Input register	Use Input register as an operand. For example:30001, 30003.
4	Holding register	Use Holding register as an operand. For example:40001, 40003.
C	Constant	For some function blocks, a constant can be defined as an operand: and during control program execution, the value of the constant is readily available rather then fetching from register memory. For example: #00001, #0020h. The former is a decimal constant, and the latter is a hexadecimal constant.
P	Pointer	For some function blocks, a pointer can be defined as an operand, and this pointer can be used for indirect addressing pointing to 0-, 1-, 3-, 4-type variable. For example: P0001
L	Label	For paired instructions (such as FOR and NEXT), their operands are label, and the label for each instruction must be the same in order for program to be executed correctly. For example: L0001.

Currently, there are three models of Embedded-PLC controllers. The memory size and the CPU capability are different between models to meet different control requirements. Therefore, the numbers of spaces available for operands are also different. The available ranges for operands for each model are listed in the following table.

Table 1.2: Available operand ranges for different models of the Embedded PLC series controller

OPERAND	Embedded PLC
0	00001~09984
1	10001~12048
3	30001~30512
4	40001~49999
L	L1~L150
C	0~65535
P	P0~P15

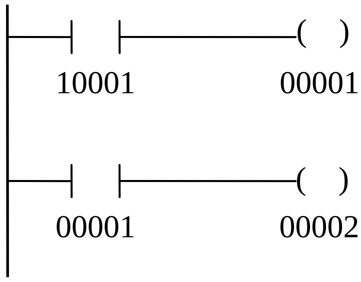
CHAPTER 2: CONTACTS

Contact elements are the most fundamental elements in Ladder Programs. Familiarization with their characteristics and usage is highly recommended.

(1) ┤ ├ Normally Open Contact:

This type of contact is usually referred to as “**A Contact**”. When a contact is energized, the said “A contact” becomes conductive; and vice versa.

【EXAMPLE】



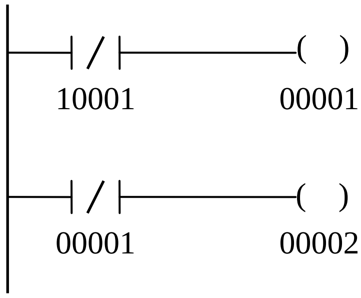
【Meaning】

When input contact 10001 is ’ON’, coil 00001 is energized, and “A contact” 00001 becomes conductive, thus, coil 00002 is energized.

(2) ┤ / ├ Normally Closed Contact:

This type of contact is usually referred to as “**B Contact”**. When a contact is not energized, the said “B contact” becomes conductive; and vice versa.

【EXAMPLE】



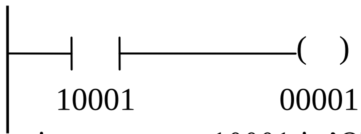
【Meaning】

When input contact 10001 is ’OFF’, coil 00001 is energized, and “B contact” 00001 becomes non-conductive, thus, coil 00002 is not energized.

(3) -( )- Output Coil:

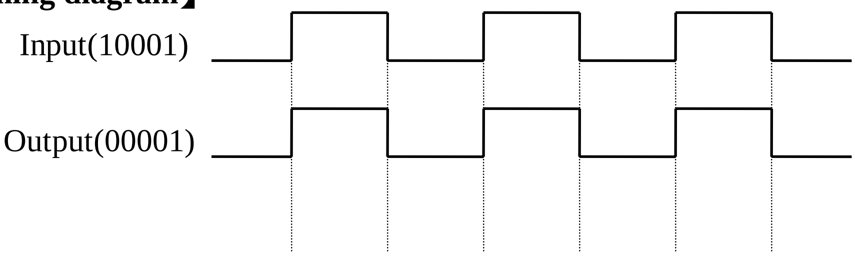
This output coil reflects the state of the elements connected to it. If the element is in the ‘ON’ state, then this coil is said to be energized; and vice versa.

【EXAMPLE】



【Meaning】 When input contact 10001 is ’ON’, then output coil 00001 is ‘ON’; When input contact 10001 is ’OFF’, then output coil 00001 is ‘OFF’

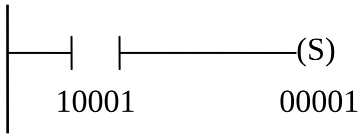
【Timing diagram】



(4) -(S)- Set Coil :

When the element connected to this coil is ‘ON’, then this set coil is set to ‘ON’ and remains in that “ON’ state until the “RESET coil” with the same reference number is energized.

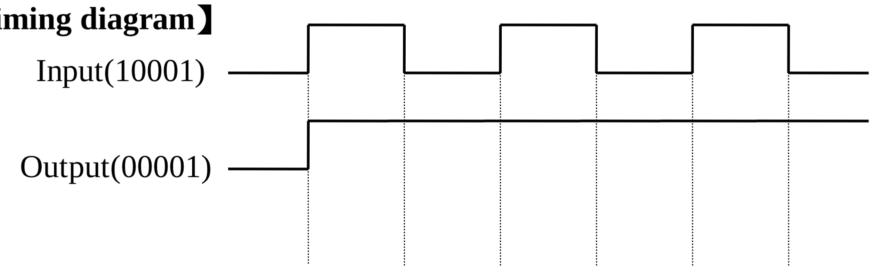
【EXAMPLE】



【Meaning】

When contact 10001 is ’ON’, the set coil 00001 is ‘ON’ and remains ‘ON’ no matter how contact 10001 is changed.

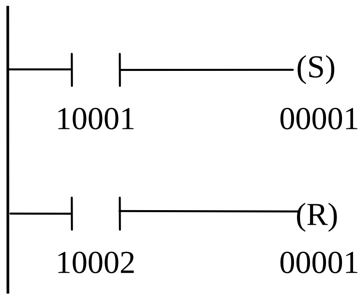
【Timing diagram】



(5) -(R)- Reset coil:

When the element connected to this coil is ‘ON’, then this set coil is set to ‘OFF’ and remains in that “OFF’ state until the “SET coil” with the same reference number is energized.

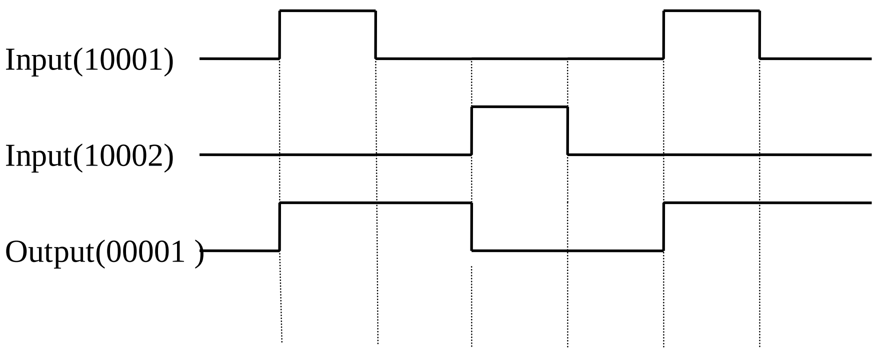
【EXAMPLE】



【Meaning】

When input contact 10001 is ’ON’, output coil 00001is set to ’ON’ and remains in that state. Until input contact 10001 is ‘OFF’ and input contact 10002 is ’ON’, then output coil 00001is set to ‘OFF’ and remains ‘OFF’.

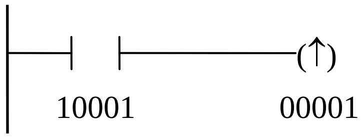
【Timing diagram】



(6) -(↑)- Positive Transitional Pulse Output Coil:

When the element connected to this output has an 'OFF'□'ON' transition, a pulse('OFF'□'ON') is generated for this output.

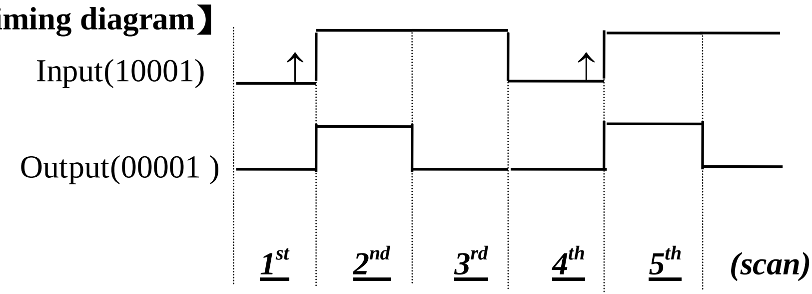
【EXAMPLE】



【Meaning】

When input contact 1000 receives a transition 'OFF'□'ON', then a pulse 'OFF'□'ON' is generated for output coil 00001. The width of the pulse is 1 scan time.

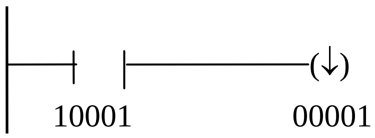
【Timing diagram】



(7) -(↓)- Negative Transitional Pulse Output Coil:

When the element connected to this output has an 'ON'□'OFF' transition, a pulse('OFF□'ON') is generated for this output.

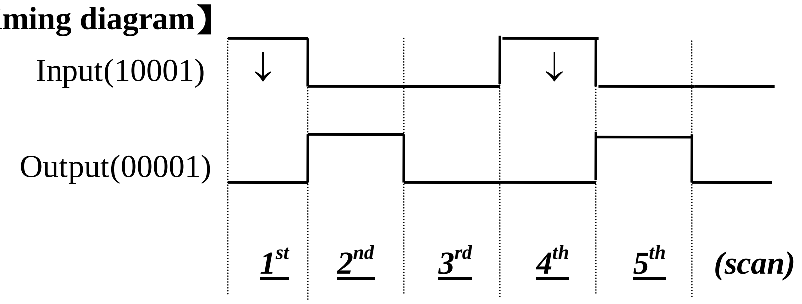
【EXAMPLE】



【Meaning】

When input contact 10001 receives a transition 'ON'□'OFF', then a pulse 'OFF'□'ON' is generated for output coil 00001. The width of the pulse is 1 scan time.

【**Timing diagram**】



(8) -(M)- Holding Coil during power loss:

This output coil reflects the state of the elements connected to it. If the element is in the 'ON' state, then this coil is said to be energized; and vice versa. The last state of the coil is maintained after system power is shut down and turned on again.

(9) -(SM)- Holding Set Coil during power loss:

When the element connected to this coil is 'ON', then this coil is set to 'ON' and remains in that "ON' state until the "RESET coil" with the same reference number is energized. The last state of the coil is maintained after system power is shut down and turned on again.

(10) -(RM)- Holding Reset Coil during power loss:

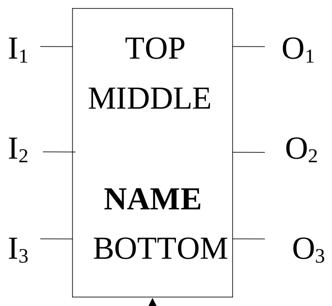
When the element connected to this coil is 'ON', then this coil is set to 'OFF' and remains in that "OFF' state until the "SET coil" with the same reference number is energized. The last state of the coil is maintained after system power is shut down and turned on again.

CHAPTER 3: FUNCTION BLOCKS

①

NAME	Full Name of Function Block	Level trigger	NAME Edge trigger

Symbol:



Operand:

	0	1	3	4	C	P	L
TOP NODE	○	○	○	○	①	○	
MIDDLE NODE							
BOTTOM NODE	○	○	○	○		○	

①0~65535

Description :

Node description:

TOP：

MIDDLE：

BOTTOM：

Input Control:

I_1 ：

I_2 ：

I_3 ：

Function Output:

O_1 ：

O_2：

O_3：

The template for the description of a function block is divided into ten areas (□~□). The meaning for each area is described as follows:

□ NAME:

NAME is an abbreviation or acronym for the operation performed by the function block. Two to four characters are used to represent the function. When displaying the ladder program on screen, the name of the function block is also displayed.

□ Full Name of Function Block:

The operation of the function block is given briefly in this area.

□ NAME:

This area is provided for easy reference to function blocks.

□Trigger mode:

The entry here is used to indicate the trigger mode of the function block. For “Level trigger” mode, when I1 is HIGH, then the function block is executed. For “Edge trigger” mode, when there is an OFF to ON transition, then the function block is executed. For edge-trigger function blocks, a “ ^ ” mark is prefixed to the name of the function block in the PP programming environment.

□ Symbol:

The symbol of the function block as used in this manual is displayed in the ladder diagram.

□ Operands

Operands available for the function block have a circle “○ “ marked in the table.

□ Function block description:

A brief description of the major function of the function block together with its input control, function output and result of the execution is given in this area.

□ Node description:

The usage of each node , whether it is a Source or a Destination, is given in this area.

□ Input Control:

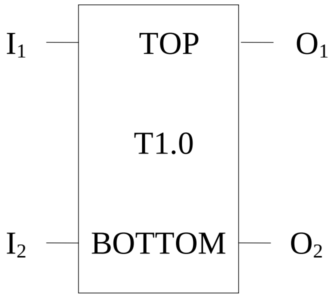
The condition(I_1) required for the function block to be executed is described here. The execution mode (I_2 and/or I_3) is also described here.

□ Function Output:

The results of the execution (O_1, O_2, O_3) are given in this area.

T1.0	**1.0 SECOND TIMER**

SYMBOL:



OPERANDS:

	0	**1**	**3**	**4**	**C**	**P**	**L**
TOP			○	○	①		
BOTTOM				○			

①0~65535

Description:

Timer increments by one at intervals of one second. When the accumulated time (stored in the BOTTOM node) reaches the timer preset (stored in TOP node), the timer stops. Input control can be used to start, stop and reset the timer. The timer status (whether the elapsed time has reached the preset time) can be detected by examining the function output.

Node description:

TOP: Preset value for timer.

BOTTOM: Accumulated value since timer started.

Input Control:

I_1 ：Execution control. When $I_1 = 1$, timer starts; $I_1 = 0$, timer stops.

I_2 ：Reset control, when $I_2 = 0$, the accumulated value is cleared to zero.

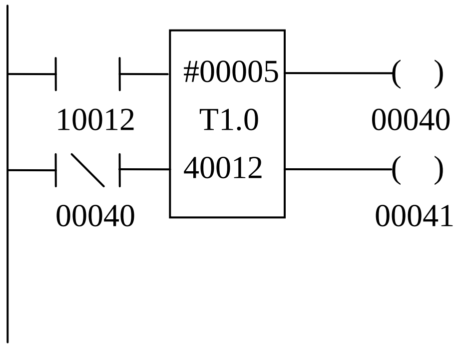
Function Output:

O_1 =1, if accumulated value **=** preset value.

=0, if accumulated value ＜ preset value.

O_2: Complement of O_1

【EXAMPLE】



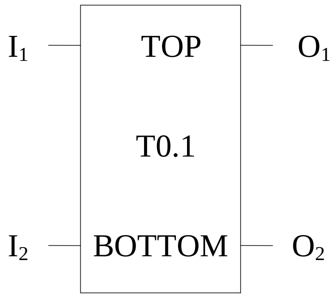
【DESCRIPTION】

This example shows a five-second timer. The decomposition of actions are:

1. 40012 is 0, then 00040='OFF' and 00041='ON' at the beginning.
2. When input control 10012 is 'ON', register 40012 increments by one for every one second.
3. When the content of register 40012 = 5 (as defined in the top node), the function output: 00040 = 'ON', 00041 = 'OFF'.
4. Since 00040 = 'ON', I_2 changes to 'OFF', and clears register 40012 to '0'.
5. Since 40012 = 0, then 00040 = 'OFF', 00041 = 'ON', register 40012 continues incrementing, and the execution continues from STEP 3.

T0.1 — 0.1 SECOND TIMER

SYMBOL:



OPERANDS:

	0	1	3	4	C	P	L
TOP			○	○	①		
BOTTOM				○			

①0~65535

Description:

Timer increments by one at intervals of 0.1 second. When the accumulated time (stored in the BOTTOM node) reaches the timer preset (stored in TOP node), the timer stops. Input control can be used to start, stop and reset the timer. The timer status (whether the elapsed time has reached the preset time) can be detected by examining the function output.

Node description:

TOP: Preset value for timer.

BOTTOM: Accumulated value since timer started.

Input Control:

I_1 ： Execution control. When $I_1 = 1$, timer starts; $I_1 = 0$, timer stops.

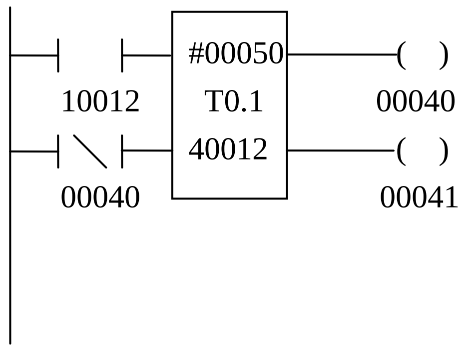
I_2 ：Reset control, when $I_2 = 0$, the accumulated value is cleared to zero.

Function Output:

O_1 =1, if accumulated value = preset value.
=0, if accumulated value ＜ preset value.

O_2: Complement of O_1

【EXAMPLE】



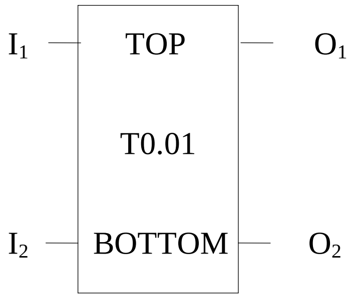
【DESCRIPTION】

This example shows a five-second timer. The decomposition of actions are:

1. 40012 is 0, then 00040='OFF' and 00041='ON' at the beginning.
2. When input control 10012 is 'ON', register 40012 increments by one for every one second.
3. When the content of register 40012 = 50 (as defined in the top node), the function output: 00040 = 'ON', 00041 = 'OFF'.
4. Since 00040 = 'ON', I_2 changes to 'OFF', and clears register 40012 to '0'.
5. Since 40012 = 0, then 00040 = 'OFF', 00041 = 'ON', register 40012 continues incrementing, and the execution continues from STEP 3.

T0.01	**0.01 SECOND TIMER**

SYMBOL:



OPERANDS:

	0	**1**	**3**	**4**	**C**	**P**	**L**
TOP			○	○	①		
BOTTOM				○			

①0~65535

Description:

Timer increments by one at intervals of 0.01 second. When the accumulated time (stored in the BOTTOM node) reaches the timer preset (stored in TOP node), the timer stops. Input control can be used to start, stop and reset the timer. The timer status (whether the elapsed time has reached the preset time) can be detected by examining the function output.

Node description:

TOP: Preset value for timer.

BOTTOM: Accumulated value since timer started.

Input Control:

I_1： Execution control. When $I_1 = 1$, timer starts; $I_1 = 0$, timer stops.

I_2：Reset control, when $I_2 = 0$, the accumulated value is cleared to zero.

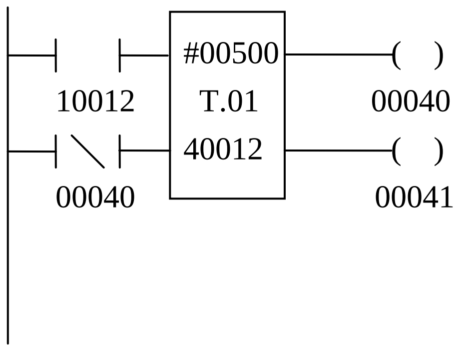
Function Output:

O_1 =1, if accumulated value = preset value.

=0, if accumulated value ＜ preset value.

O_2: Complement of O_1

【EXAMPLE】



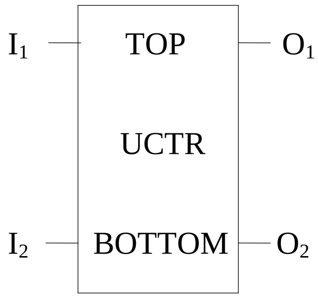
【DESCRIPTION】

This example shows a five-second timer. The decomposition of actions are:

1. 40012 is 0, then 00040 = ’OFF’ and 00041 = ’ON’ at the beginning.
2. When input control 10012 is ’ON’, register 40012 increments by one for every 0.01 second.
3. When the content of register 40012 = 500 (as defined in the top node), the function output: 00040 = ‘ON’, 00041 = ‘OFF’.
4. Since 00040 = ‘ON’, I_2 changes to ’OFF’, and clears register 40012 to ’0’.
5. Since 40012 = 0, then 00040 = ’OFF’, register 40012 continues incrementing, and the execution continues from STEP 3.

UCTR	**UP COUNTER**		

SYMBOL:



OPERANDS:

	0	**1**	**3**	**4**	**C**	**P**	**L**
TOP			○	○	①		
BOTTOM				○			

①0~65535

Description:

This counter counts the pulses presented at I_1 from 0 to a preset value. Input control can be used to start, stop and reset the counter. The counter status (whether the accumulated value has reached the preset value) can be detected by examining the function output.

Node description:

TOP: Preset value for counter.

BOTTOM: Accumulated value since counter started.

Input Control:

I_1 ： Counter control. When I_1 receives an ’OFF’□’ON’ transition, The counter is incremented by 1.

I_2 ： Reset control. When $I_2 = 0$, the accumulated value is cleared to zero.

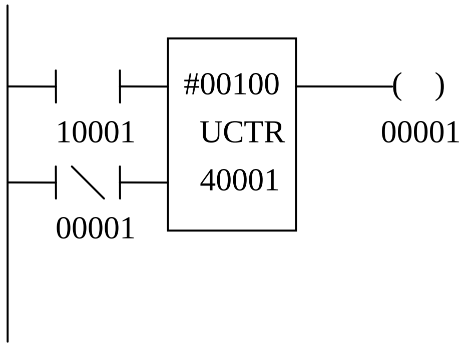
Function Output:

O_1 =1, if accumulated value=preset value.

=0, if accumulated value < preset value.

O_2: Complement of O_1

【EXAMPLE】

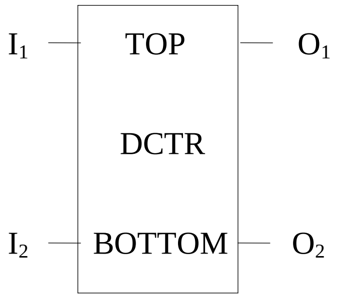


【DESCRIPTION】

When contact 10001 receives an OFF to ON transition, the accumulated value of the counter (40001) is incremented by 1. When the accumulated value reaches 100, coil 00001 is energized. When normal-close contact 00001 opens, the counter is reset.

DCTR	**DOWN COUNTER**		

SYMBOL:



OPERANDS:

	0	1	3	4	C	P	L
TOP			○	○	①		
BOTTOM				○			

①0~65535

Description:

This counter counts the pulses presented at I_1 from a preset value to 0. Input control can be used to start, stop and reset the counter. The counter status (whether the accumulated value has reached 0) can be detected by examining the function output.

Node description:

TOP: Preset value for counter.

BOTTOM: Accumulated value since counter started.

Input Control:

I_1 ：Counter control. When I_1 receives an ’OFF’□’ON’ transition, the counter is decreased by 1.

I_2 ：Reset control. When $I_2 = 0$, the accumulated value is set to preset value.

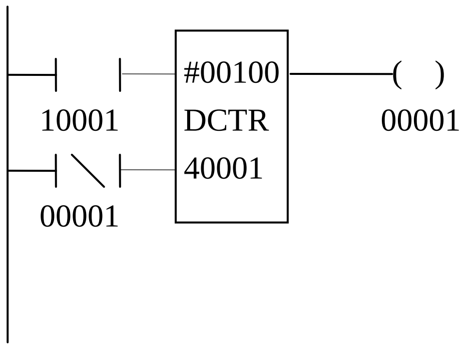
Function Output:

O_1 =1, if accumulated value=0.

=0, if accumulated value > 0.

O_2: Complement of O_1

【EXAMPLE】

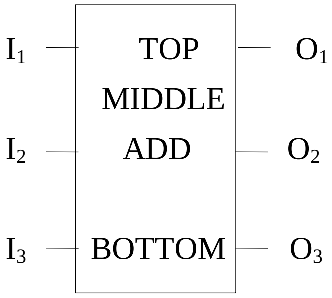


【DESCRIPTION】

When contact 10001 receives an OFF to ON transition, the accumulated value of the counter (40001) is decreased by 1. When the accumulated value reaches 0, coil 00001 is energized. When normal-close contact 00001opens, the counter is reset, and the value in counter (40001) is set to 100.

			ADD
ADD	**FOUR DIGIT DECIMAL ADDER**	⎍	↑⎍

SYMBOL:



OPERANDS:

	0	1	3	4	C	P	L
TOP			○	○	①	○	
MIDDLE			○	○	①	○	
BOTTOM				○		○	

①0~9999

word＋word→word (Decimal)

Description:

The decimal values stored in the top and middle nodes are added and the sum is stored in the bottom node.

Sum = (top + middle + I_3) MOD 10000.

Input control (I_1) is used to determine whether this function block is to be executed or not.

Function output (O_3) may be used to determine whether or not an overflow has occurred.

Node Description:

TOP: Summand, must be < 10000.

MIDDLE: Addend, must be < 10000.

BOTTOM:1.(top + middle + I_3) MOD 10000

2.If error (ref. to O_2) occurred, the content of the bottom node remains unchanged.

Input Control:

I_1: When ⎍ (↑⎍) is presented, the function block is executed.

I_2 : error in

I_3 : carry in

Function Output:

$O_1 = I_1$

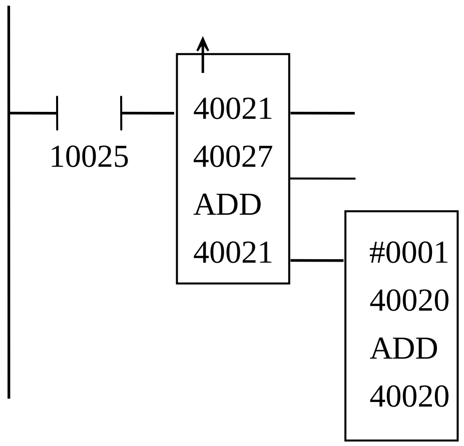
O_2 = error output (O_2 is ‘1’ if I_2 is ‘1’ or the value of either top node or middle node is over 9999)

O_3 ：overflow/carry

= 1, Sum ＞9999

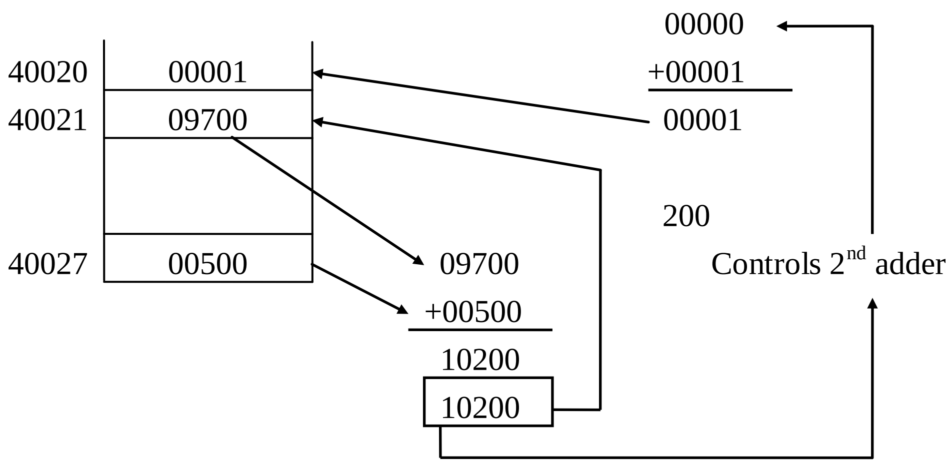
= 0, Sum ≦9999

【EXAMPLE】



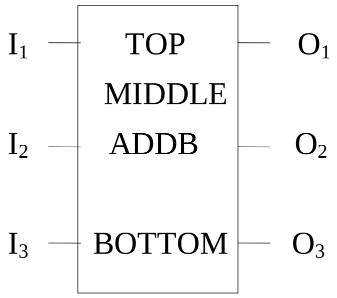
【DESCRIPTION】

When the contact 10025 has an “OFF→ON”, the content of register 40021 is added to the content of register 40027 and the sum is stored back to register (40021). Since the sum is larger than 9999, therefore, the second adder is energized.



ADDB	FOUR DIGIT HEXADECIMAL ADDER		

SYMBOL:



OPERANDS

	0	1	3	4	C	P	L
TOP			○	○	①	○	
MIDDLE			○	○	①	○	
BOTTOM				○		○	

①0~65535

word＋word→word (hexadecimal)

Description:

The values (hexadecimal) stored in the top and middle nodes are added and the sum is stored in the bottom node. Sum = (top + middle) MOD 65536.

Input control (I_1) is used to determine whether this function block is to be executed or not.

Function output (O_3) may be used to determine whether or not an overflow has occurred.

Node Description:

TOP: Summand, must be ＜65535.

MIDDLE: Addend, must be ＜65535.

BOTTOM: Sum < 65535. The carry , if any, is ignored.

Input Control:

I_1: When ⎍ (↑) is presented, the function block is executed.

Function Output:

$O_1 = I_1$

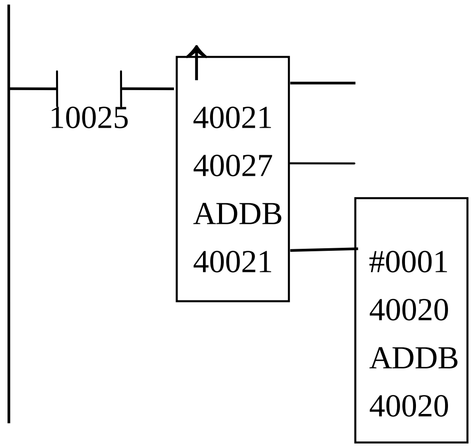
$O_2 = 0$

O_3：overflow

= 1, Sum ＞65535

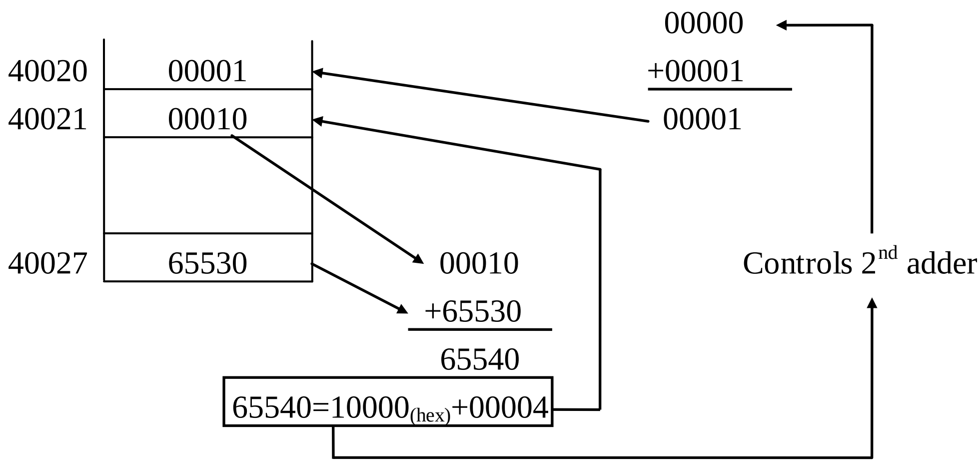
= 0, Sum ≦65535

【EXAMPLE】



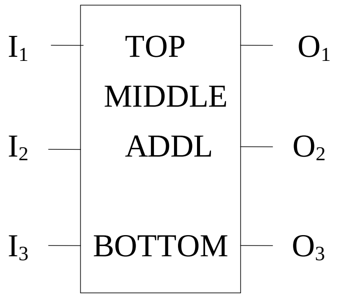
【DESCRIPTION】

When contact 10025 is energized, the content of register 40021 is added to the content of register 40027 and the sum is stored back to register 40021. Since the sum is larger than 65535, therefore, the second adder is energized.



ADDL	EIGHT DIGIT DECIMAL ADDER		

SYMBOL:



OPERANDS:

	0	1	3	4	C	P	L
TOP				○		○	
MIDDLE				○	①	○	
BOTTOM				○		○	

① 0~9999

Lword ＋ Lword → Lword (Decimal)

Description:

The values (long word, decimal) stored in the top and middle nodes are added and the sum is stored in the bottom node. Sum = MOD (top + middle + I_3) MOD 100000000.

Input control (I_1) is used to determine whether this function block is to be executed or not.

Function output (O_3) may be used to determine whether or not an overflow has occurred.

Node Description:

TOP: Summand, must be ＜100000000.

MIDDLE: Addend, must be ＜100000000.

BOTTOM :1.(top + middle + I_3) MOD 10000000.

2.If error (refer to O_2) occurred, the content of the bottom node remains unchanged.

Input Control:

I_1: When ( ) is presented, the function block is executed.

I_2: error in

I_3: carry in

Function Output:

$O_1 = I_1$

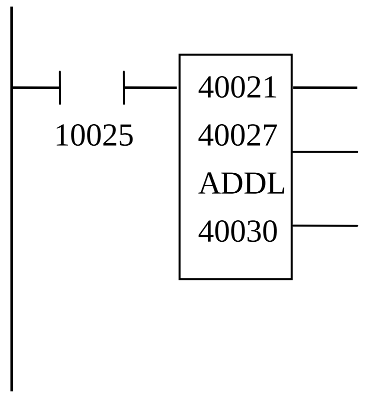
O_2 = error output (O_2 is ‘1’ if I_2 is ‘1’ or the value of either top node or middle node is over 99999999.)

O_3 ：overflow/carry

= 1, Sum ＞99999999

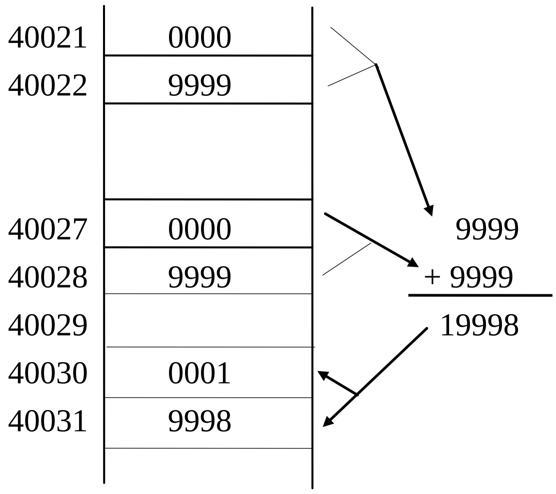
= 0, Sum ≦99999999

【EXAMPLE】



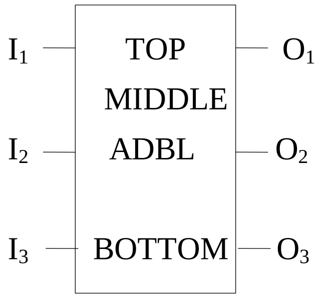
【DESCRIPTION】

When contact 10025 is "ON', the content of registers 40027/40028 is added to the content of registers 40021/40022. The sum is stored in registers 40030/40031. Since the sum is less then 99999999, thus, O_1 ：ON, $O_2 = O_3$ = OFF.



ADBL	EIGHT DIGIT HEXADECIMAL ADDER	⎍	↑⎍

SYMBOL:



OPERANDS

	0	1	3	4	C	P	L
TOP				○		○	
MIDDLE				○	①	○	
BOTTOM				○		○	

①0~65535

Lword＋Lword→ Lword (Hexadecimal)

Description:

The values (long word, hexadecimal) stored in the top and middle nodes are added and the sum is stored in the bottom node. Sum = MOD(top+middle)FFFFFFFF.

Input control (I_1) is used to determine whether this function block is to be executed or not.

Function output (O_3) may be used to determine whether or not an overflow has occurred.

Node Description:

TOP: Summand, must be ＜100000000 $_{hex}$.

MIDDLE: Addend, must be ＜100000000 $_{hex}$.

BOTTOM: Sum < 100000000 $_{hex}$. The carry , if any, is ignored.

