STUDY ON THERMAL CHARACTERISTIC OF OSCILLOSCOPE WITH NEW FORM FACTOR DESIGN.

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A project report submitted in partial fulfillment of the
requirements for the award of the degree of
Master of Engineering (Mechanical Engineering)

Faculty of Mechanical Engineering
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OCTOBER 2007

Dedicated to

My parents, Su bin Bakar and Jariah binti Rejab,

My wife, Haslishah binti Abdul Hamid,

My daughter, Nur Liyana,

My son, Muhammad Ayman

for their immeasurable love and support.

ACKNOWLEDGEMENT

ALHAMDULILLAH. Thanks to God, the most gracious and the most merciful, for His guidance to accomplish this research.

In preparing this thesis, I was very much indebted to my family, whom had without failed giving me encouragement. Especially to my parent for understanding and encouragement on any path I choose in my life. I am sincerely appreciated and thanked my wife for her support and patience during my busy time managing my career and study. Also I would like to wish special thank you to my children for understanding when sparing very less time with them prior to course completion.

I also wish to gratitude Agilent Technologies Microwave Products (Malaysia) Sdn. Bhd. for funding my Master Degree study and providing engineering tools to complete this thesis. And also wish special appreciation to management and co-workers for continuous help and support.

My sincere appreciation goes to my thesis supervisor, Dr Kahar Osman, for guidance, advices, critics and friendships. Without his encouragement, this thesis almost cannot be completed.

I am also very thankful to fellow colleagues, postgraduates students and others who have provided assistance and support at various occasions.

ABSTRACT

Nowadays, electronic products require certain specifications to be met in order to compete in the world market. In this study, a new form factor for oscilloscope will be determined using numerical approach. For cost effective, parts standardization will be applied. The study involves analysis on the current oscilloscope and new form factor to meet the market specifications will be determined via numerical approach. This study focuses on the heat transfer within the enclosure of the oscilloscope. The analysis is required due to the fact that the components have to be rearranged in the new design to satisfy heat transfer requirement. The results show new form factor of $9m^{-1}$ as compared to $1\ m^{-1}$ for the current oscilloscope. The analysis on the heat transfer shows that the design meets the product specifications. The new product is also found to be able to operate using current fan system.

ABSTRAK

Pada masa kini, produk elektronik memerlukan spesifikasi tertentu untuk bersaing di pasaran antarabangsa. Di dalam kajian ini, faktor bentuk yang baru untuk osiloskop akan ditentukan dengan menggunakan kaedah berangka. Untuk penjimatan kos, penyelarasan komponen akan dilakukan. Kajian meliputi analisa ke atas osiloskop yang sedia ada dan osiloskop dengan faktor bentuk yang baru untuk memenuhi keperluan pasaran dan akan ditentukan dengan menggunakan kaedah berangka. Kajian ini akan difokuskan kepada pemindahan haba sekitar ruang di dalam oscilloskop sahaja. Kajian ini diperlukan oleh kerana komponen-komponen perlu disusun di dalam rekabentuk yang baru untuk memenuhi keperluan pemindahan haba. Keputusan dari kajian menunjukkan osiloskop baru adalah dengan faktor bentuk $9m^{-1}$ berbanding $1\ m^{-1}$ untuk osiloskop yang sedia ada. Analisa terhadap pemindahan haba menunjukkan rekabentuk memenuhi spesifikasi produk. Produk baru juga didapati berupaya beroperasi menggunakan sistem kipas yang sedia ada.

