## Contents

1 Basic Principles of Sound
   1.1 Sound ................................................. 1
   1.2 Sources of Sound ........................................... 1
   1.3 Velocity of Sound ......................................... 2
   1.4 Frequency of Sound ......................................... 2
   1.5 Pitch .................................................. 3
   1.6 Human Speech ............................................ 4
   1.7 Frequency Bands ........................................... 4
   1.8 Audio Sub Bands ........................................... 5
   1.9 Sound Pressure Level ......................................... 6
   1.10 Equal Loudness Contours ..................................... 7
   1.11 Loudness Levels ............................................ 9
   1.12 Audio Test Signals .......................................... 11
   1.13 Problems ............................................... 12

2 Fundamentals of Acoustics
   2.1 Basic Equations of Acoustics .................................... 15
   2.2 The Acoustic Wave Equation .................................... 16
   2.3 The Plane Wave ........................................... 17
   2.4 Specific Impedance ........................................... 17
   2.5 Acoustic Energy ........................................... 18
   2.6 Acoustic Intensity .......................................... 18
   2.7 Wavelength .............................................. 19
   2.8 Particle Displacement ........................................ 19
   2.9 The Omni-Directional Spherical Wave .............................. 20
   2.10 Volume Velocity .......................................... 21
   2.11 The Simple Spherical Source .................................. 21
   2.12 Acoustic Images ........................................... 22
   2.13 The Plane Circular Piston .................................... 23
   2.14 The Pattern Beamwidth ...................................... 25
   2.15 Fresnel Diffraction Effects .................................... 26
   2.16 Acoustic Reflections ........................................ 28
   2.17 Problems ............................................... 30

