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Controlled Impedance:
Why do I need to know more?

Technical Webinar

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Controlled Impedance: Why do I need to know more?

- **The Basics:**

  Electrical Impedance: A measure of opposition to time-varying electric current in an electric circuit.

  Simplified: To slow down an electrical circuit.

  Why: As PCB designs and components become more complicated, smaller and faster, it becomes necessary to slow certain circuits down, allowing specific functions of components to perform before others.

  The increase in processor clock speed and component switching speed on modern PCB's means that the interconnecting paths (traces) can no longer be regarded as simple conductors.

Every circuit on a PCB has impedance.

The goal is to control the impedance.

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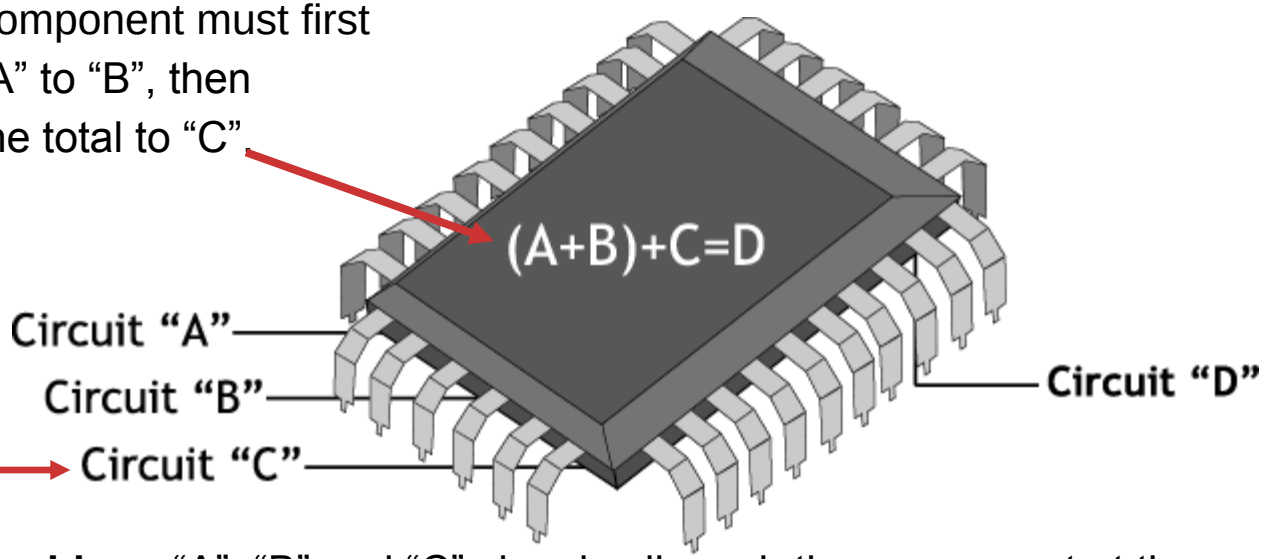
- **A Very Simple Example:**

Electrical Impedance: A measure of opposition to time-varying electric current in an electric circuit.

The component must first add “A” to “B”, then add the total to “C”



The Problem: “A”, “B” and “C” signals all reach the component at the same time.

The Solution: Apply Impedance to Circuit “C” to slow the signal enough for the component to first calculate (“A”+B”).

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- **Results:**

  Impedance (Zo) is measured in Ohms (Ω), however it should not be confused with resistance. You cannot measure impedance with an ohmmeter.

  Target impedance is usually between 25 Ω, and 125 Ω.

  Typical result of a 75 Ω controlled impedance on a .007” trace is a signal slowdown of approximately 166 ps/in.

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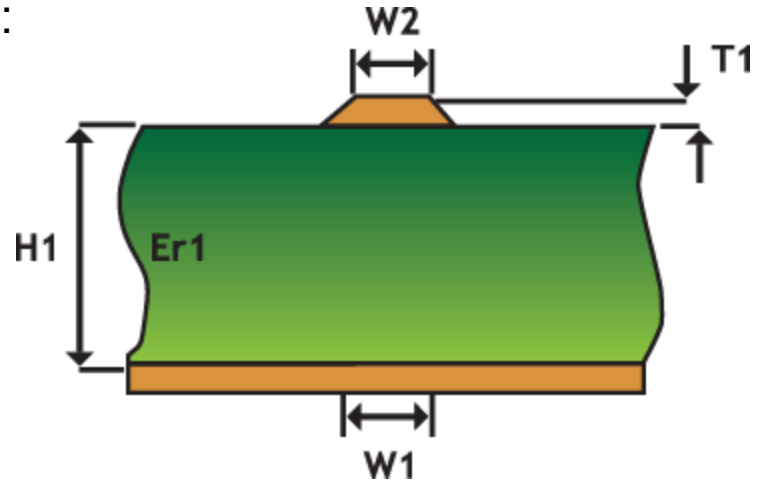
- **3 Basic Factors to Impedance:**

