

Contents

1 Introduction	1
1.1 History	1
1.2 Generic Transceiver	7
1.3 Modulation and Multiple Access	7
1.4 RF Frequency Bands	8
1.5 Channel Capacity	9
1.6 Air Propagation	9
1.7 Overview of RF Applications and Markets	11
1.8 Mobile Phones	11
1.9 Wireless Local Area Networks	15
1.10 Positioning	19
1.11 Radio Frequency Identification	24
1.12 IC Foundries and Markets	26
1.13 Overview IC Design	28
1.14 Tutorials	37
References	38
2 Transceiver Architectures	41
2.1 Receiver	41
2.2 Transmitter	52
2.3 Transceiver Example	55
2.4 Smart Antenna Transceivers	56
2.5 Tutorials	57
References	58
3 S-Parameters and Impedance Transformation	61
3.1 Reflection Coefficient	62
3.2 Smith Chart	63
3.3 Signal Flow Analysis	66
3.4 S-Parameters	68
3.5 Parameter Conversion	71
3.6 Impedance Transformation	73
3.7 Tutorials	80
References	82

4 RF Basics	83
4.1 Stability	83
4.2 Power Gain	87
4.3 Noise	92
4.4 Linearity and Compression	102
4.5 Dynamic Range	109
4.6 Tutorials	111
References	112
5 Transistors and Technologies	113
5.1 Invention of Transistor and Integrated Circuit	113
5.2 Charge Transport in Transistors	115
5.3 Materials	118
5.4 MOSFET	123
5.5 MESFET	161
5.6 HEMT	168
5.7 Bipolar Transistor	171
5.8 Heterojunction Bipolar Transistor	180
5.9 BiCMOS	183
5.10 Overview of Noise Performances	184
5.11 Conclusions	185
5.12 Tutorials	187
References	189
6 Passive Devices and Networks	195
6.1 Transmission Lines	195
6.2 Inductors	200
6.3 Transformers	214
6.4 Capacitors	219
6.5 Varactors	221
6.6 Resistors	222
6.7 Signal Pads	224
6.8 Wiring	225
6.9 Simple Filters	229
6.10 Combiners and Dividers	231
6.11 Tutorials	236
References	238
7 Basic Amplifier Circuits	241
7.1 Topologies	241
7.2 Stabilisation Networks	265
7.3 Bias Supply	267
7.4 Wideband Amplifiers	274
7.5 Tutorials	283
References	285

8 Low Noise Amplifiers	287
8.1 Design Strategies	287
8.2 Narrow-Band Design	289
8.3 Wideband Design	298
8.4 Tutorials	309
References	310
9 Power Amplifiers	313
9.1 Choice of Basic Amplifier Topology	314
9.2 Classic Current Source Based Amplifiers	315
9.3 Switched Amplifiers	327
9.4 Summary	341
9.5 Efficiency and Linearity Enhancement Techniques	343
9.6 Power Combining	352
9.7 Tutorials	355
References	357
10 Mixers	359
10.1 Nonlinearities and Mixing Products	360
10.2 Noise	363
10.3 Topologies	364
10.4 Tutorials	382
References	382
11 Oscillators	387
11.1 Simple Time Domain Model	388
11.2 Feedback Theory	390
11.3 Negative Resistance Theory	391
11.4 Noise	397
11.5 Topologies	405
11.6 Design Examples	415
11.7 Tutorials	426
References	428
12 Phase Locked Loops and Synthesisers	431
12.1 Phase Locked Loop Basics	431
12.2 Integer-N Synthesiser	438
12.3 Fractional-N Synthesisers	442
12.4 Tutorials	445
References	446
13 Amplitude Control and Switches	447
13.1 Attenuators and Switches	449
13.2 Variable Gain Amplifiers	455
13.3 Tutorials	462
References	463

14 Phase Shifters	465
14.1 Varactor Tuned Transmission Lines	465
14.2 Reflective Type Phase Shifters	470
14.3 Vector Modulators	476
14.4 Digitally Adjustable Phase Shifters	482
14.5 Phase Control Range/Frequency Multiplication	482
14.6 Comparison of Phase Shifters	484
14.7 Tutorials	484
References	484
15 RF Measurement Basics	487
15.1 Overview	487
15.2 The 50 Ω Reference Impedance	489
15.3 Basic Equipment	490
15.4 Key Measurements	495
15.5 Tutorials	502
References	503
Abbreviations and Symbols	505
Index	509
About the Author	515