

mightyZAP User Manual

(12Lf Force Control Lineup/**IR Protocol**)

Check your product series!
Does your model number start with 12Lf-?

- This manual is the dedicated manual for **12Lf FORCE control version actuator** which support force/speed control as well as position control.
- This manual is for the 12Lf Force control version user who has the model number which starts with “12Lf” with our **own IR protocol**.
- For the users with 12Lf series who uses MODBUS RTU protocol, please refer separated “Force control/MODBUS RTU” manual and for the users who have the actuator which starts with D or L, please refer to the separate “Position control” actuator manual.



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1. Before Use

1.1. Introduction

Thank you for purchasing mightyZAP mini Linear servo motors! Please peruse this manual before use to prevent any unexpected damage of product or serious injury of users.

mightyZAP mini Linear servo motors have been developed to provide reliable, high quality linear solution in compact space. mightyZAP mini Linear servo motors can be applied in various fields such as factory automation, medical devices, robotics, professional UAV and radio control hobby.

[Features]

- **Position Control** (Positional Accuracy 50~90um - see spec chart of each model)
- **Stall Force Control** based on Current feedback
- **Speed Control** by 1024 Resolution
- Built-in Drive circuit
- 4096 Step High Resolution
- High Performance Coreless Motor
- Minimized Mechanical Backlash (30um)
- Excellent Substitute for pneumatic cylinder which does not support position control
- Reasonable Cost

1.2. For Safety

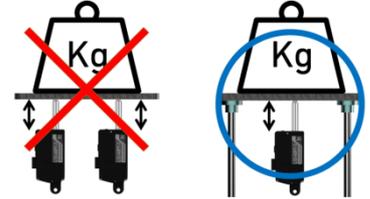
Please peruse safety instruction below to use mightyZAP safely. Please kindly note that abuse may invalidate your warranty.

1. **Do NOT press the Rod when the servo is being operated.** Motor may be damaged(burnt) if higher force than rated force is applied consistently.
2. **Apply proper input voltage** using power supply or correct battery. For instance, 7.0~12V for 12V input product(12Lf series). The motor may be burnt when higher voltage than 13V is applied to the actuator.
3. **Lifespan of motor can be varied according to the load and duty cycle and etc.**
 - 1) **Use under rated force.** For instance, rated force of 12Lf-20PT-27 is 20N(approx. 2kg). That is, lifespan of 12Lf-20PT-27 can be maximized when it is used less than 20N force condition. The lower load comparing to rated force, the longer lifespan of the motor.
 - 2) **Use under 50% of Duty Cycle** : If DC motor operates continuously without any interval (rest), motor will be overloaded and overload protection feature will cut off the power of servo motor. Therefore, user should consider "Duty cycle" which means the percentage of operating time against interval time. In other words, 50% duty cycle means that motor should rest 50% of time when motor operate during 50% of time to manage motor lifespan more efficiently. Use under 50% of duty cycle for optimized lifespan. The less duty cycle, the longer lifespan.
 - 3) **"Force Off" feature when servo motor is in standby mode may prolong the lifespan of servo motor.** However, this feature can be used when there is no problem in your system even if rod position is changed due to external force because "force off" makes servo force is released.
4. **Proper wiring:** There is little chance of incorrect wiring when using wire harness with connector provided by our factory. However, if users use soldering or a third-party connector according to user's desire, please pay attention to mis-wiring between the communication and power lines. Incorrect wiring results in fatal damage to the PC board or certain electrical components. Please refer to the

wiring pin map on “4.1.Circuit Connection” page on this manual to prevent incorrect wiring.

5. **Position command within mechanical limit** : There should be mechanical limit which servo rod can move when user install servo motor in their application. Make sure that positional command should be made within user’s mechanical limit. It is too common to mention, but we could see this mistake from time to time. If positional command is out of mechanical limit, servo will be overloaded at certain point of time and power will be cut off to protect the servo due to overload protection feature. (if overload protection is inactivated by user, motor will be not be protected.) Considering precise position control, make sure to re-check this matter when servo is applied.

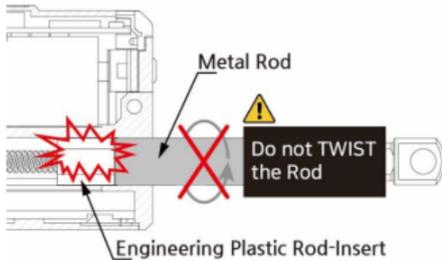
6. **It is strictly banned to use multiple qty actuators for single objective.** Due to DC motor characteristic, each actuator’s speed can be slightly varied even if they are same model and goal position is same. (may cause overload to one of actuator)



7. **Do not TWIST the rod with excessive force when tightening the rod end tip.**

If you apply excessive twisting force to the rod when tightening the rod and tip (while the body is fixed), it may cause damage to internal part (Engineering Plastic rod-insert). Follow below instruction to avoid damage.

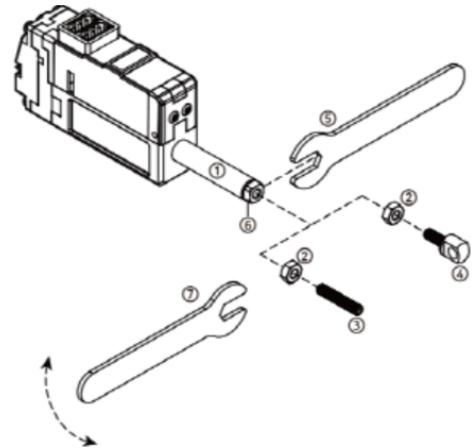
- 1) Fix the Rod-end with the included M3 spanner (⑤). This is



to prevent the rod (①) from turning badly and damage while tightening the M3 nut (②).

- 2) According to preference, install

the socket set screw (③) or rod end tip (④) to the proper positioning before hard tightening.



- 3) Adjust the angle of the rod end tip (④) to the desired angle. By using a long nose plier(or extra M3 spanner), fix the position by tightening the M3 nut (②) while rod end is fixed with M3 spanner(see above image.). This is “double nuts” concept which fixes mechanical position by friction.

8. **Use properly “Overload protection” feature to protect the servo and your system from damage.** Overload protection feature is activated from the factory, and for other protection setting, if necessary, set “**Alarm shutdown**” feature according to your system’s condition.
9. **Do NOT touch the servo case right after servo operation.** It may hot.
10. **Keep away from water, humidity, dust and oil.**
11. It is designed for indoor purpose. **Do not use in outdoor.**
12. **Keep out of reach of children. Keep hands off when servo motor operates to avoid unexpected injury.**

1.3. For Storage

Do NOT store/use servo motor under below extreme condition. It may cause malfunction or damage of product.

- Direct light and High temperature more than 70 °C or Low temperature lower than minus 20°C.
- Highly Humid space / Space having Vibrating condition / Space having Dust / Space causing Electrostatic

1.4. Constant Load / Overload Protection

Important Note : Constant load / Overload Protection Force Off Feature

Overload protection (Overload shutdown) feature is to prevent overload condition which greatly affect the service life and to motor burnout. Please read the following for proper protection and use it according to the conditions.

About mechanism of overload protection (overload shutdown) and terminology

- The overload protection mechanism of the 12Lf Force Control series uses a combination of current accumulation and operation time accumulation.
 - In case of continuous operation AT rated load, Shutdown occurs after about 30 sec as the accumulated current value.
 - In case of continuous operation UNDER rated load, Shutdown occurs after longer than 30 sec, but Shutdown will be made within max. 180 sec even at the lowest load.
 - In case of continuous operation ABOVE rated load, Shutdown occurs shorter than 30 seconds due to the high amount of current accumulation. For example, shutdown occurs within 2 seconds when the maximum current of 1.6A flows.
- Duty cycle is the ratio of the time which motor is actually driven against the time of motor rest.
- Duty cycle 50% means that 50% of the time should be restored if the motor runs 50% of the time.
- Motor operating time includes the time which the motor rotates/moves normally as well as the time which motor draws current by stuck condition without motor rotating.

Overload shutdown Disable

The overload shutdown function protects the servo actuator under overload conditions. Depending on the application, there are applications that need to be operated under severe conditions, even if the overall mechanism protection is more important than the servo actuator, or even if the life of the servo actuator is shortened. For this case, shutdown function can be disabled through mightZAP servo manager software so that shutdown does not work under overload situation. However, in the 12Lf force control series, the goal current can be set so that the motor can be protected by not exceeding the set maximum current even in an overload situation.

Recovery after overload shutdown

Since the communication line is still functioning after shutdown, it can be restored to the initial state by “Restart” command or by reconnecting power. Be sure to remove the cause of overload before restoration.

Exception and Cautions

Caution 1) When the spring is installed between the application and the actuator, or it is installed in Z axis (the direction of gravity), it makes external force to the actuator. Under these conditions, the servo actuator operates slightly, but continuously to keep its position. If this condition persists, actuator may invoke Overload shutdown in some cases. To prevent this, use Force Off command while external power is applied.

Caution 2) Each time overload shutdown is executed, it is not big but it damages the motor. Therefore, the cause of overload must be removed after the first overload shutdown so that shutdown does not occur frequently.

Overload Protection Function

Using Overload protection function, we can protect motor damage from overload condition.

Overload protection function is being activated from the factory. When it is activated, motor power will be cut off in case of overload condition to protect the servo actuator

The easiest way to set(activate/inactivate) Overload protection function is to connect servo with Servo Manager Software using IR-USB01 PC USB interface. Go to "Shutdown Alarm Setting" and simply click(activate) "Overload Error".

Another method to set Overload protection is to use a Command packet. You can send "Store data" command to the address(0X12) which is the address for Alarm Shutdown. Set bit 5 (see below) for Overload error from to "1"(Overload activation), then send "Store data" command to the servo motor. Servo force will be cut off under overload condition if the bit is set at "1".(1= Overload protection activation / 0=Inactivation)

Error	bit
NONE	7
NONE	6
Overload Error	5
NONE	4
NONE	3
NONE	2
NONE	1
Input Voltage Error	0

Refer to below example for "Store Data" command.

Command Packet

HEADER	ID	Size	Command	Factor #1	Factor #2	Checksum
				Address	Data	
0xFFFFF	0x00	0x04	0xF3	0x12	0x20	0xD6



Caution Use within Rated Load

For proper performance and better lifespan of mightZAP, it is strongly requested to use it within the rated load range.

