

Sherlock對於車用電子的隨 機振動疲勞評估與改善

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講題大綱

- 車用電子隨機振動測試簡介
- 為何使用**Sherlock**作為分析軟體
- 分析流程
- 參數設定
- 結果判讀
- 改善方案與改善結果
- 結論

車用電子隨機振動測試簡介

Vibration Spec. – ISO-16750-3

- ISO 16750-1: General
- ISO 16750-2: Electrical loads
- ISO 16750-3: Mechanical loads
- ISO 16750-4: Climatic loads
- ISO 16750-5: Chemical loads

INTERNATIONAL
STANDARD

ISO
16750-3

**Road vehicles — Environmental
conditions and testing for electrical
and electronic equipment —**

**Part 3:
Mechanical loads**

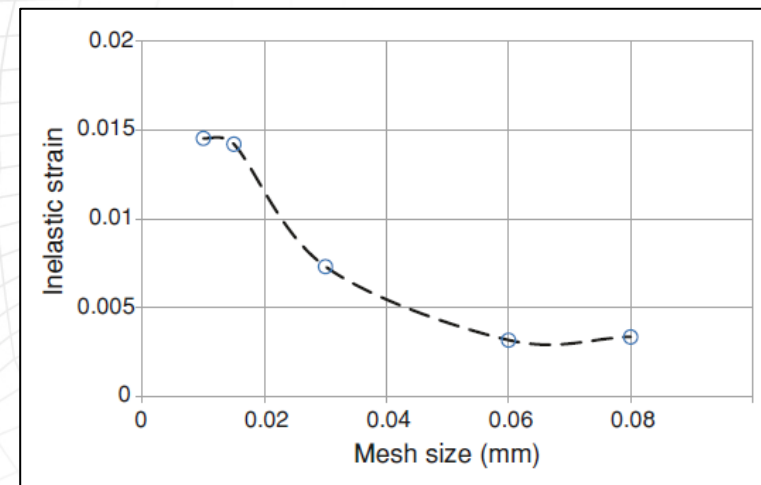
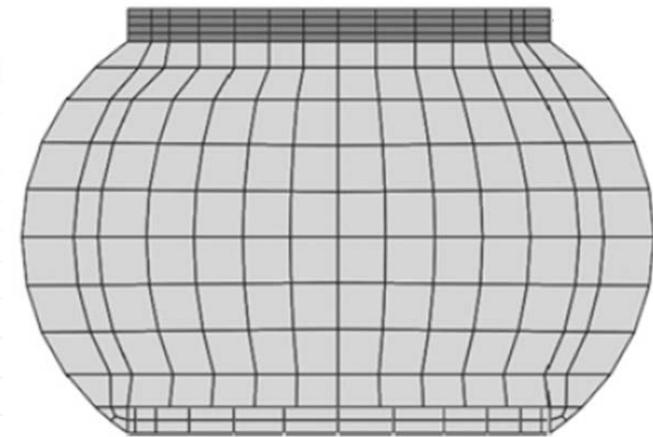
*Véhicules routiers — Spécifications d'environnement et essais de
l'équipement électrique et électronique —*

