

# UNDERSTANDING & REPAIRING

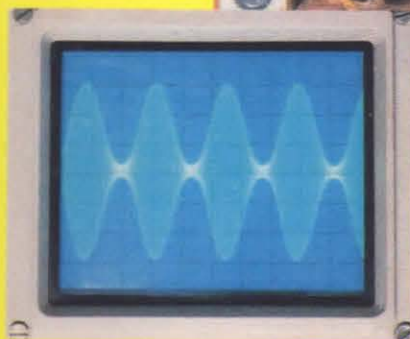
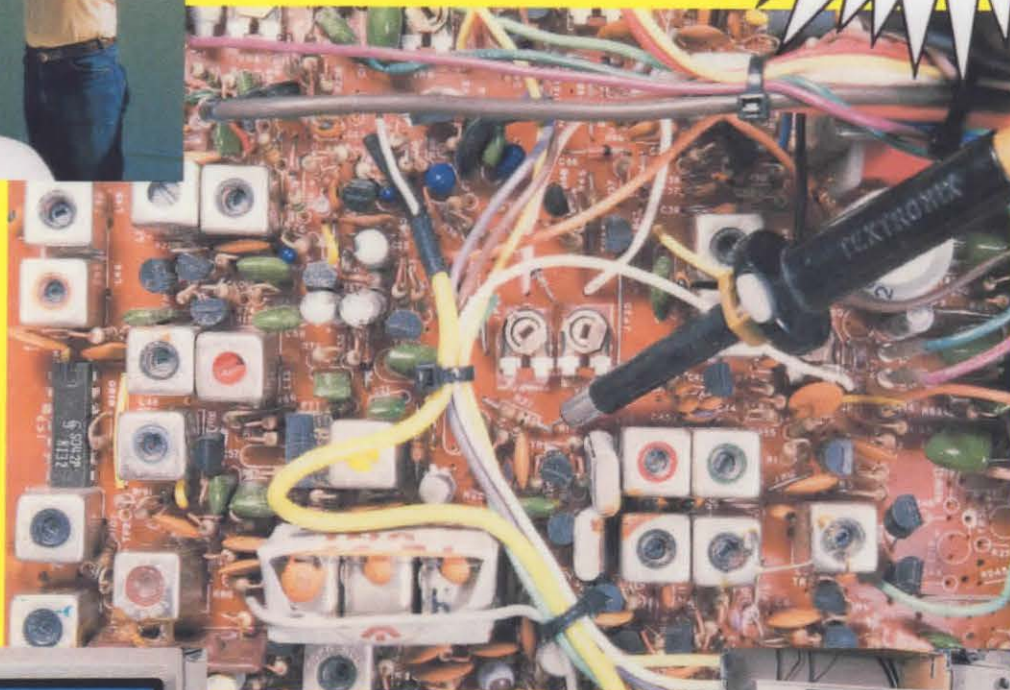
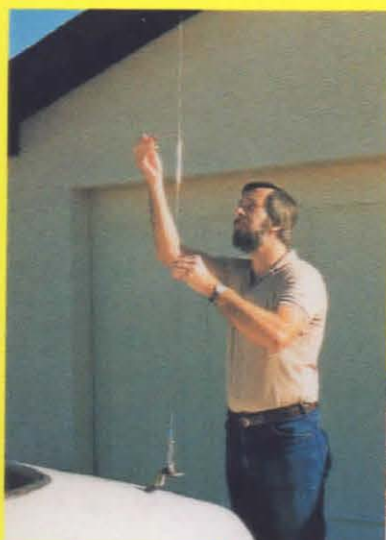
# **CB** RADIOS

**For the Professional Technician**

**Lou Franklin**

**INCLUDES:**

- AM, FM, SSB & CW models
- 23 & 40-channel circuits
- Crystal & PLL-synthesized, tube & transistor types
- American, UK, & export radios





# UNDERSTANDING & REPAIRING ***CB*** RADIOS

For the Professional Technician

Lou Franklin

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# UNDERSTANDING & REPAIRING CB RADIOS

For the Professional Technician

To the memory of Michael Moyse, who started it all.  
And to my wife Sally, who endured it all...

