BD-1 Animatronic Electronics & Wiring Guide (v3)

Updated for 3-DoF head (tilt, cant, neck-base yaw), 7 servo channels, and BOM with links.

Bill of Materials (with links)

Item	Qty	Suggested Part / Example	Link
Raspberry Pi 4 (2GB or 4GB)	1	Pi 4 Model B	https://www.raspberrypi.com/products/raspberry-p
MicroSD Card 64GB (Class 10)	1	SanDisk Ultra 64GB	https://www.amazon.com/dp/B073JYVKNX
Pi 4 Power Supply 5V 3A USB-C	1	Official Raspberry Pi PSU	https://www.raspberrypi.com/products/type-c-powe
5V 6A DC Power Supply (barrel jack)	1	MEAN WELL GST60A05	https://www.digikey.com/en/products/detail/mean-
Barrel Jack to Screw Terminal Adapter	1	Adafruit #368	https://www.adafruit.com/product/368
1000µF 6.3V+ Electrolytic Capacitor	1	Generic	https://www.amazon.com/dp/B07T1G7B2D
330Ω Resistor	2	Through-hole 1/4W	https://www.amazon.com/dp/B07ZQ2QGVV
Logic Level Shifter (3.3V↔5V)	1	BSS138 bidirectional	https://www.adafruit.com/product/757
Adafruit 16-Channel PWM/Servo Driver (PCA9685)	1	Adafruit #815	https://www.adafruit.com/product/815
MG996R Metal Gear Servo (head DoF)	3	High torque ~10kg·cm	https://www.amazon.com/dp/B07K8BL7R7
MG90S Metal Gear Micro Servo (stim drawer)	1	MG90S	https://www.amazon.com/dp/B00X7H3Z08
SG90 Micro Servo (antennas)	2	SG90	https://www.amazon.com/dp/B07L2SF3R7
Servo Extension Wires (female-female)	10	3-pin	https://www.amazon.com/dp/B07G3GQ66H
M3 Assorted Hardware Kit	1	Screws/Nuts/Standoffs	https://www.amazon.com/dp/B01N2J7X94
WS2812B LEDs (10 total)	1	1x NeoPixel 8-stick + 2 pixels OR 30 LED strip	https://www.adafruit.com/product/1426
Extra WS2812B single pixels (optional)	2	Adafruit #1612	https://www.adafruit.com/product/1612
22–24 AWG Hook-up Wire (red/black/green)	1	Wire spool set	https://www.amazon.com/dp/B07VQYXL4S
Heat-shrink Tubing Assortment	1	Assorted sizes	https://www.amazon.com/dp/B01M7Y2M2G
USB Microphone	1	Mini USB mic	https://www.amazon.com/dp/B07Y2DP6Q1
USB Speaker OR PAM8302 Mini Amp	1	Adafruit #2130	https://www.adafruit.com/product/2130
8Ω 3W Speaker	1	Adafruit #1314	https://www.adafruit.com/product/1314

Servo & LED Layout

Channel	Function
CH0	Head Tilt (Forward/Back)
CH1	Head Cant (Left/Right lean)
CH2	Head Twist (Yaw at neck base)
CH3	Antenna Left
CH4	Antenna Right
CH5	Stim Drawer
CH6	Spare / Expansion

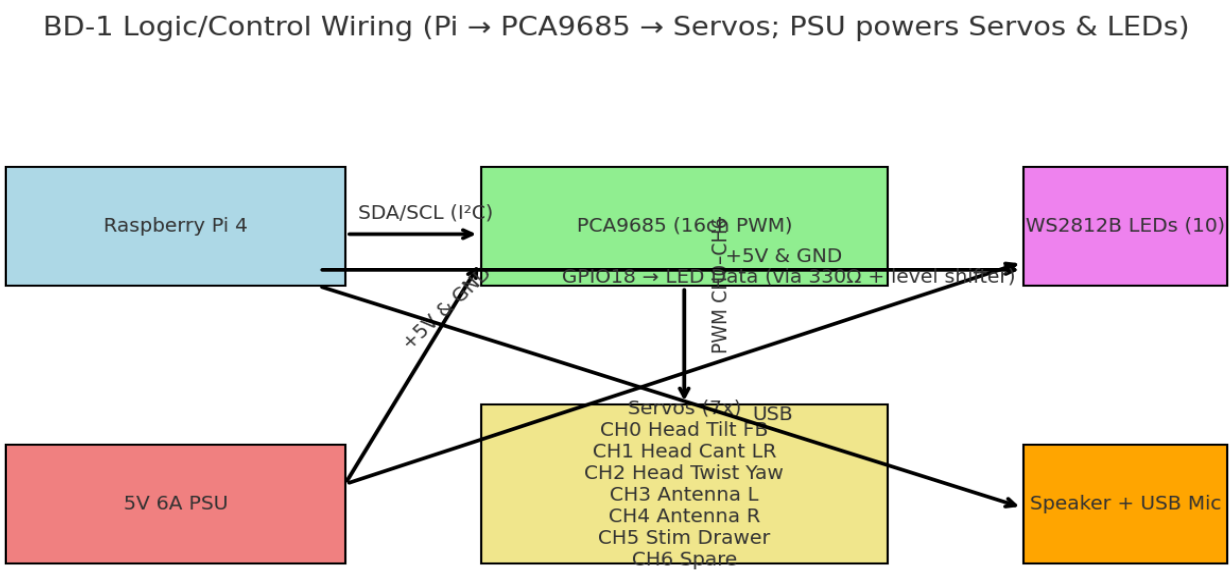
LED chain (WS2812B): LEDs 0–7 = rear head array; LED 8 = left eye; LED 9 = right eye.

