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### MX-64AR, MX-64AT

**NOTE** : Compliance has been replaced with PID Gains.

**NOTE** : Although the MX-64AT (TTL) and MX-64AR (RS-485) differ in communications protocols both have the same features and perform equally. (TTL uses 3-pin connectors while RS-485 uses 4)

**NOTE** : In order to use Protocol 2.0, please update the firmware to V39 or above. ([Update firmware](#) using R+ Manager 2.0)



**WARNING** : For MX-64(2.0) Protocol, please refer to the [MX-64\(2.0\) Control Table](#) as they are different.

## 1. Specifications

Item	Specifications
MCU	ST CORTEX-M3 (STM32F103C8 @ 72 [Mhz], 32Bit)
Position Sensor	Contactless absolute encoder (12Bit, 360 [°]) Maker : ams(www.ams.com), Part No : AS5045
Motor	Coreless(Maxon)
Baud Rate	8,000 [bps] ~ 4.5 [Mbps]
Control Algorithm	PID control

Resolution	4096 [pulse/rev]
Backlash	20 [arcmin] (0.33 [°])
Operating Mode	Joint Mode (0 ~ 360 [°]) Wheel Mode (Endless Turn)
Weight	165 [g]
Dimensions (W x H x D)	40.2 x 61.1 x 41 [mm]
Gear Ratio	200 : 1
Stall Torque	5.5 [Nm] @ 11.1 [V], 3.9 [A] 6.0 [Nm] @ 12 [V], 4.1 [A] 7.3 [Nm] @ 14.8 [V], 5.2 [A]
No Load Speed	58 [rev/min] @ 11.1 [V] 63 [rev/min] @ 12 [V] 78 [rev/min] @ 14.8 [V]
Radial Load	① 40 [N] (10 [mm] away from the horn)
Axial Load	① 20 [N]
Operating Temperature	-5 ~ +80 [°C]
Input Voltage	10.0 ~ 14.8 [V] ( <b>Recommended : 12.0 [V]</b> )
Command Signal	Digital Packet
Protocol Type	TTL Half Duplex Asynchronous Serial Communication with 8bit, 1stop, No Parity RS485 Asynchronous Serial Communication with 8bit, 1stop, No Parity
Physical Connection	RS485 / TTL Multidrop Bus
ID	254 ID (0 ~ 253)
Feedback	Position, Temperature, Load, Input Voltage, etc
Material	Full Metal Gear Metal (Front, Middle), Engineering Plastic (Back)
Standby Current	100 [mA]

① Applies to aluminum housing products(MX-28AR/AT, MX-64AR/AT, MX-106R/T).



#### **DANGER**

(May cause serious injury or death)

- Never place items containing water, flammables, and solvents near product.
- Never place fingers, arms, toes, and other body parts near product during operation.
- Cut power off if product emits strange odors or smoke.
- Keep product out of reach of children.
- Check the power polarity before wiring.



#### **CAUTION**

(May cause injury or damage to product)

- Do not operate the product at a temperature exceeding -5 ~ +80 [°C] range.
- Do not insert sharp blades nor pins during product operation.



### ATTENTION

(May cause injury or damage to product)

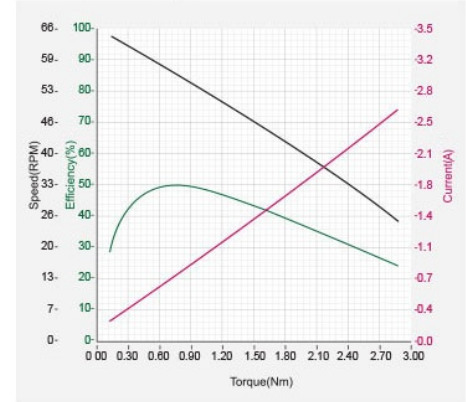
- Do not disassemble or modify product.
- Do not drop or apply strong shock to product.

## 1. 1. Performance Graph

### Data

	Unit	Data
Weight	g	135
Dimension	mm	40.2 x 61.1 x 41
Gear Ratio	type/material	200:1 (Spur/Metal)
Network	-	TTL / RS-485
Position Sensor (resolution)	-	Contactless Absolute Encoder (360°/ 4096)
Motor	-	Maxon Motor
Operation Voltage	V	10~14.8
Stall Torque	N.m	6.0 at 12V
Stall Current	A	4.1 at 12V
No Load Speed	RPM	63 at 12V

### Performance Graph



**Stall torque** Peak stall torque read from transient state

**Performance Graph(N-T Curve)** A graph shows torque measured in stable condition while increasing load. **Normally, stall torque is bigger than maximum torque on performance graph.**

**CAUTION** : When connecting to power supply:

- For the stable power supply, we recommend using ROBOTIS controller or SMPS2Dynamixel.
- Connect your DYNAMIXEL to power supply while it's off and turn on/off with the power switch.

## 2. Control Table

The Control Table is a structure of data implemented in the DYNAMIXEL. Users can read a specific Data to get status of the DYNAMIXEL with Read Instruction Packets, and modify Data as well to control DYNAMIXEL with WRITE Instruction Packets.

