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

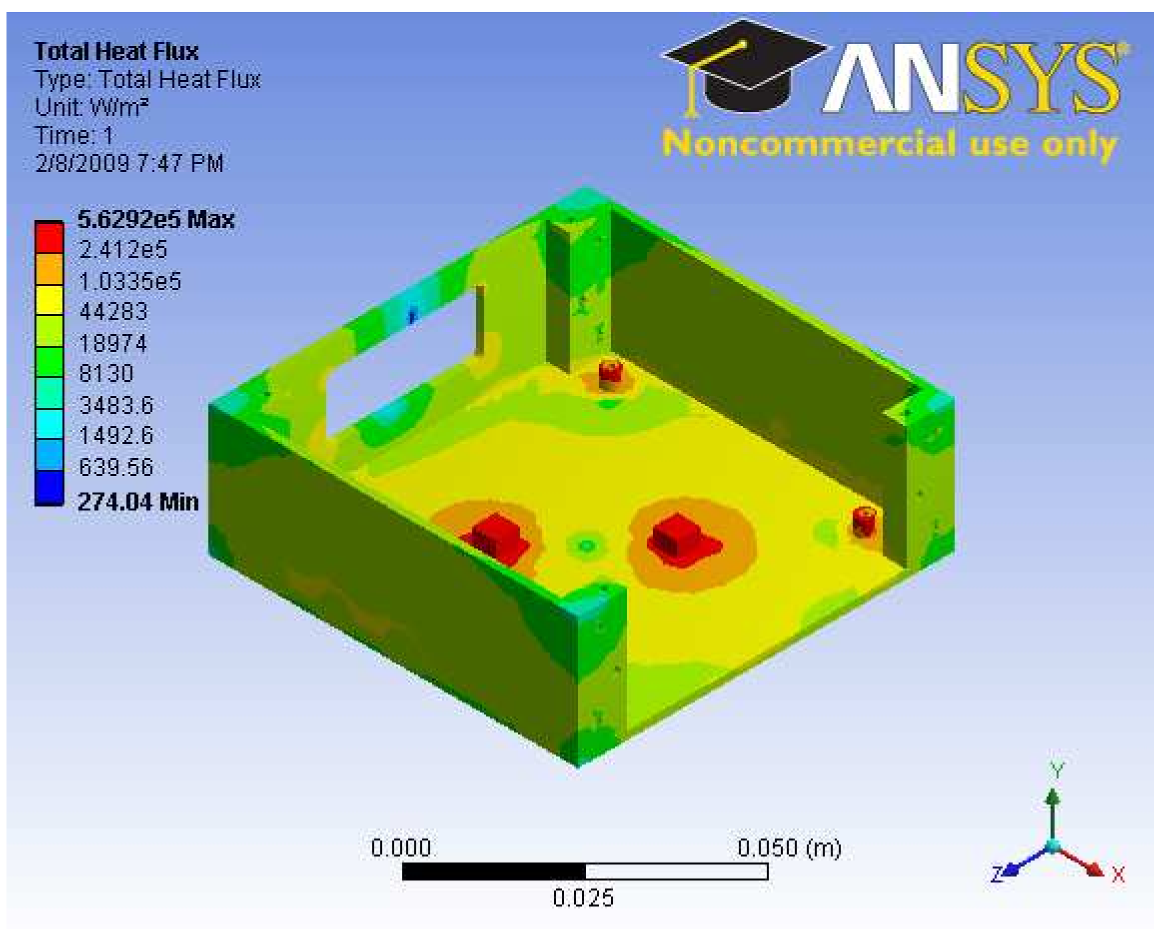
Geometry: Aluminum 6061-T6 for all parts including the PCB. Screws excluded from analysis. No Separation at all areas of contact.
Analysis Settings: Steady-State [SS]
Initial Conditions [IC]: 25 °C [25]
Convection [C]: All Surfaces [AS], Film Coefficient: 15W/m2K [15], Ambient Temperature: -40 °C [-40]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

