Comparison of
Current 3D NAND Chip & Cell Architecture

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NAND Technology/Products Roadmap

Manufacturers	2014	2015	2016	2017	2018	2019	2020	2021	2022
SAMSUNG	2D; 1X 19nm	1Y 16nm		1Z 14nm					Tech Insights
					Z-NAND (Z-SSD, V-NAND Cell, 48L SLC:1st gen.)				
	3D V-NAND™	32L 20nm	48L 20nm	64L 20nm, 64Lx1, TLC/QLC 256/512G/1T		92L 20nm, 92Lx1 256/512G/1T	128L 20nm, 64Lx2 (PUC?) 256G/512G/1T	1XXL 9XLx2	2XXL
TOSHIBA / WD Western Digital®	2D; 19Y	15nm_1st	15nm_2nd						
						XL-FLASH (Toshiba), LLF (WDC, 96L SLC/MLC)			
		3D NAND	48L (BiCS2) 19nm, 32GB TLC	64L (BiCS3) 19nm, TLC 128/256/512G		96L (BiCS4) 19nm, TLC/QLC 256/512G T/1.3T	112/128L (BiCS5) 19nm, 64Lx2 256/512G T/1.3T Q	192L (BiCS6) 96Lx2 (PUC?)	2XXL
Micron / intel / IM Flash Technologies (an intel, micron venture)	2D; 16nm				1Z				
				Intel Optane SSD/DC DIMM			Intel Optane DCPMM, Micron QuantX		
		3D NAND	32T 40nm, FG	64T 20nm, 32Lx2, TLC/QLC 256G/512G/1T		96T 20nm, FG, 48Lx2 512G TLC/1T QLC	128T Intel, Micron (CTF) 512G TLC/1T QLC	192T Intel, Micron (CTF)	2XXL
SK hynix	2D; 16nm			1Y/1Y'/1Z 15/14nm, E3NAND					
	3D NAND		36L (V2_3D) 31nm, 16 GB MLC	48L (V3_3D) 31nm, 32GB TLC	72/76L (V4_3D) 31nm, 40L+32L 256G M&T/512G	96L (V5_4D) 4D PUC 512G/1T	128L (V6_4D) 4D NAND PUC 512G/1T TLC/1T QLC	192L (V7_4D) 4D NAND PUC	2XXL
(YMTC logo)					3D NAND	32L (Gen.1) Conventional, 8GB	64L (Gen.2) Xtacking™	128L (Gen.3) Xtacking™, 64Lx2	192L
Integration Innovation	Gate Materials (CoSi/NiSi → W)	DPT → QPT, Airgap (2D) (20/19nm → 15/14nm)		3D GAA/CTF/FG, 32L/36L/48L/64L/72L/9XL (BiCS, TCAT, P-BiCS, CuA, Double-stacked)			128L/192L/256L and more (Stack, PUC, Xtacking, Triple Ox.)		

3D NAND Tech. Trend (MP on market)

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8 µm
7 µm
6 µm
5 µm
4 µm
3 µm
2 µm
1 µm

Just Built
Just Built
Just Built

24 L
32 L
48 L
64 L
92 L
48 L
64 L
96 L
32 L
64 L
96 L
36 L
48 L
72 L
76 L

2D | Samsung | Toshiba/WDC | Intel/Micron | SK Hynix

3D NAND Dice (up to date/on the market)

- ✓ Samsung 92L newly released
- ✓ Toshiba/WDC 96L newly released
- ✓ Micron/Intel 96L newly released
- ✓ SK Hynix 72L TLC (512Gb die) released
- ✓ 3D QLC Dice released
  - Samsung 64L QLC (5.6 Gb/mm²)
  - Intel 64L QLC (6.5 Gb/mm²)
- ✓ Samsung Z-NAND (Z-SSD) 1st Gen. released

Makers	3D NAND									
SAMSUNG	V1 24L MLC (128 Gb)	V2-1 32L MLC (128 Gb)	V2-2 32L TLC (128 Gb)	V3 48L TLC (256 Gb)	Z-SSD Z-NAND (48L SLC)	V4-1 64L TLC (256 Gb)	V4-2 64L TLC (512 Gb)	V4Q 64L QLC (1 Tb)	V5-1 92L TLC (256 Gb)	V5-2 92L TLC (512 Gb)
TOSHIBA / Western Digital	BiCS1 (not released)	BiCS2 48L TLC (256 Gb)	BiCS3 64L TLC (256 Gb)	BiCS3 64L TLC (512 Gb)	BiCS4 96L TLC (256 Gb)					
Micron / intel / IM Flash Technologies	G1 32L TLC (384 Gb)	G2-1 64L TLC (256 Gb)	G2-2 64L TLC (512 Gb)	G2Q 64L QLC (1 Tb)	G3 96L TLC (512 Gb)					
SK hynix	V1 (not released)	V2 36L MLC (128 Gb)	V3 48L TLC (256 Gb)	V4-1 72L 256G TLC	V4-2 72L 512G TLC					

2017 ~ 2018 Released

2018 ~ 2019 Released

3D NAND Bit Density Trend

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3D NAND Bit Density Trend

Samsung
Toshiba/WDC
Micron/Intel
SK Hynix

6.26
5.53
6.09
5.68
5.03
4.74
4.55
4.4
4.3
4.09
3.92
3.58
3.54
3.31
2.78
2.61
2.61
2.48
2.28
2.17
2.04
1.87
1.54
1.41

2D 14nm TLC NAND

32/36L
48L TLC
64/72L TLC
96L TLCL
QLC (64L)

