Communication and Message Commands

> **Notice:** Before the direct communication via communication protocol, `Transponder` is required to be burnt on M5Stack-basic, and the latest atomMain on Atom.

1 Settings of USB Communication

Make sure the following settings are prepared:

- Interface of mainline: USB Type-C connection
- Port ratio: 11520
- Data bit: 8
- Parity bit: none
- Stop bit: 1

2 Introduction to Command Frame & Sole Instruction

The main PC transmit data via M5Stakc-basic to peripheral PC. The peripheral PC decodes the data like commands with return values and then send the results back to the main PC within 500ms.

3 Formats of Message Commands' Sending and Receiving

Both sending and receiving should be represented in hexadecimal. Each command should contain 5 parts as shown below. Part 3 and 4 can be left a blank.

- 1 Pin of command: 0xFE 0xFE
    - Invariable
    - Indispensable
- 2 Effective lengthen:
    - Aggregated length including pin, serial number, functional codes and end
    - Indispensable
- 3 Serial number: 00 ~ 8F
    - Corresponding number of developed commands
    - You may leave it blank.
- 4 Functional codes:
    - Purpose-oriented
    - You may leave it blank.
- 5 End: 0XFA
    - Invariable
    - Indispensable

4 Explanation for Commands

The main PC transmit data via M5Stakc-basic to peripheral PC. The peripheral PC decodes the data like commands with return values and then send the results back to the main PC within 500ms.

Type	Data	Length	Function
Command Frame	start bit: 0	1	Head frame identification, 0XFE
	start bit: 1	1	Head frame identification, 0XFE
	bit of data length	1	Different commands correspond to different data length
	command bit	1	depending on different commands
Command Frame	data	0-16	commands with data, depending on different commands
End Frame	end bit	1	stop bit, 0XFA

5 Explanation for Sole-Instruction Commands

Powering up

Domain	Explanation	Data
Data[0]	identification frame	0XFE
Data[1]	identification frame	0XFE
Data[2]	data-length frame	0X02
Data[3]	command frame	0X10
Data[4]	end frame	0XFA

Example:

Port transmission: FE FE 02 10 FA

no return value

Power Decreasing and Connection Breaking up

Domain	Explanation	Data
Data[0]	identification frame	0XFE
Data[1]	identification frame	0XFE
Data[2]	data-length frame	0X02
Data[3]	command frame	0X11
Data[4]	end frame	0XFA

Example:

Port transmission: FE FE 02 11 FA

no return value

Checking the Status of Atom

Domain	Explanation	Data
Data[0]	identification frame	0XFE
Data[1]	identification frame	0XFE
Data[2]	data-length frame	0X02
Data[3]	command frame	0X12
Data[4]	end frame	0XFA

Example:

Port transmission: FE FE 02 12 FA

Return value: data structure

Domain	Explanation	Data
Data[0]	return value: identification frame	0XFE
Data[1]	return value: identification frame	0XFE
Data[2]	return value: data-length frame	0X03
Data[3]	return value: command frame	0X12
Data[4]	power on/off	0X01/0X00
Data[5]	end frame	0XFA

Example:

Given that Atom is powered on:

port return: FE FE 03 12 01 FA

Power Decreasing

Domain	Explanation	Data
Data[0]	identification frame	0XFE
Data[1]	identification frame	0XFE
Data[2]	data-length frame	0X02
Data[3]	command frame	0X13
Data[4]	end frame	0XFA

Example:

Port transmission: FE FE 02 13 FA

no return value

Robot System Checking: Normal

Domain	Explanation	Data
Data[0]	identification frame	0XFE
Data[1]	identification frame	0XFE
Data[2]	data-length frame	0X02
Data[3]	command frame	0X14
Data[4]	end frame	0XFA

Example:

Port transmission: FE FE 02 14 FA

Return value: data structure

Domain	Explanation	Data
Data[0]	return value: identification frame	0XFE
Data[1]	return value: identification frame	0XFE
Data[2]	return value: data-length frame	0X03
Data[3]	return value: command frame	0X14
Data[4]	connection/connection breaking up	0X01/0X00
Data[5]	end frame	0XFA

Example:

Given that Atom is successfully connected:

port return: FE FE 03 14 01 FA

Command Updating Mode (Interpolation Setting/Motion Mode Updating)

Domain	Explanation	Data
Data[0]	identification frame	0XFE
Data[1]	identification frame	0XFE
Data[2]	data-length frame	0X03
Data[3]	command frame	0X16
Data[4]	connection/connection breaking up	0X01/0X00
Data[5]	end frame	0XFA

Example:

1. Setting updating motion mode:

   Port transmission: FE FE 03 16 01 FA
2. Setting interpolation motion mode:

   Port transmission: FE FE 03 16 00 FA

Free Mode (switch off torsion output)

Domain	Explanation	Data
Data[0]	identification frame	0XFE
Data[1]	identification frame	0XFE
Data[2]	data-length frame	0X03
Data[3]	command frame	0X1A
Data[4]	turn on/off	01/00
Data[5]	end frame	0XFA

Example:

Setting free motion mode:

Port transmission: FE FE 03 1A 01 FA

Checking whether free mode is set

Domain	Explanation	Data
Data[0]	identification frame	0XFE
Data[1]	identification frame	0XFE
Data[2]	data-length frame	0X02
Data[3]	command frame	0X1B
Data[5]	end frame	0XFA

Example:

Port return: FE FE 02 1B FA

Return value: data structure

Domain	Explanation	Data
Data[0]	return value: identification frame	0XFE
Data[1]	return value: identification frame	0XFE
Data[2]	return value: data-length frame	0X03
Data[3]	command frame	0X1B
Data[4]	turn on/off	0X01/0X00
Data[5]	end frame	0XFA

Example:

Given that Atom is in free mode:

port return: FE FE 03 1B 01 FA

Reading Angles (blocking information)

Domain	Explanation	Data
Data[0]	identification frame	0XFE
Data[1]	identification frame	0XFE
Data[2]	data-length frame	0X02
Data[3]	command frame	0X20
Data[4]	end frame	0XFA

Example:

Port transmission: FE FE 02 20 FA

Return value: data structure

Domain	Explanation	Data
Data[0]	return value: head frame	0XFE
Data[1]	return value: head frame	0XFE
Data[2]	return value: data-length frame	0X0E
Data[3]	return value: command frame	0X20
Data[4]	high angle of No.1 steering gear	Angle1_high
Data[5]	low angle of No.1 steering gear	Angle1_low
Data[6]	high angle of No.2 steering gear	Angle2_high
Data[7]	low angle of No.2 steering gear	Angle2_low
Data[8]	high angle of No.3 steering gear	Angle3_high
Data[9]	low angle of No.3 steering gear	Angle3_low
Data[10]	high angle of No.4 steering gear	Angle4_high
Data[11]	low angle of No.4 steering gear	Angle4_low
Data[12]	high angle of No.5 steering gear	Angle5_high
Data[13]	low angle of No.5 steering gear	Angle5_low
Data[14]	high angle of No.6 steering gear	Angle6_high
Data[15]	low angle of No.6 steering gear	Angle6_low
Data[16]	end frame	0XFA

Example:

Return value of port: FE FE 0E 20 00 8C 00 3D FF E6 FF 3F 00 AF FF 51 FA

How to get the angle of joint 1:

temp = angle1_low+angle1_high*256

Angle1= （temp \ 33000 ?(temp – 65536) : temp）/100

Explanation: if temp is greater than 33000, temp minus 65536, and then is divided by 100; if temp is less than 33000, then temp is divided by 100 directly.

