Research Article

A Survey on Recycling and Complementary Folded Cascode Amplifier to Enhance the Different Parameters

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Abstract: Now a day, amplifiers are one which is greater in power gain. It is fundamental to modern electronics, widely used in almost all electronic equipment. The cascode amplifiers are key element to various useful circuits. It has more advantages as increasing bandwidth and high slew rate, with high gain, moderately high input impedance and higher output impedance. A recycling folded cascode amplifier (RFCA) gives improved parameters over that of the conventional folded [1]. This is obtained by using previous circuit which is idle devices in the signal path, which results in improved transconductance, gain and slew rate [1]. The cascode stage consists of a common gate and common source terminal. The complementary folded cascode amplifier (CFCA) are mirror type configured circuit, which saves its power and greater settling point. A slew rate that allows maximum frequency above the range, which will eliminates any potential errors and unwanted signal. The circuit having a slew rate above 6.3V/µs most seems as used. A unity gain bandwidth can used to amplify the signal, wider bandwidth can eliminates smaller signal.

Key words: Recycling Folded Cascode (RFC), Complementary Folded Cascode (CFC), Folded Cascode Amplifier (FCA).

1. Introduction

There is a demand for electronics and mobile component to achieve small size and high speed with better quality, wide bandwidth [2]. In analog circuits, the Operational Amplifier has more applications in switched capacitors, A/D converters, sample and hold circuits. Now advanced CMOS technology, becomes important to transistor channel length and supply voltage is continuously scale down. The input and output stages of transistor affects its overall performance of OA. The performance can be reduced with minimum efforts for their different application of single stage operational transconductance amplifier [3]

Folded cascode operational amplifier (FC) play a important role for their high Gain and high speed with low power in many analog systems. FC achieves high O/P swing but needed more power because of an added in branch. The folded cascode is fundamental amplifier structure for high DC gain and large signal swing. The FCA offers self compensation and the gain of two stage op-amp with good I/P common mode rage of OTA [5]. It is one of the popular topology with offers high gain, bandwidth, high SR and higher input impedance. The transconductance based noise reduction technique evaluates the transistor gain, noise, size and area.

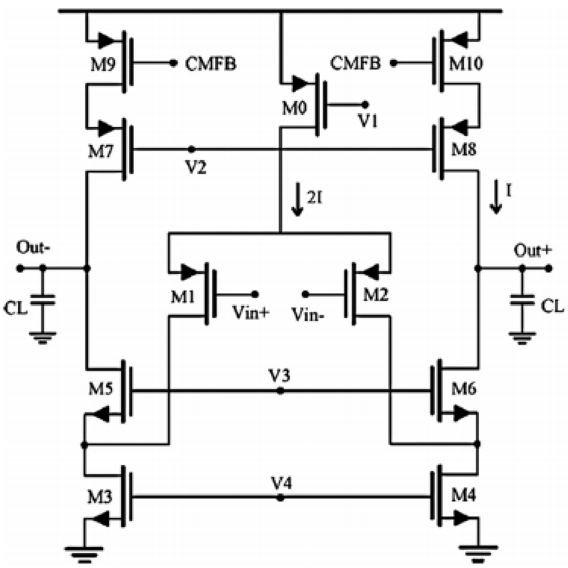

Figure 1: The CF Cascode Amplifier [4].

In this paper, we are discussing about optimization of complementary and recycling folded cascode amplifier. In this, section 1 is Introduction, section 2 is Recycling Folded Cascode Amplifier. Section 3 is Complementary Folded Cascode Amplifier. Section 4 is Conclusion.

2. Recycling Folded Cascode Amplifier

Recycling FC amplifier used to improve their performance in terms of SR, unity gain bandwidth. While doing for all such a parameter, it is difficult to maintain transistor in saturation region. There are so many methods to improve the parameters and potential distribution method (PDM) is one of them.

There is a technology for distribution method, that technology is independent from complex mathematic expression and power supply of the circuit [6]. It can be applied to short and long channel devices [7]. PDM is used to force all the transistors to be in saturation.

