Magnetiske og induktive sensorer

Måle med:

- Spole
  - Luftkjerne
  - Ferromagnetisk kjerne
- Hall sensor
- Magneto resistiv sensor
  - AMR
  - GMR
  - (CMR)
- Fluxgate sensor
- SQUID

Hva kan vi måle:

- AC felt
- DC felt
- Ferromagnetiske materialer
- Ledende materialer

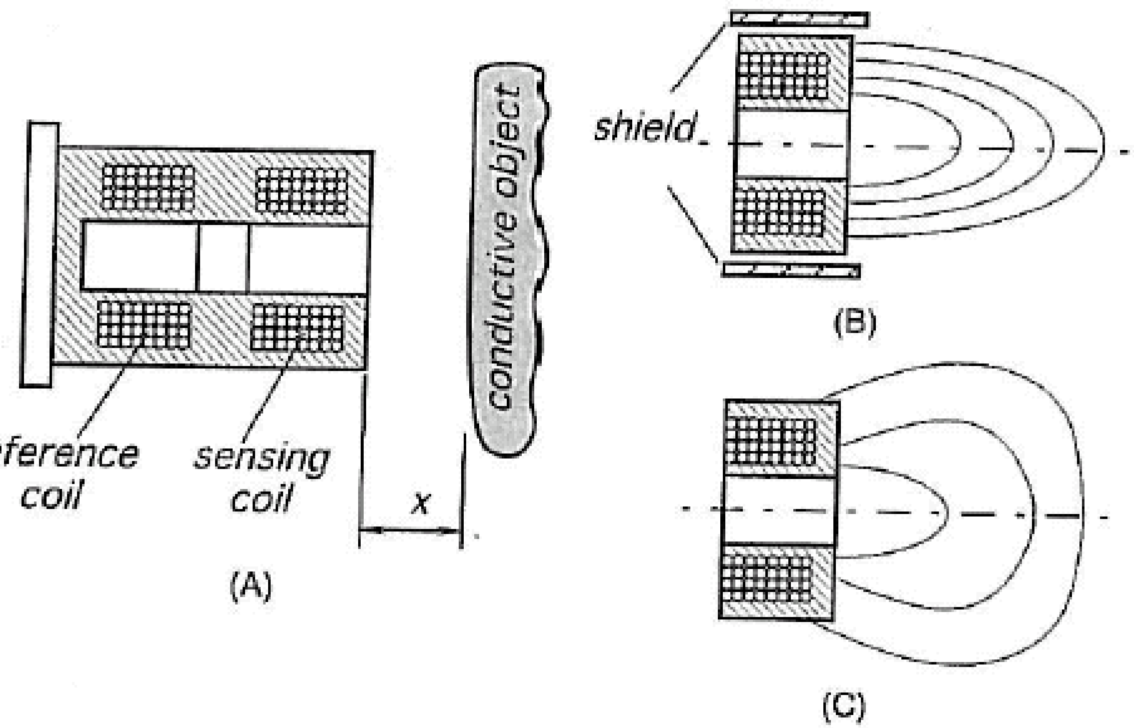
Ekstrautstyr:

- Magnet
- Eksitasjons spole

Kap 3, 7, og 10 Se figurtekst og avsnittsnummerering for referanser

Eddy current sensor – ledende materiale

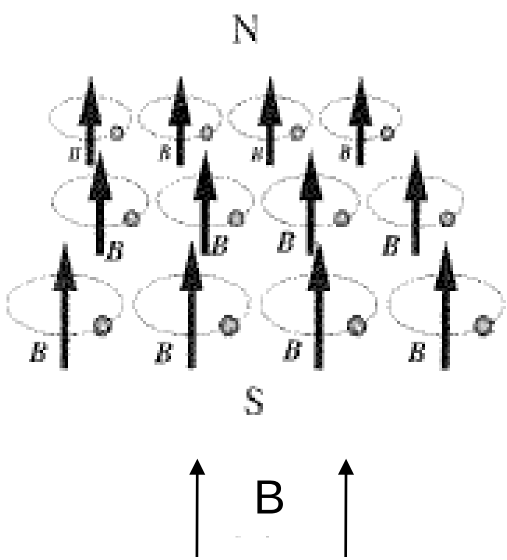
7.4 Inductive and Magnetic Sensors 265



7.11. (A) Electromagnetic proximity sensor; (B) sensor with the shielded front end; (C) ıielded sensor.

Konsekvens av feltforsterkning av dipoler

Magnetiske dipoler forsterker og "leder" fluksen i ferromagnetiske materialer.
Reluktans er an analogi til elektrisk motstand og sier noe om
hvor lett fluksen induseres og "forplanter" seg



