AIN SHAMS UNIVERSITY

FACULTY OF ENGINEERING

DEPARMENT ELECTRONICS AND COMMUNICATIONS

Optically Controlled Microstrip Devices using Photonic Crystal Waveguides

A Thesis submitted in partial fulfilment of the requirements of the degree of

Master of Science In Electrical Engineering

Electronics and Communications Engineering

By

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Bachelor of Science in Electrical Engineering

Electronics and Communications Engineering

Faculty of Engineering, Thebes Academy, May 2011

Supervised By

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Cairo - (2016)

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DATA.../…. /… ….

STATEMENT

This thesis is submitted as a partial fulfilment of Master of Science in Electrical Engineering, Faculty of Engineering, Ain Shams University.

The author carried out the work included in this thesis, and no part of it has been submitted for a degree or a qualification at any other scientific entity.

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THESIS PUBLICATIONS

[1] Heba Zakaria, Moataza Hindy, and Adel El-Henawi,“Optically Controlled Triple Notched UWB Antenna”, Proceedings of Progress in Electromagnetics Research Symposium “PIERS”, Prague, Czech Republic, July 6-9,P.P 858-860, 2015.

[2] Heba Zakaria, Moataza Hindy, and Ismail Mohamed Hafez Ismail, “Optically Controlled Microstrip UWB Band-Pass Filter”, New Paradigms In Electronics & Information Technology (PEIT'015), Luxor, Egypt,15-19 Nov. 2015.

Abstract

With the increased requirement for multi-standard/multifunction microwave systems during the last decade, extensive research has been carried out towards the development of optically controlled micro-strip devices such as filters, antennas, couplers…etc. For example, reconfigurability in antennas can be done to alter the radiation pattern, frequency and polarization to improve the overall system performance. The most common methodology adopted for reconfigurability of micro-strip designs are the inclusion of some forms of switching circuitry. Common tuning methods involve the use of varactors, PIN diodes, RF MEMs, ferroelectrics, liquid crystals and optical tuning. The PIN and varactor diodes have many disadvantages including high insertion loss, high power consumption and unacceptable distortion while RF MEMs offer low loss, high Q, less distortion but have very poor switching speeds. Ferroelectric materials also introduce high dielectric losses although they are readily tuned. Liquid crystals have high linearity, low tuning voltage but very small switching time. In contrast, optically controlled silicon switches offer high power handling capability, immunity to electromagnetic interference, very low distortion and cost-effectiveness. In this work optically controlled antennas and filters have been demonstrated.

Conventional optical fibers have some disadvantages such as limited single mode wavelength, very small diameter (difficult to launch light through it), limited power capability, high bending losses and high confinement losses. In order to overcome these problems the conventional optical fibers are replaced by Photonic crystal fiber (PCF). Through the use of photoconductive switches which are controlled using laser diode and optical router. The

microstrip devices configuration and consequently the current density on the microstrip devices may be controlled in a desirable manner to achieve the desired performance.
In this thesis chapter one is an introduction and chapter two is an over view of microstrip devices (Antenna and Filters).

Chapter three is an introduction to optical control using Photonic crystal fiber (PCF).
Chapter four provides optically controlled microstrip antenna using photonic crystal waveguides when this chapter adders a new optically controlled reconfigurable ultra-wideband antenna (UWBA) with triple notched bands. The designed coplanar fed microstrip antenna can work at eight modes using optically controlled switches. This design proposes triple narrow notched bands at center frequencies 3.5GHz “WIMAX”, 5.5GHz “WLAN” and 8.4 GHz.

Similarly optically controlled narrow band reconfigurable microstrip patch antenna using two optical switches is presented. The switch shifts the resonant frequency from 2GHz to 2.7GHz or 2.4GHz.

Chapter five provides optically controlled microstrip filter using photonic crystal waveguides. The work presents optically controlled microstrip filters using different optical power routers. Firstly, a controlled microstrip band pass filter using two optical switches is demonstrated. With the switches are in the ON state, the filter includes dual-mode (UWB) band pass. While in the OFF state, the filter includes triple-mode band pass filter.

Secondly, an optically controlled microstrip ultra-wideband band pass filter is presented. Using optical switches we can obtain either double or triple notches. With all switches are in the ON State, the circuit behaves with dual notch at 4.28 and 6.42GHz while in state 2 the notches are changed at 3GHz and 8.5GHz. But in state 3the filter response converts from a dual notched band to triple notched UWB band pass in the same frequency range. The proposed filter was simulated, manufactured, and tested.

Finally, this work offer a controlled microstrip low pass filter using a single optical switch to allow the filter application or the filter stopping.

The thesis also includes conclusions and future work, as well as a list of references.

Key words:

Reconfigurable antennas _ Band-notch _ Optical switches _ Photonic bandgap _optical control

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