

Control Table

Control Table consists of data regarding the current status and operation, which exists inside of Dynamixel. The user can control Dynamixel by changing data of Control Table via Instruction Packet.

EEPROM and RAM

Data in RAM area is reset to the initial value whenever the power is turned on while data in EEPROM area is kept once the value is set even if the power is turned off.

In EEPROM torque enable (562) can be written only if its value is 0.

Note : Two's complement rule is followed to find the negative value.

For more information, please refer to the following link ([Two's complement link](#)).

Address

Address represents the location of a data. To read from or write data to Control Table the user should assign the correct address in the Instruction Packet.

Access

Dynamixel has two kinds of data: Read-only(R) data, which is mainly used for sensing, and Read-and-Write(RW) data. (R) represents the current status value and (RW) is data for control.

Size

Dynamixel PRO control table is 1-4 bytes.

Control Table

AREA	Address	Size (byte)	Name	Description	Access	Initial Value
E E P R O M	0	2	Model Number	Model Number	R	-
	2	4	Model Information	Model Information	R	-
	6	1	Version of Firmware	Firmware Version Info	R	-
	7	1	ID	Dynamixel PRO ID	RW	1
	8	1	Baud Rate	Dynamixel Baud Rate	RW	1
	9	1	Return Delay Time	Return Delay Time	RW	250
	11	1	Operating Mode	Operating Mode	RW	3
	17	4	Moving Threshold	Moving Threshold	RW	50
	21	1	Temperature Limit	Internal Temperature Limit	RW	80
	22	2	Max Voltage Limit	Max Voltage Limit	RW	400
	24	2	Min Voltage Limit	Min Voltage Limit	RW	150
	26	4	Acceleration Limit	Acceleration Limit	RW	-
	30	2	Torque Limit	Torque Limit	RW	-
	32	4	Velocity Limit	Velocity Limit	RW	-
	36	4	Max Position Limit	Max Position Limit	RW	-
	40	4	Min Position Limit	Min Position Limit	RW	-
	44	1	External Port Mode 1	External Port Mode 1	RW	0
	45	1	External Port Mode 2	External Port Mode 2	RW	0
	46	1	External Port Mode 3	External Port Mode 3	RW	0
	47	1	External Port Mode 4	External Port Mode 4	RW	0

	48	1	Shutdown	Shutdown	RW	48
	49	2	Indirect Address 1	Indirect Address 1	RW	634
	51	2	Indirect Address 2	Indirect Address 2	RW	635
	53	2	Indirect Address 3	Indirect Address 3	RW	636
	...	...	...	...	RW	-
	559	2	Indirect Address 256	Indirect Address Value 256	RW	889
R A M	562	1	Torque Enable	Torque Enable On/Off	RW	0
	563	1	LED RED	RED LED Brightness Value	RW	0
	564	1	LED GREEN	GREEN LED Brightness Value	RW	0
	565	1	LED BLUE	BLUE LED Brightness Value	RW	0
	586	2	Velocity I Gain	Velocity I Gain	RW	-
	588	2	Velocity P Gain	Velocity P Gain	RW	-
	594	2	Position P Gain	Position P Gain	RW	-
	596	4	Goal Position	Goal Position	RW	-
	600	4	Goal Velocity	Goal Velocity Value	RW	0
	604	2	Goal Torque	Goal Torque Value	RW	0
	606	4	Goal Acceleration	Goal Acceleration Value	RW	0
	610	1	Moving	Moving	R	-
	611	4	Present Position	Present Position Value	R	-
	615	4	Present Velocity	Present Velocity Value	R	-
	621	2	Present Current	Present Current Value	R	-
	623	2	Present Input Voltage	Present Input Voltage	R	-
	625	1	Present Temperature	Present Temperature	R	-
	626	2	External Port Data 1	External Port Data 1	R / RW	0
	628	2	External Port Data 2	External Port Data 2	R / RW	0
	630	2	External Port Data 3	External Port Data 3	R / RW	0
	632	2	External Port Data 4	External Port Data 4	R / RW	0
	634	1	Indirect Data 1	Indirect Address Data 1	RW	0
	635	1	Indirect Data 2	Indirect Address Data 2	RW	0
	636	1	Indirect Data 3	Indirect Address Data 3	RW	0
	...	...	...	...	RW	0
	889	1	Indirect Data 256	Indirect Address Data 256	RW	0
	890	1	Registered Instruction	Registered Instruction	R	0
	891	1	Status Return Level	Status Return Level	RW	2
	892	1	Hardware Error Status	Hardware Error Status	R	0

Address Function Help

EEPROM Area

In EEPROM torque enable(562) can be written only if its value is 0.

