1M23Z01702

User’s Manual Ver.2.02

RS601CR

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 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 RS601CR.

1) RS601CR	1pcs
2) Screws to fix RS601CR (M2.3 x 28.5)	2pcs
3) Screws to fix RS601CR (M2.3 x 50.0)	2pcs
4) Nut for RS601CR (M2.3)	4pcs

*Screws and Nut (2) ~ 4)) are attached to the servo.

RS601CR Equipments Pack	1Set
Contents of the Pack are bellow;	
5) Servo Horn for RS601CR	1pcs
6) Screws to fix Servo Horn for RS601CR	2pcs
7) Aluminum-Shaft for RS601CR (Short)	1pcs
8) Screws to fix Servo Horn to others (M2x5)	4pcs

9) Lead Harness for RS601CR (300mm)	1pcs
10) Usage Precautions	1pcs

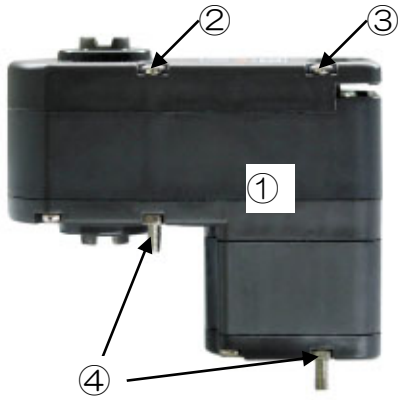


Fig. 2.1 RS601CR and attached screws

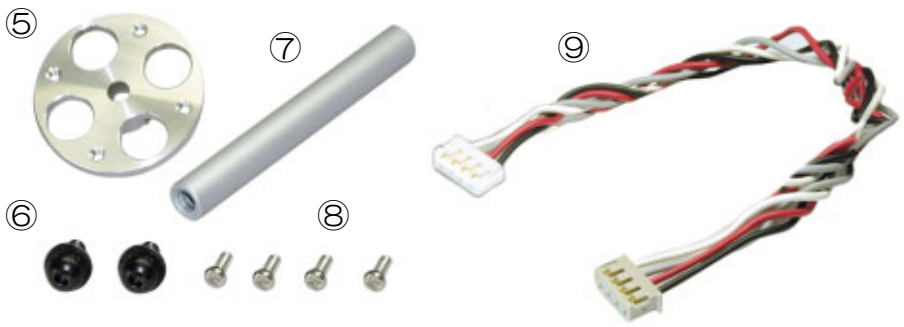


Fig. 2.2 Contents of RS601CR Equipment Pack and Lead Harness

Part and Names

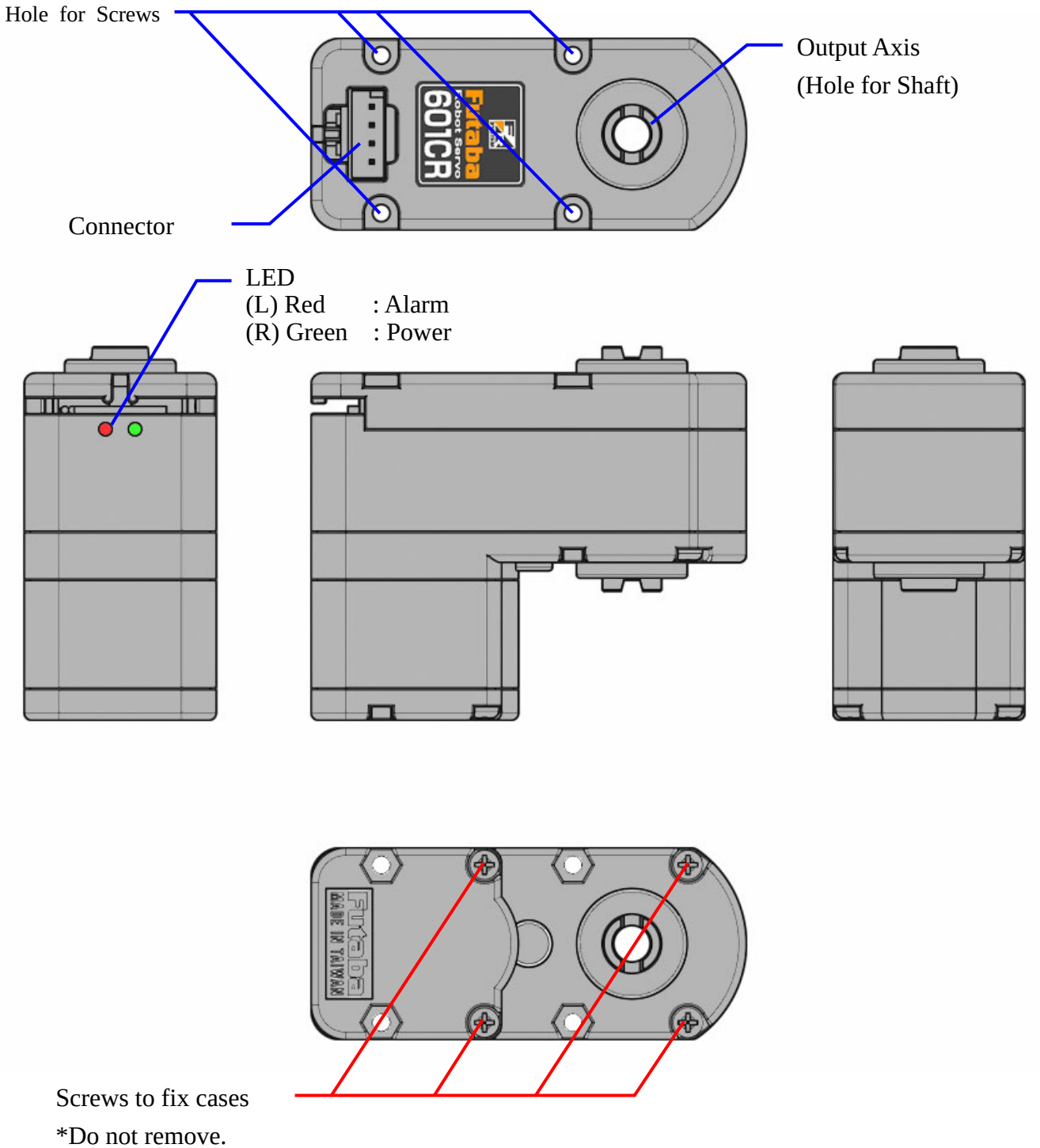


Fig. 2.3 Part and names

Caution

Use Screws to fix RS601CR (M2.3) to fix RS601CR's body to other parts.
Removing the screws to fix cases may damage the servo.

