Compact Miniature Hidden Antennas for Multi Frequency Bands Applications

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ABSTARCT

Advances in integrated RF circuitry and the growing need for multi-frequency processes have caused wireless communications technology to grow exponentially in the last decade. In this approach, measurements and the simulation investigation of the validity usages in different practical application areas of the intended designed compact miniature hidden meander antenna are presented.

KEYWORDS

Meander, Antenna, Multiband, Range, RF.

1 INTRODUCTION

In one embodiment, this paper discloses a compact antenna assembly that is adapted to receive radio waves within the 200MHz – 2800 MHz frequency band. The antenna assembly includes a meander line antenna trace of a desired geometry having a plurality of bends and strips that is configured to reduce the effect of electromagnetic interference. The antenna trace is placed on a dielectric substrate that is configured to receive the antenna trace along a surface thereon. At least one break point element is positioned along the meander line antenna trace wherein the at least one break point element is configured to be positioned along the antenna trace at various locations to adjust a resonant frequency of the antenna assembly according to the desired application.

It is known [1], [2], [3], [4], [5] and [6] that a small printed meander line antenna is a good candidate for single and multi-frequency applications. Paper [3] is devoted to a meander line antenna application in the 300 MHz frequency range. Papers [1] and [4] investigate meander line antennas for the 2.4 GHz WLAN (Wireless local area network) band.

Papers [2], [5] and 6] describe a meander line antenna for RFID (Radio frequency identification) applications. 869 MHz is a typical European frequency for RFID devices. Papers [7] and [8] explore dual band meander line antennas. The antenna described in [7] operates in 824-894 MHz for the advanced mobile phone system (AMPS). The meander antenna with multiple elements examined in [8] is intended for applications in 2 GHz and 5 GHz frequency bands. Triple band meander line antennas are presented in [9] and [10]. Quad band meander mobile phone antenna design [11] has been used with the AMPS/GSM (824-864/890-960 MHz) and the DCS/PCS (1710-1880/1850-1990 MHz) application bands.Below we will show how to use (with minimal modifications) the previously discussed compact meander line antenna intended for RKE applications [12] in different frequency range applications. The antenna shown in Figure 1, can be modified easily to resonate at different frequency bands.

2 MEASUREMENTS

The proposed antenna shown in Figure 1, has been constructed and measured in a very wide frequency range from 200 MHz up to 2800 MHz. The voltage standing wave ratio measurement results represented by the return loss S11 (dB) are shown in Figure 2. Figure 2 also shows the simulation results using software program IE3D. Notably, S11 (dB) is indicative of a reflection coefficient. These results show that the meander antenna of Figure 1 has many resonant frequencies (for example,

between 800MHz and 1000MHz, between 1400MHz and 1600MHz and between 1800MHz and 2000MHz). A satisfactory agreement between the simulated and the measured results can be clearly seen. These results show that this meander antenna has many resonant frequencies. This reflects the performance of this antenna within these resonance frequency ranges.

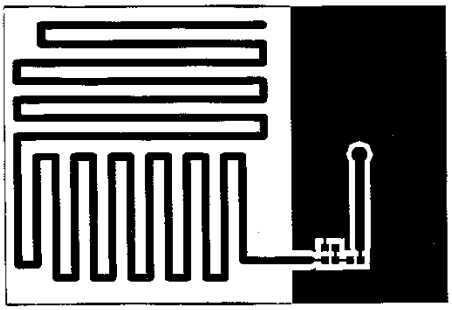

Figure 1. Intended meander antenna design under investigation.

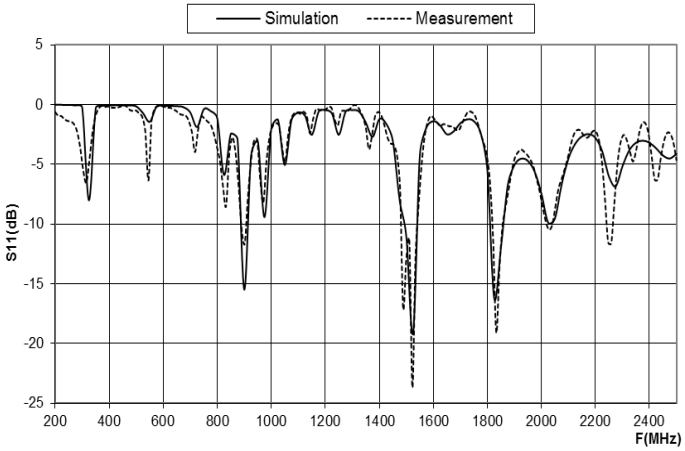

Figure 2. Simulation versus measurement results for the constructed meander antenna under investigation in the 200–2800 MHz frequency band. Solid line: simulation; dashed line: measurements.

