

# S5E V6 512Gb iTLC Full Qual Report (@ FW19.3)

19<sup>th</sup> December, 2022

# EFR Report Main Part

# EFR Summary Table

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					Fatal Failures							Non-Fatal Failures				
					Plane/Die		Uncorrectable		Total			Total GBBs		GBB Budget Exceeded		
Type	Cycles	Mode	# DUTs	# Dies	#	DPPM	#	DPPM	#	DPPM	Spec DPPM	#	#	DPPM	Spec DPPM	
eEFR	10	TLC	5050	20000	0	0	0	0	0	0	50	0	0	0	200	
		SLC			0	0	0	0	0	0		0				
EFR	20	TLC			0	0	0	0	0	0	0	50	0	0	0	200
		SLC			0	0	0	0	0	0	0					
	290	TLC			0	0	0	0	0	0	0	100	1	0	0	1000
		SLC			0	0	0	0	0	0	0					
	Cross Temp	TLC			0	0	0	0	0	0	0	100	0	0	0	1000
		SLC			0	0	0	0	0	0	0					
eEFR (BCM)	300	TLC	0	0	0	0	0	0	0	100	0	0	0	1000		
		SLC	0	0	0	0	0	0	0							

# EFR Detailed Failure Report Information

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Per Die Information				Per GBB Information													
				Failure Details						Failure Address					Failure Analysis		
Die index	# of GBBs	DP	Wafer/ X/Y	Pgm Temp	Rd Temp	Mode	Cycle	Event	Classification	Plane	Block	WL	Page #	L/M/U	Data Loss pages	FA	CA
EC4C554 F3137361 05D0F0E 0CBB060 516	1	7	16/30/35	85	85	TLC	130	PSF	PSF Correctable	0	720	33,34	16	U	2248~ 2295	WL to CH Short	New Screen

# Qual Report Main Part

# Qual8 – TLC Reliability EOL/SOL Summary

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Check-Point	Check-Point Name	Sample Size By Density	PE Cycles	Read Disturb	Data Retention	Temp. Cross	# of UECC 4KB Chunks	# of PO 4KB Chunks	# of Dies Failing Latency SPEC	Pass/Fail
2	TLC SOL Reliability	ODP : 30PKG (NAND : 240die)	0.3K	-	2.5 Year @ 50°C	△30	-	2	-	PASS
3	TLC EOL Reliability		3K	-	1Yr @ 50°C & 336hr @ 25°C	△30	-	-	-	PASS
4a	TLC SOL Reliability		0.3K	-	1Yr @ 50°C & 336hr @ 25°C	△100	-	-	-	PASS
4b	TLC EOL Reliability		3K	-	-	△100	-	-	-	PASS
4c	TLC EOL Reliability		3K	-	-	△-100	-	-	-	PASS
11	TLC EOL Reliability		3K	-	1M @ 45°C	△60	-	-	-	PASS

# Qual8 – TLC Reliability EOL/SOL Failure Info

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Check-Point	Type	Density	UID	Failure Step	Cycle Count	Ch	Die In Channel	Block	Page	4KB Chunk In Page	Root Cause
2	PO	ODP	EC4C55503736370FFC082A0F940D0516	Health monitor	300	1	3	713	2876	-	Known Issue (Radar 99382130)
								23	3059	-	

# Qual10 – TLC Latency / ESTI Reliability

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Check-Point	Check-Point Name	Sample Size By Density	PE Cycles	Read Disturb	Data Retention	Temp. Cross	# of UECC 4KB chunks	# of PO 4KB Chunks	# of Dies Failing Latency SPEC	Pass/Fail
8	TLC Latency Reliability	ODP : 30PKG (NAND : 240die)	0.3K	100K	3M @ 45`C	△30	-	-	-	PASS
9a			3K	100K	1M @ 45`C	△30	-	-	-	PASS
9c			3K	100K	1M @ 35`C	△30	-	-	-	PASS
10	TLC ESTI Reliability		3K	-	1Yr @ 50`C & 336hr @ 25`C	△30	-	-	-	PASS

# Qual12 – SLC Reliability EOL

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Check-Point	Check-Point Name	Sample Size By Density	PE Cycles	Read Disturb	Data Retention	Temp. Cross	# of UECC 4KB chunks	# of PO 4KB Chunks	# of Dies Failing Latency SPEC	Pass/Fail
3	SLC Reliability EOL	ODP : 30PKG (NAND : 240die)	100K	-	1Yr @ 50`C & 336hr @ 25`C	△30	-	-	-	PASS
4a			10K	-	1Yr @ 50`C & 336hr @ 25`C	△100	-	-	-	PASS
4b			100K	-	-	△100	-	-	-	PASS
4c			100K	-	-	△-100	-	-	-	PASS
11			100K	-	1M @ 45`C	△60	-	-	-	PASS

# Qual13 – SLC Latency / ESTI Reliability

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Check-Point	Check-Point Name	Sample Size By Density	PE Cycles	Read Disturb	Data Retention	Temp. Cross	# of UECC 4KB chunks	# of PO 4KB Chunks	# of Dies Failing Latency SPEC	Pass/Fail
8	SLC Latency Reliability	ODP : 30PKG (NAND : 240die)	10K	100K	3M @ 45°C	△30	-	-	-	PASS
9a			100K	100K	1M @ 45°C	△30	-	-	-	PASS
9c			100K	100K	1M @ 35°C	△30	-	-	-	PASS
10	SLC ESTI Reliability		100K	-	1Yr @ 50°C & 336hr @ 25°C	△30	-	-	-	PASS

# Controller Block Reliability

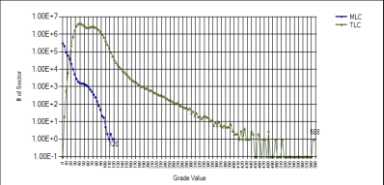
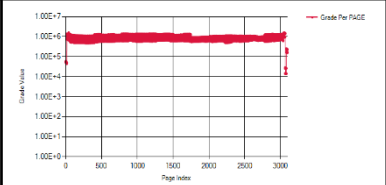
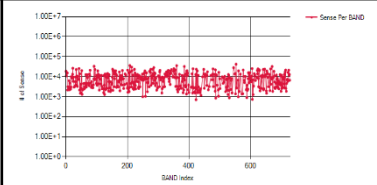
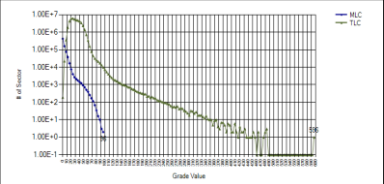
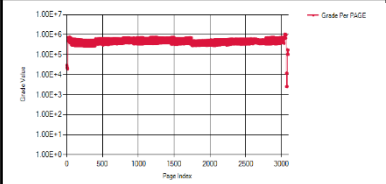
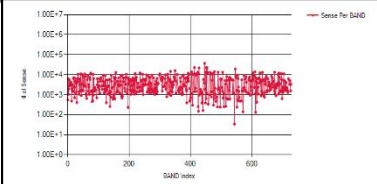
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Check-Point	Check-Point Name	Sample Size By Density	PE Cycles	Read Disturb	Data Retention	Temp. Cross	# of UECC 4KB chunks	# of PO 4KB Chunks	# of Dies Failing Latency SPEC	Pass/Fail
-	Boot Flow 1	SDP : 16PKG (NAND : 16die)	10	12M	5Yr @ 55°C	Δ100	-	-	-	PASS
		DDP : 16PKG (NAND : 32die)					-	-	-	PASS
		QDP : 16PKG (NAND : 64die)					-	-	-	PASS
		ODP : 16PKG (NAND : 128die)					-	-	-	PASS
-	Boot Flow 2	SDP : 16PKG (NAND : 16die)	100	12M	5Yr @ 55°C	Δ100	-	-	-	PASS
		DDP : 16PKG (NAND : 32die)					-	-	-	PASS
		QDP : 16PKG (NAND : 64die)					-	-	-	PASS
		ODP : 16PKG (NAND : 128die)					-	-	-	PASS

Cell Type	Check-Point	Check-Point Name	Sample Size By Density	PE Cycles	Read Disturb	Data Retention	Temp. Cross	# of UECC 4KB chunks	# of PO 4KB Chunks	# of Dies Failing Latency SPEC	Pass/Fail
TLC	1EP	TLC Latency with x-ray tolerance	SDP : 16PKG (NAND : 16die)	1N	100K	3M @ 45°C	△30	-	-	-	PASS
	8		DDP : 16PKG (NAND : 32die)	0.3K	100K	3M @ 45°C	△30	-	-	-	PASS
	9a		QDP : 16PKG (NAND : 64die)	3K	100K	1M @ 45°C	△30	-	-	-	PASS
	9c		ODP : 16PKG (NAND : 128die)	3K	100K	1M @ 35°C	△30	-	-	-	PASS
SLC	1EP	SLC Latency with x-ray tolerance	SDP : 16PKG (NAND : 16die)	1N	100K	3M @ 45°C	△30	-	-	-	PASS
	8		DDP : 16PKG (NAND : 32die)	10K	100K	3M @ 45°C	△30	-	-	-	PASS
	9a		QDP : 16PKG (NAND : 64die)	100K	100K	1M @ 45°C	△30	-	-	-	PASS
	9c		ODP : 16PKG (NAND : 128die)	100K	100K	1M @ 35°C	△30	-	-	-	PASS

# Qual8 – TLC EOL Reliability (In-depth ADSP)

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Check-Point	PE Cycles	Read Disturb	Data Retention	Temp. Cross	Range	# of sectors per grade	# of grades per page	# of senses per block
3	3K	-	1Y @ 50`C & 336hr @ 25`C	Δ30	TLC			
4a	0.3K	-		Δ100				

# Qual8 – TLC EOL Reliability (In-depth)

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Check-Point	PE Cycles	Read Disturb	Data Retention	Temp. Cross	Range	# of sectors per grade	# of grades per page	# of senses per block
2	0.3K	-	2.5 Yr @ 50°C	$\Delta 30$	TLC			
4b	3K		-	$\Delta 100$				
4c	3K		-	$\Delta -100$				
11	3K		1M @ 45°C	$\Delta 60$				

# Qual8 – TLC EOL Reliability (Hard Error)

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Check-Point	PE Cycles	Read Disturb	Data Retention	Temp. Cross	Range	# of sectors per hard error	# of hard-errors per page
3	3K	-	1Y @ 50°C & 336hr @ 25°C	Δ30	TLC		
4a	0.3K	-		Δ100			

# Qual8 – TLC EOL Reliability (Hard Error)

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Check-Point	PE Cycles	Read Disturb	Data Retention	Temp. Cross	Range	# of sectors per hard error	# of hard-errors per page
2	0.3K	-	2.5 Yr @ 50°C	△30	TLC		
4b	3K		-	△100			
4c	3K		-	△-100			
11	3K		1M @ 45°C	△60			

