

SpinRite's New Benchmarking

As Implemented in Development Pre-Release #6

SpinRite has always incorporated drive benchmarking, but it has mostly been presented as a curiosity. It only took us 34 years to figure out that what most SpinRite users want to know is how long SpinRite will take to perform a maintenance scan of any given drive. Although no short sample can be precise, the performance of the front and back of a spinning (spinner) or solid state drive can provide a useful first approximation. And we've learned that non-uniform performance of solid state drives can give some sense for the drive's health. (A future SpinRite will offer some surprising benefits for solid state (non-spinning!) mass storage.)

This screen snapshot shows SpinRite v6.1's drive enumeration of various spinning and solid-state mass storage SSD's and "thumb drives" with AHCI, ATA and USB/BIOS connections:

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Discovering System's Mass Storage Devices					
Type	Port	Hours	Size	Drive Identity	Serial
AHCI	0	49	250G	CT250BX100SSD1	1510F00402E5
AHCI	1	239	120G	KINGSTON SA400S37120G	50026B7782B885BD
AHCI	3	642	256G	addlink SATA SSD	501C079805B200064546
AHCI	4	599	256G	APS-SL3N-256	SH30C42058WL
AHCI	5	594	115G	OCZ-VERTEX2	OCZ-R9Q0P179070I2237
ATA	TM	5,419	21G	QUANTUM FIREBALLP AS20.5	892106331182
ATA	TS	124	160G	ST3160812A	4LS44A8J
ATA	TM	675	250G	Samsung SSD 860 EVO 250GB	S59WNMFPN720236U
ATA	TS	688	256G	APS-SL3N-256	SH30C42558WL
AHCI	1	1,396	16T	ST16000NM001G-2KK103	ZL26PYCR
ATA	TM	63	40G	MAXTOR 4K040H2	672129923128
BIOS	8B	...	1.0T	....	....
BIOS	8C	...	263M	....	....
BIOS	8D	...	4.1G	....	....
BIOS	8E	...	124G	....	....
BIOS	8F	...	64G	....	....
BIOS	90	...	130M	....	....

Press any key to continue...

Below, the left pane shows each drive's "ScanTime" determined by the new benchmarking:

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Select Drive to Benchmark					Drive's Measured Performance	
!	Type	Port	ScanTime	Size		
J	AHCI	0	7.3 min	250 GB	Samsung SSD 860 EVO 250GB S59WNMFPN720236U	
J	AHCI	1	3.7 min	120 GB	Based upon the performance shown below, a full SpinRite surface scan of this drive will require approximately 29.0 minutes. (will be longer if trouble found)	
J	AHCI	3	23.4 min	256 GB		
J	AHCI	4	24.5 min	256 GB	smart polling delay: 0.004 secs random sectors time: 0.000 secs front of drive rate: 143.800 MB/s midpoint drive rate: 143.804 MB/s end of drive rate: 143.802 MB/s	
J	AHCI	5	6.7 min	115 GB		
J	ATA	TM	14.0 min	21 GB		
J	ATA	TS	48.1 min	160 GB		
J	ATA	TM	29.0 min	250 GB		
J	ATA	TS	30.6 min	256 GB		
J	AHCI	1	23.3 hrs	16 TB		
J	ATA	TM	32.7 min	40 GB		
J	BIOS	8B	13.9 hrs	1.0 TB		

↑ Move the highlight bar up and down with [↑][↓]. Press Enter↵ to begin measuring the selected item's performance. The test results will be included in any logs produced if the option to do so is enabled.

Choose an item to view, Enter↵ to benchmark. ESC to return to the Main Menu.

The righthand pane above illustrates the high quality of this benchmark's measurements. Given a rock-solid performing SSD (in this case, as shown, a 256GB Samsung 860 EVO), the three separate regional measurements taken at the front, middle and end of the drive show sustained transfer rates of: 143.800, 143.804, 143.802 megabytes per second. Assuming flat and uniform performance, this benchmark's measurements demonstrate an accuracy of **five** significant digits. It's easy to say, but it's much more difficult to pull off.