Lou Franklin





# UNDERSTANDING & REPAIRING **CB** RADIOS

For the Professional Technician

Lou Franklin

# FOREWORD

This book is the result of many requests over the years from loyal readers of **THE "SCREWDRIVER EXPERT'S" GUIDE TO PEAKING OUT AND REPAIRING CB RADIOS**. At the time I originally wrote that (almost 35 years ago!) I had expected the CB boom to fade away quickly. It's now obvious that CB is here to stay, and the need for technical expertise and information continues to grow. There are several reasons why:

1. More and more people are getting into CB radio as a hobby, and therefore more trained people will be needed to install and service the radio equipment.
2. Since CB is no longer considered a fad on which to turn a quick profit before moving on to the next fad, there are few companies left making the radios, test equipment, or service books. This leaves you the technician to hunt for service information anywhere you can find it. Good luck!
3. In March of 1987, the American FCC finally announced their "Novice Enhancement" rules for Ham operators. Novices could now use the lower section of the 10-Meter band, from 28.100 MHz to 28.500 MHz for CW and SSB. This means a great many CBs will be converted to these frequencies. Since most such conversions involve simple crystal changes and retuning, the need for both radio servicing and the conversions themselves will naturally increase.
4. CB radio is now a worldwide hobby, with many countries having their own 27 MHz Citizens Band Service generally modeled after the American version in terms of frequencies, power output, modes, etc. Most foreigners look to us as their best source of technical information, since even a common schematic is often impossible for them to find locally. After all, we Yanks invented this CB stuff, right?
5. The oldtimers who really understood radio theory are slowly dying out, leaving the hotshot kids to play with computers, cell phones, or I-Pods instead. Not many people left interested in or knowledgeable about RF and radio equipment. But we'll be talking on radios for a very long time yet; somebody must know how to fix them. Might as well be you and me...

**CBC INTERNATIONAL** is one of the few early entrants to survive this business. I felt the time was right for offering a much more technical reference for CBs, picking up where **THE "SCREWDRIVER EXPERT'S" GUIDE** leaves off, and including both the latest technical changes as well as theory on older models still used by many Americans. This book is the result, and I think those people serious about servicing CB two-way radios will find it very helpful.

This book originally took me about three years to complete, long enough to not only update various changes as they happened, but also to observe trends in the CB industry itself. The CB business is growing again! For example, in the late 1980s the British and Australian CB services finally changed over to the standard FCC/CEPT frequencies, making CB radio a truly universal hobby now with standardized equipment sold everywhere. And the old time manufacturers like Cobra, Uniden, Midland, and Radio Shack are busily updating their CB product lines with new models and new features.

The only catch with all this new equipment is that the current AM-only or FM-only models are basically impossible to modify for non-CB frequencies, or else not worth the cost and trouble to do so. However the American SSB models, while now more difficult, can still be converted. On existing models, there's no expiration date for an FCC Type Acceptance. (The "FCC DATA" number on the radio's ID tag.) As long as the manufacturer doesn't change the circuit electrically, he doesn't have to reapply for a brand new Type Acceptance and the more strict technical rules that go with it.

That explains why most of the best-selling Uniden and RCI 40-channel SSB models like the President/Uniden Grant, Grant XL, Madison, early Cobra 148/2000GTL, or RCI/Galaxy are so popular; they're still easy to modify, and they can keep making them forever. Only the newer models must meet current FCC rules. This suggests increased sales of SSB type models, so prepare for them.

I've drawn upon personal knowledge as well as many other sources for this book. A few are listed in CHAPTER 1 for those wishing to learn more. I strongly suggest you add such books to your personal electronics and CB library.



Unfortunately the few older CB repair books from the major publishers are now long out of print, including the coveted SAMS CB Fotofacts. Since many readers tend to live in rural areas with no easy access to big city bookstores, libraries, or parts houses, I'll explain how you can shop by mail or the Internet for your needs.

### My Teaching Philosophy

In my earlier books I purposely did a lot of hand holding, using a "shotgun" approach to CB repairs while skipping most of the technical explanations. Since this book is intended for the serious (or hopeful) electronic technician, don't expect the same sympathy; you should already know basic solid-state electronics. If you don't know the difference between a PNP and an NPN transistor, or how a diode rectifies, you'd better start more gradually with the suggested reading list in CHAPTER 1 first.

There's probably more electronics theory in this book than you'll ever need to know. Anybody can fix CBs using the kind of simple troubleshooting guides usually found in manufacturers' service manuals. But I believe that a true technician understands the how and the why of circuit design. "Why did they put this particular resistor here?" "What happens if that capacitor is removed?" "Why the switch from transformer-coupled audio outputs to direct IC outputs?" I try to answer such questions not only from the purely technical aspect, but also from the manufacturers' marketing perspective. That way you'll understand more clearly why CB circuits evolved as they have.

