Index

ABS 260
AC dyamo principle 266
AC tachometers 266 f.
AC-excited sensors 269–297
- rotary movements 287–297
  see also linear variable differential transformers; variable inductance sensors;
  variable gap sensors; synchros; resolvers;
  inductosyns
acceleration sensors 282
action point effect 140 f.
aerospace applications 450
aggressive fluids measurements 306
air-cored coils, proximity sensors 301 f.
air-cored induction coils 207–220 ff.
- amplifier noise 214
- capacitance 219 f.
- design 207 ff.
- equivalent circuit diagram 214–220
- filling factors 208
- inductance 216
- internal noise 212 ff.
- noise equivalent magnetic field 213 ff.
- output voltage 210 ff.
- proximity effects 217 ff.
- resistance 208
- sensitivity 207–220
- skin effect 217 ff.
- weight of the winding 212
alloys, amorphous 103 ff., 308
- crystalline 104 f.
- magnetic 15, 100–106, 142, 307 ff., 317
- magnetostrictive 350 ff.
- magnetization curve 100 f.
AlNiCo alloys 307
AlNiCo magnets 15
aluminium coils 209
amorphous alloys 103 ff., 308
amorphous films 356 ff.
amorphous materials, force sensors 136
- non-contact switches 140 f.
- position and displacement sensors 138 f.
amorphous metals 15
amorphous ring-core sensors 137–141
amorphous wires 330 ff., 337
amplifier noise, air-cored induction coils 214
amplifiers, carrier 278
- current 239 ff.
- DC 278
- induction coil sensors 237–246, 250
- measuring 174 f.
- voltage 237 ff.
- analog arithmetic operations, resolvers 294
- analog position sensors 85
angle, Hall 61 ff.
- rotation 277
  see also twist-angle
angle measurements 295
angle sensors 286
anisotropy magnetization 344–350
annealing, magnetostrictive layers 360
anti-theft devices 331, 336
audio-magnetotelluric measurements 246
automotive applications 450 ff.
- magnetogalvanic sensors 88 f., 91, 113
- torductors 113
- automotive powertrain sensors 452 ff.
auxiliary fields, magnetostrictive sensors 370 ff.
axle load of lorries, measurement 135
balanced linear-tapered secondaries 271 ff.
battery control, flux gate magnetometers 176 bias fields, magnetoresistive sensors 370 ff.
hysteresis, secondaries 271 ff.
Barkhausen jumps 40, 316
Barkhausen noise 19 ff., 236, 309, 349
biasing of magnetoresistors, magnetic 68 ff.
biomagnetic fields 8
biomagnetism 457 ff.
biomedical applications 450
brushless DC motors 89 ff.
Bitter coils 24
blocking curve, magnetization 349 f.
brushless DC motors 89 f.
capacitance, air-cored induction coils 219 ff.
car wheels, rotational speed measurements 260
card reading sensors 462 ff.
carrier amplifier 278
carrier concentration, low 53
carrier velocity 45
carrier-domain magnetic sensors 74 f.
CIM 478
circuit diagram, equivalent 16, 214–220, 234 ff., 327
circuit diagram, equivalent 16, 214–220, 234 ff., 327
circuit diagram, equivalent 16, 214–220, 234 ff., 327
circuit diagram, equivalent 16, 214–220, 234 ff., 327
circuit diagram, equivalent 16, 214–220, 234 ff., 327
Co-based alloys 100 f., 317
carwheels, rotational speed measurements 260
card reading sensors 462 ff.
carrier amplifier 278
carrier concentration, low 53
carrier velocity 45
carrier-domain magnetic sensors 74 f.
ceramic materials, sensor housings 308
ceramic superconductors 436 ff., 483
core materials 307
cores, soft magnetic 303
cross-sensitivity, Hall sensors 59
cross-type force sensors 108–115, 134 f.
coaxial-type sensors 116–120
- complex coil arrangement 119
- data processing electronics 117
- electric motors 118
- principal designs 120
- sensitivity 119
Cobalt 70, 100 f., 317
card reading sensors 462 ff.
card reading sensors 462 ff.
combined-effects magnetoeleastic sensors 145 f.
compass 2
complementary tapered windings 274 f.
composite materials 15
composite wires 324
compressive force sensors 130–135
consumer applications 450 ff.
consumer equipment sensors 454
coupling factor, magnetomechanical 100
cranks, rotational speed measurements 260
critical current 434 f.
critical temperature, superconductivity 383 ff.
cross-sensitivity, Hall sensors 59
CIM 478
Cobalt 70, 100 f., 317
core materials 307
cross-sensitivity, Hall sensors 59
cross-type force sensors 108–115, 134 f.
cross-type sensors, magnetic circuits 109 ff.
Crovac 328, 332
cryogenics 406 ff.
crystalline alloys 104 ff.
Curie temperature 13
- magnetoresistive films 372
current, amplifier 239 ff.
- critical 434 ff.
- density 298
- measurements 76 ff., 79
- noise 16 f.
- shielding 388 f.
cylindrical coils 22 f.