Pin Assignment

Pin Assignment of RS601CR is shown below;

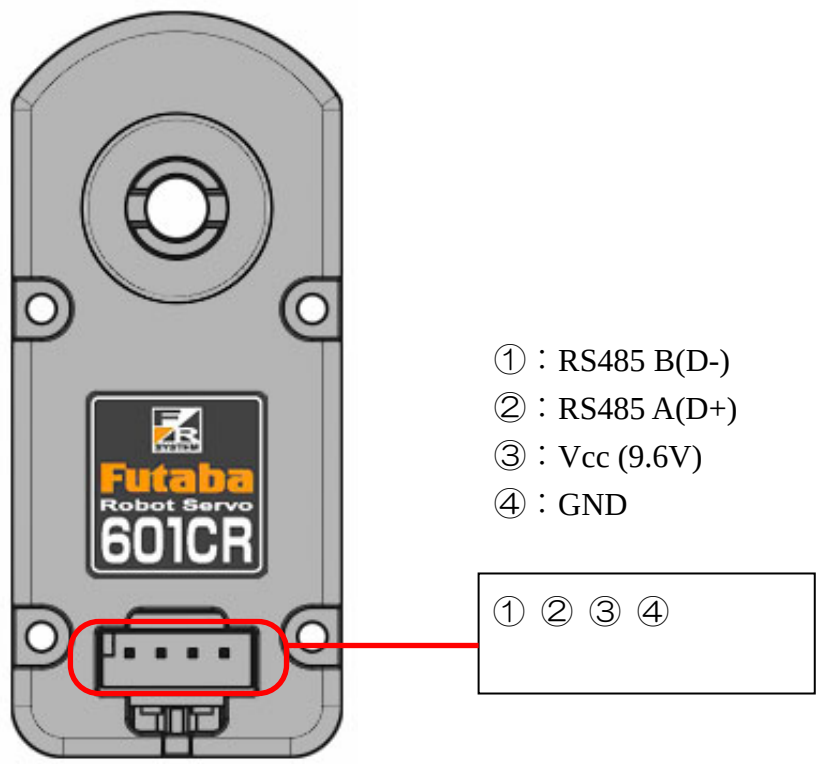


Fig. 2.4 Pin Assignment

Connector on RS601CR is;

Maker:	Japan Automatic Machine Co, Ltd.
No.:	SC25-04WS

Features

RS601CR is especially designed for robotic applications, having the following features.

● High-Torque and Tough Servo

RS601CR is designed especially for robots, offering high speed of 0.17sec/60 degrees and high torque of 21.0kgf·cm at 9.6V.

Output-shaft extending out from both sides makes RS601CR stronger by a large margin than other conventional servos. And special Aluminum Servo Horn for RS601CR having uniquely shaped serrations, can fit their output-axes very precisely.

● Command-Type Control

The servo can be controlled by commands using bidirectional RS485 half duplex communication.

A single command can convey multiple data, including a period of time to move and a target position. This relieves the robot's processor unit from load significantly.

● Data Feedback

Various kinds of information about the servo such as angular position, load, temperature, current and alarm can be obtained via RS485.

● Compliance Control

With this feature, the movement of the RS601CR 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 external force.

● Calibration

Angular position of every servo is calibrated by our standard gauge before their shipment. Even if another RS601CR servo is employed, it does not require any bothersome work for adjusting its angular position.

● Image of using optional parts

By using optional parts such as Joint Ball, Drive Spacer, etc., RS601CRs are enabled to be assembled as a 2-Axis Joint easily.

Parts	num
RS601CR	2pcs
Aluminum-Shaft for RS601CR (long)	1set (2pcs)
Joint Ball for RS601CR	1set
Drive Spacer for RS601CR	1set (2pcs)

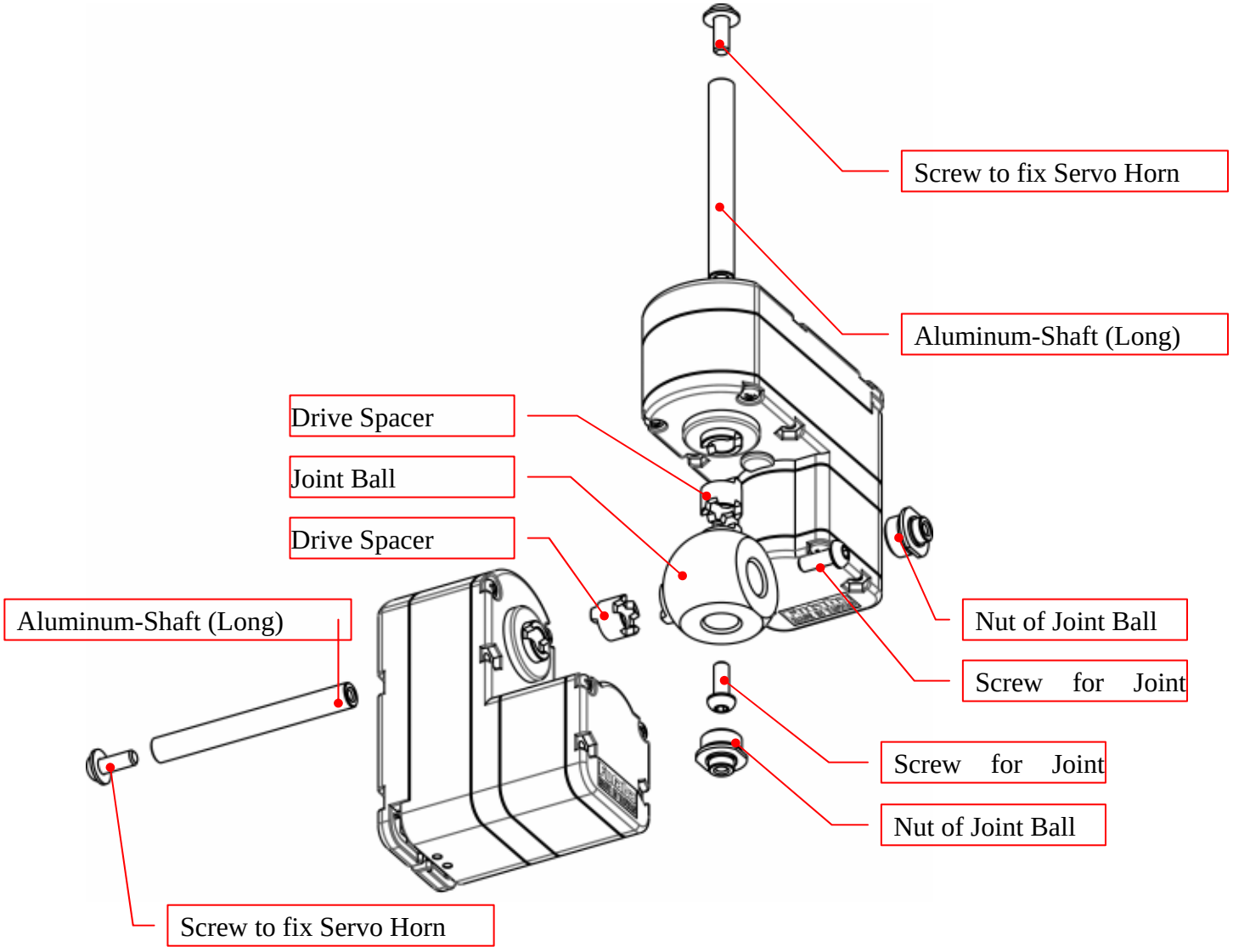


Fig. 2.5 Image of assembling 2-Axis Joint with Joint Ball

3. Connections

Systems

Systems of the robot with RS601CR are follows;

