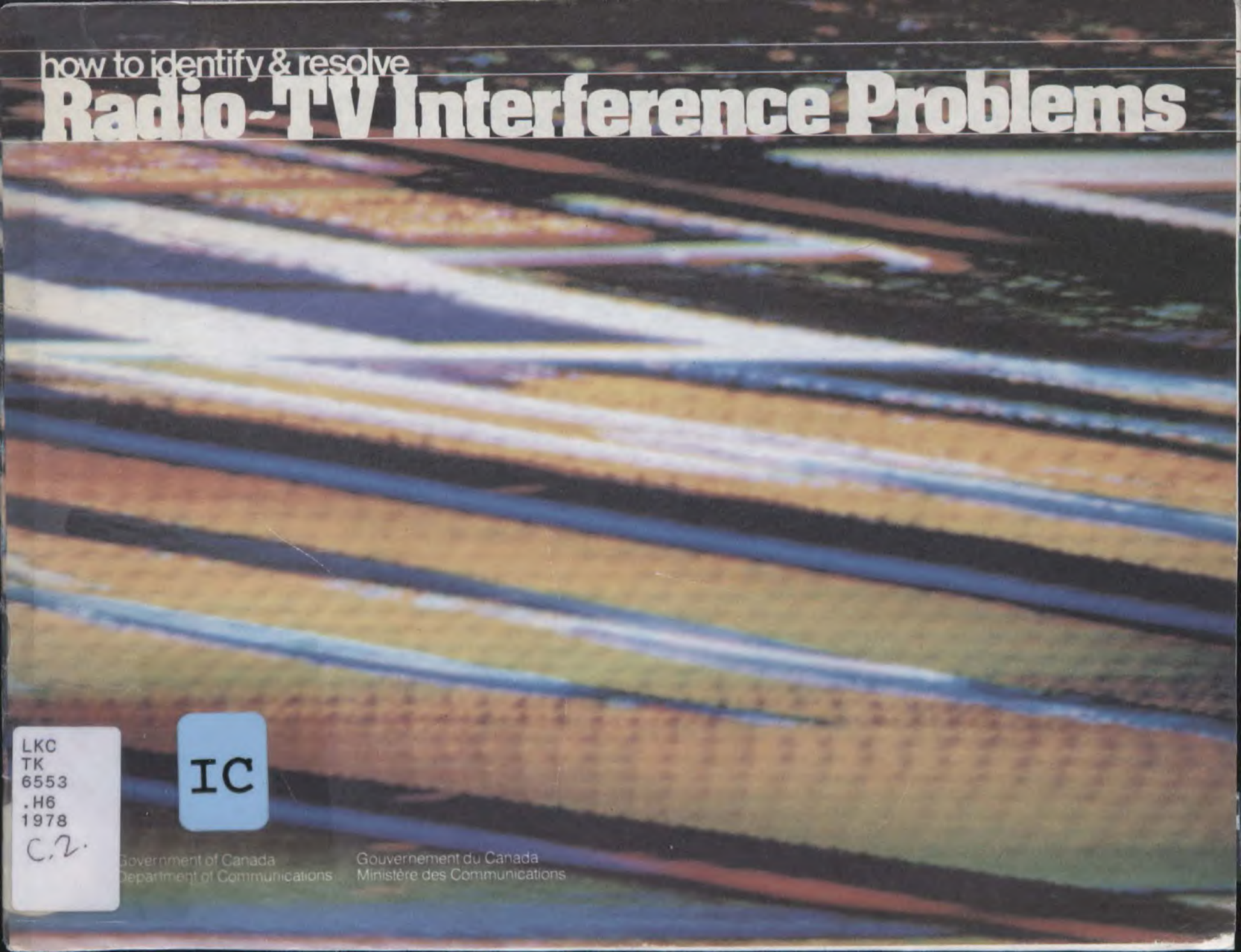
how to identify & resolve

Radio-TV Interference Problems



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Government of Canada
Department of Communications

Gouvernement du Canada
Ministère des Communications

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Radio-TV Interference Problems

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Introduction

During the past few years tremendous advances have been made in the field of radio and television communications. Communications by radio and television from any point on the earth, and sometimes from points beyond the earth, have now become commonplace. In recent years, the growth of two-way radio, permitting personal communications from motor vehicles and homes, has been explosive.

These advances in communication technology are not without problems. The radio frequency spectrum is becoming crowded and interference problems, due to lack of compatibility between the different radio systems, are becoming widespread. This is evidenced by the thousands of complaints of interference to home electronic entertainment equipment (television, stereo, electronic organ, telephone, tape recorder and other audio equipment) received by the Department of Communications (DOC) each year.

Most of these interference problems can be traced to one or more of the following factors:

1. Characteristics of the receiving system, for example, television receiver or antenna systems design and installation.
2. Environment of the receiving system, for example, distance from television transmitter and intervening terrain or presence of nearby radio transmitter.
3. Characteristics of radio frequency generating devices, for example, General Radio Service (GRS, sometimes called CB) radio transmitters.
4. Practices of radio transmitter operators, for example, a GRS user operating an illegal overpowered transmitter or amplifier.
5. Condition of the receiving system, for example, a faulty TV receiver in need of repair.

The control of some of these factors is within the jurisdiction of the Department of Communications. For example, the DOC has technical standards for radio transmitting devices such as GRS transmitters. The DOC also has regulations concerning the way in which radio transmitters are operated.

Obviously, control of some of these factors is not within the jurisdiction of DOC. The quality of the television signal received at your home is one such factor, because such quality is most often influenced by the distance you live from the television station and the intervening terrain. Also, the Department has no standards for the design and installation of television receivers and their antenna systems. As you will find in this publication, many interference problems can be corrected by modification and improvement of the television receiving system.

The purpose of this brochure is to help you identify and resolve interference problems which you can correct. By reading this brochure you will discover that identifying and resolving interference can be an interesting challenge . You will not only be doing your own detective work in locating the source, but you also will be resolving the problem by following the suggestions contained in the "Home Remedies" section.

Because most interference complaints concern television reception, you will find the first section of this brochure devoted to television interference. If the interference is to your audio equipment (stereo, telephone. AM/FM radio), simply skip to the section of this brochure which deals with audio interference.

As you begin to identify the type of interference you are experiencing, keep in mind that not only must your equipment be able to receive and amplify the desired signal, but it also must reject all unwanted signals and noise. This means that even if the equipment allegedly causing the interference is being properly operated, it is still possible to experience interference.

If you have followed the home remedies suggested, and the interference continues, you may want to contact your service representative for assistance.

