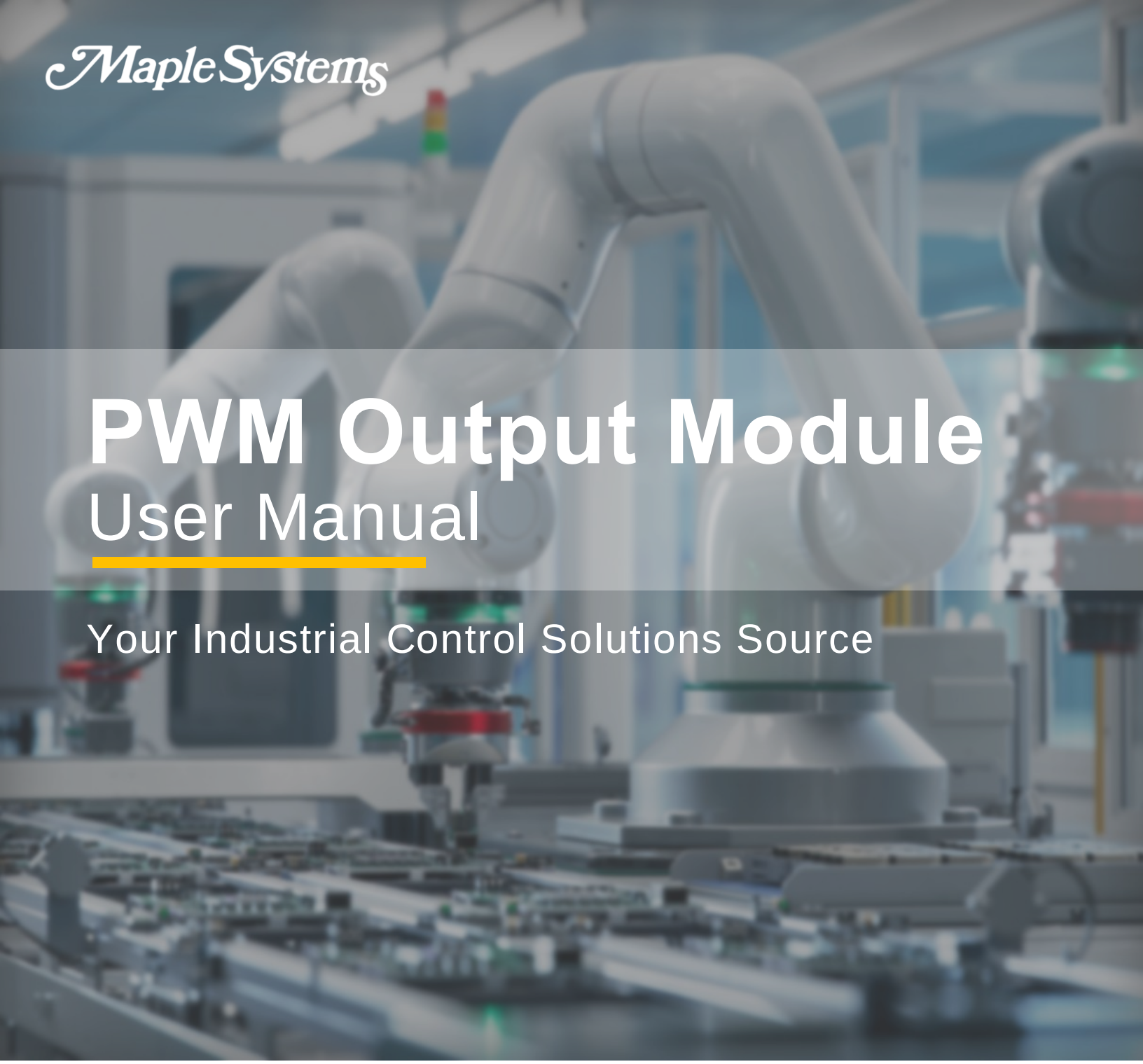


PWM Output Module
User Manual

Your Industrial Control Solutions Source

For use with the following:

- IO-SD0032PPWM

AW-10101171 REV00

Maple Systems, Inc. | 808 134th St. SW, Suite 120, Everett, WA 98204 | 425.745.3229

MapleSystems.com

Before You Start

This manual contains important information on the use and operation of this device. Please read all the information carefully for optimal performance and to prevent any damage or misuse of the device.

Safety symbols are classified into two categories, “WARNING” and “CAUTION”.

Warning This symbol describes situations that could cause major or fatal injury to the user.

Caution This symbol describes situations that may cause minor injury or damage to the device.

SAFETY SYMBOLS USED IN THIS PRODUCT MEANS:

This symbol warns the user of potential hazards.

This symbol warns the user of uninsulated voltage within the unit that can cause dangerous electric shock.

Keep this manual nearby the user operating devices so it can be easily checked.

A-class equipment (Broadcasting communication equipment for business)

This product has passed the testing for electromagnetic waves for business use, and has not been designed or manufactured to be used as a household item; users are advised as such.

Design Precautions (⚠Warning)

Please install a safety circuit to protect entire control system in case of an unexpected power shut-down and PLC module malfunction. Such anomalies may severely compromise the integrity of the overall system.

External to the PLC, please install circuits and switches to safeguard the system from mechanical damages (ex. Emergency stop, upper/lower limit switches, forward/reverse direction interlocking circuits, etc)

When the PLC detects either of the following failure conditions, it may stop operation and turn off all outputs.

- The overcurrent protection or overvoltage protection of the power supply module is activated.
- The PLC CPU detected a failure, such as the watchdog timer error or module installation failure, with its self-diagnostic function.

In addition, all outputs may be turned on when there is a failure that the PLC CPU cannot detect, such as in the relay or TR terminal. Build an extra monitoring circuit that will monitor any output signal that could cause serious accidents.

A greater than normal current passed through the PLC for an extended period of time, or a short-circuited load flows in the output module may cause a fire.

Build a circuit that turns on the external power supply after the PLC power supply is turned on. If the external power supply is turned on first, it could result in output failure or malfunction.

In order to ensure that the system operates safely, please configure an interlock circuit in the scan program for the following situations.

- When exchanging data with computer or other devices.
- When operated by a computer or other devices.

Not doing so could result in output failure or malfunction.

Precautions for design (⚠Caution)

Do not bundle the input/output signal or communications cables with the main circuit and power cables. They should be installed at least more than 100 mm (3.94inches) apart. Not doing so could result in output failure or malfunction.

Precautions for mounting (⚠Caution)

Use the PLC in the environment that meets the general specifications given in this manual. Using this PLC in any environment outside the range of the general specifications could result in electric shock, fire, malfunction, or damage to or deterioration of the product.

Please ensure that each module is installed correctly in its place. Loosely or incorrectly installed pieces may result in malfunction, failure, or free-fall.

Power supply in PLC should be turned off before mounting the module. Not doing so could cause an electric shock or damage to the device.

Install I/O devices or extension connectors correctly. If they are installed incorrectly, it may result in an input or output failure.

Do not convey direct vibration into PLC. Not doing so could cause electric shock, fire or malfunctions.

After wiring work, please make sure to close the terminal cover before turning on the power for the PLC system.

Precautions for wiring (⚠Warning)

Make sure to check the device's rated voltage and circuit arrangement before wiring. Failure to do so may cause electric shock or damage on the device.

Make sure to close the terminal cover before turning on the power of PLC system after wiring work. Failure to do so may cause electric shock.

Precautions for wiring (⚠Caution)

Make sure to check device's regular voltage and sequence of terminals. Failure to do so may cause fire, electric shock and malfunctions.

Make sure to tighten the screw with standard torque. Loose connections may cause short, fire or malfunctions.

In grounding the FG ground terminals, be sure to conduct the product at least D type (Class 3) grounding. Not doing so could result in electric shock or malfunctions.

When wiring, make sure that wiring debris do not enter the module. Failure to do so may cause fire, equipment damage or malfunctions.

Precautions for test run and repair (⚠Warning)

Please do not touch the terminals when the power is ON. Doing so could cause an electric shock or malfunctions.

When cleaning or tightening the screw, turn off the power of PLC and all other systems. Failure to do so could cause an electric shock or malfunctions.

Do not charge, disassemble, heat up, short, or solder the battery. Doing so could cause the battery to heat up, rupture or ignite thereby harming the user.

Precautions for test run and repair (⚠Caution)

Do not dissociate the PCB from the module's casing or make any modifications to the device. Doing so may cause fire, electric shock or malfunction.

When mounting or separating the module, make sure to turn off power to PLC and all other devices. Failure to do so could cause an electric shock or malfunctions.

Use radio, walkie-talkie or cellphone devices at least 30cm away from the PLC. Not doing so could result in malfunction.

CONTENTS

1 Introduction

This manual will guide the reader through installation, functions, safety use and operation of the PWM output module (IO-SD0032PPWM) of the PLC-ES. This manual will need to be read and understood before attempting to install or use the device. Store this manual in a noticeable place so that you can take it out and read it whenever necessary. Contents of this manual is as below:

- Chapter 1 discusses the overview of the manual and introduces important features of the product.
- Chapter 2 explains the general and performance specifications of the product.
- Chapter 3 explains the types and features of the data memory stored in the product.
- Chapter 4 goes over the capacities of the product, and how to control the system.
- Chapter 5 guides the user through programming examples of the product.
- Chapter 6 explains repair and maintenance methods, and how to operate the device safely.

In order to run the device properly, the following specifications are required.

