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DESIGN OF DUAL - BAND ANTENNA FOR WIRELESS STRAIN SENSING

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ABSTRACT-A dual-frequency patch antenna was designed. In this paper, two dual-band antennas operating at 5 and 10.5 GHz are proposed and investigated in terms of the strain dependency of their resonances. They are designed to operate as strain-sensing and communicating devices at the same time in a frequency-doubling strain sensor that is interrogated wirelessly by a reader. An integration of transmit and receive antennas into one dual-band structure offers a compact sensor solution. The antennas' resonance frequencies shift if strain is applied, which in the case of the proposed antennas can be used to characterize the strain not only in terms of amplitude, but also direction. A very small size is achieved for an optimized one-feed design, which leads to high strain sensitivity values along one axis.

I .INTRODUCTION

Structural health monitoring (SHM) is the process ofcontinuous surveillance and damage detection on buildings, aircrafts, machines, or other civil structures. Industrialized nations have made huge investments in civil infrastructure and attention must be given to its proper maintenance. The feasibility of applying patch antennas for strain measurement is investigated. The resonance frequency of a patch antenna is determined by the size of its metallic patch. An applied strain changes the dimensions of the metallic patch, resulting in a shift in the antenna resonant frequency. Therefore, the applied strains can be measured from the changes in antenna resonant frequency.

Structural health monitoring (SHM) is a rapidly developing field encompassing the

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technology and algorithms for sensing the state of a structural system, diagnosing the structure's current condition, performing a prognosis of expected future performance, and providing information for decisions about maintenance, safety. Advances in micro-electro-mechanical-systems (MEMS) technology in the past decade provide opportunities for sensing, wireless communication, and distributed data processing for a variety of new SHM applications. There have been several prototypes of sensor networks, emphasizing the sensing devices.

II .LITERATURE SURVEY

[1]Strain measured by two different antenna. In this paper, Atenna Two types are used that is one feed and two feed Antenna made with Roger Duroid 5880 Material. It may achieve the operating frequency 2 to 5.8 Ghz. [2] wireless structural health monitoring was done by multi sensor placed in the structure. Structural health was also monitored by mat lab coding.[3] Kapton substrate Material was used to measured a Applied Strain in a Cantilever beam. Antenna was placed at the opposite end of the beam external strain is applied to the beam and the reasonantfrequency were changed. [4] The integrity of the T-shaped decoupling structure and coupled-fed loop antenna array covers LTE700 (0.747 GHz–0.787 GHz) and WWAN (1.7 GHz– 3.04 GHz) based on −6 dB reflection coefficient and achieves isolation between elements well below −10 dB over all the operating bands. The application platform is LTE700, GSM1700, GMS1800, UMTS, Wi-Fi, Bluetooth, LTE2300, and LTE2500 bands for the 2G/3G/4G mobile terminals.

