

Model 455 DSP Gaussmeter



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Introduction

The Model 455 digital signal processing (DSP) gaussmeter combines the technical advantages of DSP technology with many advanced features at a moderate price. DSP technology creates a solid foundation for accurate, stable, and repeatable field measurements. Advanced features including DC to 20 kHz AC frequency range, peak field detection to 50 μ s pulse widths, DC accuracy of 0.075%, and up to 5 $\frac{3}{4}$ digits of display resolution make the Model 455 ideal for both industrial and research applications. For added functionality and value, the Model 455 includes a standard Lake Shore Hall probe.

DC Measurement Mode

Static or slowly changing fields are measured in DC mode. In this mode, the Model 455 takes advantage of the internal auto zero function and probe linearity compensation to provide a basic DC accuracy of $\pm 0.075\%$. Measurement resolution is enhanced by advanced signal processing capability, allowing users the choice of reading rates to 30 readings per second or high resolution to 5 $\frac{3}{4}$ digits. Front-end amplification specifically designed to complement DSP data acquisition provides high stability and repeatability. That along with probe temperature compensation provides superior stability ideally suited for demanding DC measurement applications such as field mapping.

RMS Peak Mode

Periodic AC fields are measured in RMS mode. The Model 455 provides an overall RMS frequency range of 10 Hz to 20 kHz and is equipped with both narrow and wide band frequency modes. While in narrow band mode, frequencies above 1 kHz are filtered out for improved measurement performance. The exclusive DSP algorithms free the Model 455 from the limitations of conventional RMS conversion hardware and provide for an excellent dynamic range, resolution, and frequency response.

Peak Measurement Mode

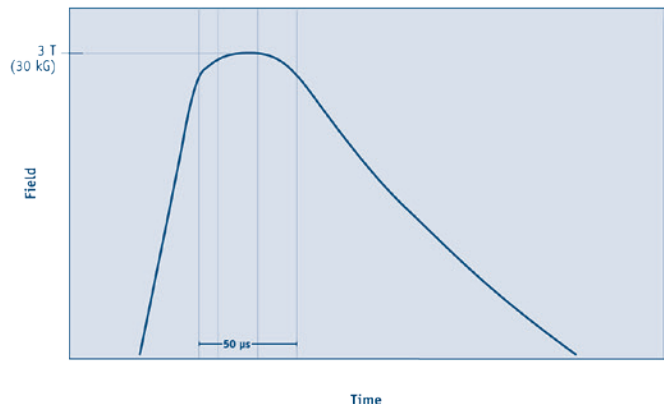
Pulsed fields are measured in Peak mode, which is a natural extension of the high-speed data acquisition necessary for DSP operation. Fast instrument sample rates permit capture of positive and negative transient fields as narrow as 50 μ s pulse widths. The peak reading can be held for an unlimited length of time with no sag. This is ideal for most magnetizers and other fast pulse applications. The Model 455 can also be configured to follow the peak of a periodic waveform for evaluation of crest factor.

- Field ranges from 35 mG to 350 kG
- DC resolution to 0.02 mG
- Basic DC accuracy of $\pm 0.075\%$
- DC to 20 kHz AC frequency response
- AC narrow and wide band modes
- Wide range of standard and custom Hall probes available
- Standard Hall probe included

The Probe Connection

The Model 455 is only half of the magnetic measurement equation. For the complete solution, Lake Shore offers a full complement of standard and custom Hall effect probes in a variety of sizes and sensitivities. One of ten common standard Hall probes is included with the Model 455. See page 5 for details on the ten Hall probes you can choose to get with the Model 455.

50 μ s Wide Magnetizing Pulse



Measurement Features

The Model 455 offers a variety of features to enhance the usability and convenience of the gaussmeter.

Auto Range: In addition to manual range selection, the instrument automatically chooses an appropriate range for the measured field. Auto range works in DC and AC measurement modes.