damping, induction coil sensors 238
data banks 478
DC amplifier 278
DC SQUIDS 395–401
- electronics 426 ff.
- energy sensitivity 423
- integrated 422–429
- noise 424 ff.
see also SQUIDS
DC tachometers 266 f.
DC-excited sensors
see permanent-magnet excited sensors; reluctance sensors
definition of magnetic sensors 3 ff.
demagnetization factor, high permeability cores 224 f.
demodulator, flux gate magnetometers 175 f.
design, air-cored induction coils 207 ff.
- coaxial-type sensors 120
- double-core flux gate magnetometers 168 ff., 174 ff.
- flux gate magnetometers 168 ff., 174 ff.
- flux gate sensors 155 f.
- magnetic circuits 84
- magnetoresistive sensors 363–370
- orthogonal gated flux gate sensors 186
- pulse height sensors 185
- pulse position type flux gate magnetometers 196 ff., 199 ff.
- ring core flux gate magnetometers 178–183
- SQUIDS 392 ff., 397 ff., 418 ff.
- Wiegand sensors 319 ff.
dewars, SQUIDS 406 ff.
diagram, electrical, force sensors 283
- reluctance sensors 264
- variable inductance sensors 283
- equivalent circuit 16, 214–220, 234 ff., 327
differential cross-anchor sensors
- see variable gap
differential magnetoresistors 68 ff., 87 f.
differential synchros 291 f.
differentiating circuit 200
digital position sensors 81 f.
direct drives 304
displacement measurements 466–470
- linear 266, 281
- rotary 470
displacement sensors 136–141, 275 f., 286
-domain walls 316 f.
domains 348 ff.
- boundaries 39 ff.
double-core flux gate magnetometers 167–177
- design 168 ff., 174 ff.
- frequency range 171
- probe types 171 ff.
- sensitivity 170 f.
- transfer factor 170 f.
see also flux gate magnetometers
AE effect 36
- magnetoelastic sensors 141 ff.
earth’s magnetic field 6 f., 377, 460 ff.
eddy current effects 261
- high permeability core induction coils 222 f., 236
eddy current sensors 124, 297–304, 469
- applications and properties 310 f.
- direct operating 299 f.
- proximity 299–304
- trends 481
eddy current tachometers 299 f.
- applications and properties 300
eddy currents 39
- pulse wires 326
effects, action point 140 f.
- AE 36, 141 ff.
eddy current see eddy current
galvanomagnetic 35 f., 45–52, 72
- Hall see Hall effect
- Josephson see Josephson
- Joule 36
- magnetic resonance 5
- magnetoelastic 36 ff.
magnetoelectric 37
magnetostriction 36 ff.
- Matteucci 37
- Meissner 42, 383 ff., 390
- physical, magnetic sensors 34 f.
- proximity 217 ff.
- short-circuiting 56
- skin, air-cored induction coils 217 ff.
- Villari 37
- Wiedemann see Wiedemann
- Zeemann 5
electric motors, coaxial-type sensors 118
- magnetic field 8
electric resistivity, specific 13
electrical diagram, force sensors 283
- reluctance sensors 264
- variable inductance sensors 283
electromagnetic systems 38 f.
electromagnetic units 6
electromagnets 23 f.
electronic amplifiers, induction coil sensors 237–246, 250
encoder, rotary 334 ff.
energy sensitivity, SQUIDS 423, 432 ff.
energy spectrum of Barkhausen noise 20
epoxy metals, sensor housings 308
equivalent circuit diagram 16
- air-cored induction coils 214–220
- high permeability core induction coils 234 ff.
- pulse wires 327
etching 410
excess noise 19, 309
exchange energy 317
extensometers 138

1/f noise 434 ff.
Faraday’s law 2, 38, 206, 257, 266
FeCo alloys 308
FeCrCo alloys 307
feedback, negative, induction coil sensors 241 ff.
feedback control of flux gate magnetometers 166 f.
FeNi alloys 308
ferromagnetic films 372
ferrite plates, proximity sensors 301 f.
ferrites, hard 15
- soft 15
ferromagnetic films 372
ferromagnetic materials 316 ff.
ferromagnetic targets 304
ferromagnetic thin layers, magnetization 344 ff.
FeSi alloys 308
Fe-Si-B wires 331
field plates 376
field probe, flux gate magnetometers 171
field strength, noise 18
figure of merit (FOM), strain gages 472
filling factors, air-cored induction coils 208
films, amorphous 356 ff.
- ferrimagnetic 372
- ferromagnetic 372
- magnetoresistive 370 ff.
- permanent magnetic 370 ff.
- thin 408 ff., 429 f.
see also layers
flow measurements 306
flowmeters 277
- see also inductive flowmeters
fluids 261, 306
flux changes 316
flux densities, orthogonal gated flux gate sensors 186 f.
- pulse position type flux gate magnetometers 192
- scales 9
flux gate magnetometers 461 f.
- basic principles of operation 162 f.
- battery control 176
- demodulator 175 f.
- design 168 ff., 174 f.
- double-core see double-core
- feedback control 166 f.
- field probe 171
- Fourier coefficients 165
- frequency doubler stage 174
- gradient probe 171 f.
- instrument adjustment 175
- magnetization curve 163 ff.
- matching procedure 170
- measuring amplifier 174 f.
- performance data 176
- point pole probe 172 f.
- probe compensation 175
- pulse-position type see pulse-postion type
flux gate sensors 153–203
- application areas 154
- fundamentals 154–160
- magnetization curve, theoretical approaches 156–160
- measuring principles 154
- orthogonal gated 185ff.
- principle design 155ff.
- pulse height 183ff.
flu x linking 38ff.
flux modulation, SQUIDS 400ff.
flux noise 432ff.
flux patterns, cross-type sensors 109
flux relations, SQUID sensors 390ff., 395ff.
flux transformers 422ff.
- SQUID sensor systems 401ff.
flux-locked loops, SQUIDS 404ff.

FOM  see figure of merit
food industry, inductive flowmeters 306
force, compressive 130-135
- Lorentz 304ff.
- reaction 123ff.
- tensile 130-135
force measurements 277
- amorphous materials 136
- cross-type 134ff.
- electrical diagram 283
- four-branch-type 134ff.
four-branch-type sensors 110-115, 127ff.
- force 134ff.
- magnetic circuits 111
- multiple 115
- sensitivity 112
Fourier coefficients, flux gate magnetometers 165
- ring core flux gate magnetometers 181ff.
frequency doubler stage, flux gate magnetometers 174
frequency measurements, rotational 261
frequency range, double-core flux gate magnetometers 171
- reluctance sensors 261
frequency response, pulse wires 326, 330
full-bridge magnetoresistive sensors 367ff.

