1M23Z06502
User's Manual Ver.1.04

RS204MD

Command Type Servo for Robot

Instruction Manual

Caution

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

For models

Futaba®

1. FOR SAFETY

To use this product safely, please pay your full attention to the followings.
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

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 use any battery as a power supply other than the specified battery.
The product is designed to be operated by Futaba's 9.6V Ni-MH battery only. Do not use any other batteries.

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 let the servo get covered with sandy dust or water.
Otherwise, the servo may stop moving or have a short circuit. The servo is not designed to be waterproof or dust-proof.

Do not use this product for any application other than indoor hobby-robots.
Futaba is cleared of all responsibility to the results caused by the usage of this product for any application other than indoor hobby-robots.

Do not turn the servo horn forcibly.
Otherwise, the servo will be damaged.

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.

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

Components

The following parts are included in RS204MD.

Please refer to p.50 “Optional parts” for optional parts and repair parts.

- 1) Servo(RS204MD) x1
  2) Servo Horn x1
  3) Screw to fix servo horn x1 (M2x8 Tapping Screw)

*Servo Horn and Screw are attached to the servo.

- 4) Cable (ADH-Connector, 70mm) x1
- 5) Free Horn (Same as for RS30x) x1
- 5) USAGE PRECAUTION x1

Features

RS204MD is specially designed for robotic applications, having the following features.

● Small and Lightweight

RS204MD is small and lightweight servos specially designed for robots, which are 12g respectively.

● Interactive High-Speed TTL Communication

TTL bi-directional communication of a maximum baud rate of 230kbps is possible and is used for the communication between the robot's processor and servos.

● Servos for Both Command Type and PWM Type

RS204MD can be controlled either as the Command Type Servo for robots or the PWM Type Servo for existing R/C servos. The type is automatically switched by the first signal sent after these products are connected.

● Feedback(Only as Command Type)

Information of sensors on the servo such as the position, load, temperature, electric current, and the alarm situation, etc. can be obtained via TTL communication.

● Compliance Control

With this feature, the movement of the RS204MD is controlled in accordance with the distance between the present and target positions. This enables the robot to move very smoothly without trembling its arms and legs and to absorb turbulence from an external force.

● Calibration

Angular position of every servo is calibrated by our standard gauge before their shipment. Even if another RS204MD servo is employed, it does not require any bothersome work for adjusting its angular position.

● Wiring from the Output Shaft

In order to avoid wires becoming entangled during operation, they are drawn out from the rear of the output shaft. Another shaft is installed on the bottom case to make the center impeller structure easy to construct.

● Horn with a mark for the reference position

凹 marks are placed on the circumference of the servo horn in order to make sure the reference position even after being built in. (one 凹 for 0° position, two 凹 s for 90° position, three 凹 s for 180 position and four 凹 s for 270° position)

Part Names / Handling Instructions

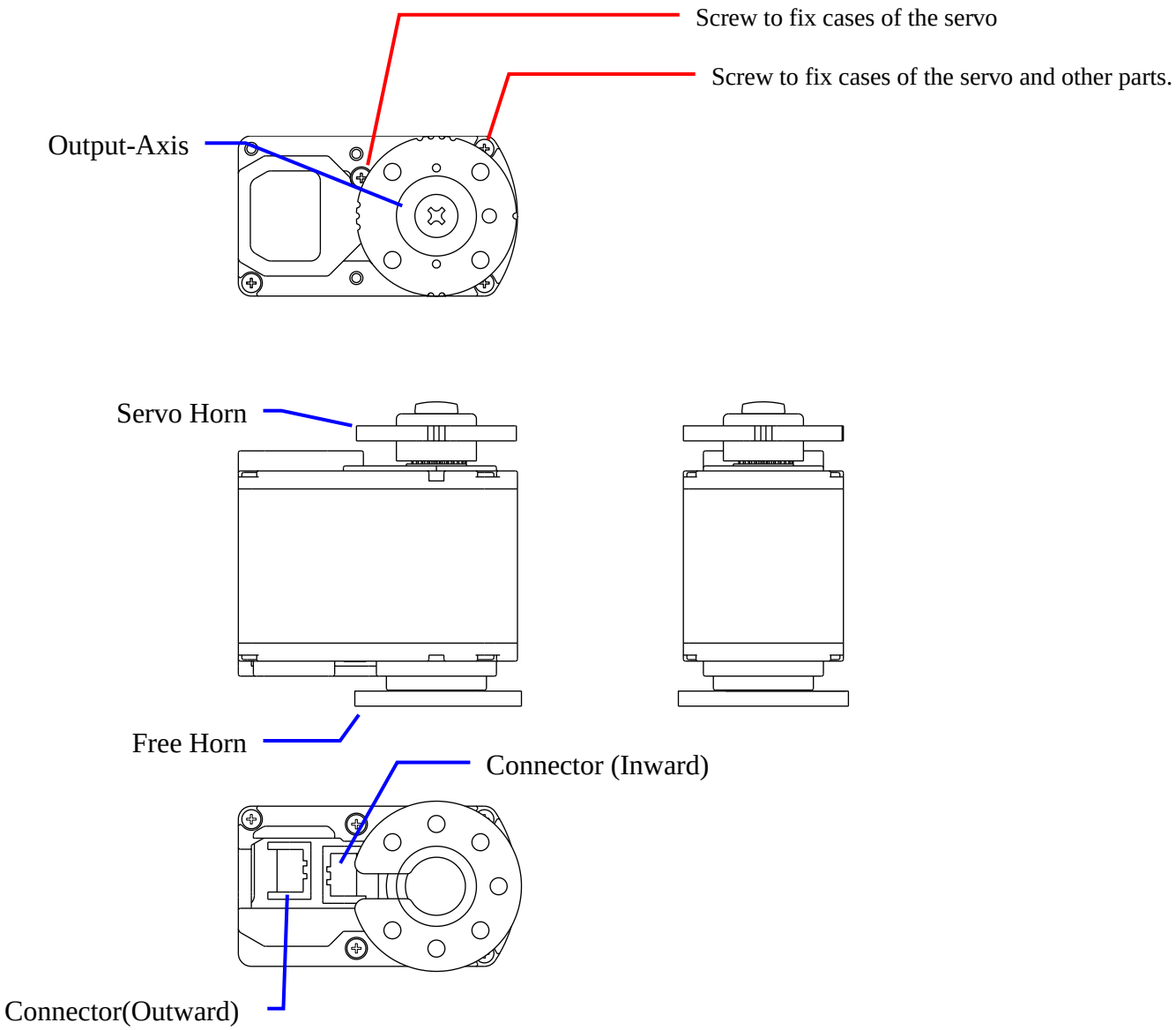


Fig. 2.1 Part Names

Caution

Do not remove screws to fix cases of the servo unless repair or replacement is needed.

When removing all case fixing screws, be careful not to get dust or foreign matter inside the case.

Route the cable through the free horn hole in the bottom case when using the Inward-Connector.

Bending cables strongly will cause disconnection and/or short circuit.

How to attach the servo

Remove some of the screws of RS204MD and use its hole to fix the servo to brackets or other frames.
Refer Fig. 2.2 for the depth of each hole.
1.8mm from each Reference-Surface of Hole (A) is Clearance Hole.

