



## Features

- 10 kOe (1 T) horizontal field superconducting magnet
- High stability operation from 2 K to 400 K
- Sample can be maintained at room temperature while system cools, reducing potential for condensation
- Multiple radiation shields optimized to minimize cryogen consumption
- Sample stage with  $\pm 5^\circ$  in-plane rotation
- Measurements from DC to 67 GHz
- Optional high vacuum to  $10^{-7}$  torr
- Accommodates up to 25 mm (1 in) diameter wafers
- Configurable with up to four thermally anchored micro-manipulated probe arms
- Probe arms with 3-axis adjustments and  $\pm 5^\circ$  planarization
- Cables, shields, and guards minimize electrical noise and thermal radiation losses
- Options and accessories for customization to specific research needs

## Model CPX-HF SUPERCONDUCTING MAGNET-BASED HORIZONTAL FIELD CRYOGENIC PROBE STATION

### Introduction

The Model CPX-HF is a versatile cryogenic micro-manipulated probe station used for non-destructive magnetic testing of devices on full and partial wafers up to 25 mm (1 in) in diameter. The CPX-HF is a platform for measurement of magneto-transport, electrical, electro-optical, parametric, high Z, DC, RF, and microwave properties of materials and test devices. Nanoscale electronics, quantum wires and dots, semiconductors, superconductors, and spintronic devices are typical materials measured in a CPX-HF. A wide selection of probes, cables, sample holders, and options makes it possible to configure the CPX-HF to meet your specific measurement applications.

Mounted on a non-magnetic table, the CPX-HF is equipped with a 10 kOe (1 T) horizontal split-pair superconducting magnet. The CPX-HF operates over a temperature range of 4.2 K to 400 K. With options, the base temperature can be extended down to 2 K. The probe station provides efficient temperature operation and control with a continuous refrigeration system using either helium or nitrogen\*. Vapor-cooled shielding optimizes efficiency and intercepts blackbody radiation before it reaches the sample. A control heater on the sample stage along with the magnet stage and radiation shield heaters provides the probe station with fast thermal response.

The CPX-HF is user configured with up to four ultra-stable micro-manipulated stages, each providing precise 3-axis control of the probe position to accurately land the probe tip on device features. Proprietary probe tips in a variety of sizes and materials minimize thermal mass and optimize electrical contacts to the device under test.

For increased versatility, CPX-HF options include a 2 K base temperature stage, high vacuum, vibration isolation systems, LN<sub>2</sub> Dewar kit\*, higher magnification microscope, vacuum turbo pumping system, and fiber optic probe arm modification.

*\*LHe required to operate magnet*

### Lake Shore Cryotronics, Inc.

575 McCorkle Boulevard ■ Westerville, Ohio 43082

Phone 614-891-2244 ■ Fax 614-818-1600

[info@lakeshore.com](mailto:info@lakeshore.com) ■ [www.lakeshore.com](http://www.lakeshore.com)

*All specifications subject to change. Rev 7/8/2010*

## Applications

- Magneto-transport measurements
- Electrical and electro-optical measurements over a wide temperature range
- RF and microwave
- Parametric testing
- Shielded/guarded/low noise characterization
- High Z
- Non-destructive, full wafer testing

## Materials

- Nanoscale electronics (carbon nanotube transistors, single electron transistors, molecular electronics, nanowires, etc.)
- Quantum wires and dots, quantum tunneling
- Single electron tunneling (Coulomb blockade)
- Superconductors
- Spintronic devices
- Basic semiconductor devices including organics, LEDs, and dilute magnetic semiconductors

## Specifications

### Magnetic Field

Maximum field	10 kOe (1 T)
Probe arm movement due to magnet field ramping to 10 kOe (1 T)	<5 μm

### Temperature

Sample temperature range—standard	4.2 K to 400 K
Sample temperature range—optional	2.0 K to 400 K*
<b>Temperature control (heater)</b>	
Sample stage	50 W
Magnet stage	100 W
Radiation shields	100 W and 50 W
Probe arm	Measurement only

\*Selectable equipment

### Probe Arm Adjustments

<b>Travel</b>	
X axis	51 mm (2 in)
Y axis	25 mm (1 in)
Z axis	18 mm (0.7 in)
<b>Translation scale</b>	
X axis	20 μm
Y and Z axes	10 μm
Planarization*	±5°
Sample stage (sample holder) in-plane rotation	±5°