3 Analogous Circuits of Acoustical Systems
   3.1 Acoustic Sources ............................................. 33
   3.2 Acoustic Impedance ........................................... 33
   3.3 The Plane Wave Tube ........................................... 34
   3.4 Acoustic Resistance .......................................... 37
   3.5 Acoustic Compliance .......................................... 39
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.6  Acoustic Mass</td>
<td>40</td>
</tr>
<tr>
<td>3.7  Acoustic Impedance on a Piston in a Baffle</td>
<td>43</td>
</tr>
<tr>
<td>3.8  Acoustic Impedance on a Piston in a Tube</td>
<td>45</td>
</tr>
<tr>
<td>3.9  Radiation Impedance on a Piston in Free Air</td>
<td>46</td>
</tr>
<tr>
<td>3.10 Problems</td>
<td>47</td>
</tr>
<tr>
<td>4    Analogous Circuits of Mechanical Systems</td>
<td>49</td>
</tr>
<tr>
<td>4.1  Mechanical Sources</td>
<td>49</td>
</tr>
<tr>
<td>4.2  Mass, Compliance, and Resistance</td>
<td>50</td>
</tr>
<tr>
<td>4.3  Mechanical Systems</td>
<td>51</td>
</tr>
<tr>
<td>4.4  Moving-Coil Transducer</td>
<td>52</td>
</tr>
<tr>
<td>4.5  Crystal Transducer</td>
<td>55</td>
</tr>
<tr>
<td>4.6  Condenser Transducer</td>
<td>56</td>
</tr>
<tr>
<td>4.7  Mechano-Acoustic Transducer</td>
<td>60</td>
</tr>
<tr>
<td>4.8  Problems</td>
<td>61</td>
</tr>
<tr>
<td>5    Microphones</td>
<td>63</td>
</tr>
<tr>
<td>5.1  Classifications</td>
<td>63</td>
</tr>
<tr>
<td>5.2  Modeling Diaphragm Reflections</td>
<td>64</td>
</tr>
<tr>
<td>5.3  Diaphragm Back Acoustical Load</td>
<td>66</td>
</tr>
<tr>
<td>5.4  Diaphragm Mechanical Parameters</td>
<td>67</td>
</tr>
<tr>
<td>5.5  Condenser Microphone</td>
<td>67</td>
</tr>
<tr>
<td>5.6  Condenser Microphone SPICE Simulation</td>
<td>70</td>
</tr>
<tr>
<td>5.7  Condenser Microphone Buffer Amplifiers</td>
<td>72</td>
</tr>
<tr>
<td>5.8  Dynamic Microphone</td>
<td>73</td>
</tr>
<tr>
<td>5.9  Ribbon Microphone</td>
<td>75</td>
</tr>
<tr>
<td>5.10 Proximity Effect</td>
<td>78</td>
</tr>
<tr>
<td>5.11 Combination Microphone</td>
<td>80</td>
</tr>
<tr>
<td>5.12 Problems</td>
<td>82</td>
</tr>
<tr>
<td>6    Moving-Coil Loudspeakers</td>
<td>85</td>
</tr>
<tr>
<td>6.1  Construction</td>
<td>85</td>
</tr>
<tr>
<td>6.2  Analogous Circuits</td>
<td>88</td>
</tr>
<tr>
<td>6.3  Combination Analogous Circuit</td>
<td>89</td>
</tr>
<tr>
<td>6.4  Infinite Baffle Analogous Circuit</td>
<td>90</td>
</tr>
<tr>
<td>6.5  Low-Frequency Solution for $U_D$</td>
<td>91</td>
</tr>
<tr>
<td>6.6  Low-Frequency Bode Plots for $U_D$</td>
<td>91</td>
</tr>
<tr>
<td>6.7  Small-Signal Parameters</td>
<td>92</td>
</tr>
<tr>
<td>6.8  High-Frequency Solution for $U_D$</td>
<td>93</td>
</tr>
<tr>
<td>6.9  On-Axis Pressure</td>
<td>94</td>
</tr>
<tr>
<td>6.10 Pressure Transfer Function</td>
<td>95</td>
</tr>
<tr>
<td>6.11 Bode Plots of On-Axis Pressure</td>
<td>95</td>
</tr>
<tr>
<td>6.12 Filter Theory Description of $G(s)$</td>
<td>97</td>
</tr>
<tr>
<td>6.13 Cutoff Frequencies</td>
<td>97</td>
</tr>
<tr>
<td>6.14 Effect of Non-Zero Generator Resistance</td>
<td>98</td>
</tr>
<tr>
<td>6.15 Frequency of Peak Response</td>
<td>99</td>
</tr>
<tr>
<td>6.16 Voice-Coil Impedance</td>
<td>100</td>
</tr>
<tr>
<td>6.17 The Lossy Voice-Coil Inductance</td>
<td>102</td>
</tr>
<tr>
<td>6.18 On-Axis Pressure Sensitivity</td>
<td>102</td>
</tr>
<tr>
<td>6.19 Acoustic Power Response</td>
<td>103</td>
</tr>
<tr>
<td>6.20 Reference Efficiency</td>
<td>105</td>
</tr>
<tr>
<td>6.21 Diaphragm Displacement Function</td>
<td>105</td>
</tr>
</tbody>
</table>
## CONTENTS

6.22 Voice-Coil Electrical Power Rating ....................................................... 106  
6.23 Displacement Limited Power Rating ....................................................... 107  
6.24 SPICE Models ......................................................................................... 107  
6.25 Problems ................................................................................................. 110

7 Closed-Box Loudspeaker Systems ................................................................. 113  
7.1 Modeling the Box ..................................................................................... 113  
7.2 The Analogous Circuits ........................................................................... 115  
7.3 The Volume Velocity Transfer Function .................................................... 116  
7.4 The On-Axis Pressure Transfer Function .................................................. 117  
7.5 Effect of the Box on the System Response ................................................ 118  
7.6 Sensitivity of the Lower Cutoff Frequency ............................................... 119  
7.7 System Design with a Given Driver ......................................................... 120  
7.8 System Verification .................................................................................. 121  
7.9 System Design From Specifications ......................................................... 121  
7.10 A SPICE Simulation Example .................................................................. 123  
7.11 Problems .................................................................................................. 124