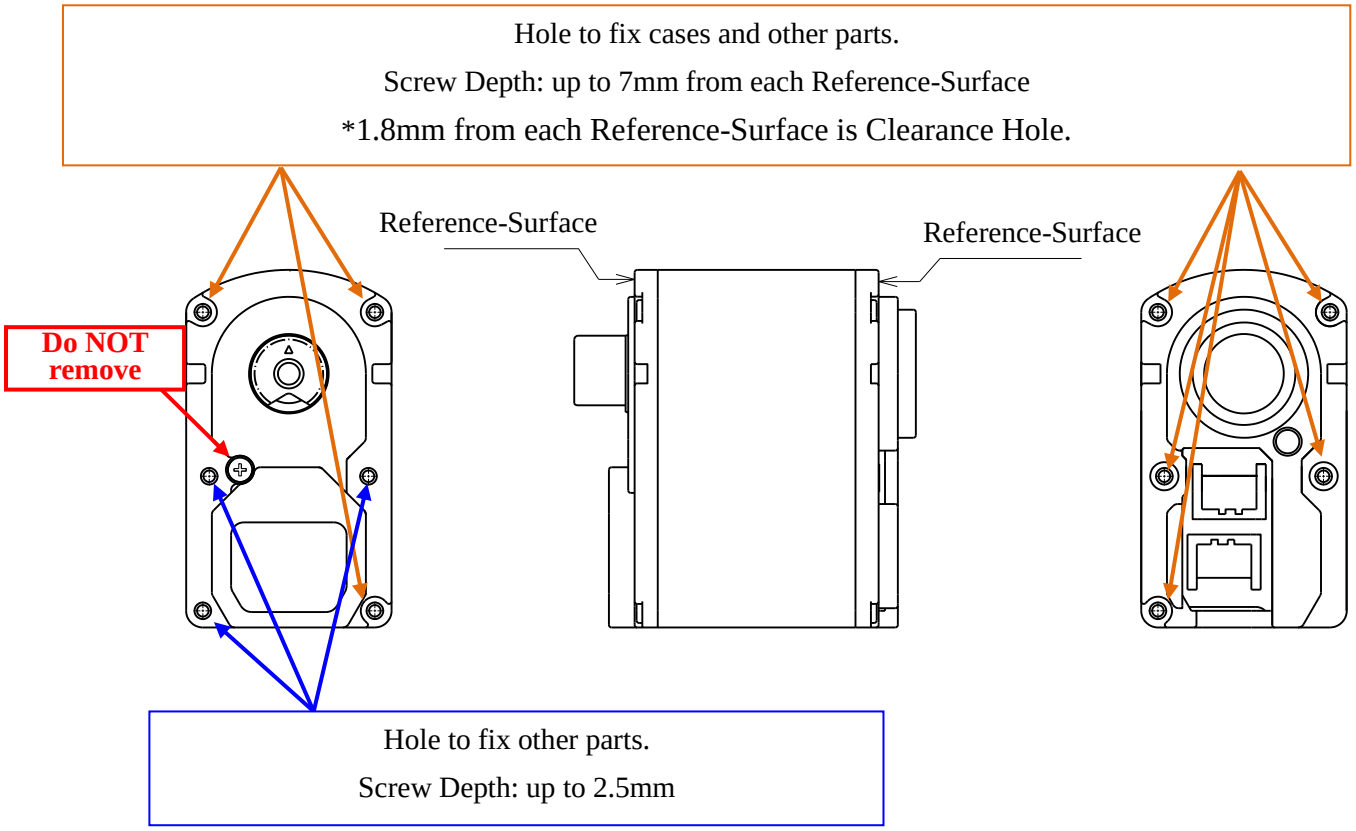


Fig. 2.2 Screw Depth

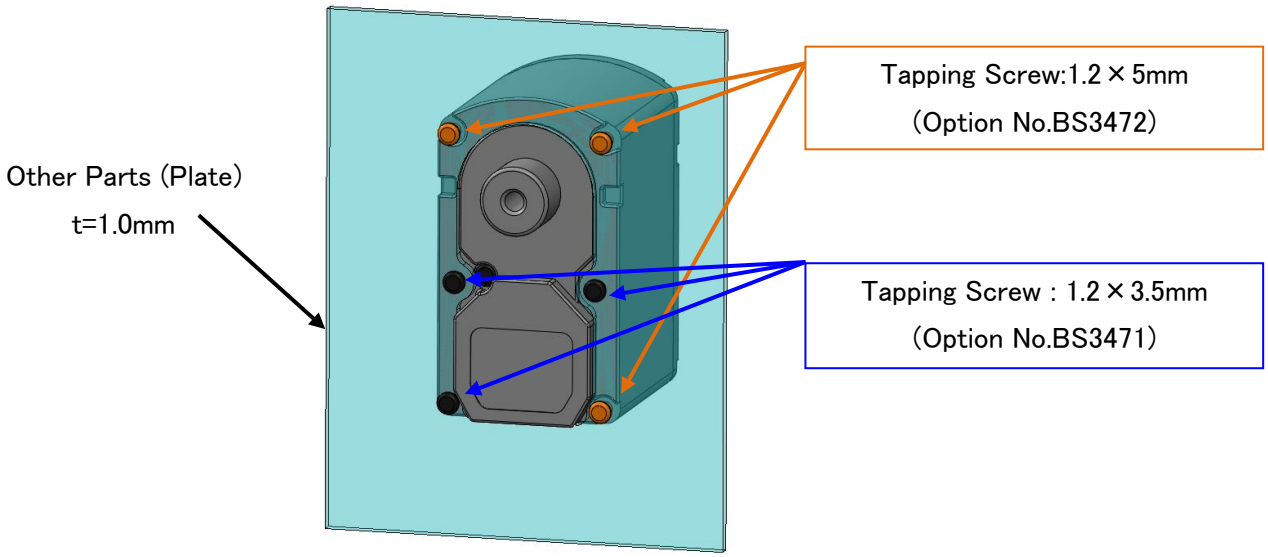
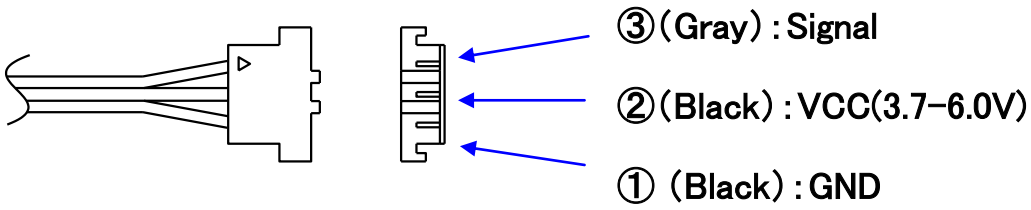


Fig. 2.3 Reference for the length of the screw to fix other parts.

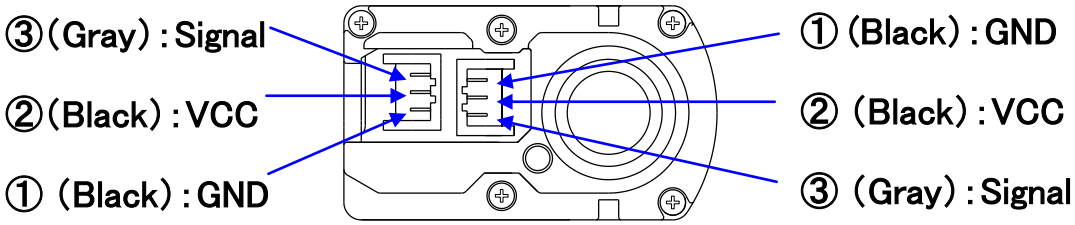
Pin Assignment of the Connector

The pin assignment of the connector of RS204MD is shown in Fig. 2..

Connector: ADH connector, J.S.T. Mfg. Co., Ltd.



a. Connector of the cable



b. Connectors of the servo

Fig. 2.4 Connector Pin Assignment

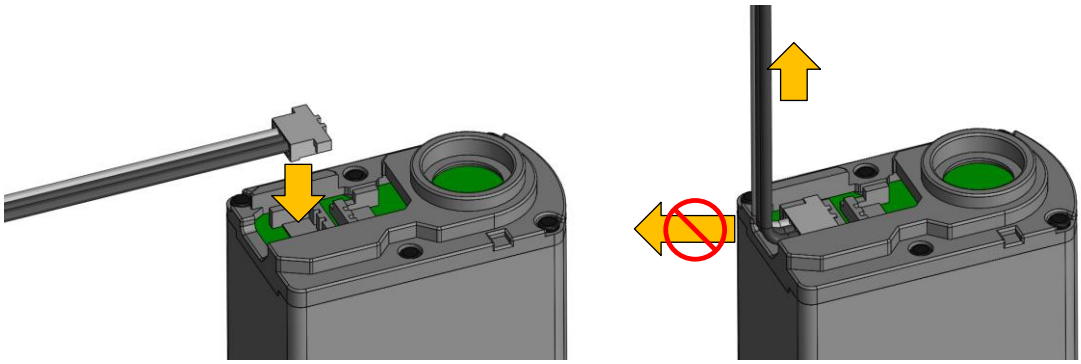
Communication Settings

Set your Communication parameters as follows:

Baud Rate	:	115.2	[kbps](9.6[kbps]～230.4[kbps], refer p.30)
Data bit length	:	8	[bit]
Parity	:	None	
Stop Bit	:	1	[bit]
Flow Control	:	None	

Installing/Unplugging the connector

When installing the connector, be careful not to apply excessive force to the board. Also, when unplugging, grasp the cable and pull it out slowly.



① Installing the connector

Push the connector from upside.

②unplugging the connector

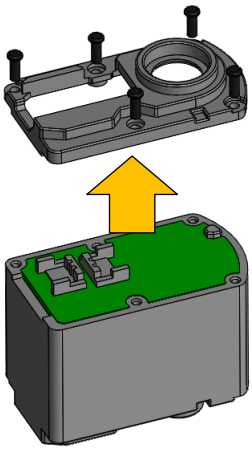
Hold the cable and pull it upward slowly.

***Do NOT pull the cable horizontal.**

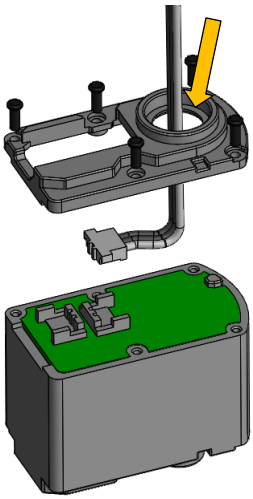
Fig. 2.5 Installing/unplugging the connector

Routing the cable

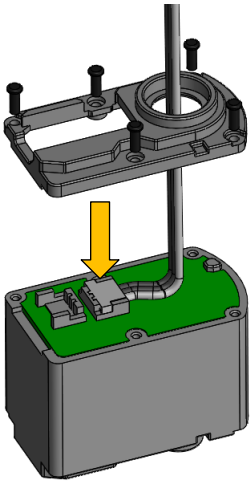
Remove the bottom case before routing the cable through the hole for Free-Horn (When using the Inward-Connector).



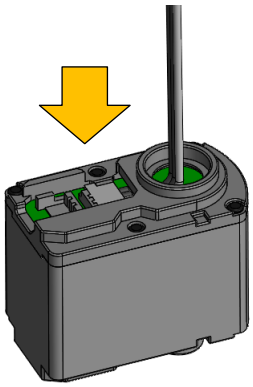
① Remove the screws and Bottom Case.



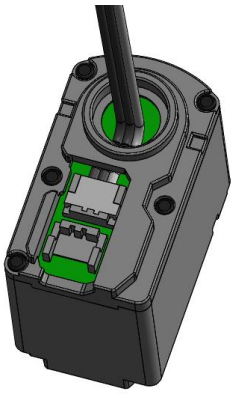
②Route the cable through the hole of the Bottom Case.



③Install the Connector.



④Re-Assemble the Bottom Case and screws.



⑤Finish.

Fig. 2.6 Routing the cable

Caution

- Use Phillips #1 screwdriver.
- Do NOT overtighten the screws.
- Do NOT pinch the cables.
- Do NOT damage the circuit-board.

Definition of Angle and its Range

● Definition of “0 degrees” and operational range

“0 degrees” and directions(+/-) of RS204MD are defined as fig. 2.7.

Operational range (for Goal Position) is 0±150deg, and Detectable range (for Present Position) is 0± 160 deg.

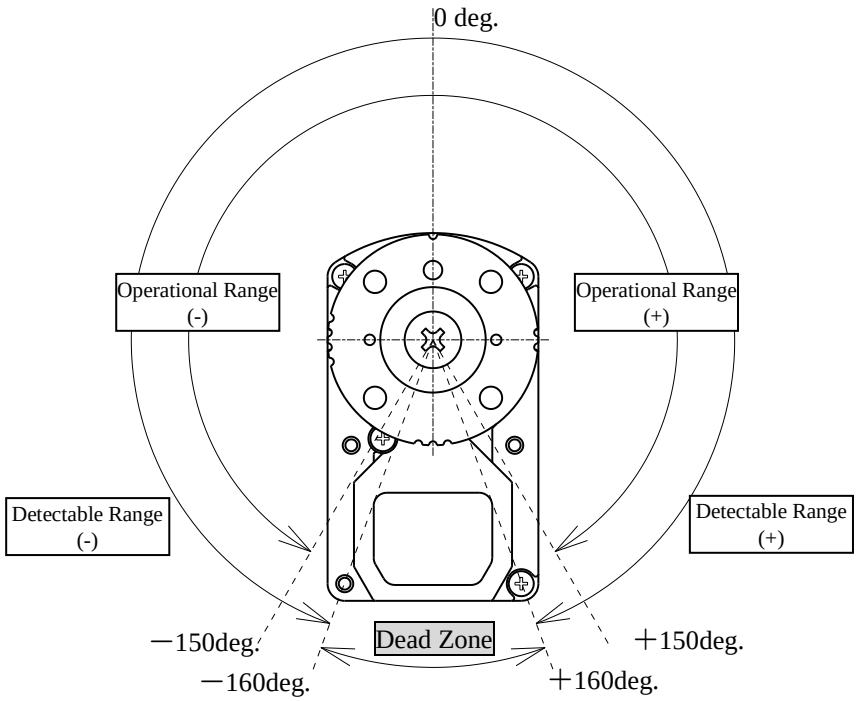


fig. 2.7 Definition of Angle

● Dead Zone(undetectable range)

The range of more than +160 degrees to less than -160 degrees in fig. 2.7 is undetectable area (“Dead Zone”) of internal angle sensor.

When in this range, ”Present Position” (p.39 エラー! ブックマークが定義されていません。) will be “555.5” and “Torque Enable”(p.38) will be “00H” (Torque-OFF).

To turn on the torque again, please move output-axis to Operational Range then send Torque-ON command.

You can rotate the output-axis by hand beyond the Dead Zone since there is no mechanical limit (stopper) on the 160 degrees and -160degrees, but please keep in mind that passing the dead zone frequently, such as continuously rotating the output shaft, will damage the angle sensor and may be shorten its life.

3. Connections

Systems

Systems of the robot with RS204MD are follows.

