Effective DC source for Power engineering and electric mobility

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Research Article

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Abstract

In linear integrated circuits, Opamp plays the vital role in the implementation of DC voltage amplification ,operational amplifier is mostly used in noninverting configuration. In this case, the feedback resistor is replaced by a capacitor to do the same function. Since capacitor acts as an open circuit for DC signal, it also provides isolation between input and output. The amplified voltage level is limited by the breakdown voltage of the transistors used to build Opamp and further the insulation breakdown limit of the capacitor. By making use of new technologies as silicon carbide technology is now in progress, the breakdown voltage of transistors can be made higher combined with high voltage engineering for capacitive insulation, this can be the beginning of the possibility for huge DC power generation beyond Analog Electronics.

I. Introduction

In Analog Electronics, DC Voltage amplification is done using non-inverting configuration of Opamps. DC is a constant signal with zero frequency. In normal DC voltage amplification circuit topology, resistors are the circuit elements. In this case, voltage noise, current noise and Johnson noise may exist in the circuit operation [1, 2].Moreover, there is a probability of some of the output current to be fed back to input which may lead to unstability problem in certain situations.

Negative capacitance effect has become the spotlight of research interest due to its interesting applications. Negative Capacitance can be exploited to do DC Voltage amplification [3]. It exhibits inductive like nature and hence it can replace the bulky inductor in circuits. Therefore, it acts as a low pass filter. In contrast to normal Opamp DC voltage amplifier circuits[4], the output current is not fed back to input, hence it is more stable. In Opamp negative capacitance converter, Miller capacitance concept is used. It can be used for capacitive load compensation in ultra low power CMOS circuits

Ii. System Or Device Description

In the proposed method, DC voltage amplification is done using negative capacitance converter as inductor used in DC-DC converter.The feedback capacitor is a miller capacitor and it acts as a high voltage decoupler between input and output .

Voltage transfer function at the output point is given by

Output voltage = (1 + R1(f/b)/R1(i/p))

Iii. Theory Of Proposed Idea

Negative capacitance converter simulation is presented below.It has the property of polarize in the opposite direction and the miller capacitor has negative capacitance in its value and hence it aids the the input potential applied and further amplified by the almost infinite gain of the operational amplifier.The concept is well-expalined in the reference cited[5] uploaded in nanohub.

https://nanohub.org/resources/36716

Iv Simulation Or Experimental Results

High voltage can be generated from Negative Capacitance Converter but it will cause breakdown of transistors in Opamp and also the capacitor dielectric should be able to withstand this voltage

Here comes Silicon Carbide technology to rescue that the breakdown voltage of SiC MOSFETs can be made higher to withstand even greater than 11 KV[6] and SiC Opamp is also available since 1995[7].

Similarly, the dielectric insulation of feedback capacitor should withstand high voltage without the possibility for capacitor failure. Some of the polymer capacitors[8] available in the market have the rating of 100 V to 150 KVdc.In this case,12 MW of power can be generated from a simple circuit.

V Plan For Implementation And Sustainability

Since it is a simple and small electronic system, in order to use in power generation, it is very easy to install and does not require any huge infrastructure establishment. It just requires a DC/AC power converter in order to integrate it into the current transmission system. Silicon Carbide technology has high thermal stability. In order to address further thermal issues, cooling units can be integrated with this electronic system and all get packed into a single small unit with input and output-2 port system.Input-1V battery, output-11KV at the output terminal fed to the input of DC-AC converter for AC transmission of 50Hz.More units can be installed in parallel in case of failure of any other unit due to continuous generation since it requires less space. Replacement is also easy since it is a 2-port system. Easy to install in electric vehicles. If the EV uses a DC drive, this can be directly connected to the DC drive of the EV. If an EV uses an AC drive, then it requires a DC-AC power converter

Vi Integration Into The Us Electric Grid

In Europe and India, the 11 KV system can be adopted. In North America, 13.8 KV and 60 Hz is used and accordingly the frequency and voltage level can be adjusted.

Vii Sustainable Silicon Carbide Technology

Green energy will be booming soon. Most of the power generation is from thermal power plants and nuclear power plants. These are from non-renewables and also pollute the environment. Hence we are going for solar, wind, tidal, and already hydropower generation but for the infrastructure establishment, huge capital is required and the tariff rate is also very high. In Europe and in India, the generation voltage is 11KV,50Hz. It can be easily generated in a simple DC voltage amplification electronic circuit, Negative

Capacitance Converter in SiC technology. This technology can able to withstand a breakdown voltage higher than 11KV.No emission as in thermal power plants and nuclear power plants. small space requirement. Low installation cost. Economical. Easy integration into the current transmission system. Finally, this electronic system can be used as a power source for electric vehicles. We know without a proper transportation system, there cannot be any development in any country.

