User's Manual Ver.1.0

RS301CR/RS302CD

Command Type Servo for Robot

Instruction Manual

Caution

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

For models

Futaba®

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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	Meaning
⚠ 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.

Warnings in Handling Batteries

⚠ Warning

Do not use any battery charger other than the specified charger.
Otherwise, the battery may be get damaged, fire, smoke or liquid leakage. Be sure to use batteries recommended by Futaba.

Do not use battery packs connected in parallel.
Connecting battery packs in parallel may cause abnormal heat generation or explosion due to the differences between charging voltages.

Do not disassemble or alter battery packs.
Otherwise, it may cause fire, explosion or liquid leakage. And please be aware that such battery packs will be no longer guaranteed even if their warranties are not expired.

Do not use batteries if any abnormal symptoms are seen.
If you find any abnormal symptoms such as cracks in coating film, abnormal heat generation from batteries or deformation of batteries, never use the battery because it may cause serious consequences.

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

Features

RS301CR/RS302CD servo is especially designed for robotic applications, having the following features.

● **Small and Lightweight**
RS301CR and RS302CD are small and lightweight servos specially designed for robots, which are 28g and 21g respectively.

● **Interactive high speed RS485 communication**
RS485 half duplex communication carries out bidirectional high-speed communication up to 460kbps. RS485 is used for the communication between the robot's processor unit and servos at very high speed.

● **Command type control**
The servo can be controlled by commands sent from the robot's processor unit through RS485. And 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 RS301CR/RS302CD 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 RS301CR/RS302CD servo is calibrated by our standard gauge before their shipment. Even if another RS301CR/RS302CD servo is employed, it does not require any bothersome work for adjusting its angular position.

● **12bit-A/D converter for precise positioning**
Angular feedback using the 12bit-A/D converters makes it possible to position the servo angle precisely.

● **Wiring from the output shaft**
Wires pass through the backside of the output shaft to avoid getting wires entwined in operation.

● **Horn with a mark for 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 for 90°, three for 180° and four for 270°）.

Part Names / Handling Instructions

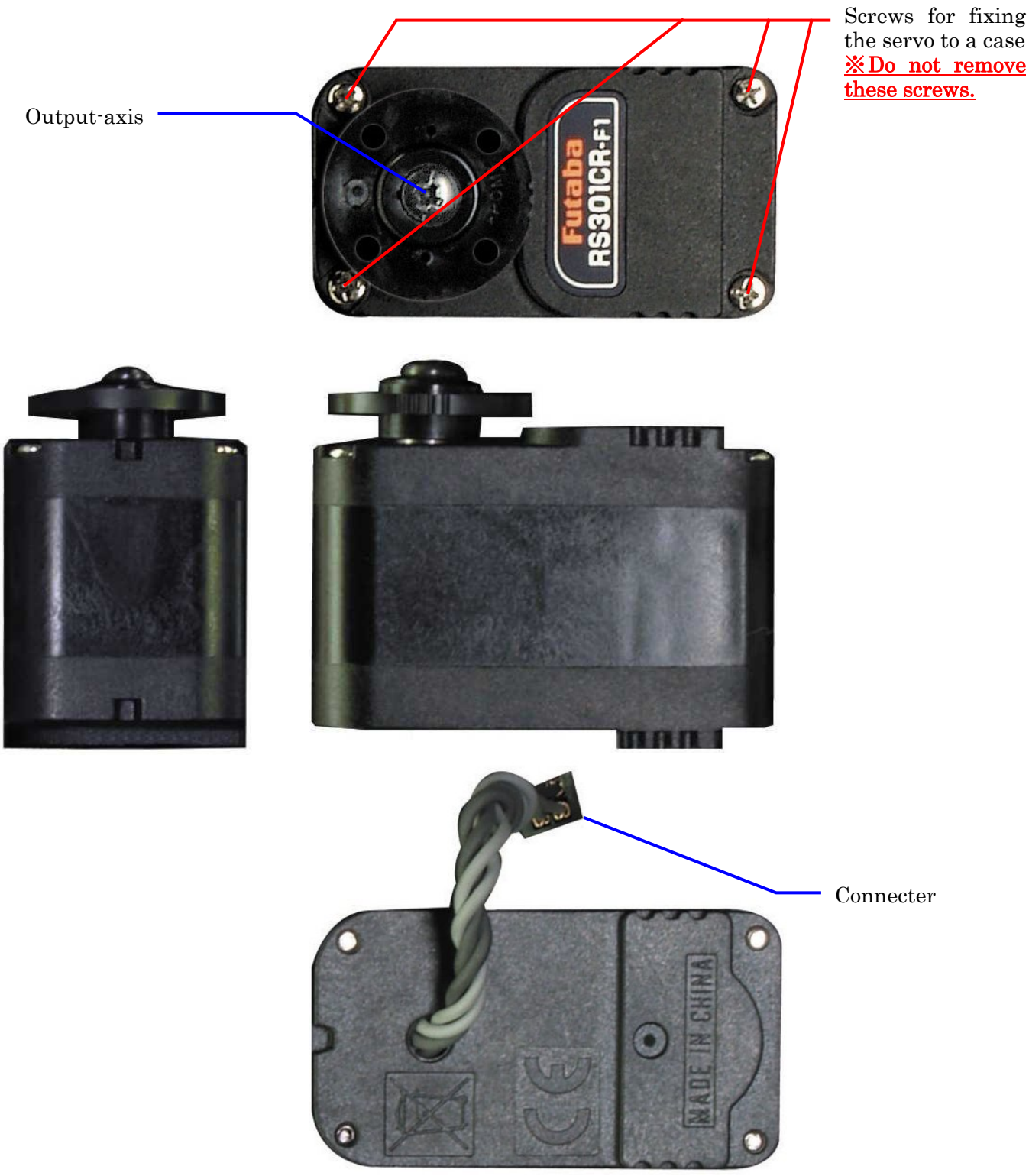


Fig.2.1 Part names

⚠ Caution

Removing the screws for fixing the servo with a case may damage the servo.

3.CONNECTION

System Configuration

The following figure shows a robotic system using RS301CR/RS302CD servos, RPU-10 processor unit and etc.