# Qual8 – TLC EOL Reliability (Latency)

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Check-Point	PE Cycles	Read Disturb	Data Retention	Temp. Cross	Bin (us)	Apple SPEC (%)	Average All S5E Packages (%)	Worst Case S5E Package (%)	Apple SPEC (us)	Average tR Worst Case Die (us)
11	3K	-	1M @ 45°C	△60	160	85	99.99956	99.99895	82	70.65224
					200	10	0.00007	0.00048		
					1300	4.9	0.00037	0.00057		
					10500	0.1	0	0		

# Qual8 – TLC EOL Reliability Throughput

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Check-Point	Density	PE Cycles	Read Disturb	Data Retention	Temp. Cross	Apple SPEC Min (MB/s)	Apple SPEC Avg (MB/s)	Average All Packages (MB/s)	Worst Average Package (MB/s)	Worst BAND (MB/s)
3	ODP	0	0	0	△30	850	1615	1713.266	1713.151	1710.966
4a		0	0	0	△100			1713.292	1713.18	1711.004
4b		0	0	0	△100			1713.294	1713.169	1711.106
4c		0	0	0	△-100			1713.294	1713.169	1711.106
11		0	0	0	△60			1713.266	1713.151	1710.966

## TEST\_COND

Check-Point	Density	PE Cycles	Read Disturb	Data Retention	Temp. Cross	Apple SPEC Min (MB/s)	Apple SPEC Avg (MB/s)	Average All Packages (MB/s)	Worst Average Package (MB/s)	Worst BAND (MB/s)
3	ODP	3K	-	1Yr @ 50°C & 336hr @ 25°C	△30	-	-	1662.459	1649.319	1470.27
4a		0.3K	-		△100			1690.054	1684.595	1608.074
4b		3K	-	-	△100			1721.595	1720.92	1705.353
4c		3K	-	-	△-100			1722.051	1721.931	1711.314
11		3K	-	1M @ 45°C	△60			425	765	1721.352

# Qual8 – TLC EOL Reliability RR Throughput

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## REF\_FRESH

Check-Point	Density	PE Cycles	Read Disturb	Data Retention	Temp. Cross	Apple SPEC Min (KIOPs)	Apple SPEC Avg (KIOPs)	Average All Packages (KIOPs)	Worst Average Package (KIOPs)	Worst BAND (KIOPs)
3	ODP	0	0	0	△30	100	180	214.607	214.186	212.527
4a		0	0	0	△100			215.226	214.338	212.747
4b		0	0	0	△100			214.925	214.331	212.397
4c		0	0	0	△-100			214.925	214.331	212.397
11		0	0	0	△60			214.607	214.186	212.527

## TEST\_COND

Check-Point	Density	PE Cycles	Read Disturb	Data Retention	Temp. Cross	Apple SPEC Min (KIOPs)	Apple SPEC Avg (KIOPs)	Average All Packages (KIOPs)	Worst Average Package (KIOPs)	Worst BAND (KIOPs)
3	ODP	3K	-	1Yr @ 50°C & 336hr @ 25°C	△30	-	-	177.921	165.697	52.236
4a		0.3K	-		△100			188.411	179.958	78.979
4b		3K	-	-	△100			215.93	215.122	213.687
4c		3K	-	-	△-100			214.523	213.883	212.386
11		3K	-	1M @ 45°C	△60			50	80	216.271

# Qual8 – TLC EOL Reliability RR 16K Throughput

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## REF\_FRESH

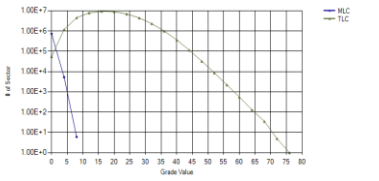
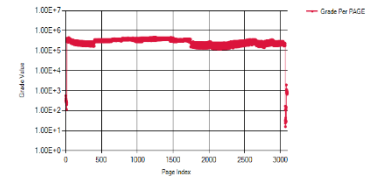
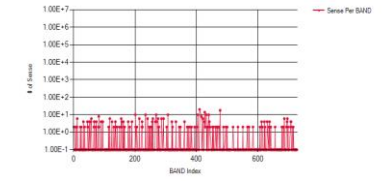
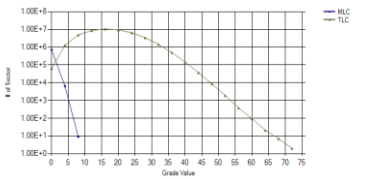
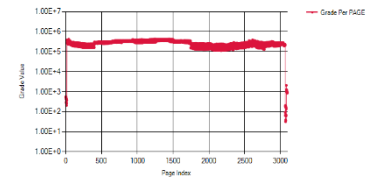
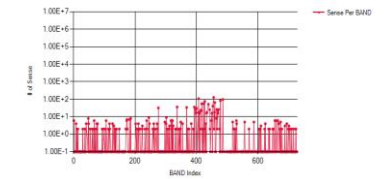
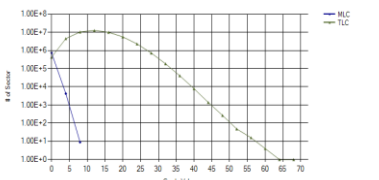
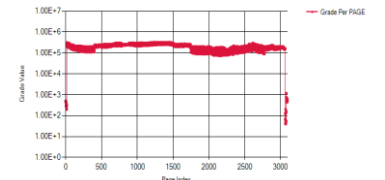
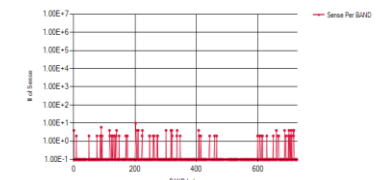
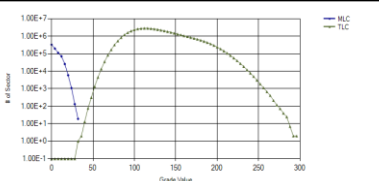
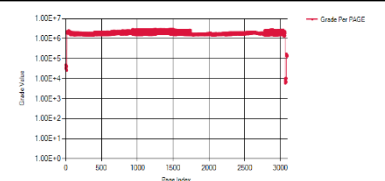
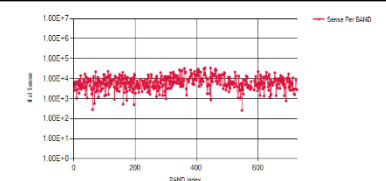
Check-Point	Density	PE Cycles	Read Disturb	Data Retention	Temp. Cross	Apple SPEC Min (KIOPs)	Apple SPEC Avg (KIOPs)	Average All Packages (KIOPs)	Worst Average Package (KIOPs)	Worst BAND (KIOPs)
3	ODP	0	0	0	△30	50	90	136.173	135.974	135.839
4a		0	0	0	△100			136.161	135.945	135.706
4b		0	0	0	△100			136.268	135.993	135.867
4c		0	0	0	△-100			136.268	135.993	135.867
11		0	0	0	△60			136.173	135.974	135.839

## TEST\_COND

Check-Point	Density	PE Cycles	Read Disturb	Data Retention	Temp. Cross	Apple SPEC Min (KIOPs)	Apple SPEC Avg (KIOPs)	Average All Packages (KIOPs)	Worst Average Package (KIOPs)	Worst BAND (KIOPs)
3	ODP	3K	-	1Yr @ 50°C & 336hr @ 25°C	△30	-	-	115.543	110.629	31.892
4a		0.3K	-		△100			123.258	118.569	51.343
4b		3K	-	-	△100			136.416	136.284	136.094
4c		3K	-	-	△-100			136.294	136.142	135.915
11		3K	-	1M @ 45°C	△60			25	40	136.243

# Qual10 – TLC Latency ESTI (In-depth)

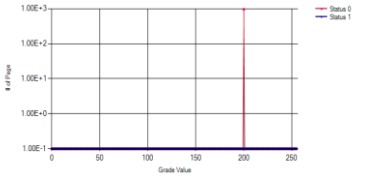
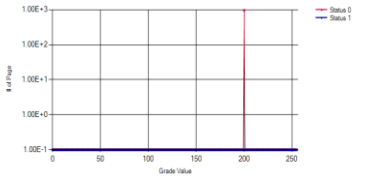
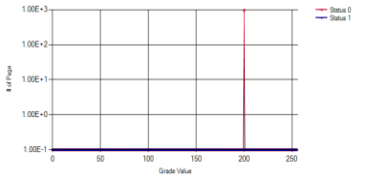
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Check-point	PE Cycles	Read Disturb	Data Retention	Temp. Cross	Range	# of sectors per grade	# of grades per page	# of senses per block
8	0.3K	100K	3M @ 45°C	△30	TLC			
9a	3K	100K	1M @ 45°C	△30				
9c	3K	100K	1M @ 35°C	△30				
10	3K	-	Erased 1M @ 50°C Programmed 11M @ 50°C LTDR 336hr	△30				

# Qual10 – TLC Latency ESTI (Hard Error)

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Check-point	PE Cycles	Read Disturb	Data Retention	Temp. Cross	Range	# of sectors per hard error	# of hard-errors per page
8	0.3K	100K	3M @ 45°C	△30	TLC		
9a	3K	100K	1M @ 45°C	△30			
9c	3K	100K	1M @ 35°C	△30			
10	3K	-	Erased 1M @ 50°C Programmed 11M @ 50°C LTDR 336hr	△30			

Check-Point	PE Cycles	Read Disturb	Data Retention	Temp. Cross	Range	Read Scan histogram
8	0.3K	100K	3M @ 45`C	Δ30	TLC	
9a	3K	100K	1M @ 45`C	Δ30		
9c	3K	100K	1M @ 35`C	Δ30		

# Qual10 – TLC Latency ESTI

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Check-Point	PE Cycles	Read Disturb	Data Retention	Temp. Cross	Bin (us)	Apple SPEC (%)	Average All S5E Packages (%)	Worst Case S5E Package (%)	Apple SPEC (us)	Average tR Worst Case Die (us)	
8	0.3K	100K	3M @ 45°C	△30	160	95	99.9999984	99.999984	82	70.4542	
					200	4.49	0	0			
					1300	0.5	0.0000016	0.000016			
					10500	0.01	0				
9a	3K	100K	1M @ 45°C	△30	160	85	100	100		70.4977	
					200	10	0	0			
					1300	4.9	0	0			
					10500	0.1	0	0			
9c	3K	100K	1M @ 35°C	△30	160	85	100	100			70.37186
					200	10	0	0			
					1300	4.9	0	0			
					10500	0.1	0	0			

