CIRCUIT DESIGN WITH DIRECT OPTIMIZATION-DRIVEN ELECTROMAGNETIC SIMULATORS
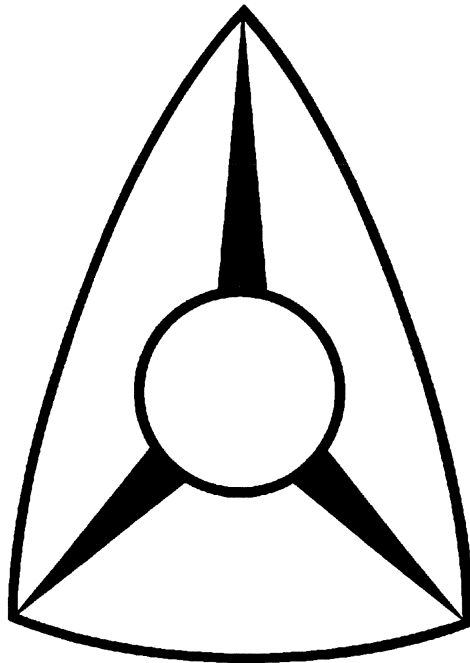
OSA-94-OS-22-V

August 22, 1994

CIRCUIT DESIGN WITH DIRECT OPTIMIZATION-DRIVEN ELECTROMAGNETIC SIMULATORS

J.W. Bandler

Optimization Systems Associates Inc.
P.O. Box 8083, Dundas, Ontario
Canada L9H 5E7

Optimization Systems Associates Inc.

Abstract

Yield-driven design is recognized as effective, not only for massively manufactured circuits, but also to ensure first-pass success in any design where the prototype development is lengthy and expensive. Recent advances in microwave CAD technology, the availability of powerful workstations and massively parallel systems, indicate the feasibility of interfacing electromagnetic (EM) simulators into optimization systems or CAD frameworks for direct application of powerful optimizers. With the increasing availability of fast, robust, commercial electromagnetic simulators it is very tempting to include them both in performance-driven and yield-driven circuit optimization. Thus, the push is to go beyond a traditional use of EM simulators for validation, for generation of equivalent circuits or look-up tables. It is to integrate EM simulations directly into the linear/nonlinear circuit design process in a manner transparent to the designer. The electromagnetic simulators, whether stand-alone or incorporated into CAD frameworks, may not realize their full potential to the designer unless they are driven by optimization routines to automatically adjust some designable parameters. This panel will address work in progress and debate computational obstacles.

Yield-Driven Circuit Design

yield-driven design is effective for massively manufactured circuits

yield-driven design is also essential to ensure first-pass success when prototypes are costly

yield-driven design is increasingly recognized by engineers and CAD vendors

Electromagnetic Simulators

recent surge of interest in electromagnetic (EM) simulation

traditional use of EM simulators:

> design validation
>
> generation of equivalent circuits
>
> generation of look-up tables

continuing advances in EM simulation technology:

> faster, more robust algorithms
>
> friendly user interface
>
> powerful workstations and massively parallel systems
>
> available and affordable commercial EM simulators

Beyond Traditional Applications of EM Simulators

to integrate EM simulations directly into the linear/nonlinear circuit design process

to make the integration of EM simulations transparent to CAD software users

to include EM simulation in CAD frameworks for automated circuit optimization

to realize the full potential of EM simulators when driven by optimization to automatically adjust designable parameters
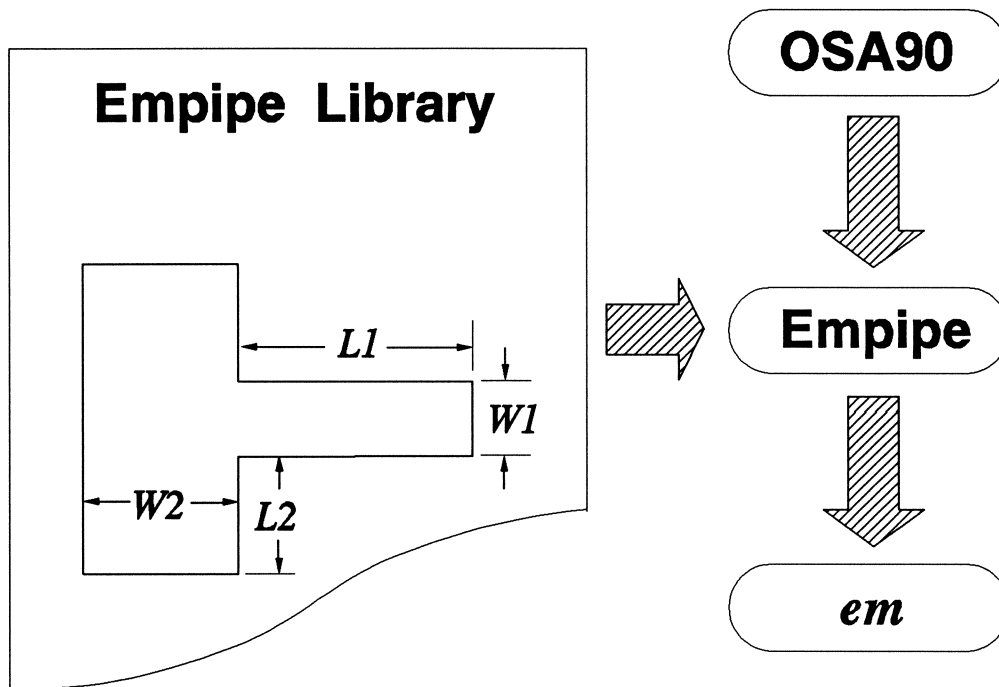
Simulation of Static Structures via Empipe

