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Computationally Efficient Method for Rf/Microwave Energy Harvesting System Using Directional Filter

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ABSTRACT: A class of RF multi-functional band pass filter with multiple frequency reconfigurable rejected bands that are embedded into its broad transmission frequency range is reported. The proposed setup consists of a rectifying circuit fed by the reject band output port of a planar directional filter, using a micro strip resonator as the matching network. This filter concept exploits an original tunable multi-band quasi band stop section as constituent block. It allows obtaining unprecedented level of spectral adaptively for its in-band notches the overall reflection to be suppressed without affecting the pass band channel. These notches can be either used to increase the number of rejected bands or their selectivity by respectively locating them at identical or different center frequencies.

Keywords --- Microwave harvesting, Rectifier circuit, Directional filter, Microstrip circuit.

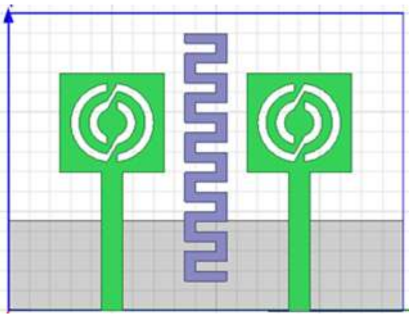
I. INTRODUCTION

Energy Harvesting (EH) is defined as the process of extracting energy from the surroundings of a system and converting it into usable electrical energy, and it is more suitable for situations where the ambient energy sources are well characterized.EH could be an alternative energy supply technology. Such systems scavenge power from human activity, ambient heat, light, radio frequency (RF), vibrations, etc. Operated battery systems are used in various applications including wireless mobile phones and hand – held devices.

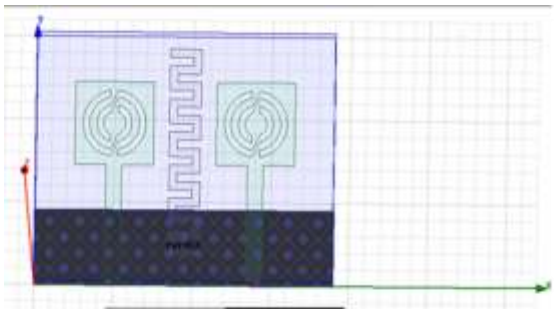
A.DIRECTIONAL FILTER

A Directional Filter is a four-port device having a band pass response between ports 1 and 4 (S41), and its complementary reject band response between port 1 and 2 (S21), no power is transmitted through port 3,and none is reflected to port 1.Directional Filter can be developed to higher dimensions. Itcan be used in 3-D to achieve frequency section. These kinds of filtering purposes to record and save signals information and features.

2. DESIGN



PERFERT E



The beam width of an antenna is a very important figure of merit and often is used as a trade-off between it and the side lobe level. Thus as the beam width decreases, the side lobe increases and vice versa. Types are HPBW and FNBW. Directivity is the ability of an antenna to focus energy in a particular direction. It is the ratio of the maximum radiation intensity of the test antenna to the radiation intensity of an isotropic antenna. Efficiency of a transmitting antenna is the ratio of power actually radiated (in all directions) to the power absorbed by the antenna terminals. The power supplied to the antenna material which is not radiated is converted into heat. This is usually through loss resistance in the antenna's conductors, but can also be due to dielectric or magnetic core losses in antennas (or antenna systems) using such components. Such loss effectively robs power from the transmitter, requiring a strong transmitter in order to transmit a signal of a given strength. A high gain antenna will radiate over a wider angle. This dimensionless ratio is usually expressed logarithmically in decibels, these units are called "decibels – isotropic" (dBi)

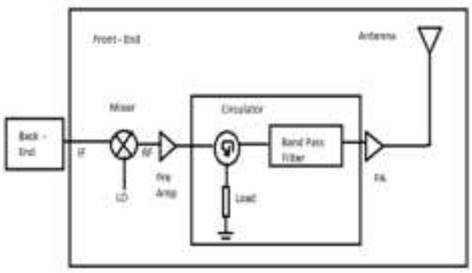
$$G_{\mathrm{dBi}} = 10 \log \frac{I}{I_{\mathrm{iso}}}$$

The effective area or effective aperture of a receiving antenna expresses the portion of the power of a passing electro - magnetic wave which it delivers to its terminals, expressed in terms of an euivalent area.

