
Contents

1	Introduction	14
1.1	Historical Development	16
1.2	Proven in several applications	18
1.3	Innovation as a driver	21

Part 1: Technical Fundamentals

2	RFID technology	24
2.1	What is an RFID system?	24
2.2	The components of an RFID system	25
2.2.1	Reading device	25
2.2.2	Antennas	28
2.2.3	Transponders	29
2.3	Classification of RFID systems	30
2.3.1	Passive systems	30
2.3.2	Semi-active systems	34
2.3.3	Active systems	35
2.4	Frequency bands and their properties	35
3	Optical codes	38
3.1	Success and limits of barcodes	38
3.2	Standards regarding the 2D code	39
3.2.1	Technology standards	39
3.2.2	Application standards	40
3.3	Data Matrix Code features	41
3.3.1	Data Matrix Code structure	41
3.3.2	Codable data with Data Matrix ECC200	42
3.3.3	Error correction and security aspects	43
3.4	Application and marking methods	44
3.4.1	Application of labels	44
3.4.2	Direct marking processes	45
3.4.3	Verification of the Code Quality	47
3.5	Reading systems and their properties	48
3.5.1	Components of a data matrix reading system	48
3.5.2	Stationary reading systems	48
3.5.3	Mobile reading systems	50

Contents

3.5.4	Physical and technical data integration	50
3.6	Achieve good read results	52
3.6.1	Optimization of the optical conditions	53
3.6.2	Minimization of the material ambient conditions' influence	54
3.6.3	Meeting the technological requirements	55
3.7	Outlook and new developments	55
4	System architecture	57
4.1	Overview	57
4.1.1	Software in RFID and Auto ID systems	57
4.1.2	System characteristics	58
4.1.3	Processes, applications, and marginal conditions	58
4.2	System levels	60
4.2.1	Components	60
4.2.2	Topologies	61
4.2.3	Application levels	62
4.2.4	Edgeware	63
4.3	Integration	64
4.3.1	System interfaces	64
4.3.2	Communication layers	64
4.3.3	Technologies	65
4.4	Data flow and data management	66
4.4.1	RFID and Auto ID data	66
4.4.2	Object identification	67
4.4.3	Distributed mobile databases	67
4.4.4	Hybrid approaches	68
4.5	System management	68
4.5.1	Device management	68
4.5.2	Edge server management	69
4.5.3	Security	69
4.5.4	Availability	70
4.5.5	Extendibility and adaptability	70
4.5.6	Invoicing functions	71
4.6	The EPCglobal Network	71
4.6.1	Overview	71
4.6.2	EPCIS and ALE	72
4.7	Summary	72
5	System selection criteria	74
5.1	Automatic identification with Data Matrix Code	75
5.2	"Open Loop" applications with RFID	77
5.3	"Closed Loop" applications in RFID	78
5.4	Conclusion: both technologies complement each other	80

6 Standardization	82
6.1 Why is standardization important?	82
6.2 Standardization basics for RFID	83
6.3 The central RFID standard ISO 18000	85
6.4 Further useful standards and guidelines	86
6.5 Standardization of visual codes	88
6.6 Standardization through EPCglobal and GS1	89
6.7 Conclusion and forecast	90

Part 2: The Practical Application of RFID and Auto ID

7 Process design and profitability	94
7.1 The fear of bad investment	94
7.2 It all starts with visions and objectives	95
7.3 How does the company work?	96
7.4 The business case for RFID	98
7.4.1 The concept of the calculation of profitability	98
7.4.2 Procedure for RFID projects	99
7.5 The RFID business case in practice	101
7.6 Technology can inspire – but it must “fit”	103
8 Introduction to the practical application of RFID	104
8.1 Feasibility test / Field test	105
8.1.1 Objectives of a feasibility test/field test	105
8.1.2 Performing the tests	106
8.1.3 Results of the feasibility/field test	107
8.2 Solution design and pilot operation	108
8.2.1 Objectives of pilot operation	109
8.2.2 Results of pilot operation	110
8.3 Roll-out	110

Part 3: Current Applications – from the Factory to the Hospital

9 Manufacturing control	114
9.1 The dilemma of modern competition	114
9.2 The production of individualized serial products	117
9.3 Autonomous production systems with Auto ID	118
9.4 Decentralizing production data with RFID	121
9.5 Technical requirements	122
9.6 Is RFID worthwhile in Production?	123

