APPENDIX A
SOLVING NOISE & INTERFERENCE PROBLEMS

There are two major types of interference that can have a great effect on CB radio operation:

1) Interference which the CB transmitter causes to other electronic equipment like TVs, stereos, telephones, VCRs, etc. (TVI and RFI.) This is generally only a problem with base station operation.

2) Interference <u>from</u> other outside sources that affects proper transceiver reception. (Automobile ignitions, electric power lines and motors, lightning crashes, etc.)

A great deal has already been written on how to locate and solve both categories of problems, mostly by guys a lot smarter than me. So I'm not going to repeat it in great detail here. Instead, we'll briefly review the subject, giving you sources for further information. It's up to you to study the reference material. Also included are pictures of the more common filter devices you should know about.

Perhaps your single best information source for the first type of problem is:

RADIO FREQUENCY INTERFERENCE: HOW TO IDENTIFY AND CURE IT. Published by the American Radio Relay League, 225 Main St., Newington CT 06111. (203) 666-1541. It's very inexpensive and it's also available from any Ham store carrying ARRL publications, like those listed in CHAPTER 1.

This great little book covers virtually all types of TVI and RFI that may be caused by HF transmitters such as CBs. It even includes photos of various TV problems so you can tell which type you are experiencing. I urge you to get this and study it completely! The ARRL RADIO AMATEUR'S HANDBOOK also covers both categories of interference problems.

Also check out the following title, which is available from the ARRL, Amazon, and others:

THE INTERFERENCE HANDBOOK, by William R. Nelson and William Orr. (1981)

INTERFERENCE FROM CB TRANSMITTERS (TVI, RFI)

There are two types of TVI: harmonic radiation, and front-end overload. Each requires slightly different filtering methods for good reduction.

Harmonic Interference

Certain American TV channels are harmonically related to the CB channels. Specifically, these are Channel 2, 5, and 9. TV Channel 2 is near 54 MHz and causes the worst problems, which is why a 54 MHz TVI trap is always included in the Final output coupling stage of a CB. The third harmonic is 81 MHz, Channel 5. And the seventh harmonic (Ch.9) falls close to 189 MHz. The strength of CB harmonics rapidly decreases with the distance from the 27 MHz fundamental.

Harmonics are reduced by placing a low-pass filter in series between the transmitter output and the antenna. This filter passes frequencies

like 27 MHz, while attenuating those signals that are above it. Hence the name. They're made with power ratings from 5-1000 watts.

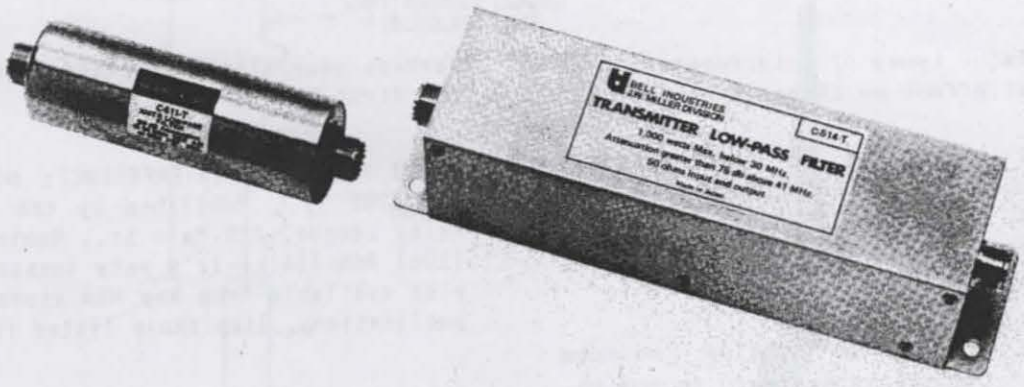
Suppliers of all types of CB filters can be found searching Google and include companies like J.W. Miller, Mouser, Digi-Key, Drake, Bencher, Kenwood, and others listed in Chapter 1, or from any good Ham dealer.

You can order directly from most of these. J.W. Miller only sells through distributors.