\*Included with microwave probes

## Frequency Range

<b>ZN50 DC/RF probe frequency range</b>	
Tungsten with cryogenic coaxial cable	0 to 50 MHz*
Tungsten with semirigid coaxial cable	0 to 1 GHz*†
Paliney 7 with cryogenic coaxial cable	0 to 50 MHz*
Paliney 7 with semirigid coaxial cable	0 to 1 GHz*†
BeCu with cryogenic coaxial cable	0 to 50 MHz*
BeCu with semirigid coaxial cable	0 to 1 GHz*†
<b>GSG microwave probe frequency range</b>	
Low frequency with K connector	0 to 40 GHz*
Mid frequency with 2.4 mm connector	0 to 50 GHz*
High Frequency with 1.85 mm connector	0 to 67 GHz*

\*Selectable equipment

† S21 > -10 dB up to 1 GHz, except for a (-40 dB) spike between 400 MHz and 800 MHz depending on probe model and placement; S11 < -3 dB up to 1 GHz

## Optical

<b>Optical viewport—located on top lids</b>	Ø54 mm (2.13 in) outer window and Ø50 mm (2 in) inner window
Outer, clear fused quartz	99% IR transmittance
Inner	IR absorbing with narrow band visible light transmittance
<b>Optical resolution—microscope</b>	
7:1 zoom	8 µm
16:1 zoom	8 µm*

\*Selectable equipment

## Sample Holder (Chuck)

<b>Maximum sample size—overall</b>	Up to Ø25 mm (1 in)
SH-1.00-G, grounded chuck	Up to Ø25 mm (1 in) and 400 K
SH-1.00-I, isolated chuck	Up to Ø25 mm (1 in) and 400 K*
SH-1.00-C, coaxial chuck	Up to Ø25 mm (1 in) and 400 K*
SH-1.00-T, triaxial chuck	Up to Ø25 mm (1 in) and 400 K*

\*Selectable equipment

## Standard Equipment

<b>Superconducting magnet</b>	10 kOe (1 T), horizontal field, split pair
<b>Superconducting magnet power supply</b>	Lake Shore Model 625
<b>Output type</b>	Bipolar, 4-quadrant, DC current source
<b>Current</b>	±60 A
<b>Voltage</b>	±5 V
<b>Flow cryostat</b>	4.2 K to 400 K
<b>Sample stage temperature sensor</b>	Lake Shore Model CX-1030-SD-HT-1.4M calibrated Cernox™ RTD
<b>Sample stage heater</b>	50 W
<b>Magnet stage temperature sensor</b>	Lake Shore Model CX-1030-SD-HT-1.4M calibrated Cernox™ RTD
<b>Magnet stage heater</b>	100 W
<b>Cooled radiation shield and cooled IR-absorbing window above the sample</b>	
<b>Radiation shield temperature sensors</b>	Two Lake Shore Model DT-670C-CU silicon diodes
<b>Radiation shield heaters</b>	100 W and 50 W
<b>Removable top lid with viewport</b>	Ø50mm (2 in) window
<b>Temperature control</b>	One Lake Shore Model 336 temperature controller, one Lake Shore Model 211 temperature monitor and one Lake Shore Model 142 200 W (two channels, 100 W each) power supply (independent regulation of sample stage and radiation shield, and probe arm temperature monitoring)
<b>Electroless nickel-plated aluminum vacuum chamber</b>	
<b>Diameter</b>	279 mm (11 in)
<b>Removable top lid with clear fused quartz viewport</b>	Ø54 mm (2.13 in) window
<b>Probe ports</b>	6 surround the sample thermal radiation shield (2 are blanked off)
<b>Pump port</b>	NW 40 (pump sold separately)
<b>Gas purge and 0.5 psi safety pop-off port</b>	NW 25
<b>Option port</b>	High vacuum
<b>Spare ports</b>	NW 40 and NW 25
<b>Machined aluminum base plate</b>	610 × 737 mm (24 × 29 in)
<b>Support stand</b>	Heavy duty welded steel stand—optional pneumatic vibration isolation system available
<b>Temperature sensor installed and wired to a 6-pin feedthrough (included on one probe arm)</b>	
<b>Grounded sample holder</b>	SH-1.00-G, accommodates up to a Ø25 mm (1 in) sample with a Ø25 mm (1 in) probe area
<b>Optics</b>	
<b>Zoom 70 microscope</b>	7:1 zoom with 8 µm resolution
<b>Color CCD camera</b>	S-video or composite output format
<b>Swing arm</b>	Optics can be manipulated to view any part of the sample or wafer, and can be retracted and swung away to allow access to the top of the vacuum chamber for sample exchange
<b>Video monitor</b>	High resolution, 17-inch
<b>Sample illumination</b>	Coaxial via fiber optic or ring light from an adjustable light source and power supply (must specify sample illumination at time of order) <b>NOTE: Coaxial illumination is recommended for highly reflective materials</b>
<b>High efficiency helium transfer line with foot valve for precise flow regulation</b>	
<b>Instrument console</b>	
<b>Basic tools and spares kit for standard operation</b>	

