

TSMC

More progress on N3 and N3E: Leading edge share rising to near-100% in "3nm era"

Recent investor queries have been focused on TSMC's progress on N3 following competitor comments about delays. Our research indicates that there have been no further delays, with different flavors of N3 progressing well. We believe that the original N3 process node is already in risk production and likely to production ramp from 4Q22. For N3E, we expect the process to be frozen by early 2Q22, with risk production in 3Q22, with multiple customers already working on test-chips for this process. Mass production for N3E is likely to commence from 2H23. From a market share perspective, we see near-100% market share for TSMC in the 3nm era in 2023 and 2024, with key swing customers like QCOM and NVDA likely to remain highly dependent on TSMC. With solid market share in N5 and strong early traction in N3, we believe that TSMC should continue to grow well above Foundry industry growth, even during a potential semiconductor industry downturn.

- **Original N3 limited to three customers, production ramp in 4Q22:** Based on our research, we believe that TSMC's N3 family schedule is largely back on track. Its original N3 is likely to still be limited to three customers (Apple, Intel and Bitmain) and should start volume ramp from 4Q22, with initial revenues in 1Q23. Due to a narrower process window, we aren't expecting N3 to be made available for a wider array of customers. We expect Apple iPhones, iPad and Mac M1 processors to use TSMC's original N3, accounting for ~70-80% of N3 demand in 2023. We also expect Bitmain to be an early adopter of N3 starting from 1H23. We also expect Intel to use TSMC N3 to manufacture some of the tiles (likely GPU) for its client CPU platforms in 2023. By the end of 2023, we expect TSMC to ramp N3 family capacity to ~80k wfpw, before reaching ~130k wfpw by end-2024.
- **N3E process likely to be frozen in early 2Q22:** Back in 4Q21, we had reported on some yield and process challenges with N3E. But these issues now appear to be largely behind us and our industry research indicates that N3E spice models / process specifications should be frozen in early 2Q22, with wider availability of PDKs (process design kits) in 3Q22. N3E will have only 1.6x area scaling compared to N5, and will also forego 4-5 EUV layers (down to 19-20 layers) as compared to original N3. We believe that the wafer price for N3E is likely to be ~\$19-20k, roughly 10-15% below original N3 prices. We also see the existence of an N3b version, primarily for HPC customers launching in 2024, but we believe there is a chance that most HPC customers may opt for N3E itself, given better yield and process maturity (*see Table 1 for details on the different variants of the N3 process*).
- **N3E to see much wider customer adoption from 2H23:** We now expect N3E mass production to start from 3Q23 (risk production likely in 2H22), with QCOM and Mediatek likely to be the early adopter customers. We also see most large Fabless customers (Apple, Intel, NVIDIA, Broadcom, Marvell etc.) are also adopting N3E in 2H23/1H24 timeframe. System and startup HPC tape-outs are also likely to rise in 2023 on N3E, judging by customer interest on this

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Overweight

2330.TW, 2330 TT

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Technology

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process node (see Table 2 for customer adoption timeline of N3 and N3E).

- Market share approaching 100% for N3:** We believe that TSMC may have near 100% market share for 3nm family process nodes in 2023 and 2024, based on tape-out decisions so far. We believe that QCOM is likely to switch to TSMC N3 for its flagship SoCs in 2024, while NVDA is also likely to move most of its 2024 leading edge GPU/AI products to TSMC N3. Even with N5/N4, we already see this shift accelerating from Samsung and it is likely to accelerate when it comes to N3. For other customers such as Apple, AMD, Broadcom, Mediatek, we believe that TSMC is likely to remain the sole source Foundry partner in N3/N3E as well.
- Intel competition not showing up any time soon, but second source interest has risen:** Post Intel's analyst day, there have been many investor queries on TSMC's delay of N3 and Intel catching up on process technology. As outlined earlier, Intel is likely to be a key customer of TSMC's N3 process in the 2023/24 timeframe, hence we believe that concerns regarding any TSMC N3 delay are overblown. We believe that TSMC's HPC customers (AMD, NVDA, ASICs from Amazon, Google) should all adopt N3 process technology for their key products in 2024, keeping them competitive and likely ahead of Intel in process technology. For products beyond 2024, we are seeing more interest from customers on Intel's process roadmap and IFS offerings. Based on our understanding, Samsung's recent challenges on its leading edge process roadmap appear to be the main motivator for some customers to start evaluating Intel as a potential second source to TSMC.
- Early read on N2 - GAA coming in 2025:** We expect TSMC to introduce its N2 process in 2025 with a migration to Gate All Around transistors (GAA) and introducing back-sided power delivery (reducing the complexity of metal layers and back-end of line processing). Our early read indicates that growth in EUV intensity is likely to slow, with N2 only adding 2-4 more EUV layers compared to N3. However, GAA transistor structure and more complicated power delivery mechanism should drive much higher spending in ALD (Atomic Layer Deposition) and CMP (Chemical Mechanical Planarization) tools.
- Stock view:** In the near term, semi cycle peak concerns and geopolitical headwinds are dragging down the stock. However, we believe that TSMC is poised to grow well above industry average, even during a downcycle scenario. We expect the relative outperformance to resume once the market starts to build more confidence on the N3 pipeline. We remain OW on the stock and TSMC is one of the few OWs in our Asia Logic Semis coverage.