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ρ	Density of the fluid
μ	Viscosity of Fluid
d	Critical Dimension
h	Convection Constant
k	Thermal Conductivity
v	Velocity of Fluid
2D	Two Dimensional
3D	Three Dimensional
CFD	Computational Fluid Dynamics
CPU	Central Processing Unit
G	Volumetric Flow Rate
LCD	Liquid Crystal Display
Nu	Nusselt number
PC	Personal Computer
PCB	Printed Circuit Board
Pr	Prandtl number
Ps	Static Pressure
PSU	Power Supply Unit
Re	Reynolds Number
STP	Standard Temperature and Pressure

CHAPTER 1

INTRODUCTION

1.1 Background

Due to electronic industries demands, electronic equipment needs to operate at increased speed, in smaller package with higher reliability. As for oscilloscope, the form factor with smaller depth is a current market trend. Oscilloscope box needs to be designed to be smaller with at least the same performance, customer want more space on workbench. Since the form factor of oscilloscope need to be redesign, the thermal characteristic inside the box also will be changed. Optimized arrangement of all electronic components and the shape of the box are important in design stage. Heat generated in box need to be flush out from the system efficiently since performance and reliability are strongly influenced by temperature. Debabrata Pal **[1]** says that the impact of temperature on reliability was shown in a survey conducted by the United State Air Force which reported that temperature contribute to more than 50% of all electronic failures. In industry, thermal analysis are often ignored in the design process or performed too late – when design changes are limited and become too costly. This shows the important of thermal analysis to be consider earlier especially in design stage.

As for this research all electronic parts for Current Oscilloscope will be maintained but they will be rearranged within new form factor. To predict the thermal characterization with new design oscilloscope, simulation tool will be used. The simulation result will be compared with Current Oscilloscope, which is proven reliable in market for years. If the result meets the Current Oscilloscope requirement, the risk of thermal issue in new design oscilloscope can be minimized.

Due to FLOTHERM is a company preference and designed especially for electronic packaging, it will be used in this research.

1.2 Objective.

To get an optimum design of new oscilloscope form factor for better thermal characterization

1.3 Scope

This research can be classified as numerical and experimental study. The scope of this project is limited on the Current Oscilloscope and new form factor Oscilloscope.

All electronic parts will be standardized as per Current Oscilloscope, which are acquisition board, power supply and fan. All parts will be rearranged in new form factor. The depth and length of new form factor is to meet Agilent Rack mount kit standard with bigger LCD and the depth can be as thin as possible.

Proposed alignments of all parts will be done and FLOTHERM simulation will be run to all proposals. The proposal with best thermal characteristic from FLOTHERM simulation that best meet the Current Oscilloscope will be chosen.

1.4 Problem Description

New form factor of oscilloscope will be developed based on current product which is released to market. The Current Oscilloscope is as per Figure 1.1. The arrangement of electrical components of this Oscilloscope is as per Figure 1.2. Form Factor of Oscilloscope need to be redesigned where it need to have a smaller depth and following Agilent standard on height and length. If the form factor changed, the thermal characterization inside Oscilloscope also will be changed. The problem is to determine whether the form factor design fulfill the thermal characterization as per Current Oscilloscope.

