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Dynamic Demand Response with Protective Facilitation Device for Renewable Power Management for Sustainable Water Pumping in Domestic Sector

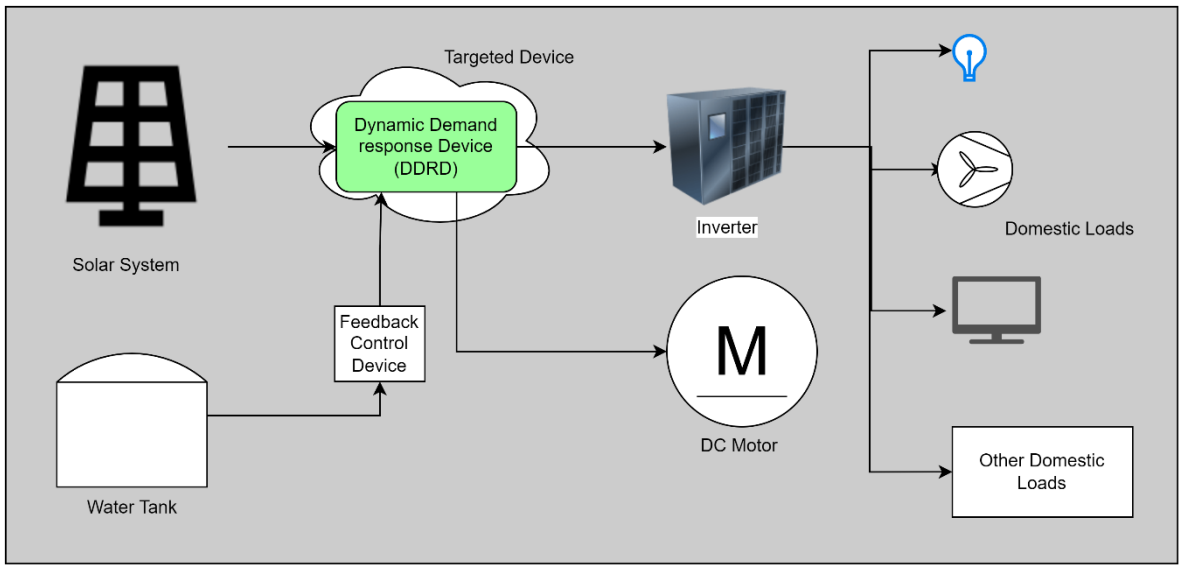
M. Karthikeyan, B.E.
Currently pursuing M.E. (PED)
PSY Engineering College
Anna University
Email: Karthikeyan.mano@gmail.com

G.Prakash, B.E.
Currently pursuing M.E. (PED)
PSY Engineering College
Anna University
Email: gpreee@gmail.com

Project Overview

To design a Dynamic Demand Response with Protective Facilitation Device that utilizes power electronics, specifically MOSFETs, to efficiently manage solar power. The system will supply energy to a home via an inverter and directly power a DC water pump from solar panels. It will include protection functionalities to isolate the load in case of faults such as overload, overvoltage, and undervoltage.

Block Diagram



Key Components

1. **3kW Solar PV Array**:

   320W Monocrystalline Solar Panel Specification

   - **Power Rating: 320W**
   - **Efficiency: 19.9%**
   - **Voltage (Vmp): 38.3V**
   - **Current (Isc): 9.48A**
   - **Dimensions: 61 x 40.2 x 1.4 inches**
   - **Temperature Coefficient: -0.37%/°C**

2. **Inverter**:

   3kW Hybrid Solar Inverter Specifications

   1. Output Power

   - **Rated Output Power: 3 kW**
   - **Surge Power: Typically 1.5 to 2 times the rated power (4.5 kW to 6 kW) for short durations.**

   2. Input Voltage

   - **Solar Input Voltage Range: 100V to 500V (varies by model)**
   - **MPPT Voltage Range: 120V to 450V for maximum efficiency.**

   3. Battery Compatibility

   - **Battery Voltage: Support for 12V, 24V, or 48V battery systems (commonly 48V for 3kW systems).**
   - **Battery Type: Compatible with lead-acid, lithium-ion, or gel batteries.**

   4. Efficiency

   - **Inverter Efficiency: 90% to 95% (peak efficiency).**
   - **MPPT Efficiency: Typically around 98% for optimal solar energy conversion.**

   5. Dimensions and Weight

   - **Size: Approx. 500 mm x 400 mm x 200 mm (varies by model).**
   - **Weight: Typically between 20 kg to 30 kg.**

   6. Operating Temperature

   - **Temperature Range: -10°C to 50°C (ambient temperature).**

- **Cooling Method: Natural convection or fan cooling.**

Converts the DC output from solar panels into AC for household use.

