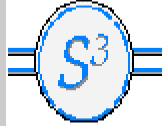

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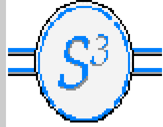
USE OF ENGINEERING TOOLS CASE HISTORIES

Phillip Spann



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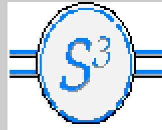
Providing Technical Products and Services to the Defense, Space, and the Intelligence communities

COMPANY PROFILE

- SMALL BUSINESS
- MINORITY AND WOMAN OWNED
- ALABAMA CORP. ESTABLISHED IN 1993
- 75+ EMPLOYEES
- PROVIDES TECHNICAL & PROGRAM MANAGEMENT SERVICES
- CUSTOMERS ARE DoD, NASA, U.S. ARMY CoE, & INTELLIGENCE COMMUNITY



SYSTEM STUDIES & SIMULATION, Inc

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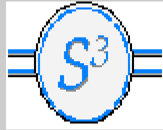
CAPABILITY PROFILE

- SYSTEM ENGINEERING & TECHNICAL ASSISTANCE
- DESIGN AND ANALYSIS
- SOFTWARE DEVELOPMENT
- PROGRAM & DATA MANAGEMENT
- LOGISTICS SUPPORT
- PAYLOAD DEVELOPMENT AND INTEGRATION
- MISSION SUPPORT



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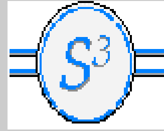
SUPPORT OF US ARMY AMCOM

- ANALYZE REQUIREMENTS
- VALIDATE DESIGNS VIA BREADBOARD
- DESIGN CONCEPTS & AUTHOR SPECS
- GENERATE MECHANICAL DESIGNS
- DEVELOP ELECTRICAL SCHEMATICS
- **DESIGN PCB'S & ELECTRONIC ASSY's**
- DEVELOP & CONDUCT ACCEPTANCE TESTS



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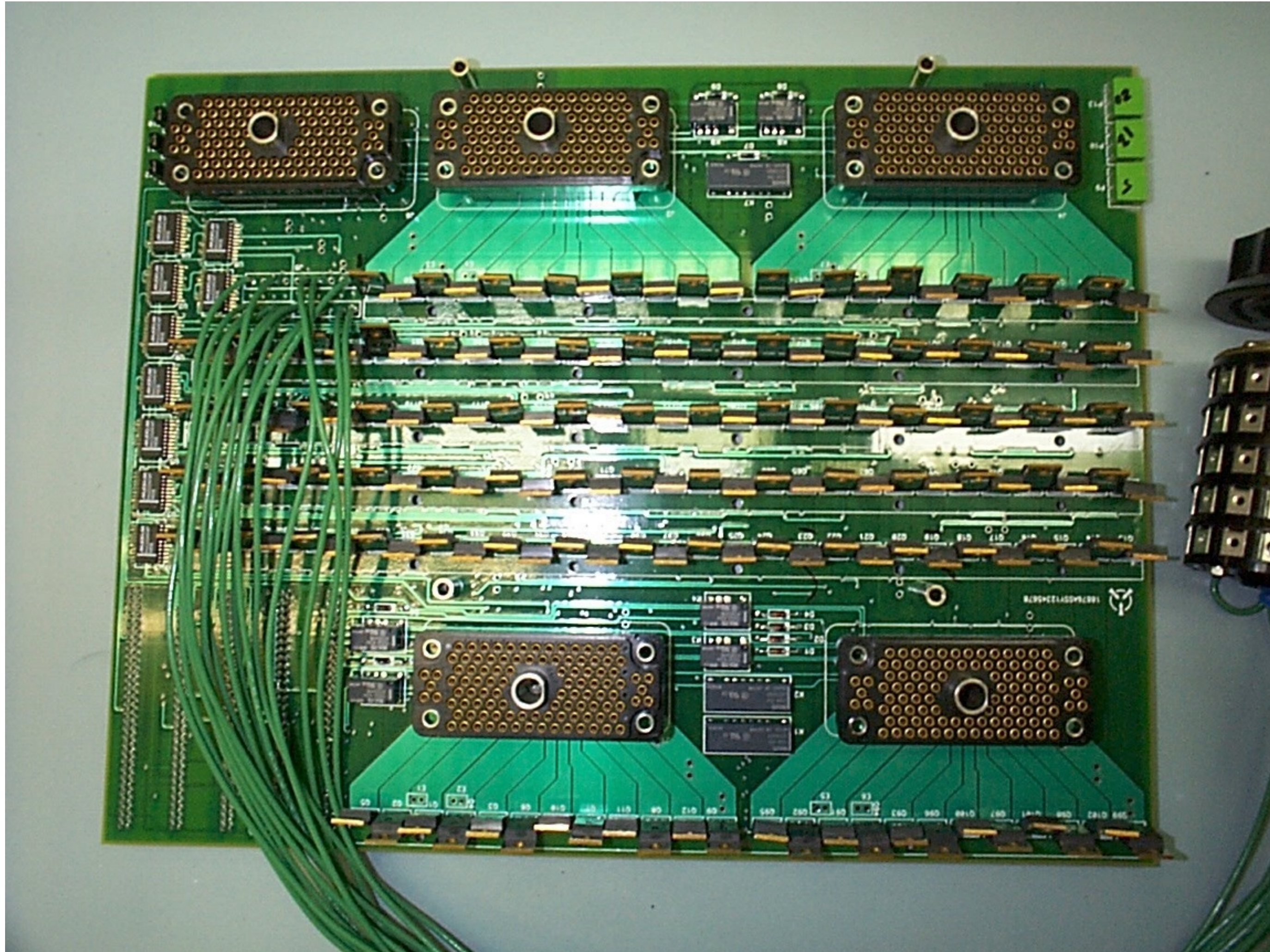
CIRCUIT BOARD DESIGN