Auto Probe Zero: Allows the user to zero all ranges for the selected measurement mode with the push of a key.

Display Units: Field magnitude can be displayed in units of G, T, Oe, and A/m.

Max/Min Hold: The instrument stores the fully processed maximum and minimum DC or RMS field value. This differs from the faster peak capture feature that operates on broadband, unprocessed field reading information.

Relative Reading: Relative feature calculates the difference between a live reading and the relative setpoint to highlight deviation from a known field point. This feature can be used in DC, RMS, or Peak measurement mode.

Instrument Calibration: Lake Shore recommends an annual recalibration schedule for all precision gaussmeters. Recalibrations are always available from the factory, but the Model 455 allows users to field calibrate the instrument if necessary. Recalibration requires a computer interface and precision low resistance standards of known value.

Instrument Probe Features

The Model 455 has the best measurement performance when used along with Lake Shore Hall probes. Firmware-based features work in tandem with the probe's calibration and programming to ensure accurate, repeatable measurements and ease of setup. Many of the features require probe characteristics that are stored in the probe connector's non-volatile memory.

Probe Field Compensation: The Hall effect devices used in gaussmeter probes produce a near linear response in the presence of magnetic field. The small nonlinearities present in each individual device can be measured and subtracted from the field reading. Model 455 probes are calibrated in this way to provide the most accurate DC readings.

Probe Temperature Compensation: Hall effect devices show a slight change in sensitivity and offset with temperature. Probe temperature effects can be measured and subtracted out of field readings. A temperature sensor in the probe tip relays real time temperature to the gaussmeter, enabling compensation. Although temperature effects contribute only a small fraction of the overall probe measurement accuracy, temperature compensation will often improve measurement and control stability.

Probe Temperature Display: The gaussmeter can display the probe's temperature in °C along with a field reading when using a probe that includes a temperature sensor.

Frequency Display: When operating in RMS mode, the gaussmeter can display the frequency of the measured AC field along with a field reading.

Probe Information: The gaussmeter reads the probe information on power up or any time the probe is changed to allow hot swapping of probes. Critical probe information can be viewed on the front panel and read over the computer interface to ensure proper system configuration.

Extension Cables: The complex nature of Hall effect measurements make it necessary to match extension cables to the probe when longer cables are needed. Keeping probes and their extensions from getting mixed up can become a problem when more than one probe is in use. The Model 455 alleviates most of the hassle by allowing users to match probes to extensions in the field. Stored information can be viewed on the front panel and read over the computer interface to ensure proper mating.

Hall Effect Generators (Magnetic Field Sensors): The Model 455 will operate with a discrete Hall effect generator when a suitable probe is not available. Users can program nominal sensitivity and serial number into an optional MCBL-6 blank connector to provide all gaussmeter functions except field and temperature compensation. If no sensitivity information is available, the Model 455 reverts to resistance measurement.



Display and Interface Features

Display

The Model 455 has a two line by 20 character vacuum fluorescent display. During normal operation, the display is used to report field readings and give results of other features such as max/min or relative. The display can also be configured to show probe temperature or frequency. When setting instrument parameters, the display gives the operator meaningful prompts and feedback to simplify operation. The operator can also control display brightness.

Following are three examples of the various display configurations:



The display configured to show the RMS field value and frequency, and the probe temperature



The display configured to show both the Maximum and Minimum DC field values



The display configured to simultaneously show the positive and negative Peak readings

Keypad

The instrument has a 22-position keypad with individual keys assigned to frequently used features. Menus are reserved for less frequently used setup operations. The keypad can be locked out to prevent unintended changes of instrument setup.

Alarm and Relay

High and low alarms are included in the instrument. Alarm actuators include display annunciator, audible beeper, and two relays. The relays can also be controlled manually for other system needs.