When you contact your service representative, we suggest that you provide that person with a copy of the Service Representative Section of this brochure. This section has been designed specifically for a technician's use. There is also a section directed to the radio operator which you may wish to show to the operator of the radio transmitter that is allegedly causing you interference.

If you find, after following the guidelines for resolving interference that are provided in this brochure, that you still are experiencing interference problems, you may want to contact the manufacturer of your equipment to determine if he will undertake the remedy of your problem. If, following this, the problem is still not satisfactorily resolved, you may wish to contact one of the DOC district offices listed in the Appendix. In doing so, please be sure to enclose a completed copy of the questionnaire at the end of this brochure along with any other relevant information you may have.

We hope this brochure will serve as a useful tool in helping you to resolve your interference problem.

CAUTION: To avoid the possibility of a shock hazard, fire or violation of your equipment warranty, any INTERNAL modifications of your equipment should be done ONLY by a qualified service representative.

Contents

Identifying Interference to Television

NORMAL PICTURE

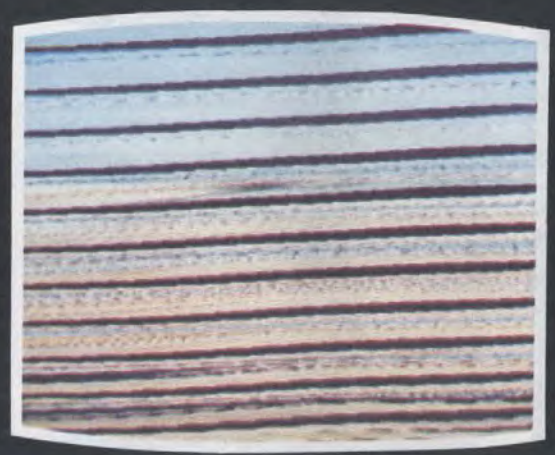
Use this normal picture for comparison with the other pictures shown on this page.

RADIO TRANSMITTER INTERFERENCE

This is what your picture looks like when it is picking up the transmission of GRS, amateur, police or other radio transmitters. It will normally affect VHF channels only. You may notice that the interference pattern changes or moves as the radio transmitter operator talks.

Steps you or the service representative can take to eliminate the interference begin on page 5. Refer to that page if you have identified this as being the type of interference you are receiving.

Do not confuse this interference with Horizontal Control Problem.



HORIZONTAL CONTROL PROBLEM

When your set requires adjustment of the horizontal hold control or replacement of a bad tube or component, the above pattern will appear on your TV picture. The sound if affected, may contain a high pitch tone.

To eliminate, simply adjust your horizontal hold control or call your service representative to replace the bad tube or component.

NORMAL PICTURE

Use this normal picture for comparison with other pictures shown on this page.

ELECTRICAL INTERFERENCE

This is what your television picture looks like when your set is reacting to any of the following devices operated in or near your home. *Hair dryers - electric shavers - mixers - blenders - power saws - vehicle ignition systems - and other similar devices.* When this type of interference is occurring, you may also hear a sizzling or buzzing sound along with the sound of the TV program.

Methods used to locate the offending device, and ways to correct the problem begin on page 7. Refer to that page if you have identified this as being the type of interference you are receiving.

Do not confuse this interference with Poor TV Signal.

POOR TV SIGNAL

This is the type of television picture you will be receiving if you are far away from the TV transmitter site or if there is a building or mountain between you and the TV station. Defective antenna, improper antenna orientation, or disconnected or broken lead-in wire may also cause this problem. The sound of your TV usually will not be affected unless the TV signal is exremely weak.

You can improve the quality of the signal by installing a higher antenna; using a directional antenna; a signal amplifier; or repairing the lead-in wire.

Check with your TV sales and service representative on antenna systems available.

3 Identifying Interference to Television

NORMAL PICTURE

Use this normal picture for comparison with the other pictures shown on this page.

FM INTERFERENCE

Interference from a nearby FM broadcast station will cause this type of pattern to appear on your TV screen. Although it normally will affect TV Channel 6 only, one additional channel in the Channel 2-13 series may occasionally be affected. It sometimes affects both the picture and sound of your set.

Note that the interference pattern may change or vary with the sound of the FM broadcast station program, NOT the sound of the TV program.

Techniques to eliminate this interference are discussed on page 8. Please refer to that page if you have identified this as being the type of interference you are receiving.

Do not confuse this interference with Fine Tuning Problem.

FINE TUNING PROBLEM

This is the type of pattern which will appear on your screen if the fine tuner of the TV set is not properly adjusted. Although it looks similar to FM interference, you will note that the pattern changes with the sound of the TV program.

Readjust the fine tuning control of the TV set to eliminate the problem.

NORMAL PICTURE

Use this normal picture for comparison with the other pictures shown on this page.

CO-CHANNEL INTERFERENCE

This is the type of pattern which will appear on your screen when your set is simultaneously receiving two TV signals. Note that the two images are different, as though one picture has been placed on top of the other.

Co-channel interference is due to either atmospheric conditions or the location of your home in relation to the location of the TV stations. If the problem is from atmospheric conditions, little can be done to correct the problem. However, the problem is usually temporary. If it is caused by the location of your home in relation to the location of the TV stations, use of a highly directional antenna may help to eliminate the problem.

Do not confuse this interference with Ghosting.

GHOSTING

This is the type of picture you will see when 1) the TV signal is reflected, or 2) the TV antenna or antenna lead-in wire are in poor condition.

When "Ghosting" occurs, it means the TV signal is being reflected off a mountain, building or other man-made structure, with the signals being sent over different paths to your TV set and arriving at slightly different times. With "Ghosting", note that the two images are the same.

Rotation of your TV antenna to a new position, or installation of shielded lead-in wire may resolve this problem. If rotation of the antenna does not resolve the problem, have a service representative check the condition and/or placement of the antenna and antenna lead-in wire.

5 Home Remedies for TV Interference

HOME REMEDIES FOR RESOLVING RADIO TRANSMITTER INTERFERENCE

Installing A High-Pass Filter

There are no set procedures for eliminating television interference—it is a matter of eliminating the most likely sources of interference a step at a time. The first step is to install an inexpensive high-pass filter on the back of your TV set. In making this installation, follow these procedures:

1. Determine the type of antenna wire that is connected to your TV set. There are two possibilities:

Coaxial Cable—a round lead-in wire which requires a filter "impedance" of 75 ohms. (See Figure 1a.)

Twin Lead Wire—a flat wire which requires a filter "impedance" of 300 ohms. (See Figure 1b.)

2. Purchase the filter which matches the type of antenna wire coming from your set. The "impedance" information mentioned above will be on the filter label. DO NOT use a combination of twin-lead and coaxial cable without proper matching transformers (often called baluns). Filters are available in most stores that sell or repair television sets. Figure 2 provides a small example of what high-pass filters look like.

