Design and Modification of Power Pack with Over/Under Voltage & Over Current Protection

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Abstract - *This paper presents the design and modification of existing power pack. Power pack is variable power supply unit which gives the DC voltage to operate the electronic devices in control room of power plant. Range of modified power pack is from 15V to 24V with a maximum output current of 10A with over/under voltage & over current protection. The approach employed here is usually an embedded system designed around a microcontroller which is given with a digitized reference voltage to control the input and the output liquid crystal display for the provision of greater precision, stability and accurate results for the electronic equipment in thermal power plants.*

Key words: ***TRIAC,*** **Transformer, Microcontroller, Power supply, Diode, Capacitors.**

INTRODUCTION

Power pack is variable power supply unit which provides the DC supply. DC power supply plays a major role in every power plant, power plant has a lot of control circuitry such as relays, control cards, sensors, transducers, actuators etc., are operates on low DC supply. This will be providing the data for monitoring and controlling in the control room. This power supply should not be interrupted at any cost for proper functioning of the plant and all of them are approximately electronics elements, which require less DC voltage.

OVERVIEW OF EXISTING POWER PACK

Since 1986 in power plant DC power supply can be achieved by using transistorized switching and voltage regulation can be done by using simple zener diode. By using the component, power pack weight & size increases. Heavy heat-sinks are required to keep cool the transistors, which may again increase the surrounding temperature due heat dissipated by heat sink.

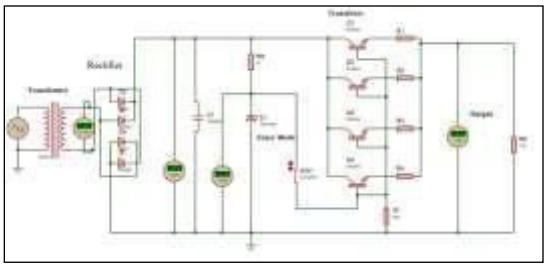

Fig-1: Circuitry of existing power pack.

DRAWBACKS

In this system there are some drawbacks such as short circuit protection, over voltage & under voltage protection. These safety protections are not provided. Any small short-circuit or over & under voltage in the circuit may lead to high maintenance cost and excess time loss.

IMPLIMENTATION

To improve functionality and reduced size of existing power-pack, implementing a thyristorised control system to control the voltages. There is provision for over/under voltage and over current protection & also make a provision to set variable voltage ranging from 15Vdc to 24Vdc maximum current capacity of 10Amp.

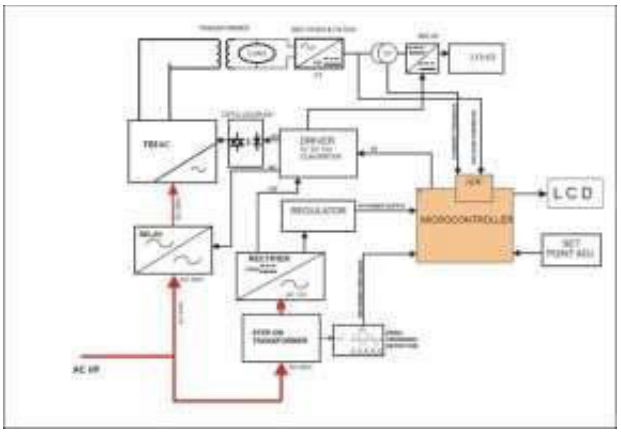

Fig-1: Modified Block diagram of power pack

COMPONENTS UESD IN POWER PACK

TRIAC (BTA16): TRIAC are used for Phase controlapplication.

Opto-coupler (MOC3041): It's used for to provide the isolation.

Transformer (220/24,10Amp)

Rectifier (1N4007) & filter: It converts 12V AC to 12V pure DC

Liquid Crystal Display (16*2): LCD is commonly used to display voltage, current, set point which may help the user to check visually.

Relay (12V 50-60Hz): It use for the protection of device.

