

All-In-One Serial Lab

Abstract

Serial communication is widely used in embedded systems, industrial automation, IoT devices, GSM modules, and field equipment. Engineers frequently depend on multiple independent software tools to monitor serial ports, validate GSM AT commands, and perform Modbus RTU testing. This fragmented approach increases debugging complexity, reduces workflow efficiency, and may create communication conflicts when multiple applications attempt to access the same COM port.

All-In-One Serial Lab is a desktop-based serial communication and protocol testing application developed using Electron and Node.js. The system integrates multi-COM serial monitoring, GSM AT command validation, Modbus RTU operations, and advanced logging into a unified environment. It supports concurrent serial connections, response verification with retry mechanisms, batched data processing for improved performance, and secure IPC-based architecture.

By consolidating these features into a single performance-optimized platform, the system improves reliability, usability, and debugging efficiency for embedded and industrial communication testing.

Existing System

In conventional development environments, engineers typically use separate applications for serial port monitoring, Modbus RTU communication testing, GSM AT command execution, and data logging. Most serial terminal software supports only a single COM port session at a time and lacks structured multi-port concurrency management.

Traditional tools often do not provide built-in response verification or automatic retry mechanisms. High baud rate communication can lead to user interface freezing due to inefficient rendering strategies. Port conflict detection is limited, and logging features are frequently basic, lacking advanced filtering, timestamping, and structured export capabilities.

As a result, debugging complex embedded systems that require simultaneous monitoring of multiple devices becomes time-consuming and inefficient.

Proposed System

The proposed system, All-In-One Serial Lab, integrates multi-COM serial communication, GSM AT command testing, and Modbus RTU operations within a single Electron-based desktop application. The system supports up to four concurrent serial connections with secure open and close lifecycle management and port conflict prevention.

Incoming serial data is processed using batched RX handling to prevent UI freezing during high-speed communication. The application provides RAW, TEXT, and HEX data visualization modes along with timestamped logging and export functionality. A response verification engine monitors incoming data for expected responses within configurable timeout intervals and supports automatic retry logic.

The integrated Modbus RTU module enables register reading, single register writing, and raw HEX frame transmission. By combining these capabilities into one secure and performance-optimized architecture, the proposed system enhances debugging efficiency, reduces tool dependency, and improves reliability for embedded system development, industrial automation testing, and IoT device validation.