ALTERNATIVE MEANS FOR CONDUCTOR BASED SHORT DISTANCE SIGNAL/DATA TRANSFER

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Abstract-This paper provides an alternative solution/means for conductor based communication system, specifically on a printed circuit board where multiple IC packages are selectively connected to each other through conductor strips to establish a desired product from number of common integrated circuits. Further, in this paper we also discuss the effect of interference due to implementation of large number of transceivers within a small area typically over a PCB or within a close proximity.

1. INTRODUCTION

In an electrical or electronic system, conducting wires/paths are invariantly used for transferring signal or data from one integrated circuit (IC) or semiconductor device to another IC that are close to each other. The conducting wires are selectively connected between one interface nodes (pads) of first IC to another interface node of another IC. In such applications, the length of the conducting paths (distance between terminals/pads) is very small. These conducting paths are generally etched over multiple metal layers in a printed circuit board. Printed Circuit Board (PCB) provides desired customized connectivity between the connecting pads of the semiconductor devices or ICs and operate as a key part of any system. Figure 1 illustrates an example electronic /electrical system built on a supporting board (PCB).

In the design phase of PCB a collection of terminals that are connected together are referred as net and identified with specific reference number. Thus each net represents a connection or a path that interconnect a desired set of node. Accordingly, list of all such nets that form a designed interconnection between various nodes are referred as netlist. Accordingly, each net operates as an non interfering independent communication channel.

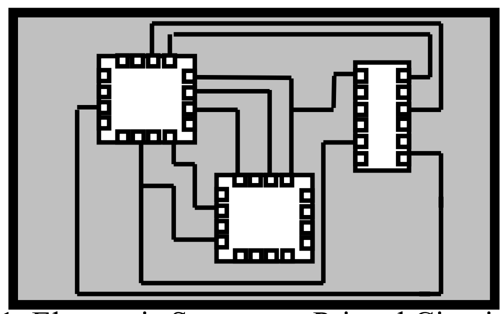

Figure 1. Electronic System on Printed Circuit Board

Various disadvantages and limitations are observed [9] [10] while developing PCB based systems. An important limitation that is perceived is that the conductor based interconnect fail to support high data rate [8]. Also various discontinuities in the PCB (Vias) pose limitations on the data speed of interconnect [10]. Thus, considering the complexity and limitations of PCB or conductor based interconnect, a wireless based interconnect that may be used to flexibly connect any two nodes within/between the integrated circuits is being proposed. In other words we propose a wireless channel that can adaptively be connected between the nodes and hence be equated to the net in the PCB design.

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Thus system designer may use these wireless interconnects to establish customized connection between ICs.

2. ELEMENTARY WIRELESS INTERCONNECT

Generally, PCB design tools provide option to represent individual connections (individual net) and bus connections (grouped net). Where, bus connections are connection between specific predetermined sets of terminal on each integrated circuit. For example, Data bus, PCI bus etc., are the set of interconnects between the terminals that are dedicated to provide such interference. Integrated circuit with option for such connection provide corresponding nodes/pins on the on the IC. Hence, we propose to classify wireless interconnects as individual wireless interconnects and bus wireless interconnects.

Example implementations of an individual wireless interconnect is discussed below.

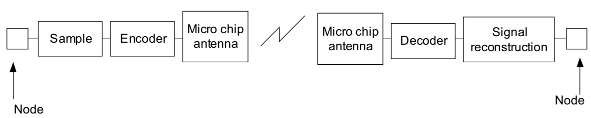

Figure 2. Elementary Individual Wireless Interconnect

Figure 2 is an elementary individual wireless interconnect/path that may be incorporated at the fabrication level. Signal available on left side node is sampled and encoded to match the requirement of the signal transmission; the encoded signal is then transmitted using appropriate modulation scheme through an on chip antenna or any other antenna embedded on the IC. Frequency band and other interface issues are not discussed and considered to be ideal at this point. The transmitted signal is received by the on chip antenna of the second device. The received signal is reconstructed and provided on the right side node. Hence connectivity is provided between the two nodes. Though any existing technology may be used to incorporate wireless connection between the nodes, it is necessary to understand channel behavior in the new scenario to suggest a proper wireless communication model that suits the present and future technology and demand. Wireless channel may operate as full duplex channel, half duplex channel or unidirectional channel. Typically, the wireless channel characteristic may be so selected to represents the closest model of a copper connection.

