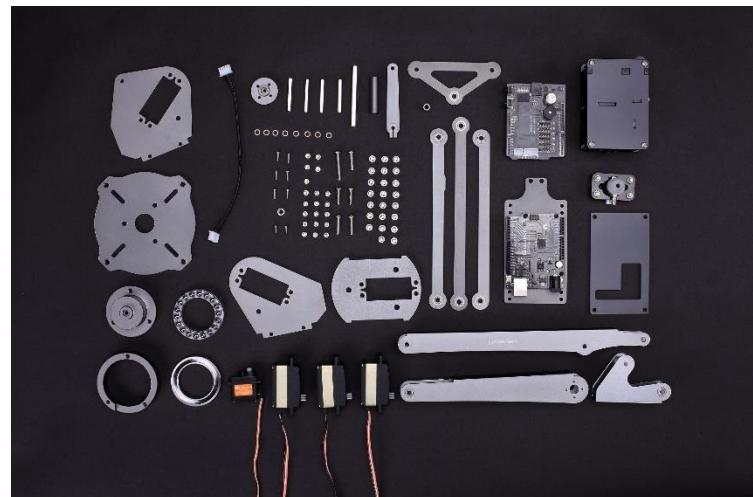




uArm Metal Developer Guide

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UFACTORY

UFACTORY TECHNOLOGY CO., LTD | NANSHAN DISTRICT, SHENZHEN, P. R. CHINA
WWW.UFACTORY.CC

Contents

• Introduction	2
• Software.....	3
• Software Installation	3
• Communication Protocol	5
• Calibration	5
• Hardware	6
uArm Metal Body	6
• Basic Information of uArm Metal Body.....	6
• uArm metal Specifications	10
• Board-Arduino.....	11
• Board Reference.....	11
• Pinout.....	12
• Control Board Diagram	12
• Board Specification	12
• Servo.....	14
• Basic Information of Servo	14
• Servo Specification	16
• The definition of port for uArm Metal servo	17
• Control	18
• Vacuum Pump	19
• Reference	20
• Protection.....	20



Introduction

Maybe now you are a
Software Engineer
Mechanism Engineer
Electronic Engineer ;

Maybe now you are studying the
Artificial Intelligence
the Computer Science the
Machine Learning ;

Maybe now you are A
Scientist
An Artist ;

Anyway, if you are reading this Guide-

You are a developer who has interest in ROBOTICS!

We are here to help you build your creative, fun, smart robot ideas come true with uArm! MAKERS COME
FROM ALL JACKS OF LIFE, SO DO UARM MASTERS!

Software

Software Installation

UFACTORY provide a link for you that you can download all documents about uArm Metal:

<https://drive.google.com/open?id=0B-L-tCvknXU9bUpPbEp5Ry1SYXM>

1. Basic Software Installation

Please refer to [Getting Started Guide](#).

2. Developer Software Installation

Windows

As Python is not defaulted inside of Windows, if you want to use these developing tools, please [DOWNLOAD and INSTALL Python](#) first.

Next, please install [pip](#). We recommend [pip-for-windows](#).

Now you can install uArm' tool kit by sending the command - `pip install pyuarm`.

Mac

What you need:

`Pip -avrduude`

Strongly recommend to use this, because it is a really very convenient tool that you type only one install command:

This command will help you with the installation and very efficient:)

```
bash -c "$(curl -fsSLhttp://download.ufactory.cc/tools/macosx/install.sh)"
```

If you would like to install by yourself, you can do so:

First, install pip - `sudo easy_install pip`

Next, install pyuarm - `pip install pyuarm`

If you need to upgrade the firmware, you need to install avrdude
-refer to Homebrew, a quick and easy way to make it.

Completing homebrew, you can start `brew install avrdude`.

Linux

What you need:

`pip -avrduude`

You can use the *installation tool* in the released version of Linux, for example, in the *debain*, you can just use:

```
sudo apt-get install python-pip python-dev build-essentialavrduude
```

After installation, you can use: - `pip install pyuarm` installation tools.

