Dragon-arm demo Datasheet

Product: Dragon-arm demo **Full name:** SpaceDragon-arm demo **Revision:** A

Robot type	Controller	Use class
Servo-based 3-axis palletizing arm	Arduino Uno series + PCA9685	Hobby / educational / prototyping

1. Product Overview

Dragon-arm demo (full name SpaceDragon-arm demo) is an open-source, 3D-printable desktop robotic arm with three servo-driven axes: base rotation, shoulder and elbow. It uses a parallel-linkage (palletizing) layout. Both arm servos are mounted on the rotating base, and a parallelogram linkage keeps the tool plate level across the whole workspace.

The arm is controlled by an Arduino Uno-series board through a PCA9685 PWM expander connected over I²C. The supported way of programming the arm is the SpaceDragon App. Users may also implement any other control method of their choice.

Dragon-arm demo is a hobby, educational and prototyping robot distributed as print-it-yourself files. It is not a certified industrial or safety-rated machine.

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2. Key Features

• 3-axis servo arm: base, shoulder, elbow	• Parallel linkage keeps the tool plate level
• Arm servos mounted on the rotating base	• Payload above 0.5 kg at full extension
• 180° range on every axis	• Repeatability ±5 mm
• Direct servo-to-joint drive, no gearing	• Arduino Uno + PCA9685 control over I²C
• Fully 3D-printable structure (PLA-CF recommended)	• Supported programming via SpaceDragon App

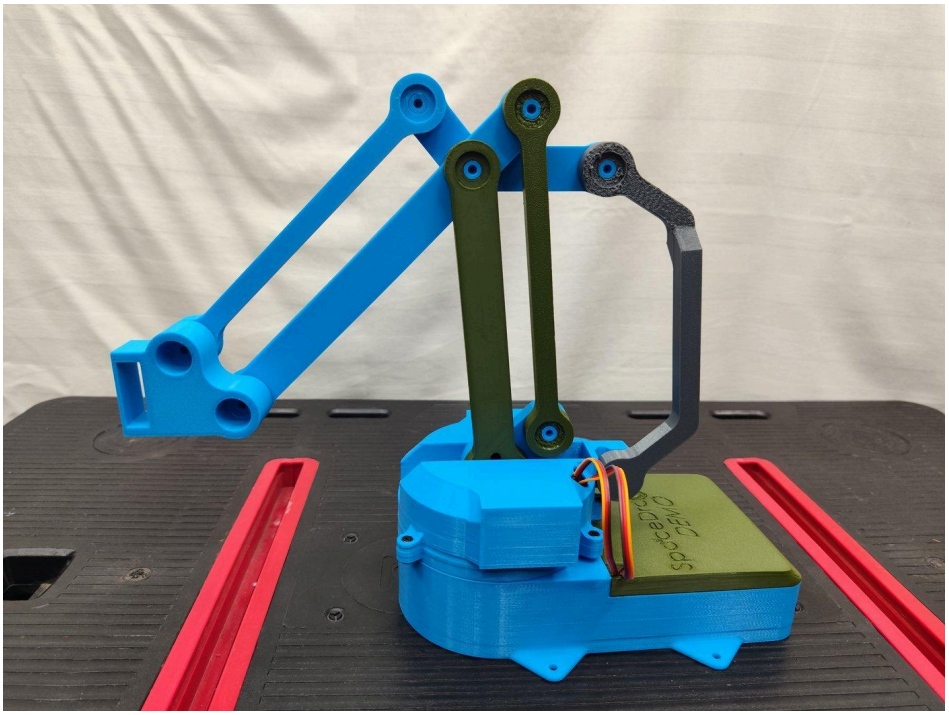


Figure 1. Dragon-arm demo, assembled (side view)

3. Technical Specifications

3.1 General Specifications

Parameter	Value
Robot type	Servo-based palletizing arm (parallel linkage)
Degrees of freedom	3 (base yaw, shoulder, elbow). End effector not included
Weight	~660 g
Base footprint	150 × 100 mm (base body, excluding mounting lugs)
Shoulder axis height	70 mm above mounting surface
Rated payload	> 0.5 kg with the arm fully extended
Repeatability	±5 mm
Controller	Arduino Uno series (Uno R4 recommended) + PCA9685 PWM expander
Servo supply	5–7 V DC, ≥ 4 A
Base mounting	4 × Ø4.4 mm holes, 120 × 80 mm pattern

