

TWENTY THIRD ANNUAL



TestConX™

May 1 - 4, 2022

DoubleTree by Hilton
Mesa, Arizona

Archive

The background is a collage of four images: top-left shows a close-up of a microchip; top-right shows a robotic arm in a factory; bottom-left shows a circular component with many small lights; bottom-right shows a detailed view of a circuit board.

TechInsights

Semiconductor and Test Market Outlook:

Is increased macro uncertainty driving the end of high growth?

May 3, 2022

Risto Puhakka

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Governments Are in The Mix:

Governments moving to invest and subsidize Semiconductor Manufacturing:

- China \$30B per year
- U.S. \$25B CHIPS act plus \$52B from Infrastructure & Jobs act
- EU €30B coming
- Korea up to \$65B support for semiconductors
- Japan to match other countries - \$50B?
- Taiwan & India?

Summary: >\$100B is on its way to “rescue” the semiconductor industry and guarantee the chip supply

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Macro Concerns against Continued Growth

1. Inflation...Feds increasing rates
 - Which means reducing money supply
2. China's irrational shut down because COVID-19
 - Permanent damage to supply chain reliability/security
3. War in Europe
 - Energy shortage in short term
 - Mis-directing resources away from growth driving initiatives/industries

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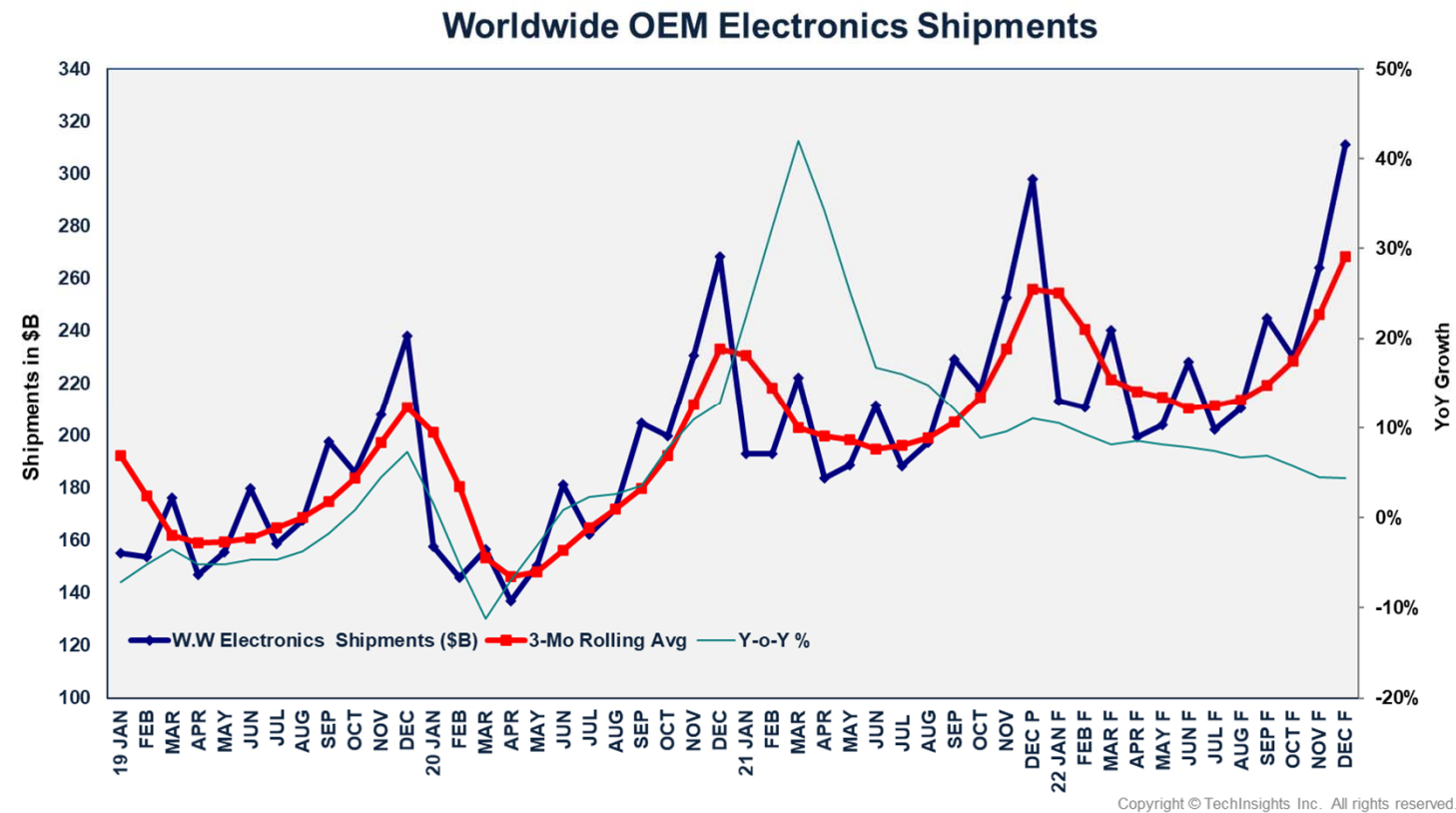
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TechInsights' forecast summary

Equipment: 2022 unchanged
IC Sales: 2022 unchanged
IC Units: 2022 unchanged
Electronics: 2022 unchanged

