Appendix 8:

Thermal Simulations
**Condition 1, 1: SS; IC, 25; C, AS, 15,-40; HF, 18, 1**

Geometry: Aluminum 6061-T6 for all parts including the PCB. Screws excluded from analysis. No Separation at all areas of contact.
Analysis Settings: Steady-State [SS]
Initial Conditions [IC]: 25°C [25]
Convection [C]: All Surfaces [AS], Film Coefficient: 15W/m2K [15], Ambient Temperature: -40 °C [-40]
Heat Flux [HF]: (through the heat sinks) 18W (100% of the 18W) [18, 1]

**Condition 1, 2: SS; IC, 25; C, AS, 15,-40; IHF, 1.8, 0.1; HF, 16.2, 0.9**

Geometry: Aluminum 6061-T6 for all parts including the PCB. Screws excluded from analysis. No Separation at all areas of contact.
Analysis Settings: Steady-State [SS]
Initial Conditions [IC]: 25 °C [25]
Convection [C]: All Surfaces [AS], Film Coefficient: 15W/m2K [15], Ambient Temperature: -40 °C [-40]
Internal Heat Generation [IHG]: (of the PCB) 1.8W (10% of the 18W) [1.8, 0.1]
Heat Flux [HF]: (through the heat sinks) 16.2W (90% of the 18W) [16.2, 0.9]

**Condition 1, 3: SS; IC, 25; C, AS, 15,-40; IHF, 4.5, 0.25; HF, 13.5, 0.75**

Geometry: Aluminum 6061-T6 for all parts including the PCB. Screws excluded from analysis. No Separation at all areas of contact.
Analysis Settings: Steady-State [SS]
Initial Conditions [IC]: 25 °C [25]
Convection [C]: All Surfaces [AS], Film Coefficient: 15W/m2K [15], Ambient Temperature: -40 °C [-40]
Internal Heat Generation [IHG]: (of the PCB) 4.5W (25% of the 18W) [4.5, 0.25]
Heat Flux [HF]: (through the heat sinks) 13.5W (75% of the 18W) [13.5, 0.75]

**Condition 1, 4: SS; IC, 25; C, AS, 15,-40; IHF, 9, 0.5; HF, 9, 0.5**

Geometry: Aluminum 6061-T6 for all parts including the PCB. Screws excluded from analysis. No Separation at all areas of contact.
Analysis Settings: Steady-State [SS]
Initial Conditions [IC]: 25 °C [25]
Convection [C]: All Surfaces [AS], Film Coefficient: 15W/m2K [15], Ambient Temperature: -40 °C [-40]
Internal Heat Generation [IHG]: (of the PCB) 9W (50% of the 18W) [9, 0.5]
Heat Flux [HF]: (through the heat sinks) 9W (50% of the 18W) [9, 0.5]

**Condition 1, 5: SS; IC, 25; C, AS, 15,-40; IHF, 13.5, 0.75; HF, 4.5, 0.25**

Geometry: Aluminum 6061-T6 for all parts including the PCB. Screws excluded from analysis. No Separation at all areas of contact.
Analysis Settings: Steady-State [SS]
Initial Conditions [IC]: 25 °C [25]
Convection [C]: All Surfaces [AS], Film Coefficient: 15W/m2K [15], Ambient Temperature: -40 °C [-40]
Internal Heat Generation [IHG]: (of the PCB) 13.5W (75% of the 18W) [13.5, 0.75]
Heat Flux [HF]: (through the heat sinks) 4.5W (25% of the 18W) [4.5, 0.25]
**Condition 1, 6: SS; IC, 25; C, AS, 15,-40; IHF, 18, 1**

Geometry: Aluminum 6061-T6 for all parts including the PCB. Screws excluded from analysis. No Separation at all areas of contact.
Analysis Settings: Steady-State [SS]
Initial Conditions [IC]: 25 °C [25]
Convection [C]: All Surfaces [AS], Film Coefficient: 15W/m2K [15], Ambient Temperature: -40 °C [-40]
Internal Heat Generation [IHG]: (of the PCB) 18W (100% of the 18W) [18, 1]
Total Heat Flux

Project: Thermal Project
Subject: Thermal Analysis
Author: Anthony J. Berwin
Prepared For: Detailed Design Review
Date: Sunday, February 08, 2009
Comments: Condition 1,1: SS; IC,25; C,AS,15,-40; HF,18,1