useful for analyzing circuits of mixed
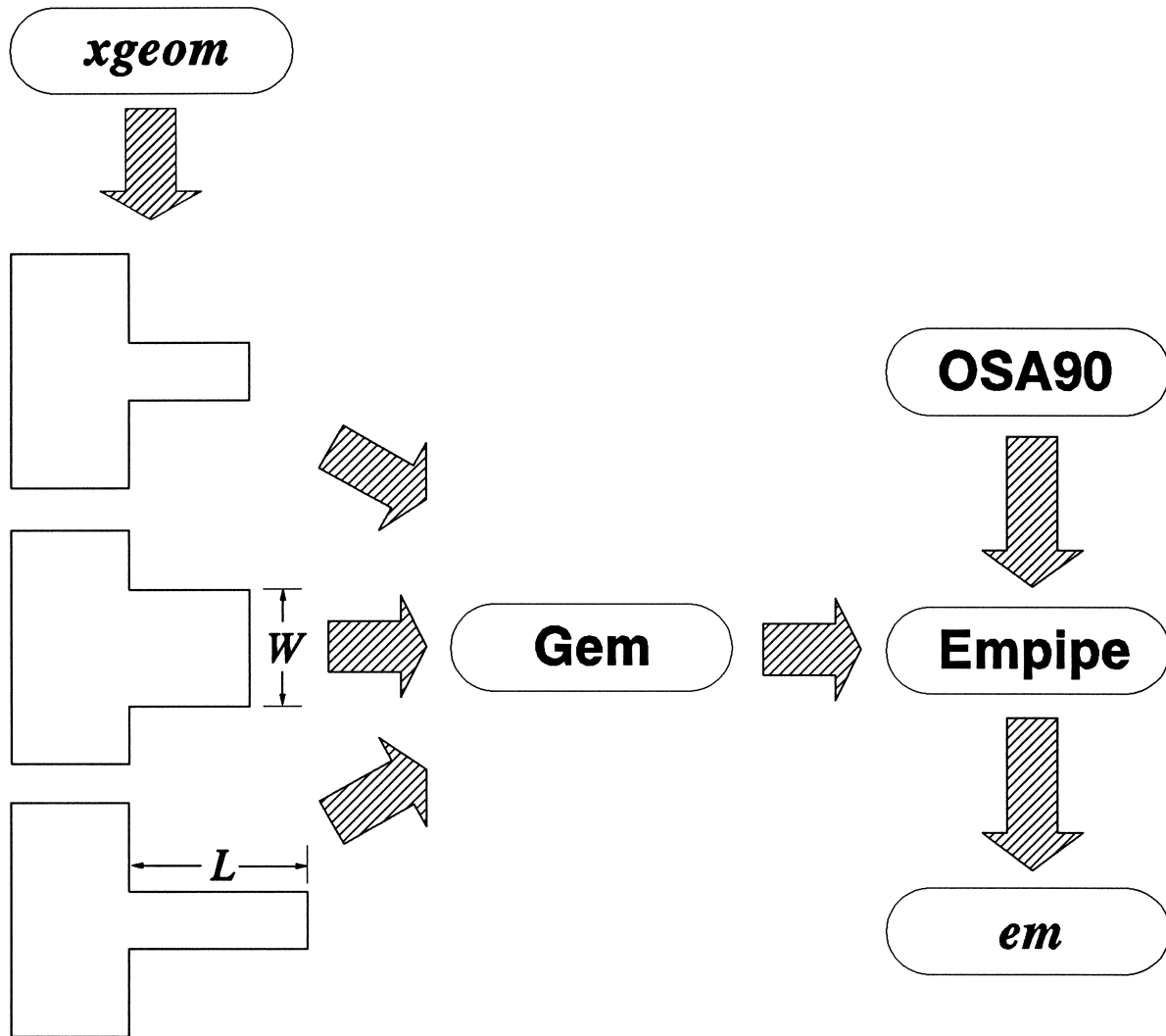EM and empirical models

unsuitable for EM optimization

Empipe Optimizable Library Structures
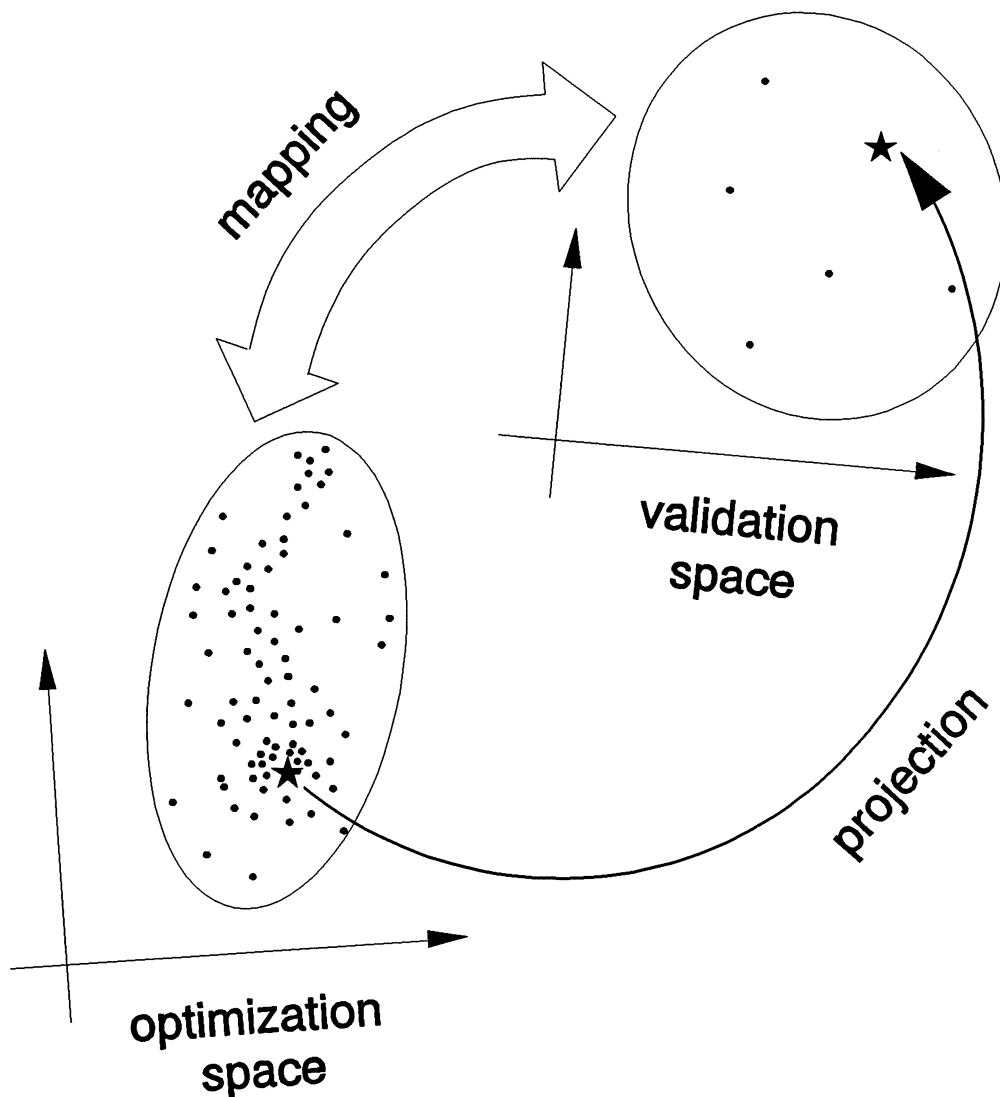
EM Optimization of Arbitrary Structures

structure parameterized for L and W

Space Mapping Optimization Technique

alignment of two models:

fast but less accurate (optimization space)
slow but more accurate (validation space)

Empipe™ Version 2.0

smart connection of OSA90/hope™ with Sonnet's *em*™ field simulator

makes EM results available for general linear/nonlinear circuit simulation and optimization, including statistical analysis and yield optimization