● Systems as Command-Type Servo

Systems with RS204MD as Command-Type Servos are shown in bellow:

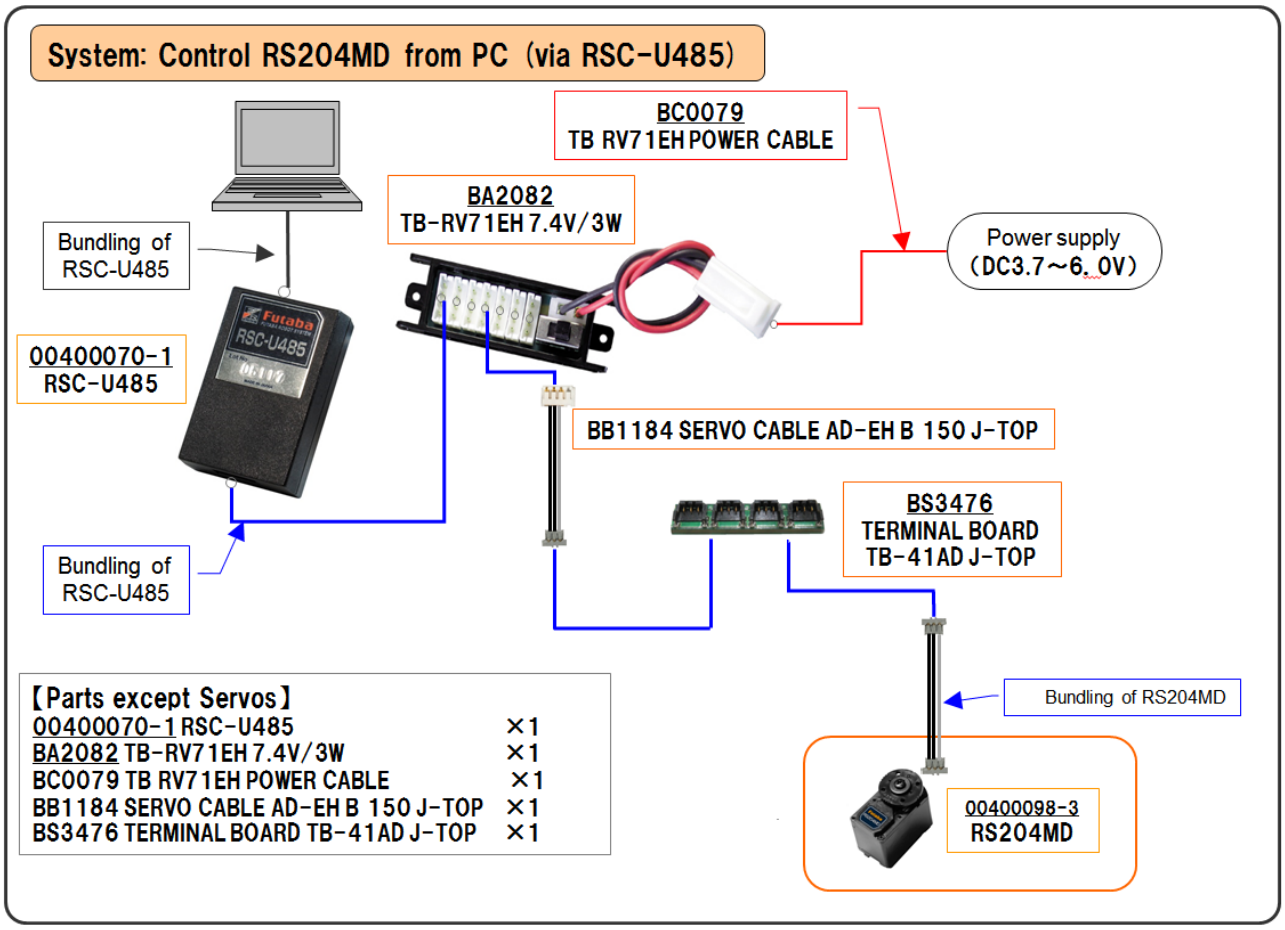


Fig. 3.1 **System with Command-Type Servos**

To Control RS204MD as Command-Type Servo with USB-RS485 Converter “RSC-U485” etc., Power Hub “TB-RV71EH 7.4V/3W” is required somewhere in the system.

The maximum number of RS204MD to be connected as TTL Command-Type Servos is 24.

When these products are used together with RS485 Command-Type Servos, the maximum number of the RS485 Command-Type Servo is 4.

Please note that when the Command-Type Servos are used together exceeding the maximum number, the servos may malfunction.

● Systems as PWM Type Servo

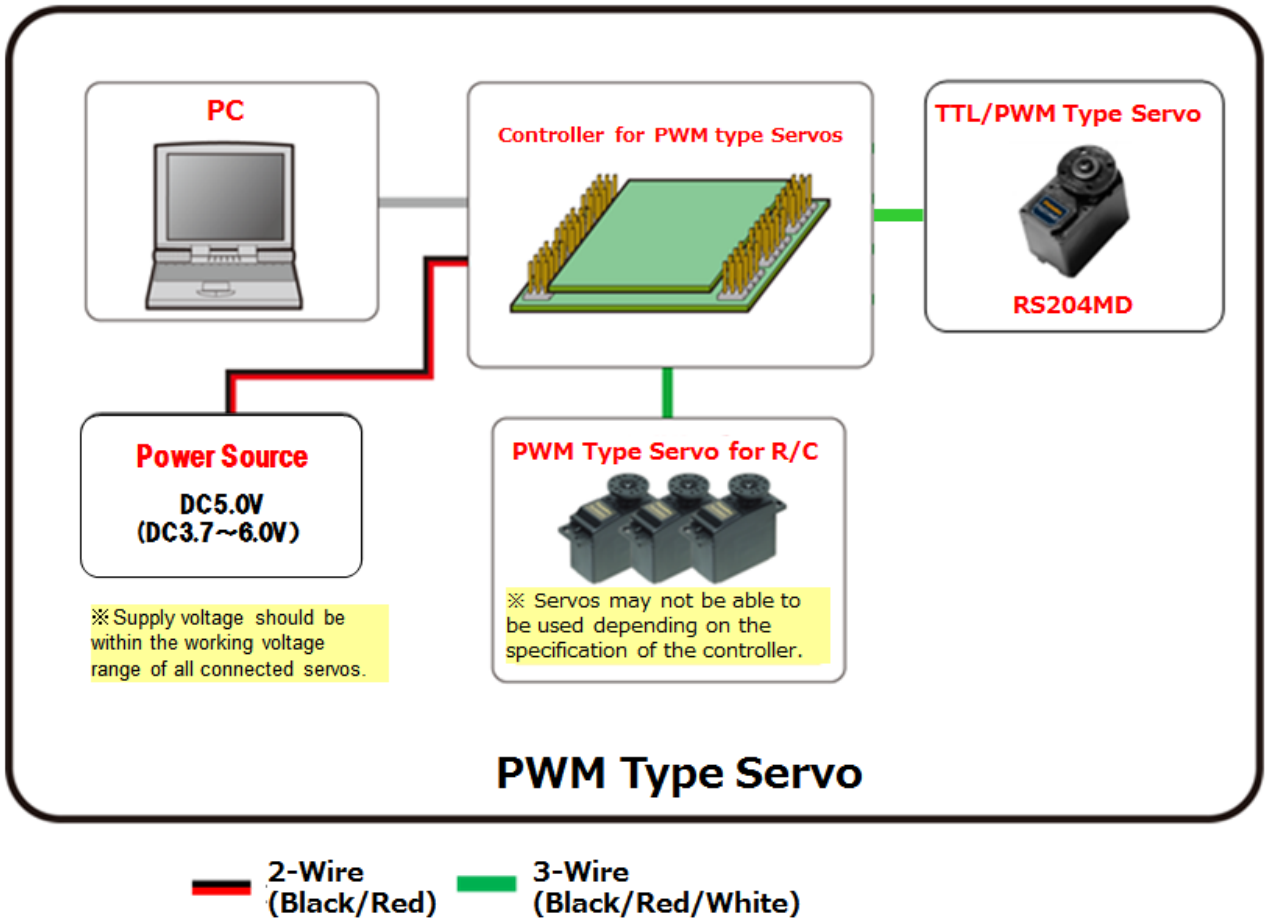


Fig. 3.2 Systems with PWM Type servo

Please note that the servos made by Futaba Corporation may malfunction, depending on the specification of the controller used for PWM servos.

Notes of Connection

RS204MD may malfunction, depending on the system configuration if they are used as TTL command Type Servo.

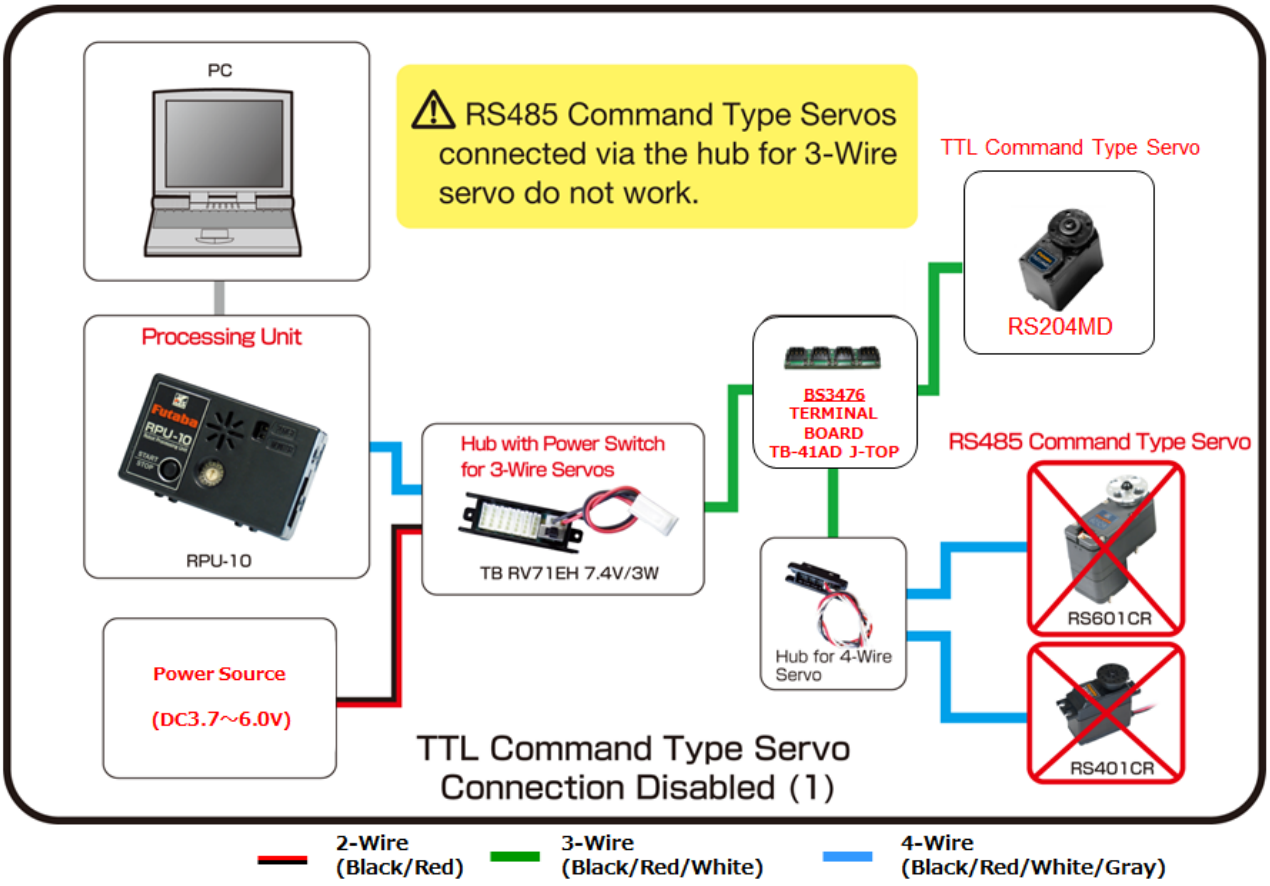


Fig. 3.3 TTL Command-Type Servo / Example of Disabled Connection (1)

RS485 Command Type Servos do not work if they are connected via the Hub for 3 Wire Servo.
When both RS485 Command Type Servos and TTL Command Type Servos are used in the same system, it is required not to create any part where three wires are placed on the route to the RS485 Command Type Servos from a processing unit (or, USB-RS485 converter).

