

TP-FAW-01: PROTOTYPE TEST PLAN

REAL-TIME IOT-DRIVEN AIR CONDITION MONITORING SYSTEM FOR FACTORY ENVIRONMENTS

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Execution Window: 30 Apr 2025 (08:00 – 18:00 EAT)

Responsible Engineer: Kirabo Jelly Rollings

DOCUMENT CONTROL

Prepared by: BSE25-5 Team

Approved by: Dr. Nasser Kimbugwe

Distribution List:

- Dr. Nasser Kimbugwe (Supervisor)
- Dr. Mary Nsabagwa (Overall Project Supervisor)
- BSE25-5 Team Members

1. INTRODUCTION

1.1 Purpose

This test plan evaluates the functional and operational performance of the FactoryAirWatch prototype in a controlled laboratory setting. The aim is to verify core requirements, identify risks, and establish readiness for field pilot deployment.

1.2 Scope

This test plan applies to FactoryAirWatch version 1.4 components, including edge nodes, cloud infrastructure, and web dashboard. Testing will be conducted at Makerere University College of Computing and Information Technology.

1.3 References

- Software Requirements Specification (SRS) - Rev 0, December 6, 2024
 - Software Design Document (SDD)
 - FactoryAirWatch Implementation Documentation
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2. TEST OBJECTIVES

The primary objectives of this test plan are to:

1. **Functional correctness** – Validate that each sensor, API endpoint, and UI control operates within the limits defined in the SRS.
 2. **Alert responsiveness** – Confirm that red-level air quality breaches trigger audible (buzzer), visual (LED), and digital (dashboard) warnings within 5 seconds.
 3. **Data resilience** – Ensure the system caches data during GSM outages and successfully uploads when connectivity resumes.
 4. **System stability** – Verify uninterrupted operation for at least 10 hours without memory leaks, watchdog resets, or missed samples.
 5. **Usability** – Confirm that a factory operator can complete key tasks (view live data, export reports) in under 4 clicks on common devices.
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3. TEST SCOPE AND COVERAGE

3.1 In Scope

- One IoT node (firmware v1.0)
- MySQL 8.1 backend
- Web dashboard (accessible on desktop and mobile browsers)

3.2 Out of Scope

- SMS alerts and multi-node deployments
- Extended soak or load tests beyond 24 hours

3.3 Subsystem Coverage

Subsystem Coverage Details

Firmware Sensor polling, LED/buzzer alerts, basic error detection

Backend 2 REST endpoints, PDF generator, threshold logic, audit logging

Database MySQL insertions, schema migration, response to load spikes

Subsystem Coverage Details

Dashboard 5 React routes, role-based access, responsiveness, dark mode rendering

4. TYPES AND LEVELS OF TESTING

4.1 Types of Testing

- **Functional** – Sensor-to-UI value chain verification
- **Performance** – Alert timing, data throughput
- **Usability** – User flow navigation under 4 clicks
- **Boundary & Stress** – Simulated outages, smoke injection, poor signal
- **Validation** – Accuracy of readings vs. expected physical inputs

4.2 Test Levels

- **Unit Tests** – Firmware logic and API utility functions (run with Unity and Jest)
 - **Integration Tests** – End-to-end sensor → API → DB → UI data path validation (via Postman)
 - **System Acceptance** – Live prototype review using test scripts (SAT 01), co-signed by the BSE25-5 team and supervisor
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5. TEST CASES

Test Case	Description	Expected Result
TC-F-PMS	Waft match smoke across PMS5003 for 3 seconds. Observe alert chain reaction.	PM2.5 & PM10 levels rise; amber LED activates; dashboard updates within 30s
TC-F-CO	Inject 50 ppm CO using calibration tube. Validate value persistence in UI.	CO level rises to 45-55ppm; value persists in database; historical view shows spike
TC-DB	Check database for correct row after simulated spike.	Row contains timestamp, sensor values, and flag for threshold breach

