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ARIES ELECTRONICS
64 pin QFP (0.5mm) Test Socket

Electrical Characterization
0.05 - 3.05 GHz

October 15, 1997

Table of Contents

Subject **page**

Summary

Objective:
The measurements are used to extract an equivalent circuit for the Aries 64-QFP socket in 50 Ω impedance environment. Moreover, the 3 dB bandwidth of the socket was directly measured.

Methodology:
A custom fixture was first designed (P/N GTL-125-AR-001 rev A1). It allows the use of coplanar probes to make the measurements in a 50 Ω environment. A second fixture was fabricated to be placed inside the socket (P/N GTL-126-AR-001 rev A1). It provides connections between the internal pins. This fixture is referred to as "surrogate package".

The Hewlett-Packard 8510 network analyzer was used to measure two-port s-parameters. The socket was measured under three conditions: open, shorted to ground and with adjacent pins connected together, and loop thru of adjacent pins with other pins shorted to fixture ground. The frequency range was 0.05 - 20.05 GHz.

Equivalent circuit models were extracted for the fixture and Aries socket separately. The effect of the Aries socket on the response is therefore readily available. All modeling was performed under HP MDS (Microwave Design System).

Equivalent-circuit model:
The equivalent-circuit topology is shown in figure 1.

Element definitions:

L_1 & L_2:	self-inductance of one socket pin
R_1 & R_2:	resistors in parallel with L_1 & L_2 used to model high-frequency losses like skin-effect and loss tangent
C_{1a} & C_{2a}:	capacitance to ground of one socket pin (PCB side)
C_{1b} & C_{2b}:	capacitance to ground of one socket pin (package side)
M_{21}:	mutual-inductance between adjacent socket pins

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

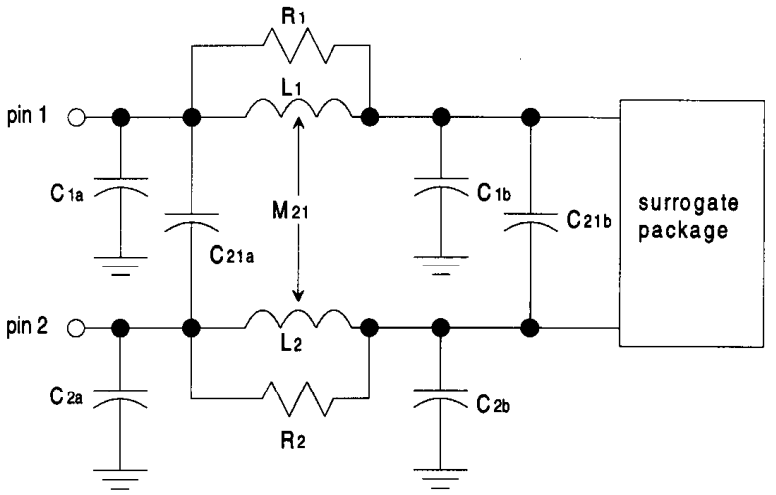


Figure 1 - Equivalent-circuit model

Element values:

Tables 1 & 2 shows the element values extracted from the s-parameter data.

Table 1: Element values

socket	L_1 & L_2 (nH)	M_{21} (nH)	R_1 & R_2 (Ω)	C_{1a} & C_{2a} (pF)	C_{1b} & C_{2b} (pF)	C_{21a} (pF)	C_{21b} (pF)
fixture	1.35	0.25	600	0.28	0.35	0.04	0.04
fixture + socket	1.35	0.30	600	0.30	0.45	0.09	0.10

Observations:

1. The socket has little effect on the response of the 50 Ω fixture. The self and mutual capacitance increase slightly. The mutual inductance increases by a small amount. The self-inductance remains constant in both cases.

2. The bandwidth of the socket was measured with a 50 Ω surrogate package. The 3 dB bandwidth is 14.3 GHz, please see page 4 of the appendix.