## Required User Configurable Equipment — Micro-manipulated Stages, Probes, Probe Tips, and Cables

### UP TO FOUR XYZ PRECISION MICRO-MANIPULATED STAGES

Part Number	Description
MMS-09	Micro-manipulated stage with thermal radiation shields, stainless steel welded bellows, and feedthrough ports—includes probe arm and base; probes, probe tips, and cables sold separately

### ZN50 DC/RF PROBES

- Ideal for: DC biasing, low/high frequency measurements, low noise shielded, and low-leakage guarded measurement
- ZN50 probe base incorporates a pair of copper braids that anchor to the magnet stage to minimize heat loss
- SMA connector mounted directly to a replaceable alumina ceramic blade with a 50 Ω stripline routed to the probe contact

We understand that today's researcher requires flexibility. Our wide selection of probes, cables, sample holders, and options make it possible to configure a probe station to meet your specific measurement applications.

Part number (probe body)	Description
ZN50-26U	50 Ω stripline probe body mount (each probe body mount requires a ceramic blade—selectable below)

Part number (ceramic blade)	Tip material	Maximum frequency (GHz)	Maximum probe temperature*	Maximum sample temperature**	Tip radius (µm)
ZN50R-03-W	Tungsten	1 Maximum frequency 50 MHz with ZN50C-G or ZN50C-T cable; maximum frequency 1 GHz with MWC-09-00K-NM cable	350 K	400 K	3
ZN50R-10-W					10
ZN50R-25-W					25
ZN50R-03-P7	Paliney 7				3
ZN50R-10-P7					10
ZN50R-25-P7					25
ZN50R-03-BECU	BeCu				3
ZN50R-10-BECU					10
ZN50R-25-BECU					25
ZN50R-100-BECU					100
ZN50R-200-BECU					200

\* As measured by the probe arm temperature sensor

\*\* Selectable equipment

### ZN50 DC/RF CABLES

Part number	Cable type	Connector type	Feedthrough type	Measurement configuration	Maximum frequency	Maximum cable temperature*	Maximum sample temperature**
ZN50C-G	Ultra-miniature cryogenic coaxial	SMA	BNC	Shielded	50 MHz	350 K	400 K
ZN50C-T	Ultra-miniature cryogenic coaxial	SMA	3-lug triaxial	Low leakage	50 MHz		
MWC-09-00K-NM	Non-magnetic semirigid microwave coaxial	K (SMA compatible)	Loss-less compression seal	High frequency	1 GHz <sup>1</sup>		

\* As measured by the probe arm temperature sensor

\*\* Selectable equipment

<sup>1</sup>S21 > -10 dB up to 1 GHz, except for a (-40 dB) spike between 400 MHz and 800 MHz depending on probe model and placement; S11 < -3 dB up to 1 GHz

## GSG MICROWAVE PROBES

- Coplanar waveguide probe with ground-signal-ground (GSG) contact geometry
- User-specified pitch (spacing)
- Optimized low thermal conductivity coaxial leading to low thermal conductivity tips
- Include a copper braid assembly to cool the probe to near sample temperature
- Limited to 400 K
- Separate planarization module with  $\pm 5^\circ$  rotation mechanism is provided

Part number	Connector type	Maximum frequency (GHz)	Maximum probe temperature*	Maximum sample temperature**	Pitch ( $\mu\text{m}$ )
GSG-050-40A-26U-E-NM	K	40	350 K	400 K	50
GSG-100-40A-26U-E-NM					100
GSG-150-40A-26U-E-NM					150
GSG-200-40A-26U-E-NM					200
GSG-250-40A-26U-E-NM					250
GSG-050-50A-26U-E-NM	2.4 mm	50	350 K	400 K	50
GSG-100-50A-26U-E-NM					100
GSG-150-50A-26U-E-NM					150
GSG-200-50A-26U-E-NM					200
GSG-250-50A-26U-E-NM					250
GSG-050-67A-26U-E-NM	1.85 mm	67	350 K	400 K	50
GSG-100-67A-26U-E-NM					100
GSG-150-67A-26U-E-NM					150
GSG-200-67A-26U-E-NM					200
GSG-250-67A-26U-E-NM					250

