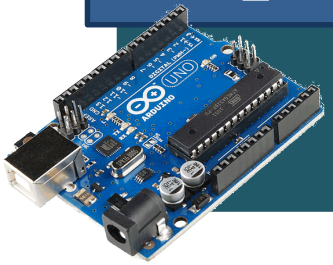
2022년 IoT기반 스마트 솔루션 개발자 양성과정



Firmware [펌웨어]

18-Step Motor

담당 교수 : 유근택

010-5486-5376

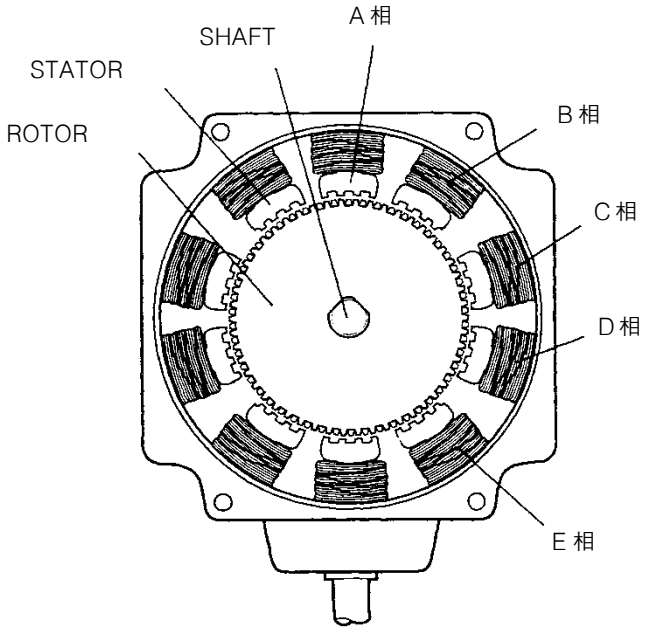
rgt3340@naver.com

Motor의 종류

용 도	Motor종류	정지 정도	속도 범위
동력용	Induction Motor	OverRun : 30~40회전	일정속도
간단한 위치결정	전자식 Braker부착 Motor	OverRun : 2~3회전	일정속도
간단한 속도제어	속도제어용 Motor	OverRun : 0.5~1회전	90~1700rpm
고정도 위치결정	Stepping Motor	±0.05′	0~2400rpm
고속도 위치결정	AC Servo Motor	±0.36′	10~3000rpm

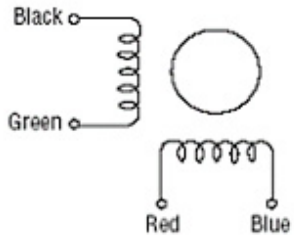
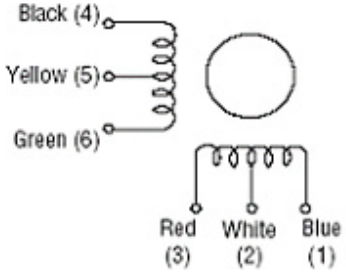
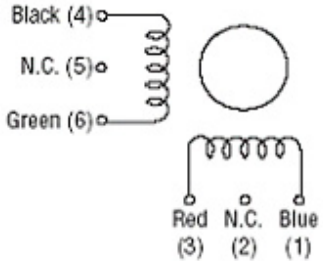
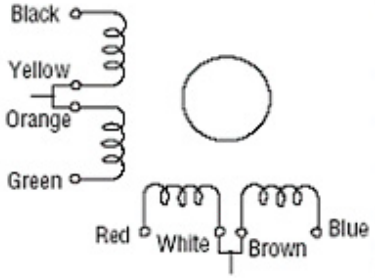
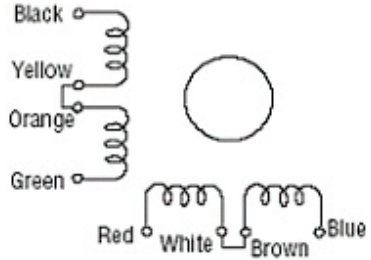
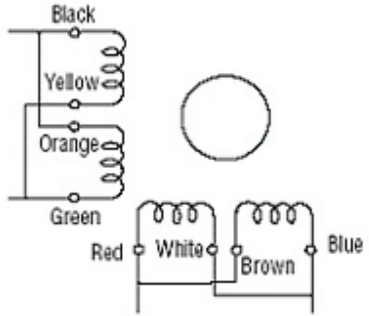
Step Motor

- 위치결정이 쉽다
  - 고분해능, 고정도 위치
- 위치결정 센서가 필요치 않다
- 디지털제어가 가능하다
- 빈번한 동작이 가능하다
- 자기 유지력이 있다
- 오차가 누적되지 않는다