### 2. 1. Control Table, Data, Address

The Control Table is a structure that consists of multiple Data fields to store status of the DYNAMIXEL or to control the DYNAMIXEL. Users can check current status of the DYNAMIXEL by reading a specific Data from the Control Table with Read Instruction Packets. WRITE Instruction Packets enable users to control the DYNAMIXEL by changing specific Data in the Control Table. The Address is a unique value when accessing a specific Data in the Control Table with Instruction Packets. In order to read or write data, users must designate a specific Address in the Instruction Packet. Please refer to [Protocol 1.0](#) for more details about Instruction Packets.

**NOTE** : Two's complement is applied for the negative value. For more information, please refer to [Two's complement](#) from Wikipedia.

### 2. 1. 1. Area (EEPROM, RAM)

The Control Table is divided into 2 Areas. Data in the RAM Area is reset to initial values when the DYNAMIXEL is turned on (Volatile). On the other hand, modified data in the EEPROM Area keeps their values even when the DYNAMIXEL is turned off (Non-Volatile). Data in the EEPROM Area can only be changed or modified when the value of Torque Enable(24) is '0' and Dynamixel is in idle state.

### 2. 1. 2. Size

The Size of data is 1 or 2 bytes depend on their usage. Please check the size of data when updating the data with an Instruction Packet. 2 bytes data will be saved according to [Little Endian](#).

### 2. 1. 3. Access

The Control Table has two different access properties. 'RW' property stands for read and write access permission while 'R' stands for read only access permission. Data with the read only property cannot be changed by the WRITE Instruction. Read only property('R') is generally used for measuring and monitoring purpose, and read write property('RW') is used for controlling DYNAMIXEL.

### 2. 1. 4. Initial Value

Each data in the Control Table is restored to initial values when the DYNAMIXEL is turned on. Default values in the EEPROM area are initial values of the DYNAMIXEL (factory default settings). If any values in the EEPROM area are modified by a user, modified values will be restored as initial values when the DYNAMIXEL is turned on. Initial Values in the RAM area are restored when the DYNAMIXEL is turned on.

## 2. 2. Control Table of EEPROM Area

Address	Size (Byte)	Data Name	Description	Access	Initial Value
0	2	<a href="#">Model Number</a>	Model Number	R	310
2	1	<a href="#">Firmware Version</a>	Firmware Version	R	-
3	1	<a href="#">ID</a>	DYNAMIXEL ID	RW	1
4	1	<a href="#">Baud Rate</a>	Communication Speed	RW	34
5	1	<a href="#">Return Delay Time</a>	Response Delay Time	RW	250
6	2	<a href="#">CW Angle Limit</a>	Clockwise Angle Limit	RW	0
8	2	<a href="#">CCW Angle Limit</a>	Counter-Clockwise Angle Limit	RW	4,095
11	1	<a href="#">Temperature Limit</a>	Maximum Internal Temperature Limit	RW	80
12	1	<a href="#">Min Voltage Limit</a>	Minimum Input Voltage Limit	RW	60
13	1	<a href="#">Max Voltage Limit</a>	Maximum Input Voltage Limit	RW	240
14	2	<a href="#">Max Torque</a>	Maximun Torque	RW	1023
16	1	<a href="#">Status Return Level</a>	Select Types of Status Return	RW	2
17	1	<a href="#">Alarm LED</a>	LED for Alarm	RW	36
18	1	<a href="#">Shutdown</a>	Shutdown Error Information	RW	36

20	2	Multi Turn Offset	Adjust Position with Offset	RW	0
22	1	Resolution Divider	Divider for Position Resolution	RW	1

## 2. 3. Control Table of RAM Area

Address	Size (Byte)	Data Name	Description	Access	Initial Value
24	1	Torque Enable	Motor Torque On/Off	RW	0
25	1	LED	Status LED On/Off	RW	0
26	1	D Gain	Derivative Gain	RW	0
27	1	I Gain	Integral Gain	RW	0
28	1	P Gain	Proportional Gain	RW	32
30	2	Goal Position	Desired Position	RW	-
32	2	Moving Speed	Moving Speed(Moving Velocity)	RW	-
34	2	Torque Limit	Torque Limit(Goal Torque)	RW	ADD 14&15
36	2	Present Position	Present Position	R	-
38	2	Present Speed	Present Speed	R	-
40	2	Present Load	Present Load	R	-
42	1	Present Voltage	Present Voltage	R	-
43	1	Present Temperature	Present Temperature	R	-
44	1	Registered	If Instruction is registered	R	0
46	1	Moving	Movement Status	R	0
47	1	Lock	Locking EEPROM	RW	0
48	2	Punch	Minimum Current Threshold	RW	0
50	2	Realtime Tick	Count Time in millisecond	R	0
68	2	Current	Consuming Current	RW	0
70	1	Torque Ctrl Mode Enable	Torque Control Mode On/Off	RW	0
71	2	Goal Torque	Goal Torque	RW	0
73	1	Goal Acceleration	Goal Acceleration	RW	0

## 2. 4. Control Table Description

### 2. 4. 1. Model Number (0)

This address stores model number of the DYNAMIXEL.

### 2. 4. 2. Firmware Version (2)

This address stores firmware version of the DYNAMIXEL.

