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TRADE LENS

Bringing investing into focus.

LENS INSIGHT / No.09

Research on HBM4 test productivity and economic value capture

HBM4 Testing Bottlenecks

Test Equipment, Yield and the Cost of Good Output

TESTING

Reducing escapes and downstream losses

VALUE CAPTURE

Effective throughput, acceptance and repeat orders

**Twice the I/O does not mean
twice the profit for test-equipment suppliers.**

Separate KGD, KGS and final test; connect the cost of reliable good output to Korean suppliers' qualification, orders and cash conversion.

01 / RESEARCH VIEW

The key metric is the cost of reliable good output

TradeLens view | Greater complexity creates opportunity, not a guarantee of equipment or profit growth.

Core view

HBM4 test creates value when early screening avoids costly downstream losses while sustaining dependable good output. For Korean suppliers, the evidence is effective throughput, stable contact and temperature control, then acceptance, repeat orders and cash collection.

01

What is changing?

Wider I/O and more complex stacks and packages require new test coverage and resource allocation.

02

Why does it matter?

A missed defect can waste otherwise good components and processing added later.

03

Who captures value?

Suppliers that remove the customer's bottleneck and monetize it through equipment, interfaces or handling.

04

What confirms the view?

Generation-specific approval, effective throughput, acceptance, repeat orders and revenue-to-cash conversion.

Keep technical necessity separate from company earnings

Commercial HBM4 shipments, a Korean tester contract and Techwing's quarterly earnings are different forms of evidence. None alone establishes a supplier's HBM4 revenue or margin. [\[1\]](#) [\[8\]](#) [\[9\]](#)

Unit of analysis

Measure total cost per output meeting the required quality—not test counts or a machine's advertised peak speed.

02 / HBM4 TRANSITION

Wider I/O reshapes the allocation of test resources

Product specifications, commercial production and sampling are distinct evidence levels.

1,024

Prior-generation data I/O

Comparison baseline [1] [2]

2,048

HBM4 data I/O

Manufacturer descriptions [1] [2]

2×

Interface width

Not an equipment-demand multiple

Samsung announced commercial HBM4 shipments using 1c DRAM and a 4nm logic base die in February 2026. Micron's March release reported high-volume shipments of 36GB, 12-high HBM4. Higher performance may increase test burden, but actual test time depends on architecture and programs. [1] [3]

Architectural change	Test-economics implication
Wider data interface	Channel, routing and contact allocation may change. I/O count is not identical to probe count or tester count.
Base die and stacked memory	Design separate coverage for individual-die functions and interconnects after assembly.
Speed, power and heat	Patterns, thermal settling and power delivery can limit parallel sites and effective throughput.

Samples do not establish current production revenue

Samsung's May HBM4E sample announcement is a development milestone. It does not align customer volume qualification, production quantities and test-equipment ordering or acceptance on one timetable. [12]

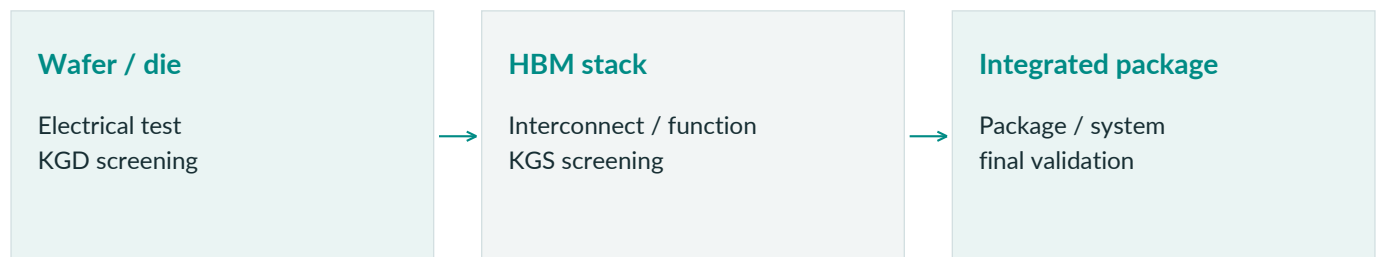
Interpretation

Test cost per resource may rise, but reuse and parallelism can offset the burden. Equipment demand must therefore be evaluated alongside effective throughput.

03 / TEST FLOW & COVERAGE

KGD, KGS and final test are not interchangeable

The device under test and the purpose of testing determine each supplier's exposure.



