Inductively Coupled Connectors

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Abstract

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AC coupled interconnects show promise to enable multi-gigabit/second data rates between high pin count IC's within a multi-chip module, while achieving significant power savings as well [3]. AC Coupling can be realized with planar inductive or capacitive elements. Inductive coupling offers many degrees of freedom for system design by varying geometric parameters to tune parasitic elements in the model, such as: the crossover capacitance between the spirals, the magnetic coupling coefficient, winding resistance, inductance ratio and impedance terminations. So far, inductively coupled interconnects have mainly shown potential for multi-Gbps signaling only in level 1 interconnections, i.e. direct chip to chip communication and 3D IC's. Multi-Gbps pulse signaling is demonstrated with inductively coupled interconnects across packaging interfaces in this dissertation. This shows feasibility of realizing sub-mm pitch, true Zero Insertion Force (ZIF) surface mount connectors and sockets (i.e. level 2 and level 3 interconnections). Inductors are fabricated on two opposing surfaces, e.g. the faces of a connector or socket. When mated, they form a transformer, which is used to carry signals through the mated interface. The main advantage of building a separable connection this way, is that it is possible to achieve a high density with a simple mechanical structure. This in turn, offers potential for cost reduction and support for true three dimensional packaging. Being a true zero-insertion force interface, very high pin counts could be easily supported. ZIF sub-mm pitch surface mount inductive connector technology also
addresses some of the signal integrity problems inherent in pressfit style connectors. It is
difficult to use capacitive coupling for this application, because the structure is placed in the
transmission line, not at one end. Thus both the driving impedance and load being driven is
50 ohms. The high, frequency-dependent impedance of a series capacitor would lead to
reflection noise (i.e. return loss). Unless large capacitors or lossy codes guaranteeing only
high frequency content are used, the transmitted swing would be too small (i.e. excessive
insertion loss). In contrast, inductively coupled connectors can achieve broad band matching
impedance and give acceptable values to return and insertion losses. Methods to optimize
signal integrity are discussed in detail for inductively coupled systems in this dissertation.
The signaling data rate achieved in this system is from 1 Gbps to 8.5 Gbps, which depends
on the 3 dB coupling frequency of the composite channel consisting of the inductive
interconnections and the transmission lines.