$$\oint \vec{B} \cdot d\vec{l} = \mu_r \mu_0 i$$

Transverse inductive proximity sensor – ferromagnetisk materiale

$$n\Phi_B = Li,$$

$$v = -\frac{d(n\Phi_B)}{dt} = -L\frac{di}{dt}.$$

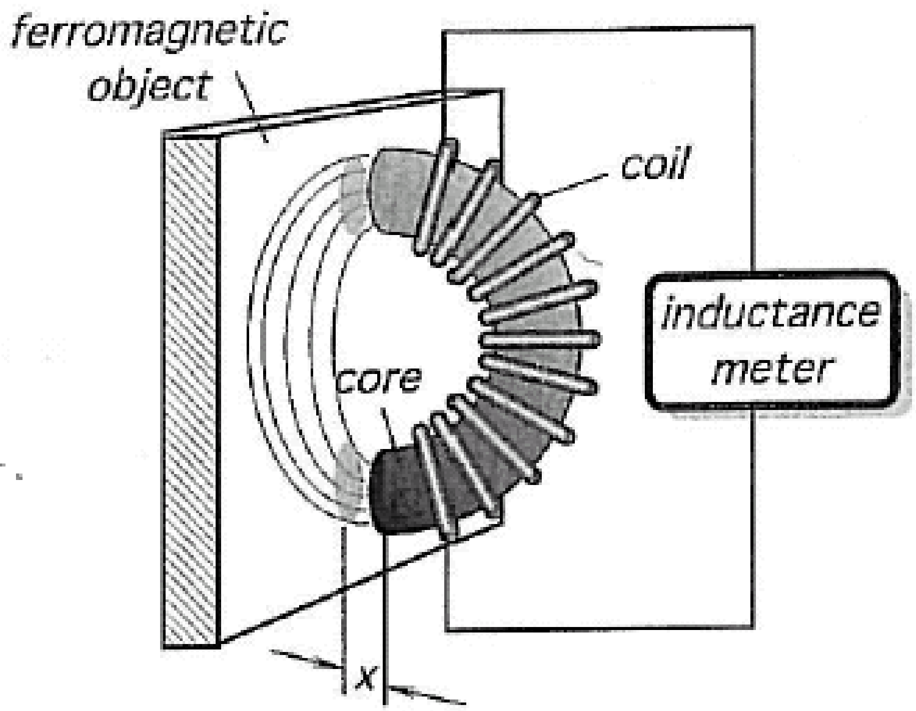
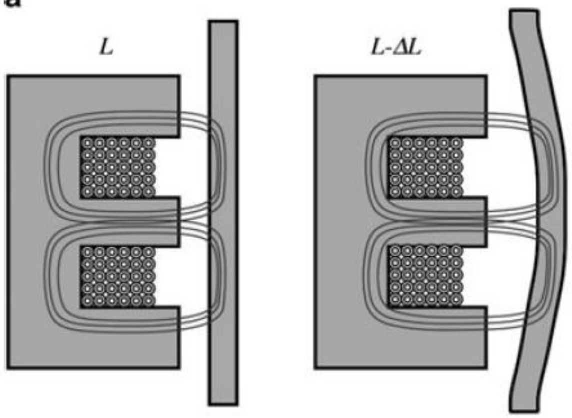


Fig. 7.12. A transverse inductive proximity sensor.

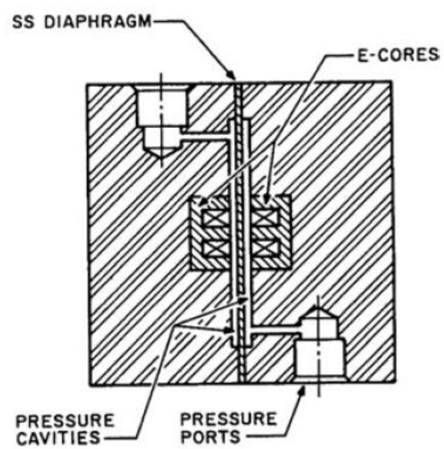
Variable reluctance pressure sensor (induktiv halvbro) – ferromagnetisk materiale

10.7 VRP Sensors

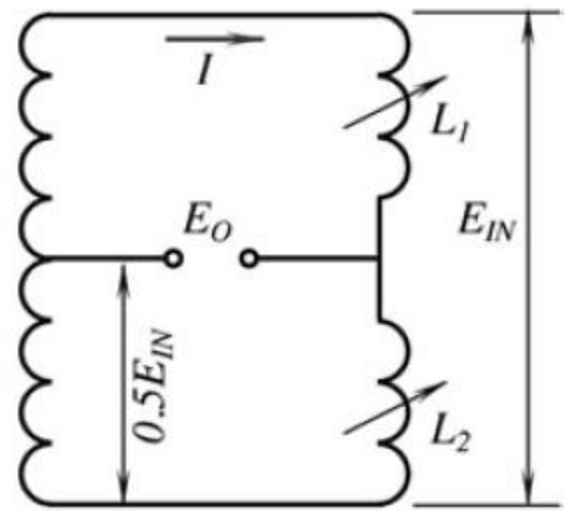
a



b



b



Hall effect (3.8)

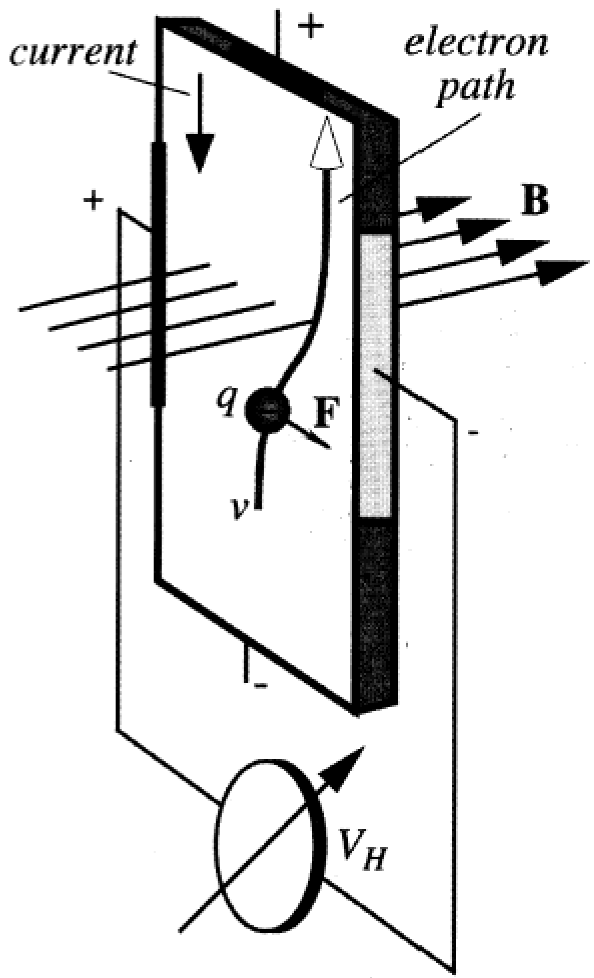
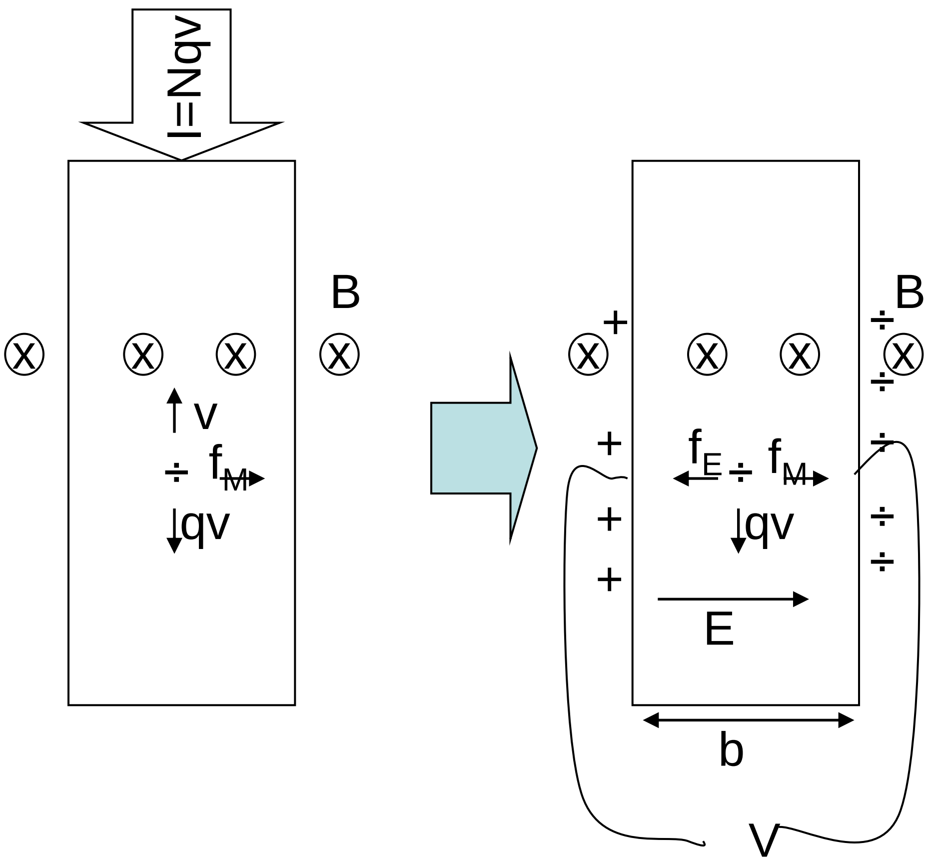