Figure 1.1 Current Oscilloscope **[2]**

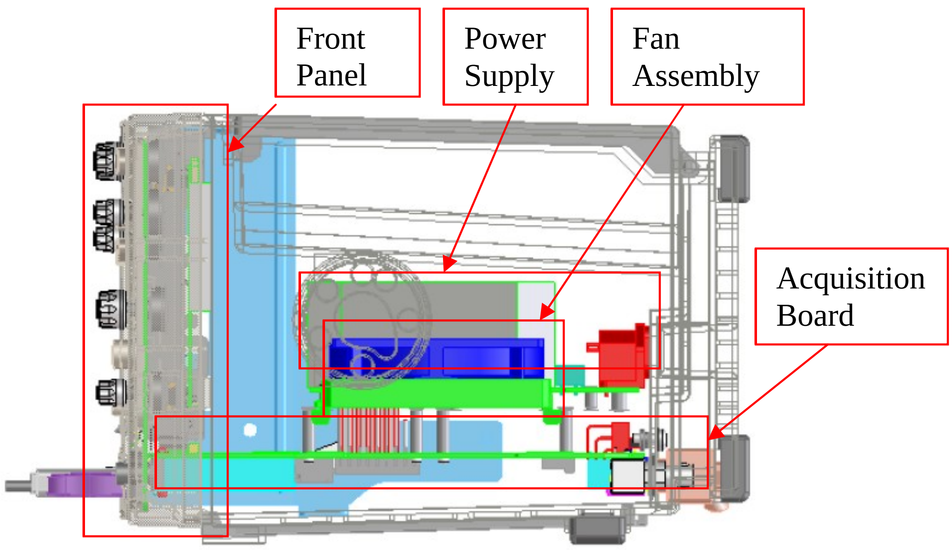

Figure 1.2 Components arrangement in Current Oscilloscope.**[2]**

1.5 FLOTHERM.

FLOTHERM is 3D simulation software for thermal design of electronic components and systems. It is first released around 1990. It is a product of the British software company Flomerics. Flomerics claims that it is the top selling program in its market, with approximately a 70% share. As of 2007, the current release of the progam is version 7.1.

Figure 1.3 below show some applications of FLOTHERM:

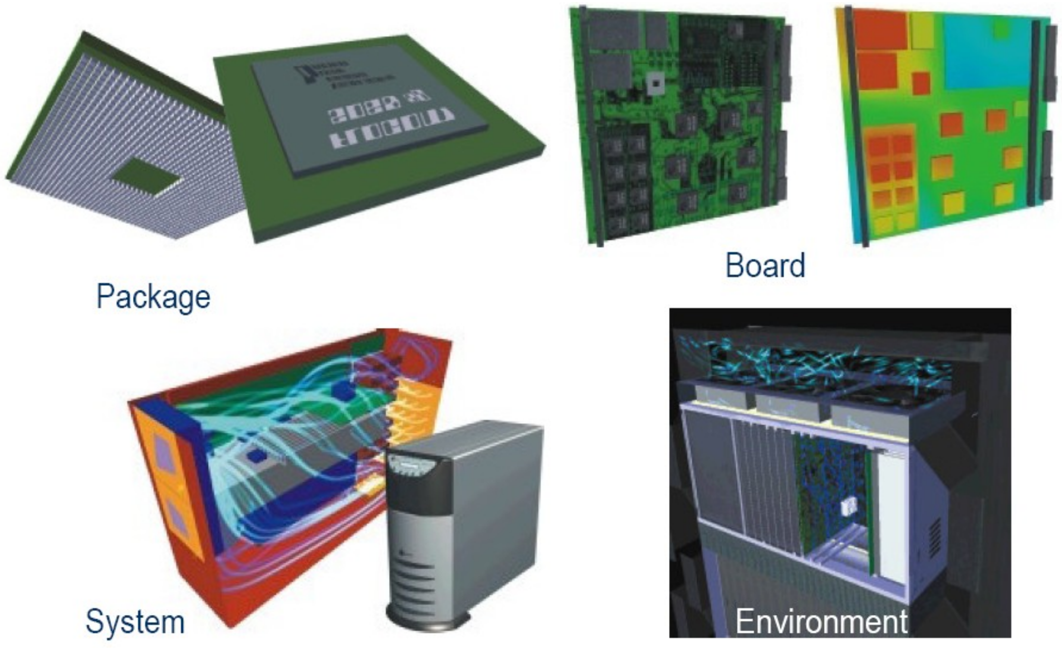

Figure 1.3 FLOTHERM Application Sample **[3]**

FLOTHERM considers three modes of heat transfer which are conduction, convection and radiation. It also has the capabilities in 2D and 3D, steady state and transient, laminar and turbulent flows, Forced, natural and mixed convection, internal and external flow also conduction only, flow only or flow and heat transfer.

FLOTHERM solution is based on CFD techniques. It is the numerical simulation of fluid flow, heat transfer and related processes such as radiation. The objective of

CFD is to provide a computer-based predictive tool that enables the analysis of the air-flow processes occurring within and around buildings, electronic enclosure, with the aim of improving and optimizing the design of new or existing heating or ventilation systems.

