



FloTHERM and T3Ster calibration on touch panel application

EPS Thermal Dept.
10 Nov 2017

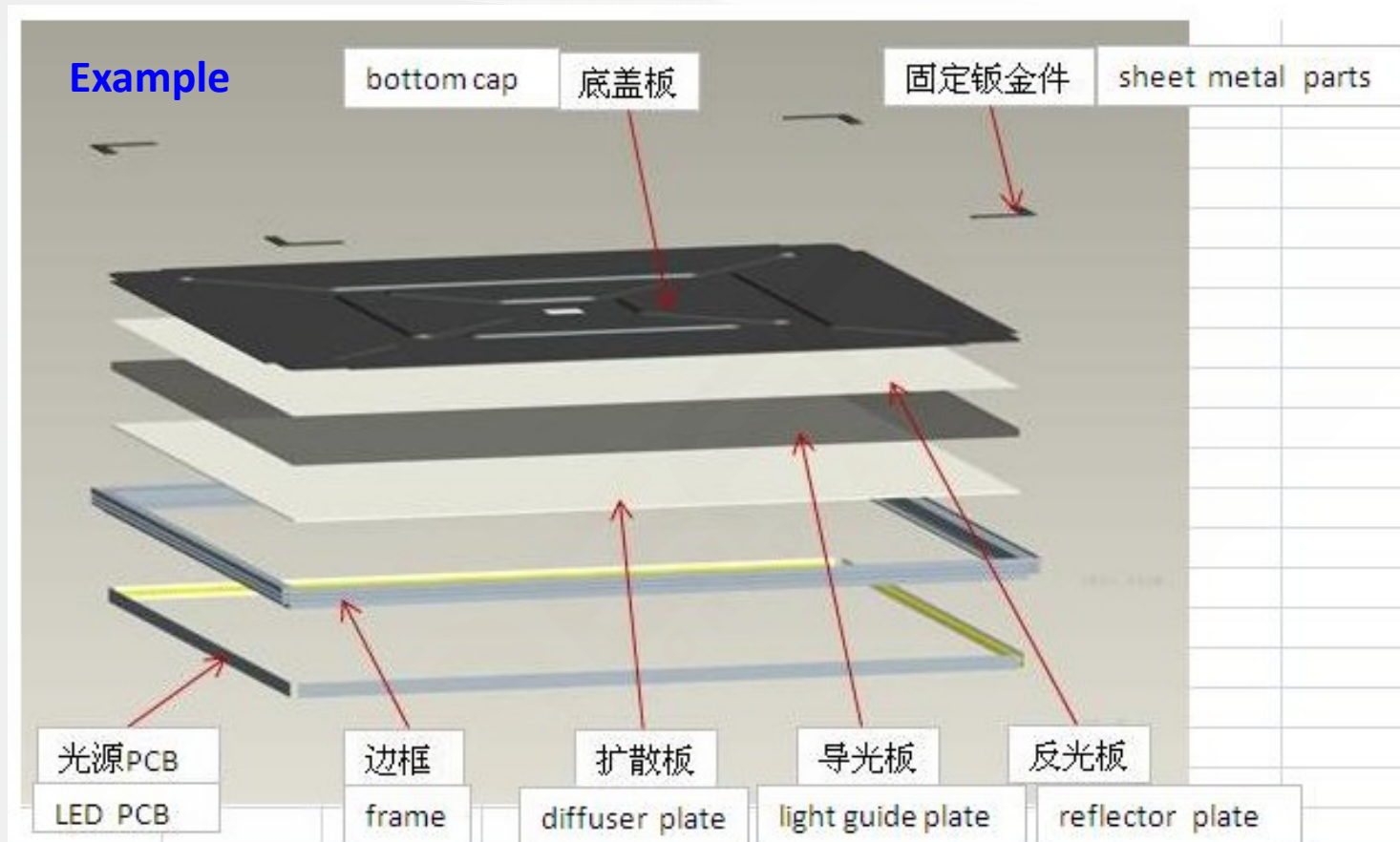
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- Objective/Assumption
- Panel structure/detail model
- Introduction of MicReD T3Ster
- Simulation with T3Ster 7.0" panel model
- Application on tablet
- Simulation with T3Ster 10.4" panel model
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- Appendix

Objective / Assumption

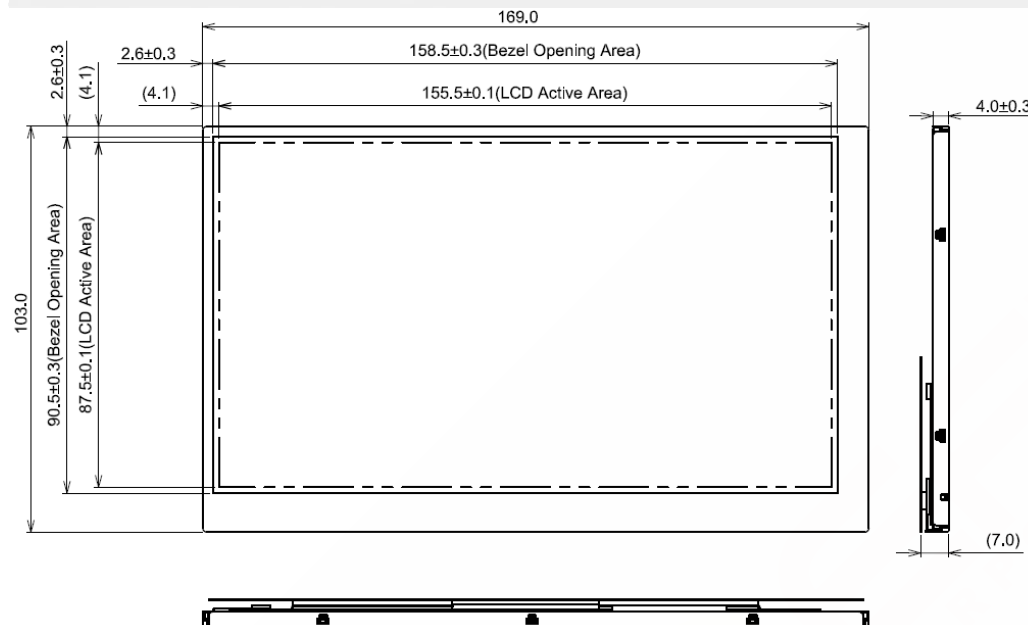
- To find an efficient panel building for simulation reference.
- We apply MicReD T3Ster to measure transient thermal resistance on the panel. And T3Ster export the structure function as a Flotherm xCTM model and compare with the real test.
- Simulation environmental setup is as below:
 1. CFD Software : FloTHERM 11.3 update1
 2. It refers to the real sample mechanism for model construction.
 3. Power on PCB is assumed and total is 0.53W.
 4. Back-light power is even and dissipated on 44(16+28)LED lights; Total power is 2.90W.
 5. Ambient temperature is set to 25/40 degree Celsius.
 6. Radiation effect is considered.

Panel structure



Panel is a complex object and consist of by many different layers of unknown material. It is very hard to build up a detail model closed to a real one. So we try to make it simple but also authentic.

7.0" Panel specification



3. GENERAL DATA

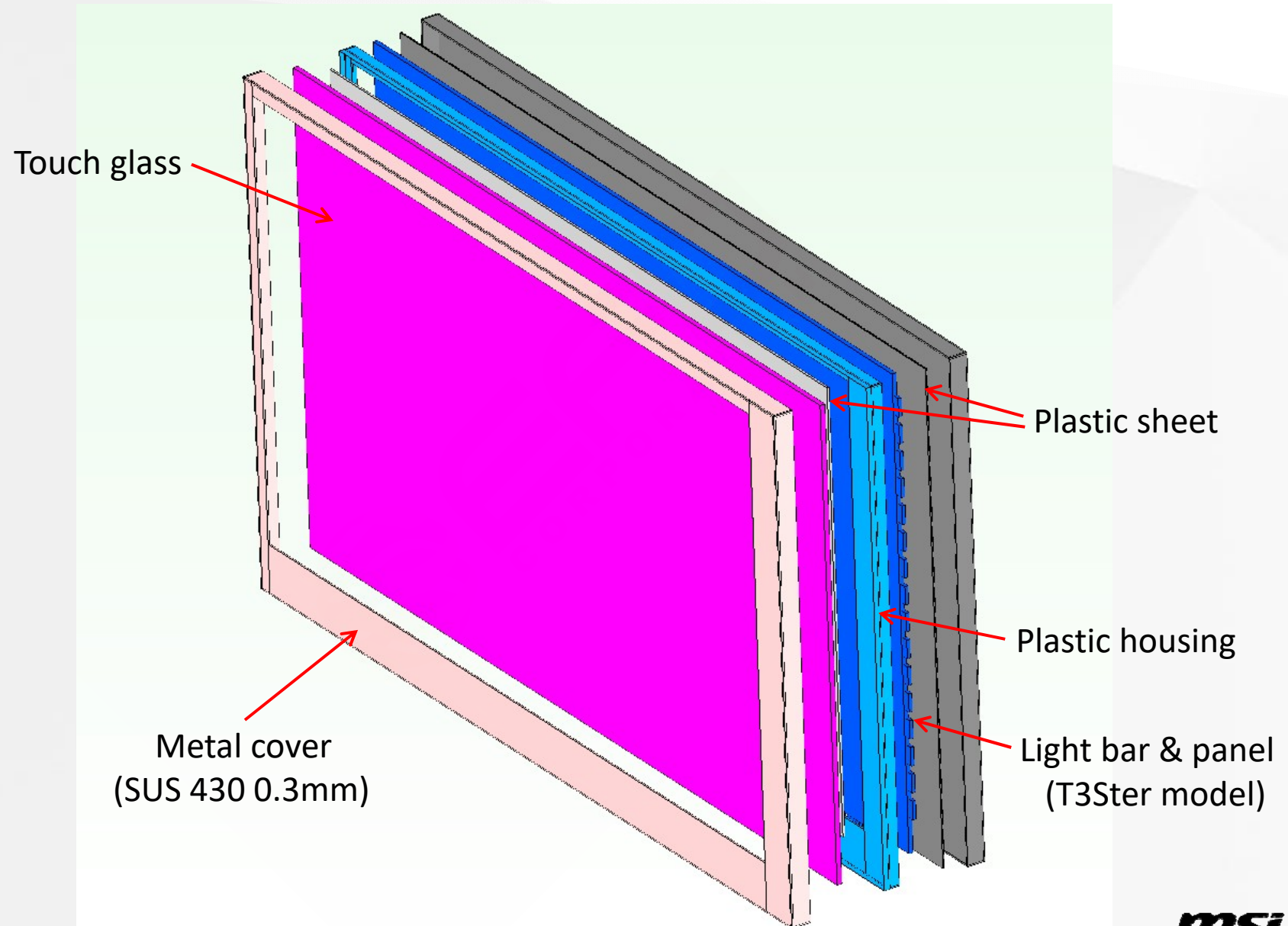
3.1 DISPLAY FEATURES

This module is a 7" FHD of 16:9 format amorphous silicon TFT. The pixel format is vertical stripe and sub pixels are arranged as R (red), G (green), B (blue) sequentially. This display is RoHS compliant, COG (chip on glass) technology and LED backlight are applied on this display.

