CHAPTER I

INTRODUCTION

1.1 General

While analog instruments have such advanced features as simple construction and low cost, they require considerable care and skill for precision measurement and parallax errors are involved in reading the measured values. Digital instruments, on the other hand, permit even unpracticed personnel to obtain reliable readings with ease. Today, these advantages have made this type of instrument extremely popular in a wide range of industries.

In the field of power measurement, analog instruments have generally been employed at commercial frequencies (the impulse type watthour meter being an exception). In recent years, remarkable progress has been made in the application of thyristors in power control, transmission systems and power-system electrical equipment, such as fluorescent lamp, motor, transformer and so on. However, when large currents are switched, the outputs of thyristor controlled circuits, instruments and devices contain higher harmonics which cause serious troubles in related systems and equipment. Precision measurement of such distorted waves is extremely difficult with conventional power measuring instruments

designed for accepting sine waves. But this will not be a problem for a properly designed digital AC power meter.

In brief, the heart of digital AC power meter is a multiplier circuit, the six most common solid-state methods are logarithmic, quarter-square, triangle averaging, variable transconductance, current ratioing, and feedback time division. There are other techniques for multiplying but these six are the most suitable for all-solid-state instrumentation. And also the feedback time division is the one which spans a wide spectrum of accuracy, speed, and cost.

1.2 Purpose of the Research

The purpose of this thesis is to design and construct a digital AC power meter with desired range using the feedback time division multiplier. Calibration methods of the meter, drawings, and parts list are also provided for an easy reference. The sequence of the research is summarized as follows.

(a) Study a method of constructing a digital AC power meter.

(b) Develop a four-quadrant multiplier circuit based on the feedback time division method.

(c) Design, experiment, and compose the other functions which are necessary for the meter, including the regulated power supplies, the current preamplifier and the voltage

preamplifier circuits, W/RMS selector circuit, signals isolator, point and unit and ranging encoder circuit, and A-to-D converter each separately in form called assembly.

(d) Interconnect all assemblies together.

(e) Test and adjust the whole instrument for highest accuracy.

(f) Discuss the limitation of accuracy and technical problems.

1.3 Capability of the Desired Instrument

To meet the requirement for measuring the power of distorted waves and their RMS value of voltage and current many problems must be consider. For example,

- How wide are the measuring ranges for both voltage and current.
- How to divide each range for most effective operation.
- What is the maximum resolution of the desired instrument.
- What kind of circuits is suitable for cach function.

Normally, the level of voltage for AC single phase in industries and commercial field are 110V, 220V, and 380V. The next step is high-voltage in range of kV, and the level of current depends upon the impedance of the load. The desired instrument should cover the measuring range from low to medium range and should cover a wide range of applications. If it is necessary to measure over

the above ranges, it can be done by reduction of voltage and current with step-down transformer in voltage and current mode respectively. If that rare condition should happen, then the selected voltage range is 3 Vrms to 600 Vrms maximum, and the current range is 0.1 Arms to 30 Arms maximum. Frequency of the measuring instrument input is from 40 to 1,200 Hz.

In our desired instrument it is necessary to use multiplier circuit to abtain the AC power and true RMS values. In general, the multiplier circuit has a higher error if a smaller input is applied. If the input is not less than 30% of full scale or the nearby upper range, the multiplier should be working properly. By this way the voltage range can be divided to 3V, 10V, 30V, 100V, 300V, and 600V, and the current range is divided to 0.1A, 0.3A, 1A, 3A, 6A, 10A, and 30A according to the requirements. The next problem is to find what kind of circuit is suitable for each function. It can be seen that the parallax errors are neglected in reading the measured values with digital meter. Then, the significant figures of the reading should consist of 3 to 4 digits. For this reason $4\frac{1}{2}$ digit A-to-D converter using the dual-slope integration method is selected. With 2 Vdc full scale the variation on the least significant digit give the resolution of the instrument to be less than 1 mV/digit.

The most important for AC power and true RMS measuring are a multiplier circuit. The author choose to study the topic of feedback time division method, because this type of multiplier does

not need any critical components,for example, matched-pair transistors. It is also possible to obtain most of components in local market, and accuracy is quite good.

1.4 Outline of the Work.

The outline of this thesis is as follows.

(a) The technical theory about the characteristics of AC power and various functions that are required for a digital AC power meter is presented in chapter II and III.

(b) A design and construction of the instrument is presented in chapter IV.

(c) In chapter V test, adjustment, and the result are given.

(d) Applications and conclusions are summarized in chapter VI.

(e) Related data and informations are also given in appendices.