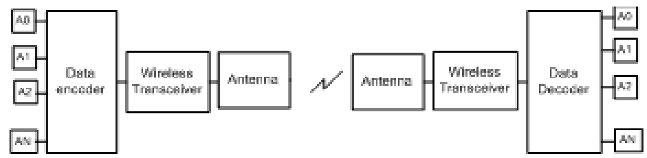

Figure 3. Elementary Bus Wireless Interconnects

Similarly, Figure 3 is an elementary implementation of bus wireless interconnects. In this case, nodes/pins A0-AN together operate as bus interface terminals and the data are synchronized as per the corresponding standard. Since, data on each node A0-AN is synchronized in some sense, it is possible to transmit the entire data on left side nodes A0-AN and reproduce each data on the destination micro chip nodes (right side nodes) using a single wireless channel or using a single modulation and coding scheme.

In order to enable creation of large number of individual nets and bus nets that are required to make customized connections, we propose use of large number of different wireless channels that are different and distinct. The channels can be set distinct in terms coding, frequency band, modulation scheme, etc. It may be necessary to standardize on the referencing of each wireless interconnect and defining all the relevant terms such as bandwidth, modulation scheme, coding, encryption, protocols etc., for each referenced wireless channel. Accordingly, the manufacturer of integrated circuit may incorporate the transceivers of the desired wireless interconnects to provide external interface. For example, an IC device that provides external interface on PCI Bus may incorporate the transceiver defined for PCI wireless interconnects in addition to other interconnects corresponding to other I/O interface.

3. INCORPORATING CUSTOMIZED CONNECTIVITY FEATURE.

4.

As discussed earlier, each net in a particular system is customized after the fabrication of the integrated circuit and distinct. The nets are created during the system design. In a similar way, each wireless interconnect (net) required to be dynamically connected between any desired circuit point in first IC and another desired circuit node in second IC. In other words, input to the sample block in and output of the reconstruction block Figure 2 needs to be dynamically connected to a desired set of nodes in the integrated circuit by product developer.

We propose use of Programmable switch network (PSN) that dynamically connects a circuit node (CN) a wireless node (WN). Where circuit node represents point of connection in the circuit built inside the IC and wireless node represents transceiver corresponding to the one of the standardized wireless interconnect. Thus, it may be presumed that WN_1 is a unique transceiver with a predetermined modulation coding and frequency band. Figure 4 is an example PSN based dynamic interconnect mechanism.

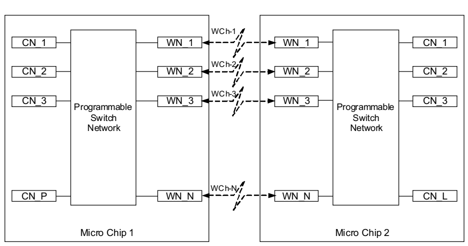

Figure 4. Dynamic Interconnection Mechanisms.

As a first elementary option for providing PSN, a fuse or transistor array may be provided between plurality of nodes in the device (CN) and the plurality of inputs of WN. The fuses may be burnt dynamically to connect desired node to the wireless path.

For example if a designer wants to connect CN1 of MicroChip1 or IC1 to CN3 of MicroChip2 or IC2, then the programmable switch network (PSN) may be implemented to connect CN_1 to WN_3 in Microchip1 and WN_3 to CN_3 in MicroChip 2. Various other possibilities may be used for providing such connection.

