Futaba®

LJ9DA41

Servo for UAS

Instruction Manual

Caution

- **Read this instruction manual before use.**
- **Keep this manual handy for immediate reference.**

For models/UAS

1M23Z05002
User's Manual ver.2.10

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1. For Safety

Please observe the following precautions to ensure safe use of this product at all times.

Be sure to read this instruction manual prior to using this product.

Warning Symbols

The warning symbols used in this text are defined as follows:

Indication	Meanings
⚠ Danger	Indicates a hazard that will cause severe personal injury, death, or substantial property damage if the warning is ignored.
⚠ Warning	Indicates a hazard that can cause severe personal injury, death, or substantial property damage if the warning is ignored.
⚠ Caution	Indicates a hazard that will or can cause minor personal injury, or property damage if the warning is ignored.

Symbols: ⃠ :Prohibited ❗ :Mandatory

Cautions for use

⚠ Warning

⃠ **NEVER use this product for the devices that is directly related to human life such as below;**

- Medical Devices
- Aerospace/ground manned vehicles
- Nucleus-related Devices

⚠ Caution

Do not disassemble or alter the servo.

Otherwise, it may cause breakage in the gear box, fire on the servo or explosion of the battery.

Do not touch the servo case during or some time after operating the servo.

Otherwise, you may get burned on the finger as the motor or electronic circuit in the servo gets very hot.

Do not use the servo underwater.

Protection level of the servo is IP64 (dust and drip proof).

Using the servo underwater may be cause of damage or crash.

Do not leave the servo locked.

If the servo continues to be locked due to a strong external force, it may cause smoke, fire or damage.

Do not revolve and/or force to move the rod of the servo.

Otherwise, the servo will be damaged.

Do not add a strong shock or vibration to the servo.

Do not drop and/or throw the servo away.

Locate the servo so that the metal parts such as heat sink will not touch other metal parts.

To touch metal parts will be cause of electrical noise and adversely affects communication.

Please use a power source with sufficient capacity of current.

When the servo is locked (fixed not to be able to move), a very large current flows.

Design the location of the servo carefully about the temperature.

The case of the servo is designed as a heat sink, it will become high-temperature.

Turn on the control signal for the servo before turning on the power on.

When using servos with Transmitter and Receiver, always make sure to turn the Transmitter power on first.

Check the operational status of all servos before using your device.

Turn off the servo before switching signals between PWM / S.BUS and RS485.

Switching between S.BUS/PWM and RS485 without turning off the power will be cause of breaking down of the servo.

Do NOT input “S.BUS” or “PWM” and “RS485” simultaneously.

Inputting S.BUS/PWM and RS485 will be cause of breaking down of the servo.

Connect the servo correctly with external equipment such as power supply and receiver.

Incorrect connection will be cause smoke, fire, or damage.

Locate the servo from the noise source.

Strong noise such as electromagnetic waves and static electricity from the external environment will be cause of malfunction or damage.

Do not connect or disconnect the servo connector while the power is ON.

When connecting and disconnecting the servo connector in a state of power-ON, the servo will mis-recognizes the control signal and might stop.

Use the servo and other devices within each range of operational voltage.

Cautions for storage

⚠ Caution

Do not store the servos in the following conditions.

Places where the temperature is over 60℃ or below -20℃.

Places where the Sun directly shines over the servos.

Places where it is very high in humidity.

Places where there is a strong vibration.

Places where there is a lot of dust.

Places where static electricity tends to be induced.

Places where infants can reach.

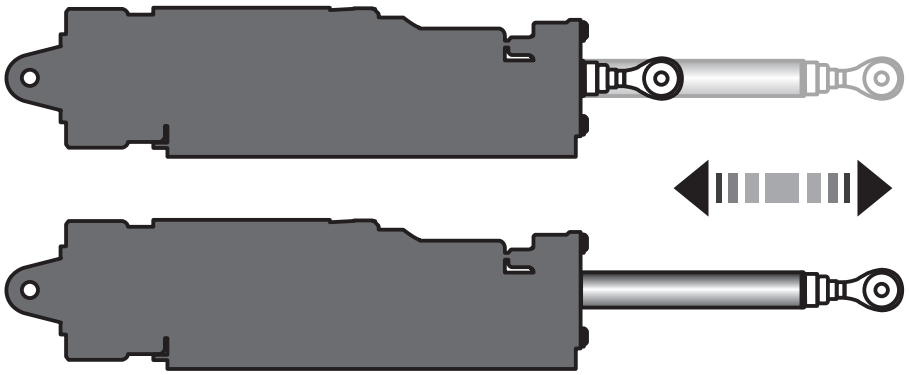
Storing the servos in the places shown above may cause deformation and failure of the servos, or hazard.

2. Introduction

Feature

LJ9DA is a servo designed for UAS (Unmanned Aerial System), UAV and UGV, etc. Our servo is driven by a linear motion mechanism, and has an integrated structure comprising the motor, deceleration mechanism, linear motion mechanism and control circuit. By using outside communication, its operation can be directed and inside information sent back.

- **Input Signal (Selectable): PWM/S.BUS/RS-485**
- **Position Feedback Output**
- **Long life Position sensor**
- **Programming Function**
- **Over Temperature Protection**
- **Shielded cable (Noise-proof)**
- **Operation temperature range － 10℃～＋ 60℃**
- **Water Resistant (IP64)**
- **Linear motion mechanism : Ball screw**



Components

- ① LJ9DA41 • 1
- ② Cable • 1
- ③ LJ9DA41 INSTRUCTION MANUAL • • • • • • • 1

Fig 2.1 ① LJ9DA41

Fig 2.2 ② Cable

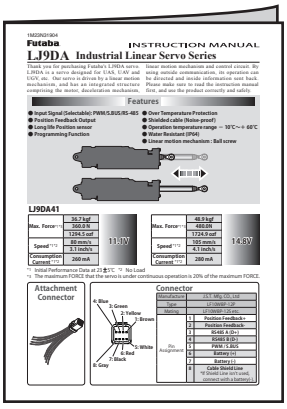


Fig 2.3 ③ LJ9DA41 INSTRUCTION MANUAL

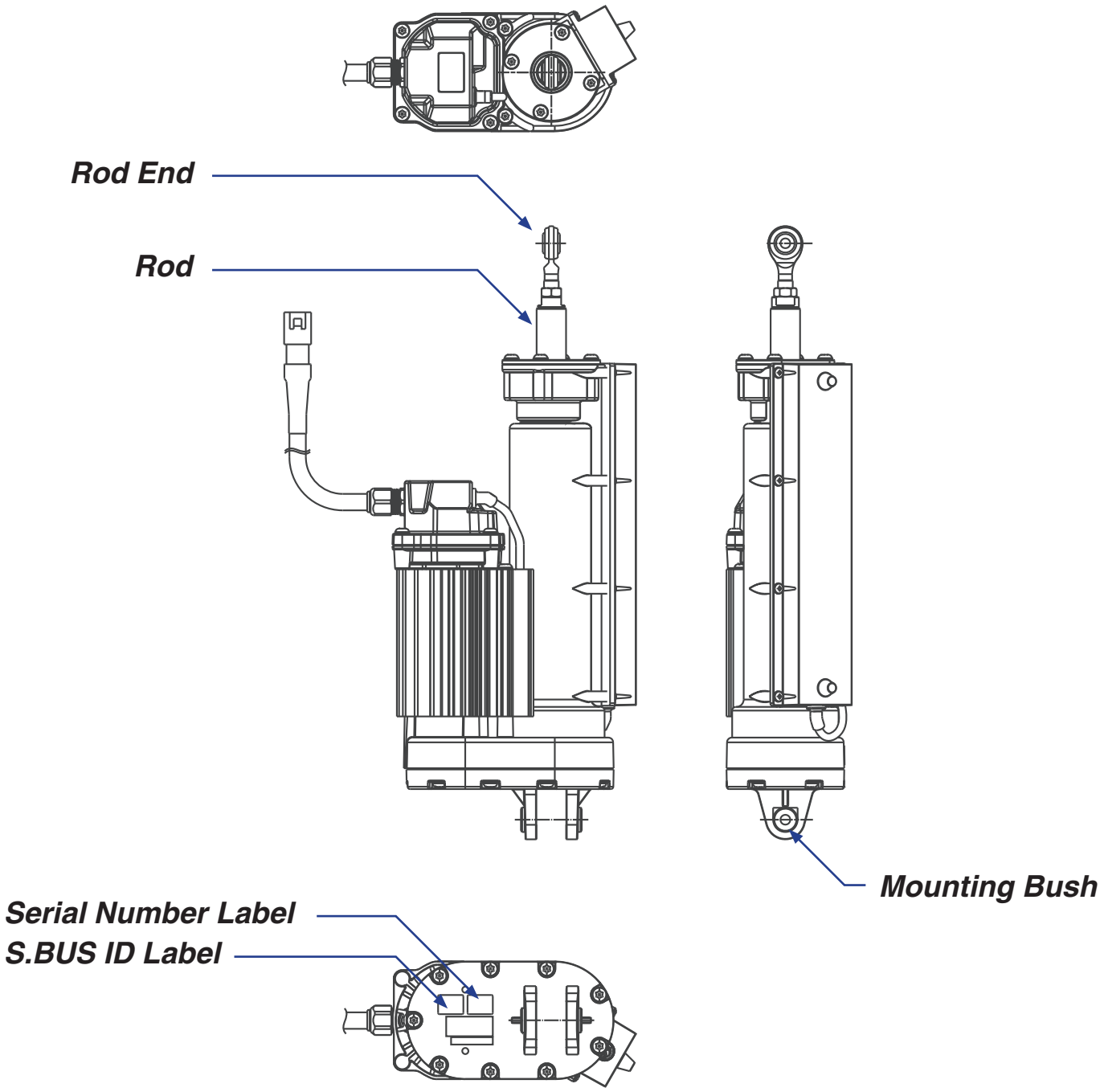


Fig 2.4 Part and Names

⚠ Caution

Do not disassemble or alter the servo.