3. The inductive and capacitive crosstalk in a 50Ω system is shown on table 2, the associated measured data is shown on pages 1 & 2 of the appendix.

Table 2: Crosstalk limits

socket	10% inductive x-talk (GHz)	10% capacitive x-talk (GHz)
64 QFP	0.75	0.75

4. A second socket with over one million test cycles was also measured. The data was virtually identical to the new socket below 5 GHz, and within 0.5 dB for transmission over 10 GHz (please see page 5 of the appendix). The crosstalk performance was within 2 dB over 10 GHz.

Background Information:

Several types of two-port parameters are available for the characterization of electronic components. For example, for the characterization of BJTs Y and H-parameters are very useful. Z-parameters are also used extensively. These parameters require the use of **perfect** shorts and opens as standards at the measurement ports. At very high frequencies shorts and opens exhibit significant parasitics (inductance and capacitance). Therefore, Y, H and Z-parameter measurements are not valid at these frequencies.

At high frequencies a good resistor is much easier to implement than a good short or open. S-parameters (aka scattering parameters) use a resistor as their port standard. The value of this resistor is known as the port impedance. The most popular port impedance is 50 Ω (HP 8510 network analyzer).

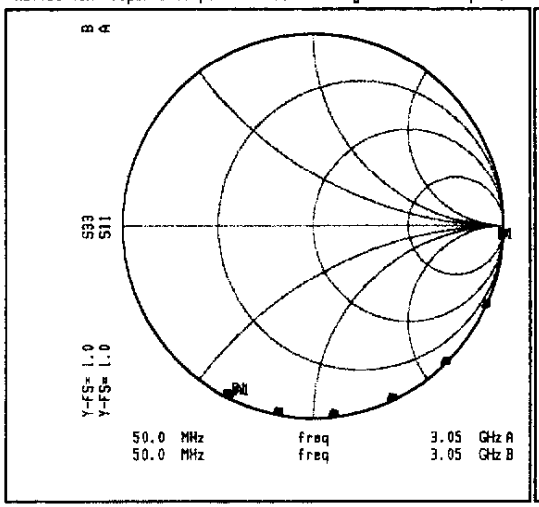
S-parameters show how voltage is distributed between the two measurement ports as a function of frequency. S_{11} is the ratio of the reflected energy to the incident energy at port 1. S_{22} is the same ratio at port 2. S_{21} is the ratio of the energy transmitted to port 2 from port 1. On a crosstalk measurement, a low number for s_{21} is desirable. On a transmission measurement, s_{21} should be as close to 0 dB as possible (i.e. all the energy is transmitted). Also s_{11} and s_{22} should be low (no energy reflected).

Appendix

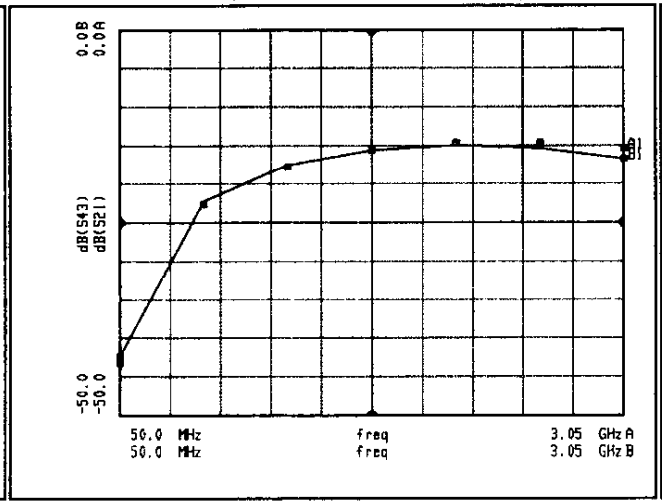
The following section shows the measured and simulated data on the 64 QFP sockets.