TechInsights' Current Forecast										
Forecast as of March 2022:	1Q21	2Q21	3Q21	4Q21	2021	1Q22	2Q22	3Q22	4Q22	2022
Semi Equipment (\$B):	\$ 28.7	\$ 30.1	\$ 32.6	\$ 32.6	\$ 124.0	\$ 31.8	\$ 35.7	\$ 40.8	\$ 40.9	\$ 149.2
Sequential Change	12.6%	4.9%	8.2%	-0.1%	34.2%	-2.4%	12.4%	14.3%	0.3%	20.3%
Capacity Utilization:	95.6%	97.6%	98.6%	96.9%	97.2%	95.5%	97.5%	98.2%	96.3%	96.9%
ICs (\$B):	\$ 109.0	\$ 119.0	\$ 129.1	\$ 135.2	\$ 492.3	\$ 133.5	\$ 138.9	\$ 147.5	\$ 148.4	\$ 568.2
Sequential Change	5.1%	9.1%	8.5%	4.7%	27.4%	-1.2%	4.0%	6.2%	0.6%	15.4%
IC Units (BU):	90.9	98.0	102.4	102.9	394.2	102.4	108.8	114.4	113.4	439.0
Sequential Change	2.5%	7.8%	4.4%	0.5%	23.7%	-0.5%	6.2%	5.2%	-0.9%	11.4%
Electronics (\$B) :	\$ 608.1	\$ 583.7	\$ 614.6	\$ 768.0	\$ 2,574	\$ 664.3	\$ 631.3	\$ 657.6	\$ 804.9	\$ 2,758
Sequential Change	-13.0%	-4.0%	5.3%	25.0%	18.9%	-13.5%	-5.0%	4.2%	22.4%	7.1%
TechInsights										
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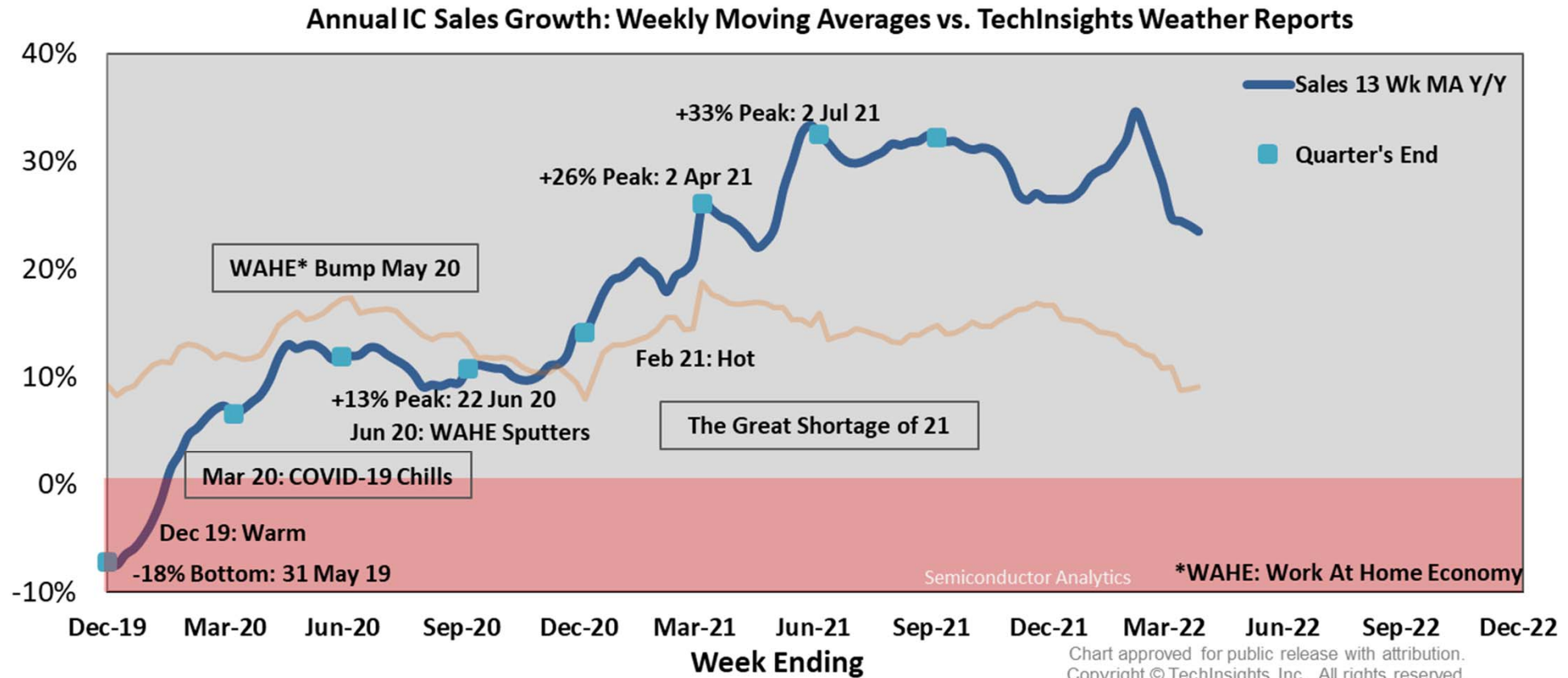
Electronic sales growth is rolling over



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Integrated Circuit Weekly Sales Trend:



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Weekly Sales Growth: DRAM, NAND, Logic, Analog & Power, and Auto