3. Carefully read the instructions that are provided with the filter. You will be installing the filter on the back of your TV set, as near to the antenna terminal as possible. The antenna terminal and the filter terminal will look like either Figure 1a or 1b depending upon the type of wire you are using—coaxial or twin lead.

4. If you are on a cable system, you may still install the filter at the antenna terminal. However, if the interference continues, contact the cable company repair service for assistance. DO NOT attempt to modify the cable system yourself.

5. The following information on installing the filter should answer any additional questions you may have.

a. Disconnect the antenna wire (twin-lead or coaxial) from the television set antenna terminals.

b. Connect the wire from the antenna to the input terminals of the filter.

c. For twin-lead wire, connect a very short 2.5 to 5.0 cm (1" to 2") "jumper" wire from the antenna input terminals of the set to the filter (see Figure 3). For coaxial cable, it will be necessary to obtain a jumper cable that has the proper connectors already installed. (This can be purchased at the time you buy the coaxial filter.)

d. Be sure that in the case of TWIN-LEAD WIRE, the actual wires are making contact with the terminals. For COAXIAL CABLE, be sure the connector plugs are properly installed on the coaxial cable.

e. If you have an amplifier in your antenna system, you should have a filter installed ahead of the amplifier and another filter ahead of the TV receiver input terminals (see Figure 4). If the amplifier is located close to the receiver, then

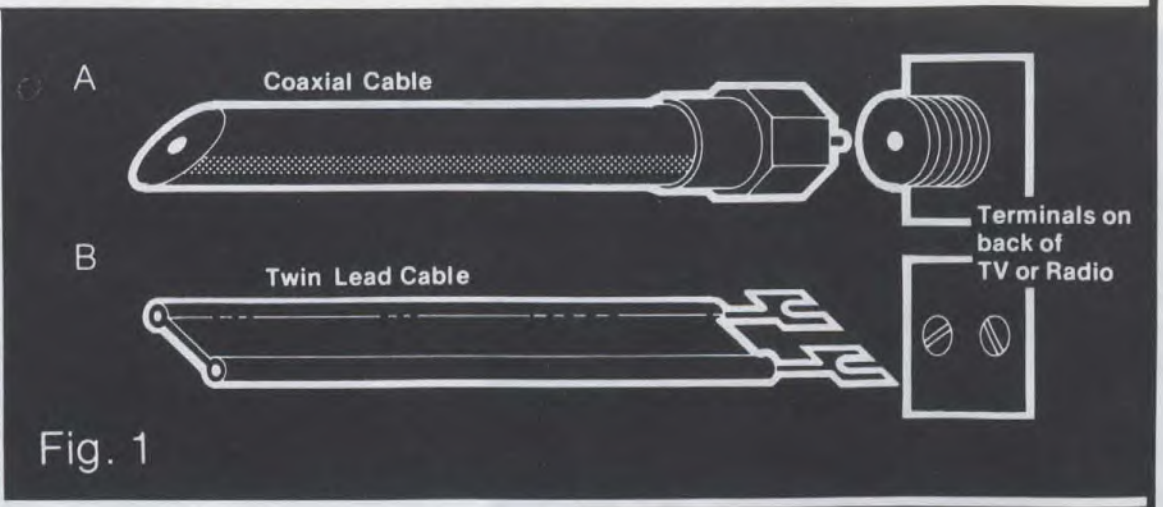


Fig. 1

Fig. 2


Montage of Filters

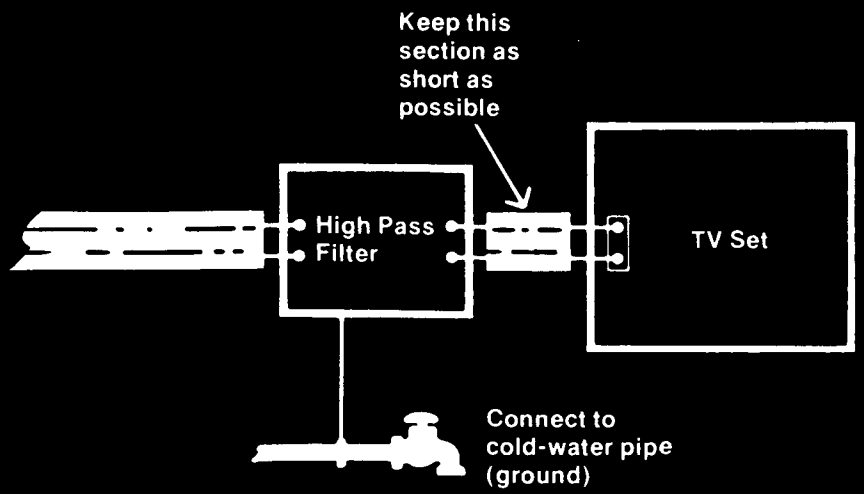
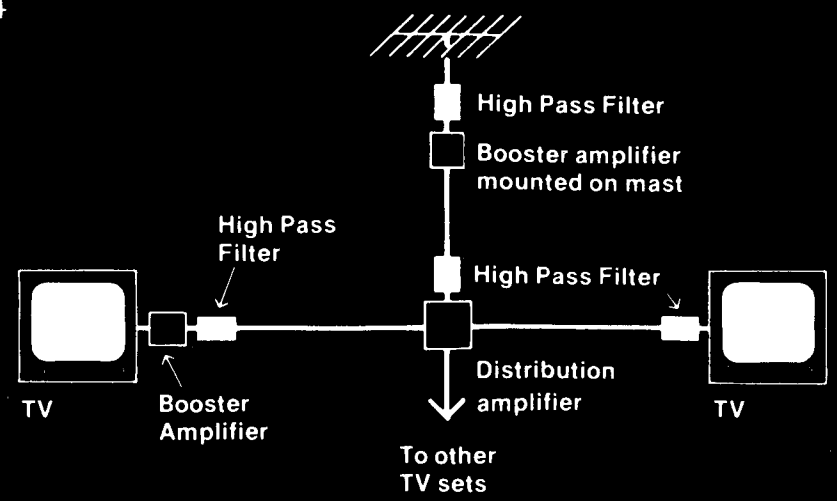


Fig. 3

Fig. 4



install the filter before the amplifier only.