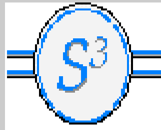
- TECHNICAL SUPPORT TO AMCOM
- REVERSE ENGINEERING
- UPDATE OBSOLETE DESIGNS
- PROVIDE NEW DESIGNS
- DESIGN FOR MANUFACTURE
- ANALYTICAL RECOMMENDATIONS
- CAM SUPPORT FOR PROTOTYPE LAB

Test Case: Missile Power Board

***Current Situation* (before analysis tools):**

- Built prototype 3 times.
- Had design changes & warpage problems.





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NEXT TIME: USE OF ENGINEERING TOOLS WARPAGE MODEL

- DESIGN THICK 10 LAYER BOARD
- CONSTRUCTION IS A VARIABLE
- DEVELOP SEVERAL OPTIONS FOR THE MULTILAYER CONSTRUCTION
- REFINE THE DESIGN BY EVALUATING THE RELATIVE WARPAGE OF EACH
- CHOOSE THE MOST STABLE DESIGN

USE OF ENGINEERING TOOLS
LAY- UP MODEL

- DEVELOP AN UNDERSTANDING OF THE MATERIAL VARIABLES USED IN MANUFACTURING
- HELP SPEED UP THE DESIGN PROCESS
- PERMIT THE QUICK CHECK OF DIFFERENT DESIGN THICKNESS

Layup Design Alternatives

Initial Design

PWB Layup Design : Detailed Layup

File

	Layer Id	Min Thickness	Normal Thickness	Max Thickness	Layer Function
Layer 1	2.00	0.0028	0.0028	0.0028	Comp Side
Core1	L210150C2/C2AC	0.0125	0.015	0.0175	Core
Layer 2	2.00	0.0028	0.0028	0.0028	Signal
Prepreg1	1080*3	0.0060	0.0069	0.0078	Prepreg
Layer 3	2.00	0.0028	0.0028	0.0028	Signal
Core2	L210150C2/C2AC	0.0125	0.015	0.0175	Core
Layer 4	2.00	0.0028	0.0028	0.0028	Signal
Prepreg2	1080*3	0.0060	0.0069	0.0078	Prepreg
Layer 5	2.00	0.0028	0.0028	0.0028	Plane
Core3	L210150C2/C2AC	0.0125	0.015	0.0175	Core
Layer 6	2.00	0.0028	0.0028	0.0028	Plane
Prepreg3	1080*3	0.0060	0.0069	0.0078	Prepreg
Layer7	2.00	0.0028	0.0028	0.0028	Signal
Core4	L210150C2/C2AC	0.0125	0.015	0.0175	Core
Layer8	2.00	0.0028	0.0028	0.0028	Signal
Prepreg4	1080*3	0.0060	0.0069	0.0078	Prepreg
Layer9	2.00	0.0028	0.0028	0.0028	Signal
Core5	L210150C2/C2AC	0.0125	0.015	0.0175	Core
Layer10	2.00	0.0028	0.0028	0.0028	Solder

