

Currents in S-Parameters

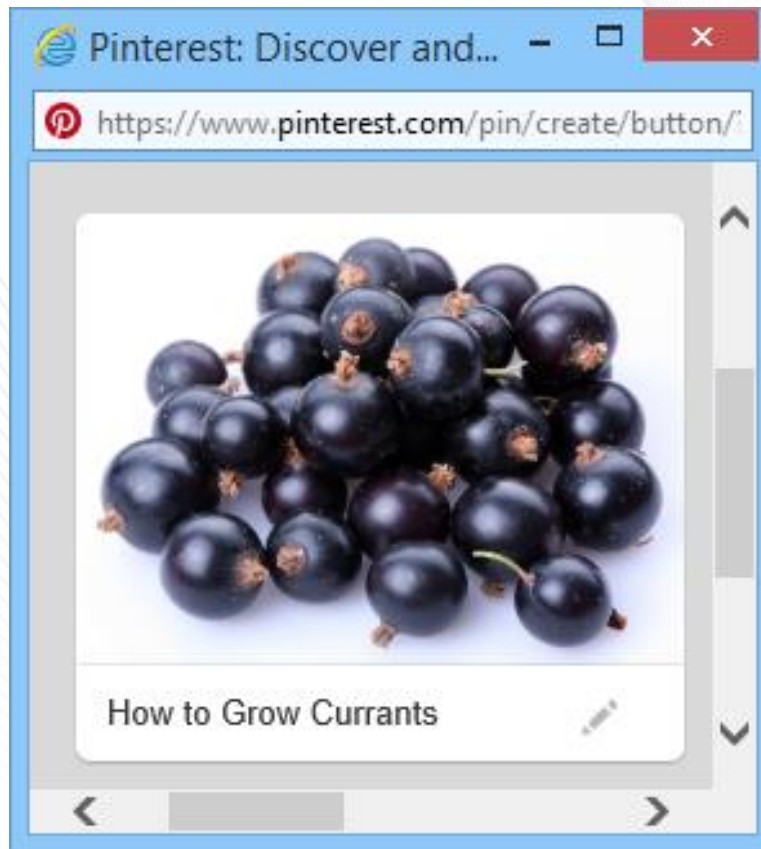
Walter Katz

Signal Integrity Software, Inc.