# Qual10 – TLC Latency ESTI Throughput

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## REF\_FRESH

Check-Point	Density	PE Cycles	Read Disturb	Data Retention	Temp. Cross	Apple SPEC Min (MB/s)	Apple SPEC Avg (MB/s)	Average All Packages (MB/s)	Worst Average Package (MB/s)	Worst BAND (MB/s)
8	ODP	0	0	0	△30	850	1615	1713.272	1713.104	1711.14
9a		0	0	0	△30			1713.295	1713.124	1711.11
9c		0	0	0	△30			1713.295	1713.124	1711.11
10		0	0	0	△30			1713.275	1713.076	1711.273

## TEST\_COND

Check-Point	Density	PE Cycles	Read Disturb	Data Retention	Temp. Cross	Apple SPEC Min (MB/s)	Apple SPEC Avg (MB/s)	Average All Packages (MB/s)	Worst Average Package (MB/s)	Worst BAND (MB/s)
8	ODP	0.3K	100K	3M @ 45`C	△30	425	1530	1713.247	1713.113	1710.195
9a		3K	100K	1M @ 45`C	△30			1713.254	1713.123	1710.996
9c		3K	100K	1M @ 35`C	△30			1713.242	1713.008	1710.082
10		3K	-	Erased 1M @ 50`C Programmed 11M @ 50`C LTDR 336hr	△30		765	1701.262	1687.078	1625.064

# Qual10 – TLC Latency ESTI RC Throughput

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## REF\_FRESH

Check-Point	Density	PE Cycles	Read Disturb	Data Retention	Temp. Cross	Apple SPEC Min (MB/s)	Apple SPEC Avg (MB/s)	Average All Packages (MB/s)	Worst Average Package (MB/s)	Worst BAND (MB/s)
8	ODP	0	0	0	△30	850	1615	1713.763	1713.568	1712.78
9a		0	0	0	△30			1713.764	1713.574	1712.785
9c		0	0	0	△30			1713.764	1713.574	1712.785
10		0	0	0	△30			1713.792	1713.659	1712.931

## TEST\_COND

Check-Point	Density	PE Cycles	Read Disturb	Data Retention	Temp. Cross	Apple SPEC Min (MB/s)	Apple SPEC Avg (MB/s)	Average All Packages (MB/s)	Worst Average Package (MB/s)	Worst BAND (MB/s)
8	ODP	0.3K	100K	3M @ 45`C	△30	425	1530	1713.747	1713.598	1713.126
9a		3K	100K	1M @ 45`C	△30			1713.771	1713.541	1713.037
9c		3K	100K	1M @ 35`C	△30			1713.779	1713.655	1713.037

# Qual10 – TLC Latency ESTI RR Throughput

Confidential

## REF\_FRESH

Check-Point	Density	PE Cycles	Read Disturb	Data Retention	Temp. Cross	Apple SPEC Min (KIOPs)	Apple SPEC Avg (KIOPs)	Average All Packages (KIOPs)	Worst Average Package (KIOPs)	Worst BAND (KIOPs)
8	ODP	0	0	0	△30	100	180	214.514	214.057	211.841
9a		0	0	0	△30			214.68	213.68	211.863
9c		0	0	0	△30			214.68	213.68	211.863
10		0	0	0	△30			214.612	214.134	212.475

## TEST\_COND

Check-Point	Density	PE Cycles	Read Disturb	Data Retention	Temp. Cross	Apple SPEC Min (KIOPs)	Apple SPEC Avg (KIOPs)	Average All Packages (KIOPs)	Worst Average Package (KIOPs)	Worst BAND (KIOPs)
8	ODP	0.3K	100K	3M @ 45`C	△30	50	160	215.242	214.522	212.442
9a		3K	100K	1M @ 45`C	△30			215.4	214.739	212.81
9c		3K	100K	1M @ 35`C	△30			214.928	214.191	212.042
10		3K	-	Erased 1M @ 50`C Programmed 11M @ 50`C LTDR 336hr	△30		80	207.68	198.92	170.724

# Qual10 – TLC Latency ESTI RR 16K Throughput

Confidential

## REF\_FRESH

Check-Point	Density	PE Cycles	Read Disturb	Data Retention	Temp. Cross	Apple SPEC Min (KIOPs)	Apple SPEC Avg (KIOPs)	Average All Packages (KIOPs)	Worst Average Package (KIOPs)	Worst BAND (KIOPs)
8	ODP	0	0	0	△30	50	90	136.15	135.946	135.607
9a		0	0	0	△30			136.181	136.048	135.828
9c		0	0	0	△30			136.181	136.048	135.828
10		0	0	0	△30			136.114	135.875	135.701

## TEST\_COND

Check-Point	Density	PE Cycles	Read Disturb	Data Retention	Temp. Cross	Apple SPEC Min (KIOPs)	Apple SPEC Avg (KIOPs)	Average All Packages (KIOPs)	Worst Average Package (KIOPs)	Worst BAND (KIOPs)
8	ODP	0.3K	100K	3M @ 45`C	△30	25	80	136.291	136.083	135.813
9a		3K	100K	1M @ 45`C	△30			136.233	136.04	135.772
9c		3K	100K	1M @ 35`C	△30			136.25	135.872	135.67
10		3K	-	Erased 1M @ 50`C Programmed 11M @ 50`C LTDR 336hr	△30		40	133.352	129.6	107.762

# Qual12 – SLC EOL Reliability (In-depth ADSP)

Confidential

Check-Point	PE Cycles	Read Disturb	Data Retention	Temp. Cross	Range	# of sectors per grade	# of grades per page	# of senses per block
3	100K	-	1Y @ 50°C & 336hr @ 25°C	Δ30	SLC			
4a	10K	-		Δ100				

# Qual12 – SLC EOL Reliability (In-depth)

Confidential

Check-Point	PE Cycles	Read Disturb	Data Retention	Temp. Cross	Range	# of sectors per grade	# of grades per page	# of senses per block
4b	100K	-	-	$\Delta 100$	SLC			
4c	100K		-	$\Delta -100$				
11	100K		1M @ 45°C	$\Delta 60$				

# Qual12 – SLC EOL Reliability (Hard Error)

Confidential

Check-Point	PE Cycles	Read Disturb	Data Retention	Temp. Cross	Range	# of sectors per hard error	# of hard-errors per page
3	100K	-	1Y @ 50°C & 336hr @ 25°C	Δ30	SLC		
4a	10K	-		Δ100			

# Qual12 – SLC EOL Reliability (Hard Error)

Confidential

Check-Point	PE Cycles	Read Disturb	Data Retention	Temp. Cross	Range	# of sectors per hard error	# of hard-errors per page
4b	100K	-	-	$\Delta 100$	SLC		
4c	100K		-	$\Delta -100$			
11	100K		1M @ 45'C	$\Delta 60$			

# Qual12 – SLC EOL Reliability (Latency)

Confidential

Check-Point	PE Cycles	Read Disturb	Data Retention	Temp. Cross	Bin (us)	Apple SPEC (%)	Average All S4E Packages (%)	Worst Case S4E Package (%)	Apple SPEC (us)	Average tR Worst Case Die (us)
11	100K	-	1M @ 45°C	△60	160	85	100	100	50	38.68866
					200	10	0	0		
					1300	4.9	0	0		
					10500	0.1	0	0		

# Qual12 – SLC EOL Reliability Throughput

Confidential

## REF\_FRESH

Check-Point	Density	PE Cycles	Read Disturb	Data Retention	Temp. Cross	Apple SPEC Min (MB/s)	Apple SPEC Avg (MB/s)	Average All Packages (MB/s)	Worst Average Package (MB/s)	Worst BAND (MB/s)
3	ODP	0	0	0	-	850	1615	1712.369	1712.122	1710.717
4a		0	0	0	-			1712.35	1712.195	1709.934
4b		0	0	0	-			1712.335	1712.189	1710.603
4c		0	0	0	-			1712.335	1712.189	1710.603
11		0	0	0	-			1712.369	1712.122	1710.717

## TEST\_COND

Check-Point	Density	PE Cycles	Read Disturb	Data Retention	Temp. Cross	Apple SPEC Min (MB/s)	Apple SPEC Avg (MB/s)	Average All Packages (MB/s)	Worst Average Package (MB/s)	Worst BAND (MB/s)
3	ODP	100K	-	1Yr @ 50°C & 336hr @ 25°C	△30	-		1712.366	1712.166	1710.229
4a		10K	-		△100			1712.338	1712.127	1710.15
4b		100K	-	-	△100			1720.795	1720.578	1710.002
4c		100K	-	-	△-100			1720.694	1720.399	1709.39
11		100K	-	1M @ 45°C	△60			425	765	1720.789

# Qual12 – SLC EOL Reliability RR Throughput

Confidential

## REF\_FRESH

Check-Point	Density	PE Cycles	Read Disturb	Data Retention	Temp. Cross	Apple SPEC Min (KIOPs)	Apple SPEC Avg (KIOPs)	Average All Packages (KIOPs)	Worst Average Package (KIOPs)	Worst BAND (KIOPs)
3	ODP	0	0	0	-	100	180	220.39	216.747	215.226
4a		0	0	0	-			220.363	217.363	215.669
4b		0	0	0	-			220.507	218.705	215.261
4c		0	0	0	-			220.507	218.705	215.261
11		0	0	0	-			220.39	216.747	215.226

## TEST\_COND

Check-Point	Density	PE Cycles	Read Disturb	Data Retention	Temp. Cross	Apple SPEC Min (KIOPs)	Apple SPEC Avg (KIOPs)	Average All Packages (KIOPs)	Worst Average Package (KIOPs)	Worst BAND (KIOPs)
3	ODP	100K	-	1Yr @ 50`C & 336hr @ 25`C	△30	-	-	221.942	217.529	215.777
4a		10K	-		△100			219.13	216.704	215.222
4b		100K	-	-	△100			220.124	216.535	215.411
4c		100K	-	-	△-100			221.24	219.017	215.114
11		100K	-	1M @ 45`C	△60			50	80	221.03

# Qual12 – SLC EOL Reliability RR 16K Throughput Confidential

## REF\_FRESH

Check-Point	Density	PE Cycles	Read Disturb	Data Retention	Temp. Cross	Apple SPEC Min (KIOPs)	Apple SPEC Avg (KIOPs)	Average All Packages (KIOPs)	Worst Average Package (KIOPs)	Worst BAND (KIOPs)
3	ODP	0	0	0	-	50	90	138.281	137.445	137.389
4a		0	0	0	-			138.226	137.818	137.722
4b		0	0	0	-			138.284	137.824	137.71
4c		0	0	0	-			138.284	137.824	137.71
11		0	0	0	-			138.281	137.445	137.389

## TEST\_COND

Check-Point	Density	PE Cycles	Read Disturb	Data Retention	Temp. Cross	Apple SPEC Min (KIOPs)	Apple SPEC Avg (KIOPs)	Average All Packages (KIOPs)	Worst Average Package (KIOPs)	Worst BAND (KIOPs)
3	ODP	100K	-	1Yr @ 50`C & 336hr @ 25`C	△30	-		138.245	137.538	137.407
4a		10K	-		△100			138.151	137.649	137.607
4b		100K	-	-	△100			138.238	137.774	137.67
4c		100K	-	-	△-100			138.253	137.614	137.553
11		100K	-	1M @ 45`C	△60			25	40	138.372