Voltage Output 1

The first voltage output gives access to amplified voltage signal directly from the probe. This voltage is corrected for the nominal sensitivity of the probe and provides the widest bandwidth of the three voltage outputs. In wide band AC mode, the signal can be viewed on an oscilloscope to observe the shape of AC fields. In peak mode, the output can be used to view a pulse shape or other characteristic of a momentary signal. Output 1 serves only as a diagnostic tool in DC and narrow band AC modes because modulation of the probe signal prevents a clear view of the field response.

Voltage Output 2

The second voltage output provides a voltage proportional to measured field with the benefits of some signal processing. The output is produced by the DSP through a fast D/A converter. The output signal is updated at 40 kHz, giving good response for low to mid frequency fields. Signal quality degrades at high frequency because of the sampling rate. This voltage can be corrected for probe offset and for the nominal sensitivity of the probe.

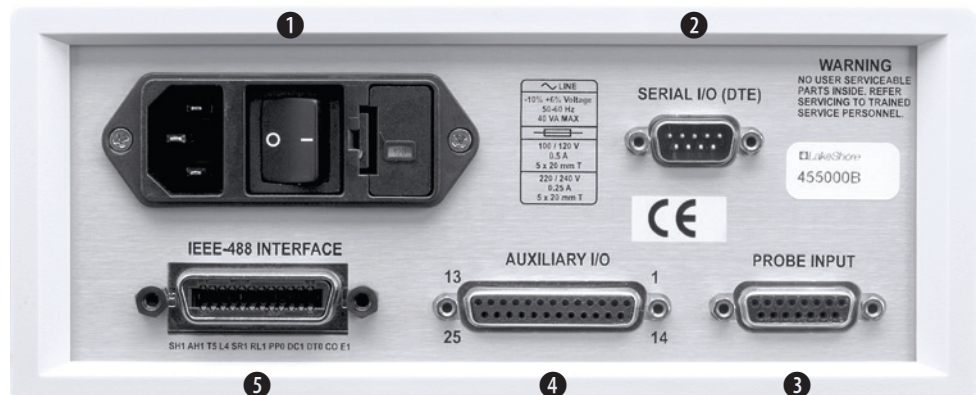
Voltage Output 3

The third output provides a voltage proportional to measured field with the most signal processing of the three outputs. All probe compensation available to the display readings, including temperature compensation, can be performed on this output. The output is produced by the micro-processor through a 16-bit D/A converter updated at 30 readings per second.

Computer Interface

Two computer interfaces are included with the Model 455: serial (RS-232C) and parallel (IEEE-488). Both allow setup of all instrument parameters and read-back of measured values. The reading rate over the interface is nominally 30 readings per second. LabVIEW™ drivers are provided to instrument users – consult Lake Shore for availability.

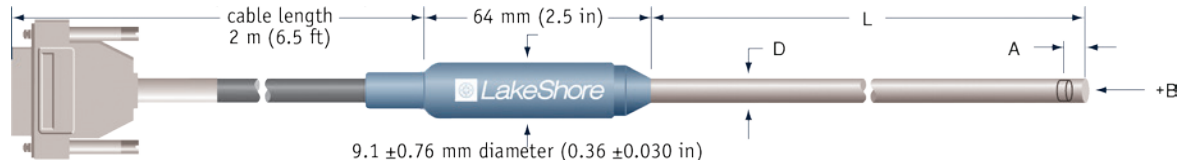
- 1 Line Input Assembly
- 2 Serial I/O (DTE)
- 3 Probe Input
- 4 Auxiliary I/O
- 5 IEEE-488 Interface



