DOKUZ EYLUL UNIVERSITY

GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES

THERMAL ANALYSIS AND NUMERICAL STUDY ON TFT LCD PANELS

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July, 2012

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THERMAL ANALYSIS AND NUMERICAL STUDY ON TFT LCD PANELS

A Thesis Submitted to the
Graduate School of Natural and Applied Sciences of Dokuz Eylül University
In Partial Fulfillment of the Requirements for the Degree of Master of Science
in Mechanical Engineering, Energy Program

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July, 2012
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M.Sc THESIS EXAMINATION RESULT FORM

We have read the thesis entitled **"THERMAL ANALYSIS AND NUMERICAL STUDY ON TFT LCD PANELS"** completed by **MURAT IZ** under supervision of **Prof. Dr. ismail HAKKI TAVMAN** and we certify that in our opinion it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Science.

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ACKNOWLEDGEMENTS

I would like to express my sincere gratitude to my advisor Prof. Dr. İsmail Hakkı Tavman for his continuous support and guidance through this work. I would also like to thank Assist. Prof. Dr. Alpaslan Turgut for his benevolence during the thesis.

This work is funded by VESTEL Electronic and Turkish Ministry of Science, Industry and Technology by a project number 00595.STZ.2010-1. I would like to thank my collegues at VESTEL and the experts who reviewed the thesis project and make it happen.

My special gratitudes must be expressed to all of my family especially to my wife, Sultan Gülçe İz for their continuous support, understanding, and encouragement.

Murat IZ

THERMAL ANALYSIS AND NUMERICAL STUDY ON TFT LCD PANELS

ABSTRACT

According to television or in short TV's worldwide market surveys and sales figures show that passing from CRT (Cathode ray tube) televisions to LCD (Liquid Crystal Display) televisions has been swiftly increasing. Producing of CRT televisions is decreasing and comes to an end gradually. New television technology in the design of LCD TV has swiftly improved in recent years. TFT (Thin Film Transistor) panels used in LCD television are divided into two panels as CCFL (Cold Cathode Fluorescent Lamp) panel and LED (Light Diffuser diode) panel.

This project aims to provide solutions for the 32inc LED panel thermal problems which are the reasons of increasing expenses, reducting of the life-time of the panel, worsening the quality of the image by using computer aided analysis programme and experimental tools.

LED Panel's normal working conditions of temperature characteristic will be determined with the help of computerized analysis program, the experimental studies and the resulting values of analysis program are compared between each other. Which parts of the panel affected by the temperature is determined by uncovering of the temperature distribution in the Panel. Improvement works will be made on available design by taking into consideration of the affected parts.

With this project, LED panel which will be produced in VESTEL by making the analysis of the heat, heat-source problems that may occur will be to minimize at the design phase. This project which is wanted to be carried out within the scope of a master thesis between VESTEL Electronics Inc. and Dokuz Eylul University, Graduate School of Natural and Applied Sciences, Mechanical Engineering Department, Energy Program

Keywords : TFT, LCD, CCFL, LED, panel, thermal analysis, backlight unit, mura, light leakage

TFT LCD PANELLERDE TERMAL ANALİZ VE NUMERİK BİR ÇALIŞMA

ÖZ

Televizyon veya kısaca TV'lerin tüm dünyadaki pazar araştırmaları ve satış rakamlarına gore Tüplü televizyondan (CRT) , LCD (Likit Kristal Ekran) televizyonlara geçiş hızlı bir şekilde artmaktadır. Tüplü televizyon üretimi giderek azaltamakta ve sonlanmaktadır. Yeni televizyon teknolojisi LCD TV tasarımlarında son yıllarda hızlı bir şekilde kendi içerisinde gelişmektedir. LCD televizyonlarda kullanılan TFT (İnce Film Transistor) LCD paneller CCFL (Soğuk Katod Floresan Lamba) panel ve LED (Işık Yayıcı Diyot) panel olarak ikiye ayrılmaktadır.

Bu proje, VESTEL tarafından yeni tasarlanan 32inc LED panelin bilgisayar destekli analiz programı ve deneysel araçlar kullanarak termal analizinin yapılıp ısı problemlerinden kaynaklanan maliyet artışı, panel ömrünün kısalması, görüntü kalitesinin bozulması gibi sorunları iyileştirmeyi amaçlamaktadır.

LED Panelin normal çalışma koşullarındaki sıcaklık karakteristiği bilgisayarlı analiz programı yardımıyla belirlenecek olup deneysel çalışmalar ile analiz programından elde edilen değerler birbirleriyle karşılaştırılacaktır. Panel içindeki sıcaklık dağılımının ortaya çıkarılması ile hangi parçaların sıcaklıktan etkilendiği belirlenecektir. Sıcaklıktan etkilenen parçalar dikkate alınarak mevcut tasarımda iyileştirme çalışmaları yapılacaktır.

Bu proje ile birlikte, VESTEL'de üretilecek LED panelin ısı analizin yapılıp panel tasarımı aşamasında ısı kaynaklı oluşabilecek problemler minimize edilmeye çalışılacaktır. Gerçekleştirilecek projenin VESTEL Elektronik A.Ş. ile Dokuz Eylül Üniversitesi, Fen Bilimleri Enstitüsü, Makina Mühendisliği, Enerji Anabilim Dalı ile ortak yürütülecek bir yüksek lisans tezi kapsamında yapılmaktadır.

Anahtar sözcükler : TFT, LCD, CCFL, LED, panel, termal analiz, arka ışık unitesi, mura, ışık sızması

CONTENTS

CHAPTER ONE
INTRODUCTION

1.1 Description

TFT panels (Thin Film Transistor) used in LCD television are divided into two panels as CCFL (Cold Cathode Fluorescent Lamp) panel and LED (light Diffuser diode). LCD televisions emerged with the CCFL technology firstly; LED technology is one of the latest technologies. LCD TV technology works with plane light source located on the back of the panel by passing liquid crystals making up color filters controlled by voltage make up the pixels. As the image on the panel is formed by lowering the light which is provided at the background in controlled manner, in the creation of the product’s determining specifications background technology has a great importance in it as well as LCD panel. LCD panel working principle is shown on schematic view of LCD panel in Figure 1.1

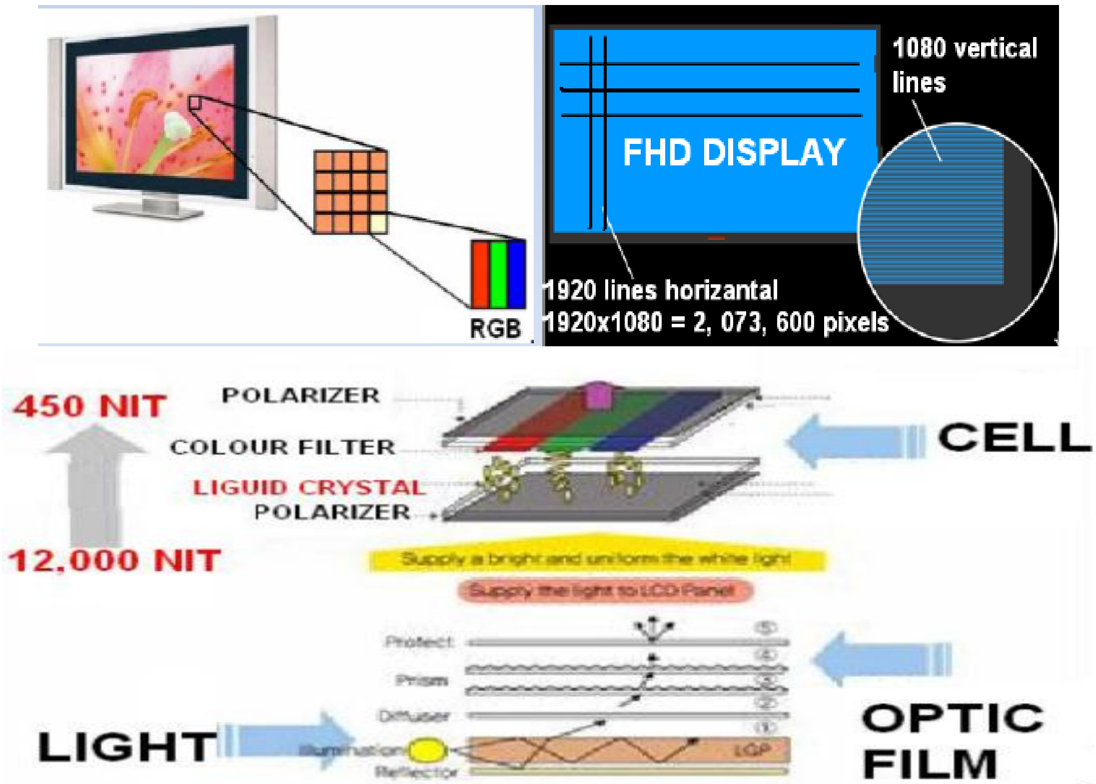

Figure 1.1 Schematic view of LCD panel (in the courtesy of Vestel Electronic Inc., from the technical notes)

Even though CCFL LCD panel lightening has a widespread usage, there are great disadvantages. CCFL LCD panels working need for high frequency and initial stress, the general structure and inner view of CCFL panel is shown on figure 1.2. And this increases power consumption of the television, total power consumption's 70%-80% part is consumed by CCFL lamps. In spite of the high power consumption, these lightening systems haven't showed the expected performance in terms of optical performance. Because mechanically CCFL panels have linear lightening behind the panel according to their structure, there is a need for creating certain volume in order to provide optical values. This volume determines the total panel thickness and effects on the total LCD TV thickness. In LCD TV market, CCFL panels don't respond the increasing thin television demands.

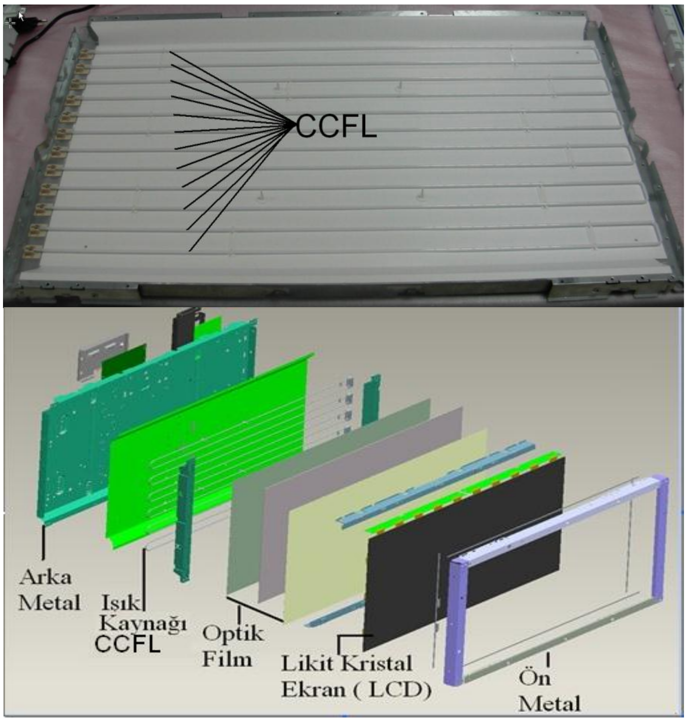

Figure 1.2 General structure and inner view of CCFL panel (in the courtesy of Vestel Electronic Inc., from the technical notes)

LED panel has a very similar technology as the CCFL panels, the general structure and inner view of LED panel is shown on figure 1.3. It is common part which creates the image is called as LCD. The great difference between two technologies is the lightening system used at the back light unit in the panel. LEDs are the cornerstone of LED lightening systems produce light by as for different power carriers formed basic diode structure between enriched two regions by joining these power carriers form the photon publishing principle.

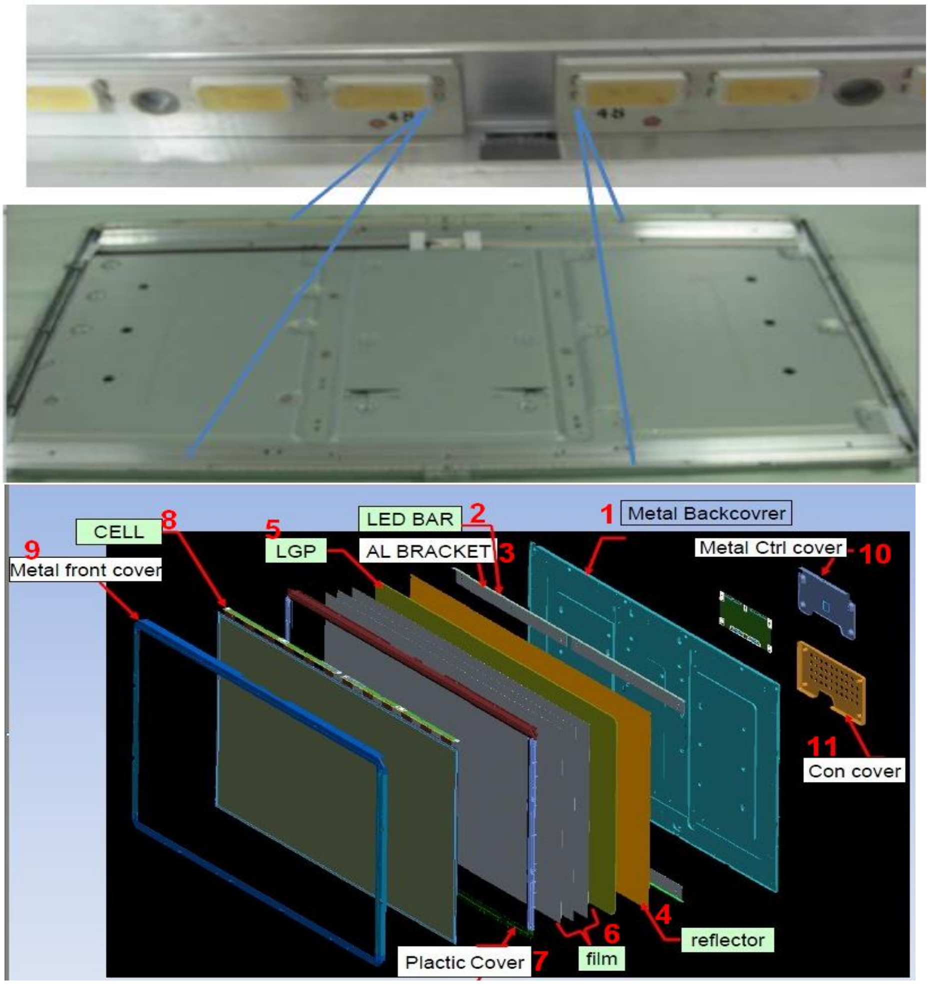

Figure 1.3 General structure and inner view of LED panel (in the courtesy of Vestel Electronic Inc., from the technical notes)

LEDs are located behind the LCD panel be in corners of the light diffuser by getting planar light source make up the edge lightening structure. This application's advantages on CCFL lightening are based upon the physical structure of the LEDs supremacy as a light source. In addition to more diffusion of light, less power necessity and wider range of colours; because mechanically LEDs are SSD (Solid State Disk, solid state Disk), they are more long lasting (durable) than CCFL's fragile structure to mechanical effects such as vibration and strike. Apart from these supremacies, edge lightening structure provides great improvements on total LCD TV’s slimness. As LED’s lightening inside the panel have less space, panel designs get thinner

We can see Benchmark of LED panels belong to LG and Samsung companies and targeted Vestel LED panel’s structure’s tables are at the table 1.1. from the examined market.

Table 1.1 Benchmark of LCD panel (in the courtesy of Vestel Electronic Inc., from the technical notes)

	EDGE LED PANEL STRUCTURE				
PART	32" LG FHD 100 Hz	32" LG FHD 50 Hz	32" SAMSUNG 50 Hz	32" SAMSUNG FHD 100 Hz	32" E-LED VESTEL
LED TYPE	2 SIDE	1 SIDE	4 SIDE	1 SIDE	2 SIDE
LED LOCATION	TOP/BOTTOM	BOTTOM	TOP/BOTTOM/LEFT/RIGHT	TOP	TOP/BOTTOM
LED BAR PCS	4 pcs	2 pcs	6 pcs	2 pcs	4 pcs
LED BAR COMPANY	LG INNOTEK	STL	???	???	LG INNOTEK
ONE BAR LED PCS	48 pcs	48 pcs	38 pcs	50 pcs	90
TOTAL LED PCS	192 pcs	96 pcs	228 pcs	100 pcs	180
BACKCOVER METAL THICKNESS	0,8 mm	0,8 mm	1,2	0,8 mm	0,8 mm
BACKCOVER METAL MATERIAL	SECC	SECC	AL	SECC	SECC
BACKCOVER WEIGHT	2100 gr	2248	1250 gr	2200 gr	
FRONT BEZEL THICKNESS	0,5 mm	0,5 mm	0,8 mm	0.6 mm	0,6mm
FRONT BEZEL MATERIAL	SECC	SECC	SGLCC	SGLCC	SGCC
FRONT BEZEL TYPE	FOUR PART	FOUR PART	FOUR PART	FOUR PART	FOUR PART
FRONT BEZEL TOTAL WEIGHT	348	328	342	342	
AL BLOCK TYPE	TWO PART	ONE ART	FOUR PART	ONE ART	TWO PART
AL BLOCK LOCATION	UP/DOWN	DOWN	UP/DOWN/LEFT/RIGHT	UP	UP/DOWN
AL BLOCK MATERIAL	AL Extrusion 6063 (T5)	AL Extrusion 6063 (T5)	AL Extrusion 6063 (T5)	AL Extrusion 6063 (T5)	Al Press 5052
AL BLOCK WEIGHT	288	270	702	452	
PLASTIC FRAME TYPE	ONE PART	ONE PART	FOUR PART	ONE PART	FOUR PART
PLASTIC FRAME MATERIAL	PC+%10GF	PC+%10GF	PC+ABS+%10GF	PC+PET+%15GF	PC+ABS+%10 GF
PLASTIC FRAME WIGHT	116	118	116	174	
TCON COVER METAL THICKNESS	0,5 mm	0,5 mm	1 mm	1 mm	0,6 mm
TCON COVER METAL MATERIAL	SECC	SECC	AL	AL	SGCC
TCON COVER METAL WEIGHT	76	84	34	34	
CONVERTER COVER MATERIAL	0,5 mm SECC	0,5 mm SECC	PLASTIC PC+Fr40		N/A
CONVERTER COVER WEIGHT	86	42		66	N/A
LIGHT GUIDE PLATE	4 mm	3.5 mm	4 mm	3 mm	4 mm
	1418	1242		1062	
THEMAL PAD	N/A	N/A	YES		Avaible
PANEL THICKNESS MB AREA	10,8mm	10,8mm	10,8 mm		10,8 mm

1.2 Literature Overview

The sales of the LCD TV quantity passed CRT TV quantity on the market in the year 2007. The TV manufacturers began to increase production of LCD TV and in the paralel CRT TV production decreases. Television producers started to search for next standard TV product after LCD TV with this choice of consumers. Television market is currently looking for 1) high image quality, 2) a thinner lighter products, 3)less energy-consuming products. LED TV has these feature. It introduced especially thin TV emphasised by manufacturers as called slim TV began to take its place on the market.

LED module is more thinner than the standard LCD module. LED TV could be made more thinner with LED module this feature. On the other hand there are some technical challenges coming from thin structure especially in the thermally induced material deformations of the panel and spreading of uniform distribution of thermal heat.

In the literature there are many researches on this subject, Chu et al investigated the temperature distribution of TFT–LCD TVs through conducting experiments and applying the CFD (ANSYS/Flotran) analysis. Chen et al., 2007 studied light leakage improvement of LCD module by numerical analysis. Kim et al., 2008 mentioned LCD panel distortion problem as called MURA on their works. Chen et al., 2009 worked on the performance of compact thermal model for LED package. Some researchers used the finite element (FEM) heat transfer method to analyze the LED package and LED backlight panel (Tsai et al., 2008; Yang et al., 2009; Kim et al., 2005a; Kim et al., 2005b).

There is also some risks after one hour aging process, the amount of deformation of the LED panel up to 30 mm was observed. LED is light source inside of panel but at the same time as the heat source that affected optical structure which raw material is plastic The heat from the LED causes stress on the plastic parts and creating plastic defortmation of the optic films as shown on figure 1.4 (Choi et al., 2009).

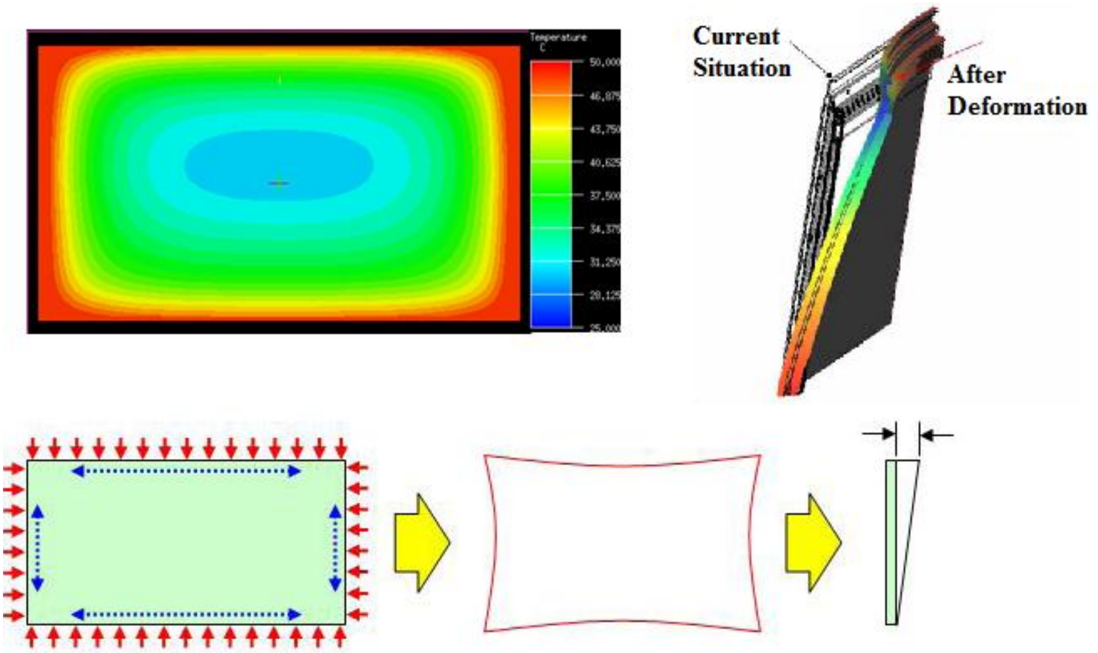

Figure 1.4 The stresses that occur as a result of heat inside of panel (Choi et al.,2009).

When any external force is applied to any section of the liquid crystal screen, there will be some light leakage problem and image distortion will occur. These distortions are called 'Mura' effect as shown on figure 1.5. This effect can result after the formation of internal stresses in the panel (Kim et al., 2008).