1.5. Force Off

Force Off Function

- After the servo actuator moves to the designated position, the operation stops unless there is an external force that causes the position value change. If the position value of the actuator is continuously changed due to vibration or external force, the actuator is operated continuously without rest to stick to the designated position value, which affects the lifespan of the motor.
- In this case, if the Force Off function is properly utilized, the motor power can be released to allow the motor to rest while maintaining its position with mechanical friction (Mechanical Self Lock function). Even when it is necessary to keep the position for a relatively long time after reaching a certain position, shutting off the power of the motor using the Force off parameter as an added safety function helps to manage the lifespan of the motor.
- Under force off condition, communication is still alive while motor power is off, so servo will move again when servo gets new position command without giving "Force ON" command.
- Force Off feature can be available for the actuator having "Mechanical self-lock" feature. Please see the chart below to see availability. (Below chart shows self-lock force of 27mm stroke mightyZAP only. Refer to the separate specification for 40/53/90mm stroke version's Self lock force.)

Rated Load Spec	Mechanical Self-Lock
10~ 20N	NOT Available
27~ 100N	Available

For Force Off, send 0x00 as a "Store data" command to the address(0X80) which is the address for Force ON/OFF. (For Force ON, send 0x01)

Refer to below example for "Store Data" command.

Command Packet

HEADER	ID	Size	Command	Factor #1	Factor #2	Checksum
				Address	Data	
0xFFFFFFFF	0x00	0x04	0xF3	0x80	0x00	0x88

TIP

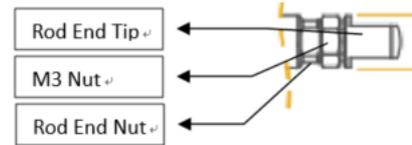
Under Force Off status, if user send "Goal Position" command, it is not necessary to send Force ON packet additionally because "Goal Position" command already includes "Force On" packet in it. .

2. Basic Information

2.1. Component



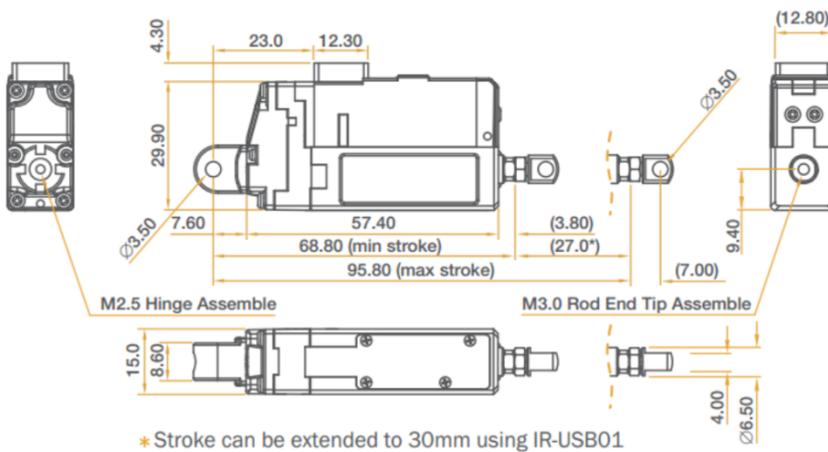
#3 M3 nut can be used to fix the hinge and hinge base. Also, M3 nut should be used between rod-end nut and rod-end tip as a stopper as shown on the picture.



2.2. Dimension

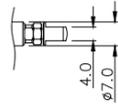
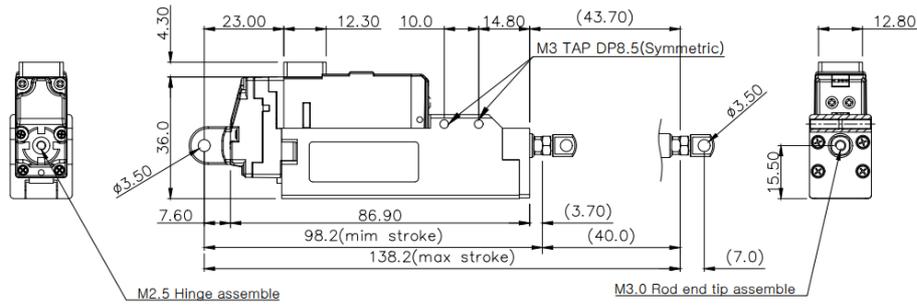
Please refer to detailed dimension from 3D drawing at our website. (www.mightyzap.com →Digital Archives →12Lf Force control series→Drawing)

[27mm Stroke Lineup]



[40mm Stroke Lineup]

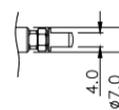
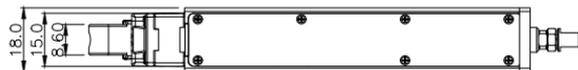
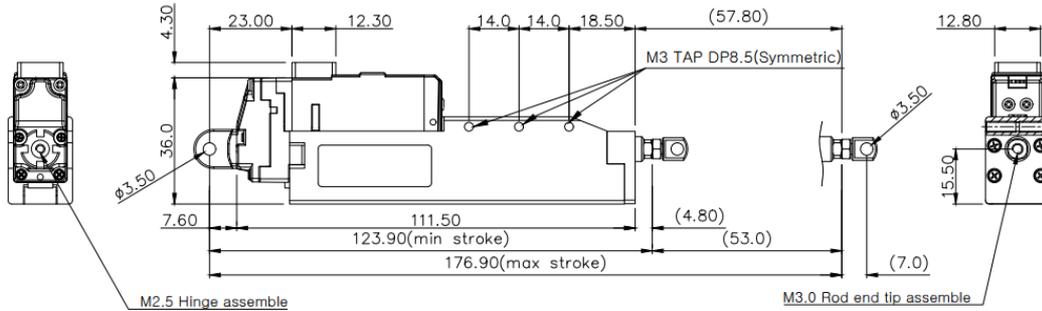
FC Version



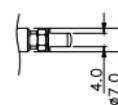
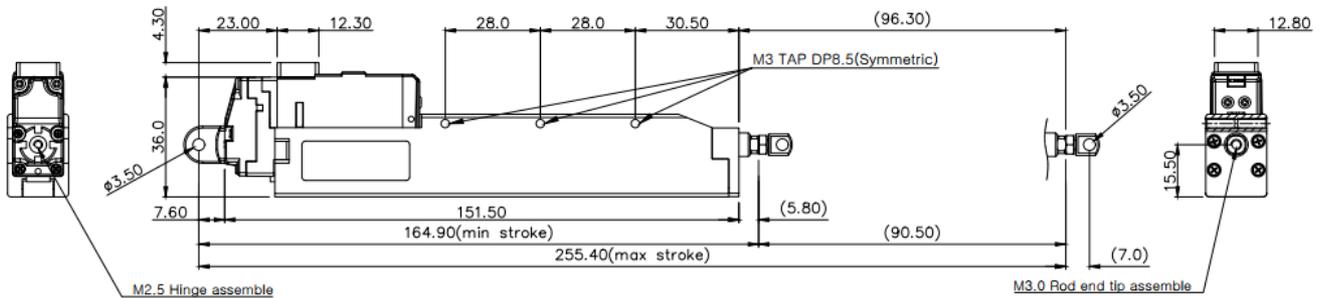
unit : mm

[53mm Stroke Lineup]

FC Version



[90mm Stroke Lineup]



2.3. Specification

12Lf Series Specifications

Rated Load	Stroke	Communication		Rated Load / Max Speed(No Load)	Stall Force at Current (1.6A / 800mA / 1000mA)	Mechanical Self Lock (Z Axis Use)	Lead Screw / Gear Ratio / Gear Type
		RS-485	TTL/PWM				
10N	40mm	12Lf-10F-40	12Lf-10PT-40	10N / 110mm/s	60N / 40N / 10N	No (Pay attention to application)	Lead Angle 20° / 10:1 / Engineering Plastic Gears
	53mm	12Lf-10F-53	12Lf-10PT-53				
	90mm	12Lf-10F-90	12Lf-10PT-90				
12N	27mm	12Lf-12F-27	12Lf-12PT-27	12N / 110mm/s	100N / 60N / 8N		
17N	40mm	12Lf-17F-40	12Lf-17PT-40	17N / 80mm/s	100N / 60N / 8N		Lead Angle 15° / 10:1 / Engineering Plastic Gears
	53mm	12Lf-17F-53	12Lf-17PT-53				
	90mm	12Lf-17F-90	12Lf-17PT-90				
20N	27mm	12Lf-20F-27	12Lf-20PT-27	20N / 80mm/s	120N / 72N / 9.6N		
27N	40mm	12Lf-27F-40	12Lf-27PT-40	27N / 28mm/s	160N / 96N / 12.8N		Lead Angle 5° / 10:1 / Engineering Plastic Gears
	53mm	12Lf-27F-53	12Lf-27PT-53				
	90mm	12Lf-27F-90	12Lf-27PT-90				
35N	27mm	12Lf-35F-27	12Lf-35PT-27	35N / 28mm/s	210N / 126N / 16.8N		
42N	40mm	12Lf-42F-40	12Lf-42PT-40	42N / 15mm/s	240N / 144N / 19.2N	Yes (Applicable)	Lead Angle 5° / 20:1 / Metal Gear
	53mm	12Lf-42F-53	12Lf-42PT-53				
55N	27mm	12Lf-55F-27	12Lf-55PT-27	55N / 15mm/s	300N / 180N / 24N		
78N	40mm	12Lf-78F-40	12Lf-78PT-40	78N / 7.7mm/s	420N / 252N / 33.6N	Lead Angle 5° / 50:1 / Metal Gears	
	53mm	12Lf-78F-53	12Lf-78PT-53				
100N	27mm	12Lf-100F-27	12Lf-100PT-27	100N / 7.7mm/s	600N / 360N / 48N		

12Lf Series Common Specifications

Repeatability	Stroke		Unidirectional	
	27mm / 40mm		30μm(0.03mm)	
	53mm		40μm(0.04mm)	
	90mm		50μm(0.05mm)	
Mechanical Backlash	0.03mm(30μm)			
Rod Type	Metal Alloy Rod			
Motor Type	Coreless Motor			
Rated Voltage	12V			
Motor Watt	26W			
Recommended Duty Cycle	At Rated Load		At Max Applicable Load	
	Max 50%		Max 20%	
Current Accuracy	±15%at Over 50mA			
Position Sensor	10KΩlinear Potentiometer			
Input Voltage Range	7 ~13V			
Current Consumption	Idle	Rated	Stall	
			Default	MAX
	20mA	380mA	800mA	1.6A
Audible Noise	Approx. 50db at 1m			
LED Indication	Two Errors Indications (Input voltage, Overload)			
Pulse Signal / Pulse Range	PWM (PT version, R/C Hobby Signal)			
	900μs(Retracted)-1500μs(Center)-2100μs (Extended)			
Data Communication / Protocol	RS-485 or TTL(PT version) / IR Robot open protocol (Default) / MODBUS RTU (Switchable)			
Ingress Protection	IP-54(Dust & Water Tight)			
Size / Weight	27mm	57.5(L)x29.9(W)x15(H)mm/ 49~52g		
	40mm	86.9(L)x36(W)x18(H)mm/ 96~99g		
	53mm	111.5(L)x36(W)x18(H)mm/ 124~127g		
	90mm	151.5(L)x36(W)x18(H)mm/ Approx. 177g		
Operating Temperature	-10°C~ 60°C			
Wire Harness	TTL(PT version) : Molex to Molex Type (Molex 50-37-5033, 3pins) / 200mm length, 0.08×60(22AWG)			
	or RS485(F version) : Molex to Molex Type(Molex 0510650400, 4pins) / 200mm length, 0.08×60(22AWG)			

* Design and Specification can be changed without prior notice for further improvement.

