MANTECH Publications

Journal of Current Trends in Electrical Engineering
Volume 1, Issue 3, September-December, 2016

Development of System for Detection of Power Quality Parameters

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Abstract

Now-a-days, power quality problems are increases because of increasing use electricity. Poor power quality is affecting sensitive loads so created instability, malfunctioning, loss of data and great loss of economy. Power quality problems can cause severe damage in the power system. This paper present development of system for detection of power quality parameters using PIC microcontroller of 16F877A Identification of power quality parameters in power system typically voltage sag, voltage spikes, voltage swell, harmonic distortion, voltage fluctuation, voltage unbalance, noise, interruption etc. this developed system is low cost hardware system. It consist of voltage sensing unit, signal conditioning system, PIC microcontroller 16F877A and display and monitoring system as well as personal computer. These senses single phase voltages and detects the problem and also send output through LCD display.

Keywords: *Hardware, PIC 16F877A, LCD display, Power quality problems, single phase system etc.*

1. INTRODUCTION

In an electrical system, power disturbances such as sag, swell, unbalance, interruption, harmonic distortion, flicker and transient are causing on customer devices. The effects are malfunctioning of equipment, scrambling of data and interruption in communication, a frozen mouse, equipment failure and cost of lost production. Power quality is a set of

boundaries of electrical properties that allows electrical systems. Quality power supply is the one which is made available, within the voltage and frequency tolerances with a pure sinusoidal waveform.

A microcontroller based hardware system is designed for this purpose. The system is standalone, com-pact, low cost and the designed hardware is not complex when compared to other systems. Microcontroller used in this hardware is PIC18F452 which is low cost, high speed, low power consumption and easy handling device. From the literature survey it has been seen that lot of study is done on power quality parameters. Mathematical models were developed and voltage sags and voltage swells were detected in single phase power supply and this system is low cost microcontroller based systems were developed to detect sag, swell in single phase system (Baby Shalini, 2014; Santhanayaki & Valluvan, 2013). This paper is organized as follows: Section 2 deals with block diagram representation of the circuit and describes the functionality of each block.

The circuit diagram and its sub-circuits are explained in Section 3. Section 4 shows the developed hardware setup. Hardware testing and results during normal condition and power quality problems are discussed in Section 5. The final conclusions are drawn in Section 6.

2. BLOCK DIAGRAM

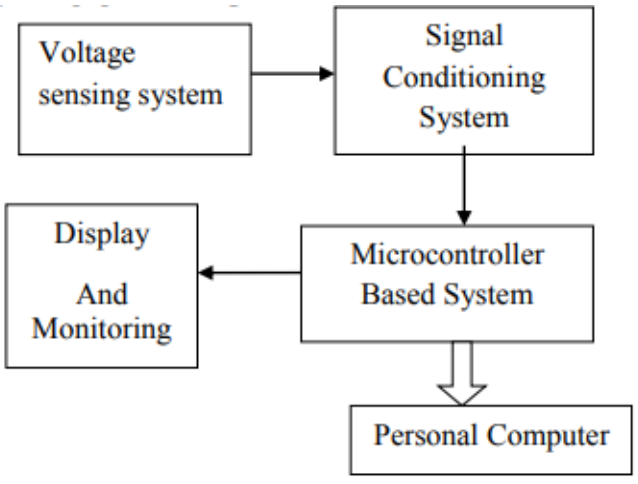

Figure1: Block Diagram for detection of power quality problems

Block diagram representing many blocks and their interconnection for the detection of power quality problems is shown in Figure 1. The main component is PIC Microcontroller. It is powered from a regulated power supply which provides constant 5 V DC from 230 V AC supply. Microcontroller receives input signals corresponding to signal phase voltages from voltage sensing unit. The program written in microcontroller checks the voltage signals and gives signals to output devices: Liquid Crystal Display (LCD), Light Emitting Diodes (LEDs). The faulty conditions of voltage sag, swell, interruption and unbalance are indicated by the respective LEDs and LCD display message. LCD clearly indicates the type of power quality problem occurred along with the p. u. voltage values.

