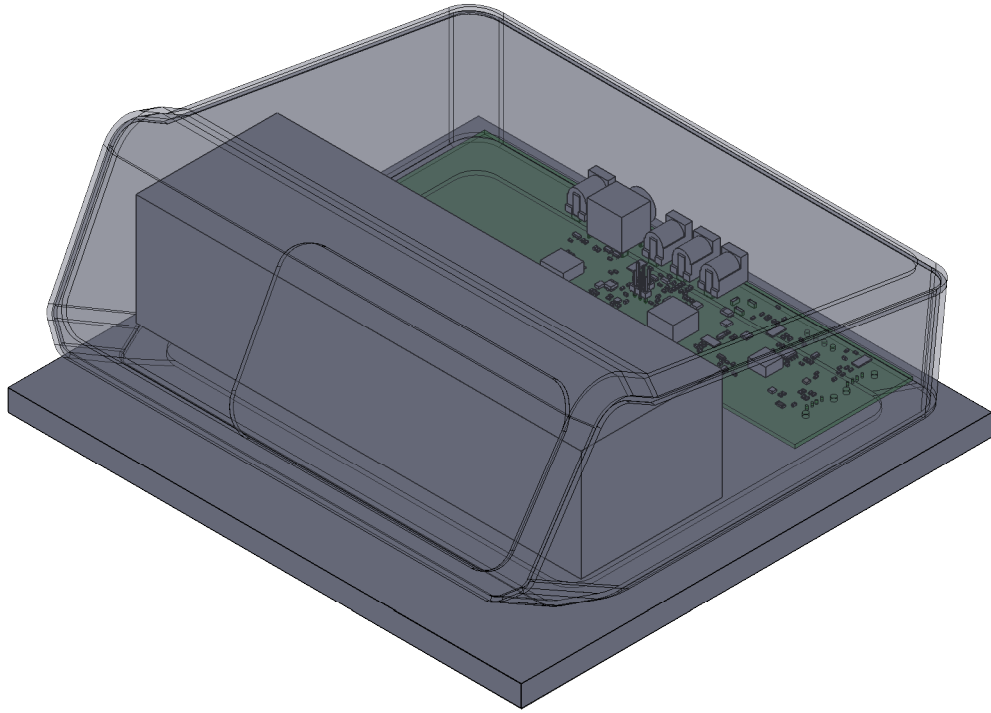
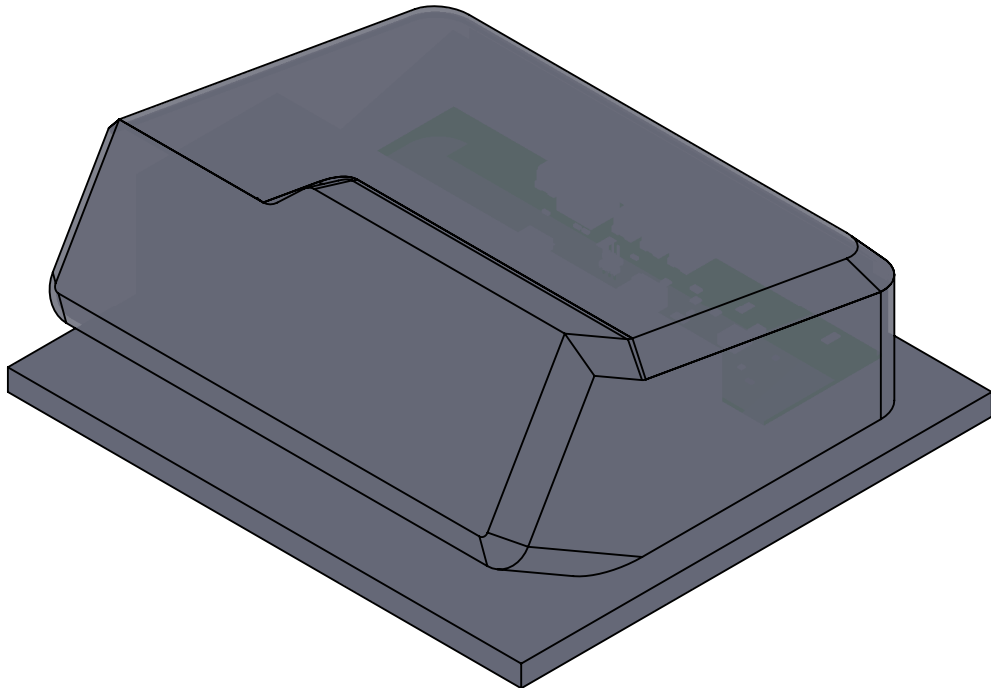


CONCEPT A ENCLOSURE:



CONCEPT D ENCLOSURE:



REVISIONS				
ZONE	REV.	DESCRIPTION	DATE	APPROVED
	1	THERMAL SIM REPORT INITIAL RELEASE 12 PAGES.	4-29-2021	3
	2	ADDED SIM REPORT FOR 2-LAYER PROTO PCB IN ENCLOSURE DESIGN 2.	5-2-2021	
	3	ADDED SIM REPORT FOR CONCEPT D; ENCLOSURE A & ENCLOSURE B OPTIONS	5-14/2021	

	NAME	SIGNATURE	DATE		
DRAWN	Norberto		4-29-2021		
CHK'D	Farhan				
APPV'D					
MFG					
Q.A					
				MATERIAL:	
				WEIGHT:	

TITLE:		<h1>Thermal Simulation Report</h1>	
DWG NO.	040421_ConceptA and ConceptD Sim Report		
		A4	
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OBJECTIVE/REQUIREMENT:

-USING THERMAL SIMULATION, IDENTIFY THE OPTIMAL LOCATION FOR THE PCB AND ENCLOSURE DESIGN WITH RESPECT TO THE BATTERY.

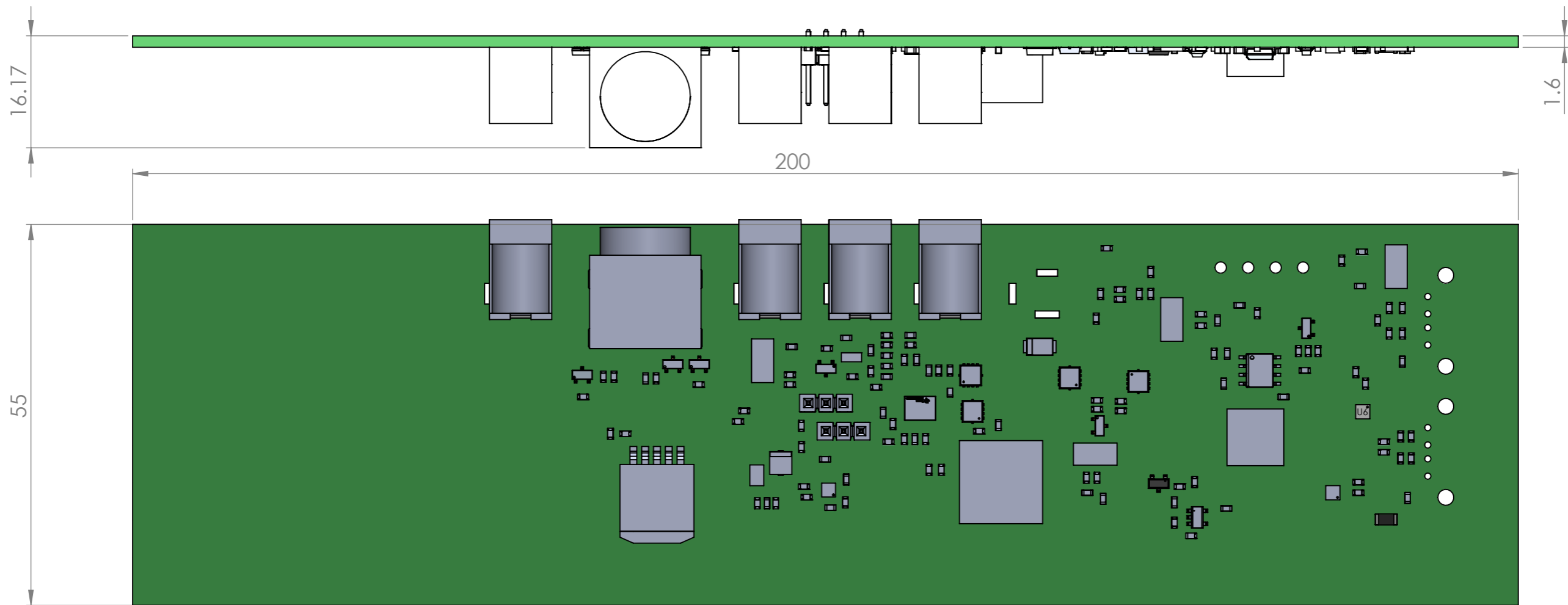
-CRITICAL REQUIREMENT IS THAT THE BATTERY CANNOT BE CHARGED WHEN THE TEMPERATURE AROUND THE BATTERY IS $\geq 45C$

OPERATING ENVIRONMENT:

-DEVICE IS IN AN AMBIENT OPERATING TEMPERATURE OF 40 C. THAT MEANS THE TEMPERATURE AROUND THE BATTERY CAN ONLY RISE FOR A MAX 5C.

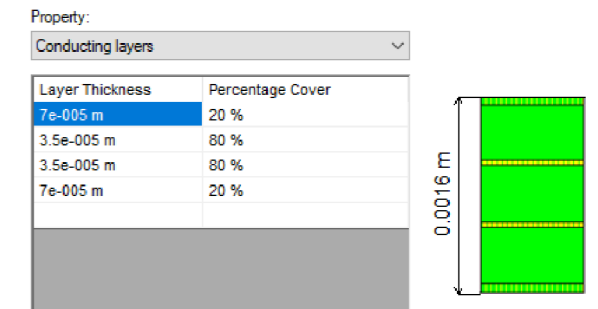
-3 DC/DC CONVERTERS OPERATING DISSIPATING A COMBINED TOTAL POWER OF APPROX.10WATTS.

TITLE:	
Objective/Requirements Operating Environment	
DWG NO.	A4
040421_ConceptA and ConceptD Sim Report	
SCALE:1:2	SHEET 3 OF 17



4 LAYER PCB

Ref	Description	Voltage	Current	Power (MPPT+VBAT OUT)	Comments	
D1	Reverse blocking diode	0.325	3.33	1.08	80W input	PMEG3050EP,115
Q1	High side MOSFET			0.60	From TI calculator	RQ3G100GN
Q2	Low side MOSFET			0.40	From TI calculator	RQ3G100GN
L1	Charger DCDC Inductor			1.30	From TI calculator	PCSH127MT6R8
R3	Current sense resistor	0.0495	5.5	0.27	9mOhm, 70W output	ERJ-MS4HF9M0U
U11	Buck Converter IC			1.22	7% losses (20W out) minus inductor power	AOZ6605PI
L3	Inductor		4	0.29	18mOhm	BWVS008080404R7M00
U5	Limit switch	0.2	2	0.40	100mOhm	AP22653FDZ-7
U6	Limit switch	0.2	2	0.40	100mOhm	AP22653FDZ-7
R113	Current sense resistor	0.04	4	0.16	10mOhm	ERJ-M1WSF10MU
U3	eFuse	0.119	3.5	0.42	34mOhm	TPS259571DSG
D7	Diode OR-ing	0.45	0.05	0.02		BAT54C-E3-08
U4	VDD LDO	9.5	0.05	0.48		AP7383-33W5-7
U8	STB LDO	0.8	1.5	1.20		BD00D0AWHFP
Q7	Switch - STB	0.084	1.5	0.13	56mOhm	DMP3098L-7
Q8	Switch - TV	0.112	2	0.22	56mOhm	DMP3098L-7
Q22	Switch - Lamps	0.084	1.5	0.13	56mOhm	DMP3098L-7
R55	Current sense resistor	0.0495	5.5	0.27	9mOhm	ERJ-MS4HF9M0U
R94	Backlight limiting resistor	9	0.06	0.54	150Ohm	ERJ-P08J151V



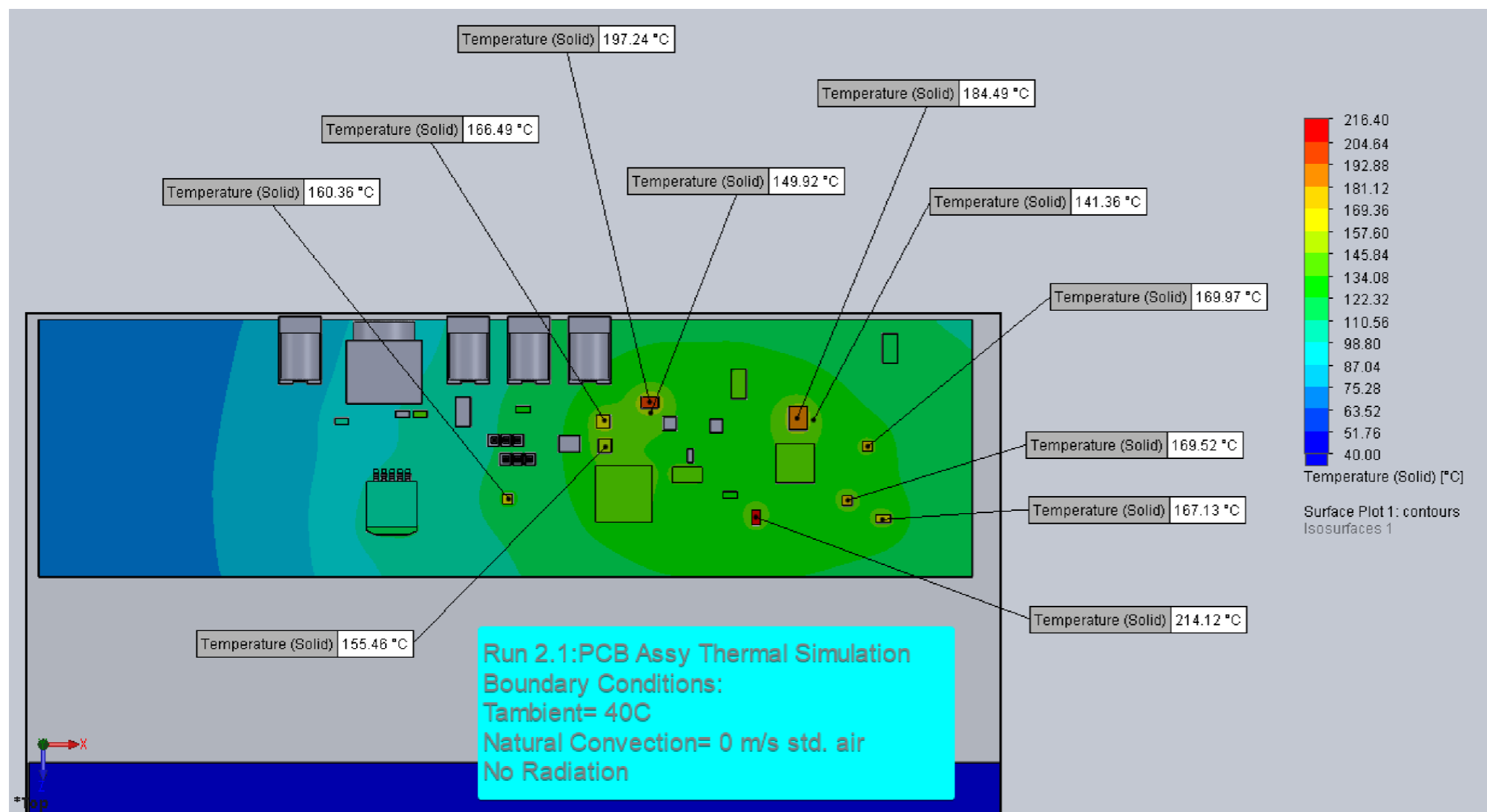
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TITLE: **PCB Assy Layout & Power Loss Budget**

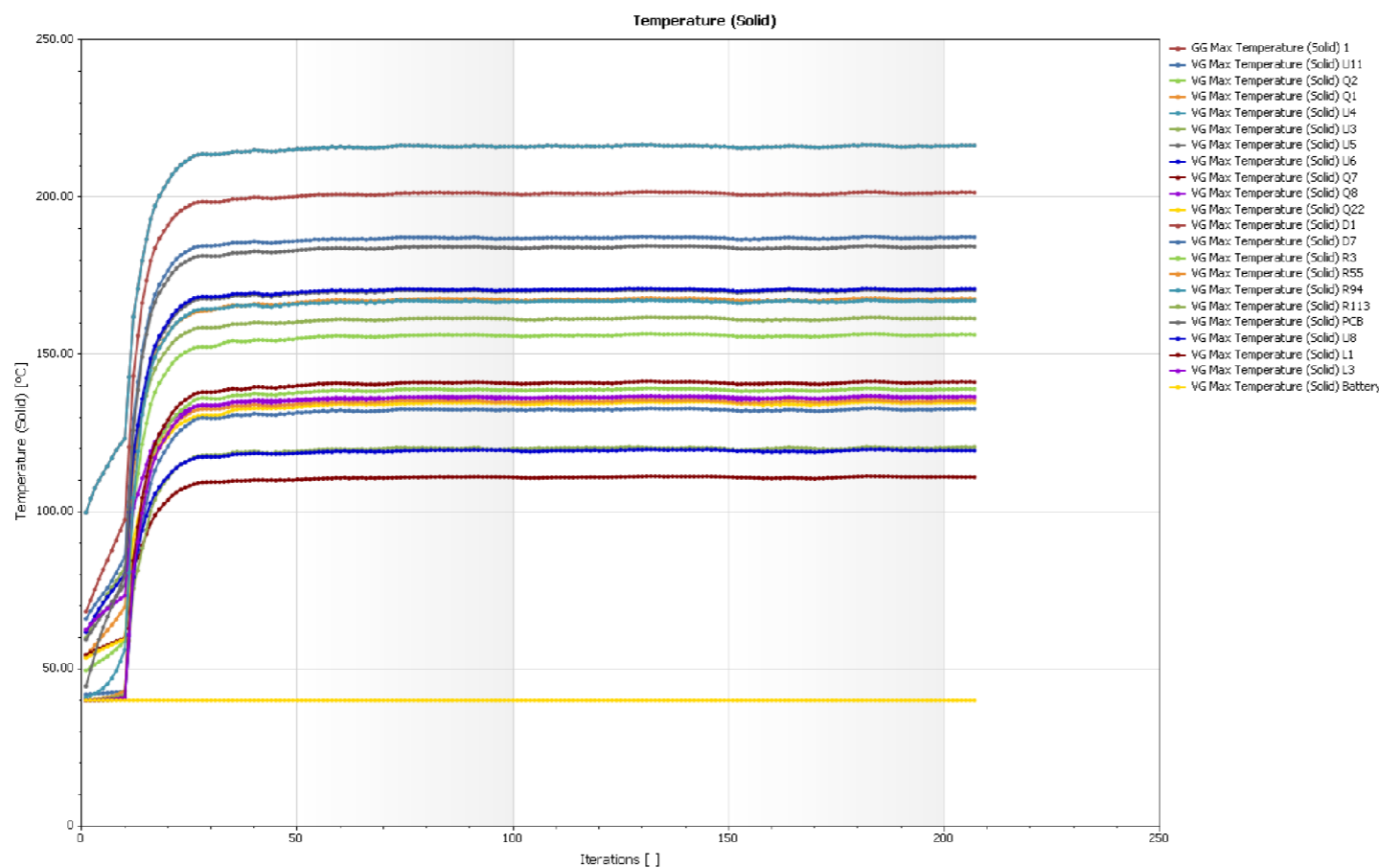
DWG NO. 040421_ConceptA and ConceptD Sim Report A3

