

Dobot Communication Protocol

Version	Date	Note
beta	2016/2/26	Create document

1.1 APPLY RANGE

This document is applied with Dobot Product for communicating commands and data between user software and Dobot controller.



Note: This protocol is only applied with the firmware ***Dobot_V1.X_XXX.hex***.



Note: The protocol will be upgrade in the future.

1.2 COMMUNICATION ROUTINE

When Dobot is powered up, the controller will take the readings from the angle sensors and reset the Servo position, then it upload the current state of the robot arm to the client. When a command is sent to the controller, Dobot will execute the action, upload the current state to the client then keep waiting for the next command to come.

1.3 COMMUNICATION FLOW CHART

Dobot will continually uploading current state parameters to the Client, which is also used as a request for informing the client there is still free space in the buffer of the controller.

2 DATA PACKET FORMAT

1. Data packet with a fixed length is adapted. The packet consists of 42 bytes, one byte for the packet head and one byte for the packet end; and rest 40 byte is valid data.
2. Data is packed with little ending byte order.

Figure 2.1 Interaction flow chart between Client and Dobot Controller

2.1 COMMEND FORMAT

2.1.1 CLIENT COMMEND DATA PACKET FORMAT

Each packet consists of 42 (2 + 4 × 10) bytes, including packet head 0xA5, packet end 0x5A and 10 float parameters. Each float parameter is structured with 4 bytes data (little ending byte order). The packet is shown in Table 3.1.

(Note: voice control using different commend format.)

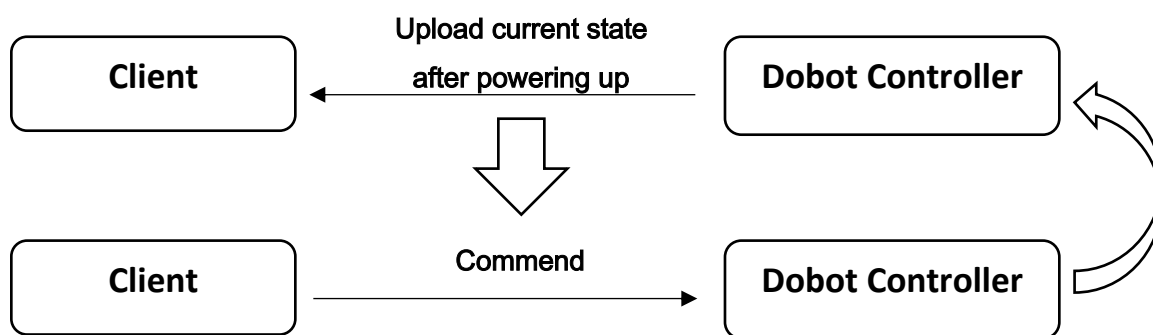


Table 2.1 Client commend Format

header	Float1	Float2	Float3	Float4	Float5	Float6	Float7	Float8	Float9	Float10	tail
0xA5	state										0x5A

In data packet, the Para1 is the state value, which can be set as different value regarding different application. Currently supported function and its state ID is shown in the following table:

Table 2.2 state ID explanation

State	1	2	3	4	5	6	7	8	9	10
Function	Mouse control	Axis Jog	Vision control	Write & Plot	Voice control	Teach & Playback	Linear Jog	Gestural control	Parameter Configuration	Teach & playback Configuration

The content of those floats represent different parameters, according to the corresponding state value and its application.

2.1.2 DOBOT CONTROLLER RETURN DATA PACKET

The return data packet here is designed for two purposes:

- (1) Uploading the current state;
- (2) Reporting the client there is a free space in the FIFO of the controller's commend list.