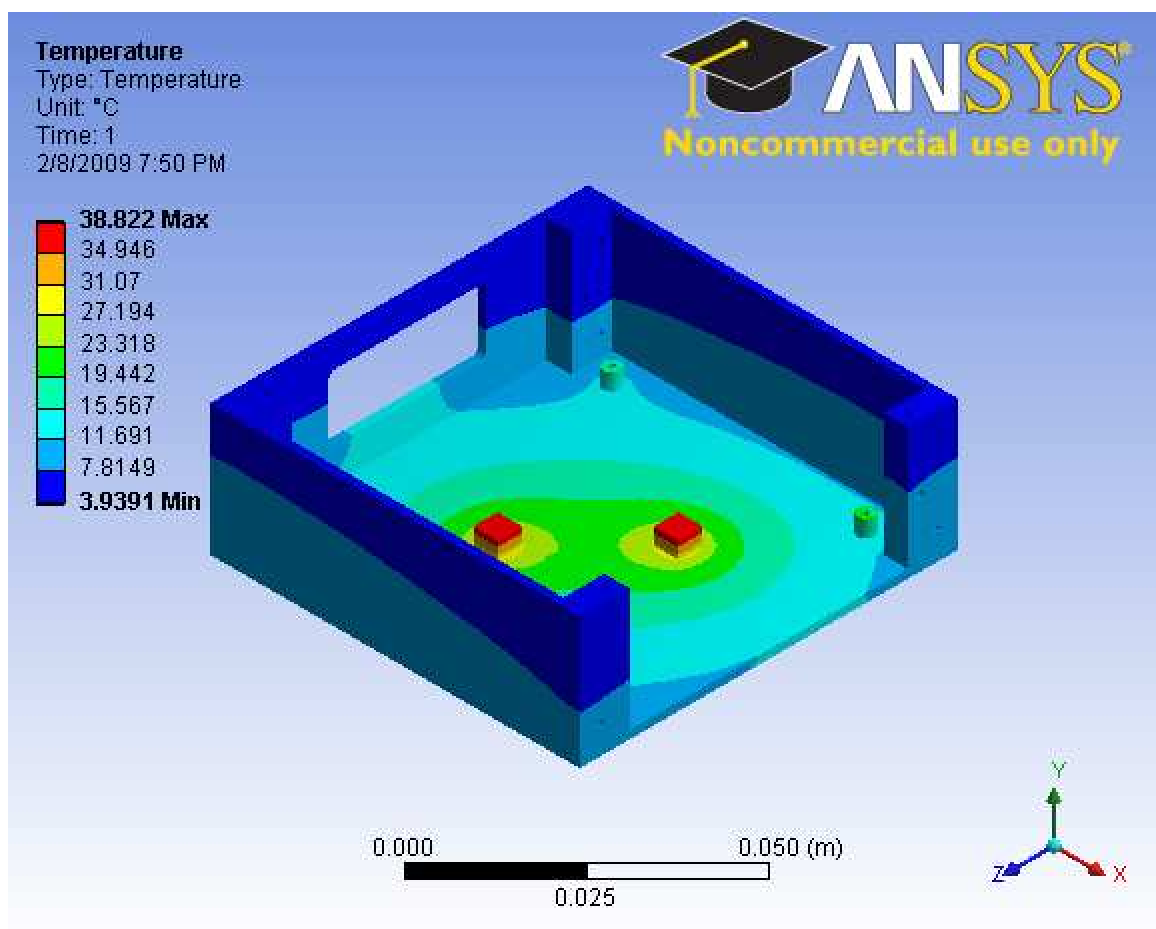
Total Heat Flux

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



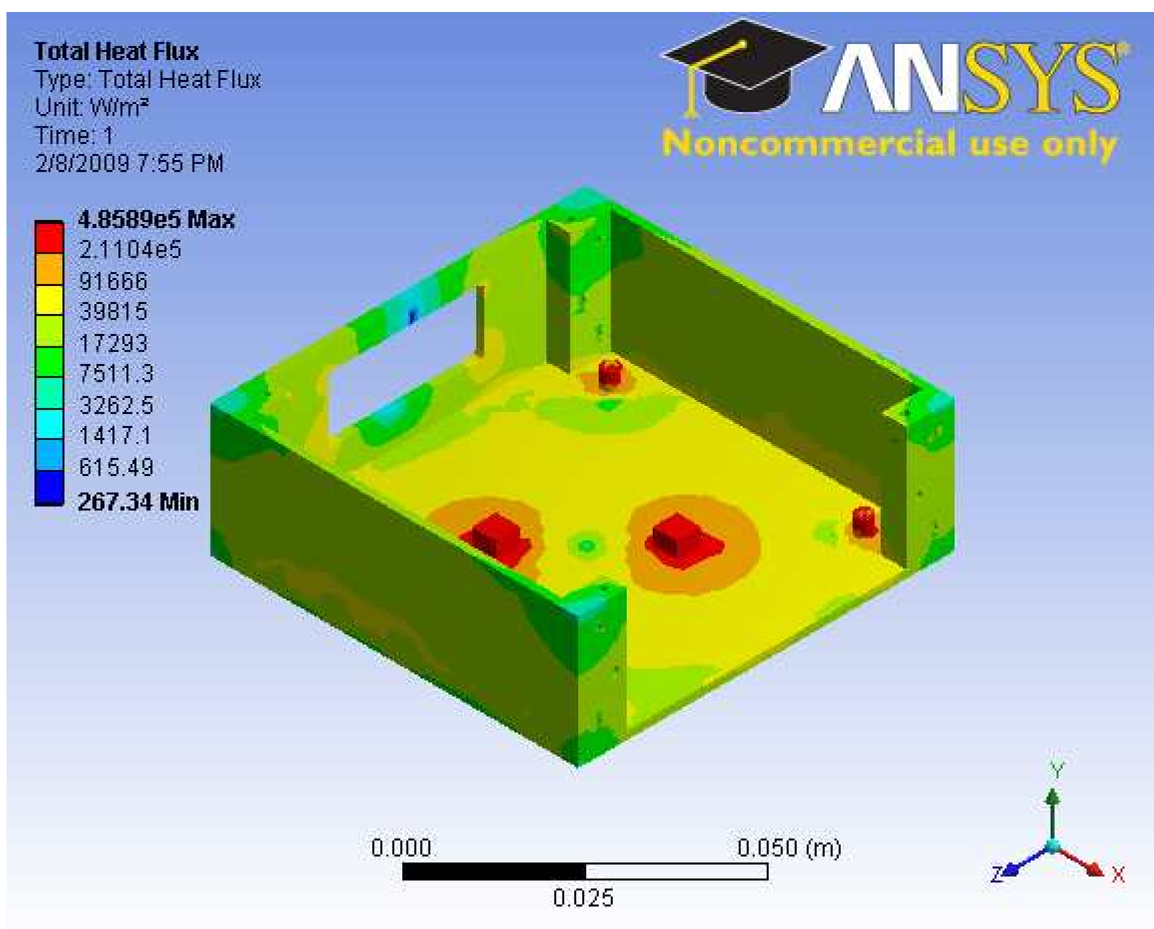
Temperature

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



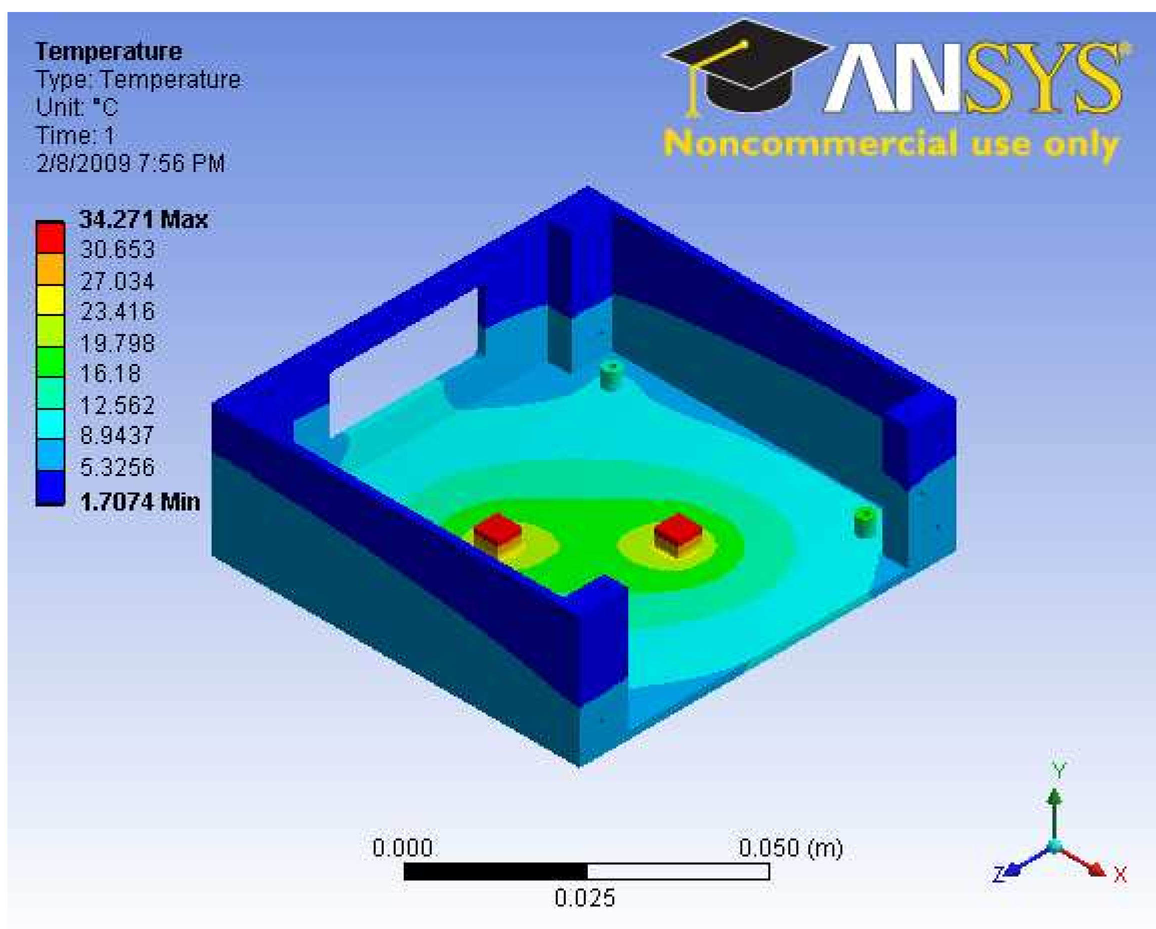
Total Heat Flux

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



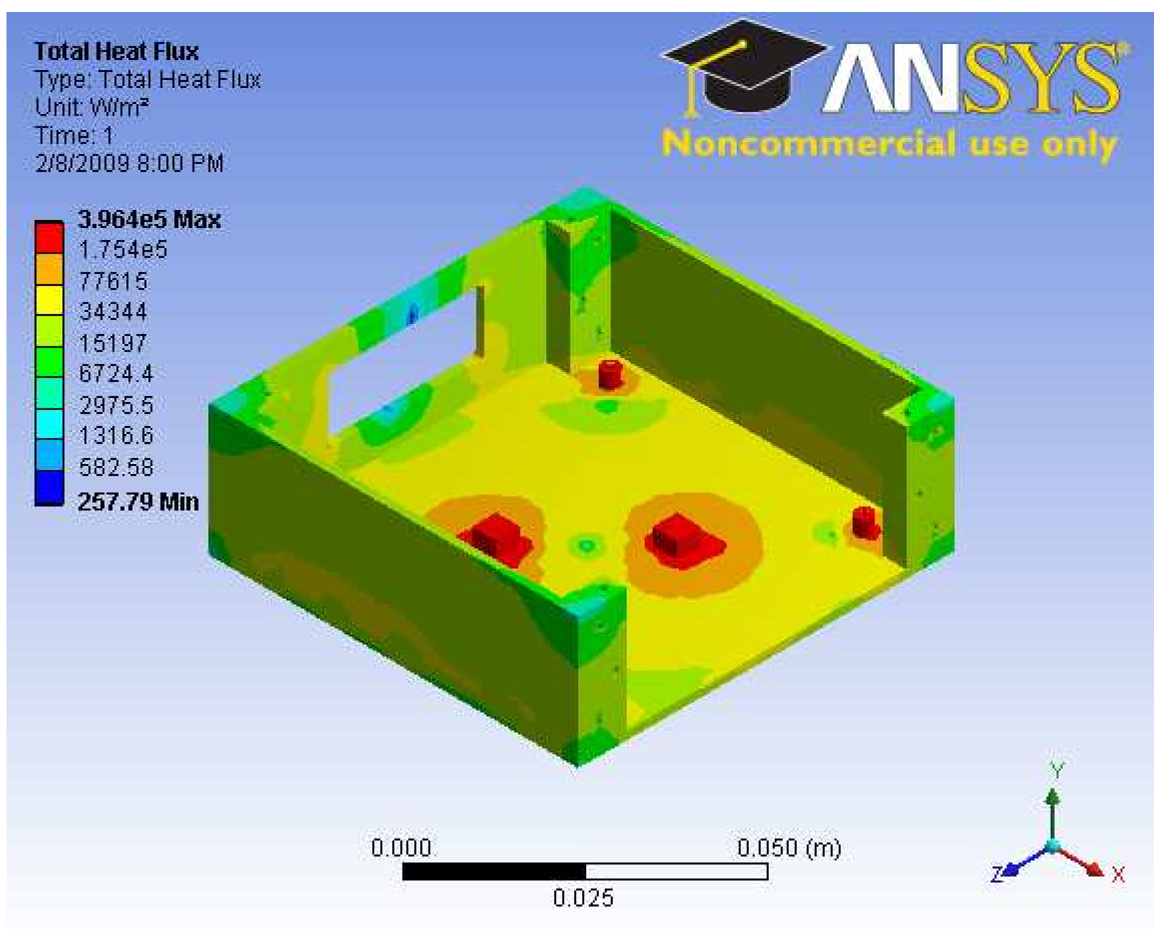
Temperature

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



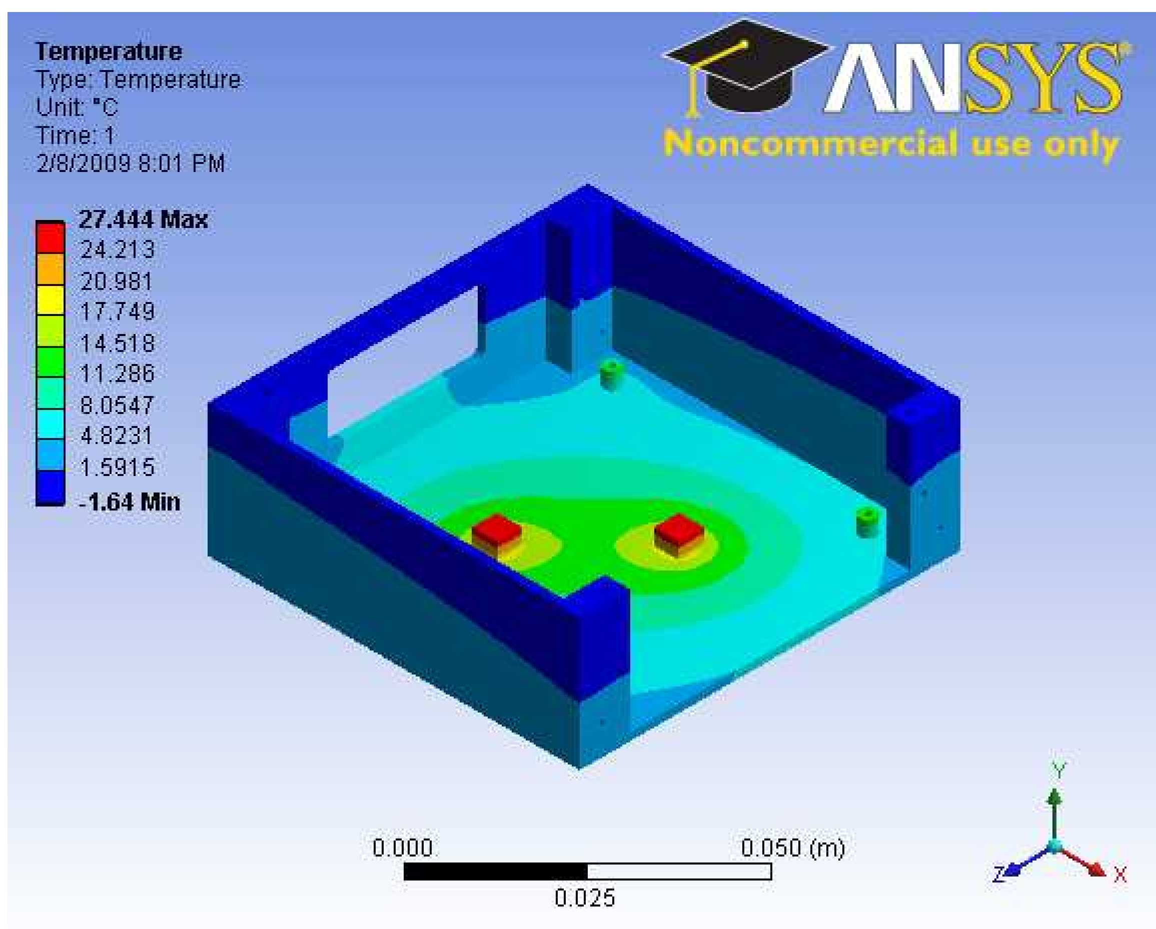
Total Heat Flux

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



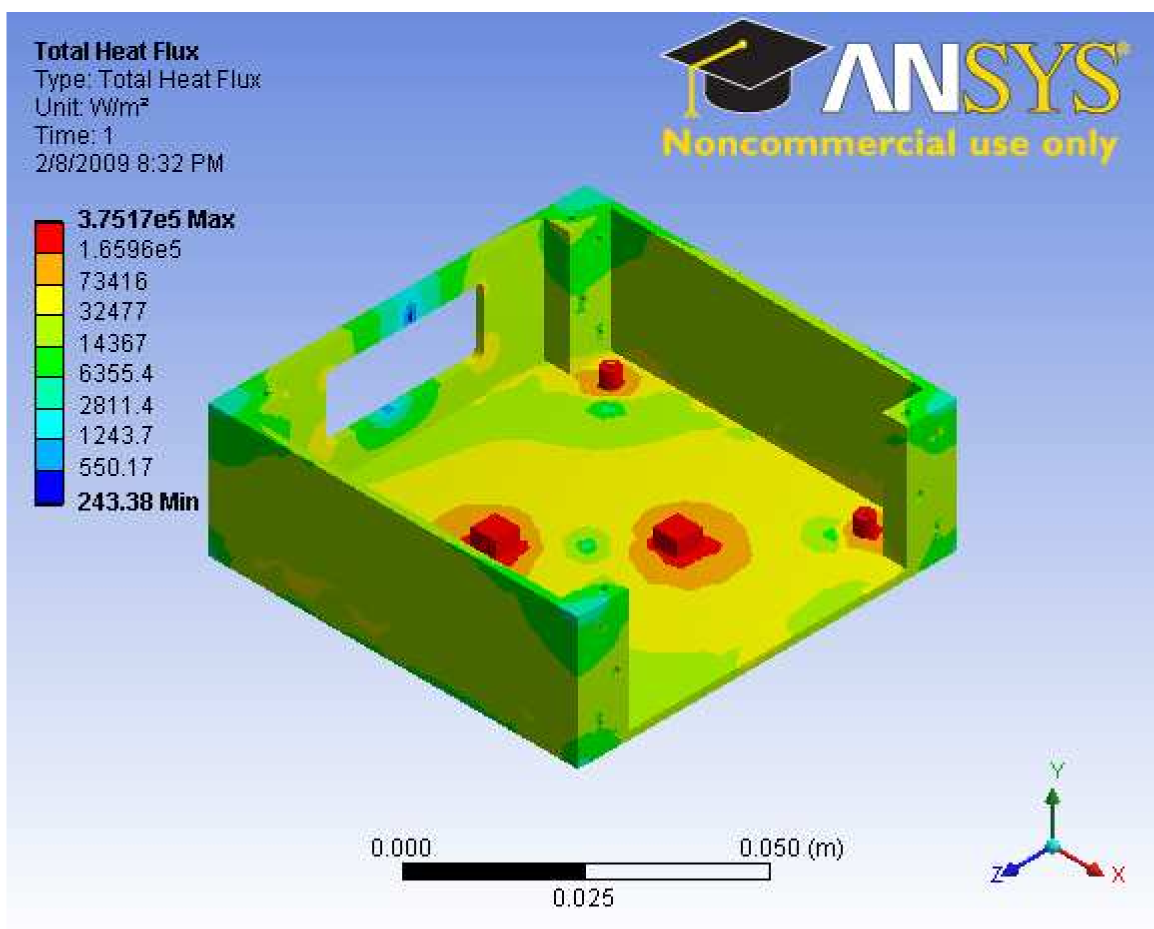
Temperature