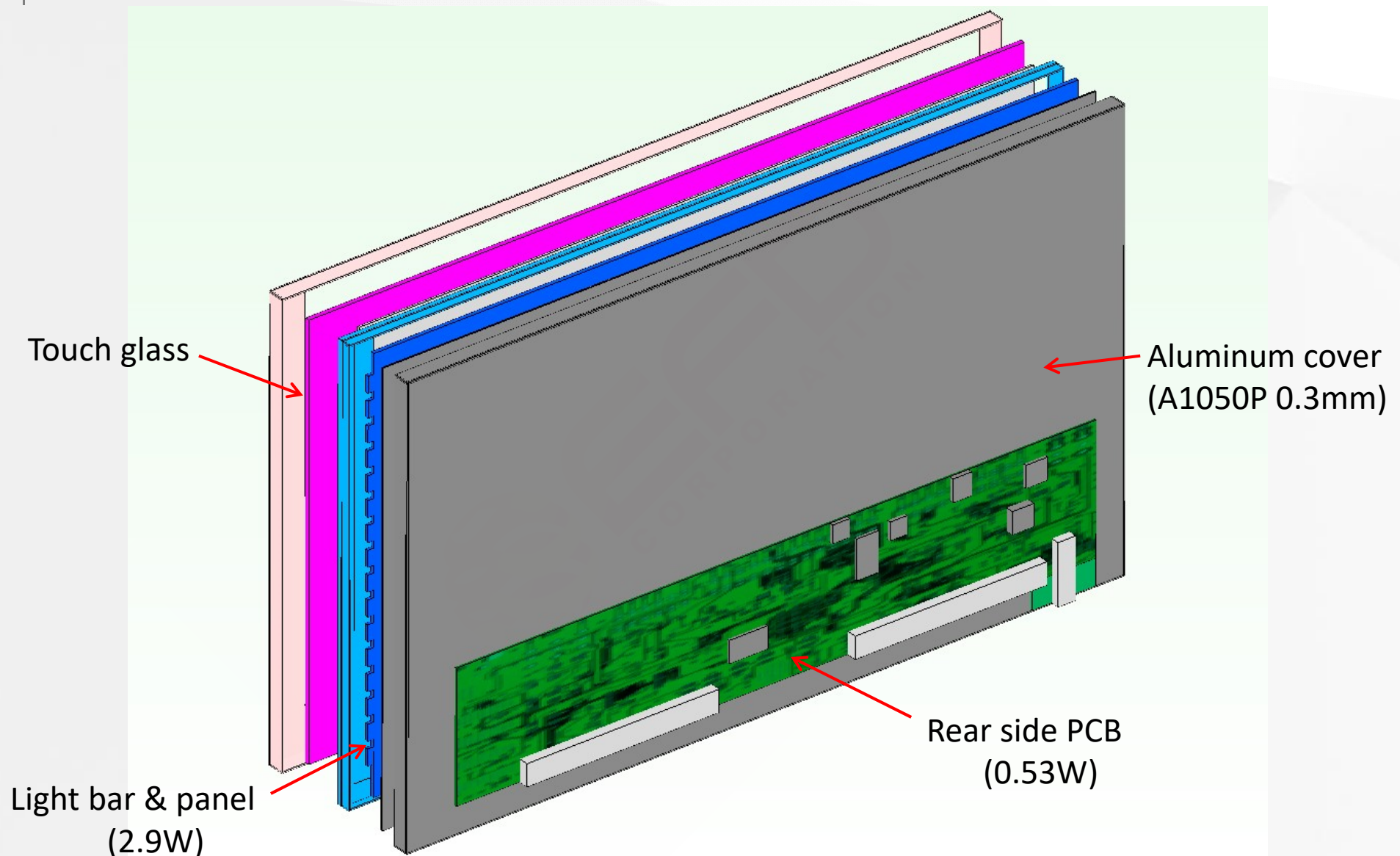
Part Name	TX18D204V/M0BAA
Module Dimensions	169.0(W) mm x 103.0(H) mm x 4.0 (D) mm (Except PCB area)
LCD Active Area	155.52(W) mm x 87.48(H) mm
Pixel Pitch	0.081(W) mm x 0.081 (H) mm
Resolution	1920 x 3(RGB)(W) x 1080(H) Dots
Color Pixel Arrangement	R, G, B Vertical Stripe
LCD Type	Transmissive Color TFT; Normally Black
Display Type	Active Matrix
Number of Colors	16.7M Colors
Backlight	Light Emitting Diode (LED)
Weight	110 g
Interface	LVDS; 20 pins
Power Supply Voltage	3.3V for LCD; 12V for Backlight
Power Consumption	0.53W for LCD; 2.9W for Backlight
Viewing Direction	Super Wide Version (In-Plane Switching)

We set the max power(2.9W) of backlight for panel model

Panel detail model (front)



Panel detail model (rear)



Introduction of MicReD T3Ster

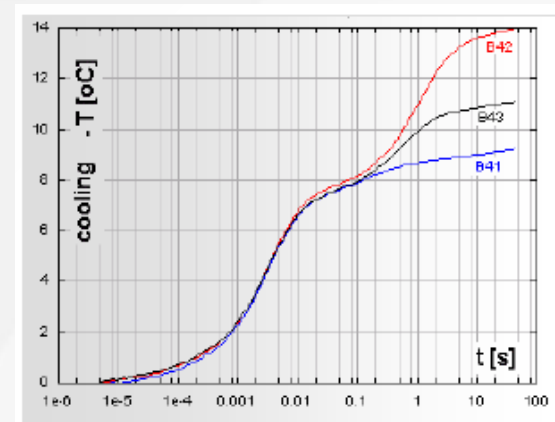
- MicReD® (Microelectronics Research and Development) 最初是由布達佩斯技術與經濟大學 (BME) 電子元件研究於1997年所創立，此團隊並於2000年藉由歐盟的專利開發出**T3Ster (Thermal Transient Test)**暫態熱阻量測儀，專門針對現行半導體元件以及發光二極體(LED)進行熱特性測試，並在該年正式對外發表完全符合國際標準熱阻側是規範JEDEC之測試平台。

-- 電性量測法(Electrical test method, ETM):

利用二極體(Diode)本身順向電壓(forward voltage)隨溫度規律變化之特性。量測電壓變化後可準確計算出溫度差。真正求得晶片之接面溫度(**Junction temperature**)變化。

-- 符合國際JEDEC 量測規範：

量測原理採**JESD51-1**規範之電性量測法。透過JEDEC JESD 51-14規範之異質熱介質暫態量測法(Transient Dual Interface Method, TDIM)，測得封裝整體熱阻。



T3Ster TSP Calibration

- 透過校正先求得溫度敏感參數(Temperature Sensitive Parameter, TSP)
溫度變化 = 順向電壓變化* K因子
- 暫態溫度變化量測，公式如下：

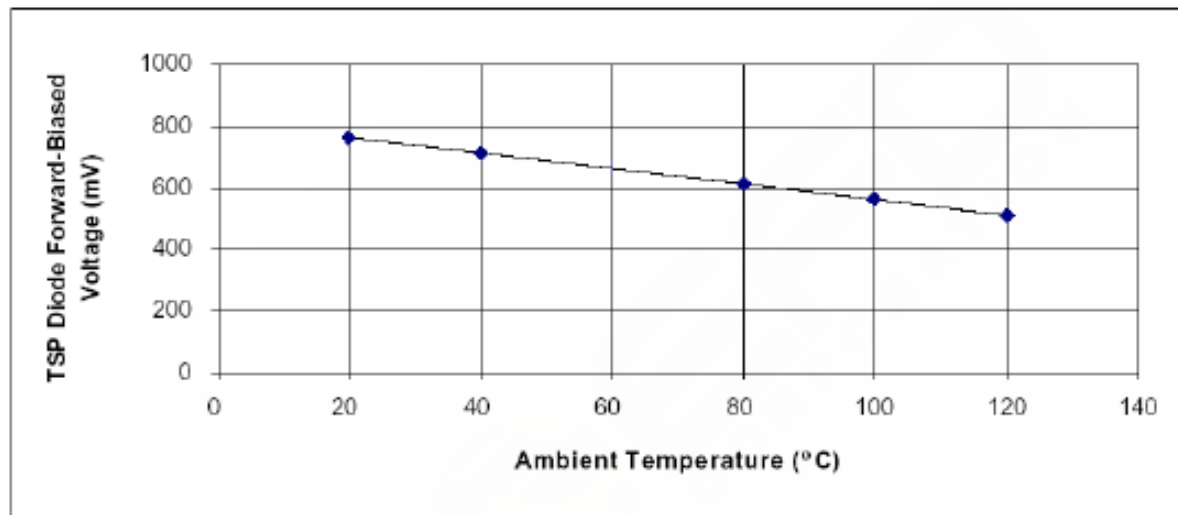


Figure 11. Typical $V_F - T_A$ curve for temperature-sensing diode forward biased with I_M .

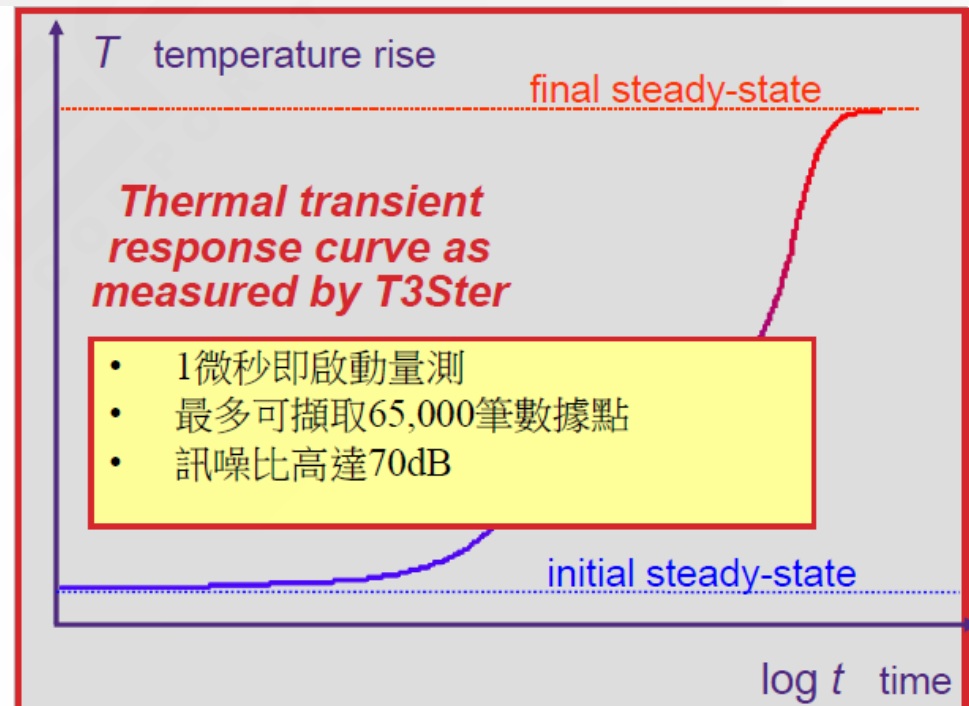
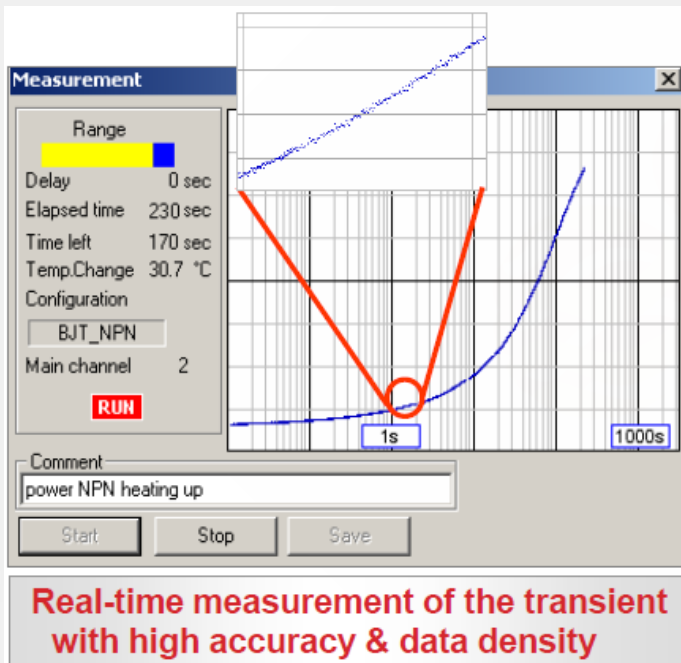
$$K = \frac{(T_{Hi} - T_{Lo})}{(V_{Hi} - V_{Lo})}$$

