RADEON™ RX 580

RADEON™ RX 570

Reviewer's Guide

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Introducing the Radeon RX 580 and Radeon RX 570

Last year AMD introduced the first Polaris generation of GPUs. With it, AMD delivered many new features, along with great performance in the latest games, and greatly improved efficiency. Since launch, AMD has been hard at work delivering continued support, as well as updating/adding features, and improving our driver ecosystem as well.

Still, many users have graphics hardware greater than 2 years old, and have yet to move to 14nm technology. AMD wanted to find a way to reach out to these users even more so than last year. So this year, AMD is excited to bring to market the 2nd generation of Polaris products, the Radeon RX 500 Series; Polaris Enhanced.

This guide is going to cover the Radeon RX 580 and the Radeon RX 570.

Specifications

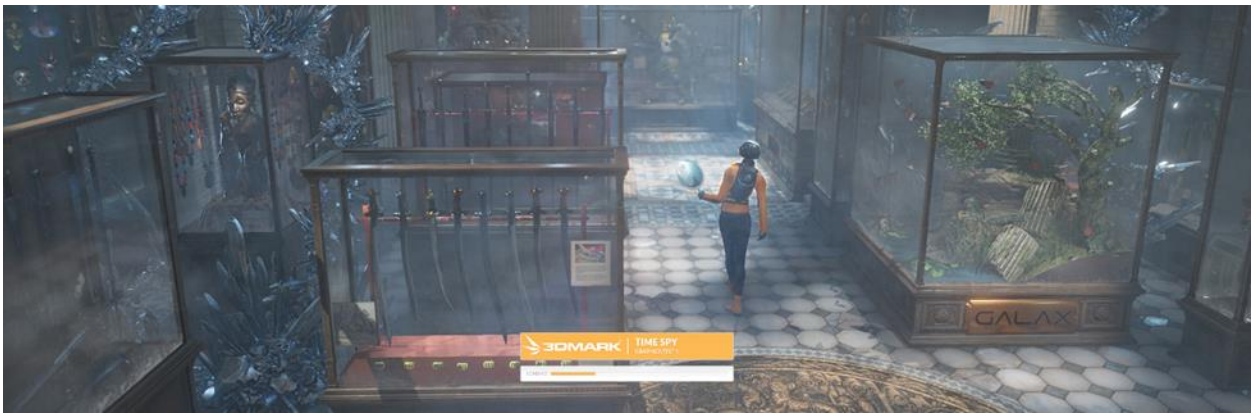
Table 1: Radeon RX 580 and RX 570 specifications table

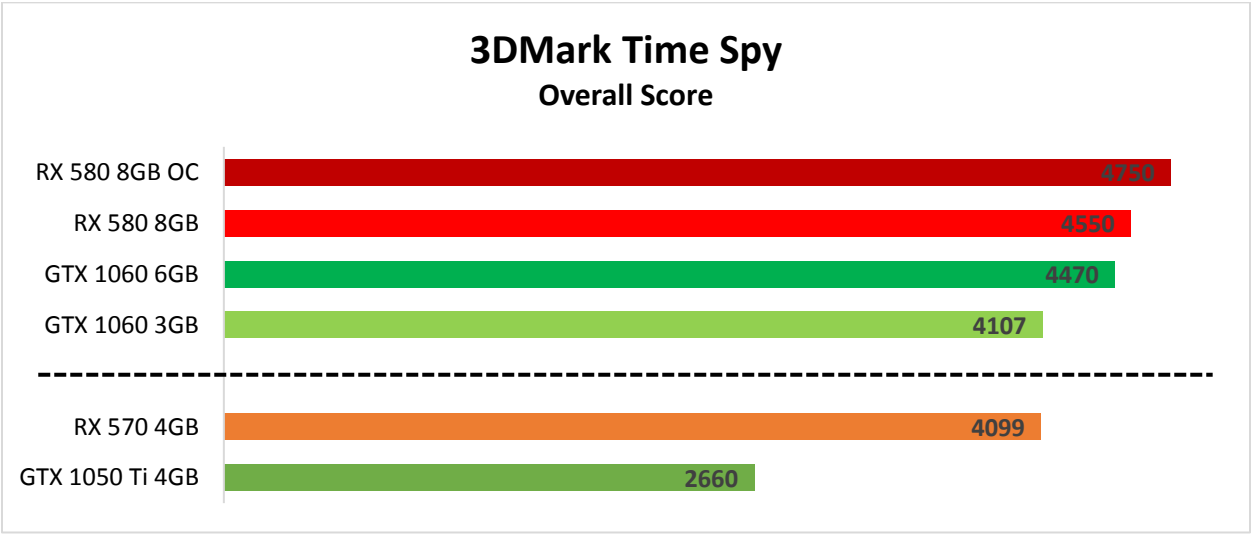
	Radeon™ RX 580	Radeon™ RX 570
GCN Architecture	4th Generation	4th Generation
Manufacturing Process	14-nm FinFET	14-nm FinFET
Die Size	232 mm^2	232 mm^2
Compute Units	36	32
Stream Processors	2304	2048
Clock Speeds (Boost / Base)	1340 MHz / 1257 MHz	1244 MHz / 1168 MHz
Peak Compute Performance	Up to 6.17 TFLOPS	Up to 5.1 TFLOPS
Texture Units	144	128
Peak Texture Fill-Rate	Up to 193.0 GT/s	Up to 159.2 GT/s
ROPs	32	32
Peak Pixel Fill-Rate	Up to 42.9 GP/s	Up to 39.8 GP/s
Memory Size	8 GB	4 GB
Memory Bandwidth	256 GB/s	224 GB/s
Memory Interface	256 bit	256 bit
Memory Type	GDDR5	GDDR5
Board Power	185W	150W
AMD FreeSync™ Technology	Yes	Yes
DirectX® 12 Support	Yes	Yes
Vulkan™ Support	Yes	Yes
DisplayPort Version	1.3 HBR / 1.4 HDR Ready	1.3 HBR / 1.4 HDR Ready

Product Positioning and Performance

The RX 580 is positioned against the GTX 1060 6GB and the RX 570 is positioned against the GTX 1050 Ti. To show the product positioning, we use 3DMark Time Spy. Time Spy is a popular synthetic benchmark used by gamers to evaluate the overall performance of a computer. The benchmark measures GPU and CPU performance through isolated tests and uses an algorithm to determine a final score.

Time Spy shows the RX 580 clearly leading ahead both variants of the GTX 1060. Similarly, the RX 570 scores well above the GTX 1050 Ti at the same test. See the graph below for the benchmark results.





