

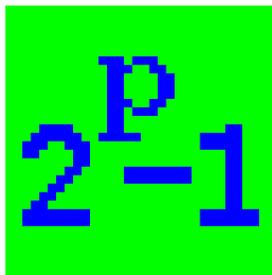
P3 Ultra Gen 2 HyperShelf Thermal Report



PROCEDURES & CONDITIONS

A series of thermal tests were conducted on seven Lenovo P3 Ultra Gen 2 units to determine their ability to operate within a HyperShelf effectively, sustainably, and without thermal throttling. In these series of tests, the seven Lenovo P3 Ultra Gen 2 units underwent maximum stress loads in varying temperature and setting conditions. The series of tests were split into three categories: Baseline, Datacenter, and Elevated Temperature Tests. In all tests, the seven Lenovo P3 Ultra Gen 2 units underwent a maximum load scenario using the programs FurMark V1.32.10, Prime95 V30.8 build 17, and CPU-Z. During each in-rack test, thermocouples were used to record the intake and outtake temperatures of the HyperShelf and Lenovo P3 Ultra Gen 2 units 1,4, and 7. Additionally, HWiNFO064 V7.36-4960, GPU-Z, and LogPro 1.5.5 OMEGA software was used to record parameters of pre-selected Lenovo P3 Ultra Gen 2 components. The parameters of pre-selected Lenovo P3 Ultra Gen 2 components recorded include:

- CPU Package Power (W): The total power consumed by the entire CPU Package including IA Cores, GT and Uncore.
- Total CPU Usage [%]: Average utilization of the entire CPU package (sum of all core/thread utilizations divided by number of cores/threads).
- GPU Board Power Draw (W): Board power draw is what draws the whole graphic card. It includes things like consumption of Memory, power cascade, fans and the Core.
- GPU Load [%]: The percentage of a graphics card's processing power being used at a particular time.



Prime 95



FurMark

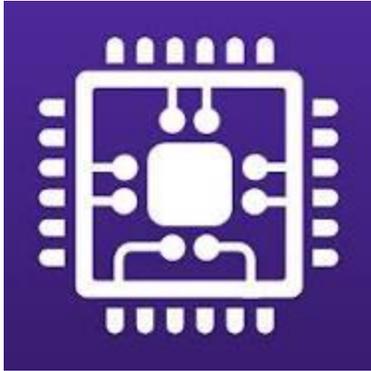
HWiNFO



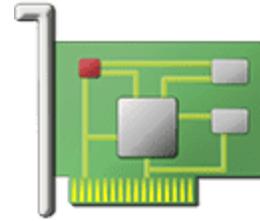
HWiNFO064



OMEGA



CPU-Z



GPU-Z

By analyzing the recorded data, it would be determined if the HyperShelf would provide sufficient airflow to the seven Lenovo P3 Ultra Gen 2 units to prevent thermal throttling in various temperature conditions, ensuring effective and sustainable operation of the units. The standards set for these test to signal thermal throttling is occurring in the Lenovo P3 Ultra Gen 2 units are as follows:

- The CPU (Intel® Core™ i9-13900k) Package Power Wattage in a Lenovo P3 Ultra Gen 2 unit not experiencing a dip once it has reached its peak after the stress load is fully applied. Through testing, this peak CPU Package Power Wattage we aimed to maintain throughout the test was observed to be a range of **65-75W**.
- The Total CPU Usage [%] value not experiencing a dip once it has reached its peak after the stress load is fully applied. Through testing, this peak Total CPU Usage Percentage we aimed to maintain throughout the test was observed to be **100%**.
- The GPU (NVIDIA RTX 4000 SFF) Board Power Draw Wattage in a Lenovo P3 Ultra Gen 2 unit not experiencing a dip once it has reached its peak after the stress load is fully applied. Through testing, this peak GPU Board Power Wattage we aimed to maintain throughout the test was observed to be a range of **68-70W**.
- The GPU Load [%] value not experiencing a dip once it has reached its peak after the stress load is fully applied. Through testing, this peak GPU Load Percentage we aimed to maintain throughout the test was observed to be **100%**.