Weekly Semiconductor Sales Growth

DRAM, NAND, Logic, Auto, Analog & Power

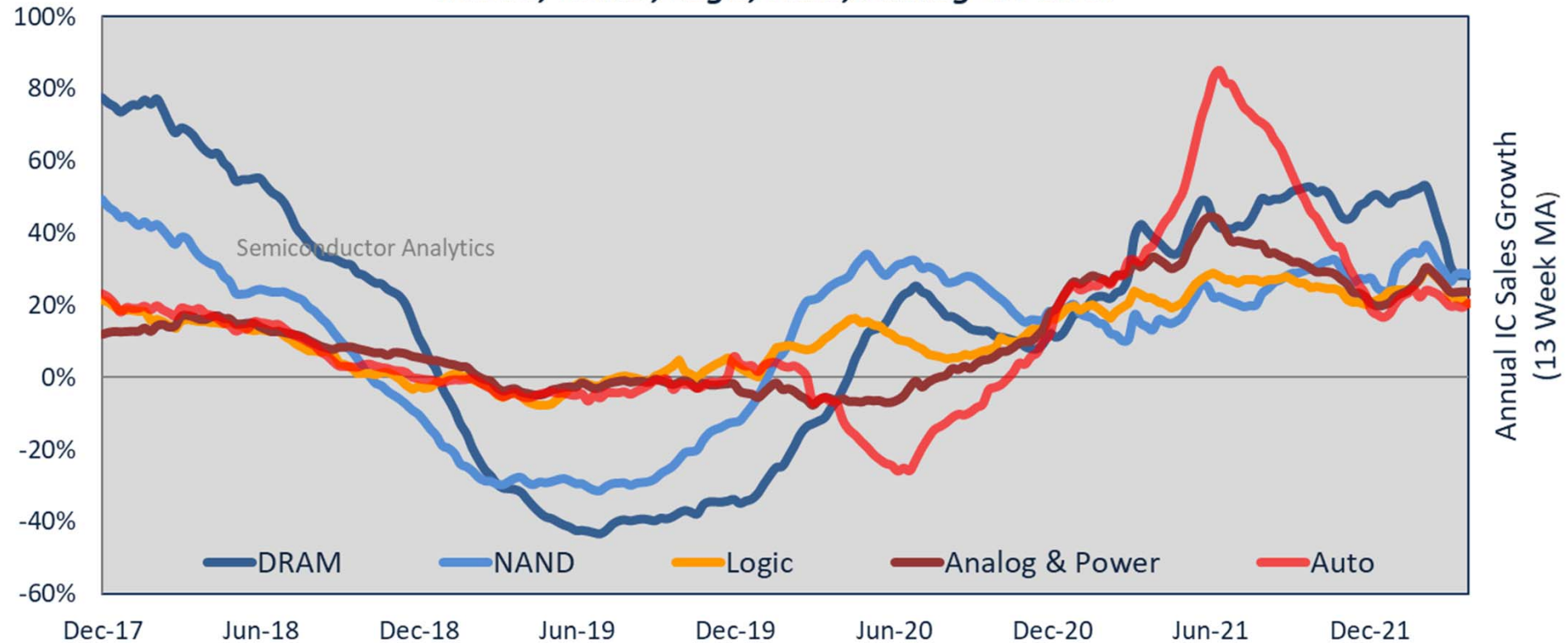
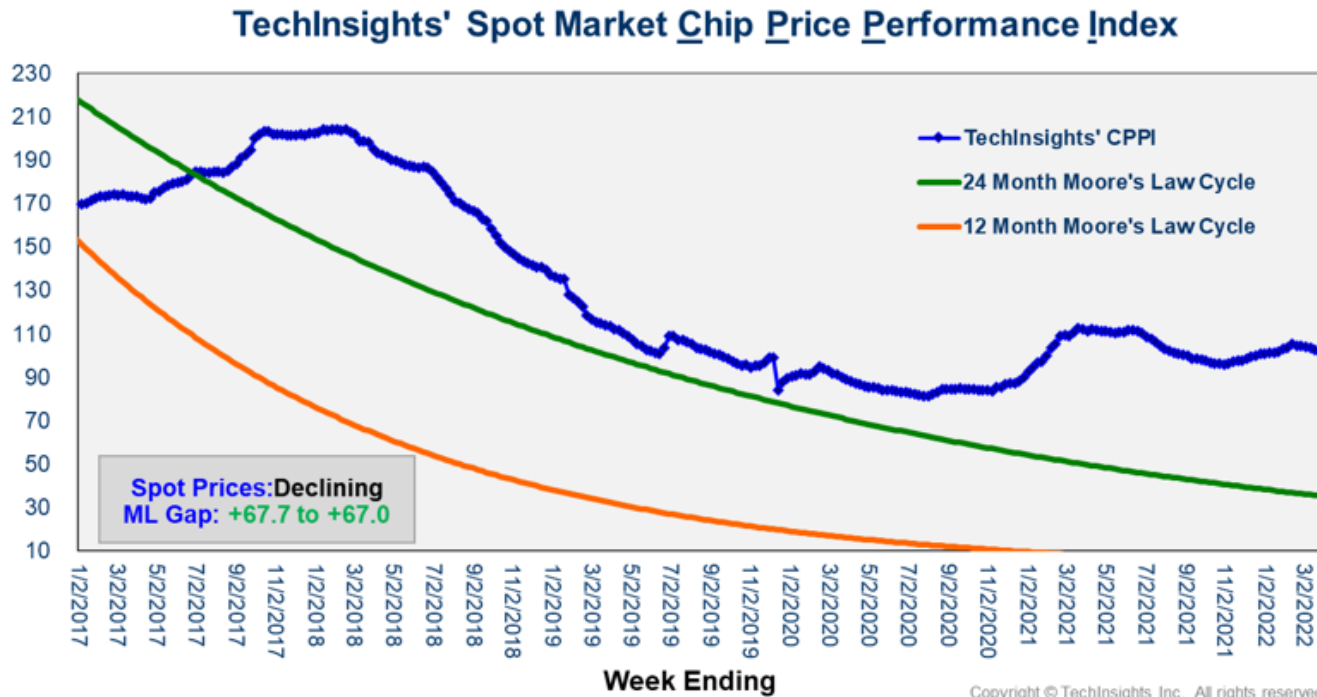


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The CPPI extended its decline



TechInsights' CPPI continued to trend lower, falling 0.9 points in the second week of April with all segments finishing in the red. The drop narrowed the CPPI-to-Moore's gap from 67.7 points to 67.0. Caution is rising among traders due to COVID shutdowns in China, the war in Ukraine, rising levels of inventories, and growing concerns about slowing consumer demand. The rate of decline of the CPPI has been modest so far, but it's beginning to indicate a shift in momentum in the latter part of 2H22.

DRAM had another rough week, tumbling by 1.5% at the headline level. It was the biggest weekly drop of the year. Mainstream DDR4 led the decline with spot prices for 4Gb, 8Gb, and 16Gb falling as much as 3%. Legacy DRAM didn't fare much better with spot prices slipping as much as 3% across the board.

NAND Flash slipped a mere 0.1% at the headline level. Low-density NAND moved higher, but high-density NAND got a hair cut with spot prices for 256Gb and 512Gb falling as much as 2%.

MPUs clocked lower for the third week in a row, this time by 0.6% amid increased pricing pressures.

