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Study and Analysis of A Simple Self Cascode Regulated Cascode Amplifier

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ABSTRACT

This article proposed a simple self cascode RGC amplifier configuration to increase the gain and bandwidth. The cascode amplifier eliminates the miller capacitance between input and output and facilitates high gain, high input and output impedance with high bandwidth. However, the cascode amplifier requires relatively high supply voltage for proper operation and it decreases the output voltage swing by overdrive voltage. These issues are overcome by self cascode based RGC amplifier; even though it has low bandwidth due to the presence of one of its pole at low frequency. The bandwidth and output impedance of the conventional RGC has increased using a split length compensation technique. To improve the overall performance of the amplifier, introduced a simple self cascode RGC without using additional passive elements. The expression of gain and output impedance for the proposed amplifier is derived using small signal analysis. The calculated value of voltage gain for the projected circuit is 58.37 dB which is more than the self cascode based RGC. The power dissipation of the proposed circuit is 1.07 µWatt and it was compared with CS, cascode, self cascode and SC based cascode, RGC, SC based RGC amplifiers.

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1. INTRODUCTION

In recent years, the requirement of low power and portable electronic devices is increasing due to its wide range of applications. The complementary metal oxide semiconductor (CMOS) technology is suitable for low power, high-speed analog and mixed signal circuit design. It arise new challenges in designing of analog VLSI circuits as the demand for compact size, high reliability and high gain amplifier [1]. To design a single stage amplifier with high gain is too difficult and this problem needs to be solved. Currently, many researchers have reported several techniques to increase the gain of amplifiers and it can be designed using long channel transistor [2, 3]. However, the cutoff frequency of the transistor is inversely proportional to the square of the channel length. As a result, the longer channel length is not a suitable solution since it will not work for low-frequency applications [4]. To eliminate these drawbacks, Cascode transistors has been proposed and it also causes a loss in linear output swing of the amplifiers. The output swing can be improved while connecting a series combination of two transistors in which the upper transistor has longer channel length than a lower transistor. This structure is known as self cascode or composite transistor and it has been proposed by Comer [5]. The self cascode technique makes the designing of amplifier circuit simple, which provides high voltage gain that can be used in op amps with low power dissipation [6]. For the further improvement of the gain of cascode amplifier was introduced in regulated cascode (RGC) amplifier [7]. The regulated cascode provides high gain; however, the bandwidth of this circuit is reduced due to one pole of the RGC located at a given low frequency. There are several techniques have been disclosed to improve the bandwidth. As described in the literature, the self cascode is the solution to most of the problem like bandwidth, output voltage swing, power dissipation [8]. Consequently, the cascode transistor is replaced by self cascode transistor in the conventional RGC amplifier which is called as self cascode based regulated cascode amplifier [9].

In this paper, a simple self cascode RGC amplifier is designed in which the input transistor is replaced by a

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cascode amplifier in order to improve the gain. The parameters like voltage gain, power dissipation, 3-dB bandwidth, output voltage swing were calculated. The calculated value of voltage gain for the proposed circuit is 58.37 dB and the power dissipation obtained is 1.071µWatt. The expression for the voltage gain and output impedance is calculated using small signal model.

2. SELF CASCODE AMPLIFIER

To fulfill the requirement of low power dissipation and high-performance amplifier, self-cascode amplifier technique is introduced which does not need high supply voltage [9]. It provides high output impedance to achieve high gain; hence it is useful in low-voltage analog circuit design.

A self-cascode amplifier consists of two transistors in which both the transistors are biased by a single input supply as shown in Figure 1, which is similar to a single composite transistor. When W/L ratio for both transistors is the same, M_1 will work in triode region and M_2 will operate in the active region and thus the single composite transistor works like a common source amplifier with high voltage gain. But when W/L ratio of M_2 is greater than that of M_1, M_1 will operate in triode region i.e. it can be replaced by a linear resistor whereas M_2 will operate in saturation region which again increases the voltage gain.

The W/L ratio of upper transistor M_2 must be larger than that of lower transistor M_1 for proper operation of self cascode structure i.e., m>1 [10, 11]. The voltage gain of self cascode amplifier is given by the following expression:

$$A_V(s) = -\frac{\left(g_{m1}\, g_{m2} r_{o2}\, R_L\right)}{1+\, r_{o2}\left(g_{m1}+\, g_{m2}+s\, C_{gs2}\right)+ R_L\left(\, sC_{gs2}+g_{m1}\right)} \qquad (1)$$

where, g_{m1} and g_{m2} are the transconductance of transistor M_1 and M_2 respectively. R_L is the load resistance of the self cascode amplifier. C_{gs2} is gate source capacitance of transistor M_2, r_{02} is the output resistance of transistor M_2.

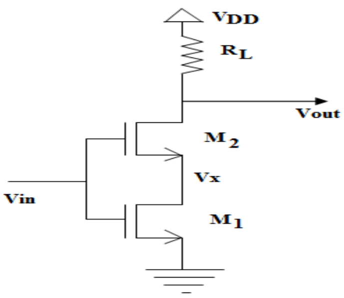


Figure 1. Self cascode amplifier

3. REGULATED CASCODE AMPLIFIER

The RGC circuit has an extra MOS transistor which forms a feedback loop between transistors M_1 and M_2 that structure is shown in Figure 2. It is connected to maintain constant drain to source voltage of input transistor M_1 and to maintain the biasing of transistor M_2. To design a circuit with larger bandwidth, minimum feature size should be followed.