However, 143.8 megabytes per second is not super fast and doesn't seem right for a high-performance SATA 3 Samsung 860 EVO SSD. SpinRite's drive information page for this drive reveals why:

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Select Drive(s) For Operation				
?	Type	Port	ScanTime	Size
-	AHCI	0	7.3 min	250 GB
-	AHCI	1	3.7 min	120 GB
-	AHCI	3	23.4 min	256 GB
-	AHCI	4	24.5 min	256 GB
-	AHCI	5	6.7 min	115 GB
-	ATA	TM	14.0 min	21 GB
-	ATA	TS	48.1 min	160 GB
-	ATA	TM	29.0 min	250 GB
-	ATA	TS	30.6 min	256 GB
-	AHCI	1	23.3 hrs	16 TB
-	ATA	TM	32.7 min	40 GB
-	BIOS	8B	13.9 hrs	1.0 TB

Samsung SSD 860 EVO 250GB		
drive inf	hardware	smart stat
access mode: direct bus master		
pci bus addr: 6:0:0		
adapter vendor: JMicron Technolgy		
vendor id: 197B		
device id: 2363		
controller reg: 9D00-9D07h, 9C02h		
bus master reg: 9B08h		
max transfer: serial 6.0 gb/sec		
drive's sector count:		
488,397,168		
drive's byte count:		
250,059,350,016		

↑ Move the highlight bar up and down with [↑|↓], press SPACE to flip the selection on or off. Use [←|→] to change pages of highlighted drive detail information. Press Enter↵ to begin SpinRite operations

When selections are correct press Enter↵. ESC to return to the Main Menu.

The Samsung SSD is attached to the computer with a JMicron Technology JMB363 combo SATA 2 and PATA (IDE parallel cable) controller which was used during development testing. As shown above, the Samsung can transfer at 6.0 Gb/sec SATA 3 speed, but it's connected to a much slower SATA 2 device.

To see what SpinRite **can** do, we can look at an SSD connected to the AMD motherboard's native SATA 3 port:

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Select Drive to Benchmark				
↑	Type	Port	ScanTime	Size
✓	AHCI	0	7.3 min	250 GB
✓	AHCI	1	3.7 min	120 GB
✓	AHCI	3	23.4 min	256 GB
✓	AHCI	4	24.5 min	256 GB
✓	AHCI	5	6.7 min	115 GB
✓	ATA	TM	14.0 min	21 GB
✓	ATA	TS	48.1 min	160 GB
✓	ATA	TM	29.0 min	250 GB
✓	ATA	TS	30.6 min	256 GB
✓	AHCI	1	23.3 hrs	16 TB
✓	ATA	TM	32.7 min	40 GB
✓	BIOS	8B	13.9 hrs	1.0 TB

Drive's Measured Performance	
CT250BX100SSD1	
1510F00402E5	
Based upon the performance shown below, a full SpinRite surface scan of this drive will require approximately 7.3 minutes. (will be longer if trouble found)	
smart polling delay:	0.003 secs
random sectors time:	0.000 secs
front of drive rate:	570.698 MB/s
midpoint drive rate:	572.857 MB/s
end of drive rate:	572.688 MB/s

↑ Move the highlight bar up and down with [↑|↓]. Press Enter↵ to begin measuring the selected item's performance. The test results will be included in any logs produced if the option to do so is enabled.

Choose an item to view, Enter↵ to benchmark. ESC to return to the Main Menu.

The CT250BX100SSD1 is an SSD made by Crucial and the screen snapshot above shows its performance clocking in at around 573 megabytes/second. This is as fast as SATA 3 can go and it's faster than most benchmarks can make it go. SATA 3 uses line rate of 6 gigabits per second and encodes each 8-bit byte of data into 10 bits on the wire. Therefore, 6 gigabits per second delivers 600 megabytes of theoretical data throughput. SATA control signal overhead of 4.5% reduces that to 573 megabytes/second. Thus, SpinRite's new hardware drivers are able to drive a system's adapters and their drives at their **maximum possible speed**. And also note that this Crucial **256GB** drive will now be scannable by SpinRite in just 7.3 minutes, making SpinRite's use for preventative maintenance far more practical.

