DESIGN OF LOCAL OSCILLATOR FOR UP-CONVERTER AT 3 GHz

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Abstract: This paper proposes a 3GHz frequency generation technique that improves its performance and power efficiency. The main idea is that a fundamental 75 MHz signal and its sufficiently strong eighth harmonic at 600 MHz are generated simultaneously in a single oscillator. The desired 3 GHz local oscillator (LO) signal is generated by further extracting fifth harmonic of 600MHz signal that is generated using balanced pin diode based frequency multiplier which reduces the complexity of multipliers. The harmonic generation and extraction techniques are proposed and applied to the frequency generator.

Keywords: 3 GHz, Frequency multiplier, Harmonic extraction, Oscillator, Diode Multiplier, PIN diode

I. INTRODUCTION

In the current era of communication, there arises need of reliable link to communicate in various environments. In many applications, indoor communication is important for transferring the data from one location to another location. For such applications 2.4 GHz band may be used, as various sub-systems are commercially available. However this band is overcrowded and interference problems may arise. In view of this, a suitable frequency band has to be adopted. Modern communications protocols, radar equipment, high frequency DAC require low phase noise, good frequency stability and low power consumption of frequency sources. A small size and low cost of the oscillators are essential as well. Considering the less co-ordination of spectrum, availability of subsystem and design complexity it is proposed that 3GHz band can be useful for such indoor application.

II. EIGHTH HARMONIC EXTRACTION

The basic concept of this work is to simultaneously generate both 75 MHz and a significant level of its 8th harmonic [1] at 600 MHz inside a 75 MHz oscillator. The generated 600 MHz signal is fed forward to natural bandpass filtering as shown in Fig. 1. Since the oscillator runs at the fundamental frequency of 75MHz, its resonant tank achieves a better Q-factor than at 600 MHz, which leads to a better PN performance. Moreover, the tank has a larger inductance (L) and capacitance (C). This increases the variable portion of the total tank capacitance and the frequency.

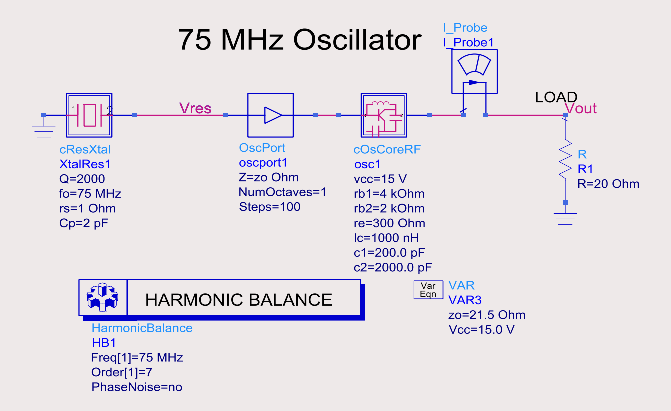

Figure 1: Basic 75 MHz oscillator design

The 8th Harmonic can be achieved through a Fifth order Chebyshev Bandpass Filter that is centered to 600 MHz, these lumped filter provides lower attenuation to 8th harmonic and higher attenuation to other harmonics thus suppressing unwanted harmonics [3]. The pass band has attenuation of less than 1dB and the stop band has attenuation greater than 20 dB. The passband ripples are estimated to be around 0.5 dB.

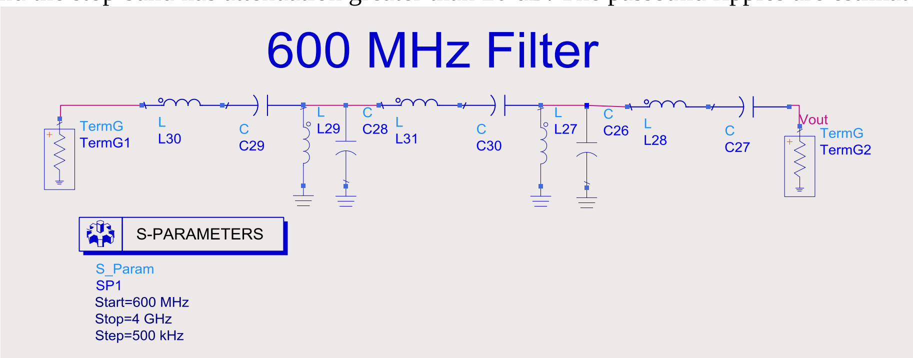

Figure 2: 600 MHz Bandpass Filter

III. AMPLIFICATION OF HARMONICS

The Amplifier section is used to magnify the power generated at 600 MHz, as the signal is of very low power which is undesirable for further harmonic generation. The power amplifiers are used to raise the overall power gain of signal at certain level. The amplifier used is a monolithic amplifier with amplification range from 0.1 GHz to 6 GHz and has Output Power @1 dB compression of 19 dB typically.