III.PROPOSED ANTENNA LAYOUT

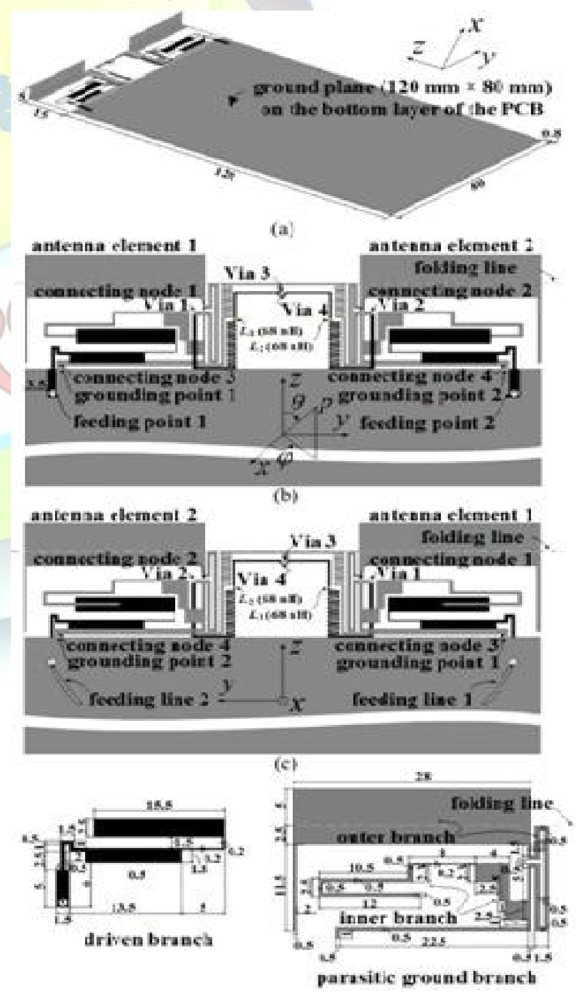

Fig. 1. Geometry and detailed dimensions

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(in millimeters) of the proposed dual-antenna system: (a) three-dimensional view; (b) top view of the unfolded dual-antenna system; (c) bottom view of the unfolded dual-antenna system;

IV.DESIGN CALCULATIONS

The width and length of the patch antenna are calculated by using transmission line design equations. The width of the microstrip patch antenna is given as in equation (1):

$$w = c\frac{c}{2fa} * \sqrt{\frac{2}{\varepsilon r+1}} \quad \text{---- (1)}$$

Where
εr= dielectric constant ofthe substrate
f 0 = frequency of operation,
c =Velocity of light (3 * 108 m/s)
The effective dielectric constant isgivenasin equation (2):

$$\varepsilon reff=\frac{\varepsilon r+1}{2} + \frac{\varepsilon r+2}{2}\left[1 + 12\frac{h}{w}\right]^{-\frac{1}{2}} \text{------- (2)}$$

Where
h=height of substrate.
The effective length is given asin equation (3):

$$leff = \frac{c}{2fo\sqrt{\varepsilon reff}} \quad \text{------ (3)}$$

The length extension isgiven as in equation (4):

$$\Delta l = 0.412h[\frac{(\varepsilon reff+0.3)\left(\frac{w}{h}+0.264\right)}{(\varepsilon reff-0.258)\left(\frac{w}{h}+0.8\right)}] \text{------ (4)}$$

The actual length is obtained byequation (5):

$$L = Leff - 2\Delta L \quad \text{---- (5)}$$

For the design, the ground plane dimensions are given as:

$$Lg= 6h + L \quad \text{---- (6)}$$

$$Wg= 6h + W \quad \text{---- (7)}$$

Strip line feeding:

A strip line fed type-feeding technique is used in this design. The feeding point must be located at that point on the patch where the input impedance is 50 ohms for the resonant frequency.

V. STRAIN MEASUREMENT

The most commonly used sensors for strain monitoring today are piezoresistive strain gauges. Extensive wiring is required to connect these sensors to a base station, which gathers the sensed data. This adds a significant amount of complexity and error sources to the system if, for example, large bridge.

VI. EFFECT OF STRAIN ON MICROSTRIP ANTENNA

The resonant frequency of a rectangular micro strip antenna that consists of a metallic layer on a substrate material with a ground plane on the other side is mainly dependent on the physical L length of the patch. Fringing field effects on the patch edges introduce an imaginary line extension delta L_{ext}, which adds up to the physical length and is linearly dependent on the substrate thickness h.

$$f_{\mathrm{res}} = \underbrace{\frac{c_0}{2\sqrt{\epsilon_{\mathrm{r,eff}}}}}_{k_1} \frac{1}{L + 2\Delta L_{\mathrm{ext}}} = \frac{k_1}{L + k_2 h}$$

where k1 and k2 are constants.

Strain as

$$\varepsilon = \frac{\Delta L}{L_0}.$$

VII. RESULT AND DISCUSS

The table show the different substrate material used for Strain sensing and its result.

Table-I

Different Types of Material Used For Strain Sensing Application

s.no	Strain %	Resonant frequency Non-Flexible FR4	Resonant frequency RT duroid 5880	Resonant frequency polyimide
1	No Load	4.4	3.0	2.4
2	1	4.38	2.97	2.37
3	3	4.37	2.93	2.34
4	5	4.36	2.88	2.30
5	7	4.34	2.83	2.26

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