1.0 HALL SENSOR HANDLING, WIRING, & SPECIFICATIONS

Lake Shore sells a series of discrete Hall sensors for applications that are unsuitable for standard gaussmeter probe configurations. This section describes the handling, wiring and specifications of the bare Hall sensors available from Lake Shore. Please consult the factory for availability of bare Hall sensor types not detailed in this instruction.

1.1 Hall Sensor Handling

CAUTION: Care must be exercised when handling the Hall sensor. The device is very fragile. Stressing the Hall sensor can alter its output. Any excess force can easily break the Hall sensor. Broken Hall sensors are not repairable.

Hall sensors are very fragile and require delicate handling. The ceramic substrate used to produce the Hall sensor is very brittle. Use the leads to move the Hall sensor. Do not handle the substrate. The strength of the lead-to-substrate bond is about 7 ounces, so avoid tension on the leads and especially avoid bending them close to the substrate. The Hall sensor is also susceptible to bending and thermal stresses.

1.2 Hall Sensor Lead Wires

Lake Shore Hall sensors (except Models HGCA-3020 and HGCT-3020) have 34 AWG solid copper lead wire with poly-nylon insulation and have the following color-coded lead configuration.

Red = $+I_C$
Green = $-I_C$ } Input (Control Current)

Blue = $+V_H$
Clear = $-V_H$ } Output (Hall Voltage)

The Models HGCA-3020 and HGCT-3020 Hall sensors have 34 AWG stranded copper lead wire with Teflon® insulation and have the following color-coded lead configuration:

Red = $+I_C$
Black = $-I_C$ } Input (Control Current)

Blue = $+V_H$
Yellow = $-V_H$ } Output (Hall Voltage)

1.3 Using a Discrete Hall Sensor with Model 475, 455, and 425 Gaussmeters

Connecting a Hall sensor to a Model 475, 455, or 425 gaussmeter is facilitated by a Lake Shore Model HMCBL-6 or HMCBL-20 cable assembly (sold separately). The cable has a 15-pin D-sub connector on one end and four leads on the other. The 4 leads, illustrated in Figure 1-1, correspond to the 4 leads on the Hall sensors given in Paragraph 1.2. The HMCBL cable contains an EEPROM for storing the sensitivity values entered by the user.

Each Hall sensor purchased from Lake Shore will come with a nominal magnetic field sensitivity value. However, we recommend that the customer always check accuracy against a reference field rather than solely using the sensitivity value sent with the Hall sensor. Because Lake Shore has no control of the conditions beyond the cable, the customer must accept responsibility for accuracy and compatibility.

In cryogenic applications, Manganin lead wire is frequently used because of its thermal conductivity properties. Manganin wire is not usually acceptable for connection to a Hall sensor because the resistance of Manganin wire is often too high. The gaussmeter current source is limited in compliance voltage. The Model 475, 455, or 425 should not drive a load (Hall sensor, customer wires, and HMCBL cable) greater than 50 Ω. In fact, for best performance, the load should be less than 30 Ω. In cryogenic applications, Hall sensors are normally connected using twisted pairs of copper wire such as 34 gauge, Teflon insulated.

1.4 Attachment to a User-Programmable Cable

The Model HMCBL-XX has a 15-pin D-sub connector on one end for direct attachment to the PROBE INPUT connection on the back panel of the gaussmeter. Four tinned wires are provided for connection to the Hall sensor. The leads may be soldered directly to these wires. The cable comes in two lengths: the HMCBL-6 is 2 m (6 ft) and the HMCBL-20 is 6 m (20 ft).