Input Control:

I_1: When ⎍ (↑⎍) is presented, the function block is executed.

Function Output:

$O_1 = I_1$

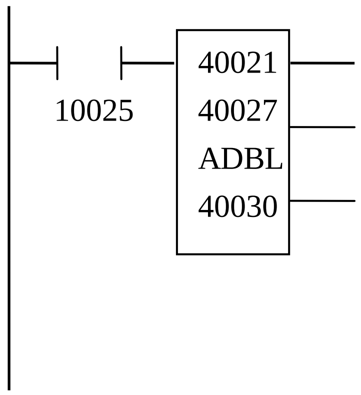
$O_2 = 0$

O_3 ：overflow

=1, Sum＞4294967295 (=100000000$_{hex}$)

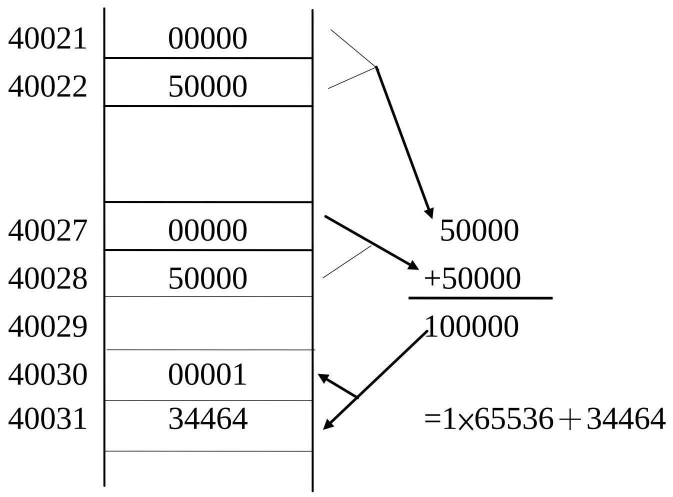
=0, Sum≦4294967295 (=100000000$_{hex}$)

【EXAMPLE】



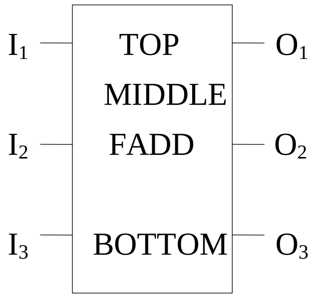
【DESCRIPTION】

When contact 10025 is "ON', the content of registers 40027 & 40028 is added to the content of registers 40021/40022. The sum is stored in the registers 40030 & 40031.



FADD	FLOATING POINT ADDER		

SYMBOL:



OPERANDS:

	0	1	3	4	C	P	L
TOP				○		○	
MIDDLE				○	□	○	
BOTTOM				○		○	

□0~65535

float ＋ float → float

Description:

The values (floating point) stored in the top and middle nodes are added and the sum is stored in the bottom node.

Input control (I_1) is used to determine whether this function block is to be executed or not.

Node Description:

TOP: Summand.

MIDDLE: Addend.

BOTTOM: Sum.

Input Control:

I_1: When ( ) is presented, the function block is executed.

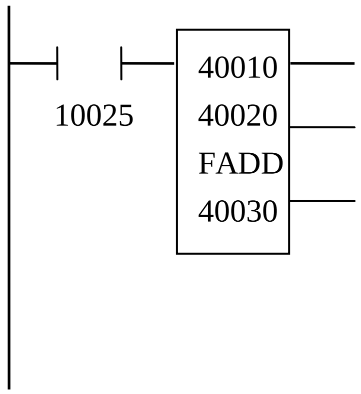
Function Output:

$O_1 = I_1$

$O_2 = 0$

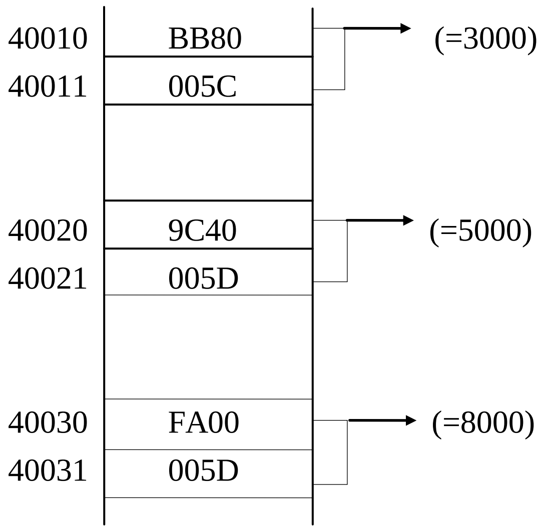
$O_3 = 0$

【EXAMPLE】



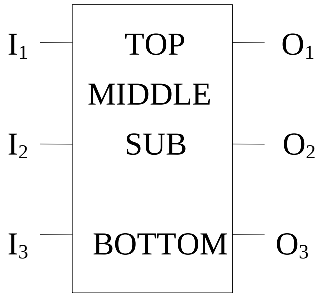
【DESCRIPTION】

When contact 10025 is "ON', the content of registers 40010/40011 is added to the content of registers 40020/40021; the sum is stored in registers 40030/40031; and O_1 ：ON, $O_2 = O_3 =$ OFF.



SUB	FOUR DIGIT DECIMAL SUBTRACTOR

SYMBOL:



OPERANDS:

	0	1	3	4	C	P	L
TOP			○	○	①	○	
MIDDLE			○	○	①	○	
BOTTOM				○		○	

①0~9999

word－word→word (Decimal)

Description:

The value stored in the middle node is subtracted from the top node, and the difference is stored in the bottom node.

Input control (I_1) is used to determine whether this function block is to be executed or not.

Function output may be used to determine the relationship between minuend and subtrahend (＞, **=,** ＜).

Node Description:

TOP: Minuend, must be ＜10000.

MIDDLE: Subtrahend, must be ＜10000.

BOTTOM: Difference.

Input Control:

I_1: When ( ) is presented, the function block is executed.

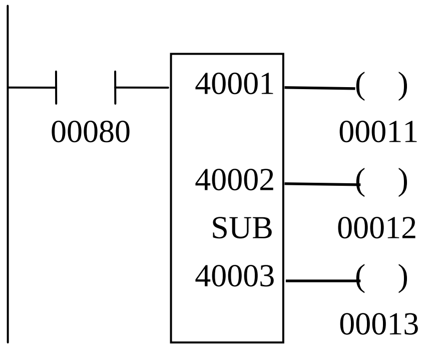
Function Output:

O_1 = 1, if difference > 0 (Top node > Middle node).

O_2 = 1, if difference = 0 (Top node = Middle node).

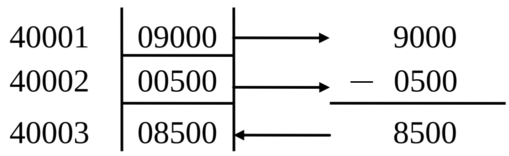
O_3 = 1, if difference < 0 (Top node < Middle node).

【EXAMPLE】



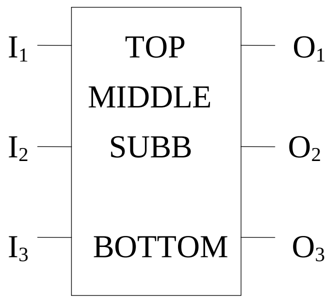
【DESCRIPTION】

Assume that register (40001)=9000(10), and (40002)=500(10). when contact 00080 is ’ON’, the subtraction: **(40003)=(40001)－(40002)** is performed. Since the minuend is larger than the subtrahend, thus coil 00011 is ‘ON’, 00012 is ‘OFF’ and 00013 is ‘OFF’.



SUBB	FOUR DIGIT HEXADECIMAL SUBTRACTOR		

SYMBOL:



OPERANDS:

	0	1	3	4	C	P	L
TOP			○	○	①	○	
MIDDLE			○	○	①	○	
BOTTOM				○		○	

①0~65535

word－word→word (Binary)

Description:

The value stored in the middle node is subtracted from the top node, and the difference is stored in the bottom node.

Input control (I_1) is used to determine whether this function block is to be executed or not.

Function output may be used to determine the relationship between minuend and subtrahend (＞、=、＜).

Node Description:

TOP: Minuend

MIDDLE: Subtrahend

BOTTOM: Difference.

Input Control:

I_1: When ( ) is presented, the function block is executed.

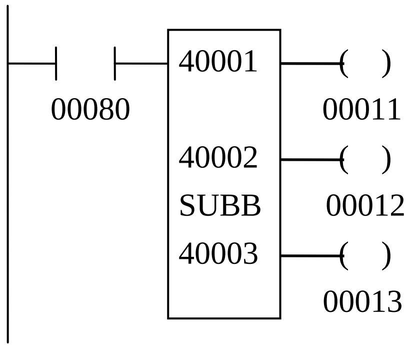
Function Output:

O_1 = 1, if difference > 0.

O_2 = 1, if difference = 0.

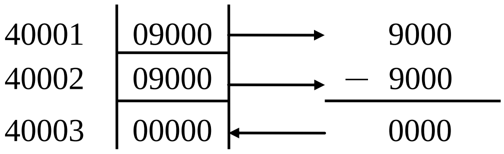
O_3 = 1, if difference < 0.

【EXAMPLE】



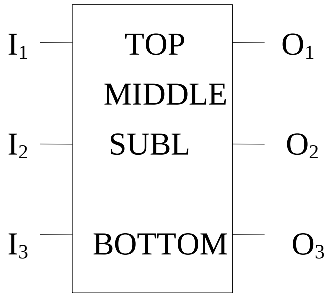
【DESCRIPTION】

Assume that register (40001)=9000(10), and (40002)=9000(10). when contact 00080 is ’ON’, the subtraction: **(40003)=(40001)－(40002)** is performed. Since the minuend is equal to the subtrahend, thus coil 00012 is ‘ON’.



SUBL	EIGHT DIGIT DECIMAL SUBTRACTOR		

SYMBOL:



OPERANDS:

	0	1	3	4	C	P	L
TOP				○	□	○	
MIDDLE				○	□	○	
BOTTOM				○		○	

□0~65535

Lword－Lword→Lword (Decimal)

Description:

The value stored in the middle node is subtracted from the top node, and the difference is stored in the bottom node.

Input control (I_1) is used to determine whether this function block is to be executed or not.

Function output may be used to determine the relationship between minuend and subtrahend (＞, =, ＜).

Node Description:

TOP: Minuend, must be ＜=99999999.

MIDDLE: Subtrahend, must be ＜=99999999.

BOTTOM: Difference.

|

Input Control:

I_1: When ( ) is presented, the function block is executed.

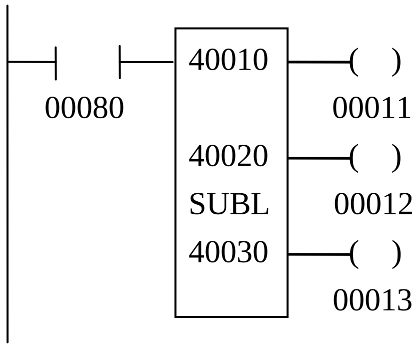
Function Output:

O_1 = 1, if difference > 0.

O_2 = 1, if difference = 0.

O_3 = 1, if difference < 0.

【EXAMPLE】



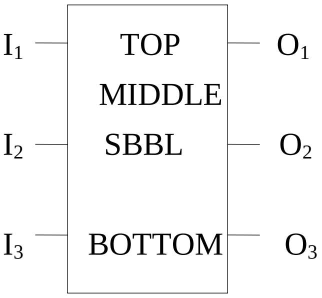
【DESCRIPTION】

Assume that long word(40010)=9999(10) and long word(40020)=9999(10.). when contact 00080is 'ON', the operation: long word**(40030)=long word(40010)－long word(40020)** is performed. Since the minuend is equal to the subtrahend, thus coil 00012 is 'ON'.

40010	0000
40011	9999
40020	0000
40021	9999
40030	0000
40031	0000

SBBL	EIGHT DIGIT HEXADECIMAL SUBTRACTOR		

SYMBOL:



OPERANDS:

	0	1	3	4	C	P	L
TOP				○	□	○	
MIDDLE				○	□	○	
BOTTOM				○		○	

□0~65535

Lword－Lword→Lword(Binary)

Description:

The value stored in the middle node is subtracted from the top node, and the difference is stored in the bottom node.

Input control (I_1) is used to determine whether this function block is to be executed or not.

Function output may be used to determine the relationship between minuend and subtrahend (＞, =, ＜).

Node Description:

TOP: Minuend.

MIDDLE: Subtrahend.

BOTTOM: Difference .

Input Control:

I_1: When ⎍ (↑⎍) is presented, the function block is executed.

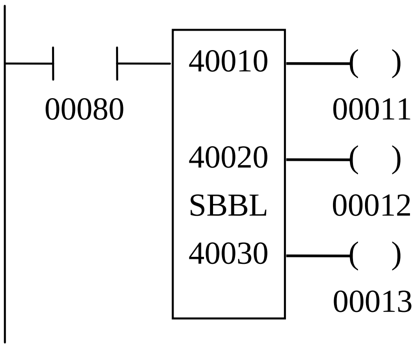
Function Output:

$O_1 = 1$, if difference > 0.

$O_2 = 1$, if difference = 0.

$O_3 = 1$, if difference < 0.

【EXAMPLE】



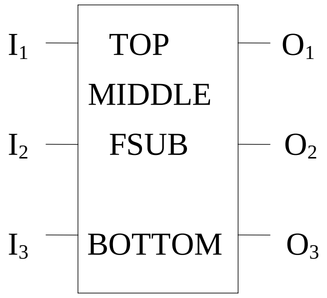
【DESCRIPTION】

Assume that long word(40010)= 65536(10) and long word(40020)= 65536(10). when contact 00080 is 'ON', the operation: long word**(40030)=long word(40010)－long word(40020)** is performed. Since the minuend is equal to the subtrahend, thus coil 00012 is 'ON'.

40010	0001
40011	0000
40020	0001
40021	0000
40030	0000
40031	0000

FSUB	**FLOATING POINT SUBTRACTOR**		FSUB

SYMBOL:



OPERANDS:

	0	1	3	4	C	P	L
TOP				○	□	○	
MIDDLE				○	□	○	
BOTTOM				○		○	

□0~65535

Float－float→float

Description:

The value stored in the middle node is subtracted from the top node, and the difference is stored in the bottom node.

Input control (I_1) is used to determine whether this function block is to be executed or not.

Function output may be used to determine the relationship between minuend and subtrahend (＞, =, ＜).

Node Description:

TOP: Minuend.

MIDDLE: Subtrahend.

BOTTOM: Difference.

Input Control:

I_1: When ( ) is presented, the function block is executed.

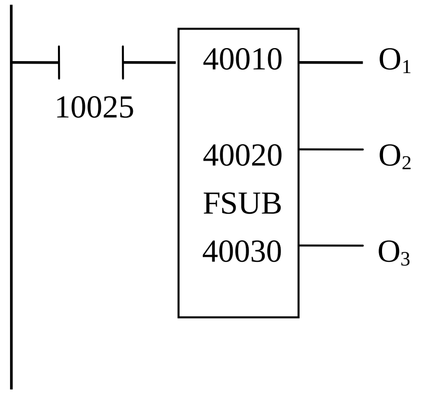
Function Output:

O_1 = 1, if difference > 0.

O_2 = 1, if difference = 0.

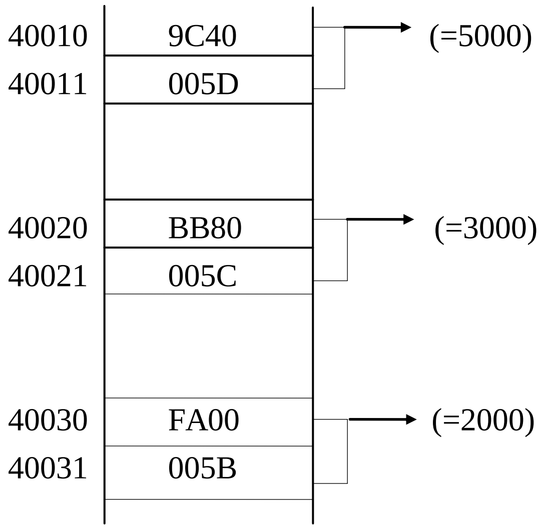
O_3 = 1, if difference < 0.

【EXAMPLE】



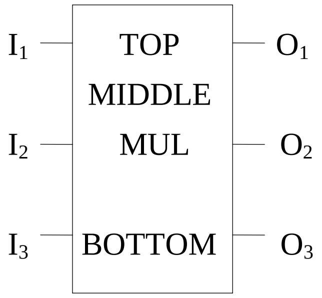
【DESCRIPTION】

When contact 10025 is "ON', the content of registers 40020/40021 is subtracted from the content of registers 40010/40011; the difference is stored in registers 40030/40031. Since the minuend is greater than the subtrahend, thus O_1 ：ON, $O_2 = O_3$ = OFF.



MUL	FOUR DIGIT DECIMAL MULTIPLIER		

SYMBOL:



OPERANDS:

	0	1	3	4	C	P	L
TOP			○	○		○	
MIDDLE			○	○	①	○	
BOTTOM				○		○	

①0~9999

word × word→Lword (Decimal)

Description:

The value in the top node is multiplied by the value in the middle node, and the product is stored in the bottom node(long word).

Input control (I_1) is used to determine whether this function block is to be executed or not.

Function output (O_3) may be used to determine whether or not an overflow has occurred.

Node Description:

TOP: Multiplicand, must be <=9999.

MIDDLE: Multiplier, must be <=9999.

BOTTOM :1.Product, Long word.

2.If error (refer to O_2) occurred, the content of the bottom node remains unchanged.

Input Control:

I_1: When ( ) is presented, the function block is executed.

I_2: error in

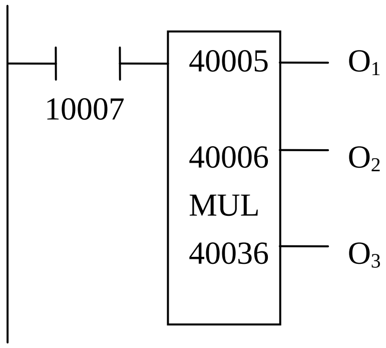
Function Output:

$O_1 = I_1$

$O_2 = 1$ (If the value of either top node or middle node is greater than 9999).

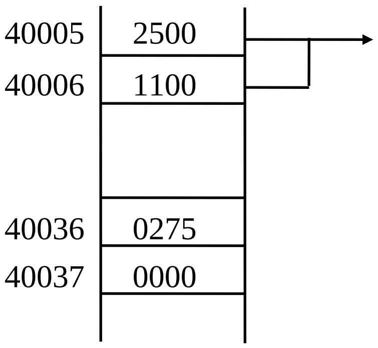
O_3 ：0

【EXAMPLE】



【DESCRIPTION】

Let register(40005)=2500 and (40006)=1100. When contact 10007 is ‘ON’, the operation: long word (40036)=(40005)×(40006) is performed.

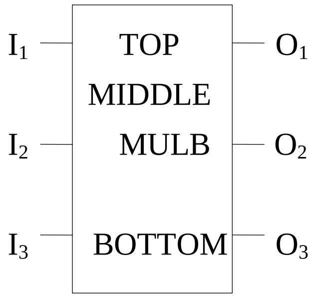


2500×1100 = 2750000

The product is stored in registers 40036/40037.

MULB	FOUR DIGIT HEXADECIMAL MULTIPLIER		

SYMBOL:



OPERANDS:

	0	1	3	4	C	P	L
TOP			○	○		○	
MIDDLE			○	○	①	○	
BOTTOM				○		○	

①0~65535

word ×word→Lword (Binary)

Description:

The value in the top node is multiplied by the value in the middle node, and the product is stored in the bottom node(long word).

Input control (I_1) is used to determine whether this function block is to be executed or not.

Node Description:

TOP: Multiplicand.

MIDDLE: Multiplier.

BOTTOM: Product, Long word.

Input Control:

I_1: When ( ) is presented, the function block is executed.

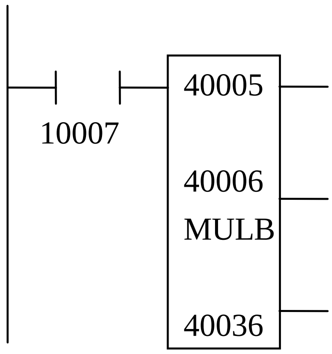
Function Output:

$O_1 = I_1$

$O_2 = 0$

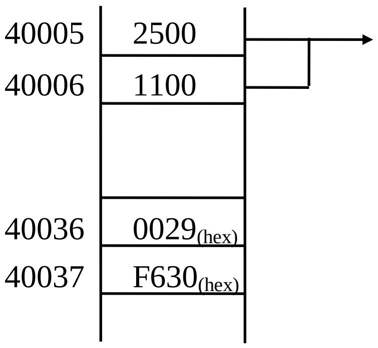
$O_3 = 0$

【EXAMPLE】



【DESCRIPTION】

Let register(40005)=2500 and (40006)=1100. When contact 10007 is ‘ON’, the operation: long word (40036)=(40005)×(40006) is performed.

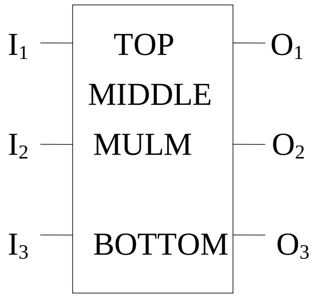


2500×1100 = 2750000

The product is stored in registers 40036/40037.

MULM	FOUR DIGIT DECIMAL MULTIPLIER		

SYMBOL:



OPERANDS:

	0	1	3	4	C	P	L
TOP			○	○		○	
MIDDLE			○	○	①	○	
BOTTOM				○		○	

①0~9999

word × word→word (Decimal)

Description:

The value in the top node is multiplied by the value in the middle node, and the product is stored in the bottom node(long word).

Input control (I_1) is used to determine whether this function block is to be executed or not.

Function output (O_3) may be used to determine whether or not an overflow has occurred .

Node Description:

TOP: Multiplicand (<= 9999).

MIDDLE: Multiplier(<=9999).

BOTTOM:1.Product.

2.If error (refer to O_2) occurred, the content of the bottom node remains unchanged.

Input Control:

I_1: When ( ) is presented, the function block is executed.

I_2: error in.

Function Output:

$O_1 = I_1$

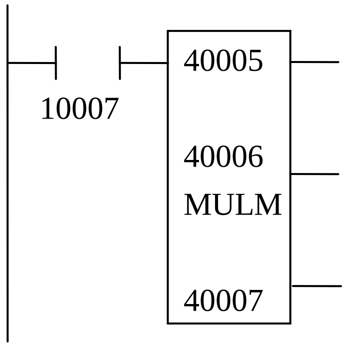
O_2 =1 (If the value of either top node or middle node is greater than 9999, or I_2 = 1)

O_3：Overflow

=1，Product≧10000

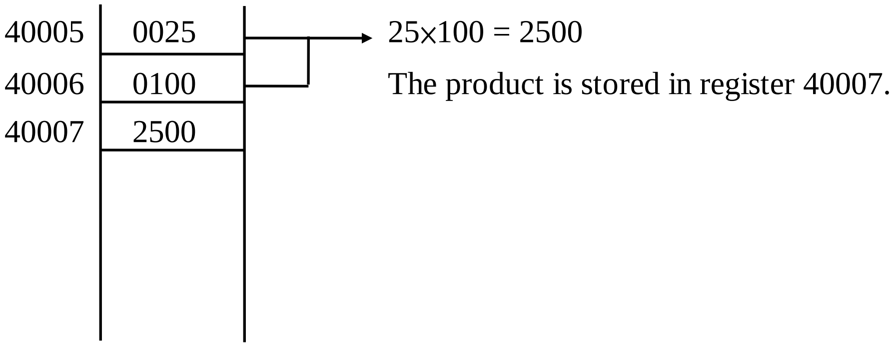
=0，Product＜10000

【EXAMPLE】



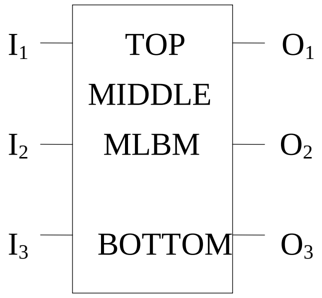
【DESCRIPTION】

Let register(40005)=25 and (40006)=100. When contact 10007 is ‘ON’, the operation: (40036)=(40005)×(40006) is performed.



MLBM	FOUR DIGIT HEXADECIMAL MULTIPLIER

SYMBOL:



OPERANDS:

	0	1	3	4	C	P	L
TOP			○	○		○	
MIDDLE			○	○	①	○	
BOTTOM				○		○	

①0~65535

word × word→word (Binary)

Description:

The value in the top node is multiplied by the value in the middle node, and the product is stored in the bottom node(long word).

Input control (I_1) is used to determine whether this function block is to be executed or not.

Function output (O_3) may be used to determine whether or not an overflow has occurred .

Node Description:

TOP: Multiplicand.

MIDDLE: Multiplier.

BOTTOM: Product.

Input Control:

I_1: When ⎍ (↑⎍) is presented, the function block is executed.

Function Output:

$O_1 = I_1$

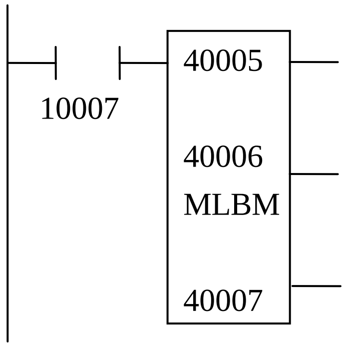
$O_2 = 0$

O_3：Overflow

=1，Product≧65536

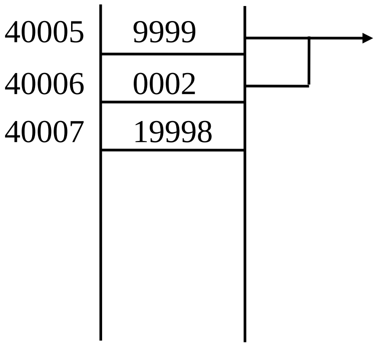
=0，Product＜65536

【EXAMPLE】



【DESCRIPTION】

Let register(40005)=9999 and (40006)=2. When contact 10007 is ‘ON’, the operation: (40036)=(40005)×(40006) is performed.

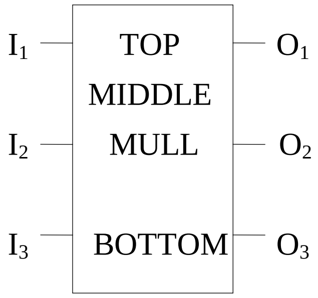


9999×2 = 19998

The product is stored in register 40007.

MULL	EIGHT DIGIT DECIMAL MULTIPLIER		

SYMBOL:



OPERANDS:

	0	1	3	4	C	P	L
TOP				○		○	
MIDDLE				○	①	○	
BOTTOM				○		○	

①0~65535

Lword × Lword→Lword (Decimal)

Description:

The value in the top node is multiplied by the value in the middle node, and the product is stored in the bottom node. All operands are long words.

Input control (I_1) is used to determine whether this function block is to be executed or not.

Function output (O_3) may be used to determine whether or not an overflow has occurred .

Node Description:

TOP: Multiplicand, must be <= 99999999.

MIDDLE: Multiplier, must be <= 99999999.

BOTTOM :1. Product.

2.If error (refer to O_2) occurred, the content of the bottom node remains unchanged.

Input Control:

I_1: When ( ) is presented, the function block is executed.

I_2: error in

Function Output:

$O_1 = I_1$

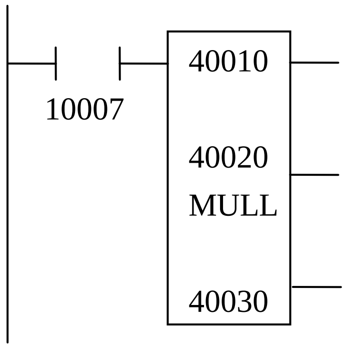
O_2 = 1 (If the value of either top node or middle node is greater than 99999999, or I_2 = 1).

O_3：Overflow

=1，Product≧100000000

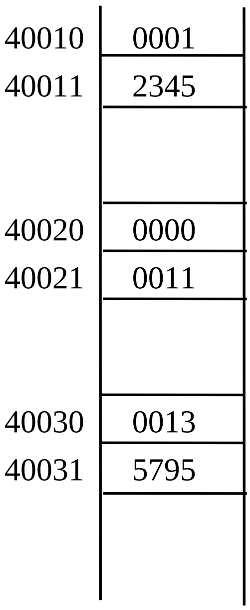
=0，Product＜100000000

【EXAMPLE】



【DESCRIPTION】

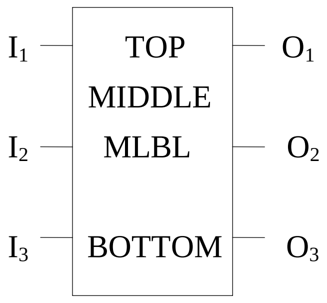
Let register(40010/40011)=12345 and (40020/40021)=11. When contact 10007 is ‘ON’, the operation: long word(40030)=long word(40010)×long word(40020) is performed.



DECIMAL

MLBL	**EIGHT DIGIT HEXADECIMAL MULTIPLIER**

SYMBIL:



OPERANDS:

	0	**1**	**3**	**4**	**C**	**P**	**L**
TOP				○		○	
MIDDLE				○	①	○	
BOTTOM				○		○	

①0~65535

Lword × Lword→Lword (Binary)

Description:

The value in the top node is multiplied by the value in the middle node, and the product is stored in the bottom node. All operands are long words.

Input control (I_1) is used to determine whether this function block is to be executed or not.

Function output (O_3) may be used to determine whether or not an overflow has occurred .

Node Description:

TOP: Multiplicand.

MIDDLE: Multiplier.

BOTTOM: Product.

Input Control:

I_1: When ( ) is presented, the function block is executed.

Function Output:

$O_1 = I_1$

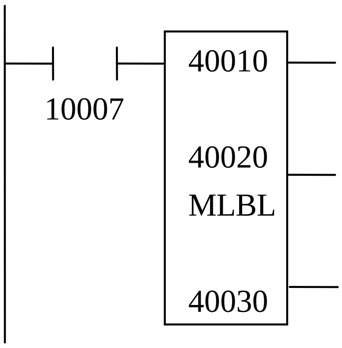
$O_2 = 0$

O_3 ：Overflow

=1, Product＞= 4294967296 (=100000000$_{hex}$)

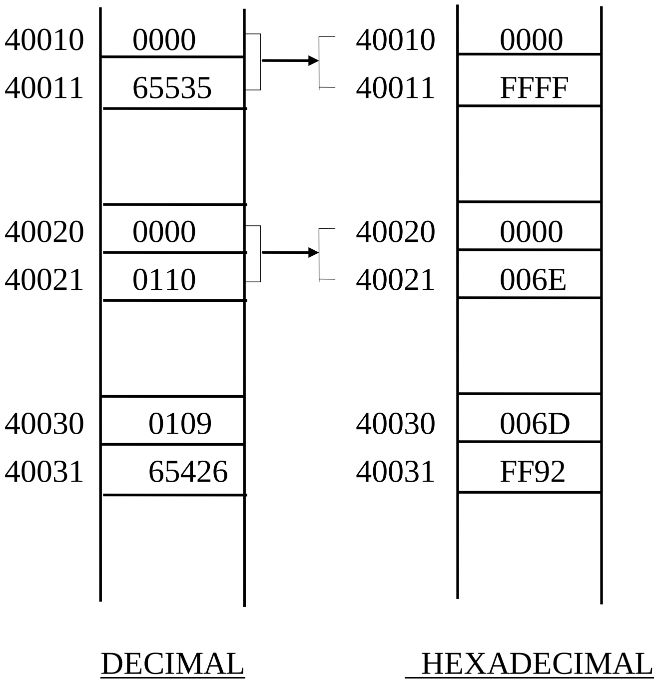
=0, Product＜ 4294967296 (=100000000$_{hex}$)

【EXAMPLE】



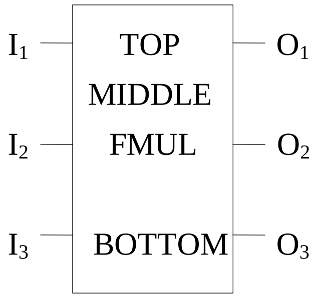
【DESCRIPTION】

Let register(40010/40011)=65535 and (40020/40021)=11. When contact 10007 is ‘ON’, the operation: long word(40030)=long word(40010)×long word(40020) is performed.



FMUL	FLOATING POINT MULTIPLIER

SYMBOL:



OPERANDS:

	0	1	3	4	C	P	L
TOP				○		○	
MIDDLE				○	①	○	
BOTTOM				○		○	

①0~65535

float × float→float

Description:

The value stored in the top node is multiplied by the value in the middle node, and the product is stored in the bottom node. All operands are long words.

Input control (I_1) is used to determine whether this function block is to be executed or not.

Node Description:

TOP: Multiplicand.

MIDDLE: Multiplier.

BOTTOM: Product.

Input Control:

I_1: When ⎍ (↑⎍) is presented, the function block is executed.

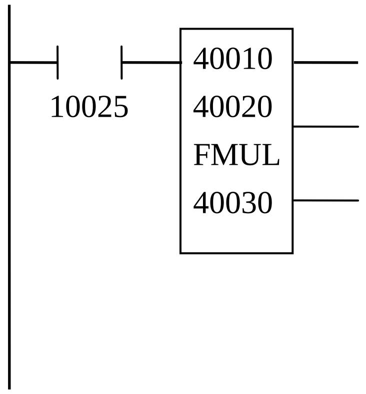
Function Output:

$O_1=I_1$

$O_2=0$

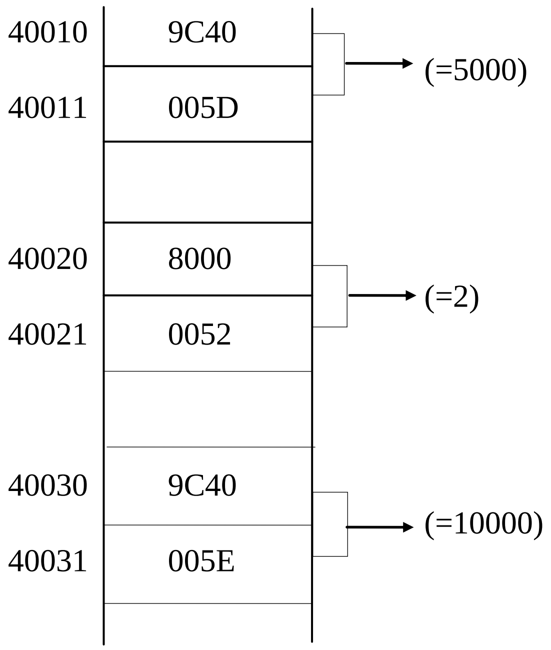
$O_3=0$

【EXAMPLE】



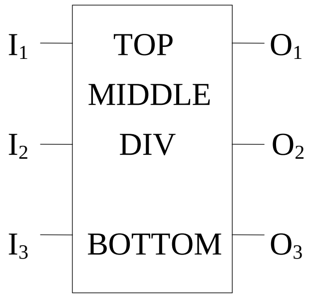
【DESCRIPTION】

Let register (40010/40011)=5000 and (40020/40021)=2. When contact 10025 is ‘ON’, the operation: long word(40030)=long word(40010)×long word(40020) is performed. Function Output: O_1 = ON, O_2 = O_3 = OFF.



			DIV
DIV	**FOUR DIGIT DECIMAL DIVIDER(1)**		

SYMBOL:



OPERANDS:

	0	**1**	**3**	**4**	**C**	**P**	**L**
TOP			○	○	①	○	
MIDDLE			○	○	①	○	
BOTTOM				○		○	

①0~9999

Lword÷word→word (Decimal)

Description:

The value stored in the top node is divided by the value in the middle node, and the result is stored in the bottom node.

