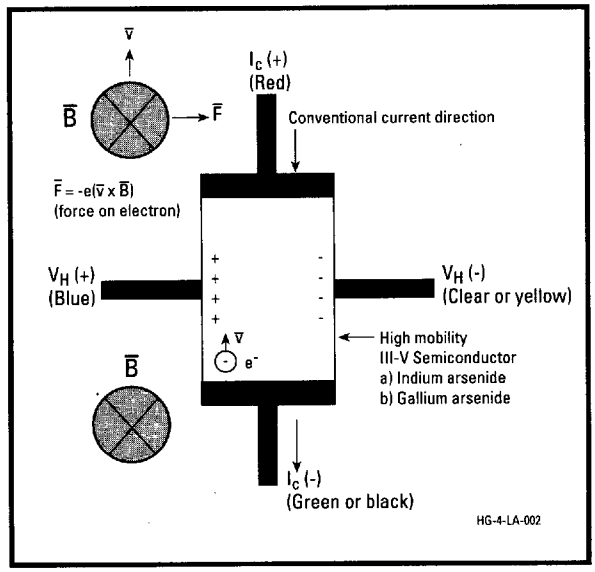
Magnetic Field Sensors
(Hall Generators)

Hall Generator Theory

A Hall generator is a solid state sensor which provides an output voltage proportional to magnetic flux density. As implied by its name, this device relies on the Hall effect. The Hall effect is the development of a voltage across a sheet of conductor when current is flowing and the conductor is placed in a magnetic field.

Electrons (the majority carrier most often used in practice) "drift" in the conductor when under the influence of an external produced electric field. These moving electrons experience a force proportional and perpendicular to the product of their velocity and the magnetic field vector. This force causes the charging of the edges of the conductor, one side positive with respect to the other, resulting in an internally generated transverse electric field which exerts a force on the moving electrons equal and opposite to that caused by the magnetic-field-related Lorentz force. The resultant voltage potential across the width of the conductor is called the Hall voltage and can be measured by attaching two electrical contacts to the sides of the conductor.



The Hall voltage can be given by the expression:

$$V_H = \gamma_B B \sin\theta$$

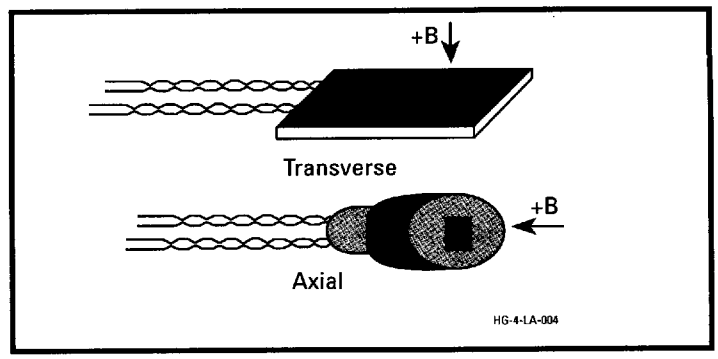
where V_H = Hall voltage (mV)

γ_B = Magnetic sensitivity (mV/kG) (at a fixed current)

B = Magnetic field flux density (kilogauss)

θ = Angle between magnetic flux vector and the plane of Hall generator.

As can be seen from the formula, above, the Hall voltage varies with the angle of the sensed magnetic field, reaching a maximum when the field is perpendicular to the plane of the Hall generator.



Hall generators come in two main configurations, axial and transverse.

Transverse devices are generally thin and rectangular in shape. They are applied successfully in magnetic circuit gaps, surface measurements and general open field measurements.

Axial sensors are mostly cylindrical in shape. Their applications include ring magnet center bore measurements, solenoids, surface field detection and general field sensing. See the individual Hall generator illustrations for physical dimensions.

Active Area

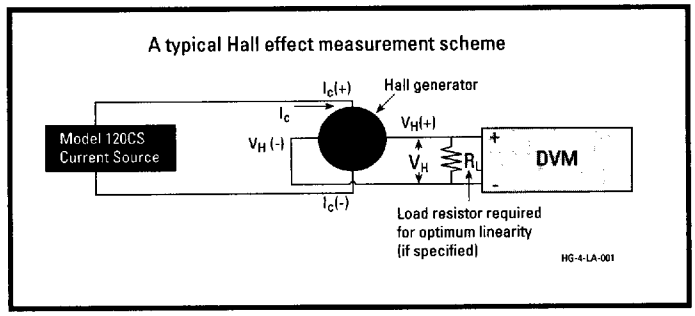
The Hall generator assembly contains the sheet of semiconductor material to which the four contacts are made. This entity is normally called a "Hall plate." The Hall plate is, in its simplest form, a rectangular shape of fixed length, width and thickness. Due to the shorting effect of the current supply contacts, most of the sensitivity to magnetic fields is contained in an area approximated by a circle, centered in the Hall plate, whose diameter is equal to the plate width. Thus, when the active area is given, the circle as described above is the common estimation.