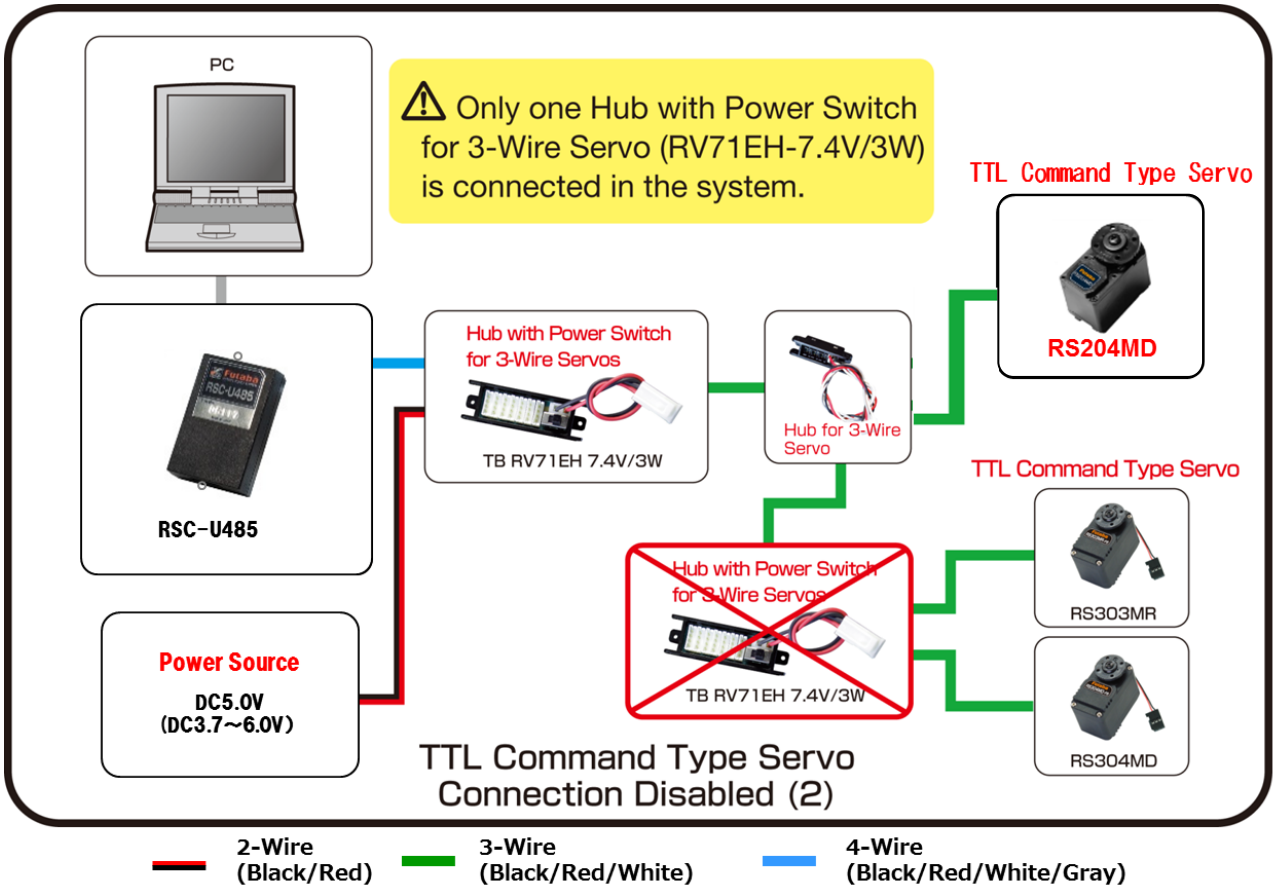


Fig. 3.4 TTL Command-Type Servo / Example of Disabled Connection (2)

The servos may malfunction if more than one Hub with Power Switch for TTL Command Type Servo (RV71EH-7.4V/3W) is connected in the same system.

4. Control

Abstract

● Switch of Command-Type and PWM-Type

RS204MD can be controlled either as the Command-Type Servo of PWM-Type Servo.
Which Type will be applied is automatically decided by the first signal sent after the power is turned on. The Type once decided never changes until the power is turned off.

When RS204MD is controlled by PC etc. via RSC-U485, they are operated as Command Type Servo.
When RS204MD is used by connecting to a radio control receiver or a controller for PWM-Type Servo, they are controlled as PWM-Type Servo.

● Communication Protocol (TTL Command-Type)

The communication protocol used for TTL Command Type Servo is asynchronous half-duplex communication. The signal line can be switched alternately for transmission or reception of data. Normally, RS204MD stand by in a receiving mode. When they receive commands to get the data of or the status of servos, the mode changes to a transmitting mode. After sending the data, they stand by again in a receiving mode.

● Control as PWM-Type Servo

To control RS204MD as a PWM-Type Servo, they are operated by changing the pulse width of the constant-frequency pulse (4ms-50ms). There is no direct relationship between the frequency, the torque, and the speed.
The relations between the pulse width and angles (positions) are as follows.

Table 4.1Pulse Width and Angles

Pulse Width	Angle(degrees)
560 μs	+144
1520 μs	0
2480 μs	-144

If there is no input for more than 80ms or an invalid value, less than 500μs or more than 2550μs, is input, the RS204MD will deactivate.
(Refer p33 No.22).

● Memory Map

RS204MD has its own memory area to store data necessary for its movement. This memory area is called “Memory Map”.
This memory map is divided into two groups. One is “RAM area” in which data will be erased when the power is turned off. The other one is “ROM area” in which data is held even after the power is turned off.

In “ROM area”, there are three different types of parameters; parameters used only for Command Type, parameters used only for PWM Type and those used for both Types. When these parameters are required to be rewritten, even parameters used only for PWM Type Servo, it is required to transfer the data as a Command Type Servo after connecting the servos to the PC with USB-RS485 converter (RSC-U485) etc.

While the servos are operated as PWM Type Servo, rewriting the parameters cannot be executed. Therefore, the servos are operated with the prewritten parameters.

● Servo ID

You can set “ID” numbers to RS204MD servos individually.
“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 RS204MD servos. 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.

● Long Packet

Long Packets are used for sending the data in the memory map toward multiple servos simultaneously.

● Return Packet

Return Packet is a packet that is sent from a servo when a return packet is requested.

Format of Packets

● 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 the 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 4.2 bit of Flag

Bit	Function
7	(Reserved)
6	Write Flash ROM
5	Reboot Servo
4	Initialize memory map data
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.

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.

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

The packet that “Write Flash ROM” and “Reboot Servo” has 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 the default value in the “Memory Map of ROM Area” (p.28 エラー! ブックマークが定義されていません。) 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 3～0 ： Direct Address of Return Packet

(1) Direct Area of Memory Map

Setting Bit 3 to Bit 0 of a Short Packet as **Table 4.3**, 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 4.3 Direct Area of memory map

Bit	3	2	1	0	Function
	0	0	0	0	No return Packet
	0	0	0	1	Return ACK/NACK Packet
	0	0	1	1	Return the data of memory map No.00～No.29
	0	1	0	1	Return the data of memory map No.30～No.59
	0	1	1	1	Return the data of memory map No.20～No.29
	1	0	0	1	Return the data of memory map No.42～No.59
	1	0	1	1	Return the data of memory map No.30～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 command 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.139 (00H~8BH).

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

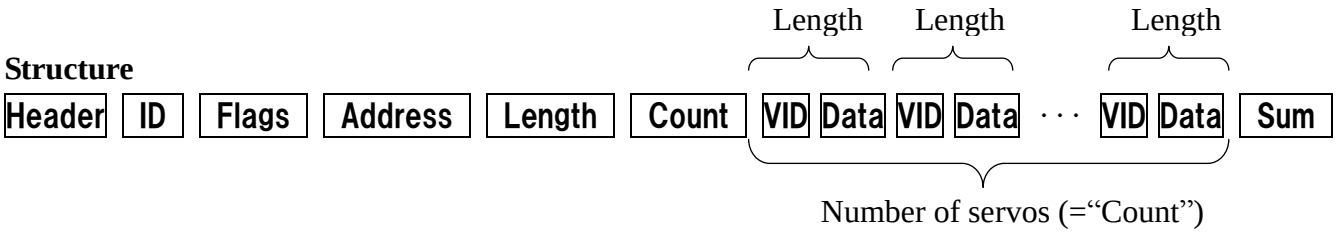
(3) ACK/NACK Packet

By sending a Short Packet with the Bit 0=1, Bit1=0, Bit2=0, Bit3=0, the servo will return ACK/NACK packet.
ACK/NACK Packet is only 1 byte of data that is **07H** = "**ACK**" or **08H** = "**NACK**".

● 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.

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.

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 angle to 10 degrees to the Servos (ID:1 and ID:2) and 50 degrees 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 4.4 Flags of Return Packet

Bit	Value	Meanings
7	0: Normal / 1: Error	Temperature Limit (Torque 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	0: Normal / 1: Error	Received Packet Error
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. It is set to "1" 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.