### 2. 4. 3. ID (3)

The ID is a unique value in the network to identify each DYNAMIXEL with an Instruction Packet. 0~252 (0xFC) values can be used as an ID, and 254(0xFE) is occupied as a broadcast ID. The Broadcast ID(254, 0xFE) can send an Instruction Packet to all connected DYNAMIXELs simultaneously.

**NOTE** : Please avoid using an identical ID for multiple DYNAMIXELS. You may face communication failure or may not be able to detect Dynamixel with an identical ID.

#### 2. 4. 4. Baud Rate (4)

Baud Rate determines serial communication speed between a controller and DYNAMIXELS.

Value	Baud Rate(bps)	Margin of Error
1	1M	0.000%
3	500,000	0.000%
4	400,000	0.000%
7	250,000	0.000%
9	200,000	0.000%
16	115200	-2.124%
34(Default)	57600	0.794%
103	19200	-0.160%
207	9600	-0.160%

**NOTE** : Less than 3% of the baud rate error margin will not affect to UART communication.

For BPS over 250 values :

Value	Baud Rate	Margin of Error
250	2,250,000	0.000%
251	2,500,000	0.000%
252	3,000,000	0.000%

#### 2. 4. 5. Return Delay Time (5)

After the DYNAMIXEL receives an Instruction Packet, it delays transmitting the Status Packet for Return Delay Time (9). For instance, if the Return Delay Time(9) is set to '10', the Status Packet will be returned after 20[μsec] when the Instruction Packet is received.

Unit	Value Range	Description
2[μsec]	0 ~ 254	Default value '250'(500[μsec]), Maximum 508[μsec]

#### 2. 4. 6. CW/CCW Angle Limit(6, 8)

The angle limit allows the motion to be restrained. The range and the unit of the value is the same as Goal Position(Address 30, 31).

- CW Angle Limit: the minimum value of Goal Position(Address 30, 31)
- CCW Angle Limit: the maximum value of Goal Position(Address 30, 31) The following three modes can be set pursuant to the value of CW and CCW.

Operation Type	CW / CCW
Wheel Mode	both are 0
Joint Mode	neither are 0
Multi-turn Mode	both are 4095

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. Multi-turn mode allows joint mode control over multiple rotations (Position range : -28,672 ~ 28,672)

#### 2. 4. 7. Temperature Limit (11)

Unit	Value Range
About 1°C	0 ~ 100

**CAUTION** : Do not set the temperature higher than the default value. When the temperature alarm shutdown occurs, wait 20 minutes to cool the temperature before re-use. Keep using the product when the temperature is high can cause severe damage.

#### 2. 4. 8. Min/Max Voltage Limit (12, 13)

It is the operation range of voltage.

Unit	Value Range	Description
About 0.1V	50 ~ 160	5.0 ~ 16.0V

For example, if the value is 80, the voltage is 8V. If [Present Voltage\(42\)](#) 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.

#### 2. 4. 9. Max Torque (14)

It is the torque value of maximum output. 0 to 1,023 (0x3FF) can be used, and the unit is about 0.1%.

For example, Data 1,023 (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 (Address 34 and 35) uses the value as the initial value.

#### 2. 4. 10. Status Return Level (16)

This value decides how to return Status Packet when Dynamixel receives an Instruction Packet.

Value	Responding Instructions	Description
0	PING Instruction	Status Packet will not be returned for all Instructions
1	PING Instruction READ Instruction	Status Packet will be returned only for READ Instruction
2	All Instructions	Status Packet will be returned for all Instructions

**NOTE** : If the ID of Instruction Packet is set to Broad Cast ID(0xFE), Status Packet will not be returned for READ and WRITE Instructions regardless of Status Return Level. For more details, please refer to the [Status Packet](#) section for [Protocol 1.0](#) or [Protocol 2.0](#).

#### 2. 4. 11. Alarm LED(17), Shutdown(18)

Dynamixel can protect itself by detecting errors occur during the operation. The errors can be set are as the table below.

Bit	Item	Description
Bit 7	0	-

Bit 6	Instruction Error	When undefined Instruction is transmitted or the Action command is delivered without the reg_write command
Bit 5	Overload Error	When the current load cannot be controlled with the set maximum torque
Bit 4	Checksum Error	When the Checksum of the transmitted Instruction Packet is invalid
Bit 3	Range Error	When the command is given beyond the range of usage
Bit 2	OverHeating Error	When the internal temperature is out of the range of operating temperature set in the Control Table
Bit 1	Angle Limit Error	When Goal Position is written with the value that is not between CW Angle Limit and CCW Angle Limit
Bit 0	Input Voltage Error	When the applied voltage is out of the range of operating voltage set in the Control Table

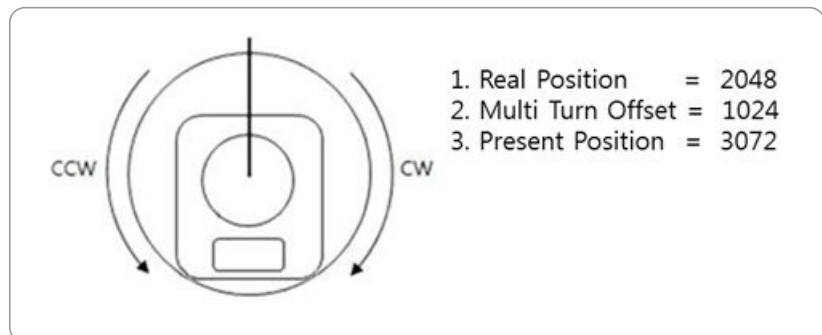
It is possible to make duplicate set since the function of each bit is run by the logic of 'OR'. That is, if 0x05 (binary 00000101) is set, both Input Voltage Error and Overheating Error can be detected. If errors occur, in case of Alarm LED, the LED blinks; in case of Alarm Shutdown, the motor output becomes 0 % by resetting the value of Torque Limit(34) to 0.

