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DESIGN AND ANALYSIS OF COMPACT MICROSTRIP CIRCULAR RESONATOR WITH SLOTTED IN GROUND PLANE AS A GRAIN MOISTURE SENSOR

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ABSTRACT

The circular microstrip resonator (CMR) as a moisture sensor was analyzed for detecting the moisture content in grains. The design was proposed with the help of CST software at operating frequency 11.5GHz on X-Band. The size of the sensor was 13mm×13mm. The substrate was used FR4 with relative permittivity, thickness and loss tangent were 4.4, 1.676, and 0.001 respectively. The reflection coefficient was found -27.58dB at operating microwave frequency 11.5GHz, satisfied the condition (≤-10dB). The voltage standing wave ratio (VSWR) was found 1.27 at selected frequency 11.5GHz, also satisfied the condition (VSWR≤ 2). The proposed design satisfied all the parameters and this design can be developed and determined actual moisture content (AMC), predicted moisture content (PMC) and mean relative error (MRE), when MRE will be find near to zero then sensor will be more accurate. Hence, it can be said that this sensor will be detect the moisture content (MC) in grains.

Contribution/Originality: The circular microstrip resonator (CMR) as a moisture sensor was analyzed for detecting the moisture content in grains.

1. INTRODUCTION

Microstrip patch antenna has been used in communications such as Wi-Fi, WIMAX, WLAN, Bluetooth etc [1-5]. Now microstrip antenna has been introduced as a moisture sensor for detecting the MC in several fields such as agricultural, textiles, medicines, food products, etc [6-9]. Many different techniques have been introduced for moisture sensor such as transmission/reflection technique, impedance bridge technique, free space technique etc [10-13]. But due to low accuracy, large measurement setup and high cost as well no more success [14-18]. After these techniques introduced the microwave oven drying weight (MODW) has been introduced and this technique is easy, low cost, small measurement setup, high accuracy with less time [19, 20].

In this design introduced for agricultural field, this design will be low cost, small measurement setup and easy to install.

2. CIRCULAR MICROSTRIP RESONATOR SENSOR

The circular microstrip resonator (CMR) sensor was designed by the CST software, top of the sensor with dimensions L_g= 13mm, W_g = 13mm, I_P = 3mm, O_P = 8mm, L_P = 2mm, and W_P = 12mm as shown in Figure 1 (a)

and the square ($L_S \times W_S$ = 3mm×3mm) was slotted in ground plane due to decrease the reflection coefficient as shown in Figure 1 (b). The dimensions of the proposed design as shown in Table 1.