A regulated cascode (RGC) amplifier is used to reduce the input impedance so that the dominating pole of the amplifier will not be located at the input. In the RGC circuit, transistor M_1 converts the input voltage V_{in} into a drain current $I_{d2,}$ that flows through the drain-source path of M_2 to the output terminal [12]. The output resistance of MOS transistor decreases with increase in channel length modulation. Thus, to obtain a high output resistance, i.e., to avoid the effect of channel-length modulation of M_1, the respective drain-source voltage must be kept stable [13]. In the regulated cascode, this is obtained by a feedback loop consisting of an amplifier (M_3). In this way, the drain-source voltage of M_1 is regulated to a fixed value. Note that the feedback mechanism upon which the stabilization is based works even if M_2 is driven into the ohmic region. It can be concluded that input impedance has been reduced by a factor of $(1+g_{m1}R_b)$ relative to a common gate input stage [14]. To obtain a more small input impedance, it is desirable to increase the factor $(1+g_{m1}R_b)$, which can be done by increasing the transconductance of the transistor M_1 (g_{m1}) or the bias resistor (R_b). These two parameters can be increased upto a certain limited value, because an increase in R_b would require a decrease in the bias current I_{d2} in order to keep M_2 in the active region. The expression for voltage gain of RGC is given as follows:

$$A_v(s) = -\frac{g_{m1} r_0^{\,2} R_l \{g_{m2} g_{m3} r_0^{\,2} R_b + R_b + r_o\}}{\{r_o^{\,3}(R_b + r_o s C_{gs2} r_o R_b)(sC_{gs3}+sC_{gs2}+g_{m2}) + sC_{gs2} g_{m3} r_o^{\,4} R_b + g_{m2} g_{m3} r_o^{\,4} R_{b))\}}} \qquad (2)$$

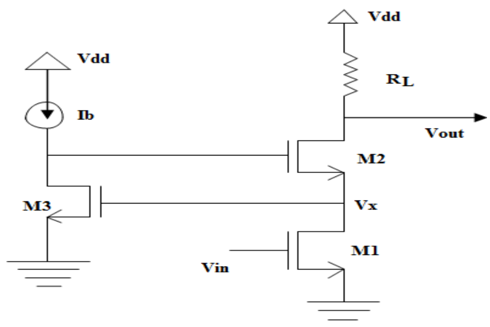


Figure 2. Regulated cascode amplifier

where, g_{m1}, g_{m2} and g_{m3} and are the transconductance of transistors M_1, M_2 and M_3, respectively and r_0 is output resistance which is considered to be the same for each MOS transistor. C_{gs2} and C_{gs2} are gate to source capacitance of M_2 and M_3, respectively, R_L is the load resistance and R_b is the bias resistance. Assuming r_o = R_b, $g_{m1}r_0$>>1 and r_0>>R_L>>1 and after performing some simplifications, the transfer function becomes:,

$$A_V(s) = -\frac{g_{m1}R_1\{g_{m2}g_{m3}r_o^2+2\}}{\{s^2c_{gs2}r_o^2(C_{gs3}+C_{gs2}) + sC_{gs2}r_o^2(g_{m2}+g_{m3})g_{m2}g_{m3}r_o^2\}} \quad (3)$$

The regulated cascode amplifier has low bandwidth because of one of its pole is located at low frequency. A further limitation of RGC structure is that the drain-source voltage of M_1 must be kept at least one threshold voltage for proper feedback operation of the MOSFETs. These problems are eliminated by self regulated based RGC amplifier.

4. SELF CASCODE BASED REGULATED CASCODE AMPLIFIER

The self cascode amplifier has higher cutoff frequency and output impedance due to its shorter channel length. So in conventional regulated cascode amplifier replace transistor M_2 by self cascode amplifier to increase the bandwidth. The self cascode based RGC amplifier is shown in Figure 3. The operating principle of self cascode based RGC is approximately similar to conventional RGC amplifier. The transistor M_1 will convert the input voltage into drain current I_{d4}. Since in the self cascode amplifier of above circuit, transistor M_4 operates in triode region so it works as a resistor. The current I_{d4} will flow through the drain of M_2 as I_{d2} and goes to the output terminal V_{out}. To reduce the channel-length modulation of M_1, the respective drain-source voltage must be kept stable. In the regulated cascode, the channel length modulation can be reduced by using feedback loop consisting of an amplifier M_3 . In this way, the drain-source voltage of M_1 is regulated to a fixed value.