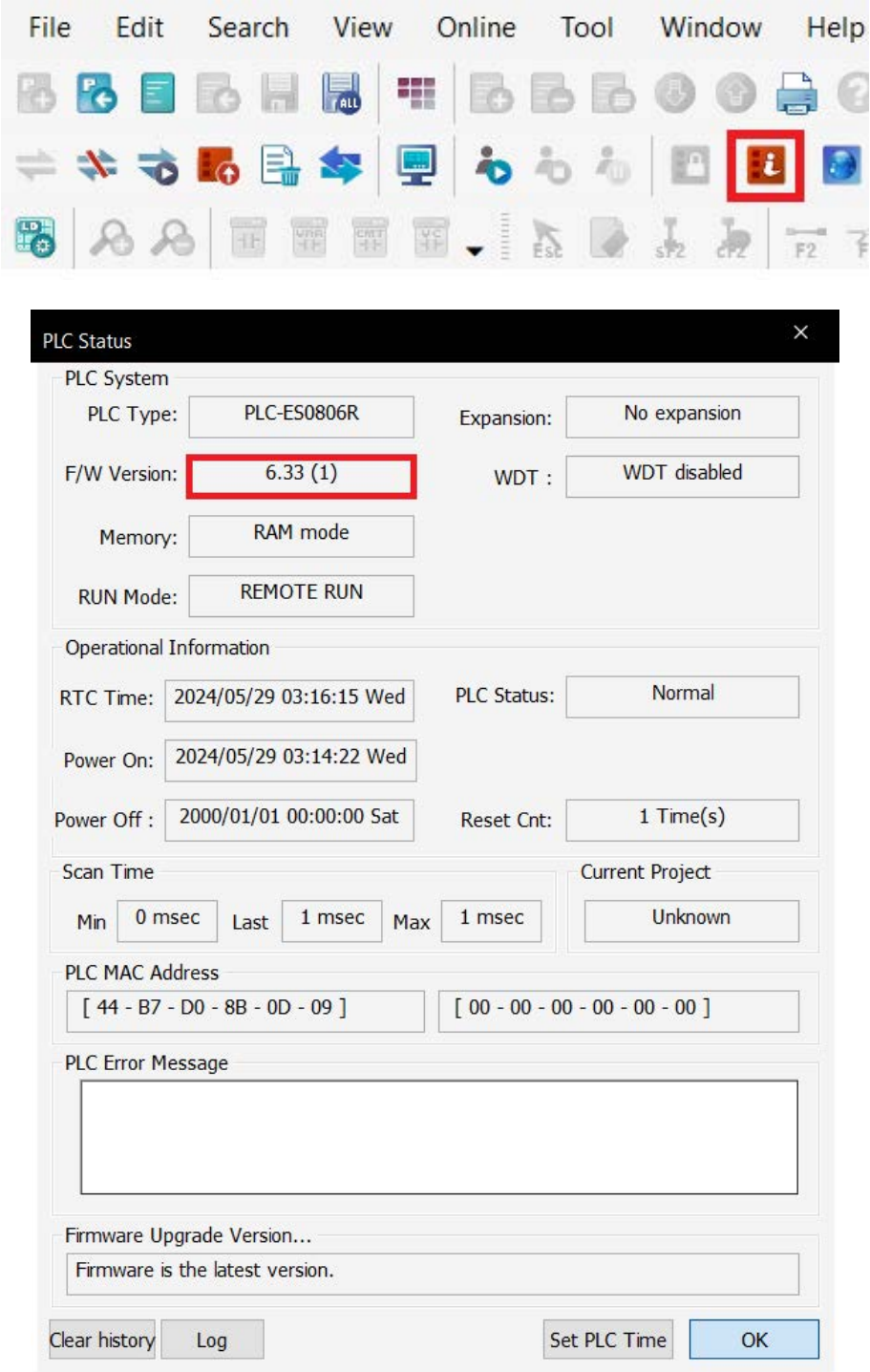
Product	Version
Software(MapleLogic)	V8.20 or above is recommended
PLC-ES CPU	V6.33 or above is recommended

Below is an instruction on how to check the latest version of the software and CPU.

Run the MapleLogic and click the [Help] - [About MapleLogic information] located in the upper right side of a menu bar. You can check the version of software in the dialog box.

[Figure 1] Route to check software version

Run MapleLogic and make a connection with PLC. Click the [Online] - [About PLC information] or the icon below. You can check the version of CPU firmware in the dialog box.



[Figure 2] Route to check CPU firmware

1.1 Features

PWM (Pulse-Width Modulation) is a digital output that can be used as an analog output by controlling the duty cycle that contains a certain frequency.

Maple Systems PWM Output Module has a pulse output function added onto the general digital output, so it has the same specifications as a IO-SD0032PPWN when used as a general digital output. The module:

- Provides general digital outputs up to 32 points.
- Supports for PWM pulse outputs up to 12 channels.

The PWM Output Module supports configurable functions such as controlling frequencies and duty cycles. You can control 4 channels as a group with one frequency, for a total of 3 groups.

Programming of the PWM pulse frequency can be done up to 4000pps, and the duty cycle of the output pulse range can be adjusted from 0.0% to 100.0%, in 1/1000 resolution.

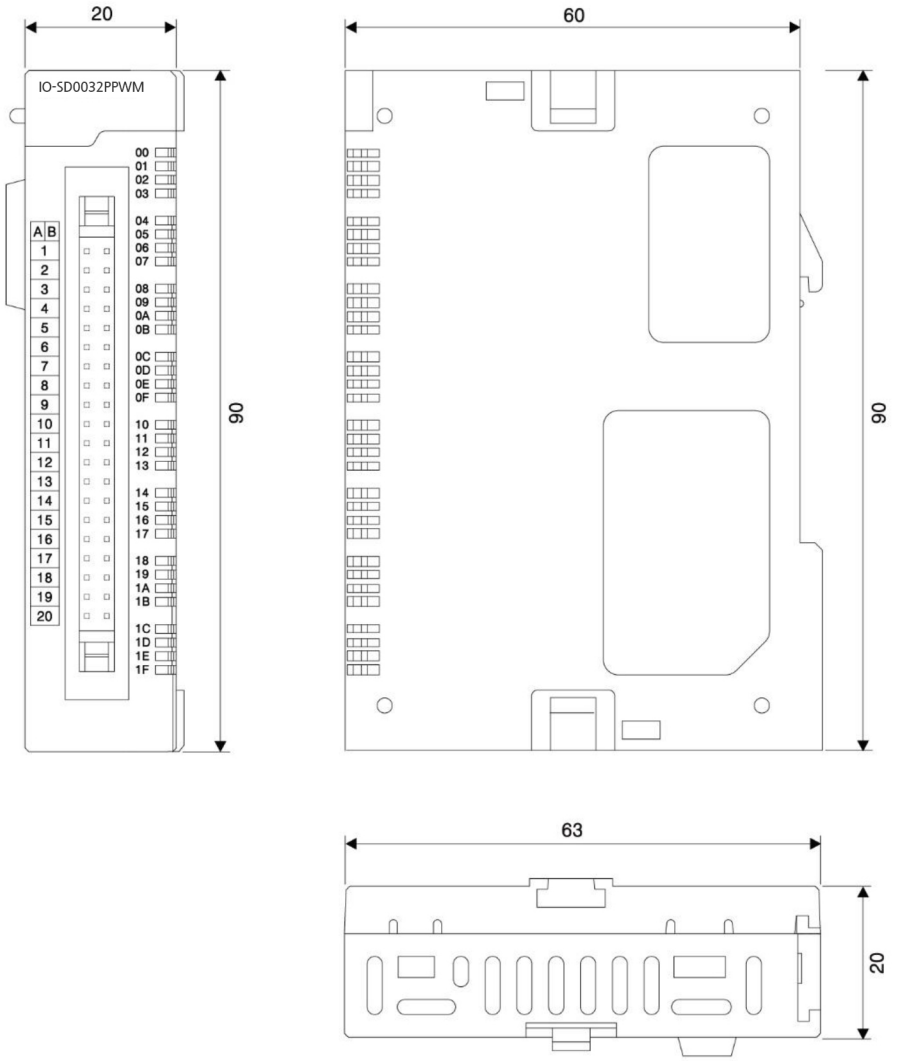
Moreover, duty cycle can be controlled individually by each channel, for up to and total of 12 duty cycles are able to be controlled individually. In addition, the product supports the ramp control on the frequency and duty cycle.

<Summary>

- Programmable duty cycle of output pulse range is from 0.0% to 100.0%, in 1/1000 resolution.
- The maximum programmable PWM pulse frequency is 4000pps.
- Frequencies can be controlled in group with 4 channels as a unit, for a total of 3 groups.
- A total of 12 duty cycles are able to be controlled individually.
- The PWM device supports ramp control on frequency and duty cycle.

1.2 Design and Dimensions

(mm)

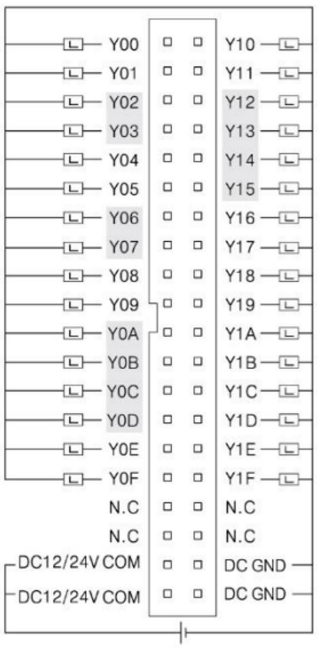


[Figure 3] PWM module appearance

1.3 Configuring terminal blocks and names

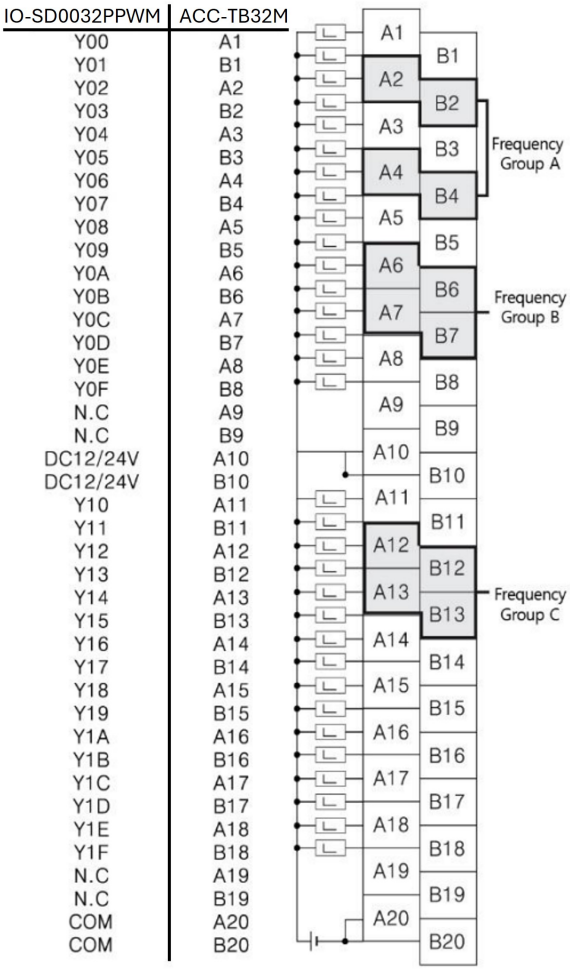
IO-SD0032PPWM + ACC-SCB15E + ACC-TB32M

Output Pin Map



Each DC12/24V and DC GND are connected to the corresponding terminal internally.

External Connection



[Figure 4] Arrangement of terminals and its notations

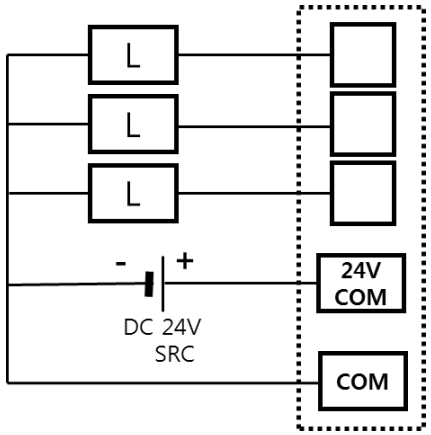
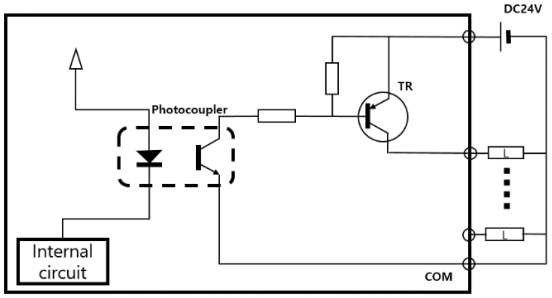
2 Specification