GaAs 92
gage heads 281
galvanomagnetic components, position sensing 83
galvanomagnetic effects 35f., 45-52
- combined 72
galvanomagnetic semiconductor sensors 86

Gauss 2
gear wheel 262ff.
gear wheel sensors 87
gearings, rotational speed measurements 260
generators, tachometer 266ff.
geomagnetism 460ff.
gradiometer configuration, high permeability core induction coils 222
gradiometers, SQUIDS 401ff.
gridded magnetoresistors 65

half-bridge magnetoresistive sensors 368
Hall angle 61ff.
Hall coefficient 47-50
Hall effect 35, 46ff.
- extraordinary (planar) 342, 351
- ordinary 342
Hall-effect chips 92
Hall-effect IC 56ff., 88ff.
Hall field 46
Hall mobility 46
Hall plates 52-60
Hall scattering factor 46, 49ff.
Hall sensors 52-60, 82, 88ff., 375ff.
- carrier concentration 53
- cross-sensitivity 59
- electron densities 57
- geometrical correction factor 53
- geometry 54ff.
- noise 58ff.
- nonlinearity 60
- offset 59ff.
- performances 57-60
- sensitivity 57ff.
- short-circuiting effect 56
- structures 56ff.
- technology 56f.
Hall voltage 36, 47, 53
hard ferrites 15, 307ff.
hard magnetic layers 372
hard magnetic materials 13ff.
helical magnetostrictive spring sensor 144
Helmholtz coils 21
high magnetic fields 23ff.
high permeability core induction coils 220-237
- calibration 222
- eddy current effects 222ff., 236
equivalent circuit diagram \(234\text{ff.}\)
- gradiometer configuration \(222\)
- hysteresis losses \(236\)
- inductance \(236\)
- internal noise \(232\text{ff.}\)
- magnetization \(223-228\)
- magnetic field patterns \(221\)
- noise equivalent magnetic field \(232\text{ff.}\)
- sensitivity \(228\text{ff.}\)
- sensors \(222, 238\)
- thermal noise \(229\)
-high-mobility semiconductors \(49\)
-high-pass filter \(242\)
-high-T, SQUIDS \(436\text{ff.}\)
-high-T, superconductors \(436\text{ff.}, 483\)
-homogeneous DC fields \(21\text{ff.}\)
-Hooke’s law \(107\)
-hybrid SQUIDS \(430\)
-hysteresis loop \(19\)
- magnetostriction \(99\)
- soft magnetic materials \(10f.\)
-hysteresis losses, high permeability core induction coils \(236\)

IC see integrated circuit identification, magnetic sensor application \(462\text{ff.}\)

\(\text{lnAs} \ 49\)

induced voltage, pulse height sensors \(184\)
- inductance, air-cored induction coils \(216\)
- high permeability core induction coils \(236\)
- mutual \(241, 423\text{ff.}\)
-inductance sensors, variable see variable inductance sensors

induction coil sensors \(4, 205-253, 468\text{ff.}\)
- applications \(246-251\)
- bandwidth \(242\)
- definition \(206\)
- electronic amplifiers \(237-246, 250\)
- high permeability core \(238\)
- noise equivalent magnetic field \(243\text{ff.}\)
- output voltage \(240\text{ff.}\)
- transformer coupled negative feedback \(241\text{ff.}\)
- trends \(480\text{f.}\)

induction coils see air-cored induction coils;
-high permeability core induction coils

inductive sensors \(4, 255-313, 468\text{ff.}\)
- AC-excited see AC-excited sensors
- applications and properties \(310\text{f.}\)
- materials \(307\text{f.}\)
- noise \(308\text{f.}\)
- trends \(481\)

see also permanent-magnet excited sensors;
eddy current sensors; reluctance sensors;
DC-excited sensors

inductosyns \(295\text{ff.}\)
- applications and properties \(296\text{f.}\)
- signal conditioning \(297\)

injection-modulation mechanism \(74\)

\(\text{InSb} \ 49, 64\text{f.}, 91\text{f.}\)

instrument adjustment, flux gate magnetometers \(175\)

integrated DC SQUIDS \(422-429\)

integrated-circuit (IC) technology, Hall sensors \(56\text{f.}, 88\text{f.}\)

interference effects, SQUIDS \(398\)

interfering effects on the torque signal \(126-130\)

interrupter for automotive \textit{use, noncontact} \(88\text{f.}\)

jitter, remagnetization \(337\text{ff.}\)

Josephson effects \(42, 383\text{ff.}\)

Josephson relations \(385\)

Josephson tunnel junctions \(408-418\)
- characteristics \(412\text{ff.}\)
- fabrication \(411\text{f.}\)
- special configurations \(416\text{ff.}\)
- techniques \(408\text{ff.}\)

Joule effect \(36\)

junctions, barrier \(417\)
- resistively shunted \(386\text{f.}, 414\text{ff.}\)
- Josephson see Josephson

layers, ferromagnetic \(344\text{ff.}\)
- hard-magnetic \(372\)
- magnetoresistive \(360\text{ff.}\)
- multi- \(208\text{f.}, 436\)
- soft-magnetic \(373\)
- thin \(344\text{ff.}, 362\text{f.}\)

see also films

lead-oxide barrier junctions \(417\)

length-to-with ratios of magnetoresistors \(62\text{ff.}\)

level measurements \(282, 306\)

level meters \(277\)

light wave conductor (LWC) \(337\)

linear displacement measurements \(266, 281\)

linear movement measurements \(269-287\)
linear position sensors 81f.
linear variable differential transformers (LVDT) 269–278
- applications and properties 275ff.
- balanced linear-tapered secondaries 271ff.
- balanced profiled secondaries 274
- complementary tapered windings 274f.
- computed magnetic field 272
- electrical circuit 270
- measuring range 276
- overwound linear-tapered secondaries 273f.
- signal conditioning 277f.
- temperature dependence 276
linear-tapered secondaries 271ff.
linearization, magnetoresistive sensors 352f.
liquid-helium storage 406ff.
lithography 408ff.
load cells 277, 282
- magnetoelastic 130f.
loops, flux-locked 404f.
Lorentz force 304ff.
low-pass filter 241f.
lumped circuit model, SQUIDS 397
LVDT see linear variable differential transformers
LWC see light wave conductor