Note that without any modifications such an antenna could be used for the following applications: Remote keyless entry (RKE) for automotive applications which fall in the 315 MHz frequency band; Radio Frequency identification (RFID) applications in North America (the frequency band authorized for these applications in North America and Mexico is 902-928 MHz); L-band digital radio in Canada (1452-1492 MHz); DCS/PCS which falls in the frequency band 1850-1990 MHz/1800-1900 MHz; WLAN application fields with a range of 2400-2484 MHz; and many other applications (Bluetooths, cellular, wireless bar code readers, wireless microphones, etc.).

Measurement results show that we can change the meander length to vary the resonant frequency without designing another antenna topology. Figure 3, shows the modified meander line antenna with resistances zero ohm (breaking points) inserted in the meander line positions where the length of the lines can be changed and adjusted according to the intended application. In Figure 3, we see three resistances located in specific positions. Let us assume that resistance number 1 is removed from the meander line. In this case, the antenna resonates at a frequency of 406 MHz which is perfect for Search and Rescue Satellite-Aided Tracking systems (SARSAT).

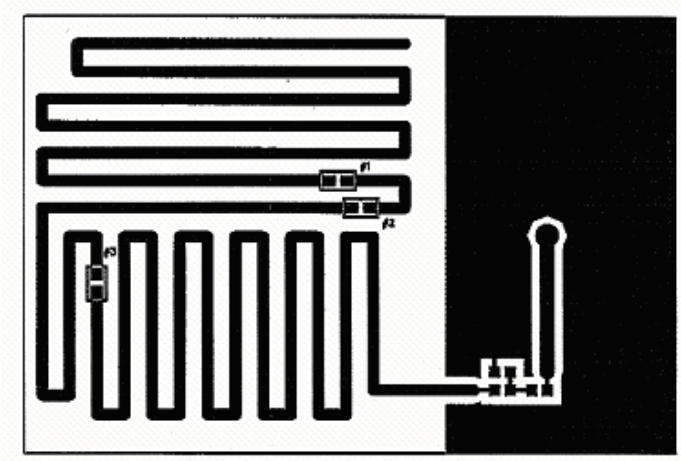

Figure 3. The meander antenna under investigation with three minor modified designed points.

VSWR measurement of the meander antenna with resistance number 1 removed is shown in Figure 4. With this minor modification, the VSWR value becomes 1.495 dB at the frequency 406.00 MHz. This value indicates that we have a very good resonance frequency, tuned and with a performable usage application antenna. VSWR is a measure that numerically describes how well an antenna's impedance matches to an associated radio or transmission line impedance. VSWR can also be seen as a measure of how much power is delivered to an antenna. A value of less than about 2 dB is generally sufficient measurement for VSWR. When resistance number 2 is removed, the meander line antenna becomes tuned to 433.9 MHz. This is an

RKE's frequency for European automotive applications. The measured VSWR for a tuned antenna with this resistance removed is shown in Figure 5.

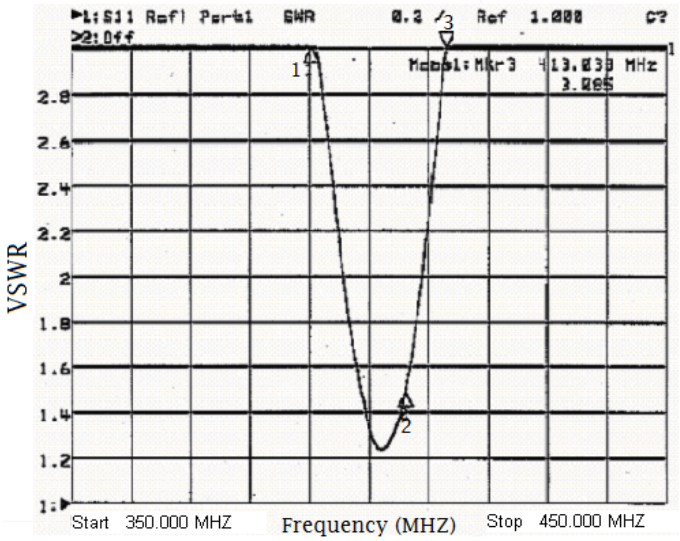

Figure 4. VSWR with resistance point number 1, shown in Figure 3, disconnected. At 406 MHz the SWR = 1.495.

