Giga Test Labs

POST OFFICE BOX 1927 CUPERTINO, CA

TELEPHONE (408) 524-2700 FAX (408) 524-2777

ARIES

KAPTON INTERPOSER SOCKET
(0.5mm pitch)

Final Report

Electrical Characterization
0.05-5.05 GHz

April 28, 2003

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Summary

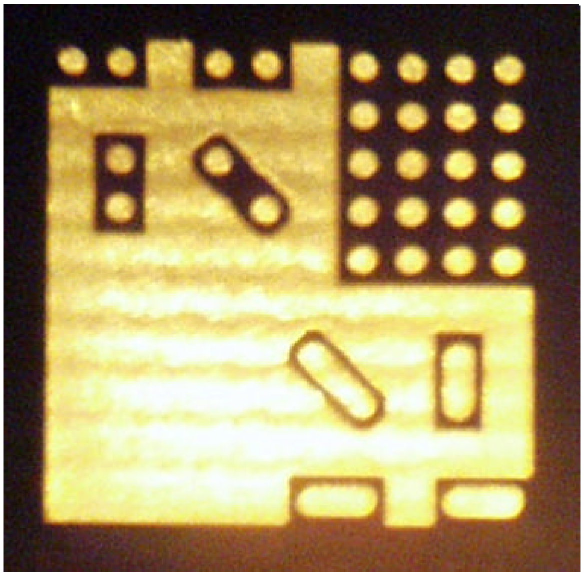
Objective

The Aries Kapton interposer socket (0.5mm pitch) was measured at GigaTest Labs to assess its electrical performance. Also, its high-speed performance limits were determined.

Methodology:

A custom fixture (GTL 287-QA-001 rev A1) was first designed by GTL which allows the use of coplanar probes to make the measurements. A second fixture was fabricated to be placed inside each socket. It provides connections between the internal pins, so pairs of pins can be measured in different load conditions. This fixture is referred to as "surrogate package". Figure 1 shows a picture the surrogate package, while figure 2 shows the top and bottom side of the fixture.

Figure 1: Surrogate Package



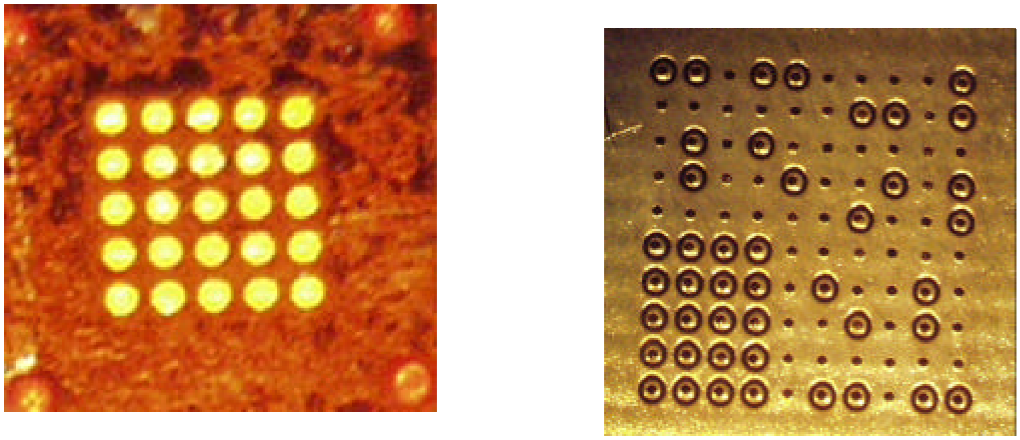


Figure 2 – Socket & Fixture

There are three load conditions used on the signal pins: the **open** measurement is performed on two pins with just unconnected surface pads on the surrogate package. The **short** measurement is done with the pins shorted to the ground on the surrogate. The **thru** is just the two pins connected together. These are illustrated on figure 3. The measured pins are denoted by the numbers 1 & 2. The adjacent pins to the measurement, usually the three nearest neighbors are grounded to the fixture ground and the surrogate package ground.