Total Heat Flux
Type: Total Heat Flux
Unit: W/m²
Time: 1
2/8/2009 7:47 PM

5.6292e5 Max
2.412e5
1.0335e5
44283
18974
8130
3483.6
1492.6
639.55
274.04 Min

0.000 0.050 (m)
0.025

file://D:\Program Files\ANSYS Inc\v110\AISOL\DesignSpace\DSPages\html\PrintPreview.htm
Temperature

Project: Thermal Project
Subject: Thermal Analysis
Author: Anthony J. Berwin
Prepared For: Detailed Design Review
Date: Sunday, February 08, 2009
Comments: Condition 1,1: SS; IC,25; C,AS,15,-40; HF,18,1
Total Heat Flux

Project: Thermal Project
Subject: Thermal Analysis
Author: Anthony J. Berwin
Prepared For: Detailed Design Review
Date: Sunday, February 08, 2009
Comments: Condition 1,2: SS; IC,25; C,AS,15,-40; IHF,1.8,0.1; HF,16.2,0.9
Temperature

Project: Thermal Project
Subject: Thermal Analysis
Author: Anthony J. Berwin
Prepared For: Detailed Design Review
Date: Sunday, February 08, 2009
Comments: Condition 1,2: SS; IC,25; C,AS,15,-40; IHF,1.8,0.1; HF,16.2,0.9
Total Heat Flux

Project: Thermal Project
Subject: Thermal Analysis
Author: Anthony J. Berwin
Prepared For: Detailed Design Review
Date: Sunday, February 08, 2009
Comments: Condition 1,3: SS; IC,25; C,AS,15,-40; IHF,4.5,0.25; HF,13.5,0.75
Temperature

Project: Thermal Project
Subject: Thermal Analysis
Author: Anthony J. Berwin
Prepared For: Detailed Design Review
Date: Sunday, February 08, 2009
Comments: Condition 1,3: SS; IC,25; C,AS,15,-40; IHF,4.5,0.25; HF,13.5,0.75
Total Heat Flux

Project: Thermal Project
Subject: Thermal Analysis
Author: Anthony J. Berwin
Prepared For: Detailed Design Review
Date: Sunday, February 08, 2009
Comments: Condition 1,4: SS; IC,25; C,AS,15,-40; IHF,9,0.5; HF,9,0.5
Temperature

Project: Thermal Project
Subject: Thermal Analysis
Author: Anthony J. Berwin
Prepared For: Detailed Design Review
Date: Sunday, February 08, 2009
Comments: Condition 1,4: SS; IC,25; C,AS,15,-40; IHF,9,0.5; HF,9,0.5
Total Heat Flux

Project: Thermal Project
Subject: Thermal Analysis
Author: Anthony J. Berwin
Prepared For: Detailed Design Review
Date: Sunday, February 08, 2009
Comments: Condition 1.5: SS; IC,25; C,AS,15,-40; IHF,13.5,0.75; HF,4.5,0.25
**Temperature**

**Project:** Thermal Project  
**Subject:** Thermal Analysis  
**Author:** Anthony J. Berwin  
**Prepared For:** Detailed Design Review  
**Date:** Sunday, February 08, 2009  
**Comments:** Condition 1,5: SS; IC,25; C,AS,15,-40; IHF,13.5,0.75; HF,4.5,0.25
Total Heat Flux

Project: Thermal Project
Subject: Thermal Analysis
Author: Anthony J. Berwin
Prepared For: Detailed Design Review
Date: Sunday, February 08, 2009
Comments: Condition 1,6: SS; IC,25; C,AS,15,-40; IHF,18,1
Temperature

Project: Thermal Project
Subject: Thermal Analysis
Author: Anthony J. Berwin
Prepared For: Detailed Design Review
Date: Sunday, February 08, 2009
Comments: Condition 1,6: SS; IC,25; C,AS,15,-40; IHF,18,1
Condition 2, 1: SS; IC, 25; C, BS, 100,-40; IHF, 1.8, 0.1; HF, 16.2, 0.9

Geometry: Aluminum 6061-T6 for all parts including the PCB. Screws excluded from analysis. No Separation at all areas of contact.
Analysis Settings: Steady-State [SS]
Initial Conditions [IC]: 25 °C [25]
Convection [C]: Bottom Surface [BS], Film Coefficient: 100W/m\(^2\)K [100], Ambient Temperature: -40 °C [-40]
Internal Heat Generation [IHG]: (of the PCB) 1.8W (10% of the 18W) [1.8, 0.1]
Heat Flux [HF]: (through the heat sinks) 16.2W (90% of the 18W) [16.2, 0.9]

