PCA9685 16-Channel 12-bit PWM Servo Driver

PCA9685 PWM controller · I2C interface · 16 three-pin servo outputs · Separate V+ servo supply terminal · Six address jumpers

V+ 6 V MAX | VCC 3-5 V | I2C 0x40 DEFAULT | 16 x 12-BIT PWM | 24 TO 1526 HZ | CHAINABLE

1 DEVICE IDENTIFICATION

ITEM	VALUE
Order code	**MOD-PCA9685-16CH**
Contents	**1 x assembled board, servo headers, right-angle control header, terminal block and capacitor fitted**
Board markings	**PCA9685, 16 x 12-bit PWM, V1246, I2C Address (Open=0/Closed=1); underside: VCC 3-5V, Logic 3-5V, V+ 6V Max, Freq 40-1000Hz**
Controller (U1)	**PCA9685PW, 16-channel 12-bit PWM controller, TSSOP28**
Output resistors	**220 Ω in series with each of the 16 PWM outputs (marked 221)**
Servo supply capacitor	**1000 µF electrolytic, 105 °C, about 8 mm diameter**
Other fitted parts	**Power LED with 470 Ω resistor, 2-way screw terminal block, six address jumper pads with 10 kΩ resistors (marked 103)**

2 PIN FUNCTIONS

PIN	FUNCTION
GND	Ground. Common to the host, VCC and V+.
OE	Output enable, active low. Low = outputs run; high = all outputs off. Tie to GND if unused.
SCL	I2C clock from the host.
SDA	I2C data.
VCC	Logic supply for the controller, 3 to 5 V. Use the host's own logic voltage.
V+	Servo supply rail, passed through to every servo header. Up to 6 V.
Terminal	2-way screw terminal: V+ (marked V+, nearest the POWER LED) and GND. The main servo supply input.
PWM / V+ / GND	16 three-pin servo headers, 2.54 mm. Rows from the board edge inwards: GND (black), V+ (red), PWM (yellow).

The 6-pin control header (right-angle pins fitted) and the 6 empty holes at the other end carry the same signals in the same order, GND at the top, so boards can be chained (section 5).

3 SPECIFICATIONS

3.1 RECOMMENDED OPERATING CONDITIONS (BOARD)

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNIT
VCC, logic supply	VCC to GND	**3.0**		**5.5**	V
Host logic level, SDA SCL OE	Same as VCC	**3.0**		**5.5**	V
V+, servo supply	Board marking		**5**	**6**	V
PWM frequency, servos	Analogue hobby servos		**50**		Hz
PWM frequency, board	Board marking	**40**		**1000**	Hz
Operating temperature	Controller rating	**-40**		**+85**	°C

VCC powers only the controller and the PWM signal level. Servo current flows through V+ and GND, never through VCC. Size the V+ supply for every servo that may move or stall at once.

The 1000 µF capacitor sits on V+. Keep V+ at or below 6 V.

3.2 CONTROLLER ABSOLUTE MAXIMUM RATINGS

PARAMETER	CONDITIONS	MIN	MAX	UNIT
Supply voltage, VCC		**-0.5**	**+6.0**	V
Voltage on an input or output pin		**-0.5**	**5.5**	V
Output current, each PWM pin			**25**	mA
Ground current, total			**400**	mA
Total power dissipation			**400**	mW
Storage temperature		**-65**	**+150**	°C

Stress limits of the controller. Operation at these limits is not implied.

3.3 CONTROLLER ELECTRICAL CHARACTERISTICS

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNIT
Supply voltage		**2.3**		**5.5**	V
Supply current	Running, no load, 1 MHz I2C		**6**	**10**	mA
Standby current	No load, bus idle		**2.2**	**15.5**	µA
Input low, SDA SCL OE		**-0.5**		**0.3 V_{DD}**	V
Input high, SDA SCL OE		**0.7 V_{DD}**		**5.5**	V
PWM output sink current	V_{OL} = 0.5 V, 2.3 to 4.5 V	**12**	**25**		mA
PWM output high	Source 10 mA, V_{DD} 4.5 V	**4.0**			V
PWM output high	Source 10 mA, V_{DD} 3.0 V	**2.3**			V
Total output sink current	All outputs			**400**	mA
Internal oscillator	Typical		**25**		MHz
I2C clock	Fast-mode Plus	**0**		**1000**	kHz
Power-on reset threshold			**1.70**	**2.0**	V

Controller figures over -40 to +85 °C and 2.3 to 5.5 V. The PWM outputs are logic signals for servo inputs, LED drivers and MOSFET gates. Each passes through a 220 Ω resistor, so they cannot power a motor, relay or servo directly.