Other joint angles are counted in a similar way.

Sending Sole Angle

Domain	Explanation	Data
Data[0]	identification frame	0XFE
Data[1]	identification frame	0XFE
Data[2]	data-length frame	0X06
Data[3]	command frame	0X21
Data[4]	serial number of steering gear	joint_no
Data[5]	high angle	angle_high
Data[6]	low angle	angle_low
Data[7]	specified speed	sp
Data[8]	end frame	0XFA

Example:

Let the No.1 steering gear move to zero position

Port transmission: FE FE 06 21 01 00 00 14 FA

joint number: 1-6

angle_high: byte

counting method: angle value is multiplied by 100 and converted into integral form to get the hexadecimal highbyte

angle_low: byte

counting method: angle value is multiplied by 100 and converted into integral form to get the hexadecimal lowbyte

no return value

Sending Entire Angles

Domain	Explanation	Data
Data[0]	identification frame	0XFE
Data[1]	identification frame	0XFE
Data[2]	data-length frame	0X0F
Data[3]	command frame	0X22
Data[4]	high angle of No.1 steering gear	Angle1_high
Data[5]	low angle of No.1 steering gear	Angle1_low
Data[6]	high angle of No.2 steering gear	Angle2_high
Data[7]	low angle of No.2 steering gear	Angle2_low
Data[8]	high angle of No.3 steering gear	Angle3_high
Data[9]	low angle of No.3 steering gear	Angle3_low
Data[10]	high angle of No.4 steering gear	Angle4_high
Data[11]	low angle of No.4 steering gear	Angle4_low
Data[12]	high angle of No.5 steering gear	Angle5_high
Data[13]	low angle of No.5 steering gear	Angle5_low
Data[14]	high angle of No.6 steering gear	Angle6_high
Data[15]	low angle of No.6 steering gear	Angle6_low
Data[16]	specified speed	Sp
Data[17]	end frame	0XFA

Example:

Send 0 angle to entire joint, and let the steering gear move to zero position.

Port transmission: FE FE 0F 22 00 00 00 00 00 00 00 00 00 00 00 1E FA

angle1_high: byte

counting method: angle value is multiplied by 100 and converted into integral form to get the hexadecimal highbyte

angle1_low: byte

counting method: angle value is multiplied by 100 and converted into integral form to get the hexadecimal lowbyte

Other angles are counted in a similar way.

no return value

Reading the Entire Coordinates

Domain	Explanation	Data
Data[0]	identification frame	0XFE
Data[1]	identification frame	0XFE
Data[2]	data-length frame	0X02
Data[3]	command frame	0X23
Data[4]	end frame	0XFA

Example:

Port transmission: FE FE 02 23 FA

Return value: data structure

Domain	Explanation	Data
Data[0]	return value: head frame	0XFE
Data[1]	return value: head frame	0XFE
Data[2]	return value: data-length frame	0X0E
Data[3]	return value: command frame	0X23
Data[4]	specify high status of x coordinate	x_high
Data[5]	specify low status of x coordinate	x_low
Data[6]	specify high status of y coordinate	y_high
Data[7]	specify high status of z coordinate	z_high
Data[8]	specify low status of z coordinate	z_low
Data[9]	low angle of No.3 steering gear	Angle3_low
Data[10]	high angle of No.4 steering gear	Angle4_high
Data[11]	low angle of No.4 steering gear	Angle4_low
Data[12]	high angle of No.5 steering gear	Angle5_high
Data[13]	low angle of No.5 steering gear	Angle5_low
Data[14]	high angle of No.6 steering gear	Angle6_high
Data[15]	low angle of No.6 steering gear	Angle6_low
Data[16]	end frame	0XFA

Example:

Port return value: FE FE 0E 23 01 BC FD A0 10 15 DC 66 FF 54 DE 21 FA

How to get x coordinate:

temp = x_low + x_high*256

x coordinate = （temp\33000 ?(temp – 65536) : temp)/10

Explanation: if temp is greater than 33000, temp minus 65536, and then is divided by 100; if temp is less than 33000, then temp is divided by 100 directly.

y coordinate is counted in a similar way.

How to get rx coordinate:

temp = rx_low + rx_high*256

x coordinate = （temp \ 33000 ?(temp – 65536) : temp）/100

Explanation: if temp is greater than 33000, temp minus 65536, and then is divided by 100; if temp is less than 33000, then temp is divided by 100 directly.

y coordinate is counted in a similar way.

Sending Parameters of Sole Coordinate

Domain	Explanation	Data
Data[0]	identification frame	0XFE
Data[1]	identification frame	0XFE
Data[2]	data-length frame	0X06
Data[3]	command frame	0X24
Data[4]	axis	x/y/z/rx/ry/rz
Data[5]	specify high status of the parameters of xyz/rxryrz	xyz/ rxryrz_high
Data[6]	specify low status of the parameters of xyz/rxryrz	xyz/rxryrz_low
Data[7]	specified speed	Sp
Data[8]	end frame	0XFA

Example:

Given that the x coordinate is 200 and target speed is 20,

port transmission: FE FE 06 24 01 07 D0 14 FA

specified axis coordinate: byte

range: 1-6

data type of xyz_high: byte

counting method: value of x/y/z coordinate is multiplied by 100 and converted into integral form to get the hexadecimal highbyte

data type of xyz_low: byte

counting method: value of x/y/z coordinate is multiplied by 100 and converted into integral form to get the hexadecimal lowbyte

data type of rxryrz_high: byte

counting method: value of rx/ry/rz coordinate is multiplied by 100 and converted into integral form to get the hexadecimal highbyte

data type of rxryrz_low: byte

counting method: value of rx/ry/rz coordinate is multiplied by 100 and converted into integral form to get the hexadecimal lowbyte

no Return Value

Sending Parameters of Entire Coordinate

Domain	Explanation	Data
Data[0]	identification frame	0XFE
Data[1]	identification frame	0XFE
Data[2]	data-length frame	0X10
Data[3]	command frame	0X25
Data[4]	specify high status of x coordinate	x_high
Data[5]	specify low status of x coordinate	x_low
Data[6]	specify high status of y coordinate	y_high
Data[7]	specify low status of y coordinate	y_low
Data[8]	specify high status of z coordinate	z_high
Data[9]	specify low status of z coordinate	z_low
Data[10]	specify high status of rx coordinate	rx_high
Data[11]	specify low status of rx coordinate	rx_low
Data[12]	specify high status of ry coordinate	ry_high
Data[13]	specify low status of ry coordinate	ry_low
Data[14]	specify high status of rz coordinate	rz_high
Data[15]	specify low status of rz coordinate	rz_low
Data[16]	specifyd speed	Sp
Data[17]	mode	0X01
Data[17]	end frame	0XFA

Example:

Given that the coordinate of the end of robotic arm is （150.3，-68.7，101.8，10.18，0，-90），and speed is 10,

port transmission: FE FE 10 25 05 DF FD 51 03 FA BC 30 00 00 DC D8 0A 01 FA

data type of x_high: byte

counting method: value of x coordinate is multiplied by 10 and get the hexadecimal highbyte

data type of x_low: byte

counting method: value of x coordinate is multiplied by 10 and get the hexadecimal highbyte

y coordinate is counted in a similar way.

data type of rx_high: byte

counting method: value of rx coordinate is multiplied by 10 and get the hexadecimal highbyte

data type of rx_low: byte

counting method: value of rx coordinate is multiplied by 100 and get the hexadecimal highbyte

ry coordinate is counted in a similar way.

no return value

Domain	Explanation	Data
Data[0]	identification frame	0XFE
Data[1]	identification frame	0XFE
Data[2]	data-length frame	0X02
Data[3]	command frame	0X26
Data[4]	end frame	0XFA

Example:

Port transmission: FE FE 02 26 FA

no return value

Judging Whether Program Stops

Domain	Explanation	Data
Data[0]	identification frame	0XFE
Data[1]	identification frame	0XFE
Data[2]	data-length frame	0X02
Data[3]	command frame	0X27
Data[4]	end frame	0XFA

Example:

Port transmission: FE FE 02 27 FA

Return value: data structure

Domain	Explanation	Data
Data[0]	identification frame	0XFE
Data[1]	identification frame	0XFE
Data[2]	data-length frame	0X02
Data[3]	command frame	0X27
Data[4]	suspend/not suspend	0X01/0X00
Data[5]	end frame	0XFA

Example:

Given that program suspends,

port return value: FE FE 03 12 01 FA

Program Restoration

Domain	Explanation	Data
Data[0]	identification frame	0XFE
Data[1]	identification frame	0XFE
Data[2]	data-length frame	0X02
Data[3]	command frame	0X27
Data[4]	suspend/not suspend	0X01/0X00
Data[5]	end frame	0XFA

Example:

Port transmission: FE FE 02 26 FA

no return value

Program Stops

Domain	Explanation	Data
Data[0]	identification frame	0XFE
Data[1]	identification frame	0XFE
Data[2]	data-length frame	0X02
Data[3]	command frame	0X29
Data[4]	end frame	0XFA

Example:

Port transmission: FE FE 02 26 FA

no return value

Whether Reaching Specified Coordinate

Domain	Explanation	Data
Data[0]	identification frame	0XFE
Data[1]	identification frame	0XFE
Data[2]	data-length frame	0X0E/0X0F
Data[3]	command frame	0X2A
Data[4]	high status of x coordinate/highbyte of angle of No.1 steering gear	x_high/Angle1_high
Data[5]	low status of x coordinate/lowbyte of angle of No.1 steering gear	x_low/Angle1_low
Data[6]	high status of y coordinate/highbyte of angle of No.2 steering gear	y_high/Angle2_high

Domain	Explanation	Data
Data[7]	low status of y coordinate/lowbyte of angle of No.2 steering gear	y_low/Angle2_low
Data[8]	high status of y coordinate/highbyte of angle of No.3 steering gear	z_high/Angle3_high
Data[9]	low status of z coordinate/lowbyte of angle of No.3 steering gear	z_low/Angle3_low
Data[10]	high status of rx coordinate/highbyte of angle of No.4 steering gear	rx_high/Angle4_high
Data[11]	low status of rx coordinate/lowbyte of angle of No.4 steering gear	rx_low/Angle4_low
Data[12]	high status of ry coordinate/highbyte of angle of No.5 steering gear	ry_high/Angle5_high
Data[13]	low status of ry coordinate/lowbyte of angle of No.5 steering gear	ry_low/Angle5_low
Data[14]	high status of rz coordinate/highbyte of angle of No.6 steering gear	rz_high/Angle6_high
Data[15]	low status of rz coordinate/lowbyte of angle of No.6 steering gear	rz_low/Angle6_low
Data[16]	coordinate/angle	0X01/0X00
Data[17]	end frame	0XFA

Example:

Judging whether robotic arm move to zero position:

port transmission: FE FE 0F 2A 00 00 00 00 00 00 00 00 00 00 00 00 00 FA

data type of x_high: byte

counting method: value of x coordinate is multiplied by 10 and converted into integral form to get the hexadecimal highbyte

data type of x_low: byte

counting method: value of x coordinate is multiplied by 10 and converted into integral form to get the hexadecimal lowbyte

y coordinate is counted in a similar way.

data type of rx_high: byte

counting method: value of rx coordinate is multiplied by 100 and converted into integral form to get the hexadecimal highbyte

data type of rx_low: byte

counting method: value of rx coordinate is multiplied by 100 and converted into integral form to get the hexadecimal lowbyte

ry coordinate is counted in a similar way.

data type of angle_high: byte

counting method: value angle is multiplied by 100 and converted into integral form to get the hexadecimal highbyte

data type of angle_low: byte

counting method: value of angle is multiplied by 100 and converted into integral form to get the hexadecimal lowbyte

Type: byte (temporarily unavailable)

Return Value: data structure

Domain	Explanation	Data
Data[0]	return value: head frame	0XFE
Data[1]	return value: head frame	0XFE
Data[2]	return value: data-length frame	0X03
Data[3]	return value: command frame	0X2a
Data[4]	reaching the point/not reaching the point	0X01/0X00
Data[5]	end frame	0XFA

Example:

Given that the robotic arm doesn't reach the point:

port return value: FE FE 03 2A 00 FA

Movement Check

Domain	Explanation	Data
Data[0]	identification frame	0XFE
Data[1]	identification frame	0XFE
Data[2]	data-length frame	0X02
Data[3]	command frame	0X2B
Data[4]	end frame	0XFA

Example:

port transmission: FE FE 02 2B FA

Return Value: data structure

Domain	Explanation	Data
Data[0]	return value: head frame	0XFE
Data[1]	return value: head frame	0XFE
Data[2]	return value: data-length frame	0X03
Data[3]	return value: command frame	0X2B
Data[4]	in motion/not in motion	0X01/0X00
Data[5]	end frame	0XFA

Example:

Given that the program is running:

port return value: FE FE 03 2B 01 FA

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jog-Joint-Oriented Movement

Domain	Explanation	Data
Data[0]	identification frame	0XFE
Data[1]	identification frame	0XFE
Data[2]	data-length frame	0X05
Data[3]	command frame	0X30
Data[4]	serial number of steering gear	Joint
Data[5]	direction of steering gear	direction
Data[6]	specified speed	sp
Data[7]	end frame	0XFA

Example:

Given that NO.1 steering gear is revolving clockwise at the speed of 20%:

port return value: FE FE 05 30 01 01 14 FA

range of serial number of joint: 1-6

di: data type of byte, either 0 or 1

sp: data type of byte, ranging from 0 to 100

no return value.