64QFP socket (0.5mm pitch) - open measurement

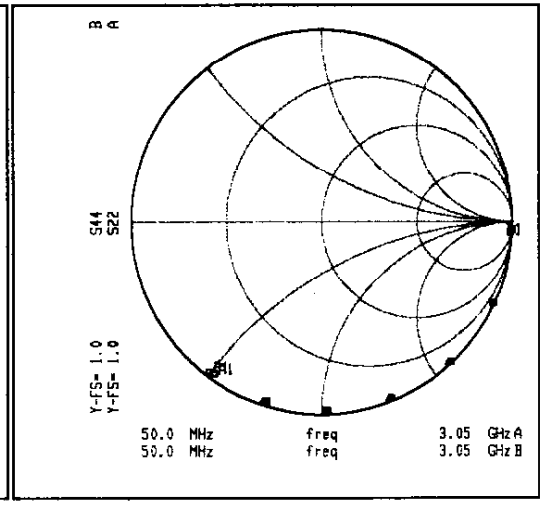
Reflection response of pin 3 - meas (triangle) vs sim (square)



Crosstalk between pins 3 & 4 - meas (solid) vs sim (square)

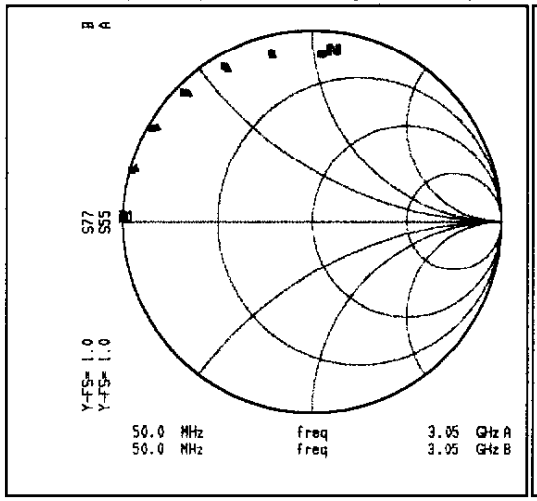


Reflection response of pin 4 - meas (triangle) vs sim (square)

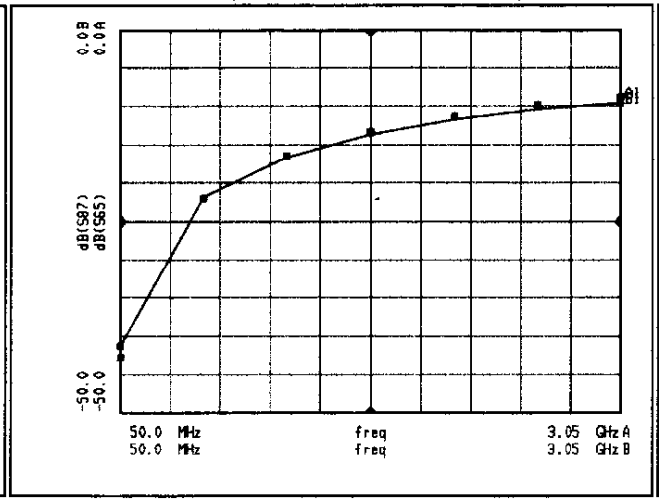


64QFP socket (0.5mm pitch) - shorted measurement

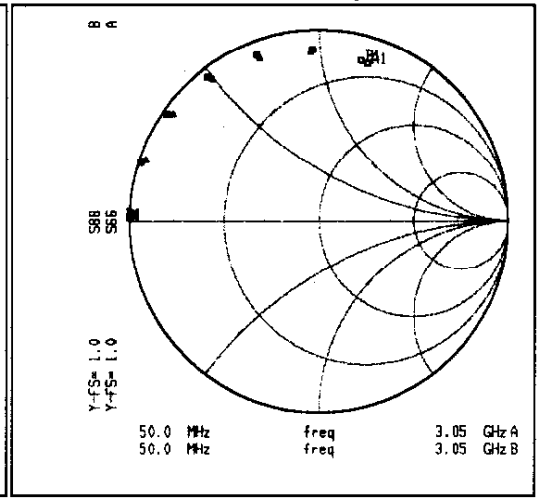
Reflection response of pin 3 - meas (triangle) vs sim (square)



