Assembly Excellence for Advanced AI Data Center Electronics

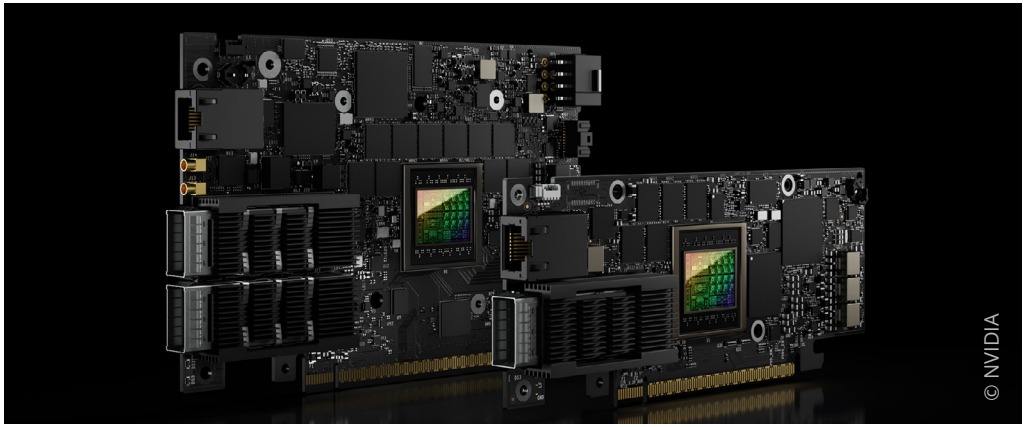
ASMPT enabling the digital world

Enabling PCBs for High-Performance Computing (HPC)

High-performance electronics used in AI-focused data centers present new challenges for SMT assembly.

The latest generation of server racks consists of large, heavy, and thick PCBs. These are populated with a wide range of components, including ICs, electrolytic capacitors, and, in particular, a very high number of passive components. Passive components are not only placed at very high densities, but often also at non-standard angles. In addition, components such as spacers must be placed and inspected before the BGA (such as TPUs and GPUs) assembly on top. The large and heavy BGAs have a very high number of interconnections with easily more than 20,000 balls. These extremely high-value assemblies require a consistently zero-defect manufacturing process.

SIPLACE placement machines from ASMPT SMT Solutions already provide the answer to these challenges.



Best in-machine solution for HPC SMT production

Placement machines

SIPLACE

Placement heads

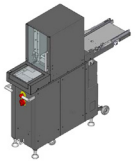
CP20 for highest speed

CPP for maximum flexibility

TWIN VHF for large & heavy component handling

Component feeding options

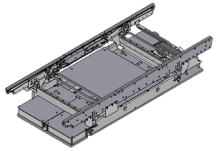
SIPLACE Waffle Pack Changer



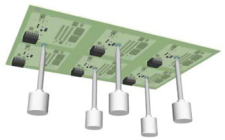
SIPLACE Smart Feeder

PCB transport & pin support

Heavy-duty conveyor

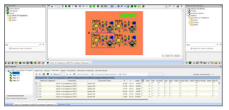


Smart Pin Support

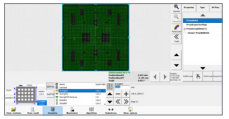


Programming system

WORKS Progamming with virtual product build

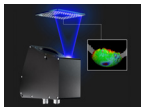


Component shape based on data import

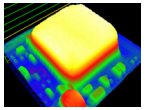


Vision system

Cameras:
- Component camera
- Stationary camera
- PCB camera
- Coplanarity camera



In-machine inspection capability



Requirements for the assembly of AI and High-Performance Computing electronics

An error-free assembly process requires precise control across all process steps.

SIPLACE Placement machines are designed to meet exactly these requirements with a fully controlled process from pick to place.

Process Chain for HPC SMT production

Establish an error-free assembly process based on proven technology.

Programming
The large number of tiny components and complex BGA connections pose a challenge for the creation of placement programs.

Feeding options
Smart component feeders and tray units need to ensure reliable material supply.

Quality control
Inspection capability in placement machine to verify the size of solder balls, the position of spacers, the presence of foreign objects, and the coplanarity or warpage of PCBs and components.

Creation of placement program → PCB handling → Component feeding → Placement of standard components → Inspection of placement positions → Inspection for foreign objects → Pickup & mounting of BGA → Visual & coplanarity inspection of BGA

Conveyor system
Extra large circuit boards must be transported, supported and held securely.

Placement heads
Both the placement of thousands of miniaturized components at exactly the right angle and in the right position, and the placement of very large and heavy BGAs must be performed without error.

Programming complex, densely populated boards

Establishing an error-free assembly process starts with programming.

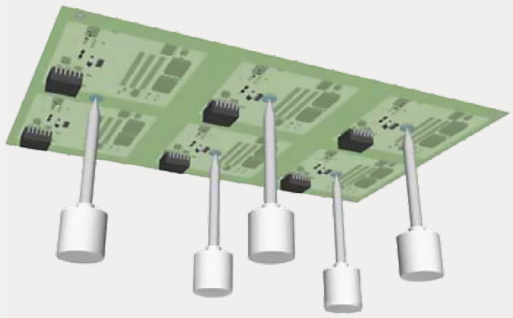
PROGRAMMING AND SIMULATION

Describing a complex layout

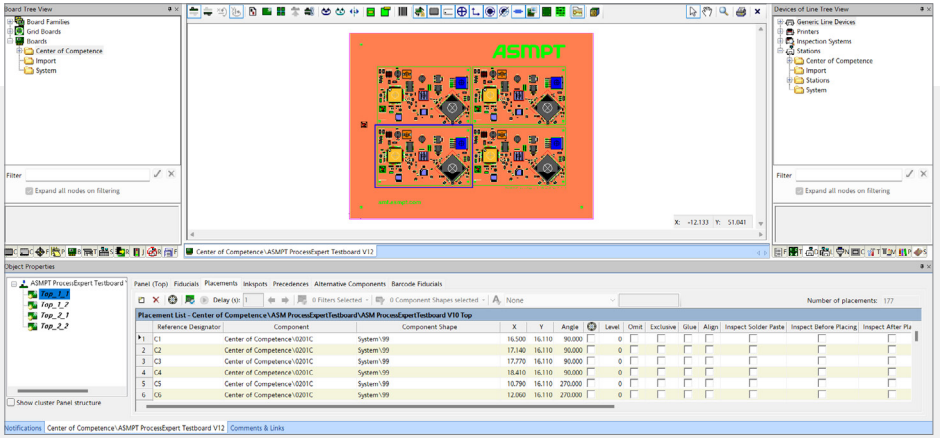
For today's processor BGAs in AI applications, several thousand balls are standard. Future generations will include components with more than 20,000 balls in an irregular pattern. The description of the package is a challenging task.

The WORKS Software Suite offers:

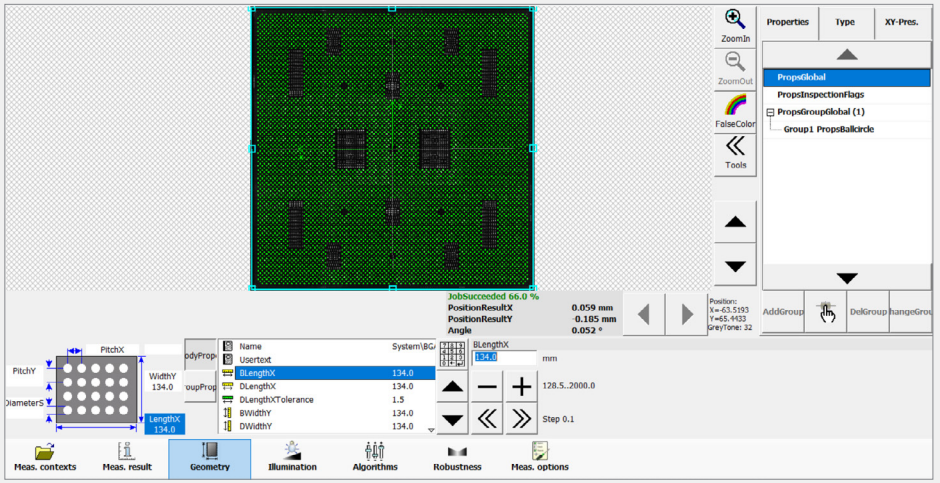
- Process-oriented offline programming
- Centralized management of programming data
- Offline simulation with virtual production steps
- ODB++ import
- Ball description import
- 3D visualization for top and bottom side for easy pin support programming



3D view of the PCB bottom side for defining support pin positions in WORKS Programming



PCB view in the WORKS Programming GUI



Import of ball position data at the station or offline station

Handling capabilities for large, heavy and thick PCBs

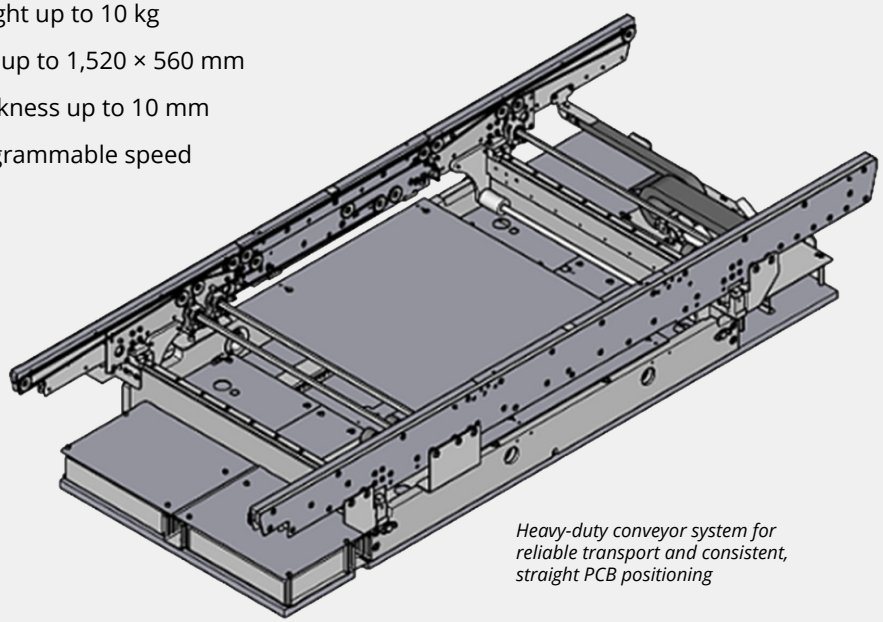
SIPLACE solutions enable reliable handling of big circuit boards throughout the entire process.

PCB TRANSPORT

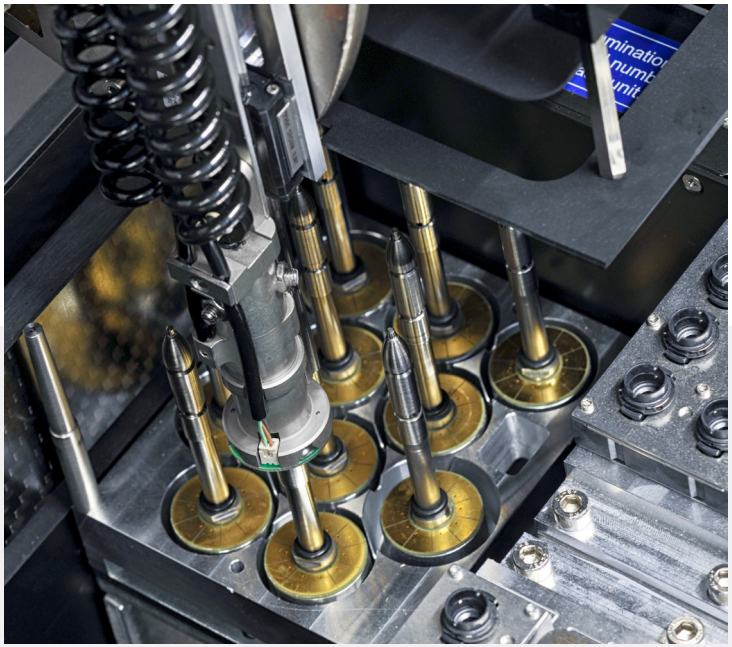
Heavy-duty conveyors

SIPLACE placement machines are already equipped with flexible transport options for handling exceptionally large, heavy and thick PCBs.