3. Application



Factory Automation

- Better Replacement of Pneumatic Cylinder
- Real-Time Automatic Width Adjustment Conveyor
- Real-Time Automatic Product Alignment (Up/Down or Left/Right)
- Automatic Value Control (oil or water)
- Automatic Dispensing with Syringe
- Automatic Clamping System
- Fitting or Adjusting Distance
- Pick & Place
- In & out / Extension & retraction
- Open & Closing (On-Off)
- Change of Direction
Hexapod/Tripod movement



Production & Test JIGs

- Hole Punching Jig
- Hole Inspection Jig
- Switch Inspection Jig
- Touch Panel Inspection Jig
- PC Board Testing Jig



Robotics

- Robot Joints
- Robot Grippers
- Linear Control Parts of Surgical Robot



UAV / Professional Drone

- Fixed wing (Aileron/Elevator/Throttle/Flap/Air Brake/ Rudder/ Throttle)
- Helicopter (Swash Plate Control/Rudder)
- Multicopter (Retract, Dropping Device)
- Linear control parts for Military products
- Pan/Tilt Camera control



Medical / Lab Equipment

- Linear position control for Medical Devices (HIFU, etc)
- Camera or Laser Focusing Control
- Laboratory Test Equipment



Education / Hobby

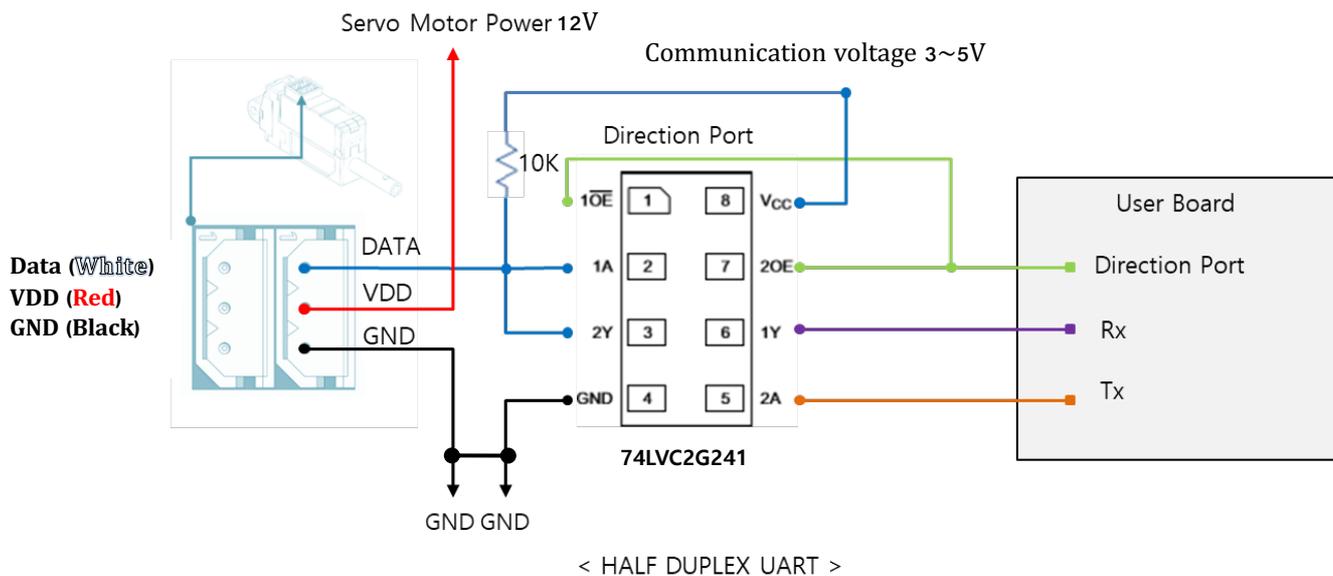
- 3D Printer
- Arduino or Raspberry Pie Control
- Maker's DIY Project

4. Servo Control

4.1. Circuit Connection

mightyZAP(12Lf-xxPT-xx) supports both data communication (Half Duplex TTL) as well as simple pulse(PWM) control. For the control under data communication, UART signal of main board should be converted into Half Duplex Type signal. TTL Conversion circuit will be as below.

■ TTL/PWM(3Pin Connector-Model 12Lfx-xxPT-xx Series)



The direction of data signal for TxD and RxD of TTL level will be determined according to the level of direction_port as below.

- The level of "direction_port" is LOW :Data signal will be inputted to RxD.
- The level of "direction_port" is HIGH :TxD signal will be outputted as Data.

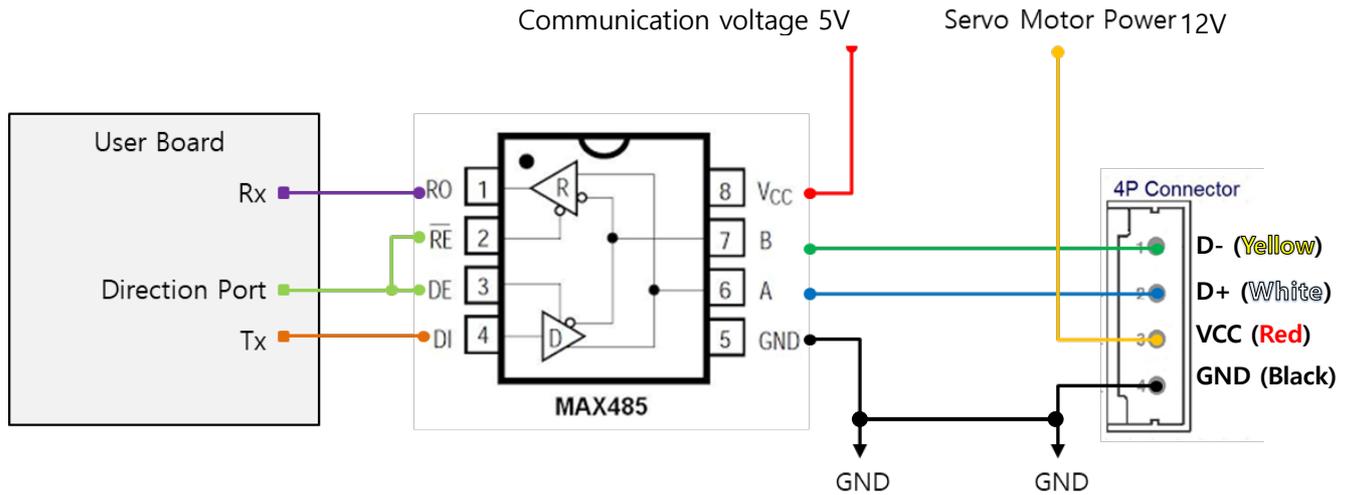
※ **Both GNDs between actuator and controller should be connected as above diagram.**

- ※ For PWM control, please connect PWM signal(3~5V) to the Data pin above. (GND,VDD are same as above)
- ※ In case of using PWM communication, position control is possible, but feedback data such as the current position value cannot be received, and serial daisy chain connection is not supported since data communication is not supported.
- ※ Feedback data reception and Daisy chain connection are possible by TTL or RS-485 communication.

■ RS-485(4Pin Connector - Model 12Lf-xxF-xx Series)

Model 12Lfxx-xxF-xx Series uses RS-485 communication. Pin map and Conversion circuit will be as below.

PIN NUMBER(COLOR)	PIN NAME	FUNCTION(RS485)
1(Yellow)	D-	RS485 -
2(White)	D+	RS485 +
3(Red)	VCC	Power +
4(Black)	GND	Power -



※ If the power is supplied from outside, you can connect to 485 D+, 485 D- only.

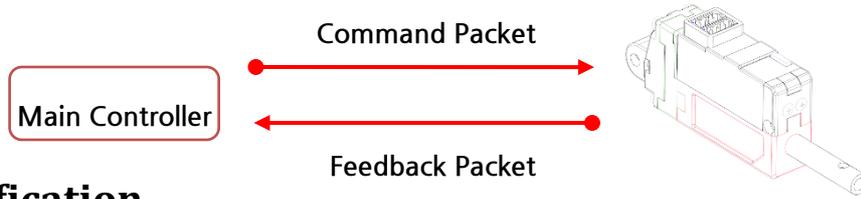
You can convert TX and RX mode by controlling "Direction_Port pin" in above circuit.

- The level of "direction_port" is LOW : Data signal will be inputted to RxD.
- The level of "direction_port" is HIGH : TxD signal will be outputted as Data

※ **Both GNDs between actuator and controller should be connected as above diagram.**

4.2. Communication

mightyZAP and your main controller will communicate by exchanging data packet. The sorts of packet are Command packet (Main controller to mightyZAP) and Feedback packet(mightZAP to your main controller)



1. Specification

① Communication specification

- **2 Mode in One** (Pulse / Data Mode Auto-Switching)
mightyZAP 12Lf-xxPT-xx series will automatically recognize the input signal between data mode(TTL) and pulse mode(PWM).

- **Data Mode (TTL/RS-485)**

Asynchronous Serial communication (8 bit, 1 Stop bit, None Parity)

Item	Spec
Structure	Half-duplex UART
Baud Rate	57600bps(default)
Data Size	8bit
Parity	non-parity
Stop Bit	One bit

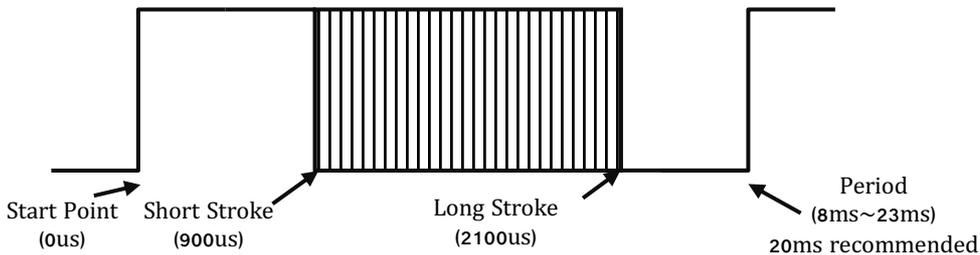
- *mightyZAP uses half duplex communication, and need to put proper delay time to prevent communication error.*
- *Recommendable delay time is 5msec for data write, 10msec for data read.*
- *Otherwise, there can be communication collision and motor failure.*
- *Above delay time is not minimum, but proper delay time for safety.*



CAUTION!

