Probe Systems

Karl Suss

# PA200

Mask Aligners
Substrate Bonders
Flip Chip Bonders
Spin Coaters
Probe Systems

## Semiautomatic Probe System

The SUSS PA200 Semiautomatic Probe System is available as two versions, one for high speed (HS) and one for high resolution (HR) applications. They are both very stable, modular and flexible probe systems for wafers and substrates up to 200 mm (8″).

The standard ProberBench® Operating System provides ease of use and programmed automation for the most demanding analytical applications. The modular design is effective, versatile and has a defined upgrade path.

## FEATURES AND BENEFITS

- Application flexibility for failure analysis, design and verification, parametric and functional tests
- Precision and stability for submicron probing
- Accommodates packaged parts and single chips as well as wafers and substrates
- Configurations for measuring from atto-Ampere level DC to 220 GHz high frequency
- Low noise and frost-free measurements from –65°C to 400°C with the SUSS ProbeShield®
- Interfaces to leading analysis instrumentation, optics, software and testers
- ProberBench operating system, fully operable with or without a PC
- Full range of accessories

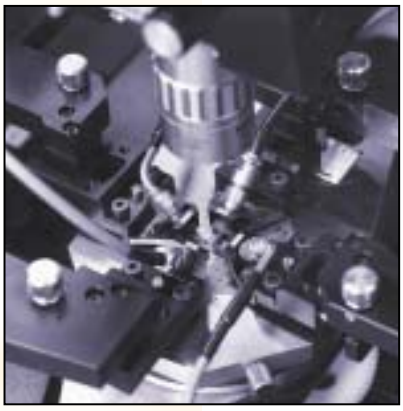
SUSS. Our Solutions Set Standards.

Karl Suss

A SÜSS MicroTec Company

# Challenges ...

Analytical DC test



High frequency test

Automated MCM test

## Improve your Yield

The value of failure analysis increases as its impact on customer satisfaction, yield, quality and reliability is realized. This reliance on failure analysis, combined with greater circuit complexity and smaller structures, enhances the role of semiautomatic probers.

## Versatility

Where a failure analysis lab once handled only packaged parts or wafers, it is now routinely asked to analyze a device at any stage of its lifecycle: from the wafer fab to an end user return. A prober must quickly adapt to handle products from wafers and single chips to packaged parts.

## Return on Investment

The cost of failure analysis will grow, particularly for leading edge technology, necessitating higher equipment utilization and demanding a better return on investment.

## Interfacing

Failure analysis, typically characterized as a hands-on procedure, manually placing probes and adjusting the device, has progressed to programmed automation for acquiring statistically relevant data across a wafer.

A prober must interface to an array of hardware and software instruments, including emission microscopes, laser cutters, data acquisition, CAD navigation software and other test equipment.

## Precision

With the increase in the number of I/O pads and the decrease in feature size, a prober is expected to provide the rigidity required to use production probecards, as well as accuracy for in-circuit stepping routines. Simultaneous use of probecard and ProbeHeads to contact submicron gates is required.

## Low Signal Measurements

The quality of all low-signal and sensitive measurements is dependent on the noise floor of the measurement system. All low signal measurement concerns were taken into consideration when designing SUSS probing equipment. This gives optimal noise reduction with superior performance capabilities. The PA200 system with a ProbeShield® is optimally configured for demanding low signal and frostfree low temperature testing.

The unique design of the SUSS ProbeShield guarantees a light-tight, gas tight, electromagnetic shielded, and ultra low noise environment while testing. It is ideal for ultra low signal measurements in the AttoAmp, FemtoFarad and MicroVolt range.

# ... and Solutions

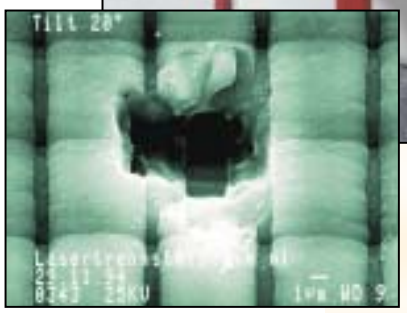
## Ease of Use

Lab environments also influence the design of semiautomatic probers. In open labs with dozens of users, the prober must be simple and easy to operate. On the other hand, a prober with a dedicated user should also maximize performance.

