P32 Goblin Full - Printable Build Guide

High-Quality Visual Assembly Instructions

Print Settings for Best Results

Recommended Print Settings:

- **Paper:** 8.5" x 11" (US Letter) or A4
- **Orientation:** Portrait
- **Color:** Full color recommended for wiring diagrams
- **Pages:** Print all sections, approximately 15 pages
- **Binding:** Three-hole punch for binder assembly

Quick Reference Component List

Component	Quantity	Key Specs
ESP32-S3-DevKitC-1	1	Main controller
GC9A01 Round Display	3	240x240px, SPI
MAX98357A Audio Amp	1	I2S digital input
HC-SR04 Sensor	1	Ultrasonic distance
4Ω Speaker	1	3W, 40mm diameter
5V Power Supply	1	2A minimum
Breadboard	1	830 tie points
Jumper Wires	1 set	Assorted colors

Critical Wiring Summary

Complete Visual Wiring Diagram

Full system connection diagram showing all components, GPIO assignments, and power distribution

Power Distribution (Most Important!)

```
5V Supply → Breadboard Red Rail → All Component VCC pins
Ground → Breadboard Black Rail → All Component GND pins
ESP32 VIN ← Breadboard Red Rail
ESP32 GND ← Breadboard Black Rail
```

GPIO Pin Chart (Print This Page!)

GPIO	Component	Function	Wire Color
4	Audio Amp	I2S BCLK	Red
5	Audio Amp	I2S WS	Black
6	Audio Amp	I2S DATA	White
9	HC-SR04	TRIG	Gray
10	HC-SR04	ECHO	Pink
12	All Displays	SPI MISO	Blue
13	All Displays	SPI MOSI	Green
14	All Displays	SPI CLK	Yellow
15	Left Eye	CS	Orange
16	Right Eye	CS	Purple
17	Mouth	CS	Brown

ESP32-S3 GPIO Pin Reference

```
        ESP32-S3-DevKitC-1 Pinout (Key Pins Used)

    ┌──────────────────────────────────────┐
    │  VIN ●                          ● 3.3V │
    │  GND ●                          ● RST  │
    │  IO3 ●                          ● IO46 │
    │  IO4 ● ← I2S BCLK (Audio)       ● IO0  │
    │  IO5 ● ← I2S WS (Audio)         ● IO45 │
    │  IO6 ● ← I2S DATA (Audio)       ● IO48 │
    │  IO7 ●                          ● IO47 │
    │  IO15● ← SPI CS1 (Left Eye)     ● IO21 │
    │  IO16● ← SPI CS2 (Right Eye)    ● IO14 │← SPI CLK (All)
    │  IO17● ← SPI CS3 (Mouth)        ● IO13 │← SPI MOSI (All)
    │  IO18●                          ● IO12 │← SPI MISO (All)
    │  IO8 ●                          ● IO11 │
    │  IO19●                          ● IO10 │← Sensor ECHO
    │  IO20●                          ● IO9  │← Sensor TRIG
    └──────────────────────────────────────┘
```

Step-by-Step Assembly

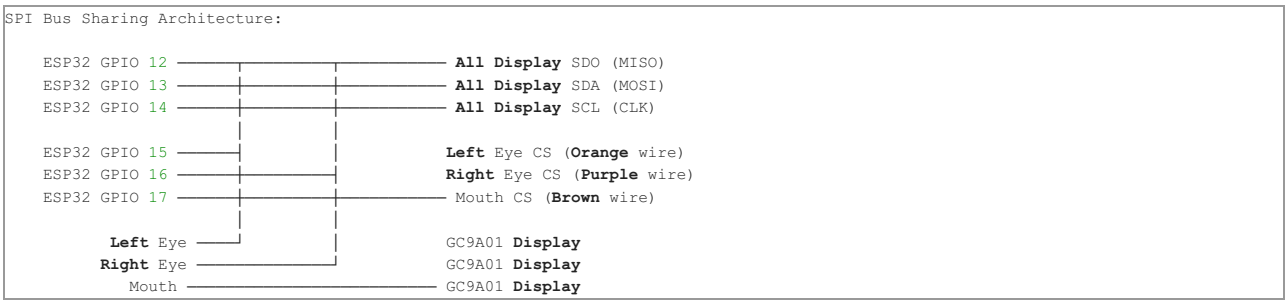
Step 1: Power Setup

[INSERT HIGH-RES PHOTO: Breadboard with power rails connected]