Mobile NAND FLASH Components

2D NAND | 2D/3D NAND

	2012	2013	2014	2015	2016	2017	2018	2019
Apple iPhone	**5** • MLC • eMMC • 8 GB/die • Toshiba • SK Hynix	**5C, 5S** • MLC • eMMC • E2NAND3.0 • 8 GB/die • Toshiba • SK Hynix	**6, 6+** • MLC • eMMC • E2NAND3.0 • 8 GB/die • Toshiba • SK Hynix	**6S, 6S+** • MLC, TLC • eMMC • E3NAND • 8, 16 GB/die • 32 GB/die • Toshiba • SanDisk • SK Hynix	**SE, 7, 7+** • MLC, TLC • eMMC • 8, 16 GB/die • 32 GB/die • Toshiba • Samsung • SK Hynix	**8, 8+, X** • MLC, TLC • eMMC • 16 GB/die • 32 GB/die • Toshiba/WD • Samsung	**XR, XS/XS Max** • TLC • Flash Storage • 32 GB/die • 64 GB/die • Toshiba/WD • Samsung • SK Hynix	
Samsung Galaxy	**S3, Note 2** • MLC • eMMC • 4, 8 GB/die • Toshiba • Samsung • SanDisk	**S4, Note 3** • MLC • eMMC • 8 GB/die • Toshiba • Samsung	**S5, Note 4** • MLC • eMMC • 8 GB/die • Toshiba • Samsung	**S6, Note 5** • MLC • UFS • 8 GB/die • Toshiba • Samsung	**S7, S7 E, Note 7** • MLC • UFS 2.0 • 8 GB/die • Toshiba • Samsung	**S8, S8+, Note 8** • MLC • eMMC • UFS 2.1 • 16 GB/die • Toshiba • Samsung	**S, S9+** • TLC • UFS 2.1 • 256Gb/die 64 GB (S9) 256 GB (S9+) • Toshiba • Samsung	**S10E, S10, S10+** • TLC • UFS 2.1 • 64L/92L 64L 256Gb/die 64L 512Gb/die 92L 512Gb/die • Samsung

iPhone XS/XS Max vs. Galaxy S10 Series

❑ iPhone X/XS/XS Max

Items	iPhone X	iPhone XS, XS Max
Device Model	A1901	A1920, A1921
RAM (Main Board)	3 GB LPDDR4 in A11 PoP PKG	4 GB LPDDR4 in A12 PoP PKG
RAM Details	SK Hynix H9HKNNNDBMAUUR-NEH 4 Dice/PKG H54M6D63M, 21nm_2nd 6 Gb/die, 0.153 Gb/mm^2	Micron Technology MT53D512M64D4SB-046 4 Dice/PKG 211N 2017, 1X nm 8 Gb/die, 0.152 Gb/mm^2
NAND	64 GB 2D TLC NAND	256 GB 3D TLC NAND (128 GB & 512 GB available)
NAND Details	Toshiba TSBL227 4 NAND dice + 1 Controller FFK8 128G, 2D 15nm_2nd 128 Gb/die, 1.28 Gb/mm^2	SanDisk SDMPEGF18 8 NAND dice + 1 Controller FRN1256G, 3D 64L (V4) TLC 256 Gb/die, 3.40 Gb/mm^2
EEPROM	STMicroelectronics (Main) ON Semiconductor (RF)	**XS Max 512 GB** **SK Hynix H23Q4T80K6MES-BC** **8 NAND dice + 1 Controller** **H25FT4MA0, 3D 72L V4 TLC** **512 Gb/die, 4.3 Gb/mm^2**
Memory in Baseband Processor	Intel PMB9948 Micron LPDDR2 128 MB 1 LPDDR2 die + 1 Processor	

❑ Galaxy S10 Series

Products	S10E (Light)	S10	S10+	S10 5G
Model	SM-G970	SM-G973	SM-G975	SM-G977
Sub-Model	970U, 970F, 970N, 9700 970W, 9708, 970X	973U, 973F, 973F/DS, 973N, 9730, 973W, 9738, 973X	975U, 975F, 975N, 9750 975W, 9758, 975X, 975F/DS	977U, 977F, 977N, 9770
NAND Storage	128GB, 256GB	128GB, 256GB	128GB (975F/DS), 512GB (975F), 1TB (975N)	256GB
NAND Components	KLUDG4U1EA	KLUDG4U1EA-B0C1	975N: KLUGGAR1FA-B2C1 (KR) 975F: KLUFG8R1EM-B0C1 (US) 975F/DS: KLUDG4U1EA-B0C1	977N: KLUEG8U1EA-B0C1 (KR)
NAND Die Markings	K9AEGD8H0A	K9AEGD8H0A	975N: K9AHGD8J0A 975F: K9AHGD8J0M 975F/DS: K9AFGD8H0A	977N: K9AFGD8H0A
NAND Die Information	4 Dies+1 Cont./PKG 64L V-NAND 256Gb Die	4 Dies+1 Cont./PKG 64L V-NAND 256Gb Die	975N: 92L V-NAND 512Gb Die 975F: 64L V-NAND 512Gb Die 975F/DS: 64L V-NAND 256Gb Die	64L V-NAND 256Gb Die
(D)RAM	8GB (6GB)	8GB	[illegible]GB (975N), 8GB (975F, F/DS)	8GB
DRAM Components	K3UH6H60BMAGCL	K3UH7H70AMAGCL	975N: K3UHAHA0AMAGCL	K3UH7H70AMAGCL
DRA				

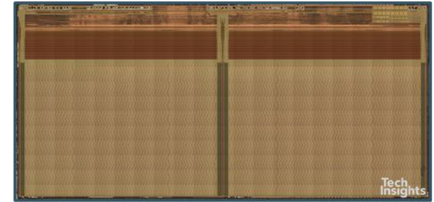
Products Model	S10+ SM-G975NCWFKOO	S10+ SM-G975F/DS	S10+ SM-G975FCKGDBT
Sales Location	Korea	US	US
NAND Storage	1 TB	128 GB	512 GB
NAND Components	KLUGGAR1FA-B2C1	KLUDG4U1EA-B0C1	KLUFG8R1EM-B0C1
NAND Die Markings	K9AHGD8J0A	K9AFGD8H0A	K9AHGD8J0M
NAND Die Details	16 Dies+1 Cont./PKG 92L V-NAND 512Gb Die	4 Dies+1 Cont./PKG 64L V-NAND 256Gb Die	8 Dies+1 Cont./PKG 64L V-NAND 512Gb Die