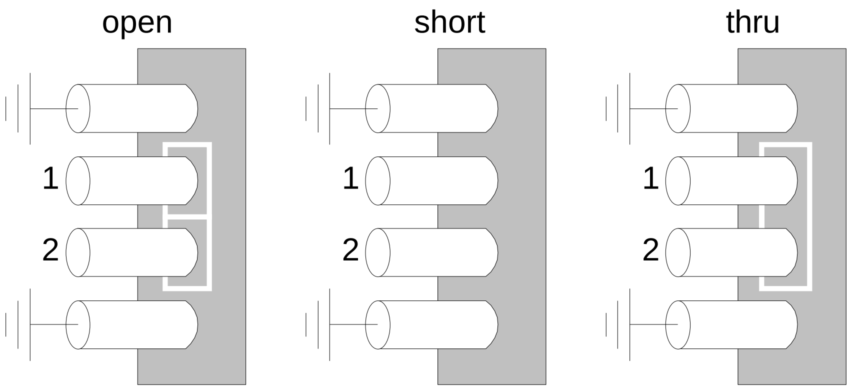


Figure 3 – Signal pin load conditions

The fixture was measured separately to extract its parasitics, so they could later be de-embedded from the overall measurement.

The Agilent 8510C network-analyzer was used to measure two-port s-parameters. The frequency range was 100 MHz – 40.1 GHz. From the s-parameter data, a SPICE-compatible equivalent circuit was derived using Agilent ADS version 2002.

Measurement system

All measurements were taken using a high-frequency measurement system. This consists of a Agilent 8510C network analyzer & GGB Picoprobes™ 450 μm pitch. The Agilent 8510C network analyzer is a frequency domain instrument. The measurements are taken as scattering parameters (a.k.a. s-parameters). The HP8510C has great calibration capabilities, which make it the most accurate high-frequency instrument available. For this work the short-open-load-thru (SOLT) calibration was used. The GGB Picoprobes provide a high-quality 50 Ω path from the network analyzer and cables to the DUT.

Equivalent-circuit model

Figure 4 shows the topology used to model the Kapton interposer socket. Please note that only two pins are shown in this schematic, however there will be similar mutual elements (M_{21}, C_{21A} and C_{21B}) to **ALL the surrounding pins**. Therefore, to implement the model for one pin, the user needs to describe it and all the pins surrounding it (a total of 9 pins). By the same reasoning, to implement two pins, then the models for 12 pins will be needed.

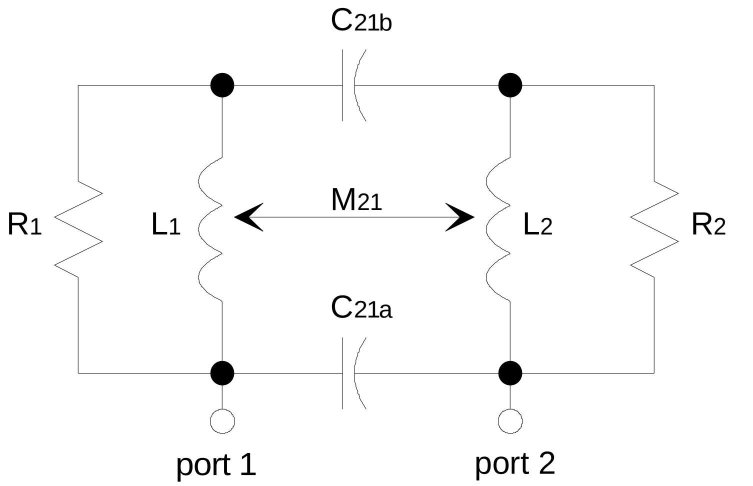


Figure 4 - Kapton interposer socket equivalent-circuit diagram

Element definitions

L_1, L_2: pin effective inductance

M_{21}: mutual inductance between adjacent pins

R_1, R_2: shunt-resistance of inductors L_1 and L_2, used to model high-frequency loss due to skin effect and dielectric loss

C_{21a}: mutual-capacitance between adjacent pins (PCB side)

C_{21b}: mutual-capacitance between adjacent pins (BGA side)

Element values

The Kapton interposer socket model is valid from DC to 5.05 GHz. The measured and modeled transmission response agrees within 0.1 dB. Models were extracted for four types of pins: adjacent field pins, corner pins, field diagonal pins and edge adjacent pins.

Table 1 – Kapton Interposer Socket element values

Pins	L_1 & L_2 (nH)	M_{21} (nH)	R_1 & R_2 (W)	C_{21a} (pF)	C_{21b} (pF)
Field adjacent	0.09	0.01	1000	0.001	0.001
Corner adjacent	0.11	0.03	1000	0.001	0.001
Field diagonal	0.09	0.01	1000	0.001	0.001
Edge adjacent	0.10	0.02	1000	0.001	0.001

Note: edge-adjacent values were interpolated

Conclusions

1. The bandwidth for the Kapton interposer socket as determined from a loop-thru measurement on two adjacent pins. The nearest row of pins was grounded (see figure 5).

