

LAB01 – Simulation of ESD Clamps

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- Model for RGNMOS clamp
- Simulation of RGNMOS clamp
- Model for GGNMOS clamp
- Simulation of GGNMOS clamp
- Model for LVTSCR clamp
- Simulation of LVTSCR clamp

Version 210405

LAB01 – Introduction

The purpose of this laboratory is to develop ESD snapback clamp models to be applied in Laboratory 02 to protect an op amp.

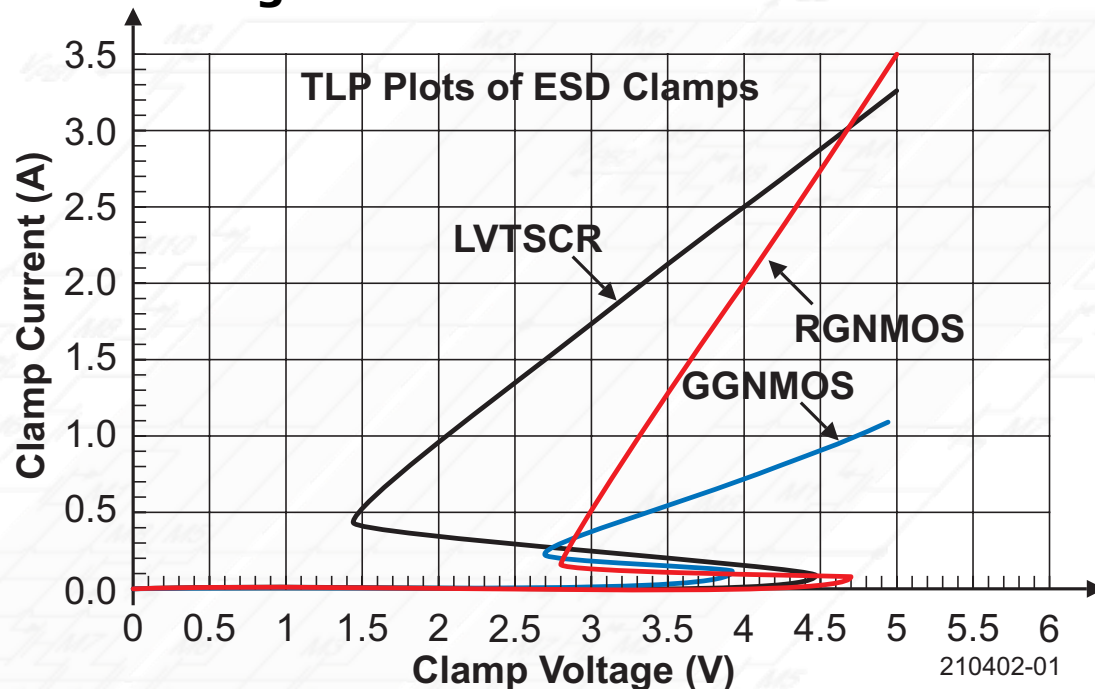
This laboratory uses the 180nm BiCMOS technology of XFAB as supported by Efabless.

Procedure:

- 1.) Use the TLP voltage-current plot on the next page to extract the model parameters for the three snapback clamps shown
- 2.) Develop the models and use NGSPICE to verify each model.
- 3.) The GGNMOS and LVTSCR clamps are to be independent of rate but the RGNMOS should be rate dependent with $k = 0.25$ for a rate of 100V/ns.

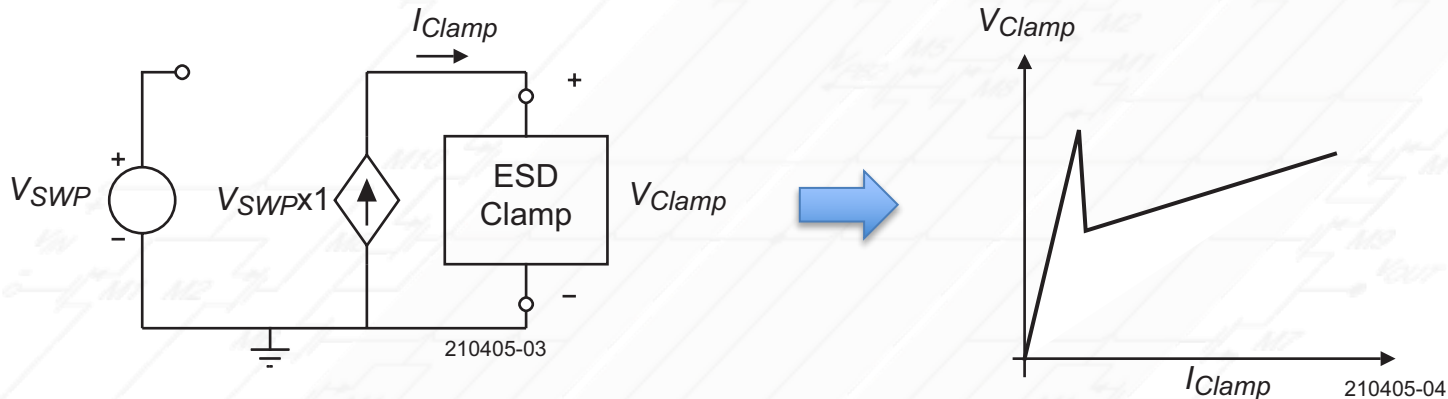
ESD TLP Clamp IV Characteristics

ESD Clamp Current-Voltage Characteristics for 180nm technology.