Crosstalk between pins 3 & 4 - meas (solid) vs sim (square)

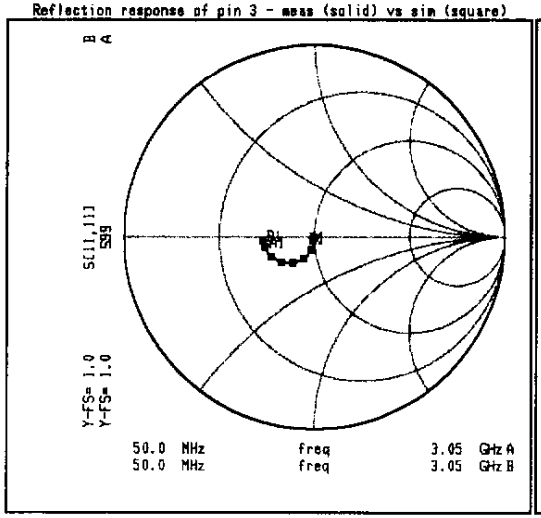


Reflection response of pin 4 - meas (triangle) vs sim (square)

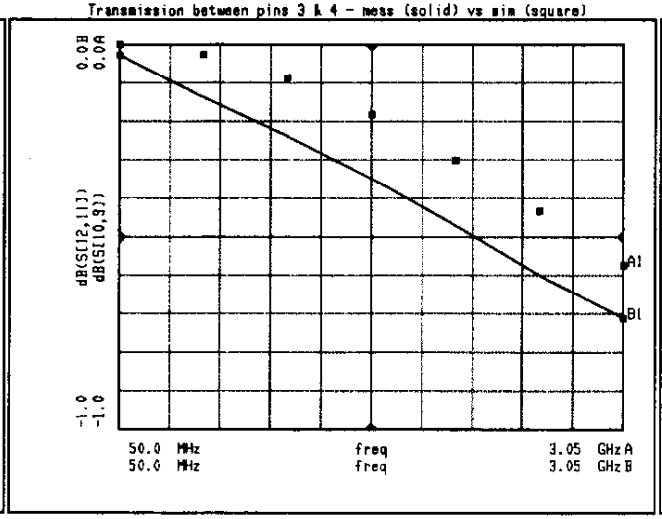


64QFP socket (0.5mm pitch) - thru measurement

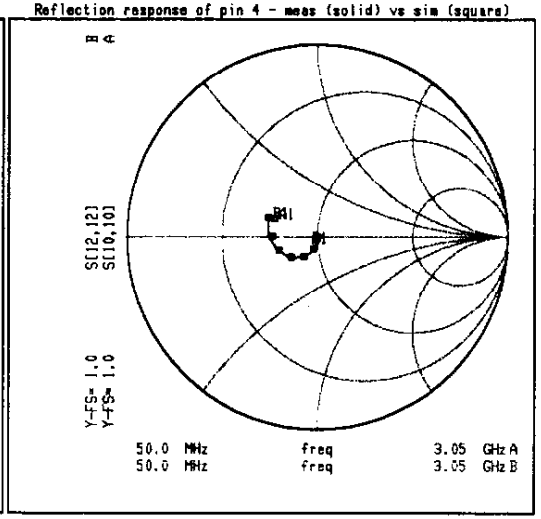
Reflection response of pin 3 - meas (solid) vs sim (square)