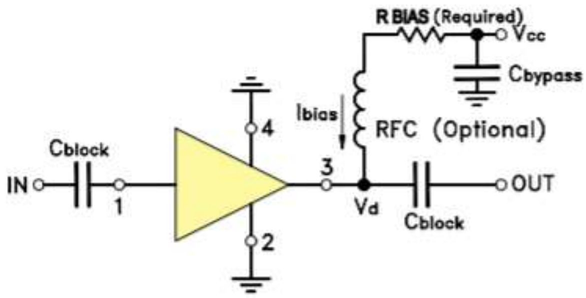

Figure 3: High power Amplifier Schematic

IV. FREQUENCY MULTIPLIER

A frequency multiplier is a circuit that generates an output signal whose output frequency is a harmonic of its input frequency. Frequency multipliers [5] consist of a nonlinear circuit that distorts the input signal and consequently generates harmonics of the input signal. A subsequent bandpass filter selects the desired harmonic frequency and removes the unwanted fundamental and other harmonics from the output. There are many approaches to design a frequency multiplier. Balanced PIN Diode Multipliers have significant advantages compared to single-ended multipliers; the most important are increased output power and inherent rejection of the fundamental frequency and of certain unwanted harmonics. The antiparallel diode connection is probably the simplest form of a balanced multiplier; it rejects even harmonics of the input frequency and consequently can be used only as an odd-order multiplier. In an antiparallel-diode multiplier, each diode effectively short circuits the other at the second harmonic, so each diode acts as a type of idler for eachother.

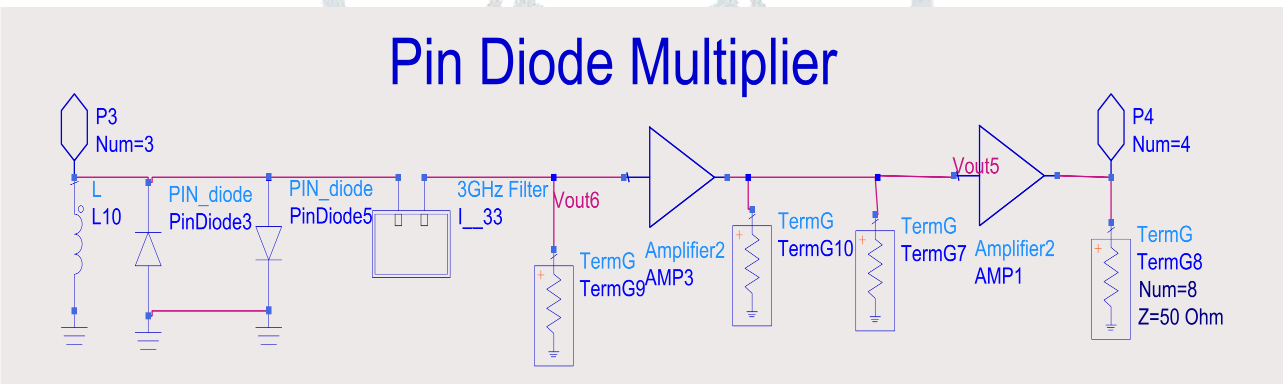

Figure 4: Pin Diode Multiplier

This circuit does not reject the fundamental frequency, however, so it requires an output filter. A typical design of a PIN diode multiplier is shown in figure with its input and output balanced impedance network. The actual output is the output of local oscillator. The Network is designed and simulated in ADS tool. The diode multiplier network is coupled with a power amplifier inorder to fetch 5th harmonic of 600MHz signal at desired level. The output of the amplifier is +14 dB @ 3GHz.

