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Power Factor Improvement by using Synchronous Condenser

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Abstract:

Because of the insulating material power issue of the inductive load and for the inextinguishable condition of energy sources, the energy are being wasted by united states of America but we've a tendency to can't notice that. So, it's a superb concern for the ability engineers to pay off this loss by the event of power think about currently each day. But with the enlargement of technological whirl, several strategies of power issue correction are projected already for automation that's desired for every system. Most of the automatic system uses programmable devices. Through this paper,we are reaching to describe the design and improvement of power issue correction pattern AVR microcontroller. For the low maintenance price and long life, synchronous condenser is used for correction technique instead of electrical condenser bank. Harmonics are set down by synchronous condenser that can't be afford by pattern electrical condenser bank. For dominant the DC excitation of synchronous condenser still on improve the facility issue, the facility issue and generation of required management signal from microcontroller are needed to measure and monitor unendingly that's in addition involved throughout this method.

Keywords —Electrical condenser banks, Synchronous condenser, Microcontroller, DC excitation, Power issue.

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I. INTRODUCTION

In the present situation of technological revolution, it's been determined that power is extremely precious. The industry is primarily increasing the inductive loading, the inductive rectifiers, Load have an effect on the ability issue therefore the power grid losses its efficiency. There are certain organization developing product during this field to improve and compensate power factor. Within the present trends the planning also are moving forwards the miniature design, this may be achieved in an exceedingly product by victimisation programmable device. Most of the merchandise are developed with microcontroller primarily based embedded technology. The advantage of victimisation microcontroller is that the reduction of price and therefore the use of additional hardware like the employment of timer, RAM and memory board can be avoided. This technology is extremely ROM thus dominant of multiple parameters is feasible, additionally the parameter are field programmable by the user. The automated power issue correction device ROM very helpful device for economical transmission of active power. If the buyer connect inductive load, then the ability issue lags, once the ability issue goes below an exact level, then the electrical company charge penalty to the buyer. Thus it's essential to keep up the ability issue inside a limit. Automatic power issue correction device reads the ability issue from the road voltage and line current, calculating the compensation demand and turn on thedifferentcapacitorbanks or synchronous condenser.

II. LITERATURE REVIEW:

1. Power -Factor control Tariff normal by, LinxiaGuo, Yu Cheng, Lizi Zhang, and Haitao Huang shows below the circumstance that the seller kind of power business is being advanced constantly in China, the present power-factor control tariff couldn't promote the electrical power shoppers to complete the reactive power effectively. Besides, the current charging mechanism for reactive power in user-side has a series of issues, and has dangerous influences to the grid. This paper studies the reality and also the issues of the present power-factor control tariff in China. Moreover, this paper additionally studies this international and domestic reactive power charging experience; some enhancements area unit created to the current power-factor control tariff in China. By establishing the classified user power-factor adjustment system considering user's power consume behaviour and confirm the power-factor normal level with restriction to the voltage quality and transmission loss, a lot of scientific power-factor assessment criterion for various sorts of purchasers is established.

2. Electricity Conservation in Automatic Power issue Correction by Embedded System by Mr. Ravindran. V. Kirubakaran shows, new methodology for power issue correction with low price drives. Power issue management could be a major role within the improvement of facility stability. Several of the present systems square measure high-priced and tough to manufacturer. Today several of the converters don't have any input power issue correction circuits. The result of power issue correction circuit is employed to eliminate the harmonics gift within the system. This kind of power issue correction circuit is generally utilized in the Switched Reluctance Motor controller drive. Fastened capacitance systems square measure continually leading power issue beneath at any load conditions. This can be unhealthy for installations of facility. The projected embedded system drive is employed to cut back the price of the instrumentality and increase the potency of the system. Experimental results of the projected systems square measure enclosed. It's more sensible choice for effective price method and energy savings.

3. Economical Single part Power issue Improvement Strategy for small grid Operation by Saeed Anwar shows a technique to enhance the facility issue (PF) at the purpose of common coupling (PCC) for small grid applications is given during this paper. The position of the compensating unit is chosen to correct the facility issue and cut back the harmonic levels of the grid current and PCC voltage in small grid connected distributed renewable energy sources. The projected compensation system for power issue improvement (PFI) is operated dynamically for each linear and nonlinear hundreds.