Note: BOOSTER amplifiers usually are located near the back of the TV set; MAST MOUNTED (outdoor) amplifiers are usually located on the antenna; and DISTRIBUTION amplifiers are usually located somewhere in the distribution system. If a distribution amplifier is in your antenna system, then be sure to trace the entire length of the antenna system, because amplifiers are usually in out-of-the-way places (for example—clothes closets, basements, etc.).

f. The connecting wires between the filter and amplifier, and between the amplifier and antenna terminal, should be as short as possible.

g. The instructions provided with the filter you bought may call for a ground connection. The wire should be as short as possible and connected between the high-pass filter ground terminal and a metallic cold water pipe or a ground rod. Use bell wire for this connection (see Figure 3). Bell wire can be obtained from most variety stores.

h. If installation of the filter at the TV antenna terminals does not entirely eliminate the interference, you should then contact your service representative to install a high-pass filter inside the TV set at the tuner input terminals. INTERNAL modifications to your set should be done ONLY by a service representative. Information to assist your service representative is contained in the Technical Information for Service Representatives section.

7

HOME REMEDIES FOR RESOLVING ELECTRICAL INTERFERENCE

Electrical interference is caused by two sources:
1. Vehicle ignition systems.
2. Electrical devices.
The first step in attempting to resolve electrical interference problems is to locate the source of interference.

Interference from Vehicle Ignition System

1. Ignition interference sounds like a "popping" noise in the sound system of your TV that rises in intensity: the "pops" occur closer and closer together as the speed of the engine speeds up. This can be caused by any vehicle ignition system, such as gasoline operated lawn mowers, snowmobiles, automobiles, etc.
2. If the interference is to television receivers, you may hear the same popping noise in the sound and also see "dancing dots" in the picture of the set. You may only see the interference, and not hear the "popping" noise in the sound.
3. If your own vehicle is causing interference, you may wish to install a commercially manufactured kit in your vehicle to reduce the ignition noise. Other remedial measures include relocating your antenna, raising the antenna, and using shielded lead-in antenna wire.

Interference from Electrical Devices

1. Any one or more of the following electrical devices may be causing the interference you are experiencing on your television set or AM/FM radio:
Electric razor, vacuum cleaner, fan, drill, electric blankets, bake ovens, fluorescent lights, arc lights, light dimmer controls, relays, static from machinery, lightning arrestors, adding machine, cash register, circuit breakers, ultra-violet lamps, germicidal lamps, defective wiring, loose fuse, arc welder, switch contacts (such as on dish-washers and other home appliances), refrigerator, water pump, sewing machine, light blinkers (including Christmas tree light blinker), electric heating pads, aquarium warmers, neon signs, door bell circuits/transformers, toys (such as electric trains), sign flashers, antifriction bearings, printing press static eliminators, calculator, insulators, incandescent lamp (new or old), sun lamps, electrical pole (ground wire cut or poor contact), loose electrical connection, electric fence unit, furnace controls, power company transformers, smoke precipitators.
2. In attempting to locate the specific device causing the interference, consider the following suggestions:
a. If you have a portable radio that is affected by the interference, use the radio as a detection device to assist in locating the source of interference. With the portable radio, move from room to room and determine in which room the interference appears to be the loudest. Then look for one of the devices listed above and unplug it to see if the interference disappears. If several devices listed above are in the room, unplug them, one at a time, until the interference disappears.
b. If a portable radio is not affected, you can go to the main fuse or circuit breaker box in your home, remove one fuse at a time, or shut off one breaker at a time, and see if the interference goes away.
c. If it does not go away when the first fuse or circuit breaker is off, replace the fuse or turn the circuit breaker back on and continue on until the interference does disappear. When the circuit that supplies the power to the TV or radio is turned off, it will be necessary to plug that device into some other circuit to determine if the interference is being generated by a device in the same room as your TV or radio.
d. When the interference disappears with a fuse removed or circuit breaker off, you should go to the room supplied by that circuit and look for any of the devices listed before. If any of the listed devices are found in the room, replace the fuse or turn the circuit breaker back on. Then unplug the device suspected of causing the interference. If several devices are in the room, unplug them, one at a time.
3. If you are unable to locate within your own home the device that is causing the problem, the interference may be coming from a device located in your neighbour's home. With the cooperation of your neighbour, follow the same procedures described above.
4. If your investigation leads you to suspect that a power line or power company equipment is the source of interference, you should contact the Department of Communications District Office nearest you (see appendix) to assist you in resolving the problem.
5. Short duration interference, such as that from electric drills and saws, may be very costly to attempt to eliminate; you may just want to "live with it."
6. To *resolve* electrical interference, modifications must be made to the interfering device. This should only be done by a qualified service representative. Information for your service representative is contained in the Technical Information for Service Representatives section.

HOME REMEDIES FOR RESOLVING FM INTERFERENCE

The installation of an inexpensive FM band rejection filter is the first step to take in resolving FM interference. In making this installation, follow these procedures:

1. Determine the type of antenna wire you have connected to your TV set. There are two possibilities:
Coaxial Cable—a round lead-in wire which requires a filter "impedance" of 75 ohms (see Figure 1a).
Twin Lead Wire—a flat wire which requires a filter "impedance" of 300 ohms (see Figure 1b).
2. Purchase the appropriate filter, according to the type of antenna wire you have. The "impedance" information mentioned above will be on the filter label. DO NOT use a combination of twin-lead and coaxial cable without proper matching transformers (often called baluns). Filters are available in most stores that sell or repair television sets.
3. Carefully read the instructions that are provided with the filter. You will be installing the filter on the back of your TV set, as near to the antenna terminal as possible. The antenna terminal and the filter terminal will look like either Figure 1a or 1b depending upon the type of wire you are using—coaxial cable or twin-lead wire.
4. If you are on a cable system, you may still install the same FM band rejection filter at the antenna terminal. However, if the interference continues, contact the cable company repair service for assistance. DO NOT attempt to modify the cable system yourself.
5. The following information on installing the filter should answer any additional questions you may have.
a. Disconnect the antenna wire (twin-lead or coaxial) from the television set antenna terminals.
b. Connect the wire from the antenna to the input terminals of the filter.
c. For twin-lead wire, connect a very short 2.5 to 5.0cm (1" to 2") "jumper" wire from the antenna input terminals of the set to the filter (see Figure 3). For coaxial cable, it will be necessary to obtain a jumper cable that has the proper connectors already installed.
d. Be sure that in the case of TWIN LEAD WIRE, the actual wires are making contact with the terminals. For COAXIAL CABLE, be sure the connector plugs are properly installed on the coaxial cable.
e. If you have an amplifier in your antenna system, you should have a filter installed before the amplifier and another filter ahead of the TV receiver input terminals (see Figure 4). If the amplifier is located close to the receiver, then install the filter before the amplifier only.
Note: BOOSTER amplifiers usually are located near the back of the TV set; MAST MOUNTED (outdoor) amplifiers are usually located on the antenna; and DISTRIBUTION amplifiers are usually located somewhere in the distribution system. If a distribution amplifier is in your antenna system, then be sure to trace the entire length of the antenna system, because amplifiers are usually in out-of-the-way places (for example—clothes closets, basements, etc.).
f. The connecting wires between the filter and amplifier, and between the amplifier and antenna terminal, should be as short as possible.
g. The instructions provided with the filter you bought may call for a ground connection. The wire should be as short as possible and connected between the FM band rejection filter ground terminal and a metallic cold water pipe or a ground rod. Use bell wire for this connection (see Figure 3). Bell wire can be obtained from most variety stores.
h. If the filter does not entirely eliminate the interference, you should call your service representative. The Technical Information for Service Representatives Section is provided to assist the service representatives.