3.2 Axis Specifications

Axis	Function	Servo	Range	PCA9685 output
Axis 1	Base rotation (yaw)	MG996R	180°	1st output
Axis 2	Shoulder (upper arm)	TD-8120MG	180°	2nd output
Axis 3	Elbow (forearm, via crank and parallel link)	MG996R	180°	3rd output

Parameter	Value
Axis angle reference	0° = maximum front position of the axis
Drive type	Direct drive. Servo output plate mounted directly to the joint, no reduction
Axis speed at 4.8 V	~0.17 s / 60°
Axis speed at 6.0 V	~0.14 s / 60°
Position control	Internal closed loop in each servo (built-in angle sensing)
Angle readback to controller	Not available through the standard 3-wire servo interface

Performance note: Actual speed and holding capability depend on supply voltage, available supply current, payload, arm pose, servo pulse calibration and print quality of the self-printed parts.

3.3 Kinematics and Workspace

Parameter	Value
Upper arm length (Axis 2 to elbow)	150 mm
Forearm length (elbow to wrist pivot)	150 mm
Forearm rear lever (elbow to drive link)	35 mm

Parameter	Value
Axis 3 crank length	35 mm
Shoulder axis height	70 mm above mounting surface
Tool plate orientation	Kept level by the parallel linkage
Geometric reach limit (wrist pivot)	300 mm from the shoulder axis (links collinear). Usable reach is lower and is limited by the Axis 2 / Axis 3 rule
Reach to tool point	Depends on the mounted tool

Axis 2 / Axis 3 angle rule
• Axis 2 angle must always be lower than Axis 3 angle.
• The difference (Axis 3 − Axis 2) must stay between 40° and 140°.
• Commands outside this rule drive the linkage into its mechanical limits and stall the servos.

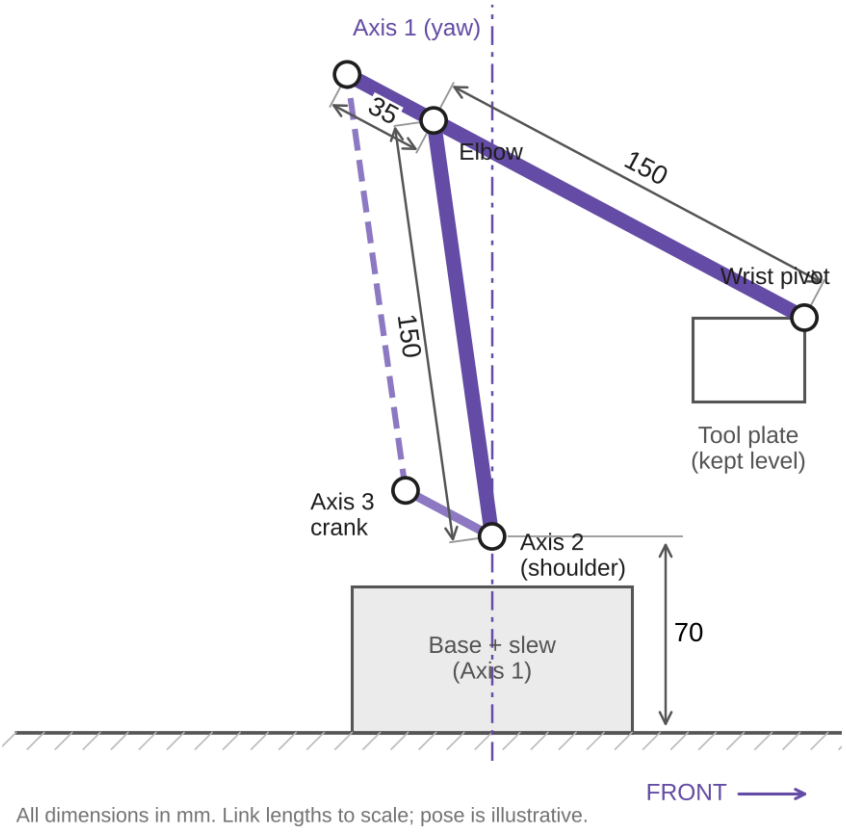


Figure 2. Kinematic layout, side view (dimensions in mm)

3.4 Material and Print Information

Parameter	Value
Recommended material	PLA-CF
Alternative material	PLA Plus
Nozzle / layer height	0.4 mm / 0.2 mm
Infill	15% gyroid

Parameter	Value
Wall loops	2 (5 for arm joints)
Top / bottom layers	5
Supports	Tree (auto)
Seam position / wall generator	Aligned / Classic
Tolerance variants	0 mm and 0.2 mm part sets, chosen with the tolerance test

Note: For self-printed parts, final performance depends on print quality, dimensional accuracy, material stiffness and the friction introduced by manufacturing tolerances. Seam position, layer height and wall generator settings noticeably affect fit. See the assembly instruction for the tolerance test procedure.