Input control (I_1) is used to determine whether this function block is to be executed or not.

Function outputs can be used to determine whether the function block has been executed, divisor is zero and overflow.

Node Description:

TOP: Constant dividend, must be ＜= 9999; **else the LONG WORD value is used.**

MIDDLE: Divisor, must be＜= 9999

BOTTOM: 1.Result of Division. The quotient is stored in the first word. **Depending on the input control, the remainder or the first four digits after decimal point of quotient are stored in the second word.**

2.If error occurred, the content of the bottom node remains unchanged.

Input Control:

I_1: When ( ) is presented, the function block is executed.

I_2 = 0, the second word of the bottom node is used to store the remainder.

= 1, the second word of the bottom node is used to store the first four digits after the decimal point.

I_3 ∶ error in

Function Output:

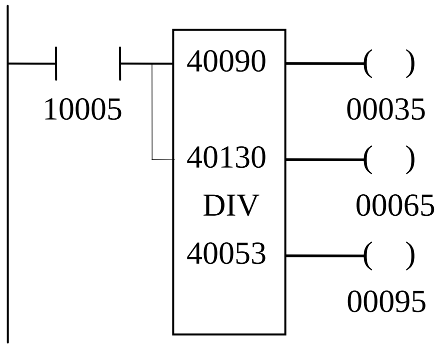
$O_1 = I_1$

O_2 = 1, if overflow, i.e. quotient＞9999

O_3 (error output)= 1 (1.If the value of either top node or middle node is greater than 9999 or

2.If divisor = 0)

【EXAMPLE】



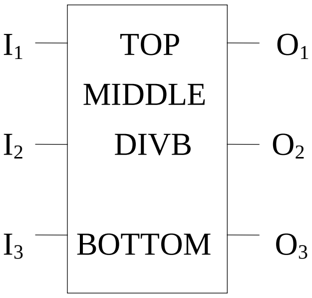
(DESCRIPTION)

Let **long word**(40090)=9999 and (40130) =10. When contact 10005 is energized, I_1 and I_2 = 'ON'. The quotient (=999) is stored in register 40053. Since I_2 = 'ON', thus the first four digits (=9000) are stored in register 40054.

40053	0999	Integer portion of the quotient	
40054	9000	First four digits of the fractional portion of the quotient	
40090	0000	Dividend	9999÷10 = 999.9000
40091	9999		
40130	0010	Divisor	

DIVB	EIGHT DIGIT HEXADECIMAL DIVIDER(1)

SYMBOL:



OPERANDS:

	0	1	3	4	C	P	L
TOP			○	○	①	○	
MIDDLE			○	○	①	○	
BOTTOM				○		○	

①0~65535

Lword÷word→word (Binary)

Description:

The value stored in the top node is divided by the value in the middle node, and the result is stored in the bottom node.

Input control (I_1) is used to determine whether this function block is to be executed or not.

Function outputs can be used to determine whether the function block has been executed, divisor is zero and overflow.

Node Description:

TOP: Dividend, (**long word**)

MIDDLE: Divisor

BOTTOM: 1.Result of Division. The quotient is stored in the first word. **Depending on the input control, the remainder or the first four digits after decimal point of quotient are stored in the second word.**

2.If error occurred, the content of the bottom node remains unchanged.

Input Control:

I_1: When ⎍ (↑⎍) is presented, the function block is executed.

I_2 =0, the second word of the bottom node is used to store the remainder.

=1, the second word of the bottom node is used to store the first four digits after the decimal point.

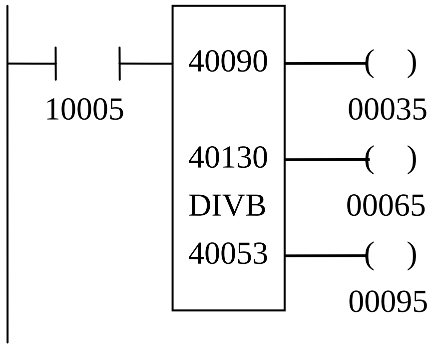
Function Output:

$O_1 = I_1$

O_2 = 1, if overflow, i.e. quotient＞65535

O_3 (error output)= 1, if divisor = 0.

【**EXAMPLE**】



【**DESCRIPTION**】

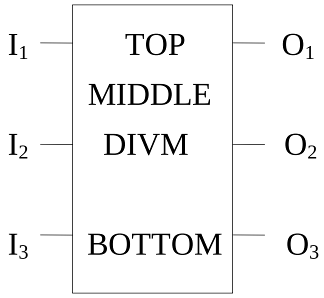
Let **long word**(40090)=65535 and (40130) =12. When contact 10005 is energized, I_1 = ‘ON’, and the quotient (=5461) is stored in register 40053. Since I_2 = ‘OFF’, the remainder (=0003) is stored in register 40054.

40053	5461	Quotient
40054	0003	Remainder
40090	0000	Dividend
40091	65535	
40130	0012	Divisor

65535÷12 = 5461, remainder 3

DIVM	FOUR DIGIT DECIMAL DIVIDER(2)		

SYMBOL:



OPERANDS:

	0	**1**	**3**	**4**	**C**	**P**	**L**
TOP			○	○	①	○	
MIDDLE			○	○	①	○	
BOTTOM				○		○	

①0~9999

word÷word→word (Decimal)

Description:

The value stored in the top node is divided by the value in the middle node, and the result is stored in the bottom node.

Input control (I_1) is used to determine whether this function block is to be executed or not.

Function outputs can be used to determine whether the function block has been executed, divisor is zero and overflow.

Node Description:

TOP: Dividend, must be <= 9999.

MIDDLE: Divisor, must be <= 9999.

BOTTOM :1.Result of Division. The quotient is stored in the first word. **Depending on the input control, the remainder or the first four digits after decimal point of quotient are stored in the second word.**

2.If error occurred, the content of the bottom node remains unchanged.

Input Control:

I_1: When ( ) is presented, the function block is executed.

I_2 =0, the second word of the bottom node is used to store the remainder.

=1, the second word of the bottom node is used to store the first four digits after the decimal point.

I_3 = error in

Function Output:

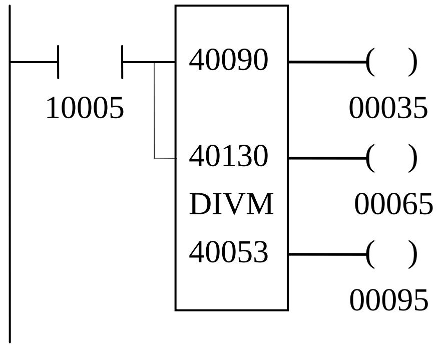
$O_1 = I_1$

$O_2 = 0$

O_3 (error output)= 1 (1. If divisor = 0 or

2. If the value of either top node or middle node is greater than 9999.)

【EXAMPLE】



【DESCRIPTION】

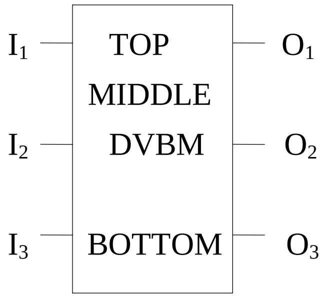
Let **long word**(40090)=9999 and (40130) =10. When contact 10005 is energized, I_1 and I_2 = ‘ON’. The quotient (=999) is stored in register 40053. Since I_2 = ‘ON’, thus the first four digits (=9000) are stored in register 40054.

9999÷10 = 999.9000

40053	0999	Quotient
40054	9000	First four digits of the fractional portion of the quotient
40090	9999	Dividend
40130	0010	Divisor

DVBM	FOUR DIGIT HEXADECIMAL DIVIDER

SYMBOL:



OPERANDS:

	0	1	3	4	C	P	L
TOP			○	○	①	○	
MIDDLE			○	○	①	○	
BOTTOM				○		○	

①0~65535

word÷word→word (Binary)

Description:

The value stored in the top node is divided by the value in the middle node, and the result is stored in the bottom node.

Input control (I_1) is used to determine whether this function block is to be executed or not.

Function outputs can be used to determine whether the function block has been executed, divisor is zero and overflow.

Node Description:

TOP: Dividend.

MIDDLE: Divisor.

BOTTOM: 1.Result of Division. The quotient is stored in the first word. **Depending on the input control, the remainder or the first four digits after decimal point of quotient are stored in the second word.**

2.If error occurred, the content of the bottom node remain unchanged.

Input Control:

I_1: When ( ) is presented, the function block is executed.

I_2 =0, the second word of the bottom node is used to store the remainder.

=1, the second word of the bottom node is used to store the first four digits after the decimal point.

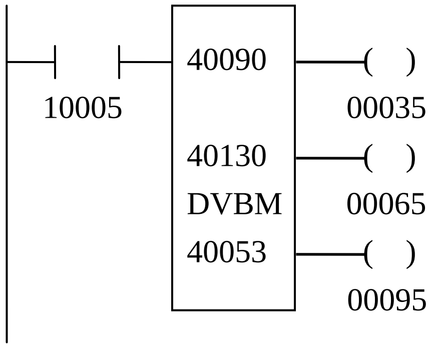
Function Output:

$O_1 = I_1$

$O_2 = 0$

O_3 (error output)= 1, if divisor = 0.

【EXAMPLE】



【DESCRIPTION】

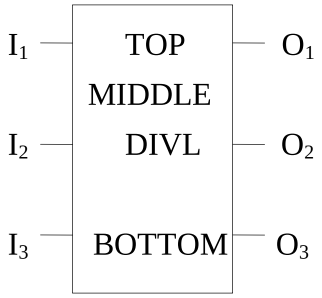
Let **long word** (40090)=65535 and (40130) =12. When contact 10005 is energized, I_1 = ‘ON’, and the quotient (=5461) is stored in register 40053. Since I_2 = ‘OFF’, the remainder (=0003) is stored in register 40054.

40053	5461	Quotient
40054	0003	Remainder
40090	65535	Dividend
40130	0012	Divisor

65535÷12 = 5461, remainder 3

DIVL	**EIGHT DIGIT DECIMAL DIVIDER(2)**		

SYMBOL:



OPERANDS:

	0	1	3	4	C	P	L
TOP				○	□	○	
MIDDLE				○	□	○	
BOTTOM				○		○	

□0~65535

Lword÷Lword→Lword (Decimal)

Description:

The value stored in the top node is divided by the value in the middle node, and the result is stored in the bottom node. Input control (I_1) is used to determine whether this function block is to be executed or not. Function outputs can be used to determine whether the function block has been executed, divisor is zero and overflow.

Node Description:

TOP: Dividend, must be <= 99999999.

MIDDLE: Divisor, must be <= 99999999.

BOTTOM:1.Result of Division. The quotient is stored in the first and second words. Depending on the input control, the remainder or the first eight digits after decimal point of quotient are stored in the third and fourth words.

2.If error occurred, the content of the bottom node remains unchanged.

Input Control:

I_1: When ( ) is presented, the function block is executed.

I_2 =0, the third and the fourth words of the bottom node is used to store the remainder.

=1, the third and the fourth words of the bottom node is used to store the first eight digits after the decimal point.

I_3 ∶ error in

Function Output:

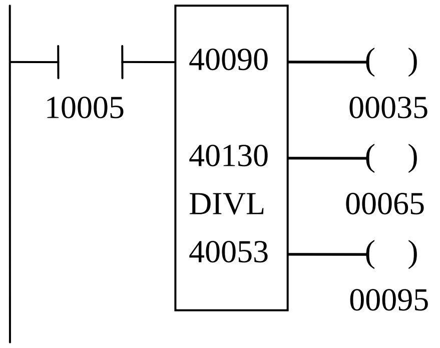
$O_1 = I_1$

$O_2 = 0$

O_3 (error output)= 1 (1. If divisor = 0 or

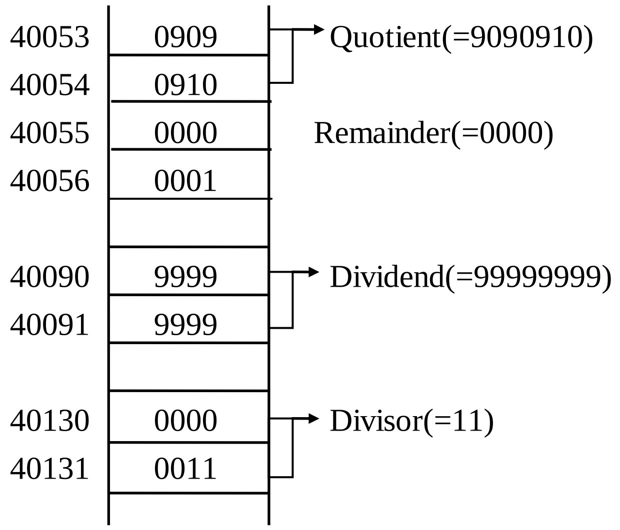
2. If the value of either top node or middle node is greater than 99999999)

【EXAMPLE】



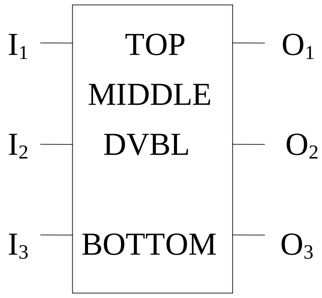
【DESCRIPTION】

Let **long word**(40090)=99999999 and **long word**(40130) =11. When contact 10005 is energized, I_1 = ‘ON’, and the quotient (=9090910) is stored in the **long word** 40053. Since I_2 = ‘OFF’, the remainder (=0001) is stored in register 40055 and 40056.



DVBL	EIGHT DIGIT HEXADECIMAL DIVIDER

SYMBOL:



OPERANDS:

	0	1	3	4	C	P	L
TOP				○	①	○	
MIDDLE				○	①	○	
BOTTOM				○		○	

①0~65535

Lword÷Lword→Lword

Description:

The value stored in the top node is divided by the value in the middle node, and the result is stored in the bottom node.

Input control (I_1) is used to determine whether this function block is to be executed or not.

Function outputs can be used to determine whether the function block has been executed, divisor is zero and overflow.

Node Description:

TOP: Dividend.

MIDDLE: Divisor.

BOTTOM: Result of Division. The quotient is stored in the first and second words. Depending on the input control, the remainder or the eight digits after decimal point of quotient are stored in the third and fourth words.

Input Control:

I_1: When ⎍ (↑⎍) is presented, the function block is executed.

I_2 =0, the third and the fourth words of the bottom node is used to store the remainder.

=1, the third and the fourth words of the bottom node is used to store the first eight digits after the decimal point.

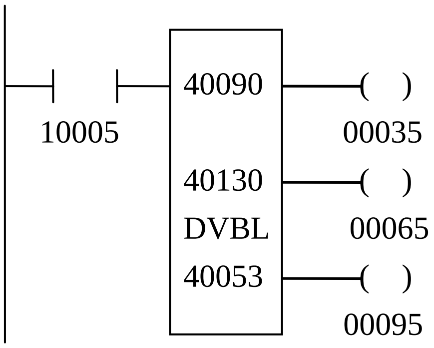
Function Output:

$O_1 = I_1$

$O_2 = 0$

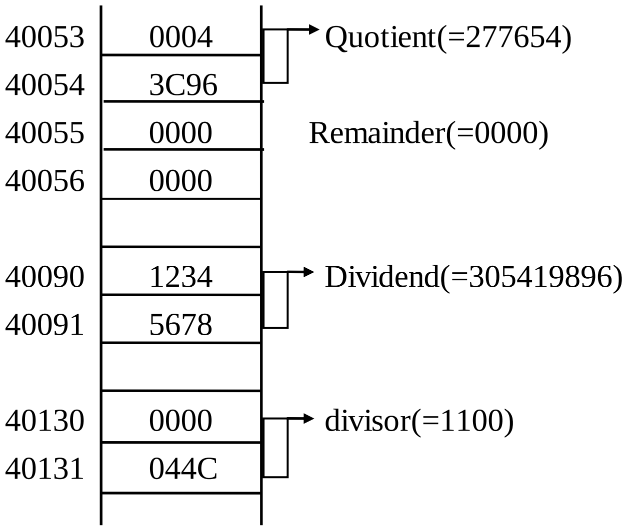
$O_3 = 1$, if divisor = 0.

【EXAMPLE】



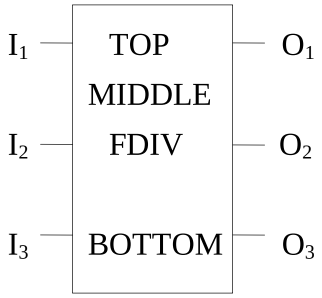
【DESCRIPTION】

Let **long word**(40090)=305419896 and **long word**(40130) =1100. When contact 10005 is energized, I_1 = 'ON', and the quotient (=277654) is stored in **long word** 40053. Since I_2 = 'OFF', the remainder (=0000) is stored in register 40055 and 40056.



FDIV	FLOATING POING DIVIDER		

SYMBOL:



OPERANDS:

	0	1	3	4	C	P	L
TOP				○	①	○	
MIDDLE				○	①	○	
BOTTOM				○		○	

①0~65535

float÷float→float

Description:

The value stored in the top node is divided by the value in the middle node, and the result is stored in the bottom node.

Input control (I_1) is used to determine whether this function block is to be executed or not.

Function outputs can be used to determine whether the function block has been executed, divisor is zero and overflow.

Node Description:

TOP: Dividend.

MIDDLE: Divisor.

BOTTOM: Quotient.

Input Control:

I_1: When ( ) is presented, the function block is executed.

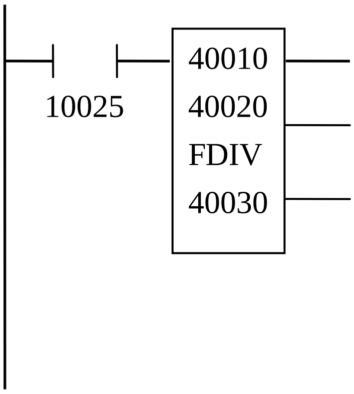
Function Output:

$O_1 = I_1$

$O_2 = 0$

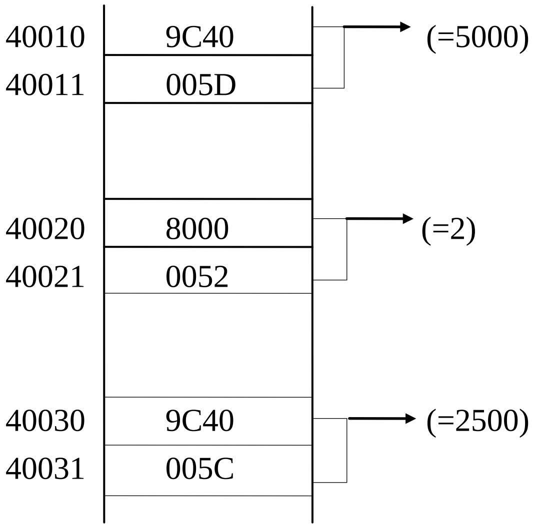
$O_3 = 1$, if divisor = 0.

【EXAMPLE】



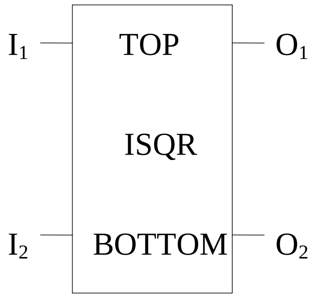
【DESCRIPTION】

Let register(40010/40011)=5000 and (40020/40021)=2. When contact 10025 is ‘ON’, the operation: long word(40030)=long word(40010)÷long word(40020) is performed. Function Output: O_1 = ON, O_2 = O_3 = OFF.



ISQR — SQUARE ROOT OF AN INTEGER

SYMBOL:



OPERANDS:

	0	1	3	4	C	P	L
TOP			○	○		○	
BOTTOM				○		○	

Description:

The square root of the value stored in the top node is found and stored in the bottom node. The result of the square root operation is truncated to integer. Input control (I_1) is used to determine whether this function block is to be executed or not. Function outputs can be used to determine whether the function block has been executed.

Node Description:

TOP: An integer whose square root is desired.
BOTTOM: Square root.

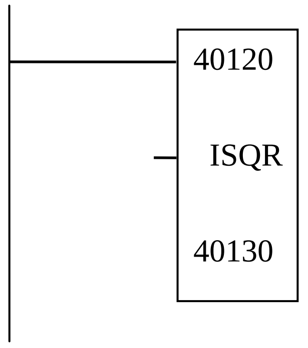
Input Control:

I_1: When ( ) is presented, the function block is executed.

Function Output:

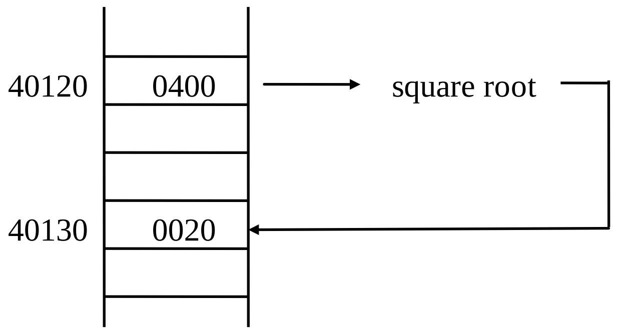
$O_1 = I_1$
$O_2 = 0$

【**EXAMPLE**】



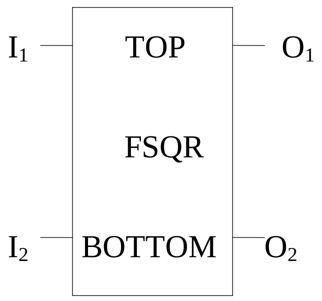
【**DESCRIPTION**】

Let (40120)=400. When this rung is scanned, the square root of the values stored in the top node are stored in the bottom node.



FSQR	SQUARE ROOT OF A FLOATING POINT NUMBER		

SYMBOL:



OPERANDS:

	0	**1**	**3**	**4**	**C**	**P**	**L**
TOP				○		○	
BOTTOM				○		○	

Description:

The square root of the value stored in the top node is found and stored in the bottom node. Input control (I_1) is used to determine whether this function block is to be executed or not. Function outputs can be used to determine whether the function block has been executed.

Node Description:

TOP: A floating point number whose square root is desired.

BOTTOM: Square root.

Input Control:

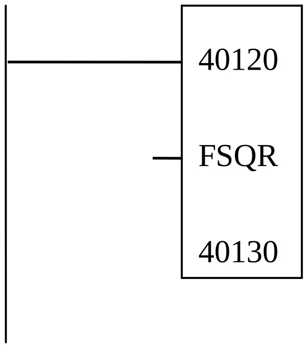
I_1: When ( ) is presented, the function block is executed.

Function Output:

$O_1 = I_1$

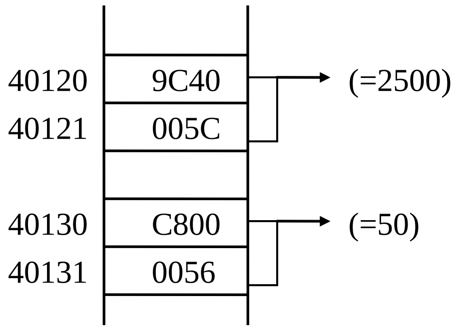
$O_2 = 0$

【EXAMPLE】



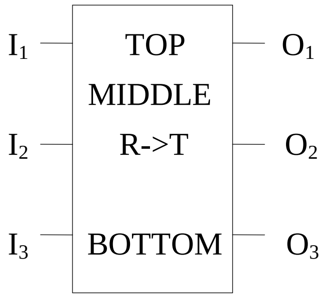
【DESCRIPTION】

Let (40120/40121)=2500. When this rung is scanned, the square root of the values stored in the top node are stored in the bottom node (40130/40131).



R->T	MOVE FROM REGISTER TO TABLE

SYMBOL:



OPERANDS:

	0	1	3	4	C	P	L
TOP	○	○	○	○		○	
MIDDLE	○			○		○	
BOTTOM					①		

①1~255

Description:

The content of the top node is filled onto the table defined in the following address(es) by the middle node. Table length is defined in the bottom node.

Input control (I_1) is used to determine whether this function block is to be executed or not.

Input control (I_2) is used to define the action mode of the INDEX.

Input control (I_3) is used to clear the INDEX.

Function outputs can be used to determine whether the function block has been executed and whether the INDEX exceeded the table length.

Node Description:

TOP: Source register.

MIDDLE: Reference register. First word defined as INDEX into the target table. If the value of the INDEX is equal to zero, then the INDEX is pointing to the first entry in the target table. The target table starts with the second word.

BOTTOM: Table Length. If the INDEX value is greater than or equal to this number, table movement is prohibited disregarding the state of I_1.

Input Control:

I_1: When ( ) is presented, the function block is executed.

I_2: INDEX control.

=0, INDEX is incremented by one after each execution.

=1, INDEX remains unchanged.

I_3: Reset INDEX.

=1, clear INDEX to 0.

Function Output:

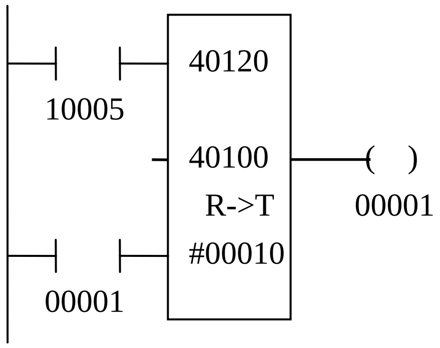
O_1= I_1

O_2: INDEX indicator.

=1, INDEX≧table length, the INDEX is pointing to an address beyond table limit.

O_3=0

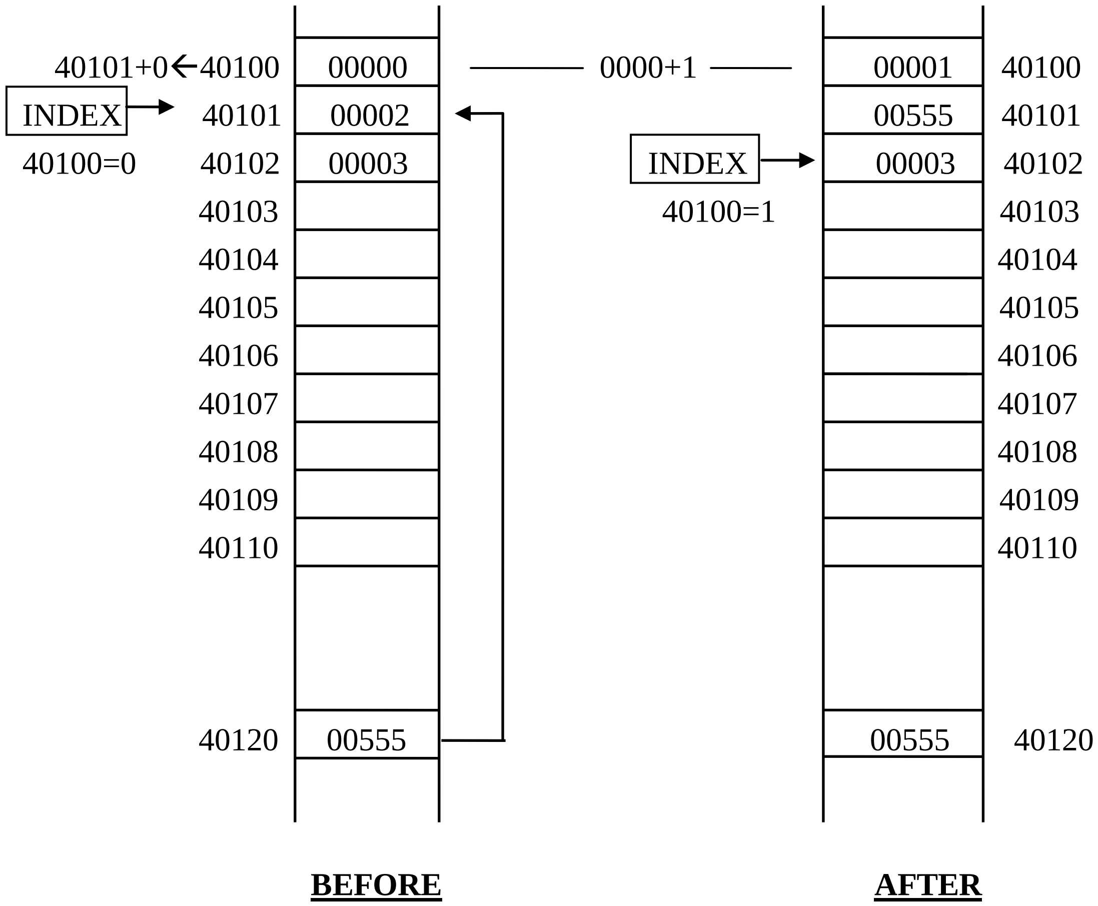
【EXAMPLE】



【DESCRIPTION】

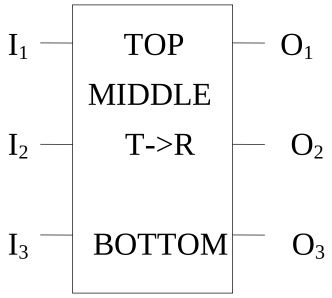
When contact 10005 is energized, the content of input register 40120 is copied to table registers (40101~40110), one register per scan. During the action INDEX(40100) increments by one after each scan.

When INDEX (in 40100) reaches preset value of BOTTOM node (#00010), then coil 00001 is energized and the content of register 40100 is cleared. The movement continues until contact 10005 is OFF.



T->R	MOVE FROM TABLE TO REGISTER		

SYMBOL:



OPERANDS:

	0	1	3	4	C	P	L
TOP	○	○	○	○		○	
MIDDLE	○			○		○	
BOTTOM					①		

①1~255

Description:

The content of the top node is moved to the following address(es) defined by the middle node. Table length is defined in the bottom node.

Input control (I_1) is used to determine whether this function block is to be executed or not.

Input control (I_2) is used to define the action mode of the INDEX.

Input control (I_3) is used to clear the INDEX.

Function outputs can be used to determine whether the function block has been executed and whether the INDEX exceeded the table length.

Node Description:

TOP: Source table.

MIDDLE: Source INDEX is defined at the first word. If the value of the INDEX is equal to zero, then the INDEX is pointing to the first entry in the source table. The target register is in the second word.

BOTTOM: Table Length. If the INDEX value is greater than or equal to this number, table movement is prohibited disregarding the state of I_1.

Input Control:

I_1: When ( ) is presented, the function block is executed.

I_2: INDEX control.

=0, INDEX is incremented by one after each execution.

=1, INDEX remains unchanged.

I_3: Reset INDEX.

=1, clear INDEX to 0.

Function Output:

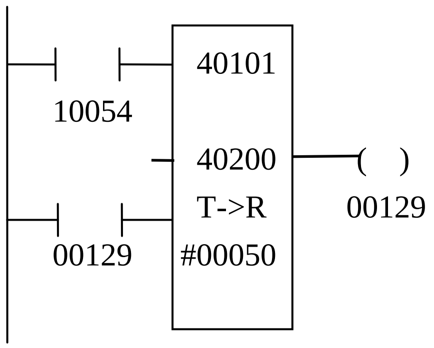
O_1= I_1

O_2: INDEX indicator.

=1, INDEX≧table length, the INDEX is pointing to an address beyond table limit.

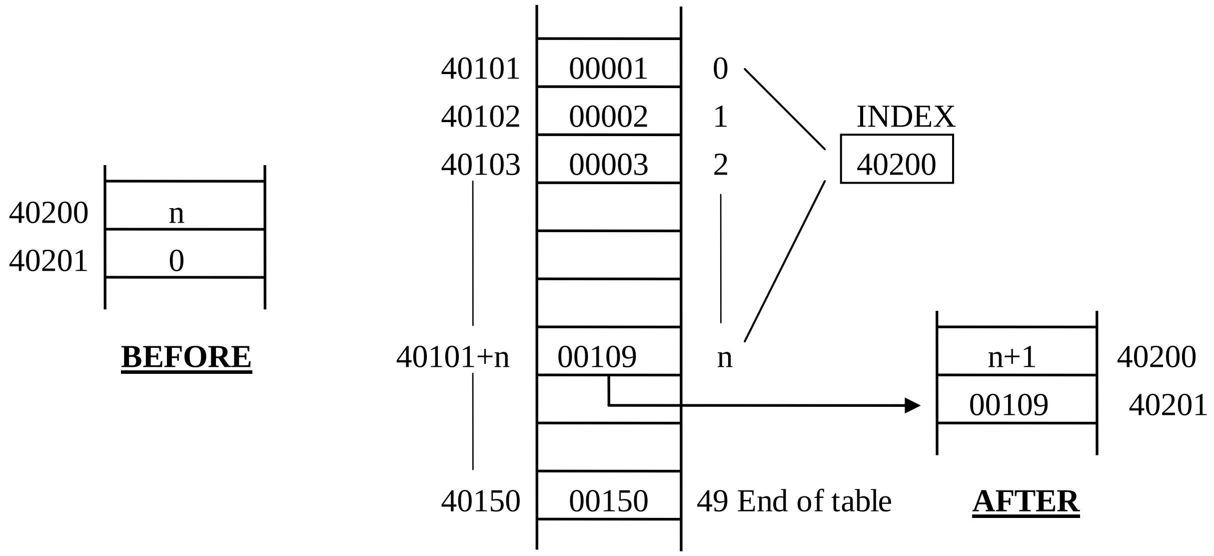
O_3=0

【EXAMPLE】



【DESCRIPTION】

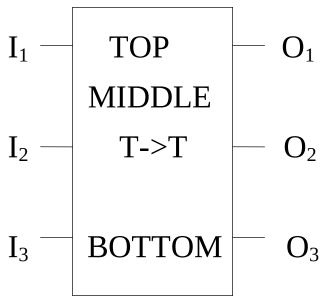
When contact 10054 is energized, source data pointed to by INDEX(40101) is moved to 40201 (the next address defined by the middle node). For every scan of the PLC controller, data movement occurs once until the INDEX reaches the end of table(#00050). Then Coil 00129 is energized and the INDEX is cleared. In this manner, data movement can be repeated. The following is the state after the nth scan since INDEX reset to 0.



Table

T->T	MOVE FROM ONE TABLE TO ANOTHER TABLE		

SYMBOL:



OPERANDS:

	0	1	3	4	C	P	L
TOP	○	○	○	○		○	
MIDDLE	○			○		○	
BOTTOM					①		

①1~255

Description:

The content of the top node is moved to the following address(es) defined by the middle node. Table length is defined in the bottom node. Input control (I_1) is used to determine whether this function block is to be executed or not. Input control (I_2) is used to define the action mode of the INDEX. Input control (I_3) is used to clear the INDEX. Function outputs can be used to determine whether the function block has been executed and whether the INDEX exceeded the table length.

Node Description:

TOP: Source table.

MIDDLE: INDEX is defined at the first word. If the value of the INDEX is equal to zero, then the INDEX is pointing to the first entry in the target register. The target table starts at the second word.

BOTTOM: Table Length. If the INDEX value is greater than or equal to this number, table movement is prohibited disregarding the state of I_1.

Input Control:

I_1: When (↑) is presented, the function block is executed.

I_2: INDEX control.

=0, INDEX is incremented by one after each execution.

=1, INDEX remains unchanged.

I_3: Reset INDEX.

=1, clear INDEX to 0.

Function Output:

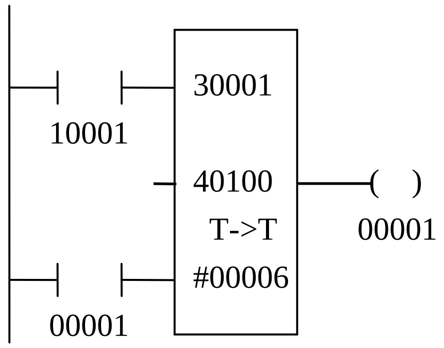
O_1= I_1

O_2: INDEX indicator.

=1, INDEX≧table length, the INDEX is pointing to an address beyond table limit.