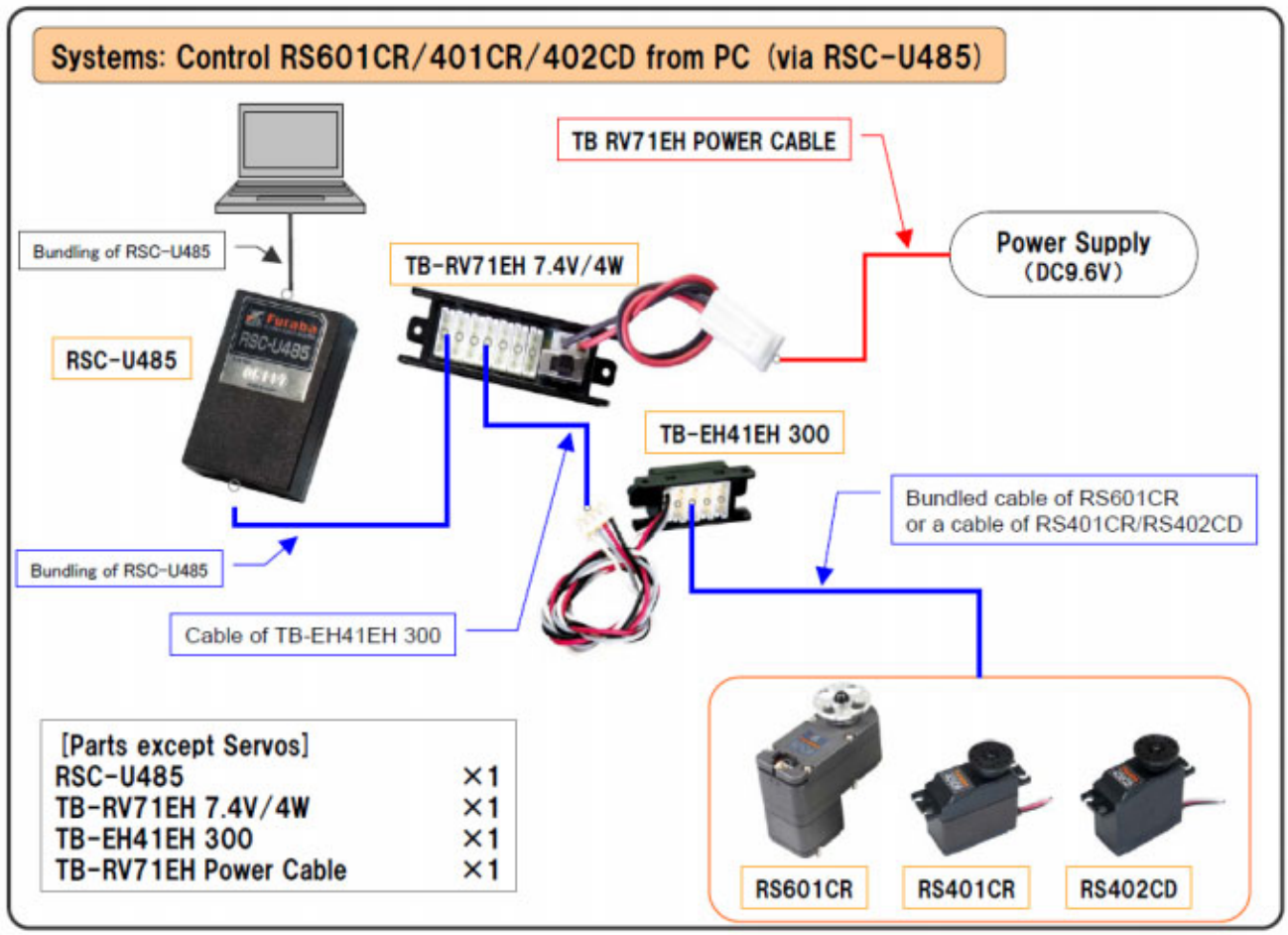


Fig. 3.1 System with RS601CR/RS401CR/RS402CD and RSC-U485

RS485 Command-Type Servos are controlled from PC with USB-RS485 Converter “RSC-U485” and possible to receive commands from software on PC and to send information of internal sensors to PC (Some sample programs are shown on our Web site).

[Communication Settings of PC]

Baud Rate	:	115.2	[kbps] (9.6[kbps]～1.3[Mbps], See P.22 for more details)
Data Bit	:	8	[bit]
Parity	:	None	
Stop Bit	:	1	[bit]
Flow Control	:	None	

4. Control

Abstract

● Communication Protocol (RS485 Command-Type)

The communication protocol used for RS485 Command-Type Servo is asynchronous half-duplex communication. The signal line can be switched alternately for transmission or reception of data.
Normally, Command-Type Servos stand by in a receiving mode.
When the servo receives a command to send its data, the servo changes its mode to transmitting mode. After sending the data, they stand by again in a receiving mode.

● Memory Map

Command-Type Servos 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.

● 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 Command-Type 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 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 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

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.21) 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 4.2, 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 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

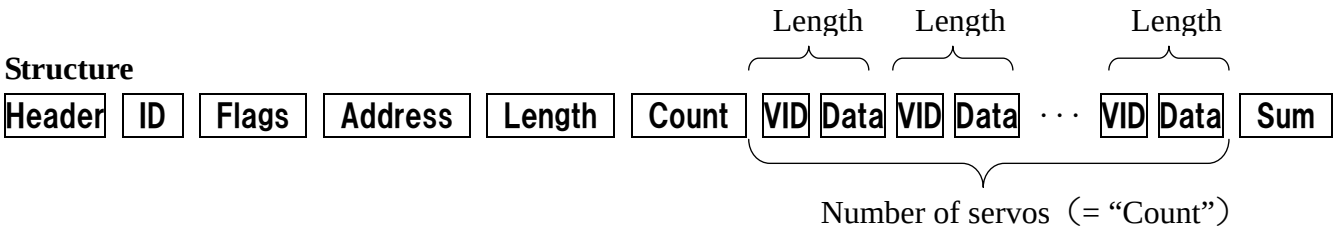
By sending a Short Packet with the Bit 0=1, Bit1=0, Bit2=0, Bit3=0, the servo will return ACK/NACK packet.

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.

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 4.3 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 4.4 Invariable ROM Area

Area	Address DEC	HEX	Initial	Name	R/W
Invariable	00	00H	10H	Model Number L	R
	01	01H	60H	Model Number H	R
	02	02H	01H	Firmware Version	R
	03	03H	00H	Reserved	-

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

It is the Model Number（Name of the servo）.
“60 10” means RS“601”CR.