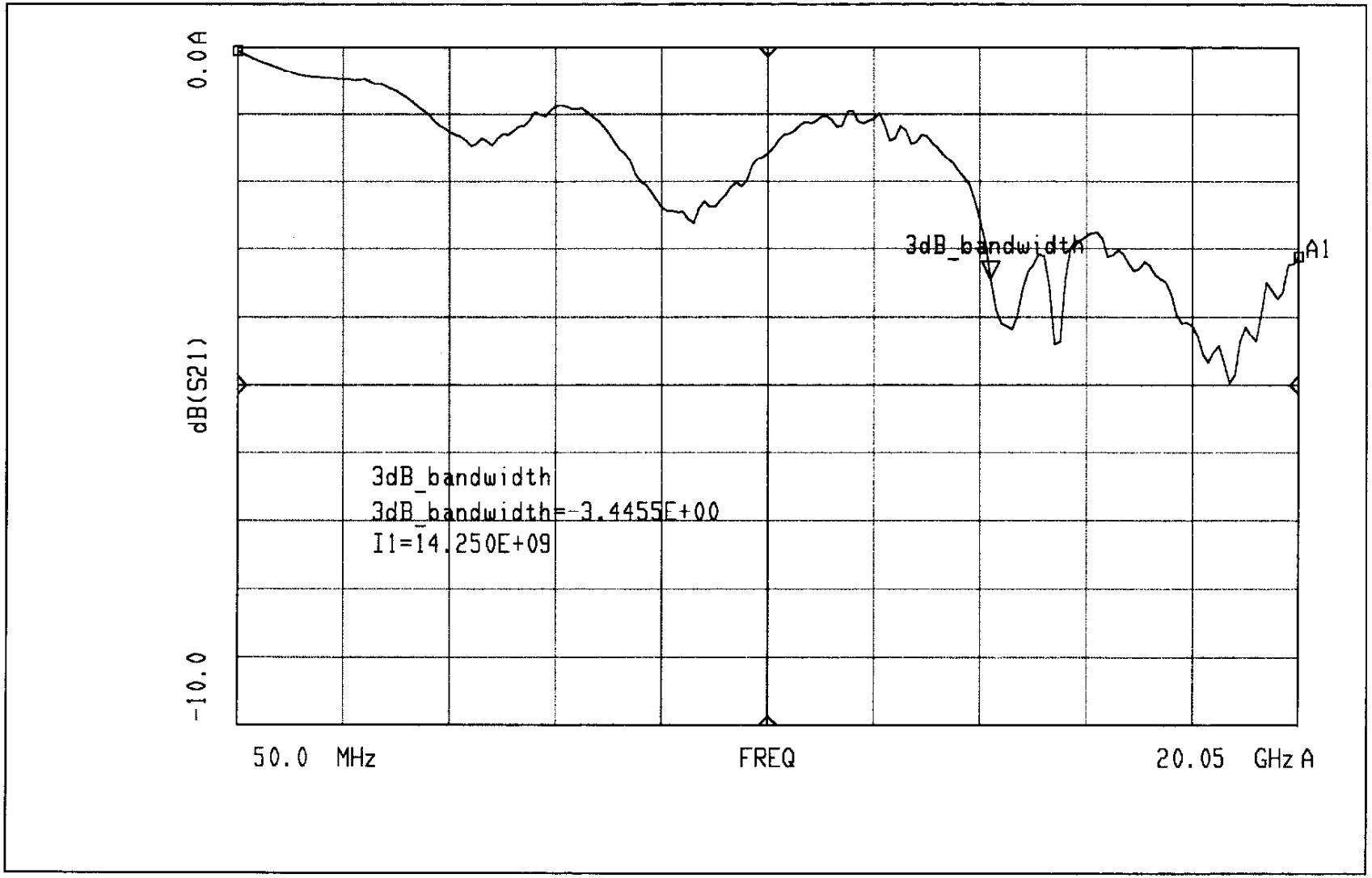
Transmission between pins 3 & 4 - meas (solid) vs sim (square)