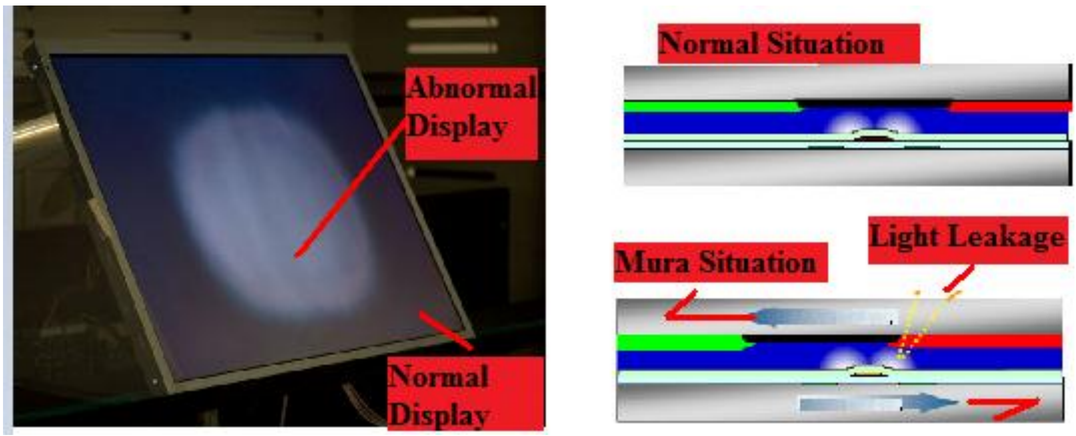

Figure 1.5 Mura effect (Kim et al., 2008).

The spreading of the temperature inside the panel as a nonuniform can affect interior parts and occur light leakage problem due to internal stresses. The distribution of temperature inside the panel can be measured by a computer aided programs and experimental studies.

It can be time consuming and costly studies development of a prototype or the actual model used in experimental studies. These studies can be done by defining all the data to the computer environment. A heat source, heat transfer type between materials, initial and boundary conditions data will be needed with computer thermal analysis of a panel. In these studies, based on computer simulation CFD (Computational Fluid Dynamics) are used. On the other hand infared camera and thermocouple devices as used for experimental analysis which are shown on figure 1.6 (Chen et al., 2007; Chu et al., 2010; Tsai et al., 2008).

The computer analysis result can be compared with experimental studies. After all the result is proven accuracy eachother, The various design change to improvement of design concept inside of panel structure or alternative material tested for cost down of total structure cost can be done (Yang et al., 2009).

There are some optical films inside of panel that emitting the light and distributes it to become uniform light as layer on the backlight unit of panel. The optical films raw material is plastic based such as polyethylene (PET), polycarbonate (PC), Polybutylene terephthalate (PBT). All these plastic material is easly affected by heat (Kim et al., 2005a; 2005b).

All the common point of all of these studies, distribute the heat uniformly inside of panel with analysis of panel tharmal structure. Engineering analysis will be sufficient to reach a solution. At the end we can make a panel design more reliable and low cost structure without any extra cost up solution.

This project is aimed producing a solution for heat problem inside of panel to be performed by computer aided analysis and experimental analysis.

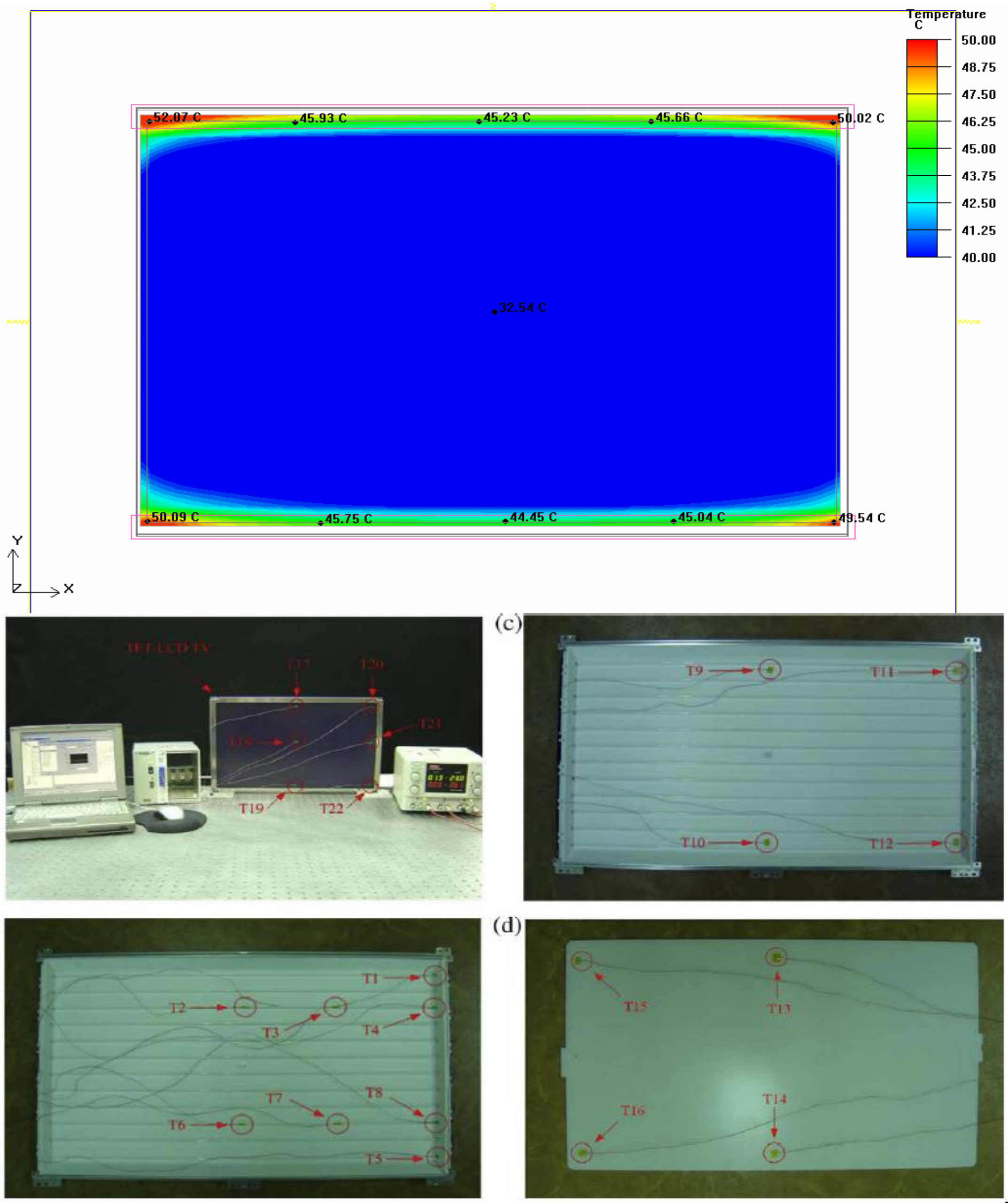

Figure 1.6 The top picture shows computer aided analysis (Chen et al., 2007) , The below pictures shows experimental set up (Chu et al., 2010).

CHAPTER TWO
MECHANICAL DESIGN

2.1 Backround

After products of panel manufacturers are examined, points to consider in the project have been determined. 32’’ Vestel LED panel’s target design specs are made with the learned information from here.

Mechanical parts list to use is formed with the best price performance ratio and standard part’s specs (CELL, etc…) to use in the project are provided. How many LEDs to use in the panel are become apparent after LG Innotek Company and Vestel R &D Optical design group’s working. The specified measurements are adapted to the mechanical design. Also LED bars electronic, circuit board and Converter (Encoder) mechanical dimensions are worked with Vestel R & D Power group.

LED panel’s 3-dimensional solid model according to specified structure is modeled on computer with Pro/ENGINEER program as shown on figure 2.1. 2D AutoCAD program is used for part’s technical drawings as shown on figure 2.2.

LED range, reflective optic film structure, electronic card settlements in this design are placed into 3D design. All the parts and their functionality have been checked over the model.

Kind of materials and selected parts have a place in LEDs at the back light source’s heat diffusion for transmitting out. Natural convection fields and conductivity have been taken into consideration in this design.

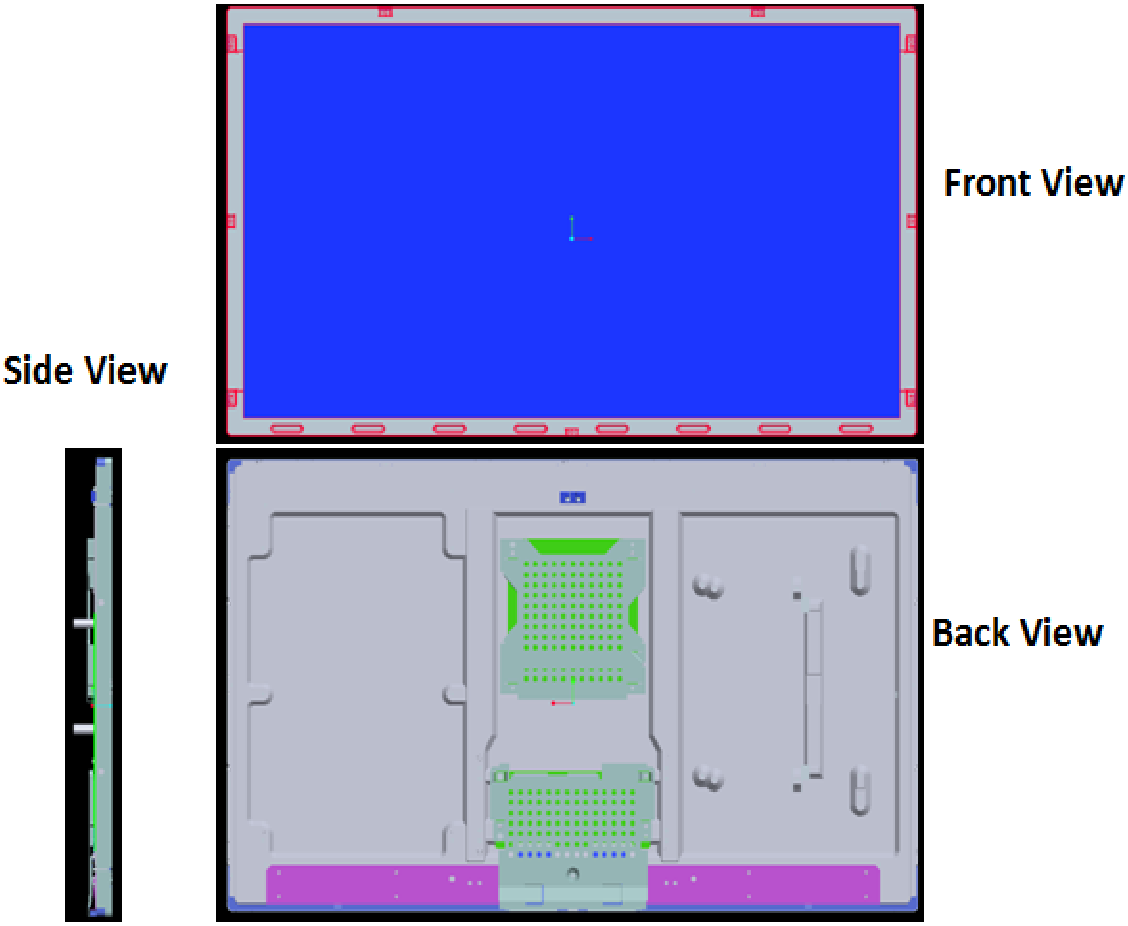

Figure 2.1 3D view of Vestel 32" LED panel (in the courtesy of Vestel Electronic Inc., from the technical notes)

Metal pcb is called LED BAR in which LEDs are assembled. LED Bars are screwed in order to provide better Al bracket surface area contact in the design. Al bracket is assembled to the back cover metal. There are 4 pieces of LED panel in total, two of them are at the upside, two of them are bottomside. LED bar design is worked with Korean LED manufacturer LG Innotek company. LED bar's pcb will become available. Optical film and LPG mechanical drawings determined by mechanical design are shared with Vestel R & D Optical group.

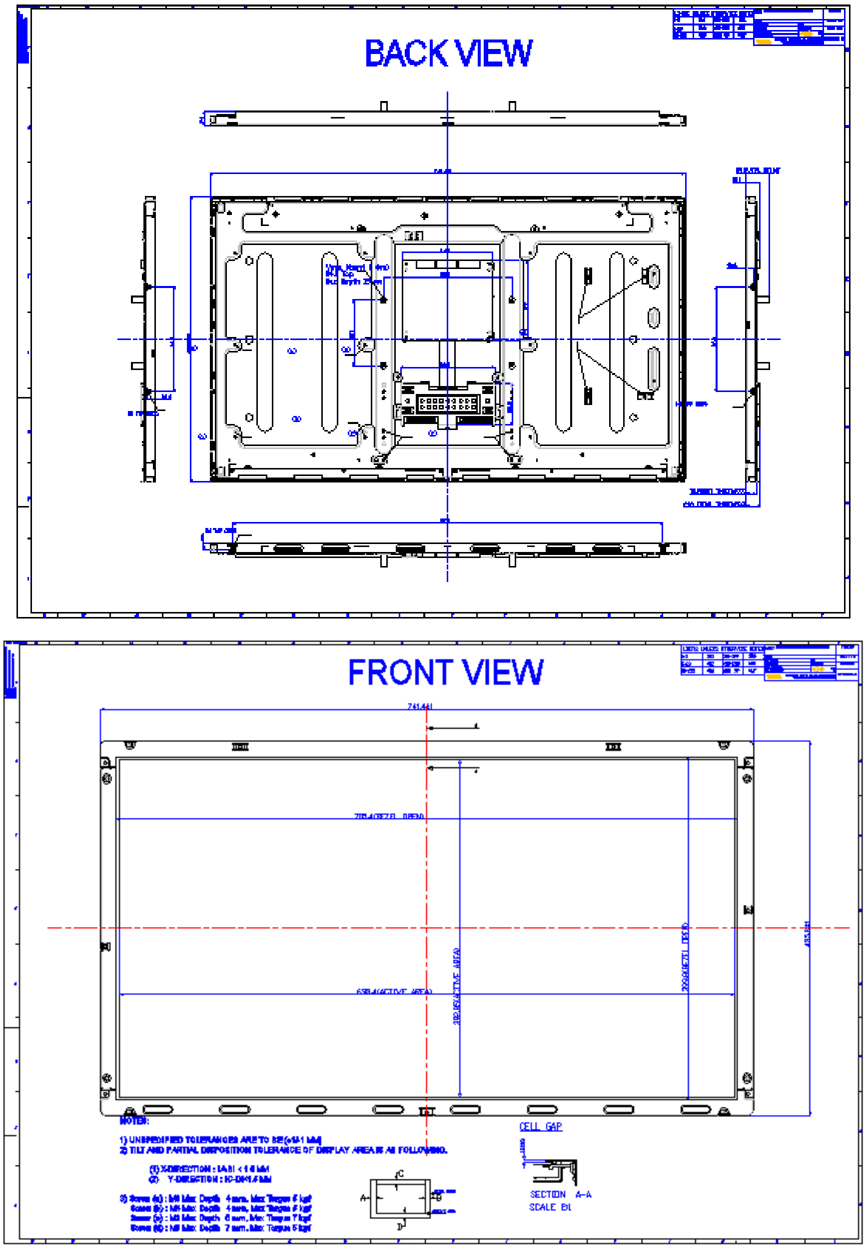

Figure 2.2 2D view of Vestel 32" LED panel (in the courtesy of Vestel Electronic Inc., from the technical notes

LED panel supported financially with this project are used in vestel LED TV products. Specific advantages to our panel are created by taking into consideration of these in LED panel design in TV production process. While TV mother board and power boards are connected to the standart panels with extra intermediate metals, electoric boards can be connected to the Vestel LED panel directly. And this brings the number of pieces and piece cost advantages, at the same time it enables in TV production's bands process improvement and reducing of operator.

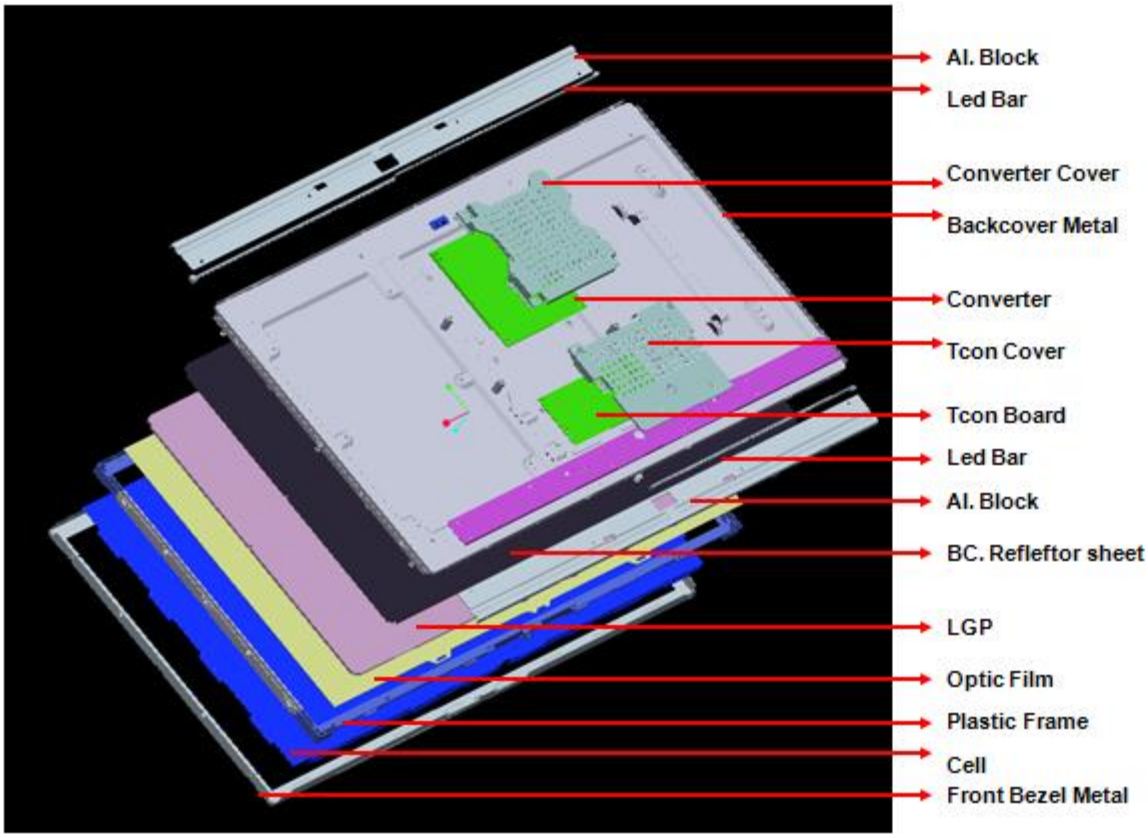

Figure 2.3 Thermal analysis model of a TFT LED panel (in the courtesy of Vestel Electronic Inc., from the technical notes)

Prototype sets are made to confirm committed design works as shown figure 2.3. Mechanic design controls are made over these prototypes. The first aim of mechanic control is to see if there is any intersection or embarkation problems between pieces. Also production simulation is made with this commited prototype; arranging of assembly line to produce panel and the assembly line of the pieces are determined. Prototypes are also used in optical and electronic works, and then experimental measurement is made over the prototypes.

2.2 LED Panel General Part Properties

2.2.1 Metal Backcover (Back Cover Metal)

Metal backcover is the general carrier metal of the panel system as shown on figure 2.4. Its material is generally galvanized sheet metal. Galvanic process is used for preventing of corrosion in metal; there are two types of galvanic as dipping galvanic (SGCC) or electro galvanic sheet (SECC). Galvanized metal is SECC in the Far East; SGCC usage is common in our country. According to panel size to produce as thickness, it is used in 0.8 mm or 1mm designs. Al material can be chosen on the condition when cooling is not enough on the panel as a back cover metal. Back cover metal is the main part in which all panel parts are assembled and hold TV's internal structure system.

Figure 2.4 Metal backcover view

2.2.2 LED BAR (LED light source)

LED BAR is the light source of the panel system as shown on figure 2.5 and 2.6. LED BAR is a part on which one pcb and LED' diodes are lined up. LED Bar's pcb is generally made by metal Al material to increase conduction of heat. There are copper ways in order to provide electric current between protective layers on Al material and LED diodes. LED bar's pcb is generally made by metal pcb in large screen panels (>26'' and above). Classic dielectric material pcb (FR4) are used in small screen size (<26'' and below) where heat formation is less in order to reduce cost per unit.

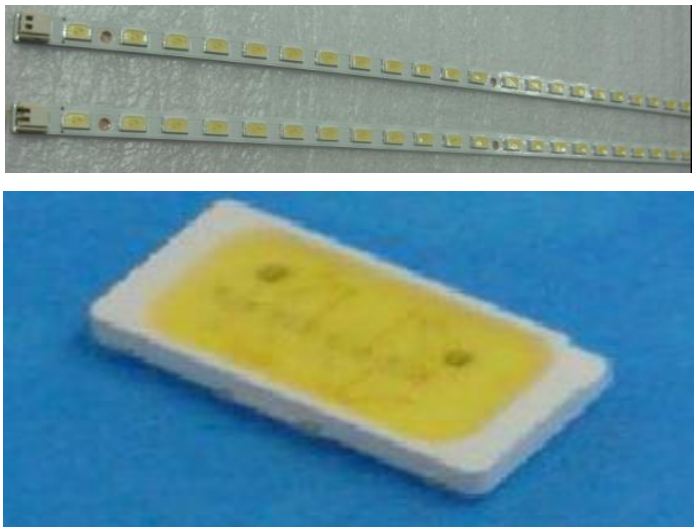

Figure 2.5 LED PCB and LED package (in the courtesy of Vestel Electronic Inc., from the technical notes)

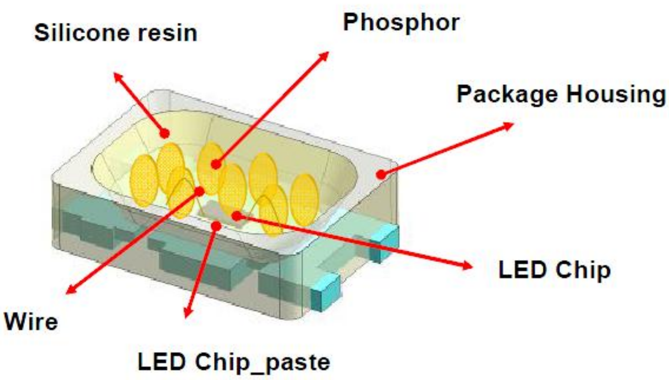

Figure 2.6 LED package structure (in the courtesy of Vestel Electronic Inc., from the technical notes)

Structure of LED Package :

LED Pacakage Housing: Housing is used to hold the parts together

LED Chip: Light source on LED package

LED Chip Paste: Provides stability of LED Chip

LED Resin: Resin is made of Silicone, providing protection in outdoor environments

Phosphor: its colour is yellow , Chip light colour is blue and its merge eachother to crate white light

Wire: to use conductivity between LED Chip and LED Housing

2.2.3 AL Bracket (AL Cooler)

AL Bracket (AL Cooler) is the part which LED Bar's pcb is assembled in the panel system as shown on figure 2.7. It is used with the aim of cooling LED bars and throwing heat formed on LED bars swiftly to the Backcover metal surface. LED bars are assembled over Al Bracket with screws or thermal bands. Screw assembly provides best contact of Led Bar surface and Al Bracket Surface, and so conduction of heat is increased, but screw assembly requires extra workmanship as production. Thermal band assembly is easier as production process, but in time there is a risk of untying of thermal bands because of the heat formation in inside under panel working conditions. Suitable assembly type can be determined by panel reliability tests.

