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A HIGH QUALITY FACTOR TUNED AMPLIFIER CIRCUIT AT HIGH FREQUENCY

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Tuned amplifiers are mostly used for the amplifications of high or radio frequencies. Since, radio frequencies are generally single and the tuned circits permits their selection and efficent amplification. So, selection of parameters for tuned circuit play an important role in the design of tuned amplifiers. In the present paper modification of parasitic capacitance transistor circuit has been studied. Simulated result provides modified tuned amplifier with high quality factor. It is also seen that frequency response curve is independent of temperature from –50°C to 150°C.

KEY WORDS: Parasitic capacitance, inductor, frequency response, Fourier transform, simulation.

INTRODUCTION

Most of the audio amplifiers work at high frequencies more than 50 KHz. However, they suffer from two major problems. First, such amplifier mostly have resistive load and consequently their gain is independent on signal frequency over a large bandwidth. In other words, an audio amplifier, amplifies a wide band of frequencies equally well and does not permit the selection of a particular desired frequency while rejected all other frequencies. Secondally they become less efficient at radio frequency [1, 2, 3].

However, sometimes it is desired that an amplifier should select a desired frequency of narrow band signal for amplification. For instance radio and television transmission are carried on a specific radio frequency assigned to the broadcasting station. The radio receiver is required to pickup and amplify the radio frequency desired while discriminating all others. To achieve it, the simple resistive load is replaced by an inductor with load whose impedance strongly depend upon frequency such that tuned circuit become very selective and gain is very high for narrow range of frequencies on either sides, giving tuned amplifier with high quality factor [4, 5, 6, 7, 8, 9, 10].

Fig. (1) shows a reference parastic capacitance transistor circuit which consist of an a.c. source of 1m *Vac*, which provides the input signal to the circuit [11, 12, 13]. Capacitor C_1 = 10 μ*f* is the base capacitor which block if any D.C. component available in the input source, *Rsig* = 1 K is the signal resistance, R_1 = 40 K and R_2 = 10 K provide potential divider biasing of transistor so that it works in active region, C_i = 6 pf is the input capacitor, *Cbe* = 36 pf, *Cce* = 1 pf and *Cbc* = 4pf are the parasitic capacitance of base-emitter, collector-emitter and base-collector respectively, *Re* = 2 K is the emitter resistor and *Ce* = 20 μf is the bypass emitter capacitor, *Cc* = 0.5 μf is coupling capacitor, *Co* = 8 pf is output capacitor, R_l = 2.2 K is the load resistance and *Rc* = 4 K collector resistance. The amplifier circuit is designed using the *npn* transistor Q_1 = 2N2222 with gain β = 255.9. For simulation the power supply voltage V_{cc} = 20 V_{dc} is taken.

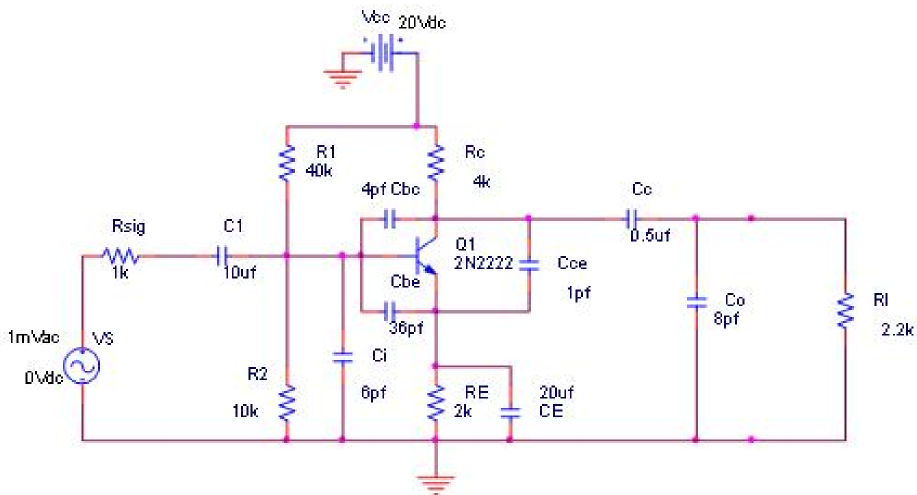

Fig. 1. Reference parasitic capacitance transistor circuit

The proposed tuned amplifier circuit is shown in Fig. 2. In proposed circuit an inductor L_1 = 0.10 micro henry is placed in parallel to *Co*. This combination of LC circuit constitutes a tunnig circuit, which can be tuned by varying inductor. In the present investigation a typical value of L_1 = 0.10 micro henry has been choosen.

