Basic Circuit Structures for Electromagnetic Compatibility Evaluation inside an Integrated Circuit

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Abstract

The subject of this work is to design a system which will help the Electromagnetic Compatibility's study (EMC). This will be done by designing and building an integrated circuit system, with CCS-UNICAMP technology, composed by various functional blocks, and making them to run, monitoring the response of the others. What is to be observed is the amount of Electromagnetic Interference, EMI, caused and suffered by each module.

1. Introduction

This article was made from the design of an integrated circuit, conceived with the aim of studying its EMC properties. Firstly a review will be done, in respect of that theme, justifying the action that leads the steps of this work. Then we will be introducing the functional blocks which compose the IC, justifying their presence, and also showing some module layouts. Finally, the results obtained with each block will be shown, including pictures and graphics, in order to illustrate its characteristics operations.

2. The Electromagnetic Compatibility (EMC)

In designing of electronic circuits, either digital or analog, either discrete or integrated, there must be always paid a lot of attention in the EMC factor. Despite the main target of the designer is to achieve optimum clocking, gain, amplitude, and so on, it has to be clear that there is a trade off in selecting, dimensioning and placing components, trails and even functional blocks. This goes because of the fact that in each pair of trails, switching or geometrical discontinuity, there are Capacitive Coupling, Electromagnetic Radiation or changes in parameters that can change the voltage or current characteristics. The (low) EMC problems must be divided in three parts: the EMI source, the EMI Energy Path and the EMI receptor. Only after straight definition of these parts one can think of fix that problem.

There can be many kinds of EMI sources. The switching of a digital module makes a relatively high current to flow in the circuit, inducing a relatively strong magnetic field in its neighborhood. A high-amplitude waveform in the output of an amplifier also can provoke

Electromagnetic Radiation. No matter how the radiation is generated, it will find a path to propagate. This path may be a conductive or a radiated one, and each type deserves a special care. At the other edge of, lays the EMI receptor. As the frequency of the signal increases, the wave length gets more and more nearly the devices and trails size, making them to respond to that signal. Those interferences may be of a certain level that disturb or even blow up any right operation of a system. It is the designer's responsibility to predict the risks, or at least, prevent the circuit from the EMI related problems.

3. The Integrated Circuit

The integrated circuit developed in this work is composed of various modules.

The Oscillator – two ring-oscillators were conceived in the CHIP, one of 700 MHz and other with 200 MHz. Both of them have five stages differed only by its transistor dimensions. This will be used to source the high frequency noise to the other modules, besides suffering the interference of them. Fig. 1 shows the schematic. In fig. 4 it is possible to visualize the 700 MHz oscillation and fig. 7 shows its layout.

The Shift-Register – with this module, it will be able to monitor the interference on a dynamic digital circuit. It is composed by three stages. In fig. 3 it is possible to visualize one of the stages. Fig. 6 shows the response of all stages and fig. 8 the layout of one stage.

The Adder – this will be used to analyze the behavior of a static digital circuit in the EMI infected environment. The adder has two inputs (two bits each) and has three outputs. Fig. 2 shows its schematic, fig. 5 shows its input and output signals.

4. Conclusion

At the end, the system developed will allow students and researchers to know more about the EMC problem, besides to help them make decisions. The modules built in this CHIP will be part of a bigger system, and it needed to be studied how much one module interfered in the others.

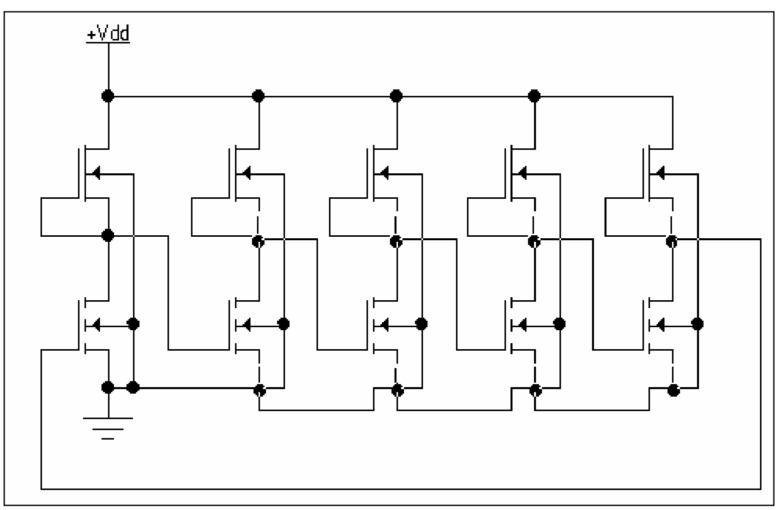

Figure 1 - 700MHz ring-oscillator.