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jod-Absolute Control

Domain	Explanation	Data
Data[0]	identification frame	0XFE
Data[1]	identification frame	0XFE
Data[2]	data-length frame	0X06
Data[3]	command frame	0X31
Data[4]	serial number of steering gear	Joint
Data[5]	highbyte of angle of steering gear	Angle_high
Data[6]	lowbyte of angle of steering gear	Angle_low
Data[7]	specified speed	sp
Data[8]	end frame	0XFA

Example:

Given that No.1 steering gear moves to 45° at the speed of 20

port transmission: FE FE 06 31 01 11 94 14 FA

range of serial number of joint: 1-6

data type of Angle_high: byte

counting method: value of Angle_high is multiplied by 100 and converted into integral form to get the hexadecimal highbyte

data type of Angle_low: byte

counting method: value of Angle_low is multiplied by 100 and converted into integral form to get the hexadecimal lowbyte

sp: data type of byte, ranging from 0 to 100

no return value

jog-Coordinate-Oriented Movement

Domain	Explanation	Data
Data[0]	identification frame	0XFE
Data[1]	identification frame	0XFE
Data[2]	data-length frame	0X05
Data[3]	command frame	0X32
Data[4]	specified coordinate	axis
Data[5]	direction of steering gear	di
Data[6]	specified speed	sp
Data[7]	end frame	0XFA

Example:

Given that robotic arm moves towards x coordinate at the speed of 20

port transmission: FE FE 06 32 01 01 14 FA

axis ranges from 1 to 6, representing x, y, z,rx, ry, rz

di: data type of byte, either 0 or 1

sp: data type of byte, ranging from 0 to 100

no return value

jog-Stepper Model

Domain	Explanation	Data
Data[0]	identification frame	0XFE
Data[1]	identification frame	0XFE
Data[2]	data-length frame	0X06
Data[3]	command frame	0X31
Data[4]	serial number of steering gear	Joint
Data[5]	highbyte of angle of steering gear	Angle_high
Data[6]	lowbyte of angle of steering gear	Angle_low
Data[7]	specified speed	sp
Data[8]	end frame	0XFA

Example:

Given that the angle of No.1 steering expand by 45° and revolves at the speed of 20

port transmission: FE FE 06 33 01 11 94 14 FA

serial number of joint ranges from 1 to 6

data type of angle_high: byte

counting method: value angle is multiplied by 100 and converted into integral form to get the hexadecimal highbyte

data type of angle_low: byte

counting method: value of angle is multiplied by 100 and converted into integral form to get the hexadecimal lowbyte

sp: data type of byte, ranging from 0 to 100

no return value

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jog-Stop

Domain	Explanation	Data
Data[0]	identification frame	0XFE
Data[1]	identification frame	0XFE
Data[2]	data-length frame	0X02
Data[3]	command frame	0X34
Data[4]	end frame	0XFA

Example:

Stop moving

port transmission: FE FE 02 34 FA

no return value

Sending Potential

Domain	Explanation	Data
Data[0]	identification frame	0XFE
Data[1]	identification frame	0XFE
Data[2]	data-length frame	0X05
Data[3]	command frame	0X3A
Data[4]	serial number of steering gear	Joint
Data[5]	high status of potential	Encoder_high
Data[6]	low status of potential	Encoder_low
Data[7]	end frame	0XFA

Example:

Given that No.5 joint is set to 2048

port transmission: FE FE 05 3A 05 08 00 FA

serial number of joint ranges from 0 to 5

data type of Joint: byte

data type of Encoder_high: byte

counting method: get the high status of potential (in hexadecimal form)

data type of Encoder_low: byte

counting method: get the low status of potential (in hexadecimal form)

no return value

Get the Potential

Domain	Explanation	Data
Data[0]	identification frame	0XFE
Data[1]	identification frame	0XFE
Data[2]	data-length frame	0X03
Data[3]	command frame	0X3B
Data[4]	serial number of joint	joint
Data[5]	end frame	0XFA

Example:

get the potential of NO.2 steering gear

serial number of joint ranges from 1 to 6

Return Value: data structure

Domain	Explanation	Data
Data[0]	return value: identification frame	0XFE
Data[1]	return value: identification frame	0XFE
Data[2]	return value: data-length frame	0X04
Data[3]	return value: command frame	0X3B
Data[4]	high status of potential	Encoder_high
Data[5]	low status of potential	Encoders_low
Data[6]	end frame	0XFA

Example:

port transmission: FE FE 04 3B 08 07 FA

How potentials are counted:

potential = low status of potential + high status of potential * 256

Sending Potential of Six Steering Gears

Domain	Explanation	Data
Data[0]	identification frame	0XFE
Data[1]	identification frame	0XFE
Data[2]	data-length frame	0X0E/0X0F
Data[3]	command frame	0X3C
Data[4]	highbyte of No.1 steering gear	encoder_1_high
Data[5]	lowbyte of No.1 steering gear	encoder_1_low
Data[6]	highbyte of No.2 steering gear	encoder_2_high
Data[7]	lowbyte of No.2 steering gear	encoder_2_low
Data[8]	highbyte of No.3 steering gear	encoder_3_high
Data[9]	lowbyte of No.3 steering gear	encoder_3_low
Data[10]	highbyte of No.4 steering gear	encoder_4_high
Data[11]	lowbyte of No.4 steering gear	encoder_4_low
Data[12]	highbyte of No.5 steering gear	encoder_5_high
Data[13]	lowbyte of No.5 steering gear	encoder_5_low
Data[14]	highbyte of No.6 steering gear	encoder_6_high
Data[15]	lowbyte of No.6 steering gear	encoder_6_low
Data[16]	specified speed	Sp
Data[17]	end frame	0XFA

Example:

Given that the potential of all is 2048, and the speed is 20

port transmission: FE FE 0F 3C 08 00 08 00 08 00 08 00 08 00 08 00 14 FA

Refer to the chart above for each potential.

data type of encoder_1_high: byte

counting method: convert the potential of No.1 steering gear into integral form and get the highbyte hexadecimal

data type of encoder_1_low: byte

counting method: convert the potential of No.1 steering gear into integral form and get the lowbyte hexadecimal

sp: data type of byte, ranging from 0 to 100

no return value

Domain	Explanation	Data
Data[0]	identification frame	0XFE
Data[1]	identification frame	0XFE
Data[2]	data-length frame	0X02
Data[3]	command frame	0X3D
Data[4]	end frame	0XFA

Example:

Port transmission: FE FE 02 3D FA

Return value: data structure

Domain	Explanation	Data
Data[0]	identification frame	0XFE
Data[1]	identification frame	0XFE
Data[2]	data-length frame	0X0E
Data[3]	command frame	0X3D
Data[4]	highbyte of No.1 steering gear	encoder_1_high
Data[5]	lowbyte of No.1 steering gear	encoder_1_low
Data[6]	highbyte of No.2 steering gear	encoder_2_high
Data[7]	lowbyte of No.2 steering gear	encoder_2_low
Data[8]	highbyte of No.3 steering gear	encoder_3_high
Data[9]	lowbyte of No.3 steering gear	encoder_3_low
Data[10]	highbyte of No.4 steering gear	encoder_4_high
Data[11]	lowbyte of No.4 steering gear	encoder_4_low
Data[12]	highbyte of No.5 steering gear	encoder_5_high
Data[13]	lowbyte of No.5 steering gear	encoder_5_low
Data[14]	highbyte of No.6 steering gear	encoder_6_high
Data[15]	lowbyte of No.6 steering gear	encoder_6_low
Data[17]	end frame	0XFA

Example:

Given that all robotic arms are set in zero position,

port return value: FE FE 0E 3D 08 00 08 00 08 00 08 00 08 00 08 00 FA

How to count potential

How potentials are counted:

potential = low status of potential + high status of potential * 256

Reading Potential of Six Steering Gears

Domain	Explanation	Data
Data[0]	identification frame	0XFE
Data[1]	identification frame	0XFE
Data[2]	data-length frame	0X02
Data[3]	command frame	0X3D
Data[4]	end frame	0XFA

Example:

Port transmission: FE FE 02 3D FA

Return value: data structure

Domain	Explanation	Data
Data[0]	identification frame	0XFE
Data[1]	identification frame	0XFE
Data[2]	data-length frame	0X0E
Data[3]	command frame	0X3D
Data[4]	highbyte of No.1 steering gear	encoder_1_high
Data[5]	lowbyte of No.1 steering gear	encoder_1_low
Data[6]	highbyte of No.2 steering gear	encoder_2_high
Data[7]	lowbyte of No.2 steering gear	encoder_2_low
Data[8]	highbyte of No.3 steering gear	encoder_3_high
Data[9]	lowbyte of No.3 steering gear	encoder_3_low
Data[10]	highbyte of No.4 steering gear	encoder_4_high
Data[11]	lowbyte of No.4 steering gear	encoder_4_low
Data[12]	highbyte of No.5 steering gear	encoder_5_high
Data[13]	lowbyte of No.5 steering gear	encoder_5_low
Data[14]	highbyte of No.6 steering gear	encoder_6_high
Data[15]	lowbyte of No.6 steering gear	encoder_6_low
Data[17]	end frame	0XFA

Example:

Given that all robotic arms are set in zero position,

port return value: FE FE 0E 3D 08 00 08 00 08 00 08 00 08 00 08 00 FA

How potentials are counted:

potential = low status of potential + high status of potential * 256

Reading Speed

Domain	Explanation	Data
Data[0]	identification frame	0XFE
Data[1]	identification frame	0XFE
Data[2]	data-length frame	0X02
Data[3]	command frame	0X40
Data[4]	end frame	0XFA

Example:

Port transmission: FE FE 02 3D FA

Return value: data structure

Domain	Explanation	Data
Data[0]	identification frame	0XFE
Data[1]	identification frame	0XFE
Data[2]	data-length frame	0X03
Data[3]	command frame	0X40
Data[4]	specified speed	Sp
Data[5]	end frame	0XFA

Example:

Given that the speed is 50%

port return value: FE FE 03 40 32 FA

Setting Speed

Domain	Explanation	Data
Data[0]	identification frame	0XFE
Data[1]	identification frame	0XFE
Data[2]	data-length frame	0X03
Data[3]	command frame	0X41
Data[4]	specified speed	Sp
Data[5]	end frame	0XFA

Sp: data type of byte, ranging from 0 to 100

Example:

Given that the speed is 50%

port return value: FE FE 03 41 32 FA

Reading the Smallest Angle

Domain	Explanation	Data
Data[0]	identification frame	0XFE
Data[1]	identification frame	0XFE
Data[2]	data-length frame	0X03
Data[3]	command frame	0X4A
Data[4]	serial number of steering gear	Joint_number
Data[5]	end frame	0XFA

Example:

Reading the smallest angle of joint 2

Port transmission: FE FE 03 4A 02 FA

serial number of joint ranges from 1 to 6

Return value: data structure

Domain	Explanation	Data
Data[0]	return value: identification frame	0XFE
Data[1]	return value: identification frame	0XFE
Data[2]	return value: data-length frame	0X04
Data[3]	return value: command frame	0X4A
Data[4]	serial number of joint	Joint_number
Data[5]	high angle of steering gear	Angle_high
Data[6]	low angle of steering gear	Angle_low
Data[7]	end frame	0XFA

Example:

port return value: FE FE 05 4A 02 F9 F2 FA

How smallest angles are counted:

temp = angle1_low+angle1_high*256

Angle1=（temp \ 33000 ?(temp – 65536) : temp）/10

Explanation: if temp is greater than 33000, temp minus 65536, and then is divided by 10; if temp is less than 33000, then temp is divided by 10 directly.

Reading the Smallest Angle

Domain	Explanation	Data
Data[0]	identification frame	0XFE
Data[1]	identification frame	0XFE
Data[2]	data-length frame	0X03
Data[3]	command frame	0X4A
Data[4]	serial number of steering gear	Joint_number
Data[5]	end frame	0XFA

Serial number of joint ranges from 1 to 6

Example:

Reading the largest angle of joint 2

Port transmission: FE FE 03 4B 02 FA

Return value: data structure

Domain	Explanation	Data
Data[0]	return value: identification frame	0XFE
Data[1]	return value: identification frame	0XFE
Data[2]	return value: data-length frame	0X04
Data[3]	return value: command frame	0X4B
Data[4]	serial number of joint	Joint_number
Data[5]	high angle of steering gear	Angle_high
Data[6]	low angle of steering gear	Angle_low
Data[7]	end frame	0XFA

Example:

port return value: FE FE 05 4B 02 06 72 FA

How the largest angles are counted:

temp = angle1_low+angle1_high*256

Angle1= （temp \ 33000 ?(temp – 65536) : temp）/10

Explanation: if temp is greater than 33000, temp minus 65536, and then is divided by 10; if temp is less than 33000, then temp is divided by 10 directly.

Setting the Smallest Angle

Domain	Explanation	Data
Data[0]	return value: identification frame	0XFE
Data[1]	return value: identification frame	0XFE
Data[2]	return value: data-length frame	0X05
Data[3]	return value: command frame	0X4C
Data[4]	serial number of joint	Joint_number
Data[5]	high angle of steering gear	Angle_high
Data[6]	low angle of steering gear	Angle_low
Data[7]	end frame	0XFA

Example:

Given that the smallest angle of joint 2 is 0

Serial number of joint ranges from 1 to 6

port return value: FE FE 03 41 32 FA

data type of angle1_high: byte

counting method: angleis multiplied by 100 and converted into integral form to get the hexadecimal highbyte

data type of angle1_low: byte

counting method: angleis multiplied by 100 and converted into integral form to get the hexadecimal lowbyte

Port transmission: FE FE 05 4C 02 00 00 FA

no return value

Setting the Largest Angle

Domain	Explanation	Data
Data[0]	identification frame	0XFE
Data[1]	identification frame	0XFE
Data[2]	data-length frame	0X05
Data[3]	command frame	0X4D
Data[4]	serial number of joint	Joint_number
Data[5]	highbyte of steering gear	Angle_high
Data[6]	lowbyte of steering gear	Angle_low
Data[7]	end frame	0XFA

Example:

Given that the largest angle of joint 2 is 45

Serial number of joint ranges from 1 to 6

port return value: FE FE 03 41 32 FA

data type of angle1_high: byte

counting method: angleis multiplied by 100 and converted into integral form to get the hexadecimal highbyte

data type of angle1_low: byte

counting method: angleis multiplied by 100 and converted into integral form to get the hexadecimal lowbyte

Port transmission: FE FE 05 4C 02 11 94 FA

no return value

Checking Connection

Domain	Explanation	Data
Data[0]	identification frame	0XFE
Data[1]	identification frame	0XFE
Data[2]	data-length frame	0X03
Data[3]	command frame	0X50
Data[4]	serial number of steering gear	Joint_number
Data[5]	end frame	0XFA

