

Contents

Introduction *xi*

1 Introduction to RF electronics *1*

- The electromagnetic spectrum *1*
- Units and physical constants *2*
- Microwave letter bands *5*
- RF components, layout, and construction *7*
- Coaxial cable transmission line (“coax”) *14*
- Warning *18*

2 RF components and tuned circuits *19*

- Tuned resonant circuits *19*
- Vectors *19*
- Inductance and inductors *21*
- Capacitors and capacitance *33*
- Voltage and current in capacitor circuits *40*
- Tuned RF/IF transformers *51*

3 Variable capacitors in RF circuits *59*

- Straight-line capacitance vs straight-line capacitors *63*
- Special variable capacitors *64*
- Varactor applications *69*
- Note and warning! *70*

4 Winding your own coils *73*

- Amidon Associates coil system *74*
- Making your own toroid-core inductors and RF transformers *77*
- Ferrite and powdered-iron rods *92*
- Project 4-1 *95*
- References *104*

5 Radio receivers: Theory and projects 105

- The tuner 106
- Tuned radio-frequency (TRF) receivers 110
- Superheterodyne receivers 112
- Receiver circuits you can build 126

6 Direct-conversion radio receivers 143

- Basic theory of operation 143
- Problems associated with DCR designs 146
- Some practical design approaches 156
- References and notes 170

7 RF amplifier and preselector circuits 171

- JFET preselector circuits 173
- MOSFET preselector circuits 176
- Noise and preselectors 179
- Broadband RF preamplifier for VLF, LF, and AM BCB 179
- Broadband RF amplifier (50- Ω input and output) 187
- Broadband or tuned RF/IF amplifier using the MC-1350P 188
- VLF preamplifier 189
- Conclusion 192

8 Building IF amplifiers 193

- Amplifier circuits 193
- Cascode pair amplifier 195
- “Universal” IF amplifier 196
- Coupling to other filters 200
- IC IF amplifiers 200
- IF processing ICs 203
- Successive detection logarithmic amplifiers 203
- Filter switching in IF amplifiers 205
- References 206

9 Interpreting radio receiver specifications 207

- A hypothetical radio receiver 207
- Units of measure 211
- Dynamic performance 230
- Dynamic range 235
- Receiver improvement strategies 240
- References 241

10 Building signal-generator and oscillator circuits 243

- Types of oscillator circuits 243
- 1- to 20-MHz crystal oscillator 245
- HF/VHF buffer amplifier 247

455-kHz AM IF-amplifier test-and-alignment oscillator 248
Signal generator for the AM and shortwave bands 249

11 RF directional couplers 253

Conclusion 257
References 257

12 The RF hybrid coupler 259

Applications of hybrids 259
Phase-shifted hybrids 262
Conclusion 264

13 Building simple VLF radio receivers 267

Receiver types 268
Tuning circuit problems 270
A VLF receiver project 276
References and notes 284

14 What's that mess coming from my receiver? 285

Radio station interference 285
Other interference 289

15 Filtering circuits against EMI 293

Means of EMI transmission 293
Electronic noise 295
Counters to EMI 296
Common mode and differential currents 298
AC power line filtering 302
Special medical EMI problems 302
Computer EMI 303
Conclusion 304

16 Measuring inductors and capacitors at RF frequencies 305

VSWR method 305
Voltage divider method 307
Signal generator method 309
Frequency-shifted oscillator method 309
Using RF bridges 310
Finding parasitic capacitances and inductances 315
Conclusion 317

17 Building and using the RF noise bridge 319

Adjusting antennas 321
Resonant frequency 322
Capacitance and inductance measurements 324

18 Vectors for RF circuits 327

19 Impedance matching: Methods and circuits 331

- Impedance matching approaches 332
- L-section network 332
- Pi- (π) networks 334
- Split-capacitor network 335
- Transmatch circuit 335
- Coaxial cable balun transformers 338
- Matching stubs 338
- Quarter-wavelength matching sections 339
- Series-matching section 340

20 Using the double-balanced mixer (DBM) 343

- Diplexer circuits 344
- JFET and MOSFET doubly balanced mixer circuits 347
- Doubly balanced diode mixer circuits 350
- Bipolar transconductance cell DBMs 355
- Preamplifiers and postamplifiers 359
- Conclusion 363
- References 363

21 PIN diodes and their uses 365

- PIN diode switch circuits 366
- PIN diode applications 369
- Conclusion 373

22 UHF and microwave diodes, transistors, and integrated circuits 375

- Diode devices 375
- Introduction to negative resistance ($-R$) devices 382
- UHF and microwave RF transistors 399
- Semiconductor overview 400
- Selecting transistors 413

23 LC RF filter circuits 431

- Low pass, high pass, bandpass, and notch 431
- Filter applications 432
- Filter construction 434
- Filter design approach 435
- Low-pass filters 435
- High-pass filters 437

Bandpass filters	440
Notch filters	443
More on bandpass filters	447
Conclusion	447

24 Time-domain reflectometry on a budget 449

The basis of TDR	449
The pulse source	450
Test set-up	451
Some actual measurements	451

25 Solving frequency drift problems 455

Frequency shift problems	455
Drift problems	457
VHF problems	458
Problems with older equipment	462
Heat problems	462
Equipment modifications	462

26 The Smith chart 463

Smith chart components	463
Smith chart applications	475

27 Detector and demodulator circuits 487

AM envelope detectors	487
Noise	494
Balanced demodulators	494
Synchronous AM demodulation	495
Double-sideband (DSBSC) and single-sideband (SSBSC) suppressed carrier demodulators	495
FM and PM demodulator circuits	502
Discriminator circuits	503
Ratio detector circuits	504
Pulse-counting detectors	506
Phase locked loop FM/PM detectors	507
Quadrature detector	508

Index 511

About the author 534