Source Code and API Documentation

arduino IDE: <https://www.arduino.cc/en/Main/Software>

PLEASE DO NOT download your Arduino IDE from https://www.arduino.org , because you may not be able to use that. We recommend Arduino IDE V1.6.12 or later.

arduino API: <http://uarm-developer.github.io/UArmForArduino/index.html>

Python API: <http://pyuarm.readthedocs.io/en/latest/>

Pyuarm API: <https://pypi.python.org/pypi/pyuarm>

uArm protocol: <https://github.com/uArm-Developer/UArmForArduino/blob/master/PROTOCOL.md>

Arduino UNO board intro: <https://www.arduino.cc/en/Main/ArduinoBoardUno?setlang=cn>

uArm Metal 3D document: <https://grabcad.com/library/uarm-metal-1>

Communication Protocol

uArm Metal's Communication Protocol

We write uArm's Communication Protocol in order to help you program with your preferred languages at PC.

Once you send the command (via uArm Protocol), it will automatically analyze it and act as related. If you would like to write your own uArm protocol for communication, please refer to our [communication Protocol on github](#).

Calibration

Why calibration?

The analog data ADC adopted is not accurate, what's more, the inaccuracy of analog data is different from each other, so we need to conduct the liner calibration once.

How to calibrate by yourself?

It was calibrated before sale.

1. Please DON'T calibrate it if not necessary. All uArms were calibrated by us before sale. Frequent calibration will cause damage to the uArm.
2. If you have to calibrate, Please use **uarmAssistant** , function **Re-calibration**.
3. uarmAssistant is limited to the purchase of uArm users before April 2016, **after April 2016, the user does not have calibration problems, DO NOT DO THIS STEP.**

