Tech Hardware - Asia Pacific

The essence of FAU: alignment and automation

Industry Overview

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Equity
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Tech Hardware

Katherine Zhu >>
Research Analyst
Merrill Lynch (Hong Kong)
kexin.zhu@bofa.com

Robert Cheng >>
Research Analyst
Merrill Lynch (Taiwan)
robert.cheng@bofa.com

Doris Kao >>
Research Analyst
Merrill Lynch (Taiwan)
doris.kao@bofa.com

For acronyms, please refer to Exhibit 13

FAU: lots of new entrants, but few likely winners

FAU acts as a highway connecting fiber to the optical engine for data transmission, and is essential to pluggable transceiver/NPO/CPO. Currently, FAUs are mostly supplied by legacy Asia supply chains, and FAU for CPO is 100% supplied by a Chinese vendor. We see more new entrants aiming to ramp up CPO/FAU-related components – e.g. fiber array, micro lens, prism, etc. However, in our view, not many of them could succeed due to high entry barriers, and we see Largan's progress as faster than other new entrants as it has moved on to certification after sampling/testing for two quarters. We highlight two key bottlenecks: (1) micron-level alignment, i.e. controlling the pitch tolerance at ≤ ±0.5µm or even lower to ensure low-loss transmission; and (2) automatic alignment and testing to deliver consistent tolerance while lift efficiency. We note this know-how will take years of accumulated experience in precision optic manufacturing, mass production, as well as strong in-house automation capability.

CPO to take off in '28-29; FAU at 5-10% BOM/ $8bn TAM

Based on our checks, Nvidia's CPO switch volume may remain relatively low near-term, and a meaningful volume could happen in 2028-29, on rising penetration at scale-up. BofA tech team expects Nvidia CPO switch shipments to reach 14k/52k/190k units in 2026/27/28E. Among key components, we expect FAU to contribute 5-10% of the BOM, with the ASP ranging from US$80-200. The TAM for FAU in Nvidia CPO switches could hit US$8bn by 2030E. Amid multiple new optical solutions, we believe pluggable will remain a mainstream in scale-out into 2028-30. Within scale-up, the penetration of NPO and CPO depends on key CSPs' preference as well as CPO's overall yield and cost.

GlassBridge: in early stage, not a replacement for FAU

Amid market's concern about potential threat from Corning's GlassBridge solution (to replace FAU), we argue that GlassBridge is still at an early stage, and is unlikely to be adopted in current and next-generation CPO design. Although GlassBridge could indeed improve the assembly yield, several bottlenecks need to be addressed, including misalignment with PIC due to the waveguide's uneven surface, rising manufacturing difficulty when channel numbers rise to 70+, etc. Also, under GlassBridge solution, a fiber array is still needed but likely with a lower precision-alignment requirement.

Upgrade Largan to Buy, Neutral on Sunny Optical

We see the datacom supply chain as a more closed ecosystem vs consumer electronics, given much higher requirements. Besides capability, customer engagement is another key. We upgrade Largan to Buy from Neutral on faster progress at CPO (see Largan report). We reiterate Neutral on Sunny Optical given the lack of concrete projects.

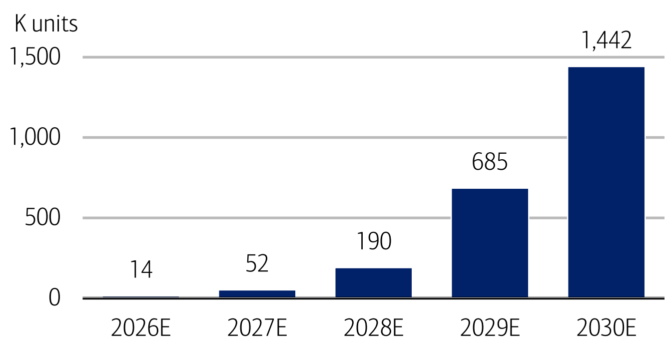
FAU in CPO: $8bn TAM by '30 on volume take-off from '28

Based on our supply chain check, Nvidia's CPO switch shipment may remain relatively low near-term, and a meaningful volume likely takes off in 2028-29 following rising penetration at scale-up. BofA tech team expects volume to reach 14k/52k/190k units in 2026/27/28E. Among key components, optical engine (OE) acts as the core to convert electric and light signals, while FAU acts as a highway connecting optical fiber and optical engine for data transmission. Outside of CPO switch, external laser source (ELS) is responsible for projecting laser that helps drive light signal through optical fiber, while MPO/MMC are connectors that connect optical fibers housed in the shuffle box to external ports. Looking at the BOM of a CPO switch, optical engine, ELS, and FAU are likely contribute 40-55%, 10-15% and 5-10% of the total BOM, respectively.