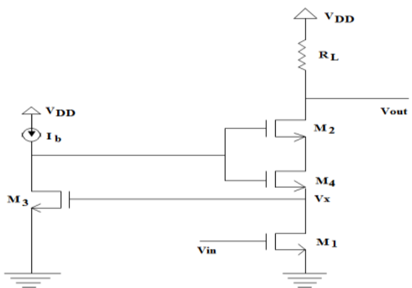


Figure 3. Self cascode based RGC amplifier

Assuming $r_{o1} = r_{o2} = r_{o3} = r_o$ and $g_{mi}r_o>>1$ (i= 1–4), the transfer function obtained is given by, Where, g_{m1}, g_{m2} g_{m3} and g_{m4} are the transconductance of transistor M_1, M_2, M_3 and M_4, respectively. R_L is the load resistance of the circuit. r_0 is the output resistance which is assumed to be the same value for each MOS.

$$A_V(s) - \frac{(g_{m1}g_{m2}g_{m3}g_{m4}r_oR_L)}{(s^2C_{gs2}C_{gs3}g_{m4}(r_o+R_L) + sC_{gs2}g_{m4}g_{m3}(r_o+R_L) + g_{m2}g_{m3}g_{m4}r_o} \quad (4)$$

The regulated cascode amplifier provides the large voltage gain and larger output impedance than that of cascode amplifier. To further increase the voltage gain of self cascode based regulated cascode amplifier, a simple self cascode RGC amplifier has been proposed.

5. SIMPLE SELF CASCODE RGC AMPLIFIER CIRCUIT

The proposed simple self cascode RGC circuit is shown in Figure 4. It consists of a cascode amplifier constructed by transistor M_1 and M_5 in order to improve the gain, a self cascode amplifier having transistor M_2 and M_4 and one transistor M_3 coupled in feedback to preserve the constant drain to source voltage of cascode circuit. The feedback mechanism sustains the biasing of self cascode stage and the biasing current for the circuit is taken 10 µA.

The transistor M_1 produces a drain current I_{d1} by converting the input voltage V_{in} into a current. Since M_5 is working as a current buffer, drain current of M_5 is equal to I_{d1}. Transistor M_1 will operate in triode region while M_5 will be in saturation region for suitable operation. The self cascode stage in the above circuit is operating in triode region so the output current will be the same as I_{d1}. The transistor M_3 which is connected as feedback functioning in triode region. It maintains the constant drain to source voltage of cascode transistor and holds the biasing of self cascode amplifier.

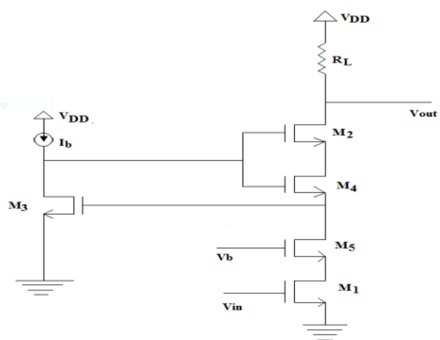


Figure 4. Proposed simple self cascode RGC circuit

The proposed simple self cascode RGC amplifier small signal model is shown in Figure 5.

From this model, applying KCL at points 'a, b, c, d and e' and considering $r_{01} = r_{02} = r_{04} = r_{05} = r_0$ we get the following equations:

$$\left(\frac{1}{R_L}+\frac{1}{r_{o2}}\right)-\frac{V_{S2}}{r_{o2}}+g_{m2}\left(V_{d4}-V_{S2}\right)=0 \tag{5}$$

$$V_{S2}\left(\frac{1}{r_{o2}}+SC_{gs2}+g_{m2}\right)-g_{m4}V_{d5}-\left(g_{m2}+SC_{gs2}\right)V_{d3}-\frac{v_o}{r_{o2}}=0 \tag{6}$$

$$V_{d3}\left(\frac{1}{r_{o4}}+\frac{1}{R_b}+SC_{gs2}\right)g_{m3}\left(V_{d3}-V_{s2}\right)-SC_{gs2}V_{s2}=0 \tag{7}$$

$$\frac{V_{d1}-V_{d5}}{r_{o1}}+\left(V_{d1}-V_{s2}\right)g_{m4}+\left(V_{d5}-V_{d1}sC_{gs3}\right)=0 \tag{8}$$

$$\frac{V_{d1}-V_{d5}}{r_{o1}}+\left(V_{d1}-V_{d5}\right)sC_{gs3}+\frac{V_{d1}}{r_{o1}}+g_{m1}V_{in}=0 \tag{9}$$

By solving the above equations and putting $r_{01}= r_{02}= r_{04}= r_{05}= r_0$ we get

$$A_V(S)=\frac{\left\{V_{s2}\left(g_{m4}+s\,C_{gs2}\right)-g_{m4}\,V_{d5}-V_{d3}s\,C_{gs2}\right\}\,g_{m1}\,R_L}{\left\{\begin{array}{l}V_{d5}\left(\frac{1}{r_0}+s\,C_{gs3}\right)\\-\;V_{d1}\left(\frac{1}{r_0}+sC_{gs2}\right)\end{array}\right\}} \tag{10}$$

where g_{m1}, g_{m2}, g_{m3}, g_{m4} and g_{m5} are the transconductance of transistor M_1, M_2, M_3, M_4 and M_5, respectively. C_{gs2} and C_{gs3} are gate source capacitance of transistor M_2, and M_3, respectively and r_o is the output resistance of the MOS transistors. R_L is load resistance of the circuit and V_{d1} and V_{d5} are the drain voltage of transistor M_1 and M_5 in that order.