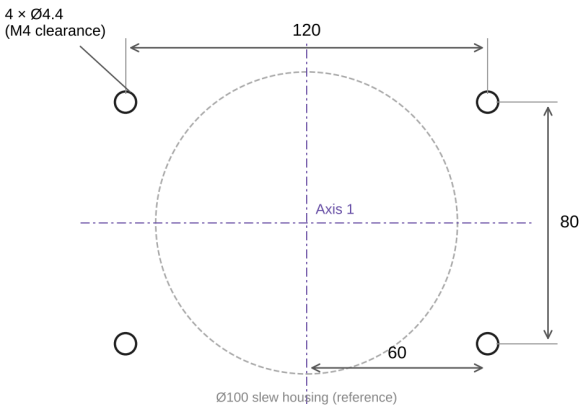
3.5 Required Components

Parameter	Value
Controller	1 × Arduino Uno series (R4 recommended)
PWM expander	1 × PCA9685
Servos	2 × MG996R, 1 × TD-8120MG
Joint bearings	9 ×
Base bearing	1 ×
Threaded inserts	15 × M3, 4.2 mm
Screws	21 × M3 × 6 mm (cone head hex recommended)
Servo power supply	5–7 V DC, ≥ 4 A

Note: The full component list, tools and step-by-step build procedure are given in the Dragon-arm demo Assembly Instruction.

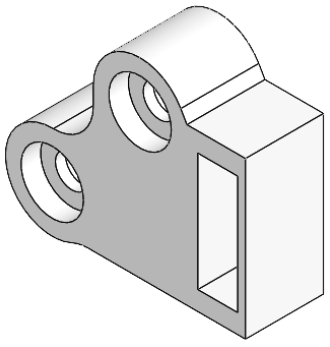
4. Mechanical Interfaces

4.1 Base Mounting

Parameter	Value
Mounting holes	4 × Ø4.4 mm (M4 clearance)
Hole pattern	120 × 80 mm, centred on Axis 1
Hole distance from robot centre	60 mm (along the 120 mm direction)
Mounting pattern	

Important: Bolt the base to a rigid surface before working with payloads. With 0.5 kg at full extension, the tipping moment on the base is larger than the arm's own weight (~660 g) can resist.

4.2 Tool Interface

Parameter	Value
Interface	Tool plate at the wrist pivot
Orientation	Kept level by the parallel linkage
Tool / end effector	Not included in this document. Reach and payload at the tool point depend on the tool used
Tool plate	

5. Electrical Interfaces

Dragon-arm demo uses an external Arduino Uno-series board and a PCA9685 PWM expander. Servo power and controller power are separate.

5.1 Control Electronics

Parameter	Value
Controller	Arduino Uno series (Uno R4 recommended)
PWM expander	PCA9685, 16-channel
Controller–expander link	I²C (SDA, SCL) + logic supply and GND
Controller power	Arduino USB-C port
Servo power	Separate DC supply connected to the PCA9685 servo power input
Power switch / emergency stop	Not included

5.2 Power Supply

Parameter	Value
Servo supply voltage	5–7 V DC
Servo supply current	≥ 4 A
Recommended source	USB-C power module (other DC sources may be used)
Common ground	Required between Arduino, PCA9685 and servo supply

Important: Never power the servos from the Arduino 5 V pin. Three servos under load draw far more current than the board can supply, which causes resets or damage.

5.3 Servo Channel Assignment

PCA9685 output	Axis	Servo
1st output	Axis 1 · Base rotation	MG996R
2nd output	Axis 2 · Shoulder	TD-8120MG
3rd output	Axis 3 · Elbow	MG996R

Note: Most PCA9685 software libraries number outputs from 0, so the 1st output is channel 0 in code.

