FEIC 2026 • ST8 BIOMEDICAL • PAPER ID: E-46

RadTrack

Development of a Low-Cost Photodiode-Based Sensing and Alert Prototype Towards Affordable Radiation Monitoring

For Diagnostic X-Ray Environments • University of Lagos



AUTHORS

Olorode Feyisayomi • Odiwe Emeka • Anichukwu Jessica • Isaac Emmanuel • Ugochi .C Uregbulam •Ephraim O. Nwoye

Department of Biomedical Engineering

18th – 20th November 2026

Occupational Scatter Radiation Gap

Unmonitored Scatter Exposure

Diagnostic X-ray suites expose staff and nearby personnel to scatter radiation, where acceptable area dose-rate limits range between 0.11 and 1.47 µSv/hr (Oduola et al., 2026).



Delayed Quarterly Dosimetry

Standard badges require 3-month lab processing without immediate alerts.



High Cost of Survey Meters

Calibrated monitors remain cost-prohibitive for widespread local deployment.

Aim and Proposed Hardware Architecture

Develop and bench-characterize an affordable, locally assembled photodiode alarm prototype.

PIN Photodiode Sensor

BPW34 silicon sensor with light-tight foil shielding.

TIA Signal Stage

OPA350 amplifier with 1 MΩ feedback resistor.