- Weight up to 10 kg
- Size up to 1,520 × 560 mm
- Thickness up to 10 mm
- Programmable speed



Heavy-duty conveyor system for reliable transport and consistent, straight PCB positioning



Automatic placement of support pins with continuous position monitoring

PCB SUPPORT

Automatic Smart Pin Support

To prevent bending and vibration, PCBs must be reliably supported during the assembly process. SIPLACE Smart Pin Support provides a faster and significantly more reliable solution compared to manual methods.

Features:

- Pins are automatically and precisely positioned based on the definitions in WORKS Programming
- 3D visualization enables early detection and prevention of collisions with sensitive components during the programming phase
- All pins are continuously monitored for correct position and height

Feeding all kinds of components

Placing components ranging from miniature passive SMDs, such as 016008M chips, to large, heavy BGAs requires intelligent feeding solutions.

VIA TAPE AND REEL

SIPLACE Smart Feeder

SIPLACE Smart Feeder are intelligent tape feeder modules designed for flexible production environments.

- Contactless data and power transmission
- Maintenance-free tape feeding modules
- Automatic calibration of pickup position
- Automatic pickup offset compensation
- Automatic splice detection
- Automatic pitch learning
- Unique ID for reliable setup verification
- 1 mm pitch capability

SIPLACE Smart Feeder are accurate, intelligent, lightweight, wireless, and maintenance-free.

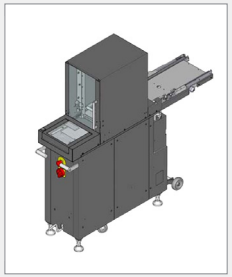
VIA TRAY

SIPLACE Waffle Pack Changer

For feeding large, odd-shaped components, the SIPLACE Waffle Pack Changer (WPC) is the most efficient solution.

Features of the tray unit WPC:

- Automatic and fast tray exchange
- Non-stop refill of component trays
- Full setup verification and traceability



SIPLACE Waffle Pack Changer enables non-stop feeding of tray-based components in a compact, space-saving design.

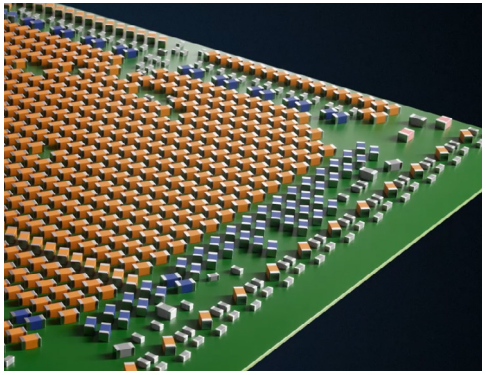
SIPLACE WAFFLE PACK CHANGER	
Specification	**Capability**
Required feeder tracks	30
Dimensions of waffle pack tray carrier (L×W×H)	360 × 260 × 6 mm
Dimensions of waffle pack tray (LxWxH)	347 × 235 × 15 mm
Storage capacity	Up to 28 tray carriers
Height of waffle pack tray including component	Up to 45 mm
Tray changeover time	~1.9 s (over 1 level)

High-speed placement of standard components

ASMPT's placement heads play a key role in the outstanding performance and flexibility for standard component placement.

SIPLACE placement heads offer maximum accuracy and advanced process control features:

- Component presence/absence check
- Pickup offset compensation before pickup
- Nozzle tip contamination inspection
- Component height measurement
- Software-controlled and programmable placement process, including force control

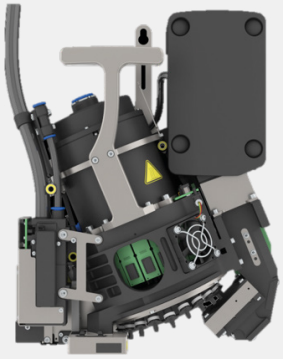


MAXIMUM SPEED

Placement Head CP20

The Placement Head CP20 is the ideal collect-and-place head for high-speed placement of standard components at the beginning of an SMT line.

- Rotary head with 20 independent segments enables offset correction and placement at all required angles
- Component-specific vision parameters enable high-density placement at any placement angle within a single head cycle
- Very high-speed placement of components from 016008M up to 8.2 × 8.2 mm
- Precise monitoring of Z-axis movement for warpage compensation



MAXIMUM FLEXIBILITY

Placement Head CPP

The Placement Head CPP switches between three different placement modes in response to software commands.