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



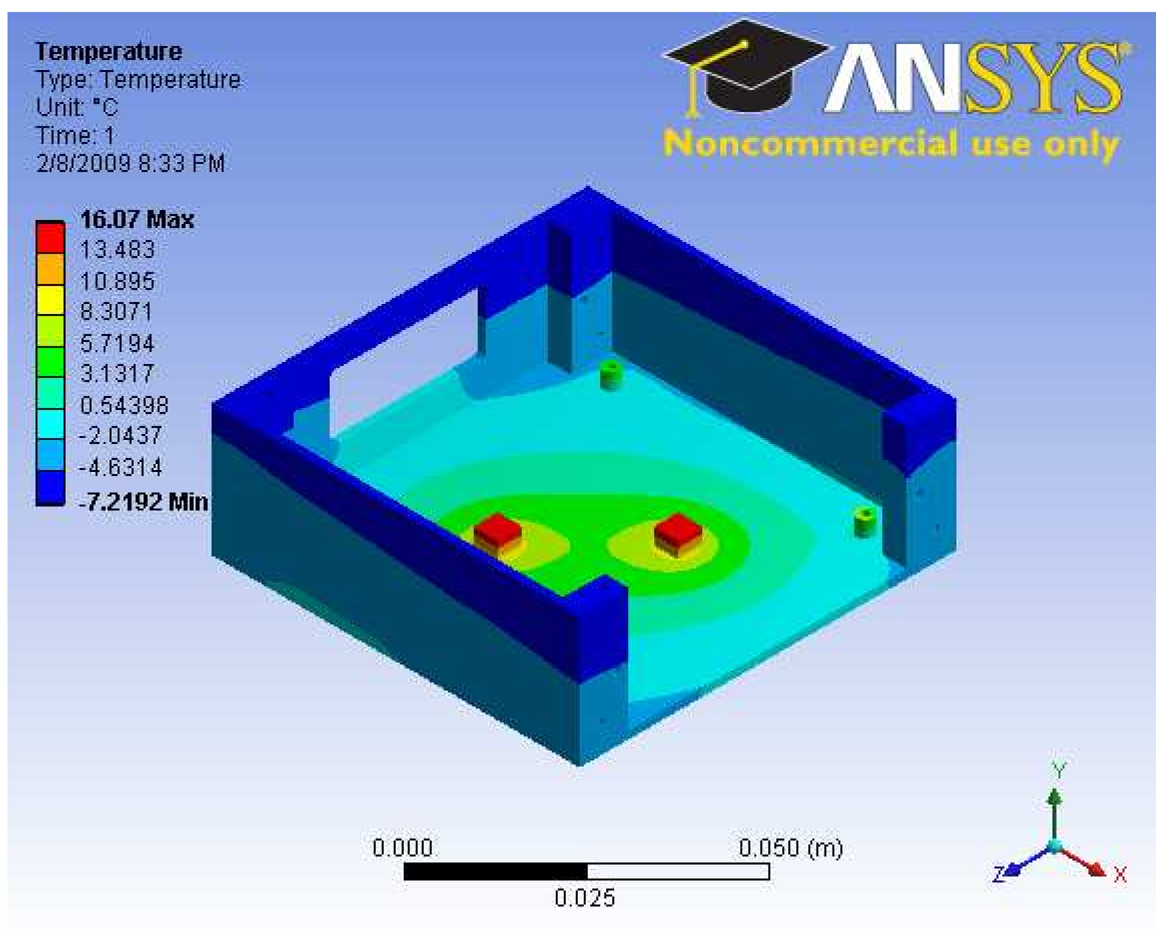
Total Heat Flux

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



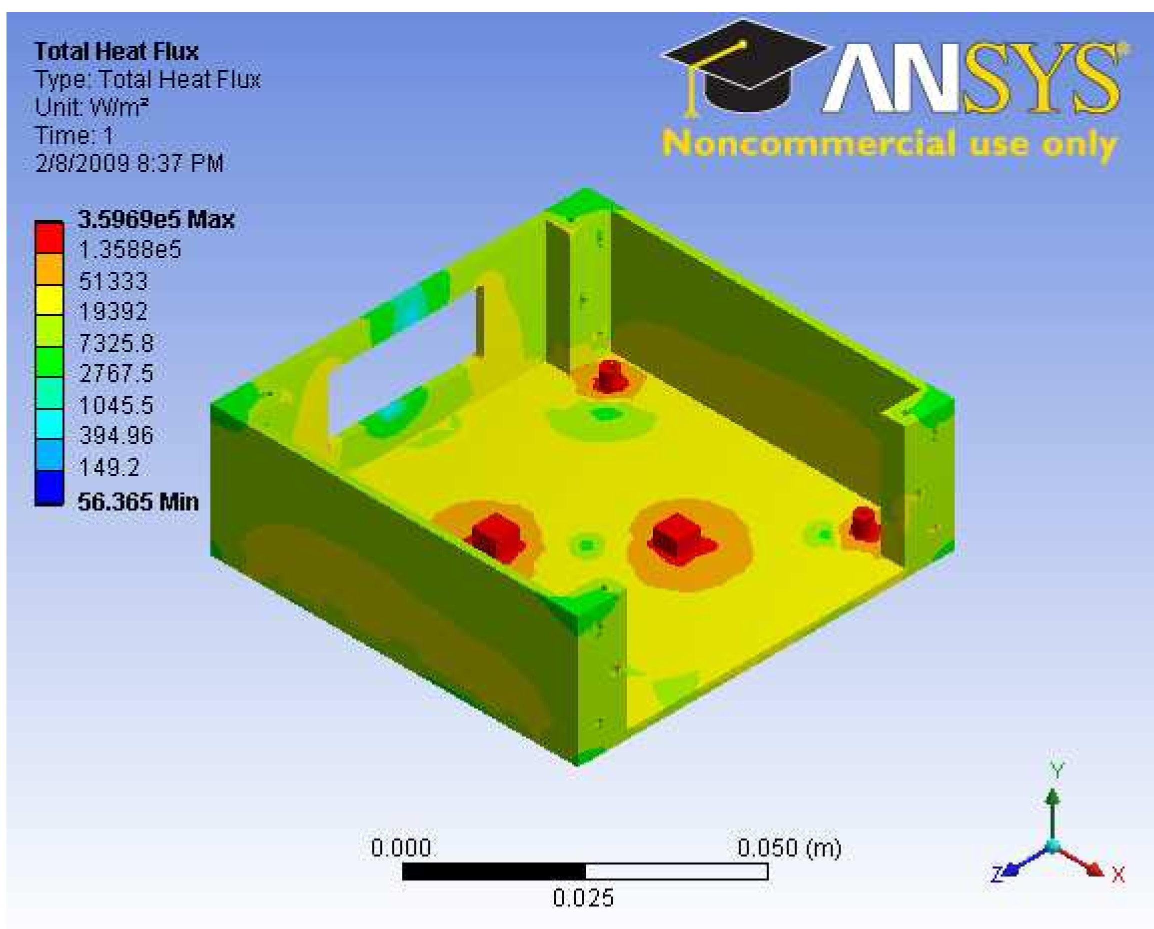
Temperature

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



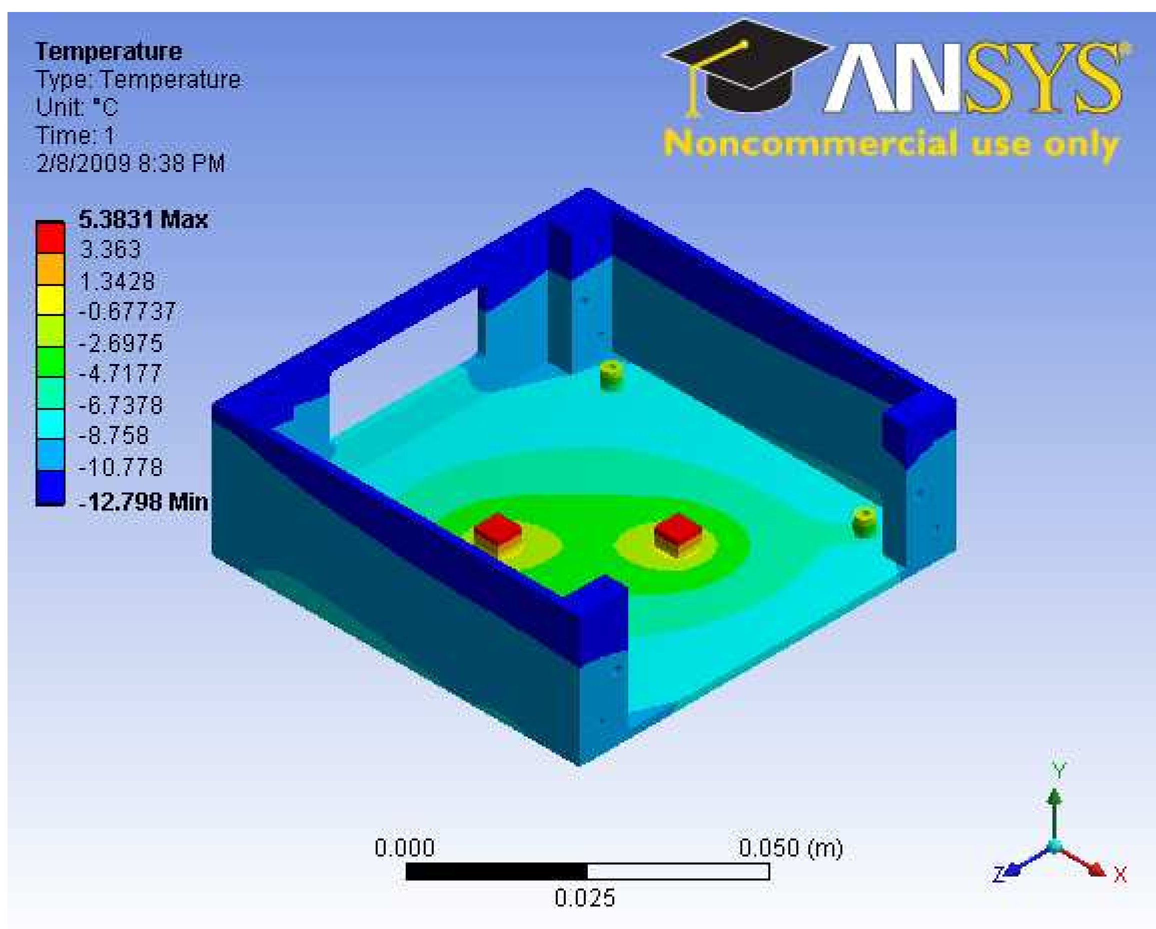
Total Heat Flux

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



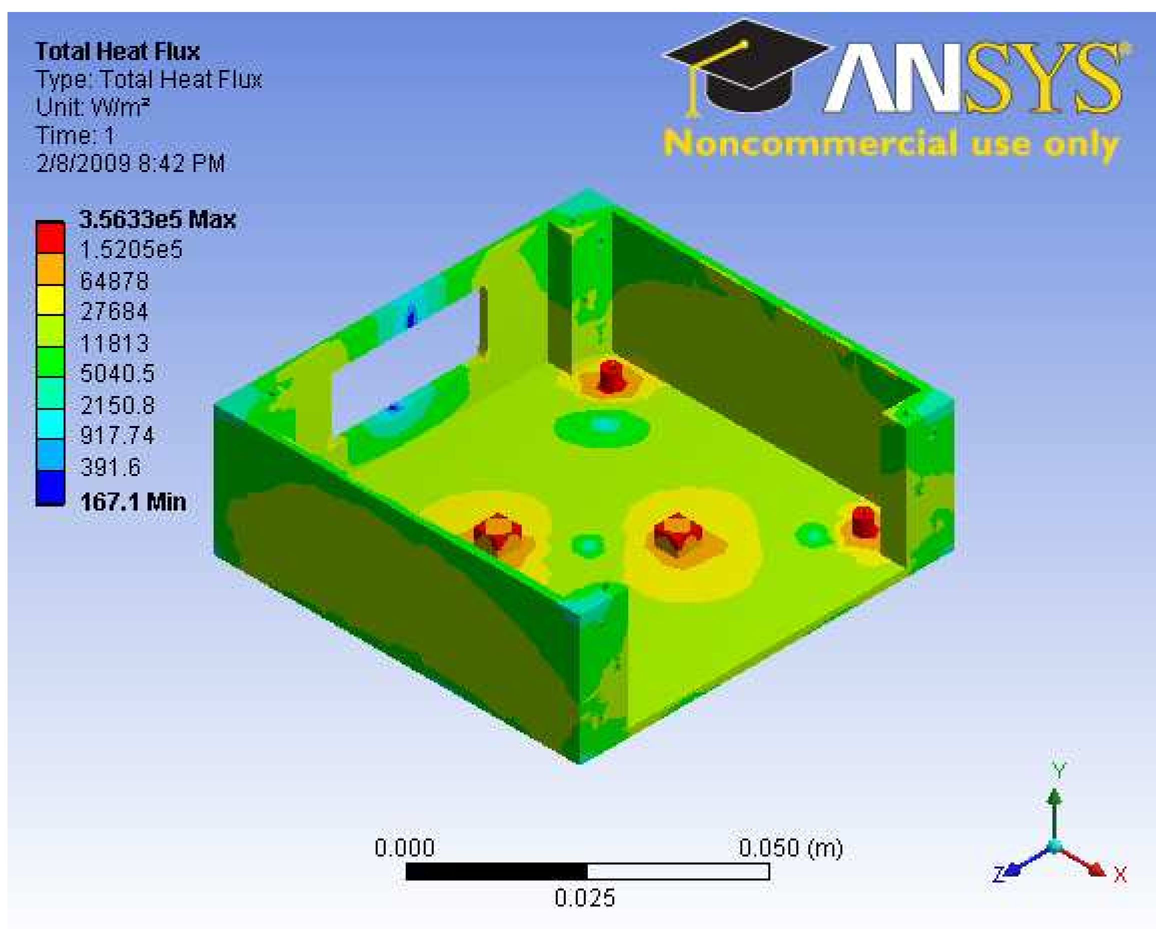
Temperature

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



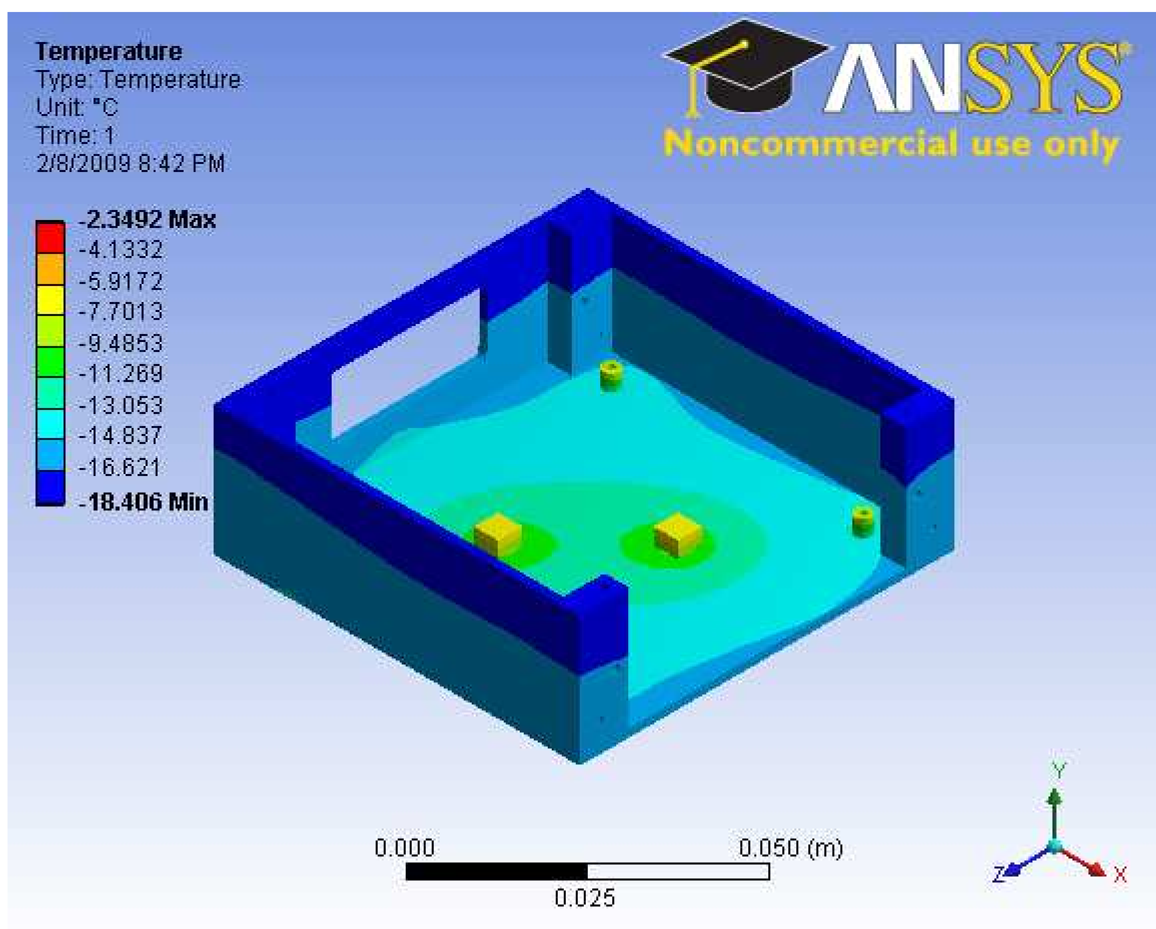
Total Heat Flux

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/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]