Physical characteristics of impedance trace:

- Height of Trace (T1)
- Width of Trace at Top (W2)
- Width of Trace at Bottom (W1)
- Distance to other Copper Features (H1)
- Dielectric Constant of PCB Material (Er1)



Other factors can be involved, however they have much less affect on Impedance such as Speed of circuit, environment, etc…

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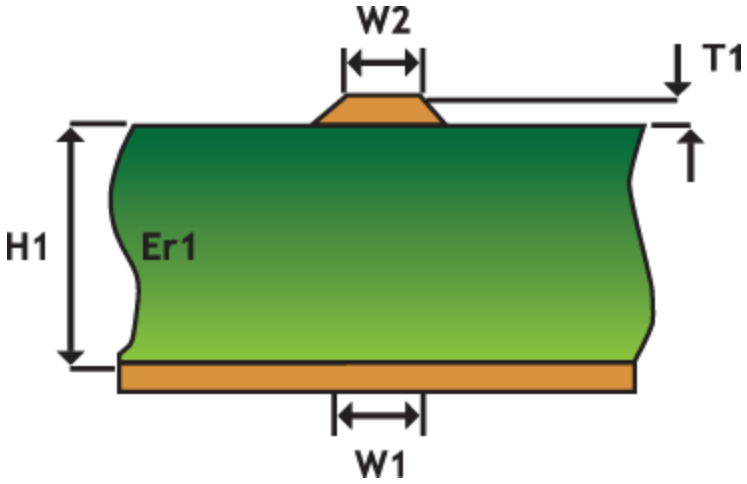
- **Dk (Er) Discussion:**
  - Dielectric Constant (Dk or Er) is the relative permittivity of a material
  - All PCB materials (cores, prepreg, soldermask) have a Dk value
  - Values typically range between 3.5 to 5.9
  - DK values can vary from factory to factory, material to material, even the factory in which the material was manufactured
  - Resin content of material is the largest factor to Dk
  - Factories must constantly maintain their material Dk values through testing feedback



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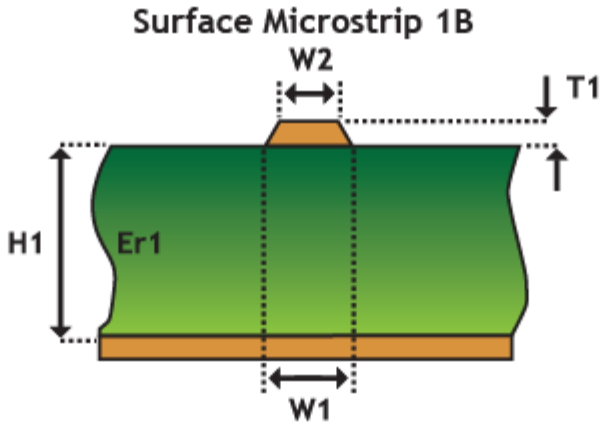
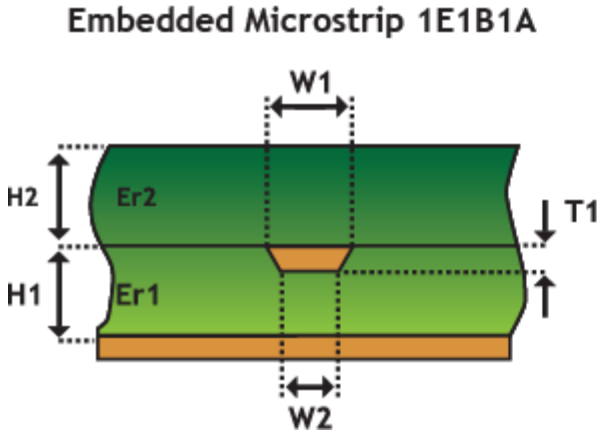
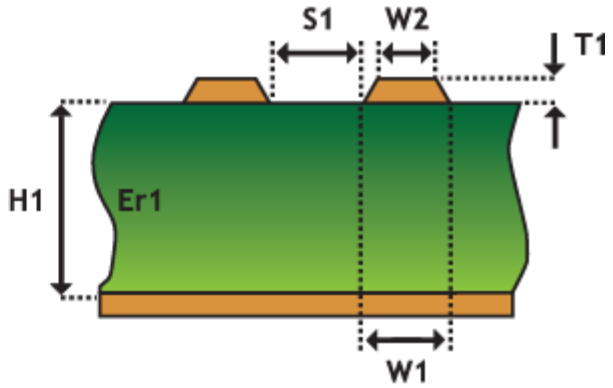
- **Simple Impedance Models:**