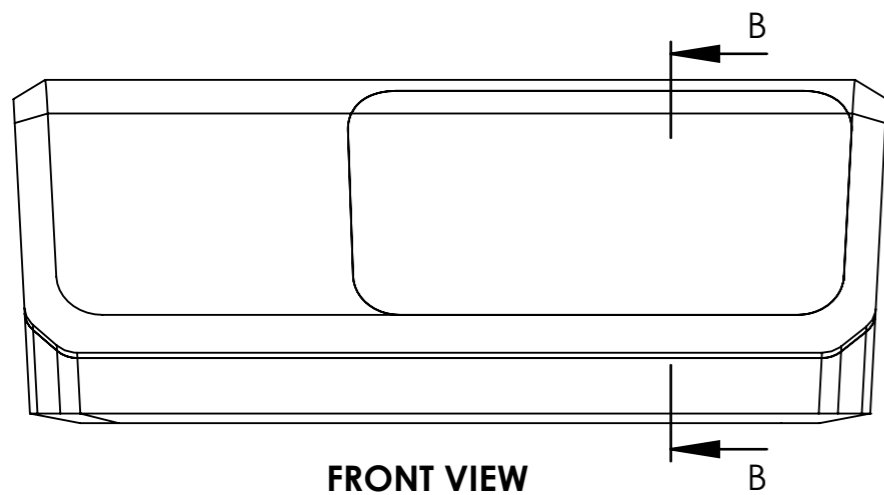
SCALE:1:2 SHEET 4 OF 17

9.52

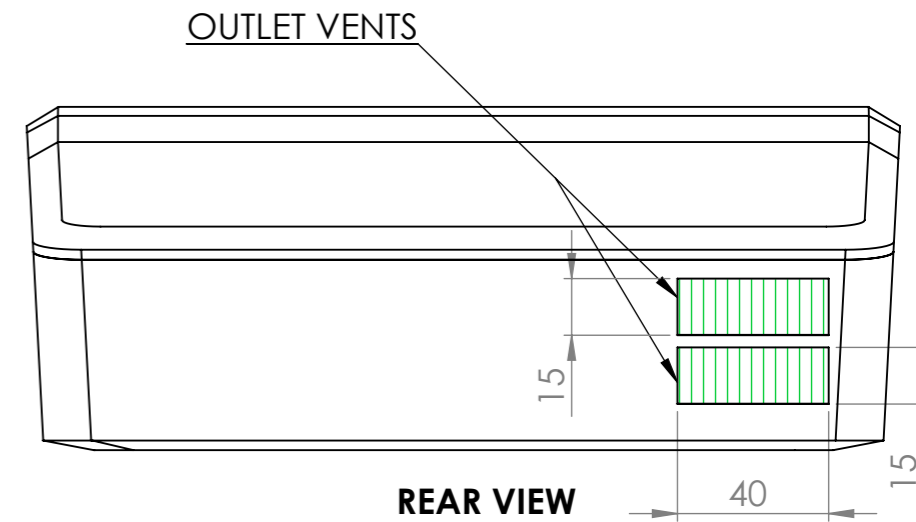
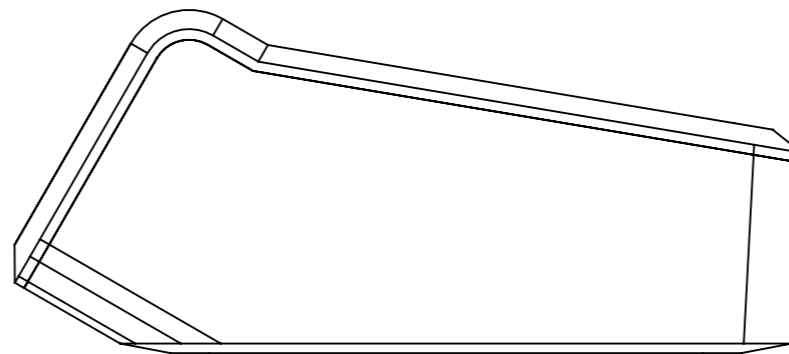


Goal Name	Unit	Sim Value	Actual
GG Max Temperature (Fluid) 1	[°C]	216.40	
GG Max Temperature (Solid) 1	[°C]	216.40	
VG Max Temperature (Solid) U11	[°C]	187.27	
VG Max Temperature (Solid) Q2	[°C]	156.23	
VG Max Temperature (Solid) Q1	[°C]	167.61	
VG Max Temperature (Solid) U4	[°C]	216.40	
VG Max Temperature (Solid) U3	[°C]	161.37	
VG Max Temperature (Solid) U5	[°C]	170.37	
VG Max Temperature (Solid) U6	[°C]	170.88	
VG Max Temperature (Solid) Q7	[°C]	111.00	
VG Max Temperature (Solid) Q8	[°C]	136.50	
VG Max Temperature (Solid) Q22	[°C]	134.61	
VG Max Temperature (Solid) D1	[°C]	201.40	
VG Max Temperature (Solid) D7	[°C]	132.73	
VG Max Temperature (Solid) R3	[°C]	138.95	
VG Max Temperature (Solid) R55	[°C]	135.44	
VG Max Temperature (Solid) R94	[°C]	167.13	
VG Max Temperature (Solid) R113	[°C]	120.55	
VG Max Temperature (Solid) PCB	[°C]	184.24	
VG Max Temperature (Solid) U8	[°C]	119.42	
VG Max Temperature (Solid) L1	[°C]	141.18	
VG Max Temperature (Solid) L3	[°C]	136.39	
VG Max Temperature (Solid) Battery	[°C]	40.00	

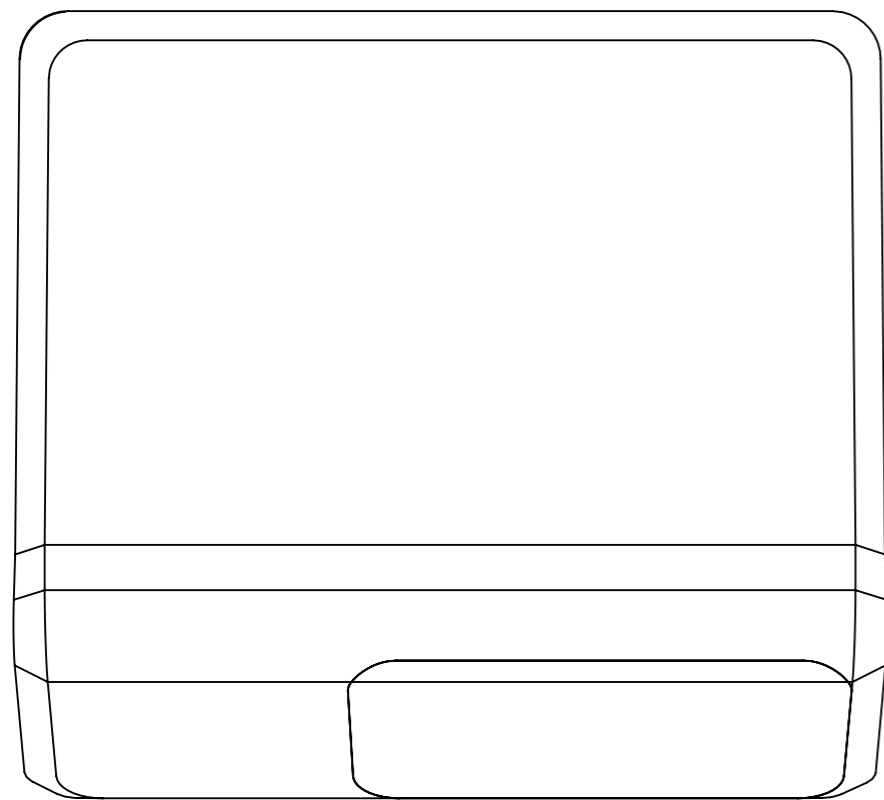




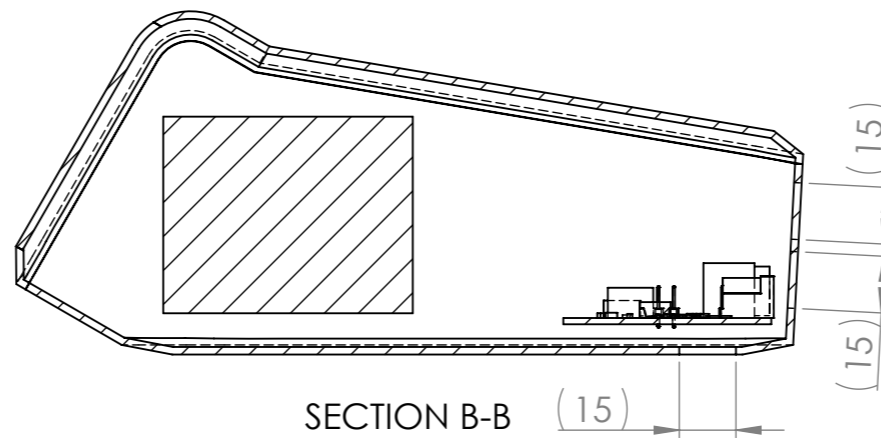
FRONT VIEW



REAR VIEW

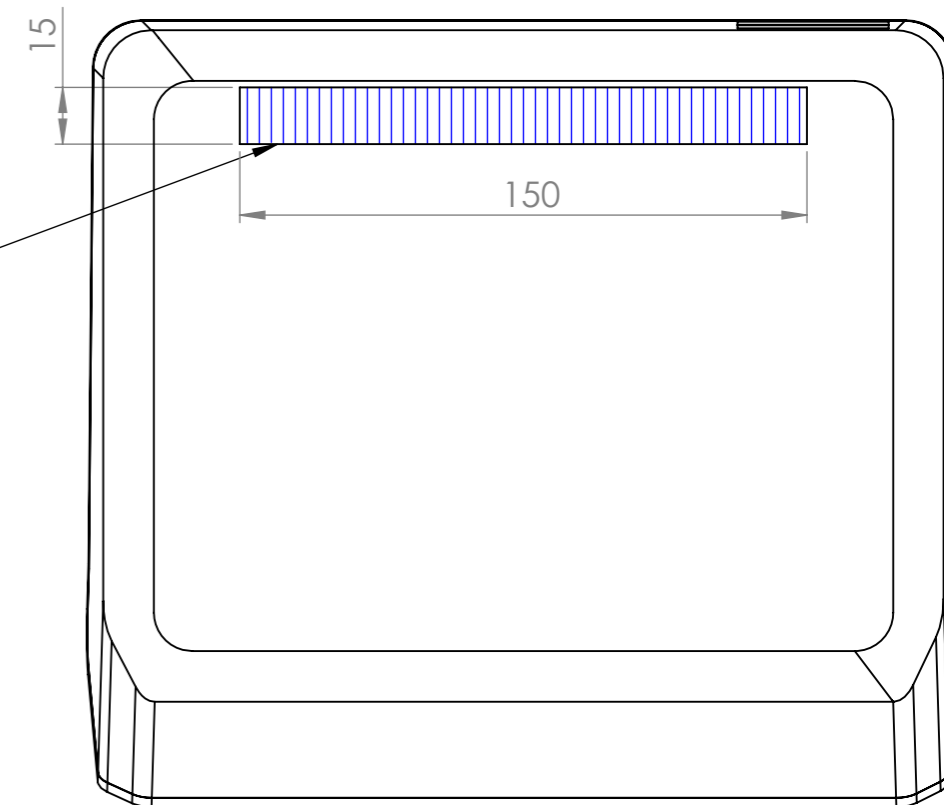


TOP VIEW



SECTION B-B

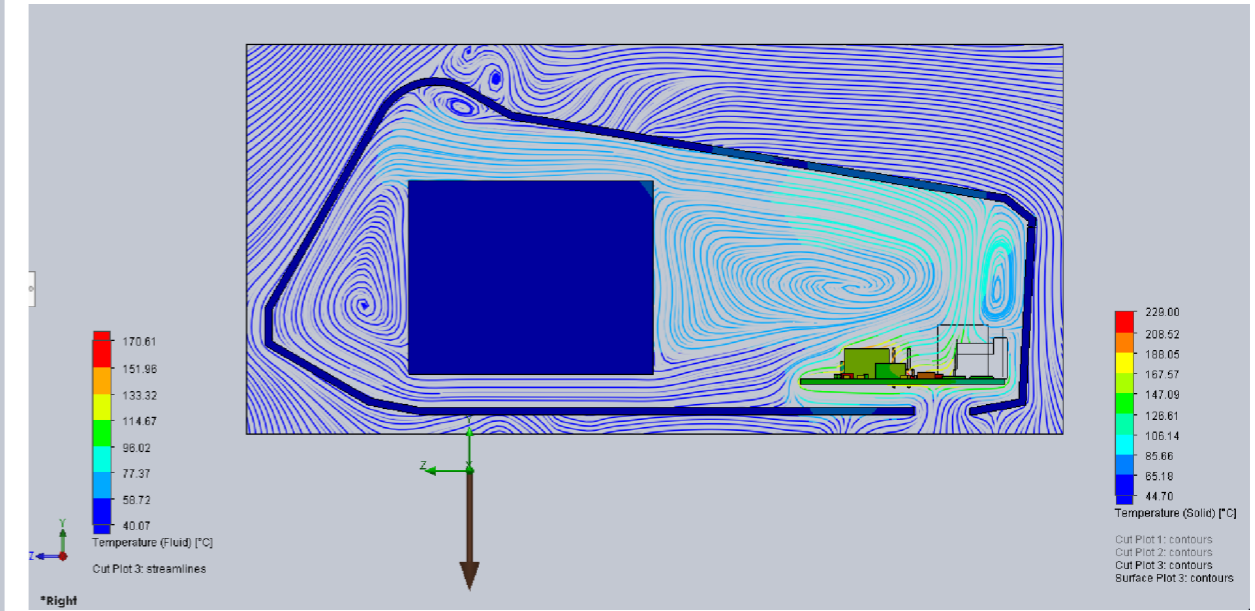
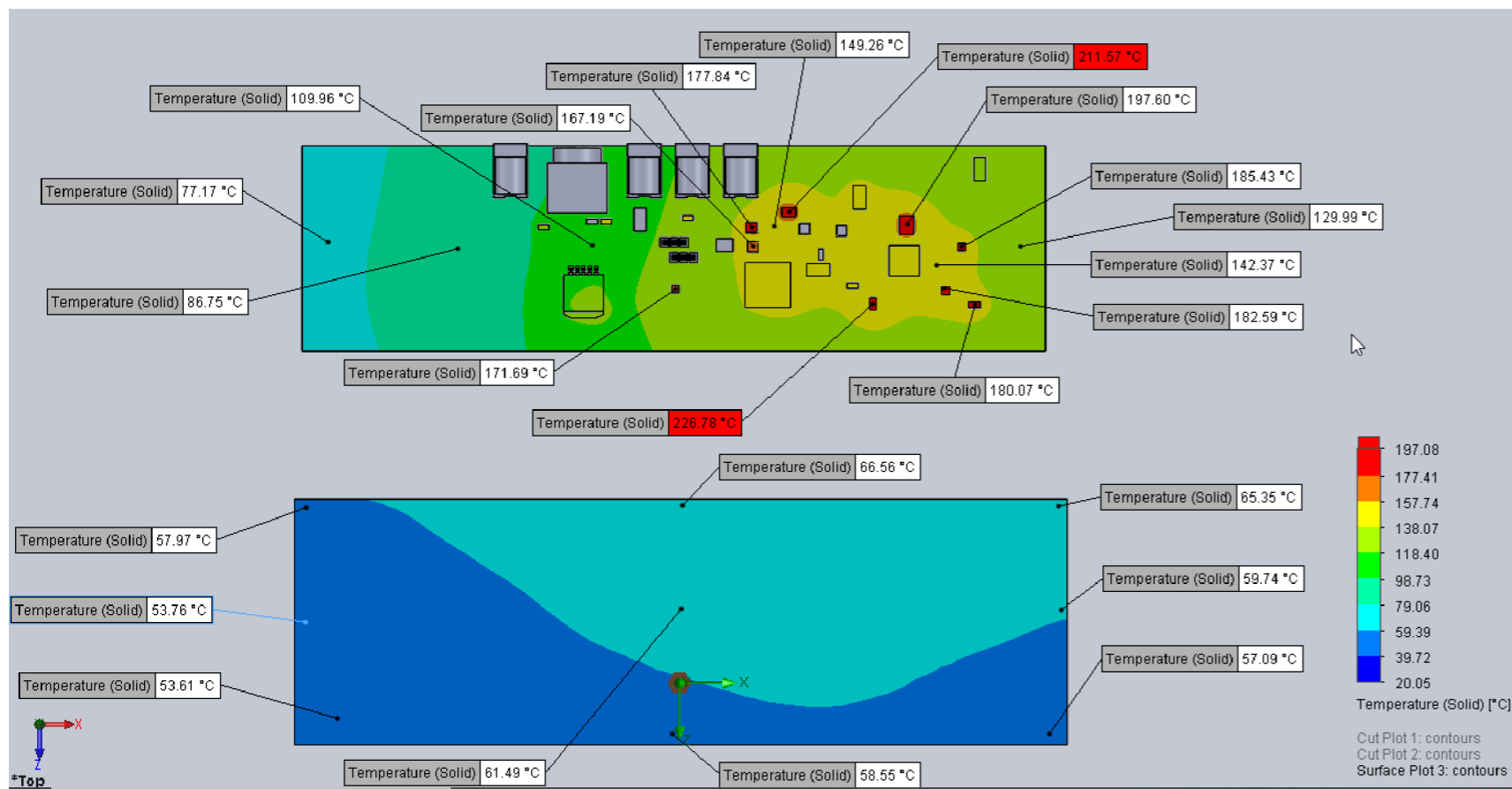
INLET VENTS



BOTTOM VIEW

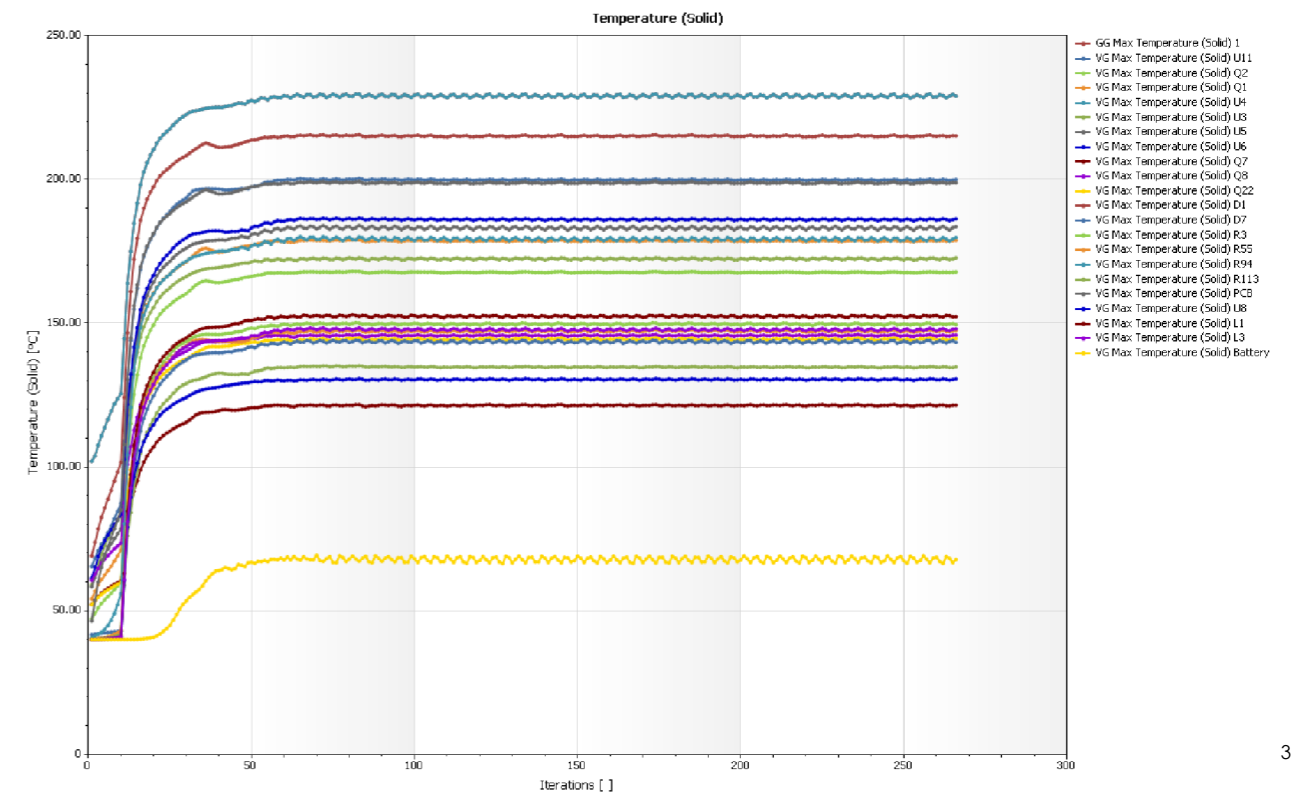
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TITLE:	Enclosure Design 1: Outlet/Inlet Vents (No Baffle Plate)	
DWG NO.	040421_ConceptA and ConceptD Sim Report	A3
SCALE:1:2	SHEET 6 OF 17	



