ESD event is a phenomenon that a finite amount of charges transfer between two objects with different potential in quite a short time. Such event contains a large energy and the ICs without proper ESD protection could be destroyed easily, so ESD protection solutions are essential to semiconductor industry. The basic idea of ESD protection design is to provide a path with low impedance which directs most of the ESD current to flow through itself instead of the core circuit, and the ESD protection path must be robust enough to make sure that it does not fail before the core circuit.

Automotive electronics has been a popular subject in semiconductor industry, and due to the special requirement of the automotive applications, the ESD protection device used in such applications need to be specially designed. In this dissertation, a few SCRs with minimized/without snapback are discussed in detail.

The typical operating temperature for ICs is up to 125 °C, however in automotive applications, the operating temperature may extend up to 850 °C. In this dissertation, the high temperature characteristics of ESD protection devices is measured and discussed in detail.

ESD protection are also highly needed for electronics working in some other extreme environment like the space. Therefore, the investigation of the radiation effects on ESD protection devices are necessary. In this dissertation, the total ionizing dose effects on ESD protection devices are investigated.

Single ESD protection devices are essential part constructing the ESD protection network, however the optimization on ESD clamp circuit design is also important on building an efficient whole chip ESD protection network. In this dissertation, the design and simulation of a novel voltage triggered ESD detection circuit and a novel ESD clamp with low leakage current are introduced.