# Qual13 – SLC Latency ESTI (In-depth)

Confidential

Check-point	PE Cycles	Read Disturb	Data Retention	Temp. Cross	Range	# of sectors per grade	# of grades per page	# of senses per block
8	10K	100K	3M @ 45°C	△30	SLC			
9a	100K	100K	1M @ 45°C	△30				
9c	100K	100K	1M @ 35°C	△30				
10	100K	-	Erased 1M @ 50°C Programmed 11M @ 50°C LTDR 336hr	△30				

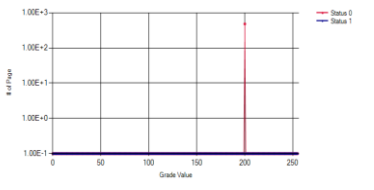
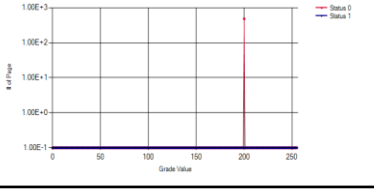
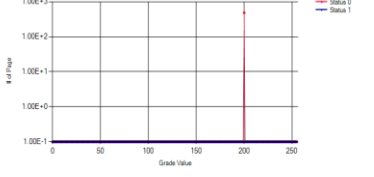
# Qual13 – SLC Latency ESTI (Hard Error)

Confidential

Check-point	PE Cycles	Read Disturb	Data Retention	Temp. Cross	Range	# of sectors per hard error	# of hard-errors per page
8	10K	100K	3M @ 45°C	△30	SLC		
9a	100K	100K	1M @ 45°C	△30			
9c	100K	100K	1M @ 35°C	△30			
10	100K	-	Erased 1M @ 50°C Programmed 11M @ 50°C LTDR 336hr	△30			

# Qual13 – SLC Latency ESTI (Read Scan)

Confidential

Check-Point	PE Cycles	Read Disturb	Data Retention	Temp. Cross	Range	Read Scan histogram
8	10K	100K	3M @ 45`C	Δ30	SLC	
9a	100K	100K	1M @ 45`C	Δ30		
9c	100K	100K	1M @ 35`C	Δ30		

# Qual13 – SLC Latency ESTI Latency

Confidential

Check-Point	PE Cycles	Read Disturb	Data Retention	Temp. Cross	Bin (us)	Apple SPEC (%)	Average All S5E Packages (%)	Worst Case S5E Package (%)	Apple SPEC (us)	Average tR Worst Case Die (us)
8	10K	100K	3M @ 45°C	△30	90	95	100	100	50	38.44215
					125	4.49	0	0		
					800	0.5	0	0		
					6500	0.01	0	0		
9a	100K	100K	1M @ 45°C	△30	90	85	100	100		38.62023
					125	10	0	0		
					800	4.9	0	0		
					6500	0.1	0	0		
9c	100K	100K	1M @ 35°C	△30	90	85	100	100		38.6258
					125	10	0	0		
					800	4.9	0	0		
					6500	0.1	0	0		

# Qual13 – SLC Latency ESTI Throughput

Confidential

## REF\_FRESH

Check-Point	Density	PE Cycles	Read Disturb	Data Retention	Temp. Cross	Apple SPEC Min (MB/s)	Apple SPEC Avg (MB/s)	Average All Packages (MB/s)	Worst Average Package (MB/s)	Worst BAND (MB/s)
8	ODP	0	0	0	△30	850	1615	1712.388	1712.096	1710.41
9a		0	0	0	△30			1712.374	1712.164	1710.512
9c		0	0	0	△30			1712.374	1712.164	1710.512
10		0	0	0	△30			1712.374	1712.229	1710.592

## TEST\_COND

Check-Point	Density	PE Cycles	Read Disturb	Data Retention	Temp. Cross	Apple SPEC Min (MB/s)	Apple SPEC Avg (MB/s)	Average All Packages (MB/s)	Worst Average Package (MB/s)	Worst BAND (MB/s)
8	ODP	10K	100K	3M @ 45`C	△30	425	1530	1712.377	1712.246	1710.524
9a		100K	100K	1M @ 45`C	△30			1712.356	1712.185	1709.81
9c		100K	100K	1M @ 35`C	△30			1712.361	1712.162	1710.467
10		100K	-	Erased 1M @ 50`C Programmed 11M @ 50`C LTDR 336hr	△30		765	1712.337	1712.096	1710.002

# Qual13 – SLC Latency ESTI RC Throughput

Confidential

## REF\_FRESH

Check-Point	Density	PE Cycles	Read Disturb	Data Retention	Temp. Cross	Apple SPEC Min (MB/s)	Apple SPEC Avg (MB/s)	Average All Packages (MB/s)	Worst Average Package (MB/s)	Worst BAND (MB/s)
8	ODP	0	0	0	△30	850	1615	1713.717	1713.396	1712.9
9a		0	0	0	△30			1713.776	1713.396	1712.971
9c		0	0	0	△30			1713.776	1713.396	1712.971
10		0	0	0	△30			1713.739	1713.512	1713.039

## TEST\_COND

Check-Point	Density	PE Cycles	Read Disturb	Data Retention	Temp. Cross	Apple SPEC Min (MB/s)	Apple SPEC Avg (MB/s)	Average All Packages (MB/s)	Worst Average Package (MB/s)	Worst BAND (MB/s)
8	ODP	10K	100K	3M @ 45`C	△30	425	1530	1713.758	1713.55	1713.096
9a		100K	100K	1M @ 45`C	△30			1713.742	1713.428	1712.735
9c		100K	100K	1M @ 35`C	△30			1713.774	1713.53	1713.187

# Qual13 – SLC Latency ESTI RR Throughput

Confidential

## REF\_FRESH

Check-Point	Density	PE Cycles	Read Disturb	Data Retention	Temp. Cross	Apple SPEC Min (KIOPs)	Apple SPEC Avg (KIOPs)	Average All Packages (KIOPs)	Worst Average Package (KIOPs)	Worst BAND (KIOPs)
8	ODP	0	0	0	△30	100	180	219.81	217.217	215.49
9a		0	0	0	△30			220.79	217.289	215.537
9c		0	0	0	△30			220.79	217.289	215.537
10		0	0	0	△30			220.784	217.192	215.535

## TEST\_COND

Check-Point	Density	PE Cycles	Read Disturb	Data Retention	Temp. Cross	Apple SPEC Min (KIOPs)	Apple SPEC Avg (KIOPs)	Average All Packages (KIOPs)	Worst Average Package (KIOPs)	Worst BAND (KIOPs)
8	ODP	10K	100K	3M @ 45`C	△30	50	160	221.254	217.538	215.599
9a		100K	100K	1M @ 45`C	△30			219.739	216.349	215.321
9c		100K	100K	1M @ 35`C	△30			220.745	216.309	215.326
10		100K	-	Erased 1M @ 50`C Programmed 11M @ 50`C LTDR 336hr	△30		80	222.178	218.92	216.438

# Qual13 – SLC Latency ESTI RR 16K Throughput

Confidential

## REF\_FRESH

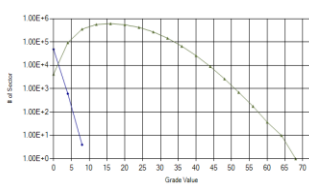
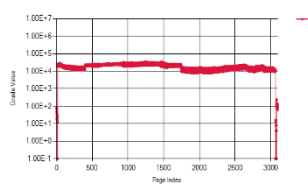
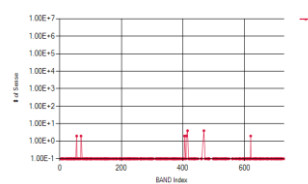
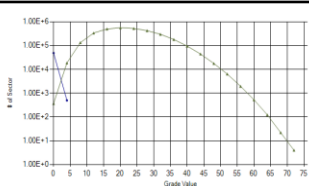
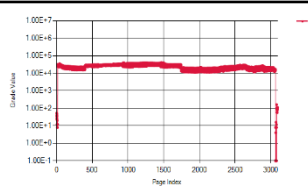
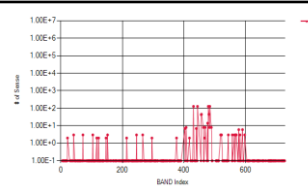
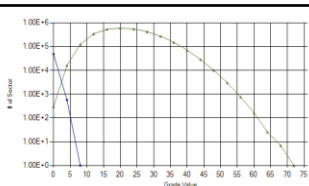
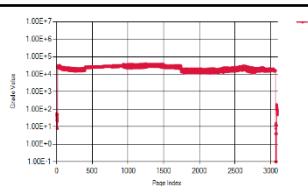
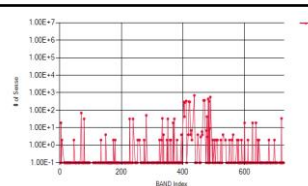
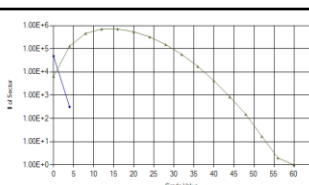
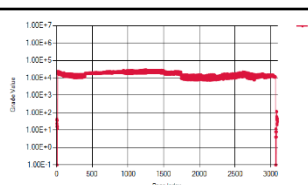
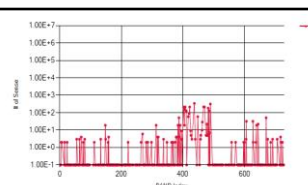
Check-Point	Density	PE Cycles	Read Disturb	Data Retention	Temp. Cross	Apple SPEC Min (KIOPs)	Apple SPEC Avg (KIOPs)	Average All Packages (KIOPs)	Worst Average Package (KIOPs)	Worst BAND (KIOPs)
8	ODP	0	0	0	△30	50	90	138.194	137.215	137.154
9a		0	0	0	△30			138.14	137.373	137.307
9c		0	0	0	△30			138.14	137.373	137.307
10		0	0	0	△30			138.268	138.078	137.988

## TEST\_COND

Check-Point	Density	PE Cycles	Read Disturb	Data Retention	Temp. Cross	Apple SPEC Min (KIOPs)	Apple SPEC Avg (KIOPs)	Average All Packages (KIOPs)	Worst Average Package (KIOPs)	Worst BAND (KIOPs)
8	ODP	10K	100K	3M @ 45`C	△30	25	80	138.252	137.604	137.554
9a		100K	100K	1M @ 45`C	△30			138.294	137.759	137.666
9c		100K	100K	1M @ 35`C	△30			138.195	137.511	137.392
10		100K	-	Erased 1M @ 50`C Programmed 11M @ 50`C LTDR 336hr	△30		40	138.224	137.99	137.84