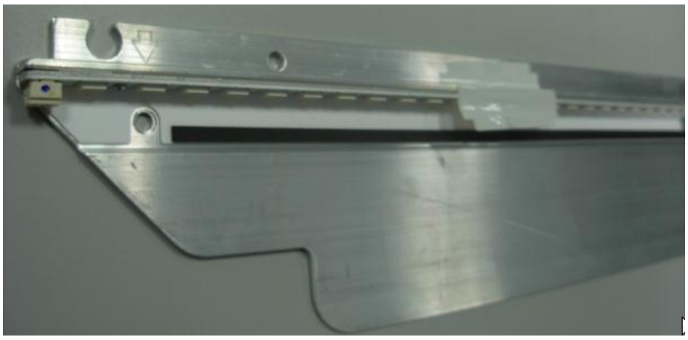

Figure 2.7 AL Bracket view

2.2.4 Reflector Film (Reflective Film)

Reflector panel increase the total light intensity to provide re-reflection to front surface by collecting wincer lights inside the panel as shown on figure 2.8. It also prevents light output to the back surface. Film thickness is between 0.2 mm and 0.3 mm. PET or PC is used as material.

Figure 2.8 Reflector Film view

2.2.5 Light Guide Plate (LPG)

Light Guide Plate is transparent acrylic material which distributes homogeneously by changing the way of lights comes from LEDs on panel surface as shown on figure 2.9. Poly Methyl Methacrylate (PMMA) is used commonly as material. Part's thickness is changed from depending on LEDs used in LED bars. There are surfaces clustered in panctiform over the part. By collecting light over these dot surfaces provides intended dispersion on surface. If the conduction of heat isn't provided well inside LED panels, there can be deformations in LGP materials in time. And this causes unwanted defects at image.

Figure 2.9 Light Guide Plate view

2.2.6 Optical Film (Reflective and collector film)

They are optical layers which collect light clusters focused on LGP homogenously in the panel and fix the level of light formed on surface as shown on figure 2.10 and 2.11. PET and PC are used as material. Part thickness is between 0.2 mm and 0.4 mm. Optical films like Light Guide Plate is effected by heat easily and permanent deformations can occur on film layers. Movable areas of films should be anticipated by taking into consideration of expansions in films at the panel design. Films are several types according to their properties.

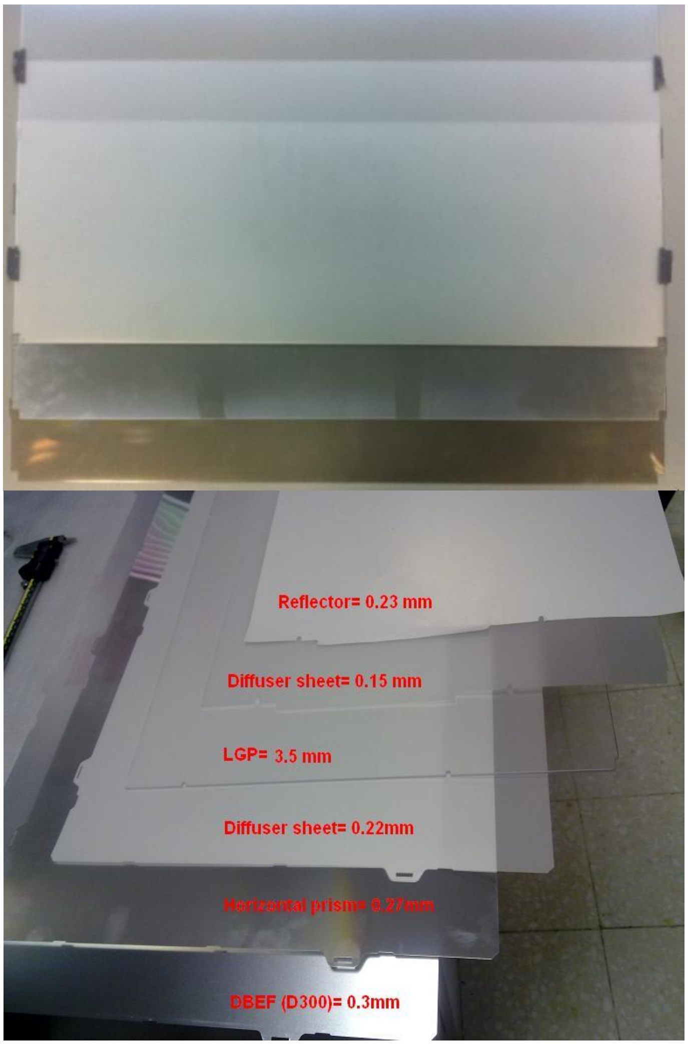

Figure 2.10 Optical film view

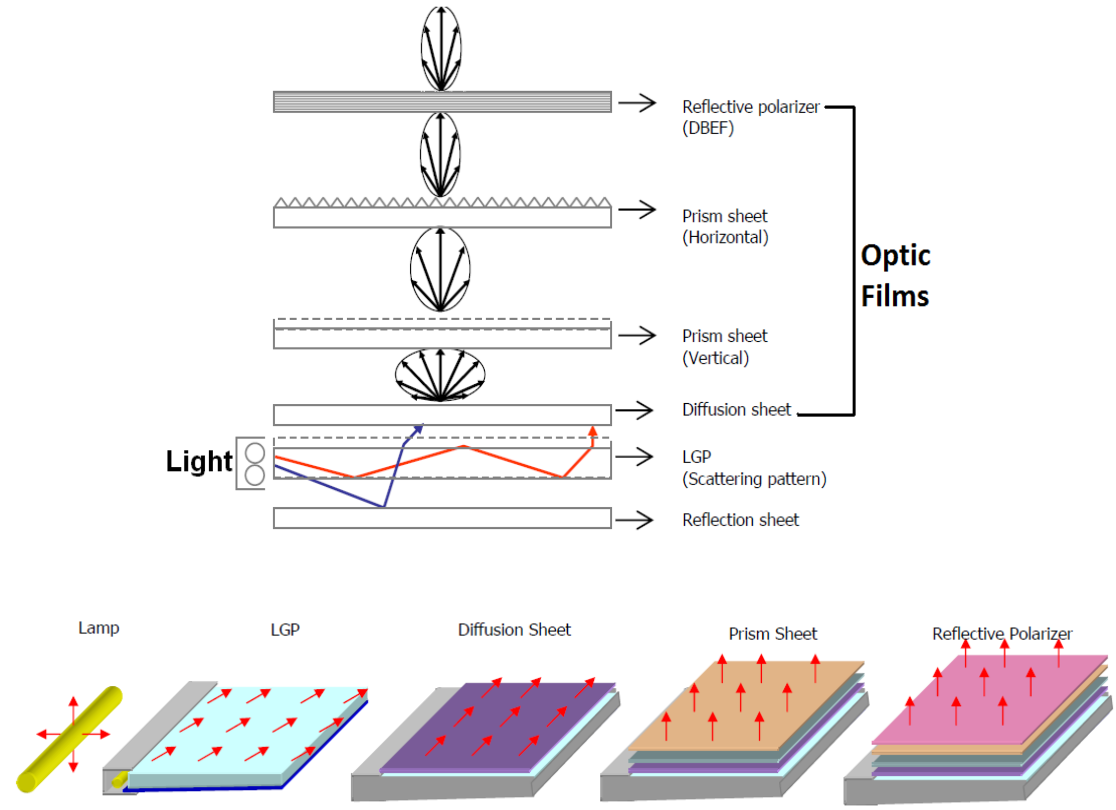

Figure 2.11 The principle of light reflection each films (in the courtesy of Vestel Electronic Inc., from the technical notes)

2.2.7 Plastic Cover

Plastic cover is a plastic material which forms Backlight Unit (BLU) called as back light unit by creating a closed volume inside the panel with metal backcover as shown on figure 2.12. There is glass fiber is in the plastic material in order to provide durability of structure and not to be effected from heat. PC+%10-15 GF or PC +ABS+%10-15 GF is used generally as material. There are designs as one part or four parts according to their assembly and their production type.

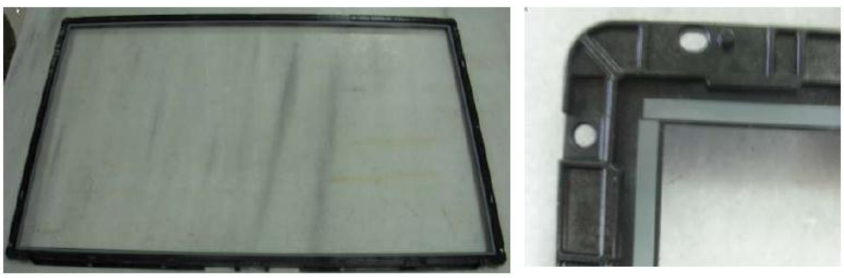

Figure 2.12 Plastic cover view

2.2.8 TFT LCD CELL

Cell is the liguid crystal screen part of the panel that the image is formed as shown on figure 2.13.

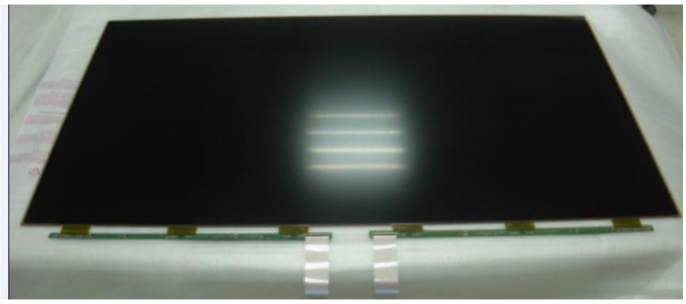

Figure 2.13 TFT cell view

2.2.9 Metal Front Cover

Back light unit becomes panel after Cell assembly. Metal front Cover part is a part which is set at panel assembly and it is used in order to immobilize Cell and to prevent dust or particulates to come from outside as shown on figure 2.14. It has got one piece or divided structure as to design and production management. Galvanic sheet metal is used like metal backcover as material. Part thickness is between 0.6 mm and 0.8 mm.

Figure 2.14 Metal front cover view

CHAPTER THREE
COMPUTER ANALYSIS ON TFT LCD PANELS

After mechanical design part is completed, thermal analysis works are started with heat analysis program FLOEFD. The data obtained from mechanical design part were simplified with the aim of reaching the analysis results of thermal analysis works in a faster way and reducing the surfaces effecting on analysis results minimum as shown on figure 3.1.

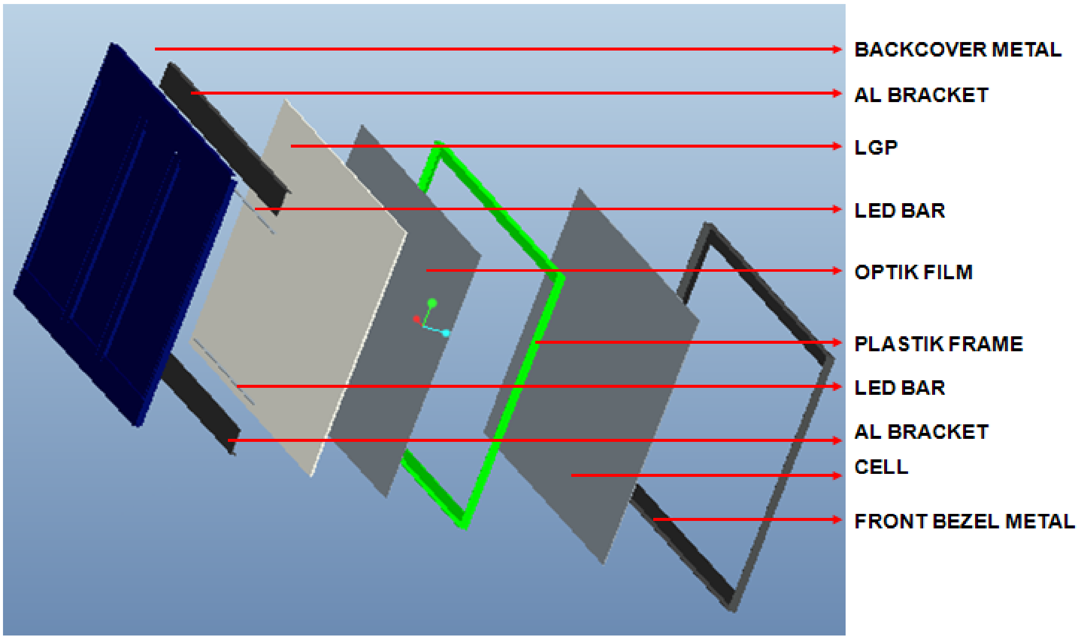

Figure 3.1 Thermal analysis model of a TFT LED Panel (in the courtesy of Vestel Electronic Inc., from the technical notes)

3.1 Material Properties of TFT Led Panel Components

The materials used inside the LED panel are determined in the light of learned informations from previous section. New materials are created by entering properties of materials for the materials which aren't involved in FLOEFD CFD programs as shown on table 3.1.

Table 3.1 Material properties of TFT LED panel components used in the thermal analysis

TFT LED panel component	***Thickness & Material***	***Thermal conductivity***
Backcover metal	0.8 mm SECC (Galvanized Steel)	63 W/mK
Led bar pcb	AL 1.5t + Insulation + Copper	200 W/mk
Al bracket	1.5 mm AL 5053	170 W/Mk
Reflector sheet	0.33 mm PET (SL330)	0.2 W/mk
LGP	0.4 mm PMMA	0.2 W/mk
Optic film Prism sheet horizantal	0.26 mm PET (PTX 338)	0.2 W/mk
Optic film Prism sheet vertical	0.26 mm PET(PTX 338)	0.2 W/mk
Optic film Diffuser sheet	0.25 mm PET (SD843)	0.2 W/mk
Plastic frame	1.5 mm PC+ABS+%15 GF	0.2 W/mk
Cell	1.8 mm Glass	30 W/mk
Metal front cover	0.6 mm SECC	63 W/mk

3.2 LED Package Properties

LEDs to use inside panels are 5630 named packages as shown on figure 3.2. and 3.3. LEDs located on metal pcb are identified with the sizes of packages. The number 56 stated on package symbolizes the size of package in short 5.6mm , the number 30 stated on package symbolizes the width of package in short 3mm. The number of LED to be found in each LED bar pcb and the total LED number to use inside the panel are determined after the joint studies of Vestel R&D Optical Group and Korean LGIT company. Stated package’s LED design and LED specs coming from LGIT company are modelled by one to one design and it is transmitted to data to analyse.

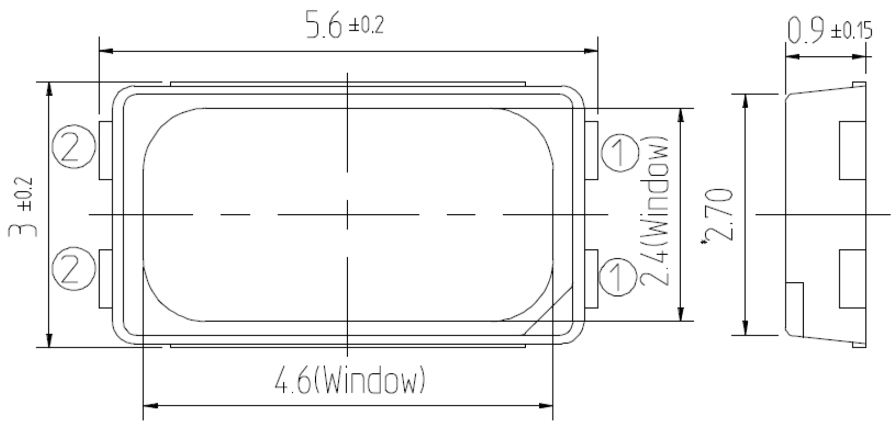

Figure 3.2 LED package dimension (in the courtesy of Vestel Electronic Inc., from the technical notes)

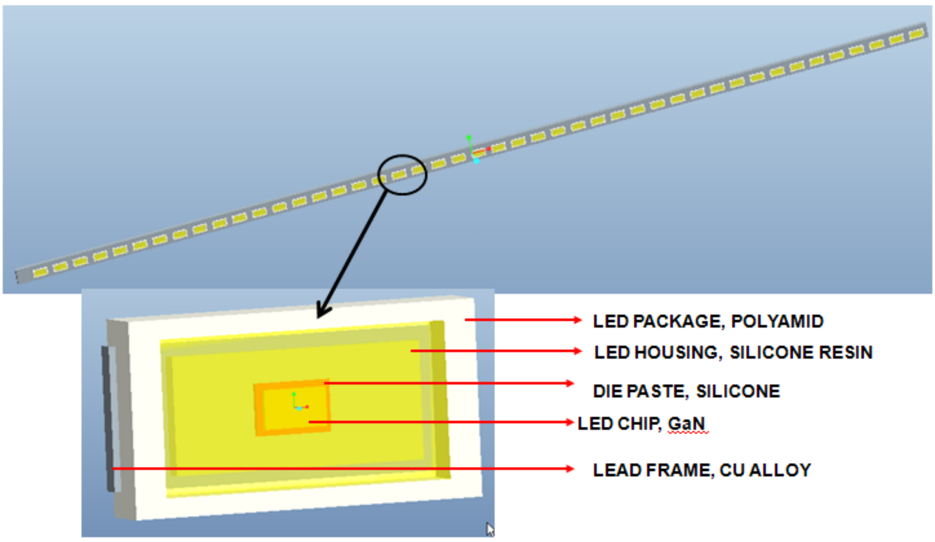

Figure 3.3 Thermal analysis model of LED package (in the courtesy of Vestel Electronic Inc.,from the technical notes)

3.3 Calculation of the Heat Generated Per LED

General power distrubution occured in each LED is revealed by the studies on section one. The heat transfer shapes inside panel is also determined by taking previous works as referance. According to this, LEDs inside panel spread 25% of the energy they receive on average as a light source, the remaining 75% spreads inside the panel as a light source. The heat transfer in the panel is become by conduction and natural convection. If the heat transfer isn't provided well, there will be a decrease in LED's lifetime caused by reducing light intensity, and such problems as this is occurred at the last product TV's panel and this end is an unwanted situation by user. Both LED panel's mechanical design and thermal characteristics are studied to minimize these risks in this project. Schematic view of thermal transport through the TFT-LCD panel is shown figure 3.4.

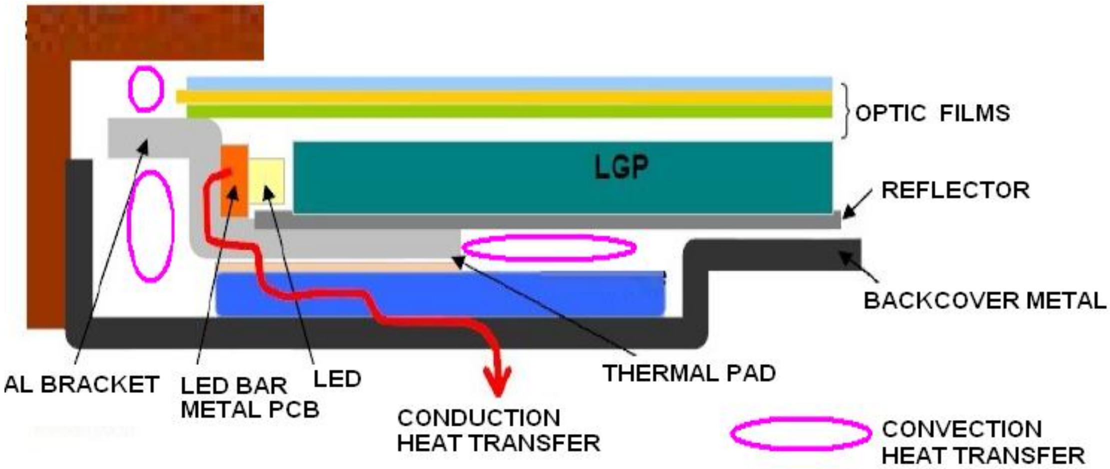

Figure 3.4 Schematic view of thermal transport through the TFT-LCD panel (in the courtesy of Vestel Electronic Inc., from the technical notes)

After the analysis done by power system groups and mechanical design groups, how much energy was needed by one unit LED was calculated. In addition the energy created by the light source and converted to the heat through the outsource was calculated.

Power consumption by LED Bar calculation method ;
The current value of the LEDs : 55 mA
The voltage value of the LEDs : 6.3 V
The number of LEDs in the panel : 180 (4 adet)
The amount of power consumed by all LEDs = 6.3V x 0.055A x 180 (ea) = 62.37 W
The amount of heat generated on LED Bar = 62.37 W x %75= 46.77 W
*(%75 average energy converted to heat)
The amount of heat generated one One LED Bar = 46.77 W / 4 pcs = 11.7 W
The amount of heat generated one One LED Package = 11.74 W/ 45 pcs = 0.26W

As a reult one LED package is generate 0.26 W on LED Bar.

3.4 Heat Transfer Types On LED

The heat formed in LED package is formed at LED chip and the heat is transmitted to meat pcb with conduction and natural convection heat taransfer occur from here.Values calculated from here is given as volumetric heat source by choosing LED chips modelled in LED packages in FLOEFD program. This assignment is done by choosing each LED chip in the program.