The pre and post processing tools of FLOTHERM can be described in Figure 1.4 below:

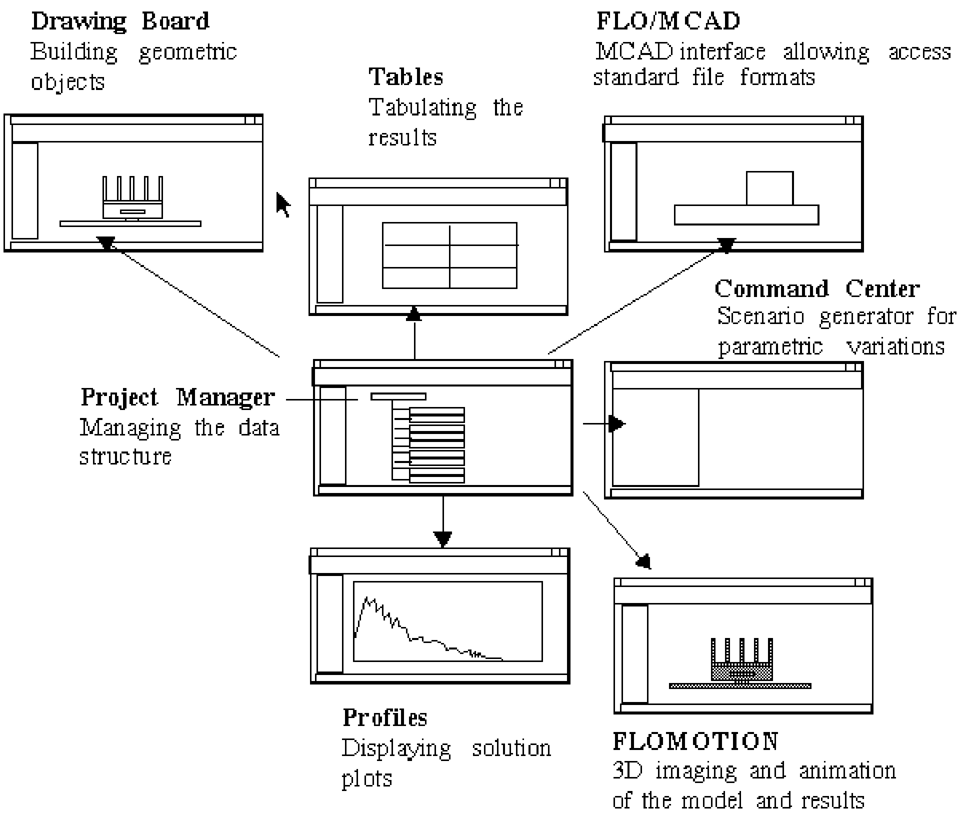

Figure 1.4 Pre and Post Processing of FLOTHERM software **[3].**

1.6 Research Process Step

Proposed process step can be representing in the flow chart in *Figure 1.5*.