Hardware

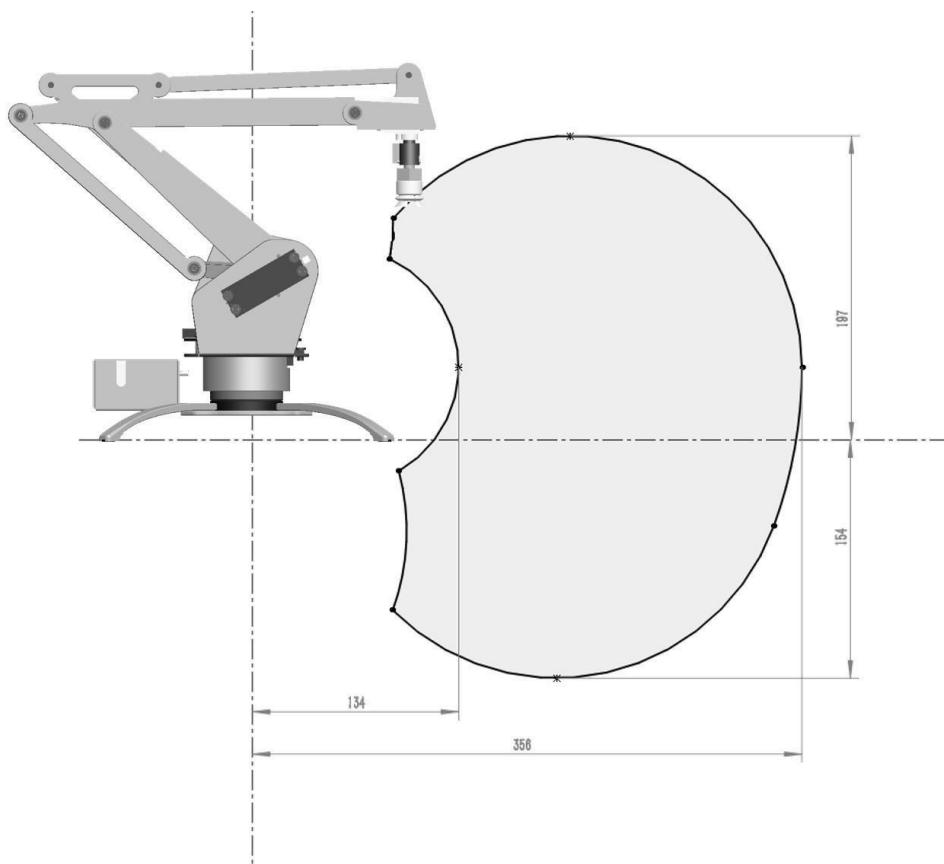
uArm Metal Body

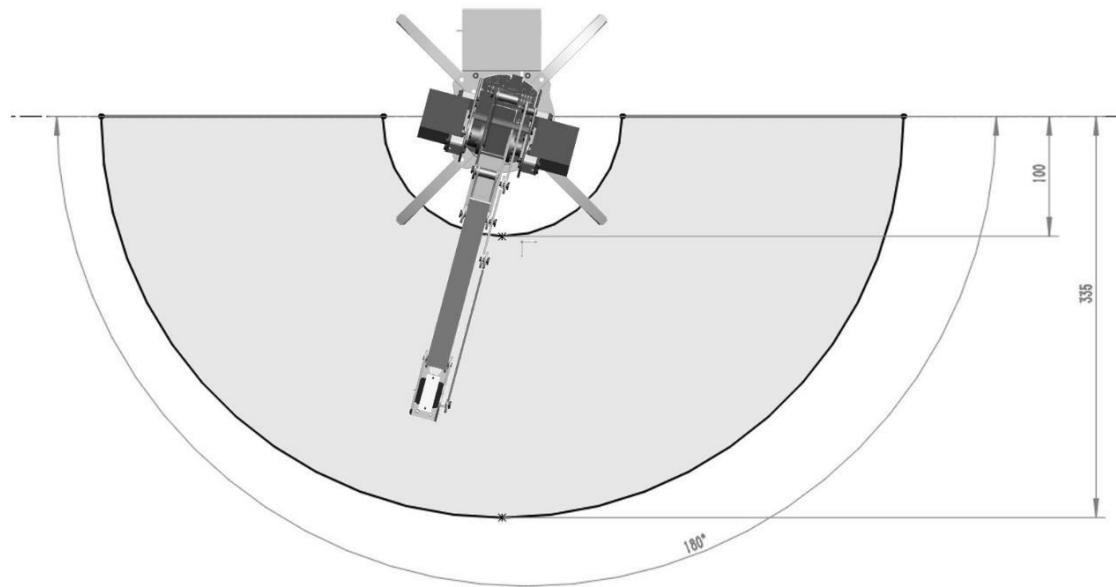
Basic Information of uArm Metal Body

Work Range

You might have guessed the work range with the Limits of XYZ, and the work range for uArm is not a regular area. However, you might not know there are somewhere which is out of the work range, so we have set restraints for those places which uArm cannot reach, and return an Error. *WorkRangeDiagramofuArm*