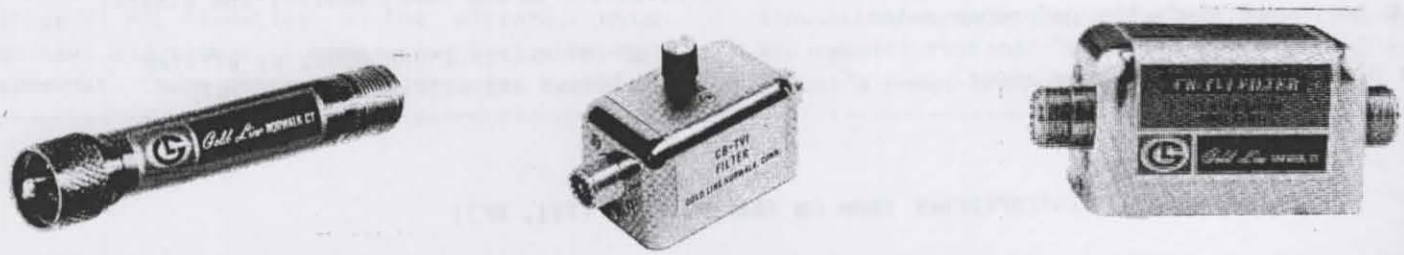
There are two very important precautions when installing any external filter:

1) Keep the connection <u>short</u>, under 4". The best way is through a double-male coax connector. This prevents coax radiation

2) The filter should be the last item in series between the CB and the antenna. Any other accessories like an SWR meter, antenna switch or matcher should be placed between the filter and the radio.



MILLER C-511-T (25 W) & C-514-T (1 KW) LOW-PASS FILTERS
(Courtesy J.W. Miller div. Bell Industries)



LOW-PASS FILTERS: #1118 (4 W, STACKABLE), #1051 (TUNABLE), #1077 (100 W)
(Courtesy Gold Line Inc.)

TV Front-End Overload

When you get interference on other channels that aren't harmonically related, the problem is usually front-end overloading. Remember, a TV channel is 6 MHz wide and its receiver is very broadbanded. Use of a linear amp or close proximity between CB and TV antennas can cause non-linear mixing, similar to IMD.

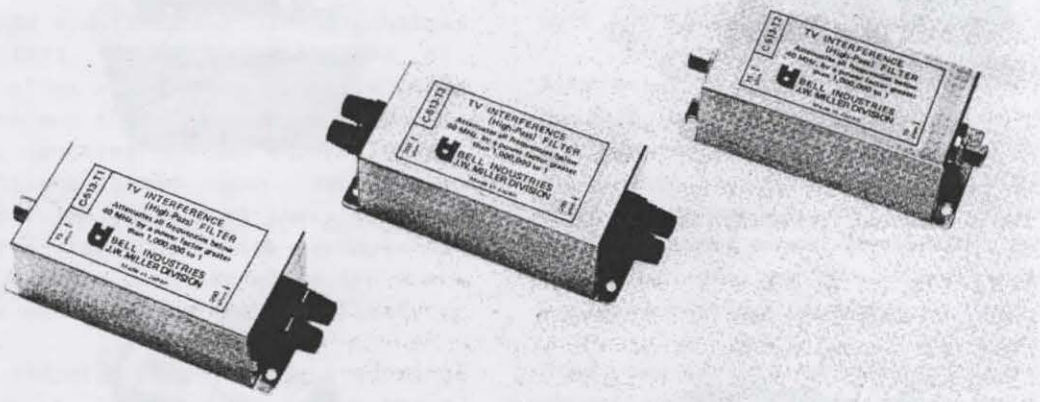
The usual cure is a high-pass filter, which is placed at the TV antenna terminals and has the opposite effect of the low-pass filter; i.e., any signals below its cutoff frequency (about 40 MHz) are attenuated. Again, keep the leads very short. Ground the filter case to the TV when applicable. CAUTION: Many TV sets have a hot chassis, so determine this first!