8 Vented-Box Loudspeaker Systems ............................................................ 127  
8.1 Modeling the Enclosure ............................................................................... 127  
8.2 Effect of the Vent ....................................................................................... 128  
8.3 The On-Axis Pressure Transfer Function .................................................. 129  
8.4 Voice-Coil Impedance Function .................................................................. 130  
8.5 The Magnitude-Squared Function ............................................................. 131  
8.6 The B4 Alignment ..................................................................................... 132  
8.7 The QB3 Alignments .................................................................................. 133  
8.8 The Chebyshev Alignments ....................................................................... 133  
8.9 Example Pressure Responses ..................................................................... 135  
8.10 Design with a Given Driver ....................................................................... 135  
8.11 System Verification .................................................................................. 140  
8.12 Design from Specifications ....................................................................... 140  
8.13 Vented-Box SPICE Example .................................................................... 141  
8.14 Problems .................................................................................................. 145

9 Acoustic Horns .............................................................................................. 147  
9.1 The Webster Horn Equation ....................................................................... 147  
9.2 Salmon’s Family of Horns .......................................................................... 147  
9.3 Finite Length Horn Size ............................................................................. 150  
9.4 A Horn Analogous Circuit .......................................................................... 150  
9.5 SPICE Examples ....................................................................................... 151  
9.6 Horn Driving Units .................................................................................... 155  
9.7 Mid-Frequency Range ................................................................................. 156  
9.8 Condition for Maximum $P_{AR}$ ................................................................ 157  
9.9 The Horn Efficiency .................................................................................. 157  
9.10 The Low-Frequency Range ....................................................................... 158  
9.11 The High-Frequency Range ..................................................................... 158  
9.12 Low-Frequency System Design ................................................................ 159  
9.12.1 Design with a Given Driver ................................................................. 159  
9.12.2 System Design from Specifications ..................................................... 161  
9.13 Problems .................................................................................................. 162
10 Crossover Networks 163
  10.1 Role of Crossover Networks ..................................... 163
  10.2 Passive Crossover Networks ..................................... 164
  10.3 L-Pad Design ............................................. 167
  10.4 Effect of the Voice-Coil Impedance ................................. 169
  10.5 Effect of the Driver Phase Response ................................ 170
  10.6 Constant-Voltage and All-Pass Functions ............................. 175
  10.7 Active Crossover Networks ...................................... 178
  10.8 A SPICE Modeling Example ................................... 180
  10.9 Problems ............................................... 182

11 A Loudspeaker Potpourri 187
  11.1 The Isobaric Connection ....................................... 187
    11.1.1 The Acoustical Analogous Circuit ............................. 187
    11.1.2 The Small-Signal Parameters ................................ 188
    11.1.3 SPICE Simulation Example .................................. 188
  11.2 4th-Order Bandpass Systems .................................. 190
    11.2.1 System Description ...................................... 190
    11.2.2 Output Volume Velocity ................................... 190
    11.2.3 On-Axis Pressure ........................................ 191
    11.2.4 Fourth-Order Band-Pass Functions ............................. 192
    11.2.5 System Parameters ...................................... 192
    11.2.6 Design with a Given Driver ................................ 193
  11.3 6th-Order Bandpass Systems .................................... 193
    11.3.1 System Transfer Function .................................. 193
    11.3.2 System Alignment Functions ................................ 195
    11.3.3 System Design from Specifications ............................ 196
    11.3.4 Example System Design ................................... 197
  11.4 Passive Radiator Systems ..................................... 198
    11.4.1 System Transfer Function .................................. 198
    11.4.2 Example System Design ................................... 200
  11.5 Assisted Vented-Box Alignments ................................ 201
    11.5.1 System Transfer Functions .................................. 201
    11.5.2 5th-Order Alignments .................................... 202
    11.5.3 6th-Order Alignments .................................... 203
    11.5.4 The Vented-Box System Parameters ............................. 204
    11.5.5 Example Design from Specifications ............................. 204
  11.6 A Closed-Box System Equalizer ................................ 206
    11.6.1 Equalizer Transfer Function ................................ 206
    11.6.2 Equalizer Circuit ....................................... 207
    11.6.3 Example Realization ...................................... 207
  11.7 Driver Parameter Measurements ................................ 208
    11.7.1 Basic Theory .......................................... 208
    11.7.2 The Measurement Test Set .................................. 209
    11.7.3 Measuring $R_E$, $f_S$, $Q_{MS}$, $Q_{ES}$, and $Q_{TS}$ ........ 210
    11.7.4 Measuring $V_{AS}$ ....................................... 211
    11.7.5 Conversion to Infinite-Baffle Parameters ...................... 212
    11.7.6 Measuring the Voice-Coil Inductance ........................... 212
  11.8 Parameter Measurement Summary Sheet ............................. 215
CONTENTS