- **PWM Pulse Mode**

PPM(Pulse Position Modulation) Compatible [Radio-Control Servo Pulse Mode]
(900us(Retracted)~1500 us(Center)~2100 us(Fully Extended). Under PWM mode, position command available without feedback data.



※ Short stroke : Retract stroke / Long stroke : Extend stroke

※ Since PWM control is vulnerable to noise, it is highly recommended to control with a saturation-type PWM signal (continuous PWM) rather than a single PWM signal, so that it does not break at a specific frequency. Recommended frequency is 50Hz(20ms).

※ In case of using PWM communication, position control is possible, but feedback data such as the present position value cannot be received, and serial daisy chain connection is not supported since data communication is not supported. Feedback data reception and Daisy chain connection are possible by TTL or RS-485 communication.

※ Alternatively, PWM control is possible in the following way.
Frequency 50Hz / Duty rate 4.5% ~ 10.5%. (Control by 0.05% unit)

② Data specification

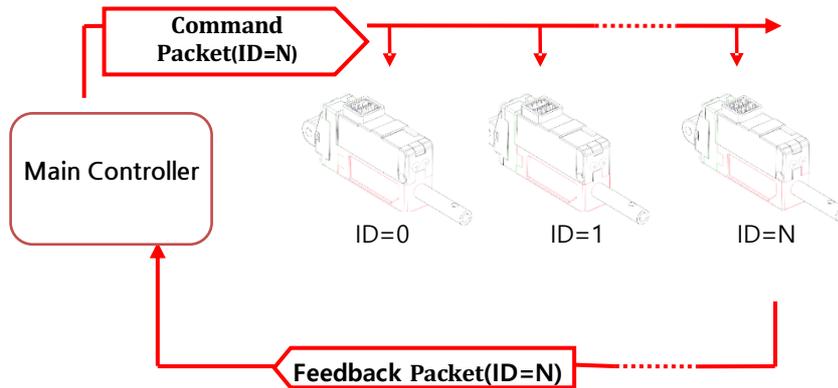
Data range is basically determined as below in both Data and Pulse modes.

Rod Stroke	Data Mode	Pulse Mode
Short (Retracting) Stroke	0	900us
Half Stroke	2047	1500us
Long (Extending) Stroke **	4095**	2100us

**For 27mm stroke mightyAP, long stroke limit is set at 27mm, but user is able to extend the long stroke to max.30mm. Data value for 27mm stroke is 3686. (for better mechanical stability against lateral load, 27mm is recommended.)

③ Daisy-Chain Connection

After receiving Command Packet at multiple qty of mightZAPs, the servo whose ID is N will be operated only. (Only N ID servo will send Feedback packet and execute Command.)



Caution Unique ID

- Each mightZAP servo must have an individual ID to prevent interference between same IDs. Therefore, you need to set individual IDs for each servo in the network node.
- User may assign 253 different IDs and connect 253pcs servos in serial via TTL protocol. For RS-485 protocol, 253 IDs can be assigned, but available serial connection is up to 32pcs servo motors due to RS-485 node regulation.
- As factory default ID is 0, so please assign different, individual IDs for each actuator from ID0~253 for daisy chain connection.

2. Packet Description

① Command Packet

It is command packets for servo operation. Its structure and elements are as below.

■ Structure



■ Element

Index	Data	Description
0	Start Byte 1	Start Byte 1 (0xFF)
1	Start Byte 2	Start Byte 2 (0xFF)
2	Start Byte 3	Start Byte 3 (0xFF)
3	ID	Servo ID (Range: 0 ~ 253, Broadcast ID: 254)
4	SIZE	Packet Size (COMMAND+FACTOR+CHECKSUM)
5	COMMAND	Instruction
5+1	FACTOR #1	First Parameter
5+m	FACTOR #m	"m"th Parameter
5+N	FACTOR #N	Last Parameter
5+N+1	Check Sum	Check Sum = 0xff - (LOWER_BYTE(ID + SIZE + COMMAND + FACTOR#1 + ... + FACTOR#N))

■ Element Description

1. HEADER (3Byte)

- Code to recognize Packet start : 0xFFFFF

2. ID (1Byte)

- The ID is an unique number of each servo to support Daisy Chain connection.
- Factory default value(ID) is 0.
- In case of ID = 0 ~253, ID "N" which is stored in the servo will be operated.
- In case of ID = 254 (0xFE), it is operated under "Broadcasting Mode (move all servos)" and Feedback Packet does not work.

3. SIZE (1Byte)

- Packet length in Byte unit
- Data counting value after "Size" data (COMMAND+FACTOR+CHECKSUM)
- That is, Size value = Number of byte of "Factor" + 2

4. COMMAND (1Byte)

- Command codes defining the purpose of Packet

Function	CODE	Description
Echo	0xF1	Feedback Packet Reception
Load Data	0xF2	Send "Address" and get feedback of Data
Store Data	0xF3	Send "Address" and "Data". Then Save.
Send Data	0xF4	Send "Address" and "Data" for temporary storage
Execution	0xF5	Execute temporarily stored data that is made by SendData.
Factory Reset	0xF6	Reset to Factory default parameter value
Restart	0xF8	Restart servo system
F A C Store	0x73	Store data in the same address of multiple qty servos.

TOR

- Additional Packet factor according to Command

6. CHECKSUM

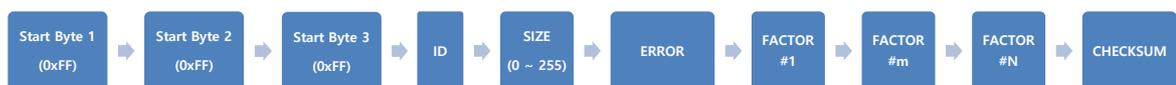
Verification data to check omission and any changes of Packet data. The interaction formula will be as below.

- Checksum = $0xff - (\text{LOWER_BYTE}(\text{ID} + \text{SIZE} + \text{COMMAND} + \text{FACTOR}\#1 + \dots + \text{FACTOR}\#N))$
- LOWER_BYTE = Only the lower 1 byte is taken among the summed data values.
= Divide the summed data value by 0x100 and take only the remainder.
- Here is the formula for above.
 $\text{LOWER_BYTE}(\text{ID} + \text{SIZE} + \text{COMMAND} + \text{FACTOR}\#1 + \dots + \text{FACTOR}\#N) = (\text{ID} + \text{SIZE} + \text{COMMAND} + \text{FACTOR}\#1 + \dots + \text{FACTOR}\#N) \% 0x100$

② Feedback Packet

After reception of command packet, servo sends Feedback packet including requested information. Its structure and factors are as below.

■ Structure



■ Element

Index	Data	Description
0	Start Byte 1	Start Byte 1 (0xFF)
1	Start Byte 2	Start Byte 2 (0xFF)
2	Start Byte 3	Start Byte 3 (0xFF)
3	ID	Servo ID (Range: 0 ~ 253, Broadcast ID: 254)
4	SIZE	Packet Size (COMMAND+FACTOR+CHECKSUM)
5	ERROR	Error Code
5+1	FACTOR #1	First Parameter
5+m	FACTOR #m	"m"th Parameter
5+N	FACTOR #N	Last Parameter
5+N+1	Check Sum	Check Sum = $0xff - (\text{LOWER_BYTE}(\text{ID} + \text{SIZE} + \text{ERROR} + \text{FACTOR}\#1 + \dots + \text{FACTOR}\#N))$

■ Element Description

1. HEADER (3Byte)

- Recognizing "Packet start" code. 0xFFFFFFFF

2. ID (1Byte)

- Individual ID number for each servo (0 ~253)

3. SIZE (1Byte)

- Packet length in Byte unit
- Data counting value after "Size" data (ERROR+FACTOR+CHECKSUM)
- That is, Size value = Number of byte of "Factor" + 2

4. Hardware ERROR (1Byte)

- Error status during operation for each bit

Error	bit	Description	LED
None	7	TBD	None
None	6	TBD	None
Overload Error	5	In case that current load cannot be controlled with the designated maximum force, it will be set as "1".	Red Blink
None	4	TBD	None
None	3	TBD	None
None	1	TBD	None
Input Voltage Error	0	In case that the input voltage is out of operating voltage range designated in the Control table, it will be set as "1".	Red On

5. FACTOR

- Additional Packet factor according to Feedback data.

6. CHECKSUM

Verification data to check omission and any changes of Packet data. The interaction formula will be as below.

- $Checksum = 0xff - (LOWER_BYTE(ID + SIZE + ERROR + FACTOR\#1 + \dots + FACTOR\#N))$
- LOWER_BYTE = Only the lower 1 byte is taken among the summed data values.
= Divide the summed data value by 0x100 and take only the remainder.
- Here is the formula for above.
 $LOWER_BYTE(ID + SIZE + ERROR + FACTOR\#1 + \dots + FACTOR\#N) == (ID + SIZE + ERROR + FACTOR\#1 + \dots + FACTOR\#N) \% 0x100$

3. Data Map

① Data Memory Map

■ Memory using data (Non-volatile)

- Data to be saved in non-volatile memory which maintains data even after power OFF/ON.
- All data will be reset to default value when Factory Reset command is executed.

