Low-Level Design (LLD)

NanoRiego

1. Introduction

This Low-Level Design (LLD) document provides a detailed technical specification of the internal modules, hardware pin configurations, logic flows, data structures, and software routines implemented in the NanoRiego irrigation system. It serves as a reference for developers and system integrators tasked with implementing or modifying the system at the code and circuit level.

2. Hardware Pin Mapping (Arduino Nano)

Module	Arduino Pin	Description
Relay 1 (Valve 1)	D2	Digital output
Relay 2 (Valve 2)	D3	Digital output
Relay 3 (Valve 3)	D4	Digital output
Relay 4 (Pump)	D5	Digital output
HC-05 TX	D10 (RX)	Serial communication (Bluetooth RX)
HC-05 RX	D11 (TX)	Serial communication (Bluetooth TX)
DS1307 SDA	A4	I2C data
DS1307 SCL	A5	I2C clock

Level shifters are used between HC-05 RX and Arduino TX to match 3.3V logic tolerance.

3. EEPROM Data Structure

Memory Allocation (Bytes)

Address Range	Purpose
0–9	System time + sync flags
10–49	Valve 1 schedule data
50–89	Valve 2 schedule data
90–129	Valve 3 schedule data
130–159	General system flags and states

Data Format Example (Per Valve)

```
struct ScheduleEntry {
  byte hour;    // start hour
  byte minute;  // start minute
  byte duration; // in minutes
  byte days;  };  // bitmask: 0b0111110 for Mon–Fri
```

4. System Logic

4.1 Initialization

- Initialize UART and I2C interfaces
- Load schedule and config from EEPROM
- Sync time with Android device if available

4.2 Scheduler Loop

- Read current time from RTC every second
- For each zone, check if a schedule match exists
- If yes, activate relay for duration
- Prevent multiple valves from running simultaneously
- Always activate pump relay with zone relay

4.3 Manual Override

- Bluetooth command M:Zx:ON/OFF toggles zone x
- Manual override bypasses schedule but still enforces mutual exclusion

4.4 Bluetooth Command Set

Command	Description
S:HH:MM	Set system time
D:DD/MM/YY	Set system date
Zx:T:HH:MM:DUR:WDAYS	Set schedule for zone x
M:Zx:ON	Manually turn on zone x
M:Zx:OFF	Manually turn off zone x
SYNC	Sync time with mobile device

5. User Interface Behavior (NanoRiegoAPP)

Connected State:

- Display live zone status via polling
- Enable all control buttons
- Indicate Bluetooth connection in green

Disconnected State:

- Disable controls (except Bluetooth menu)
- Indicate Bluetooth status in red

6. Safety and Fault Tolerance

- Enforce 1-valve-at-a-time rule
- Validate all incoming Bluetooth commands before execution
- Use watchdog timer for unexpected resets

7. Development Tools

- Arduino IDE 1.8+
- EEPROM library, Wire.h, SoftwareSerial
- Android Studio for NanoRiegoAPP development

8. Version Control and Repository

- GitHub: github.com/MikeMakes/nanoRiego
- Branches: main (stable), dev (experimental)

This LLD document is subject to revision based on testing outcomes, hardware iteration, and user feedback.