III. METHODOLOGY:

1. BLOCK DIAGRAM:

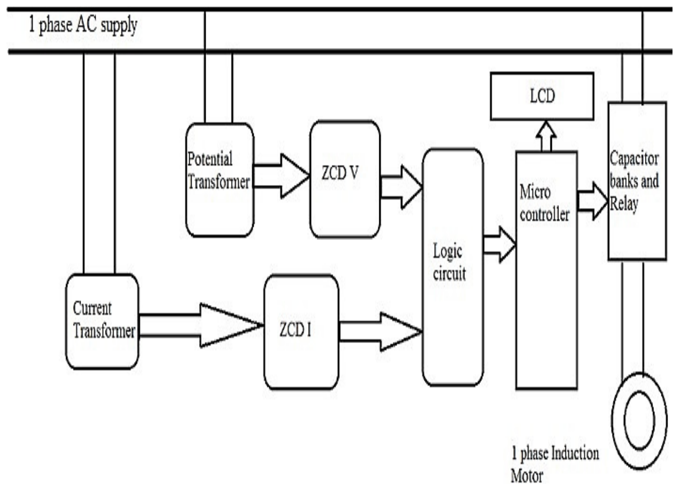


Figure1: Block Diagram of Power Factor Improvement

The design aims at measuring the phase angle between voltages and current continuously, calculating the power factor of the circuit from the phase angle and a correction action is initialized to supplement this phase difference by synchronous condenser using the proposed control scheme.

The circuit shown in figure uses pic16f 72 microcontroller as a main control unit. Current sensor acs712 with zero crossing detector is connected to pin number 2 of microcontroller. The voltage sensor zmpt101b output is connected to pin number 3 of microcontroller. The DC voltage required for excitation of synchronous machine is control wire Pulse-width modulation control technique. For this DC voltage control IGBT 25N120 is used. This IGBT is controlled by OPTO coupler driver circuit formed by IC 4N35. Resistance of 10 K Ohm is connected for current limiting at the input side. Wherecombination of 1K and 10k ohm resistance at the output side of OPTO coupler driver ensures safe triggering of IGBT. A pot is connected to analogue pin number 2 for setting the reference signal for PWM.The microcontroller is programmed to measure the time difference between zero crossings of voltage and current waveform. By measurement of this time difference, power factor estimation can be done by converting this time period into the angle.

Depending upon this value, the controller takes action to either increase or decrease the duty cycle of PWM pulses. These PWM pulses are fixed frequency variable duty cycle pulses. The increase in time period between zero crossing instance of voltage and current indicates decrease in power factor and vice versa. Hence the duty cycle of PWM pulses is directly proportional to the time difference.

2. SYSTEM MODEL

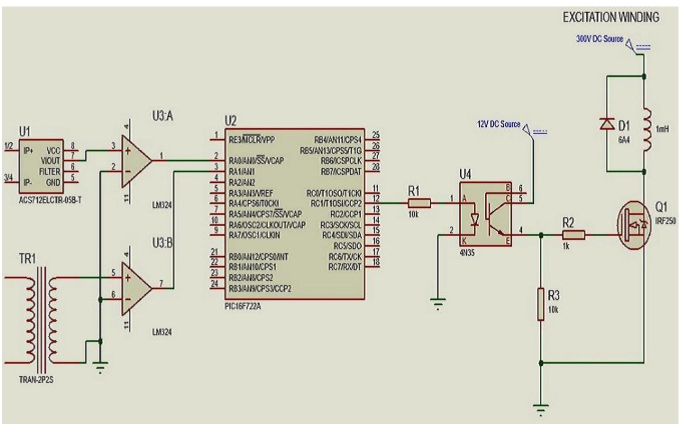


Figure 2: System Model with Microprocessor

Figure 2 provides the simplified circuit description of the total system. The system can be divided into different parts. These are:-

- DC power supply unit.
- Power factor measurement unit.
- Automatic control unit.
- Power factor correction unit.

The principle of operation:-

- Current Transformer (CT) and Potential Transformer (PT) step down the voltage and current level.
- The output of CT and PT are as input for ZCD.
- ZCD translate sinusoidal voltage and current wave from CT and PT into square wave.
- Two square waves corresponding to voltage and current are set to the input of XOR gate.
  - If there is a phase difference between two inputs of XOR gate, the output of the XOR gate remains high for a period equal to that phase difference.
- The output of XOR is given as the input of microcontroller
- Microcontroller calculates the phase difference between them as well as power factor.
- According to the difference between measured power factor and desired power factor, microcontroller generates control signal and controls the excitation current of synchronous condenser.
- LCD module is connected to the PORT A of AVR microcontroller.
- The system power factor can be monitored by LCD.
- This process continues until the measured power factor equals the desired power factor.

3. CONTROL SCHEME

The PIC 16F72 microcontroller is chosen for overall circuit functionality and power. The following are the main characteristics of this microcontroller.