Memory Map

4.1. Invariable ROM Area

Table 4.5 Invariable ROM Area

Area	Address DEC	HEX	Initial	Name	R/W
Invariable	00	00H	40H	Model Number L	R
	01	01H	20H	Model Number H	R
	02	02H	03H	Firmware Version	R
	03	03H	--	Reserved	-

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

It is the Model Number (Name of the servo).
"20 40" means RS"204"MD

Model Number L = 40H
Model Number H = 20H

● No.2 Firmware Version(1Byte, Hex, Read)

It is the version of the servo's firmware.
Its value is depending on the version at production (0x03 in the example below).
Firmware Version = 03H

※Saving 2-Byte data

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 Angle to 29.2 degrees to servo (ID:23)
Target angle is stored in "Goal Position" (Address 30/31) with unit of 0.1 degrees.
(29.2 [degrees] = 292 [0.1degrees, DEC] = 0124[0.1degrees, HEX])
Stored data is below:

Goal Position (L) = 24H
Goal Position (H) = 01H

4.2. Variable ROM Area

Table 4.6 Variable ROM Area

Area	Address DEC.	HEX.	Initial	Name	R/W
Variable ROM	04	04H	01H	Servo ID	RW
	05	05H	00H	Reverse	RW
	06	06H	07H	Baud Rate	RW
	07	07H	00H	Return Delay	RW
	08	08H	DCH	CW Angle Limit L	RW
	09	09H	05H	CW Angle Limit H	RW
	10	0AH	24H	CCW Angle Limit L	RW
	11	0BH	FAH	CCW Angle Limit H	RW
	12	0CH	--	Reserved	-
	13	0DH	--	Reserved	-
	14	0EH	37H	Temperature Limit L	R
	15	0FH	00H	Temperature Limit H	R
	16	10H	--	Reserved	-
	17	11H	--	Reserved	-
	18	12H	--	Reserved	-
	19	13H	--	Reserved	-
	20	14H	--	Reserved	-
	21	15H	--	Reserved	-
	22	16H	00H	Torque in Silence	RW
	23	17H	C8H	Warm-up Time	RW
	24	18H	02H	CW Compliance Margin	RW
	25	19H	02H	CCW Compliance Margin	RW
	26	1AH	01H	CW Compliance Slope	RW
	27	1BH	01H	CCW Compliance Slope	RW
	28	1CH	08H	Punch L	RW
	29	1DH	00H	Punch H	RW

● No.4　Servo ID (1Byte, Hex, Read/Write)

This value can be changed ONLY when the Torque is OFF (“Torque-Enable” is “00H”).

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

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

This value can be changed ONLY when the Torque is OFF (“Torque-Enable” is “00H”).

It is the direction of rotation of the servo.

Its initial value is 00H that means the normal rotation, and the value of 01H means reverse rotation.

“Angle Limit” will be reversed according to “Servo Reverse”.

Ex) Reverse the servo (ID:1):

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

● No.6　Baud Rate(1Byte, Hex, Read/Write)

It is the baud-rate of communication.

The values and baud rate are assigned as shown in エラー! 参照元が見つかりません。.

Table 4.7Baud Rate

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

The Initial value is 07H (115,200bps) and the settable range is from 0 to 9 (00H to 09H).

Even after the value is rewritten, the servos are operated at the previous baud rate.
In order to operate under the new baud rate, it is required to write Flash ROM and Reboot Servo.

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

After sending above packet, "Write Flash ROM" packet and "Reboot Servo" packet must be sent.

● No.7 Return Delay(1Byte, Hex, Read/Write)

This value can be changed ONLY when the Torque is OFF ("Torque-Enable" is "00H").
It is the delay time for reply when the Return Packet is required.

The servo sends the return packet in 100μs after receiving data with the setting of 0.
The parameters of No.7 are in units of 001H = 50μs.
If you want to set the delay time for reply to 1ms, write 18 (12H). (1ms=100μs+18x50μs)

Hdr	ID	Flg	Adr	Len	Cnt	Dat	Sum
FA AF	01	00	07	01	01	12	14

● No.8/No.9/No.10/No.11 Angle Limit (2 Byte, Hex, Read/Write)

This value can be changed ONLY when the Torque is OFF (“Torque-Enable” is “00H”).

It is the maximum operating angle based on 0 degrees (units: 0.1 degree).

No.8 and No.9 are used for CW (clockwise) direction and No.10 and No.11 are for CCW (counterclockwise) direction.

When the set angle is larger than the set Angle Limit, the servo rotates to the maximum operating angle.

The Initial value and settable range is;

Direction	Initial	range
CW	+150(05DCH)	0 (0000H) ～ +150 (05DCH)
CCW	-150(FA24H)	0 (0000H) ～ -150 (FA24H)

Ex. 1) Set the CW Angle Limit of servo (ID: 1) to 100.0 degrees.

Since the angle is set in 0.1 degree units, 100.0 degrees = 1000(03E8H) is set.

CW Angle Limit L = E8H, CW Angle Limit H = 03H

Hdr	ID	Flg	Adr	Len	Cnt	Dat	Sum
FA AF	01	00	08	02	01	E8 03	E1

Ex. 2) Set the CCW Angle Limit of servo (ID: 1) to -100.0 degrees.

-100.0 degrees = -1000(FC18H).

CCW Angle Limit L = 18H, CCW Angle Limit H = FCH

Hdr	ID	Flg	Adr	Len	Cnt	Dat	Sum
FA AF	01	00	0A	02	01	18 FC	EC

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

*Note that rewriting this value will null and void the product warranty.

The servo torque is automatically turned OFF when the detected temperature inside the servo reaches the set value so that the servo will not break down due to the temperature rise of the motor etc.

In this case, turn off the servo power, and turn it on again after the temperature drops.

The unit is ° C, which is the value of the temperature sensor on the board inside the servo. The temperature is set to 55 ° C, but the motor that is most likely to get the highest temperature is higher than this temperature.

This memory map value can’t be rewritten.

⚠ Caution

Repeatedly restarting the servo in the high temperature condition will cause the servo failure.

● No.22 Torque in Silence(1 Byte, Hex, Read/Write, for PWM)

It is the condition of the servo's output torque.

When there is no input for more than 80ms or continuous invalid input that the pulse width is less than 0.5ms or more than 2.55ms, the servos' torque condition changes to the specified condition.

The initial value is 0(00H) and the relationship between the set value and the condition is shown as below:

Table 4.8 Torque Conditions

Value	Condition
0(00H)	Torque OFF
1(01H)	Torque ON and keep the same angle*
2(02H)	Brake mode (refer p.38)

*The servo continues to maintain the angle directed just before the losing input or invalid input is started.

● No.23 Preparation Time (1 Byte, Hex, Read/Write, for PWM)

It is the time of the first movement after the power is turned on.

Setting this parameter enables the servo to avoid moving suddenly just after turning on the power.

Its unit is 10ms and the settable range is 0~255 (00H~FFH).

The Initial value is 200(C8H).

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

It is the allowable range of the angle around the goal angle.
If the error between the present angle 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 CW and No.25 is for CCW.
The unit is 0.1 degree, the initial value is 2(02H) and the settable range is 0~255(00H~FFH) for both directions.

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

It is the range that output torque of the servo increases in proportion to the error between the present angle and aim angle. The flexibility of the servo increases in proportion to this value.

No.26 is for CW and No.27 is for CCW.
The unit is 1.0 degree, the initial value is 1(01H) and the settable range is 0~255(00H~FFH) for each direction.

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

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

The unit is 0.01% of the maximum torque and the settable range is 0~10,000(00H~2710H)
The initial value is 0008H (3.1%).

The relationship of the output torque, error (=between the present angle and the goal position) and compliance parameters are shown in エラー! 参照元が見つかりません。.

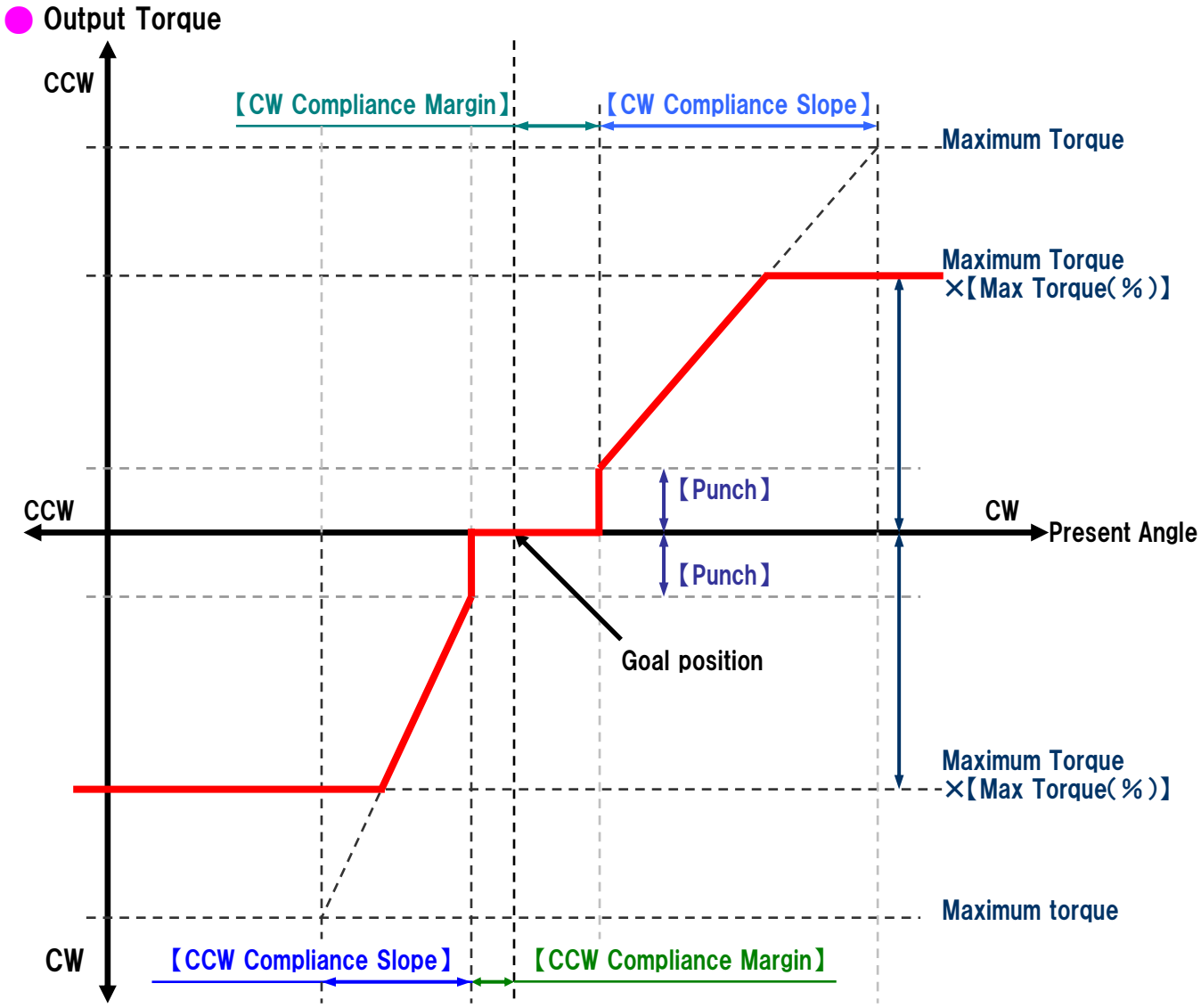


Fig. 4.1 **The relationship of Output Torque, Angle and Compliance settings**

Ex.1) Set Punch of the servo (ID: 1) to 1[%](= 100(0064H)).