\*As measured by the probe arm temperature sensor

\*\*Selectable equipment

## GSG MICROWAVE CABLES

- Loss-less compression seal
- Semirigid with Teflon® dielectric

Part number	Cable type	Feedthrough type	Maximum cable temperature*	Maximum sample temperature**	Connector type	Maximum frequency
MWC-09-00K-NM	Non-magnetic semirigid microwave coaxial	Loss-less compression seal	350 K	400 K	K (SMA compatible)	40 GHz
MWC-09-240-NM					2.4 mm	50 GHz
MWC-09-185-NM					1.85 mm	67 GHz

\*As measured by the probe arm temperature sensor

\*\*Selectable equipment

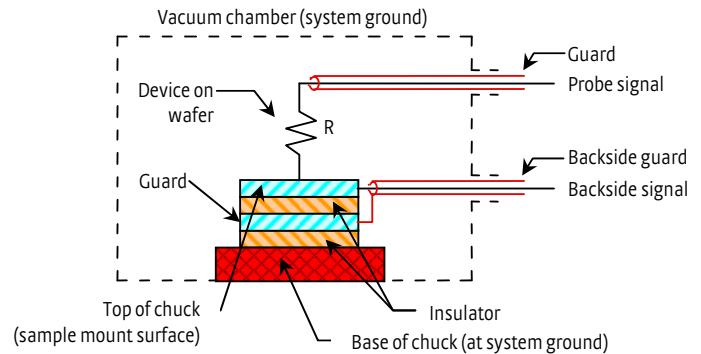
## Sample Holders (Chucks)

Typical sample holder configuration characterized by:

- Leakage resistance between
  - Top surface and guard
  - Guard and ground
- Capacitance between
  - Top surface and guard
  - Guard and ground

### Types of sample holders

- Grounded sample holder—sample mount surface at system ground
- Isolated sample holder—backside contact not needed; sample mount surface is electrically non-conductive and isolated from ground
- Coaxial sample holder—backside contact can be made; sample mount surface is isolated from ground
- Triaxial sample holder—guarded backside contact can be made; sample mount surface has guarded isolation from ground



Part number	Measurement configuration	Separate feedthrough required	Maximum sample (diameter)	Maximum temperature
SH-1.00-G	Grounded	No	Ø25 mm (1 in)	400 K
SH-1.00-I	Isolated			
SH-1.00-C	Coaxial	Yes*		
SH-1.00-T	Triaxial	Yes**		

\*Coaxial sample holders require one FT-BNC or FT-TRIAX feedthrough as listed below

\*\*Triaxial sample holders require one FT-TRIAX feedthrough as listed below

Part number	Description
FT-BNC	Coaxial feedthrough and coaxial cable, installed and wired
FT-TRIAX	Triaxial feedthrough and coaxial cable, installed and wired

## Equipment Options

Part number	Description
PS-HV-CPX	High vacuum option. Ensures that condensation does not accumulate in the sample environment during cooldown. This is critical for measuring organic semiconductors and for high Z and low current applications. Includes HVAC port, Varian V301 turbo pump kit, and related HVAC components. Vacuum specifications: radiation shields at room temperature with DUT at maximum sample stage temperature: $10^{-5}$ torr; room temperature: $10^{-6}$ torr; cold radiation shields with DUT at maximum sample stage temperature: $10^{-6}$ torr; cold radiation shields with DUT at room temperature or below: $10^{-7}$ torr
PS-SSVAC-CPX	Stainless steel vacuum chamber upgrade; supplied in place of standard nickel-plated aluminum vacuum chamber
PS-FOA	Fiber optic probe arm modification. Transmit or receive light or IR/UV radiation. Fiber optic terminated with SMA connector or compression feedthrough. (Fiber optic wire not included. Fiber optic and probe cannot be used simultaneously.)
PS-Z16	16:1 zoom microscope upgrade; provides 8 $\mu$ m resolution NOTE: consult Lake Shore for field upgrade
PS-LT	2.0 K base temperature stage pumping option—includes system modifications, stainless steel flex hose for pump connection, and Varian DS402 rotary pump (12.3 CFM at 60 Hz with oil mist eliminator on output [with oil return], and inlet oil demister); 50 Hz operation may increase base temperature
PS-PLVI-25	Pump-line vibration isolator—includes NW 25 fittings, 1 m stainless steel bellows, clamps, and rings (placed between pump cart and system); requires one bag of cement. NOTE: for use with PT-LT or PS-HV-CPX
PS-V81DPC	Compact turbo pumping system—includes Varian V-81 turbo pump with oil free dry scroll backing pump, vacuum gauge for high vacuum, controller, and adaptors (specify 120 V/60 Hz or 220 V/50 Hz)
PS-PLVI-40	Pump-line vibration isolator with NW 40 fittings, 1 m stainless steel bellows, clamps, and rings (placed between pump cart and system); requires one bag of cement. NOTE: for use with PS-V81DP

