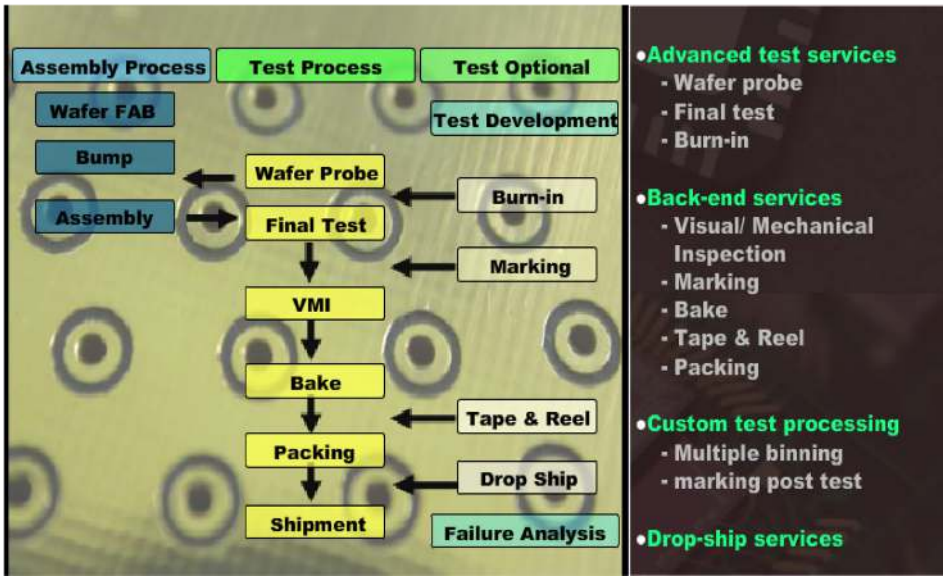
Semiconductor IC Test Services

Amkor provides a complete range of semiconductor testing services including wafer testing, various types of final testing, system level testing, strip testing and complete end-of-line services up to and including final shipping.

We have testing operations in our facilities in China, Japan, Korea, the Philippines and Taiwan, which enables fast feedback, streamlined logistics and short cycle times. We also offer many specialized logistical services including security certification and anti-counterfeit measures. In 2011, we tested over six billion units for over 100 customers.



We test a variety of device types across all of our package families including radio frequency, analog and mixed signal, digital, power management, memory and various combinations such as application-specific integrated circuits, multi chip modules, system-in-package (SiP), and stacked chips. We also test biometric devices, accelerometers, gyrometers, haptics, pressure sensors and other types of MEMS devices.

Our test hardware and contacting solutions are aligned with Amkor's advanced bump and package technologies. Examples include custom package size SiP, dual-sided contacting solutions for Package on Package (PoP), TMV PoP, FusionQuad® sockets, multiple-row MicroLeadFrame® (MLF), and probe solutions for fine-pitch copper pillar.

Our test equipment and test floors are well integrated with CIM / CAM tools, yield analysis and performance monitoring to deliver very high efficiency and first pass yield. We support numerous adaptive test processes for our customers and offer distributed test flows for SiP and other complex assembly flows.

Our experienced technical staff provides a full range of test consultation, development and engineering services across our customers' entire product lifecycle. They understand the unique markets and testing requirements for SiP, automotive, networking, gaming, graphics, computing, RF / wireless and emerging 2.5D / 3D Through Silicon Via (TSV) devices.

Our customers' product lifecycle & Amkor Test Services

Development	Introduction	Growth	Maturity	Decline
Test Strategy	Characterization	Yield Analysis	Multi-site Test	Test Time Reduction
Equipment Selection	NPI Processes	Test Time Reduction	Further Optimization	Next Generation Planning
Failure Analysis	Quality	Test Efficiency	Re-visit Test Strategy	

Test Development Services

Amkor offers a full range of test software, hardware, integration, product engineering services and project management to bring our customers' products to market swiftly and with high quality.