O_3=0

【EXAMPLE】



【DESCRIPTION】

When contact 10001 is energized and after six scan cycles, data stored in registers 30001~30006 are moved to registers 40101~40106. When the INDEX in the middle node = 6, the coil 00001 is energized and the INDEX is cleared. Data movement continues until contact 10001 is OFF.

SOURCE		INDEX 40100	TARGET	
		0	40100	00000
30001	00111		40101	00111
30002	00222		40102	00000
30003	00333		40103	
30004	00444		40104	
30005	00555		40105	
30006	00666		40106	

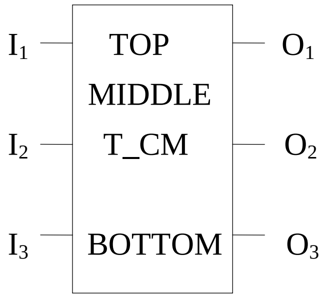
BEFORE

		INDEX		
		0	40100	00006
30001	00111		40101	00111
30002	00222		40102	00222
30003	00333		40103	00333
30004	00444		40104	00444
30005	00555		40105	00555
30006	00666		40106	00666

After 6 scans

T_CM	TABLE COMPARE		

SYMBOL:



OPERANDS:

	0	1	3	4	C	P	L
TOP	○	○	○	○		○	
MIDDLE				○		○	
BOTTOM					①		

①1~255

Description:

This function compares the tables pointed by the top and middle node. If a difference is found between the corresponding table locations, then that the index of that element is stored in the middle node. Table length is in the bottom node.

Input control (I_1) is used to determine whether this function block is to be executed or not.

Input control (I_2) is used to define the action mode of the INDEX.

Function outputs can be used to determine whether the function block has been executed and whether those tables are different or not.

Node Description:

TOP: Starting address of the first table.

MIDDLE: INDEX is defined in the first word. The starting address of the second table is defined in the second word. The INDEX has two uses. First, it is used to indicate the index of the difference data after the last comparison. Second, it is used to indicate the next comparison will start below this index.

BOTTOM: Table length.

Input Control:

I_1: When ( ) is presented, the function block is executed. Based on the state of I_2 , comparison continues until a difference is found or the end of table is reached. When execution terminates, the INDEX points to the address where the difference is found or zero (if no difference).

I_2: Action mode of INDEX.

=0, start comparison from the next address pointed to by the INDEX.

=1, start comparison from the first entry of the table.

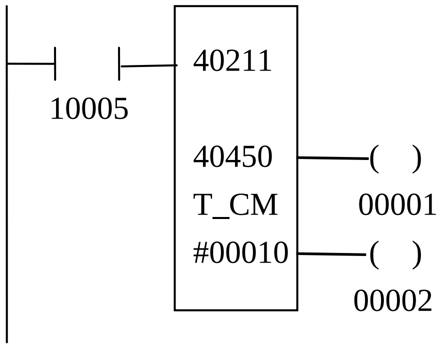
Function Output:

$O_1 = I_1$

O_2 =1, if tables are different.

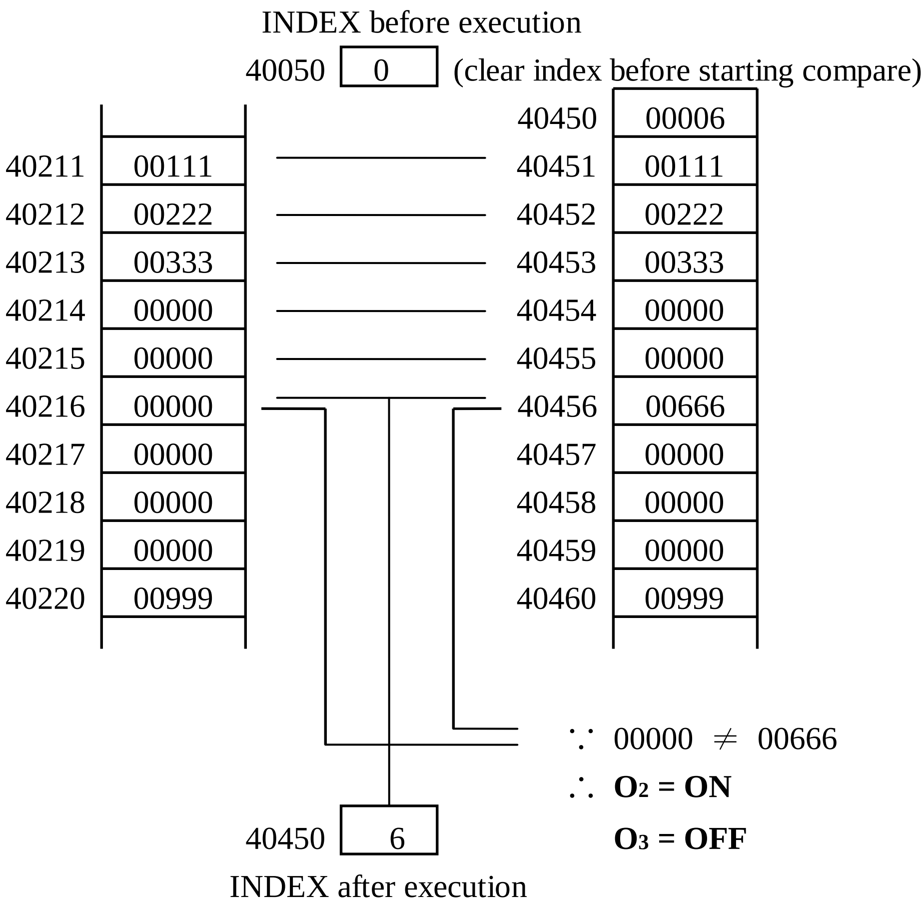
O_3 is the complement of O_2.

【EXAMPLE】



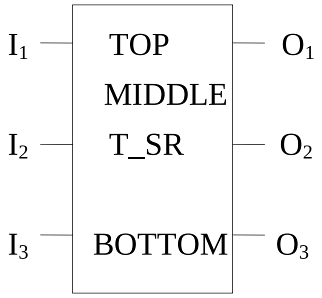
【DESCRIPTION】

When contact 10005 is energized, the table starting from 40211 is compared against the table starting from 40451. Since the 6th entries in both tables are different, then register 40450=00006 , and coil 00001='ON'.



T_SR	TABLE SEARCH		

SYMBOL:



OPERANDS:

	0	1	3	4	C	P	L
TOP	○	○	○	○		○	
MIDDLE				○		○	
BOTTOM					①		

①1~255

Description:

Reference value is defined in the second word of the middle node. Search starts from the table defined in the top node. If the same value as the reference is found, then this function stops and the INDEX where the same value was found is stored in the middle node. Table length is defined in the bottom node.

Input control (I_1) is used to determine whether this function block is to be executed or not.

Input control (I_2) is used to define the action mode of the INDEX.

Function outputs can be used to determine whether the function block has been executed and whether a same value with the reference has been found.

Node Description:

TOP: Starting address of the table.

MIDDLE: INDEX is defined in the first word. The reference value is defined in the second word of the middle node. The INDEX has two uses. First, it is used to indicate the index of the same data after the last search. Second, it is used to indicate the next search will start below this index.

BOTTOM: Table length.

Input Control:

I_1: When ( ) is presented, the function block is executed. Based on the state of I_2 , search continues until a match is found or the end of the table is reached. When execution terminates, the INDEX points to the address where the difference is found.

I_2: Action mode of INDEX.

=0, start search from the next address pointed to by the INDEX.

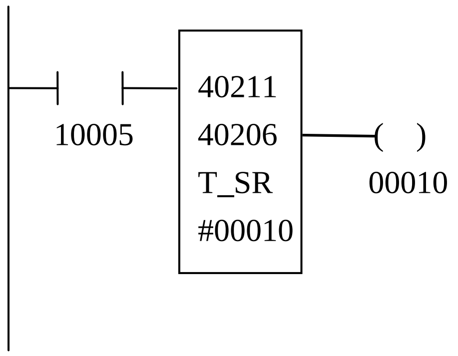
=1, start search from the first entry of the table.

Function Output:

$O_1 = I_1$

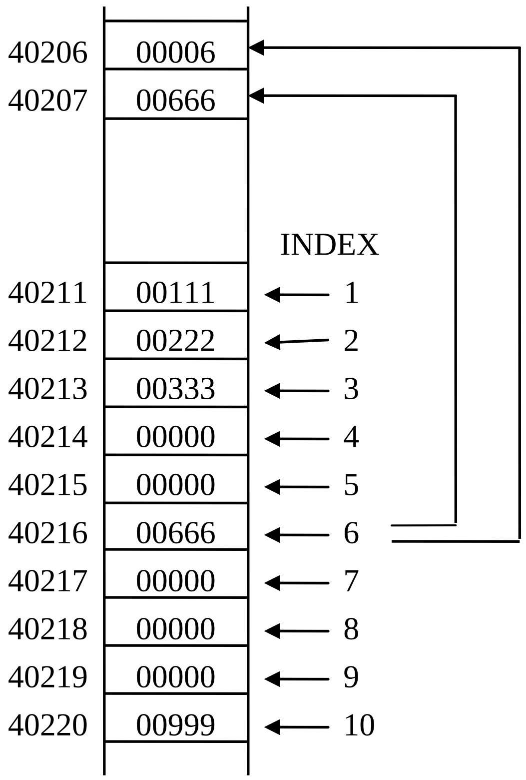
O_2 =1, if tables are different.

【EXAMPLE】



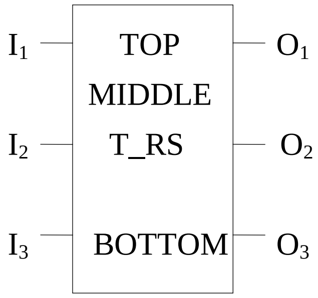
【DESCRIPTION】

When I1=1, search starts from the table starting from 40211. INDEX(40206) reset to 0 at the beginning. If a table entry is found to be the same as the value of 40207 (next address defined in the middle node), in this example, (40216)=00666=(40207), then 00006 is stored in the middle node, and coil 00010='ON'.



T_RS	TABLE ROTATE/SHIFT	⎍	↑⎍

SYMBOL:



OPERANDS:

	0	1	3	4	C	P	L
TOP	○	○	○	○		○	
MIDDLE				○		○	
BOTTOM					①		

①1~255

Description:

Using register as a unit, this function performs table rotate or shift. The table is defined in the top node.
Table length is defined in the bottom node.
Input control (I_1) is used to determine whether this function block is to be executed or not.
Input control (I_2) is used to define the direction.
Input control (I_3) is used to define the mode.
Function outputs can be used to determine whether the function block has been executed.

Node Description:

TOP: Starting address of the table.
MIDDLE: Table after processing.
BOTTOM :Table length.

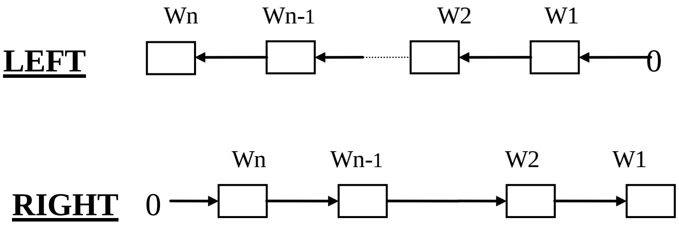
Input Control:

I_1: Execution control.
When ⎍ (↑⎍) is presented,
the function block is executed.
I_2: Direction.
=0, Left.
=1, Right.
I_3: mode.
=0, Shift.
=1, Rotate.

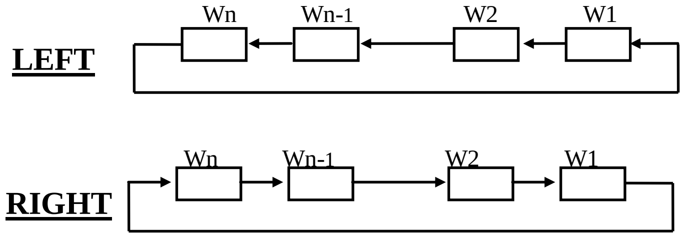
Function Output:

O_1= I_1
O_2=0
O_3=0

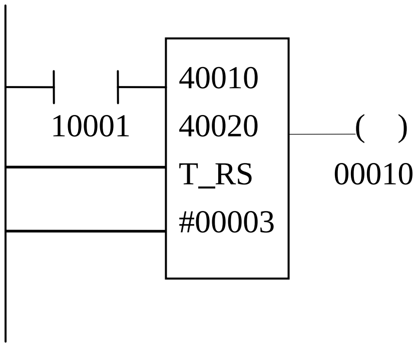
SHIFT MODE



ROTATE MODE

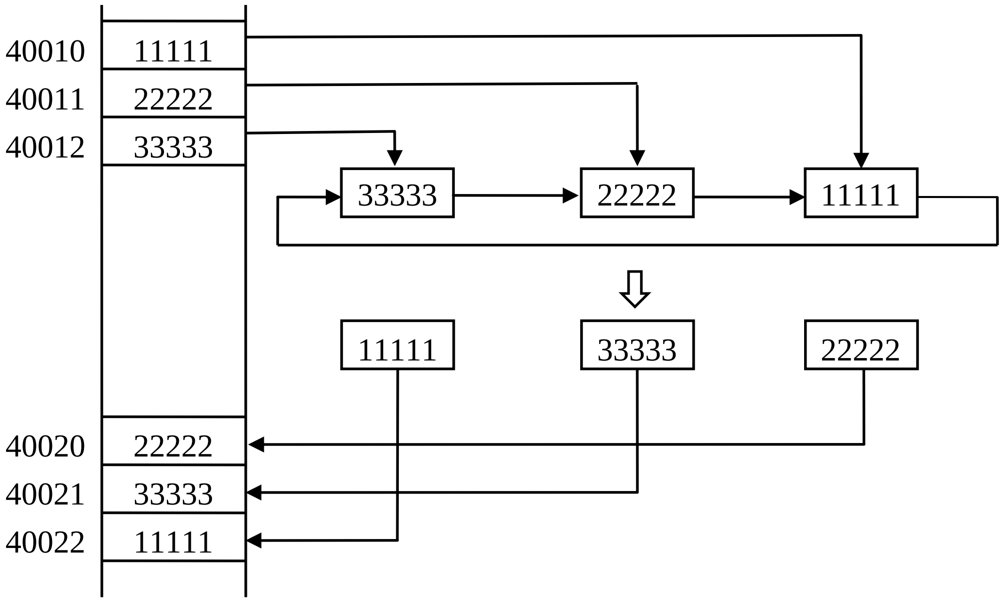


【EXAMPLE 1】

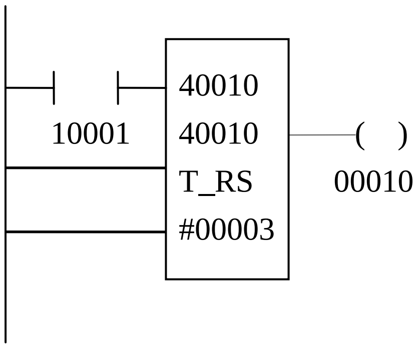


【DESCRIPTION】

When contact 10001 receives a transition from ‘OFF’ to ‘ON’ and $I_2=I_3=1$, then a right rotate operation is performed.



【EXAMPLE 2】

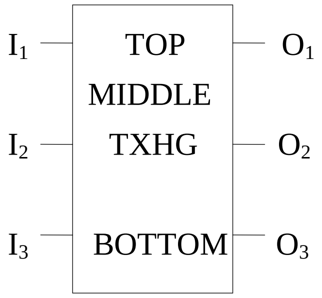


【DESCRIPTION】

	BEFORE		AFTER
40010	1111	40010	2222
40011	2222	40011	3333
40012	3333	40012	1111

TXHG	TABLE EXCHANGE

SYMBOL:



OPERANDS:

	0	1	3	4	C	P	L
TOP	○			○		○	
MIDDLE	○			○		○	
BOTTOM					①		

①1~255

Description:

Entries exchange between two tables. Tables are defined in the top and middle nodes. Table length is defined in the bottom node.

Input control (I_1) is used to determine whether this function block is to be executed or not.

Function outputs can be used to determine whether the function block has been executed.

Node Description:

TOP: The first table.

MIDDLE: The second table.

BOTTOM: Table length.

Input Control:

I_1: When ⎍ (↑⎍) is presented, the function block is executed.

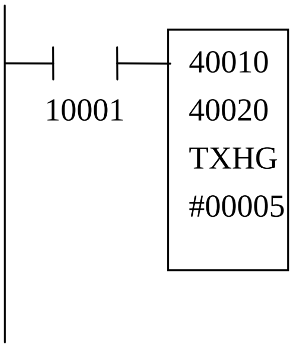
Function Output:

$O_1 = I_1$

$O_2 = 0$

$O_3 = 0$

【EXAMPLE】



【DESCRIPTION】

When 10001 receives a transition from ‘OFF’ to ‘ON’, then the entries of the two tables as defined in the top and middle nodes are swapped.

40010	01111	40020	06666
40011	02222	40021	07777
40012	03333	40022	08888
40013	04444	40023	09999
40014	05555	40024	00000

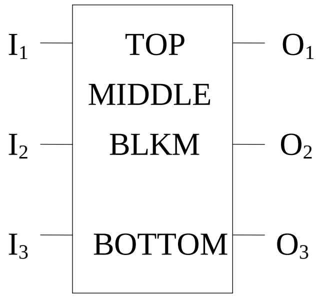
BEFORE

40010	06666	40020	01111
40011	07777	40021	02222
40012	08888	40022	03333
40013	09999	40023	04444
40014	00000	40024	05555

AFTER

BLKM	**MEMORY BLOCK MOVE**		

SYMBOL:



OPERANDS:

	0	**1**	**3**	**4**	**C**	**P**	**L**
TOP	○	○	○	○		○	
MIDDLE	○			○		○	
BOTTOM					①		

①1~255

Description:

Memory contents of the table defined in the top node are copied to the table defined in the middle node in one scan. Table length is defined in the bottom node.

Input control (I_1) is used to determine whether this function block is to be executed or not.

Function outputs can be used to determine whether the function block has been executed.

Node Description:

TOP: Starting address of the source memory block.

MIDDLE: Starting address of the target memory block.

BOTTOM: Block length.

Input Control:

I_1: When ⎍ (↑⎍) is presented, the function block is executed.

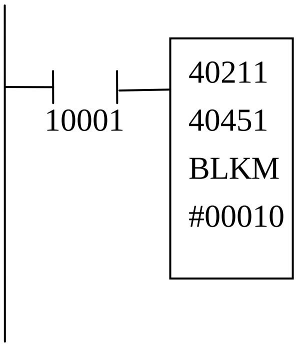
Function Output:

$O_1= I_1$

$O_2=0$

$O_3=0$

【EXAMPLE】



【DESCRIPTION】

When 10001 receives a transition from ‘OFF’ to ‘ON’, then the entries of the first tables as defined in the top node(40211) are moved to the second table defined in the middle node(40451).

40211	01111
40212	02222
40213	03333
40214	04444
40215	05555
40216	06666
40217	07777
40218	08888
40219	09999
40220	00000

BEFORE

40451	00000
40452	00000
40453	00000
40454	00000
40455	00000
40456	00000
40457	00000
40458	00000
40459	00000
40460	00000
40461	00000

BEFORE

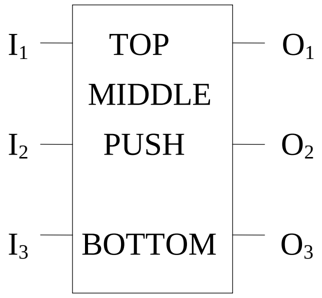
⇨

40451	01111
40452	02222
40453	03333
40454	04444
40455	05555
40456	06666
40457	07777
40458	08888
40459	09999
40460	00000

AFTER

PUSH	**PUSH FROM REGISTER TO STACK**		

SYMBOL:



OPERANDS:

	0	**1**	**3**	**4**	**C**	**P**	**L**
TOP	○	○	○	○		○	
MIDDLE				○		○	
BOTTOM					①		

①1~255

Description:

This function pushes the content of a register (TOP NODE) to a predefined stack(MIDDLE NODE). Stack size is defined in the BOTTOM NODE.

Input control (I_1) is used to determine whether this function block is to be executed or not.

Input control (I_2) is used to define the stack mode.

Function outputs can be used to determine whether the function block has been executed, and whether the stack is full.

Node Description:

TOP: Data to be pushed into stack.

MIDDLE: INDEX is defined in the first word. The starting of the stack is defined in the second word of the middle node. If the INDEX is equal to zero, then the INDEX is pointing to the top of the stack.

BOTTOM: Length of stack.

Input Control:

I_1: When ( ) is presented, the function block is executed. INDEX is incremented by 1.

I_2 =0, data is pushed into the stack at designated address. (LIFO). Used as STACK.

=1, data is put into the bottom of the stack , the original content at the top of the stack is moved to the next word. (FIFO). Used as QUEUE.

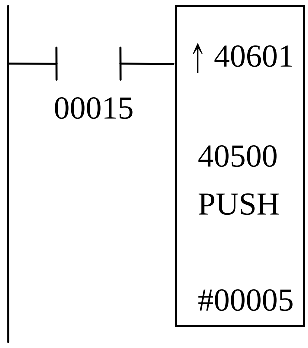
Function Output:

O_1= I_1

O_2: =1, if stack is full, i.e. INDEX= stack length.

O_3=0

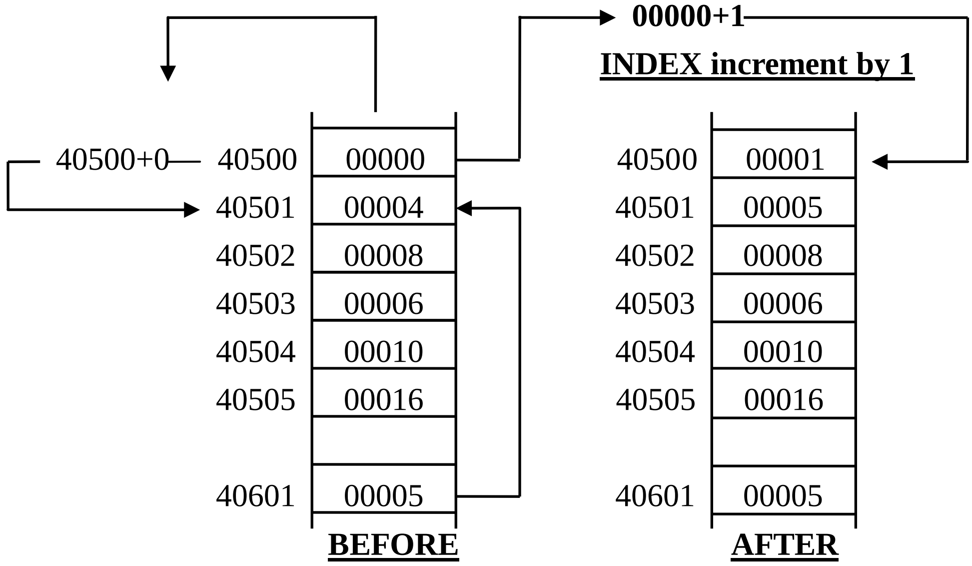
【EXAMPLE 1】



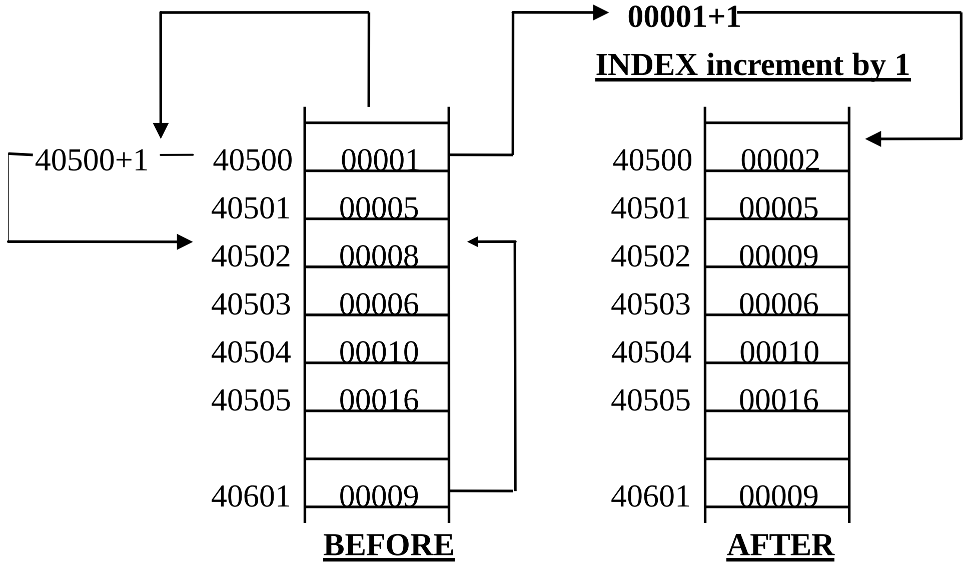
【DESCRIPTION】

Since I_2 = 'OFF', thus the operation mode is LIFO (Last In First Out).

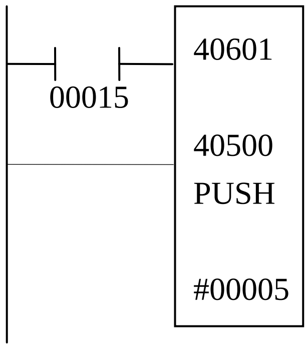
When I_1 receives an "OFF→ON" transition, the PUSH function is executed as follows:



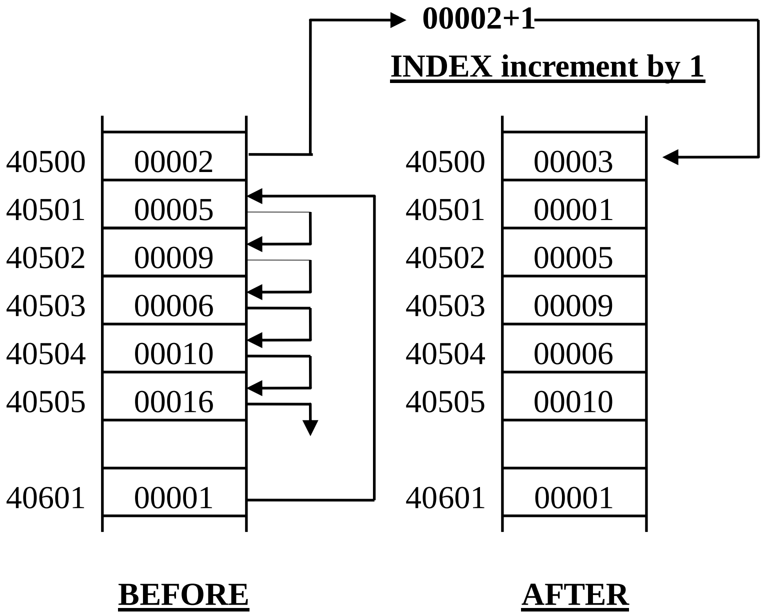
For the next "OFF→ON" transition on I_1:



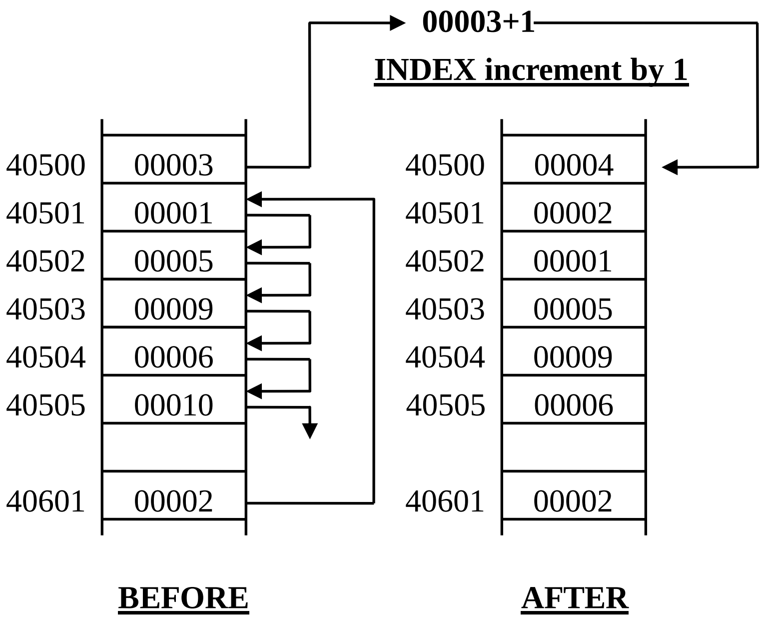
【EXAMPLE 2】



【DESCRIPTION】Since I_2 = ’ON’, thus the operation mode is FIFO (First in first out).
When I_1 receives an “OFF→ON” transition, the PUSH function is executed as follows:

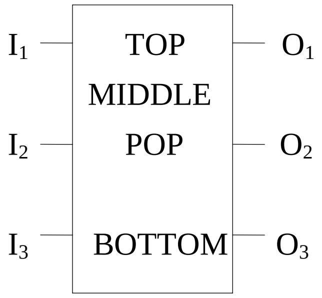


For the next “OFF→ON” transition on I_1:



POP	POP FROM STACK TO REGISTER		

SYMBOL:



OPERANDS:

	0	1	3	4	C	P	L
TOP				○		○	
MIDDLE	○	○	○	○		○	
BOTTOM					①		

①1~255

Description:

This function moves the content of a stack defined in the top node to the register defined in the middle node.

Input control (I_1) is used to determine whether this function block is to be executed or not.

Function outputs can be used to determine whether the function block has been executed, and whether the stack is empty.

Node Description:

TOP: INDEX is defined in the first word. The starting of the stack is defined in the second word of the middle node. If the INDEX is equal to zero, then the INDEX is pointing to the top of the stack.

MIDDLE: Data retrieved from stack.

BOTTOM: stack length.

Input Control:

I_1: When ( ) is presented, the function block is executed. INDEX is decremented by 1 first, then the data is retrieved according to the INDEX.

Function Output:

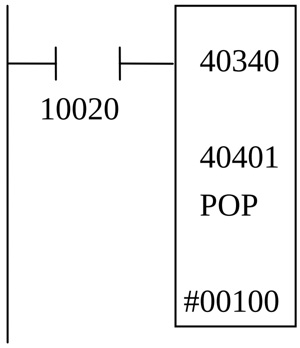
$O_1 = I_1$

$O_2 = 0$

O_3 = Stack status.

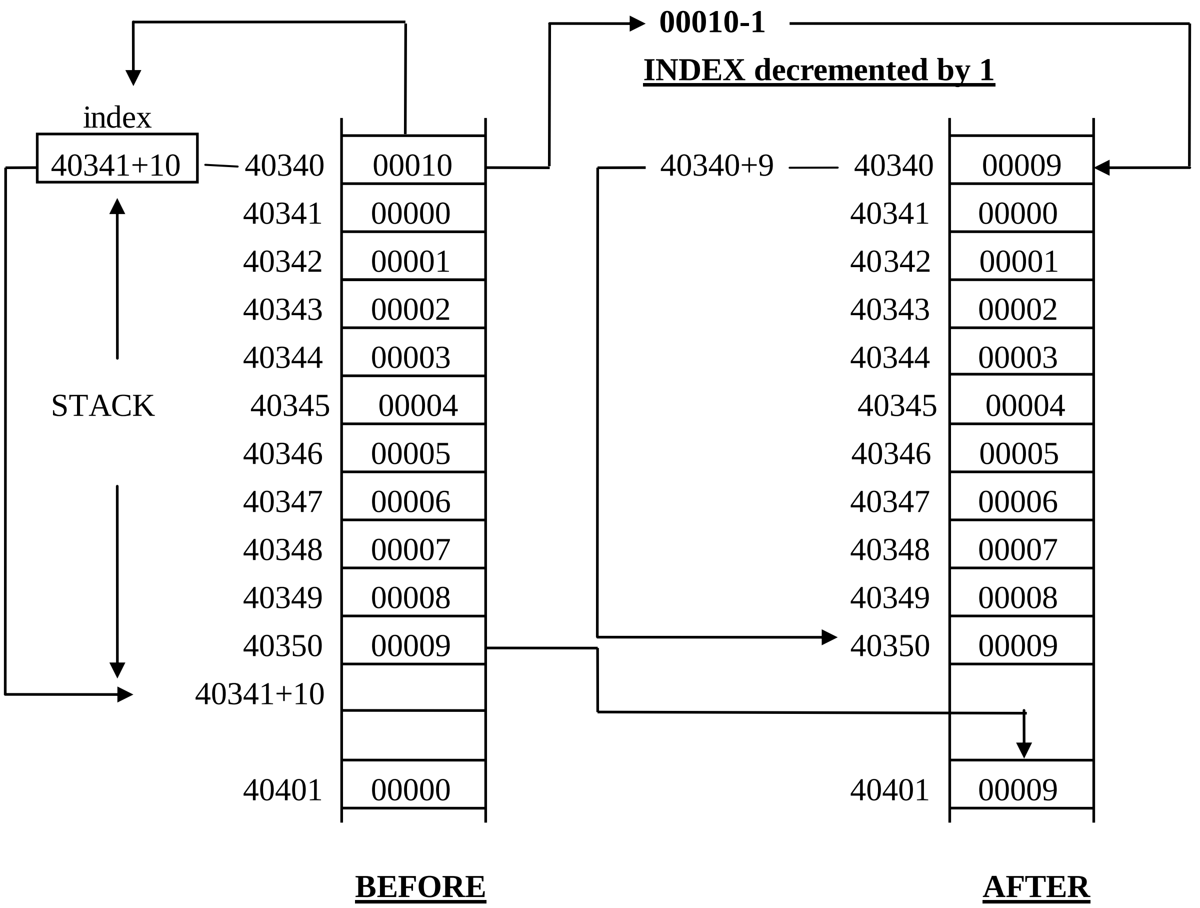
=1, if stack is empty, i.e. INDEX = 0.

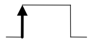
【EXAMPLE】



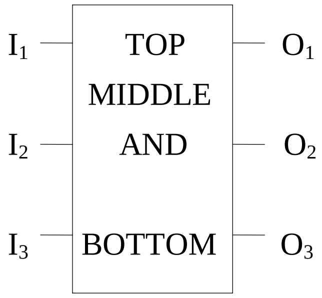
【DESCRIPTION】

When contact 10020='ON', the INDEX (40340) is decremented by 1; then the value pointed by the INDEX is retrieved and stored in the location pointed by the middle node. Through repeated conducting of contact 10020, the values in the stack are POPed successively.



AND	AND OPERATION FOR ARRAYS		

SYMBOL:



OPERANDS:

	0	1	3	4	C	P	L
TOP	○	○	○	○	①	○	
MIDDLE	○			○		○	
BOTTOM					②		

①0~65536

②1~255

Description:

The contents of top and middle nodes are ANDed, and the result is stored in the middle node.

Input control (I_1) is used to determine whether this function block is to be executed or not.

Function outputs can be used to determine whether the function block has been executed.

Remark: When the content of the top node is a constant, the constant and the contents of middle node are ANDed and the result is stored in the middle node.

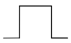
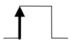
Node Description:

TOP: Source Array 1, or constant.

MIDDLE: Source Array 2, Resultant Array (after processing).

BOTTOM: Length of Array.

Input Control:

I_1: When  () is presented, the function block is executed.