Recent research[9] have shown that SiC can be produced from electronic wastes and hence it is eco-friendly. Initially, rare earth elements are used to produce SiC. Also, SiC increases the sustainability of renewable energy process.It is mostly used in power electronics.

Viii Conclusion And Future Work

The problem of fabricating SiC opamp had been addressed earlier by GE electrics even in 1995.This method can be used effectively for DC-DC conversion at the integrated circuit level in Si technology since no inductor required. As DC transformer by providing different values of resistance in the feedback resistor at the inverting terminal. If milliohm resistor is used, it can be used to step down the voltage. Similarly, it can be used in DC power generation by making use of SiC technology and high k-dielectric in Negative Capacitance Converter.

Electric polarisation, caused by an external electric field, is a tiny relative movement of the positive and negative electric charge in opposition to one another within an insulator or dielectric. When an electric field bends the negative cloud of electrons surrounding a positive atomic nucleus in the field's opposite direction, polarisation results. Due to this very tiny charge separation, one side of the atom is relatively positive and the other is somewhat negative. Some of the polarisation in some materials, such as water molecules, whose molecules are permanently polarised by chemical forces, is brought on by molecules rotating into the same alignment under the effect of the electric field. Electric dipole moment, which equals the distance between the slightly displaced centres of positive and negative charge, is one metric for polarisation.

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Figures

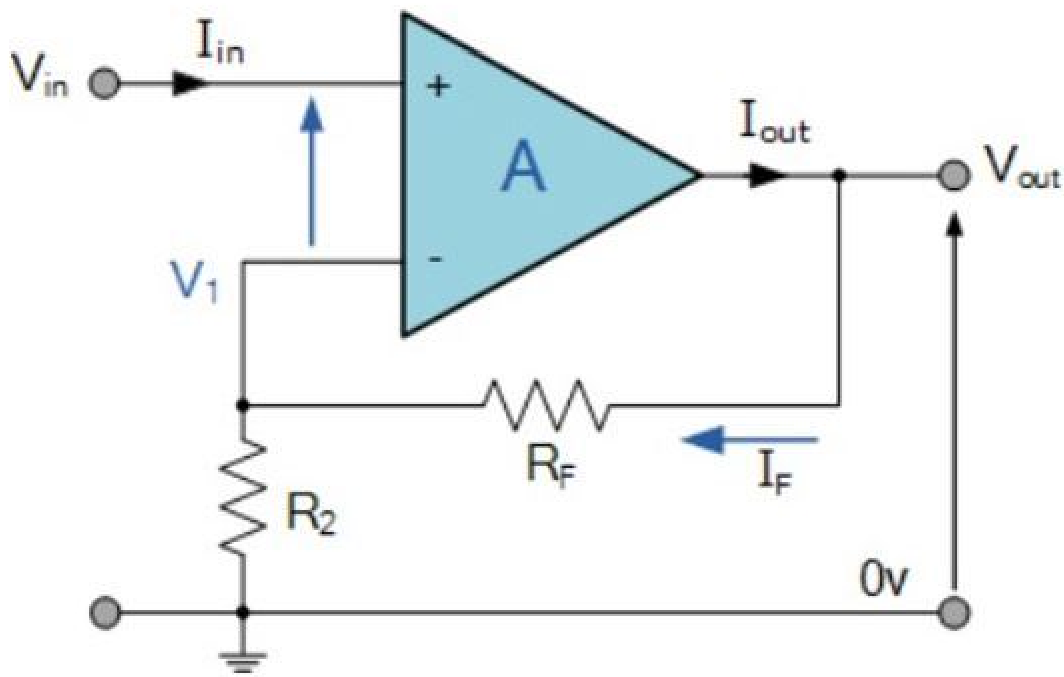
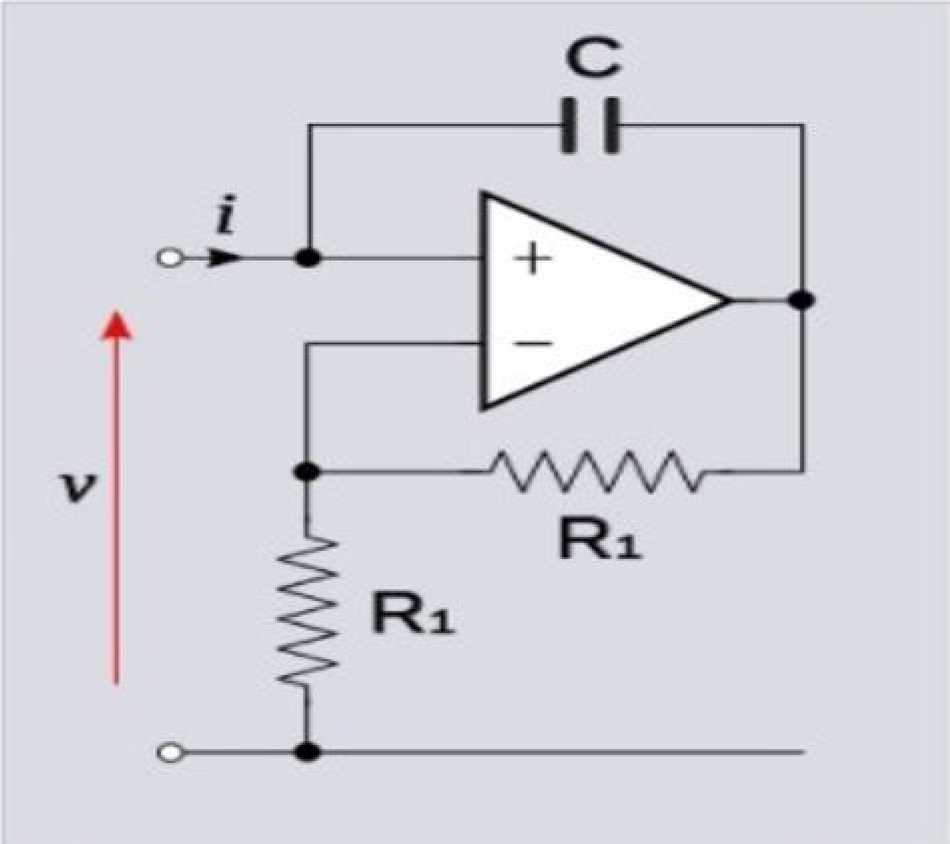