The SUSS PA200 Semiautomatic Probe System meets these challenges through innovative design, precision and reliability.

A Graphical User Interface provided by the renowned SUSS ProberBench software makes the PA200 a fully functional, flexible yet simple tool where various set-ups can be stored for individual tasks.

A typical CAD Navigation set-up



Laser Cutting

## Precise Mechanics

The SUSS PA200 Semiautomatic Probe System relies on a cast base frame and massively machined components to provide an extremely stable probing environment as well as software compensation. Precise resolution and accuracy results from using a ball-screw drive and glass scales in closed-loop positioning.

## Modular Design

Modular construction provides application flexibility and cost effectiveness. Microscope mounts include fixed, manual and programmable, as well as programmable focus and magnification. ProbeHead platens are available for DC, HF and specialized applications, with fixed or manual movement.

The standard chuck secures single chips to 8″ wafers; optional chucks handle fragile III-V compound wafers and rectangular substrates.

Adaptation to the height differences between wafers and packaged parts is accomplished by the chuck and platen having 30/15 (HR/HS) and 20 mm of travel respectively, for approx. 50 mm (2″) of working clearance. DUT boards are secured by vacuum to the standard wafer chuck, so chuck planarity is not affected.

## User-Friendly

The ProberBench® Operating System is a powerful multitasking system with joystick controller, graphical and remote interfaces. The Windows® based graphical interface includes Navigator on-screen joystick and setup, TableView spreadsheet, graphical WaferMap and optical VideoTracker navigation and data acquisition modules. Standard remote interfaces are IEEE488 and RS232. The prober is fully operable without a PC.

# Application flexibility

PA200 with ProbeShield® EMC for low signal and low temperature probing

Application flexibility is defined by the diversity of applications, as well as the specific requirements of each. There are many aspects to consider: Measurement type and integrity, integration into a test system and how the user interacts with the system as well as mechanical stability and accuracy. SUSS addresses these issues with a modular or customer specific design and with our wide range of accessories.

## DC Parameter testing

For DC parametrics, the software can be configured as a simple, easy to use interface for scanning a wafer during fast step-and-repeat patterns. Hardware choices include high pin-count probecard adapters, triaxial probes, chucks (standard and thermal), and the SUSS ProbeShield® for low current and capacitance measurements. The unique *Quiet Mode* removes power to all motors to reduce the noise floor. SUSS precision allows the reliable, automatic probing of transistors and the smaller pads of monitor chips.

## Failure Analysis

For failure analysis mechanical versatility provides quick changeover between packaged parts and wafers. The ProberBench operating system has been integrated with the most common failure analysis tools, including emission microscopes, CAD navigation software, laser cutters and data acquisition/analysis software. All ProbeHeads can be simultaneously used with a probecard and with active probes. SUSS stability allows the smallest features to be easily probed at the highest magnifications, especially when used with the SUSS MFI Probe for scanning and probing below 0.2 µm.

## High Frequency

The SUSS PA200 has the stability for HF on-wafer probing without compromising flexibility. A complete range of accessories for probing up to 220 GHz is available and includes: Probes, calibration substrates and software, positioners, chucks, cables and IC-CAP interfacing.