10 Production logistics	126
10.1 Logistics and corporate success	126
10.2 Processes in production logistics	127
10.3 RFID in production logistics	128
10.4 Application examples	130
10.4.1 Automatic order consolidation increases efficiency	130
10.4.2 RFID optimizes picking for assembly provision	131
10.4.3 Transparent processes in reusable transport trusses	131
10.4.4 Replenishment is ensured	132
10.4.5 The matching seat for the right car	132
10.5 Summary and forecast	133
11 Container and Asset Management	135
11.1 Requirements for Container Management	135
11.1.1 Motivation	136
11.1.2 Objectives	137
11.1.3 Standardizing	137
11.1.4 Technical Specifications	139
11.1.5 Data structures	139
11.1.6 Additional peripheral processes	141
11.2 Economic viability	141
11.3 Container and Asset Management in Practice	142
11.4 Business models	145
11.4.1 Rental	145
11.4.2 Sale and repurchase model	146
11.5 Perspective	146
12 Tracking and Tracing	148
12.1 Application areas	149
12.1.1 Discrete manufacturing	149
12.1.2 Process industry	151
12.1.3 Tracking and Tracing in logistics	152
12.2 Drivers for Tracking and Tracing	153
12.2.1 Corporate advantages	153
12.2.2 Legal regulations and standards	153
12.2.3 Consumer protection	153
12.2.4 Transparency for end users	154
12.3 Advantages of Tracking and Tracing	154
12.3.1 Reactive Quality management	155
12.3.2 Proactive Quality Assurance	155
12.4 Tracking and Tracing in practice	155
12.5 Perspective	157

13 Optimization of Supply Networks	158
13.1 Increasing variety	158
13.2 Change of the demands on business processes	159
13.3 New business processes require new technologies	161
13.4 Advantages of RFID employment across the board	162
13.5 Further development options	164
14 Vehicle logistics	167
14.1 Special requirements	167
14.2 Technical basis	168
14.3 Application scenarios	169
14.3.1 Utilization at automobile groups	170
14.3.2 Fleet management for public local transport	172
14.3.3 Dock and yard management	174
15 RFID at the airport	177
15.1 Processes in airport logistics	177
15.2 Areas of use for RFID in airport logistics	180
15.2.1 Process optimization on the airside and landside	180
15.2.2 RFID on container transport container transport systems	181
15.2.3 RFID BagTag	182
15.2.4 RFID-supported servicing	183
15.2.5 Improvement in the catering area	184
15.2.6 RFID in Cargo Logistics	185
15.2.7 Advantages due to RFID	186
15.3 Perspectives	186
16 Postal automation	188
16.1 Auto ID in postal logistics	189
16.2 RFID – the innovative Auto ID technology	191
16.2.1 RFID-based application systems	193
16.3 Outlook	196
16.3.1 Printable transponders with polymer technology	196
16.3.2 RFID transponders with visual, readable information	196
16.3.3 “Internet of things”	196
16.3.4 RFID in future postal logistics	197
17 RFID in hospitals	198
17.1 Potential of RFID in the health sector	198
17.2 Reference projects	199
17.2.1 Jacobi Medical Center and Klinikum Saarbruecken	199
17.2.2 MedicAlert	200
17.2.3 “Klinikum rechts der Isar”	201

17.3	The economical value of RFID	204
17.4	RFID in the future	204
17.5	Conclusion	207

Part 4: How to proceed?

18	RFID – printed on a roll	210
18.1	Protection of trade marks with printed electronics and RFID .	211
18.1.1	Trade mark protection for flawless mixtures	211
18.1.2	Dine without disgust	212
18.1.3	Identifiability creates clarity in the supply chain	212
18.2	Technological basics	213
18.3	Possible solutions using printed RFID	215
19	RFID and sensors	217
19.1	Motivation	217
19.2	Technical basis	218
19.2.1	Schematic structure of RFID sensors	218
19.2.2	Decentralized sensor data storage	219
19.2.3	Systems available	219
19.2.4	Central sensor data storage	222
19.3	Initial applications	223
19.3.1	Temperature monitoring for blood preserves	223
19.3.2	Quality assurance for worldwide container transports ..	224
19.4	Possible future applications	224
19.4.1	Temperature	224
19.4.2	Temperature and relative air humidity	225
19.4.3	Acceleration	225
20	RFID security	227
20.1	Data protection	227
20.1.1	Personal profiles	228
20.1.2	External attacks	228
20.2	Information security	230
20.2.1	Protection of saved data	230
20.2.2	Protection of data transmission	230
20.3	Classic protection measures	231
20.3.1	Symmetrical encryption	231
20.3.2	Problems in the use of symmetrical encryption	232
20.4	Protection against complex threats	233
20.4.1	Creation of RFID clones	233
20.4.2	Protection measures by means of certificate-based solutions	234

Contents

20.4.3 Asymmetric cryptography and PKI	235
20.4.4 RFID and PKI	235
20.5 Security in RFID standardization	236
21 Epilogue: En route to the “internet of things”	238
Bibliography	245
Editor and authors	247
Index	252