Partie 3: Contraintes mécaniques

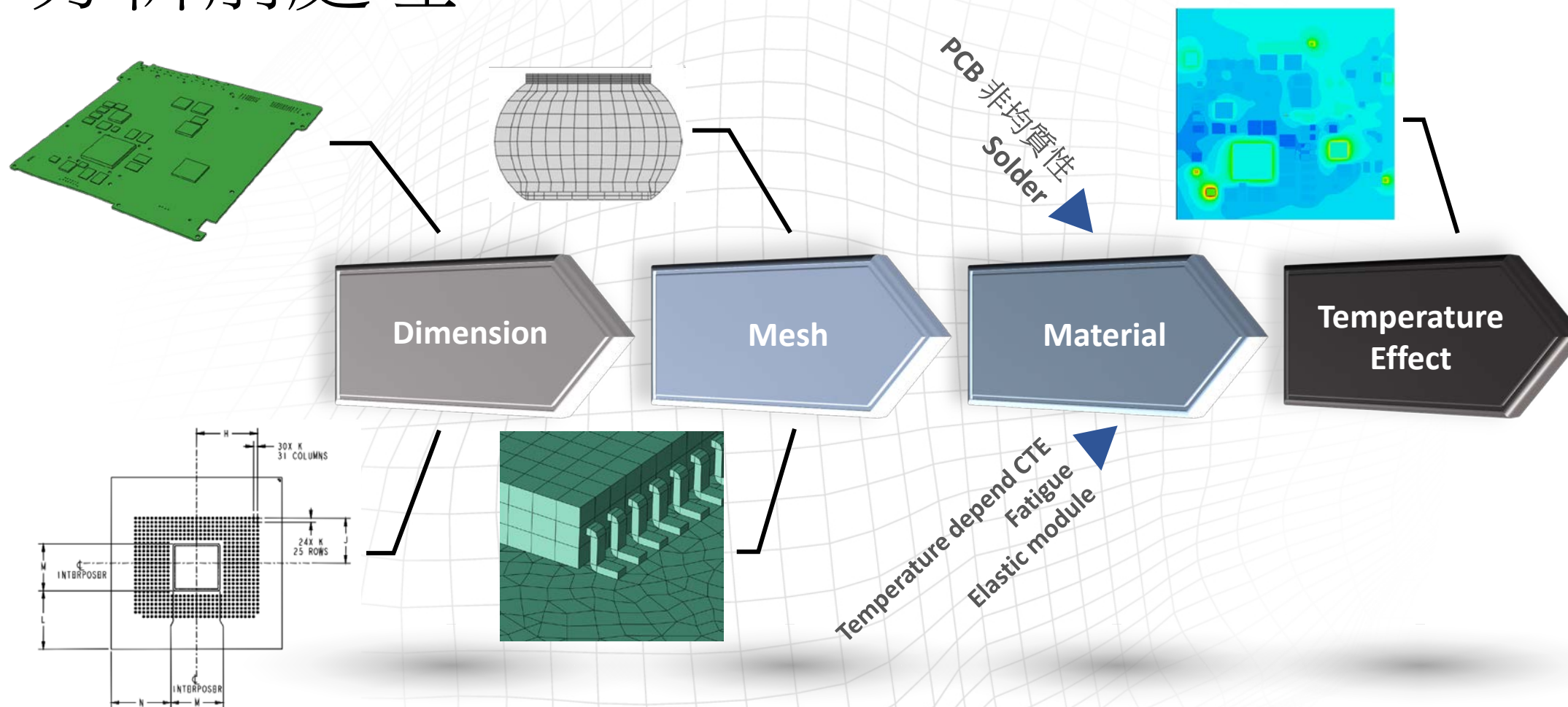
為何使用Sherlock作為分析軟體

分析目標

- PCB上的solder crack
- 長時間振動+thermal cycling、多次數衝擊與疲勞問題
- 整體分析時間須符合產品開發時程



分析前處理

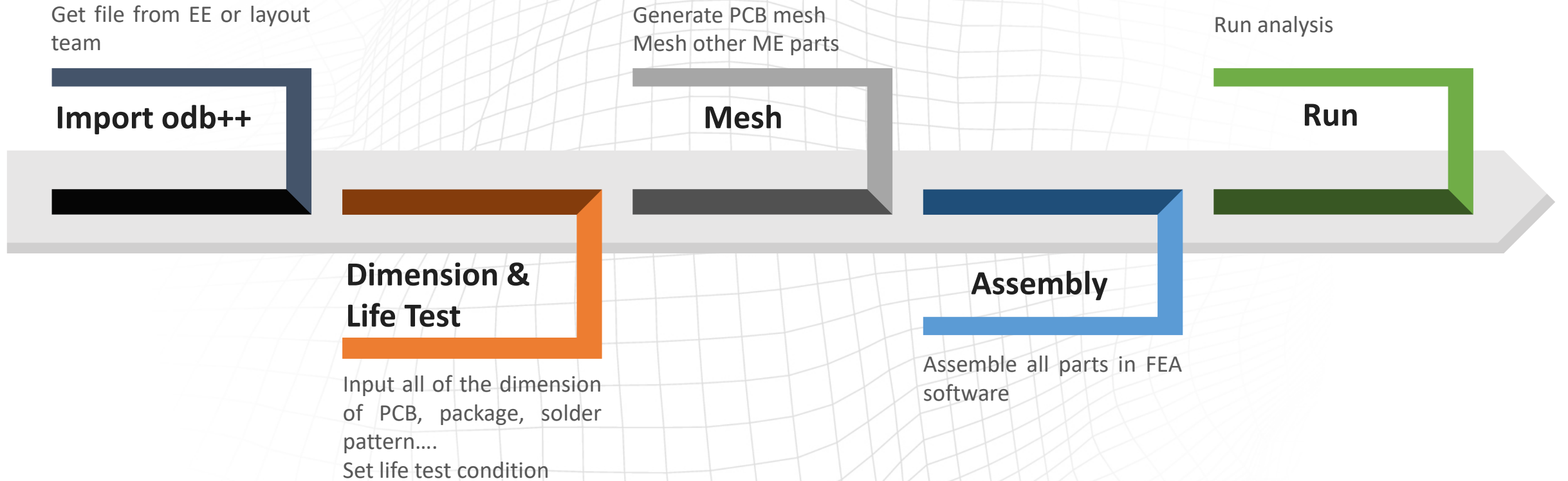


Sherlock 優點

- 多樣化的封裝種類直接套用
- 直接由ECAD產生solder ball pattern
- 根據ECAD的內銅線分布給定PCB各區域的局部性質
- 直接產生整個PCB的mesh model
- 大量材料性質資料庫，如solder、package material與PCB
- 讀溫度分布圖的*.jpg檔即可獲得高溫分布，不用另外跑熱膨脹分析
- 可搭配其他有限元素軟體分析