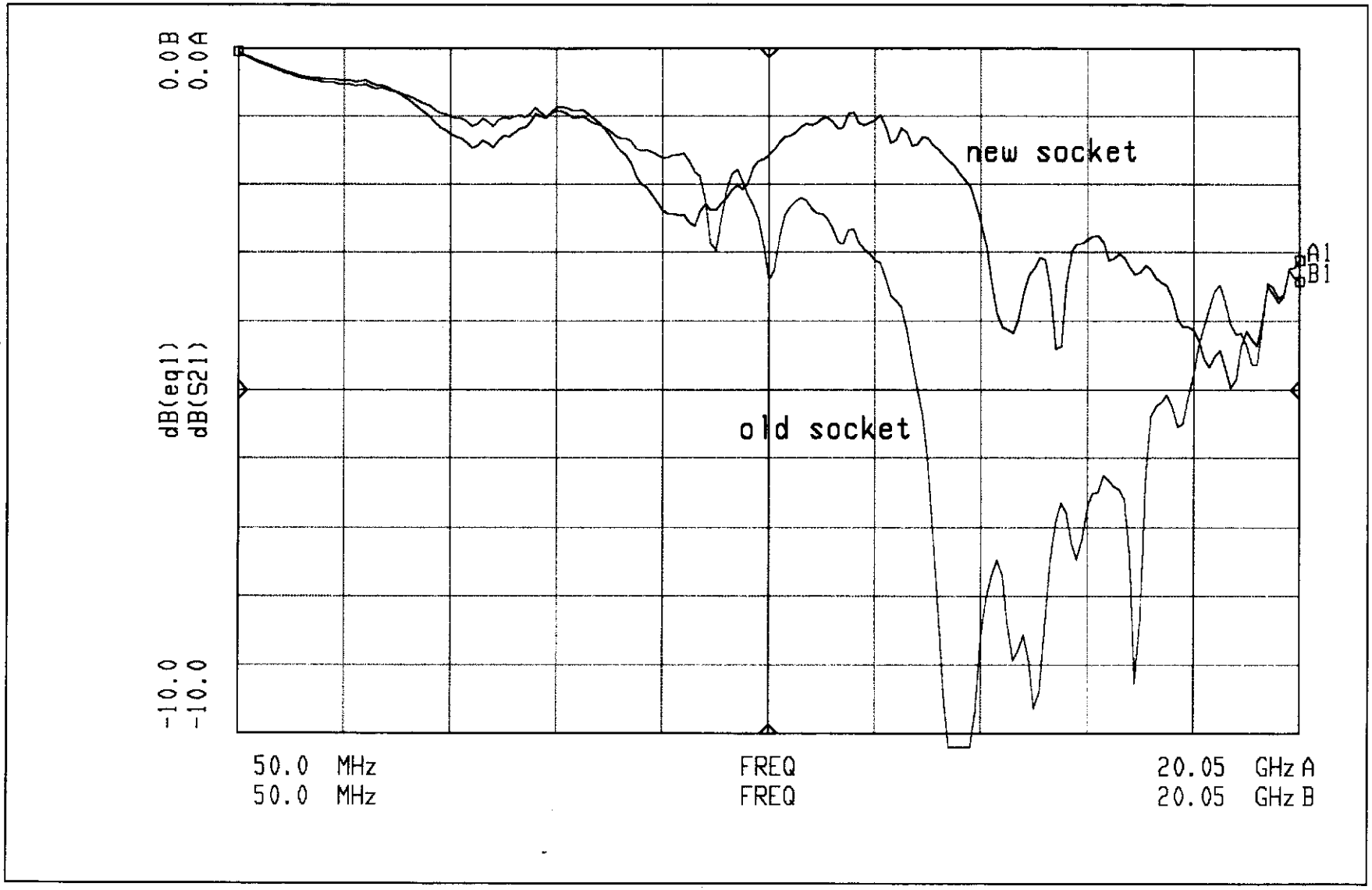
Reflection response of pin 4 - meas (solid) vs sim (square)



