PULSE OUTPUT MODULE

Pulse Train Output (PTO)/ Pulse Width Modulation (PWM) output module

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Pulse Output Module

1. Introduction

Pulse output modules from EZAutomation are plug-in modules for EZPLC. These programmable intelligent modules provide Pulse Train Output (PTO) and Pulse Width Modulation (PWM) outputs. PTO consists of 50% duty cycle pulses of varying frequencies, while PWM output consists of pulses at a certain frequency but with varying duty cycle.

The module is available in 3 type of outputs: Sourcing, Sinking, and Differential. Models with sourcing outputs (EZ-PWM-P), or with sinking outputs (EZ-PWM-N) offer 2 channels of outputs. Each channel can independently be programmed for PTO or PWM output. The differential output model EZ-PWM-D offers only 1 channel of output which can be programmed to be PTO or PWM output.

1.1 Part Numbers:

EZIO-PWM-P:	2 Channel, Sourcing Outputs
EZIO-PWM-N:	2 Channel, Sinking Outputs
EZIO-PWM-D:	1 Channel, Differential Output

1.2 Features:

- User programmable Module with up to 2 Channels of outputs (Modules with differential outputs support only one channel)
- Each channel independently programmable as PWM, Pulse Train Output
- PTO/PWM maximum frequency of 150 KHz for single channel and up to 100KHz for two channels
- Factory ordered – Sourcing, Sinking or Differential outputs

1.3 Requirements:

The module requires

- Firmware version D.12 or later
- EZPLC software editor version 1.6 or later

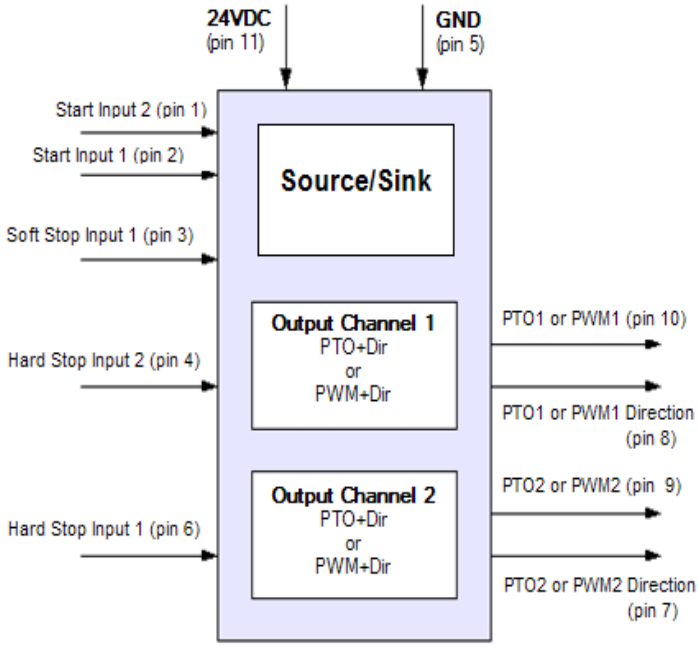
2. Specifications

Module Functions	
Output Functions	
Source/Sink outputs Model EZIO-PWM-P EZIO-PWM-N	2 channels Each channel independently programmable as PWM+Dir, PTO+Dir
Differential outputs Model EZIO-PWM-D	1 channel Programmable as PWM+Dir, or PTO+Dir
PTO Specifications	
Number of Channels	Up to 2, each consisting of an output and direction
Maximum number of Pulses	2^32
Maximum Frequency	150 KHz with only one channel; 100 KHz when both channels are used
PWM Specifications	
Number of Channels	Up to 2, each consisting of an output and direction
Maximum Frequency	150 KHz with only one channel; 100 KHz when both channels are used
Duty Cycle range	10 to 90%
Environment	
Environment	0-60 deg C, Humidity non-condensing 5-95%

Electrical	
Input Voltage Vs+ (Pin 11)	7-30VDC
Current	120 mA
Inputs	
Input Voltage range	14-28VDC
Input current	2.5mA @ 14 VDC 5 mA @ 28 VDC
ON State	>14VDC
OFF State	< 2 VDC
Min ON current	2.5 mA
Min Off Current	0.2 mA
Optical Isolation	2500 VRMS
Off to On response time	Inputs (Pins 1,2,3,4,6): 2 Micro Sec. Typ.
On to Off response time	Inputs (Pins 1,2,3,4,6): 40 Micro Sec. Typ.
Outputs	
Output type	Sourcing/Sinking/Differential
Max Steady State Current	4-20mA per output 80mA Max per module
Max Leakage current	100 micro amp @ 30VDC
On Voltage drop	1.9VDC
Optical Isolation	2500 VRMS
Off to ON response time	<4 micro sec
On to Off response time	<4 micro sec