M 1040, magnetization curve 160
- probe core 169
machine tooling 304, 470
MAGFETS 73
magnetic alloys 15, 100–106, 142, 307ff., 317
magnetic biasing of magnetoresistors 68ff.
magnetic circuits 89
- closed 81f.
- cross-type sensors 109ff.
- design 84
- four-branch-type sensors 111
magnetic effects for sensors 2
magnetic field gradient sensors, SQUIDS 401ff.
magnetic field intensities, orthogonal gated flux
gate sensors 186
magnetic field measurements 451–464
magnetic field measuring principles 155
magnetic field patterns, high permeability core
induction coils 221
magnetic field sensors 4, 205–253
see also magnetometers
magnetic field strength, pulse-position type flux
gate magnetometers 190ff.
magnetic fields, AC, shielding 26f.
- bio- 8
- conventional coils 9
- DC 21ff., 24f.
- earth’s 6f., 377, 460ff.
- energy 18
- fluctuating 16
- high 23f.
- linear variable differential transformers
- 272
- natural 6ff.
- noise 8
- noise equivalent 213ff., 232ff., 243ff.
- outer space 7f.
- permanent magnets 8f.
- proximity sensors 302f.
- scales 9
- standard 20–24
- superconducting coils 9
- technical 8f.
- time-varying, air-cored induction coils 210
magnetic flux, reluctance sensors 259
magnetic flux linking 38f.
magnetic foils 116f.
magnetic heads 4
magnetic induction, fluctuating 430ff.
magnetic materials 9–16, 102ff.
- coercivity 105
- hard 13ff., 307f., 372
- mechanical properties 15
- permanent 14
- shielding 24–29
- soft 10–13, 303
- stress-strain curves 104f.
magnetic measurements 76ff.
magnetic noise 8, 16–20
see also noise
magnetic pickups 257–264
see also permanent magnets
magnetic resonance effects 5
magnetic sensors, applications 447–476
- carrier-domain 74f.
- classification 4, 34, 448ff., 456
- definition 3ff.
- historical background 2f.
- physical effects 34f.
- physical principles 33–42
- trends 477–483
magnetic shielding 250
- closed 27
Index

- materials 24–29, 250
- openings 27
magnetic sleeve 121
magnetic strain gages 147
magnetic switching elements 316
magnetic terms and units 5f.
magnetic vane switch 89
magnetic yoke materials 307
magnetically conducting materials 83ff.
magnetically tunable delay line 143
magnetization, anisotropy 344–350
- ferromagnetic materials 316ff.
- ferromagnetic thin layers 344ff.
- high permeability cores 223–228
- stabilized 348ff.
magnetization curve, alloys 100ff.
- blocking curve 349f.
- flux gate magnetometers 163ff.
- flux gate sensors 156–160
- piecewise linear function 158f.
- polynomial approach 156ff.
- pulse height sensors 184
- theoretical approaches 156–160
- trigonometric function 160
magnetocardiography 483
magnetodiodes 72
magnetoelastic components, realization 120ff.
magnetoelastic effects 36ff.
magnetoelastic interaction 98ff.
magnetoelastic load cells 130f.
magnetoelastic sensor systems 105f.
magnetoelastic sensors 4, 97–151, 470
- combined-effects 145f.
- special types 146f.
- trends 479
- ultrasonic-wave-propagation 143
magnetoelastic coupling effects 37
magnetoencephalography 459, 483
magnetogalvanic sensors 4, 43–96
- applications 75–92, 113
- history 44ff., 91f.
- trends 478f.
magnetomechanical coupling factor 100, 102
magnetometers 146, 161–201, 377, 451–464
- DC SQUIDS 422–430
see also flux gate; magnetic field sensors
magneto-optical sensors 4
magnetoresistance 51f.
magnetoresistive films 370ff.
magnetoresistive layers 360ff.
- properties and characteristics 362f.
magnetostrictive materials 356–363
magnetostrictive sensors 4, 341–380, 466f.
- applications 376f.
- auxiliary fields 370ff.
- characteristics 351ff., 373ff.
- design 363–370
- fabrication 356–376
- full-bridge 367ff.
- geometries 350f.
- gradient 369f.
- half-bridge 368
- linearization 352f.
- sensitivity 354f.
- trends 482
magnetostrictors (MR) 61–71, 82
- differential 68ff., 87f.
- geometry(-dependent) factor 61ff.
- gridded 65
- length-to-with ratios 62ff.
- magnetic biasing 68ff.
- materials 63f.
- NiSb needles 65ff.
- properties 67f.
- resistance 62ff., 70
- sensitivity 70
- technology 64ff.
- temperature compensation 71
magnetostriiction 98ff.
- effects 36ff.
- types of energy 99f.
magnetostrictive ribbons 147
magnetostrictive spring sensor 144
magnetotelluric measurements 246
magnetotransistors 73f.
magnets, AlNiCo 15
- electro- 23f.
- permanent see permanent magnets
- Rare earth/Cobalt 70
malleable alloys 15
matching procedure for flux gate magnetometers 170
materials, amorphous see amorphous
- ceramic 436ff.
- composite 15
Index

