北京智能佳科技有限公司

XL-320

Part Photo

[XL-320]

※ XL-320 is a different product from the OLLO Geared and Servo Motor.

H/W Specification

- Weight : 16.7g
- Dimension : 24mm *36mm * 27mm
- Resolution : 0.29°
- Motor : Cored Motor
- Gear Reduction Ratio : 238 : 1
- Stall Torque : 0.39 N.m (at 7.4V)
- No load speed : 114 rpm (at 7.4V)
- Running Degree
  - 0° ~ 300°
  - Endless Turn
- Running Temperature : -5℃ ~ +70℃
- Voltage : 6 ~ 8.4V (Recommended Voltage 7.4V)
- Command Signal : Digital Packet

地址：北京海淀区中关村 E 世界 A913 室 电话：010-82488500/8501
网址：www.bjrobot.com 邮箱：znj@bjrobot.com 全国客服热线：400-099-1872

- Protocol Type : Half duplex Asynchronous Serial Communication (8bit,1stop,No Parity)
- Link (Physical) : TTL Level Multi Drop (daisy chain type Connector)
- ID : 253 ID (0~252)
- Communication Speed : 7343bps ~ 1 Mbps
- Feedback : Position, Temperature, Load, Input Voltage, etc.
- Material : Engineering Plastic

Stall torque is the maximum instantaneous and static torque
Stable motions are possible with robots designed for loads with 1/5 or less of the stall torque

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.

Address

It represents the location of 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 data, which is mainly used for sensing, and Read-and-Write data, which is used for driving.

Initial Value

In case of data in the EEPROM Area, the initial values on the right side of the below Control Table are the factory default settings. In case of data in the RAM Area, the initial values on the right side of the above Control Tables are the ones when the power is turned on.

Highest/Lowest Byte

In the Control table, some data share the same name, but they are attached with (L) or (H) at the end of each name to distinguish the address. This data requires 16bit, but it is divided into 8bit each for the addresses (low) and (high). These two addresses should be written with one Instruction Packet at the same time.

Area	Address (Hexadecimal)	Size(byet)	Name	Description	Access	Inital Value	Min	Max
E E P	0	2	Model Number	Model number	R	350	-	-
	2	1	Version of Firmware	Information on the version of firmware	R	-	-	-

R O M	3	1	ID	ID of Dynamixel	RW	1	0	252
	4	1	Baud Rate	Baud Rate of Dynamixel	RW	3	0	3
	5	1	Return Delay Time	Return Delay Time	RW	250	0	254
	6	2	CW Angle Limit	clockwise Angle Limit	RW	0	0	1023
	8	2	CCW Angle Limit	counterclockwise Angle Limit	RW	1023	0	1023
	11	1	Control Mode	Control Mode	RW	2	1	2
	12	1	Limit Temperature	Internal Limit Temperature	RW	65	0	150
	13	1	lower Limit Voltage	Lowest Limit Voltage	RW	60	50	250
	14	1	Upper Limit Voltage	Upper Limit Voltage	RW	90	50	250
	15	2	Max Torque	Lowest byte of Max. Torque	RW	1023	0	1023
	17	1	Return Level	Return Level	RW	2	0	2
	18	1	Alarm Shutdown	Shutdown for Alarm	RW	36	0	127
R A M	24	1	Torque Enable	Torque On/Off	RW	0	0	1
	25	1	LED	LED On/Off	RW	0	0	7
	27	1	D Gain	D Gain	RW	0	0	254
	28	1	I Gain	_I Gain	RW	0	0	254
	29	1	P Gain	P Gain	RW	32	0	254
	30	2	Goal Position	Goal Position	RW	-	0	1023
	32	2	Goal Velocity	Goal Speed	RW	-	0	2047
	35	2	Goal Torque	Goal Torque	RW	-	0	1023
	37	2	Present Position	Current Position	R	-	-	-
	39	2	Present Speed	Current Speed	R	-	-	-
	41	2	Present Load	Current Load	R	-	-	-
	45	1	Present Voltage	Current Voltage	R	-	-	-
	46	1	Present Temperature	Present temperature	R	-	-	-
	47	1	Registered Instruction	Registered Instruction	R	0	-	-
	49	1	Moving	Moving	R	0	-	-
	50	1	Hardware Error Status	Hardware error status	R	0	-	-
	51	2	Punch	Punch	RW	32	0	1023

Address Function Help

EEPROM Area

Model Number

It represents the Model Number.

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

It represents the communication speed.

0: 9600, 1:57600, 2:115200, 3:1Mbps

> 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).

CW/CCW Angle Limit

The angle limit allows the motion to be restrained.