It's true you don't have to know exactly what's going on inside an IC to decide if it's good or bad, but it sure helps! That's what separates a real technician from all the "shade tree" CB mechanics. I've therefore included a lot of background on CB circuit design theory. There's also a psychological bonus in such knowledge: with so many amateurs working on CBs, if you're better educated your customers will notice, and you'll get more business and more respect.

Unlike many technical writers, I don't use theoretical circuit descriptions except where absolutely necessary. No point in studying a SAMS or factory service manual if the real circuit looks so different from the theoretical one that you can't recognize it. Not my style. I'll emphasize circuits from real radios so you'll recognize them when you see them. These will be the circuits you'll see on a day-to-day repair work basis. Schematics may refer to a

specific chassis, but the circuit will usually be so classic and generic that it applies to most other American and foreign models too.

I've often redrawn the manufacturers' original schematics, and sometimes omitted obvious components not essential to the discussion for simplicity. Certain parts have their actual values included when important to the discussion, while others on the same drawing may not. I've chosen as examples the most popular and representative chassis types. The same models are often used repeatedly for convenience, but similar models will use virtually the same circuitry anyway.

A few readers have criticized me for not being more up-to-date, but I stand by my view that CB circuits have changed very little electrically over the years. What appears to be a more modern circuit is usually nothing more than a new manufacturing technique or a newer component to accomplish exactly the same results. If you understand my examples, you'll also understand any of the newer circuits you may see.

To that end, circuits were purposely included from some older 23-channel and tube type radios. They're still quite common in the U.S., especially now that Hams are grabbing them up for 10M use or to sell on Ebay. While this may seem like ancient history to some readers, Americans will find it useful; these rigs will still be around and still need servicing for many more years. I've also included information on many of the so-called "export" radios, since they've widely used here and abroad. The combination of old and new should make this a truly international reference.

This book will be read by many people outside the U.S., but since virtually all CBs work the same way, the principles can be applied equally to foreign models. Yes, British FM-CB isn't that much different! Once you understand these basic principles, you'll be comfortable working on any type of CB transceiver that comes along.

Please don't take my word for everything. Read other books. Read everything on two-way radio repair you can find. If you live in a small town or rural area, take a correspondence course or find the info you seek on the Internet. Try one of the Heath self-study electronics courses, which I think are the best available and reasonably priced. If you live in a bigger city, take an electronics course at the local community college. Get a part-time job at a two-way radio shop, where you can look over the



shoulder of a more experienced tech. I've done all these things myself over the years.

### Book Organization

In the following eight chapters I'll try to teach you all about how CB transceivers work, including their circuit design criteria and installation to the outside world via the antenna and power connection. Those who've already read **THE "SCREWDRIVER EXPERT'S" GUIDE** or **THE CB PLL DATA BOOK** may recognize some minor duplication of text or drawings; however subjects are treated in a more technical way here, so don't automatically skip over them.

We'll begin by defining major CB transceiver technical specifications. How would you know a radio's working properly unless you know what "proper" is? Next we'll describe a shopping list of basic tools and equipment that any respectable shop should have, including tips on where to find them. Unlike the boom days, there's no longer any current test gear made specifically for CB servicing. You'll have to use existing test equipment that's still available on the new, used, or surplus markets. I'll tell you where to find it. (See my special note at the top of Page 19.) I'll also throw in some of my famous "cheap and dirty" testing shortcuts using inexpensive circuits you can easily build yourself.

Troubleshooting basics are covered next, with detailed descriptions of receiver and transmitter circuitry in block diagram form for simplicity. The use of logic and other methods to find faults are explained. Following that is a chapter on developing the various required signal frequencies, including synthesizers and mixers. Then come specific circuits for the receiver and transmitter. There's a separate chapter on Single Sideband (SSB) emphasizing its unique circuitry. Power Supplies are covered next. The final chapter discusses antennas and transmission lines. Finally, there's some reference material for solving ignition noise and TVI/RFI problems.

### About The Subject Index

The subject index at the end of this book will be very helpful. I spent many days trying to make it as detailed as possible, and it's now hundreds of entries long. Many common CB problems are included there alphabetically, under specific names such as "No Transmit", "Audio Distortion", or "High SWR".

### SMD & the Future of CB Radio Servicing

In many ways learning CB repair is a lot easier than most other areas of electronics like computers, medical electronics, avionics, or even automotive repair. These fields require constant re-training as their technologies get more sophisticated. But the basic CB circuitry won't change from its current state-of-the-art unless manufacturers decide there's enough of a market to justify using the newer technologies. For example, they still haven't bothered to make high-power VLSI ICs, where most of a 5-watt transmitter could be put on a single chip.