Model_Number L	10H
Model_Number H	60H

● No.2 Firmware Version (1 Byte, 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 bellow:

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

4.2. Variable ROM Area

Table 4.5 Variable ROM Area

Area	Address DEC	HEX	Initial	Name	R/W
Variable	04	04H	01H	Servo ID	RW
	05	05H	00H	Reserved	-
	06	06H	07H	Baud Rate	RW
	07	07H	00H	Reserved	-
	08	08H	CEH	CW Angle Limit L	RW
	09	09H	04H	CW Angle Limit H	RW
	10	0AH	32H	CCW Angle Limit L	RW
	11	0BH	FBH	CCW Angle Limit H	RW
	12	0CH	00H	Reserved	-
	13	0DH	00H	Reserved	-
	14	0EH	00H	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	01H	CW Compliance Margin	RW
	25	19H	01H	CCW Compliance Margin	RW
	26	1AH	02H	CW Compliance Slope	RW
	27	1BH	02H	CCW Compliance Slope	RW
	28	1CH	FFH	Punch L	RW
	29	1DH	00H	Punch H	RW

● No.4 Servo ID (1 Byte, Hex, 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	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 previous ID if it was not written to the Flash ROM before turning off the power.

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

It is the baud-rate of communication.

Initial value is 07H (115,200bps) and the settable range is from 0 to 12 (00H to 0CH)

Table 4.6 Baud Rate

value	Baud Rate	Value	Baud Rate	Value	Baud Rate
00H	9,600bps	05H	57,600bps	0AH	460,800bps
01H	14,400bps	06H	76,800bps	0BH	691,200bps
02H	19,200bps	07H	115,200bps	0CH	1,382,400bps
03H	28,800bps	08H	153,600bps		
04H	38,400bps	09H	230,400bps		

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

It is the maximum operating angle based on 0 degree (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.

The initial value is CW: +123, CCW: -123, and it is the maximum value of CW (minimum of CCW).
Do not set a value that is more than the maximum value or less than the minimum value because it may cause troubles.

When the set angle is larger than the set Angle Limit, the servo rotates to the maximum operating angle.
Initial value and settable range is;

Direction	Initial	range
CW	+123(04CEH)	0 (0000H) ～ +123 (04CEH)
CCW	-123(FB32H)	0 (0000H) ～ -123 (FB32H)

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	10	02	01	18 FC	F6

● No.14/ No.15 Temperature Limit (2 Byte, Hex, 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 torque to avoid troubles, and the red LED of the servo turns on.
To turn on the torque again, cool the servo and reboot it.
*Note that rewriting this value will null and void the product warranty.

● 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 about 0.08 degree, initial value is 1(01H) 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 about 0.08 degree, initial value is 2(02H) and the settable range is 0~255(00H~FFH) for each directions.

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

It is the minimum torque (electric current) that is generated when 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~ 1,701 (00H~06A5H).
The initial value is 00FFH.

The relationship of the output torque, error (=between the present angle and the goal position) and compliance parameters are shown in Fig. 4.1.

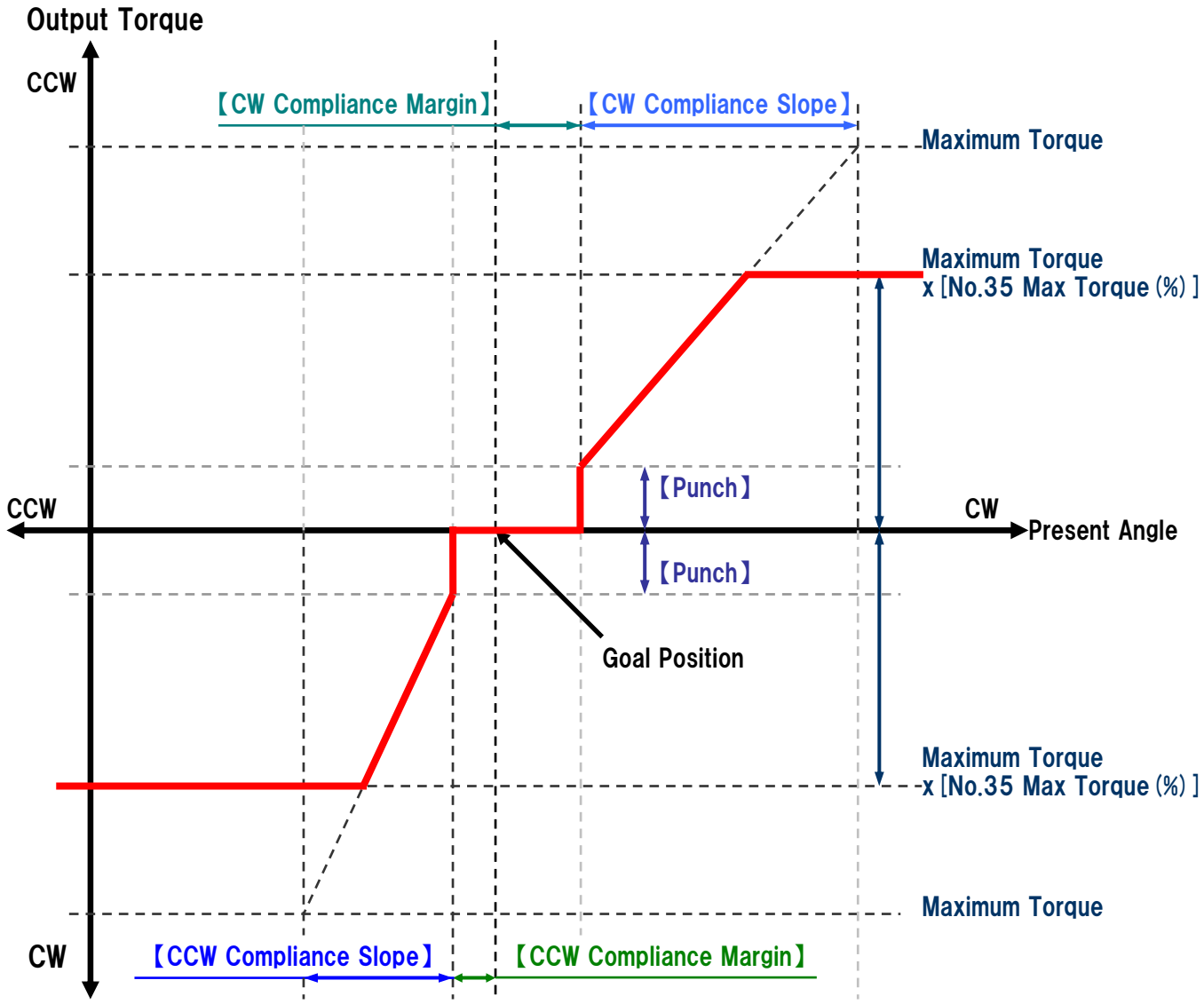


Fig. 4.1 The relationship of Output Torque, Angle and Compliance settings

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 4.7 Variable RAM Area

Area	Address DEC	HEX	Initial	Name	R/W
Variable RAM 1Area	30	1EH	00H	Global Position L	RW
	31	1FH	00H	Global Position H	RW
	32	20H	00H	Global Time L	RW
	33	21H	00H	Global Time H	RW
	34	22H	00H	Acceleration Time	RW
	35	23H	64H	Max Torque	RW
	36	24H	00H	Torque Enable	RW
	37	25H	00H	LED	RW
	38	26H	64H	PID Coefficient	RW
	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	R
	47	2FH	00H	Reserved	R
	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	Reserved	-
	53	35H	00H	Reserved	-
	54	36H	00H	Reserved	-
	55	37H	00H	Reserved	-
	56	38H	00H	Reserved	-
	57	39H	00H	Reserved	-
	58	3AH	00H	Reserved	-
	59	3BH	00H	Reserved	-

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

This parameter is the target angle of the servo and the unit is 0.1 degree.
Center of the movable range is 0 degrees and CW direction is “+” and CCW direction is “-” from the top of the servo (nameplate side).