CONTROL MODE

Value	Return of Status Packet
1	Wheel Mode
2	Join Mode

The wheel mode can be used to wheel-type operation robots since motors of the robots spin infinitely.

The joint mode can be used to multi-joints robot since the robots can be controlled with specific angles.

The Highest Limit Temperature

> Caution : Do not set the temperature lower/higher than the default value.
> When the temperature alarm shutdown occurs, wait 20 minutes to cool the temperature before re-use.
> Using the product when the temperature is high may and can cause damage.

The Lowest (Highest) Limit Voltage

It is the operation range of voltage.

50 to 250 (0x32 ~ 0x96) can be used. The unit is 0.1V.

For example, if the value is 80, it is 8V.

If Present Voltage (Address42) is out of the range, Voltage Range Error Bit (Bit0) of Status Packet is returned as '1' and Alarm is triggered as set in the addresses 17 and 18.

Max Torque

It is the torque value of maximum output. 0 to 1023 (0x3FF) can be used, and the unit is about 0.1%. For example, Data 1023 (0x3FF) means that Dynamixel will use 100% of the maximum torque it can produce while Data 512 (0x200) means that Dynamixel will use 50% of the maximum torque. When the power is turned on, Torque Limit (Addresses 34 and 35) uses the value as the initial value.

Status Return Level

It decides how to return Status Packet. There are three ways like the below table.

Value	Return of Status Packet
0	No return against all commands (Except PING Command)
1	Return only for the READ command
2	Return for all commands

> When Instruction Packet is Broadcast ID, Status Packet is not returned regardless of Status Return Level.

Alarm LED

Alarm Shutdown

Dynamixel can protect itself by detecting errors occur during the operation.

The errors can be set are as the table below.

it	Name	Contents
bit7	-	-
bit6	-	-
bit5	-	-
bit4	-	-
bit3	-	-
bit2	ERROR_INPUT_VALTAGE	Voltage is out of operational voatage range
bit1	ERROR_OVER_HEATING	Temperature is out of operational temperature range
bit0	ERROR_OVERLOAD	Motor cannot output max load due to load being applied continouosly

It is possible to make duplicate set since the function of each bit is run by the logic of 'OR'. That is, if 0X05 (binary 00000101) is set, both Input Voltage Error and Overheating Error can be detected. If errors occur, in case of Alarm LED, the LED blinks; in case of Alarm Shutdown, the motor output becomes 0 % by making the value of Torque Limit(Address 34, 35) as 0.

RAM Area

Torque Enable

Value	Meaning
0	Keeps Torque from generating by interrupting the power of motor.
1	Generates Torque by impressing the power to the motor.

LED

Bit	명칭	내용
bit0+bit1+bit2	WHITE LED	 When the bit is set the white LED turns on

bit0+bit2	PINK LED	 When the bit is set the pink LED turns on
bit1+bit2	BLUE-GREEN LED	 When the bit is set the blue-green LED turns on
bit0+bit1	YELLOW LED	 When the bit is set the yellow LED turns on

bit2	BLUE LED	 When the bit is set the blue LED turns on
bit1	GREEN LED	 When the bit is set the green LED turns on
bit0	RED LED	 When the bit is set the red LED turns on

PID Gain

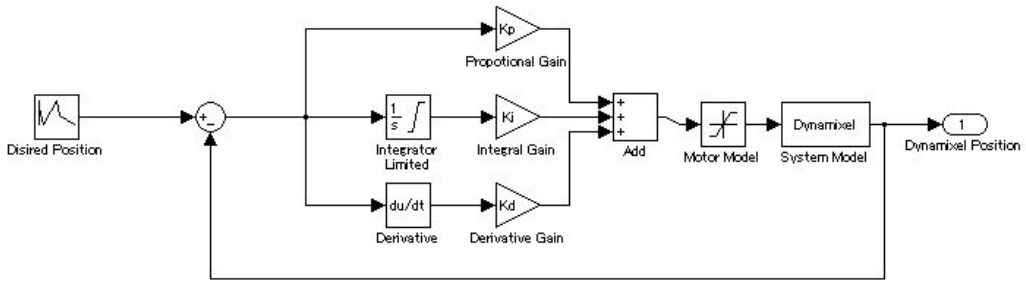
XL series will use the PID controller as a main control method.

P gain refers to the value of proportional band.

I gain refers to the value of integral action.

D Gain refers to the value of derivative action.

Gains values are in between 0~254.



K_p = P Gain / 8
K_i = I Gain * 1000 / 2048
K_d = D Gain * 4 / 1000

※ The relationship between Compliance Slope and PID

Slope	P Gain
8	128
16	64
32	32
64	16
128	8

The less the P gain, The larger the back lash, and the weaker the amount of output near goal position.

