TECHNICAL WHITE PAPER

CONTENTS & NAVIGATION

HP ZBOOK CREATE AND ZBOOK STUDIO INNOVATIONS WHITE PAPER

HP has been a major pioneer in the electronics industry since the company's inception in the 1930s. Our long history of innovation continues with the latest generation of Z mobile products. Two of the new generation seven models that exemplify this commitment to innovation are the new HP ZBook Create and ZBook Studio.

This whitepaper goes into deep technical detail on a few of the major innovations in the latest generation, including advances in thermal technology, acoustics, intelligent performance enhancement and modern standby. These innovations allow you to work and play without being interrupted by noise, heat or running out of battery at a bad time. They keep your system ready and waiting for when that flash of inspiration strikes. We've even included technology that responds to the way you use the notebook. This keeps you in the creative zone longer without unwanted distractions.

We designed these ZBooks for you, the creative professional. We sincerely hope you have as much fun using them as we had creating them.

Vapor Chamber Heat Sink System

The powerful CPU and GPUs that can be used in the HP ZBook Create and ZBook Studio products necessitated an efficient thermal design that would meet internal component and customer accessible touch-surface temperature specifications. The traditional approach in notebook thermal design is to route heat pipes from the heat source to the heat sinks, which are then air-cooled by fans. While cost effective and thoroughly vetted in electronics cooling applications, the heat pipe is limited in its heat carrying capability primarily due to its one-dimensional and concentrated heat transfer path. To meet this challenge in the new HP ZBook Create and ZBook Studio platforms, an innovative approach using a new technology that includes a vapor chamber heatsink was designed by the HP thermal team.

A vapor chamber has the same working principles as a heat pipe but in two dimensions instead of one. As Figure 1 shows, the heat source vaporizes the liquid in the vapor chamber, creating a pressure gradient from the heat source to the cooler heat sink regions. This drives the vapor towards the heat sink where the vapor condenses and travels back to the heat source via capillary forces created by various wick structures. The details of the wick structures, vapor space and walls determine the overall efficiency of the vapor chamber and are typically customized for every heat source/sink layout.

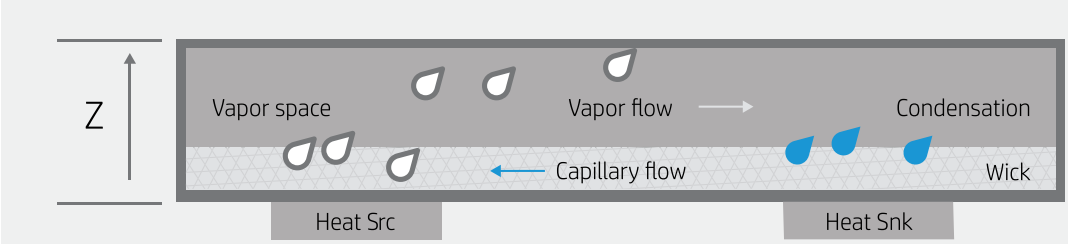

Figure 1. Working principle of a vapor chamber or heat pipe

The two-dimensional structure of the vapor chamber allows for efficient heat spreading in the plane of the vapor chamber, thus reducing the heat source component temperatures as well as reducing surface hotspots that would negatively impact the user experience.

The vapor chamber design for the HP ZBook Studio and ZBook Create is shown in Figure 2. The vapor chamber transfers from the CPU and GPU to the heatsinks and ultimately to the air that is forced through the fins (not shown) by two fans.

