

Appendix C

Magnetic Curves

Introduction

HONEYWELL Sensing and Control is not a manufacturer of magnets, but does offer a number of magnets (with and without mounting provisions) for use with Hall effect sensors. Few, if any, magnet suppliers are willing to specify flux (gauss levels) at some given distance from the magnet, however, HONEYWELL Sensing and Control does. Available flux is a critical factor in operating Hall effect sensors.

The most common magnet for operating Hall effect sensors is a bar magnet. For head-on actuation, there should be sufficient magnet travel to provide at least 10% overdrive of both Max. Operate and Min. Release characteristics of the sensor. For slide-by actuation, the magnet should pass the sensing surface at a distance that provides at least 10% overdrive above Max. Operate.

Ring magnets are another means of operating sensors. These magnets are magnetized on the outside diameter with alternating

north and south poles. Each pole pair (N and S) produces one pulse with standard devices. Ring magnets are particularly useful with bipolar sensors, which require both south and north poles be presented to the device face.

The graphs included in this section are plots of gauss versus distance for some typical magnets. The magnetic curves were developed using a 732SS21-1 calibrated Hall device which is no longer available and a X98834-SS calibrated Hall device. See Appendix D for details on how to use a calibrated Hall device.

Head-on mode magnetic characteristics

Figures C-1 through C-11 illustrate graphs of the magnetic flux (gauss) at the sensor, versus distance (inches) for various magnetic material in the head-on mode of actuation. The magnet's axis is oriented perpendicular to the surface of the sensor and centered over the point of maximum sensitivity. The direction of movement is directly toward and away from the sensor with the magnetic lines of flux passing through the center of the device. The magnet is oriented so the S pole of the magnet will approach the sensitive face of the sensor. The graphs show that the magnetic field strength increases exponentially as the magnet approaches the sensor. All measurements are at 25°C.

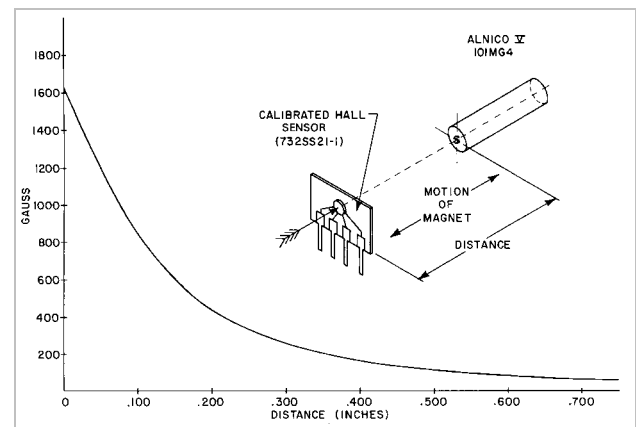


Figure C-1 Alnico V 1.25" x .25" dia. Calibrated magnet (420 gauss @ .205"). Can be used for either digital or linear applications

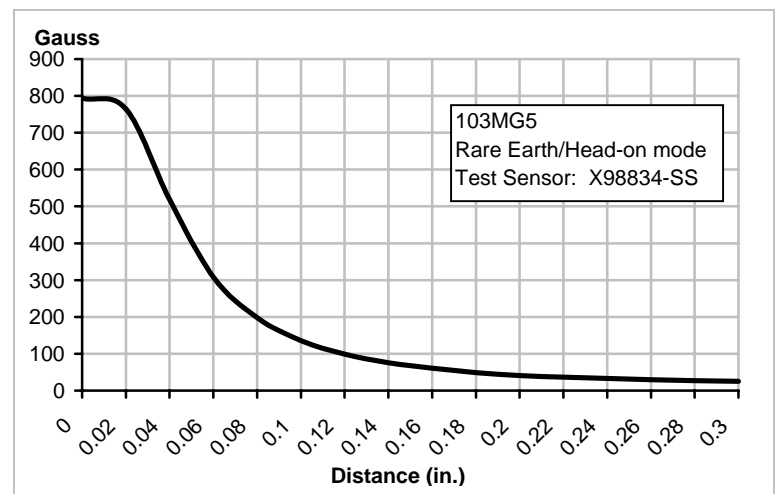


Figure C-2 Rare earth .078" sq. x .040" thick magnet. Can be used for either digital or linear applications; a bias magnet is recommended.

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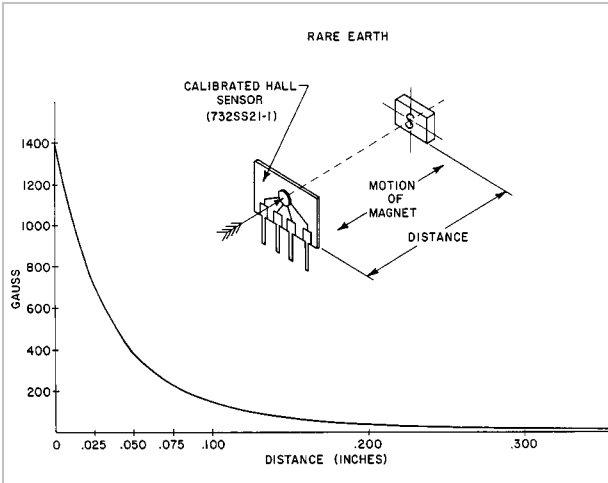


