
Contents

Preface	ix
Chapter 1. Introduction to Chipless RFID Technology	1
1.1. Introduction	1
1.2. Introduction to RFID	1
1.2.1. Introduction	1
1.2.2. Passive, semi-passive and active transponders	2
1.2.3. RFID versus barcode	5
1.3. Chipless RFID	5
1.3.1. Principle of operation	5
1.3.2. Chipless RFID in-between RFID and the barcode	7
1.3.3. UWB chipless RFID	9
1.4. Conclusion	19
Chapter 2. UWB Chipless RFID Reader: State of the Art	21
2.1. Introduction	21
2.2. SFCW approach	23
2.3. FMCW approach	24
2.3.1. Frequency-coded tag reader	25
2.3.2. Time-coded tag	30
2.4. SFCW-FMCW versus IR-UWB	33
2.4.1. Introduction	33
2.4.2. UWB regulations	34
2.4.3. Link budget	35
2.4.4. Conclusion	38
2.5. Conclusion	38

Chapter 3. IR-UWB Chipless RFID Reader Design	41
3.1. Introduction.	41
3.2. IR-UWB reading system based on test equipment	42
3.3. Sequential equivalent time principle	44
3.4. Intermediate reader version	46
3.4.1. Schematic	46
3.4.2. Implementation of the sequential equivalent time principle	48
3.5. Integrated reader design	50
3.5.1. Hardware architecture	50
3.5.2. Improvement of S/H amplifier–ADC connection	54
3.5.3. FPGA architecture	56
3.5.4. Reader specifications.	59
3.6. Measurement results of frequency-coded tags	60
3.7. Conclusion	64
Chapter 4. Optimized IR-UWB Chipless RFID Reader	67
4.1. Introduction.	67
4.2. ADC noise theory	68
4.3. Reduced reader jitter: implemented hardware solution	72
4.3.1. Temporal characterization of reader’s RF front-end	76
4.4. FPGA architecture.	77
4.4.1. Reducing reading time	78
4.4.2. Solving acquisition synchronization problems.	83
4.4.3. Demonstration of the resolution of synchronization problems.	89
4.5. Reader specifications	90
4.6. Reader’s power supply board	91
4.7. Reader’s tag measurements	92
4.8. Frequency-based reader versus IR-UWB with different jitter levels	95
4.9. Conclusion	99
Chapter 5. UWB Pulse Generator and Antenna Design	101
5.1. Introduction.	101
5.2. UWB pulse generator design	102
5.2.1. Introduction to UWB pulse generator design	102
5.2.2. B-UWB-PG architecture.	104
5.2.3. B-UWB-PG simulation model	108
5.2.4. Measurement results	112
5.2.5. Output stage considerations.	116

5.2.6. Conclusion	121
5.3. Measurement of a UWB pulse generator frequency-coded tag	122
5.3.1. Measurement results of the pulse generator	123
5.3.2. Conclusion	125
5.4. UWB antenna design	126
5.5. Conclusion	129
Chapter 6. UWB Chipless RFID Reading System Independent of Tag Orientation	133
6.1. Introduction.	133
6.2. Principle of operation	134
6.3. VNA balanced measurements	139
6.3.1. Variation of the transmitting signal direction α_t	139
6.3.2. Isolating the cross-polarized component in reception.	145
6.3.3. Measurements of cross-polarized tags.	145
6.4. Tag measurements using the VNA: a simplified approach	148
6.4.1. Practical approach	148
6.5. Optimized reader approach.	152
6.6. Conclusion	157
Appendices	159
Appendix 1. Matlab[®] GUI Acquisition Software for Agilent DSO91204A	161
Appendix 2. PC Application Software for First Reader Version in Chapter 3.	165
Appendix 3. Matlab[®] GUI Reader in Chapter 4	169
Appendix 4. Schematic Power Supply Board Reader in Chapter 4.	171
Appendix 5. Matlab[®] GUI Acquisition Software for VNA N5222A Performing Balanced Measurement.	173
Bibliography	177
Index	185