2.1 Functional Block Diagram

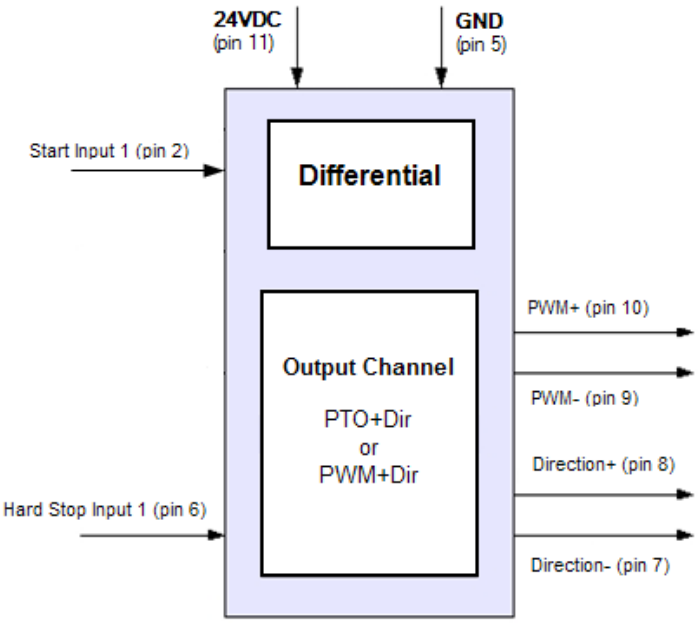
Models with Sourcing output (EZIO-PWM-P) and Sinking outputs (EZIO-PWM-N):



Notes:

- ***All inputs are rising edge sensitive***
- **Start**: starts modules function (PTO or PWM), provided parameters for the function are latched before the rising edge (0 to 1 transition) of the input.
- **Hard Stop**: immediately terminates the PTO or PWM without going through Ramp-down.
- **Soft Stop**: immediately starts a Ramp down.
- These operation can also be done programmatically using Base Reg+1 for channel 1, and Base Reg+9 register for channel 2 (see Commands table on page 16 below)

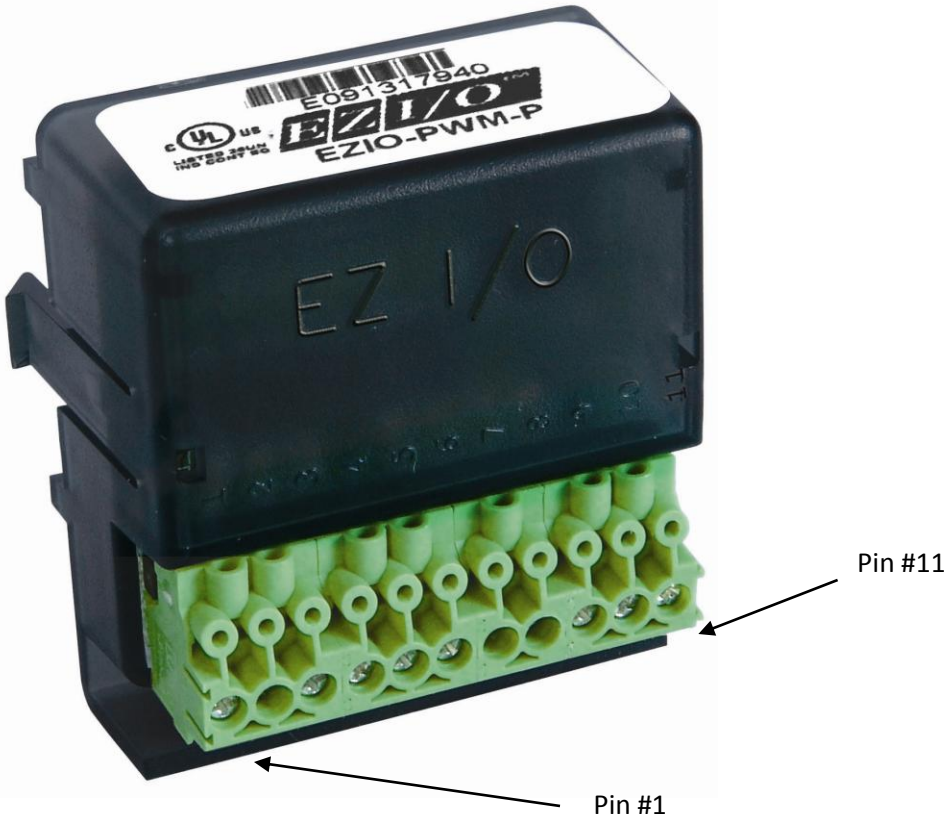
Model with Differential outputs (EZIO-PWM-D)



