Power Quality improvement by using Microcontroller & Active shunt Filter

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ABSTRACT : In this present paper, stress has been laid upon the present scenario of power quality in every grid. With more and more use of non linear electrical loads instead of linear loads, we get increased efficiency, pure power quality with reduced power requirements; however this degrades the power quality of whole power system. Power quality is basically determined by the voltage magnitude and frequency in a system. To improve it, we can use voltage regulators and active shunt filters ,etc. In this paper use of voltage regulator using PIC16F877A microcontroller has been presented, which works on concept automatic voltage regulator and can be called as a smart circuit. It provides good automated regulation without consuming much power. Only major drawback is the presence of harmonics in the output, thus improvement in power quality the by using Active shunt filter.

Keywords: Power quality, non linear electrical loads, voltage regulator, Active Filter, automated regulation.

1.0 INTRODUCTION

Power quality is the set of limits of electrical properties that allows electrical systems to function in their intended manner without significant loss of performance or life. The term is used to describe electric power that drives an electrical load and the load's ability to function with that electric power. Without the proper power, an electrical device (or load) may malfunction, fail prematurely or not operate at all. While "power quality" is a convenient term for many, it is the quality of the voltage - rather than power or electric current - that is actually described by the term. Power is simply the flow of energy and the current demanded by a load is largely uncontrollable. Automatic voltage regulators are widely used in electrical power field to obtain the stability and good regulation of the electric system. In typical AVRs, switching is done by electromagnetic relays, or servomotor, or electronic device, which automatically selected tap sinc the transformer together required voltage to boost (add) or buck (subtract) the input voltage.

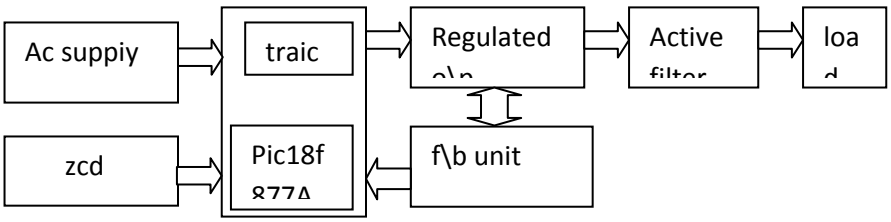


Fig 1.0 Block diagram

2. LINEAR AND NON-LINEAR LOADS

Linear Loads: AC electrical loads where the voltage and current waveforms are sinusoidal. The current at any time is proportional to voltage. Linear loads are: incandescent lamps, heaters, power factor improvement capacitors.

Non-Linear Loads: Applies to those ac loads where the current is not proportional to the voltage. Foremost among loads meeting their definition is gas discharge lighting having saturated ballast coils and thyristor (SCR) controlled loads. The nature of non-linear loads is to generate harmonics in current waveform. This distortion of current waveform leads to distortion of voltage waveforms. Non linear loads are: Computer, Laser Printers, SMPS, Rectifier, PLC, Electronic Ballast, Refrigerator, laptops, Electronics devices, TV ,etc. This brings about nonlinear loads which draw current independent of utility voltage but depends on power required. One such commonly used load was static UPS, used to provide regulated output voltage to the critical load. If utility voltage decreases, UPS compensates for it by drawing more current. One of the major advances in power supply design is the switch mode power supply (SMPS). These new devices cost less and use less power, however cause major problems with power quality.

3. POWER QUALITY PROBLEMS:

Include all possible situations in which the waveforms of the supply voltage or load current deviate from the sinusoidal waveform at rated frequency with amplitude corresponding to the rated rms value for all three phases of a three-phase system. power quality disturbance covers sudden, under voltage, overvoltage as well as steady- state deviations, such as harmonics .

Some of the power quality problems are:

- Under voltage
- Over Voltage
- harmonics

3.1Over voltage and under voltage

Long-duration voltage variations that are outside the normal limits (that is, too high or too low) are most often caused by unusual conditions on the power system. For example, out-of- service lines or transformers sometimes cause *under voltage* conditions. These types of root- mean-square (RMS) voltage variations are normally short term, lasting less than one or two days. In addition, voltage can be reduced intentionally in response to a shortage of electric supply

3.2Harmonics

The pure sine wave, the deviation is in the form of a periodic function and by definition, the voltage distortion contains harmonics. When a sinusoidal voltage is applied to a certain type of load, the current drawn by the load is proportional to the voltage and impedance and follows the envelope of the voltage wave form. These loads are referred to as Non linear loads (loads where the voltage and current follow one another without any distortion to their pure sine waves) such as resistive heaters, incandescent lamps and constant speed induction and synchronous motors. In contrast some loads cause the current to vary disproportionately with the voltage during each half cycle. These loads are classified as nonlinear loads and the current and voltage have waveforms that are non sinusoidal containing distortions where by 50 Hz waveform has numerous additional waveforms superimposed upon it creating multiple frequencies within the normal 50 Hz sine wave. The multiple frequencies are harmonics of the fundamental frequency.

4.0 Solution of Power Quality Problems

4.1Mitigation of Harmonics

Active Shunt Filter

4.2Mitigation of Under Voltage and overvoltage

Automatic Voltage Regulator

5.0 Hardware Implementation

The basic building blocks for this design include a PIC l6f 628 microcontroller, a triac, a 400V autotransformer, a zero crossing circuitry, and a load voltage sensing circuitry.