Figure 6 shows the small signal model of the proposed simple self cascode RGC circuit for output impedance calculation. For the computation of output impedance, applying KCL at node 'a' and 'c' the results in following equations:

$$\frac{V_o-V_{s2}}{r_{o2}}+g_{m2}\left(V_{d3}-V_{s2}\right)-I_{out}=0 \tag{11}$$

$$V_{d3}\left(\frac{1}{R_b}+\frac{1}{r_{o3}}+sC_{gs2}\right)-sC_{gs2}V_{s2}+g_{m3}V_{g3}=0 \tag{12}$$

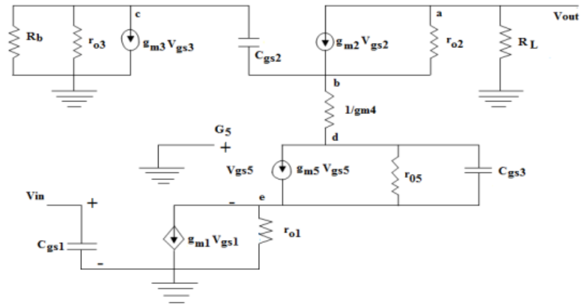


Figure 5. Small signal model for proposed simple self cascode RGC circuit

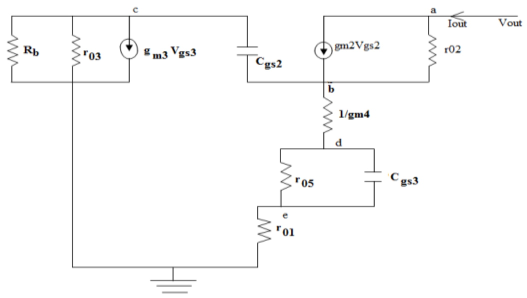


Figure 6. Small signal model for output impedance calculation

The node voltage at b and d is given by the following equations:

$$V_{s2}=I_{out}\left(\frac{\frac{1}{r_{o1}}+\frac{1}{r_{o5}}+sC_{gs3}+g_{m3}V_{g3}}{g_{m4}\left(\frac{1}{r_{01}}+\frac{1}{r_{05}}\right)+sC_{gs3}}\right) \tag{13}$$

$$V_{g3}=\frac{I_{out}}{\frac{1}{r_{01}}+\frac{1}{r_{05}}+sC_{gs3}} \tag{14}$$

From Equation (12)

$$V_{d3}=\frac{sC_{gs2}V_{s2}-g_{m3}V_{g3}}{\frac{1}{R_b}+\frac{1}{r_{03}}+sC_{gs2}} \tag{15}$$

Taking $r_{01}= r_{02}= r_{04}= r_{05}= r_0$ we obtain

$$Z_{out}=r_0\,\frac{r_0g_{m4}\left(\frac{2}{r_0}+sC_{gs3}\right)\left(\frac{1}{R_b}+\frac{1}{r_0}+sC_{gs2}\right)-r_0g_{m2}sC_{gs2}\left(\frac{2}{r_0}+sC_{gs3}+g_{m4}\right)+g_{m2}g_{m3}g_{m4}r_0}{r_0g_{m4}\left(\frac{2}{r_0}+sC_{gs3}\right)\left(\frac{1}{R_b}+\frac{1}{r_0}+sC_{gs2}\right)} \tag{16}$$

Putting $s = 0$

$$R_{out} = r_0\left(1+\frac{g_{m2}g_{m3}r_0}{2\left(\frac{1}{R_b}+\frac{1}{r_0}\right)}\right) \quad (17)$$

Bandwidth of the proposed circuit is given by,

$$W_0 \cong \frac{V_{d1}-V_{d5}}{\left(C_{gs3}V_{d5}-C_{gs2}V_{d1}\right)r_0} \quad (18)$$

The expression for bandwidth of the proposed simple self cascode RGC circuit is inversely proportional to r_0 and it also depends on the gate source capacitance of the transistor M_2 and M_3 and it increase the bandwidth.

6. SIMULATION AND RESULTS AND ANALYSIS

In the proposed simple self cascode RGC circuit replacing the input transistor M_1 by a cascode amplifier (M_1 and M_5) in the self cascode based RGC amplifier to improve the gain. The various amplifiers are constructed and calculated the significant parameters such as voltage gain, output impedance, bandwidth and power dissipation. TANNER EDA tool 12.5 using180 nm technologies have been adopted for designing the amplifiers circuits with the device parameter given in Table 1.

The performances of the amplifiers are investigated under I-V characteristics, DC analysis, AC analysis with varying frequency range of 1 to 10 GHz and transient analysis executed with time interval of 0 to 100 ns.