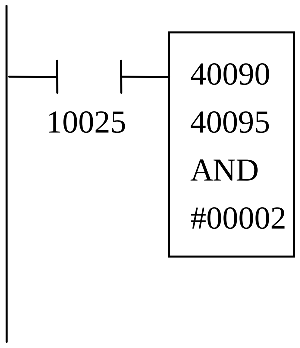
Function Output:

$O_1 = I_1$

$O_2 = 0$

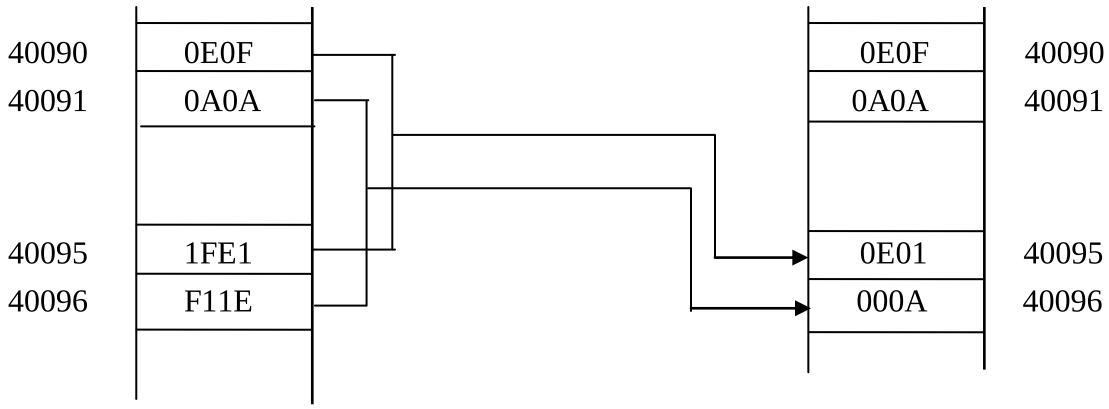
$O_3 = 0$

【EXAMPLE 1】

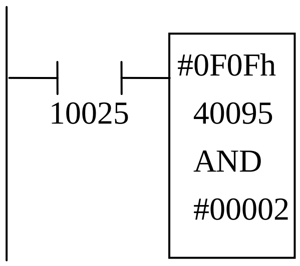


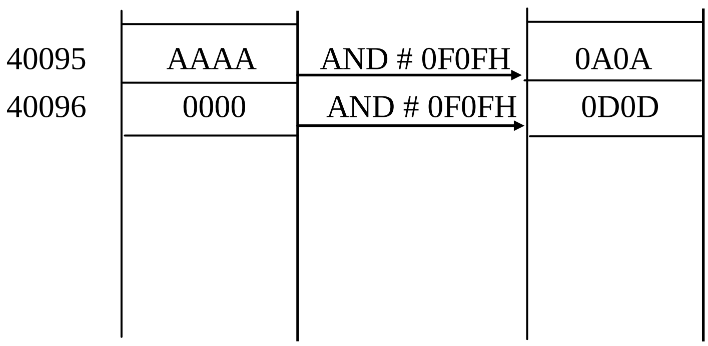
【DESCRIPTION】

When contact 10025 is energized, the contents of registers 40090 and 40095 are ANDed, and the result is returned to register 40095.



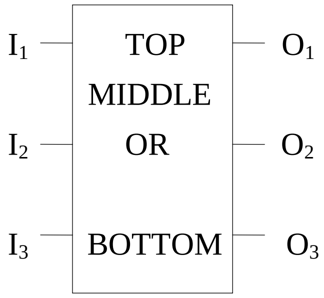
【EXAMPLE 2】





OR	OR OPERATION FOR ARRAYS

SYMBOL:



OPERANDS:

	0	1	3	4	C	P	L
TOP	○	○	○	○	①	○	
MIDDLE	○			○		○	
BOTTOM					□		

①0~65535

□1~255

Description:

The contents of top and middle nodes are ORed, and the result is stored in the middle node.

Input control (I_1) is used to determine whether this function block is to be executed or not.

Function outputs can be used to determine whether the function block has been executed.

Remark: When the content of the top node is a constant, the constant and the contents of middle node are ORed and the result is stored in the middle node.

Node Description:

TOP: Source Array 1, or constant.

MIDDLE: Source Array 2, Resultant Array (after processing).

BOTTOM: Length of Array.

Input Control:

I_1: When ( ) is presented, the function block is executed.

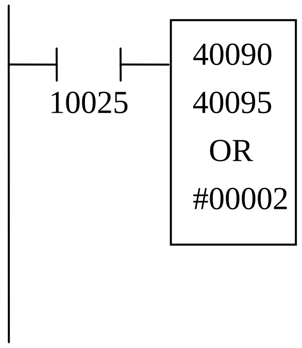
Function Output:

$O_1= I_1$

$O_2=0$

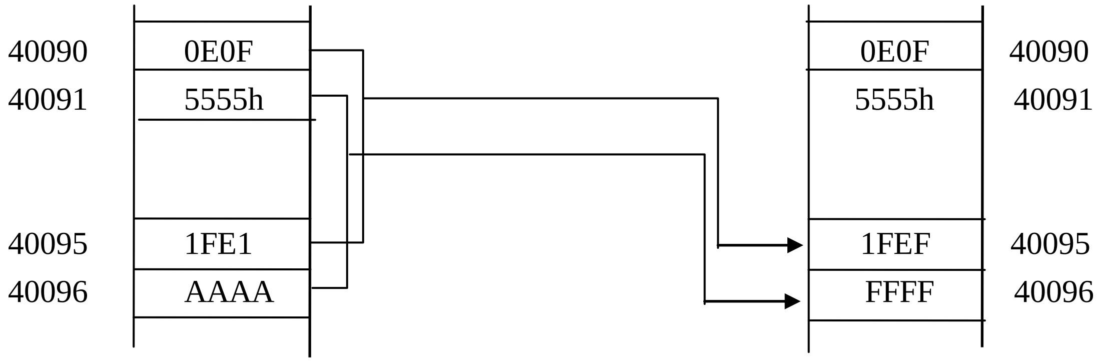
$O_3=0$

【EXAMPLE 1】

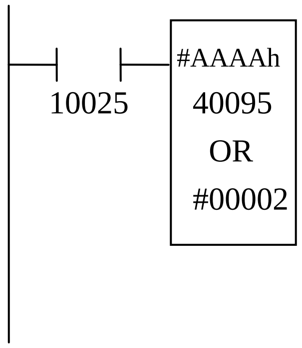


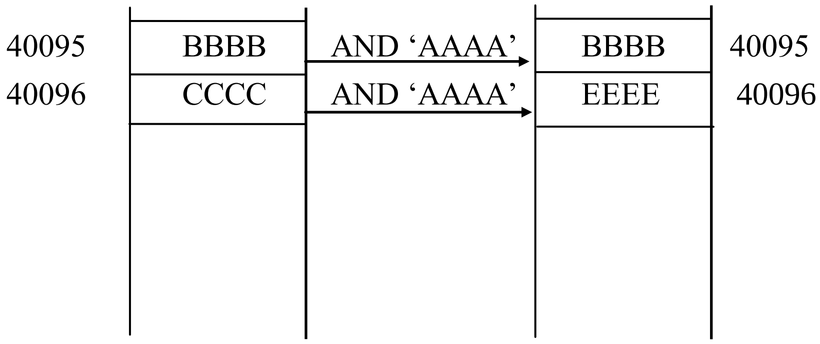
【DESCRIPTION】

When contact 10025 is energized, the contents of registers 40090 and 40095 are ORed, and the result is returned to register 40095.



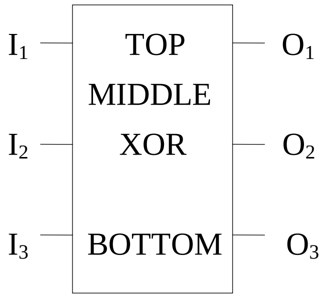
【EXAMPLE 2】





XOR	XOR OPERATION FOR ARRAYS		

SYMBOL:



OPERANDS:

	0	1	3	4	C	P	L
TOP	○	○	○	○	①	○	
MIDDLE	○			○		○	
BOTTOM					②		

① 0~65535

② 1~255

Description:

The contents of top and middle nodes are XORed, and the result is stored in the middle node.

Input control (I_1) is used to determine whether this function block is to be executed or not.

Function outputs can be used to determine whether the function block has been executed.

Remark: When the content of the top node is a constant, the constant and the contents of middle node are XORed and the result is stored in the middle node.

Node Description:

TOP: Source Array 1 or constant.

MIDDLE: Source Array 2, Resultant Array (after processing).

BOTTOM: Length of Array.

Input Control:

I_1: When ( ) is presented, the function block is executed.

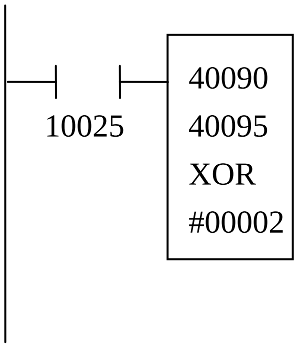
Function Output:

$O_1 = I_1$

$O_2=0$

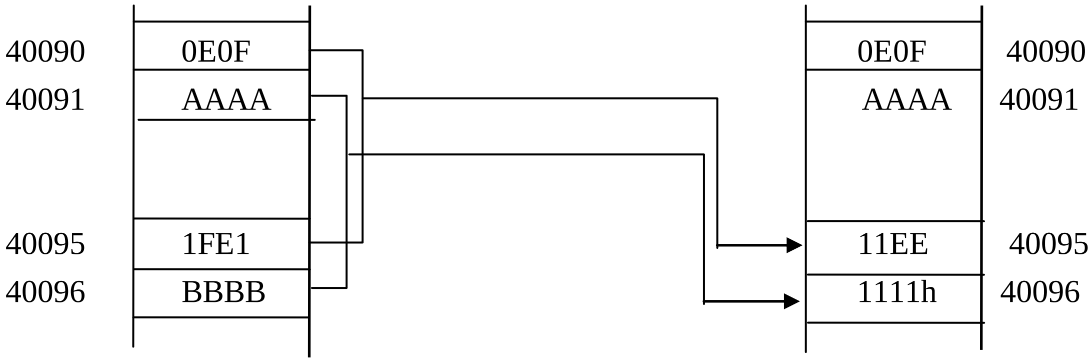
$O_3=0$

【EXAMPLE 1】

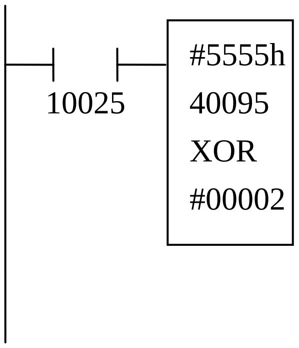


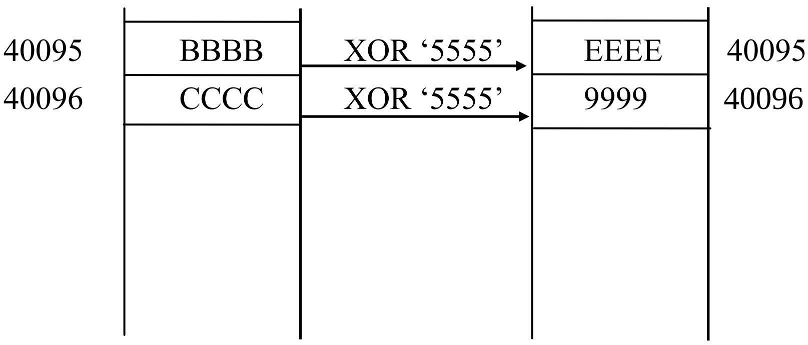
【DESCRIPTION】

When contact 10025 is energized, the contents of registers 40090 and 40095 are XORed, and the result is returned to register 40095.



【EXAMPLE 2】





COMP	1'S COMPLEMENT FOR ARRAYS		

SYMBOL:

I_1	TOP	O_1
	MIDDLE	
I_2	COMP	O_2
I_3	BOTTOM	O_3

OPERANDS:

	0	1	3	4	C	P	L
TOP	○	○	○	○		○	
MIDDLE	○			○		○	
BOTTOM					①		

①1~255

Description:

1's complement is obtained for the content of the top node, and the result is stored in the middle node.
Input control (I_1) is used to determine whether this function block is to be executed or not.
Function outputs can be used to determine whether the function block has been executed.

Node Description:

TOP: Source Array.
MIDDLE: Resultant Array.
BOTTOM: Length of Array.

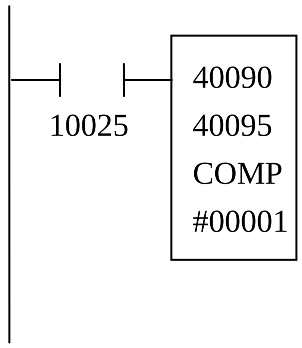
Input Control:

I_1: When ( ) is presented, the function block is executed.

Function Output:

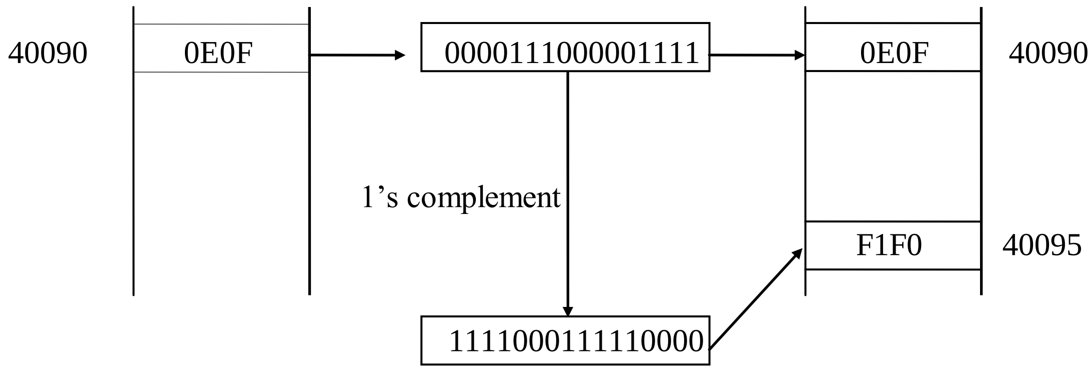
$O_1 = I_1$
$O_2=0$
$O_3=0$

【EXAMPLE】



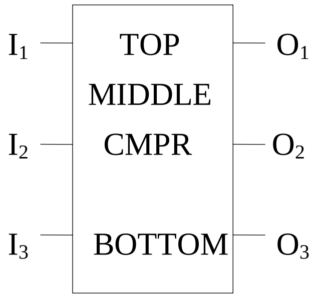
【DESCRIPTION】

When contact 10025 is energized, 1's complement is obtained for the content of register 40090, and the result is returned to register 40095.



CMPR	BIT COMPARISON BETWEEN TWO MATRIX		CMPR

SYMBOL:



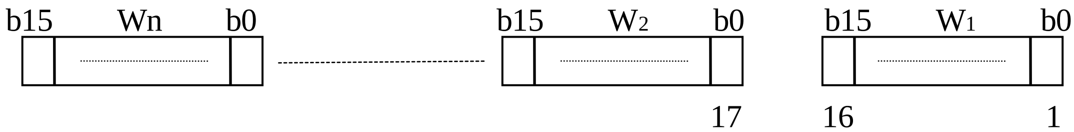
OPERANDS:

	0	1	3	4	C	P	L
TOP	○	○	○	○		○	
MIDDLE				○		○	
BOTTOM					①		

①1~255

Description:

This function compares the matrix pointed by the top and middle nodes. If a difference is found between the corresponding matrix locations, then the index of that element is stored in the middle node. Input control (I_1) is used to determine whether this function block is to be executed or not. Input control (I_2) is used to indicate the position where comparison is started. Function outputs can be used to determine whether the function block has been executed and whether those tables are different or not.



Node Description:

TOP: matrix 1.

MIDDLE: Index and matrix 2. INDEX is stored in the first word. Matrix 2 is stored starting from the second word. If the value of the INDEX is zero after searching, it represents that the contents of the two matrixes are identical.

BOTTOM: Length of matrix (word).

Input Control:

I_1: When ( ) is presented, the function block is executed. When a difference is found, the INDEX points to the position where the difference is found.

I_2: Start position of the comparison.

=0, start from the position pointed to by the INDEX.

=1, start from the first position

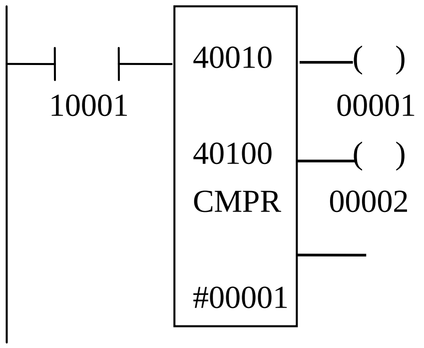
Function Output:

$O_1 = I_1$

O_2=1, if a difference is found.

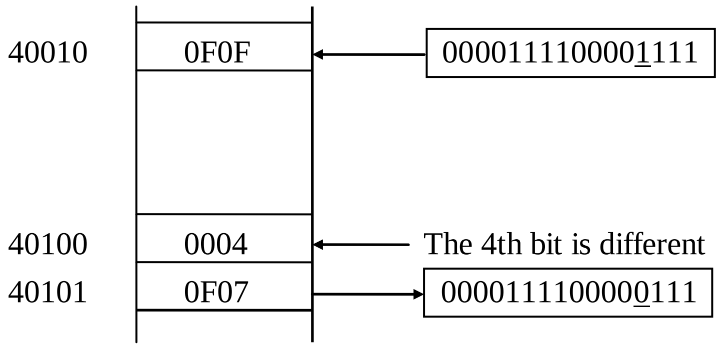
O_3=0

【EXAMPLE】



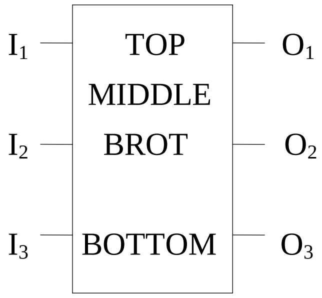
【DESCRIPTION】

When contact 10001 is energized, the matrix starting from 40010 is compared against the matrix starting from 40100. Since the fourth bit is different, then the index of that location is stored in the middle node and coil 00002 is energized.



BROT — BIT ROTATE/SHIFT FOR MATRIX

SYMBOL:



OPERANDS:

	0	1	3	4	C	P	L
TOP	○	○	○	○		○	
MIDDLE	○			○		○	
BOTTOM					①		

①1~255

Description:

Using the bit as a unit, this function performs array rotate or shift. The result is stored in the middle node.

The matrix is defined in the top node.

Table length is defined in the bottom node.

Input control (I_1) is used to determine whether this function block is to be executed or not.

Input control (I_2) is used to define the direction.

Input control (I_3) is used to define the mode.

Function outputs can be used to determine whether the function block has been executed.

Node Description:

TOP: Source matrix.

MIDDLE: Target matrix.

BOTTOM: Length of matrix (word).

Input Control:

I_1: Execution control.

When ⎍ (↑⎍) is presented,

rotate/shift operation is performed one bit per scan.

I_2: Direction

=0, Left.

=1, Right.

I_3: Mode.

=0, Shift.

=1, Rotate.

Function Output:

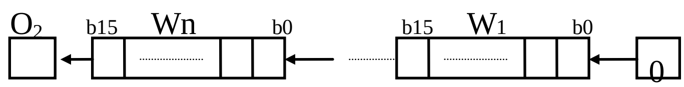
O_1= I_1

O_2: Bit shifted into this position.

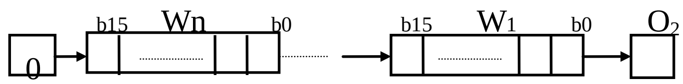
O_3=0

SHIFT MODE

LEFT

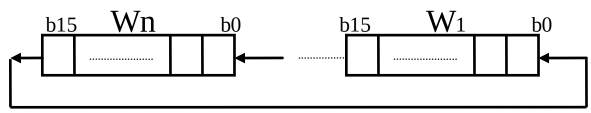


RIGHT

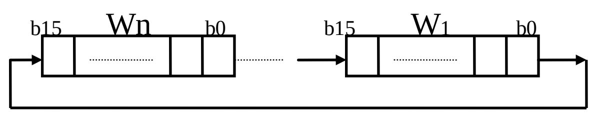


ROTATE MODE

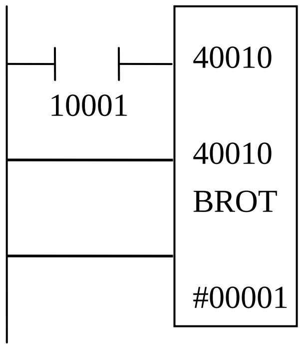
LEFT



RIGHT



【EXAMPLE】



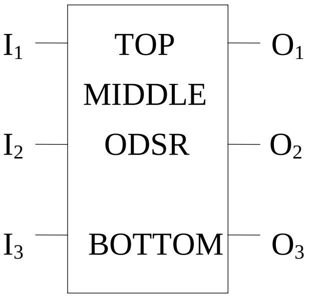
【DESCRIPTION】

When contact 10001 receives a transition from ‘OFF’ to ‘ON’ and I_2=I_3=1, then a right rotate operation is performed.

INITIAL STATE	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	1	40010
AFTER 1st SCAN	1	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	40010
AFTER 2nd SCAN	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	1	40010

			ODSR
ODSR	**NIBBLE ROTATE/SHIFT FOR MATRIX**		

SYMBOL:



OPERANDS:

	0	1	3	4	C	P	L
TOP	○	○	○	○		○	
MIDDLE	○			○		○	
BOTTOM					①		

①1~255

Description:

Using the nibble as a unit, this function performs array rotate or shift. The result is stored in the middle node. The matrix is defined in the top node. Table length is defined in the bottom node.

Input control (I_1) is used to determine whether this function block is to be executed or not.

Input control (I_2) is used to define the direction.

Input control (I_3) is used to define the mode.

Function outputs can be used to determine whether the function block has been executed.

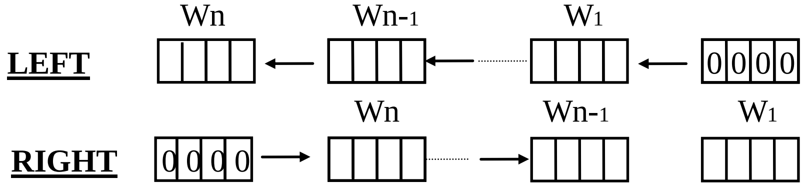
Node Description:

TOP: Source matrix

MIDDLE: Target matrix

BOTTOM: Length of matrix (word)

SHIFT MODE



Input Control:

I_1: Execution control.

When ( ) is presented,

rotate/shift operation is performed one nibble per scan.

I_2: Direction

=0, Left

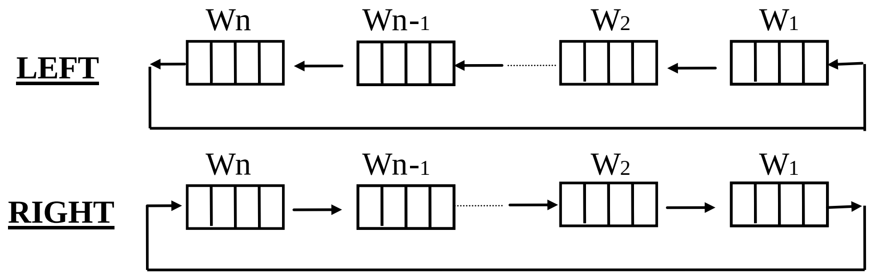
=1, Right

I_3: Mode.

=0, Shift.

=1, Rotate.

ROTATE MODE



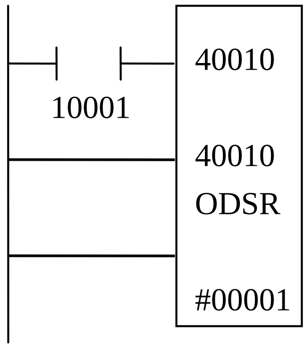
Function Output:

$O_1 = I_1$

$O_2=0$

$O_3=0$

【EXAMPLE】



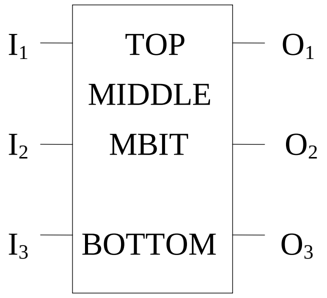
【DESCRIPTION】

When contact 10001 receives a transition from ‘OFF’ to ‘ON’ and I_2=I_3=1, then a right rotate operation is performed.

Initial State	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	40010
After 1st Scan	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	40010
After 2nd Scan	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	40010

MBIT	**MODIFY BIT MATRIX**	⎍	↑⎍

SYMBOL:



OPERANDS:

	0	**1**	**3**	**4**	**C**	**P**	**L**
TOP			○	○	①	○	
MIDDLE	○			○		○	
BOTTOM					②		

①1~65535

②1~255

Description:

This function is used to SET or CLEAR a certain bit in a matrix. Bit location is defined in the top node. Array to be modified is defined in the middle node. Array length (WORD)is defined in the bottom node.

Input control (I_1) is used to determine whether this function block is to be executed or not.

Input control (I_2) is used to define the action (SET or Clear).

Input control (I_3) is used to define the behavior of the INDEX.

Function outputs can be used to determine whether the function block has been executed, and the status of the INDEX.

Node Description:

TOP: INDEX (pointing to the bit to be modified). INDEX=1 ➔ The first bit.

MIDDLE: Source matrix.

BOTTOM: Matrix length (word).

Input Control:

I_1: When ⎍ (↑⎍) is presented, the function block is executed.

I_2: Action.

=0, bit clear

=1, bit set

I_3: INDEX control. If I_3=1 and TOP = 4xxxx, then the INDEX is incremented by 1 after execution.

Function Output:

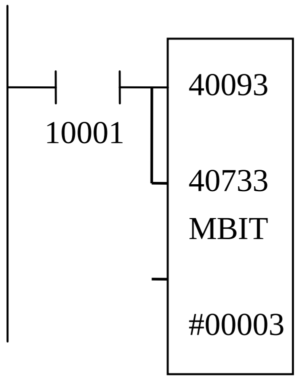
O_1= I_1

O_2= I_2

O_3: Status of the INDEX.

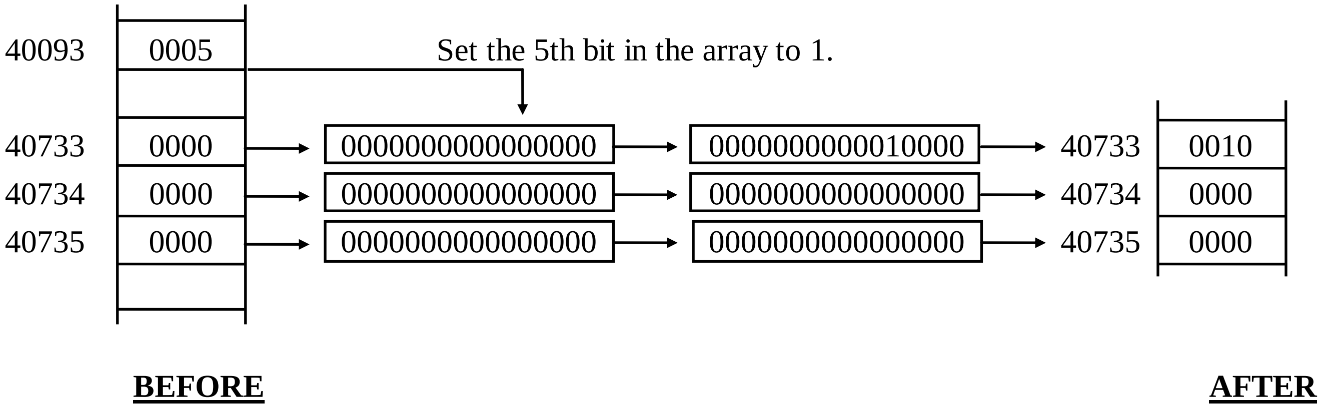
=1, if INDEX is larger than the value of the BOTTOM node times 16.

【EXAMPLE】



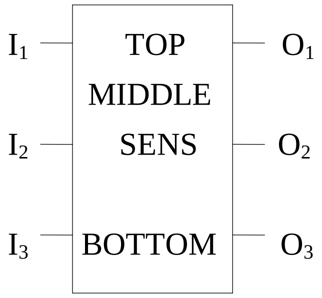
【DESCRIPTION】

00005 is stored in the top node (40093). When contact 10001 is energized, and I_2=1, then the 5th bit of the matrix starting from 40733 to 40735 is set to 1.



SENS	SENSING OF A BIT IN MATRIX		

SYMBOL:



OPERANDS:

	0	1	3	4	C	P	L
TOP			○	○	①	○	
MIDDLE	○			○		○	
BOTTOM					②		

①1~255

②1~65535

Description:

This function is used to sense a certain bit in a matrix. Bit location is defined in the top node. Matrix to be modified is defined in the middle node. Array length is defined in the bottom node.

Input control (I_1) is used to determine whether this function block is to be executed or not.

Input control (I_2) is used to define the behavior of the INDEX.

Input control (I_3) is used to reset the INDEX.

Function outputs can be used to determine whether the function block has been executed, and the status of the INDEX.

Node Description:

TOP: INDEX (pointing to the bit to be checked). INDEX=1 ➔ The first bit.

MIDDLE: Source matrix.

BOTTOM: Matrix length (word).

Input Control:

I_1: When ( ) is presented, the function block is executed.

I_2 : INDEX control. If I_3=1 and the top node is 4XXXX, then the INDEX is incremented by 1 after execution.

I_3: INDEX control.

=1, Reset INDEX.

Function Output:

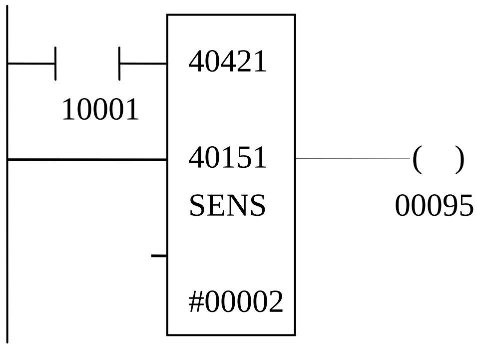
$O_1 = I_1$

O_2 = The state of the bit sensed.

O_3: Status of the INDEX.

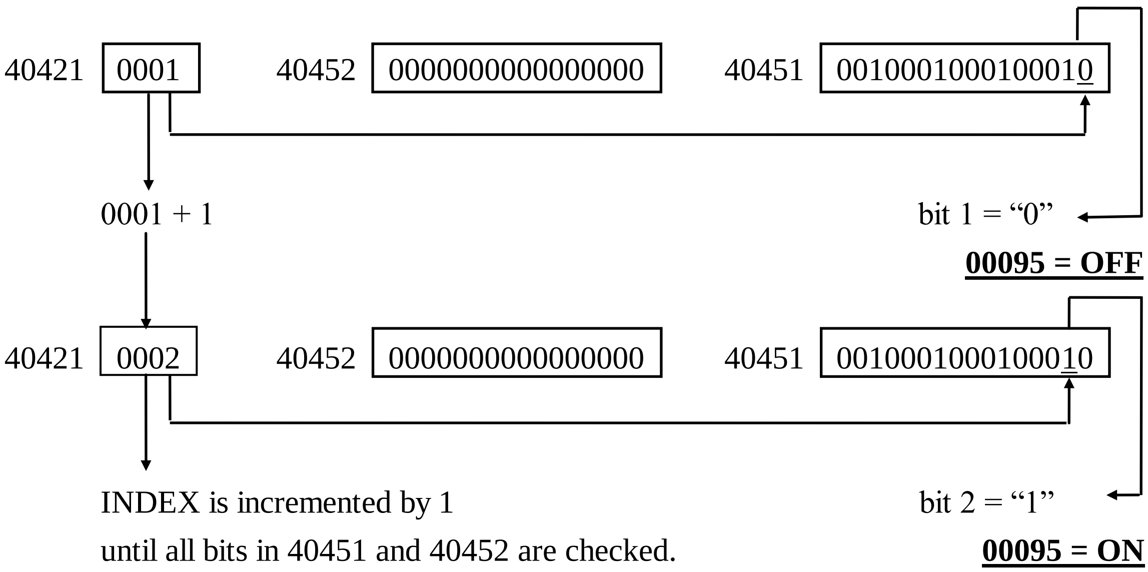
=1, if INDEX is equal to zero or larger than the value of the BOTTOM node times 16.

【EXAMPLE】



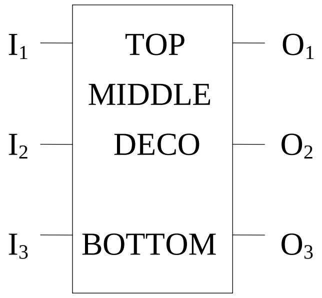
【DESCRIPTION】

When contact 10001 is energized and I_2=1, the state of coil 00095 is set to that of the bit checked. Since (40421)=0001, The 1st bit is checked. And since the bottom node is #00002, thus the registers 40151～40152 are checked.



DECO	**DECODER (4->16)**		

SYMBOL:



OPERANDS:

	0	**1**	**3**	**4**	**C**	**P**	**L**
TOP	○	○	○	○		○	
MIDDLE	○			○		○	
BOTTOM					①		

①0~3

Description:

This function is a 4 bit to 16 bit decoder. The top node contains 4 sets of 4-bit data. The set of data to be decoded is defined in the bottom node.

Input control (I_1) is used to determine whether this function block is to be executed or not.

Function outputs can be used to determine whether the function block has been executed.

Node Description:

TOP: Input to decoder, only four bits (nibble) are used.

MIDDLE: Decoder output.

BOTTOM: Determine which nibble in the TOP node is to be decoded.

Input Control:

I_1: When ( ) is presented, the function block is executed.

Function Output:

$O_1= I_1$

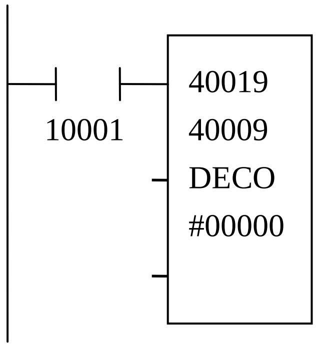
$O_2=0$

$O_3=0$

TRUTH TABLE

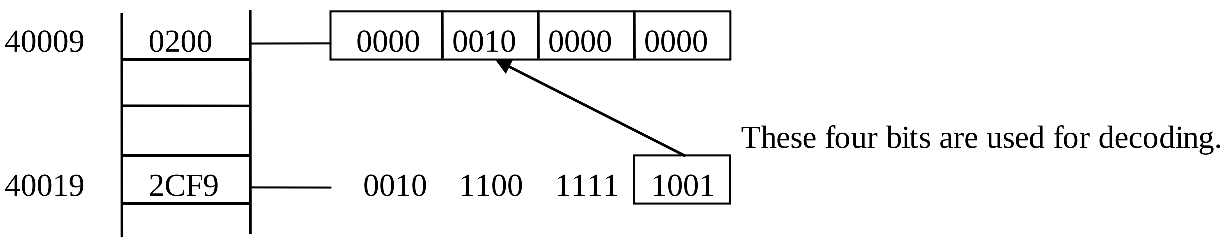
INPUTS				OUTPUT WORD															
3	**2**	**1**	**0**	**15**	**14**	**13**	**12**	**11**	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**
0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**	0
0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**	0	0
0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	**1**	0	0	0
0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**	0	0	0	0
0	1	0	1	0	0	0	0	0	0	0	0	0	0	**1**	0	0	0	0	0
0	1	1	0	0	0	0	0	0	0	0	0	0	**1**	0	0	0	0	0	0
0	1	1	1	0	0	0	0	0	0	0	0	**1**	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	**1**	0	0	0	0	0	0	0	0
1	0	0	1	0	0	0	0	0	0	**1**	0	0	0	0	0	0	0	0	0
1	0	1	0	0	0	0	0	0	**1**	0	0	0	0	0	0	0	0	0	0
1	0	1	1	0	0	0	0	**1**	0	0	0	0	0	0	0	0	0	0	0
1	1	0	0	0	0	0	**1**	0	0	0	0	0	0	0	0	0	0	0	0
1	1	0	1	0	0	**1**	0	0	0	0	0	0	0	0	0	0	0	0	0
1	1	1	0	0	**1**	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	1	1	1	**1**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

【EXAMPLE】



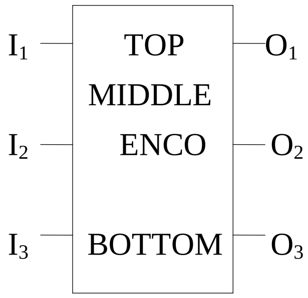
【DESCRIPTION】

Let register 40019 = 2CF9h = 0010 1100 1111 1001B, and #00000 is defined in the bottom node. #00000 indicates that the first set of 4-bit data is to be used as the decoder function input. The first 4-bit set in this example is 1001B, which is equal to 9. Therefore, the 10th bit (0 means the 1st bit and 15 means the 16th bit) in the middle node (40009) will be set after contact 10001 is energized.



