Gaussmeter Exposure to External Magnetic Fields

Gaussmeter applications often require placement of the instrument in areas that expose it to large volume, external magnetic fields of varying magnitude. This is especially true in high energy physics facilities (particle accelerators) and near medical diagnostics (MRI) equipment. To maintain acceptable measurement accuracy, a user must consider ambient field strength allowances for their gaussmeter.

Though Lake Shore gaussmeters maintain their accuracy in most laboratory and manufacturing magnetic field environments, there are some situations like those mentioned above where the user must be cognizant of detrimental accuracy effects. Not only is field strength an important factor, but field direction and gaussmeter model are variables that must also be considered.

Field Direction

Testing at Lake Shore has concentrated on horizontal (along the plane of the instrument) and vertical (through the top and bottom of the gaussmeter) field components (figure 1). Gaussmeters exhibit different accuracy variation depending on the field direction, which can result in a gain error or a zero error.

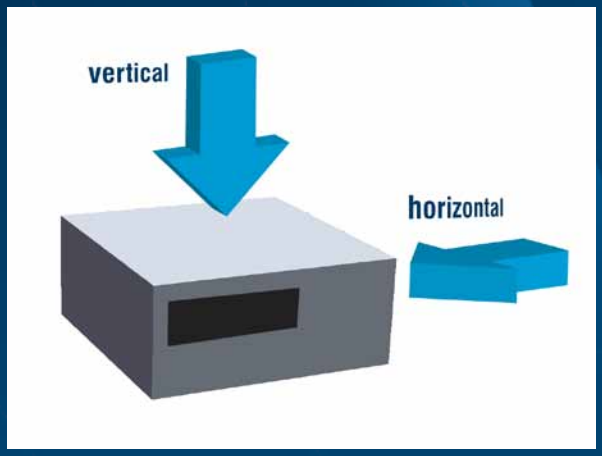


Figure 1: **Vertical and Horizontal Fields**

Gaussmeter Gain (Calibration) Error

As a rule, most users should attach the probe and zero the gaussmeter/probe set (with the probe in a zero gauss chamber) while the instrument is exposed to the external magnetic field. Table 1 describes the gain error for each gaussmeter model when the user has zeroed the probe under this condition.

Field direction	Model	Gain error	When exposed to fields:
Horizontal	420, 421, 450, 460	None	<200 Oe (15.9 kA/m)
	455 and 475	0.005%	<200 Oe (15.9 kA/m)
	425	<0.001%	<150 Oe (11.9 kA/m)
Vertical	420, 421, 450, 460	0.025%	<200 Oe (15.9 kA/m)
	455 and 475	<0.001%	<200 Oe (15.9 kA/m)
	425†	<0.001%	<150 Oe (11.9 kA/m)

† Model 425 usage is restricted to ≤150 Oe (11.9 kA/m); data for all other models is given for <200 Oe (15.9 kA/m)

It is difficult to predict how these field changes would affect absolute accuracy, as it depends on the zero-field, base accuracy of the particular gaussmeter. It is safest to assume the worst case error, which is the instrument-specified error plus the external field induced error (e.g., for a Model 450, 0.10% + 0.025% = 0.125%).

Gaussmeter Zero (Offset) Error

If the gaussmeter cannot be zeroed in the final external magnetic field, the user must be aware that the zero will change after the instrument is exposed. This may invalidate the field measurements, especially when reading lower values, or may be insignificant when measuring high fields. Table 2 describes the effects for each gaussmeter.

	Model*	Gaussmeter range	Zero error
Horizontal	420, 421, 450, 460	300 G (30 mT)	0.6 G (0.060 mT)
		3.0 kG (300 mT)	0.000065 kG (0.065 mT)
	455 and 475	350 G (35 mT)	0.25 G (0.025 mT)
		3.5 kG (350 mT)	0.00057 kG (0.057 mT)
	425	350 G (35 mT)	0.084 G (0.0084 mT)
		3.5 kG (350 mT)	0.00007 kG (0.007 mT)
Vertical	420, 421, 450, 460	300 G (30 mT)	0.023 G (0.0023 mT)
		3.0 kG (300 mT)	0.00005 kG (0.005 mT)
	455 and 475	350 G (35 mT)	0.04 G (0.004 mT)
		3.5 kG (350 mT)	0.00004 kG (0.004 mT)
	425	350 G (35 mT)	0.003 G (0.0003 mT)
		3.5 kG (350 mT)	0.00002 kG (0.002 mT)

**For the Model 425, table shows max zero shifts when exposed to external fields <150 Oe; data for all other models is given for 200 Oe*

NOTE: the Model 425 should never be used in external fields greater than 150 Oe (11.9 kA/m).

Removing the Gaussmeter from the Field

If the external field exceeds 200 Oe (150 Oe for the Model 425) or the above errors are greater than can be tolerated, the next approach is to remove the gaussmeter to an area of low environmental magnetic field. If the gaussmeter/probe combination can be zeroed in the final external ambient field, all models maintain full accuracy specification in fields up to 30 G (3 mT).

Probe Extension Cable

The easiest method of removing a gaussmeter from high ambient fields is to use an extension cable with the probe. Lake Shore offers a full line of standard extension cables for all gaussmeter models mentioned above. Stock lengths are 10 ft (3 m), 25 ft (7.6 m), 50 ft (15.3 m), and 100 ft (30.5 m). Always choose the shortest cable to accomplish the task. Standard extension cables from Lake Shore add no error to the field measurements. Field-calibrated cables (available only with the Model 425, Model 455 and Model 475) add less than 0.1% error.

