Robust Mini Linear Servo Actuator

mightyZAP User Manual

(12Lf Force Control Lineup / MODBUS Protocol)

Check your product group!
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.
- MODBUS RTU Protocol is available for Force control lineup (RS-485 and TTL) only.
- This manual is for the MODBUS protocol users of the Force control lineup actuators who have the model number which starts with "12Lf".
- For the users who needs IR Robot own protocol with the Force control actuators, please refer to the separate "Force control/IR Protocol" actuator manual.
- For the users who have the actuator which starts with D or L, please also refer to the separate "Position control" actuator manual.

IR ROBOT

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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** (Uni-directional Positional Accuracy 30~60um - see spec chart of each model)
- **Stall Force Control** based on Current feedback
- **Speed Control** by 1024 Resolution
- Embedded 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.

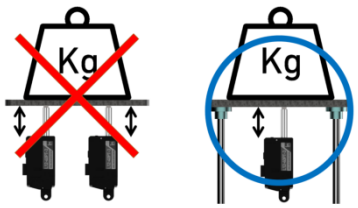
    2) **Use under 50% of Duty Cycle** : If DC motor operates continuously without any interval (rest), motor will be overloaded and overload protection feature will cut off the power of servo motor. Therefore, user should consider "Duty cycle" which means the percentage of operating time against interval 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

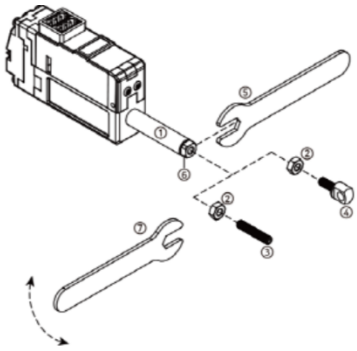
wiring pin map on 4.1 Circuit connection page of the user manual to prevent incorrect wiring.

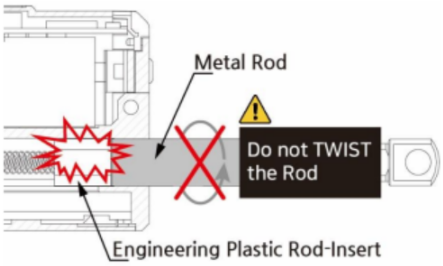
5. **Position command within mechanical limit :** There should be mechanical limit which servo rod can move when user install servo motor in their application. Make sure that positional command should be made within user's mechanical limit. It is too common to mention, but we could see this mistake from 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 below 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 Function

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 Force Control version 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 force control version, 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. (Specific data will be announced later)

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 "Write Single Register" command to the address(0X0a) which is the address for Alarm Shutdown. Set bit 5 (see below) for Overload error to "1"(Overload activation), then send " Write Single Register" 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
Overload Error	5
Input Voltage Error	0

Refer to below example for" Write Single Register" command.

Address	Function	Starting Address Hi	Starting Address Lo	No of Register Hi	No of Register Lo	CRC Lo	CRC Hi
0x01	0x06	0x00	0x0a	0x00	0x21	0x69	0xd0

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 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 "Write single register" command to the address(0x32) which is the address for Force ON/OFF. (For Force ON, send 0x01)

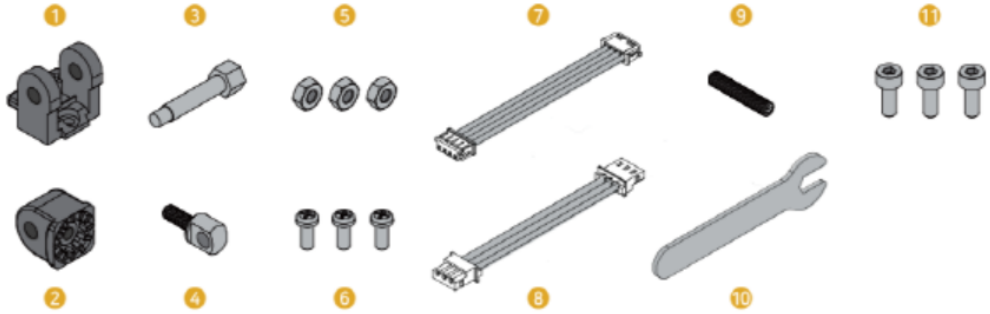
Refer to below example for " Write single register " command.

Address	Function	Starting Address Hi	Starting Address Lo	No of Register Hi	No of Register Lo	CRC Lo	CRC Hi
0x01	0x06	0x00	0x32	0x00	0x00	0x28	0x05

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.**

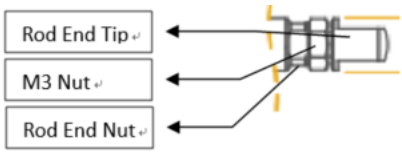
2. Basic Information

2.1 Component



1. Hinge Base 1pc
2. Hinge 1pc
3. Hinge Shaft 1pc
4. Rod End Tip 1pc
5. M3 NUT 3pcs
6. M2.5x5 Screws 3pcs
7. Wire(**F** Version) : 4Pin Molex to Molex(RS-485)
8. Wire(**PT** Version) : 3Pin Molex to Molex(TTL)
9. Socket Set Screw 1pc
10. Wrench for M3 NUT 1pc
11. Socket head M3.0 X 8 mounting bolt 3pcs (**40~96mm Stroke line-up** only)

