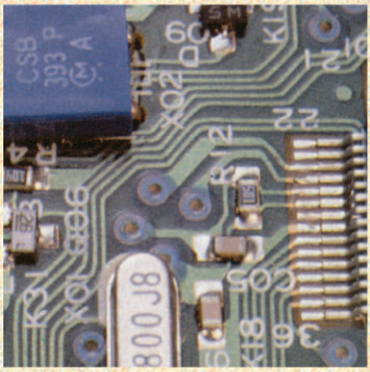
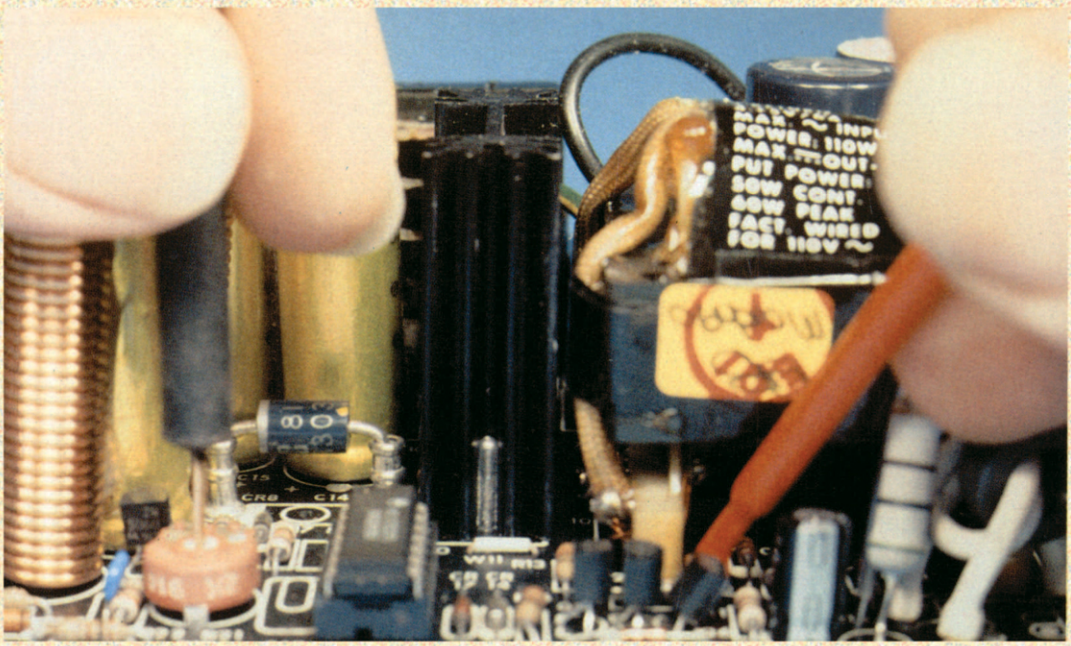
Practical Electronic Fault Finding and Troubleshooting





ROBIN PAIN

PRACTICAL ELECTRONIC FAULT FINDING AND TROUBLESHOOTING

To Mouse, Mike and Quentin

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Preface

Fault finding is a peculiar art that is not easy to categorize. I feel the reason for the popularity of the term 'trouble shooting' is something to do with shooting first and asking the questions later (if at all). As Professor C. Northcote Parkinson said:

> The English are content with diagnosis and are surprised by a request for the cure while the French are concerned only with the cure, happy to leave the diagnosis until afterwards (if at all) . . . the English method is unquestionably more scientific.

While this book is written in the spirit of the English method, its origin, and perhaps its appeal, are 'French'.

Fault finding is an awfully effective way to learn electronics, because it gets to you like nothing else can. It forces you to think inventively but act logically; to harbour fantasy but banish prejudice. What do you remember about your electronics or computing course? What really sticks in your mind?

Evidently the way to becoming a good fault finder is to fix a lot of faults, not to read a book about how to fix faults. I calculated that a lot of set mathematical exercises would be good exam practice but not necessarily apropos intuitive fault finding. (If you are already on a course then you will have plenty of text books with exercises.) It seemed to me that the book should concentrate, as entertainingly as possible, on one simple theme, i.e. the 'variety within unity principle'.

Anyway that was the general idea; I hope that you enjoy this book as much as I enjoyed writing it, but before you begin, let me explain the format.

Although this book begins with voltage, current and resistance, it assumes that you are aware of these things and would recognize a resistor or a capacitor and could perhaps read their values.

The first chapter introduces the theme, the potential divider, in a very gradual way that would appear to be completely at odds with the 'advanced treatment' towards the end of the book – you cannot get from 'Ohm's law' to processors in 200 pages – which is true, as far as *absolute* knowledge goes but it can be done *relatively*, for fault finding.

The first chapter, having introduced the theme the potential divider, goes on to introduce source impedance, not theoretically but as an obvious living thing. The third chapter, Capacitance, inductance and impedance, develops the theme frequency-wise, i.e. reactively. The fourth chapter, Diodes and transistors, expands the theme to its limit for a single component. The first part of the book ends with a chapter on Analogue fault finding expanding the theme to its conclusion for the analogue signal path.

The second half of the book, Fault finding, *depends* on the theme for the subtle bus observations to work.

In this relative sense there is no *disparity* between beginning and end. In another sense, the hardest part of the book is the exposition of the theme and not the recapitulation!

Enough! Otherwise you will start to think this is a book of theory: most definitely not, it is the product of 20 years of fault finding, most of it grafting on production lines. But as I said above, experience cannot be gained from a book, but perhaps the distilled essence of it can, hence the mix of 'English and French' methods.

I have deliberately avoided the explanation of any analogue 'systems' for two reasons: (1) this would dilute the essence of the fault finding method and (2) there are so many excellent specialist

and general books on the market that whatever I produced would be a pale copy of these anyway.

In contrast to this I have included brief general descriptions of 'digital sub systems' because this area is still relatively new and not nearly so well supported.

Finally, and above all else, I did my very best to be clear and simple, possibly a little too simple in places, but not (I hope) at the expense of accuracy (some 'simple' sentences get rather long because of qualifying insertions – like this one!).

Robin Pain

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Part One

Basics

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1 Introduction

Microprocessor systems and analogue circuits are entirely different, forcing this book to be split into two parts, but there is a strong relationship between the two from the fault finder's point of view. Faults themselves are, by their nature, analogue, and a digital fault finder must understand analogue fault finding too.

Analogue fault finding

The radio, television and tape recorder, to name some analogue examples, are primarily amplifiers. A small signal goes in at one end and a much larger one comes out at the other. In a television, the aerial receives signal strengths of the order of microvolts and produces sound and video of the order of tens or hundreds of volts.

The method for fault finding such an arrangement is to start in the middle of the signal path and look for some amplified portion of the original signal. If that signal is present, then we must of course move further along the path towards the output. If the signal were not as expected (missing, or wrong level, or distorted) then we must look more toward the input and so on.

This simple procedure relies on previous knowledge of what the signals along the path should look like or enough knowledge about the local circuitry to be able to guess how it should affect the signals passing through it.

For lower frequency/larger energy signals this procedure is easier to apply but becomes progressively more difficult if the frequencies involved are higher and/or the energies are lower.

Having located the place in the signal path where the signal changes unexpectedly, the fault itself must be found. This requires a special understanding, not only of how circuitry works but also of how it does not work.