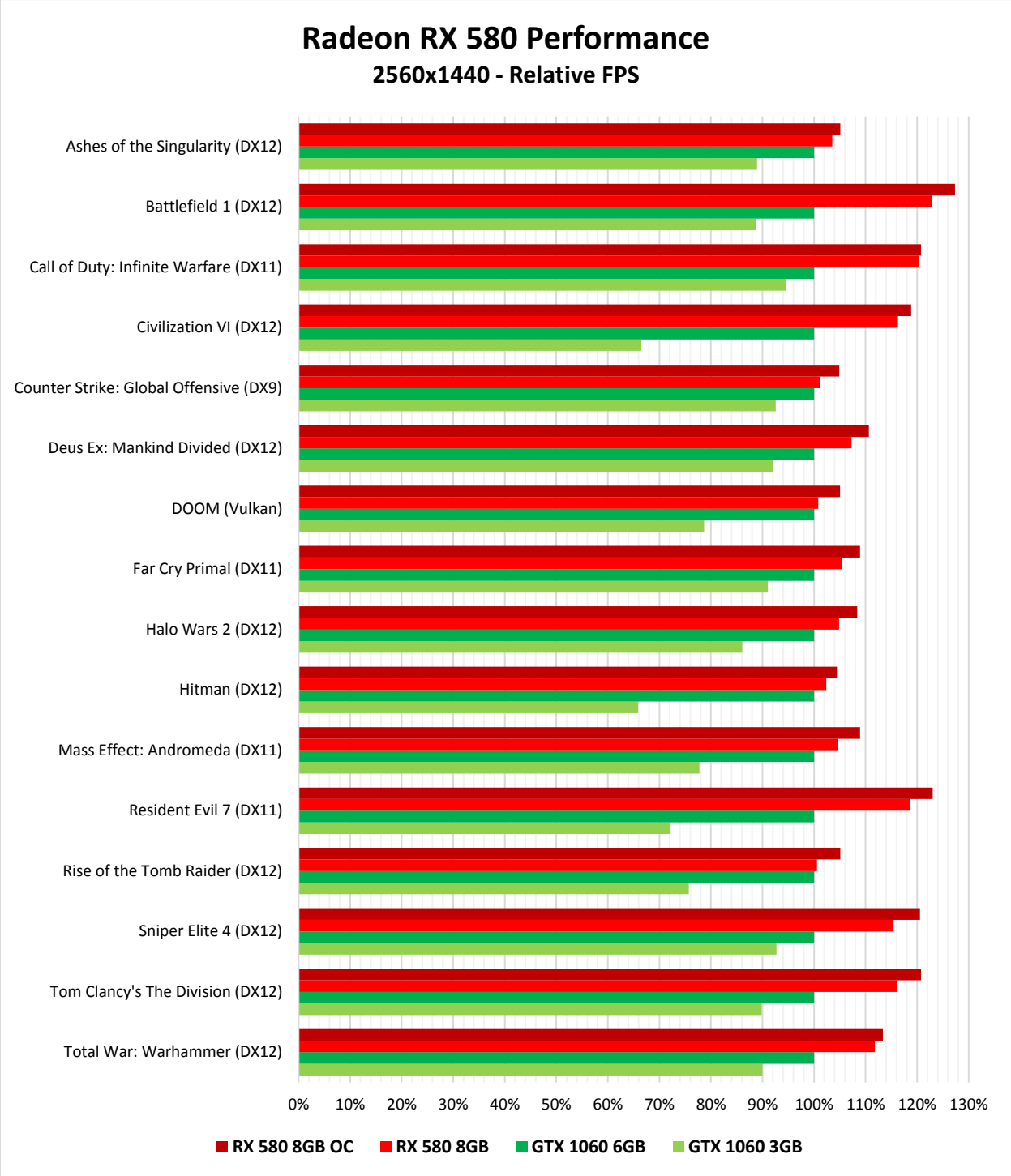
*Primary benchmark system used. Please see Appendix 2 for details.

Time Spy provides a rough estimate of how a system will perform compared to others. In order to determine the gaming performance, we need to test some actual games. We compiled a list of popular games which gamers are playing today.

For games which support a built-in benchmark, we use the benchmark to capture the results. For other games we use third-party tools, specifically PresentMon and FRAPS to capture performance using an in-game scene. Details on how to use PresentMon and FRAPS is described in Appendix 3 and Appendix 4 respectively. Information on the game settings and scene is detailed in Appendix 1.

Radeon RX 580

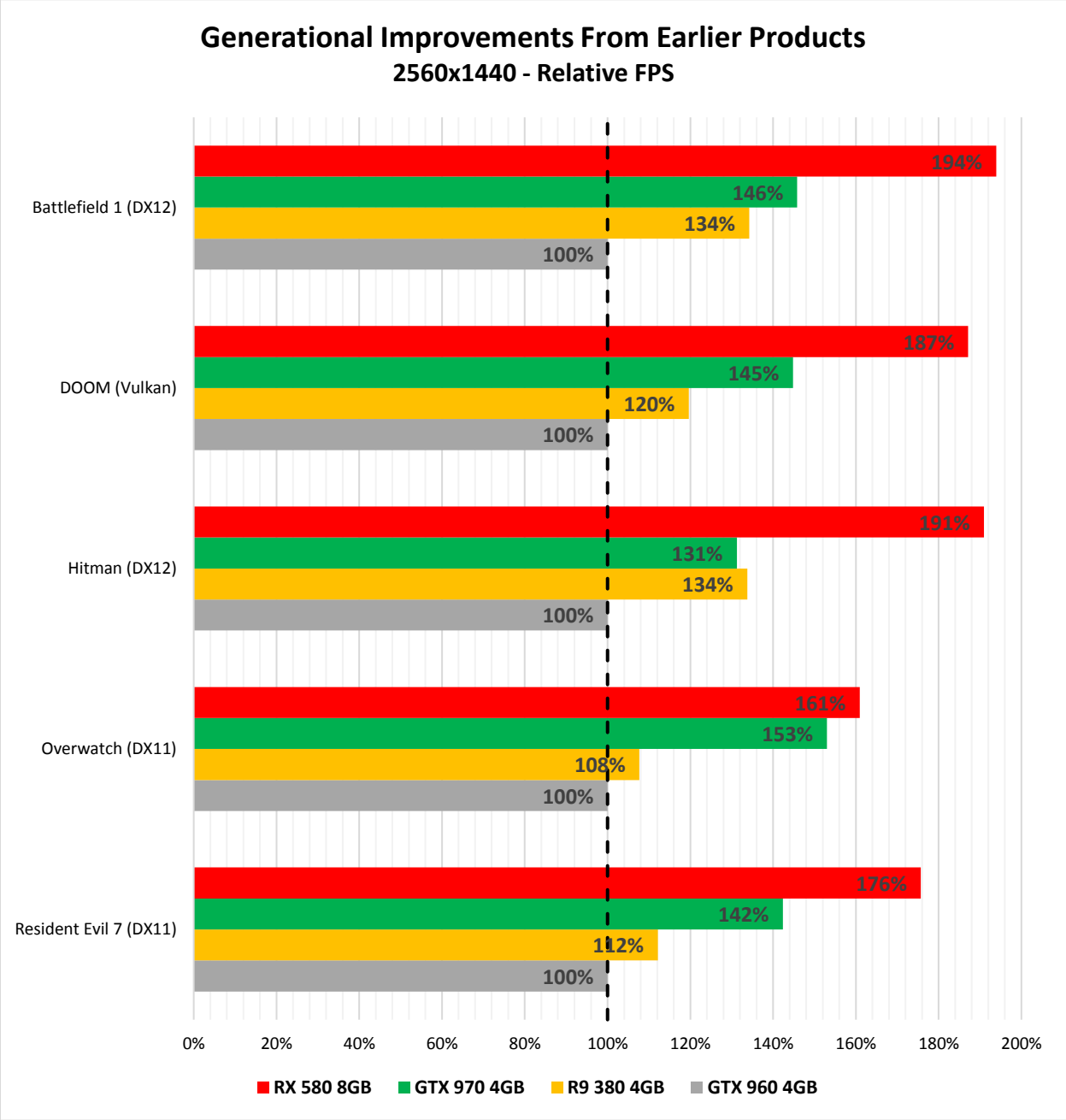
Engineered for excellent performance at 1440p, the Radeon RX 580 performs well against its main competitor, the GeForce GTX 1060 6GB, across a wide range of AAA games. See the graph below for gaming results on the RX 580 against the GTX 1060 6GB and GTX 1060 3GB.