Pin-to-Pin Wiring Table

From (Pi)	Pin #	To (Device)	Notes
GPIO2 (SDA)	3	PCA9685 SDA	I²C data
GPIO3 (SCL)	5	PCA9685 SCL	I²C clock
5V (logic)	2	PCA9685 VCC	Logic only (not servo rail)
GND	6	PCA9685 GND	Common ground
GPIO18	12	WS2812B Data In	330Ω inline; use level shifter
PSU +5V	—	PCA9685 V+ & WS2812B V+	Power servos + LEDs
PSU GND	—	PCA9685 GND & WS2812B GND	Return path; tie to Pi GND
PCA9685 CH0–CH6	—	Servos	Signal-only from PCA9685

Visual Wiring Diagram (Logic & Control)

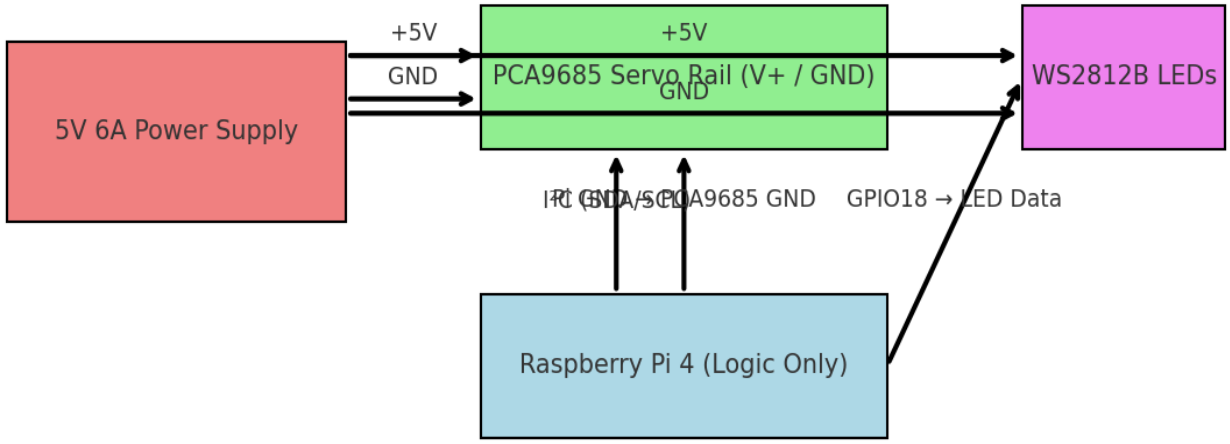
Pi → PCA9685 over I²C; PCA9685 → Servos over PWM; PSU powers PCA9685 servo rail + LEDs; Pi provides LED data only.



Power Wiring Schematic

Common ground between Pi, PCA9685, and PSU. Place a 1000µF capacitor at LED input; add 330Ω resistor on LED data line.

BD-1 Power Wiring Schematic (Common Ground; PSU feeds PCA9685 + LEDs)



Python Test Bench Script (3-DoF Head)

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from adafruit_servokit import ServoKit import board, neopixel, time, pygame # I2C must be enabled; PCA9685 on default address 0x40 kit = ServoKit(channels=16) # LEDs: 10 pixels on GPIO18 (use level shifter) pixels = neopixel.NeoPixel(board.D18, 10, auto_write=False) pygame.mixer.init() # USB audio def center_all(): for ch in [0,1,2,3,4,5]: # CH6 spare kit.servo[ch].angle = 90 time.sleep(1) def test_head(): # CH0: tilt forward/back for a in [60, 90, 120, 90]: kit.servo[0].angle = a; time.sleep(0.4) # CH1: cant left/right for a in [60, 90, 120, 90]: kit.servo[1].angle = a; time.sleep(0.4) # CH2: twist (yaw) at neck base for a in [60, 90, 120, 90]: kit.servo[2].angle = a; time.sleep(0.4) def test_antennas_and_drawer(): # Antennas CH3/CH4 wiggle for _ in range(3): kit.servo[3].angle = 60; kit.servo[4].angle = 120; time.sleep(0.25) kit.servo[3].angle = 120; kit.servo[4].angle = 60; time.sleep(0.25) # Stim drawer CH5 open/close kit.servo[5].angle = 60; time.sleep(1.0) kit.servo[5].angle = 90; time.sleep(0.5) def test_leds(): # back array = red for i in range(8): pixels[i] = (255,0,0) # eyes = blue pixels[8] = (0,0,255); pixels[9] = (0,0,255) pixels.show(); time.sleep(1.5) pixels.fill((0,255,0)); pixels.show(); time.sleep(1.5) pixels.fill((0,0,0)); pixels.show() def test_audio(): try: pygame.mixer.music.load("bd1_sound.mp3") pygame.mixer.music.play() while pygame.mixer.music.get_busy(): time.sleep(0.1) except Exception as e: print("Audio test skipped:", e) if __name__ == "__main__": center_all() test_head() test_antennas_and_drawer() test_leds() test_audio()
```