Model Number

It represents the Model Number.

Model Name	Default Value	Hexadecimal
RH-P12-RN	35073	8901

Firmware Version

It represents the firmware version.

ID

It is a unique number to identify Dynamixel.

The range from 0 to 252 (0xFC) can be used, and, especially, 254(0xFE) is used as the Broadcast ID.

If the Broadcast ID is used to transmit Instruction Packet, we can command to all Dynamixels.

※ Please be careful not to duplicate the ID of connected Dynamixel.

Baud Rate

Communications speed with the controller.

Value	Baud Rate [bps]	Comm Error [%]
0	9600	0
1	57600	0
2	115200	0
3	1M	0
4	2M	0
5	3M	0
6	4M	0
7	4.5M	0
8	10.5M	0

Note : Maximum Baud Rate error of 3% is within the tolerance of UART communication.

Return Delay Time

It is the delay time per data value that takes from the transmission of Instruction Packet until the return of Status Packet.

0 to 254 (0xFE) can be used, and the delay time per data value is 2 usec.

That is to say, if the data value is 10, 20 usec is delayed. The initial value is 250 (0xFA) (i.e., 0.5 msec).

Operating Mode

0 : Torque Control Mode : Only torque can be controlled

1 : Reserved

2 : Reserved

3 : Reserved

4 : Reserved

5 : Current based Position Control Mode : Allows control of position and torque

Moving Threshold

If current velocity is higher than this value then Moving becomes 1. If current velocity is less than this value then Moving becomes 0. This is movement's basic velocity. Values range from 0 to 2147483647.

Temperature Limit

Values for operating temperature, range from 0 ~100 and each value unit is in Celsius degrees. For example, a value of 80 is 80°C. If the internal temperature of the Dynamixel which is represented as Present Temperature(625) is greater than the Temperature Limit, the setting of the Over Heating Error Bit and Hardware Error bit in the Hardware Error Status(892) will be set to 1. If the Over Heating Error is set to 1 under Shutdown(48), the Torque Enable(562) will become 0 and the Torque will turn off. Refer to Shutdown(48) for more information.

Max Voltage Limit, Min Voltage Limit

Values for operating voltage which range from 0 ~ 400 and each value unit is 0.1V.

For example, a value of 80 is 8.0V.

If the current voltage value is out of range, then the Status Packet sends an Input Voltage Error Bit (Bit0) with a value of 1; if the input voltage error under Shutdown is set, the torque will disable.

Acceleration Limit

Goal velocity value margin. Input value cannot exceed Goal accelation(606) value. If a higher value is entered then value is not written followed by Limit error bit by Status Packet. Values range from 0 to 2147483647.

Torque Limit

Goal torque value margin. Input value cannot exceed Goal torque(604) value. If a higher value is entered then value is not written followed by Limit error bit by Status Packet. Values range from 0 to 820.

Velocity Limit

Goal velocity value margin. Input value cannot exceed Goal velocity (600) value. If a higher value is entered then value is not written followed by Limit error bit by Status Packet. Values range from 0 to 2147483647.

Max Position Limit, Min Position Limit

Max/Min position values. Input values cannot exceed the Goal position(596). If greater values are entered, it will not be written and the error data will return as a Data Limit Error from the Status Packet. Value ranges from 0 ~ 1150. However, position limit is not triggered when operating in an extended position control.

Model Name	Max Position (Close)	Min Position (Open)
RH-P12RN	1150	0

External Port Mode 1, 2, 3, 4

External Port Data

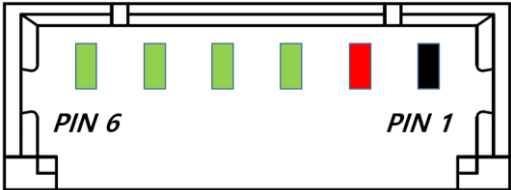
Dynamixel PRO is equipped with multi-purpose expansion ports.