Ex.1) Move servo (ID: 1) to 90.0 degree.

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 degree

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”.

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.
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.

Ex.1) Move the servo (ID: 1) to 90.0 degree in 5 sec.
90.0 degree = 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 degree in 10 sec.
-120.0 degree = -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.34 Acceleration Time (1 Byte, Hex, Read/Write)

It is the time for acceleration and slowdown of a servo's movement. The bigger the set value is, the smoother the movement. On the other hand, the error of the goal time will be bigger.

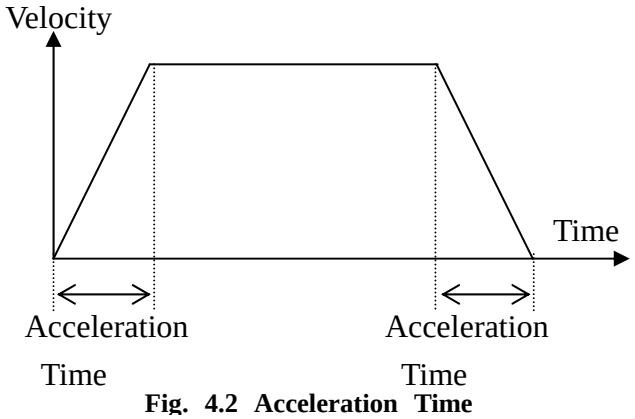


Fig. 4.2 Acceleration Time

The unit is 10msec and settable range is 0~255(00H ~ FFH).

Ex) Set "Acceleration Time" of the servo (ID: 1) to 30(1EH).

Hdr	ID	Flg	Adr	Len	Cnt	Dat	Sum
FA AF	01	00	22	01	01	1E	3D

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

This parameter set the maximum torque of the servo.

The unit is 1 % with the torque described in this manual (p.34) 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;

Table 4.8 Torque Conditions

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

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.37 LED (1 Byte, Hex, Read/Write)

It is the condition of RS601CR's LED.

Table 4.9 LED Conditions

Value	Green	Red
0(00H)	OFF	OFF
1(01H)	ON	OFF
2(02H)	OFF	ON
3(03H)	ON	ON

Ex) Turn on the Red and Green LED of the servo (ID: 1)

Hdr	ID	Flg	Adr	Len	Cnt	Dat	Sum
FA AF	01	00	25	01	01	03	27

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

It is the PID-Gain of the internal motor control.

The smaller the set value is, the smaller the hunting become. On the other hand, the output torque to maintain the position will be small.

The unit is 1% and settable range is 0~255(00H~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 Goal Position is 0.1 degree and its range is -1200~+1200.

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

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.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;

						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	06	00	00 BA	03	00	00	00	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 A/D converted value of temperature sensor's output to show the internal temperature.
It has no unit and the value will be about 940~950(03ACH~03B6H) when the temperature is about 20 degrees Celsius.
The higher the temperature is, the smaller the "Present Temperature" is.

When "Present Temperature" is low temperature 13 than its value at 20 degrees Celsius, "Temperature Alarm" (Bit 5 of Flag of Return Packet) becomes "1" and Red LED turns on.

When "Present Temperature" is low temperature 26 than its value at 20 degrees Celsius, "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.

When "Temperature Limits" becomes "1", 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	BA	03	00	00	00	00	A6

2 Byte as No.50 and No.51 of "Data" is the "Present Temperature", and then the value is 03BAH.
*The value of "Data" varies according to the conditions of the real servo.

5. References

Specs

Application	Actuators for Robot			
Dimensions	59 x 26 x 47.1		[mm]	
	*Refer next page for more details.			
Weight	93		[g]	
Consumption Current	(in suspension)	45	[mA]	
(Room Temperature, No Load)	(in operation)	150	[mA]	
Maximum Output Torque	21.0		[kgf]	(9.6V)
Maximum Speed	0.17		[sec/60degree]	(No Load, at 9.6V)
Direction	CW	Present Position < Goal Position		
	CCW	Present Position > Goal Position		
Angle Range	CW	120[degree]		
	CCW	120[degree]		
Supply Voltage	DC	9.6	[V]	
Temperature Range	(to operate)	0	~	+40[degrees Celsius]
	(to store)	-20	~	+60[degrees Celsius]
Communication	Baud Rate	Maximum 1.3MBps		
Protocol:	8bit, Stop bit 1, None Parity, Asynchronous			

