1 INTRODUCTION TO CB SERVICING

It's been said, "A carpenter is only as good as his tools." Let's rephrase that to say, "A technician is only as good as his test equipment." You'll waste a lot of time without the right tools. That's the difference between making a repair, or embarrassing yourself by admitting to a customer that you can't fix his CB because you just don't have the right tools.

About 75% of all repair problems are easy to diagnose and fix. An experienced tech can probably trace these down with only a VOM, a "buzz-it" generator and a few simple tools. The fact that the majority of repair problems are easy to find was my reason for writing **THE "SCREWDRIVER EXPERT'S" GUIDE** in the first place. It's the other 25% or "tough dogs" that require a lot more time, experience, and money invested in the right test equipment.

If you're serious about CB repairs, don't think you can get away with ignoring that other 25%. New customers come to you expecting an expert, and one with all the right tools. If you disappoint them, the guy down the street will provide what you couldn't, and eventually you won't even get the easy jobs.

In this section I'll discuss the tools and equipment that any respectable CB repair shop needs. Some items you can even build yourself. And if you're a smart shopper, you can find the important stuff on the used or surplus markets. I'll show how you can outfit a complete shop using only your telephone, UPS, or the Internet if you can't get to the sources yourself.

Following are the things I use most, along with appropriate comments. These are in no special order and are by no means complete; they just demonstrate the range of equipment available. Pages 19–25 show some contact info to help you find them. Test set-ups are shown later.

IMPORTANT!
In books like this, I can't possibly guarantee the accuracy of specific listings. Things like Web sites, brand names, addresses, and phone or model numbers change a lot. You need to use the Internet! See the boxed note on Page 19.

TEST EQUIPMENT SUMMARY

SERVICE MANUALS, SCHEMATICS, SAMS FOTOFACTS: Your most important tool! It's incredible how many people try to fix a radio without these. Would you drive in strange country without a roadmap? You need radio roadmaps too, and lots of them. You need one for virtually every chassis type you'll see. Once you're familiar with the radios you'll know which brands and models are the same; this can save you lots of money when buying, for example, SAMS Fotofacts. If ten different radios are exactly the same, why buy ten SAMS Fotofacts, one for each brand name? Besides, most SAMS are now out of print and you'll often be lucky to find even one chassis type that's still in print.

For the major manufacturers still actively marketing CB radios (Cobra, Courier, Uniden, Midland, G.E., K-40, Radio Shack, Regency), you can get service manuals directly from them. Their addresses appear later. For all the other companies now out of business, you'll have to hunt around. Many of those companies used the same chassis types as the current companies; see **THE CB PLL DATA BOOK** or **THE "SCREWDRIVER EXPERT'S" GUIDE** for cross referencing.

POWER SUPPLY: Another essential tool. All mobile transceivers are designed to operate on a DC voltage input of about 13.8 VDC. Since you'll most often be working on the bench, this converts the AC mains to the required low-voltage DC. (We often use the term "12 VDC" instead of 13.8, which is the actual charging voltage on a battery with the engine running. Means the same thing.) This supply should be well regulated. In addition it should have current limiting to protect it from direct shorts, as well as a "crowbar" overvoltage limiter; in the unlikely event the regulator's series-pass transistor shorts collector to emitter, as much as 24-28 VDC could be applied

to the test radio! Current and voltage metering are nice extras, but not essential.

In the early CB days a 2 Amp supply was OK; however with the popularity of SSB and export radios you really need one with 3-3.5 A minimum capability. (The President Jackson for example has a 6 A fuse.) And if you run two radios simultaneously, consider something even bigger. DC supplies of this type can generally be purchased new for under $60 from sources such as Radio Shack, or any test equipment supplier like those listed on Page 23 or the back pages of electronics magazines. MCM Electronics sells some nice Taiwan-made Tenma supplies for only $35 and up. (Address on Page 24.)

At least two DC supplies are actually needed. You never know when you may need to test a base radio's supply, provide an AGC or VCO clamping voltage, have two mobiles on at the same time, etc. I suggest one supply capable of high current output in the 10-20 A range. The high current allows testing of linear amplifiers, several radios at once, etc. It should have at least two voltage output ranges, preferably adjustable, and preferably metered. Again, current and voltage limiting are important.

Current metering can be very useful for checking the current drain of a radio under test. DC power supplies of this type are generally in the $100 and up price range, but are absolutely required for serious radio work. Some typical good examples are made by Sencore, Hickok, and Tenma.

MULTIMETER (VOM): Here I distinguish between analog and digital types. But one of each is recommended. These meters read AC/DC current, AC/DC voltage, and resistance over many ranges. The analog types are most useful when you need to see the meter needle moving, like during alignment procedures, or testing semiconductors with the ohmmeter function. Get one rated at least "20,000 Ohms-Per-Volt"; this provides good sensitivity and a high input impedance to prevent loading down sensitive circuits.

This last requirement is extremely important: when measuring a high-impedance circuit on a low voltage scale the meter impedance can easily be lower than the circuit being tested, which means substantial current will flow into the meter and give false voltage readings. For your analog VOM this can be anything from a simple Radio Shack #22-109 ($25) to the famous (but expensive) Simpson 260, around $220.

For just about everything else, a digital meter (DVM) is preferred. For precise adjustments like a PLL VCO it's absolutely essential, since 0.02 volt change can move the synthesizer over to the next channel! The "3 ½ digit" meter is pretty much standard now. This means it has three digits that read 0-9 and a left-most digit that only displays a "1." Therefore the maximum reading on any range (ignoring the decimal point) is "1999." Digital meters have input impedances on the order of 10M_, which eliminates potential loading or RF effects.

A nice feature of the more expensive types is "autoranging," which means it automatically jumps to the next highest range when the range in use is exceeded. This frees your hands from having to turn the range knob, handy when both hands are already busy. Nice, but not essential on a low budget.

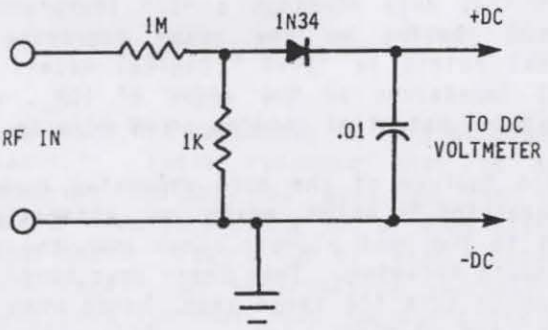
Finally, digital meters have the advantage of being much more immune to strong RF fields which can make most analog meters useless. You can't possibly measure the DC voltages on the transmitter power stages with an analog voltmeter. After 30+ years, I'm still using a Data Precision #935 which was one of the first handhelds on the market. Nowadays everybody makes them including Fluke, Beckman, Hickok, Radio Shack, Dick Smith, and many others. Radio Shack has nice digital autoranging meters like the 22-813 ($40) or the 22-039 ($70). As the price goes up you get the extra features described here, and a lot more ranges too.

VTVM OR FET-VOM: This is an optional item which is handy when you don't want your test probe loading down a sensitive circuit like an oscillator. The Vacuum-Tube-Voltmeter (VTVM) is much less sensitive to RF than solid-state devices. Since both have probe inputs in the megohms, there are virtually no loading effects. The advantage of the FET meter is its portability, but RF sensitivity can sometimes be a problem. I'm really stingy, so I still use my old Heathkit FET-VOM, and an Eico VTVM.

RF PROBE: This is simply a device which when attached to the input of a DC voltmeter can show relative RF measurements. Very handy when peaking RF stages, or for signal tracing transmitter stages without a 'scope. Although there are commercially available probes they're simple to build yourself. See Figure 1-1. Remember though that it shows relative, not absolute, voltage readings. For the truly lazy you can still get these ready-made from Dick Smith Electronics, including the banana clips, but remember you'll be paying a lot more for the Air Mail shipping.

OSCILLOSCOPE: No CB bench would be complete without this extremely useful and versatile

FIGURE 1-1
A SIMPLE RF PROBE



instrument. This is your biggest investment, so consider the choice carefully. An audio type service 'scope just won't do the job; you need one that's capable of viewing the 27 MHz signal directly, and with accurate P-P measurements. In this price range the 'scopes generally come with dual-trace capability, triggered sweep, delayed sweep, and other useful features too.

You can't conveniently adjust AM modulation to the required levels unless you can view the actual waveform. It's possible to connect a simple audio type 'scope to use the trapezoidal measurement method, and we'll demonstrate this later. However you still need a high frequency response for things like transmitter signal tracing. When I was starting out and couldn't afford a 'scope, I did a lot of signal tracing with a VOM and RF probe. This method works, but without a 'scope you can't analyze the more subtle problems like noise and distortion. A good 'scope is actually cheaper today than when I was starting, due to Far East competition and improved production methods. You don't need a Tektronix, even though everybody wants one; excellent instruments are now made by B&K, Hitachi, Kikusui, Hickok, Leader, and others.

A simple 'scope extender may help for small budgets. This is basically a mixer circuit and local oscillator, designed to down-convert signals up to say, 50 MHz, so they're visible on a simple 5 MHz type 'scope. Search for something in the ARRL HANDBOOK or the Internet.

FREQUENCY COUNTER: Another essential tool, but a lot more affordable. You can't possibly measure channel frequencies for correct tolerances or analyze other signals in a CB transceiver without one. The important factors to consider are upper frequency limit, accuracy, and sensitivity. The 30 MHz counters are the low end pricewise and are quite passable if good on the other two qualities. For accuracy you need at least one order of magnitude more than the measurements you'll be making, which means at least seven digits total. For sensitivity, 25 mV will catch even low-level oscillators and mixers. Also desirable is a high-impedance input to prevent loading the measured circuit. Some counters have switchable or separate HIGH-LOW impedance inputs. Thanks to improved production methods there are many good brands of AC-powered or portable counters for under $100.

A neat little add-on gadget for both your 'scope and frequency counter is an "RF Sniffer" preamp. This is a battery powered broadband amp in a small aluminum box with BNC jacks. When connected to a 'scope or counter, it can really boost low-level signals without loading down the test circuit, since there's no physical connection. You just put its probe near the stage to be measured and it "sniffs" the RF signal. Keying a 4-watt CB into a dummy load will make your counter read out in the next room! You won't be able to read oscillator signals except on Receive though; the transmitted 27 MHz signal will overpower all other signals. My unit was made by a company that's now out of business, but I've seen them, advertised by companies like Ramsey Electronics (Page 24) for around $40.

RF SIGNAL GENERATOR: This will be your most important instrument for testing receivers. It must produce a 27 MHz carrier signal with high stability and calibrated output levels down to the 0.1 µV level. It must also provide for modulating the carrier up to 50%, preferably using standard 400 Hz and 1 KHz tones. Most generators have AM modulators; only the most expensive have FM ability with fully adjustable deviation levels. A nice extra feature would be separate outputs for standard 455 KHz and 10.695 MHz IF signals, although if it's tunable through these ranges that's OK too. Another nice feature is multiple BNC output jacks so you can couple one of them directly to your frequency counter; since channelized CB signal generators are no longer made and the dial calibration of most other generators is notoriously inaccurate, you'll need the extra jack to monitor the exact output frequency.

Unfortunately generators with these features aren't cheap! But I have a suggestion worth

investigating: my generator is an old surplus URM25/F, made for the Navy by Uncle Sam in the 1950s. (You can see this just in front of my head in the photo on the front cover.) It probably cost American taxpayers $10,000 then. Mine cost $150 in working condition. My friend Norman used to bid on government surplus and he picked up a bunch of these boat anchors for a few bucks, and sold one to me. They have all the above features, plus an incredible range of 10 KHz to 50 MHz. It's built like a tank and uses common tubes which are still readily available. The only modification I'd suggest is a vernier reduction drive on the tuning shaft, or it'll whiz right past the CB band. This instrument is still available on the surplus market from places like Fair Radio Sales.