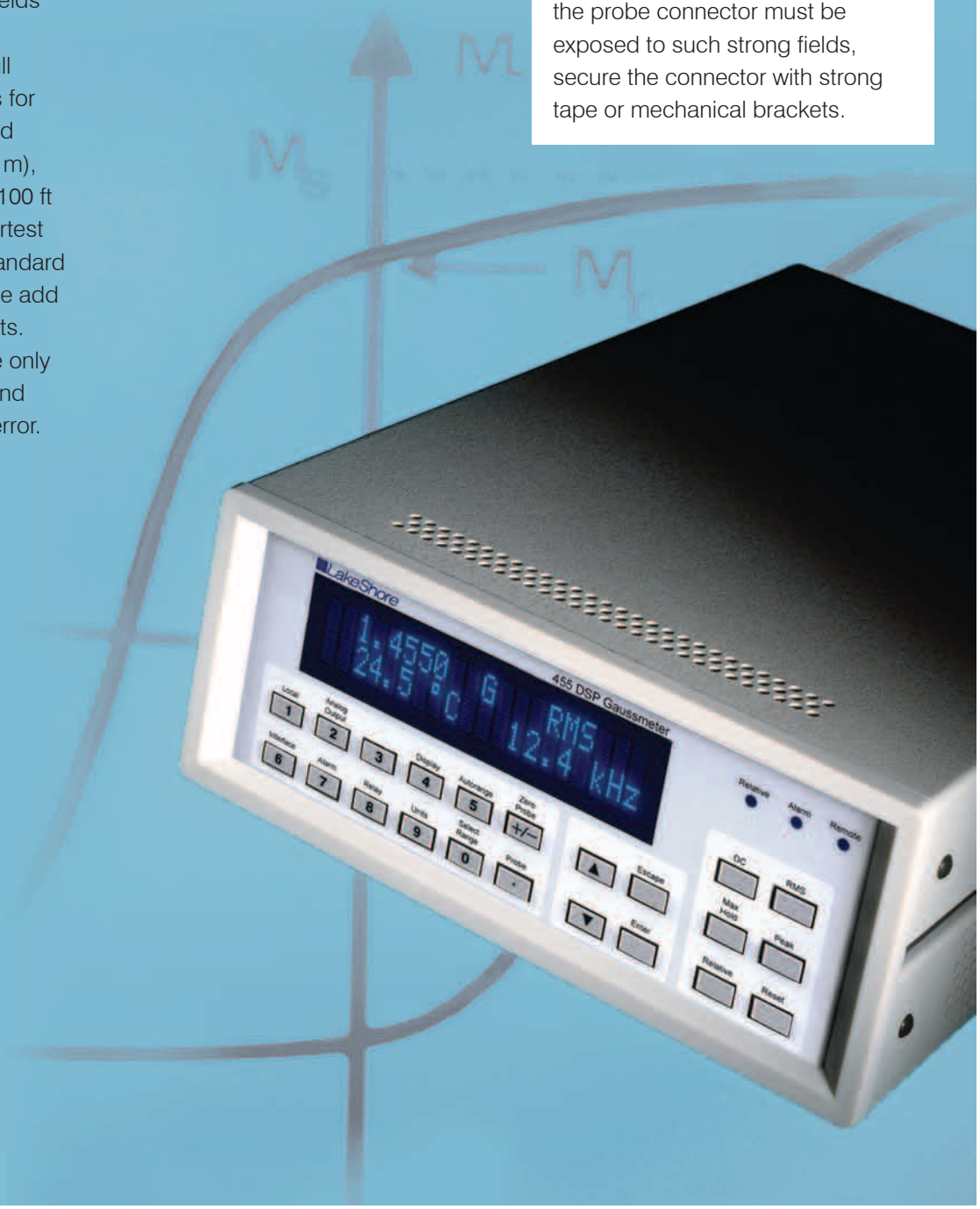
Special Probe Cable Length

An extension cable is not desirable for all situations. For example, a user may need to remove the probe connectors from the field forces (see sidebar warning). In these cases, a special probe with a longer cable may be the preferred solution. Please contact Lake Shore for information on probes with custom cables up to 100 ft (30.5 m) long.

WARNING

Sometimes ambient magnetic fields are quite high, and extra precautions must be exercised to prevent injury to the user.

Both the gaussmeter and the probe cable connector contain ferrous materials; therefore, physical force strong enough to move the instrument or connector may be exerted on them. No gaussmeter should ever be used in this situation, and must be removed from the field. In instances where the probe connector must be exposed to such strong fields, secure the connector with strong tape or mechanical brackets.



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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.

Ordering Information

Part number	Description
MPEC-10	Calibrated probe extension cable for Model 420/421/450/460, 10 ft
MPEC-25	Calibrated probe extension cable for Model 420/421/450/460, 25 ft
MPEC-50	Calibrated probe extension cable for Model 420/421/450/460, 50 ft
MPEC-100	Calibrated probe extension cable for Model 420/421/450/460, 100 ft
HMPEC-10	Calibrated probe extension cable for Model 455/475, 10 ft
HMPEC-25	Calibrated probe extension cable for Model 455/475, 25 ft
HMPEC-50	Calibrated probe extension cable for Model 455/475, 50 ft
HMPEC-100	Calibrated probe extension cable for Model 455/475, 100 ft
HMPEC-10-U	Uncalibrated probe extension cable for Model 455/475, 10 ft
HMPEC-25-U	Uncalibrated probe extension cable for Model 455/475, 25 ft
HMPEC-50-U	Uncalibrated probe extension cable for Model 455/475, 50 ft
HMPEC-100-U	Uncalibrated probe extension cable for Model 455/475, 100 ft

All specifications are subject to change without notice 050809