

The science behind the report:

Work happy on the go with greater unplugged performance and longer battery life using an HP EliteBook 645 G10 Notebook

This document describes what we tested, how we tested, and what we found. To learn how these facts translate into real-world benefits, read the report *Work happy on the go with greater unplugged performance and longer battery life using an HP EliteBook 645 G10 Notebook PC*.

We concluded our hands-on testing on June 15, 2023. During testing, we determined the appropriate hardware and software configurations and applied updates as they became available. The results in this report reflect configurations that we finalized on April 19, 2023 or earlier. Unavoidably, these configurations may not represent the latest versions available when this report appears.

Our results

To learn more about how we have calculated the wins in this report, go to <http://facts.pt/calculating-and-highlighting-wins>. Unless we state otherwise, we have followed the rules and principles we outline in that document.

Table 1: Results of our testing.

	HP EliteBook 645 G10 Notebook PC	Dell™ Latitude™ 5440 laptop
Performance benchmark results		
PassMark PerformanceTest (higher is better)		
Plugged-in score	4,277.0	4,801.8
Unplugged score (higher is better)	3,831.7	3,401.6
Cinebench R23 multi-core benchmark (higher is better)		
Plugged-in score	9,672	10,533
Unplugged score	9,626	6,393
Battery life results		
MobileMark 2018 "best power efficiency" mode battery life testing (205 nits) benchmark (higher is better)		
Battery life (hr:mm)	13:44	10:53
Minutes per WHr	16.2	12.1
Performance score	681	560

	HP EliteBook 645 G10 Notebook PC	Dell™ Latitude™ 5440 laptop
MobileMark 2018 “best performance” mode battery life testing (205 nits) benchmark (higher is better)		
Battery life (hr:mm)	10:49	9:45
Minutes per WHr	12.7	10.8
Performance score	1,251	1,487
MobileMark 25 “best power efficiency” mode battery life testing (205 nits) benchmark (higher is better)		
Battery life (hr:mm)	12:36	9:36
Minutes per MHR	14.8	10.7
Performance score	406	263
MobileMark 25 “performance” mode battery life testing (205 nits) benchmark (higher is better)		
Battery life (hr:mm)	9:05	8:07
Minutes per MHR	10.7	9.0
Performance score	499	575
Thermal testing		
Thermal performance and surface temperatures during a sustained Cinebench R23 workload		
Sustained performance score (higher is better)	9,543	8,040
Keyboard deck temp (°F) (lower is better)	105.9	110.2
Underside temp (°F) (lower is better)	118.0	136.1