2.1 General specification

<table>
<tr><th>Items</th><th colspan="7">Specification</th><th>Standards</th></tr>
<tr><td>Operating Temperature</td><td colspan="7">-10 ~ 55 ℃ (14 ~ 131℉)</td><td></td></tr>
<tr><td>Preserving Temperature</td><td colspan="7">-25 ~ 80 ℃ (-13 ~ 176℉)</td><td></td></tr>
<tr><td>Operating Humidity</td><td colspan="7">Relative Humidity 5 ~ 95%, Avoid condensation</td><td></td></tr>
<tr><td>Preserving Humidity</td><td colspan="7">Relative Humidity 5 ~ 95%, Avoid condensation</td><td></td></tr>
<tr><td rowspan="2">Inner Vibration</td><td rowspan="2">Frequency (Hz)</td><td colspan="2">Continual Vibration</td><td colspan="2">Intermittent Vibration</td><td rowspan="2">Number</td><td rowspan="2">IEC61131-2</td></tr>
<tr><td>Acceleration (㎨)</td><td>Amplitude (mm)</td><td>Acceleration (㎨)</td><td>Amplitude (mm)</td></tr>
<tr><td>10 ≤ f < 57
57 ≤ f ≤150Hz</td><td>4.9 {0.5G}</td><td>0.035</td><td>9.8 {1G}</td><td>0.075</td><td>10 times for each direction X, Y, Z</td></tr>
<tr><td>Inner Impact</td><td colspan="7">Maximum impact acceleration : 147 ㎨ (15G)
Impression time : 11ms
Pulse wave : a sine half-wave pulse (3 times for each direction ±X, ±Y, ±Z, total on 3 times)</td><td>IEC61131-2</td></tr>
<tr><td rowspan="7">Inner Noise</td><td>Square wave impulse noise</td><td colspan="5">±2kV(10 minutes)</td><td>Internal Test Standard</td></tr>
<tr><td>Electromagnetism discharge</td><td colspan="5">Voltage : 4kV(Contact Discharge)</td><td>IEC61131-2
IEC61000-4-2</td></tr>
<tr><td>Radiation EMF Noise</td><td colspan="5">27 ~ 500 MHz 10V/m</td><td>IEC61131-2
IEC61000-4-3</td></tr>
<tr><td rowspan="4">FAST transient burst Noise</td><td colspan="3">Power supply Module</td><td colspan="2">2kV</td><td rowspan="4">IEC61131-2
IEC61000-4-4</td></tr>
<tr><td colspan="3">Digital input output (≥24V)</td><td colspan="2">1kV</td></tr>
<tr><td colspan="3">Digital input output (<24V)</td><td colspan="2" rowspan="2">0.25kV</td></tr>
<tr><td colspan="3">Analog input output
Communication interface</td></tr>
<tr><td>Ambient Conditions</td><td colspan="7">Avoid Corrosive gas and dusts</td><td></td></tr>
<tr><td>Operating Altitude</td><td colspan="7">≤2000m</td><td>IEC61131-2</td></tr>
<tr><td>Pollution level</td><td colspan="7">≤2</td><td>IEC61131-2</td></tr>
<tr><td>Colling System</td><td colspan="7">Air natural cooled</td><td></td></tr>
</table>

[Table 1] General specification of PWM module

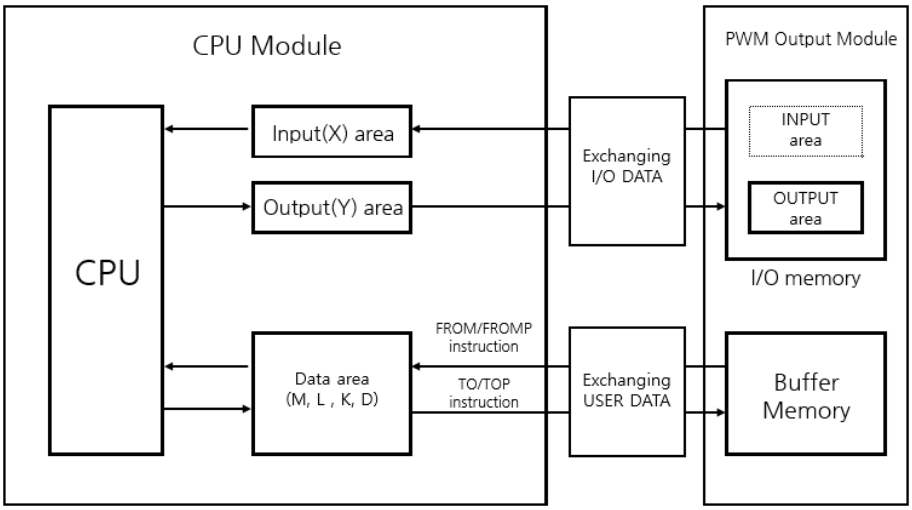
2.2 I/O Specification

Types	Specifications of item
Rated input/output voltage	DC 12V ~ 24V
Response time	≤1ms
Operating indicator	LED lighting when the power ON
Insulation for anticorrosion	Photocoupler
Input method	-
Output method	Source
External connection circuit	
Internal circuit	

[Table 2] I/O Specification of PWM module

3 Data Memory

Data memory is largely classified into two categories: I/O memory and buffer memory. I/O memory exchanges I/O data with the CPU through the X and Y area. Buffer memory exchanges user data with data areas in CPU module using FROM· FROMP/TO·TOP instruction.



[Figure 5] Data exchange between PWM module and CPU

3.1 I/O Memory

I/O memory is an input/output memory area which is provided by the module. This area can be operated in the scan program. The addresses of the X and Y are determined by the location where the module is mounted. Please refer to Appendix 2 for details. PWM output module can offer 32-pin output through the I/O memory area. Please refer to the table in 3.1.1 to check for more details of each point.

3.1.1 Output area

An output area of digital output module outputs the value of data received from the CPU.

- External indicator: LED (a LED per channel)
- 32 Y points (Yn0 ~ Y(n+1)F) ('n' states a number that can be decided by mounted in slots.

Signal Direction : CPU → PWM Output Module			
Output	Signal Name	Output	Signal Name
Y20	General output	Y30	General output
Y21	General output	Y31	General output
Y22	**Frequency A, CH1, PWM output (or a general output)**	**Y32**	**Frequency C, CH9, PWM output (or a general output)**
Y23	**Frequency A, CH2, PWM output (or a general output)**	**Y33**	**Frequency C, CH10, PWM output (or a general output)**
Y24	General output	**Y34**	**Frequency C, CH11, PWM output (or a general output)**
Y25	General output	**Y35**	**Frequency C, CH12, PWM output (or a general output)**
Y26	**Frequency A, CH3, PWM output (or a general output)**	Y36	General output
Y27	**Frequency A, CH4, PWM output (or a general output)**	Y37	General output
Y28	General output	Y38	General output
Y29	General output	Y39	General output
Y2A	**Frequency B, CH5, PWM output (or a general output)**	Y3A	General output
Y2B	**Frequency B, CH6, PWM output (or a general output)**	Y3B	General output
Y2C	**Frequency B, CH7, PWM output (or a general output)**	Y3C	General output
Y2D	**Frequency B, CH8, PWM output (or a general output)**	Y3D	General output
Y2E	General output	Y3E	General output
Y2F	General output	Y3F	General output

[Table 3] Usage of each point of PWM module

※ Stated points will follow the table above it the device is mounted in the first slot.

※ All points can be used to emit as general output. The PWM output could only be operated as the points where it says ‘PWM output’.

3.2 Buffer Memory

The PWM output module is equipped with shared memories inside to exchange the data with CPU. One of these is called buffer memory, which is a collection of word (16Bit)-unit data. This buffer memory is readable and configurable on scan program, using FROM·FROMP/TO·TOP instructions. Please refer to the Appendix 1 to get information about FROM·FROMP/TO·TOP instructions.

The PWM output module offers 64words of buffer memory in total. Following table shows the meaning and usage of each data.

OFFSET	Item	Set-up value parameter	Initial value	Access
0	PWM output Enable	BIT #0~#11 (Total 12 channels)	0	R/W
1	CH1,2,3,4 Frequency	0~4000(pps)	0	R/W
2	CH5,6,7,8 Frequency	0~4000	0	R/W
3	CH9,10,11,12 Frequency	0~4000	0	R/W
4	*Available Later*			
5	CH1,2,3,4 Frequency ramp control time(x10ms) Ex) When Frequency ramp control time is set to 100, 100 x 10ms = 1,000ms (1sec)	0~65535 (x 10ms)	0	R/W
6	CH5,6,7,8 Frequency ramp control time(x10ms)	0~65535	0	R/W
7	CH9,10,11,12 Frequency ramp control time(x10ms)	0~65535	0	R/W
8	*Available Later*			
9	*Available Later*			
10	CH1 duty cycle ratio Ex) When duty cycle ratio is set to 100, 100 x 0.1% = 10.0%	0~1000 (x 0.1%)	0	R/W
11	CH2 duty cycle ratio	0~1000	0	R/W
12	CH3 duty cycle ratio	0~1000	0	R/W
13	CH4 duty cycle ratio	0~1000	0	R/W
14	CH5 duty cycle ratio	0~1000	0	R/W
15	CH6 duty cycle ratio	0~1000	0	R/W
16	CH7 duty cycle ratio	0~1000	0	R/W
17	CH8 duty cycle ratio	0~1000	0	R/W
18	CH9 duty cycle ratio	0~1000	0	R/W
19	CH10 duty cycle ratio	0~1000	0	R/W

OFFSET	Item	Set-up value parameter	Initial value	Access
20	CH11 duty cycle ratio Ex) When duty cycle ratio is set to 100, 100 x 0.1% = 10.0%	0~1000 (x 0.1%)	0	R/W
21	CH12 duty cycle ratio	0~1000	0	R/W
22	*Available Later*			
30	CH1 duty cycle ramp time(x10ms) Ex) When Frequency ramp control time is set to 100, 100 x 10ms = 1,000ms (1sec)	0~65535 (x 10ms)	0	R/W
31	CH2 duty cycle ramp time(x10ms)	0~65535	0	R/W
32	CH3 duty cycle ramp time(x10ms)	0~65535	0	R/W
33	CH4 duty cycle ramp time(x10ms)	0~65535	0	R/W
34	CH5 duty cycle ramp time(x10ms)	0~65535	0	R/W
35	CH6 duty cycle ramp time(x10ms)	0~65535	0	R/W
36	CH7 duty cycle ramp time(x10ms)	0~65535	0	R/W
37	CH8 duty cycle ramp time(x10ms)	0~65535	0	R/W
38	CH9 duty cycle ramp time(x10ms)	0~65535	0	R/W
39	CH10 duty cycle ramp time(x10ms)	0~65535	0	R/W
40	CH11 duty cycle ramp time(x10ms)	0~65535	0	R/W
41	CH12 duty cycle ramp time(x10ms)	0~65535	0	R/W
…	*Available Later*			
63	OS Version		0	R
…	*Available Later*			

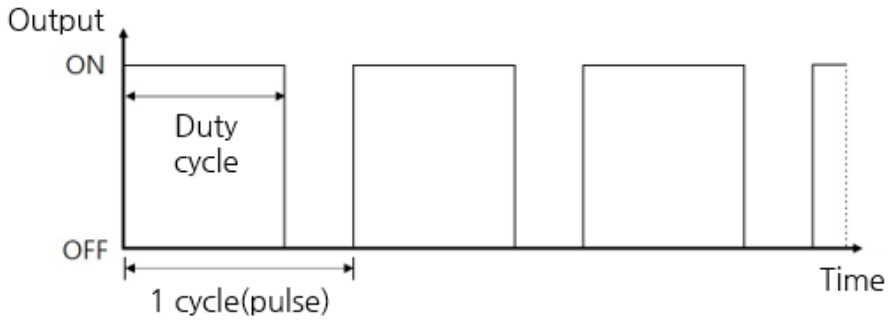
[Table 4] Usage and meaning of each buffer memory (PWM module)

※ R/W represents for the module's Read/Write accesses from the CPU. (R: Read W: Write)

※ All values in buffer memory will be erased and set to 0 when the power to the CPU is turned off or stopped.