Recent NAND Components on the market

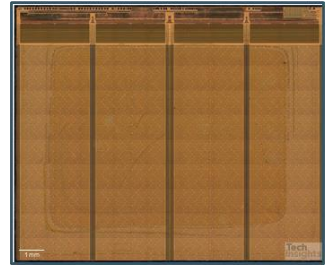
Category	Parent Devices	NAND Component	Manufacturer	#Die/PKG	Description
Mobile Phone	Samsung Galaxy S10+	THGAF8T0T43BAIR	Toshiba	4	128 GB 3D TLC (64L)
	Xiaomi Mi 9 SE	H9HQ53AECMMDAR-KEM	SK Hynix	11	BGA: 16 GB 3D TLC
	Huawei Honor V20	KLUDG4U1EA-B0C1	Samsung	4	128 GB 3D TLC (64L)
	LG Stylo 4+	MT29TZZZ7D7DKLAH	Micron	3	eMMC: 32 GB TLC (2D)
Tablets /Notebook	Dell XPS 13	H27Q1T8P0A2R (SSD)	SK Hynix	4	32 GB 3D TLC (72L)
	Apple iPad Pro 11	TSB3245	Toshiba	8	256 GB 3D TLC (64L)
	Google Pixelbook C0A	KLMDG4UERM-B041	Samsung	4	32 GB 3D TLC (48L)
	Microsoft Surface Go	H26M74002HMR	SK Hynix	4	64 GB TLC (2D)
IoT	Amazon Echo Dot	KMFJ20005A-B213	Samsung	1	eMMC: 4 GB (2D)
SSD	Samsung Z-SSD 983 ZET	K9QHGB8J0M-CCB0	Samsung	8	64 GB Z-NAND (48L, SLC)
	Samsung SSD PM983	K9DUGB8H1A-DCK0	Samsung	16	512 GB 3D TLC (64L)
	Intel SSD 660p	29F04T2ANCQHI	Intel	4	512 GB 3D QLC (64L)
	Intel SSD DC P4511	29F04T2ANCTHI	Intel	8	512 GB 3D TLC (64L)

Comparison Die Design

❑ Conventional Die Design (Planes)

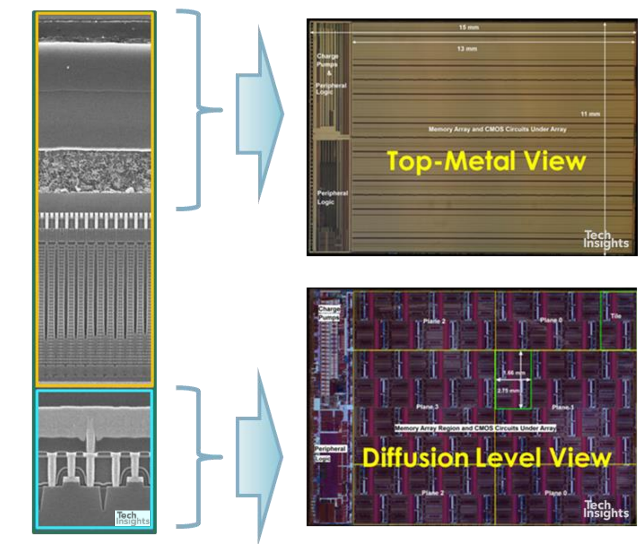


3D V-NAND (Samsung 64L eUFS2.1)

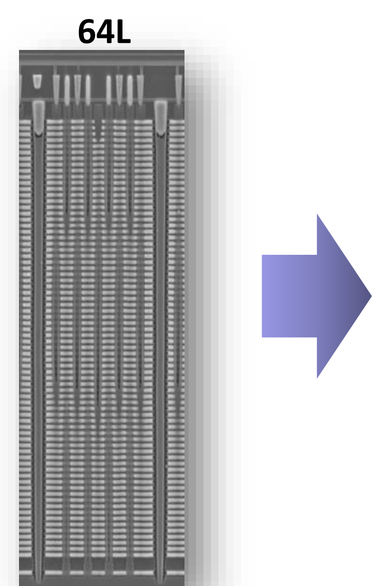


Ref. 2D NAND (SK Hynix 2Z)

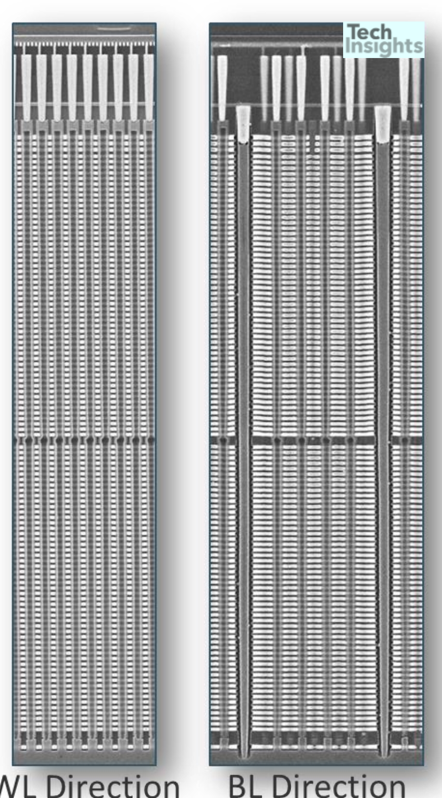
❑ Intel/Micron Die Design (Tiles/CuA)



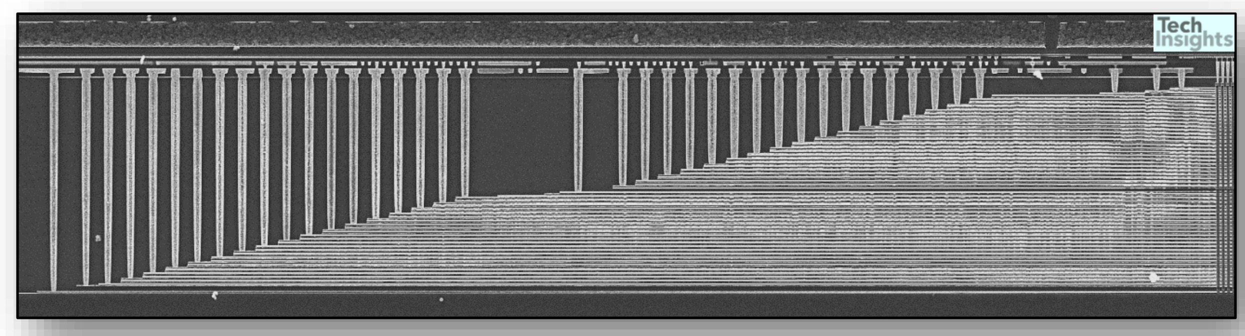
Toshiba/WDC 96L BiCS4 Cell Architecture



Items	Toshiba/WDC 96L BiCS4
Device Type	CTF BiCS4
Total Number of Gates including dummy gates & selectors	109
Gates Configuration (Likely)	3 USGs 2 DWLs (upper, 2nd stack) 48 WLs (2nd stack) 2 DWLs (lower, 2nd stack) 2 DWLs (upper, 1st stack) 48 WLs (1st stack) 2 DWLs (lower, 1st stack) 1 GST / 1 LSG
NAND String Stack	Double stack
LSG Process (Lower Selector)	SEG
# Holes between CSLs including dummy hole	9
WLP Trimming Mask	Line + Castle Type + Line
BL Half-Pitch (Patterning)	19.0 nm
VC Hole Height	6.17 µm
CSL Materials	Poly-Si/TiN with W capping
# Metals	4