Figure 1

Opamp Non-inverting configuration



Negative capacitance circuit

$$Z_{\mathrm{in}} = \frac{v}{i} = \frac{j}{\omega C}$$

Figure 2

Negative capacitance converter

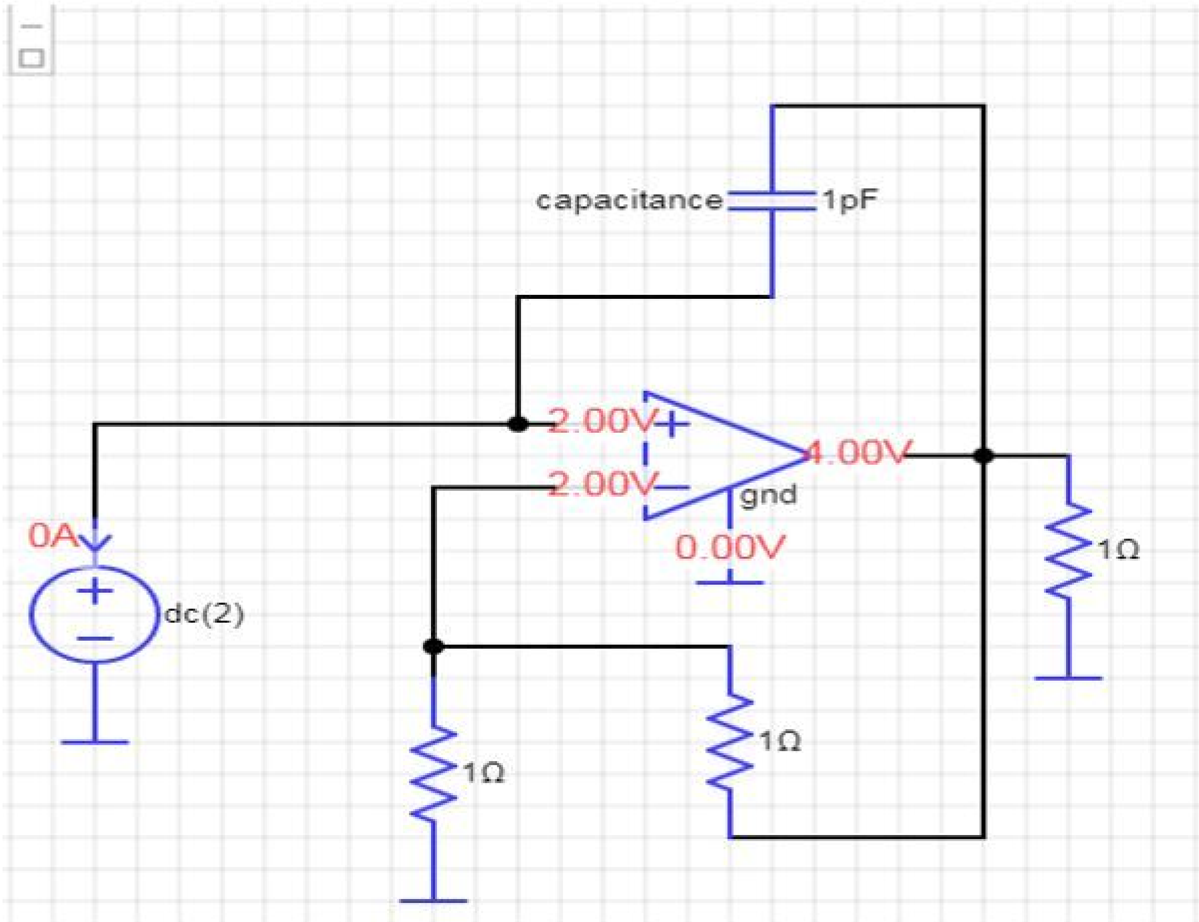


Figure 3

NCC amplifying 2V to 4V with zero f/b current

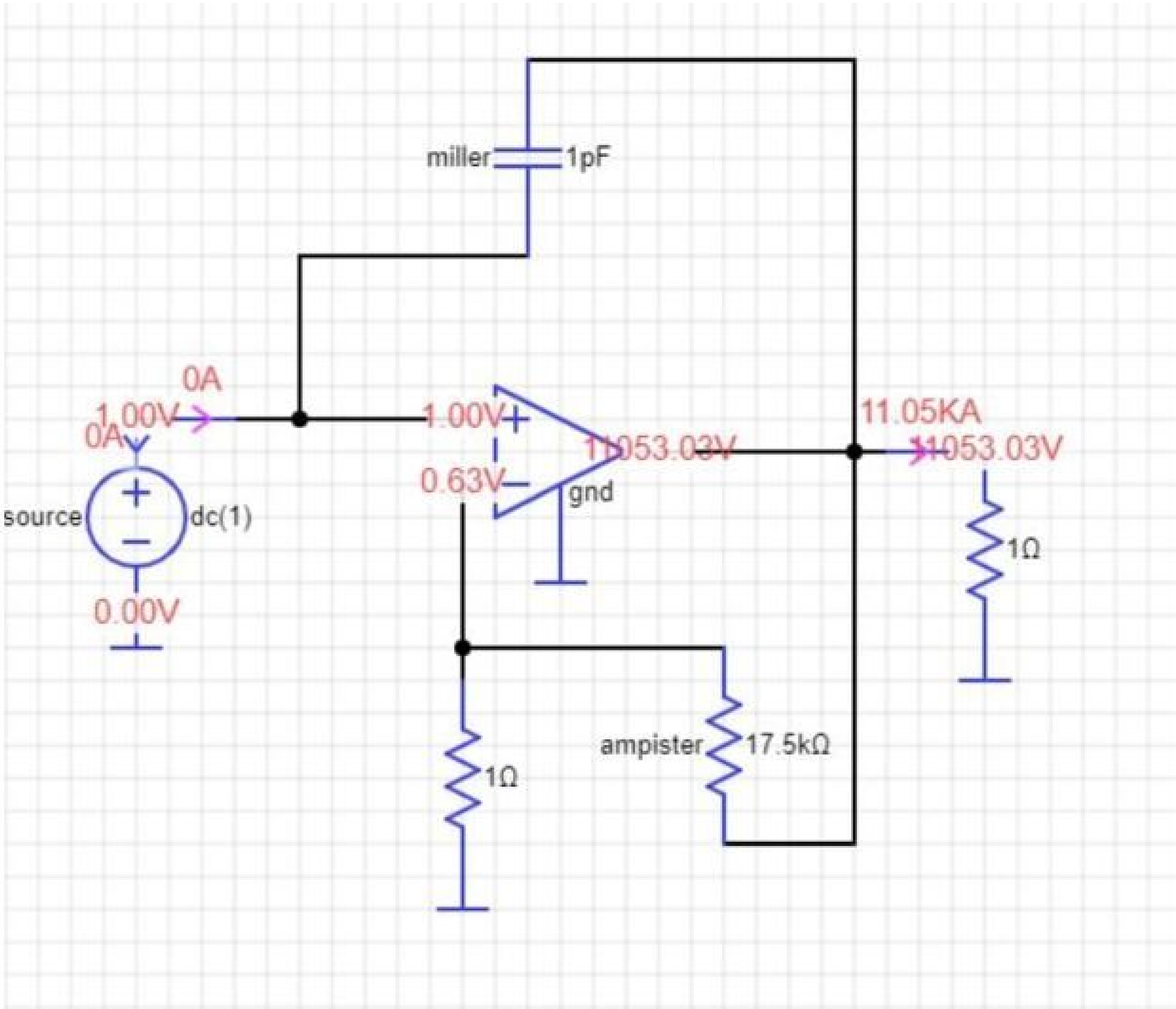


