

Samsung Solid State Drive **RAPID mode**

White Paper



Improving System Responsiveness with Samsung RAPID mode

Innovative solution pairs advanced SSD technology with cutting-edge storage management techniques.

At the 2013 Samsung SSD Global Summit on July 18th, Samsung introduced a powerful performance enhancement tool called RAPID (Real-time Accelerated Processing of I/O Data) Mode. Designed to increase the overall performance of PCs, RAPID mode analyzes the user's application and data usage, optimizes all storage-related I/O for Samsung SSDs and eliminates system performance bottlenecks.

In order to deliver the fastest and the most reliable user experience, RAPID mode focuses on improving random I/O performance with small size data at low queue depth. When frequently used data (hot data) is recognized, RAPID mode can also enhance the sequential performance.



Key Benefits

Highest Performance.

RAPID operates at the block and file system level to analyze application and data usage and eliminates system performance bottlenecks by dynamically leveraging system DRAM as a read/write cache.

Easy Installation, Fully Automated.

The software is fully automated, installed via Samsung SSD Magician; no user management is necessary.

What is RAPID mode?

RAPID mode is paired exclusively with Samsung 840 EVO SSDs and available as a feature of the accompanying Samsung SSD Magician Software Toolset (version 4.2 and later).

When enabled, RAPID mode is inserted as a filter driver in the Windows storage stack. The driver actively monitors all storage-related activity between and among the operating system, user applications and the SSD. The RAPID technology analyzes system traffic and leverages spare system resources (DRAM and CPU) to deliver **read acceleration** through intelligent caching of hot data and **write optimization** through tight coordination with the SSD.

Read Acceleration for Fast Access to Active Data

Exceed SATA limits

**SPEED
LIMIT
550 MB/s**

**YOUR
SPEED
1200**

Wouldn't it be wonderful if your computer could "learn" your computer habits, such that it can actually improve your user experience? For example, if your PC could magically learn that you launch Outlook every morning and browse to your home page(s), it would make your e-mail database instantly available and make the home page(s) load faster.

This is possible with the read acceleration technology in RAPID mode, which leverages spare system DRAM and CPU resources to manage a cache of "hot data". System performance is improved when this hot data is automatically stored in memory such that future requests for that data can be served directly from DRAM, rather than going to the storage device. This improves the latency and throughput for the most active data, and directly improves daily user experience.

RAPID mode behaves as an extension of the OS cache, which takes a rather simple approach to caching the most recently accessed data, while RAPID mode handles not only newer data, but also takes into account access frequency, file types, system status, RAM availability, etc.

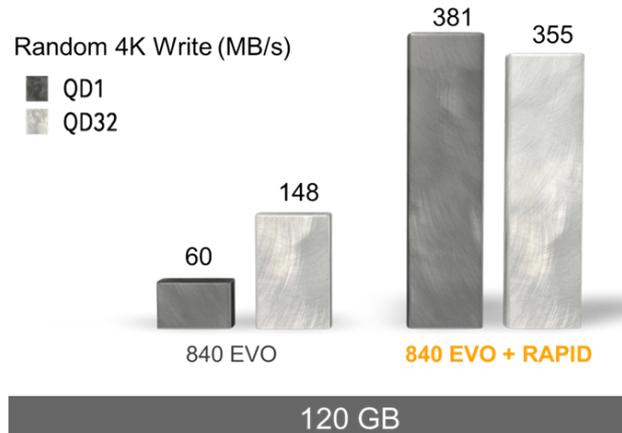
In order to further improve cache efficiency, RAPID mode may exclude certain data from the cache based on a variety of factors. This prevents unnecessary data from polluting the cache and allows us to keep the

memory footprint to a minimum. For example, files that are meaningless to cache (like large media files) are automatically dismissed. Finally, the hot data is cumulative and persistent across multiple sessions and reboots such that if you have been working on a specific files or applications, you will be able to access that data faster as well. Your Microsoft Outlook email database, for example, would be a prime target for cache acceleration.