分析流程

前處理



後處理

Import result file to
Sherlock

**Import Result
File**

Check RMS displacement
around the failed
component

**Displacement
Contour**

Pass Result

**Reliability
Data**

Check reliability result and
life prediction

Improve

Propose action for the
failed result

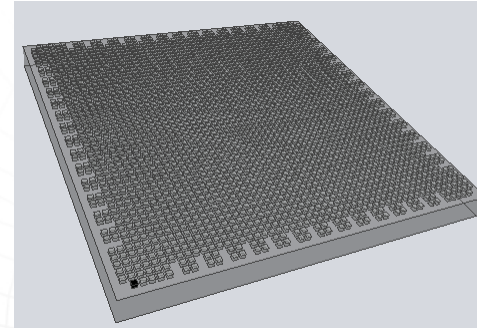
1990
1990

2010
2010

2030
2030

參數設定

PCB & Component



Layer	Type	Material	Construction
1	SIGNAL	COPPER (85.4%) / COPPER-RESIN	
2	Laminate	EM-370Z / Resin Content (64.0%)	1080 0.003 in Prepreg [64% resin]
3	SIGNAL	COPPER (92.7%) / COPPER-RESIN	
4	Laminate	EM-370Z / Resin Content (64.0%)	1080 0.003 in Prepreg [64% resin]
5	SIGNAL	COPPER (76.4%) / COPPER-RESIN	
6	Laminate	EM-370Z / Resin Content (64.0%)	1080 0.003 in Prepreg [64% resin]
7	SIGNAL	COPPER (93.3%) / COPPER-RESIN	
8	Laminate	EM-370Z / Resin Content (65.0%)	1080 0.0029 in Prepreg [65% resin]
9	SIGNAL	COPPER (75.9%) / COPPER-RESIN	
10	Laminate	EM-370Z / Resin Content (65.0%)	1080 0.0032 in Prepreg [65% resin]
11	SIGNAL	COPPER (94.7%) / COPPER-RESIN	
12	Laminate	EM-370Z / Resin Content (42.0%)	7628x3 0.021 in Core [41.5% resin]
13	SIGNAL	COPPER (94.7%) / COPPER-RESIN	
14	Laminate	EM-370Z / Resin Content (65.0%)	1080 0.0032 in Prepreg [65% resin]
15	SIGNAL	COPPER (75.9%) / COPPER-RESIN	
16	Laminate	EM-370Z / Resin Content (65.0%)	1080 0.0029 in Prepreg [65% resin]
17	SIGNAL	COPPER (93.3%) / COPPER-RESIN	
18	Laminate	EM-370Z / Resin Content (64.0%)	1080 0.003 in Prepreg [64% resin]
19	SIGNAL	COPPER (76.4%) / COPPER-RESIN	
20	Laminate	EM-370Z / Resin Content (64.0%)	1080 0.003 in Prepreg [64% resin]
21	SIGNAL	COPPER (92.7%) / COPPER-RESIN	
22	Laminate	EM-370Z / Resin Content (64.0%)	1080 0.003 in Prepreg [64% resin]
23	SIGNAL	COPPER (85.4%) / COPPER-RESIN	

