CIRCUIT EXPRESS, INC.

"Quality in Every Process"

USE OF ENGINEERING TOOLS
CASE HISTORIES

JAKE ROBERTS

CIRCUIT EXPRESS, INC.
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COMPANY PROFILE

- SMALL BUSINESS
- ESTABLISHED IN 1987
- ARIZONA CORPORATION
- EMPLOYEE OWNED WITH 35 EMPL.
- PRINTED CIRCUIT BOARD MANUF.
- MILITARY AND COMMERCIAL
- SHORT INTERVAL MANUFACTURER

CAPABILITY PROFILE

- DOUBLE SIDED THROUGH 20 LAYERS
- EPOXY, POLYIMIDE, TEFLON, KAPTON
- RIGID, FLEX, AND RIGID FLEX
- CONTROLLED IMPEDANCE
- BLIND AND BURIED VIAS
- 7 MIL PITCH AND 5 MIL LINES/SPACES
- HIGH ASPECT RATIO

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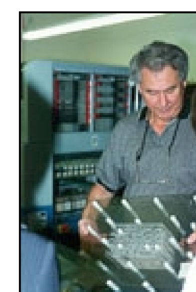
CAPABILITY PROFILE

- SURFACE FINISHES
  - SOLDER COAT AND FUSED TIN LEAD
  - GOLD, NICKEL, TIN NICKEL
  - IMMERSION TIN

- ELECTRICAL TESTING
  - SIMULTANEOUS TOP AND BOTTOM
  - FIXTURED NET LIST AT 80 MIL GRID
  - FIXTURELESS FLYING PROBE



EXPERTISE

- MFG. COMPLEX PRODUCTS
- ENGINEERING SOLUTIONS
- DELIVERY IN SHORT INTERVAL
- DESIGN FOR MANUFACTURE
- PROCESS CONSISTENCY
- FOCUS ON CUSTOMER SATISFACTION

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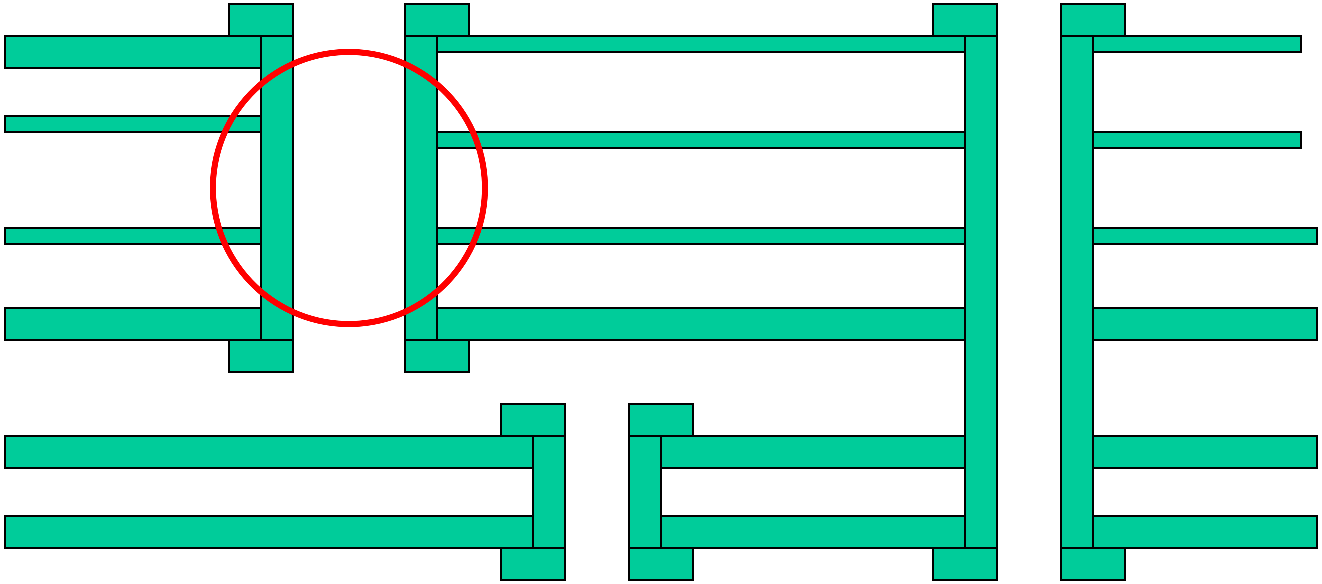
USE OF ENGINEERING TOOLS CASE 1