When observing these parameters for each unit, the amount of power being recorded has a direct correlation to the thermal output of the unit; the unit has a procedure in place for when an undesired thermal output is detected. When this undesired thermal output is detected, the unit experiences thermal throttling. This occurrence will lead to a dip in both the wattage to the unit, and in CPU Usage/GPU Load percentage in an attempt to cool the unit. Utilizing this relationship and monitoring both the wattages and usage/load percentages of the CPU and GPU components, we can determine whether a unit experienced a thermal throttling event. Each test ran for a duration of 60-75 minutes.

Airflow

Baseline Test-

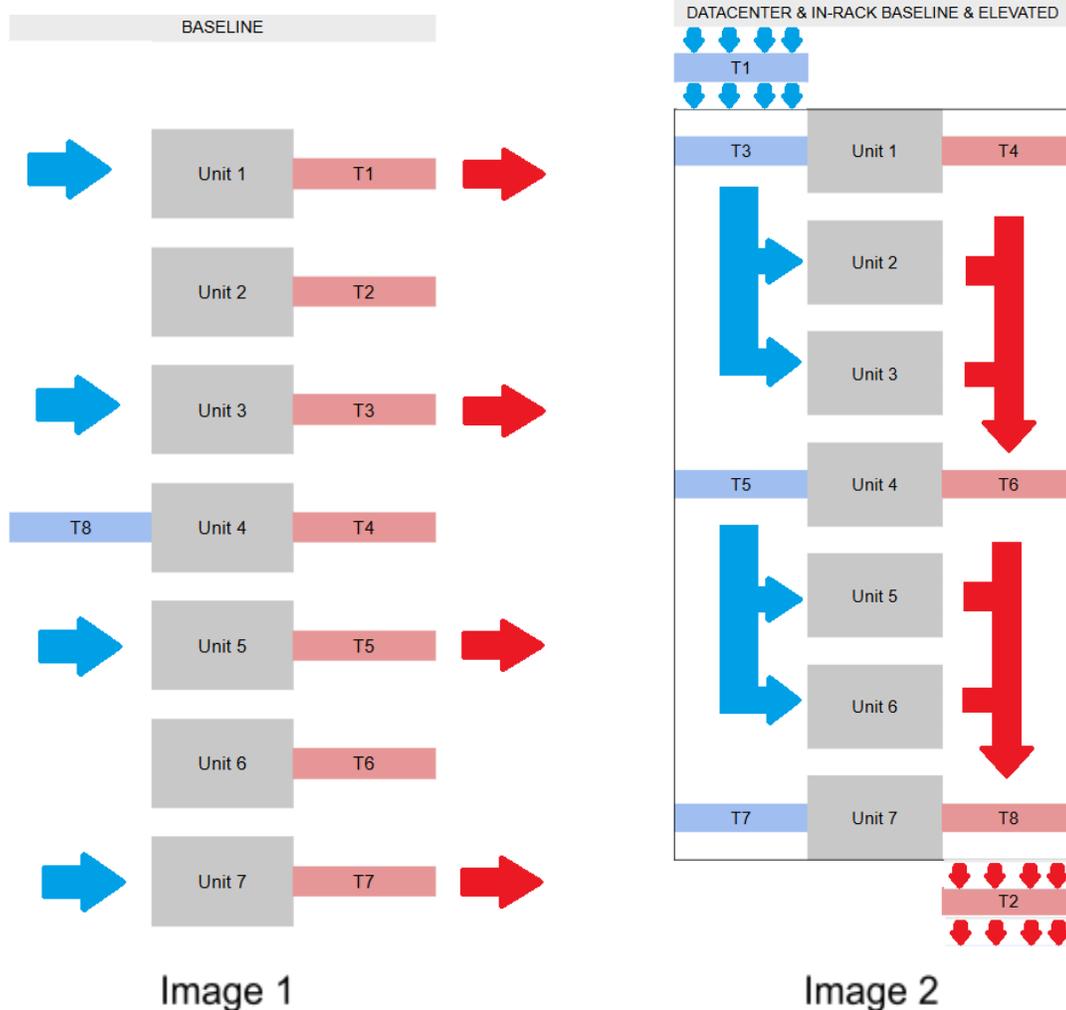
The airflow during the Baseline test is illustrated in Image 1. This test was conducted with the seven Lenovo P3 Ultra Gen 2 units placed on a tabletop in an environment under normal room temperature conditions. The built-in fans in the seven Lenovo P3 Ultra Gen 2 units were utilized to pull air through the units.