Typical projects are full test solutions for new devices, cost down solutions for high volume / long lifetime products, derivative product solutions and conversions/migrations to alternative tester, probers and handlers.

Our test development centers are located in Korea and the Philippines and provide complete solutions covering product specific testing software, all necessary hardware for handling and contacting, correlation, release to mass production and post production support. These centers are in close proximity to many of our customers' design centers.

Wafer Test Services

Amkor's advanced wafer probe and inspection services support: high speed digital using direct docking, known good die (KGD), thin wafers, Wafer Level Packaging (WLP), temperature and RF probe. For lower cost / higher parallelism our probers support up to 300 to 400Kg of probe force required for multi-site probe. Amkor probe is participating in the leading wafer process nodes across major market segments. Here are a few highlights:

- Low K dielectrics
- Engagement on 28nm, 32nm and 40nm process nodes
- Largest die size in production probe ~400mm ^ 2
- Highest probe count in production 14,000
- High current and high power probe (up to 90 amps and 100 watts)
- Highly parallel WLCSP probe (x16/x32)

Wafer Prober Portfolio/Roadmap

Our portfolio of wafer probers supports -55°C to +200°C probe temperatures, fine alignment and thin wafers:

Wafer Size	Prober	Temp Range (°C)	Comments
200mm	TEL P8	20** – 150	
	TEL P8 WDF (Film Frame Probers)	Ambient	Capable down to 50μm wafer thickness
	EG 4090μ/μ+	20** – 150	±4 μm pin-to-pad accuracy (μ) ±3 μm pin-to-pad accuracy (μ+)
300mm	TEL P12XLn+	-55** – 150	±1.8 μm pin-to-pad accuracy up to 100kg z-force
	TEL Precio	-55** – 150	±1.8 μm pin-to-pad accuracy up to 200kg z-force Precio Nano capable of up to 400kg z-force
	Accretech (TSK) UF3000EX	-55** – 200	±1 μm pin-to-pad accuracy, max z-force 200kg (Option 300kg)
	Semics OPUS3	-55** – 200	±1.5 μm pin-to-pad accuracy, max z-force 300kg
450mm	Qual plan (Y2013~2014)		Mass production from Y2015

Notes: ** - With chiller/cold chuck option (some TEL probers within Amkor have this option)

Probe Card Technology

Amkor uses a wide range of probe card technologies well aligned with advanced wafer process nodes and Amkor's bump and pillar roadmap.

Capability vs. Amkor Package Technology Roadmap

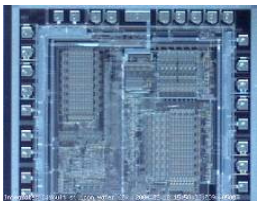
Wafer Probe Capability Roadmap - Minimum Pitch (µm)

Technology	Current	2013	2014	Notes
Bump Full Array	125	125	110	1
Bump (Solder or Cu Pillar) In-line & staggered*	40 30/60* 3-row	40 30/60* 3-row	40 30/60* 3-row	3
In-line / Multi-row Pads	40	40	40	2
Leadframe	35	35	35	2
WLCSP	280	280	250	1

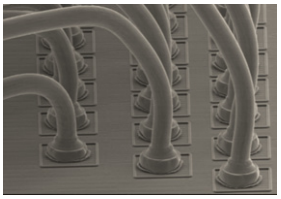
Notes	
	1 - Standard vertical probe technology
	2 - Cantilever probe current vendor capability 30/60µm for 4 row, 25/50µm for 2 or 3 row, 35µm for inline single row
	3 - Advanced vertical probe technology required

Risk Legend	
	Proven
	Not proven, in development or supplier claim
	Not proven, not currently in development

