(**Available on SSRN. SSRN is an open-access online preprint community, owned by Elsevier**.)

International Conference on Contents, Computing & Communication (ICCCC-2022)

26th and 27th February,2022

Skin Effect and its Impact on Resistance of Conductor Traces in High Speed Printed Circuit Board Design.

Rajesh Rehpade[a], Prof.(Dr.)G K Kharate[b]

[a] *Research Scholar, MCOERC, Nashik (422105), Maharashtra, India, rehpaderajesh@gmail.com*
[b] *Principal, MCOREC, Nashik (422105) Maharashtra, India, gkkharate@rediffmail.com*

Abstract

Skin effect is phenomenon related with dependence conductivity of conductors on the frequency of signals they carry. Skin effect is more visible at frequencies above 100Mhz. Due to skin effect the effective area of copper available for conduction decreases and hence the resistance of conductor traces on Printed Circuit Boards increase. The increase in the resistance leads to noise which distorts the signals to be carried by the traces. The increase in trace resistance is more pronounced at high frequencies. It is therefore very important to mitigate this effect. This can be done through careful design of printed circuit board traces. The methodology used to reduce the skin effect resistance includes use of wider conductors, and greater thickness for PCB copper foil. The simulations carried out show that effective decrease in the resistance is more pronounced and easily controllable with the trace width than with thickness.

Keywords : Skin depth ; Resistance ; PCB Trace ; Proximity effect..

1. Introduction

Printed circuit boards (PC Boards) are an essential component of all electrical circuits and devices. PCBs used to operate at frequencies as low as a few MHz until 1980. The introduction of fast computers and their rapid processors enhanced the speed of signals in computer motherboards.. The High frequency effects come into play particularly at frequencies above 500 MHz, and are of more concern for signals with fast rise times and long trace lengths[3]. Skin effect is one of the problems associated with signal and power traces of high speed printed circuit boards. The skin effect losses are due frequency dependence of conductivity of PCB traces .This paper gives an account on the impact of skin effect on design of traces of High Speed PC Boards.

2. Physics Behind Skin effect

According to Faraday's law, a change in current in one conductor alters the magnetic field, forcing a current to flow in the opposite direction in the neighbouring conductor. In a similar vein, if the conductor's magnetic field changes, a current in the opposite direction can be induced in the same conductor. This is inductance's most fundamental feature. When the current in a conductor increases suddenly, the magnetic field in the conductor changes as well, and the changing magnetic field around the conductor induces a current in the opposite direction that cancels out the initial current, resulting in a net change equals zero. The varying magnetic field slowly decreases and at the next moment of time, and a modest net current begins to flow. The magnetic field decays over time, resulting in a greater flow of net current. This is how inductance affects current flow. If the aforementioned procedure is interrupted in the middle, it restarts from the beginning, but in the opposite direction.

As a result, if the energy source's frequency is exceedingly high, the whole current will never travel across the conductor's cross-section. The current will flow where the magnetic field is weakest, and the magnetic field is least at the region away from the source, which is along the conductor's centre. As a result, the highest current flow is along the conductor's outer surface. This property of electrons to get confined to outer surface of conductor is called skin effect [1,7].

The skin is the usable conductor area, and the skin depth is the depth of the usable area measured linearly from the conductor's outermost edge. The skin depth of a conductor is determined by the resistivity and permittivity of the conductor material, as well as the frequency.