Fig. 3.30. Hall effect sensor. A magnetic field deflects movement of electric charges.

Gedanken experiment



$$f_M = f_E$$

$$qvB = qE$$

$$E = \frac{I}{Nq} B$$

Geometry

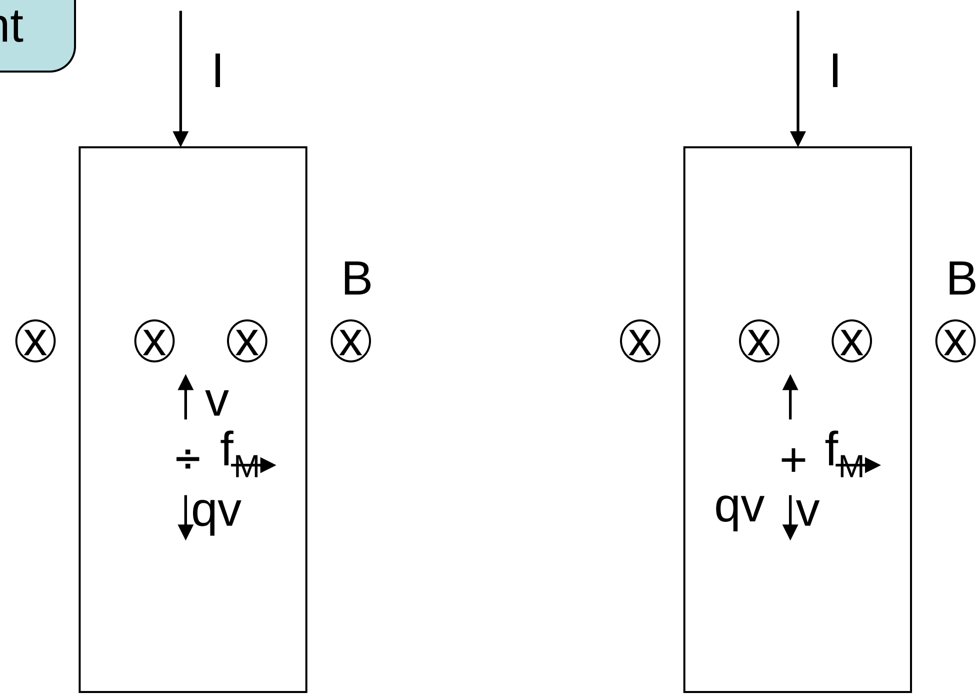
Hall coefficient

$$V = bE = b\frac{1}{Nq}BI$$

Material characterization

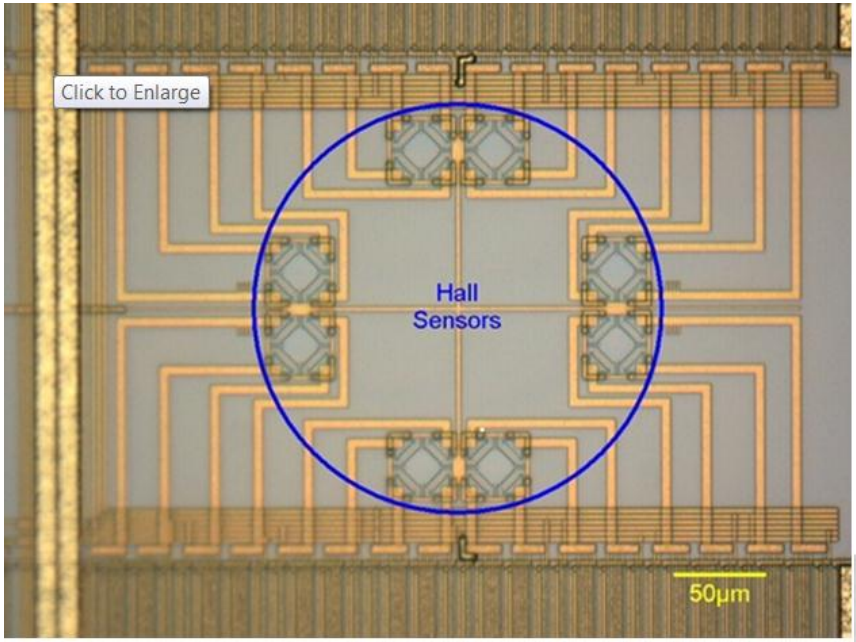
Hall coefficient

$$V = b\frac{1}{Nq}BI$$



Polarity of induced voltage can be used to determine the polarity of majority carriers

