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**SUBJECT:** Intellectual property report for a variable hardware inductance simulator

## INTRODUCTION

The following report details the present intellectual property pertaining to the design and construction of a variable hardware inductance simulator. This simulator, designed to model a wide, user-defined range of inductance values, has been constructed and is in the testing and modification phase of the design process. This intellectual property report is necessary in order understand similar designs and patented ideas pertaining to the design. This understanding will keep the new design from infringing upon those previously claimed, and it will help to avoid redesigning modules that have already been well tested and documented. The following report consists of a review of the nature of the intellectual property involved, a summary of relevant patented ideas, a discussion of the knowledge attained from these patents, and a conclusion.

## TYPE OF INTELLECTUAL PROPERTY

The concept behind the variable hardware inductance simulator is to model an inductance by inverting the impedance of a capacitor. A simple capacitive voltage integrating circuit can be found in any circuits textbook, as can a simple current measurement circuit (see figure 1). Similarly, a circuit that transduces a voltage into a current, whether directly through the base of a transistor or indirectly through pulse width modulation, is widely understood and very much in the realm of public domain. Therefore, only the combination of these simpler circuits can be found in intellectual property documentation, a circuit designed to simulate an inductance and series resistance commonly referred to as a gyrator circuit (see figure 2). Various configurations of this gyrator circuit are currently patented.

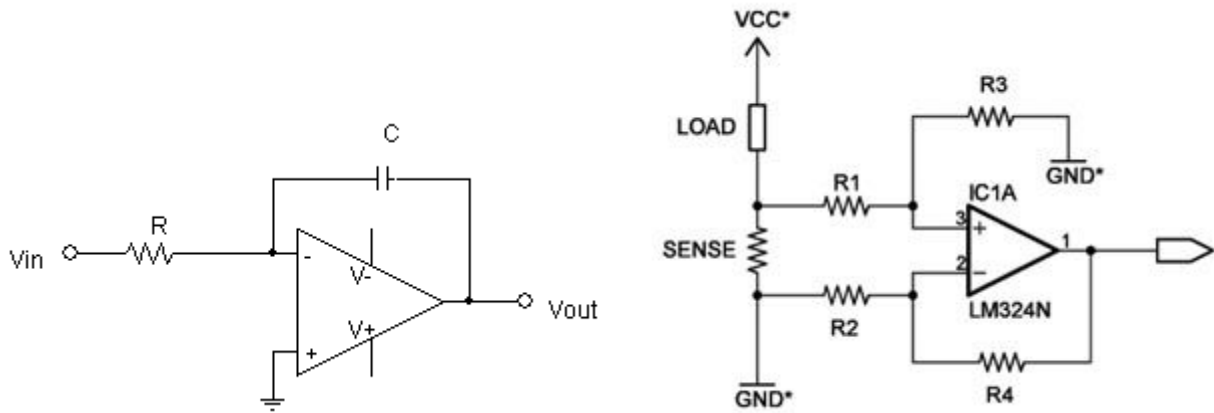


Figure 1: Integrator circuit (left), current sensing circuit (right)

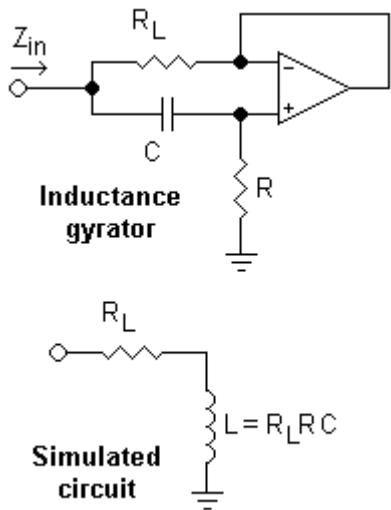


Figure 2: Gyrator circuit

## RESULTS OF THE SEARCH

After a thorough search of US and international patents, two US patents were found relevant to the design of a variable hardware inductance simulator. US patent 5825265 is titled, “Grounded inductance circuit using a gyrator circuit,” and outlines a configuration of operational amplifiers to achieve a simulated inductance similar to the variable hardware inductance simulator design. This patent describes a circuit that will model the characteristics of an inductor up to several micro-Henrys with a series resistance in the hundreds of Ohms. This simulated inductor will perform well as long as current above

the maximum output current of the operational amplifier is not demanded. This maximum current will be on the order of hundreds of milliamps.

US patent number 4812785 is titled, "Gyrator circuit simulating and inductance and the use thereof as a filter of oscillator." Although the discussion of this particular configuration is more relevant to the design of a second-order filter, this patent outlines the different implementation of a simulated inductor more suitable for high-frequency response. Basically, the configuration described in this patent is not limited by the frequency response of the operational amplifier (usually tens of kHz), but rather it is only limited by the frequency response of the analog components involved (usually hundreds of MHz).

## LESSONS LEARNED

The biggest difference between the designs described in the patents on file and the design of the variable hardware inductance circuit is performance requirements. Circuits documented in these patents were designed for implementation in a low-current, high-frequency environment. However, the variable hardware inductance simulator is required to perform accurately at currents up to 20 amps and at input voltages up to 200V. This high-power implementation requires new ideas and redesign on a component-by-component level. While the basic circuit theory and outline in these patents can be applied to this new design, safely upgrading the power of this circuit will dominate the design process.

Fortunately, the high-frequency (over 10kHz) response documented in US patent number 4812785 will not be necessary, as the highest frequency component of the input will be 2kHz, well within the frequency response of the operational amplifiers that will be implemented.

## CONCLUSION

This intellectual property report documents the ownership of the ideas and designs incorporated in the construction of a variable hardware inductance simulator. Based on the research performed in this intellectual property study, it is apparent that, with the exception of specific implementations, the concepts and circuit theories involved in the design of a variable hardware inductance simulator are largely public domain. While these documented designs are useful in outlining the structure of this new product, a vast majority of the design time must be spent in safely adapting the circuit to respond to high-power input. Should the specific implementation of the final product prove to be a unique and novel design, it will be patented just other specific implementations have been patented.

## REFERENCES

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