Datacenter Test-

The airflow during the Datacenter test is illustrated in Image 2. This test was conducted with the seven Lenovo P3 Ultra Gen 2 units mounted in a HyperShelf within a datacenter rack under ideal datacenter temperature and airflow management conditions. Within the HyperShelf, hot and cold air is contained in separate aisles; an additional fan is mounted at the end of the HyperShelf's hot aisle to exhaust hot air from the HyperShelf.

Elevated Temperature Tests-

The airflow during the Elevated Temperature tests is illustrated in Image 2. These tests were conducted with the seven Lenovo P3 Ultra Gen 2 units mounted in a HyperShelf within an enclosed rack under elevated temperature conditions. Within the HyperShelf, hot and cold air is contained in separate aisles; an additional fan is mounted at the end of the HyperShelf's hot aisle to exhaust hot air from the HyperShelf.



Category 1 - Baseline Test

The Baseline test was conducted with seven Lenovo P3 Ultra Gen 2 units outside of a HyperShelf and placed on a tabletop in an environment with an average temperature of 21.91°C / 71.44°F. The purpose of this test was to establish the baseline intake and exhaust temperatures of the seven Lenovo P3 Ultra Gen 2 units. This test was also used to establish the baseline values of the pre-selected Lenovo P3 Ultra Gen 2 components when running in normal room temperature conditions.



Category 2 - Datacenter Test

The Datacenter test was conducted with seven Lenovo P3 Ultra Gen 2 units mounted in a HyperShelf within a datacenter rack. The Datacenter used for the test had an average temperature of 14.25°C / 57.66°F and hot and cold aisle containment. To mimic ideal real world application, unused “U” spaces within the rack were filled with filler panels and a second shelf was mounted in the “U” space above the HyperShelf. The purpose of this test was to collect temperature readings of the intake and exhaust of Lenovo P3 Ultra Gen 2 units 1, 4, and 7. This test was also used to collect the value readings of the pre-selected Lenovo P3 Ultra Gen 2 components when running in ideal temperature and airflow management conditions. Lastly, it was observed if any of the seven Lenovo P3 Ultra Gen 2 units experienced thermal throttling during the test.



Category 3 - Elevated Temperature Tests

A Elevated Temperature test was conducted with seven Lenovo P3 Ultra Gen 2 units mounted in a HyperShelf within an enclosed rack with an average temperature of 23.65°C / 74.57°F. To mimic ideal real world application, unused “U” spaces within the rack were filled with filler panels and a second shelf was mounted in the “U” space above the HyperShelf. The purpose of the first Elevated Temperature test at 23.65°C / 74.57°F was to collect temperature readings of the intake and exhaust of Lenovo P3 Ultra Gen 2 units 1, 4, and 7. This test was also used to collect the wattages and percentages of the pre-selected Lenovo P3 Ultra Gen 2 components when running at an elevated ambient air temperature. Lastly, it was observed if any of the seven Lenovo P3 Ultra Gen 2 units experienced thermal throttling during this test.

An additional Elevated Temperature test was conducted with seven Lenovo P3 Ultra Gen 2 units mounted in a HyperShelf within an enclosed rack with an average temperature of 27.26°C / 81.07°F. To mimic ideal real world application, unused “U” spaces within the rack were filled with filler panels and a second shelf was mounted in the “U” space above the HyperShelf. The purpose of the second Elevated Temperature test at 27.26°C / 81.07°F was to collect temperature readings of the intake and exhaust of Lenovo P3 Ultra Gen 2 units 1, 4, and 7. This test was also used to collect the wattages and percentages of the pre-selected Lenovo P3 Ultra Gen 2 components when running at a further elevated ambient air temperature. Lastly, it was observed if any of the seven Lenovo P3 Ultra Gen 2 units experienced thermal throttling during this test.