3 akse kompass iphone



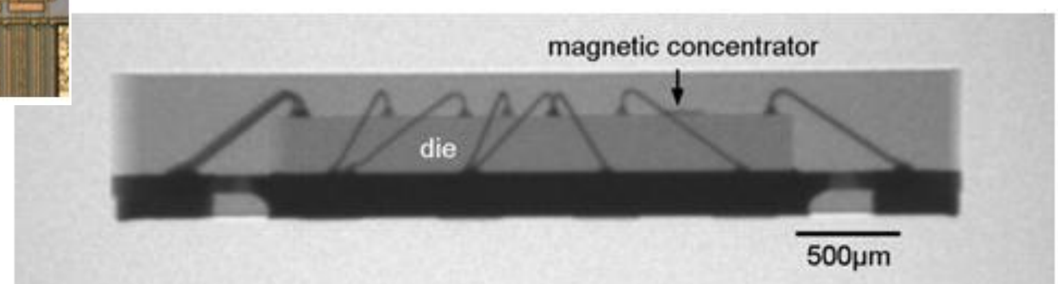


Figure 1: AK8973 package X-ray.

http://www.memsinvestorjournal.com/2011/02/motion-sensing-in-the-iphone-4-electronic-compass.html

Characteristics

Table 3.2. Typical Characteristics of a Linear Hall Effect Sensor.

Control current	3 mA
Control resistance, R_i	2.2 kΩ
Control resistance versus temperature	+0.8%/°C
Differential output resistance, R_0	4.4 k Ω
Output offset voltage	5.0 mV (at $B = 0$ G)
Sensitivity	60 μV/G
Sensitivity versus temperature	+0.1%/°C
Overall sensitivity	20 V/ΩkG
Maximum magnetic flux density, B	Unlimited

Source: Ref. [27].

Table 1.1 Magnetic field strengths (A m^{-1}) in a variety of situations, showing a range of 19 orders of magnitude

10^{14} ~10^8 Tesla	Surface of neutron stars
10^8 ← 100 Tesla	Implosive magnets (microsecond duration)
$2\text{–}5\times10^7$	Pulsed electromagnets (microsecond duration)
$1\text{–}3\times10^7$	High field electromagnets
$1\text{–}1.5\times10^7$	Superconducting magnets
$1\text{–}2\times10^6$	Laboratory electromagnet
1×10^6 ← Tesla	Strongest permanent magnets
10^2 (126 μT) typisk 50 μT	Earth's magnetic field on the surface
10	Stray fields from electrical machinery
1	Urban magnetic noise level
5×10^{-2}	Contours for geomagnetic anomaly maps
10^{-4}	Magnetocardiograms
10^{-5}	Fetal heartbeat
10^{-6}	Magnetic field from human brain
10^{-8} 10^{-14} Tesla	Limits of detection for SQUIDS

The equivalent magnetic induction B in free space, measured in tesla, can be obtained by multiplying these values by $4\pi\times10^{-7}$ H m^{-1}.

Gauss = 100 μTesla tilsvarer ca 80 A/m

To akse melexis hall sensor

Permanent magnet + Hall sensor

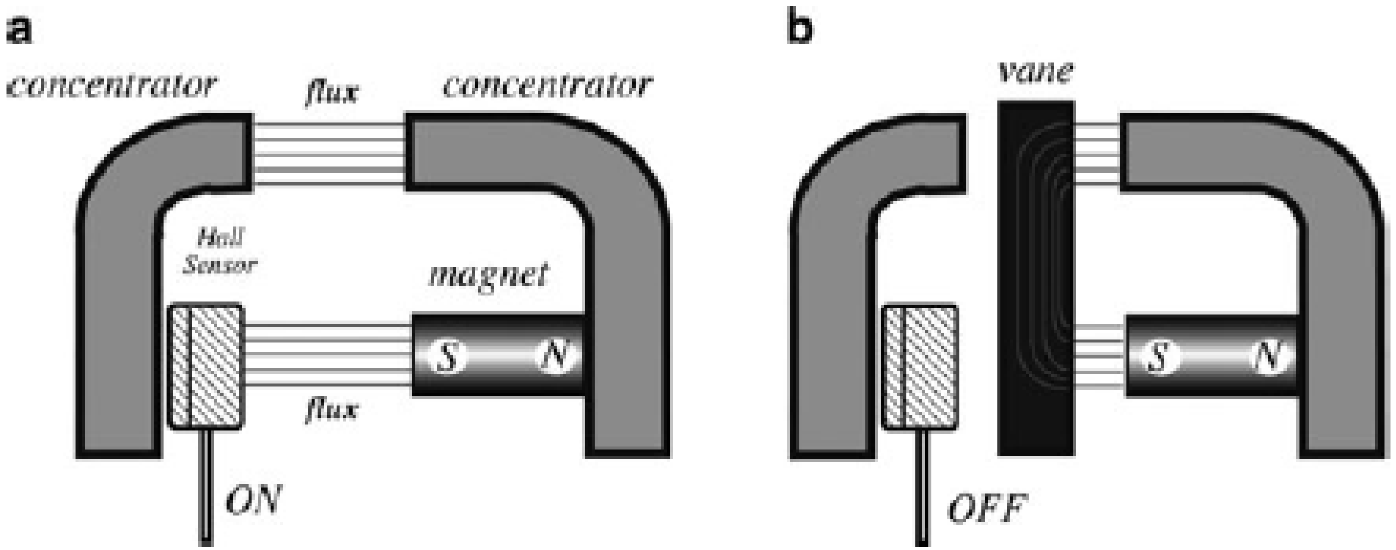


Fig. 7.19 The Hall effect sensor in the interrupter switching mode
The magnetic flux turns the sensor on (a); the magnetic flux is shunted by a vane (b) (after [5])