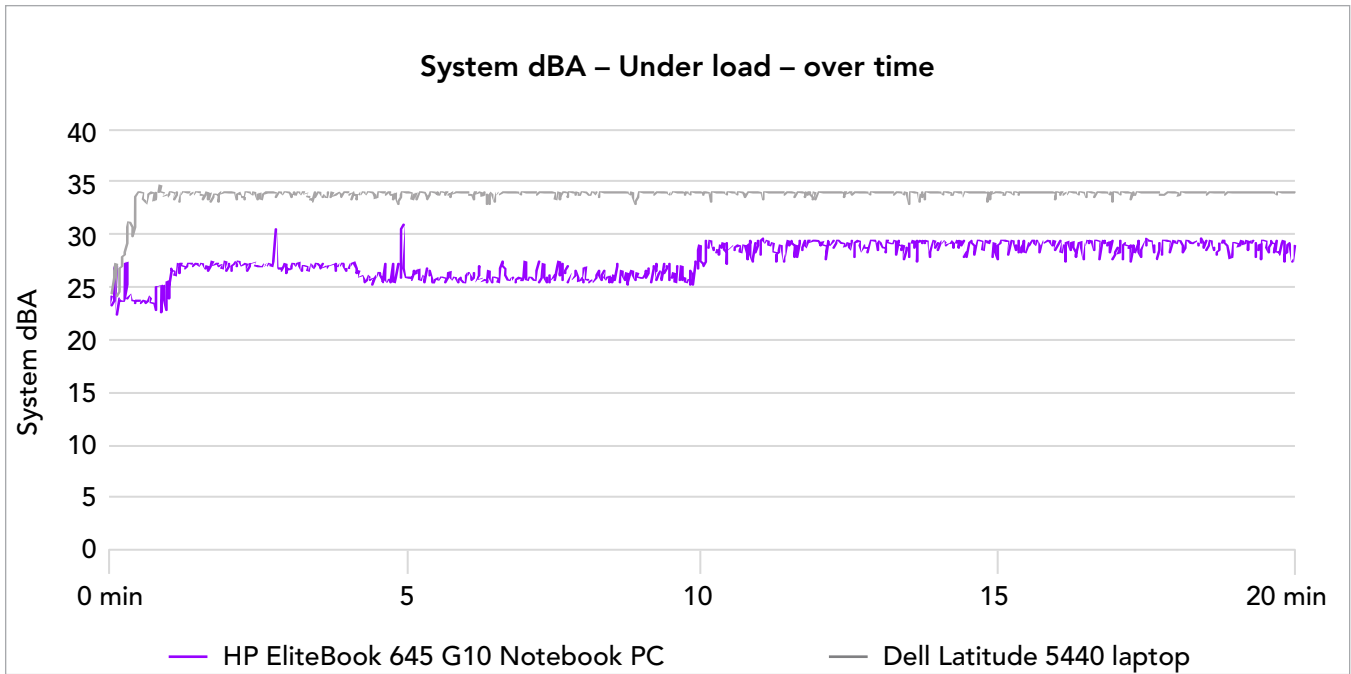


Figure 9: Acoustic testing results, in A-weighted decibels. Lower is better. Source: Principled Technologies.

System configuration information

Table 2: Detailed information on the systems we tested.

System configuration information	HP EliteBook 645 G10 Notebook PC	Dell Latitude 5440
Processor		
Vendor	AMD	Intel®
Name	AMD Ryzen™ 7 7730U	Intel Core™ i7-1355U
Core frequency (GHz)	2.0 – 4.5	1.7 – 5.0
Number of cores	8	10
Number of threads	16	12
Cache (MB)	16	12
Memory		
Amount (GB)	32GB (2x 16)	32GB (2x 16)
Type	DDR4-3200	DDR4-3200
Speed (MHz)	3,200	3,200
Graphics		
Vendor	AMD	Intel
Model number	AMD Radeon™ Graphics	Iris Xe® Graphics
Storage		
Model number	KIOXIA® KBG50ZNV512G	Western Digital SN740
Amount (GB)	512	512
Type	4x NVMe® PCIe® Gen 4	4x NVMe PCIe Gen 4
Connectivity/expansion		
Wireless internet	MediaTek Wi-Fi 6E MT7922	Intel Wi-Fi 6E AX211
Bluetooth	5.3	5.2
USB	1x USB Type-C 10Gbps signaling rate (USB Power Delivery, DisplayPort 1.4) 3x USB Type-A 5Gbps signaling rate (USB Power Delivery)	2x Thunderbolt 4 ports with DisplayPort Alt Mode/USB Type-C/USB4/Power Delivery 1x USB 3.2 Gen 1 port with PowerShare 1x USB 3.2 Gen 1 port
Video	1x HDMI 2.1	1x HDMI 2.0
Battery		
Type	Lithium-polymer	Lithium-polymer
Rated capacity (WHr)	51	54
Cells	3	3
Display		
Size (in.)	14	14
Type	LED IPS UWVA Anti-Glare FHD (1920x1080) 400 nits	LED IPS UWVA Anti-Glare FHD (1920x1080) 400 nits

System configuration information	HP EliteBook 645 G10 Notebook PC	Dell Latitude 5440
Resolution	1920x1080	1920x1080
Touchscreen	No	No
Operating system		
Vendor	Windows	Windows
Name	11 Pro	11 Pro
Build number or version	22H2 2200.22621.1702	22H2 2200.22621.1702
BIOS		
BIOS name and version	HP V77 Ver. 01.01.01	Dell 1.2.0
Dimensions		
Height (in.)	0.78	0.75
Width (in.)	12.67	12.65
Depth (in.)	8.42	8.35
Weight (lbs.)	3.1	3.0