2.2 Pin functions

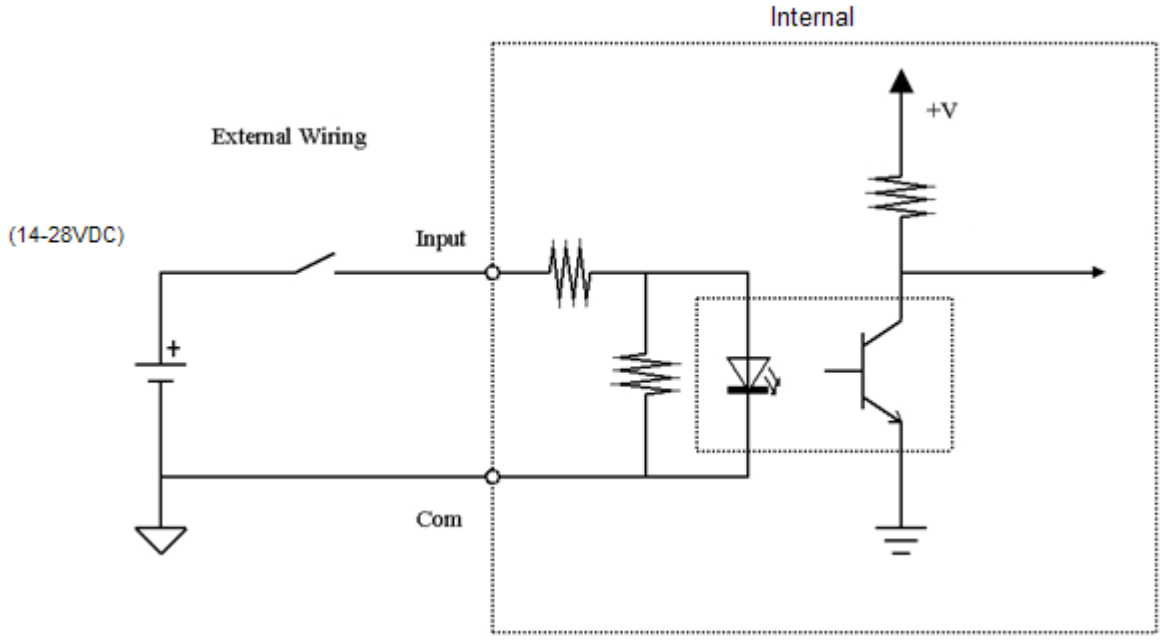
Modules with Source or sink outputs offer two channels of outputs, while differential output offers only one output channel as shown below:

		Pin Functions			
		Source (EZIO-PWM-P **)/ Sink (** EZIO-PWM-N) **Output Models**		**Differential Output Model** (EZIO-PWM-D)	
Pin #	Input/ Output	PTO Output	PWM Output	PTO Output	PWM Output
1	Input	Start Input 2	Start Input 2		
2	Input	Start Input 1	Start Input 1	Start Input 1	Start Input 1
3	Input	Soft Stop Input 1	Soft Stop Input 1	Soft Stop Input 1	Soft Stop Input 1
4	Input	Hard Stop Input 2	Hard Stop Input 2	*Do not use*	*Do not use*
5	GND				
6	Input	Hard Stop Input 1	Hard Stop Input 1	Hard Stop Input 1	Hard Stop Input 1
7	Out	PTO 2 Direction	PWM 2 Direction	PTO1 Direction-	PWM1 Direction-
8	Out	PTO 1 Direction	PWM 1 Direction	PTO1 Direction+	PWM1 Direction+
9	Out	PTO 2 Out	PWM 2 Out	PTO1-	PWM1-
10	Out	PTO 1 Out	PWM 1 Out	PTO1+	PWM1+
11	VS+				