ENCO	**ENCODER (16->4)**		

SYMBOL:



OPERANDS:

	0	**1**	**3**	**4**	**C**	**P**	**L**
TOP	○	○	○	○		○	
MIDDLE	○			○		○	
BOTTOM					①		

①0~3

Description:

This function is a 16-bit to 4-bit encoder. The top node contains the data to be encoded. The bottom node indicates the 4-bit set to be used to store the encoded result, and the encoded data is stored in the middle node.

NOTE: If more than one bit is set in the top node, then the bit which is closer to the most significant bit will be used for encoding.

Input control (I_1) is used to determine whether this function block is to be executed or not.

Function outputs can be used to determine whether the function block has been executed.

Node Description:

TOP: Input to encoder.

MIDDLE: Encoder result.

BOTTOM: Nibble (0~3) where the encoder result is stored.

Input Control:

I_1: When ( ) is presented, the function block is executed.

Function Output:

$O_1 = I_1$

O_2 = indicator

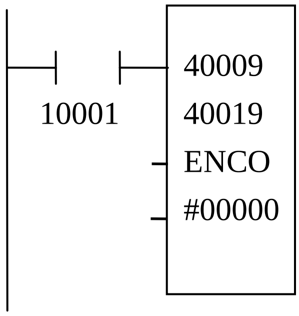
=1, if the valued stored in the TOP node is zero.

O_3=0

TRUTH TABLE

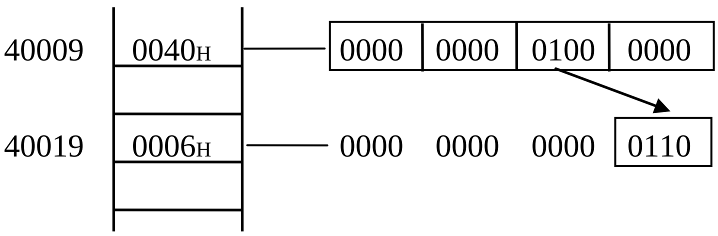
INPUT WORD																OUTPUTS			
15	**14**	**13**	**12**	**11**	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**	**3**	**2**	**1**	**0**
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**	0	0	0	0	1
0	0	0	0	0	0	0	0	0	0	0	0	0	**1**	0	0	0	0	1	0
0	0	0	0	0	0	0	0	0	0	0	0	**1**	0	0	0	0	0	1	1
0	0	0	0	0	0	0	0	0	0	0	**1**	0	0	0	0	0	1	0	0
0	0	0	0	0	0	0	0	0	0	**1**	0	0	0	0	0	0	1	0	1
0	0	0	0	0	0	0	0	0	**1**	0	0	0	0	0	0	0	1	1	0
0	0	0	0	0	0	0	0	**1**	0	0	0	0	0	0	0	0	1	1	1
0	0	0	0	0	0	0	**1**	0	0	0	0	0	0	0	0	1	0	0	0
0	0	0	0	0	0	**1**	0	0	0	0	0	0	0	0	0	1	0	0	1
0	0	0	0	0	**1**	0	0	0	0	0	0	0	0	0	0	1	0	1	0
0	0	0	0	**1**	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1
0	0	0	**1**	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0
0	0	**1**	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1
0	**1**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1

【EXAMPLE】



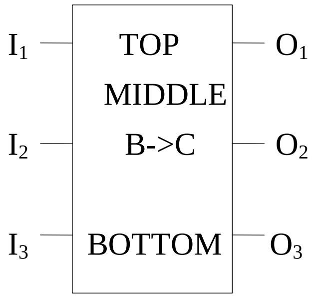
【DESCRIPTION】

Let 40009 = 0040h = 0000 0000 0100 0000h, and #00000 is given in the bottom node. Since MSB is the 16th bit and LSB is the first bit in a 16-bit register, thus, the 7th bit is encoded to 6; and 6 is equal to 0110B. This 0110B 4-bit set is moved to the 1st 4-bit set of register 40019 as defined in the bottom node(#00000)



B->C	BINARY TO BCD CONVERTION		

SYMBOL:



OPERANDS:

	0	1	3	4	C	P	L
TOP	○	○	○	○		○	
MIDDLE	○			○		○	
BOTTOM					①		

①1~2

Description:

This function performs binary to binary-coded-decimal conversion. The data to be converted is defined in the top node, and the converted data is stored in the middle node. The bottom node defines the conversion type (word or long word).

Input control (I_1) is used to determine whether this function block is to be executed or not.

Function outputs can be used to determine whether the function block has been executed and whether the result is correct or not.

Node Description:

TOP: data set (binary) to be converted, must be＜=9999(decimal).

MIDDLE: Conversion result.

BOTTOM:1.Word conversion.

2.Long word conversion.

Input Control:

I_1: When ⎍ (↑⎍) is presented, the function block is executed.

Function Output:

$O_1 = I_1$

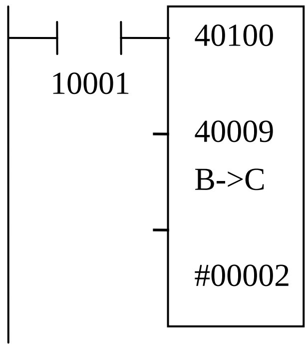
O_2= indicator

= 1, if the valued stored in the TOP node is ＞9999(decimal) when the value of bottom node is ‘1’.

= 1, if the valued stored in the TOP node is ＞99999999(decimal) when the value of bottom node is ‘2’.

$O_3 = 0$

【EXAMPLE】



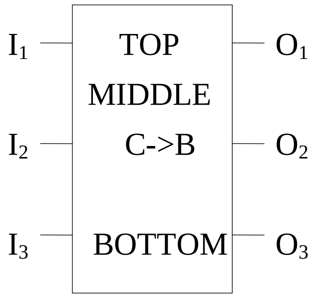
【DESCRIPTION】

Let register (40100)= 0001h, and register (40101)= 0002h. When contact 10001 is energized, since #00002 is defined as a long word conversion, then the top node long word (40100) 10010h=65538d are converted and stored in registers 40009 and 40010.

40100	0000	0000	0000	0001	
40101	0000	0000	0000	0010	10010h
40009	0000	0000	0000	0110	
40010	0101	0101	0011	1000	65538d

C->B	BCD TO BINARY CONVERTION		

SYMBOL:



OPERANDS:

	0	1	3	4	C	P	L
TOP	○	○	○	○		○	
MIDDLE	○			○		○	
BOTTOM					①		

①1~2

Description:

This function performs binary-coded-decimal to binary conversion. The data to be converted is defined in the top node, and the converted data is stored in the middle node. The bottom node defines the conversion type (word or long word).

Input control (I_1) is used to determine whether this function block is to be executed or not.

Function outputs can be used to determine whether the function block has been executed and whether the result is correct or not.

Node Description:

TOP: data set (BCD) to be converted.

MIDDLE: Conversion result.

BOTTOM:1. Word

2. Long word

Input Control:

I_1: When ( ) is presented, the function block is executed.

Function Output:

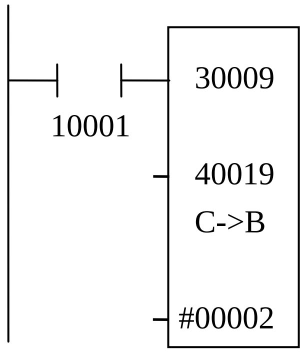
$O_1 = I_1$

O_2 = indicator

= 1, if the valued stored in the TOP node is not in BCD format.

O_3=0

【EXAMPLE】



【DESCRIPTION】

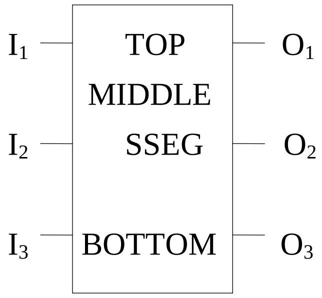
Science this is a long word conversion (bottom node is #00002). When contact 100d is energized, the top node long word (30009) = 65538d is converted to 10010h and stored in middle node (40019), (40020).
Let register (30009) = 8888d = 22B8h, and register (30010) = 7777d = 1E61h.
When contact 10001 is energized, since #00002 is defined to the bottom node, then the converted BCD codes are stored in registers 40019 and 40020.

30009	0000	0000	0000	0110	
30010	0101	0101	0011	1000	65538d
40019	0000	0000	0000	0001	
40020	0000	0000	0000	0010	10010h

SSEG

SSEG — SEVEN-SEGMENT DECODER

SYMBOL:



OPERANDS:

	0	1	3	4	C	P	L
TOP	○	○	○	○		○	
MIDDLE	○			○		○	
BOTTOM					①		

①1~4

Description:

The register for the top node is divided into four 4-bit sets of data, and each set is converted for 7-segment display format. The bottom node defines the size (1~4) to be converted. The result is stored in the middle node.

Input control (I_1) is used to determine whether this function block is to be executed or not.

Function outputs can be used to determine whether the function block has been executed.

Node Description:

TOP: data to be converted.

MIDDLE: conversion result.

BOTTOM: number of digits to be converted (1digit = 4 bits).

Input Control:

I_1: When ⎍ (↑) is presented, the function block is executed.

I_2 : Leading zero display control

=0, normal display.

=1, leading zero suppressed.

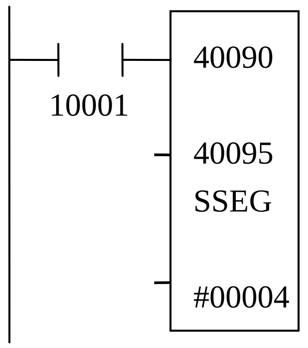
Function Output:

$O_1 = I_1$

$O_2 = 0$

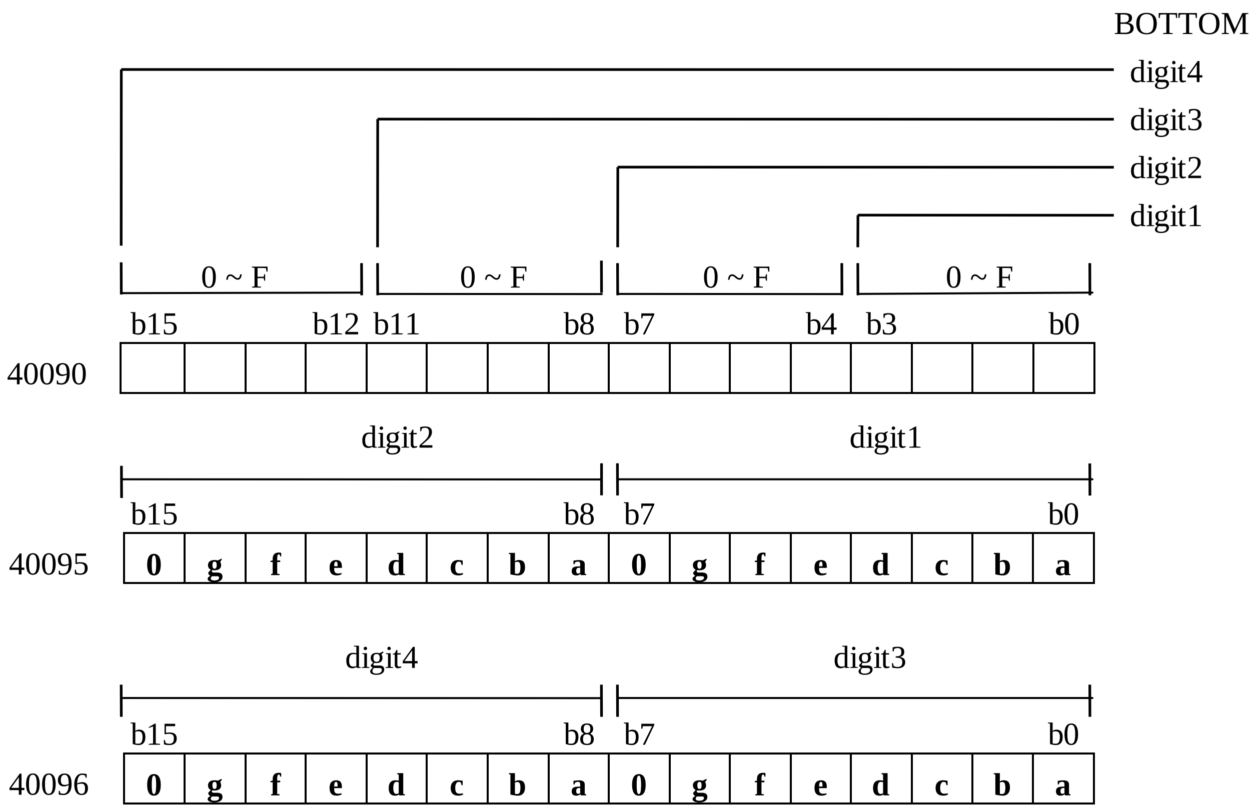
$O_3 = 0$

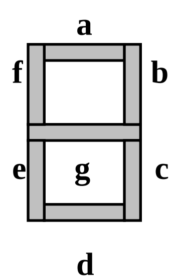
【EXAMPLE】



【DESCRIPTION】

When I_1=1, the data contained in register 40095 is divided into four 4-bit sets and converted to 7-segment display format. Since the bottom node is given #00004, thus, all four 4-bit sets are converted and stored in the middle node registers 40095 and 40096.





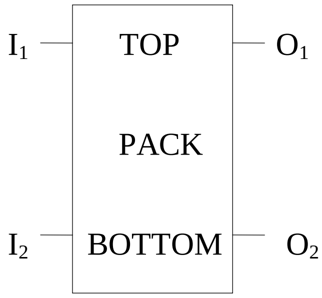
TRUTH TABLE

Display	number	a	b	c	d	e	f	g
0	0	1	1	1	1	1	1	0
1	1	0	1	1	0	0	0	0
2	2	1	1	0	1	1	0	1
3	3	1	1	1	1	0	0	1
4	4	0	1	1	0	0	1	1
5	5	1	0	1	1	0	1	1
6	6	1	0	1	1	1	1	1
7	7	1	1	1	0	0	0	0
8	8	1	1	1	1	1	1	1
9	9	1	1	1	1	0	1	1
A	A	1	1	1	0	1	1	1
b	B	0	0	1	1	1	1	1
C	C	1	0	0	1	1	1	0
d	D	0	1	1	1	1	0	1
E	E	1	0	0	1	1	1	1
F	F	1	0	0	0	1	1	1

*** Leading zeroes are converted to 0's.**

PACK	WORD PACK/UNPACK		

SYMBOL:



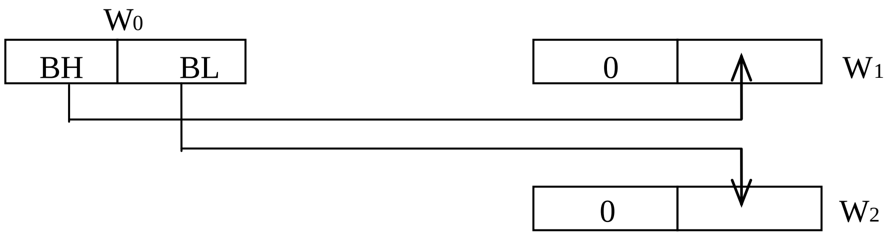
OPERANDS:

	0	1	3	4	C	P	L
TOP	○	○	○	○		○	
BOTTOM	○			○		○	

Description:

Depending on I_2, this function splits the contents of the top node into two bytes, and stores them in the middle node; or, takes two LOW BYTEs from the top node, concatenate to form a new 16-bit word and stores it in the middle node.

Input control (I_1) is used to determine whether this function block is to be executed or not.



Node Description:

TOP: Data to be processed.

BOTTOM: Process result.

Input Control:

I_1: When ⎍ (↑⎍) is presented, the function block is executed.

I_2: Pack/Unpack

=0, Unpack (splits the source data into two words and stores them in the bottom node).

=1, Pack (concatenate the lower bytes of two words and stores the word in the bottom node).

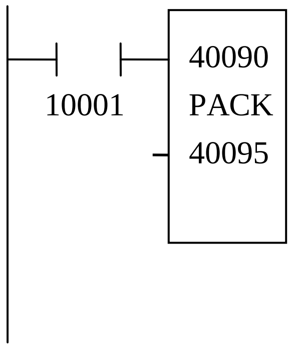
Function Output:

$O_1 = I_1$

$O_2 = 0$

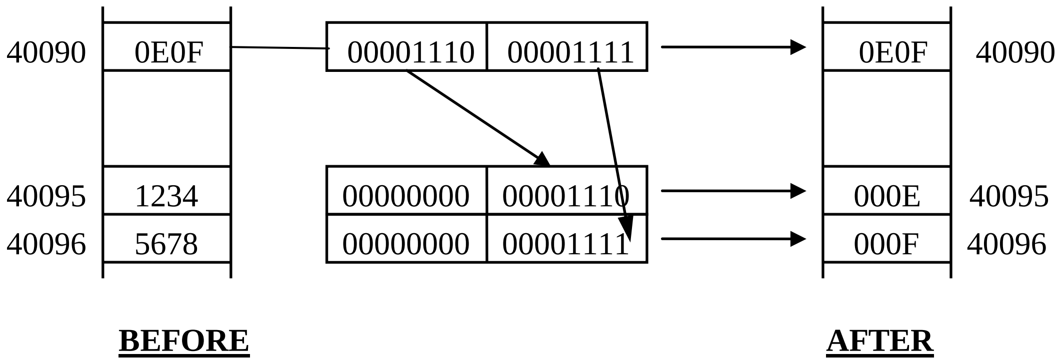
【EXAMPLE 1】

UNPACK



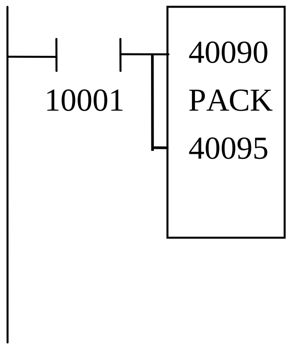
【DESCRIPTION】

When contact 10001 is energized, the content of the top node(40090) is split into two bytes which are stored in the middle node (40095 and 40096)



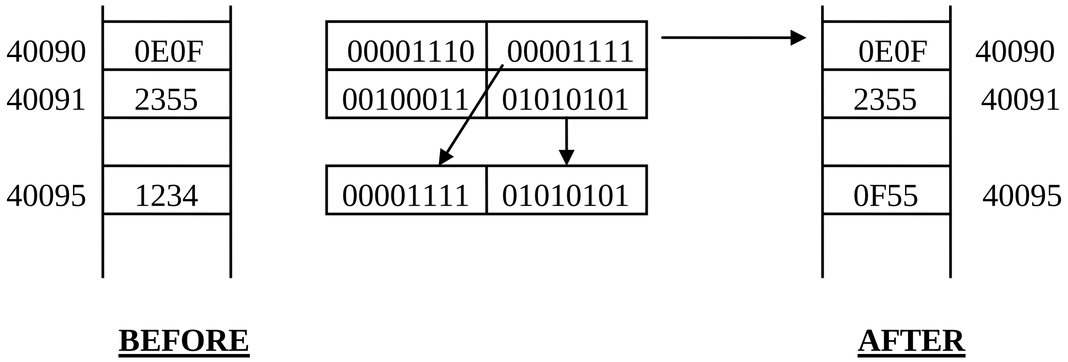
【EXAMPLE 2】

PACK



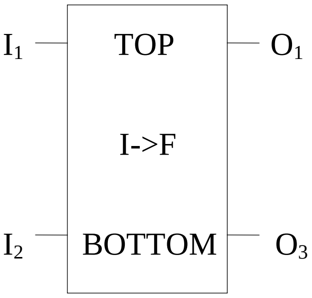
【DESCRIPTION】

When contact 10001 is energized, two LOW BYTEs taken from the top node(40090 and 40091), are concatenated to form a new 16-bit word which is stored in the middle node(40095).



I->F	INTEGER TO FLOATING POINT CONVERSION		

SYMBOL:



OPERANDS:

	0	1	3	4	C	P	L
TOP			○	○		○	
BOTTOM				○		○	

Description:

This function converts an integer stored in the top node to a floating point number and stores in the registers defined in the middle node.

Input control (I_1) is used to determine whether this function block is to be executed or not.

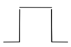
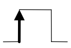
Function outputs can be used to determine whether the function block has been executed.

Node Description:

TOP: Data to be converted, integer (16 bits).

BOTTOM: Conversion results (32 bits).

Input Control:

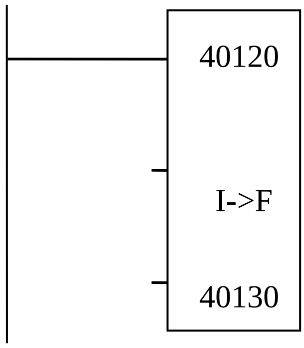
I_1: When  () is presented, the function block is executed.

Function Output:

$O_1 = I_1$

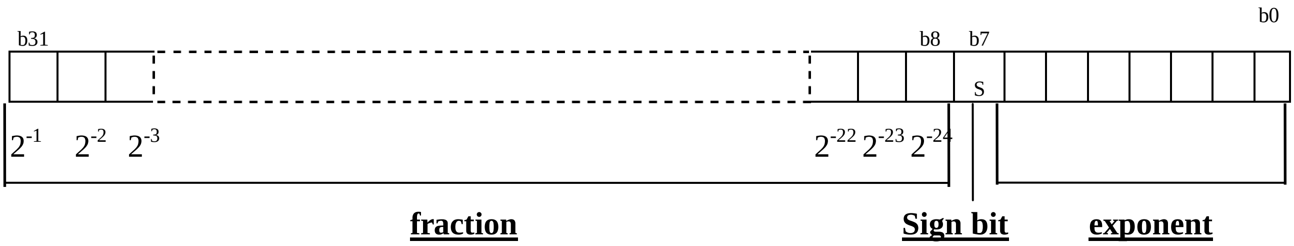
$O_2 = 0$

【EXAMPLE】



【DESCRIPTION】

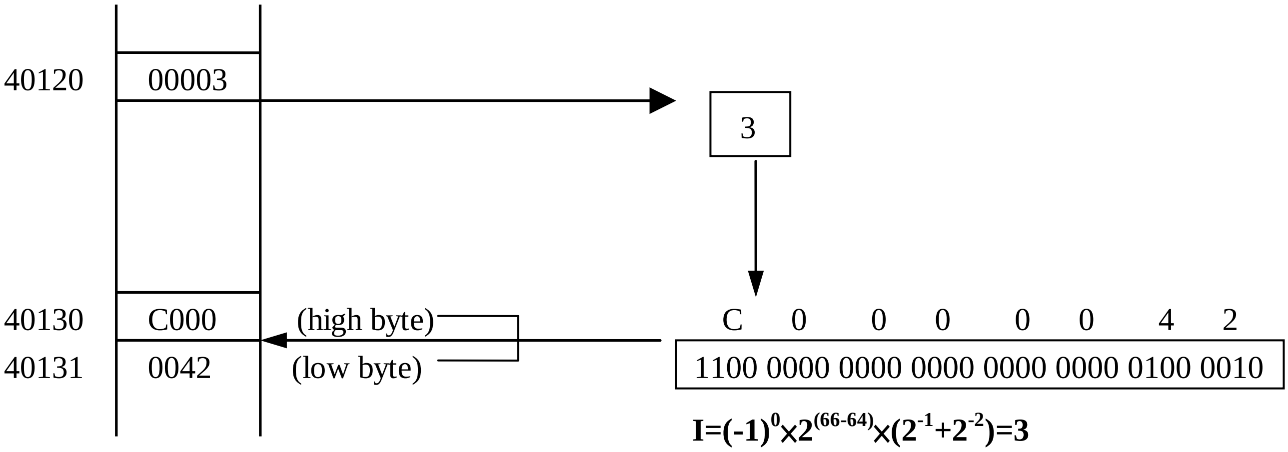
Converts the integer stored in the top node (40120) to a floating number and stores in the middle node(40130 & 40131). A floating point number is represented by two words: bit0~bit6 represent the exponent, bit7is the sign bit(0: positive, 1:negative), and bit8~bit31 represent the fraction.



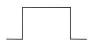
Formula:

$$\mathbf{I = (-1)^{S} \times 2^{(E-64)} \times Fr}$$

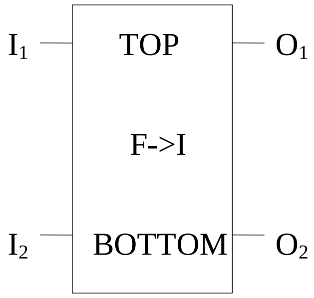
S= sign bit, E=exponent



$$\mathbf{I=(-1)^{0}\times 2^{(66-64)}\times(2^{-1}+2^{-2})=3}$$

F->I	FLOATING POINT TO INTEGER CONVERSION		

SYMBOL:



OPERANDS:

	0	1	3	4	C	P	L
TOP				○		○	
BOTTOM				○		○	

Description:

This function converts a floating point number stored in the top node to an integer and stores in the registers defined in the middle node.

Input control (I_1) is used to determine whether this function block is to be executed or not.

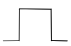
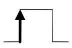
Function outputs can be used to determine whether the function block has been executed.

Node Description:

TOP: Data to be converted, **floating point number** (32 bits).

BOTTOM: Conversion results. **Integer** (16 bits).

Input Control:

I_1: When  () is presented, the function block is executed.

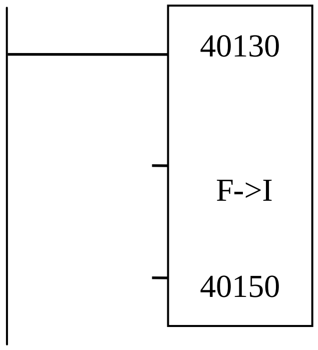
Function Output:

$O_1 = I_1$

O_2: Error output

=1, (overflow or < 0)

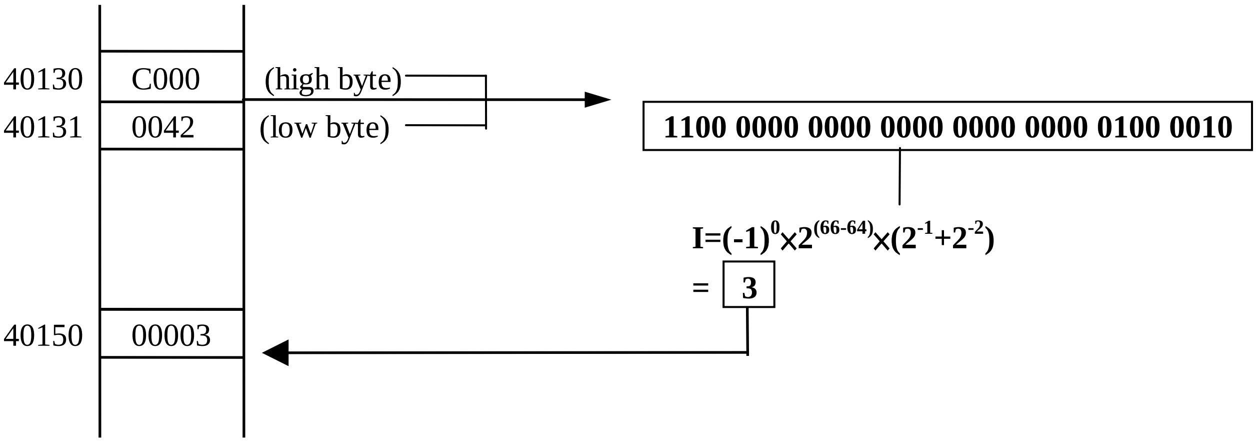
【EXAMPLE】



【DESCRIPTION】

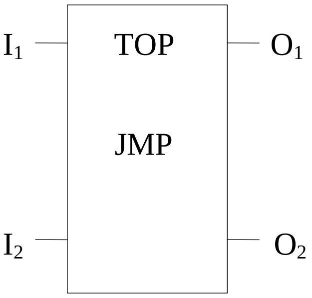
For a floating point number C000, 0042 stored in registers 40130 and 40131 respectively, the conversion returns 0003 stored in 40150.

$$\mathbf{I=(-1)^0 \times 2^{(66-64)} \times (2^{-1}+2^{-2})=3}$$



JMP	**JUMP**

SYMBOL:



OPERANDS:

	0	1	3	4	C	P	L
TOP							①

①L1~L150

Description:

This instruction is used to instruct the program to JUMP to the other portion of the program with matched label number and EOJ instruction.

Input control (I_1) is used to determine whether this instruction is to be executed or not.

Function outputs can be used to determine whether the instruction has been executed.

Node Description:

TOP: Label where JUMP is intended.

Input Control:

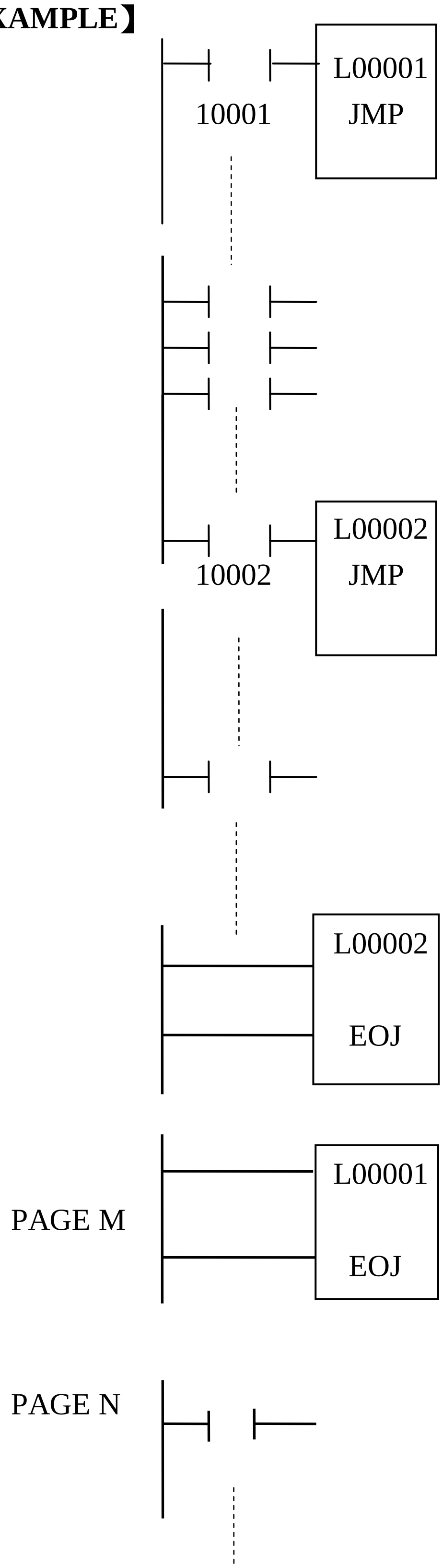
I_1: When ( ) is presented, the instruction is executed.

Function Output:

$O_1 = I_1$

$O_2 = 0$

【EXAMPLE】



【DESCRIPTION】

When contact 10001 is energized, the program between JMP L00001and EOJ L00001 is skipped. The execution continues from PAGE N.

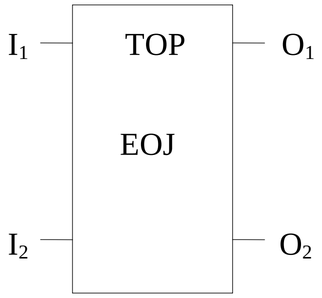
If contact 10001 is not energized, then no JUMP action is performed.

If contact 10001 is not energized, but contact 10002 is energized, then the program between JMP L00002 and EOJ L00002 is skipped.

The execution continues from PAGE M.

EOJ	**END OF JUMP**		

SYMBOL:



OPERANDS:

	0	**1**	**3**	**4**	**C**	**P**	**L**
TOP							①

①L1~L150

Description:

This instruction is used with JMP instruction. The label numbers must be matched. Only one JMP-EOJ pair is allowed in a ladder page. The label number must not be repeated. The program between JMP and EOJ is skipped if the Input Control condition is met.

Node Description:

TOP: Label indicating the end of JUMP.

Input Control:

I_1: don't care.

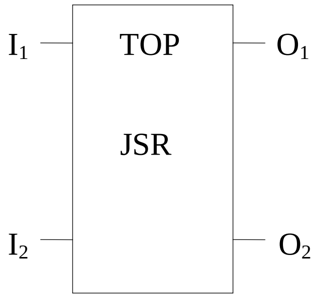
Function Output:

$O_1 = I_1$

$O_2 = 0$

JSR	**JUMP to SUBROUTINE**

SYMBOL:



OPERANDS:

	0	**1**	**3**	**4**	**C**	**P**	**L**
TOP							①

①L1~L32

Description:

This instruction is used to call the subroutine whose label is the same as the one defined in the Top node.
Subroutine calls may be nested, but only 16 levels are allowed.
Programming requirements are: ①SBR and RET are paired. ②SBR instruction is behind the JSR instruction, and ③RET instruction is behind the SBR instruction.
Input control (I_1) is used to determine whether this instruction is to be executed or not.
Function outputs can be used to determine whether the instruction has been executed.

Node Description:

TOP: Label of the subroutine to be called.

Input Control:

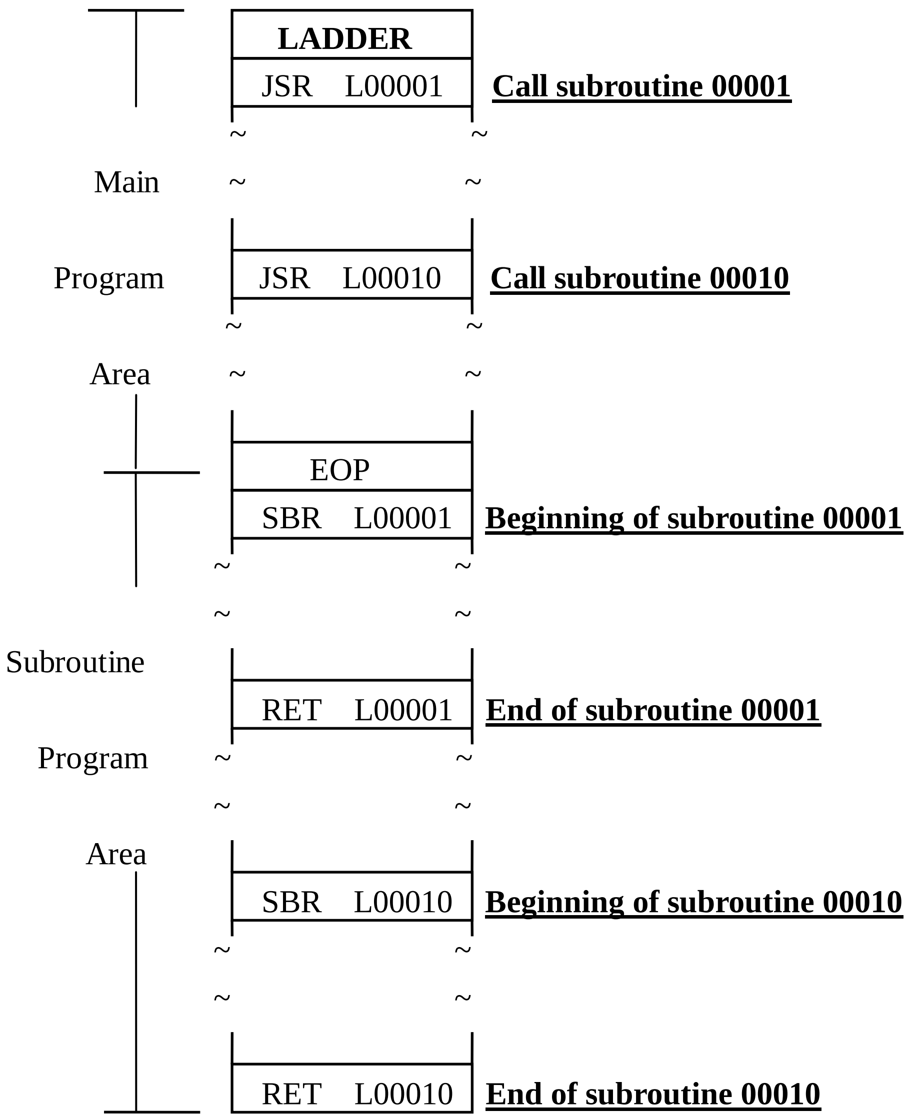
I_1: When ( ) is presented, the instruction is executed.