At some extent, it is like a combined concept of margine and slope.

It does not exactly match the previous concept of compliance. So it is obvious if you see the difference in terms of motion.

※ Explanation for PID required.

For the brief explanation about general PID, please refer to the website(link) below.

http://en.wikipedia.org/wiki/PID_controller

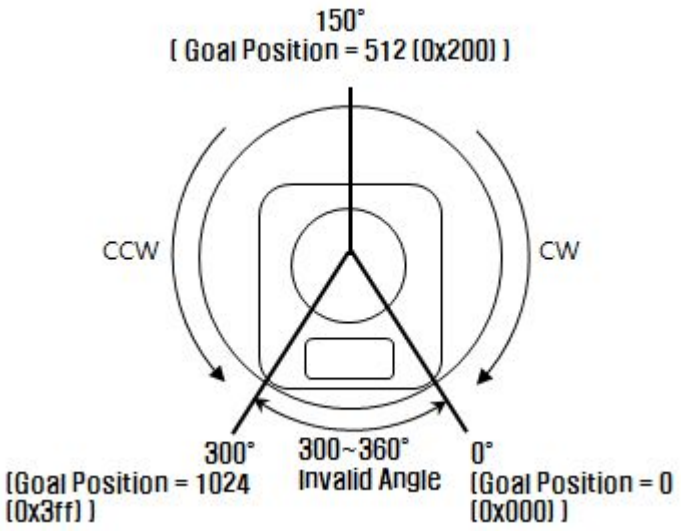
FYI, PID control theory is not only limited to the control of motor(actuator) but is a generic theory that can be applied to all kinds of control.

Goal Position

It is a position value of destination.

0 to 1023 (0x3FF) is available. The unit is 0.29 degree.

If Goal Position is out of the range, Angle Limit Error Bit (Bit1) of Status Packet is returned as '1' and Alarm is triggered as set in Alarm LED/Shutdown.



<The picture above is based on the front of relevant model>

> If it is set to Wheel Mode, this value is not used.

Moving Speed

It is a moving speed to Goal Position.

The range and the unit of the value may vary depending on the operation mode.

- Join Mode

  0~1023 (0X3FF) can be used, and the unit is about 0.111rpm.

  If it is set to 0, it means the maximum rpm of the motor is used without controlling the speed.

  If it is 1023, it is about 114rpm.

  For example, if it is set to 300, it is about 33.3 rpm.

> Notes: Please check the maximum rpm of relevant model in Joint Mode. Even if the motor is set to more than maximum rpm, it cannot generate the torque more than the maximum rpm.

- Wheel Mode

  0~2047(0X7FF) can be used, the unit is about 0.1%.

  If a value in the range of 0~1023 is used, it is stopped by setting to 0 while rotating to CCW direction.

  If a value in the range of 1024~2047 is used, it is stopped by setting to 1024 while rotating to CW direction.

  That is, the 10th bit becomes the direction bit to control the direction.

  In Wheel Mode, only the output control is possible, not speed.

For example, if it is set to 512, it means the output is controlled by 50% of the maximum output.

Torque Limit

It is the value of the maximum torque limit.

0 to 1023 (0x3FF) is available, and the unit is about 0.1%.

For example, if the value is 512, it is about 50%; that means only 50% of the maximum torque will be used.

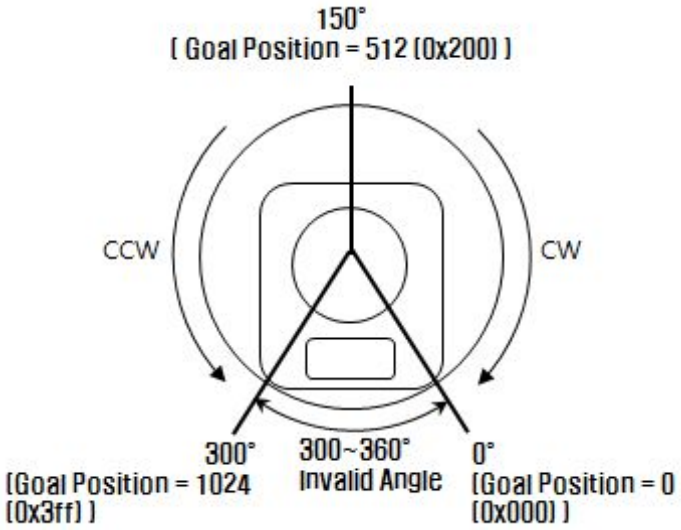
If the power is turned on, the value of Max Torque (Address 14, 15) is used as the initial value.