040421 ConceptA.SLDASM [ENC 1: System Flow Sin

Goal Name	Unit	Sim Value	Actual Value
GG Max Temperature (Fluid) 1	[°C]	229.00	
GG Max Temperature (Solid) 1	[°C]	229.00	
VG Max Temperature (Solid) U11	[°C]	199.98	
VG Max Temperature (Solid) Q2	[°C]	167.80	
VG Max Temperature (Solid) Q1	[°C]	178.77	
VG Max Temperature (Solid) U4	[°C]	229.00	
VG Max Temperature (Solid) U3	[°C]	172.69	
VG Max Temperature (Solid) U5	[°C]	183.53	
VG Max Temperature (Solid) U6	[°C]	186.26	
VG Max Temperature (Solid) Q7	[°C]	121.46	
VG Max Temperature (Solid) Q8	[°C]	145.88	
VG Max Temperature (Solid) Q22	[°C]	144.66	
VG Max Temperature (Solid) D1	[°C]	215.12	
VG Max Temperature (Solid) D7	[°C]	143.34	
VG Max Temperature (Solid) R3	[°C]	149.49	
VG Max Temperature (Solid) R55	[°C]	147.33	
VG Max Temperature (Solid) R94	[°C]	179.78	
VG Max Temperature (Solid) R113	[°C]	134.80	
VG Max Temperature (Solid) PCB	[°C]	198.88	
VG Max Temperature (Solid) U8	[°C]	130.63	
VG Max Temperature (Solid) L1	[°C]	152.27	
VG Max Temperature (Solid) L3	[°C]	148.00	
VG Max Temperature (Solid) Battery	[°C]	67.79	



Iterations []: 266
Analysis interval: 114

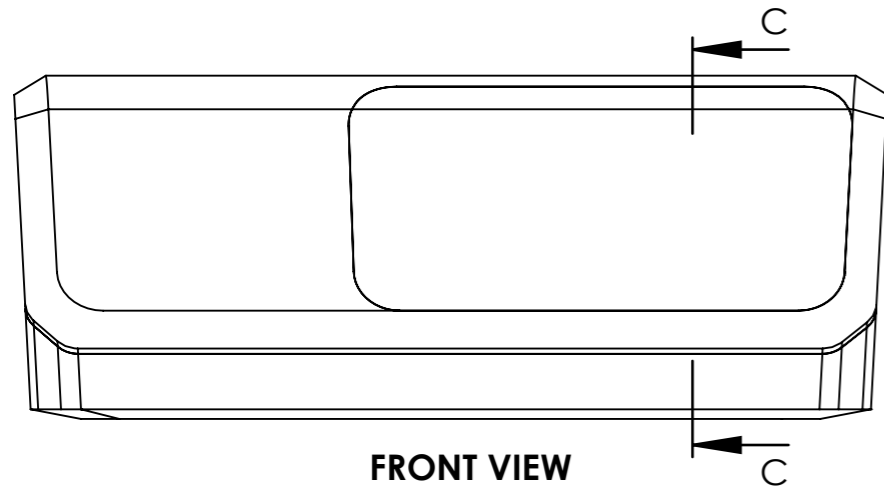
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DWG NO. 040421_ConceptA and ConceptD Sim Report

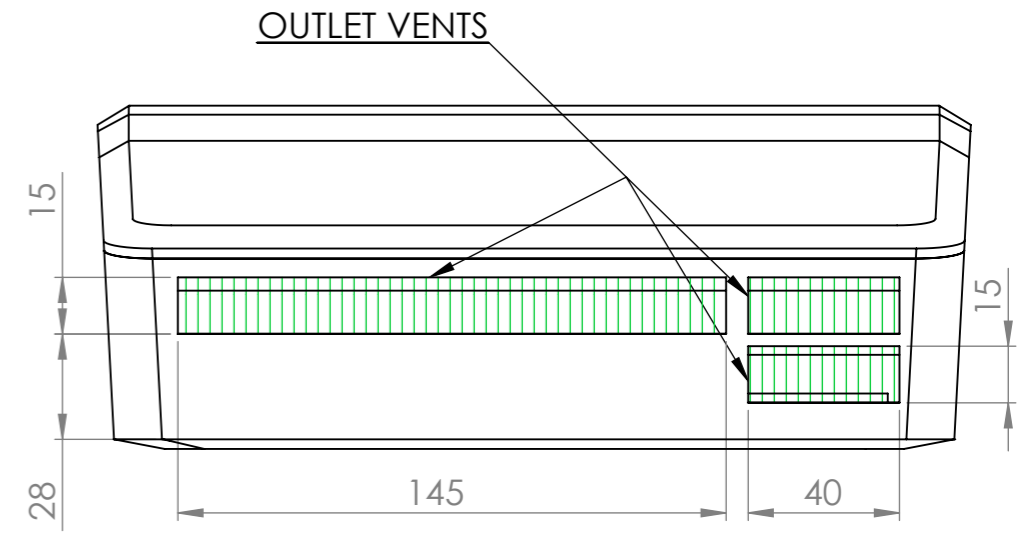
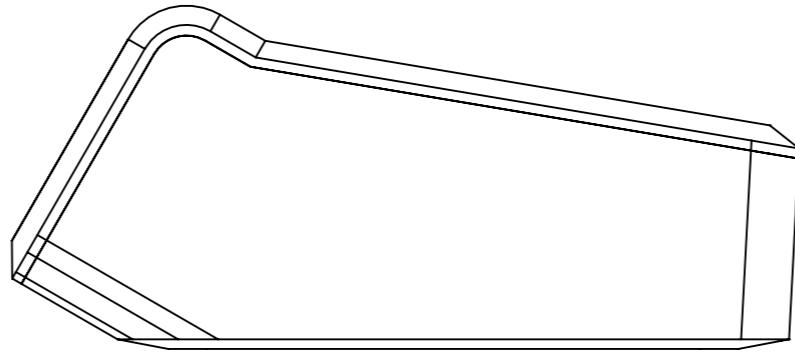
A3

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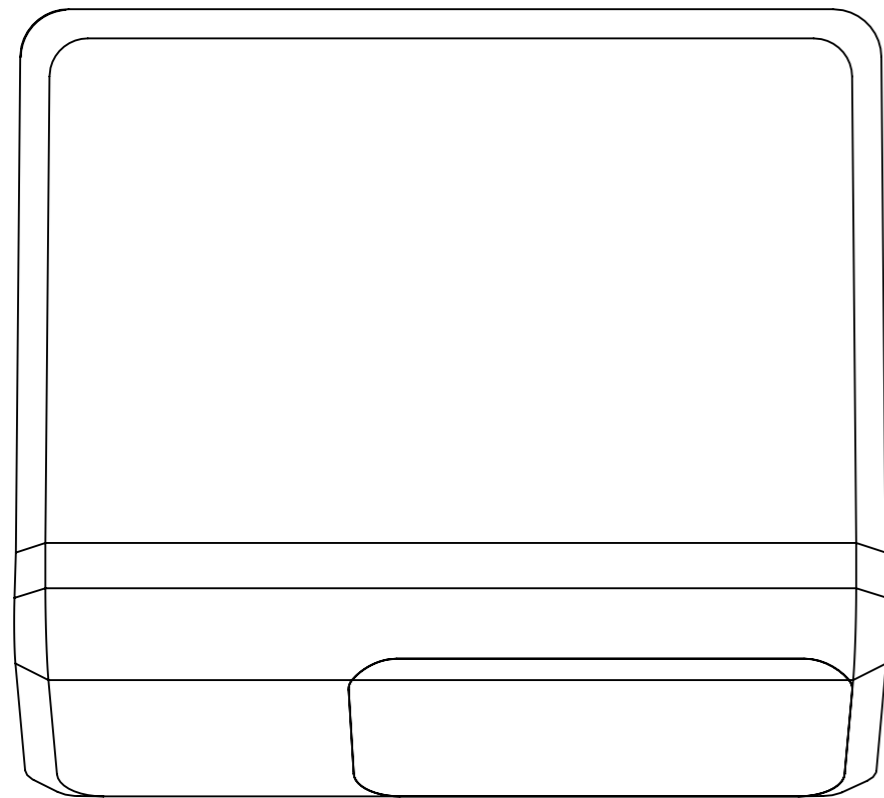
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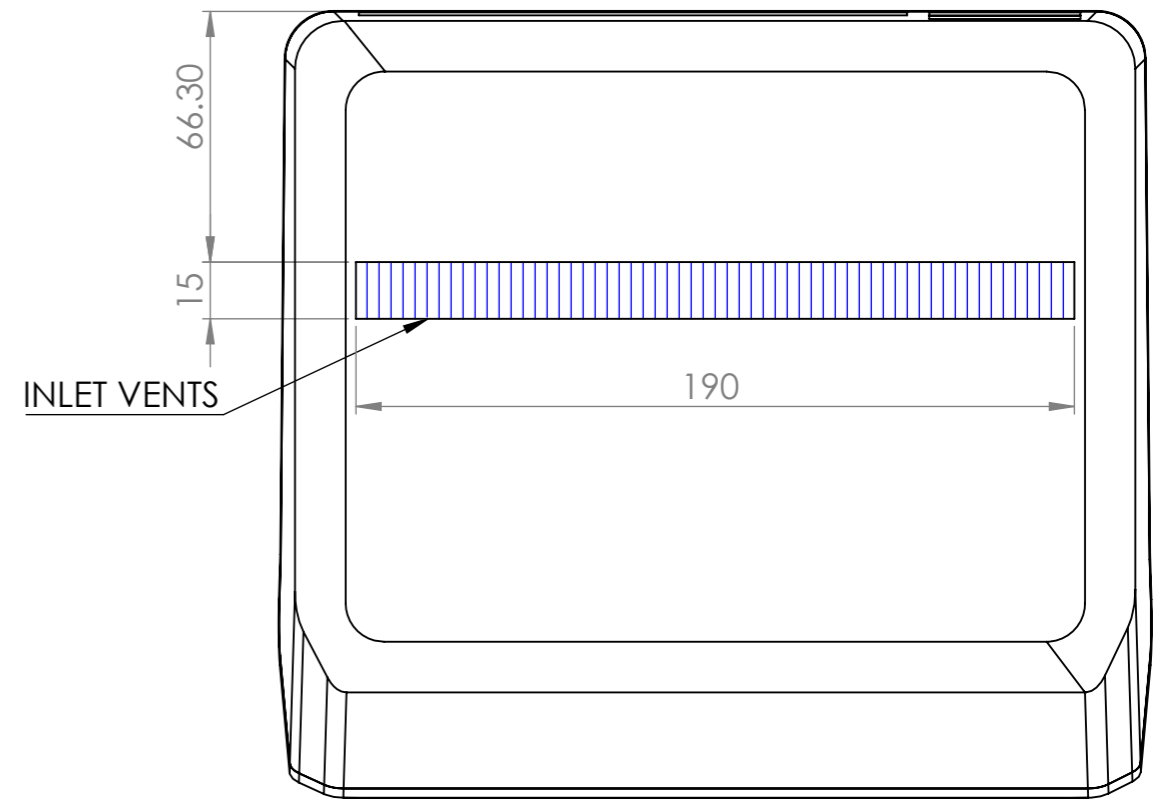
FRONT VIEW



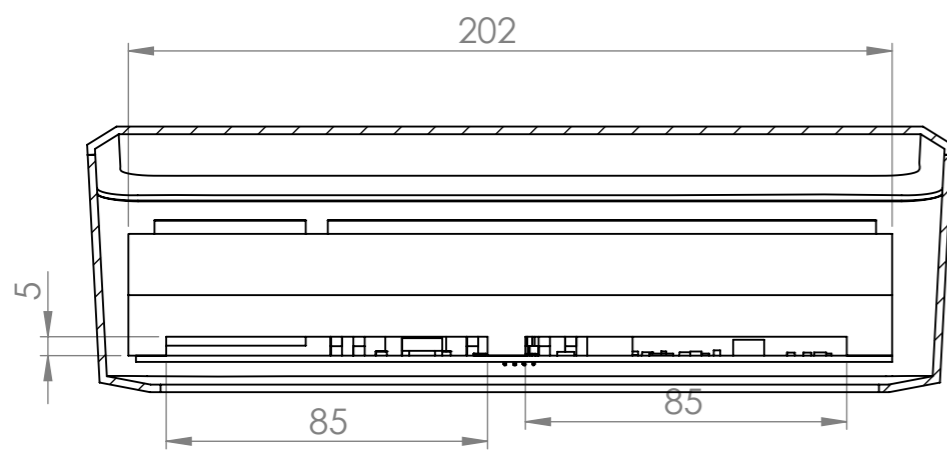
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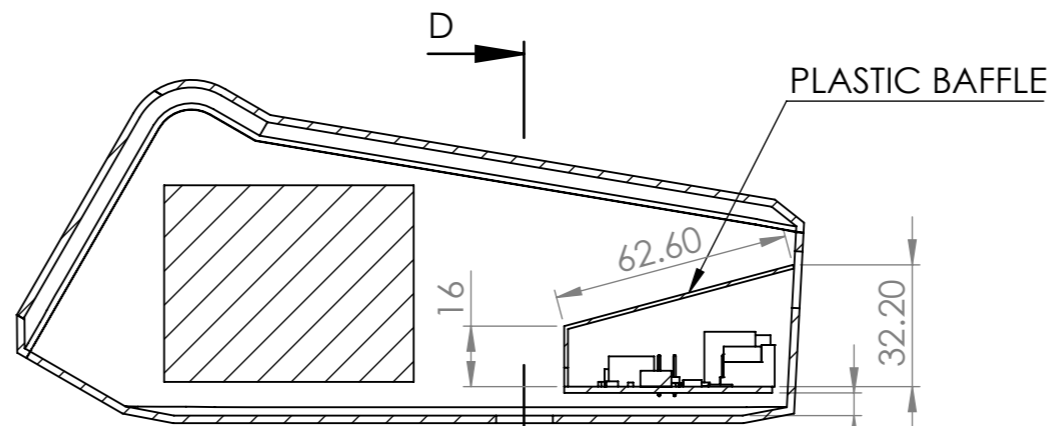
TOP VIEW



BOTTOM VIEW

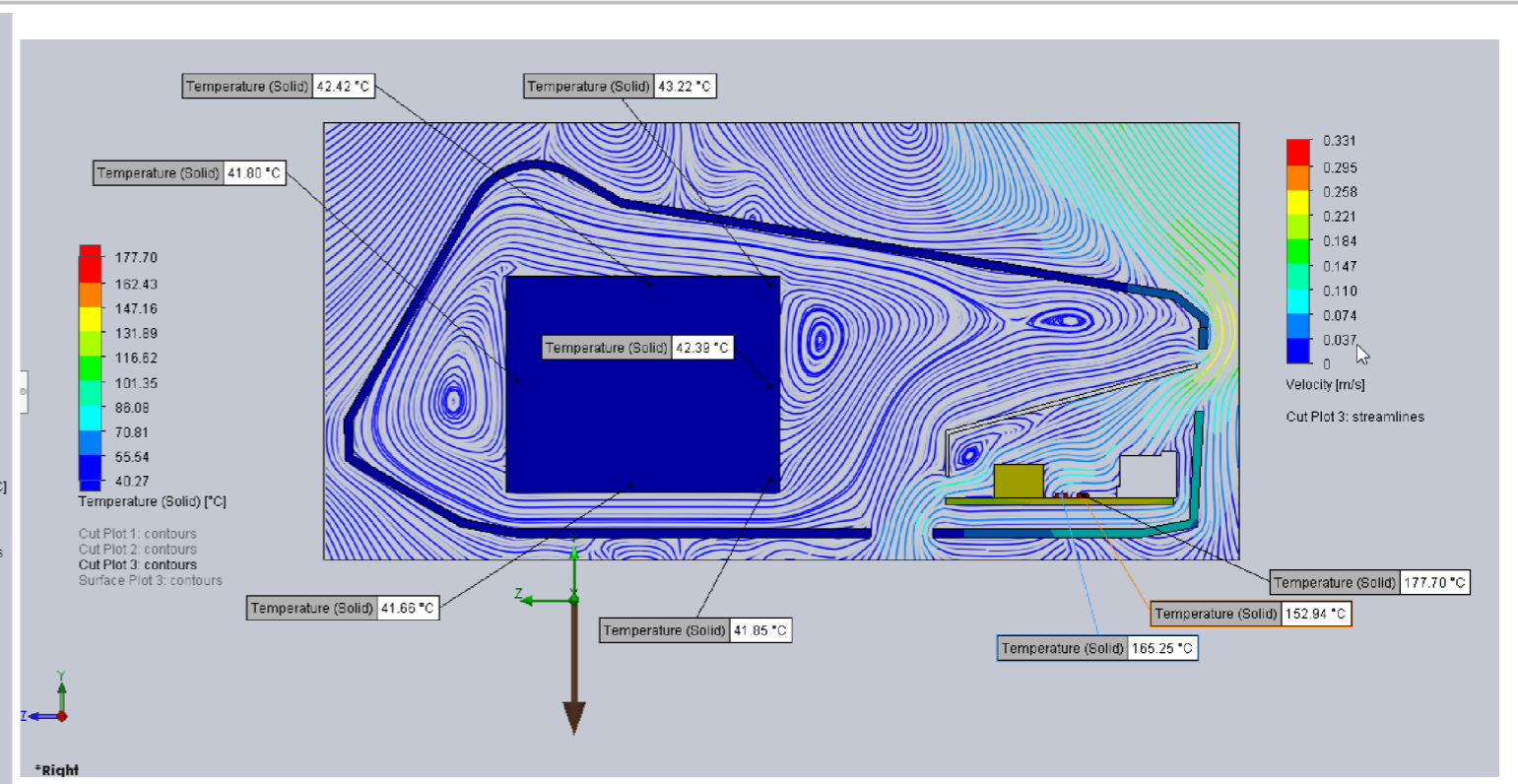
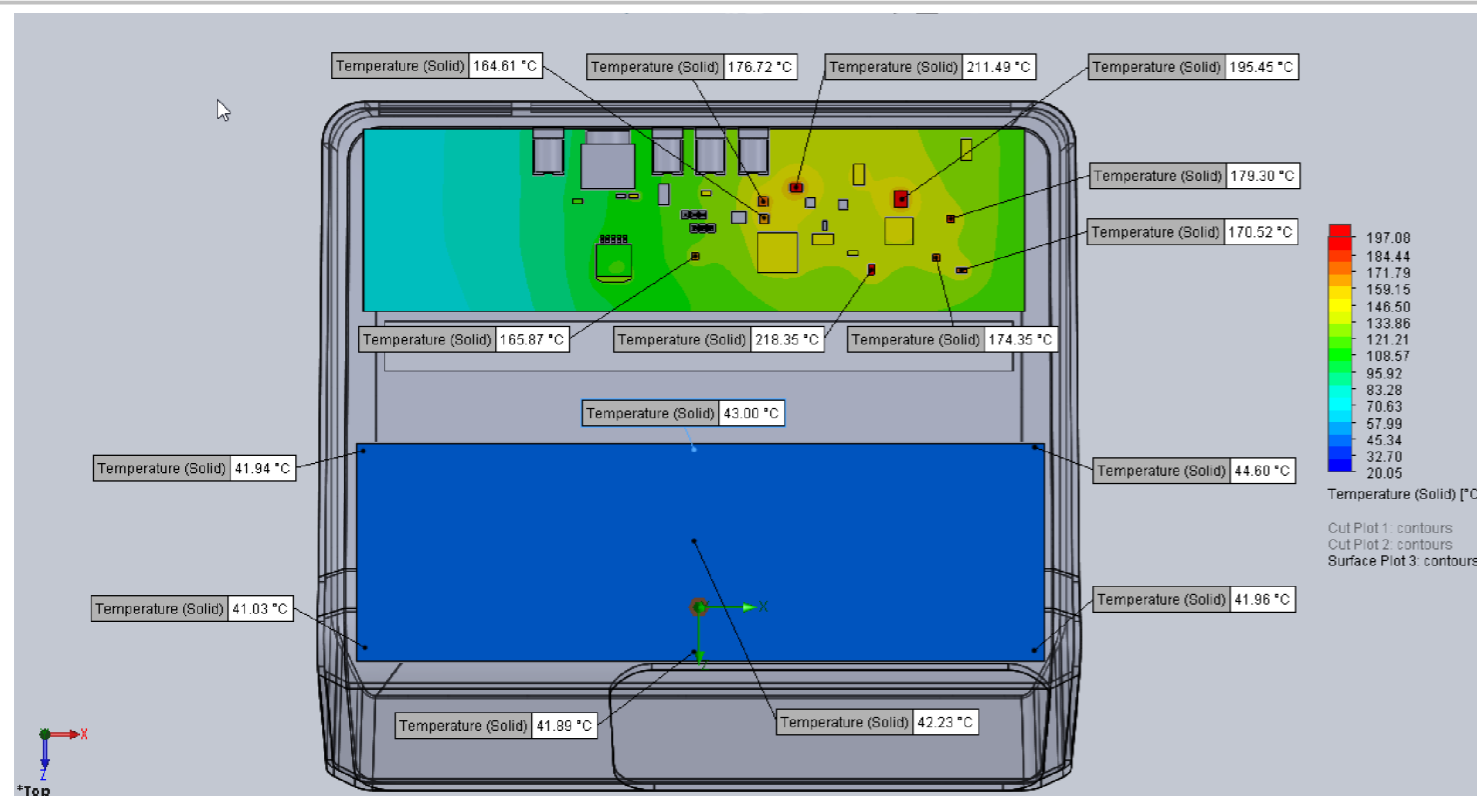


