Frequency Reconfigurable Active Antenna

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Abstract - **The objective is to design a frequency reconfigurable active antenna which involves the integration of active device such as FET with a passive structure. Here the dual port dual band antenna is independently designed and later connected to one port amplifier using matching network. The passive antenna serves as radiator, frequency selector as well as feedback network for the oscillator. First the two port, dual band antenna is simulated in CST. Then the S parameters of the antenna were substituted in ADS as two port item. Here annular slot antenna with shorted slots was selected as radiator which was designed to resonate at 2.4 GHz and 5.2 GHz respectively. The antenna was connected to the amplifier, the active antenna was then simulated and the simulated results were validated through measurement. When tested the oscillator was found to oscillate at 2.097 and 4.576 respectively.**

***Index Terms* —Active Antenna (AA), Annular Slot Antenna (ASA), radiation pattern, frequency reconfigurable**

I. Introduction

In recent times, a lot of work on frequency reconfigurable active antenna had been reported [1-4]. Compared to the reported structures, the proposed structure was found to exhibit substantially less frequency shift in oscillating frequency.

Here in this paper, negative resistance approach is used to design frequency reconfigurable AA. The oscillator type frequency reconfigurable AA involves the design of dual band, dual port annular slot antenna with shorted slots. Here unloaded antenna simultaneously resonates at two resonant frequency that is at 2.4 GHz and 5.2 GHz. The one port destabilized amplifier is independently designed in ADS such that the amplifier is unstable only at desired frequencies. Later the amplifier is connected to antenna through some matching network in order to satisfy oscillation condition. Here, the frequency reconfigurability is not incorporated in antenna but in active antenna, where reconfigurability is attained by switching paths between one port destabilized amplifier and antenna as shown in Fig.1.

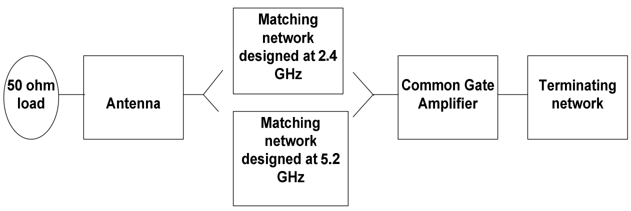
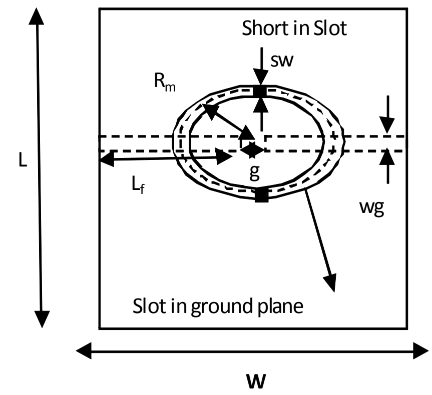
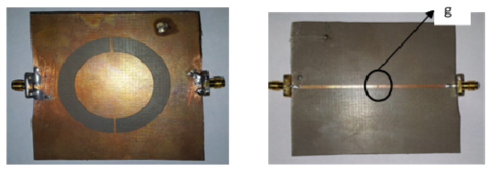


Fig. 1. Schematic of Active Antenna

II. Design of Active Antenna



(a)



(b)

Fig. 2. Annular Slot Antenna with shorted slots : (a) schematic, (b) photograph

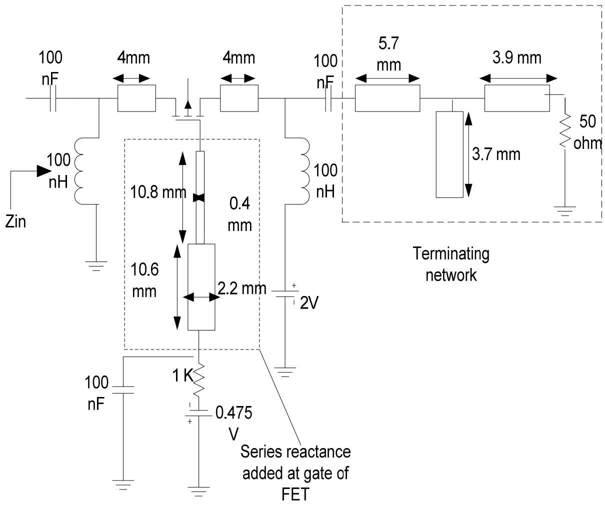


Fig. 3. One port destabilized amplifier with terminating network

Fig.2. shows the layout of annular slot antenna with shorted slots. The AA was printed on 30 mil neltec substrate with dielectric constant ε_r=3.2. The dimensions of the radiator are (in mm): W=L=80, R_m =22, sw=6, g=0.5, w_g =1.85 mm and L_f=40 mm. The radiator which serves as resonator and feedback network is then connected to one port destabilized