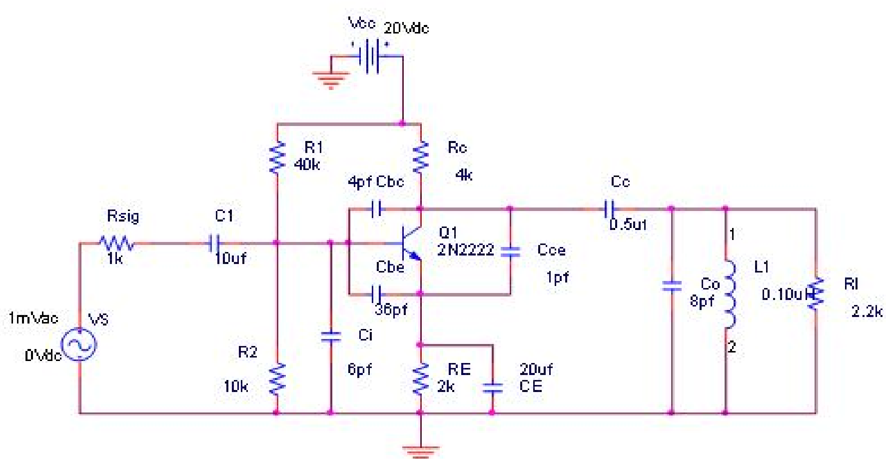

Fig. 2. Modified parasitic capacitance transistor circuit

Result and discussions

The proposed circuit has been simulated using or CAD tool. The frequency response curve for circuits of Fig.1 and Fig. 2 are shown in Fig. 3 in which frequency varies from 1.0 KHz to 1.0 GHz.

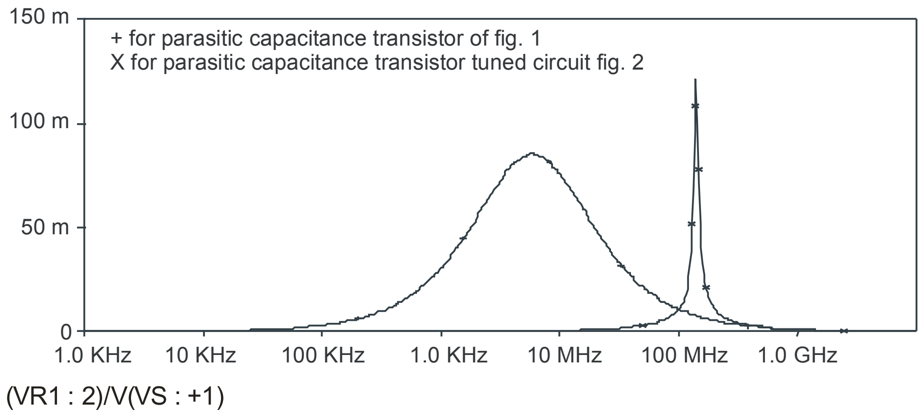

Fig. 3. Frequency response curve of fig.1 and fig. 2.