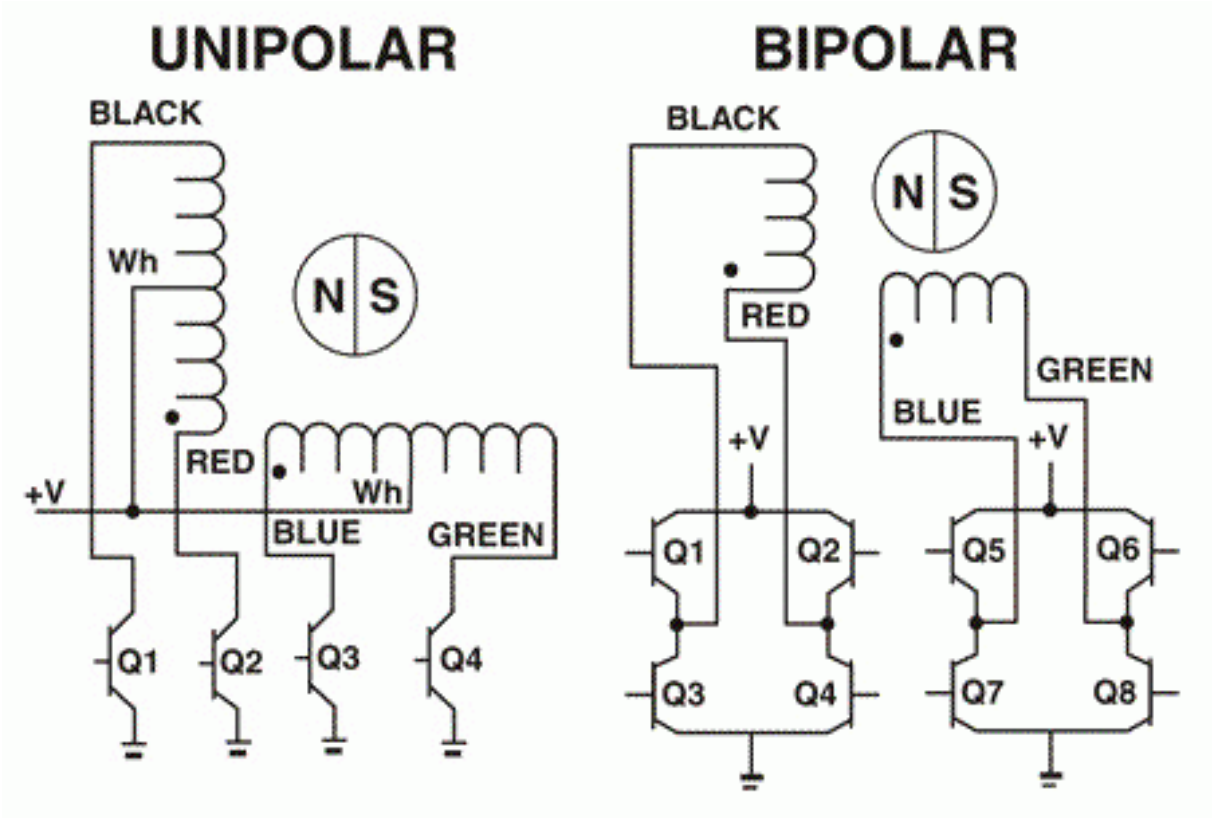


결선 방식

Wire Connection Diagrams

4 Lead Bipolar Connection	6 Lead Unipolar Connection	6 Lead Bipolar (Series) Connection
		
8 Lead Unipolar Connection	**8 Lead Bipolar (Series) Connection**	**8 Lead Bipolar (Parallel) Connection**
		

Power supply



Full step / Harlf step

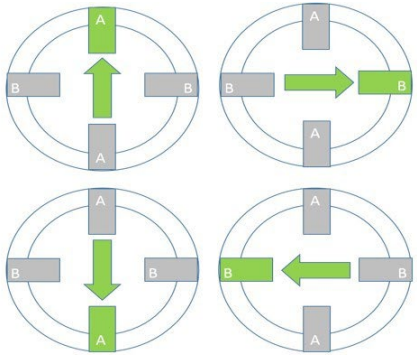


Fig 1 – One phase on – full step

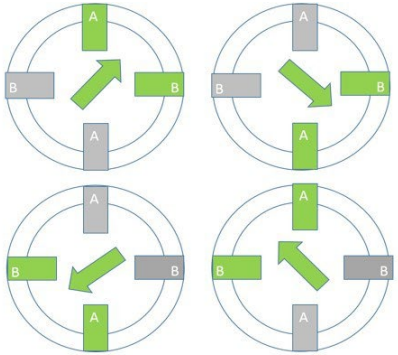


Fig2 – Two phase on – full step

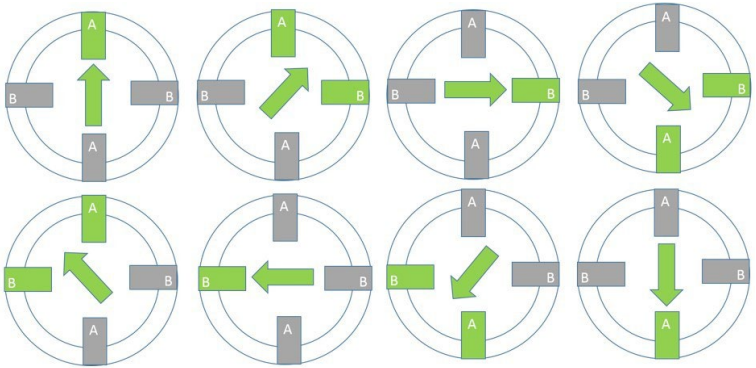
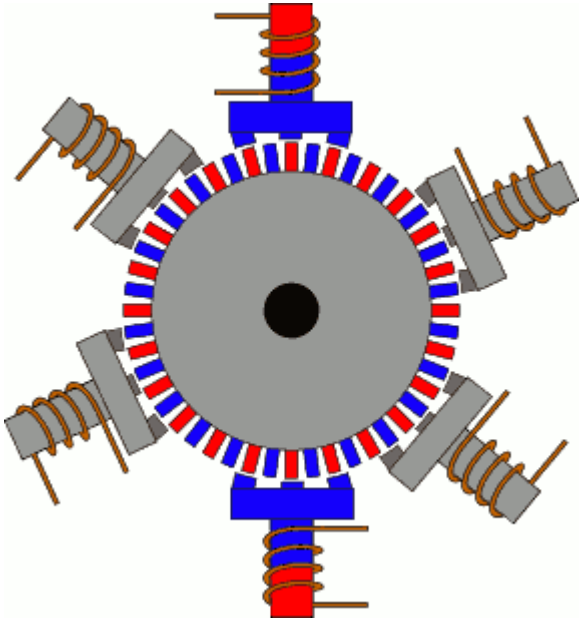
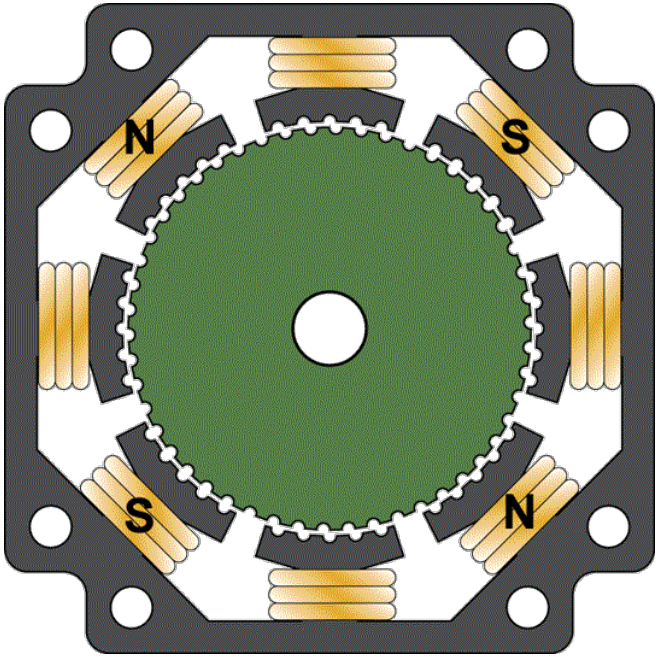