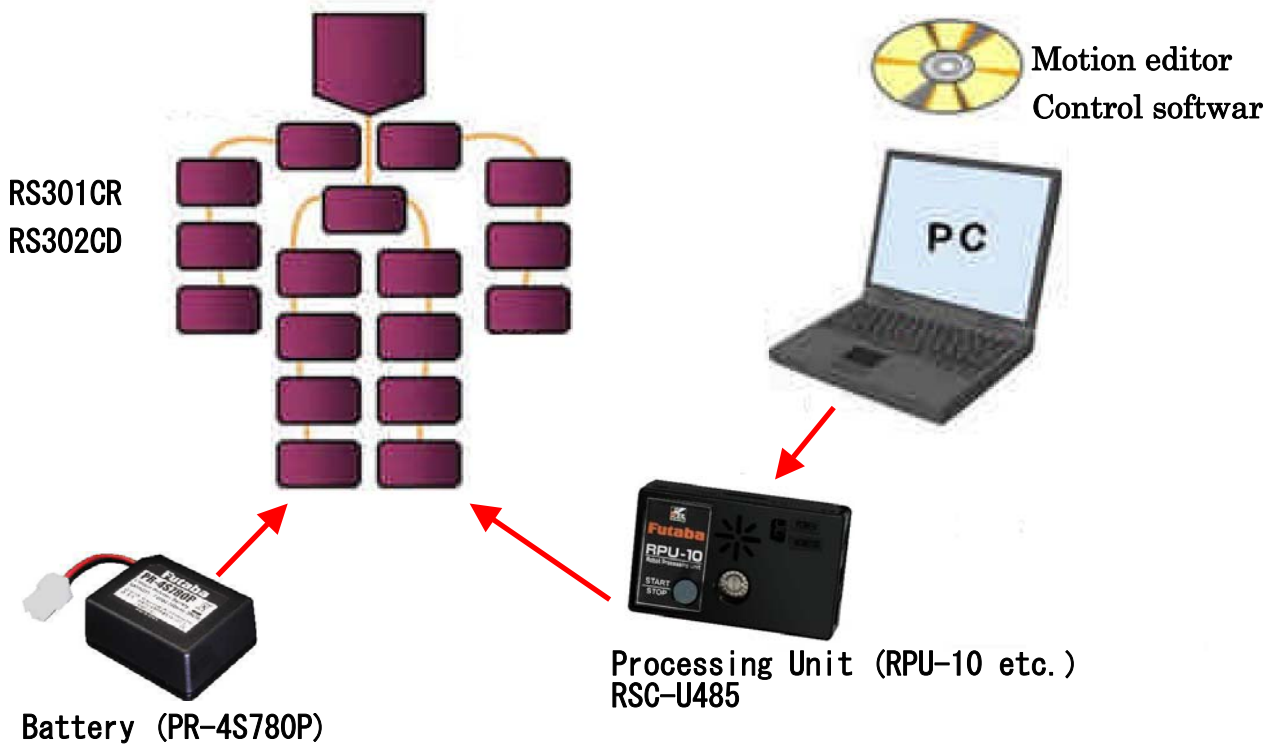
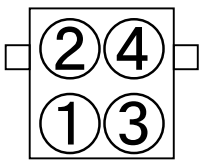


Fig. 3.1 Robotic system configuration

Pin Assignment

Pin assignment of the RS301CR/RS302CD servo is shown below.



① Gray : RS485(D−)
② Black : RS485(D+)
③ Gray : VCC(7.4V)
④ Black : GND

Fig. 3.2 Pin assignment

Cautions when Connecting

Please refer to the figure below for connecting RS301CR/RS302CD and RPU-10.

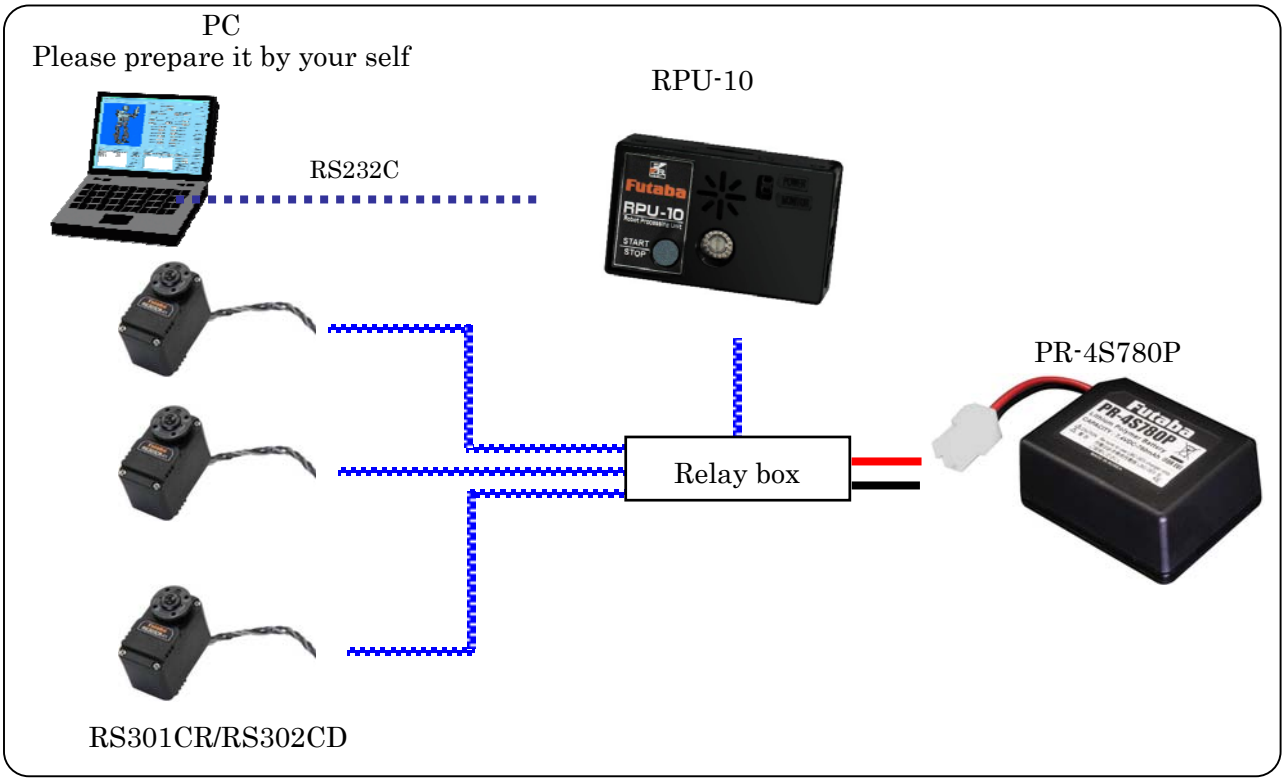


Fig. 3.3 Operating with RPU-100

Allowable current for relay connectors is 2A and for servo harness is 3A each for continues use.