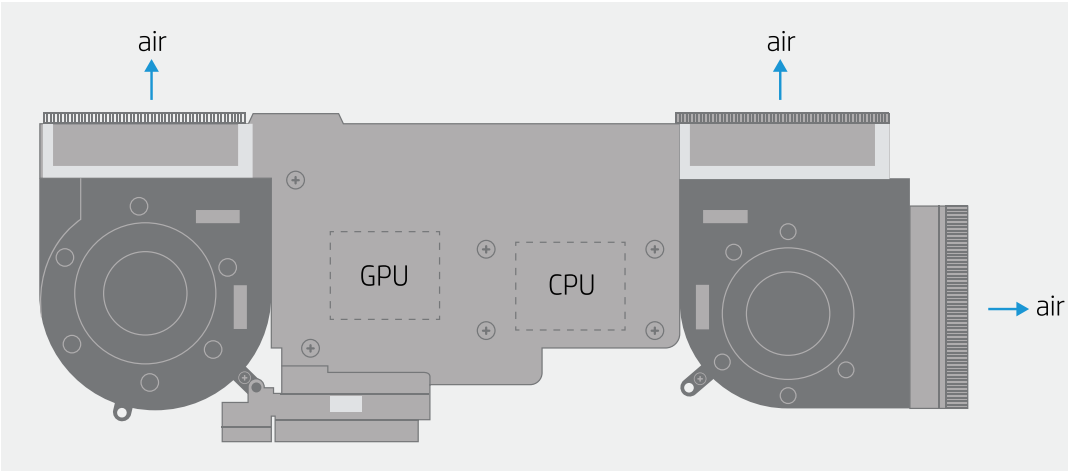

Figure 2. HP ZBook Studio Vapor Chamber and fans

Unlike other products that use vapor chamber heatsinks for cooling, the new HP ZBook Create and ZBook Studio have three exit ports instead of the usual two, which also helps with getting the heat out in a more efficient manner.

Fan Blade Optimization

The fans used in the system are needed to provide the cooling airflow to carry away the waste heat collected by the vapor chamber. To do this more effectively, and without increasing the system sound level, a new liquid crystal polymer (LCP) formulation allows thinner fan blades that are used to move the air. Thinner blades allow more blades in the same fan volume. The result is a higher performance fan with more volumetric airflow capacity and more static pressure capability compared to traditional notebook fans. Using this enhanced feature, we can support higher power and higher performance features. The difference in fan performance is illustrated in Figure 3.

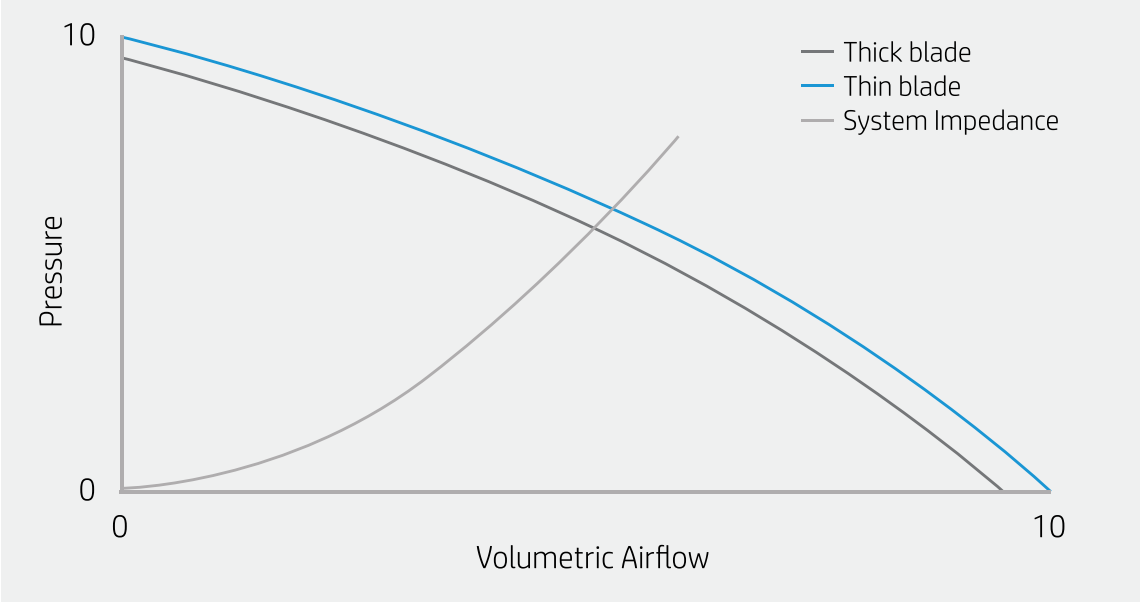

Figure 3. Fan Performance Enhancements

Fan & Venting Layout

The high power requirements drove a two-fan, three-sided vent layout, as shown in Figure 2. This design, like most thermal module designs, is the result of an optimization of heat spreading and temperature uniformity in the vapor chamber, total surface area of the heat sinks, and pressure and airflow rate generated from the two fans.