The internal oscillator varies between parts, so the real PWM frequency can be a few percent off the value set in software. For accurate servo timing, measure it once and correct it in software (section 4.3).

4 I2C INTERFACE AND PWM TIMING

4.1 I2C ADDRESS

ITEM	VALUE
Address format	**1 A5 A4 A3 A2 A1 A0, 7-bit, 0x40 to 0x7F**
Default	**0x40, all six jumpers open**
Setting an address	**Bridge a jumper pad pair with solder to set that bit to 1 (Open = 0, Closed = 1)**
Do not use	**0x70 (LED All Call, on at power-up) for a single board**
Also reserved	**General call 0x00 with byte 0x06 is the software reset**
Boards per bus	**Up to 62 on one I2C bus**

The six jumper pairs are not labelled A0 to A5 on the board. To find which bit a jumper sets, bridge one and run an I2C scanner: the address it reports tells you. 0x41 means A0, 0x42 A1, 0x44 A2, 0x48 A3, 0x50 A4, 0x60 A5.

4.2 PWM TIMING

ITEM	VALUE
Resolution	**12 bit, 4096 steps per period, each channel set on its own**
Frequency	**One frequency shared by all 16 outputs, 24 to 1526 Hz on the controller**
Prescale	**round(25 MHz / (4096 x f)) - 1, from 3 to 255. Default 30, about 200 Hz**
Step at 50 Hz	**20 ms / 4096 = about 4.9 µs**
Servo pulses at 50 Hz	**1.0 ms = about 205 steps, 1.5 ms = 307, 2.0 ms = 410**
At power-up	**All outputs low until the host writes them**

4.3 SOFTWARE SUPPORT

PLATFORM	PACKAGE AND USE
Arduino IDE	Adafruit PWM Servo Driver Library 3.0.3 from the Library Manager (search PCA9685). Accept its dependency, Adafruit BusIO. Example: File > Examples > Adafruit PWM Servo Driver Library > servo. Use `setPWMFreq(50)` and `writeMicroseconds(channel, us)`.
Frequency trim	`setOscillatorFrequency()` corrects for the oscillator. Start with 27000000; to fine-tune, measure the real frequency and use the oscillator example.
ESPHome	`pca9685` output component, frequency 50 Hz for servos.
Raspberry Pi	Python ServoKit or PCA9685 libraries over the Pi's I2C pins, VCC from the Pi's 3.3 V pin.

4.4 OUTPUT BEHAVIOUR

- Outputs are push-pull by default (sink 25 mA, source 10 mA at 5 V on the controller side of the 220 Ω resistors).
- Setting a channel fully on or fully off gives a steady high or low, so a channel can also switch a logic input or a MOSFET gate.
- OE high turns every output off at once, without changing the stored settings.
- The servo headers carry no current limit or fuse. A stalled servo draws its full stall current from V+.

5 APPLICATION AND IMPLEMENTATION

5.1 HOST CONNECTIONS

BOARD PIN	UNO / NANO	MEGA 2560	ESP32 DEV MODULE	RASPBERRY PI
GND	GND	GND	GND	GND (pin 6)
SDA	A4	20	GPIO21	GPIO2 (pin 3)
SCL	A5	21	GPIO22	GPIO3 (pin 5)
VCC	5V	5V	3V3	3.3V (pin 1)
OE	GND, or a spare output pin to switch all outputs off			
V+	Leave unconnected here. Feed V+ through the terminal block.			

Match VCC to the host's logic voltage: 5 V on an Uno, Nano or Mega, 3.3 V on an ESP32 or Raspberry Pi. The PWM signal then swings to the same voltage, which servos accept either way.

5.2 CHAINING BOARDS

- Give each board its own address with the jumpers, then link the 6-pin end of one board to the 6 holes at the far end of the last.
- GND, OE, SCL, SDA, VCC and V+ all pass along the chain. Feed servo power into one terminal block per board, or at least every few boards.
- The side header V+ pins bypass the terminal block, so connect them the right way round.