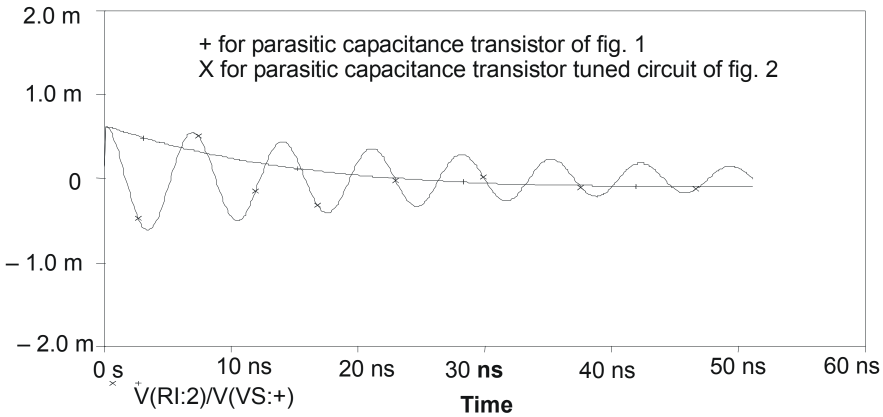

Fig. 4. Fourier transform curve of fig.1 and fig. 2.

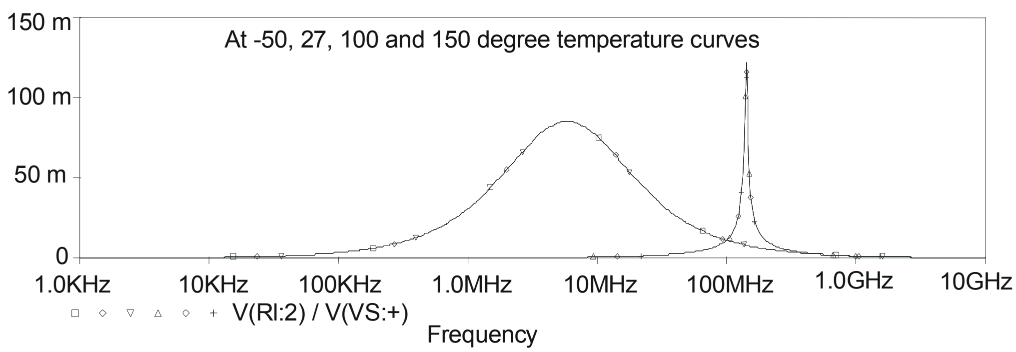

Fig. 5. Temperature analysis curve of fig.1 and fig. 2.

In fig. 3 the result shown by '+' shows the simulation result of fig. 1 in which the reference circuit is simulated using 10 microfarad input capacitance along with parasitic capacitance and the result shown by 'x' shows the simulation result of fig. 2 in which the modified circuit is simulated using 10 microfarad input capacitance along with parasitic capacitance. The simulation result shows that the reference circuit is working properly in the frequency range 5MHz-40MHz whereas the modified circuit is working at high frequency in the frequency range 136MHz-146MHz with higher gain and high quality factor. For $L = 0.01$ μH, the gain and bandwidth of modified circuit is 0.12 and 3.981 MHz respectively whereas for the reference circuit gain and bandwidth is 0.0849 and 12.9201 MHz respectively. Thus modified circuit is useful for application of narrow range of frequencies such as tuned amplifier design. Simulation result provides information that if we decrease the value of L then we can design tuned amplifier at high frequency with the help of parasitic capacitances.

Fig. (4) shows Fourier analysis of reference circuit (Fig. 1) and modified circuit (Fig. 2) by '+' and '×' respectively. The Fourier analysis has been simulated for time interval 0 second to 60 nano second. The simulation result shows that the response for reference circuit is overdamped and losses its energy at faster rate whereas in the case of modified circuit the nature of response is underdamped which gives the better response.

The Fig. 5 shows the temperature variation of the reference and modified circuits presented in Fig. 1 and Fig. 2 respectevely. The simulation result shows that the both circuits are independent of temperature between –50°C to 150°C. Thus circuit shows good temperature stability.

Conclusion

From above discussion it is concluded, that the parasitic transistor with load inductor played an important role in the design of tuned amplifier with high quality factor and temperature independent circuit. Present simulation also yields that modified circuit is better for tuned amplifier applications having higher quality factor than reference circuit which has low gain and higher bandwidth with poor quality factor. Our attempt is also to reduce bandwidth further so that one can get tuned amplifier with very high gain and high quality factor which is useful in design of amplifiers for various communication system applications. Present analysis also encourage that using parasitic capacitance circuits together with only some additional circuit element placed in proper topology we can design tuned amplifier which can be used at very high frequencies.

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