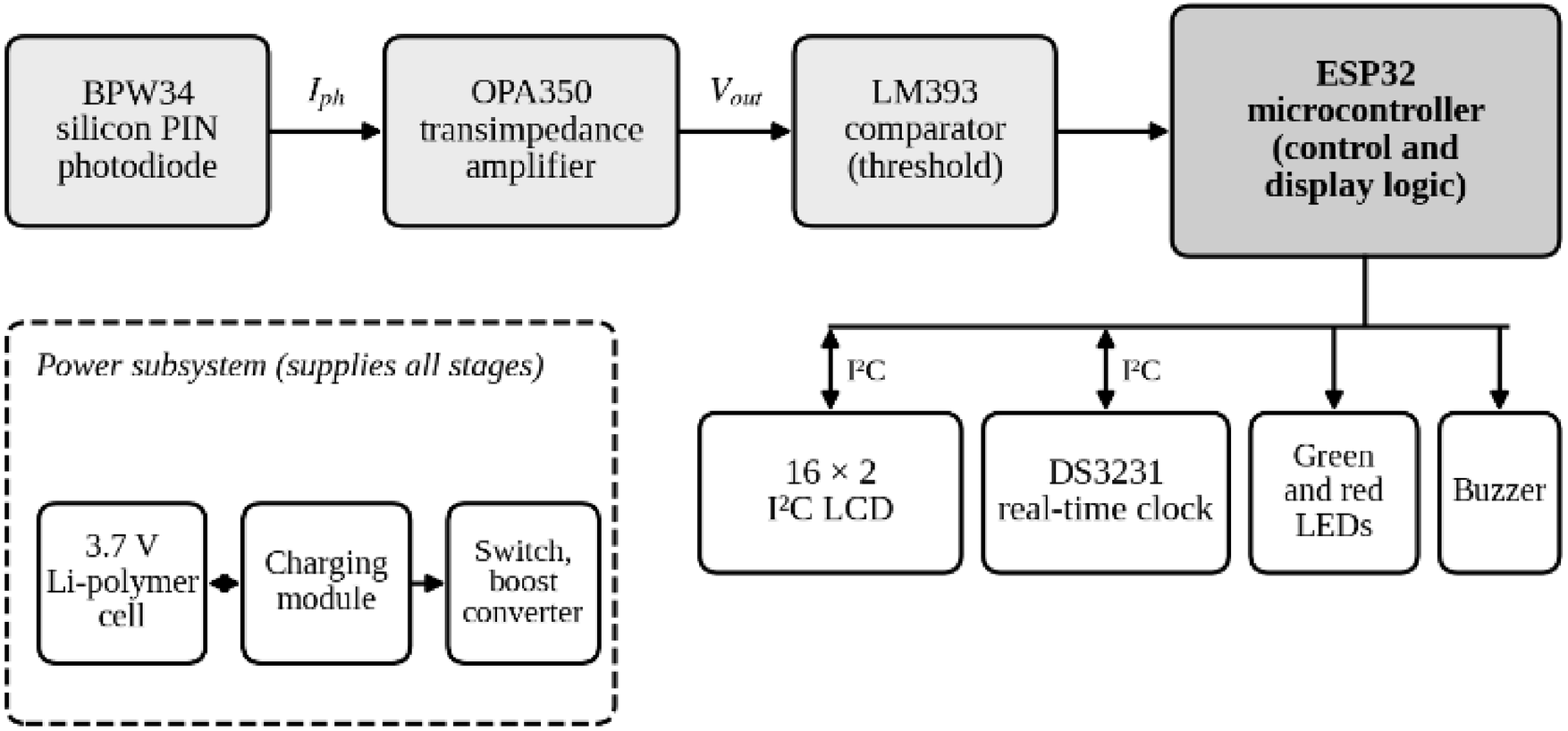
Threshold Gating

LM393 comparator and ESP32-C3 edge processing.

Real-Time Local Alerts

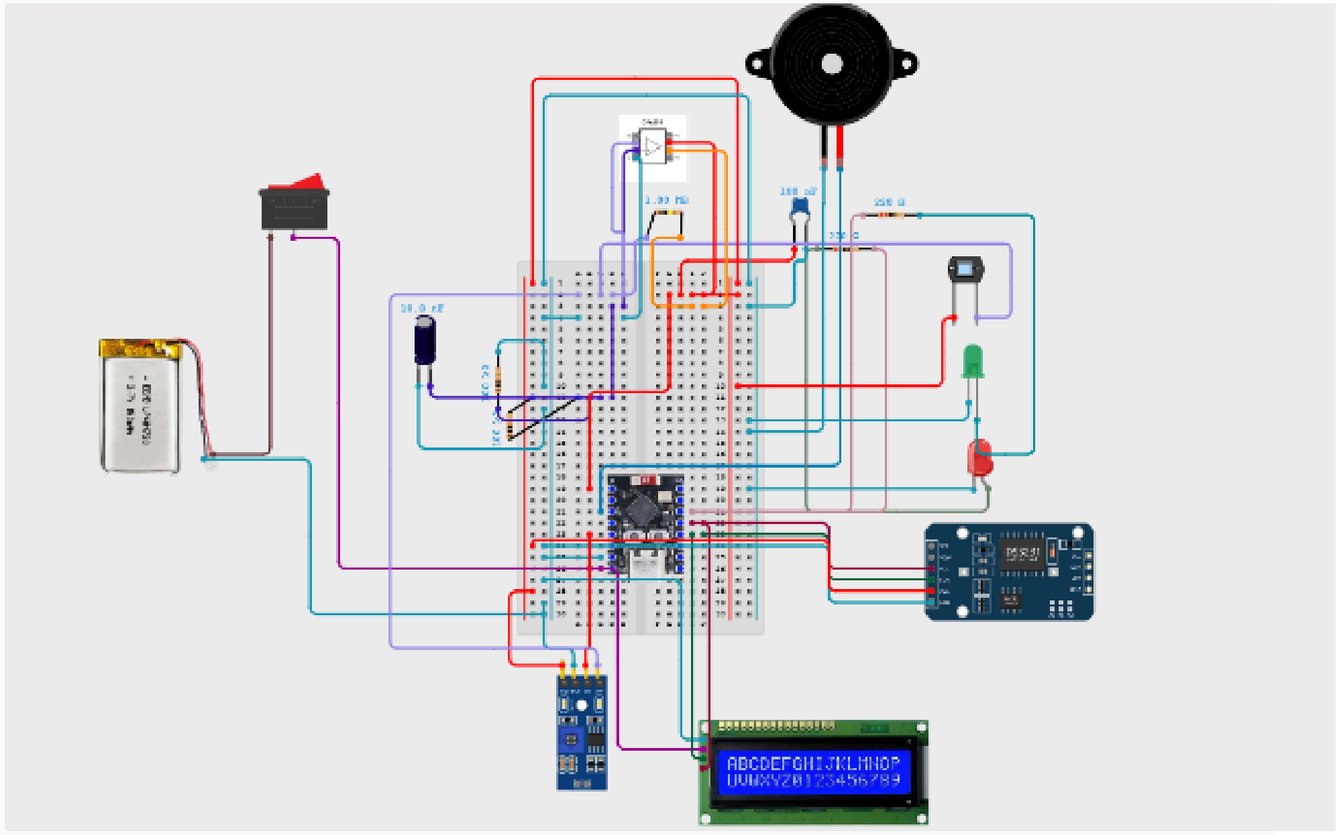
16×2 I²C LCD, status LEDs, and active buzzer.