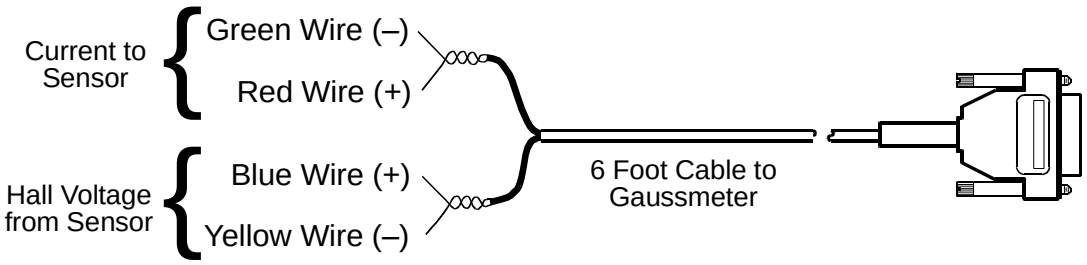


Figure 1-1. Model HMCBL-XX User-Programmable Cable Accessory

CAUTION: The Hall sensor should be isolated from all line voltages (or voltages referenced to earth ground). *If not, damage to the gaussmeter is almost a certainty.*

Refer to Paragraph 1.5 for a partial list of compatible Hall sensors manufactured by Lake Shore. Once connections are made, refer to Paragraph 2.0 for instructions on programming parameters into the internal EPROM.

1.5 Hall Sensor Specifications

This section covers three types of Hall sensors available from Lake Shore: HGCA & HGCT Series cryogenic Hall sensors (Figures 1-2 and 1-3) with specifications (Table 1-1), HGA Series axial Hall sensors (Figure 1-3) with specifications (Table 1-2), and HGT Series transverse Hall sensors (Figure 1-4) with specifications (Table 1-3).

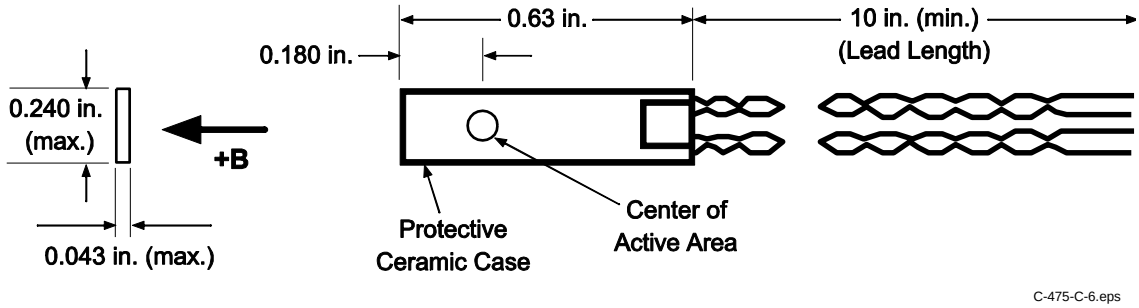


Figure 1-2. Transverse Hall Sensor HGT-3010, HGT-3030, and HGCT-3020 Dimensions

Table 1-1. Cryogenic Hall Sensor Specifications

Cryogenic	HGCA-3020	HGCT-3020
Description	Cryogenic axial; HST-type; phenolic package	Cryogenic transverse; HST-type; ceramic package
Active area (approximate)	0.030 in diameter circle	0.040 in diameter circle
Input resistance (approximate)	1 Ω	1 Ω
Output resistance (approximate)	1 Ω	1 Ω
Nominal control current (I_{CN})	100 mA	100 mA
Maximum continuous current (non-heat sinked)	300 mA	300 mA
Magnetic sensitivity (I_C = nominal control current)	0.55 to 1.05 mV/kG	0.55 to 1.05 mV/kG
Maximum linearity error (sensitivity vs. field)	±1.0% rdg (-30 to +30 kG) ±2.0% rdg (-150 to +150 kG)	±1.0% rdg (-30 to +30 kG) ±2.0% rdg (-150 to +150 kG)
Zero field offset voltage (I_C = nominal control current)	±200 µV (max)	±200 µV (max)
Operating temperature range	1.5 K to 375 K	1.5 K to 375 K
Mean temperature coefficient of magnetic sensitivity	±0.01%/K (approx) *See below	±0.01%/K (approx) *See below
Mean temperature coefficient of offset (I_C = nominal control current)	±0.4 µV/K (max)	±0.4 µV/K (max)
Mean temperature coefficient of resistance	±0.6%/K (max)	±0.6%/K (max)
Leads	34 AWG copper w/Teflon insulation	34 AWG copper w/Teflon insulation

