Section 1
A Collection of Thoughts, Tips and Techniques for Microwave Circuit Design

by

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November 2020

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Hello, my name is Bob Eisenhart.

This set of 8 sections was taken from a day long seminar presented to companies and universities as lecture/discussion. I have modified some pages and the full presentation by including notes to make this collection of topics stand-alone, removing any need for discussion with the presenter. With some of the subjects this may be a stretch, however, I hope you still feel it a worthwhile review.

Unfortunately, all the animation within the pages is “frozen” in the .pdf format.

If you have a question, feel free to write me at R.L.Eisenhart@ieee.org.

Quick Introduction

What do I have to offer? → **Experience**

This "Collection" will present a short review of the design process by discussion and showing some examples. These will be aimed at fundamental understanding of a wide variety of microwave circuits, components and antennas that I have had in over a 50 year career in University, Aerospace and Consulting.

I'll be discussing the design of microwave circuits/antennas.
Some of the techniques discussed would require the use of an Electromagnetic Simulator Computer Program as a tool, however, that is not a prerequisite to benefit from the presentation. The software is not used directly and most of the pages are self sufficient for the discussion.

So, let's get started.

Who is the Audience?

- Prepared for those having some basic familiarity with microwave circuits -

Most of the material is pretty basic, often with a little different perspective, so everyone should be able to get something out of it.

A quick review of the topics

Sections Contents

The subject matter falls into 7 basic sections, plus one complex design section which I'll use to tie it all together.

1 - After this Introduction, I'll focus first on
2 - Transmission lines and how to connect them together.
3 - Then, we'll look at some Planar Circuits issues.
4 – Next on to Waveguide Circuits,
5 – Following is a section on Antenna single Elements.
6 – Then shift into Antenna Arrays, a bit on all sizes.
7 - The Extraneous Items section has some things that didn't quite fit in the others.
8 - I'll finish up reviewing a full Antenna System Design, using all the parts.

So let's talk about the design process.

Design Process

What are the steps in the design process?

1. **Set Requirements** → Concept → Drawings → Fab Parts → Assemble → Test → Iterate → Solution

Requirements Examples

Given	- What does it do?	- Port Configuration
	- Operation frequency	- Weight limits
	- Size (3 dimensional constraints)	
Desired	- Input Match (S_{11})	- Transmission Loss (S_{12})
	- Power handling (Voltage Breakdown)	
	- Affordable /Producible /Maintainable /Reliable	
	- Frequency Bandwidth	
Program	- Cost	- Schedule

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Designing is all about answering questions. Why this, why that, what's the best way? Performance vs. cost vs. schedule vs. size vs. manufacturing vs. etc. The process hasn't changed, just the tools.

Set Requirements –

There's the whole step by step process.

1 - However, now consider the shaded area as a "Virtual Laboratory" replacing the **Drawings to Solution** sequence with a computer.

Project Parameters

You have to know what you want to do and all the conditions on the job.

Consider all the examples that have to be met.

How to do it?

Design Steps (cont'd)

2. **Come up with a Concept**
   - Typically start with an earlier design and make improvements

3. **Break down** concept into definable problem areas and isolate the truly tough issues. Continue with characterization of each area and address separately in the design

4. **Finalize Prototype design and Fabricate**
   - Prototyping is still typically done but with high "first - pass" success

5. **Iterate design as needed** (as requirements firm up?)

Now the work begins. What to build?

2. We need a concept or approach. This is your opportunity to be innovative.

3 -5 steps forward. Sounds straight forward enough. Today most of this can be done on a computer.

Computers also allow breaking the project down into smaller sections and focusing on each part individually before putting all the parts back together for a full component checkout.

To design a microwave circuit you need to understand the parts you're going to work with. Let's start out by considering transmission lines in Section 2.

Quality is never an accident,

it's a result.

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Something to remember when running a project.