Otherwise, it may cause breakage in the gear box, fire on the servo or explosion of the battery.

Do not revolve and/or force to move the rod of the servo.

Otherwise, the servo will be damaged.

Definition of servo stroke position

The stroke of the servo is defined as shown in Fig 2.5.

The center of the full stroke (50 mm) is 0.00 mm.

The extending direction is “+”, the shrinking direction is “-”.

This definition is common in all control methods and position feedback.

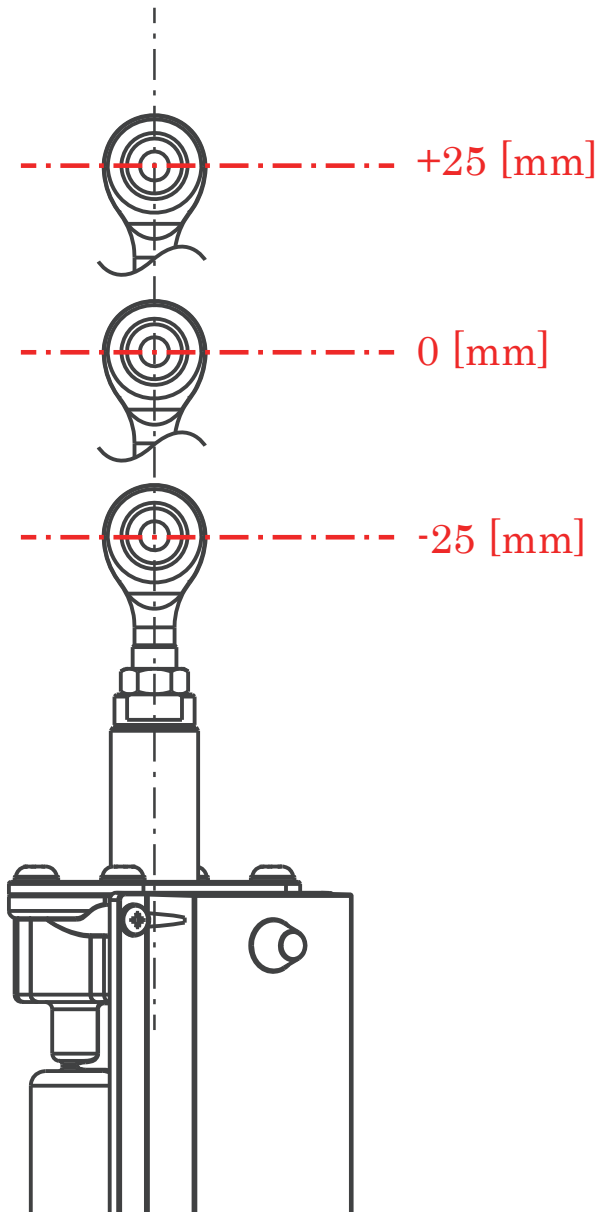


Fig 2.5 Definition of servo stroke positions

Mount of servo

Attach the rod end to the movable frame, the mounting bush (2 places) to the stationary frame. The figure below is an example of how to mount.

The rod end is a ball link and it can be used by tilting it within an allowable angle. Although the allowable angle is 12 degrees at maximum, it may become less than 12 degrees when the movable side frame and a part of the servo come into contact.

(The movable side frame and the stationary frame are not attached in product.)

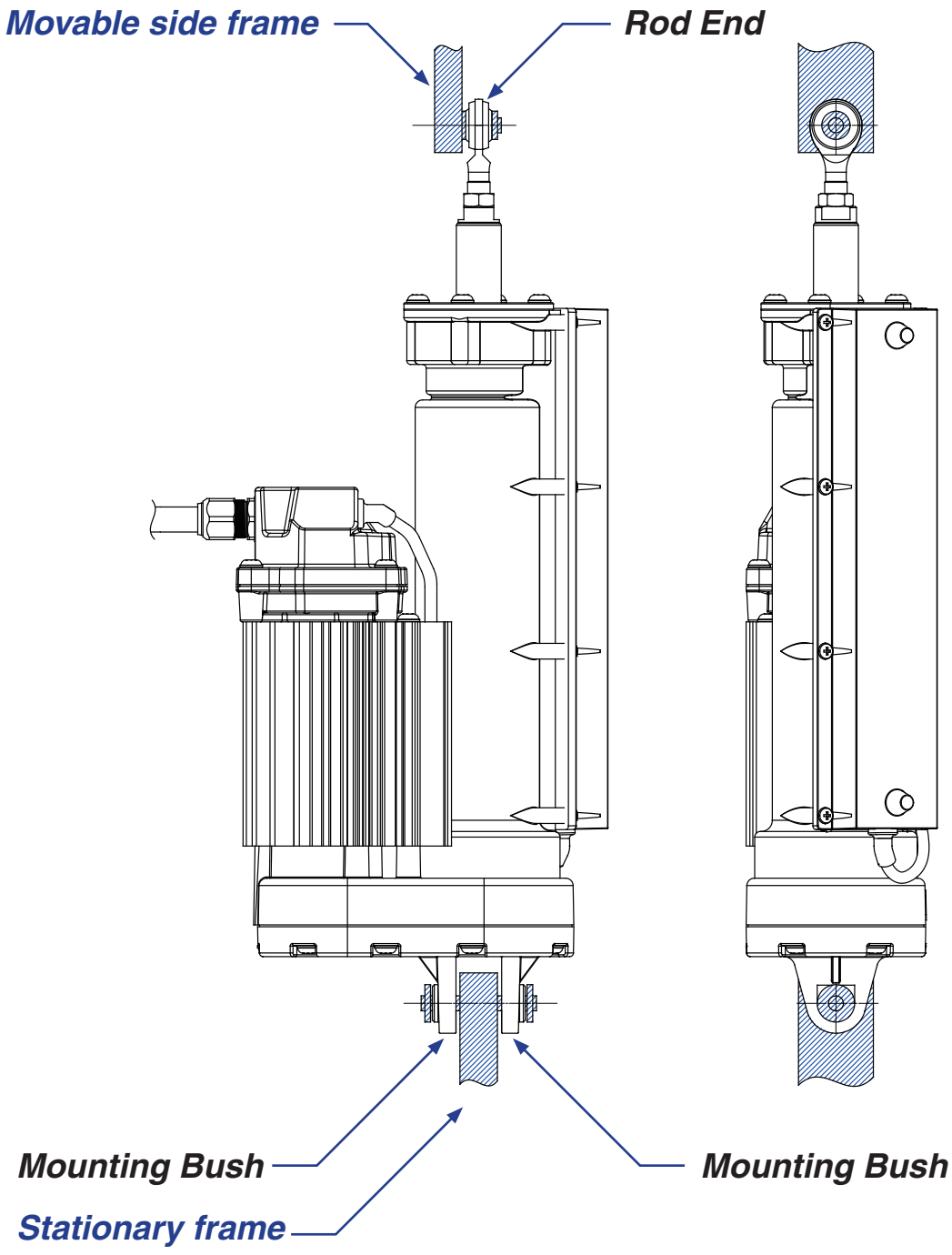


Fig 2.6 Ex. Mount of servo

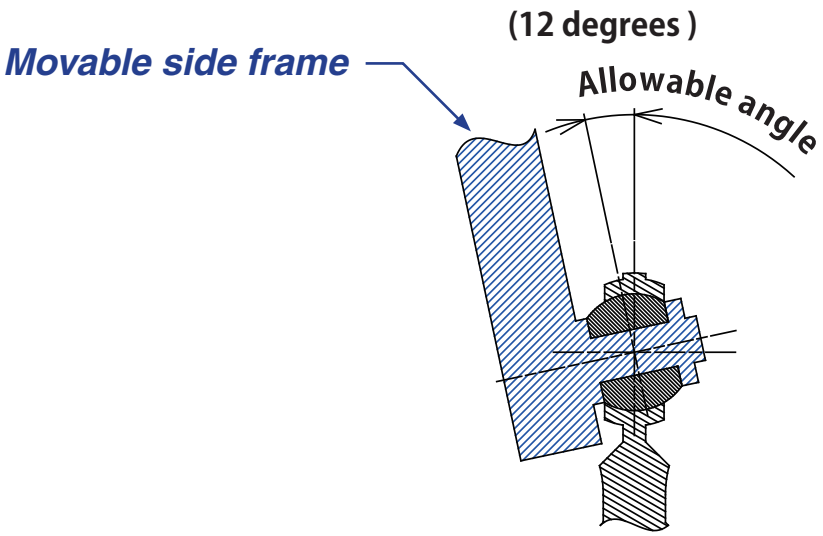


Fig 2.7 Allowable angle of rod end (sectional view)

⚠ Caution

Do not use parts other than the mounting bush and rod end for servo mounting. In addition, be sure to mount the servo by using 2 mounting bushes.