Specifically for FAU, we believe its TAM in Nvidia CPO switch could reach US$8bn by 2030E, based on an assumption of 1.4mn units of CPO switch and 115 units of 1.6T equivalent OEs per switch. Our check suggests FAU's ASP ranges from US$80-200, depending on current specs. General FAU consists of fiber array (V-groove and optical fiber), lid, substrate and casing, etc, while some high-end FAU also integrate optical components like micro lens, prism and MT ferrules. For example, Spectrum 6810 adopts 36 channels of dFAU, and dFAU pricing could be in the range of US$150-200. With volume gradually rising into 2030, the ASP could fall to US$100. However, as specs migrate to 70-100 channels and potential muti-layer design, FAU could witness content value upside.

Exhibit 1: We expect Nvidia CPO switch shipment to reach 14k/52k/190k units in 2026/27/28E

Nvidia CPO switch shipment, 2026-30E



Source: BofA Global Research estimates

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Exhibit 2: Spectrum 6810 features 36 FAUs (include 4 redundancy)

Nvidia CPO switch component summary

	Quantum X800 Q3450	Spectrum 6810	Spectrum 6800
Switch chip	4	1	4
OE	72	36	144
FAU	72	36	144
ELS	18	16	64
Laser	144	128	512
MPO/MMC	144	128	512

Source: Company data, BofA Global Research

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Exhibit 3: We estimate FAU value per switch could reach US$6-7k

Nvidia CPO switch BOM analysis

US$	Quantum Q3450	Spectrum 6810
Switch chip	12,000	5,000
OE	64,800	32,400
FAU	6,120	6,480
ELS	11,700	10,400
MPO & shuffle box	8,760	9,400
Others (substrate, PCB, cooling, power, etc)	15,000	15,000
	118,380	**78,680**

Source: BofA Global Research estimates

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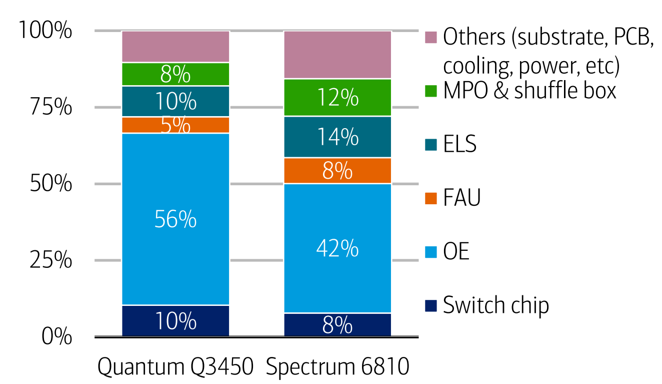
Exhibit 4: FAU roughly contributes 5-10% BOM of a Nvidia CPO switch

Nvidia Quantum and Spectrum CPO switch BOM analysis



Source: BofA Global Research estimates

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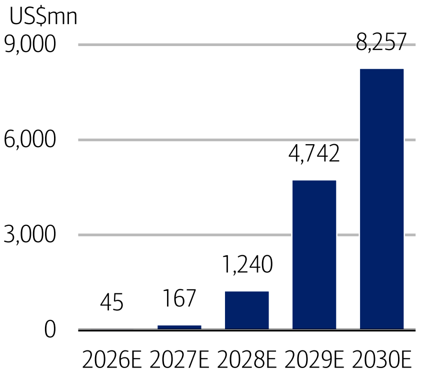
Exhibit 5: We expect FAU's TAM for CPO switch to reach US$8bn by 2030E
FAU (for CPO) TAM analysis, 2026-30E