9 Audio Interference

IDENTIFICATION OF AUDIO INTERFERENCE

Interference to audio devices, such as tape recorders, record players, electronic organs, telephones, hi-fi amplifiers, etc., is caused when the equipment responds to the transmission of a nearby radio transmitter.

Audio interference (often called audio rectification) may also affect the sound (audio) portion of your TV and AM/FM radio.

When this type of interference is occurring, you will hear the voice transmissions of the radio transmitter and/or the volume level of the audio device you are using may decrease.

If you have determined that this is the type of interference you are receiving, refer to the following Home Remedies section for suggested methods for eliminating audio interference.

HOME REMEDIES FOR RESOLVING AUDIO INTERFERENCE

Audio interference is a condition that usually requires internal modification of your equipment. For safety reasons, it is recommended that any modifications be made by a qualified service representative.

Due to the complexity of receiving interference to an electronic organ, again, servicing should be done only by an experienced service representative. More detailed information should be obtained from the equipment manufacturer.

For telephone interference, contact your local telephone company.

For all other audio devices, you may wish to take the following steps before calling your service representative.

1. Replace UNSHIELDED wire between the amplifierand speakers with SHIELDED wire.

2. Ground the affected equipment to a metallic cold water pipe or ground rod. A ground connection can be made with a short piece of "bell wire" which can be obtained at most variety stores. DO NOT ground "AC-DC" type devices. Normally devices which may safely be grounded will provide a grounding terminal. If no terminal is provided, then you should consult a qualified service representative for advice.

3. If the interference is not eliminated after taking these steps you must call a qualified service representative. The Technical Information for Service Representatives section is provided to assist your service representative in resolving the problem. You may also wish to discuss the matter with the operator of the radio transmitter, sharing the information in the Radio Operator Guidelines section of this brochure.

Technical Information 10

TECHNICAL INFORMATION FOR SERVICE REPRESENTATIVES

Resolving Radio Transmitter Interference

There are no set procedures for eliminating television interference—it is a matter of eliminating the most likely sources of interference a step at a time. You may be required to take several steps before the interference problem is resolved. Once you have installed the filter called for, or made the adjustment that you were instructed to do, leave the modifications in place and proceed to the next step.

To begin, check to see if a high-pass filter has been installed on the TV set at the antenna terminals. If not, read the Home Remedy information beginning on page 5. If the interference is still present after the installation of a high-pass filter proceed with the following steps.

Check Radio Transmitter

1. Contact the operator of the radio transmitter identified as the source and, with his/her cooperation, determine if the transmitter is operating properly. You may also wish to share the Radio Operator Guidelines section of this brochure with the operator.
Areas of concern should be:
a. Is the transmitter properly grounded? (This means a good radio frequency (RF) ground. A single piece of wire to a ground rod may be an open circuit to RF.)
b. Are harmonics and/or spurious emissions present?
c. Is the transmitter cabinet radiating energy?
2. If the transmitter is not grounded, connect the chassis to a good earth ground with large diameter wire or copper strap. This should assist in eliminating radiation of energy from the cabinet.
3. Next, install a low-pass filter on the transmitter antenna circuit to see if any difference occurs in the interference pattern. If a change occurs, the interference is probably caused by harmonics and/or spurious emissions from the transmitter. If no change occurs in the interference pattern, it is probably being generated at some point in the TV reception system.

Check TV Reception System

1. Conduct a visual inspection of the TV antenna, lead-in wire and lightning arrestors. This may reveal a source of trouble. Corroded connections or deteriorated lead-in-wire could be a fault and should be repaired.
2. Assuming no faulty conditions are found, or if found, they are corrected, and the interference is still present, look for an amplifier in the line. Amplifiers are highly susceptible to radio frequency (RF) energy.
Note: BOOSTER amplifiers usually are located near the back of the TV set; MAST MOUNTED (outdoor) amplifiers are usually located on the antenna; and DISTRIBUTION amplifiers are usually located somewhere in the distribution system. If a distribution amplifier is in the antenna system, then be sure to trace the entire length of the antenna system, because amplifiers are usually in out-of-the-way places (for example—clothes closets, basements, etc.).
3. If an amplifier is in the system, remove it from the circuit. If you find that this eliminates the interference, reconnect the amplifier, but protect the amplifier by a) grounding, b) enclosing it in a metallic RF-proof housing and grounding the housing, or c) installing a high-pass filter at the input to the amplifier. If one filter improves the condition, but does not entirely eliminate the interference, install two filters in series.
4. If no amplifier is utilized, or the interference still persists after following one or all of the above steps, check the TV receiver system.

Check TV Receiver System

1. An AC power line RF filter should be installed to determine if the RF from the transmitter is entering the TV via the power cord. (A line filter may be either purchased or one may be constructed by following the schematic in Figure 5.)
2. If no change is found with the power line filter installed, and the antenna disconnected, then the set itself is responding to the RF energy.
3. The most likely internal circuit in the set to be affected by a radio transmitter is the tuner. Disconnect the antenna input lead inside the set

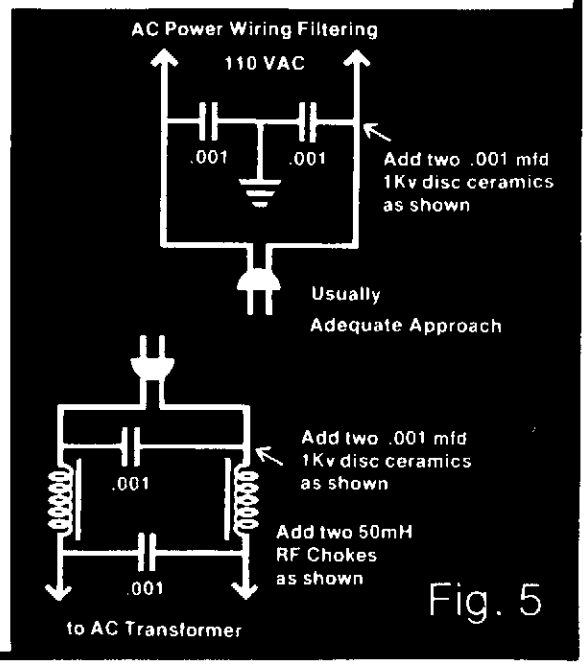


Fig. 5

directly at the tuner. If the interference is eliminated, then install a high-pass filter at the tuner.
4. If the interference is still present after installing the filter at the tuner, it will be necessary to refer to service data for the set and check each stage of the set for undesired response.

