

# Inhaltsverzeichnis

<b>List of Acronyms</b> .....	<b>5</b>
<b>1 Introduction</b> .....	<b>7</b>
1.1 Millimeter-Wave Systems and Antenna Integration .....	7
1.2 Outline of the Thesis .....	9
1.3 Main Contributions .....	10
References.....	11
<b>2 Basic Considerations on Planar mm-Wave Antenna Development</b> .....	<b>14</b>
2.1 Fundamental Parameters of Antennas .....	14
2.1.1 Field Regions .....	14
2.1.2 Radiation Patterns and Antenna Gain .....	15
2.1.3 Antennas in Wireless Systems .....	17
2.2 Planar Antennas .....	19
2.2.1 Planar Dipole Antenna .....	19
2.2.2 Rectangular Patch Antenna.....	23
2.2.3 Vivaldi Antenna .....	25
2.2.4 Antenna Arrays.....	26
2.3 Substrates .....	27
2.3.1 Dielectric Characterization.....	27
2.3.2 Substrate Waves .....	29
2.4 Antenna Measurement .....	35
2.5 Preliminary Considerations on mm-Wave Antenna Design and Integration .....	38
2.5.1 Chip-on-Board with Integrated PCB Antenna .....	38
2.5.2 Antenna Integrated In-Package and Antenna Integrated On-Chip.....	40

2.6	Design Flow and Methodology .....	44
2.7	Conclusions .....	46
	References .....	47
<b>3</b>	<b>Integrated PCB Antenna Designs for 60 GHz Applications .....</b>	<b>54</b>
3.1	Introduction .....	54
3.2	RF PCB Substrates Characterization and Selection .....	55
3.2.1	Theory of Planar Transmission Line Approach for Substrate Characterization.....	57
3.2.2	Prototype Measurement and Verification .....	59
3.3	Millimeter-Wave Interconnects .....	63
3.3.1	Wire-Bonding and Bond-Wire Compensation.....	63
3.3.2	Flip-Chip and Stud Bumps .....	67
3.4	60 GHz Antenna Designs and Demonstrators .....	69
3.4.1	Differential Bunny-Ear Antenna.....	69
3.4.2	60 GHz Demonstrator with Bunny-Ear Antenna .....	73
3.4.3	Differential Patch Array Antenna .....	75
3.4.4	Differential Patch Array Antenna with Beamforming Function .....	80
3.5	Conclusions .....	82
	References .....	83
<b>4</b>	<b>Integrated On-Chip Antennas .....</b>	<b>87</b>
4.1	State-of-the-Art On-Chip Antenna Solutions in Silicon Technologies.....	88
4.2	Technology Overview.....	90
4.3	On-Chip Antenna Designs with Air Cavity Under the Radiator .....	91
4.3.1	130 GHz Antenna Design and Prototype Measurement .....	91
4.3.2	245 GHz Transceiver with Integrated On-Chip Antenna .....	96
4.4	On-Chip Antenna Designs with Air Trenches Around the Radiator .....	100
4.4.1	Patch Antenna.....	100
4.4.2	Double Folded Dipole Antenna .....	105
4.5	Conclusions .....	109
	References .....	109

<b>5 Antenna Designs by Applying Wafer-Level Integration Technology</b> .....	<b>112</b>
5.1 Technology Overview.....	112
5.2 122 GHz Antenna Design.....	113
5.3 Prototype Measurement.....	115
5.3.1 Transition Structure and Interconnect Characterization.....	115
5.3.2 Antenna Measurement.....	117
5.4 Conclusions.....	120
References.....	121
<b>6 Conclusions and Future Work</b> .....	<b>124</b>
References.....	126
<b>Appendix A</b> .....	<b>128</b>
<b>Publications</b> .....	<b>130</b>