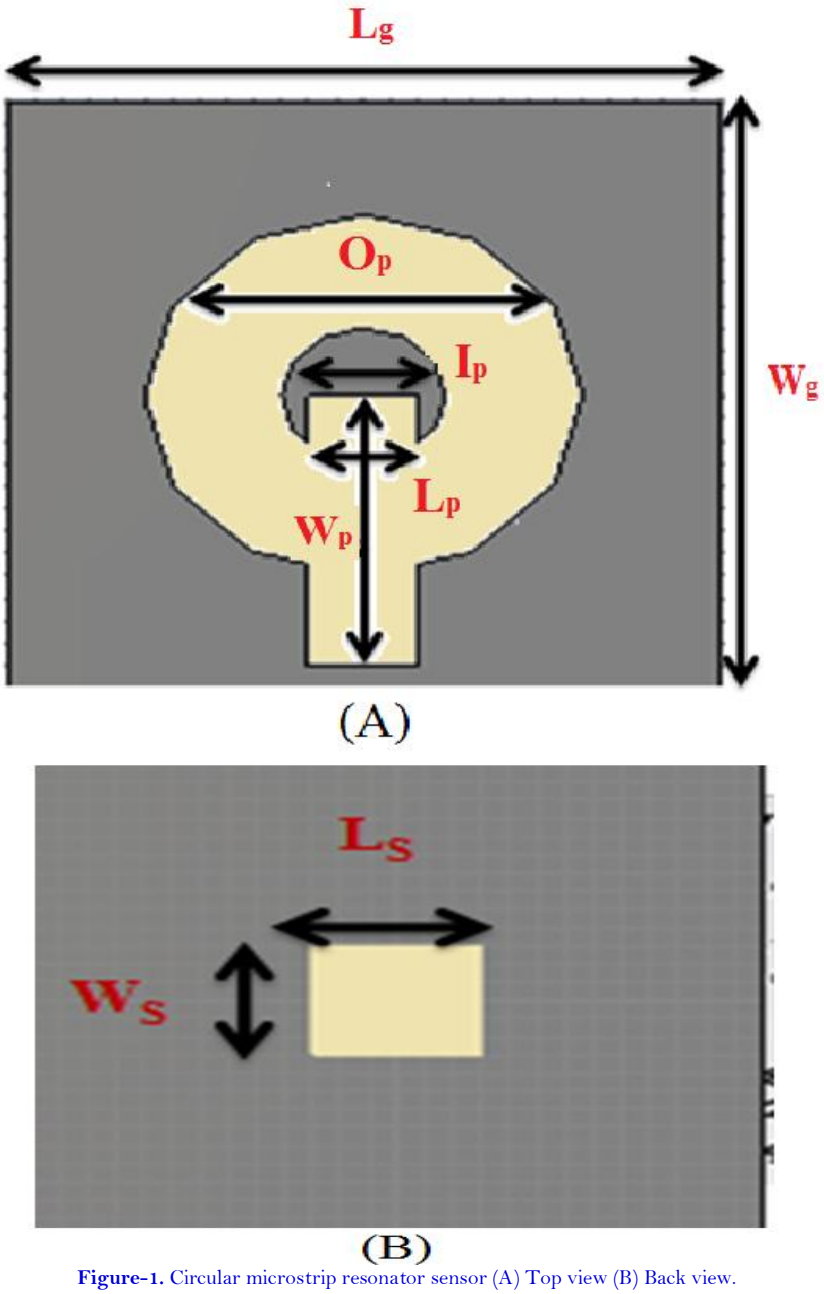

Figure-1. Circular microstrip resonator sensor (A) Top view (B) Back view.

Table-1. Optimized dimensions of Microstrip circular resonator sensor

Parameters	Value
Length of the ground (L)	13mm
Width of the ground (W)	13mm
Outer Radius (O_P)	8mm
Inner Radius (I_3)	3mm
Relative Permittivity (ε_r)	4.4
Loss Tangent (tanδ)	0.001
Thickness (h)	1.676mm

3. RESULTS AND DISCUSSIONS

The proposed design was found -27.59dB at operating frequency 11.5GHz, it is clear that the microstrip patch antenna as a sensor will be helpful for detecting the moisture content in grains because it is satisfied the reflection coefficient condition as shown in Figure 2.

The VSWR of proposed design was 1.27 at operating frequency 11.5GHz, satisfied the VSWR condition (VSWR≤ 2) as shown in Figure 3.

The surface current distribution was found 65.9A/m at operating frequency 11.5GHz, it show as the maximum current density in the design as shown in Figure 4.

