

Contents

Abstract	1
Zusammenfassung	3
Nomenclature	5
1 Introduction	9
1.1 Motivation	10
1.2 State-of-the-Art Comparison	11
1.3 Approach and Challenges	13
2 Fundamentals	15
2.1 Microstrip Line	15
2.2 Antenna Fundamentals	18
2.2.1 General	18
2.2.2 Properties	20
2.3 Packaging	24
2.4 Radar	24
2.5 Simulation	28
2.5.1 Commercial Electromagnetic Solvers	28
2.5.2 System Modeling	29
3 Antenna Design	31
3.1 Overview	31
3.2 On-Chip Antennas	34
3.3 Off-Chip Antennas	40
3.3.1 Fabrication Process of Quartz Wafers	40
3.3.2 Patch Antenna	42
3.3.3 Array Antenna	44
3.3.4 Stacked Patches	44
3.4 Improval Extensions	56
3.4.1 Array	56
3.4.2 Reflector	59
3.4.3 Lens	59
3.5 Summary	60
4 System Design	63
4.1 System Model	63

4.2	Printed Circuit Boards	67
4.2.1	Carrier Board	67
4.2.2	Submount	71
4.3	Monolithic Microwave Integrated Circuits	74
4.3.1	$\times 12$ Frequency Multiplier	75
4.3.2	Transmitter $\times 3$ Frequency Multiplier	76
4.3.3	Receiver and Frequency Multiplier	76
4.3.4	System Simulation	77
4.4	Packaging	78
4.4.1	Packaging of the $\times 12$ Frequency Multiplier	78
4.4.2	Packaging of the $\times 3$ Frequency Multiplier	81
4.4.3	Transition to the Antenna	82
4.4.4	System Simulation	84
4.5	Lens Fabrication	85
4.5.1	Single Antenna Lens	85
4.5.2	Double Antenna Lens	87
4.5.3	System Simulation	90
4.6	Summary	91
5	Module Measurements	93
5.1	Transmitter Module at 300 GHz	93
5.2	Transceiver Module at 300 GHz	97
6	Conclusions	105
A	Matlab Model	109
	Bibliography	113