Work Range PIC 1





Work Range PIC2

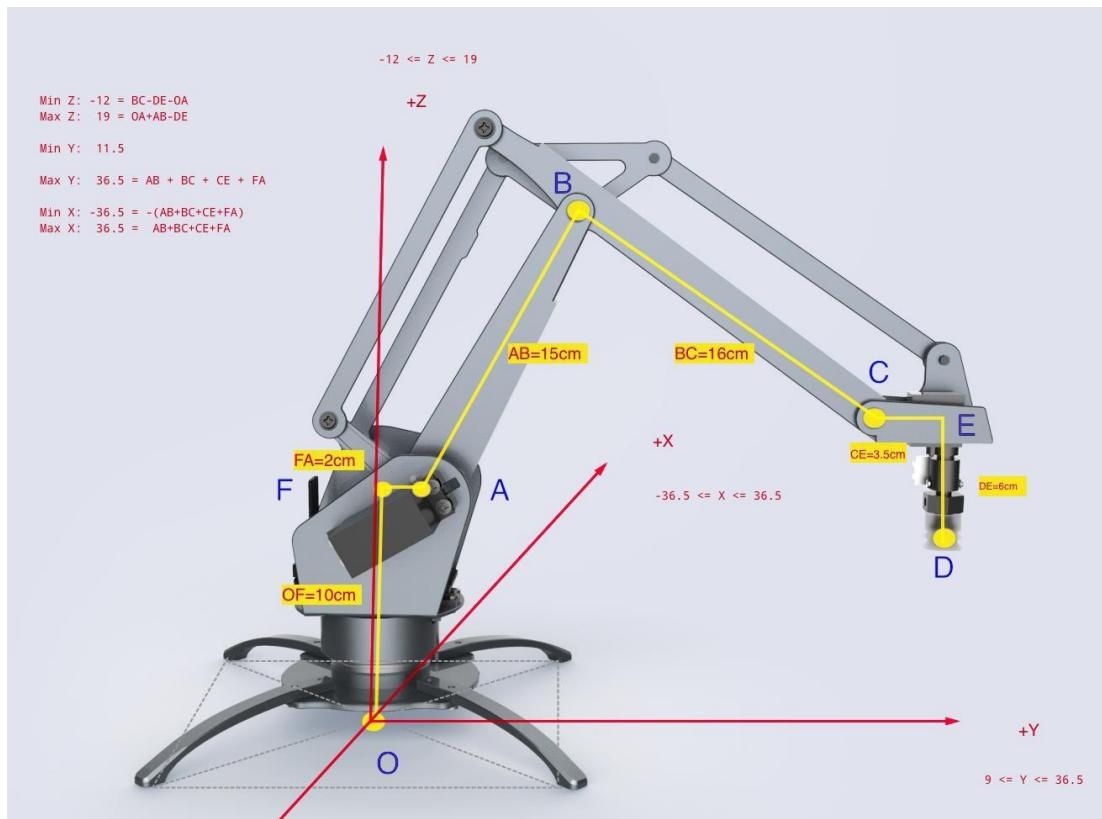
Accuracy and Offset

Theoretically, the offset is around $\pm 0.5\text{CM}$. In fact, the range is related with the payload for uArm. Servo has less offset when working in the range between 40° and 140° ; but when it is less than 40° or greater than 140° , the offset will become wider.

So, please control the payload, don't make uArm work out of its range, and pay attention not to push servo working a wide range beyond its limit.

Three Dimension coordination

We use mathematical model- Three Dimension Coordination to describe uArm's work range. Please refer to the pic below Dimension Diagram



PIC Three Dimension Diagram

1) PointofJunction

- O** Original Point (0,0,0)
- A** The middle point of Left/ Right Axis
- B** The middle point between two screws--each screw is correspondently on one side of Link 2 as the linkage of Point B.
- C** The middle point between two screws-- each screw is correspondently on one side of Link 2 as the linkage of Point C.
- D** The Center Point on the bottom of Suction Cup.
- E** It is an interaction of DE and CE, which are perpendicular to each other. Like in the picture, DE is paralleled with coordinate axis Z and CE is paralleled with coordinate axis Y.
- F** It is an interaction of OF and AF, which are perpendicular to each other. Like in the picture, OF

is paralleled with coordinate axis Z and AF is paralleled with coordinate axis Y.

2) Line

OA Distance of Original Point O to the center of L/R axis A

OF = 10CM Shadow of OA on coordinate axis +Z **AF** = 2CM

Shadow of OA on coordinate axis +Y **AB** = 14.8 CM Length

of Link2

BC = 16CM Length of Link1

CE = 3.5 CM Length of Front Part

DE = 6CM Length of Suction Cup

Extreme/Limits = [-36.5cm ~ 36.5cm]

Max X = AB + BC + CD + AF [Y] =

[11.5 cm ~ 36.5cm] **MIN Y** = Min Y

Max Y = Max X

[Z] = [-12cm ~ 19cm] **Max**

Z = OA + AB -DE **Min Z** = BC

- DE - OA

uArm metal Specifications

1. Apply Environmental Condition

No.	Item	Specification
1.1	Storage Temperature Range	-20°C ~ 70°C
1.2	Operate Temperature Range	0°C ~ 30°C

2. Standard Test Environment

No.	Item	Specification
2.1	Temperature Range	-10°C ~ 60°C
2.2	Humidity Range	65%±10%

3. Mechanical Specification

No.	Item	Specification
3.1	Size	300*270*110mm
3.2	Weight	1.9kg
3.3	Material	Aluminum
3.4	Water Resistance	NO
3.5	Repeatability	10mm(Maximum)
3.6	Action Radius	12CM~32CM
3.7	Max Lifting Weight	500g /with 15kg
3.8	Accuracy	6~10MM (typical)
3.9	Lifetime	>100000 times

4.Electrical Specification

No.	Item	Specification
4.1	Operat voltage	DC5V
4.2	Idle current	200MA
4.3	working current	3.5A

Board-Arduino

Board Reference

We use Arduino UNO to modify but have not change the basic working theory. You can learn from the [Arduino Official Website](#), if you are interested.