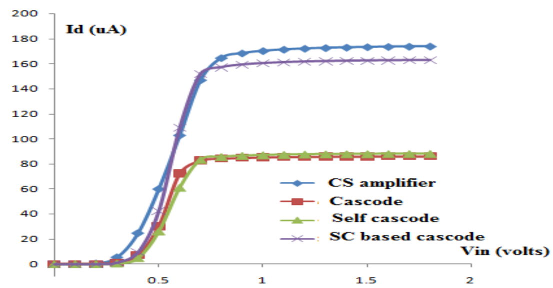
6. 1. Case 1: I-V Characteristics for Different Amplifiers To plot I-V characteristics of various amplifier circuits, the power supply voltage is considered as 1.8 V and the input voltage is varied from 0 to 1.8 V. Figure 7(a) shows the I-V characteristics for common source amplifier, cascode amplifier, self cascode amplifier and self cascode based cascode amplifier. The maximum value of drain current at the output of common source amplifier is 173.88 µA and for self cascode based cascode amplifier it is almost similar which is equal to 162.81 µA. For cascode amplifier and self cascode the value of drain current is approximately the same as 86.11 µA and 87.98 µA, respectively. Figure 7(b) shows the I-V characteristics for RGC, SC based RGC and proposed simple self cascode RGC circuit. From this figure, it can be concluded that the captured value of drain current at the output terminal is approximately the same for all the three amplifiers.

6. 2. Case 2: DC Analysis Figure 8(a) shows the DC transfer characteristics for CS amplifier, cascode amplifier, self cascode amplifier and self cascode based cascode amplifier. For CS amplifier the output voltage swing is from 1.8 to 0.52 Volts and for cascode amplifier the output voltage swing is varying from 1.8 to 0.45 Volts. The output voltage swing for self cascode amplifier is 1.8 to 0.40 Volts whereas for self cascode based cascode voltage swing is measured as highest from 1.8 to 0.27 Volts. The DC transfer characteristics for RGC, self cascode based RGC and proposed circuit is plotted in Figure 8(b). The output voltage swing for RGC amplifier is varying from 1.8 to 0.23 Volts while for self cascode based RGC is 1.8 to 0.33 Volts that slightly less than RGC. The proposed simple self cascode RGC circuit is facilitated the maximum output voltage swing from 1.8 to 0.19 volt.

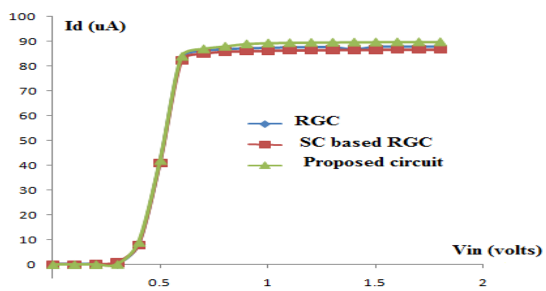
6. 3. Case 3: AC **Analysis** The ac analyses of the various amplifiers are performed for calculating the voltage gain and bandwidth of the circuits.

TABLE 1. Physical device parameter of MOSFET

Device parameters	Values
Threshold voltage of NMOS	V_{THN} = 0.399 V
Threshold voltage of PMOS	V_{THP} = -0.42 V
Doping concentration of channel in	5.92 x 10^{17} cm^{-3}
Doping concentration of channel in PMOS	5.92 x 10^{17} cm^{-3}
Beta for NMOS	30 µA/V^2
Beta for PMOS	30 µA/V^2

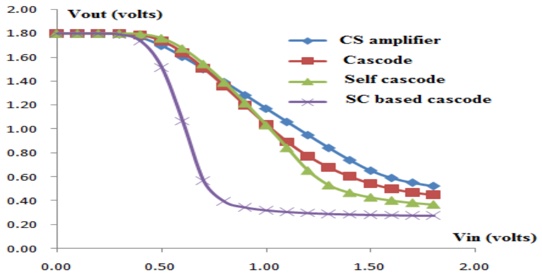


(a)

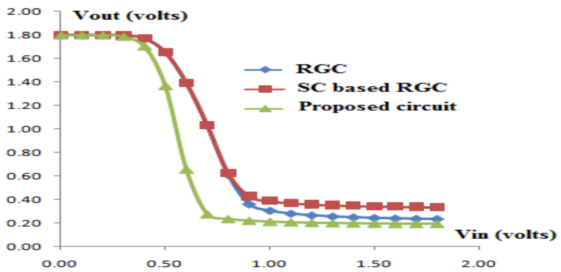


(b)

Figure 7. I-V characteristics (a) CS, Cascode, Self cascode and SC based cascode amplifier (b) RGC, SC based RGC and proposed simple self cascode RGC circuit



(a)



(b)

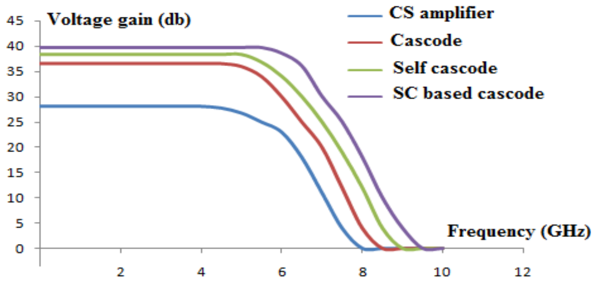
Figure 8. (a) DC analysis of CS, Cascode, Self cascode and SC based cascode amplifiers and (b) DC analysis of RGC, Self cascode based RGC and proposed simple self cascode RGC circuit