Write Optimization to Maintain Consistently High Performance

A persistent performance bottleneck in PCs is due to the many background tasks undertaken by the operating system, like updating logs or indexing. Failure to complete these frequent, small random transactions in a timely manner is what causes the stuttering you may have encountered with your PC. Recognizing that SSDs (including the 840 EVO SSD) favor transactions that can be processed in parallel, RAPID mode specifically identifies low-queue-depth random write requests and combines them into larger packets of data that can be processed at higher queue depths and written more like large transfers across many NAND die. This dramatically improves the completion time for those small transactions, virtually eliminating any storage-related stuttering in your system.

The following chart demonstrates the effectiveness of this approach -



How do I enable RAPID mode?

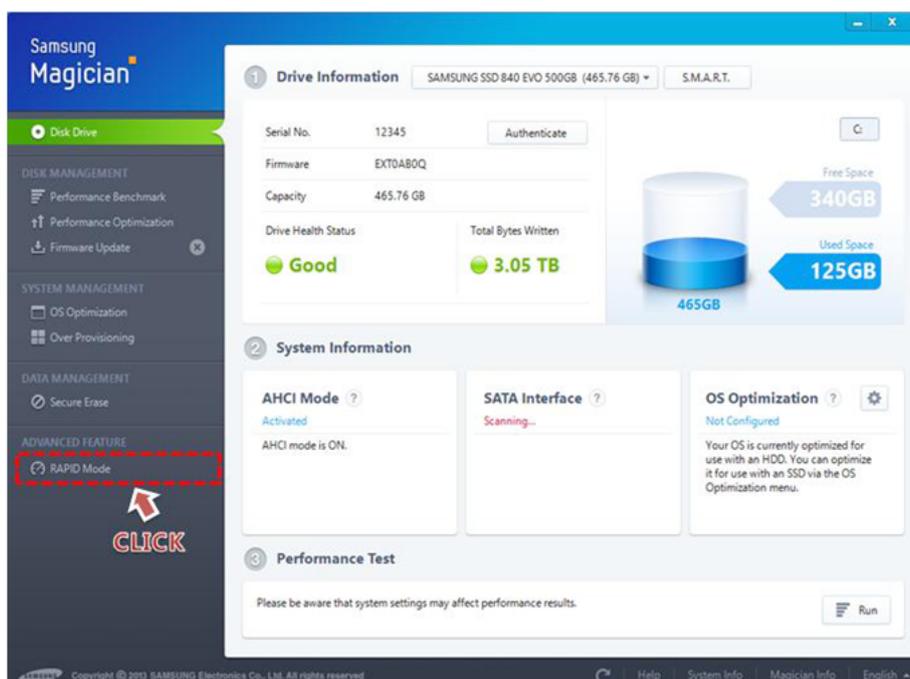
1. Connect SAMSUNG SSD 840 EVO to your PC

2. Install Magician v4.2

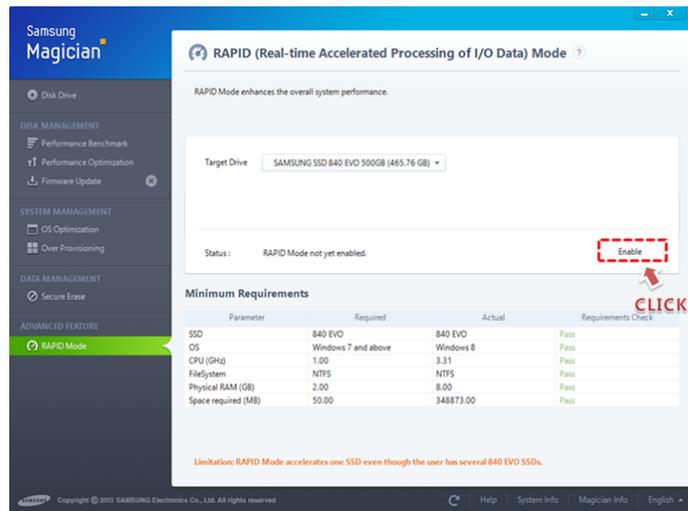
- RAPID mode is available as an Advanced Feature in Magician 4.2.