- SIX LAYER DOUBLE BLIND VIA
- PROBLEM OF FATIGUE FAILURE IN VIA
- CUSTOMER W/O ANALYTICAL TOOLS
- SEARCHED THE WEB FOR SOLUTIONS
- LOCATED "U-ENGINEER" AT GA TECH
- SOLICITED HELP FROM GA -TECH
- FINITE ELEMENT ANALYSIS

CASE 1 LAY-UP

- LAYER 1-4 BLIND & 5-6 BLIND

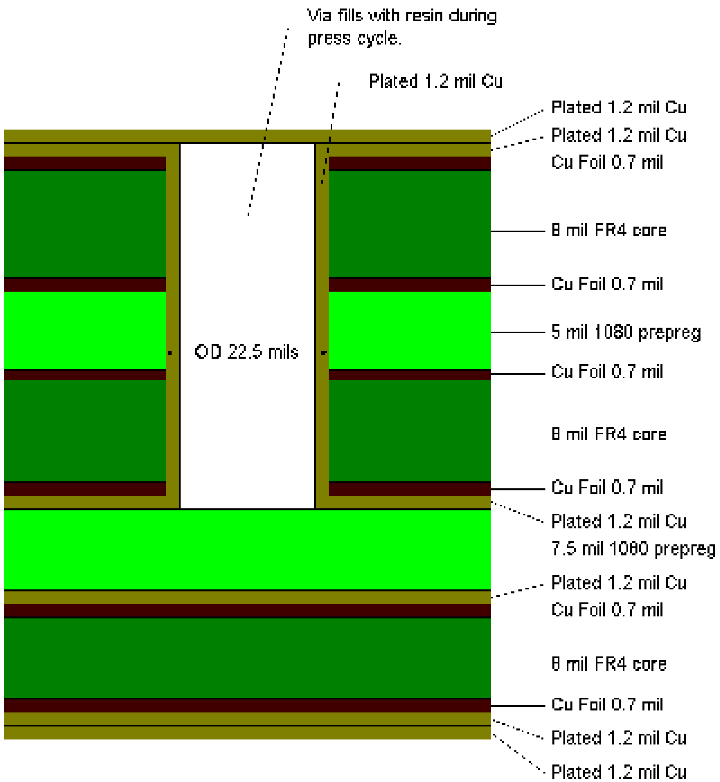


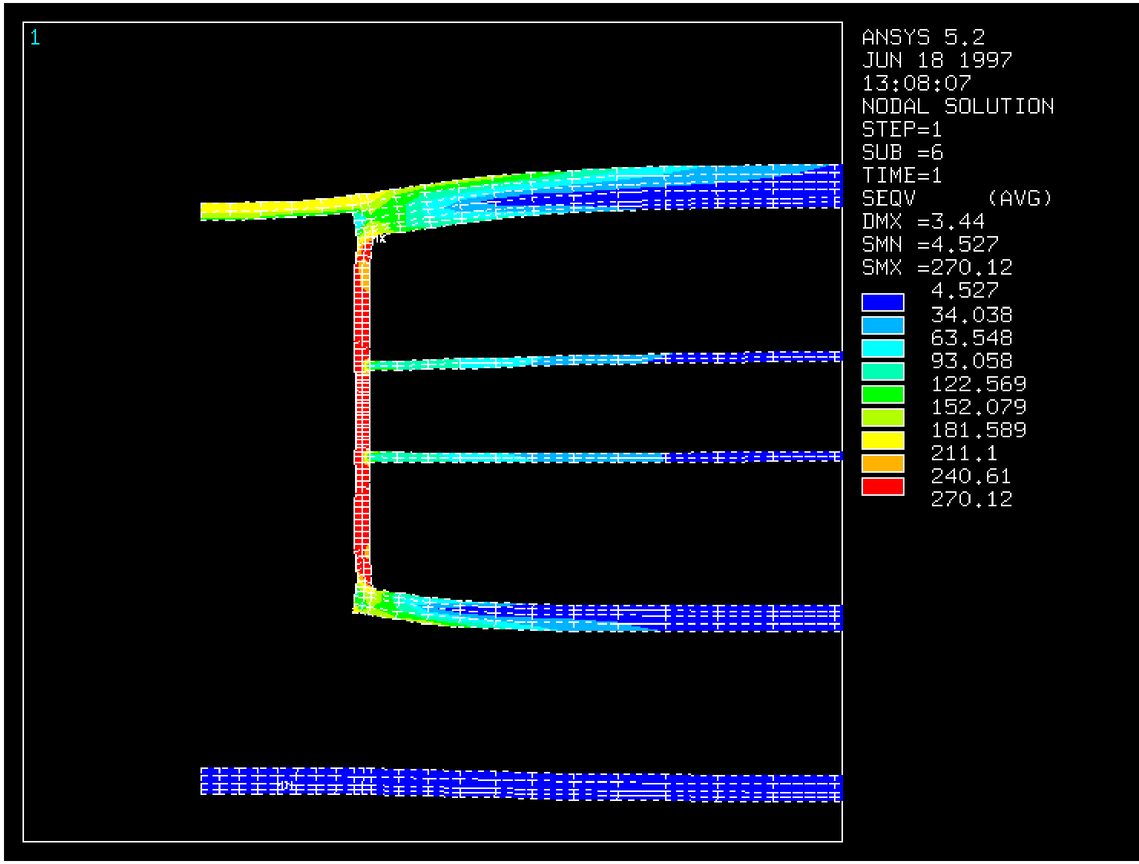
USE OF ENGINEERING TOOLS CASE 1 CONTINUED