Otherwise, the servo will be damaged.

Do not remove the rod end from the servo.

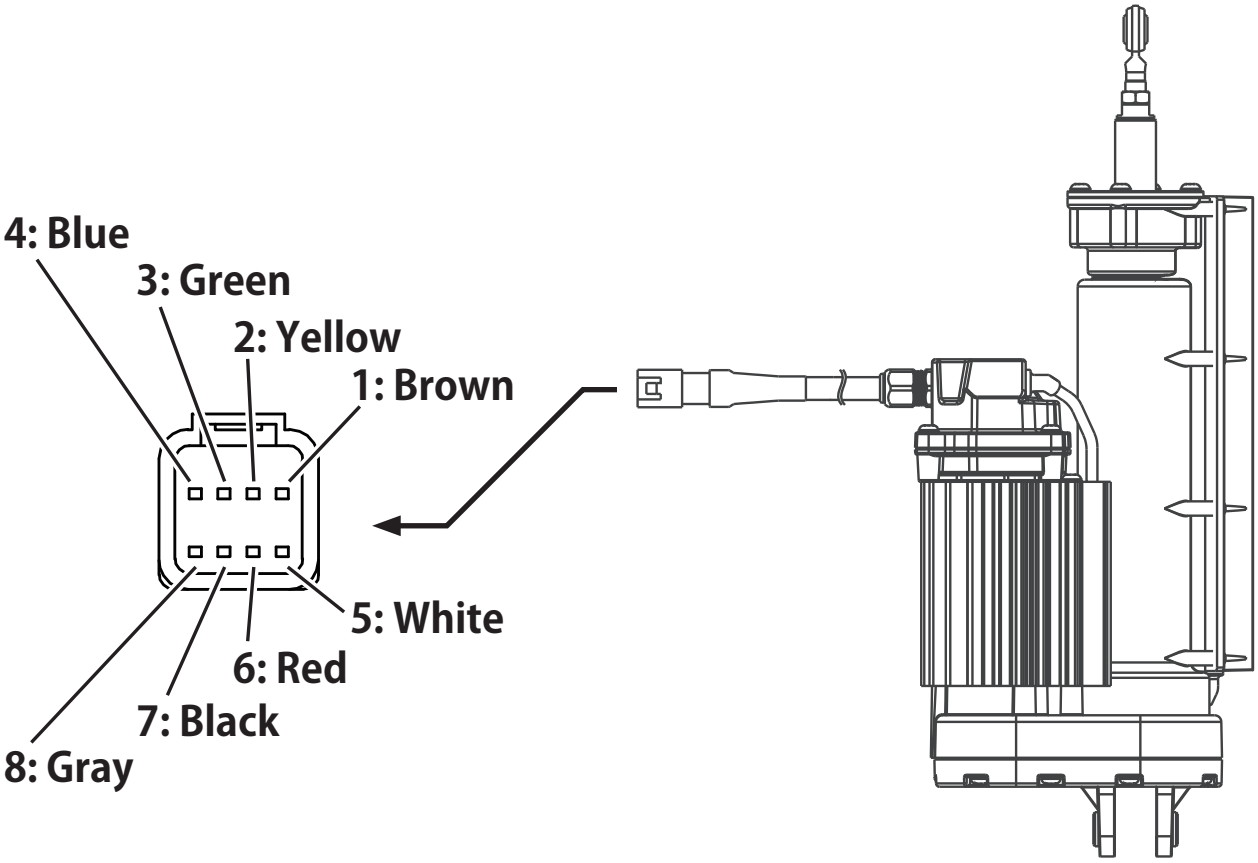
It will lose its water resistant function.

Do not exceed the allowable angle of the rod end.

If the allowable angle of the rod end is exceeded, the servo will be damaged.

Pin Assignment

Pin Assignment of LJ9DA is shown below;



Manufacture	J.S.T. Mfg. CO., Ltd	
Type	08T-JWPF-VSLE-D	
Mating	08R-JWPF-VSLE-D etc.	
Pin Assignment	1	**Position Feedback+**
	2	**Position Feedback-**
	3	**RS485 A (D+)**
	4	**RS485 B (D-)**
	5	**PWM/S.BUS**
	6	**Battery (+)**
	7	**Battery (-)**
	8	**Cable Shield Line** *If Shield Line isn't used, connect with a battery(-).

Fig 3.1 Pin Assignment

Control method

LJ9DA series can be controlled by “S.BUS”, “PWM” and “RS485 Command”, and has a “Position Feedback” function.

⚠ Caution

Do NOT input “S.BUS” or “PWM” and “RS485” simultaneously.

Inputting S.BUS/PWM and RS485 will be cause of breaking down of the servo.

Connector Pin for S.BUS and PWM is same, and the servo will change the control mode automatically according to the input signal (S.BUS or PWM).

When you change the control mode, you will have to reboot the servo.

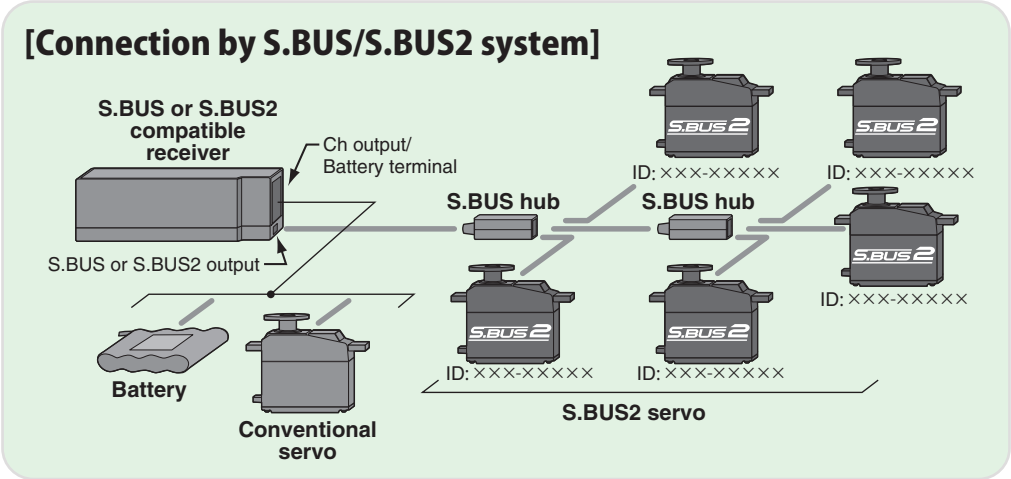
After the reboot, the servo stays in force-OFF (No output force) until the servo receives S.BUS or PWM (p.16) is input.

3.1. S.BUS (Input)

“S.BUS” is Futaba’s original protocol for R/C, and is used to be controlled by receivers with “S.BUS Port” or to change the parameters from PC with “S-Link” via USB adapter “CIU-2/3”.

The data of S.BUS includes commands to multiple servos such as “move the channel 3 servo to 15 mm, move the channel 5 servo to 20 mm”, and the S.BUS servos execute only the part of the command that the ID is equal to its ID.

For this, it can be used by connecting multiple servos to the same signal line.



• S.BUS2

S.BUS2 is advanced protocol of S.BUS that enables bi-directional communication and used for S.BUS servos and telemetry sensors.

LJ9DA is connectable with both S.BUS and S.BUS2.

• S-Link

”S-Link” is FREE software for S.BUS servos and can be downloaded from Futaba’s Website.

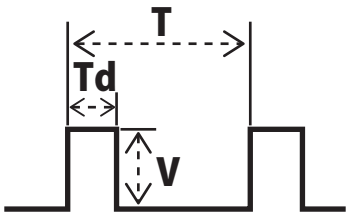
Fig 3.2 S-Link

3.2. PWM (Input)

“S.BUS” is Futaba’s original protocol for R/C.

Specify the position with the pulse width (Td in Table 3.1).

Table 3.1 PWM Specification

Signal Voltage : V	HIGH : min. 3.0 V max. 16.8 V
	LOW : min. 0.0 V max. 0.45 V
Frame Rate : T	3.0 ～ 30 ms (Default 14.25 ms)
Goal Position: Td	920 ～ 2120 (Center:1520) µs
Resolution	≤ 1 µs
	

● Goal Position (PWM)

The settable range of “Td” is 920 to 2120 [µs]. The target position at 1520 µs is 0.00 mm.