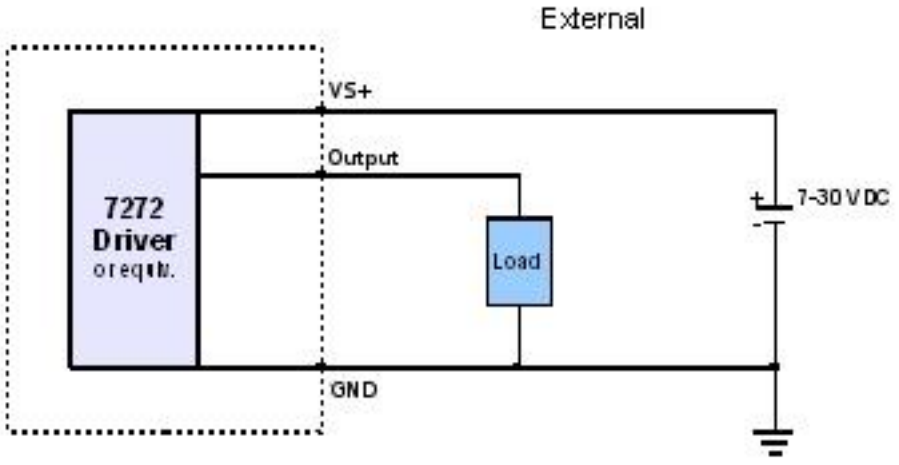
3. Wiring

3.1 Typical Input on the module (Input pins 1 – 4, 6; Com = pin 5)



3.2 Typical Outputs on the Module

Typical P Type (Source) Output

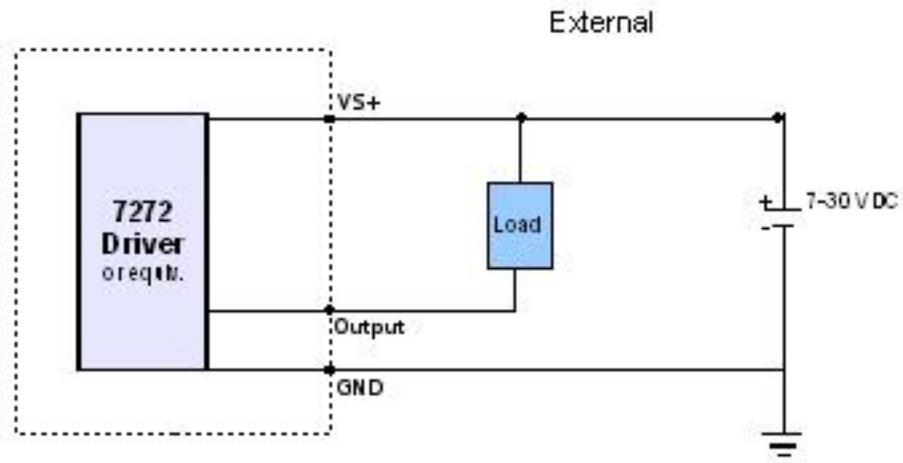


VS+ = Pin 11

Output = Pins 7, 8, 9, or 10

GND = Pin 5

Typical N Type (Sink) Output

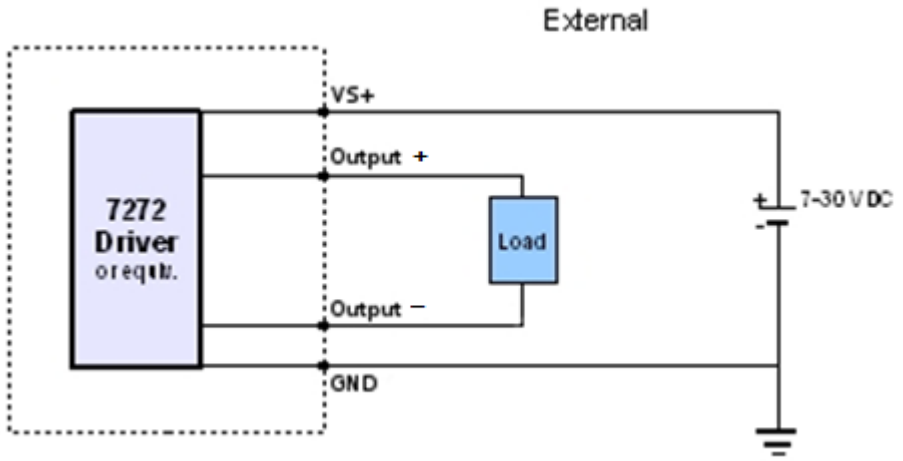


VS+ = Pin 11

Output = Pins 7, 8, 9, or 10

GND = Pin 5

Differential Output



VS+ = Pin 11

Output + on Pins 8, 10

Output - on Pins 7, 9

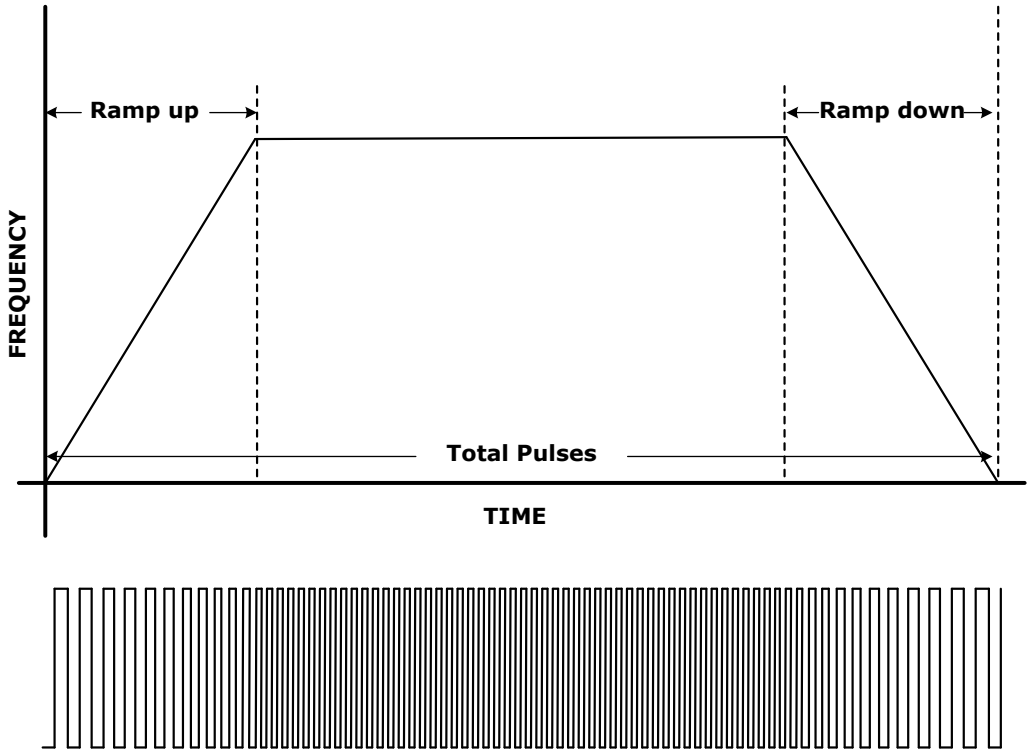
GND = Pin 5

4. High Speed Pulse Output

4.1 Pulse Train Output (PTO) outputs

PTO provides 50% duty cycle pulses. Typically the frequency of pulses starts from a minimum value to a maximum value, providing ramp-up or acceleration time for devices, and similarly the frequency is decreased over a period of time to provide ramp-down time.

To use the module in PTO mode (in addition to selecting PTO mode), user specifies Ramp-up and Ramp-down time, total number of pulses to output (includes those generated during ramp up and down), and the frequency at run time. The module generates a pulse train output that ramps up from a minimum frequency (approx 40 Hz) to the user programmed maximum frequency within the ramp-up time. The module would ramp down at such a time so that the total number of pulses generated equals programmed number of pulses. In addition to the PTO output, the module provides a user controlled Direction output for each channel.