Set your PC's communication parameters as follows;

Baud rate	: 115.2 bps (adjustable between 9.6kbps and 460kbps, Refer to Table 4.6 Baud rate in p.19)
Data bit length	: 8 bits
Parity	: none
Stop bit	: 1 bit
Flow control	: none

4.CONTROL METHOD

Abstract

● Communication Protocol

The communication protocol of the RS301CR/RS302CD servo is based on RS485 (IEEE485) half duplex communication. Data transmission and reception are carried out alternatively on the same signal line.

Normally, the RS301CR/RS302CD servo stands by in reception mode. But, when it receives from RPU-10 a command to send the servo's data and status, it switches to transmission mode, sends them out and finally returns to reception mode.

● Memory Map

The RS301CR/RS302C servo 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

You can set ID numbers to RS301CR/RS302C servos individually.

These ID numbers are used to identify servos during communication. The default number of every servo is set to "1". When you use multiple servos in a single communication network, give them different ID numbers.

● Packet

A packet is a block that is used for sending a command to or receiving data from RS301CR/RS302C servos. Packets are divided into the following three groups, having different formats.

(1) Short Packet(→p.11)

Short packets are used for sending the data in the memory map toward a single servo.

(2) Long Packet(→p.14)

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

(3) Return Packet(→p.16)

This is a packet that is sent from a servo when a return packet is requested.

Packet Format

●Short Packet

Short packets are used for sending the data in the memory map toward a single servo.

Packet structure

Header	ID	Flags	Address	Length	Count	Data	Sum

Header This is a line head of a packet. FAAFH is used for short packets.
"xH" denotes Hexadecimal number.

ID This is a servo's ID. The valid numbers are from 1 through 127 (00H ~ 7FH). When ID is set to 255, commands are commonly effective to all servos. The processor unit cannot obtain any data from servos at this time.

Flags Each bit has the following meaning.

Table 4.1 Send packet flags

Bit	Function
7	Reserved
6	Write in Flash ROM
5	Reboot servo
4	Initialize memory map data
3	Return-packet's address
2	
1	
0	

Bit7 : Reserved

Set this bit always at "0."

Bit6 : Write in Flash ROM

Setting this bit to "1" (Flags=40H) and sending a packet of address=FFH, length = 00H and count = 00H to a servo will write the data of the memory map from No.4 through 29(04H~1DH) into the non-volatile Flash ROM. It takes about 1 second for writing.

Ex) Write the data of the ID1 servo into the Flash ROM.

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 by using a short packet 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.

Bit5 : Reboot servo

Setting this bit to "1" (Flags=20H) and sending a packet of address=FFH, length = 00H and count = 00H to a servo will reboot a servo.

Ex) Reboot the ID1 servo.

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

Setting both Bit6 and Bit5 to "1" makes it possible to write Flash ROM and reboot the servo consecutively.

Ex) Write into the Flash ROM of the ID1 servo and reboot the servo.

Hdr	ID	Flg	Adr	Len	Cnt	Sum
FA AF	01	60	FF	00	00	9E

Bit4 : Initialize the contents of memory map No.4 ~ No.29

Setting this bit to "1" (10H) and sending a packet of address=FFH, length = FFH, count = 00H and data=FFH to a servo will initialize the memory map from No.4 through No.29 to their initial values.

Please refer to initial values in the "ROM area of Memory Map" (p.18) for more details.

Ex) Initialize the memory map from No.4 through No.29 to their initial values.

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

Caution

If you reset to the factory initial value, the ID becomes 1.

Bit3 ~ Bit0 : Address assignment of a return packet

(1) Data return from predetermined addresses

Setting the Bit3 through Bit0 like the table below when sending a short packet makes it possible to receive the data of the specified addresses in the servo's memory map. The Bit0 indicates whether to require a return packet (Bit0=1) or not (Bit0=0). Please refer to the Table 4.1 Send packet flags (p.11) for setting these bits in sending short packets. The RS485 half duplex communication, which is used to communicate with servos, 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 reception of the return packet.

Table 4.2 Address assignment of return packet

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 the memory map No.00 ~ No.29
	0	1	0	1	Return the data of the memory map No.30 ~ No.59
	0	1	1	1	Return the data of the memory map No.20 ~ No.29
	1	0	0	1	Return the data of the memory map No.42 ~ No.59
	1	0	1	1	Return the data of the memory map No.30 ~ No.41
	1	1	1	1	Return the specified number of bytes of data starting from the specified address.

(2) Data return from user-defined addresses

Setting the Bit3 through Bit0 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 in the memory map addresses from No.42 (2AH) through No.43 (2BH) of the ID1 servo.

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

(3) ACK/NAK Packet

If a servo receives a request of sending ACK the Flags being set at Bit0=1, Bit1=0, Bit2=0 and Bit3=0, the servo send ACK.

The return packet is constituted by only one byte of data like bellow:

Return packet = 07H: "ACK"

Address This notation indicates an address on the memory map. Using this address makes it possible to write the data of the specified number of bytes determined by the "Length" into the memory map.

Length This notation indicates the length of a data block.
Length = the number of bytes of data

Count This notation indicates the number of servos, which should be set at "1" for a short packet.

Data This notation indicates the data to be stored in the memory map.