Fig3 - One-two phase on - half step

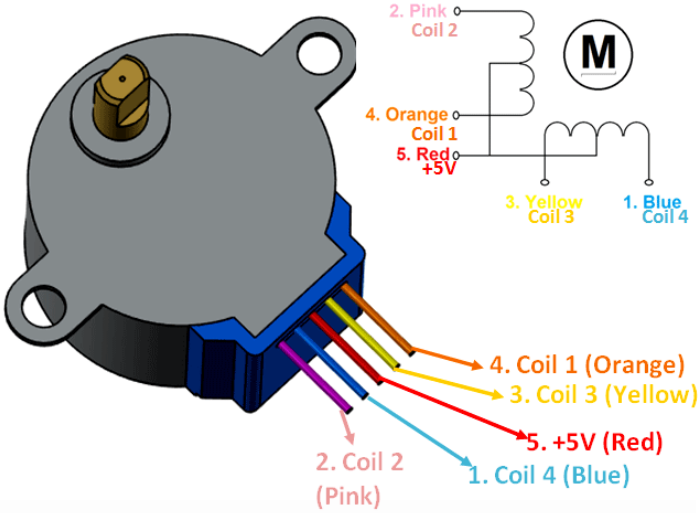
Stepping Motor의 동작



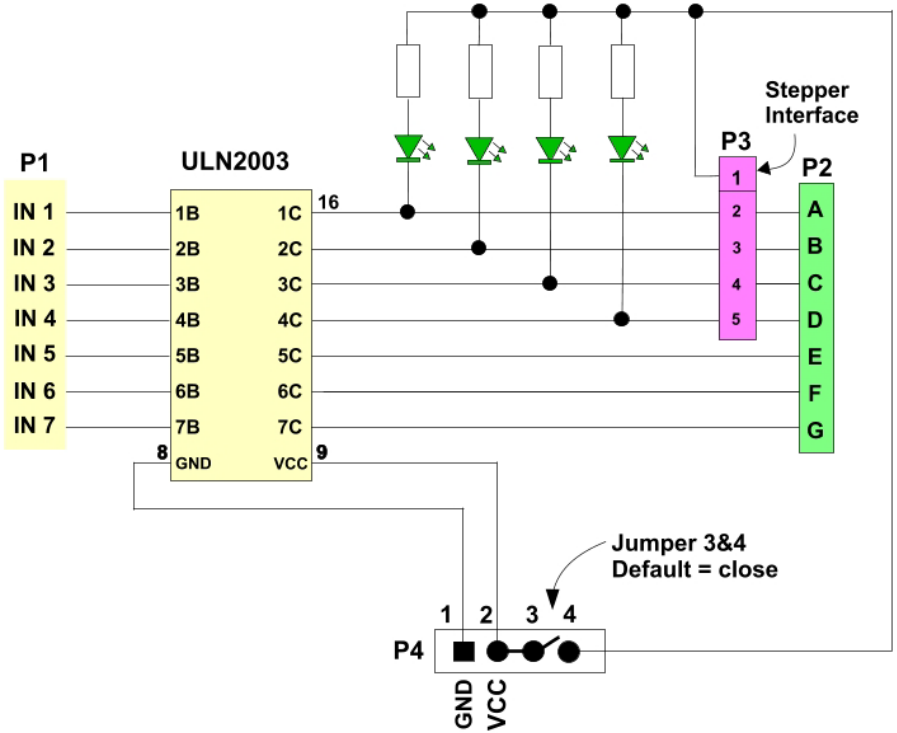


28BYJ-48 Parameters

- Model : 28BYJ-48
- Rated voltage : 5VDC
- Number of Phase : 4
- Speed Variation Ratio : 1/64
- Stride Angle : 5.625° /64
- Frequency : 100Hz
- DC resistance : 50Ω±7%(25℃)
- Idle In-traction Frequency : > 600Hz
- Idle Out-traction Frequency : > 1000Hz
- In-traction Torque >34.3mN.m(120Hz)
- Self-positioning Torque >34.3mN.m
- Friction torque : 600-1200 gf.cm
- Pull in torque : 300 gf.cm
- Insulated resistance >10MΩ(500V)
- Insulated electricity power : 600VAC/1mA/1s
- Insulation grade : A
- Rise in Temperature <40K(120Hz)
- Noise <35dB(120Hz,No load,10cm)