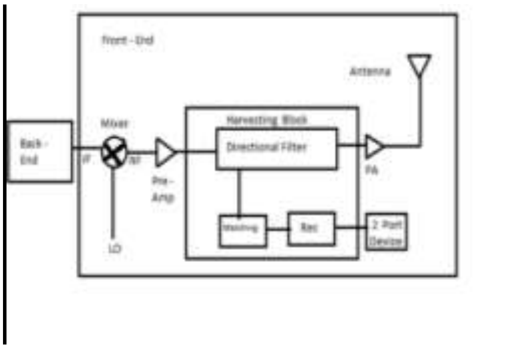
$$A_{\mathrm{eff}} = \frac{\lambda^2}{4\pi} G$$

As an electro-magnetic wave travels through the different parts of the antenna systems. At each interface, depending on the impedance match, some fraction of the wave's energy will reflect back to the source, forming a standing wave in the feed line. Maximum power transfer requires matching the impedance of an antenna system (as seen looking into the transmissin line) to the complex conjugate of the impedance of the reciver or transmitter.

BLOCK DIAGRAM



(a)



(b)

The proposed circuit operates internally in the front-end of a communication system, where usually, there exists a bandpass (BP) filter between the pre-amp and the power amplifier (PA), as shown in Fig. 1(a); the signals reflected from the filter input are sent to a load through a circulator in order to avoid standing waves and interference at that stage. In this proposal, the energy outside the passband of the filter is lead to a rectifying circuit, and thus it can be harvested by converting it into DC; Fig. 1(b) shows a block diagram of the proposed circuit, which substitutes the circulator and filter of the front-end of Fig. 1(a).

(i)A Circulator is a passive, non-reciprocal three or four-port device, in which a microwave or radio-frequency signal entering any point is transmitted to the next port in rotation.

(ii)A rectenna is a rectifying antenna. It is a special type of antenna that is used for converting electromagnetic energy into direct current(DC) electricity**.**

(iii) It amplify extremely weak signals before they fed to additional amplifier circuits**.**

Table:

Description	Existing Values	Proposed Values
Return loss	15 dB	21,22 dB
Gain	5.9 dB	9.7 dB
VSWR	1.2 dB	1.5,1.7 dB
Efficiency	78%	93%
Frequency	1.13 GHZ	3.4 GHZ,3.7GHZ

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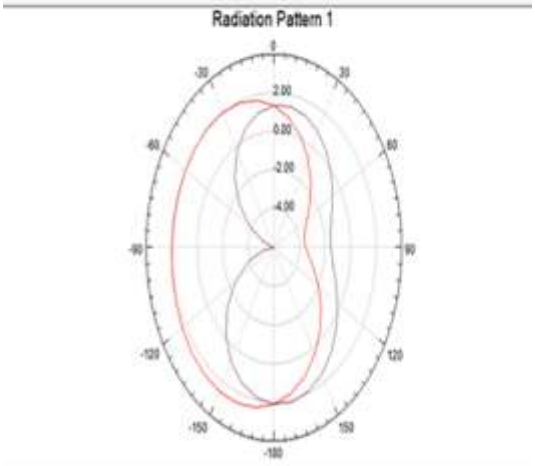
II. RESULTSANDDISCUSSION

(a)RETURNLOSS

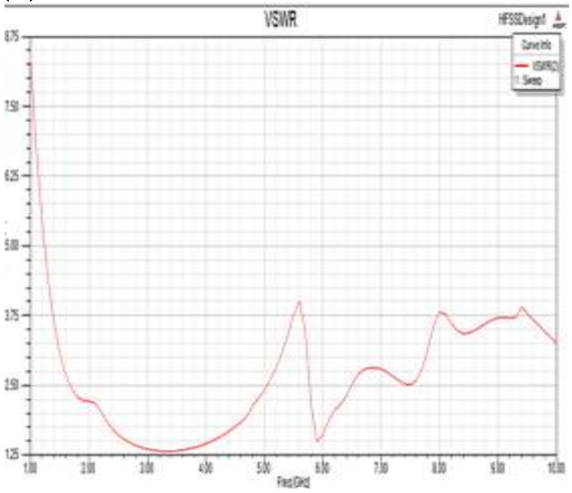
[a]The loss of signal power resulting from the reflection caused due to improper matching of the antenna to its feed line is called return loss. An increasedreturn loss corresponds to high VSWR and affect the antenna gain to a largeextent. The returnloss is analyzed using scattering parameters.