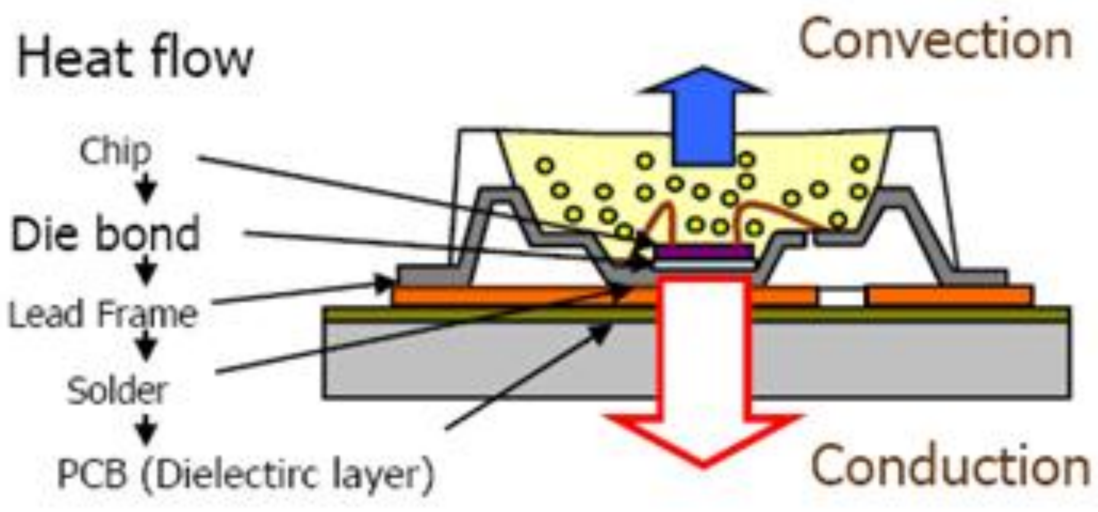

Figure 3.5 The heat transfer types from LED package (in the courtesy of Vestel Electronic Inc., from the technical notes)

3.5 FLOEFD

FLOEFD program is found inside the 3D solid model program ProEngineer used at Vestel Electronic R& D as embedded within the program and thus works conjugatedly. Changes made on 3D in ProEngineer program can be seen momentarily in FLOEFD program.

a) Project creation is start up flow analysis icon on ProEngineer screen

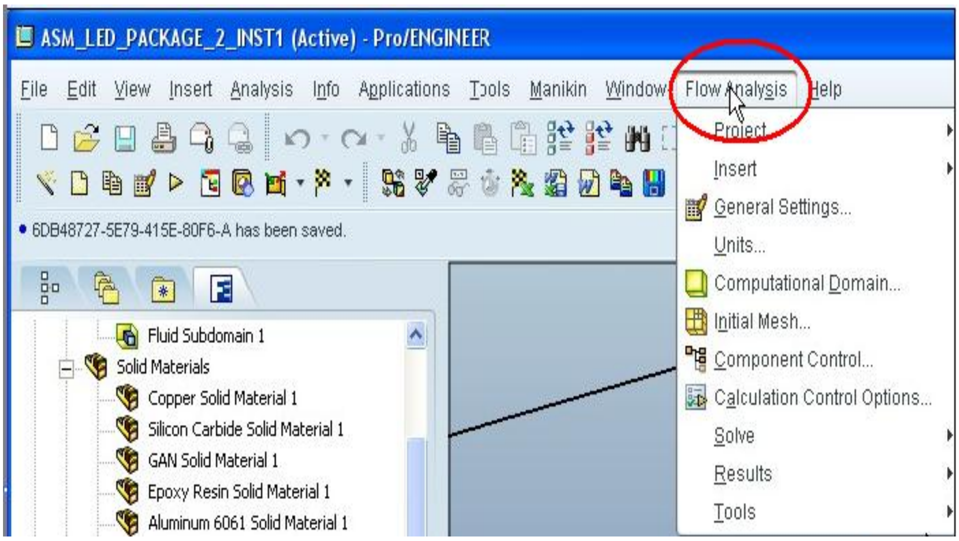

Figure 3.6 FLOEFD start up screen view

b) After click Flow Analysis, The Project wizard screen can be seen, You can create new project or use current project on there

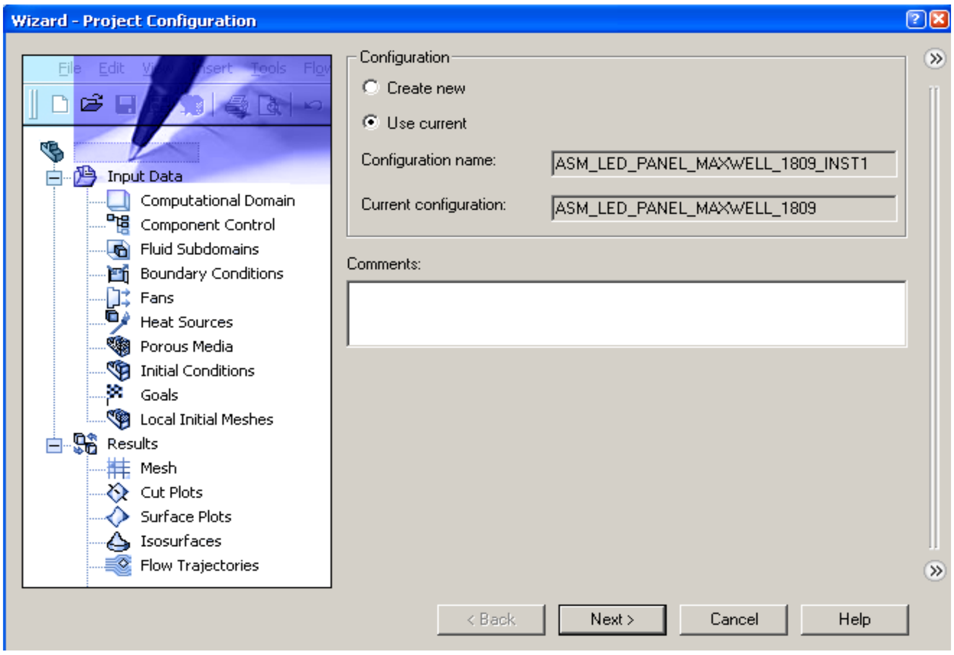

Figure 3.7 FLOEFD project wizard screen view

c) We can choose unit system of project on wizard screen

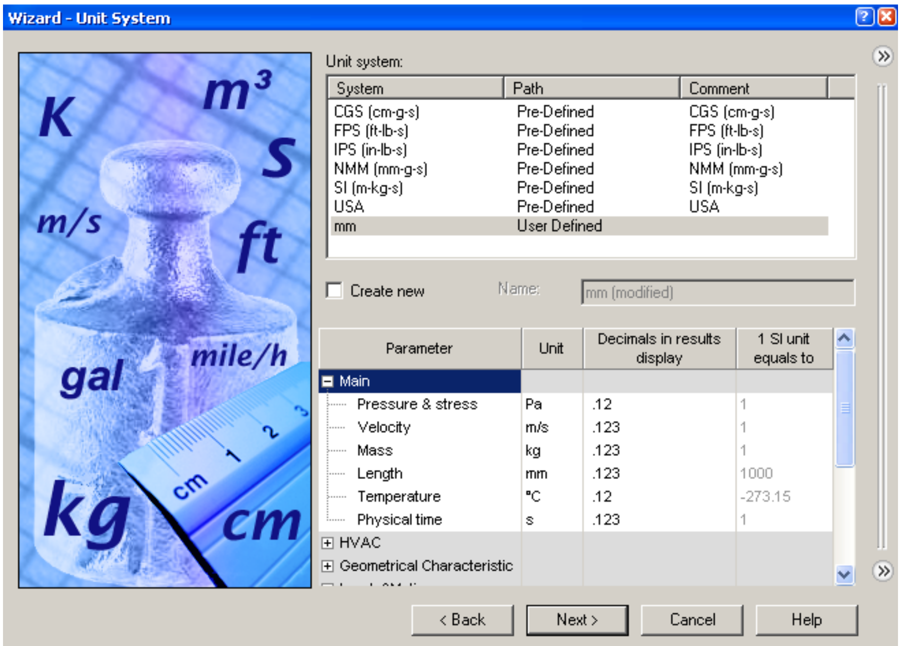

Figure 3.8 FLOEFD unit system selection screen view

d) We must define default solid material and fluid material at the begining of project

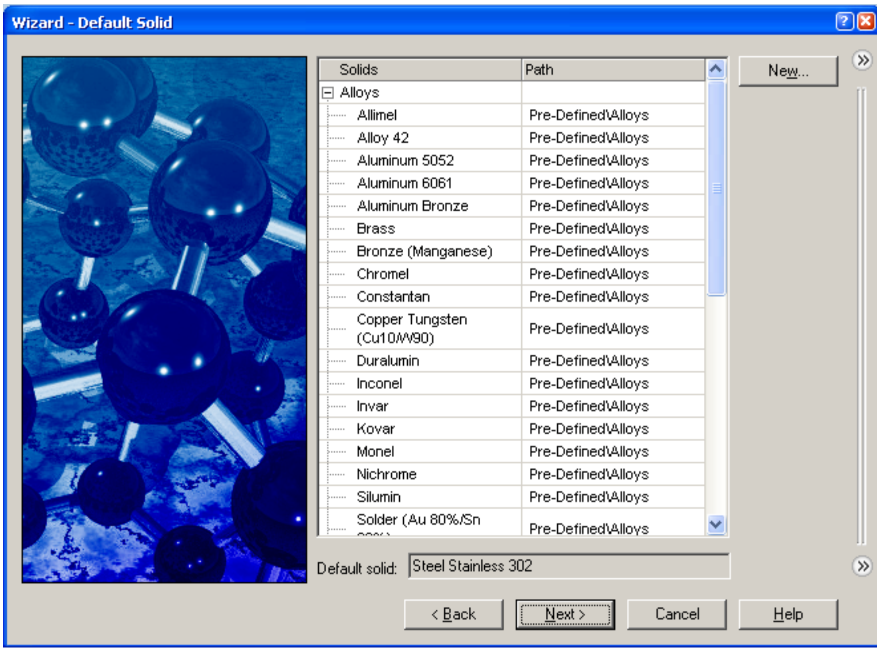

Figure 3.9 FLOEFD solid material selection screen view

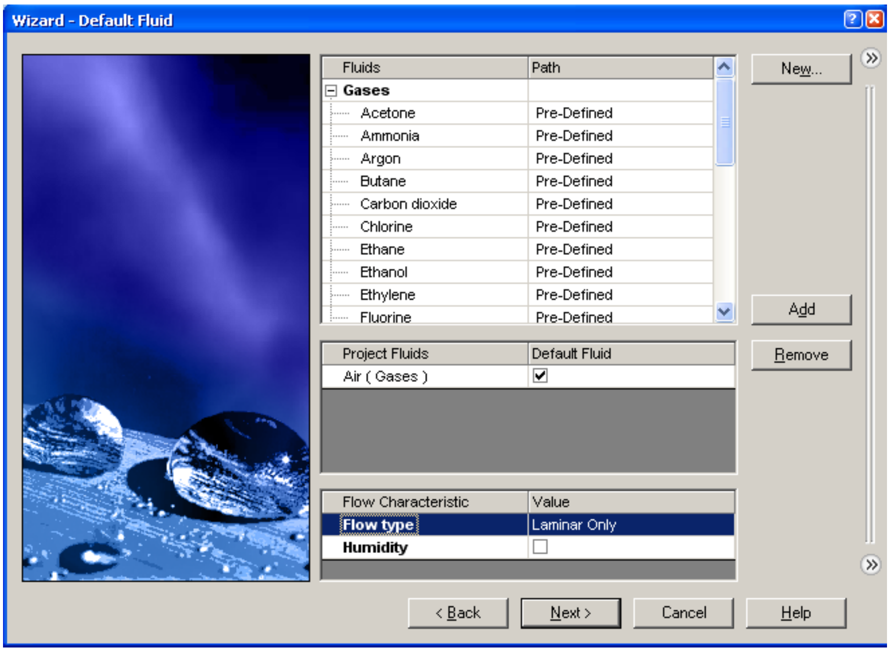

Figure 3.10 FLOEFD fluid material selection screen view

e) After define material of parts , we should fix analysis type on selection screen

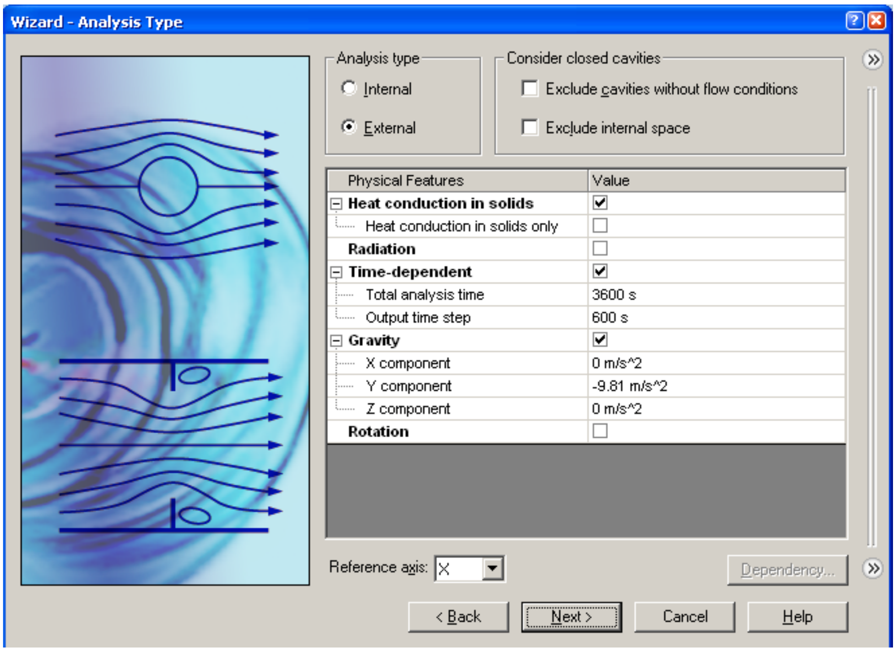

Figure 3.11 FLOEFD analysis type selection screen view

e) After analysis type selection screen, we can set initial and ambient conditions on wizard

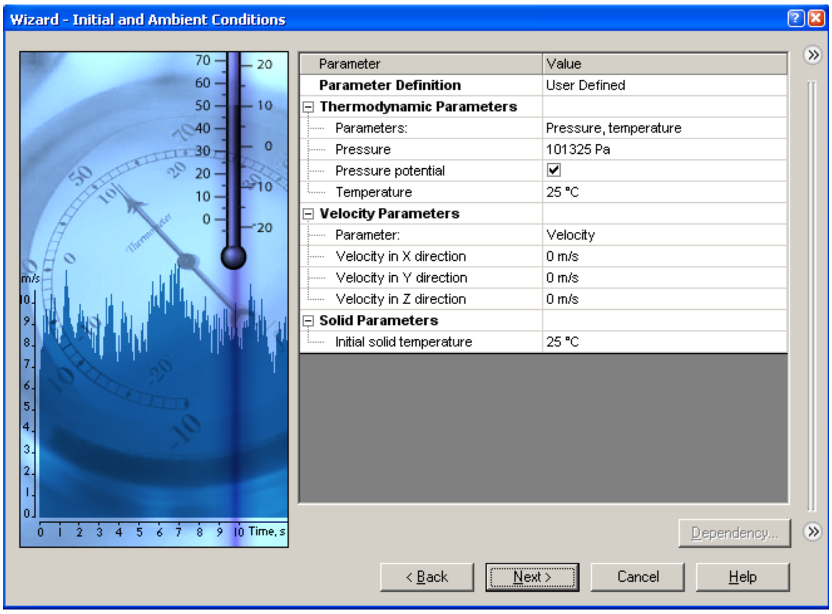

Figure 3.12 FLOEFD initial and ambient conditions selection screen view

f) After define all specification, we can select general mesh level of analyis system In here level 1 has low mesh value, level 7 is maximum mesh inside of sytem. And we also specified local mesh level inside of general sytem. In this way we can control of analyis time to prevent extra time lost

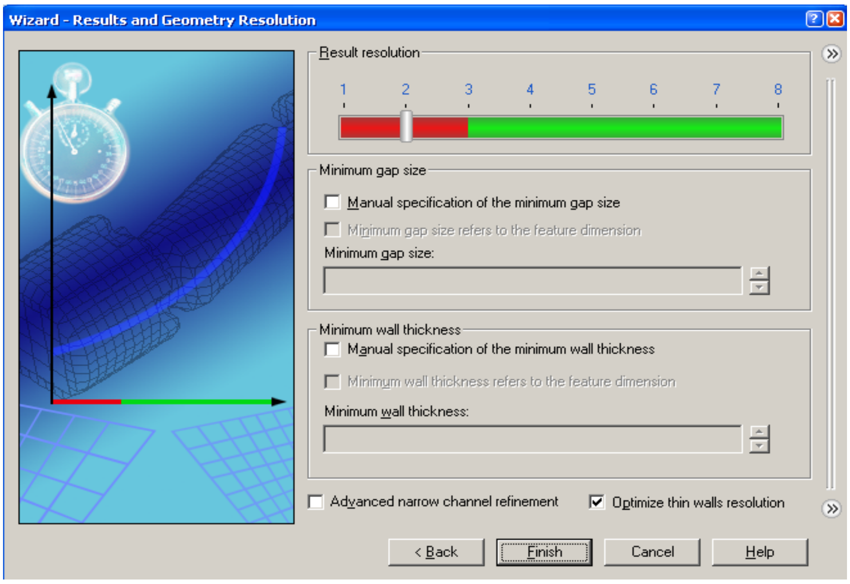

Figure 3.13 FLOEFD mesh level of analyis system selection screen view

e) After all initial and boundary condition set-up completed than we can start to analysis to click run icon.

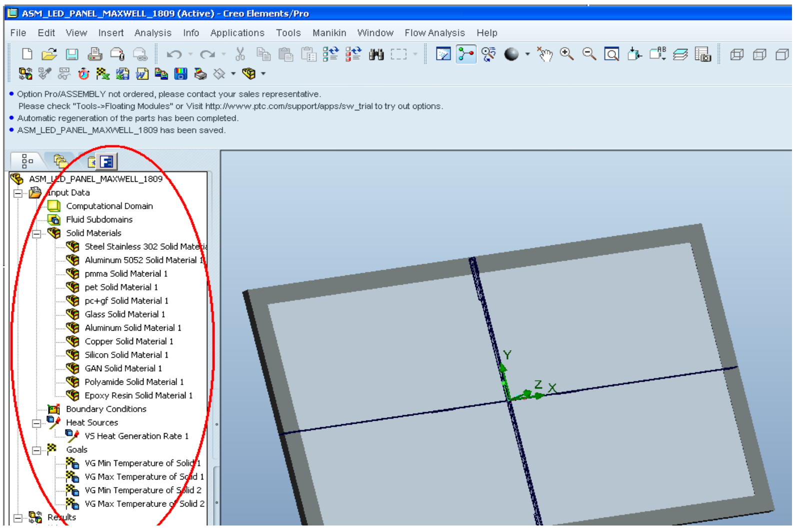

Figure 3.14 FLOEFD ready to start analysis

When analysis in FLOEFD program is started, program gives a start firstly to selected mesh level on solid model mesh operation. Elapsed time from mesh throwing in the analysis is changed depending on selected mesh level initially and the smallest interface range entering in solid model. Air, liquid and solid’s dimension’s mesh level in model can be arranged manually. In LED panel’s heat analysis studies mesh level is chosen generally as Level 3 and the smallest interface range taking over model command is marked. Also mesh level is increased at the parts where are LEDs in the panel, an average mesh level is identified in other solid areas.

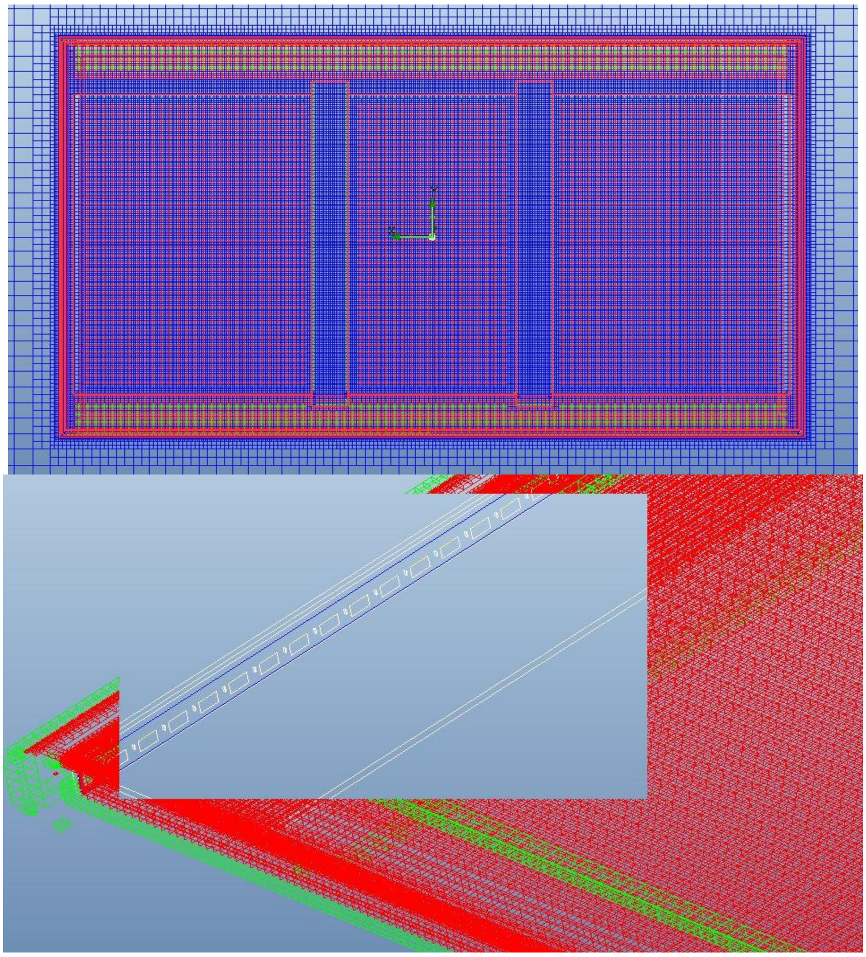

Figure 3.15 Mesh models of LED panel (in the courtesy of Vestel Electronic Inc., from the technical notes)

From mesh scanning's sections on solid model as seen coloured, blue ones represent air, red one represents lower mesh level solid model and green one represents higher mesh level solid model.

After mesh scanning in the program is finished; analysis studies, initial conditions entered in the program, identified material's properties, heat transfer types, heat values are proceeded as to intended results. Air temperature in the environment is selected as 25° C.