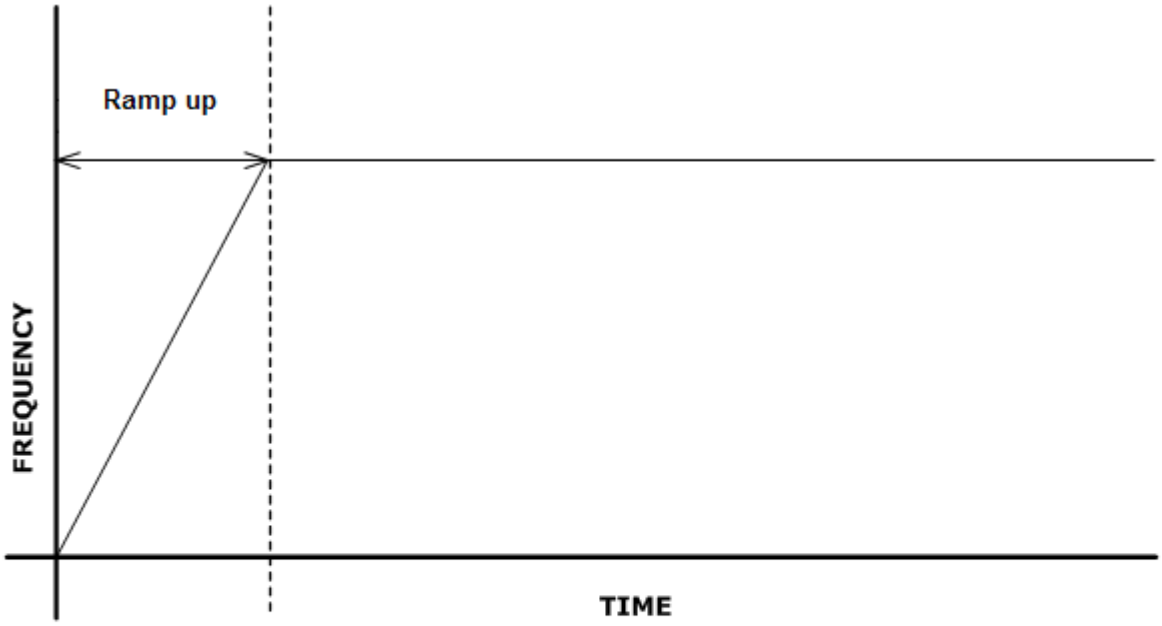


Pulse Train Output

4.2 Pulse Width Modulation (PWM) Outputs

In PWM mode, the module generates a Pulse output with varying duty cycle. The frequency of the pulses is fixed.

To use the module in PWM mode (in addition to selecting PWM mode), user programs Ramp-up time, frequency and duty cycle, and the module generates a pulse outputs waveform with the specified parameters. The duty cycle goes from approx 10% to the programmed value within the ramp up time. User also has control over Direction output for each channel.



Pulse Width Modulation

5. EZPLC and Module interface

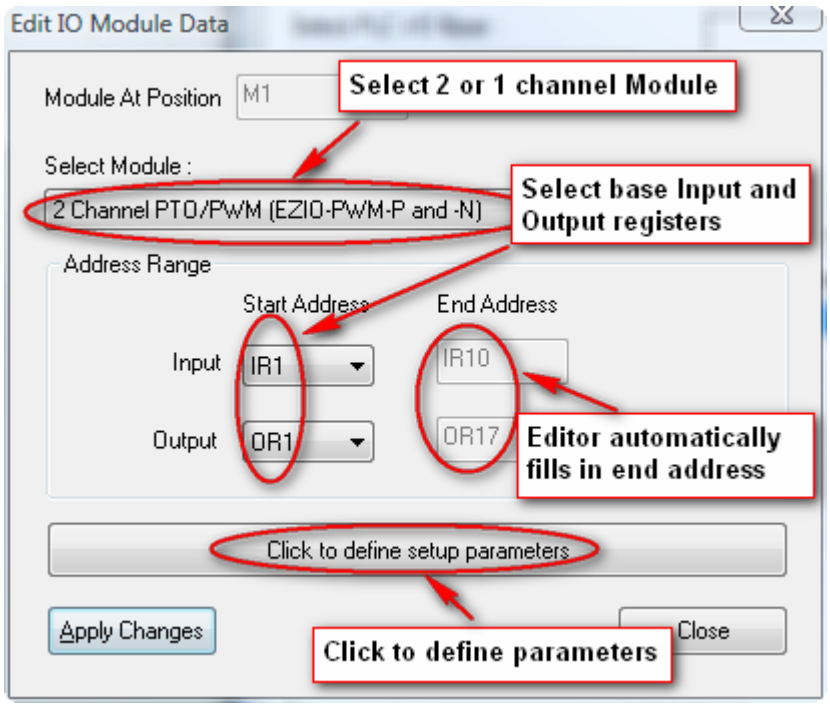
The module communicates with EZPLC using a number of output- and input-registers (ORs & IRs). The module is configured by EZPLC using a number of output registers (ORs), and the module provides feedback to the EZPLC using several input registers (IRs). Once configured the module generates PTO or PWM outputs independent of the EZPLC CPU. Some of the configuration values can also be changed on the fly.