SECTION D-D



SECTION C-C

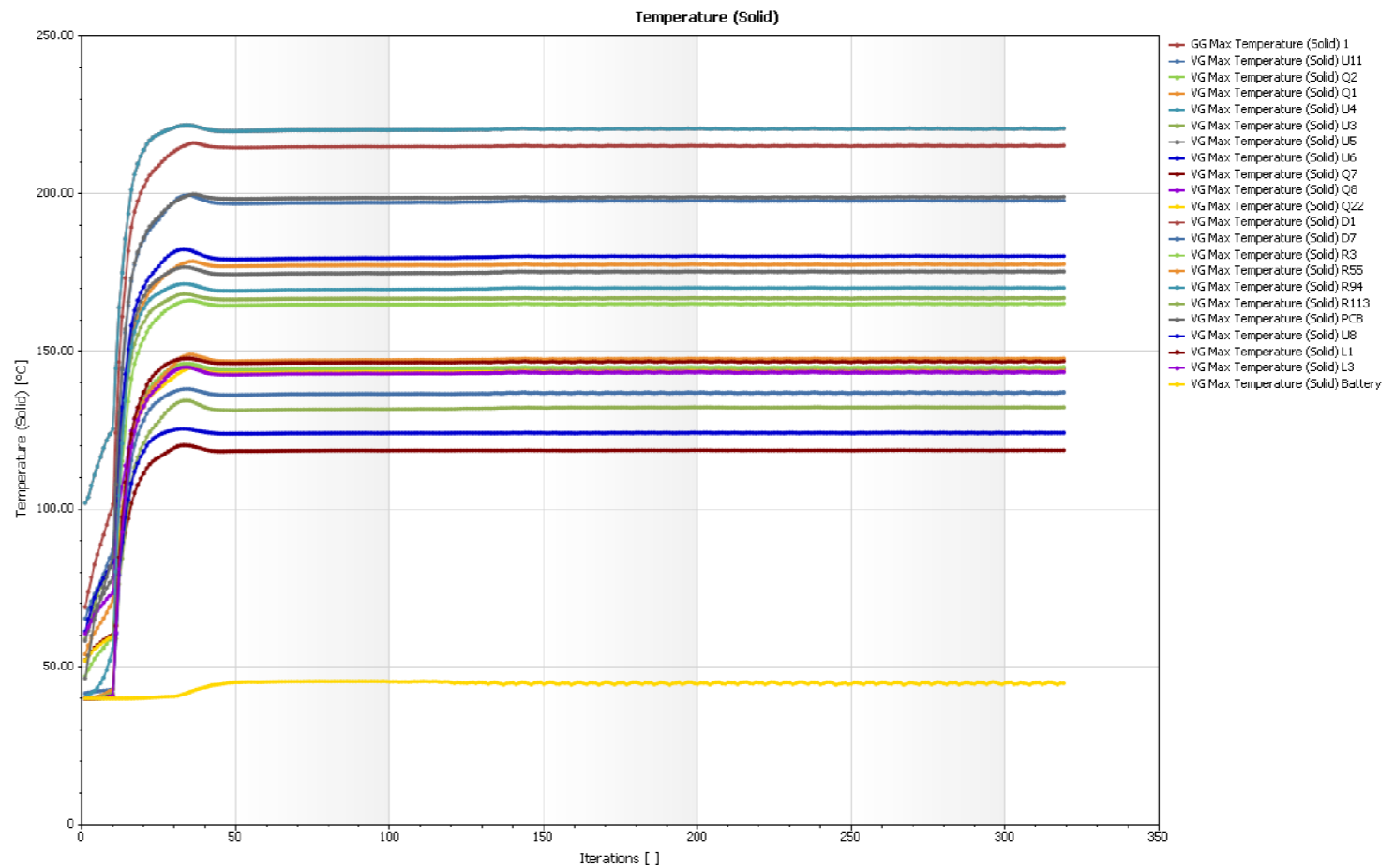
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DWG NO.	040421_ConceptA and ConceptD Sim Report	A3
SCALE:1:2	SHEET 8 OF 17	

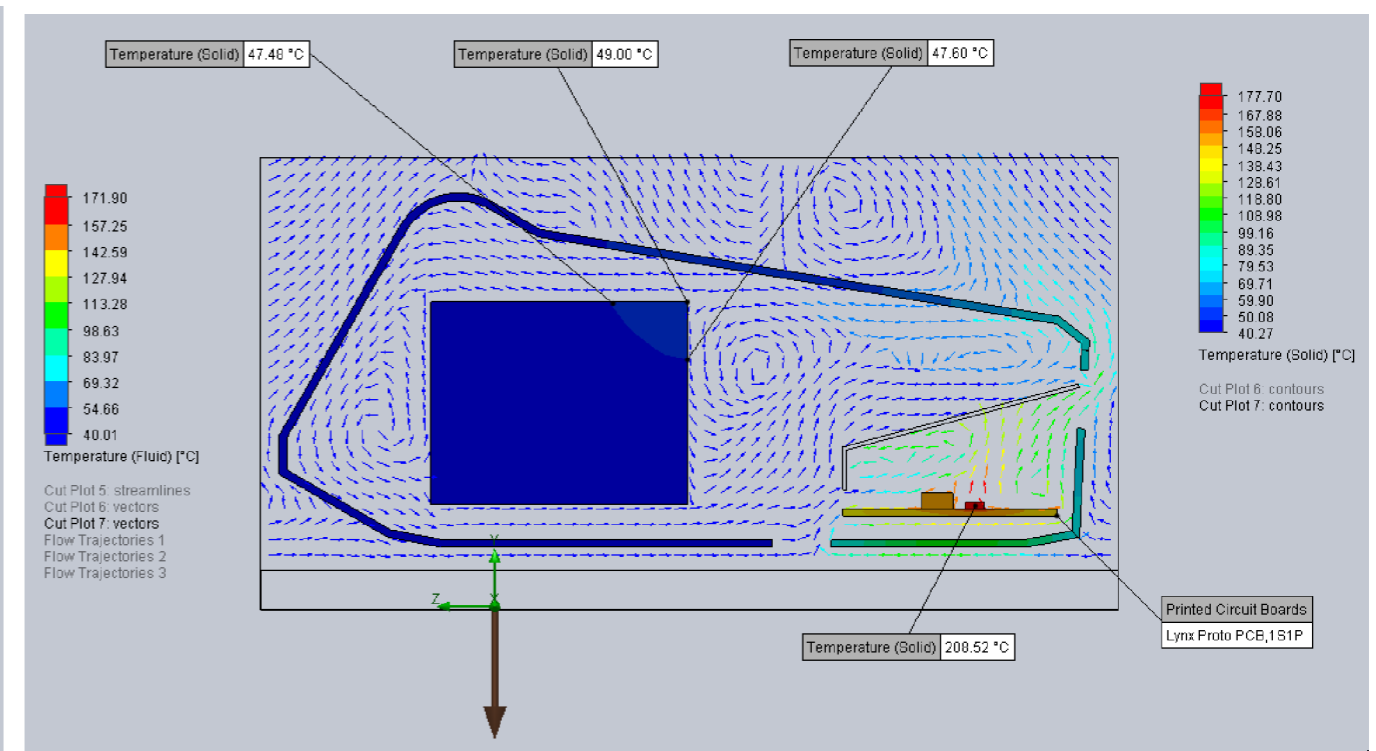
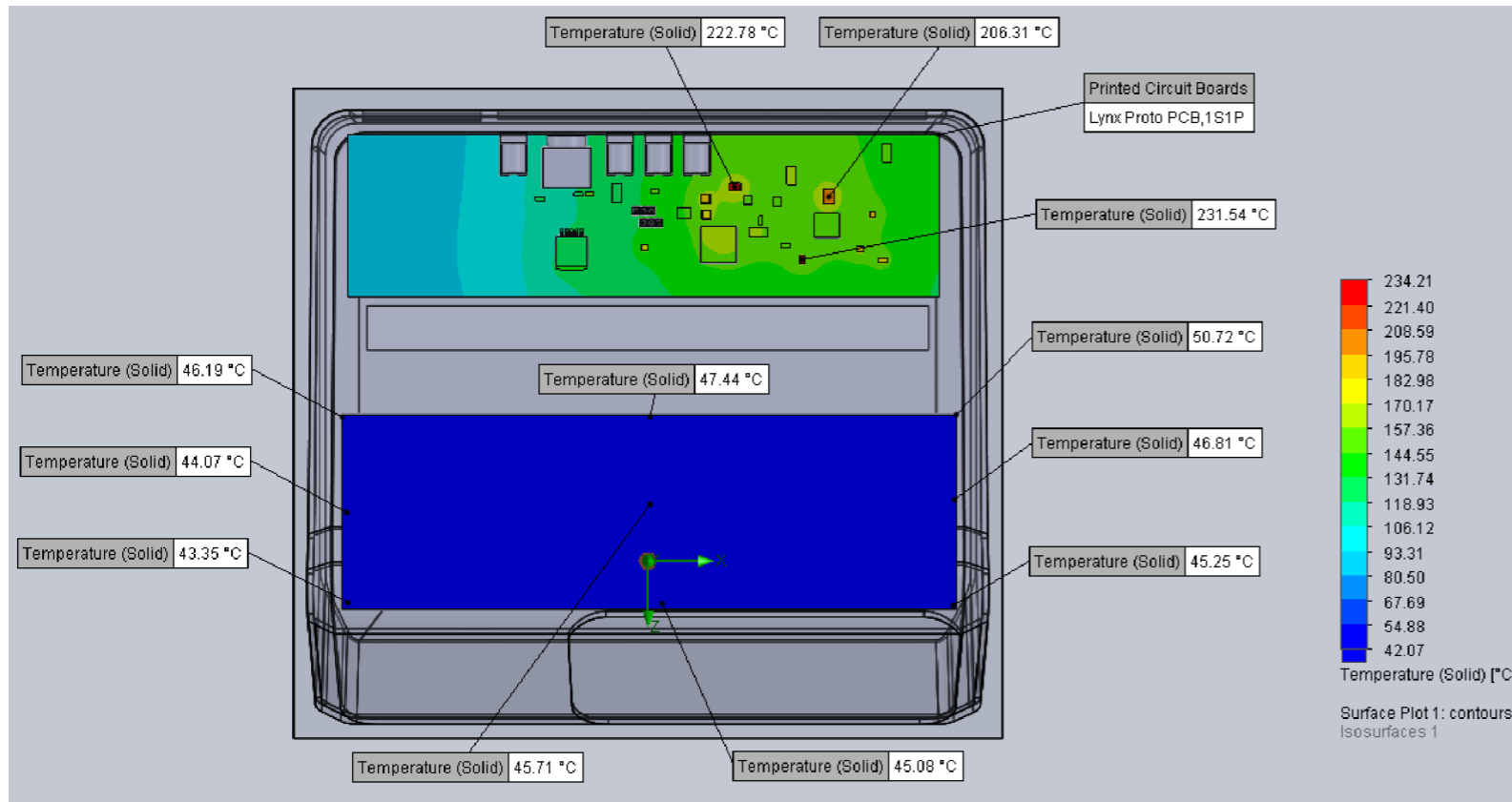


040421_ConceptA.SLDASM [ENC 2:Syst

Goal Name	Unit	Sim Value	Actual Value
GG Max Temperature (Fluid) 1	[°C]	220.73	
GG Max Temperature (Solid) 1	[°C]	220.73	
VG Max Temperature (Solid) U11	[°C]	197.85	
VG Max Temperature (Solid) Q2	[°C]	165.25	
VG Max Temperature (Solid) Q1	[°C]	177.70	
VG Max Temperature (Solid) U4	[°C]	220.73	
VG Max Temperature (Solid) U3	[°C]	166.96	
VG Max Temperature (Solid) U5	[°C]	175.39	
VG Max Temperature (Solid) U6	[°C]	180.29	
VG Max Temperature (Solid) Q7	[°C]	118.75	
VG Max Temperature (Solid) Q8	[°C]	144.52	
VG Max Temperature (Solid) Q22	[°C]	143.81	
VG Max Temperature (Solid) D1	[°C]	215.30	
VG Max Temperature (Solid) D7	[°C]	137.11	
VG Max Temperature (Solid) R3	[°C]	145.10	
VG Max Temperature (Solid) R55	[°C]	147.75	
VG Max Temperature (Solid) R94	[°C]	170.23	
VG Max Temperature (Solid) R113	[°C]	132.38	
VG Max Temperature (Solid) PCB	[°C]	199.09	
VG Max Temperature (Solid) U8	[°C]	124.28	
VG Max Temperature (Solid) L1	[°C]	146.93	
VG Max Temperature (Solid) L3	[°C]	143.51	
VG Max Temperature (Solid) Battery	[°C]	44.87	

Iterations []: 319
 Analysis interval: 119

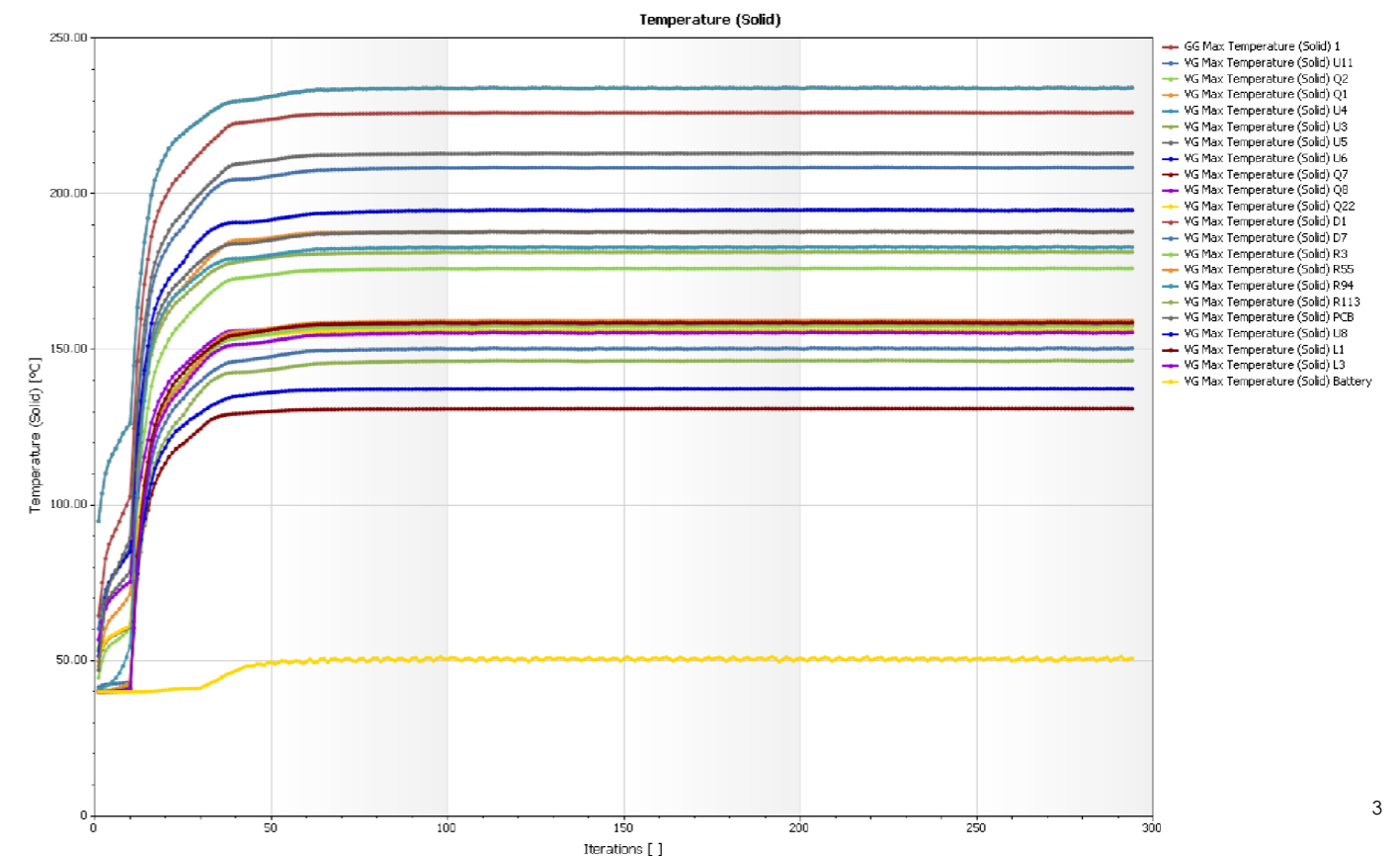




040421_ConceptA.SLDASM [ENC 2.1: System Flow Simulation]