> Notes: If the function of Alarm Shutdown is triggered, the motor loses its torque because the value becomes 0. At this moment, if the value is changed to the value other than 0, the motor can be used again.

Present Position

It is the current position value of Dynamixel.

The range of the value is 0~1023 (0x3FF), and the unit is 0.29 degree.



<The picture above is based on the front of relevant model>

> Caution: If it is set to Wheel Mode, the value cannot be used to measure the moving distance and the rotation frequency.

Present Speed

It is the current moving speed.

0~2047 (0X7FF) can be used.

If a value is in the rage of 0~1023, it means that the motor rotates to the CCW direction.

If a value is in the rage of 1024~2047, it means that the motor rotates to the CW direction.
That is, the 10th bit becomes the direction bit to control the direction, and 0 and 1024 are equal.
The unit of this value varies depending on operation mode.

- Joint Mode
  The unit is about 0.111rpm.
  For example, if it is set to 300, it means that the motor is moving to the CCW direction at a rate of about 33.3rpm.
- Wheel Mode
  The unit is about 0.1%.
  For example, if it is set to 512, it means that the torque is controlled by 50% of the maximum torque to the CCW direction.

Present Load

It means currently applied load.
The range of the value is 0~2047, and the unit is about 0.1%.
If the value is 0~1023, it means the load works to the CCW direction.
If the value is 1024~2047, it means the load works to the CW direction.
That is, the 10th bit becomes the direction bit to control the direction, and 1024 is equal to 0.
For example, the value is 512, it means the load is detected in the direction of CCW about 50% of the maximum torque.

BIT	15~11	10	9	8	7	6	5	4	3	2	1	0
Value	0	Load Direction	Data (Load Ratio)									

Load Direction = 0 : CCW Load, Load Direction = 1: CW Load

> Notes: Current load is inferred from the internal torque value, not from Torque sensor etc. For that reason, it cannot be used to measure weight or torque; however, it must be used only to detect which direction the force works.

Present Voltage

It is the size of the current voltage supplied.
This value is 10 times larger than the actual voltage. For example, when 10V is supplied, the data value is 100 (0x64)

Present Temperature

It is the internal temperature of Dynamixel in Celsius.
Data value is identical to the actual temperature in Celsius. For example, if the data value is 85 (0x55), the current internal temperature is 85℃.

Registered Instruction

Value	Meaning
0	There are no commands transmitted by REG_WRITE
1	There are commands transmitted by REG_WRITE.

Notes: If ACTION command is executed, the value is changed into 0.

Moving

Value	Meaning
0	Goal position command execution is completed.
1	Goal position command execution is in progress.

HARDWARE ERROR STATUS

Current hardware error staus

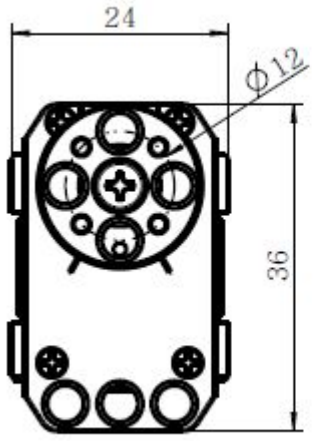
Alarm shudown error value

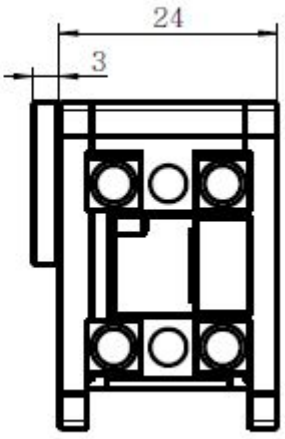
Punch

Current to drive motor is at minimum.

Can choose vales from 0x20 to 0x3FF.