KGD: Known-Good Die. KGS: Known-Good Stack. These are test-based classifications. The flow is conceptual; customer processes and conditions vary. [\[4\]](#) [\[6\]](#)

Stage	Focus	Residual exposure
Wafer / individual die	Electrical functions and early defects in memory or logic	Defects introduced in later thinning, bonding or assembly
Completed stack	Post-stack connectivity, function and screening conditions	Issues arising after integration with an accelerator or interposer
Package / system	Interactions and operating conditions after integration	Latent defects and long-term behavior outside test coverage

FormFactor describes Altius as supporting HBM KGD and KGS testing. Advantest's HA1200 tests high-power SoC dies before assembly. The latter illustrates the economics of early screening; it is not evidence of an HBM4-specific equipment win. [\[4\]](#) [\[6\]](#)

Do not compare every stage at the same test rate

Early electrical tests, stress screening and final at-speed validation serve different purposes. Applying the product's maximum transfer rate to every test stage can overstate equipment requirements.

04 / RESIDUAL-DEFECT MODEL

Stacking compounds residual defect exposure

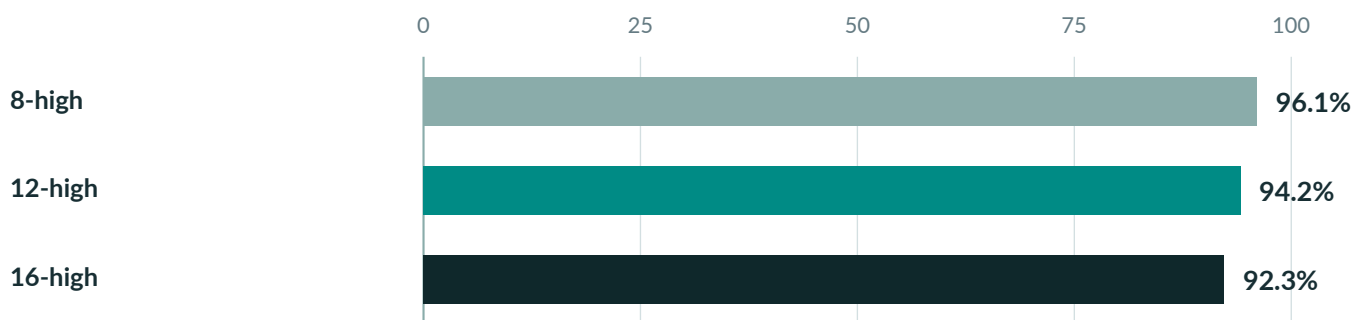
Illustrative model | Residual defect risk after screening is not manufacturing yield.

Model A assumptions

Let p be the probability that a prescreened die is actually defect-free. With n independent, identically distributed dies, the probability that every die is defect-free is p^n . Base-die defects, bonding defects, repair and correlated failures are excluded.

Probability all dies are good when $p = 99.5\%$

% · illustrative



Per-die p	8-high	12-high	16-high
99.0%	92.27%	88.64%	85.15%
99.5%	96.07%	94.16%	92.29%
99.9%	99.20%	98.81%	98.41%

Calculation: $p^n \times 100$. These are hypothetical probabilities, not wafer or stack yields for any manufacturer.

Screening changes where losses are recognized

Stricter screening can lower the pass rate yet save good components and downstream processing. Actual manufacturing-yield improvement must be demonstrated separately through fewer defect causes.

Decision criterion

Evaluate escapes, false rejects and downstream losses together rather than treating a higher pass rate as automatically better.