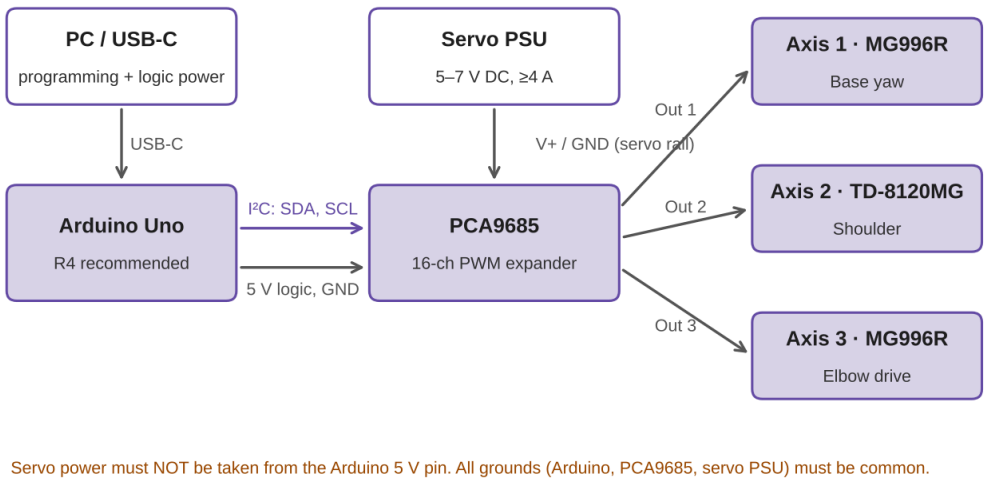


Figure 3. Control and power architecture

6. Control and Software Interface

6.1 Supported Programming Method

The supported way of programming Dragon-arm demo is the SpaceDragon App, which generates code for the arm. App functions are described in separate documentation. The app is available at:
https://www.spacedragon.online/spacedragon-app

6.2 Control Architecture

Parameter	Value
Typical architecture	SpaceDragon App or user code → Arduino → PCA9685 → servos
Command level	Joint (axis) angles
In App Cartesian / inverse kinematics	Not currently supported (future feature)
Custom control	Any control method may be implemented by the user

6.3 Servo Pulse Calibration

Each axis is assembled with its servo at the 90° position, so that servo angle matches arm angle. If a servo cannot travel the full 180°, it uses a different (non-default) pulse range. Adjust the pulse range in the SpaceDragon App or directly in the Arduino code until the servo travels the whole 180°.

7. Startup and Operating Notes

- There is no fixed home position. A home pose can optionally be set in the SpaceDragon App, and the arm can start from any position.
- When servo power is switched on, the servos move immediately to the first commanded position. Keep clear of the arm at power-up.
- The controller does not read back the actual servo angles. Arm position is known only from the commands sent.
- Without power, the arm stays in position unless it is under heavy load.
- Correct axis angles depend on each servo being mounted at its 90° position during assembly.
- Always observe the Axis 2 / Axis 3 angle rule (section 3.3).
- Servos draw current continuously while holding a load. Avoid holding heavy payloads at full extension for long periods.
- No power switch or emergency stop is included. To stop the arm, disconnect the servo power supply.

8. Environmental Information

8.1 Environmental Specifications

Parameter	Value
Intended environment	Indoor, dry, desktop use
Formal ingress protection rating	None
Water exposure suitability	Not intended for contact with water
Operating temperature range	Not specified

Note: PLA-based parts have limited heat resistance. Keep the arm away from heat sources and direct sunlight.

9. Safety Information

9.1 Intended Use

Dragon-arm demo is intended only for hobby projects, education, prototyping and desktop demonstration.

9.2 Restrictions

- Do not use Dragon-arm demo in medical devices.
- Do not use Dragon-arm demo in human-interactive safety-relevant machines.
- Do not use Dragon-arm demo in animal-interactive systems.
- Do not use Dragon-arm demo in life-critical or safety-critical applications.
- Do not use Dragon-arm demo in devices exposed to water.

9.3 Handling Warnings

- Do not touch moving parts during operation. The parallel linkage creates pinch points between links.
- Keep fingers, tools and loose materials out of the arm's workspace while servo power is on.
- Servos move without warning when power is applied or a command is sent.
- Verify wiring and supply polarity before power-up.
- Secure the base before operating with a payload.
- The user is fully responsible for safe assembly, programming and operation.