Dimension





CRC calculator

CRC16 calc code

```
unsigned  short update_crc(unsigned short crc_accum, unsigned char *data_blk_ptr,un
signed short data_blk_size)
{
    unsigned short i, j;
    unsigned short crc_table[256] = {
        0x0000, 0x8005, 0x800F, 0x000A, 0x801B, 0x001E, 0x0014, 0x8011,
        0x8033, 0x0036, 0x003C, 0x8039, 0x0028, 0x802D, 0x8027, 0x0022,
        0x8063, 0x0066, 0x006C, 0x8069, 0x0078, 0x807D, 0x8077, 0x0072,
        0x0050, 0x8055, 0x805F, 0x005A, 0x804B, 0x004E, 0x0044, 0x8041,
        0x80C3, 0x00C6, 0x00CC, 0x80C9, 0x00D8, 0x80DD, 0x80D7, 0x00D2,
        0x00F0, 0x80F5, 0x80FF, 0x00FA, 0x80EB, 0x00EE, 0x00E4, 0x80E1,
        0x00A0, 0x80A5, 0x80AF, 0x00AA, 0x80BB, 0x00BE, 0x00B4, 0x80B1,
        0x8093, 0x0096, 0x009C, 0x8099, 0x0088, 0x808D, 0x8087, 0x0082,
        0x8183, 0x0186, 0x018C, 0x8189, 0x0198, 0x819D, 0x8197, 0x0192,
        0x01B0, 0x81B5, 0x81BF, 0x01BA, 0x81AB, 0x01AE, 0x01A4, 0x81A1,
        0x01E0, 0x81E5, 0x81EF, 0x01EA, 0x81FB, 0x01FE, 0x01F4, 0x81F1,
        0x81D3, 0x01D6, 0x01DC, 0x81D9, 0x01C8, 0x81CD, 0x81C7, 0x01C2,
        0x0140, 0x8145, 0x814F, 0x014A, 0x815B, 0x015E, 0x0154, 0x8151,
        0x8173, 0x0176, 0x017C, 0x8179, 0x0168, 0x816D, 0x8167, 0x0162,
        0x8123, 0x0126, 0x012C, 0x8129, 0x0138, 0x813D, 0x8137, 0x0132,
        0x0110, 0x8115, 0x811F, 0x011A, 0x810B, 0x010E, 0x0104, 0x8101,
        0x8303, 0x0306, 0x030C, 0x8309, 0x0318, 0x831D, 0x8317, 0x0312,
        0x0330, 0x8335, 0x833F, 0x033A, 0x832B, 0x032E, 0x0324, 0x8321,
        0x0360, 0x8365, 0x836F, 0x036A, 0x837B, 0x037E, 0x0374, 0x8371,
        0x8353, 0x0356, 0x035C, 0x8359, 0x0348, 0x834D, 0x8347, 0x0342,
        0x03C0, 0x83C5, 0x83CF, 0x03CA, 0x83DB, 0x03DE, 0x03D4, 0x83D1,
        0x83F3, 0x03F6, 0x03FC, 0x83F9, 0x03E8, 0x83ED, 0x83E7, 0x03E2,
        0x83A3, 0x03A6, 0x03AC, 0x83A9, 0x03B8, 0x83BD, 0x83B7, 0x03B2,
        0x0390, 0x8395, 0x839F, 0x039A, 0x838B, 0x038E, 0x0384, 0x8381,
        0x0280, 0x8285, 0x828F, 0x028A, 0x829B, 0x029E, 0x0294, 0x8291,
        0x82B3, 0x02B6, 0x02BC, 0x82B9, 0x02A8, 0x82AD, 0x82A7, 0x02A2,
        0x82E3, 0x02E6, 0x02EC, 0x82E9, 0x02F8, 0x82FD, 0x82F7, 0x02F2,
        0x02D0, 0x82D5, 0x82DF, 0x02DA, 0x82CB, 0x02CE, 0x02C4, 0x82C1,
        0x8243, 0x0246, 0x024C, 0x8249, 0x0258, 0x825D, 0x8257, 0x0252,
        0x0270, 0x8275, 0x827F, 0x027A, 0x826B, 0x026E, 0x0264, 0x8261,
        0x0220, 0x8225, 0x822F, 0x022A, 0x823B, 0x023E, 0x0234, 0x8231,
        0x8213, 0x0216, 0x021C, 0x8219, 0x0208, 0x820D, 0x8207, 0x0202
```

```
    };

    for(j = 0; j < data_blk_size; j++)
    {
        i = ((unsigned short)(crc_accum >> 8) ^ data_blk_ptr[j]) & 0xFF;
        crc_accum = (crc_accum << 8) ^ crc_table[i];
    }

      return  crc_accum;
}
```

Instruction/Status Packet

1. Instruction Packet is command data sent from the main controller to Dynamixel.

Instruction Packet structure is illustrated below.

0xFF	0xFF	0xFD	0x00	ID	LEN_L	LEN_H	INST	Param1	…	ParamN	CRC_L	CRC_H
Header			Reserved	ID	Packet Length		Instruction	Parameter			16bit CRC	

A. Header : Field indicating start of packet

B. Reserved : 0x00 (cannot use 0xFD)

C. ID : Dynamixel ID designated for Instruction Packet processing

① Value range: 0 ~ 252 (0x00 ~ 0xFC) 253 unique values

② 253(0xFD), 255(0xFF) in Header prohibited use.

③ 254 (0xFE): Broadcast ID, ALL connected Dynamixels controlled by Instruction Packet.