OSA's Geometry Capture™ provides user-parameterization of arbitrary geometries

OSA's Geometry Capture™ facilitates breakthrough optimization of arbitrary structures

with OSA90/hope™ providing a significant step towards integrated design offering

> simulation, modeling, parameter extraction
> optimization, sensitivity analysis, statistical analysis
> error analysis (probability of satisfying error specs)
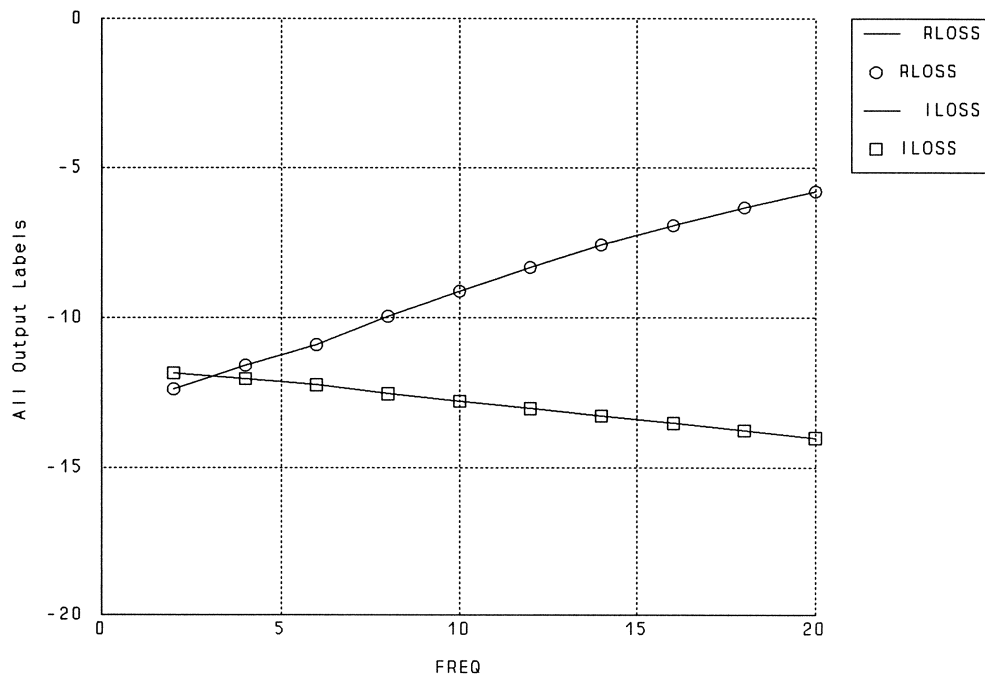> automated processing of circuit/field/measurement data
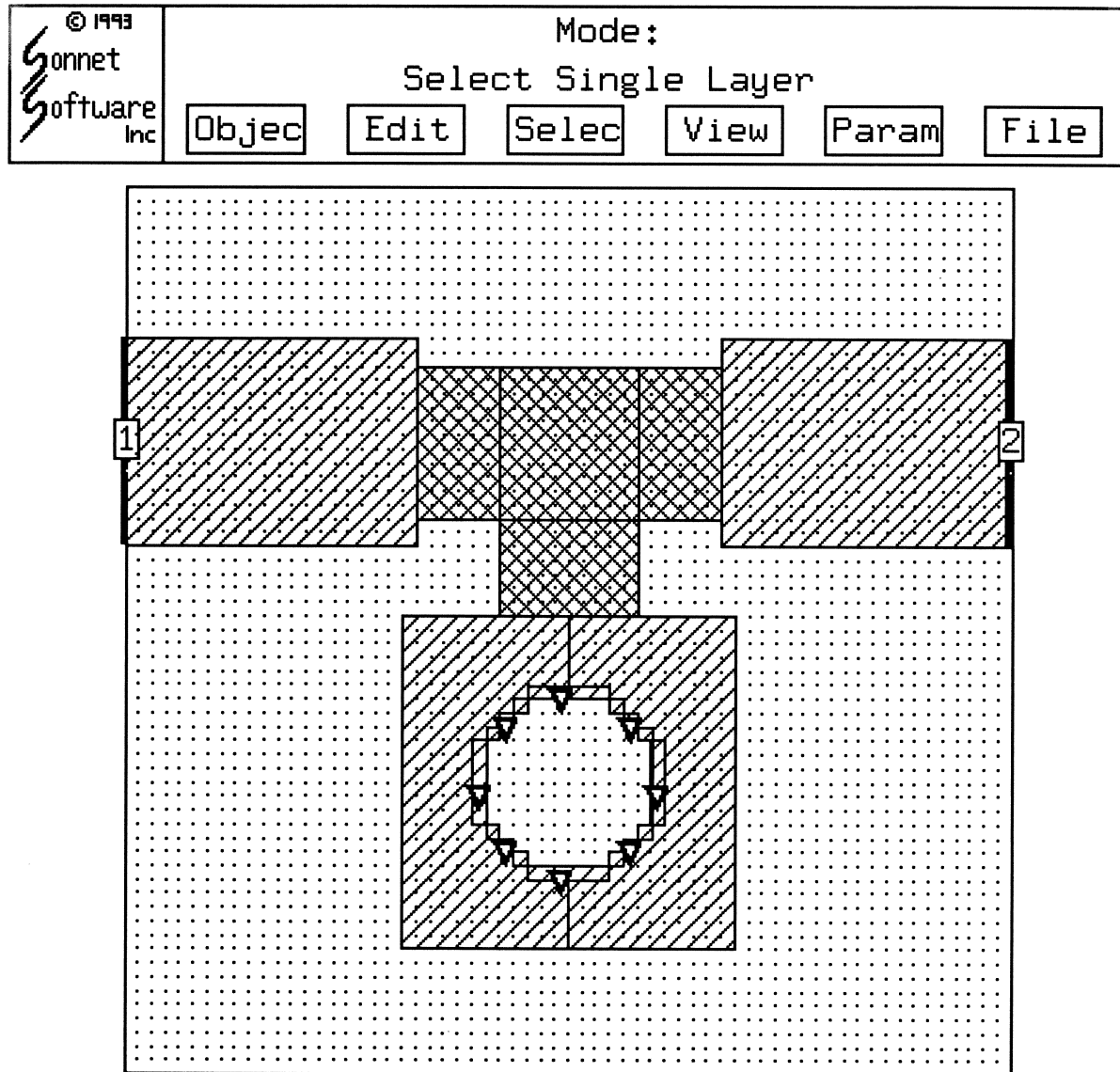
Optimization Systems Associates Inc.