4 Functions

PWM (Pulse-Width Modulation) is a digital output that can be used as an analog output by controlling the duty cycle that contains a certain frequency. Duty cycle is a ratio of the ON to OFF status in 1 cycle (pulse).



[Figure 6] Definition of PWM output and duty cycle

As illustrated above, the PWM controls the output from minimum to maximum values by changing the duty cycle of the pulse.

Maple Systems PWM output module can be either general digital output or PWM output. The general digital output can be used up to 32-pin points. From these 32-pin points, a total of 12-pin points support PWM output. Also, you can prevent drastic change of the frequency and duty cycle by using the ramp control.

4.1 Enable of PWM output (Buffer Memory Offset 0)

When PWM-capable points' BIT value is set to 0, it will be possible to use them as general output points. Similarly, if it is set to 1, it will be operated as PWM output. The PWM output function can be enabled by using TO instruction in the buffer memory Offset 0. Please refer to the 3.2 for information about the buffer memory.

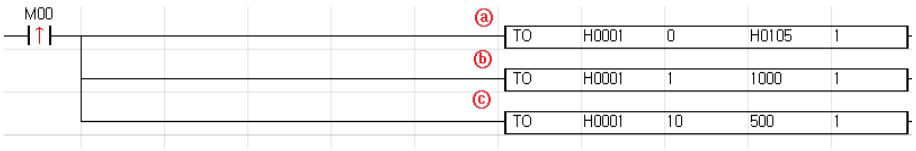
BIT 15	BIT 14	BIT 13	BIT 12	BIT 11	BIT 10	BIT 9	BIT 8	BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0	Buffer Memory Offset 0
Disable				CH 12	CH 11	CH 10	CH 9	CH 8	CH 7	CH 6	CH 5	CH 4	CH 3	CH 2	CH 1	Channel No.

[Table 5] Enabled points of PWM output

Example 1: Enable PWM Output

Example to enable PWM output of CH1, 3, 9 and output the frequency of CH1 to 1000pps and duty cycle to 50.0%.

BIT 15	BIT 14	BIT 13	BIT 12	BIT 11	BIT 10	BIT 9	BIT 8	BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0	Buffer Memory Offset 0
0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	1	Binary (H0105)
Disable				CH 12	CH 11	CH 10	CH 9	CH 8	CH 7	CH 6	CH 5	CH 4	CH 3	CH 2	CH 1	Channel No.



Operates as below when M00 is ON:

a) Enable the PWM output in CH1, CH3, CH9.
b) Set the frequency of CH1 as 1000pps.
c) Set the duty cycle of CH1 as 50.0%.

⚠ In case of power reset or CPU stop, enable the PWM output again by using TO instruction as all value of the buffer memory will be initialized to 0.

4.2 Controlling frequency (Buffer Memory Offset 1 ~ 3)

The PWM can control the range of frequency from 0pps to 4000pps, and 4 channels per group for a total of 3 groups. The frequencies of each group are set by TO instruction at OFFSET 1~3 area of buffer memory.

Frequency A (or a general output)		Frequency B (or a general output)		Frequency C (or a general output)	
CH1	Y02	CH5	Y0A	CH9	Y12
CH2	Y03	CH6	Y0B	CH10	Y13
CH3	Y06	CH7	Y0C	CH11	Y14
CH4	Y07	CH8	Y0D	CH12	Y15

[Table 6] Terminal No. of the frequency group

The four PWM outputs within the same group are operated with a single frequency. Since three groups can be controlled, three different frequency outputs will be feasible.

When using TO instruction on the buffer memory, the output terminal outputs the designated frequency instantly. To prevent drastic change of frequency, please refer to the ramp control at 4.4.

⚠ If the frequency value goes above 4000pps, both valid range of the duty cycle and the degree of precision will be decreased. Please be advised that this product guarantees stated performance up to 4000pps.

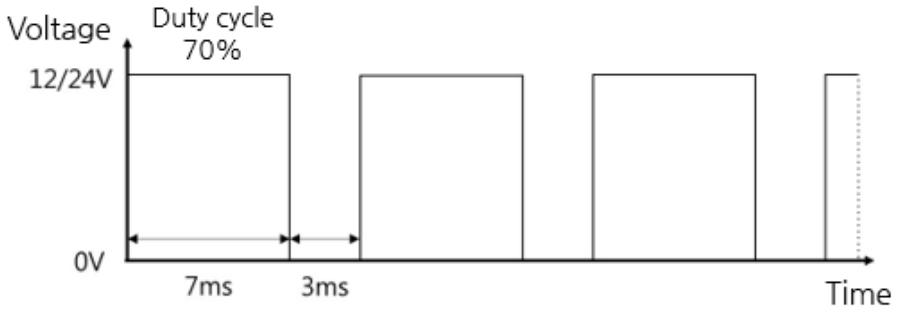
Frequency(pps)	Minimum value of duty cycle(%)	Maximum value of duty cycle(%)
5000	1.0	98.0
10000	1.5	95.0
15000	3.0	94.0
20000	4.0	93.0
25000	5.0	91.0
30000	6.0	89.0
35000	7.0	87.0
40000	9.0	85.0
45000	10.0	83.0
50000	12.0	82.0
55000	13.0	80.0
60000	14.0	78.0
65000	15.0	75.0

[Table 7] Valid setting range of duty cycle per frequency area

4.3 Controlling duty cycle (PWM) (Buffer Memory Offset 10 ~ 21)

The PWM provides functions to control the duty cycle from 0.0% to 100.0% with a 1/1000 resolution. Duty cycles can be controlled by a channel, for a maximum of 12 channels. Duty cycle can be set by using TO instruction at OFFSET 10~21 area of buffer memory. For more information, please refer to Section 3.2.

When using TO instruction on the buffer memory, the output terminal will be configured to set the duty cycle and being output. To prevent the drastic changes in the duty cycle, please refer to the section on ramp control (Sec 4.4).



[Figure 7] Example of duty cycle control (PWM)

If 70.0% of duty cycle is set for a digital signal of 12V/24V voltage, an average output of 8.4V/16.8V will be available. Duty cycle control(PWM) can be utilized in various way to substitute analog signal. For example, the velocity of motor or the ratio of valve opening (open/closed) can be configured.

⚠ Please note that if the value of the duty cycle is set to be greater than 100.0%, it will be recognized as a 100.0%.

4.4 Ramp control

Ramp control serves the purpose of preventing drastic changes in the pulse frequency and duty cycle. If ramp control is enabled (non-zero control time), the output changes gradually. If it is disabled (control time is set to zero), output signals change immediately, without any processing.

Please be advised that:

⚠ Ramp control time should be entered prior to the value for intended purposes.

⚠ In case of power reset or CPU STOP during ramp operation, enter the value again by using TO instruction as all set value of buffer memory will be set back to initial value(0).

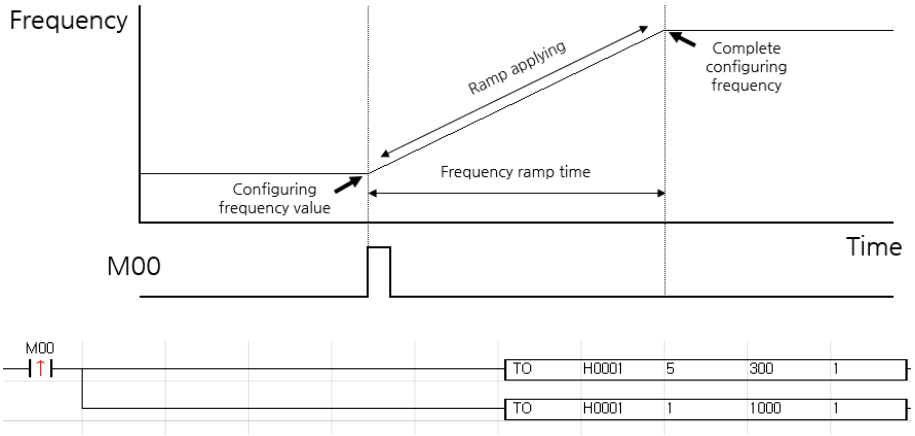
4.4.1 Frequency ramp control (Buffer memory Offset 5 ~ 7)

If frequency ramp control time is configured prior to a change in frequency value, any change in pulse frequency will be applied gradually. Frequency ramp control time can be operated by using TO instruction on buffer memory Offset 5 ~ 7.

⚠ If frequency ramp control time is changed during ramp operation, the change will be applied not to the current operation, but to the next operation.

⚠ In case of power reset or CPU STOP, enter the value again by using TO instruction as all value of buffer memory will be set back to initial value(0).

Example 2: Frequency Ramp Control



When M00 turns on, operate as below:

a) Input the frequency ramp control time value 300(3seconds) to buffer memory Offset 5 by using TO instruction.

b) Now, if 1000pps is entered into the buffer memory Offset 1, the new frequency value will be introduced gradually over 3 seconds.

⚠ Note: Please perform step a) before step b).

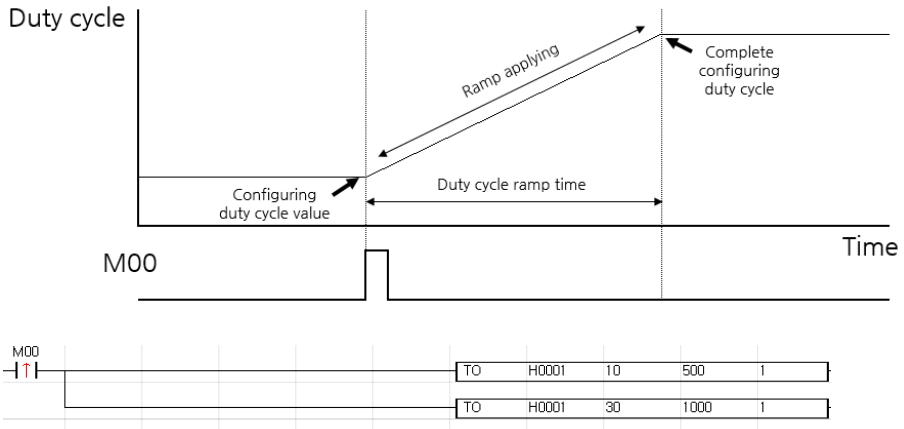
4.4.2 Duty cycle ramp control (Buffer memory Offset 30 ~ 41)

If duty cycle ramp control time is configured prior to setting a duty cycle value, any change in the duty cycle will be applied gradually. The duty cycle ramp control can be operated by using TO instruction on buffer memory Offset 30~41.

⚠ If duty cycle ramp control time is changed during ramp operation, the change will be applied not to the current operation, but to the next operation.

⚠ In case of power reset or CPU STOP, enter the value again by using TO instruction as all value of buffer memory will be set back to initial value(0).

Example 3: Duty Cycle Ramp Control



When M00 turns on, operate as below

a) Input duty cycle ramp control time value 500(5seconds) to buffer memory Offset 30 by using TO instruction.

b) Now, if ramp cycle value of 1000(100.0%) is entered into the buffer memory Offset 10, the new duty cycle value will be introduced gradually over 5 seconds.