Sum This is the check sum of a packet using 8 bits. Check sum is the value obtained from XOR operation on all bytes from ID through Data in a packet by a unit of a byte.

If the number of bytes from ID through Data in a packet is two or larger, divide them byte-by-byte and conduct XOR operation on them.

Ex) Send a command ordering ID1 servo to move to 0 degree.

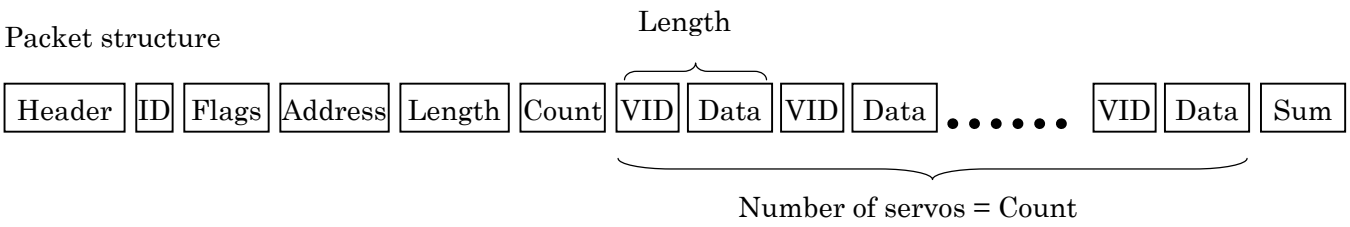
Hdr	ID	Flg	Adr	Len	Cnt	Dat	Sum
FA AF	01	00	1E	02	01	00 00	1C

The check sum of the transmission data above is as follows:
01H XOR 00H XOR 1EH XOR 02H XOR 01H XOR 00H XOR 00H

●Long Packet

The long packet is used to send the data in the memory map to multiple servos. Please note, however, that the memory address and the length of the data to be sent are the same to all the servos.

Packet structure



Header This notation indicates the front of a packet. Set "FAAFH" for long packets.
"xH" denotes Hexadecimal number.

ID

This should be always kept at 00H.

Flags

This should be always kept at 00H.

Address This indicates an address on the memory map. Using this address makes it possible to write the data of the specified number of bytes determined by the “Length” into the memory maps of multiple servos.

Length This is used to specify the number of bytes of the data for a servo.
Length = the number of bytes of data + 1

Count This notation indicates the number of servos that data is sent to. VID and data are sent to all of them.

VID This field represents the ID of each servo which sends data. Data corresponding to the number of servos is sent with VID and Data as one set.

Data This field is the data of one servo which is written to the memory map. Data corresponding to the number of servos is written with VID and Data as one set.

Sum This field is made up of eight bits which represent the check sum of the packet. The check sum is the XOR, in byte units, of the set bits from the ID field to the end of the Data field of the packet string. If there is a packet of 2 bytes or more between the ID and DATA fields, delimit it into single bytes before XORing.

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

●Return Packet

A return packet is the packet returned from the servo when the Flag field requests a servo to send a return packet.

Packet structure

Header	ID	Flags	Address	Length	Count	Data	Sum

Header This field denotes the beginning of the packet. For a short packet, the header is FDDFH.

ID This field represents the servo ID.

Flags This field represents the flags which are set in the packet. Each bit shown in the table below represents a servo state.

Table 4.3 Return packet flags

Bit	Value	Function
7	0:Normal, 1:Error	Temperature error(Torque off over temperature limit)
6	N/A	Reserved
5	0:Normal, 1:Error	Temperature alarm
4	N/A	Reserved
3	N/A	Reserved
2	N/A	Reserved
1	0:Normal, 1:Error	Received packet error
0	N/A	Reserved

Address This field represents the servo memory map address No.

Length This field represents the length of one data block. The length of one return packet data block is: Length = Number of return VID + Data bytes

Count This field represents the number of servos. For a return packet, 1 is always set here.

Sum This field is the check sum. It is the XOR, in byte units, of all the set bits from the ID field to the end of the data field of a command packet.

Memory Map

●Invariable ROM area

Table 4.4 Invariable ROM area

Area	Adress No. DEC	Adress No. HEX	Initial value	Name	Property
Invariable ROM	00	00H	10H(20H)	Model Number L	R
	01	01H	30H	Model Number H	R
	02	02H	01H	Firmware Version	R
	03	03H	00H	Reserved	-

( ) For RS302CD

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

This field represents the model No. (servo model). For the RS301CR, it is:

Model Number L = 10H

Model Number H = 30H

For RS302CD, they are as follows.

Model Number L = 20H

Model Number H = 30H

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

This field represents the servo firmware version. Its value varies depending on the version at production (0x01 in the example below).

Firmware Version = 01H

※ Storing two-byte data to memory map

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

Ex.) Issue a 29.2 degrees operation command to servo ID=23.

The command angle is saved to the Target Position item. The commanded value is 29.2 degrees, but since this is 0x0124 in hexadecimal notation, the data actually stored is:

Target Position(L) = 24H

Target Position(H) = 01H

●Variable ROM area

Table 4.5 Variable ROM area

Area	Adress No. DEC	HEX	Initial value	Name	Property
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	00H	Reserved	-
	13	0DH	00H	Reserved	-
	14	0EH	50H(46H)	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	02H	CW Compliance Margin	RW
	25	19H	02H	CCW Compliance Margin	RW
	26	1AH	0AH(0FH)	CW Compliance Slope	RW
	27	1BH	0AH(0FH)	CCW Compliance Slope	RW
	28	1CH	B4H(C8H)	Punch L	RW
	29	1DH	00H	Punch H	RW

( ) For RS302CD

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

This data represents the servo ID. Its initial value is 01H.

The setting range is 1 ~ 127 (01H ~ 7FH).

Ex) Rewrite servo ID1 to ID5.

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

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

Note that after the ID was rewritten, if it was not written to the flash ROM, when the power is turned off, it will return to the previous ID.

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

This shows rotation directions of the servo. The initial value of 00H means the normal rotation and 01H means the reverse rotation.

If the servo is set with 01H, the limited range of rotation angles is also reversed.

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

This data represents the communication speed.