Figure C-3 Rare earth .125" x .078" x .040" thick magnet

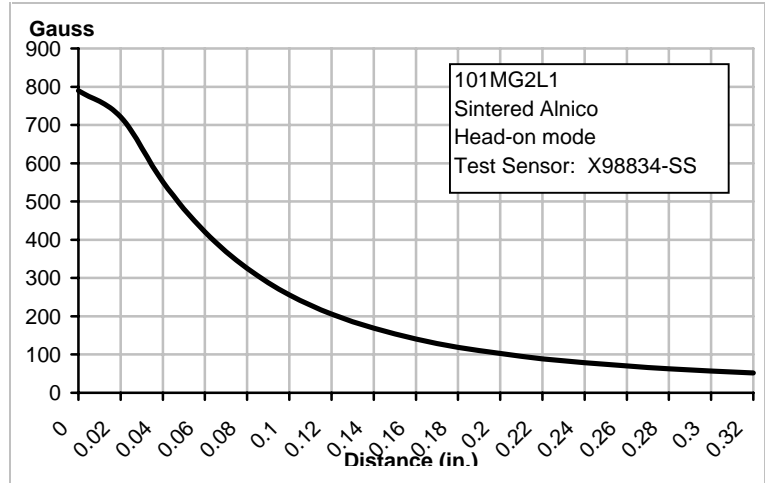


Figure C-4 Sintered Alnico 37 .375" x .125" magnet. Can be used for either digital or linear applications

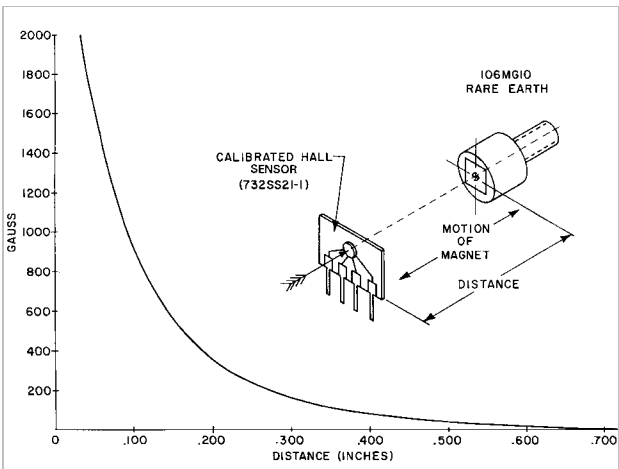


Figure C-5 Rare earth .22" sq. x .20" long magnet in threaded actuator. Can be used for either digital or linear applications

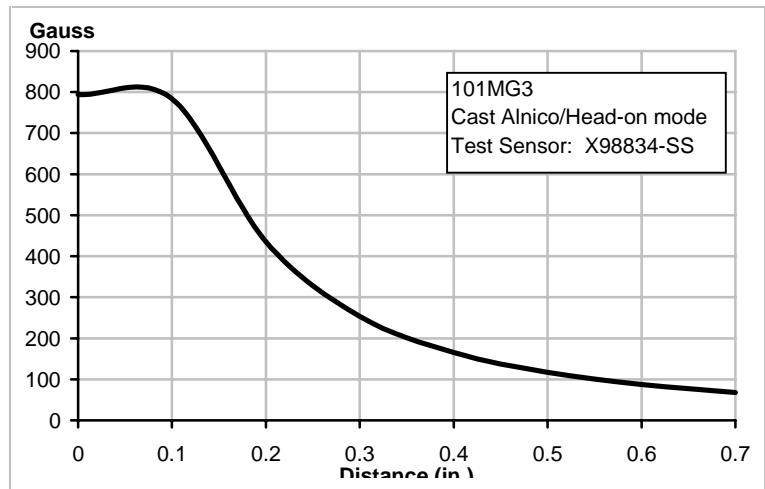


Figure C-7 Cast Alnico 1.25" x .25" dia. magnet

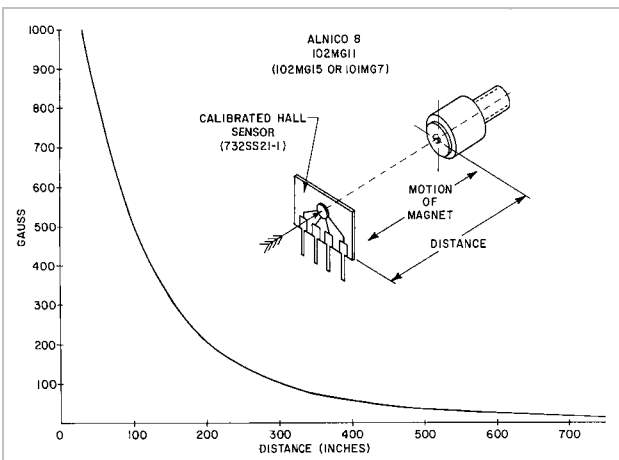


Figure C-6 Alnico VIII H.E. .25" x .25" dia. magnet in threaded actuator. Recommended for linear applications

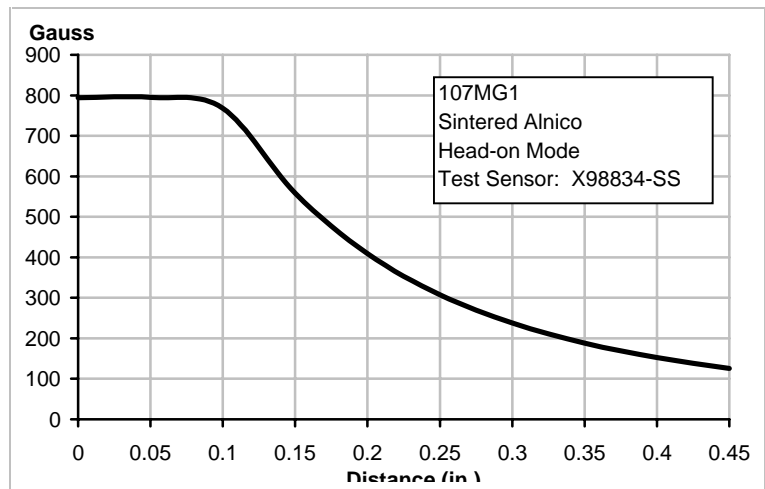


Figure C-8 Sintered Alnico .600" x .325" dia.