Driver IC (ULN2003): It is used to operate the protective relay from low voltage.

Zero Crossing Detectors**:** A Zero Crossing Detectors (ZCD) is used to find the point where an AC waveform crossing the 0 voltage points in the wave.

MICROCONTROLLER (PIC16886): The main component of this section is the microcontroller. The PIC16F886 microcontroller was chosen because of the large number of input/output data pin (28). The large memory and the ability to be reprogrammed via a programmer was also part of the design considerations.

Voltage regulator (IC l7805): The regulator circuit provides a fixed voltage to microcontroller unit.

CONCEPT

For required output here we are controlling the primary side of transformer, by controlling the firing angle (α) of TRIAC. Sine wave of single phase 230V shownbelow.

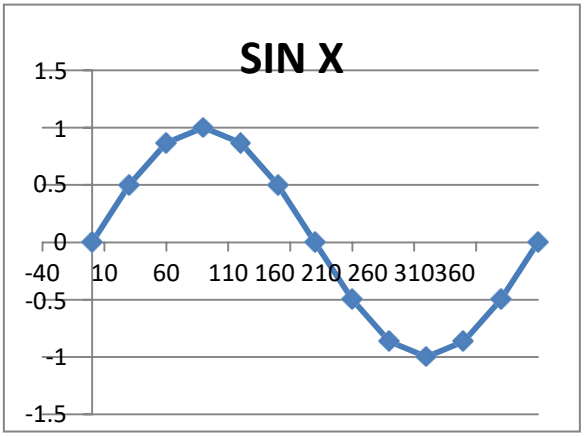

Fig.3. Single Phase Sine Wave Form

From the above figure

F= 50Hz

T= 1/F

T= 0.02 S or 20ms

360:=20ms

1ms = 18:

1 half cycle= 10ms=10,000µs

By using microcontroller we set phase delay for 15V DC

Phase Delay =0.02*α / 360:

8700μs=0.02*α / 360

α = 156.6:

156.6:=15DC V (+0.9&-0.2)

α =180: Phase Delay= 0.01Sec

α= 90: Phase Delay=0.01/2=0.005 Sec

α= 90:=peak voltage =220V (1 ø supply)

α= 180: =0V

Phase delay controlled by using the ZCD and microcontroller for the required voltage for the load in range 15V to 24V.