Rectangular 10 dB Attenuation Pad
(*Swanson, 1994*)

four optimization variables: lengths and widths of the "tee"
resistive pad

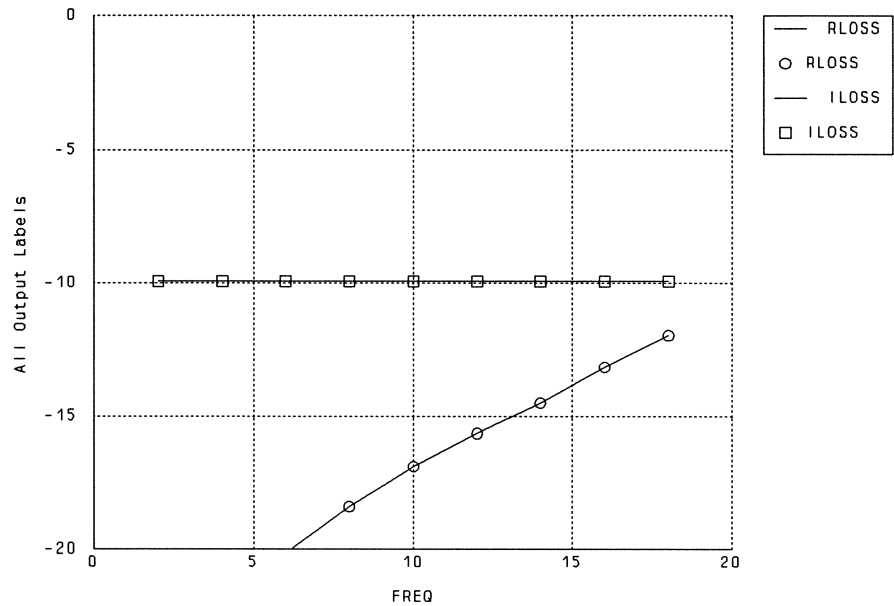## Rectangular 10 dB Attenuation Pad Before Optimization (*Swanson, 1994*)

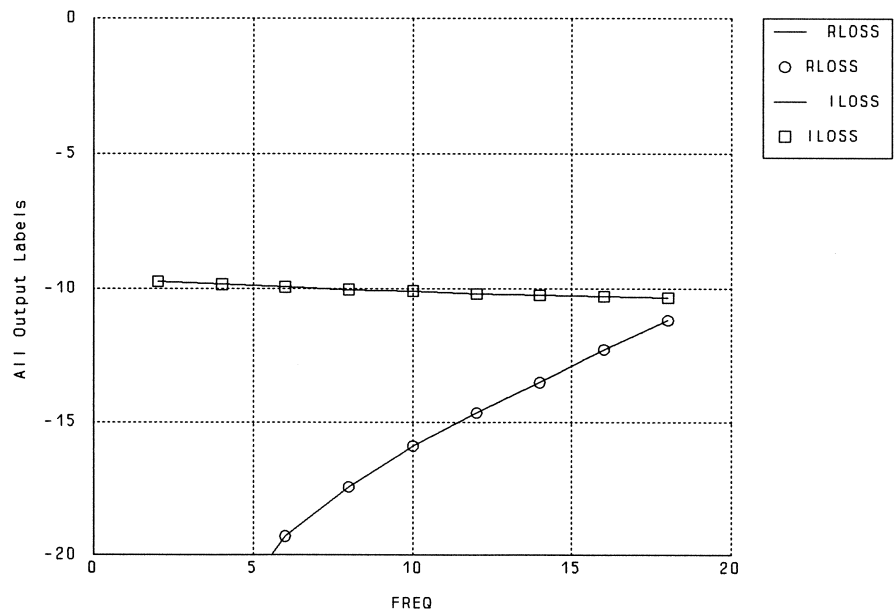specifications for frequencies from 2 GHz to 20 GHz:

9 dB < insertion loss < 11 dB
return loss > 10 dB

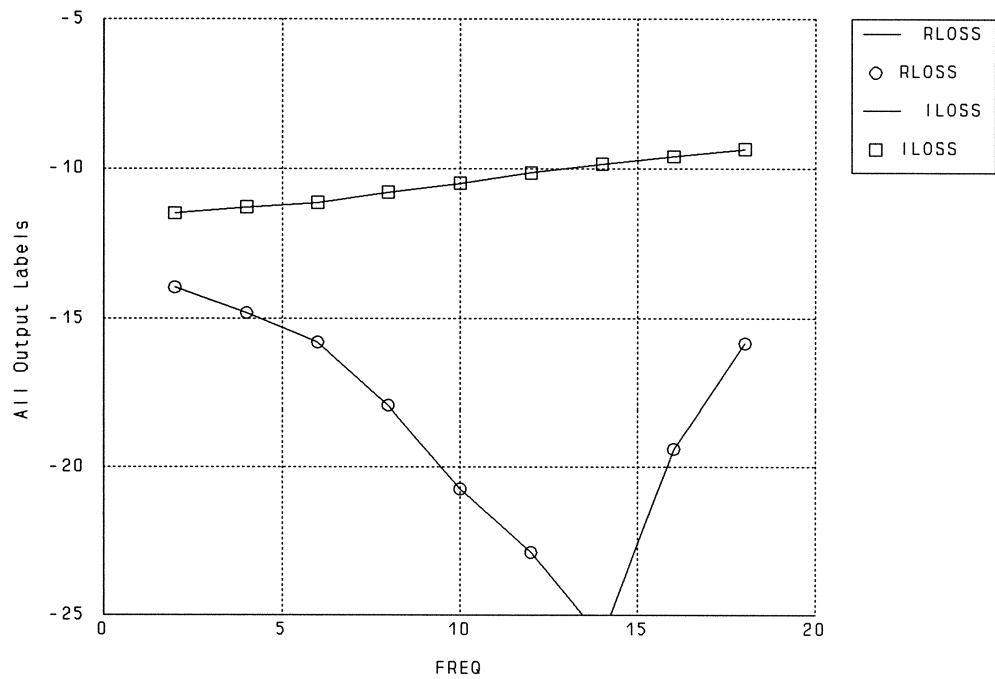# Rectangular 10 dB Attenuation Pad After Optimization