Goal Name	Unit	Sim Value	Actual Value
GG Max Temperature (Fluid) 1	[°C]	234.21	
GG Max Temperature (Solid) 1	[°C]	234.21	
VG Max Temperature (Solid) U11	[°C]	208.52	
VG Max Temperature (Solid) Q2	[°C]	176.08	
VG Max Temperature (Solid) Q1	[°C]	187.94	
VG Max Temperature (Solid) U4	[°C]	234.21	
VG Max Temperature (Solid) U3	[°C]	181.27	
VG Max Temperature (Solid) U5	[°C]	187.89	
VG Max Temperature (Solid) U6	[°C]	194.77	
VG Max Temperature (Solid) Q7	[°C]	130.98	
VG Max Temperature (Solid) Q8	[°C]	157.84	
VG Max Temperature (Solid) Q22	[°C]	156.23	
VG Max Temperature (Solid) D1	[°C]	226.16	
VG Max Temperature (Solid) D7	[°C]	150.41	
VG Max Temperature (Solid) R3	[°C]	157.56	
VG Max Temperature (Solid) R55	[°C]	159.31	
VG Max Temperature (Solid) R94	[°C]	182.92	
VG Max Temperature (Solid) R113	[°C]	146.45	
VG Max Temperature (Solid) PCB	[°C]	213.03	
VG Max Temperature (Solid) U8	[°C]	137.35	
VG Max Temperature (Solid) L1	[°C]	158.71	
VG Max Temperature (Solid) L3	[°C]	155.50	
VG Max Temperature (Solid) Battery	[°C]	50.72	

Iterations []: 294
Analysis interval: 125



Lynx Proto PCB,1S1P

Property:
Conducting layers

Layer Thickness	Percentage Cover
7e-005 m	70 %
7e-005 m	90 %



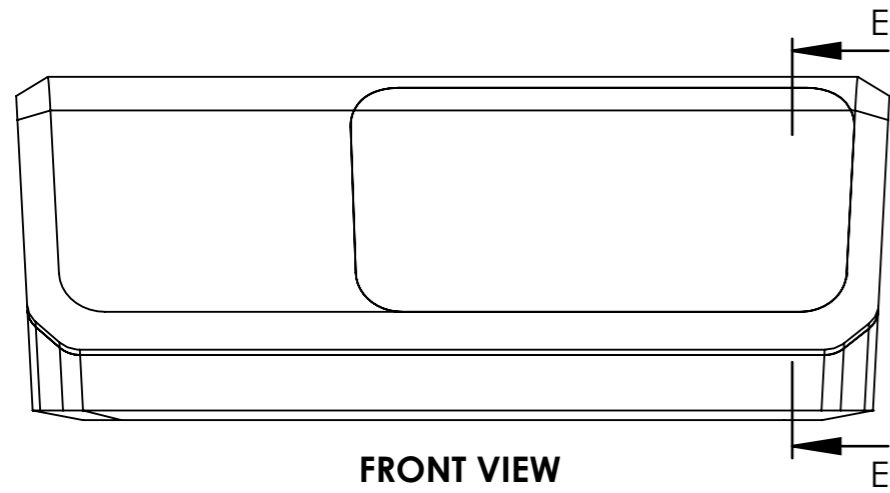
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Using 2-Layer PCB
Thermal Simulation

DWG NO. 040421_ConceptA and
ConceptD Sim Report

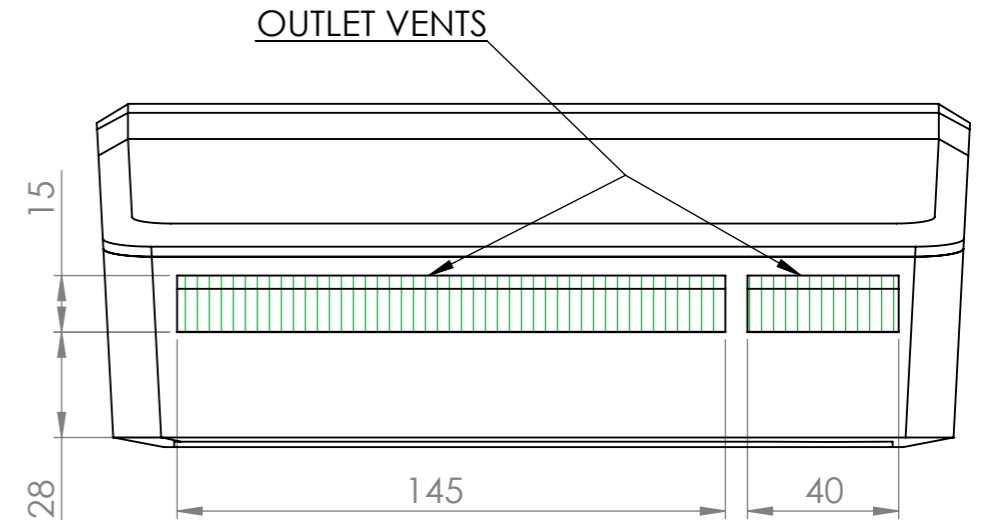
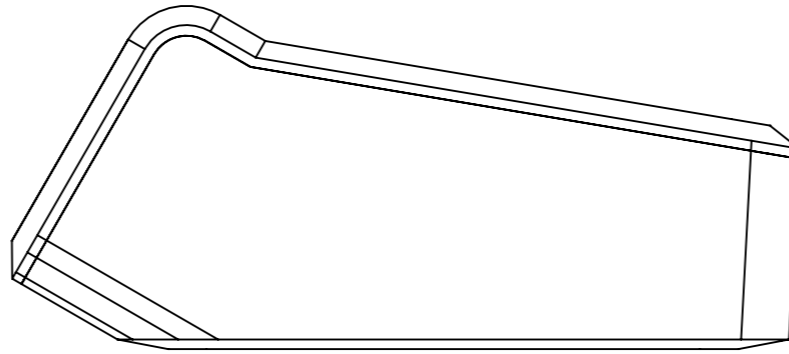
A3

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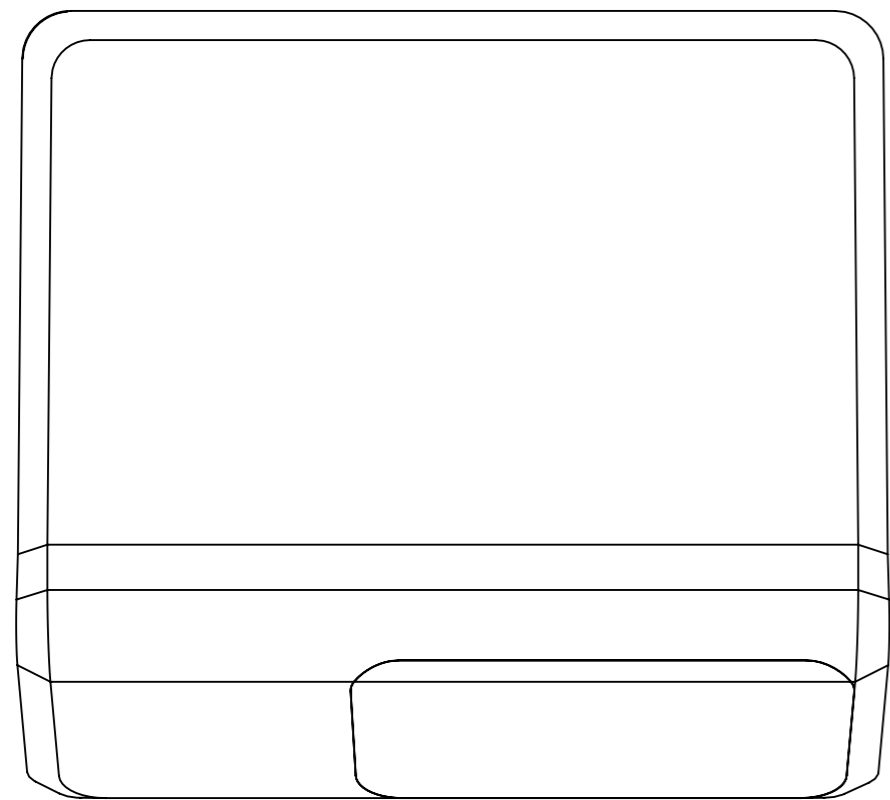
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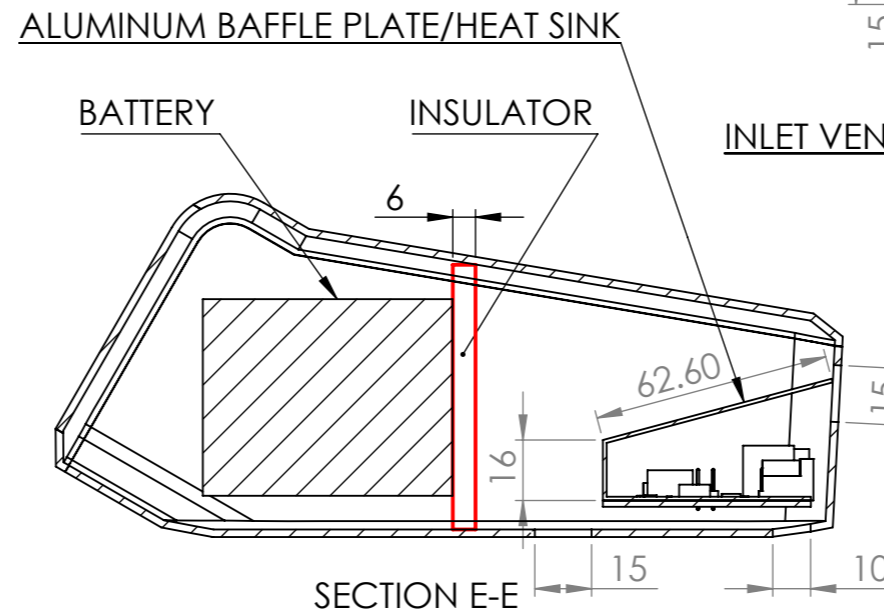
FRONT VIEW



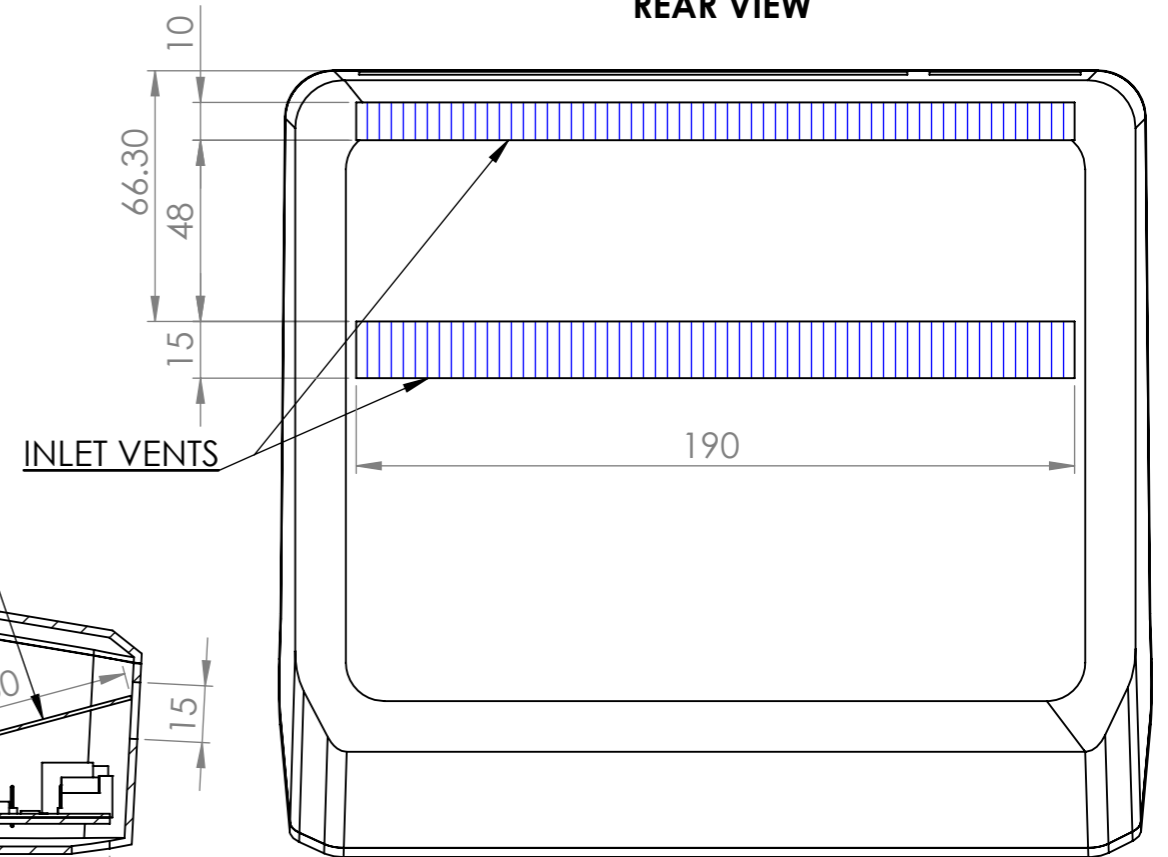
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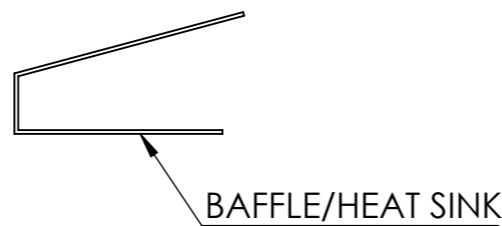
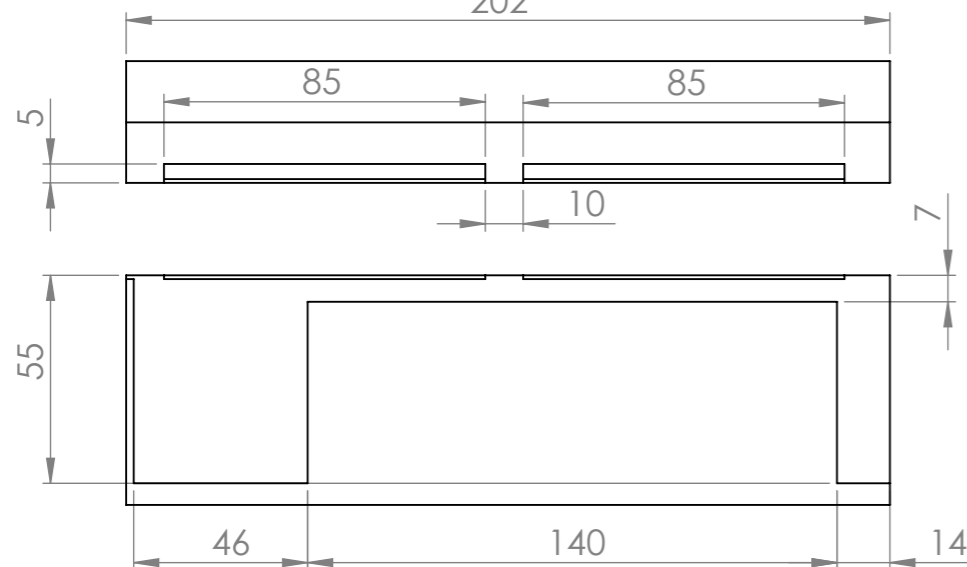
TOP VIEW



SECTION E-E

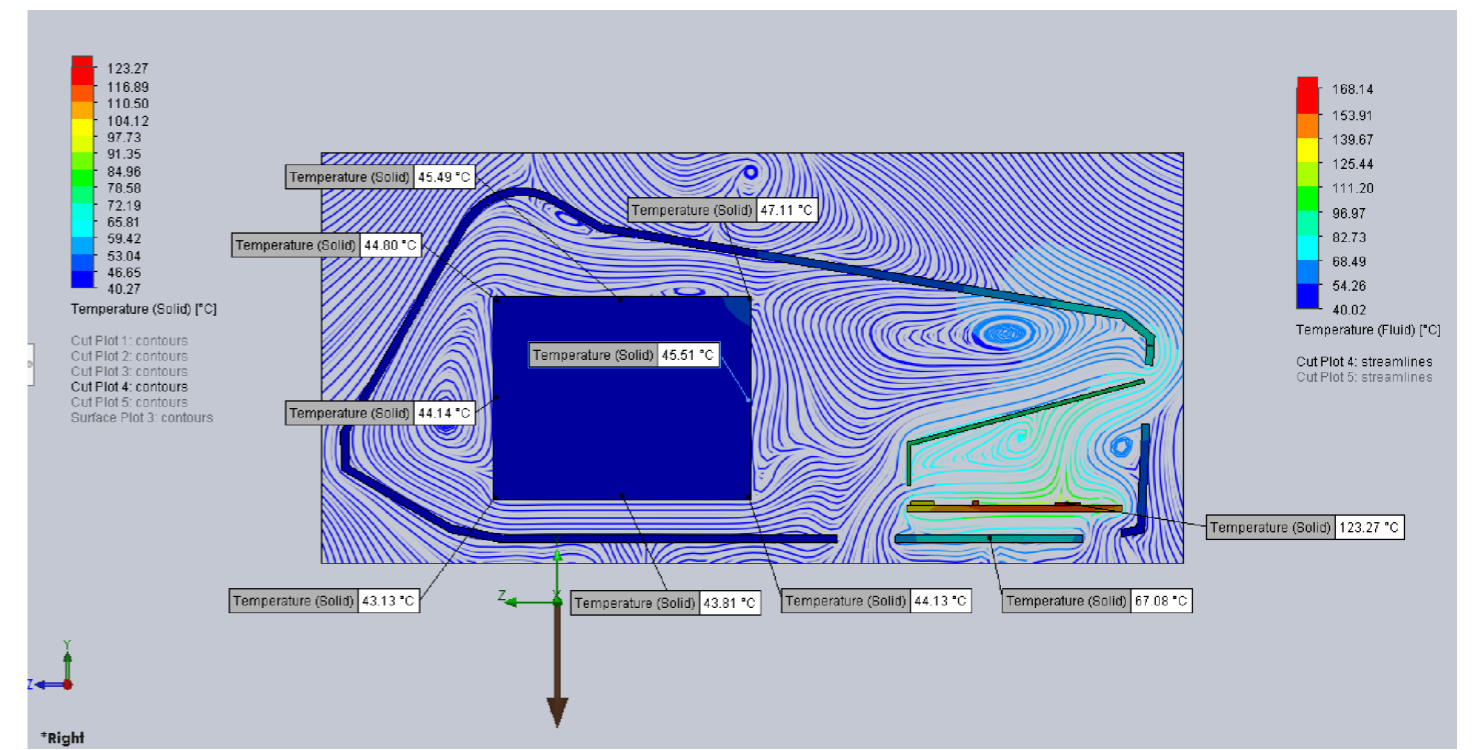
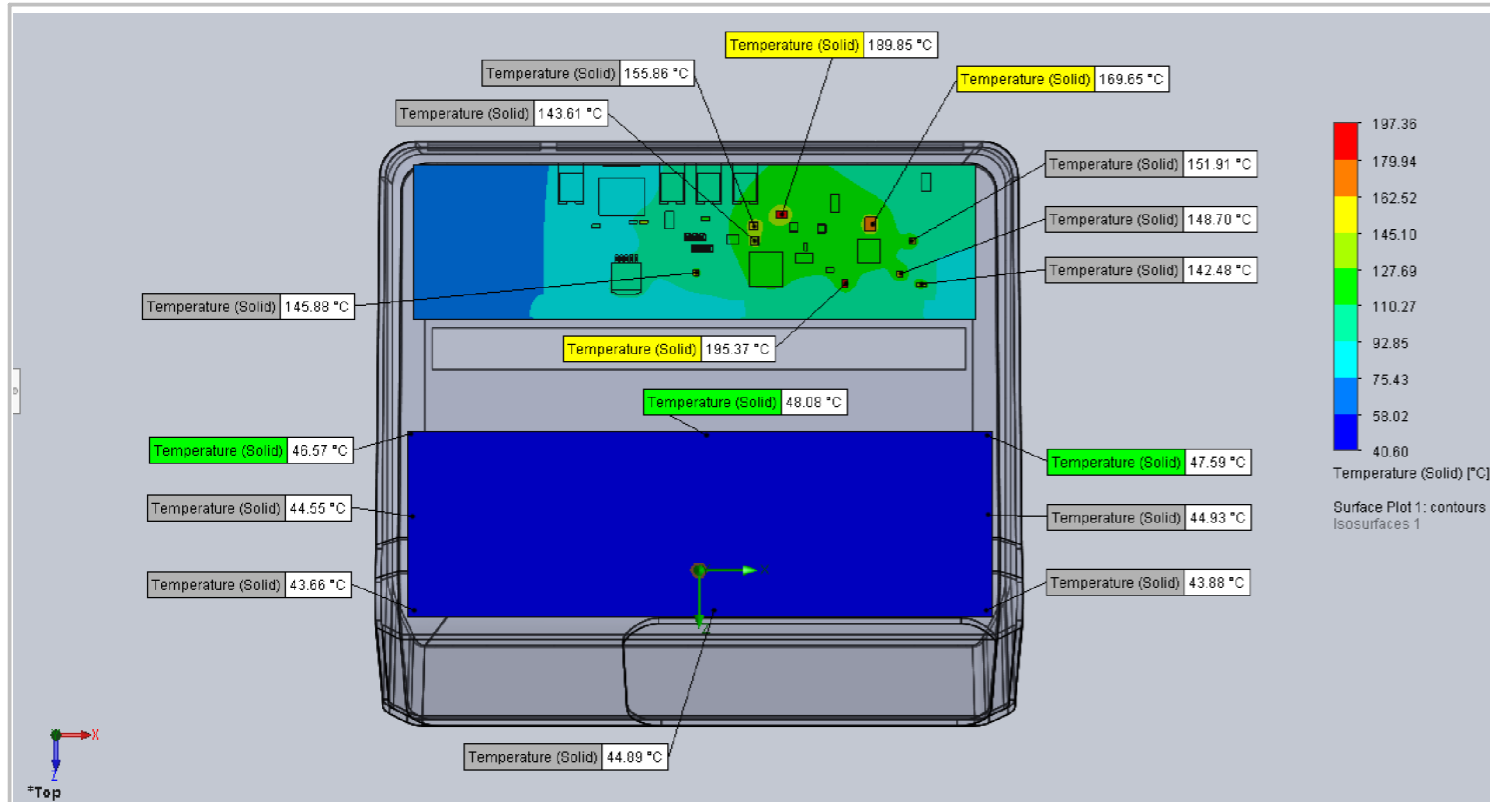