# 1G X-ray HTDR SDP In-depth (TLC)

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Check-Point	PE Cycles	Read Disturb	Data Retention	Temp. Cross	Range	# of sectors per grade	# of grades per page	# of senses per block
1EP	1	100K	3M @ 45°C	△30	TLC			
8	0.3K	100K	3M @ 45°C	△30				
9a	3K	100K	1M @ 45°C	△30				
9c	3K	100K	1M @ 35°C	△30				

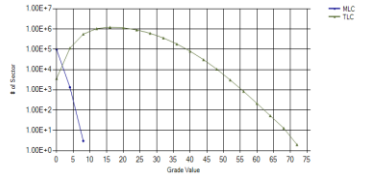
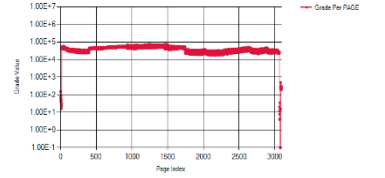
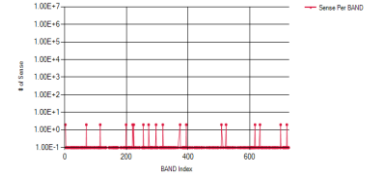
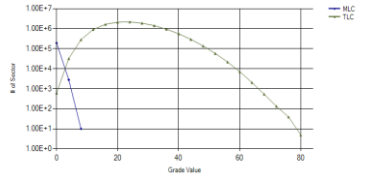
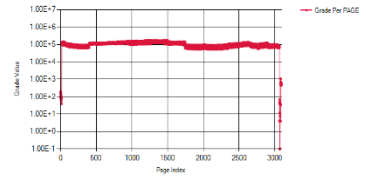
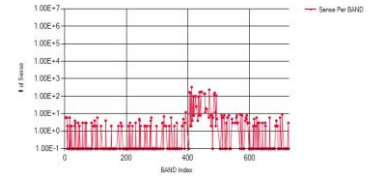
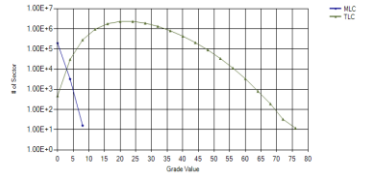
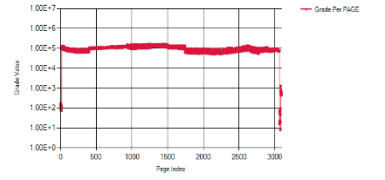
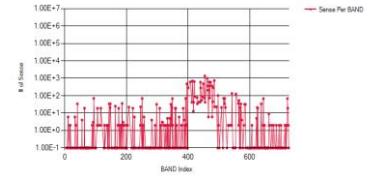
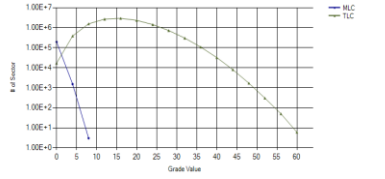
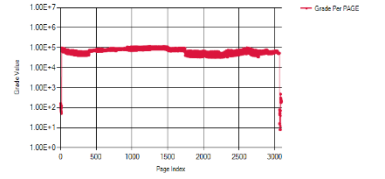
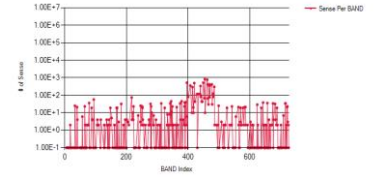
# 1G X-ray HTDR DDP In-depth (TLC)

Confidential

Check-Point	PE Cycles	Read Disturb	Data Retention	Temp. Cross	Range	# of sectors per grade	# of grades per page	# of senses per block
1EP	1	100K	3M @ 45°C	△30	TLC			
8	0.3K	100K	3M @ 45°C	△30				
9a	3K	100K	1M @ 45°C	△30				
9c	3K	100K	1M @ 35°C	△30				

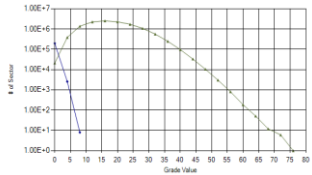
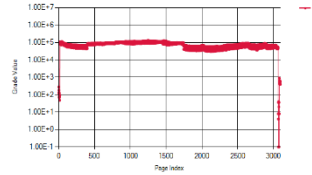
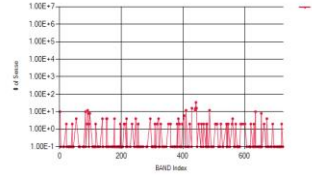
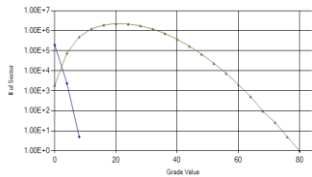
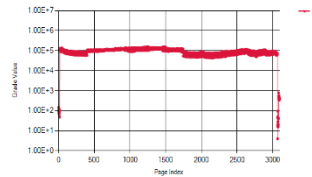
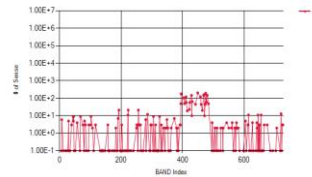
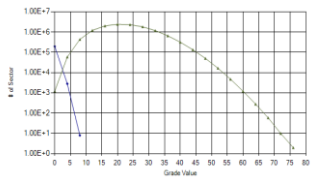
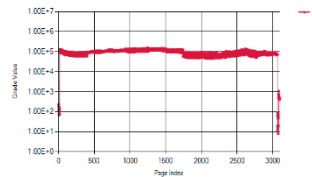
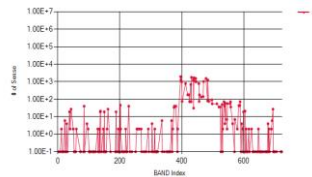
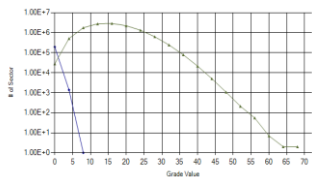
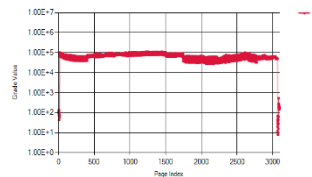
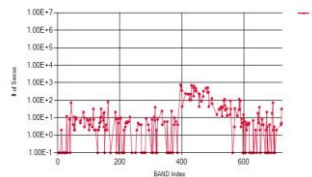
# 1G X-ray HTDR QDP In-depth (TLC)

Confidential

Check-Point	PE Cycles	Read Disturb	Data Retention	Temp. Cross	Range	# of sectors per grade	# of grades per page	# of senses per block
1EP	1	100K	3M @ 45°C	△30	TLC			
8	0.3K	100K	3M @ 45°C	△30				
9a	3K	100K	1M @ 45°C	△30				
9c	3K	100K	1M @ 35°C	△30				

# 1G X-ray HTDR ODP In-depth (TLC)

Confidential

Check-Point	PE Cycles	Read Disturb	Data Retention	Temp. Cross	Range	# of sectors per grade	# of grades per page	# of senses per block
1EP	1	100K	3M @ 45°C	△30	TLC			
8	0.3K	100K	3M @ 45°C	△30				
9a	3K	100K	1M @ 45°C	△30				
9c	3K	100K	1M @ 35°C	△30				

# 1G X-ray HTDR SDP Hard error (TLC)

Confidential

Check-Point	PE Cycles	Read Disturb	Data Retention	Temp. Cross	Range	# of sectors per hard error	# of hard-errors per page
1EP	1	100K	3M @ 45°C	△30	TLC		
8	0.3K	100K	3M @ 45°C	△30			
9a	3K	100K	1M @ 45°C	△30			
9c	3K	100K	1M @ 35°C	△30			

# 1G X-ray HTDR DDP Hard error (TLC)

Confidential

Check-Point	PE Cycles	Read Disturb	Data Retention	Temp. Cross	Range	# of sectors per hard error	# of hard-errors per page
1EP	1	100K	3M @ 45°C	△30	TLC		
8	0.3K	100K	3M @ 45°C	△30			
9a	3K	100K	1M @ 45°C	△30			
9c	3K	100K	1M @ 35°C	△30			

# 1G X-ray HTDR QDP Hard error (TLC)

Confidential

Check-Point	PE Cycles	Read Disturb	Data Retention	Temp. Cross	Range	# of sectors per hard error	# of hard-errors per page
1EP	1	100K	3M @ 45°C	△30	TLC		
8	0.3K	100K	3M @ 45°C	△30			
9a	3K	100K	1M @ 45°C	△30			
9c	3K	100K	1M @ 35°C	△30			

# 1G X-ray HTDR ODP Hard error (TLC)

Confidential

Check-Point	PE Cycles	Read Disturb	Data Retention	Temp. Cross	Range	# of sectors per hard error	# of hard-errors per page
1EP	1	100K	3M @ 45°C	△30	TLC		
8	0.3K	100K	3M @ 45°C	△30			
9a	3K	100K	1M @ 45°C	△30			
9c	3K	100K	1M @ 35°C	△30			

# 1G X-ray HTDR Read Scan (TLC)

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CP	PE Cycles	Read Disturb	Data Retention	Read Scan histogram			
				SDP	DDP	QDP	ODP
1EP	1	100K	3M @ 45°C				
8	0.3K	100K	3M @ 45°C				
9a	3K	100K	1M @ 45°C				
9c	3K	100K	1M @ 35°C				

# 1G X-ray HTDR TLC Latency

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Check-Point	PE Cycles	Read Disturb	Data Retention	Bin	Apple SPEC (%)	Average All S5E Packages				Worst Case S5E Package				Apple SPEC (us)	Average tR Worst Case Die				
						SDP	DDP	QDP	ODP	SDP	DDP	QDP	ODP		SDP	DDP	QDP	ODP	
1EP	1	100K	3M @ 45°C	160	95	100	100	100	100	100	100	100	100	82us	72.62747	73.10144	71.93189	70.16641	
				200	4.49	0	0	0	0	0	0	0	0						0
				1300	0.5	0	0	0	0	0	0	0	0						0
				10500	0.01	0	0	0	0	0	0	0	0						0
8	0.3K	100K	3M @ 45°C	160	95	99.99996	99.99998	99.99992	99.9999	99.99987	99.99993	99.99977	99.99987		72.16788	72.71588	72.42605	70.53092	
				200	4.49	0	0	0	0	0	0	0	0						0
				1300	0.5	0.00004	0.00002	0.00008	0.0001	0.000013	0.00007	0.00023	0.00013						
				10500	0.01	0	0	0	0	0	0	0	0						0
9a	3K	100K	1M @ 45°C	160	85	99.99984	99.99984	99.99979	99.99968	99.99975	99.99981	99.99968	99.99946		72.66101	71.76352	72.17029	70.14587	
				200	10	0	0	0	0	0	0	0	0						0
				1300	4.9	0.00016	0.00016	0.00021	0.00032	0.00025	0.00019	0.00032	0.00054						
				10500	0.1	0	0	0	0	0	0	0	0						0
9c	3K	100K	1M @ 35°C	160	85	99.99998	99.99999	99.99995	99.99994	99.99987	99.99994	99.99987	99.9999		72.15023	72.04516	72.79858	70.315	
				200	10	0	0	0	0	0	0	0	0						0
				1300	4.9	0.00002	0.00001	0.00005	0.00005	0.00013	0.00006	0.00013	0.0001						
				10500	0.1	0	0	0	0	0	0	0	0						0