For the AC analysis, supply voltage 1.5 Volt with the varying frequency ranges from 1 Hz to 10 GHz have been considered. Figure 9(a) shows the gain vs frequency curve for CS amplifier, cascode amplifier, self cascode amplifier and SC based cascode amplifier. The value of voltage gain for CS amplifier is 28.12 dB whereas for the cascode amplifier is equal to 36.58 dB. For self cascode amplifier gain is 38.32 dB and SC based cascode amplifier is 39.63 dB that illustrate an increase in the voltage gain. Figure 9(b) shows the gain vs frequency curve for RGC, SC based RGC and proposed simple self cascode RGC circuits. The calculated voltage gain for RGC amplifier is 48 dB and self cascode based RGC gain is almost same as 48.29 dB. For the proposed simple self cascode RGC circuit, the voltage gain is 58.37 dB that proofed the voltage gain is increased. The bandwidth of the proposed simple self cascode RGC circuit is measured as 45.85 MHz.

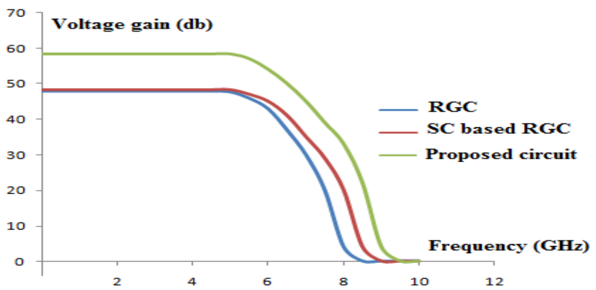
6. 4. Case 4: Transient Analysis From the transient analysis, average power consumption is calculated for the various amplifier circuits. For this analysis, the input signal is considered as a pulse of magnitude 1.5 V. Figure 10(a) shows the transient analysis from the variation of input and output voltages (Volts) with respect to time (ns) for common source amplifier. The power dissipation of the common source amplifier is 1.002 µwatt at 1ns.

Figure 10(b) shows the transient analysis of the cascode amplifier and it captures the power dissipation 1.06 µWatt. Figures 10(c) and 10(d) show transient analysis for self cascode amplifier and self cascode based cascode amplifier. The calculated value of power dissipation for self cascode amplifier is 2.07 µWatt whereas for self cascode based cascode amplifier is 1.07 µWatt calculated at 1 ns. Figure 10(e) shows the variation of input and output voltage with respect to time for RGC amplifier. The power dissipation of the RGC amplifier is 1.045 µWatt at 1 ns, which is comparatively less than common source and cascode amplifier. Figure 10(f) shows the transient analysis of self cascode based RGC amplifier and power dissipation for this circuit is 1.045 µWatt which is same as RGC amplifier but less than common source and cascode amplifier. Figure 11 shows the slew rate and noise analysis for regulated cascode amplifier and proposed simple self cascode RGC circuit.

The performances of the various amplifiers have been investigated with different parameters that are shown in Table 2. For common source (CS) amplifier voltage gain is obtained 28.12 dB, output voltage swing 1.28 volts, output impedance 37 KΩ with bandwidth of 12.5 MHz and power dissipation is approximately 1 µWatt.



(a)



(b)

Figure 9. (a) Gain vs frequency curve for CS amplifier, Cascode amplifier, self cascode amplifier and self cascode based cascode amplifier (b) Gain vs frequency curve for RGC amplifier, SC based RGC amplifier and for Proposed simple self cascode RGC circuit