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/m2K [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/m2K [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

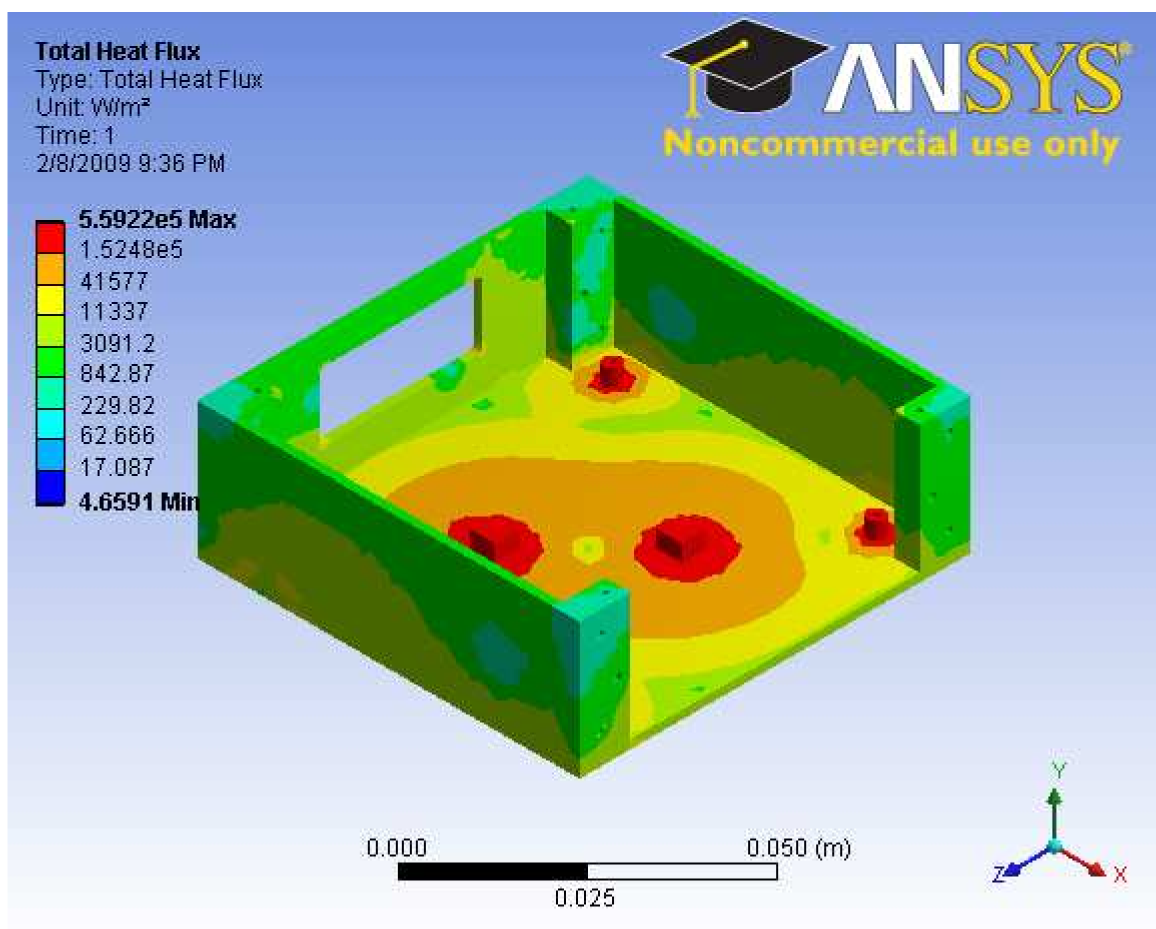
Geometry: Aluminum 6061-T6 for all parts including the PCB. Screws excluded from analysis. No Separation at all areas of contact.
Analysis Settings: Steady-State [SS]
Initial Conditions [IC]: 25 °C [25]
Convection [C]: Bottom Surface [BS], Film Coefficient: 750W/m2K [750], Ambient Temperature: -40 °C [-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]

