Position Control of Multiple Servos and Stepper Motors

with an Arduino

Control of multiple servos and stepper motors by a single Arduino is demonstrated with a 16 channel I2C device incorporating a PCA9685 IC. All details are contained in this document which can be found in the GitHub repository: …..

Useful for robotics etc.

Add 2 pictures: both of assemblies

Revision History

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| **Revised on** | **Version** | **Description** | **By** |
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# PCA9685 PWM module

https://www.adafruit.com/product/815

Servos: Generally, 50 Hz is used (20 ms period).

LEDs and Motors: Can use higher frequencies, e.g., 200-1000 Hz. ChatGPT

See appendix I

# Application - Servo motor

## Parts

### Servos

Miuzei MG90S 9G Micro Servo Motor Metal Geared Motor Kit for RC Car Robot Helicopter, Mini Servos for Arduino Project (10)

<https://www.amazon.ca/gp/product/B0BWJ26PX2/ref=ppx_yo_dt_b_asin_title_o00_s00?ie=UTF8&th=1>

Operating Current (5.0V): ~2.7mA (idle), ~70mA (no load), ~400mA (Stall)

Yes, the pulse widths stay the same for positions, even if the frequency changes.

Pulse detail

Common Pulse Width Ranges:

1.0 ms → Full counterclockwise (minimum position)

1.5 ms → Center position (neutral)

2.0 ms → Full clockwise (maximum position)

20 ms period (50 Hz signal) → Typical cycle time for hobby servos

### Buck converter

## Schematic

## Assembly

## Sketch

# Application - Stepper motors

## Parts

### Stepper motor

Iverntech Nema

1.8 Stepper Angle

0.8A per phase, resulting in 200 steps per revolution​

2 Phase

4-Lead

<https://www.amazon.com/dp/B07PNV7RBW?ref=ppx_yo2ov_dt_b_fed_asin_title&th=1>

### Stepper driver

DRV8825 Stepper Motor Driver Module with Heat

<https://www.amazon.ca/dp/B0BLKPQ5NY?ref=ppx_yo2ov_dt_b_fed_asin_title>

DRV8825 stepper motor driver current: 2.5A

maximum current: 2.5A

supports up to 32 subdivisions

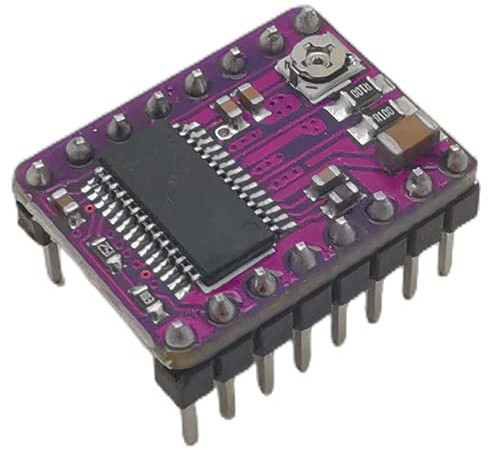


Figure 1 – DRV8825 driver module

See appendix for max speed calculation

See appendix for current limiting, VRef…..

**Recommended Voltage:** **12V - 24V**

Pulse detail - See appendix

### Expansion Board

Expansion Module DRV8825/A4988 42 Stepper Motor Driver Expansion Board for UNO R3 3D Printer

<https://www.amazon.ca/dp/B07TWW8Z26?ref=ppx_yo2ov_dt_b_fed_asin_title>

A close-up of a black circuit board

AI-generated content may be incorrect.