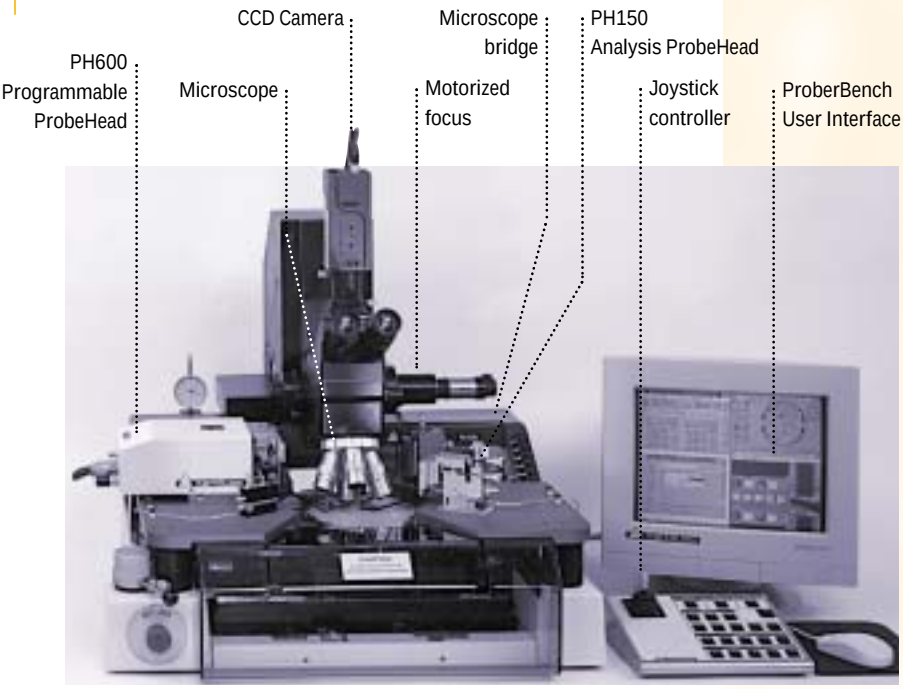
## Temperature Probing

The SUSS ProbeShield also provides an innovative approach to probing down to –65°C. Frost-free low temperature probing requires that the air surrounding the cold chuck is pressurized, clean and dry. Just enough pressure is required to keep the ambient air out of the chamber. The air is dried so that its dew point is lower than the chuck temperature.

For thermal low signal applications, SUSS supplies a range of low leakage thermal chucks up to 300°C.

PA200 high frequency application

# The Design




SUSS PA200 Semiautomatic Probe System

The prober mechanics are based on a web-reinforced, aluminum casting for excellent rigidity and vibration damping. The wrap-around design places the stage and platen drives into, rather than on top of, the base further increasing stability. All surfaces are finished in cleanroom grade paint or are anodized.

The X-Y stage is constructed of steel for temperature stability. Linear accuracy and torsional stiffness are enhanced with wide spaced bearings and the use of ground in place of the more typical rod and ball slides. A ball-screw drive is utilized which automatically compensates for wear and ensures the system will remain backlash-free. The DC servo closed loop positioning system uses linear encoders to read the actual stage position and to preclude leadscrew induced thermal errors. In addition to the superior mechanical design, two software compensation routines are used: linear and matrix. “Linear” adjusts positioning by an equal amount over the 200 mm travel range and can be used to correct thermal chuck induced wafer expansion/contraction. “Matrix” maps the stage throughout its travel for finer accuracy. Axes orthogonal error is also compensated. The Z and theta axes are DC servo closed loop driven.

The microscope is supported by a cast aluminum bridge for stability at the highest magnifications. The bridge design allows rearward access for cable routing. The cantilevered load of a microscope is a design challenge addressed by using bearing ways. The programmable microscope movement closed loop DC servo drive provides 50 mm of travel. Software compensation is used, and is aligned to the chuck stage for parallel movement between the stages. Programmable focus, and magnification on some microscope models, is also available.

The ProbeHead Platen is the most versatile component of a prober. For DC applications the material is typically aluminum which is hard-coated for durability and uses vacuum hold-down. High frequency applications require greater rigidity, therefore steel is used for magnetic, bolt-down and kinematic mounting. Probecard adapters are available for all platens. Although the platen can be mounted in a fixed position, a manual drive mechanism is more commonly used. The mechanism consists of four columns with ball-cage bearings providing an extremely stabile, linear and repeatable movement. The drive knob, conveniently located at the left front corner, provides a fine 400 µm contact/separation stroke, as well as 20 mm of coarse travel for adjusting to test fixturing and thermal chucks.

The mechanics are controlled by the SUSS ProberBench Operating System consisting of the drive electronics, joystick controller and Windows user interface. Interfacing flexibility is provided with an IEEE488 port in the electronics and an IEEE488 and an RS232 port in the PC. All ports can be used simultaneously. This is the same for all SUSS Probe Systems.