Tangamperemeter

Fluks konsentrator

Måler fluksen her

$$\oint \vec{B} \cdot d\vec{l} = \mu_0 i$$

Hall basert vinkel sensor

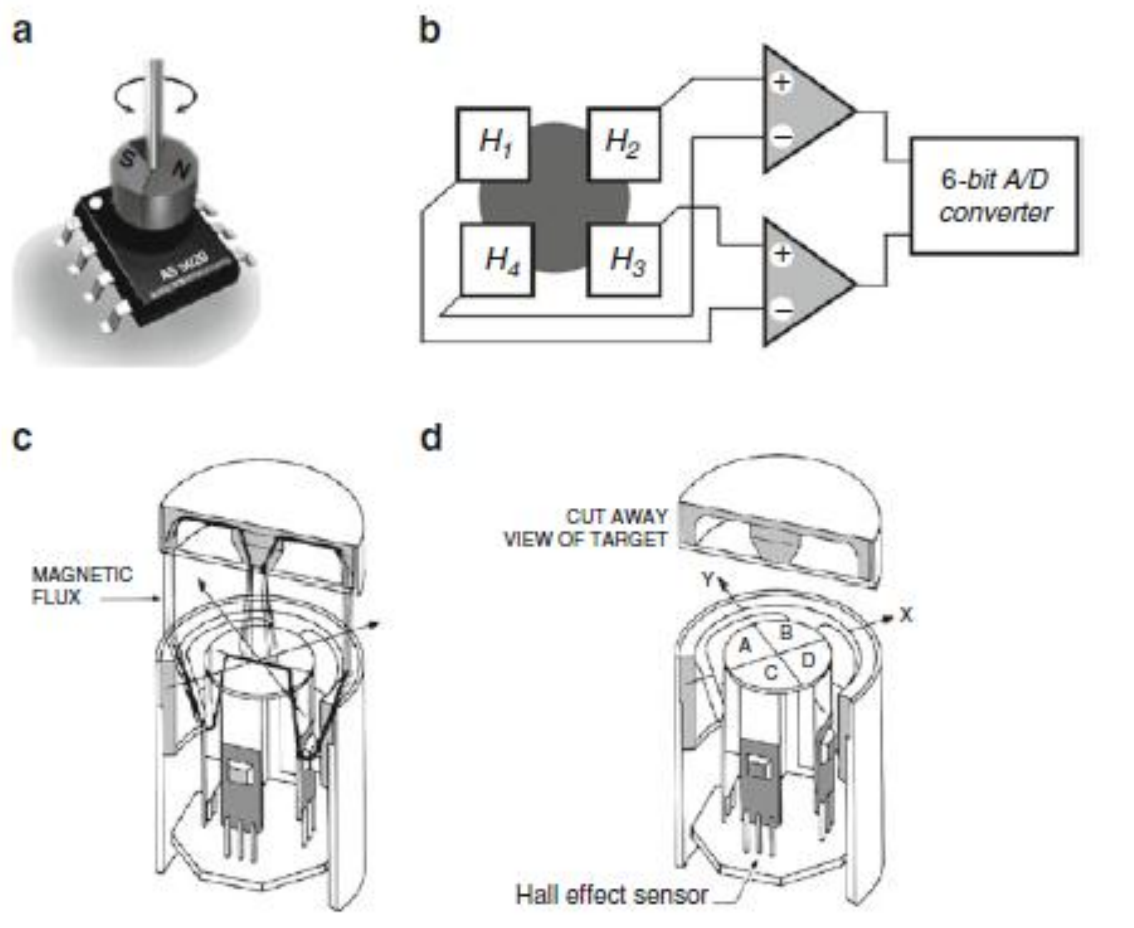


Fig. 7.20 Angular Hall-sensor bridge (**a**) and the internal sensor interface (**b**) (courtesy of Austria Micro Systems).
A cutaway view (**c**) of the sensor with the target and the probe shows the magnetic flux paths. A cut-away view (**d**) shows four Hall effect sensors with four flux return path

Magneto resistive sensorer (MRS)

3 ”effekter”:

- Anisotropic magneto resistive (AMR)
- Giant magneto resistive (GMR)
- Colossal magneto resistive

AMR sensor:

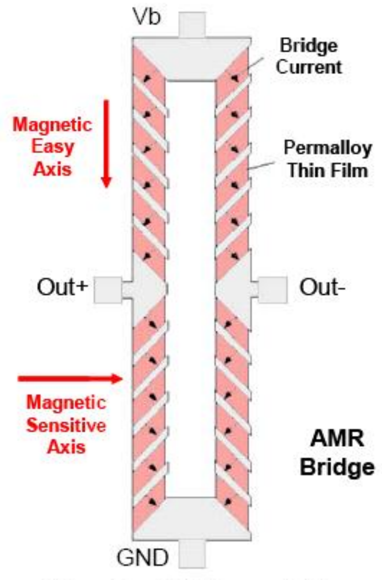


Figure 2 - AMR Sensor Bridge

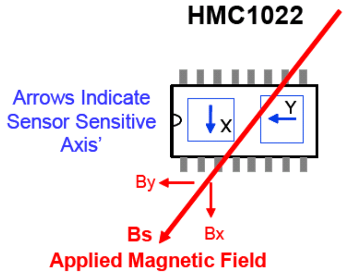
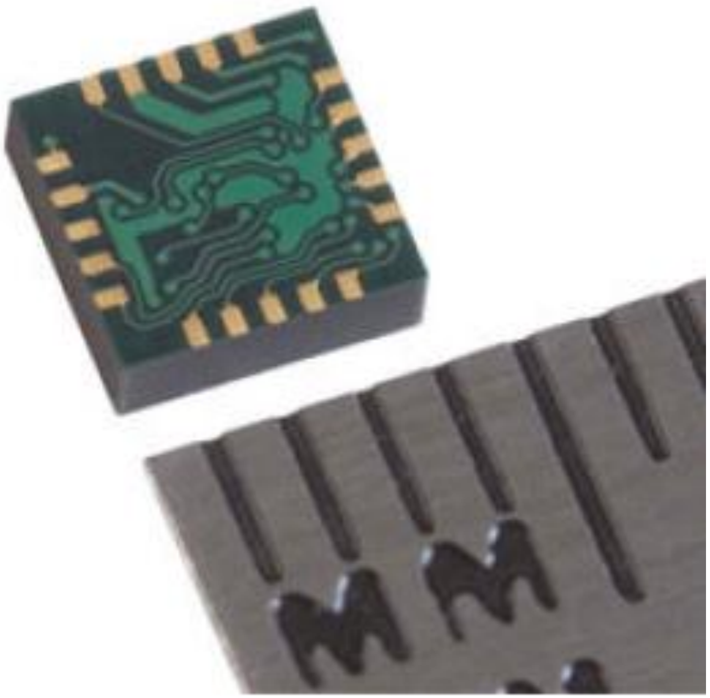


Figure 3 - 2-Axis Magnetic Field Sensing

Honeywell: Application Note – AN218
Vehicle Detection Using AMR Sensors

3-akse AMR kompass



I^2C: Inter IC (Buss)

HMC5843

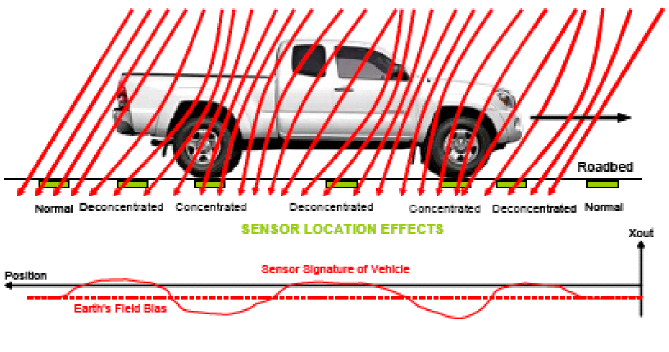
SPECIFICATIONS (* Tested at 25°C except stated otherwise.)

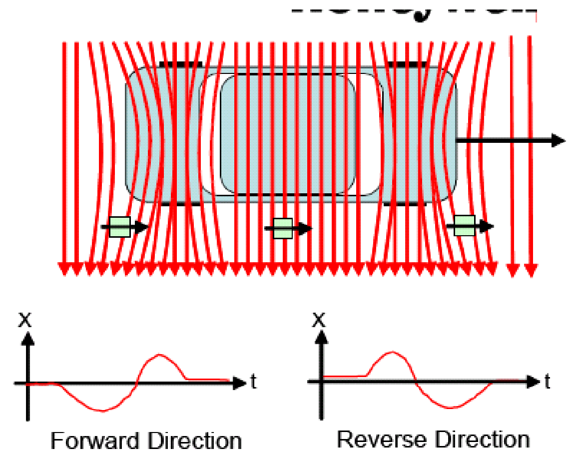
Characteristics	Conditions*	Min	Typ	Max	Units
Power Supply					
Supply Voltage	AVDD Referenced to AGND	2.5		3.3	Volts
	DVDD Referenced to DGND	1.6	1.8	2.0	Volts
Current Draw	Sleep Mode (dual supplies)	-	2.5	-	uA
	Idle Mode (dual supplies)	-	240	-	uA
	Measurement Mode	-	0.8	-	mA
	AVDD = 2.5 volts, DVDD = 1.8 volts				
	Sleep Mode (single supply)	-	110	-	uA
	Idle Mode (single supply)	-	340	-	uA
	Measurement Mode	-	0.9	-	mA
	AVDD = 2.5 volts				
Performance					
Field Range	Full scale (FS) – total applied field	-4		+4	gauss
Cross-Axis Sensitivity	Cross field = 0.5 gauss, Happlied = ±3 gauss		±0.2%		%FS/gauss
Disturbing Field	Sensitivity starts to degrade. Use S/R pulse to restore sensitivity.			20	gauss
Max. Exposed Field	No perming effect on zero reading			10000	gauss
Measurement Period	Output Rate = 50Hz (10Hz typ.)		-	10	msec
I^2C Address	7-bit address		0x1E		hex
	8-bit read address		0x3D		hex
	8-bit write address		0x3C		hex
I^2C Rate	Controlled by I^2C Master	-10		+10	%
I^2C bus pull-up	Internal passive resistors		50		kilo-ohms
I^2C Hysteresis	Hysteresis of Schmitt trigger inputs on SCL				
	and SDA - Fall (DVDD=1.8V)		0.603		Volts
	Rise (DVDD=1.8V)		1.108		Volts
Self Test	Positive and Negative Bias Mode		±0.55		gauss
Mag Dynamic Range	3-bit gain control	±0.7	±1.0	±4.0	gauss
Linearity	Full scale input range			0.1	±% FS
Gain Tolerance	All gain/dynamic range settings		±5		%
Bandwidth	-3dB point		10		kHz
Resolution	AVDD=3.0V, GN		7		milli-gauss
Signal-to Noise Ratio		70			dB
Turn-on Time			200		us
General					
ESD Voltage				700	V
Operating Temperature	Ambient	-30		85	°C
Storage Temperature	Ambient, unbiased	-40		125	°C
Weight	Nominal		50		milli-grams

