Ain Shams University
Faculty of Engineering
Electrical Power & Machines Department

AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING
CAIRO - A. R. E.

Investigation and Comparison of Different Methods for High Precision Measurements of AC Voltage and Current

By

Eng. Rasha sayed Attiya Mohammed

A THESIS

Submitted in partial fulfillment of the requirements for the degree of M.Sc. in Electrical Engineering

Supervised by:

Prof. Dr. Mohamed Abdel-latif Badr
Prof. Dr. Ibrahim M. Hassan Saad
Dr. Mamdouh Mostafa M. Halawa

Cairo 2005

SUPERVISION SHEET

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Signature

Prof. Dr. Ahmed Asad Mahmoud
Faculty of Engineering – Ain Shams University-

Prof. Dr. Mohammed Mohammed Khodir
National Institute for Standards (NIS)

Prof. Dr. Mohamed Abdel-latif Badr
Faculty of Engineering –Ain Shams University-

STATEMENT

This thesis is submitted to Ain Shams University in partial fulfillment of the requirements for the degree of M. Sc. in Electrical Engineering

The included work in this thesis was carried out by the author at Department of the Electrical & Electronic Measurements, the National Institute for Standards (NIS). No part of this thesis has been submitted for a degree or a qualification at any other university or institution.

Name: ***Rasha Sayed***
Date: October 2005

C.V.

Personal Information:

Name: Rasha Sayed Attiya Mohammed Ali
Date Of Birth: 2 August,1979
Nationality: Egyptian
Marital Status: Married
Address: El-Zahraa,city in El Helmya
Dar El-Ala No.7
Tel. No.: (02) 6365597
Mobile: 0103342242
E-Mail: Rasha_sama79@hotmail.com

Qualification:

Bachelor in Electrical Engineering-2001
Power & Elec. Machine Department.
Faculty of Engineering – **Ain shams** University.
Grade of final year: **Excellent**
General Grade: **Very Good**

Project:

Distribution In Big Building

Project Grade: Excellent

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ABSTRACT

The AC voltage measurements and the calibration of alternating voltages and currents embrace a wide range of equipment and topics. To meet these demands, much of the equipment and many of the methods in current use were developed in the 1960's. Special instruments have been developed in the Metrology field for the measurement of current and voltage over rather wide ranges.

Since there is no AC counterpart to the standard cell and Zener diode standards, measurement of AC quantities are made relative to these same standards. Most common types of accurate AC voltage measurements are classified into two categories, Direct devices (Electrostatics. Electrodynamics and Digital Multimeters) and Indirect devices (Electronic Device and Thermal Devices). Complete Comparison between the direct methods (DMMs) and indirect methods (Thermal elements) was investigated in this thesis.

A high sensitive precision digital multimeters (DMMs), 8½ digits, as an example of the direct method, was used to measure the AC voltage and current accurately at frequencies from 50 Hz to 20 kHz. Also, a single junction thermal voltage converter as an example of indirect method, which have a flat and known frequency response was used to measure the same ranges of currents and voltages at the same frequencies. In case of current measurements, special current shunts to transfer the applied current into potential difference were used. All practical experiments were performed under same conditions exactly.

Complete Comparison between the direct methods (DMMs) and indirect methods (Thermal elements) was practically and theoretically investigated in this thesis. Four categories of these responses were observed during the practical work (High accuracy-Low uncertainties, Low accuracy-Low uncertainties, High accuracy-High uncertainties, Low accuracy-High uncertainties). The overall results of the calculations of the uncertainty according to the ISO guide are given in details. They are given for all ranges of voltages and currents at all ranges of frequencies.

CONTENTS

Chapter (2)

Direct Methods for Accurate Measurements of AC Voltage and Current

Chapter (3)

Indirect Methods for Accurate Measurements of A.C Voltage and Current

Chapter (4)

Uncertainty in Measurement of A.C Voltage and current

Chapter (5)

Comparison Between the Most Accurate Methods

LIST OF FIGURES