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Dual Band Detection in Radio Receiver with Single Oscillator

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Abstract- The common radio transmission and reception activities are accomplished through modulation at single carrier frequency. Channels linking information sources and receivers are one of the fundamental blocks of all communication system. In free space, the signal for transmission and reception suffers from diffraction, scattering and interference due to the presence of dust particles, rain drops, heat and other obstacles. A concurrent dual band receiver is designed to operate at two frequency band with two Local Oscillators (LO) at the detection level. A frequency multiplier is introduced to use Single Oscillator (SO). This architecture reduces component cost, low power consumption and complexity of the receiver thereby enhancing its performance.

Index Terms- Concurrency, Dual Frequency, Dual Detection, Frequency Multiplier, Oscillator

I. Introduction

Due to the ever-increasing number of data users, there is a strong motivation in developing multiband and wideband devices for transmitters and receivers to accommodate multiple frequencies in one transceiver system. The multiband and multi-standard radio architectures [1], [2] also allow for seamless transition from the older standard [e.g., third generation (3G)] to new standards [e.g., fourth generation (4G)] with backward compatibility.

Most of today's wireless receivers use any of these general architectures: heterodyne, homodyne, low-IF, and image rejection receivers such as the ones originally proposed by [3]. Similarly, all these architectures have been employed in the multi-band receivers for various applications.

However, the upcoming generation of wireless communication signals [e.g., fifth generation (5G)], which are promoting schemes such as carrier aggregation techniques [4], requiring concurrent transmission of signals at more than one frequency band, has renewed interest in the design of dual-band [5], [6] and broadband [7] power amplifiers (PAs) and dual-band signal receivers.

The problem of image with direct conversion can be overcome using super heterodyne receiver. This is the traditional radio receiver architecture for wireless communication. The solution is to place a filter before the mixer to remove the image. A very high quality band pass filter is needed, to provide the desired performance. To achieve good selectivity by down-converting the received RF signal in multiple steps. In multi-band heterodyne radio architecture, there will be higher power consumption. Also at the end, the received signal information, though of high quality, is usually weak [8].

In [9] and [10], a feedback receiver (vector signal analyzer) is employed to access the demodulated concurrent PA outputs and the frequency-selective linearization concept is extended to include time-selective memory effects, and is denoted as 2-D digital predistortion (2-D DPD).

This design focuses more on the receiver's enhancement to detect the dual-band signal.

II. DUAL BAND DETECTION IN RADIO RECEIVER

In the [11], two distinct oscillators were used. In this work, we intend to use a single oscillator with a doubler circuit during detection. This may reduce the cost of the final circuit. The proposed architecture is illustrated in figure 1.

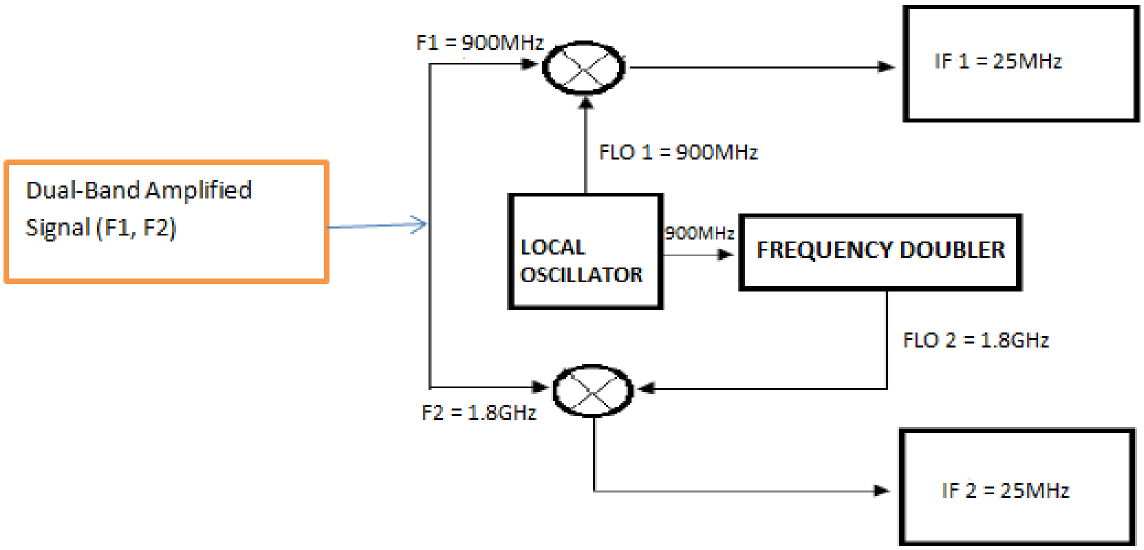

Figure 1: Block diagram of dual band radio detection

The circuit block includes a dual band amplified signal, local oscillator, frequency doubler, mixer and information signal. The modulated frequency F1 is mixed with carrier frequency FC1 of LO to produce intermediate frequency (IF1). Also, the signal F1 from the LO is doubled in the multiplier and mixed with modulated frequency F2 to produce intermediate frequency (IF2). The design of these three circuits; the dual band filter, the amplifier and the frequency multiplier are presented below.