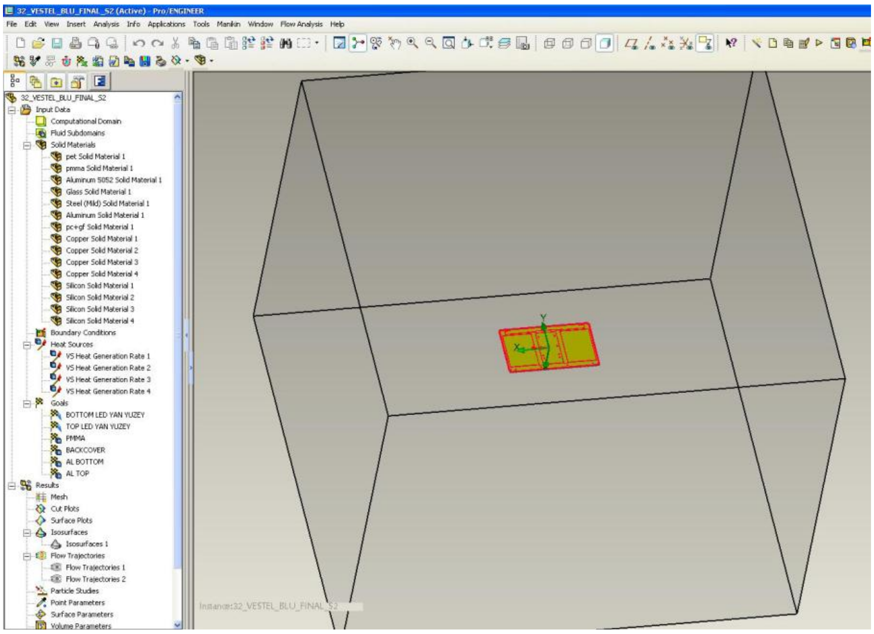

Figure 3.16 Computer analysis view of LED in room conditions

The first results of LED panel are showed at below picture.According to results, heat distribution inside LED panel is much more at upper and lower areas as expected. Heat distrubition is decreasing by going centre on panel. As it is shown in the child segment’s picture, heat quantity increases at areas where LED’s pcb is assembled on AL Bracket and Metal Backover; and plastic materials around LEDs is effected by heat.

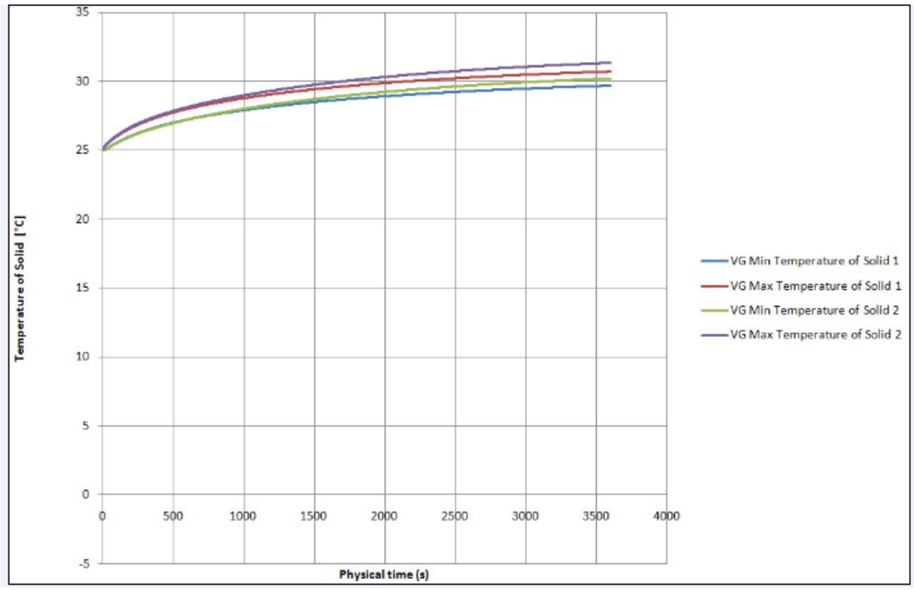

Figure 3.17 Initial result of fist computer analyis LED panel

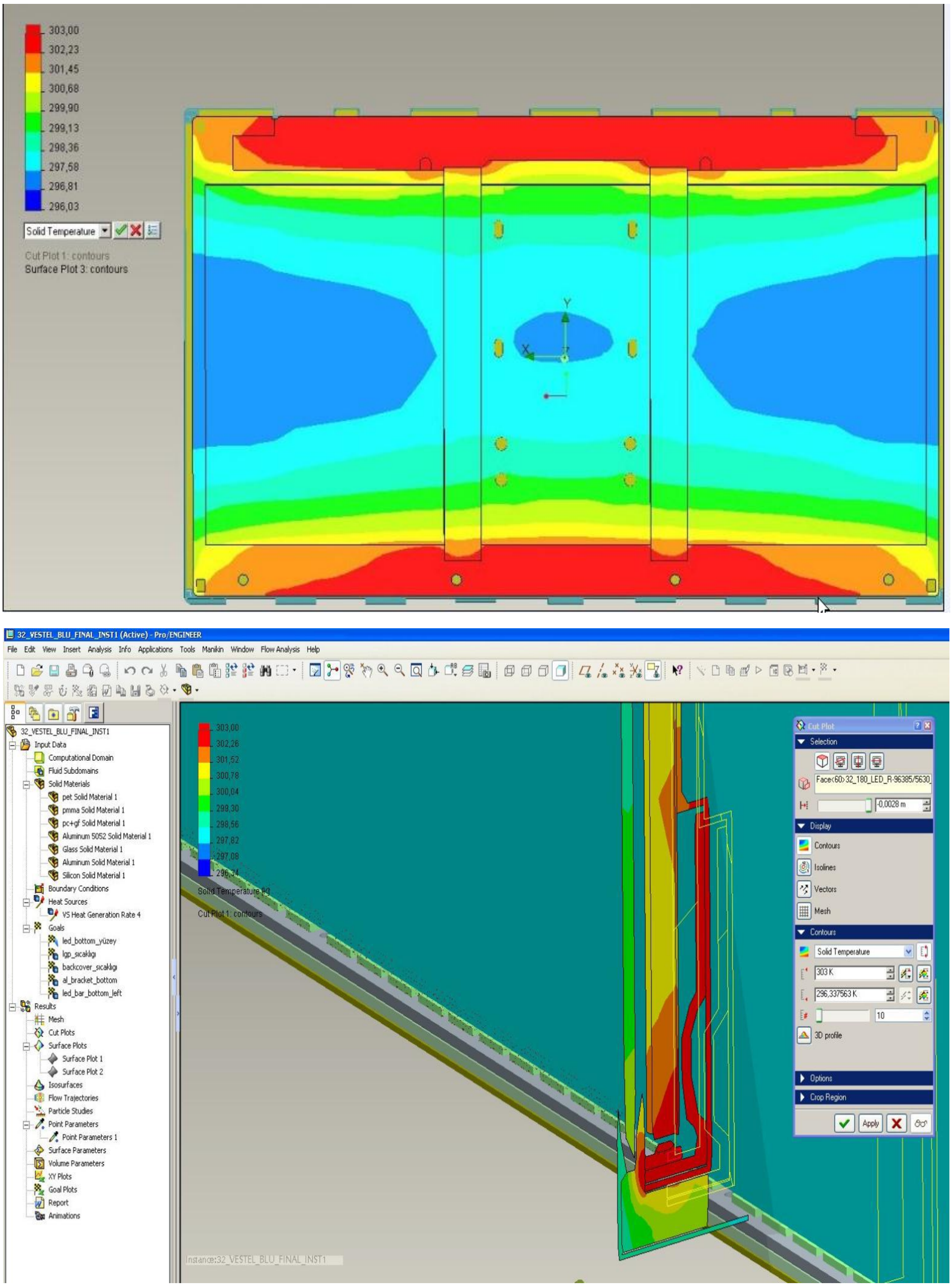

Figure 3.18 Computed temperature distributions on LED panel

CHAPTER FOUR

EXPERIMANTAL ANALYSIS ON TFT LCD PANEL

Experimental Analysis studies are made at Realiability department clinging to Vestel Electronic R&D. Thermacouple and infrared thermal cameras found at department are used at studies. Panels are operated one hour at room conditions by giving voltage values and suitable current from invertor boards to the LED panels. Tests are taken after heated panels in order to simulate fully on panel’s working conditions.

Figure 4.1 Illustration of the experimental set-up test equipment

Experimental design approach is done by an IR and thermocouple. The temperature distribution was measured by K-type thermocouples placed mainly on the top and bottom edges of the LCD displays, near the heat sources (LEDs), where temperatures were expected to reach their maximum values, (Fig.6). K-type thermocouples have a reliable sensitivity range from -10 to 200 °C and a measurement error less than ±0.5 °C. The data acquisition system consists of an Agilent 34970A Data Acquisition / Data Logger device with 22-bit internal DMM, scanning up to 250 channels per second. FLIR Thermacam SC 2000 test device was also used to obtain thermal camera images of the displays.

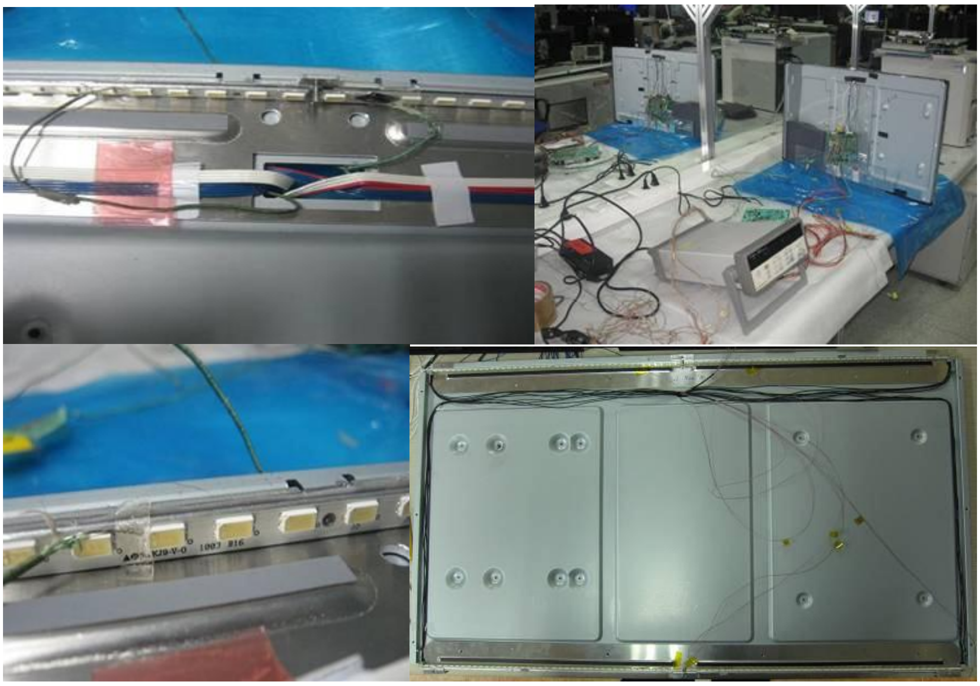

Figure 4.2 Experimental set-up - temperature measurements

Thermal tape is used between AL metal pcb and AL bracket to transfer heat well at LED pcb's assembly(3M, TM-670SA, K 0.5W/mK). It has been studied on the cancellation of this part at experimental analysis studies by thinking of difficulty of assembly and because of the cost of thermal tape.

Measurement with thermal band and measurement without thermal band's results are taken from measured panel to see their effects.According to this, results obtained by different numbers of LEDs without thermal tape temperature is 3~4°C higher than with thermal tape system. However without thermal tape condition temperature is still under critical temperature below 70°C. We can cancel thermal tape on part list.

Table 4.1 Experimental Result From 168 pcs and 148 pcs Led on thermal tape condition

LED QUANTITY	**THERMAL TAPE**	**LED MAX TEMP ◦C**
168 pcs LED (55mA)	with	57.6
	without	60.5
148 pcs LED (55mA)	with	54.1
	without	55

Temperature values are taken from the 168 pcs LED panel quantity panel result is showing below table with thermocouple points. According to this result We can see that panel bottom side temperature is 1~3°C more higher than top side.

Table 4.2 Experimental Result From 168 ea LED inside of panel

168 pcs LED 55mA				
Maximum temperature of measuring points in LCD display (Unit ◦C)				
Measurement Points	T1	T2	T3	T4
Measurement Value	54.5	55	56	58

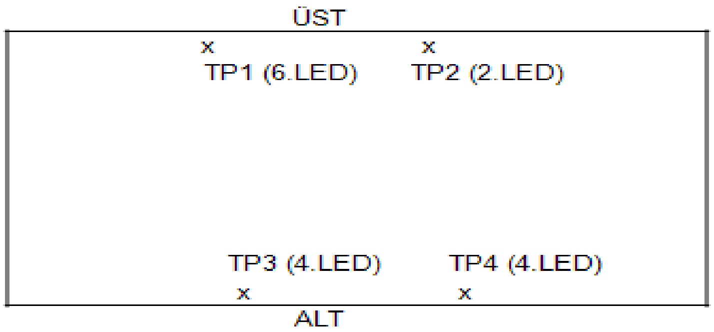

Figure 4.3 168 pcs LED experimental study thermocouple points

Table 4.3 Experimental Result From 180 pcs LED inside of panel

180 pcs LED 55mA										
Maximum temperature of measuring points in LCD display (Unit ◦C)										
Measurement Points	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10
Measurement Value	58.4	57.3	57.9	57.5	54.1	56.3	58.7	60.3	62.1	56.9

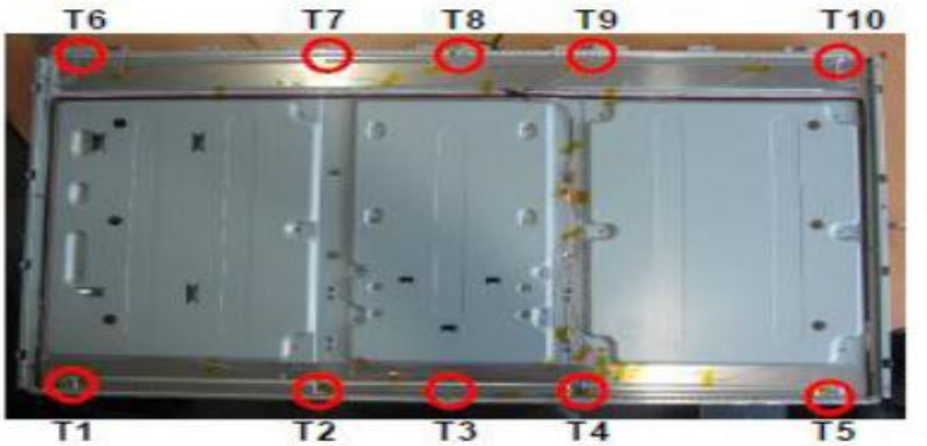

Figure 4.4 180 pcs LED experimental study thermocouple points inside of the panel

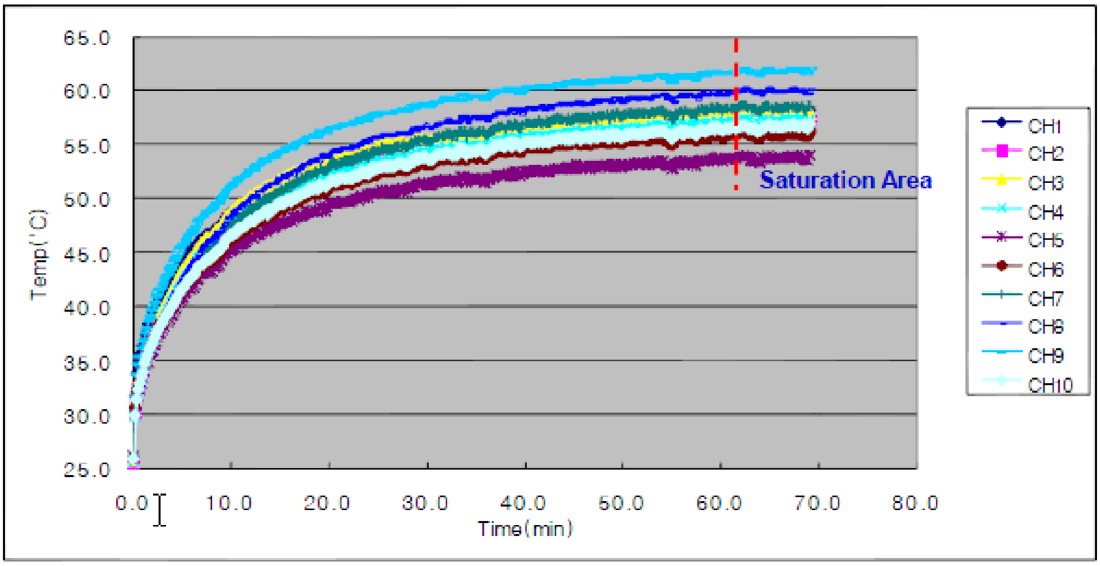

Figure 4.5 180 pcs LED panel experimental study result graph

Table 4.4. Experimental Result From 180 pcs LED outside of panel

180 ea LED 55mA outside of panel						
Maximum temperature of measuring points in LCD display (Unit ◦C)						
Measurement Points	T1	T2	T3	T4	T5	T6
Measurement Value	61.9	64.1	40.3	57.9	43.9	39.5

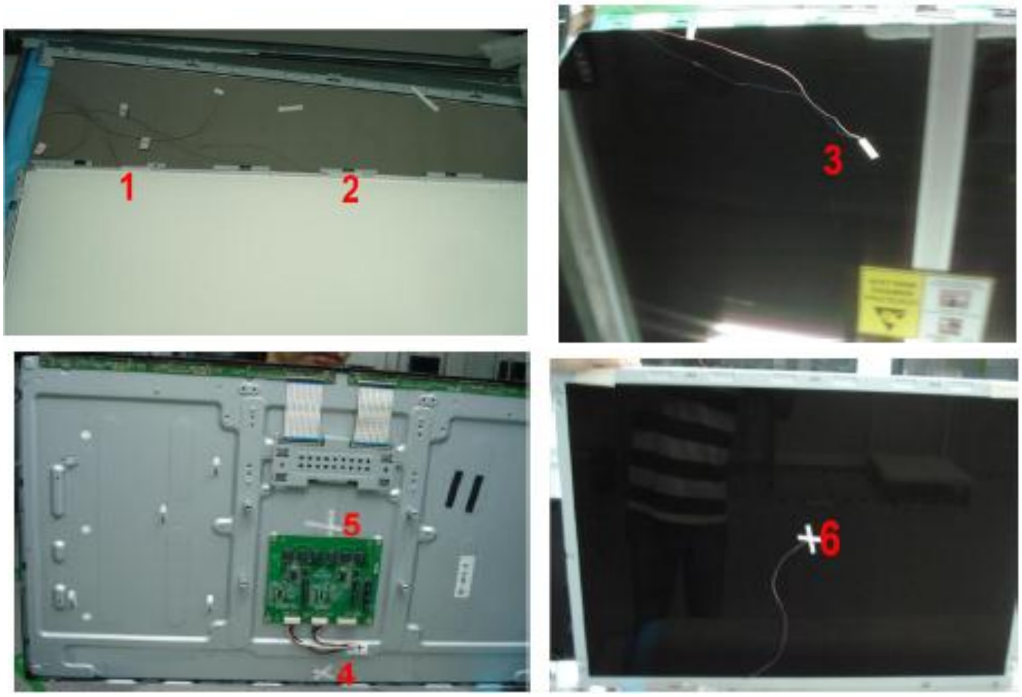

Figure 4.6 180 pcs LED experimental study thermocouple points outside of panel

We can see also LED panel instant heat dissipation view using the infared camera as follwing figure.

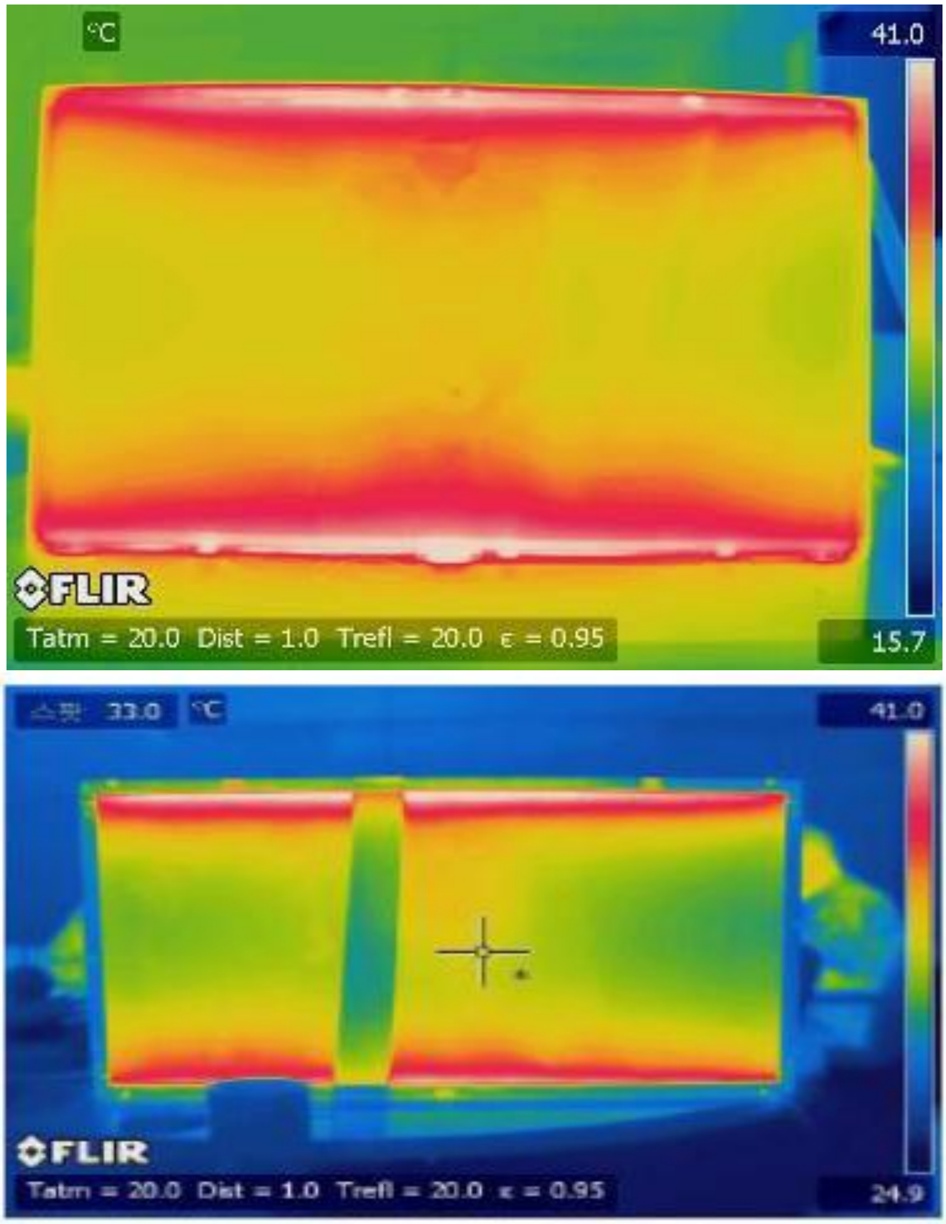

Figure 4.7 Thermal camera image on the TFT LCD Front Metal & CELL surface

CHAPTER FIVE

THERMAL ANALYSIS VALIDATION AND IMPROVEMENT STUDIES

Optical group clinging to Vestel Electronic and power systm's department is worked closely as mechanical design during LED panel design. Power system department designs converter board which operates and nourishes panel cycle determined mechanical sizes suitable to thin panel structure being an output of the project in the meantime. LED's need of current and voltage levels are changed according to connection type and numbers of LEDs used in panels. Converter pcb arrange direct current for LED inside of panel. Intended cluster of lights inside panel is made up by working of LEDs.