*Primary benchmark system used. Please see Appendix 2 for details.

Upgrading to the Radeon RX 580

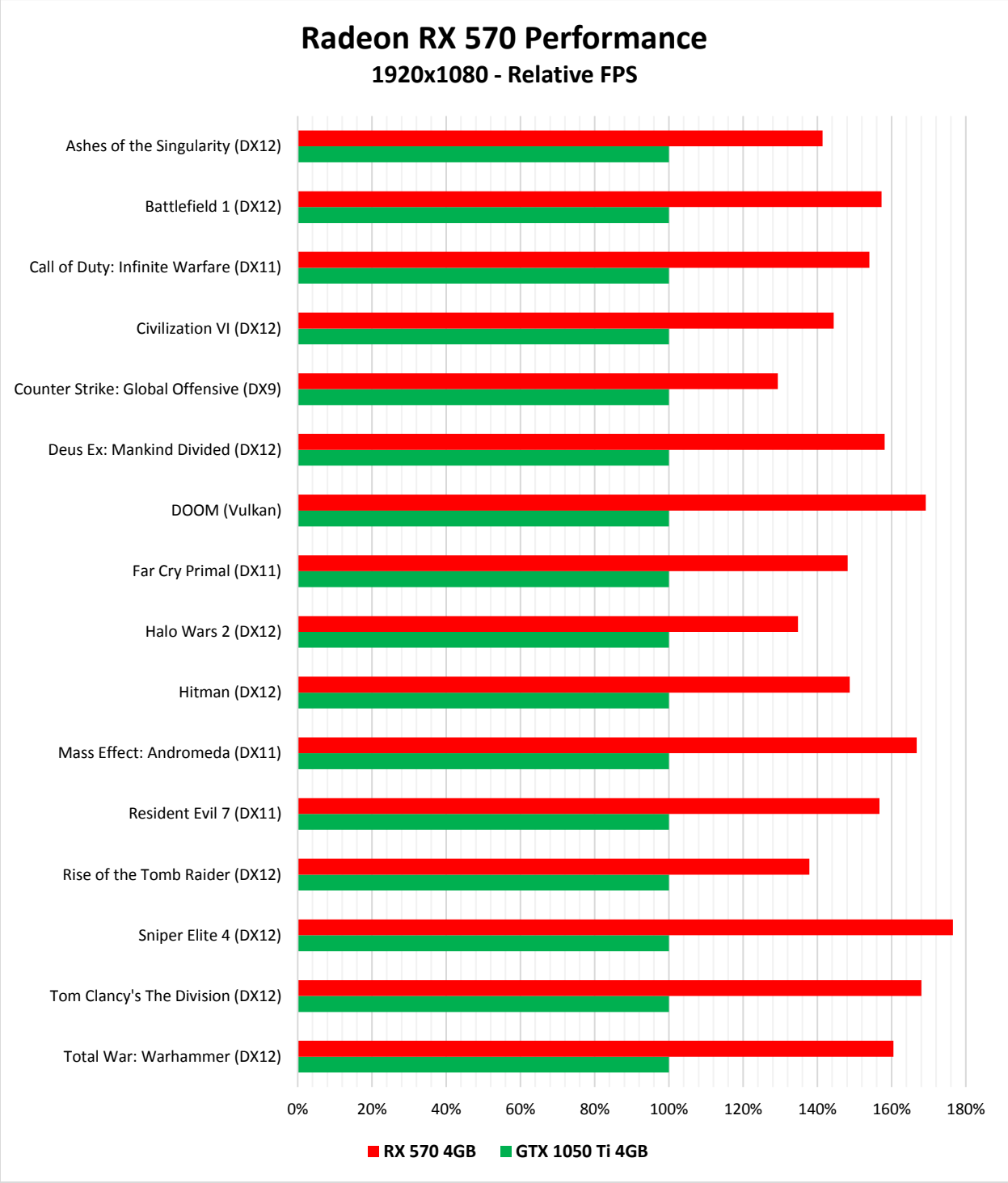
The RX 580 is a logical choice for any PC gamer looking to upgrade their system from previous products. Compared to the GTX 960, performance almost doubles by upgrading to the RX 580. Older high-end products such as the R9 380 and the GTX 970 are outperformed by the newer RX 580. See the performance improvements by upgrading to a RX 580 in the graph below.



*Primary benchmark system used. Please see Appendix 2 for details.

