

Table of Content

1	Introduction	1
1.1	Radio and microwave amplification technologies	2
1.1.1	KI-TWPAs	3
1.2	Mathematical model of KI-TWPAs	5
1.3	Identification of the problem	6
1.4	Hypothesis	6
1.5	Objectives of the thesis	6
1.6	Outline of the thesis	7
2	Theoretical framework	8
2.1	Parametric Amplification	8
2.2	Superconductors	10
2.3	Transmission Lines	12
2.3.1	Basics	12
2.3.2	Geometries	14
2.3.3	Superconductors instead of conductors	17
2.3.4	Dispersion engineered transmission lines	19
2.4	Four-wave-mixing	23
2.5	Multiple scales method	24
2.6	Summary	25
3	Solution to the non-linear wave equation in four-wave-mixing	27
3.1	Models and zones	27
3.2	Solution to each model	28
3.3	Pump alone (p case)	29
3.4	Target signal and pump ($s - p$ case)	30
3.5	Inclusion of the idler signal ($s - p - i$ case)	31
3.6	Inclusion of $3\omega_p$ ($s - p - i - 3p$ case)	31
3.7	Important remarks	32
3.8	General considerations	32
3.9	Summary	33
4	CPW simulations: zones and models	34
4.1	Design	34
4.2	Pump frequency near 2 nd stopband	36
4.3	Pump frequency near 1 st stopband	44

4.4	Conclusions	45
5	Microstrip simulations: a design guide	47
5.1	Step 1: obtain large $\delta\beta$	47
5.2	Step 2: suppress $3\omega_p$ with ω_p in zone 3 where the non-linear term is larger than RG term	49
5.3	Gain results	52
5.4	Conclusions	54
6	Artificial-CPW simulations: for future experimental validation of the models	56
6.1	Pump frequency near 1 st stopband	56
6.2	Conclusions	58
	Conclusions and future work	64
	Bibliography	65
A	Derivation of models	69
A.1	Definition of zones (step 1)	69
A.2	Derivation of the amplitude equations	72
A.2.1	Step 2	72
A.2.2	Step 3	72
A.2.3	Step 4	73
A.2.4	Step 5	73