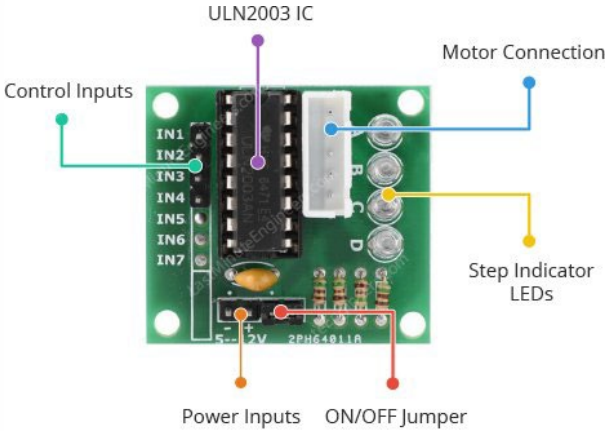


ULN2003

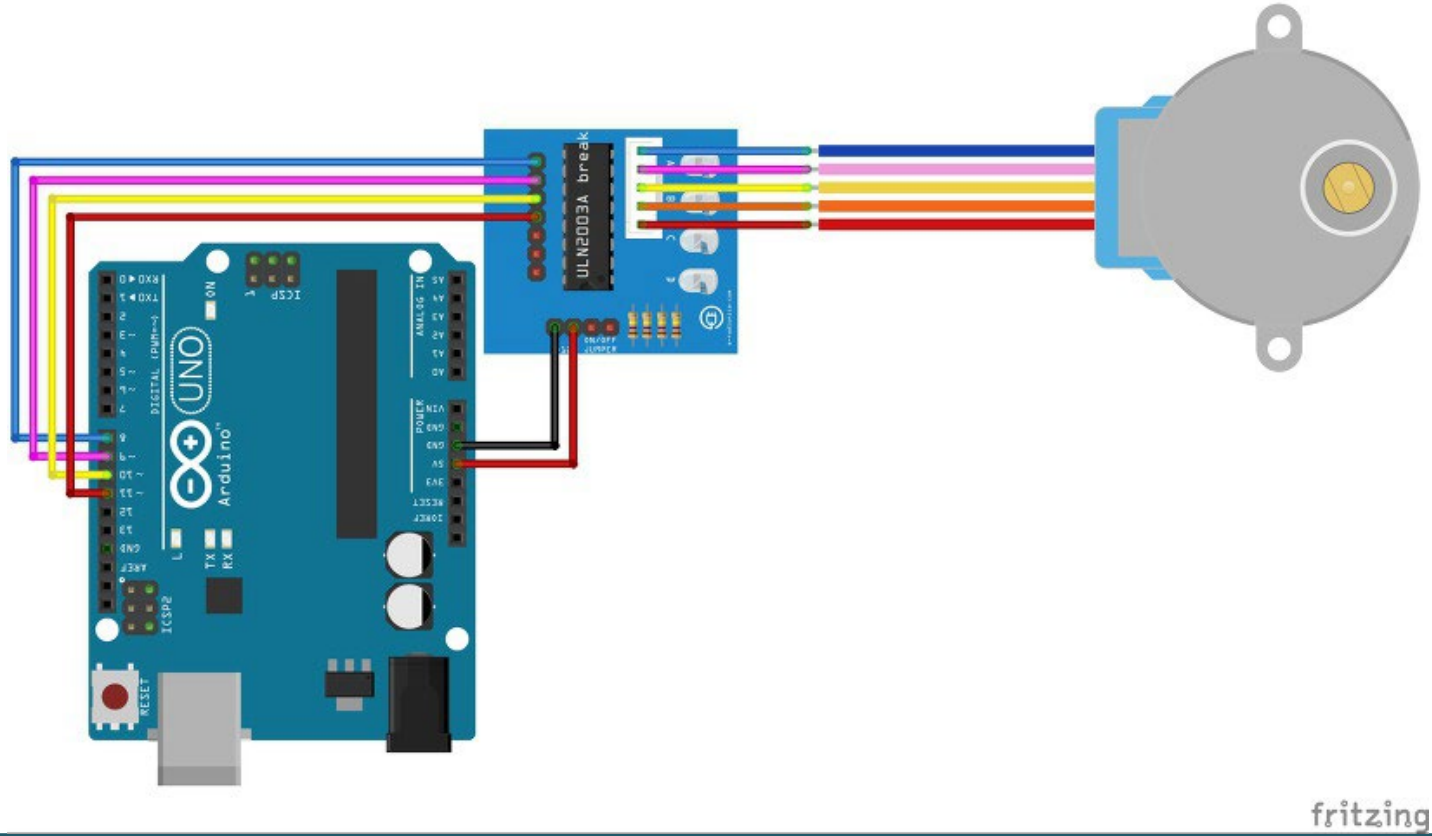

P1
ULN2003
IN 1
IN 2
IN 3
IN 4
IN 5
IN 6
IN 7
1B
2B
3B
4B
5B
6B
7B
GND
1C
2C
3C
4C
5C
6C
7C
VCC
16
8
9
Stepper
Interface
P3
P2
1
2
3
4
5
A
B
C
D
E
F
G
Jumper 3&4
Default = close
1
2
3
4
P4
GND
VCC


IN1
IN2
IN3
IN4
IN5
IN6
IN7
A
B
C
D
- +
5--12V

28BYJ-48 + ULN2003



Wiring



Steps

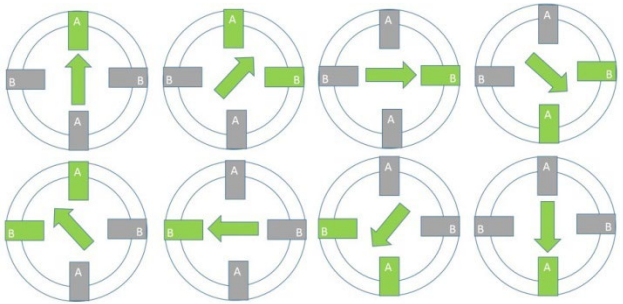


Fig3 - One-two phase on - half step

Step	1	2	3	4	5	6	7	8
A (A)	1	1	0	0	0	0	0	1
B (B)	0	1	1	1	0	0	0	0
C (A′)	0	0	0	1	1	1	0	0
D (B′)	0	0	0	0	0	1	1	1

관련 수식

- 회전각 = Step각도 x Pulse 수
- 속도(RPM)= (Step각도/360′) x Pulse 속도(Hz) x 60
- 이동 거리 : Pully의 지름, 기어 피치 등에 관련하여 계산

StepMotor-1

Stride Angle : 5.625° * 2 =11.25
Gear Ratio : 1/64 //63.684
Frequency : 100Hz

1회전 Step = (360/Stride Angle) * Gear Ratio
= (360 / 11.25) * 64
= 2048
1회전 Time = 1회전 Step / Frequency
= 2048 / 100
= 20.48 Sec
최대 속도(RPM) = 60sec / 1회전 Time
= 2.9296 = 3rpm

```
#include <Stepper.h>
const int stepsPerRevolution = 2048;
Stepper step28BYJ48(stepsPerRevolution, 8,10,9,11);

void setup( ) {
  step28BYJ48.setSpeed(3);
  Serial.begin(9600);
}

void loop( ) {
  Serial.println("Clockwise");
  step28BYJ48.step(stepsPerRevolution);
  delay(500);

  Serial.println("counterClockwise");
  step28BYJ48.step(-stepsPerRevolution);
  delay(500);
}
```

Ex : millis( )

- millis( ) 함수를 이용하여 1회전 시간을 측정하여 보자
- Number of milliseconds passed since the program started (unsigned long)
- **Syntax**

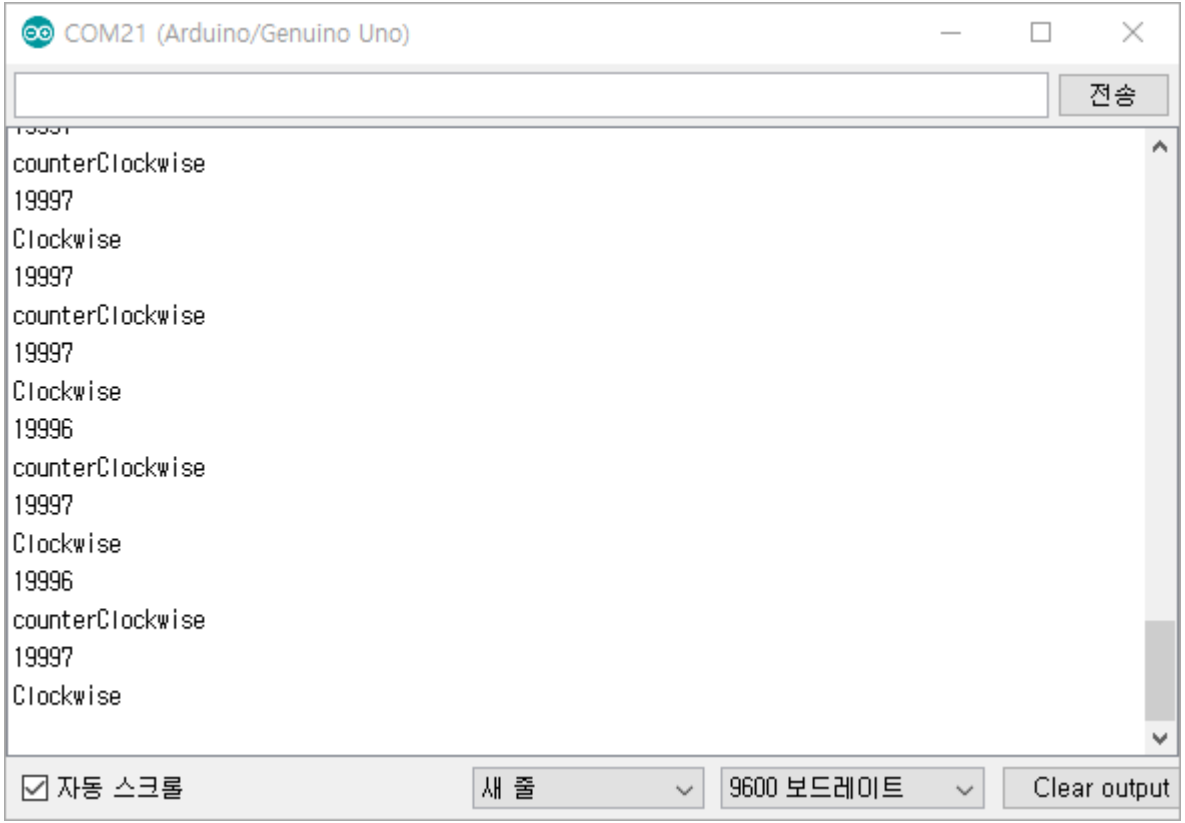
  time = millis()