Another possible cure is a notch filter tuned to 27 MHz. You can make a simple LC circuit using formulas in the ARRL HANDBOOK and place it in series with the TV antenna at the set. But they're much harder to adjust, making the high-pass method more popular.

You can also try a different orientation or spacing between each antenna. Place the CB and TV antennas at different horizontal elevations above ground, and as far apart as possible.

RF can also get into the TV via the AC power lines. There are also filters made for this purpose. If the combination of CB/low-pass and TV/high-pass doesn't completely solve the problem, consider this possibility. Remember the coax isolation choke decribed on Page 348? You can make a simple AC line filter from the circuits in the ARRL books. Commercial examples are the J.W. Miller C-508-L and C-509-L.

The advent of cable has solved many of these problems because shielded coax is used. However cable TV often causes new and unique problems, especially at the individual home drop. Most CB operators seem to live in small towns or rural areas where cable isn't available. Converting the standard 300Ω twin lead over to 75Ω coax often helps. Parts are sold at do-it-yourself home building suppliers, Radio Shack, etc.



MILLER C-513-T1 (300-TO-75Ω), C-513-T3 (300Ω), & C-513-T2 (75Ω)
HIGH-PASS FILTERS
(Courtesy J.W. Miller div. Bell Industries)

Radio & Audio Interference (RFI)

This problem is caused either by overloading or mixing in the RF stages of FM tuners, or by audio rectification. The overload is very similar to TV overload. Rectification causes the CB signal to be heard in such things as speakers, telephones, or even your teeth!

Poor solder joints and poor grounding are major causes of RFI. Example: My first CB shop was in Monterey, California, in an old tin shed. And I had the incredible bad luck to be right next door to a recording studio. Combined with the salt air corrosion, guess what? My building was basically one big semiconductor, and the RFI was too hard to cure. I had to agree to do my DXing only at night, when the studio was closed.

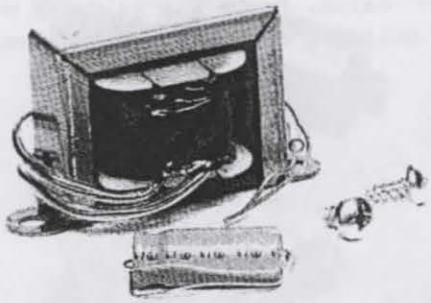
Remember that ground loops (Page 278) can be formed by using multiple grounding points. Try moving these around or changing their lengths.

I had an interesting RFI problem when moving into my current house. A leg of my 40/75 Meter dipole is stretched across the roof. The house had an AC-powered smoke detector. Every time I keyed up on 75M only, the alarm sounded. Great for group code practice! Obviously the AC wires

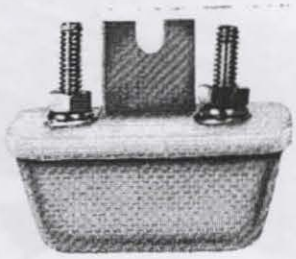
run through the attic and were overloading with RF. None of the usual filter methods worked, and I finally had to replace the smoke alarm itself with a battery-powered type.

Anything that's not absolutely at ground potential looks like a conductor to RF. For example, old electrolytic capacitors that dry out develop high internal resistance and will drop large RF voltages. Bridge a new one across anything suspicious. And don't overlook the AC power mains either. You'll often need a combination of these methods before the problem is solved. See the ARRL book for filtering examples used in many other electronic devices.

In FM tuners, determine if the RFI is before or after the VOLUME control. Rectification points before it may be a mike, tape deck, phono cartridge, etc. Points after the VOLUME control include long and/or unshielded speaker wires, which may be resonant. An 8' length is 1/4-wavelength! In any case, LC filters are usually effective. Commercial audio filters are made by J.W. Miller for stereo amp inputs (#C-505-R) and speaker lines (C-506-R). In tough cases you may actually have to get inside an amp and put ferrite beads and/or bypass capacitors right at the appropriate transistor or IC.