Radeon RX 570

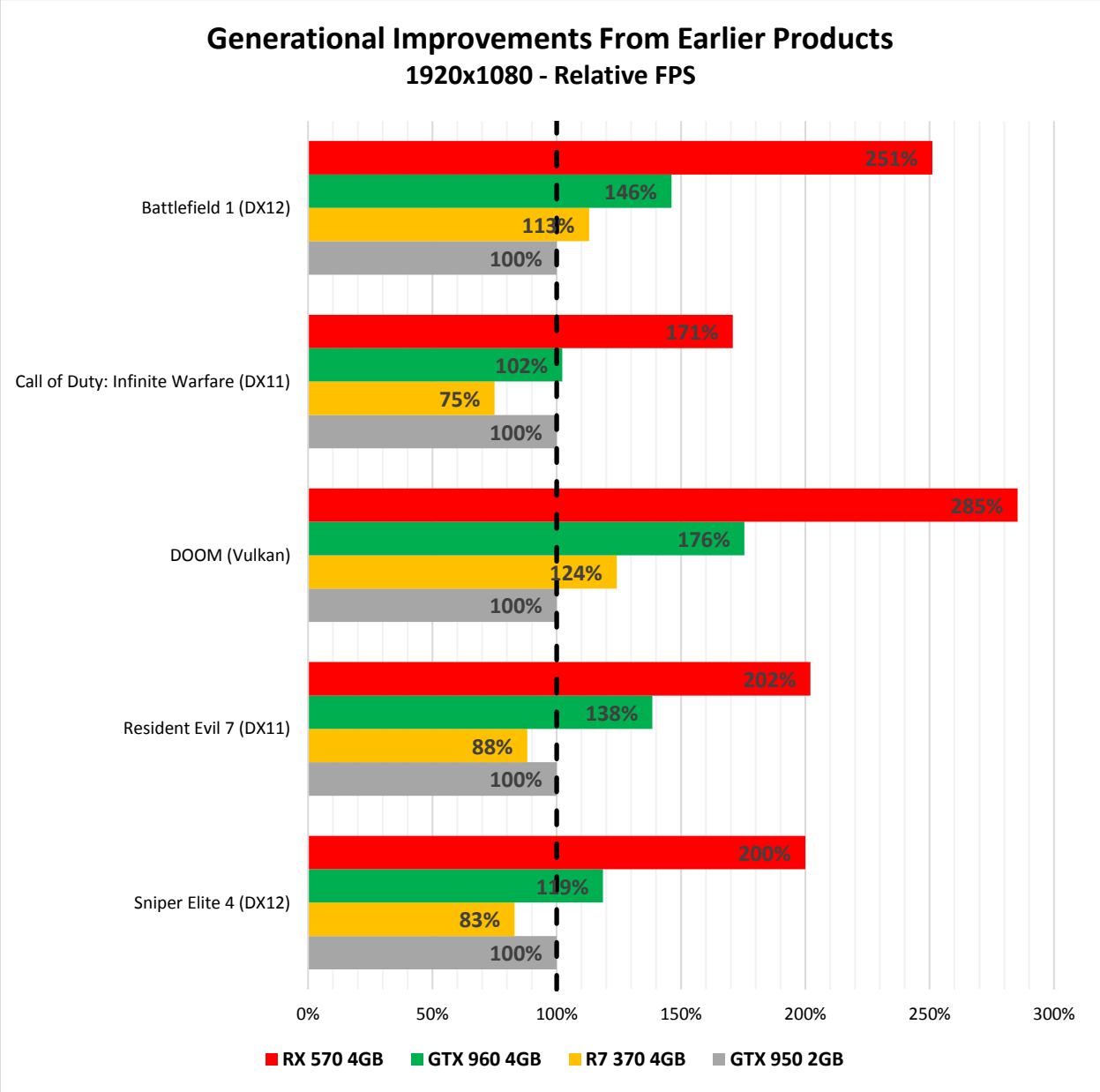
Engineered for optimal performance at 1080p, the Radeon RX 570 unquestionably outperforms its main competitor, the GeForce GTX 1050 Ti. See the graph below for gaming results on the RX 570 against the GTX 1050 Ti.



*Primary benchmark system used. Please see Appendix 2 for details.

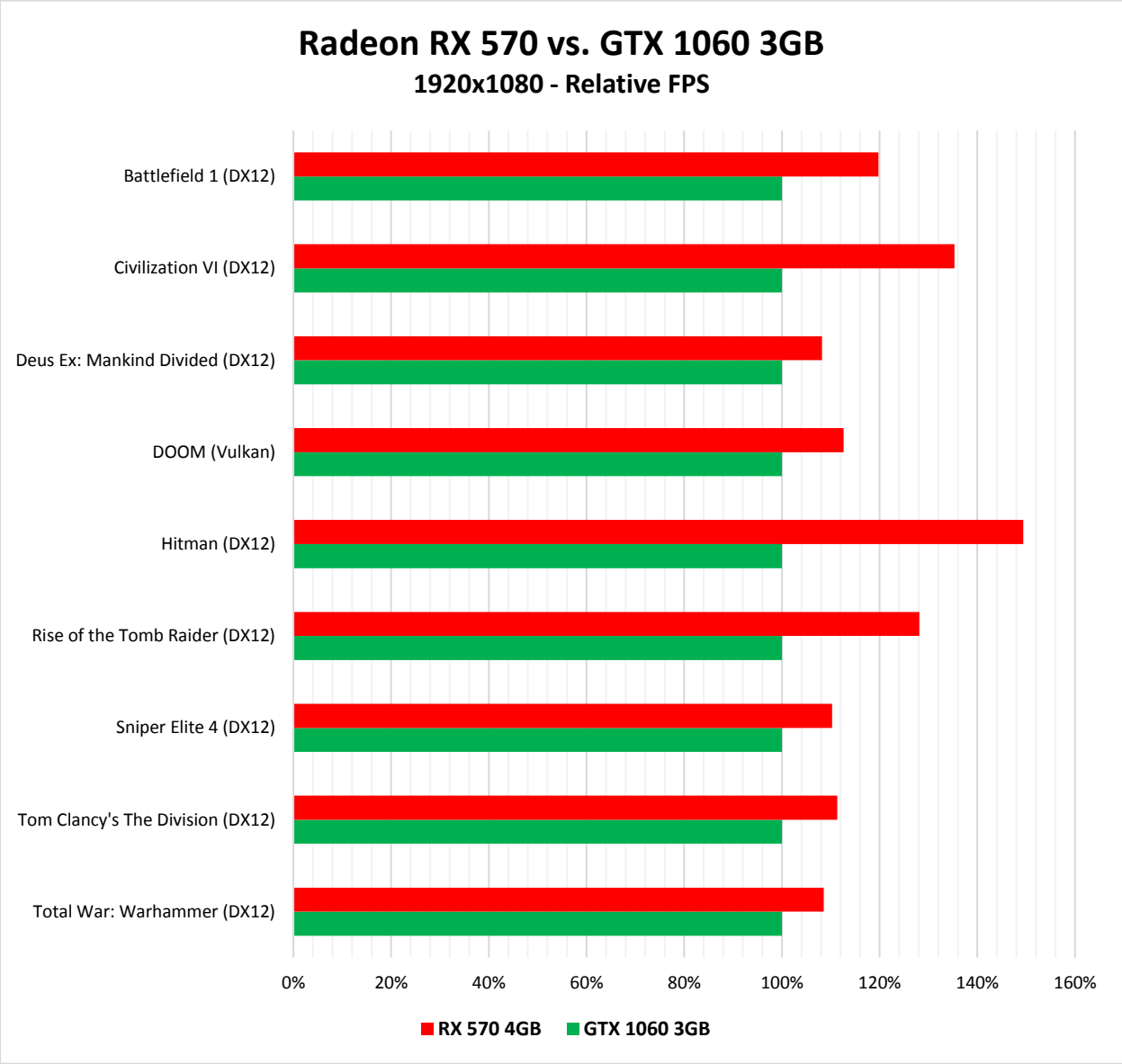
Upgrading to the Radeon RX 570

The RX 570 provides an excellent upgrade path to any owners who are currently using the GTX 950 or the R7 370. Performance of the RX 570 has more than doubled the aging R7 370 and almost doubled the performance of the GTX 950 in most titles. See the performance improvements by upgrading to a RX 570 in the graph below.



Radeon RX 570 vs. GTX 1060 3GB

Although the Radeon RX 570 competes with the GTX 1050 Ti, it can even outperform the GTX 1060 3GB. See the graph below on how the RX 570 stacks up against the GTX 1060 3GB in games that support next generation APIs such as DirectX 12 and Vulkan.



Anyone who is looking to purchase a GTX 1050 Ti or a GTX 1060 3GB right now should definitely consider the RX 570. The RX 570 delivers great 1080p performance which easily passes the GTX 1050 Ti and rivals the GTX 1060 3GB.

Introducing Radeon Chill

Radeon Chill is a new software feature that aims to reduce excessive GPU power consumption while delivering the same gaming experience for the end user.