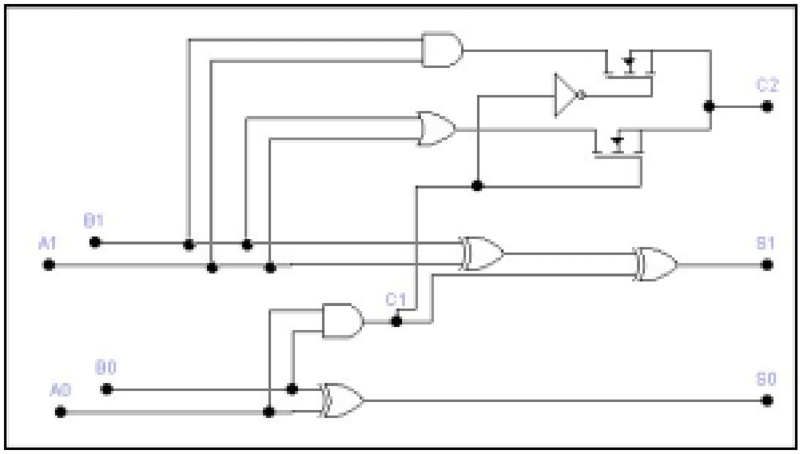

Figure 2 - 2bit adder schematic.

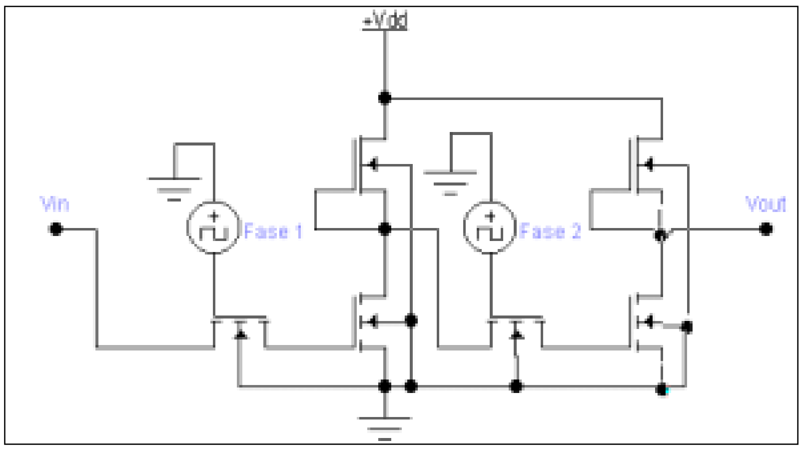

Figure 3 - Shift-register's stage.

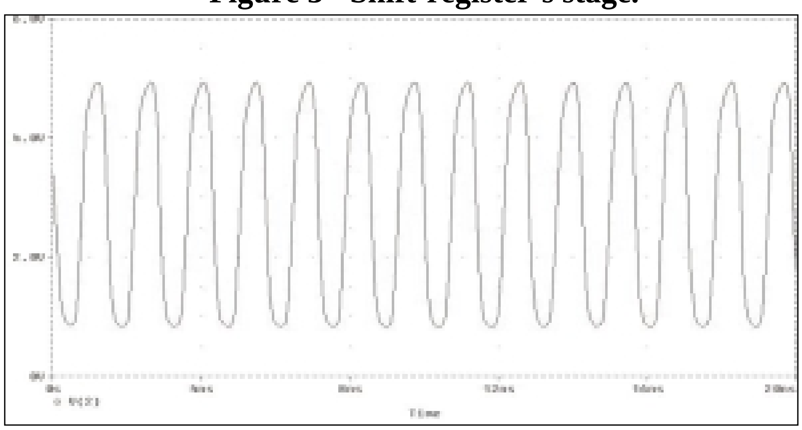

Figure 4 - Ring oscillator's output (700 MHz).