05 / EFFECTIVE THROUGHPUT

Parallelism can offset longer test time

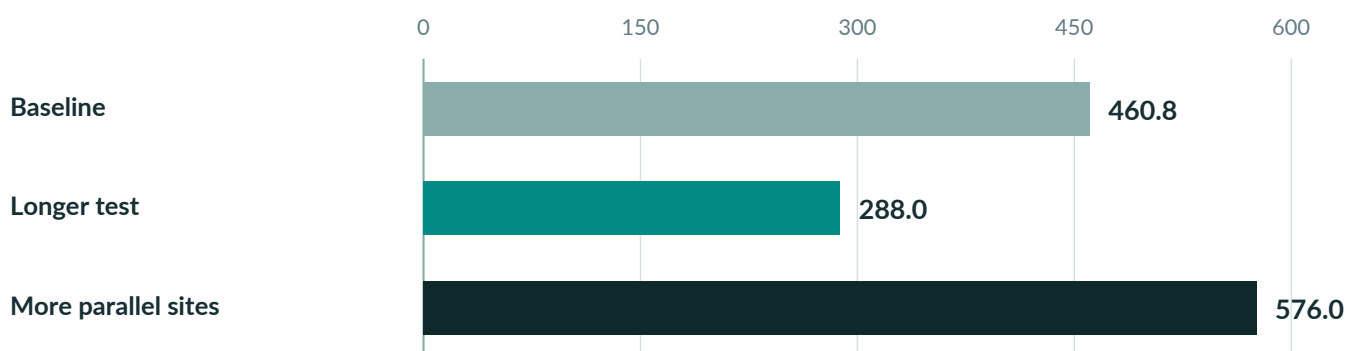
Illustrative model | Compare usable test capacity, not advertised peak throughput.

Model B | Effective throughput of input units

Hourly throughput $Q = 3,600 \times \text{parallel sites } N \times \text{availability } u / \{(\text{test time } t + \text{handling/settling } h) \times (1 + \text{retest burden } r)\}$. t and h are seconds; r is average additional cycle burden. Below, $r=0$ and $u=80\%$; good-output yield is not included.

Effective hourly throughput

units/hour · illustrative



Scenario	N	t / h	Q
Baseline	16	80 / 20	460.8
Longer test	16	140 / 20	288.0
More parallel sites	32	140 / 20	576.0

For a fixed output target, required test-cell count varies inversely with effective throughput. Yet more sites can require extra channels, power, interfaces and thermal control, changing cell cost. Fewer machines need not mean lower capital spending.

Variables that must be evaluated together

Measure sites, availability, retesting and cell cost together. FormFactor's wafer-test documentation likewise treats parallelism and stable contact and temperature as distinct performance factors. [\[5\]](#)



06 / SCREENING ECONOMICS

Extra screening must cost less than the loss avoided

Illustrative model | Full inspection must still be assessed against escapes, false rejects and total cost.

Assumption per input unit	Symbol	Value
Incremental escape-rate reduction	Δe	0.4 pp
Downstream loss per escaped defect	L	USD 500
Incremental false-reject rate	Δf	0.2 pp
Economic value per falsely rejected good unit	V	USD 100
Incremental total screening cost	c	USD 1.00

$$\text{Net benefit} = \Delta e \times L - \Delta f \times V - c$$

$$0.004 \times 500 - 0.002 \times 100 - 1.00 = \text{USD } 0.80$$

$$\text{Break-even downstream loss } L^* = (c + \Delta f \times V) / \Delta e = \text{USD } 300$$

Sensitivity to L	Escape loss avoided	Reject + test cost	Net benefit
USD 100	0.40	1.20	-0.80
USD 300	1.20	1.20	0.00
USD 500	2.00	1.20	+0.80

USD per input unit. All inputs are independent assumptions, not actual HBM/GPU prices, supplier costs or equipment quotations. L denotes net loss after salvage or rework.

The economic case strengthens before costly downstream steps

Testing does not itself increase device performance. Its value is the avoidable cost of detecting defects before expensive assembly. Include capacity-delay costs in c and do not count defects that another stage would already catch.

Implication for purchasing

The best system is not simply the one with the highest detection rate, but the combination that meets quality requirements while improving net benefit and output.

07 / SYSTEM BOTTLENECKS

Tester, contact and thermal control form one system

The binding constraint—not a single headline specification—sets usable productivity.

Constraint	Economic effect	Evidence to request
Tester resources	Limited channels, memory or patterns can force a trade-off between coverage and parallel sites	Sites, pattern time and resource-sharing conditions
Probe / socket contact	Unstable contact increases retesting, false rejects and cleaning downtime	Contact resistance, lifetime and cleaning intervals
Temperature / power	Differences between set and actual die temperature, or voltage droop, weaken repeatability	Settling time, thermal variance and power headroom
Handling / alignment	Slow alignment, changeovers or stoppages constrain even a fast tester	Non-test time, availability and recovery time

Altius targets fine-pitch, low-force contact; HA1200 uses active thermal control. Their specifications cannot be combined into the performance of one HBM4 test cell. SmartMatrix's parallel wafer-test capability is likewise stage- and configuration-specific. [\[4\]](#) [\[5\]](#) [\[6\]](#)

Integration can support pricing power

If buyers value validated process combinations over isolated peak specifications, interface engineering, setup and failure diagnosis gain value. Interoperability and competitive sourcing can instead weaken any one supplier's pricing power. This is a conditional TradeLens assessment.