The value assigned to each baud rate is shown below.

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		
02H	19,200bps	07H	115,200bps		
03H	28,800bps	08H	153,600bps		
04H	38,400bps	09H	230,400bps		

(Date Bits : 8 bit,Stop Bit :1 bit,Parity : None,Flow Control : None)

Its initial value is 07H (115,200bps).

※When a value other than the set values listed above was set, the communication speed becomes 115,200bps.

Ex.) Set Baud_Rate of servo ID=1 to 38,400bps.

Write Baud Rate=04H. At this time, a command with 1 set in bits 5 and 6 of the Flag field is sent and writing to ROM and restarting of the servo are executed simultaneously.

Hdr	ID	Flg	Adr	Len	Cnt	Dat	Sum
FA AF	01	60	06	01	01	04	63

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

This indicates 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	60	07	01	01	12	74

•No.8~No.11 Angle Limit(2Bytes, Hex Number, Read/Write)

These data specify the CW (clockwise rotation), CCW (counterclockwise rotation), and maximum operating angle based on 0 degree. Set these bits to match the usage environment.

The rotation limit angle is the maximum value, which can be initially set (±123 degrees). Never set an angle exceeding this value, because the servo may be damaged. Even if a command value greater than the rotation limit angle is given, the maximum operating angle is not exceeded.

The setting range is
CW Angle Limit →0° (0000H) ～ +150° (05DCH)
CCW Angle Limit →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, when 100.0 degrees is specified, 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 set values of servo ID=1 to -100.0 degrees (FC18H).
CCW Angle Limit L = 18H , CCW Angle Limit H = FCH

Hdr	ID	Flg	Adr	Len	Cnt	Dat	Sum
FA AF	01	00	08	02	01	18 FC	EE

•No.14 / No.15 Temperature Limit(2Bytes, Hex Number, Read Only)

If an overload is applied to a servo, the heat generated by the motor, etc. will cause the internal temperature to rise. If the internal temperature exceeds the temperature set here, the torque will be disabled so trouble will not occur at the servo and the red LED on the servo will light. To reset the stopped state, send a No. 36 Torque Enable command.

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

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

These data specify the allowable range of the servo stop position. If the present value is within the range set here relative to the specified target position, the servo is judged to have reached the target position and is stopped. CW and CCW can be set individually. Setting is in approximately 0.1 Degree units.

The initial value is 02H(0.2 degree). We recommend that the initial value not be changed because in most cases, it is the optimum value.

The setting range is 00H ~ FFH (approximately 25.5 degrees).

※ Please refer to the chart in"●No.28/No29 Punch".

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

These data set the range of the torque which attempts to return the servo to the target position when the present position has deviated from the target position. In the range specified here, the torque which attempts to return the servo to the target position is proportion to the difference between the target position and the present position. The CW and CCW directions can be set individually. Hunting can be reduced and shock can be absorbed by using this function.

Setting is in approximately 1.0 degree units.

The setting range is 00H ~ 96H (approximately 150 degrees).

The initial values are 0AH(10 deg.) for RS301CR, and 0FH(15 deg.) for RS302CD.

※ Please refer to the chart in "●No.28/No29 Punch".

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

The minimum current applied to the internal motor when a servo is driven can be set. The region in which the servo does not operate even when a minute movement command is given can be reduced and the servo can be more accurately stopped at the target position by setting this value to the optimum value.

The setting should be by 0.01% of the maximum torque.

The setting range is 00H ~ 2710H(100%).

The initial value for RS301CR is B4H(1.8%) and for RS302CD is C8H(2.0%).

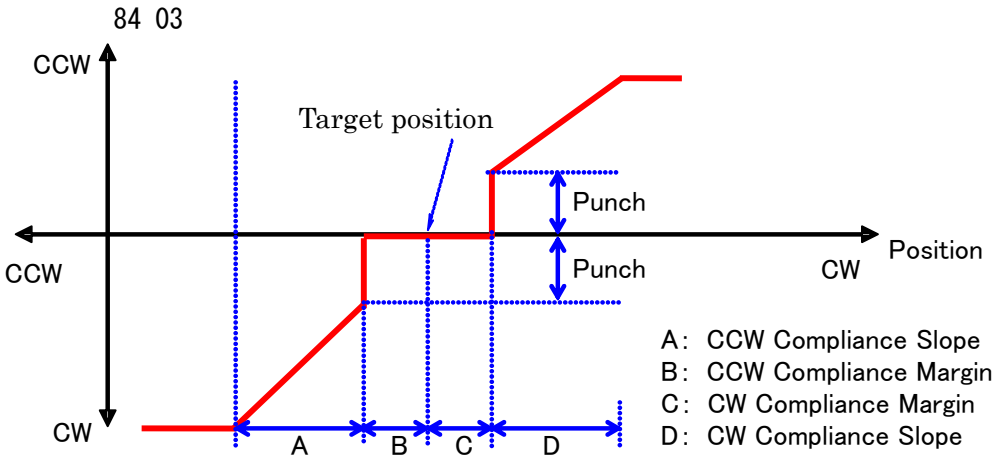


Fig. 4.1 Compliance control

Ex. 1) Set punch to 0064H(1%).

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

Ex. 2) Servo ID=1 is set as follows:

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

The 6 bytes from memory addresses 24 to 29 are set at one time.

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

●Variable RAM Area

Table 4.7 Variable RAM area

Area	Adress No. DEC	HEX	Initial value	Name	Property
RAM	30	1EH	00H	Goal PositionL	RW
	31	1FH	00H	Goal PositionH	RW
	32	20H	00H	Goal TimeL	RW
	33	21H	00H	Goal TimeH	RW
	34	22H	00H	Reserved	-
	35	23H	64H(4DH)	Max Torque	RW
	36	24H	00H	Torque Enable	RW
	37	25H	00H	Reserved	RW
	38	26H	00H	Reserved	RW
	39	27H	00H	Reserved	RW
	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	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 Voltage L	R
	53	35H	00H	Present Voltage H	R
	54	36H	00H	Reserved	R
	55	37H	00H	Reserved	R
	56	38H	00H	Reserved	R
	57	39H	00H	Reserved	R
	58	3AH	00H	Reserved	-
	59	3BH	00H	Reserved	-

( ) For RS302CD

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

A servo can be moved to the specified angle. The center of the movement range is 0 degree. Viewed from the top of the servo (nameplate side), the CW (clockwise rotation) direction is "+" and the CCW (counterclockwise rotation) direction is "−". When the "No.5 Servo Reverse" is 01H, CW direction is "-" and the CCW direction is "+".