There were some special CB-only signal generators made during the boom days like the B&K 2040, Sencore CB42, and Hickok 266. You might still find one from ads in Ham type swap sheets or other electronics magazines. All are excellent and probably sell used for $200-$400.

A simple RF generator I often use is the "buzz-it" type, which is a battery-powered oscillator that generates lots of RF hash and harmonics well into the VHF region. It's about the size of a pocket penlight. When you stick the probe into the coax socket or a working receiver stage, the speaker hiss noise increases, so it's good for simple in/out signal tracing. You can find these at many electronics stores for under $20. (Eg., Dick Smith #Q-1270.)

AUDIO SIGNAL GENERATOR: This is often useful for tracing signals through the transceiver's audio stages. Many RF type generators have a separate output jack from their internal modulation which can also be used. However for servicing SSB transceivers a two-tone audio signal is absolutely necessary. Besides if you want to perform overall frequency response tests, you must be able to sweep the entire voice audio range, typically 300-2500 Hz. The unit should have an output calibrated in millivolts (mV) so you can properly adjust the AMC or ALC of a transmitter. Audio generators are fairly inexpensive, typically $50 on up. You can build a Heathkit or find any number of commercial models. You can also build a simple fixed output two-tone generator from an IC or transistors for even less money.

SIGNAL TRACER: This is extremely handy in troubleshooting IF and audio receiver stages, the transmitter mike amps, add-ons like Speech Processors, etc. Basically it's an audio amplifier with a built-in speaker and a diode RF detector. By using its probe and injecting a signal, you can determine exactly which stage is not passing the signal and isolate it more specifically. It's fairly cheap; Heathkit makes one, the IT-5283, for $60. Mine's an old tube-type Heathkit IT-12, which could probably be found on the used market.

There's also a much cheaper and simpler tracing method: Radio Shack makes a little 200 mW audio amp with built-in speaker, Catalog #277-1008 ($11.95), which is perfect for this use. It runs on a 9-volt battery and has an input jack and an output jack for an external speaker. With a simple diode detector for a probe, you can use it at RF/IF frequencies too. (Heathkit makes a switchable AF/RF detector probe, #337-C kit, $12.95.) NOTE: If you get the R/S unit, be sure to modify the input by adding a coupling capacitor of about .01 µF in series with the center conductor of the input jack. Otherwise you may load down the test circuit since the input goes directly to its VOLUME control wiper, which is a low-impedance ground path.

RF WATTMETER & SWR METER: Two more necessary instruments that determine correct transmitter and antenna operation. The directional thru-line types such as the Bird 43 are the most popular. You just rotate the plug-in element to get the actual forward and reflected readings directly in watts. Thus it's also an accurate SWR Meter, but you need a special nomograph to compute the SWR value. The Bird is probably the industry standard because it's extremely rugged, accurate, and offers a wide choice of plug-in elements for many power levels and frequency ranges. A variation of this popular meter is the Bird 4314; it adds a peak-reading (PEP) function for SSB work. Price around $200.

There are many other SWR and RF power meters. I suggest a quality instrument for each function, since most of the cheap combination types are notoriously inaccurate. You get what you pay for. The power metering in the combo units is generally useless when connected to a reactive antenna rather than a pure 50Ω dummy load. With reactance, the sampled RF voltage driving the meter is phase-sensitive, and can make it read power that's too high or too low. You do need an SWR indicator of some sort to know you even have a reactive load, but don't settle for less than precision instruments here.

If you have the slightest doubt about wattmeter accuracy, use the basic electronic formula,

$$P = \frac{E^2}{R}$$

where P = power in watts,
E = measured RMS RF voltage
R = resistance in ohms.

Since "R" will always be 50 when using a standard dummy load, connect an RF probe from an FET-VOM or a VTVM to the center coax pin, either from inside the chassis or with a coax "T" connector. For example, if the measured RMS RF voltage is 15 V, the power will be

$$\frac{15 \times 15}{50} = \frac{225}{50} = 4.5 \text{ watts}$$

If you use a 'scope for RF measurements, remember they read peak-to-peak (P-P) voltage, not RMS like voltmeters. This means you must first convert the P-P 'scope voltage to RMS. The conversion formula is

$$V\ (RMS) = \frac{V\ (P\text{-}P)}{2.828}$$

For example, with an unmodulated AM carrier into a 50Ω dummy load reading 40 V P-P on the 'scope, the RMS voltage would be

$$\frac{40}{2.828} = 14.14427\ V_{RMS}$$

Now use the standard formula:

$$\frac{14.14427 \times 14.14427}{50} = \frac{200}{50} = 4.0 \text{ watts}$$

Some of the newest state-of-the-art 'scopes (Tektronix 2246, etc.) now offer pushbutton choices of P-P or Average displays; no more calculations, if you can afford these!

RF AMMETER: You can sometimes save money with a thermocouple RF Ammeter instead of the more expensive RF Wattmeters. (See photo later in this chapter.) Buy a surplus RF Ammeter of a suitable current range for CB use and mount it in an aluminum meter box with standard SO-239 coax sockets on each side. Wire the meter terminals in series with the center pins of the coax sockets. Then make up a little conversion chart which you can attach to the back of the meter box. The chart converts the RF amp reading directly into watts. Use the formula,

$$P = I^2R,$$

where P = power in watts,
I = RF current in amps,
R = resistance in ohms.

Use your pocket calculator and compute about 20 different current values from zero to the full-scale meter reading. "R" will always be 50 ohms, because you terminated one coax socket in a non-inductive 50Ω dummy load.

For example, I bought two RF Ammeters at a surplus place, one with a scale of 0-1.5 RF Amps, and one with a scale of 0-0.5 RF Amps. Using the formula, the 0-0.5 RF Amp meter gives a full-scale watt reading of 12.5 watts, and the 0-1.5 RF Amp meter a full-scale reading of 112.5 watts. Thus I have one meter suitable for AM/SSB CB rigs, and one for testing many medium power Ham transmitters, linear amps, commercial VHF rigs, etc.

The RF Ammeter makes an excellent wattmeter for SSB power testing, because the reading is proportional to the actual power consumed by the load. PEP measurements with two-tone tests are therefore quite accurate. Also the needle moves more slowly and with less bounce than a DC current meter. That's because the meter works on the principle of heat, not magnetism. The sensing element is actually a strip of thermostat type metal attached to the needle, and it heats up as RF flows through it. (If you've ever received an RF burn, or cooked with a microwave oven, you know that RF does burn!) The heating of the dissimilar metals generates a small DC voltage which is applied to a DC milliammeter calibrated in AC units instead.

You'll find these meters at surplus stores or major electronic parts suppliers for about $30-$50, which is a lot cheaper than the $200-$300 you'd pay for a Bird or similar instrument.

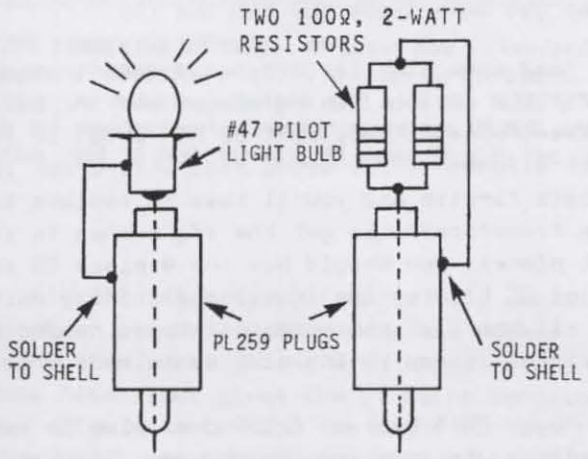
NOTE: RF Ammeters are compressed at the low end of the scale, making reading there difficult. Get one having a range where the expected deflection will be near the mid-scale for more linear reading.

DUMMY LOAD: (See photos in CHAPTER 8.) You'll need something to dissipate the power of a transmitter under test without actually getting on the air and causing interference. A dummy

load serves this purpose. It's a special resistor which appears to be a pure 50Ω antenna to the transmitter output stage. However it's very important that the load be non-inductive and purely resistive; any reactance will cause inaccurate wattmeter readings.

There are all sorts of commercial loads available and the only real difference is the maximum power rating. For CB work you can get a simple 5-watt "sponge" type load from companies like Gold Line (#1072) for about $4. This has a small resistor soldered directly to a PL-259 coax plug. Another popular load is the Heathkit "Cantenna" or Gold Line "KW Kan," which are big resistors inside a one-gallon paint can of transformer or mineral oil. These will handle 1000 watts when transformer oil is used. For intermediate power, try Dick Smith Electronics (15 W-#D7025, 100 W-#D7010, 300 W-#D7030), or Gold Line (100 W-#1054B) models.

FIGURE 1-2
SIMPLE 50Ω 4-WATT DUMMY LOADS



For you builders, a low-power load can be made from a few carbon composition (not wirewound!) resistors, or a #47 flashlight bulb (Radio Shack 272-1110) soldered across a PL-259 coax plug. Even though a light bulb is actually a wirewound resistor, for some reason the #47 makes an almost perfect 50Ω non-reactive load. These "modulation bulbs" are still sold by Dick Smith (#D7024) and Gold Line (#1057) for about $4. I like them because you can whistle up a modulation test on a CB when its own S/RF meter may not work properly. Figure 1-2 shows how to make your own simple dummy loads.

When testing antennas you'll occasionally need a special dummy load which you must make yourself. For example, I have several 5 W loads made from various junked antenna fittings. One fits the standard 5/8" threaded trunk lid mount, one fits the oversize A/S "Big Momma" type coil mount, one fits the K-40, one fits the Hustler base-load type, etc. When you can't match a loaded mobile antenna with a decent low SWR, these homebrew loads allow you to quickly determine if the problem is in the coax or the antenna itself. Get a junked loading coil of every major type, break it open and remove the coil, saving only the threaded metal base which is usually brass. Parallel two 100Ω, 2 W carbon resistors and solder them across the center and outer parts of the coil base. You now have an extremely useful dummy load which may save you countless headaches when troubleshooting SWR-related problems. More on this in CHAPTER 8.

The following miscellaneous items are also quite helpful at times.

FM DEVIATION METER: There's been a flood of CB radios with FM capabilities into the U.S., as well as converters for existing radios. Some foreign countries allow the legal use of FM CB. And Ham operators convert CBs to the 10-Meter Amateur Band. For these reasons, expect to work on FM CB radios. It's very difficult to set the proper modulation level on an FM transmitter without a Deviation Meter. If the radio has excessive deviation, it won't even be detected in other FM receivers.

These instruments are usually very expensive and are normally part of a multi-function tester for commercial VHF/UHF radio servicing. The best-known names are Cushman, Gertsch, and Lampkin, and the prices of $2,000-$10,000 could never be justified in a shop doing only CB servicing. However there are a few more reasonable ways to make this measurement:

1. Build your own. Check the chapter on "Tests & Measurements" in any edition of THE RADIO AMATEUR'S HANDBOOK.
2. An English company called CIRKIT makes a complete kit for about U.S.$20 with shipping. Stock #46-010040. All you add is an aluminum mounting box. Address is Park

Lane, Broxbourne, Herts. EN10 7NQ, ENGLAND. Telephone (0992) 444111. (American readers can write for the price in Pounds Sterling and then buy an International Money Order in British currency from your local bank.)

3. Use a second FM CB like one of the export models to check both the received and transmitted FM signal of the test radio.

TRANSISTOR CHECKER: Personally I rarely use one, instead choosing an ohmmeter for quick go/no-go tests. With a tester you can measure gain and leakage more accurately, and also identify leads of PNP or NPN types. This can be useful if you're unsure of the lead basing and have no device information. However as we'll show later, an ohmmeter can easily be used to determine bipolar transistor basing. Transistor Checkers come in all price ranges, from the Radio Shack and Heathkit models on up to the more sophisticated types.