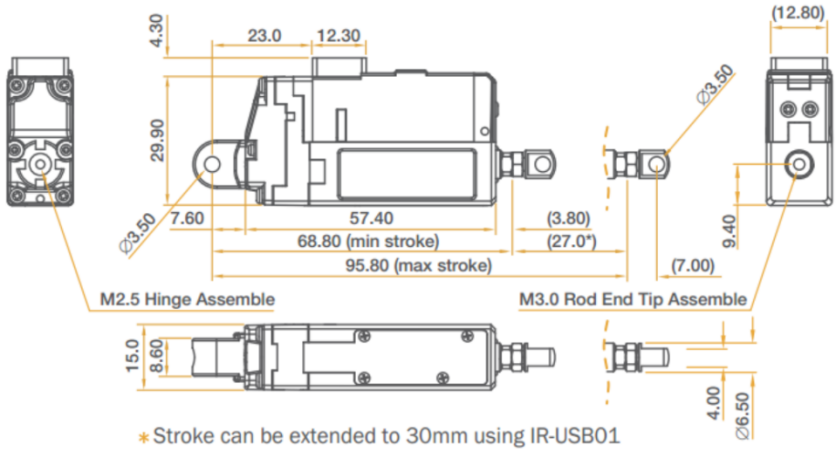
#3 M3 nut can be used to fix the hinge and hinge base. Also, M3 nut should be used between rod-end and rod-end tip as a stopper.



2.2 Dimension

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

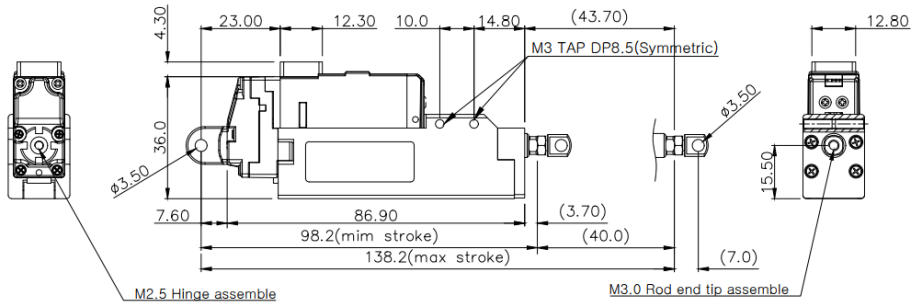
[27mm Stroke Lineup]



****For 27mm stroke actuator, if necessary, user can extend it to 30mm through the servo manager program (recommended to use 27mm for better mechanical stability)**

[40mm Stroke Lineup]

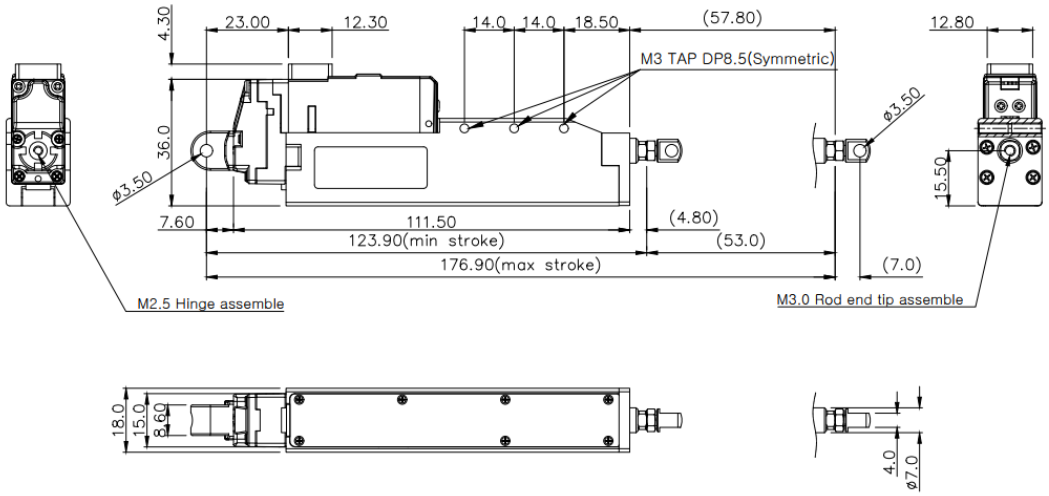
FC Version



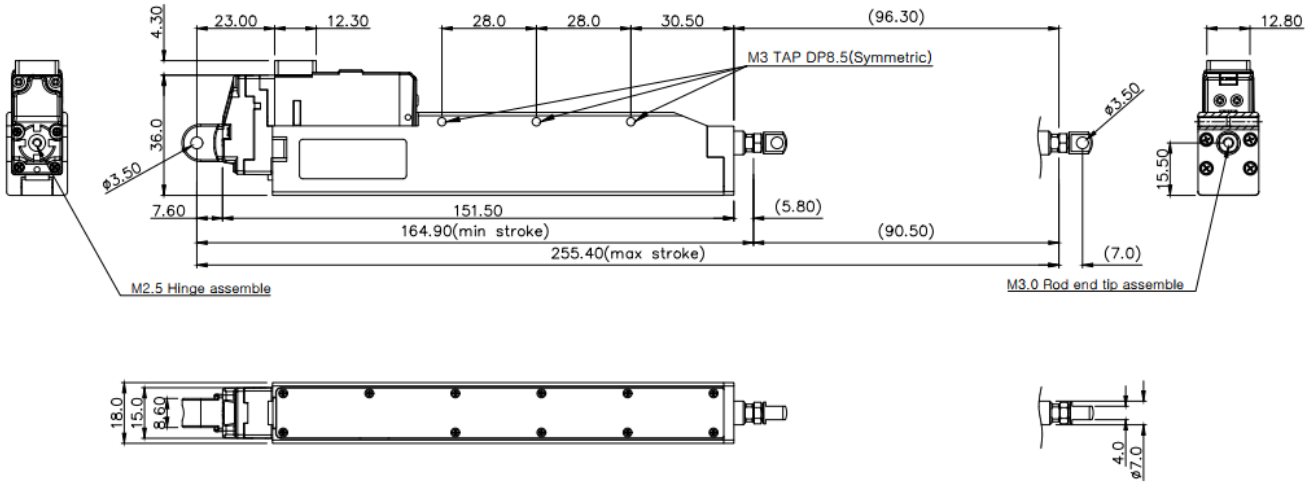
unit : mm

[53mm Stroke Lineup]