How we tested

Setting up the systems

Creating and updating the OEM Windows 11 Pro Image

1. Boot the system.
2. Follow the on-screen instructions to complete installation, using the default selections when appropriate.
3. In the bottom right corner, click the battery icon, and adjust the Windows Power mode (plugged in) to Best Performance.
4. Unplug the system, and in the bottom right corner, click the battery icon, and adjust the Windows Power mode (on battery) to Best Performance. Plug the system back in.
5. Set DPI scaling to 100%, and set Screen and Sleep options to Never:
 - Right-click the desktop, and select Display settings.
 - Under the Scale and layout section, for the Change the size of text, apps, and other items option, select 100%.
 - From the left column, select Power & Sleep.
 - For all power options listed under Screen and Sleep, select Never.
6. Disable User Account Control notifications:
 - Select Windows Start, type UAC, and press the Enter key.
 - Move the slider control to Never notify, and click OK.
7. Run Windows Update, and install all updates available.
8. Launch the Windows Store app, and install all Store app updates.
9. Launch each vendor's proprietary utility app installed on each system, and update any drivers or BIOS files:
 - For Dell, run the Dell Command Update utility.
 - For HP, run the HP Support Assistant utility.
10. Verify the date and time are correct, and synchronize the system clock with the time server.
11. Disable Automatic Windows Update:
 - Right-click the Windows Start button.
 - Select Computer Management.
 - Select Services and Applications.
 - Select Services.
 - Scroll down, and double-click Windows Update.
 - Click Stop.
 - From the Startup type drop-down menu, select Disabled.

Capturing an image

1. Connect an external HDD to the system.
2. Click Windows Menu button, and type Control Panel in the search bar. Click Control Panel→System and Security→Backup and Restore (Windows 7)→Create a system image.
3. Verify that the external HDD is selected as the save drive, and click Next.
4. Verify that all drives are selected to back up, and click Next.
5. Click Start backup.
6. When the system asks if you want to create a system repair disc, select No, and close the dialogs.

Restoring an image

1. Connect an external HDD to the system.
2. Press and hold the Shift key while Restarting the system.
3. Select Troubleshoot.
4. Select Advanced options.
5. Select See more recovery options.
6. Select System image recovery.
7. Select the User account.
8. Enter the system password, and click Continue.
9. At the Restore system files and settings screen, select Next.
10. Verify that the external HDD is selected, and click Next.
11. Once the recovery has completed, click Finish.

Measuring performance with PassMark PerformanceTest

Setting up the test

1. Download PassMark Performance Test from <https://www.passmark.com/products/performance-test/download.php>.
2. To begin the installation, click Install.
3. To accept the license agreement, select Accept, and click Next.
4. After the installation is complete, deselect Launch Performance Test, and click Finish.

Running the test

1. Boot the system.
2. Select Windows Start.
3. Type `cmd`, and press Ctrl+Shift+Enter.
4. Type `Cmd.exe /c start /wait Rundll32.exe advapi32.dll,ProcessIdleTasks`. Do not interact with the system until the command completes.
5. After the command completes, wait 5 minutes before running the test.
6. To launch PassMark PerformanceTest, select the PassMark PerformanceTest icon.
7. Press Run Benchmark.
8. When the test completes, record the results.
9. Repeat steps 6 through 8 two more times, and report the median of the three runs.

Measuring performance with Cinebench R23

Setting up the test

1. Download and install Cinebench from <https://www.maxon.net/en/downloads/cinebench-r23-downloads>.

Running the test

1. Boot the system.
2. Select Windows Start.
3. Type `cmd`, and press Ctrl+Shift+Enter.
4. Type `Cmd.exe /c start /wait Rundll32.exe advapi32.dll,ProcessIdleTasks`. Do not interact with the system until the command completes.
5. After the command completes, wait 5 minutes before running the test.
6. Launch Cinebench.
7. Select File→Advanced benchmark.
8. Set the Minimum Test Duration to Off.
9. Select either CPU (Multi Core) or CPU (Single Core), and click Start.
10. Record the result.
11. Wait 10 minutes before re-running.
12. Repeat steps 7 through 11 twice more, and record the median result.

Measuring thermals and sustained performance with Cinebench R23

These tests require the following items:

- A FLIR E6xt Infrared Camera
- Cinebench R23

Running the test

1. Boot the system.
2. Select Windows Start.
3. Type `cmd`, and press `Ctrl+Shift+Enter`.
4. Type `Cmd.exe /c start /wait Rundll32.exe advapi32.dll,ProcessIdleTasks`. Do not interact with the system until the command completes.
5. After the command completes, wait 5 minutes before running the test.
6. Launch Cinebench R23.
7. Select `File`→`Advanced benchmark`.
8. Verify that the Minimum Test Duration is set to the default 10 minutes (Test Throttling).
9. Select `CPU (Multi Core)`, and click `Start`.
10. Record the performance results for the next five back-to-back 10-minute iterations. At the end of each run, note the ambient room temperature, and take a skin temperature photo with the FLIR E6xt Infrared Camera of the top and bottom. Report the hottest spots.

