Date: November 15, 1996
To: X3T10
From: Larry Barnes, Symbios Logic
Subject: Universal Backplanes

Commentary:

Further examination of the literature indicates that there are two basic types of coupled transmission line construction microstrip and stripline.

Microstrip is the construction with two parallel lines laid on the surface of a PCB with an AC ground plane.

Stripline is the construction with two parallel lines buried in a PCB between two AC ground planes. Stripline has two configurations, edge-coupled, when the lines have the same Y coordinate and vary in placement in the X direction; broadside-coupled, when the lines have the same X coordinate and vary in placement in the Y direction. Broadside-coupled lines have better coupling characteristics but are more difficult to bring to the surface without compromising electrical characteristics. Edge-coupled lines are easier to bring to the surface without compromising electrical characteristics, but have a lower coupling coefficient.

The graphical data were from an article by Seymour Cohn, "Shielded Coupled-Strip Transmission Line", IRE Transactions on Microwave Theory and Techniques, October 1955. This is the standard reference article for edge-coupled stripline. He also presents a good description of the odd-even mode transmission characteristics. Further information on coupled microstrip and broadside-coupled stripline can be found in the following articles respectively: Garg, Ramesh and Bahl, "Characteristics of Coupled Microstrip", IEEE Transactions on Microwave Theory and Techniques", July 1977. Bahl and Bhartia, "The Design of Broadside-Coupled Stripline Circuits", IEEE Transactions on Microwave Theory and Techniques", February 1981

The following data show that for coupled microstrip, the tighter the coupling between the two lines the higher the even-mode differential impedance and single-ended impedance, for a give odd-mode differential impedance. Remember that the differential impedance is 2 time the odd-mode impedance.

Universal Backplane - Case 1			
Construction	Microstrip		
Frequency	240 MHz	Units	mil
Board Stackup			
Layer #	Dielectric Constant	Dissipation Factor	Thickness
1	1	0	
2	1	0	1.35
3	4.5	0	20.0
Ground Plane	n/a	n/a	1.35
Conductors			
Conductor #	Width	X Coordinate	Sigma
1	24.0	0	5.800e+07
2	24.0	50.0	5.800e+07
Ground Plane	n/a	n/a	5.800e+07
Coupled Characteristics of Modes			
Mode	Zo	Effective ε_r	Attenuation dB/mil
Odd	54.59-j0.29	2.93	1.042e-05
Even	68.58-j0.26	3.47	8.296e-06
Single Ended Characteristics of Conductors			
Line #	Zo	Delay ns/mil	Attenuation dB/mil
1	61.48-j0.27	1.525e-04	9.255e-06
2	61.48-j0.27	1.525e-04	9.255e-06

Universal Backplane - Case 2			
Construction	Microstrip		
Frequency	240 MHz	Units	mil
Board Stackup			
Layer #	Dielectric Constant	Dissipation Factor	Thickness
1	1	0	
2	1	0	6.0
3	4.5	0	20.0
Ground Plane	n/a	n/a	1.20
Conductors			
Conductor #	Width	X Coordinate	Sigma
1	15.0	0	5.800e+07
2	15.0	35.0	5.800e+07
Ground Plane	n/a	n/a	5.800e+07
Coupled Characteristics of Modes			
Mode	Zo	Effective ε_r	Attenuation dB/mil
Odd	57.88-j0.36	2.56	1.114e-05
Even	85.24-j0.40	3.24	9.405e-06
Single Ended Characteristics of Conductors			
Line #	Zo	Delay ns/mil	Attenuation dB/mil
1	71.03-j0.38	1.467e-04	1.018e-05
2	71.03-j0.38	1.467e-04	1.018e-05

Universal Backplane - Case 3			
Construction	Microstrip		
Frequency	240 MHz	Units	mil
Board Stackup			
Layer #	Dielectric Constant	Dissipation Factor	Thickness
1	1	0	
2	1	0	2.7
3	4.6	0	20.0
Ground Plane	n/a	n/a	1.2
Conductors			
Conductor #	Width	X Coordinate	Sigma
1	12.0	0	5.800e+07
2	12.0	21.0	5.800e+07
Ground Plane	n/a	n/a	5.800e+07
Coupled Characteristics of Modes			
Mode	Zo	Effective ε_r	Attenuation dB/mil
Odd	54.85-j0.46	2.55	1.481e-05
Even	105.94-j0.51	3.24	9.676e-06
Single Ended Characteristics of Conductors			
Line #	Zo	Delay ns/mil	Attenuation dB/mil
1	77.68-j0.46	1.517e-04	1.182e-05
2	77.68-j0.46	1.517e-04	1.182e-05