Hall Probe Selection

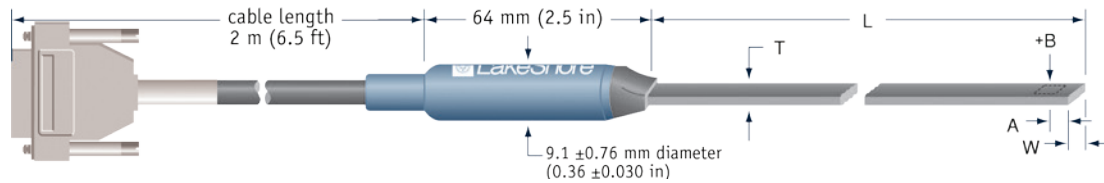
Listed below are the probes that you can choose from to include with your Model 455. Our experts can guide you through the probe selection process. Other standard probes are available at an additional cost. Lake Shore prides itself on making every attempt to satisfy customer requests for special probes. If you need a custom probe, contact Lake Shore for availability.

Axial Probes



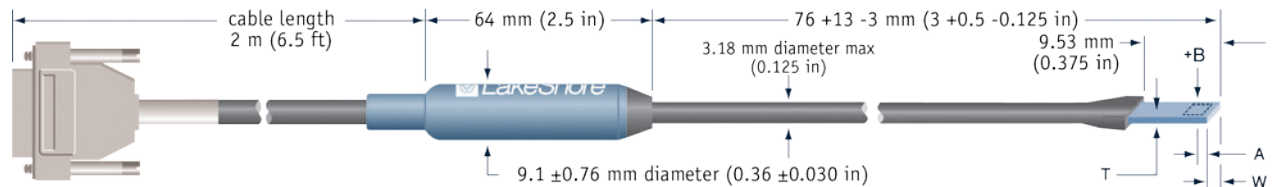
	L (in)	D (in)	A (in)	Active area (in)	Stem material	Frequency range	Usable full scale ranges	Corrected accuracy (% rdg)	Operating temp range (°C)	Temp coefficient (max) zero	Temp coefficient (max) calibration	Contains temp sensor
HMNA-1904-VR	4 ± 0.125	0.187 dia ± 0.005	0.005 ± 0.003	0.030 dia (approx)	Fiberglass epoxy	DC to 20 kHz	HSE 3.5 G, 35 G, 350 G, 3.5 kG, 35 kG	± 0.20% to 30 kG and ± 0.25% 30 to 35 kG	0 °C to +75 °C	± 0.09 G/°C	± 0.04%/°C	Yes
HMMA-2502-VR	2 ± 0.063	0.25 dia ± 0.006	0.015 ± 0.005		Aluminum	DC to 10 kHz						
HMNA-1904-VF	4 ± 0.125	0.187 dia ± 0.005	0.005 ± 0.003		Fiberglass epoxy	DC to 800 Hz	HST-4 35 G, 350 G, 3.5 kG, 35 kG	± 0.10% to 30 kG and ± 0.15% 30 to 35 kG		± 0.13 G/°C	-0.005%/°C	
HMMA-2502-VF	2 ± 0.063	0.25 dia ± 0.006	0.015 ± 0.005		Aluminum	DC to 400 Hz						

Transverse Probes



	L (in)	T (in)	W (in)	A (in)	Active area (in)	Stem material	Frequency range	Usable full scale ranges	Corrected accuracy (% rdg)	Operating temp range	Temp coefficient (max) zero	Temp coefficient (max) calibration	Contains temp sensor
HMMT-6J04-VR	4 ± 0.125	0.061 max	0.180 ± 0.005	0.150 ± 0.050	0.040 dia (approx)	Aluminum	DC to 800 Hz	HSE 3.5 G, 35 G, 350 G, 3.5 kG, 35 kG	± 0.20% to 30 kG; ± 0.25% 30 to 35 kG	0 °C to +75 °C	± 0.09 G/°C	± 0.04%/°C	Yes
HMNT-4E04-VR	4 ± 0.125	0.045 max	0.150 ± 0.005			Fiberglass epoxy	DC to 20 kHz						
HMMT-6J04-VF	4 ± 0.125	0.061 max	0.180 ± 0.005			Aluminum	DC to 400 Hz	HST-4 35 G, 350 G, 3.5 kG, 35 kG	± 0.10% to 30 kG; ± 0.15% 30 to 35 kG		± 0.13 G/°C	-0.005%/°C	
HMNT-4E04-VF	4 ± 0.125	0.045 max	0.150 ± 0.005			Fiberglass epoxy	DC to 800 Hz						