- core 307
- ferromagnetic 316ff.
- high-$T_c$ 436ff.
- inductive sensors 307ff.
- magnetic see magnetic materials
- magnetically conducting 83f.
- magnetoelastic 121
- magnetoresistive 356–363
- magnetoresistors 63ff.
- nonmagnetic 304, 308
- powder composite 15
- reluctance sensors 259
- shielding see magnetic materials; magnetic shielding materials testing 261
Matteucci effect 37
Maxwell’s laws 2
measurands, classification of magnetic sensors 448ff.
measurements, aggressive fluids 306
- angle 295
- audio-magnetotelluric 246
- corrosive fluids 306
- current 76ff.
- displacement 266, 281, 466–470
- flow 306
- force 277
- frequency 261
- level 282, 306
- linear displacement 266, 281
- linear movement 269–287
- magnetic 76ff.
- magnetic field 451–464
- mechanical 465–475
- micropulsion 246
- nonconductive fluids 306
- periodic field 369
- position 304, 376ff.
- power 79ff.
- pressure 271, 282
- proximity 260
- revolution 266
- rotary displacement 470
- rotary movement 287–297
- rotation angles 277
- rotational frequency 261
- rotational speed 260
- speed 260, 265f.
- streaming fluid 261
- strip tension 133
- velocity 260
- weight 277, 282
measuring amplifier, flux gate magnetometers 174ff.
mechanical measurements 465–475
mechanical properties of magnetic materials 15
mechanical sensors 454
Meissner effect 42, 383ff., 390
metals, amorphous 15
- crystalline 15
micro field probe, flux gate magnetometers 172
micropack packages 67, 91
microprocessor control, pulse-position type flux gate magnetometers 198ff.
micropulsion measurements 246
miniature sensors, high permeability core induction coils 222
MKSA system 5
Mo Permalloy 179
MOS transistors 73
motors, brushless DC 89ff.
movement measurements, linear 269–287
- rotary 287–297
moving permanent magnets, reluctance sensors 264ff.
MR see magnetoresistors
multi-coil arrangements 22
multilayer air-cored induction coils 208ff.
multilayer techniques 436
multivibrator circuit, two-core 138
mutual inductance 241, 423ff.
natural magnetic fields 6ff.
nickel-iron based alloys 103, 142, 317
NiSb 65ff., 91
noise, air-cored induction coils 212ff.
- Barkhausen see Barkhausen
- current 16ff.
- excess 19, 309
- 1/f 434ff.
- field strength 18
- flux 432ff.
- Hall sensors 58ff.
- high permeability core induction coils 232ff.
- inductive sensors 308ff.
- magnetic 8, 16–20
- energy calculation 18
- Nyquist 16ff., 309
- resistance 16
- SQUIDS 424ff., 430–438
Index

