International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2013): 6.14 | Impact Factor (2013): 4.438

Active Antenna for VHF Band Applications

Sachin V. Padalwar[1], Vaishnavi Navale[2]

[1]Pune University, A.I.S.S.M.S's COE, Kennedy Road, Pune

[2]Assistant Professor, A.I.S.S.M.S. College of Engineering, Pune University, Kennedy Road, Pune

Abstract: ***This paper gives an idea of designing an active antenna using an active device of field effect transistor (FET).In this active antenna, an active circuit using an active device HEMT is designed with a monopole at its input. The active circuit is mainly used for trans-impedance characteristics. This active antenna can be used to receive VHF band (174-216MHz) frequencies of around 200MHz. Thus a small size antenna having high gain, low noise, large bandwidth can be developed using this technique.***

Keywords: HEMT, FET, active antenna, VHF.

1. Introduction

In today's world there is vast interest in the field of antenna especially integrated circuits and antenna integrated circuits using MIC or MMIC having a very small size. Thus the active antenna is a new concept having different advantageous characteristics as compare to passive antenna. The name is given active antenna because of the active electronic device used in this antenna.

The active antenna used for VHF band applications consist of active circuit and the passive antenna in an integrated form. The active antenna thus made has characteristics such as small size, high gain, high signal to noise ratio, low power consumption etc. The active circuit of the antenna provides the amplifying characteristics .As we know frequency is inversely proportional to the wavelength. For VHF band application antenna size or wavelength required is quite large. But because of the active device technology a trans-impedance circuit is built in the form of active circuit which provides a small size integrated antenna for 200MHz frequency.

Thus a passive monopole is connected at the input of the active circuit which consist of an active device HEMT. The entire combination is used as a receiver at VHF band frequency. The basic use of the HEMT device is to provide high electron mobility, switching and integrated form characteristics.

2. Literature Survey

Active antenna is a new growing area and various types of active antenna are designed. Basically active antenna is an antenna in which active electronic component is used. Hence different active devices can be used with different techniques to develop an active antenna according to the application.

Kai Chang, Robert A. York and Peter S. Hall have briefly discussed the various applications and history remarks of active antenna technology. They designed first an oscillator type active antenna in which a general active oscillator antenna is designed with an active device. In Gunn patch antenna oscillator circuit a Gunn diode is used with a patch antenna. Coupled oscillator array for phase control and high power amplifier active antenna are also designed. In a simultaneous transmit receive active antenna two FET oscillator circuit connected by LNA is used [1].

Ick-Jae Yoon, Se-Huan Park and Young- Eil Kim has designed a frequency tunable active antenna for mobile TV signal reception. They have designed a helical antenna which is frequency tunable and with that a matching as well as tuning circuit. This matching and tuning circuit provides the frequency selectivity characteristics and a matching is provided to match the high reactance and low resistance of the small size antenna [2].

Yu Chang Liu and Hong-Yeh Chang has developed an active antenna with the help of voltage controlled oscillator and Yagi antenna for millimeter wave applications. The V band active antenna is designed by using GaAs PHEMT technology and proper gain is achieved at 69.5 GHz frequency [3].

Kyeongrae Cho and Songcheol Hong has designed a UHF/VHF/L band low power active antenna for mobile handsets. They used a small passive antenna connected by a multiband LNA. This combination of multiband antenna is connected to the saw filter and receiver circuits. Thus this triple band antenna consist of a passive helical antenna consumes a very less power [4].

Ick-Jae Yoon and Evgeny Balzovsky has designed a small size FET based active antenna for mobile TV signal reception at VHF band. This antenna consist of passive monopole at the input followed by the band pass filter. The active circuit with HEMT as an active device acts as a receiver antenna [5].

3. Methodology

The circuit diagram of the proposed active antenna is shown in figure 1. The active element E-PHEMT is used. This active device has characteristics of small scale integration. The active device schematic is designed using ATF55143 from Avago technologies. This active device has low noise and low power consumption. In this design we have used open end microstrip line which acts as a monopole is used at

the input of the active circuit as passive antenna which is of the size $5 \times 50 mm^2$.