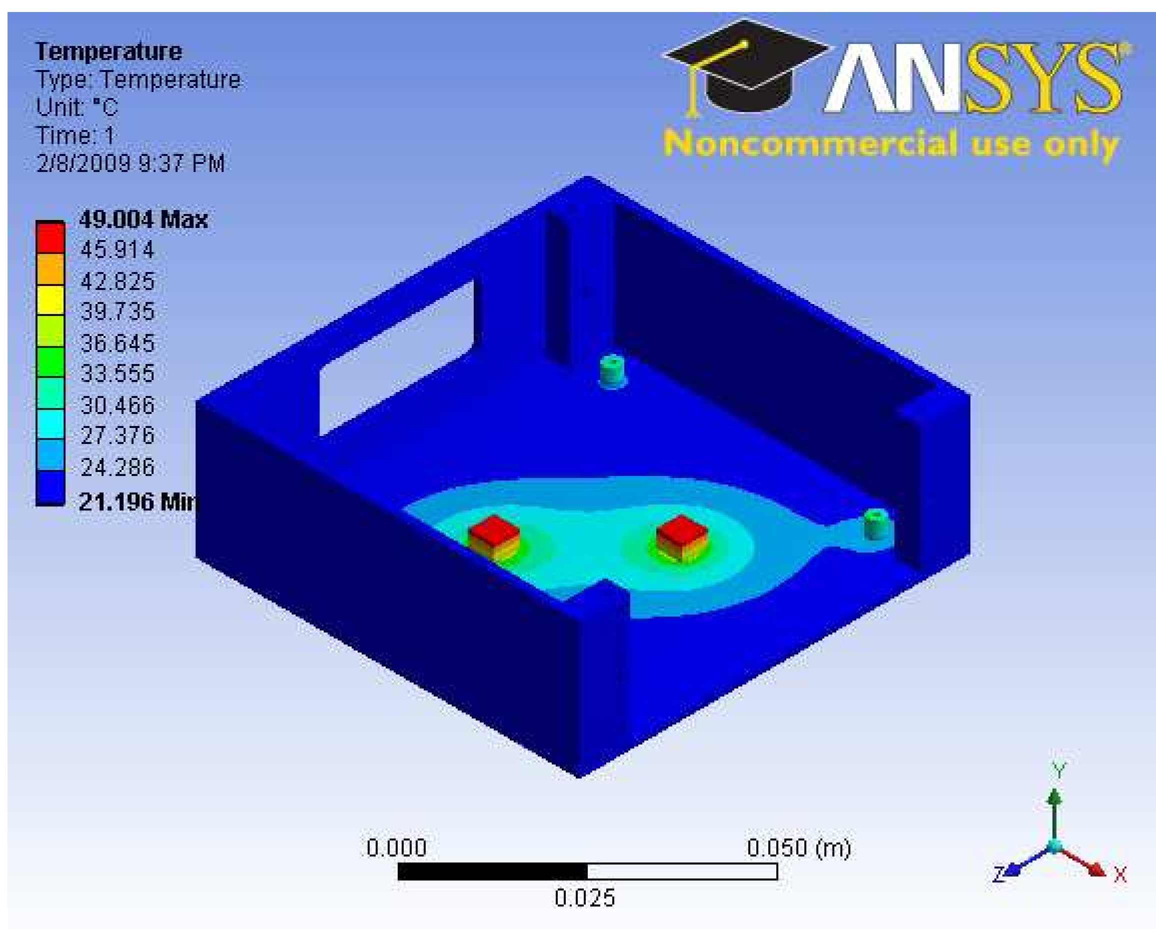
Total Heat Flux

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



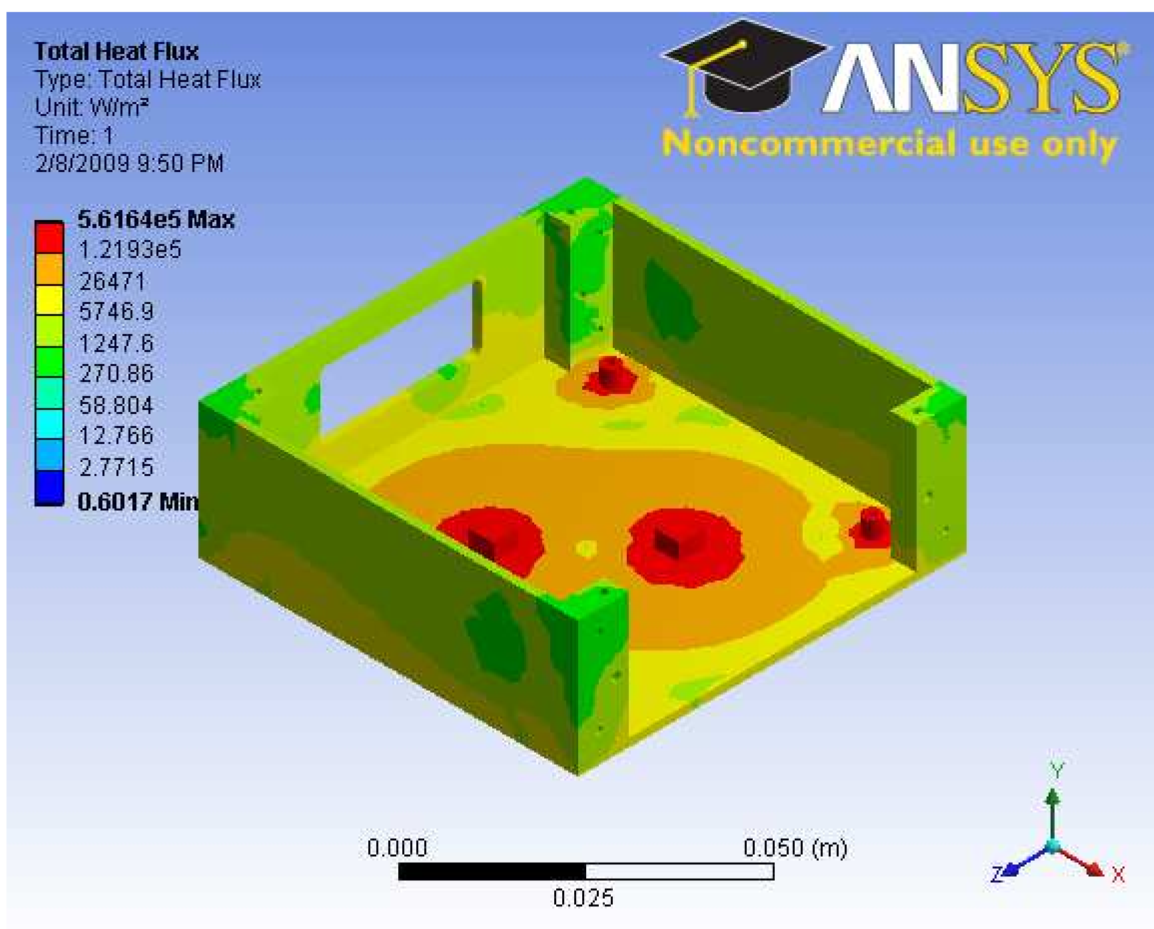
Temperature

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



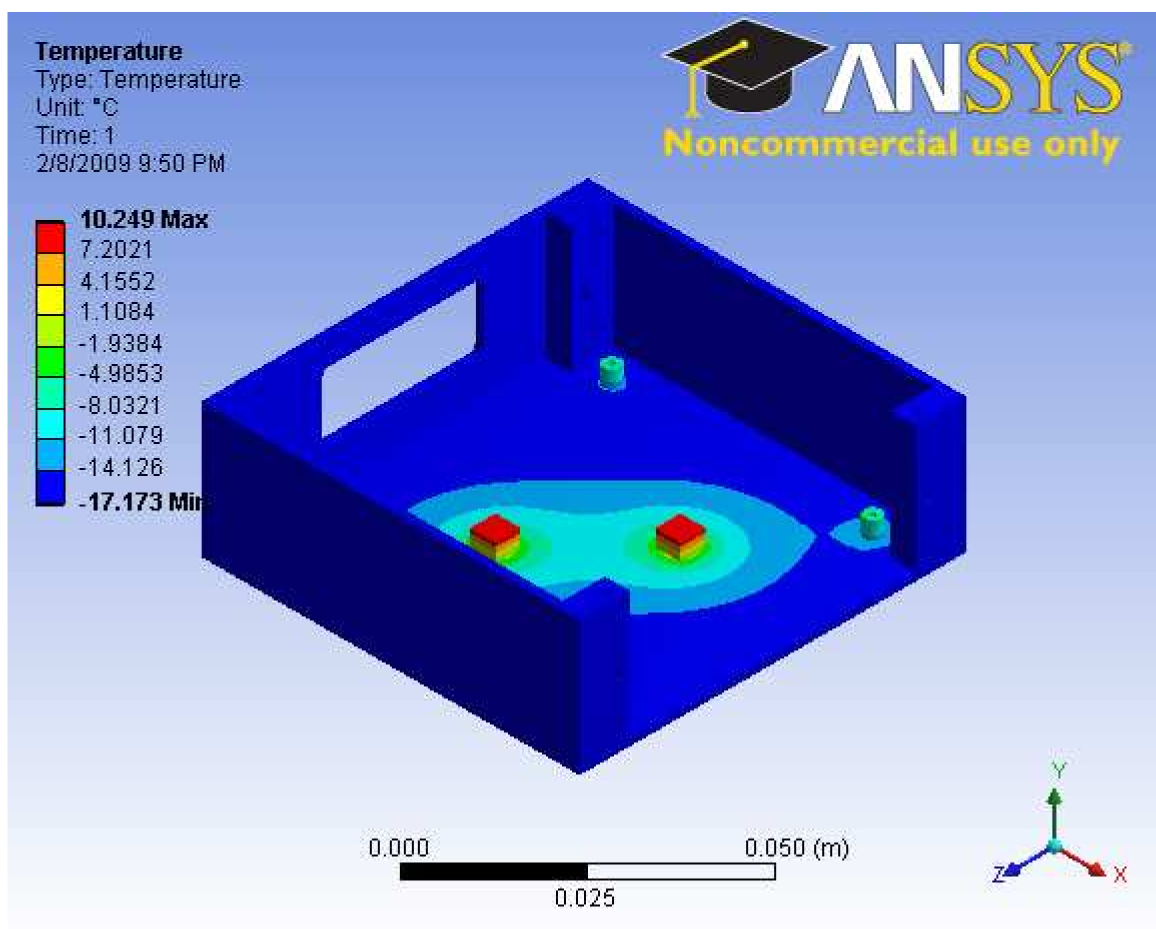
Total Heat Flux

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



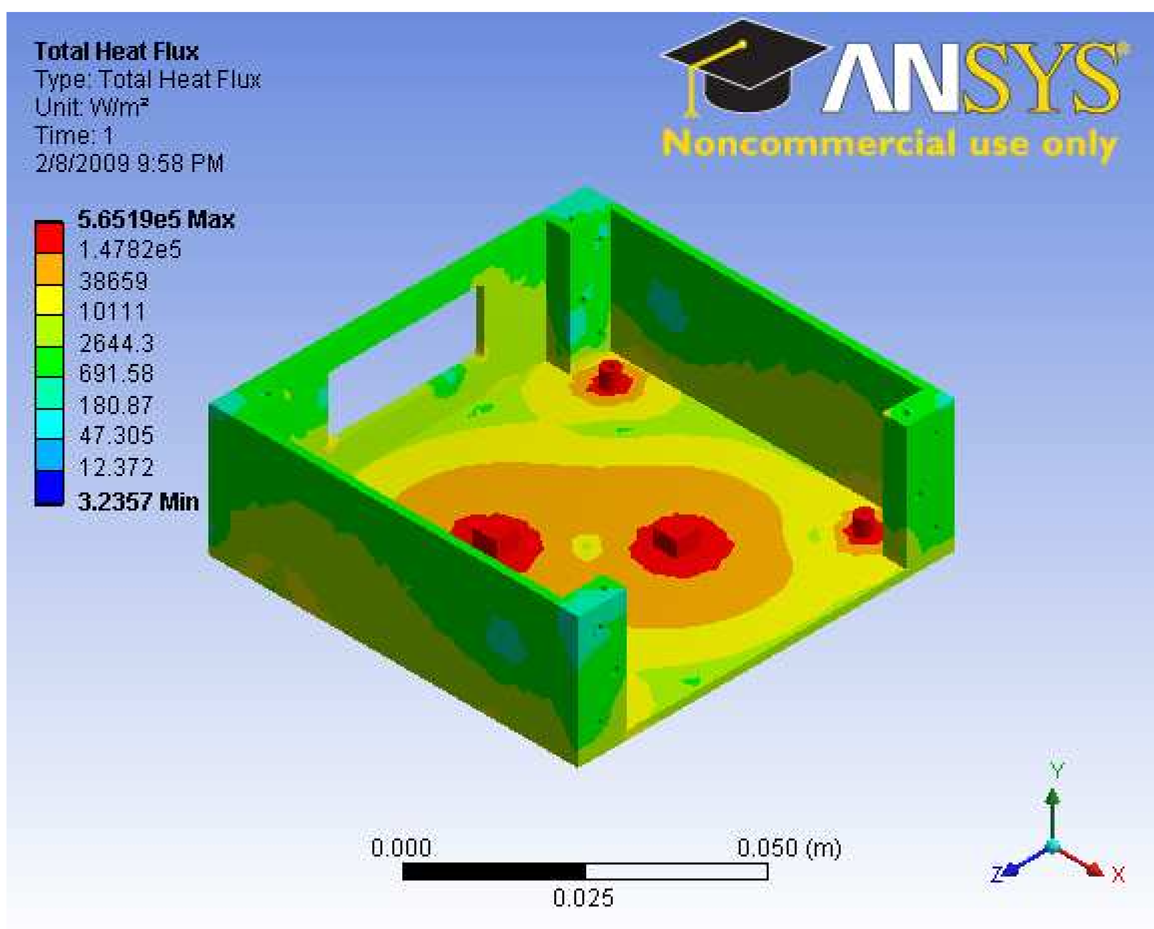
Temperature

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



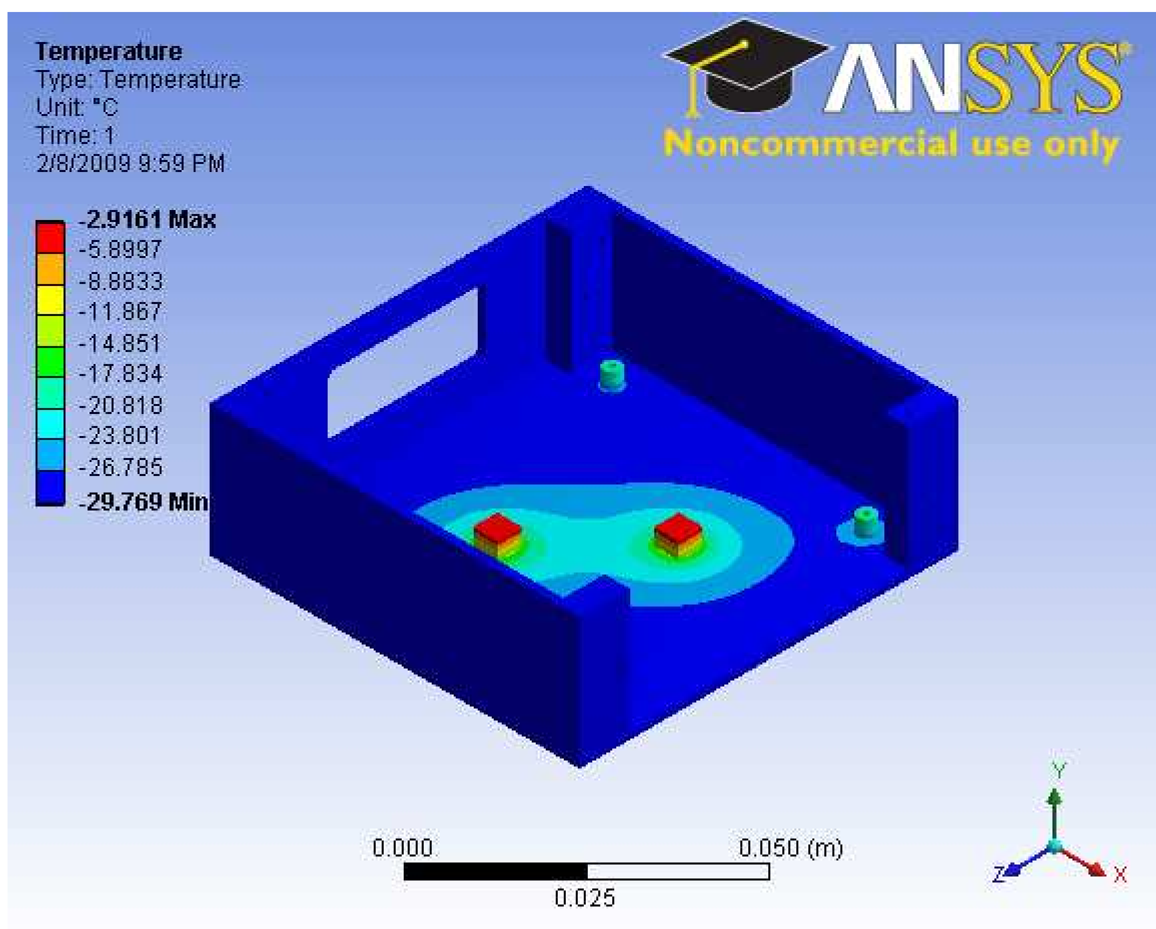
Total Heat Flux

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



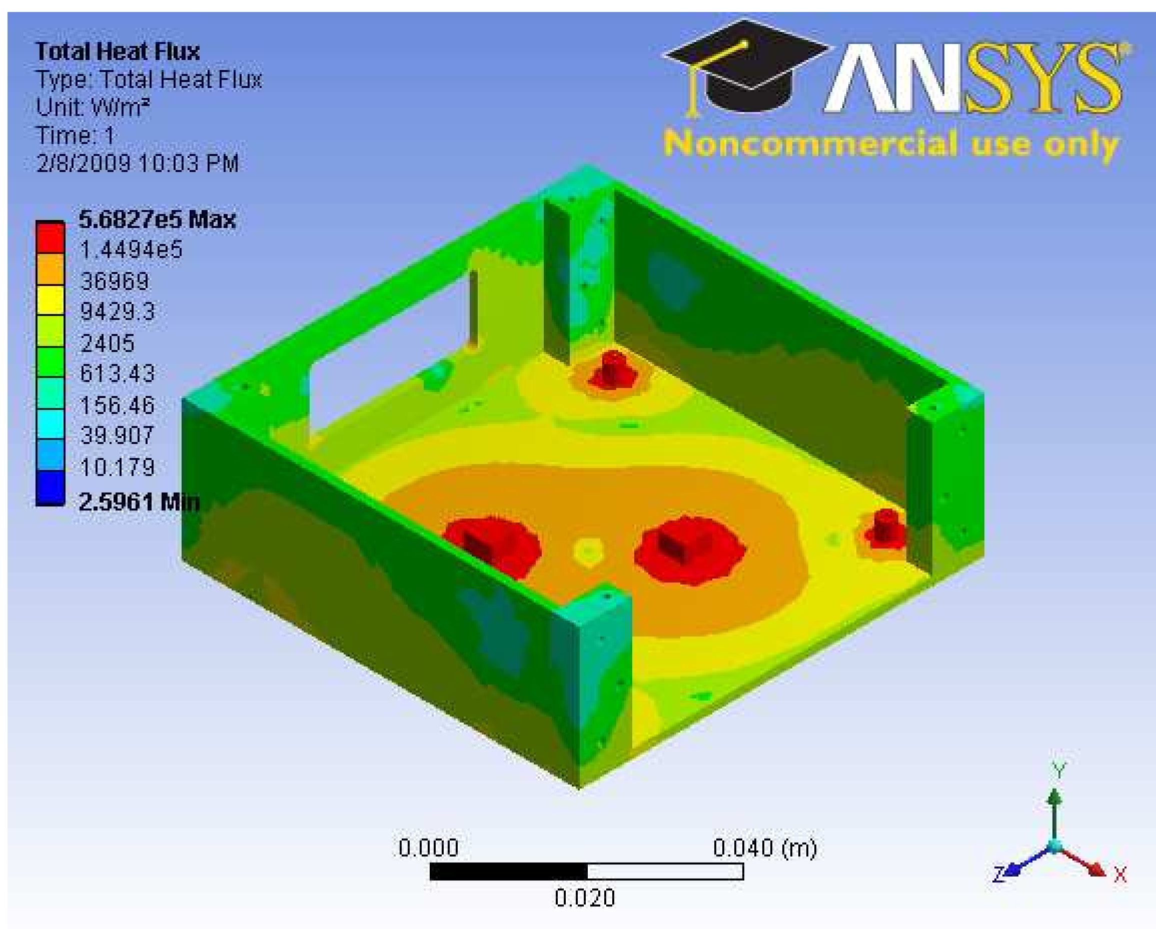