StepMotor-2

```
#include <Stepper.h>

const int stepsPerRevolution = 2048;
Stepper step28BYJ48(stepsPerRevolution, 8,10,9,11);
long StartTime;

void setup( ) {
  step28BYJ48.setSpeed(3);
  Serial.begin(9600);
}
```

```
void loop( ) {
  Serial.println("Clockwise");
  StartTime=millis( );
  step28BYJ48.step(stepsPerRevolution);
  Serial.println(millis( )-StartTime);
  delay(500);

  Serial.println("counterClockwise");
  StartTime=millis( );
  step28BYJ48.step(-stepsPerRevolution);
  Serial.println(millis( )-StartTime);
  delay(500);
}
```

StepMotor-2 RUN



Ex : Second Hand

- 시계의 초침을 구현하여 보자
- 1초의 Steps = 1회전 Steps / 60 = 34.13
- millis( ) 함수에 의해 1초 계산

StepMotor-3

```
#include <Stepper.h>
const int stepsPerRevolution = 2048;
Stepper step28BYJ48(stepsPerRevolution, 8,10,9,11);
int anglePerSecond=2048 / 60;
long StartTime;

void setup( ) {
  step28BYJ48.setSpeed(15);
  Serial.begin(9600);
  StartTime=millis( );
}

void loop( ) {
  if ((millis( )-StartTime)>1000){
    StartTime=millis( );
    step28BYJ48.step(anglePerSecond);
}
}
```

Ex : 프로그램 운전

- 미리 계획된 프로그램 데이터에 의해 순차적으로 실행
- 순서(각도) 반복

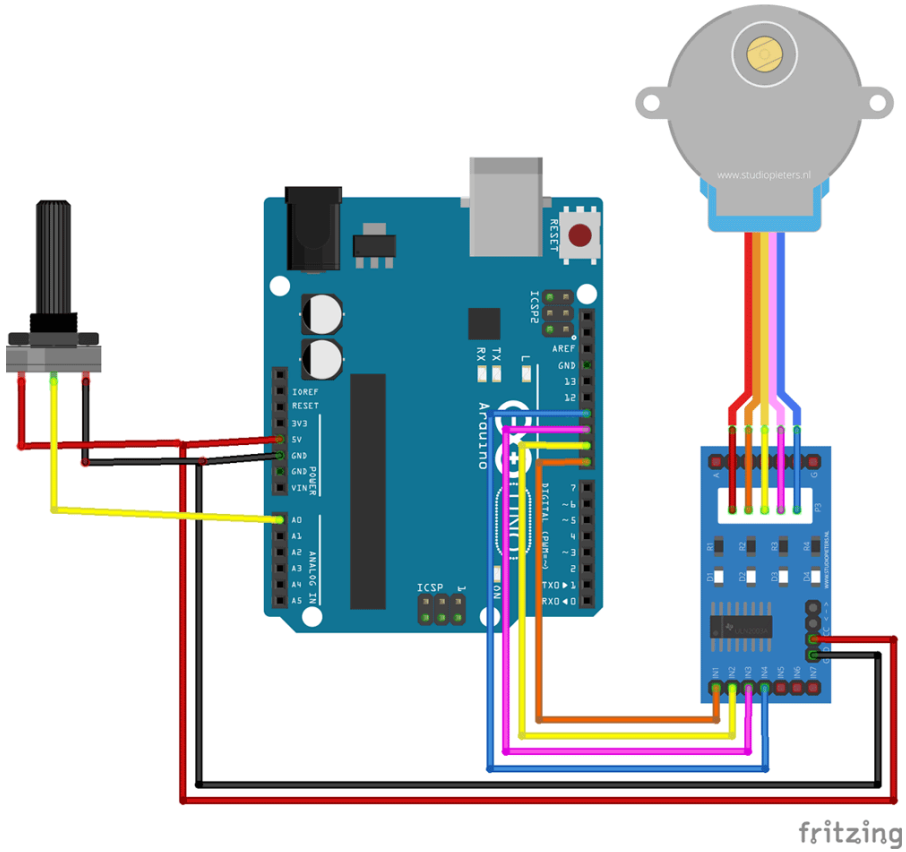
  90 -> 45 -> 270 -> 90 -> 180 -> 0

StepMotor-4

```
const int stepsPerRevolution = 2048;
Stepper step28BYJ48(stepsPerRevolution, 8,10,9,11);
float stepPerAngle=2048.0/360.0;
#define programCount 6
int programData[programCount]={90,45,270,90,180,0};
int programPoint=0;
int currentAngle=0;
signed int steps;

void setup( ) {
  step28BYJ48.setSpeed(15);
  Serial.begin(9600);
}
```

```
void loop( ) {
  steps=(int)(programData[programPoint]-currentAngle)*stepPerAngle;
  step28BYJ48.step(steps);
  currentAngle=programData[programPoint];
  if (++programPoint>=programCount)
      programPoint=0;
  delay(1000);
}
```