BOTTOM VIEW



BAFFLE/HEAT SINK

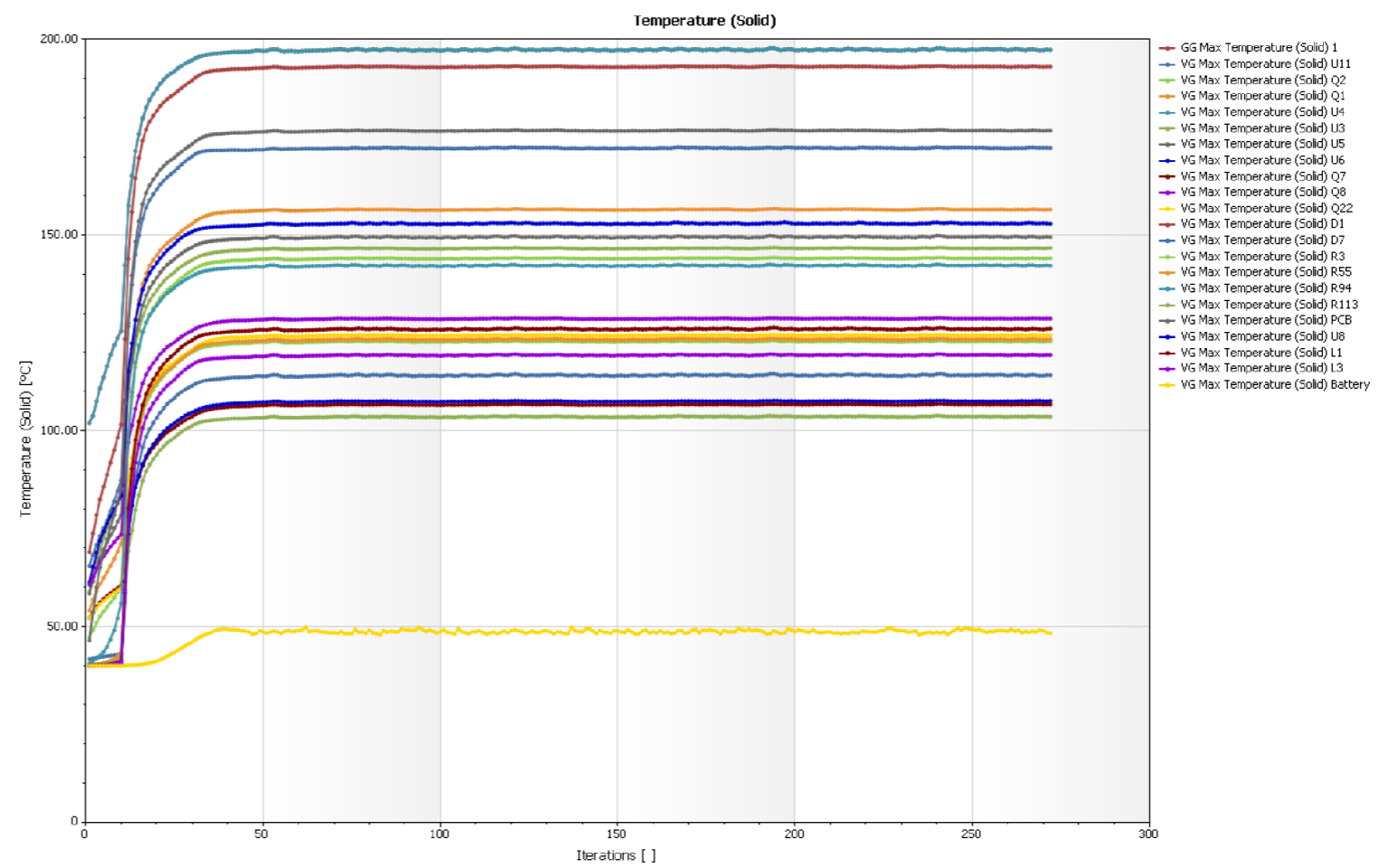
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DWG NO.	040421_ConceptA and ConceptD Sim Report	A3
SCALE:1:2	SHEET 11 OF 17	



040421 ConceptA.SLDASM [ENC 3: Syst

Goal Name	Unit	Sim Value	Actual Value
GG Max Temperature (Fluid) 1	[°C]	197.36	
GG Max Temperature (Solid) 1	[°C]	197.36	
VG Max Temperature (Solid) U11	[°C]	172.29	
VG Max Temperature (Solid) Q2	[°C]	144.09	
VG Max Temperature (Solid) Q1	[°C]	156.55	
VG Max Temperature (Solid) U4	[°C]	197.36	
VG Max Temperature (Solid) U3	[°C]	146.71	
VG Max Temperature (Solid) U5	[°C]	149.48	
VG Max Temperature (Solid) U6	[°C]	152.91	
VG Max Temperature (Solid) Q7	[°C]	106.74	
VG Max Temperature (Solid) Q8	[°C]	128.69	
VG Max Temperature (Solid) Q22	[°C]	124.39	
VG Max Temperature (Solid) D1	[°C]	193.03	
VG Max Temperature (Solid) D7	[°C]	114.20	
VG Max Temperature (Solid) R3	[°C]	122.86	
VG Max Temperature (Solid) R55	[°C]	123.37	
VG Max Temperature (Solid) R94	[°C]	142.19	
VG Max Temperature (Solid) R113	[°C]	103.61	
VG Max Temperature (Solid) PCB	[°C]	176.73	
VG Max Temperature (Solid) U8	[°C]	107.65	
VG Max Temperature (Solid) L1	[°C]	126.09	
VG Max Temperature (Solid) L3	[°C]	119.35	
VG Max Temperature (Solid) Battery	[°C]	48.30	

Iterations []: 272
Analysis interval: 122



TITLE: Enclosure Design 3: Thermal Simulation

DWG NO. 040421_ConceptA and ConceptD Sim Report

A3

SCALE:1:2 SHEET 12 OF 17

FINDINGS/INTERPRETATION OF SIM RESULTS:

1.THERMAL SIMULATION OF PCB ASSY LEVEL AT 40 C AMBIENT(NO ENCLOSURE) IDENTIFY THE HOT COMPONENTS ABOVE JUNCTION TEMPERATURE OF 150 C. A 4-LAYER PCB WAS USED IN THE SIMULATION RUN WHICH ALSO REVEALED THE HOT SECTION OR AREAS OF THE PCB.

2.SYSTEM LEVEL THERMAL SIMULATION OF PCB ASSY INSIDE "ENCLOSURE DESIGN 1(WITHOUT BAFFLE)" AT 40 C AMBIENT(NATURAL CONVECTION) IDENTIFY THE HOT COMPONENTS ABOVE JUNCTION TEMPERATURE OF 150 C.

-HIGHEST COMPONENT TEMP. **REACHED 229 C MAX.**

-A 4-LAYER PCB WAS USED IN THE SIMULATION RUN WHICH ALSO REVEALED THE HOT SECTION OR AREAS OF THE PCB.

-THE TEMPERATURE AROUND THE **BATTERY REACHED 67.79 C MAX.**

3.SYSTEM LEVEL THERMAL SIMULATION OF PCB ASSY INSIDE "ENCLOSURE DESIGN 2(WITH PLASTIC BAFFLE)" AT 40 C AMBIENT(NATURAL CONVECTION) IDENTIFY THE HOT COMPONENTS ABOVE JUNCTION TEMPERATURE OF 150 C.

-HIGHEST COMPONENT TEMP. **REACHED 220.73 C MAX.** COMPONENTS TEMP. SIGNIFICANTLY IS COOLER THAN WITHOUT BAFFLE.

-A 4-LAYER PCB WAS USED IN THE SIMULATION RUN WHICH ALSO REVEALED THE HOT SECTION OR AREAS OF THE PCB.

-THE TEMPERATURE AROUND THE **BATTERY REACHED ONLY 44.87 C MAX.**

4.SYSTEM LEVEL THERMAL SIMULATION OF PCB ASSY INSIDE "ENCLOSURE DESIGN 3(WITH METAL BAFFLE/HEATSINK)" AT 40 C AMBIENT(NATURAL CONVECTION) IDENTIFY THE HOT COMPONENTS ABOVE JUNCTION TEMPERATURE OF 150 C.

-HIGHEST COMPONENT TEMP. **REACHED 197.36 C MAX.** COMPONENTS TEMP. SIGNIFICANTLY IS COOLER THAN ENCLOSURE DESIGN 2.

-A 4-LAYER PCB WAS USED IN THE SIMULATION RUN WHICH ALSO REVEALED THE HOT SECTION OR AREAS OF THE PCB.

-THE TEMPERATURE AROUND THE **BATTERY REACHED ONLY 48.30 C MAX.**

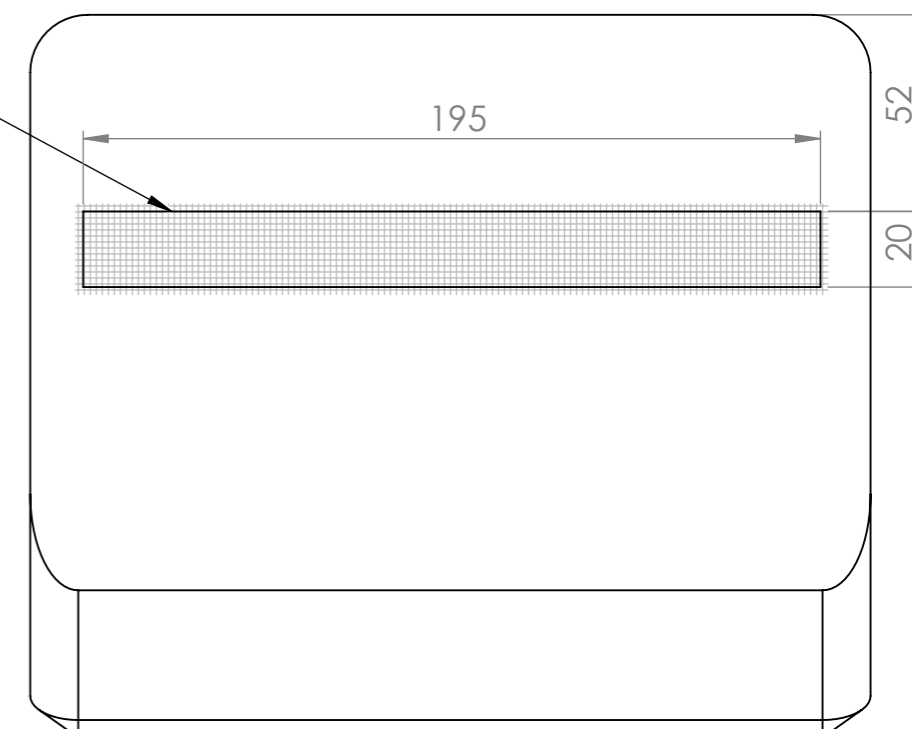
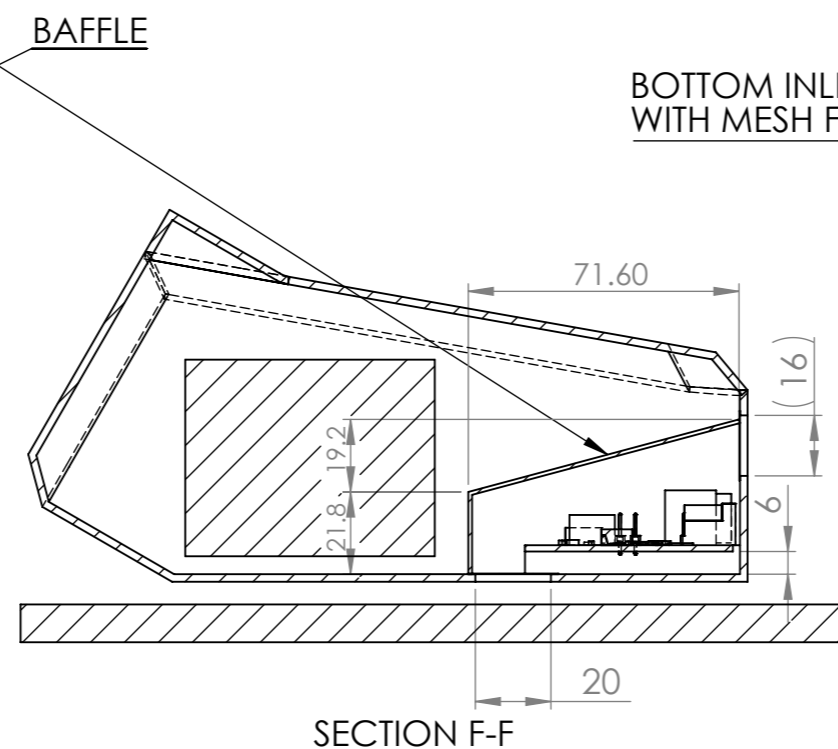
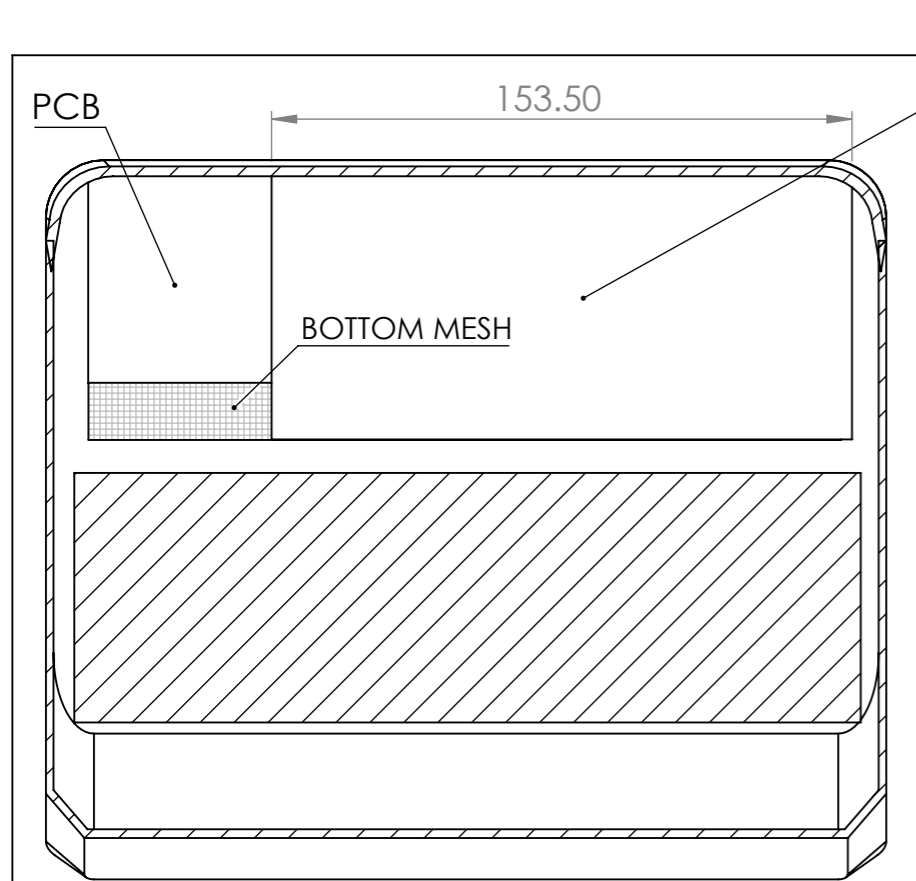
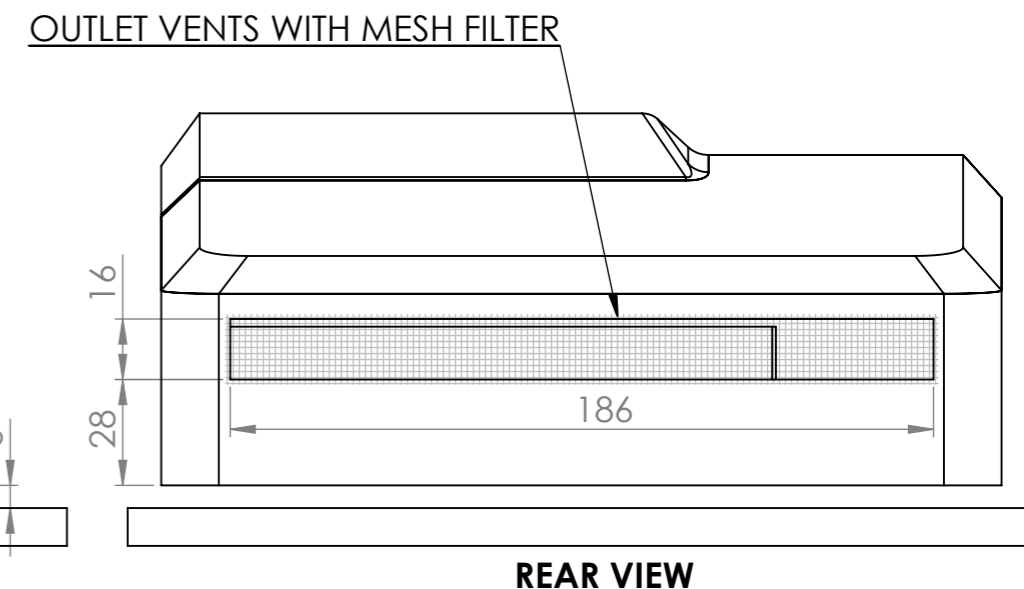
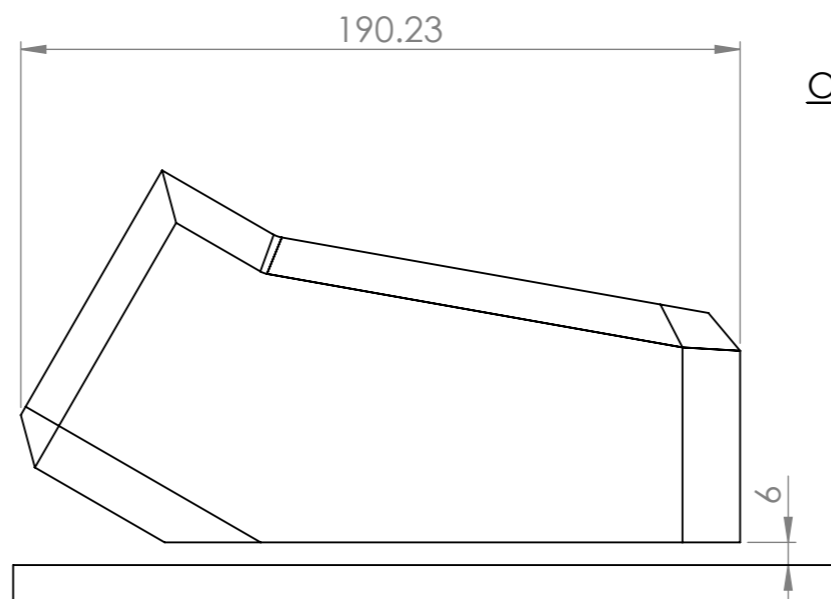
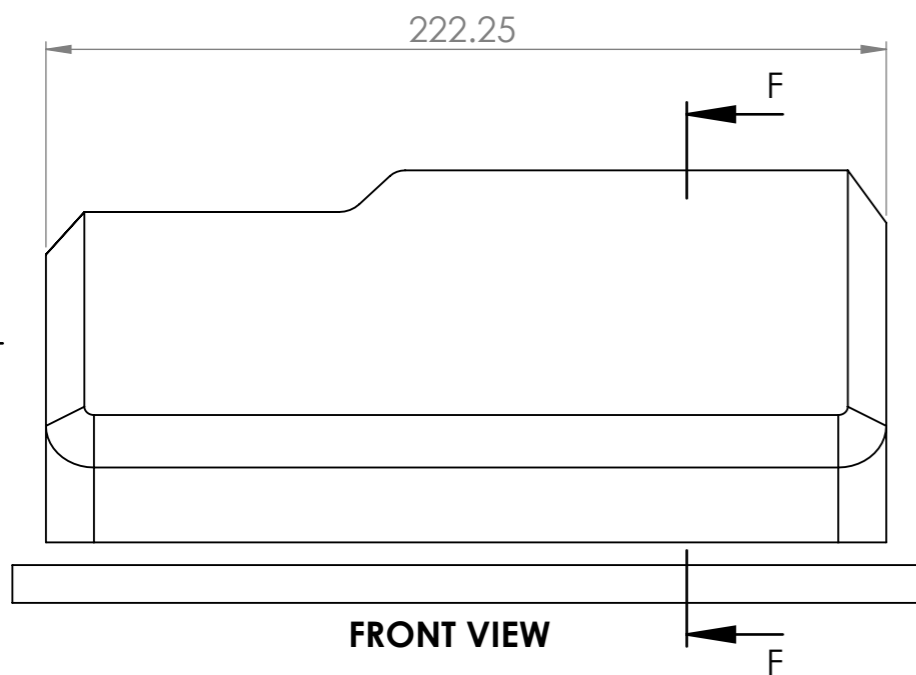
RECOMMENDATION:

1.ENCLOSURE DESIGN 3 IS PREFERRED SINCE COMPONENTS RUN COOLER DUE TO HEATSINK EFFECT OF BAFFLE PLATE BUT NEED TO ADD INSULATOR NEAR/ON BATTERY TO MAINTAIN TEMP. AROUND BATTERY TO ~45 C MAX.

2.ENCLOSURE DESIGN 2 IS NEXT PREFERRED SINCE IT WILL NOT NEED ADDED INSULATOR BUT NEED TO CHECK/VERIFY ACTUAL COMPONENT TEMP.

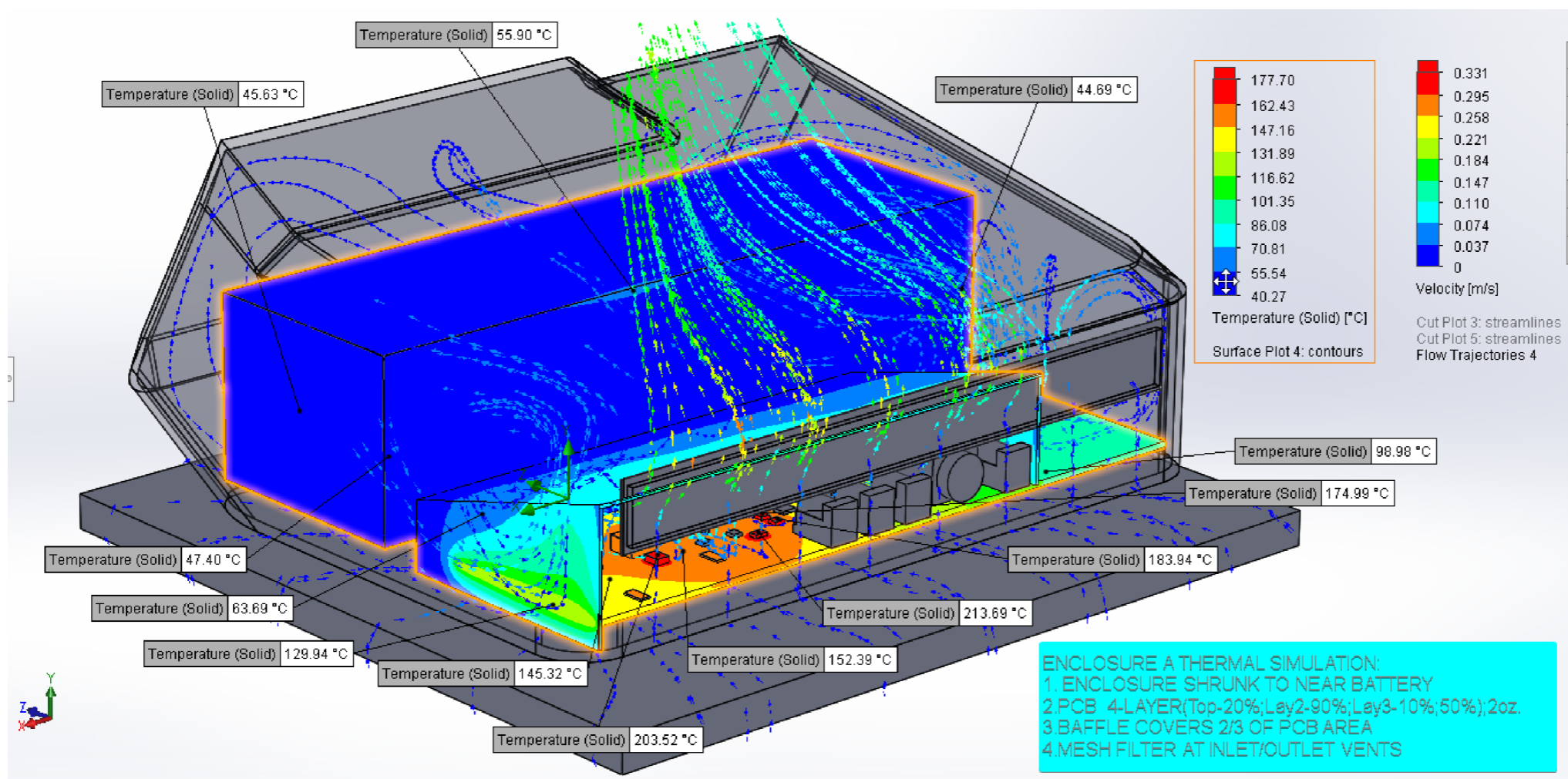
3

TITLE:	INTERPRETATION OF RESULTS/ RECOMMENDATION	
DWG NO.	040421_ConceptA and ConceptD Sim Report	A4
SCALE:1:2	SHEET 13 OF 17	



3

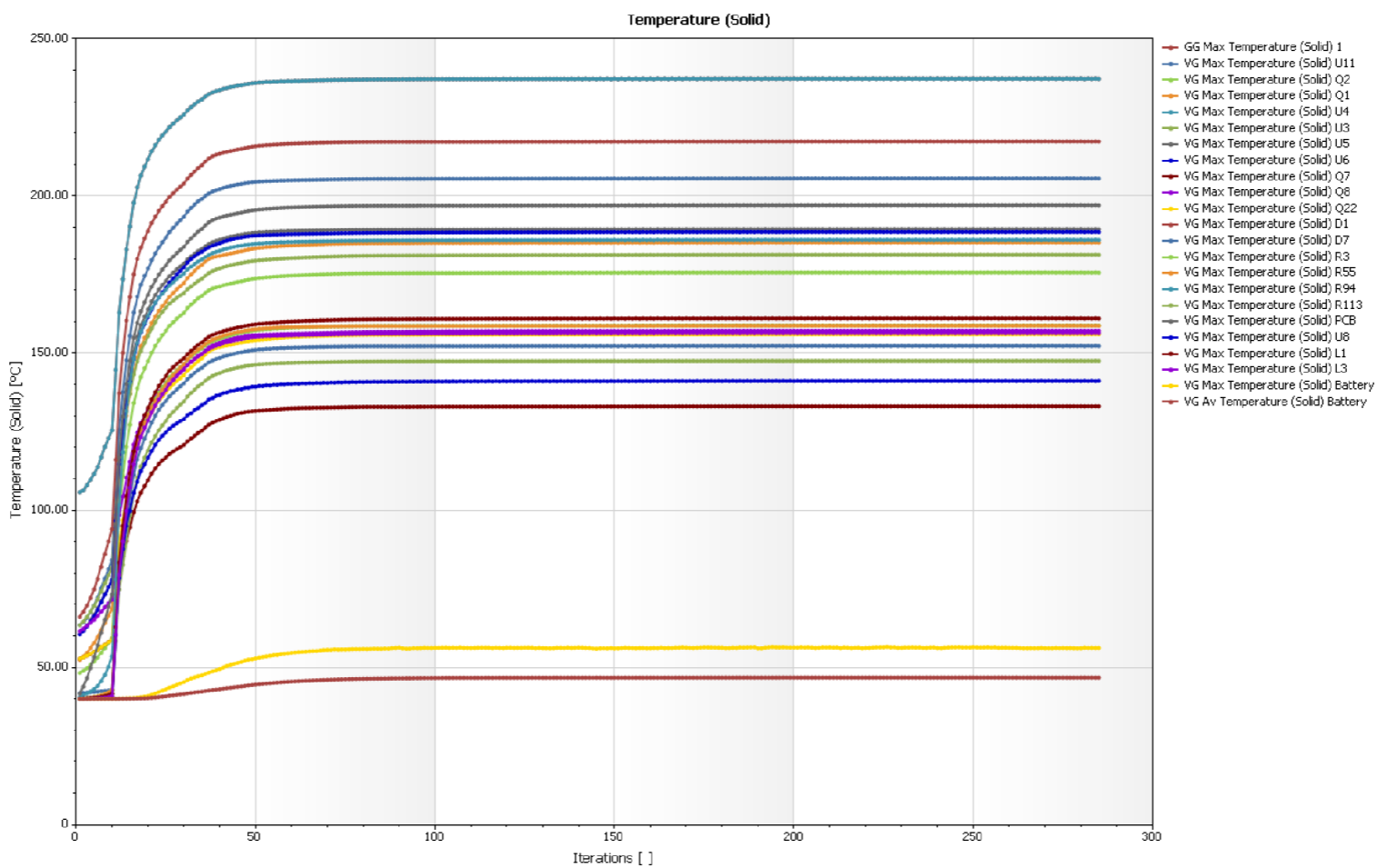
TITLE:	Enclosure Design A: 2/3 Baffle, In/OutVents, Mesh Filter (Concept D)	
DWG NO.	040421_ConceptA and ConceptD Sim Report	A3
SCALE:1:2	SHEET 14 OF 17	



040421_ConceptD.SLDASM [Enclosure A

Goal Name	Unit	Sim Value	Actual Value
GG Max Temperature (Fluid) 1	[°C]	237.22	
GG Max Temperature (Solid) 1	[°C]	237.22	
VG Max Temperature (Solid) U11	[°C]	205.57	
VG Max Temperature (Solid) Q2	[°C]	175.60	
VG Max Temperature (Solid) Q1	[°C]	185.16	
VG Max Temperature (Solid) U4	[°C]	237.22	
VG Max Temperature (Solid) U3	[°C]	181.28	
VG Max Temperature (Solid) U5	[°C]	189.41	
VG Max Temperature (Solid) U6	[°C]	188.51	
VG Max Temperature (Solid) Q7	[°C]	133.09	
VG Max Temperature (Solid) Q8	[°C]	157.08	
VG Max Temperature (Solid) Q22	[°C]	155.97	
VG Max Temperature (Solid) D1	[°C]	217.30	
VG Max Temperature (Solid) D7	[°C]	152.23	
VG Max Temperature (Solid) R3	[°C]	158.75	
VG Max Temperature (Solid) R55	[°C]	158.70	
VG Max Temperature (Solid) R94	[°C]	185.95	
VG Max Temperature (Solid) R113	[°C]	147.55	
VG Max Temperature (Solid) PCB	[°C]	197.02	
VG Max Temperature (Solid) U8	[°C]	141.20	
VG Max Temperature (Solid) L1	[°C]	161.01	
VG Max Temperature (Solid) L3	[°C]	156.35	
VG Max Temperature (Solid) Battery	[°C]	56.22	
VG Av Temperature (Solid) Battery	[°C]	46.76	
GG Max Static Pressure 1	[Pa]	103981.13	
GG Max Velocity 1	[m/s]	1.72	
SG Av Velocity at Outlet	[m/s]	0.13	
SG Av Velocity at Inlet	[m/s]	0.09	