# 1G X-ray HTDR TLC Throughput

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## REF\_FRESH

Check-Point	Density	PE Cycles	Read Disturb	Data Retention	Apple SPEC Min (MB/s)	Apple SPEC Avg (MB/s)	Average All Packages (MB/s)	Worst Average Package (MB/s)	Worst BAND (MB/s)
1EP	SDP	0	0	0	245	465.5	489.399	485.444	485.366
8		0	0	0			489.384	485.457	485.408
9a		0	0	0			489.376	485.487	485.422
9c		0	0	0			489.376	485.487	485.422
1EP	DDP	0	0	0	495	940.5	976.34	970.397	970.265
8		0	0	0			976.345	970.518	970.431
9a		0	0	0			976.343	970.392	970.29
9c		0	0	0			976.343	970.392	970.29
1EP	QDP	0	0	0	850	1615	1712.932	1712.886	1712.594
8		0	0	0			1712.93	1712.887	1712.594
9a		0	0	0			1712.925	1712.853	1712.458
9c		0	0	0			1712.925	1712.853	1712.458
1EP	ODP	0	0	0	850	1615	1713.275	1713.05	1711.246
8		0	0	0			1713.279	1713.134	1711.534
9a		0	0	0			1713.272	1712.971	1711.59
9c		0	0	0			1713.272	1712.971	1711.59

# 1G X-ray HTDR TLC Throughput

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## TEST\_COND

Check-Point	Density	PE Cycles	Read Disturb	Data Retention	Apple SPEC Min (MB/s)	Apple SPEC Avg (MB/s)	Average All Packages (MB/s)	Worst Average Package (MB/s)	Worst BAND (MB/s)
1EP	SDP	0.3K	100K	3M @ 45`C	122.5	441	489.174	485.278	485.22
8		0.3K	100K	3M @ 45`C			489.133	485.212	485.172
9a		3K	100K	1M @ 45`C			489.219	485.305	485.247
9c		3K	100K	1M @ 35`C			489.257	485.381	485.303
1EP	DDP	0.3K	100K	3M @ 45`C	247.5	891	976.28	972.048	971.932
8		0.3K	100K	3M @ 45`C			976.209	971.97	971.864
9a		3K	100K	1M @ 45`C			976.317	972.18	972.074
9c		3K	100K	1M @ 35`C			976.441	972.142	972.01
1EP	QDP	0.3K	100K	3M @ 45`C	425	1530	1712.871	1712.824	1712.442
8		0.3K	100K	3M @ 45`C			1712.875	1712.834	1712.458
9a		3K	100K	1M @ 45`C			1712.905	1712.83	1712.139
9c		3K	100K	1M @ 35`C			1712.915	1712.826	1712.48
1EP	ODP	0.3K	100K	3M @ 45`C	425	1530	1713.298	1713.069	1711.912
8		0.3K	100K	3M @ 45`C			1713.238	1712.898	1711.095
9a		3K	100K	1M @ 45`C			1713.195	1712.935	1711.606
9c		3K	100K	1M @ 35`C			1713.198	1712.963	1711.053

# 1G X-ray HTDR TLC RC Throughput

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## REF\_FRESH

Check-Point	Density	PE Cycles	Read Disturb	Data Retention	Apple SPEC Min (MB/s)	Apple SPEC Avg (MB/s)	Average All Packages (MB/s)	Worst Average Package (MB/s)	Worst BAND (MB/s)
1EP	SDP	0	0	0	245	465.5	489.536	485.644	485.609
8		0	0	0			489.51	485.639	485.603
9a		0	0	0			489.23	485.301	485.237
9c		0	0	0			489.23	485.301	485.237
1EP	DDP	0	0	0	495	940.5	977.128	973.165	973.11
8		0	0	0			977.133	973.139	973.075
9a		0	0	0			977.123	973.159	973.095
9c		0	0	0			977.123	973.159	973.095
1EP	QDP	0	0	0	850	1615	1713.933	1713.807	1713.739
8		0	0	0			1713.936	1713.805	1713.732
9a		0	0	0			1713.946	1713.827	1713.667
9c		0	0	0			1713.946	1713.827	1713.667
1EP	ODP	0	0	0	850	1615	1713.785	1713.634	1713.155
8		0	0	0			1713.735	1713.491	1713.134
9a		0	0	0			1713.729	1713.475	1712.844
9c		0	0	0			1713.729	1713.475	1712.844

# 1G X-ray HTDR TLC RC Throughput

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## TEST\_COND

Check-Point	Density	PE Cycles	Read Disturb	Data Retention	Apple SPEC Min (MB/s)	Apple SPEC Avg (MB/s)	Average All Packages (MB/s)	Worst Average Package (MB/s)	Worst BAND (MB/s)
1EP	SDP	0.3K	100K	3M @ 45`C	122.5	441	489.456	485.582	485.541
8		0.3K	100K	3M @ 45`C			489.421	485.543	485.52
9a		3K	100K	1M @ 45`C			489.513	485.6	485.569
9c		3K	100K	1M @ 35`C			489.544	485.667	485.625
1EP	DDP	0.3K	100K	3M @ 45`C	247.5	891	976.884	972.655	972.614
8		0.3K	100K	3M @ 45`C			976.808	972.564	972.53
9a		3K	100K	1M @ 45`C			976.969	972.785	972.742
9c		3K	100K	1M @ 35`C			977.058	972.772	972.689
1EP	QDP	0.3K	100K	3M @ 45`C	425	1530	1713.867	1713.799	1713.692
8		0.3K	100K	3M @ 45`C			1713.839	1713.776	1713.665
9a		3K	100K	1M @ 45`C			1713.87	1713.774	1713.608
9c		3K	100K	1M @ 35`C			1713.89	1713.782	1713.707
1EP	ODP	0.3K	100K	3M @ 45`C	425	1530	1713.747	1713.51	1712.858
8		0.3K	100K	3M @ 45`C			1713.755	1713.589	1713.292
9a		3K	100K	1M @ 45`C			1713.772	1713.552	1713.154
9c		3K	100K	1M @ 35`C			1713.746	1713.531	1713.032

# 1G X-ray HTDR TLC RR Throughput

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## REF\_FRESH

Check-Point	Density	PE Cycles	Read Disturb	Data Retention	Apple SPEC Min (KIOPs)	Apple SPEC Avg (KIOPs)	Average All Packages (KIOPs)	Worst Average Package (KIOPs)	Worst BAND (KIOPs)
1EP	SDP	0	0	0	15.5	27.9	29.793	29.48	29.467
8		0	0	0			29.962	29.637	29.63
9a		0	0	0			30.021	29.652	29.638
9c		0	0	0			30.021	29.652	29.638
1EP	DDP	0	0	0	32	57.6	59.858	59.11	59.073
8		0	0	0			59.806	59.213	59.171
9a		0	0	0			59.921	59.041	58.988
9c		0	0	0			59.921	59.041	58.988
1EP	QDP	0	0	0	61.5	110.7	120.867	120.034	119.91
8		0	0	0			120.607	119.602	119.459
9a		0	0	0			121.054	119.687	119.584
9c		0	0	0			121.054	119.687	119.584
1EP	ODP	0	0	0	100	180	215.006	214.708	213.265
8		0	0	0			214.742	213.981	212.991
9a		0	0	0			214.97	214.402	210.95
9c		0	0	0			214.97	214.402	210.95

# 1G X-ray HTDR TLC RR Throughput

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## TEST\_COND

Check-Point	Density	PE Cycles	Read Disturb	Data Retention	Apple SPEC Min (KIOPs)	Apple SPEC Avg (KIOPs)	Average All Packages (KIOPs)	Worst Average Package (KIOPs)	Worst BAND (KIOPs)
1EP	SDP	0.3K	100K	3M @ 45`C	7.75	24.8	29.869	29.535	29.524
8		0.3K	100K	3M @ 45`C			29.912	29.508	29.503
9a		3K	100K	1M @ 45`C			29.986	29.698	29.685
9c		3K	100K	1M @ 35`C			29.909	29.638	29.623
1EP	DDP	0.3K	100K	3M @ 45`C	16	51.2	59.76	59.192	59.144
8		0.3K	100K	3M @ 45`C			59.9	59.309	59.275
9a		3K	100K	1M @ 45`C			59.888	59.287	59.244
9c		3K	100K	1M @ 35`C			60.354	59.631	59.59
1EP	QDP	0.3K	100K	3M @ 45`C	30.75	98.4	120.995	120.315	120.169
8		0.3K	100K	3M @ 45`C			121.026	119.718	119.63
9a		3K	100K	1M @ 45`C			120.622	119.525	119.453
9c		3K	100K	1M @ 35`C			120.838	119.947	119.871
1EP	ODP	0.3K	100K	3M @ 45`C	50	160	214.823	213.948	209.804
8		0.3K	100K	3M @ 45`C			215.546	214.638	213.279
9a		3K	100K	1M @ 45`C			216.112	215.203	214.036
9c		3K	100K	1M @ 35`C			215.968	215.243	214.095

# 1G X-ray HTDR TLC RR 16K Throughput

Confidential

## REF\_FRESH

Check-Point	Density	PE Cycles	Read Disturb	Data Retention	Apple SPEC Min (KIOPs)	Apple SPEC Avg (KIOPs)	Average All Packages (KIOPs)	Worst Average Package (KIOPs)	Worst BAND (KIOPs)
1EP	SDP	0	0	0	8.5	15.3	23.083	22.924	22.919
8		0	0	0			23.061	22.882	22.878
9a		0	0	0			23.07	22.882	22.878
9c		0	0	0			23.07	22.882	22.878
1EP	DDP	0	0	0	17	30.6	45.011	44.743	44.723
8		0	0	0			44.936	44.507	44.477
9a		0	0	0			45.043	44.673	44.652
9c		0	0	0			45.043	44.673	44.652
1EP	QDP	0	0	0	32	57.6	87.555	86.997	86.91
8		0	0	0			87.421	87.127	87.06
9a		0	0	0			87.575	86.752	86.667
9c		0	0	0			87.575	86.752	86.667
1EP	ODP	0	0	0	50	90	136.33	135.924	135.871
8		0	0	0			136.25	135.959	135.869
9a		0	0	0			136.219	135.833	135.769
9c		0	0	0			136.219	135.833	135.769