* Change in magnetic sensitivity, referenced to room temperature:

300 K	REF
200 K	+0.05%
100 K	-0.04%
80 K	-0.09%
20 K	-0.40%
4 K	-0.70%

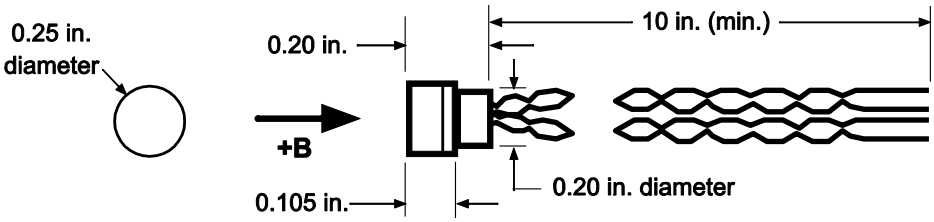


Figure 1-3. Axial Hall Sensor HGA-3010, HGA-3030, and HGCA-3020 Dimensions

Table 1-2. Axial Hall Sensor Specifications

Axial	HGA-3010	HGA-3030
Description	Instrumentation quality axial; HST-type; low temperature coefficient; phenolic package	Instrumentation quality axial; HSE-type; phenolic package
Active area (approximate)	0.030 in diameter circle	0.030 in diameter circle
Input resistance (approximate)	1 Ω	2 Ω
Output resistance (approximate)	1 Ω	2 Ω
Nominal control current (I_{CN})	100 mA	100 mA
Maximum continuous current (non-heat sinked)	300 mA	300 mA
Magnetic sensitivity (I_C = nominal control current)	0.55 to 1.05 mV/kG	6.0 to 10.0 mV/kG
Maximum linearity error (sensitivity versus field)	±1% rdg (–30 to +30 kG) ±1.5% rdg (–100 to +100 kG)	±0.30% rdg (–10 to +10 kG) ±1.25% rdg (–30 to +30 kG)
Zero field offset voltage (I_C = nominal control current)	±50 µV (max)	±75 µV (max)
Operating temperature range	–40 to +100 °C	–40 to +100 °C
Mean temperature coefficient of magnetic sensitivity	-0.005%/°C (max)	–0.04%/°C (max)
Mean temperature coefficient of offset (I_C = nominal control current)	±0.4 µV/°C (max)	±0.3 µV/°C (max)
Mean temperature coefficient of resistance	+0.15%/°C (approx)	+0.18%/°C (approx)
Leads	34 AWG copper with poly-nylon insulation	34 AWG copper with poly-nylon insulation

NOTE: A load resistor may be specified with the Hall sensor data.
It is very important that this load resistor be applied across the $+V_H$, $–V_H$ Hall sensor leads, rather than at the HMCBL connector, to duplicate the sensitivity and linearity data.