5.1Microcontroller PIC16F877A

The reducing the size and cost compared to a design that uses a separate microprocessor, memory, and input/output devices, microcontrollers make it economical to digitally control even more devices and processes. Mixed signal microcontrollers are common, integrating analog components needed to control non-digital electronic systems. Some microcontrollers may use four-bit words and operate at clock rate frequencies as low as 4 kHz, for low power consumption (mill watts or microwatts). They will generally have the ability to retain functionality while waiting for an event such as a button press or other interrupt; power consumptionwhilesleeping(CPUclockandmostperipheralsoff)maybejustnanowatts,making many of them well suited for long lasting battery applications. Other microcontrollers may serve performance-critical roles, where they may need to act more like a digital signal processor (DSP), with higher clock speed and power consumption.

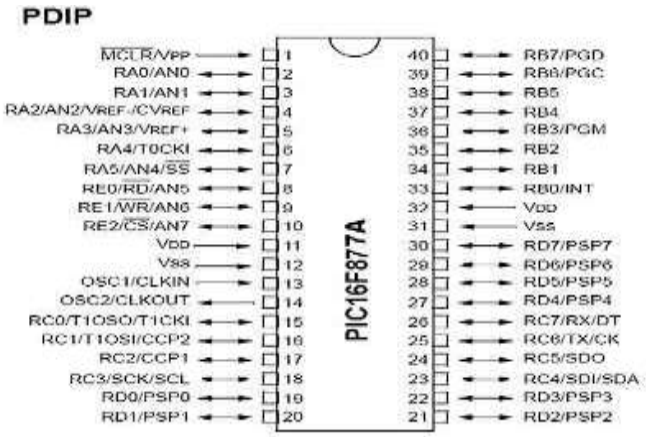


Fig5.1 Pin Diagram pic877A

5.2 Active shunt filter

Harmonic filter are used to eliminate the harmonic distortion causes by nonlinear load. Specially harmonics filter are designed. Filter are used most common solution that is to mitigate the harmonics from nonlinear load. Filters can be designed to trap these currents and, through the use of a series of capacitors, coils, and resistors, shunt them to ground. Thus the basic principle of shunt active Filter is that it generates a current equal and opposite to the harmonic current drawn by the load and injects it to the point of coupling there by forcing the source current to be pure sinusoidal. This type of Shunt Active Power Filter is called the Current Injection type AsF.

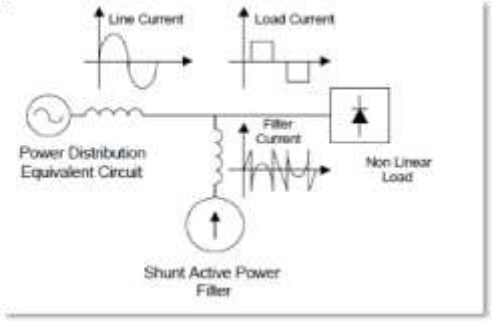


Fig5.2 shunt Active Filter

5.3 Automatic Voltage Regulator

A switching regulator converts the dc input voltage to a switched voltage applied to a power MOSFET or BJT switch. The filtered power switch output voltage is fed back to a circuit that controls the power switch on and off times so that the output voltage remains constant regardless of input voltage or load current changes. Switching regulator has three common topologies: buck (step-down), boost (step-up) and buck- boost(step-up/step-down). Other topologies include the fly back, SEPIC, Cuk, push-pull, forward, full-bridge, and half-bridge topologies.

Voltage Regulator Using PIC16F877A

. It acts within 100ms to produce a smoothly varying output whenever inputs mains voltages.(Servo stabilizers Voltage stabilizers are used for many appliances in commercial, &IT industries. The mains supply suffers from large voltage drops due to losses on the distribution lines. A voltage stabilizer maintains the voltage to the appliances at the nominal value of around 230volts even if the inputs main fluctuates over a wide range. The circuit of an automatic voltage regulator can be adapted to any power rating. Its intelligence lays in the program on PIC16F877A-a low cost microcontroller that is readily available. The circuit, when used with any appliances, will maintain the voltage at around 230V even if the input mains voltage varies between 180V and 250V .Here the circuit is shown for a 5A stabilizer move a variable contact on a toroidal auto transformer to adjust the output when input goes up and down, which take seconds.)

6.0 Result and Conclusion

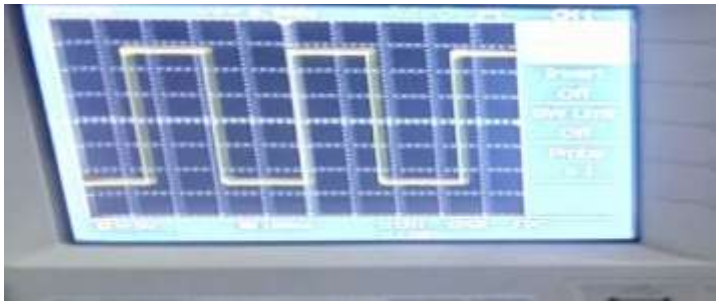
Output Waveform of auomatic Voltage Regulator

Fig. 6.0 Output Voltage Waveform

Resultant waveform

The Voltage Regulator using PIC16F877A microcontroller is automatic voltage regulator good for nonlinear

load applicable and pure filter output waveform as shown in below. it can give an output voltage of 230V in the range of voltage variation of 180V to 250V mains. However it is accompanied by some harmonic content as seen from the above waveform.



7.0 Conclusion

Voltage regulator using microcontroller PIC16F877A is a good, efficient technique to regulate voltage because it makes use of intelligence of microcontroller for its functioning. Also it is completely automated voltage regulator circuit with least user intervention for its functioning. However the output voltage contains lot of harmonics (3rd, 5th harmonics) that makes use of a harmonic active shut filter, in series of circuit, it is necessary. If current capacity of various equipments used in circuit is increased it may be used for industrial as well as commercial purpose.

8.0 References

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