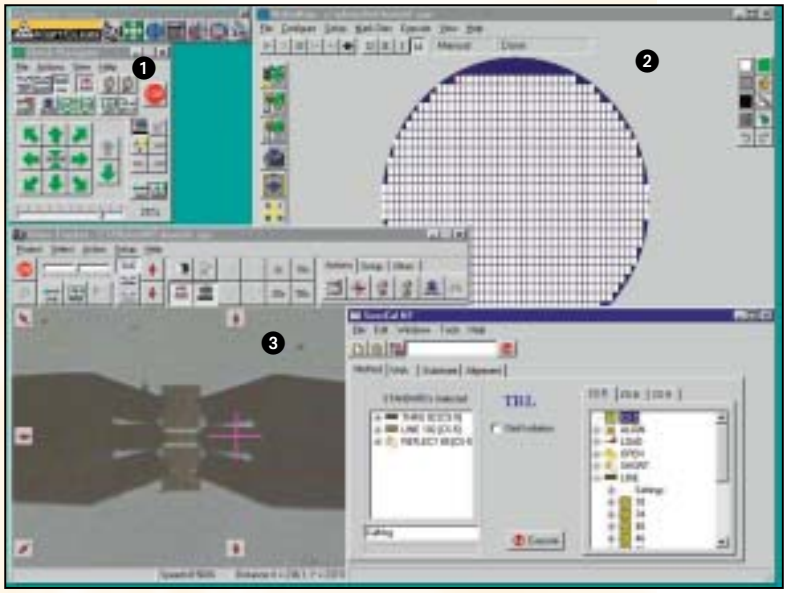
# Flexible and versatile

## Drive Electronics

The drive electronics which use standard SUSS components are housed in a standard 6×19″ cabinet. As a separate unit there is greater flexibility. Furthermore the mechanics are smaller and electrically quieter.

All motorized prober functions are integrated at the electronics, so there are no additional boxes or controllers. In addition to the chuck and microscope stages, up to four ProbeHeads and two contact sense cards can be accommodated.

The system complies with leading guidelines, including SEMI S2-93, IEC 204-1 and EC-Low Voltage Directive (CE-Mark) and EN61010-1.




ProberBench within the SUSSCAL Calibration Software

## Joystick Controller

The joystick controller is solidly constructed of stainless steel and uses rotary encoders for proportionally precise, uni- or bi-directional control. It is more than a simple joystick controller, providing full prober functionality via fixed and LED-defined programmable keys. Included are two-point theta alignment, setting index, home and contact, as well as go load and scope lift are provided.

## User Interface

The Windows® user interface consists of joystick, spreadsheet, graphical and video control modules.

The Navigator ❶ on-screen joystick provides navigation by mouse and the entry of all setup parameters.

TableView controls stage movement by coordinates, which are in spreadsheet format and are entered by recording the current position, keyboard, pasting and importing. Up to 96 columns are available for test results, binning or comments.

The graphical WaferMap ❷ can be used to quickly move to dies using coordinates or as part of an automated test routine and has sub-site probing capability.

VideoTracker ❸ conveniently displays a video image in a window of the PC monitor and has the ability to save the image to disk. Chuck, microscope and ProbeHead positioning is as simple as clicking on the image.

All setup parameters are contained in project files, whereas the data from the TableView and WaferMap modules is saved in ASCII-format files for easy transfer to and from other instruments. Temperature compensations are no longer necessary as seperate wafer maps with different temperature settings can be stored for the same project.

This electronic rack, joystick controller and user interface combination is common to all SUSS programmable Probe Systems, thus reducing the learning curve and ensuring compatibility of instrument and software drivers.

# The PA200 modular Probe System

## Microscope stages

| Stage type | Travel | Resolution | Access lift options | Recommended microscope | Application |
|---|---|---|---|---|---|
| Programmable | 50×50 mm | 0.25 µm | Standard 80 mm pneumatic or 130 mm motorized | High magnification or stereo view | Internal die navigation and remote control |
| Manual | 50×50 mm | 40 mm/rev. | Fixed, manual or pneumatic tilt-back | High magnification or stereo view | Internal die |
| High resolution manual | 50×50 mm | 0.25 mm/rev | Fixed, manual or pneumatic tilt-back | High magnification | Internal die and laser cutting |
| Adjustable | 30×30 mm | | Fixed | Stereo view | Minimal movement required |