5.3 SERVO POWER

1. Connect a separate 5 V or 6 V supply to the terminal block: + to the screw marked V+, nearest the POWER LED, and - to the other screw.
2. Join the supply ground and the host ground. The board does this through its GND pins once both are connected.
3. Never power servos from VCC or from the host's 5V pin. A moving servo pulls enough current to reset the host.
4. Allow the servo's stall current for each servo that can move at the same time, from its own datasheet, and add a margin.
5. Check polarity before switching on. Treat the terminal block as unprotected: a reversed supply can damage the capacitor and the servos.

5.4 FIRST TEST

1. Wire as in 5.1 and plug a servo into channel 0, brown or black wire to GND, nearest the board edge.
2. Install the library (4.3) and run an I2C scanner. It should report 0x40.
3. Upload the sweep sketch from the Quick Start. The servo moves between its two ends and the centre once a second.
4. Servo buzzes at the ends: narrow the pulse range, for example 1100 to 1900 µs.

6 MECHANICAL DATA

6.1 DIMENSIONS AND MOUNTING HOLES

Holes ~3.0 mm (M2.5). Origin: bottom-left corner. Servo rows from the edge: GND, V+, PWM.

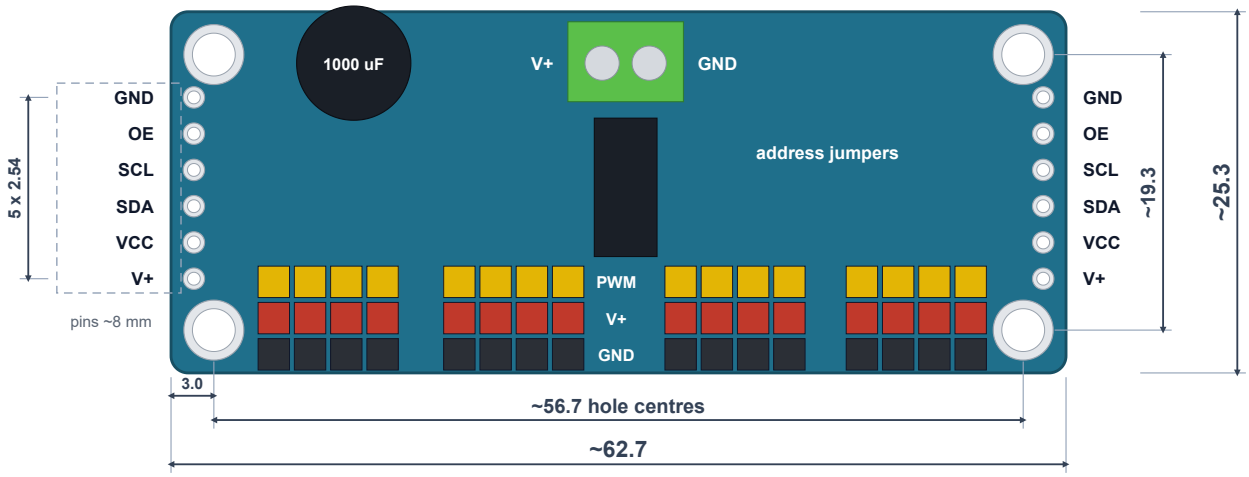


Figure 1. Component side, PCA9685 text upright, control header on the left. Simplified, not to scale. Dimensions in mm from the bottom-left corner of the board, approximate (±0.5 mm), measured from stock against the 2.54 mm header pitch.

6.2 HOLE AND CONNECTOR TABLE

FEATURE	X	Y	MM
Mounting holes, left pair	~3.0	~3.0, ~22.3	
Mounting holes, right pair	~59.7	~3.0, ~22.3	
Control header, GND to V+	~1.6	~19.3 to ~6.6	
Chain holes, GND to V+	~61.1	~19.3 to ~6.6	
Servo GND row (edge row)	~7.2 to ~56.2	~1.3	
Terminal block screws	~30.2, ~33.5	~21.7	
Capacitor centre	~12.8	~21.7	

Board about 62.7 x 25.3 mm. Four holes about 3.0 mm diameter, for M2.5 screws or standoffs, centres about 3 mm in from each edge: about 56.7 mm apart along the board and 19.3 mm across.

6.3 HEIGHTS AND OVERHANGS

FEATURE	VALUE	MM
Servo header pins above the board	~8.5	
Capacitor, tallest part	~13	
Control header pins past the left edge	~8	
Solder joints below the board	~1.5	

Servo plugs push straight down onto the 3-pin headers. Leave about 15 mm above the board for plugs and leads, and room past the left edge for the jumper wires on the right-angle header.

7 REVISION HISTORY

REV	DATE	CHANGE
1	2026-10-22	Initial release.