FC Version



[90mm Stroke Lineup]



2.3 Specification

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	Yes (Applicable)	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		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

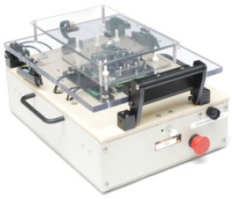
<table>
<tr><td rowspan="4">Repeatability</td><td colspan="2">Stroke</td><td colspan="2">Unidirectional</td></tr>
<tr><td colspan="2">27mm / 40mm</td><td colspan="2">30μm(0.03mm)</td></tr>
<tr><td colspan="2">53mm</td><td colspan="2">40μm(0.04mm)</td></tr>
<tr><td colspan="2">90mm</td><td colspan="2">50μm(0.05mm)</td></tr>
<tr><td>Mechanical Backlash</td><td colspan="4">0.03mm(30μm)</td></tr>
<tr><td>Rod Type</td><td colspan="4">Metal Alloy Rod</td></tr>
<tr><td>Motor Type</td><td colspan="4">Coreless Motor</td></tr>
<tr><td>Rated Voltage</td><td colspan="4">12V</td></tr>
<tr><td>Motor Watt</td><td colspan="4">26W</td></tr>
<tr><td rowspan="2">Recommended Duty Cycle</td><td colspan="2">At Rated Load</td><td colspan="2">At Max Applicable Load</td></tr>
<tr><td colspan="2">Max 50%</td><td colspan="2">Max 20%</td></tr>
<tr><td>Current Accuracy</td><td colspan="4">±15%at Over 50mA</td></tr>
<tr><td>Position Sensor</td><td colspan="4">10KΩlinear Potentiometer</td></tr>
<tr><td>Input Voltage Range</td><td colspan="4">7 ~13V</td></tr>
<tr><td rowspan="2">Current Consumption</td><td rowspan="2">Idle</td><td rowspan="2">Rated</td><td colspan="2">Stall</td></tr>
<tr><td>Default</td><td>MAX</td></tr>
<tr><td>20mA</td><td>380mA</td><td>800mA</td><td>1.6A</td></tr>
<tr><td>Audible Noise</td><td colspan="4">Approx. 50db at 1m</td></tr>
<tr><td>LED Indication</td><td colspan="4">Two Errors Indications (Input voltage, Overload)</td></tr>
<tr><td>Data Communication / Protocol</td><td colspan="4">RS-485 or TTL(PT version) /
IR Robot open protocol (Default) / MODBUS RTU (Switchable)</td></tr>
<tr><td>Ingress Protection</td><td colspan="4">IP-54(Dust & Water Tight)</td></tr>
<tr><td rowspan="4">Size / Weight</td><td>27mm</td><td colspan="3">57.5(L)x29.9(W)x15(H)mm/ 49~52g</td></tr>
<tr><td>40mm</td><td colspan="3">86.9(L)x36(W)x18(H)mm/ 96~99g</td></tr>
<tr><td>53mm</td><td colspan="3">111.5(L)x36(W)x18(H)mm/ 124~127g</td></tr>
<tr><td>90mm</td><td colspan="3">151.5(L)x36(W)x18(H)mm/ Approx. 177g</td></tr>
<tr><td>Operating Temperature</td><td colspan="4">-10℃~ 60℃</td></tr>
<tr><td rowspan="2">Wire Harness</td><td colspan="4">TTL(PT version) : Molex to Molex Type (Molex 50-37-5033, 3pins) / 200mmlength, 0.08×60(22AWG)</td></tr>
<tr><td colspan="4">or RS485(F version) : Molex to Molex Type(Molex 0510650400, 4pins) / 200mm length, 0.08×60(22AWG)</td></tr>
</table>

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

3. Applications

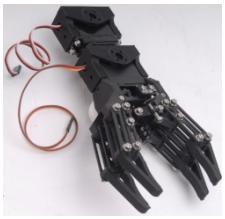
Factory Automation

- Better Replacement of Pneumatic Cylinder
- Real-Time Automatic Width Adjustment Conveyer
- 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

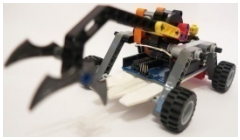
- Robot Joints
- Robot Grippers
- Linear Control Parts of Surgical Robot