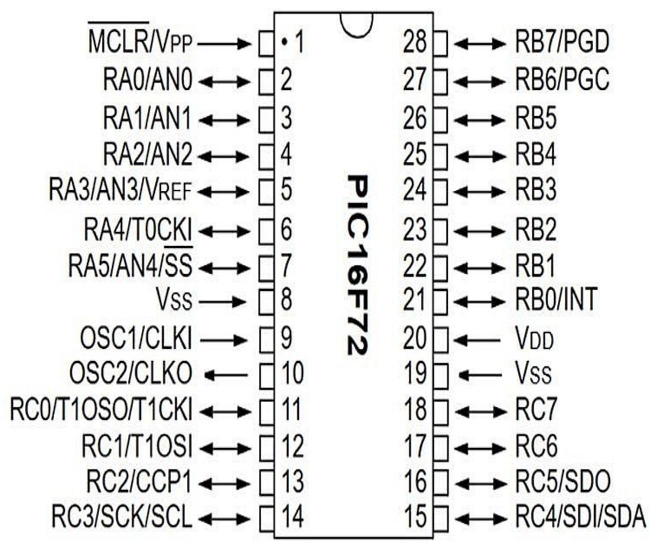


Figure 3: Pin diagram of PIC 16F72 Microcontroller

Processing Units	Baseline 8-bit
Number of Pins	28
Operating Voltage (V)	2-5.5V
Number of I/O pins	22
ADC Module	8-bit, 5-channel
Timer Module	2 x 8-bit 1 x 16-bit
Capture/Compare/PWM Peripherals	1 x 16-bit Capture module 1 x 16-bit Compare module, 1 x 10-bit PWM module,
DAC Module	Nil
Communication Peripherals	1 x SSP (SPI / I2C)
External Oscillator	Up to 20Mhz
Internal Oscillator	Nil
Program Memory (KB)	3.5KB
CPU Speed (MIPS)	5 MIPS
RAM Bytes	128
Data EEPROM	Nil

Table 1: Specifications of PIC 16F72 Microcontroller.

Algorithm:

An algorithm is developed to make the input and respond accordingly .An algorithm of control scheme is shown in following figure.

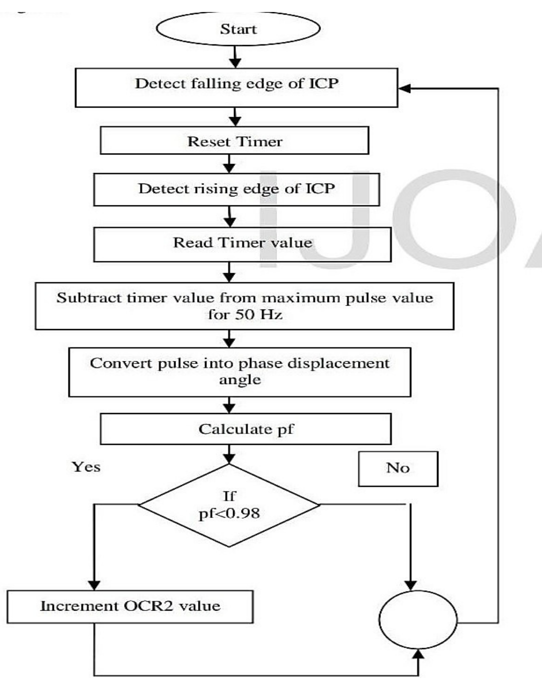


Figure 3: Step By Step Representation of Microcontroller

4. MATLAB SIMULATION

Simulink modelling is used in the MATLAB simulation. The simulation experiments are carried out in stages, with various load and power factor correction conditions. The power factor of the selected load is first measured without the use of a synchronous condenser. Then with excitation voltages of 30v, 100v and 220v, the correction of the power factor with incremental excitation control is addressed.

Without Synchronous Condenser:

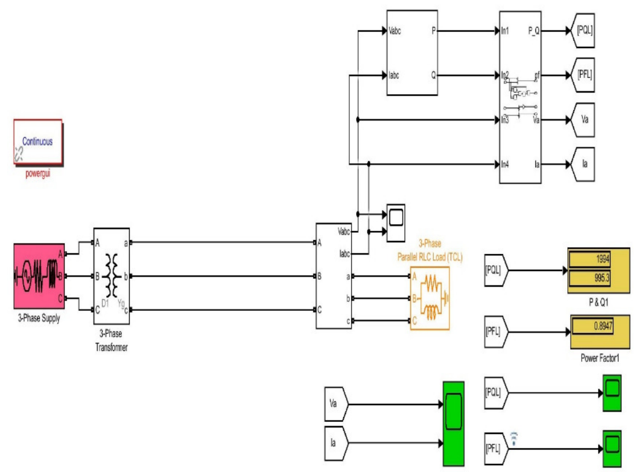
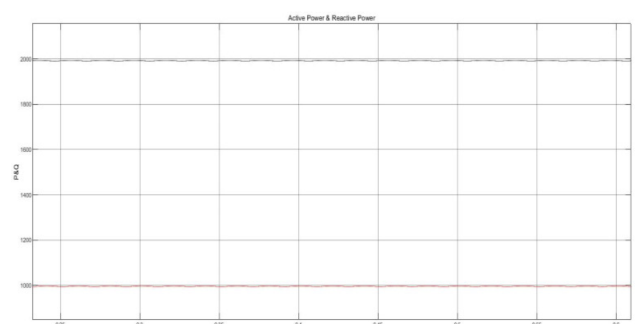
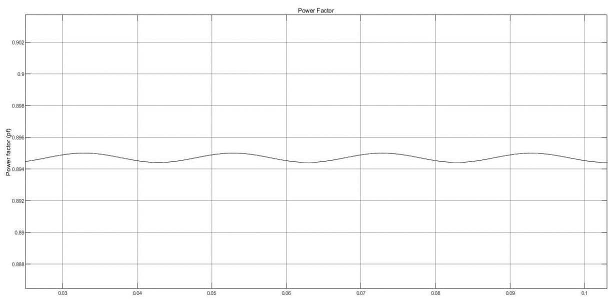