Temperature

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



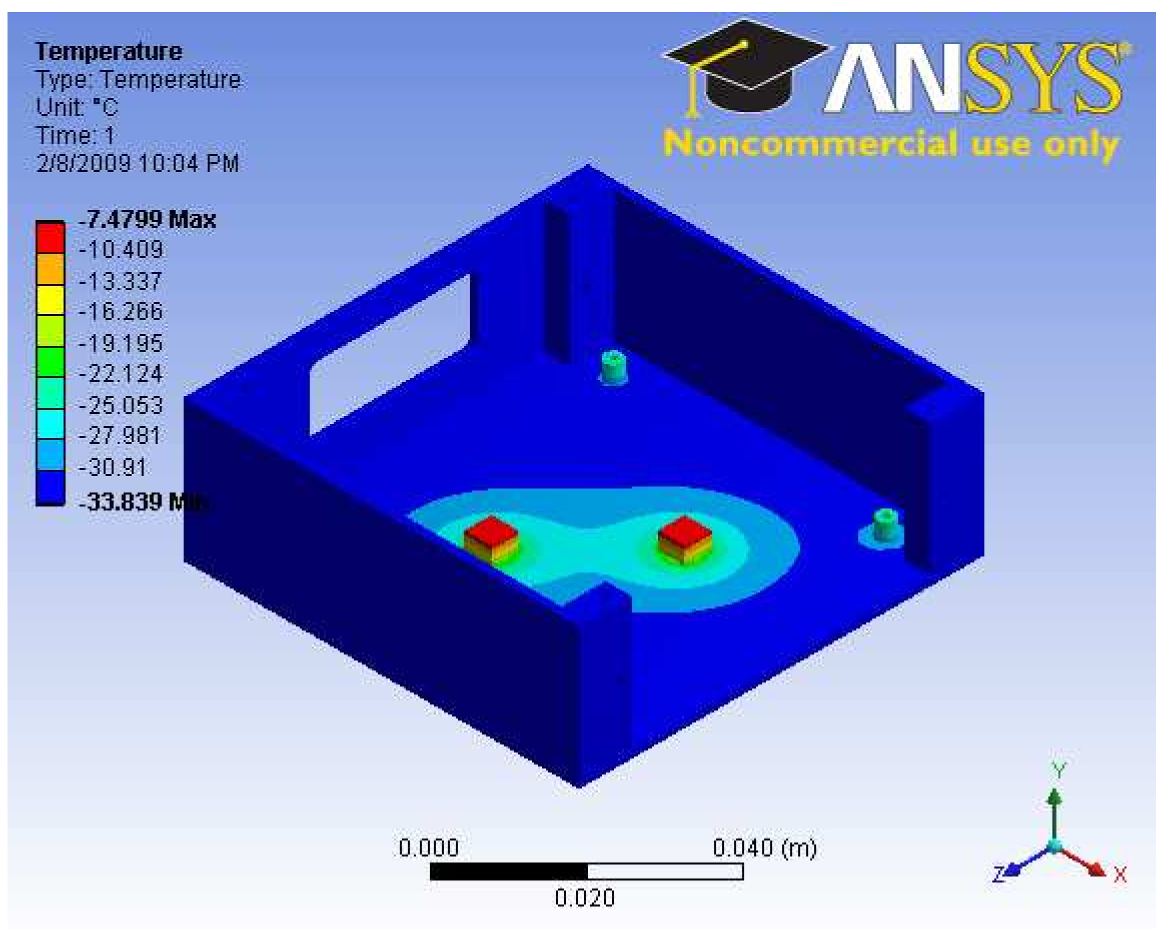
Total Heat Flux

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



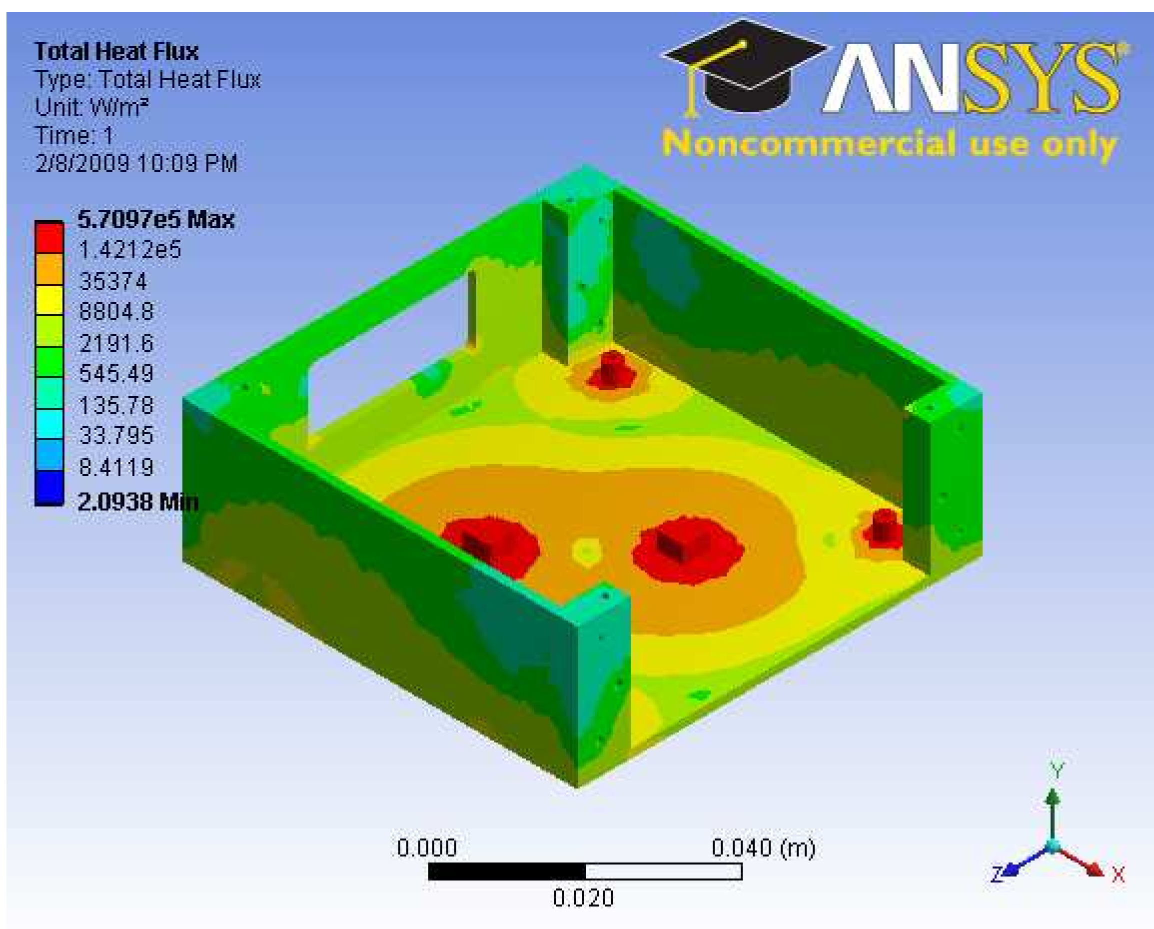
Temperature

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



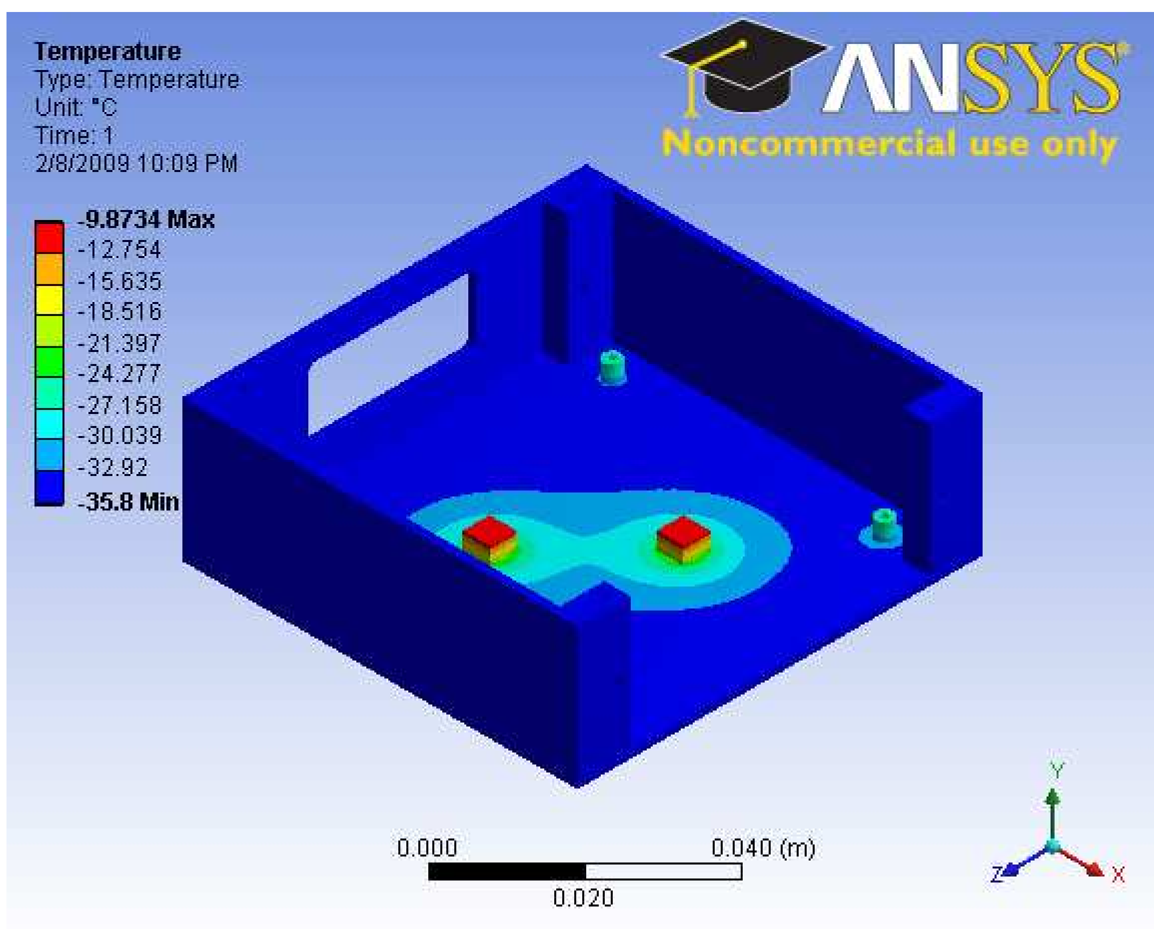
Total Heat Flux

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]

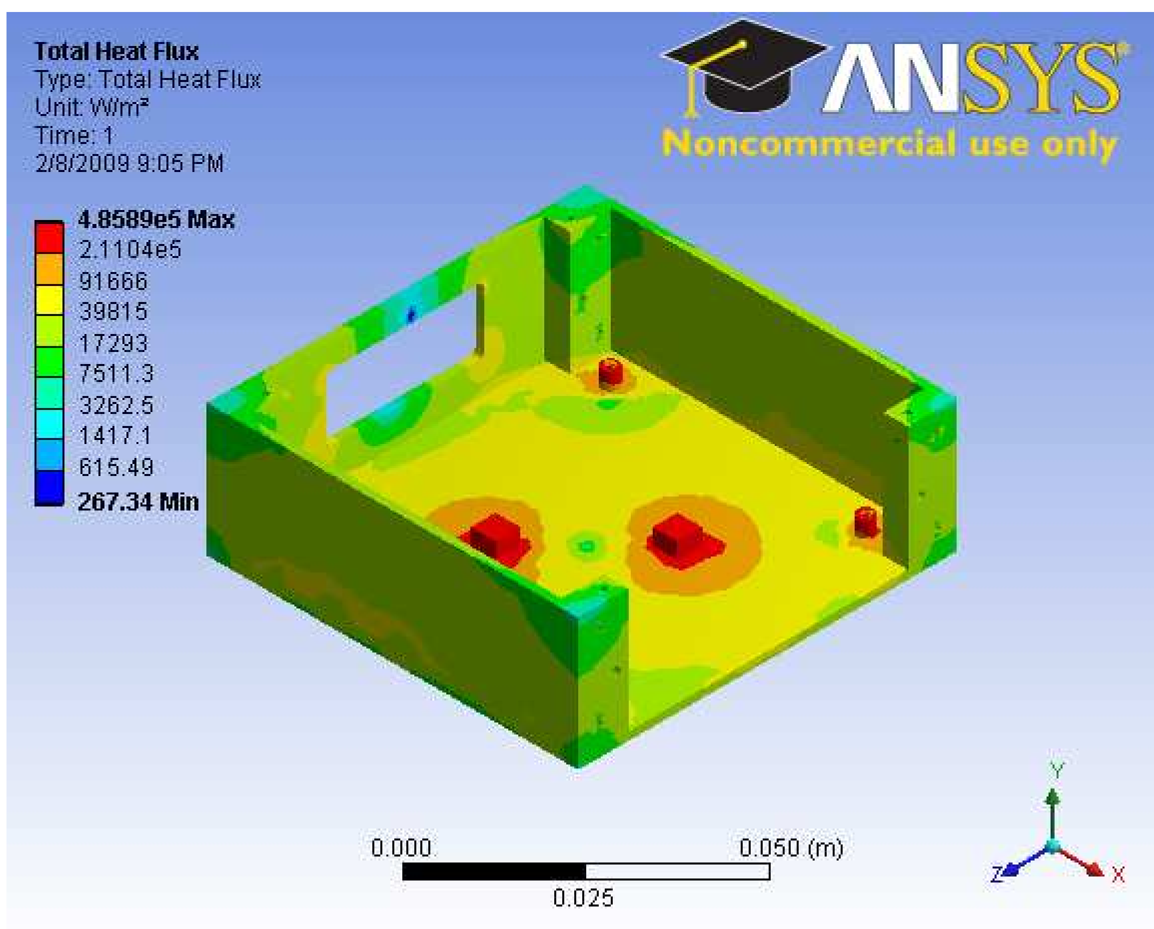
Condition 3, 5: SS; IC, 25; C, AS, 100,-40; IHF, 1.8, 0.1; HF, 16.2, 0.9

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]