Test Case	Description	Expected Result
TC-GSM	Disconnect antenna for 10 minutes; verify cache and resend on reconnection.	Data stored locally on SD card; automatically uploaded when GSM reconnects
TC-STAB	Leave system running for 10 hours; monitor heap growth and reset status.	No memory leaks; no watchdog resets; all samples transmitted
TC-UI	User logs in, views live data, exports PDF report—all within 4 clicks.	Tasks completed efficiently; PDF contains expected data
TC-LED-ERR	Simulate undervoltage; validate system handles LED logic fault gracefully.	System logs error; continues operation with degraded alerts
TC-TIMEZONE	Login from different time zone; check timestamp consistency on dashboard.	All timestamps display in user's local time with correct UTC offset

6. EXECUTION SEQUENCE

Time	Activity	Test Cases
08:00–10:30	Execute functional and integration test cases	TC-F-PMS, TC-F-CO, TC-DB
10:30–12:30	Alert timing and GSM disconnect	TC-GSM
12:30–18:00	Continuous operation soak test with UI spot checks	TC-STAB, TC-UI

7. TEST ENVIRONMENT AND CONFIGURATION

7.1 Hardware

- Arduino Mega 2560 R3, SIM800L v2, PMS5003, MQ series sensors, tri-color LED, buzzer
- USB power monitor for current consumption tracking
- Calibrated test gas samples (CO 200ppm)
- Controlled smoke generator for particulate testing

7.2 Software

- Server: Ubuntu 22.04 LTS, Node.js 18, MySQL 8.1
- Client: Chrome 114, Firefox 120, Edge 124
- Monitoring: USB serial console, network packet capture

7.3 Tools

- USB serial console
 - Stopwatch for timing measurements
 - Power supply with adjustable voltage
 - Network traffic analyzer
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8. ENTRY AND EXIT CRITERIA

8.1 Entry Criteria

- All hardware components assembled and verified functional
- Firmware successfully flashed to MCU
- Cloud backend deployed and accessible
- Test environment prepared and calibrated
- Test data prepared and available

8.2 Exit Criteria

- All test cases executed with results documented
 - Critical defects identified and documented
 - Performance benchmarks measured and recorded
 - Test report completed and approved
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9. SUSPENSION AND RESUMPTION CRITERIA

9.1 Suspension Criteria

- Critical hardware failure preventing further testing
- Major software defect blocking test case execution

- Test environment becoming unstable or unreliable
- Safety concern requiring immediate attention

9.2 Resumption Criteria

- Root cause of suspension identified and resolved
 - Test environment restored to stable condition
 - Test plan updated if necessary to address discovered issues
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10. DELIVERABLES

- Completed test cases with pass/fail status
 - Test execution logs and screenshots
 - Performance measurement data
 - Defect reports for any identified issues
 - Final test summary report (TPR-FAW-01)
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11. ROLES AND RESPONSIBILITIES

Role	Responsibility	Assigned To
Test Lead	Overall test coordination	Kirabo Jelly Rollings
Hardware Tester	Firmware and physical component testing	Alanda Ambrose
Cloud Tester	Backend services and API validation	Mugarura Kevin B
UI Tester	Dashboard functionality and usability	Musiimenta Cynthia
Observer	Independent assessment of test execution	Dr. Nasser Kimbugwe

12. RISKS AND CONTINGENCIES

Risk	Impact	Mitigation
GSM network reliability issues	Incomplete connectivity tests	Prepare alternative network provider SIM
Test gas supply limitations	Incomplete sensor calibration	Pre-calibrate sensors in lab conditions
Hardware damage during testing	Test delays	Have spare components available
Time constraints	Incomplete test coverage	Prioritize critical test cases

13. APPROVAL

This test plan has been reviewed and approved for execution.

Approved by: Dr. Nasser Kimbugwe

Date: April 25, 2025

Approved by: BSE25-5 Team Lead

Date: April 27, 2025