Test Bench for Rate Independent ESD Clamps

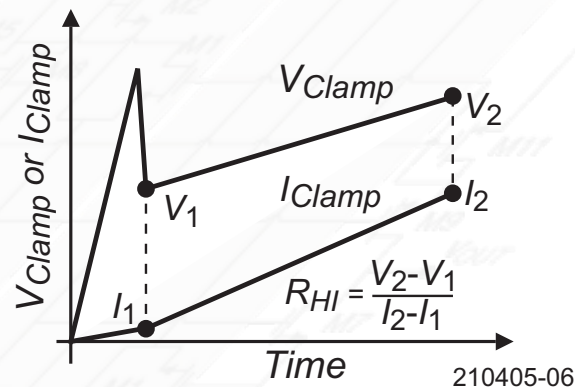
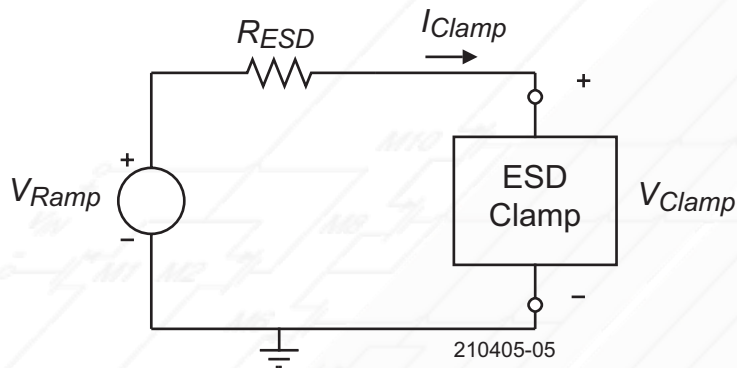
DC Sweep



You can interchange the axes if you wish but it is not necessary to demonstrate that the clamp model is valid.

Test Bench for Rate Dependent ESD Clamps

Transient Analysis

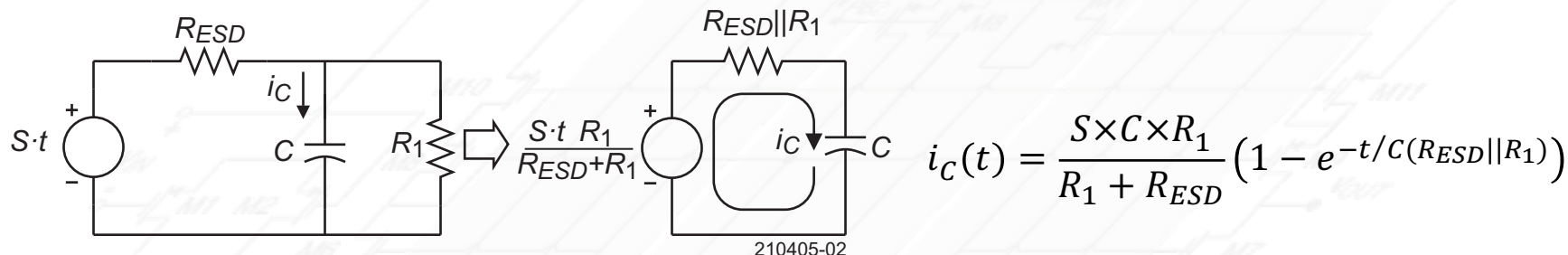


You can interchange the axes if you wish but it is not necessary to demonstrate that the clamp model is valid.

Tips and Tricks

Helpful Ideas for Lab01

1. The performance of the rate dependent models are influenced by the test circuitry. Consider the model before snapback:



If $(R_{ESD} || R_1)C$ is small, $i_C(t) \approx \frac{S \times C \times R_1}{R_1 + R_{ESD}}$ and the current in the capacitor will be smaller than desired which is $S \times C$. Try to keep $R_{ESD} < R_1$.

Performing Lab01

Instructions

1. Go to efabless.com
2. Register using your LinkedIn account (get one if you don't already have one)
3. Agree to the terms
4. Receive approval to access the efabless platform by email
5. Use Electric to create your design and NGSpice to perform simulation.
6. When you have completed your lab, send Dr. Allen a copy of the results to pallen@ece.gatech.edu and I will send you a copy of my solution for the laboratory.

Help with Electric and NGSpice

Videos

The following two lessons provide examples of how to use Electric for schematic capture and NGSpice and SymProbe for simulation and viewing.

Lesson 8 – How to Use Electric

Lesson 9 – How to Use NGSpice

Summary – ESD Lab01

Developing and Simulating Models for ESD Clamps

- Understand the general ideal of ESD snapback clamp modeling
- Develop a simulation model for the GGNMOS, RGNMOS, and LTVSCR snapback clamps
- Simulate and verify the models
- Summarize your lab results and send a copy to Dr. Allen
- Obtain a copy of the lab solution