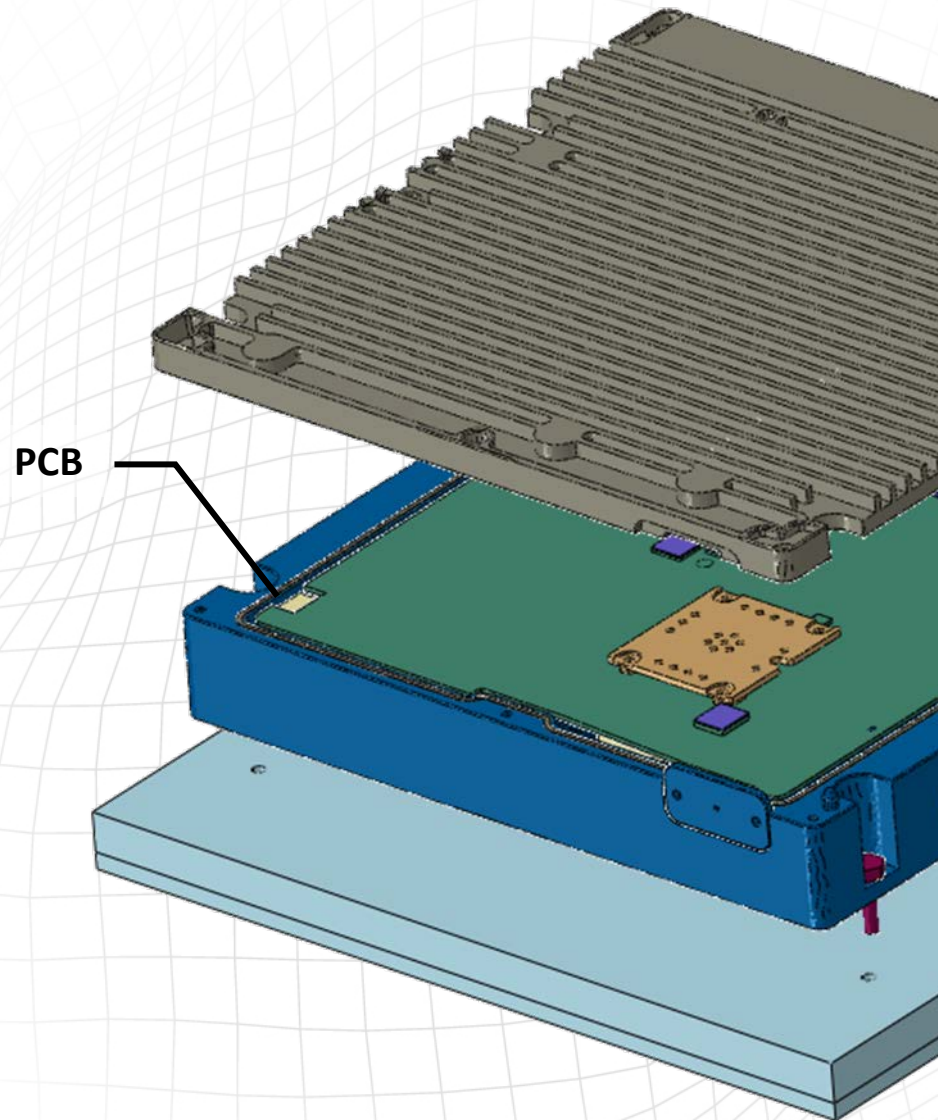
PCB

ID
Package
Location
Ball
Pad
Solder
Electrical
Thermal
Die
Flag
Test
Semiconductor Wearout

Ball Pattern: ?	NETLIST
Ball Count: ?	2588
Ball Units: ?	mm
Ball Pitch: ?	0.7
Ball Diameter: ?	0.48
Ball Package Diameter: ?	0.48
Ball Pad Diameter: ?	0.48
Ball Height: ?	0.35
Ball Chan Width: ?	12.6001
Ball Material: ?	SAC305
Ball Modeling: ?	TWO ELEMENTS
Ball Perimeter Rows: ?	
Ball Perimeter Cols: ?	
Ball Island Rows: ?	1
Ball Island Cols: ?	