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



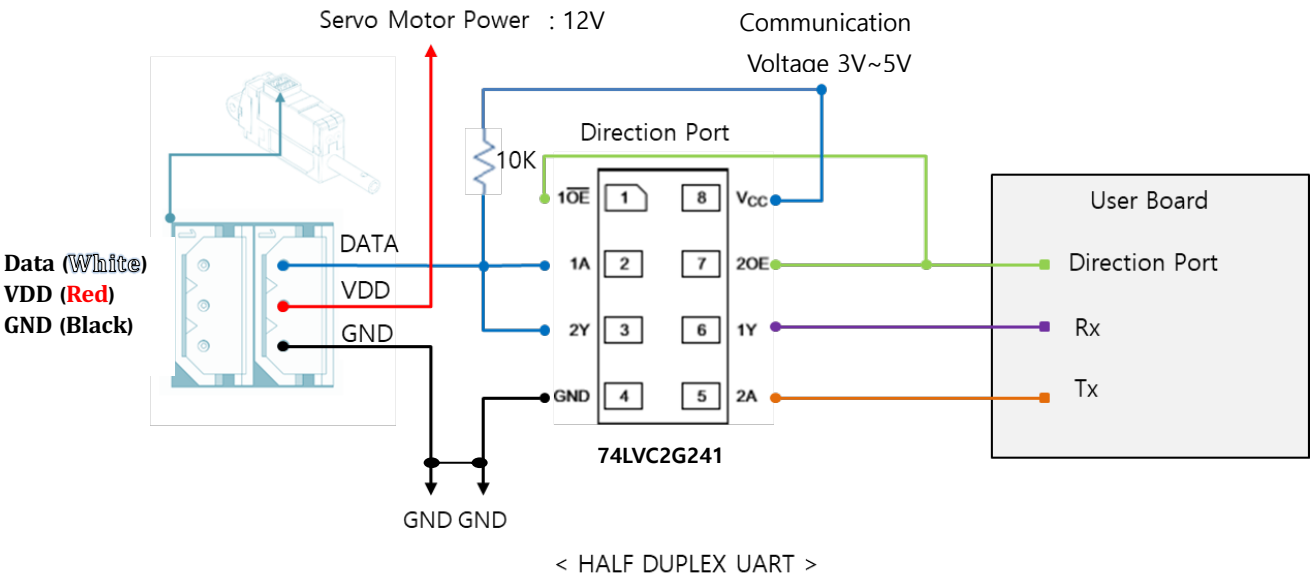
Education / Hobby

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

4. Servo Control

4.1 Circuit Connection

■ TTL (3Pin Connector-Model 12Lf-xx-xxPT-x Series)



< HALF DUPLEX UART >

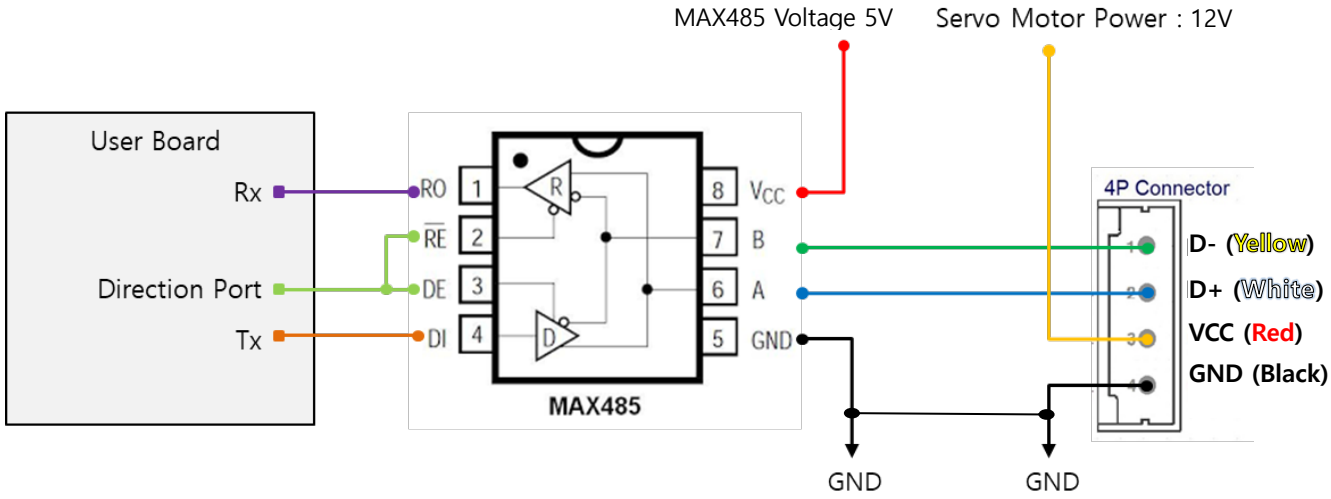
The direction of data signal for TxD and RxD of TTL level will be determined according to the level of direction_port as below.

- 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.

■ 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 -



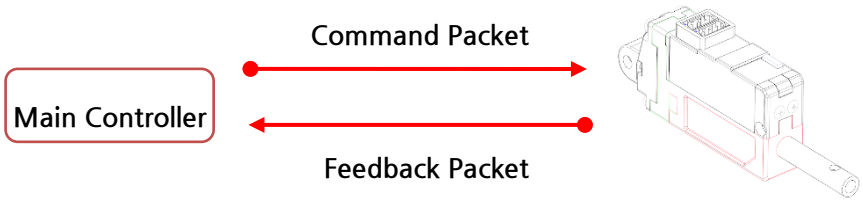
※If the power is supplied from outside, you can connect to 485 D+, 485 D- only.

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

4.2 Communication

mightyZAP and your main controller will communicate by exchanging data packet via RS-485 or TTL data communication. There are two packets, the one is Command packet (Main controller to mightyZAP) and the other is the Feedback packet(mightZAP to your main controller). PWM does not support feedback data.



4.2.1 Specification

① Communication specification

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

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

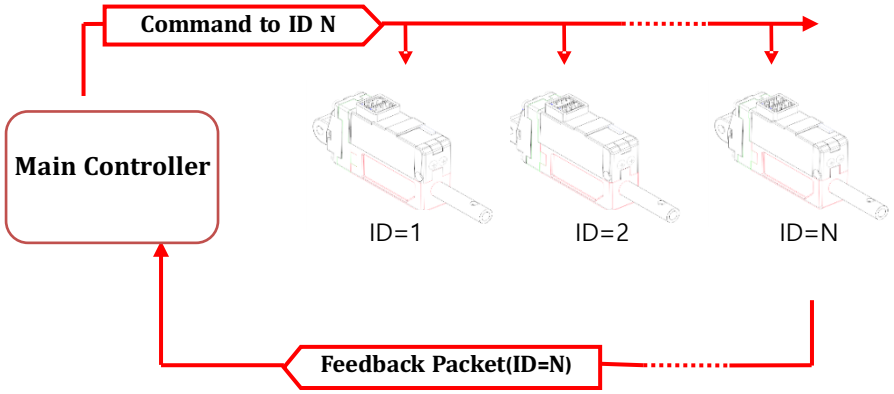
Item	Spec
Structure	Half-duplex UART
Baud Rate	57600bps(default)
Data Size	8bit
Parity	non-parity
Stop Bit	One bit

CAUTION!

