

A case-study on preventing desensitization of Radio Frequency Receivers



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Abstract-Desensitisation of radio receivers is important where a number of radio signals are present in close proximity to each other in an area. This may happen in Wi-Fi to cellular communications to Bluetooth as well as in many more traditional applications. When a signal is being received in the presence of a strong interfering signal, then non-linearities within the receiver mixer and amplifier results in generation of spurious IF. If the interfering signal is sufficiently strong, the resulting product will suppress all other signals reducing the effective gain of the device. This is caused by the odd order intermodulation products within a receiver amplifier or mixer chain. These affect the signal in such a way that the desired signal strength is reduced. A solution for this can be implemented if the check for spurious IF is made with the help of software and the result is utilized to switch on the non-interfering oscillator frequency for the microcontroller.

Keywords-Desensitization, spurious IF, odd order inter-modulation, oscillator frequency.

INTRODUCTION

Given below is the diagram of double super heterodyne receiver, by which we would see the effect of desensitization. In the first stage the received signal is converted to the first IF. Let f_{CH} be the channel frequency, now in a double super-heterodyne receiver, the first Intermediate Frequency (IF) equal to 10.7 MHz, as

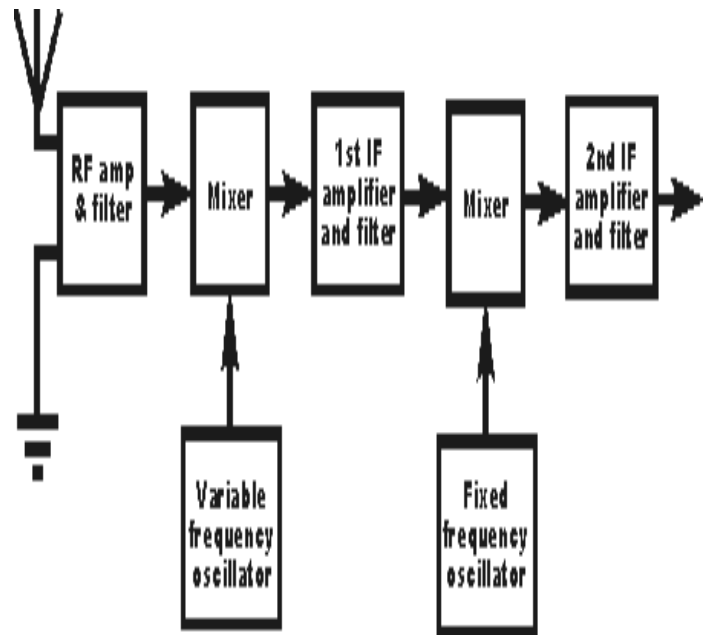


Fig 1: Super-heterodyne receiver

It is the IF standard for VHF FM transceiver system. so the loop equation for the first mixer is $f_{CH} \sim f_{LO1} = 10.7 \text{ MHz}$ (1)

where,

f_{LO} is the first Local Oscillator frequency and f_{CH} is the channel frequency,.

Now due to the non-linear characteristics in a clock-based receiver, spurious IF can be generated and this is given by the :

$$m \times f_{CLK} \sim n \times f_{LO} = 10.7 \text{ MHz} \quad (2)$$

where,
 both m and n are positive integers.

we can say there are some interference if this condition is satisfied causing the desensitization of receiver.

In 2nd stage a second mixer convert it down to a lower intermediate frequency. The f_{LO2} is fixed for a given receiver, finally the detector receives the modulating signal.

PLAN FOR IMPLEMENTATION

A solution is to check the spurious IF with the help of RSSI and then with the help of software the non-interfering oscillator frequency is chosen for the microcontroller. This is explained below.

We first get the RSSI signal, which is the measure of the IF signal strength. Now we use this to measure the level of RF interference inside the radio receiver. The circuit and its operation is driven by the micro-controller.

The operation is given below:

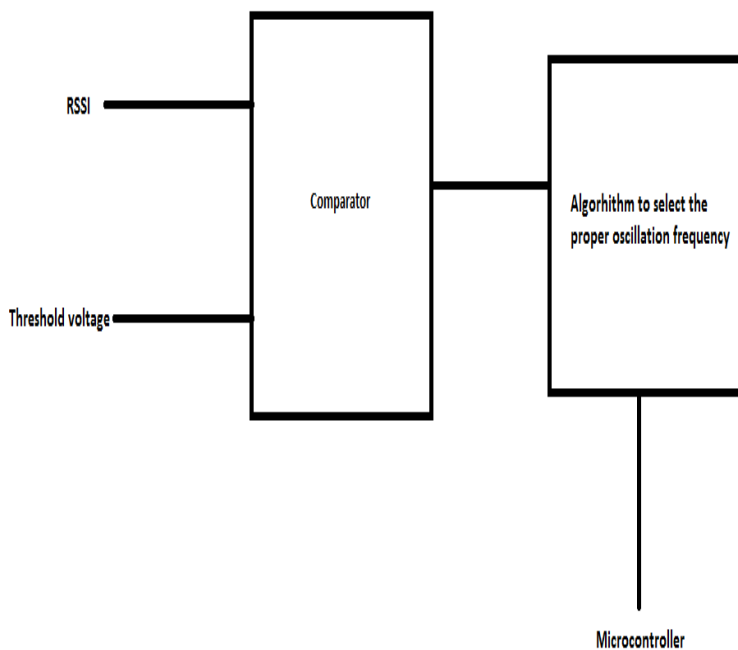


Fig 2: Circuit to determine the interference level

The RSSI signal and the threshold voltage is connected to the non-inverting and inverting input of the OP-AMP respectively. We select the threshold voltage in such a way that we get the best

possible result. It is to be ensured that the SINAD value should be higher than 12 dB. Now if the RSSI becomes equal or greater than the threshold voltage, then the comparator output selects the proper 'oscillator frequency' for the microcontroller via an algorithm.

