

Contents

1	Introduction	1
2	Tunable Microwave Dielectrics	3
2.1	Dielectric Properties	3
2.2	Pyroelectricity	5
2.3	Ferroelectricity	6
2.4	Piezoelectricity and Electrostriction	9
2.5	Electrostatic Properties	11
3	Processing of Ferroelectric Films and Components	13
3.1	Processing of BST Thick-Film Components	13
3.1.1	Screen-Printed Thick-Film Ceramics	13
3.1.2	Planar Circuitry Realization and Reliability	17
3.2	Processing of BST Thin-Film Components	25
3.2.1	BST Thin-Film by RF Sputtering and Pulsed Laser Deposition	25
3.2.2	Realization of Thin-Film Components	28
3.3	Characterization and Modeling of Lossy Varactors	31
4	Novel Multilayer Components on BST Thin-Films	37
4.1	Acoustic-Free BST Thin-Film Varactor	37
4.1.1	Acoustic Properties	38
4.1.2	Modeling of Multilayer Acoustic Resonator	43
4.1.3	Suppression of Acoustic Resonances	46
4.2	Programmable Bi-stable Capacitor	49
4.2.1	Non-volatile Bi-stability by Induced Hysteresis	50
4.2.2	Long-Term Stability	54
5	Tunable Multiband Ferroelectric Devices	55
5.1	Tunable Multiband Antennas	56
5.1.1	Theoretical Analysis: Q Factor, Bandwidth and Tunability	57

5.1.2	Nonlinear Model of Capacitively Loaded Planar Inverted-F Antenna.....	66
5.1.3	Suppression of Harmonic Radiation by BST Thick-Film Varactors	76
5.1.4	Independently Tunable Multiband Slot Antenna.....	79
5.1.5	Integrated Duplex Ceramic Antenna	84
5.2	Tunable Single-Band Impedance Matching Network for Antennas.....	87
5.2.1	Theoretical Analysis: Single-Band Design Guidelines.....	88
5.2.2	Optimal Design with Lossy Components	97
5.2.3	Antenna Bandwidth Enhancement	100
5.2.4	System in Package Realization	104
5.2.5	Efficiency of Adaptive Control	110
5.3	Tunable Multiband Matching Network	116
5.3.1	Polynomial Synthesis Method for Impedance Matching ...	116
5.3.2	Polynomial Optimization for Component Loss Compensation	121
5.3.3	Impedance Matching Ranges	124
5.3.4	Proof of Concept	127
5.4	Tunable Substrate Integrated Waveguide Bandpass Filter	130
5.4.1	Bandpass Filter Design	131
5.4.2	Tunable Evanescent-Mode Substrate Integrated Waveguide Cavity.....	132
5.4.3	Tunable Impedance Matching Network	133
5.4.4	Realization and Measurement	135
6	Summary and Outlook	137
A	Technology Parameters	141
	References	143