# 1G X-ray HTDR TLC RR 16K Throughput

Confidential

## TEST\_COND

Check-Point	Density	PE Cycles	Read Disturb	Data Retention	Apple SPEC Min (KIOPs)	Apple SPEC Avg (KIOPs)	Average All Packages (KIOPs)	Worst Average Package (KIOPs)	Worst BAND (KIOPs)
1EP	SDP	0.3K	100K	3M @ 45`C	4.25	13.6	23.08	22.92	22.915
8		0.3K	100K	3M @ 45`C			23.063	22.842	22.837
9a		3K	100K	1M @ 45`C			23.049	22.88	22.873
9c		3K	100K	1M @ 35`C			23.089	22.935	22.931
1EP	DDP	0.3K	100K	3M @ 45`C	8.5	27.2	44.988	44.524	44.509
8		0.3K	100K	3M @ 45`C			45.006	44.636	44.621
9a		3K	100K	1M @ 45`C			44.934	44.679	44.66
9c		3K	100K	1M @ 35`C			45.087	44.827	44.807
1EP	QDP	0.3K	100K	3M @ 45`C	16	51.2	87.556	87.136	87.065
8		0.3K	100K	3M @ 45`C			87.504	86.907	86.803
9a		3K	100K	1M @ 45`C			87.617	87.317	87.229
9c		3K	100K	1M @ 35`C			87.685	87.244	87.18
1EP	ODP	0.3K	100K	3M @ 45`C	25	80	136.312	136.101	136.016
8		0.3K	100K	3M @ 45`C			136.33	136.082	136.043
9a		3K	100K	1M @ 45`C			136.279	135.835	135.781
9c		3K	100K	1M @ 35`C			136.24	135.819	135.742

# 1G X-ray HTDR SDP In-depth (SLC)

Confidential

Check-Point	PE Cycles	Read Disturb	Data Retention	Temp. Cross	Range	# of sectors per grade	# of grades per page	# of senses per block
1EP	1	100K	3M @ 45°C	△30	SLC			
8	10K	100K	3M @ 45°C	△30				
9a	100K	100K	1M @ 45°C	△30				
9c	100K	100K	1M @ 35°C	△30				

# 1G X-ray HTDR DDP In-depth (SLC)

Confidential

Check-Point	PE Cycles	Read Disturb	Data Retention	Temp. Cross	Range	# of sectors per grade	# of grades per page	# of senses per block
1EP	1	100K	3M @ 45°C	△30	SLC			
8	10K	100K	3M @ 45°C	△30				
9a	100K	100K	1M @ 45°C	△30				
9c	100K	100K	1M @ 35°C	△30				

# 1G X-ray HTDR QDP In-depth (SLC)

Confidential

Check-Point	PE Cycles	Read Disturb	Data Retention	Temp. Cross	Range	# of sectors per grade	# of grades per page	# of senses per block
1EP	1	100K	3M @ 45°C	△30	SLC			
8	10K	100K	3M @ 45°C	△30				
9a	100K	100K	1M @ 45°C	△30				
9c	100K	100K	1M @ 35°C	△30				

# 1G X-ray HTDR ODP In-depth (SLC)

Confidential

Check-Point	PE Cycles	Read Disturb	Data Retention	Temp. Cross	Range	# of sectors per grade	# of grades per page	# of senses per block
1EP	1	100K	3M @ 45°C	△30	SLC			
8	10K	100K	3M @ 45°C	△30				
9a	100K	100K	1M @ 45°C	△30				
9c	100K	100K	1M @ 35°C	△30				

# 1G X-ray HTDR SDP Hard Error (SLC)

Confidential

Check-Point	PE Cycles	Read Disturb	Data Retention	Temp. Cross	Range	# of sectors per hard error	# of hard-errors per page
1EP	1	100K	3M @ 45°C	△30	TLC		
8	10K	100K	3M @ 45°C	△30			
9a	100K	100K	1M @ 45°C	△30			
9c	100K	100K	1M @ 35°C	△30			

# 1G X-ray HTDR DDP Hard Error (SLC)

Confidential

Check-Point	PE Cycles	Read Disturb	Data Retention	Temp. Cross	Range	# of sectors per hard error	# of hard-errors per page
1EP	1	100K	3M @ 45°C	△30	TLC		
8	10K	100K	3M @ 45°C	△30			
9a	100K	100K	1M @ 45°C	△30			
9c	100K	100K	1M @ 35°C	△30			

# 1G X-ray HTDR QDP Hard Error (SLC)

Check-Point	PE Cycles	Read Disturb	Data Retention	Temp. Cross	Range	# of sectors per hard error	# of hard-errors per page
1EP	1	100K	3M @ 45°C	△30	TLC		
8	10K	100K	3M @ 45°C	△30			
9a	100K	100K	1M @ 45°C	△30			
9c	100K	100K	1M @ 35°C	△30			

# 1G X-ray HTDR ODP Hard Error (SLC)

Confidential

Check-Point	PE Cycles	Read Disturb	Data Retention	Temp. Cross	Range	# of sectors per hard error	# of hard-errors per page
1EP	1	100K	3M @ 45°C	△30	TLC		
8	10K	100K	3M @ 45°C	△30			
9a	100K	100K	1M @ 45°C	△30			
9c	100K	100K	1M @ 35°C	△30			

# 1G X-ray HTDR Read Scan (SLC)

Confidential

CP	PE Cycles	Read Disturb	Data Retention	Read Scan histogram			
				SDP	DDP	QDP	ODP
1EP	1N	100K	3M @ 45°C				
8	10K	100K	3M @ 45°C				
9a	100K	100K	1M @ 45°C				
9c	100K	100K	1M @ 35°C				

# 1G X-ray HTDR SLC Latency

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Check-Point	PE Cycles	Read Disturb	Data Retention	Bin	Apple SPEC (%)	Average All S5E Packages				Worst Case S5E Package				Apple SPEC (us)	Average tR Worst Case Die						
						SDP	DDP	QDP	ODP	SDP	DDP	QDP	ODP		SDP	DDP	QDP	ODP			
1EP	1	100K	3M @ 45°C	90	95	100	100	100	100	100	100	100	50us	42.72085	40.70184	40.51778	38.4441				
				125	4.49	0	0	0	0	0	0	0						0			
				800	0.5	0	0	0	0	0	0	0						0			
				6500	0.01	0	0	0	0	0	0	0						0			
8	10K	100K	3M @ 45°C	90	95	100	100	100	100	100	100	50us		41.74041	41.49041	41.20354	38.68988				
				125	4.49	0	0	0	0	0	0							0	0		
				800	0.5	0	0	0	0	0	0							0	0		
				6500	0.01	0	0	0	0	0	0							0	0		
9a	100K	100K	1M @ 45°C	90	85	100	100	100	100	100	100			50us	41.67319	42.57219	40.82614	38.66988			
				125	10	0	0	0	0	0	0								0	0	
				800	4.9	0	0	0	0	0	0								0	0	
				6500	0.1	0	0	0	0	0	0								0	0	
9c	100K	100K	1M @ 35°C	90	85	100	100	100	100	100	100				50us	41.71411	41.20795	41.27837	38.69622		
				125	10	0	0	0	0	0	0									0	0
				800	4.9	0	0	0	0	0	0									0	0
				6500	0.1	0	0	0	0	0	0									0	0

# 1G X-ray HTDR SLC Throughput

Confidential

## REF\_FRESH

Check-Point	Density	PE Cycles	Read Disturb	Data Retention	Apple SPEC Min (MB/s)	Apple SPEC Avg (MB/s)	Average All Packages (MB/s)	Worst Average Package (MB/s)	Worst BAND (MB/s)
1EP	SDP	0	0	0	400	760	798.993	797.802	797.754
8		0	0	0			798.992	797.802	797.754
9a		0	0	0			798.992	797.804	797.754
9c		0	0	0			798.992	797.804	797.754
1EP	DDP	0	0	0	800	1520	1595.208	1595.108	1594.995
8		0	0	0			1595.205	1595.106	1594.995
9a		0	0	0			1595.206	1595.101	1594.955
9c		0	0	0			1595.206	1595.101	1594.955
1EP	QDP	0	0	0	850	1615	1710.23	1710.162	1709.991
8		0	0	0			1710.235	1710.147	1710.014
9a		0	0	0			1710.242	1710.155	1710.014
9c		0	0	0			1710.242	1710.155	1710.014
1EP	ODP	0	0	0	850	1615	1712.338	1712.23	1710.501
8		0	0	0			1712.317	1712.166	1710.728
9a		0	0	0			1712.339	1712.172	1710.444
9c		0	0	0			1712.339	1712.172	1710.444

# 1G X-ray HTDR SLC Throughput

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## TEST\_COND

Check-Point	Density	PE Cycles	Read Disturb	Data Retention	Apple SPEC Min (MB/s)	Apple SPEC Avg (MB/s)	Average All Packages (MB/s)	Worst Average Package (MB/s)	Worst BAND (MB/s)
1EP	SDP	0.3K	100K	3M @ 45`C	200	720	798.986	797.79	797.754
8		0.3K	100K	3M @ 45`C			798.987	797.791	797.734
9a		3K	100K	1M @ 45`C			798.984	797.789	797.734
9c		3K	100K	1M @ 35`C			798.984	797.79	797.714
1EP	DDP	0.3K	100K	3M @ 45`C	400	1440	1595.158	1595.069	1594.916
8		0.3K	100K	3M @ 45`C			1595.156	1595.064	1594.916
9a		3K	100K	1M @ 45`C			1595.158	1595.061	1594.877
9c		3K	100K	1M @ 35`C			1595.154	1595.075	1594.561
1EP	QDP	0.3K	100K	3M @ 45`C	425	1530	1710.248	1710.156	1709.991
8		0.3K	100K	3M @ 45`C			1710.25	1710.166	1710.014
9a		3K	100K	1M @ 45`C			1710.234	1710.14	1709.968
9c		3K	100K	1M @ 35`C			1710.235	1710.156	1710.014
1EP	ODP	0.3K	100K	3M @ 45`C	425	1530	1712.32	1712.219	1710.206
8		0.3K	100K	3M @ 45`C			1712.334	1712.138	1710.206
9a		3K	100K	1M @ 45`C			1712.322	1712.107	1710.717
9c		3K	100K	1M @ 35`C			1712.341	1712.224	1710.977