A SECOND CB TRANSCEIVER: This is probably the easiest and cheapest way around the problem of expensive test equipment, although purists will disagree since exact measurements can't be made. I've done it this way for years except in cases requiring the standard bench equipment. With another radio permanently on your bench, you have a very handy modulated RF signal source for testing a receiver, and a sensitive receiver for testing a transmitter.

I suggest one of the multimode export type radios having AM/FM/SSB capabilities and the additional "expanded" frequencies. Almost every CB you see will already have been modified for extra channels anyway. And there are so many export radios out there with FM in them that you need a good FM Receive/Transmit source. The other use for a second bench CB is for precise SSB offset adjustments. If your bench rig is known to be accurately on frequency when the Clarifier's centered, you can tune the LSB and USB offsets for the most natural voice quality rather than the frequency specified in the service manual. More on this in CHAPTER 6.

CAPACITANCE METER: These are nice to have and nowadays the price is very reasonable. In critical circuits like oscillators you sometimes need to know more than just whether a capacitor is shorted or open. A few picofarads can change everything. I got this neat little digital meter called a Krista for about $50 from one of the mailorder houses that advertise in RADIO-ELECTRONICS magazine. I've seen what appears to be the same meter under various brand names and since all the prices are comparable, the guts are probably made by a single manufacturer with everybody putting their own names on the case.

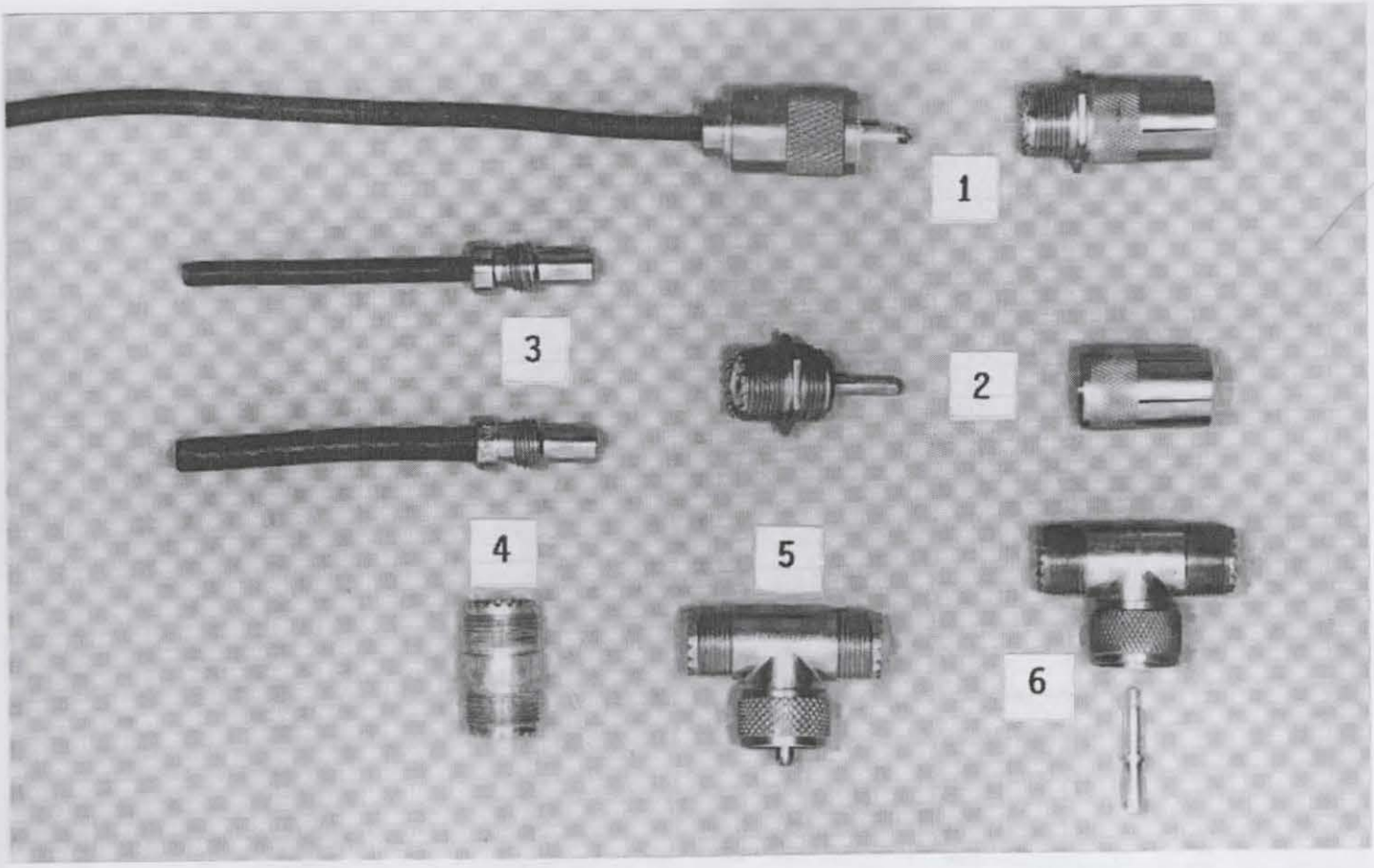
Here are a few more goodies which are strictly optional in most cases: A Tube Tester (yes, many CBs still use them!), Grip Dip Oscillator (handy for finding the resonant frequency of unknown coils, for antenna tuning, as a broadband portable RF source), a Walkie/Talkie for quick mobile troubleshooting, and a Spectrum Analyzer. (Handy for just about everything dealing with radio but priced beyond the reach of most of us!)

ODDS & ENDS:

Clip leads are a must. Get more than one size. (Radio Shack 278-1156, 278-1157, etc.) Besides the standard alligator clips, you need some insulated spring-hook types. They're similar to 'scope probe hooks but smaller. These can be attached to transistor leads and other very tight spaces without causing shorts. The biggest source for these is Pomona Electronics, although Radio Shack does sell just the hooks. Better get some leads for SMD use too.

You need some plastic CB-type alignment tools to fit the various tuning slugs used in coils and transformers. They must be non-metallic for proper alignment. The wrong tool will crack the delicate ferrite and you'll have to replace the whole transformer, so get the right ones in the first place! You should buy the 8-piece CB set made by GC Electronics (Catalog #18-530), which has all the slot and hexagonal types needed to fit virtually any tuning slug or trimpot.

The "push-fit" type of PL259 coax plug is very convenient for everyday bench use. It has a springy outer shell instead of the standard threaded shell, so you can quickly push the plug on and off the radio's coax socket as needed. The Gold Line #96 is an adapter that simply screws on to a standard PL259, and the Amphenol #83-5SP is designed for direct soldering to RG58 coax. I have two RG58 cables using these: one with a BNC on the far end to my signal generator for receiver tests, and one with a standard PL259 on the far end to connect a splitter that drives my various transmitter monitoring equipment. ('Scope, dummy load, frequency counter, wattmeter, etc.)



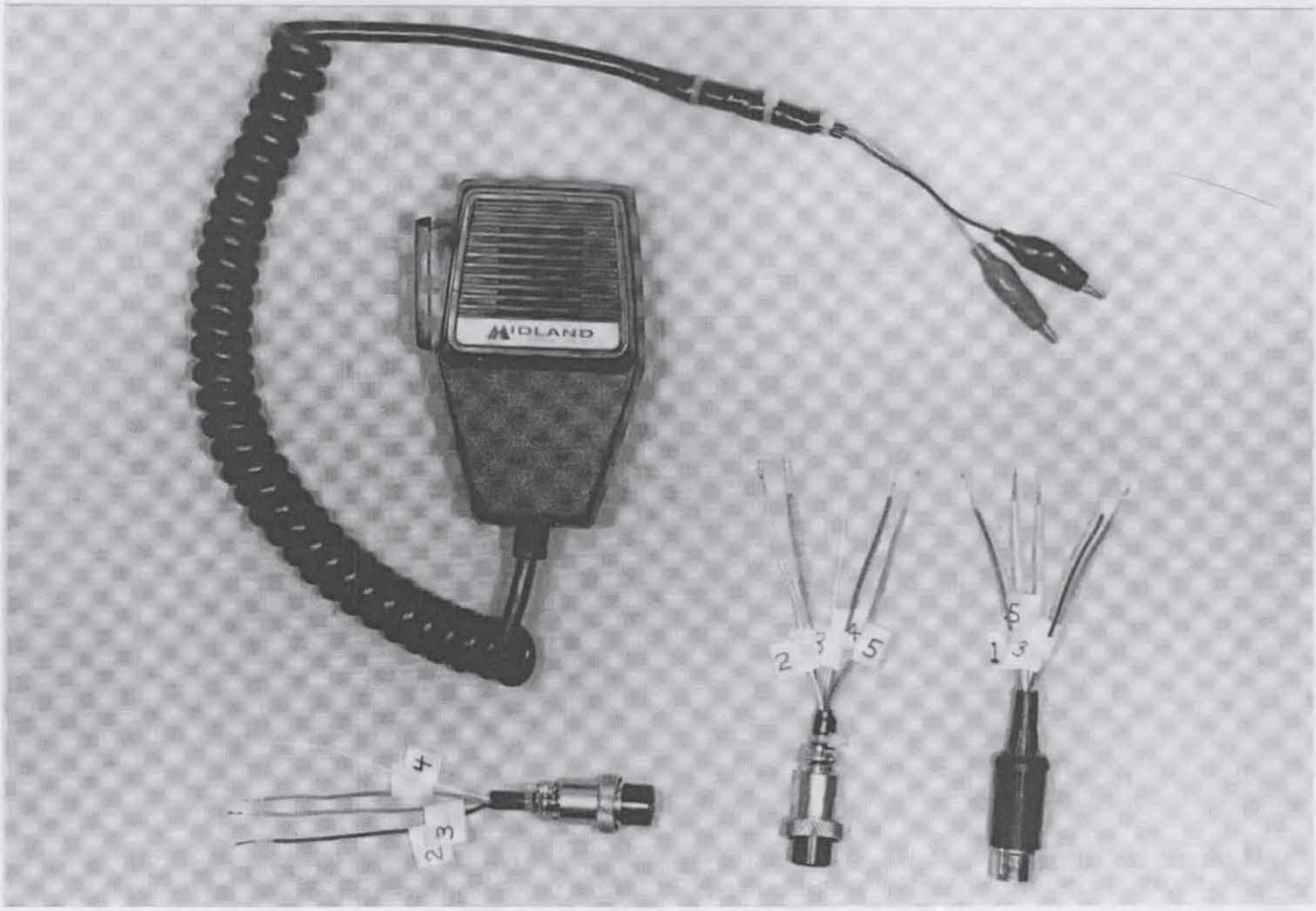
COAX CONNECTOR HARDWARE: #1 shows how a standard PL259 plug can be adapted to a push-fit plug (Gold Line #GL259-PF, Amphenol 83-5SP) for quick hookups on the bench. #2 shows the two threaded pieces that make up this special plug. #3 shows the reducing adapters used with the PL259 plug; the UG175/U is for RG58 coax, and the UG176/U is for RG59 coax. #4 is the double-female "barrel" connector (PL258) used to splice cables with PL259 plugs. #5 is the "T" connector (M358) often used in test set-ups; #6 shows it with the center pin removed to make the RF sampler described in CHAPTER 5.

A flexible magnifying lamp is very useful for finding cracks in PC boards and other close inspection work. Along with this, a penlight type flashlight gives the pinpoint backlighting you often need to find the right PC foil trace. They use those pre-focused #222 bulbs which you can put right up against the PC board for maximum pinpoint intensity.

An external speaker is very useful to quickly indicate if the radio's own speaker is open, damaged, or missing continuity from the PC board. Many radios don't have lugs on the speaker wires and are soldered directly; this is a real pain when constantly turning a radio over and over. If the work's going to be involved, I unsolder the radio speaker after unscrewing the cabinet, and connect my bench speaker to the "EXT SP" jack until I'm done.