Serial number of joint ranges from 1 to 6

Example:

Checking whether No.1 steering gear is connected

Port transmission: FE FE 03 50 01 FA

Return value: data structure

Domain	Explanation	Data
Data[0]	return value: identification frame	0XFE
Data[1]	return value: identification frame	0XFE
Data[2]	return value: data-length frame	0X03
Data[3]	command frame	0X50
Data[4]	serial number of joint	Joint_number
Data[5]	connected/not connected	0X01/0X00
Data[6]	end frame	0XFA

Example:

No.1 steering gear is connected

Port return value: FE FE 04 50 01 01 FA

Checking Whether All Steering Gears Are Powered On

Domain	Explanation	Data
Data[0]	identification frame	0XFE
Data[1]	identification frame	0XFE
Data[2]	data-length frame	0X02
Data[3]	command frame	0X51
Data[5]	end frame	0XFA

Example:

Port transmission: FE FE 02 51 FA

Return value: data structure

Domain	Explanation	Data
Data[0]	return value: identification frame	0XFE
Data[1]	return value: identification frame	0XFE
Data[2]	return value: data-length frame	0X03
Data[3]	return value: command frame	0X51
Data[4]	power on/off	0X01/0X00
Data[5]	end frame	0XFA

Example:

Not all steering gears are powered on

Port transmission: FE FE 03 51 01 FA

Reading Servo Parameters

Domain	Explanation	Data
Data[0]	identification frame	0XFE
Data[1]	identification frame	0XFE
Data[2]	data-length frame	0X04
Data[3]	command frame	0X53
Data[4]	serial number of joint	Joint_number
Data[5]	data address	data_id
Data[6]	end frame	0XFA

Example:

Reading ratio parameter of P position of No.1 steering gear

Port transmission: FE FE 03 51 01 FA

Serial number of joint ranges from 1 to 6

Data_id: data type byte, referring to the chart below for specific value:

Address	Function	Range	Initial Value	Explanation
20	LED siren	0-254	0	1\0: turn on/off LED siren
21	position loop P	0-254	10	control the ratio coefficient
22	position loop I	0-254	0	control the differential coefficient
23	position loop D	0-254	1	control the integral-action

Address	Function	Range	Initial Value	Explanation
23	position loop D	0-254	1	coefficient
24	minimum starting force	0-1000	0	set the smallest torque output capability 1000 = 100%

Return value: data structure

Domain	Explanation	Data
Data[0]	return value: identification frame	0XFE
Data[1]	return value: identification frame	0XFE
Data[2]	return value: data-length frame	0X03
Data[3]	return value: command frame	0X53
Data[4]	return value: data	data
Data[5]	end frame	0XFA

Setting Servo Parameters

Domain	Explanation	Data
Data[0]	identification frame	0XFE
Data[1]	identification frame	0XFE
Data[2]	data-length frame	0X05
Data[3]	command frame	0X52
Data[4]	serial number of joint	Joint_no
Data[5]	data address	data_id
Data[6]	end frame	0XFA

Example:

Reading ratio parameter of P position of No.1 steering gear

Port transmission: FE FE 05 52 01 15 01 FA

Serial number of joint ranges from 1 to 6

no return value

Data_id: data type byte, referring to the chart below for specific value:

Address	Function	Range	Initial Value	Explanation
20	LED siren	0-254	0	1\0: turn on/off LED siren
21	position loop P	0-254	10	control the ratio coefficient
22	position loop I	0-254	0	control the differential coefficient
23	position loop D	0-254	1	control the integral-action coefficient
24	minimum starting force	0-1000	0	set the smallest torque output capability 1000 = 100%

Setting Zero Position of Steering Gear

Domain	Explanation	Data
Data[0]	identification frame	0XFE
Data[1]	identification frame	0XFE
Data[2]	data-length frame	0X03
Data[3]	command frame	0X54
Data[4]	serial number of joint	Joint_no
Data[6]	end frame	0XFA

Example:

Reading zero position of No.1 steering gear

Port transmission: FE FE 03 54 01 FA

Serial number of joint ranges from 1 to 6

no return value

Braking Single Motor

Domain	Explanation	Data
Data[0]	identification frame	0XFE
Data[1]	identification frame	0XFE
Data[2]	data-length frame	0X02
Data[3]	command frame	0X55
Data[4]	serial number of joint	Joint_no
Data[5]	end frame	0XFA

Example:

Serial number of joint ranges from 1 to 6

Braking No.1 steering gear,

Port transmission: FE FE 03 55 01 FA

no return value

Power Failure of Single Motor

Domain	Explanation	Data
Data[0]	identification frame	0XFE
Data[1]	identification frame	0XFE
Data[2]	data-length frame	0X03
Data[3]	command frame	0X56
Data[4]	serial number of steering gear	Servo_no
Data[5]	end frame	0XFA

Example:

Let No.3 steering gear reducing power

Serial number of servo ranges from 1 to 6

no return value

Powering On a Single Motor

Domain	Explanation	Data
Data[0]	identification frame	0XFE
Data[1]	identification frame	0XFE
Data[2]	data-length frame	0X03
Data[3]	command frame	0X57
Data[4]	serial number of steering gear	Servo_no
Data[5]	end frame	0XFA

Example:

power on No.1 steering gear

Port transmission: FE FE 03 57 01 FA

Serial number of servo ranges from 1 to 6

no return value

Setting Mode of Atom

Domain	Explanation	Data
Data[0]	identification frame	0XFE
Data[1]	identification frame	0XFE
Data[2]	data-length frame	0X04
Data[3]	command frame	0X60
Data[4]	serial number of pin	pin_no
Data[5]	input/output	00X00/00X01
Data[6]	end frame	0XFA

Example:

setting atom pin22 as input mode

Port transmission: FE FE 04 60 16 00 FA

Pin_no: data type byte

Pin_mode：0/1

no return value

Setting Atom IO (setDigitalOutput)

Domain	Explanation	Data
Data[0]	identification frame	0XFE
Data[1]	identification frame	0XFE
Data[2]	data-length frame	0X04
Data[3]	command frame	0X61
Data[4]	serial number of pin	pin_no
Data[5]	signal of electrical level	00X00/00X01
Data[6]	end frame	0XFA

Example:

setting atom pin23 as high electrical level

Port transmission: FE FE 04 61 17 01 FA

no return value

Reading Atom IO(getDigitalInput)

Domain	Explanation	Data
Data[0]	identification frame	0XFE
Data[1]	identification frame	0XFE
Data[2]	data-length frame	0X04
Data[3]	command frame	0X61
Data[4]	serial number of pin	pin_no
Data[5]	end frame	0XFA

Example:

reading signal of electrical level of pin23

Port transmission: FE FE 03 62 16 FA

Return value: data structure

Domain	Explanation	Data
Data[0]	return value: identification frame	0XFE
Data[1]	return value: identification frame	0XFE
Data[2]	return value: data-length frame	0X03
Data[3]	return value: command frame	0X53
Data[4]	pin number	pin_no
Data[5]	signal of electrical level	0X00/0X01
Data[6]	end frame	0XFA