The goal position unit is about 0.1 deg. To make 90 degrees the target position, set "900" (900→384H). When an angle larger than the limit angle set at memory addresses No. 8~11 was commanded, the servo operates up to this limit angle. When the Torque is changed from disable to enable, the servo holds the present position where it was enabled.

Ex. 1) Move servo ID=1 to 90.0° (900→384H).

Hdr	ID	Flg	Adr	Len	Cnt	Dat	Sum
FA AF	01	00	1E	02	01	8403	9B

Ex. 2) Move servo ID=1 to -90.0 degrees (−900→FC7CH).

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

●No.32 / No.33 Goal Time(2Bytes, Hex Number, Read/Write)

The movement duration of a servo up to the goal position can be set. The duration is set is 10ms units. When a command value exceeding the maximum speed of the servo was set. the servo moves at its maximum speed.

Ex. 1) Move servo ID=1 to 90.0 degrees (900→384) in 5 seconds (since this is 5000ms, 500(01F4H).

Hdr	ID	Flg	Adr	Len	Cnt	Dat	Sum
FA AF	01	00	20	04	01	84 03 F4 01	A5

Ex. 2) Move servo ID=1 to −120.0 degrees (−1200→FB50H) in 10 seconds (since this is 10000ms, 1000(03E8H).

Hdr	ID	Flg	Adr	Len	Cnt	Dat	Sum
FA AF	01	00	20	04	01	50 FB E8 03	64

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

The maximum torque output by the servo can be set. The servo torque can be set in 1% units with the torque of the servo described in this manual as 100%. However, consider this an approximate standard. Even if a value over 100% is set, the maximum torque becomes 100%.

64H（100%）is the initial value for RS301CR,and 4DH（77%）is for RS302CD.

The setting range is between 0H and 64H.

Ex) Set the maximum torque of 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(1Byte, Hex Number, Read/Write)

The servo torque can be enabled and disabled. 01H enables the torque and 00H disables the torque. When the power is turned on, the torque is disabled (00H). When 02H is set, the servo enters the brake mode and the servo horn can be freely rotated by hand, but a weak torque is generated.

*When the Torque is changed from disable to enable, the servo holds the present position.

Ex. 1) Enable servo ID=1 torque.

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

Ex. 2) Disable servo ID=1 torque.

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

Ex. 3) Set servo ID=1 to the brake mode.

Hdr	ID	Flg	Adr	Len	Cnt	Dat	Sum

●No.42 / No.43 Present Position(2Bytes, Hex Number, Read Only)

The present angle of a servo can be read. The angle information of the present position can be obtained in 0.1 degree units within a range of -150 degrees in the CCW (counterclockwise rotation) direction and 150 degrees in the CW (clockwise rotation) direction with the center of the variation range as 0 degree as shown in the Fig. 4-2.

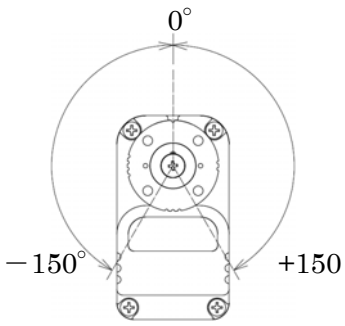


Fig. 4-2 servo range

Ex.) Read the present position of servo ID=1.

To obtain the value of address Nos. 42 and 43 of the servo as a return packet, send a “Flag” bit 3=1, bit2=0, bit1=0, bit0=1 send packet. After this packet is sent, the value of memory map address Nos. 42 to 59 is returned from the servo(See the Flags item of “Short packet” on p.13 for more information.) Here, The Torque Enable command and the flag of memory map address Nos. 42 ~ 59 are sent to servo ID=1.

If you send only flags, set [COUNT] =1 with [ADRESS]=0 and [LENGTH]=0, and nothing should be written in「Data」.

Hdr	ID	Flg	Adr	Len	Cnt	Dat	Sum
FA AF	01	09	24	01	01	01	2D

Return Packet

Hdr	ID	Flg	Adr	Len	Cnt		Sum
FD DF	01	00	2A	12	01	84 03 00 00 00 00 06 00 BA 03 00 00 00 00 00 00 00 00	00

Memory Map No. 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59

As the 2 bytes from the beginning of the return packet data are memory map address Nos. 42 and 43, the present position is 0384H(90.0 degrees).

●No.44 / No.45 Present Time(2Bytes, Hex Number, Read Only)

The present time is the time that has elapsed from reception of the command by the servo to the start of movement. When movement is complete, the present time is held last data.

Ex.) Read the present time of servo ID=1.

To obtain the value of memory map address Nos. 44 and 45 of the servo as a return packet, send a Flag bit3=1, bit2=0, bit1=0, bit0=1 send packet. After this packet is sent, the value of memory map address Nos. 42 to 59 is returned from the servo. (See the Flags item of “Short packet” on p.11 for more information.)

If you send only flags, set [COUNT] =1 with [ADRESS]=0 and [LENGTH]=0, and nothing should be written in「Data」.

Hdr	ID	Flg	Adr	Len	Cnt	Dat	Sum
FA AF	01	09	24	01	01	01	2D

Return Packet

Hdr	ID	Flg	Adr	Len	Cnt	Dat	Sum
FD DF	01	00	2A	12	01	5C FF 37 02 00 00 07 00 BA 03 00 00 00 00 00 00 00 00	00

Memory Map No. 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59

The value 0237H (5670ms) from memory map address Nos. 44 and 45 of the return packet is the present time. (As the receive data is in 10ms units, when multiplied by 10, the receive data becomes ms units.)

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

You can get the servo's current rotation speed on deg/sec basis.