optimized solution

All Output Labels — FREQ

Legend: RLOSS, ○ RLOSS, ILOSS, □ ILOSS

optimized solution rounded to the grid

All Output Labels — FREQ

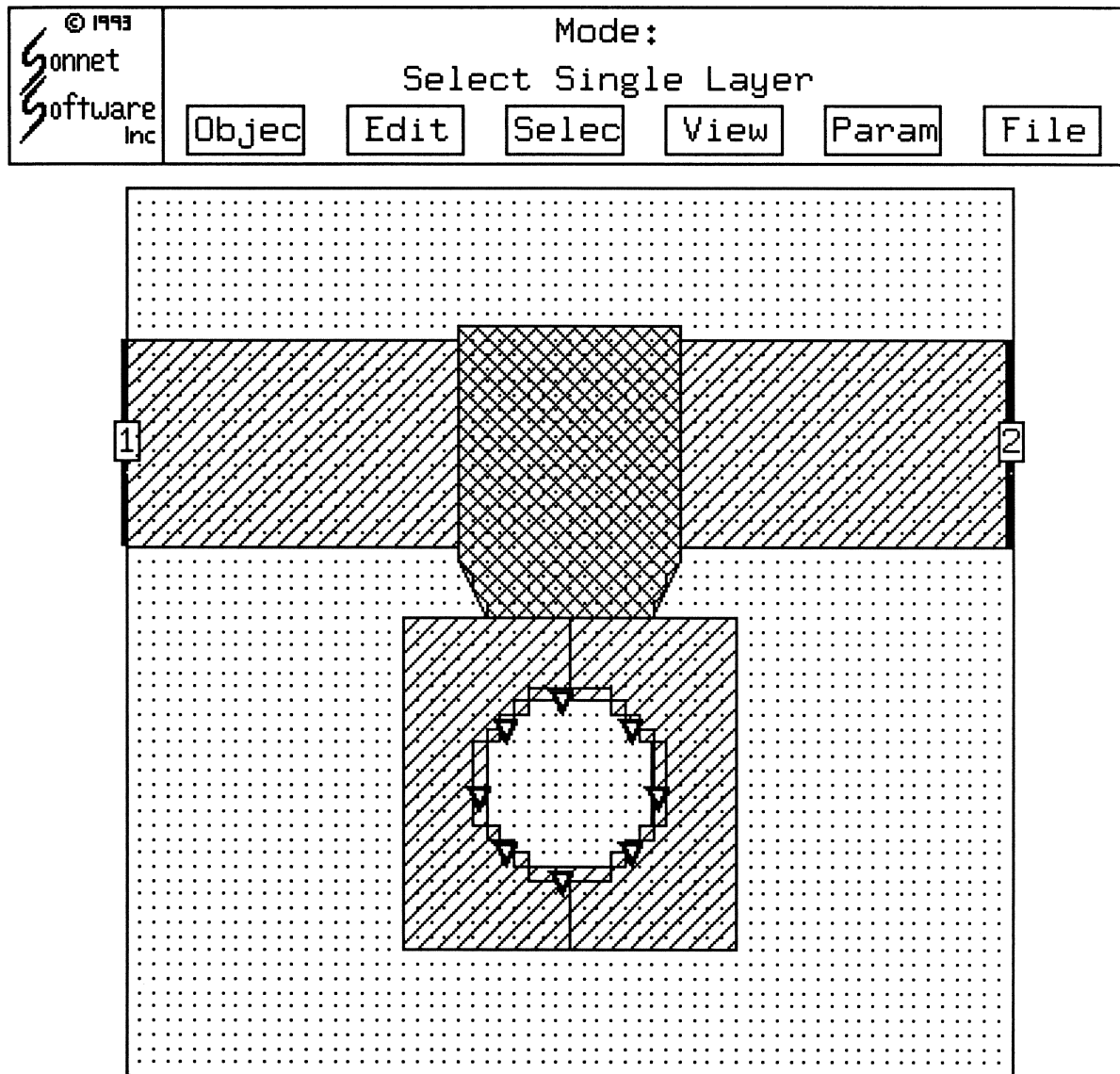Legend: RLOSS, ○ RLOSS, ILOSS, □ ILOSS

Rectangular 10 dB Attenuation Pad Optimized for Positive Gain Slope
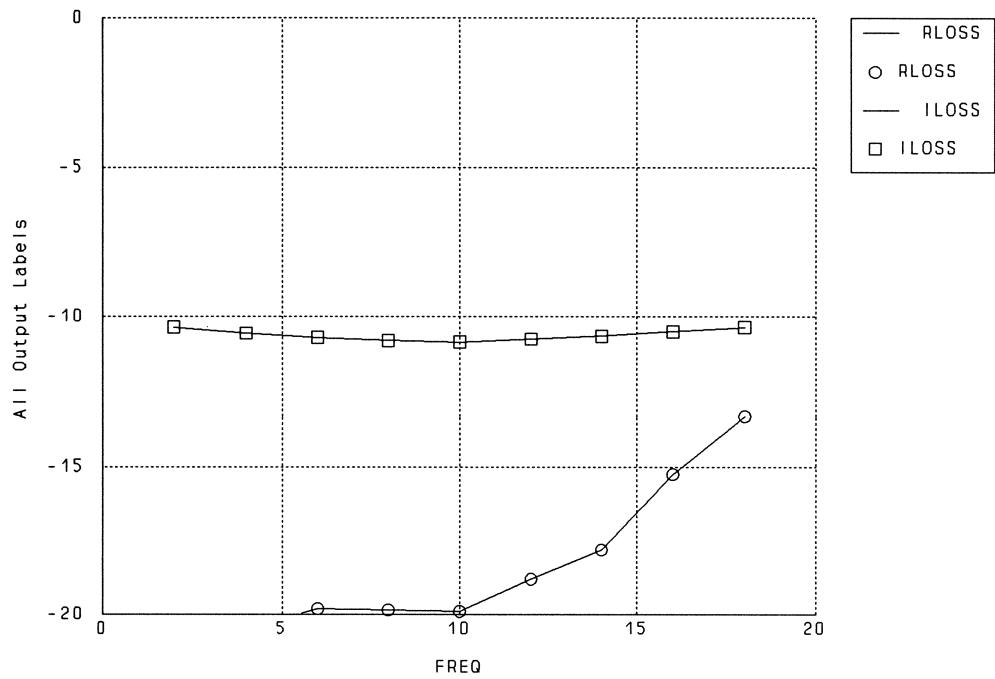
Trapezoidal 10 dB Attenuation Pad
(*Swanson, 1994*)

four optimization variables: dimensions of the trapezoidal "tee" resistive pad
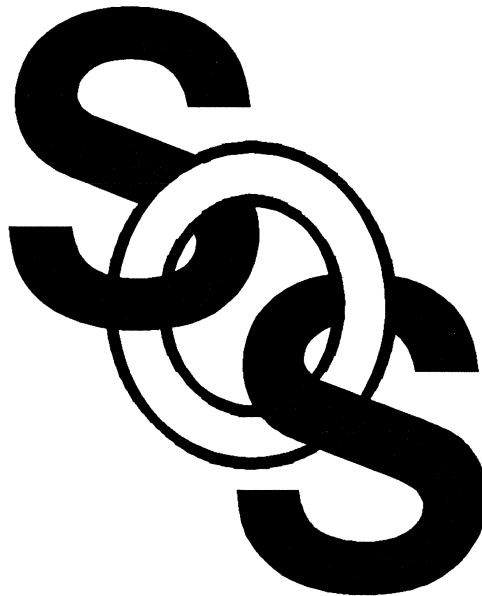
Trapezoidal 10 dB Attenuation Pad After Optimization

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Simulation Optimization Systems Research Laboratory
and Department of Electrical and Computer Engineering
McMaster University, Hamilton, Canada L8S 4L7

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Simulation Optimization Systems
McMaster University