The constraints include the allowable surface temperatures and fan acoustic specifications, which are targeted for user comfort and component reliability. While maximum airflow through the heat sinks is a primary goal, it can come at a cost of area for user accessible connectors and other structural features on the perimeter of the system as well as space for internal components. In addition, the efficiency of the vapor chamber becomes poorer in regions that are far from the heat sources and where the heat transfer path is narrow or convoluted, enabling the bulk of the waste heat to ergonomically vent away from the user's hands and body. Significant CFD (computational fluid dynamics) simulations and experiments were conducted to arrive at the final thermal design for the HP ZBook Studio and ZBook Create platforms, which optimizes all of these considerations.

The final design resulted in the following Gen to Gen improvements[1]:

- 2.7X higher CPU+GPU power
- 1.1mm Z-height reduction
- 60-70% higher compute performance

Sound Quality and Level

The fans used in the HP ZBooks make use of HP's Fan Tonality 2.0 procedure to enhance listening quality. We do this by ensuring the fans operate only in the portions of their operating range that are the most pleasing to the human ear. By excluding undesired frequencies (prominent tones), the result is a more enjoyable customer experience, free of irritating tonality issues, like whistles and whining.

To reduce sound levels in general, all new HP ZBooks use an improved fan control called the Z Predictive Fan Algorithm. This algorithm minimizes the need for fans to increase in speed under light to moderate system usage. Rapid and sudden changes in fan speed can be very distracting for the user. The Z Predictive Fan Algorithm changes fan speeds only when various sensors detect the need to maintain system performance or retain ergonomic touch temperatures for surfaces expected to be contacted by the user.

[1]BASED ON HP INTERNAL TESTING DURING DEVELOPMENT

Speaker System

There are a total of four speakers present in the Z Create and Z Studio products. Audiophiles will be happy to hear that they are comprised of two tweeters for high frequency and two woofers for lower frequency audio. They deliver high fidelity with an ultrawide frequency bandwidth not seen in notebooks of this type before. The bandwidth range is from 150 Hz to 20 kHz, easily covering the dynamic range of most digital content with crisp sounding highs and strong bass response. Unlike conventional speakers, the woofers in the Z Create and Z Studio products utilize a "spider" type pattern that minimizes distortion while keeping the diaphragm of the woofer displacement as even as possible. This ensures consistent reproduction of hard-hitting deep tones with minimal distortion of the speaker cone.

The amplifiers used in these systems include smart technology that protects the speakers from being damaged by over-excursion of the speaker elements and over heating of voice coils. These are the phenomena that occur when a speaker is "blown". The smart amplifier included in the Z Create and Z Studio platforms will protect the speakers at the highest audio levels, so feel free to crank it up!

AI-based Noise Reduction

The Z Create and Z Studio products also include HP proprietary artificial intelligence based noise suppression and reduction technologies. These real-time noise cancellation technologies rely on Deep Neural Network Technology. This is a revolution in noise cancellation technology. In the past, we could only suppress constant noise sources like engine noise or constant background chatter of large groups. But this new AI-based solution allows the Z Create and Z Studio products to eliminate non-stationary noises like sirens, pens clicking, bags crackling, doors slamming or even your baby crying in the background during an important meeting with the boss. All of this noise suppression is possible while still maintaining the integrity and quality of your speaking voice during a digital collaboration.

Customer Selectable Performance: HP's enhancements to Microsoft Power Slider+ (select configs only)

HP understands that different users have different needs of their systems. And these needs can also vary across the workday. HP has empowered its ZBook customers to control whether they prioritize their systems to operate in a balanced manner, or if they prefer compute performance over acoustics. This is done at any time, and without the need to reboot, using HP's enhancements to Microsoft Power Slider UI (user interface) that many customers already use and are familiar with. HP takes it to the next level by integrating HP's enhancements to Microsoft Power Slider+ into the system's DPTF power & performance management and fan control systems. By default, the system is set to Better Performance – a balance of performance, acoustics, and battery life. Adjust the software slider to Best Performance and your system shifts into higher gear, providing more performance[2], with extra cooling capacity enabled to keep the system within ergonomic touch limits. Adjust the software slider the other direction to Best Battery and power consumption is reduced. This will extend battery life when needing to run off battery power for longer periods. It also has the additional benefit of further reducing acoustic levels by up to 3dB[3].