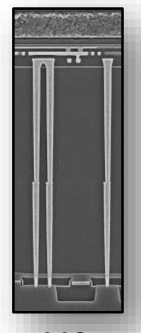


Toshiba/WDC 96L BiCS4 WLPC & MC



WLP Contacts

BL Direction (Edge/Dummy)



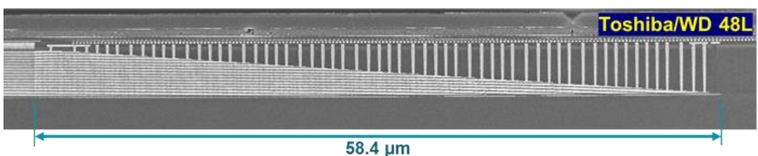
MC

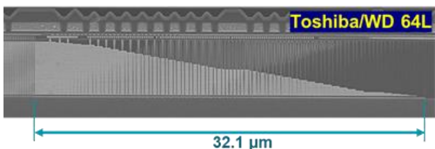
- ✓ Trimming/Sliming for 1st deck
- ✓ MC1
- ✓ Trimming/Sliming for 2nd deck
- ✓ MC2
- ✓ WLP Contacts

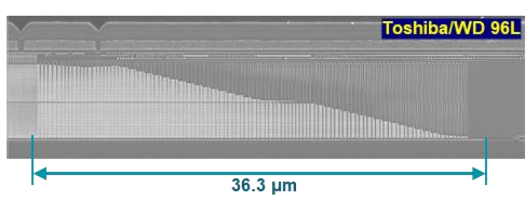
Toshiba/WDC 3D BiCS NAND: 48L *vs.* 64L *vs.* 96L

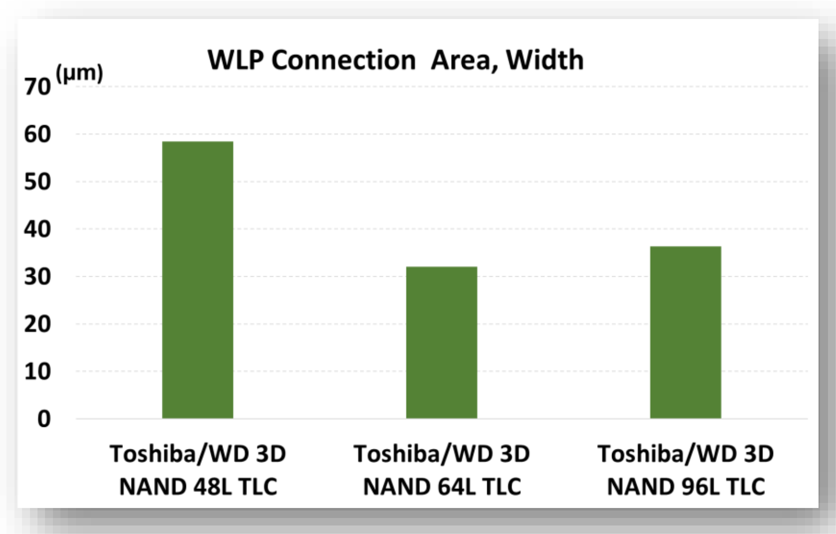
❑ WLP Connection Size, Width (Area Penalty)

- ✓ 48L to 64L: Area Penalty 45 % reduced by trimming mask/process changes
- ✓ 64L to 96L: Area Penalty 13 % increased