The software algorithm is as follows-

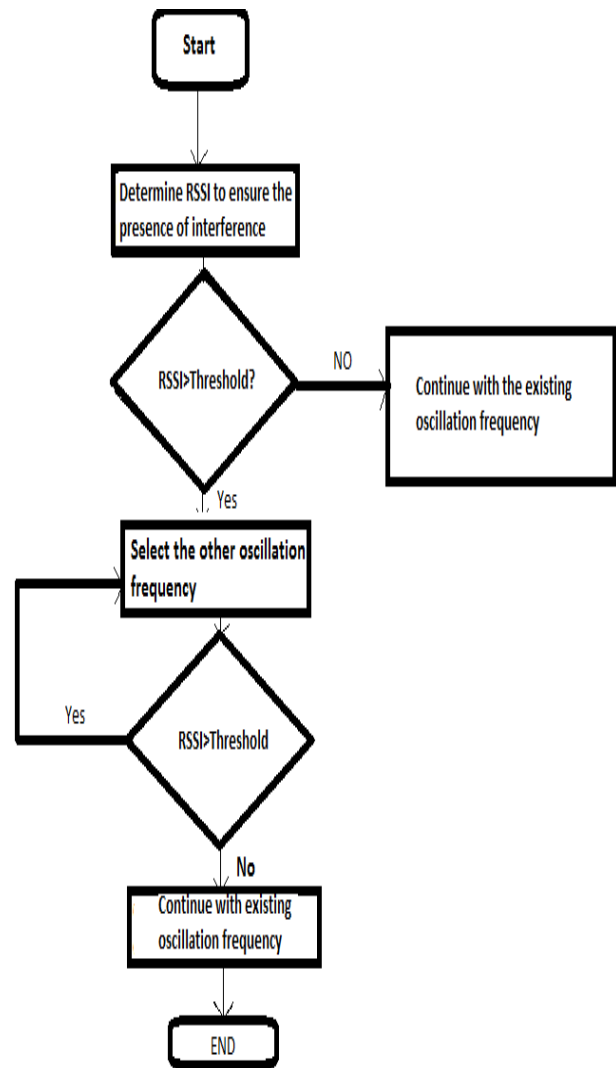


Fig 3: Algorithm to check the proper oscillator frequency

First we check for the interference by the help of the RSSI, if the RSSI value is greater than the threshold voltage level then there should be some interference and we have to change the oscillator frequency. Otherwise it will continue with the existing oscillator frequency. The microcontroller first enables the 1st crystal by default, after that the

checking is made again to decide whether the RSSI is greater than or equal to the threshold voltage or not. If yes then it will change the crystal otherwise it will continue with the present oscillator frequency. It is to mention that this modified design is not interfering with this crystal.

So in this way the output of this stage is used to enable the required oscillator frequency input for the microcontroller. After selecting the correct oscillator frequency it is fed to the 1st IF stage. We can use many crystals to generate the oscillator frequency. So it is a very flexible circuit. The arrangement is shown below.

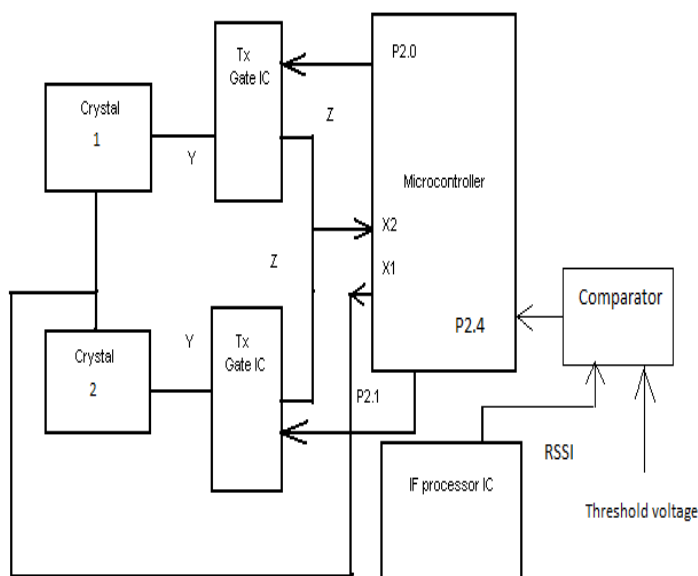


Fig 4 : Proposed circuit diagram of 1st IF stage involving two crystal oscillators incorporating desensitization

CONCLUSION

In this paper, we have tried to eliminate the effect of desensitization which is the main cause of the generation of spurious IF and we have tried to eliminate that by using the proper oscillation frequency with the help of a control logic. If it finds that any spurious intermediate frequency has been generated then with the help of the above mentioned control algorithm it will select the proper crystal and the interference is reduced. now using this design many crystals can be connected

to the input of the microcontroller. Transmission gates are used for each of the crystal. So the circuit becomes more simple and flexible. this arrangement will give better results from the point of view of SINAD and the BER(bit error rate) will also be reduced.

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