Condition 2, 2: SS; IC, 25; C, BS, 250,-40; IHF, 1.8, 0.1; HF, 16.2, 0.9

Geometry: Aluminum 6061-T6 for all parts including the PCB. Screws excluded from analysis. No Separation at all areas of contact.
Analysis Settings: Steady-State [SS]
Initial Conditions [IC]: 25 °C [25]
Convection [C]: Bottom Surface [BS], Film Coefficient: 250W/m\(^2\)K [250], Ambient Temperature: -40 °C [-40]
Internal Heat Generation [IHG]: (of the PCB) 1.8W (10% of the 18W) [1.8, 0.1]
Heat Flux [HF]: (through the heat sinks) 16.2W (90% of the 18W) [16.2, 0.9]

Condition 2, 3: SS; IC, 25; C, BS, 500,-40; IHF, 1.8, 0.1; HF, 16.2, 0.9

Geometry: Aluminum 6061-T6 for all parts including the PCB. Screws excluded from analysis. No Separation at all areas of contact.
Analysis Settings: Steady-State [SS]
Initial Conditions [IC]: 25 °C [25]
Convection [C]: Bottom Surface [BS], Film Coefficient: 500W/m\(^2\)K [500], Ambient Temperature: -40 °C [-40]
Internal Heat Generation [IHG]: (of the PCB) 1.8W (10% of the 18W) [1.8, 0.1]
Heat Flux [HF]: (through the heat sinks) 16.2W (90% of the 18W) [16.2, 0.9]

Condition 2, 4: SS; IC, 25; C, BS, 750,-40; IHF, 1.8, 0.1; HF, 16.2, 0.9

Geometry: Aluminum 6061-T6 for all parts including the PCB. Screws excluded from analysis. No Separation at all areas of contact.
Analysis Settings: Steady-State [SS]
Initial Conditions [IC]: 25 °C [25]
Convection [C]: Bottom Surface [BS], Film Coefficient: 750W/m\(^2\)K [750], Ambient Temperature: -40 °C [-40]
Internal Heat Generation [IHG]: (of the PCB) 1.8W (10% of the 18W) [1.8, 0.1]
Heat Flux [HF]: (through the heat sinks) 16.2W (90% of the 18W) [16.2, 0.9]
Condition 2, 5: SS; IC, 25; C, BS, 1000,-40; IHF, 1.8, 0.1; HF, 16.2, 0.9

Geometry: Aluminum 6061-T6 for all parts including the PCB. Screws excluded from analysis. No Separation at all areas of contact.
Analysis Settings: Steady-State [SS]
Initial Conditions [IC]: 25 °C [25]
Convection [C]: Bottom Surface [BS], Film Coefficient: 1000W/m²K [1000], Ambient Temperature: -40 °C [-40]
Internal Heat Generation [IHG]: (of the PCB) 1.8W (10% of the 18W) [1.8, 0.1]
Heat Flux [HF]: (through the heat sinks) 16.2W (90% of the 18W) [16.2, 0.9]
Total Heat Flux

Project: Thermal Project
Subject: Thermal Analysis
Author: Anthony J. Berwin
Prepared For: Detailed Design Review
Date: Sunday, February 08, 2009
Comments: Condition 2,1: SS; IC,25; C,BS,100,-40; IHF,1.8,0.1; HF,16.2,0.9
Temperature

Project: Thermal Project
Subject: Thermal Analysis
Author: Anthony J. Berwin
Prepared For: Detailed Design Review
Date: Sunday, February 08, 2009
Comments: Condition 2,1: SS; IC,25; C,BS,100,-40; IHF,1.8,0.1; HF,16.2,0.9
Total Heat Flux

Project: Thermal Project
Subject: Thermal Analysis
Author: Anthony J. Berwin
Prepared For: Detailed Design Review
Date: Sunday, February 08, 2009
Comments: Condition 2,2: SS; IC,25; C,BS,250,-40; IHF,1.8,0.1; HF,16.2,0.9
Temperature

Project: Thermal Project
Subject: Thermal Analysis
Author: Anthony J. Berwin
Prepared For: Detailed Design Review
Date: Sunday, February 08, 2009
Comments: Condition 2,2: SS; IC,25; C,BS,250,-40; IHF,1.8,0.1; HF,16.2,0.9
Total Heat Flux

Project: Thermal Project
Subject: Thermal Analysis
Author: Anthony J. Berwin
Prepared For: Detailed Design Review
Date: Sunday, February 08, 2009
Comments: Condition 2,3: SS; IC,25; C,BS,500,-40; IHF,1.8,0.1; HF,16.2,0.9

[Diagram of Total Heat Flux with color scale from 3.2357 Min to 5.6519e5 Max]
Temperature