Table 2– Kapton interposer socket Frequency Loss

Pins	GHz
Field adjacent (1:5 signal to gnd ratio)	12.5
Corner adjacent (1:3 signal tognd ratio)	15.0
Field diagonal (1:2 signal to gnd ratio)	14.9
Edge adjacent (1:7 signal to gnd ratio)	16.2

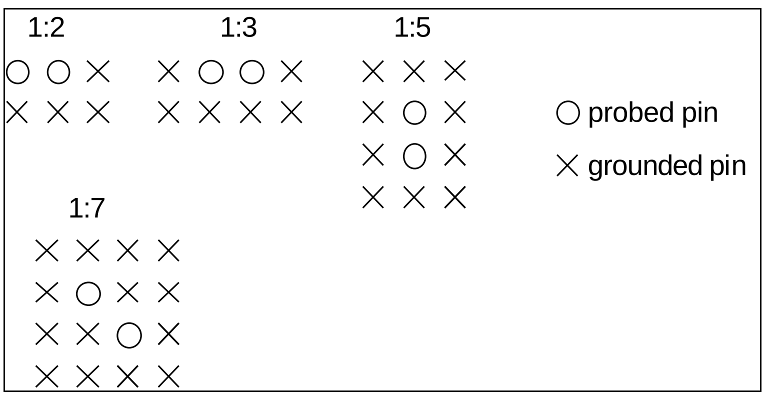


Figure 5 – Signal-to-Ground ratio setups

2. The model bandwidth is DC-5.05 GHz, which will easily handle signals with 200 ps edges.
3. The parasitics of the Kapton interposer socket are negligible compared to those of a typical PCB. In most cases this socket will behave as additional plating on the PCB contact pads.

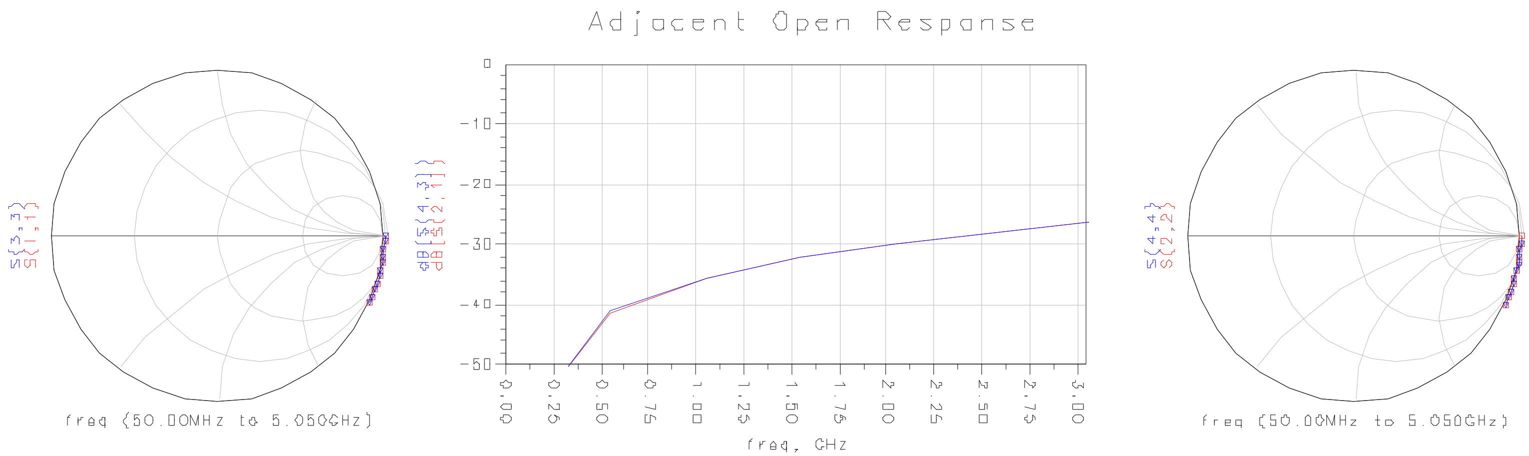
Appendix

The appendix shows the measured and simulated output data.