A test mike with clip leads is very handy. Take a good dynamic mike from a junked radio and remove the plug. Jumper the audio line across the PTT switch so it's always hot. Cut off the T/R switching wires since you won't need them. Install a clip lead on the shield and audio wires. Now you can conveniently isolate mike audio vs. radio audio problems by direct substitution.

Along with the test mike, I suggest some mike test plugs with colored wires about 6"-12" on the pins. Make one for each major type, like the 4-pin, 5-pin, or 6-pin female with threaded coupling nut, 5-pin DIN, 6-pin DIN, etc. Use a different color for each pin on the plug. Label each wire with its pin number. Now you have a handy way to determine the audio, ground, and T/R lines in an unknown radio. You'll get lots



MIKE TESTERS: A standard dynamic CB mike is often convenient for tracing mike-related problems. Jumper the PTT switch so the audio is always hot, and remove the T/R wires. Also shown are three common mike plugs which can be used to figure out mike socket functions without a schematic. Connect colored wires to each pin, and number each pin as shown. (See text for details.)

of radios with no mike, no schematic, customer wants a power mike installed, etc. It's also useful for testing a suspicious mike with internal wire breaks or a faulty PTT switch. If the radio works when shorting the correct test plug wires you've isolated the problem.

For professional PC board cleanup, use a solder flux solvent. The old type Freon has now been banned in place of something less polluting. The new one seems to work well but can still remove paint from parts markings. And like all solvents it will dissolve plastic, which means sloppy spraying will ruin the plastic trim or S-Meter face. Especially if it's a brand new radio! The stuff I use comes in a regular aerosol spray can with an optional special hose and brush attachment that snaps on to replace the tip. You can then clean up PC soldering with the trigger on the brush attachment; the solvent flows right out of the bristles. The proper stuff is available from:

Miller-Stephenson Chemical Co.
Danbury CT 06810
(203) 743-4447, (800) 992-2424
www.miller-stephenson.com/contact_us.aspx

Ask for their solvent which replaces the old Freon they sold as "MS-190HD." It's expensive but the price drops way down if you buy the 24-can case, Assuming you plan to do a lot of radio work. The hose/brush used to be about $15. Contact M-S for your nearest rep. (There is also the GC Electronics #10-620.) It's a lot easier to spot bad solder joints or broken

traces when there's no solder flux to hide them! And customers will be impressed by the neatness of your work; they probably won't even be able to find the area you worked on.

On the subject of chemicals, no bench should be without a good cleaning spray for noisy pots or dirty switch contacts. I use Chemtronics' Tun-O-Wash. Many cleaners also have lubricants in them, but I prefer a separate lubricant after cleaning. A good one is Tech Spray's Blue Stuff. These are sold at all major electronics parts stores, especially those catering to TV repairmen. Similar chemicals are available from Radio Shack and GC Electronics.

Don't forget the thermal heat-sink compound. If you replace power ICs or transistors, you must include this or the new part may overheat and fail too. This is a silicone-based white grease that you apply to the mica insulator and/or metal heatsink before bolting in the new part. Good examples are Dow-Corning #340, Radio Shack #276-1372, and GC Electronics #10-8108.

How about a crystal checker? Could save you lots of head scratching, and crystals often go bad. All you need is an oscillator circuit and your 'scope, frequency counter, or voltmeter/RF probe. Figure 1-3 shows the simple Colpitts oscillator of the type used in virtually every CB crystal oscillator. (See following photo.) With the capacitance values shown you can check fundamental crystals from about 7-20 MHz and third-overtone types too. (These are generally in the 36 MHz range.) Connect your monitoring instrument to the loose end of the output coupling capacitor; a good crystal would typically generate a level of 1.5-2.5 V P-P RF output in this circuit.

Alignment of Noise Blanker circuits requires a source of broadband noise. You can build a

FIGURE 1-4
20dB ATTENUATOR PAD FOR SIGNAL GENERATOR

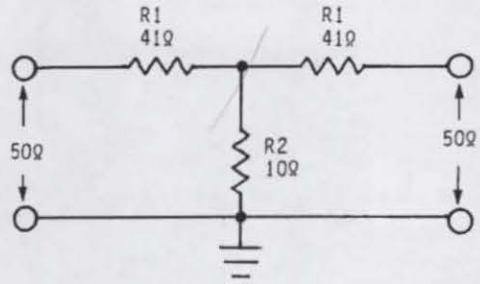
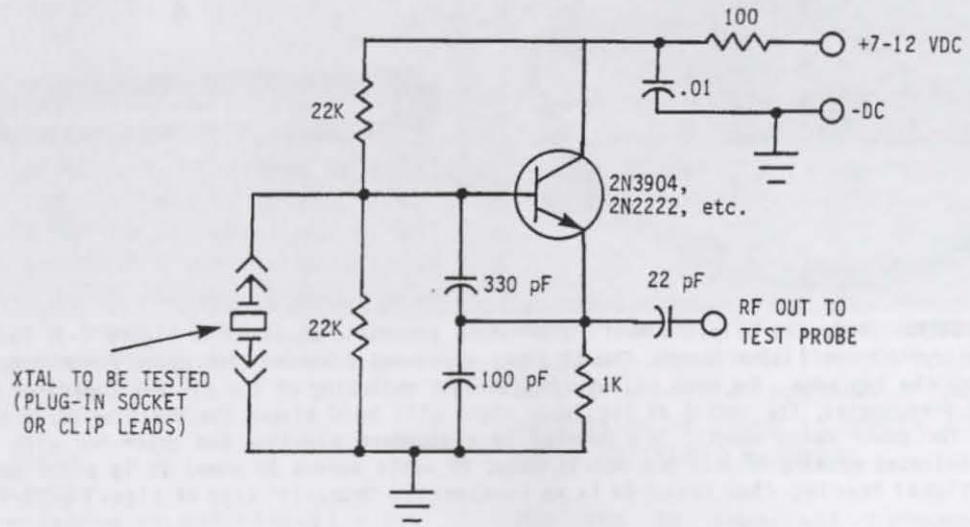
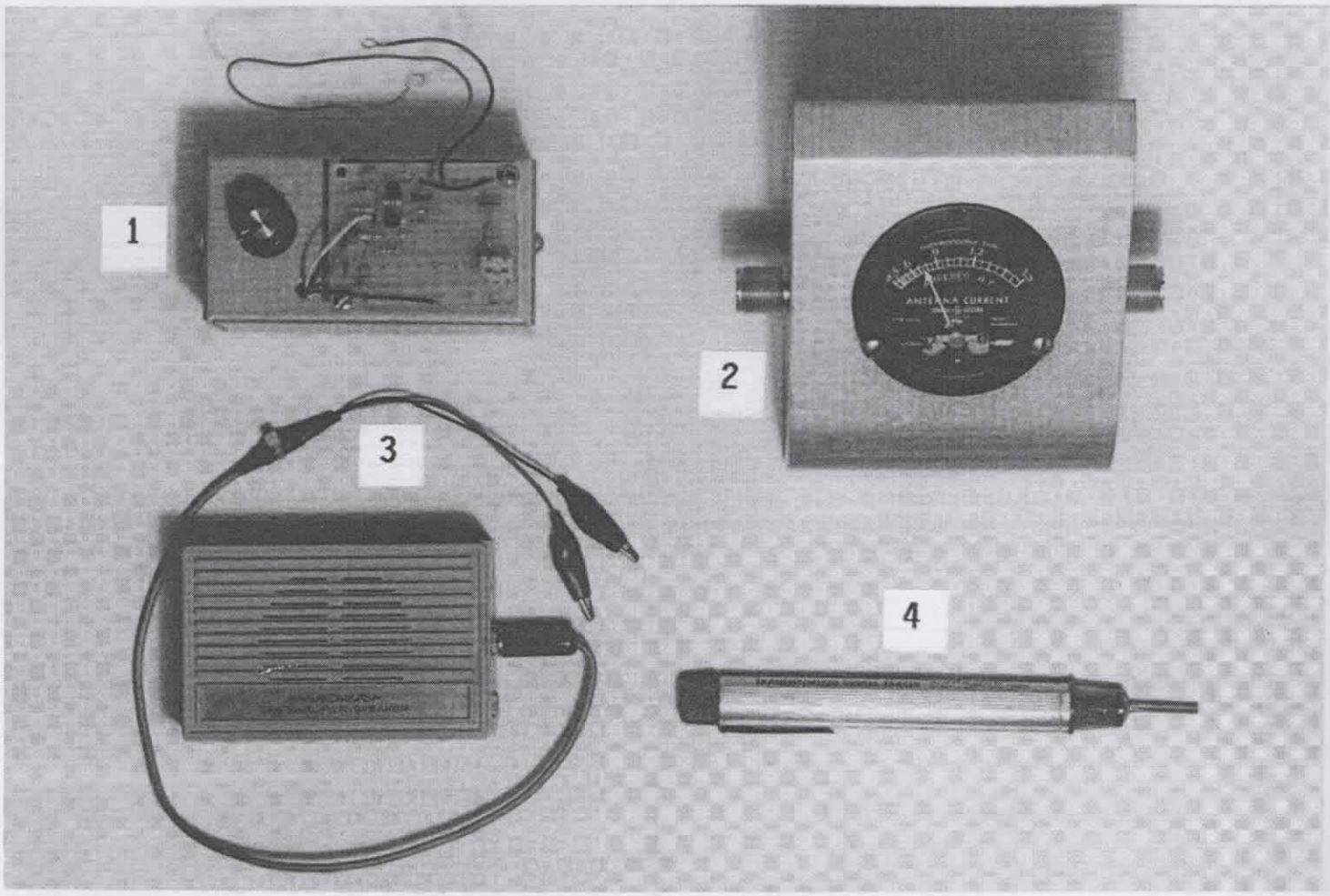


FIGURE 1-3
CRYSTAL CHECKER



simple diode noise generator for this purpose; the RADIO AMATEUR'S HANDBOOK shows examples. You could even use a hair drier or electric drill as noise sources but these are less reliable. Better to inject the noise directly into the coax socket.

Most RF signal generators have calibrated output steps down to about 0.3 µV. Modern SSB transceivers have extremely good sensitivities, often as low as 0.15 µV. Obviously you can't measure this accurately without some help, like a resistive attenuator pad in series with the generator and test receiver. A 20 dB pad is shown in Figure 1-4. The most convenient way to get ultra-low signals is to insert this pad in series while setting your generator for a higher output range. The value of 20 dB is purposely chosen for simplicity in converting the readings, since 20 dB equals a voltage ratio of 10:1. The pad therefore cuts the output from the generator to 1/10 what it says it is. For example, if you needed a 0.1 µV signal, a 20 dB pad in series with 1.0 µV from the generator gives the required 0.1 µV.



MISCELLANEOUS TESTERS: #1 is the Colpitts oscillator whose schematic appeared in Figure 1-3. This was made from one of our EXPANDER 160 crystal oscillator boards. The DC power wires and a hooked test point for a 'scope or frequency counter are located along the top edge. The knob allows simultaneous switching of the divider capacitor values to test a wide range of crystal frequencies. The socket at its lower right will hold either the HC/18 or HC/25 crystal types. #2 is an RF Ammeter used for power measurements. It's mounted in a standard aluminum Bud meter box with SO-239 coax sockets on each side. The indicated reading of 0.75 RFA equals about 28 watts across 50 ohms. #3 is a 200 mW Radio Shack audio amp used for audio signal tracing. (See text.) #4 is an inexpensive "buzz-it" type RF signal generator.

The T-pad shown doesn't really require these precise resistance values; a standard 39Ω resistor could be used for R1. This pad is designed for a 50Ω impedance and it's very important to keep the leads short to minimize stray reactances that would spoil the impedance matching. Mount the circuit in a small aluminum box with BNC jacks at both ends and you're all set. You can also find ready-made pads at the same surplus places that sell the URM25/F signal generators.

CB TECHNICAL SPECIFICATIONS DEFINED

Now that you have an idea of the type of test equipment you'll need, I'll explain more exactly what they tell you about a radio's performance. All the major measurement areas are discussed in the following paragraphs.

