

**AN OPTIMAL MEASUREMENT PLACEMENT METHOD FOR  
POWER SYSTEM HARMONIC STATE ESTIMATION**

**CHAKPHED MADTHARAD**

**A THESIS SUBMITTED TO GRADUATE SCHOOL IN  
PARTIAL FULFILLMENT OF THE REQUIREMENTS  
FOR THE DEGREE OF  
DOCTOR OF PHILOSOPHY  
IN ELECTRICAL ENGINEERING**

ลิขสิทธิ์มหาวิทยาลัยเชียงใหม่

Copyright© by Chiang Mai University  
All rights reserved

**GRADUATE SCHOOL  
CHIANG MAI UNIVERSITY  
FEBRUARY 2004**

**AN OPTIMAL MEASUREMENT PLACEMENT METHOD FOR  
POWER SYSTEM HARMONIC STATE ESTIMATION**

CHAKPHED MADTHARAD

THIS THESIS HAS BEEN APPROVED  
TO BE A PARTIAL FULFILLMENT OF THE REQUIREMENTS  
FOR THE DEGREE OF DOCTOR OF PHILOSOPHY  
IN ELECTRICAL ENGINEERING

**EXAMINING COMMITTEE**

*SPen*

.....CHAIRPERSON

Asst. Prof. Dr.Suttichai Premrudeepreechacharn /

*W. Tayati*

.....MEMBER

Assoc. Prof. Dr.Worawit Tayati /

*S. Uatrongjit*

.....MEMBER

Asst. Prof. Dr.Sermsak Uatrongjit /

*Neville R. Watson*

.....MEMBER

Dr.Neville R. Watson /

*Ratchai*

.....MEMBER

Asst. Prof. Dr.Ratchai Saeng-udom /

2 February 2004

©Copyright by Chiang Mai University

## ACKNOWLEDGMENT

I wish to sincerely thank my supervisor and co-supervisor, Asst. Prof. Dr. Suttichai Premrudeepreechacharn and Senior Lecturer Dr. Neville R. Watson for their great assistance, advice, patience and warm friendship during the course of this research. I am also very grateful to my supervising committee, Assoc. Prof. Dr. Worawit Tayati, Asst. Prof. Dr. Sermsak Uatrongjit, and Asst. Prof. Dr. Ratchai Saeng-udom.

The financial support from the Thailand Research Fund through the Royal Golden Jubilee Ph.D. Program (Grant No. PHD/004/2546) is gratefully acknowledged. Special recognition is due to my employer, the Provincial Electricity Authority (PEA), Thailand, the financial supports of international presentations is deeply appreciated.

This thesis was carried out at the Department of Electrical Engineering, Chiang Mai University, Thailand and the Department of Electrical and Computer Engineering, University of Canterbury, New Zealand. I would also like to thank the staff and colleagues of both departments for their helpful encouragement. Dr. Somboon Nuchprayoon who carefully reviewed of this thesis is very much appreciated.

My wholehearted gratitude goes to my wife Mrs. Tidarat, and my sons Theewara and Thayanit, who provide unceasing understanding and encouragement. Finally, thanks are due to my parents Mr. Won and Mrs. Malee, my wife's parent Mr. Thonwa and Mrs. Sunantha, my brothers and sisters who cared, I offer my warmest thanks.

Chakphed Madtharad

ลิขสิทธิ์มหาวิทยาลัยเชียงใหม่  
Copyright© by Chiang Mai University  
All rights reserved