3. Enable RAPID mode

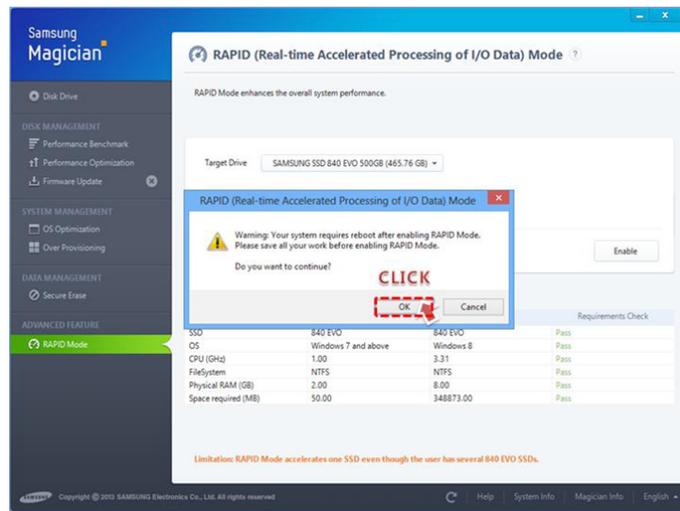
- Click "RAPID mode" tab



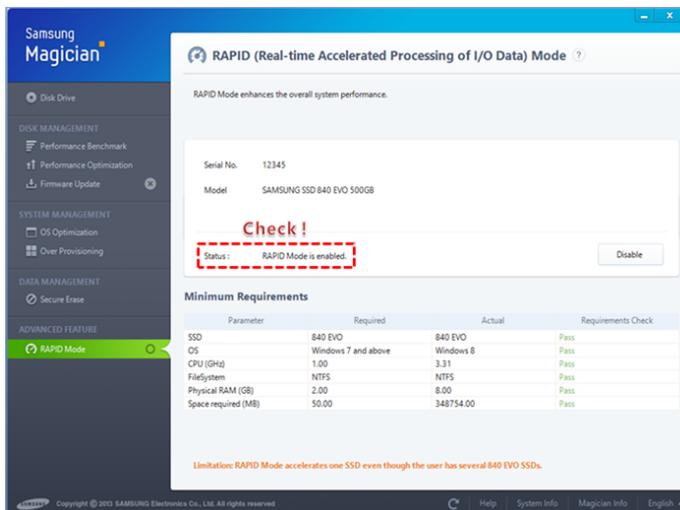
- Check the Minimum Requirements, Select Target drive and Click "Enable".



- Click "OK" for system reboot.



- RAPID is enabled.



Are there any risks with using RAPID mode?

RAPID was specifically designed to not add any additional risk to user or system data, even in the event of a power-loss. In fact, RAPID strictly adheres to Windows conventions in its treatment of any buffered writes in DRAM -- RAPID obeys all "flush" commands, so any writes buffered by RAPID will make it to the persistent media just like the Windows OS cache or the HDD cache. (Consequently, the data loss risk is identical to that of Windows OS cache or HDD cache).

Furthermore, RAPID mode is mindful of any changes in system behavior or resource availability, meaning that RAPID will scale back or release (and re-acquire) system resources seamlessly based on system activity and requirements. RAPID consumes at most 25% of the installed DRAM, up to a maximum of 1GB, but will scale down resource usage and eventually revert to a pass-through mode if the CPU core(s) or DRAM is occupied with other system tasks. (This technology is really designed to make use of excess system resources).

The software story around Samsung's SSD 840 EVO is quite possibly the strongest we've ever seen from an SSD manufacturer. Samsung's SSD Magician got a major update not too long ago, giving it a downright awesome UI.
- AnandTech

Closing Thoughts

Samsung believes that the 840 EVO SSD and RAPID mode combination represents a compelling mix of killer technology and a creative and efficient use of spare system resources to deliver an optimal and seamless end-user experience. As the SSD industry continues to evolve, Samsung will continue to be on the cutting edge, and Samsung's RAPID mode is just one of the many ways we intend to deliver on our view that the evolution of storage will require not just device side technology advancements, but also host-side software innovation.