- High speed and a wide component range combined in one placement head enable optimal line balancing and bottleneck elimination
- Placement of components in collect-and-place, pick-and-place, and mixed mode
- Placement of components up to 27 × 27 mm in collect-and-place mode
- Placement of components up to 40 × 50 mm in pick-and-place mode with the same head

Verification of components after placement

Before placing high-value BGAs, the presence and placement accuracy of components underneath must be verified.

IN-MACHINE QUALITY CONTROL

Visual inspection

SIPLACE placement machines are equipped with (high-performance) PCB cameras, which can be used to inspect already placed components.

Possible inspection checks:

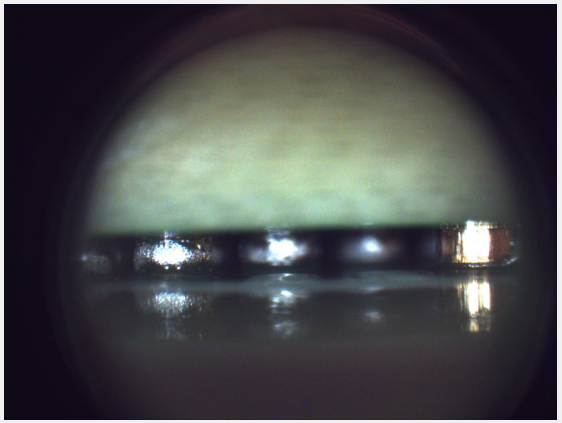
- Check for component presence/ absence
- Check for component placement position within specified tolerances

Possible inspection locations:

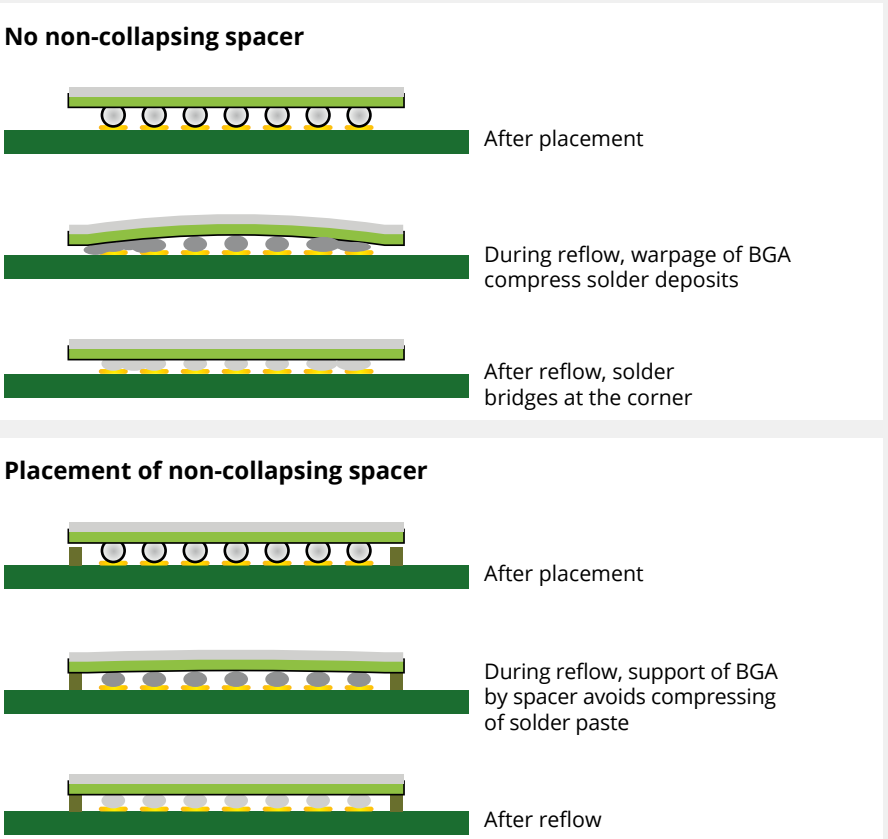
- In the placement machine directly after placement
- In the placement machine further down the line before placing additional components

Use case for HPC applications:

- Typically, spacers (thin discs) are placed underneath the BGA
- Prevents solder bridging: Maintains minimum height under components to avoid shorts caused by warped BGA corners
- Spacers are inspected after placement for presence and correct position
- Placement of the BGA is enabled only after successful verification



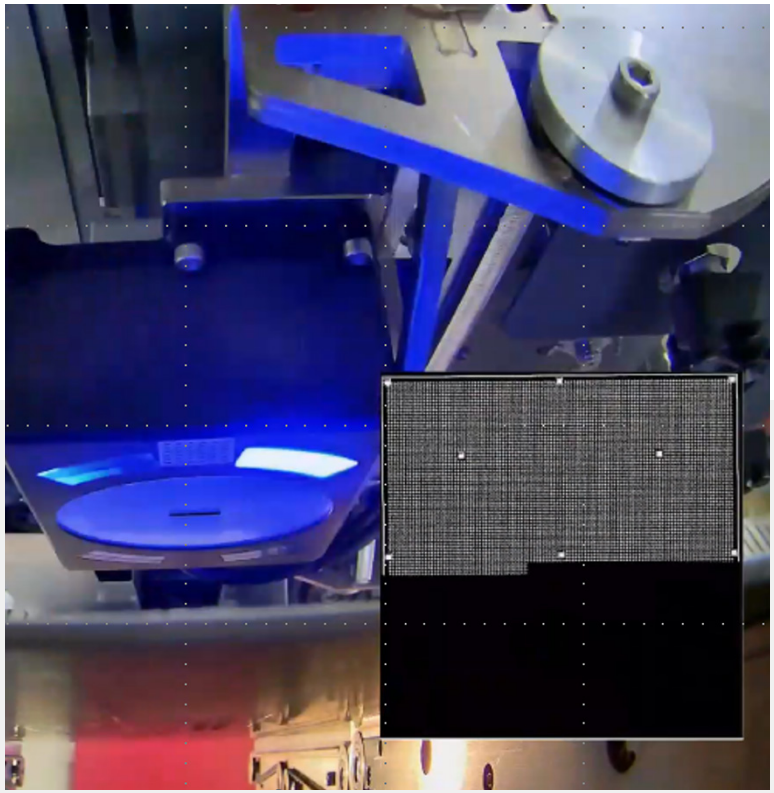
Microscope picture of BGA after reflow with solder balls and spacer



Reason for spacer placement

Detection of foreign objects in the placement area

Tens of thousands of solder balls with diameters of 0.5 to 0.6 mm and pitch values ranging from 0.8 to 1.0 mm make BGA placement a critical process. It is essential to ensure that no foreign objects are present in this area.



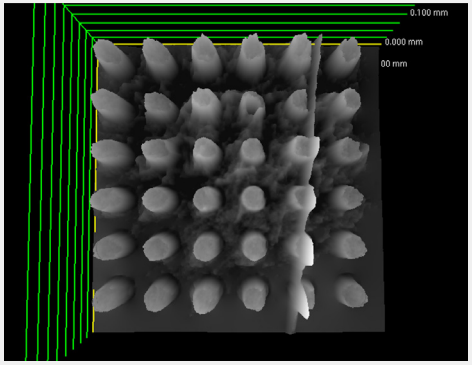
DETECTING FOREIGN OBJECTS

Avoiding defects

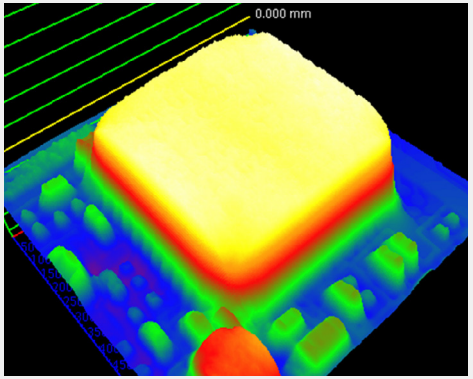
SIPLACE placement machines feature high-resolution inspection for maximum reliability.