12 Audio Power Amplifiers 217
12.1 Power Specifications .......................... 217
12.2 Effects of Feedback ........................... 219
  12.2.1 Feedback Amplifier Gain ................... 219
  12.2.2 Effect of Feedback on Distortion and Noise 220
  12.2.3 Effect of Feedback on Output Resistance........ 220
12.3 Amplifier Model ............................... 221
  12.3.1 Open-Loop Transfer Function ............... 222
  12.3.2 Gain Bandwidth Product .................... 223
  12.3.3 Slew Rate ................................. 224
  12.3.4 Relations between Slew Rate and Gain-Bandwidth Product 224
  12.3.5 Closed-Loop Transfer Function .............. 225
  12.3.6 Transient Response ......................... 225
  12.3.7 Input Stage Overload ....................... 226
  12.3.8 Full Power Bandwidth ....................... 227
  12.3.9 Effect of an Input Low-Pass Filter .......... 229
  12.3.10 JFET Diff Amp ............................ 231
  12.3.11 Diff Amp with Current-Mirror Load ........ 232
12.4 Signal Tracing .................................. 233
12.5 The Stability Criterion ....................... 236
  12.5.1 The Bode Stability Theorem .......... 236
  12.5.2 Single-Pole Amplifier ............... 238
  12.5.3 Two-Pole Amplifier ....................... 239
  12.5.4 An Alternate Stability Criterion ........ 241
12.6 Techniques for Compensating Feedback Amplifiers 242
  12.6.1 Gain Constant Reduction ............... 243
  12.6.2 First Pole Lag Compensation .......... 244
  12.6.3 Second Pole Lead Compensation .......... 245
  12.6.4 Feedforward Compensation .............. 246
12.7 Output Stage Topologies ...................... 247
  12.7.1 Common-Collector Stage .................. 247
  12.7.2 Common-Emitter Stage .................... 249
  12.7.3 Quasi-Complementary Output Stage .... 250
  12.7.4 MOSFET Output Stages ................. 250
12.8 Voltage Gain Stage ............................ 251
12.9 Input Stage .................................... 252
12.10 Completed Amplifier Circuit ................. 254
12.11 Protection Circuits .......................... 256
  12.11.1 BJT Protection Circuits ............... 256
  12.11.2 MOSFET Protection Circuits .......... 259
12.12 Power Supply Design ......................... 260
12.13 Decoupling and Grounding ................. 262
12.14 Power Dissipation and Efficiency .......... 264
12.15 The Class-D Amplifier ....................... 265
12.16 Amplifier Measurements ..................... 271
12.17 Problems .................................... 275

A References 281

B Electroacoustic Glossary of Symbols 283

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Preface

This book is an outgrowth of a senior level elective course in audio engineering that I have taught to electrical engineering students at the Georgia Institute of Technology. The first part of the book covers basic acoustics. The emphasis is on that part of acoustics that pertains to the field of audio engineering. Most of the remainder of the book concerns the application of the tools of electroacoustics to the analysis and synthesis of microphones, loudspeakers, crossover networks, and acoustic horns. The book also concludes with a chapter that covers the basic theory of audio amplifier design.

Electroacoustics is that part of acoustics that pertains to the modeling of acoustical systems with electrical circuits. Because most acoustical devices have a mechanical part, the modeling of mechanical systems with electrical circuits is a basic part of electroacoustics. Separate chapters in the book are devoted to analogous circuits of mechanical systems and to analogous circuits of acoustical systems. The traditional approach in these circuits has been to use transformers to model the coupling between the electrical, the mechanical, and the acoustical parts. A major departure in this book is the use of controlled sources to model the coupling. An advantage of this approach is that it avoids the need for mobility analogs. In addition, I have found that students have much less difficulty with the approach. Perhaps this is because the controlled-source circuits are more intuitive than the transformer circuits. The circuits can be easily analyzed with circuit simulation software such as SPICE.