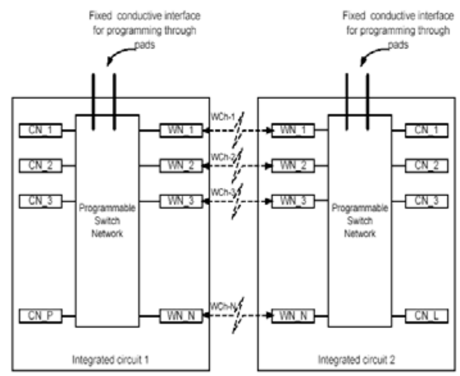

Figure 5. Physical interface to PSN

PSN may be accessed by physical means as shown in figure 5 or through a dedicated wireless channel (WPgl) as shown in figure 6.

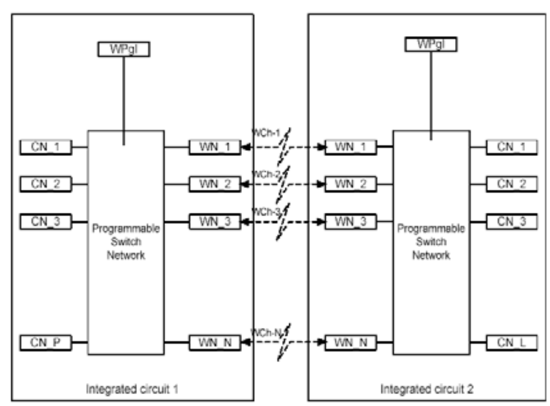

Figure 6. Wireless Interface to PSN

5. CHANNEL BEHAVIOUR.

Various factors may affect the practicability of the proposed idea. One of many such factors is the channel behavior in the new scenario. It is necessary to simulate the condition of the new scenario to understand the wireless channel properties to suitably determine the modulation can code techniques.

As a first step, we studied the effect of interference due to large number of transceiver within an small area.

6. INTERFERENCE BEHAVIOR

Interferences may be mainly classified as the man made interference and co-channel interference. Man made interference is impulsive in nature and easily detected when the signal is less than few GHz. On the other hand, co-Channel interferences can be mitigated by adapting various coding technique and proper channel allocation. No standard model is found to express the effect of interferences in a channel [4]. In general, interference between overlapping channels is influenced by the transmission power, distance between transmitters, channel spacing and transceiver characteristics. It is observed that, in majority of the cases, interference effects are obtained from experimental data [8]. Typically, channels are separated in frequency or in time to reduce the effect of the interference. For example, in OFDM system, carriers are so selected to be orthogonal to each other.

Considering the high density of transceivers in the scenario being studied, a closest experimental model [2] is employed to understand the behavior of the interference with respect to 1) larger number of interfering signals, 2) correlations among the signals and 3) transmit power. Various experimental results performed using Matlab ® is presented below.

Figure 7 is a graph drawn for CIR mean in dBm Vs number of transmitting signals. Here as all transmitting signals are represented as un correlated random sequences drawn from Gauss distribution with a signal power set to -80dB.

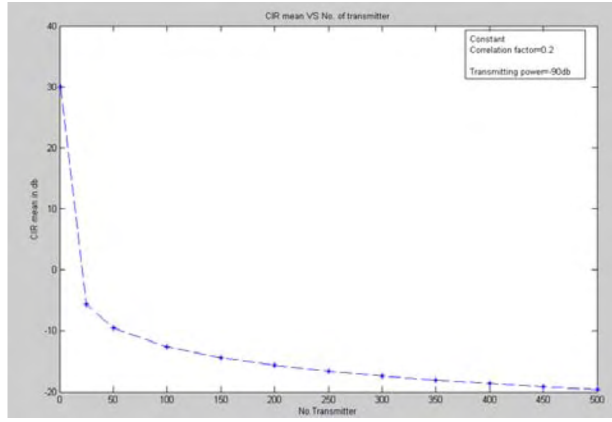

Figure 7. Number of Transmitting signals Vs CIR mean

It is observed that, the decrease in CIRmean is significant for number of co-channels less than 10. Thereafter as the number of transmitter increase, the CIR mean in dBm flattens and more or less remain constant. This can be inferred as the effect of co-channel interference in the present scenario of large number of transceiver is not significant compared to its effect when there are fewer number of interfering signals. Graph in Figure 8 represents corresponding CIR std deviation. It may be observed that the standard deviation remain flat indicating the predictability of the interference noise.