After power-on, the servo stays in force-OFF (No output force) until the servo receives PWM that “Td” is in the settable range.

When “Td” go out of settable range in PWM-Mode, the servo will hold the position just before being out of the range.

● Maximum Travel Stroke (PWM/S.BUS)

The target position of “Td”=920 µs (2120 µs) is -25 mm (+25 mm).

The settable range of these strokes (Maximum Stroke) is 50% to 150% (±12.5 mm to ±25.0 mm).

● Soft Start Delay (PWM/S.BUS)

To avoid servo's sudden movement, the movement of the servo to the first target position is slow.

When the actual position approaches enough to the target position, or the target position is changed, the servomotor works with the original speed.

3.3. RS485 Command (Input/Output)

RS485 Command is interactive serial communication protocol for Futaba's Servos for Robots, and to be used for sending target position or getting data of internal sensors such as Position, Temperature, Load (Current) and Voltage.

The protocol of "RS485 Command" is Asynchronous Half-Duplex communication and the signal line can be switched alternately for transmission or reception of data.

Normally, LJ9DA stands by in a Receiving-Mode. When they receive commands to get the data, they changes to Transmitting-Mode. After sending the data, they stand by again in a Receiving-Mode.

Table 3.2 Specifications of RS485 Command

Bit/s:	**115.2 [kbps] (selectable from 9.6 [kbps] to 460.8 [kbps])**
Data bit	**8 [bit]**
Parity	**None**
Stop bit	**1 [bit]**
Flow Control	**None**

3.4. Position Feedback (Output)

The voltage between Position Feedback (+) and Position Feedback (-) increases and decreases according to the position of the rod (refer Fig 3.1 in p.13).

This output will go on as long as the power is supplied to the servo.

The output voltage can be expressed from the position of the output stroke as follows, but use it only as a reference value.

When using the output voltage, please understand the actual relationship between the position of the output stroke and the output voltage.

Ex.

Output Voltage = 1.53 + Stroke position [mm] x 0.0352 [V]

Position of the Output stroke	Output Voltage
+25.00 [mm]	**2.41 [V]**
0.00 [mm]	**1.53 [V]**
- 25.00 [mm]	**0.65 [V]**

3.5. Protection Function (Temperature-Limit)

LJ9DA Series has a protection function (temperature limit function) to prevent the damage caused by the heat of the motor.

The behavior of the servo when the protection function acted and method to reboot is determined by its control method.

• PWM/S.BUS

The output force gradually decreases when the sensed temperatures of the internal sensor exceed 90 degrees Celsius, and becomes 0 (force OFF) when it exceeds 95 degrees Celsius.

The output Force gradually increases when it falls less than 95 degrees Celsius, and becomes 100% when it falls less than 90 degrees Celsius.

• RS485

The servo will be force-OFF when the Present Temperature (p.41) exceeds temperature Limit (p.32 85 degrees Celsius).

To turn on the force again, turn off-and-on the power (or) and send force-ON command after the temperature becomes less than temperature limit.

4. RS485 Command

Features

• Communication Protocol

The protocol of “RS485 Command” is Asynchronous Half-Duplex communication and the signal line can be switched alternately for transmission or reception of data.

Normally, LJ9DA stands by in a Receiving-Mode. When they receive commands to get the data, they changes to Transmitting-Mode. After sending the data, they stand by again in a Receiving-Mode.

• Memory Map

LJ9DA has its own memory area to store data necessary for its movement. This memory area is called “Memory Map”.

“Memory Map” is divided into two groups. One is “RAM Area” in which data will be erased when the power is turned off, and the other is “ROM Area” in which data will be held even after the power is turned off.

• Servo ID

“ID” is used to identify servos during communication.

The default number of every servo is set to “1”. When you use plural servos in a single communication network, give them different “ID” numbers.

• Packet

“Packet” is a block that is used for sending a command to or receiving data from the servo.

Packets are divided into the following three groups, having different formats.

• Short Packet

Short Packets are used for sending the data in the memory map toward a single servo. (→ p.20)

• Long Packet

Long Packets are used for sending the data in the memory map toward multiple servos. (→ p.24)

• Return Packet

Return Packet is a packet that is sent from a servo when a return packet is requested. (→ p.26)

Format of the Packet

• Short Packet

Short Packet is used for sending the data in the memory map to a single servo.

Structure

Header	ID	Flag	Address	Length	Count	Data	Sum

Header

This is a line head of a packet. Set “FA AF” for short packets.

ID

Set “ID” of the servo to be sent the packet.

By setting “FF” (=255), commands are commonly effective to all servos.

Flag

“Flag” shows reaction of the servo such as sending Return Packet or write ROM Area and so on.

For details, refer subsequent pages.

Address

Set the starting address of Memory Map to be changed.

Length

“Length” is the length of the data. Set the number of bytes of “Data”.

Count

“Count” is the number of servos to be sent “Data”. Set “1” for a short packet.

Data

“Data” to be written in the memory map of the servo.

Sum

“Sum” is the value obtained from XOR operation on all bytes from ID through Data in a packet by a unit of a byte.

Ex.) ”Sum” of following packet is “1C”.

Hdr	ID	Flg	Adr	Len	Cnt	Dat	Sum
FA AF	01	00	1E	02	01	00 00	1C

01H XOR **00H** XOR **1EH** XOR **02H** XOR **01H** XOR **00H** XOR **00H** = **1C**

Details of Flag

Each bit has the following meaning.

Table 4.1 Bit of Flag

Bit	Function
7	(Reserved)
6	Write Flash ROM
5	Reboot Servo
4	Initialize Memory Map
3	Direct Address of Return Packet
2	Direct Address of Return Packet
1	Direct Address of Return Packet
0	Direct Address of Return Packet

Bit 7: Reserved

Set “0” to this bit always.

Bit 6: Write Flash ROM

By setting this bit to “1” (Flags=40H) and sending a packet of address = FFH, Length = 00H, Count = 00H to a servo, data of the memory map from No.4 to No.29 is written in Flash ROM.

After the flash write command, wait at least 1 second and then perform the next operation (reboot, command etc.).

Ex.) Write Flash ROM of the servo (ID:01)

Hdr	ID	Flg	Adr	Len	Cnt	Sum
FA AF	01	40	FF	00	00	BE

The servo’s memory should be renewed with the data you want to write into the Flash ROM by transferring the data beforehand.

The servo ID becomes effective only after receiving a packet. The ID returns to the previous number on the next boot up unless the ID is written into the Flash ROM.

Caution

Never turn off the power while the Flash ROM is being written.

Turning off the servo will cause the damage of the servo.

Bit 5: Reboot Servo

Setting this bit to “1” (Flags=20H), and sending a packet with Address = FFH, Length = 00H, Count = 00H to a servo will reboot a servo.

Ex.) Reboot servo (ID:01)

Hdr	ID	Flg	Adr	Len	Cnt	Sum
FA AF	01	20	FF	00	00	DE

A packet for “Write Flash ROM” and a packet for “Reboot Servo” have to be sent separately.
“Reboot Servo” packet must be sent after finishing “Write Flash ROM”.

Bit 4: Initialize the memory map from No.4 to No.29

Setting this bit to “1” (Flags=10H), and sending a packet with Address = FFH, Length = 00H, Count = 00H and data = FFH to a servo will initialize the memory map from No.4 to No.29 to their default value.

Please refer to default value in the “Memory Map of ROM Area” (p.28) for more details.

Ex.) Initialize the memory map of the servo (ID:01)

Hdr	ID	Flg	Adr	Len	Cnt	Sum
FA AF	01	10	FF	FF	00	11

Caution

After initializing the servo, “ID” of the servo becomes “1”.

Bit 3 to 0 : Direct Address of Return Packet

(1) Direct Area of Memory Map

Setting Bit 3 to Bit 0 of a Short Packet as Table 4.2, you can receive return data of the specified area of servo's memory map.

The RS485 half-duplex communication does not allow addressing more than one servo that can send a return packet. After requesting a return packet, do not send next data until completing receiving of the return packet.

Table 4.2 Bit of Flag

Bit 3 2 1 0	Function
0 0 0 0	No return Packet
0 0 0 1	Return ACK Packet
0 0 1 1	Return the data of memory map No.00 to No.29
0 1 0 1	Return the data of memory map No.30 to No.59
0 1 1 1	Return the data of memory map No.20 to No.29
1 0 0 1	Return the data of memory map No.42 to No.59
1 0 1 1	Return the data of memory map No.30 to No.41
1 1 1 1	Return the specified number of bytes of data starting from the specified address

(2) Direct specified address

Setting the Bit 3 to Bit 0 to "1" and sending a short pcakcet with the starting address whose data you want to receive, the length of data and the count = 00H makes it possible to return the specified number of bytes of the data starting from the specified address.