DATA & RESULTS

Baseline Test

The results from the Baseline Test at 21.91°C / 71.44°F can be seen below in the following table:

		CPU Package Power [W]		GPU Board Power Draw [W]		Average Intake Temperature [F]
		AVG	Desired Value	AVG	Desired Value	Tavg
	Unit 1	75.02	65 - 75	69.50	~68-72	71.44
	Unit 2	74.99	65 - 75	68.92	~68-72	
	Unit 3	75.08	65 - 75	69.24	~68-72	
	Unit 4	75.05	65 - 75	68.29	~68-72	
	Unit 5	75.00	65 - 75	68.47	~68-72	
	Unit 6	75.11	65 - 75	69.81	~68-72	
	Unit 7	75.02	65 - 75	68.71	~68-72	
Unit 1 Outtake	T1	-	-	-	-	114.27
Unit 2 Outtake	T2	-	-	-	-	118.05
Unit 3 Outtake	T3	-	-	-	-	113.34
Unit 4 Outtake	T4	-	-	-	-	115.22
Unit 5 Outtake	T5	-	-	-	-	111.57
Unit 6 Outtake	T6	-	-	-	-	115.00
Unit 7 Outtake	T7	-	-	-	-	111.74
Intake	T8	-	-	-	-	71.44

The CPU Package Power and GPU Board Power Draw Wattages in each Lenovo P3 Ultra Gen 2 unit DID NOT experience a dip in value once it reached its peak after the stress load was fully applied. Throughout the test, the peak CPU Package Power and GPU Board Power Draw wattages of **75W** and **70W** were maintained. The Total CPU Usage and GPU Load percentages in each Lenovo P3 Ultra Gen 2 unit DID NOT experience a dip in value once it reached its peak after the stress load was fully applied. Throughout the test, the peak Total CPU Usage and GPU Load percentages of **100%** were maintained.

Datacenter Test

The results from the Datacenter Test at 14.25°C / 57.66°F can be seen below in the following table:

		CPU Package Power [W]		GPU Board Power Draw [W]		Average Intake Temperature [F]
		AVG	Desired Value	AVG	Desired Value	Tavg
	Unit 1	74.90	65 - 75	69.51	~68-72	57.66
	Unit 2	75.00	65 - 75	69.30	~68-72	
	Unit 3	75.06	65 - 75	70.38	~68-72	
	Unit 4	75.04	65 - 75	69.16	~68-72	
	Unit 5	74.94	65 - 75	68.61	~68-72	
	Unit 6	75.13	65 - 75	69.67	~68-72	
	Unit 7	75.01	65 - 75	68.75	~68-72	
Shelf Intake	T1	-	-	-	-	57.66
Shelf Outtake	T2	-	-	-	-	104.22
Unit 1 Intake	T3	-	-	-	-	58.63
Unit 1 Outtake	T4	-	-	-	-	134.68
Unit 4 Intake	T5	-	-	-	-	62.92
Unit 4 Outtake	T6	-	-	-	-	154.51
Unit 7 Intake	T7	-	-	-	-	69.03
Unit 7 Outtake	T8	-	-	-	-	132.66

The CPU Package Power and GPU Board Power Draw Wattages in each Lenovo P3 Ultra Gen 2 unit DID NOT experience a dip in value once it reached its peak after the stress load was fully applied. Throughout the test, the peak CPU Package Power and GPU Board Power Draw wattages of **75W** and **70W** were maintained. The Total CPU Usage and GPU Load percentages in each Lenovo P3 Ultra Gen 2 unit DID NOT experience a dip in value once it reached its peak after the stress load was fully applied. Throughout the test, the peak Total CPU Usage and GPU Load percentages of **100%** were maintained. After analyzing the data, it is observed that when utilized inside of a rack in an optimal data center environment, the HyperShelf succeeds in preventing the Lenovo P3 Ultra Gen 2 units from thermal throttling when all units are applied a maximum load for the duration of the test.

