# DEVELOPMENT OF POWER QUALITY MANAGEMENT SYSTEM

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"I hereby declared that I have read through this report and found that it has comply the partial fulfillment for awarding the degree of Bachelor of Electrical Engineering (Control, Instrumentation and Automation)"

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This report is submitted in partial fulfillment of requirement for the degree of Bachelor in Electrical Engineering
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" I hereby declared that this report is a result of my own work expert for the excerpts that have been cited clearly in the references"

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## ABSTRACT

This project is to be design base on monitoring system. The application of this project are to monitor power quality by analyze and interpret raw data into useful information with minimum human intervention. Power quality monitoring is often driven by the demand for improving the system wide power quality performance. The Matlab software was used to develop monitoring system and Microsoft Excel was used as a database for this project. There are several types of disturbance at power quality which are the voltage sag, flicker, voltage regulation (unbalance), transient and harmonic distortion. The monitoring system will calculate the value of root mean square (RMS), instantaneous frequency using zero crossing method and frequency domain analysis using Fast Fourier transform. From the calculation value it will produce several graph that can enable the analysis and monitoring of the power signal. This project provides the opportunity to learn how to develop database system by using Matlab and also learn about mechanism of power quality.

# ABSTRAK

Projek ini telah direka berdasarkan kepada system pengawasan. Aplikasi projek ini adalah untuk mengawasi kualiti kuasa dengan cara menganalisis data dan menterjemahkan data kasar kepada sesuatu maklumat yang berguna dengan penglibatan manusia yang minimum. Pengawasan kualiti kuasa adalah suatu keperluan yang sangat penting untuk meningkatkan prestasi system keseluruhan kualiti kuasa. Untuk projek ini, perisian MATLAB telah digunakan untuk membangunkan system pengawasan manakala Microsoft Excel telah digunakan sebagai pengkalan data untuk projek ini. Seperti yang diketahui, terdapat beberapa jenis gangguan kepada kualiti kuasa iaitu *'voltage sag',' flicker',' voltage regulation (unbalance)', 'transient'* dan *'harmonic distortion'*. Sistem pengawasan tersebut akan mengira nilai *'root mean square (RMS)'*, *'instantaneous frequency'* menggunakan *'zero crossing'* teknik dan analisis *'frequency domain'* menggunakan *'fast fourier transform'*. Daripada pengiraan tersebut akan menghasilkan beberapa graph yang membolehkan analisis dilakukan dan pengawasan terhadap isyarat kuasa dapat dilakukan. Projek ini memberikan peluang untuk mempelajari bagaimana untuk membangunkan system pengkalan data dengan menggunakan Matlab dan juga mempelajari mengenai mekanisma kualiti kuasa.

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# CHAPTER I

# INTRODUCTION

## 1.1 Background of Project

Development of Power Quality Management System is a project that is focused on monitoring power quality system. The application of this project are to monitor power quality by analyze and interpret raw data measurement into useful information with minimum human intervention. The power quality management system will used off-line power quality data assessment which is carried out separately from the monitoring instruments.

Power quality is characteristic of the power supply that enables the equipment to work properly. In other words, power quality can be described as a set of electrical boundaries that allows a piece of equipment to function in its intended manner without significant loss of performance or life expectancy. Any power problem manifested in voltage, current or frequency deviations that result in failure or miss operation of customer equipment also known as power quality.

There are a few objectives of monitoring which are monitoring to characterize system performance, monitoring as part of an enhanced power quality service, monitoring as part of predictive or just-in-time maintenance. Through a output signal produce from the power quality monitoring system, a power utility would be able to gauge the level of the quality of power being supplied to the end-users. While plant equipment manufacturers, by knowing the characteristic of the

supply side can focus on designing better plant equipment that is robust enough to ride through the power supply variations. The end-user can then focus on production without having to worry about power quality problems.