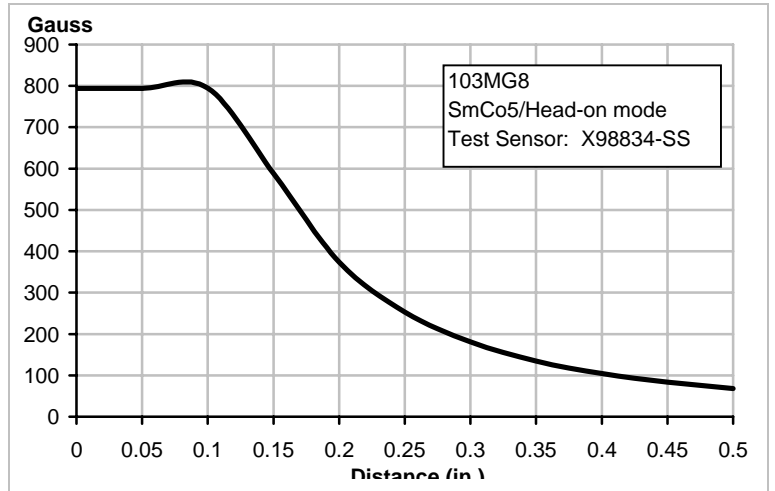


Figure C-9 SmCo5 .22" sq. x .2 in. thick

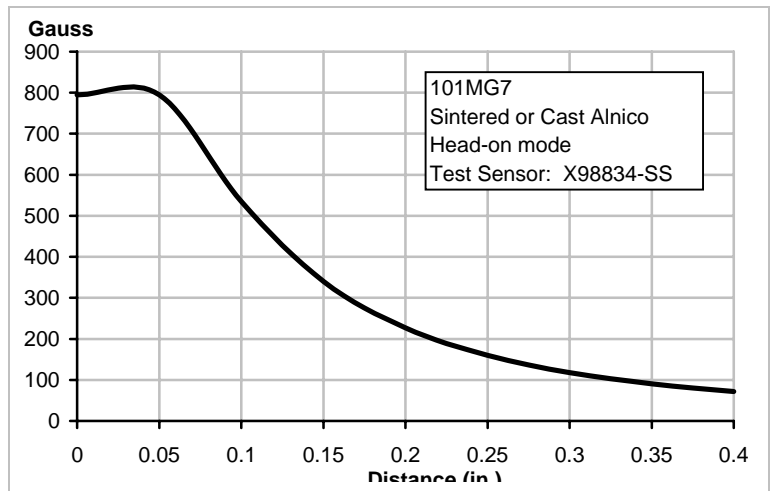


Figure C-10 Sintered or Cast Alnico .250" x .250" dia.

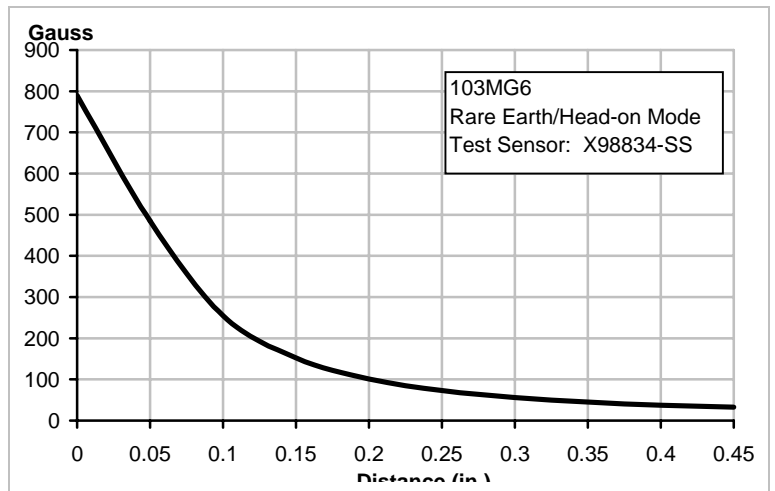


Figure C-11 Sintered Rare earth .08" sq. x .120" thick

Slide-by mode magnetic characteristics

Figures C-12 through C-26 illustrate graphs of the magnetic flux (gauss) at the sensor, versus distance (inches) for various magnetic materials in the slide-by mode of actuation. The magnet's axis is oriented perpendicular to the surface of the sensor and is moved across at some constant gap distance. In addition to the obvious advantage of never placing the sensor in any danger of being physically struck, slide-by will typically result in a lower differential (distance from operate to release) than occurs in head-on mode for the same magnet. All measurements are at 25°C.