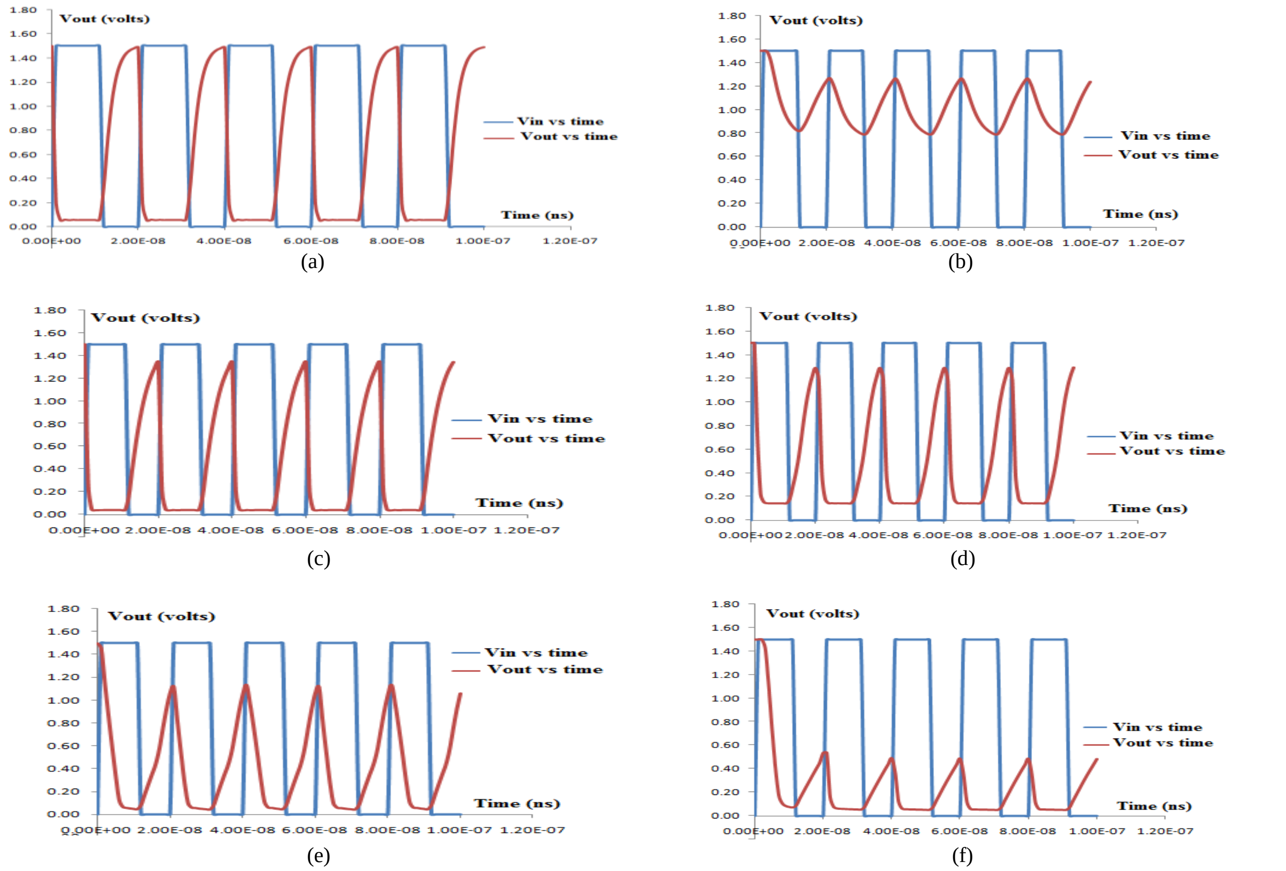


Figure 10. Transient analysis of (a) common source amplifier, (b) cascode amplifier, (c) self cascode amplifier, (d) self cascode based cascode amplifier, (e) RGC amplifier and (f) self cascode based RGC amplifier

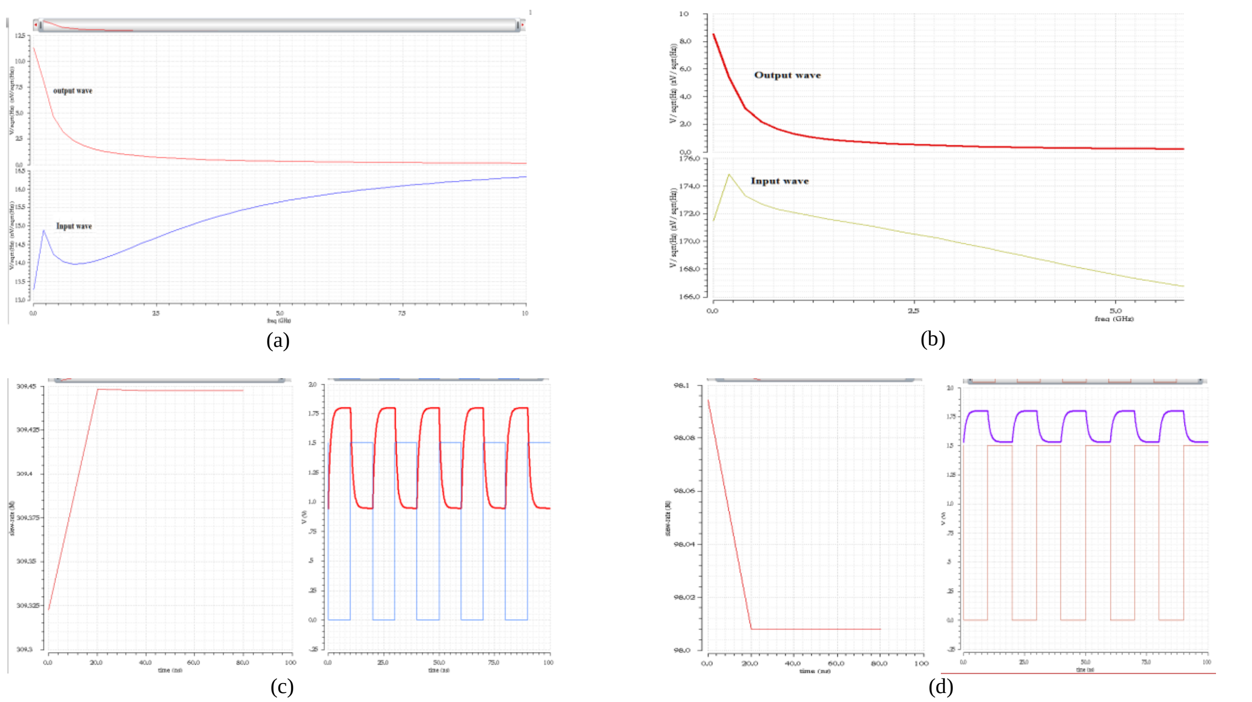


Figure 11. (a) Noise responses for Regulated cascode amplifier (RGC) (b) Noise responses for proposed simple self cascode RGC circuit (c) Slew rate for Regulated cascode amplifier (RGC) (d) Slew rate for proposed simple self cascode RGC circuit