- ANALYSIS OF PLATED THROUGH HOLES
- PREDICTED FATIGUE FAILURE OF BLIND VIA DURING 2ND PRESS CYCLE
- BOARD REDESIGNED TO REDUCE BARREL STRESSES

Case 1 Analysis Results

Plated Through Via





Barrel Stress > Ultimate Strength (~260MPa), so predicts original design will fail.

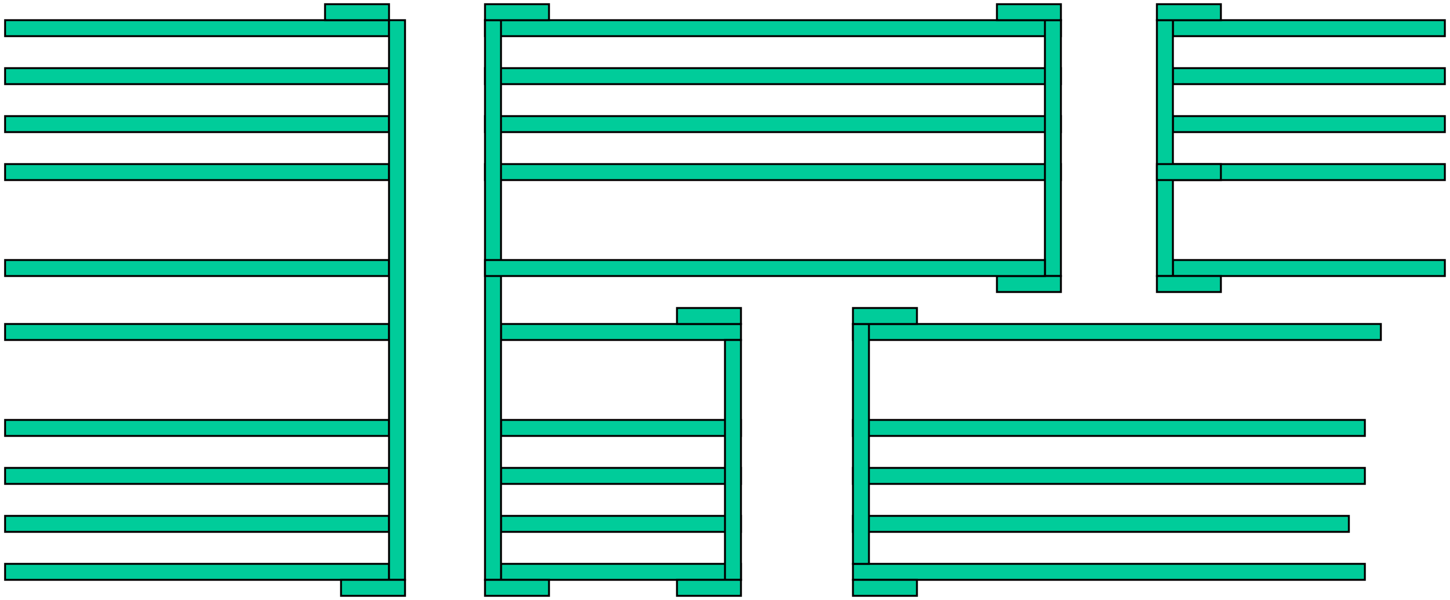
Conclusion: Analysis before mfg. would have prevented scrap & delays.