How does Chill work?

The Chill algorithm monitors user inputs in order to determine whether or not quick motion is happening on the screen during a game. If the user is standing still and the display is mostly static, Chill quickly scales down frame rates to a lower threshold in order to save power. As soon as the user begins moving or interacting with the scene, Chill responds by instantaneously increasing frame rates to preserve a sense of fluid motion and responsiveness.

Meanwhile, at all times, Chill avoids running the game at excessively high frame rates that would waste power with little or no end-user benefit.

Because Chill's responses are very quick, gamers may not notice that anything is happening as they play. The Chill algorithm has been designed to avoid having any perceptible negative effect on the gaming experience.

Benefits of Chill

Chill has the potential to reduce the GPU's power consumption, heat production, temperatures and cooling noise without perceptibly altering the gaming experience.

The benefits of Chill will vary depending on the game and on the performance of the system in question. In cases where frame rates are very high, with relatively easy GPU workloads like eSports games, Chill has the potential to pay the biggest dividends.

In one scenario we tested with DOTA 2 on a RX 580, Chill did the following:

- Decreased average GPU board power consumption by 31.5%, from 168W to 115W.
- Decreased average GPU temperature by 12° Celsius.
- Decreased average FPS by 47%. **However**, the gameplay experience **felt the same** since the 99% of all frames rendered was kept above the minimum Chill setting of 60FPS (16.67ms).

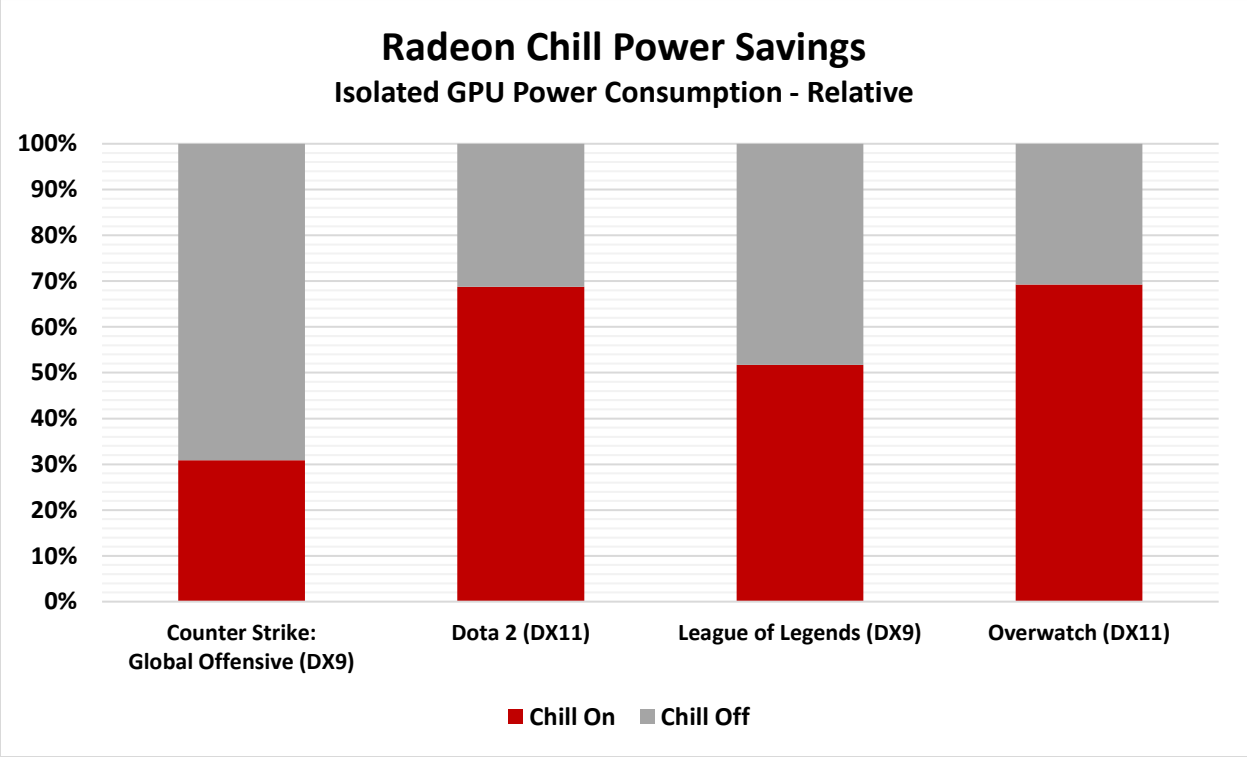
Your experience with Chill may differ from this scenario, so we encourage you to test it for yourself. In some of our tests, we could tell whether Chill was on or off simply by listening to the speed of the fans on our video card.

Power Savings with Chill

Some of the biggest titles in eSports such as Counter Strike: Global Offensive, Dota 2, League of Legends and Overwatch are ideal candidates to pair with Chill. These games run at high FPS on enthusiast-class GPUs due to low system requirements in order to attract a wider audience.

Powerful GPUs such as the RX 580 or RX 570 will easily handle these titles at 1080p and 1440p. Rather than wasting power on extra FPS, Chill can help save power and lower GPU temperatures without impacting the gameplay experience.

From our own testing through a series of offline and multiplayer matches, we were able to save a substantial amount of GPU power shown in the graph below.



*Results were measured using Chill FPS range of 60FPS minimum to 144FPS maximum on the secondary benchmark system. Power savings are directly influenced by the amount of activity in the game and the Chill FPS range, results can significantly vary according to user settings and playstyle. See Appendix 1, Table 11 for detailed results.

List of Supported Games with Chill

Not every game is a good candidate for seamless compatibility with the Chill algorithm. At present, Chill works on a limited set of games that AMD has qualified. We believe Chill provides a good experience in games from the table below.

Table 2: Whitelist of games which support Radeon Chill

Game Title	**API**
Counter Strike: Global Offensive	DX9
CrossFire	DX9
Dark Souls III	DX11
Deus Ex	DX11
Dota 2	DX9/DX11
Fallout 4	DX11
Far Cry 4	DX11
Far Cry Primal	DX11
League of Legends	DX9
Overwatch	DX11
Paragon	DX11
PlanetSide 2	DX9
Rise of the Tomb Raider	DX11
The Elder Scrolls V: Skyrim	DX9
Team Fortress 2	DX9
Tomb Raider (2013)	DX9/DX11
Warframe	DX11
The Witcher 3: Wild Hunt	DX11
World of Warcraft	DX9/DX11

How to enable Chill

In Radeon Settings, go to the Gaming tab, choose Global Settings, and click Global WattMan. Scroll to the bottom of the window and you'll the Chill control area shown in Figure 1.