End-to-End Sensing and Alert Signal Chain



Photocurrent (Iph) converts to voltage (Vout), triggering ESP32-C3 local LCD, LED, and buzzer alerts.

Signal Conditioning and Firmware Logic



Analog front-end, LM393 comparator, and ESP32-C3 connections

- **Transimpedance Gain**

Vout = Iph × Rf with Rf = 1 MΩ (1 µA yields 1 V).

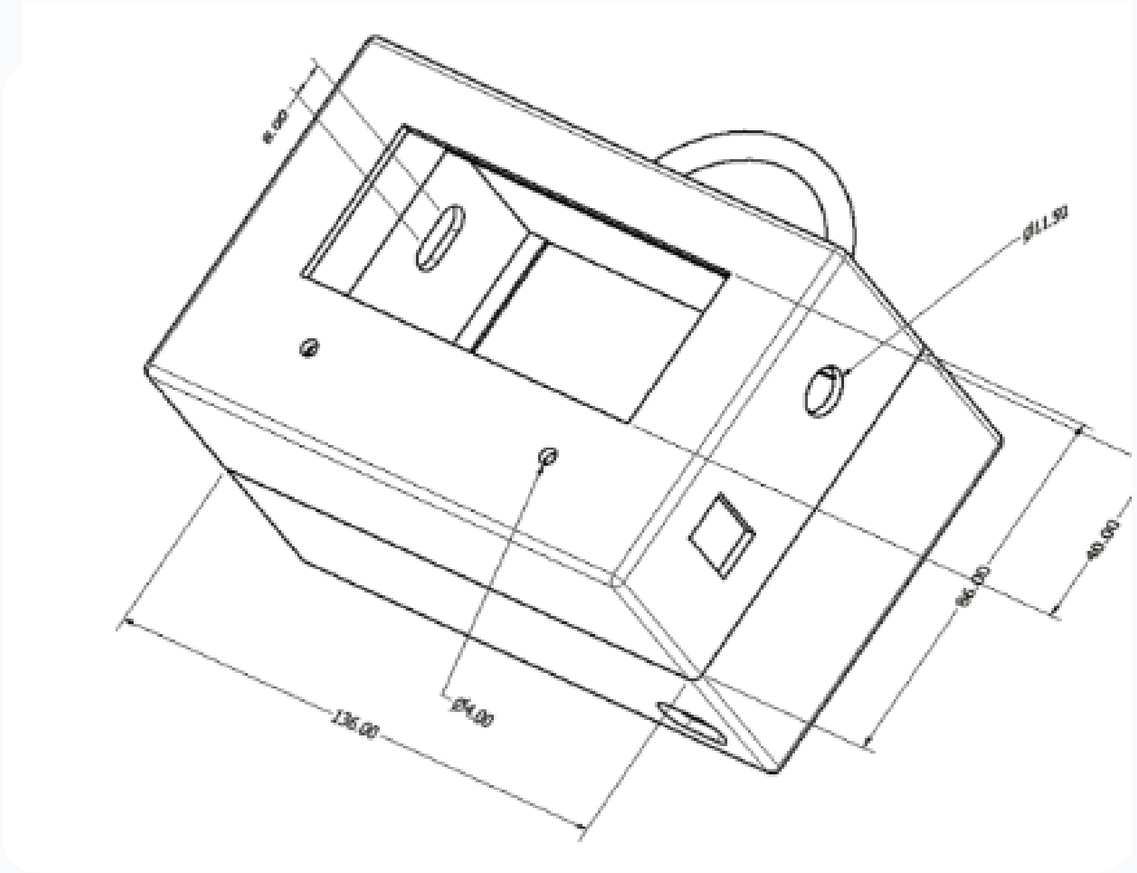
- **Virtual-Ground Biasing**

Dual 100 kΩ divider sets 1.65 V reference; 100 nF/10 nF filter noise.