Flexible Transverse Probes



	W (in)	T (in)	A (in)	Active area (in)	Stem material	Frequency range	Usable full scale ranges	Corrected accuracy (% rdg)	Operating temp range	Temp coefficient (max) zero	Temp coefficient (max) calibration	Contains temp sensor
HMFT-3E03-VR	0.135 max	0.025 max	0.125 ± 0.005	0.040 dia (approx)	Flexible plastic tubing	DC to 20 kHz	HSE 3.5 G, 35 G, 350 G, 3.5 kG, 35 kG	± 0.20% to 30 kG; ± 0.25% 30 to 35 kG	0 °C to +75 °C	± 0.09 G/°C	± 0.015%/°C	Yes
HMFT-3E03-VF						DC to 800 Hz						

Model 455 Specifications

General Measurement

(Does not include probe error, unless otherwise specified)

Input type: Single Hall effect sensor

Probe features: Linearity compensation, temperature compensation, auto probe zero, and hot swap

Measurement features: Autorange, max/min hold, relative mode, and frequency

Connector: 15-pin D style

DC Measurement

Probe type ranges	5¼-digit resolution	4¼-digit resolution	3¼-digit resolution
HST Probe			
350 kG	000.001 kG	000.01 kG	000.1 kG
35 kG	00.0001 kG	00.001 kG	00.01 kG
3.5 kG	0.00001 kG	0.0001 kG	0.001 kG
350 G	000.003 G	000.02 G	000.1 G
35 G	00.0030 G	00.015 G	00.04 G
HSE Probe			
35 kG	00.0001 kG	00.001 kG	00.01 kG
3.5 kG	0.00001 kG	0.0001 kG	0.001 kG
350 G	000.001 G	000.01 G	000.1 G
35 G	00.0003 G	00.002 G	00.01 G
3.5 G	0.00030 G	0.0015 G	0.004 G
UHS Probe			
35 G	00.0001 G	00.001 G	00.01 G
3.5 G	0.00001 G	0.0001 G	0.001 G
350 mG	000.003 mG	000.02 mG	000.1 mG
35 mG	00.0030 mG	00.015 mG	00.04 mG

Measurement resolution (RMS noise floor): Indicated by value in above table for shorted input (probe effects not included); value measured as peak-to-peak divided by 6.6

Display resolution: Indicated by number of digits in above table

	5¼-digit resolution	4¼-digit resolution	3¼-digit resolution
3 dB bandwidth	1 Hz	10 Hz	100 Hz
Time constant	1 s	0.1 s	0.01 s
Max reading rate	10 rdg/s	30 rdg/s	30 rdg/s

DC accuracy: ±0.075% of reading ±0.005% of range

DC temperature coefficient: ±0.01% of reading ±0.003% of range per °C

AC RMS Measurement

Probe type ranges	4¼-digit resolution
HST Probe	
350 kG	000.01 kG
35 kG	00.001 kG
3.5 kG	0.0002 kG
350 G	000.02 G
35 G	00.020 G
HSE Probe	
35 kG	00.001 kG
3.5 kG	0.0001 kG
350 G	000.02 G
35 G	00.002 G
3.5 G	0.0020 G
UHS Probe	
35 G	00.001 G
3.5 G	0.0002 G
350 mG	000.02 mG
35 mG	00.020 mG

Measurement resolution (RMS noise floor): Indicated by value in above table for shorted input

Display resolution: Indicated by number of digits in above table

Max reading rate: 30 rdg/s

AC accuracy: ±1% of reading ≥1% of full scale range, 10 Hz to 20 kHz

AC frequency range: 10 Hz to 1 kHz, narrow band mode, 135 Hz to 20 kHz, wide band mode