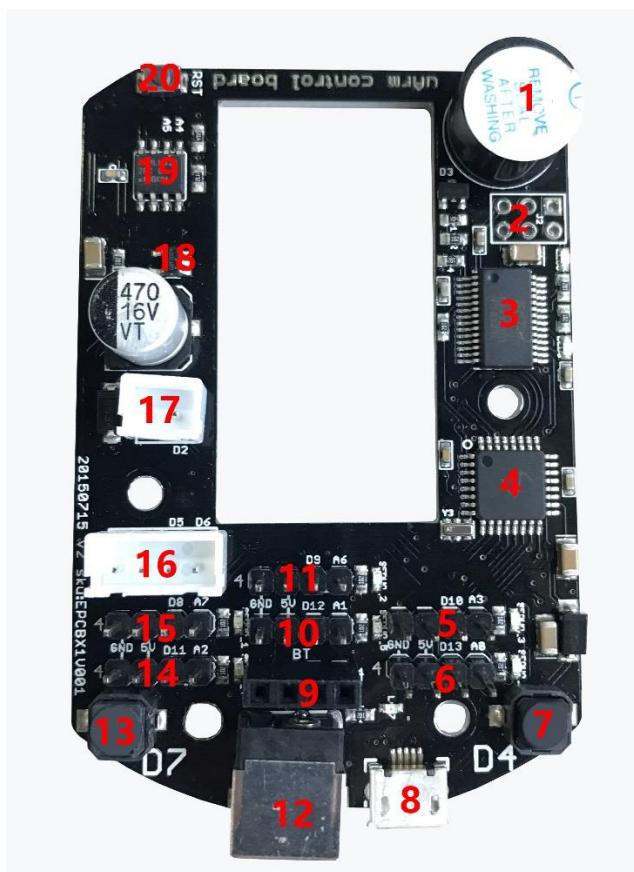
Board Pinout

[Pic link](#) of pinout (You can refer to "Developer Pack"/Arduino/ PIC of "pinout".)

Control Board Diagram

As for Control Board, please [Check the Link here.](#) (You can refer to "Developer Pack"/Arduino/ PIC of "uArm-Control Board.)

Board Specification



No.	Item	Description
1	buzzer	Sound reminder- to remind you the position of uArm, port D3-PD3(INT1).
2	ISP download port	Starting in the upper left corner in clockwise order: RESET-PC6(RESET)->D13-PB5(SCK)->D12-PB4(MISO)-> VCC(+5V)-> D11-PB3(MOSI)->GND; PB/PC Port is in the ATmega328p.
3	USB converts to Serial port	Online debug; communication-FT232RL
4	ATmega328p	Master chip

5	Servo 3 Connector (Control the arm end of the servo)	From Left to Right: GND->VCC(+5V)->D10- PB2(SS)->A3-PC3(ADC3); D10 is PWM output and A3 is analog input.
6	Servo 1 Connector (Control the left servo)	From Left to Right: GND->VCC(+5V)->D13-PB5(SCK)->A0-PC0(ADC0); D10 is PWM output and A3 is analog input.
7	Switch D4-PD4(T0)	uArm condition exchange.
8	MINIUSB-A	Download software and in-out communication.
9	Bluetooth port	From Left to Right: D1-PD1(TXD)->D0-PD0(RXD)->VCC(+5V)->GND; uArm condition and specification setting and operation.
10	Servo 0 Connector (Control the base servo)	From Left to Right: GND->VCC(+5V)->D12-PB4(MISO)->A1PC1(ADC1); D12 is PWM output and A1 is analog input.
11	Servo Connector (Control the electric griper)	From Left to Right: GND->VCC(+5V)->D9-PB1(OC1)->A6-(ADC6); D9 is PWM output and A6 is analog input.
12	Power	5V power adapter and input currency >5A
13	Switch D7-PD7(AIN1)	Change uArm condition.
14	Servo 2 Connector (Control the right servo)	From Left to Right: GND->VCC(+5V)->D11- PB3(MOSI)->A2-PC2(ADC2); D11 is PWM output and A2 is analog input.
15	Servo connector (preserved)	From Left to Right: GND->VCC(+5V)->D8- PB0(ICP)->A7-(ADC7); D8 is PWM output and A7 is analog input.
16	Pump connector	From Left to Right: GND->VCC(+5V)->D8- PB0(ICP)->A7-(ADC7). D8 is PWM output and A7 is analog input.
17	End suction tip limit switch interface	From Left to Right: GND->D2
18	LDO	5V transfer 3.3V
19	EEPROM External power-down memory	64KB
20	Reset	

Servo

Basic Information of Servo

Servo Schematics

When we talk about the servo control, we have to mention Arduino. Thanks to Arduino, we can have thousand open sourced libraries. For uArm, our servo motor supports Arduino's `servo.h` library.