Figure 4

NCC amplifying 1V to 11 KV with output current of KiloAmps

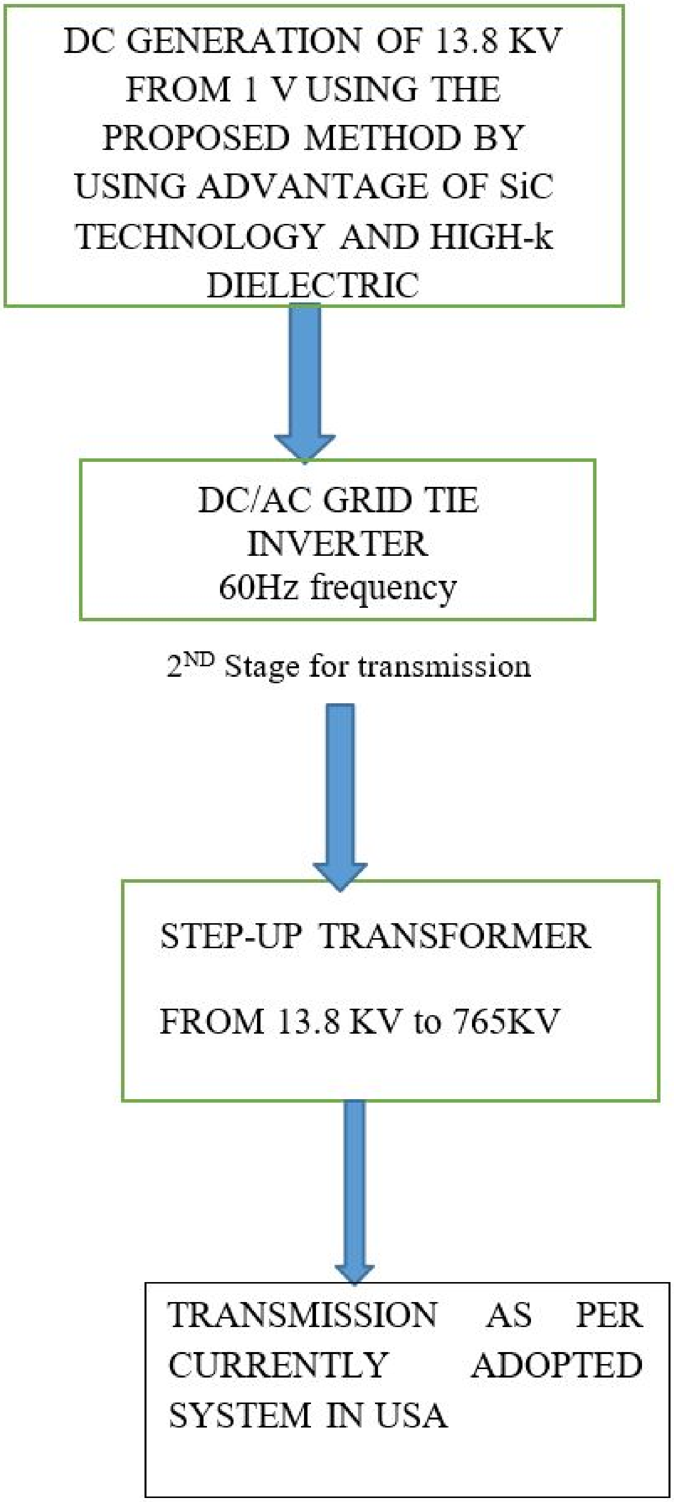


Figure 5

Legend not included with this version