## Equipment Options, continued

<b>PS-DPC</b>	Automatic Dewar (gas) pressure controller, regulates Dewar liquid flow
<b>PS-LN2</b>	Nitrogen Dewar with stainless fittings, gauges, and adaptors; allows LN <sub>2</sub> use with the LHe transfer line
<b>PS-PVIS</b>	Pneumatic vibration isolation system—gimbal piston isolator, actuators, and supports (isolator natural frequency: vertical 0.8 Hz, horizontal 1.0 Hz; isolation efficiency at 5 Hz: vertical 80 to 97%, horizontal 60 to 90%; efficiency at 10 Hz: vertical 90 to 99%, horizontal 70 to 95%); requires 40 psi nitrogen or air
<b>PS-OAC</b>	Oil-less compressor for PS-PVIS (only available in 120 V)
<b>PA-SEN</b>	Probe arm modification with temperature sensor installed and wired to a 6-pin feedthrough
<b>PS-PAB-09</b>	Probe arm and base
<b>CS-5</b>	Calibration substrate for GSG probes—pad size: 50 μm <sup>2</sup> ; calibration type: SOLT (short-open-load-through), LRL (line-reflective-line), LRM (line-reflective-match); pitch range: 75 to 250 μm
<b>CS-15</b>	Calibration substrate for GSG probes—pad size: 25 μm <sup>2</sup> ; calibration type: SOLT (short-open-load-through), LRL (line-reflective-line), LRM (line-reflective-match); pitch range: 40 to 150 μm

***Lake Shore Cryotronics is a leading supplier of cryogenic, superconducting magnet-based, electromagnet-based, high vacuum, and load-lock probe stations. We offer a full line of standard probe stations to meet your research requirements.***

*Our standard line of probe stations includes:*

### Model TTPX

- Up to six micro-manipulated probe stages
- Temperature range capabilities from 3.2 K to 675 K
- Up to 51 mm (2 in) diameter wafer capabilities
- Optical access through sample stage

### Model CPX

- Up to six micro-manipulated probe stages
- Temperature range capabilities from 1.5 K to 675 K
- Up to 51 mm (2 in) diameter wafer capabilities
- ±5° sample stage rotation
- Load-lock and high vacuum options

### Model FWPX

- Up to six micro-manipulated probe stages
- Temperature range capabilities from 3.5 K to 475 K
- ±5° sample stage rotation
- Up to 102 mm (4 in) diameter wafer capabilities

### Model CPX-HF

- 1 T horizontal field split pair superconducting magnet
- Up to four micro-manipulated probe stages
- Temperature range capabilities from 2 K to 400 K with field on or off
- ±5° sample stage rotation
- Up to 25 mm (1 in) diameter wafer capabilities
- High vacuum option

### Model CPX-VF

- 2.5 T vertical field solenoid superconducting magnet
- Up to six micro-manipulated probe stages
- Temperature range capabilities from 2 K to 400 K with field on or off
- ±5° sample stage rotation
- Up to 51 mm (2 in) diameter wafer capabilities
- High vacuum option

### Model EMPX-HF

- 0.55 T horizontal (in-plane field) electromagnet
- Up to four micro-manipulated probe stages
- Temperature range capabilities from 3.2 K to 400 K
- Up to 25 mm (1 in) diameter wafer capabilities
- 360° sample stage rotation option

### Model CRX-4K

- Low vibration, cryogen-free closed cycle refrigerator
- Up to six micro-manipulated probe stages
- Temperature range capabilities from 4.5 K to 475 K
- Up to 51 mm (2 in) diameter wafer capabilities