Elevated Temperature Test (23.65°C / 74.57°F)

The results from the Elevated Temperature Test at 23.65°C / 74.57°F can be seen below in the following table:

		CPU Package Power [W]		GPU Board Power Draw [W]		Average Intake Temperature [F]
		AVG	Desired Value	AVG	Desired Value	Tavg
	Unit 1	74.92	65 - 75	68.89	~68-72	74.57
	Unit 2	68.49	65 - 75	68.90	~68-72	
	Unit 3	68.22	65 - 75	71.50	~68-72	
	Unit 4	72.91	65 - 75	68.97	~68-72	
	Unit 5	75.01	65 - 75	69.03	~68-72	
	Unit 6	75.11	65 - 75	68.88	~68-72	
	Unit 7	75.05	65 - 75	69.83	~68-72	
Shelf Intake	T1	-	-	-	-	74.57
Shelf Outtake	T2	-	-	-	-	127.39
Unit 1 Intake	T3	-	-	-	-	79.54
Unit 1 Outtake	T4	-	-	-	-	157.02
Unit 4 Intake	T5	-	-	-	-	84.03
Unit 4 Outtake	T6	-	-	-	-	173.17
Unit 7 Intake	T7	-	-	-	-	80.85
Unit 7 Outtake	T8	-	-	-	-	159.76

The CPU Package Power and GPU Board Power Draw Wattages in each Lenovo P3 Ultra Gen 2 unit DID NOT experience a dip in value once it reached its peak after the stress load was fully applied. Throughout the test, the peak CPU Package Power and GPU Board Power Draw wattages of **75W** and **70W** were maintained. The Total CPU Usage and GPU Load percentages in each Lenovo P3 Ultra Gen 2 unit DID NOT experience a dip in value once it reached its peak after the stress load was fully applied. Throughout the test, the peak Total CPU Usage and GPU Load percentages of **100%** were maintained. After analyzing the data, it is observed that when utilized in an environment with an average temperature of 23.65°C / 74.57°F, the HyperShelf succeeds in preventing the Lenovo P3 Ultra Gen 2 units from thermal throttling when all units are applied a maximum load for the duration of the test.

Elevated Temperature Test (27.26°C / 81.07°F)

The results from the Elevated Temperature Test at 27.26°C / 81.07°F can be seen below in the following table:

		CPU Package Power [W]		GPU Board Power Draw [W]		Average Intake Temperature [F]
		AVG	Desired Value	AVG	Desired Value	Tavg
	Unit 1	68.11	65 - 75	64.55	~68-72	81.07
	Unit 2	59.20	65 - 75	60.35	~68-72	
	Unit 3	57.73	65 - 75	67.40	~68-72	
	Unit 4	59.25	65 - 75	68.63	~68-72	
	Unit 5	71.16	65 - 75	69.03	~68-72	
	Unit 6	74.93	65 - 75	70.01	~68-72	
	Unit 7	74.88	65 - 75	70.01	~68-72	
Shelf Intake	T1	-	-	-	-	81.07
Shelf Outtake	T2	-	-	-	-	146.76
Unit 1 Intake	T3	-	-	-	-	99.01
Unit 1 Outtake	T4	-	-	-	-	175.64
Unit 4 Intake	T5	-	-	-	-	95.53
Unit 4 Outtake	T6	-	-	-	-	178.46
Unit 7 Intake	T7	-	-	-	-	104.62
Unit 7 Outtake	T8	-	-	-	-	168.56

The CPU Package Power and GPU Board Power Draw Wattages in Lenovo P3 Ultra Gen 2 units 1, 2, 3, and 4 DID experience a dip in value once they reached their peak after the stress load was fully applied. Throughout the test, the peak CPU Package Power and GPU Board Power Draw wattages of **75W** and **70W** were not maintained in those units. The Total CPU Usage and GPU Load percentages in Lenovo P3 Ultra Gen 2 units 1, 2, 3, and 4 DID experience a dip in value once they reached their peak after the stress load was fully applied. Throughout the test, the peak Total CPU Usage and GPU Load percentages of **100%** were not maintained in those units. After analyzing the data, it is observed that when utilized in an environment with an average temperature of 27.26°C / 81.07°F, the HyperShelf does not succeed in preventing the Lenovo P3 Ultra Gen 2 units from thermal throttling when all units are applied a maximum load for the duration of the test.

Conclusion

With the utilization of the HyperShelf to mount seven Lenovo P3 Ultra Gen 2 units, the HyperShelf provides sufficient airflow to the seven Lenovo P3 Ultra Gen 2 units to prevent thermal throttling in environments with a temperature up to 23.65°C / 74.57°F; ensuring effective and sustainable operation of the units.