Honeywell :3-Axis Digital Compass IC HMC5843

Vehicle detection

Earths magnetic field





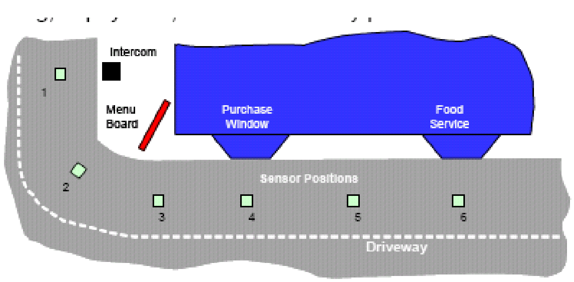
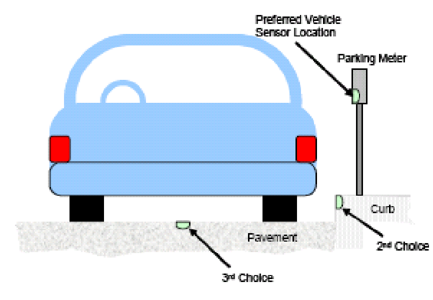


Figure 17 - Fast Food Vehicle Detection Example



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Vehicle Detection Using AMR Sensors

Magnetoresistiv vinkelsensor

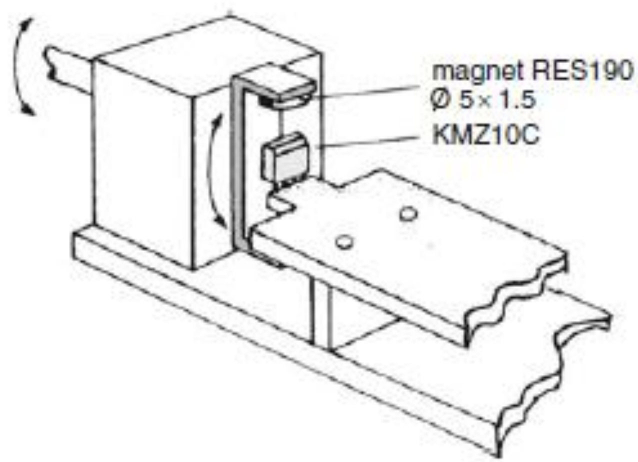
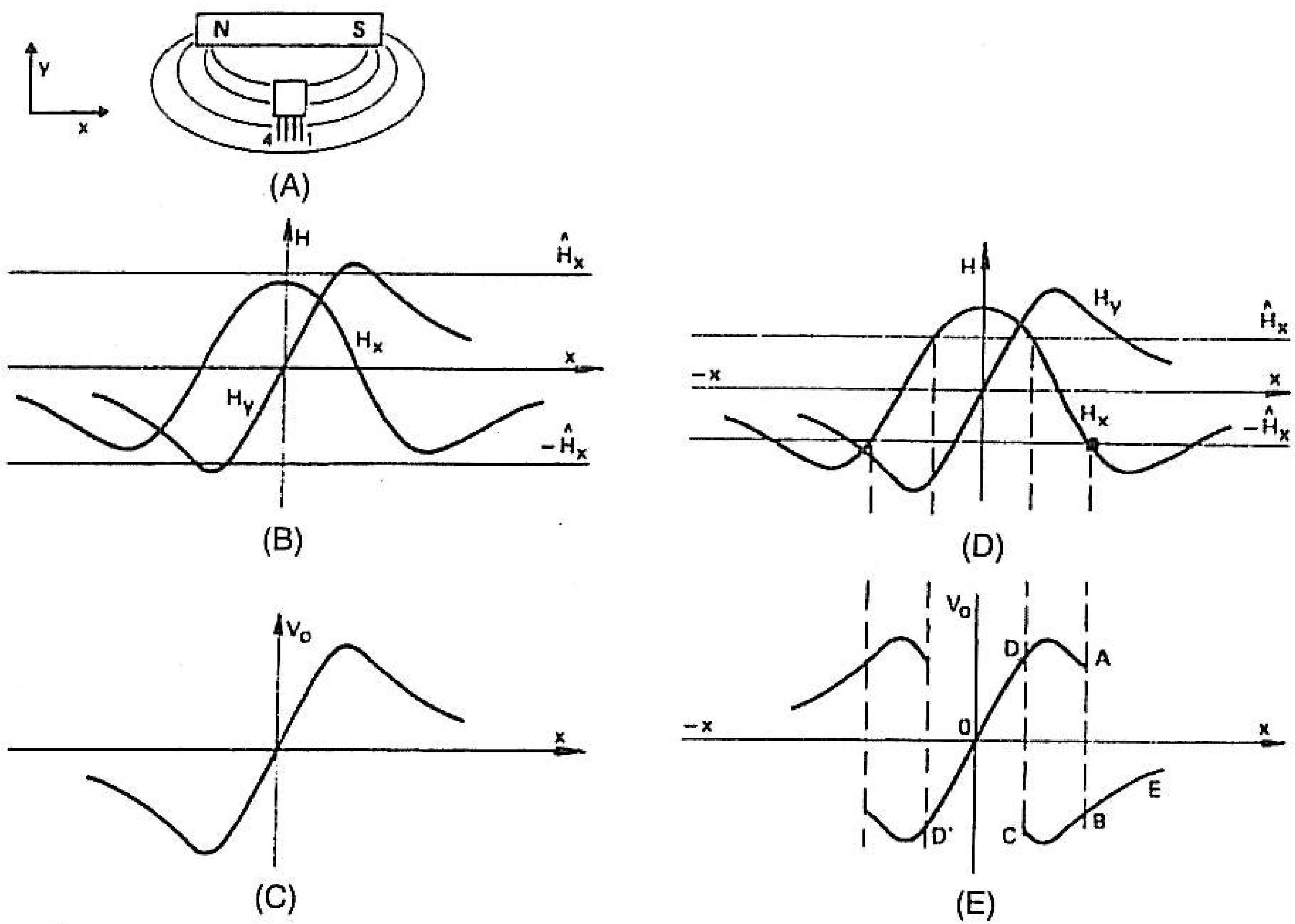
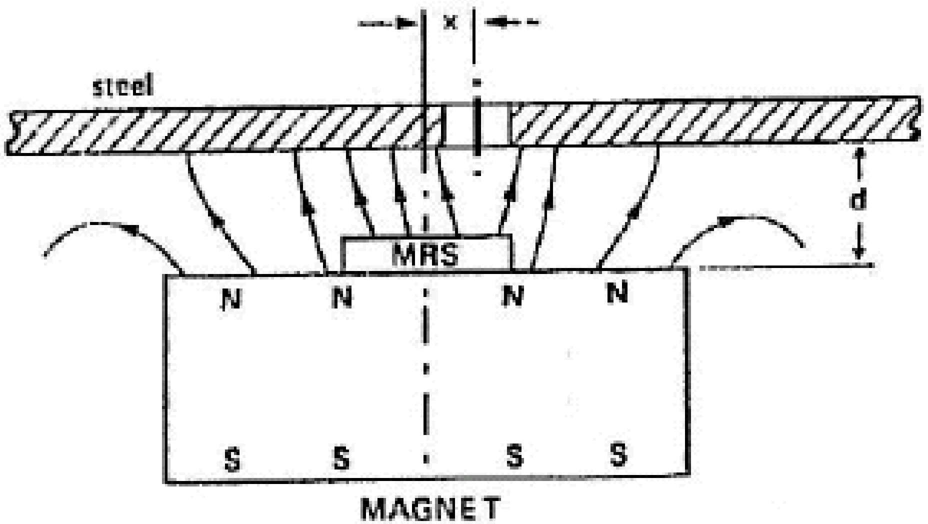