Component

Assembly



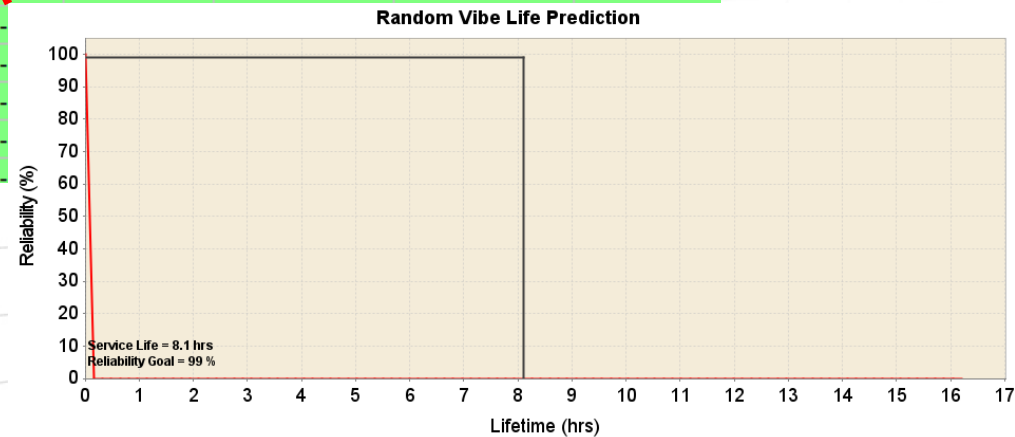
結果判讀

Failure Probability & Score

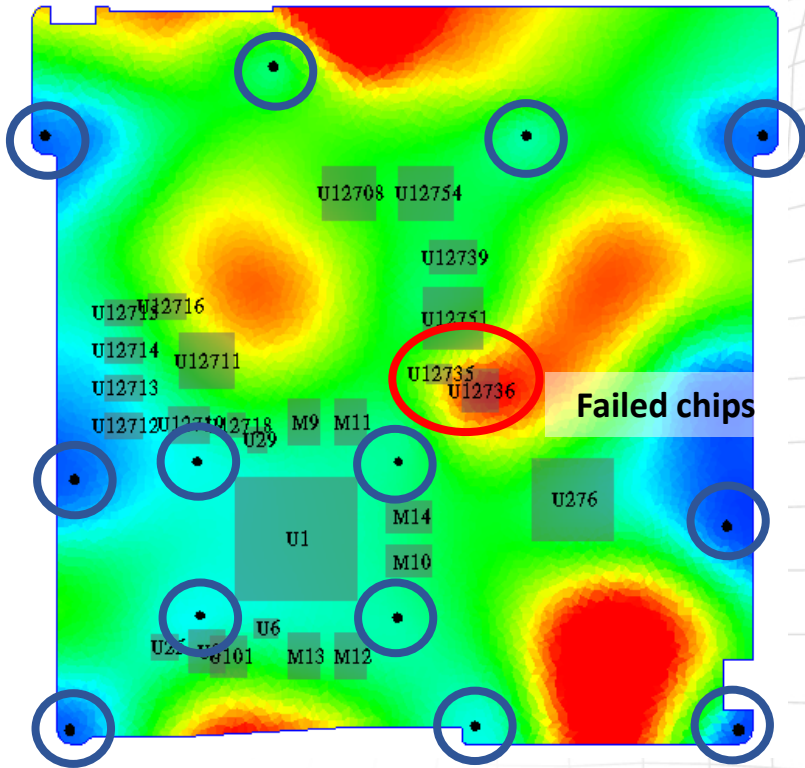
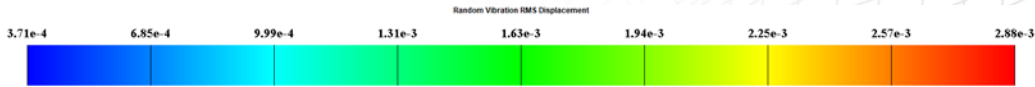
RefDes	Package	Part Type	Side	Solder	Max Disp	Max Strain	Damage	TTF (hrs)	Failure Prob	Score
U12736	BGA153-MICRON-...	IC	BOT	SAC305	2.9E-3	6.9E-4	3.3E2	0.0	100.0	0.0
U12735	BGA24-MXIC-MX2...	IC	BOT	SAC305	2.3E-3	3.3E-4	2.1E0	3.9	100.0	0.0
U12751	BGA525-NXP-PS32...	IC	TOP	SAC305	2.0E-3	1.7E-4	2.5E-2	>81	0.0	10.0
U276	BGA_0292_P080_17...	IC	TOP	SAC305	1.3E-3	1.3E-4	3.1E-3	>81	0.0	10.0
U8	BGA_0153_P050_11...	IC	BOT	SAC305	1.3E-3	1.1E-4	1.0E-3	>81	0.0	10.0
U101	BGA_0153_P050_11...	IC	TOP	SAC305	1.5E-3	5.6E-5	9.3E-6	>81	0.0	10.0
U12739	BGA200-MICRON-...	IC	TOP	SAC305	1.3E-3	5.2E-5	5.4E-6	>81	0.0	10.0
U6	BGA_0024_P010_08...	IC	TOP	SAC305	9.8E-4	1.5E-5	1.0E-6	>81	0.0	10.0
M9	BGA_0200_P080_P0...	MOTOR	TOP	SAC305	1.5E-3	1.1E-5	1.0E-6	>81	0.0	10.0
U25	BGA_0076_P080_08...	IC	TOP	SAC305	1.0E-3	3.9E-5	1.0E-6	>81	0.0	10.0
U12708	BGA273-REALTEK-...	IC	TOP	SAC305	1.8E-3	4.0E-5				
U29	BGA_0024_P010_08...	IC	BOT	SAC305	1.1E-3	1.1E-5				
M11	BGA_0200_P080_P0...	MOTOR	TOP	SAC305	1.3E-3	1.9E-5				
M10	BGA_0200_P080_P0...	MOTOR	TOP	SAC305	1.2E-3	7.1E-5				
M13	BGA_0200_P080_P0...	MOTOR	TOP	SAC305	1.5E-3	2.7E-5				

