Design and Implementation of an Automatic Power Supply from Four Different Source Using Microcontroller

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Citation

Abstract
This project is designed to automatically supply continuous power to a load through one of the four sources of supply that are: solar, mains, thermal, and wind when any one of them is unavailable. The four switches represent the four causes. The switches are connected to an 8051 microcontroller of which they provide input signals. Whenever a switch is pressed, it shows the absence of that particular reference. A relay driver is used that receives microcontroller generated output and switches that specific relay to provide continuous power supply. A lamp or bulb is used as a load for demonstration purpose which draws power from main. When the primary fails to supply power, automatically next available source is used like thermal. If thermal fails then the next one is used and so on. An LCD is used to show which power supply is on.

1. Introduction
For a very long time, power outages, power interrupts and also unexpected routine power line maintenance is one of the major problems faced in industries, hospitals, offices, and homes whole over the world. For that case, this project provides an automatic operation of electrical power distribution systems; the rapid and reliable transfer of the system from one power source to another during specific events such as power outages, power interrupts, routine power line maintenance, to achieve the reliability of such systems [1-2].

Electrical power supply is one of the primary essential needs of human life today, that is to say, without electrical power supply, most human works become stand still, postponed and even cancelled since most human actions are dependent on the electrical power supply.

Furthermore, the need for power supply through access to electricity by the masses of the population of any country, both developed and developing countries is very important to the development of the economy of that particular country. In other words, the power sector plays an essential role in the socio-economic development of any country [3].

Therefore, this project provides a practical solution to provide an alternative power supply or uninterrupted power supply in automated mode to the load during frequent power cuts or in cases where power cuts or power outages cannot be avoided.
2. Materials and Methods

Components Description

The design and implementation of each of the fundamental circuit units and how the program was implemented to, control the plan and perform the required functionality. The steps involved in designing this project involve:

a. Transformer
b. Bridge Rectifier
c. Filter capacitor
d. Voltage Regulator LM7805A
e. Resistor
f. Relay Driver
g. LCD
h. 8051 Microcontroller

2.1. Transformer

This system uses a step down transformer which converts 230V AC to 12V AC with less power loss depending on the turns ratio.

The input ac varies in the event of input ac at 230V AC section varies from 160V to 270V in the ratio of the transformer primary voltage $V_p$ to Secondary Voltage, $V_s$ governed by formula;

$$\frac{V_p}{V_s} = \frac{N_p}{N_s}$$

Thus, if the transformer delivers 12V at 220V input, it will

At 160V; $\frac{160}{220} = \frac{160 \times 12}{220} = 8.72V$

And 270V; $\frac{270}{220} = \frac{270 \times 12}{220} = 14.72V$

Therefore, a step down between 8V to 15V was sufficient since current limitation was handled by the regulator.

2.2. Bridge Rectifier

Next stage was the AC/DC conversion process that involved inverting the negative cycles of the AC input. The process required the use of a full wave rectifier diode bridge and required specific bridge rectifier that would be able to handle a peak voltage of 20V and 2A. The 2W04G rectifier was used for simulation process.

At 220V; input voltage $Vs = 12V$

Output dc voltage $= 0.9Vs = 0.9 \times 12 = 10.8V$

The bridge rectifier delivers pulsating DC

![Figure 1. Shows Block Diagram of the power supply system.](image-url)
Ripple factor = \sqrt{(V_{rms}/V_{dc})^2 - 1} \\
= \sqrt{((12/10.8)^2 - 1)^{0.5}} = 0.66

Efficiency = \frac{P_{dc}}{P_{rms}} \times 100\% \\
= \frac{(10.8/12)}{100\%} = 90\%

2.3. Filter Capacitor

The capacitance value was needed to minimize the voltage ripple. The output of the transformer was 12V AC at 50Hz. The required minimum capacitor value can be calculated from the formula;

\[ C = \frac{I_{out}}{(2 \times f \times RF \times V_{in})} \]

\[ I_{out} = I_{max} = 1A, \text{ since it is the maximum output current of the LM7805 regulator} \]

\[ C = \frac{1}{(2 \times 50 \times 0.66 \times 12)} \approx 1000\mu F \]

Therefore, an electrolytic capacitor of about 470\mu F to 1000\mu F to filter the output DC from the bridge rectifier.

2.4. Voltage Regulator LM7805

Since the filtered DC being unregulated, IC LM7805 was used in simulation process to get 5V DC at its pin number 3 irrespective of input DC varying for 8V to 15V, and the regulated output from the LM7805 remains at a 5V constant.