1. Connect 5V supply positive to breadboard red rail
2. Connect 5V supply ground to breadboard black rail
3. Connect ESP32 VIN to breadboard red rail
4. Connect ESP32 GND to breadboard black rail

Critical: Verify 5V on red rail with multimeter before proceeding!

Step 2: Display Wiring



Shared SPI Bus (connect to ALL displays):

- GPIO 12 (blue) → SDO pin on all displays
- GPIO 13 (green) → SDA pin on all displays
- GPIO 14 (yellow) → SCL pin on all displays

Individual Chip Select:

- GPIO 15 (orange) → Left eye CS pin
- GPIO 16 (purple) → Right eye CS pin
- GPIO 17 (brown) → Mouth CS pin

Power & Control:

- Red rail → VCC on all displays
- Black rail → GND on all displays
- 3.3V → RES pin on all displays
- 3.3V → DC pin on all displays

Step 3: Audio System

[INSERT HIGH-RES PHOTO: Audio amplifier and speaker wiring]

I2S Digital Audio:

- GPIO 4 (red) → BCLK pin
- GPIO 5 (black) → LRCK pin
- GPIO 6 (white) → DIN pin

Power & Output:

- Red rail → VCC pin
- Black rail → GND pin
-
  - terminal → Speaker positive
-
  - terminal → Speaker negative

Step 4: Distance Sensor

[INSERT HIGH-RES PHOTO: HC-SR04 sensor mounted and wired]

Digital Interface:

- GPIO 9 (gray) → TRIG pin
- GPIO 10 (pink) → ECHO pin

Power:

- Red rail → VCC pin (5V required)
- Black rail → GND pin

Physical Mounting Positions

[INSERT HIGH-RES PHOTO: Assembled goblin head showing component positions]

3D Coordinate System (Nose Center = Origin)

Component	X Position	Y Position	Z Position
Left Eye	-1.05"	+0.7"	-0.35"
Right Eye	+1.05"	+0.7"	-0.35"
Mouth	0"	-1.05"	0"

Nose Sensor	0"	0"	+0.25"
Speaker	-0.5"	+0.5"	-1.0"

Key Measurements:

- Eye spacing: 3.0" center-to-center
- Total face width: ~4.5"
- Face height: ~3.5"
- Sensor protrusion: 0.25" from face

[INSERT HIGH-RES PHOTO: Dimensional diagram with ruler for scale]

Software Installation Checklist

Prerequisites

□ Visual Studio Code installed
□ PlatformIO extension installed
□ Git for Windows installed
□ USB-C cable available

Project Setup

□ Clone repository: `git clone https://github.com/reussered/p32-animatronic-bot.git`
□ Open folder in VS Code
□ Verify PlatformIO detects project
□ Check `src/p32_component_config.h` contains: `#define ENABLE_GOBLIN_COMPONENTS`

Build & Upload

□ Run: `pio run` (should complete successfully)
□ Connect ESP32-S3 via USB-C
□ Run: `pio run -t upload`
□ Start monitor: `pio device monitor`

Expected Results:

- Build: ~5.8% RAM, ~51.7% Flash usage
- Upload: Successful to detected COM port
- Monitor: Loop messages showing all components active

[INSERT HIGH-RES PHOTO: VS Code showing successful build output]

Testing & Verification

Visual Confirmation

□ All three displays show content
□ Eyes display blinking animation
□ Mouth displays color changes
□ Colors change automatically over time

[INSERT HIGH-RES PHOTO: All three displays active with different colors]