#### 2. 4. 12. Multi Turn Offset (20)

Adjusts offset position. This offset value is added to the Present Position(36).

Initial value is 0 and the range is from -24,576 to 24,576.

Dynamixel with a Present position of 2,048 with an offset of 1,024 will return an adjusted Present position of 3,072.



**NOTE** : This offset feature is only available in multi-turn mode.

#### 2. 4. 13. Resolution Divider (22)

It allows the user to change Dynamixel's resolution.

The default Resolution Divider Value is set as 1. (1 ~ 4 available)

When resolution is lowered, revolutions (in both directions) can be increased (up to 28 turns in each direction).

$$\text{Present Position} = \text{Real Position} / \text{Resolution Divider}$$

For example, a Real Position of 2048 with a Resolution Divider set as 2 will yield a Present Position value of 1024 ( $2048/2 = 1024$ ).

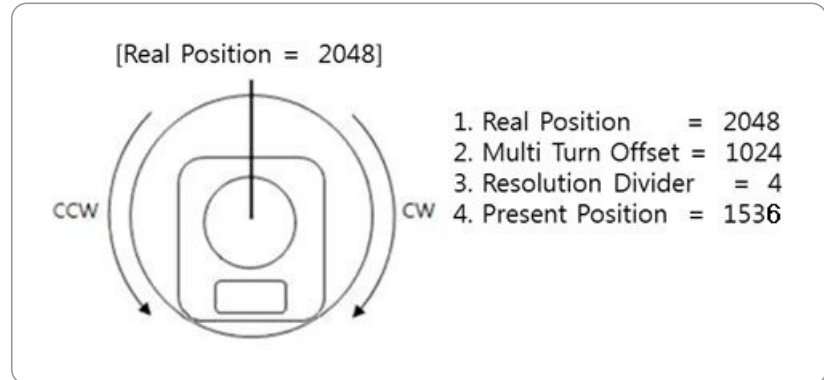
A Dynamixel with Resolution Divider set as 2 will have a resolution 2048 for a single revolution.

The Present Position can be obtained while Multi-turn Offset and Resolution Divider are taken into account.

$$\text{Present position} = (\text{Real Position} / \text{Resolution Divider}) + \text{Multi-turn 0}$$



For example, a Dynamixel with a Real Position of 2048 with a Resolution Divider set as 4 and Multi-turn Offset as 1024 will yield a Present Position of 1535 ( $(2048/4) + 1024 = 1535$ ).



**NOTE** : This feature is only applied in multi-turn mode and will be ignored in other modes.

#### 2. 4. 14. Torque Enable (24)

Value	Description
0	Turn off the torque(Free run state)
1	Turn on the torque and lock EEPROM area

#### 2. 4. 15. LED (25)

Turn on or turn off the LED on Dynamixel.

Bit	Description
0(Default)	Turn OFF the LED
1	Turn ON the LED

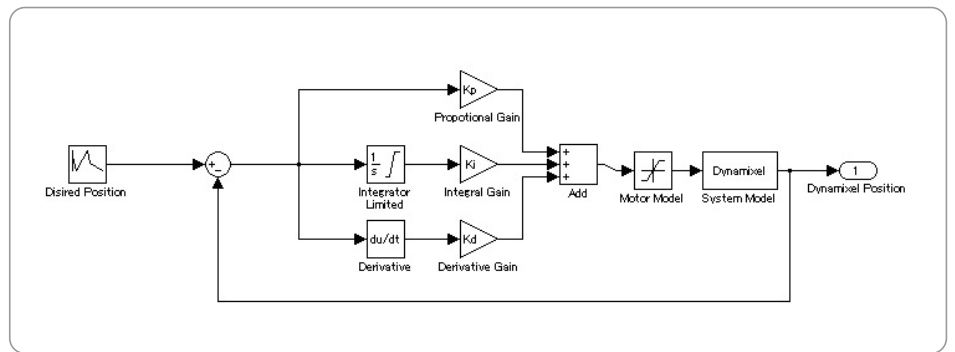
**NOTE** : The LED indicates present status of the device.

Status	LED Representation
Booting	LED flickers once
Factory Reset	LED flickers 4 times
Alarm	LED flickers
Slave Mode(MX-106)	LED flickers 3 times
Boot Mode	LED On

#### 2. 4. 16. PID Gains (26, 27, 28)

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

- **P gain** : value of proportional band.
- **I gain** : value of integral action.
- **D Gain** : value of derivative action. Gains values are in between 0 ~ 254.