$$\Delta T = \Delta V_F \cdot K$$

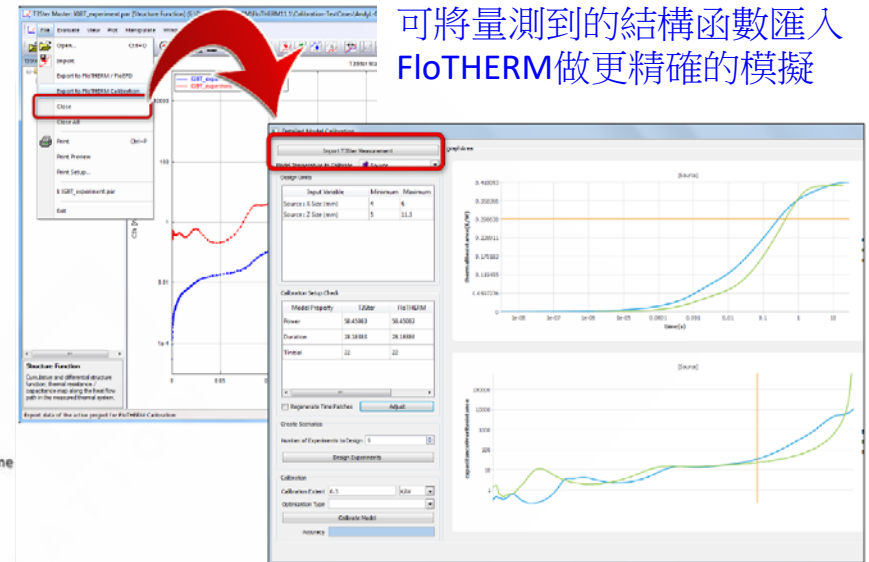
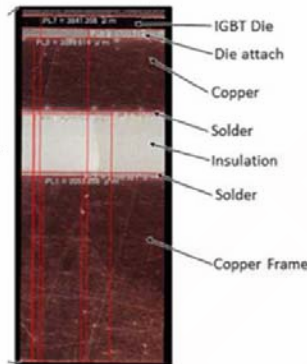
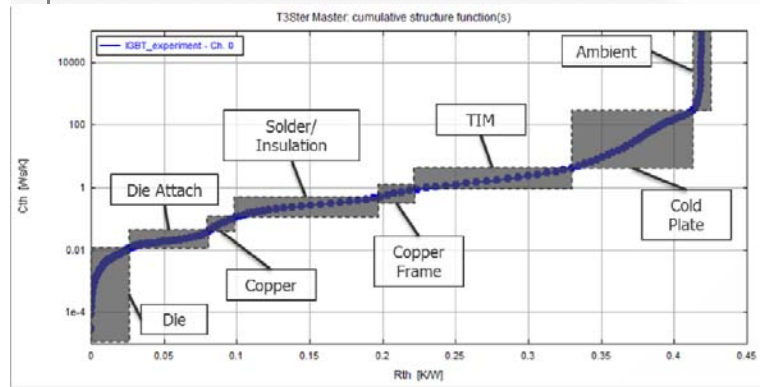
where T_{Hi} & T_{Lo} = High & Low temperatures [°C]
 V_{Hi} & V_{Lo} = corresponding High & Low TSP voltages [mV]

T3Ster 暫態溫度變化量測

- 改變待測元件輸入功率，元件溫度隨之改變：
 - 先輸入LED操作電流(大電流，大功率)，待元件本身溫度與溫控環境達到平衡。此為**初始穩定狀態(initial steady state)**
 - 切換成量測電流(小電流，小功率)，元件降溫，待元件與溫控環境達到平衡。此為**最終穩定狀態(final steady state)**
 - 切換為小電流之瞬間即啟動量測，並即時量測兩個穩定狀態間之溫度暫態變化。



T3Ster 結構函數



可將量測到的結構函數匯入 FloTHERM 做更精確的模擬

- 結構函數：
可藉由結構函數分析待測元件各層熱阻與熱容值。
- 接面溫度變化曲線 T_j variation：
可得到實際接面溫度。
- 暫態熱阻函數圖 (Z_{th})：
熱阻對應時間之圖形，JESD 51-14 量測規範。
- Pulse 熱阻函數圖
可得到不同 **duty cycle** 下之元件熱阻特性。

Benchmark with T3Ster



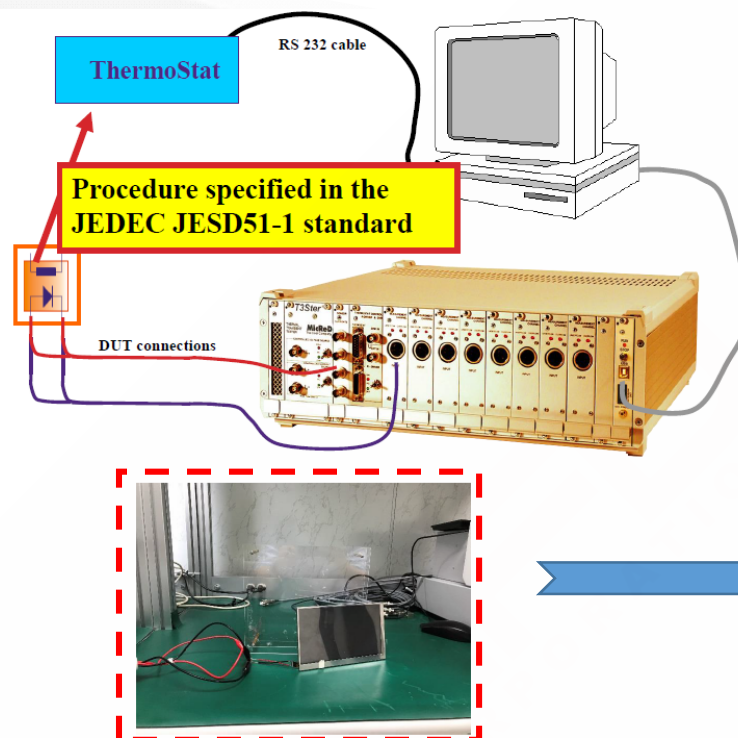
T3Ster主機



150V/10A Booster



Thermostat 溫控模組



Vertical measurement

- This Benchmark is to measure the $R_{th}(ja)$
- DUT is in air environment and do the measurement
- Measurement Parameter as bellow:

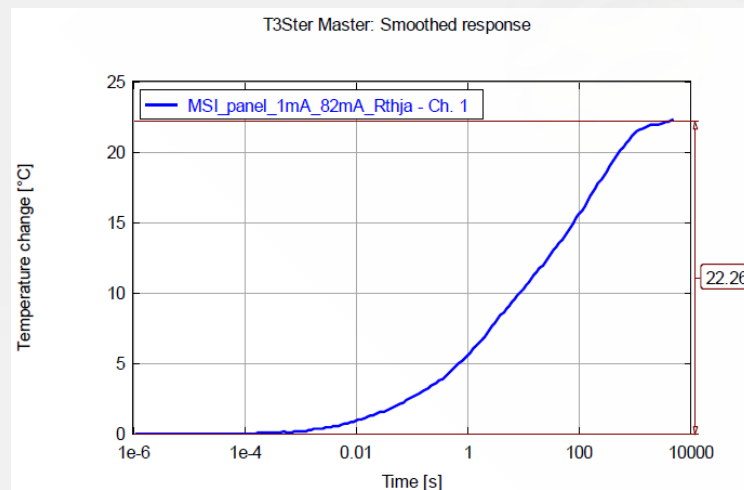
Set Parameter	MSI Panel
I_m	1 mA
I_d	82mA
Ambient Temp.	25 °C (按照當日空調預設)

T3Ster Measurement result

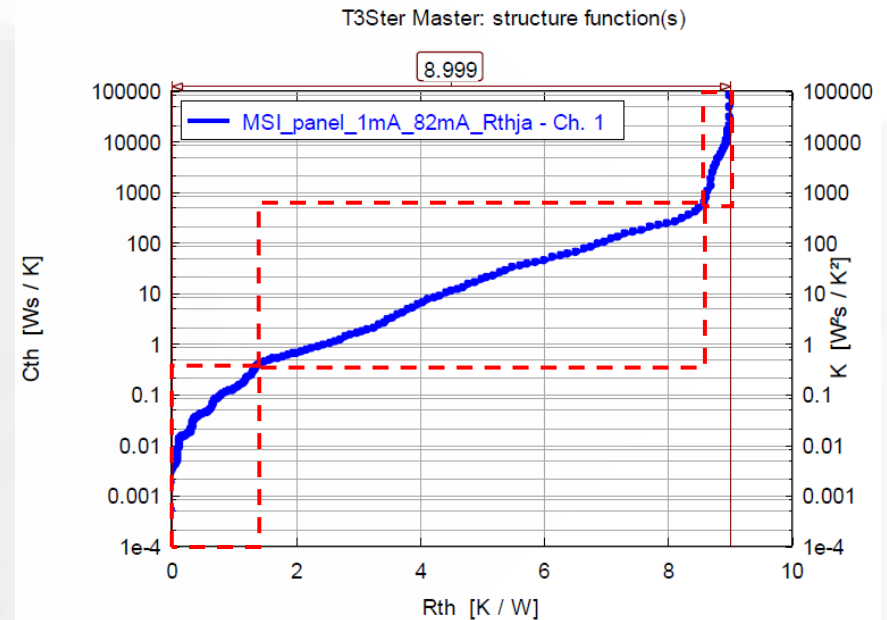
TSP calibration

DUT	MSI PANEL	
Item	T (°C)	Vf (V)
T1	20	28.3
T2	40	28.1
T3	60	27.6
T4		
Remark	10 mA	
Sensitivity (mV/K)	17.5	

T_j(variation) of MSI Panel@25°C is 22.26°C
 T_j = T_j(variation) + T(ref.) = 22.26 + 25 = 47.26°C



Structure Function

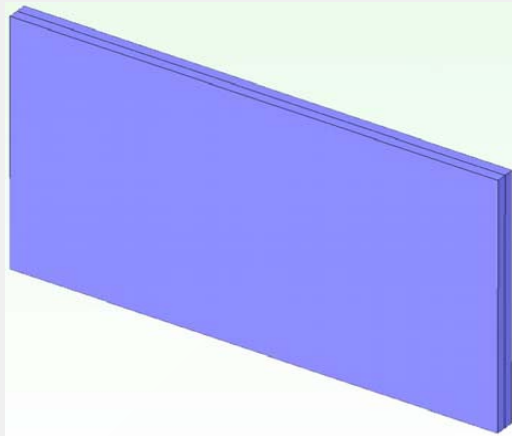


Test result

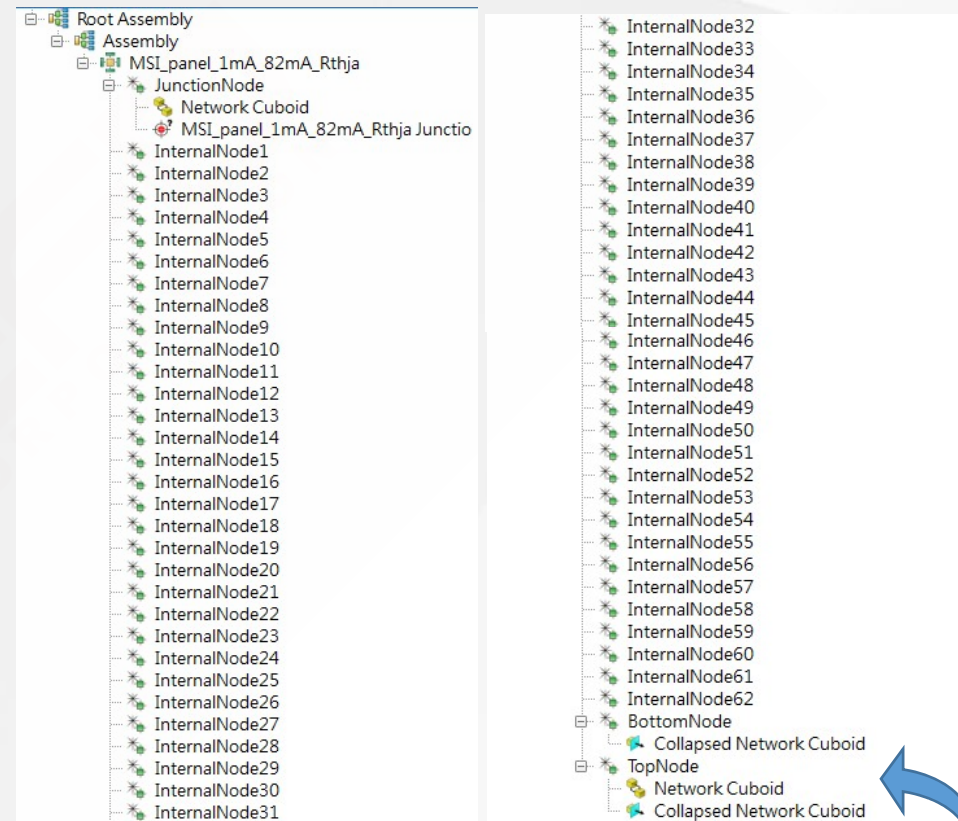
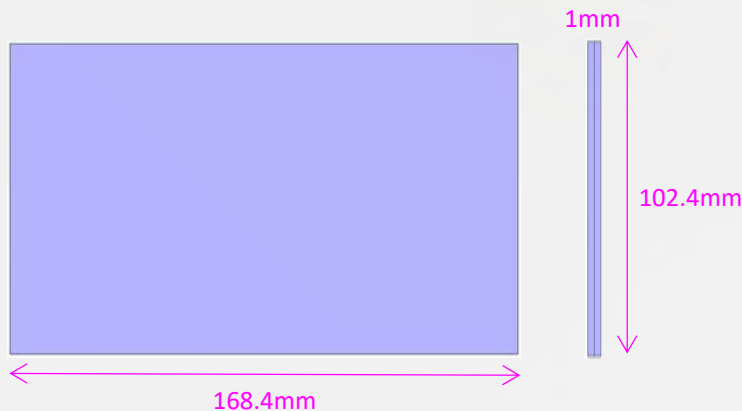
Item	MSI Panel
TSP(溫度敏感參數) mv/K	17.5
Delta T _j (度)	22.26
T _j (度)	47.26
Rthja (K/W)	8.999

Simulation with T3Ster 7.0" panel model

- We cut off the structure function besides panel and back-light to export the xCTM file as Flotherm compact model.