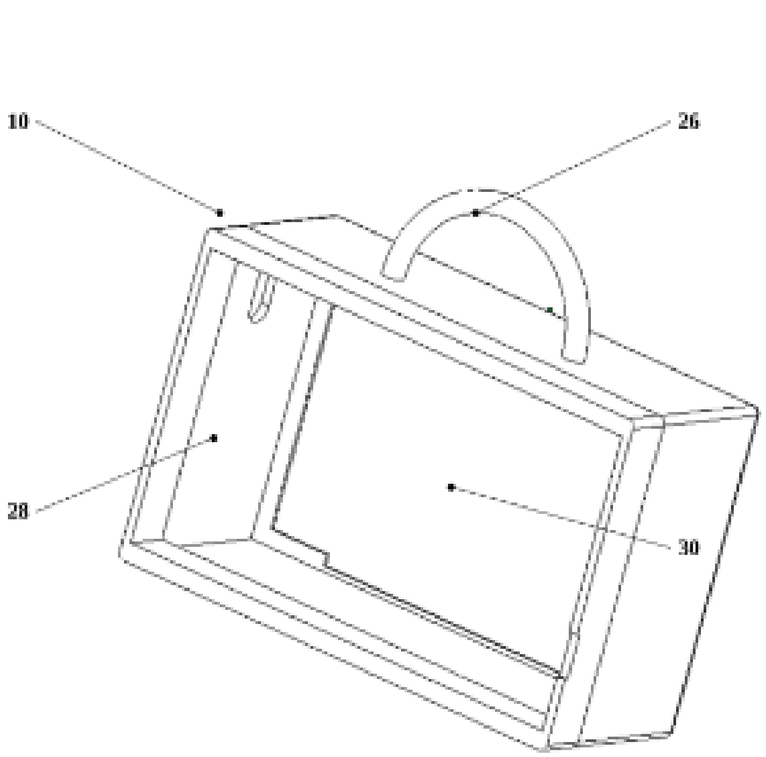
- **Threshold & RTC Logging**

ESP32-C3 monitors 1.13 V threshold and logs timestamped events via DS3231.

3D-Printed Enclosure Design (136 × 86 × 40 mm)



External CAD dimensions with LCD, LED, and switch cutouts



Internal bays: housing (10), handle (26), battery (28), PCB mount (30)

Optical Response Verification

MEASURED AMPLIFIER STEP

+0.80 V

Transition from 0.20 V covered baseline to 1.00 V illuminated (~0.80 µA photocurrent change).

Test Condition	Output	Implied Current
Photodiode Covered	0.20 V	Baseline offset
Exposed to Light	1.00 V	~1.00 µA total
Net Signal Delta	**+0.80 V**	**~0.80 µA step**

Note: Verifies circuit continuity under visible light; does not yet demonstrate X-ray sensitivity.

Key Achievements and Technical Limitations

Key Achievements

Integrated Signal Chain: BPW34, OPA350, LM393, and ESP32-C3 verified.

Clear Optical Response: 0.80 V step confirms front-end amplification.

Local Fabrication: Accessible components and custom 3D-printed housing.

Current Limitations

No X-Ray Exposure Data: Requires controlled kVp/mAs reference testing.

TIA Gain Constraint: 1 MΩ yields µV–mV for pA–nA X-ray currents.

Battery Runtime: 150 mAh LiPo limits continuous runtime to ~1.5–3 hrs.

Roadmap to RadTrack V2 Clinical Validation

RadTrack establishes a functional hardware foundation; four upgrades target clinical X-ray readiness.

01

Front-End Sensitivity

Scale Rf to 100 MΩ–1 GΩ or couple a scintillator.

02

Noise & Repeatability

Quantify dark offset across n ≥ 10 repeated trials.

03

Controlled X-Ray Tests

Benchmark kVp, mAs, and distance against reference meters.

04

Power & Casing

Expand battery capacity and optimize 3D print cost.

Selected References

IAEA (2018): Radiation Protection and Safety in Medical Uses of Ionizing Radiation, SSG-46.

Ylimaula et al. (2024): X-ray scatter in projection radiography, *Radiat. Prot. Dosimetry*, 200(2), 120–129.

Koch et al. (2023): Reduction of radiation dose using real-time visual feedback dosimetry, *JACMP*, 24(2).

Damulira et al. (2021): BPW34 photodiode and cold white LED as diagnostic X-ray detectors, *Appl. Radiat. Isot.*, 170.

Nazififard et al. (2016): Low-cost PIN photodiode dosimetry system for diagnostic radiology, *Rev. Sci. Instrum.*, 87(7).

FEIC 2026 • UNIVERSITY OF LAGOS

Thank You

Questions & Discussion • RadTrack (Paper ID: E-46)

Olorode Feyisayomi • Odiwe Emeka • Anichukwu Jessica • Isaac Emmanuel • Ugochi .C Uregbulam •Ephraim O. Nwoye

Department of Biomedical Engineering, University of Lagos • odiwebenedict@gmail.com