THE INSTITUTE FOR

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Design Guidelines for Electronic Packaging Utilizing High-Speed Techniques

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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, thermomechanical environmental protection, and heat dissipation. High-speed designs are defined as designs in which the interconnecting 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.