PROJECT ABSTRACT

Fiber-Optic Audio Transmission Link with 650nm Transmitter and Photodiode Receiver

A working fiber-optic audio link: Arduino-driven 650nm LED transmitter module, plastic optical fiber, photodiode receiver with LM386 speaker stage, and a side-by-side EMI immunity experiment. Delivered built-to-order with modules, fiber, firmware, report, PPT and viva kit.

01. Title

Fiber-Optic Audio Transmission Link with 650nm Transmitter and Photodiode Receiver

02. Introduction / Background

Optical fiber carries the world's data, yet most electronics students meet it only as a textbook diagram of total internal reflection. The engineering reality — coupling light into a fiber, modulating a source, recovering a weak optical signal at the far end, and proving the link ignores electrical noise — is rarely touched in a lab. This project builds a complete working fiber-optic audio link from student-friendly parts: a 650nm red LED transmitter module driven by an Arduino, a coil of plastic optical fiber, a photodiode receiver module, and an LM386 audio stage driving a small speaker. Audio fed into one end emerges from the other carried entirely by light, and a comparison experiment against a copper cable makes the electromagnetic immunity of fiber audible rather than theoretical.

03. Problem Statement

Fiber-optic communication is taught as physics (total internal reflection, acceptance angle, attenuation) while the systems skills — source modulation, fiber coupling, photodetection, link verification — are never practiced. Students graduate able to draw the ray diagram but unable to explain how a bit actually crosses a fiber. This project addresses that gap with a demonstrable end-to-end optical link where every stage is visible and measurable: modulate, couple, propagate, detect, amplify — plus a noise-immunity experiment that proves why industry chose fiber.

04. Objectives

- Build a 650nm LED transmitter module stage modulated by an Arduino from audio or test tone.
- Couple the optical signal into a plastic optical fiber coil with a buyer-run alignment procedure.
- Recover the signal with a silicon photodiode receiver module and transimpedance stage.
- Amplify the recovered audio with an LM386 stage to drive the supplied speaker.
- Demonstrate EMI immunity with a side-by-side optical-vs-copper experiment near a noise source.
- Provide buyer-run measurement procedures for attenuation and coupling loss.
- Deliver the complete student kit: modules, fiber, firmware, report, PPT and viva Q&A.;

05. Proposed Methodology

The system is developed in three stages. (1) Transmitter: the Arduino varies the 650nm LED drive current in step with the audio waveform (intensity modulation), coupled into the plastic fiber through the module's connector. (2) Channel and receiver: light propagates by total internal reflection; the photodiode converts arriving optical power to photocurrent, the transimpedance stage to voltage, and the LM386 to speaker-level audio. (3) Verification: the student measures received level versus fiber length, deliberately misaligns the coupling to quantify loss, and runs the copper-comparison noise experiment — all results recorded for the report.

06. System Architecture / Working

Audio from a line-level source or firmware test tone reaches the Arduino, which modulates the 650nm LED current. The light enters the plastic fiber's core within its acceptance cone and is guided by total internal reflection at the core-cladding boundary. At the receiver, the photodiode produces a photocurrent proportional to light intensity; the transimpedance stage converts it to voltage and the LM386 amplifies it to the speaker. For the immunity demo, the same audio also travels a copper cable past a switching load, and the two outputs are compared directly.

07. Hardware / Software Requirements

- Arduino Uno (ATmega328P)
- 650nm red LED transmitter module with fiber connector
- PMMA plastic optical fiber coil (approx. 10 m, design target) with fitted connectors
- Silicon photodiode receiver module with transimpedance stage
- LM386 audio amplifier stage with speaker
- Breadboard, jumpers, 5000 mAh USB power bank
- Copper cable and switching load for the noise-comparison experiment
- Arduino IDE (C/C++ modulation firmware)

08. Expected Outcomes

- A working optical audio link: audio in, light through fiber, audio out of the speaker.
- Student-measured attenuation and coupling-loss figures from buyer-run procedures.
- A documented EMI-immunity comparison between the fiber and copper paths.
- A complete report, PPT and viva Q&A; covering fiber theory, modulation and link verification.

09. Applications

- Teaching optical communication end to end in electronics labs.
- Demonstrating total internal reflection, attenuation and acceptance angle physically.
- Classroom proof of fiber's electromagnetic immunity for communications courses.

10. Future Scope

- Digital UART-over-fiber extension using on-off keying of the same hardware.
- Bit-error observation with longer fiber runs.
- Two-wavelength duplex demonstration as an advanced study.