Dimensions

● RS601CR

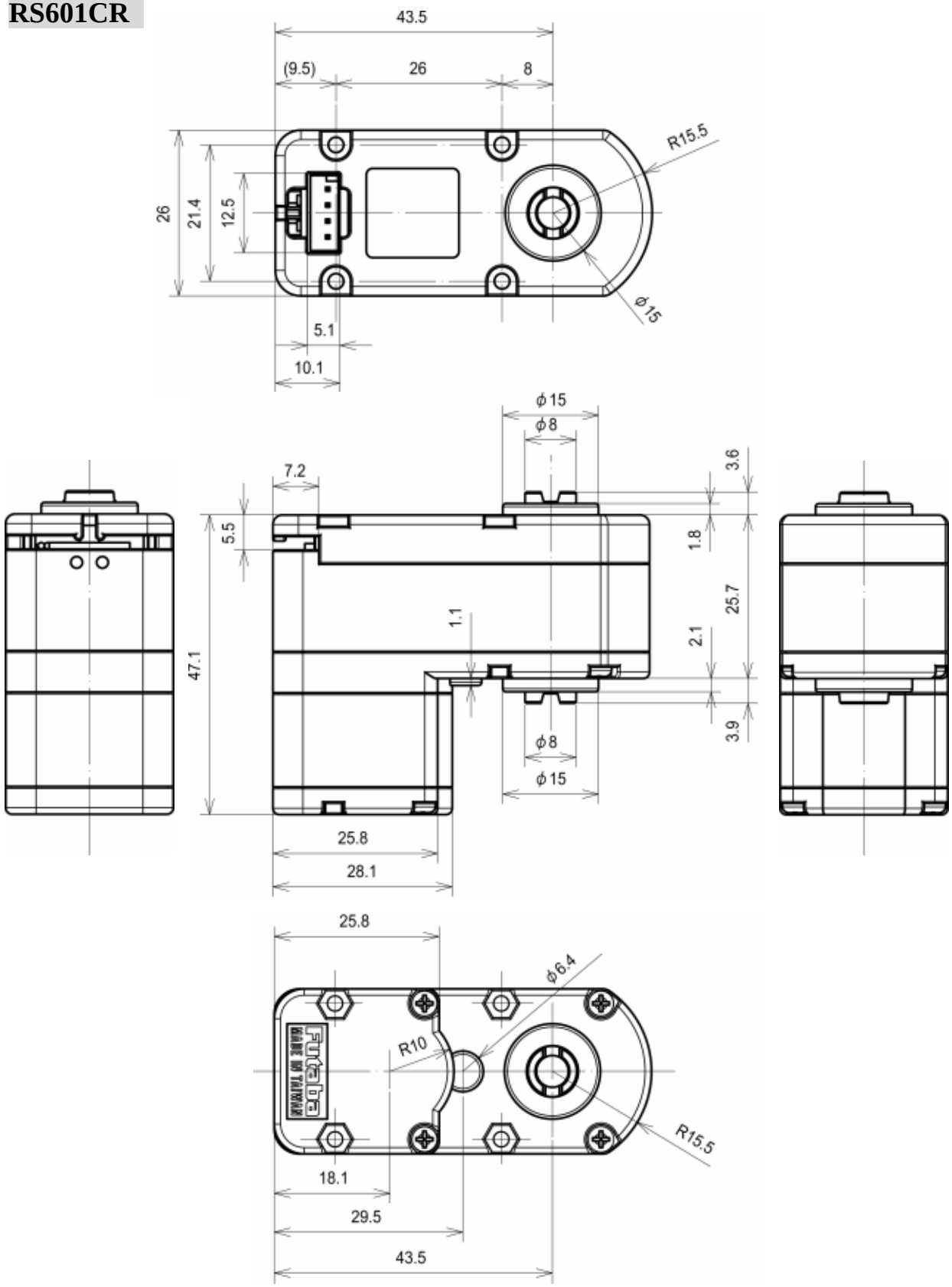


Fig. 5.1 Dimensions of RS601CR

● Servo Horn for RS601CR

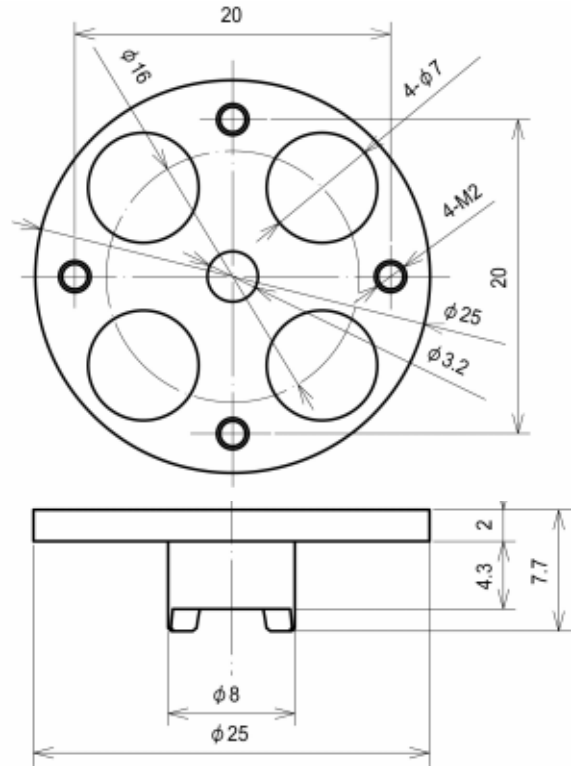


Fig. 5.2 Servo Horn for RS601CR

Servo Horn for RS601CR is attachable to both sides of RS601CR.