Failed

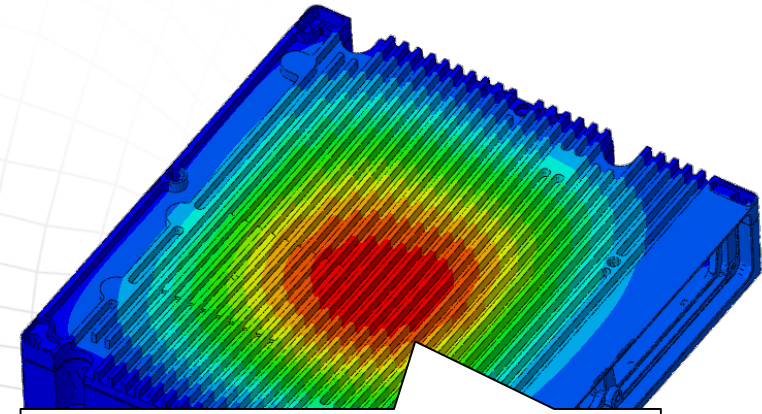
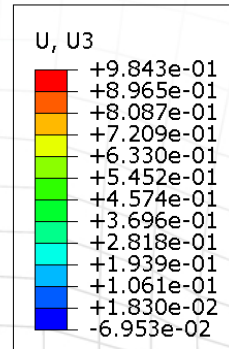
Color	Score
■	Score ≥ 7
■	$7 > \text{Score} \geq 3$
■	Score < 3



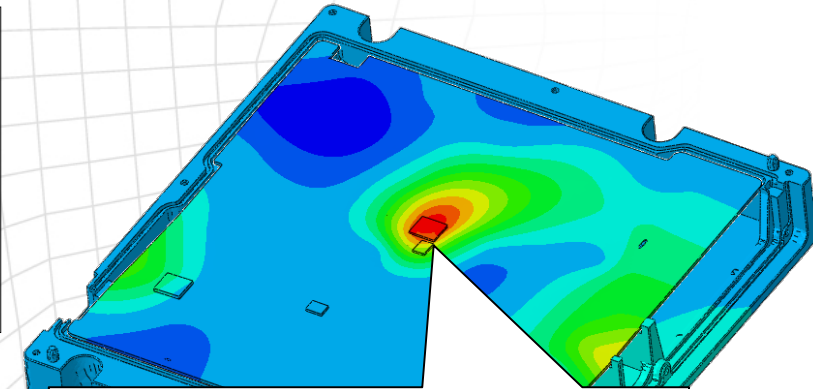
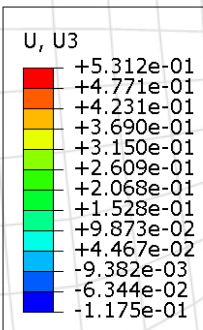
Displacement