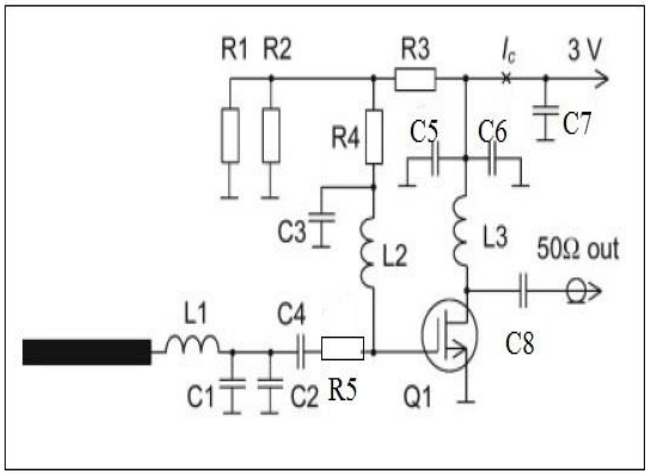

Figure 1: Basic circuit diagram of active antenna

As shown in the above figure 1, the black portion is represented by the monopole passive antenna. This passive antenna is connected at the input of the active circuit. The active circuit consists of an active device HEMT. The rest of the circuit consist of the decoupling capacitors and inductors which acts as RF chokes called the biasing network and the impedance matching network.

4. Design and Simulation of Active Antenna

The above active antenna circuit can be simulated using RF Spice software. The network analysis of the antenna gives us the details of the antenna gain, return loss, transmission coefficient, reflection coefficient using S parameters.

4.1 Simulation circuit of active antenna using RF Spice

The circuit in figure 1 is implemented in the RF spice software. The network analysis mode is selected from the TEST option. In the network analysis mode connections were given between input and output port. The sweep voltage is maintained between 100MHz to 500MHz. In the output section Cartesian S parameters are selected.

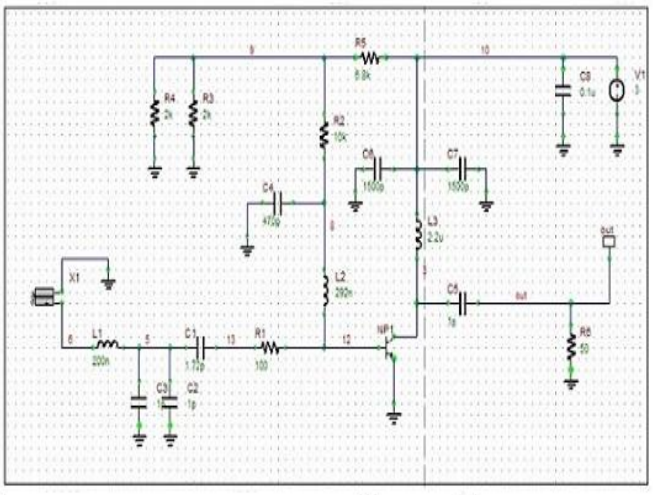

Figure 2: Circuit design of Active antenna in RF Spice.

As shown in the above figure, the circuit diagram of figure 1 is implemented in the RF spice software. In this simulation design, ATF 55143 model transistor is chosen which acts as an amplifier. The proposed antenna is fabricated at the drain current of 20mA and 3V bias voltage.

Table 1: Components list

Components	*Values*
R1	2K ohm
R2	2K ohm
R3	6.8K ohm
R4	10K ohm
R5	90 ohm
C1	1pF
C2	1pF
C3	470pF
C4	1.72pF
C5	1500pF
C6	1500pF
C7	0.1uF
C8	1pF
L1	455nH
L2	292nH
L3	2.2uH

4.2 Simulation Results and Graphs of Active Antenna

The active antenna design is implemented according to the figure 2. In the output of the network analysis test of the RF Spice software Cartesian S parameters are selected then following results are achieved.