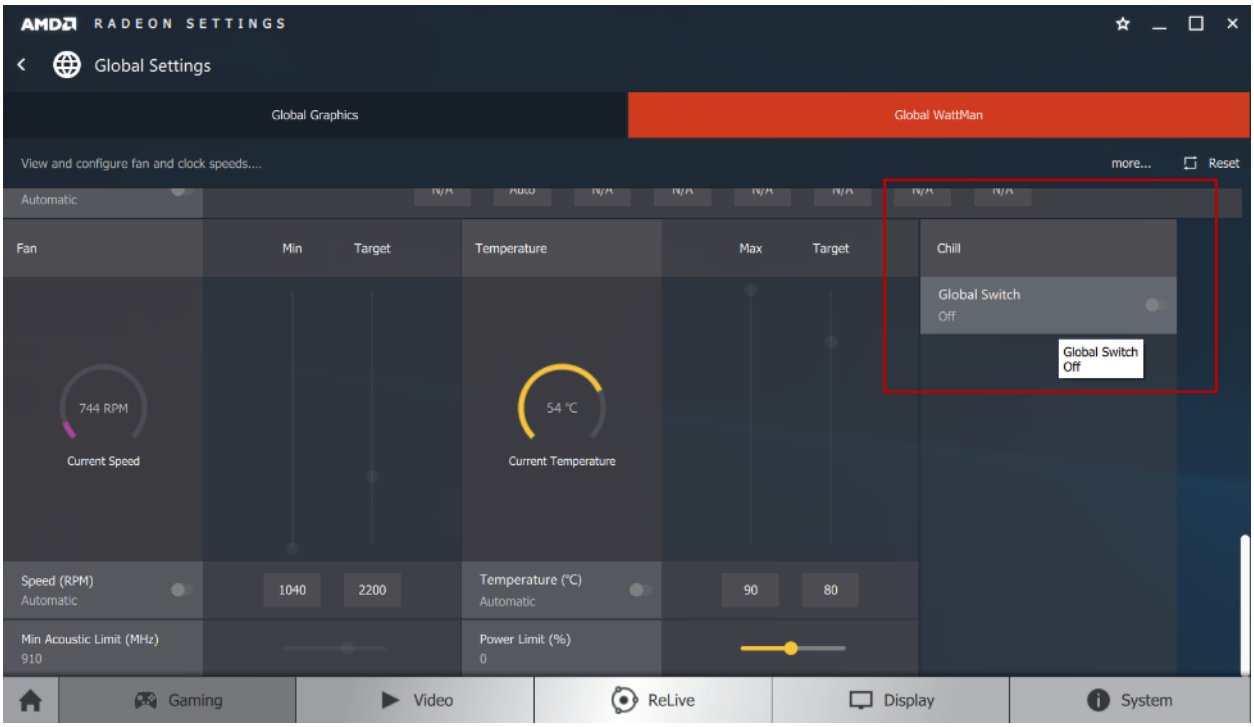


Figure 1: WattMan settings within the Radeon Settings panel

Set Global Switch to "On" to enable Chill. Choose a hotkey to enable/disable Chill while in a game in the Global Hotkey settings.

When running a game that supports Chill with the Global Switch enabled, you can press the hotkey to toggle Chill on and off. You will hear an audible indicator (three tones escalating in pitch) and the NumLock key will flash five times when Chill is enabled. When Chill is disabled, there will be a similar indicator: two tones of the same lower pitch and the NumLock key flashing once.

Beyond that, without an FPS counter or a power meter running, you may not be able to tell that Chill is active. Some users may notice less fan noise from their graphics cards in certain cases with Chill enabled.

Chill also has a minimum and maximum FPS range which can be configured through the game profile under the Gaming tab. The global switch for Chill must be enabled first before the game specific settings can be configured. If the game is not present, you can use the Add button which has a Scan and Browse option. Once the game profile is present, there will be an app-specific Chill section under Profile WattMan to configure the FPS range shown in Figure 2.

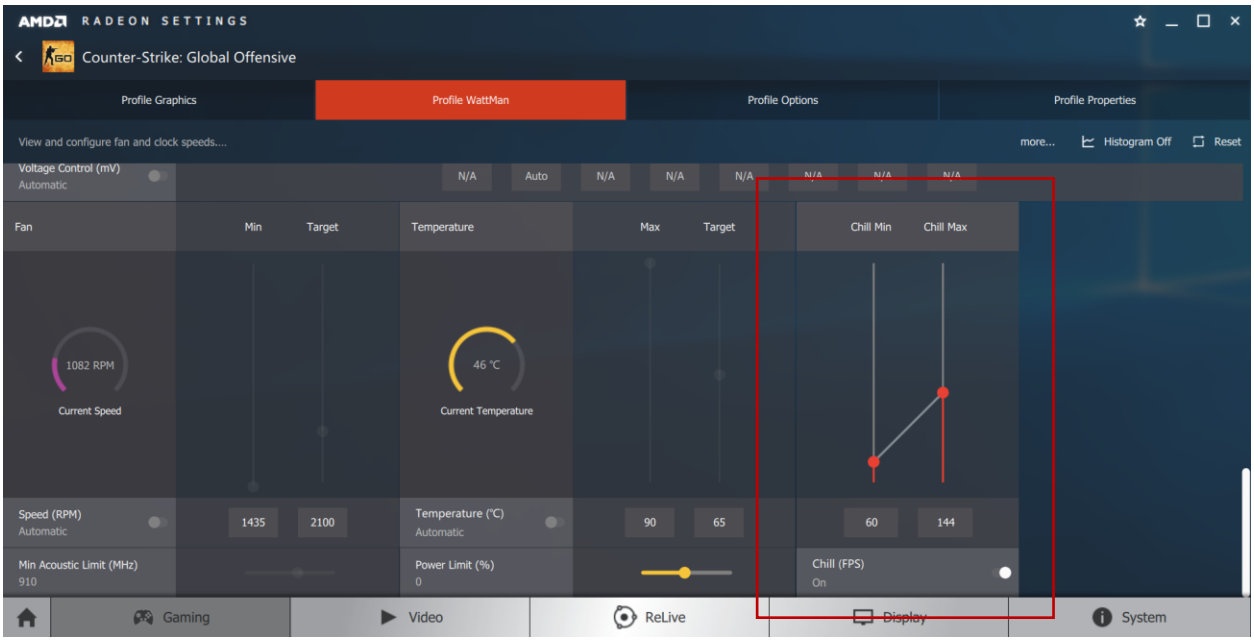


Figure 2: Configuring FPS range for Chill in Radeon Settings for Counter Strike: Global Offensive

The default range is 40-144FPS which can be changed by holding down the slider and moving the mouse vertically or by entering the desired value in the number boxes.

For our testing we used the range of 60-144FPS. We increased the minimum FPS from 40 to 60 to match the refresh rate of the monitor to ensure that we are always above 60FPS during gameplay. Feel free to adjust the Chill FPS range according to your needs. Note that the FPS range will directly influence the amount of power savings Chill provides.

Improvements to Power Consumption

All Radeon 500 series GPUs have received improvements to the overall foundry process in addition to a new memory clock state. These improvements reduce power consumption when plugging in two displays and when watching multimedia content.

Previous generation GPUs from AMD only supports 2 memory clock states, one for maximum performance and the other is aimed at idle or light workloads. Under the 2 state scheme, plugging in an additional display would force the GPU to select the high performance state, which in turn leads to higher power consumption.

By introducing a 3rd intermediate state, the RX 580 and RX 570 now draws much less power at idle when a second display is connected.