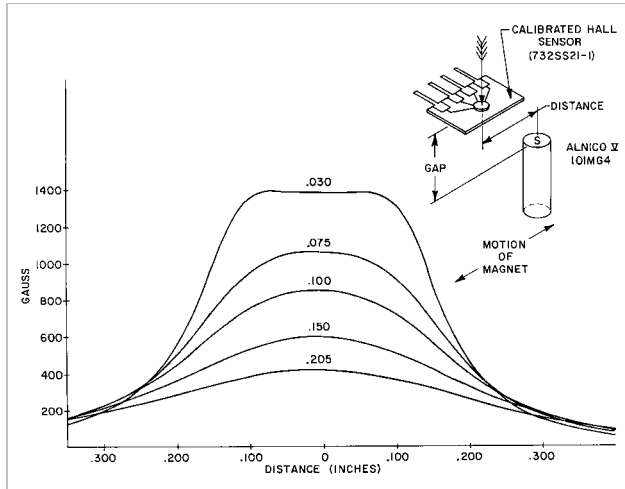


Figure C-12 Alnico V 1.25" x .25" dia. calibrated magnet (420 gauss @ .205")

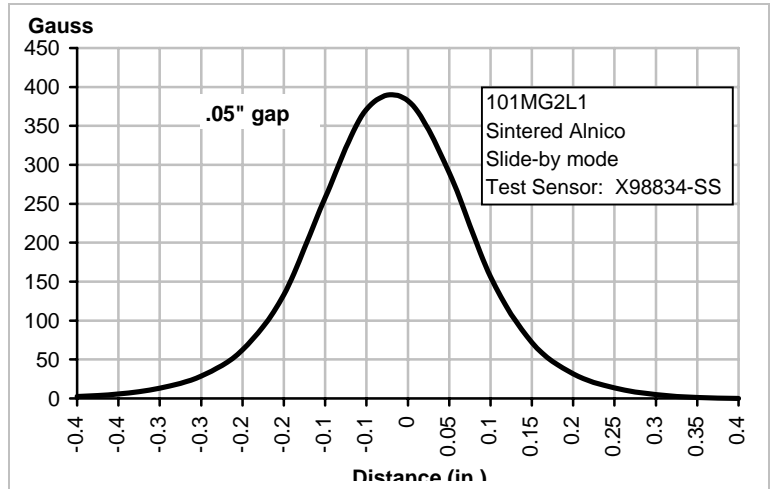


Figure C-13 Sintered Alnico 37 .375" x .125" magnet

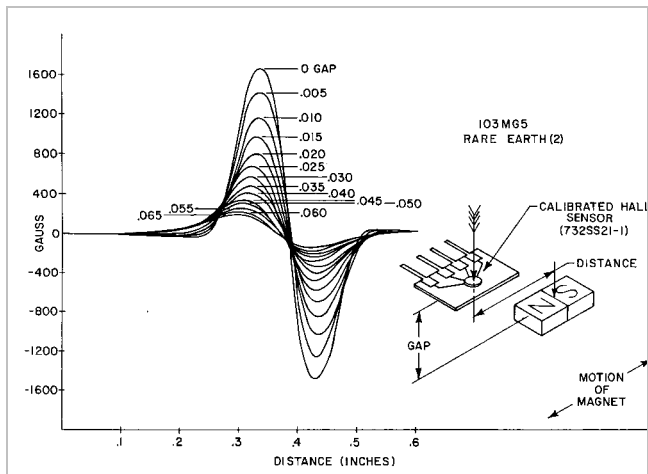


Figure C-14 (2-side by side) Rare earth .078" sq. x .040" thick magnet

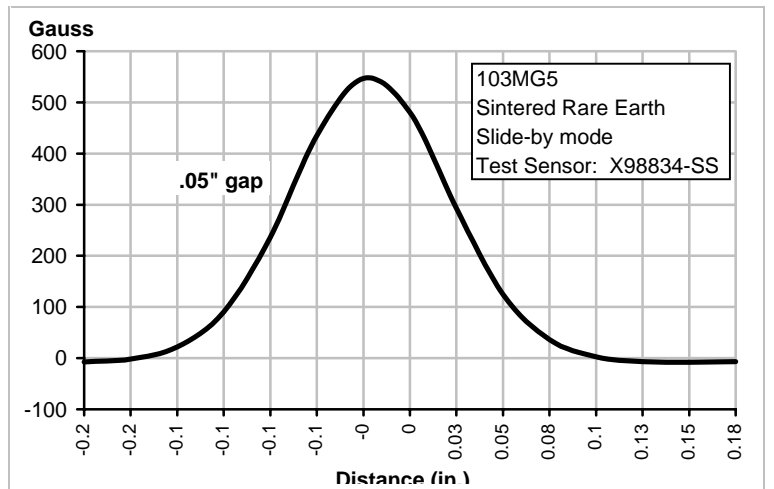


Figure C-15 Rare earth .078" sq. x .040" thick magnet

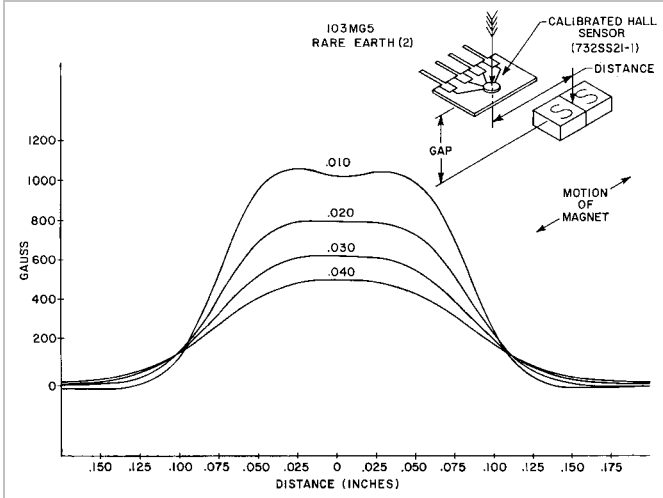


