Xs	The surface reactance.
X_r	The antenna reactance.
YBCO	Yttrium Barium Copper Oxide.
Z0	Characteristic impedance.

Chapter 1
Introduction

1.1 History

Superconductivity was discovered in 1908, when H. Kamerlingh Onnes initiated the field of low-temperature physics when he successfully liquefied Helium in his laboratory by cooling it to 4°K. In 1911, Onnes found that the dc resistance of solid Mercury suddenly vanished at 4.2°K, and according to him, "Mercury has passed into a new state, which on account of its extraordinary electrical properties may be called the superconductive state", and so the field of superconductivity was born. The next year Onnes discovered that the application of a sufficiently strong axial magnetic field restored the resistance to its normal value. In 1913, he found that Lead was superconductor at 7.2° K, and he was awarded the Nobel Prize [1, 2].

In 1933 the next important step in conductivity occurred, when Meissner and Ochsenfeld found that superconductors are more than a perfect conductor of electricity, they also have an interesting magnetic property of excluding a magnetic field, not allowing a magnetic field to penetrate its interior. The report of the Meissner effect led the London brothers, Fritz and Heinz in 1935, to propose equations that explain this effect and predict how far a static external magnetic field can penetrate into a superconductor [1, 3].

In1941Niobium Nitride was found to superconduct at 16°K. The next theoretical advance came in 1950 when combined the Landau's theory of second order phase transition with a Schrodinger-like wave equation, this leads to the phenomenological Ginzburg-Landau theory, which described superconductivity in terms of an order parameter and practically predicts the division of superconductors into the two categories type | (LTS) and type|| (HTS).

In the same year it was predicted theoretically by Maxwell and Reynolds et al. that the transition temperature would decrease as the average isotopic mass increased. This effect, called the isotope effect which provided support for the electron–phonon interaction mechanism of superconductivity.

The present theoretical understanding of the superconductivity nature is based on the BCS microscopic theory proposed by J. Bardeen, L. Cooper, and J. R. Schrieffer in 1957, and they received the Nobel Prize in Physics for it, in 1972 [1].

In 1962, the first commercial superconducting wire –a Niobium Titanium alloy- was developed by researchers at Westinghouse. In the same year, Josephson made the important theoretical prediction that superconduct can flaw between two pieces of superconductor separated by a thin layer of insulator.

The period from 1930 to 1986 can be called the Niobium Era of superconductivity, and the new period that began in 1986 might become the Copper Oxide Era, when a brief article, entitled 'Possible High Tc Superconductivity in the La–Ba–Cu–O System' was published. In 1986, IBM researchers Georg Bednorz and Alex Müller were experimenting with a particular class of metal oxide ceramics called Perovskites. Bednorz and Müller surveyed hundreds of different oxide compounds. Working with ceramics of Lanthanum, Barium, Copper, and Oxygen they found indications of superconductivity at 35°K, a startling 12°K above the old record for a superconductor [1].

By the beginning of 1987, a Perovskite ceramic material was found to superconduct at 92°K. This discovery was very significant because now it became possible to use liquid Nitrogen as a coolant. As a practical matter, 77°K, the boiling point of liquid Nitrogen, is an important milestone because liquid Nitrogen is relatively cheap and readily available.

Early 1988, Allen Hermann of the University of Arkansas makes a superconducting ceramic (Tl–Ba–Ca–Cu–O) containing Calcium and Thallium that superconducts at 120 °K. Soon after, IBM and AT&T Bell Labs scientists produce a ceramic that superconducts at 125°K.

In September 1992, Putillin et al. found that the $HgBa_2CuO_x$ compound with only one CuO_2 layer showed a Tc of up to 94°K. It was, therefore, rather natural to speculate that Tc can increase if more CuO_2 layers are added in the per unit formula to the compound [2].

In 1993, A. Schilling, M. Cantoni, J. D. Guo, and H. R. Ott from Zurich, Switzerland, produces the highest temperature superconductor, which was a ceramic material ($HgBa_2Ca_2Cu_3O_x$) consisting of Mercury, Copper, Barium, Calcium, and Oxygen, with Tc=138°K. [1, 2].

In 2001, the discovery of the first high-temperature superconductor that Does Not Contain Any Copper has been, at or above the temperature of Liquid Nitrogen, or −196 °C (77° K) [2].

In 2005, Superconductors.org discovered that increasing the weight ratios of alternating planes within the layered Perovskites can often increase Tc significantly. This has led to the discovery of no less than 30 new high-temperature superconductors, including a candidate for a new world record [4].

In 2008, Iron-based family of high temperature superconductors was discovered. Hideo Hosono of the Tokyo Institute of Technology and Colleagues found that Lanthanum, Oxygen, Fluorine, Iron and Arsenide ($LaO_{1-x}F_xFeAs$) an

Oxypnictide becomes a superconductor at 26 Kelvin. Subsequent research from other groups suggests that replacing the Lanthanum in $LaO_{1-x}F_xFeAs$ with other rare earth elements such as Cerium, Samarium, Neodymium and Praseodymium leads to superconductors that work at 52°K. Experts hope that having another family to study will simplify the task of explaining how these materials work [2].

The thesis is built around two objectives:

1. To provide an in-depth coverage of the characteristics of tunable resonators made of superconductor materials and its appliances in electronic circuits, which are used in communication systems specifically in the mobile communication systems.
2. To enhance the quality factor of the dielectric tunable resonant filter by reducing the size of the filter.

1.2 Organization of the Thesis

Following this introduction, Chapter 2, illustrates essential information about superconductors, their types, properties, and the important theories in this field.

In Chapter 3, the High Temperature Superconductors (HTS) are illustrated in detail. In addition to an illustrating for the superior microwave characteristics that could be known from the measurements of the surface impedance, which is described in terms of the relevant two-fluid model. An outlined comparison between conventional (CTF) versus empirical (ETF) two fluid models is presented. Finally, the HTS applications are presented in brief.

In Chapter 4, Contains, an overview of microstrip, its effective dielectric constant, wavelength and its characteristic impedance. A comparison of various transmission line types used in microwave ICs is reported. In addition, an illustration of the most important issues that must be concerned in choosing the HTS films substrate and a brief listing for conventional dielectric substrates is given.

In Chapter 5, Ferroelectric materials, their properties, the spontaneous polarization, and Hysteresis Loop of Ferroelectrics are illustrated. A brief comparison between normal and Relaxor Ferroelectrics is reported. Moreover, of Ferroelectrics Perovskite Structure, materials and dielectric properties are illustrated in details elucidating the terms of tunability and the quality factor. Finally, Ferroelectrics applications are discussed, and the Tunable Microstrip Filter is describer in details as an application of the Ferroelectrics in communication systems.

In Chapter 6, some potential electronic HTS applications require multiple layers of superconductor interspersed with ferroelectric material; the most studied example is YBCO thin film on STO substrate material, which is presented in this thesis, studying the propagation characteristics and the quality factor of this Microstrip Resonator numerically, to verify the accuracy of the ETF results over the CTFs, affirming the recent published results. Moreover in this chapter, the ferroelectric size effect is studied and is taken in consideration in simulating HTS Microstrip Resonator Microwave Characteristics. A proposed approach is presented to enhance the quality factor with reducing the dimension of the resonator line, and a study of the dielectric response of depositing STO on NGO is presented.

Lastly, Chapter 7, provides concluding remarks, some of the remaining problems in HTS thin film fabrication, and a brief suggestion for future research work conclude the thesis.

The glossary presents list of definitions for important terms and abbreviations.