Available addresses in the memory map are from No.00 to No.59 (00H~3BH).

Ex.) Return the data of addresses from No.42 (2AH) through No.43 (2BH) of the servo (ID:1).

Hdr	ID	Flg	Adr	Len	Cnt	Sum
FA AF	01	0F	2A	02	00	26

(3) ACK Packet

By sending a Short Packet with the Bit 0=1, Bit1=0, Bit2=0, Bit3=0, the servo will return ACK packet.

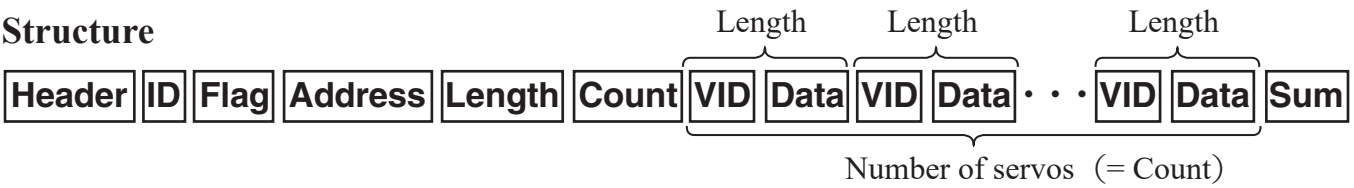
ACK Packet is only 1 byte of data that is **07H**="ACK"

• Long Packet

“Long Packet” is used to send the data to multiple servos.

(“Address” and “Length” are the same to all servos.)

Structure



Header

This notation indicates the front of a packet. Set “FA AF” for Long Packet.

ID

Set “0” for Long Packet always.

Flags

Set “0” for Long Packet always.

Address

Set the starting address of Memory Map to be changed.

Length

“Length” is the length of the data for each servo.

Length = the number of bytes of the data for each servo + 1 (byte of VID).

Count

“Count” is the number of servos to be sent “Data”.

VID

“VID” is the ID of each servo.

Data

“Data” to be written in the memory map of each servo of a byte.

Sum

"Sum" is the value obtained from XOR operation on all bytes from ID through Data in a packet by a unit of a byte.

Ex.) Set position to 10 mm to the servos (ID:1 and ID:2) and 50 mm to the servo (ID:5).

Hdr	ID	Flg	Adr	Len	Cnt	VID	Dat	VID	Dat	VID	Dat	Sum
FA AF	00	00	1E	03	03	01	64 00	02	64 00	05	F4 01	ED

The check sum of the send data above is:

00H XOR **00H** XOR **1EH** XOR **03H** XOR **03H** XOR **01H** XOR **64H** XOR **00H** XOR **02H** XOR **64H** XOR **00H** XOR **05H** XOR **F4H** XOR **01H** = **ED**

• Return Packet

“Return Packet” is the packet returned from the servo when the Flag field requests a servo to send a return packet.

Structure

Header	ID	Flags	Address	Length	Count	Data	Sum

Header

This notation indicates the front of a packet. “FD DF” is set to Return Packet.

ID

This is the “ID” of the servo that sent Return Packet.

Flags

“Flags” of the Return Packet shows conditions of the servo.

Table 4.3 Bit of Flag

Bit	Value	Function
7	0: Normal/1: Error	Temperature Limit (Force OFF)
6	0	(Reserved)
5	0: Normal/1: Error	Temperature Alarm
4	0	(Reserved)
3	0: Normal/1: Error	Write Flash ROM Error
2	0	(Reserved)
1	Not Defined	(Reserved)
0	0	(Reserved)

Address

“Address” shows starting address of the data of return packet.

Length

“Length” shows the number of bytes of “Data”.

Count

“Count” Shows the number of servos. “1” is set for Return Packet.

Sum

“Sum” shows check sum of the Return Packet, and its value is the XOR from “ID” to the end of “Data” in byte units.

• Storing 2-Byte date

Two-byte data is stored to the memory map in two individual 8-bit bytes of H (High byte) and L (Low byte).

Ex.) Set Position to 2.92 mm to servo (ID:23).

Target position is stored in “Goal Position” (Address 30/31) with unit of 0.01 mm.

(2.92 [mm] = 292 [0.01 mm, DEC] = 0124 [0.01 mm, HEX])

Stored data is bellow;

Goal Position (L) = 24H

Goal Position (H) = 01H

4.1. Invariable ROM Area

Table 4.4 Memory Map (Invariable ROM Area)

Area	Address		Initial	Name	R/W
	DEC	HEX			
Invariable	00	00H	N/D	Model Number L	R/W
	01	01H	N/D	Model Number H	R
	02	02H	N/D	Firmware Version	R
	03	03H	00H	Reserved	-

*N/D; Not Defined, or the value is defined according to each models.

• No.0/No.1 Model Number (2 Byte, Read)

The relations of Model Name and Model Number are shown below;

Table 4.5 Model Name and Model Number

Model Name	Model Number L	Model Number H
LJ9DA41	10H	75H

• No.2 Firmware Version (1 Byte, Read)

It is the version of the servo's firmware.

Its value is depending on the version at production (0 x 01 in the example below).

Firmware Version = 01H

4.2. Variable ROM Area

Table 4.6 Variable ROM Area

Area	Address DEC	Address HEX	Initial	Name	R/W
Variable	04	04H	01H	Servo ID	RW
	05	05H	00H	Reverse	RW
	06	06H	07H	Baud Rate	RW
	07	07H	00H	Return Delay Time	RW
	08	08H	C4H	Plus Position Limit L	RW
	09	09H	09H	Plus Position Limit H	RW
	10	0AH	3CH	Minus Position Limit L	RW
	11	0BH	F6H	Minus Position Limit H	RW
	12	0CH	00H	Reserved	-
	13	0DH	00H	Reserved	-
	14	0EH	55H	Temp Limit L	R
	15	0FH	00H	Temp Limit H	R
	16	10H	00H	Reserved	-
	17	11H	00H	Reserved	-
	18	12H	00H	Reserved	-
	19	13H	00H	Reserved	-
	20	14H	00H	Reserved	-
	21	15H	00H	Reserved	-
	22	16H	00H	Reserved	-
	23	17H	00H	Reserved	-
	24	18H	08H	Plus Compliance Margin	RW
	25	19H	08H	Minus Compliance Margin	RW
	26	1AH	00H	Plus Compliance Slope	RW
	27	1BH	00H	Minus Compliance Slope	RW
	28	1CH	C4H	Punch L	RW
	29	1DH	09H	Punch H	RW

• No.4 Servo ID (1Byte, Read/Write)

It is the “ID” of the servo.

Its Initial value is 01H and the settable range is from 1 to 127 (01H to 7FH).

Ex.) Set ID to “5” to the servo (ID:1).

Hdr	ID	Flg	Adr	Len	Cnt	Dat	Sum
FA AF	01	20	04	01	01	05	00

The servo begins to operate under the new ID as soon as the ID rewrite packet is received.

Note that the ID returns to previous ID if it was not written to the Flash ROM before turning off the power.

• No.5 Servo Reverse (1 Byte, Read/Write)

It is the expansion/contraction direction of the servo. Its initial value is 00H that means the normal direction, and the value of 01H means reverse direction.

When it is set to 01H (reverse direction), the Position Limit is also reversed.

• No.6 Baud Rate (1Byte, Read/Write)

It is the baud-rate of communication.

Initial value is 07H (115,200 bps) and the settable range is from 0 to 10 (00H to 0AH).

The values and baud rate is assigned as shown in Table 4.7.

Table 4.7 Baud Rate

Value	Baud Rate	Value	Baud Rate	Value	Baud Rate
00H	9,600 bps	04H	38,400 bps	08H	153,600 bps
01H	14,400 bps	05H	57,600 bps	09H	230,400 bps
02H	19,200 bps	06H	76,800 bps	0AH	460,800 bps
03H	28,800 bps	07H	115,200 bps		

The initial value is set to 07H (115,200 bps).

* Do not set values other than the above set values.

Ex.) Set baud rate as 38,400 bps to the servo (ID:1).

Hdr	ID	Flg	Adr	Len	Cnt	Dat	Sum
FA AF	01	00	06	01	01	04	03

Baud Rate, Servo ID, writing to ROM, and rebooting of servo cannot be performed at the same time. Be sure to separately execute writing to ROM and servo reboot after writing data.

• No.7 Return Delay Time (1 Byte, Read/Write)

"Return Delay Time" is the time before sending Return Packet after receiving a packet requiring Return Packet.

The unit is 1 [ms] and the initial value is 0 (00H).

Ex.) Set Return Delay Time of the servo (ID:01) to 1 [ms].

Hdr	ID	Flg	Adr	Len	Cnt	Dat	Sum
FA AF	01	00	07	01	01	01	07

• No.8/No.9/No.10/No.11 Position Limit (2 Byte, Read/Write)

It is the maximum operating position based on 0.00 mm (units: 0.00 mm).