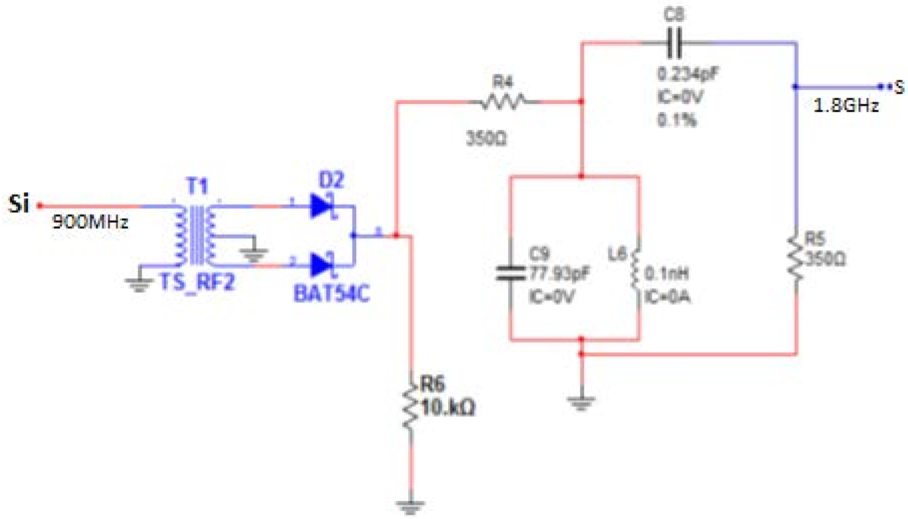

Figure 2: Frequency multiplier circuit of 900MHz to generate 1800 MHz

III. DUAL DETECTION

In this case, a single oscillator is used to generate 900MHz of carrier signal. An interesting effect that results from choice of the single LO Frequencies is in-band leakage to the antenna. That is, if FLO1 =900MHz is mixed with FLO2 = 1800MHz, both 900MHz and 1.8GHz components are generated at the receiver output, FLO2 is generated using frequency multiplier circuit. At the output of the multiplier a single stage filter is designed, to filter 1800MHz. This will help to further smooth the doubling output.

In the above circuit, full wave rectifier is used to double the given frequency with RF centered tapped transformer and schottky diode.

The *Schottky* diode possesses two unique features as compared to an ordinary P-N junction diode. It is unipolar device because it has electrons as the majority carrier on both side of the junction. An ordinary P-N junction diode is a bipolar device because it has both electrons and hole as the majority carriers. Since no holes are available in metals, there is depletion layer or stored charged to worry about. Hence, schottky diode can switch off faster than bipolar diode. Because of these qualities, schottky diode can easily rectify signal of frequency exceeding 300MHz.

Frequency multiplication can also be done using bridge rectifier with a capacitor and an ordinary diode, but the above method is better. Resistors in (KΩ) were used across the output to obtain large voltage drop. At the receiving end, the same information can be received at different frequencies.

IV. RESULT ANALYSIS

In figure 3, the magnitude of frequency doubling at 900MHz to 1.8GHz is indicated.

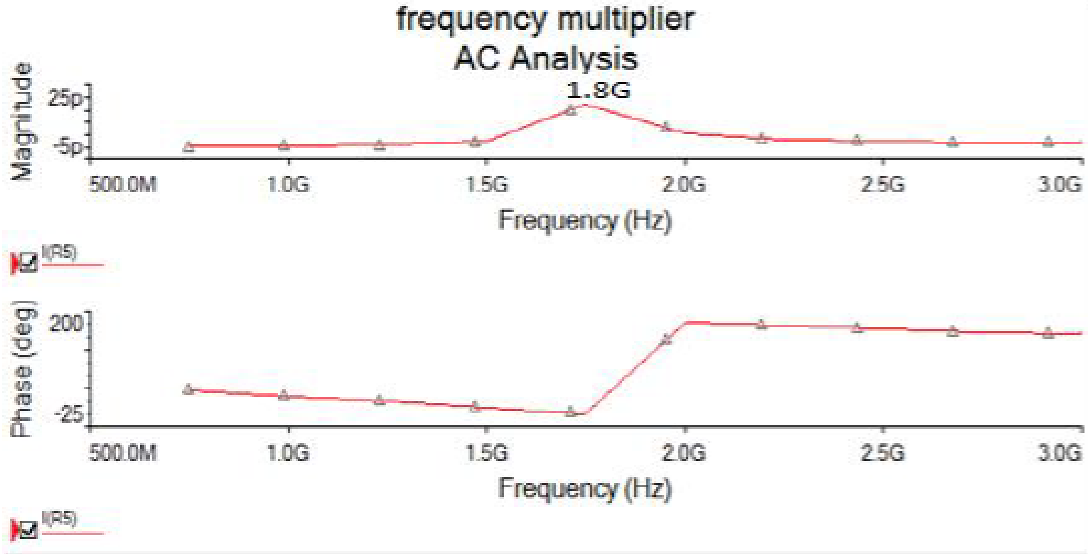

Figure 3: The AC analysis output of multiplier circuit

V. CONCLUSION

We are able to demonstrate that the replacement of two oscillators with a single one is feasible in the detection section of the architecture. The architecture is found to be feasible with additional advantages of low power consumption, light and small chip area. This result implies that, the problem of channel condition can be reduced if this architecture is adopted at both transmission and reception points.

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