⚠ Note: Please perform step a) before step b).

5 Operating the PWM Output Module

Through examples, this chapter outlines a method to configure a program using the PWM output module.

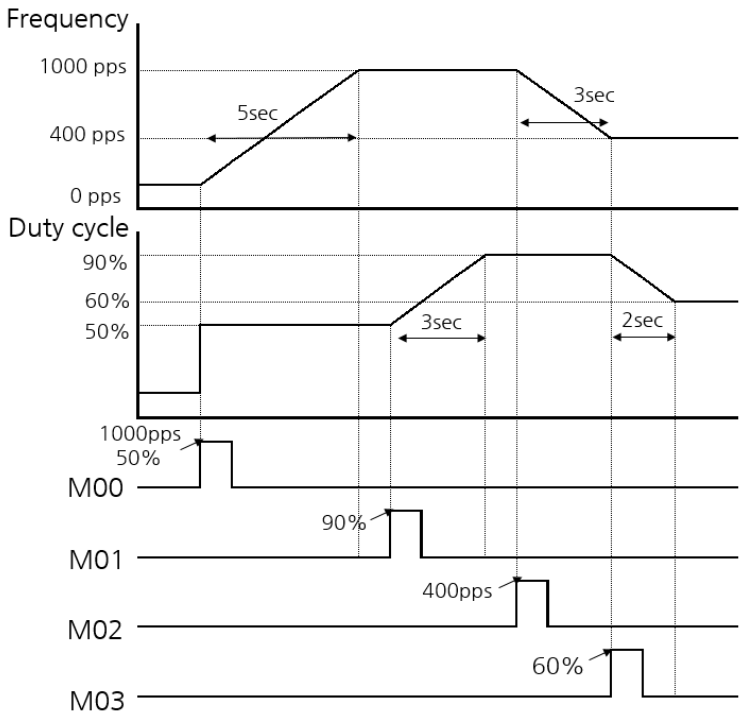
⚠ In order to use the ramp control time as intended, please set up the ramp control time prior to inputting frequency or duty cycle values.

⚠ In case of power reset or CPU STOP, enter the value again by using TO instruction as all value of buffer memory will be set back to initial value(0)

5.1 Example for basic operation

Example 1: PWM Basic Operation

This item is an example that changes the frequency and the duty cycle in channel 2 (Y03).

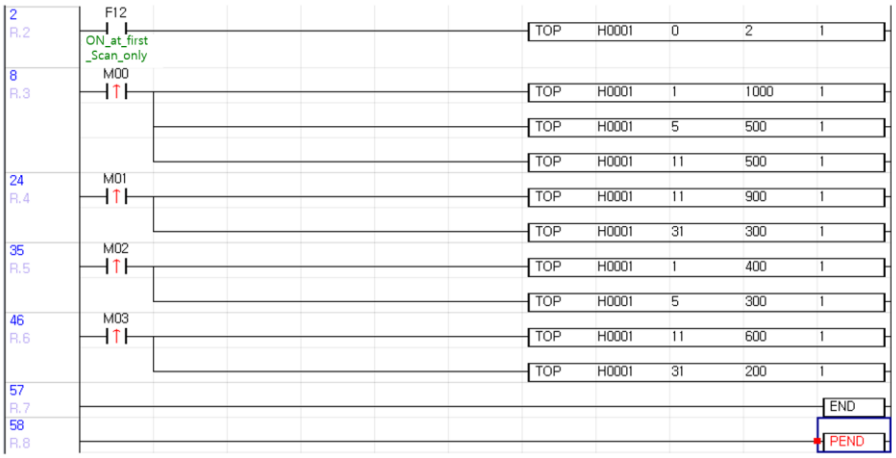


When M00 turns on, the system operates below:

a) Set duty cycle 50.0% so that gradually increase the frequency 0pps to 1000pps for 5 seconds.

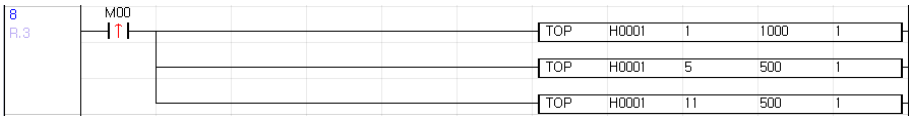
b) Gradually increase the duty cycle from 50.0% to 90.0% for 3 seconds.
c) Gradually decrease the frequency from 1000pps to 400pps for 3 seconds.
d) Gradually decrease the duty cycle from 90.0% to 60.0% for 2 seconds.

Entire scan program is as below.

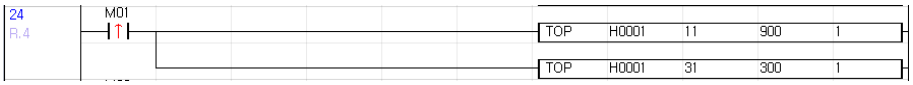


(1) Use TOP instruction to enter value 2 on buffer memory Offset 0 to enable channel PWM output.

(2) Receive the M00 value and trigger the function. Enter 1000 on buffer memory Offset 1, 500 on Offset 5 and 500 on Offset 11 by using TOP instruction so they can be changed 0pps to 1000pps for 5 seconds with a duty cycle of 50.0%.



(3) Receive the M01 value. Enter 900 on buffer memory Offset 11 and 300 on Offset31 by using TOP instruction. The duty cycle changes from 50.0% to 90.0% for 3 seconds.



(4) Receive the M02 value. Enter 400 on buffer memory Offset 1 and 300 on Offset5 by using TOP instruction. The frequency changes from 1000pps to 400pps for 3 seconds.

(5) Receive the M03 value. Enter 600 on buffer memory Offset 11 and 200 on Offset 31 by using TOP instruction. The duty cycle changes from 90.0% to 60.0% for 2 seconds.

5.2 Practical Examples

The following are examples about how to utilize PWM output module. Example 1 is about motor control using frequency ramp control function. Example 2 is about PID temperature control using frequency ramp control function and duty cycle.

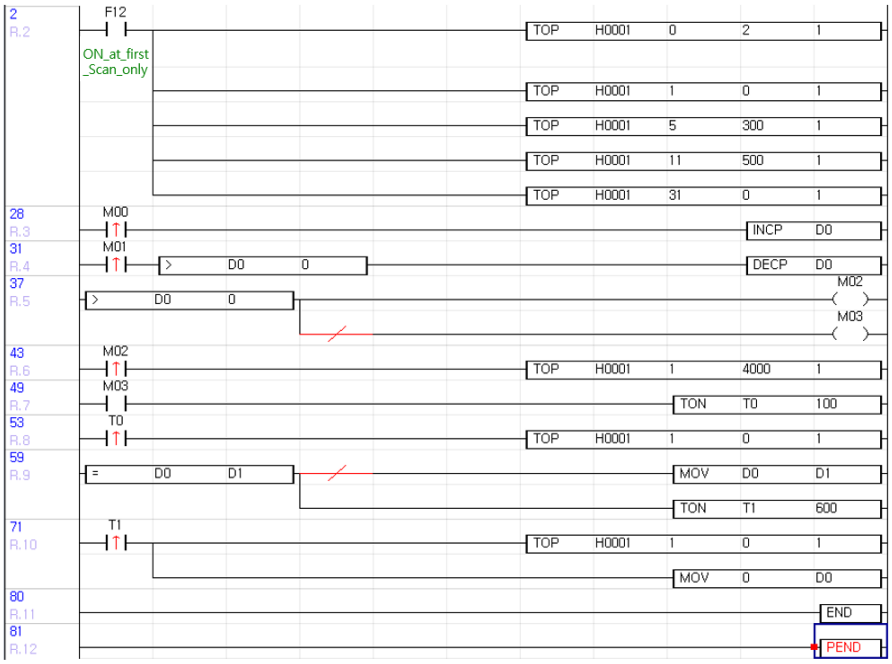
Example 1: Softstart Using Ramp Control

This is an example to control an escalator using stepping motor control. Basic requirement of the system is as below.

<Requirements>

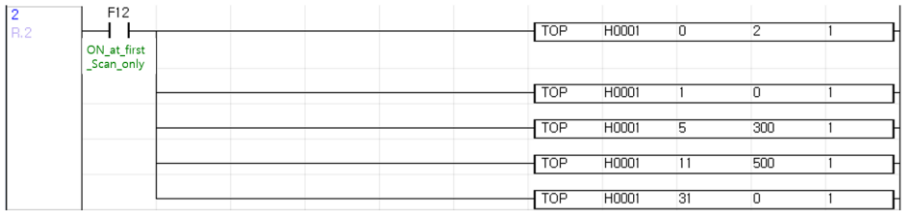
- It should be able to identify the number of passengers on board by counting who have been in-and-out through escalator sensor.
- Run the stepping motor when the number of passenger becomes 1 from 0.
- When the motor starts to run/activated, gradually increase the speed for 3 seconds then move to the maximum speed(4000pps) later.
- When the number of passenger on escalator becomes 0, wait 10 seconds then stop running.
- When the number of passenger on escalator does not change for 1 minute, then stop running.
- To stop the stepping motor, gradually decrease the speed for 3 seconds, then stop completely(0pps) later.

Entire scan program is as below.

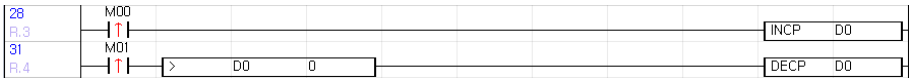


(1) Initialize module parameter as below.

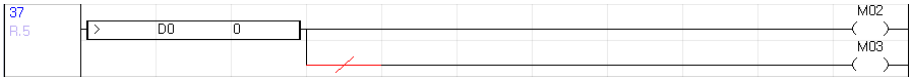
- Enable CH2 PWM (Buffer memory Offset 0)
- Initial frequency 0pps (Buffer memory Offset 1), frequency ramp control time 3 seconds(Buffer memory Offset 5).
- Duty cycle 50.0% (Buffer memory Offset 11), No duty cycle ramp control time(Buffer memory Offset 31).



(2) M00 checks passengers who go into the escalator, and M01 checks passengers who come out from the escalator. In case of passenger entering, increase the number of passenger(D0). In case of passenger exiting, decrease the number of passenger(D0) but only if the number is higher than 0.

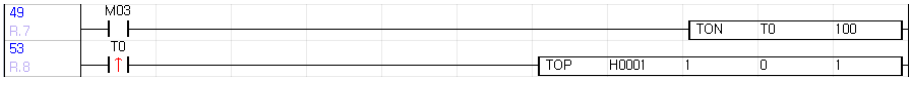


(3) Check whether the number of passenger is 0 or higher than 0.-

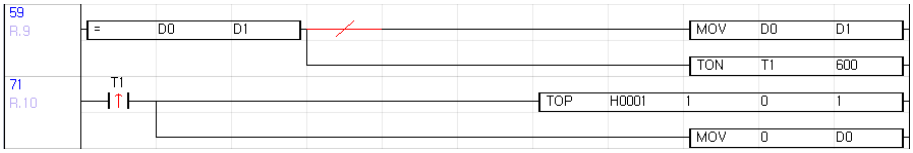


(4) In case the number of passenger is higher than 0, configure frequency to 4000pps. (As frequency ramp control time is set to 3 seconds, frequency will gradually increase from 0pps to 4000pps for 3 seconds.)