Figure4:MATLAB Simulation without Synchronous Condenser

1. Active and Reactive Power:



2. Power Factor:



With Synchronous Condenser:

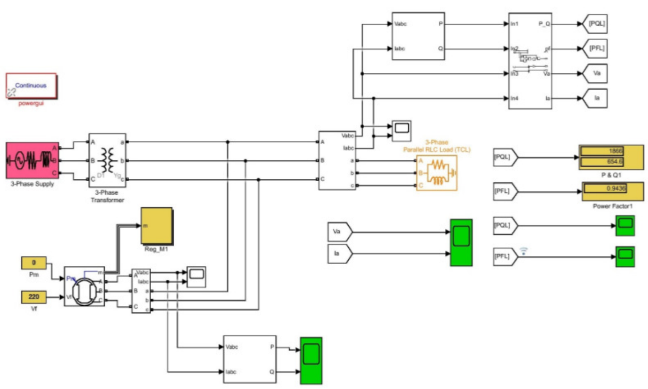
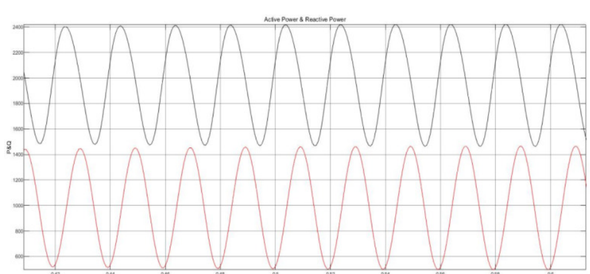
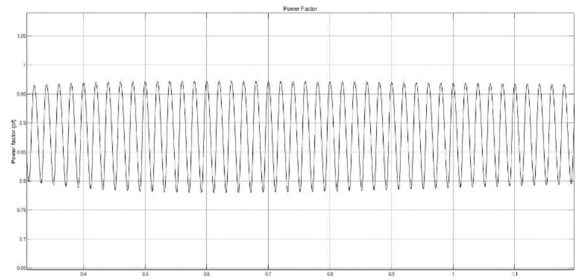


Figure 5:MATLAB Simulation without Synchronous Condenser

1. Active and Reactive Power:



2. Power Factor:



5. RESULT

Both measurements must be taken separately with and without the synchronous condenser for the parallel RLC load. For each case, quantities such as supply voltage, frequency, current drawn by the load, power consumed, and power factor must be measured. The amount of energy used must therefore be tracked for a set period of time to ensure that all energy savings are realized

Sr No.	Field Voltage (V_f in V)	Active Power (P_L in W)	Reactive Power (Q_L in VAR)	Power Factor
1	Without Condenser	1994	995.3	0.8947
2	30	2008	1011	0.8931
3	100	2096	815.2	0.932
4	220	1866	654.5	0.9436

Table 2: Observations from Simulation

III. CONCLUSION

The MATLAB simulation shows that the power factor can be increased from 0.8947 to 0.9436. Controlling the DC excitation of the excitation winding allows for fine tuning of synchronous machine. PWM control useful for precisely regulating excitation.A well-organized technique for power factor calculation and correction is shown throughout this paper.Because of high value of synchronous condenser the correction technique has been given in theory however the PF calculation has been done varied. It is necessary to use synchronous condenser in high voltage system rather than capacitor bank as a results of long period of time of condenser.The power factor of the road is continuously monitored through the microcontroller. Here required controlled signal is created automatically for correction and it's a time saving technique. The technique is additionally very economical in comparison with capacitor bank.In order to strengthen power issue a variable speed synchronous condenser may even use in any high voltage conductor so the speed of synchronous condenser can be controlled by microcontroller through the zero cross detector.

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