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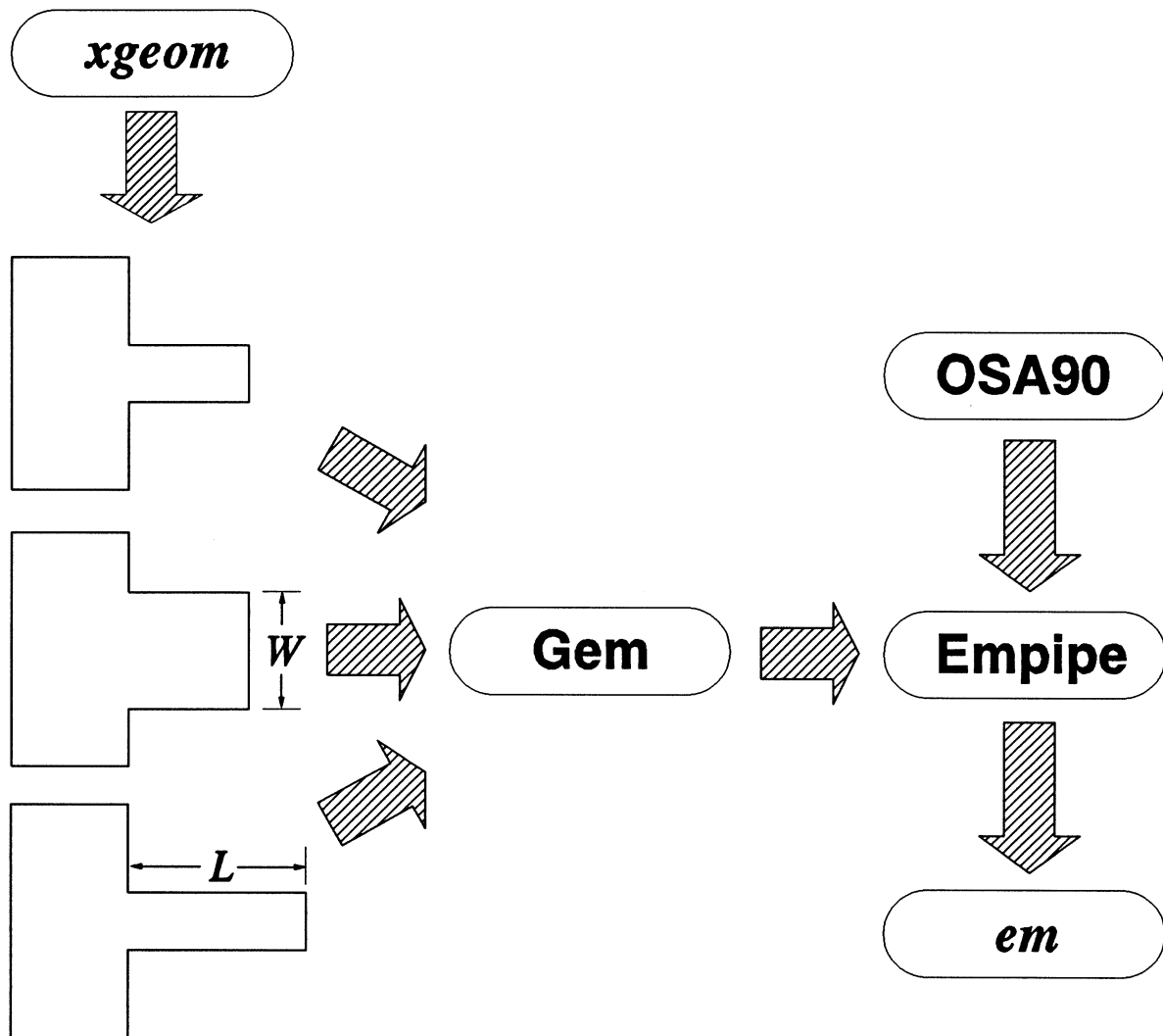EM and empirical models

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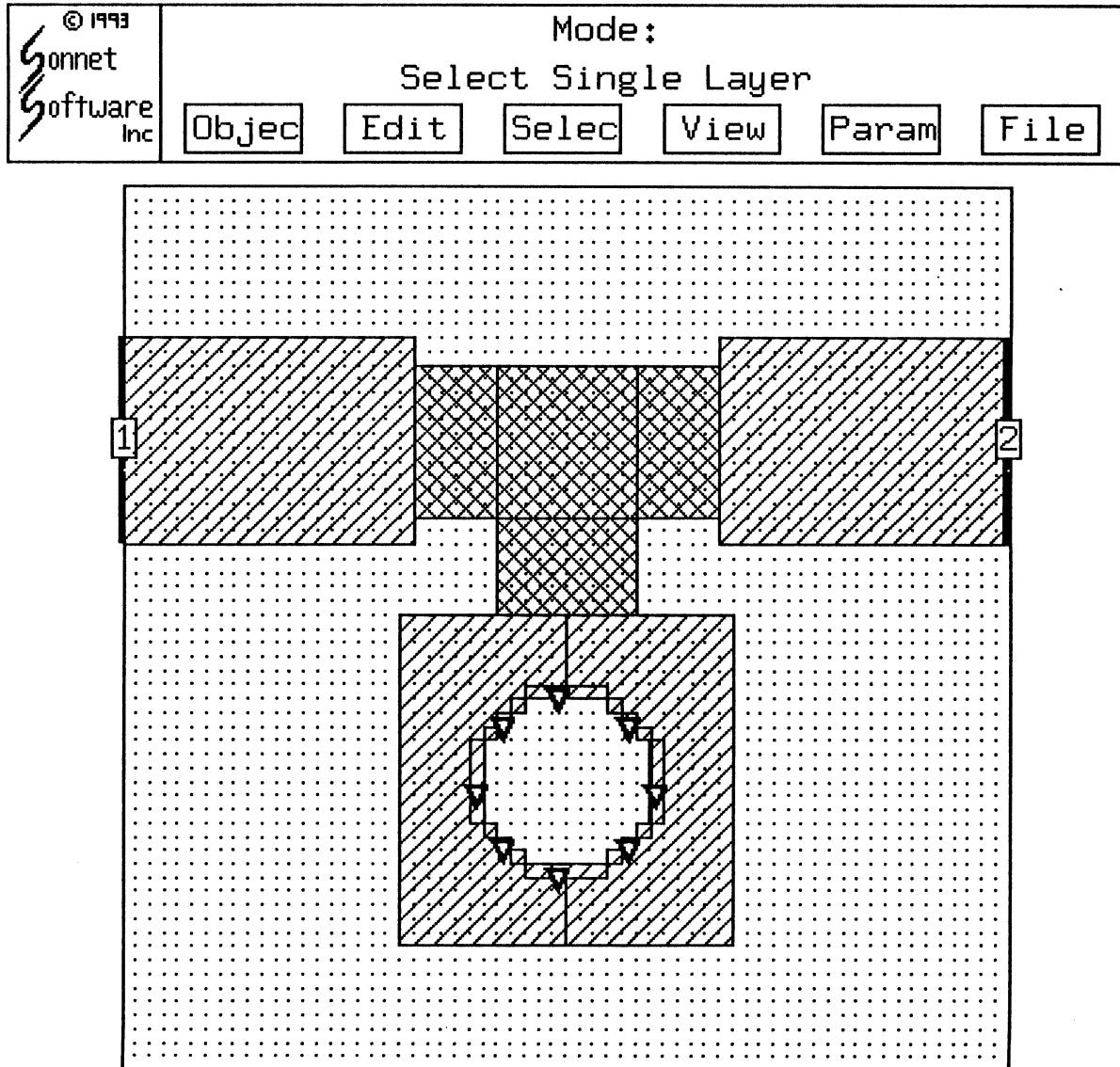
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L