Address	Name	Description	Access	Default
0 (0x00)	Model Number(L)	Lower byte of Model number	R	
1 (0x01)	Model Number(H)	High byte of Model number	R	
2 (0x02)	Version of Firmware	Firmware version info	R	-
3 (0x03)	ID	Servo ID	RW	0 (0x00)
4 (0x04)	Baud Rate	Communication Speed	RW	32 (0x20)
6 (0x06)	Short Stroke Limit(L)	Lower byte of Short Stroke Limit	RW	0 (0x00)
7 (0x07)	Short Stroke Limit(H)	High byte of Short Stroke Limit	RW	0 (0x00)
8 (0x08)	Long Stroke Limit(L)	Lower byte of Long Stroke Limit	RW	102 (0x66)
9 (0x09)	Long Stroke Limit(H)	High byte of Long Stroke Limit	RW	14 (0x0E)
10 (00x0A)	Protocol Type	Comm. Protocol (MODBUS RTU or IR Open)	RW	0x01 (IRPROTOCOL)
12 (0x0C)	the Lowest Limit Voltage	Lowest Voltage Limit	R	Each SPEC
13 (0x0D)	the Highest Limit Voltage	Highest Limit Voltage	R	Each SPEC
14 (0x0E)	Motor Operating Rate(L)	Lower byte of Motor Operating Rate	RW	255 (0xFF)
15 (0x0F)	Motor Operating Rate (H)	High byte of Motor Operating Rate	RW	3 (0x03)
16 (0x10)	Feedback Return Mode	Feedback Return Mode	RW	1 (0x01)
17 (0x11)	Alarm LED	Alarm LED Function	RW	33 (0x21)
18 (0x12)	Alarm Shutdown	Alarm Shutdown Function	RW	33(0x21)
19 (0x13)	Start Compliance Margin	Start Compliance Margin	RW	Each SPEC
20 (0x14)	End Compliance Margin	End Compliance Margin	RW	Each SPEC
21 (0x15)	Speed Limit(L)	Lower byte of average motor speed limit	RW	255(0xFF)
22 (0x16)	Speed Limit(H)	High byte of average motor speed limit	RW	3(0x03)
24 (0x18)	Calibration Short Stroke (L)	Lower byte of Calibration Short Stroke	R	0 (0x00)
25 (0x19)	Calibration Short Stroke (H)	High byte of Calibration Short Stroke	R	0 (0x00)
26 (0x1A)	Calibration Long Stroke (L)	Lower byte of Calibration Long Stroke	R	255 (0xFF)
27 (0x1B)	Calibration Long Stroke (H)	High byte of Calibration Long Stroke	R	15 (0x0F)
33 (0x21)	Acceleration Ratio	Moving Acceleration Ratio	RW	Each SPEC
34 (0x22)	Deceleration Ratio	Moving Deceleration Ratio	RW	Each SPEC
35 (0x23)	Current I Gain	Current Integral Gain	RW	Each SPEC
36 (0x24)	Current P Gain	Current Proportional	RW	Each SPEC

Gain				
37 (0x25)	Speed D Gain	Derivative Gain	RW	Each SPEC
38 (0x26)	Speed I Gain	Integral Gain	RW	Each SPEC
39 (0x27)	Speed P Gain	Proportional Gain	RW	Each SPEC
46 (0x2E)	Min Position Calibration	Min Position Value Trim	RW	Each SPEC
47 (0x2F)	Max Position Calibration	Max Position Value Trim	RW	Each SPEC
52 (0x34)	Current Limit (L)	Lower Byte of Current Limit	RW	32 (0x20)
53 (0x35)	Current Limit (H)	High Byte of Current Limit	RW	3 (0x03)

② Parameter Map

■ Parameter Using Data (Volatile)

- All data to be reset to default value whenever power is On.

Address	Name	Description	Access	Default
128 (0x80)	Force ON/OFF	Force On/ Off	RW	0 (0x00)
129 (0x81)	LED	LED On/Off	RW	0 (0x00)
134 (0x86)	Goal Position(L)	Low byte of Goal position value	RW	-
135 (0x87)	Goal Position(H)	High byte of Goal position value	RW	-
136 (0x88)	Goal Speed(L)	Low byte of Goal speed value	RW	Speed Limit
137 (0x89)	Goal Speed(H)	High byte of Goal speed value	RW	Speed Limit
138 (0x8a)	Goal Current(L)	Low byte of Goal curent value	RW	Current Limit
139 (0x8b)	Goal Current(H)"	High byte of Goal curent value	RW	Current Limit
140 (0x8C)	Present Position(L)	Low byte of present position value	R	-
141 (0x8D)	Present Position(H)	High byte of present position value	R	-
142 (0x8e)	Present Current (L)	Low byte of present Current	R	-
143 (0x8f)	Present Current (H)	High byte of present Current	R	-
144 (0x90)	Present Motor Operating Rate (L)	Low byte of present motor operating value	R	-
145 (0x91)	Present Motor Operating Rate (H)	High byte of present motor operating value	R	-
146 (0x92)	Present Voltage	Current voltage	R	-
150 (0x96)	Moving	Moving status	R	0 (0x00)

4. Data Description

Non-Volatile Memory

1) Model Number

- The model number of MightyZAP
- "Read" only to discriminate & recognize concerned model

2) Version of Firmware

Check if current firmware is the latest version.

3) ID

ID to discriminate each servo. Different IDs should be assigned in Daisy-Chain system.

- In case of ID = 0, it will be deemed as stand-alone(single) connection and communicate regardless of ID. (except for Echo, Load Data)
- In case of ID = 1 ~253, ID "N" which is stored in the servo will be operated.
- In case of ID = 254 (0xFE), it is operated under "Broadcasting Mode (move all servos)" and Feedback Packet does not work.

ID is a non-volatile memory area. If you change the data, communication may stop for a short time during saving process. Therefore, please be careful of frequent value changes during operation.

4) Baud Rate

- Determining communication speed. Default value is 57600bps
- Servo system should be rebooted to apply changed baud rate to the servo.

[Setting

Value	Baud Rate(bps)
16 (0x10)	115200
32 (0x20)	57600
48(0x30)	38600
64 (0x40)	19200
128 (0x80)	9600

Value]

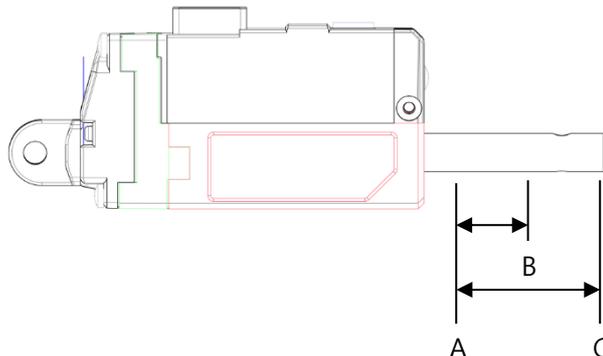
In old Firmware version 1.5 or lower, Baudrate 38600bps is not provided.

Baud Rate is a non-volatile memory area. If you change the data, communication may stop for a short time during saving process. Therefore, please be careful of frequent value changes during operation.

5) Stroke Limit

Stroke limit between Short Stroke (A) and Long Stroke (C) which is the max/min. value of Goal Position. If the Goal Position value is smaller than the Short Stroke Limit value or greater than the Long Stroke Limit value, Goal Position value is replaced with the Stroke Limit value.

(Range: 0 ~ 4095)



non-volatile memory area. If you change the data, communication may stop for a short time during saving process. Therefore, please be careful of frequent value changes during operation.

6) Protocol Type

Value	Protocol	Description
0 (0x00)	MODBUS RTU	Industrial RS485 Standard Communication Protocol ※ Refer to the separate MODBUS Protocol user manual.
1(0x01)	IR Protocol	IRROBOT Open Protocol

non-volatile memory area. If you change the data, communication may stop for a short time during saving process. Therefore, please be careful of frequent value changes during operation.

In old Firmware version 1.5 or lower, only IR Protocol is provided. (MODBUS available from V2.0 or higher)

7) Highest / Lowest Limit Voltage

Max/Min. value of input voltage (unit : 0.1V)

According to input voltage, speed and force of actuator can be varied.

For detailed info, please refer to the data sheet of each model.

Input Volt	Default Value
Lowest Voltage	7.0 [V]
Highest Voltage	13 [V]

- If higher voltage than 13V supplied, input voltage error will be triggered and motor power will be shutdown.

8) Motor Operating Rate [0~1023 / Default : 1023]

It represents the maximum operating rate of the motor and the maximum PWM value supplied to the motor. If it is set to less than 400, the motor may not operate. Please note that changing the Motor Operating Rate also changes the speed and stall force.

non-volatile memory area. If you change the data, communication may stop for a short time during saving process. Therefore, please be careful of frequent value changes during operation.

9) Feedback Return Mode

Feedback packet return mode after receipt of Command Packet

Mode	Feedback Packet Return or NOT
0	Do NOT sending Feedback packet for all Commands. (Except for Echo command)
1	Sending Feedback packet only for Load Data Command.
2	Sending Feedback packet for all Commands.

non-volatile memory area. If you change the data, communication may stop for a short time during saving process. Therefore, please be careful of frequent value changes during operation.

Under Broadcast ID(0xFE) mode, feedback packet will NOT be sent regardless values of Feedback Return Mode.

10) Alarm LED

If concerned bit is set as "1" when error occurs, error LED indication will be activated. (1 : activate, 0: deactivate)

Error	bit	LED Indicate
Overload Error	5	Red Blink
Input Voltage Error	0	Red Steadily ON

In case of Input Voltage Error, the alarm is immediately cleared when the error is resolved.

In case of Overload Error, the alarm is not cleared even after overload condition is resolved, but can be cleared by rebooting the power or restarting the system.

non-volatile memory area. If you change the data, communication may stop for a short time during saving process. Therefore, please be careful of frequent value changes during operation.

11) Alarm Shutdown

Force will be OFF if concerned bit is set as "1" when error occurs. (1 : activate, 0: deactivate)

Error	bit
Overload Error	5
Input Voltage Error	0

Overload error / Input voltage error shutdown feature is activated from the factory. These can be disabled by user using mightyZAP manager software according to their wish, but please consider carefully to protect the motor.

In case of Lowest Input Voltage Error, the motor will NOT be shut-down(force off).

In case of Highest Input Voltage Error and Overload Error, the motor will be shut-down(force off) and shut-down status will be cleared by rebooting the power or restarting the system.

Alarm Shutdown is a non-volatile memory area. If you change the data, communication may stop for a short time during saving process. Therefore, please be careful of frequent value changes during operation.

12) Compliance Margin

Start Compliance Margin (Recommended margin value : 7)

- Minimum margin value for the servo actuator to start position movement.
- For example, if the compliance margin is 7 and the current position value is 400, motor start will be made when positional value between 407(400+7) and 393(400-7) is set.
- Likewise, when the positional change occurs by more than +/-7(out of 393~407) from the present position value due to physical external pressure or electrical noise, the motor starts to run to compensate position.
- For this reason, the larger this value means more stable operation without jittering even in the environment where the external pressure, electrical noise, or the clearance increases, but the sensitivity to drive to the desired position may be reduced. In other words, generally, increasing this value increases durability, and reducing it increases precision.
- This value must be equal to or greater than the "End compliance margin value" described below. Setting it to a lower value may cause an error.

End Compliance Margin (Recommended margin value : 4)

- Minimum margin value for the servo actuator to complete position movement.
- For example, if actuator is instructed to move to a position value of 400, and assuming that it cannot physically stop at a position value of 400 exactly due to software & mechanical clearance, acceleration, etc. of the servo, End compliance margin will be a criteria to judge if the positional command has been performed properly. If this value is set to 4 and the position command value is set to 400, actuator judges that positional movement has been made properly when it reaches within 396~404 range and then stop movement.
- If this value is increased for stable operation, you should not increase it beyond the "Start Compliance Margin" value which is described above, and if this value is decreased too much to increase the accuracy, it may bring adverse effect such as jitter.
- The smaller the End Compliance Margin, the more sensitive and better the positioning accuracy. However, if it is reduced below a certain value, the effect becomes insignificant.
- If the End Compliance Margin is increased, the operation becomes cleaner and more stable when the target position is reached. Especially, the faster the product, the better the effect. However, if it is too large, conversely, the precision may deteriorate.

non-volatile memory area. If you change the data, communication may stop for a short time during saving process. Therefore, please be careful of frequent value changes during operation.