Another point of note is a very large 16 terabyte spinning Seagate drive:

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Select Drive to Benchmark				
↑	Type	Port	ScanTime	Size
↓	AHCI	0	7.3 min	250 GB
↓	AHCI	1	3.7 min	120 GB
↓	AHCI	3	23.4 min	256 GB
↓	AHCI	4	24.5 min	256 GB
↓	AHCI	5	6.7 min	115 GB
↓	ATA	TM	14.0 min	21 GB
↓	ATA	TS	48.1 min	160 GB
↓	ATA	TM	29.0 min	250 GB
↓	ATA	TS	30.6 min	256 GB
↓	AHCI	1	23.3 hrs	16 TB
↓	ATA	TM	32.7 min	40 GB
↓	BIOS	8B	13.9 hrs	1.0 TB

Drive's Measured Performance	
ST16000NM001G-2KK103 ZL26PYCR	
Based upon the performance shown below, a full SpinRite surface scan of this drive will require approximately 23.29 hours. (will be longer if trouble found)	
smart polling delay:	0.083 secs
random sectors time:	0.127 secs
front of drive rate:	264.746 MB/s
midpoint drive rate:	227.115 MB/s
end of drive rate:	117.123 MB/s

↑ Move the highlight bar up and down with [↑][↓]. Press Enter↵ to begin measuring the selected item's performance. The test results will be included in any logs produced if the option to do so is enabled.

Choose an item to view, Enter↵ to benchmark. ESC to return to the Main Menu.

It's connected through a Marvell Technology SATA 3 adapter, but its speed is limited by its density and rotation rate, not its adapter. We see the characteristic transfer speed reduction toward the end of spinning drives which is caused by reduced track circumference allowing for fewer bits to be stored on the inner tracks. And here again, even though the benchmark indicates that it will take about a day (23.29 hours), SpinRite v6.1 can scan an entire 16TB spinning drive in a practical amount of time.

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Select Drive to Benchmark				
↑	Type	Port	ScanTime	Size
↓	AHCI	0	7.3 min	250 GB
↓	AHCI	1	3.7 min	120 GB
↓	AHCI	3	23.4 min	256 GB
↓	AHCI	4	24.5 min	256 GB
↓	AHCI	5	6.7 min	115 GB
↓	ATA	TM	14.0 min	21 GB
↓	ATA	TS	48.1 min	160 GB
↓	ATA	TM	29.0 min	250 GB
↓	ATA	TS	30.6 min	256 GB
↓	AHCI	1	23.3 hrs	16 TB
↓	ATA	TM	32.7 min	40 GB
↓	BIOS	8B	13.9 hrs	1.0 TB

Drive's Measured Performance	
BIOS Access Drive (unknown make, model, serial no.)	
Based upon the performance shown below, a full SpinRite surface scan of this drive will require approximately 13.88 hours. (will be longer if trouble found)	
smart polling delay:	no smart
random sectors time:	0.002 secs
front of drive rate:	20.512 MB/s
midpoint drive rate:	20.507 MB/s
end of drive rate:	20.479 MB/s

↑ Move the highlight bar up and down with [↑][↓]. Press Enter↵ to begin measuring the selected item's performance. The test results will be included in any logs produced if the option to do so is enabled.

Choose an item to view, Enter↵ to benchmark. ESC to return to the Main Menu.

The slowest performer is shown above. It's a nice 1 terabyte external drive attached to the system via USB. The benchmark is only able to squeeze 20.5 megabytes/second of read performance from this system's USB BIOS. (We expect to see BIOS performance varying widely by motherboard.)

As you may know from the current SpinRite development roadmap...

<https://www.grc.com/miscfiles/GRC-Development-Roadmap.pdf>

... SpinRite won't be getting native USB drivers until it is moved over to the OnTime RTOS-32 OS for UEFI booting. So, depending upon the system (motherboard BIOS) where SpinRite is run, USB-attached drives will remain slow until native USB support can be added. But once that's done, we can expect to see USB 3.0 delivering the same performance as SpinRite's other new native hardware drivers.

Where we are at this moment (November 15th, 2021):

This 6th development release needs a bit more work to handle benchmarking error recovery and manual interruption when attempting to benchmark extremely troubled drives. Once that's complete it will be turned over to the gang of testers at GRC's spinrite.dev newsgroup for their testing across a much wider range of hardware.

SpinRite's current drive identification and benchmarking subsystems thoroughly test **all** of SpinRite's new hardware dependent device driver code. So, we won't proceed until what we have is working universally, for everyone, everywhere.

Then, once we have that -- and we do appear to be close -- SpinRite's new foundation will have been solidified and the work on its data recovery systems can be completed.