amplifier (shown in fig.3.) through a matching network such that the oscillation conditions are met. The FET used is NE3210S01 depletion type, n channel HJFET. The matching network includes a low pass filter designed at 5.8 GHz in order to filter out undesired frequencies. Fig.4 shows frequency reconfigurable active antenna on 110 mm X 120 mm substrate. The two different matching network were designed to oscillate at 2.4 GHz and 5.2 GHz respectively, shown in Fig.6. The only difference between the two matching network is the presence of quarter-wavelength stub

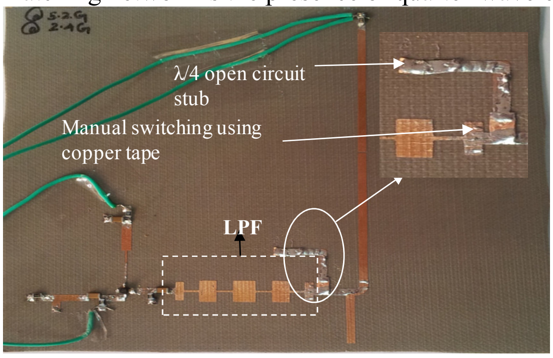


Fig. 4. Frequency Reconfigurable Active Antenna [front view]

which is designed to suppress the first resonance frequency of antenna. Because it was observed that the active antenna though designed for 5.2 GHz had the tendency to oscillate at the first resonant frequency of passive antenna.

III. Measurement results

For radiation pattern measurement, standard UWB Horn Antenna was used as receiving antenna and the received signal was observed at spectrum analyzer. Here active antenna is transmitting antenna and is separated by the receiving antenna by 2.1 m.

The oscillator oscillates at 2.09 GHz and maximum power level is -38.359 dBm. We observe shift in the designed and the measured oscillating frequency. It was observed that with the change in the bias voltage of the oscillator, the oscillating frequency as well as its amplitude changes. The peak power received is -38.359 dBm. The effective isotropic radiated power (EIRP) is the product of gain of transmitting antenna, G_t and output oscillating power, P_t [8]

$EIRP = G_t P_t$

The EIRP measured was 1.67 dBm for 2.4 GHz AA.

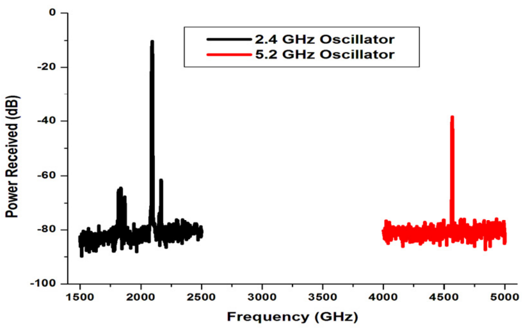


Fig. 6. Measured Frequency Spectrum of AA

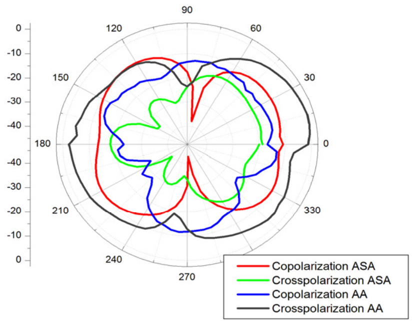


Fig. 8. E plane radiation pattern of Passive and Active Antenna at 2.4 GHz

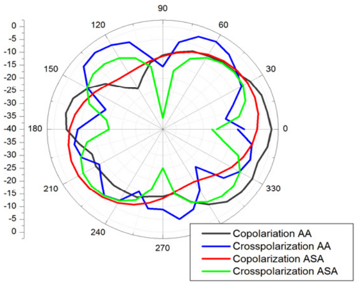


Fig. 9. H plane radiation pattern of Passive and Active Antenna at 2.4 GHz

IV. Conclusion

The measured results shows that the active antenna oscillates at 2.09 GHz but was designed at 2.4 GHz while the oscillator designed at 5.2 GHz, when designed and tested, found to oscillate at 4.576 GHz. The EIPR calculated at 2.09 GHz was 1.67 dBm. The power received by oscillator type AA was very small and hence the radiation pattern could not be measured. The design can be further optimized to obtain better results.

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