- $K_p$  : P Gain / 8
- $K_i$  : I Gain \* 1,000 / 2,048
- $K_d$  : D Gain \* 4 / 1,000

### The relationship between Compliance Slop 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 margin 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](http://en.wikipedia.org/wiki/PID_controller)

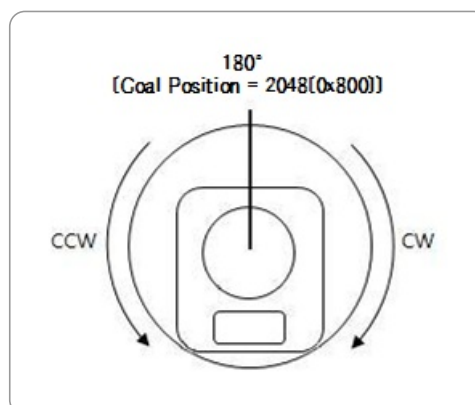
FYI, PID control theory is not only limited to the control of motor(actuator) but is a generic theory that can be applied to all kinds of control.

### 2. 4. 17. Goal Position (30)

It is a position value of destination.

0 to 4,095 (0xFFFF) is available. The unit is 0.088 [°].

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 the front view of Dynamixel*

In multi-turn mode Dynamixel has a range from -28,672 to 28,672 (can turn up to 7 revolutions in either CW or CCW direction).

When resolution divider is set to a different value revolutions can increase.

**NOTE** : If it is set to Wheel Mode, Goal Position value is not used.

#### 2. 4. 18. Moving Speed (32)

- Join Mode, Multi-Turn mode It is a moving speed to Goal Position. 0~1023 (0X3FF) can be used, and the unit is about 0.114rpm. 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 116.62rpm. For example, if it is set to 300, it is about 34.2 rpm. However, the rpm will not exceed the No Load Speed.
- Wheel Mode It is a moving speed to Goal direction. 0~2047 (0X7FF) can be used, and the unit is about 0.114rpm. 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.

**NOTE** : Wheel mode allows to check max rpm. Any values higher than max rpm will not take effect.

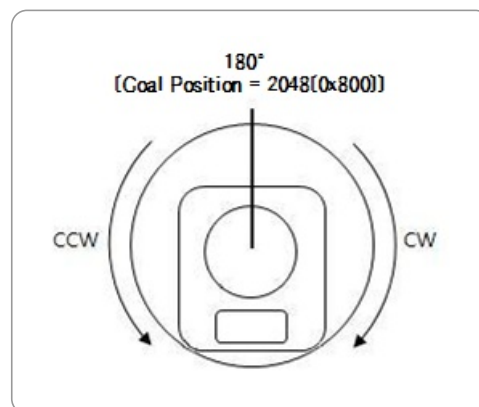
#### 2. 4. 19. Torque Limit (34)

It is the value of the maximum torque limit. 0 ~ 1,023(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.

**NOTE** : If the function of Alarm Shutdown is triggered, the motor loses its torque because the value becomes 0. Once error conditions are resolved and this value is changed to the value other than 0, the motor can be operated again.

#### 2. 4. 20. Present Position (36)

It is the present position value of Dynamixel. The range of the value is 0~4095 (0xFFFF), and the unit is 0.088 [°].



*The picture above is the front view of Dynamixel.*

In multi-turn mode, the range is from -28,672 to 28,672 with unit values dependent on Resolution Divider (0.088 \* Resolution Divider)

**NOTE** : In multi-turn mode, Present position depends on resolution divider and

#### 2. 4. 21. Present Speed (38)

Is the current moving speed.

0 ~ 2,047 (0x000 ~ 0x7FF) can be used.

If a value is in the range of 0 ~ 1,023 then the motor rotates to the CCW direction.

If a value is in the range of 1,024 ~ 2,047 then the motor rotates to the CW direction.

The 10th bit becomes the direction bit to control the direction; 0 and 1,024 are equal.

The value unit is about 0.11rpm.

For example, if it is set to 300 then the motor is moving to the CCW direction at a rate of about 34.33rpm.

#### 2. 4. 22. Present Load (40)

It means currently applied load. The range of the value is 0~2047, and the unit is about 0.1%. If the value is 0~1,023, it means the load works to the CCW direction. If the value is 1,024~2,047, it means the load works to the CW direction. That is, the 10th bit becomes the direction bit to control the direction, and 1,024 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 ~ 0
Value	0	Load Direction	Data (Load Ratio)

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

**NOTE** : Present load is an inferred value based on the internal output value; not a measured value using torque sensor, etc. Therefore, it may be inaccurate for measuring weight or torque. It is recommended to use it for predicting the direction and size of the force being applied to the joint.

#### 2. 4. 23. Present Voltage (42)

It is the size of the present voltage supplied. This value is 10 times larger than the actual voltage. For example, when 10V is supplied, the data value is 100 (0x64) If Present Voltage(42) value is out of range, Voltage Range Error Bit (Bit0) of Status Packet is returned as '1' and Alarm is triggered and set the address 17 and set 1 to the Bit 0 of the address 18.

#### 2. 4. 24. Present Temperature (43)

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°C.