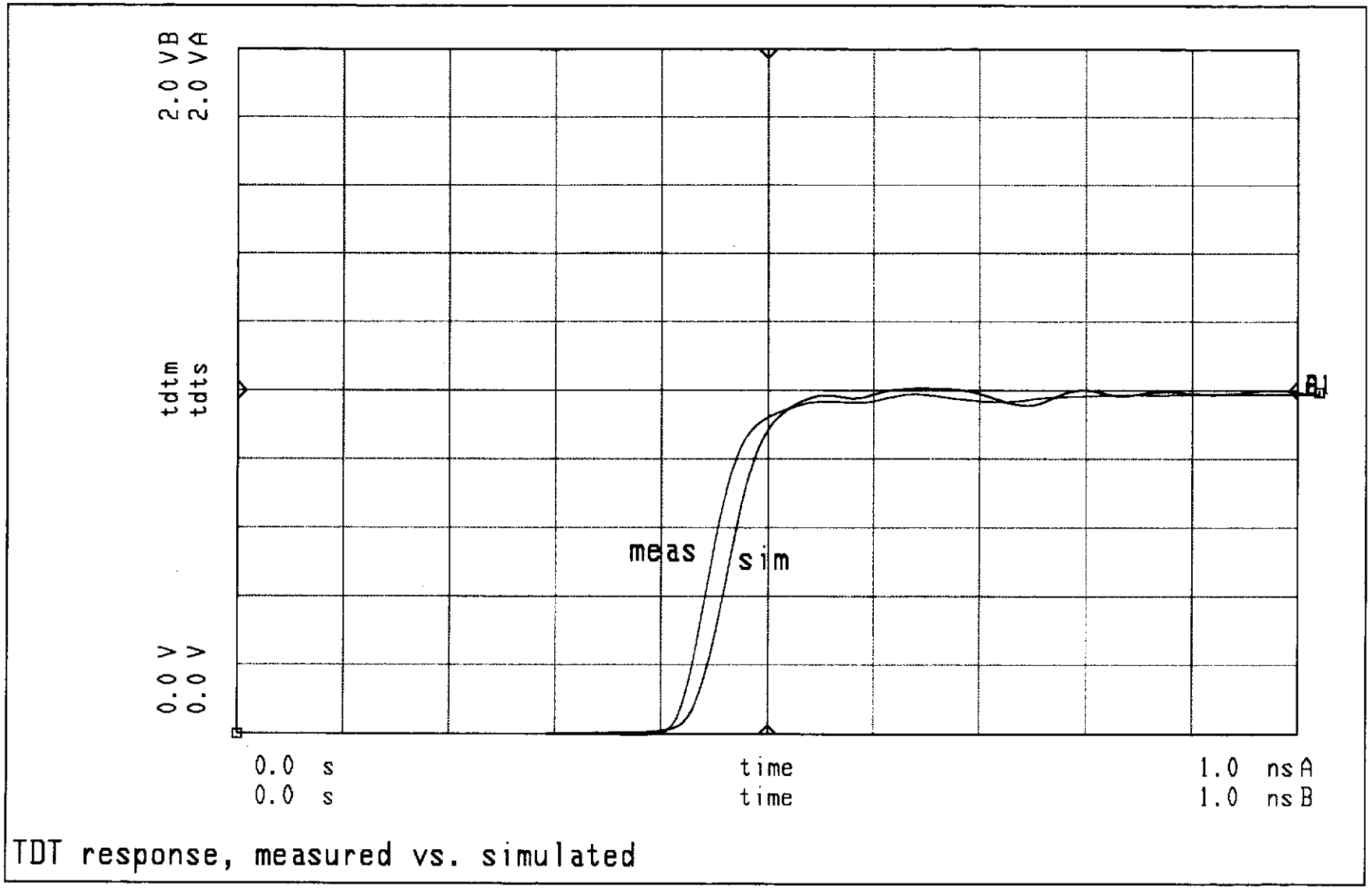
64QFP socket (0.5mm pitch) - Thru measurement



64 QFP sockets (old and new)
Thru measurement w/ 50 ohm transmission line



64QFP socket (0.5mm pitch) - Time-domain thru measurement



TDT response, measured vs. simulated