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IC Supply/Demand Heat Map

Qtr or Week	Overall	DRAM	NAND	IDM	Foundry:	More Moore	More than Moore	OSAT	Analog & Power	Auto	Qtr or Week
2Q 2020	Tight	Saturated	Balanced	Tight	Shortage	Shortage	Shortage	Shortage	Tight	Glut	2Q 2020
3Q 2020	Tight	Tight	Balanced	Tight	Tight	Tight	Shortage	Tight	Tight	Glut	3Q 2020
4Q 2020	Tight	Shortage	Balanced	Tight	Tight	Tight	Shortage	Tight	Tight	Tight	4Q 2020
1Q 2021	Shortage	Shortage	Tight	Tight	Shortage	Shortage	Shortage	Tight	Tight	Shortage	1Q 2021
2Q 2021	Shortage	Tight	Tight	Tight	Shortage	Shortage	Shortage	Tight	Tight	Shortage	2Q 2021
3Q 2021	Balanced	Glut	Tight	Tight	Balanced	Balanced	Balanced	Tight	Tight	Shortage	3Q 2021
4Q 2021	Tight	Balanced	Tight	Tight	Balanced	Balanced	Balanced	Shortage	Tight	Shortage	4Q 2021
1Q 2022	Tight	Shortage	Shortage	Tight	Balanced	Balanced	Loose	Shortage	Tight	Shortage	1Q 2022
2Q 2022 NowCast	Tight	Tight	Shortage	Tight	Balanced	Balanced	Loose	Shortage	Tight	Shortage	2Q 2022 NowCast
21-Jan-22	Tight	Shortage	Tight	Tight	Balanced	Balanced	Loose	Shortage	Tight	Shortage	21-Jan-22
28-Jan-22	Tight	Shortage	Tight	Tight	Saturated	Loose	Saturated	Tight	Tight	Shortage	28-Jan-22
4-Feb-22	Tight	Shortage	Tight	Tight	Saturated	Saturated	Saturated	Tight	Tight	Shortage	4-Feb-22
11-Feb-22	Tight	Shortage	Tight	Tight	Loose	Loose	Balanced	Tight	Tight	Tight	11-Feb-22
18-Feb-22	Tight	Shortage	Tight	Tight	Saturated	Saturated	Loose	Tight	Tight	Shortage	18-Feb-22
25-Feb-22	Tight	Shortage	Tight	Tight	Saturated	Saturated	Saturated	Tight	Tight	Shortage	25-Feb-22
4-Mar-22	Tight	Shortage	Shortage	Tight	Balanced	Balanced	Saturated	Shortage	Shortage	Shortage	4-Mar-22
11-Mar-22	Tight	Shortage	Shortage	Tight	Balanced	Balanced	Loose	Shortage	Shortage	Shortage	11-Mar-22
18-Mar-22	Shortage	Tight	Shortage	Tight	Tight	Tight	Balanced	Shortage	Shortage	Shortage	18-Mar-22
25-Mar-22	Shortage	Balanced	Shortage	Tight	Tight	Shortage	Tight	Shortage	Shortage	Shortage	25-Mar-22
1-Apr-22	Shortage	Balanced	Shortage	Tight	Tight	Tight	Balanced	Shortage	Shortage	Shortage	1-Apr-22
8-Apr-22	Tight	Loose	Tight	Balanced	Saturated	Saturated	Loose	Shortage	Tight	Shortage	8-Apr-22
15-Apr-22	Tight	Loose	Tight	Balanced	Saturated	Saturated	Saturated	Tight	Tight	Shortage	8-Apr-22
22-Apr-22	Balanced	Loose	Tight	Balanced	Saturated	Saturated	Saturated	Balanced	Tight	Shortage	22-Apr-22
Range:	Shortage	Tight	Balanced	Loose	Saturated	Glut					

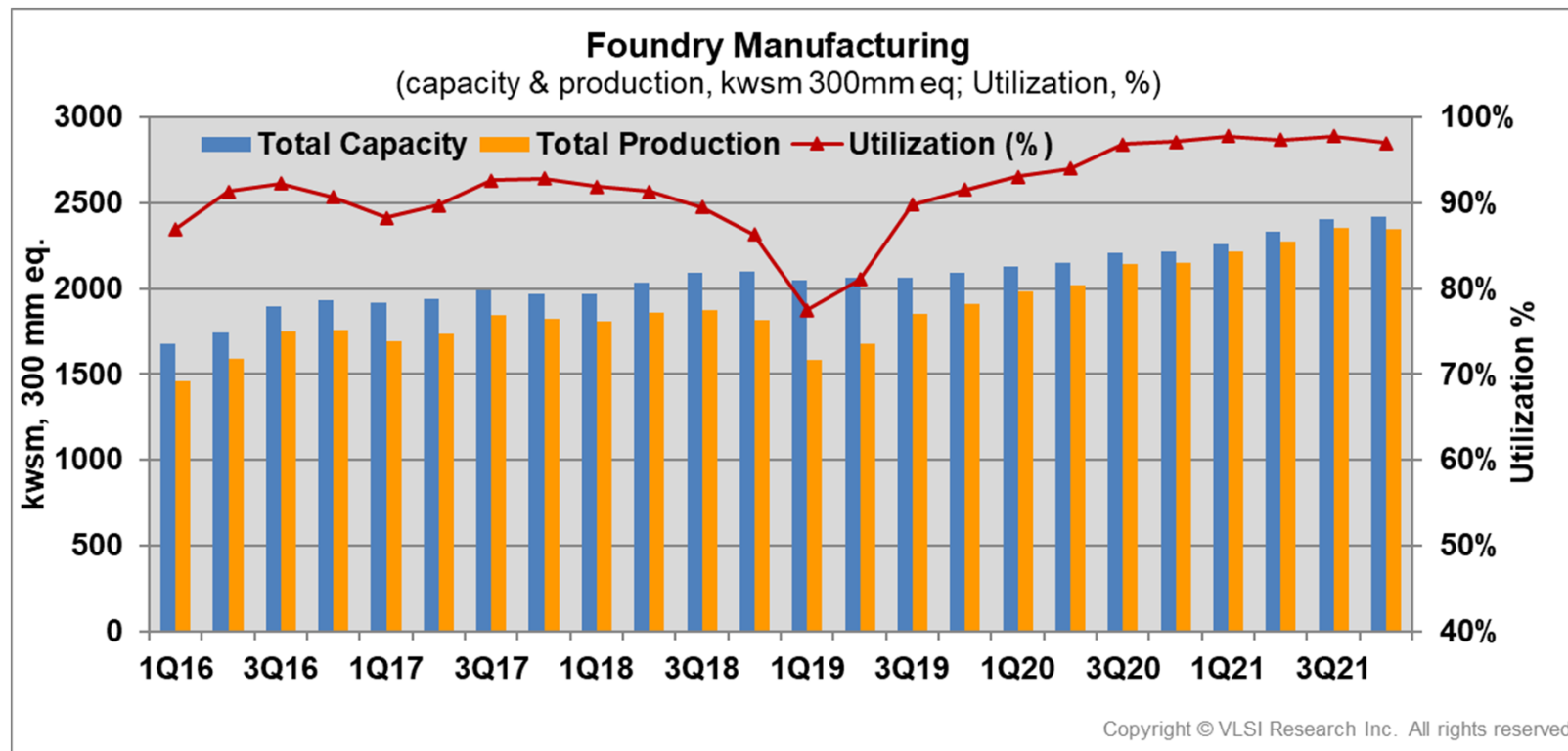
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Capacity for Top Five Foundries*