## Microscopes

| Microscope type | Models available | Application |
|---|---|---|
| Stereo view | Olympus SZ4045 Series, Leica M5-12 Series | Pad probing and internal features down to 5 µm |
| High magnification w/out Eyepieces | Mitutoyo FS-70 Series, A-Zoom | Offers the most flexibility and options for features down to 0.5 µm |
| | Optem | HF applications and use with TV systems |

## ProbeHead platens

| PH Mounts | Application |
|---|---|
| Vacuum | Most common, offers ease of use and flexibility |
| Magnetic | Offers more rigidity than vacuum. Commonly used when magnetic base ProbeHeads are already used |
| Mechanical | Mechanical T-nut mount providing high rigidity |
| HF Universal | Offers vacuum, magnetic, bolt down and kinematic mounting. Kinematic requires additional kit |
| Customized | Custom designs are available for specialized applications, such as testhead docking, substrates and MCM test |

## Software interfaces

| Application | Vendors |
|---|---|
| CAD Navigation | Knights Technology, Schlumberger, Raith |
| Emission Microscopy | Hypervision, Hamamatsu, EDO Barnes |
| Data Acquisition | Metrics ICV, NI LabView, Lab Windows/CVI, Keithley, TestPoint, Mosaid, Agilent VEE |
| Design and Modeling | Agilent IC-CAP, Silvaco |
| Programming | MS Visual Basic, C++, Delphi |
| Laser Cutting | New Wave Research |
| Thermal Chucks | Temptronic, ERS, Trio Tech |

## Accessories

**Probes:** Active, passive, HF, triaxial, coaxial, low impedance, Kelvin

**Probe tips:** Tungsten, tungsten-carbide, palladium, copper shaft

**Probecards:** SUSS supports all major probecard manufacturers

**Manual ProbeHeads:** Contacting bond pads & internal nodes down to 1 µm

**Remote controlled ProbeHeads:** For submicron probing, programmable

**ShieldEnclosure SE1000:** Light-tight or EM-shielded versions

**Laser cutter:** Depassivating, cutting traces, trimming and blowing fuses

**Ultrasonic cutter:** Depassivating brittle materials

**Utility pumps:** Vacuum, pressure or combinations

**Standard chucks:** From 4″ to 8″ (100–200 mm), usually made of stainless steel

**Triaxial chucks:** For low-signal measurements

**High insulation chucks:** Power device test, low capacitance demands

**Microwave chucks:** Designed for brittle III-IV compounds and high measurement stability. Auxiliary chucks for calibration and burnishing substrates

**Thermal chucks:** Adaptor kits for all hot chucks on the market available

**ProbeShield®:** Completly light-tight, gas-tight and EM-shielded design for low-signal and frost-free low temperature probing

**Material handling:** Provides system automation, as well as eliminates user handling, and possible damage to wafers

**Pattern recognition:** Complete system automation for cassette-to-cassette operation, vision module

**Packaged device holders:** Held down by vacuum on the chuck's surface

**Fixtures and chuck accessories:** Quickly manufactured to hold down substrates, provide alignment pins, or allow bottom side probing

**Chuck surfaces:** Standard: stainless steel. Options: gold plated, Teflon coated, aluminum hard coated, nickel plated

**Camera and monitors:** Facilitates contact bond pads or internal nodes

**Tables:** Vibration isolation tables VIT 800, 801, 802, depending on application

# PA200 HR/HS Semiautomatic Probe System

## Chuck Stage

### X-Y Movement

| Closed-loop, DC servo with linear encoder feedback | HR | HS |
|---|---|---|
| Travel | 200×200 mm | 200×200 mm |
| Resolution | 0.5 µm | 1.0 µm |
| Repeatability | ± 1.0 µm | ± 2.0 µm |
| Accuracy | ± 1.5 µm | ± 5.0 µm |
| Planarity | 8 µm | 8 µm |
| Maximum speed | 50 mm/sec | 100 mm/sec |

### Z Movement

| DC servo with rotary encoder feedback | HR | HS |
|---|---|---|
| Travel | 30 mm | 15 mm |
| Resolution | 0.25 µm | 0.25 µm |
| Repeatability | ±1.0 µm | ±1.0 µm |