For this project, the power quality monitoring process will be monitor by using a computer. The computer is consists a few software such as Matlab and Microsot Excel. Matlab is used to develop monitoring system for monitoring purpose where is all the calculation part will be prepared. Excel is used as a database for the measurement data that need for monitoring will put in together in this system. There are some methods that are used for analysis such as calculation on root means square (RMS), discrete fourier transform (DFT) and zero crossing. After that, some analysis can be done by interpret the output signal. The output signals will describe the type of disturbance that occurs at feeder pillar at distribution line. The monitoring process will be done off line without connect to any network.

## 1.2 Problem Statement

The ultimate reason by doing this project is because nowadays newer generation load equipment, with microprocessor-based controls and power electronic devices, is more sensitive to power quality variations so it will give economic values which are impact on utilities, customers and suppliers of load equipment. The process of gathering data is usually carried out by continuous measurement of voltage and current over an extended period. Power quality monitoring programs are often driven by the demand for improving the system wide power quality performance.

Power quality is characteristic of the power supply that enables the equipment to work properly. There was a need for monitor power quality by analyze and interpret raw data into useful information with minimum human intervention. The monitoring system must be able to calculate and display the significant value of the

signal such as root mean square (RMS) value, the parameter in time domain and frequency domain as well as the instantaneous frequency.

The process of analysis and interpretation has been traditionally performed manually, but recent advances in signal processing and artificial intelligence fields have made it possible to design and implement intelligent systems to automatically analyze and interpret raw data into useful information with minimum human intervention. This project will use Matlab software to design power quality monitoring system where is all the calculation and monitoring works will be done at the monitoring system. Other than that, Excel as a database will keep the data for analyzing purpose.

## 1.3 Objective of Project

The project has four objectives to be achieved:

1) To study the fundamental and importance of power quality monitoring in power system.
2) To study the several techniques or algorithm that can be used to analyze the power quality signal.
3) To extract the relevant information in power signal by using signal processing technique.
4) To design the power quality monitoring system using Matlab GUI.

## 1.4 Scope of Project

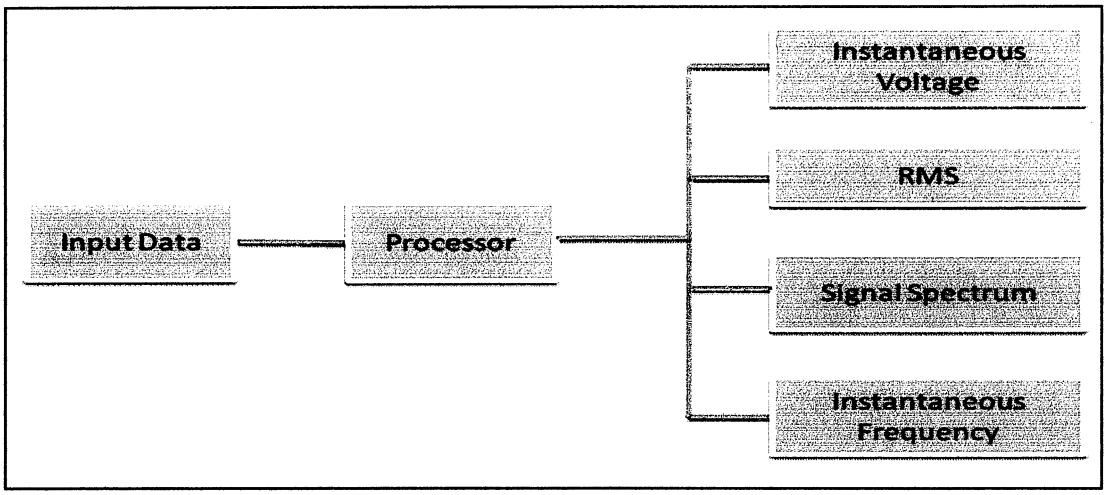


Figure 1.1: Scope of Project Block Diagram

Figure 1.1 shows scope of project block diagram which contain three stages of project scope which are input data, processor and output. Input data is a data at distribution line that had given from Tenaga Nasional Berhad for analysis purpose. The input data will contains value of instantaneous phase current, voltage phase, voltage line, voltage sine wave and RMS phase current, voltage line, voltage phase and phase angle.