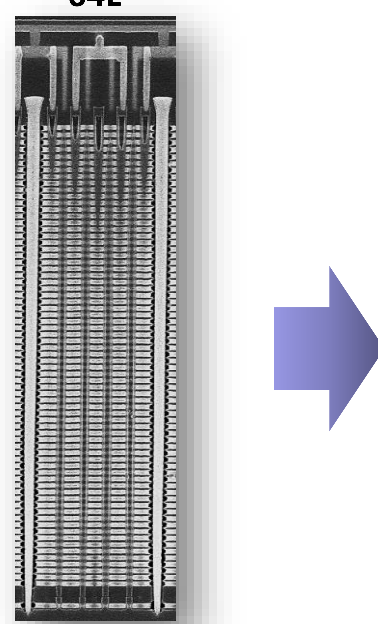




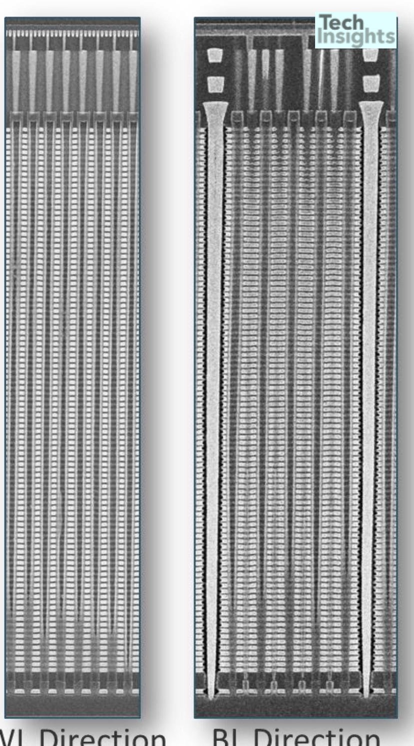




Samsung 92L V-NAND Cell Architecture

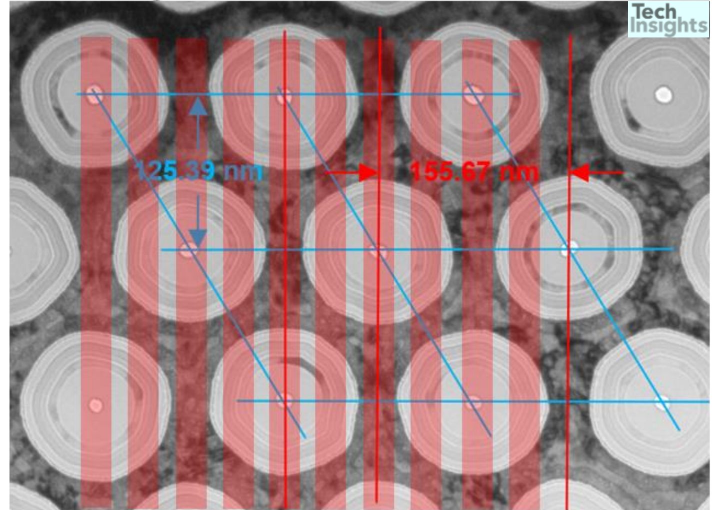


Items	Samsung 92L V-NAND
Device Type	CTF V-NAND
Total Number of Gates including dummy gates & selectors	100
Gates Configuration (Likely)	2 SSTs 3 DWLs (upper) 92 WLs 2 DWLs (lower) 1 GST
NAND String Stack	1-stack
GST Process (Lower Selector)	SEG
# Holes between CSLs including dummy hole	9
WLP Trimming Mask	Castle Type
BL Half-Pitch (Patterning)	19.5 nm
VC Hole Height	5.28 µm
CSL Materials	W
# Metals	4



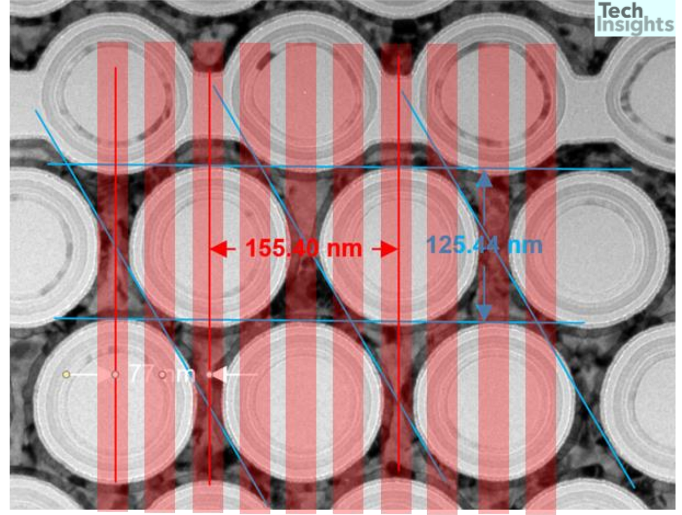
Samsung V-NAND VC Pitch: 64L *vs.* 92L

Samsung 64L



BL Pitch ~ 39nm

Samsung 92L

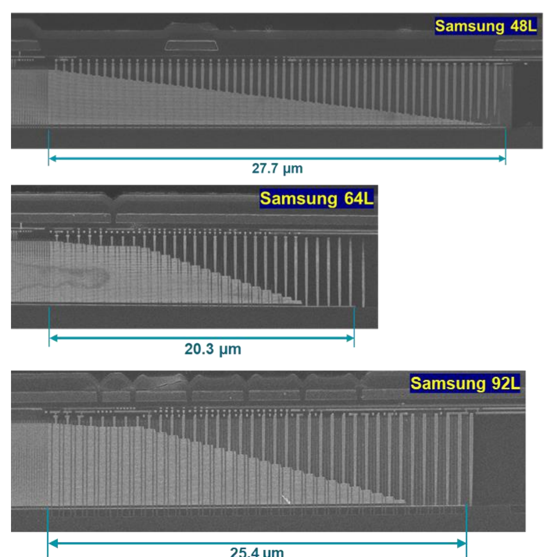


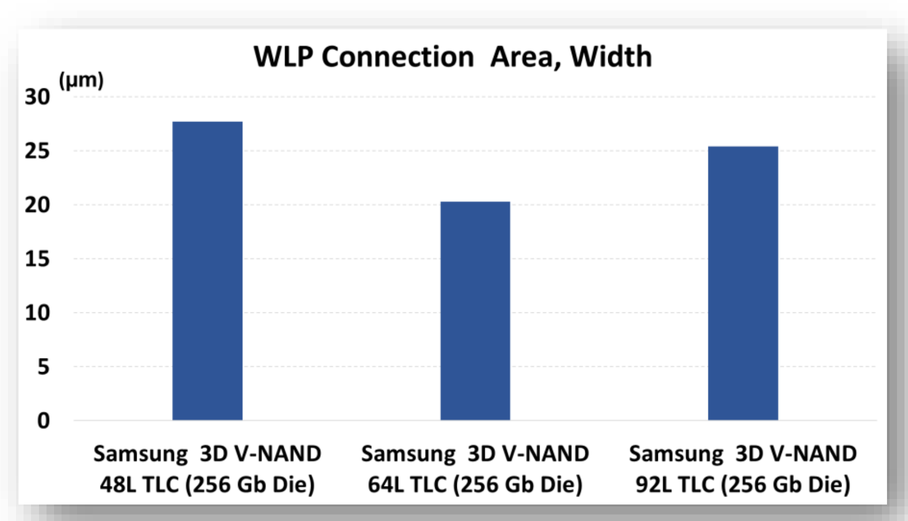
BL Pitch ~ 39nm

Samsung 3D V-NAND: 48L *vs.* 64L *vs.* 92L

❑ WLP Connection Size, Width (Area Penalty)

- ✓ 48L to 64L: Area Penalty 27 % reduced by trimming mask/process changes
- ✓ 64L to 92L: Area Penalty 25 % increased





WLP Connection Size: Samsung vs. Toshiba/WDC

❑ WLP Connection Size, Width (Area Penalty)

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WLP Size_Width (µm)