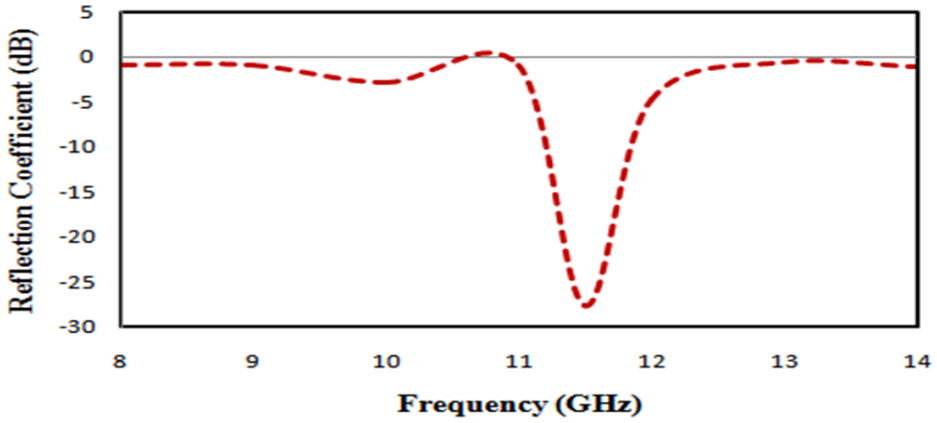

Figure-2. Reflection Coefficient of circular microstrip resonator sensor.

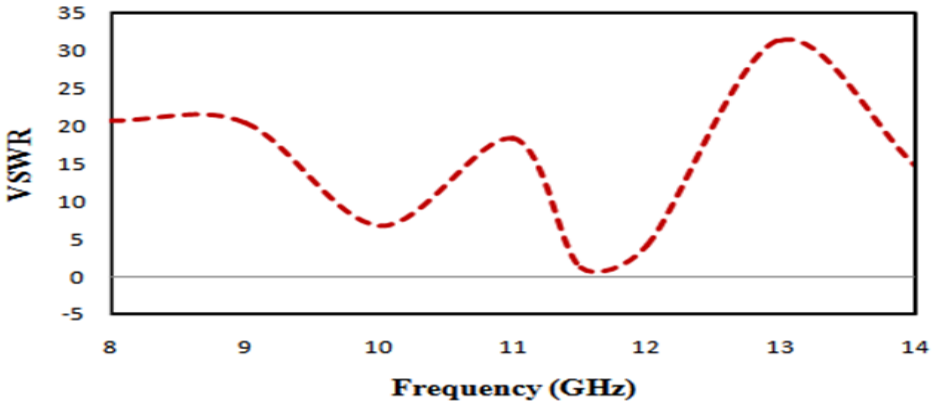

Figure-3. VSWR of circular microstrip resonator sensor.

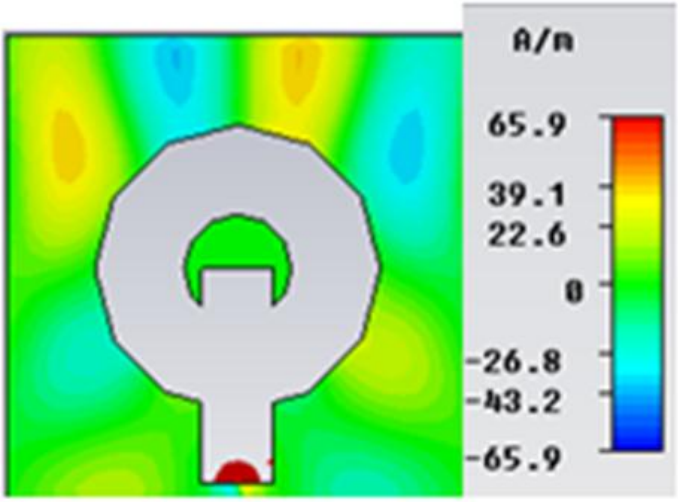

Figure-4. Surface current distribution of circular microstrip resonator sensor.

It is clear, from the given parameters i.e. reflection coefficient, VSWR, and surface current distribution, this design will be helpful for agricultural field with the help of microwave oven drying weight technique.

4. CONCLUSION

The circular microstrip resonator (CMR) as a grain moisture sensor has been beneficial in grains; it will be fabricated on FR4 substrate at operating frequency 11.5GHz on X-Band and measured the reflection coefficient with the help of vector network analyzer (VNA). It can be said that, this sensor will be detect the moisture content (MC) in grains.

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