5.1 Module configuration – Base register Selection

Each module uses 17 Output Registers (OR) and 10 Input Registers (IR). The OR registers are used to configure and control module, The IR registers provide status and other information back to the ladder logic. User provides a base OR and base IR register address. The Programming software would then allocate 17 OR registers starting from the OR Base, and 10 IR registers starting from the IR Base register. For example if user defines OR10 as the base OR register for the block, then Programming editor would automatically allocate OR10 through OR26 for the module.

CAUTION: Don't use OR and IR registers allocated to the module for any other purpose.

To select the Base Output and Input register, simply select desired register start addresses the Edit I/O module Data dialog box (brought up using Config I/O button in initial dialog box or by menu Setup> I/O configuration, and then by clicking Add/Edit button):

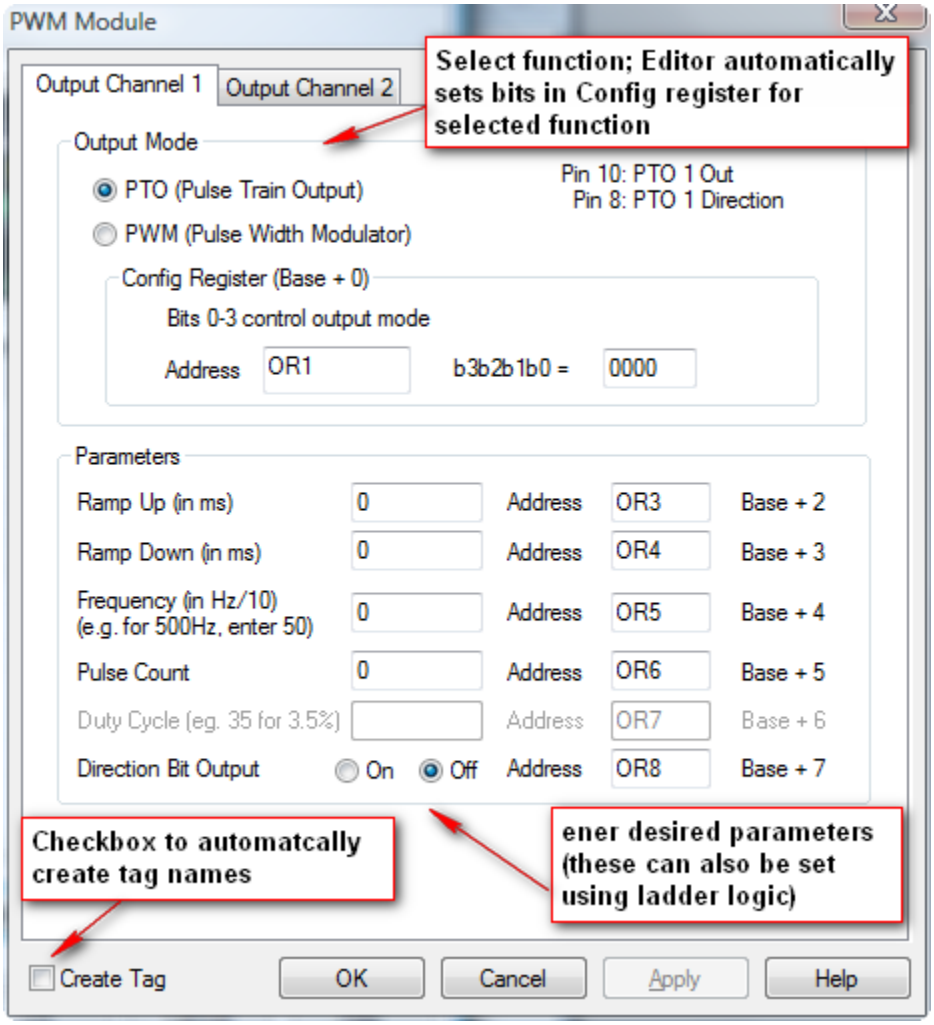


Once you click "Click to define setup parameters" button, you get dialog box shown in next section – Parameter programming.

5.2 Module Configuration – Parameter Programming

A block of 17 OR (Output Registers) is used to define the function of module, and program various parameters for the selected function.

This dialog box allows you to program module function for each channel, and then setup values for the function.



Notes:

- Based on the function selected, inapplicable fields are disabled (e.g. Duty Cycle is not applicable in PTO mode, and is disabled if PTO is selected as shown above).
- Ramp Up/Down time is programmed in milliseconds. For example to program Ramp Up time of 600 ms, use value 600.
- Frequency is programmed in Hz/10. For example, for 5000 Hz, program value 500.
- Duty cycle is programmed in desired duty cycle in % multiplied by 10. For example for a duty cycle of 50%, enter 500. For a duty cycle of 15.7, enter 157.
- Pulse count is 32 bit word; EZPLC will automatically take care of MSW and LSW of a 32 bit long word.

