THE 3-D OSCILLOSCOPE:
A Practical Manual and Guide

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ABOUT THE AUTHOR

The author's work in 3-D CRT displays began in 1949 with the independent conception, design, and construction of an oscilloscope to generate stereo images on a pair of type 3JP1 CRTs. The early success served as an impetus to continue this work, first reported in the literature in 1966.[1]

A monocular 3-D display developed by the author was marketed by Optical Electronics, Inc., beginning in 1965. This is

[1]Tilton, H. B., "3-D Display," *Instruments and Control Systems*, Aug. 1966, pp. 83–85.

the *scenoscope*—so-called because it produces scenographic (perspective) projections as do today's computer-generated 3-D displays. The scenoscope uses all-analog circuitry as opposed to the mostly digital circuitry used with the bulk of today's computer-generated displays. The scenoscope is noteworthy for that reason; for its early appearance on the scene; and because it implements a large number of depth cues—typically four or more depending on the model.

In one scenoscope model, the observer is tracked and the resulting position information is used to modify the CRT image so that he can "look around" displayed 3-D visual objects.

From 1968, the parallactiscope 3-D oscilloscope became the focus of the author's 3-D CRT work. Descriptions of the design, construction, and use of a practical laboratory parallactiscope form the subject matter of the bulk of this volume.

This author has also written a book *WAVEFORMS: A Modern Guide to Nonsinusoidal Waves and Nonlinear Processes* for Prentice-Hall published in 1986.

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Also acknowledged for stimulating conversations on 3-D and related subjects are James Butterfield (in memoriam), John Caulfield, Robert Collender, David Goodman, Bruce Lane, Lowell Noble, and especially Bill Greenwood.

DEDICATION

This book is dedicated to all those pioneers of the past, present, and future engaged in the pursuit of the third dimension.

WELCOME TO THE WORLD OF 3-D OSCILLOGRAPHY!

This book is a practical guide that takes you into another dimension of oscillography. It chronicles the path of researchers' efforts that led to the present state of oscillography. It then shows you how to adapt your own standard oscilloscope to produce three-dimensional *holoform* (hologram-like) images, and how to use 3-D oscillography in solving a wide range of problems, in Chapters 13 and 14. These "problems" come in basically two categories: displays that allow you to analyze the operation of a device or system, and displays that synthesize a particular desired space curve or surface for study or educational purposes.

Examples of the first category are:

- Three-dimensional "waveforms" that show the current and voltage characteristics of a diode or other device versus time;
- Surfaces which are characteristic of devices requiring three variables to characterize them—an example is the saddle-shaped surface characteristic of analog-multiplier operation;
- Medical uses such as the display of vectorcardiograms (VCGs).

Examples of the second category include classic surfaces of solid geometry such as:

- Helixes, including the double helix of DNA
- Cones of two nappes
- Spheres, spheroids, and ellipsoids
- Conoids—a surprising surface "discovered" by use of a 3-D oscilloscope
- Hyperbolic paraboloids, and more

However, the "problem" that may be most exciting to solve could well be one of those discussed in Chapter 16:

- All-electronic real-time holoform displays
- Holoform TV, movies
- Computer-generated holoform 3-D, and so on

As one anonymous reviewer eloquently put it, "Fame and fortune await the one who finds out how to apply this (holoform) principle to consumer electronics." The book is designed to set you on a course in hot pursuit of these goals.

The book pinpoints key factors leading to the development of practical 3-D displays on cathode-ray tube screens. It begins with the invention of the cathode-ray tube screens and ends with a list of challenges for you.

The central focus is the detailing of steps by which you can build your own 3-D oscilloscopes; starting with a stereoscopic oscilloscope (stereo oscilloscope) and culminating with a parallactic oscilloscope called "parallactiscope." The parallactiscope produces real-time holoform images having the dramatic depth cues of stereo and movement parallax; the latter allows you to "see around" displayed images simply by moving to one side as you would with a hologram or a real object.

The parallactiscope differs from moving-mirror displays in that it produces a controlled parallax by "reconstructing" light-ray directions as does a hologram. Holograms use wavefront interference to that end; parallactiscopes use a direction-sensitive "spatial" filter. Thus, parallactiscope images are holoform whereas moving-mirror images are not. The differences have a practical significance, which is explained in Chapters 2 and 5.

You will not be building an oscilloscope, nor will you be modifying one. You will simply be constructing subassemblies that will enable your oscilloscope to produce three-dimensional spatial images. Only hand tools are required, and no exotic parts or materials are needed. Photographs and diagrams guide you through the construction process.

"Multiscopic" photo sequences of 3-D displays are given (primarily in Chapters 13 and 14). These are static representations of the dynamic patterns you will see when you build and operate your own parallactiscope. The book tells you how those displays were generated, so you can produce them for "live" viewing on your own 3-D oscilloscope. To see stereo in the photos in this book you may need a stereoscope; but to experience hologram-like sensations with live parallactiscope displays, all you need are two eyes. Even if you close one eye, you can still "see around behind" the live parallactiscope images simply by moving left or right.

Applications for the parallactiscope certainly exist not only in the engineering fields, but also in the optical, biological, medical, and even the psychological sciences—as well as in pictorial art.

In summary, this book is concerned with the developing science and art of spatial imaging as it pertains to real-time CRT displays. The book is designed to set you on a course in the

direction of accomplishment of one or more of the "blue-sky" projects described in the final chapter.

Set your sights high; for time and again, it has been found that the limits we encounter are limits that we, ourselves, have set!

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