USE OF ENGINEERING TOOLS CASE STUDY 2

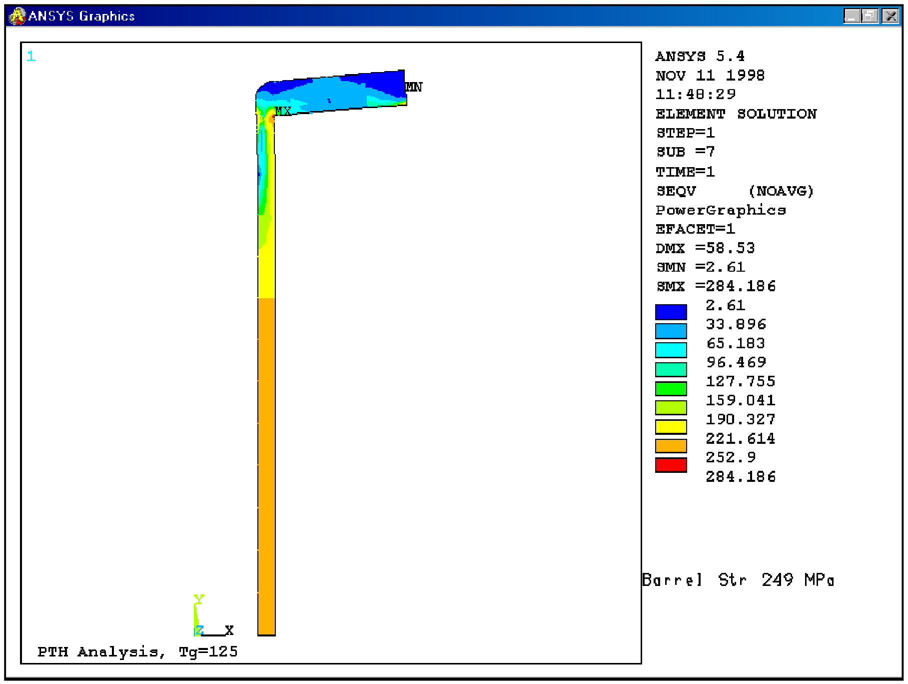
- TEN LAYER DOUBLE BLIND VIA
- EPOXY, FIVE CORE, 80 MILS THICK
- COST SENSITIVE
- RELIABILITY ISSUES AFTER THERMAL CYCLE
- FATIGUE ANALYSIS PREDICTED RELIABILITY WITH POLYIMIDE