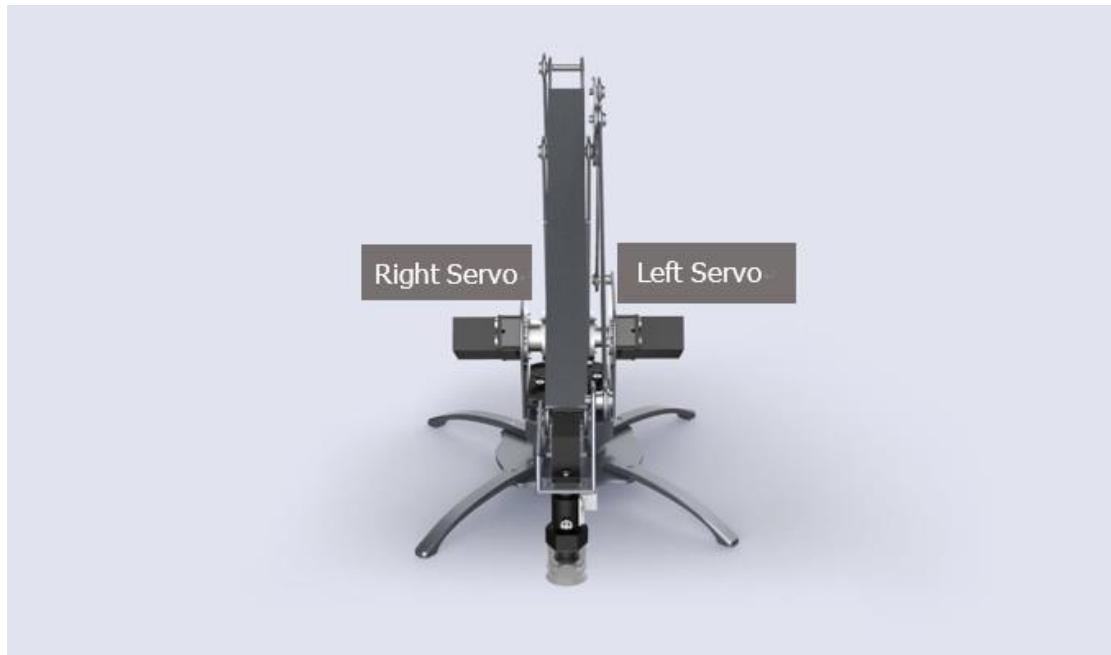
Servo Attach/Detach

Before using servo, it is a must to attach servos. At this time, servos will be locked.

Rotation Ranges of Servo

We use default functions for servo `servoWrite()`. The unit of its rotation is *degree*, ranging from 0 to 180.

When assembling, we install the servo to uArm with a fixed angle.



The servo on the left can range from 0° to 150° and the one on the right is 20° to 150°.

Now you can control the movement of uArm by read the servo's angle, but this is not visible, and somehow dangerous. Because the linkage of servos may lock each other, it is a factor lead to burn the servo. We would like to suggest you to construct a three dimension coordination to control uArm' move.

Read the servo angle

There is a build-in ADC (analog and digital convertor), which can change the current analog signal into digital one. And then, with the function `analogRead` which is defaulted in Arduino, the digital data can be read out and get the current angle with this

formula $intercept + analog * slope$.

Servo Specification

1. Condition

Storage Temperature Range	-20°C ~ 70°C
Operating Temperature Range	-10°C ~ 60°C

2. Mechanism

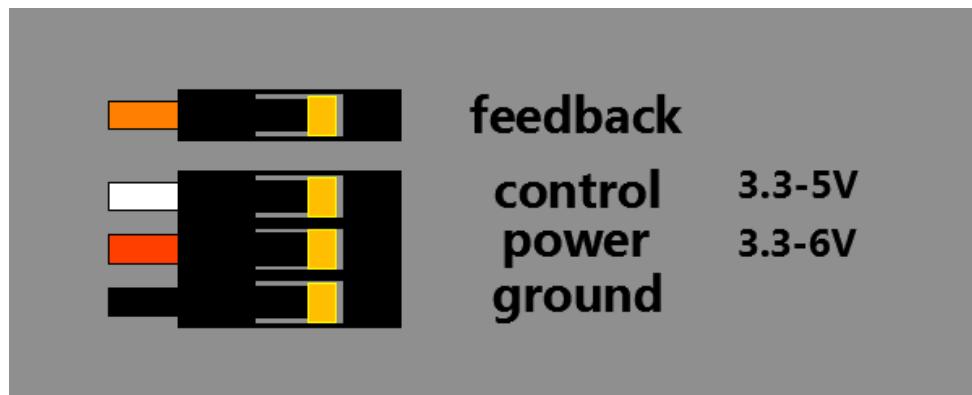
Size	40×20×38mm
Weight	56g
Gear type	metal gear
Limit angle	210°±5°
Bearing	2BB
Horn gear spline	25T
Horn type	Plastic, POM
Case	Engineering plastics(Polyamide)
Motor	DC motor
Splash water resistance	No