Function Output:

$O_1 = I_1$

$O_2 = 0$

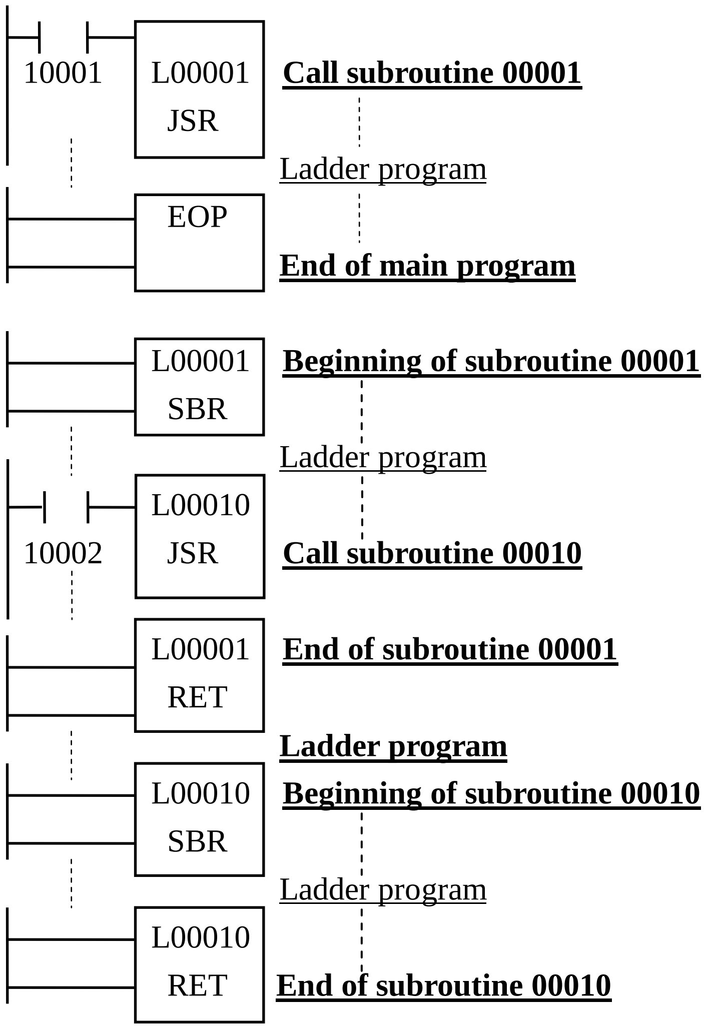
【EXAMPLE】



【DESCRIPTION】

The main program area and the subroutine area are separated by the EOP instruction.
If the EOP instruction does not exist, then the first SBR instruction is used as a program delimiter.

【EXAMPLE】

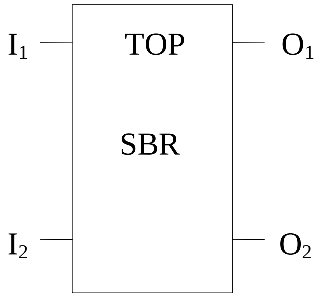


【DESCRIPTION】

When contact 10001 is energized, subroutine L00001 is executed. The program control is returned to the main program when RET L00001 is encountered. The execution of the main program is terminated when the EOP instruction is encountered.
During the execution of subroutine L00001, if contact 10002 is energized, then subroutine L00010 is executed until RET L00010 is encountered. When RET L00001 is encountered, the program control returns to the main program.
If contact 10001 is not energized, then neither subroutine L00001 nor L00010 is executed.

SBR	**SUBROUTINE**		

SYMBOL:



OPERANDS:

	0	1	3	4	C	P	L
TOP							①

①L1~L32

Description:

This instruction is used to define the beginning of a subroutine. A matched label RET instruction is required to define the end of the subroutine. When the subroutine is called, the program control is transferred from the main program to the next page of the program where the SBR is defined.

Node Description:

TOP: Label of the subroutine defined.

Input Control:

I_1: Don’t care.

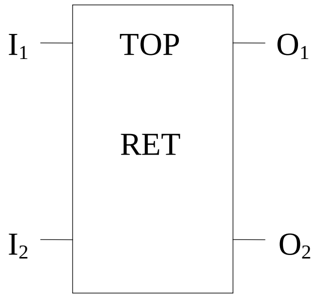
Function Output:

O_1= 0

O_2= 0

RET	**RETURN FROM SUBROUTINE**		

SYMBOL:



OPERANDS:

	0	1	3	4	C	P	L
TOP							①

①L1~L32

Description:

This instruction is used to define the end of a subroutine. The label number is defined in the top node and must be the same as the calling SBR label number.

Node Description:

TOP: Label of the subroutine.

Input Control:

I_1: Don't care

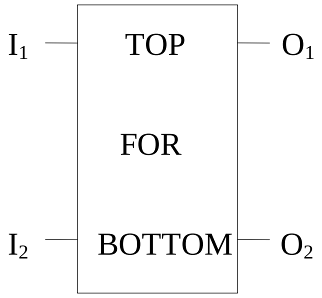
Function Output:

O_1= 0

O_2= 0

FOR	LOOP		

SYMBOL:



OPERANDS:

	0	1	3	4	C	P	L
TOP							②
BOTTOM				○	①	○	

① 1~255

② L1~L64

Description:

The program segment between the FOR and NEXT instructions with the same label number (defined in the TOP node) is repeated for a number of times (as defined in the BOTTOM node).

Loops may be nested. Maximum of 8 levels are allowed.

Node Description:

TOP: Label of the loop.

BOTTOM: Number of repetitions.

Input Control:

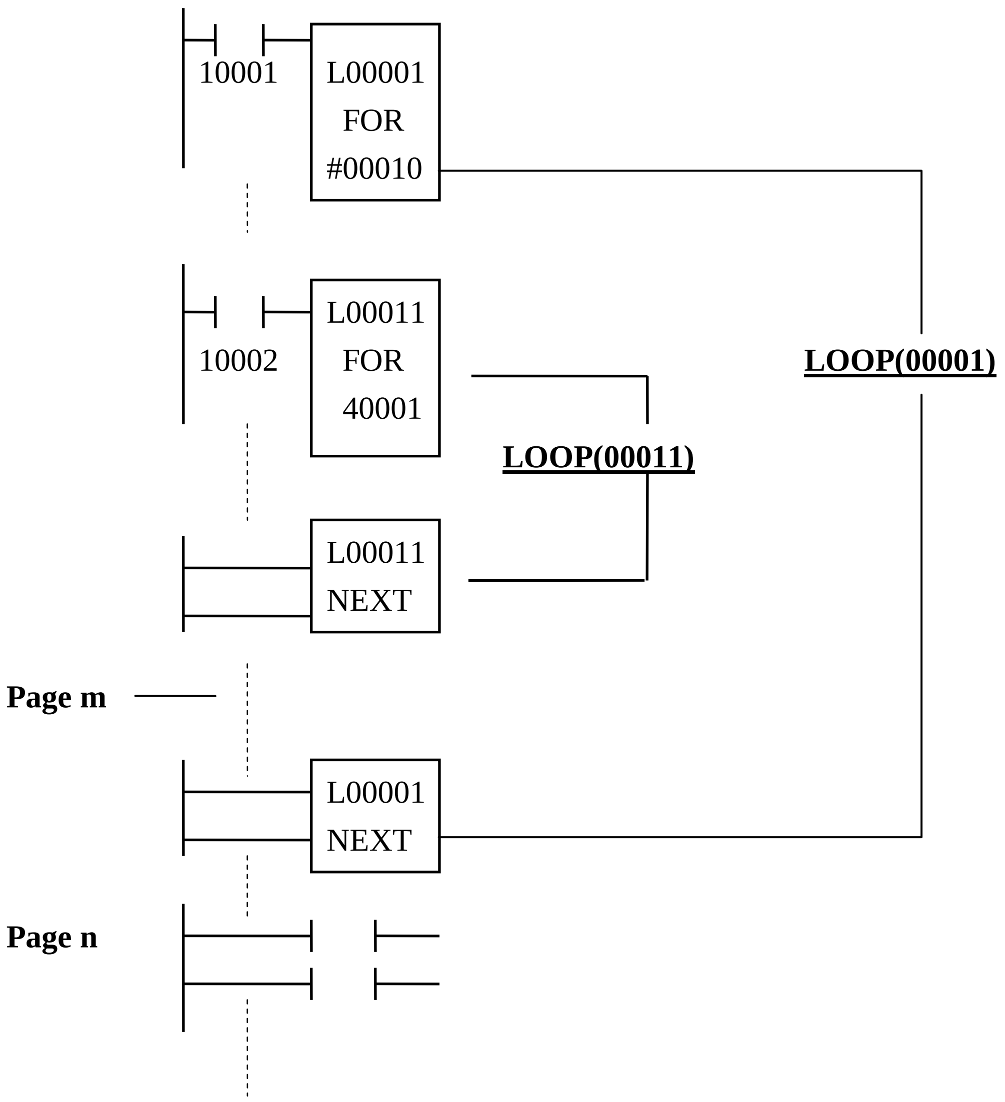
I_1: When ( ) is presented, a matched label NEXT instruction is found whose position is behind the FOR instruction. Then, this instruction is executed.

Function Output:

O_1= 0

O_2= 0

【EXAMPLE】

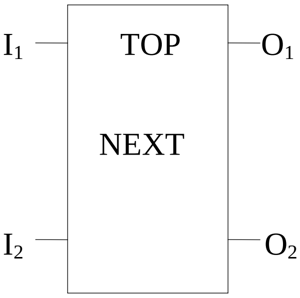


【DESCRIPTION】

When contact 10001is energized, the loop (L00001) is executed 10 times, then the program resumes from page n. If contact 10001 is not energized, the loop (L00001) is skipped. If both contacts 10001 and 10002 are energized, then loop L0011 is executed N times (as defined in the bottom node 40001), and loop L00001 is executed 10 times. If contact 10001 is energized while contact 10002 is not, then the loop (L00001) is executed for 10 times, while loop L0011 is skipped.

NEXT	**END of LOOP**		

SYMBOL:



OPERANDS:

	0	**1**	**3**	**4**	**C**	**P**	**L**
TOP							①

①L1~L64

Description:

This instruction is used to define the end of a loop with the same label number.

Node Description:

TOP: Label of the loop.

Input Control:

I_1: no action.

Function Output:

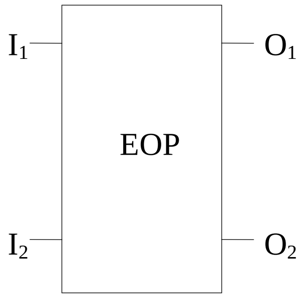
$O_1 = I_1$

$O_2 = 0$

CHAPTER 4: FLOW CONTROL INSTRUCTIONS

EOP	END of MAIN PROGRAM		

SYMBOL:



OPERANDS:

	0	1	3	4	C	P	L

Description:

This instruction is used to define the end of a program. All the programming behind this instruction is ignored. The program scan terminates when this instruction is encountered.

Node Description:

Input Control:

I_1: Don't care

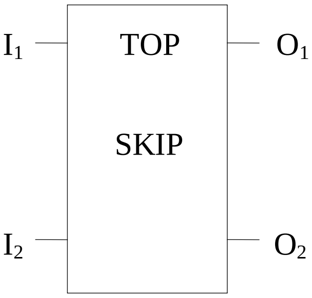
Function Output:

$O_1=0$

$O_2=0$

SKIP	**SKIP**		

SYMBOL:



OPERANDS:

	0	**1**	**3**	**4**	**C**	**P**	**L**
TOP			○	○	○	○	

Description:

This instruction is used to control the sequence of the program execution.
Input control (I_1) is used to determine whether this instruction is to be executed or not.
Users are recommended to have only a SKIP instruction in a ladder page.

Node Description:

TOP: number of program pages to be skipped. If this value is equal to 0, then the program scan is terminated.

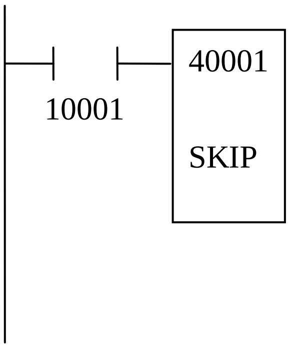
Input Control:

I_1: When ( ) is presented, the instruction is executed.

Function Output:

O_1= 0
O_2= 0

【EXAMPLE】

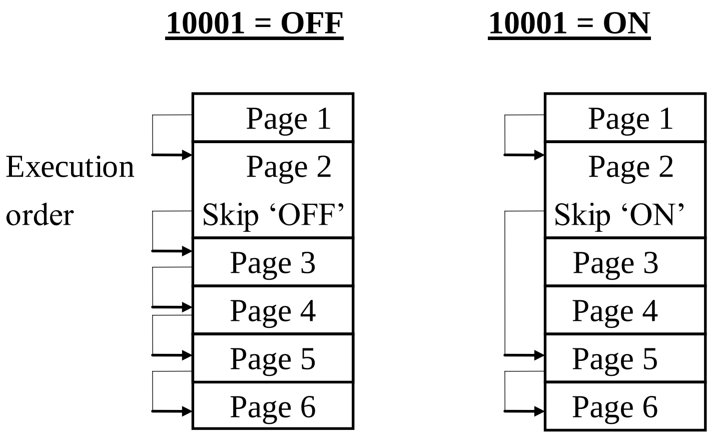


【DESCRIPTION】

When contact 10001 is energized, then the skip instruction is executed.

1. If the content of register 40001is #00002, then the next two pages are skipped.
2. If the content of register 40001is 0, then the program execution for this scan is terminated.

Let register (40001)=00002:

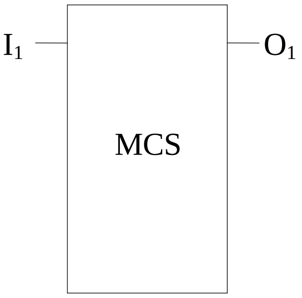


The **SKIP** instruction is at the bottom of Page 2.

MCS

MCS	MASTER CONTROL SET		

SYMBOL:



OPERANDS:

	0	1	3	4	C	P	L

Description:

This function block is used for controlling the program flow. There must be a matched label MSE (Master control end) function block for the ladder program to execute correctly. The power rail input of the ladder program segment between the MCS-MSE pair is determined by the I_1 of MCS. If I_1 is ON, the power rail input of the ladder program segment between the MCS-MSE pair is ON or rice versa.
Input control (I_1) is used to determine whether this function block is to be executed or not.
Function outputs can be used to determine whether the function block has been executed.
Nesting MCS are not supported.

Node Description:

Input Control:

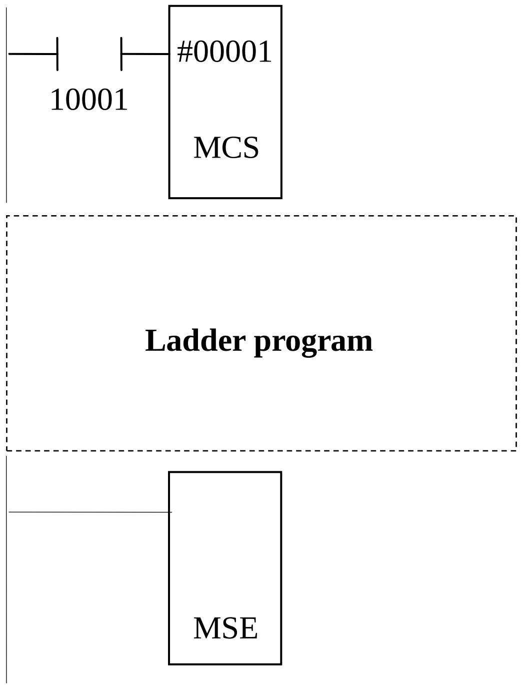
I_1: Power control

Function Output:

O_1: I_1

O_2=0

【EXAMPLE】

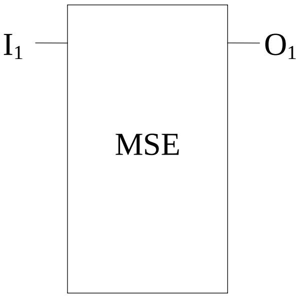


【DESCRIPTION】

When contact 10001 is energized, the power rail input of ladder program segment between the MCS-MSE function blocks is OFF. If the contact 10001 is not energized, then the ladder program segment is executed as usual.

			MSE
MSE	**MASTER CONTROL END**		

SYMBOL:



OPERANDS:

	0	1	3	4	C	P	L

Description:

This function block is the matched ending instruction for MCS function block.

Node Description:

Input Control:

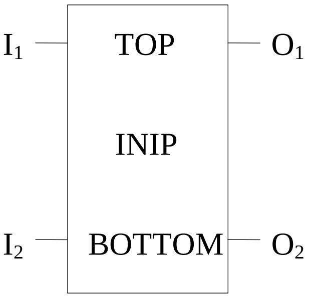
Function Output:

O_1=0

O_2=0

INIP	INITIALIZATION OF POINTER		

SYMBOL:



OPERANDS:

	0	1	3	4	C	P	L
TOP	○	○	○	○			
BOTTOM						①	

①P0~P15

Description:

This function is used to define the content of a pointer. The constant in the bottom node is used to define which pointer is to be initialized, and the number in the top node is the initialization value.

Input control (I_1) is used to determine whether this function block is to be executed or not.

Node Description:

TOP: Type of register and its number.

BOTTOM: Pointer to be defined.

Input Control:

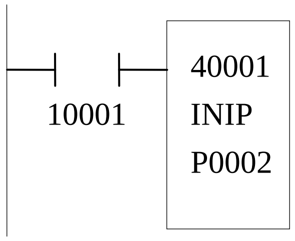
I_1: When ⎍ (↑⎍) is presented, the instruction is executed.

Function Output:

$O_1=I_1$

$O_2=0$

【EXAMPLE】

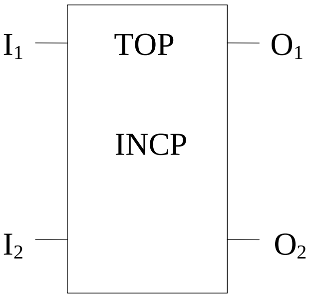


【DESCRIPTION】

When contact 10001 is energized, the relationship: (P0002)=40001is defined.
This means the (P0002) pointer points to this 40001 register.

INCP	**INCREMENT OF POINTER**		

SYMBOL:



OPERANDS:

	0	**1**	**3**	**4**	**C**	**P**	**L**
TOP						①	

①P0~P15

Description:

This function is used to increment the pointer by one. The constant in the top node defines which pointer is to be incremented.

Input control (I_1) is used to determine whether this function block is to be executed or not.

Node Description:

TOP: Pointer to be incremented.

Input Control:

I_1: When ( ) is presented, the instruction is executed.

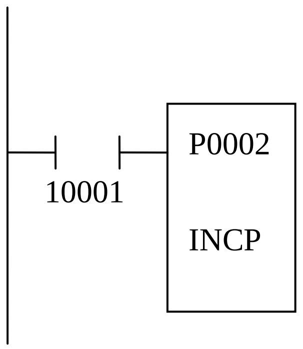
Function Output:

O_1=I_1

O_2=Error

=1, When this function is called, the reference number pointed by the pointer is already pointed to the last reference number of that reference type.

【EXAMPLE】



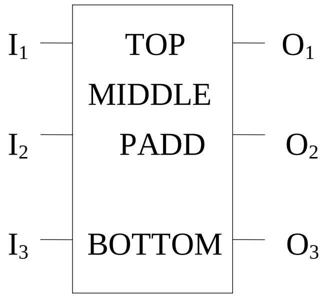
【DESCRIPTION】

Assume that pointer 2 contains 40001, when 10001=1. Then, pointer 2=40002, i.e. P0002=40002 after execution.

	PADD

PADD	ADDITION OF POINTER		

SYMBOL:



OPERANDS:

	0	1	3	4	C	P	L
TOP						①	
						②	
						①	

①P0~P15

②0~9999

Description:

The content of the pointer is the top node and the constant in middle node are added and the sum is stored in the content of the pointer in the bottom node.

Node Description:

TOP: Pointer of top node

Middle: A constant

Bottom: Pointer of buttom node

Input Control:

I_1: When ( ) is presented, the function block is executed.

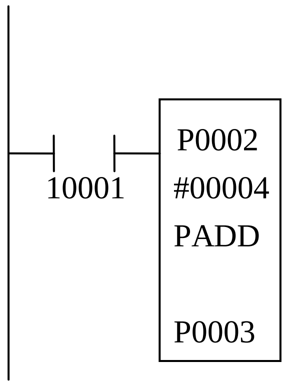
Function Output:

O_1= I_1 (O_1 will be ‘0’ when O_3 is ‘1’)

O_2= 0

O_3= 1 (error output)=1, if pointer is beyond the upper limited address.

【EXAMPLE】

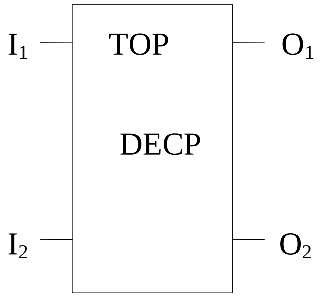


【DESCRIPTION】

When the contact 10001 is energized, the content of pointer P0002 is added 4 and the sum is stored to the content of pointer P0003.

DECP	DECREMENT OF POINTER		

SYMBOL:



OPERANDS:

	0	1	3	4	C	P	L
TOP						①	

①P0~P15

Description:

This function is used to decrement the pointer by one. The constant in the top node defines which pointer is to be decremented.

Input control (I_1) is used to determine whether this function block is to be executed or not.

Node Description:

TOP: Pointer to be incremented.

Input Control:

I_1: When ( ) is presented, the instruction is executed.

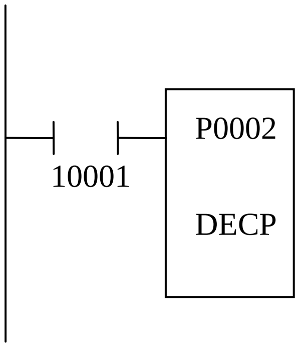
Function Output:

O_1=I_1

O_2= Error

= 1, when this function is called, the reference number pointed by the pointer is already pointed to the first reference number of that reference type.

【EXAMPLE】

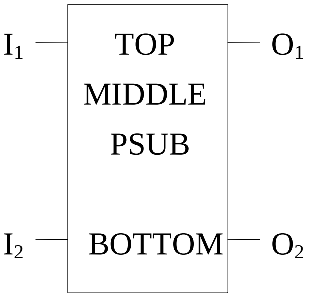


【DESCRIPTION】

Assume that pointer 2 contains 40011, when 10001=1. Then, pointer 2=40010, i.e. P0002=40010 after execution.

PSUB	SUBRATION OF POINTER		

SYMBOL:



OPERANDS:

	0	1	3	4	C	P	L
TOP						①	
						□	
BOTTOM						①	

①P0~P15
□0~9999

Description:

The content of the pointer in the top node is substrated by a constant in middle node and the result is stored in the content of the pointer in the bottom node.

Node Description:

TOP: Source pointer
MIDDLE: A constant
BOTTOM: Destination pointer

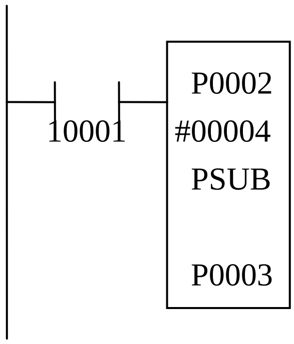
Input Control:

I_1: When ( ) is presented, the function block is executed.

Function Output:

O_1= I_1 (O_1 will be '0' when O_3 is '1')
O_2= 0
O_3 (error output)=1, if pointer is lower than the low limited address.

【EXAMPLE】

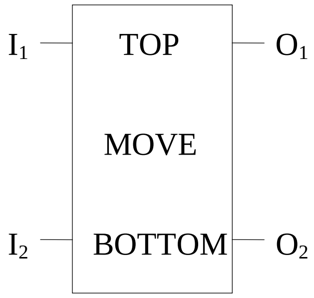


【DESCRIPTION】

When the contact of 10001 is energized, the content of pointer P0002 is substrated 4 and the sum is stored to the content of pointer P0003.

MOVE	DATA MOVE		

SYMBOL:



OPERANDS:

	0	1	3	4	C	P	L
TOP	○	○	○	○	①	○	
BOTTOM	○			○		○	

①0~65535

Description:

This function is used to define the content of a register (4xxxx) or discrete output (0XXXX).

Input control (I_1) is used to determine whether this function block is to be executed or not.

Node Description:

TOP: Referenced (or source) register or a constant.

BOTTOM: Register or (0XXXX) to be initialized (target).

Input Control:

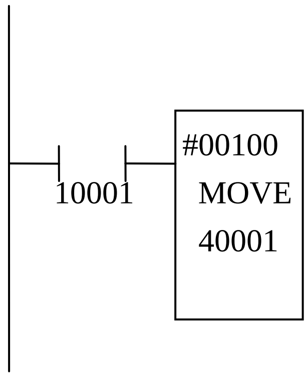
I_1: When ( ) is presented, the instruction is executed.

Function Output:

$O_1=I_1$

$O_2=0$

【EXAMPLE】

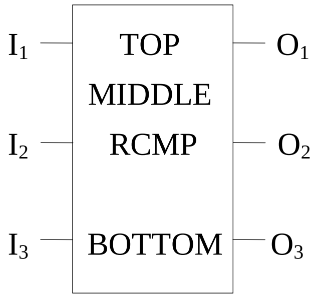


【DESCRIPTION】

When contact 10001 is energized, the constant #00100 is stored in register 40001, i.e. (40001)=100.

RCMP	REGISTER COMPARE		

SYMBOL:



OPERANDS:

	0	1	3	4	C	P	L
TOP	○	○	○	○	①	○	
MIDDLE	○	○	○	○	①	○	
BOTTOM				○	②	○	

①0~65535

②1~2

Description:

This function is used to compare the data in the top node and the middle node.

Input control (I_1) is used to determine whether this function block is to be executed or not.

Outputs (O_1, O_2, O_3) are represented the comparing result (>, =, <) of top node and the middle node when this function block is executed.

Node Description:

TOP: Top node data.

MIDDLE: Middle node data.

BOTTOM: Length to be compared (1: Word, 2: Long word)

Input Control:

I_1: When ⎍ (↑) is presented, the instruction is executed.

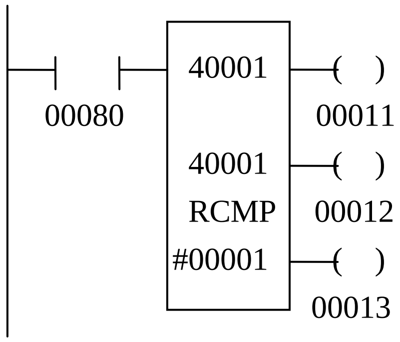
Function Output:

O_1 : comparing result (data of top node > middle node)

O_2 : comparing result (data of top node = middle node)

O_3 : comparing result (data of top node < middle node)

【EXAMPLE】

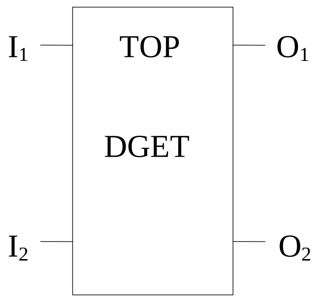


【DESCRIPTION】

Assumed that the content of register (40001) = 9000(10) and the content of register (40002) = 500(10): When the contact of 00080 is energized, the coil of 00011 will be 'ON' because the content of (40001) > (40002).

DGET	GET CALENDAR DATE		

SYMBOL:



OPERANDS:

	0	1	3	4	C	P	L
TOP				○		○	

Description:

This function is used to obtain the system date. The result is stored in the top node (two words).
The high byte of the first word represents year; the low byte of the first word represents month; the high byte of the second word represents date in a month; and the low byte of the second word represents day in a week. All numbers are in BCD format.
Input control (I_1) is used to determine whether this function block is to be executed or not.

Node Description:

TOP: Register to store the calendar date.

Input Control:

I_1: When ( ) is presented,
the instruction is executed.

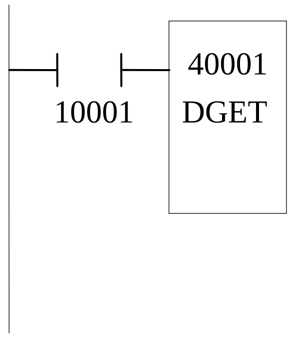
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
W_1	(19 or 20)BCD CODE								Years							
W_2	Month(01~12)BCD CODE								Date(01~31)BCD CODE							

Function Output:

$O_1=I_1$

$O_2=0$

【EXAMPLE】



【DESCRIPTION】

When contact 10001 is energized, the system date is copied to registers 40001and 40002 in BCD format. Assume that the date reads:

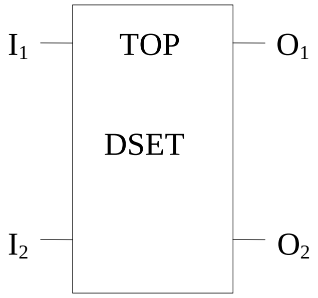
(40001)= 1996_H

(40002)= 0918_H

Then the date is Sept. 18th, 1996.

DSET	**SET CALENDAR DATE**		

SYMBOL:



OPERANDS:

	0	**1**	**3**	**4**	**C**	**P**	**L**
TOP				○		○	

Description:

This function is used to set the system date. The date is stored in the top node (two words).
The high byte of the first word represents year; the low byte of the first word represents month, the high byte of the second word represents date in a month; and the low byte of the second word represents day in a week. All numbers are in BCD format.
Input control (I_1) is used to determine whether this function block is to be executed or not.
Function outputs can be used to determine whether the function block has been executed.

Node Description:

TOP: Date, two words.

Input Control:

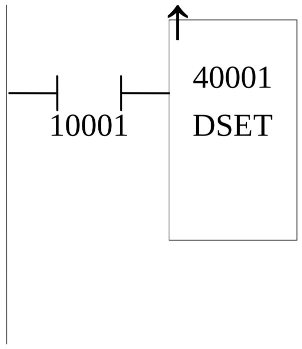
I_1: When ⎍ is presented,
the instruction is executed.

Function Output:

$O_1 = I_1$

$O_2 = 0$

【EXAMPLE】



【DESCRIPTION】

When contact 10001 is energized, the data stored in registers 40001and 40002 are used to set the system date.

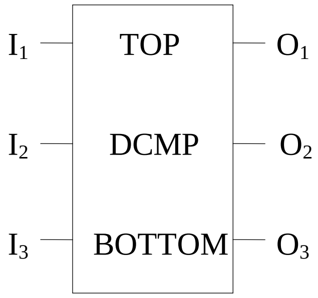
If (40001) = 1996_H

(40002) = 0918_H

the setting date is Sept 18th, 1996.

DCMP — CALENDAR DATE COMPARE

SYMBOL:



OPERANDS:

	0	1	3	4	C	P	L
TOP				○	□		
BOTTOM					①		

①0~65535

Description:

This function is used to compare the system date with the reference date stored in the top node. (For data storage format, please refer to DGET or DSET functions.) The bottom node defines the MASK for comparison.

Input control (I_1) is used to determine whether this function block is to be executed or not.

Node Description:

TOP: Reference date, two words.

BOTTOM: MASK. This word is divided into three nibbles. Each nibble corresponds to the portion of the Year, Month, and Date respectively. If a corresponding nibble is zero, then that portion is ignored during comparison.

Input Control:

I_1: When ( ) is presented, the instruction is executed.

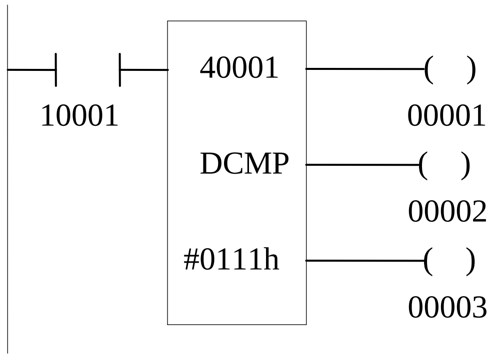
Function Output:

O_1: Reference date ＞System date.

O_2: Reference date = System date.

O_3: Reference date ＜ System date.

【EXAMPLE】



【DESCRIPTION】

When contact 10001 is energized, the reference date stored registers 40001, and a constant 0111h is compared against the system date for any difference.

If the bottom node is represented by X_1, X_2, X_3, X_4 (hex format) then

X_0: reserve

X_1: nibble mask for the Year

X_2: nibble mask for the Month

X_3: Date

Assume the system date is Sept. 18th, 1996, and

$40001=1996_H$

$40002=0917_H$

Bottom mode $=0111_H$ - (Day comparison is suppressed.)

Since the reference date (17) is smaller than the system date (18), thus, coil 00003 is turned 'ON'.

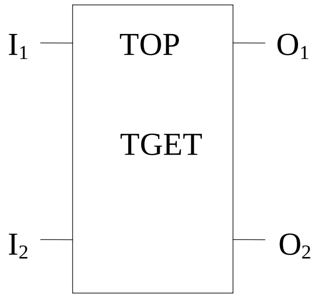
Note: The date comparison is made according to the following order:

Year->Month->Date

If any difference is found while comparing the higher ranked unit, the function output is set based on the comparison result, and the rest of the data is ignored.

TGET	GET SYSTEM TIME		

SYMBOL:



OPERANDS:

	0	1	3	4	C	P	L
TOP				○		○	

Description:

This function is used to obtain the system time. The result is stored in the top node (two words).

The high byte of the first word represents day in a week; the low byte of the first word represents hour, the high byte of the second word represents minute; and the low byte of the second word represent second. All numbers are in BCD format.

Input control (I_1) is used to determine whether this function block is to be executed or not.

Node Description:

TOP: Register to store the system time.

Input Control:

I_1: When ( ) is presented,
the instruction is executed.

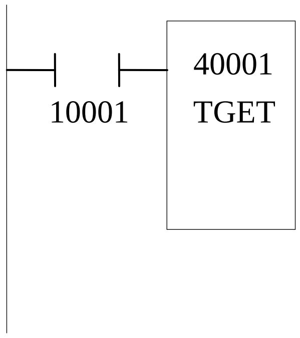
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
W_1	Day in a week(01~07)$_{BCD}$								Hour(00~23)$_{BCD}$							
W_2	Minute (01~59)$_{BCD}$								Second (00~59)$_{BCD}$							

Function Output:

$O_1=I_1$

$O_2=0$

【EXAMPLE】



【DESCRIPTION】

When contact 10001 is energized, the system time is copied to registers 40001and 40002 in BCD format. Assume that the time reads:

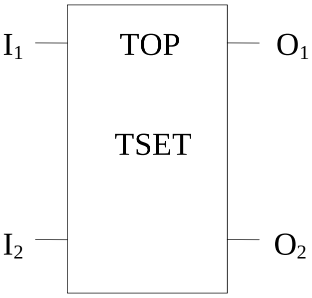
(40001)= 0212_{BCD}

(40002)= 2345_{BCD}

Then the system time is Tuesday, 23 minutes 45 seconds past 12 o’clock.