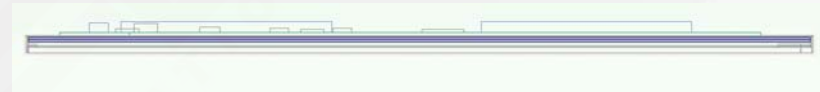
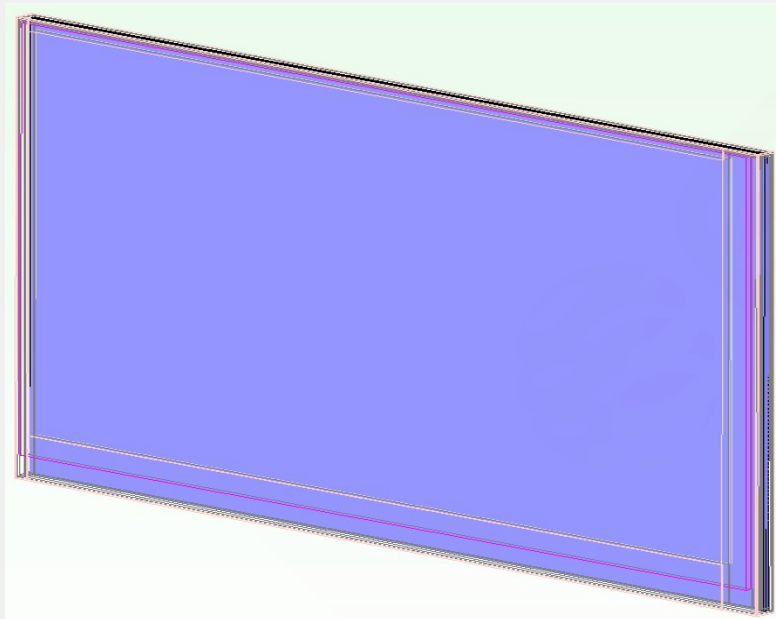
Total power : 2.90W



The 7.0" compact model consists of two main cuboids and 62 InternalNodes

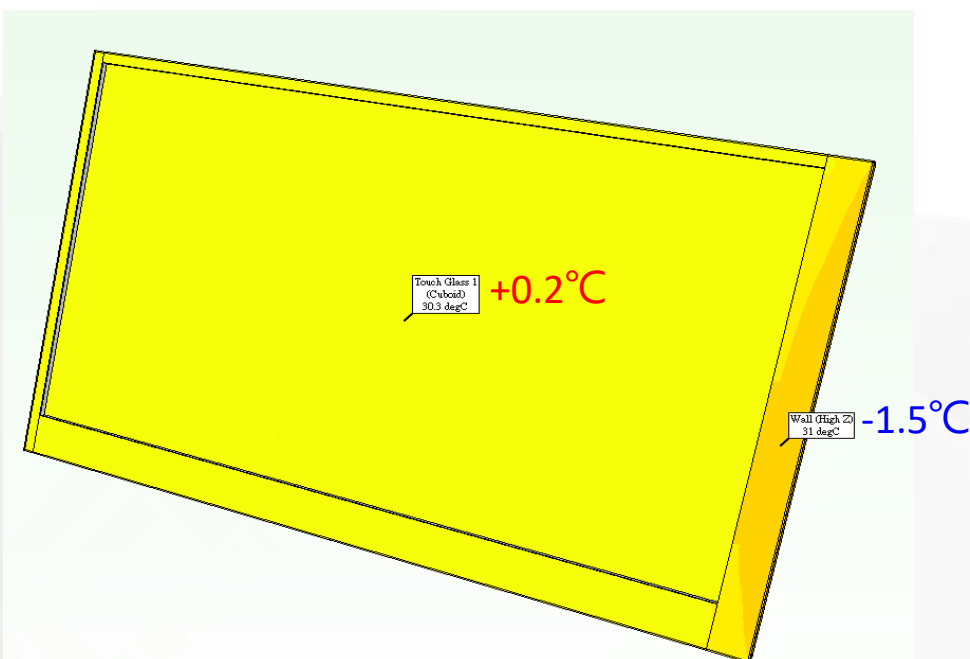
7.0" detail panel model

- Then we import the compact model to replace the panel and back-light in the detail model.



Panel Temperature Profile (front)

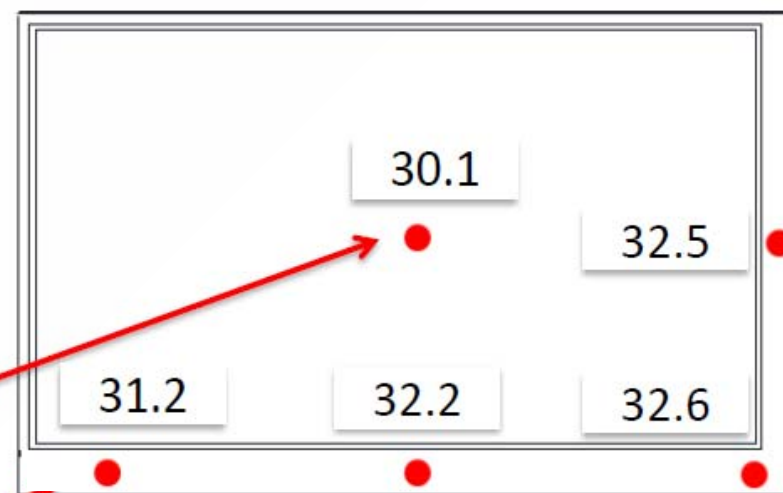
There is only $\leq 1.5^{\circ}\text{C}$ difference between the T3Ster model and real panel temperature.



◆ Operation condition:

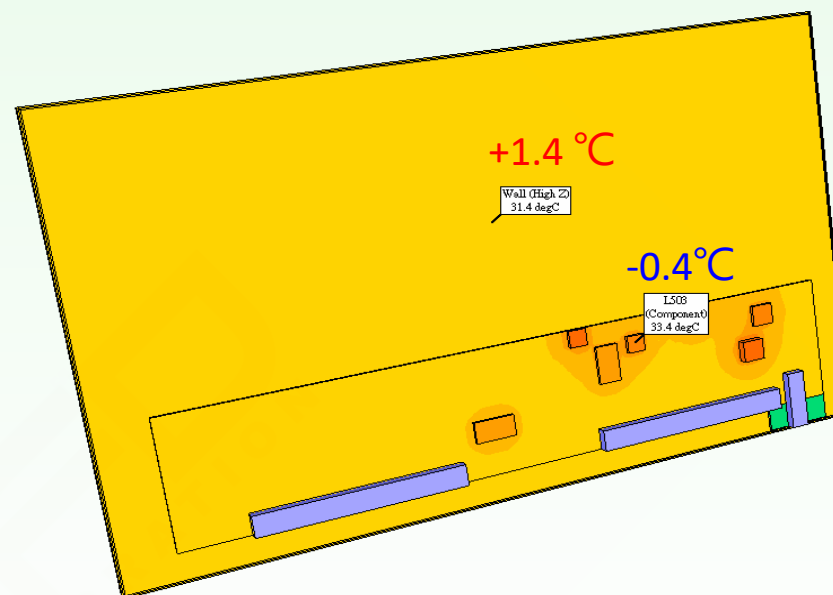
- ◆ TX18D204VM0BAA
- ◆ 25 degrees @30 mins
- ◆ 12V @242mA
- ◆ Measured the specific position by DA130 YOKOHAMA

Center point of LCD

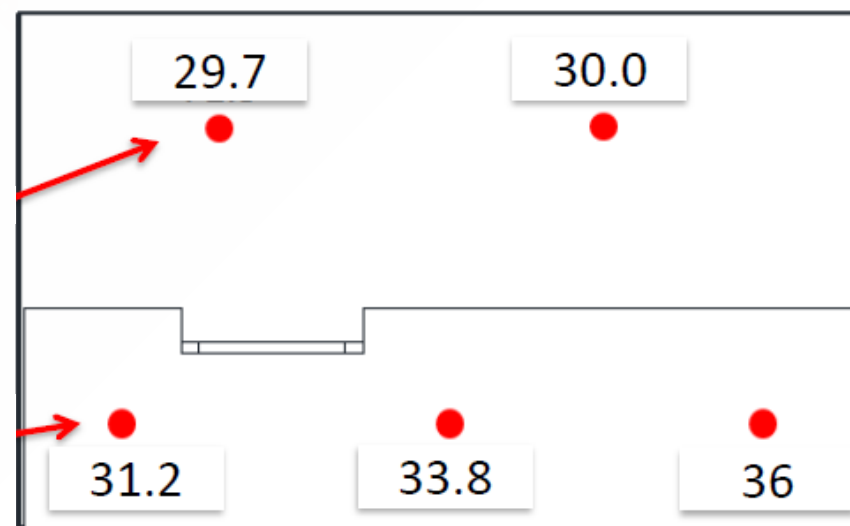


Panel Temperature Profile (rear)