### Theta Movement

| DC servo with rotary encoder feedback | |
|---|---|
| Travel | ± 6.0° |
| Resolution | 0.0001° |

### Programmable Microscope Movement

| DC servo with rotary encoder feedback | |
|---|---|
| Travel | 50×50 mm |
| Resolution | 0.25 µm |
| Repeatability | ± 1.0 µm |
| Accuracy | ± 2.5 µm |
| Access lift | 80 mm pneumatic<br>or 130 mm motorized |

### Manual Platen Movement

| | |
|---|---|
| Drive type | Compound knob |
| Contact/separation stroke | 0.4 mm linear |
| Coarse adjustment | 20 mm |

### Graphical User Interface

Windows 2000 or NT based

### Remote Interfaces

| | |
|---|---|
| PC | RS232, IEEE488 |
| Electronics | IEEE488 |

### Utilities

| | |
|---|---|
| Power | 115/230 V, 50/60 Hz, 500 W |
| Vacuum | Less than 200 mbar abs |
| Compressed air | 4 bar min |
| Vacuum/air inputs | 6 mm, 1/4″ (USA) |

### Dimensions (W×D×H)

| | |
|---|---|
| Mechanic (microscope in raised position) | 742×815×770 mm,<br>29×32×30″ |
| Electronics (with connectors installed) | 520×600×160 mm<br>20.5×23.5×6.3″ |

### Joystick controller

| (with connector installed) | 260×260×120 mm<br>1.3×10.3×4.7″ |
|---|---|

### Weight

| | |
|---|---|
| Mechanics | 133 kg, 300 lb |
| Electronics | 13 kg, 28 lb |

Data depends on individual process conditions and will vary according to equipment configurations



# Karl Suss Worldwide


## North America

KARL SUSS America, Inc.
228 Suss Drive · Waterbury Center, VT 05677 · USA
Phone (802) 244-5181 · Fax (802) 244-5103

KARL SUSS America, Inc.
Regional Sales + Service Center
8240 S. Kyrene Road · Suite 101 · Tempe, AZ 85284 · USA
Phone (480) 557-9370 · Fax (480) 557-9371

KARL SUSS America, Inc.
Regional Sales + Service Center
2694 Orchard Parkway · San Jose, CA 95134-2020 · USA
Phone (408) 432-3071 · Fax (408) 432-3072

## Germany

KARL SUSS KG GmbH & Co.
Schleissheimer Strasse 90 · D-85748 Garching b. München · Germany
Phone (+49)-[0] 89/3 20 07-0 · Fax (+49)-[0] 89/3 20 07-162

KARL SUSS Dresden GmbH
Süss - Strasse 1 · D-01561 Sacka b. Dresden · Germany
Phone (+49)-[0] 35240-73-0 · Fax (+49)-[0] 35240-73-700

KARL SUSS Vaihingen GmbH
Planckstr. 9 · D-71665 · Vaihingen/Enz · Germany
Phone (+49)-[0] 7042 / 955-0 · Fax (+49)-[0] 7042 / 955-100

## France

KARL SUSS France S.A.
Avenue des Colombières · F-74490 Saint Jeoire · France
Phone (+33) [0] 4 50 35 83 92 · Fax (+33) [0] 4 50 35 88 01

## Great Britain

KARL SUSS Great Britain Ltd.
23 Ivanhoe Road · Hogwood Lane Industrial Estate
Finchampstead · Wokingham · Berkshire
GB - RG40 4QQ · England
Phone (+44) [0] 11 89-732144 · Fax (+44) [0] 11 89-734395

## Japan

KARL SUSS Japan K.K.
**カール・ズース・ジャパン株式会社**
〒226-0006 神奈川県横浜市緑区白山1-18-2
ジャーマン・インダストリー&トレード・センター
GITC 1-18-2, Hakusan, Midori-ku · Yokohama, Kanagawa 226-0006
Phone (+81)-45-931-5600 · Fax (+81)-45-931-5601

## Asia

KARL SUSS Asia Co., Ltd.
212/2 Soi Ladprao 10
Ladprao Road, Ladyao · Jatujak · Bangkok 10900 · Thailand
Phone (+66)-2 938 44-26, -27 · Fax (+66)-2 512 5569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