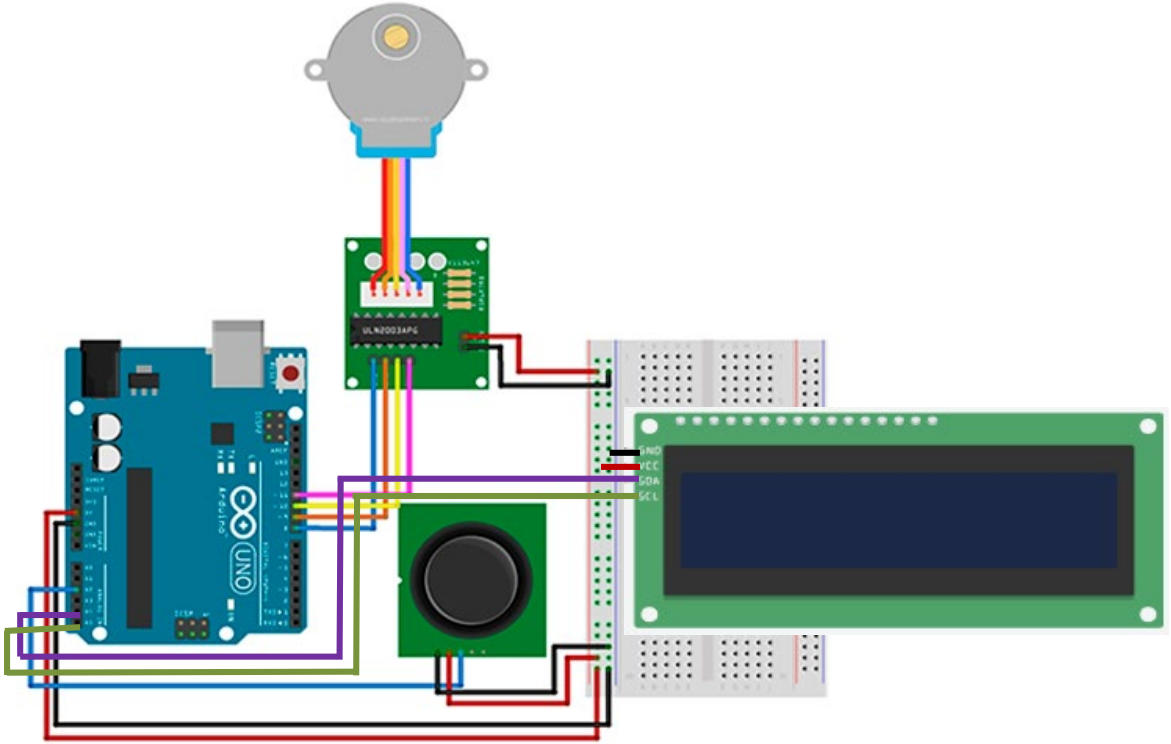
Stepper speed control



coding

```
#include <Stepper.h>

const int stepsPerRevolution = 200;  // change this to fit the number of steps per revolution
// for your motor


// initialize the stepper library on pins 8 through 11:
Stepper myStepper(stepsPerRevolution, 8, 10, 9, 11);

int stepCount = 0;  // number of steps the motor has taken

void setup() {
  // nothing to do inside the setup
  Serial.begin(9600);
}
void loop() {
  // read the sensor value:
  int sensorReading = analogRead(A0);
  // map it to a range from 0 to 100:
  int motorSpeed = map(sensorReading, 0, 1023, 100, 0);
  Serial.println(motorSpeed);
  // set the motor speed:
  if (motorSpeed > 0) {
    myStepper.setSpeed(motorSpeed);
    // step 1/100 of a revolution:
    myStepper.step(-stepsPerRevolution / 100);
  }
}
```

Stepper - Joystick



[결선 회로도]

Stepper - Joystick

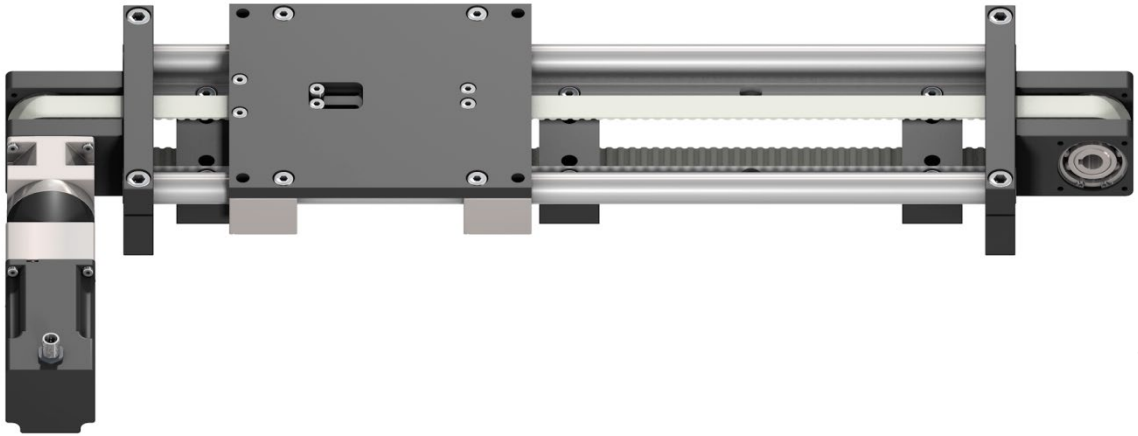
```
#include <Stepper.h>

const int stepsPerRevolution = 64;

//모터별 스탭 수 설정 (28YBJ-48의 경우64)
Stepper stepper(stepsPerRevolution, 8,
  10, 9, 11);

void setup()
{
// 속도 설정
  stepper.setSpeed(220);
}
```

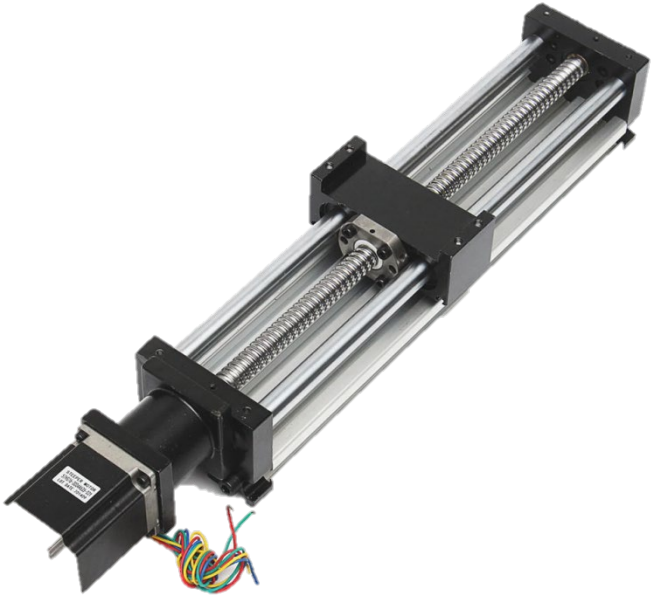
```
void loop() {
  // 조이스틱 X축 A2에 연결

  int sensorReading = analogRead(A2);
  if (sensorReading < 300)
{
   //시계방향으로 회전
    stepper.step(1);
  }
  if (sensorReading > 800)
{
    // 반시계방향 회전
    stepper.step(-1);
 }
}