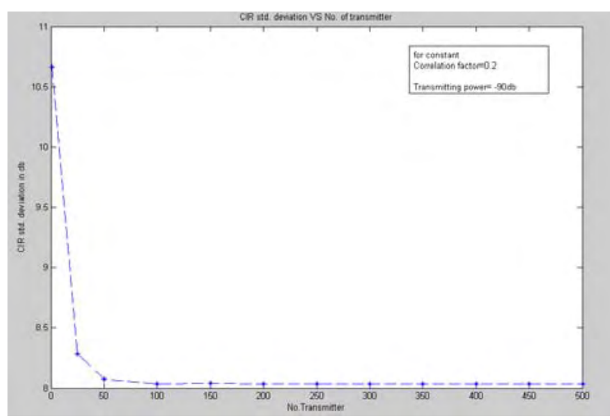

Figure 8. Number of Transmitting signals Vs CIR std Deviation.

Figure 9 represents the variation of CIR mean with respect to correlation respectively. Here we have set number of transmitter equal to 6 and transmit power set [2] varying between -80 dBm to -120dB.

It may be observed that the CIR mean marginally increase (by 1dBm) with correlation factor. We propose to use of codes with good cross correlation properties in such scenario to reduce the correlation effect.

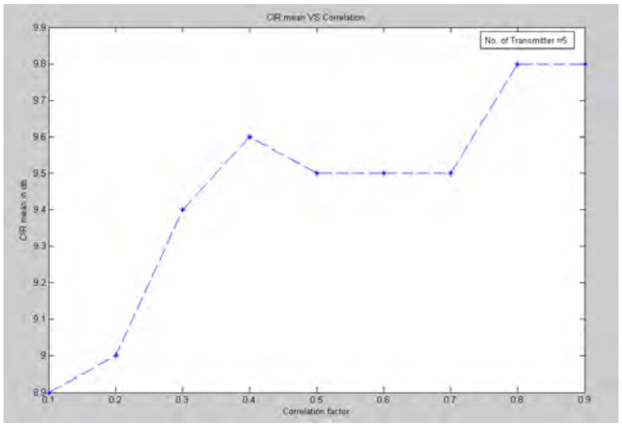

Figure 9. Correlation Vs CIR Mean

Similarly, Variation of CIR mean is plotted in Figures 10. It may be observed that, CIR mean remain constant for increase in transmitter power. Thus, co-channel interference may not be limiting factor for deciding the transmit power. It may be necessary to analyze other factors before determining the link budget for the present scenario.

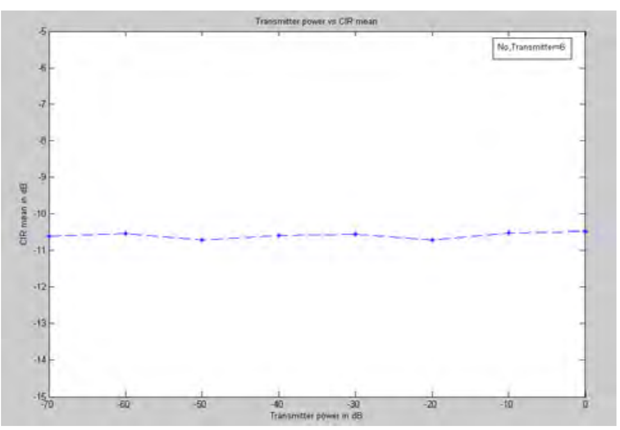

Figure 10. Transmitter power Vs CIR Mean

7. CONCLUSION.

From the foregoing discussion, it may be appreciated that there would be enormous advantage in terms of cost, time manpower and power requirement, if the wireless nodes are implemented as alternative to the conductor interconnects. However, several issues need to be studied and common standards need to be adapted among the entire device manufacturers to provide dynamic selectability of nodes to the wireless path. The interferences that appeared primary limiting factor seems to have little effect on the implementation.

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