Ex.）To read the current rotation speed of the servo in ID=1

If you want to get the values of No.46 and No.47 in the servo's memory map as return packets, send the packets with the bits of 1 to 3 in the "Flag" set to bit3=1、bit2=0、bit1=0 and bit0=1. After sending, the values for the items between No.42 and No.59 in the memory map will be sent back to you from the servo.

(Please refer to Flags for "Send-Packet" on Page 11 for details.)

If you send only flags, set [COUNT] =1 with [ADRESS]=0 and [LENGTH]=0, and nothing should be written in「Data」.

Send flags for return packets between No.42 and No.59 in the memory map.

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

Return Packet

Hdr	ID	Flg	Adr	Len	Cnt	Dat	Sum
FD DF	01	00	2A	12	01	5C FF 37 02 2C 01 07 00 BA 03 00 00 00 00 00 00 00 00	3D
			Memory Map No.			42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59	

The present rotation speed is 012CH (300deg/sec), which is identified by the values of No.46 and No.47 in the return packet. If you change the unit of the incoming data to a decimal number, the values show angle rates since the incoming data is based on deg/sec.

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

This shows the load (electric current) on the servo.

The data can be read on mA basis. Please use this data just as a guide since there are servos, which do not show "0" in case of no load.

Ex.）To read the current load on the servo in ID=1

If you want to get the values of No.48 and No.49 in the servo's memory map as return packets, send the packets with the bits of 3 to 0 in the "Flags" set to bit3=1,bit2=0,bit1=0 and bit0=1. After sending, the values for the items between No.42 and No.59 in the memory map will be sent back to you from the servo. Read the data that fall under No.48 and No.49. (Please refer to Flags for "Short Packet" on Page 12 for details.)

If you send only flags, set [COUNT] =1 with [ADRESS]=0 and [LENGTH]=0, and nothing should be written in "Data".

Ex.) To send flags for the return packets between No.42 and No.59 in the memory map.

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

Return Packet

Hdr	ID	Flg	Adr	Len	Cnt	Dat	Sum
FD DF	01	00	2A	12	01	4E FB 00 00 00 00 06 00 BA 03 00 00 00 00 00 00 00 00	32
			Memory Map No.			42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59	

The present load is 0006H, which is identified by the values of No.48 andNo.49 in the return packet

It shows that the motor is live with electricity of 6mA at this time

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

This shows the present temperature on the board of the servo. Each temperature sensor has its own characteristics and there is a difference of about ± 3℃ between one another in measuring temperature. An alarm flag is raised 10℃ before reaching the preset temperature. If the temperature goes up higher than the preset temperature, an error flag for temperature is raised one second later, and at the same time the servo comes into the break mode, which situation is like deadening the torque a little bit. When it is in the break mode, the value for "Torque ON" of No.36 in the memory map becomes 2.

Please be aware that Torque-On-Command does not function unless resetting is carried out or turning on the power again if temperature limit works. Also, be careful not to burn yourself since the temperature around the servo motor is somewhere between 120℃ and 140℃ when errors in temperature happen. Please make sure that the temperature goes down sufficiently before you use it again.

Ex.）To read the current temperature of the servo in ID=1

If you want to get the values of No.50 and No.51 in the servo's memory map as return packets, send the packets with the bits of 3 to 0 in the "Flags" set to bit3=1,bit2=0,bit1=0 and bit0=1. After sending, the values for the items between No.42 and No.59 in the memory map will be sent back to you from the servo.

(Please refer to the Flags on Page 11 for details.)

If you send only flags, set [COUNT] =1 with [ADRESS] =0 and [LENGTH] =0, and nothing should be written in "DATA".

Ex.）To send flags for return packets between No.42 and No.59 in the memory map.

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

Return Packets

Hdr	ID	Flg	Adr	Len	Cnt	Dat	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
			Memory Map No.			42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59	

The current temperature is 002DH(45℃), which is identified by the values of No.50 and No.51 in the return packet.

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

This shows the voltage that is currently used for the servo. Although the meter is indicated in units of 10mV, there is an approximately ± 0.5V difference between voltage sensors since each sensor has its own characteristics.

Ex.）To read the current voltage of the servo in ID=1

If you want to get the values of No.52 and No.53 in the servo's memory map as return packets, send the packets with the bits of 3 to 0 in the "Flags" set to bit3=1,bit2=0,bit1=0,and bit0=1. After sending, the values for the items between No.42 and No.59 in the memory map will be sent back to you from the servo.
(Please refer to Flags on Page 11 for details.)

If you send only flags, set [COUNT] =1 with [ADRESS] =0 and [LENGTH] =0, and . nothing should be written in "DATA".

Ex.）To send flags for return packets between No.42 and No.59 in the memory map.

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

Return Packet

Hdr	ID	Flg	Adr	Len	Cnt	Dat	Sum
FD DF	01	00	2A	12	01	4E FB 00 00 00 00 06 00 2D 00 E4 02 00 00 00 00 00 00	40
			Memory Map No.			42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59	

The current voltage is 02E4H (7.4V), which is identified by values of No.52 and No.53 in the return packet.

5. REFERENCE

Specifications

APPLICATION	ROBOT ACTUAT0R		
FEATURES	RS485 SERIAL COMMINUCATION		
OTHERS	MOTOR CONTROL by SOFTWARE		
SIZE（L×W×H）:	RS301CR	35.8 × 19.6 × 25.0 [mm]	
	RS302CD	35.8 × 19.6 × 25.0 [mm]	
WEIGHT :	RS301CR	28	[g]
	RS302CD	21	[g]
Operation Current			
: IN SUSPENSION	RS301CR	40±20	[mA]
（ROOM TEMPERATURE, No Load, 7.4V）	RS302CD	40±20	[mA]
: IN WORKING	RS301CR	110±40	[mA]
（ROOM TEMPERATURE, No Load, 7.4V）	RS302CD	100±40	[mA]
MAXIMUM OUTPUT TORQUE:	RS301CR	7.1	[kg·cm]
(7.4V)	RS302CD	5.0	[kg·cm]
MAXIMUM SPEED:	RS301CR	0.11	[sec/60°]
(7.4V)	RS302CD	0.16	[sec/60°]