TABLE 2. Value of various parameters for different amplifiers

Performance factor	Common source (CS)	Cascode amplifier	Self cascode (SC)	SC based cascode	RGC	SC based RGC	Proposed circuit
Voltage Gain (dB)	28.12	36.58	38.32	39.63	48	48.29	58.37
Voltage swing (Volts)	1.28	1.35	1.40	1.53	1.57	1.47	1.61
Bandwidth (M Hz)	12.5	37.1	46.7	58.7	42.6	43.698	45.85
Output resistance (KΩ)	37	116	118	59.6	131.63	131.62	185.47
Power dissipation (μwatt)	1.002	1.06	1.0702	1.07	1.045	1.045	1.071

Using cascode amplifier gain increases to 36.58 dB with bandwidth of 37.1 MHz. the power dissipation for cascode amplifier is the same as that of CS amplifier whereas output resistance and output voltage swing increases to 116 KΩ and 1.35 volts, respectively. In self cascode amplifier, the voltage swing has increased up to 1.40 volts while all other parameters are almost of same value as cascode amplifier. Output voltage swing and voltage gain are increased in RGC and self cascode based RGC circuits up to a value of 48 dB, 1.57 volts and 48.29 dB, 1.47 volts, respectively.

The output impedance and bandwidth for RGC and self cascode based RGC raised to 131.63 K Ω, 42.6 MHz and 131.62 K Ω, 43.69 MHz, respectively. Power dissipation of the proposed simple self cascode RGC circuit is 1.071 μWatt and voltage gain is 58.37 dB which is approx 10 dB more than the RGC amplifier. The bandwidth of the proposed circuit is 45.85 dB which is approximately same as self cascode based RGC amplifier. The output impedance is 185.47 KΩ and output voltage swing 1.61 volts. The proposed circuit voltage gain is enhanced and also increases bandwidth compared to other amplifiers.

7. CONCLUSION

Cascode structured amplifier has been employed in various low voltage applications. It provides higher output impedance and reduces the effect of miller capacitance of the amplifier. The proposed simple self cascode RGC circuit consists of a self casocode amplifier and the input transistor of RGC amplifier is replaced by cascode amplifier to increase the gain. The self cascode amplifier is used to enhance the output impedance and bandwidth of RGC amplifier and one MOS transistor is connected in feedback to maintain the constant drain to source voltage of cascode circuit. While designing the low power amplifier circuit, several factors are taken into consideration such as power supply, input voltage, biasing current and power dissipation. The performances of the various amplifiers have been analyzed and with different parameters voltage gain, output voltage swing, output impedance, bandwidth and power dissipation. From the investigation, the proposed simple self cascode RGC amplifier voltage gain is enhanced. It also increases output impedance and bandwidth compared to other amplifiers.

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Study and Analysis of A Simple Self Cascode Regulated Cascode Amplifier

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چکیده

در این مقاله، یک پیکربندی آمپلی‌فایر RGC خودکامپیوتر ساده برای افزایش سود و پهنای باند پیشنهاد شده است. آمپلی‌فایر کاسکوود ظرفیت میلز را بین ورودی و خروجی حذف می‌کند و امپدانس بالا، ورودی بالا و پهنای باند بالا را تسهیل می‌کند. با این حال، تقویت‌کننده کواکدون نیاز به ولتاژ منبع تغذیه نسبتاً بالا برای عملکرد مناسب دارد و نوسان ولتاژ خروجی را با ولتاژ overdrive کاهش می‌دهد. این مسائل با آمپلی‌فایر RGC مبتنی بر خودکامپیوتر غلبه می‌کند؛ حتی اگر پهنای باند کم با توجه به حضور یک قطب آن در فرکانس پایین باشد. پهنای باند و امپدانس خروجی RGC معمولی با استفاده از روش جبران تقسیم طول موج افزایش یافته است. برای بهبود عملکرد کلی تقویت‌کننده، یک RGC خود کاسکت ساده بدون استفاده از عناصر منفعل اضافی معرفی شده است. بیان امپدانس افزایش و امپدانس برای تقویت‌کننده پیشنهادی با استفاده از تحلیل سیگنال کوچک مشتق شده است. مقدار محاسبه شده از ولتاژ برای مدار پیش‌بینی شده ۵۸/۳۷ dB است که بیشتر از RGC مبتنی بر خود کاسکو است. از دست دادن قدرت مدار پیشنهادی ۱/۰۷ مگاوات است و با CS، cascode، self cascode و cascode based SC، RGC، SC تقویت‌کننده‌های RGC مقایسه شده است.

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