A-Z Mandible — Expanded Build Guide v2.0

Laboratory-Ready Instructions for Building a Functional Prototype

Aziel Eliab

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Abstract

This expanded build guide is designed so that a competent engineer or maker can take it into a laboratory and build a fully functional A-Z Mandible prototype. It includes detailed materials lists, exact circuit diagrams, full Arduino code, step-by-step instructions for all phases, testing procedures, and guidance for Phase 4 intraoral integration with bone conduction feedback.

Contents

Chapter 1

Overview and Goals

This guide covers four progressive phases:

1. Phase 1: Prove that jaw movement produces a usable electrical signal.
2. Phase 2: Amplify and clean the raw signal.
3. Phase 3: Classify simple patterns (YES / NO).
4. Phase 4: Integrate into an intraoral form factor with bone conduction self-hearing feedback.

Phases 1–3 have been physically completed and validated. Phase 4 is the transition to a wearable prototype.

Chapter 2

Materials List (Complete)

Electronics (Core Prototype):

- Piezoelectric disc sensor, 27mm diameter (common buzzer type) — Qty: 3
- Arduino Nano or Uno (3.3V or 5V version)
- LM358 Dual Op-Amp IC (or OPA2134 for significantly better noise performance)
- Resistors: 1M (3 pcs), 10k (5 pcs), 100k (3 pcs)
- Capacitors: 0.1µF ceramic (5 pcs), 1µF electrolytic (3 pcs), 10µF electrolytic (3 pcs)
- Breadboard (full size) and jumper wires (male-to-male and male-to-female)
- USB cable for Arduino programming

For Phase 4 (Intraoral + Feedback):

- Medical-grade biocompatible silicone or dental-grade resin for housing
- Small bone conduction transducer (from bone conduction earphones or similar)
- Low-power Class-D audio amplifier board (PAM8403 or equivalent, 3W or less)
- Small LiPo battery (optional, for wireless testing)
- LiPo charging/protection board (optional)
- Conformal coating spray or medical-grade epoxy for moisture sealing
- 3D printer filament (PLA or PETG recommended for prototyping housings)

Tools Recommended:

- Soldering iron + solder
- Digital multimeter
- Oscilloscope (highly recommended for signal analysis)
- 3D printer (for Phase 4 housings)
- Helping hands or PCB holder

Chapter 3

Phase 1 — Signal Proof (Detailed Laboratory Instructions)

Objective: Prove that jaw movement produces a distinct electrical signal.

Circuit Wiring:

1. Connect the positive leg of the piezo disc to Arduino analog pin A0.
2. Connect the negative leg of the piezo disc to Arduino GND.
3. Connect a 1M resistor between Arduino A0 and GND (this provides a bias path).

Arduino Code (Phase 1):

```
int sensorPin = A0;
int threshold = 25;   // Adjust this value after initial testing

void setup() {
  Serial.begin(115200);
  Serial.println("A-Z Mandible Phase 1 - Signal Proof");
}

void loop() {
  int sensorValue = analogRead(sensorPin);
  Serial.print("Raw: ");
  Serial.print(sensorValue);

  if (sensorValue > threshold) {
    Serial.print("  --> JAW MOVEMENT DETECTED");
  }
  Serial.println();

  delay(15);  // ~67 Hz sampling rate
}
```

Testing Procedure:

1. Upload the code and open the Serial Monitor at 115200 baud.
2. Sit still and observe the baseline value (should be relatively stable, typically 0–10 when idle).
3. Gently clench your jaw or make silent "yes" / "no" movements.
4. You should see clear spikes in the readings during movement.
5. Adjust the 'threshold' value in the code until detection is reliable but not overly sensitive.

Success Criteria:

- Stable baseline when jaw is relaxed.
- Clear, repeatable spikes during jaw movement.
- Different movements produce visibly different signal patterns.

Chapter 4

Phase 2 — Whisper Amp Lite (Amplification)

Objective: Cleanly amplify the weak raw signal from the piezo.

Circuit (Non-Inverting Op-Amp):

- Use LM358 or (preferably) OPA2134 op-amp.
- Connect piezo through 1M bias resistor to the non-inverting input.
- Use 100k feedback resistor and 10k ground resistor for approximately 11x gain.
- Output of the op-amp goes to Arduino A0.

Testing:

1. Compare Serial Monitor readings with and without the op-amp stage.
2. You should see significantly stronger and cleaner signals.
3. Adjust gain if the signal is clipping (too high) or still too weak.

Chapter 5

Phase 3 — Pattern Classification

Objective: Detect simple binary patterns (YES / NO).

Logic:

- YES = Two short, distinct peaks close together
- NO = One longer, sustained peak

Implement peak detection with timing windows in Arduino code. Tune thresholds and timing parameters until you achieve reliable classification on your own patterns (target 75-80

Chapter 6

Phase 4 — Intraoral Integration Guidance

Goals:

- Move from breadboard to a wearable intraoral device
- Add bone conduction self-hearing feedback
- Ensure comfort, moisture resistance, and reliable coupling

Key Design Considerations:

- Housing should be thin (ideally ¡ 5mm in critical areas)
- Sensor should maintain consistent contact with teeth or jaw bone
- All electronics must be fully moisture-sealed
- Bone conduction transducer placement (behind ear or along jaw) must be comfortable for extended wear

Recommended Next Steps:

1. Design simple retainer-style housing in CAD software
2. 3D print test versions in PLA or PETG
3. Embed sensor and test signal quality while wearing
4. Integrate bone conduction transducer and test feedback loop
5. Apply conformal coating and test moisture resistance

Chapter 7

Final Notes for Laboratory Build

- Start with Phase 1 on a breadboard — it is the foundation.
- Document your baseline readings and threshold values.
- Move to Phase 2 once Phase 1 is stable and repeatable.
- Only move to Phase 4 (intraoral) after Phases 1–3 are working reliably.
- For bone conduction feedback, begin with simple analog routing before moving to processed audio.

This guide, combined with the sensor science, circuit diagrams, and architecture documents in the rest of the series, provides everything needed to build a working prototype in a laboratory environment.