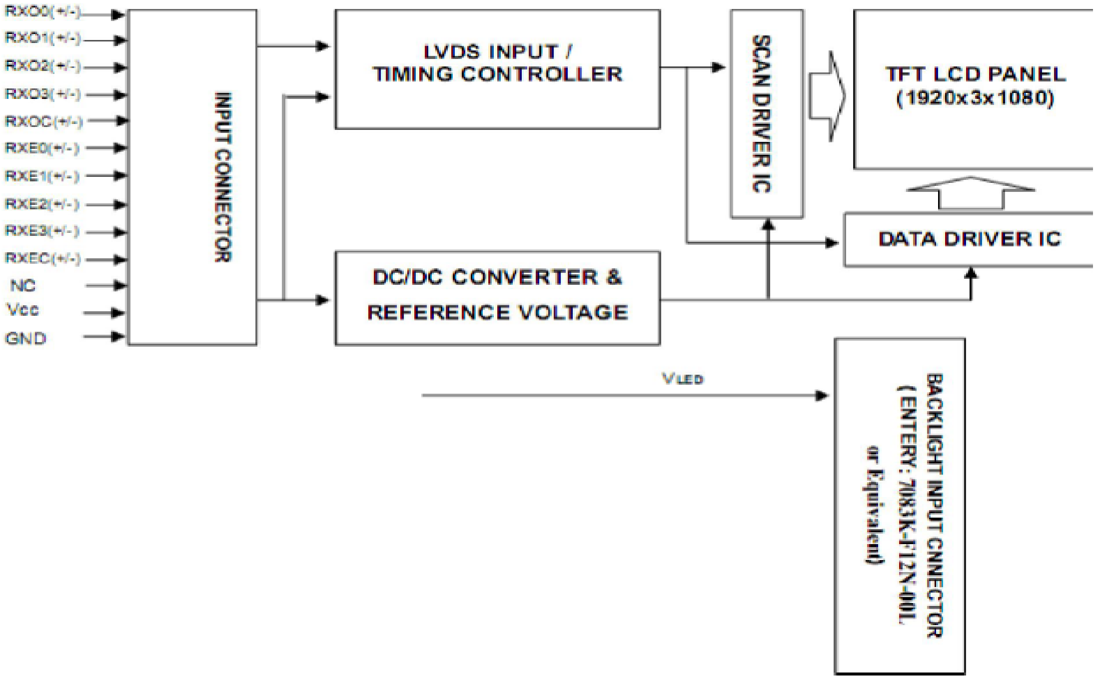

Figure 5.1 Electornic circuit diagram of LED panel (in the courtesy of Vestel Electronic Inc., from the technical notes)

Converter board design has taken its final form by taking measurements from optical laboratories and giving feedback to power system design group at workings on prototype. Lower cycle time (cycle time) in meaning of productivity is obtained by not using module boards such as conveter card to assemble LED panel directly at LED panel mechanical design workings

Light source inside panel is initiated with brightness of light source, colour coordinates and examined equal distrubitions prototype samples. LED panel's performance is examined with to be used optical film structure ; brightness, colour coordinates, equal distrubition and MURA performance measurements have been made. By taking into consideration of such parameters as panel's brightness, equal distrubution and angular performance; optical film structure is determined by seeing costs of last products at different LED numbers.

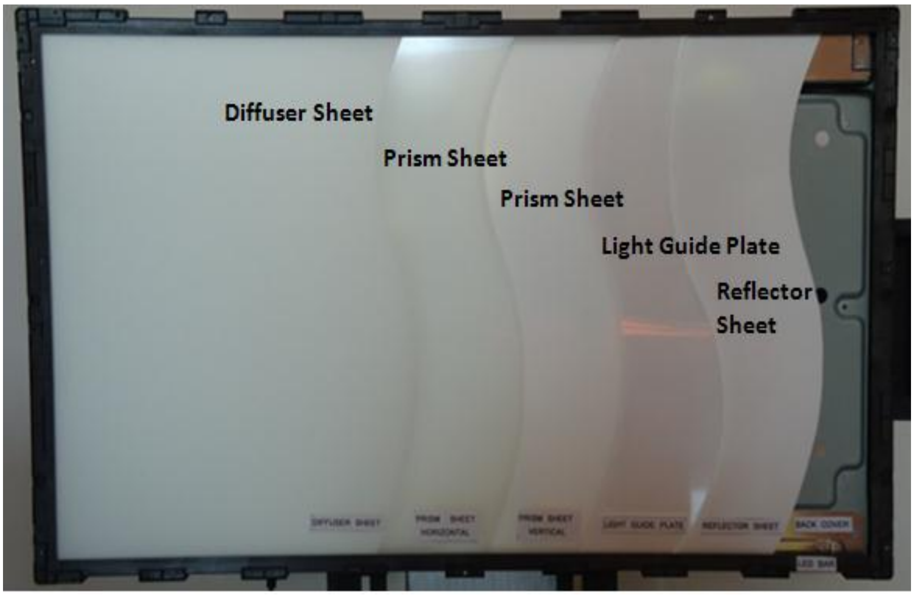

Figure 5.2 The cross sectional view of Vestel LED panel

LED panels are working on it according to alternaive LED quantity and optical film structure as follows ;

1) Optical film strucuture of 148 pcs and 168 pcs LED panel

- Reflector
- Light Guide Plate
- Microlens film

- Prishm Sheet
- DBEF

Optical film strucuture 180 pcs LED panel

- Reflector
- Light Guide Plate
- Prism Sheet Vertical
- Prishm Sheet Horizantal
- Microlens film

With evaluating of first computer analaysis works and results getting from experimental analysis works, targetted differences as proportional is confirmed at the results of LED panel's measured same surface or points. Determined error rate is taken in order to define if these differences are sufficient level or not. Error rate used inour analysis is found by formulation shown at below.

Error rate= (experimental analysis result- computerized analysis result) / Experimental Analysis result* 100%

According to this, error rate is 10% which is determined by us as a team with experimental analysis and computerized analysis result.

By comparing all of the available data with this way ,computerized analaysis studies are repeated until we get targetted results to areas which are above error rate. We have benefited from work package and also literature researches at studies here.

The studies of analysis is much more different than the computerized analysis studies, and this result prove that there are data which we identified as deficient or false in the program. The circumstances which we come across are quated by contacting with agent of FLOEFD Turkey in order to correct our studies in here. Moreover, thermal analysis studies of electronical devices are reviewed by university and Vestel team in parallel with the other study. From the results of these studies, resistance coefficients between materials in LED packet aren't entered, this situation is noticed by initials conditials at the part of computerized analysis studies. The heat has carried out natural convection and heat transfer as transmition without any resistance at our first computerized analysis studies, and thus the heat is easily thrown outside and intended heat levels at parts haven't been reached. Materials in LED packet has been searched with the learned information from here and have a contact with Korean company produced LED packet. Parts of materials in LED packet has been identified, resistance coefficents interrelated with parts necessary definitions in FLOEFD have been made from computerized analysis studies.

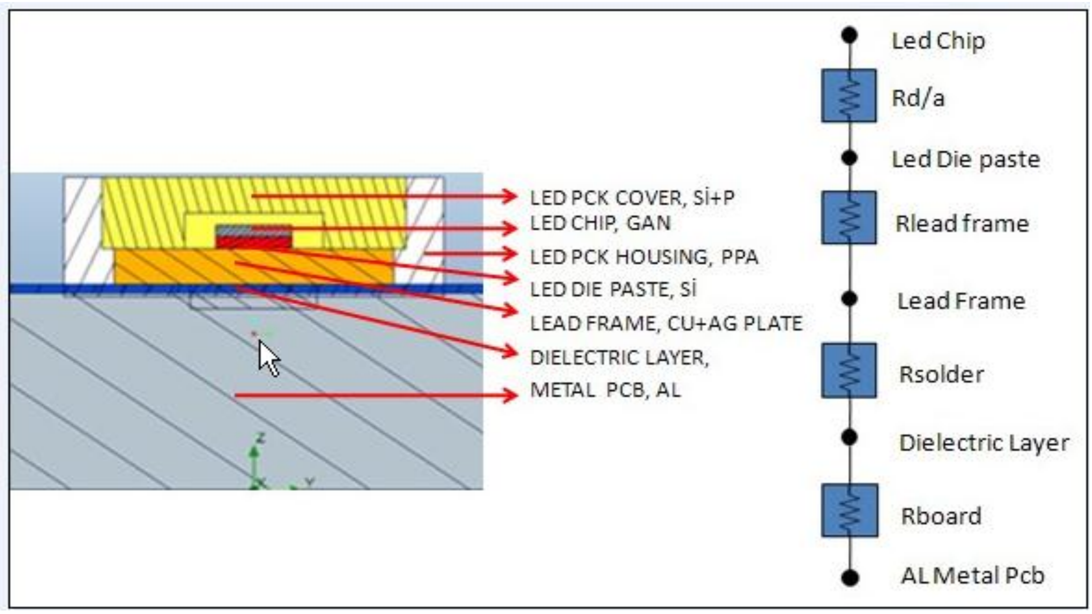

Figure 5.3 Thermal analysis and resistor model of LED package (in the courtesy of Vestel Electronic Inc., from the technical notes)

LED consist of several layer, the led junction is the area of the chip that creates light. This area of the chip gets hot under working condition of BLU.

Heat generated in the LED spreads to the surrounding through convection and conduction and the effect of radiation is neglected. Running an LED above its rated maximum junction temperature will decrease life time and accelerate lumen depreciation. As a result of an increase in diode junction temperature there is a decrease in the LED efficiency and a shift in the emission wavelength. Therefore, the LED operating temperature must be kept well below its maximum operating temperature for optimum efficiency operation and small color variation.

A method for creating compact thermal models of single-chip and multi-chip LED package is developed and evaluated with good agreement between the finite volume simulation and experimental data. The junction temperature predictions from the single-thermal-resistance model. And the -thermal-resistance model gives the most consistent and accurate prediction for the junction temperature (Chen et al., 2009)

Junction temperature (Tj) can be calculated as following equations ;

Tj= Tsp + Rth*If*Vf

- Tsp : is measured solder point temperature
- Rth : is the specified thermal resistance of the LED in (K/W)
- If : is measured the forward current in Amperes
- Vf : is measured the forward volatages in Volts

The amount of total resistance on LED is calculated by following eguations ;

Rth= Rd/a +Rlead frame+Rsolder+Rboard

Table 5.1 Thermal Resistance values of LED package

Layer	**Resistor**	**Thermal Resistance (K/W)**
Led Chip + Led Die paste	$R_{d/a}$	4
Led Die Paste + Lead Frame	$R_{lead\ frame}$	13
Lead Frame + Dielectric Layer	R_{solder}	16
Dielectric Layer + AL Metal Pcb	R_{board}	22

Table 5.2 Thermal Conductivity values of LED package

Led package component	**Thermal conductivity(W/mK)**
Led Chip Gan	150
Led Die Paste Silicon	124
Lead Frame Cu-Alloy	350
Led Housing Silicone Resin	0.2
Led Package Polyamid	0.3

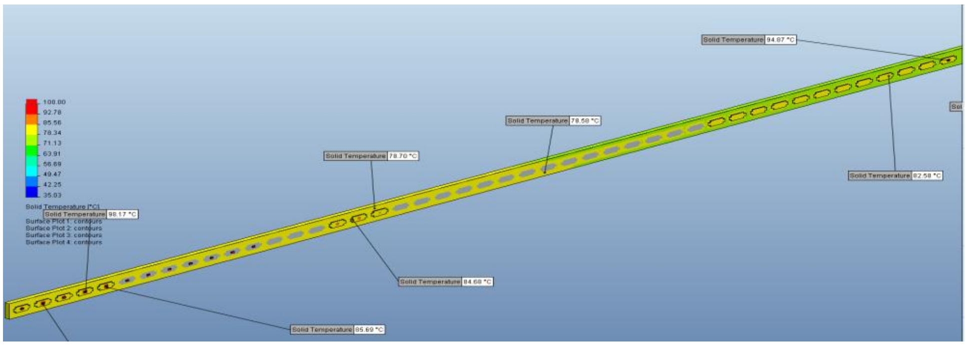

Figure 5.4 Steady state computed temperature distributions on the LED BAR out of BLU

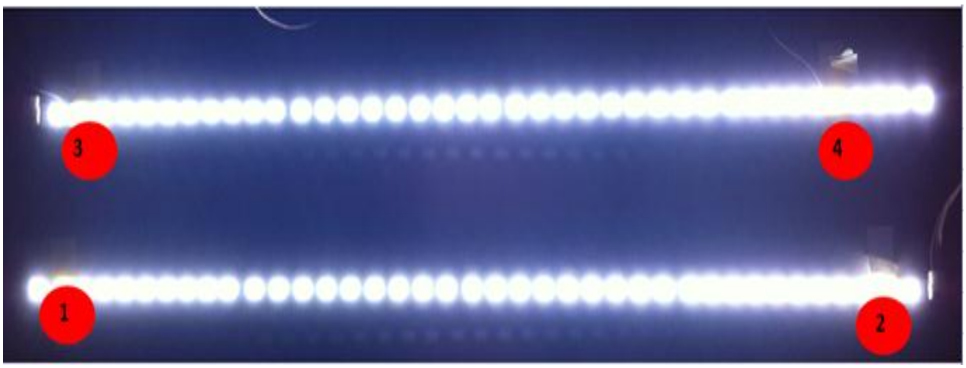

Figure 5.5 Illustration of thermocouple mounting on the AL Bracket

Table 5.3 Temperature of measuring point on LED Bar with AL Bracket and without AL Bracket

Maximum temperature of measuring points out of BLU			
on LED Bar		***on Al. Bracket***	
Points	**(°C)**	**Points**	**(°C)**
1	98	1	54.5
2	93.5	2	57
3	92	3	56
4	96	4	55.5

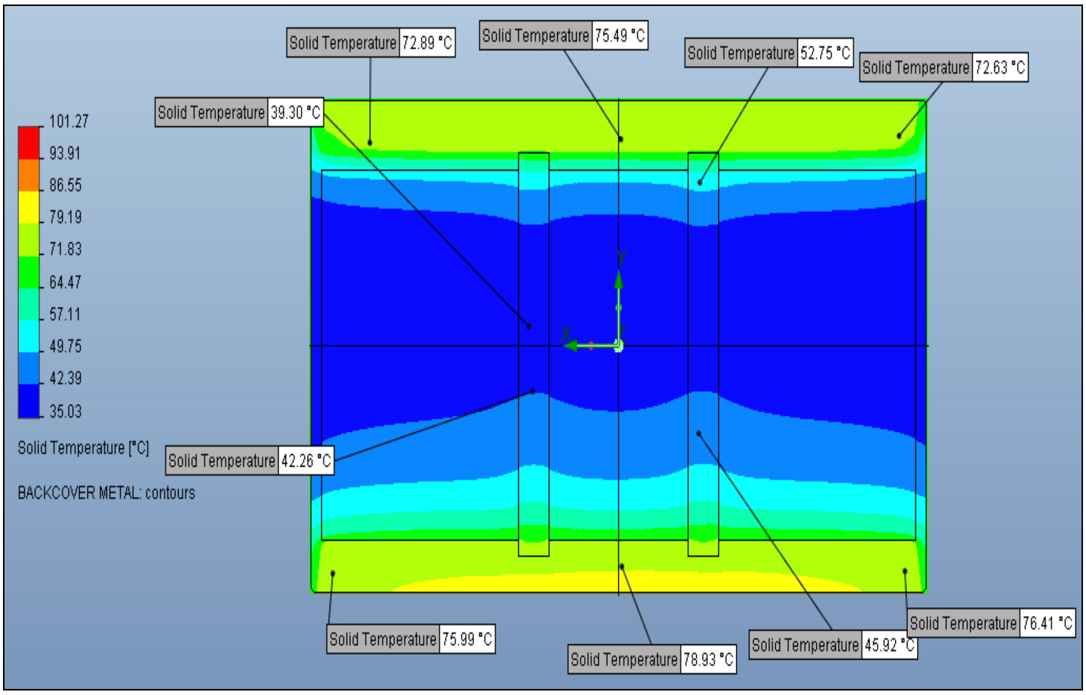

Figure 5.6 Steady state computed temperature distributions on the TFT LCD Back cover Metal surface

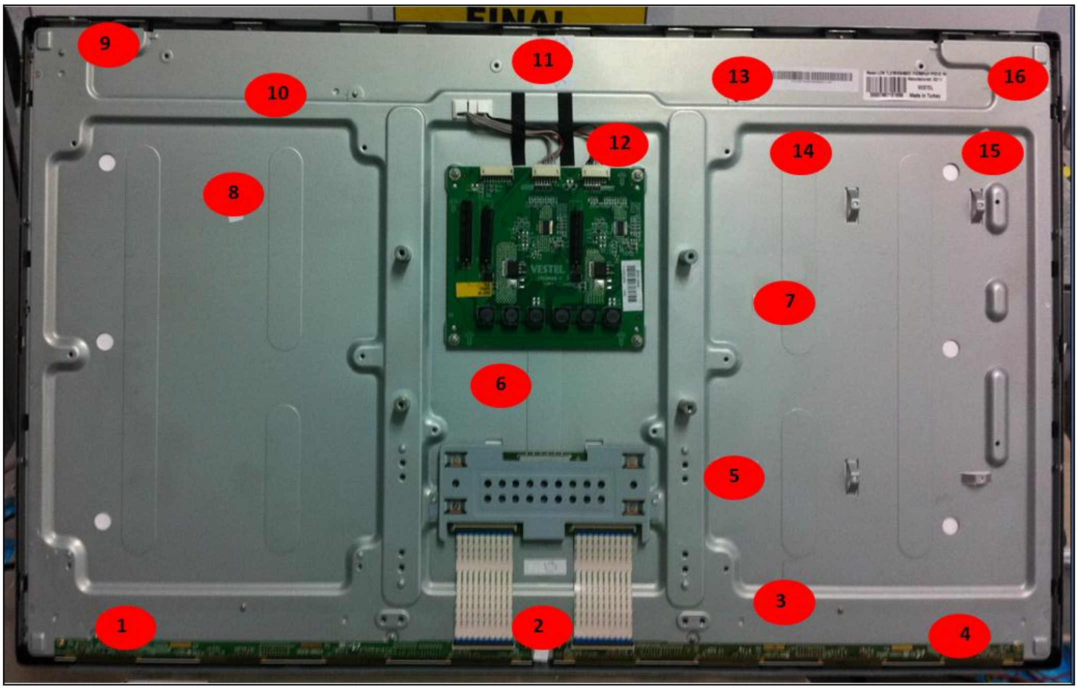

Figure 5.7 Illustration of thermocouple mounting on the TFT LCD   Back cover Metal surface

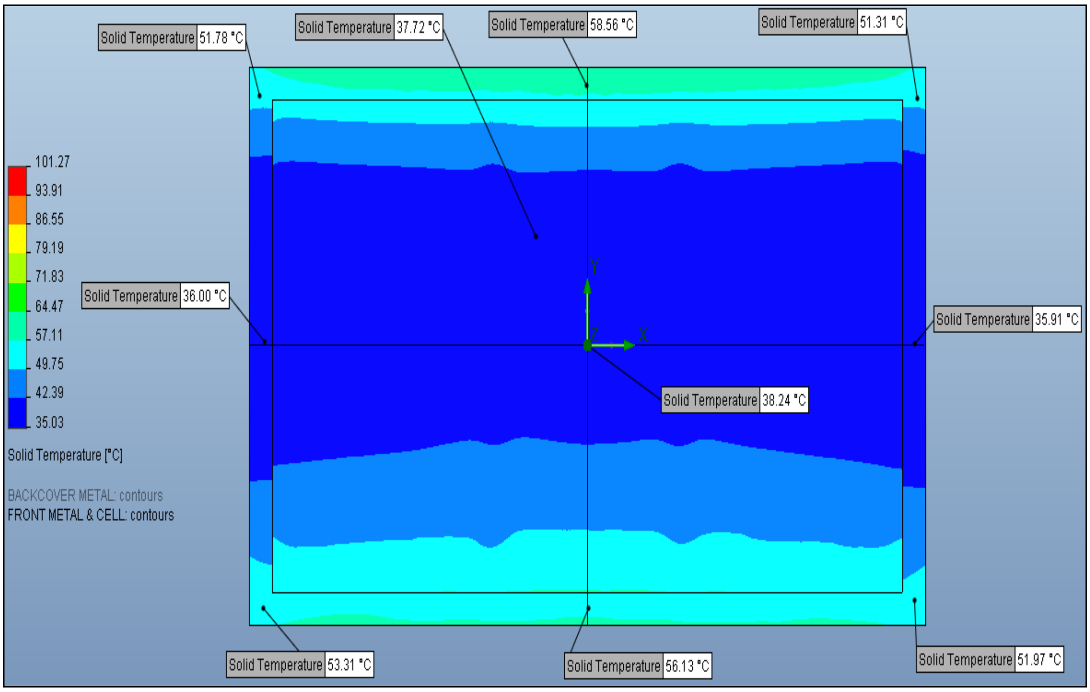

Figure 5.8 Steady state computed temperature distributions on the TFT LCD Front Metal & CELL surface

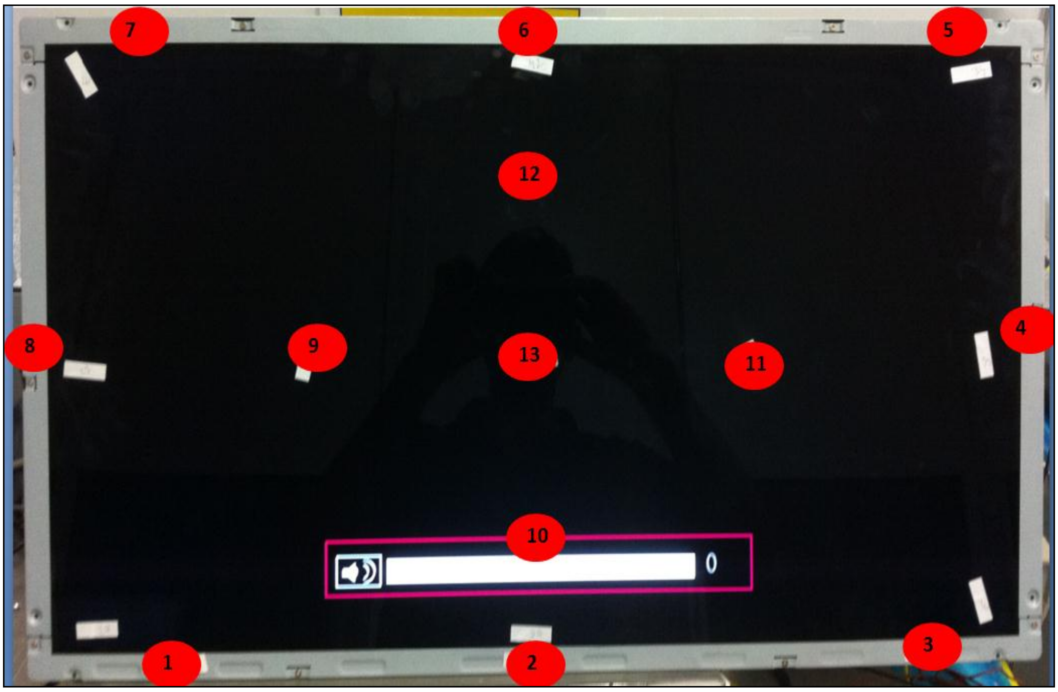

Figure 5.9 Illustration of thermocouple mounting on the TFT LCD Front Metal & CELL surface