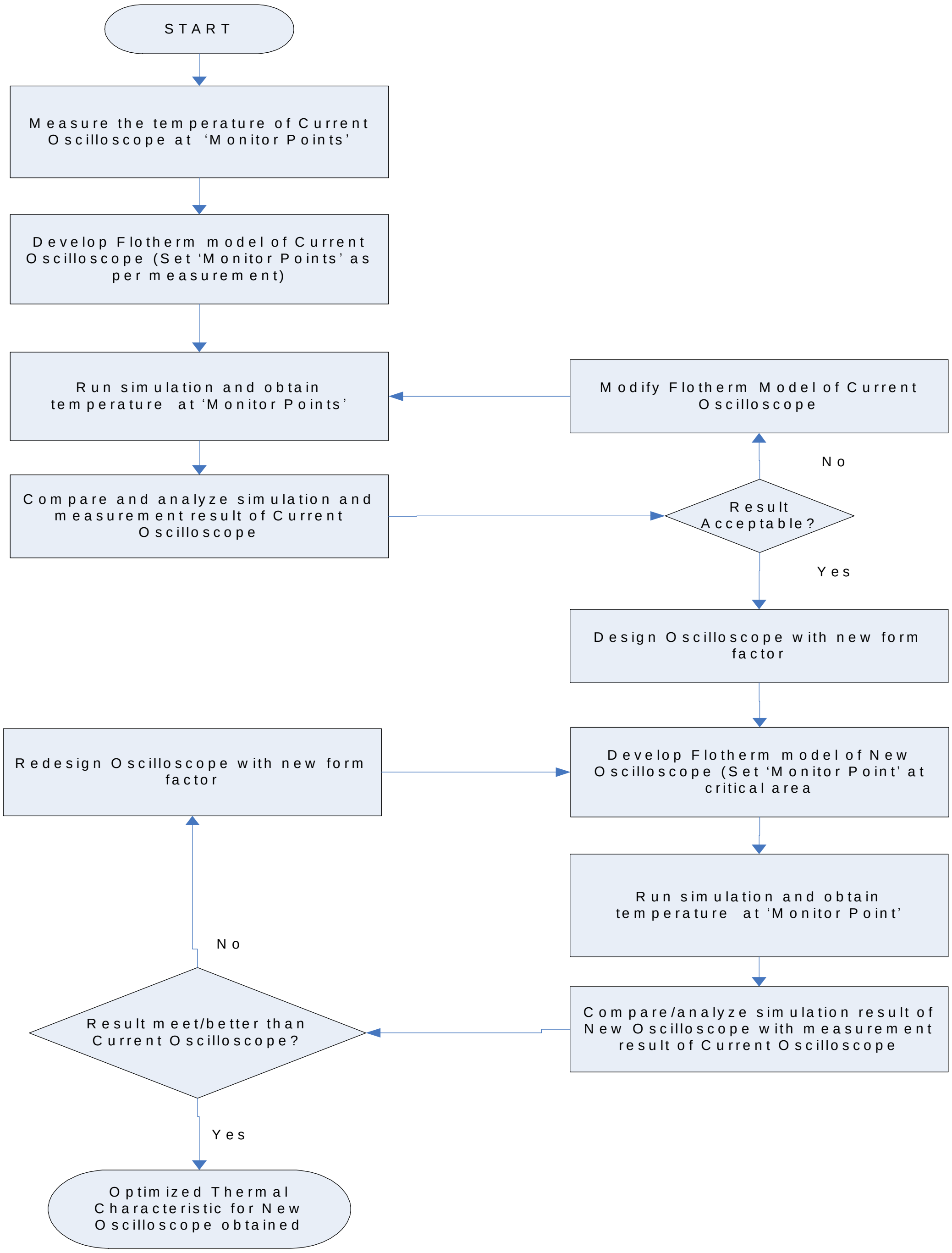

Figure 1.5 Research Process Step Flow Chart.

This Flowchart can be described as below:

1. Measure the temperature and air flow of Current Oscilloscope at Monitor Points which will be the same position in FLOTHERM model. This monitor points are at high temperature spots, important components and as for Acquisition board they are scattered around top of the board and two points represent the bottom side of the board.

2. Develop FLOTHERM model of Current Oscilloscope.

3. Set some ‘Monitor Points’ as in the model and get the temperature reading.

4. Compare the result between simulation and measurement.

5. If the error between simulation and measurement is high, analyze and revise the parameter setting in FLOTHERM model and compared again with measurement data. Repeat this step until get the low error.

6. If the error between simulation and measurement data very low, it is verified that the simulation model can represent the actual product. Simulation tools give almost accurate data.

7. Reposition all electrical components and redesign the oscilloscope with new form factor design in FLOTHERM.

8. Run the analysis and study the result compared. Thermal characterization of new design must be at least following the current running-fine oscilloscope.

9. Try to optimize the components arrangement and form factor design to get the best thermal characterization.