Source: BofA Global Research estimates

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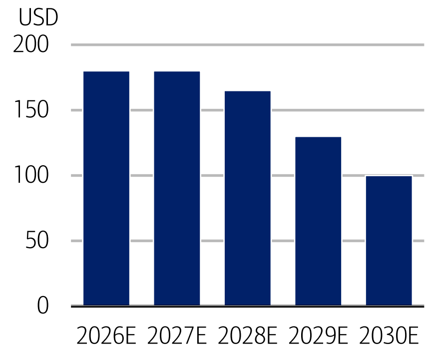
Exhibit 6: We see dFAU ASP at around USD180 in recent 1-2 years
dFAU ASP trend (36-channel, 3.2T equivalent), 2026-30E



Source: BofA Global Research estimates

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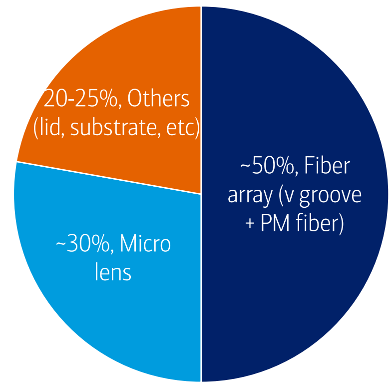
Exhibit 7: FA likely to contribute 50% of the BOM, followed by micro lens at ~30%
BOM analysis of FAU (with micro lens, prism etc)



Source: BofA Global Research estimates

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Exhibit 8: Key FAU suppliers are mostly located in Asia (China, Japan, Taiwan)
Key suppliers in CPO supply chain

Component	Key suppliers					
Optical engine	Nvidia	Broadcom	Marvell	TSMC (foundry)		
FAU						
V-groove	TFC	Senko	Orbray	Corning	Focuslight	
Optical fiber	Corning	Fujikura	YOFC			
Micro lens	TFC	Coherent	Focuslight	Largan	Himax	
FAU	TFC	Senko	FOCI	Coherent	Corning	Largan (potential)
ELS						
Laser	Lumentum	Coherent	Broadcom	Furukawa	Yuanjie	DS Precision
Module	TFC	Lumentum	Coherent	Innolight	Eoptolink	DS Precision
Shuffle box	Corning (T&S)	Browave	Senko	Molex	TFC	
MPO/MMC	US Conec	Senko	T&S			
Assembly/testing	Fabrinet	Hon Hai/FII	ASE/SPIL	USI		
Equipment	Chroma	FiconTEC				

Source: BofA Global Research

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Alignment and automation lift entry barrier

FAU acts as a highway connecting optical fiber to the optical engine for data transmission, and is essential to pluggable transceiver/NPO/CPO. Currently, FAUs are mostly supplied by legacy Asia supply chains, while FAU for CPO is 100% supplied by Chinese vendors. We highlight two key bottlenecks faced by the supply chain: (1) micron-level alignment, i.e. controlling the pitch error tolerance at ≤ ±0.5µm (or even ≤ ±0.3µm) to ensure light signal efficiency; and (2) automatic alignment to deliver consistent accuracy while lifting efficiency.

Alignment: solving the pitch tolerance

Fiber array used in FAU acts as a multi-lane highway for light, allowing multiple data channels to be connected simultaneously with the optical engine for conversion of electronic and light signals. Under a fiber array, multiple optical fibers are densely seated on a V-groove (features parallel and microscopic V-shaped channels). The process requires highly precise alignment to achieve low-loss transfer. To compare, an optical transceiver usually has a pitch tolerance (i.e. alignment accuracy) of ±0.5µm to ±1.0µm. NPO's pitch tolerance is likely at ≤ ±0.5 µm, while CPO's pitch tolerance could be ≤ ±0.3 µm. As V-groove and fiber also have their own geometric tolerance, alignment error could accumulate linearly when channel numbers rise. V-groove's etching depth and angle variation could introduce misalignment from channel to channel. Even if a V-groove is perfectly etched, optical fiber could also lead to alignment difficulties. A single-mode fiber generally has a diameter of 80-125µm (core at 6-10µm); any diameter variation of a fiber could cause it to sit higher or lower on a V-groove, leading to alignment mismatch. Additionally, for dFAU, maintaining positioning tolerance after multiple detach/plug processes is also key.