Capacity for the top 5 Foundries expected to increase 8% in 2021, compared to 5% 2019



* TSMC, Samsung LSI, SMIC, GLOBALFOUNDRIES, UMC

Semiconductor sales upgraded

SEMICONDUCTOR SALES

(worldwide sales, \$B, calendar year)

	2019	2020	2021	2022
Analog	56	58	76	89
	-4%	3%	30%	18%
DRAM	63	67	96	111
	-37%	7%	42%	16%
NAND	41	50	61	69
	-25%	24%	21%	13%
MPU	56.2	62.4	68.0	73.3
	2%	11%	9%	8%
Other Logic	132	145	187	220
	-2%	9%	29%	18%
Discrete, Opto & Oth	82	82	98	113
	3%	1%	19%	16%
Total Semiconductor	430	465	585	676
	-11%	8%	26%	15%

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SEMICONDUCTOR SHIPMENTS

(worldwide sales, B units, calendar year)

	2019	2020	2021	2022
Analog	166	176	219	244
	-6%	6%	25%	11%
DRAM	17	19	22	24
	12%	12%	13%	9%
NAND	11	12	14	15
	-2%	5%	14%	11%
MPU	0.6	0.7	0.7	0.8
	-4%	9%	10%	7%
Other Logic	86	93	120	134
	-9%	9%	28%	12%
Discrete, Opto & Oth	637	637	761	852
	-8%	0%	20%	12%
Total Semiconductor	919	938	1137	1270
	-8%	2%	21%	12%

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The Chip Insider® *Semiconductor Manufacturing Markets*

Foundry & IDM Capital Expenditures

- Changes Since Last Forecast
- Company Focus
- Advanced Logic & Foundry
- DRAM & NAND
- Semiconductor Manufacturing CapEx
- VLSI's View



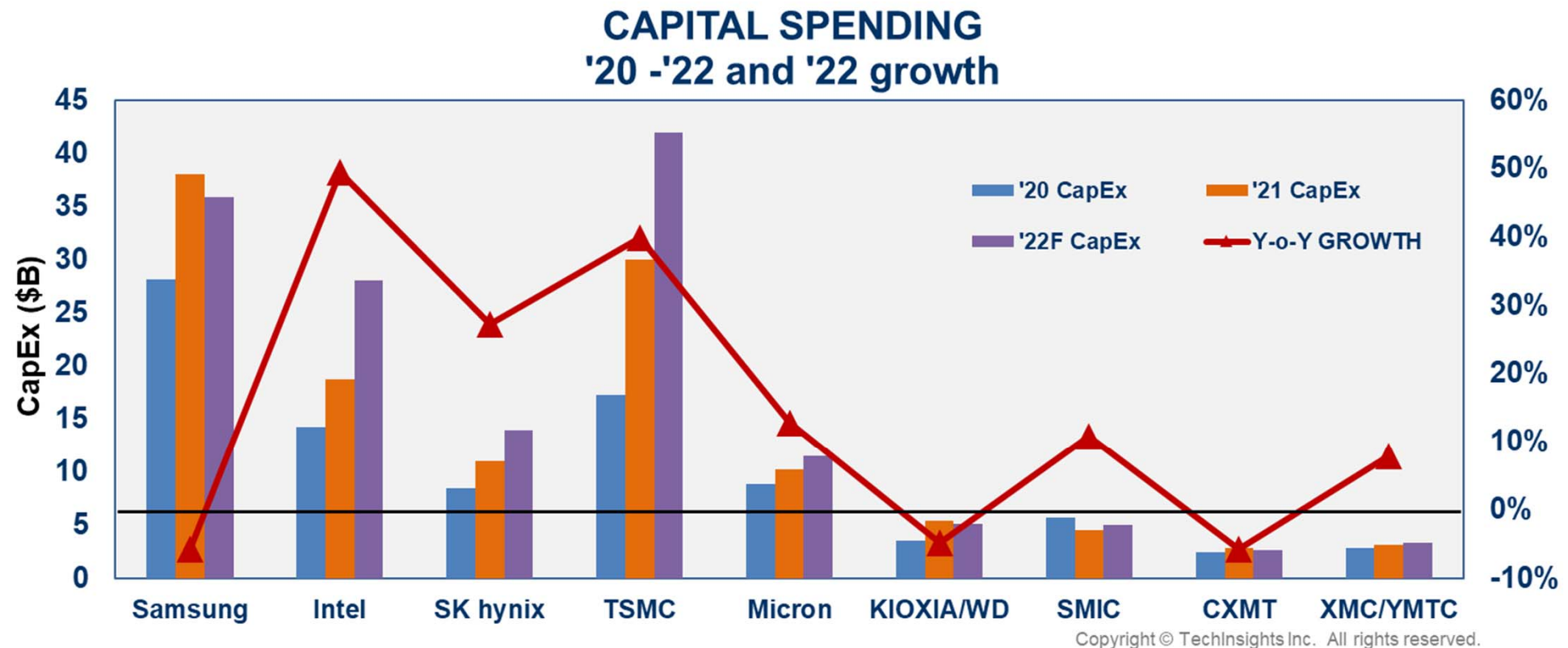
WildPhotons: Never let life's hardships to...

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Company Focus

Spending is increasing in 2022 as chipmakers bring more capacity online to meet end demand



