JEDEC STANDARD

Solid-State Drive (SSD) Endurance Workloads

JESD219

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1 Scope

This standard defines workloads for the endurance rating and endurance verification of SSD application classes. These workloads shall be used in conjunction with the Solid State Drive (SSD) Requirements and Endurance Test Method standard, JESD218.

NOTE The draft version of this standard included only the enterprise workloads. The client workloads were still under development at that time and are to be added when available.

2 Reference documents

JESD218, Solid State Drive (SSD) Requirements and Endurance Test Method

3 Enterprise endurance workload

The enterprise endurance workload consists of random data distributed across an SSD in a manner similar to some enterprise workload traces that are publicly available for review.

Prior to running the workload, the SSD under test shall have the user-addressable LBA space filled with valid data (e.g., the drive does not return a data read error because of the content of the LBA prior to being written during the test routine). Initialization may not be necessary if the formatted SSD satisfies this requirement.

a) The enterprise endurance workload shall be comprised of random data with the following payload size distribution:

- 512 bytes (0.5k) 4%
- 1024 bytes (1k) 1%
- 1536 bytes (1.5k) 1%
- 2048 bytes (2k) 1%
- 2560 bytes (2.5k) 1%
- 3072 bytes (3k) 1%
- 3584 bytes (3.5k) 1%
- 4096 bytes (4k) 67%
- 8192 bytes (8k) 10%
- 16,384 bytes (16k) 7%
- 32,768 bytes (32k) 3%
- 65,536 bytes (64k) 3%
3    Enterprise endurance workload (cont’d)

b) The data payloads greater than or equal to 4096 bytes data payload sizes shall be arranged such that the data payloads less than 4096 bytes are pseudo randomized among the data payloads greater than or equal to 4096 bytes. Data payloads greater than or equal to 4096 bytes are aligned on 4k boundaries.

c) The workload shall be distributed across the SSD such that the following is achieved:

1) 50% of accesses to first 5% of user LBA space (LBA group a)
2) 30% of accesses to next 15% of user LBA space (LBA group b)
3) 20% of accesses to remainder of user LBA space (LBA group c)

d) To avoid testing only a particular area of the SSD, the distribution described in c) is offset through the user LBA space on different units under test such that all of the SSD LBAs are subjected to the highest number of accesses (e.g., SSD 1 has LBA group a applied to the first 5% of LBAs, SSD 2 has LBA group a applied to the next 5% of LBAs, etc).

e) The write data payload size distribution shall be applied to each of the three LBA groups concurrently. The write sequence across the LBA groups may be applied in either a deterministic fashion or randomly, depending on the capabilities of the test tools, so long as the percentage of accesses to each LBA group conforms to those specified in 3c. An example of a deterministic method is given in Annex A.1 and an example of a random method is given in Annex A.2.

f) Random data for the payload may be generated by various means. The intent of the randomization is to emulate encrypted data such that if data compression/reduction is done by the SSD under test, the compression/reduction has the same effect as it would on encrypted data. An informative example script for generating the random data and the read/write distribution across LBA groups is provided in Annex A.2. This script uses open-source software that may be found at vdbench.org.
Annex A (informative) Examples of write sequence methods

A.1 Deterministic method example

The write data payload size distribution is applied to each of the three LBA groups. Accesses are mixed among the LBA groups such that the sequence of single write commands of the defined data payload sizes are performed within the following LBA group:

LBA group a
LBA group b
LBA group a
LBA group c
LBA group a
LBA group b
LBA group a
LBA group c
LBA group a
LBA group b
Back to 1) and repeat sequence

A.2 Random method example

This script is provided as an example only. It is not intended to imply a preferred method for generating the enterprise workload. Due to possible updates made to this open-source software, minor changes to the script may be required to achieve the desired functions. The following are instructions for running a VDbench script.

1. Latest VDbench installed and java jre6 or greater on a Windows platform.
2. Copy scripts into VDbench working directory.
3. Identify the physical drive number of the device to be exercised.
4. Run maxio.cmd.
5. maxio.cmd may be modified according to the user (i.e., the start thread count can be changed to expedite test time).
6. maxio.cmd may be modified according to the user to change the Read/Write ratio from the currently set 40/60 to what is desired.
7. maxio.cmd is currently set to run for 1000 hours, which may be changed by the user for different duration.
8. maxio.cmd is currently set to stop on 10 errors (i.e., uncorrectable read error), this can be changed by the user to stop after a set number of errors. Errors are logged.
9. Analysis may be done on the logfile.html in the results file directory.

NOTE The script may be wrapped to the next line due to margin limitations. Function identifiers begin each line of script.
A.2 Random method example (cont’d)

MAXIO.CMD

echo off
echo **
Echo ** usage example :
echo **
echo ** SSDIO 1 50 3000 MySSD_results
echo ** use Storage Device physicaldrive = 1
echo ** Apply max. Thread count/workload definition = 50
echo ** IO rate set = 3000 IOs per second
echo ** output directory name for results = MySSD_results
echo **
echo Test using SD=%1 Threads=%2 IOrate=%3 results=%4
echo on
pause
echo off
REM ==============================================================
REM   SSDIO Endurance Profile Example
REM ==============================================================
set Drv=%1%
set T=%2%
set IO=%3%
set /A A1=%IO%*90
set /A A=%A1%/100
set /A B1=%IO%*80
set /A B=%B1%/100
set /A C1=%IO%*50
set /A C=%C1%/100
set /A D1=%IO%*10
set /A D=%D1%/100
set /A E=%IO%/100
REM ***************************************************************************
REM enduration time set by elapse time=1000h (hours)
REM set data errors to 10 Any greater then device testing should not continue
REM ***************************************************************************
REM
echo * SSDIO Profile > ssdio.go
echo sd=sd1,lun=\\physicaldrive%Drv%,align=4k,threads=%T% >> ssdio.go
echo data_errors=10
echo
wd=wd1,sd=sd1,rdpct=40,seek=100,xfersize=(512,4,1k,1,1.5k,1,2k,1,2.5k,1,3k,1,3.5k,1,4K,67,8k,10,16k,7,32k,3,64k,3),range=(1,5),skew=50 >> ssdio.go
echo
wd=wd2,sd=sd1,rdpct=40,seek=100,xfersize=(512,4,1k,1,1.5k,1,2k,1,2.5k,1,3k,1,3.5k,1,4K,67,8k,10,16k,7,32k,3,64k,3),range=(6,20),skew=30 >> ssdio.go
echo
wd=wd3,sd=sd1,rdpct=40,seek=100,xfersize=(512,4,1k,1,1.5k,1,2k,1,2.5k,1,3k,1,3.5k,1,4K,67,8k,10,16k,7,32k,3,64k,3),range=(21,100),skew=20 >> ssdio.go
echo rd=SSD_Sustain,wd=wd*,iorate=%3%,elapsed=1000h,interval=60 >> ssdio.go
REM echo Please Check these values are correct!
REM pause
vdbench -f ssdio.go -o %4%
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The purpose of this form is to provide the Technical Committees of JEDEC with input from the industry regarding usage of the subject standard. Individuals or companies are invited to submit comments to JEDEC. All comments will be collected and dispersed to the appropriate committee(s).

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1. I recommend changes to the following:
   - Requirement, clause number
   - Test method number
   - Clause number

   The referenced clause number has proven to be:
   - Unclear
   - Too Rigid
   - In Error
   - Other

2. Recommendations for correction:

   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________

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   ____________________________________________________________
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   ____________________________________________________________
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