3. **DC Water Pump**:

   Operates directly on DC power supplied from the solar panels.

   - **Power Rating:** 1 HP (suitable for higher flow rates)
   - **Voltage:** 110V or 220V (check for DC options)
   - **Max Head:** 180 ft or more
   - **Flow Rate:** Up to 12 GPM

4. **Smart Load Control Switch**:

   - **MOSFETs**: Used as electronic switches to dynamically manage power allocation between the inverter and the water pump. MOSFETs provide efficient switching and are ideal for handling the DC loads.

5. **Protection Circuitry**:

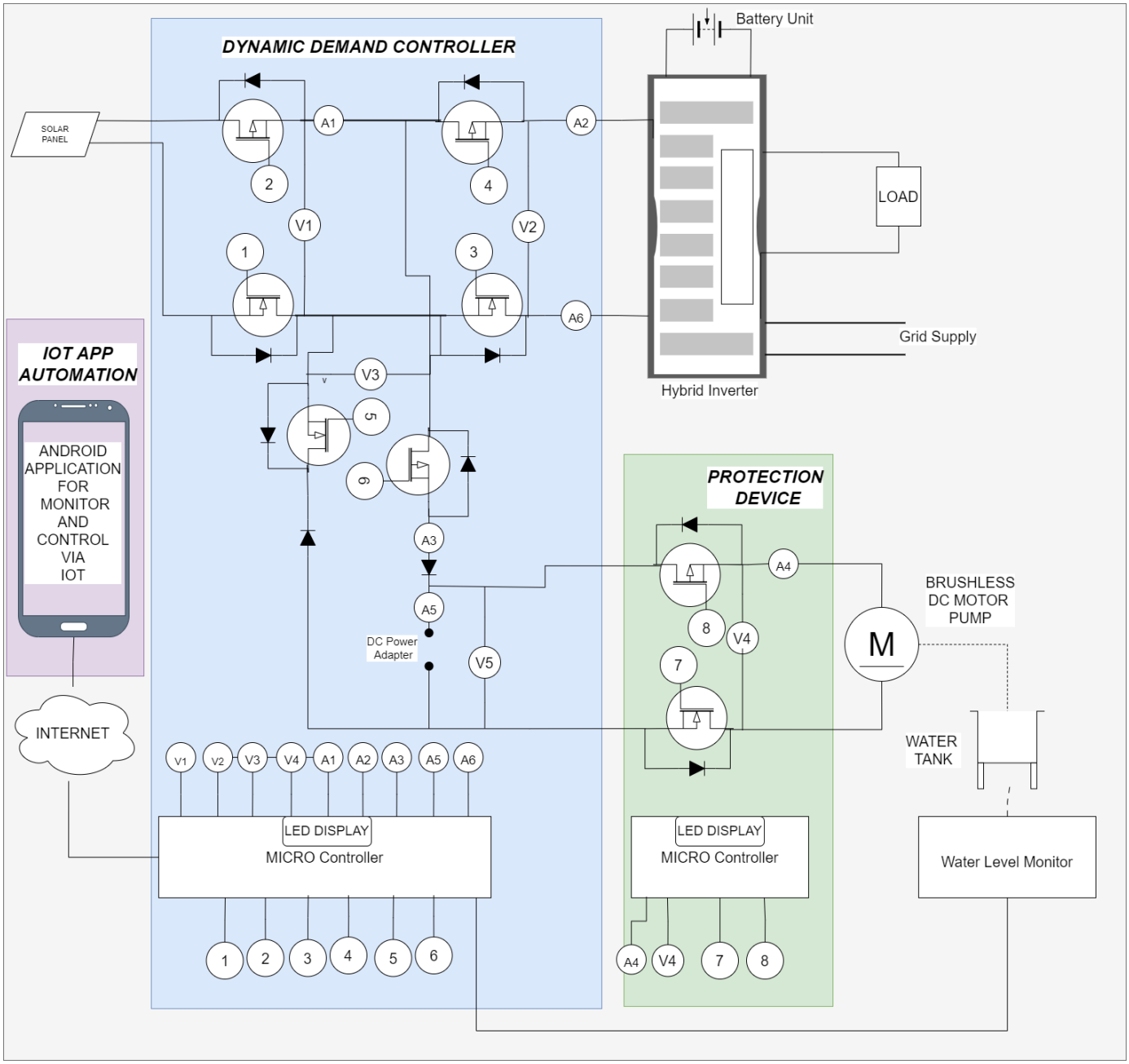
   - **Current and Voltage Sensors**: Monitor operational parameters (current and voltage) of the system.
   - **Control Circuit**: Uses feedback from sensors to activate or deactivate MOSFETs based on operational conditions.
   - **Protection Features**:
     - **Overload Protection**: Detects excessive current and isolates the load by turning off the MOSFETs.
     - **Overvoltage Protection**: Disconnects the load when voltage exceeds a specified threshold.
     - **Undervoltage Protection**: Ensures the system disconnects if voltage falls below a safe level.