Hdr	ID	Flg	Adr	Len	Cnt	Dat	Sum
FA AF	01	00	1C	02	01	64 00	7A

Ex.2) Set the servo (ID: 1) as shown below;

CW Compliance Margin	=	03H
CCW Compliance Margin	=	03H
CW Compliance Slope	=	14H
CCW Compliance Slope	=	14H
Punch	=	0064H

Hdr	ID	Flg	Adr	Len	Cnt	Dat	Sum
FA AF	01	00	18	06	01	03 03 14 14 64 00	7A

4.3. Variable RAM Area

Table 4.9 Variable RAM Area

Area	Address DEC.	Address HEX.	Initial	Name	R/W
Variable RAM Area	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	--	Reserved	-
	35	23H	64H	Max Torque	RW
	36	24H	00H	Torque Enable	RW
	37	25H	--	Reserved	-
	38	26H	64H	PID coefficient	RW
	39	27H	--	Reserved	-
	40	28H	--	Reserved	-
	41	29H	--	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	Present Speed L	R
	47	2FH	00H	Present Speed H	R
	48	30H	00H	Present Current L	R
	49	31H	00H	Present Current H	R
	50	32H	00H	Present Temperature L	R
	51	33H	00H	Present Temperature H	R
	52	34H	00H	Present Volts L	R
	53	35H	00H	Present Volts H	R
	54	36H	--	Reserved	-
	55	37H	--	Reserved	-
	56	38H	--	Reserved	-
	57	39H	--	Reserved	-
	58	3AH	--	Reserved	-
	59	3BH	--	Reserved	-

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

This parameter is the target angle of the servo.
Center of the movable range is 0 degrees and CW direction is "+" and CCW direction is "-" from the top of the servo (nameplate side).
Unit of Goal Position is 0.1 degree and its settable range is -1500~+1500.

A packet to set Goal Position received while in Torque-Off condition will be ignored.
When a packet that direct Torque ON and set Goal Position in 1 packet (packet to write No.30~36 at once) is received, the servo turns on its torque but not moves.

If the set value is out of the range specified by the No.8~No.11 ("Angle Limit"), the servo moves to the set maximum or minimum angle.
Ex.1) Move servo (ID: 1) to 90.0 degrees.

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

Ex.2) Move servo (ID: 1) to -90.0 degrees

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, Hex, Read/Write)

This parameter is the time to move to "Goal Position".
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.

The unit is 10ms and the settable range is 0~16,383(3FFFH), but note that error occurs about up to 5% when the set value is too big.

Ex.1) Move the servo (ID: 1) to 90.0 degrees in 5 sec.
90.0 degrees = 900(0384H), 5 sec = 500 (01F4H)

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

Ex.2) Move the servo (ID: 1) to -120.0 degrees in 10 sec.
-120.0 degrees = -12000(FB50H) , 10 sec = 1000(03E8H)

Hdr	ID	Flg	Adr	Len	Cnt	Dat	Sum
FA AF	01	00	1E	04	01	50 FB E8 03	5A

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

This parameter set the maximum torque of the servo.

In PWM-Type Control, the servo always moves with the initial value (100%) regardless of set value.

The unit is 1 % with the torque described in this manual (p.エラー! ブックマークが定義されていません。) as 100%.

The initial value is 100(64H) and the settable range is 0~100(00H~64H)

Ex) Set Maximum Torque of the servo (ID: 1) to 80%(=50H).

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

● No.36 Torque Enable (1 Byte, Hex, Read/Write)

It is the condition of the servo's torque.

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

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

The initial value is 0(00H) when the power is turned on.

In "Brake mode", the servo does not have output torque, but weak resistance torque occurs when it is turned from the outside.

When the output-axis is in Dead Zone, the value will be 0(00H) automatically and could not be changed.

To turn on the torque again, please move output-axis to Operational Range then send Torque-ON command.

Ex.1) Turn on the torque of the servo (ID: 1).

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

Ex.2) Turn off the torque of the servo (ID: 1)

Hdr	ID	Flg	Adr	Len	Cnt	Dat	Sum
FA AF	01	00	24	01	01	00	25

Ex.3) Set the servo (ID: 1) to "Brake mode "

Hdr	ID	Flg	Adr	Len	Cnt	Dat	Sum

FA AF	01	00	24	01	01	02	27

● No.38　PID Coefficient (1 Byte, Hex, Read/Write)

It is the PID-Gain of internal motor control.
The smaller the set value is, the smaller the hunting becomes, on the other hand, the output torque to hold the position will be small.

The unit is 1% and the settable range is 01H~FFH.

Ex) Set “PID Coefficient” of the servo (ID:1) to 90%.

Hdr	ID	Flg	Adr	Len	Cnt	Dat	Sum
FA AF	01	00	26	01	01	5A	7D

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

It is the angle of the servo.
Center of the movable range is 0 degrees and CW direction is “+” and CCW direction is “-” from the top of the servo (nameplate side). Unit of Present Position is 0.1 degree and its range is -1600~+1600.

<u>When the output-axis is in “Dead zone”, the value will be 15B3H(555.5degrees).</u>

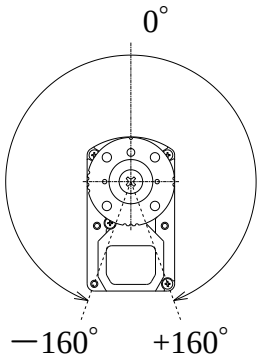


Fig. 4.2　角度検出範囲

Ex) Get “Present Position” of the servo (ID: 1)
To get the value of “Present Position”(No.42 and No.43 of the Memory Map) as a Return Packet, a Short Packet (“Flag”:bit3=1, bit2=0, bit1=0, bit0=1,”Address”=0, “Length”=0, “Count”=1 and no ”Data”) is required to be sent.

A Short Packet to require Return Packet with Memory Map No.42 ~ No.49 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	・・・	・・・	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

2 Byte from the top of “Data” is “Present Position” (No.42 and No.43 of Memory Map), then “Present Position” is 0384H=900= 90.0degrees.
*The value of "Data" varies according to the conditions of the real servo.

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

It is an elapsed time after a servo receives a packet to move.

When movement is completed, it maintains the last value.
If the “Goal Time” of the movement is “0(00H)”, “Present Time” will not be rewritten (maintain last value).

Ex) Get “Present Time” of the servo (ID: 1)
A Short Packet to require Return Packet with Memory Map No.42 ~ No.49 is the same as the previous paragraph.

A Short Packet to require Return Packet with Memory Map No.42 ~ No.49 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	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

The 3rd and 4th Byte of the “Data” is “Present Time” (No.44 and No.45 of Memory Map), then “Present Time” is 0237H=567=5670msec.

*The value of "Data" varies according to the conditions of the real servo.

● No.46/No.47 Present Speed (2 Byte, Hex, Read)

It is the rotational speed and its unit is deg/sec.

Ex) Get “Present Speed” of the servo (ID: 1)

A Short Packet to require Return Packet with Memory Map No.42 ~ No.49 is the same as the previous paragraphs.

A Short Packet to require Return Packet with Memory Map No.42 ~ No.49 is;

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

An example of Return Packet is;

An example of Return Packet is;

						Data										
Hdr	ID	Flg	Adr	Len	Cnt	42	43	44	45	46	47	···	···	58	59	Sum
FD DF	01	00	2A	12	01	5C	FF	37	02	2C	01	07	00 ・・・ 00	00	00	84

2 Byte as No.46 and No.47 of “Data” is the “Present Speed”, then “Present Speed” is 012CH=300 deg/sec.

*The value of "Data" varies according to the conditions of the real servo.

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

It is the electric current of the servo and its unit is 1mA.
It is almost proportional to output torque, but does not become 0 even in the condition of Torque-OFF.

Ex) Get “Present Current” of the servo (ID: 1)
A Short Packet to require Return Packet with Memory Map No.42 ~ No.49 is the same as the previous paragraphs.

A Short Packet to require Return Packet with Memory Map No.42 ~ No.49 is;

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

An example of Return Packet is;

A Short Packet to require Return Packet with Memory Map No.42 ~ No.49 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	06	00	BA	03	00	00	00	00	32

2 Byte as No.48 and No.49 of “Data” is the “Present Current”, then “Present Current” is 0006H=6mA.
*The value of "Data" varies according to the conditions of the real servo.

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

It is the temperature of the board in the servo.
The sensor has an individual difference about up to ±3 degrees Celsius.

When “Present Temperature” reaches low temperature 10 degrees Celsius than a “Temperature Limit” (No.14 and No.15 of Memory Map), “Temperature Alarm” (Bit 5 of Flag of Return Packet) becomes “1”.
When “Present Temperature” Exceeds “Temperature Limit”, “Temperature Limit” (Bit 7 of Flag of Return Packet) becomes “1” and the servo will be “Brake mode” (No.36 of Memory Map becomes to “2”) automatically.

The temperature reaches “Temperature Limit” once, the servo will not accept Torque-ON command until it is rebooted or is turned off-and-on the power again.

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

Ex) Get “Present Temperature” of the servo (ID: 1)
A Short Packet to require Return Packet with Memory Map from No.42 and No.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							A6

2 Byte as No.50 and No.51 of “Data” is the “Present Temperature”, then the value is 002DH=45degrees Celsius.
*The value of "Data" varies according to the conditions of the real servo.

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

It is the voltage of the power applied to the servo and its unit is 10mV.

The sensor has an individual difference about up to ±0.3V.

Detectable range is 3.7V~6.0V.

Ex) Get “Present Voltage” of the servo (ID: 1)

A Short Packet to require Return Packet with Memory Map from No.42 and No.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	F4	01	00	00	00	00	00	00	53

2 Byte as No.52 and No.53 of “Data” is the “Present Voltage”, then the value is 01F4H=5.0V.

*The value of "Data" varies according to the conditions of the real servo.

5. References

Specs

Application	Actuators for Robots				
Dimensions	27.9 x 16.0 x 23.9 [mm] *Refer next page for more details.				
Weight	12 [g]				
Consumption Current	(in suspension)	10 [mA]	(Room Temp., No Load, 5.0V)		
	(in operation)	60 [mA]	(Room Temp., No Load, 5.0V)		
	(in Stall Condition)	500[mA](*1)	(Room Temp., Locked, 5.0V)		
Output Torque	(Maximum)	2.1 [kgf·cm]	(0.21 [N·m])	(5.0V)	
	(Rated)	0.42[kgf·cm]	(0.041 [N·m])(*2)	(5.0V)	
Maximum Speed	0.19[sec/60degree](53[rpm])	(5.0V)			
Direction	CW	Present Position < Goal Position			
	CCW	Present Position > Goal Position			
Angle Range	CW	150[degree] (Command-Type) / 144 [degree] (PWM-Type)			
	CCW	150[degree] (Command-Type) / 144 [degree] (PWM-Type)			
Supply Voltage	3.7	~	6.0	[V]	
Temperature Range	(to operate)	0	~	+40	[degrees Celsius]
	(to store)	-20	~	+60	[degrees Celsius]
Power Source	DC3.7V~6.0V				
Communication	Baud Rate:	Maximum 230.4 kbps			
	Protocol:	8bit, Stop bit 1, None Parity, Asynchronous			

*1. Current Limit Function works automatically when the current reaches 510mA or more to avoid large current and to protect peripheral circuits.

By this function, the current is limited to about 510mA in usual, but it may be up to about 700mA instantaneously.

Applying a large load that is enough to be effect the current limit function for a long time will cause the servo to be damaged.

*2. The value is by Futaba's measurement.