Measured and simulated data **page**

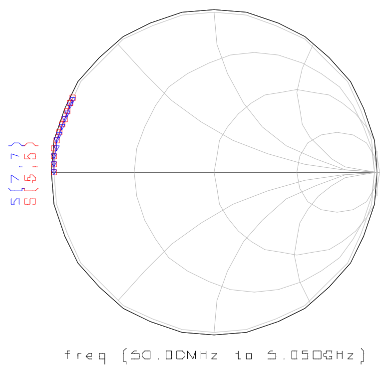
Adjacent pins open

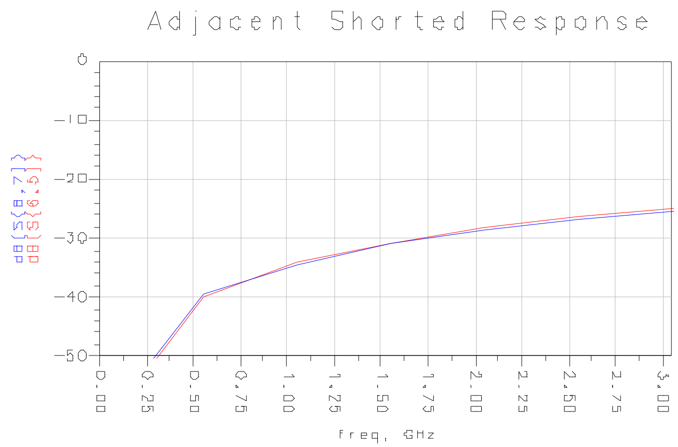
Measured s-parameters in blue, simulated s-parameters in red

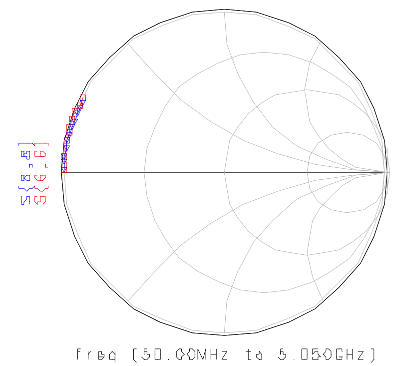


Adjacent pins shorted to ground

Measured s-parameters in blue, simulated s-parameters in red

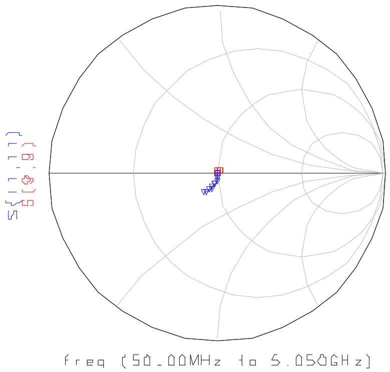


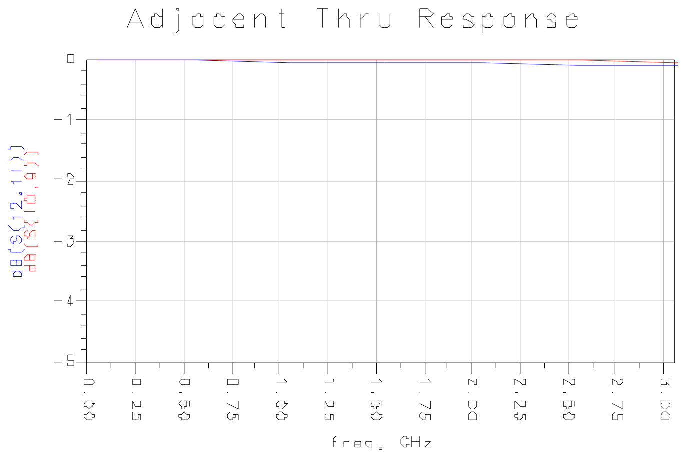


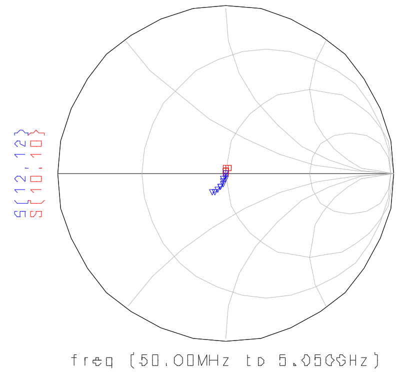


Adjacent pins connected together (loop-thru)