Samsung RAPID mode - FAQ

Question	Answer
1) What is RAPID mode?	<p>RAPID mode from Samsung increases the overall performance of your computer by pairing the industry's most advanced SSD with cutting-edge storage management techniques to deliver the fastest and most reliable user experience.</p> <p>RAPID mode is installed as a filter driver in the Windows storage stack. The RAPID mode technology analyzes system traffic to the Samsung SSD and leverages excess system resources (unused DRAM, CPU cycles) to deliver optimized write I/Os to the SSD and caching hot data for improved responsiveness based on frequency, recency, file type, etc.</p> <p>RAPID mode is available as a part of the Samsung SSD Magician Software Toolset.</p>
2) What are the key features of RAPID?	<p>Read/Write Cache. RAPID mode uses system DRAM as a cache of "hot data" based on frequency, recency, file type, etc, such that subsequent requests can be served directly from DRAM, rather than going to the SSD.</p> <p>Write Optimization. System write requests are processed for optimized performance with Samsung EVO SSD.</p> <p>File Awareness. RAPID mode may exclude certain files from caching based on a variety of factors, including file type, file size, etc. This prevents unnecessary data from polluting the cache.</p> <p>Persistent Cache. RAPID mode maintains cache map across system reboot to maintain consistent high-performance operation.</p> <p>Cache Compression. RAPID mode dynamically compresses and de-compresses cache contents to dramatically improve cache efficiency. Optimized for Samsung EVO. RAPID Mode was co-developed and optimized for the Samsung MEX controller.</p>
3) What are the key benefits of RAPID mode?	<p>Highest Performance. RAPID mode operates at the block and filesystem level to analyze application and data usage and eliminate system performance bottlenecks by dynamically leveraging system DRAM as a read/write cache.</p> <p>Easy Installation, Fully Automated. The software is fully automated, installed via Samsung SSD Magician; no user management is necessary.</p>
4) What happens when my applications require more memory?	<p>RAPID mode will release and re-acquire system resources seamlessly based on system activity and requirements. RAPID mode consumes at most 25% of the installed DRAM, up to a maximum of 1GB.</p>
5) Does RAPID mode keep its improvement across system reboot?	<p>RAPID mode maintains its cache across reboots.</p> <p>NOTE: RAPID mode was not designed to improve boot performance. In fact, RAPID mode does not go into effect until the system is quiescent (about 60 seconds). This is because the system and/or user may try to launch some applications at boot up so the system may already be under stress, so we intentionally delay RAPID activity to avoid interference with the user's boot sequence.</p>
6) How does EVO compare with and without RAPID?	<p>Samsung EVO is the industry's highest performing SSD solution across all dimensions of measure (sequential/random read/write, longevity, cost, etc). RAPID mode extends Samsung's advantages by leveraging spare system resources to provide even more performance, especially for random requests with low queue depths and smaller data sizes.</p>
7) Why did Samsung develop RAPID mode?	<p>Samsung believes that future advancements in storage technology will come from both device-side inventions as well as host-side software innovation. RAPID mode is the first step in a family of new technologies under development and investigation from the team at Samsung.</p>
8) What user scenarios are most improved with RAPID mode?	<p>RAPID mode will provide performance improvements across the board. Most noticeable will be small random write performance, access to frequently-used data, and overall system responsiveness.</p> <p>NOTE: although some sequential accesses are accelerated by RAPID mode, the technology is not intended to accelerate large sustained reads/writes.</p>
9) Is RAPID mode used to mask Samsung EVO problems?	<p>Absolutely not. Samsung EVO is the most advanced SSD on the market. RAPID mode simply augments the already excellent performance of EVO by leveraging spare system resources to further accelerate the storage interface.</p>
10) What are the system requirements to use RAPID mode?	<p>RAPID mode requires the following –</p> <ol style="list-style-type: none">1) Window7 or Window 8 (32- or 64-bit)2) 2GB DRAM (minimum)3) Samsung 840 EVO SSD