Identify the bottleneck empirically

Distinguish a shorter test routine from a genuine improvement in throughput after retests, downtime and false rejects.

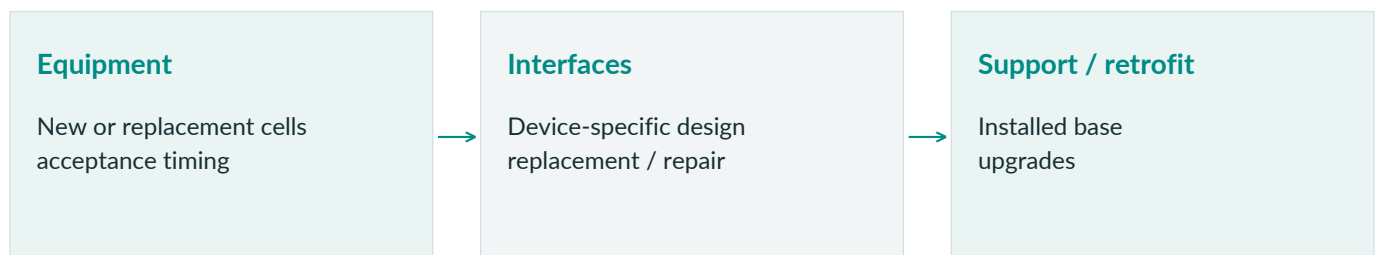
08 / KOREAN VALUE CHAIN

Korean suppliers monetize different test functions

Separate established business scope from a generation-specific HBM4 contract.

Company	Supported scope / contract	Limit of interpretation
Techwing 089030	Company filing: handlers, probe stations, Cube Prober, parts and upgrades [7]	Group equipment and parts results do not identify HBM4-only revenue or margin
UniTest 086390	July 2026 disclosure-based report of an HBM4 WAFER TESTER contract with SK hynix [9]	The specified tester does not establish coverage of all final HBM testing
TSE 131290	H1 2025 filing: probe cards, interface boards and test sockets [10]	Historical scope does not prove 2026 HBM4 qualification or volume delivery

Three revenue units to separate



TradeLens business-model classification; it does not assign identical revenue shares to suppliers.

Testers and bonders may be ordered within the same backend investment program, but their functions and revenue units differ. This report focuses on electrical test, handling and contact; it does not merge bonding or optical metrology into one tester market.

Common evidence standard for Korean suppliers

Technology → process qualification → order → acceptance → repeat order → collection. An earlier milestone does not establish cash from a later one.

09 / TECHWING EVIDENCE

Techwing: earnings recovery and HBM4 contribution

Consolidated preliminary earnings establish recovery, not product-level value attribution.

878

Revenue • KRW100m

3Q26 consolidated preliminary [8]

180

Operating profit • KRW100m

3Q26 consolidated preliminary [8]

20.5%

Operating margin • calculated

180 / 878, rounded

The October 14 filing-based report gives year-on-year growth of 110.2% in revenue and 153% in operating profit. This report uses those rounded figures. The calculated margin is a group-level reference, not the margin on HBM4 equipment. [8]

Analytical item	Evidence needed	Alternatives to distinguish
Revenue mix	Disclosed equipment, parts and upgrade revenue	New HBM testing versus legacy memory / non-memory investment
Repeatability	Follow-on orders and growth of installed base	Initial deliveries or clustered acceptance versus recurring demand
Cash conversion	Receivables, inventory and operating cash together	More deliveries occurring alongside slower collections

When installed base supports parts revenue

Techwing's Q1 filing describes COK replacement when devices change, plus parts, boards and upgrades. This is a potential recurring-revenue mechanism; it does not establish that every Cube Prober has the same consumables economics as a legacy handler. [7]

Assessment

Quarterly earnings are a starting point. HBM4 exposure needs an additional test: generation-specific acceptance, repeat orders, related parts revenue and collection.