D. Packet Length : Packet length after Packet Length field

① [*Instruction*] [*Parameter*] [*CRC_L*] [*CRC_H*] , Parameter length + 3.

E. Instruction: individual packet's command field

value	designation	description

0x01	Ping	corresponding device ID command to check if packet reaches
0x02	Read	Data read commnad
0x03	Write	Data write command
0x04	Reg Write	When receiving a write command packet data is not immediately written instead it goes into standby momentarily until action command arrives
0x05	Action	Go command for Reg Write
0x06	Factory Reset	All data to factory default settings
0x08	Reboot	Reboot device
0x55	Status(Return)	Instruction Packet response
0x82	Sync Read	Read data from the same location and same size for multiple devices simultaneously
0x83	Sync Write	Write data from the same location and same size for multiple devices simultaneously
0x92	Bulk Read	Read data from the different locations and different sizes for multiple devices simultaneously
0x93	Bulk Write	Write data from the different locations and different sizes for multiple devices simultaneously

F. Parameter: when auxiliary data is required. Depends on the instruction.

G. 16bit CRC : CRC-16 values to verify reliability of data.

2. Status Packet (Return Packet) basic structure

0xFF	0xFF	0xFD	0x00	ID	LEN_L	LEN_H	0x55	Error	Param1	…	ParamN	CRC_L	CRC_H
Header			Reserved	ID	Packet Length		Instruction	Error	Parameter			16bit CRC	

A. Header, Reserved, ID, Packet Length, 16bit CRC (same sequence as Instruction Packet)

B. Instruction has 0x55 (Status) fixed

C. Error : Instruction Packet error result (shown below)

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Alert	Error Number						

① Alert : When the device detects a problem it returns a 1. Check the Control Table's Device Status Check values to determine the cause.

② Error Number : Instruction Packet 's error

value	designation	description
0x01	Result Fail	Failed process of Instruction Packet

0x02	Instruction Eror	- undefined Instruction - action without Reg Write
0x03	CRC Error	Failed Packet's CRC value match
0x04	Data Range Error	Over the range value of data of corresponding address
0x05	Data Length Error	Data length shorter than required length to corresponding address (ex: 4-byte value if only 2 bytes long)
0x06	Data Limit Error	Data length longer than required length to corresponding address

D. Parameter is Instruction Packet's instruction field value.

3. Packet pre-transmission / post-processing (Header emerging pattern byte stuffing update)

A. Transmission sequence

① Generated according to Instruction Packet

② byte stuffing in 0xFF and 0xFD patterns; from length (excluding instruction) to CRC16. (if 0xFF 0xFF 0xFD show 0xFF 0xFF 0xFD 0xFD; additional 0xFD added at the end)

③ Length modified with byte stuffing

④ Byte stuffing adds the last 2 bytes to the CRC16 calculation

⑤ transmission

B. Reception sequence

① Find Header (0xFF 0xFF 0xFD). 0xFF 0xFF 0xFD 0xFD ignored.

② When Header shows, ID is verified, after getting ID or 0xFE move on to next field for data of length Length.

③ While receiving all data in 1 byte chunks to be matched with CRC16 (byte stuffing included).

④ After CRC calculation if 0xFF 0xFF 0xFD 0xFD pattern appears discard the last 0xFD; use only 0xFF 0xFF 0xFD (byte stuffing eliminated)

⑤ Last 2 bytes matched and verified with CRC.

Dynamixel Protocol 2.0 Instruction Parameter

1. Ping

A. Instruction Packet Parameter：none

B. Status Packet Parameter

Parameter Byte	Description
Parameter 0	Error Byte (please refer to the basic structure)
Parameter 1	Model number LSB
Parameter 2	Model number MSB
Parameter 3	Firmware version

C. Instruction

① Command for device presence and basic information

② Response level value. Ping returns a value regardless

③ ID field 0xFE (Broadcast ID) prevents all devices from conflicting with each other and send a Status Packet

2. Read

A. Instruction Packet Parameter

Parameter Byte	Description
Parameter 0	Read data start address LSB
Parameter 1	Read data start address MSB
Parameter 2	Read data length LSB
Parameter 3	Read data length MSB

B. Status Packet Parameter (read data length: N)

Parameter Byte	Description
Parameter 0	Error Byte (please refer to the basic structure)
Parameter 1	Read data start address 1st byte
Parameter 2	Read data start address 2nd byte
…	…
Parameter N	Read data start address Nth byte

B. Instruction

① Description for control table values

3. Write

A. Instruction Packet Parameter (Write data length: N)

Parameter Byte	Description
Parameter 0	Write data start address LSB
Parameter 1	Write data start address MSB
Parameter 2	Write data 1st byte
Parameter 3	Write data 2nd byte
…	…
Parameter N+1	Write data Nth byte

B. Status Packet Parameter : basic form

Parameter Byte	Description
Parameter 0	Error Byte (please refer to the basic structure)

C. Instruction

① Description for control table write values

4. Reg Write

A. Instruction Packet Parameter : same as Write Instruction

B. Status Packet Parameter : basic form

C. Instruction

① Write command, but different when writing in Control Table

② When Write command is sent to Instruction Packet Reg Write's received Instruction Packet gets saved to a buffer and said value is not written in control table. The control table is registered with a 1.