There is however one major technical change now occurring: the use of tiny Surface Mount Devices (SMD) in manufacturing. These are sometimes called "flatpack" or "chip" components and are often as small as 1/8" long. What is SMD? It's a special miniaturization process where the holes for PCB components are not used. Instead the leads are soldered directly to the top of the SMD-PCB. They can be bent down from the device in a gull-wing shape and soldered to the PC foils, or even folded underneath the device itself before soldering or oven heating.

In mass production, SM parts are first glued to the PC board to temporarily hold them in the right place before the leads are soldered. Needless to say, the component density is incredible. And since there are no lead holes, you can actually put two entirely different circuits on the same PCB, one circuit on each side. Imagine the possibilities!

It's very likely you've already seen some SMD CBs. One of the simplest new CB uses has been the inclusion of a separate VHF weather receiver. For example, some popular Cobra models like the 25LTD and 29LTD became the 25LTD-WX and 29LTD-WX by adding a tiny weather PC board with SMD parts. The PCBs are so small they can bolt the entire WX unit anywhere convenient on the main chassis or the frame, then add a few wires and a switch. Another SMD use is in the PLL synthesizer of more complex multimode rigs like the HR2510 or RCI2950.

When SMD first appeared, there were some people who tried to stop progress by convincing customers to boycott such SMD equipment. They mistakenly thought this would force CB makers to return to using standard leaded components, but the idea failed. Why? Because manufacturing practices in electronics are always dictated by what's already being used in TVs, stereos, DVDs, digital cameras, medical instruments, etc.



Manufacturers are forced to design around whatever the component manufacturers are currently offering. Like the man said, "When you've got 'em by the balls, their hearts and minds will follow."

The biggest drawback to SMD is that servicing and parts replacement is now that much more difficult. New skills and new equipment are needed. It's not impossible, but you will need tweezers, a magnifying glass, and special soldering/desoldering tools. Not to mention patience, good eyesight, and steady hands. The better magazines like POPULAR ELECTRONICS are always running SMD ads and articles, and you should read them regularly.

I suppose you could just refuse to work on SMD models, forcing your customer to go elsewhere. Or convincing him to buy a new radio from you. You might make extra money this way at first, but eventually you'll lose your technical edge along with most of your service income. Meanwhile, the guy down the street who already knows about SMD will get all your old business.

By the early 2000s, standard parts with lead wires on them became harder to find. You won't be able to fix the latest rigs without SMD experience. This factor alone could become the biggest challenge to your future income and enjoyment of hobby radio.

You'll also need a new sales and marketing strategy. Most CBers think "bigger is better" and wouldn't consider a CB radio that's maybe just 5" square as having much inside it worth the price, despite how many bells and whistles they can cram into a small box. It'll be your job to re-educate these guys too.

SMD could become a blessing in disguise. Those do-it-yourself CBers and weekend wizards may finally learn (!!!) to keep their hands out of the radios and leave the work to professionals.

### Final Thoughts

Many people have asked where I got my training in CB repair. Mostly I taught myself through many years of Ham radio, broadcast engineering, CB radio, VHF servicing, and a lot of reading. I got many shocks and RF burns along the way. The reading is required. Shocks and burns are optional if you get careless.

I won't make any moral judgments about "legal" or "illegal" CB operation here. Most of you already know the specific operating rules of

your respective countries. What you do about them is your business. Don't expect this book to give you step-by-step procedures on how to modify a standard CB; those subjects are covered in other references like our **CB PLL DATA BOOK**. A simple reading between the lines there will answer those questions.

The purpose of this book is to teach you how to properly repair and maintain a CB radio within the manufacturer's specifications. Besides, if you happen to have an FCC General Radiotelephone License, or plan to get one, you're responsible for the proper operation of radios you service. If this is your living, you can't afford to lose your license.

Finally, as I write this latest introduction, the current sunspot cycle (Cycle 24) is in its 11-year high of solar activity. Which means plenty of skip to play with! This can only mean good news for continued CB use. And that translates to more work for the good techs, more CB sales, more conversions to Ham Radio, more DX, and more all around fun.

Over the years, my radio updating information has often come from readers, who send me schematics on new CB models as they appear. I always welcome your comments and sincerely hope this book helps you. Good luck and let's begin!

L.F., Tucson, Arizona

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