Table 1. VSWR vs Frequency values at each cursor in Figure 4.

Cursor #	Frequency (MHZ)	VSWR
1	390.4000	3.220
2	406.0000	1.495
3	413.0333	3.085

Finally, by removing resistance number 3, we can tune the antenna to a DCS frequency range (1710-1880 MHz). The corresponding curve for the VSWR is presented in Figure 6. As can be seen, the VSWR is optimum for both frequencies (1710 and 1880 MHz), which confirms the validity of this antenna design for this frequency range.

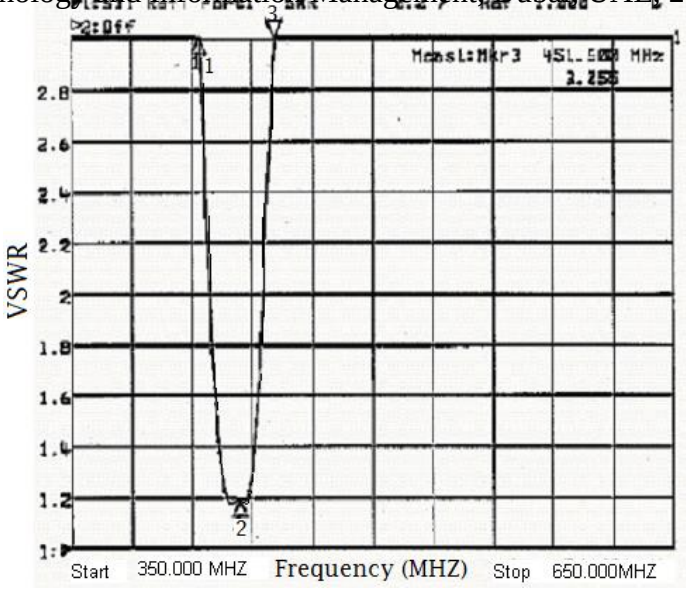

Figure 5. VSWR with resistance point number 2, shown in Figure 3, disconnected. At 433.9 MHz the SWR = 1.195.

Table 2. VSWR vs Frequency values at each cursor in Figure 5.

Cursor #	Frequency (MHZ)	VSWR
1	413.8000	3.230
2	433.9000	1.195
3	451.6000	3.055

3 CONCLUSIONS

The research revealed that meander antennas have minimum VSWR fluctuations within allowable tolerances of the lumped matching elements. Consequently, small size meander line antennas have very stable tolerances, do not require low quality inductors in the matching circuits, and are preferable in production processes. Based on the matched agreement between the measured and the simulated results, the optimum VSWR, the multi-resonance frequency, and the ease of redesign with minor and minimal modifications, the meander line antenna, designed for the 315 MHz RKE application, is dependable, reliable and versatile. It can be used with a wide range of different communication systems that demand different frequencies.

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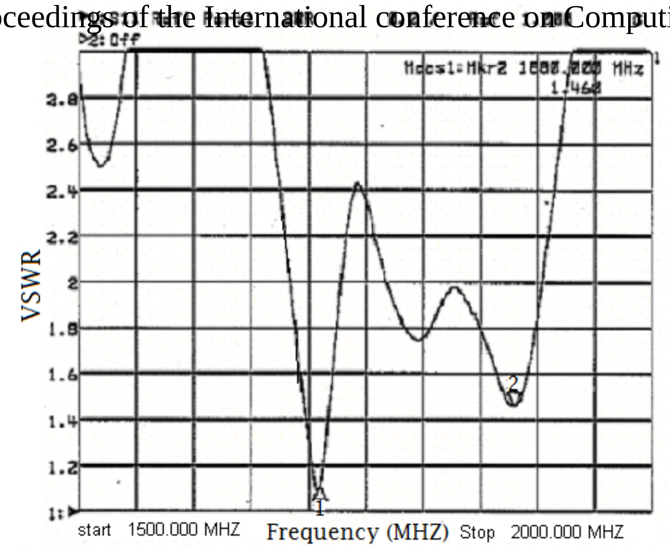

Figure 6. VSWR with resistance point number 3, shown in Figure 3, disconnected. At 1710 MHz the SWR = 1.108 and at 1880 MHz the SWR = 1.460.

Table 3. VSWR vs Frequency values at each cursor in Figure 6.

Cursor #	Frequency (MHZ)	VSWR
1	1710.000	1.108
2	1880.000	1.460

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