Audio Confirmation

□ Speaker produces startup sounds
□ Audio quality is clear (not distorted)
□ Volume level appropriate

Sensor Confirmation

□ Distance readings change when objects approach nose
□ Serial monitor shows changing distance values
□ System responds to proximity with mood changes

[INSERT HIGH-RES PHOTO: Serial monitor showing sensor readings]

Mood System Reference

The goblin cycles through 9 emotional states:

Emotion	Color Theme	Animation Style	Trigger
FEAR	Pale/White	Rapid movement	Sudden proximity
ANGER	Red	Intense stare	Sustained proximity
IRRITATION	Orange	Narrowed eyes	Repeated interaction
HAPPINESS	Bright/Yellow	Wide eyes	Positive interaction
CONTENTMENT	Soft/Blue	Relaxed	Extended calm
HUNGER	Green	Searching	Time-based
CURIOSITY	Blue	Alert	Motion detection
AFFECTION	Pink	Gentle gaze	Gentle interaction
EXCITEMENT	Flashing	Rapid changes	High activity

[INSERT HIGH-RES PHOTO: Grid showing each emotion's display appearance]

Common Problems & Solutions

No Display Output

Problem: Black screens on all displays
Check: Power connections, SPI wiring, CS pin assignments
Solution: Verify 5V power and individual CS pins

[INSERT HIGH-RES PHOTO: Multimeter checking 5V on display VCC pin]

Compilation Errors

Problem: Build fails with "undefined reference" errors
Check: `p32_component_config.h` file
Solution: Ensure `#define ENABLE_GOBLIN_COMPONENTS` is present

No Audio Output

Problem: Silent speaker
Check: I2S wiring, amplifier power, speaker connections
Solution: Verify GPIO 4,5,6 connections and 5V power to amplifier

Sensor Not Responding

Problem: Fixed distance readings
Check: 5V power (3.3V won't work), GPIO 9,10 connections
Solution: HC-SR04 requires full 5V, verify with multimeter

[INSERT HIGH-RES PHOTO: Troubleshooting setup with multimeter and test points]

Safety & Best Practices

Electrical Safety

- Always disconnect power when making wiring changes
- Use multimeter to verify voltages before connecting components
- Install 1A fuse in 5V supply line for overcurrent protection
- Keep work area clean and organized

Component Handling

- Handle ESP32-S3 with anti-static precautions
- Store unused components in anti-static bags
- Double-check wiring before applying power
- Use color-coded wires consistently

[INSERT HIGH-RES PHOTO: Organized workspace with tools and components]

Expansion Ideas

With 26+ unused GPIO pins, consider adding:

- **Servo-controlled neck movement** (PWM on GPIO 18,19)
- **Camera module** (I2C or SPI interface)
- **Microphone input** (I2S or ADC)
- **Additional displays** (expand SPI bus)
- **LED strips** (WS2812B on data pins)
- **Wheeled base** (motor controllers)

[INSERT HIGH-RES PHOTO: Example expanded system with additional components]

Final Assembly Photos

[INSERT HIGH-RES PHOTO: Completed goblin head - front view]
[INSERT HIGH-RES PHOTO: Completed goblin head - side view showing wiring]
[INSERT HIGH-RES PHOTO: Completed goblin head - back view showing connections]
[INSERT HIGH-RES PHOTO: System in operation showing animated displays]

Contact & Support

- **GitHub Issues:** Report problems at repository
- **Documentation:** Complete specs in `/docs` folder
- **Community:** Project forums and discussion groups
- **Hardware Support:** Component manufacturer resources

Build completion checklist:
□ All components powered and functional
□ Serial monitor shows continuous operation
□ All three displays animate correctly

□ Audio output clear and appropriate volume
□ Distance sensor responds to proximity
□ Mood system cycles through emotional states

Congratulations! Your P32 Goblin Full animatronic is complete!

This guide is designed for high-quality printing. For digital viewing and additional resources, see the complete documentation at: https://github.com/reussered/p32-animatronic-bot