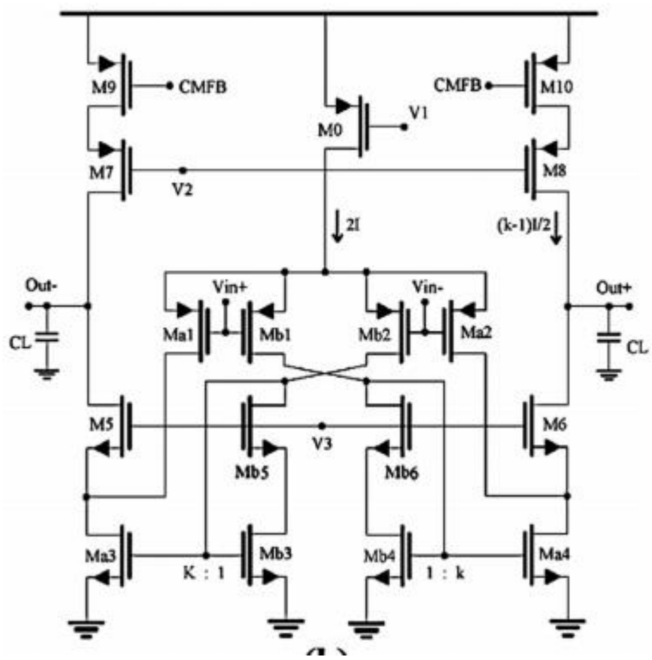

Figure 2: The Recycling FC Amplifier [4].

The power factor of RFC improvements is difficult without power of a circuit and it will be able to hold better SR as compared to FC. RFC has emerged under to low-voltage constraint for power and area-efficient performance of FC. The low power and low voltage of recycling folded cascode amplifier benifits to achieve higher transconductance, gain and slew rate. The growth of an portable devices is fast and it is only possible by the advancement in integrated circuit with low power and fast operating speed [8]. Operational transconductance amplifiers are suitable for low power and low voltage portable devices. It also demands fast settling point, which required wide gain-bandwidth and large SR [9]. By applying compensation technique, recycling circuit achieves better unity gain bandwidth and slew rate.

2.1 DC Gain of Recycling FC amplifier

The frequency gain of an operational transconductance amplifier is expressed as

Av=gmrout (1)

It can be increased by different approaches and now, by increasing in effective transconductance or by O/P impedance or both in an operational transconductance amplifier [10].

2.2 Slew Rate of Recycling FC Amplifier

Slew rate is obtained by applying a large signal at which is applied in the input stage and by assuming capacitive load C_L. It is a parameter which affects the settling point of the operational transconductance amplifier which is derived as given in equation 1.

$$SR=\frac{2IB}{CL} \quad (2)$$

The faster in information transmission, higher in the slew rate. To shorting two nodes of the conventional recycling FC circuit, it makes double in the slew rate.

2.3 Phase margin of Recycling FC Amplifier

The PM is discussed about the stability of the given circuit [11]. For system stability, TF is determined by poles and zeros by the load capacitors. The cross over connection of current mirror technique is used to improve phase margin [20].

2.4 Transconductance of Recycling FC Amplifier

A floating voltage source is adapted to splits DC biasing current between inner and outer stage of differential pair. This can be enhanced its transconductance of mirrored recycling folded cascode amplifier. After adapting this technique, the aspect ratio of transistor is same as the conventional folded cascode amplifier. A positive feedback path is introduced to achieve improved transconductance without increasing their power and area.

2.5 CMRR of Recycling FC amplifier

Common mode rejection ratio is an ability to reject common mode signal. It should be infinite for ideal op-amp.

Table 1: Transistor Size of Recycling and Improved Recycling Folded Cascode Amplifier [4]

Device	ARFC	IRFC
M_0	54.6/05	54.6/05
M_{a1}, M_{a2}	26/0.18	26/0.18
M_{b1}, M_{b2}		
M_{a3}, M_{a4}	k×12/0.18	k×12/0.18
M_{b3}, M_{b4}	12/0.18	12/0.18
M_{b5}, M_{b6}	12/0.18	12/0.18
M_5, M_6	12/0.36	12/0.36
M_7, M_8	26/0.18	26/0.18
M_9, M_{10}	26/0.63	26/0.63
M_{c1}, M_{c2}	0.6/0.18	-
R_m	-	15*0.18
C_{mim}	-	13*13
M_{11}, M_{12}, M_P	(k-1)×26/0.5	(k-1)×26/0.5
M_{n1}-M_{n4}	12/0.18	12/0.18
M_{n5}, M_{n6}	k×12/0.18	k×12/0.18

3. Complementary FC Amplifier

Now, the high speed application of ADC and FC amplifiers is chosen to design the circuit for their low noise, large DC gain an high UGBW characteristics [1]. The operational transconductance amplifier is major building blocks of mixed and analogy circuits, many of these circuits are high power consuming for an operation [13]. FC is large O/P swing and higher gain of single pole op-amp [14]. The negative feedback is suitable because it is having small signal gain is large.

