Chapter 8
Bundled SWCNT for Global VLSI Interconnects

Raj Kumar
Panjab University, India

Shashi Bala
Chandigarh Group of Colleges, Landran, India

ABSTRACT

Carbon nanotube (CNT) has been declared the most attractive and suitable material for VLSI sub-micron technology. Because of CNT's phenomenal physical, electrical, and mechanical properties, it is more advantageous than copper interconnect material. In this chapter, RLC equivalent model of bundled single-wall CNT (SWCNT) is presented by using driver-interconnect-load (DIL) system with CMOS driver. The crosstalk delay is calculated for two-line bus architecture made of two parallel lines (i.e., upper as aggressor and lower as victim). From the simulation, it has been observed that crosstalk delay increases with increase in interconnect length and transition time, whereas it decreases with increased spacing between the lines (aggressor and victim). However, crosstalk delay decreases as the number of tubes in a bundle increases.

1. INTRODUCTION

Interconnects are basically used to establish communication between various components on-chip and modules on system board. Interconnects has become important to take into account in deep submicron technology. As the technology shrinking, the minimum width of 5nm interconnects and the minimum spacing

DOI: 10.4018/978-1-7998-1393-4.ch008

between two interconnects decrease. It is When looking at the scaling of on-chip interconnects, it is important to study interconnects because in deep sub-micron technology interconnects are no longer remain as resistor (Banerjee & Srivastava, 2006). The related parasitic such as inductance and capacitance are also important to take into consideration in deep submicron technologies. These parasitic are responsible for delay in a propagating signal through interconnects (Wei, Vajtai, & Ajayan, 2001; Srivastava, Joshi & Banerjee, 2005). As the size of the chip increases the interconnects also come very close to each other thus the coupling capacitance occurs between the wires or interconnects will increases (Naeemi & Meindl, 2006; Rossi, Cazeaux, Metra & Lombardi, 2007). The feature size of ICs is shrinking to improve the propagation delay, power consumption, silicon area, and cost characteristics. The technology scaling in VLSI interconnects causes increase in density. This increased density results in the increasing of the coupling effect. Interconnect plays a vital role in the performance of a high-speed VLSI chip.

Earlier, metals were used as VLSI interconnects material. In the last few years, carbon nanotubes (CNTs) have been appeared as most attractive and suitable interconnects material for future deep sub-micron technology. Carbon nanotubes have phenomenal current carrying capability, high thermal conductivity, high ballistic transport, resilient to electromigration and tremendous mechanical properties. Carbon nanotubes are considered for VLSI interconnects because of these remarkable properties (Srivastava, Joshi, & Banerjee, 2005; Srivastava & Banerjee, 2005).

Crosstalk coupling effect affects the righteousness of signal by producing glitches and unwanted voltage spikes on the adjacent lines. It also causes a delay at the output port of the system. The delay appeared at output mainly rely on upon coupling capacitance and relative strength of drivers, that drives the signal into the lines either in-phase or out-of-phase, that is responsible for the different skew rates of signal to the components. Therefore, reliability has been a major concern of crosstalk effect. Crosstalk noise effect in coupled lines splits into two types: (1) functional crosstalk noise (2) dynamic crosstalk noise (Javey & Kong, 2009; Pu, Yin, Mao, & Liu, 2009; Majumder, Das, Kaushik, & Manhas, 2012). If the victim line undergoes a voltage spike when signal applied to an aggressor line is presumed under functional crosstalk category (Majumder, Das, Kaushik, & Manhas, 2012). Whereas, dynamic crosstalk is calculated as the signal applied to aggressor and victim line simultaneously. This paper emphasized on dynamic crosstalk effect. The crosstalk mainly causes by parasitics such as resistance, inductance and capacitance. The crosstalk effect will decrease with reduction in parasitic. In this paper, numbers of SWCNTs are increased in a bundle to reduce the value of parasitics. Thereby, the crosstalk delay was analyzed for two bus line architecture.