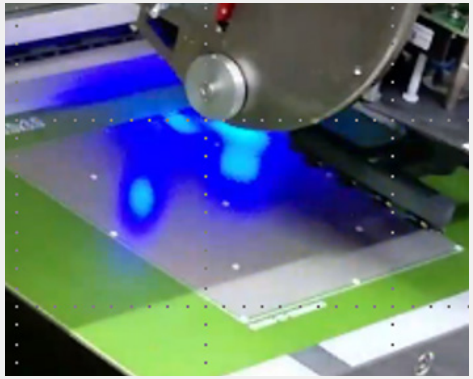
- Inspection with the PCB camera before component placement in predefined areas, e.g. under shields or BGAs
- Immediately before placing critical components, the system checks that no foreign objects are present in the target placement position
- On-demand inspection capability
- Inspection area of up to 175 × 175 mm
- Software option: On-Board PCB Inspection

Detection of fabric with On-Board PCB Inspection



3D image of On-Board PCB Inspection





On-Board PCB Inspection for foreign object detection

Secure handling of large and high-value BGAs

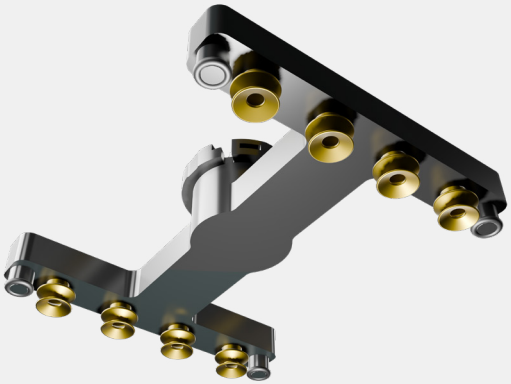
The pickup and placement of the BGA is the final step in the assembly of HPC server boards. A combination of a high-performance placement head, specialized nozzles, and precise process control ensures reliable results.

BGA MASTERING

Placement Head TWIN VHF

The Placement Head TWIN VHF (Very High Force) is designed for particularly large and unusually shaped components.

- Placement of components up to 175 × 175 mm
- Placement of components with a weight up to 650 g
- Individual control and programming of all axes
- A wide range of special nozzles and grippers for nearly any component shape
- Keep-out areas (e.g. on top of processor units) are considered during nozzle design



Special nozzle for pickup on the outer ring only

The Placement Head TWIN VHF opens up new possibilities in the assembly of complex BGAs

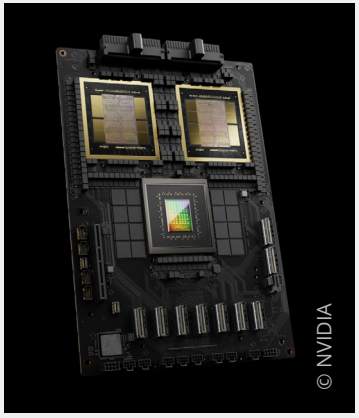


Illustration of next-generation AI accelerator (combining one CPU and two GPUs)

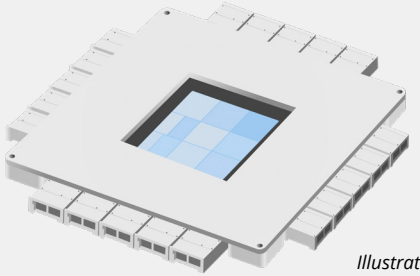


Illustration of a co-packaged optics (CPO) component for high-speed switches

Ensure reliable solder paste connection for High-Density BGAs

Between pickup and placement of the BGA, vision-based inspections ensure an error-free final process stage.

VISUAL INSPECTION

Inspection of BGA

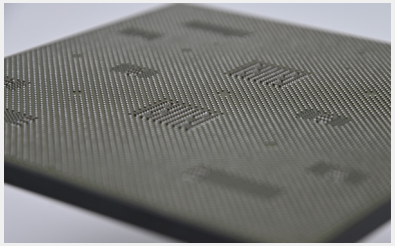
Visual inspection has become even more important with the new generation of BGAs.

SIPLACE high-resolution cameras provide all required inspection capabilities for complex components.

Six illumination angles combined with feature-based algorithms ensure reliable and repeatable inspection results.