5.3 Output Register Details

The registers and their functions are described in table below:

Output REGISTER #	Function
Base + 0	Module Function Register: Determines functionality (PTO or PWM) for each channel Bits 0-3 determines output functions for channel 1, For PTO, Value = 0; for PWM, value =2 Bits 4-7 determines output functions for channel 2 For PTO, Value = 0; for PWM, value =2 (See table "Module Function Register" below for details)

PTO Output **PWM Output**

PTO/PWM Output channel 1 Parameters

Base + 1	Channel 1 Output Control (*See control register below*)	
Base + 2	Channel 1 Ramp-up time in milliseconds	
Base + 3	Channel 1 Ramp-Down time in milliseconds	*Not used*
Base + 4	Channel 1 Frequency programmed in desired Hz divided by 10. (e.g. for 50KHz, enter 50000/10=5000)	
Base + 5	Channel 1 Total Pulse count	*Not used*
Base + 6		Channel 1 Duty Cycle- Enter in desired duty cycle in % multiplied by 10. (e.g. for a duty cycle of 50.5, use number 505)
Base + 7	Channel 1 Direction (A non-zero value energizes Direction output, 0 value de-energizes)	
Base + 8	Channel 1 Force output state (A non-zero value will force energize the output provides Force output command has been given (See output control register))	

PTO/PWM Output channel 2 Parameters

Base + 9	Channel 2 Output Control (*See control register below*)	
Base + 10	Channel 2 Ramp-up time in milliseconds	
Base + 11	Channel 2 Ramp-Down time in milliseconds	*Not used*
Base + 12	Channel 2 Frequency programmed in desired Hz divided by 10. (e.g. for 50KHz, enter 50000/10=5000)	
Base + 13	Total Pulse count	*Not used*
Base + 14		Channel 2 Duty Cycle- Enter in desired duty cycle in % multiplied by 10. (e.g. for a duty cycle of 50.5, use number 505)
Base + 15	Channel 2 Direction (A non-zero value energizes Direction output, 0 value de-energizes)	
Base + 16	Channel 2 Force output state (A non-zero value will force energize the output provides Force output command has been given (See output control register))	

Module Function Register (OR Base+0)

Bits within this register control the output function (PTO or PWM) of each channel.

Desired Channel 2 Function (Bit 7-4 of the register)	Desired Channel 1 Function (Bits 3-0 of the register)	Set Register Value to: (*Any other value may result in unpredictable behavior*)
PTO	PTO	0
PTO	PWM	2
PWM	PTO	32
PWM	PWM	34

Control Register Details (OR Base +2 for channel 1, OR Base +9 for Channel 2)

There is an control register for each channel. The bits within the output control register control different functions. Table below shows which bits do what:

Bit15	B14	B13	B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	Bit0
DO NOT USE				User_move_ID				New Command Bit	Command						

New-Command-Bit (Bit 7)

(Applicable with Command values 1, 2, 7 and 9 only; see ***command*** below)

The New-Command-bit works in conjunction with several commands (bits 6-0). In particular, it is used with command values 1, 2 and 7, which setup operating parameters for PTO/PWM, and in case of 1, 2 initiate moves.

The New-Command-Bit must make a transition from 0 to 1 to get commands 1, 2, and 7 recognized by the module. For example if we want to issue a command 1, the lower 8 bits may transition from 0x00 to 0x81. With Bit 7 going from 0 to 1, the value in bits 6-0 would be considered as a new command (in this case command 1). Now suppose we want to issue another command 1, then we would need to make bit 7 first equal to 0 and then bring back again to value 1. Thus we will need to make the register value again go to 0x00 and then to 0x81.

User_Move_ID (bits 11-8)

These optional bits can be used to tag a move with a 4 bit identifier (0 to 15 decimal values for the identifier). You can setup parameter for up to 3 moves while a move is being executed allowing you to executer moves sequentially.

The move ID, if used, of the move being executed is echoed back in an input register providing user feedback as to which move is being executed at any time.

See next page for details of Output Control Register.

Command:

Bits 6-0 of the Control Register determine the command. Following table lists permissible values and corresponding commands