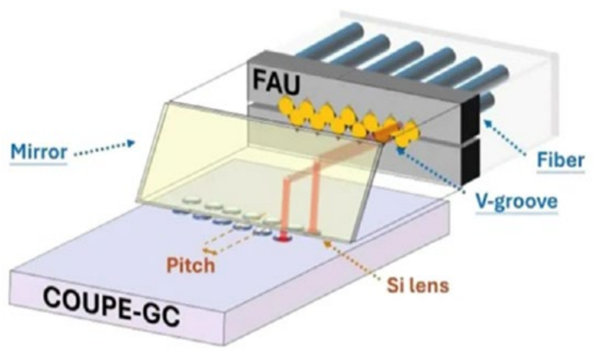
This level of precision alignment usually requires years of accumulation, deep know-how in optic coupling and mass production experiences. Although smartphone optic suppliers could leverage their active alignment (AA) know-how used in lens/module, the level of precision still has a big gap (for example, telephoto camera's AA tolerance is ≤ ±5µm).

Automation: crucial when channel numbers continue rising

As optical fiber channel numbers are expected to increase to 60-100 from the current 20-36 channels while CPO volume is waiting for take-off in 2028-29, fiber array alignment based on labor-intensive process looks increasingly difficult. Thus, automation becomes crucial. It could not only reduce labor intensity and lift efficiency, but more importantly help troubleshoot alignment issues and improve accuracy. As the industry has no standard automation/testing at current stage, suppliers able to ramp up automation faster or have in-house automation capability could have a better edge.

Exhibit 9: FAU assembles PM fibers on a V-groove to direct light, and leverages micro lens and prism to project light onto PIC

Illustration of FAU under grating coupler solution



Source: FOCI

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Exhibit 10: CPO has the lowest pitch error tolerance at ≤ ±0.3µm

FAU spec summary under different applications

	Pluggable transceiver	NPO	CPO
FAU location	Inside module	On host PCB	On substrate
Pitch error tolerance	±0.5µm - ±1.0µm	≤ ±0.5µm	≤ ±0.3µm
Channel count	4 to 16	16 to 32	32 to 128+
Insertion loss target	<0.5dB	<0.3dB	<0.2dB

Source: BofA Global Research

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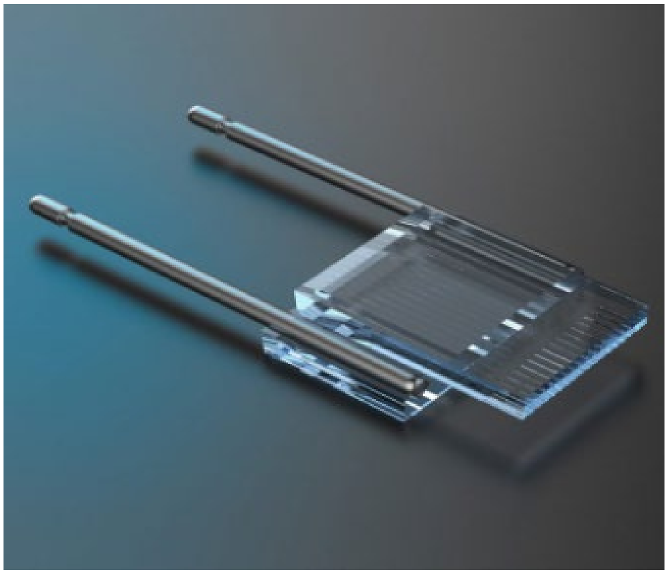
GlassBridge not a threat near-term, also not a replacement

We note market's concern about Corning's GlassBridge, a wafer-based fiber-to-PIC technology, which could be an alternative solution to FAU. We argue that GlassBridge is still at an early stage and is unlikely to be adopted in current and next-generation CPO design. Although GlassBridge could indeed improve the assembly yield, several bottlenecks need to be addressed, including misalignment with PIC due to the waveguide's uneven surface (due to edge coupling), rising manufacturing difficulty when channel numbers rise to 70+, etc. Further, GlassBridge uses edge coupling technology – i.e. horizontal coupling, with light projected directly into the PIC horizontally. Compared with grating coupling (vertical coupling), edge coupling is not able to conduct wafer-scale testing, leading to potentially lower efficiency. The horizontal design also faces space limitations and demands an extreme alignment requirement.