Toshiba/WDC
Samsung

58.4
27.7
32.1
20.3
36.3
25.4

48L
64L
9XL

Samsung Z-NAND Technology

Items	Samsung 48L TLC NAND Die	Samsung Z-NAND Die
Parent Products	Example: K9DUGB857M Portable T3 2TB SSD	H9QHGB8J0M-CCB0 Z-SSD MZ-PZA960 (960 GB)
Die Markings	K9AFGD8U0M	K9FCGD8J0M
Memory Cap. / Die	256 Gb	64 Gb
Cell Operation	TLC	SLC
Die Size	99.84 mm^2 (7.8 mm x 12.8 mm)	101.26 mm^2 (8.3 mm x 12.2 mm)
Bit Density	2.56 Gb/mm^2	0.63 Gb/mm^2
Array Area Efficiency	70.0 %	51.8 %
Tech. Node	48L 3D V-NAND	48L 3D V-NAND
# Dies / PKG	16 NAND Dies + 2 F-Chips	8 NAND Dies + 1 F-Chip
# Planes	2	8
Die Photograph		

Micron/Intel 3D FG CuA NAND: 32L vs. 64L vs. 96L

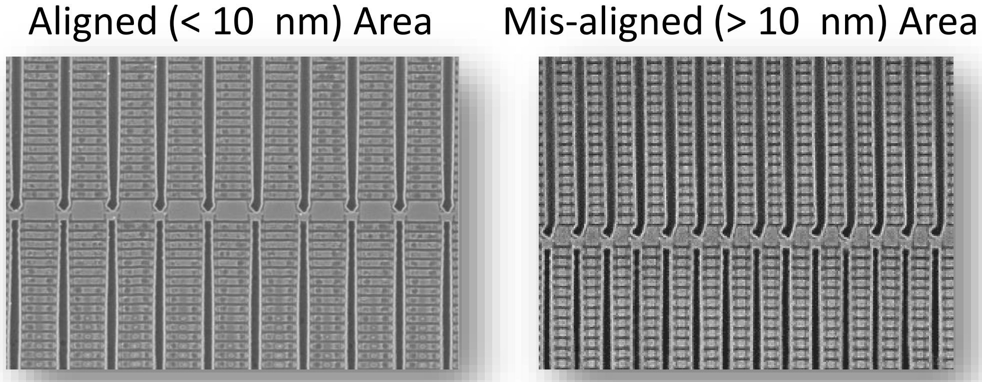
Items	32L TLC (384 Gb Die)	64L TLC (512 Gb Die)	96L TLC (512 Gb Die)
Product (Ex.)	Crucial MX300 750 GB SSD	Intel SSD DC P4511 Gloway GW64T171 SSD	Crucial BX500 960 GB SSD
Die Markings	L06B	B17A	B27A
Bit Density	2.28 Gb/mm^2	4.74 Gb/mm^2	6.25 Gb/mm^2
Die Size (Sealed)	168.2 mm^2 (15.36 mm x 10.95 mm)	108.1 mm^2 (13.83 mm x 7.81 mm)	81.76 mm^2 (11.20 mm x 7.31 mm)
# Tiles / Die	32	32	32
Array Efficiency	84.9 %	92.0 %	91.5 %
Die Floorplan	1 Tile; Tech Insights	1 Tile; Tech Insights	1 Tile; Tech Insights

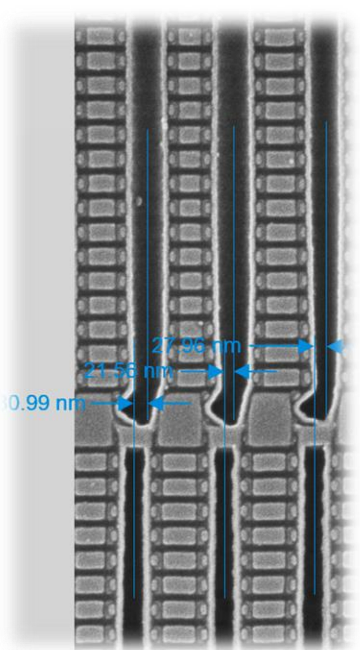
Micron/Intel 3D FG CuA NAND: 32L vs. 64L vs. 96L

Items	32L TLC (384 Gb Die)	64L TLC (512 Gb Die)	96L TLC (512 Gb Die)
Bit Density	2.28 Gb/mm^2	4.74 Gb/mm^2	6.25 Gb/mm^2
Stack	Single	Double	Double
# Active Gates	32	66	98
# Total Gates (Including Selectors)	40 (38 +2)	76 (37 + 37 + 2)	108 (53 + 53 + 2)
Gate Assigned	1 SGD 3 DWLs (Top) 32 TLC 3 DWLs (Bottom) 1 SGS	1 SGD 2 DWLs (Top/upper deck) 33 WLs (1 SLC, 1 MLC, 31 TLC) 2 DWLs (Bottom/upper deck) 2 DWLs (Top/lower deck) 33 WLs (1 SLC, 1 MLC, 31 TLC) 2 DWLs (Bottom/lower deck) 1 SGS	1 SGD 3 DWLs (Top/upper deck) 48 WLs (48 TLC) 2 DWLs (Bottom/upper deck) 2 DWLs (Top/lower deck) 48 WLs (48 TLC) 3 DWLs (Bottom/lower deck) 1 SGS
# Metals	4 (3W, 1Al), 2 Ms (CuA)	6 (4W, 1Cu, 1Al), 3 Ms (CuA)	6 (4W, 1Cu, 1Al), 3 Ms (CuA)
Cell Array Image (X-section SEM)			

Micron/Intel 96L Double Deck Mis-alignment

- ✓ Max. 31 nm mis-aligned (Measured)
- ✓ Buffer Layer & Poly-Si pad layer between decks





3D NAND Process Flow & Integration

❑ Intel/Micron 64L NAND (ex.)