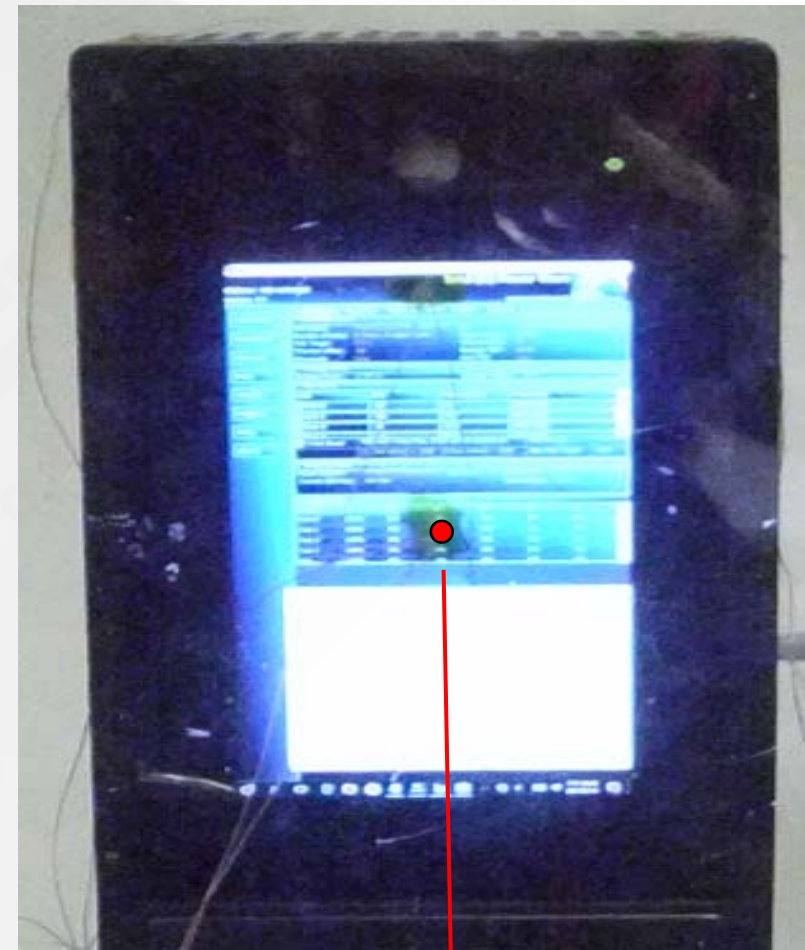
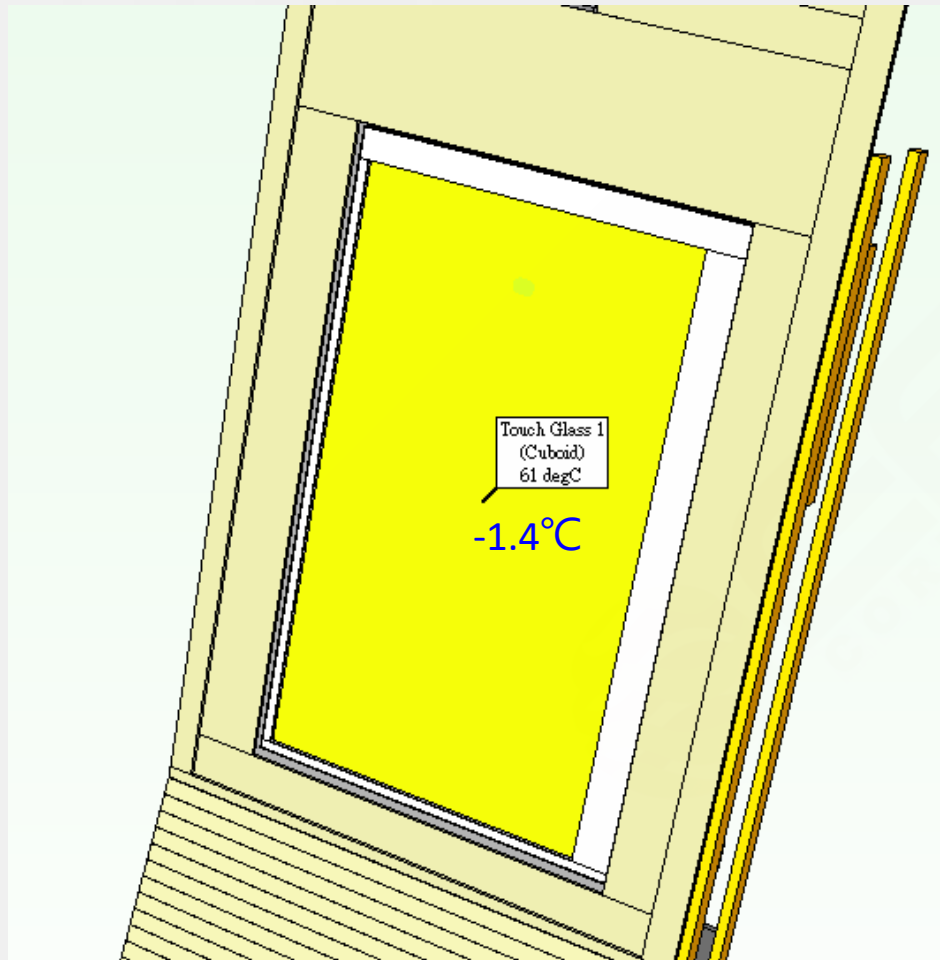
And the rear side is also $\leq 1.5^{\circ}\text{C}$ difference between the T3Ster model and real panel temperature.



- ◆ Operation condition:
 - ◆ TX18D204VM0BAA
 - ◆ 25 degrees @30 mins
 - ◆ 12V @242mA
 - ◆ Measured the specific position by DA130 YOKOHAMA

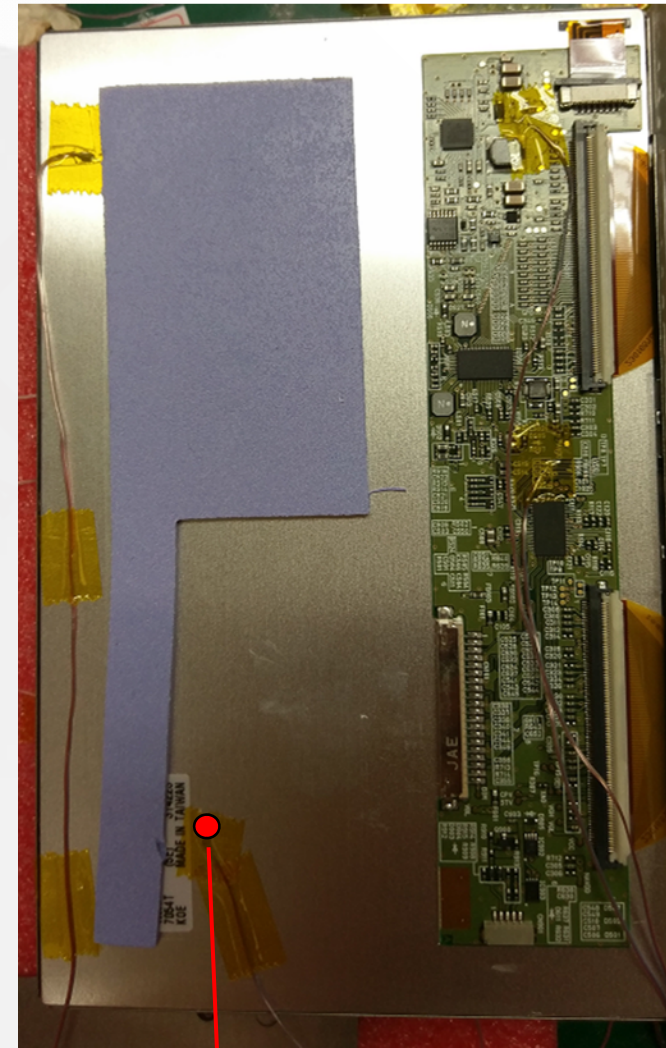
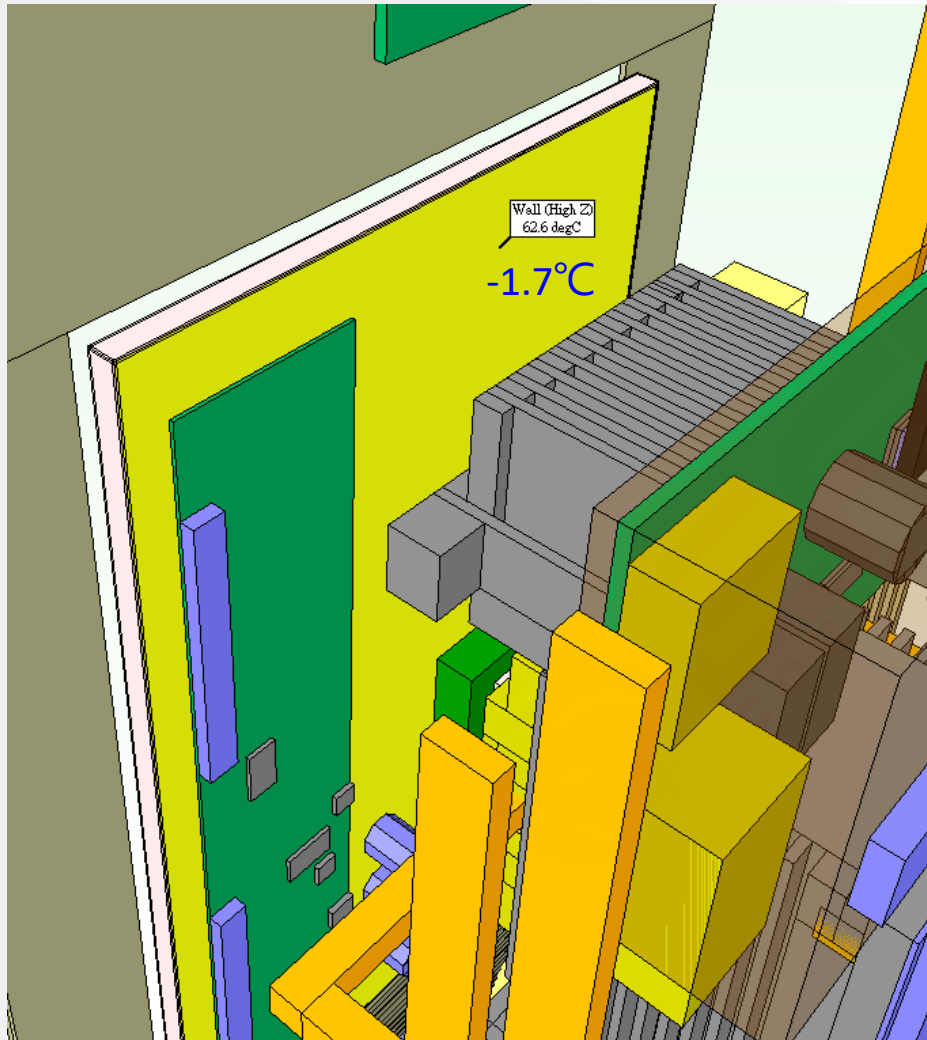


LCD model for total system simulation (front)



Testing data
= 62.8C

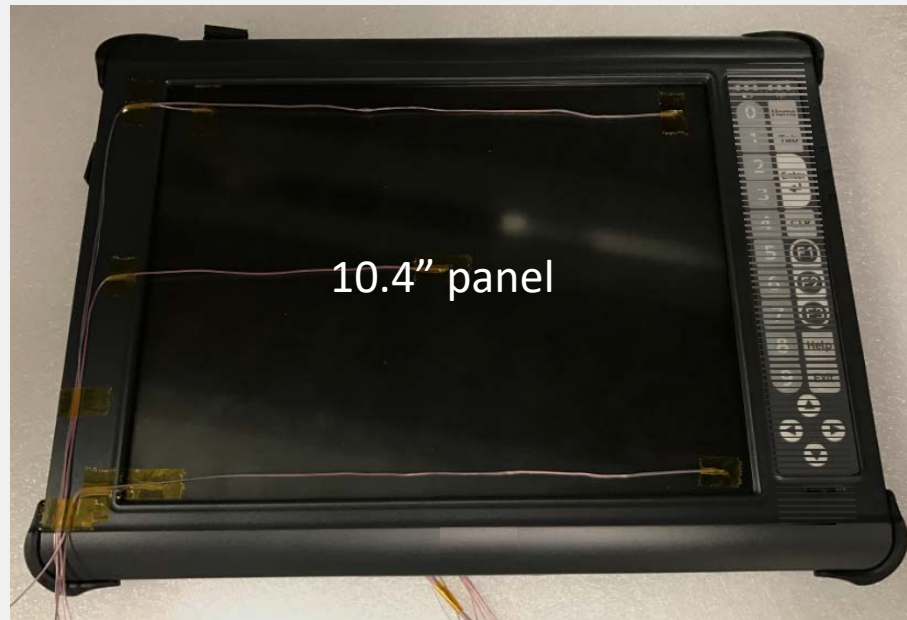
LCD model for total system simulation (rear)