Exhibit 11: GlassBridge is a wafer-based fiber-to-PIC technology platform

Corning's GlassBridge connector



Source: Corning

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Exhibit 12: Edge coupling is more efficient in insertion loss, but faces limitation in terms of wafer-level testing and spatial constraint

Comparison of grating coupling and edge coupling

	Grating coupling	Edge coupling
Coupling type	Vertical	Horizontal
Insertion loss	Good efficiency	High efficiency
Alignment tolerance	High	Extreme
Wafer level testing	Yes	No
Spatial constraint	No	Yes

Source: BofA Global Research

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Exhibit 13: Summary of acronyms used in this report

Acronym

Acronym	
AI	Artificial Intelligence
ASP	Average Selling Price
BOM	Bill of Materials
CPO	Co-packed Optics
ELS	External Laser source
FA	Fiber Array
FAU	Fiber Array Unit
dFAU	Detachable Fiber Array Unit
MPO	Multi-fiber Push-On
MMC	Multiport Modular Connector
MT	Mechanical Transfer
NPO	Near-packaged Optics
OE	Optical Engine
PIC	Photonic Integrated Circuit
PCB	Printed Circuit Board

Source: BofA Global Research

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Exhibit 14: Stocks mentioned in this report

Stocks mentioned

BofA Ticker	Bloomberg Ticker	Company Name	Price (LC)	Rating
LGANF	3008 TT	Largan Precision	4345.00	B-1-7
SNPTF	2382 HK	Sunny Optical	55.05	C-2-8

Source: BofA Global Research

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Investment Rationale

Largan Precision

We have a Buy rating on Largan, eyeing on rising visibility on potential CPO project gain. We believe CPO will drive valuation a re-rating and a potential earning upside from 2028E. Besides, legacy business should stay resilient thanks to iPhone's multi-year spec upgrade cycle.

Price objective basis & risk

Largan Precision (LGANF)

Our PO of NT$5,600 is based on 25x 2028E P/E. 25x is at Largan's historical peak P/E during last earnings upcycle. We believe CPO take-off from 2028 will drive another new multi-year earnings upcycle for Largan, justifying our valuation multiple.

Downside risks are: 1) weaker than expected end-demand, which leads to pressured topline and margin on lower utilization rate, 2) more intense competition from Greater China competitors including Sunny Optical, Genius and AAC, 3) slower than expected spec upgrade, and 4) slower than expected progress at CPO.

Upside risks are: 1) better than expected end demand and faster than expected spec upgrade, 2) higher than expected ASP and market on competitors' inferior execution, 3) eased competition from key peers, and 4) faster than expected progress at CPO.

Sunny Optical (SNPTF)

We set our PO at HK$69, on 17x 2026E P/E, we view 17x, around -0.5SD, is justified by potentially slower margin improvement amid uncertainties at smartphone shipment and spec into 2026, while reflect business diversification into datacom.

Downside risk: (1) demand at consumer electronics further deteriorate with continuous de-spec, (2) slower than expected share gain at iPhone, (3) slower-than-expected auto momentum and slower ADAS penetration, (4) intensified competition at both smartphone and auto. (5) Government subsidy is removed.

Upside risk: (1) better than expected demand/spec at consumer electronics, (2) faster than expected share gain at iPhone, (3) strong auto momentum and faster ADAS penetration, (4) eased competition at both smartphone and auto, and (5) faster than expected progress at datacom.

Analyst Certification

We, Katherine Zhu and Robert Cheng, hereby certify that the views each of us has expressed in this research report accurately reflect each of our respective personal views about the subject securities and issuers. We also certify that no part of our respective compensation was, is, or will be, directly or indirectly, related to the specific recommendations or view expressed in this research report.