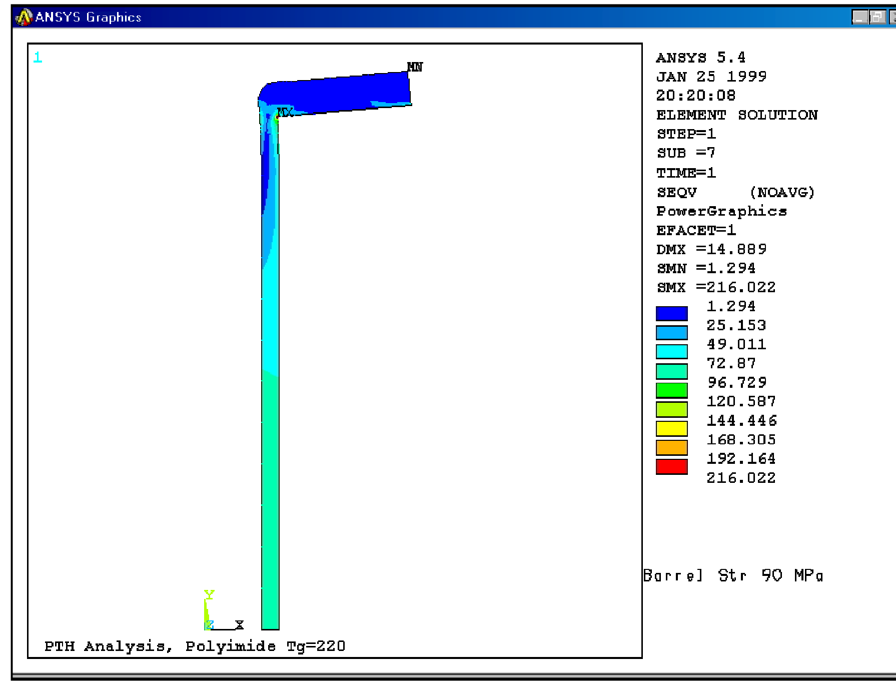
CASE 2 LAY- UP

- LAYERS 1-5 & 6-10 ARE BLIND



Case 2 Analysis Results





Standard FR4
σ_{barrel} = 249 MPa

64% Reduction

T_g = 220 °C Polyimide
σ_{barrel} = 90 MPa

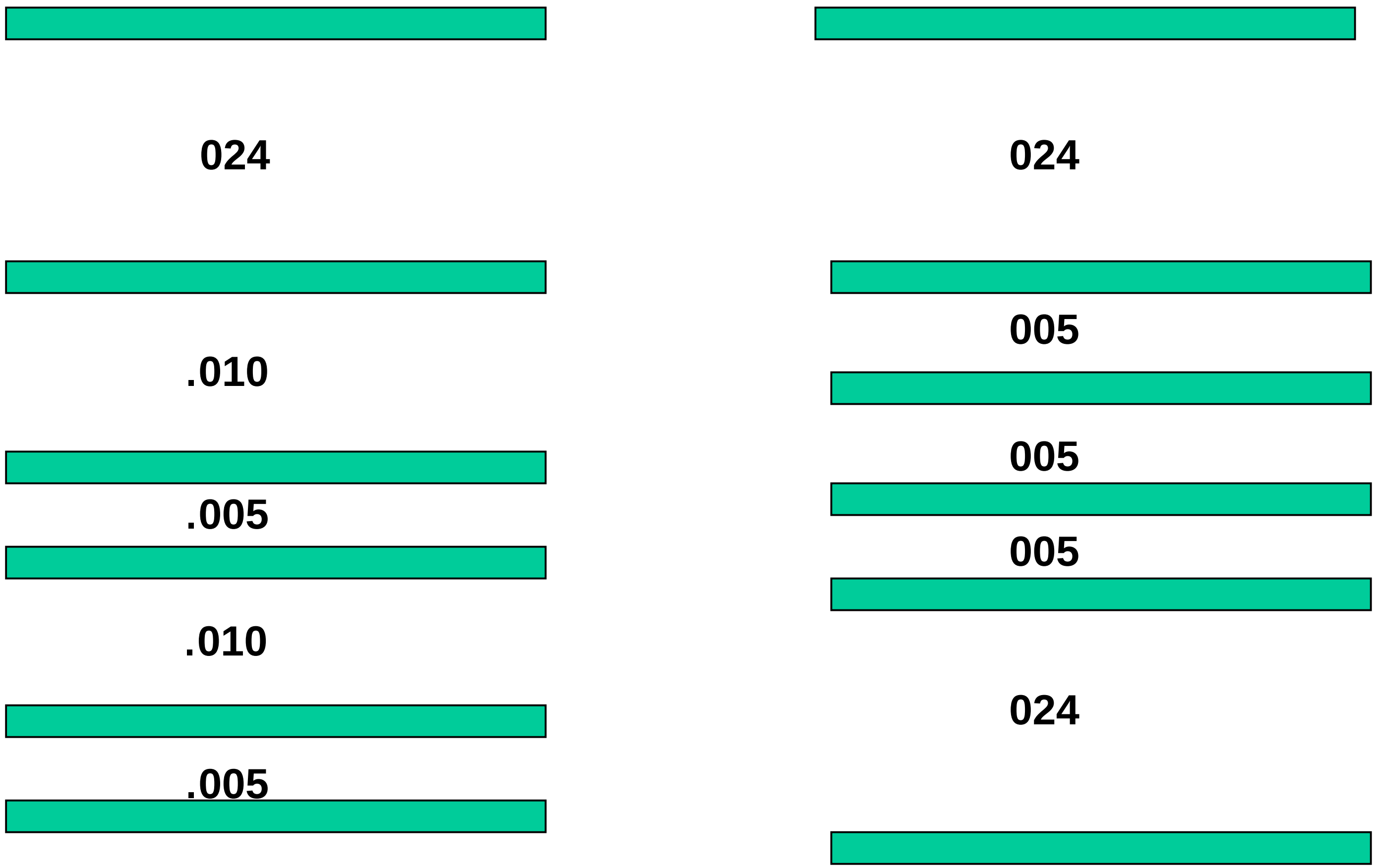
Conclusion: Polyimide design chosen to reduce stress and increase reliability