Processor will use the input data to do some analysis for monitoring purpose. There are two several types of software that will be using at processor which are Matlab and Microsoft Excel. The calculation part will be prepared by using Matlab software and that software will also do power quality monitoring by analyzing, and interpreting raw measurement data into useful information. There are four outputs signal that can interpret from the processor which is root mean square (RMS), instantaneous frequency, fast fourier transform and zero crossing. From the output signal, the type of disturbance can be classified and power quality monitoring process is completed.

## 1.5 Outline of the Report

The report for Power Quality Management System is divided into 5 chapter. The first chapter will describe about project background, objective of the project which consists four objectives to achieve, scope of the project which explain the element of the RMS, instantaneous frequency, instantaneous voltage and signal spectrum. The second chapter will discuss about the literature review that being covered for this project. There are some elements that being reviewed, they are the power quality and its objective. The type of voltage disturbance also being reviews and discuss. In term of develop the project, the appropriate software also being review which is the Matlab. The third chapter is the Methodology. The outline of this chapter included the project flow, the calculation and formula involve in this project and also the Matlab program and GUI development. The fourth chapter discussed about the result and analysis from the project. It showed the output from the development process including collecting data from database created. The chapter five wrapped up all the reports. The project will be concluded and recommendations will be given to improve the project for future.

# CHAPTER II

# LITERATURE REVIEW

## 2.1 Introduction

This chapter had been covered about researches related to the subject of the project. Upon the researches, it will provide clearer understanding about power quality and gain some idea to develop monitoring system. This chapter also covers some literature review about software that will use to develop the monitoring system. This project is about the development of power quality management system and the monitoring system is based on using Matlab GUI and Matlab programming to develop the algorithm of power quality analysis.

## 2.2 Power Quality

### 2.2.1 Definition of Power Quality

The term of power quality is applied to a wide variety of electromagnetic phenomena on the power system. Power quality is a term that means different things to different people. Institute of Electrical and Electronic Engineers (IEEE) Standard IEEE1100 defines power quality as the concept of powering and grounding sensitive electronic equipment in a manner suitable for the equipment. As appropriate as this description might seem, the limitation of power quality to sensitive electronic equipment might be subject to disagreement. All electrical devices are prone to failure or malfunction when exposed to one or more power quality problems. The

electrical device might be an electric motor, a transformer, a generator, a computer, a printer, communication equipment, or a household appliance. All of these devices and others react adversely to power quality issues, depending on the severity of problems. A simpler and perhaps more concise definition might state power quality is a set of electrical boundaries that allows a piece of equipment to function in its intended manner without significant loss of performance or life expectancy. The definition embraces two things that we demand from an electrical device which are performance and life expectancy.

### 2.2.2 General Classes of Power Quality Problems

The terminology presented here reflects recent United States and international efforts to standardize definitions of power quality terms. The IEEE Standards Coordinating Committee 22 (IEEE SCC22) has led the main effort in the United States to coordinate power quality standards. It has the responsibilities across several societies of the IEEE, principally the Industry Applications Society and the Power Engineering Society. It coordinates with international efforts through liaisons with the IEC and the Congress Internationale des Grand Réseaux Électriques aHaute Tension (CIGRE; in English, International Conference on Large High-Voltage Electric Systems). The International Electrotechnical Comission (IEC) classifies electromagnetic phenomena into the groups shown in Table 2.1