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APR - Technology Hardware Coverage Cluster

Investment rating	Company	BofA Ticker	Bloomberg symbol	Analyst
BUY				
	AAC Technologies	AACAF	2018 HK	Katherine Zhu
	Asia Vital Components	AVMPF	3017 TT	Doris Kao
	BizLink	BIZLF	3665 TT	Doris Kao
	BOE Technology Group Co., Ltd	XCJQF	000725 CH	Brad Lin
	Chenbro	CEOMF	8210 TT	Doris Kao
	Cowell	CWLLF	1415 HK	Katherine Zhu
	Crystal-Optech	XMKAF	002273 CH	Katherine Zhu
	Delta Electronics Inc.	DLTEF	2308 TT	Robert Cheng
	Duksan Neolux	XDSXF	213420 KS	Simon Woo, CFA
	Dynamic Holding	XLHCF	3715 TT	Mike Yang
	E Ink Holdings	PVWIF	8069 TT	Doris Kao
	Elite Material	ETMCF	2383 TT	Mike Yang
	Foxconn Industrial Internet	XDAZF	601138 CH	Robert Cheng
	Goertek	XGKCF	002241 CH	Katherine Zhu
	Gold Circuit	GOCCF	2368 TT	Doris Kao
	Hana Microelectronics	XHNNF	HANA TB	Suppapong Iemkongaek, CFA, CMT
	Hon Hai Precision Industry	HNHAF	2317 TT	Robert Cheng
	Huaqin	XHUAF	603296 CH	Katherine Zhu
	Huaqin	XPEZF	3296 HK	Katherine Zhu
	ISU Petasys	IPTYF	007660 KS	Matt Shin
	Jentech	XVFSF	3653 TT	Doris Kao
	King Slide	KGSLF	2059 TT	Doris Kao
	Kinsus	KNSUF	3189 TT	Mike Yang
	Largan Precision	LGANF	3008 TT	Robert Cheng
	Lens Tech	XLTVF	6613 HK	Katherine Zhu
	LG CNS	XLGLF	064400 KS	Simon Woo, CFA
	LG Electronics	LGEAF	066570 KS	Simon Woo, CFA
	LG Innotek	XLGQF	011070 KS	Simon Woo, CFA
	Lotes	ZYZTF	3533 TT	Doris Kao
	Luxshare	XNJQF	002475 CH	Robert Cheng
	Netweb Technologies	XNTZF	NETWEB IN	Jatin Kalra, CFA
	NYPCB	NANYF	8046 TT	Mike Yang
	Quanta Computer	QUCPF	2382 TT	Robert Cheng
	Samsung Electro-Mechanics	SMSGF	009150 KS	Simon Woo, CFA
	Samsung SDI	SSDIF	006400 KS	Simon Woo, CFA
	Samsung SDS	XWPBF	018260 KS	Simon Woo, CFA
	Shennan Circuits	XAMKF	002916 CH	Katherine Zhu
	Taiwan Union Technology Corporation	TWUNF	6274 TT	Mike Yang
	Unimicron	UMCRF	3037 TT	Mike Yang
	Universal Display	OLED	OLED US	Simon Woo, CFA
	Victory Giant	XENEF	300476 CH	Katherine Zhu
	Wistron	WICOF	3231 TT	Doris Kao
	Wiwynn	XWIQF	6669 TT	Robert Cheng
	Xiaomi Corporation	XIACF	1810 HK	Robert Cheng
	Yageo	YGEQF	2327 TT	Robert Cheng
	Zhen Ding Tech	XFAGF	4958 TT	Doris Kao
	Zhongji Innolight	XZICF	300308 CH	Katherine Zhu
	ZTE Corporation	SHZZF	000063 CH	Katherine Zhu
	ZTE Corporation	ZTCOF	763 HK	Katherine Zhu
NEUTRAL				
	Advantech	ADTEF	2395 TT	Robert Cheng
	Asustek	AKCPF	2357 TT	Robert Cheng
	AU Optronics	AUOTF	2409 TT	Brad Lin
	AU Optronics	AUOTY	AUOTY US	Brad Lin
	Auras Technology	AUTCF	3324 TT	Doris Kao
	BYD Electronic	BYDIF	285 HK	Katherine Zhu
	DS Precision	XBASF	002384 CH	Katherine Zhu
	Innolux Corporation	CMLXY	3481 TT	Brad Lin
	Lenovo Group	LNVGF	992 HK	Robert Cheng
	Lenovo Group	LNVGY	LNVGY US	Robert Cheng
	Lite-On Tech	LOTZF	2301 TT	Doris Kao
	Sunny Optical	SNPTF	2382 HK	Katherine Zhu
	TCL Technology Group Corp	XTOOF	000100 CH	Brad Lin