By simply moving the HP's enhancements to Microsoft Power Slider indicator (like shown below in Figure 4), HP enables you to orchestrate system characteristics that provide more performance or more battery life when you want it. You decide, you're in control!

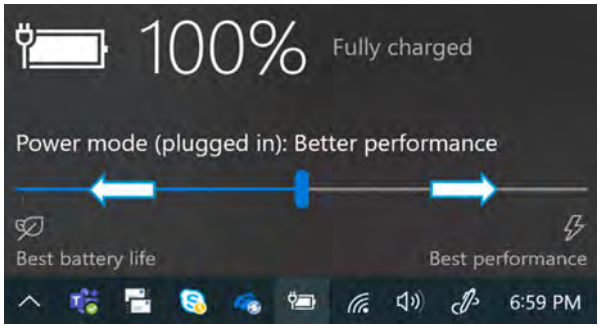

Figure 4. The HP's enhancements to Microsoft Power Slider+ interface

Intelligent Performance Enhancement

Another new power management feature present in the new HP ZBook Create and ZBook Studio products is Intelligent Performance Enhancement. This firmware level feature allows HP ZBooks to sense how you are using your system and prioritize higher CPU performance when doing compute intensive applications, or GPU performance when utilizing graphics more. This allows the system to dynamically allocate power and thermal resources where they are needed automatically. The user doesn't even need to adjust a slider. The power of simplicity!

[2, 3]REFER TO YOUR SYSTEM'S DOCUMENTATION FOR SPECIFIC PERFORMANCE AND ACOUSTIC LEVEL EXPECTATIONS, AS IT CAN VARY WITH MODEL AND CONFIGURATION.

Modern Standby

Introduction

Modern Standby, known as Always On Always Connected (AOAC) or Connected Standby, enables smartphone functionality on a computer. This allows for experiences like “Instant On,” keeping data updated while in sleep mode. This allows for more efficient use of the system battery and many other benefits familiar to cellphone users.

Traditionally, when a computer is put into sleep mode (S3), power is turned off internally to conserve battery power while providing a faster resume experience than from S4 or S5. For S3, Drivers do not require any “smarts”. When power is cut, the device is off, when power is restored, the device turns back on.

Conversely, on a Modern Standby enabled computer, internal power is always on. Drivers and components are expected to have “smarts” to determine if they are needed or not while in sleep mode. If needed, drivers put themselves into the lowest power state possible where they can still function. If not needed, they turn themselves off. This is a very complex situation and must be carefully managed to work.

By keeping the computer in an S0 state (fully on), the computer can resume faster than from S3 sleep producing an “Instant On” experience. In other words, in a Modern Standby system, all the parts of the computer are smart enough to know when they should be on, and when they should be off, saving you valuable time.

How Modern Standby Manages Network Connections

Windows controls connectivity in sleep on Modern Standby systems while on battery power to provide Internet connectivity when the user needs it. If connectivity isn’t needed, the system can disconnect from the network to provide better battery life.

When lid is closed, Windows take an inventory of apps that are running. “Important” apps that were recently used are allowed access to the network. “Important apps include VOIP and all apps that user sets in “Allow to run background tasks” in the Battery User Experience. In below scenarios, Windows would remain network connected before entering Modern Standby sleep mode:

User scenarios that require network connectivity, e.g. Skype/inbox Mail UWP applications.
Wake on Remote Desktop is enabled.
UWP apps notifications are allowed.

Comparison between Modern Standby sleep mode, Legacy S3 sleep mode, and Hibernation

Modern Standby connected and disconnected (a.k.a MSC & MSD) states transitions follow a very similar process. The biggest difference is maintaining network connection. When in the lowest power state, systems may look very similar to systems in the S3 state—processors are powered off, memory is in self-refresh. The difference is in the path of how it enters and exits low power state. For S3 systems, the system is either active or in S3. For Modern Standby, the transition from the active to the low power state is a series of steps to lower power consumption. Components are powered down when they are not in use. The transition into and out of a lower power state is much quicker on a Modern Standby system than on an S3 system. This design also helps with the speed of entry and exit from Standby as it doesn’t require any firmware interactions.

The comparison table below shows the differences among MSC/MSD/Legacy S3/Hibernation, also pointing out the benefits of Modern Standby Sleep mode.