Project: Thermal Project
Subject: Thermal Analysis
Author: Anthony J. Berwin
Prepared For: Detailed Design Review
Date: Sunday, February 08, 2009
Comments: Condition 2,3: SS; IC,25; C,BS,500,-40; IHF,1.8,0.1; HF,16.2,0.9
Total Heat Flux

Project: Thermal Project
Subject: Thermal Analysis
Author: Anthony J. Berwin
Prepared For: Detailed Design Review
Date: Sunday, February 08, 2009
Comments: Condition 2,4: SS; IC,25; C,BS,750,-40; IHF,1.8,0.1; HF,16.2,0.9
**Temperature**

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<th>Thermal Project</th>
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<tr>
<td>Subject:</td>
<td>Thermal Analysis</td>
</tr>
<tr>
<td>Author:</td>
<td>Anthony J. Berwin</td>
</tr>
<tr>
<td>Prepared For:</td>
<td>Detailed Design Review</td>
</tr>
<tr>
<td>Date:</td>
<td>Sunday, February 08, 2009</td>
</tr>
<tr>
<td>Comments:</td>
<td>Condition 2.4: SS; IC,25; C,BS,750,-40; IHF,1.8,0.1; HF,16.2,0.9</td>
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</table>

![Temperature Diagram](image-url)
Total Heat Flux

Project: Thermal Project
Subject: Thermal Analysis
Author: Anthony J. Berwin
Prepared For: Detailed Design Review
Date: Sunday, February 08, 2009
Comments: Condition 2,5: SS; IC,25; C,BS,1000,-40; IHF,1.8,0.1; HF,16.2,0.9
Temperature

Project: Thermal Project
Subject: Thermal Analysis
Author: Anthony J. Berwin
Prepared For: Detailed Design Review
Date: Sunday, February 08, 2009
Comments: Condition 2,5: SS; IC,25; C,BS,1000,-40; IHF,1.8,0.1; HF,16.2,0.9
**Condition 3, 1: SS; IC, 25; C, AS, 15,-40; IHF, 1.8, 0.1; HF, 16.2, 0.9**

Geometry: Aluminum 6061-T6 for all parts including the PCB. Screws excluded from analysis. No Separation at all areas of contact.
Analysis Settings: Steady-State [SS]
Initial Conditions [IC]: 25 °C [25]
Convection [C]: All Surfaces [AS], Film Coefficient: 15W/m²K [15], Ambient Temperature: -40 °C [-40]
Internal Heat Generation [IHG]: (of the PCB) 1.8W (10% of the 18W) [1.8, 0.1]
Heat Flux [HF]: (through the heat sinks) 16.2W (90% of the 18W) [16.2, 0.9]

**Condition 3, 2: SS; IC, 25; C, AS, 25,-40; IHF, 1.8, 0.1; HF, 16.2, 0.9**

Geometry: Aluminum 6061-T6 for all parts including the PCB. Screws excluded from analysis. No Separation at all areas of contact.
Analysis Settings: Steady-State [SS]
Initial Conditions [IC]: 25 °C [25]
Convection [C]: All Surfaces [AS], Film Coefficient: 25W/m²K [25], Ambient Temperature: -40 °C [-40]
Internal Heat Generation [IHG]: (of the PCB) 1.8W (10% of the 18W) [1.8, 0.1]
Heat Flux [HF]: (through the heat sinks) 16.2W (90% of the 18W) [16.2, 0.9]

**Condition 3, 3: SS; IC, 25; C, AS, 50,-40; IHF, 1.8, 0.1; HF, 16.2, 0.9**

Geometry: Aluminum 6061-T6 for all parts including the PCB. Screws excluded from analysis. No Separation at all areas of contact.
Analysis Settings: Steady-State [SS]
Initial Conditions [IC]: 25 °C [25]
Convection [C]: All Surfaces [AS], Film Coefficient: 50W/m²K [50], Ambient Temperature: -40 °C [-40]
Internal Heat Generation [IHG]: (of the PCB) 1.8W (10% of the 18W) [1.8, 0.1]
Heat Flux [HF]: (through the heat sinks) 16.2W (90% of the 18W) [16.2, 0.9]

**Condition 3, 4: SS; IC, 25; C, AS, 75,-40; IHF, 1.8, 0.1; HF, 16.2, 0.9**

Geometry: Aluminum 6061-T6 for all parts including the PCB. Screws excluded from analysis. No Separation at all areas of contact.
Analysis Settings: Steady-State [SS]
Initial Conditions [IC]: 25 °C [25]
Convection [C]: All Surfaces [AS], Film Coefficient: 75W/m²K [75], Ambient Temperature: -40 °C [-40]
Internal Heat Generation [IHG]: (of the PCB) 1.8W (10% of the 18W) [1.8, 0.1]
Heat Flux [HF]: (through the heat sinks) 16.2W (90% of the 18W) [16.2, 0.9]