Electroacoustic models are developed for the more common microphone types and for the moving-coil loudspeaker driver. Separate chapters cover closed-box and vented-box loudspeaker systems. Although the emphasis is on basic system theory, practical methods of design are also presented. Because crossover networks are such an important part of loudspeaker systems, a chapter is devoted to crossover networks. Acoustic horns are a vital component in public address systems. A chapter is devoted to horn models. A chapter entitled “A Loudspeaker Potpourri” covers topics such as the isobaric loudspeaker connection, band-pass systems, passive-radiator systems, equalized systems, and loudspeaker parameter measurements. In all cases, SPICE simulation examples are presented where appropriate.

One might ask why a chapter on audio amplifiers is included in a book that is primarily concerned with electroacoustics. Without a power amplifier, a loudspeaker could not make sound. Therefore, one might say that the role of an amplifier in a system is just as important as the role of a loudspeaker. The chapter on amplifiers is not intended to be an in-depth chapter on electronic theory. Instead, it addresses the more important aspects of amplifier design with an emphasis on the basic operation of the circuits. Practical examples are presented that illustrate how some of the pitfalls of amplifier design can be avoided.

In the text, two parallel lines between variables denote the product divided by the sum, i.e.

\[ \frac{x}{y} = \frac{xy}{x + y} \]

An errata and updates can be found at http://users.ece.gatech.edu/mleach/audiotext/.

W. Marshall Leach, Jr.
April 2003
Index

A-weighting filter, 10
Acoustic compliance, 37, 39, 114
Acoustic horn
    Analogous circuit, 151
    Catenoidal, 148
    Condition for maximum power, 157
    Conical, 148
    Cutoff frequency, 149
    Efficiency, 158
    Exponential, 148
    High-frequency range, 158
    Horn driving unit, 155
    Hyperbolic, 148
    Low-frequency range, 158
    Mid-frequency range, 156
    Mouth area, 150
    Phase correction plug, 155
    Power radiated, 156
    Propagation constant, 149
    Salmon’s family of horns, 147
    SPICE examples, 151
    Throat admittance, 149
    Upper cutoff frequency, 159
    Webster horn equation, 147
Acoustic image, 22
Acoustic impedance, 34, 44
Acoustic intensity, 18
Acoustic low-pass filter, 42
Acoustic pressure, 34, 37, 40, 114, 128
Acoustic mass, 6, 15
Acoustic reflections, 28
Acoustic resistance, 34, 36, 37
Acoustic suspension system, 116
Acoustical absorber, 113
Adiabatic process, 15
Air suspension system, 116
Ambient pressure, 2, 16
Amplifier
    Amount of feedback, 219
    Average power, 217, 271
    Bandwidth, 271
    BJT safe operating area, 257
    Bode stability criterion, 237, 241
    Bridge rectifier, 260, 261
    Bridged configuration, 218, 267
    Center clipping, 248
    Central ground, 260, 262
    Class A, B, AB, and C, 249
    Class D, 265
    Clipping voltage, 261
    Closed-loop gain, 219
    Closed-loop transfer function, 225
    Common collector output stage, 247
    Common drain output stage, 250
    Common emitter output stage, 249
    Common source output stage, 250
    Compensating capacitor, 221, 245
    Crossover distortion, 248
    Current limiter, 256, 259
    Current-mirror diff-amp load, 232
    Damping factor, 221, 272
    Dc feedback, 100%, 234, 254
    Differential input range, 227
    Distortion, 220
    Efficiency, 264
    Electronic notation, 217
    Feedback ratio, 219, 254
    Feedforward compensation, 246, 249, 254
    Filter capacitors, 262
    Filterless Class D, 270
    Full-power bandwidth, 228
    Fusing, 261
    Gain constant reduction, 243
    Gain peaking, 240, 243
    Gain-bandwidth product, 223
    Ground loop, 262
    Grounding and decoupling, 262, 263
    Heat sink dissipation, 264
    Input low-pass filter, 253
    Input stage, 252
    Input stage overload, 227, 229, 230, 253
    Intermodulation distortion, 274
    Intrinsic emitter resistance, 222, 253
    JFET input stage, 231
    Lag compensation, 245