Figure 2 – Expansion board for DRV8865 driver

## Schematic

Optionally, connect the EN (enable) pin to a digital pin on the Arduino if you wish to control the driver's enable state; otherwise, it can be tied low to enable the driver permanently. ChatGPT

## Assembly

## Sketch

#include <Wire.h>

#include <Adafruit\_PWMServoDriver.h>

#define DIR\_PIN 9 // Direction pin for stepper driver

#define PWM\_CHANNEL 0 // PCA9685 channel connected to STEP pin

#define FREQUENCY 1000 // 1 kHz PWM for step pulses

#define numSteps 200 // Number of steps to move the motor

#define stepDelay 1 // Delay in milliseconds for pulse timing

Adafruit\_PWMServoDriver pwm = Adafruit\_PWMServoDriver(0x40); // Default I2C address

void setup() {

Serial.begin(115200);

pinMode(DIR\_PIN, OUTPUT);

pwm.begin();

pwm.setPWMFreq(FREQUENCY); // Set PWM frequency to 1000 Hz

delay(10); // Small delay to stabilize

Serial.println("Stepper motor control started.");

}

void loop() {

// Set direction (HIGH = CW, LOW = CCW)

digitalWrite(DIR\_PIN, HIGH);

for (int i = 0; i < numSteps; i++) {

pwm.setPWM(PWM\_CHANNEL, 0, 2048); // 50% duty cycle for a step pulse

delay(stepDelay);

pwm.setPWM(PWM\_CHANNEL, 0, 0); // Turn off pulse

delay(stepDelay);

}

Serial.println("Stepper move complete.");

delay(1000); // Wait before next move

}

# References

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| --- | --- |
| [1] | T. Rashid, Make Your Own Neural Network, Illustrated edition ed., CreateSpace Independent Publishing Platform, 2016. |
| [2] | “Wikipedia (Neurons),” [Online]. Available: https://en.m.wikipedia.org/wiki/List\_of\_animals\_by\_number\_of\_neurons#. |

Appendix I – Maximum PWM frequency of PCA9685

PWM Frequency=25,000,000​ / (4096×(prescale+1) )

where:

**25,000,000 Hz** is the internal clock frequency.

**4096** is the resolution (12-bit PWM).

**Prescale** is a register value (0xFE register) that sets the frequency. (=5 by default?) Chatgpt says: 0xiE = 30 -> about 200Hz

Appendix II – Servo PWM pulse

Appendix III – Setting VRef to limit current

Measure the VREF voltage using a multimeter between the VREF pin and GND.

Adjust the potentiometer to set the desired voltage.

Ensure proper cooling if setting current near or above 1.5A, as the DRV8825 can overheat

**Current Limiting**: The DRV8825 allows you to set a **current limit** (using a small potentiometer on the driver). This is important because even though you are supplying a higher voltage (e.g., 12V or 24V), the driver will limit the current to the rated current of the motor. This ensures that the motor operates within its rated current specifications, even though the supply voltage is higher.[ChatGPT]

**Potentiometer (Trimpot)** → Adjusts the current limit.

**VREF Test Point** → Small metal pad or potentiometer itself.

**GND Pin** → Ground reference for multimeter.

Appendix IV – Maximum stepper motor speed

To calculate the **maximum RPM** of a **200-step per revolution stepper motor** with a **1000 Hz step input**, use the following formula:

1.8 deg/step

Given:

* **Step Frequency** = 1000 Hz
* **Steps per Revolution** = 200

The maximum speed of the stepper motor with a **1000 Hz step pulse** is **300 RPM**.

Appendix V – Minimum step time and minimum pulse time

The **minimum step time** for a stepper motor to move **one step** is determined by the **step pulse period**, which is the inverse of the **step frequency**.

Formula for Step Time:

Given:

Step Frequency = 1000 Hz

The minimum step time to move one step at 1000 Hz is 1 millisecond (ms).

DRV8825: Requires a pulse width of 1.9 µs and a low duration of 1.9 µs.

Appendix VI - Power Supply calculation for stepper motor

The total power supply current (A) depends on the motor's rated current and the number of motors you are using.

Formula to Estimate Power Supply Current:

Ipower=2×Imotor×efficiency factorI\_{\text{power}} = 2 \times I\_{\text{motor}} \times \text{efficiency factor}Ipower​=2×Imotor​×efficiency factor

Efficiency factor ≈ 1.5 (due to driver losses).

Example: For one NEMA 11 motor rated at 1.0A: