

Research on Carrier Leakage Cancellation Technology of FMCW System

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Abstract— A single antenna receiver scheme is usually used in the radio FMCW system, which can cause the carrier leakage between the RF signal transmitter and receiver, and the receiver performance is affected. In this paper, a closed loop adaptive microstrip carrier leakage cancellation technique is proposed. The circuit is designed by using microstrip circuit. The ADS software is used to simulate and test the model. The improvement of the ratio of the before and after the improvement is given. The experimental results show that the cancellation circuit has an evident cancellation effect.

Keywords—FMCW; Zero Intermediate Frequency; Carrier Leakage; Carrier Leakage Cancellation Technology

I. INTRODUCTION

FMCW system is the use of the frequency of the intermediate frequency signal to calculate the delay time of the echo signal, is usually used as a result of digital signal processing method of intermediate frequency signal processing, anti-interference ability strong, height measurement accuracy higher. The continuous wave signal of FMCW has the characteristics of low peak power and wide operating frequency range. In order to make the whole machine can be simple, light weight and small volume. It can be integrated in microwave and millimeter wave band. Because the distance between the FMCW system and the measurement range is determined by the bandwidth of FMCW signal, the distance between the spectral lines of the FMCW system is small, and the FMCW is not there. The echo time delay of FMCW system is far less than that of the transmitted signal, and the transmitted signal and the received echo signal are simultaneously carried out, and the system is easy to be realized by using the FFT algorithm, and the FMCW has good electronic counter and low cutting performance. However, due to the FMCW emission signal into the frequency modulation, so the separation between the transmission and receiving channels is higher, the need to do the same frequency suppression and elimination.

II. THE WORKING PRINCIPLE AND THE EXISTING PROBLEMS OF THE FMCW RECEIVING/SENDING MODULE

The reception of a radio frequency signal can be received by a complex or a relatively simple zero IF receiver. Super heterodyne receiver is usually applied to broadband high sensitivity receiver. For the FMCW radio set, it is a zero IF receiving mode. Its outstanding advantages are: simple frequency conversion and clear circuit composition. The main drawback is that the carrier leakage will be generated. And receiving sensitivity is relatively.

FMCW is a system of transmitting and receiving antenna, which has a serious leakage phenomenon[1]. The direct coupling of the antenna, feeder leakage and surrounding objects reflect the noise directly coupled to the receiver, and the strong leakage signal can cause the receiver to be saturated, and even make the microwave mixer or the front low noise amplifier saturation.

A important factor that effect performance of FMCW system is the circulator isolation problem. Because of the isolation between ports circulator hole is not easy to do very high, such low isolation will bring some problems. First is the linearity of the receiver, target echo information of the receiver RF signal from the antenna port of the circulator to receive port, then circulator antenna port also includes large modulation of the power of an RF signal, signals are transmitted may be leakage to the ground leakage to the receive port by two ways, one is through the antenna port directly leak to the receive port, another is from the launch port of the circulator leakage to the receive port. Between port circulator isolation Low will cause leakage to the receive port of the transmit signal power is far greater than the received reflected signal power, but also has very high power level. It is easy to cause the receiver front-end circuit can not work normally.

In the practical engineering application, the effective measures to solve the interference of radio frequency carrier collection and release are mainly based on the system architecture of the hardware system[2-4]. The inhibition is based on the processing of the received signal algorithm, which is based on the processing of the received signal

channels. The purpose of the algorithm is to eliminate the interference. In this paper, a closed loop adaptive microstrip carrier leakage cancellation technique is proposed. The circuit is designed by using microstrip circuit[5]. The ADS software is used to simulate and test the model, the technology eliminate the leakage interference and the Doppler frequency shift, and increase the sensitivity and detection probability of the signal detection.

III. CARRIER LEAKAGE CANCELLATION TECHNOLOGY

The circulator to achieve single antenna signal transmitting and receiving, due to leakage circulator, echo reflection creates the frequency modulated continuous wave signal carrier inevitable leakage to the receiver, causing co frequency interference, so at the receiving end increasing RF leakage suppression closed-loop feedback control circuit, RF component closed-loop carrier leakage cancellation system block diagram as shown in figure 1.

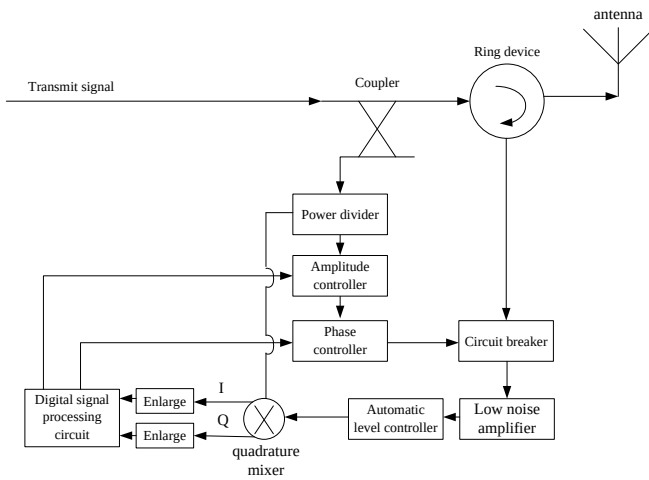


Figure1 block diagram of the closed loop cancellation system for radio frequency carrier leakage

In Figure 1, the RF leakage suppression circuit includes the power divider, the amplitude controller, the phase controller, the circuit breaker, the amplitude and phase of the signal. The signal is detected by the signal processing circuit.

From the transmitter coupled via the coupler output signal, after power divider, amplitude and phase controller from RF the cancellation signal, through the use of microstrip delay and amplitude control controller and a phase controller to adjust the amplitude and phase of the signals with same frequency and cancellation, a phase difference of 180 degrees, then put into combiner to cancel. In order to achieve the desired effect, the digital signal processing circuit according to the parameters of the control amplitude controller and phase controller, the control signal is generated by the digital signal processing.

IV. DESIGN AND SIMULATION OF MICROSTRIP CIRCUIT FOR CARRIER LEAKAGE CANCELLATION TECHNOLOGY

The amplitude controller is used to change the amplitude of the signal. The phase controller is used to change the phase of

the signal. In order to achieve the desired effect, the parameters of the amplitude controller and phase controller are controlled. Simulation results are shown in Figure 2. Adjust the attenuator and phase shifter parameters, after many simulations, the attenuator parameters are 14.5dB, and the phase shifter parameter is set to 121.9 degrees. To eliminate the effect of the best.

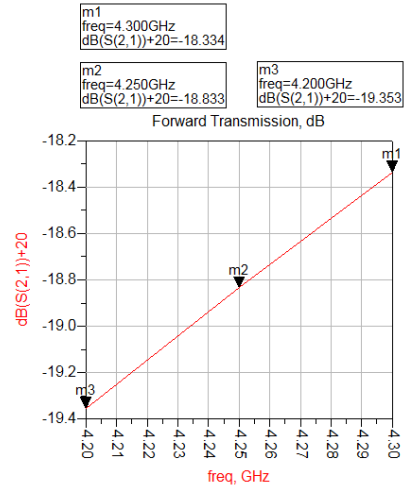


Figure2 simulation results

The simulation results are shown in Figure 2, the frequency range of 4.25GHz-4.35GHz is greater than that of 18dB (including 3dB). Emission signal power is 20dbm, circulator isolation is 20dB. Before the increasing RF leakage suppression circuit, leakage to the receiving end signal power for -3dB, increasing RF leakage suppression and leakage to the receiving end signal power is less than -18dBm.

The amplitude controller is used to adjust the power of the signal to the consumer, so as to achieve the best results with the leakage signal. The attenuation amplitude parameter can be externally controlled, but the input power is greater than 20dBm, and the working frequency range is 4.2GHz-4.4GHz, the attenuation value is greater than 20dB. The phase controller is used to adjust the phase of the signal phase of the cancellation branch, so as to achieve the best results with the leakage signal. The working frequency range is 4.2GHz-4.4GHz, the phase adjustment range is 0-1800 and the phase error is small. Test block diagram of RF leakage suppression circuit is shown in figure 3.

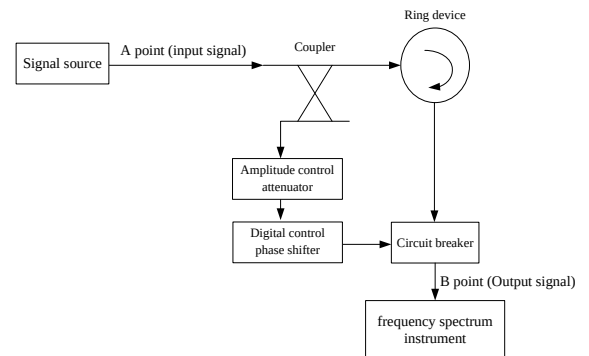


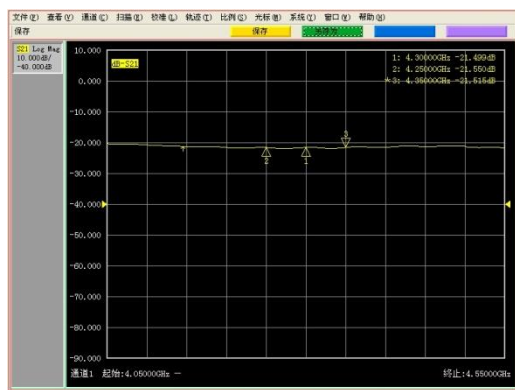
Figure3.Test block diagram of RF leakage suppression circuit

A point to a signal source to provide input signal; B point to a spectrum analyzer, test output signal power Test contents and data of RF leakage suppression circuit are shown in table1.

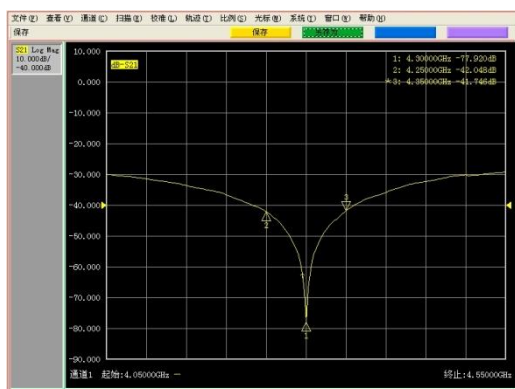
TABLE1 TEST CONTENTS AND VALUES

Input signal frequency f/Power Pi	Output signal frequency f/PowerPo	Elimination ratio
4.25GHz/0dBm	4.25GHz/-43dBm	20
4.30GHz/0dBm	4.30GHz/-79dBm	56
4.35GHz/0dBm	4.35GHz/-43dBm	20

The comparison of test contents results is shown in Figure 4.



(a) Elimination before



(b) Elimination after

Fig.4 Comparison of cancellation test results

V. CONCLUTIONS

Original meaning first carrier offset technique is applied to 4.3GHz band FMCW setting system, the microstrip circuit carrier leakage cancellation circuit design is completed. According to the design results of the prototype test, the test results show that the use of this technology, elimination ratio is 56. The results not only ensure the linearity of the receiver. It can also increase the low noise preamplifier in the receiving channel, and realize the purpose of increasing the range of the FMCW system.

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