Example:

Given that pin 22 is of high electrical level

Port return value: FE FE 04 62 16 01 FA

Reading the Angle of Gripper

Domain	Explanation	Data
Data[0]	identification frame	0XFE
Data[1]	identification frame	0XFE
Data[2]	data-length frame	0X02
Data[3]	command frame	0X65
Data[4]	end frame	0XFA

Example:

Port transmission: FE FE 02 65 FA

Return value: data structure

Domain	Explanation	Data
Data[0]	return value: identification frame	0XFE
Data[1]	return value: identification frame	0XFE
Data[2]	return value: data-length frame	0X03
Data[3]	return value: command frame	0X65
Data[4]	span of gripper's opening	value
Data[5]	end frame	0XFA

value：0-100%

Example:

Given that gripper is completely opening

Port return value: FE FE 03 65 64 FA

value: 6 * 16 + 4 = 100

Setting the Mode of Gripper

Domain	Explanation	Data
Data[0]	identification frame	0XFE
Data[1]	identification frame	0XFE
Data[2]	data-length frame	0X04
Data[3]	command frame	0X66
Data[4]	gripper opening/closing	0X00/0X01
Data[5]	speed	Sp
Data[6]	end frame	0XFA

Example:

making gripper open at the speed of 50

Port transmission: FE FE 04 66 00 32 FA

no return value

Setting Angles of Gripper

Domain	Explanation	Data
Data[0]	identification frame	0XFE
Data[1]	identification frame	0XFE
Data[2]	data-length frame	0X04
Data[3]	command frame	0X67
Data[4]	span of gripper's opening/closing	value
Data[5]	speed	Sp
Data[6]	end frame	0XFA

Example:

Given that gripper opens by 50% at the speed of 30

Port transmission: FE FE 04 67 32 14 FA

The value can be converted into hexadecimal

no return value

Setting the Gripper to Zero Position

Domain	Explanation	Data
Data[0]	identification frame	0XFE
Data[1]	identification frame	0XFE
Data[2]	data-length frame	0X02
Data[3]	command frame	0X68
Data[4]	end frame	0XFA

Example:

Setting the Gripper to Zero Position

Port transmission: FE FE 02 68 FA

Checking Whether the Gripper is Moving

Domain	Explanation	Data
Data[0]	identification frame	0XFE
Data[1]	identification frame	0XFE
Data[2]	data-length frame	0X02
Data[3]	command frame	0X69
Data[4]	end frame	0XFA

Port transmission: FE FE 02 69 FA

Return value: data structure

Domain	Explanation	Data
Data[0]	identification frame	0XFE
Data[1]	identification frame	0XFE
Data[2]	data-length frame	0X04
Data[3]	command frame	0X69
Data[4]	stop/move	00/01
Data[6]	end frame	0XFA

Given that gripper stops working

Port transmission: FE FE 03 69 00 FA

Setting RGB of Atom

Domain	Explanation	Data
Data[0]	identification frame	0XFE
Data[1]	identification frame	0XFE
Data[2]	data-length frame	0X05
Data[3]	command frame	0X6A
Data[4]	R	0X00/0XFF
Data[5]	G	0X00/0XFF
Data[6]	B	0X00/0XFF
Data[7]	end frame	0XFA

Example:

Setting RGB color as blue

Port transmission: FE FE 05 6A 00 00 FF FA

no return value

Setting IO Output

Domain	Explanation	Data
Data[0]	identification frame	0XFE
Data[1]	identification frame	0XFE
Data[2]	data-length frame	0X04
Data[3]	command frame	0Xa0
Data[4]	pin number	Pin_no
Data[5]	signal of electrical level	0X00/0X01
Data[4]	end frame	0XFA

Example:

Setting high electrical level of pin 2

Port transmission: FE FE 02 a0 02 01 FA

Reading IO Output

Domain	Explanation	Data
Data[0]	identification frame	0XFE
Data[1]	identification frame	0XFE
Data[2]	data-length frame	0X03
Data[3]	command frame	0Xa1
Data[4]	pin number	Pin_no
Data[4]	end frame	0XFA

Port transmission: FE FE 02 a0 02 01 FA

Return value: data structure

Domain	Explanation	Data
Data[0]	return value: identification frame	0XFE
Data[1]	return value: identification frame	0XFE
Data[2]	return value: data-length frame	0X04
Data[3]	return value: command frame	0Xa1
Data[4]	pin number	Pin_no
Data[5]	signal of electrical level	0X00/0X01
Data[6]	end frame	0XFA

Example:

Given that pin 2 has high electrical level

Port return value: FE FE 04 a1 02 01 FA

Acquirng WiFi Account & Password

Domain	Explanation	Data
Data[0]	identification frame	0XFE
Data[1]	identification frame	0XFE
Data[2]	data-length frame	0X02
Data[3]	command frame	0Xb1
Data[4]	end frame	0XFA

Example:

Port transmission: FE FE 02 b1 FA

port return value: ssid: MyCobotWiFi2.4G password: mycobot123

ssid: WiFi account

password: WiFi password

Setting Port Number

Domain	Explanation	Data
Data[0]	identification frame	0XFE
Data[1]	identification frame	0XFE
Data[2]	data-length frame	0X04
Data[3]	command frame	0Xb2
Data[4]	highbyte of port	port_high
Data[5]	lowbyte of port	port_low
Data[6]	end frame	0XFA

Example:

Given that port number is 7000

Port transmission: FE FE 04 b2 1b 58 FA

port_high: highbyte of hexadecimal port number

port_low: lowbyte of hexadecimal port number

No return value

Setting Tool Coordinate

Domain	Explanation	Data
Data[0]	identification frame	0XFE
Data[1]	identification frame	0XFE
Data[2]	data-length frame	0X0E
Data[3]	command frame	0X81
Data[4]	specify high status of x coordinate	x_high
Data[5]	specify low status of x coordinate	x_low
Data[6]	specify high status of y coordinate	y_high
Data[7]	specify low status of y coordinate	y_low
Data[8]	specify high status of z coordinate	z_high
Data[9]	specify low status of z coordinate	z_low
Data[10]	specify high status of rx coordinate	rx_high
Data[11]	specify low status of rx coordinate	rx_low
Data[12]	specify high status of ry coordinate	ry_high
Data[13]	specify low status of ry coordinate	ry_low
Data[14]	specify high status of rz coordinate	rz_high
Data[15]	specify low status of rz coordinate	rz_low
Data[16]	end frame	0XFA

Example:

Given that （0，0，50，0，0，0）is tool coordinate,

Port transmission: FE FE 0E 81 00 00 00 00 13 88 00 00 00 00 00 00 FA

no return value

Acquiring Tool Coordinate

Domain	Explanation	Data
Data[0]	identification frame	0XFE
Data[1]	identification frame	0XFE
Data[2]	data-length frame	0X02
Data[3]	command frame	0X82
Data[4]	end frame	0XFA

Example:

Port transmission: FE FE 04 b2 1b 58 FA

Return value: data structure

Domain	Explanation	Data
Data[0]	identification frame	0XFE
Data[1]	identification frame	0XFE
Data[2]	data-length frame	0X0E
Data[3]	command frame	0X81
Data[4]	specify high status of x coordinate	x_high
Data[5]	specify low status of x coordinate	x_low
Data[6]	specify high status of y coordinate	y_high
Data[7]	specify low status of y coordinate	y_low
Data[8]	specify high status of z coordinate	z_high
Data[9]	specify low status of z coordinate	z_low
Data[10]	specify high status of rx coordinate	rx_high
Data[11]	specify low status of rx coordinate	rx_low
Data[12]	specify high status of ry coordinate	ry_high
Data[13]	specify low status of ry coordinate	ry_low
Data[14]	specify high status of rz coordinate	rz_high
Data[15]	specify low status of rz coordinate	rz_low
Data[16]	end frame	0XFA

Port return value: FE FE 0E 82 00 00 00 00 13 88 00 00 00 00 00 00 FA

How to get x coordinate:

temp = x_low + x_high*256

x coordinate = （temp\33000 ?(temp – 65536) : temp)/10

Explanation: if temp is greater than 33000, temp minus 65536, and then is divided by 100; if temp is less than 33000, then temp is divided by 100 directly.

y coordinate is counted in a similar way.