Using a Hall Generator

A Hall generator is a four lead device. The control current (I_c) leads are normally attached to a current source such as the Lake Shore Model 120CS. The Model 120CS provides several fixed current values compatible with various Hall generators.

Caution: Do not exceed the maximum continuous control current given in the specifications.

The Hall voltage leads may be connected directly to a readout instrument, such as a high impedance voltmeter, or can be attached to electronic circuitry for amplification or conditioning. Device signal levels will be in the range of microvolts to hundreds of millivolts.



The Hall generator input is not isolated from its output. In fact, impedance levels on the order of the input resistance are all that generally exist between the two ports. To prevent erroneous current paths, which can cause large error voltages, the current supply must be isolated from the output display or the down stream electronics.

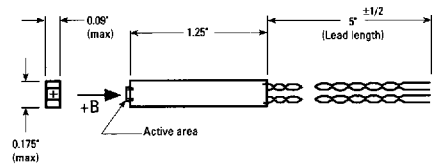
Specifications

Axial	HGA-2010	HGA-3010	HGA-3030
Description	General purpose axial; high sensitivity.	Instrumentation quality axial; low temperature coefficient; phenolic package.	Instrumentation quality axial; phenolic package.
Active area	0.005" x 0.005 " square.	0.030" dia. circle	0.030" dia. circle
Input resistance	450 to 900 ohms	1 ohm (approx)	2 ohms (approx)
Output resistance	550 to 1350 ohms	1 ohm (approx)	2 ohms (approx)
Nominal control current (I_{CN})	1 mA	100 mA	100 mA
Maximum continuous current (non- heat sinked)	10 mA	300 mA	300 mA
Magnetic sensitivity (I_C = nominal control current)	11 to 28 mV/kG	0.55 to 1.10 mV/kG	6.0 to 10.0 mV/kG
Maximum linearity error (sensitivity versus field)	±1% RDG (-10 to +10 kG) ±2% RDG (-20 to +20 kG)	±1% RDG (-20 to +20 kG) ±1.5% RDG (-100 to +100 kG)	±0.25% RDG (-10 to +10 kG) ±1.00% RDG (-30 to +30 kG)
Zero field offset voltage (I_C = nominal control current)	±2.8 mV (max.)	±50 µV (max.)	±75 µV (max.)
Operating temperature range	-20 to 75 °C	-40 to +100 °C	-40 to +100 °C
Mean temperature coefficient of magnetic sensitivity	-0.06%/°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 (max.)
Mean temperature coefficient of resistance	+0.15%/°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.
Data provided with each Hall generator at room temperature	Single sensitivity value at I = ImA.	Field (B) vs error (gauss) up to 20 kG	Room temperature, 30 kG data supplied.