6. **Microcontroller** :

   - Interfaces with sensors and controls the MOSFETs based on the monitored parameters & Conditions
   - Pulse Width Modulation (PWM) controllers can be used to control the voltage and current supplied to the motor, allowing for gradual acceleration.
   - Provides precise control over motor speed and reduces current spikes during startup.
   -

7. **User Interface**:
    - LCD display or LED indicators to show system status and alert for any faults.

Proposed System Block Circuit diagram and Illustration



Features

- **Dynamic Power Management**:
  - Efficiently allocates solar power to both the home and the DC water pump using MOSFETs for low-loss switching.
- **Fault Detection and Isolation**:
  - Automatically disconnects the load via MOSFETs in case of faults to prevent damage.
- **Real-Time Monitoring**:
  - Continuously checks voltage and current levels, providing alerts for abnormal conditions.
- **User-Friendly Interface**:
  - Displays operational status, alerts, and fault conditions.

Steps to Implement

1. **System Design**:
   - Create a detailed schematic diagram illustrating the connections between the solar panels, inverter, smart load control switch (MOSFETs), DC pump, and protection circuitry.
2. **Component Selection**:
   - Select appropriate MOSFETs based on current and voltage ratings, as well as suitable solar panels, inverter, and sensors.
3. **Protection Circuit Design**:
   - Implement the protection features using current and voltage sensors in conjunction with MOSFETs for effective isolation.
4. **Microcontroller Programming**:
   - Develop software to monitor sensor data, control the MOSFETs, and manage fault conditions.
5. **Hardware Assembly**:
   - Assemble all components, ensuring proper connections and adherence to safety standards.
6. **Testing and Calibration**:
   - Simulate fault conditions (overcurrent, voltage spikes) to verify the functionality of the protection system and the MOSFET operation.
7. **User Interface Development**:
   - Create an interface that clearly indicates normal operation and alerts for any detected faults.

Expected Outcomes

- A robust smart load control switch system that efficiently utilizes solar energy while ensuring safety through power electronics.
- Enhanced system reliability and longevity through integrated fault protection mechanisms.

Other application Areas

- ✓ **Garden Watering system**
- ✓ **Agricultural irrigation system**
- ✓ **Automatic fire fighting system**
- ✓ **Fire truck water pumping system**
- ✓ **Portable water pumping system**

Conclusion

To Design and develop an Efficient Dynamic Demand Response with Protective Facilitation Device for Renewable power management For Sustainable water pumping in Domestic Sector.

To Design and develop an Efficient DC Protection device by incorporating intelligent control and protection functionalities, the system will enhance energy efficiency and reliability for residential applications.

To Design and develop an Efficient IOT Android Application to Monitor and control these above Devices in Domestic Sector.