Dimensions

● RS204MD

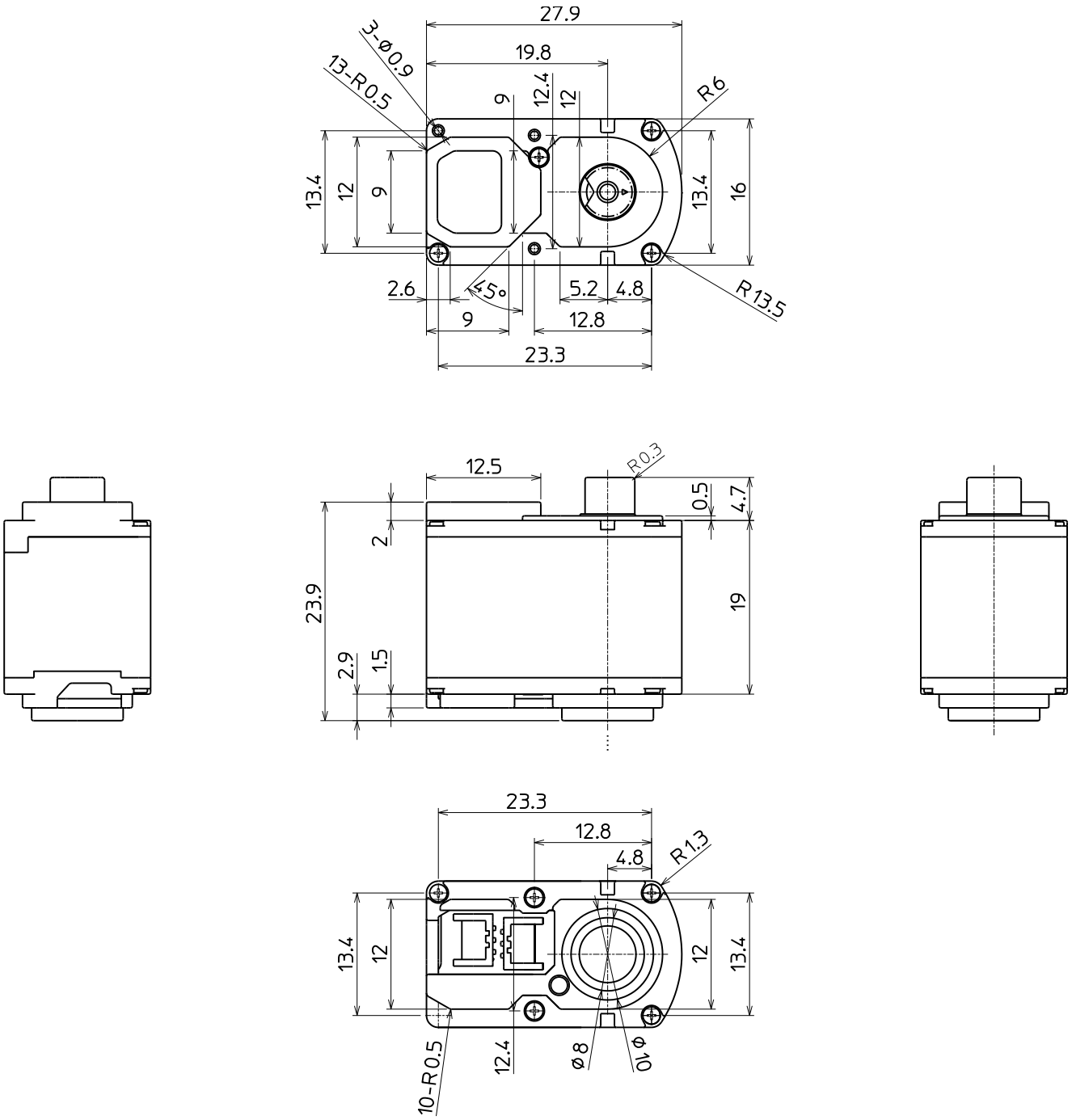


Fig. 5.1 RS204MD without Servo Horn (mm)

● Dimensions with Servo Horn and Free Horn

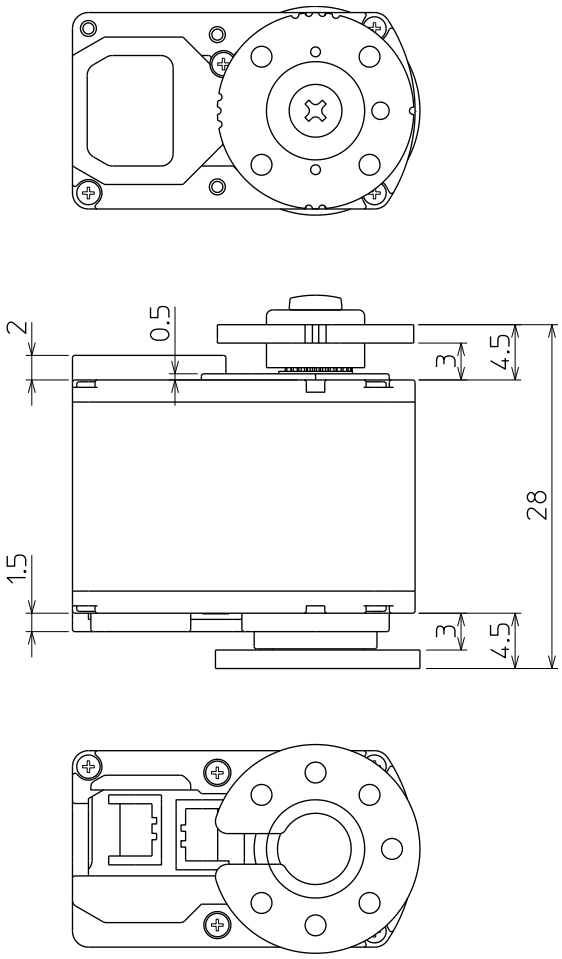


Fig.5.2　RS204MD with Servo Horn and Free Horn (mm)

*A gap of 0.3mm occurs between Servo Horn and the body of servo when the Servo Horn is attached exactly.

*Free Horn is not fixed to the servo. It turns freely around the axis of the bottom case and is unlocked along to the axis of the bottom case.

● Servo Horn and Free Horn for RS20x/RS30x

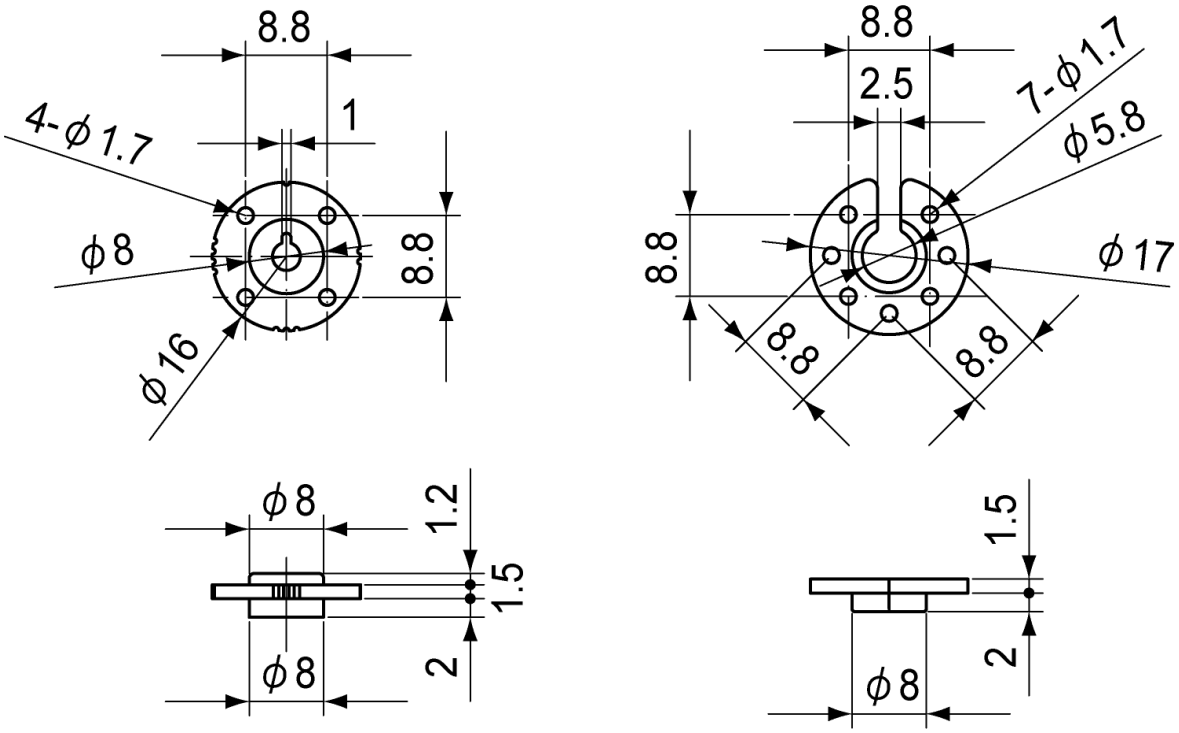


Fig. 5.3 (L)Servo Horn (R)Free Horn

Option Parts

Table 5.1 Option Parts for RS204MD

Code	Name	
“Bracket Set” to joint RS204MD		
BS3468	BRACKET SET RS204MD	・Bracket Part 6pcs ・Tapping Screw 1.2x5 20pcs ・Tapping Screw 2.0x8 20pcs ・Washer 1.2mm 20pcs
Terminal BOX		
BS3476	TERMINAL BOARD TB-41AD	Terminal Board with 4 ADH Connectors
BA2082	TB-RV71EH-7.4V/3W	Terminal Box with 7 EH connectors and Power Switch for TTL Command-Type Servo
BC0079	TB-RV71EH POWER CABLE	Power supply cable with connector for TB-RV71EH
BS3308	TB-EH41EH-300	Terminal Box with 4 EH Connectors
BB0132	TB22PP	Terminal Box with 4 Servo Connectors
Cables		
BB1182	SERVO CABLE AD-RC B 150	To convert ADH connector to Servo Connector, 150 mm
BB1183	SERVO CABLE AD-RC B 300	To convert ADH connector to Servo Connector, 300mm
BB1184	SERVO CABLE AD-EH B 150	To convert ADH connector to EH Connector, 150 mm
BB1185	SERVO CABLE AD-EH B 300	To convert ADH connector to EH Connector, 300 mm
BB1186	SERVO CABLE AD-AD B 70	Cable with ADH connector on both ends, 70 mm
BB1187	SERVO CABLE AD-AD B 150	Cable with ADH connector on both ends, 150 mm
BB1188	SERVO CABLE AD-AD B 300	Cable with ADH connectors on both ends, 300mm
BB1189	SERVO CABLE AD-C B 300	Cable with ADH connector on one end, 300 mm

Code	Name	
Screws		
BS3471	TAPPING SCREW 1.2X3.5	Tapping Screw 1.2 mm×L3.5mm (30pcs)
BS3472	TAPPING SCREW 1.2X5	Tapping Screw 1.2 mm×L5.0mm (30pcs)
BS3473	TAPPING SCREW 1.2X6	Tapping Screw 1.2 mm×L6.0mm (30pcs)
BS3474	TAPPING SCREW 1.2X8	Tapping Screw 1.2 mm×L8.0mm (30pcs)
BS3475	PLANE WASHER 1.2X2.8	Plane Washer 1.2mm (30pcs)
Repair Parts		
BS3470	CASE SET RS204MD	Cases(Upper, Middle, Bottom)
BS3469	GEAR SET RS204MD	Gears(gears, shafts, Ball bearings)
BS3477	GREASE MULTIPURPOSE	Grease for servos 8g (Appropriate amount 0.05g for RS204MD)
Horns		
BS0532	RS302_304 SCREW 2x8	Screw to fix Servo Horn for RS302CD/RS304MD/RS204MD (10pcs)
BS3354	ROBOT SERVO HORN RH01	Servo Horn for RS30x/RS20x (5pcs)
BS0168	RS30x FREE HORN SET	Free Horns for RS30x/RS20x (5pcs)

Fig. 5.4 BB1182 SERVO CABLE AD-RC B 150

Fig. 5.5 BB1185 SERVO CABLE AD-EH B 300

Fig. 5.6 BB1186 SERVO CABLE AD-AD B 70

How to use “Bracket”

BRACKET SET RS204MD is used to fix RS204MD to other parts easily.

