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Model CPX-VF

SUPERCONDUCTING MAGNET-BASED VERTICAL FIELD CRYOGENIC PROBE STATION

Features

- 25 kOe (2.5 T) vertical 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 ±5° in-plane rotation
- Measurements from DC to 67 GHz
- Optional high vacuum to 10^{-7} torr
- Accommodates up to 51 mm (2 in) diameter wafers
- Configurable with up to six thermally anchored micro-manipulated probe arms
- Probe arms with 3-axis adjustments and ±5° planarization
- Cables, shields, and guards minimize electrical noise and thermal radiation losses
- Options and accessories for customization to specific research needs

Introduction

The Model CPX-VF is a versatile cryogenic micro-manipulated probe station used for non-destructive magnetic testing of devices on full and partial wafers up to 51 mm (2 in) in diameter. The CPX-VF 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-VF. A wide selection of probes, cables, sample holders, and options makes it possible to configure the CPX-VF to meet your specific measurement applications.

Mounted on a non-magnetic table, the CPX-VF is equipped with a 25 kOe (2.5 T) vertical field superconducting magnet. The CPX-VF 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 liquid helium or liquid 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-VF is user-configured with up to six 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-VF options include a 2 K base temperature stage, high vacuum, vibration isolation systems, LN_2 Dewar kit*, higher magnification microscope, vacuum turbo pumping system, and fiber optic probe arm modification.

**LHe required to operate magnet*

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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	25 kOe (2.5 T)
Probe movement due to magnet field ramping to 25 kOe (2.5 T)	<5 µm

Temperature

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

** Selectable equipment*

Probe Arm Adjustments

Travel	
X axis	51 mm (2 in)
Y axis	25 mm (1 in)
Z axis	18 mm (0.7 in)
Translation scale	
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

ZN50 DC/RF probe frequency range	
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*†
GSG microwave probe frequency range	
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

Optical viewport—located on top lids	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
Optical resolution—microscope	
7:1 zoom	4 µm
16:1 zoom	4 µm*

** Selectable equipment*

Sample Holders

Maximum sample size—overall	Up to Ø51 mm (2 in)
SH-1.25-G, grounded	Up to Ø32 mm (1.25 in) and 400 K
SH-1.25-I, isolated	Up to Ø32 mm (1.25 in) and 400 K*
SH-1.25-C-VF, coaxial	Up to Ø32 mm (1.25 in) and 400 K*
SH-1.25-T-VF, triaxial	Up to Ø32 mm (1.25 in) and 400 K*
SH-2.00-G, grounded	Up to Ø51 mm (2 in) and 400 K*
SH-2.00-C-VF, coaxial	Up to Ø51 mm (2 in) and 400 K*
SH-2.00-T-VF, triaxial	Up to Ø51 mm (2 in) and 400 K*

**Selectable equipment*

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Standard Equipment

Superconducting magnet	25 kOe (2.5 T), vertical field
Superconducting magnet power supply	Lake Shore Model 625
Output type	Bipolar, 4-quadrant, DC current source
Current	±60 A
Voltage	±5 V
Flow cryostat	4.2 K to 400 K
Sample stage temperature sensor	Lake Shore Model CX-1030-SD-HT-1.4M calibrated Cernox™ RTD
Sample stage heater	50 W
Magnet stage temperature sensor	Lake Shore Model CX-1030-SD-HT-1.4M calibrated Cernox™ RTD
Magnet stage heater	100 W
Cooled radiation shield and cooled IR-absorbing window above the sample	
Two radiation shield temperature sensors	Lake Shore Model DT-670C-CU silicon diode
Two radiation shield heaters	100 W and 50 W
Removable top lid with viewport	Ø50 mm (2 in) window
Temperature control	Two Lake Shore Model 336 temperature controllers (independent regulation of sample stage and radiation shield, and probe arm temperature monitoring)
Electroless nickel-plated vacuum chamber	
Diameter	279 mm (11 in)
Removable top lid with clear fused quartz viewport	Ø54 mm (2.13 in) window
Probe ports	6 surround the sample thermal radiation shield
Pump port	NW40 (pump sold separately)
Gas purge and 0.5 psi safety pop-off port	NW25
Option port	High vacuum
Spare ports	NW 40 and NW 25
Machined aluminum base plate	610 mm × 737 mm (24 in × 29 in)
Support stand	Heavy duty welded steel stand—optional pneumatic vibration isolation system available
Temperature sensor installed and wired to a 6-pin feedthrough (included on one probe arm)	
Grounded sample holder	SH-1.25-G, accommodates up to a Ø32 mm (1.25 in) sample with a Ø25 mm (1 in) probe area
Optics	
Zoom 70 microscope	7:1 zoom with 4 µm resolution
Color CCD camera	S-video or composite output format
Swing arm	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
Video monitor	High resolution, 17-inch
Sample illumination	Coaxial via fiber optic or ring light from an adjustable light source and power supply (must specify sample illumination at time of order) **NOTE: Coaxial illumination is recommended for highly reflective materials**
High efficiency helium transfer line with foot valve for precise flow regulation	
Instrument console	
Basic tools and spares kit for standard operation	

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

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
ZN50-55I	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†		

** As measured by the probe arm temperature sensor*
*** 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

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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 ±5° rotation mechanism is provided