Mode	Name	Description	Comment
0	Analog input mode	Convert the analog values from the external port to digital values.	

		This values automatically updates in External port data(626 ~ 632)	
1	Output mode	External port voltage can be adjusted to 0V or 3.3V. External port data value of 0 is 0V, 1 for 3.3V.	
2	Pull-up input mode	Verifies if the external port value is 0 or 1. External value is converted. based on the input value of the external port. External port data value of 0 is 0V, 1 for 3.3V. This port is a weak pull up and additional strong pull-up can be added if necessary.	
3	Pull-down input mode	Verifies if the external port value is 0 or 1. External value is converted. based on the input value of the external port. External port data value of 0 is 0V, 1 for 3.3V. This port is a weak pull up and additional strong pull-up can be added if necessary.	

Operating Range
Voltage : 0~3.3V
Current : 0~5mA

Pin Functions and Position of the External Expansion Port



- 1 : GND
- 2 : 3.3V
- 3 : PORT1
- 4 : PORT2
- 5 : PORT3
- 6 : PORT4

Shutdown

Hardware error status

Dynamixel PRO can protect itself by detecting dangers to its integrity.

Below are the settings that the user can be set.

Bit	Name	Description
Bit 7	-	-
Bit 6	-	-
Bit 5	Over Current	Over current
Bit 4	Electronical Shock Error	Motor not operational due to electrical shock to the circuit or insufficient voltage.
Bit 3	Motor Encoder Error	Motor encoder not operating
Bit 2	Over Heating Error	Internal operating temperature exceeds limit
Bit 1	Motor Hall Sensor Error	Motor hall sensor value exceeds limits
Bit 0	Input Voltage Error	Input voltage exceeds limit

The error bits can be applied in 'OR' configuration. For example, 0x05 (00000101 binary) setup means Overheating and Input Voltage error are activated. When danger occurs, the Torque Enable value becomes 0 so that the motor output becomes 0%. Dynamixel PRO cannot be used after this safety mode kicks in until it is rebooted. (Dynamixel must be powered off then back on)

Indirect address 1~256

Indirect data 1~256

The user can use this function to gather any necessary parts of the control table.

Setting a specific address in the Indirect Address Table has the same effect/function as the Indirect Address Table.

For example, write a value of 563 to Indirect address 1 (49); and 255 to Indirect data 1 (634) a red LED flashes. The value LED RED (563) or 255 is written. Or, when RED LED (563) is written with a value Indirect data 1 becomes the same. Setting a specific address in Indirect address Indirect data will become the same.

One important point to keep in mind when the control table is over 2 bytes setting indirect addresses becomes necessary. Set every byte in indirect address from Control table item for proper operations.

For example, follow the list below when using indirect data 2 for Goal position (596).

Indirect address 2 = 596

Indirect address 3 = 597

Indirect address 4 = 598

Indirect address 5 = 599

Or, when writing 0x12345678 indirectly to Goal position (596)

Indirect address 2 = 0x78

Indirect address 3 = 0x56

Indirect address 4 = 0x34

Indirect address 5 = 0x12

In other words assign the corresponding item's length to its corresponding indirect address.

RAM Area

Torque Enable

A value of 1 in the EEPROM cannot be modified.

Value	Description
0	Cut off motor power supply to deactivate torque
1	Torque active when power is supplied to motor