THE DECIBEL

Perhaps the most common power measurement unit in electronics is the "decibel" or "dB." The strength of a signal may be defined in terms of its relative loudness to the human ear, which responds to an increase or decrease in loudness by the ratio of the power levels without regard to their absolute values. If a listener estimates that a signal sounds "twice as loud" when going from say, 5 W to 10 W, he'd also estimate that a change from 1 KW to 2 KW sounds twice as loud. In other words, the ear responds to logarithmic changes.

Such changes are the basis for the decibel, which is a unit of relative power. The definition of "1 dB" is that amount of loudness change (up or down) which is just detectable to a listener under ideal conditions. The exact mathematical relationship is one of the most basic of electronic formulas:

$$dB = 10 \log P_2 \div P_1$$

Common logarithms (Base 10) are used, and the larger value is always P_2 so the ratios will be greater than 1. Logarithms can be found using a scientific pocket calculator, or looked up in a table in electronics or math books. For example, what would be the dB power gain of an RF amplifier which produces 4 watts output from a 0.4 watt (400 mW) input signal? Ignore any circuit losses for the moment. Using the above formula, determine the P_2/P_1 ratio first and the rest is a snap:

$$\frac{4 \text{ watts}}{0.4 \text{ watts}} = 10;$$

the log of 10 (from tables or calculator) = 1.

Therefore the dB power gain is 10 x 1 = 10 dB. Simple eh? (By the way, the figure of 10 dB power gain is typical of the Driver and Final RF stages in most solid-state CB transmitters.)

Since decibels are based on logarithms, they can be added or subtracted algebraically. For example, what's the net gain (or loss) of an antenna system with 6 dB antenna gain and 1 dB loss in the coax feedline? The answer is

$$(+6 \text{ dB}) + (-1 \text{ dB}) = +5 \text{ dB system gain.}$$

Note the dB is based upon power ratios. However many times you're not dealing with power but with voltage or current instead. So it's convenient to use the decibel for these units, if the measurements are made across the same value of impedance. When the input and output impedances are equal, the formulas are:

$$dB = 20 \log V_2 \div V_1 \text{ (for voltage ratios)}$$
$$dB = 20 \log I_2 \div I_1 \text{ (for current ratios)}$$

Recalling the 20 dB pad used with the signal generator, you'll see that 20 dB of voltage change is equal to a ratio of 10.

The dBm Reference

A related measurement unit is the "dBm," which means "dB referenced to 1 milliwatt." It's often handy to have some zero reference point from which to make a measurement, and the dBm fits this purpose since dB units may be added to or subtracted from the zero reference level. The dBm value is found by the formula

$$dBm = 10 \log [20(V_{RMS})^2],$$

where dBm is the power referenced to one milliwatt and V is the RMS voltage across the output source's impedance. The values can be calculated or found in charts like those in THE RADIO AMATEUR'S HANDBOOK.

The dBm is important because an alignment procedure sometimes specifies signals in dBm rather than microvolts, which may confuse you

if you don't know what it means. For example, an RF signal of 1.0 µV equals -107 dBm. So if the alignment procedure said to "inject a signal of -107 dBm" you'd know what that means, especially if the signal generator is calibrated in microvolts. Or suppose an RF amplifier stage had a 20 dB gain. Injecting a signal of -107 dBm at its input would result in an output signal of -107 dBm + 20 dB = -87 dBm.

A SAMPLE TRANSCEIVER

Figure 1-5 is typical of the specifications found in CB radio service manuals. These particular specs come from the popular Cobra 148GTL-DX/Superstar 360FM Uniden chassis. I've purposely chosen this model because it has FM as well as AM/SSB modes and there are some unique properties of FM worth pointing out. First we'll list all the specs, then we'll talk about what the most important ones mean. We'll skip the obvious specs like size, weight, number of channels, etc.

Definitions (From Chart Page 15)

FREQUENCY TOLERANCE: This spec refers to the guaranteed carrier frequency accuracy. It's usually expressed as a percentage, like ".005%" in this example. Sometimes the actual tolerance in Hz is given; the Cobra 2000GTL specifies ±130 Hz. To figure the tolerances, multiply the carrier frequency by the tolerance percentage. Assuming a frequency of 27.185 MHz (Ch.19) and a tolerance of .005%, the actual value is

$$27{,}185{,}000 \times .00005 = \pm 1359 \text{ Hz}$$

Note the tolerance will change slightly from Ch.1 (1348 Hz) to Ch.40 (1370 Hz), since you're multiplying by different channel frequencies. (That's why the SAMS Fotofacts from Volume #194 on show the actual frequency limits, where earlier volumes only listed the center carrier frequency itself.

By the way, the value of .005% is the FCC maximum, and practically all PLL CBs exceed this. As shown above, the Cobra 2000GTL with its ±130 Hz tolerance is ten times better than the specs allow! The older crystal type radios needed that extra tolerance for drift caused by temperature and voltage fluctuations.

FREQUENCY STABILITY: This figure, expressed as a percentage of the center carrier frequency, indicates how much the frequency will drift after the unit warms up for 30 minutes. This is a measure of the transceiver's voltage regulation, operating temperature range, quality of crystals used, and general overall design. Again with PLL control, frequency stability is excellent.

MICROPHONE: Nowadays these are always dynamic types with an impedance of 300-1KΩ. They may plug in or wire directly into the chassis as in some older 23-channel types. The dynamic element is the most desirable since it's very rugged, immune to temperature and humidity changes, and being low-impedance is compatible with solid-state audio amps without needing transformers or other impedance matching circuits. Oldtimers may remember the Johnson CB line with its high-impedance ceramic mikes; being less common, they were harder to repair.

While we're at it, let's clear up all the confusion about "low-impedance" and "high-impedance" mikes. The only mikes that are truly high-Z are the crystal or ceramic types; the impedance is generally about 50K-100KΩ or more. Being high-Z the output levels are somewhat higher than dynamic types, but modern high-gain mike amp circuits are cheap and easy to design so the output level is no longer important. All other mike types are low-Z, <u>including</u> power mikes. The output of a power mike amp is generally 1K-5KΩ which can be considered low-Z. Even if the mike element itself is high-Z (like the ceramic element of the popular D-104) its amplifier has already converted the high-Z input to a low-Z output at the mike cable, which is all the radio input sees anyway.

INPUT VOLTAGE: This describes the permissible range of DC input voltages for proper operation. The nominal value of 13.8 VDC is generally the charging voltage across the battery terminals of a running auto engine, so this figure has become standardized for solid-state mobile equipment. Since the modern CB has been designed for proper biasing from a main input source of 13.8 VDC, even the base versions set their AC-to-DC converter at this level. Walkie-Talkies are the only real exceptions and actually do run on 12 VDC from internal batteries.

It's extremely important to maintain the proper

FIGURE 1-5
CB TECHNICAL SPECIFICATIONS

GENERAL

Frequency Tolerance:	.005%
Frequency Stability:	.001%
Microphone:	Dynamic, 600 ohms
Input Voltage:	13.8 VDC nominal, 15.9 VDC max., 11.7 VDC min., pos/neg ground
Current Drain:	TX: AM full mod., 2.2 A. SSB 12 W PEP, 2.0 A. RX: Squelched, 0.3 A. Maximum audio, 0.7 A.

TRANSMITTER

Power Output:	AM/FM/CW, 5 watts. SSB, 12 watts PEP.
Modulation:	High and low-level Class B, AM. Variable capacitance, FM.
FM Deviation:	±1.5 KHz @ 20 mV 1 KHz audio.
SSB Carrier Suppression:	-55 dB.
Unwanted Sideband Suppression:	-50 dB.
SSB Intermodulation Distortion:	3rd order, more than -25 dB. 5th order, more than -35 dB.
Spurious Harmonic Radiation:	-65 dB.
Output Impedance:	50Ω unbalanced.

RECEIVER

Sensitivity:	SSB/CW: 0.25 µV for 10 dB (S+N)/N at more than 1/2 watt audio output. AM: 0.5 µV for 10 dB (S+N)/N at more than 1/2 watt audio output. FM: 1.0 µV for 20 dB (S+N)/N at more than 1/2 watt audio output.
Selectivity:	AM/FM: -6 dB @ 3 KHz, -50 dB @ 9 KHz. SSB/CW: -6 dB @ 2.1 KHz, -60 dB @ 3.3 KHz.
Cross Modulation:	-60 dB
Adjacent-Channel Rejection:	AM/FM: -60 dB; SSB/CW: -70 dB.
Image Rejection:	More than -65 dB.
IF Frequency:	AM/FM: 10.695 MHz 1st IF; 455 KHz 2nd IF. SSB/CW: 10.695 MHz.
Automatic Gain Control (AGC):	Less than 10 dB change in audio output for inputs from 10 µV to 100,000 µV.
Squelch Range:	Adjustable, 0.5 µV to 1,000 µV.
Audio Frequency Response:	450-2500 Hz TX, 300-2500 Hz RX.
Maximum Audio Power Output:	4 watts into 8 ohms.
Audio Power Output @ 10% THD:	3 watts.

input voltage. Low voltage won't damage anything but will degrade receiver sensitivity and greatly reduce transmitter output power. But excess input voltage can quickly burn out the transmitter RF amplifier stages, as well as ICs and other voltage-sensitive components. Always verify correct input voltage on radios you're servicing!

All modern transceivers operate with positive or negative ground electrical systems, which means the main PC board isn't making a direct electrical connection to the radio frame but is "floating" instead. This allows the radio to be bolted directly to the body of a positive-ground vehicle without causing a short circuit, and is a convenience feature since some large trucks and foreign autos do use positive ground electrical systems. The PC board is grounded to the radio frame for RF via several disc decoupling capacitors, and that's why you'll see two different ground symbols on the schematic. One symbol actually means "vehicle body" ground and one means "chassis common tie point." Mixing the two different grounds can cause ground loops and other problems which may drive you crazy trying to solve!

CURRENT DRAIN: The CB transceiver will draw different amounts of power depending upon operating mode. This spec can help determine if an internal problem is causing excessive current draw, and also suggests an adequate power supply size for the type of radio being serviced. Typical values are:

Transmit AM/FM/SSB @ full modulation = 2.2 A*
Receive squelched = 300 ma to 650 ma
Receive @ full rated audio = 700 ma to 1.2 A

*Higher power radios like the President Jackson may draw over 3.0 A on transmit; use a heavier power supply.

TRANSMITTER POWER OUTPUT: This is the RF power output measured at the antenna jack when terminated in a non-inductive 50Ω load. The power output depends upon the mode, and is the unmodulated value for AM (and FM) and the peak-envelope-power (PEP) for SSB. For American CBs this is always 4 watts for AM and 12 watts PEP for SSB. Since these levels are the legal limits, the manufacturer is never going to say his equipment puts out less power! For export models the RF power may be higher, and in some (President Jackson, Franklin, Grant, Ranger AR3300, Super Galaxy and Galaxy II, etc.) is actually double the normal power.

MODULATION: This is almost always high- and low-level Class B for AM, and variable capacitance for FM. Exceptions include the Uniden Jackson and all the CPI radios, which use low-level AM. We'll discuss classes of operation and FM generation in CHAPTER 5. This is really more of a circuit description than a specification, since it can't be changed.

FM DEVIATION: This refers to the amount of frequency shift above and below the unmodulated carrier frequency. Since the total deviation depends upon both the modulating frequency in Hz and the input amplitude in millivolts, these figures must always be included for the spec to be meaningful.

SSB CARRIER SUPRESSION: The whole idea of SSB is that supression of the unwanted carrier allows more useful power to apply to the sidebands. This spec indicates how well that's being done. If the carrier is not fully supressed the listener will hear an annoying heterodyne along with the voice. The higher the dB suppression figure, the better. Modern CBs generally specify at least -45 to -55 dB, which is good to excellent. Carrier supression is affected by both the balanced modulator circuit used, and the crystal filter which eliminates the unwanted sideband.