No.8 and No.9 are used for Plus direction and No.10 and No.11 are for Minus direction.

When the set position is larger than the set Position Limit, the servo moves to the maximum operating position.

Initial value and settable range is;

Direction	Range
Plus Position Limit	0.00 [mm] (0000H) to +25.00 [mm] (09C4H)
Minus Position Limit	0.00 [mm] (0000H) to -25.00 [mm] (F63CH)

Initial value is the maximum value (±25.00 mm) and Do NOT set a value bigger than this because it will be cause of damage of the servo.

Ex. 1) Set the Plus Position Limit of servo (ID: 1) to 20.00 mm.

Since the position is set in 0.01 mm units, 20.00 mm = 2000 (07D0H) is set.

Plus Position Limit L = 0 x D0, Minus Position Limit H = 0 x 07

Hdr	ID	Flg	Adr	Len	Cnt	Dat	Sum
FA AF	01	00	08	02	01	D0 07	DD

Ex. 2) Set the Minus Position Limit of servo (ID: 1) to -20.00 mm (F830H).

Plus Position Limit L = 0 x 30, Minus Position Limit H = 0 x F8

Hdr	ID	Flg	Adr	Len	Cnt	Dat	Sum
FA AF	01	00	0A	02	01	30 F8	C0

• No.14/No.15 Temperature Limit (2 Byte, Read)

It is the limit value of the internal temperature of the servo.

When the internal temperature is increased by the heat of the motor, etc. and exceeds the set value, the servo will automatically turns off its force to avoid troubles.

To turn on the force again, cool the servo and reboot it.

"Temperature Limit" is not changeable.

Temperature limit behavior varies depending on the communication mode. For details, refer to "Protection Function (Temperature-Limit)" (p.18).

⚠ Caution

Do not continue using in the high temperature by repeating reboot before the temperature of the servo decreases enough because it will cause the trouble of the servo.

• No.24/No.25 Compliance Margin (1 Byte, Read/Write)

It is the allowable range of the position around the goal position.

If the error between the present position and the goal position is in the set range, the servo recognized itself to be in the goal position and stop moving.

No.24 is for Plus direction and No.25 is for Minus direction.

The unit is 0.01 mm, Initial value is 08H (0.08 [mm]) and the settable range is 0 to 2.55 mm (00H to FFH) for both directions.

In most case, the initial value is the most suitable value and changing it is not recommended.

• No.26/No.27 Compliance Slope (1 Byte, Read/Write)

It is the range that output Force of the servo increases in proportion to the error between the present position and aim position. The flexibility of the servo increases in proportion to this value. By utilizing this function, it is possible to reduce hunting and absorb shock.

No.26 is for Plus and No.27 is for Minus.

The unit is 0.1 mm, initial value is 0.0 mm (00H) and the settable range is 0~25.5 mm (00H~FFH) for each directions.

• No.28/No.29 Punch (2 Byte, Read/Write)

It is the minimum force (electric current) that is generated when present position of the servo exceeds the range of Compliance Margin.

By setting this value to optimum, it is possible to reduce the area where the servo does not operate even if a slight command is given, and it can stop more accurately at the target position.

The unit is 0.00208%, initial value is 0000H (0%) and the settable range is 0000H to 7FFFH (68.2%).

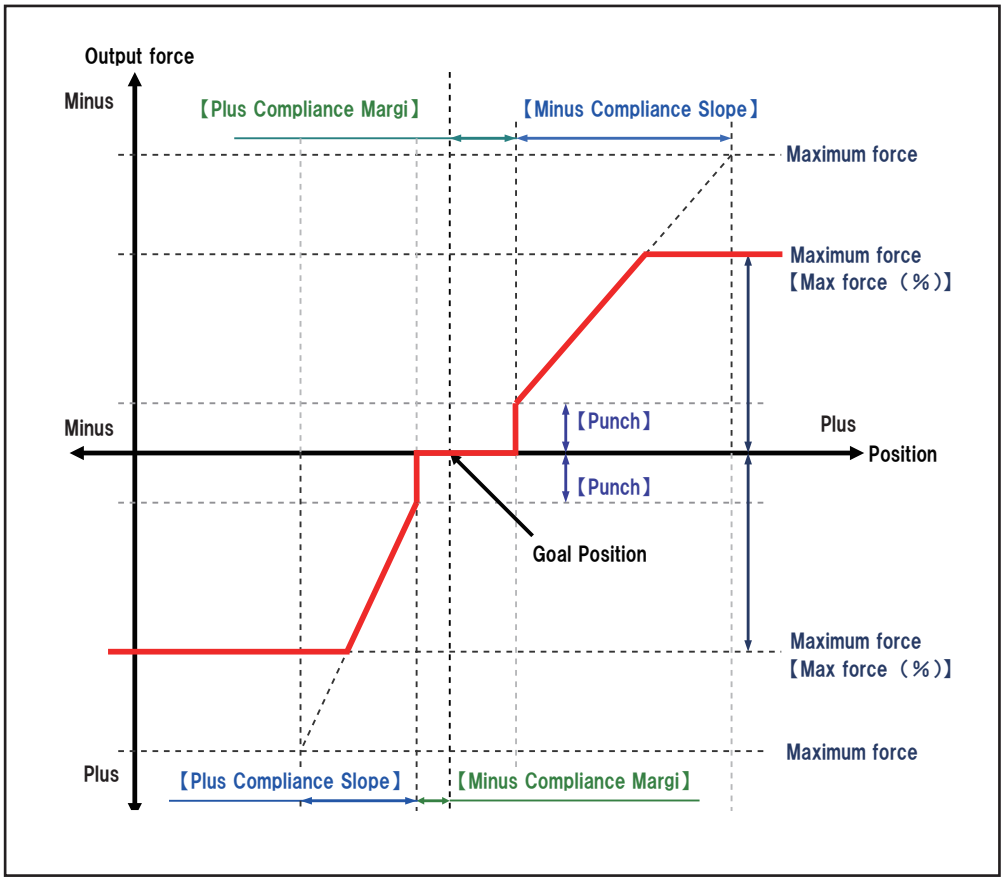


Fig 4.1 The relationship of Output Force, Position and Compliance settings.

Ex.1) Set Punch of the servo (ID:01) to 0120H.

Hdr	ID	Flg	Adr	Len	Cnt	Dat	Sum
FA AF	01	00	1C	02	01	20 01	3F

Ex.2) Set the servo (ID:01) as shown below;

Plus Compliance Margin	=	01H
Minus Compliance Margin	=	01H
Plus Compliance Slope	=	10H
Minus Compliance Slope	=	10H
Punch	=	0120H

Hdr	ID	Flg	Adr	Len	Cnt	Dat	Sum
FA AF	01	00	18	06	01	01 01 10 10 20 01	3F

4.3. Variable RAM Area

Table 4.8 Variable RAM Area

Area	Address DEC	Address HEX	Initial	Name	R/W
Variable RAM	30	1EH	00H	Goal Position L	RW
	31	1FH	00H	Goal Position H	RW
	32	20H	00H	Goal Time L	RW
	33	21H	00H	Goal Time H	RW
	34	22H	00H	Reserved	-
	35	23H	64H	Max Force	RW
	36	24H	00H	Force Enable	RW
	37	25H	01H	Reserved	-
	38	26H	64H	Reserved	-
	39	27H	00H	Reserved	-
	40	28H	00H	Reserved	-
	41	29H	00H	Reserved	-
	42	2AH	00H	Present Position L	R
	43	2BH	00H	Present Position H	R
	44	2CH	00H	Present Time L	R
	45	2DH	00H	Present Time H	R
	46	2EH	00H	Reserved	-
	47	2FH	00H	Reserved	-
	48	30H	00H	Present Load L	R
	49	31H	00H	Present Load H	R
	50	32H	00H	Present Temperature L	R
	51	33H	00H	Present Temperature H	R
	52	34H	00H	Present Voltage L	-
	53	35H	00H	Present Voltage H	-
	54	36H	00H	Reserved	-
	55	37H	00H	Reserved	-
	56	38H	00H	Reserved	-
	57	39H	00H	Reserved	-
	58	3AH	00H	Reserved	-
	59	3BH	FFH	Reserved	-

● No.30/No.31 Goal Position (2 Byte, Read/Write)

“Goal Position” is the target position of the servo.

The center of the movable range is 0.00 mm, the extending direction is “+”, the shrinking direction is “-”.

The unit of the target position is 0.01 mm increments, and the initial target position is 0 x 0000 (0.00 mm). The setting can be done in units of 0.01 mm, but the theoretical internal accuracy is about 0.02 mm.

To set 9.00 mm to the target position, set "900" (900 → 0384H). When sending the output ON command (p.37), the current position is set to the target position. If the value is larger than the Position Limit set for No. 8 to 11, the servo moves to the Position Limit and the value is changed to the value of Position Limit automatically.

Ex.1) Move the servo (ID:01) to 9.00 [mm] (900=0384H).