STI ~ Metal 3 Under Array

1st stack VC Etch

Buffer Layer Between stacks

2nd stack VC Channel

BL Etch

BEOL (~M6)

Choe/TechInsights

Reference Reports: PFA-1801-801, PFF-1807-801

SK Hynix 72L PBiCS

SK Hynix 72L TLC Die

36L

Block Slit
Channel
Slit
PGs

48L

72L

Upper Stack (40 G)
Lower Stack (42 G)
PG

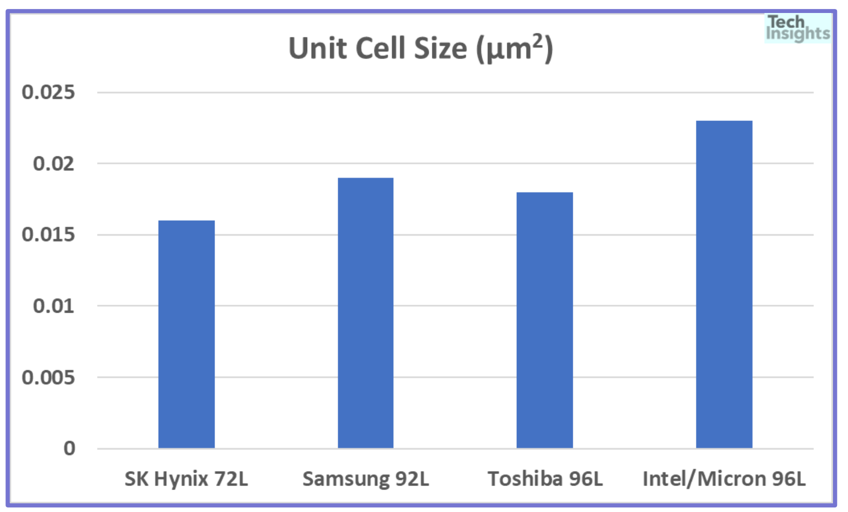
TechInsights Memory Design on Cell Array Report (MDC)

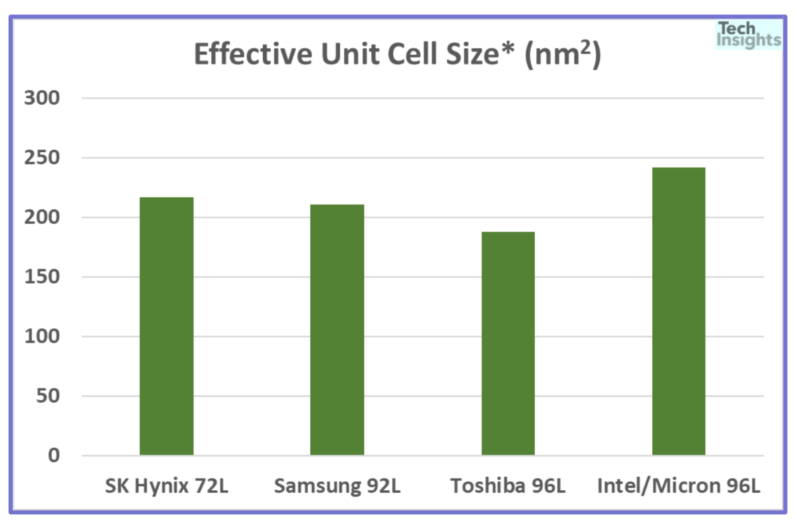
BL
SL
DSG1 SSG1 SSG1 DSG1
DSG2 SSG2 SSG2 DSG2
DSG3 SSG3 SSG3 DSG3
DWL0 DWL0 DWL0 DWL0
DWL3 DWL3 DWL3 DWL3
WL143 WL0 WL0 WL143
WL142 WL1 WL1 WL142
WL112 WL31 WL112 WL31
DWL4 DWL4 DWL4 DWL4
DWL5 DWL5 DWL5 DWL5
WL111 WL32 WL111 WL32
WL72 WL71 WL72 WL71
DWL6 DWL6 DWL6 DWL6
lower PG
upper PG

SK Hynix Memory Cell Array: VC Misalignment

- ✓ Max. 10 nm mis-aligned (Measured)
- ✓ Without any buffer layer or poly-Si pad layer between decks

Comparison Unit Cell Size (3D NAND)





* Effective unit cell size is a unit cell size divided by total number of active cells in a NAND string.

Comparison Double Stack Interface Structure

Items	Intel/Micron	SK Hynix	Toshiba/WDC
Device Type	3D 64L or 96L NAND	3D 72L NAND	3D 96L NAND
Stack	37L (l)+ 37L (u) 53L (l)+ 53L (u)	40L (l) + 42L (u)	54L (l) + 55L (u)
Interface Structure	64L: AlO (54 nm) SiO (12 nm) SiN (67 nm) 96L: SiN (110 nm) only	Nothing (without any additional layers)	SiO (95 nm) only
Ref.	Channel plug & poly-Si capping	Misalign can be found	Channel plug
Images	64L / 96L upper stack / lower stack	upper stack / lower stack	upper stack / lower stack

3D NAND Comparison: Source/Plate

Choe/TechInsights

Items	Intel/Micron	SK Hynix	Toshiba/WDC	Samsung
Device Type	3D 64L or 96L NAND	3D 72L NAND	3D 96L NAND	3D 92L NAND
Source Side Structure	SGS on Plate	Connected to Dual PCGs	GSL with SEG channel	GSL with SEG channel
Layers	SGS SiO (3.8 nm) AlO (54 nm) SiO (7.6 nm) poly-Si (As-d., 64 nm) WSix (plate, 140 nm)	Floated Dual PCGs with 4 poly-Si layers	VC Open SEG (GSL) Si-Sub.	VC Open SEG (GSL) Si-Sub.
Images (SEM & TEM)	AlO As-doped poly-Si Source Plate TechInsights	PCG TechInsights	SEG Select TR Si-Sub. TechInsights	SEG Select TR Si-Sub. TechInsights

3D NAND Comparison: VC Capping Structure

Choe/TechInsights

Items	Intel/Micron	SK Hynix	Toshiba/WDC	Samsung
Device Type	3D 64L or 96L NAND	3D 72L NAND	3D 96L NAND	3D 92L NAND
VC Capping Structure (Process)	Oxide Recess Poly-Si Fill & CMP Landing Plug BL Stud	Plug Contact Oxide Recess Poly-Si Fill & E/B Metal fill	Oxide Recess Poly-Si Fill & CMP Landing Plug BL Stud	Oxide Recess Poly-Si Fill & CMP Landing Plug BL Stud
Layers	Landing Plug (W) Poly-Si (Thick)	Metal (W) Plug Cont. 2 (W) Plug Cont. 1 (Poly-Si)	BL Stud (W) Landing Plug (W) Poly-Si (Thick)	BL Stud (W) Landing Plug (W) Poly-Si (Thick)
TEM Images				