3. Electric

Horn type	Plastic, POM
Case	Engineering plastics(Polyamide)
Connector wire	300mm±5mm
Motor	DC motor
Splash water resistance	No

The definition of port for uArm Metal servo

DM1500A is fully compactable with normal 3 pin port and the forth is used for the output of potentiometer as positon feedback of uArm.



Voltage and angle

An	Value (TYP)
0°	0.364V
90	1.723V
18	3.076V

Ps:1, because of the correspondence-difference of potentiometer inside servo, different servo might have $\pm 10\%$ difference.

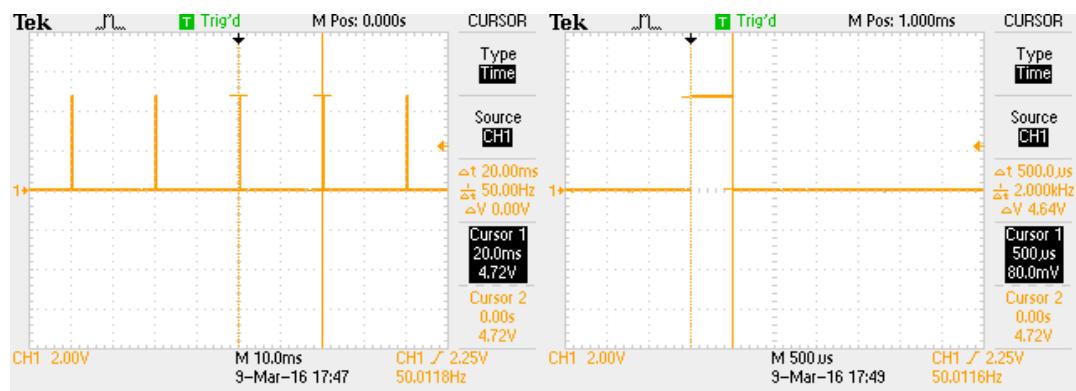
2, Different ADC will leads different sample number when output.

Control

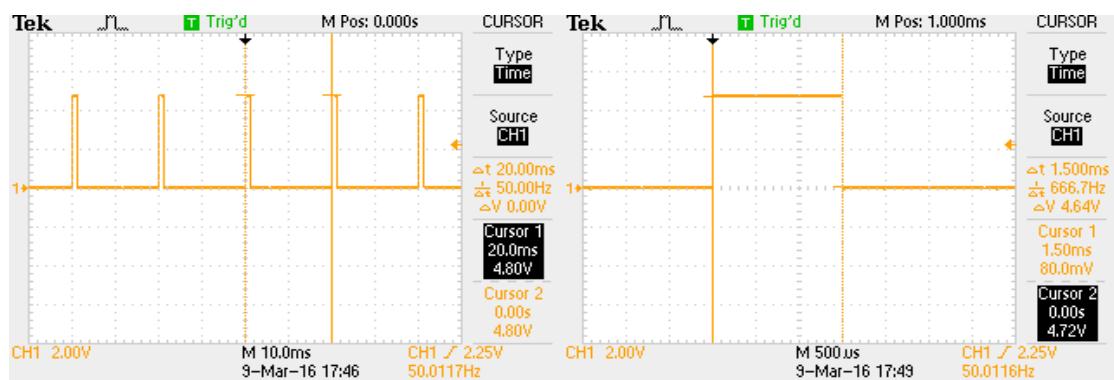
PWM and specification as following:

Command signal	Pulse width modification
Pulse frequency	50Hz
Pulse width range	500 ~ 2500usec
Neutral position	1500usec
Running degree	$180^\circ \pm 3^\circ$ (when 500 ~ 2500usec)
Dead band width	2 usec
Rotating direction	Clock wise(when 500 ~ 2500usec)