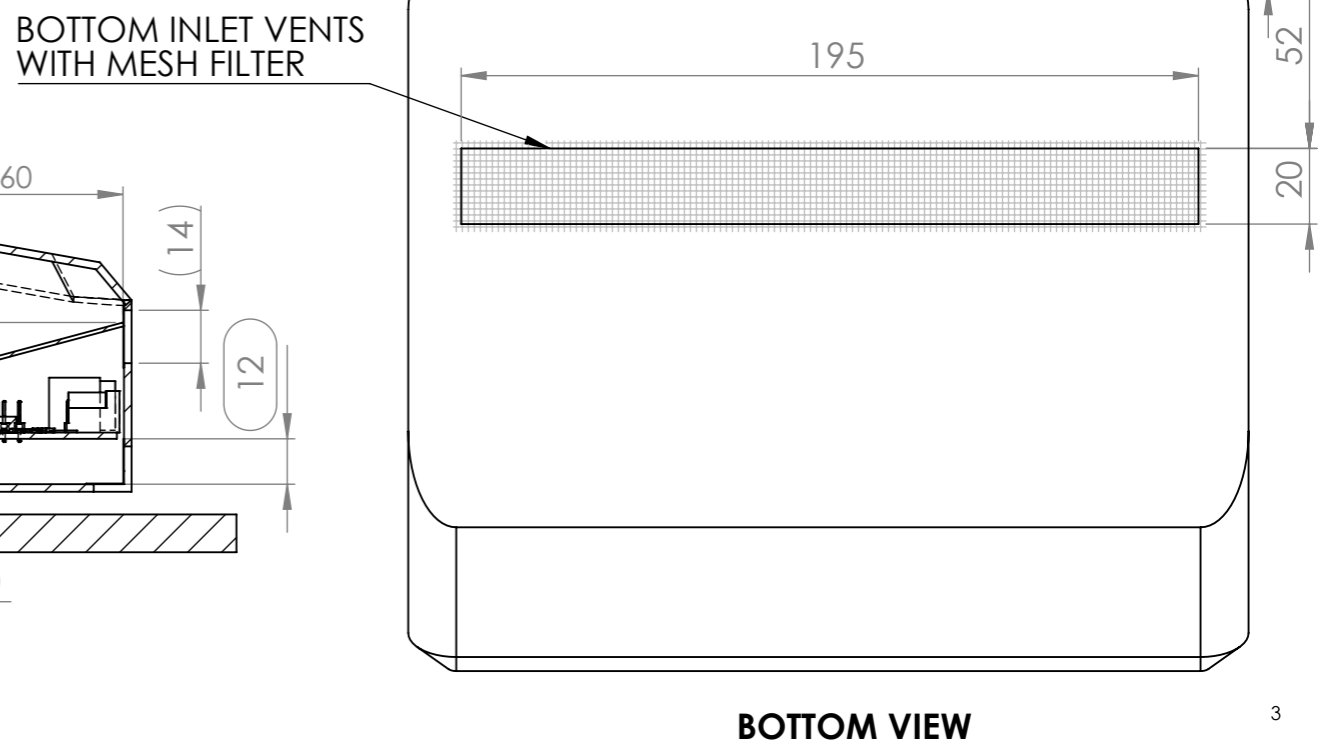
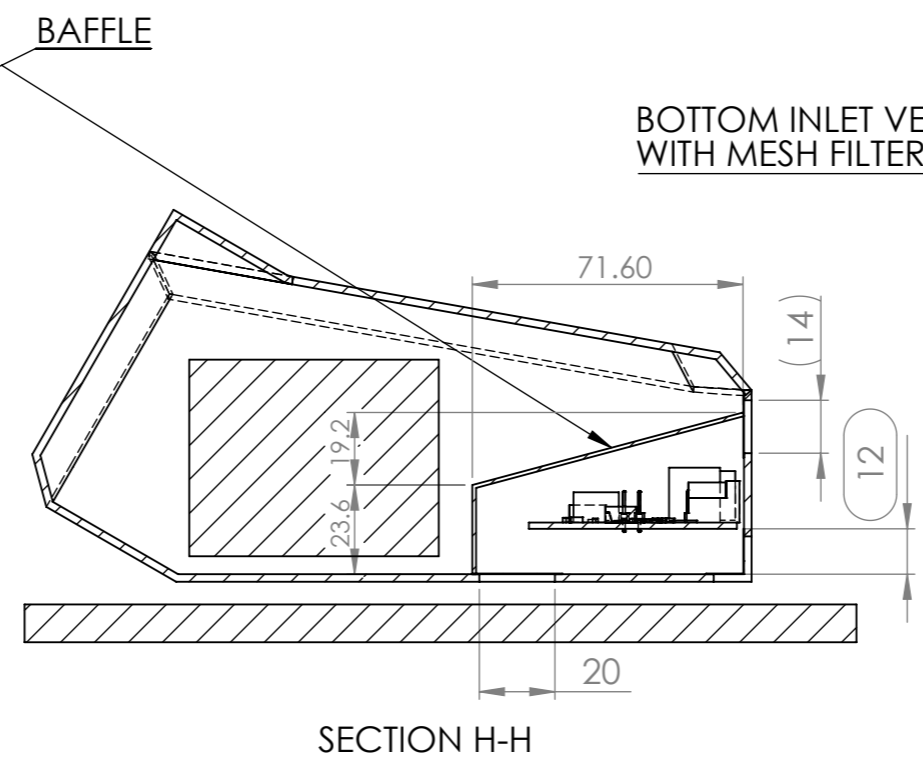
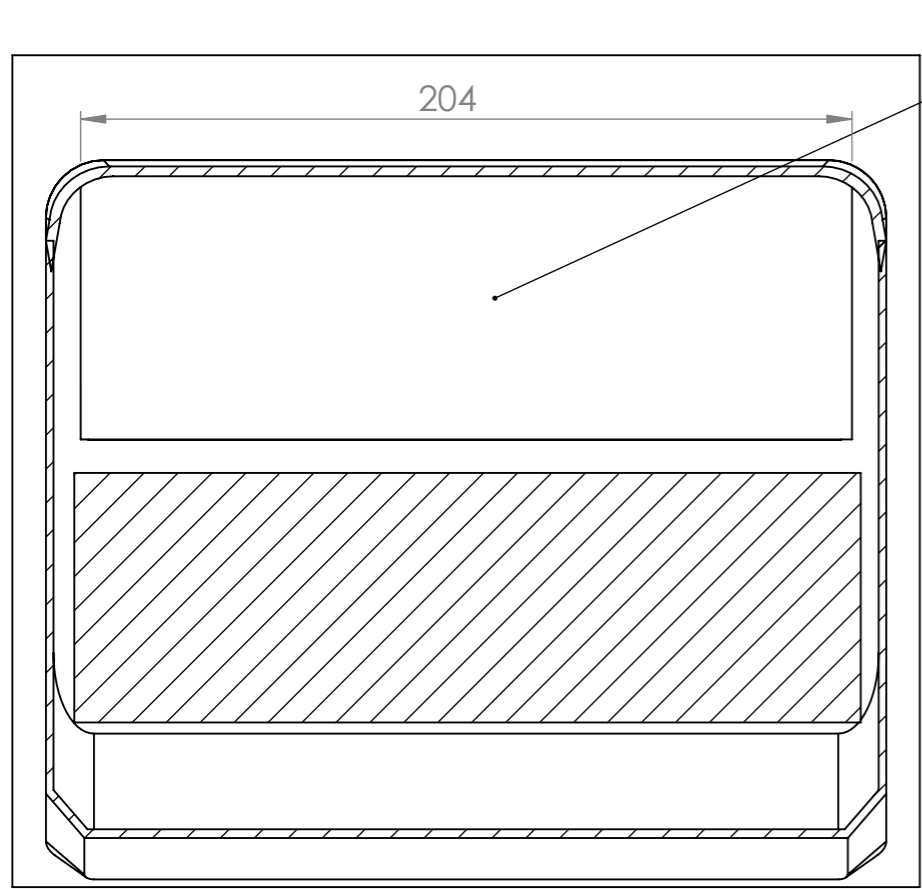
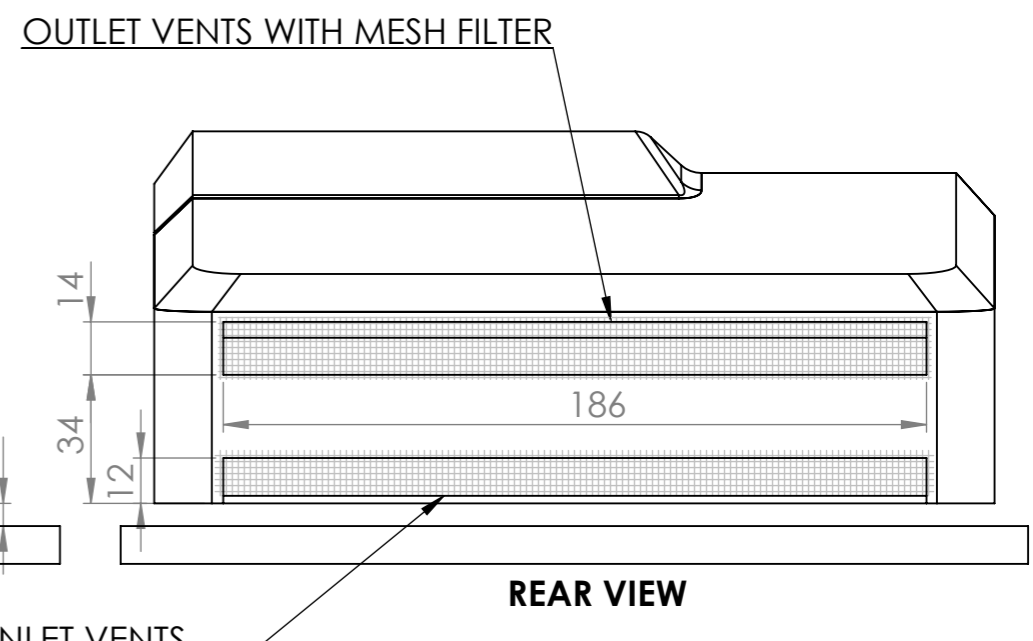
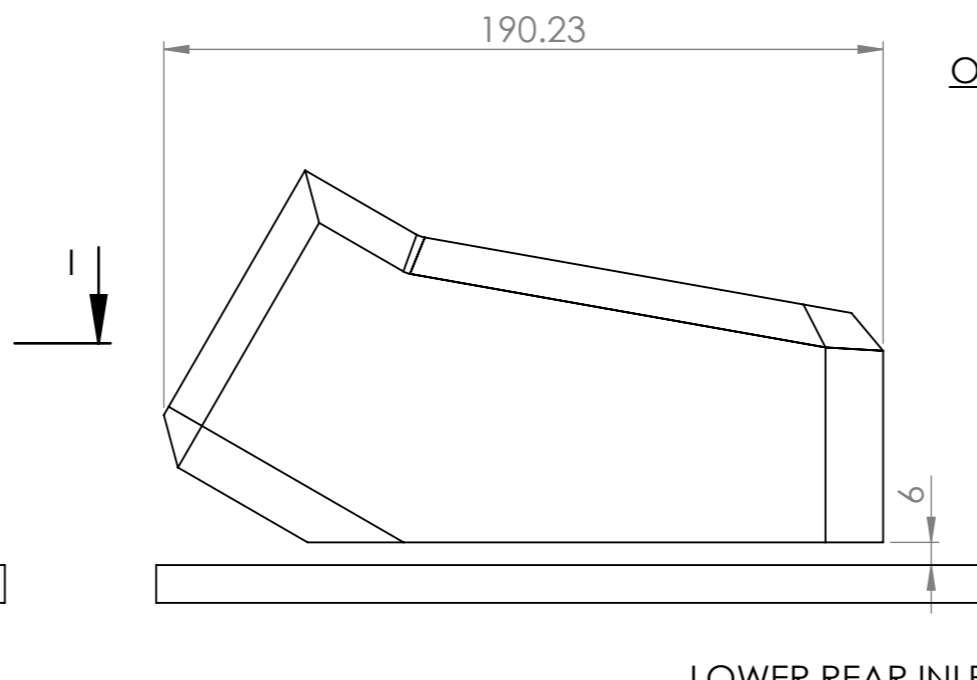
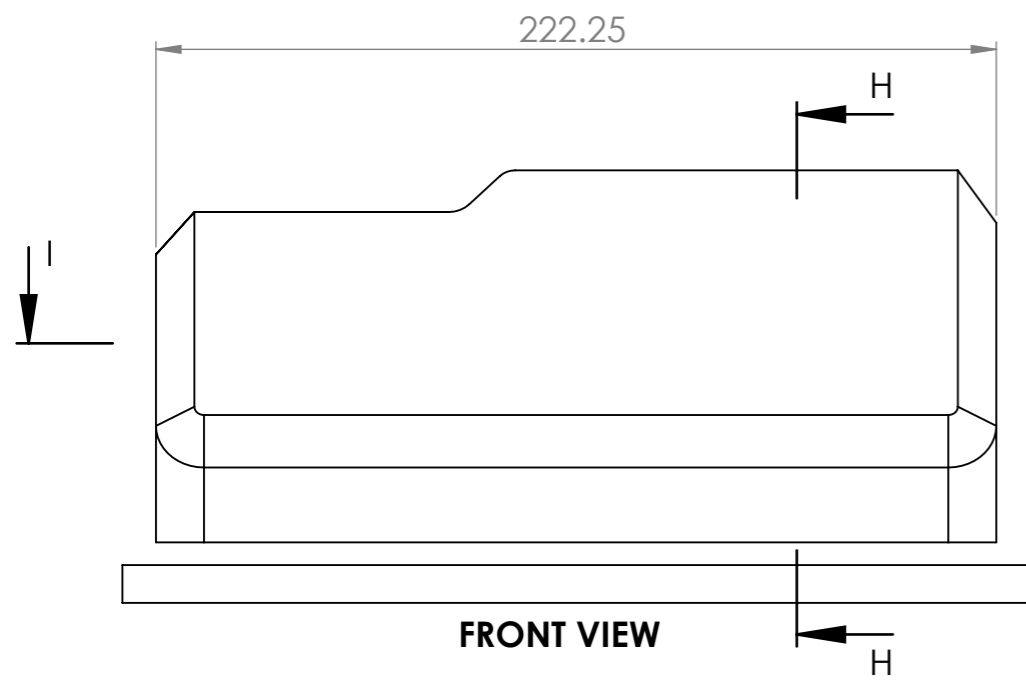
Iterations []: 285
Analysis interval: 128



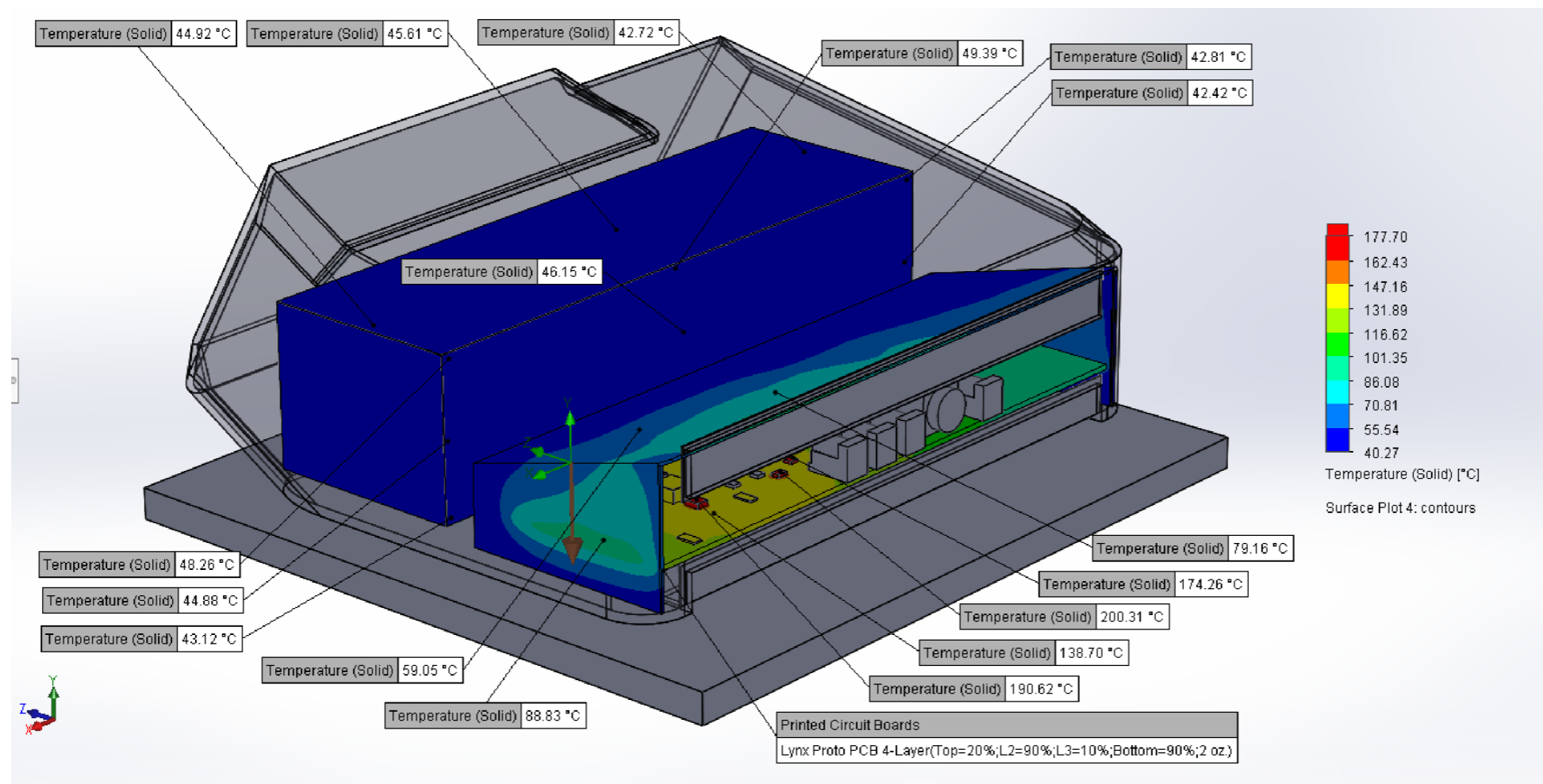
TITLE: Enclosure Design A: Thermal Simulation

DWG NO. 040421_ConceptA and ConceptD Sim Report A3

SCALE:1:2 SHEET 15 OF 17



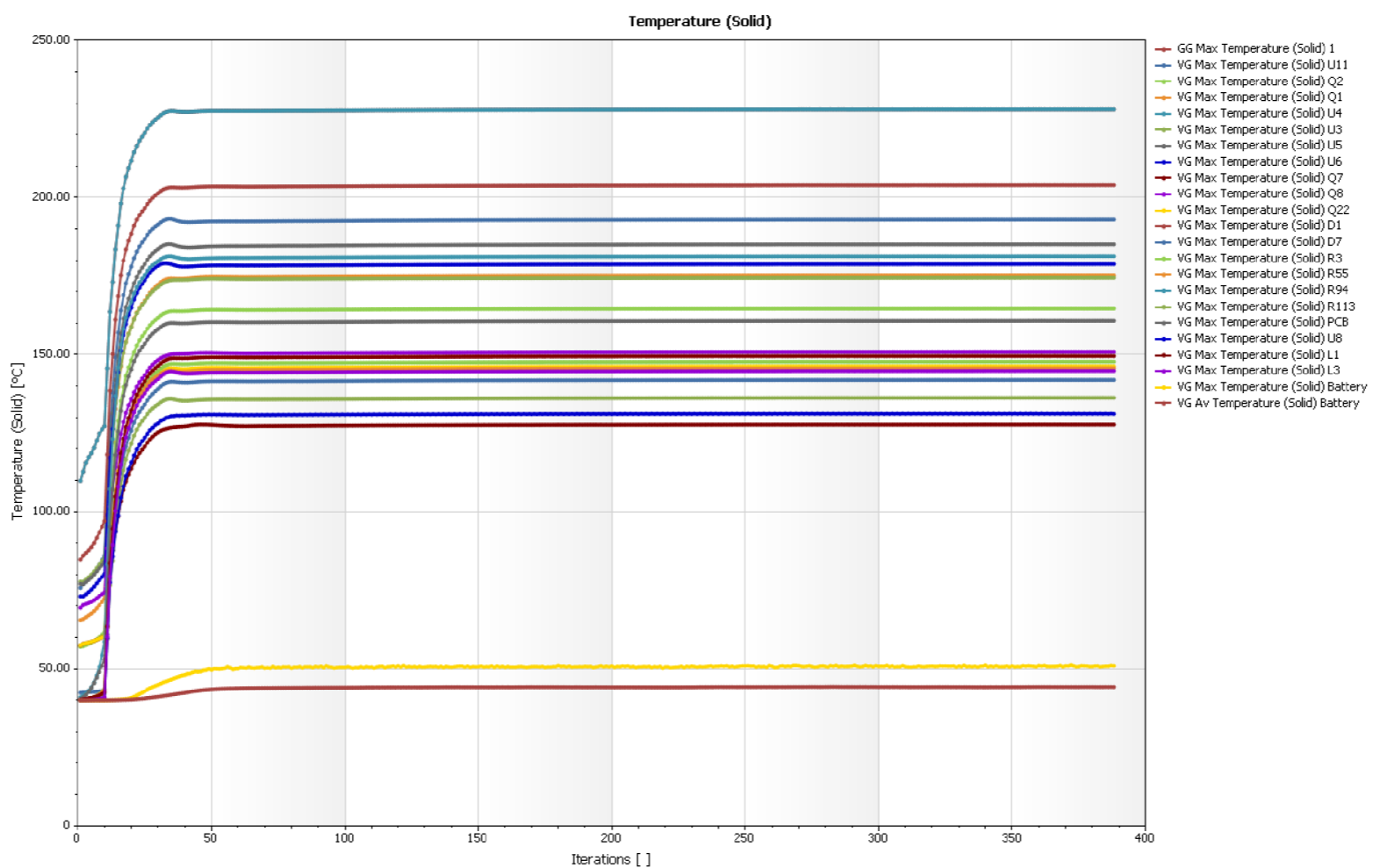
TITLE: Enclosure Design B: Baffle, 2x Inlet/1x Outlet Vents, Mesh Filter, Raised PCB (Concept D)	
DWG NO. 040421_ConceptA and ConceptD Sim Report	A3
SCALE:1:2	SHEET 16 OF 17



040421_ConceptD.SLDASM [Enclosure B:

Goal Name	Unit	Sim Value	Actual Value
GG Max Temperature (Fluid) 1	[°C]	228.05	
GG Max Temperature (Solid) 1	[°C]	228.05	
VG Max Temperature (Solid) U11	[°C]	192.99	
VG Max Temperature (Solid) Q2	[°C]	164.67	
VG Max Temperature (Solid) Q1	[°C]	175.25	
VG Max Temperature (Solid) U4	[°C]	228.05	
VG Max Temperature (Solid) U3	[°C]	174.54	
VG Max Temperature (Solid) U5	[°C]	185.08	
VG Max Temperature (Solid) U6	[°C]	178.84	
VG Max Temperature (Solid) Q7	[°C]	127.72	
VG Max Temperature (Solid) Q8	[°C]	150.89	
VG Max Temperature (Solid) Q22	[°C]	146.23	
VG Max Temperature (Solid) D1	[°C]	204.00	
VG Max Temperature (Solid) D7	[°C]	141.94	
VG Max Temperature (Solid) R3	[°C]	147.73	
VG Max Temperature (Solid) R55	[°C]	145.68	
VG Max Temperature (Solid) R94	[°C]	181.36	
VG Max Temperature (Solid) R113	[°C]	136.29	
VG Max Temperature (Solid) PCB	[°C]	160.84	
VG Max Temperature (Solid) U8	[°C]	131.22	
VG Max Temperature (Solid) L1	[°C]	149.54	
VG Max Temperature (Solid) L3	[°C]	144.84	
VG Max Temperature (Solid) Battery	[°C]	50.99	
VG Av Temperature (Solid) Battery	[°C]	44.26	
GG Max Static Pressure 1	[Pa]	102863.24	
GG Max Velocity 1	[m/s]	0.80	
SG Av Velocity at Outlet	[m/s]	0.19	
SG Av Velocity at Bottom Inlet	[m/s]	0.04	
SG Av Velocity at Lower Rear Inlet	[m/s]	0.08	

Iterations []: 388
Analysis interval: 124



TITLE:		Enclosure Design B: Thermal Simulation
DWG NO.	040421_ConceptA and ConceptD Sim Report	A3
SCALE:1:2	SHEET 17 OF 17	