A self biasing technique is used to save power and area of circuit, less sensitive variation. A folded cascode topology was proposed to low noise amplifiers for low voltage applications. The major concern is that low gain, where consumption of current is limited.

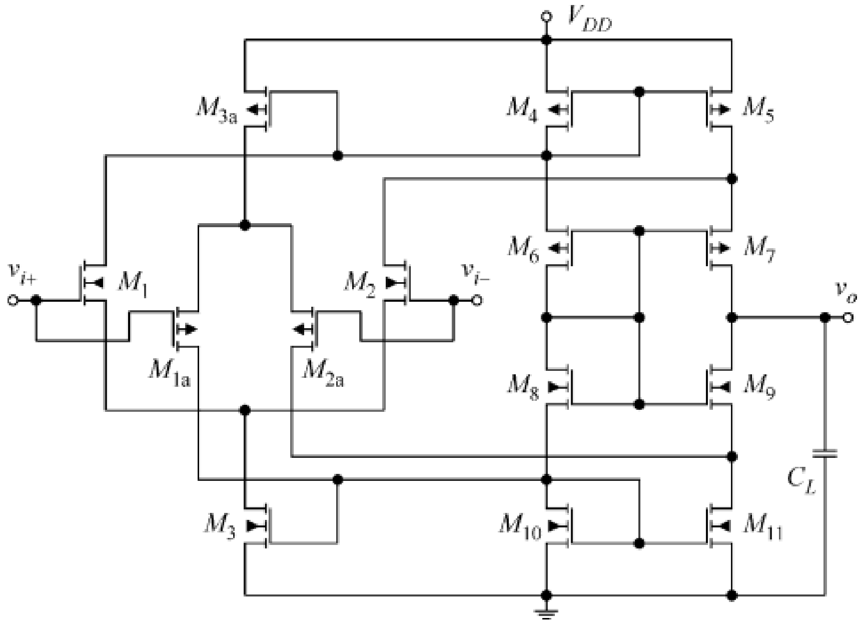

Figure 3: Self biased CFCA [15].

An amplifier has to meet two different requirements for charge transfer and fast settling point [16]. Which are high loop gain and high speed. The high loop gain required having multistage design with low current level and high speed required single stage with high current level. By this, both are different in criteria, have to meet with one singe value of an amplifier.

3.1 Slew Rate of Complementary FC amplifier

Slew Rate is described as there is an change in minimum rate of op-amp. SR is having different specification with respect to bandwidth and differential I/P signal of ±100 mv or less. Basic formula to calculate slew rate (SR) is given in equation 2.

$$SR=2\pi fv \quad (3)$$

Where f is frequency and v is output voltage of op-amp circuit.

The slew rate of an operational transconductance amplifier is proportional to the maximum current and it is available in first stage of the op-amp [17]. Increase in the SR, increase in the bias current source, which will increases in power dissipation of the circuit.

3.2 Settling Point of Complementary FC amplifier

A fast settling point of operational amplifier is a common and required [18]. There are two different periods. 1st, which is depends on its large signal circuit behaviour which is called as slew rate (SR). 2nd, which is depends on small signal circuit behaviour and called as unity gain frequency. It is derived by the ratio of SR and unity gain frequency.

3.3 Unity Gain Bandwidth of Complementary FC amplifier

The unity gain bandwidth of CFCA is simply the frequency of an input signal at which open loop gain is equal to 1 [19]. It can be calculated by the product of gain (A) and input frequency (BW), gain bandwidth product (GBWP) as given in equation 3.

$$GBWP=A\times BW \quad (4)$$

4. Conclusions

This work throws improvements that can be achieved by adopting several methods [11]. If one parameter is disturbed than it may affect to entire function of circuit. For example, higher in slew rate higher in base current and that cause to increased current. The unity gain bandwidth product is the ratio of frequency and gain. If anyone of these get increased then it causes to reduce in unity gain bandwidth product. The complete circuit is sensitive with all the different products. In this case, if anyone of these important to improve then other parameter can be ignored and that must be less as much as it is reduced.

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