10. Product Images

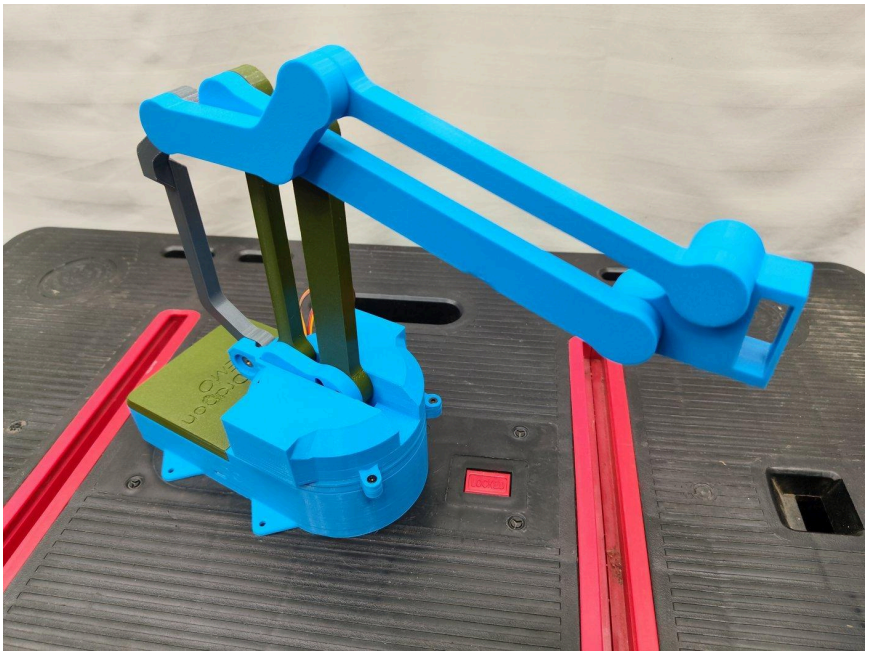


Figure 4. Arm extended forward

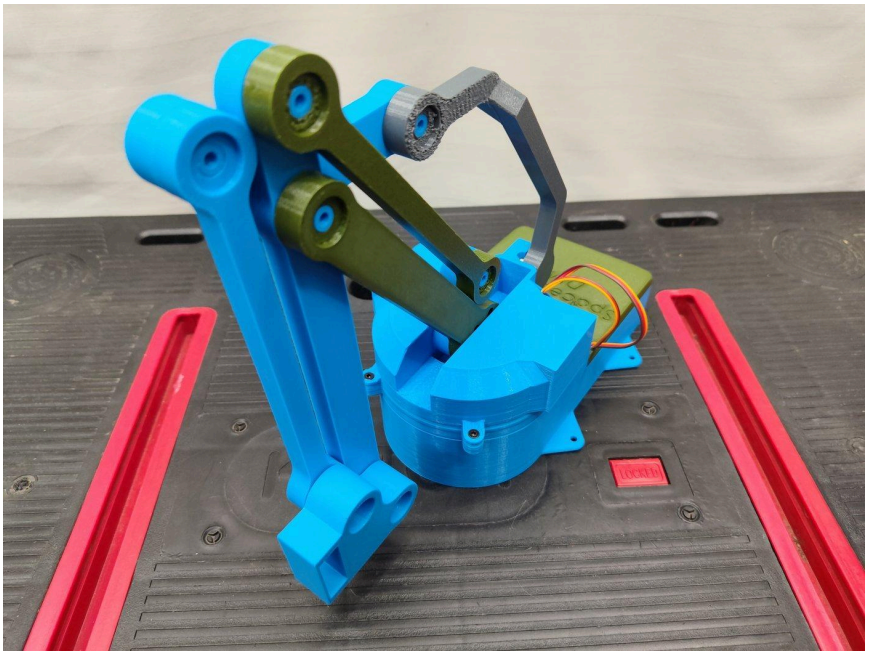


Figure 5. Arm raised, front-side view

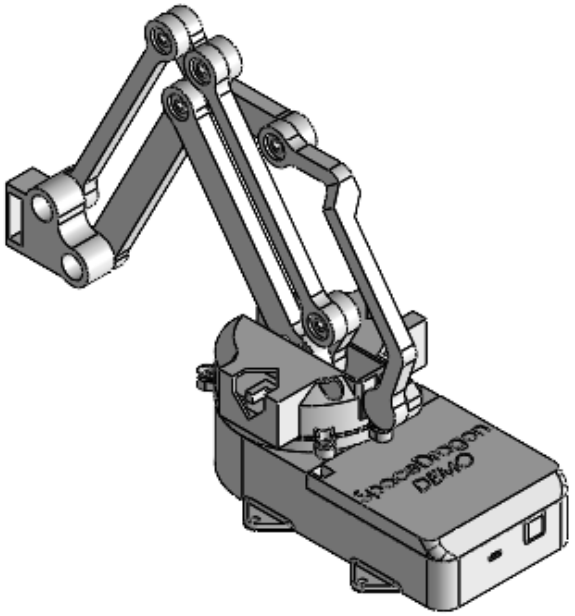


Figure 6. CAD assembly

11. Revision History

11.1 Document Revisions

Parameter	Value
A	Initial release