LED RED

LED BLUE

LED GREEN

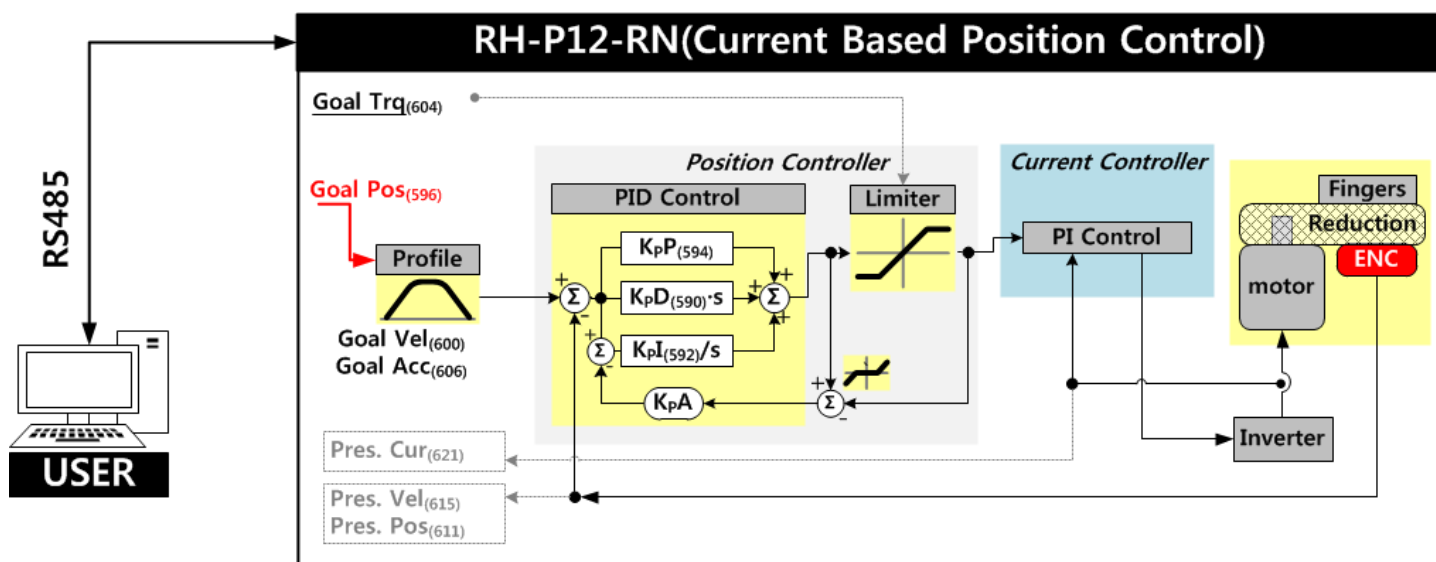
Each LED can have its brightness set. Values range from 0 to 255.

Position D Gain, Position I Gain, Position P Gain

These gains are used in current based position control mode. The value varies from 0 to 32767. Below figure is a block diagram describing the current based position control mode. K_pD , K_pI and K_pP stands for Position D Gain, Position I Gain and Position P Gain respectively.

When a command is given to operate the gripper, below processes will be handled to interpret the command and then the gripper will be operated..

- ① The command is registered to the Goal Position(596).
- ② The Goal Position(596) is calculated as Position Trajectory and Velocity Trajectory based on the Goal Velocity(600) and the Goal Acceleration(606).
- ③ The PID controller calculates goal current of the motor based on trajectories from step 2..
- ④ Goal Torque(604) regulates actual current that will be supplied to the motor by limiting the calculated goal current from step 3.
- ⑤ Current controller decides PWM output value based on the actual goal current from step 4.
- ⑥ The PWM value is applied to the motor via the Inverter, and the gripper will be operated.
- ⑦ The result can be read from Present Position(611), Present Velocity(615) and Present Current(621).

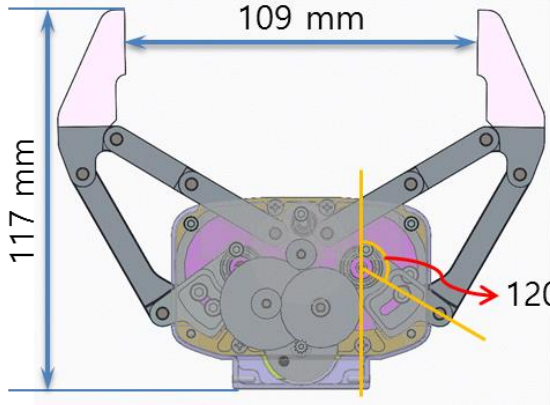
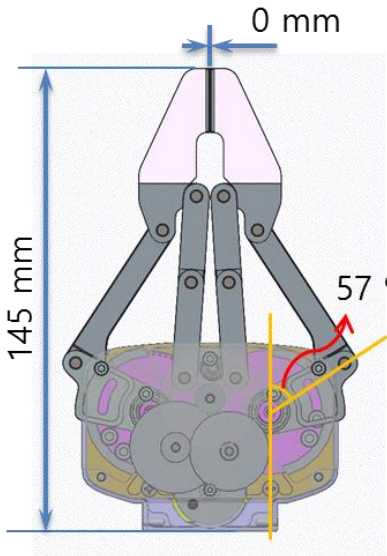


K_pA stands for Anti-windup Gain which cannot be modified by user.