We measured GPU power at idle from the Windows desktop using two 4K displays connected via DisplayPort. Table 3 shows a dramatic difference in the power consumption with the RX 580 and RX 570 compared to previous generation products. A 1.5W increase in power consumption on the RX 580 compared to an enormous 23.2W increase on the older R9 390X just by plugging in an additional display.

Table 3: Isolated GPU power consumption on single and dual display setups at idle

	RX 580 8GB	RX 570 4GB	RX 480 8GB	R9 380
Single Display	**11.9W**	**11.8W**	**17.4W**	**18.3W**
Dual Displays	**13.4W**	**13.2W**	**25.2W**	**41.5W**
Difference	**1.5W**	**1.4W**	**7.8W**	**23.2W**

*Secondary benchmark system used. Please see Appendix 2 for details.

The RX 580 and RX 570 also draws less power when watching multimedia content such as a YouTube video. We measured a 24.8W decrease in power shown in Table 4 when playing a 1080p video on the RX 580 compared to the previous generation RX 480.

Table 4: Isolated GPU power consumption while playing a 1080p Youtube video

	RX 580 8GB	RX 480 8GB	Difference
Single Display	**14.0W**	**38.8W**	**24.8W**

*Secondary benchmark system used. Please see Appendix 2 for details.

Appendix 1: Performance Reference

A series of tables have been included below to allow for easy lookups of performance figures that have been measured by AMD. Please don't hesitate to contact us if you are having trouble reproducing any of the scores quoted here. For specific benchmark system configuration details, please see Appendix 2.

Table 5: RX 580 3DMark Time Spy scores

Version 1.0	RX 580 8GB OC	RX 580 8GB	GTX 1060 6GB	GTX 1060 3GB	RX 570 4GB	GTX 1050 Ti 4GB
Score	4750	4550	4470	4107	4099	2660

Table 6: RX 580 average FPS in games at 1440p

Game	Preset	AA	AF	Other Settings	RX 580 8GB OC	RX 580 8GB	GTX 1060 6GB	GTX 1060 3GB
Ashes of the Singularity (DX12)	High	1xMSAA	0x	Benchmark AsyncCompute = On	59.4	58.5	56.5	50.3
Battlefield 1 (DX12)	Ultra	TAA	Ultra	GPU Memory Restriction = Off	69.4	66.9	54.5	48.3
Call of Duty: Infinite Warfare (DX11)	High	Filmic SMAA 1x	16x		75.7	75.5	62.7	59.3
Civilization VI (DX12)	Ultra	4xMSAA	0x	Benchmark AsyncCompute = On	68.3	66.8	57.5	38.2
Counter Strike: Global Offensive (DX9)	Ultra	8xAA	16x		214.1	206.5	204.1	188.9
Deus Ex: Mankind Divided (DX12)	High	None	4x	Benchmark	45.8	44.4	41.4	38.1
DOOM (Vulkan)	Ultra	TSSAA-8TX	8x		77.4	74.3	73.7	58.0
Far Cry Primal (DX11)	High	SMAA	16x	Benchmark	61.0	59.0	56.0	51.0
Halo Wars 2 (DX12)	High	SMAA	16x		76.9	74.4	70.9	61.1
Hitman (DX12)	Ultra	SMAA	16x	Benchmark	64.6	63.3	61.9	40.8
Mass Effect: Andromeda (DX11)	High	TAA	High		50.0	48.0	45.9	38.5
Resident Evil 7 (DX11)	Ultra	SMAA	16x		76.5	73.8	62.2	44.9
Rise of the Tomb Raider (DX12)	Very High	FXAA	16x	Benchmark	53.9	51.6	51.3	38.8
Sniper Elite 4 (DX12)	High	Med.	Med.	AsyncCompute=on	56.3	53.9	46.7	43.3
Tom Clancy's The Division (DX12)	High	None	8x	Benchmark	64.0	61.6	53.0	47.6
Total War: Warhammer (DX12)	Ultra	MLAA	16x	Benchmark	57.8	57.0	51.0	45.9

Table 7: Generational improvements of RX 580 from earlier products at 1440p

Game	Preset	AA	AF	Other Settings	RX 580 8GB	GTX 970 4GB	R9 380 4GB	GTX 960 4GB
Battlefield 1 (DX12)	Ultra	TAA	Ultra	GPU Memory Restriction = Off	66.9	50.3	46.3	34.5
DOOM (Vulkan)	Ultra	TSSAA-8TX	8x		74.3	57.5	47.5	39.7
Hitman (DX12)	Ultra	SMAA	16x	Benchmark	63.3	43.5	44.4	33.2
Overwatch	Ultra	TAA	High		77.4	73.6	51.8	48.1
Resident Evil 7 (DX11)	Ultra	SMAA	16x		73.8	59.8	47.1	42.0

Table 8: RX 570 average FPS in games at 1080p

Game	Preset	AA	AF	Other Settings	RX 570 4GB	GTX 1050 Ti 4GB
Ashes of the Singularity (DX12)	High	1xMSAA	0x	Benchmark AsyncCompute = On	59.9	39.8
Battlefield 1 (DX12)	Ultra	TAA	Ultra	GPU Memory Restriction = Off	84.1	49.5
Call of Duty: Infinite Warfare (DX11)	High	Filmic SMAA 1x	16x		89.5	58.1
Civilization VI (DX12)	Ultra	4xMSAA	0x	Benchmark AsyncCompute = On	70.6	44.1
Counter Strike: Global Offensive (DX9)	Ultra	8xAA	16x		251.8	194.7
Deus Ex: Mankind Divided (DX12)	High	None	4x	Benchmark	62.0	38.7
DOOM (Vulkan)	Ultra	TSSAA-8TX	8x		95.6	56.5
Far Cry Primal (DX11)	High	SMAA	16x	Benchmark	80.0	54.0
Halo Wars 2 (DX12)	High	SMAA	16x		90.5	67.2
Hitman (DX12)	Ultra	SMAA	16x	Benchmark	78.0	47.6
Mass Effect: Andromeda (DX11)	Medium	TAA	Med.		98.9	59.3
Resident Evil 7 (DX11)	Ultra	SMAA	16x		99.2	63.3
Rise of the Tomb Raider (DX12)	Very High	FXAA	16x	Benchmark	67.2	43.9
Sniper Elite 4 (DX12)	High	Med.	Med.	AsyncCompute=on	70.8	40.1
Tom Clancy's The Division (DX12)	High	None	8x	Benchmark	79.3	45.7
Total War: Warhammer (DX12)	Ultra	MLAA	16x	Benchmark	72.4	45.2

Table 9: Generational improvements of RX 570 from earlier products at 1080p

Game	Preset	AA	AF	Other Settings	RX 570 4GB	GTX 960 4GB	R7 370 4GB	GTX 950 4GB
Battlefield 1 (DX12)	Ultra	TAA	Ultra	GPU Memory Restriction = Off	84.1	49.0	37.9	33.5
Call of Duty: Infinite Warfare (DX11)	Ultra	TSSAA-8TX	8x		89.5	53.6	39.3	52.4
DOOM (Vulkan)	Ultra	SMAA	16x		95.6	58.8	41.6	33.5
Resident Evil 7 (DX11)	Ultra	TAA	High		99.2	68.0	43.3	49.1
Sniper Elite 4 (DX12)	Ultra	SMAA	16x		70.8	42.0	29.4	35.4