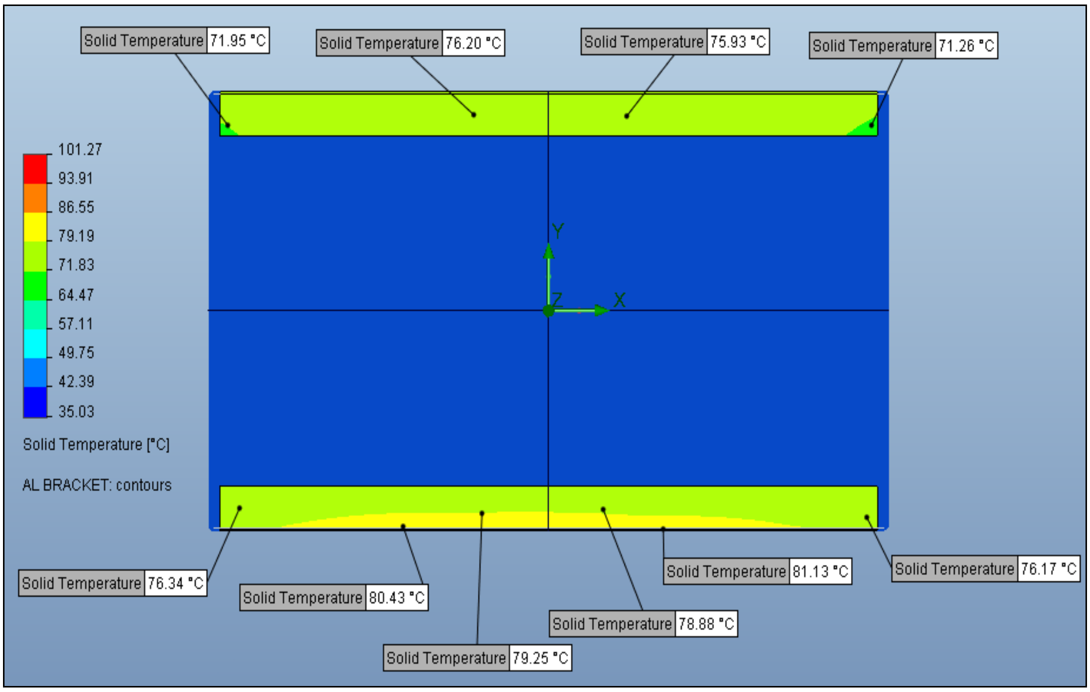

Figure 5.10 Steady state computed temperature distributions on the TFT LCD Al. Bracket surface

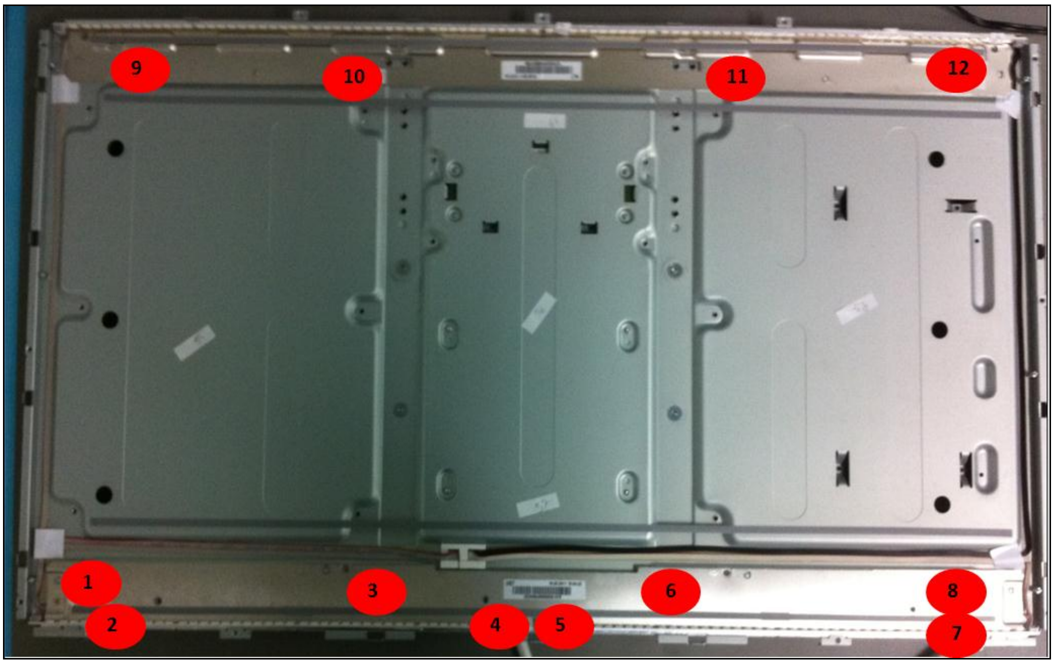

Figure 5.11 Illustration of thermocouple mounting on the TFT LCD Al. Bracket surface

Table 5.4 Maximum temperatures of measuring points

Maximum temperature of measuring points in LCD display					
on Backcover Metal		***on front metal and cell lead***		***on Al. Bracket lead***	
Points	**(°C)**	**Points**	**(°C)**	**Points**	**(°C)**
1	50	1	40	1	51
2	50	2	39	2	55
3	50	3	40	3	58
4	48	4	37	4	59
5	42	5	42	5	55
6	41	6	41	6	56
7	37	7	42	7	55
8	47	8	35	8	50
9	53	9	36	9	53
10	52	10	37	10	57
11	56	11	37	11	58
12	48	12	37	12	53
13	51	13	38		
14	45				
15	44				
16	48				

At evaluation of Vestel LED panel experimental measurement and computerized measurements results, studies with each other have been confirmed by getting lower results than error rate determined initially. By this way, changes of heat inside panel have been observed with various variant at computerized analysis studies.

Computerized analysis study have been repeated by making a change with LED panel back metal raw material at the study shown at below table. Galvanic sheet as Backcover Metal part's raw material have been used in the left picture, AL is chosen as backcover metal part at analysis in the right picture. When we evaluate the results of analysis, there is 3°C difference between AL and galvanic sheet. Calculating of LED's junction heats used inside LED panel have been calculated as galvanic sheet, and this raw material usage is suitable in the current situation. If junction heat in LEDs is at higher level than intended level, AL bracket can be considered as Backcover Metal raw.

Film structure to be used inside panel has been effected from number of LEDs. These should be determined at intended optical specs to make product at the begining of the project. There are price range on product at main items found at below graphic inside LED panel. The most important part and the highest cost inside panel is LED as it is understood from the garphic. It is necessary that provides intended heat conditions at LED's working level and the optimization of the number of LED.

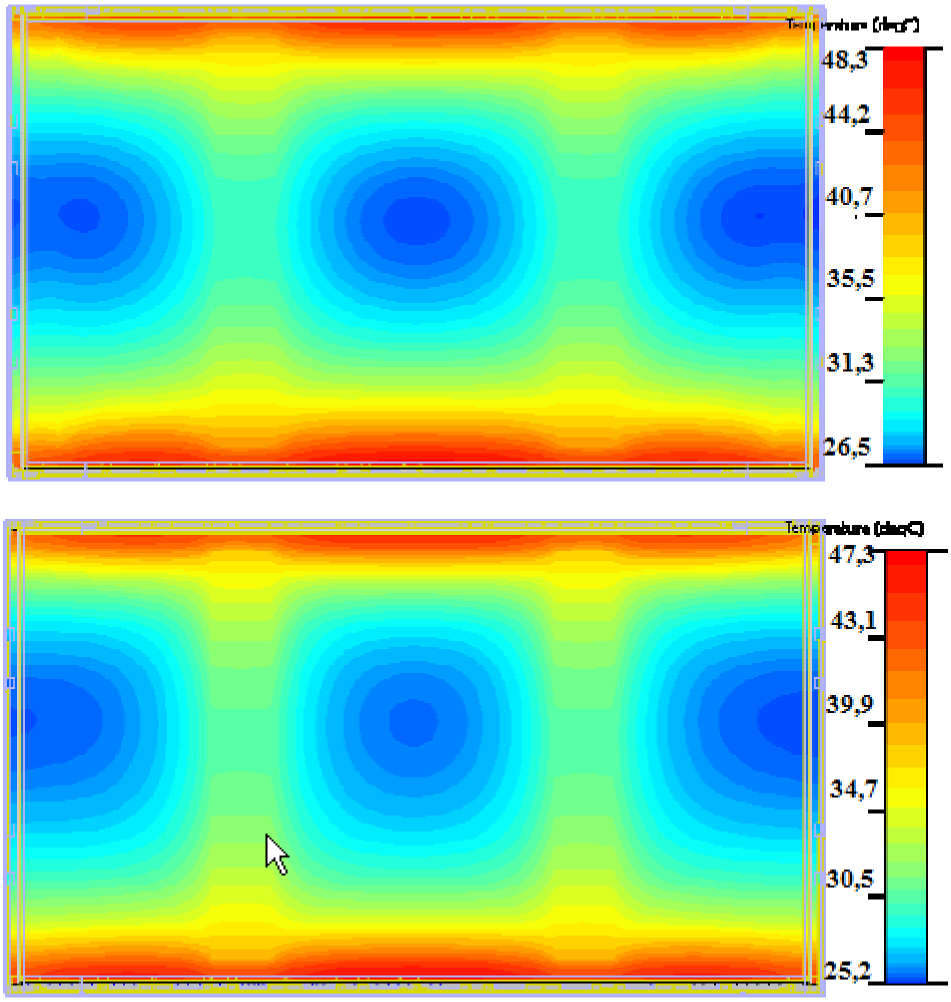

Figure 5.12 Computed temperature distributions on the TFT LCD with diffrent Backcover Metal raw material. raw material. a) Top side result belongs to Backcover raw material is SGCC. b) Bottom side result belongs to Backcover raw material is Al.

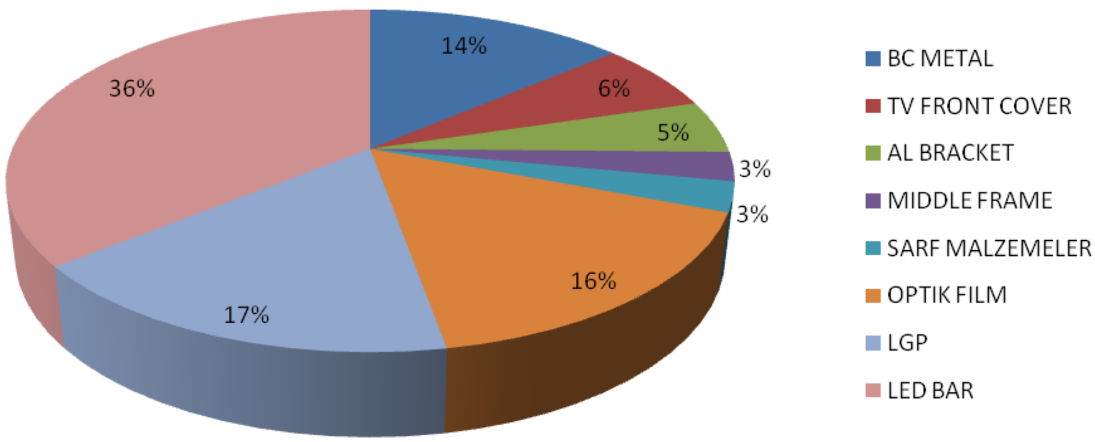

Figure 5.13 Cost analysis of TFT LCD LED panel according to component

Usage of LED's only one-sided version inside LED panel have been determined as Vestel at project's contination. In available design, LEDs are lined up both above and below , and total number of LED is determined as 180. Benchmark products are come to Vestel lastly and it has been decided to reduce the number of LEDs at panel design under cost reduction workings. We have both cost reductions of optical structure and having opportunity of slimmer design at targetted TV product at panel design to be made newly. In the current situation, 180 in number LED structures are reduced to 72 in number with new design. LEDs are placed underside inside the panel. And so, slimmer structure can be used at top zone of the panel.

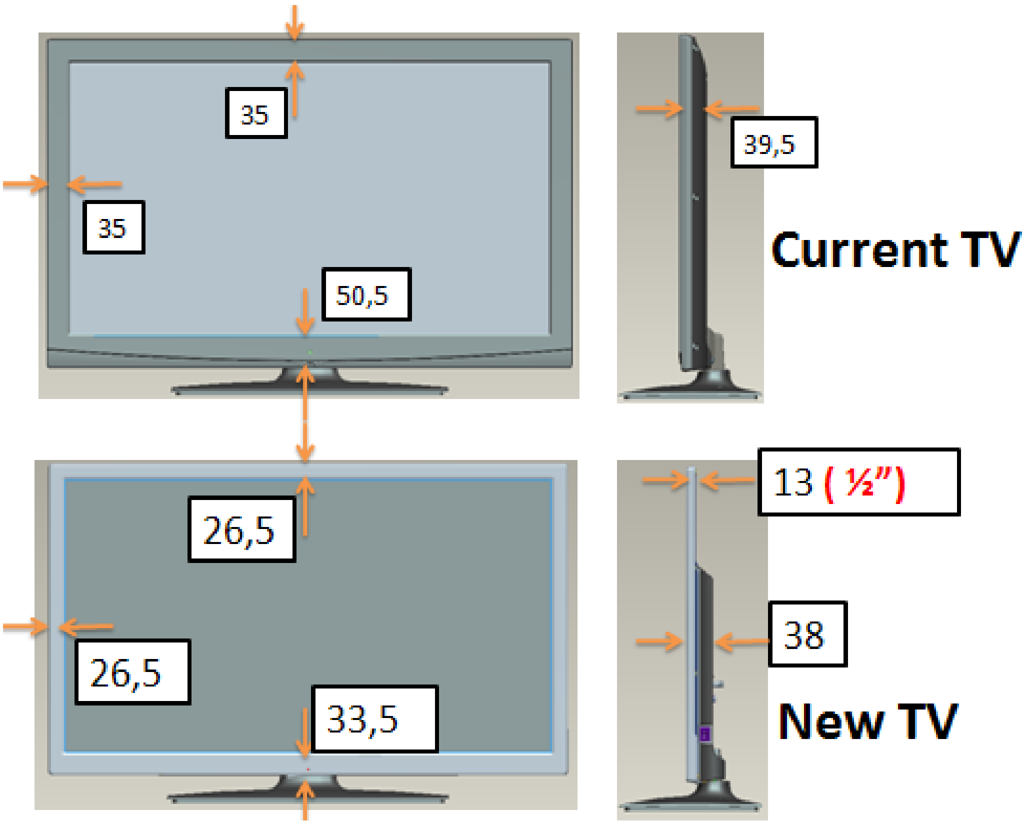

Figure 5.14 Comparison dimension of TV outside between current design and new design

We get a TV size which is about 1 inch in other words 13 mm with new design, this size was 39 mm in previous design. Certainly, heat levels inside panel can be controlled again with thinning in here. This thinness has advantages as a TV product, but it will also have disadvantages in terms of confidence. Heat characteristic inside the product should be taken with computerized analysis workings and experimental measurements, and these values should be controlled according to material's and product's specs.

Available design can be adapted to new design easily. We make use of earlier panel design experiences acquired from our learning in here. Thinning in television size has been a new trend recently. These changes in television sizes have turned a competition between Vestel rivals such as Samsung and LG. Vestel has to do the adaptations swiftly in production and designing of panels in order to show that it takes part in the competition by increasing the number of production and keep its seat in the market.

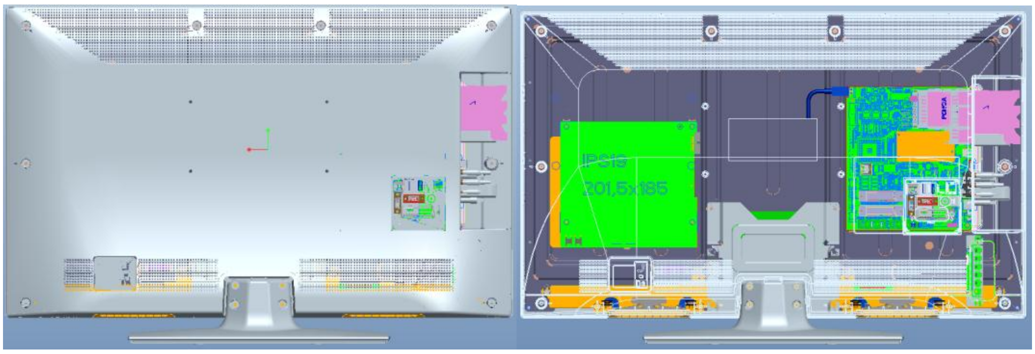

Figure 5.15 Current TV set backview and inner structure design

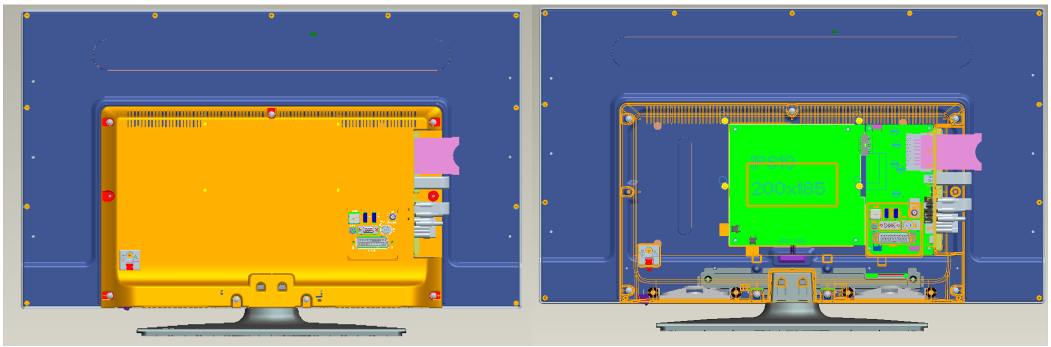

Figure 5.16 New TV set backview and inner structure design

With complete learning of computerized analysis studies, LED panel's heat characteristic has been found out by making the analysis studies of new design. In this section We analysed here both ambient temperature 25 $^{\circ}$C and heat chamfer test concititon 45 $^{\circ}$C.

Table 5.5 Experimental analysis result on bottom single side LED Bar position LED panel according to ambient temperature

Ambient Temp ˚C	**25 ˚C**	**45 ˚C**
Spec.	**LED 72 pcs , 100 mA**	**LED 72 pcs , 100 mA**
Maksimum Temp ˚C	42.4 ˚C	57 ˚C
Maksimum LED PKG Junt.Temp ˚C	65.5 ˚C	81,4 ˚C

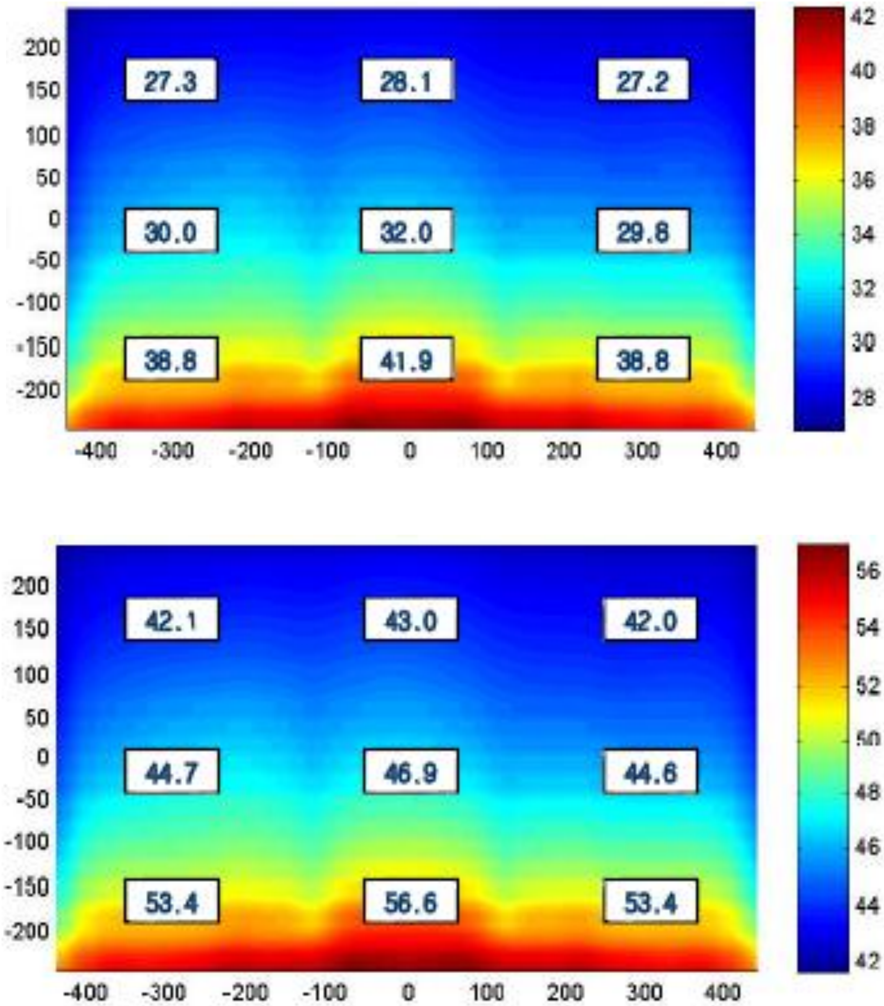

Figure 5.17 Computed analyis result on bottom single sid LED Bar position ambient temperature top figure a) 25 ˚C and bottom figure b) 45 ˚C

Moreover, one more study has done in order to see how the heat in LED panels in ambient temperature can change with current according to earthly current ratings changes in panel power cards.

Table 5.6 Experimental analysis result on bottom single side LED Bar position LED panel according to LED current

LED Current (mA)	100	110	120	130	140	150
Maksimum Temp °C	42.4	43.7	45	46.2	47.5	48.8
Maksimum LED PKG Junc. Temp °C	65.5	69.2	72.8	76.4	80.0	83.6

The studies made up to now is only as LED panel. If we want to make a heat analysis study as Television; initial conditions, heat sources, ventilating slits inside television's back cover and pressure factors in here same as in panel analysis can be logged in.