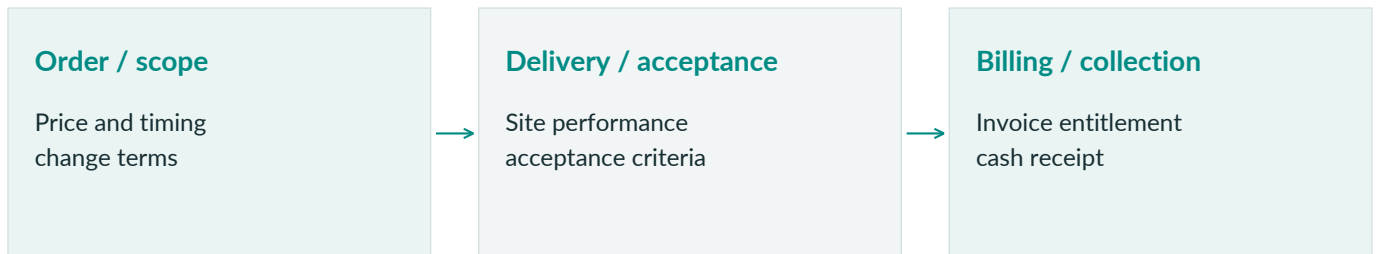
10 / ORDERS, ACCEPTANCE & CASH

A contract is not cash collection

UniTest case | Establish only the disclosed product, value and contract period.

Disclosure-based contract report [9]

On July 23, 2026, UniTest reported an **HBM4 WAFER TESTER** contract with SK hynix for **KRW22.68 billion**, covering **July 23–October 8**. Passing the scheduled end date does not establish completed installation, customer acceptance or cash collection.



General review sequence. Revenue recognition depends on contract and accounting judgments, including performance obligations and transfer of control.

Disclosure / IR evidence	Economic meaning
Delivery amendments	Separate changes in scope or timing from the timing of revenue and cash
Repeat orders	Differentiate an initial test deployment from sustained production demand
Acceptance / warranty / support	Assess extra personnel, parts and support cost as supply scope expands
Receivables / inventory / advances	Track the funding gap between upfront production cost and customer payment

Conditions for cash realization

Expanding capacity before acceptance can increase both growth and working-capital needs. Assess the continuity of acceptance and collection, not contract value alone.



11 / COMPETITION & VALUE CAPTURE

Competition extends from components to validated systems

Technology partnerships target production constraints; they do not predetermine supplier wins.

FormFactor and Teradyne announced a collaboration on October 12, 2026 combining probe, interface and test capabilities. The release demonstrates a joint-development direction in response to complexity, not loss of Korean suppliers' customers or exclusive sourcing. [\[11\]](#)

Revenue model	Condition for value capture	Potential margin constraint
Dedicated equipment / cells	Superior in-process performance, delivery and service	Customization, warranty or field support outruns pricing
Contact / interfaces	Replacement and redesign tied to device changes and useful life	Interoperability, multisourcing or longer life pressures unit revenue
Retrofit / software / support	Active installed base with paid upgrades or support renewals	Bundling, staffing and development costs rise

Customer savings and supplier profit are different

Customers benefit from fewer escapes and stoppages. Suppliers must capture part of that benefit through equipment pricing, services or parts. Customer savings are not all supplier revenue, and incremental revenue still bears R&D, setup and warranty costs.

TradeLens view

A validated combination that lowers the customer's cost of good output can matter more than peak component specifications. Korean suppliers need to turn compatibility and field execution into repeat contracts.

12 / SCENARIOS & MONITORING

Capacity additions and productivity gains can coexist

Assess volume, test intensity, effective throughput and supplier allocation together.

Conditional scenario	Equipment / interface implication	Evidence to monitor
A. Ramp + more intensive test	New cell and interface demand can rise if production growth exceeds productivity gains	Generation-specific qualification, repeat orders and acceptance
B. Ramp + parallelism / reuse	Units can grow faster than machine count; retrofit and interface opportunities may differ	Effective throughput, retrofits and replacement demand
C. Slow acceptance + higher support cost	Orders may coexist with weak revenue conversion, collections and margin	Delivery amendments, inventory, receivables and support burden

Evidence that strengthens the base view

The strongest combination is better good-output throughput in customer HBM4 processes, follow-on orders for the same product/generation, and cash collection keeping pace with inventory and receivables. One quarter of group revenue growth is not a substitute.

Evidence that weakens the view

The view weakens if faster programs and retrofits absorb capacity needs, or if retesting, stoppages and customer support erase the new system's benefit. Changes in allocation under multisourcing must also be tracked separately.