③ When Action Instruction Packet is received the saved buffer is then written to the control table. The control table is registered with a 0.

5. Action

A. Instruction Packet Parameter : none

B. Status Packet not sent

C. Instruction

① Command for Reg Write to perform write task

② With many devices there might be a difference between command for the first device and command for the last device.

③ When this takes place Action command via Reg Write with broadcast ID.

6. Factory Reset

A. Instruction Packet Parameter

Parameter Byte	Description
Parameter 0	OPTION : - 0xFF : reset all values - 0x01 : reset all values except ID - 0x02 : reset all values except ID and baud rate

B. Status Packet Parameter : basic form

C. Instruction : command to reset all values in control table to factory default.

7. Reboot

A. Instruction Packet Parameter : none

B. Status Packet Parameter : basic form

C. Instruction: command to restart device

8. Sync Read

A. Instruction Packet Parameter

Parameter Byte	Description
Parameter 0	Common read data start address LSB
Parameter 1	Common read data start address MSB
Parameter 2	Common read data length LSB
Parameter 3	Common read data length MSB
Parameter 4	Read value of 1st device ID
Parameter 5	Read value of 2nd device ID
…	…
Parameter N+3	Read value of Nth device ID

B. Status Packet Parameter : N number of Read Status packets

C. Instruction

① One transmitted Instruction Packet command for many connected devices with the same start address and same data length

② Packet ID field 0xFE (Broadcast ID) transmission.

9. Sync Write

A. Instruction Packet Parameter

Parameter Byte	Description
Parameter 0	Common write data start address LSB
Parameter 1	Common write data start address MSB
Parameter 2	Common write data length (L) LSB
Parameter 3	Common write data length (L) MSB
Parameter 4	Write data for ID of 1st device (ID 1)
Parameter 5	ID 1 write data 1st byte
Parameter 6	ID 1 write data 2nd byte
…	…
Parameter (L+1)+3	ID 1 write data Lth byte
Parameter (L+1)+4	Write data for ID of 2nd device (ID 2)
Parameter (L+1)+5	ID 2 write data 1st byte
Parameter (L+1)+6	ID 2 write data 2nd byte
…	…
Parameter 2(L+1)+3	ID 2 write data Lth byte
…	…

B. Status Packet not sent

C. Instruction

① Command for one transmittable instruction packet to control multiple devices. However, start address and length data must concur.

② Packet's ID field 0xFE (Broadcast ID) is for broadcast transmission.

10. Bulk Read

A. Instruction Packet Parameter

Parameter Byte	Description
Parameter 0	ID of 1st device (ID 1)
Parameter 1	ID 1 start address LSB
Parameter 2	ID 1 start address MSB
Parameter 3	ID 1 data length LSB
Parameter 4	ID 1 data length MSB

Parameter 5	ID of 2nd device (ID 2)
Parameter 6	ID 2 start address LSB
Parameter 7	ID 2 start address MSB
…	…
Parameter 5(N-1)+0	ID of Nth device (ID N)
Parameter 5(N-1)+1	ID N start address LSB
Parameter 5(N-1)+2	ID N start address MSB
Parameter 5(N-1)+3	ID N data length LSB
Parameter 5(N-1)+4	ID N data length MSB

B. Status Packet Parameter : Read status packet (N packets, from N devices)

C. Instruction

① Command for synch read for transmitted of instruction packet of multiple devices. However, each device's Bulk Read data may be of different lengths.

② Operation not possible with devices having the same ID. In other words, each ID is read once. Use indirect addressing for sparsely read.

③ Packet's ID field 0xFE (Broadcast ID) is for broadcast transmission.

④ The IDs packet get monitored in the data bus then when status packet gets transmitted back the interval is minimal between is minimal.