GRS Interference to TV Channel 2

1. Second harmonic interference from a GRS transmitter to Channel 2 television may exist even though the transmitter meets DOC specifications for harmonic radiation. In such cases, a tuned filter across the antenna terminals of the television should help. The filter may be an inductor and capacitor in series as in Figure 6. The filter should be tuned for minimum interference.
2. A second method is to put an open circuit, quarterwave, tuned stub across the antenna terminals. The stub should be made of the same type of wire as the antenna input terminals of the television. The initial stub length should be 94cm (37") for RG-59/U coax; and 122cm (48") for 300 ohm twin lead.
3. After connecting the stub, cut the unterminated end of the stub off in 0.32cm (1/8") to 0.6cm (1/4") sections until the interference is eliminated. Refer to Figure 7. For harmonics falling on other TV channels, such as channel 5, 6, or 9, the length of the stub may be appropriately shortened according to the following formula:

$$\text{Length in centimetres} = \frac{7500V}{f}$$

where V = Velocity factor of line
and f = frequency in megahertz

Amateur Interference to TV Channel 2

1. One additional type of interference from a nearby transmitter is unique to the amateur 6 meter band—50 - 54 MHz. Since 6 meters is immediately adjacent to Channel 2 television (54-60 MHz), interference to Channel 2 may occur.
2. In most cases, installation of an open circuit, quarterwave, tuned stub at the antenna terminals of the television set should be effective. It should be connected as shown in Figure 7.
3. If RG-59/U is used as the TV lead-in wire, the initial length of the stub should be 107cm (42"). If 300 ohm twin lead is used, the initial length should be 135cm (53").
4. After the stub is attached to the television, begin cutting off the unterminated end of the stub 0.32cm (1/8") to 0.6cm (1/4") at a time until the interference is eliminated. If the interference is reduced, but not eliminated by this method, add a second stub directly to the input terminals of the tuner. The theoretical final length of the stub should be:

$$\text{Length in centimetres} = \frac{7500V}{f}.$$

Where V = Velocity factor of line
and f = frequency in megahertz

5. If the interference continues, share the information in the Radio Operator Guidelines section with the operator of the radio transmitter.

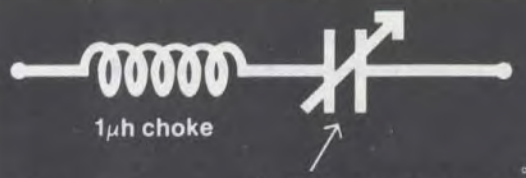
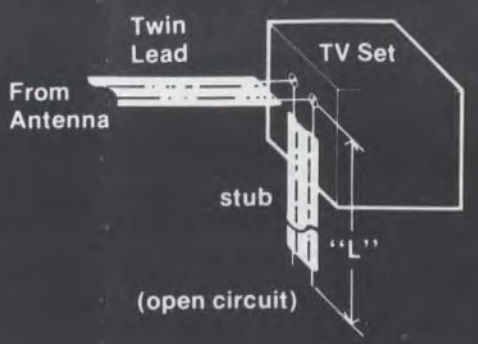


Fig. 6



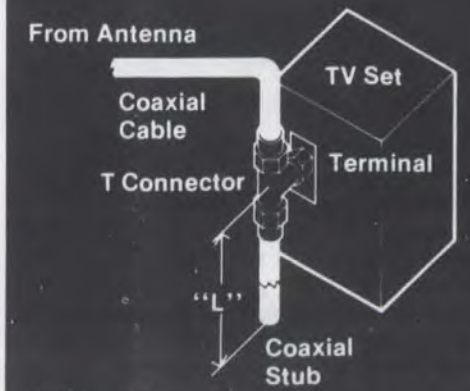


Fig. 7

Resolving Electrical Interference

1. Please read through the procedures outlined in the Home Remedies section, beginning on page 7, before proceeding. If the steps in the previous section have been taken, you should now know the source of the interference.
2. Before proceeding with the following steps to modify the device located as the source of interference, you should check the local electrical codes to determine if the device may be modified, and whether a licensed electrician must modify the device.
Caution: All bypassing of devices with capacitors should be done with extreme care to insure that the capacitors do not short out the AC line. Dangerous voltages exist which can cause electrocution if mishandled. Also, avoid power wiring which can cause the full AC line voltage to appear on the case of the device.
3. Since interference from an electric drill or saw may be of short duration, we suggest no modifications be made to the device, mainly because it may be very difficult and time-consuming to modify the device. If, however, interference is of a long duration, and you wish to take on this task, proceed as follows:
Interference from a drill or saw is actually caused by arcing between the brushes and commutator. The interference then is transmitted through the power cord. Bypassing each side of the line to ground with a capacitor, and each side to the other may be helpful. Also bypass the switch. Figure 8 shows the schematic involved. The bypassing should be internal to the device in question.
4. Electric blankets, fish tank heaters, and other thermostatically controlled appliances, with worn and pitted contacts, cause interference because of contact arcing of the breaker points. This can be eliminated by bypassing the contacts with a 0.001 mfd capacitor or replacing the worn or pitted contacts. (See Figure 9.)
5. Defective devices such as doorbell transformers should be replaced.
6. Dimmer switches that utilize an SCR or triac can produce tremendous interference and it is very difficult to eliminate. This is due to the approximate square wave output that is produced by the switching at the SCR or triac. However, bypassing in a manner shown in Figure 10 may be helpful.
7. Since resolving electrical interference has to proceed on a case-by-case basis, you should always consider adequately bypassing any component of the circuit that arcs or distorts the AC sine wave with ceramic condensers.