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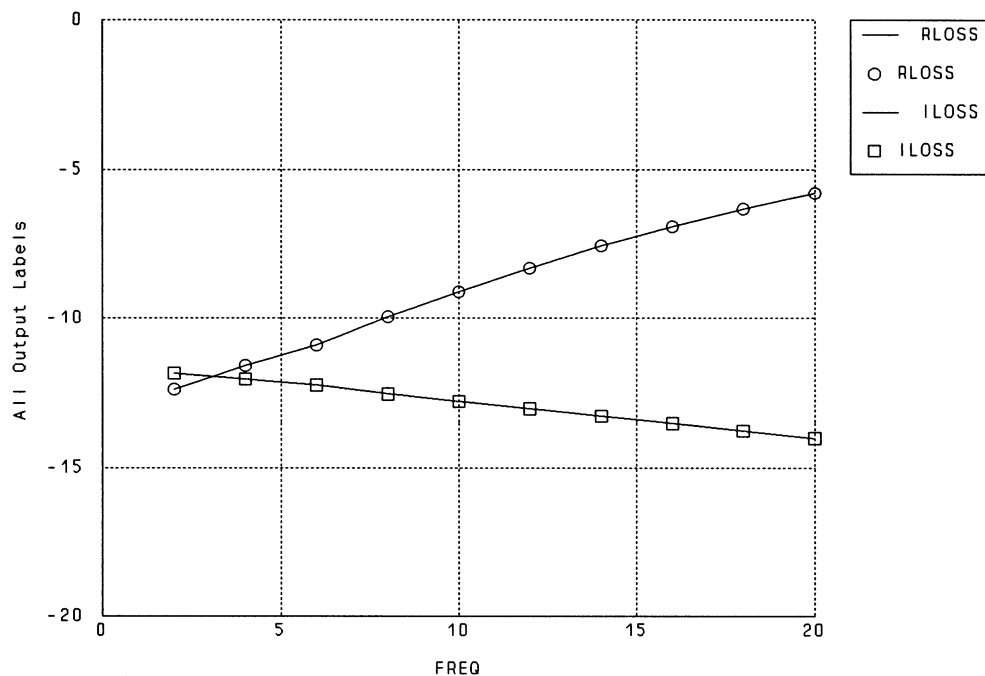
OSA90

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em

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Rectangular 10dB Attenuation Pad
(*Swanson, 1994*)

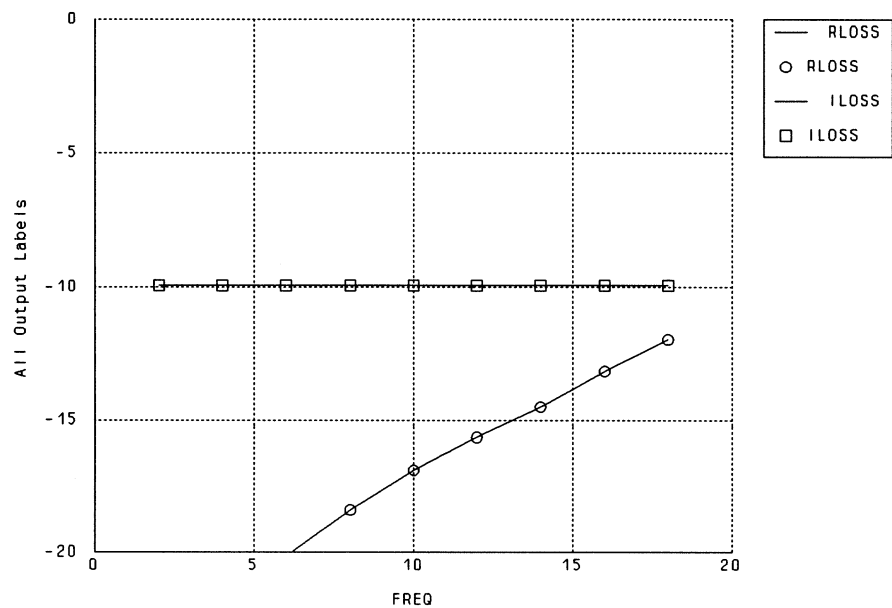four optimization variables: lengths and widths of the "tee" resistive pad

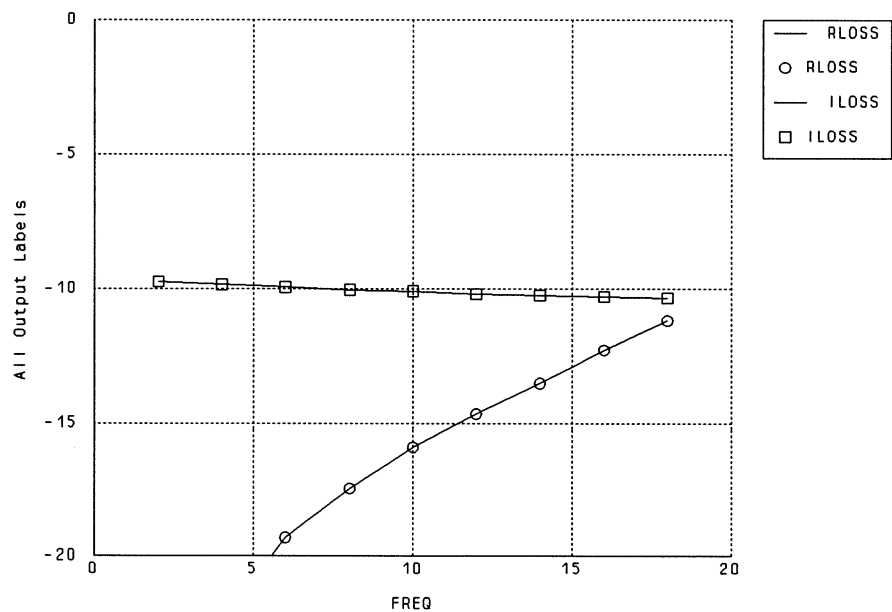## Rectangular 10dB Attenuation Pad Before Optimization (*Swanson, 1994*)

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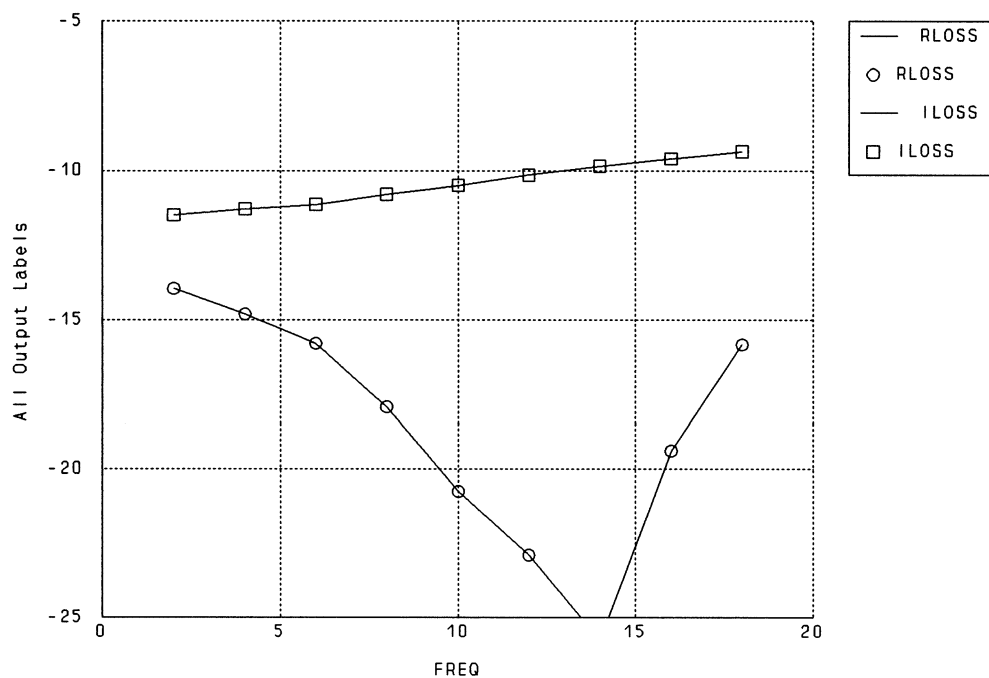
optimized solution

