Contents

1 Introduction **19**

2 Basic Considerations **23**

2.1 Devices for a Polymer Transponder 24

2.1.1 Polymer Capacitors 25

2.1.2 Polymer Diodes 30

2.1.3 Polymer Field Effect Transistors 34

2.1.4 Digital Polymer Circuits 40

2.2 Applicable RF Links 44

2.2.1 Backscatter 45

2.2.2 Capacitive Coupling 48

2.2.3 Inductive Coupling 49

3 Outline of the RFID System **55**

3.1 Inductively Coupled Antennas 56

3.1.1 Antenna Model 56

3.1.2 The Coupling Coefficient 62

3.2 Inductively Coupled Resonance Circuits 66

3.2.1 Resonance Conditions 66

3.2.2 Transfer Function of Coupled Resonance Circuits . 67

3.2.3 Load Modulation 70

3.3 The Reader Front End 73

3.3.1 Power Supply via Lossless Transmission Lines . . . 73
3.3.2 Reader Antenna Matching 75
3.3.3 Antenna Power and H-Field Intensity 78
3.4 Transfer Function of the RFID System 79

4 Polymer Rectifiers 87
4.1 The Polymer Diode Model 88
4.1.1 Static Current-Voltage Characteristic 89
4.1.2 Capacitance-Voltage Characteristic 90
4.1.3 Polymer Diode Parameter Extraction 93
4.1.4 Transient Behavior of the Polymer Diode 95
4.1.5 The Polymer Diode Based Rectifier 100
4.1.6 Design and Optimization of the Polymer Diode . . 101
4.2 Performance of Polymer Rectifiers 104
4.2.1 Transfer Characteristic 106
4.2.2 Frequency Characteristic 107
4.2.3 Load Characteristic 108
4.2.4 Charging Time 110
4.3 Polymer Rectifiers Applied to Resonance Circuits 113
4.3.1 Input Capacitance of the Polymer Rectifier 113
4.3.2 Input Resistance of the Polymer Rectifier 115
4.3.3 Load Modulation Characteristic 119

5 System Design and Results 123
5.1 System Design and Optimization 125
5.1.1 Polymer Transponder Chip 125
5.1.2 Rectifier Selection 127
5.1.3 Transponder Antenna Design 129
5.1.4 Operating Range 131
5.2 Realization of a Polymer 13.56MHz Transponder 134
5.3 System Simulation 137
5.3.1 Overall RFID System Model 138
5.3.2 Transponder Modulation Circuit 140

5.3.3 Coding and Communication Protocols 141
5.3.4 Reader Demodulation Circuit 143
5.3.5 The Influence of Motion 145

6 Summary and Outlook **153**

A Measurement Devices **157**

B Simulation Software **159**

Glossary **161**

Bibliography **168**