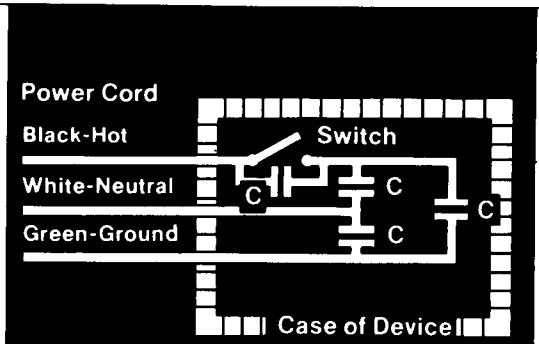


Fig. 8 C=.001 mfd., disc ceramic

Fig. 9

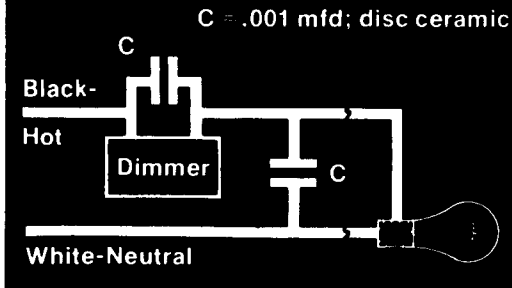


Fig. 10

Resolving FM Interference

There are no set procedures for eliminating FM interference—it is a matter of eliminating the most likely sources of interference a step at a time. You may be required to take several steps before the interference problem is resolved. Once you have installed the filter called for, or made the adjustment that you were instructed to do, leave the modifications in place and proceed to the next step.
1. To begin, check to see if an FM band rejection filter has been installed on the TV set at the antenna terminals. If not, read the Home Remedies section of this brochure beginning on page 8.
2. If the installation of an FM band rejection filter is not effective, then a tuned stub trap should be constructed (see example in Figure 11). The trap should be placed on and parallel to the lead-in and tuned for minimum interference. Then slide the trap along the line to further reduce interference. Finally, tape the trap to the lead-in in the most effective position.
3. Another type of stub, called an open circuit,

quarterwave type, can be made from the same type of wire as the antenna lead-in wire (see, Figure 12). The initial length of the stub should be 61cm (24") for RG-59/U coaxial cable or 74cm (29") for 300 ohm twin-lead wire. For other cables, the initial length can be determined by the general formula:

Length in centimeters = (89) (Velocity factor of line)

Note: If "F" type tee connectors are not available, you may use BNC type connectors.

4. If connecting the stub to the antenna terminals is not completely effective, connect a second stub of the same length directly to the input terminals of the tuner, inside the television set. This should eliminate the interference.

Resolving Audio Interference

1. Audio interference is defined as reception of radio frequency (RF) energy by an audio amplifier. The RF energy is then rectified, or more properly "detected", by an electron tube, transistor, diode, poor solder joint or ground, or integrated circuit. The detected signal is then treated identically as a normal audio signal appearing at the amplifier input terminals. The effects of audio interference vary with the type of modulation employed by the transmitter. The following chart shows expected effects:

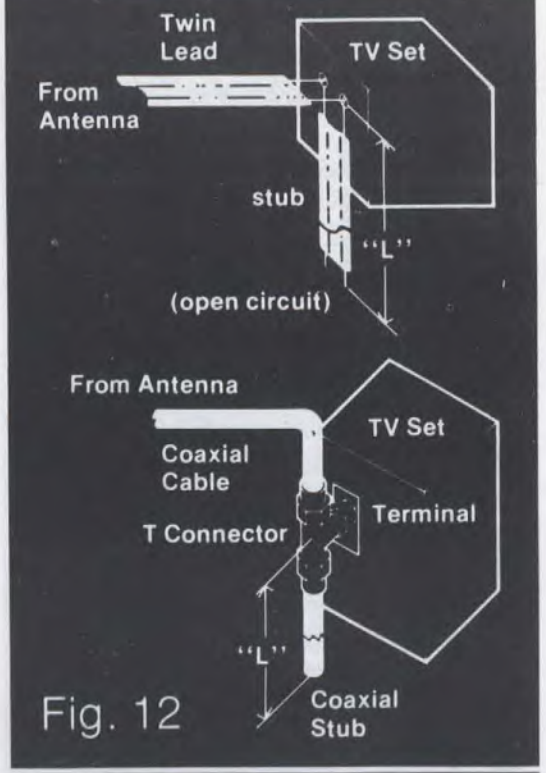


Fig. 12

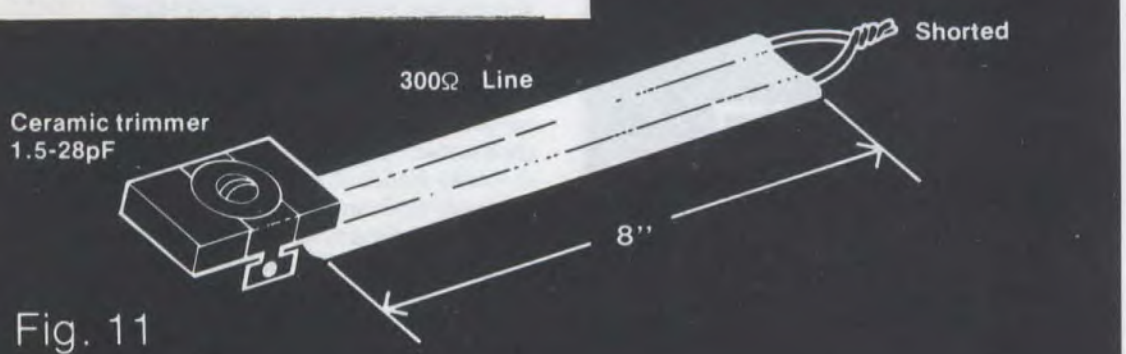


Fig. 11

AM—The voice or music will be heard as any normal audio signal applied to the amplifier. The voice or music may be extremely loud and slightly distorted.

SSB—Single Sideband—The voice will sound practically unintelligible and garbled.

FM—Usually no sound will be heard; however, a decrease in the volume of the amplifier will be noted when the radio transmitter is on. Clicks may be heard when a two-way radio transmitter is keyed and unkeyed. A "frying" noise (such as bacon sizzling) may also be heard.

TV—Audio rectification of a TV signal will sound like a buzz. The buzz will change its sound as the television picture changes.

2. In attempting to isolate where in the audio chain the rectification is taking place, check to determine if the volume control has any effect on the interference. If the volume of the interfering signal changes with a change in the volume control, then the rectification is occurring BEFORE the volume control. If the volume control has minimal or no effect, the rectification is occurring AFTER the volume control. You should next proceed to the appropriate set of solutions. If the solutions described on the next page do not resolve the audio interference problem, contact the manufacturer of the audio device for further assistance.