- ***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.***

② 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

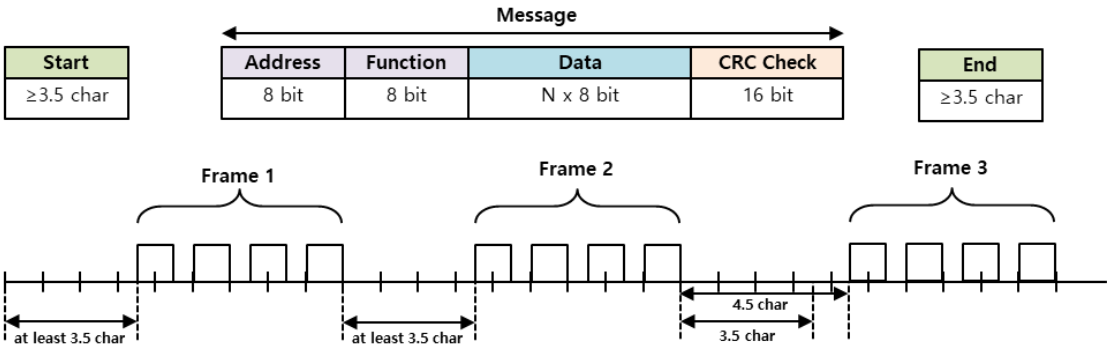
- Each mightZAP servo must have an individual ID to prevent interference between same IDs. Therefore, you need to set individual IDs for each servo in the network node.
- User may assign 247 different IDs, but the number of connectable actuators are 32 due to the limit of nods of RS-485 standard regulation.
- As factory default ID is 1, please assign different, individual IDs for each servo. It will be easier if you assign each ID when you connect each servo in Daisy-chain network one by one.

4.2.2 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**	≥3.5 char
1	**Address**	Servo ID (Range : 1 ~ 247, Broadcast ID: 0)
2	**Function**	Modbus Function Code
3	**Data**	N x 8bit
4	**CRC**	16bit

■ Element Description

1. Start

- The minimum time to distinguish between different frames.
- At a communication speed of 57600bps, 1bit transmission time is 0.017msec, and in the above case (3.5 character times, 1 Character = 8bit), Start Time is 0.486msec.
- If another frame is transmitted before the start time, it is recognized as a continuation of the previous frame.
- The spacing between each field must be within 10bit.

2. Address (1Byte)

- Identifier for the ID of each actuator so that actuators can be connected via serial Daisy chain. When ID = 0 (Factory default), it is a Broadcasting ID.
- ID range = 1 ~247

3. Function (1Byte)

- Various designated codes for commanding from Master to Slave (Actuator).
- The main code is '03 and 06'. (Refer to the function code for detailed info.)

Function	CODE	Description
Read Holding Register	0x03	Read Actuator Data
Write Single Register	0x06	Set data value to the specific address of actuator
SP Function code 1	0xf6	System Memory Reset
SP Function code 2	0xf8	System Restart

4. **Data(1Byte)**

- Varies depends on the function code, and the field configuration is at least 2bytes.
- Composed of Register Address, Data, Byte-Count, etc.

5. **CRC Check**

- Consists of 2 bytes.
- Transmission order is in the order of lower 1 byte + upper 1 byte.
- CRC Check Method is CRC-16(X^16 + X^15+X^2 + 1)

② Function File

The codes used in the function field are as follows.

- **'03': Read Holding Register (0x03)**

  - The code that reads the parameters of the target actuator.

  - One parameter or multiple consecutive parameter values can be read.

  - Register is the order of parameters (40001 ~ 4xxxx), and the corresponding Data Address is "0000 ~ xxxx".

- **'06' : Write Single Register (0x06)**

  - The code to set the specific parameter value of the target actuator.

  - Set the value by designating one specific parameter.

- **SP(Special) Function Code(Not used for standard Modbus)**

  - This is not a universally used code, but it is a function code used for special functions of mightyZAP actuators.

  ▶ System Memory Reset

  - Reset the internal parameters of the actuator.

  - Depending on the option, Servo ID and Baudrate cannot be reset.

option	Bit	Reset Action
Servo ID	0	Initialize servo ID to 1
Baud-Rate	1	Initialize Baud-rate to 32(57600)

▶ System Restart

- Reboot the actuator
- Overload Shutdown Alarm to be released.

4.2.3 Data Map

① Data Memory Map

- Multi write function is not supported.
- All data will be reset to default value when Reset command is executed.