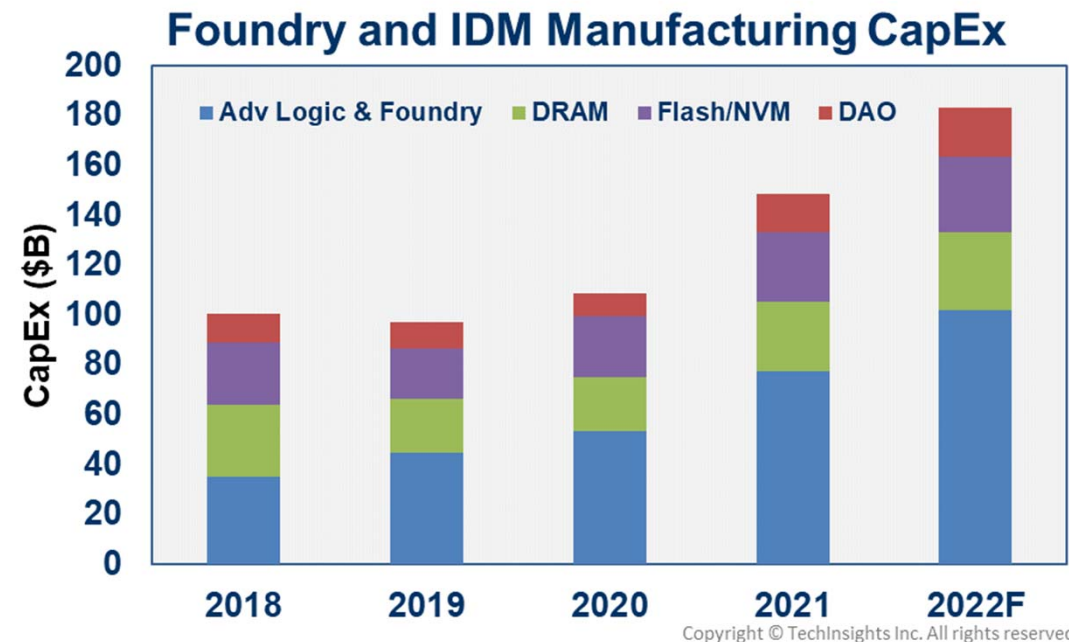
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Manufacturing CapEx

Bullish business sentiment is driving a higher CapEx outlook

- 2021 CapEx surged 34%
 - Adv Logic & Foundry +45%
 - DRAM +27%
 - NAND/NVM +17%
 - Other +61%
 - Strong CapEx growth in 2021 and solid outlook for 2022
- 2022 CapEx is expected to grow 23%, reaching over \$182B
 - Adv Logic & Foundry +32%
 - DRAM +12%
 - NAND/NVM +7%
 - Other +31%



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The Chip Insider® *Semiconductor Manufacturing*

Test & Related Equipment Outlook

- Strong demand through supply chains
- Changes since last forecast
- Test in 2021 and outlook 2022
- Test relative to Electronics and ICs
- Strategic View on Test

WildPhotons: Be careful when using sports analogies...



Test Outlook 2022

Broad demand across all test segments continues

Test Equipment Sales

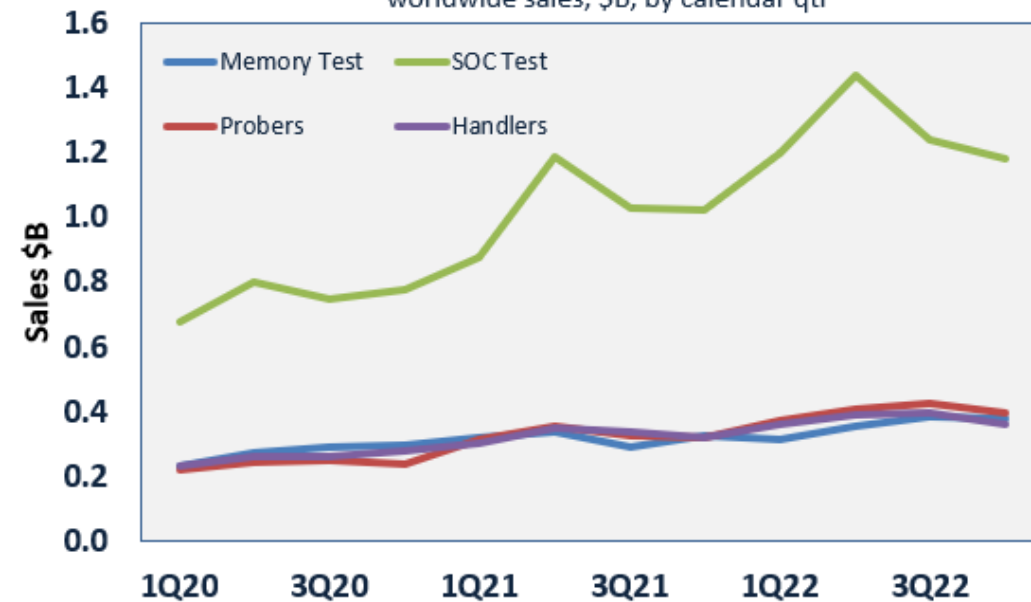
(worldwide sales, \$B, CY 2019 - 2022)

	2020	2021	2022
Memory Test	1.1	1.3	1.4
y-o-y growth	62%	16%	13%
SOC Test	3.0	4.1	5.1
y-o-y growth	9%	37%	23%
Other Test	0.3	0.4	0.4
y-o-y growth	3%	15%	2%
Handlers	1.0	1.3	1.5
y-o-y growth	-2%	27%	15%
Probers	0.9	1.3	1.6
y-o-y growth	16%	38%	22%
Total Semiconductor	6.4	8.3	9.9
y-o-y growth	13.9%	30.9%	19.2%

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Test & Related Equipment Sales

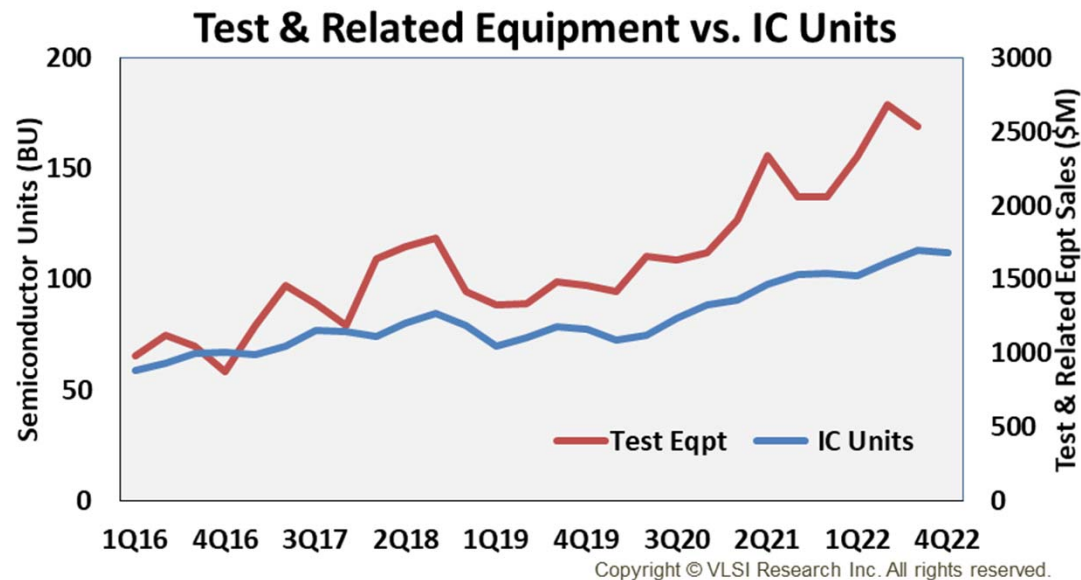
worldwide sales, \$B, by calendar qtr



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Test Equipment Demand

Test intensity is growing as sales growth is outpacing IC units



- ATE demand is solid through 2022
- Probers and handlers follow overall industry trends
- Test & Related Equipment sales are above long-term trend-line