Table 10: Comparison of average FPS in games at 1080p with a RX 570 and GTX 1060 3GB

Game	Preset	AA	AF	Other Settings	RX 570 4GB	GTX 1060 3GB
Ashes of the Singularity (DX12)	High	1xMSAA	0x	Benchmark AsyncCompute = On	59.9	59.0
Battlefield 1 (DX12)	Ultra	TAA	Ultra	GPU Memory Restriction = Off	84.1	70.2
Civilization VI (DX12)	Ultra	4xMSAA	0x	Benchmark AsyncCompute = On	70.6	52.2
Deus Ex: Mankind Divided (DX12)	High	None	4x	Benchmark	62.0	57.3
DOOM (Vulkan)	Ultra	TSSAA-8TX	8x		95.6	84.9
Hitman (DX12)	Ultra	SMAA	16x	Benchmark	78.0	52.2
Rise of the Tomb Raider (DX12)	Very High	FXAA	16x	Benchmark	67.2	52.5
Sniper Elite 4 (DX12)	High	Med.	Med.	AsyncCompute=on	70.8	64.2
Tom Clancy's The Division (DX12)	High	None	8x	Benchmark	79.3	71.3
Total War: Warhammer (DX12)	Ultra	MLAA	16x		72.4	66.7

Table 11: Power, temperature, frame time and FPS with Chill in eSports games on a RX 580 8GB

Setting	Metric	Counter Strike: Global Offensive (DX9)	Dota 2 (DX11)	League of Legends (DX9)	Overwatch (DX11)
Chill On	Average FPS	86.4	87.8	91.3	86.4
	99th Percentile Frame Time (ms)	16.5	16.6	16.7	16.7
	Average GPU Power (W)	39.5	115.5	27.1	130.4
	Average GPU Temperature (C)	46.7	62.3	48.9	70.5
Chill Off	Average FPS	283.0	167.1	203.5	149.0
	99th Percentile Frame Time (ms)	6.6	10.7	7.0	8.5
	Average GPU Power (W)	127.9	168.0	52.4	188.3
	Average GPU Temperature (C)	62.7	74.3	51.3	79.6

Appendix 2: Benchmark Platform Configuration

All data and testing presented in this guide has been collected using the system configurations listed below. All test systems used Windows 10 64-bit (build 14393).

Primary Benchmark System	
CPU	Intel Core i7 5960X (3.0GHz)
Motherboard	GIGABYTE X99-UD4
Memory	16GB Corsair Vengeance LPX (4x4GB) DDR4-2666
HDD	2TB Seagate Barracuda 7200 RPM
Display	Samsung U28D590D 3840x2160 Display
Display Driver Version	AMD Crimson 17.4.1, NVIDIA Driver 378.92 WHQL

Secondary Benchmark System	
CPU	Intel Core i7-6700k (4.0GHz)
Motherboard	ASUS Z170-A
Memory	8GB Corsair Vengeance LPX (2x4GB) DDR4-2666
HDD	2TB Seagate Barracuda 7200 RPM
Display	Samsung U28D590D 3840x2160 Display
Display Driver Version	AMD Crimson 17.4.1, NVIDIA Driver 378.92 WHQL

Appendix 3: How to Benchmark with PresentMon

How to obtain PresentMon

1. Go to PresentMon's release page at https://github.com/GameTechDev/PresentMon/releases
2. Download the latest release (we used v1.0.0) executable, PresentMon64.exe, under the Downloads section.

Benchmarking with PresentMon

There are a few things you need to know before beginning:

EXE Name	PresentMon needs to know the name of the EXE file for the game you want to benchmark. For example, the game DOOM uses "DOOMx64.exe".
Data Logging Duration	60 seconds is a good starting point, but adjust as you desire.
Delay time before beginning	If you would like a moment to 'get ready' before data logging begins, you can specify a DELAY parameter (in seconds).
Output filename	This is optional, and overrides the default output log which is automatically named and placed in the same folder that PresentMon64.exe resides in.

1. Launch the game and reach a scene you would like to benchmark. A saved game or checkpoint may be convenient for this purpose.
2. Switch to the Windows desktop (using Alt-Tab) and open a Command Prompt with Administrator access, right click on the Start menu and choose Command Prompt (Admin).
3. Change drive and directory to the location of PresentMon64.exe.
4. Launch PresentMon with your desired parameters, example for the game DOOM:

   PresentMon64 –process_name DOOMx64.exe –timed 60 –delay 5

5. Switch back into the game (Alt-Tab) and start your test sequence. In the above example, PresentMon will wait 5 seconds (enough time to switch back into the game and get ready) and then record data for the next 60 seconds.
6. Alt-Tab back to the Windows desktop. You will find the results file in the same folder as PresentMon64.exe
7. Open the results file in a spreadsheet program and analyze the results.

The "MsBetweenDisplayChange" column is the frame time column. To calculate average FPS, you can:

- COUNT the rows in the spreadsheet to determine the number of frames
- SUM the values in the MsBetweenDisplayChange column to total time in ms Divide by 1000 to get total time in seconds.
- DIVIDE total number of frames by total time in seconds to determine average frames per second

Alternately:

- AVERAGE the results in the MsBetweenDisplayChange column to determine the average frame time in ms.
- 1/(average frame time in ms) will give you frames per millisecond.
- Multiply by 1000 to get average frames per second.

Appendix 4: How to Benchmark with FRAPS

FRAPS is a Windows based application that can be used with DirectX® and OpenGL games to measure and record graphics performance in frames per second (FPS). You can download FRAPS at http://www.fraps.com/download.php and install it on your test system.

The default key to begin recording FPS using FRAPS is F11. When you hit F11, you will notice the FPS counter at the top left of your screen briefly go green and then disappear. This is normal. Hit F11 again to stop FRAPS. When you stop FRAPS, the FPS counter will appear on the screen again and will display a number briefly in red. This number is the average FPS recorded during that duration. Do not worry if you do not catch that number in time. FRAPS will output that result to a log file in the FRAPS folder that you can access once you exit your game.

If you have any questions regarding FRAPS, you can visit their FAQ section for a more detailed explanation on the various functions, including how to do screen captures and video captures. Their FAQ section can be found at http://www.fraps.com/faq.php

When manually benchmarking a game with FRAPS, there are a few steps that should be taken in order to maximize consistency between compared runs.

Start by choosing an area in the game that is indicative of the entire games general graphics style and performance. For example, a rule of thumb is that if a game takes place in mostly outdoor scenes, it may be best to benchmark at an outdoor location in the game.

When a location is decided upon, practice the path you plan to follow when benchmarking the game. Try to choose a path for your benchmark that can be easily replicated. Avoid using portions of the game that include randomized events like enemy spawns or dynamic weather changes.

Once benchmarking has started, it is a general best practice to do 3-5 runs to generate a single data point. An average FPS between multiple runs is generally more accurate than a single FPS data point from one run.

Contact Information

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