#### 2. 4. 25. Registered Instruction (44)

Value	Description
0	REG_WRITE instruction is not received
1	REG_WRITE instruction is received

**NOTE** : If ACTION instruction is executed, the value will be changed to 0.

#### 2. 4. 26. Moving (46)

Value	Description
0	Goal position command execution is completed
1	Goal position command execution is in progress

#### 2. 4. 27. Lock (47)

Value	Description
0	EEPROM area can be modified
1	EEPROM area cannot be modified

**CAUTION** : If Lock is set to 1, the power must be turned off and then turned on again to change into 0.

#### 2. 4. 28. Punch (48)

Minimum current to drive motor. This value ranges from 0x20 to 0x3FF.

#### 2. 4. 29. Realtime-Tick (50)

This value indicates Dynamixel's time.

Unit	Value Range	Description
1 ms	0 ~ 32,767	The value resets to '0' when it exceeds 32,767

**NOTE** : This feature is available from Firmware v40.

#### 2. 4. 30. Current (68)

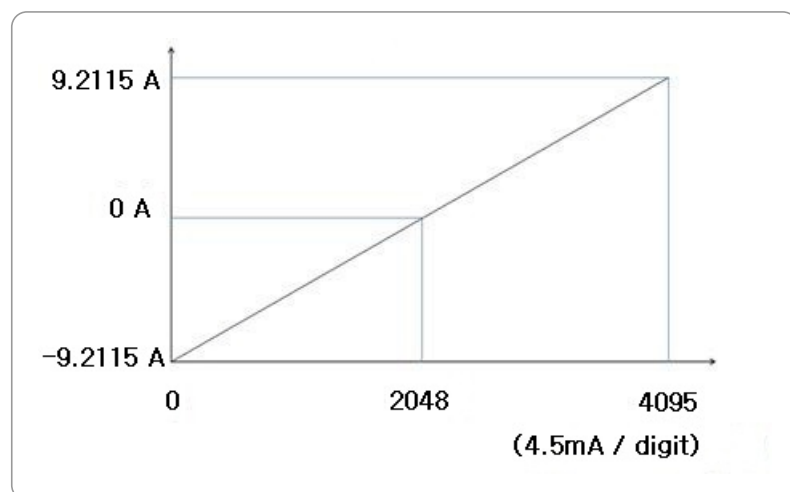
At an idle state without current flow, this value is 2,048(0x800).

When positive current flows, this value becomes larger than 2,048(0x800) while negative current flow returns a value smaller than 2,048(0x800).

The following is current flow calculation formula.

$$I = ( 4.5\text{mA} ) * ( \text{CURRENT} - 2048 ) \text{ in amps unit (A)}$$

For example, 68 gives a value of 2148, which corresponds to 450mA of current flow.



#### 2. 4. 31. Torque Control Mode Enable (70)

Value	Meaning
0	Turn off the torque mode. Executes Joint mode or Wheel mode
1	Turn on the torque mode. Cannot control the position or moving speed but

When Torque Control Mode Enable is 1, DYNAMIXEL behaves like the followings

- DYNAMIXEL does not control position or velocity.
- DYNAMIXEL is controlled by the Goal Torque value.
- DYNAMIXEL does not affected by the Goal position and Goal speed values.
- Since position/moving speed is not controlled, DYNAMIXEL behaves as if it is in the wheel mode.

#### 2. 4. 32. Goal Torque (71)

You can use 0 ~ 2,047 (0x7FF) and the unit is 4.5mA (Torque is directly proportional to the current value).

If you use a value between 0 ~ 1,023, torque is applied to the CCW direction, and setting it to 0 will stops.

If you use a value between 1,024 ~ 2,047, torque is applied to the CW direction, and setting it to 1,024 will stops.

That means, 10th bit becomes the CW/CCW direction bit, which controls rotational direction.

Goal Torque cannot be bigger than Torque Limit(34,35).

#### 2. 4. 33. Goal Acceleration (73)

This is Goal Acceleration value.

It can be used from 0~254(0xFE) and the unit is approximately 8.583 [ $^{\circ}$  / sec<sup>2</sup>].

When it is set to 0, there is no control over acceleration and moves with the maximum acceleration of the motor.

When it is set to 254, it becomes 2,180 [ $^{\circ}$  / sec<sup>2</sup>].

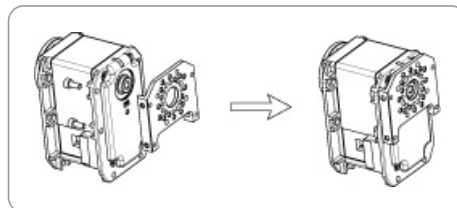
For example, the present speed of Dynamixel is 0, and Goal Acceleration is 10.

The speed of Dynamixel after 1 second will be 14.3 [RPM].