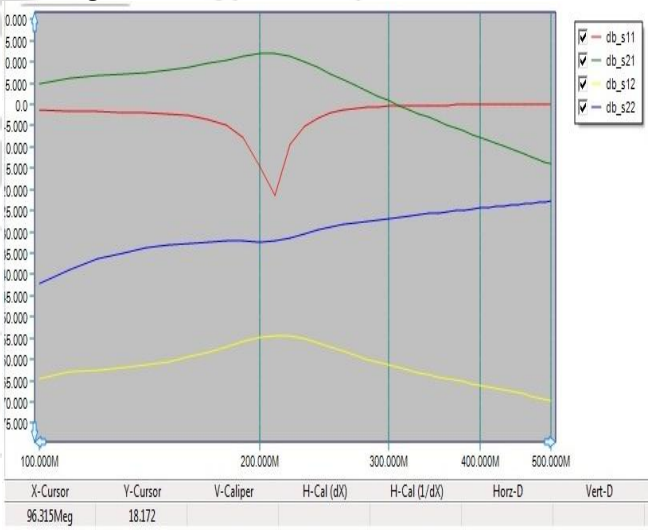

Figure 3: Simulation results of antenna

From the above simulation results, we can see that we obtain a gain (S_21) of 13.4 db. The input reflection coefficient (S_11) of -16.38 db, reverse transmission coefficient (S_12) of -54.34db and output reflection coefficient (S_22) of -32.65db are obtained. As we know for complete transmission (S_21) should be 0db but as this an amplifier design we should get a of more than 0db. From the above results we can conclude that the amplifier design is completely valid at 200MHz frequency.

5. Conclusion and Future Scope

Thus we have designed an active antenna which acts as a

receiver at 200MHz frequency. The small size antenna is achieved with moderate gain for such a small frequency of VHF band. The simulated results show, with the help of active circuit design in active antenna, a gain of 13.4db is achieved which proves its amplification characteristics. Thus from the results we can conclude that this active antenna can receive VHF band frequency signal with proper gain and return loss which can be used for various VHF band frequency applications such as mobile TV signal reception etc. In the future, we can develop and use this antenna for various VHF band applications. We can develop an antenna which can work on frequency even less than this such as HF for such frequency band applications.

References

[1] Kai Chang, Robert A. York, P. S. Hall, "Active Integrated Antennas," IEEE transactions on microwave theory and techniques, vol.50, no.3, March 2002.
[2] Ick-Jack Yoon, Se-Hyun Park, Young-Eil Kim, "Frequency Tunable antenna for Mobile TV Signal Reception," Samsung Institute of Technology, Korea, 2007.
[3] Yu-Cheng Liu, Hong-Yeh Chang, "Design of a V-band Active Integrated Antenna with Voltage Controlled Oscillator," National Central University, Taiwan, 2012.
[4] Kyeongrae Cho, Songcheol Hong "Design of VHF/UHF/L-Band Low Power Active Antenna for Mobile Handsets," IEEE antennas and wireless propagation letters, vol.11, 2012.
[5] Ick-Jack Yoon, Evgeny Balzovsky, Yuri Buyonav, Se-Hyun Park, Youngeil Kim, Vladimir Koshelev, "Active Integrated Antenna for Mobile TV Signal Reception," microwave and optical technology letters, vol.49, no.12, 2007.

Author Profile

Sachin Padalwar received the B.E. degree in Electronics and Telecommunication Engineering from Yeshwantrao Chavan College of Engineering in 2013 and now pursuing M.E. degree in Microwave Engineering from A.I.S.S.M.S. College of Engineering.

Prof. V. S. Navale received the B.E. degree in Electronics Engineering from AVCOE College of Engineering in 2005 and M.E. degree in Microwave engineering from PICT College of Engineering in 2013. Currently she is working as Assistant Professor in A.I.S.S.M.S. College of Engineering, Pune.