Address	addr	Name	Access	Default	MIN	MAX	Type
40001	0x0000	Model Number	R	-			Non-volatile
40002	0x0001	Version of Firmware	R	-			
40003	0x0002	ID	RW	1	1	247	
40004	0x0003	Baud Rate	RW	32(0x20)	16	128	
40005	0x0004	Protocol Type (MODBUS/IRROBOT)	RW	0	0	1	
40006	0x0005	Short Stroke Limit	RW	0(0x0000)	0	4095	
40007	0x0006	Long Stroke Limit	RW	Individual Spec	0	4095	
40008	0x0007	Lowest Limit Voltage	R	70	-	-	
40009	0x0008	Highest Limit Voltage	R	130	-	-	
40010	0x0009	Alarm LED	RW	32	-	-	
40011	0x000a	Alarm Shutdown	RW	32	-	-	
40012	0x000b	Start Compliance Margin	RW	7	0	255	
40013	0x000c	End Compliance Margin	RW	2	0	255	
40014	0x000d	Speed Limit	RW	1023	0	1023	
40015	0x000e	Current Limit	RW	800	0	1600	
40016	0x000f	Calibration Short Stroke	R	Individual Spec	0	4095	
40017	0x0010	Calibration Long Stroke	R		0	4095	
40018	0x0011	Acceleration Ratio	RW		0	255	
40019	0x0012	Deceleration Ratio	RW		0	255	
40020	0x0013	Current I Gain	RW		0	255	
40021	0x0014	Current P Gain	RW		0	255	
40022	0x0015	Speed D Gain	RW		0	255	
40023	0x0016	Speed I Gain	RW		0	255	
40024	0x0017	Speed P Gain	RW		0	255	
40025	0x0018	Min Stroke Position	RW		0	255	
40026	0x0019	Max Stroke Position	RW		0	255	
40051	0x0032	Force ON/OFF	RW	0	0	1	volatile
40052	0x0033	LED	RW	0	0	255	
40053	0x0034	Goal Position	RW	-	0	4095	
40054	0x0035	Goal Speed	RW	Speed Limit	0	1023	
40055	0x0036	Goal Current	RW	Current Limit	0	1600	
40056	0x0037	Present Position	R	-	0	4095	
40057	0x0038	Present Current	R	-	0	1600	
40058	0x0039	Present Motor Operating Rate	R	-	0	2048	
40059	0x003a	Present Voltage	R	-	0	255	
40060	0x003b	Moving	R	-	0	1	
40061	0x003c	Hardware Error State	R	0	0	255	

4.2.4 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 [1~247 / Default : 1]

ID to discriminate each servo. Different IDs should be assigned in Daisy-Chain system. (Default ID : 1)

- In case of ID = 0, it is operated under "Broadcasting Mode (move all actuators)" and Feedback Packet does not work.
- In case of ID = 1 ~247, ID "N" which is stored in the servo will be operated individually.

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 MUST be rebooted to apply changed baud rate to the actuator.

[Setting Value]

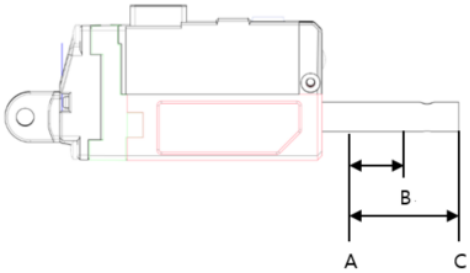
Value	Baud Rate(bps)
16 (0X10)	115200
32 (0X20)	57600
48 (0X30)	38600
64 (0X40)	19200
128 (0X80)	9600

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.

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

5) Stroke Limit [0~4095]

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.



Stroke limit 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.

6) Protocol type

Select the communication protocol method.

Value	Protocol	Description
0 (0x00)	MODBUS RTU	Industrial RS485 standard communication protocol
1(0x01)	IR Protocol	IRROBOT's own typical Protocol ※Please refer to the IR Protocol user manual. This manual is for MODBUS protocol only.

Protocol Type 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.

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

7) The Highest / Lowest Limit Voltage

Upper/lower limit of input power voltage (unit: 0.1V / Not changeable). The speed and force of the actuator can be changed according to the input voltage. For details, refer to the datasheet of the model.

Parameter	Default Value
Lowest voltage	7.0[V] (70)
Highest Voltage	13[V] (130)

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.

Motor operating 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.

9) Alarm LED [0~255 / Default : 33]

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**

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.

Alarm LED 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.

10) Alarm Shutdown [0~255 / Default : 33]

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**

TIP **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.

11) Compliance Margin

Start Compliance Margin (Recommended margin value : 7 ~ 15)

- 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 : 3~4)

- 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.

Stroke Compliance Margin 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) Speed Limit [0~1023 / Default : 1023]

- It is the 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.
- If you change the Speed Limit value, the Goal Speed is also changed.
- Speed limit is a non-volatile memory parameter. Use it as the initial value of the desired speed. If you want to change the speed during operation, use the volatile memory parameter, Goal Speed.

Speed Limit 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.

Under old Firmware Version 1.5, the same command is named as Goal Speed. With the new firmware V2.0, Goal speed is volatile parameter while its function is same as Speed Limit in non-volatile parameter.

13) Current Limit [0~1600 / Default : 800]

- Maximum current limit of the motor (0~1600).
- Set the control value from 0 to 1600, and the control value 1600 represents the maximum current value of 1600mA.
- It is recommended to set the Current Limit value only in the initial setting, and for current control during operation, use the Goal Current parameter instead which is volatile one.
- Current Limit value 800 (800mA) is default, and maximum speed at rated load is guaranteed at this level.
- The current limit value for the rated force is about 380~400, and if it is set below that value, a force lower than the rated force can be implemented.
- The closer the current limit is set to the stall force, the higher the maximum force that the motor can produce in an overload situation, but it may also shorten the life of the motor.
- If the non-volatile Current Limit value is changed, the volatile parameter Goal Current is also changed.

Current Limit 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.

Under old Firmware Version 1.5, the same command is named as Goal Current. With the new firmware V2.0, Goal Current is volatile parameter while its function is same as Current Limit in non-volatile parameter.