Peak Measurement

Probe type ranges	4¼-digit resolution
HST probe	
350 kG	000.01 kG
35 kG	00.001 kG
3.5 kG	0.0002 kG
350 G	000.02 G
35 G	00.020 G
HSE probe	
35 kG	00.001 kG
3.5 kG	0.0001 kG
350 G	000.02 G
35 G	00.002 G
3.5 G	0.0020 G
UHS probe	
35 G	00.001 G
3.5 G	0.0002 G
350 mG	000.02 mG
35 mG	00.020 mG

Measurement resolution (RMS noise floor): Indicated by value in above table for periodic mode and shorted input

Display resolution: Indicated by number of digits in above table

Max reading rate (periodic mode): 30 rdg/s

Peak accuracy (5 Hz to 20 kHz): ±2% of reading ≥1% of full scale range (50 μs or longer pulse width)

Peak frequency range (periodic mode): 50 Hz to 5 kHz

Peak frequency range (pulse mode): 5 Hz to 20 kHz

Temperature Measurement

Temperature range: Probe dependent (typically 0 °C to 75 °C)

Measurement resolution: 0.01 °C

Temperature display resolution: 0.01 °C

Electronic accuracy: ±0.7 °C

Front Panel

Display type: 2 line × 20 character, vacuum fluorescent with 9 mm high characters

Display resolution: To ±5¼ digits

Display update rate: 5 rdg/s

Display units: gauss (G), tesla (T), oersted (Oe), and ampere per meter (A/m)

Units multipliers: μ, m, k, M

Display annunciators:

DC – DC measurement mode

RMS – AC RMS measurement mode

PK – Peak measurement mode

MX – Max hold value

MN – Min hold value

SP – Relative setpoint value

LED annunciators:

Relative reading mode

Alarm active

Remote IEEE-488 operation

Keypad: 22 full travel keys

Front panel features: Display prompts, front panel lockout, and brightness control

Interfaces

RS-232C

Baud: 9600, 19200, 38400, and 57600

Update rate: 30 rdg/s (ASCII)

Software support: LabVIEW™ driver

Connector: 9-pin D-style, DTE configuration

IEEE-488.2

Capabilities: SH1, AH1, T5, L4, SR1, RL1, PP0, DC1, DT1, CO, and E1

Update rate: 30 rdg/s

Software support: LabVIEW™ driver

Alarm

Settings: High/low setpoint, inside/outside, and audible

Actuators: LED annunciator, beeper, and relays

Relays

Number: 2

Contacts: Normally open (NO), normally closed (NC), and common (C)

Contact rating: 30 VDC at 2 A

Operation: Follows alarm or operated manually

Connector: Shared 25-pin I/O connector

Voltage Output 1

Configuration: Real-time analog voltage output of wide band AC signal

Range: ± 3.5 V

Scale: ± 3.5 V = \pm full scale on selected range

Frequency response: 10 Hz to 20 kHz (wide band AC)

Accuracy: Probe dependent

Noise: ± 1.0 mV RMS

Minimum load resistance: 1 k Ω (short-circuit protected)

Connector: Shared 25-pin I/O connector

Voltage Output 2

Configuration: Voltage output of field value, generated by DAC

Range: ± 5 V

Scale: ± 3.5 V = \pm full scale on selected range

Resolution: 16-bit, 0.15 mV

Update rate: 40,000 updates/s

Accuracy: ± 10 mV

Noise: ± 0.3 mV RMS

Minimum load resistance: 1 k Ω (short-circuit protected)

Connector: Shared 25-pin I/O connector

Voltage Output 3

Configuration: Voltage output of compensated DC or RMS field value, generated by DAC

Range: ± 10 V

Scale: User specified (defaults same as voltage output 2)