Each packet consists of 42 (2 + 4 × 10) bytes, including packet header 0xA5, packet end 0x5A and 10 float parameters. Each float parameter is structured with 4 bytes data (little ending byte order). Returned data packet is shown in following table:

Table 2.3 Return packet format

Index	header	Float1	Float2	Float3	Float4	Float5
Name	Header	X	Y	Z	rHead	baseAngle
Explanation	0xA5	X coordinat e	Y coordinat e	Z coordinat e	Rotation value	Base angle
Index	Float6	Float7	Float8	Float9	Float10	ender
Name	longArmA ngle	shortArm Angle	pawArmA ngle	isGrab	GripperAn gle	end
Explanation	rear arm angle	Fore arm angle	Servo angle	Pump state	Gripper angle	0x5A

2.2 FUNCTION INTRODUCTION

As introduced before, regarding the state value, the corresponding data packet is introduced below.

2.3 MOUSE CONTROL(ADDITIVE COORDINATE) MODE

When state= 1, Dobot is working in mouse control mode.

Table 2.4 Mouse Control Mode

Index	header	Float1	Float2	Float3	Float4	Float5
Name	header	state	reserved	Y	X	Z
Explanation	0xA5	1		additive value of Y axis	additive value of X axis	additive value of Z axis
Index	Float6	Float7	Float8	Float9	Float10	tail
Name	RHead	isGrab	reserved	reserved	reserved	tail
Explanation	Rotation angle	Suction cap ON/OFF				

2.3.1 JOINT JOG AND LINEAR JOG MODE

When state= 2 and state =7, the robot arm is working under joint jog mode and linear jog mode, is same as how we manipulate the robot arm in Teach & playback. The parameters used are in following Table.

Table 3.5 Jog mode illustration

Index	header	Float1	Float2	Float3	Float4	Float5
Name	header	State	Axis	reserved	reserved	reserved
Explanation	0xA5	2 or 7	Range: 1-14			
Index	Float6	Float7	Float8	Float9	Float10	tail
Name	reserved	reserved	StarVel	reserved	reserved	tail
Explanation			Range: 1-100 Percentage of the maximum speed			0x5A

The parameters Axis indicate the corresponding joint or axis, regarding the state value. Details are listed below.

Table 2.5 Axis value and corresponding joint and axis

State value Axis value	2 Joint Jog	7 Linear Jog
0	button released	
1	Joint1 + (CCW)	X +
2	Joint1 - (CW)	X -
3	Joint2 + (CCW)	Y +
4	Joint2 - (CW)	Y -
5	Joint3 + (CCW)	Z +
6	Joint3 - (CW)	Z -
7	Servo + (CCW)	
8	Servo - (CW)	
9	Suction cap ON	
10	Suction cap OFF	
11	Gripper + (Open)	
12	Gripper + (Close)	
13	Laser ON	
14	Laser OFF	

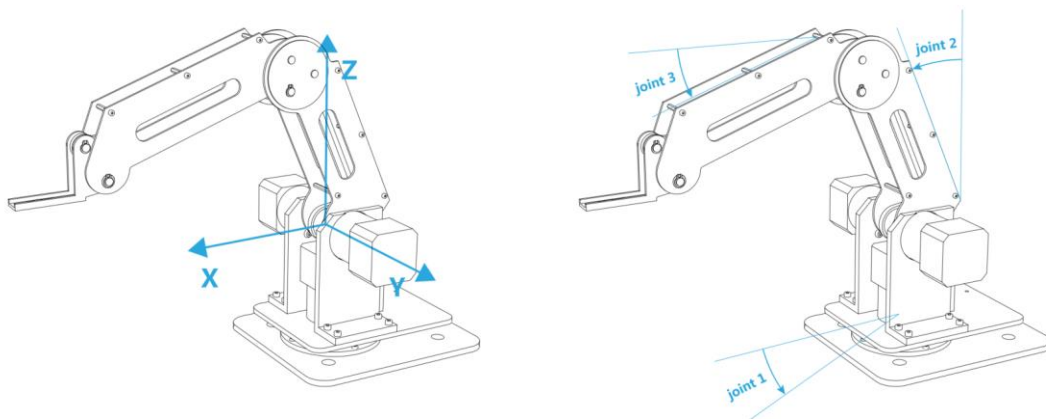


Figure 3.1 Reference Frame of Dobot

2.3.1 TARGET MOVING MODE

When state =3 & 6, the robot is operating in a target moving mode. The data packet consists of the data that gives a full description of Dobot. And Dobot will run from current position to the targeted one, and then change the gripper or pump state.