Table 1: N3 Process node variants

Process node	Current status	Mass production timeline	Number of EUV layers	Price per wafer	Area scaling vs N5 node	Customers
N3	In risk production	4Q22	24-25	\$22k+	1.7x	Apple, Bitmain, Intel
N3E	Enter risk production in 3Q22	3Q23	19-20	\$19-20k	1.6x	Apple, QCOM, Mediatek, AMD, NVDA, Intel, Broadcom, Marvell
N3B	Early design, chances of being rolled into N3E	2H2024	19-20	Uncertain	1.3-1.4x (HPC version)	AMD, other HPC specific customers

Source: J.P. Morgan estimates.

Table 2: Timeline for N3/N3E product launch for key TSMC customers

Timeline of adoption	N3	N3E	Comment
Apple	4Q22	1H24	Apple will be lead customer on N3 and will migrate some products to N3E for cost purposes
Intel	2H23	NA	Intel should adopt ~20k wfpw peak volume of N3 in 2023
Bitmain	1H23	NA	Early adopter on N3, N3E status is uncertain
AMD	No	2H24	AMD will be a late adopter in 2H24, given first products on N5 will arrive only in 2H22
QCOM	No	Early 2024	Likely flagship SoC for 2024
Mediatek	No	Early 2024	Likely flagship SoC for 2024
NVDA	No	1H24	Next GPU / AI Chips in 2024 after Hopper/ Ada Lovelace architecture on N5 in 2022

Source: J.P. Morgan estimates.

Intel, AMD, NVDA, Marvell are covered by Harlan Sur. Apple and QCOM covered by Samik Chatterjee. Samsung Electronics is covered by JJ Park.

Investment Thesis

TSMC is now firmly positioned as the key enabler of the new computing revolution in the semiconductor industry, with multiple architectures, chip platforms and design teams competing to push computing and AI innovation.

Once the current logic semiconductor upcycle starts to peak, we believe that TSMC should reverse its relative underperformance in 2022.

We believe that the structural aspects of TSMC's growth (continued share gains in leading-edge, rapid proliferation of HPC and fragmentation of the compute platform) will help the company to outgrow the Foundry industry significantly in 2022 and beyond.

Older process technologies should see some utilization pressure in late 2022 and 2023, given the prospects of an inventory correction and cyclical downturn, but we believe that the impact is likely to be manageable, given TSMC has been much less opportunistic on Foundry pricing and the mix of revenues are now overwhelmingly leading-edge (almost 2/3rd of revenues should be from 7nm and below by 2023).

Valuation

Our Dec-22 PT of NT\$780 is based on 23x FY23E EPS, higher than a mid-cycle multiple to reflect a P/E re-rating and benchmarking global semis leaders like ASML and TXN, due to growing HPC opportunities.

Risks to Rating and Price Target

Key downside risks include: (1) market share losses to Samsung Foundry; and (2) worse-than-expected Foundry competitive landscape in 2023.

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TSMC (2330.TW, 2330 TT) Price Chart



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Initiated coverage Apr 28, 2002. All share prices are as of market close on the previous business day.

Date	Rating	Price (NT\$)	Price Target (NT\$)
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18-Apr-19	OW	261.5	300
28-May-19	OW	231.0	275
18-Jul-19	OW	252.0	280
25-Sep-19	OW	265.0	320
18-Oct-19	OW	293.5	350
17-Jan-20	OW	334.5	370
13-Mar-20	OW	294.0	335
01-Apr-20	OW	274.0	325
09-Jul-20	OW	341.0	355
17-Jul-20	OW	357.5	375
24-Jul-20	OW	381.5	500
11-Oct-20	OW	453.0	550
16-Oct-20	OW	453.0	570
04-Jan-21	OW	530.0	620
15-Jan-21	OW	592.0	780
05-Sep-21	OW	620.0	800
08-Dec-21	OW	607.0	780

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