Figure C-16 (2) Rare earth .078" sq. x .040" thick magnet

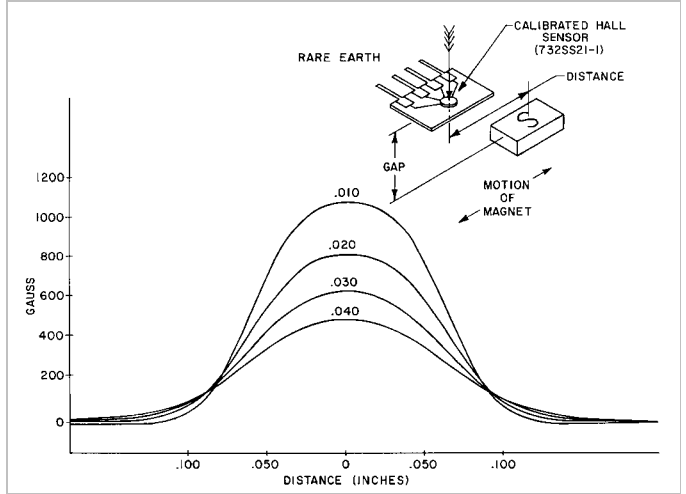


Figure C-17 Rare earth .125" x .078" x .040" thick magnet

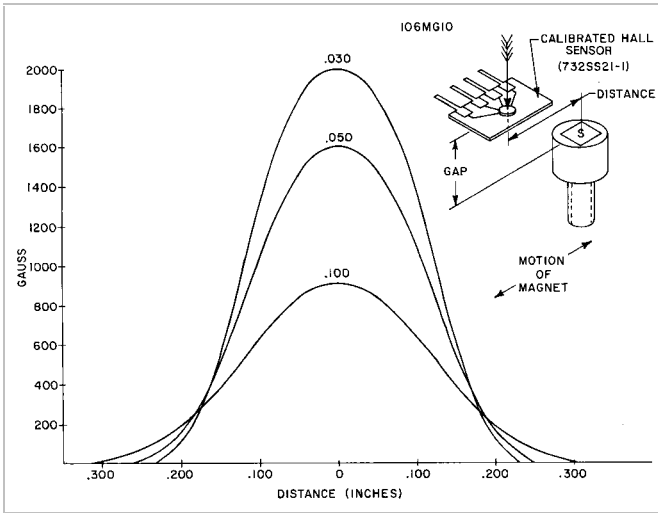


Figure C-18 Rare earth .22" sq. x .20" long magnet in threaded actuator

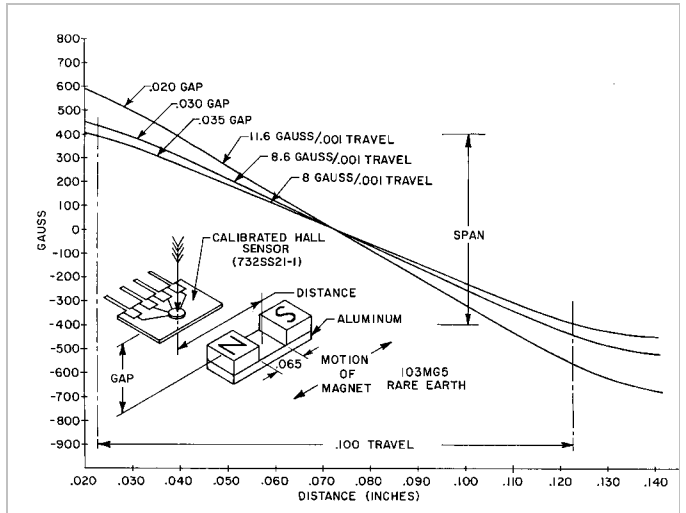


Figure C-21 (2) Rare earth .078" x .040" thick magnet. Recommended for linear applications.

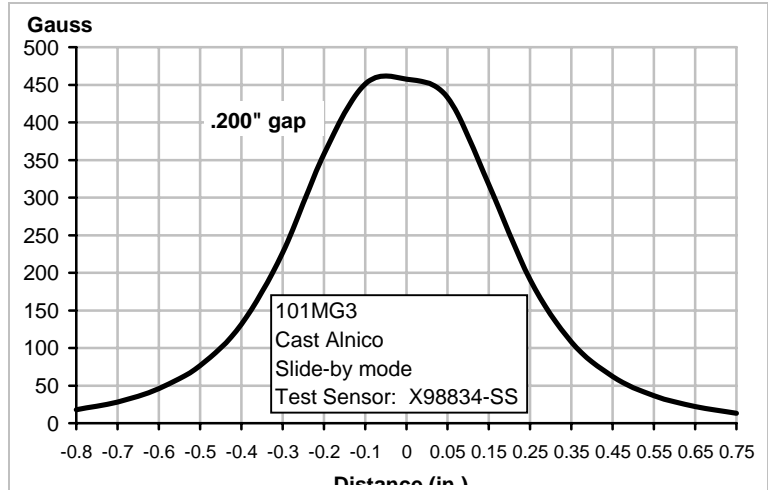


Figure C-22 Cast Alnico 1.25" x .25" dia.