13) Speed Limit

- Average moving speed limit value of the motor (0~1023). When it is 0, the starting power is OFF, and when it is 1023, the maximum speed is achieved.
- Changing the Speed Limit does not affect the Force.
- However, if the speed limit is set too low, the response of the motor may be delayed or it may not be able to move.
- When the Speed Limit value is changed, the Goal Speed is also changed.

non-volatile memory area. If you change the data, communication may stop for a short time during saving process. Therefore, please be careful of frequent value changes during operation.

It is same as "Goal Speed" in the old Firmware version 1.5 or lower.

14) Calibration Stroke

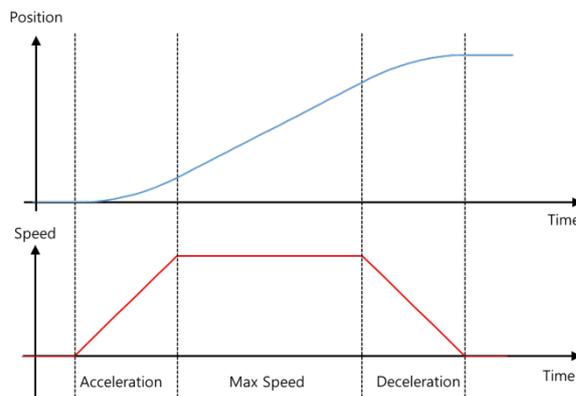
- Calibration Short Stroke : Short Stroke calibration value, Short Stroke Calibration value which is set at the factory will be saved.
- Calibration Long Stroke : Long Stroke calibration value, Long Stroke Calibration value which is set at the factory will be saved.

15) Acceleration / Deceleration [0~255 / Default : Individual Spec]

Indicates the acceleration/deceleration rate of the motor.

- **Acceleration:** The acceleration value when the motor starts moving. If the value is high, the motor accelerates rapidly. Conversely, if the value is low, smooth acceleration, but if it is too low, the motor may not move.
- **Deceleration:** The deceleration value when the motor reaches the position. If the value is high, it decelerates rapidly and may stop outside the goal position with a bounding phenomenon occurs that moves from the deviating position to the goal position. In this case, normal braking may not be achieved.

If the deceleration is too low, the actuator becomes too slow and the time to reach the goal position may be delayed.



It is a non-volatile memory area. If you change the data, communication may stop for a short time during saving process. Therefore, please be careful of frequent value changes during operation.

When correcting Acceleration / Deceleration, test after applying a small change value.

16) Current PI

- PI value for motor current control
- If you apply a larger PI value than the set value, it may operate harshly against the error with the Goal Current.
- If you apply a smaller PI value than the set value, it may operate smoothly against the error with the Goal Current, but the error with the Goal Current value may appear large.

Please test by applying from small change values.

non-volatile memory area. If you change the data, communication may stop for a short time during saving process. Therefore, please be careful of frequent value changes during operation.

17) Speed PID [0~255 / Default : Individual Spec]

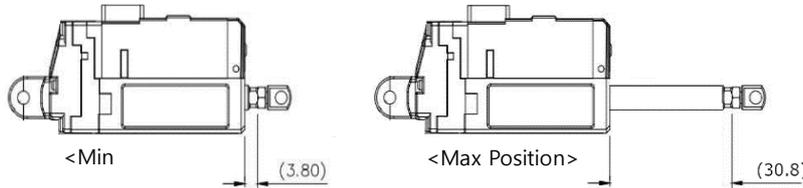
- PID value for speed control of motor.
- If a PID value larger than the set value is applied, the motor may vibrate without being able to stop at the set position value due to overshoot or over-response state due to rough operation against the error between the goal speed and the current speed.
- If a PI value smaller than the set value is applied, it operates smoothly in the error between the goal speed and the current speed, but the error between the goal speed value may appear large.

It is a non-volatile memory area. If you change the data, communication may stop for a short time during saving process. Therefore, please be careful of frequent value changes during operation.

Test from applying a small change value.

18) Min/Max Position Calibration [0~255 / Default : Individual Spec]

- Min Position: The position of the minimum stroke when the Goal Position value is '0'.
- Max Position: The maximum stroke position when the Goal Position value is '4095'.
- Unlike the Stroke Limit command, the range of the Goal Position value [0~4095] is not limited and the length of the actual used stroke is changed.
- Min/Max Position value of each actuator has a mechanical tolerance of $\pm 0.5\text{mm}$.
So, Position Calibration command can be used to synchronize the start and end positions of slightly different servos for the same Goal Position value by correcting each error value.



Parameter	Goal Position Range	Remark
Stroke Limit	Short Stroke Limit ~ Long Stroke Limit	No limit on the available stroke range, only limit G/P input range (0~4095)
Position Calibration	0 ~ 4095(Full range)	Input range (0~4095) is not limited, but the available stroke range may vary.

- For example, if the Min Position Calibration value at Min Position 3.8mm of 12Lf-20F-27 is 5, increasing the Min Position Calibration value increases the Min Position value and the entire stroke range will be reduced as the Min Position increases.

It is a non-volatile memory area. If you change the data, communication may stop for a short time during saving process. Therefore, please be careful of frequent value changes during operation.

Volatile Memory

19) Force ON/OFF

Setting for Force On and OFF (0 : OFF, 1 : ON)

value	Description
0	Cut off power to the motor and Force is OFF.
1	Power to be supplied to the motor and Force is ON.

TIP

mightyZAP keeps its position due to mechanical design even after motor power is off. For instance, mightyZAP having more than 27N rated load, rod sticks to its position firmly when motor power is off. So, in case servo motor needs to keep certain position (if mechanical frictional force is able to keep its position under power off condition against your load), apply FORCE OFF parameter. In this case, communication line is still alive and only motor power can be off which helps **longer lifespan** of the servo. Upon new positional command, servo will be FORCE on and do its next movement.

20) LED

Control LED when there is no Error indication.

bit	Description
0	LED Disable (All LEDs will be Off when it is 1)
1	RED LED Control
2	GREEN LED Control

21) Goal Position [0~4095]

- Goal position value which is desired position value to move. The goal position value will be affected by both short/long stroke limit. (i.e. move only to the stroke limit position even if the position command is out of the stroke limit range)
- For the 27mm stroke product, the goal position value at 27mm is 3686 due to the long stroke limit setting. It can be extended to 30mm (4095) if desired.

22) Goal Speed [0~1023 / Default : Speed Limit value]

- Goal speed is the average moving speed value of motor (0 ~ 1023) and it is volatile memory parameter.
- When the servo motor power is applied or the Restart command is applied, the value of Speed Limit, which is a non-volatile parameter, is copied to Goal Speed.
- It reacts faster than the Speed Limit command and can be used to change the speed in real time during operation.
- When it is 0, the maneuverability is OFF and when it is 1023, it gives the maximum speed.
- Changing the Goal Speed does not affect the force.
- However, if the GoalSpeed setting is too low, the motor response may be slowed down or it may not be able to move.

23) Goal Current [0~1600 / Default: 800]

- Goal current is volatile memory and Force is able to be controlled by controlling the maximum current of the motor, and the maximum current of the motor here means the average value of the maximum current. [Error range :+/-15%]
- When the servo motor is powered on or when the Restart command is executed, the value of Current Limit, which is a non-volatile memory, is copied to Goal Current.
- It responds faster than the Current Limit command, which is a non-volatile memory, and can be used to change the amount of current in real time during operation.
- The control value is from 0 to 1600. The control values 1600 represent the same maximum current value of 1600mA. The control value 800 (800mA) is the default and when the control value is 800, the maximum speed at the rated load is guaranteed.
- The Goal current control value that secures the rated force is about 380 ~ 400, and if it is set below the value, the force lower than the rated force can be made.
- The closer the goal current is set to the stall force, the higher the maximum force the motor can produce in an overload situation, but it may also cause shortening of the motor lifespan.
- If the goal current control value and the goal speed control value are set too low at the same time, the actuator may not start.

24) Present Position [0~4095]

- Current Position value.
- Range is between 0~4095, and even after the motor is stopped, the minute position change within the margin value can be made, and this is a normal operation.

25) Present Motor Operating Rate [0~2047]

- Current Motor operating rate value. It can be affected by Goal current, Goal speed, Acceleration/ Deceleration adjustment.
- To be shown in the range of 0~2047
- Value 0 indicates the motor is stopped.
- Between 1~1023: Motor operating rate on short stroke direction (retract direction).
Between 1024~2047: Motor operating rate on long stroke direction (extend direction).

26) Present Current [0~1600]

- Present motor Current value.
- To be displayed in the range of 0 ~ 1600.
- The value includes the error(+/-15%) of the actual current value. Please use it just for reference.

27) Present Voltage

- Current input voltage. The unit is 0.1V
- For instance, 74 means 7.4V, 120 means 12V.

28) Moving

Moving status

Value	Description
0	Goal Position command execution is completed. (Motor stop)
1	Goal Position command execution is under operation. (Motor moving)

5. Command Example Packet

- 1) **Echo** Receiving Feedback Packet (Refer to the " Load Data" parameter for feedback on position values, etc.)

Command Packet

HEADER	ID	Size	Command	Checksum
0xFFFFFFFF	0x00	0x02	0xF1	0x0C

- Command packet to recognize status of servo connection.

Feedback Packet

HEADER	ID	Size	Error	Checksum
0xFFFFFFFF	0x00	0x02	0x00	0xFD

- Feedback packet to inform status of servo connection. (Including Error information)

- 2) **Factory Reset** Reset to factory default parameter value.

Command Packet

HEADER	ID	Size	Command	Factor Option	Checksum
0xFFFFFFFF	0x01	0x03	0xF6	0x01	0x04

- Basic parameter (Memory & Parameter) to be reset to Default value. Additional Reset to be determined according to options.

- Servo ID to be reset to 0(ID Default) and Baud Rate to be maintained current status.

- If concerned bit is "1", it means Reset. If it is "0", it means Hold.

Option	bit	Description
Servo ID	0	Reset servo ID to 0
Baud Rate	1	Reset to 32 (57600 bps)

Feedback Packet

HEADER	ID	Size	Error	Checksum
0xFFFFFFFF	0x01	0x02	0x00	0xFC

- Feedback packet informing receipt of Factory reset.

- 3) **Restart** Servo system Restart

Command Packet

HEADER	ID	Size	Command	Checksum
0xFFFFFFFF	0x00	0x02	0xF8	0x05

- Command packet to reboot servo system.

