ECG Heart Monitor with AD8232 and OLED Waveform Display

A single-lead ECG heart monitor built around the AD8232 analog front-end, plotting the live heartbeat waveform on an OLED and computing heart rate from R-peaks. Strictly an educational prototype — not a medical device. Delivered built-to-order with prototype, firmware, electrode guide, report, PPT and viva kit.

Title

ECG Heart Monitor with AD8232 and OLED Waveform Display — biopotential signal acquisition, filtering and real-time waveform display.

Introduction / Background

The heart's electrical activity at the skin surface is a millivolt-level signal buried in noise — mains hum, muscle artifacts and electrode-motion artifacts all dwarf it, which is why measuring it cleanly is a genuine instrumentation challenge. The AD8232 was designed exactly for this: an integrated analog front-end combining an instrumentation amplifier, high-pass and low-pass filtering, and lead-off detection for single-lead ECG.

This project builds a working heart monitor around it: three disposable electrodes feed the AD8232, an Arduino samples the conditioned signal at approx. 200 Hz, an OLED draws the scrolling ECG trace in real time, and firmware detects R-peaks to compute beats per minute. The student sees their own PQRST complex appear on the display and writes a report on the signal chain that produced it — with the explicit, honest boundary that this is a teaching prototype, not clinical equipment.

Problem Statement

Students of instrumentation learn about instrumentation amplifiers and biopotential filtering in theory but rarely acquire a real physiological signal themselves. The project addresses this by providing a complete, student-built ECG acquisition chain — electrodes, analog front-end, sampling, digital peak detection and display — with honest, documented limits: single-lead only, motion-sensitive, educational-only, and never to be used for any medical decision.

Objectives

- Acquire a single-lead ECG with the AD8232 front-end (instrumentation amplifier plus high-pass/low-pass filtering).
- Interface three electrodes (RA, LA, RL drive) with a documented placement and skin-preparation guide.
- Sample the conditioned signal at approx. 200 Hz (design target) and draw a scrolling waveform on a 0.96-inch OLED.
- Compute heart rate from R-peak detection over a rolling window.
- Implement lead-off detection warnings when an electrode detaches.
- Log raw samples over serial for PQRST plots in the report.

- Deliver the complete student kit: prototype, firmware, wiring docs, electrode guide, report, PPT and viva Q&A.;

Proposed Methodology

The system is developed in three stages. (1) Analog front-end: electrodes connect to the AD8232 module, which amplifies the differential biopotential, removes baseline drift with high-pass filtering and high-frequency noise with low-pass filtering; the right-leg-drive output actively cancels common-mode mains interference. (2) Digital: the Arduino ADC samples the conditioned output; firmware draws the scrolling trace on the OLED, runs a threshold-based R-peak detector, and computes BPM from the R-R interval over a rolling window; the AD8232 lead-off pins trigger a display warning on detachment. (3) Documentation: the student follows the electrode-placement guide, records traces at rest, and plots the PQRST complex from serial logs for the report.

System Architecture / Working

Three disposable electrodes pick up the biopotential; the AD8232 amplifies the differential signal while rejecting common-mode noise through its instrumentation amplifier and right-leg-drive. Filtered output is sampled by the Arduino ADC, drawn as a scrolling waveform on the OLED, and scanned by the R-peak detection algorithm. Heart rate is computed from successive R-R intervals and displayed beside the trace; if the AD8232 flags a detached electrode, the display shows a lead-off warning instead of a flat line.

Hardware / Software Requirements

- AD8232 single-lead ECG front-end module
- Arduino Nano (ATmega328P)
- 0.96-inch OLED display
- Disposable ECG electrodes with snap leads
- Arduino IDE (C/C++ firmware)

Expected Outcomes

A working single-lead ECG monitor showing the PQRST waveform and heart rate on an OLED.

Serial-logged sample traces the student plots in the report.

A documented electrode-placement and noise-reduction procedure.

An explicit educational-only boundary: the report states this prototype is not a medical device and must never be used for diagnosis, screening or any clinical decision.

Applications

- Teaching instrumentation amplifiers, biopotential filtering and real-time signal processing.
- Demonstrating analog-to-digital signal chains in biomedical instrumentation labs.
- A viva-ready demo of embedded acquisition and display design.

Future Scope

- Bluetooth waveform streaming to a phone app for classroom display.
- Heart-rate-variability analysis from the R-R intervals (educational scope only).
- Multi-channel extension study (documented as a design exercise, not clinical).

- Digital notch-filter study comparing software vs right-leg-drive mains rejection.