```

Stepper-Joystick-I2C LCD

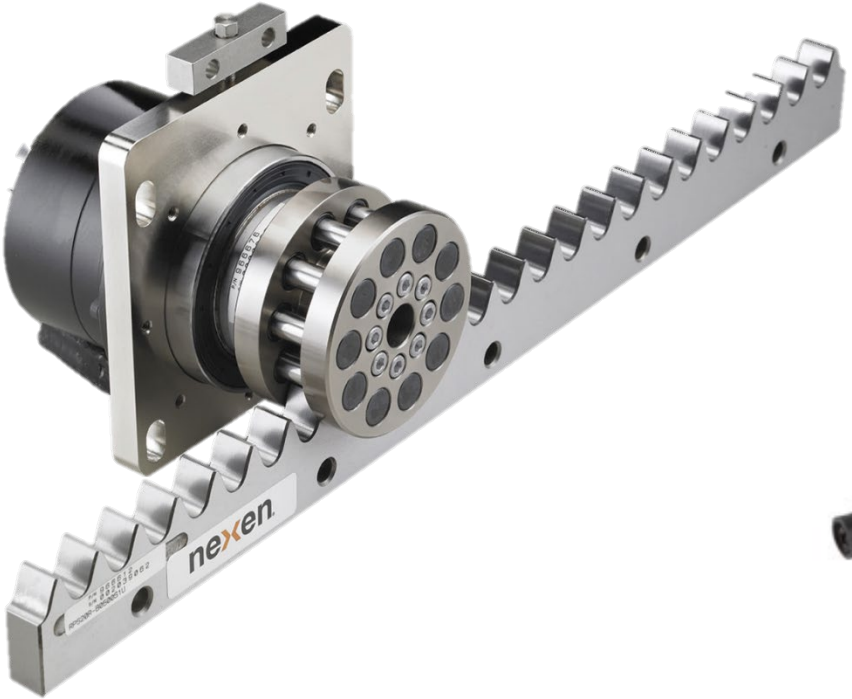
```
#include <LiquidCrystal_I2C.h>
#include <Stepper.h>

LiquidCrystal_I2C lcd(0x27,16,2);

const int stepsPerRevolution = 64; // 모터별 스탭수 (28YBJ-48의 경우 64)
Stepper stepper(stepsPerRevolution, 8, 10, 9, 11);
int point=0;

void setup( ){
  stepper.setSpeed(220); // 속도 설정
  lcd.init();
  lcd.backlight();
  lcd.setCursor(0,0);
  lcd.print("Stepper control");
  lcd.setCursor(1,1);
  lcd.print("Joystick Move");
  delay(2000);
  lcd.clear();  }

void loop( ){
   int sensorReading = analogRead(A2); // 조이스틱 X축 A2에 연결
  if(point==18){ point=0; }
  if(sensorReading < 300) {
    lcd.setCursor(4,0);
    lcd.print("Step LEFT");
    lcd.setCursor(6-point%6,1);
    lcd.print(char(0x7F));
    stepper.step(15);  // 시계방향으로 회전
    delay(100);
    lcd.clear();
    }
  if((sensorReading >= 300)&&(sensorReading <= 800))
    {point=-1;
    lcd.setCursor(4,0);
    lcd.print("NonMove");
    lcd.setCursor(7,1);
    lcd.print(char(0x3D));
    lcd.setCursor(8,1);
    lcd.print(char(0x3D));
    }
  if(sensorReading > 800) {
    lcd.setCursor(4,0);
    lcd.print("Step RIGHT");
    lcd.setCursor(9+point%6,1);
    lcd.print(char(0x7E));
    stepper.step(-15);  // 반시계방향 회전
    delay(100);
    lcd.clear();
    }
    point++;
  }
```