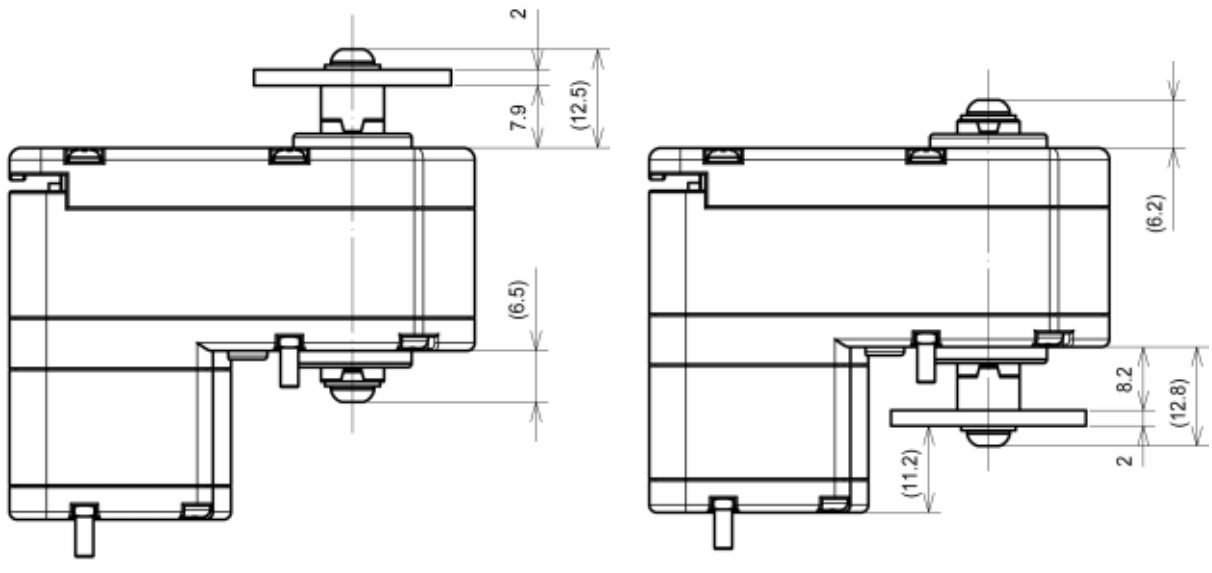


Fig. 5.3 Dimensions of RS601CR and Servo Horn

● RS601CR Option Parts

【JOINT BALL SET】

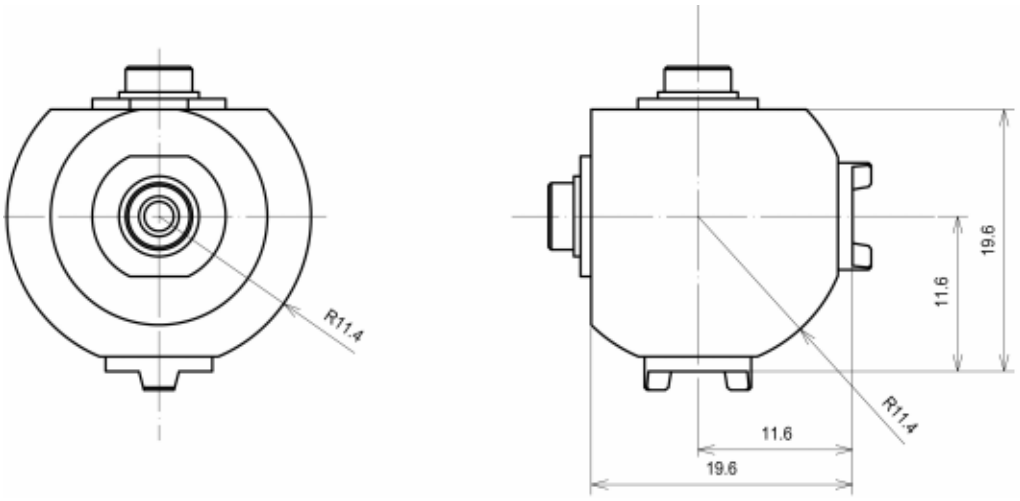


Fig. 5.4 Joint Ball for RS601CR

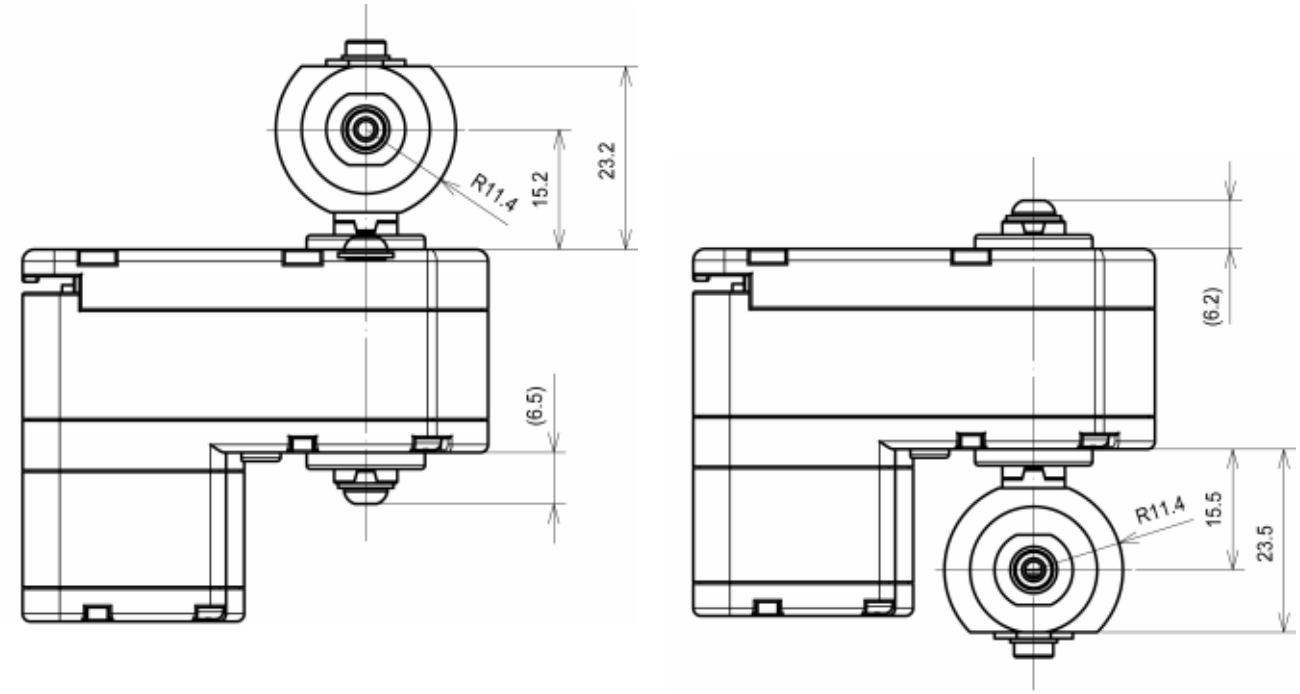


Fig. 5.5 Dimensions of RS601CR and Joint Ball

【RS601CR DRIVE SPACER】

Fig. 5.6 RS601CR Drive Spacer

"Drive Spacer" is used between the body of RS601CR and the Servo Horn or Joint Ball to enlarge the movable angle range.

<u>"RS601CR Long Shaft" is needed to use "Drive Spacer".</u>

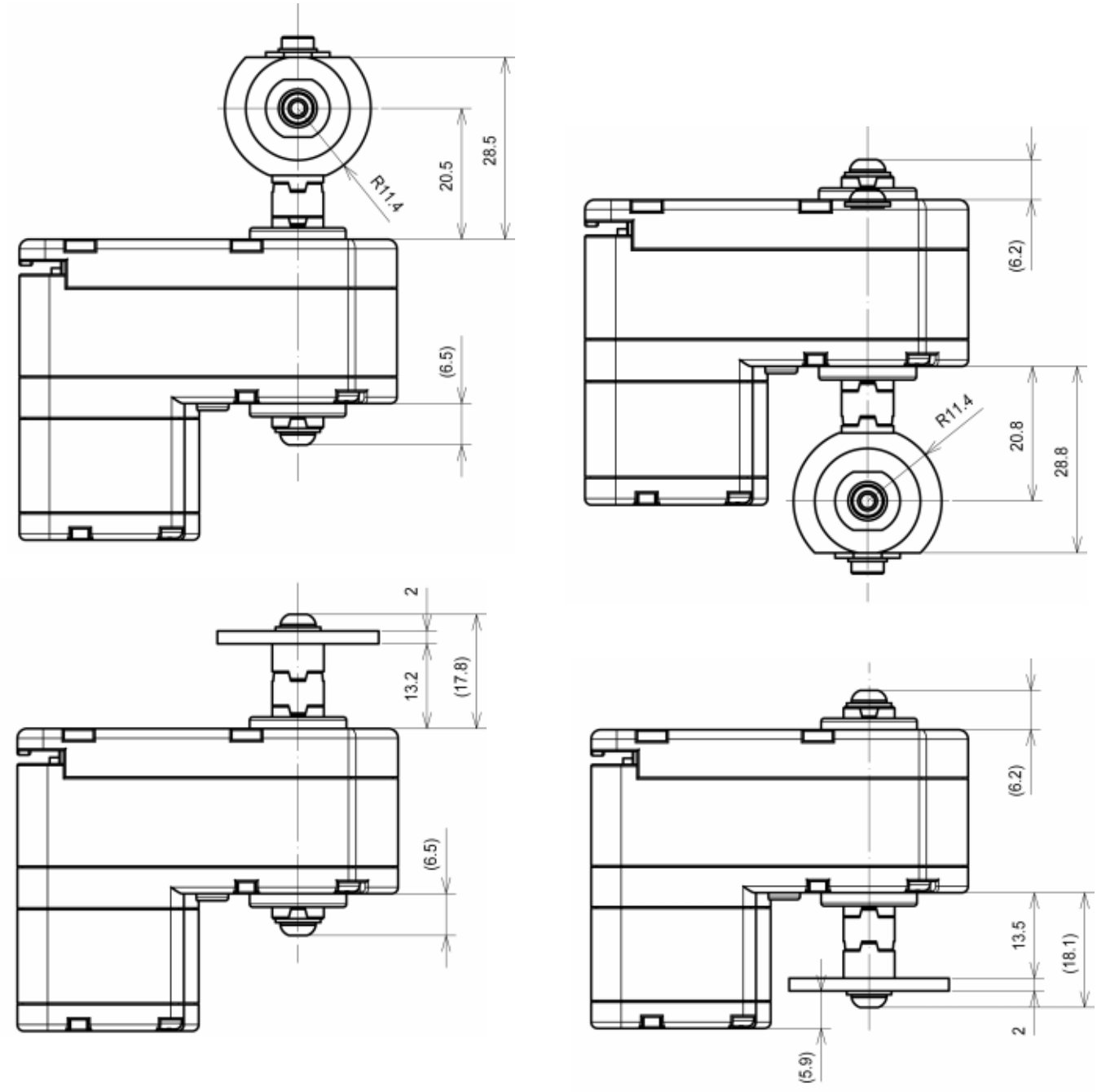


Fig. 5.7 Dimensions of RS601CR and Servo Horn/Joint Ball with Drive Spacer

【RS601CR LONG SHAFT】

“RS601CR Long Shaft” is also used to attach 2 Servo Horns or Joint Balls.