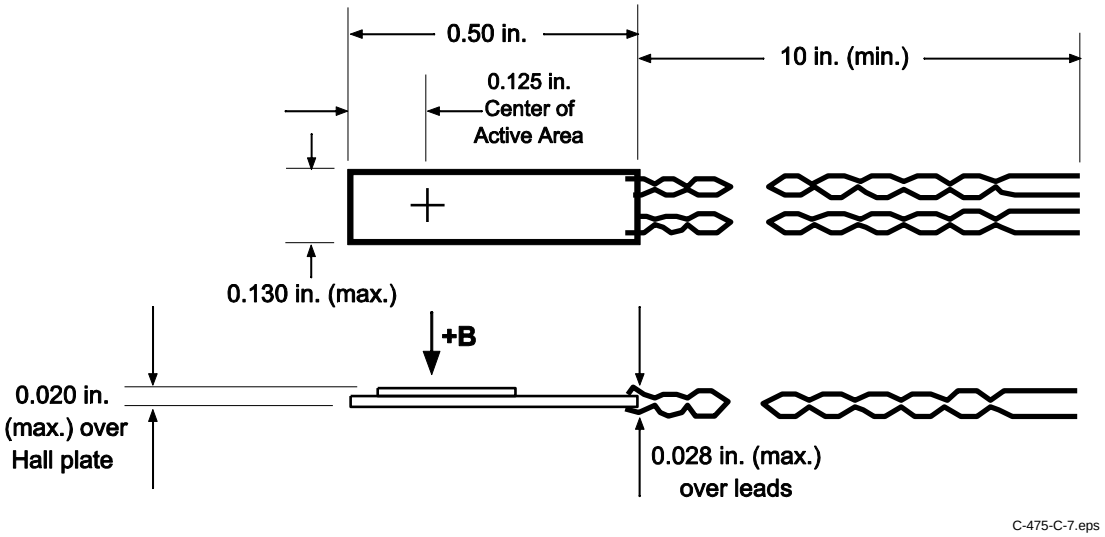


Figure 1-4. Transverse Hall Sensor HGT-1010 Dimensions

Table 1-3. Transverse Hall Sensor Specifications

Transverse	HGT-1010	HGT-3010	HGT-3030
Description	General purpose transverse; 0.020 in thick; HSE-type	Instrumentation quality transverse; HST-type; low temperature coefficient; ceramic package	Instrumentation quality transverse; HSE-type; ceramic package
Active area (approximate)	0.040 in diameter circle	0.040 in diameter circle	0.040 in diameter circle
Input resistance (approx)	2 Ω	1 Ω	2 Ω
Output resistance (approx)	2 Ω	1 Ω	2 Ω
Nominal control current (I_{CN})	100 mA	100 mA	100 mA
Maximum continuous current (non-heat sinked)	250 mA	300 mA	300 mA
Magnetic sensitivity (I_C = nominal control current)	7.5 to 12.5 mV/kG	0.55 to 1.05 mV/kG	6.0 to 10.0 mV/kG
Maximum linearity error (sensitivity versus field)	±1.0% rdg (-10 to 10 kG)	±1% rdg (-30 to 30 kG) ±1.5% rdg (-100 to 100 kG)	±0.30% rdg (-10 to 10 kG) ±1.25% rdg (-30 to 30 kG)
Zero field offset voltage (I_C = nominal control current)	±100 µV max	±50 µV max	±75 µV max
Operating temperature range	–40 to +100 °C	–40 to +100 °C	–40 to +100 °C
Mean temperature coefficient of magnetic sensitivity	–0.08%/°C max	-0.005%/°C max	–0.04%/°C max
Mean temperature coefficient of offset (I_C = nominal control current)	±1 µV/°C max)	±0.4 µV/°C max	±0.3 µV/°C
Mean temperature coefficient of resistance	+0.18%/°C approx	+0.15%/°C approx	+0.18%/°C approx
Leads	34 AWG copper with poly-nylon insulation.	34 AWG copper with poly-nylon insulation	34 AWG copper with poly-nylon insulation

NOTE: A load resistor may be specified with the Hall sensor data.
It is very important that this load resistor be applied across the $+V_H$, $–V_H$ Hall sensor leads, rather than at the HMCBL connector, to duplicate the sensitivity and linearity data.

2.0 Setup of Models 475, 455, and 425 For Direct Hall Sensor Operation

The gaussmeter Models 475, 455, and 425 will operate with a discrete Hall sensor. Users can program nominal sensitivity and serial number into an EEPROM (located in an HMCBL-XX, ordered separately) to provide all gaussmeter functions except field and temperature compensation. Note that, unlike a fully calibrated probe, the accuracy is affected by the Hall sensor linearity. If the HMCBL cable is not loaded with sensitivity information (or a 0.0 sensitivity is mistakenly entered), the gaussmeter reverts to resistance measurement, otherwise the instrument will use the previously loaded sensitivity.