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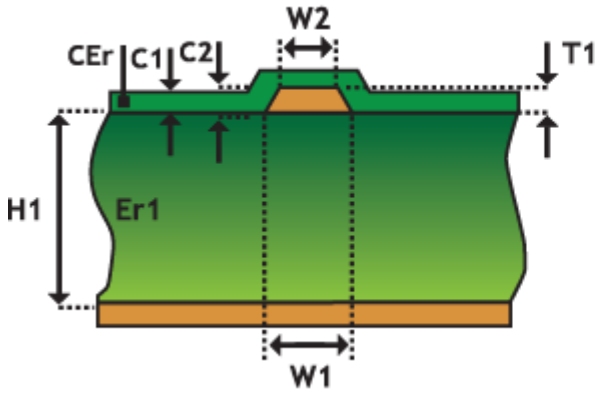
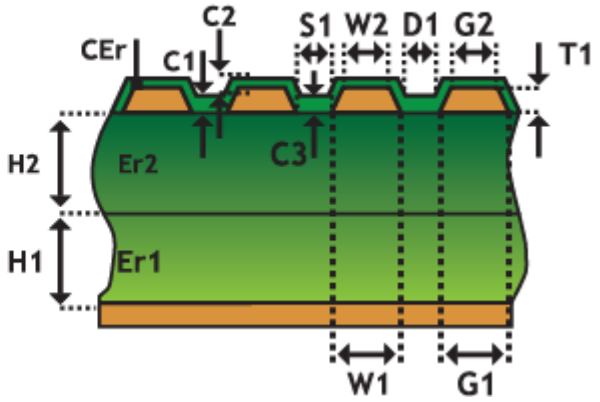
- **Complicated Impedance Models:**

  Some PCB's may have multiple Impedance requirements!
  More Impedance requirements mean more impedance coupons, which can decrease the amount of usable panel space for PCB's.

Coated Microstrip 1B



Diff Coated Coplaner Strips with Ground 2B



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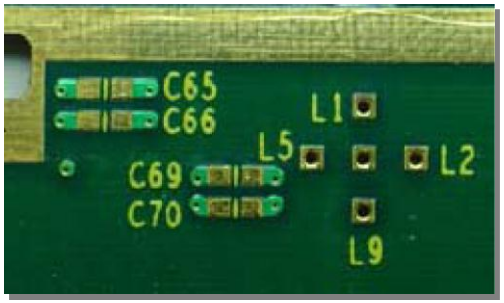
- **Testing / Modeling:**
  Impedance Modeling Software: Polar, Apsim
  Impedance Testing Hardware: Polar, Omicron, others

Testing is general done on coupons only.
Coupons are designed for specific hardware.



Failed impedance coupons do not mean failed boards!!!

Ask the factory to section the board and verify results Through their impedance Modeling software.

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The Difference is Quality and Delivery

1. ***Quicker Delivery*** - Epec's technology infrastructure and people, including the Asian and US based operations and engineering teams, enable jobs to get started the same day the order data is electronically received by our factory.

2. ***Accurate Information*** - Epec's on-site personnel provide accurate daily Work In Process reports so customers can receive immediate order status information, along with in person verification of all daily reports by Epec staff.

3. ***Better Quality*** - Epec ensures higher levels of quality through three key additional processes. On-site QA inspectors at each facility provide an additional audit before it leaves Asia, Epec maintains dual UL approval at each facility with quarterly audits, and perform QA audits at our headquarters in Boston, MA.

4. ***Flexibility*** - Each of our manufacturing facilities have been selected for their best-in-class niche product and delivery solutions, ensuring our optimal facility is building every order.

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