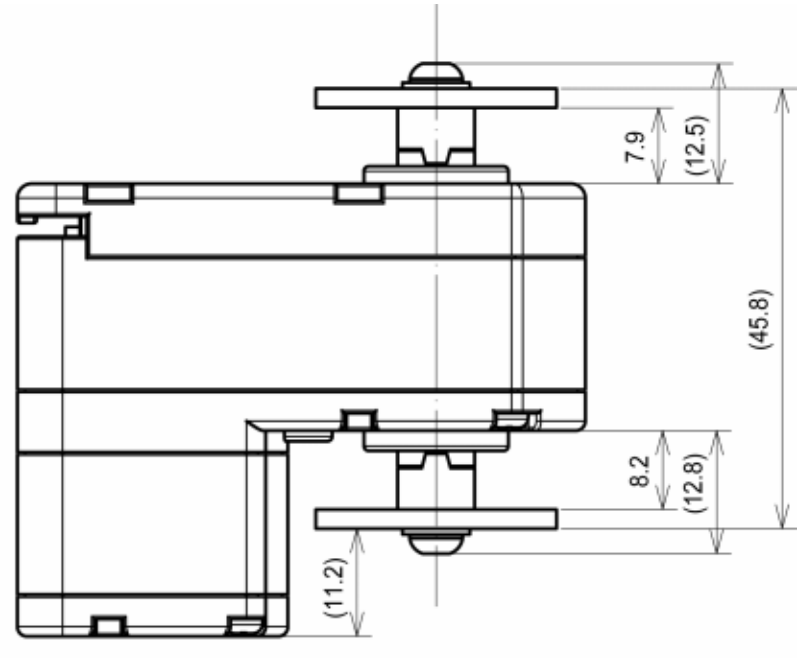


Fig. 5.8 RS601CR and 2 Servo Horns with Long Shaft

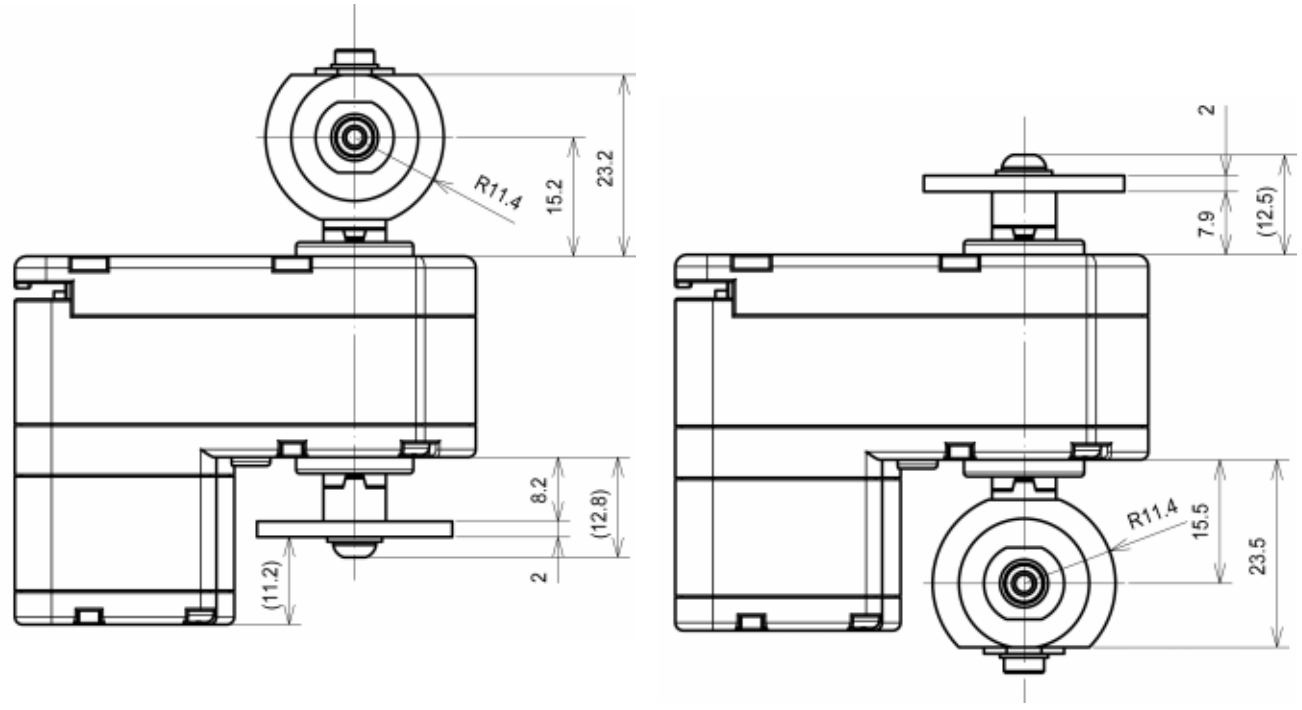


Fig. 5.9 RS601CR and Joint Ball with Long Shaft

Option Parts

Table 5.1 Option Parts for RS601CR

Name	Descriptions
JOINT BALL SET	Joint Ball Set for RS601CR
NYLON NUT 2.3	Nylon nut (M2.3), 20pcs
PMS 2.3x32.5	Screws to fix RS601CR (Short), M2.3x32.5, 20pcs
PMS 2.3x54	Screws to fix RS601CR (Long), M2.3x54,.0 20pcs
PMS 2X5 Ni FE	Screws to fix Servo Horn to Other Parts, M2x5, 40pcs
FLANGE BEARING 850	Bearing Set for Joint Ball
RS601CR HORN	Servo Horns and Screws for RS601CR, 2pcs
RS601CR SHORT SHAFT	Aluminum-Shaft for RS601CR(Short), 2pcs
RS601CR LONG SHAFT	Aluminum-Shaft for RS601CR(Long), 2pcs
RS601CR DRIVE SPACER	Drive Spacers for RS601CR, 2pcs
3P BOX SCREW 3X8	Screws to fix Servo Horn for RS601CR, M3x8, 20pcs
2P BOX SCREW 3X8	Screws to fix Joint Ball for RS601CR, M3x8, 20pcs
SX SPIRAL LEAD 100	Lead Harness for RS601CR, 100mm, 2pcs
SX SPIRAL LEAD 150	Lead Harness for RS601CR, 150mm, 2pcs
SX SPIRAL LEAD 200	Lead Harness for RS601CR, 200mm, 2pcs
SX SPIRAL LEAD 300	Lead Harness for RS601CR, 300mm, 2pcs
TB-EH41EH(300)	Terminal Box with 1 lead harness(300mm) and 4 connectors

Fig. 5.10 JOINT BALL SET

Fig. 5.11 RS601CR HORN

Fig. 5.12 TB-EH41EH

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