(b)2DRADIATION PATTERN



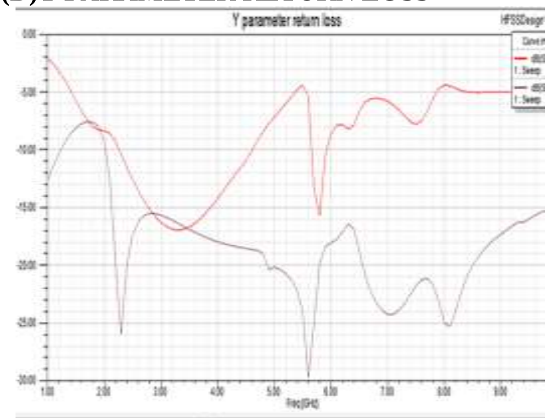
[b] Radiation pattern is a plot of the far field radiation from the antenna and indicates the power radiated per unit solid angle. The power pattern is usually plotted on a logarithmic scale or more commonly in decibels (dB).

(C)VSWR

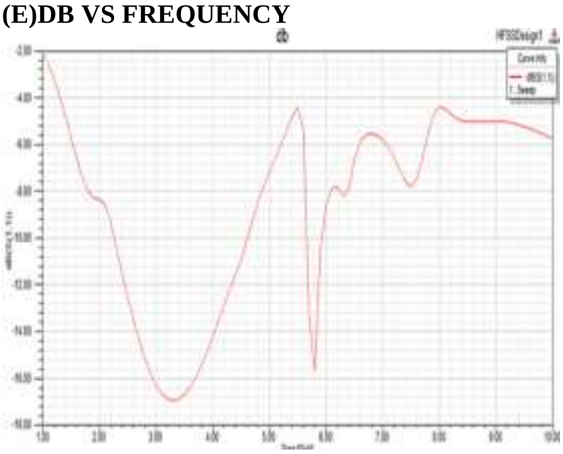


[C] standing wave ratio is defined as the ratio of maximum to minimum current or voltage on a line having standing waves. It is also the measure of the mismatch between the load and the transmission line.

(D)Y PARAMETER RETURN LOSS



(E)DB VS FREQUENCY



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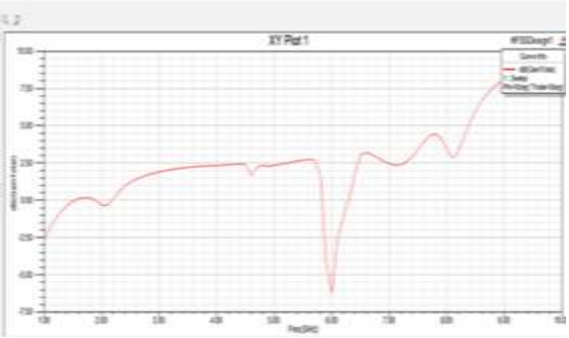
(F)GAIN



ADVANTAGE

- Less area compare to existing system.
- Fabrication cost is low.
- It compactable all radar communication.
- Less impedance.

APPLICATION

- It is used in wireless communication medium at transmitter and receiver circuits.
- It isused in optical communication are like LIDARS.
- It is also used in medical field instruments like EEG.

III. CONCLUSION

The design of a novel RF/microwave harvesting circuit with the capability to operate inside a front – end system has been presented; each stage composing the proposed circuit has been described and the simulated and experimental results are reported. The system takes advantage of the properties of a directional filter which is able to manage a pass band and a reject band producing no energy reflection. Moreover, a resonant circuit for matching the rectifying stages has been used and reported, instead of a conventional coupling network. In simulations, Vout = 6.7V was obtained for Pin = 20dBm, while in experiments, Vout = 0.83V for Pin = 10dBm. The output DC voltage can be used to feed a small-power consumption circuits or for energy storage using a battery.

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