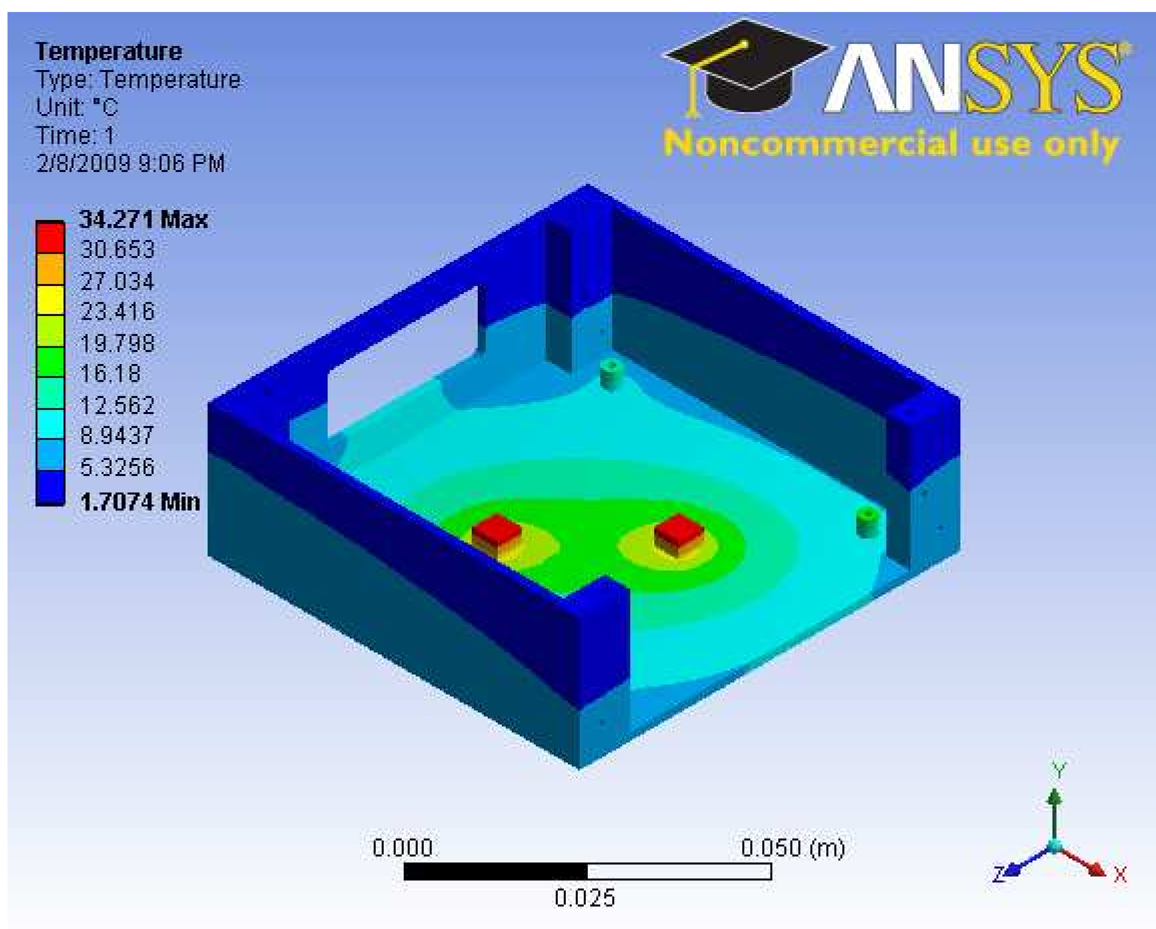
Total Heat Flux

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



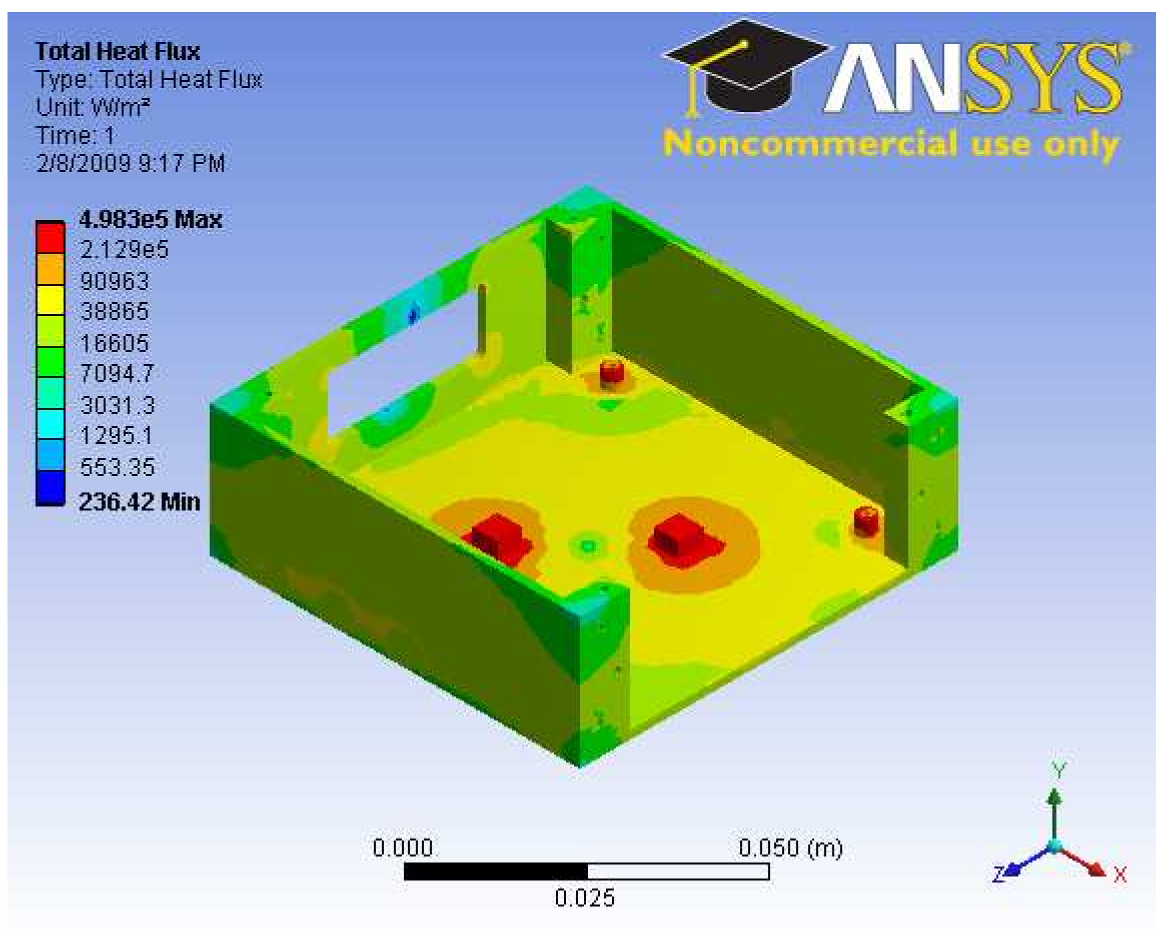
Temperature

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



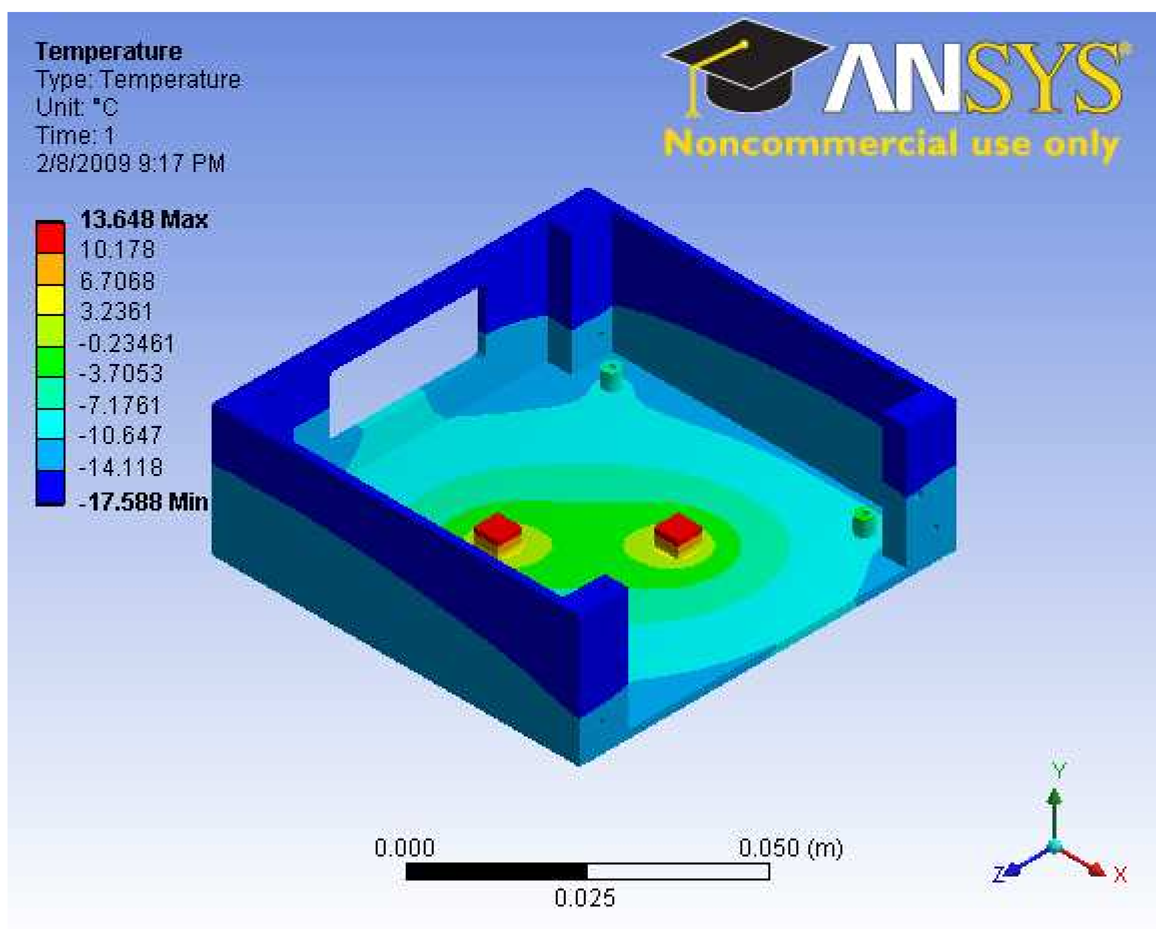
Total Heat Flux

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



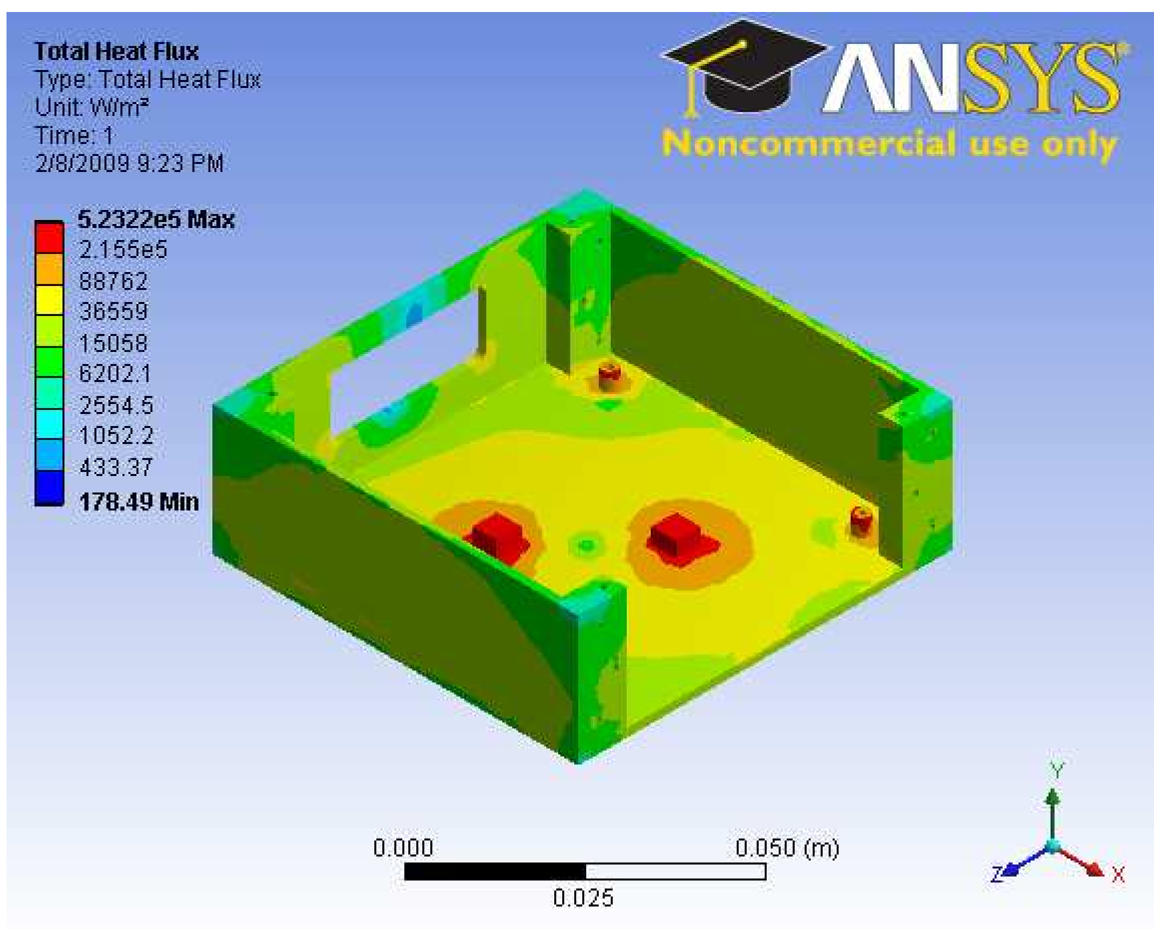
Temperature

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