Part number	Connector type	Maximum frequency (GHz)	Maximum probe temperature*	Maximum sample temperature**	Pitch (µm)
GSG-050-40A-55I-E-NM	K	40	350 K	400 K	50
GSG-100-40A-55I-E-NM					100
GSG-150-40A-55I-E-NM					150
GSG-200-40A-55I-E-NM					200
GSG-250-40A-55I-E-NM					250
GSG-050-50A-55I-E-NM	2.4 mm	50			50
GSG-100-50A-55I-E-NM					100
GSG-150-50A-55I-E-NM					150
GSG-200-50A-55I-E-NM					200
GSG-250-50A-55I-E-NM					250
GSG-050-67A-55I-E-NM	1.85 mm	67			50
GSG-100-67A-55I-E-NM					100
GSG-150-67A-55I-E-NM					150
GSG-200-67A-55I-E-NM					200
GSG-250-67A-55I-E-NM					250

** As measured by the probe arm temperature sensor*
*** Selectable equipment*

GSG MICROWAVE CABLES

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

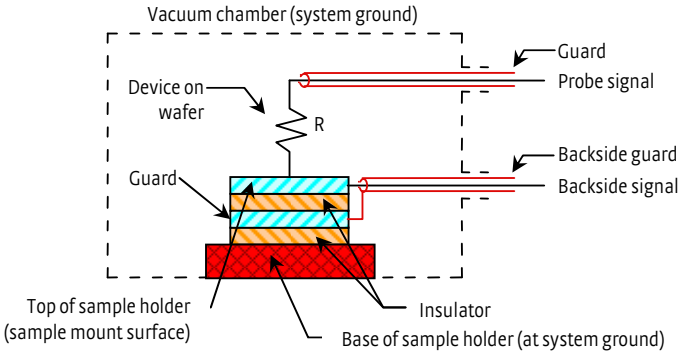
Part number	Cable type	Feedthrough type	Maximum cable temperature*	Maximum sample temperature**	Connector type	Maximum frequency
MWC-09-00K-NM	Non-magnetic semirigid microwave coaxial	Loss-less compression seal	350 K	400 K	K (SMA compatible)	40 GHz
MWC-09-240-NM					2.4 mm	50 GHz
MWC-09-185-NM					1.85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

** As measured by the probe arm temperature sensor*
*** Selectable equipment*

Sample Holders

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-1.25-G	Grounded	No	Ø32 mm (1.25 in)	400 K
SH-1.25-I	Isolated			
SH-1.25-C-VF	Coaxial	Yes*		
SH-1.25-T-VF	Triaxial	Yes**		
SH-2.00-G	Grounded	No	Ø51 mm (2 in)	
SH-2.00-C-VF	Coaxial	Yes*		
SH-2.00-T-VF	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 condensation does not accumulate in the sample environment during cooldown, which is critical for measuring organic semiconductors and for high Z and low current applications. Includes HVAC port, V301 turbo pump kit, related HVAC components, and full range vacuum gauge **NOTE: consult Lake Shore for field upgrade**
PS-FOA	Fiber optic probe arm modification. Transmit or receive light or IR/UV radiation. Fiber optic terminated with SMA connector or compression feedthrough **NOTE: fiber optic and probe cannot be used simultaneously; consult Lake Shore for fiber optic selections**
PS-Z16	16:1 zoom microscope upgrade; provides 4 µm resolution **NOTE: ring light illumination not available for the PS-Z16 when used with the EMPX-HF and CPX-HF; consult Lake Shore for field upgrade**
PS-LT	2.0 K base temperature assembly; 2 K to 400 K control range ; includes system modifications, stainless steel bellows and DS402 rotary pump **NOTE: 50 Hz operation may increase base temperature; consult Lake Shore for field upgrade**
PS-PLVI-25	Pump-line vibration isolator with NW 25 fittings and 1 m bellows; requires one bag of cement (not included) **NOTE: for use with PS-LT or PS-HV-CPX**
PS-V81DPC	Compact turbo pumping system; includes V-81 turbo pump with oil free dry scroll backing pump, high vacuum gauge, controller, and adaptors (specify 120 V/60 Hz or 220 V/50 Hz)
PS-PLVI-40	Pump-line vibration isolator with NW 40 fittings and 1 m bellows; requires one bag of cement (not included) **NOTE: for use with PS-V81DPC**
PS-LN2	50 L nitrogen Dewar with 12.7 mm (0.5 in) top withdrawal

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Equipment Options, continued

PS-TLF-LNA	High flow capacity transfer line with shortened Dewar leg (500 mm (20 in) shorter than standard transfer line) for better fit with PS-LN2 **NOTE: not compatible with FWPX**
PS-DPC	Automatic Dewar pressure controller provides digital readout and pressure regulation over normal station operation **NOTE: requires >68.9 kPa (10 psi) source of helium or nitrogen gas for use with either LHe or LN_2**
PS-PVIS	Pneumatic vibration isolation system; includes gimbal piston isolator, actuators, and supports; requires 40 psi nitrogen or air
PS-OAC	Oil-less compressor for PS-PVIS (only available in 120 V)
PA-SEN	Additional probe arm sensor installed and wired to a 6-pin feedthrough (requires purchase of PS-PAB-09)
PS-PAB-09	Replacement probe arm and base (cable sold separately)
CS-5	75 to 250 µm pitch range calibration substrate for GSG probes—pad size: 50 µm2; calibration type: SOLT, LRL, LRM
CS-15	40 to 150 µm pitch range calibration substrate for GSG probes—pad size: 25 µm2; calibration type: SOLT, LRL, LRM

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