Function Categories		MSC	MSD	Legacy S3	Hibernation
Background Network Activities	Receive Mail/Skype call while the system is in sleep mode	Yes	No	No	No
	Windows Update preforms while sleep	Yes	No	No	No
Background Audio Playback	Allow media player to play music while the system is in sleep mode	Yes	No	No	No
New Wake Scenarios	Allow wake on finger printer/Cortana	Yes	Yes	No	No
	Wake on Bluetooth HID devices (Band, Phone, Pen)	Yes	Yes	No	No
	Wake on push notifications (3rd party UWP apps)	Supported	Not supported	Not supported	Not supported

Function Categories		MSC	MSD	Legacy S3	Hibernation
Performance	How long it takes to wake up system from sleep mode?	UMA 0.5~1 sec	0.5~1 sec	3~6 secs	15+ secs
		DIS 2~2.5 secs	DIS 2~2.5 secs		
	Adaptive Hibernation	Supported	Supported	Not Supported	n/a
	Battery Life in sleep mode	S4 > Legacy S3 > MSD > MSC			

Other Benefits of Modern Standby

Background Network Activities – With Modern Standby Connected system, it allows UWP Mail/Skype Apps with network background services to receive mail/Skype calls while system is in sleep mode. However, this only works with UWP applications downloaded from windows store, win32 applications (such as Microsoft Office) are not allowed to update network contents in background.

Background Audio Playback – With Modern Standby Connected system, UWP media player (such as Groove Player) are allowed to play local audio media content while the system is in sleep mode. This functionality is limited to only UWP mode players, which are common in the Microsoft Store.

New Wake Scenarios – With Modern Standby system, we can support several wake scenarios from Legacy S3/Hibernation:

1. Wake on finger printer enroll -- If system is equipped with finger printer device
2. Wake on Cortana (a.k.a Wake on Voice) -- Allow users to wake up system by voice input of "Hey Cortana" This feature has been disabled from MSFT Cortana since 20H1
3. Wake on Bluetooth HID devices (Keyboard/Mouse) -- Allow users to wake up system by Keyboard/Mouse input
4. Wake on push notifications (3rd party UWP apps) -- Allow UWP apps such as Skype call/Mail/Alarm to wake up system and send notifications

Performance – “Instant on” is a major improvement for the user experience. It only takes 0.5~1 sec to wake up system from sleep mode, compared with Legacy S3/Hibernation, which can take several seconds to minutes.

Because the system needs to remain powered for devices to be working in the background during MSC sleep mode, battery life may be affected. Fortunately, HP systems include an “Adaptive Hibernate mode”* for Modern Standby systems, which will automatically trigger system to Hibernation during sleep mode under 2 conditions:

- Battery drains over 5%
- System is in Modern Standby sleep mode over 4 hrs.

*Refer to the below link for more information about Adaptive Hibernation.
https://docs.microsoft.com/zh-tw/windows-hardware/customize/power-settings/adaptive-hibernate#default-behavior

MSC Power Related Settings	Definition	HP Customized Settings
Hibernate after (DC)	Define the period that system go to Hibernate from MSC on battery.	960 minutes (16 hrs)
Hibernate after (AC)	Define the period that system go to Hibernate from MSC when plugged in.	Never
Standby Budget Percent	Defines the battery drain % that the user is allowed in a standby session.	15%

Listed below are some examples of new Modern Standby features you will find on the HP ZBook Create and ZBook Studio platforms.

- Wake on Finger Printer Sensor (FPS)
  - Authenticate first with a single touch (scanning of FPS) to wake up the system, it provides better usability with a single scanning of FPS including authentication + wake up the system
- Wake on Cortana (a.k.a Wake on Voice)

On systems that are Wake on Voice-capable and have a hardware keyword spotter (HW-KWS), voice input of "Hey Cortana" from the user can wake the SoC from the deepest idle state and cause the display to turn on. On systems with Multiple Voice Assistants (MVA) support with an MVA-capable driver, additional voice assistant commands can wake the SoC from the deepest idle state and cause the display to turn on. This feature is disabled by default, users may enable this feature from BIOS setup menu.

Conclusions

The innovations discussed here are just a sample of the new features that have been included in the latest HP ZBook G7 models. Contact your local sales representative to learn more about other features that enable you to reach the highest levels of productivity and creativity.

CONTACT US

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