UNWANTED SIDEBAND SUPPRESSION: This measures the ability of the SSB transmitter to eliminate the unused sideband. Like carrier suppression more is better, with -40 dB the FCC minimum but -55 dB being more typical of modern equipment. The spec is most affected by the quality of the crystal filter removing the unwanted sideband. This filter may also be used for SSB reception and therefore affects receiver IF selectivity. You'll find that the radios with the poorest adjacent-channel rejection also have the worst spec in this category.

INTERMODULATION DISTORTION (IMD): This measures signal purity in the mixer stages. If excessively strong RF signals are fed to the mixer, its output no longer changes linearly with the input. When not purely linear, distortion products form which can cause interference to nearby frequencies on Transmit or desensitization on Receive. The IMD products are similar to harmonics and are assigned numbers indicating their strengths relative to the carrier. The most important products are

the 3rd, 5th, 7th, and 9th "order", which is why they're often specified individually. Once again, the more IMD suppression the better.

CROSS MODULATION: This is a form of receiver distortion closely related to IMD and most noticeable on AM. It's possible for a signal on a nearby frequency to modulate the signal on a desired frequency, even though the unwanted carrier is well outside the receiver's IF passband. A good spec for this is -60 dB, and is typical of better radios. It's basically a reflection of careful receiver design.

FREQUENCY RESPONSE: This indicates the range of audio frequencies transmitted and received. Since voice communications require a much narrower range than say, a hi-fi FM stereo, only a narrow band is allowed to pass through the audio circuits. There's little reason to even specify this, since virtually all two-way radio equipment operates in the audio range of about 300-2500 Hz anyway.

OUTPUT IMPEDANCE: Why this is even listed I'll never understand, since it's always 50 ohms by design. This is standard for virtually all two-way radio equipment. "Unbalanced" means there's a single hot conductor, with the radio's frame providing the ground return. This allows the use of coaxial cable to connect the equipment to the antenna.

SPURIOUS RADIATION: When CB really got popular in the mid 1970s, TV viewers screamed bloody murder from all the interference they received. During the 23-to-40 channel conversion period the FCC tightened certain technical specs, including this one. This is a measure of all the unwanted junk (like harmonics) radiating from the radio cabinet. The FCC spec is -60 dB. All American CB manufacturers must comply anyway, so any 40-channel FCC-approved model is going to specify this figure. (Unless of course the radio is even better.) This spec is determined by the amount of metal shielding and filtering used in the transmitter circuits. You oldtimers from the 23-channel era have probably noticed all the extra metal shielding in the 40-channel transceivers. Spurious radiation is measured with a Spectrum Analyzer, a very expensive instrument usually reserved for the R&D lab and not the average CB shop.

RECEIVER SENSITIVITY: This is one of the best indicators of quality and careful design, and measures the ability to detect very weak signals against the normal background noise. The zero reference level is the noise itself, and a standard figure of 10 dB compares the signal to the noise. Hence the term, "Signal + Noise to Noise Ratio," or "(S+N)/N." The signal strength in microvolts when it's 10 dB louder than the noise is the rated sensitivity. For this measurement less is better; the lower the µV reading the better the sensitivity. Anything under 1.0 µV is good, with many transceivers having even hotter specs. An audio output level like "1/2 watt" is often included to give the spec a meaningful reference.

Note different specs were quoted for the AM, FM, and SSB/CW modes. Note also that SSB sensitivity is better than AM, and FM is specified differently than AM. The reason SSB is better is because the signal is being passed through a narrower IF filter which occupies only half the bandwidth of a comparable AM or FM signal. Since the receiver bandwidth is narrower, less noise gets through, thus improving the S+N/N ratio.

FM is unique. When the received signal is strong enough to start limiting action the set begins to "quiet," meaning the background noise disappears. FM sensitivity is rated in terms of the amount of input signal required to produce a given amount of quieting, usually 20 dB. In other words, the amount of signal required to reduce the background noise by 20 dB is the rated sensitivity. With modern IC FM Detectors, sensitivities of less than 1.0 µV are easily attainable. Because of the inherent noise reduction of FM it can function with much higher background noise levels. This partly explains why the background hiss noise is so much louder than AM in a multimode radio. Note the µV rating is for 20 dB quieting, compared to the 10 dB S+N/N for comparable AM.

SELECTIVITY/ADJACENT-CHANNEL REJECTION: These are the other major indicators of quality receiver design. Some manufacturers give both specs and some use only the Selectivity spec, but both mean almost the same thing. The listener shouldn't be bothered by "bleedover" interference from an adjacent channel during normal reception. Basically this says a signal of a given strength will be so many dB weaker one channel (10 KHz) higher or lower than in the center of the desired channel. For the Adjacent-Channel spec, more is better; -30 dB is the absolute minimum and the better radios may specify up to -70 dB. The spec will be

better for SSB (or CW), since a narrower IF filter is used. (See CHAPTER 6.)

Selectivity is defined in a slightly different way. It states the attenuation as a function of how far removed the signal is from the center frequency: at so many KHz from center, the signal will be reduced so many dB. Two points are chosen and a graph of attenuation vs. center frequency has the shape of a skirt; i.e., flat across the top and dropping off sharply on both sides. Hence the term "skirt selectivity." The IF bandwidth at the -6 dB and -60 dB points is most often used, although CB manufacturers vary widely in their choice of measuring points. In our example, the AM/FM spec states that "at ±3 KHz from center, the signal will be reduced by 6 dB, and at ±9 KHz, by 50 dB." Notice again the SSB/CW spec is better due to its narrower IF filter.

Receiver selectivity depends upon factors like the number of tuned circuits, single- vs. double-conversion, etc. More in CHAPTER 4.

IMAGE REJECTION: Images appear whenever two signals mix together to form an Intermediate Frequency, or IF. If not attenuated they can be annoying and show up as "birdies" at many places around the band. This spec indicates how well they're reduced. More is better. Some of the cheaper CBs have only about -40 dB image rejection even with dual-conversion, while the good ones measure more than -60 dB.

IF FREQUENCY: This isn't really a spec but a circuit definition. The industry standards are 455 KHz and 10.695 MHz, and these are used in most modern CBs. Some radios use 7.8 MHz, 11.275 MHz, 9.785 MHz, 4.3 MHz, and other odd frequencies for the high IF. All this really tells you is whether the radio has a single- or dual-conversion receiver. Dual-conversion is better. Radios having FM will always be dual-conversion because narrow-band FM of the CB type is easy to detect at 455 KHz but not at the higher IFs of single-conversion receivers, which have much narrower IF bandwidths.

AUTOMATIC GAIN CONTROL (AGC): This is a circuit that keeps the receiver volume level constant with widely fluctuating input levels. It's especially important for SSB, since with no carrier the signal strength changes only with speech. Without AGC you'd be blasted out of your chair whenever a stronger signal came on the channel, and that signal would probably be very distorted too.

This spec measures how wide a range of signal inputs can be handled by the receiver, called its "dynamic range." The EIA (Electronic Industries Association) specifies that audio output should be maintained within 30 dB for input levels from 1-50,000 µV for AM receivers, and within 16 dB for SSB receivers. Most CBs (including our example) specify an audio change of no more than 10 dB, which obviously exceeds the EIA specs. The better the AGC circuit, the wider the dynamic range it can handle. AGC may be specified in terms of signal strength limits, or by a straight dB figure for dynamic range. The example quotes 10-100,000 µV for the signal range. We could easily convert this to dynamic range using the previous formula,

$$dB = 20 \log E_2 \div E_1$$

Remember we're dealing with (micro)volts so we use that formula. Dividing 100,000 by 10 equals 10,000. The log of 10,000 is 4. Multiplying 20 x 4, we get the answer of 80 dB. This is a very good AGC dynamic range figure and is typical of the better CBs; 100 dB would be outstanding.

SQUELCH RANGE or SQUELCH SENSITIVITY: Usually one or the other is specified. The sensitivity figure, which is the most common, indicates the weakest signal that will break squelch. This is usually close to the main sensitivity spec; i.e., about 0.5 µV. When stated as a range this tells you the weakest and strongest input signals that can be squelched. A good squelch circuit can handle from 300-1,000 µV, right on down to the rated receiver sensitivity.

AUDIO OUTPUT POWER: This is specified at some percentage of total harmonic distortion (THD), usually 10%, and across some load impedance like 8Ω, but occasionally 4Ω or 16Ω. There's nothing you can do to increase the audio power output so if a customer needs the radio's PA function, suggest one having a 4-watt output rating which is about the maximum available. Many older models only had about 2 watts output, barely adequate for a PA or inside the cab of an 18-wheeler. All the better radios have 3-4 watts of output power.

AUDIO FREQUENCY RESPONSE: This range is about 300-2500 Hz for communications purposes and you'll never see anything much different. RC filtering in the receiver and transmitter audio circuits keeps the response within this range.

This sums up all the most common transceiver specs you're likely to see. I've left out the obvious ones like Clarifier Range, RF Gain control range, metering, dimensions, number of semiconductors, etc. In later chapters we'll learn how many of these specifications can be measured or affected by alignment.

WHERE TO FIND JUST ABOUT EVERYTHING

Following is a partial shopping section. U.S. readers can probably find most things for a complete CB shop here, or on the Internet. Foreign readers should try to use local sources or the Internet. Many of these sources offer free catalogs if you ask for them.

IMPORTANT NOTE!
In a book like this which may only get reprinted every few years, it's almost impossible to keep this section updated. People and companies move, go out of business, change their phone numbers, merge with other companies, etc. If a particular company shown here winds up a dead end, I strongly suggest searching the Internet; specifically, see Amazon, Google, our Web site, or other places for newer contact details. We do try to keep an updated, categorized list at:
www.cbcintl.com/suppliers.htm

Please tell us if you come up empty. Meanwhile, many good sources for parts, books, and test equipment are in any of the Ham Radio magazines like **CQ** and **QST**. (QST is the ARRL's Ham magazine; see column at right.) Most of the other general electronics mags have either changed to computers or fallen victim to the Internet. Among the best Ham magazines are:

CQ AMATEUR RADIO MAGAZINE
25 Newbridge Rd., Hicksville NY 11801
(800) 853-9797 • www.cq-amateur-radio.com

A sneaky way to get a free sample is to ask them about advertising by using your printed letterhead, and they'll usually do it. A very good idea in case you live in the boonies or can't find it locally. All the good books and magazines can be found in the pages of CQ or any of the other sources shown on our Web page.

A very handy source for all kinds of electronic parts and manufacturers (by category) is the annual ELECTRONIC INDUSTRY TELEPHONE DIRECTORY. It's expensive ($60+), but you can often find a used EITD on Amazon. There's probably an online version by now too. Try their publisher:

HARRIS PUBLISHING CO.
2057 E. Aurora Rd., Twinsburg OH 44087
(330) 425-9000

REFERENCE READING LIST

Some of the following are classics and are now out of print. Check with the publisher or your local book store, library, or online for availability, or if there's a newer edition.

THE CB PLL DATA BOOK, by Lou Franklin ($25).
Published by CBC INTERNATIONAL
P.O. Box 30655, Tucson AZ 85751
FAX: (520) 298-7980. Internet: www.cbcintl.com

How PLLs work and how to modify them for more channels or 10-Meter Ham use. This is my complete reference with simplified circuit theory, complete pin-out specs for every known chip, PLL block diagrams of most common types, all cross-referenced by make and model, etc.

THE ARRL RADIO AMATEUR'S HANDBOOK
American Radio Relay League Inc.
225 Main St., Newington CT 06111
www.arrl.org • QST Magazine
Main: (860) 594-0200, Orders: (800) 243-7767

This is the classic "bible" of radio communications and no bookshelf is complete without a copy. Originally intended for Hams, many people (including me) consider it the single most important reference for any serious electronics student. Detailed background theory, building ideas, and reference tables. The editions from 1986 on are huge, and now include PC artwork for many test equipment construction projects. Starting with the 1996 edition, they've combined this with their equally great **ARRL ANTENNA HANDBOOK**. That one has the most detailed antenna theory you'll find short of an engineering library. Learn the dope on SWR once and for all. Includes many practical antenna projects for mobile and base HF and VHF/UHF antennas. One huge new electronics reference work in a beautiful hardbound cover. You need this one! The ARRL also has a big bookstore, sunspot info, etc.