Fig. 7.24 Angular measurement with the KMZ10 sensor

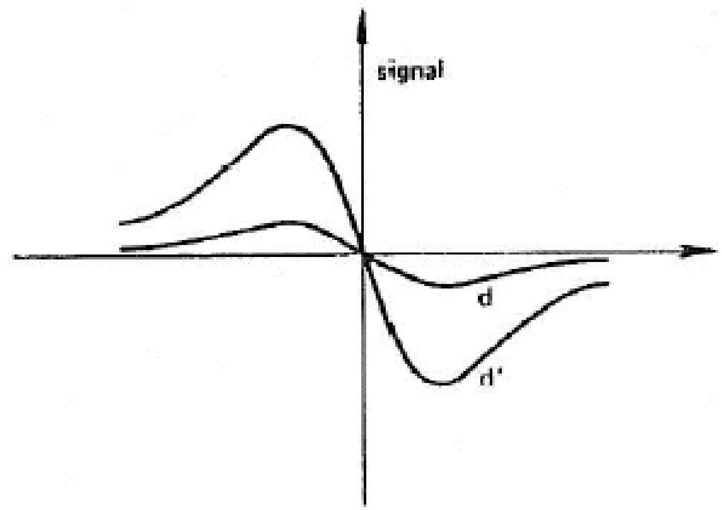


;. 7.19. Magnetoresistive sensor output in the field of a permanent magnet as a function of its ɔlacement x parallel to the magnetic axis (A–C). The magnet provides both the axillary and ısverse fields. Reversal of the sensor relative to the magnet will reverse the characteristic. and E) Sensor output with a too strong magnetic field.

Permanent field 1

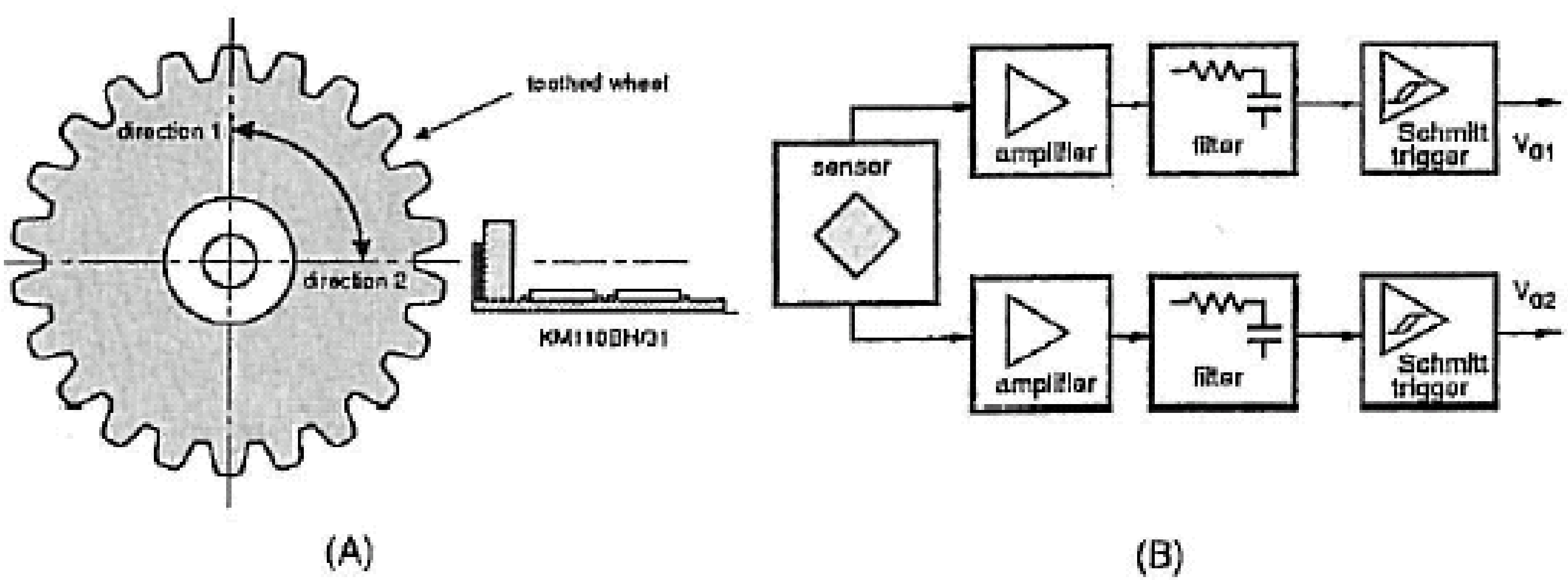


(A)



(B)

Permanent field 2



;. 7.22. (A) Optimum operating position of a magnetoresistive module. Note a permanent gnet positioned behind the sensor. (B) Block diagram of the module circuit.