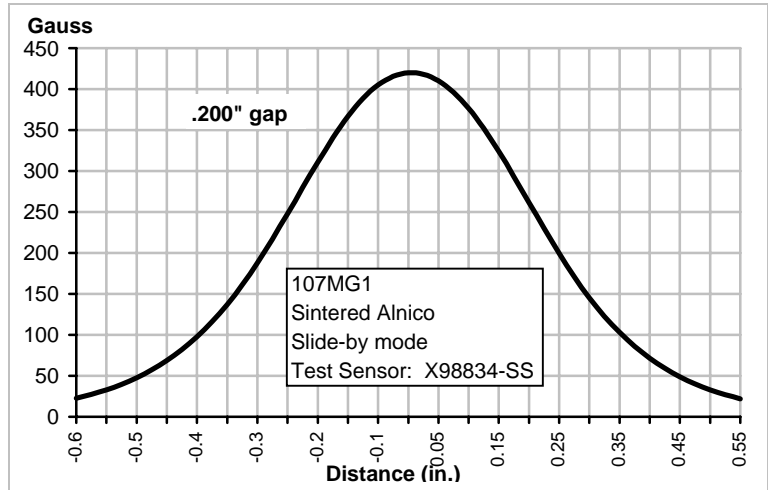


Figure C-23 Sintered Alnico .600" x .325" dia.

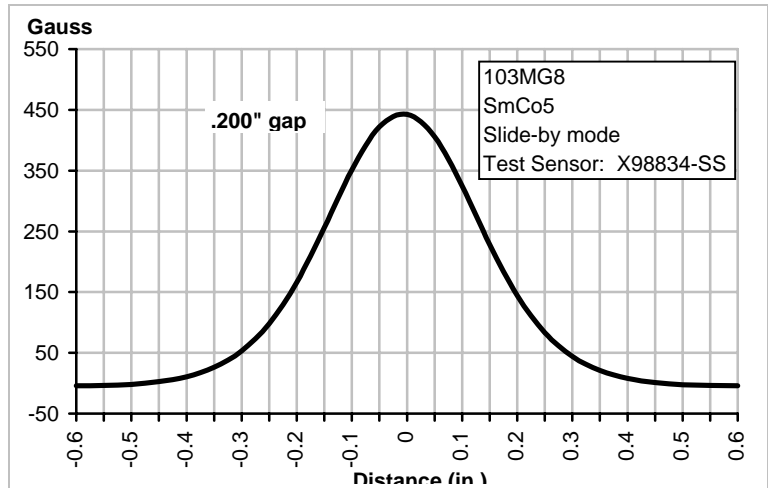


Figure C-24 SmCo5 .22"sq. x .20" thick

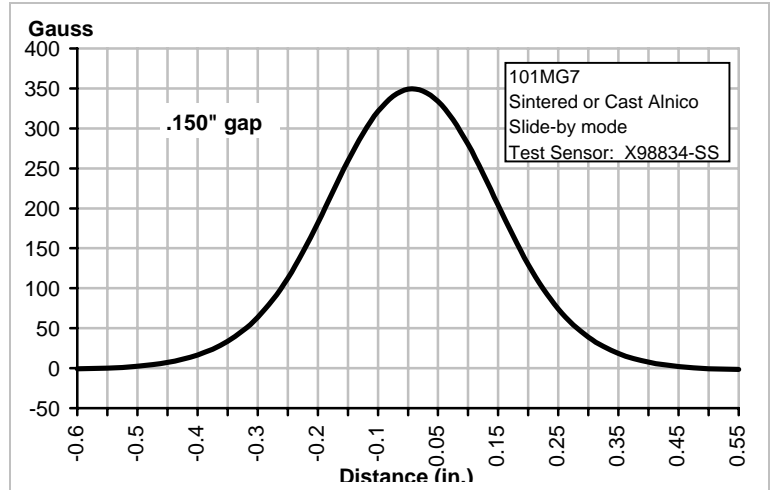


Figure C-25 Sintered or Cast Alnico .250" x .250" dia.

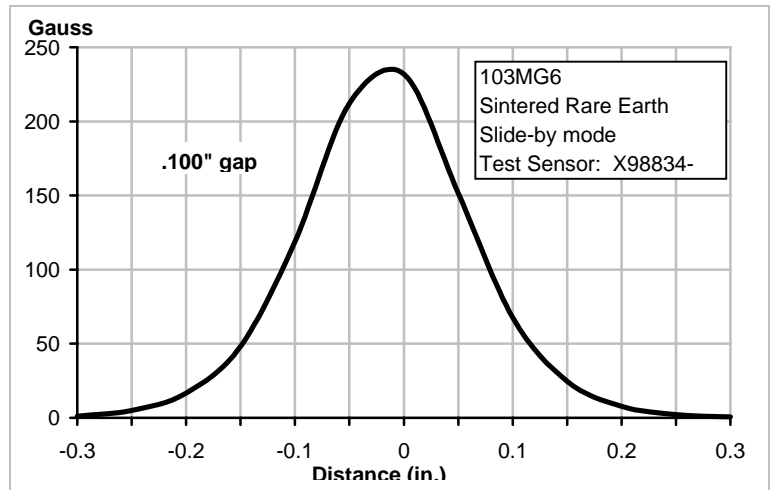


Figure C-26 Sintered Rare earth .080" sq. x .120" thick

Rotary mode magnetic characteristics

Figures C-27 through C-30 illustrate graphs of the magnetic flux (gauss) at the sensor, versus degrees of rotation for various ring magnets. The curves were developed at various gap distances from the surface of the calibrated Hall device. The magnets were centered over the point of maximum sensitivity. The gauss levels illustrated are worst case. Higher levels may be achieved with calibrated devices that utilize flux concentrators. Note how the gauss levels for the various magnets decrease with the number of pole pairs. That is, as the mass of the magnetic material per pole decreases, the peak flux decreases. All measurements are at 25°C.