**Condition 3, 5: SS; IC, 25; C, AS, 100,-40; IHF, 1.8, 0.1; HF, 16.2, 0.9**

Geometry: Aluminum 6061-T6 for all parts including the PCB. Screws excluded from analysis. No Separation at all areas of contact.
Analysis Settings: Steady-State [SS]
Initial Conditions [IC]: 25 °C [25]
Convection [C]: All Surfaces [AS], Film Coefficient: 100W/m²K [100], Ambient Temperature: -40 °C [-40]
Internal Heat Generation [IHG]: (of the PCB) 1.8W (10% of the 18W) [1.8, 0.1]
Heat Flux [HF]: (through the heat sinks) 16.2W (90% of the 18W) [16.2, 0.9]
Total Heat Flux

Project: Thermal Project
Subject: Thermal Analysis
Author: Anthony J. Berwin
Prepared For: Detailed Design Review
Date: Sunday, February 08, 2009
Comments: Condition 3,1: SS; IC,25; C,AS,15,-40; IHF,1.8,0.1; HF,16.2,0.9
Temperature

Project: Thermal Project
Subject: Thermal Analysis
Author: Anthony J. Berwin
Prepared For: Detailed Design Review
Date: Sunday, February 08, 2009
Comments: Condition 3,1: SS; IC,25; C,AS,15,-40; IHF,1.8,0.1; HF,16.2,0.9
Total Heat Flux

Project: Thermal Project
Subject: Thermal Analysis
Author: Anthony J. Berwin
Prepared For: Detailed Design Review
Date: Sunday, February 08, 2009
Comments: Condition 3,2: SS; IC,25; C, AS,25, -40; IHF, 1.8, 0.1; HF, 16.2, 0.9

![Total Heat Flux](image)

Total Heat Flux
Type: Total Heat Flux
Unit: W/m²
Time: 1
2/8/2009 9:17 PM

4.983e5 Max
2.129e5
90963
38865
16605
7094.7
3031.3
1295.1
553.35
236.42 Min

0.000
0.025
0.050 (m)
Temperature

Project: Thermal Project
Subject: Thermal Analysis
Author: Anthony J. Berwin
Prepared For: Detailed Design Review
Date: Sunday, February 08, 2009
Comments: Condition 3,2: SS; IC,25; C,AS,25,-40; IHF,1.8,0.1; HF,16.2,0.9
Total Heat Flux

Project: Thermal Project
Subject: Thermal Analysis
Author: Anthony J. Berwin
Prepared For: Detailed Design Review
Date: Sunday, February 08, 2009
Comments: Condition 3,3: SS; IC,25; C,AS,50,-40; IHF,1.8,0.1; HF,16.2,0.9
Temperature

Project: Thermal Project
Subject: Thermal Analysis
Author: Anthony J. Berwin
Prepared For: Detailed Design Review
Date: Sunday, February 08, 2009
Comments: Condition 3,3: SS; IC,25; C,AS,50,-40; IHF,1.8,0.1; HF,16.2,0.9
Total Heat Flux

Project: Thermal Project
Subject: Thermal Analysis
Author: Anthony J. Berwin
Prepared For: Detailed Design Review
Date: Sunday, February 08, 2009
Comments: Condition 3,4: SS; IC,25; C,AS,75,-40; IHF,1.8,0.1; HF,16.2,0.9
Temperature

Project: Thermal Project
Subject: Thermal Analysis
Author: Anthony J. Berwin
Prepared For: Detailed Design Review
Date: Sunday, February 08, 2009
Comments: Condition 3,4: SS; IC,25; C,AS,75,-40; IHF,1.8,0.1; HF,16.2,0.9
Total Heat Flux

Project: Thermal Project
Subject: Thermal Analysis
Author: Anthony J. Berwin
Prepared For: Detailed Design Review
Date: Sunday, February 08, 2009
Comments: Condition 3.5: SS; IC, 25; C, AS, 100, -40; IHF, 1.8, 0.1; HF, 16.2, 0.9
Temperature

Project: Thermal Project
Subject: Thermal Analysis
Author: Anthony J. Berwin
Prepared For: Detailed Design Review
Date: Sunday, February 08, 2009
Comments: Condition 3.5: SS; IC,25; C,AS,100,-40; IHF,1.8,0.1; HF,16.2,0.9