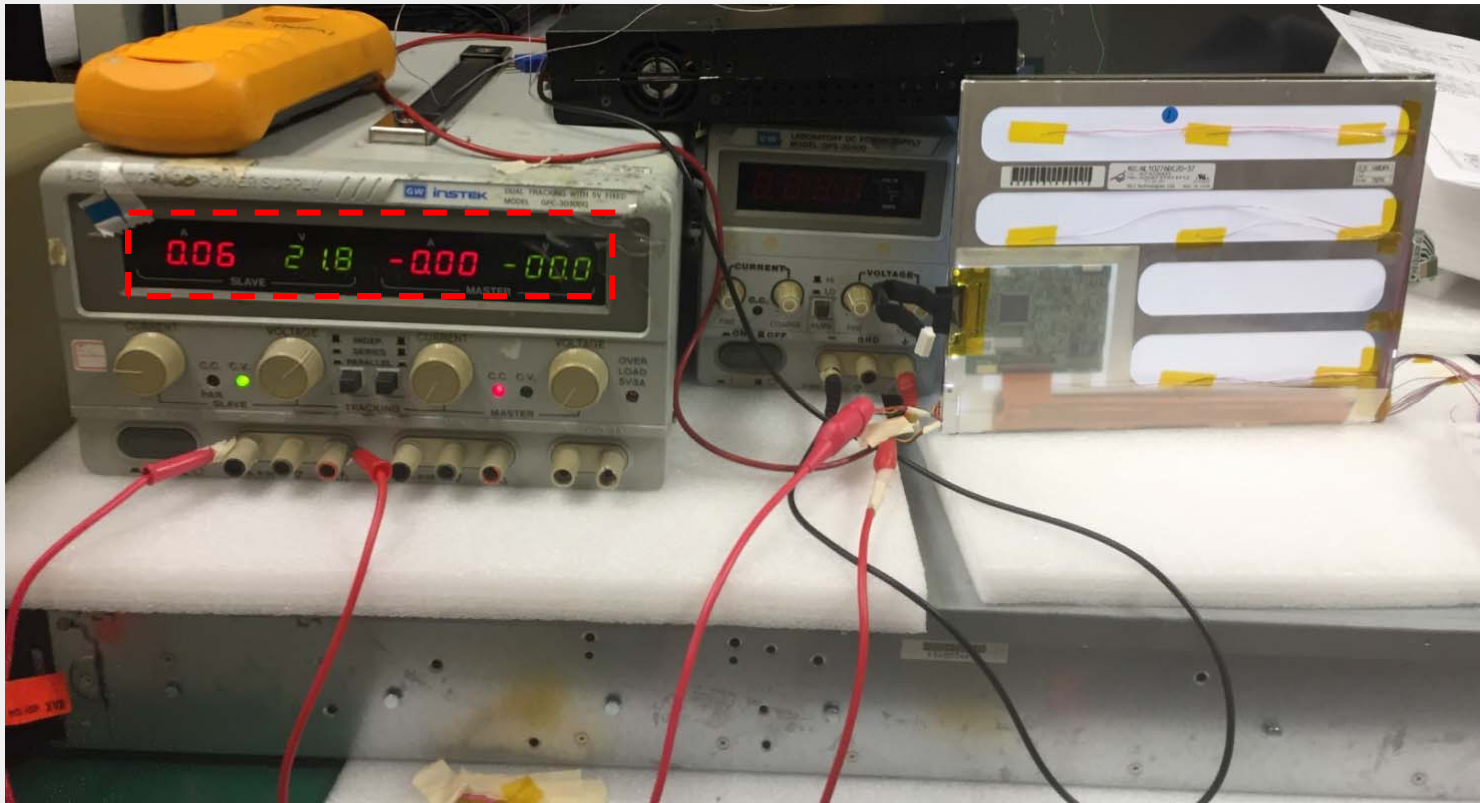
Testing data = 64.3C

Application on tablet

- We will verify another system(Tablet) to compare the temperature between the real test and the T3Ster model.

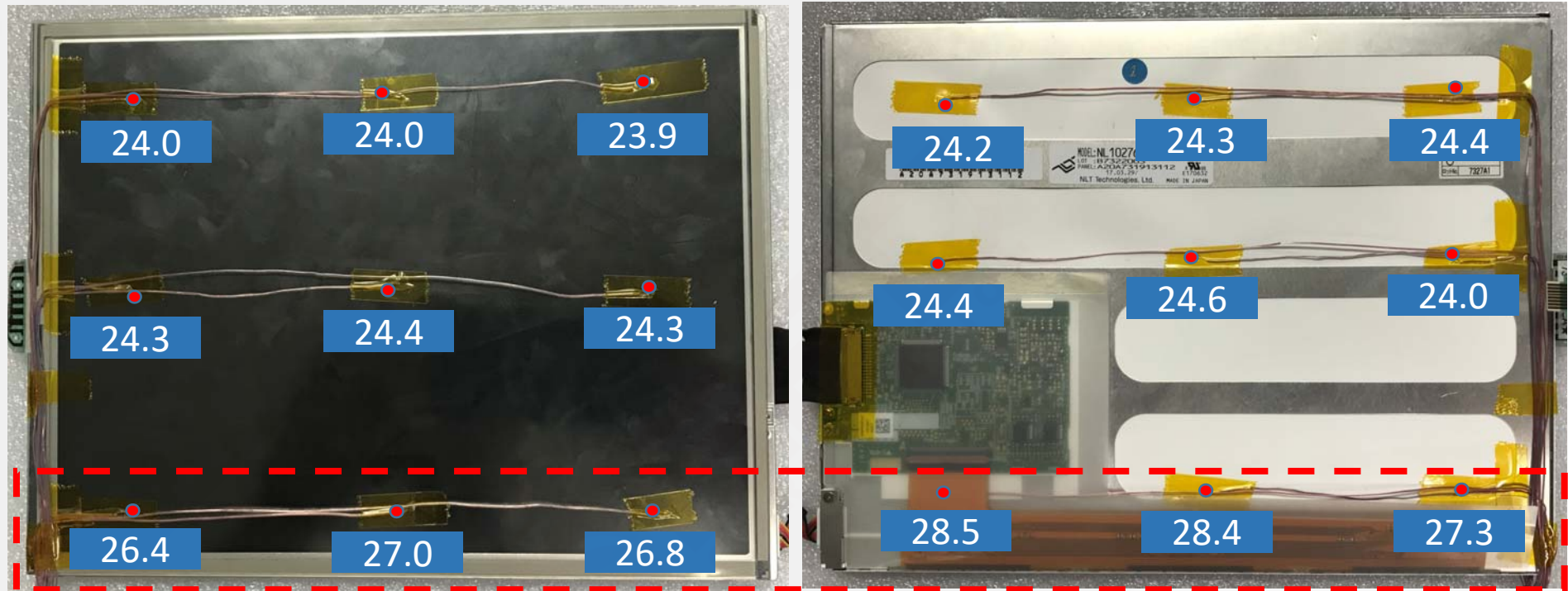


Real test@23degC ambience



- Using a D/C source power supply to input 21.8V/0.06A voltage/current for back-light power only.

Real test result (front/rear)



- Since the light bar in this panel is at the lower side, we can find there is also the hot area.

Benchmark with T3Ster (10.4")



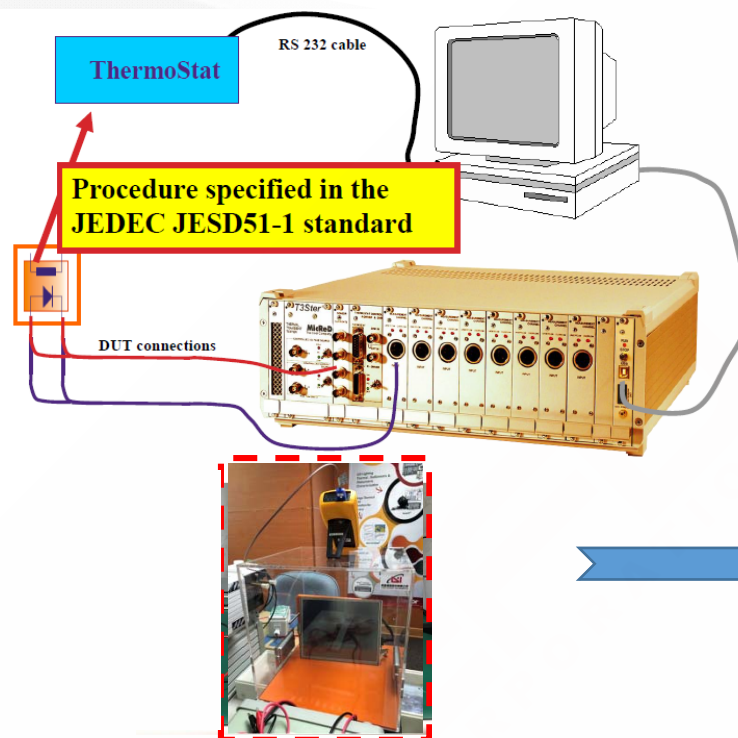
T3Ster主機



150V/10A Booster



Thermostat 溫控模組



Vertical measurement

- This Benchmark is to measure the $R_{th}(ja)$
- DUT is in air environment and do the measurement
- Measurement Parameter as bellow:

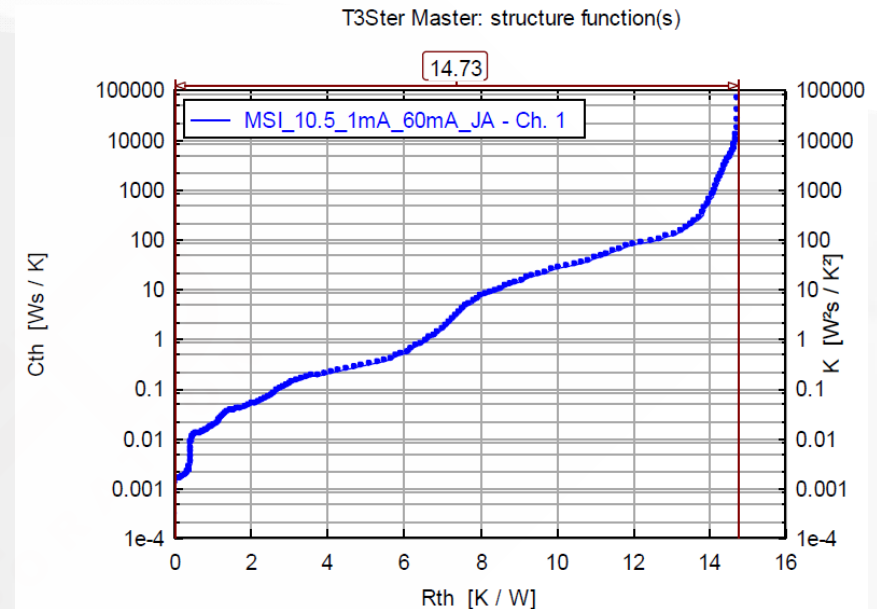
Set Parameter	MSI 10.4" Panel
I_m	1 mA
I_d	60mA
Ambient Temp.	24 °C

T3Ster Measurement result

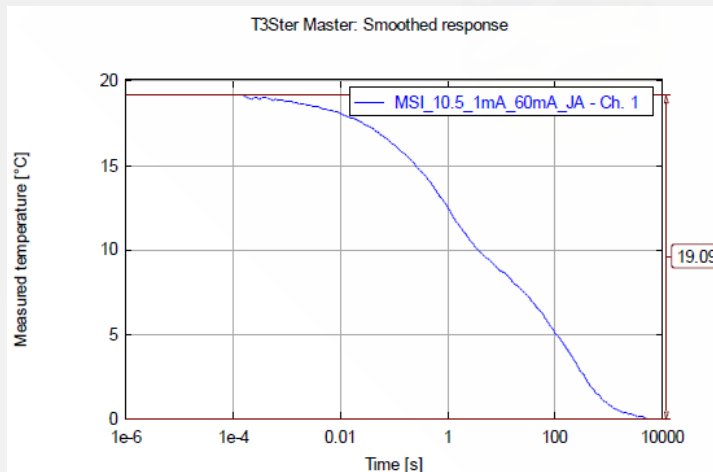
TSP calibration

DUT	MSI PANEL	
Item	T (°C)	Vf (V)
T1	25.43	28.22
T2	50.48	27.88
T3	75.42	27.66
Remark	1mA	
Sensitivity (mV/K)	8.582	

Structure Function



$T_j(\text{variation})$ of MSI Panel@24°C is 19.09°C
 $T_j = T_j(\text{variation}) + T(\text{ref.}) = 19.09 + 24 = 43.09^\circ\text{C}$

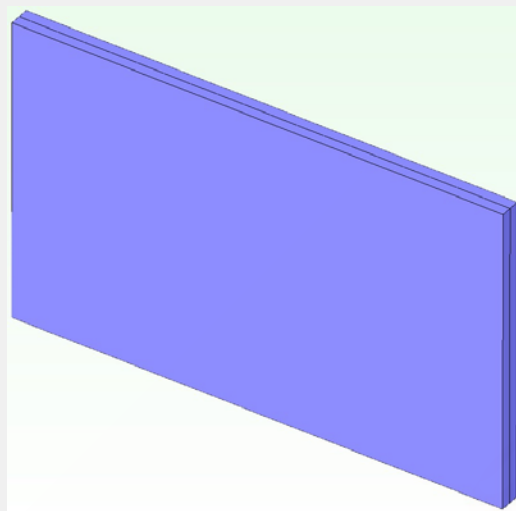


Test result

Item	MSI Panel
TSP(溫度敏感參數) mv/K	8.582
Delta Tj (度)	19.09
Tj (度)	43.09
Rthjc (K/W)	14.73

Simulation with T3Ster 10.4" panel model

- We cut off the structure function besides panel and backlight and export the xCTM file. to Flotherm to obtain a T3Ster model.