286
Lead compensation, 242, 245
Loop-gain transfer function, 236
Measurements, 271
Model, 221
MOSFET threshold current, 252
Noise, 220
Op-amp approximation, 219
Open-loop gain, 219
Oscillations, Conditions for, 237
Output resistance, 221, 272
Parasitic oscillations, 248, 254, 259
Peak power, 218
Phase margin, 237, 239, 240, 242, 243
Power supply, 260
Power supply voltage, 261
Power switch, 261
Power transformer, 260–262
Protection circuits, 256
Quasi-complementary output stage, 250
Ringing, 240
Shoot through, 269
Signal tracing, 233
Signal-to-noise ratio, 272
Slew limited output voltage, 227
Slew rate, 224, 272
Strapped configuration, 218
Sziklai output stage, 249
Thermal runaway, 248, 252
Total harmonic distortion, 273
Transient response, 226, 240
Triangle wave generator, 269
Unity-gain frequency, 223, 238, 239
VI limiter, 257
Voltage gain, 271
Voltage gain stage, 251

Bandpass systems
Fourth order, 190
Pressure sensitivity, 192
Sixth order, 193
Pressure sensitivity, 196

Capacitor transducer, 56
Cardioid microphone, 80
Cardioid pattern, 81
Cavity microphone, 63
Charles-Boyle gas law, 15
Closed-box system, 113
Analogous circuits, 115
Combination analogous circuit, 115
Compliance ratio, 115
Design from specifications, 121

Design with a given driver, 120
Diaphragm volume displacement, 122
Effect of box volume, 118
Equalized, 206
Equalizer circuit, 207
Lower cutoff frequency, 119
On-axis pressure, 117
Reference efficiency, 121
Relations to infinite-baffle parameters, 117
Rule of thumb for $Q_{MC}$, 117
Sensitivity of lower cutoff frequency, 119
Small-signal parameters, 116
SPICE example, 123
Comb filter effect, 29
Combination microphone, 80
Compliance ratio, 115
Condenser microphone, 56, 67
Buffer amplifier, 72
Critical polarizing voltage, 70
Equivalent circuit, 70
Phantom powering, 72
SPICE example, 70
Condenser transducer, 56, 68
Crossover frequency, 163
Crossover network, 163
Active filter networks, 178
All-pass functions, 175
Constant-voltage functions, 175
Cutoff frequency, 163
Effect of driver phase response, 170
Effect of voice-coil impedance, 169
First order networks, 164
L-pad design, 167
Matching network, 169, 182
Second order networks, 165
SPICE example, 180
Third order networks, 166
Zobel network, 169
Crystal transducer, 55
Coupling coefficient, 56