The European equivalent is the **RSGB RADIO COMMUNICATION HANDBOOK**. Available from the Radio Society of Great Britain, Alma House, Cranborne Road, Potters Bar, Herts. EN6 3JW, England. Also stocked by Ham Radio Outlet in the U.S.; see Page 21.

The following titles are a few of the many books available. Although some are old, they're just as relevant to CB technology today. I've got them all in my personal library, and in fact have used them all in researching this book. Nothing's more important than reading everything you can find and learning from it. You're not a true technician unless you also understand the theory and can design simple circuits yourself, or at least being able to modify them or draw them schematically. That makes you better than the next guy and gets you the extra business!

Many of these books are available in the better Ham Radio stores such as those listed here. As of early 2013 I searched for all of them online and found they're still available, new or used, at Amazon, Google Books, Barnes & Noble, etc. If you search these sites you'll find them and a lot more electronics books.

LANDMOBILE AND MARINE RADIO TECHNICAL HANDBOOK
by Edward M. Noll
SAMS Technical Publishing
9850 E. 30th St., Indianapolis IN 46229
Orders: (800) 428-7267 • **www.samswebsite.com**
An excellent 576-page SAMS book covering all aspects of two-way radio operation and repair, including solid-state radio fundamentals, CB, marine, VHF/UHF, testing procedures.

MOBILE RADIO SERVICING HANDBOOK
by Belcher, Ogley, & Fitch.
Heinemann-Newnes Books, London, England
Like the SAMS "Landmobile" handbook above. Emphasis is on evolution of radios to the current state-of-the-art, diagnostic and component replacement procedures, what to do in the absence of proper circuit data.

RADIO HANDBOOK, by William I. Orr
Sams Technical Publishing. (See above.)
One of the world's most famous Hams, Bill Orr (W6SAI) wrote countless books and articles on all areas of electronics. The "W6SAI HANDBOOK" is yet another author's way of teaching, and some areas are more or less detailed than the comparable subject in the **ARRL HANDBOOK.** Loaded with theory and many electronic construction projects. This book is also a free download!

ELECTRONIC COMMUNICATION, by Robert L. Shrader
McGraw-Hill Publishing Co.
Orders: (800) 262-4729
www.mhprofessional.com
Another classic textbook. The fact that it's still around after all these years attests to its quality. Covers all areas of two-way radio and broadcasting. I used it to study for and pass the FCC 1st Class Commercial license exam.

PRACTICAL RF COMMUNICATIONS DATA by Doug DeMaw.
Available online, at the **ARRL** & **SAMS**
SAMS: (800) 428-7267 • ARRL: (800) 243-7767
www.samswebsite.com
DeMaw is an engineer and former president of the ARRL who really knows his stuff. This is a great little book on designing all kinds of RF circuits like crystal oscillators and VFOs, mixers, filters, linear amplifiers, etc.

MODERN ELECTRONIC COMMUNICATION
by Gary M. Miller
Prentice-Hall Inc.
(800) 383-2419, (201) 592-2000
An excellent start-of-the-art reference that details radio, TV, microwave, and digital communications theory. Heavily technical and mathematical though, for those of you who really like to dig into the subject.

BASIC DIGITAL ELECTRONICS WITH MSI APPLICATIONS
by John A. Dempsey
Addison-Wesley Pearson Co. (800) 447-2226
This 1977 book is still worth a trip to the library, or get a used one online. All you ever wanted to know about digital stuff. Modern CBs use ICs and even microprocessors. But the only real difference is that those earlier ICs had separate functions which today are found in just one or more really large chips. An example was the SBE Formula D, one of the very first digital CBs whose PLL used 9 individual chips (several with multiple circuits); today all those PLL circuits can be found inside one very large IC.

GENERAL RADIOTELEPHONE LICENSE HANDBOOK
by Edward M. Noll
This and many others with similar titles can be found by searching Barnes-Noble, Google, or Amazon. Excellent Q&A/Theory books to help you prepare for the commercial FCC exams.

NOTE: An FCC license is no longer required to legally repair CBs. A license is still needed for certain other radio services. To learn about the new requirements, write to the FCC, Field Operations Bureau, Washington, DC 20554.

THE TRUTH ABOUT CB ANTENNAS
ALL ABOUT CUBICAL QUAD ANTENNAS
THE BEAM ANTENNA HANDBOOK
all by William Orr
Everything you need to understand CB antennas in general, and high-gain base beams in particular. These guides and lots of other good books are available from the sources mentioned here.

Other Web sites with good book sources include: **eham.net, qrz.com, radio-ware.com,** etc. The Web is the obvious place to start looking.

AMATEUR RADIO EQUIPMENT & DEALERS

HAM RADIO OUTLET (HRO)
933 N. Euclid St., Anaheim CA 92801
(800) 854-6046, (714) 533-7273
hamradio.com/contact.cfm
Probably the biggest, now 12 stores nationwide. The main store is shown here. Or you can use the link above to find your closest store.

HENRY RADIO
2050 S. Bundy Dr., Los Angeles CA 90025
(800) 877-7979, (310) 820-1234
Another great Ham store that refuses to die!

MFJ ENTERPRISES
See listing details under TEST EQUIPMENT – NEW

SPECIALIZED SERVICE INFORMATION

SAMS "FOTOFACTS" CB Radio Series
See address on Page 1. Orders: (800) 428-7267
They finally stopped publishing the CB series of Fotofacts in 1981, after 293 volumes. Each volume covered 3 or 4 models. You will now need to buy a photocopy of an individual CB Fotofacts model from them, or try to find your info elsewhere online. The index from Volume #293 lists every CB they ever covered. This index is also on my Web at: www.cbcintl.com/sams.htm

The last time I checked, SAMS would sell you photocopies for out-of-print Fotofacts. But be prepared to pay about $25 each; there's no other way to get them now unless somebody has put a model online. SAMS schematics are much easier to read than those microscopic Asian drawings, so it's well worth using them. Since they are probably the biggest American publisher of electronics books, a search will probably show many titles of interest to electronic techs.

Many newbies ask me where they can find books on things like how to read schematics, how to use an oscilloscope, etc. SAMS and the other firms here offer titles on these and many other electronic subjects, whether beginner or expert.

SEMICONDUCTOR PARTS SUBSTITUTION MANUAL. Always keep a copy of this handy. The ECG/SK parts lines were bought by NewTone Electronics (NTE), so that's where you need look now. (This also applies to any other ECG/SK references in this book that I might have forgotten to change!)

NTE ELECTRONICS
44 Farrand St., Bloomfield NJ 07003
(973) 748-5089 • (800) 683-6837
www.nteinc.com

JAPANESE TRANSISTOR SPEC/SUBSTITUTION MANUALS. These are great little books straight from the source, updated every year. In many cases this is the only way to get the specs or lead basing on a particular Asian device. If you're an experienced tech you know that many times the TCG/ECG/SK replacement has the same electrical characteristics but different lead basing. With these books you can figure out the basing and the electrical specs for correct substitution. There's also a Japanese Substitution Book, a Japanese FET Book, etc.

One minor problem: the books are written in Japanese, with just enough English words to get by. What I did to figure out their basing diagrams was to use a known Japanese transistor like a 2SC2312 and look up its base drawing; then I wrote the letters E, B, C next to the Japanese characters for these terminals. Now whenever I have to look up an unknown transistor, I compare that Japanese script with the one previously marked.

The only good source I know of now for these great little Asian device books is at Amazon, but there are probably others. I recently saw a 6-book online deal that included not only bipolar devices, but also FETs, diodes, etc.

This section wouldn't be complete without mentioning one of the biggest and most useful CB sites that's ever been online, namely:

www.cbtricks.com

They went to a lot of trouble to put schematics, board layouts, and a lot of other handy info into a huge, all-in-one Web site. Check it out.

CB RADIO MANUFACTURERS

You'll often get a CB where the manufacturer is now out of business, or the customer has no service manual. Many CBs never appeared in SAMS, and newer models have come along since the Fotofacts ended. Following are those companies still in the business, who can provide certain parts and service manuals for their CB radios.

It's not impossible to find a rare part from an extinct CB model, if the main chassis had an equivalent made by a current manufacturer. For example, suppose you need the Audio IC for a Lafayette HB740 radio, a nice chassis (Cybernet PLL02A 2-crystal AM) that's been sold under dozens of other brand names. Midland is still around and has used that very same chassis, so try to get it by specifying <u>their</u> corresponding model number. You can learn which models are identical from the information listed in our **TUNEUP & MODIFICATION REPORTS**, or send a stamped SASE or email. (Cont'd on next page.)

CB RADIO MANUFACTURERS, cont'd

NOTE: You won't find exact replacements for any Uniden or Cybernet export models, unless they're the same parts used in the American versions. The main non-standard parts are the broadband tuning coils; if you need one and can't take one from a junker, you'll have to use the stock narrow-bandwidth American coil. These guys will deny any knowledge of "export" radios, even though their name's on it!

ALAN ELECTRONICS GmbH
(Includes **Albrecht** & some **Midland** models)
www.alan-electronics.de
Daimlerstrasse 1k • 63303 Dreieich, Germany
A very popular brand name all over Europe.

COBRA ELECTRONICS CORP. (DYNASCAN CORP.)
6500 W. Cortland, Chicago IL 60607
Customer Service: (773) 889-3087
Main: (773) 889-8870 • **www.cobra.com**

GALAXY INC.
Repairs: (760) 480-8800 • **www.galaxyradios.com**
Email: techsupport@galaxyradios.com
They only service radios having a "DX" prefix, like "DX-959" or similar. If there's no "DX" on it, it's a cheap copy and they will not fix it! Their address is a big secret too, only revealed when you call to ship your radio to them.

MIDLAND INTERNATIONAL
5900 Parretta Dr., Kansas City MO 64120
(816) 241-8500 • **www.midlandradio.com**
Midland's another possible source for Cybernet parts, which were used a lot in their earlier models. The current AM models use the Korean Maxon chassis, and SSB models are Unidens.

BEARCAT, PRESIDENT, REGENCY – See UNIDEN

RADIO SHACK (Nationwide)
(800) 843-7422 • www.radioshack.com
You can often order a specific service manual or part from your local R/S store, assuming the item's still available. In the last few years R/S has made very few new CBs under their own name, instead choosing to sell some other main CB brands like Cobra, Midland, and Uniden.

RANGER COMMUNICATIONS INC. (RCI)
(Includes Ranger, RCI, Texas Ranger, & some Galaxy)
867 Bowsprit Rd., Chula Vista, CA 91914
www.rangerusa.com

Parts & Service	**Amateur & CB**
Local: (619) 426-6440	Local: (702) 262-0772

UNIDEN AMERICA CORP.
4700 Amon Carter Bl., Ft. Worth TX 76155
(800) 297-1023, (817) 858-3300 • **www.uniden.com**
Includes many rigs with the Bearcat, Cobra, President, Stalker, Teaberry and Uniden labels, plus the main inside guts of many other models like the Midland 79-260, Radio Shack TRC451, TRC453, TRC465, etc.

CB ANTENNA MANUFACTURERS

Quality CB antennas are getting harder to find, since there are fewer distributors other than CB specialty shops. This is a real problem if you live in a small town and have no local sources. The following are known major manufacturers. Contact them to see about buying their products through distributors, or sometimes directly. NOTE: Some of the Websites listed (2013) are old and may be gone by now. Keep searching!

ANTENNA SPECIALISTS CO.
They merged so many times, I cannot find them! But they're out there, still selling CB stuff.