Hdr	ID	Flg	Adr	Len	Cnt	Dat	Sum
FA AF	01	00	1E	02	01	84 03	9B

Ex.2) Move the servo (ID:01) to -9.00 [mm] (-900=FC7CH).

Hdr	ID	Flg	Adr	Len	Cnt	Dat	Sum
FA AF	01	00	1E	02	01	7C FC	9C

● No.32 / No.33 Goal Time (2 Byte, Read/Write)

“Goal Time” is the time to move to “Goal Position”. The unit is 10 [ms] and initial value is 0 (0000H).

In the case that the speed required by “Goal Position” and “Goal Time” is faster than the maximum speed of the servo, the servo moves with its maximum speed.

When external force is applied, it may not be able to operate at the specified time.

Ex.1) Move the servo (ID: 1) to 9.00 [mm] in 5 [s]. (9.00 [mm]=900 (0384H), 5 [s]=500 (01F4H))

Hdr	ID	Flg	Adr	Len	Cnt	Dat	Sum
FA AF	01	00	1E	04	01	84 03 F4 01	68

● No.35 Maximum Force (1Byte, Read/Write)

“Maximum Force” is a ratio of real output for the maximum force of the servo (shown in p43).

The unit is 1 [%], initial value is 100 (64H) and the settable range is 0 to 100 (00H to 64H).

If the value is larger than 100 (64H), the value changes to 100 (64H) automatically.

Ex) Set maximum Force of the servo (ID:01) to 80% (50H).

Hdr	ID	Flg	Adr	Len	Cnt	Dat	Sum
FA AF	01	00	23	01	01	50	72

No.36 Servo Enable (1Byte, Read/Write)

“Servo Enable” is the condition of the servo’s ON (Enable) or OFF (Disable).

The initial value is 0 (00H) and settable range is 0 to 2 (00H to 02H).

The relationship of the value and the condition is shown as below:

Value	condition
0 (00H)	Disable (Force OFF)
1 (01H)	Enable (Force ON)
2 (02H)	Brake mode

In “Brake mode”. The servo does not have output force, but weak resistance force occurs when it is turned from the outside.

It is 00H (output OFF) when power is turned on.

When sending the output ON command, the present position (p.38) is set to the target position (p.36).

When the present position (p.38) is outside the range specified by the limit position (p.31) (+ 25 mm or more or -25 mm or less in the initial state), it will not turn ON (the set value remains at 00H).

In order to turn on the output, it is necessary to move the output axis from the outside, return it within the range specified by the limit position, and send the output ON command again.

Ex.1) ON the servo (ID:01).

Hdr	ID	Flg	Adr	Len	Cnt	Dat	Sum
FA AF	01	00	24	01	01	01	24

Ex.2) OFF the servo (ID:01).

FA AF	01	00	24	01	01	00	25

Ex.3) Set the servo (ID:01) to “Brake Mode”.

FA AF	01	00	24	01	01	02	27

● No.42/No.43 Present Position (2Byte, Read)

“Present Position” is the real position of the servo’s output shaft.

The unit is 0.1 [mm] and the detectable range is -25.00 mm to +25.00 mm.

Since the servo resolution is different from the display unit (0.01 mm), the value may not change continuously depending on the position.

Ex) Read “Present Position” of the servo (ID:01).

To get Memory Map No.42 to 59 as a Return Packet, a Short Packet with “Flag”: bit3=1, bit2=0, bit1=0 and bit0=1 is required to be sent.

For details, refer to the "Flags" section of "Format of the packet". (→ P.20)

When sending only the flag, Address = 0, Length = 0, Count = 1, Data is absent (omitted), Sum transmits a packet set as a checksum from ID to Count.

The packet to require Return Packet with Memory Map No.42 to 59 is;

Hdr	ID	Flg	Adr	Len	Cnt	Sum
FA AF	01	09	00	00	01	09

An example of Return Packet is;

Hdr	ID	Flg	Adr	Len	Cnt	42	43 ・・・	・・・58	59	Sum
FD DF	01	00	2A	12	01	84	03 00 00 00 00 06 00 ・・・	00 00 00 00 00 00		B9

* Data and Sum are according to the real condition.

Top 2 bytes of Data shows No.42 and No.43 of Memory Map.

In the example above, it means 0384H=9.00 [mm].

• No.44/No.45 Present Time (2Byte, Read)

“Present Time” is the elapsed time after the servo receives a packet to move.

The unit is 10 [ms]. When movement is finished, the value will be “0”.

Ex) Read “Present Time” of the servo (ID:01).

To get Memory Map No.42 to 59 as a Return Packet, a Short Packet with “Flag”: bit3=1, bit2=0, bit1=0 and bit0=1 is required to be sent.

For details, refer to the "Flags" section of "Format of the packet". (→ P.20)

When sending only the flag, Address = 0, Length = 0, Count = 1, Data is absent (omitted), Sum transmits a packet set as a checksum from ID to Count.

The packet to require Return Packet with Memory Map No.42 to 59 is;

Hdr	ID	Flg	Adr	Len	Cnt	Sum
FA AF	01	09	00	00	01	09

An example of Return Packet is;

Hdr	ID	Flg	Adr	Len	Cnt	42	43	44	45	・・・	・・・	58	59	Sum
FD DF	01	00	2A	12	01	5C	FF	37	02	00	00	07	00	・・・	00	00	00	00	00	00	A9

* Data and Sum are according to the real condition.

In the example above, it means 0237H=5670 ms.

● No.48/No.49 Present Load (2Byte, Read)

“Present Load” shows detected electric current of the servo. The unit is 10 [mA].

It is almost proportional to output force, but does not become 0 even in the condition of force-OFF.

Ex) Get “Present Current” of the servo (ID:01).

To get Memory Map No.42 to 59 as a Return Packet, a Short Packet with “Flag”: bit3=1, bit2=0, bit1=0 and bit0=1 is required to be sent.

For details, refer to the "Flags" section of "Format of the packet". (→ P.20)

When sending only the flag, Address = 0, Length = 0, Count = 1, Data is absent (omitted), Sum transmits a packet set as a checksum from ID to Count.

The packet to require Return Packet with Memory Map No.42 to 59 is;

Hdr	ID	Flg	Adr	Len	Cnt	Sum
FA AF	01	09	00	00	01	09

An example of Return Packet is;

						Data																		
Hdr	ID	Flg	Adr	Len	Cnt	42	43	・・・			・・48	49				・・・				58	59	Sum
FD DF	01	00	2A	12	01	4E	FB	00	00	00	00	60	00	00	BA	03	00	00	00	00	00	00	00	32

* Data and Sum are according to the real condition.

In the example above, it shows 0060H=960 [mA].

• No.50/No.51 Present Temperature (2Byte, Read)

“Present Temperature” is detected temperature on the circuit board in the servo.

The unit is 1 [degrees Celsius].

The sensor has individual difference about up to ±8 [degrees Celsius].

When “Present Temperature” exceeds “Temperature Limit”, “Temperature Limit” (Bit 7 of Flag of Return Packet) becomes “1” and the servo will turn off its force (“Force Enable” becomes “0”).

Once the temperature exceeds “Temperature Limit”, the servo will NOT accept force-ON Command until it is rebooted or is turned off-and-on the power again.

When “Present Temperature” reaches “Temperature Limit”, temperature around the motor of the servo reaches 120 to 140 degrees Celsius. Please be careful about burns and use the servo after the temperature fell enough.

Ex) Read “Present Temperature” of the servo (ID:01).

To get Memory Map No.42 to 59 as a Return Packet, a Short Packet with “Flag”: bit3=1, bit2=0, bit1=0 and bit0=1 is required to be sent.

For details, refer to the "Flags" section of "Format of the packet". (→ P.20)

When sending only the flag, Address = 0, Length = 0, Count = 1, Data is absent (omitted), Sum transmits a packet set as a checksum from ID to Count.

The packet to require Return Packet with Memory Map No.42 to 59 is;

Hdr	ID	Flg	Adr	Len	Cnt	Sum
FA AF	01	09	00	00	01	09

An example of Return Packet is;

						Data												
Hdr	ID	Flg	Adr	Len	Cnt	42	43	• • •	• • •	50	51	• • •	• • •	58	59	Sum		
FD DF	01	00	2A	12	01	4E	FB	00	00	00	00	06	00	2D	00	00	00	00	00	00	00	00	00	32

* Data and Sum are according to the real condition.

9th and 10th value of Data shows No.50 and No.51 of Memory Map.

In the example above, it shows 002DH=45 [degrees Celsius].

● No.52/No.53 Present Voltage (2Byte, Read)

“Present Voltage” shows detected voltage of the power applied to the servo.

The unit is 10 [mV].

The sensors has individual difference about up to ±0.5 [V].

Ex) Read “Present Voltage” of the servo (ID:01).

To get Memory Map No.42 to 59 as a Return Packet, a Short Packet with “Flag”: bit3=1, bit2=0, bit1=0 and bit0=1 is required to be sent.