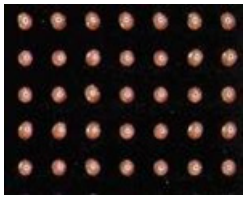
Copper Pillars

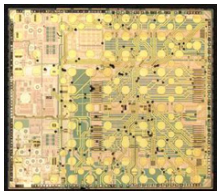


In-line peripheral pads



Multi-row peripheral pads





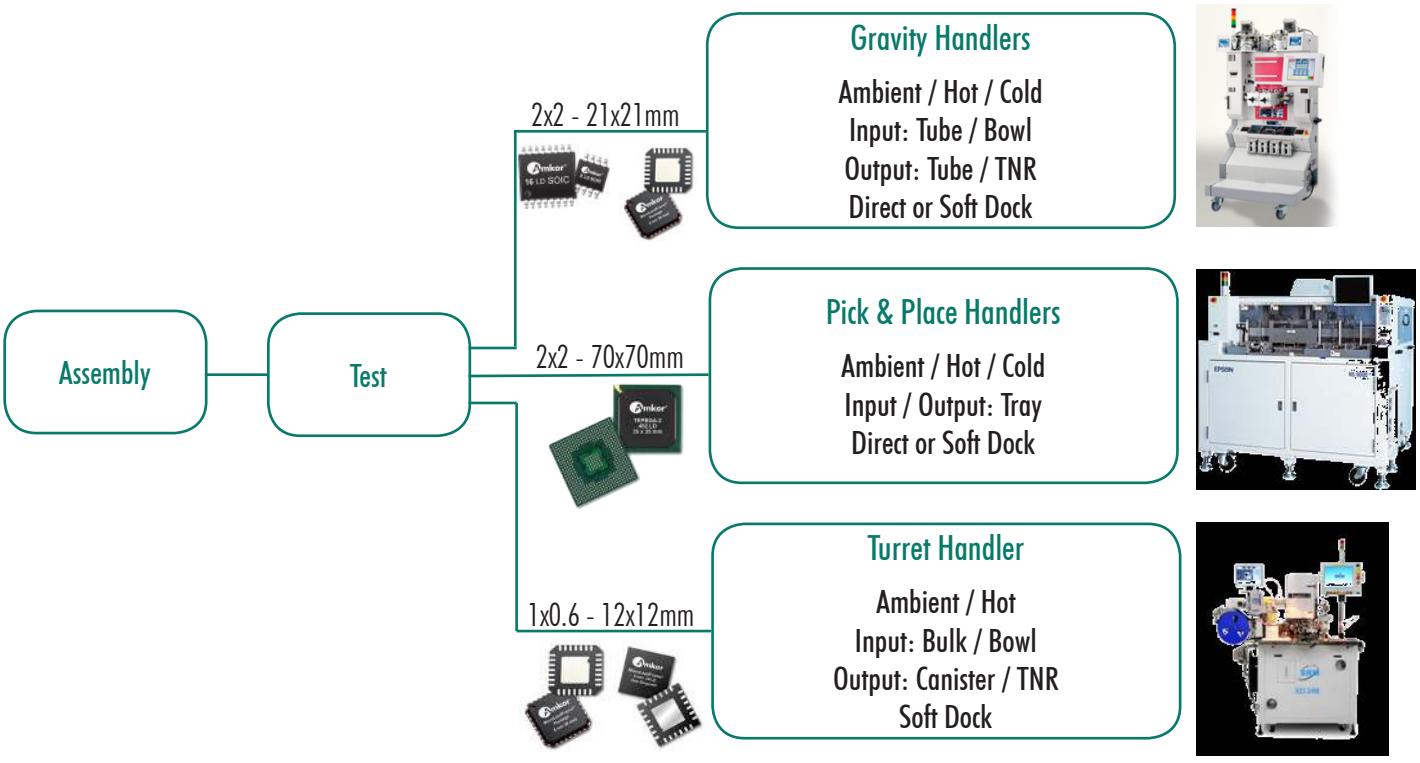
Full Array Bumps

Final Test Services

Amkor's final test spans a range of rigor and complexity depending on the device and end market application (testing multiple times under different electrical and temperature conditions, and before and after device reliability stresses, such as burn-in). In addition to electrical testing, specialized solutions are required for sensors that require non-electrical stimuli (acceleration, angular velocity, and atmospheric pressure, magnetic or acoustical stimulus). The electrical tests are a mix of functional, structural and system-level depending on the customer's requirements and cost and reliability parameters. The equipment we use includes commercially available automated test equipment, customized and proprietary system level test equipment and innovative types of low-cost test equipment developed by Amkor. System level experience and capabilities cover: 802.11, 802.16, cellular, graphics and gaming. Our main tester roadmap and locations are:

Tester Model	Tester Model	Locations			
		Korea	Philippines	Taiwan	China
Advantest-Verigy	T2000	√		√	√
	T5xxx (Memory)	√	√		√
	V93000 series	√	√	√	√
LTX-Credence	X-Series, D10/40	√	√	√	
Teradyne	Flex series	√	√	√	√
	J750 & J750Ex	√	√		√
	Nextest Magnum	√	√		√

Our handler portfolio for singulated test addresses all ranges of package sizes, process flow, temperatures and stringent thermal management required in gaming, computing and graphics.



VISIT AMKOR TECHNOLOGY ONLINE FOR LOCATIONS AND TO VIEW THE MOST CURRENT PRODUCT INFORMATION.

Amkor Technology

Contactor Technologies

Test hardware and contacting is a critical element of an efficient test solution – Amkor continuously stays aligned with our advanced packages:

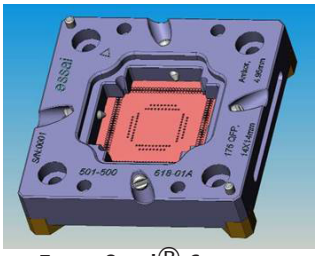
Capability vs. Amkor Package Technology Roadmap

Package Test Capability Roadmap - Minimum Pitch (µm)

Technology	Current	2013	2014	Notes
FCBGA/PBGA	500	400	400	
QFP/Leaded	400	400	400	
FusionQuad®	400	400	400	
MLF (Single Row)	400	300	300	1
MLF (Dual Row)	500/400	400	400	1
CSP/vfBGA	400	300	300	1
PoP/TMV® (top/bot)	400/400	400/300	400/300	1,2

Notes	
	1 - vfBGA at 400 µm in production Sockets for 300 µm pitch available, not yet proven within Amkor
	2 - Qualification of dual-sided contactor capability for 500 µm top and 400 µm bottom PoP/TMV® was completed in Q1 2010

Risk Legend	
	Proven
	Not proven, in development or supplier claim
	Not proven, not currently in development



FusionQuad® Contactor

ThruMoldVia® (TMV®)

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Strip Test Handler Portfolio

For certain applications with long test times and product lifecycle – parallel testing in a strip format is very cost-effective. Amkor is a world leader in this technology.

Assembly Format	Temp (˚C)	Packages
Std Leadframe	-60 to +160 (+/-3)	TQFP up to 32 lead, 7x7
		SOIC-N 150 mil, SOIC-W 300 mil, SOIC std 208 mil
		TSSOP up to 29 lead (3.0 and 4.4 mm body sizes)
		PDIP up to 8 lead
	-55 to +160 (+/-1)	Partial Saw MLF up to 6x6
Film Frame	Ambient	Saw MLF up to 6x6

Failure Analysis Capabilities

Amkor offer a broad array of failure analysis capabilities to assist our customers:

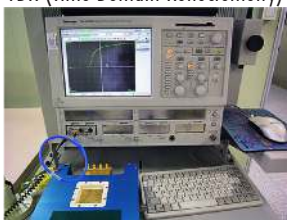
Automated Curve Tracer

FE-SEM (Field Emission Scanning Electron Microscope

Decapsulation

Emission Microscope

TDR (Time Domain Reflectometry)



- **E/L bench test**
- **Non-destructive analysis**
- **Destructive analysis**
- **Defect localization**
- **Visual inspection**

REI (Reactive Ion Etcher)

X-ray

SAT (Scanning Acoustic Tomography)

Grinder/Polisher

Precision Parallel Lapping

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Amkor Technology