For more details about the PID controller, please refer to the below website. http://en.wikipedia.org/wiki/PID_controller

Goal position

Value of targeted position that can be used from 0~1150(0x47E) in units of 0.088 degrees. Only values within Max position limit(36) and Min Position limit(40) can be used.

Model	Relationship between angle(deg) and position value
RH-P12-RN	<div><p>[Goal Position = 0]</p></div> <div><p>[Goal Position = 716]</p></div>

Goal Velocity

Velocity to move to the Goal Position that can be from 0~1023(0X3FF) in units of 0.114rpm.
Setting to 0 means it will use max rpm without velocity control. 1023 becomes about 117.07rpm.
For example, if set to 300, it becomes 34.33rpm.

Goal torque

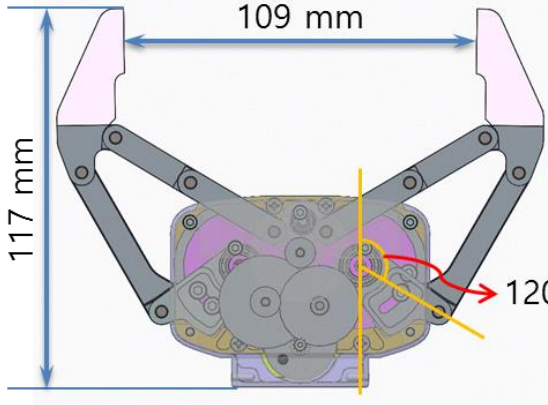
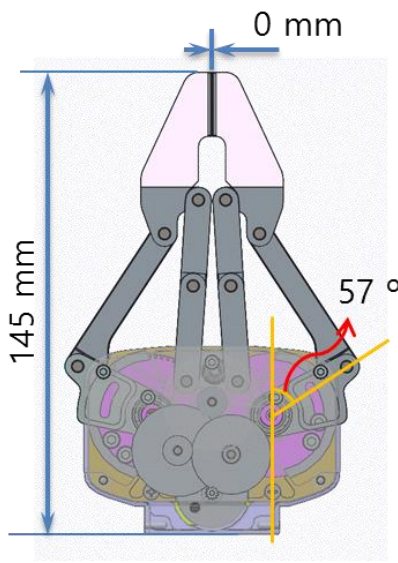
Use Goal Torque(604) to set Goal Torque. Can be used as different purposes based on the Operating Mode(11).
0: Torque Control Mode – Use Goal Torque Value
5: Torque based Position Control Mode – Use Torque Limit Value

Goal acceleration

Set the Goal acceleration. Goal Acceleration can be used when the Operating Mode(11) is in Position Control Mode and Torque based Position control mode. If the value of the Goal Acceleration(606) and Goal Velocity(600) is 0, acceleration is not applied.
Range is between 0 ~ 2147483647.

Present position

Value of the present position in 0.088 degrees.

Model	Relationship between angle(deg) and position value
RH-P12-RN	<div> [Goal Position = 0]</div> <div> [Goal Position = 716]</div>

Present Velocity

Present moving velocity which uses values -1023~1023. If the value is within 0~1023 range it rotates in CCW direction, and if set as -1023~0, it rotates in CW direction. The unit of the value is 0.114rpm. For example, if set to 300 it moves in CCW direction at 34.33rpm.

Present Current

Present current value in 4.02mA unit.

Present Input Voltage

Present input voltage in 0.1V unit. For example, if the value is 100, then it's 10V.

Present Temperature

Present temperature value in 1°C unit. For example, if the value is 85, then it's 85°C.

Registered Instruction

Value	Description
0	No command passed to REG_WRITE
1	Command passed to REG_WRITE

Note: When running ACTION command this value becomes 0

Status Return Level

Method of Status Packet return.

value	method
0	No return to all commands (excludes PING command)
1	Returns only READ commands
2	Returns all commands

Note: Instruction packet does not return a Status Packet in Broadcast ID.