The regulated 5V DC is further filtered by a small electrolytic capacitor of 10\mu F for any noise generated by the circuit.

STANDARD CONNECTIONS TO THE AT89S51

3. Working Principle

This project uses an arrangement where four different sources of supply are channelized to a load to have an uninterrupted operation of the load. As it is not practicable to get four sources of supply such as mains supply, wind supply, thermal supply and solar supply, we use relays only. The project has taken one source of 230v mains supply and assumed as if being fed from 4 different sources by connecting all the four incoming sources in parallel as seen in the schematic circuit diagram. The ac source to the lamp is connected to relay 1 to relay 2 to relay 3 and relay four by making the entire ‘NO’ (normally open) contacts parallel and all the common contacts in parallel. Four push button switches representing a failure of corresponding supply such as mains, wind, thermal, solar are respectively connected to port 3.4, 3.5, 3.6 and 3.7.

3.1. Logic Design

The project basically supplies continuous power to a load in automated mode through one of the four sources of supply that are: solar, mains, thermal, and wind when any one of them is unavailable.

Four switches are used for four respective sources. These are connected to a microcontroller of 8051 families that provides input signals to it. Whenever a switch is pressed, it shows the absence of that particular source. A relay driver receives microcontroller generated an output signal and switches that particular relay to provide continuous power supply. A lamp was used as a load for demonstration purpose which draws power from main. When mains fails to supply power, automatically next available source is used say thermal. If thermal fails then the next one is used and so on. An LCD is also used to display

Figure 2. Shows circuit diagram of AT89S51.
which source is currently used for power supply.

Schematic Circuit Diagram

Figure 3. Shows Complete Schematic Diagram of the power supply system of four different sources.

3.2. Flow Chart of the System

![Flow Chart Diagram](image)

Figure 4. Shows the Flow chart Diagram of the System.
4. Results and Discussions

4.1. Construction

The construction of the project is done based on the components layout, components assembly on Vero board and soldering process followed on making up the circuit to make sure that all components are permanently mounted.

4.2. Testing

Continuity test was carried out to check if there was current flow in the project circuitry and was aimed at finding electrical open paths in the circuitry after completing soldering and configuration. A multimeter was used to perform a continuity test on the electric circuit by measuring electric current flow.

Procedures
a. A multimeter is kept in buzzer mode.
b. Then it is connected to the ground terminal of the multimeter then to the ground.
c. Finally, both terminals are connected to the path that needs to be checked, and there is continuity in the way, the multimeter would produce a beep sound.

4.3. Results and Discussion

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<thead>
<tr>
<th>Table 1. Showing results of power supply circuit of the microcontroller.</th>
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<tr>
<td>Output of the bridge rectifier</td>
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<tr>
<td>11.9VDC</td>
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<th>Table 2. Showing result of power supply circuit to the microcontroller.</th>
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<tr>
<td>Power source</td>
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<tr>
<td>Solar</td>
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<tr>
<td>Solar</td>
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<td>Mains</td>
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<td>Thermal</td>
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4.4. Power on Test

Power on test was performed to check whether the voltage at different terminals is according to the requirements or not. A multimeter was switched to voltage mode, note that, this test was performed without the microcontroller to avoid damage to the microcontroller due to any excessive voltages.

The output of the transformer was checked and measured and the required 12V AC voltage was obtained, which was then applied to the power supply circuit and the terminal voltages of 12.00V, 0.00V, 4.308V and 7.692V DC voltage at positive, negative terminals, AC1 and AC2 of the bridge rectifier were measured respectively. This voltage was then applied to the 470uF capacitor, and the voltage at the anode terminal and cathode of the capacitor was 12.00V and 0.00V respectively. Then this voltage was applied to the voltage regulator LM7805, i.e, an input of 12VDC and output of 5VDC were obtained according to the requirements.

5. Results

This project prototype was implemented, tested and integrated before testing the entire system. The input from the four sources is given to the microcontroller.
Then the output of the microcontroller is given to the relay which maintains continuous power supply to the load. Finally, the current status of the available source is displayed on the LCD.

6. Conclusions

This project of AUTOMATIC POWER SUPPLY FROM FOUR DIFFERENT SOURCES (Solar, Mains, Wind, and Thermal) USING A MICROCONTROLLER is used to handle power supply from mains, solar, wind and thermal most effectively.

The outline of the project is the selection of supply from mains, solar, wind and thermal automatically using microcontroller concept.

The significance of this project lies in the various and wide places of applications such as; schools, hospitals, and most especially manufacturing industries and mining industries where a continuous supply of power is vital.

References


