Contents

1 Introduction **1**
- 1.1 Astronomical relevance of the Q and W Bands . . . 1
- 1.2 Heterodyne Receivers . . . 2
  - 1.2.1 Receiver Noise . . . 4
- 1.3 Focal Plane Imaging Arrays . . . 4
- 1.4 Millimeter-Wave Mixers . . . 6
- 1.5 Low Noise Amplifiers . . . 7
- 1.6 Hypothesis . . . 7
- 1.7 Objectives . . . 8
- 1.8 Outline of this thesis . . . 8

2 Tapered Slot Antennas **9**
- 2.1 Introduction . . . 9
- 2.2 Design . . . 10
  - 2.2.1 Antenna Design . . . 10
  - 2.2.2 Transition from Slot Line to Waveguide . . . 16
  - 2.2.3 Clamping of the Antenna . . . 18
- 2.3 Construction and Measurements . . . 18
- 2.4 Conclusion . . . 19

3 Mixers **26**
- 3.1 Introduction . . . 26
- 3.2 Single-Ended diode mixer . . . 27
- 3.3 Sub-harmonic Mixers . . . 28
- 3.4 Schottky Diodes . . . 29
- 3.5 W-Band Mixer . . . 31
  - 3.5.1 UMS Diodes . . . 31
  - 3.5.2 Design . . . 31
  - 3.5.3 Construction and Measurement . . . 34
- 3.6 Band-2+3 Mixers . . . 36
  - 3.6.1 Design . . . 36
  - 3.6.2 Construction and measurement . . . 38
- 3.7 MMIC Mixer . . . 38
  - 3.7.1 Design . . . 38
- 3.8 Conclusions . . . 46

4 Low Noise Amplifiers **47**
4.1 High Electron-Mobility Transistors (HEMTs) . . . 47
4.1.1 HEMT Modelling . . . 48
4.2 Design of Low Noise Amplifiers . . . 49
4.2.1 Design of a Single Stage Amplifier . . . 49
4.2.2 Noise . . . 50
4.2.3 Stability . . . 51
4.3 Q-Band LNA . . . 51
4.3.1 Single Transistor . . . 52
4.3.2 MMIC . . . 52
4.3.3 Input and Output Lines . . . 54
4.3.4 Matching Lines . . . 54
4.3.5 Mechanical Design . . . 55
4.3.6 Measurements . . . 55
4.3.7 Cryo3 + MMIC Amplifier . . . 59
4.4 W-Band LNA . . . 60
4.4.1 Waveguide to microstrip transition: . . . 62
4.4.2 Noise measurement . . . 63
4.5 Conclusions . . . 68

5 Compact down-converter module **69**
5.1 Introduction . . . 69
5.2 Construction . . . 69
5.3 Measurements . . . 70
5.4 Conclusions . . . 72

6 Conclusions and Future Work **73**

Bibliography **75**