- thermal  see thermal noise
- voltage 16
- noise equivalent magnetic field, air-cored induction coils 213ff.
- high permeability core induction coils 232ff.
- induction coil sensors 243ff.
- noise power spectra 434f.
- nonconductive fluids measurements 306
- noncontact interrupter for automotive use 88f.
- noncontact position sensors 81ff.
- noncontact switches 140f.
- nondestructive stress analysis 134ff.
- nonlinearity, Hall sensors 60
- nonmagnetic materials 304, 308
- Nyquist noise 16f., 309
- Oersted 2
- offset, Hall sensors 59f.
- orthogonal gated flux gate sensors 185ff.
  - design 186
- oscillator, flux gate magnetometers 174
- oscillator coils, proximity sensors 301
- outer space magnetic fields 7f.
- output signals, pulse-position type flux gate magnetometers 193ff.
  - SQUIDS 403ff.
- output voltage, air-cored induction coils 210ff.
  - induction coil sensors 240f.
  - reluctance sensors 261ff.
  - ring core flux gate magnetometers 180f.
- overwound linear-tapered secondaries 273f.
- packages, micropack 67, 91
- passivation layers, magnetoresistive 361
- performance, ring core flux gate magnetometers 182
- periodic field measurements 369
- Permalloy 179, 356ff.
- permanent magnetic films 370ff.
- permanent magnetic materials 14
- permanent magnetic wires 324
- permanent magnets 307f., 331f., 369
  - fixed 257–264
  - moving 264f.
- permanent-magnet excited sensors 257–268
  see also inductive sensors; reluctance sensors permeability, initial 12f.
  see also high permeability
- permeability probe, flux gate magnetometers 173f.
- permeability tensor 298
- pickup coils, SQUID sensor systems 401f.
- pickup winding, flux gate magnetometers 164
- piecewise linear function, magnetization curve 158f.
- pipeline monitoring 135
- plastic materials, sensor housings 308
- point pole probe, flux gate magnetometers 172f.
- Poisson ratio 108
- polarization, saturation 11f.
- polynomial approach to the magnetization curve 156ff.
- position measurements 304, 376f.
- position sensors 81ff., 136–141, 275f.
  - amorphous materials 138f.
  - analog 85
  - digital 81f.
- pot core, proximity sensors 303
- powder composite materials 15
- power measurements 79ff.
- power spectra, noise 434f.
- premagnetization field, pulse-position type flux gate magnetometers 189
  - square wave 179ff.
- premagnetization generator, pulse-position type flux gate magnetometers 199
- Pressductor 130ff.
  - measurement of strip tension 133
- pressure cans 90f.
- pressure measurements 277, 282
- pressure sensors 286, 475
- probe compensation, flux gate magnetometers 175
- probe types of double-core flux gate magnetometers 171ff.
- process and production engineering 304
- prospecting 450
- proximity effects, air-cored induction coils 217ff.
- proximity measurements 260
- proximity sensors 299–304
  - applications and properties 304
  - magnetic field distribution 302f.
- pulse characteristics, ferromagnetic materials 317ff.
  - Wiegand sensors 320ff.
- pulse height sensors 183ff.
  - induced voltage 184
  - magnetization curve 184
  - principal design 185
<table>
<thead>
<tr>
<th>Index</th>
<th>495</th>
</tr>
</thead>
<tbody>
<tr>
<td>pulse-position type flux gate magnetometers</td>
<td>187-201</td>
</tr>
<tr>
<td>- code converter</td>
<td>201</td>
</tr>
<tr>
<td>- design</td>
<td>196ff., 199ff.</td>
</tr>
<tr>
<td>- differentiating circuit</td>
<td>200</td>
</tr>
<tr>
<td>- magnetic flux density</td>
<td>192</td>
</tr>
<tr>
<td>- microprocessor-controlled</td>
<td>198ff.</td>
</tr>
<tr>
<td>- operation</td>
<td>188ff.</td>
</tr>
<tr>
<td>- output signal</td>
<td>193ff.</td>
</tr>
<tr>
<td>- premagnetization field</td>
<td>189</td>
</tr>
<tr>
<td>- premagnetization generator</td>
<td>199</td>
</tr>
<tr>
<td>- sensitivity</td>
<td>195ff., 198</td>
</tr>
<tr>
<td>- transfer function</td>
<td>190-198</td>
</tr>
<tr>
<td>see also flux gate</td>
<td></td>
</tr>
<tr>
<td>pulse-wire sensors</td>
<td>4, 41, 315-339, 464</td>
</tr>
<tr>
<td>- trends</td>
<td>481f.</td>
</tr>
<tr>
<td>pulse wires</td>
<td>324-330</td>
</tr>
<tr>
<td>- applications</td>
<td>331-339</td>
</tr>
<tr>
<td>- eddy currents</td>
<td>326</td>
</tr>
<tr>
<td>- equivalent circuit diagram</td>
<td>327</td>
</tr>
<tr>
<td>- frequency response</td>
<td>326, 330</td>
</tr>
<tr>
<td>- high pulse voltages</td>
<td>324-328</td>
