

# PART II. The Intrinsic Connector: Ultrabroadband Properties of ERmetZD for High Speed Backplane Applications.

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## ABSTRACT

As the data rate handling of both processors and communication chips keep climbing unabated, the architectural possibilities for backplane designs are also evolving in a very dramatic way. The multigigabit, switched fabric architectures are transforming the entire high performance backplane industry by requiring commensurate data rate increases at the backplane. Since the performance of backplane designs is severely impacted by the quality of backplane interconnections, the modeling and characterization of high performance connector products is reviewed and redefined for accurate model implementation in the differential mode. The S-parameter based modular model of the interconnecting assembly is represented as consisting of three principal elemental structures: an **intrinsic connector** block; a generally low impedance transmission line formed by the via **barrels** and; low impedance extensions of the via barrels that are unterminated and create low impedance **stubs**. Whereas it is well understood that the overall signal quality is established by the electromagnetic interactions between the elemental blocks, the degree of this interaction is entirely determined by the electromagnetic qualities of the individual elemental blocks such as impedance profile and the degree of cross talk coupling. Also, since actual high performance backplane connector products are still an exception rather than the rule, these definitions provide means for a standardized approach for uniform product performance comparison and evaluation, which does not exist today. In this context, it is shown that, whereas the broadband characteristics of the intrinsic connector are uniquely defined by the connector designer, the features and the broadband characteristics of barrels and stubs are determined by a combination of routing options allowed by the connector designer as well as by the specific **choices that are made by the backplane designer**. These choices can either take advantage of the qualities incorporated into the intrinsic block or entirely mask and destroy them. These issues are discussed with the aid of specific case studies with measured broadband characteristics supplied for many of the examples. Various design options as well as the implementation of designs are illustrated in software. A number of design rules ensue from these considerations.

## SUMMARY

As the data rate handling of both processors and communication chips keep climbing unabated, the architectural possibilities for backplane designs are also evolving in a very dramatic way. The introduction of very high speed SERDES chips into a switched fabric architecture is placing new demands on signal integrity and, with them, is transforming the entire high performance backplane industry. These changes are requiring commensurate data rate increases at the backplane and help leapfrog the staid performance of conventional bus speeds to the multigigabit capabilities of modern designs.

Since the performance of backplane designs is severely impacted by the quality of backplane interconnections, the modeling and characterization of high performance connector products is reviewed and redefined for accurate model implementation in the differential mode. A modular, S-parameter based approach is described such that all the significant elements of the interconnection are incorporated and accurately characterized for high speed design applications. The entire card-to-backplane (or backplane-to-cable or card-to-cable) interconnection is shown as consisting of elemental electromagnetic components.

At the center of the assembly is the **intrinsic connector** block. On a PCB, the transitions from the PCB traces to this block are generally achieved by way of via barrel transmission lines, referred to as TL barrels or, simply, **barrels**. At the junctures made by the PCB traces and the via barrels, there generally remain varying lengths of unterminated via barrel transmission line stubs, referred to as TL stubs or simply **stubs**. It is shown that these definitions provide the user of high performance interconnection products means for a better understanding of high performance design and of its limits. Also, since high performance backplane connector products are still an exception rather than the rule, the definitions provide means for a standardized approach for uniform product performance comparison and evaluation, which does not exist today.

It is particularly shown that, whereas the broadband characteristics of the intrinsic connector are uniquely defined by the connector designer and manufacturer, the features and the broadband characteristics of barrels and stubs consist of a combination of options allowed by the connector designer as well as the specific **choices that are made by the backplane designer**. It is stressed that the behavior of the assembly depends on two factors: the broadband electromagnetic properties of each intrinsic element and the electromagnetic interactions between these contiguous elements. Thus, the quality of the intrinsic block defines only some of the overall signal qualities in the high speed interconnection. Nevertheless, it is important to know, for example, what is the level of coupling within the intrinsic block to other differential pairs and whether or not the coupling contributes significantly to the overall level of cross talk within the interconnecting structure. Also, the impedance profile of the intrinsic block may have a greater or a smaller tolerance for the impedance mismatches of the barrels and stubs, which are generally characterized by low impedance.

It is stressed, therefore, that the maximum performance of a backplane interconnection is determined by three major considerations, two of which are provided by the connector manufacturer: a) the quality of the broadband characteristics of the intrinsic block and b) the features and spaces allowed for trace routing within the connector footprint. The third, no less defining, is influenced by the choices made by the backplane designer. It is demonstrated that these choices establish a number of very impacting properties of the barrels and stubs such as their impedances and lengths. It is well known that extreme values of these parameters can influence significantly, if not dominantly, the high speed behavior of the entire assembly and, therefore, mask and destroy the high qualities achieved in the design of the intrinsic block. These issues are discussed in the context of specific case studies with measured broadband characteristics supplied for many of the examples. Various design options as well as the implementations of designs are illustrated in software. A number of design rules ensue from these considerations.



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