In any electronic systems, it is not practical nor is it necessary to eliminate all the noise, as noise is not a problem until it interferes with the surrounding circuitries or radiates electromagnetic energy that exceeds FCC limits and or degrades the system performance. When noise interferes with other circuits it is called crosstalk. Crosstalk can be transmitted through electromagnetic radiation or electrically coupling, such as when unwanted signals propagate on the power and ground planes or couple onto the adjacent circuits. One of the most challenging problems designers are facing in today’s electronic systems is to determine the source of crosstalk, especially in the case where crosstalk randomly causes system failures. Because components are so tightly packed into a very small printed circuit board (PCB). This chapter outlines the crosstalk mechanisms and design methodologies to minimize the effects of crosstalk.

3.1 CURRENT RETURN PATHS

In designing a system, it is crucial for designers to understand the current return paths as these current returns are the main sources of electromagnetically and electrically coupling. For example, the digital signal current return crosses the analog section of the design and causes noise on the analog waveforms or the current return generates a large current loop area which radiates onto the adjacent circuitries.
Current returns follow different paths depending on their frequency. A high frequency current flow tends to concentrate on the surface of the conductor as supposed to distribute uniformly across the conductor like a low frequency current. This phenomenon is known as skin effect and it modifies the current distribution and changes the resistance of the conductor. Due to skin effect, signals above 10 MHz tend to follow one return path while those below 10 MHz follow another. The low-speed signal current returns on the path of least resistance, normally the shortest route back to the source as shown in Figure 3.2. In Figure 3.1, the high-speed signal current, on the other hand, returns on the path of least inductance, normally underneath the signal trace. Knowing the current return paths is important for designers to optimize the system design to reduce crosstalk.

![Figure 3.1. High Frequency Current Return Paths (>10MHz)](image)

![Figure 3.2. Low Frequency Current Return Paths (<10MHz)](image)