○ Fix points of PCB



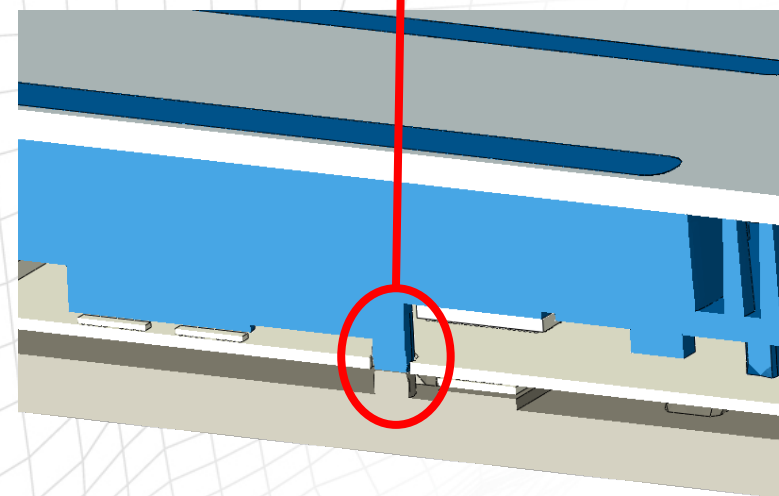
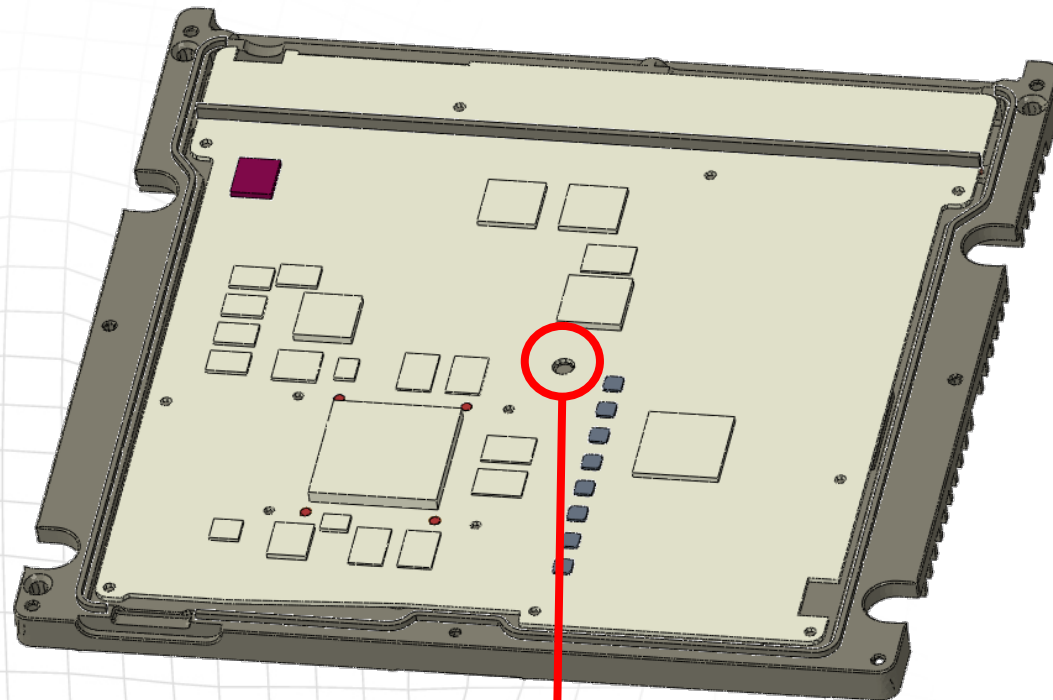
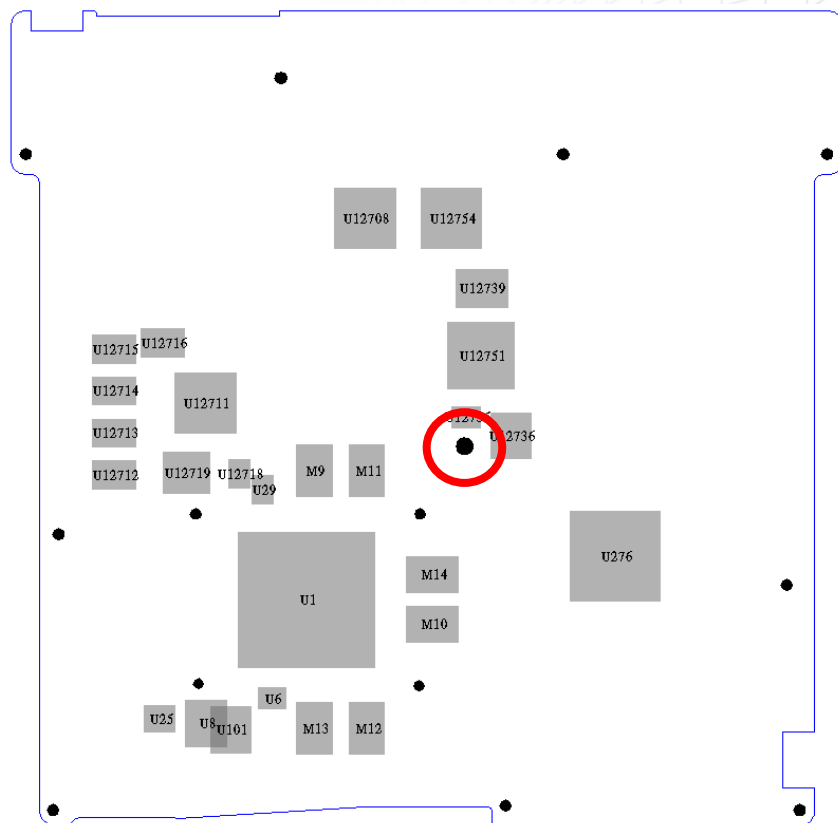
Large displacement of 3rd mode at center area of top case.