Table 3.7 Illustration of the target moving mode

Index	header	Float1	Float2	Float3	Float4	Float5
Name	header	state	reserved	X	Y	Z
Explanation	0xA5	3		x coordinat e	y coordinat e	z coordinat e
		6		Joint1 angle	Joint2 angle	Joint3 angle
Index	Float6	Float7	Float8	Float9	Float10	tail
Name	RHead	isGrab	MovingM ode	GripperVal ue	PauseTim e	tail
Explanation state: 3	Rotation angle	Suction cap ON/OFF	0:Jump, 1: MovL, 2: MovJ	Range: 90 to -90	Pause time after the action (unit: s)	0x5A
state: 6						

- The difference between 3 and 6 is what you send to the robot arm, joint angle or coordinate. The reference frame has been introduced in Figure 3.1.
- Rotation angle is different from Joint 4 angle. The rotation angle refers to the relative rotation angle of the end effector (e.g. gripper or suction cap) to the base, while the Joint 4 angle indicates how much it rotates comparing its 0 point, which is parallel to the Forearm.
- Moving mode consists of 3 types: JUMP, MOVL, and MOVJ. Which can be tested form the teach and play back.

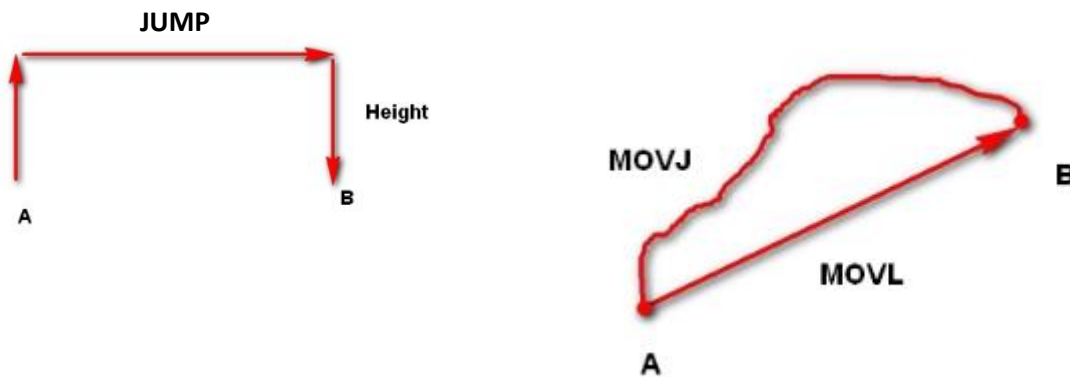


Figure 3.2 Illustration of 3 moving style

Moving Style:

- 1) **JUMP**: from point A to point B the jump trajectory is shown below, the end effector will lift Hight and move horizontally to point B and then move down Hight to reach point B. Hight can be configured in the Playback tab of the Config Dobot Module, the default value is 20 mm. Click send to configure dobot after changing the value.
- 2) **MOVJ** : joint movements , from point A to point B, each joint will run smoothly from initial angle to its target angle, regardless the trajectory. The requirement is for each joint, the running time equals, so that each joint will start and finish the movement at the same time.
- 3) **MOVL** : The joints will cooperate in order to perform a line trajectory from point A to point B.

2.3.2 WRITING AND LASER MODE

When state = 4, Dobot is operating in writing and Laser mode. The parameters are described as follows.