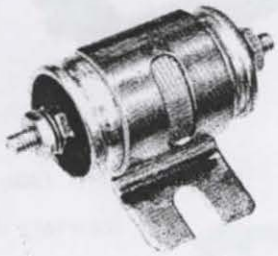


HOT LEAD IGNITION NOISE FILTER
(Courtesy Gold Line Inc.)



FEED-THRU TYPE SUPPRESSOR FILTER
(Courtesy Gold Line Inc.)

ALTERNATOR & GENERATOR FILTER
(Courtesy Gold Line Inc.)



COAXIAL TYPE BYPASS CAPACITOR
(Courtesy Gold Line Inc.)

INTERFERENCE TO CB RADIO RECEIVERS

This problem can be very annoying because it masks weak signals, especially on AM or SSB. FM reception has the advantage of amplitude noise reduction so it's not as noticeable. One of the best preventative measures is to start with a good radio having an RF/IF type Noise Blanker.

Automotive Ignition Noise

The hissing, "frying eggs" sound heard in many AM mobile receivers is ignition noise. It gets louder with higher engine RPM and is caused by the high-voltage discharge of the spark plugs

as they fire. The reason it can be so irritating to CB operation is because such noise is broadbanded in nature, having its maximum energy around 35 MHz. Not very far from the CB band! This explains why your AM/FM car radio works fine but the CB may not; broadcast signals are much further removed from 27 MHz.

Ignition noise can get into the CB either by conduction in the vehicle's electrical system, or by radiation. Conduction is the most common. The way to determine this is to simply replace the CB antenna with a dummy load; if the noise is still present, it's being conducted.

You can pinpoint the noise source with a simple RF probe. Take a length of RG58/U coax with a PL259 at one end, and long enough to reach from the radio to the engine. Strip a few inches of the shield away from the other end. Use this center conductor end to probe around the engine compartment for the point of loudest noise.

Most vehicles had simple inductive discharge systems before 1975. In such cases the use of resistive spark plugs and wires could cure the problem. You can buy these at most auto parts suppliers. Newer vehicles now use sophisticated electronic ignitions based upon capacitive discharge action. The wires must therefore be relatively low resistance or engine performance suffers. Don't replace plugs or wires in such vehicles without consulting a mechanic first.

In the case of radiated noise, good grounding will usually stop it. First make sure the radio and antenna are properly grounded. Then get some heavy ground braids, or make your own using the shield of old RG8/U coax with its center removed. Bond all the major metal surfaces together, such as the hood to the firewall and the exhaust pipes to the frame. Replace any wire that seems to be radiating with a shielded one. Any poorly grounded metal of the right length can resonate, generating RF noise. And don't overlook a possible bad plug, dirty rotor, or cracked distributor cap.

Poor grounding is the main reason why magnetic CB antennas don't work well. Changing from a mag mount to a grounded type can be all that's needed to eliminate ignition noise in a CB.

Many people try to eliminate ignition noise by using a coax cable for the DC power to the radio, running it through the firewall directly to the battery. This sometimes works but often does not, because the noise is being radiated, not conducted. Besides, with a constant DC power source like this you must always remember to turn the radio off manually or it could wear down the battery. Conducted noise can only be stopped at its source, as described next.

Other Automotive Interference

Any electrical device on a car can cause noise, such as the fuel pump, gauges, wiper or blower motors, voltage regulator or alternator. These sources can generally be controlled with bypass capacitors and series chokes, but first you must identify the sources.

Alternator or generator whine is a high-pitched musical sound that increases with engine RPM. Voltage regulators make a ragged or raspy noise which is irregular. Gauge sending units and fuel pumps make an irregular clicking noise. "Switch pops" can be caused by switching electrical devices like brake lights, seat belt buzzers, electric windows, or turn signals.

Once you isolate the source, install a bypass capacitor at its power leads. The coaxial type is more effective at HF and VHF than standard disc types, so invest the extra money. If the problem persists, add series inductance of a suitable current rating, or shield the wire. The same type bypass capacitor can also be used on the radio's positive DC power lead.

Good sources for multi-stage DC power line filters include Radio Shack, most good computer stores, and many others.