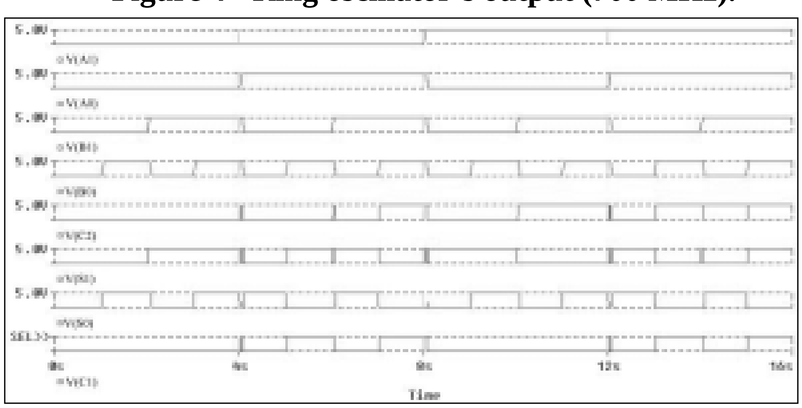

Figure 5 - 2bit-adder's time response.

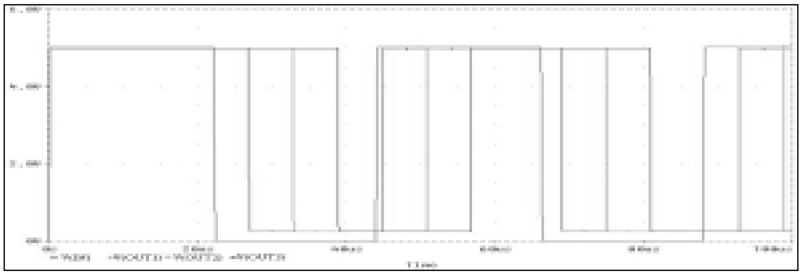

Figure 6 - Shift-register's behavior.

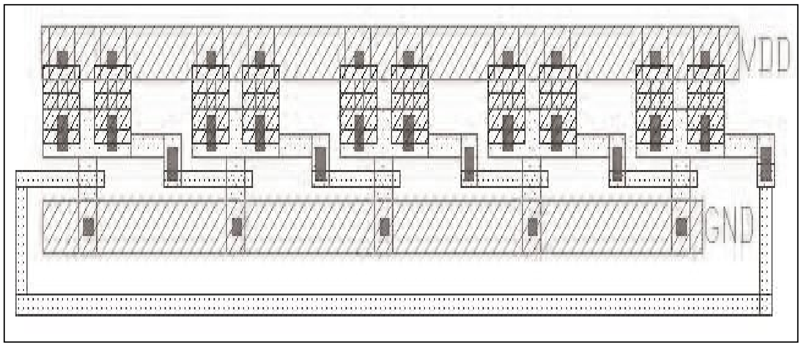

Figure 7 - Ring oscillator's layout.

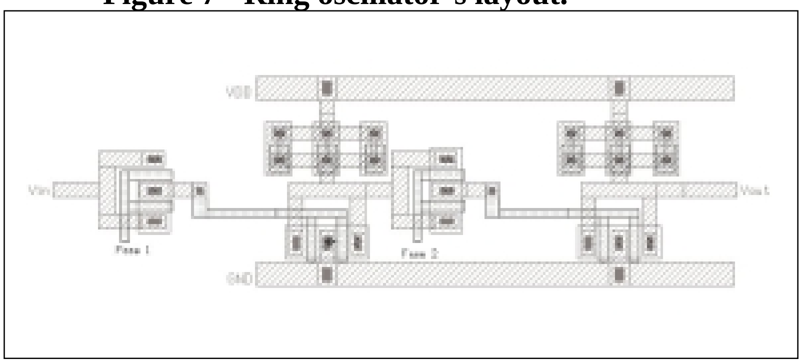

Figure 8 - Shift-register stage layout.

5. References

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