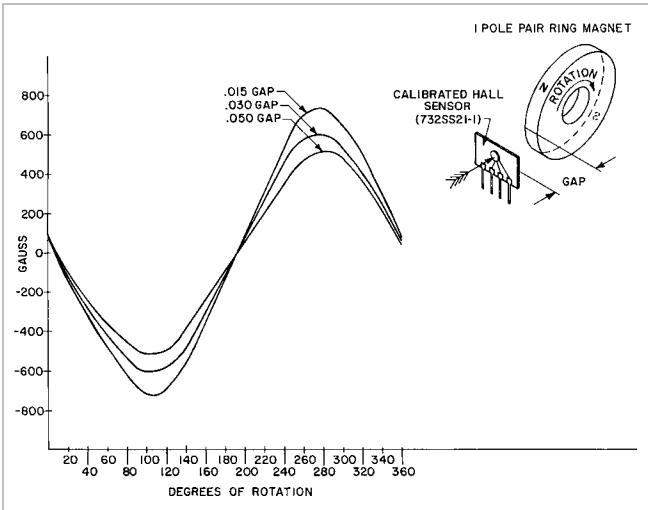


Figure C-27 Ceramic .75" dia. (3/8" mounting hole) ring magnet. Recommended for linear applications

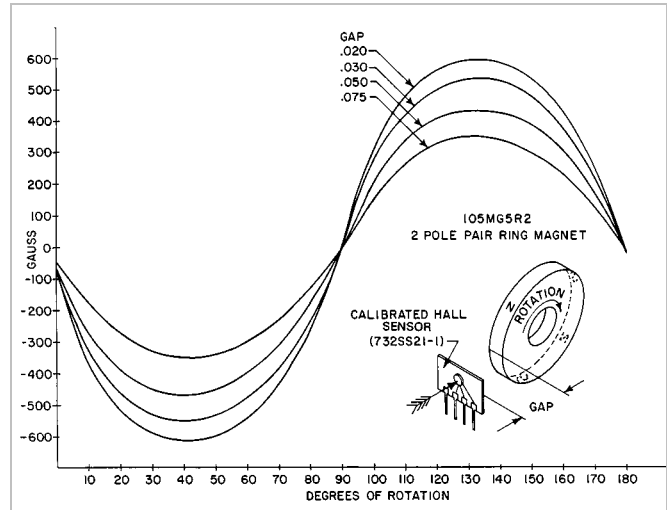


Figure C-28 Incox .625" dia. x .20" thick ring magnet

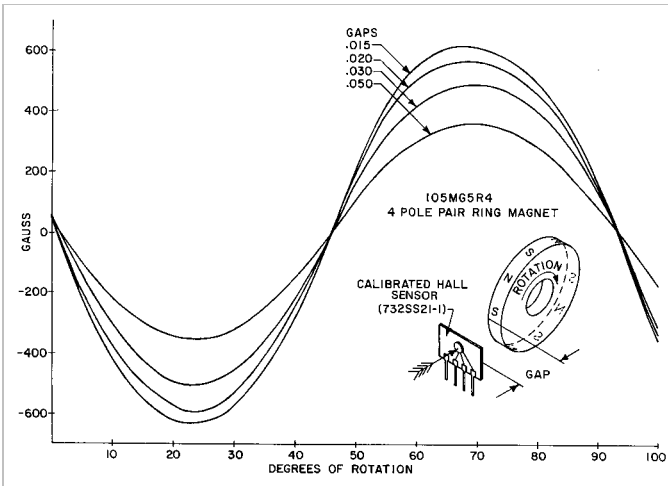


Figure C-29 Incox .625" dia. x .20" thick ring magnet

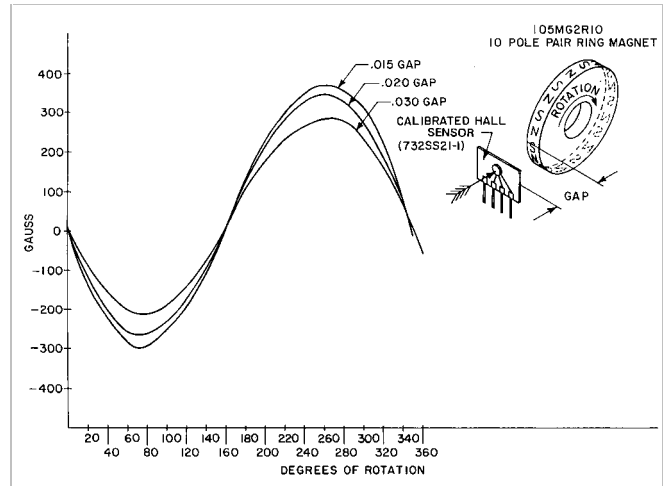


Figure C-30 Lodex 42 1.75" dia. x .14" thick ring magnet

Toroid core magnetic characteristics

Figures C-31 through C-34 illustrate graphs of magnetic flux (gauss) at the sensor, versus ampere-turns for various toroid cores. When choosing toroid cores, choose ferrite (magnetic ceramic) over tape (wound electrical steel) if fast response or high frequency is required or where minimum offset and hysteresis is needed. Use tape for currents over 200 amperes.