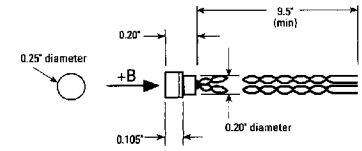
Transverse	HGT-1010	HGT-2010	HGT-2100	HGT-3010	HGT-3030
Description	General purpose transverse; 0.020" thick.	General purpose transverse; high sensitivity.	Low cost; high sensitivity; surface mount.	Instrumentation quality transverse; low temperature coefficient; ceramic package.	Instrumentation quality transverse ceramic package.
Active area	0.040" dia. circle	0.005" x 0.005" square	0.005" x 0.005" square	0.040" dia. circle	0.040" dia. circle
Input resistance	2 ohms	450 to 900 ohms	450 to 900 ohms	1 ohm (approx)	2 ohms (approx)
Output resistance	2 ohms	550 to 1350 ohms	550 to 1350 ohms	1 ohm (approx)	2 ohms (approx)
Nominal control current (I_{CN})	100 mA	1 mA	5 mA	100 mA	100 mA
Maximum continuous current (non- heat sinked)	300 mA	10 mA	10 mA	300 mA	300 mA
Magnetic sensitivity (I_C = nominal control current)	7.7 to 12.5 mV/kG	11 to 28 mV/kG	55 to 140 mV/kG	0.55 to 1.10 mV/kG	6.0 to 10.0 mV/kG
Maximum linearity error (sensitivity versus field)	±1.0% RDG (-10 to 10 kG)	±1% RDG (-10 to 10 kG) ±2% RDG (-20 to 20 kG)	±1% RDG (-10 to 10 kG) ±2% RDG (-20 to 20 kG)	±1% RDG (-20 to 20 kG) ±1.5% RDG (-100 to 100 kG)	±0.25% RDG (-10 to 10 kG) ±1.00% RDG (-30 to 30 kG)
Zero field offset voltage (I_C = nominal control current)	±100 µV (max.)	±2.8 mV (max.)	±14 mV (max.)	±50 µV (max.)	±75 µV (max.)
Operating temperature range	-40 to +100 °C	-20 to +75 °C	-55 to +125 °C	-40 to +100 °C	-40 to +100 °C
Mean temperature coefficient of magnetic sensitivity	-0.08%/°C (max.)	-0.06%/°C (max.)	-0.06%/°C (max.)	±0.005%/°C (max.)	-0.04%/°C (max.)
Mean temperature coefficient of offset (I_C = nominal control current)	±1 µV/°C (max.)	±1 µV/°C (max.)	±5 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)	+0.15%/°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.	Not applicable.	34 AWG copper with poly-nylon insulation.	34 AWG copper with poly-nylon insulation.
Data	Uncalibrated.	Uncalibrated.	Uncalibrated.	Room temperature, 20 kG data supplied.	Room temperature, 30 kG data supplied.

Cryogenic	HGCA-3020	HGCT-3020
Description	Cryogenic axial; phenolic package.	Cryogenic transverse; ceramic package.
Active area	0.030" dia. circle	0.040" dia. circle
Input resistance	1 ohm (approx)	1 ohm (approx)
Output resistance	1 ohm (approx)	1 ohm (approx)
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 1.10 mV/kG	0.55 to 1.10 mV/kG
Maximum linearity error (sensitivity versus 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	4.2 K to 375 K	4.2 K to 375 K
Mean temperature coefficient of magnetic sensitivity	±0.01%/K (approx)	±0.01%/K (approx)
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 with teflon insulation.	34 AWG copper with teflon insulation.
Data	Room temperature, 30 kG data supplied.	Room temperature, 30 kG data supplied.

HGA-2010

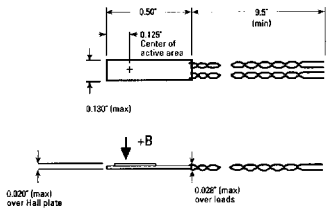


HGA-3010
HGA-3030
HGCA-3020

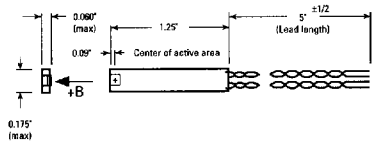


The active area is symmetrical with the center line of the assembly and is located approximately 0.030" behind the front surface of the assembly.

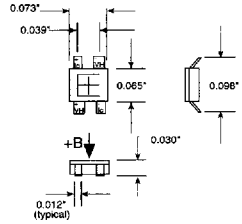
HGT-1010



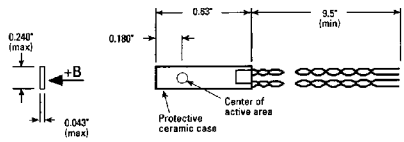
HGT-2010



HGT-2100



HGT-3010
HGT-3030
HGCT-3020



Lead Color Code: HGT-1010, HGA-2010, HGT-2010, HGA-3010, HGT-3010, HGA-3030, HGT-3030

Red	$+I_c$
Green	$-I_c$
Blue	$+V_H$
Clear	$-V_H$

Cryogenic Lead Color Code: HGCA-3020, HGCT-3020

Red	$+I_c$
Black	$-I_c$
Blue	$+V_H$
Yellow	$-V_H$

Ordering Information

Model	Description
HGT-1010	Transverse Hall generator.
HGA-2010	Axial Hall generator.
HGT-2010	Transverse Hall generator.
HGT-2100	Surface mount Hall generator.
HGT-2100-10	Surface mount Hall generator, qty 10.
HGT-2100-100	Surface mount Hall generator, qty 100.
HGT-2100-1000	Surface mount Hall generator, qty 1000.
HGA-3010	Axial Hall generator.
HGT-3010	Transverse Hall generator.
HGA-3030	Axial Hall generator.
HGT-3030	Transverse Hall generator.
HGCA-3020	Cryogenic axial Hall generator.
HGCT-3020	Cryogenic transverse Hall generator.