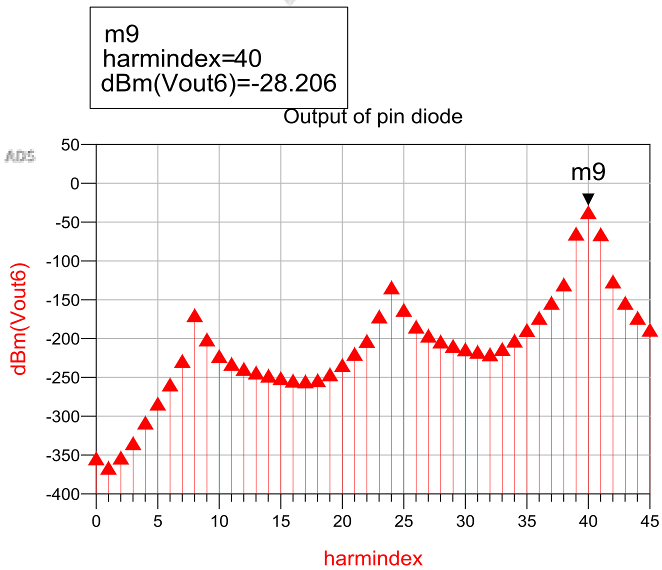

Figure 5: Output of Pin diode Multiplier

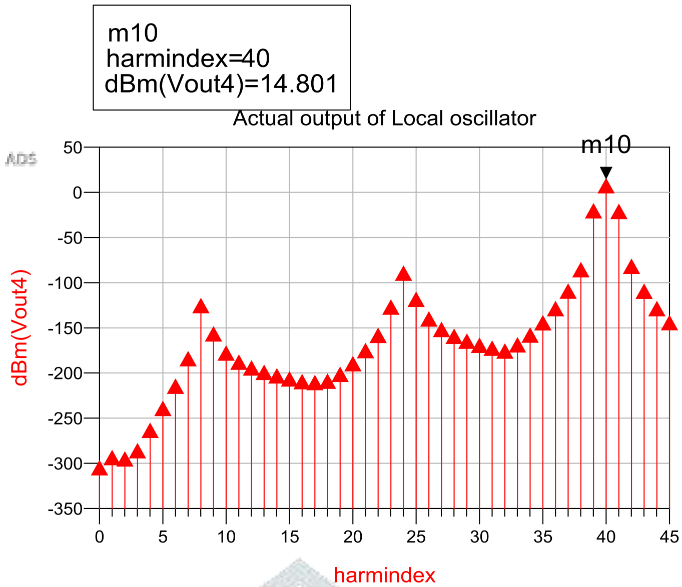

Figure 6: Output of Pin diode Multiplier with Amplification

V. MICROSTRIP LINE FILTER

Microstrip line filter is employed in the pin diode multiplier as a Bandpass filter, the lumped component are not accurate at high frequency as they tend to be unstable after 1 GHz frequency. These limitations of lumped component can be overcome by Microstrip line filter. In this design the microstrip filter is centered to 3 GHz thus suppressing other harmonics. It expected that the output level of filter is sufficient to drive the load or an amplifier section will be added depending upon the requirement of output power.

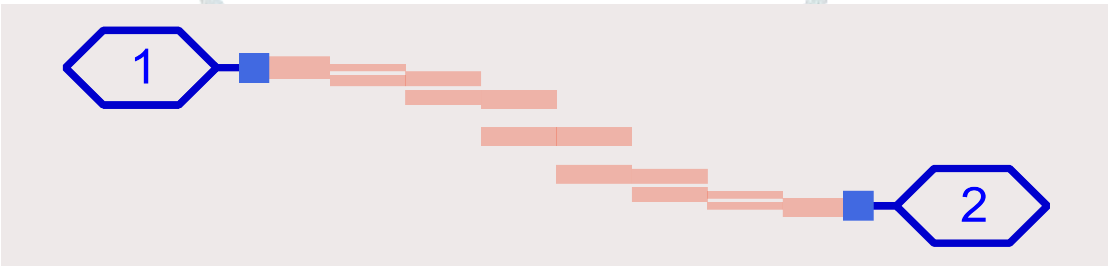

Figure 7: 3 GHz Coupled Microstrip Line Filter

VI. CONCLUSION

A 3 GHz frequency generator based on multiple harmonic extractions is proposed to improve power efficiency and performance of a 3 GHz source. A harmonic boosting technique is described and applied to a 75 MHz oscillator to increase its eight-harmonic level and further extraction of harmonics is achieved by pin based multiplier which contributes equally. The undesired fundamental tones other than eighth harmonic is suppressed using lumped filter and the higher frequency harmonic tones are suppressed using microstrip line filter which terminates harmonics other than centered frequency and the 3 GHz component appears amplified at the output.

VII. REFERENCES

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