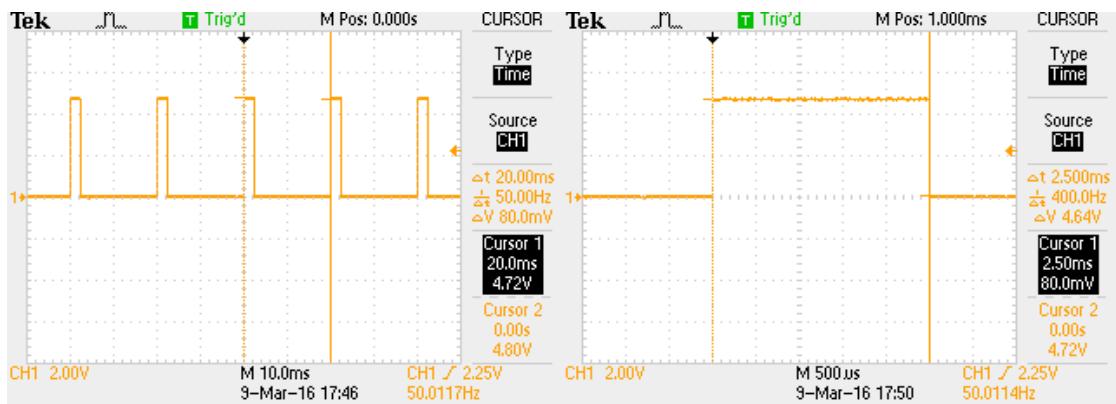
When control port is 0°, the oscillo-gram is the pic below (the pic on the right is enlarged drawing of a single wave).



When control port is 90°, the oscillo-gram is the pic below (the pic on the right is enlarged drawing of a single wave)

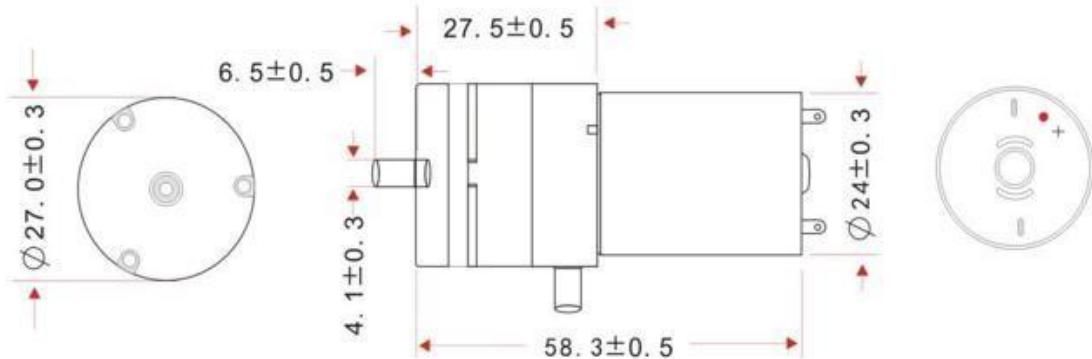


When control port is 180°, the oscillo-gram is the pic below (the pic on the right is enlarged drawing of a single wave).



Vacuum Pump/mechanical Gripper/ Universal Holder

Pump



Voltage : DC 4-5V

Current : <400mA

Reference

1. [Pump Specification](#)(You can refer to "Developer Pack"/Pump/ "Pump Specification".)
 2. [Pump User Guide](#)(You can refer to "Developer Pack"/Pump/ "uArm Vacuum System User Guide".)
- [Gripper](#) (You can refer to "Developer Pack"/Gripper/ "gripper user guide".)
- [Universal Holder](#) (You can refer to "Developer Pack"/Gripper/ "holder user guide".)

Protection

How to prevent damaging uArm?

Make sure you use our firmware and it is updated, the payload and work range is not go beyond of its limits.

Under what circumstances will the servo be burned or damaged?

1, The payload is out of its limit or work with the load almost its limit for a long time; 2,

The servo is hit hard;

3, Use the wrong power supply, which often burn the servo.

Under what circumstances should I unplug uArm ASAP?

When you see the red light is flashing, which means something wrong already happen, please unplug ASAP.

5. uArm Community

Welcome to the uArm Community! Now, you can explore uArm with the world of robot enthusiasts, Makers, sartists and scientists!

Official Website:

<https://www.ufactory.cc/>

Official Forum:

<https://forum.ufactory.cc/>

Official WeChat Account:



Official Media:



More Help?

[【Contact Us】.](#)