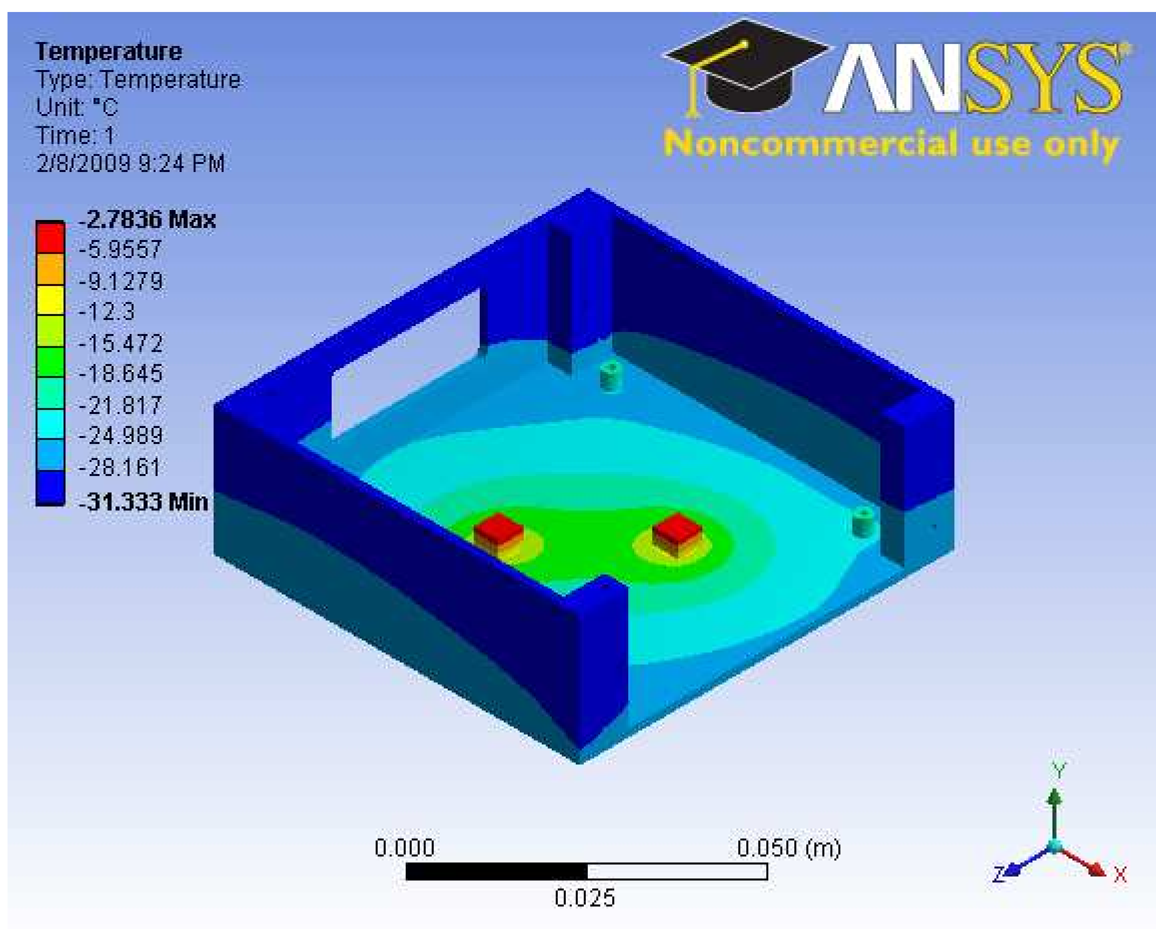
Total Heat Flux

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



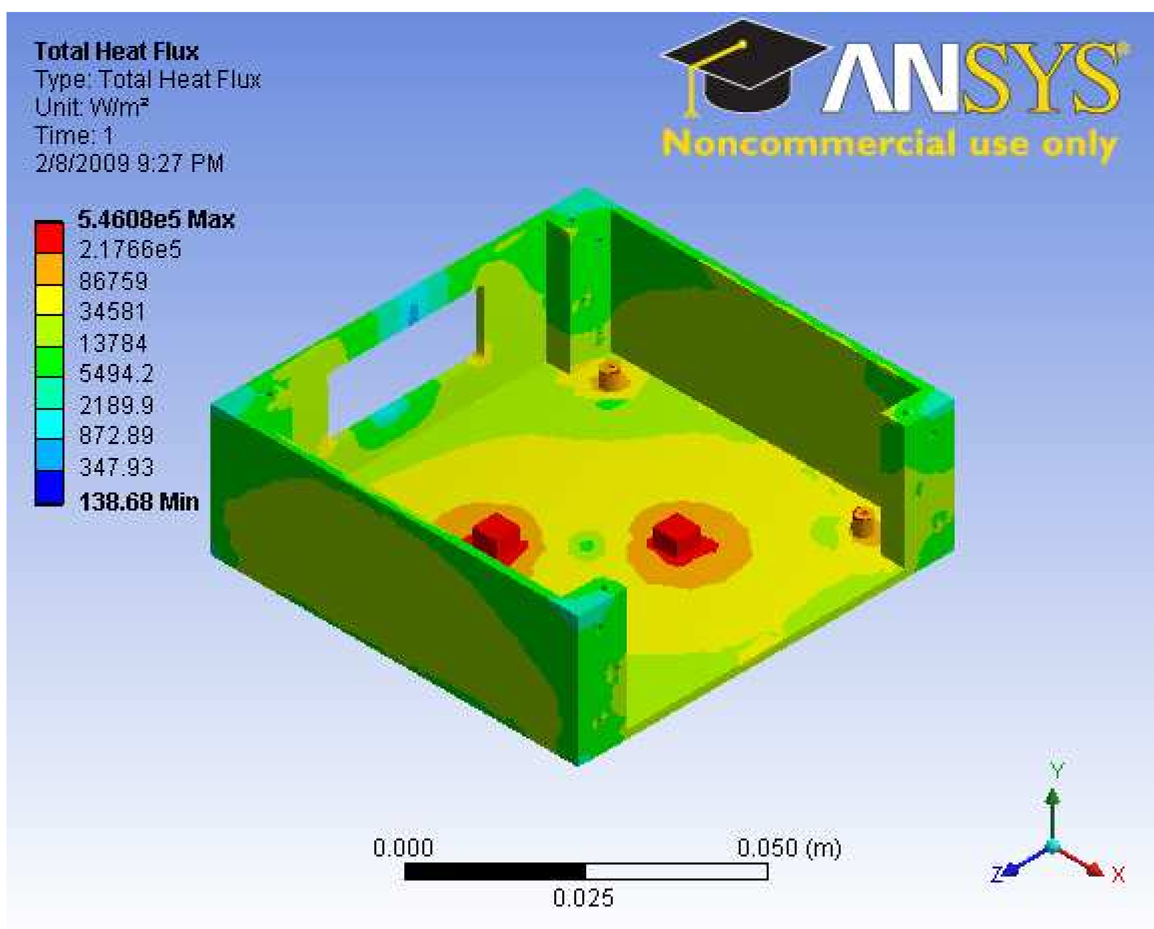
Temperature

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



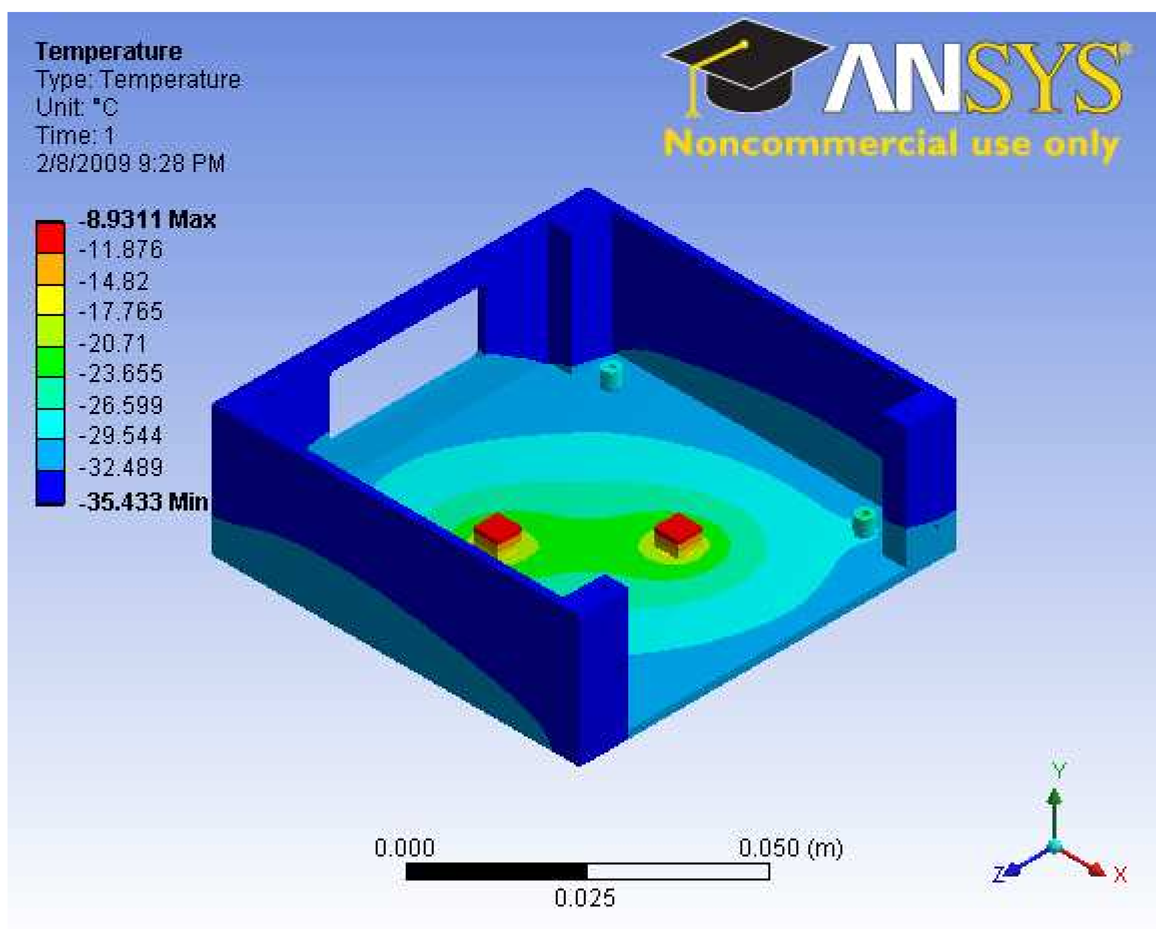
Total Heat Flux

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



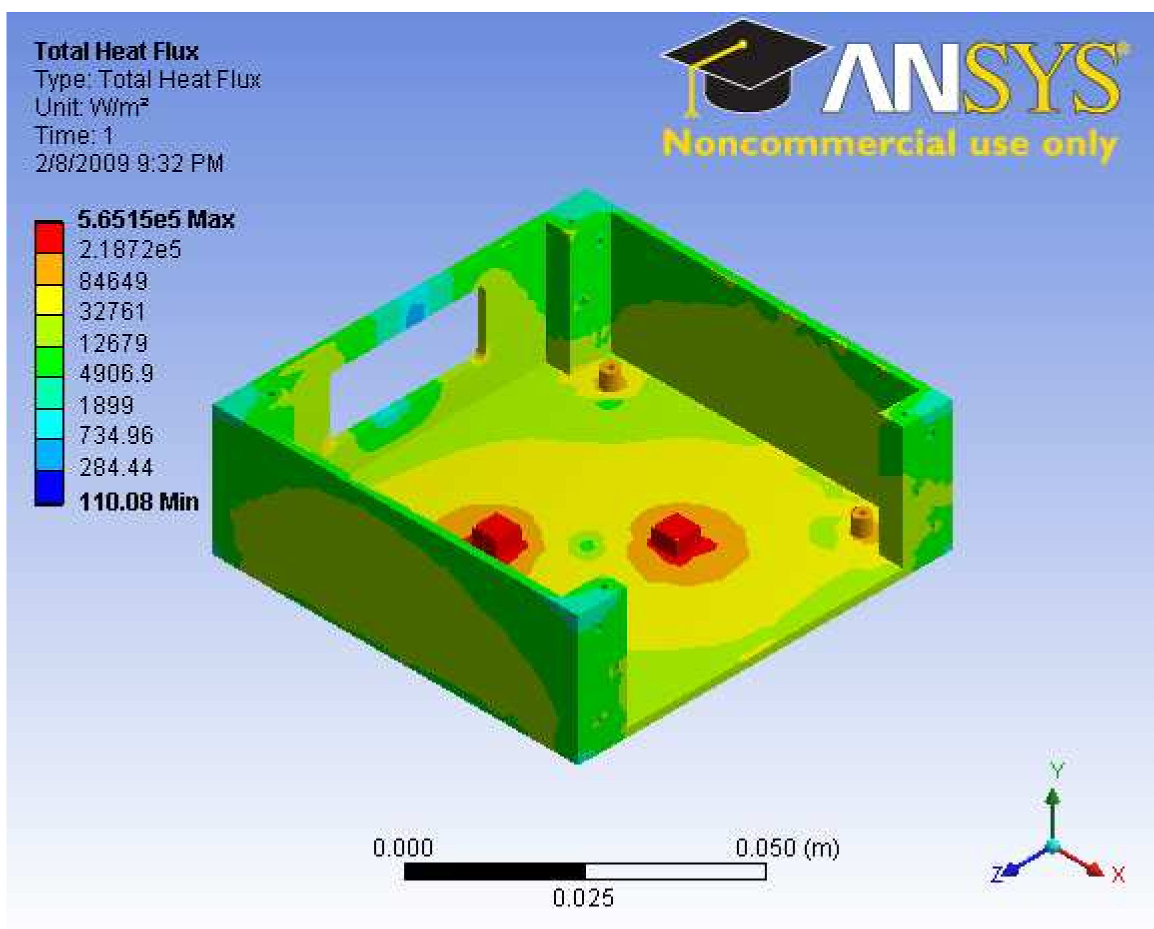
Temperature

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