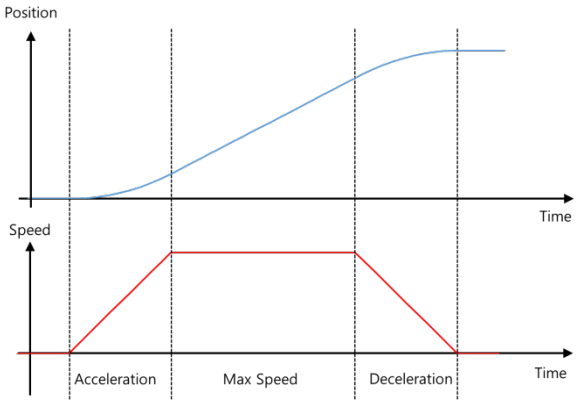
14) Calibration Stroke

- 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 [0~255 / Default : Individual Spec]

- PI value for motor current control. If a larger PI value than the set value is applied, it may behave harshly for the error between Goal Current and Present Current.
- When a PI value smaller than the set value is applied, the error between the Goal Current and Present Current works smoothly, but the error between the Goal Current and the Goal Current 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.

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

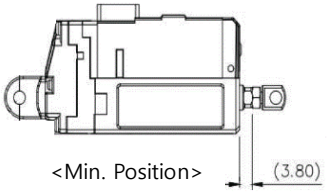
- PID value for speed control of motor.
- If a PID value larger than the set value is applied, the motor may vibrate without being able to stop at the set position value due to overshoot or over-response state due to rough operation against the error between the goal speed and the current speed.
- If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

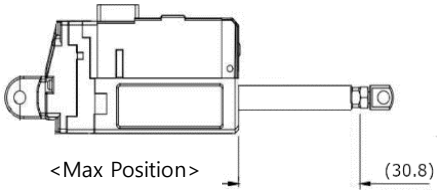
It is a non-volatile memory area. If you change the data, communication may stop for a short time during saving process. Therefore, please be careful of frequent value changes during operation.

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 ±0.5mm.
  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

migtyZAP keeps its position due to mechanical design even after motor power is off. For instance, mightyZAP having more than 27N or higher rated load spec, 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 monitoring.
- 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 monitoring. 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.
- Between1~1023: Motor operating rate on short stoke direction (retract direction).
  Between 1024~2047: Motor operating rate on long stoke direction (extend direction).

26) Present Current [0~1600]

- Present motor Current value monitoring.
- 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 monitoring. 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)

29) Hardware Error State

Displays the hardware error status of the actuator.

Error	bit	Note
NONE	7	TBA
NONE	6	TBA
Overload Error	5	*** Set when overload occurs**
NONE	4	TBA
NONE	3	TBA
NONE	2	TBA
NONE	1	TBA
Input Voltage Error	0	**Set when the input voltage is out of lower/higher limit**

- Overload: Overload is calculated using the accumulation of current per unit time. Overload is set when the actuator is operated continuously for 30 seconds under rated load condition without any short rest. The maximum operating time at the minimum current setting is 3 minutes.

4.2.5 Command Example Packet

1) '03' : Read Holding Register(0x03) Example

Request

Address	Function	Starting Address Hi	Starting Address Lo	No of Register Hi	No of Register Hi	CRC Lo	CRC Hi
0x01	0x03	0x00	0x37	0x00	0x01	0x35	0xc4

Response

Address	Function	Byte Count	Register Value Hi	Register Value Lo	CRC Lo	CRC Hi
0x01	0x03	0x02	0x08	0x00	0xbf	0x84

2) '06' :Write Single Resister(0x06) Example

Request

Address	Function	Starting Address Hi	Starting Address Lo	No of Register Hi	No of Register Hi	CRC Lo	CRC Hi
0x01	0x06	0x00	0x34	0x08	0x00	0xcf	0xc4

Response

Address	Function	Starting Address Hi	Starting Address Lo	No of Register Hi	No of Register Hi	CRC Lo	CRC Hi
0x01	0x06	0x00	0x34	0x08	0x00	0xcf	0xc4

- In case of normal communication, the value sent by command is returned.

3) 'f6' : Memory Reset(0xf6) Examples

Option

Value	Description
0	All data is initialized and the system is reset.
1	All data except 'Baudrate' are initialized and the system is reset.
2	All data except 'Remind ID' are initialized and the System is reset.
3	All data except 'Baudrate' & 'Remind ID' are initialized and the System is reset.

Request option 0 (All data is initialized and the system is reset.)

Address	Function	Starting Address Hi	Starting Address Lo	No of Register Hi	No of Register Hi	CRC Lo	CRC Hi
0x01	0xf6	0x00	0x00	0x00	0x00	0xc9	0xdf

Request option 1 (All data except 'Baudrate' are initialized and the system is reset.)

Address	Function	Starting Address Hi	Starting Address Lo	No of Register Hi	No of Register Hi	CRC Lo	CRC Hi
0x01	0xf6	0x00	0x00	0x00	0x01	0x08	0x1f

4) 'f8' : System Restart

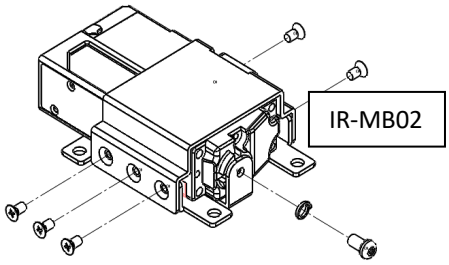
Request option 0

Address	Function	Starting Address Hi	Starting Address Lo	No of Register Hi	No of Register Hi	CRC Lo	CRC Hi
0x01	0xf8	0x00	0x00	0x00	0x00	0xa0	0x1e

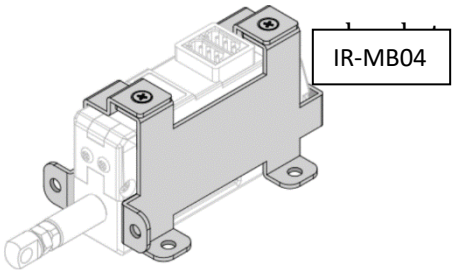
5. Optional Accessories

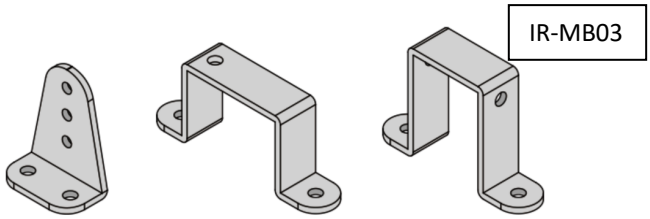
Metal Bracket (IR-MB02/IR-MB03/IR-MB04)

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 at their end.