USE OF ENGINEERING TOOLS CASE STUDY 3

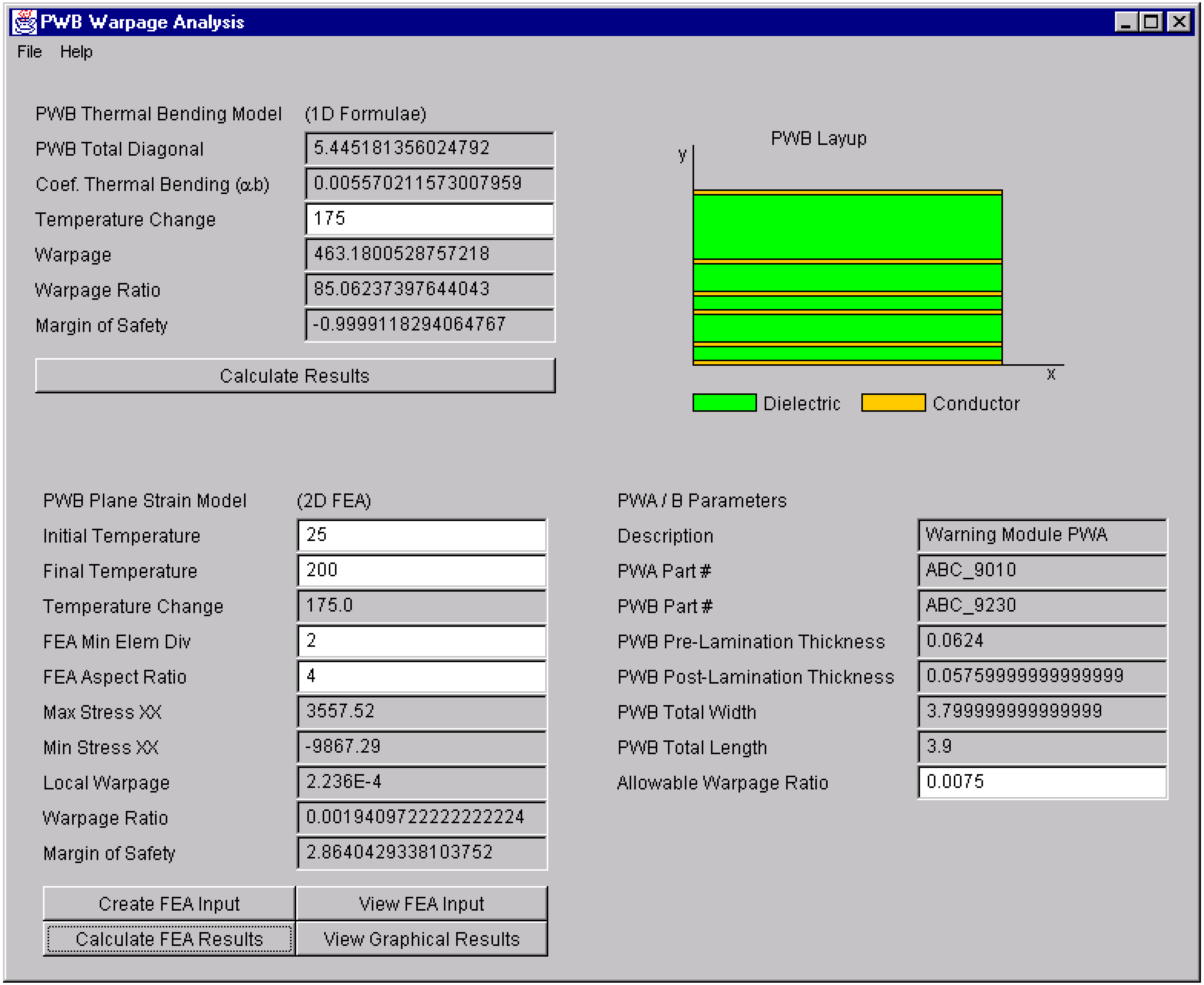
- SIX LAYER, 67 MILS THICK WITH NON-SYMMETRICAL Z AXIS
- SEVERE WARP
- WARP ANALYSIS PREDICTED THERMAL DISTORTION
- MODELED CONSTRUCTION VARIABLES - REDUCED DISTORTION