OPERATION OF MODIFIED POWER PACK

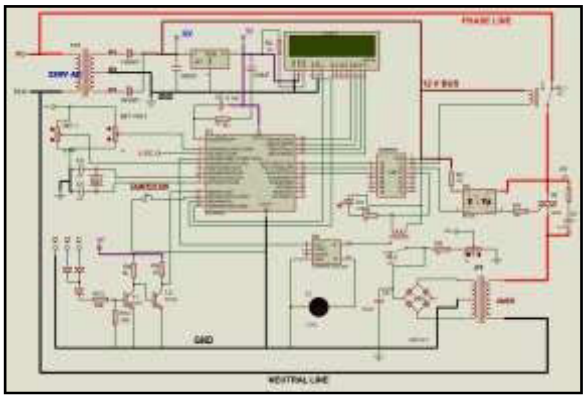

Fig. Circuit Diagram of Modified Power Pack

The single phase220V AC supply is given to step down transformer, step down transformer step down 220V into 12V. The reason behind selecting a 220V by 12V transformer is that, in case of mains voltage falls up to the 50% that is up-to 110 volt ac, in this case also transformer give at least 6 volts ac. In our project, some components required constant 5 volt like microcontroller, LCD, ZCD, drivers IC ULN2003 and some requires 12 volts like relays. Further the output of step down transformer is converted to DC with the help of full wave rectifierusing diodes1N007. The output of rectifier is pulsating dc which further filters by a filter capacitor. The rectified DC output is an unregulated which cannot be directly gives to the circuit, as microcontroller works on 5V DC only. To convert the unregulated rectified DC to constant 5V .the capacitor C_2 is used as a storage capacitor which stores 5V DC. The reason behind taking this capacitor is that there is only regulator IC 7805 which gives 5V to all the circuits, and if all the components requires a 5V at a time in that case output of regulator falls, which may results to resetting the microcontroller. Hence in case of loading to regulator, a capacitor D_2 delivers the 5V stores inside it to the components and protects a microcontroller against a fractional reset. Microcontroller interface with the driver IC to operate the relay. Relay RL_1 provides the protection for the entire control circuit. In case Triac gets damage for the protection purpose optocoupler is there which provides the isolation between the low power circuit & high power circuit. When the main supply is off the common of relay RL_1 is connected to the NC. When supply is on, the common move from NC to NO. Bridge rectifier output given to common of relay then microcontroller sense the output when output is more than 15V Relay RL_2 is getsON.

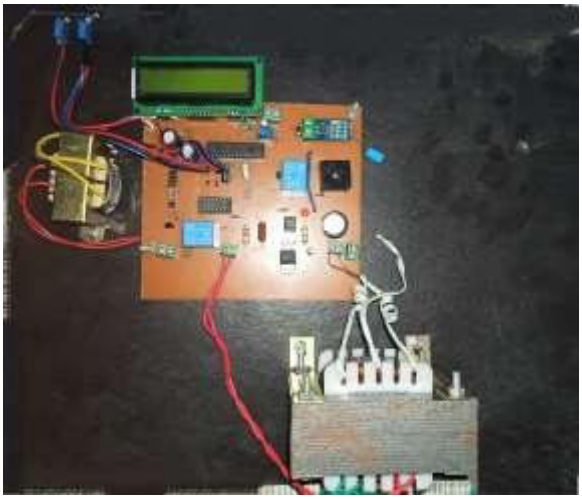

Fig. Model of Power Pack

EXPERIMENTAL RESULTS OF POWER PACK

Table 1: Shows the results of unit when load is not connected

Sr. No.	Firing angle (α)	Set Current(A)	Set Voltage(V)	Load Voltage(V)
1	89	3.9 A	19	19.7
2	88	3.9 A	19.5	19.4
3	87	3.9 A	20	20.7
4	88	3.9 A	20.5	21.1
5	87	3.9 A	21	21.2
6	86	3.9 A	21.5	21.9
7	86	3.9 A	22	21.8
8	85	3.9 A	22.5	22.7
9	84	3.9 A	23	23.5
10	84	3.9 A	24	24.4

Table 2 Shows the results of unit when load is connected

Sr. No.	Firing angle (α)	Set Current(A)	Load Current(A)	Set Voltage(V)	Load Voltage (V)
1	76	3.9 A	0.3	19	19.3
2	74	3.9 A	0.3	19.5	19.9
3	74	3.9 A	0.3	20	20.6
4	74	3.9 A	0.4	20.5	20.6
5	73	3.9 A	0.6	21	21.3
6	71	3.9 A	0.5	21.5	21.8
7	71	3.9 A	0.5	22	22.1
8	69	3.9 A	0.5	22.5	23.2
9	67	3.9 A	0.4	23	23.7
10	65	3.9 A	0.4	24	24.4

From the above experimental reading tables for no load and on load condition following results areobtained:

1) It can be seen that the resulting load voltage from the circuit is in the range of desirablefluctuationi.e.setvoltage+.9/-.2 set in the programed microcontroller.

2) In Power circuit when we set the voltage different values of firing angle are observed. This firing angle is observed to be decreasing with increase in the set voltage value i.e. when set voltage increases the firing angledecreases.

CONCLUSION

This work has successfully presented a variable power supply unit with protection by using the TRIAC & MICROCONTROLLER PIC16F886.It Produces a DC voltage 15V to 24V. The step down transformer steps down the main 220V supply to required 15V to 24V this can be done by controlling the primary side voltage of main transformer using the TRIAC by generating a required firing angle with the help of zero crossing detector &microcontroller.

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