Measuring acoustics

These tests require the following items:

- Extech SDL600 Sound Level Meter/Datalogger with SD card
- Cinebench R23

Setting up the test

1. Place the system under test in a sound-proofed professional sound booth.
2. Set the Extech SDL600 on a tripod so that it is 30 centimeters in front of and 40 centimeters above the system under test.

Measuring acoustics while idle

Running the test

1. Boot the laptop.
2. Select Windows Start.
3. Type `cmd`, and press `Ctrl+Shift+Enter`.
4. Type `Cmd.exe /c start /wait Rundll32.exe advapi32.dll,ProcessIdleTasks` Do not interact with the laptop until the command completes.
5. After the command completes, wait 5 minutes before running the test.
6. Start the Extech SDL600 Sound Level Meter/Datalogger and allow the laptop to run at idle for 10 minutes.
7. At the end of the 10 minutes, stop the Extech SDL600, and record the average sound level (in dB) while idle.
8. Shut down the laptop.
9. Repeat steps 1 through 8 twice more.

Measuring acoustics while running Cinebench R23

Running the test

1. Boot the laptop.
2. Select Windows Start.
3. Type `cmd`, and press `Ctrl+Shift+Enter`.
4. Type `Cmd.exe /c start /wait Rundll32.exe advapi32.dll,ProcessIdleTasks` Do not interact with the laptop until the command completes.
5. After the command completes, wait 5 minutes before running the test.
6. Launch Cinebench R23.

7. Simultaneously start the Extech SDL600 Sound Level Meter/Datalogger and click CPU (Multi Core) Start.
8. At the end of the Cinebench R23 run, stop the Extech SDL600, and record the average sound level (in dBA) while running Cinebench R23.
9. Shut down the laptop for 40 minutes, and let it return to room temperature.
10. Repeat steps 1 through 9 twice more.

Measuring battery life with MobileMark 2018

This test requires an X-Rite - i1Display Plus colorimeter.

Avoiding antivirus software conflicts

MobileMark 2018 is not compatible with any virus-scanning software, so we uninstalled any such software present on the systems before we installed the benchmark.

Avoiding pre-installed software conflicts

MobileMark 2018 installs the following applications, which its test scripts employ:

Productivity

- Adobe Acrobat® Pro DC
- AutoIT 3.3.14.2
- Google Chrome
- Microsoft Excel 2016
- Microsoft OneNote 2016
- Microsoft Outlook 2016
- Microsoft PowerPoint 2016
- Microsoft Word 2016
- Windows Zip

Creativity

- Adobe Photoshop CC
- Adobe Lightroom Classic CC
- CyberLink PowerDirector® 2015

Web Browsing

- Google Chrome
- Microsoft Movies & TV

If any of these applications already exist on the system under test, they could cause problems with the benchmark due to software conflicts. To avoid any such issues, we uninstalled all conflicting pre-installed software applications—including different versions of any of the programs MobileMark 2018 uses—before we installed the benchmark.

Adjusting display brightness and power settings

The brightness of a notebook's display affects its battery life. Therefore, BAPCo requires that, before you test with MobileMark 2018, you ensure the brightness of the notebook's monitor is greater than or equal to 200 nits in the center of a completely white screen while the notebook is unplugged and running on battery power. The measurement follows the standards from the Video Electronics Standards Association (www.vesa.org).

We complied with this standard for all our tests by setting each system's brightness as close to 200 nits as we could without going below that level. We used the following procedure before we started each test. Note: This procedure assumes we began with the notebook plugged into the power supply.

1. To create a completely blank, white screen, open Microsoft Paint by clicking Start→All Programs→Accessories→Paint.
2. Press Ctrl+W to open the Resize and Skew dialog.
3. Under Horizontal and Vertical, enter 200, and click OK.
4. Click the View tab.
5. To view a white screen, click Full screen.
6. To allow the screen to warm, wait 45 minutes.
7. Unplug the notebook from the power supply, and measure the display's brightness using a luminance meter in the center of the screen. (We used an X-Rite - i1Display Plus colorimeter.)
8. If the reading is below or significantly greater than 200 nits, adjust the screen brightness to as close to that amount as you can without going under, and retest:
 - a. Click the Windows Start button.
 - b. In the Windows Start search box, type `display settings`
 - c. Adjust the slider to change the Display brightness to the correct percentage that produces no less than 200 nits.
9. Allow the system to run on battery power for 10 minutes, re-measure the display, and adjust the brightness up or down as necessary.
10. Verify that the notebook saved the brightness setting by plugging in the system, unplugging it, and taking another reading.