# 1G X-ray HTDR SLC RC Throughput

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## REF\_FRESH

Check-Point	Density	PE Cycles	Read Disturb	Data Retention	Apple SPEC Min (MB/s)	Apple SPEC Avg (MB/s)	Average All Packages (MB/s)	Worst Average Package (MB/s)	Worst BAND (MB/s)
1EP	SDP	0	0	0	400	760	801.461	800.262	799.316
8		0	0	0			801.461	800.264	799.306
9a		0	0	0			801.461	800.264	799.306
9c		0	0	0			801.461	800.264	799.306
1EP	DDP	0	0	0	800	1520	1600.342	1600.294	1597.978
8		0	0	0			1600.342	1600.297	1598.038
9a		0	0	0			1600.343	1600.303	1598.018
9c		0	0	0			1600.343	1600.303	1598.018
1EP	QDP	0	0	0	850	1615	1713.561	1713.499	1712.204
8		0	0	0			1713.557	1713.469	1712.192
9a		0	0	0			1713.551	1713.496	1712.181
9c		0	0	0			1713.551	1713.496	1712.181
1EP	ODP	0	0	0	850	1615	1713.689	1713.453	1713.064
8		0	0	0			1713.702	1713.382	1713.15
9a		0	0	0			1713.705	1713.495	1713.17
9c		0	0	0			1713.705	1713.495	1713.17

# 1G X-ray HTDR SLC RC Throughput

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## TEST\_COND

Check-Point	Density	PE Cycles	Read Disturb	Data Retention	Apple SPEC Min (MB/s)	Apple SPEC Avg (MB/s)	Average All Packages (MB/s)	Worst Average Package (MB/s)	Worst BAND (MB/s)
1EP	SDP	0.3K	100K	3M @ 45`C	200	720	801.461	800.261	799.306
8		0.3K	100K	3M @ 45`C			801.461	800.262	799.306
9a		3K	100K	1M @ 45`C			801.461	800.262	799.306
9c		3K	100K	1M @ 35`C			801.461	800.262	799.306
1EP	DDP	0.3K	100K	3M @ 45`C	400	1440	1600.342	1600.293	1597.978
8		0.3K	100K	3M @ 45`C			1600.342	1600.299	1597.998
9a		3K	100K	1M @ 45`C			1600.342	1600.297	1597.998
9c		3K	100K	1M @ 35`C			1600.342	1600.303	1597.998
1EP	QDP	0.3K	100K	3M @ 45`C	425	1530	1713.537	1713.457	1712.181
8		0.3K	100K	3M @ 45`C			1713.553	1713.467	1712.204
9a		3K	100K	1M @ 45`C			1713.543	1713.457	1712.181
9c		3K	100K	1M @ 35`C			1713.531	1713.443	1712.192
1EP	ODP	0.3K	100K	3M @ 45`C	425	1530	1713.691	1713.442	1713.14
8		0.3K	100K	3M @ 45`C			1713.754	1713.438	1713.164
9a		3K	100K	1M @ 45`C			1713.692	1713.482	1713.307
9c		3K	100K	1M @ 35`C			1713.719	1713.568	1713.221

# 1G X-ray HTDR SLC RR Throughput

Confidential

## REF\_FRESH

Check-Point	Density	PE Cycles	Read Disturb	Data Retention	Apple SPEC Min (KIOPs)	Apple SPEC Avg (KIOPs)	Average All Packages (KIOPs)	Worst Average Package (KIOPs)	Worst BAND (KIOPs)
1EP	SDP	0	0	0	29	52.2	58.074	57.596	57.56
8		0	0	0			58.111	57.62	57.583
9a		0	0	0			58.11	57.564	57.454
9c		0	0	0			58.11	57.564	57.454
1EP	DDP	0	0	0	58	104.4	111.529	110.42	110.208
8		0	0	0			110.787	109.131	108.981
9a		0	0	0			112.01	110.209	110.081
9c		0	0	0			112.01	110.209	110.081
1EP	QDP	0	0	0	100	180	198.46	195.613	194.081
8		0	0	0			197.256	195.595	193.112
9a		0	0	0			198.85	195.161	193.843
9c		0	0	0			198.85	195.161	193.843
1EP	ODP	0	0	0	100	180	220.153	218.874	215.573
8		0	0	0			220.674	217.147	215.716
9a		0	0	0			221.408	219.328	216.08
9c		0	0	0			221.408	219.328	216.08

# 1G X-ray HTDR SLC RR Throughput

Confidential

## TEST\_COND

Check-Point	Density	PE Cycles	Read Disturb	Data Retention	Apple SPEC Min (KIOPs)	Apple SPEC Avg (KIOPs)	Average All Packages (KIOPs)	Worst Average Package (KIOPs)	Worst BAND (KIOPs)
1EP	SDP	0.3K	100K	3M @ 45`C	14.5	46.4	57.561	57.312	57.268
8		0.3K	100K	3M @ 45`C			58.034	57.576	57.491
9a		3K	100K	1M @ 45`C			57.868	57.429	57.377
9c		3K	100K	1M @ 35`C			58.067	57.581	57.507
1EP	DDP	0.3K	100K	3M @ 45`C	29	92.8	110.986	109.865	109.642
8		0.3K	100K	3M @ 45`C			111.296	110.532	110.384
9a		3K	100K	1M @ 45`C			111.495	110.621	110.412
9c		3K	100K	1M @ 35`C			111.555	110.004	109.828
1EP	QDP	0.3K	100K	3M @ 45`C	50	160	198.189	195.635	194.861
8		0.3K	100K	3M @ 45`C			198.971	196.808	194.607
9a		3K	100K	1M @ 45`C			198.631	196.514	195.259
9c		3K	100K	1M @ 35`C			198.326	194.261	193.206
1EP	ODP	0.3K	100K	3M @ 45`C	50	160	220.986	220.436	215.275
8		0.3K	100K	3M @ 45`C			220.976	217.316	215.556
9a		3K	100K	1M @ 45`C			221.826	220.086	215.658
9c		3K	100K	1M @ 35`C			220.844	218.772	215.743

# 1G X-ray HTDR SLC RR 16K Throughput

Confidential

## REF\_FRESH

Check-Point	Density	PE Cycles	Read Disturb	Data Retention	Apple SPEC Min (KIOPs)	Apple SPEC Avg (KIOPs)	Average All Packages (KIOPs)	Worst Average Package (KIOPs)	Worst BAND (KIOPs)
1EP	SDP	0	0	0	14.5	26.1	40.183	40.049	40.037
8		0	0	0			40.193	40.089	40.079
9a		0	0	0			40.166	40.06	40.041
9c		0	0	0			40.166	40.06	40.041
1EP	DDP	0	0	0	29	52.2	76.975	76.541	76.506
8		0	0	0			77.684	76.869	76.829
9a		0	0	0			77.195	76.438	76.391
9c		0	0	0			77.195	76.438	76.391
1EP	QDP	0	0	0	47.5	85.5	121.65	120.87	120.761
8		0	0	0			121.599	120.08	119.967
9a		0	0	0			121.876	121.385	121.246
9c		0	0	0			121.876	121.385	121.246
1EP	ODP	0	0	0	50	90	138.212	137.64	137.557
8		0	0	0			138.09	137.785	137.74
9a		0	0	0			138.442	138.114	138.053
9c		0	0	0			138.442	138.114	138.053

# 1G X-ray HTDR SLC RR 16K Throughput

Confidential

## TEST\_COND

Check-Point	Density	PE Cycles	Read Disturb	Data Retention	Apple SPEC Min (KIOPs)	Apple SPEC Avg (KIOPs)	Average All Packages (KIOPs)	Worst Average Package (KIOPs)	Worst BAND (KIOPs)
1EP	SDP	0.3K	100K	3M @ 45`C	7.25	23.2	40.187	40.074	40.063
8		0.3K	100K	3M @ 45`C			40.216	40.036	40.026
9a		3K	100K	1M @ 45`C			40.193	40.071	40.054
9c		3K	100K	1M @ 35`C			40.257	40.196	40.186
1EP	DDP	0.3K	100K	3M @ 45`C	14.5	46.4	77.354	76.952	76.916
8		0.3K	100K	3M @ 45`C			77.226	75.979	75.949
9a		3K	100K	1M @ 45`C			76.76	75.914	75.861
9c		3K	100K	1M @ 35`C			76.814	76.004	75.971
1EP	QDP	0.3K	100K	3M @ 45`C	23.75	76	121.549	120.638	120.462
8		0.3K	100K	3M @ 45`C			122.239	120.844	120.734
9a		3K	100K	1M @ 45`C			121.256	120.816	120.643
9c		3K	100K	1M @ 35`C			121.798	119.891	119.709
1EP	ODP	0.3K	100K	3M @ 45`C	25	80	138.413	137.704	137.566
8		0.3K	100K	3M @ 45`C			138.135	136.812	136.706
9a		3K	100K	1M @ 45`C			138.215	137.698	137.66
9c		3K	100K	1M @ 35`C			138.378	138.025	137.968

# Controller Block Reliability 1 (SDP/DDP)

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Check-Point	Density	PE Cycles	Read Disturb	Data Retention	Temp. Cross	Range	Bit-flip histogram	Maintenances histogram
Boot Flow 1	SDP	10	10M	5 Year @ 55°C	△100	SLC		
			12M		△40			
	DDP	10	10M	5 Year @ 55°C	△100	SLC		
			12M		△40			

# Controller Block Reliability 1 (QDP/ODP)

Confidential

Check-Point	Density	PE Cycles	Read Disturb	Data Retention	Temp. Cross	Range	Bit-flip histogram	Maintenances histogram
Boot Flow 1	QDP	10	10M	5 Year @ 55°C	△100	SLC		
			12M		△40			
	ODP	10	10M		△100	SLC		
			12M		△40			

# Controller Block Reliability 2 (SDP/DDP)

Confidential

Check-Point	Density	PE Cycles	Read Disturb	Data Retention	Temp. Cross	Range	Bit-flip histogram	Maintenances histogram
Boot Flow 2	SDP	100	10M	5 Year @ 55°C	Δ100	SLC		
			12M		Δ40			
	DDP	100	10M		Δ100	SLC		
			12M		Δ40			

# Controller Block Reliability 2 (QDP/ODP)

Confidential

Check-Point	Density	PE Cycles	Read Disturb	Data Retention	Temp. Cross	Range	Bit-flip histogram	Maintenances histogram
Boot Flow 2	QDP	100	10M	5 Year @ 55°C	Δ100	SLC		
			12M		Δ40			
	ODP	100	10M	5 Year @ 55°C	Δ100	SLC		
			12M		Δ40			

FLOW	Density (GB)	Full Qual			
		tProg (us)		tBERS (us)	
		Max	Avg	Max	Avg
Qual8 – TLC EOL Reliability	512	803.0229	767.1802	4571.164	4523.464
Qual10 – TLC Latency Reliability		798.6916	763.1131	4575.146	4527.847
Qual12 – SLC EOL Reliability		9	9	4155.354	3479.846
Qual13 – SLC Latency Reliability		9	9	4181.229	3501.121