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Dynamic Demand Controller (DDC) Implementation for Dynamic Demand Load Response Device (DDLRD)

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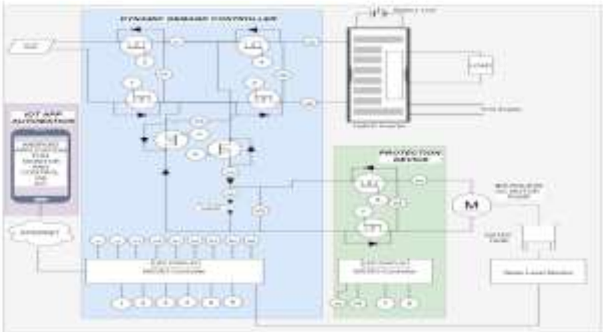
Project Overview

The Dynamic Demand Load Response Device (DDLRD) optimizes solar power utilization by intelligently diverting DC power between an inverter (for AC loads) and a DC water pump. This Phase focuses on building/testing the **Dynamic Demand Controller (DDC)**, a core subsystem that uses MOSFET switches to dynamically reroute solar DC power based on simulated demand signals.

Implement and test the DDC as a **Proof-of-Concept (POC)** at low voltage:

- Dynamic power allocation between two DC loads (simulating an inverter vs. water pump).
- Control logic triggered by user inputs (push buttons replacing tank sensors).



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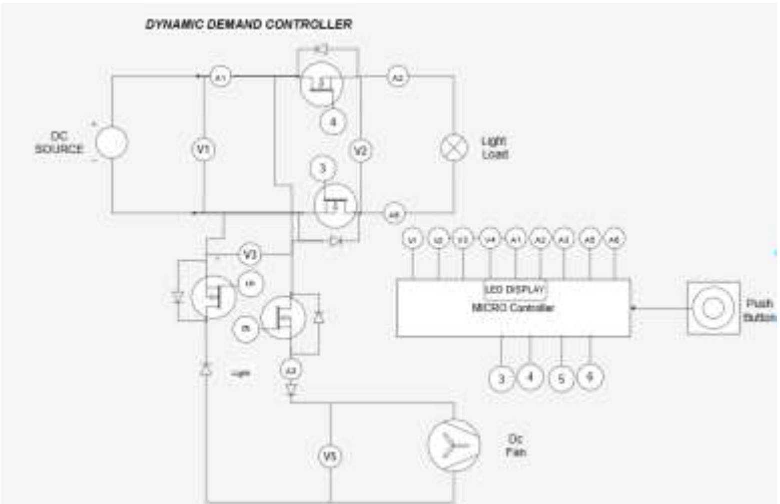
Circuit Topology

Prototype Setup (Low-Voltage POC):

- **Input Source: 12-24V DC (simulating solar output)**
- **Load 1 (Inverter Simulation): 12V Light Bulb**
- **Load 2 (Pump Simulation): 12V DC Fan**
- **Control Interface: Tactile Push Button (replaces tank sensors)**
- **Power Path 1 (Inverter Simulator):** MOSFET Q1 → Light Load (e.g., LED/bulb).
- **Power Path 2 (Pump Simulator):** MOSFET Q2 → DC Motor Load (e.g., fan).
- **Control Hub:** STM32 MCU reads button presses → IR2110 gate driver → Triggers MOSFETs.



Testing Procedure & Results

Test 1: Single Click (Inverter Mode)

Action: Button pressed once

Result:

- Q1 MOSFET fully ON (Light at 100% intensity)
- Q2 MOSFET OFF (Fan stopped)

Test 2: Double Click (Pump Priority Mode)

Action: Button pressed twice

Result:

- ➢ Q1 at 22% duty (Light dimmed)
- ➢ Q2 fully ON (Fan at full speed)

Test 3: Triple Click (System Shutdown)

Action: Button pressed three times

Result:

- ➢ Both MOSFETs OFF (Loads isolated)
- ➢ Validates protection circuitry readiness

Achievements:

- ✓ Dynamic power routing between loads
- ✓ STM32-based control logic with PWM precision
- ✓ Hardware validation at Low Voltage DC
- ✓ Protection circuit foundation (emergency shutdown)

Future Phase Scope

1. Finalization of protection circuit (overvoltage/overcurrent).
2. Full sensor integration (overhead tank level sensing).
3. Integration with Android app for user monitoring and control.
4. Backup utility conversion to DC supply in poor sunlight conditions.
5. Rated motor driver design based on real pump specifications.

Conclusion

The successful development and testing of the DDC system at prototype level demonstrate the feasibility of direct DC load diversion using microcontroller-based logic. The implementation reduces conversion loss, improves dynamic power utilization, and provides a scalable model for smart renewable systems. Phase 3 will extend this with sensor integration and real-world applications.