CASE 3 LAY- UP

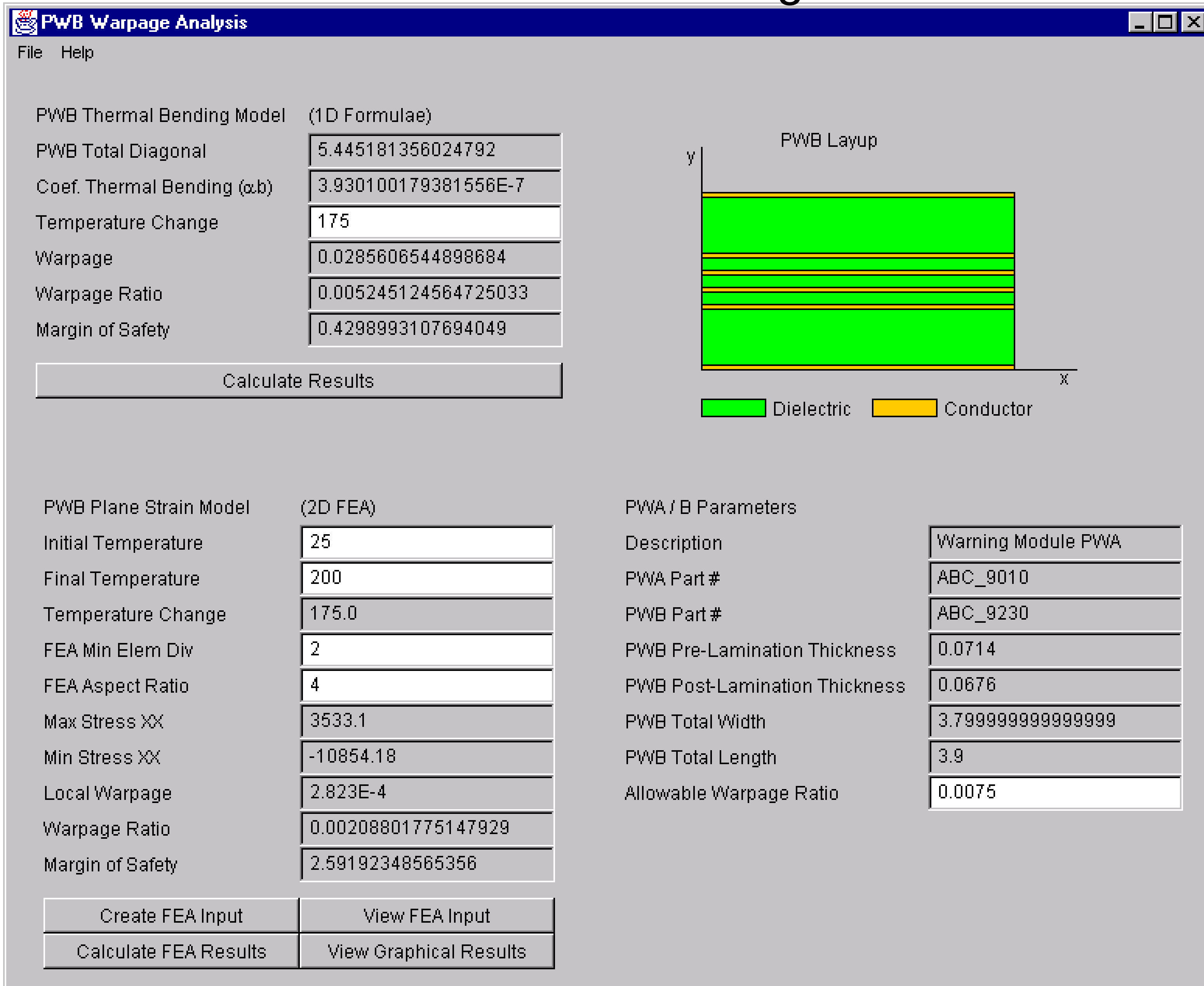
ORIGINAL | **REVISED**



Case 3 Original



Case 3 Re-Design



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CONCLUSIONS

- WE ARE A SMALL BUSINESS WITH LIMITED ENGRG. RESOURCES
- U - ENGINEER HAS PERMITTED US TO SOLVE SOME COMPLEX PROBLEMS
- WE NOW HAVE THE CAPABILITY TO PROVIDE A VALUABLE SERVICE TO THE CUSTOMER