● Fixing Brackets to RS204MD

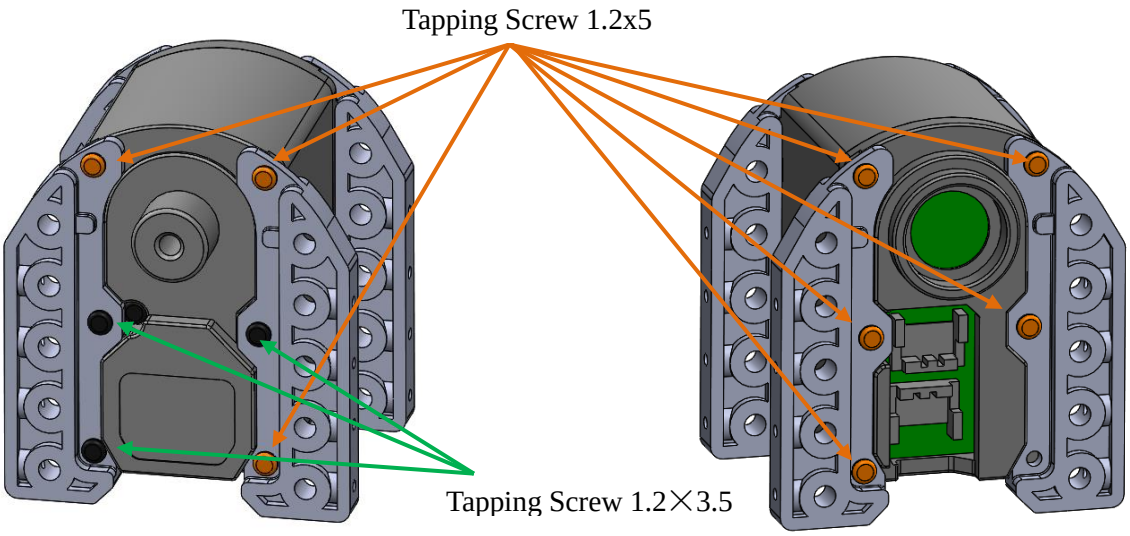


Fig. 5.7 RS204MD with Brackets

● Jointing Other Parts/Servos

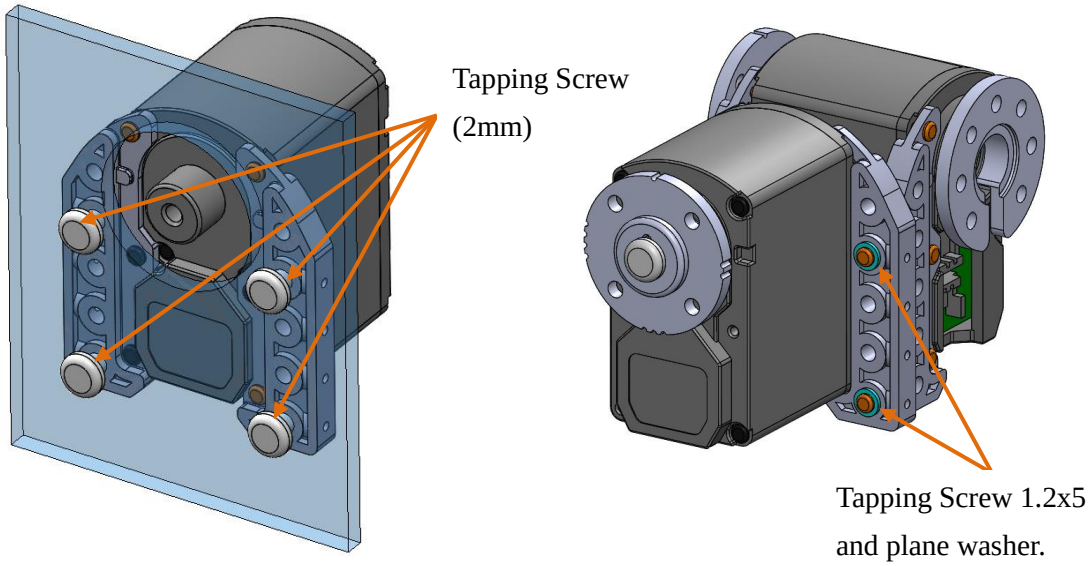


Fig. 5.8 Jointing RS204MD

● Usage of Brackets

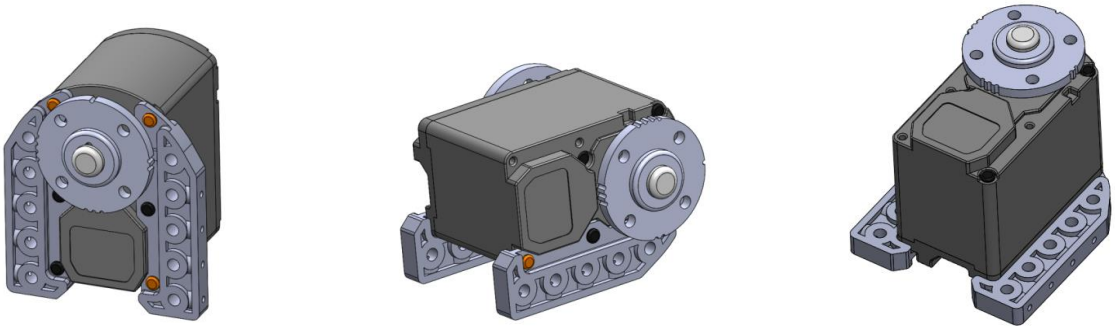


Fig. 5.9 RS204MD with Brackets

● Dimensions with Brackets

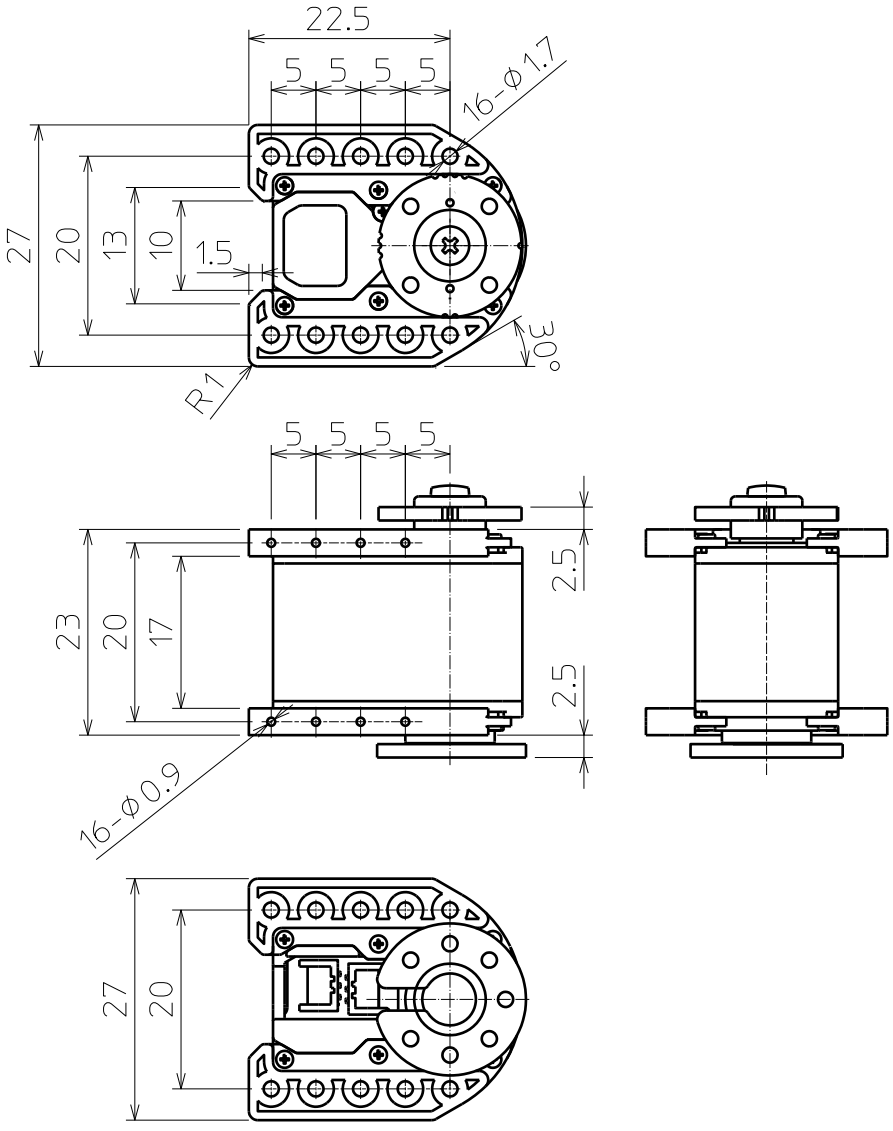


Fig. 5.10 RS204MD with Brackets (mm)

Dimensions of Terminal Board

*Use tape to fix TB-41AD.

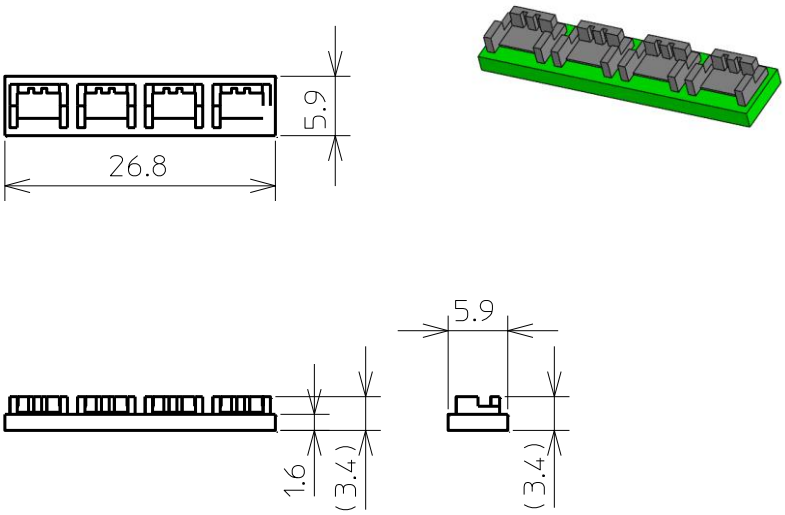


Fig. 5.11 Dimensions of TB-41AD (mm)

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