(5) Check whether the passenger is on board and if there are none, configure the frequency to 0 after 10seconds. (As frequency ramp control time is set to 3 seconds, frequency will gradually decrease from 4000pps to 0pps in 3 seconds.)



(6) Check whether the number of passenger changes and if it does change, initialize the timer. But if it does not change for 1 minute, then set the frequency to 0pps and initialize the number of passenger.



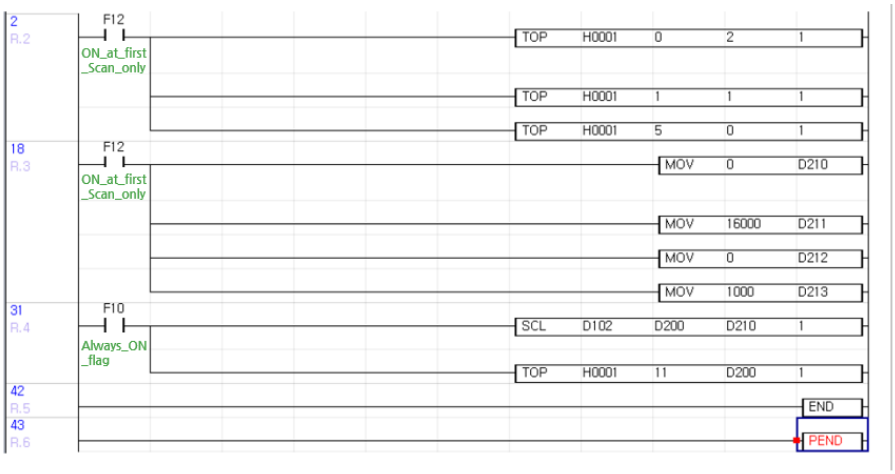
Example 2: PWM PID Control

This is an example about PID temperature control of the heater which turns on at 24V and turns off on at 0V. Basic requirement of the system is as below.

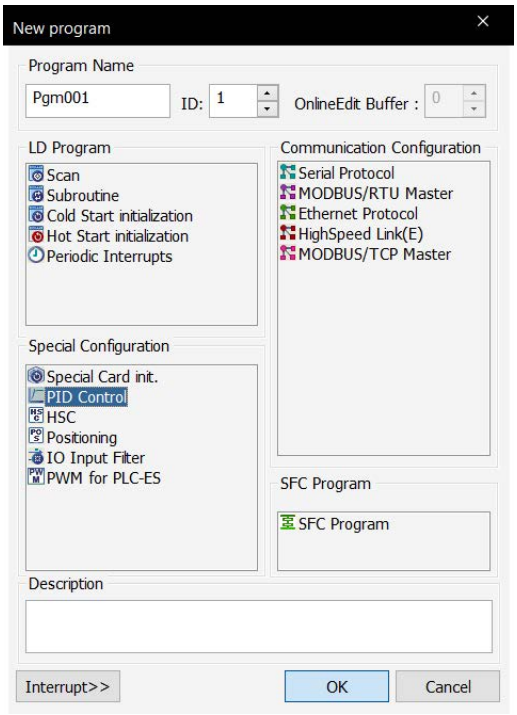
〈Requirements〉

- Temperature value of the system should be controlled by PID control.
- MV value should be applied to control every second.
- The device should be controlled by the ON-OFF button.
- MV value with range from 0 to 16000 should be applied as range from 0.0% to 100.0%(Duty cycle control).

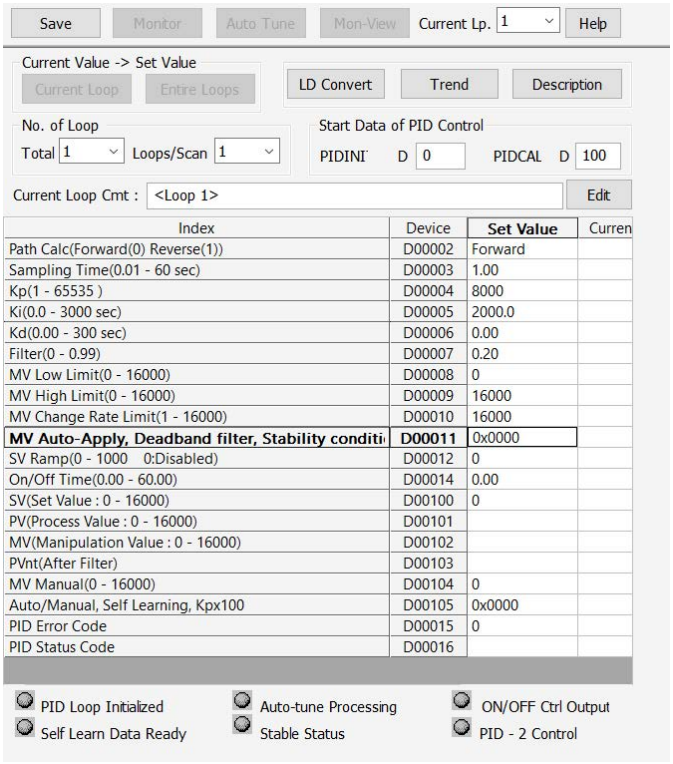
Entire scan program is as below.



(1) Create a new PID program.

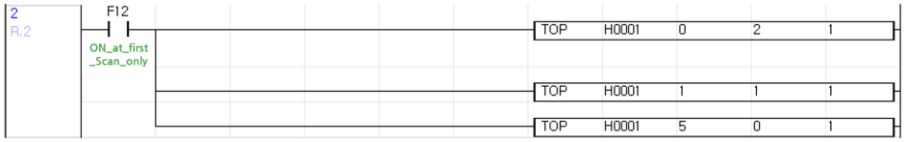


(2) Set proper Kp, Ki, Kd value and set sampling cycle to 1 second.



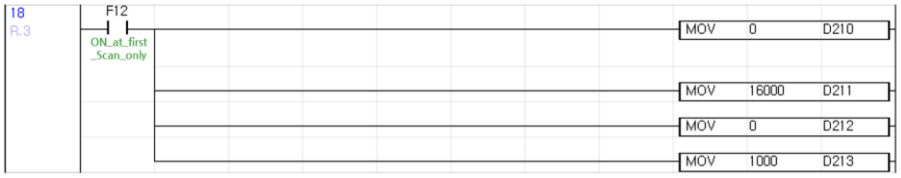
(3) Enable PWM output of CH2 to write value 2 to buffer memory Offset 0 by using TOP instruction.

(4) Set frequency and frequency ramp control time. Set 1(1pps) to buffer memory Offset 1 and 0(frequency ramp control time) to buffer memory Offset 5 by using TOP instruction.



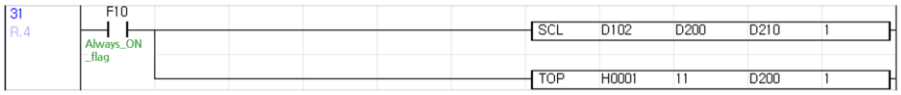
(5) Configure the MV value from a range of 0 to 16000 to a range of 0 to 1000. Set range value of before to D210 and D211 by using MOV instruction. (0~16000)

(6) Set the configured value to D212 and D213 by using MOV instruction. (0~1000)



(7) Scale transform the MV value(D102) by using SCL instruction and save the value to D200.

(8) Set the duty cycle by using configured D200 value. Set D200 value to buffer memory Offset 11 by using TOP instruction.



6 Maintenance work and repair

It is recommended to have the PLC checked and diagnosed regularly to maintain its ideal performance. The following describes what is to be done in a maintenance work.

6.1 Maintenance work

✓ Daily checkup

There are two items that should be checked daily.

(1) LED status of module

LED of module	Item to check
Output module	Lighting when output On, lights out when output Off (Problems on besides states)

(2) Link status of cable

Check if the screws are tightly attached to the terminal of I/O modules.

✓ Maintenance

These are items that should be checked once every six months to a year. Also, it is required to do a maintenance work if there is a relocation of devices or shifts in wiring.

(1) General standard items

Item	Item to check
Operating temperature	-10 ~ 55℃ (14 ~ 131℉)
Operating humidity	5 ~ 95% RH
Ambient conditions	Avoid corrosive gases and dusts

(2) Power supply voltage checkup

Check if the standard has conformity by measuring DC input voltage (DC 10~26V).

(3) Installation status of module

Check if the module is solidly mounted and debris-free.

6.2 Repair

✓ Replacing a module

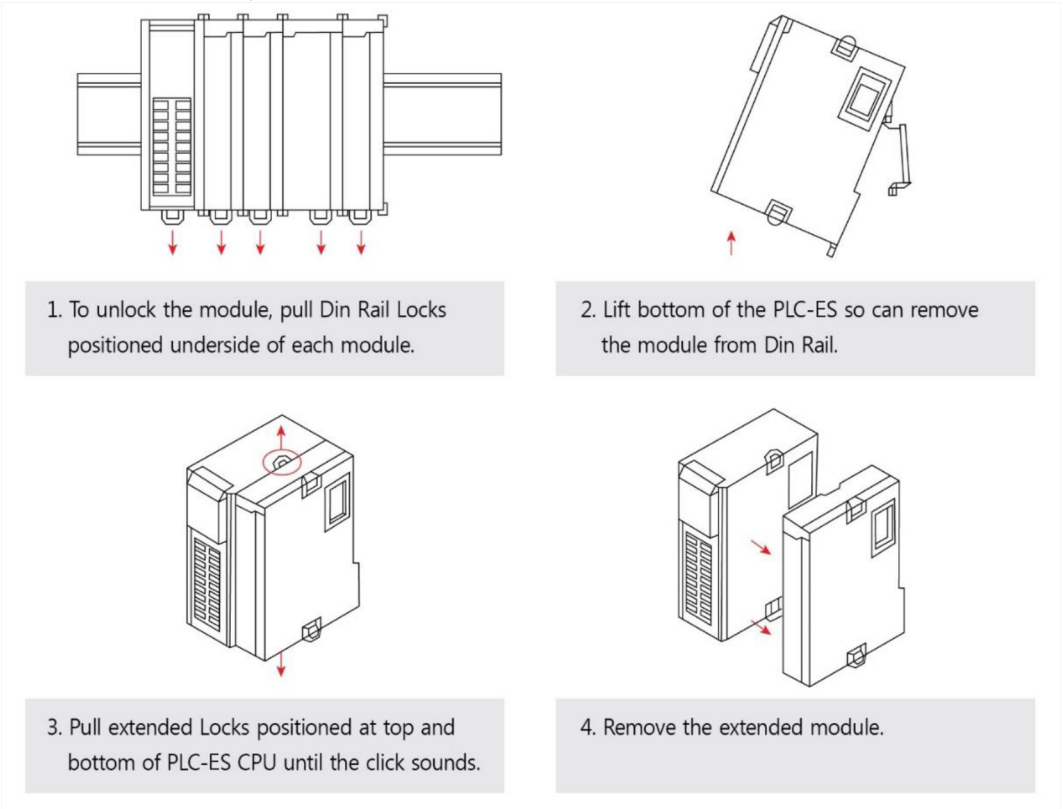
If a module requires replacement due to damage or failure, the following procedure should be followed.

a) Turn the PLC drive power supply off.

b) Isolate the connector from PLC-ES.

c) Remove Din rail fixing hook and remove the PLC.

d) Release PLC-ES fixing hook and remove/replace the module.



