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Design Guidelines for Electronic Packaging Utilizing High-Speed Techniques

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Design Guidelines for Electronic Packaging Utilizing High-Speed Techniques

1.0 General

1.1 Purpose The object of this document is to provide guidelines for the design of high speed circuitry. The subjects presented here represent the major factors that may influence a high speed design. This guide is intended to be used by circuit designers, packaging engineers, circuit board fabricators, and procurement personnel so that all may have a common understanding of each area.

1.2 Scope The goal in electronic packaging is to transfer a signal from one device to one or more other devices, through a conductor. Considerations include electrical noise, electromagnetic interference, signal propagation time, thermo-mechanical environmental protection, and heat dissipation. High-speed designs are defined as designs in which the inter-connecting properties effect circuit function and require consideration. Every electrical concept has relevant physical implementation data provided to match the electrical and mechanical relationships. This guideline presents first order approximations for each of the subject areas covered. If more detail is required, the papers presented in the bibliography may provide more accurate data.

1.3 Symbology, Terms and Definitions

1.3.1 Symbology

| Symbol | Description |
|-------------------|-----------------------------------------------|
| AC | Alternating Current |
| CMOS | Complimentary Metal Oxide Semiconductor |
| COB | Chip-On-Board |
| CTE | Coefficient of Thermal Expansion |
| CTE _{xy} | X and Y-Axis Coefficient of Thermal Expansion |
| CTE _z | Z-Axis Coefficient of thermal expansion |
| DC | Direct Current |
| DIP | Dual In-line Package |
| DWB | Discrete Wiring Board |
| ECL | Emitter Coupled Logic |
| EMI | Electromagnetic Interference |
| FR-4 | Epoxy Glass Dielectric Material |
| H _L | High-to-Low Signal Edge Transition |
| IC | Integrated Circuit |
| K _B | Backward Crosstalk |
| K _F | Forward Crosstalk |
| L _G | Ground Plane Inductance |
| L _H | Low-High Signal Edge Transition |
| L _P | Power Plane Inductance |
| PWB | Printed Wiring Board |
| R _C | Series Lead Resistance |
| R _G | Ground Plane Resistance |

| | |
|------------------|---------------------------------------------|
| R _P | Power Plane Resistance |
| R _T | Sheet Resistance |
| SM | Surface Mount |
| TAB | Tape Automated Bonding |
| Tan (δ) | Dissipation Factor (Loss Tangent) |
| TDR | Time Domain Reflectometer |
| T _P | Total Signal Line Propagation Delay Time |
| T _{PD} | Propagation Delay Per Unit Length |
| T _R | 10%–90% Edge Transition Time (Rise or Fall) |
| TTL | Transistor Transistor Logic |
| Z _O | Characteristic Line Impedance (Unloaded) |
| Z _O ' | Characteristic Line Impedance (Loaded) |
| ε _r | Relative Permittivity |
| ε _r ' | Effective Relative Permittivity |
| δ | Skin Depth |

1.3.2 Terms and Definitions The terms listed below are used in this document. Their definitions are given in order to help the new reader. These definitions are also found in IPC-T-50, "Terms and Definitions for Interconnecting and Packaging Electronic Circuits." Where possible, definitions that appear in the body of this document are referred to as follows: "Bus – 5.6.5.2". This indicates that a definition for "Bus" appears in section 5.6.5.2, and will not be repeated here.

AC Impedance—The combination of resistance, capacitive, reactance, and inductive reactance seen by AC and/or time-varying voltage.

Alternating Current (AC)—A current that varies with time. This label is commonly applied to a power source that switches polarity many times per second, such as the power supplied by utilities. May take a sinusoidal shape, but could be a square or triangular wave shape.

Amplitude—The height or magnitude of a voltage signal as measured with respect to a reference plane, such as signal ground.

Dual-Strip Line—A stripline signal conductor that is embedded between two ground planes, and is not centered between them (closer to one ground plane than the other).

Attenuation—Reduction in the amplitude of a signal due to losses in the media through which it is transmitted.

Backporching—A term used to describe the reflections which follow a fast rise or fall time signal traveling down a long transmission line that has not been properly terminated. Looks like a stair step.

Backward Crosstalk—Noise induced into a quiet line placed next to an active line as seen at the end of the quiet line close to the signal source.

Bus—See section 5.6.5.2.