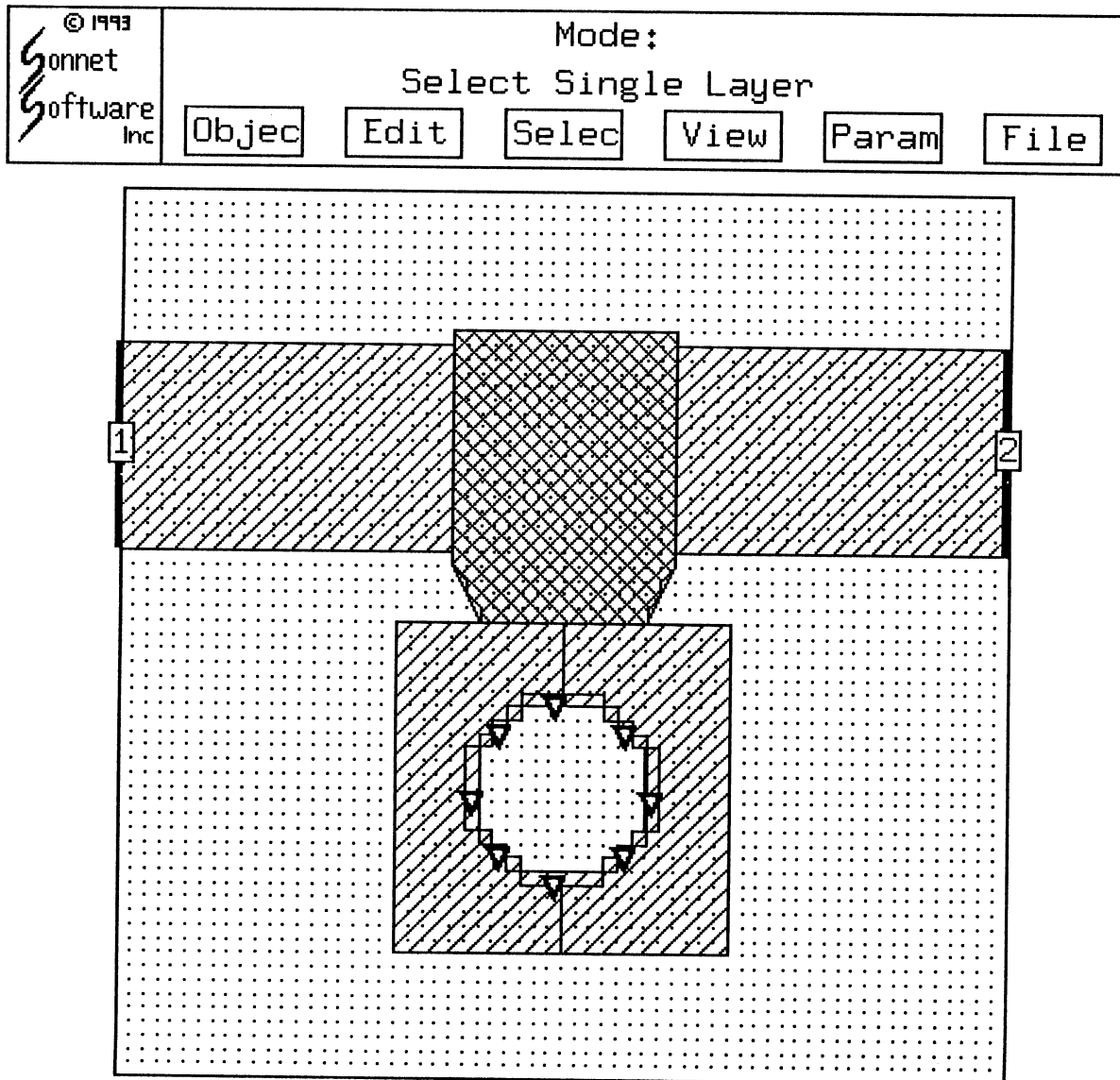## optimized solution rounded to the grid

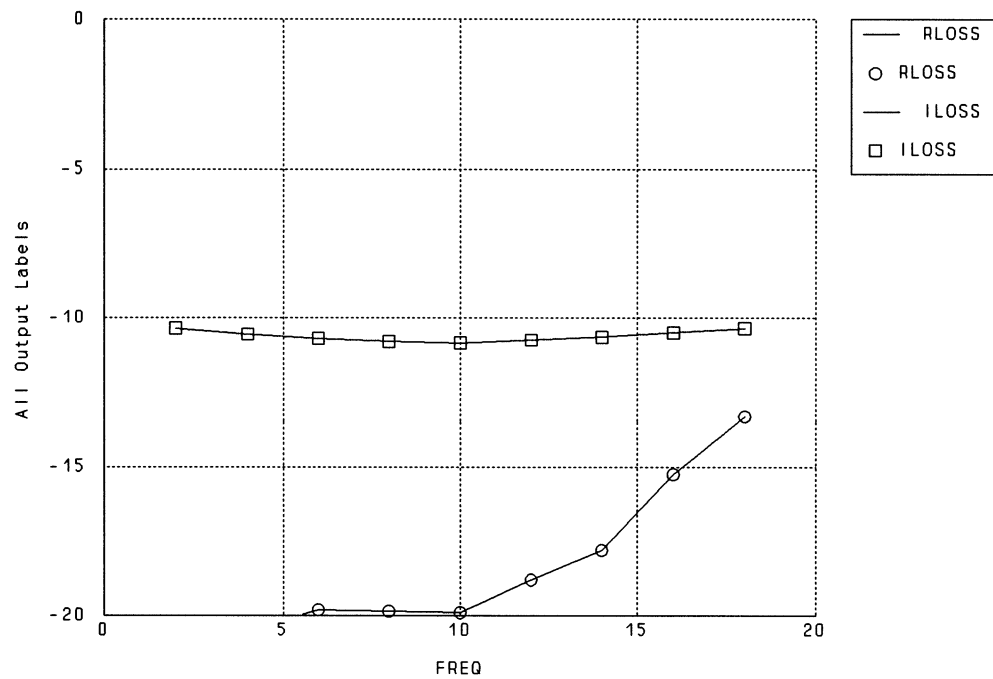# Rectangular 10dB Attenuation Pad Optimized for Positive Gain Slop

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