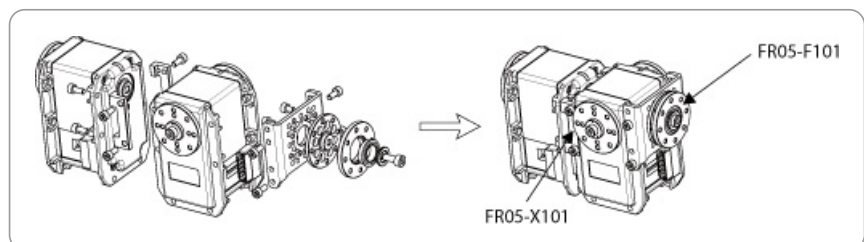
### 3. How to Assemble

#### 3. 1. Optional Frames

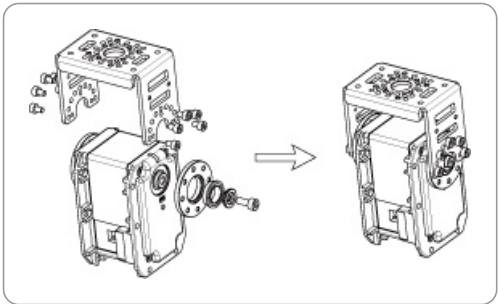
- FR05-B101



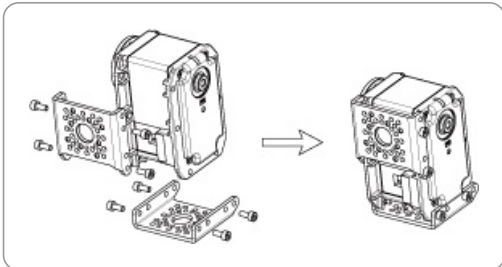
- FR05-F101 and FR05-X101



- FR05-H101



- FR05-S101

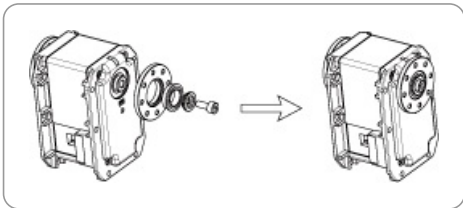


### 3. 2. Horns

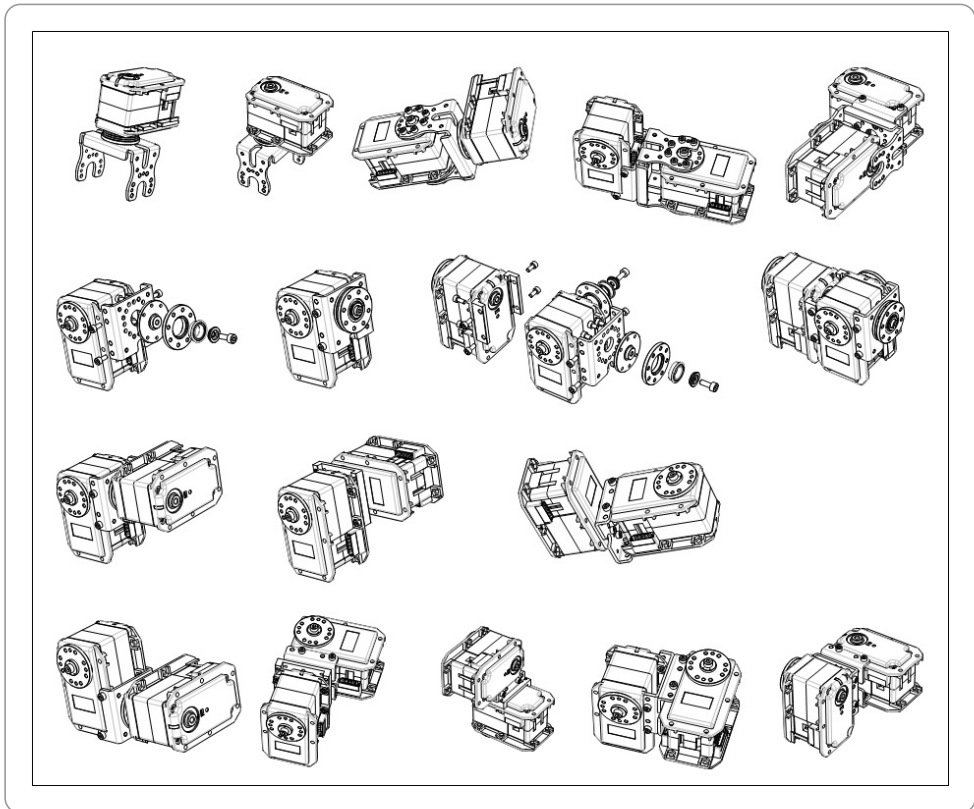
- HN05-I102



- HN05-N101



### 3. 3. Combination Structures



## 4. Maintenance

### 4. 1. Horn and Bearing Replacement

The horn is installed on the front wheel gear serration of the DYNAMIXEL whereas the bearing set is installed on the back.



#### 4. 1. 1. Installing the Horn

Place the thrust horn washer into the actuator before inserting the horn. You must carefully align the horn to the wheel gear serration by aligning dots.



Once alignment is properly done, gently push the center of the horn toward the actuator. Make sure that the horn washer is in place as you tighten the bolt.

#### 4. 1. 2. Installing the Bearing Set

You may need to remove the bearing set from the previous actuator and reinstall it into the new actuator. The bearing set can also be purchased separately. As bearing set is rotating freely, therefore alignment is not required when assembling to DYNAMIXEL.