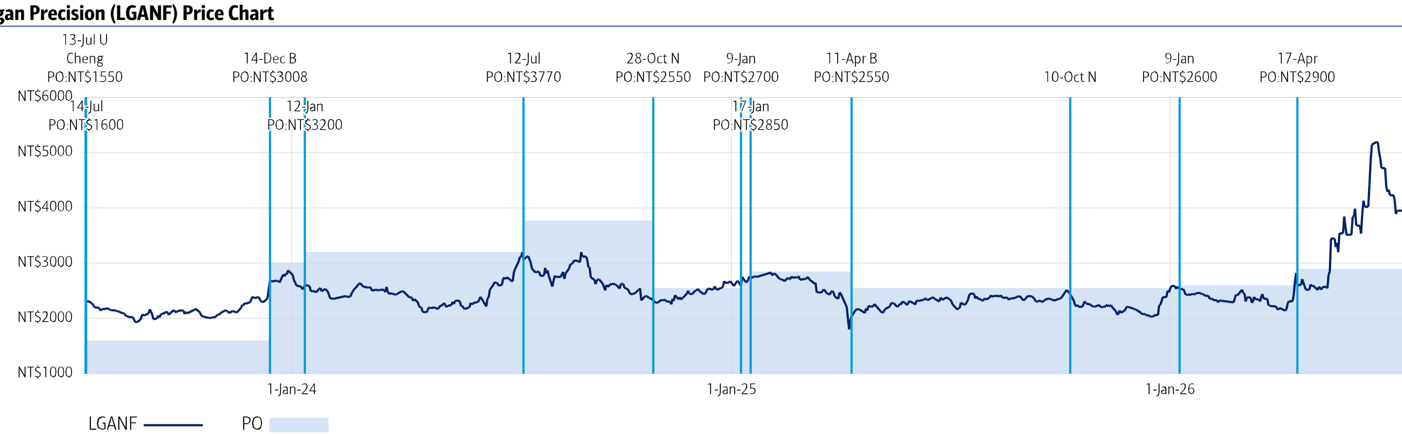
APR - Technology Hardware Coverage Cluster

Investment rating	Company	BofA Ticker	Bloomberg symbol	Analyst
UNDERPERFORM				
	Acer	ASIYF	2353 TT	Robert Cheng
	Catcher Tech	CHERF	2474 TT	Robert Cheng
	Compal Electron	XLCPF	2324 TT	Doris Kao
	Delta Electronics (Thailand)	XLETF	DELTA TB	Suppapong Iemkongaek, CFA, CMT
	Everwin Precision	XSHZF	300115 CH	Katherine Zhu
	Genius Electronic Optical	GNSEF	3406 TT	Robert Cheng
	Lens Tech	XLTGF	300433 CH	Katherine Zhu
	LG Display	LPHLF	034220 KS	Simon Woo, CFA
	LG Display-ADR	LPL	LPL US	Simon Woo, CFA
	Lianchuang Electronic	XWOFF	002036 CH	Katherine Zhu
	Pegatron	PGTRF	4938 TT	Robert Cheng
	Sanan Opto	XEQYF	600703 CH	Katherine Zhu
	Seoul Semiconductor	SLSOF	046890 KS	Simon Woo, CFA
	Shengyi	DGUNF	600183 CH	Mike Yang
	Sunway Communications	XWSVF	300136 CH	Katherine Zhu
	Tianma	XVZLF	000050 CH	Brad Lin
	Transsion	XCINF	688036 CH	Robert Cheng