3D QLC NAND

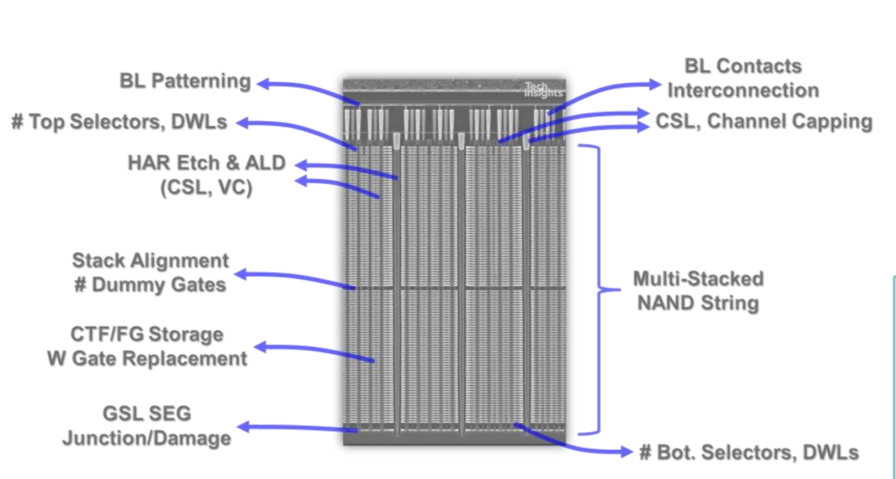
❑ Samsung 3D TLC *vs.* QLC

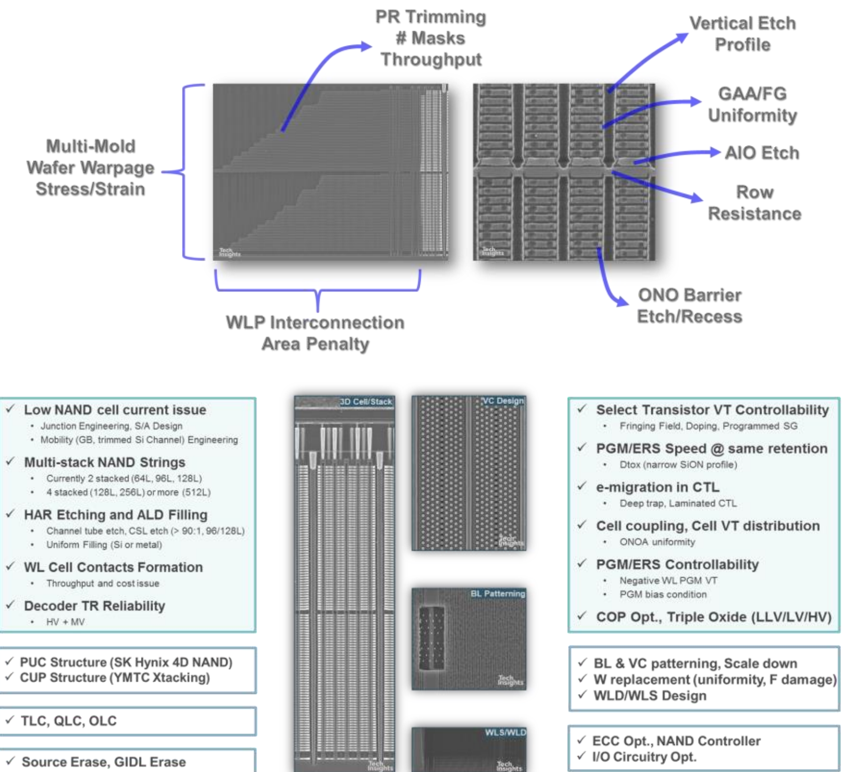
Items	Samsung 256 Gb TLC	Samsung 1 Tb QLC
Products	PM981, SSD T5, UFS2.1, Galaxy S9+, µ-SD Card, etc.	Samsung 860 QVO SSD SATA, 6 Gb/s
Memory / Die	256 Gb	1024 Gb (1 Tb)
Die Size	5.94 mm x 12.60 mm (74.84 mm²)	14.25 mm x 12.66 mm (180.40 mm²)
Memory Density	3.42 Gb/mm²	5.68 Gb/mm²
Die Photograph		
Vertical Cell Structure	64L	64L
Technology Node	20 nm	20 nm
Cell Array Area Efficiency	64.6 %	79.8 %

❑ Intel 3D TLC *vs.* QLC

Items	Intel 64L TLC	Intel 64L QLC
Products		
Die Markings	B16A	N18A
Memory / Die	256 Gb	1024 Gb
Die Size	7.43 mm x 7.83 mm (58.17 mm²)	13.83 mm x 11.33 mm (156.70 mm²)
Memory Density	4.4 Gb/mm²	6.53 Gb/mm²
Die Photograph		
Vertical Cell Structure	64L Double Stack	64L Double Stack
Technology Node	20 nm	20 nm
# Tiles	64	128

Challenges on 3D NAND





Summary: NAND Technology

❑ 1H2019

- ✓ Samsung 92L V-NAND: SEG used, conventional single deck with 100 gates
- ✓ Toshiba/WDC 96L BiCS: SEG used, 2 decks, 2 MCs, 109 gates
- ✓ Micron/Intel 96L FG: PUC, tile floor plan, FG for storage, 108 gates
- ✓ SK Hynix 72L TLC and 76L MLC: PBiCS, 2 decks (cf. 96L/128L PUC without PCG)
- ✓ 64L QLC dice from Intel and Samsung (1 Tb/Die), Z-NAND 1st gen. (SS)

❑ 2H2019 & 2020

- ✓ 128L MP and more (18xL or 19xL) on market, > 10 Gb/mm^2
- ✓ 96L QLC from Toshiba/WDC, PUC (4D NAND, 96L & 128L) from SK Hynix
- ✓ Xtacking from YMTC, Z-NAND 2nd gen. (SS), XL-FLASH (Toshiba) expected
- ✓ Multi-deck (3 or more) 3D NAND cell Array expected

Thank You!

Q&A

For more information, please contact TechInsights!

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