</tr>
<tr>
<td>- low pulse voltages</td>
<td>328ff.</td>
</tr>
<tr>
<td>- properties</td>
<td>325ff., 328ff.</td>
</tr>
<tr>
<td>- remagnetization jitter</td>
<td>337ff.</td>
</tr>
<tr>
<td>see also pulse-wire sensors</td>
<td></td>
</tr>
<tr>
<td>radiation sensors</td>
<td>454</td>
</tr>
<tr>
<td>rare earth-cobalt alloys</td>
<td>308</td>
</tr>
<tr>
<td>rare earth-cobalt magnets</td>
<td>15, 70</td>
</tr>
<tr>
<td>reaction-force meters</td>
<td>123ff.</td>
</tr>
<tr>
<td>reading heads, magnetoresistive sensors</td>
<td>376</td>
</tr>
<tr>
<td>recording heads, magnetoresistive</td>
<td>370</td>
</tr>
<tr>
<td>refractory-artificial barrier junctions</td>
<td>417</td>
</tr>
<tr>
<td>reluctance sensors</td>
<td>257-266, 469-471</td>
</tr>
<tr>
<td>- applications</td>
<td>260f.</td>
</tr>
<tr>
<td>- c-shaped</td>
<td>260</td>
</tr>
<tr>
<td>- construction</td>
<td>258</td>
</tr>
<tr>
<td>- electrical diagram</td>
<td>264</td>
</tr>
<tr>
<td>- frequency range</td>
<td>261</td>
</tr>
<tr>
<td>- materials</td>
<td>259</td>
</tr>
<tr>
<td>- moving permanent magnets</td>
<td>264ff.</td>
</tr>
<tr>
<td>- output voltage</td>
<td>261ff.</td>
</tr>
<tr>
<td>- properties</td>
<td>260f.</td>
</tr>
<tr>
<td>- signal conditioning</td>
<td>261ff.</td>
</tr>
<tr>
<td>remagnetization, ferromagnetic materials</td>
<td>316ff.</td>
</tr>
<tr>
<td>- jitter</td>
<td>337ff.</td>
</tr>
<tr>
<td>residual field probe, flux gate magnetometers</td>
<td>173</td>
</tr>
<tr>
<td>residue resistivity ratio (RRR)</td>
<td>409</td>
</tr>
<tr>
<td>resistance, air-cored induction coils</td>
<td>208</td>
</tr>
<tr>
<td>- magnetoresistors</td>
<td>62ff., 70</td>
</tr>
<tr>
<td>resistance noise</td>
<td>16</td>
</tr>
<tr>
<td>resistively shunted junction (RSJ) model</td>
<td>386ff., 414ff.</td>
</tr>
<tr>
<td>resistivity, specific electric</td>
<td>13</td>
</tr>
<tr>
<td>resolvers</td>
<td>293ff.</td>
</tr>
<tr>
<td>- applications and properties</td>
<td>294f.</td>
</tr>
<tr>
<td>- brushless</td>
<td>294</td>
</tr>
<tr>
<td>resonance effects, magnetic</td>
<td>5</td>
</tr>
<tr>
<td>revolution counters</td>
<td>87f., 331ff.</td>
</tr>
<tr>
<td>revolution measurements</td>
<td>266</td>
</tr>
<tr>
<td>RF SQUIDS</td>
<td>390-394</td>
</tr>
<tr>
<td>- design</td>
<td>418ff.</td>
</tr>
<tr>
<td>- electronics</td>
<td>420ff.</td>
</tr>
<tr>
<td>- staircase pattern</td>
<td>393f.</td>
</tr>
<tr>
<td>- two-hole</td>
<td>418-422</td>
</tr>
<tr>
<td>ring core flux gate magnetometers</td>
<td>177-183</td>
</tr>
<tr>
<td>- design</td>
<td>178-183</td>
</tr>
<tr>
<td>- Fourier coefficients</td>
<td>181f.</td>
</tr>
<tr>
<td>- functional units</td>
<td>183</td>
</tr>
<tr>
<td>- output voltage</td>
<td>180f.</td>
</tr>
<tr>
<td>- performance</td>
<td>182</td>
</tr>
<tr>
<td>- square wave premagnetization field</td>
<td>179ff.</td>
</tr>
<tr>
<td>see also flux gate</td>
<td></td>
</tr>
<tr>
<td>ring core sensors</td>
<td>137-141</td>
</tr>
<tr>
<td>ring cores, slotted ferrite</td>
<td>250</td>
</tr>
<tr>
<td>ring torductors</td>
<td>see torductors</td>
</tr>
<tr>
<td>robots, drive motors</td>
<td>332</td>
</tr>
<tr>
<td>rotary displacement measurements</td>
<td>470</td>
</tr>
<tr>
<td>rotary encoder, incremental</td>
<td>334ff.</td>
</tr>
<tr>
<td>rotary movement measurements</td>
<td>287-297</td>
</tr>
<tr>
<td>rotation angles measurements</td>
<td>277</td>
</tr>
<tr>
<td>rotational frequency measurements</td>
<td>261</td>
</tr>
<tr>
<td>rotational frequency sensors</td>
<td>331-335</td>
</tr>
<tr>
<td>rotational speed measurements</td>
<td>260, 262f.</td>
</tr>
<tr>
<td>RRR see residue resistivity ratio</td>
<td></td>
</tr>
<tr>
<td>RSJ see resistively shunted junction</td>
<td></td>
</tr>
<tr>
<td>saturation polarization</td>
<td>11f.</td>
</tr>
<tr>
<td>scattering factor, Hall</td>
<td>46, 49ff.</td>
</tr>
<tr>
<td>Schmitt trigger</td>
<td>263</td>
</tr>
<tr>
<td>scientific applications</td>
<td>450</td>
</tr>
<tr>
<td>screen printing, ferrimagnetic films</td>
<td>372</td>
</tr>
<tr>
<td>search coil sensors</td>
<td>205-253</td>
</tr>
<tr>
<td>- trends</td>
<td>480f.</td>
</tr>
<tr>
<td>second harmonic flux gate magnetometers</td>
<td>161-183</td>
</tr>
<tr>
<td>secondaries, balanced profiled</td>
<td>274</td>
</tr>
<tr>
<td>- linear-tapered</td>
<td>271ff.</td>
</tr>
</tbody>
</table>
Index