TSET	SET SYSTEM TIME		

SYMBOL:



OPERANDS:

	0	1	3	4	C	P	L
TOP				○		○	

Description:

This function is used to set the system time. The time is stored in the top node (two words).

The high byte of the first word represents day in a week; the low byte of the first word represents hour, the high byte of the second word represents minute; and the low byte of the second word represents second.

All numbers are in BCD format.

Input control (I_1) is used to determine whether this function block is to be executed or not.

Function outputs can be used to determine whether the function block has been executed.

Node Description:

TOP: Register to set the system time, 2 word format as follows :

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
W_1	Day in a week$(01\sim07)_{BCD}$								Hour $(00\sim23)_{BCD}$							
W_2	Date$(01\sim31)_{BCD}$								Second $(00\sim59)_{BCD}$							

Input Control:

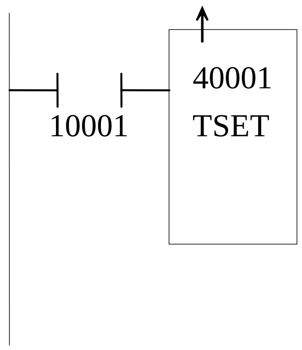
I_1: When ↑ is presented,
the instruction is executed.

Function Output:

$O_1=I_1$

$O_2=0$

【EXAMPLE】



【DESCRIPTION】

When contact 10001 is energized, the data stored in registers 40001and 40002 are used to set the system time.

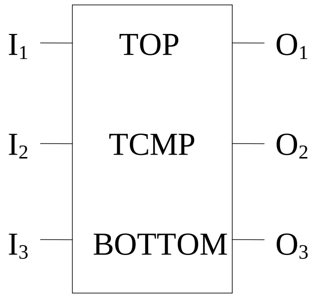
If (40001) = 0212 $_{BCD}$

(40002) = 2345 $_{BCD}$

The setting date is Tuesday, 23 minutes and 45 seconds past 12 o’clock.

TCMP	TIME COMPARE		

SYMBOL:



OPERANDS:

	0	1	3	4	C	P	L
TOP				○	□		
MIDDLE							
BOTTOM					□		

□ 0~65535

Description:

This function is used to compare the system time with the reference time stored in the top node. (For data storage format, please refer to TGET or TSET functions.) The bottom node defines the MASK for comparison.

Input control (I_1) is used to determine whether this function block is to be executed or not.

Node Description:

TOP: Reference time, two words.

BOTTOM: MASK. This word is divided into four nibbles. Each nibble corresponds to the portion of the Week, Hour, Minute, Second respectively. If a corresponding nibble is zero, then that portion is ignored during comparison.

Input Control:

I_1: When ( ) is presented, the instruction is executed.

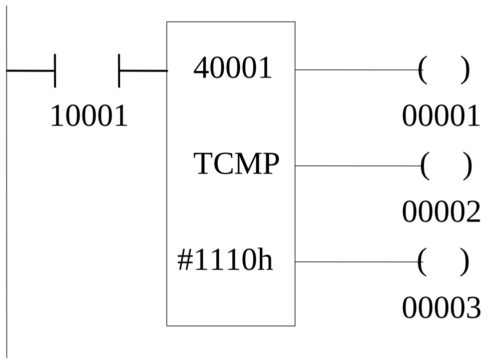
Function Output:

O_1: Reference time ＞System time

O_2: Reference time = System time

O_3: Reference time ＜ System time

【EXAMPLE】



【DESCRIPTION】

When contact 10001 is energized, the reference time stored in registers 40001, and a constant 1110h is compared against the system time for any difference.

If the bottom node is represented by X_1, X_2, X_3, X_4 (hex), then

X_1: nibble mask for the day in a WEEK

X_2: nibble mask for the HOUR

X_3: nibble mask for the MINUTE

X_4: nibble mask for the SECOND

Assume the system time is Tuesday, 25 minutes 34 seconds past 7 o'clock, and

$40001=0208_{BCD}$

$40002=2536_{BCD}$

Bottom node $=1110_H$ - (Second comparison is suppressed.)

Since the reference hour (8) is larger than the system hour (7), thus, coil 00001 is turned 'ON'.

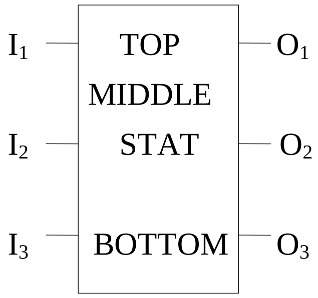
Note: The date comparison is made according to the following order:

Week->Hour->Minute ->Second.

If any difference is found while comparing the higher ranked unit, the function output is set based on the comparison result, and the rest of the data is ignored.

STAT	**STATUS**		

SYMBOL:



OPERANDS:

	0	**1**	**3**	**4**	**C**	**P**	**L**
TOP				○	①	○	
MIDDLE	○			○		○	
BOTTOM					②		

①0~63

②1~64

Description:

This function is used to obtain the system status (configuration table)

Input control (I_1) is used to determine whether this function block is to be executed or not.

Function outputs can be used to determine whether the function block has been executed.

Node Description:

TOP: Address of the system configuration table where the read action is intended.

MIDDLE: Starting address of the register where the data is stored.

BOTTOM: Number of words to be read.

Input Control:

I_1: When ⎍ (↑⎍) is presented, the instruction is executed.

Function Output:

$O_1=I_1$

O_2=Read indicator

=1, if the read action is performed beyond the configuration table limit.

$O_3=0$

PLC STATUS Description:

Word Order	Description	
000	Reserved	
001	Second	Minute
002	Hour	Day of a week
003	Month	Date
004	Year	Dummy byte
005	Maximum scan time, unit: 100 us	
006	Minimum scan time, unit: 100 us	
007	Current scan time, unit: 100 us	
008	PLC Elapsed time since powered on (minute)	
009	PLC Elapsed time since powered on(hour)	
010	Run-time Status(1)	
011	Self-diagnosis Status(2)	
012	PLC link - group ID	
013	PLC link - link flag	
014	PLC link - real time response state	
015	Drop used state	

Detailed Description:

Word - 000: Reserved

Word-001 ~ Word - 004: System date and time.

Word-005: Maximum Scan Time, unit: 100 us

Word-006: Minimum Scan Time, unit: 100 us

Word-007: Current Scan Time, unit: 100 us

Word-008 : Elapse time since powered on (minute)

Word-009 : Elapse time since powered on (hour)

Word-010 ~ Word - 011: Run-time and Self-diagnosis:

a .Word-010: Self-diagnosis Status(1)

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

bit00: RAM checksum error

bit01: Real time timer error

bit02: Watch dog timer error

bit03: Status RAM fail

bit04: Ladder RAM fail

bit05: Remote I/O module fail

bit06: Battery low

bit07: Ladder error

bit08: I/O map error

bit09: reserve

bit12: reserve

bit13: reserve

bit14: Local I/O module fail

b. Word - 011: Self-diagnosis Status(2)

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

bit00: Local I/O mismatch

bit01: Installed I/O points are over the system limitation

bit02: Remote I/O mismatch

bit04: Ladder syntax error

bit05: Rack I/O mismatched

bit06 ~ bit15: Reserved

Word-012 : Group ID (Hexadecimal) for PLC link

Word-013 : Link flag map of master station

Bit1 to Bit15 are corresponding to the slave station #1 to station #15.

bit = '1' : The corresponding slave station is required to be linked.

bit = '0' : The corresponding slave station is not required to be linked.

Word-014 : PLC link–linking status

Bit1 to Bit15 are corresponding to the slave station #1 to station #15

bit = '1' : Link normal, the corresponding station is required to be linked.

bit = '0' : Link abnormal, the corresponding station is not required to be linked.

Word-015 : Communication status of the remote drops

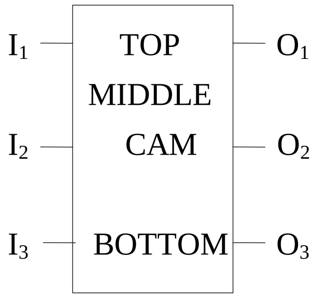
Bit1 to Bit 15 are corresponding to the drop #1 to drop #15.

Bit = '1' the corresponding drop has occurred communication error.

CHAPTER 6: OTHERS

			CAM
CAM	**CAM SWITCH**		

SYMBOL:



OPERANDS:

	0	**1**	**3**	**4**	**C**	**P**	**L**
TOP			○	○	①	○	
MIDDLE				○		○	
BOTTOM	○			○			

①0~65535

Description:

This function is similar to a 16-contact stepping switch. The source register (defined in the TOP node) is compared against the table formed by 32 target registers (16 sets in total, defined in the middle node), and the corresponding bit is set to 'ON' in the bottom node.

Input control (I_1) is used to determine whether this function block is to be executed or not.

Remark: The restriction of the middle node is that the content of the first register must be hero than the content of the second register for each pair.

Node Description:

TOP: Target register

MIDDLE: 16 pairs of data, 32 registers.

BOTTOM: Comparison result. (Assume that the top node is represented by W_b and the middle node pair is represented by W_0, W_1.)

= 1: if $((W_b)>=(W_0))$ and $((W_b)<(W_1))$

Input Control:

I_1: When ( ) is presented, the instruction is executed.

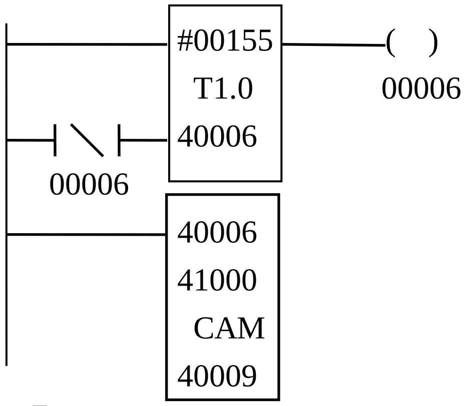
Function Output:

$O_1=I_1$

$O_2=0$

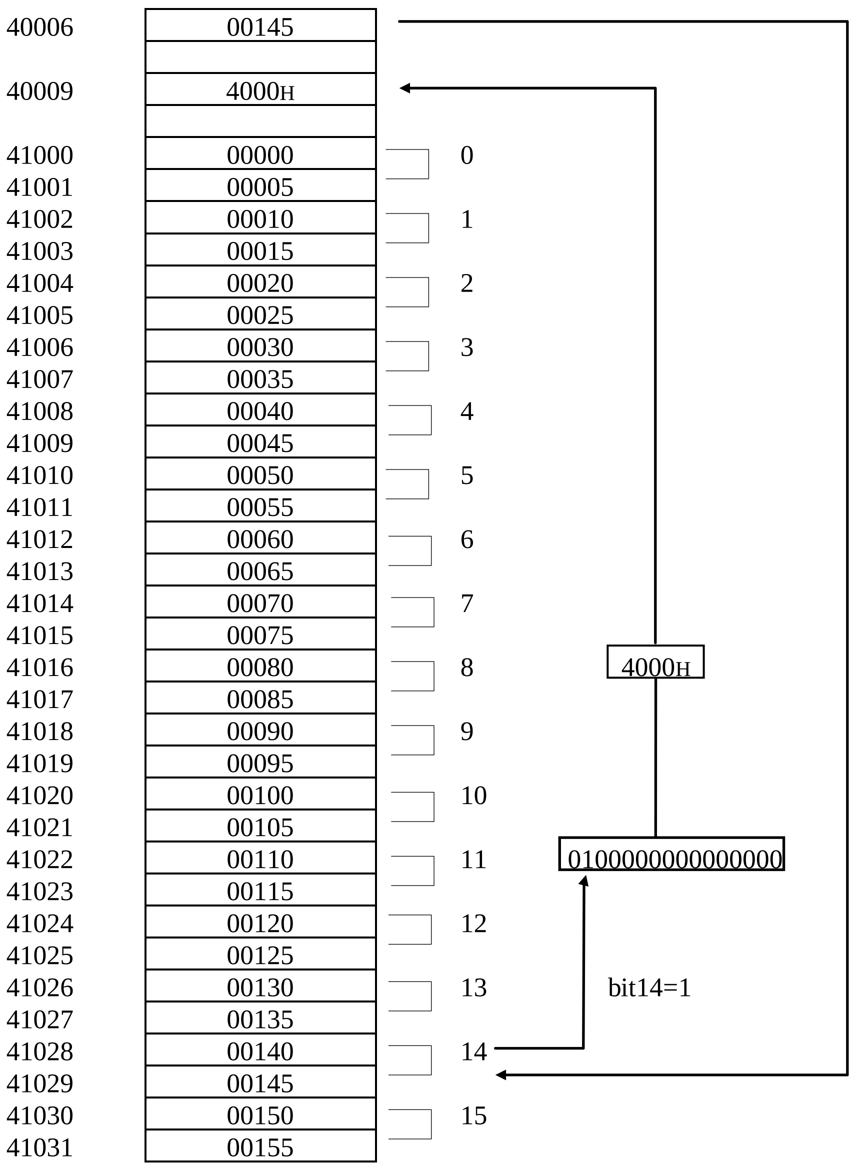
$O_3=0$

【EXAMPLE】



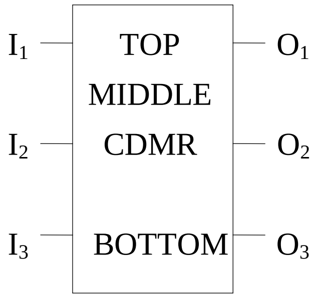
【DESCRIPTION】

The top node of the CAM switch is coming from a T1.0 timer register. It cycles from 0~155. The CAM table is defined in the middle node. It starts from 0 and has an increment of 5. After comparing the content of register 40006(for example 145) and the CAM table, this function sets the 14th bit to on and returns 16384 to the bottom node. After 5 seconds, the 15th bit would be “ON”. After another 5 seconds, the 1st bit would be ‘ON. This behavior is very similar to that of a CAM switch.



CDMR	COMMON DATA MEMORY READ		

SYMBOL:



OPERANDS:

	0	1	3	4	C	P	L
TOP					①		
MIDDLE				○		○	
BOTTOM					□		

①Please refer to the next page for detailed description.

□1~64

Description:

This function block is used to read the common data memory from an intelligent module.

Input control (I_1) is used to determine whether this function block is to be executed or not.

Input control (I_2) is used to reset this function.

Node Description:

TOP: Location of the intelligent module, please refer to the next page.

MIDDLE:3 words, please refer to the next page.

BOTTOM: Data length.

Input Control:

I_1: When is presented, the function is executed.

I_2: Reset

=1, Reset execution status.

Function Output:

O_1 : Execution status

=1, Executing

=0, non-executing

O_2: Finishing status

=1, Finished

=0, not finished yet.

O_3: Parameter status

=0, Parameter OK

=1, Parameter error.

TOP Node: Location of the intelligent module

The location of an intelligent module is defined via **Drop.Rack.Slot.** The range of Drop number is from 0 to 15. The range of Rack number is from 1 to 4. The Range of Slot number is from 1 to 8.

Middle Node: Common Data Memory

	b15	b14	b13	b12	b1	b10	b09	b08	b07	b06	b05	b04	b03	b02	b01	b00
word 1	Intelligent module address offset															
word 2	Reserved										N3		N2			N1
word 3	Target address															

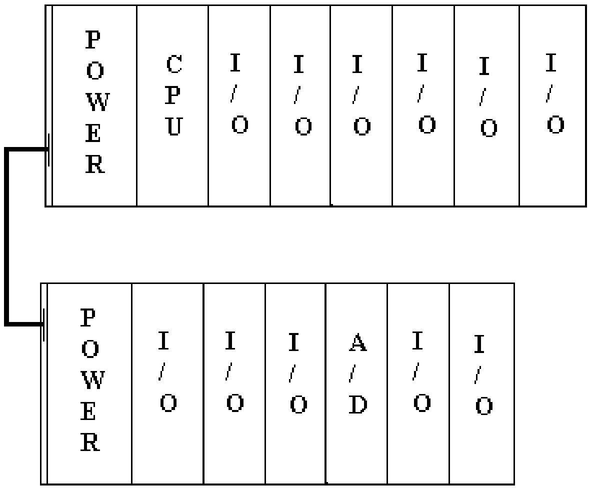
Word 1: Intelligent module CDM data address offset

Word 2: **Reserved.**

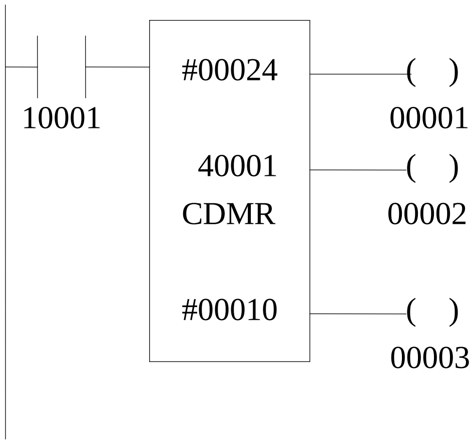
Word 3: Target data starting address of the register for store data after read from CDM . This address is mapping to 4xxxx registers. For example, if word3 = 00010, then the data is stored starting from register 40010.

【**EXAMPLE**】

To read the first 10 words in PAGE0 of the common data memory for an A/D module installed at Rack 2, Slot 4, and store the result in registers 40100~40109, set the middle node as follows:
(40001)=0000, (40003)=0100.



Ladder program:

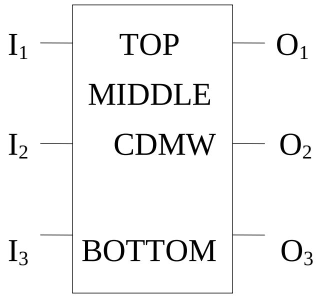


【**DESCRIPTION**】

Assume that (40001)=0000, and (40003)=100; when there is an OFF→ON transition for contact 10001, the CDMR function is executed. During execution, coil 00001is 'ON'. After execution, coil 00001 = coil 00003 = 'OFF', and coil 00002 = 'ON'.

CDMW	COMMON DATA MEMORY WRITE		↑

SYMBOL:



OPERANDS:

	0	1	3	4	C	P	L
TOP					①		
MIDDLE				○		○	
BOTTOM					□		

①Please refer to the next page for detailed description.

□1~64

Description:

This function block is used to write the common data memory from an intelligent module.

Input control (I_1) is used to determine whether this function block is to be executed or not.

Input control (I_2) is used to reset this function.

Function outputs can be used to determine whether the function block has been executed.

Node Description:

TOP: Location of the intelligent module, please refer to the next page.

MIDDLE:3 words, please refer to the next page.

BOTTOM: Data length.

Input Control:

I_1: When ↑ is presented, the function is executed.

I_2: Reset

=1, Reset execution status.

Function Output:

O_1 : Execution status

=1, Executing

=0, non-executing

O_2: Finishing status

=1, Finished

=0, not finished yet.

O_3: Parameter status

=0, Parameter OK

=1, Parameter error.

TOP Node: Location of the intelligent module

The location of an intelligent module is defined via **Drop.Rack.Slot.** The range of Drop number is from 0 to 15. The range of Rack number is from 1 to 4. The range of Slot number is 1 to 8.

Middle Node: Common Data Memory

<table>
<tr><th></th><th>b15</th><th>b14</th><th>b13</th><th>b12</th><th>b1</th><th>b10</th><th>b09</th><th>b08</th><th>b07</th><th>b06</th><th>b05</th><th>b04</th><th>b03</th><th>b02</th><th>b01</th><th>b00</th></tr>
<tr><td>word 1</td><td colspan="16">Intelligent module address offset</td></tr>
<tr><td>word 2</td><td colspan="10">Reserve</td><td colspan="2">N3</td><td colspan="3">N2</td><td>N1</td></tr>
<tr><td>word 3</td><td colspan="16">Target address</td></tr>
</table>

Word 1: Intelligent module address offset

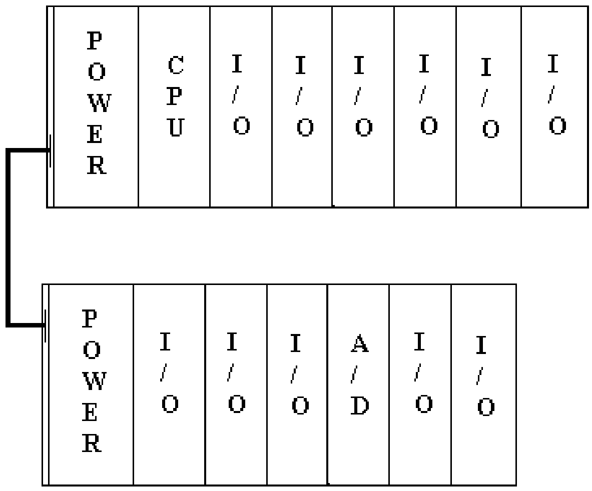
Word 2: **Reserved.**

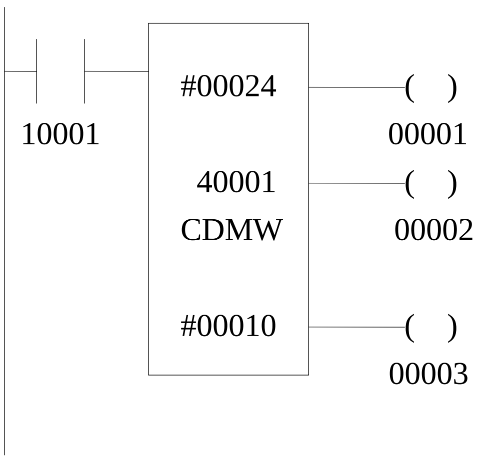
Word 3: Source data starting address of the register for copy data to CDM . This address is mapping to 4xxxx registers. For example, if word3 = 00010, then the data is transferred to the intelligent module starting from register 40010.

【EXAMPLE】

To read the 10 words data in registers 40100~40109 and write to PAGE0 of the common data memory for an A/D module installed at Rack 2, Slot 4, set the middle node as follows:

(40001)=0000, (40003)=0100.



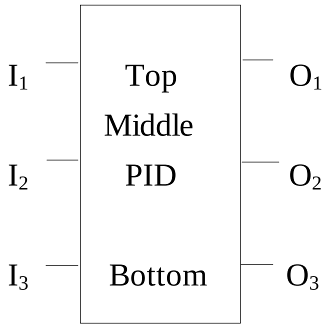


【DESCRIPTION】

Assume that (40001)=0000, and (40003)=100; when there is an OFF→ON transition for contact 10001, the CDMW function is executed. During execution, coil 00001is 'ON'. After execution, coil 00001 = coil 00003 = 'OFF', and coil 00002 = 'ON'.

PID	PID Control

Symbol



Operands

	0	1	3	4	C	P	L
Top				○			
Middle				○			
Bottom					○		

Descriptions:

This function block calculate the difference between the present value and the set-point, and produce control signal to minimize the difference via PID calculation.

Nodes:

Top: PID function parameters. Please see the next page.

Middle: Working Area and Status area for PID function. Please see the following page.

Bottom: Cycle time for PID Function, unit: 1/10 sec.

INPUT:

I_1:Auto/Manual Mode

= 1, Output is controlled by PID function, = 0, Output is obtained from manual input. Error detecting is still enabled.

I_2: Bumpless transition during Manual to Auto mode switching.

= 1, Bumpless transition enabled, = 0, Bumpless transition disabled.

I_3 : Direct/Reverse Mode

= 1, Decrease Output as Error increases. = 0, Increase Output as Error increases.

OUTPUT:

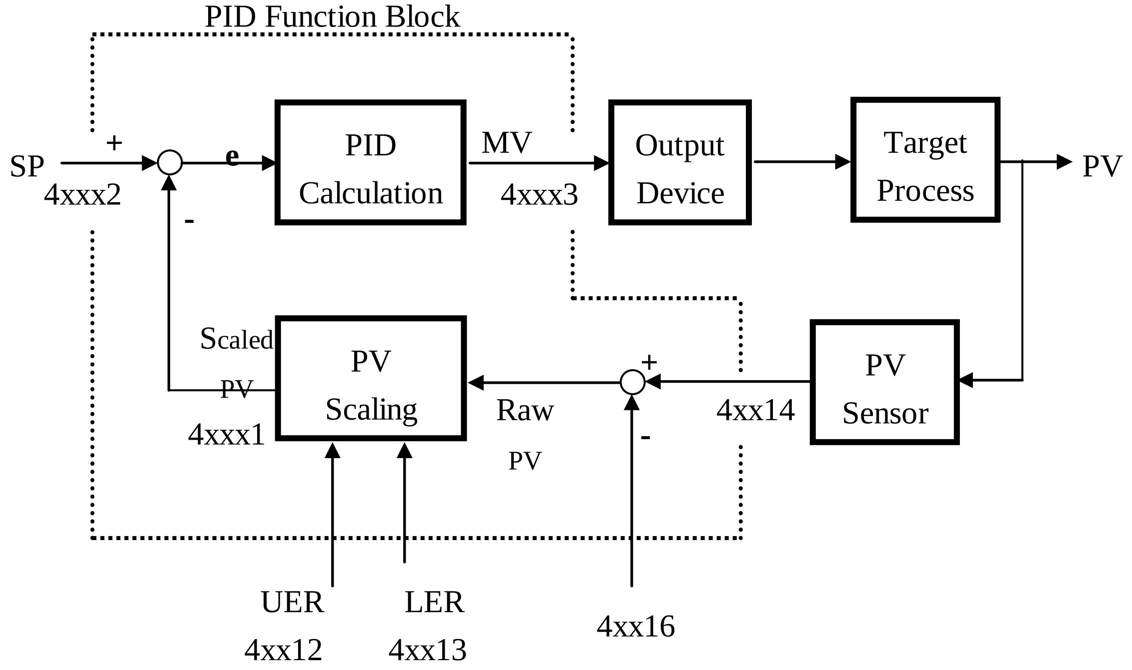
O_1: = 1, if there is any parameter error.

O_2: = 1, if the present value (scaled PV) is higher than the high alarm limit.

O_3: = 1, if the present value (scaled PV) is lower than the low alarm limit.

Description:

PID Control Loop:



PID formula:

$$MV(t) = \frac{100}{P_b}\left[e(t) + K_I \int e(t)dt + K_D\left(\frac{de(t)}{dt}\right)\right] + Bias$$

Where:

MV(t) = Control Output

Pb = Proportional Band

e(t)= Error (Difference between Scaled PV and SP)

K_I = Constant for Integration Term, or, reset time constant

K_D = Constant for Derivative Term, or, rate time constant

Bias = Correction Value, or offset to Output

TOP Node: Register: 4xxx1 ~ 4xx16

4xxx1: An internal register used to store the scaled PV in Engineering Unit.

$$\text{Scaled PV} = \frac{\text{Raw PV}}{\text{Sensor Range}} * (\text{UER} - \text{LER}) + \text{LER}$$

Where: Raw PV: Obtained from the difference of Register 4xx14 and 4xx16.

UER : Upper bound of Engineering measurement Range

(See also Register 4xx12)

LER : Lower bound of Engineering measurement Range

(See also Register 4xx13)

Sensor Range: **4096**. Assuming that an AD020 module is used to convert Raw PV signal (0~10V) to digital data (0~65535), then the Raw PV must be divided by **16** first to maintain consistency.

4xxx2: Set Point in Engineering Unit. (0~9999)

4xxx3: PID control output MV (0~4096). Please use a proper scaling factor to scale this control output and then send to the Output Device.

In Auto Mode (I_1 =1), the data in this register is the result of PID calculation. In Manual Mode (I_1 =0), filling this register by user is required.

4xxx4: High alarm limit in Engineering Unit (0~9999). This number should be greater than the Set Point.

4xxx5: Low alarm limit in Engineering Unit (0~9999). This number should be less than the Set Point.

4xxx6: Proportional Band (Pb:5~500). The term Proportional Band is also referred to as the "sensitivity". The reciprocal of Pb is "Gain". As seen from the PID formula, the "Gain" is the proportional factor between "Error" and output MV. For example: if Pb=5, then MV is amplified 20 times.

4xxx7: Constant for Integration Term, or, Reset time Constant (K_I: 0~9999). As seen from the PID formula, the K_I represents the contribution of the Integral. If K_I = 0, then this function block becomes a PD function block.

4xxx8: Constant for Derivative Term, or, Rate time Constant (K_D: 0~9999). As seen from the PID formula, the K_D represents the contribution of the Derivative. If K_D = 0, then this function block becomes a PI function block. If both K_I = 0 and K_D = 0, then this function block becomes a proportional control function block.

4xxx9: Bias, Correction Value, or offset to Output (0~4095).

4xx10: High integral wind-up limit, or, upper bound of output. Usually this value is set at 4095.

4xx11: Low integral wind-up limit, or, lower bound of output. Usually this value is set at 0000.

4xx12: Upper bound of Engineering Range (0001~9999). Specify the upper limit of the sensor output in Engineering Unit in this register. For example, a RTD10 module produce unsigned digital data 1500 ~7500 for temperature 0℃~600℃, then specify 600 for this register. This number should be greater than the Set Point.

4xx13: Lower bound of Engineering Range (0000~9998). Specify the lower limit of the sensor output in Engineering Unit in this register. For example, a RTD10 module produce unsigned digital data 1500 ~7500 for temperature 0℃~600℃, then specify 0000 for this register. This number should be less than the Set Point.

4xx14: Raw PV. Move the data from the output PV sensor to this register. (See also Register 4xx16)

4xx15: Internal Register for storing the status of "Auto" or "Manual" mode. If the content of this register is 11(Hex), the PID function block is in Manual mode. If 55(Hex), Auto mode.

4xx16: Correction value for Row PV. (0~4096). Specify a correction value in this register. This value is subtracted from the Raw PV (obtained from Register 4xx14), and the result is then used in the calculation of Register 4xxx1.

Middle Node: Register 4yyy1~4yyyy5

4yyy1: PID function Block Status.

Bit 1: =1, if there is any parameter error.
Bit 2: =1, if High Alarm limit is exceeded.
Bit 3: =1, if Low Alarm limit is exceeded.
Bit 4 ~ Bit 5: Reserved.
Bit 6: =1, if PID function Block is in "Auto" mode and computing.
Bit 7 ~ Bit 12: Reserved.
Bit 13: $=I_3$
Bit 14: $=I_2$
Bit 15: $=I_1$
Bit 16: Reserved.

4yyy2: Internal Register for PID Loop timer.

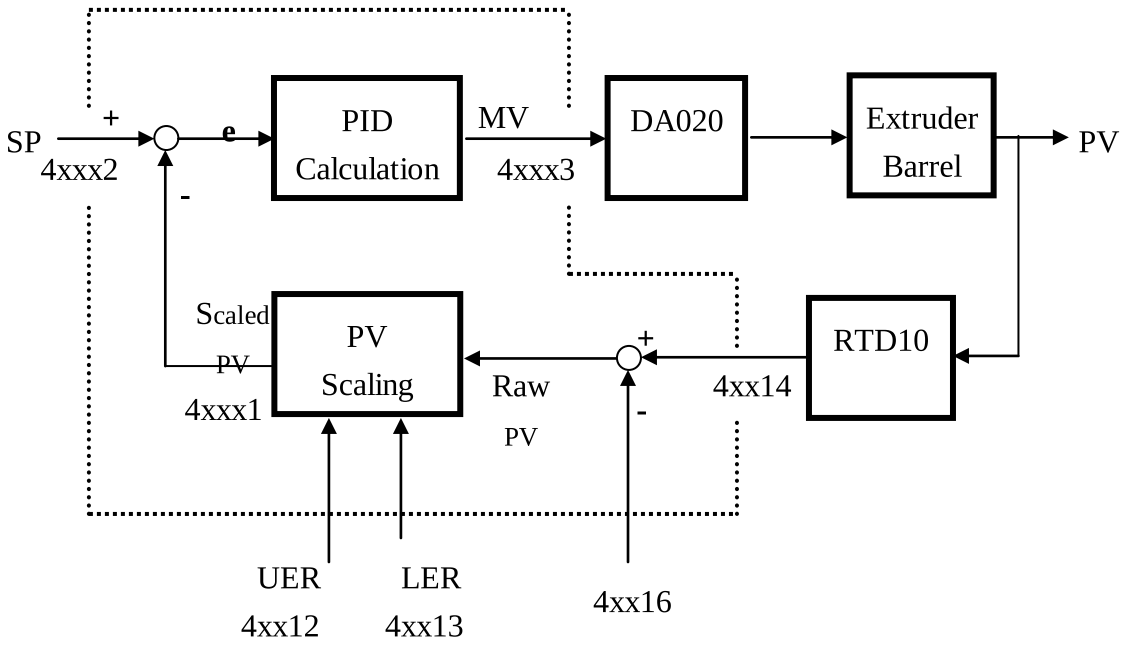
4yyy3: Internal Register for storing High order integral summation.

4yyy4: Internal Register for storing Low order integral summation.

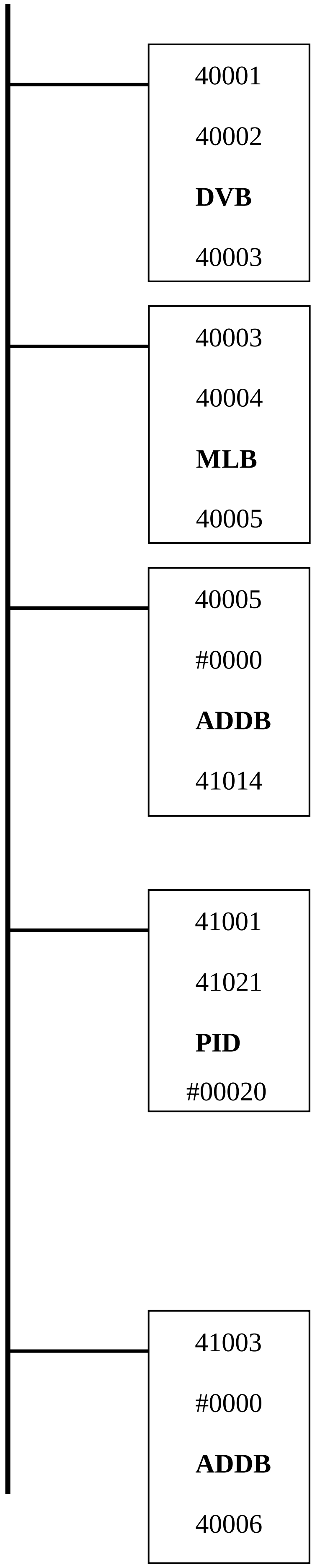
4yyy5: Internal Register for storing Scaled PV used in the previous scan.

Bottom Node: Cycle time, unit: 1/10 sec. 00010 stands for one second.

Example:



SP
4xxx2
+
-
e
PID
Calculation
MV
4xxx3
DA020
Extruder
Barrel
PV
Scaled
PV
4xxx1
PV
Scaling
Raw
PV
+
-
4xx14
RTD10
UER
4xx12
LER
4xx13
4xx16



40001: Obtain from RTD module

40002: 1770(Hex)=6000 (=7500-1500) ,
Data range for 0~600℃

40003: Quotient

40004: 1000(Hex)=4096, Sensor Range

40005: Product, Raw PV

Move Raw PV to PID's TOP node
Register 41014.

41001
41002: 0220℃, processing temperature
for HDPE
41003: Control Output (MV)
41004: 0250℃, High Alarm Limit
41005: 0200℃, Low Alarm Limit
41006: 0200, Proportional Band
41007: 0300, KI
41008: 0000, thus, PI control only.
41009: 0000, Bias
41010: 4095, upper bound of MV
41011: 0000, lower bound of MV
41012: 0600℃, UER
41013: 0000℃, LER
41014: Raw PV
41015: 0055, Auto mode
41016: 0000, Correction for Raw PV
Bottom Node: Cycle time, 2 sec.

Move PID output to DA020 module