- Reliable vision detection of 50,000+ solder balls
- Potential vision checks:
  - Missing or defective connections
  - Incorrect ball size
  - Incorrect ball position
  - Landside capacitors
  - Barcode / Data Matrix code reading
  - Verification of orientation marks
- Measurement data and camera images can be saved and analyzed

COMPONENT CAMERA TYPE 56	
Specification	**Capability**
Field of View	66 × 50 mm
Min. component size	0.2 × 0.2 mm
Max. component size	200 × 200 mm
Min. lead pitch	200 / 300 µm
Min. lead width	100 µm
Min. ball pitch	140 / 300 µm
Min. ball diameter	80 µm



BGA with high amount of balls and landside capacitors

COPLANARITY INSPECTION

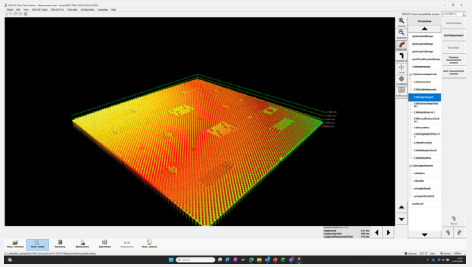
All connections must be within reach

The 3D Coplan Module ensures that all connections come into contact with the solder paste.

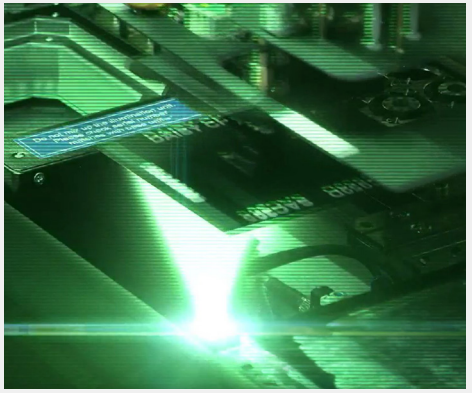
Measurement principle:

- Height profile measurement using laser triangulation
- Calculation of the seating plane
- Verification that all connections can be in contact with the solder paste
- Inspection of 50,000+ solder balls

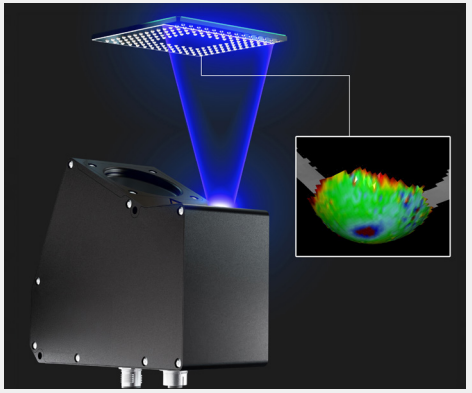
3D COPLAN MODULE	
Specification	**Capability**
Component size	Up to 200 × 200 mm
Height resolution	0.5 µm
Min. lead pitch	300 µm
Min. lead width	100 µm
Min. ball pitch	400 µm
Min. ball diameter	200 µm



Result of 3D coplanarity measurement displayed at the station



3D coplanarity measurement of BGA in SIPLACE placement machine



Measurement principle laser triangulation

PLACEMENT MACHINES

SIPLACE solutions for HPC manufacturing

Typical machine specification in a line for high performance computing

SIPLACE X S

SIPLACE X S PLACEMENT MACHINE	
Specification	**SIPLACE X4 S**
Placement head	CP20 / CPP / TWIN
Component size max.	120 × 120 mm
Component weight	up to 160 g
Feeder capacity	160 × 8 mm feeder
Tray Supply	Waffle Pack Changer non-stop refill or matrix tray unit
PCB size (L×W×H)	850 × 685 × 10 mm
PCB weight	up to 10 kg
Options:	Smart Pin Support
	3D Coplan Module
Software:	On-Board PCB Inspection
	OSC Package

SIPLACE SX

SIPLACE SX PLACEMENT MACHINE	
Specification	**SIPLACE SX2**
Placement head	CP20 / CPP / TWIN / TWIN VHF
Component size max.[1]	175 × 175 mm
Component weight [2]	up to 650 g
Feeder capacity	120 × 8 mm feeder
Tray Supply	Waffle Pack Changer non-stop refill
PCB size (L×W×H)	1,525 × 560 × 10 mm
PCB weight	up to 10 kg
Options:	Smart Pin Support
	3D Coplan Module
Software:	On-Board PCB Inspection
	OSC Package

[1] 240 × 240 mm available soon [2] Up to 2.0 kg available soon

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