Using the MobileMark built-in configuration tool

This tool supports three levels of configuration:

1. Only makes changes that are **REQUIRED** for the benchmark to run.
2. Additionally, makes changes that are **RECOMMENDED** for repeatable results.
3. Additionally, makes **OPTIONAL** changes that help ensure best results.

The configuration tool makes the following configuration changes at each of the three levels:

Level 1 - Required

- Disables User Account Control (UAC)
- Set DPI Scaling to 100%
- Disables Low Battery Actions
- Disables Network Proxies
- Disables System Sleep and Hibernate
- Disables Windows Update
- Enables Windows Search

Level 2 - Recommended

- Create BAPCo power scheme
- Set Power Plan Type to Balanced
- Set CPU Adaptive Mode
- Disables Battery Saver Dimming
- Verifies Battery Saver Threshold
- Disables Disk Defrag
- Disables Windows Error Reporting
- Disables Windows Lock Screen
- Disables Windows Pop-ups
- Disables Screen Saver and Monitor Timeout
- Disables Windows Sidebar/Gadgets
- Disables Desktop Slideshow
- Disables Windows Defender
- Disables Windows Firewall
- Set Font Smoothing

Level 3 - Optional

- Disables Hard Disk Timeout
- Disables System Restore
- Ignores Laptop Lid Close

We chose the official BAPCo “Run Benchmark” default as outlined in the BAPCo MobileMark2018 User Guide (http://bapco.com/wp-content/uploads/2019/03/BAPCo_MobileMark2018_user_guide_v1.3.pdf), which runs the benchmark using the Required and Recommended options.

Setting up the performance-qualified battery life test

1. On a separate system, install the i1Profiler software from <https://www.xrite.com/categories/formulation-and-quality-assurance-software/i1profiler> and connect the X-Rite - i1Display Plus colorimeter to that PC.
2. On the system under test, verify that the wireless adapter is enabled and connected to a wireless router that is not connected to the internet.
3. On the system under test, verify that the Lower screen brightness when using battery saver is turned off:
 - Select Windows Start, type `Battery saver`, and press the Enter key.
 - Next to Turns on at 20%, click the down arrow. Next to Lower screen brightness when using battery saver, toggle the button to Off.
4. On the system under test, verify that the volume is set to 50%.
5. On systems with AMD processors, disable Vari-Bright to prevent the screen from automatically dimming:
 - Launch AMD Software.
 - Click on the Settings gear icon.
 - Select the Display tab, and disable Vari-Bright.
6. Verify that the screen brightness is set to no less than 200 nits.
7. Install MobileMark 2018 with the default options.

Running the performance-qualified battery life test

1. Boot the system.
2. Select Windows Start.
3. Type `cmd`, and press Ctrl+Shift+Enter.

4. Type `Cmd.exe /c start /wait Rundll32.exe advapi32.dll,ProcessIdleTasks`. Do not interact with the system until the command completes.
5. After the command completes, wait 5 minutes before running the test.
6. Launch MobileMark 2018.
7. Click the Settings gear icon.
8. Verify that Conditioning Run is enabled.
9. Enter a name for the benchmark run.
10. To return to the main menu, click the Back button.
11. Click Run Benchmark.
12. When prompted, unplug the AC power adapter. The test will begin immediately.

The benchmark is complete when the system under test has fully depleted its battery and is no longer operational when running on battery power.

We executed the MobileMark 2018 benchmark three times on the system and took the median battery life score run as the representative performance score result for that test.

Testing performance with MobileMark 25

This test requires an X-Rite – i1Display Plus colorimeter.

Avoiding antivirus software conflicts

MobileMark 25 is not compatible with any virus-scanning software, so we uninstalled any such software present on the notebook PCs before we installed the benchmark.

Avoiding pre-installed software conflicts

MobileMark 25 installs the following applications, which its test scripts employ:

Productivity

- Adobe Acrobat Pro DC
- Audacity
- Corel WinZip 24.0 Enterprise
- Google Chrome
- Microsoft Excel 2019 Professional Plus VL
- Microsoft Outlook 2019 Professional Plus VL
- Microsoft PowerPoint 2019 Professional Plus VL
- Microsoft Word 2019 Professional Plus VL
- Shotcut

Creativity

- Adobe Photoshop CC
- Adobe Lightroom Classic CC
- Adobe Premiere Pro CC

If any of these applications already exist on the system under test, they could cause problems with the benchmark due to software conflicts. To avoid any such issues, we uninstalled all conflicting pre-installed software applications—including different versions of any of the programs MobileMark 25 uses—before we installed the benchmark.

