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A X-band SPDT Switch

Jiang Deng [1,a,*]**, Xuchun Gan**[1,b]

[1] Sichuan Institute of Solid State Circuits, China Electronics Technology Group Corp.

Chongqing 400060, P. R. China

[a] bdengjiang@126.com, [b] axcg135@163.com

*corresponding author

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Abstract: A x-band SPDT switch is presented in this paper. This switch has been realized by 0.5um GaAs process.it exhibits high performance: over DC~10.6GHz, insertion loss is lower than -1.7dB; the ripple variation of insertion loss is less than ±0.3dB; The isolation is lower than -50dB; input return loss is lower than -15dB; on state, output return loss is lower than -15dB; off state, output return loss is lower than -15dB; on and off time are less than 10ns.

1. Introduction

Wireless communication industry has grown very rapidly in the last decade, there is a great demand for very high speed communication networks. To respond to those demands, an ultra wideband communication technique which enables wireless communications in high speed wide band together with existing wireless communication services is under development. the ultra wideband frequency band ranging from 3.1 to 10.6GHz[1].

Switches are commonly used in various electronics circuits such as a transmitter in a wireless communication device. Switches may be implemented with various types, such as MOSFET, GaAs pHEMT, PIN diode, MEMS and so on. A switch may receive an input signal at one terminal and a control signal. The switch may pass the input signal to the other terminal if it is turned on by the control signal and may block the input signal if it is turned off by the control signal[2].

Increasing needs for RF systems covering ultra wideband bands have been leading us to the development of the ultra wideband switch, switches is one of the most crucial components in RF systems.

2. Circuit Design

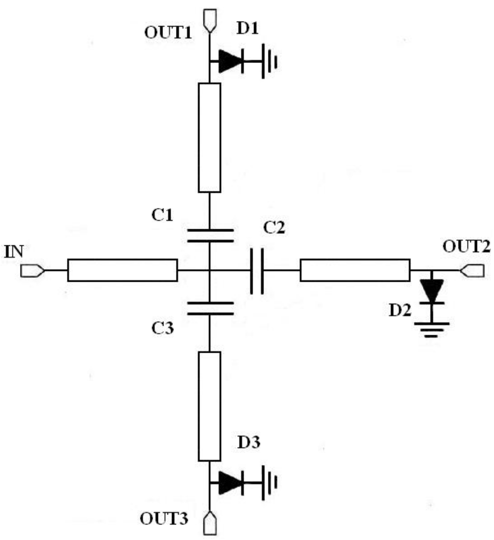

Figure 1 PIN Diode Switch

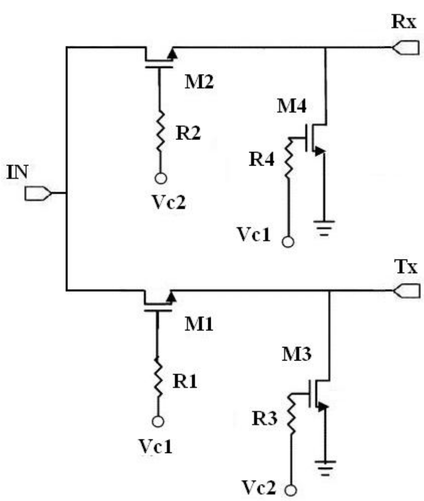

Figure 2 CMOS Switch

With the active development and research on ultra wideband, various switches designs have been made to implement the switch available in the ultra wideband.

As shown in Figure 1,a PIN diode SP3T switch is given. PIN diode switch have the advantage of small size, low insertion loss, switch fast and high power handling ability. In order to control the PIN diode, DC power consumption is need[3~4].

Figure 2 shows a CMOS switch, which is a well integrated with CMOS technology. CMOS switches have low cost and capability of integration of device and control circuitry into single chips. But CMOS switches have high insertion loss and CMOS material characteristics like lossy substrate and low breakdown voltages due to low mobility of electrons prevent CMOS technology from being used in high power applications[5~7].

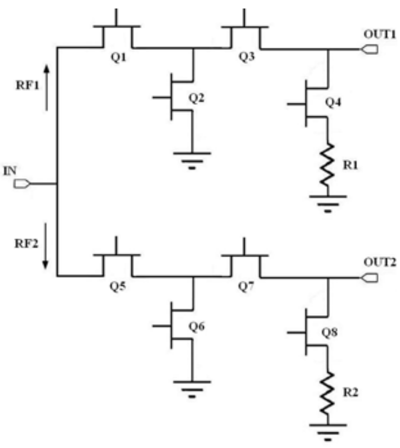

Figure 3 Conventional SPDT Switch

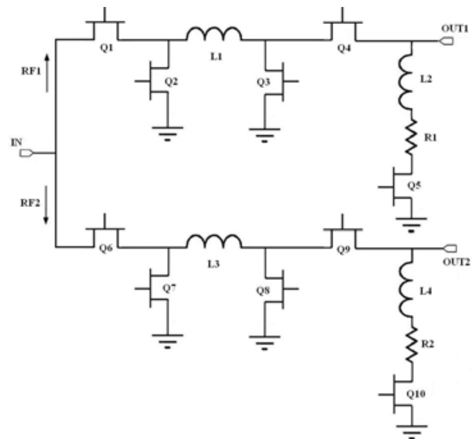

Figure 4 Ultra Wideband SPDT Switch

Presently among existing popular topologies of wideband switchs, the excellent performance capabilities of GaAs pHEMT switches configuration as a wideband stage have been clearly demonstrated, GaAs pHEMT switches have low insertion loss with no DC power consumption.

Referring to Figure 3, a conventional SPDT switch is shown. pHEMT in series have high insertion loss, high isolation at low frequency, low isolation at high frequency. pHEMT in parallel have low insertion loss with commonly isolation.

Figure 4 is a schematic circuit diagram of the Ultra Wideband Switch, these aspects are achieved by providing input and output match circuit for ultra wideband .

The ultra wideband SPDT switch have two SPST switches A1 and A2. A1 comprises five pHEMT Q1, Q2, Q3, Q4 and Q5.a resistor R1, two inductors L1 and L2. The second switch A2 is the same structure with A1, comprisesives five pHEMT Q6, Q7, Q8, Q9 and Q10, a resistor R2, two inductors L3 and L4.

Considering parasitic resistors, parasitic capacitors of the pHEMT; parasitic capacitors, parasitic resistors and parasitic inductors of integration inductor, when switch A1 is on state, add to a integration inductor L1 in series, A1 make up of a filter in the end for providing a good wideband match of the input resistance and wideband frequency response. when switch A1 is off state, adding the L2 and R1 in parallel also make A1 providing a good wideband match of the output resistance and wideband frequency response.

3. Simulation

With Using the new configuration, a switch has been realized by 0.5um GaAs process. The simulation of our switch with package have been presented based on the ADS2011. Over DC-10.6GHz, insertion Loss is lower than -1.624dB , the ripple variation of insertion Loss is less than ±0.25dB (Figure 5).The isolation is lower than -51.336dB (Figure 6). input Return Loss is lower than -16.402dB (Figure 7), on state, output Return Loss is lower than -15.919dB(Figure 8). off state, output Return Loss is lower than -18.294dB (Figure 9). The Switching Characteristics of the switch is shown in Figure 10, on and off time are less than 4ns. Figure 11 presents the layout of the switchs with a chip size of 1.05*1.06 mm2.

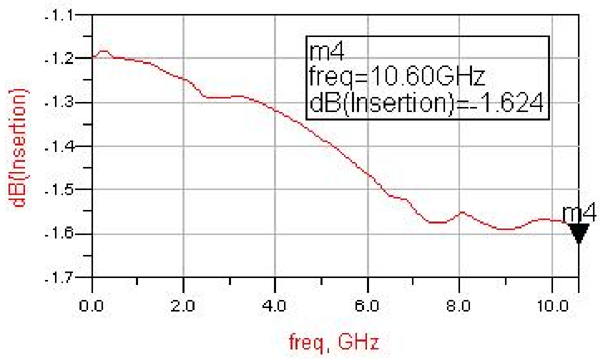

Figure 5 Simulated Insertion Loss

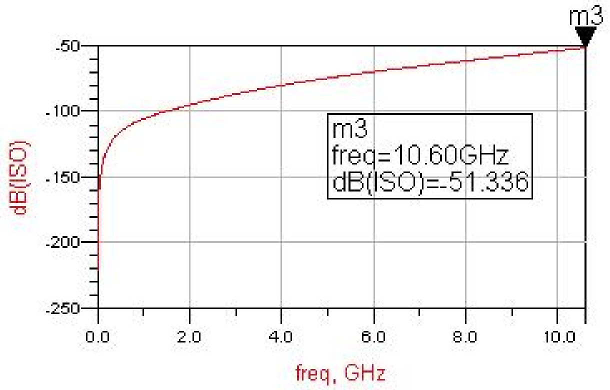

Figure 6 Simulated Isolation

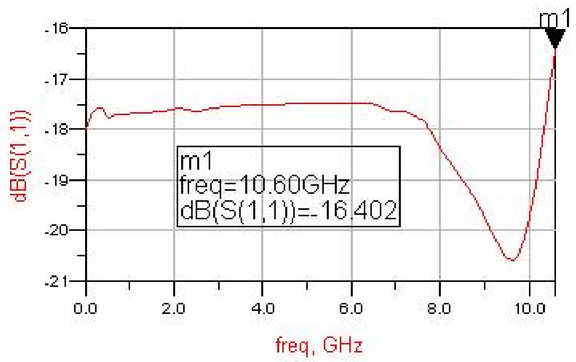

Figure 7 Simulated Iutput Return Loss

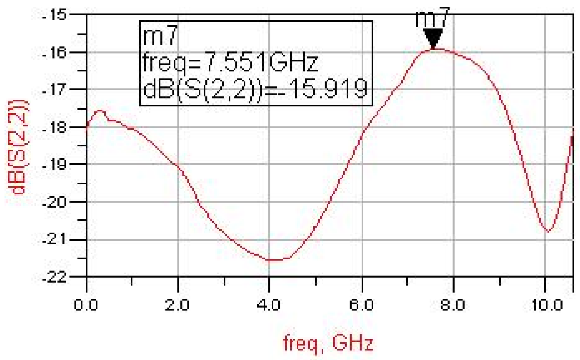

Figure 8 Simulated Output Return Loss(on)

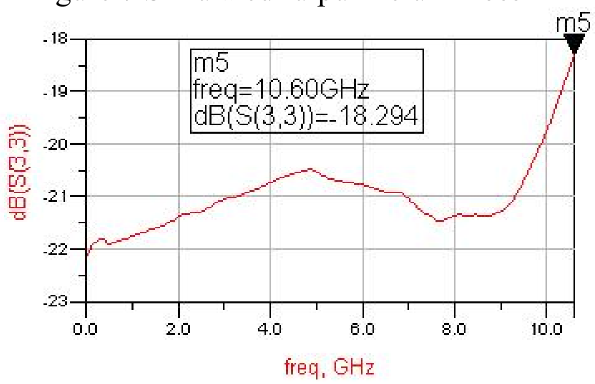

Figure 9 Simulated Output Return Loss(off)

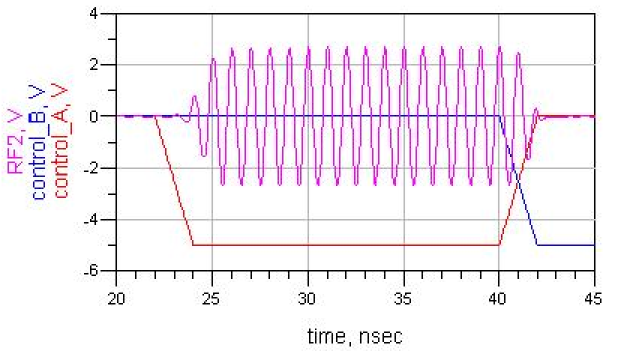

Figure 10 Simulated Switching Characteristics

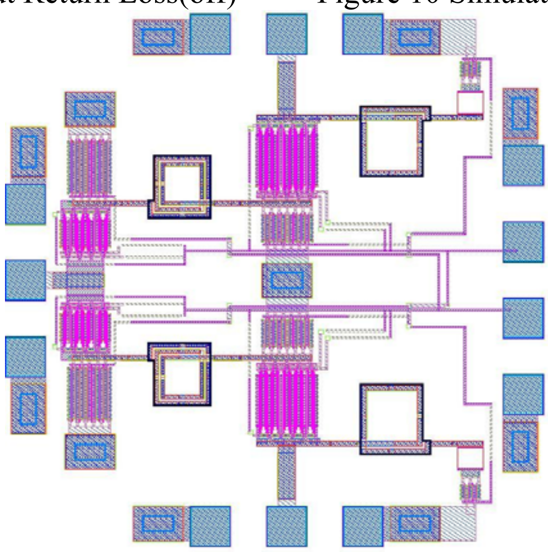

Figure 11 Layout of the switch

4. Conclusion

In this paper a new configuration is used for a ultra wideband switch. the measurement results shows over DC-10.6GHz, insertion loss is lower than -1.624dB , the ripple variation of insertion Loss is less than ±0.25dB.The isolation is lower than -51.336dB. input return loss is lower than -16.402dB, on state, output return loss is lower than -15.919dB. off state, output return loss is lower than -18.294dB. The on and off time are less than 4ns. the proposed one is good candidate for ultra wideband switch applications..

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