<table>
<tr><th>Command Value</th><th>Function when the value is</th></tr>
<tr><td>0</td><td>No Operation</td></tr>
<tr><td>1</td><td>LATCH/RUN
(If NEW-COMMAND-BIT (Bit 7) = 1, AND has transitioned from 0 to 1), Latch new Operating parameters for a PTO Trapezoidal move, or for PWM, and Start the motion by going through the programmed Ramp-up to run frequency (PTO) or to duty-cycle (PWM)
• (PTO) Once Started, PTO completes the move as programmed unless interrupted by HardSTOP or SoftSTOP or RESET commands, or by physical stop inputs
• (PWM) Once started PWM continues to run until interrupted by HardSTOP or RESET commands, or physical inputs.
• No change in parameters to current motion are accepted during the move; however you may queue the next move (up to 3 total moves can be queued; If Queue is full, an error is returned. See Error codes table)</td></tr>
<tr><td>2</td><td>LATCH/JOG
(If NEW-COMMAND-BIT (Bit 7) = 1, AND has transitioned from 0 to 1), Latch new Operating parameters (Frequency for PTO, and Duty cycle for PWM) for a JOG and Start the move with No RAM-up,
• Output starts at programmed frequency (PTO) or duty cycle (PWM)
• User may change PTO frequency or PWM duty cycle during the JOG mode.
• Command value should remain 2 during JOG</td></tr>
<tr><td>3</td><td>Soft STOP: (PTO only) Starts ramp-down immediately; (PWM) Not Applicable</td></tr>
<tr><td>4</td><td>HardSTOP: Terminates PTO/PWM Immediately</td></tr>
<tr><td>5</td><td>FORCE
Force ON or OFF the Pulse Out and Direction pin. The ON or OFF depends up on the State set in Direction and Force Out Registers, which should set to desired state before using this command.
<table>
<tr><td></td><td>Direction</td><td>Force Output</td></tr>
<tr><td>Channel 1</td><td>OR Base +7</td><td>OR Base +8</td></tr>
<tr><td>Channel 2</td><td>OR Base +15</td><td>OR Base +16</td></tr>
</table></td></tr>
<tr><td>7</td><td>LATCH
(If NEW-COMMAND-BIT (Bit 7) = 1, AND has transitioned from 0 to 1), Latch new Operating parameters
• Unlike command values 1, and 2, NO RUN takes place
• Command value 9 or the physical start input can be used to start move</td></tr>
<tr><td>9</td><td>RUN
(If NEW-COMMAND-BIT (Bit 7) = 1, AND has transitioned from 0 to 1), Run with already latched operating parameters
(Note: Operating Parameters must be latched before External Start or Run command is performed)</td></tr>
<tr><td>32</td><td>RESET
resets modules to power up condition i.e. parameters are cleared, moves, if in progress are immediately terminated , Move queue cleared</td></tr>
</table>

5.4 Module Status and Monitoring- Input Registers (IRs)

Module status is read through several Input Registers. User programs a base input register for the module. A block of 10 registers starting from the base register is used for various status reporting. Table below provides details of the register functions in the block:

Input registers (Block of 10 registers)

Input Register #	Functions	
Base +0	Module Personality (Echoes the same value as programmed in OR Base+0)	
Base +1	I/O Status (see table IO Status Register below)	
	PTO	**PWM**
Channel 1		
Base +2	Channel 1 Status (See PTO/PWM Status below)	
Base +3	Channel 1 Current Frequency	
Base +4	Channel 1 Pulses sent	Not used
Base +5		Channel 1 Current duty cycle
Channel 2		
Base +6	Channel 2 Status (See PTO/PWM Status below)	
Base +7	Channel 2 Current Frequency	
Base +8	Channel 2Pulses sent	Not used
Base +9		Channel2 Current duty cycle

I/O Status register (IR Base + 1)

I/O status register reflects the status of all the I/O pins in the module. If an input or the output pin is at logic high, the corresponding bit is set to 1. The bit assignment is as follows:

Bit #	Status of Pin #	Type	Function
0 (LSB)	1	In	Start Input 2
1	2	In	Start Input 1
2	4	In	Hard Stop 2
3	6	In	Hard Stop 1
4	7	Out	Direction 2
5	8	Out	Direction 1
6	-	-	*Not used*
7	3	In	Soft Stop 1

PTO/PWM Status Register (IR Base + 2 for channel 1, and IR Base + 8 for channel 2)

Bit #	If Bit = 0
0	Set if PTO/PWM output active (motor running), cleared otherwise
1	Set during Acceleration (Ramp-up), clear otherwise
2	Set during the constant speed part of the move, clear otherwise (Set at max frequency for PTO, and Max duty cycle for PWM)
3	Set during deceleration, clear otherwise
4	Set if some error occurred, clear otherwise
5	Set if there is free space in Move queue
6-7	Not used
8-11	Error code (see table below)
12-15	Echoed from Bits 11-8 of respective Output control register

Error Codes

Value	Meaning
0	No error
1	Channel busy
2	Invalid frequency (0 -150 KHz only)
3	Invalid duty cycle (0% - 100% only)
4	Invalid trapezoid parameters (pulse count)
5	Invalid ramp-up time (cannot be zero)
6	Move queue full
7	Channel not ready

6. Operation

The guide so far has described the details of the module. Following is the summary of how to use the module:

6.1 Define Module's personality or the function

First define the personality or function of each channel of the module (PTO or PWM). This can be done either though the editor (*section 4.2, page 13*), or by using ladder logic to write appropriate value in the Base+0 register (*section 4.3, page 14*).

6.2 Program Parameters for selected personality

Now program various parameters for the selected personality for each channel. Again it can be done either though dialog box (*section 4.2, page 13*), or by using ladder logic to write appropriate value in the Base+0 register (*section 4.3, page 14*). If you are going to use only one set of parameters, then dialog box would be more convenient. However if parameters would change during run-time, you would need to use ladder logic to write appropriate parameters to the module.

You can maintain a queue of moves within the module, by writing the parameters for next move while a move is taking place. A max of 3 moves can be stored. Queued moves are automatically executed once current move is completed.

6.3 Initiate action or move

Initiate action by writing a command value to control register to initiate move. The command value can only be written using ladder logic. *See page 15 and 16* for details of commands.

6.4 Monitor Module

Module provides feedback using several Input registers. See *pages 17-18* for details.

6.5 Move Queues

As mentioned before, you can program next move while a move is being executed. The queued move is automatically executed after the current move (unless terminated by Hard or Soft Stop). This allows you to create complex continuous moves. Bit 5 in PTO/PWM Status register is set if the queue has space (see page 18).