security systems, magnetic sensor application 462 ff.
semiconductor sensors, galvanomagnetic 86
semiconductors 61 ff., 71 ff.
- high-mobility 49
- physical properties 64
sensitivity
- air-cored induction coils 209–214
- coaxial-type sensors 119
- double-core flux gate magnetometers 170 ff.
- four-branch-type sensors 112
- Hall sensors 57 ff.
- high permeability core induction coils 228 ff.
- magnetodiodes 72
- magnetoresistive sensors 354 ff.
- magnetoresistors 70
- pulse-position type flux gate magnetometers 195 ff., 198
- SQUIDS 423, 430–438
- variable gap sensors 284
sensor systems, magnetoelastic 105 f.
sensors, AC-excited see AC-excited
- acceleration 282
- angle 286
- barber pole 368, 372, 374
- c-shaped 260
- carrier-domain magnetic 74 f.
- chemical 454
- choice 85 f.
- coaxial-type see coaxial-type
- cross-type see cross-type
- DC-excited see permanent-magnet excited
- sensors; reluctance sensors
- differential cross-anchor see variable gap
- displacement 136–141, 275 f., 286
- eddy current see eddy current
- flux gate see flux gate
- force see force
- four-branch-type see four-branch-type
- galvanomagnetic 86
- gradient see gradiometers
- Hall see Hall
- high permeability core induction coils see high permeability
- induction coil see induction coil
- inductive see inductive
- magnetic see magnetic
- magnetic effects 2
- magnetic-field 4, 205–253
- magnetoelastic see magnetoelastic
- magnetogalvanic see magnetogalvanic
- magneto-optical 4
- magnetoresistive see magnetoresistive
- magnetoresistor see magnetoresistors
- mechanical 454
- orthogonal gated flux gate 185 ff.
- permanent-magnet excited 257–268
- position see position
- pressure 286, 475
- proximity see proximity
- pulse height see pulse height
- pulse-wire see pulse-wire
- radiation 454
- reluctance see reluctance
- ring-core see ring-core
- search coil see search coil
- shock-stress 144 f.
- smart 92, 479
- SQUID see SQUID
- strain 286, 472 f.
- temperature 454
- tension 147
- torque see torque
- variable gap see variable gap
- variable inductance see variable inductance
- velocity 471 f.
- vibration 282
- Wiedemann-effect 144 f.
- Wiegand see Wiegand
- shaft-swinging sensor 286
shafts, coatings 122
- material 112
- torque measurements 107 f.
shear modulus 107, 143
shear stress 107
shear wave magnetometry 143
shielded room 28 f.
shielding, magnetic 24–29, 250
- SQUIDS 407 f., 420
shielding current, superconductors 388 f.
shielding factor 26, 28
ship propellers 114
- shock-stress sensors 144 f.
- short-circuit straps 64 f.
- short-circuiting effect, Hall sensors 56
signal conditioning, inductive flowmeters 306 f.
- inductosyns 297
- linear variable differential transformers 277 f.
- reluctance sensors 261 ff.
- tachometer generators 268
- variable gap sensors 287
- variable inductance sensors 282f.
signal input coupling, SQUID sensor systems 401ff.
silicon Hall-effect IC 88f.
single-core flux gate magnetometers 166f.
Sixtus-Tonks experiment 39f., 316
skin depth 303
skin effect, air-cored induction coils 217ff.
skin penetration depth, air-cored induction coils 217
smart sensors 92, 479
soft ferrites 15
soft magnetic alloys 308
soft magnetic cores 303
soft magnetic materials 10–13, 303
soft-magnetic layers 373
solenoids 236
solid mechanical transducers 465–475
sound velocity, measurement 142
space flight flux gate magnetometers 179
space research 460ff.
spacecraft applications, induction coil sensors 249
speed control, rotary 262f.
speed measurements 260, 265f.
see also velocity
sputtering, Josephson tunnel junctions 409
- magnetoresistive layers 360
square wave premagnetization field, ring core
 flux gate magnetometers 179ff.
SQUID sensor systems 401–408
- signal input coupling 401ff.
SQUID sensors 4, 42, 381–445
- characteristics 392ff., 397ff.
- magnetic flux relations 390ff., 395ff.
- periphery 406ff.
- practical devices 408–430
- special configurations 429f.
- trends 482
SQUIDS, bulk 429
- DC see DC SQUIDS
- design 392ff., 397ff., 418ff.
- flux modulation 400f.
- flux-locked loops 404f.
- gradiometers 401ff.
- high-$T_c$ 436ff.
- hybrid 430
- interference effects 398
- lumped circuit model 397
- magnetic field gradient sensors 401ff.
- magnetometers 422–430
- noise 430–438
- output signals 403ff.
- RF see RF SQUIDS
- sensitivity 430–438
- shielding 407ff., 420
- thin-film 429f.
stabilized magnetization 348ff.
staircase pattern, RF SQUIDS 393f.
standard magnetic fields 20–24
steels 103
Stokes theorem 388
Stoner-Wohlfarth theory 344ff.
strain gage heads 277
strain gage torqueometers 123ff.
strain gages, magnetic 147
- figure of merit (FOM) 472
strain sensors 286, 472f.
streaming fluid measurements 261
stress analysis, nondestructive 134ff.
stress anisotropy 316f.
stress sensor 286
strip tension, measurement 133
substrates, magnetoresistive layers 360
superconducting coils 24
- magnetic fields 9
superconductivity 383ff., 436ff., 483
superconductors, ceramic $(hightc)$ 436ff., 483
- shielding current 388f.
surface energy 317
surveying 450
switching time, remagnetization 317f.
synchos 287ff.
- applications and properties 288–293
- control-type 291ff.
- differential 291f.
- torque-type 289ff.
tachometer generators 266ff.
- signal conditioning 268
tachometers 334, 471f.
- eddy current 299f.
targets, magnetoresistive layers 360
technical magnetic fields 8ff.
temperature, critical 383ff.
- Curie 13, 371
temperature compensation, magnetoresistors 71
temperature dependence, linear variable differential transformers 276
temperature sensors 454
tensile-force sensors 130-135
tension measurements 133
tension sensors 147
terms, magnetic 5f.
testing, materials 261
thermal energy 18
thermal noise 16-19
- air-cored induction coils 214
- high permeability core induction coils 229
thermomagnetic noise 16-19
thin films, techniques 356ff., 370ff., 408ff.
see also films
thin-film SQUIDS 429f.
thin layers, ferromagnetic 344ff.
- magnetoresistive effect 362f.
see also layers
tooling, machine 304, 332
torqueductors 112ff.
- automotive applications 113
torque measurements, shafts 107f.
torque sensors 106-130, 473 ff.
- coaxial 128
- complex coil arrangement 119
- data processing electronics 117
- reaction force meters 123
- strain gage 123 ff.
- twist-angle 124
torque signal, interfering effects 126-130
torque-type synchros 289ff.
transducers, solid mechanical 465-475
transfer factor, double-core flux gate magnetometers 170 ff.
transfer function, flux gate magnetometers 163ff.
- induction coil sensors 238
- low-pass filter 241 f.
- pulse-position type flux gate magnetometers 190-198
- flux gate magnetometers 163ff.
transformer coupled negative feedback, induction coil sensors 241 ff.
transformers, linear variable differential see linear variable differential
- magnetic field 8
triple probe, flux gate magnetometers 171
tunnel junctions see Josephson
twist-angle torquemeters 124 f.
two-core multivibrator circuit 138
ultrasonic-wave-propagation, magnetoelastic sensors 143
units, electromagnetic 5f.
Vacoflux 318, 324
Vacon 324
vacuum evaporation, magnetoresistive layers 360
vane switch, magnetic 89
variable gap sensors 283-287
- applications and properties 286f.
- construction 284 f.
- sensitivity 284
- signal conditioning 287
variable inductance sensors 278-283
- applications and properties 280 ff.
- construction 279 ff.
- electrical diagram 283
- signal conditioning 282 f.
variable leakage path (VLP) sensors see variable inductance sensors
vector potential 298
velocity, carrier 45
- sound 142
velocity measurements 260, 265 f.
velocity sensors 471 f.
vibration sensors 282
Vickers hardness 15
Villari effect 37
voltage, air-cored induction coils 210ff.
- Hall 36, 47, 53
- induction coil sensors 240 f.
- noise 16
- pulse height sensors 184
- pulse wires 324 ff.
- reluctance sensors 261 ff.
- ring core flux gate magnetometers 180 ff.
voltage amplifiers, induction coil sensors 237 ff.
waste-water managements, applications of inductive flowmeters 306
weight measurements 277, 282
weight of the winding, air-cored induction coils 212
welding, automatic 304
Wiedemann effect 37
Wiedemann-effect sensors 144 f.
Wiegand sensors 4, 41, 315-339, 464
- design and properties 319 ff.
- drive conditions 321 ff.
- switching behavior 322 ff.
- trends 481 ff.

Wiegand wires, applications 331–339
- remagnetization jitter 337 ff.
windings, complementary tapered 274 ff.
wire explosion spraying 122 ff.

wires, amorphous 330 ff., 337
- composite 324
- permanent magnetic 324

- pulse see pulse wires
- Wiegand see Wiegand

yield strength 15
yoke materials, magnetic 307
Young’s modulus 15, 36, 108

Zeemann effect 5
zero-field detectors 377