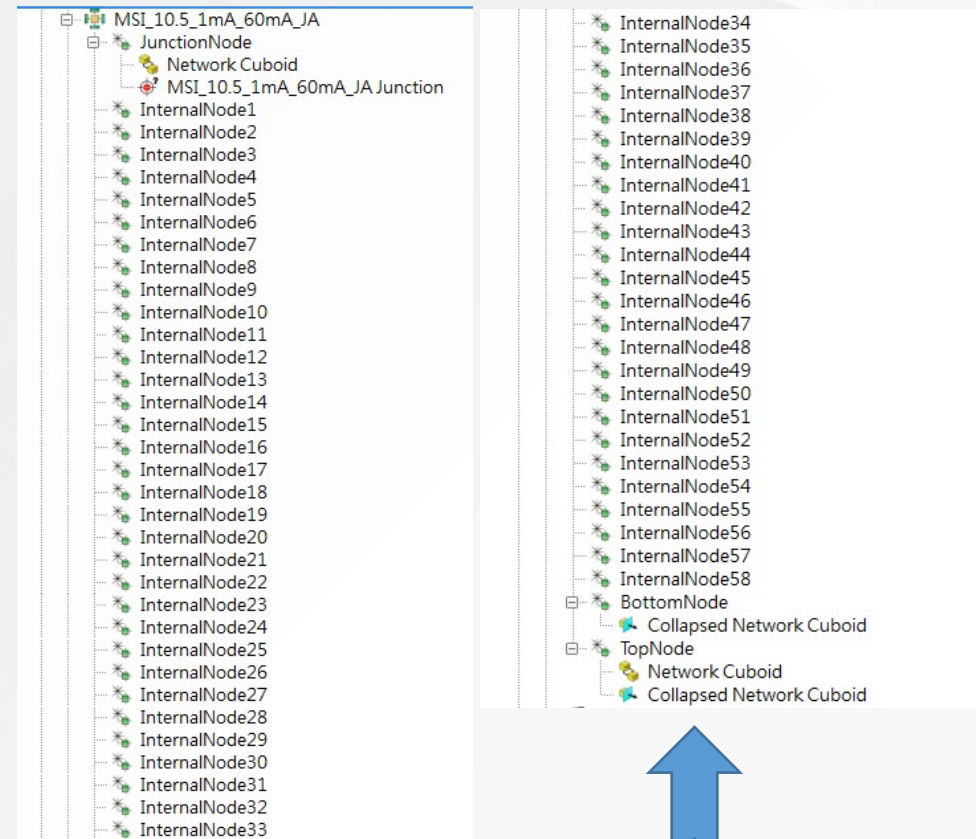
Total power : 1.308W



2.9mm

169.0mm

222.0mm

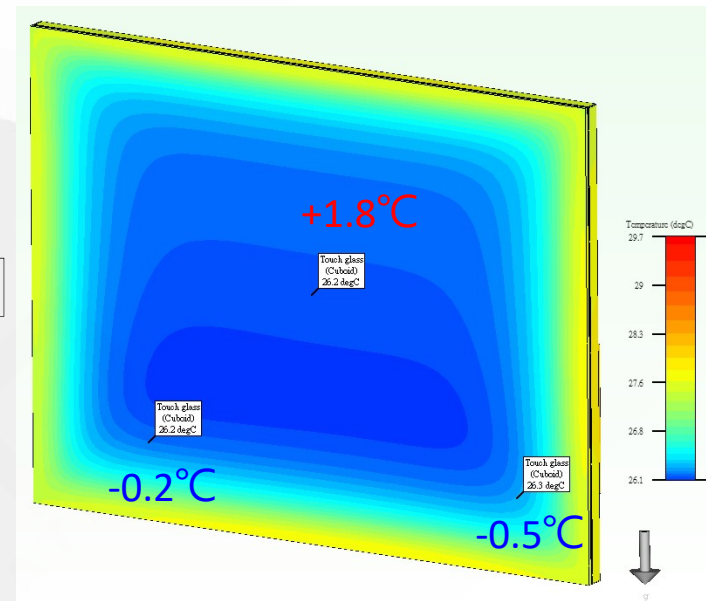


The 10.4" compact model consists of two main cuboids and 58 InternalNodes

Panel Temperature Profile

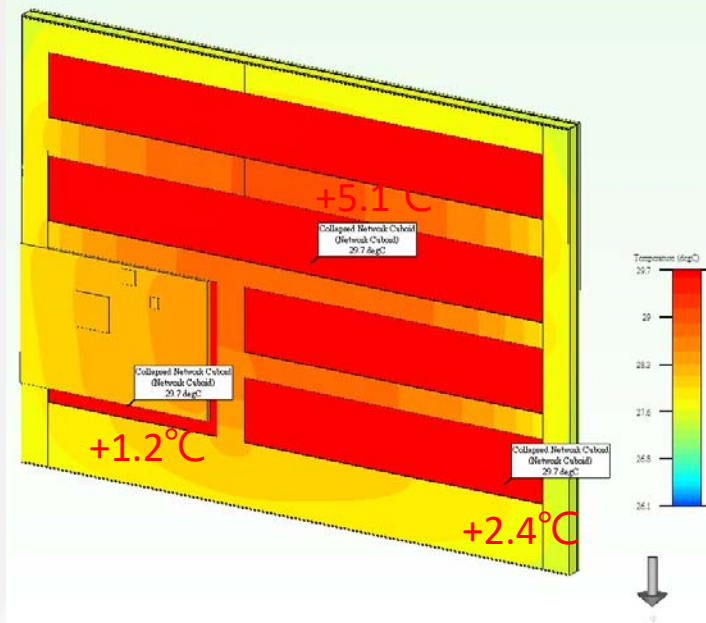
There is only $\leq 1.8^{\circ}\text{C}$ difference between the T3Ster model and real 10.4" panel temperature.

Front View



The difference reaches 5.1°C between the T3Ster model and real panel temperature.

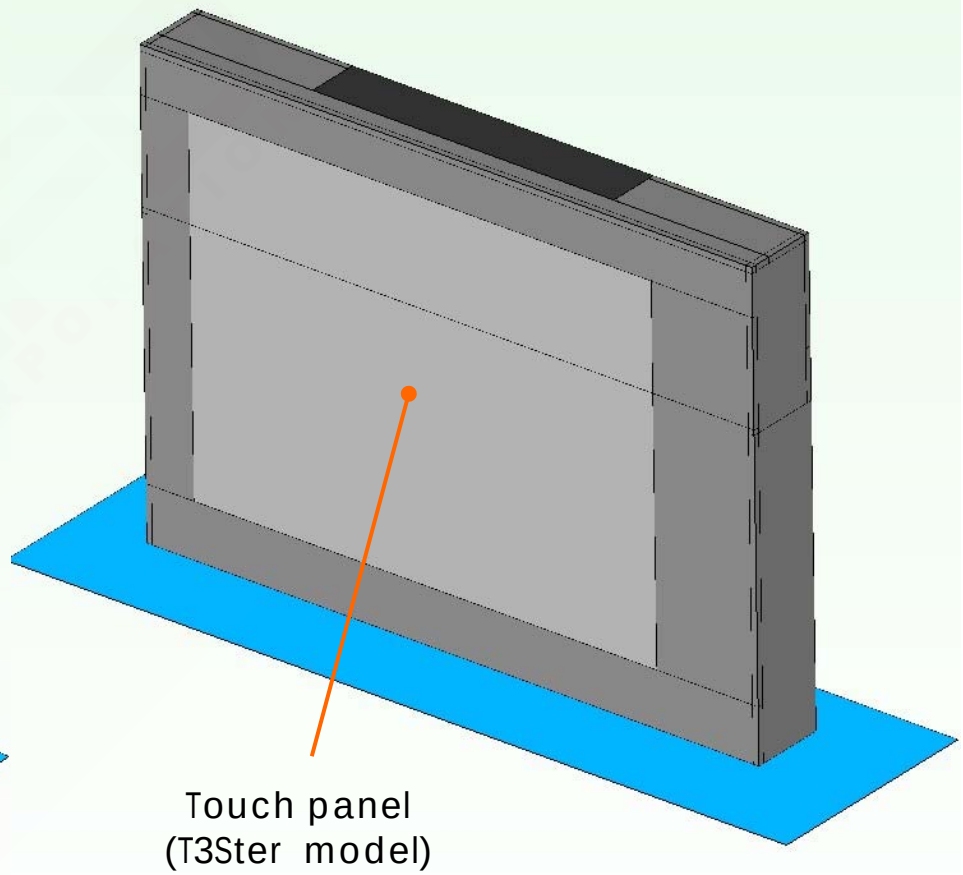
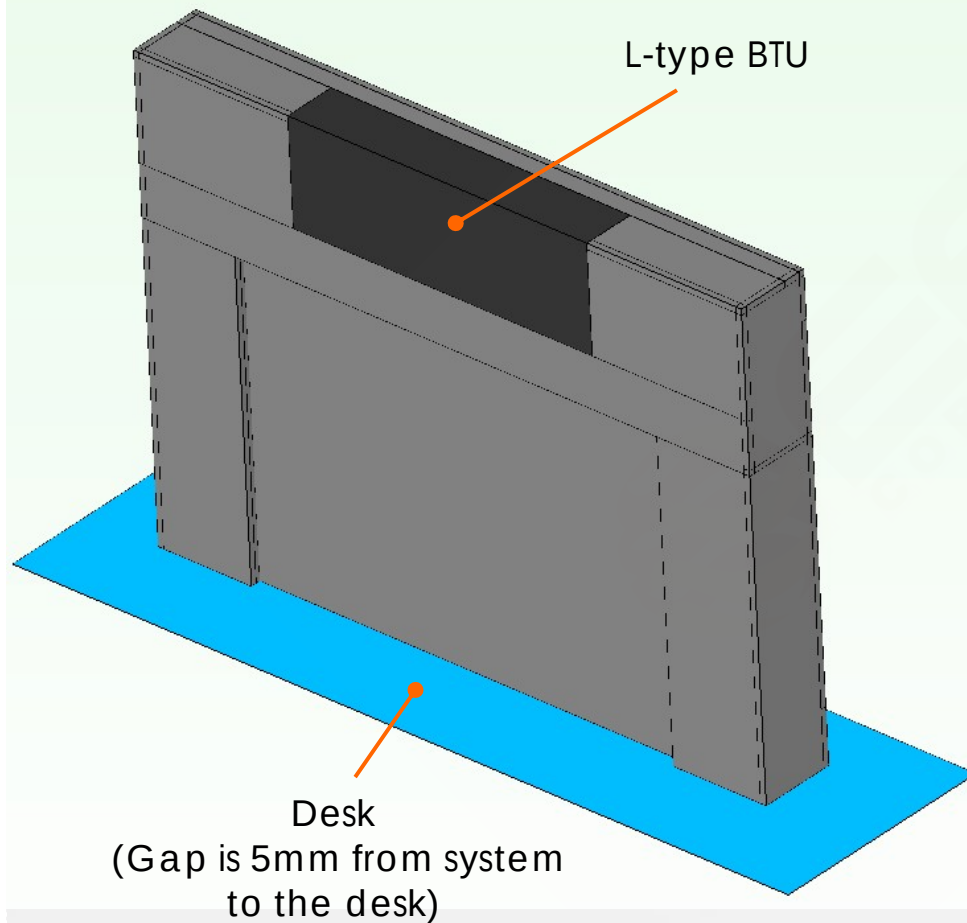
Rear View