Timming Belt / Ball Screw

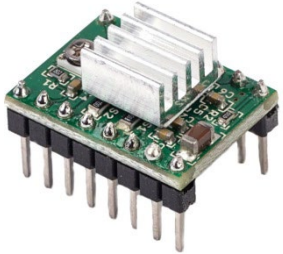


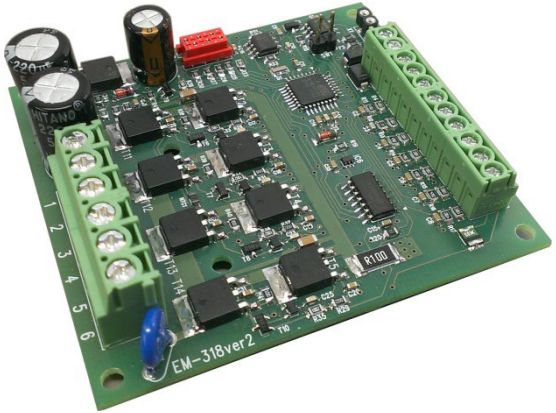


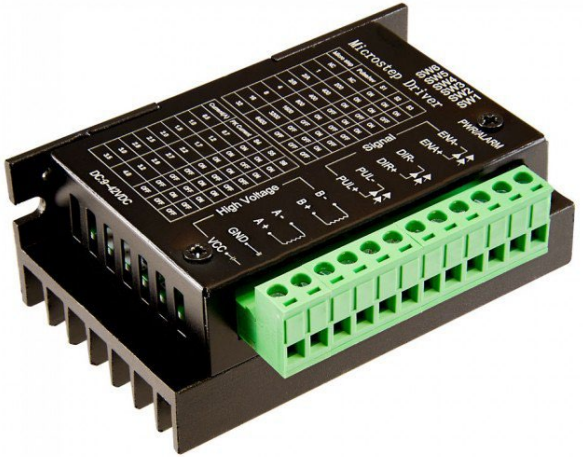
Rack Pinon / Index Table



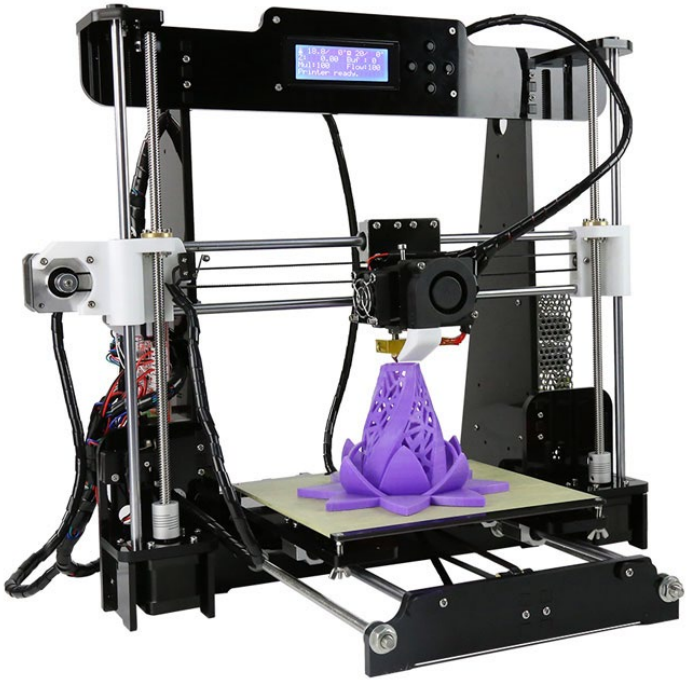
Driver



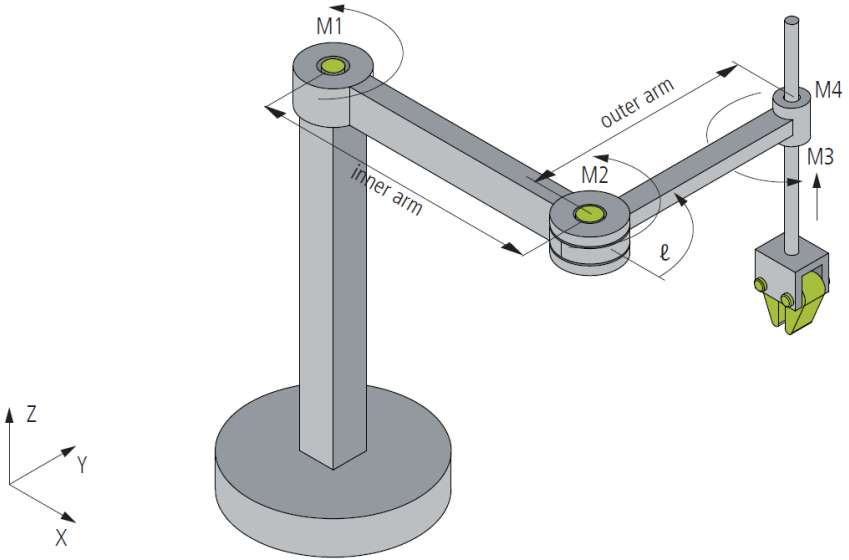

EM-318ver2

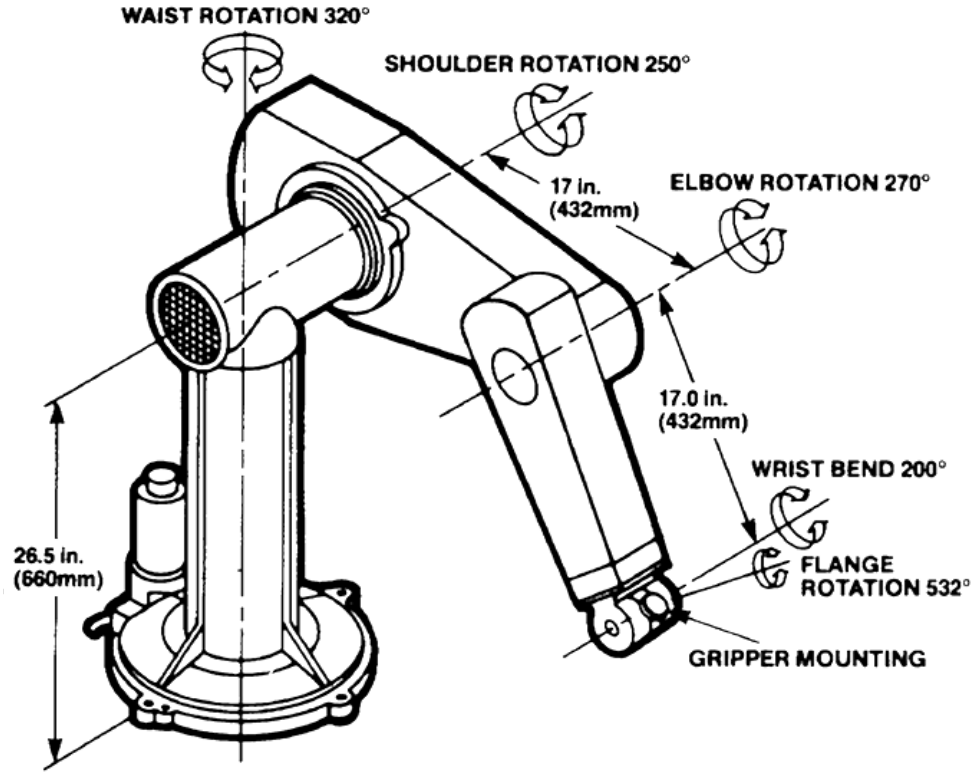

Microstep Driver
High Voltage
GND
VCC
ENA+
ENA-
DIR+
DIR-
PUL+
PUL-

Application

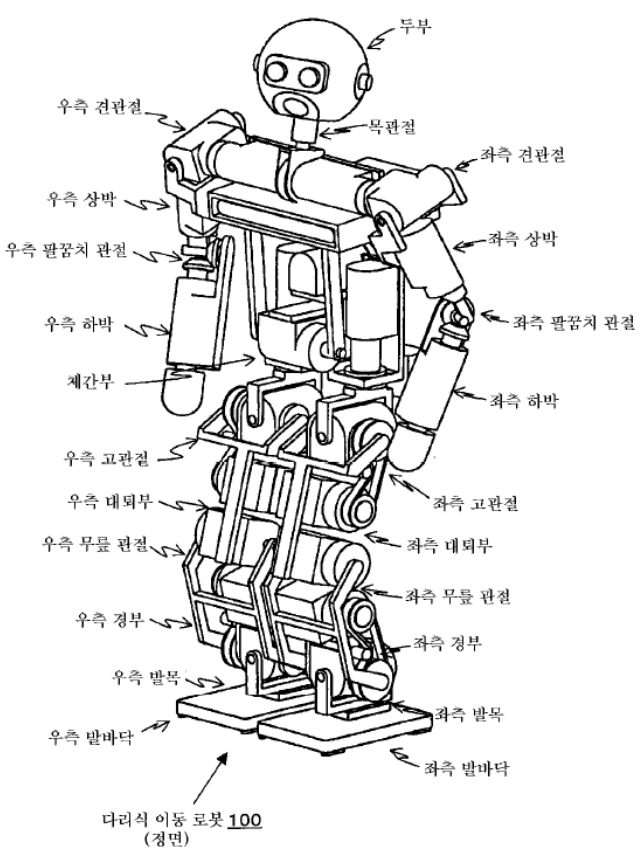


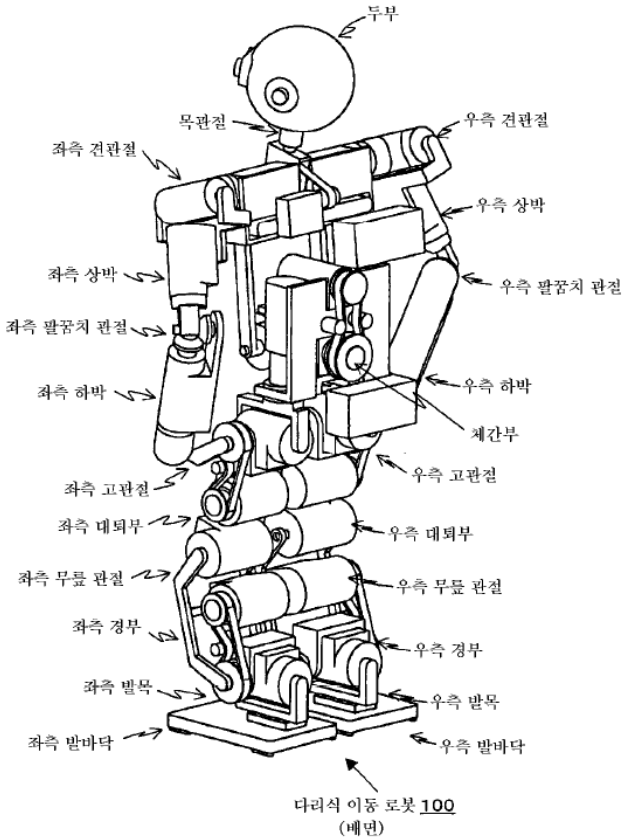
Scala Robot / Puma Robot





2족 보행 로봇


두부
우측 견관절
목관절
좌측 견관절
우측 상박
좌측 상박
우측 팔꿈치 관절
좌측 팔꿈치 관절
우측 하박
체간부
좌측 하박
우측 고관절
좌측 고관절
우측 대퇴부
좌측 대퇴부
우측 무릎 관절
좌측 무릎 관절
우측 경부
좌측 경부
우측 발목
좌측 발목
우측 발바닥
좌측 발바닥
다리식 이동 로봇 100
(정면)


두부
목관절
우측 견관절
좌측 견관절
우측 상박
좌측 상박
우측 팔꿈치 관절
좌측 팔꿈치 관절
우측 하박
좌측 하박
체간부
우측 고관절
좌측 고관절
우측 대퇴부
좌측 대퇴부
우측 무릎 관절
좌측 무릎 관절
우측 경부
좌측 경부
우측 발목
좌측 발목
우측 발바닥
좌측 발바닥
다리식 이동 로봇 100
(배면)