Disclosures

Important Disclosures

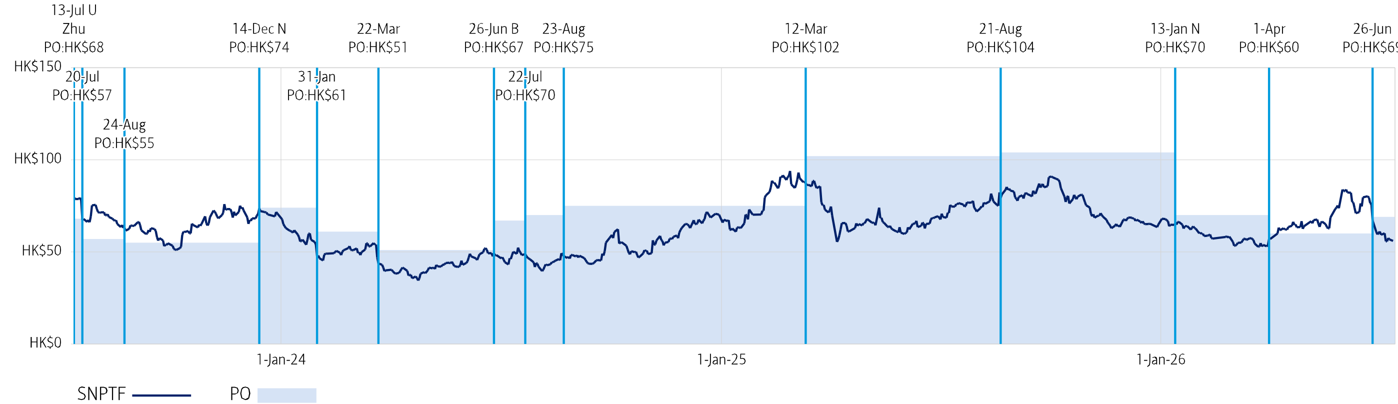
Largan Precision (LGANF) Price Chart



B: Buy, N: Neutral, U: Underperform, PO: Price Objective, NA: No longer valid, NR: No Rating

The Investment Opinion System is contained at the end of the report under the heading "Fundamental Equity Opinion Key". Dark grey shading indicates the security is restricted with the opinion suspended. Medium grey shading indicates the security is under review with the opinion withdrawn. Light grey shading indicates the security is not covered. Chart is current as of a date no more than one trading day prior to the date of the report.

Sunny Optical (SNPTF) Price Chart



B: Buy, N: Neutral, U: Underperform, PO: Price Objective, NA: No longer valid, NR: No Rating

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Equity Investment Rating Distribution: Industrials/Multi-Industry Group (as of 30 Jun 2026)

Coverage Universe	Count	Percent	Inv. Banking Relationships R1	Count	Percent
Buy	68	62.39%	Buy	36	52.94%
Hold	15	13.76%	Hold	7	46.67%
Sell	26	23.85%	Sell	12	46.15%

Equity Investment Rating Distribution: Technology Group (as of 30 Jun 2026)

Coverage Universe	Count	Percent	Inv. Banking Relationships R1	Count	Percent
Buy	243	60.60%	Buy	123	50.62%
Hold	87	21.70%	Hold	45	51.72%
Sell	71	17.71%	Sell	21	29.58%

Equity Investment Rating Distribution: Global Group (as of 30 Jun 2026)

Coverage Universe	Count	Percent	Inv. Banking Relationships R1	Count	Percent
Buy	1987	56.11%	Buy	1190	59.89%
Hold	797	22.51%	Hold	496	62.23%
Sell	757	21.38%	Sell	391	51.65%

R1 Issuers that were investment banking clients of BofA Securities or one of its affiliates within the past 12 months. For purposes of this Investment Rating Distribution, the coverage universe includes only stocks. A stock rated Neutral is included as a Hold, and a stock rated Underperform is included as a Sell.

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Investment rating	Total return expectation (within 12-month period of date of initial rating)	Ratings dispersion guidelines for coverage cluster R2
Buy	≥ 10%	≤ 70%
Neutral	≥ 0%	≤ 30%
Underperform	N/A	≥ 20%

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