IBIS Interconnect

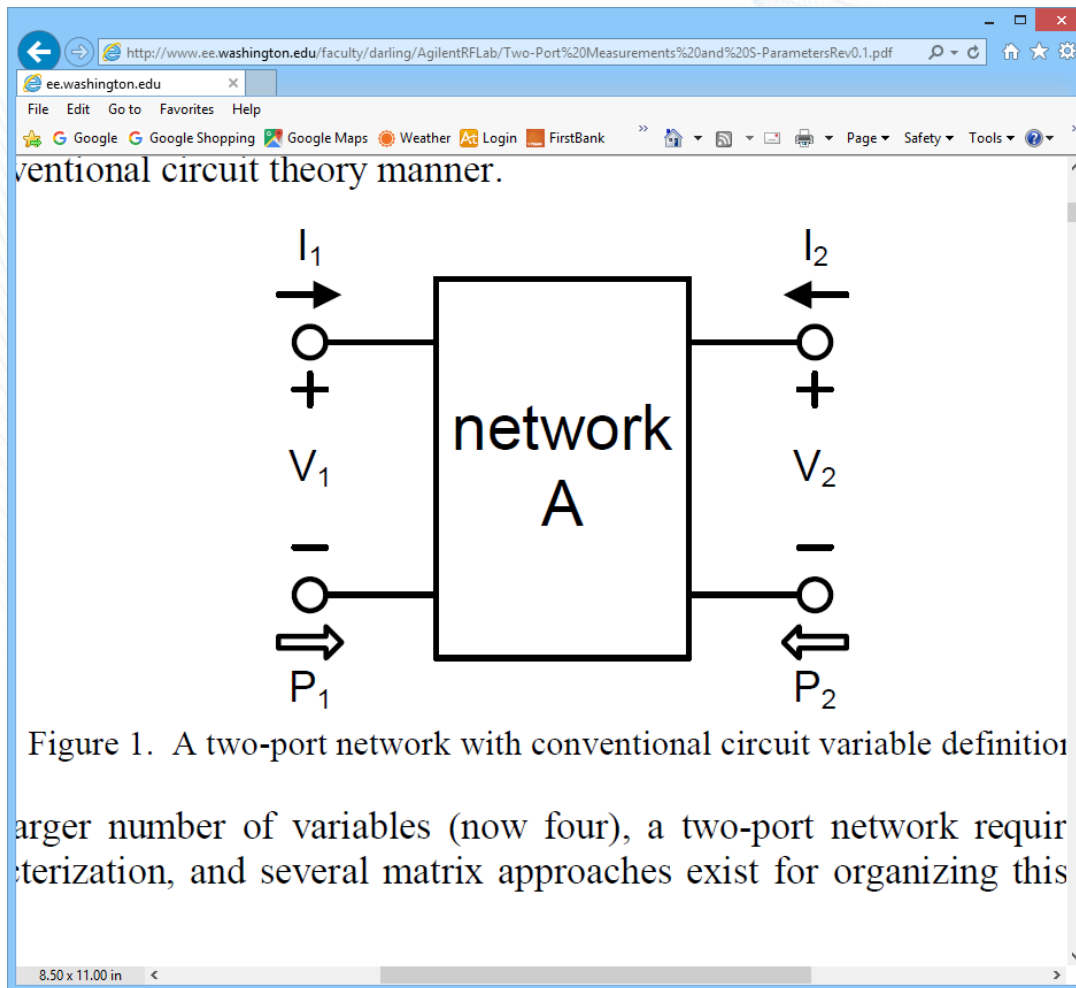
March 2, 2016

Sorry, I Meant Current



This is What I Meant

<http://www.ee.washington.edu/faculty/darling/AgilentRFLab/Two-Port%20Measurements%20and%20S-ParametersRev0.1.pdf>



Each Port of an S-Parameter has Two Terminals

- A Port consists of two terminals (+ and -)
- Each of the terminals has a voltage and a current.
- In the world of Signal Integrity Interconnect we call the + terminal the signal terminal and the – terminal the return terminal.
- We usually ignore the – terminal in schematics
 - It is physically there
 - It exists
- An S-Parameter between a package bump pad (at the die) and a package ball (at the PCB) is made with two differential probes.
- The + probe at the bump pad is connected to the signal pad and the – probe is connected to a nearby return pad. This return pad is usually on a ground signal.
- The + probe at the ball is connected to the signal ball and the – probe is connected to a nearby return ball. This return ball is usually on a ground signal.
- **The current on the – probe is equal and opposite to the current on the + probe.**

Since the Sum of the Currents of the Two Terminals at Each Port is 0.0 Amps, then the Total Current Into and Out of an S-Parameter Block is Zero, Nada

- What does the Nport+1 representation in an HSPICE (IBIS-ISS) netlist mean?
 - It is simply a simulator reference node for the voltages at the + terminals of the ports.
 - It draws no current, because there is no current to draw.
- When I simulate, how do I account for the return currents if I do not have a way of hooking them up to something?

But The Simulator Knows!!!

- In the S-Parameter math world, when a port of one S-Parameter is connected to a port of a second S-Parameter, both the + and – terminals of the ports are connected.
- We need to make an assumption that when measuring the two S-Parameters the same point was used as the return node for the connecting ports on the two S-Parameters.
 - So when measuring the package S-Parameter at a signal ball, a nearby return ball is used for the – probe.
 - When measuring the PCB S-Parameter at the PCB signal pad, the same return pad should be used.

Cascading Two 2-Port S-Parameters

http://www.ee.washington.edu/faculty/darling/AgilentRFLab/Two-Port%20Measurements%20and%20S-ParametersRev0

ee.washington.edu

File Edit Go to Favorites Help

Google Google Shopping Google Maps Weather Login

two 2-ports, as shown in Fig. 10 below.

The diagram shows two 2-port networks, 'network A' and 'network B', connected in cascade. Network A has an input port with voltage V_1 and power P_1 (indicated by an arrow pointing right). Its output port has voltage V_2 and power P_2 (indicated by an arrow pointing right). Network B has an input port with voltage V_2 and power P_2 (indicated by an arrow pointing right). Its output port has voltage V_3 and power P_3 (indicated by an arrow pointing right). The output of network A is connected to the input of network B via red lines. The input current to network A is I_1 (arrow pointing right), and the output current is $-I_2$ (arrow pointing right). The input current to network B is I_2 (arrow pointing right), and the output current is $-I_3$ (arrow pointing right).

Figure 10. Cascade connection of two 2-port networks for T -matrices.

8.50 x 11.00 in

OK, smart tush. What happens when my S-Parameter port is connected to some other SPICE element like a Buffer I/O pad!

- Every terminal of a SPICE element has a return terminal, event though it may not be obvious.
- In the case of Buffer subckt it would be the Pulldown or GND Clamp terminal (in IBIS terminology).
- For an S-Parameter package model to work, the return terminal for this port needs to be connected to the return terminal of the Buffer.

So What Does the S-Parameter Shortcut Mean?

- The simulator is responsible for making the connection between the return path terminal of each port to the corresponding return path terminal of the terminals the port is connected to.
- Therefore, if we choose to support an S-Parameter shortcut in our package modeling:
 - We should describe to the model maker what the EDA tool will expect the return terminal for each port to be connected to.
 - We do not need to tell the EDA tool how to netlist the S-Element for its simulator, it has all of the information it needs to do this since the Interconnect BIRD describes where each port is connected.