Feedback Packet

HEADER	ID	Size	Error	Checksum
0xFFFFFFFF	0x00	0x02	0x00	0xFD

- Feedback packet informing receipt of Restart command of servo system (Only feedback in the Feedback Return Mode 2)

- 4) **Store Data** Store data after sending Address and Data to set ID, goal position, Force limit, Stroke limit, Speed, Force On/Off and etc.

- **ID change : Change ID'0' into ID '1'(0x01)**

HEADER	ID	Size	Command	Factor #1	Factor #2	Checksum
				Address	Data	
0xFFFFFFFF	0x00	0x04	0xF3	0x03	0x01	0x04

- ID : Servo motor ID
- Command : Save data at respective address in order.
- Address : the address which servo motor ID is saved. (see (3)Data Map)
- Data : Desired Servo ID (put 0x01 at address 0x03)

- **Goal Position command 1: Command packet to assign goal position to 2047(0x07FF)**

HEADER	ID	Size	Command	Factor	Factor	Factor	Checksum
				#1	#2	#3	
				Address	Data #1	Data #2	
0xFFFFFFFF	0x01	0x05	0xF3	0x86	0xFF	0x07	0x7A

- ID : Servo motor ID
- Command : Save data at respective address in order.
- Address : the address which goal position value is saved. (see (3)Data Map)
- Data #1 : Desired goal position's lower byte (address 0x86 : 0xFF)
- Data #2 : Desired goal position's upper byte (address 0x87 : 0x07)

※ Goal position value Hex change (decimal number → hexadecimal number) : 2047 → 0x07FF

- **Goal Position command 2 : Command packet to assign goal position to 1000 (0x03E8)**

HEADER	ID	Size	Command	Factor	Factor	Factor	Checksum
				#1	#2	#3	
				Address	Data #1	Data #2	
0xFFFFFFFF	0x01	0x05	0xF3	0x86	0xE8	0x03	0x95

- ID : Servo motor ID
- Command : Save data at respective address in order.
- Address : the address which goal position value is saved. (see (3)Data Map)
- Data #1 : Desired goal position's lower byte (address 0x86 : 0xE8)
- Data #2 : Desired goal position's upper byte (address 0x87 : 0x03)

※ Goal position value Hex change (decimal number → hexadecimal number) : 1000 → 0x03E8

- **Goal Speed 1 : Command packet to assign Goal Speed to 512(0x0200)**

HEADER	ID	Size	Command	Factor	Factor	Factor	Checksum
				#1	#2	#3	
				Address	Data #1	Data #2	
0xFFFFFFFF	0x01	0x05	0xF3	0x15	0x00	0x02	0xEF

- ID : Servo motor ID
- Command : Save data at respective address in order.
- Address : the address which Goal Speed value is saved. (see (3)Data Map)
- Data #1 : Desired Goal Speed value's lower byte (address 0x15 : 0x00)
- Data #2 : Desired Goal Speed value's upper byte (address 0x16 : 0x02)

※ Goal Speed value Hex change (decimal number → hexadecimal number) : 512 → 0x0200

- **Goal Speed 2: Command packet to assign Goal Speed to 400(0x0190)**

HEADER	ID	Size	Command	Factor	Factor	Factor	Checksum
				#1	#2	#3	
				Address	Data #1	Data #2	
0xFFFFFFFF	0x01	0x05	0xF3	0x15	0x90	0x01	0x60

- ID : Servo motor ID

- Command : Save data at respective address in order.

- Address : the address which Goal Speed value is saved. (see (3)Data Map)

- Data #1 : Desired Goal Speed value's lower byte (address 0x15 : 0x90)

- Data #2 : Desired Goal Speedvalue's upper byte (address 0x16: 0x01)

※ Goal Speedvalue Hex change (decimal number→hexadecimal number) : 400 →0x0190

- **Goal Current1 : Command packet to assign Goal Current to 800(0x0320)**

HEADER	ID	Size	Command	Factor	Factor	Factor	Checksum
				#1	#2	#3	
				Address	Data #1	Data #2	
0xFFFFF	0x01	0x05	0xF3	0x34	0x20	0x03	0xAF

- ID : Servo motor ID

- Command : Save data at respective address in order.

- Address : the address which Goal Current value is saved. (see (3)Data Map)

- Data #1 : Desired Goal Current value's lower byte (address 0x34: 0x20)

- Data #2 : Desired Goal Current value's upper byte (address 0x35: 0x03)

※ Goal Current value Hex change (decimal number→hexadecimal number) : 800→0x0320

- **Goal Current 2: Command packet to assign Goal Current to 400(0x0190)**

HEADER	ID	Size	Command	Factor	Factor	Factor	Checksum
				#1	#2	#3	
				Address	Data #1	Data #2	
0xFFFFF	0x01	0x05	0xF3	0x34	0x90	0x01	0x41

- ID : Servo motor ID

- Command : Save data at respective address in order.

- Address : : the address which Goal current value is saved. (see (3)Data Map)

- Data #1 : Desired Goal Current value's lower byte (address 0x34 : 0x90)

- Data #2 : Desired Goal Current value's upper byte (address 0x35 : 0x01)

※ Goal Current value Hex change (decimal number→hexadecimal number) : 400 →0x0190

- **Stroke Limit 1 : Command packet to assign Short Stroke limit to 100(0x0064)**

HEADER	ID	Size	Command	Factor	Factor	Factor	Checksum
				#1	#2	#3	
				Address	Data #1	Data #2	
0xFFFFF	0x01	0x05	0xF3	0x06	0x64	0x00	0x9C

- ID : Servo motor ID

- Command : Save data at respective address in order.

- Address : the address which short stroke limit value is saved. (see (3)Data Map)

- Data #1 : Desired Short stroke limit value's lower byte (address 0x06 : 0x64)

- Data #2 : Desired Short stroke limit value's upper byte (address 0x07 : 0x00)

※ Stroke limit value Hex change(decimal number→hexadecimal number) : 100 → 0x0064

- **Stroke Limit 2: Command packet to assign Long Stroke limit to 3800(0x0ED8)**

HEADER	ID	Size	Command	Factor	Factor	Factor	Checksum
				#1	#2	#3	
				Address	Data #1	Data #2	
0xFFFFFFFF	0x01	0x05	0xF3	0x08	0xD8	0x0E	0x18

- ID : Servo motor ID

- Command : Save data at respective address in order.

- Address : the address which long stroke limit value is saved. (see (3)Data Map)

- Data #1 : Desired Long stroke limit value's lower byte (address 0x08 : 0xD8)

- Data #2 : Desired Long stroke limit value's upper byte (address 0x09 : 0x0E)

※ Stroke limit value Hex change(decimal number→hexadecimal number) : 3800 → 0x0ED8

- **Force On/Off : Command packet to cut off Motor power while communication is alive.**

HEADER	ID	Size	Command	Factor #1	Factor #2	Checksum
				Address	Data #1	
0xFFFFFFFF	0x01	0x04	0xF3	0x80	0x00	0x87

- ID : Servo motor ID

- Command : Save data at respective address in order.

- Address : the address which Force On/Off value is saved. (see (3)Data Map)

- Data : Desired Force On/Off Data byte (address 0x80 : 0x00(Off) / 0x01(On))

- After force-off, automatically Force On when next goal position command is made.

- **Feedback Return Mode 1: Command packet to send Feedback packet for Load Data command only.**

HEADER	ID	Size	Command	Factor #1	Factor #2	Checksum
				Address	Data #1	
0xFFFFFFFF	0x01	0x04	0xF3	0x10	0x01	0xF6

- ID : Servo motor ID

- Command : Save data at respective address in order.

- Address : the address which Feedback Return Mode value is saved. (see (3)Data Map)

- Data : Feedback Return Mode Data (address 0x10 : 0x01)

(1: Send Feedback packet only to Load Data(0xF3) Command)

- **Feedback Return Mode 2: Command packet to send Feedback packet for All commands.**

HEADER	ID	Size	Command	Factor #1	Factor #2	Checksum
				Address	Data #1	
0xFFFFFFFF	0x01	0x04	0xF3	0x10	0x02	0xF5

- ID : Servo motor ID

- Command : Save data at respective address in order.

- Address : the address which Feedback Return Mode value is saved. (see (3)Data Map)

- Data : Feedback Return Mode Data (address 0x10 : 0x02)

(2: Send Feedback packet to All)

5) **Load Data** Send address and Get data feedback

*Load data is data read. To avoid communication collision, at least 10msec communication delay is required in case of 57600bps baud rate.

● Present Position : Command packet to read present Position

Command Packet

HEADER	ID	Size	Command	Factor #1	Factor #2	Checksum
				Address	Length	
0xFFFFFFFF	0x00	0x04	0xF2	0x8C	0x02	0x7B

- ID : Servo motor ID

- Command : Read byte (equivalent to the Length number) from Address

- Address : Address where present position value is saved. (see (3)Data Map)

- Length: The number of byte to read from Address (present position value consists of 2byte.)

Feedback Packet

HEADER	ID	Size	Error	Factor #1	Factor #2	Checksum
0xFFFFFFFF	0x00	0x04	0x00	0xFF	0x07	0xF5

- ID : Servo motor ID / Error : Error indication during operation

- Factor 1 : Present position value's lower byte (ex> 0xff)

- Factor 2 : Present position value's upper byte (ex> 0x07)

※ Present position value Hex change(hexadecimal number → decimal number) : 0x07ff→2047

● Present Motor Operating Rate: Command packet to read present Motor Operating Rate.

Command Packet

HEADER	ID	Size	Command	Factor #1	Factor #2	Checksum
				Address	Length	
0xFFFFFFFF	0x00	0x04	0xF2	0x90	0x02	0x77

- ID : Servo motor ID

- Command : Read byte (equivalent to the Length number) from Address

- Address : Address where present motor operating rate value is saved. (see (3)Data Map)

- Length: The number of byte to read from Address (present load value consists of 2byte.)

Feedback Packet

HEADER	ID	Size	Error	Factor #1	Factor #2	Checksum
0xFFFFFFFF	0x00	0x04	0x00	0xFF	0x03	0xF9

- ID : Servo motor ID

- Error : Error indication during operation

- Factor 1 : Present motor operating rate value lower byte (ex> 0xff)

- Factor 2 : Present motor operating rate value upper byte (ex> 0x03)

※ Present motor operating rate value Hex change(hexadecimal number → decimal number) : 0x03ff→1023

● Present Voltage: Command packet to read present input Voltage

Command Packet

HEADER	ID	Size	Command	Factor #1	Factor #2	Checksum
				Address	Length	
0xFFFFFFFF	0x00	0x04	0xF2	0x92	0x01	0x76

- ID : Servo motor ID

- Command : Read byte (equivalent to the Length number) from Address

- Address : Address where present voltage value is saved. (see (3)Data Map)

- Length: The number of byte to read from Address (present voltage value consists of 2byte.)