Question	Answer
11) Why not let advanced users allocate more than 1GB of RAM to RAPID mode?	This is a fairly conservative setting, in order to provide a nice performance boost with minimal cost, to a broad range of users. Obviously, if RAPID mode allocated a larger amount of memory, we would be able to provide even more acceleration and sustained performance across larger workloads, but we decided to stick to a max of 1GB as our initial setting until we have further characterized performance across more systems and users. We are keeping our eyes/ears open for your feedback, so could potentially change this setting in a future release, if it looks like we are being too conservative.
12) Can RAPID mode be used with other SSD?	Currently, RAPID mode is only supported with and optimized for Samsung 840 EVO SSD. Future versions of RAPID mode will be backwards compatible with selected Samsung SSDs, including 840 Pro.
13) What is the difference between the 1GB cache on-board with the SSD and the cache in RAPID mode?	The onboard LPDDR RAM cache is used by the SSD controller for block management and wear-leveling purposes and SSD mapping table.
14) What is the difference between the 3GB (or more) TurboWrite cache and the RAPID mode cache?	RAPID mode and TurboWrite work hand-in-hand to optimize write performance for the SSD. Since RAPID mode operates at the block and filesystem level, it can provide awareness of how the data should be stored and retrieved. RAPID mode then coalesces and optimizes write I/O at the host for TurboWrite. TurboWrite acts as a large SLC buffer for incoming writes. In the background, TurboWrite will transfer user data from the buffer to primary storage.
15) What are the typical performance results with RAPID mode?	<p>Since RAPID mode utilizes spare CPU cycles and DRAM capacity, together with Samsung 840 EVO SSD, to deliver improved system level performance, measured performance (via benchmarks, user scenarios) will vary depending on all the above factors.</p> <p>For our benchmark system, with Z77 platform, Core i7 CPU, 8GB DRAM, and 240GB 840 EVO SSD attached and accelerated by RAPID as a secondary drive has shown the following performance results in Crystal Disk Mark (no other applications running) –</p> <p>Seq RD = 774 MB/s, WR = 1133 MB/s, 512K RD = 1102 MB/s, WR = 971.4 MB/s 4KQD1 RD = 106.8 MB/s, WR = 445.0 MB/s 4KQD32 RD = 484.2 MB/s, WR = 447.2 MB/s</p>
16) What does RAPID mode write optimization entail?	RAPID write-optimization consists of a number of features to improve write (and subsequent read) performance. One of the features we described was our ability to maintain higher queue depths.
17) When writes are flushed from the RAPID mode cache, are they treated as a normal writes and funnelled through TurboWrite, or do they go directly to the TLC?	Writes flushed from RAPID are treated as normal writes; they go directly to the TurboWrite buffer.
18) Is there any risk to using RAPID mode?	RAPID was specifically designed to not add any additional risk to user or system data, even in the event of a power-loss. In fact, RAPID strictly adheres to Windows conventions in its treatment of any buffered writes in DRAM -- RAPID obeys all "flush" commands, so any writes buffered by RAPID will make it to the persistent media just like the Windows OS cache or the HDD cache. (Consequently, the data loss risk is identical to that of Windows OS cache or HDD cache)
19) How does RAPID mode compare to Ramdisk?	A Ramdisk is a solution which creates a temporary storage device using a fixed amount of system DRAM. Ramdisk will often compete with other applications for DRAM. The Ramdisk contents are lost after a power-loss. Ramdisk content needs to be actively managed by the user (copy, delete, rebuild). Eventually, all data needs to be written to the SSD for data integrity reasons.
20) How does RAPID mode compare to SuperFetch?	Superfetch is an important Windows feature which preloads certain frequently used applications into DRAM to improve initial program launch. RAPID is different in that it caches both application files as well as frequently used user data. RAPID also caches both read and write I/O.
21) How does RAPID mode compare to Windows DRAM cache?	Windows DRAM cache will store recently used data in the DRAM cache in anticipation of quick reuse by the user. For example, if a user opens a document, then wants to reopen the document again shortly later. The DRAM cache is only active per-session, so it is not retained across reboots like RAPID mode is.



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