11. Bulk Write

A. Instruction Packet Parameter

Parameter Byte	Description
Parameter 0	ID of 1st device (ID 1)
Parameter 1	Write data start address of ID 1 LSB
Parameter 2	Write data start address of ID 1 MSB
Parameter 3	Write data length of ID 1 LSB
Parameter 4	Write data length of ID 1 MSB
Parameter 5	ID 1 write data 1st byte
Parameter 6	ID 1 write data 2nd byte
…	…
Parameter L+4	ID 1 write data Lth byte
Parameter L+5	ID of 2nd device (ID 2)
Parameter L+6	Write data start address of ID 2 LSB
…	…

B. Status Packet not sent

C. Instruction

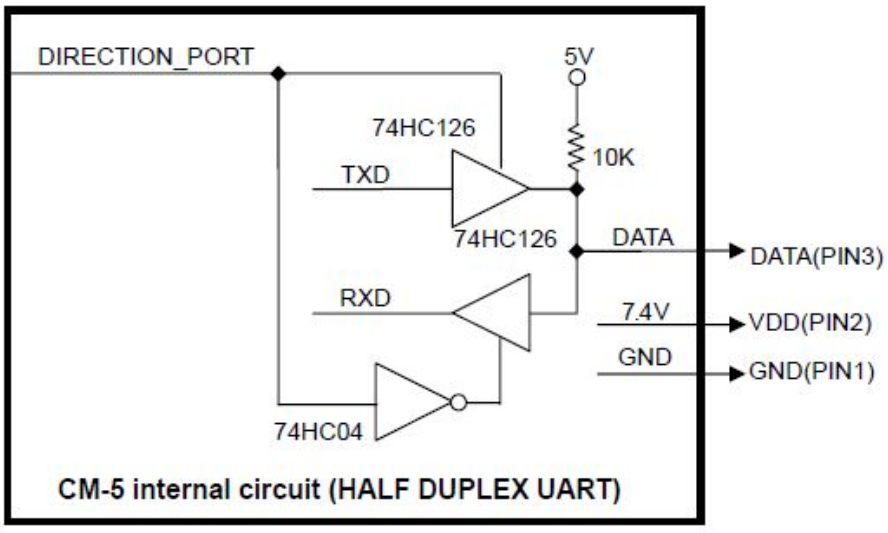
① Sync write's command for one transmittable instruction packet to control multiple devices. However, with Bulk write each device may have different addresses and data lengths.

② Operation not possible with devices having the same ID. In other words, each ID is written once. Use indirect addressing for sparsely write.

③ Packet's ID field 0xFE (Broadcast ID) is for broadcast transmission..

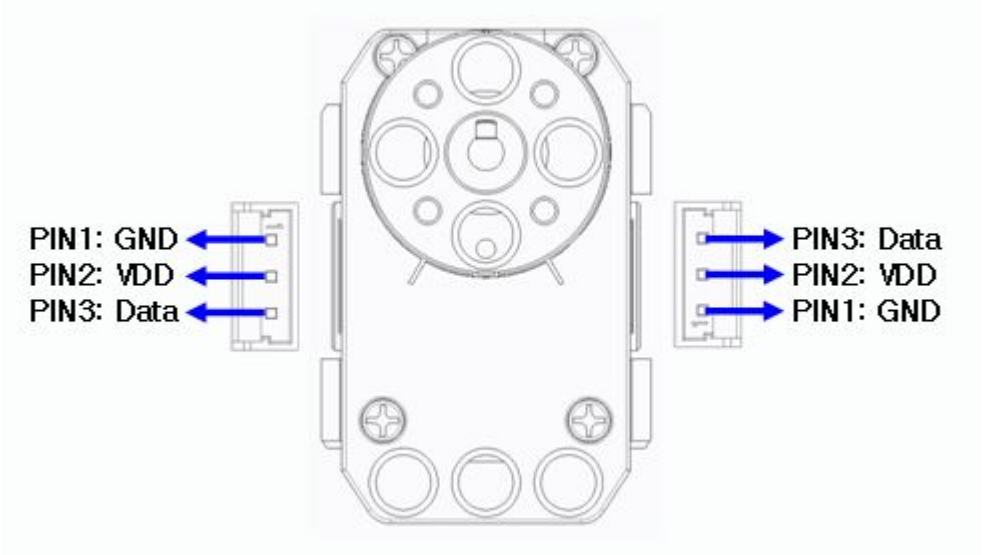
Connection to UART

To control the Dynamixel actuators, the main controller needs to convert its UART signals to the half duplex type. The recommended circuit diagram for this is shown below.



Pin Assignment

The connector pin assignments are as the following. The two connectors on the Dynamixel are connected pin to pin, thus the XL-320 can be operated with only one connector attached.



Confirmation of Connection

The LED of XL-320 flickers once if the power is supplied to XL-320 properly via wiring.