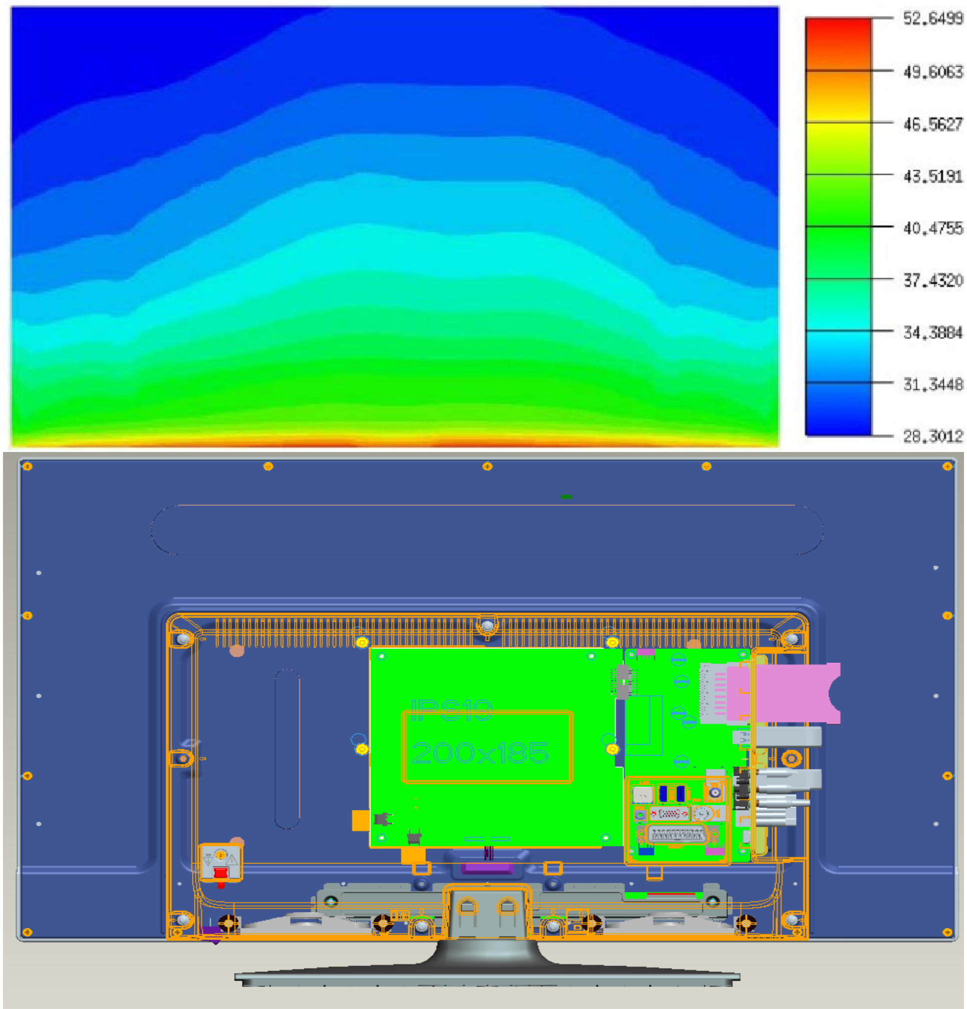

Figure 5.18 Steady state computed temperature distributions TV set on single side LED Bar

Computation each LED current is 0.14 A and each LED voltage is 3.2 V

The total of Heat generated from LEDs = 0.14A x 3.2V x 72 pieces x 0.75 =24.2 W

The total of Heat generated from TV Mainboard = 30W x heating rate

The total of Heat generated from TV Powerboard = 18W x heating rate

The total of Heat generated from TFT Cell IC = 8W x heating rate

According to this, LED chip heat changes and panel's ambient temperature changes is directly proportional with each other regarding with heat rate of cards inside television. If the cards inside television cannot be ventilated properly and if there isn't enough ventilating slits; this will cause increasing of panel's heat and depreciation of panel's life value.

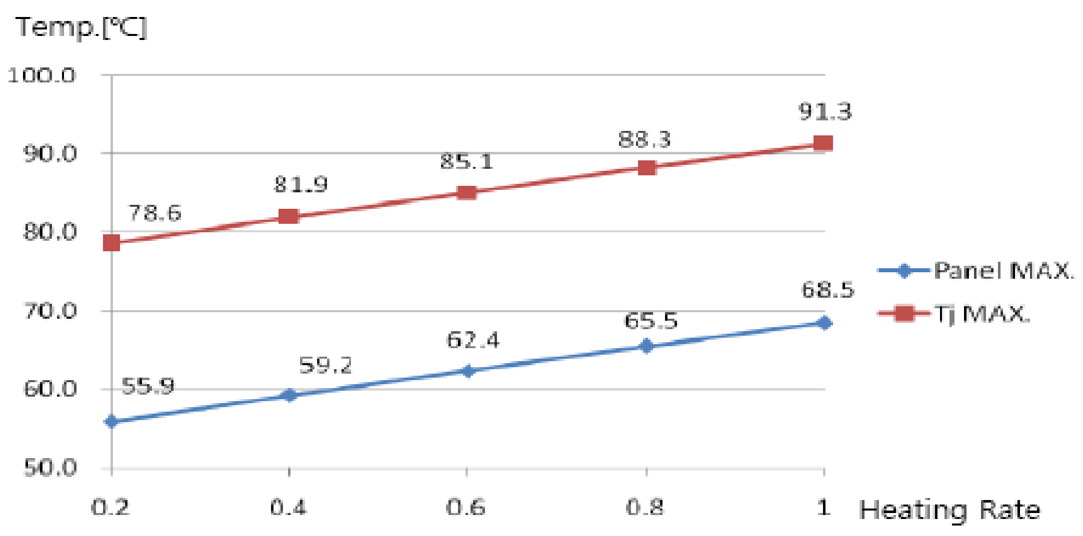

Figure 5.19 Panel and LED juction temperature correleration with heating rate depends on TV board

In this project, there will be a problem in ejaculating of heat different from available TV designs because of thinning design. Back cover, front cover, assembly points, and speaker brackets have to be designed for providing heat transfer in order to overcome this problem. In these areas, air coming from bottom ejaculated from top has been provided by providing air flow at areas where there are cards and ventilating slits. Thus, air circulation is aimed by creating a stack effect from bottom to top. Ventilating slits' pitches ranges and bar study methods will be reviewed with abiding by International Safety criteria. Instruction and channels can be taken into consideration by making various measurements at different parts from panel, with the aim of ejaculating of heat in an easier way.

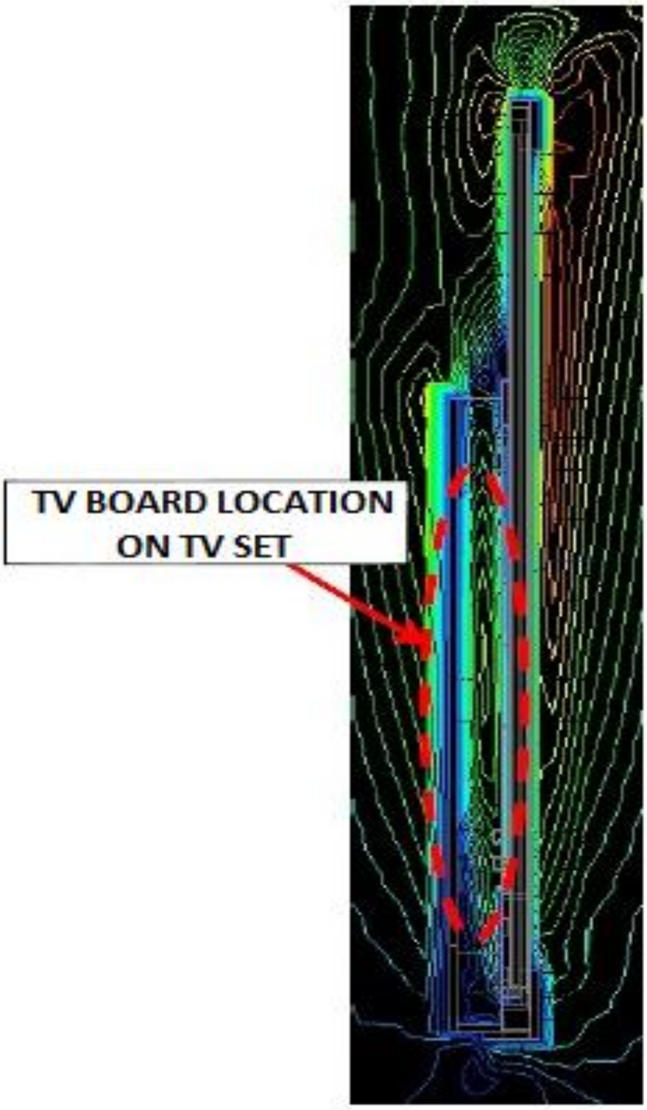

Figure 5.20 Temperature air flow on LED TV set.

We also measured 72 pcs single side LED panel as time dependent with experimental study. Measured results are compared with computerized studies and its accuracy is confirmed.

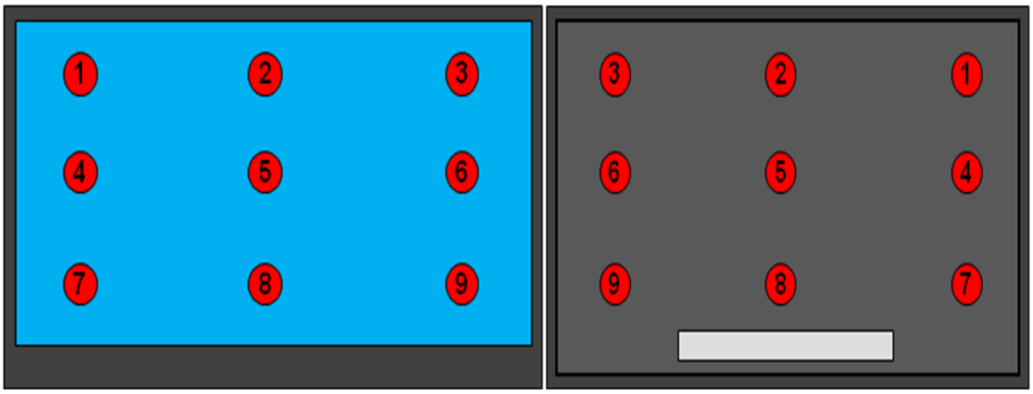

Figure 5.21 Illustration of thermocouple mounting a) Front surface measuring points b) Backsurface measuring points

Table 5.7 Maximum Temperature Of Measuring points on Front and Backsurface of singe side LED Bar TFT LCD panel

PANEL NO	POINTS	FRONT SURFACE ◦C	BACK SURFACE ◦C
PANEL 1	1	31.2	30.7
	2	31.6	31.2
	3	31.7	31.3
	4	32.6	32.2
	5	33.5	33.5
	6	33,2	32.5
	7	41.6	42.8
	8	45.3	44.7
	9	41.7	44.1
PANEL 2	1	31.6	31.1
	2	32.7	31.8
	3	31.7	31.5
	4	33.6	34.6
	5	34.5	35.8
	6	34.8	35.9
	7	42	43.8
	8	45.4	44.3
	9	42.8	45.9

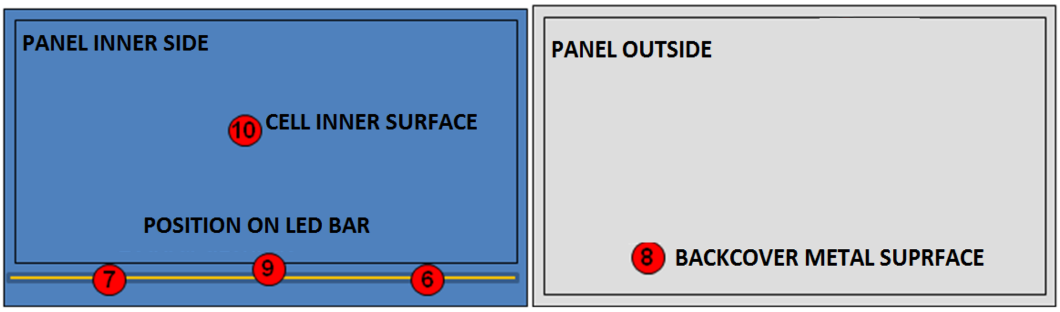

Figure 5.22 Illustration of thermocouple mounting on the single side LED BAR of TFT LCD panel

Table 5.8 Maximum Temperature Of Measuring points on inside of singe side LED Bar TFT LCD panel with time dependent

PANEL NO	POINTS	0-30 min ◦C	0-1 h ◦C	0-2 h ◦C	0-8 h ◦C
PANEL 1	6	51.3	53.1	53.1	51.4
	7	50.9	51.7	52.4	50.5
	8	54.9	56	56.6	54.8
	9	63.2	64.2	64.8	63
	10	31.8	32.2	32.5	31
PANEL 1	6	50.3	51.6	51.9	53.6
	7	50.8	52.1	51.9	52.3
	8	64.6	66	66	68.2
	9	59.5	61	60.9	62.1
	10	31.6	32.6	32.6	33.2

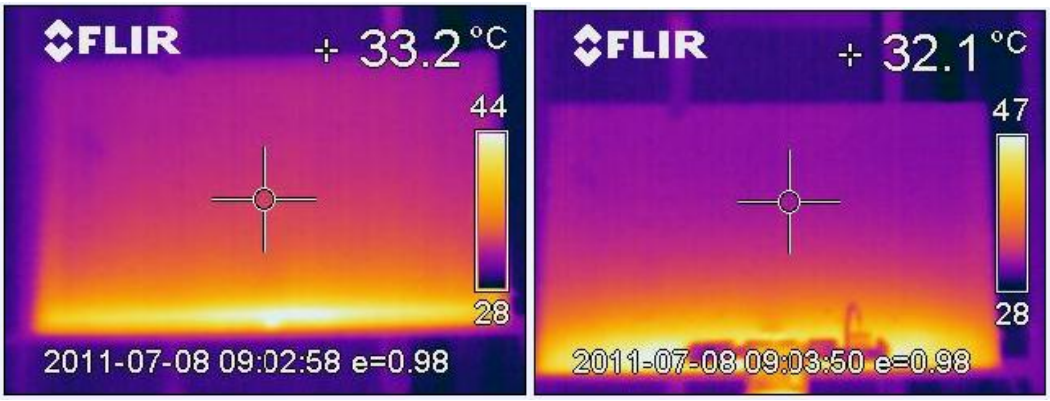

Figure 5.23 Thermal camera image on the singe side LED Bar TFT LCD panel

CHAPTER SIX
CONCLUSION AND FUTURE WORK

In this part heat analysis results in LED panels which is a new product for Vestel will be evaluated, design betterment studies acquired from begining will be reflected to the final LED panel mechanical design. And so, panel design whose total part costs are suitable by not using an extra component for heat dissipation and solving the heat problem in Vestel specs will be financed.

Parts whose bars are completed according to designs , their test production has been occured. According to this, product to be produced before serial production in production bands has been tested by relevant parts. Product which is undertaken panel's thermal and mechanical tests is introduced as a mechanical design team. The product is confirmed by the teams being responsible for production bands, it is made ready to serial production after customer confirmation for orders.

In this study, acquired technical information and learnings are subtracted for using next panel design. Technical informations are kept in written and recorded as research and development department. The data here will be reference for other projects. Moreover, information transfer is provided between technical team and other groups with regular informing meetings presentations. Transfering of these information periodically to other departments inside firm has been aimed. Within this scope, Vestel will use such systems having data management platforms as Wiki, Vestel Portal, Tracker, Clear Quest.

As it is known, television technology in our time has turned at very big scale from tube structure into liquid crystal display panel structure. This transformation is occurred faster than it is expected and new technology's productivity, if it is environment friendly or not and weak sides in regard to previous technology aren't taken into consideration. Light source used in available liquid crystal display panels is fluorescent; it hasn't given extensive and saturated white light.

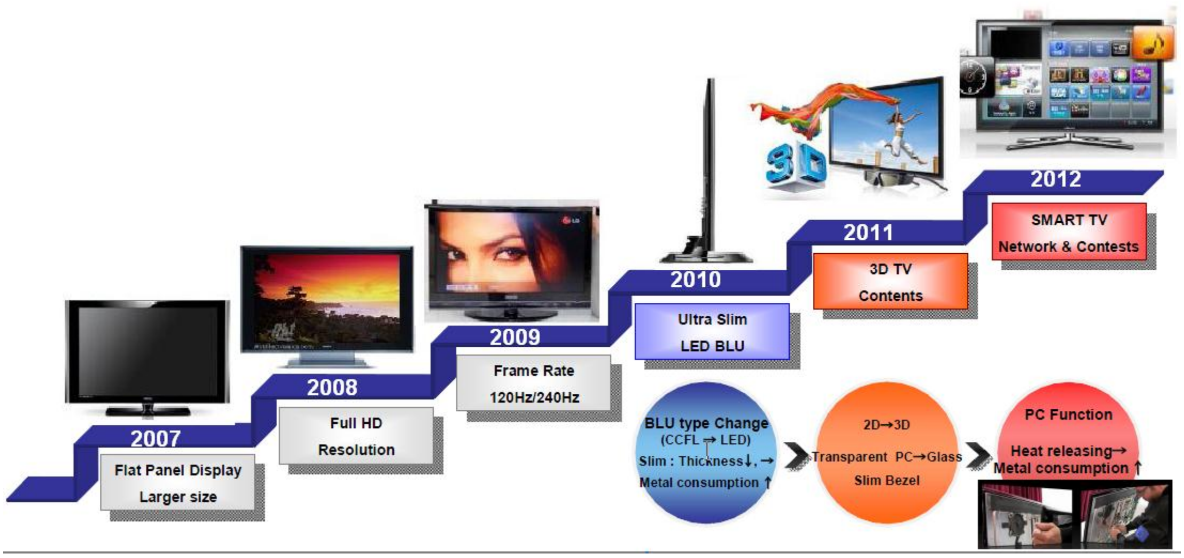

Figure 6.1 The rapid development in LCD TV from 2007 till 2012

Moreover, LED is a more successful technology in terms of colour saturation. Beside this, as CCFL includes mercury, it is a threat in terms of enviromental health. Spent energy and acquired image performance in using television has been a frequently questioned condition in terms of productivity. In this thesis, it is thougt to be an advantage to produce new generation LED panels.

With LED panel being this project's output in the market, we think to increasing marketshare with LED TVs and competitive product in addition to conventional LCD TVs. Vestel has aimed at being one of the firstly firms getting into the market with this competitive product including innovation. This project's technical added-value ; this project accelerates the passing to such technologies as organic LED and Field Emission Light at LCD panel's back light technology with acquired experience, project's output is LCD panels which are productized incrementally will gain a place at the market.

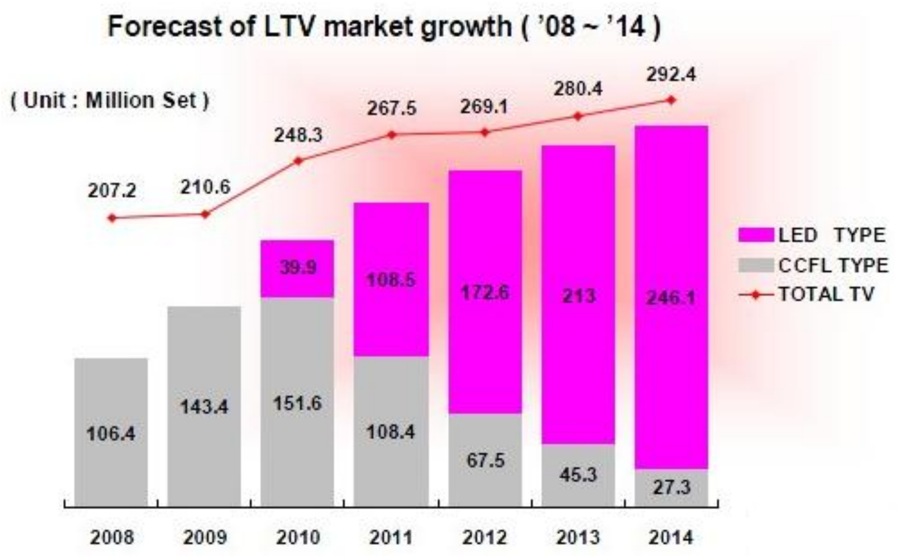

Figure 6.2 The forecast of LCD TV market growth between 2008-14.

Thinner designs are features shined out at rapidly changing customer's electronic's trend. This project is carried out in this direction by providing customer's expectations. Television using Vestel LED panel has taken its place among top segment products in the market with its unique design and 13mm thickness. Vestel is a plus value which catches the trend of thinness in general panel size at sector as providing thinner product with LED panel.

Figure 6.3 The final product designed after this work.

Exorbitant sum prices are demanded for panel design in case of panel's designing at abroad normally. Technological addiction has become in terms of design and production because technical and mechanical specs of foreign panels are different and limited. Cost advantage, design and production flexibility is provided with the help of this project by decreasing this addiction.

As panel design and production has been carried out totally within Vestel with this project, exporting of national capital has been prevented. The production costs were reduced by 7.5$ per module and 10$ per television by eliminating some components in mechanic, optic and electronic parts.

As panel production is occurred within Vestel, this will increase our present market share mostly and accelerate our competitive power. In respect of being included market conditions, transition period has been existed. New generation which will be worked for all sizes has the characteristic of foundation for thinner televisions.

This product having a domestic and foreign market goal is a commercial product. It is a product design to protect available market share from the point of TV market; a new market segment is aimed with especially panel production and panel sale. This product has competed with companies such as Samsung, LG, Panasonic and Sony at domestic market and so increasing of Vestel's domestic market share and national competitive power are aimed.

The most important cost item of TVs is panel (Total cost is 60 %.). If TV producers provide panel from abroad, it can decrease the chance of rivalry. Companies' producing their own panel at consumer electronics sector is very few. Companies which can produce panel have increased their competitive advantage against other companies day by day. Companies which are addicted to abroad in respect of panel have withdrawn from television manufacturing sector nowadays such as ; Philips, Profilo, JVC. The cost of panel will be reduced to at the rate of 20% with this project and maintaining of commercial activities will be provided on behalf of Vestel.

By having the image of not only designing of TV but also designing of panel, Vestel provides a competitive advantage from the point of flexibility and speed along with lowering the cost.

This project’s output is the most important research and development study in the way of producing Vestel’s own panel. Because of difficulty in designing project and in view of the target of unique panel production, research and development staffs that are brought up about mechanical design will be needed. In consequence of this project, a new engineering field is opened in the meaning of research and development. Information learned from here will be used for next projects with a success of this project.

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