3. CIRCUIT DIAGRAM

Figure 2 shows the circuit for detection of power quality problems. The overall circuit diagram comprises these sub-circuits: Regulated DC power supply circuit, Voltage sensing unit, LCD interfacing circuit, LED interfacing circuit. The functionality of each sub-circuit is explained as follows:

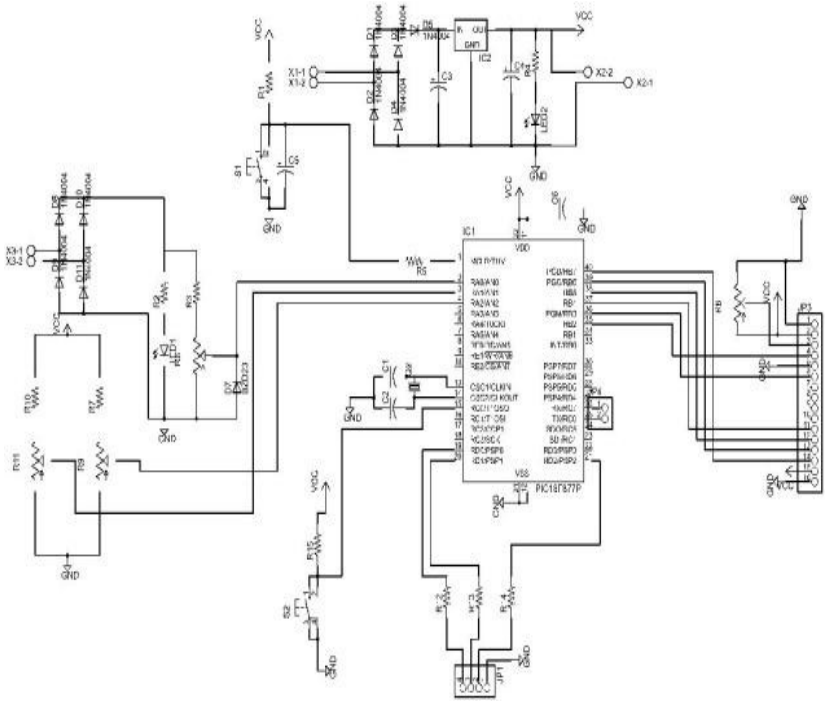

Figure 2 Circuit Diagram of detection of power quality problem

Regulated DC power supply circuit

In electronic systems, AC input voltage should be converted to DC voltage with the correct value and degree of stabilization. The common DC voltages that are required to power up the devices are generally in the range of 3–30 V DC. Typically, the fixed types of DC voltages are 5, 9, 12, 15, and 18 V. The regulated power supply unit converts AC to constant 5 V DC to give supply to the microcontroller. 230 V, 1-phase AC supply is given to step down transformer which step downs to 12 V AC. This 12 V AC supply is given to the diode bridge rectifier which converts AC supply to DC supply. The DC supply is passed through a filter which removes ripples in unidirectional supply from the bridge rectifier. The filtered DC supply is given to 7805 regulator to regulate the voltage at 5 V and is given to power the PIC Microcontroller.

Voltage sensing unit

The voltage sensing unit senses 1-phase AC voltages and converts them into the required form to be given to the microcontroller for processing. 230 V AC supply is stepped down to 12 V AC by using a transformer. 12 V AC is rectified, filtered and regulated to 5 V DC by using the diode bridge rectifier, filter and voltage regulator respectively. Voltage signals obtained from the voltage sensing units are given to analog to digital converter pins of PIC 16F877A microcontroller, to generate digital signals internally required by the microcontroller. Here, potentiometers one for each phase are used at the output of regulators to generate voltage conditions to be given to the microcontroller for detection of power quality problems. Voltage can be varied from 0 to 5 V using POTs. Microcontroller is programmed to take the low voltage level of 0 V as 0.0 p.u. and the high voltage level of 5 V as1.8 p.u. This enables it to detect both under and over voltages of wide ranges.

LCD interfacing circuit

A 16 × 2 LCD is used to display normal and abnormal conditions along with the voltage values in p.u. The LCD is connected to the microcontroller. LCD receives signals from microcontroller and displays as “NC”, “SAG”, “SWELL”, “INTERRUPTON” and “UNB” for normal condition, voltage sag, swell, interruption and unbalance condition, respectively.

LED interfacing circuit

Developed system are used LED. LED is indicating different power quality problem occurring in the system and also shows the occurrence of voltage unbalance, sag,

swell and interruption, respectively. LED is connected to microcontroller. The microcontroller activates the corresponding LED when any power quality problem occurs.

4. HARDWARE SETUP

Figure 3 shows the hardware setup that is arranged to conduct the experiments to test the performance of the hardware built up. To generate power quality problems with varied magnitudes, three potentiometers of 10kΩ are used at the outputs of rectifiers in single phases. The resistances of these potentiometers are varied to get different voltage conditions. A PIC18F452 microcontroller is used to store and execute the program written for classification of power quality problems based on the inputs received from the potentiometers. Microcontroller is interfaced with LCD, LEDs for indicating the occurrence of power quality problems.

5. HARDWARE TESTING AND OBSERVED RESULTS

Hardware is tested for different voltage conditions such as normal voltage, voltage sag, swell, inter-eruption and unbalance conditions etc.