Board bending caused by top case deformation

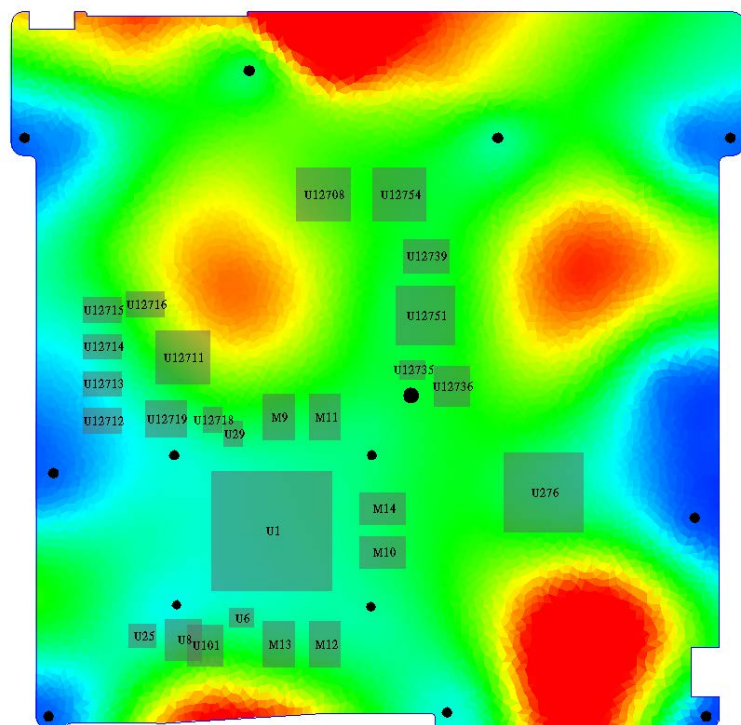
改善方案與改善結果

改善方案



改善結果

3.85e-4 6.95e-4 1.01e-3 1.32e-3 1.63e-3 1.94e-3 2.25e-3 2.56e-3 2.87e-3



RefDes	Package	Part Type	Side	Solder	Max Disp	Max Strain	Damage	TTF (hrs)	Failure Prob	Score
U276	BGA_0292_P080...	IC	TOP	SAC305	1.3E-3	6.8E-5	3.7E-5	>81	0.0	10.0
U12751	BGA525-NXP-PS3...	IC	TOP	SAC305	1.4E-3	4.7E-5	3.0E-6	>81	0.0	10.0
U8	BGA_0153_P050...	IC	BOT	SAC305	1.3E-3	4.4E-5	1.8E-6	>81	0.0	10.0
U6	BGA_0024_P010...	IC	TOP	SAC305	1.0E-3	2.9E-5	1.0E-6	>81	0.0	10.0
M9	BGA_0200_P080...	MOTOR	TOP	SAC305	1.5E-3	1.1E-5	1.0E-6	>81	0.0	10.0
U25	BGA_0076_P080...	IC	TOP	SAC305	1.0E-3	3.8E-5	1.0E-6	>81	0.0	10.0
U101	BGA_0153_P050...	IC	TOP	SAC305	1.5E-3	3.5E-5	1.0E-6	>81	0.0	10.0
U12708	BGA273-REALTE...	IC	TOP	SAC305	1.8E-3	3.1E-5	1.0E-6	>81	0.0	10.0
U29	BGA_0024_P010...	IC	BOT	SAC305	1.2E-3	7.6E-6	1.0E-6	>81	0.0	10.0
M11	BGA_0200_P080...	MOTOR	TOP	SAC305	1.4E-3	1.1E-5	1.0E-6	>81	0.0	10.0
M10	BGA_0200_P080...	MOTOR	TOP	SAC305	1.2E-3	6.5E-6	1.0E-6	>81	0.0	10.0
M13	BGA_0200_P080...	MOTOR	TOP	SAC305	1.5E-3	3.5E-5	1.0E-6	>81	0.0	10.0
M12	BGA_0200_P080...	MOTOR	TOP	SAC305	1.4E-3	3.6E-5	1.0E-6	>81	0.0	10.0
U12715	BGA78-MICRON-...	IC	TOP	SAC305	1.4E-3	7.2E-6	1.0E-6	>81	0.0	10.0
M14	BGA_0200_P080...	MOTOR	TOP	SAC305	1.2E-3	3.7E-6	1.0E-6	>81	0.0	10.0
U12714	BGA78-MICRON-...	IC	TOP	SAC305	1.1E-3	9.9E-6	1.0E-6	>81	0.0	10.0
U12736	BGA153-MICRON...	IC	BOT	SAC305	1.4E-3	3.1E-5	1.0E-6	>81	0.0	10.0
U12739	BGA200-MICRON...	IC	TOP	SAC305	1.3E-3	1.9E-5	1.0E-6	>81	0.0	10.0

結論

結論

- Sherlock 可考慮銅線分佈以及PCB分層對於材料性質的影響
- 節省大量前處理建模時間，簡化錫球陣列、針腳排列、元件尺寸與材質的設定
- 簡化模擬流程，不須再跑熱膨脹分析
- 搭配FEA軟體觀察後處理內容可協助解決產品失效問題

Reference

Reference

- Solder Joint Reliability Assessment: Finite Element Simulation Methodology