2.1 User Programmable Cable

If the gaussmeter detects the presence of an HMCBL cable with no sensitivity information (a new, blank cable), the instrument will display a message indicating "Invalid Probe." Press the **Enter** button to clear the message. The instrument will jump directly to the probe setup screens beginning with the probe serial number entry screen. If the instrument is already displaying a reading, the probe information may be changed.

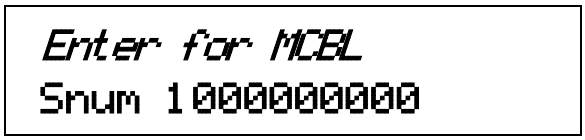
To configure the HMCBL cable, *press and hold* the **Probe** key for approximately 4 s. The following screen appears as a prompt for selecting the programming method.

Use the ▲ or ▼ key to select the MCBL Program (user programmable cables). Press **Enter** to accept the new selection and continue to the next setting screen. Press **Escape** to cancel the selection and return to the normal display.

If an invalid HMCBL cable is attached (for instance, a fully calibrated Lake Shore probe), and the MCBL program is attempted, the following message will appear for approximately 5 s.

If this occurs, verify that the cable is properly connected. If the “invalid” message continues, either replace the cable with a proper HMCBL cable or contact Lake Shore Service.

If a valid HMCBL cable is attached, the next MCBL Program screen appears as a prompt for serial number entry.



Use the number entry keys to enter the numeric serial number, up to 10 digits. Press **Enter** to accept the new value and continue to the next setting screen. If desired, press **Escape** to restart the setting sequence and enter a new value. Press **Escape** again to cancel the sequence and return to the normal display.

The next MCBL program screen appears as a prompt for entering the Hall sensor control current (Note that the current selected can alter the sensitivity. See the paragraph below). Most Lake Shore Hall sensors are specified at 100 mA. A current other than 100 mA can be used.

Use the ▲ or ▼ key to select the Hall control current to be used. Press **Enter** to accept the new selection and continue to the next setting screen.

The next MCBL program screen appears as a prompt for entering the nominal sensitivity in mV/kG. This sensitivity is based on the control current to be used (1 mA, 10 mA, or 100 mA). Note that the sensitivity of Lake Shore Hall sensors is specified at 100 mA in most cases. (For instance, if a current of 10 mA is used for a Hall sensor with a sensitivity specified at 100 mA, the proper sensitivity to enter is approximately 0.1 that of the 100 mA value.)

Use the data entry keys to enter the nominal sensitivity value from one of the following ranges: between 0.550 and 1.100 mV/kG; between 5.500 and 11.000 mV/kG; and between 550 and 1100 mV/kG (when using a control current of 100 mA). Press **Enter** to accept the new value and return to the normal display. If desired, press **Escape** to restart the setting sequence and enter a new value. Press **Escape** again to cancel the sequence and return to the normal display.

The gaussmeter will adjust the available ranges based on the values entered for the current and sensitivity.

NOTE: Using a sensitivity outside the above 100 mA ranges (or their equivalent 10 mA, and 1 mA ranges) may cause reduced performance. Values near, but lower than the minimum of the ranges shown above will reduce resolution. Values near, but above the maximum of the ranges shown above may cause an instrument overload “OL” condition before full scale range is reached. Hence, using Hall sensors with sensitivities outside the above-indicated ranges is discouraged.

All of the above entries will be stored in the HMCBL cable PROM (located in the connector). Thus, any time the cable/Hall sensor combination is used, the Lake Shore gaussmeter will recognize the stored parameters, and operation may proceed. The HMCBL cables may be reprogrammed for other Hall sensors as needed.

A Hall sensor can be connected directly to a Model 475, 455, or 425 without using an HMCBL cable. Probe parameters can be configured as stated above, but the settings will be lost if power is cycled or a RESET command is sent by interface.