Resolution: 16-bit, 0.3 mV

Update rate: 30 updates/s

Accuracy: ± 2.5 mV

Noise: ± 0.3 mV RMS

Minimum load resistance: 1 k Ω (short-circuit protected)

Connector: Shared 25-pin I/O connector

General

Ambient temperature: 15 °C to 35 °C at rated accuracy, 5 °C to 40 °C with reduced accuracy

Power requirement: 100, 120, 220, and 240 VAC (+6%, -10%), 50 Hz or 60 Hz, 20 VA

Size: 216 mm W \times 89 mm H \times 318 mm D (8.5 in \times 3.5 in \times 12.5 in), half rack

Weight: 3 kg (6.6 lb)

Approval: CE mark

Probes and Extensions

Probe compatibility: Full line of standard and custom probes available

– see page 5 for included (additional standard probes available)

Hall sensor compatibility: Front panel programmable sensitivity and serial number for user supplied Hall sensor

Extension cable compatibility: Calibrated or uncalibrated probe extension cables with an EEPROM are available from 10 ft to 100 ft.

Lake Shore calibrated extension cables maintain the same accuracy as the Model 455 probe.

The uncalibrated version involves the operator loading the matching probe data file into the cable PROM directly from the Model 455 front panel. Additional errors caused by the uncalibrated extension cables are $\pm 0.02\%$ of field reading error and 1 °C temperature reading error.

Ordering Information

Part number	Description
455	Model 455 DSP gaussmeter
455-HMXX-XXXX-XX	Model 455 DSP gaussmeter with standard probe choice – specify selected probe number for HMXX-XXXX-XX (see page 5)

Please indicate your power/cord configuration:

100 VAC, U.S. power cord
120 VAC, U.S. power cord
220 VAC, European power cord
240 VAC, European power cord

Accessories included

106-253	I/O mating connector
106-264	I/O mating connector shell
4060	Zero gauss chamber
MAN-455	Model 455 gaussmeter user manual

Accessories available

4005	1 m (3.3 ft) long IEEE-488 (GPIB) computer interface cable assembly – includes extender required for simultaneous use of IEEE cable and auxiliary I/O connector
4065	Large zero gauss chamber for gamma probe
RM-1/2	Rack mount kit for one 1/2-rack gaussmeter in 483 mm (19 in) rack
RM-2	Rack mount kit for two 1/2-rack gaussmeter in 483 mm (19 in) rack
HMCBL-6	User programmable cable with EEPROM (6 ft)
HMCBL-20	User programmable cable with EEPROM (20 ft)
HMPEC-10	Probe extension cable with EEPROM (10 ft), calibrated
HMPEC-10-U	Probe extension cable with EEPROM (10 ft), uncalibrated
HMPEC-25	Probe extension cable with EEPROM (25 ft), calibrated
HMPEC-25-U	Probe extension cable with EEPROM (25 ft), uncalibrated
HMPEC-50	Probe extension cable with EEPROM (50 ft), calibrated
HMPEC-50-U	Probe extension cable with EEPROM (50 ft), uncalibrated
HMPEC-100	Probe extension cable with EEPROM (100 ft), calibrated
HMPEC-100-U	Probe extension cable with EEPROM (100 ft), uncalibrated

Calibration service

CAL-N7-DATA	New instrument calibration for Model 455/475 with certificate and data
CAL-455-CERT	Instrument recalibration with certificate
CAL-455-DATA	Instrument recalibration with certificate and data

All specifications are subject to change without notice

LakeShore®

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Established in 1968, Lake Shore Cryotronics, Inc. is an international leader in developing innovative measurement and control solutions. Founded by Dr. John M. Swartz, a former professor of electrical engineering at the Ohio State University, and his brother David, Lake Shore produces equipment for the measurement of cryogenic temperatures, magnetic fields, and the characterization of the physical properties of materials in temperature and magnetic environments.