Measured s-parameters in blue, simulated s-parameters in red



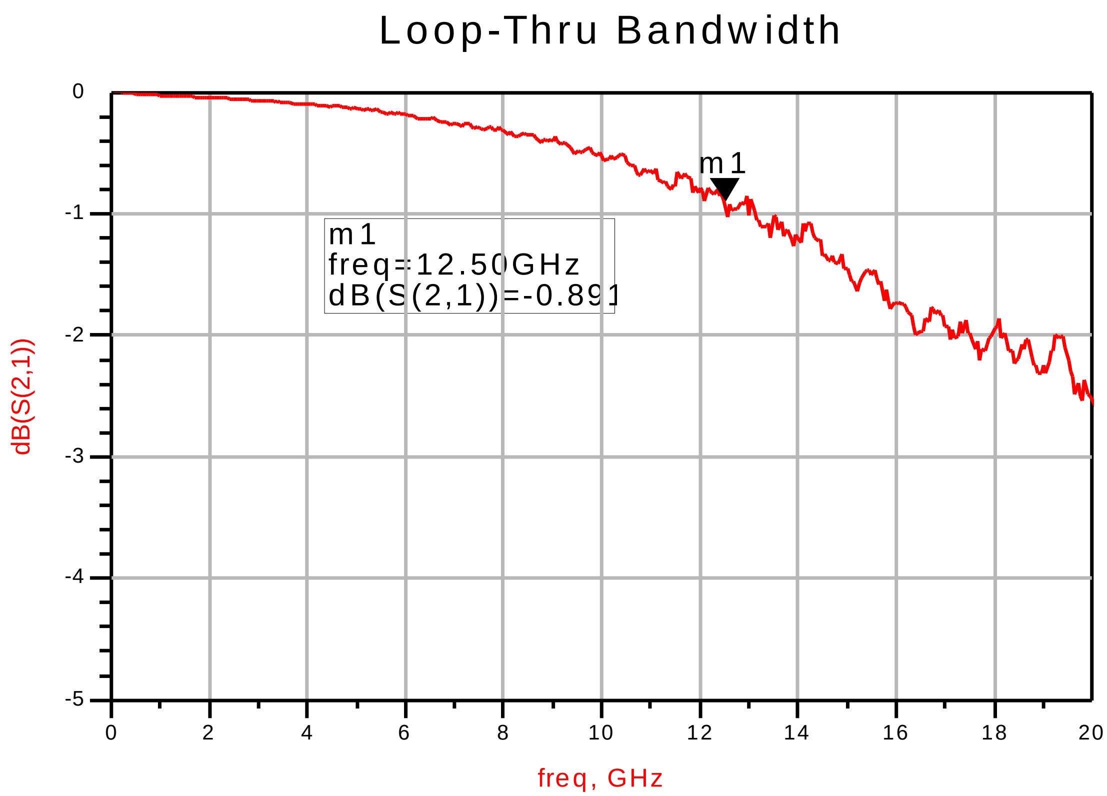




Adjacent Loop-thru Bandwidth Measurement

Measured insertion loss versus frequency for two pins in series

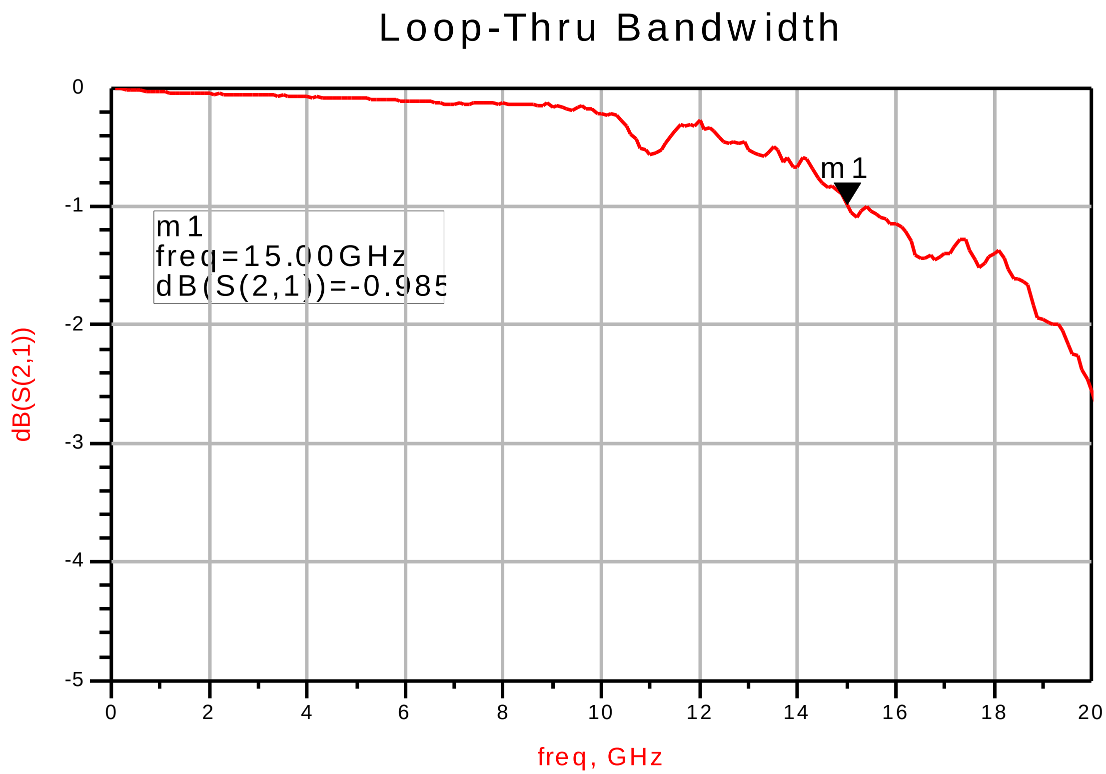
“1-5 signal to ground ratio”