Layup, Cap, Cond, Gene, Diele, IPC-4, Diele, Allied

Nesting factor: 1.0

Solve

Total Post-Lamination Nom Thick: 0.11715999999999999

Coefficient of Thermal Bending: 3.9064225924153626E-7

Run PWB Warpag

<<Previous

exit

Re-Design (thinner)

PWB Layup Design : Detailed Layup

File

	Layer Id	Min Thickness	Normal Thickness	Max Thickness	Layer Function
Layer 1	2.00	0.0028	0.0028	0.0028	Comp Side
Core1	L210080C2/C2AC	0.0060	0.0080	0.01	Core
Layer 2	2.00	0.0028	0.0028	0.0028	Signal
Prepreg1	1080*3	0.0060	0.0069	0.0078	Prepreg
Layer 3	2.00	0.0028	0.0028	0.0028	Signal
Core2	L210080C2/C2AC	0.0060	0.0080	0.01	Core
Layer 4	2.00	0.0028	0.0028	0.0028	Signal
Prepreg2	1080*3	0.0060	0.0069	0.0078	Prepreg
Layer 5	2.00	0.0028	0.0028	0.0028	Plane
Core3	L210080C2/C2AC	0.0060	0.0080	0.01	Core
Layer 6	2.00	0.0028	0.0028	0.0028	Plane
Prepreg3	1080*3	0.0060	0.0069	0.0078	Prepreg
Layer7	2.00	0.0028	0.0028	0.0028	Signal
Core4	L210080C2/C2AC	0.0060	0.0080	0.01	Core
Layer8	2.00	0.0028	0.0028	0.0028	Signal
Prepreg4	1080*3	0.0060	0.0069	0.0078	Prepreg
Layer9	2.00	0.0028	0.0028	0.0028	Signal
Core5	L210080C2/C2AC	0.0060	0.0080	0.01	Core
Layer10	2.00	0.0028	0.0028	0.0028	Solder

Layu, Cap, Cond, Gene, Diele, IPC-4, Diele, Allied

Nesting factor: 1.0

Solve

Total Post-Lamination Nom Thick: 0.08216

Coefficient of Thermal Bending: 3.90642570912907E-7

Run PWB Warpag

<<Previous

exit

Analysis Results: Re-Design

Thinner board gives better PTH aspect ratio (t/d), but may cause warpage problem.
Checked that warpage is still same ball-park.

PWB Warpage Analysis

File Help

PWB Thermal Bending Model	(1D Formulae)
PWB Total Diagonal	16.401219466856727
Coef. Thermal Bending (αb)	3.90642570912907E-7
Temperature Change	175
Warpage	0.19235877641971869
Warpage Ratio	0.011728321592698253
Margin of Safety	-0.36052230997235757

Calculate Results

PWB Layup

y

x

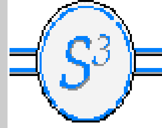
Dielectric Conductor

PWB Plane Strain Model	(2D FEA)
Initial Temperature	25
Final Temperature	200
Temperature Change	175.0
FEA Min Elem Div	2
FEA Aspect Ratio	4
Max Stress XX	2374.13
Min Stress XX	-6879.96
Local Warpage	3.688E-4
Warpage Ratio	0.0022444011684518016
Margin of Safety	2.3416485900216917

Create FEA Input | View FEA Input

Calculate FEA Results | View Graphical Results

PWA / B Parameters	
Description	A String
PWA Part #	A String
PWB Part #	ABC_9230
PWB Pre-Lamination Thickness	0.09559999999999995
PWB Post-Lamination Thickness	0.08216
PWB Total Width	10.0
PWB Total Length	13.0
Allowable Warpage Ratio	0.0075



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CONCLUSIONS

- DESIGN GROUP IS A SMALL GROUP
- WE NEED TECHNICAL TOOLS
- U - ENGINEER HAS PROVIDED AN AWARENESS OF TECHNICAL HELP
- ENGINEERING TOOLS WILL ASSIST THE DESIGNER TO CREATE A PRODUCT THAT SHOULD BE EASIER TO MANUFACTURE