TABLE 2.1: Principal Phenomena Causing Electromagnetic

| Disturbances as Classified by the IEC |
|---|
| Conducted low-frequency phenomena |
| Harmonics, interharmonics |
| Signal systems (power line carrier) |
| Voltage fluctuations (flicker) |
| Voltage dips and interruptions |
| Voltage imbalance (unbalance) |
| Power frequency variations |
| Induced low-frequency voltages |

| |
|---|
| DC in ac networks |
| Radiated low-frequency phenomena |
| Magnetic fields |
| Electric fields |
| Conducted high-frequency phenomena |
| Induced continuous-wave (CW) voltages or currents |
| Unidirectional transients |
| Oscillatory transients |
| Radiated high-frequency phenomena |
| Magnetic fields |
| Electric fields |
| Electromagnetic fields |
| Continuous waves |
| Transients |
| Electrostatic discharge phenomena (ESD) |
| Nuclear electromagnetic pulse (NEMP) |

### 2.2.3 The Need for Power Quality Monitoring

The ultimate reason that power quality is interesting is economic value. There are economic impacts on utilities, their customers and suppliers of load equipment. The quality of power can have a direct economic impact on many industrial consumers. If there have power quality problem, electric power utilities will lose the opportunity to meet the maximum demand at the end-user points during restarting plant operation. This could mean end-user loss of several hour of production time. [5]

On the one hand, if power quality is bad, it will speed up the insulation aging of the devices, reduce the efficiency and utilization ratio of electrical devices and effect normal operation of communication system. As a result, it will bring huge losing to the industry which has the require to the high power quality. On the other

hand, power, as merchandise, is operated independently by electric power supply company and electric power generation at the mechanism of power market. This environment, which is open and encourages competition, will bring forward higher request to power quality. The quality of supply power will affect market share of electric power supply company directly. Therefore, it is the active demand to deal with the pollution of the electric network by effective measure, improve the level of the power quality and increase the development and research of new electric power technology. And it is meaningful to constitute a power quality monitoring system which is environmental and high quality.

## 2.3 Objective of Power Quality Monitoring

The monitoring objectives often determine the choice of monitoring equipment, triggering thresholds, methods for data acquisition and storage, and analysis and interpretation requirements. Several common objectives of power quality monitoring are summarized here.

### 2.3.1 Monitoring to Characterize System Performance

This is the most general requirement. A power producer may find this objective important if it has the need to understand its system performance and then match that system performance with the needs of customers. System characterization is a proactive approach to power quality monitoring. By understanding the normal power quality performance of a system, a provider can quickly identify problems and can offer information to its customers to help them match their sensitive equipment's characteristics with realistic power quality characteristics.[1]

### 2.3.2 Monitoring to Characterize Specific Problems

Many power quality service departments or plant managers solve problems by performing short-term monitoring at specific customer sites or at difficult loads.

This is a reactive mode of power quality monitoring, but it frequently identifies the cause of equipment incompatibility, which is the first step to a solution.[1]

### 2.3.3 Monitoring as Part of an Enhanced Power Quality Service

Many power producers are currently considering additional services to offer customers. One of these services would be to offer differentiated levels of power quality to match the needs of specific customers. A provider and customer can together achieve this goal by modifying the power system or by installing equipment within the customer's premises. In either case, monitoring becomes essential to establish the benchmarks for the differentiated service and to verify that the utility achieves contracted levels of power quality.[1]

### 2.3.4 Monitoring as Part of Predictive or Just-in-time Maintenance.

Power quality data gathered over time can be analyzed to provide information relating to specific equipment performance. For example, a repetitive arcing fault from an underground cable may signify impending cable failure, or repetitive capacitor-switching restrikes may signify impending failure on the capacitor-switching device. Equipment maintenance can be quickly ordered to avoid catastrophic failure, thus preventing major power quality disturbances which ultimately will impact overall power quality performance.[1]

## 2.4 Type of Disturbance

### 2.4.1 Voltage Sag

A sag is a decrease between 10 and 90% below nominal voltage in rms voltage at the power frequency for durations from 0.5 cycle to 1 min. Voltage sags are usually associated with system faults but can also be caused by energization of heavy loads or starting of large motors. Figure 2.1 shows typical voltage sag that can