Corner Loop-thru Bandwidth Measurement

Measured insertion loss versus frequency for two pins in series

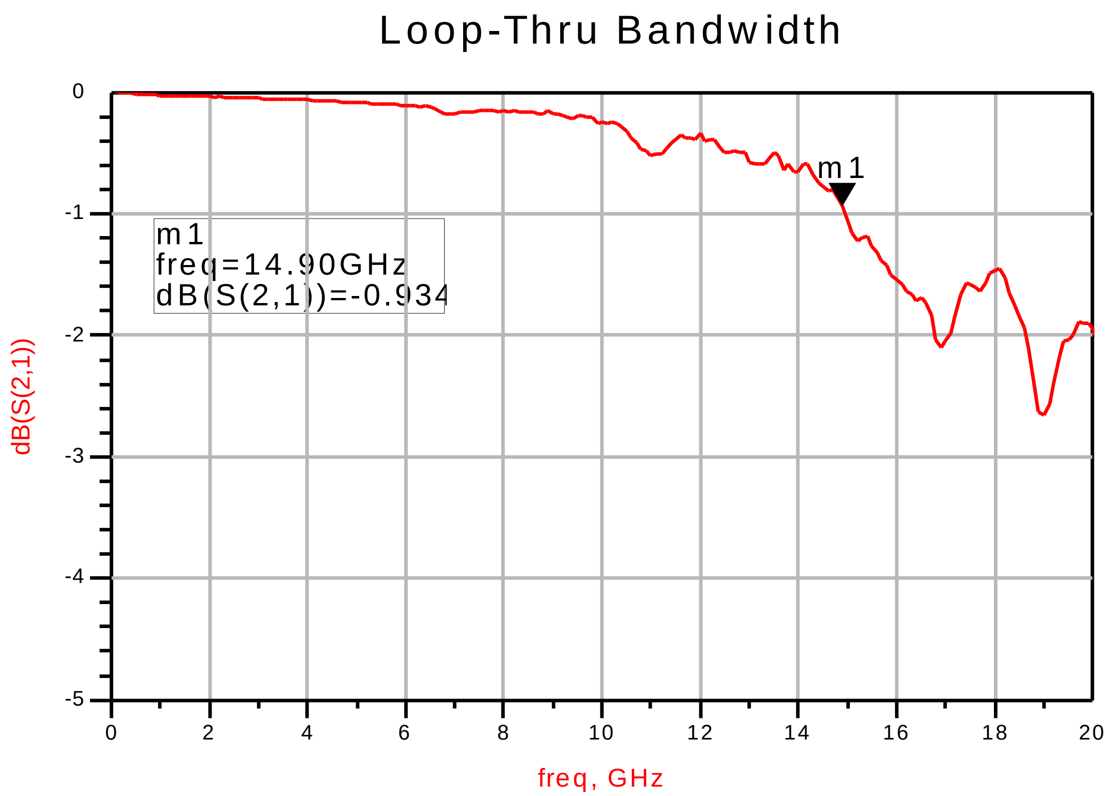
“1-2 signal to ground ratio”



Edge Loop-thru Bandwidth Measurement

Measured insertion loss versus frequency for two pins in series

“1-3 signal to ground ratio”



Diagonal Loop-thru Bandwidth Measurement

Measured insertion loss versus frequency for two pins in series

“1-7 signal to ground ratio”