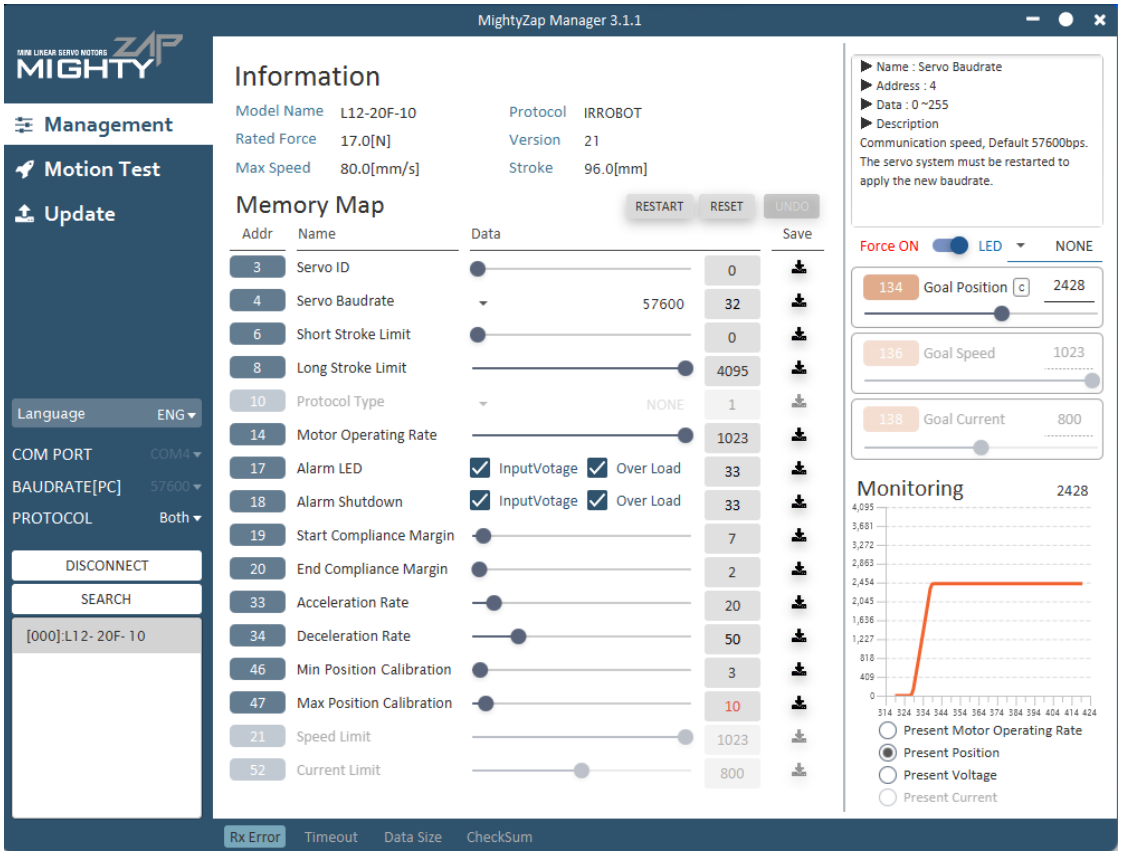




PC USB Interface (IR-USB02)

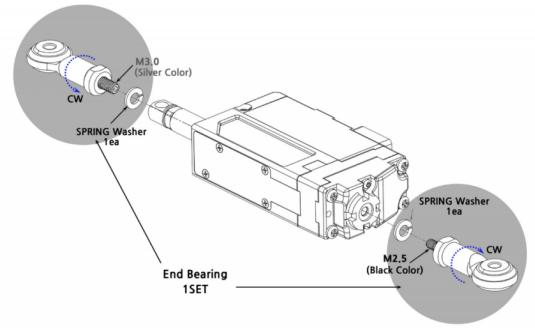
USB Interface between mightyZAP and user's PC. Through PC software, mightyZAP manager, user is able to control below.

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



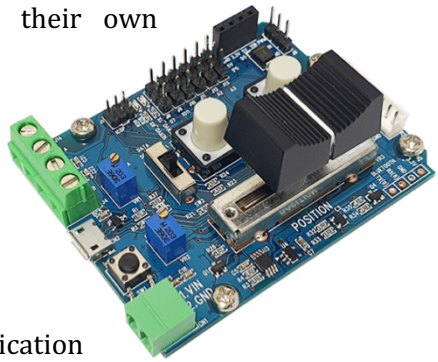
End-Bearing (IR-EB01)

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)

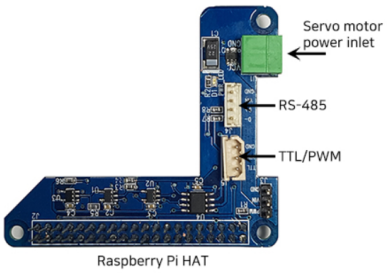
- mightyZAP controller/tester for customers who do not have their own controller
- Arduino based simple operation
- Built-in basic control program, User programmable (Arduino example provided)
- Built-in position setting dials, position command button switches and position command slide
- Controllable 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-STS02)

IR-STS02 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.



Raspberry Pi HAT

Extension Wire (IR-EW01~10)

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.


Rod-End Grip Tip

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

6. Warranty

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 :

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- E-mail : cs@irrobot.com

Thank you.