Feedback Packet

HEADER	ID	Size	Error	Factor #1	Checksum
0xFFFFFFFF	0x00	0x03	0x00	0x7B	0x81

- ID : Servo motor ID
- Error : Error indication during operation
- Factor 1 : Present Voltage value byte (ex> 0x7B)
- ※ Present voltage value Hex change(hexadecimal number → decimal number):
0x7B→123(12.3V)

6) Send Data Send "Address" and "Data", Then temporarily store it.**Command Packet**

HEADER	ID	Size	Command	Factor #1	Factor #2	Factor #3	Checksum
				Address	Data #1	Data #2	
0xFFFFFFFF	0x01	0x05	0xF4	0x86	0xFF	0x07	0x79

- Command packet for temporary store of goal position as 2047(0x07FF).

Feedback Packet

HEADER	ID	Size	Error	Checksum
0xFFFFFFFF	0x01	0x02	0x00	0xFC

- Feedback packet informing receipt of temporary store for servo goal position.

7) Execution Execute temporarily stored data that is made by Send Data.**Command Packet**

HEADER	ID	Size	Command	Checksum
0xFFFFFFFF	0x01	0x02	0xF5	0x07

- Command packet to execute all temporarily stored data at the same time.

Feedback Packet

HEADER	ID	Size	Error	Checksum
0xFFFFFFFF	0x01	0x02	0x00	0xFC

- Feedback packet informing receipt of execution command for temporarily stored data. (Only feedback in the Feedback Return Mode2)

8) Symmetric Store Save data in the same address of multiple servos.

- Goal Position : Command packet to assign multiple servo's goal positions.
- Servo ID 1 : 1023(0x03FF), Servo ID 2 : 2047(0x07FF)

HEADER	ID	Size	Command	Factor #1	Factor #2
				Address	Length
0xFFFFFFFF	0xFE	0x0A	0x73	0x86	0x02

Factor #3	Factor #4	Factor #5	Factor #6	Factor #7	Factor #8	Checksum
1> ID	1> Data #1	1>Data #2	2>ID	2> Data #1	2> Data #2	
0x01	0xff	0x03	0x02	0xFF	0x07	0xF1

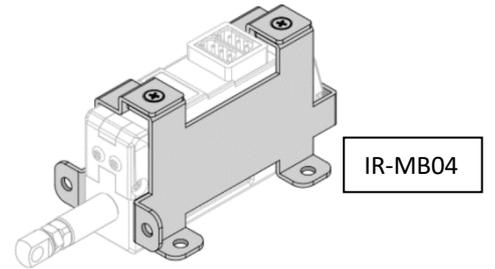
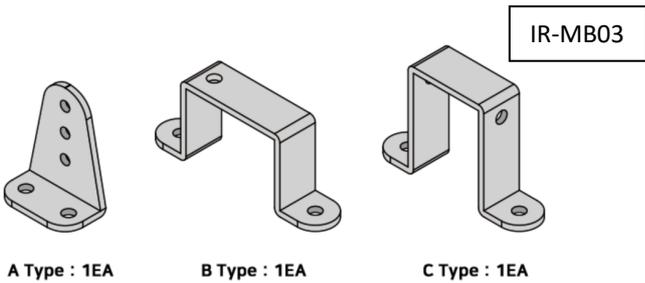
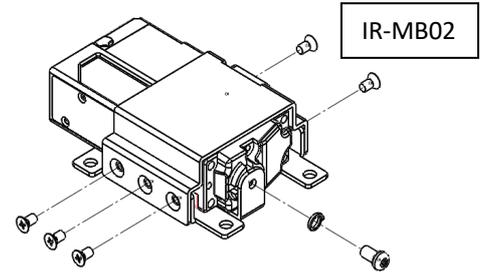
- Command packet to assign respective goal position to multiple qty servo motors at the same time.
- Better synchronization without delay than respective command is made for each servo motor.
- ID : Broadcast ID (Command to all connected IDs)
- Command : Send data at the same time to the ID defined in Factor (1>ID, 2>ID ...)
- Address : Address present position value is saved. (See (3)Data Map)
- Length: The number of byte to read from Address (present position value consists of 2byte.)
- feedback Packet : No Feedback.

5. Optional Accessories

Metal Bracket (IR-MB02/IR-MB03/IR-MB04)

IR-MB02 is the LATERAL mounting bracket for 27mm stroke lineup only and MB04 is the VERTICAL bracket for 27mm stroke mightyZAP.

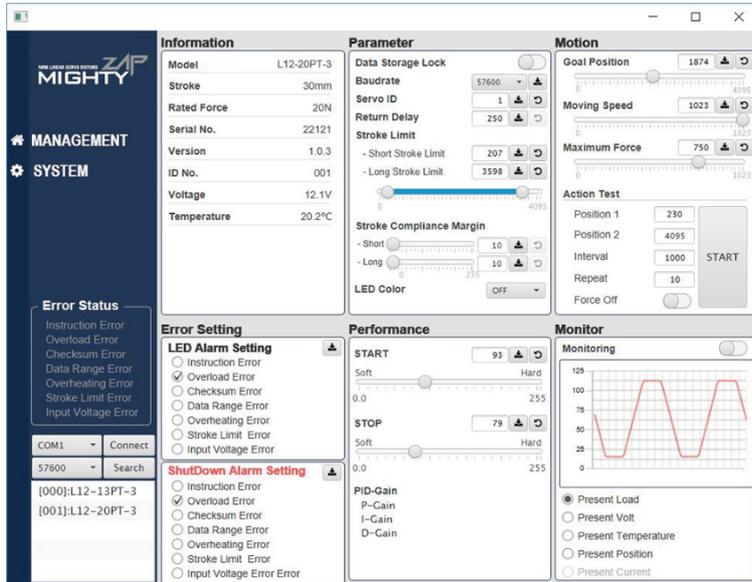
For 41~90mm stroke lineup, they can be mounted via built-in mounting holes on the case. Or, if you wish more flexible mounting, you can use IR-MB03 for 40~90mm stroke versions. The drawing is open at our website, so you may make this bracket at their end.



PC USB Interface (IR-USB01)

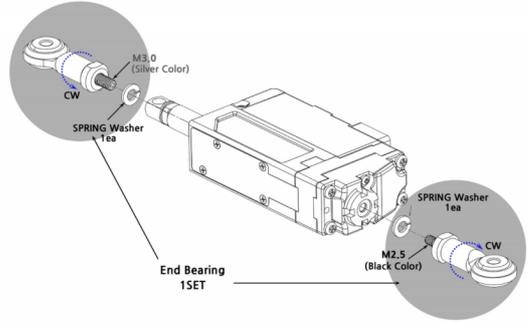
USB Interface between mightyZAP and user's PC. Through PC software, mightyZAP manager, user is able to control below.

- Parameter and Memory setting
- Motion test
- Voltage, temperature, present position, force monitoring
- System initialization and Firmware update



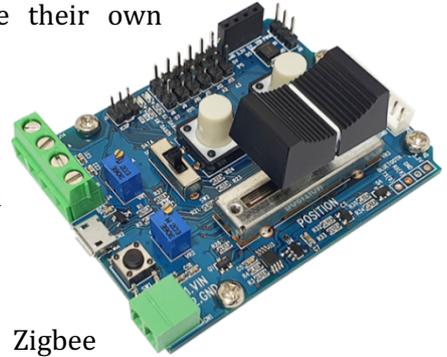
End-Bearing (IR-EB01)

Mount mightyZAP on applications using this end bearings for most optimal installation. Put it on the rod end(M3) and on the end of servo case(M2.5). Two end bearings (M3 & M2.5) to be packed in a set.



EZ Controller (IR-CT01)

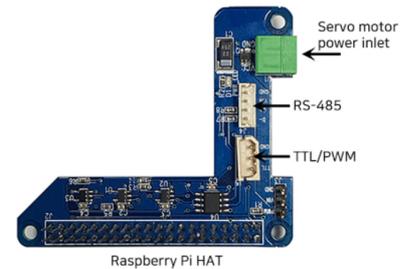
- mightyZAP controller/tester for customers who do not have their own controller
- Arduino based simple operation
- Built-in basic control program, User programmable (Arduino example provided)
- Built-in position setting dials, position command button switches and position command slide
- Controllable through external switch or voltage level signal
- 6 x I/O pins for analog/digital sensor connection
- External communication terminal for Bluetooth or Zigbee communication



Raspberry Pi HAT (IR-STSo2)

IR-STSo2 is a Raspberry Pi HAT(Hardware Attached on Top) which is compatible with Raspberry Pi B3 or Raspberry Pi Zero.

With TTL/RS-485/PWM communication interface, power connector and GPIO pins, user is able to control mightyZAP on Raspberry Pie. API and Library can be downloaded from our web.



Extension Wire (IR-EW01~04)

Optional extension wires for applications which need longer wire harness.

- IR-EW01 :Extension wire - 3pin TTL 1000mm
- IR-EW02 :Extension wire - 3pin TTL 2000mm
- IR-EW03 :Extension wire - 4pin RS-485 2000mm
- IR-EW04 :Extension wire - 4pin RS-485 4000mm
- IR-EW08 :Extension wire - 3pin TTL 500mm
- IR-EW09 :Extension wire - 4pin RS-485 500mm
- IR-EW10 :Extension wire - 4pin RS-485 1000mm

- ✓ Above extension wires are NOT shielded wires. For the customer's application having considerable electrical noise, please use shielded wires. Make shielded wires and we are selling optional Molex connector housings and terminals for it.



Rod End Tips (IR-GT01)

The IR-GT01 Rod-End Grip tip is an accessory that prevents physical damage to the application object by attaching a grip tip with a soft pad onto the rod-end of mightyZAP.

For example, by attaching a rubber/silicone pad to the flat grip tip, it can be used to push or touch an object that is easy to be scratched or damaged, or to hold or lift an object using the frictional force of the silicone.



For more information for all available accessories, please visit our website - www.mightyzap.com.

6. Warranty Service

6.1. Warranty & Service

The warranty period of mightZAP is 1 year from the date of purchasing the goods. Please prepare some evidence showing the date of purchase and contact your product supplier or IR Robot.

Warranty service will not cover the malfunctions of product which are derived from customer's abuse, mistake, or carelessness (including normal wearing of gear train, tear of wire harness and motor burnt-out). Please kindly note that all service should be processed by designated engineers and voluntary disassembly or maintenance may void warranty.

IR Robot Customer Service Team :

- Tel : +82- 070-7600-9466

- Address : (ZIP 14502) 1303, Bucheon Techno Park 401, Pyeongcheon-Ro 655, Wonmi-Gu, Gyeonggi-Do, Korea.

- E-mail : cs@irrobot.com

Thank you.