For details, refer to the "Flags" section of "Format of the packet". (→ P.20)

When sending only the flag, Address = 0, Length = 0, Count = 1, Data is absent (omitted), Sum transmits a packet set as a checksum from ID to Count.

The packet to require Return Packet with Memory Map No.42 to 59 is;

Hdr	ID	Flg	Adr	Len	Cnt	Sum
FA AF	01	09	00	00	01	09

An example of Return Packet is;

						Data														
Hdr	ID	Flg	Adr	Len	Cnt	42	43	• • •				• • •	52	53	• • •			• • •	58	59	Sum
FD DF	01	00	2A	12	01	4E FB	00	00	00	00	06	00	2D	00	56 04	00	00	00	00	00	F4

* Data and Sum are according to the real condition.

In the example above, it shows 0456H=11.1 [V].

Specs *1

*1 ALL Specifications are subject to change without prior notice.

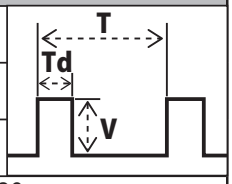
LJ9DA41

		11.1 V		14.8 V
Max. Force *2*4*5	36.7 kgf 360.0 N 1294.5 ozf		Max. Force *2*4*5	48.9 kgf 480.0 N 1724.9 ozf
Rated Force *2	7.3 kgf 72.0 N 258.9 ozf		Rated Force *2	9.8 kgf 95.9 N 345.0 ozf
Speed *2*3	80 mm/s 3.1 inch/s		Speed *2*3	105 mm/s 4.1 inch/s
Consumption Current *2*3	260 mA		Consumption Current *2*3	280 mA

*2 Initial Performance Data at 23 ± 5℃ *3 No Load

*4 The maximum FORCE that the servo is under continuous operation is 20% of the maximum FORCE.

*5 Use the shrinking (negative) direction within the rated force. Refer to the "Definition of servo stroke position" (p. 10) for the operating direction.

Item	Specification	Remark		
Communication Interface *6	PWM	Signal Voltage : V	HIGH : min. 3.0 V max. 16.8 V LOW : min. 0.0 V max. 0.45 V	
		Frame Rate : T	3.0 ～ 30 ms (Default 14.25 ms)	
		Pulse width : Td	2120/1520/920 µs (Recommended resolution is less than 1 µs.)	
	S.BUS	Futaba Serial Protocol (Please ask us for more information.)		
	RS485	Command control (Half-duplex communication, Band Rate 9.6 ～ 460.8 kbps)		
Rated Voltage	DC 11.1 V ～ DC 14.8 V	—		
Operating Voltage *6	DC 9.0 V ～ DC 16.8 V	—		
Travel Stroke	+0.98 inch (+25 mm) 920 µs -0.98 inch (-25 mm) 2120 µs	—		
Max.Travel Stroke	+0.98 inch (+25 mm) 920 µs -0.98 inch (-25 mm) 2120 µs	—		
BackLash	≤ 0.5 mm	—		
Operating Temperature Range	-10℃～ +60℃ (14°F～ 140°F)	—		
Operating Humidity Range	≤ 90%RH	—		
Storage Temperature Range	-30℃～ +80℃ (-22°F～ 176°F)	—		
Storage Humidity Range	≤ 90%RH	—		
Outer Dimension	3.91 × 2.01 × 7.78 inch (99.3 × 51.1 × 197.6 mm)	Excluding a Rod, Cable		
Weight	25.4 oz (720 g)	—		
Case Material	Resin	—		
Gear Set Material	1st : Resin/Final : Metal	—		
Linear motion mechanism	Ball Screw			
Cable	Shielded Cable	Cable Length : 15.75 inch (400 mm)		

*6 Note that the signal voltage range of the communication Interface is different from the operating voltage range.

● LJ9DA41

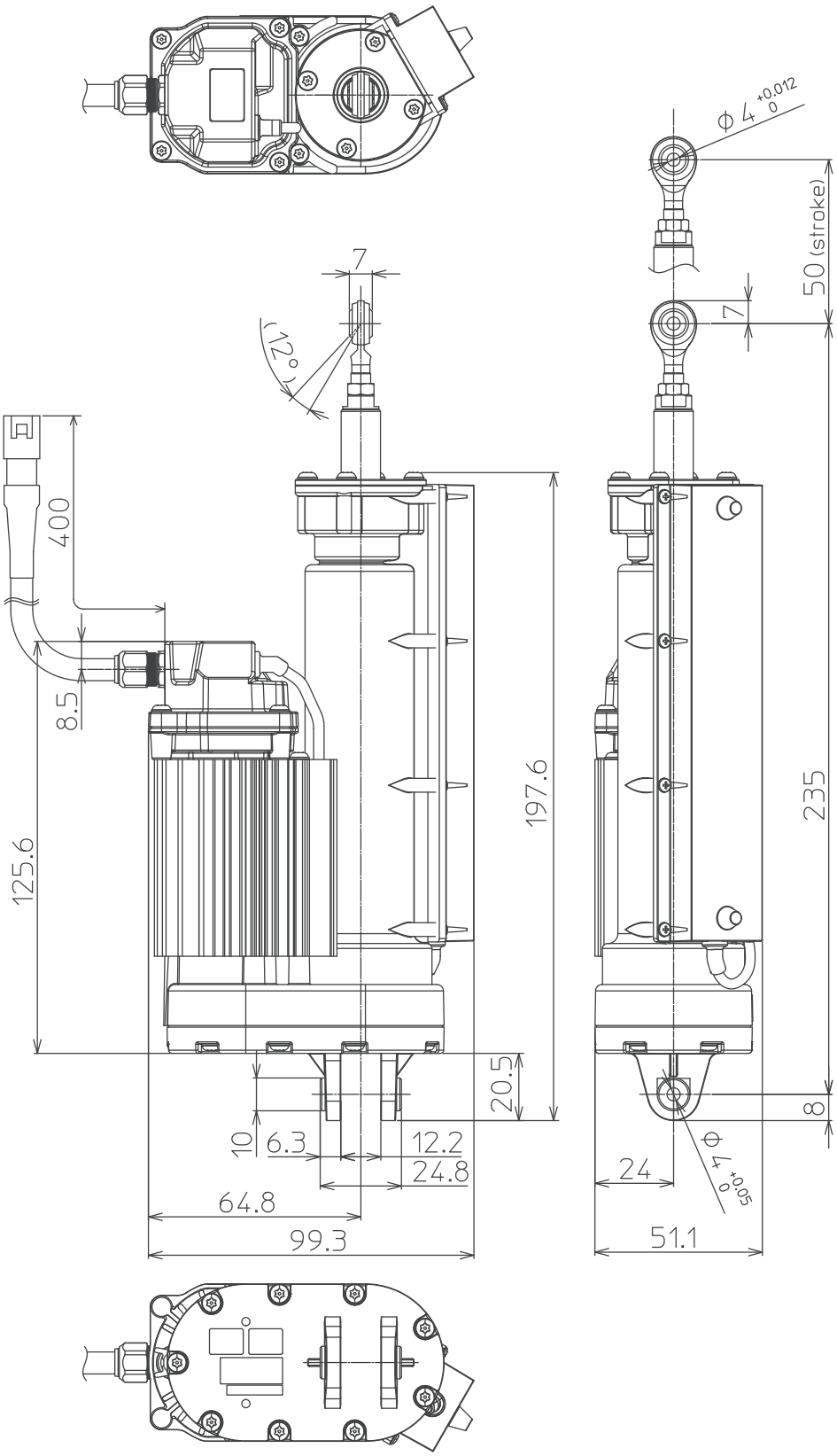


Fig 5.1 LJ9DA41 (unit : mm)

● LJ9DA41 Cable

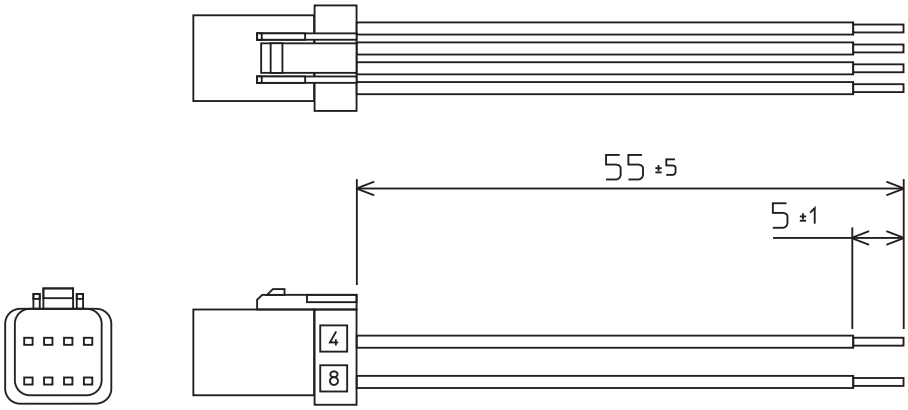


Fig 5.2 LJ9DA41 Cable (unit : mm)

Futaba®