Density of air, 2, 16
Diaphragm reflections, 64
Driver parameter measurements, 209
Compliance box, 211
Measurement summary sheet, 215
Test setup, 209
Voice-coil inductance, 212
Drone cone, 198
Dual circuits, 52
Dual Helmholtz system, 193
Dynamic microphone, 73
Effective acoustic volume, 114
Effective density, 114
Electret condenser microphone, 68
Electromagnetic-mechanical transducer, 52
Electrostatic loudspeaker, 56
Electrostatic-mechanical transducer, 55
End corrections, 41
Equal-loudness contours, 7
Euler equation, 147
Far-field distance, 25
Filling, 113
Fletcher-Munson contours, 7
Force source, 49
Free-field microphone, 63
Frequency band
  Audible, 2
  Human speech, 4
  Infrasonic, 2
  Octave, 4
  Ultrasonic, 2
Fresnel diffraction, 26
Gradient microphone, 77
Graphic equalizer, 5
Helmholtz equation, 17
Helmholtz frequency, 128
Helmholtz resonator, 42, 127
Hookup wire, 262
Impedance analogous circuit, 33, 49
Infinite-baffle system, 116
Infrasonic band, 2
ISO frequencies, 4
Isobaric connection, 187
Isobaric region, 187
Isothermal process, 113
Kinetic energy density, 18
Loudness compensation, 8
  Loudness control, 8
Loudspeaker enclosure
  Dimension ratios, 120
  Internal bracing, 121
  Internal dimensions, 121
  Volume occupied by driver, 120
Mass loading factor, 114
Mechanical compliance, 50
Mechanical diagram, 51
Mechanical mass, 50
Mechanical resistance, 50
Mechanical systems, 51
Mechano-acoustic transducer, 60
Mel pitch, 3
Mobility analogous circuit, 33, 49
Moving-coil loudspeaker, 85
  Acoustic power response, 104, 105
  Combination analogous circuit, 89, 90
  Diaphragm, 85
  Diaphragm displacement, 105
  Diaphragm displacement limit, 87
  Displacement limited power rating, 107
  Dust cover, 86
  Eddy current losses, 88
  Electrical power rating, 106
  Electrical quality factor, 92
  Former, 86
  Frequency of peak displacement, 105
  Frequency of peak response, 99
  High-frequency analogous circuit, 93
  Long voice coil, 86
  Low-frequency analogous circuit, 91
  Lower cutoff frequency, 97, 98
  Magnet assembly, 86
  Mechanical quality factor, 92
  Motional impedance, 100
  On-axis pressure phase response, 96
  On-axis pressure transfer function, 95
  Parameter measurements, 209
  Peak diaphragm displacement, 106
  Piston radius, 87
  Pressure function alignments, 97
  Pressure sensitivity, 102
  Reference efficiency, 105
  Resonance frequency, 91
  Short voice coil, 86
  SPICE models, 108
  SPL sensitivity, 102
  Suspension, 85
  Total quality factor, 91
  Upper cutoff frequency, 98, 99
  Voice coil, 86
  Voice-coil equivalent circuit, 101
  Voice-coil impedance, 100
  Voice-coil inductance, 88, 102
  Voice-coil resistance, 88
  Volume compliance, 92
  Volume velocity transfer function, 91
Moving-coil transducer, 52, 73
Mutual coupling, 48
Near-field diffraction, 27
Octave, 4
Particle displacement, 19
Particle velocity, 15
Passive radiator system, 198
Pattern beamwidth, 25
Phase of transfer function, 171
Phon, 9
Piston area, 21
Piston range, 163
Pitch, 3
  Perception of, 4
Plane circular piston, 23, 43, 45, 46
Plane wave, 17
Plane-wave tube, 34
Potential energy density, 18
Pressure source, 33
Pressure-zone microphone, 63
Proximity effect, 79, 81
Pulsating sphere, 21, 34
Radiation pattern, 25
Radiation resistance, 22
Reactance annulling, 149
Real-time spectrum analyzer, 5, 12
Reduced wave equation, 17
Ribbon microphone, 75
Root mean square, 6
Sallen-Key filter, 178, 179, 205
Simple spherical source, 21
Sone, 9
Sound level meter, 7
Sound pressure level, 6, 7, 10
Specific impedance, 17, 20
Spectral density, 12
Spherical wave, 20
Steradian, 22
Test signals
  Pink noise, 5, 11, 12
  Sine wave, 11
  Square wave, 11
Three-way system, 163
Total volume compliance, 116
Two-way system, 163
Ultrasonic band, 2
Velocity microphone, 77
Velocity of sound, 2, 16
Velocity source, 49
Vented-box system, 127

Analogous circuits, 127
B4 alignment, 132
C4 alignment, 133
Combination analogous circuit, 128
Design from specifications, 140
Design with a given driver, 135
Effect of the vent, 128
Equalized, 201
Example pressure responses, 135
Fifth-order alignment, 202
Magnitude-squared function, 131
On-axis pressure, 130
QB3 alignment, 133
Rule of thumb for $Q_L$, 135
Sixth-order alignment, 203
SPICE examples, 141
Vent length formula, 136
Voice-coil impedance, 130
Virtual work, 58
Voice-coil polarity, 172
Volume velocity, 21
Volume-velocity source, 33
Wave equation for $p$, 16
Wave equation for $\vec{u}$, 16
Wavelength, 19
Wavenumber, 17
Zobel network, 169, 254