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ROTATION DIRECTION :

CW	CURRENT POSITION<COMMAND POSITION	(CLOCKWISE)
CCW	CURRENT POSITION<COMMAND POSITION	(ANTICLOCKWISE)

OPERATING ANGLE:

CW	150[degree] (ON THE BASIS OF 0 degree)	(CLOCKWISE)
CCW	150[degree] (ON THE BASIS OF 0 degree)	(ANTICLOCKWISE)

SUPPLY VOLTAGE: 7.2 ~ 7.4[V]

OPERATING TEMPERATURE RANGE: 0 ~ +40[℃]

STORAGE TEMPERATURE RANGE: −20 ~ +60[℃]

OTHERS: BATTERY : LITHIUM POLYMER BATTERY
RS485 COMMUNICATION MAXIMUM BAUD RATE: 460kbps
(DEPENDING ON THE COMMUNICATION ENVIRONMENT)

PROTOCOL: 8BIT, 1 STOP BIT, NO PARITY, ASYNCHRONOUS

DIMENSIONS

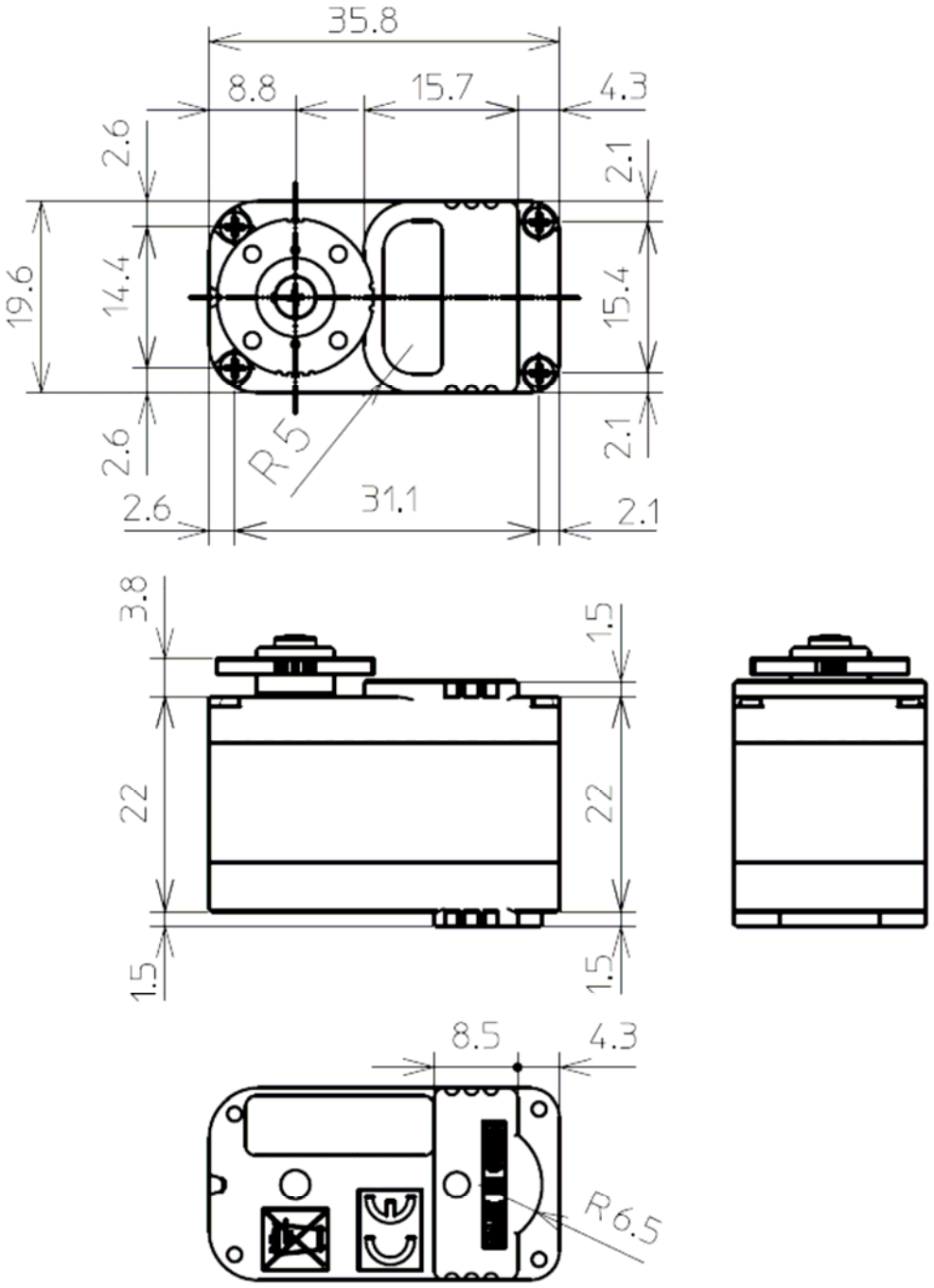

Figure 0-1 Dimensions with using Joint-Ball

TROUBLESHOOTING

If your servo does not operate, it intermittently stops operating, or it operates erroneously, take the action shown in the table below. If this does not correct the trouble, please contact a Futaba dealer.

Table 0-1 Check list

Check point	Check item	Action
Battery	Dead battery.	Replace the battery.
	Incorrect loading voltage.	Charge the LiPo battery. Reload the batteries in the correct polarity. Change the recommanded battery
Connecter	Faulty contact connection.	If the contact pin is deformed, correct it.
	Dirty contacts.	Wipe with a dry cloth
Servo horn	Looseness of screws	Fasten the screws
Command	ID, baud rate, check sum	Conform the command packet rules
Cable	Short-circuit	Change the cable

Before requesting repair, read this instruction manual again and recheck your system. Should the problem continue, request repair service as follows:

Describe the problem in as much detail as possible and send it with a detailed packing list together with the parts that require service.

_Symptom (Including when the problem occurred)

_System(Application configuration)

_Model Numbers and Quantity

_Your Name, Address, e-mail address, and Telephone Number.

If you have any questions regarding this product, please consult your local Futaba dealer.

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