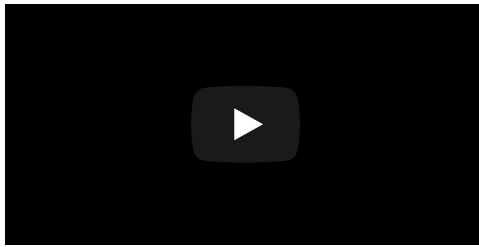


## 5. Reference

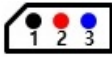
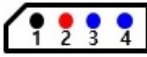




**NOTE :** [Compatibility Guide](#)



## 5. 1. Videos



## 5. 2. Connector Information

Item	TTL	RS-485
Pinout	<ul style="list-style-type: none"><li>1 GND</li><li>2 VDD</li><li>3 DATA</li></ul>	<ul style="list-style-type: none"><li>1 GND</li><li>2 VDD</li><li>3 DATA+</li><li>4 DATA-</li></ul>
Diagram		
Housing	 <a href="#">MOLEX 50-37-5033</a>	 <a href="#">MOLEX 50-37-5043</a>
PCB Header	 <a href="#">MOLEX 22-03-5035</a>	 <a href="#">MOLEX 22-03-5045</a>
Crimp Terminal	<a href="#">MOLEX 08-70-1039</a>	<a href="#">MOLEX 08-70-1039</a>
Wire Gauge	21 AWG	21 AWG

**WARNING: Check the pinout!** The pinout of Dynamixel can differ from the pinout of connector manufacturer.

## 5. 3. Drawings

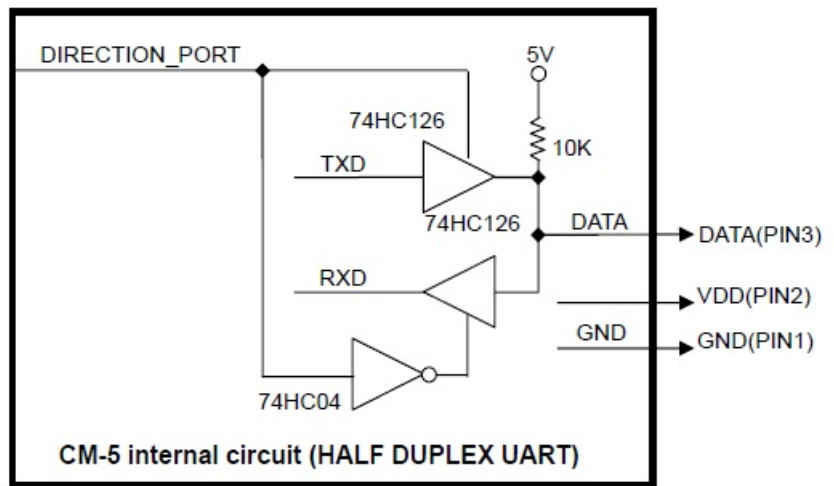
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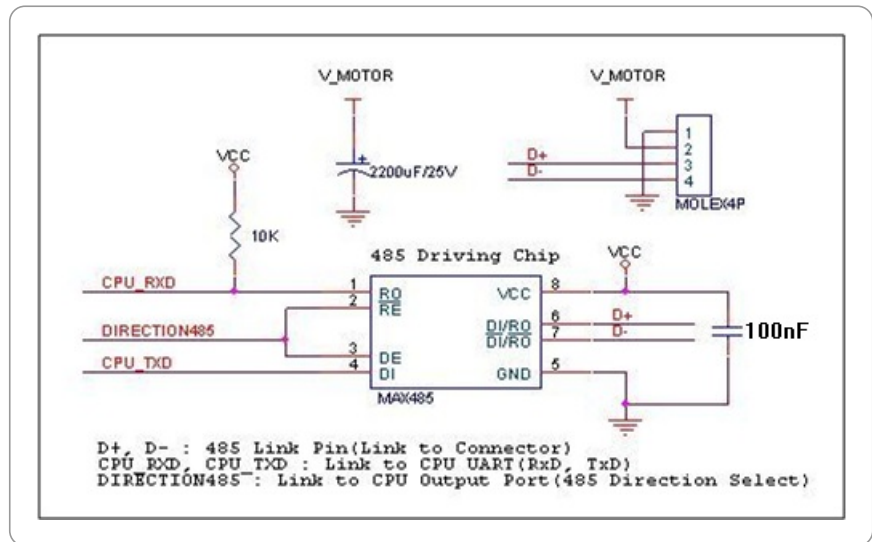
## 5. 4. Communication Circuit

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.

### 5. 4. 1. TTL Communication



#### 5. 4. 2. RS-485 Communication



The power of Dynamixel is supplied via Pin1(-), Pin2(+).

(The above circuit is built into Dynamixel-only controller.)

In the above circuit diagram, the direction of data signal of TxD and RxD in the TTL Level is determined according to the level of DIRECTION 485 as follows:

In case of DIRECTION485 Level = High: The signal of TxD is output to D+ and D-

In case of DIRECTION485 Level = Low: The signal of D+ and D- is output to RxD

**WARNING: Check the pinout!** The pinout of Dynamixel can differ from the pinout of connector manufacturer.