How to get rx coordinate:

temp = rx_low + rx_high*256

x coordinate = （temp \ 33000 ?(temp – 65536) : temp）/100

Explanation: if temp is greater than 33000, temp minus 65536, and then is divided by 100; if temp is less than 33000, then temp is divided by 100 directly.

ry coordinate is counted in a similar way.

Setting World Coordinate

Domain	Explanation	Data
Data[0]	identification frame	0XFE
Data[1]	identification frame	0XFE
Data[2]	data-length frame	0X0E
Data[3]	command frame	0X81
Data[4]	specify high status of x coordinate	x_high
Data[5]	specify low status of x coordinate	x_low
Data[6]	specify high status of y coordinate	y_high
Data[7]	specify low status of y coordinate	y_low
Data[8]	specify high status of z coordinate	z_high
Data[9]	specify low status of z coordinate	z_low
Data[10]	specify high status of rx coordinate	rx_high
Data[11]	specify low status of rx coordinate	rx_low
Data[12]	specify high status of ry coordinate	ry_high
Data[13]	specify low status of ry coordinate	ry_low
Data[14]	specify high status of rz coordinate	rz_high
Data[15]	specify low status of rz coordinate	rz_low
Data[16]	end frame	0XFA

Port return value: FE FE 0E 84 00 00 00 00 13 88 00 00 00 00 00 00 FA

How to get x coordinate:

temp = x_low + x_high*256

x coordinate = (temp\33000 ?(temp – 65536) : temp)/10

Explanation: if temp is greater than 33000, temp minus 65536, and then is divided by 100; if temp is less than 33000, then temp is divided by 100 directly.

y coordinate is counted in a similar way.

How to get rx coordinate:

temp = rx_low + rx_high*256

x coordinate = （temp \ 33000 ?(temp – 65536) : temp）/100

Explanation: if temp is greater than 33000, temp minus 65536, and then is divided by 100; if temp is less than 33000, then temp is divided by 100 directly.

ry coordinate is counted in a similar way.

Setting Base Coordinate

Domain	Explanation	Data
Data[0]	identification frame	0XFE
Data[1]	identification frame	0XFE
Data[2]	data-length frame	0X03
Data[3]	command frame	0X85
Data[4]	base coordinate/world coordiante	00/01
Data[5]	end frame	0XFA

Example:

Given that the coordinate should be set as world coordinate

port transmission: FE FE 03 85 01 FA

no return value

Acquiring Base Coordinate

Domain	Explanation	Data
Data[0]	identification frame	0XFE
Data[1]	identification frame	0XFE
Data[2]	data-length frame	0X02
Data[3]	command frame	0X86
Data[4]	end frame	0XFA

Example:

port transmission: FE FE 02 86 FA

Return value: data structure

Domain	Explanation	Data
Data[0]	return value: identification frame	0XFE
Data[1]	return value: identification frame	0XFE
Data[2]	return value: data-length frame	0X03
Data[3]	return value: command frame	0X86
Data[4]	base coordinate/world coordiante	00/01
Data[5]	end frame	0XFA

Example:

port transmission: FE FE 03 86 01 FA

Setting End Coordinate

Domain	Explanation	Data
Data[0]	identification frame	0XFE
Data[1]	identification frame	0XFE
Data[2]	data-length frame	0X03
Data[3]	command frame	0X89
Data[4]	flange	00/01
Data[5]	end frame	0XFA

Example:

Given that end coordinate are set as tool

port transmission: FE FE 03 89 01 FA

no return value

Acquiring End Coordinate

Domain	Explanation	Data
Data[0]	identification frame	0XFE
Data[1]	identification frame	0XFE
Data[2]	data-length frame	0X02
Data[3]	command frame	0X8a
Data[4]	end frame	0XFA

Example:

port transmission: FE FE 02 8a FA

Return value: data structure

Domain	Explanation	Data
Data[0]	identification frame	0XFE
Data[1]	identification frame	0XFE
Data[2]	data-length frame	0X03
Data[3]	command frame	0X8a
Data[4]	flange	00/01
Data[5]	end frame	0XFA

Example:

port return value: FE FE 03 86 01 FA

Appendix

The specific method of adding coordinate-exchanging programs from Atom repository and sports repository are listed as following.

1. Change end coordinate.
2. Set end coordinate by setEndType and getEndType.

   FLANGE: Setting EndType as FLANG; TOOL: Setting EndType as TOOL End.
3. Read tool coordinate via setToolReference and getToolReference. (FLANGE serves as relative coordinate and information about tool end is relevant to FLANGE coordinate.)
4. After setting EndType as FLANGE, GetCoords and WriteCoords are counted depending on FLANG's position.
5. After setting EndType as TOOL, GetCoords and WriteCoords are counted depending on end's position.
6. Change base coordinate.
7. Set base coordinate by setReferenceFrame.

   RFType: Base means setting robotic pedestal as base coordinate; RFType:WORLD means make world coordinate as base coordinate; getReferenceFrame serves to read the type of base coordinate.
8. setWorldReference and getWorldReference works to read information about base coordinate. World coordinate serves as relative coordinate to type pedestal information of robots that is relevant to world coordinate.
9. If base coordinate acts as pedestal, GetCoords and WriteCoords take base coordinate as reference coordinate.
10. If world coordinate acts as pedestal, GetCoords and WriteCoords take world coordinate as reference coordinate.

Information Updating About Communication

These are newly-added functions: setting and reading of end coordinate, world coordinate, present coordinate, type of end, as well as moving method, and sending and receiving of information on robotic arms.

The communication is temporarily set as from 0x80 to 0x8A.

The roboticMessages space is specially added in ParameterList.h for more communication information. Now only `No Analytical Solution` signal has been added, while more will be added later.

The outline of MOVEL are listed as follows:

First, count the Euclidean Distance between starting point and target point. Second, interpolation points are inserted every 10mm, based on the Euclidean Distance. If interpolation points do not have analytical solution, then search for plus or minus PI/30 from three unchangeable direction for analytical solution. Avoid singular value and some distinctive position that cannot get analytical solution.

Change the interval between MOVEL and JOG into dynamic time. And then, count the time spend moving through the maximum joint. And then, minus the moving time by specific period to take it as interval.