Cyclical Growth for Test

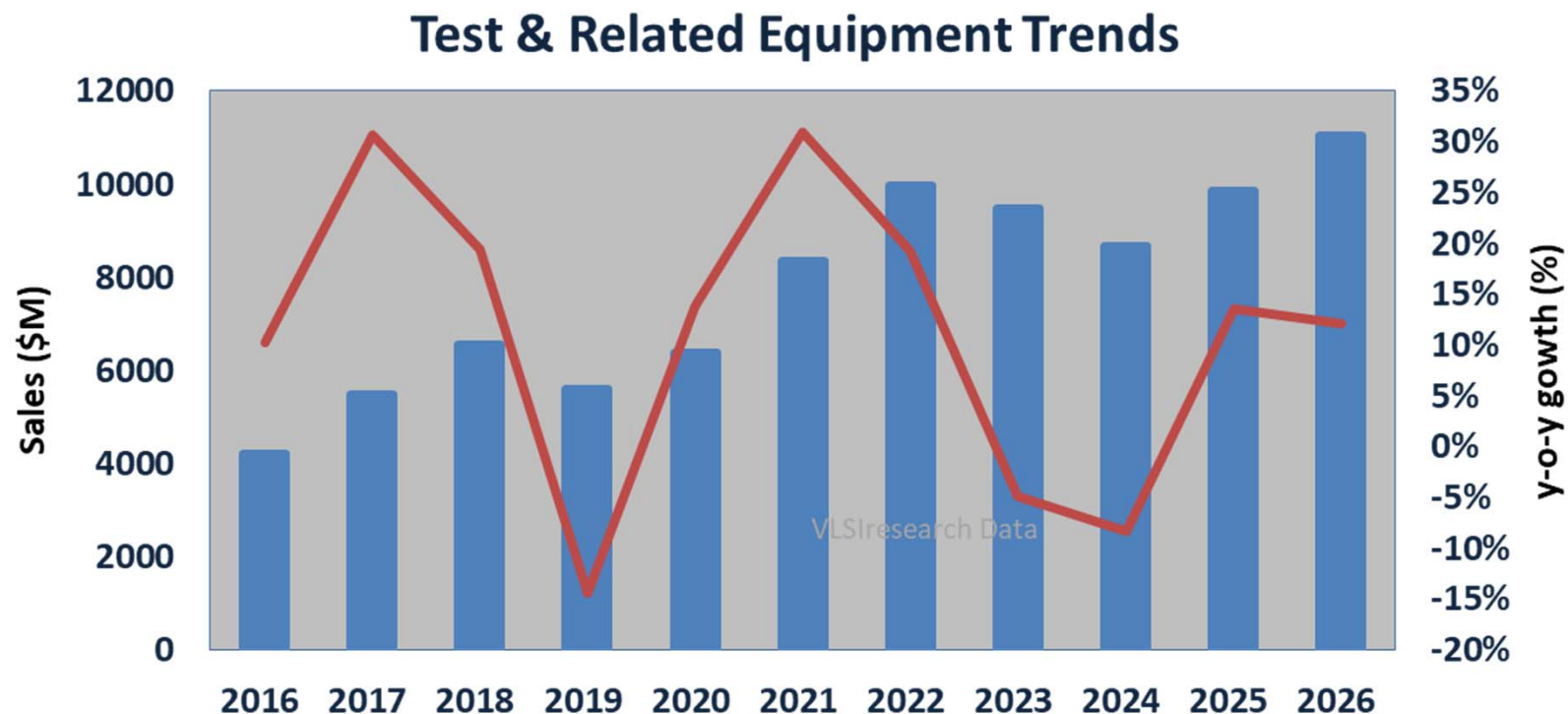


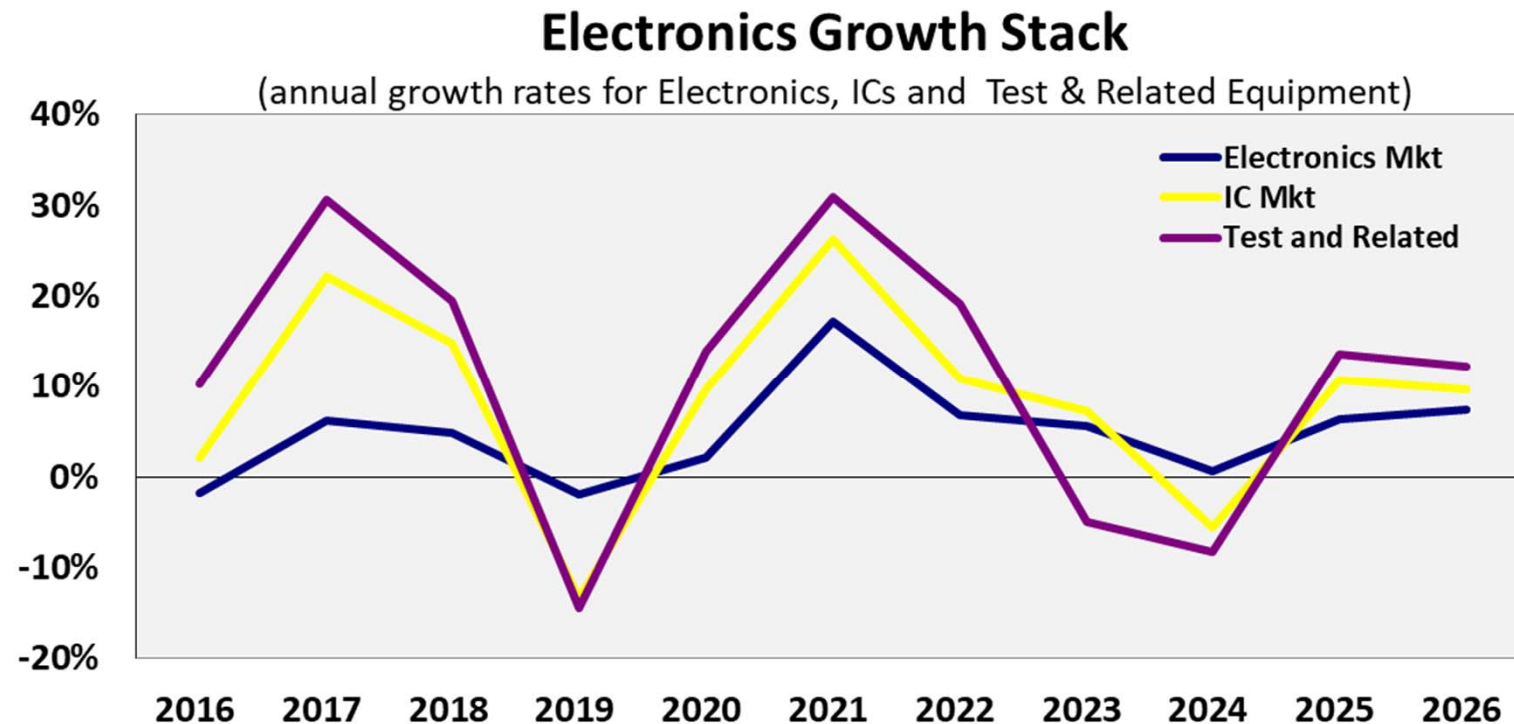
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Test Equipment Relative to Electronics and ICs