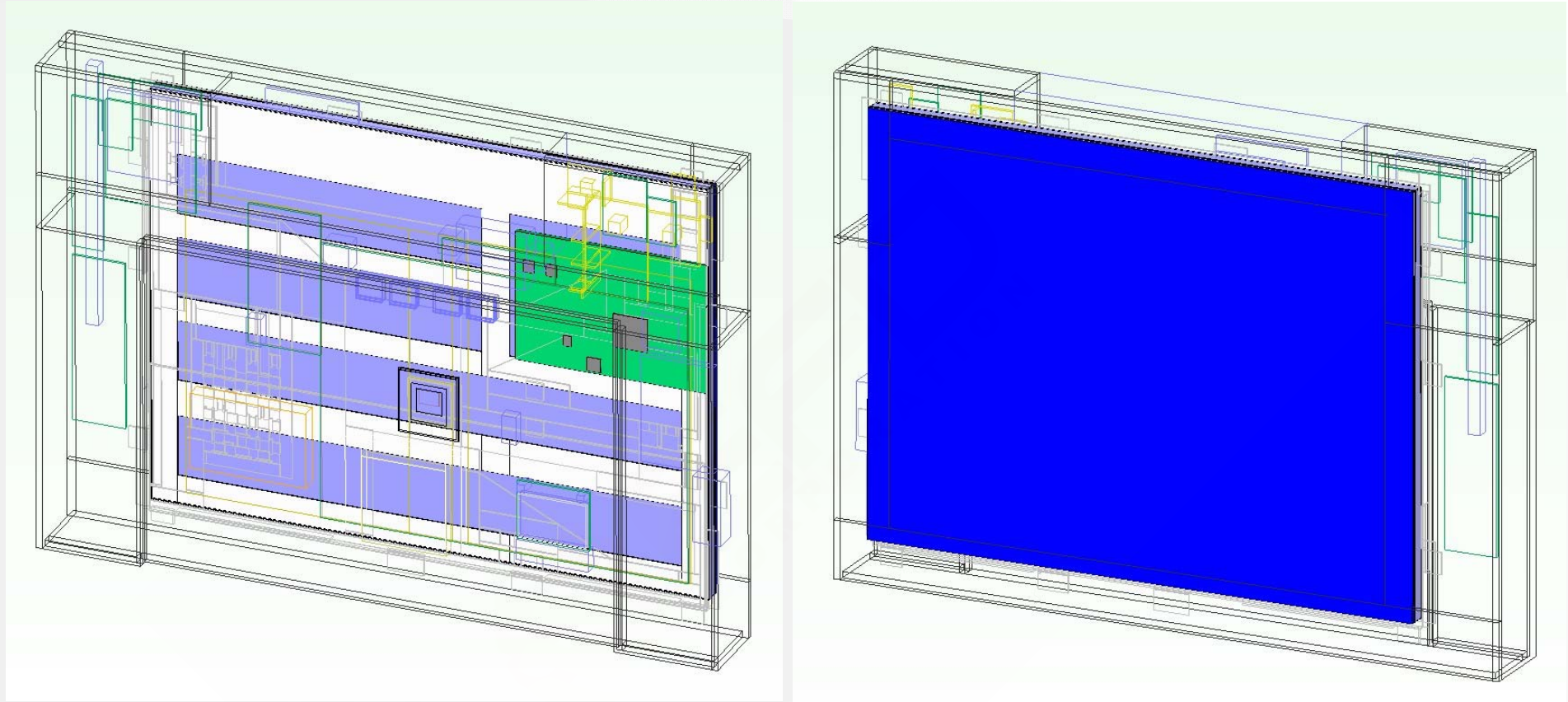
CFD Model – System Overview (1/2)

Rear View

Front View

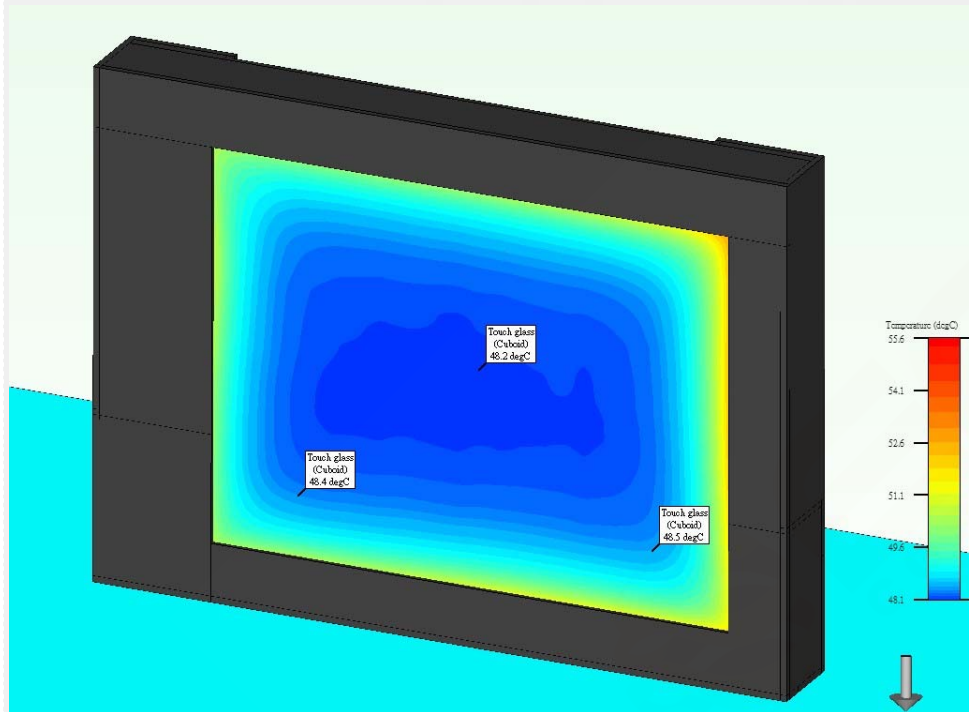


CFD Model – System Overview (2/2)



- In the same way, we import the compact model to replace the panel and back-light in the tablet model for system simulation.

LCD model for total system simulation (front)



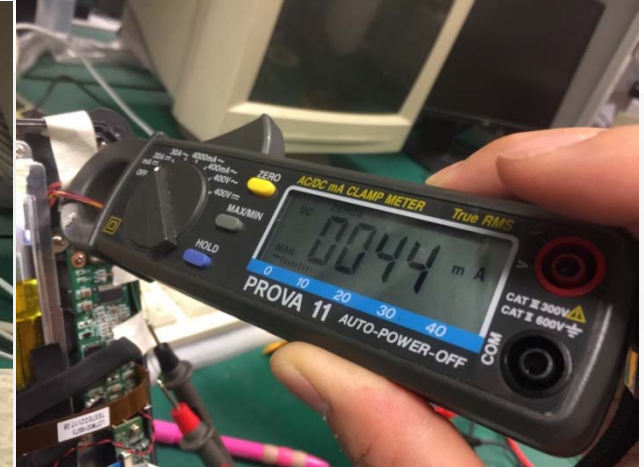
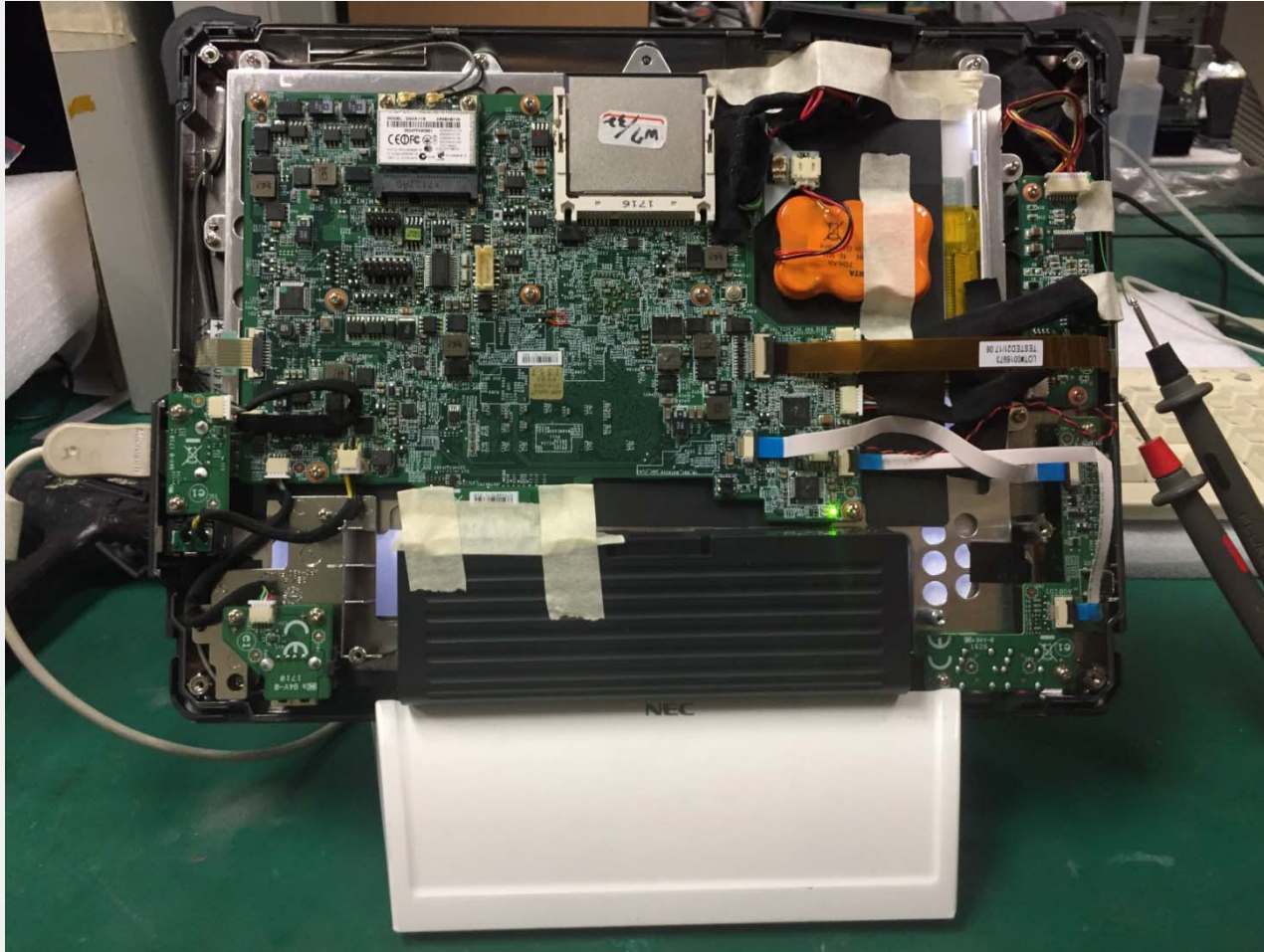
Status			Real test	Simulation
Position type			Vertical	Vertical
	Atmosphere Temperature		40	40
	Test table material		ACRYLIC	ACRYLIC
Measurement Point		Spec (°C)	GR-HM	GR-HM
1	CPU Tj	110	64.5	64.3
2	DDR1 (K4B4G1646D-BYK0)	85	59.6	62.1
3	DDR2 (K4B4G1646D-BYK0)	85	59.7	62.6
4	Panel, center	50	49.7	48.2
5	Panel, lower-right	50	48.4	48.5
6	Panel, lower-left	50	48.6	48.4
7	PCHOKE 4	105	64.9	67.2
8	PCHOKE 3	105	64.7	66.5

- The panel surface temperature on real test and simulation is very close that is less than 1.5degC difference.

Conclusions

1. According to above result, the temperature of T3Ster model is closed to the real test; especially on the hot area.
2. Since the T3Ster model characteristic, the temperature distribution will be the same on the compact model surface.
3. MicReD T3Ster can provide a precise measurement for the panel transient thermal resistance.
4. This way can be applied on future cases for panel simulation.

Appendix





Thank you very much for
Your attention