[Figure 8] Ejecting order in case of module replacement

6.3 Trouble shooting

This section describes errors that may happen during run-time and actions to be taken.

See the following items before making a judgement on PLC problems.

(1) Check if the power is on. (Does PLC drive input voltage enabled normally?)

(2) Check that each module is mounted (such as power supply, CPU, I/O, special modules) or wired (Such as I/O signal, cable) properly.

Please be advised that as the size of the scan program increases, response time will decrease accordingly.

See the following table for recommended actions when troubleshooting signal failures.

✓ Recommended action for signal failures

Error	Remedy
General output is disabled	- Check if the PLC module wired or mounted correctly. - Check that the buffer memory (PWM enable) channel per BIT is OFF. The Y interface does not operate as general output in ON status.
PWM output is disabled	- Check if the PLC module wired or mounted correctly. - Check that the buffer memory (PWM Enable, frequency, Duty cycle) is set properly. The PWM output operates when corresponding BIT per channel of PWM buffer is in ON status. - Check if the frequency and the duty cycle are set properly. The PWM output does not operate when the frequency or the duty cycle is 0.

Appendix 1 Using FROM·FROMP/TO·TOP Instructions

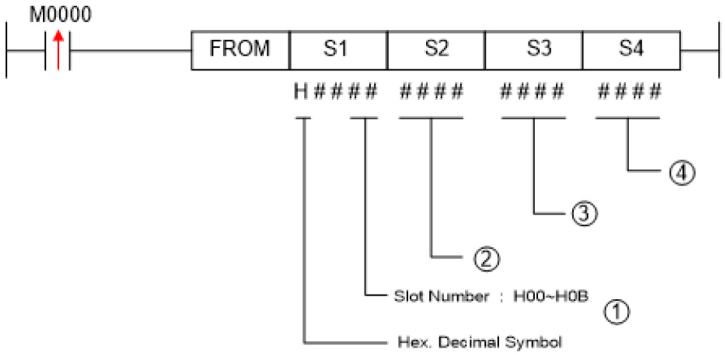
The Maple Systems PLC is composed of various special modules such as AD, DA, High Speed Counter, etc. All of these have a shared memory in their hardware for data exchange with CPU module. The CPU module can send various operation instructions, and receive data through shared memory. In the same way, a scan program can read from and write to shared memories of special module by using dedicated instructions to this purpose, FROM·FROMP and TO·TOP.

In the Maple Systems PLC system, shared memory is called "Buffer memory". To use FROM· FROMP/TO·TOP instructions appropriately, a programmer must know the memory map of the target special module. Every special module which has a shared memory has a map in its manual to guide users.

1. FROM/FROMP instruction

FROM/FROMP instruction reads Word data from shared memory of special module, and stores them to the internal device of CPU. The data contain such as the converted value of AD module, the temperature value of RTD or TC module, etc.

The typical usage of the instruction can be represented by following LD.



[Figure 9] How to use FROM / FROMP instruction

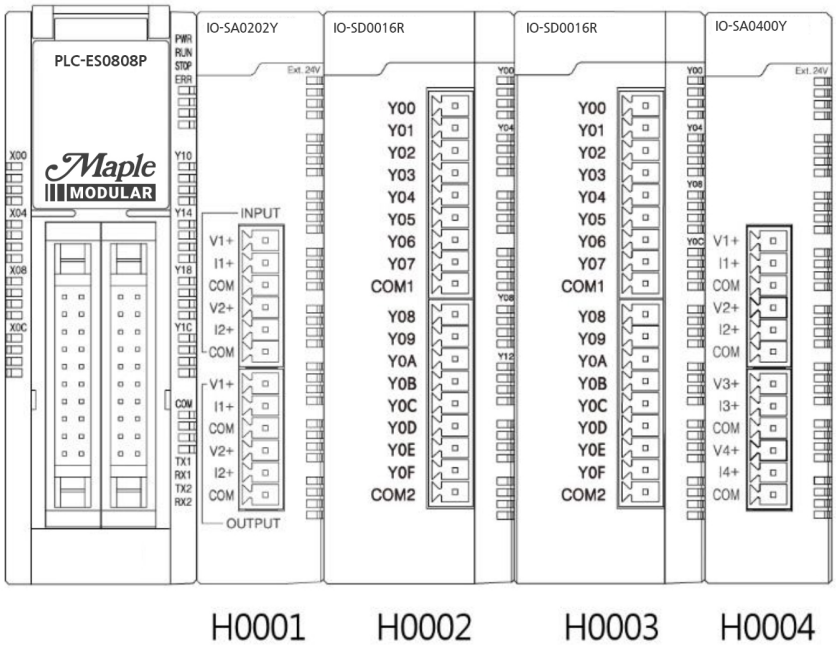
Form	Content	Remarks
S1	Slot number where the special module is installed	H00 01: Slot No.1 *As PLC-ES Series have no expansion function. So Upper No. is H00
S2	Start address of buffer memory	Check the buffer memory address of the module as buffers memory start address of each module varies.
S3	Start address of the device where read data are stored	Save the value from buffer memory of module from device area of CPU.
S4	Number of words to read	Save a number of data to S4-designated area in order as the number of data(word) to read.

[Table 8] Notation and form of FROM / FROMP instruction

(1) S1 (slot number)

Maple Systems PLC can be expanded up to 11 modules.

The first operand of FROM / FROMP instruction must be the slot number. The upper Byte is assigned as 00 and the lower Byte is assigned as slot number.



[Figure 10] Example of PLC-ES Series module extension

(2) S2 (Start address of buffer memory)

Designate the start address of buffer memory to read. Please refer to the manual or quick-reference guide of objective module.

(3) S3 (Start address of device)

Designate the start address of device where read values will be stored. Y/M/L/K/D/Z areas are available.

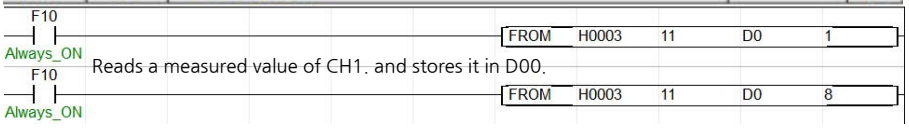
(4) Number of words to read and store

Designate the number of Words to read and store.

Example 1: How To Use FROM/FROMP Instruction

The following is an example program which reads one word and eight words. It assumes the special module is IO-SA0202Y and installed in fourth slot.

Address		Details	Default	R/W
Hex.	Dec.			
0H	0	CH.1 Digital conversion value (AD)	-	R
1H	1	CH.2 Digital conversion value (AD)	-	R
2H	2	CH.1 Precise value (AD)	-	R
3H	3	CH.2 Precise value (AD)	-	R
4H	4	CH.1 Percentile value (AD)	-	R
5H	5	CH.2 Percentile value (AD)	-	R
6H	6	High alarm status (AD)	-	R
7H	7	Low alarm status (AD)	-	R
8H	8	CH.1 Setup input signal range (AD)	0	R/W
9H	9	CH.2 Setup input signal range (AD)	0	R/W
AH	10	Setup Raw Value digital output (AD)	0	R/W
BH	11	CH.1 Average processing setting value (AD)	2000h	R/W
CH	12	CH.2 Average processing setting value (AD)	2000h	R/W
DH	13	CH.1 Maximum alarm setting value (AD)	0	R/W
EH	14	CH.2 Maximum alarm setting value (AD)	0	R/W
FH	15	CH.1 Minimum alarm setting value (AD)	0	R/W
10H	16	CH.2 Minimum alarm setting value (AD)	0	R/W
11H	17	CH.1 Digital Filter Constant (AD)	30	R/W
12H	18	CH.2 Digital Filter Constant (AD)	30	R/W
13H	19	DA Enable/Disable setup (DA conversion)	0	R/W
14H	20	CH.1 DA output type (Current 2types, Voltage 4types)	0	R/W
15H	21	CH.2 DA output type (Current 2types, Voltage 4types)	0	R/W
16H	22	CH.1 DA Range of digital value	0	R/W
17H	23	CH.2 DA Range of digital value	0	R/W
18H	24	CH.1 DA Channel Hold/Clear	0	R/W
19H	25	CH.2 DA Channel Hold/Clear	0	R/W
1AH	26	CH.1 digital output value (DA)	0	R/W
1BH	27	CH.2 digital output value (DA)	0	R/W
1CH	28	AD / DA Resolution setting	0	R/W
1DH	29	Error Code	-	R
1EH	30	OS Version	-	R

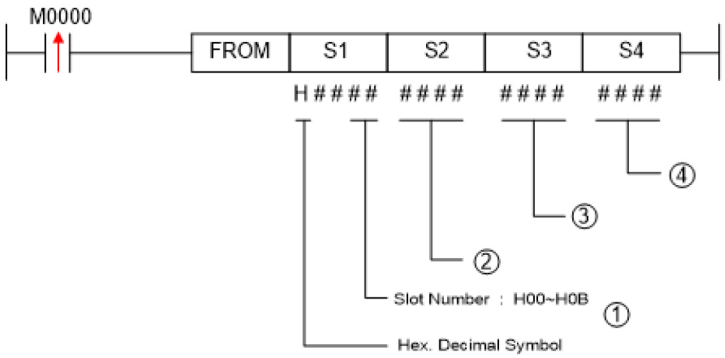


Reads a measured value of CH1. and stores it in D00.

Reads 8 measured values (CH1 to CH8) and stores them in D00 - D07.

2. TO/TOP instruction

'TO/TOP' instruction writes word data to shared memory of special module such as DA modules. The typical usage of the instruction can be represented by following LD.



[Figure 11] How to TO/TOP instruction

Form	Content	Note
S1	Slot number where the special module is installed. Lower: Slot No.	H00 01: 1st Slot *PLC-ES Series Upper No. is H00.
S2	Start address of the point where Buffer memory will write	Each modules have different start address of Buffer memory. Please check the address of Buffer memories you use.
S3	Constant value or start address of device where to write	Device area or constant value where to write at Buffer memory of module.
S4	Length of words to write	Write value starting at the designated area of S4 by turns, as many as data (word) which will be written by Buffer memory address.

[Table 9] Notation of TO/TOP instruction in use and meaning of its form

(1) S1 (slot number)

Please refer to 'FROM / FROMP' instruction.

(2) S2 (Start address of user program memory)

Designate the start address of user program memory where to write. Please refer to the manual or quick-reference guide of objective module.

(3) S3 (Constant value or start address of device)

Designate the start address of word device storing value to write. X/Y/M/L/K/F/D/Z devices are available. This operand can be designated with constant value to write. In this case, only one value can be written to user program memory at once.

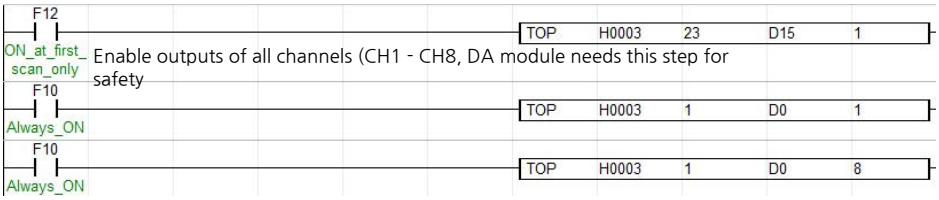
(4) Number of words to write

Designate the number of words to write.