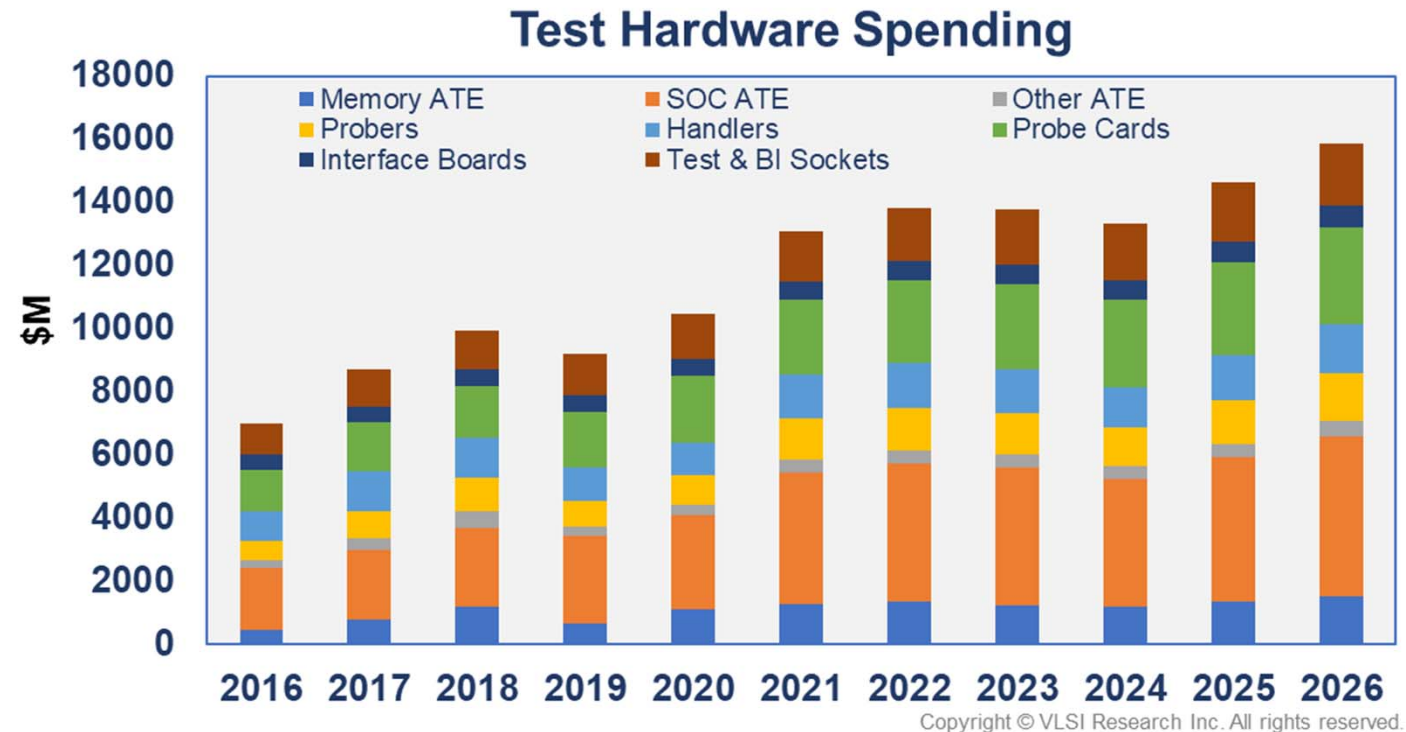
Follows ICs and electronics



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Strategic View – Overall Test Investment

- Total Test Hardware spending exceeded \$13B in 2021
- '16 – '21 CAGR 13.3%
- '21 – '26 CAGR 5.1%



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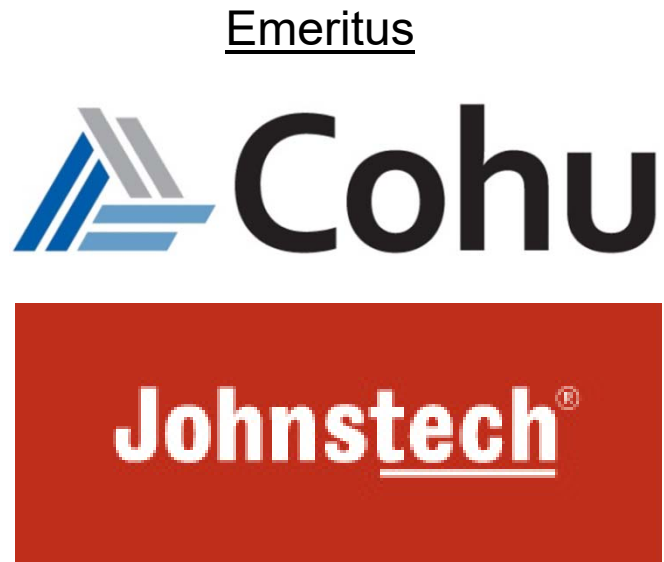
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