ANTTRON ANTENNA CO.(SOLARCON)
1426 E. Indianola Av., Youngstown OH 44502
(330) 788-9404

FIRESTIK ANTENNA CO. (PAL Firestik)
2614 E. Adams, Phoenix AZ 85034
(602) 273-7151 • **www.firestik.com**

FRANCIS INDUSTRIES INC.
431 W. Broad, Pataskala OH 43062
(740) 927-4091

HUSTLER INC. (Includes **NEW-TRONICS** and **ANTLER**)
#1 New-Tronics Pl, Mineral Wells TX 76067
(817) 325-1386

JO GUNN ENTERPRISES
3138 County Road 30, Ethelsville AL 35461
(205) 658-2229 • **www.jogunn.com**

K-40 ELECTRONICS
Contact them through:
DAS: (800) 228-1291
www.k40.com

SHAKESPEARE CO.
6111 Shakespeare Rd., Columbia, SC 29223
P.O. Box 733, Newberry SC 29108
(800) 845-7750, (803) 227-1590

SIGNAL ENGINEERING
1172 Aster Av.
Sunnyvale CA 94086
(408) 247-2300
www.signalengineering.com

(cont'd on next page)

CB ANTENNA MANUFACTURERS, cont'd

WILSON ANTENNA
724 Lawn Rd., Palmyra PA 17078
(800) 542-6263
www.wilsonantenna.com

CB DISTRIBUTORS & SPECIALTY SOURCES

SCANNER WORLD USA
17 Interstate Av., Albany NY 12205
(800) 476-8050, (518) 436-9606
All major brands of CBs, scanners, & accessories

GC ELECTRONICS
1801 Morgan St., Rockford IL 61102
(815) 316-9080
Best known for their CB accessories like DC power plugs, dummy loads, antenna hardware, chemicals, mike connectors, tuning tools, etc. Get the name of your local distributor.

RF PARTS CO.
435 S. Pacific St., San Marcos CA 92069
(800) 760-744-1943 • **www.rfparts.com**
Huge stock of RF transistors and tubes, Ranger line of 10-Meter transceivers, many CB-related accessories, Antron antennas, etc. Also the best source around for linear amp schematics when yours blows up. Schematics, NOT the amps!

TALLEY COMMUNICATIONS
12976 Sandoval St., Santa Fe Springs CA 90670
(800) 949-7079, (562) 906-8000
www.talleycom.com
One of the few reputable CB wholesalers left, for serious dealers only. Brand lines include Cobra, Uniden, and many others.

CONTINUING EDUCATION & CORRESPONDENCE COURSES

FREE ELECTRONICS COURSES & TUTORIALS
By IAN C. PURDIE, VK2TIP
plus U.S. NAVY TRAINING SERIES (NEETS)

www.electronics-tutorials.com/site-tree.htm
www.fcctests/neets/neets.htm

Great self paced, online electronics training. These are FREE and online to fit your schedule and convenience. Separate modules for each subject to quickly choose only those you need. Over 120 topics last time I checked. Plus kit projects to help you learn, and some sample FCC license tests from the latest question pool. The price is right, and you'd be crazy not to check this out. Most were written by an Australian Ham named Ian C. Purdie, VK2TIP. Plain English, easy to read and understand!

TEXAS INSTRUMENTS "UNDERSTANDING ELECTRONICS"
The famous computer chip giant also made a very well written series of books. The basic book "UNDERSTANDING SOLID-STATE ELECTRONICS" is an excellent self-study work, with quizzes for each chapter. They also offer cassette courses to go along with the books. You can still find these used on Google and Amazon.

TEST EQUIPMENT - NEW

MFJ ENTERPRISES
300 Industrial Park Rd., Starkville MS 39759
(800) 647-1800, (662) 323-5869
www.mfjenterprises.com

CONTACT EAST
P.O. Box 786, N. Andover MA 01845
(508) 682-2000

POMONA ELECTRONICS
1500 E. 9th St., Pomona CA 91766
(909) 623-3463.
Perhaps the biggest specialty source of test accessories. Regular and SMD clipleads, probes, connectors, coax adapters of all family types.

TUCKER ELECTRONICS
1717 Reserve St., Garland TX 75042
(800) 527-4642, (214) 348-8800
All the major brands of new and used test equipment, professional tools, repairs and calibrations, hobby radios and scanners.

TEST EQUIPMENT - USED

FAIR RADIO SALES COMPANY INC.
2395 St. Johns Rd., Lima OH 45804
(419) 223-2196, 227-6573 • **www.fairradio.com**
Here's where to find one of those vintage URM25 RF signal generators, RF ammeters, etc. A huge warehouse crammed full of surplus electronic parts, used HP and Tektronix test equipment, etc. Many hard-to-find items you'll never see in the usual chain stores. Free catalog.

NUTS & VOLTS MAGAZINE
430 Princeland Ct., Corona CA 92879
(951) 371-8497 • **www.nutsvolts.com**
Subscriptions: (800) 783-4624, (877) 525-2539
Another big (monthly) swap sheet read by about 50,000 Hams and other electronic scroungers. You just might find what you need here, or sell off your unwanted junk. Ask for a sample.

GENERAL REPAIR PARTS

You're much better off buying from these guys than the manufacturers, who mark up everything about 500%. Unless you need a really special part (Channel Selector switch, dual-ganged pot, etc.) use the following companies. Over the years I've dealt with all of them personally. Most carry a wide range of test equipment and tools too. We've been buying all the parts for our CBC catalog kits from **DIGI-KEY, MOUSER,** and **CIRCUIT SPECIALISTS** for over 20 years now. All have fast delivery, and almost never seem to be out of stock on catalog items. The other companies listed are smaller, but just as good.

ALL ELECTRONICS CORP.
14928 Oxnard St., Van Nuys CA 91411
(888) 826-5432, (818) 904-0524
www.allelectronics.com
A large mailorder supplier for new and surplus parts and test equipment. Free catalog.

ALLIED ELECTRONICS CORP.
7151 Jack Newell Blvd. South
Ft. Worth, TX 76118
(866) 433-5722 • **www.alliedelec.com**
I remember these guys from when I was a kid, drooling over catalog products from their single huge store in Chicago. Their catalog is still a few inches thick but it's free, so they probably have what you're looking for nowadays. Contact the corporate office shown above, then you can search their Web for a sales branch near you.

CIRCUIT SPECIALISTS INC
P.O. Box 3047, Scottsdale AZ 85271
(800) 528-1417 outside AZ, (602) 464-2485
Excellent source for all general replacement parts like semiconductors, chokes, capacitors, resistors, trimmers, etc. Free catalog.

DALIS ELECTRONICS
3645 E. Atlanta Av. #2, Phoenix, AZ, 85040
(800) 888-1408, (602) 275-2626
www.daliselectronics.com
All general new replacement parts, including NTE semiconductors, GC Electronics items, Amphenol and Belden coax, etc. Accepts small orders.

DIGI-KEY CORPORATION
P.O. Box 677, Thief River Falls MN 56701
(800) 344-4539, (218) 681-6674
www.digikey.com
Huge inventory of general parts, particularly the cheaper Asian types. Also some of the CB type Toko coils and transformers. Free catalog.

GENERAL REPAIR PARTS, cont'd

MCM ELECTRONICS INC.
405 S. Pioneer Bl., Springboro OH 45066
Sales: (888) 235-4692
Tech Support: (800) 824-8324
www.mcmelectronics.com
Major source for Japanese transistors and ICs. Large selection of connectors and major test equipment. Free catalog.

MOUSER ELECTRONICS
1000 N. Main St., Mansfield TX 76063
National sales: (800) 346-6873
www.mouser.com
Like **CIRCUIT SPECIALISTS** and **DIGI-KEY**, with a giant parts inventory. They also stock the NTE semiconductor replacements, some exotic hardware (like those special metric cabinet screws), test equipment, etc. Free catalog.

NEMAL ELECTRONICS INC.
12240 NE 14th Av., Miami FL 33161
(800) 522-2253, (305) 899-0900
www.nemal.com
A major Amphenol distributor when you need any type of coax cable or special coax connectors. And they are willing to accept small or individual orders.

RAMSEY ELECTRONICS
590 Fishers Station Dr., Victor NY 14564
www.ramseyelectronics.com
(800) 446-2295 • (585) 924-4560 EST
A great place that's been around for about 40 years. Sells all kinds of electronic parts for the hobbyist, and especially some cool kits to build yourself.

TOKO AMERICA
1250 Feehanville Dr., Mt. Prospect IL 60056
(847) 297-0070 • **www.toko.co.jp**
The major manufacturer of virtually all CB-type tuned coils and transformers. Certain parts are sold by **DIGI-KEY** and **AVNET.** Get their complete inductor catalog, as this may be the only way to find replacements for the low-Q tuned coils used in the export models, or for broadbanding the USA versions. Strictly wholesale; you can't buy directly, so get the contact info for their U.S. distributors from the above Web site, or:

DIGIKEY: At left. **AVNET EXPRESS:** (800) 332-8638

CRYSTALS

The following companies still cater to individuals, and are willing to sell small quantities of special-order crystals. Expect to wait two weeks or longer for such orders.

CRYSTEK CORP.
12730 Commonwealth Dr., Ft. Myers FL 33913
(800) 237-3061, (239) 561-3311
NOTE: They sell some crystals through Mouser and Digikey, no minimum order, fast shipping, etc.

INTERNATIONAL CRYSTAL MFG.
10 N. Lee Av., Oklahoma City OK 73102
(800) 725-1426, (405) 236-3741
www.icmfg.com

JAN CRYSTALS
P.O. Box 60017, Ft. Myers FL 33906
(239) 936-2397
www.jancrystals.com

PETERSEN RADIO
2735 Av. A, Council Bluffs IA 51501
(712) 323-7539

RADIO RESOURCE PAGES
www.af4k.com/mega/xtals.htm
This guy keeps a long list of Ham radio type parts resources, including crystal sources from all over the world. There are lots more than we can list here. Check it out!

VACUUM TUBES & OLD PARTS

ANTIQUE RADIO CLASSIFIED
P.O. Box 802
Carlisle MA 01741
TEL: (508) 371-0512
FAX: (508) 371-7129
www.antiqueradio.com
Big monthly magazine that specializes in articles and ads on this subject. Restoration parts, tubes, services, early TV, Ham, telegraph, books, and much more.

ANTIQUE ELECTRONIC SUPPLY
6221 S. Maple Av.
Tempe AZ 85283
TEL: (480) 820-5411
FAX: (480) 820-4643
www.tubesandmore.com
Similar to above.

POWER & AUDIO TRANSFORMERS, or FILTER CHOKES for all CBs, especially old Tube type rigs

The source listings on the next page and on Page 302 are a good place to start. Here's where to look for those iron-core parts you thought were impossible to find. Whether just repairing or completely restoring old vintage radios, check these out. You don't need exact replacements to make old CBs work again

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FOREIGN PARTS SOURCES

Foreign readers should first check the ads in their local CB and electronics magazines, since buying from the U.S. can be slow and expensive.

Here's a quick foreign dialing lesson. The international access code from the U.S. is "011." Using a Touch-Tone phone to direct dial from the U.S., the sequence would be:

011 + [country code] + [city code] + [local number]

EXAMPLE: Suppose you want to direct-dial a VISA card order to AVERA in Holland. You'd press:

011 + 31 + (0)76 596-3820

Don't include the "0" in the city code part of the number (shown in parenthesis above), such as (0)76 above for Holland.

AUSTRALIA:

DICK SMITH ELECTRONICS PTY. LTD.
P.O. Box 321, North Ryde 2113 NSW
AUSTRALIA
Tel: +61 + (02) 888-3200

EUROPE/NETHERLANDS:

AVERA bv
Hazeldonk 6259, 4836 LG Breda
NETHERLANDS
www.avera.eu
Tel: +31 + (0)76 596-3820

EUROPE/GREAT BRITAIN:

TRUCK KING
P.O. Box 8913
Newark, Notts. NG24 9BX
UNITED KINGDOM
www.truck-king.co.uk/index.html
Tel: 44-01636-676-898