Example 2: How To Use TO/TOP Instruction

The following is an example program which writes one word and eight words. It assumes the special module is IO-SA0202Y and installed in fourth slot.

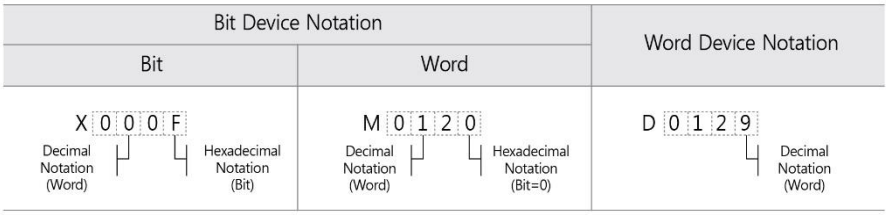
Address		Details	Default	R/W
Hex.	Dec.			
0H	0	CH.1 Digital conversion value (AD)	-	R
1H	1	CH.2 Digital conversion value (AD)	-	R
2H	2	CH.1 Precise value (AD)	-	R
3H	3	CH.2 Precise value (AD)	-	R
4H	4	CH.1 Percentile value (AD)	-	R
5H	5	CH.2 Percentile value (AD)	-	R
6H	6	High alarm status (AD)	-	R
7H	7	Low alarm status (AD)	-	R
8H	8	CH.1 Setup input signal range (AD)	0	R/W
9H	9	CH.2 Setup input signal range (AD)	0	R/W
AH	10	Setup Raw Value digital output (AD)	0	R/W
BH	11	CH.1 Average processing setting value (AD)	2000h	R/W
CH	12	CH.2 Average processing setting value (AD)	2000h	R/W
DH	13	CH.1 Maximum alarm setting value (AD)	0	R/W
EH	14	CH.2 Maximum alarm setting value (AD)	0	R/W
FH	15	CH.1 Minimum alarm setting value (AD)	0	R/W
10H	16	CH.2 Minimum alarm setting value (AD)	0	R/W
11H	17	CH.1 Digital Filter Constant (AD)	30	R/W
12H	18	CH.2 Digital Filter Constant (AD)	30	R/W
13H	19	DA Enable/Disable setup (DA conversion)	0	R/W
14H	20	CH.1 DA output type (Current 2types, Voltage 4types)	0	R/W
15H	21	CH.2 DA output type (Current 2types, Voltage 4types)	0	R/W
16H	22	CH.1 DA Range of digital value	0	R/W
17H	23	CH.2 DA Range of digital value	0	R/W
18H	24	CH.1 DA Channel Hold/Clear	0	R/W
19H	25	CH.2 DA Channel Hold/Clear	0	R/W
1AH	26	CH.1 digital output value (DA)	0	R/W
1BH	27	CH.2 digital output value (DA)	0	R/W
1CH	28	AD / DA Resolution setting	0	R/W
1DH	29	Error Code	-	R
1EH	30	OS Version	-	R



Writes 8 output values to CH1 - CH8 by single instruction.
Output values are stored in D00 ~ D07

Appendix 2 Method of Address Allocation

1. Address Allocation



[Figure 12] Notation of each Bit/Word device

(1) Bit Data Designation

Composition	[Device Symbol] + [Card No.] + [Bit No.]
Device Symbol	X, Y, M, K, L, F
Card No.	Notated in 3 digits of decimal number
Bit No.	Notated in 1 digit of hexadecimal number
Example	X000E, Y0012, M034F, K0120, L023C, F0093

(2) Word Data Designation

Composition	[Device Symbol] + [Card No.]
Device Symbol	D, Z, T, C
Card No.	Notated in 4 digits of decimal number
Example	D1234, Z0001, T0011, C1023

(3) Timer, Counter Output Designation

Composition	[Device Symbol] + [Bit No.]
Device Symbol	T, C
Card No.	Notated in 4 digits of decimal number
Example	T0003, C0567

(4) Step Controller Pin Designation

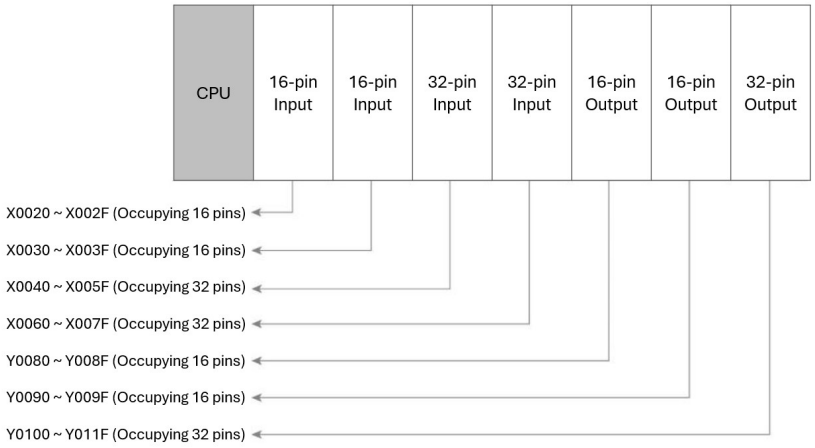
Composition	[Device Symbol] + [Card No.] + [.] +[Bit No.]
Device Symbol	S
Card No.	Notated in 2 digits of decimal number
Step No.	Notated in 2 digits of decimal number
Example	S00.00, S12.78

(5) Designating Bit Device to Word (Card) Unit

Composition	[Device Symbol] + [Card No.] + [0]
Device Symbol	X, Y, M, K, L, F
Card No.	Notated in 3 digits of decimal number
Example	X0110, Y0330, M0440, K0000, L0040, F0130

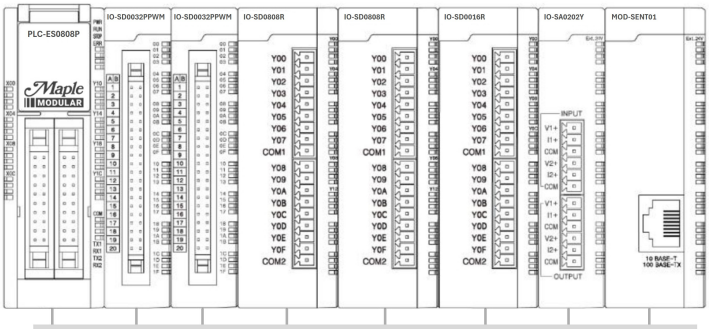
2. I/O Address Allocation

I/O Address Allocation is to assign each modules a number to output the data from the input module. Address number starts from No.0. Analog, Communication, Special modules and empty slots occupy 16pins (1Word).



[Figure 13] I/O Address Allocation of PLC-ES Series

- Composition: CPU 32-pin + 32-pin Output Module +32-pin Output Module + 16-pin I/O Module +16-pin I/O Module + Output 16-pin + Analog Module 16-pin + Communication Module 16-pin



X0000~X000F, Y0010~Y001F (Occupying 32 pins)	Slot 0: PLC-ES CPU Module: X0000~X000F, Y0010~Y001F
Y0020~Y003F (Occupying 32 pins)	Slot 1: 32-pin Output Module: Y0020~Y003F
Y0040~Y005F (Occupying 32 pins)	Slot 2: 32-pin Output Module: Y0040~Y005F
X0060~X0067, Y0068~Y006F (Occupying 16 pins)	Slot 3: 16-pin I/O Module: X0060~X0067, Y0068~Y006F
X0070~X0077, Y0078~Y007F (Occupying 16 pins)	Slot 4: 16-pin I/O Module: X0070~X0077, Y0078~Y007F
Y0080~Y008F (Occupying 16 pins)	Slot 5: 16-pin Output Module: Y0080~Y008F
X0090~X009F, Y0090~Y009F (Occupying 16 pins)	Slot 6: Analog I/O Module: X0090~X009F, Y0090~Y009F
X0100~X010F, Y0100~Y010F (Occupying 16 pins)	Slot 7: Communication Module: X0100~X010F, Y0100~Y010F

[Figure 14] Example of PLC-ES Series Module composition

3. X/Y I/O area allocation

(1) X area (Bit / Output device)

This is an Input pin which receives a signal from Input Card. This is a read-only device which user cannot input the value randomly. X area is Bit Type. It means that the size of detailed table signifies the number of Bit. In case it is used as Word Type, it is same as the Word Instruction of Bit Device.

- I/O Allocation: Device Allocation of X/Y area of PLC Modules (I/O Card / Special Card), except CPU.

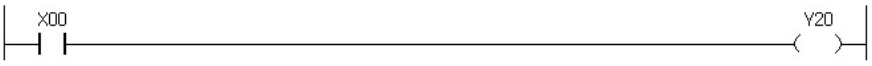
1. PLC Card occupies 16-pin (1Word) as a default.

2. I/O Card under 16-pin: occupies 16-pin (1Word).

3. 32-pin I/O Card: occupies 32-pin (2Word).

4. Special Card except I/O Card occupies 16-pin (1Word).

Ex)



It outputs "Y20" when "X00" is ON.

(2) Y area (Bit / Output Device)

This is an output pin which shows the result of calculation by Output Card. Y area is Bit Type. It means that the size of detailed table signifies the number of Bit. In case it is used as Word Type, it is same as the Word Instruction of Bit Device.

- I/O Allocation: Device Allocation of X/Y area of PLC Modules (I/O Card / Special Card), except CPU.

1. PLC Card occupies 16-pin (1Word) as a default.

2. I/O Card under 16-pin: occupies 16-pin (1Word).

3. 32-pin I/O Card: occupies 32-pin (2Word).

4. Special Card except I/O Card occupies 16-pin (1Word).

Ex)

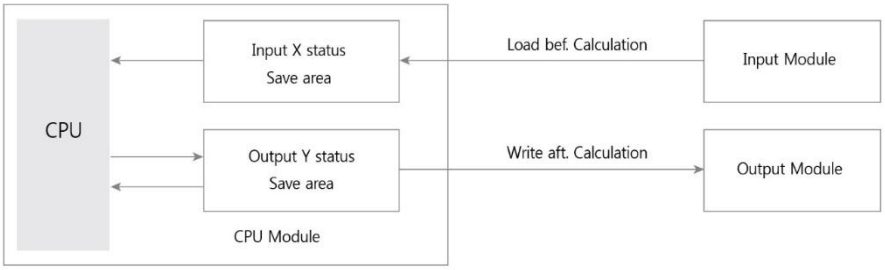
It outputs "Y20" when "X00" is on.

4. Features

I/O X, Y respond to external devices. X is to receive the signal of input device such as Push button switch, Limit switch and etc. Y is to convey the calculation results from Output Device such as Solenoid Valve, Motor, Lamp and etc.

Input section X conserves the input status inside of PLC which enables to use the A, B pin. Output section Y only uses the A-pin output.

[Figure 15] Example of I/O configuration.



[Figure 16] I/O Area Implementation Method

As in Figure 19, X, Y area have one-to-one responding area on the one pin of each I/O Module. While PLC is scanning, it calculates with the memory (X, Y) inside of the CPU, regardless of status of I/O Module. After the calculation, it outputs the content of inner memory Y which responds to the output. Later, it saves the pin-status to the inner memory X which corresponds to Input, for the next calculation.

INDEX

[Figure Reference List]

[Table Reference List]

Version History

Released Date	Version	Description
04/08/2025	V1.0	First Edition

AW-10101171 REV00

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