Core monitoring framework

Process performance → qualification → acceptance → repeat revenue → cash. Technical, demand and earnings evidence must move in the same direction.

13 / CONCLUSION

Value rests in loss reduction, not test intensity alone

A new lens | Evaluate the test ecosystem by bottlenecks removed, not a multiplier on memory volume.

Overall assessment

HBM4 increases the need to coordinate electrical test, contact and thermal control. Opportunity is not uniform across suppliers. The strongest economic position belongs to those that reduce escapes, retesting and downtime, then convert performance into accepted deliveries and repeat contracts.

01

What is happening?

Product complexity is changing test coverage and resources—not imposing one uniform test speed on every stage.

02

Why is it important?

Early screening can avoid costly downstream loss, but test cost, false rejects and capacity delays must be deducted.

03

Who captures the benefit?

Suppliers that prove throughput and quality in the customer's process and monetize them through prices, parts and services.

04

What changes the conclusion?

Greater equipment reuse or multisourcing, or delays in acceptance and cash conversion, can reduce expected supplier gains.

The criterion for Korean-market readers

Techwing's preliminary earnings, UniTest's explicit HBM4 contract and TSE's interface business are different evidence types and dates. Rather than grouping them as identical HBM beneficiaries, verify which performance and earnings milestones each has actually reached. [\[7\]](#) [\[8\]](#) [\[9\]](#) [\[10\]](#)

Company names illustrate business exposure; they are not trading recommendations or forecasts of HBM4 earnings.



14 / SOURCE REGISTER

Connect each material claim to its underlying source

Select a teal citation, source title or “Open source” to open the underlying material.

01. Samsung Electronics HBM4 commercial shipments 2026.02.12 · Company release · commercial shipments and architecture	Open source
02. SK hynix HBM4 development and mass-production readiness 2025.09.12 · Company release · 2,048 I/O and generational change	Open source
03. Micron HBM4 high-volume production for NVIDIA Vera Rubin 2026.03.16 · Company release · 36GB 12H production versus 48GB 16H samples	Open source
04. FormFactor Altius probe cards As of 2026.10.17 · Product documentation · KGD/KGS, contact and parallel test	Open source
05. FormFactor SmartMatrix full-wafer testing As of 2026.10.17 · Product documentation · wafer parallelism, contact and temperature	Open source
06. Advantest HA1200 die-level prober As of 2026.10.17 · Product documentation · SoC die test and thermal control, not HBM4-specific	Open source
07. Techwing Q1 2026 report 2026.05.15 · Company filing reproduced by Ohgong · product and parts scope	Open source
08. Yonhap Techwing Q3 results 2026.10.14 · Filing-based news · rounded consolidated preliminary results	Open source
09. Edaily UniTest HBM4 contract 2026.07.23 · Filing-based news · KRW22.68bn, equipment and contract period	Open source
10. TSE H1 2025 report 2025.08.14 · KIND filing · historical scope of probe cards, boards and sockets	Open source
11. FormFactor · Teradyne Strategic collaboration on semiconductor testing 2026.10.12 · Joint release · probe, interface and tester collaboration	Open source
12. Samsung Electronics HBM4E sample shipments 2026.05.29 · Company release · sample milestone, not volume-production proof	Open source

Source scope: technical claims are manufacturer descriptions; earnings and the contract are filing-based news. [7] reproduces a company filing; [10] establishes historical scope only. Models are not actual yields, equipment quotations or company forecasts.

Methodology, disclaimer and use of this report

Distinguish disclosed facts, company descriptions and plans, TradeLens analysis and illustrative assumptions.

Item	Applied basis
Analysis date	17 October 2026. Product, contract and earnings dates and periods are separately identified.
Industry scope	Electrical test, handling, contact and thermal control. Korean cases are KOSDAQ-listed; foreign firms are technology / competitive benchmarks.
Model A · p.5	p^n assumes independent, identical residual die risks after screening. No actual yields, bonding/correlated defects or repair.
Model B · p.6	$Q=3,600Nu/[(t+h)(1+r)]$. Hypothetical sites, seconds and availability. Good-output yield and cell pricing are separate.
Model C · p.7	Net benefit= $\Delta eL-\Delta fV-c$. USD per input; Δe and Δf are decimal rates. All prices and rates are assumptions.
Financial / contract data	Techwing consolidated preliminary figures are rounded reported values. UniTest's contract is not revenue or cash; HBM4 profit is not imputed.

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