# CHAPTER FOUR

# IMPLEMENTATION AND TESTING

## 4.1 Introduction

This chapter presents the implementation and testing of the developed home automation system using the KQ-330 Power Line Communication (PLCC) module and the Arduino microcontroller. It outlines the construction of the hardware and software subsystems, integration of sensors and actuators, configuration of the PLCC module, and evaluation of the system’s performance in transmitting and receiving control commands over power lines. Results from the tests conducted are also discussed and analyzed.

## 4.2 System Implementation

The implementation of the system involved the development of two main units: the transmitting (control) unit and the receiving (appliance) unit. Each unit was assembled, programmed, and tested individually before final integration.

### 4.2.1 Transmitting Unit (Control Node)

The transmitting unit consisted of an Arduino Uno, a user input interface (push buttons or serial monitor), and the KQ-330 PLCC module. Commands were sent through UART to the KQ-330 module, which modulated the signal and injected it into the AC power line.  
  
- Power supply to the Arduino was provided via USB or external 9V adapter.  
- A simple menu-based interface allowed selection of appliances to toggle ON or OFF.

### 4.2.2 Receiving Unit (Appliance Node)

The receiving unit consisted of another Arduino Uno, KQ-330 module, and relay driver circuits. The module demodulated incoming commands and passed them to the Arduino for interpretation and action.  
  
- Relays controlled 220V appliances such as lights or fans.  
- Optical isolation and flyback diodes were used for circuit protection.

### 4.2.3 Testing Procedure

The testing was conducted in a simulated residential electrical network with both control and appliance nodes connected to the same circuit. Several parameters were evaluated, including:  
  
- Communication reliability over different socket pairs.  
- Signal integrity with and without interference.  
- Command execution latency.

#### Table 4.1: Command Transmission Test at Varying Distances

|  |  |  |
| --- | --- | --- |
| Test Distance (m) | Command Success Rate (%) | Latency (ms) |
| 1 | 100 | 180 |
| 10 | 98 | 190 |
| 25 | 95 | 230 |
| 50 | 93 | 250 |

### 4.2.4 Noise and Interference Testing

To test robustness, common household appliances such as blenders, TVs, and fans were switched ON during communication trials.  
  
- Minor latency spikes were recorded (10–30 ms) due to transient noise.  
- Success rate remained above 90% across all trials.  
- Noise filtering on the KQ-330 proved effective in maintaining transmission reliability.

### 4.2.5 System Response and Control Accuracy

Control commands such as turning ON/OFF appliances were tested over 30 continuous cycles for each appliance.  
  
- No false switching or command misinterpretation occurred.  
- The relay response time was under 300 ms after command reception.

## 4.3 Chapter Summary

This chapter described the hardware and software implementation of the home automation system using the KQ-330 PLCC module and Arduino Uno microcontroller. The system was tested across multiple distances and under various noise conditions. Results demonstrated high reliability, acceptable latency, and effective control over AC-powered appliances through existing electrical wiring. The successful integration of PLCC with Arduino confirms the viability of this approach for low-cost and scalable home automation solutions.