Normal condition

Hardware is tested without any power quality disturbance. Normal condition is created in the hardware by varying the potentiometers to obtain voltages in the range of 0.9–1.1 p.u. The output is shown in Figure 4. The LCD shows normal condition and voltage values displayed for single phases 1.00 p.u. LEDs are OFF which indicates no disturbance in the system.

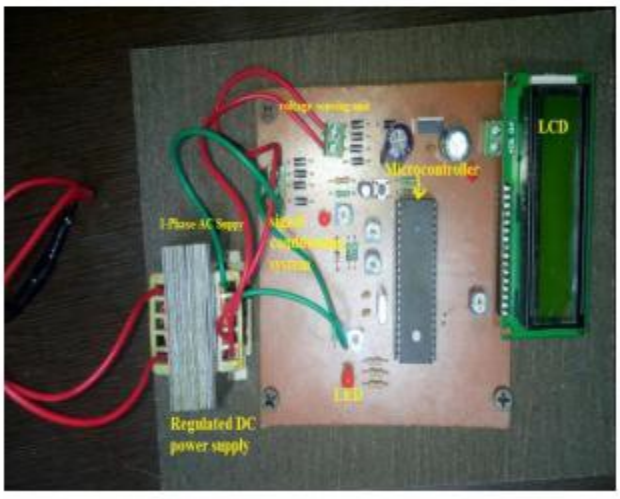

Figure3. Hardware setup for detection of power quality parameters

Figure4. Hardware output for normal condition.

Voltage sag condition

Sag condition is created by decreasing the resistance of potentiometers, i.e. the voltages are set between 0.1 and 0.9 p.u. The output is shown in Figure 5. The LCD displayed sag condition with sag voltage of 0.60 p.u.

Figure 5 Hardware output for voltage sag.

Voltage Swell Condition

Swell condition is created by increasing the resistance of potentiometers, i.e. the voltages are set between 1.1 and 1.8 p.u. The output is shown in Figure 6. The LCD displayed swell condition with swell voltage of 1.42 p.u.

Figure6. Hardware output for voltage swell

D. Interruption Condition

Hardware is tested for interruption condition, by setting the input voltages below 0.1 p. u. by reducing potentiometers resistances. The output observed is shown in Figure 7. The LCD displayed interruption condition with voltage of 0.00 p. u.

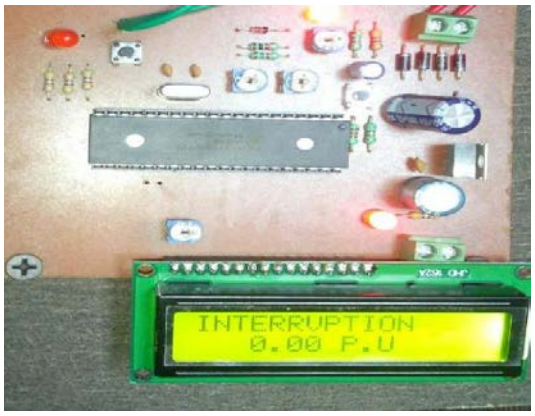

Figure 7 Hardware Output for Interruption Condition

E. Voltage Unbalance Condition

Unbalance condition is created in the hardware model by varying the potentiometers. The output is shown in Figure 8. The LCD displayed unbalance condition with 30.76% of unbalance percentage and voltage values is 1.2 p. u.

Figure 8 Hardware output for voltage unbalance

The outputs of the hardware are observed by testing it for different voltage conditions and some of the values noted for each condition are summarized in Table 1.

Table 1 Output of Hardware Testing

Condition & Microcontroller Input voltage	Normal condition 2.7V at input	Sag 1.6V at input	Swell 3.9V at input	Interruption 0.06V at input
LCD output	NC 1.00	SAG 0.60	SWELL 1.42	INTERRUPTION 0.00
Sag Indicator	OFF	ON	OFF	OFF
Swell Indicator	OFF	OFF	ON	OFF
INTERRUPION Indicator	OFF	OFF	OFF	ON

CONCLUSION

The hardware of developed system for detection of power quality parameters in power system is constructed and tested. The system hardware correctly detected normal condition like a voltage sags, voltage swells, voltage surges or spikes, under voltage, distortion, voltage fluctuations etc. when normal condition occurs to the system LCD indicates the condition and voltages. During to sag, swell and interruption, LCD indicates the power quality problems and the magnitude of voltage. Hardware of system is simple, secure and low cost. System will be minimizing losses in failure of the equipment and to increase plant productivity. The proposed method is simple, convenient and less expensive.

ACKNOWLEDGEMENTS

The authors would like to thank the authorities of SKN College of Engineering, Pandharpur, India for providing all facilities to do the research work at the institution and also the anonymous reviewers for the valuable comments and suggestions

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