

Ain Shams University
Faculty of Engineering
Electrical Power & Machines Department



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:

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Prof. Dr. Ibrahim M. Hassan Saad
Dr. Mamdouh Mostafa M. Halawa**

Cairo 2005

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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.

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ACKNOWLEDGMENT

I wish to express my deep gratitude and respect to my supervisors committee: Prof. Dr. Ibrahim Hasan Saad, Prof. Dr. Mohamed Abdel-Latif Badr and Dr. Mamdouh Mostafa Halawa for their guidance and support. Their helpful and valuable discussions were the core reason for accomplishing this work.

My deep gratitude goes to Prof. Dr. Ibrahim Hasan Saad for his precious advice. My very special thanks are dedicated to Dr. Mohamed Abdel-Latif Badr and Dr. Mamdouh Mostafa Halawa for his close following up, continuous advice and guidance all throughout the review of the work. My thanks and gratitude also are dedicated to every member of my family and my colleagues at the National Institute for Standards (NIS), Egypt for their patience and understanding all along the way.

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.

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