Using the MobileMark built-in configuration tool

This tool supports three levels of configuration:

1. Only makes changes that are **REQUIRED** for the benchmark to run.
2. Additionally, makes changes that are **RECOMMENDED** for repeatable results.
3. Additionally, makes **OPTIONAL** changes that help ensure best results.

The configuration tool makes the following configuration changes at each of the three levels:

Level 1 – Required

- Disables User Account Control (UAC)
- Set DPI Scaling to 100%
- Disables Low Battery Actions
- Disables Network Proxies
- Disables System Sleep and Hibernate
- Disables Windows Update
- Enables Windows Search
- Disables WinSAT

Level 2 – Recommended

- Create BAPCo power scheme
- Set Power Plan Type to Balanced
- Set CPU Adaptive Mode
- Disables Battery Saver Dimming
- Verifies Battery Saver Threshold
- Disables Disk Defrag
- Disables Windows Error Reporting
- Disables Windows Lock Screen
- Disables Screen Saver and Monitor Timeout
- Disables Windows Security Center
- Set Font Smoothing

Level 3 – Optional

- Disables Hard Disk Timeout
- Disables System Restore
- Ignores Laptop Lid Close
- Enables Dark Mode
- No Wait for OpenMP Threads

We chose the official BAPCo “Run Benchmark” default as outlined in the BAPCo MobileMark25 User Guide (https://bapco.com/wp-content/uploads/2021/09/bapco_mobilemark25_user_guide_v1.1.pdf), which runs the benchmark using the Required and Recommended options.

Setting up the performance-qualified battery life test

1. On a separate system, install the i1Profiler software from <https://www.xrite.com/categories/formulation-and-quality-assurance-software/i1profiler> and connect the X-Rite - i1Display Plus colorimeter to that system.
2. On the system under test, verify that the wireless adapter is enabled and connected to a wireless router that is not connected to the internet.
3. On the system under test, verify that the Lower screen brightness when using battery saver is turned off.
 - Select Windows Start, type `Battery saver`, and press the Enter key.
 - Next to Turns on at 20%, click the down arrow. Next to Lower screen brightness when using battery saver, toggle the button to Off.
4. On the system under test, verify that the volume is set to 50%.
5. On systems with AMD processors, disable Vari-Bright to prevent the screen from automatically dimming:
 - Launch AMD Software.
 - Click on the Settings gear icon.
 - Select the Display tab, and disable Vari-Bright.
6. Verify the system is no less than 250 nits.
7. On the system under test, install MobileMark 25 with the default options.

Running the performance-qualified battery life test

1. Boot the system.
2. Select Windows Start.
3. Type `cmd`, and press Ctrl+Shift+Enter.
4. Type `Cmd.exe /c start /wait Rundll32.exe advapi32.dll,ProcessIdleTasks`. Do not interact with the system until the command completes.
5. After the command completes, wait five minutes before running the test.
6. Launch MobileMark 25.
7. Click Run Benchmark.
8. Click the Brightness Profiler button.
 - Allow the white screen to warm up for 30 minutes. After 30 minutes, click Skip.
 - At the Panel Dark Luminance pop-up, to use the value that is queried from the display, select Yes.
 - Place the X-Rite - i1Display Plus colorimeter in the outlined spot on the screen.
 - On the system under test, toggle the F1 button to turn off the test overlay.

- On the colorimeter system, start i1Profiler program, and select Advanced.
- Click Display, and click Profiling.
- Next to Luminance, click the drop-down menu, and select Measure.
- In the drop-down menu that appears below, select Paper in booth.
- In the box with the image that says, “Place your paper in the light booth,” scroll down so that you can click the Measure button.
- On the system under test, adjust the slider until the Target White luminance is met on the colorimeter system.
- Once the correct Target White luminance is met on the system under test, click Done.

9. Click Continue.

10. The test will begin immediately. When prompted, unplug the AC power adapter.

The benchmark is complete when the system under test has fully depleted its battery and is no longer operational when running on battery power.

We executed the MobileMark 25 benchmark three times on the system and took the median battery life score run as the representative performance score result for that test.

Read the report at <https://facts.pt/X88p92V>



This project was commissioned by HP and AMD.



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