The diameter of the core will effect the location of the knee. If it is larger, the knee will be higher. If it is smaller, the knee will be lower. The cross-sectional area is not important as long as it is large enough to cover the sensor. Also, the position of the wire in the toroid is not critical with small gaps. Making the gap larger reduces the gauss per ampere, but tends to make it less linear, thus the position of wire becomes more critical. One wire through the core with 100 amperes produces the same effect as 100 turns with 1 ampere.

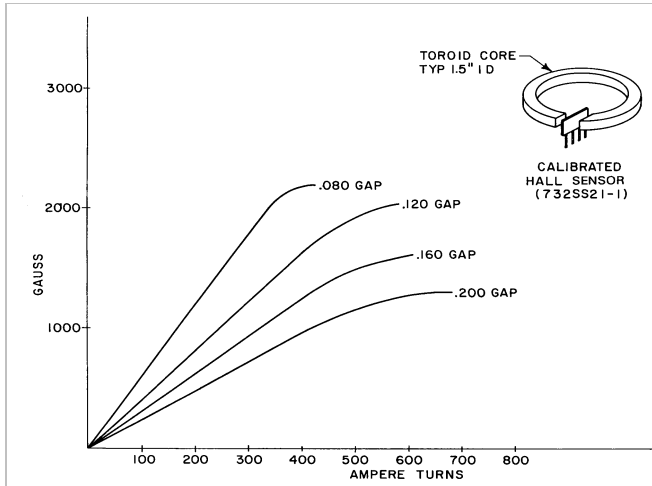


Figure C-31 Effect of gap on typical tape toroid core

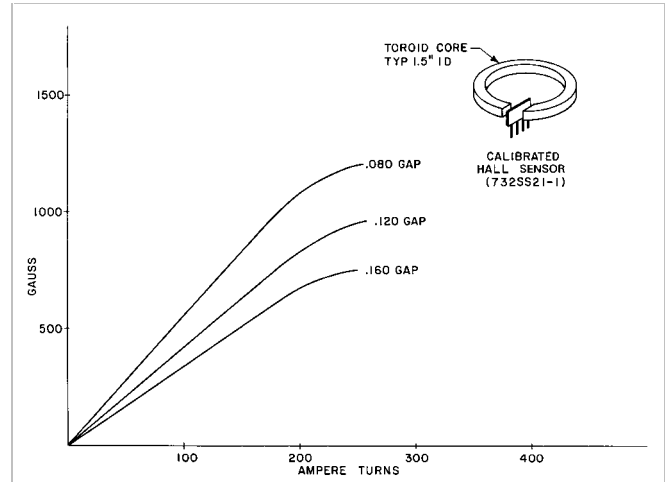


Figure C-32 Effect of gap on typical ferrite toroid core

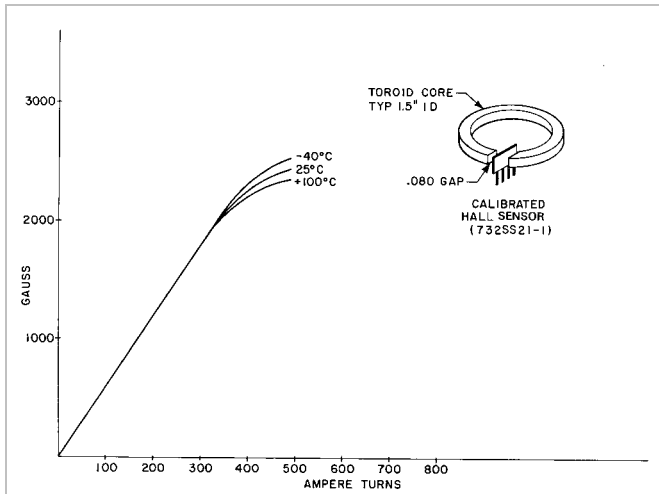


Figure C-33 Effect of temperature on typical tape toroid core with .080" gap

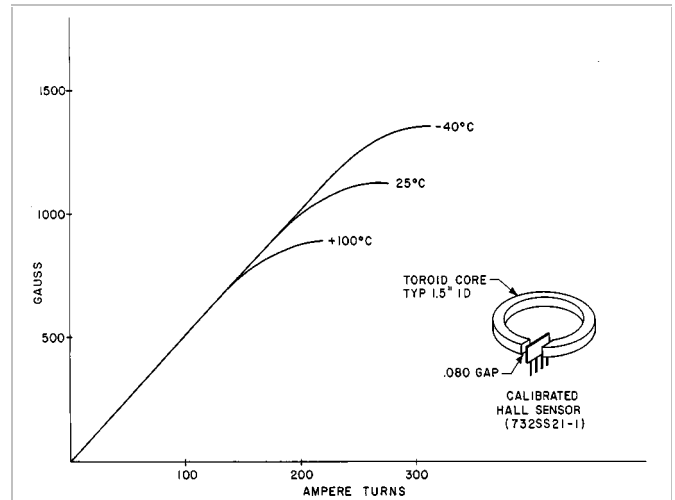


Figure C-34 Effect of temperature on typical ferrite toroid core with .080" gap

Purchasing magnets

When specifying a magnet based on reading a particular level of gauss (as determined by the Hall sensor), it is important that the magnet vendor specify his magnet the same way. Specify exactly what the magnet should do using the Hall device. Most magnet suppliers will work with buyers to supply the magnets desired. Incoming inspection should have the capability to verify that a particular magnet does meet the specified requirements.