Table 2.6 Paramter illustration for writing and drawing Mode

Index	header	Float1	Float2	Float3	Float4	Float5
Name	header	state	mode	X	Y	Z
Explanation	0xA5	4	0: writing 1: laser	additive value of Y axis	additive value of X axis	additiv e value of Z axis
Index	Float6	Float7	Float8	Float9	Float10	tail
Name	reserved	isLaser	StartVel	EndVel	MaxVel	tail
Explanation		0: laser ON 0: laser OFF	initial speed	final speed <i>when Dobot reach its target point</i>	Maximum speed	0x5A

In this mode, a vector(x, y, z) indicates the additive coordinate form current point to the target point is given. And the controller will plan its moving speed and trajectory based on the initial speed, final speed and the max speed during this trajectory.

2.3.3 PARAMETERS CONFIG

The parameters should be configured before controlling the robot arm to move. State =9 gives us the function to set parameters of Dobot.

- Since we are using fixed length data packet, the floats that not used should be filled with 0 as well.
- Since different end effectors have different center coordinate regarding the Dobot frame, we need to set the value with mode 4. We will providing methods to set user defined center coordinate in the next version.

Table. 3.9 Commend List for Dobot parameters configuration

Index	header	Float1	Float2	Float3	Float4	Float5
Name	header	state	mode	Para1	Para2	Para3
Explanation	0xA5	9	0 Teach configuration	joint jog speed	joint jog acceleration	joint 4 speed
			1 Playback configuration	max joint moving speed	max joint moving acceleration	max servo speed
			2 writing configuration	writing acceleration		
			3 manually set initial angle	joint2 angle	joint3 angle	
			4 end effector settings	0: suction cap 1: Gripper 2: Laser		
		10	0 playback speed adjustment	playback moving acceleration percentage	playback moving speed percentage	Teaching mode moving speed percentage
Index	Float6	Float7	Float8	Float9	Float10	tail
Name	Para4	Para5	Para6	Para7	Para8	tail
<i>mode: 0</i>	joint 4 acceleration	linear jog speed	linear jog acceleration			0x5A
<i>mode: 1</i>	max servo acceleration	max linear moving seed	max linear moving acceleration	default pause time (unit: s)	JUMP height	
<i>mode: 2</i>						
<i>mode: 3</i>						
<i>mode: 4</i>						
<i>state: 10</i> <i>mode: 0</i>						

APPENDIX 1 PROTOCOL COMMEND LIST

Mode name	header	Float1	Float2	Float3	Float4	Float5	Float6	Float7	Float8	Float9	Float10	tail
Mouse control(additive coordinate) mode	0XA5	1		additive value of Y axis	additive value of X axis	additive value of Z axis	Rotation angle	Suction cap ON/OFF				0X5A
Joint Jog		2	Range: 1-14						Range: 1-100 Percentage of the maximum speed			
Linear Jog		7										
Target moving mode		3		x coordinate	y coordinate	z coordinate	Rotation angle	Suction cap ON/OFF	0:Jump 1:MovL 2: MovJ	Range: 90 to -90	Pause time after the action (unit: s)	
		6		Joint1 angle	Joint2 angle	Joint3 angle						
Writing and laser mode		4	0: writing 1: laser	additive value of Y axis	additive value of X axis	additive value of Z axis		0: laser ON 0: laser OFF	initial speed	final speed when Dobot reach its target point	Maximum speed	
Config Dobot		9	0 Teach configuration	joint jog speed	joint jog acceleration	joint 4 speed	joint 4 acceleration	linear jog speed	linear jog acceleration			
			1 Playback configuration	max joint moving speed	max joint moving acceleration	max servo speed	max servo acceleration	max linear moving seed	max linear moving acceleration	default pause time (unit: s)	JUMP height	
			2 writing configuration	writing acceleration								
			3 manually set initial angle	joint2 angle	joint3 angle							
	4 end effector settings		0: suction cap 1: Gripper 2: Laser									
	10	0 playback speed adjustment	playback moving acceleration percentage	playback moving speed percentage	Teaching mode moving speed percentage							
	<div><div>* note1 : the empty cells should be filled with 0(float, four bytes).</div><div>* note2: state= 5 & state= 8 is used for voice control and gesture control, not introduced here.</div></div>											