Rectification Before the Volume Control

1. A multiple input audio amplifier may be susceptible to audio interference on only one or some of the available inputs. Generally, low-level, high-impedance inputs, such as those in turn-tables, cartridges, tape heads, or microphones, are the most susceptible. If, for example, the only input affected is from a turn-table, then disconnect the turn-table cartridge from the amplifier at the input terminals of the amplifier.
2. If the interference is eliminated, then the cartridge or wire between the cartridge and amplifier, is sensing the RF. Proper gounding, connections, shielding, and RF bypassing are the keys to solving audio rectification. Often, a "process of elimination" approach must be used.

Grounding

1. All grounding should be to a good earth ground such as a metallic cold water pipe or 2.5m (8') ground rod. Ground leads should be as short as possible. Remember, a DC ground may appear as an open circuit to RF energy. Ground leads should be of as large a diameter wire as practicable. Finally, grounding of the chassis, shields of speaker leads, and other external connections should be made to a common point to avoid ground loops. (Ground loops are circuits that form a DC ground, but contain RF circulating currents.) Figure 15 shows the correct and incorrect methods of grounding components.
Caution: Some equipment chassis are at line voltage potential and cannot be connected directly to ground. In these circumstances, a ceramic capacitor of 0.001 mfd at 1Kv should be placed in the ground lead. This capacitor appears as a short to RF, but an open circuit to AC.

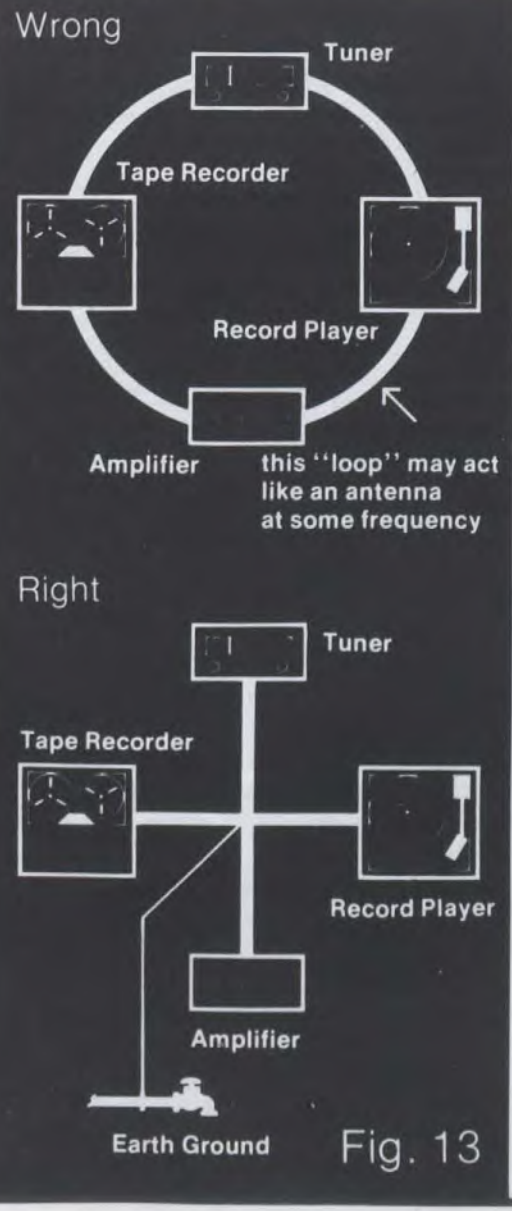


Fig. 13

Shielding

1. All speaker leads from audio equipment should be made of two conductor shielded wires. The shield should be grounded only at the amplifier end, and should not be used as an audio conductor. The two internal wires should be connected to the speaker.

Power Line Filter

1. RF may be entering the audio device through the AC power line. Several power line filters are commercially available. If necessary, a power line filter like the one shown in Figure 5 may be constructed, placing the filter as close as possible to the point where the AC cord enters the amplifier.

Poor Electrical Connections

1. Occasionally, poor solder connections or old electrolytic capacitors may be the cause of the audio rectification problem. If tests to this point have failed, try resoldering all connections in the amplifier and replacing electrolytic capacitors. Before actually replacing the electrolytic capacitor, try paralleling the capacitor with another one of like value. This should reveal the presence of a bad capacitor.

Rectification After The Volume Control

1. When the volume control is in its minimum position, and the interference is still heard, then an RF filter is required in the audio amplifier. It is extremely important that the filter does not affect the audio response of the amplifier.

Tube Type Equipment

1. Interference in tube type equipment can be avoided by connecting an RF choke (ranging in value from 2 milihenry to 5 milihenry) in the upper end of the cathode circuit as shown in Figure 14.
2. The choke coil must NOT be bypassed by a capacitor because the DC resistance of such a coil in generally quite low and the bias voltage is not greatly affected. However, if the DC resistance does affect the bias voltage, the value of bias resistor may be decreased to compensate for the DC resistance of the choke.
3. A grid-stopping or "swamping" resistor can also be employed. A resistor, ranging in value from 1 k to 75 k ohms, can be connected in series with the grid as shown in Figure 15.
4. Capacitors, RF chokes and resistors can be used in combinations to make filters to eliminate the interference. For circuits such as those shown in Figure 16. use a choke of 2 to 6 microhenries and a capacitor of about 10 picofarads. A combination RF filter is shown in Figure 17 with the recommended values.

Transistor Equipment

1. Interference in transistor equipment can usually be eliminated with the use of a shunt capacitor as shown in Figure 18. A resistor/ capacitor combination can be used as shown in Figure 19. It is important that the filter network does not affect the biasing of the transistor or the frequency response of the amplifier.

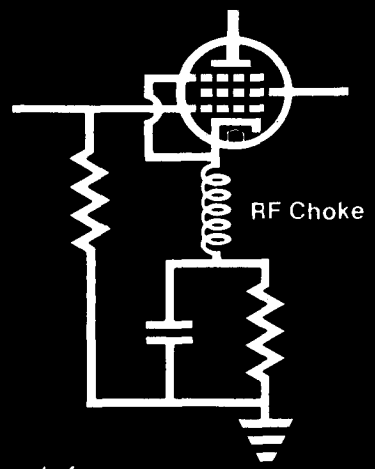


Fig. 14

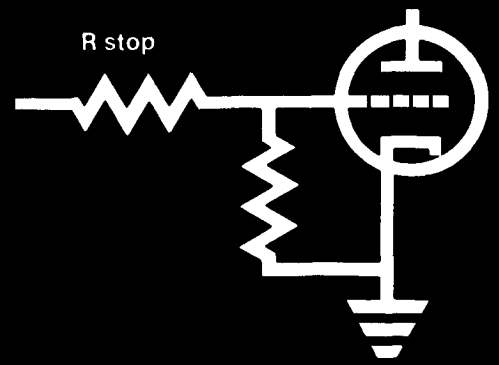


Fig. 15

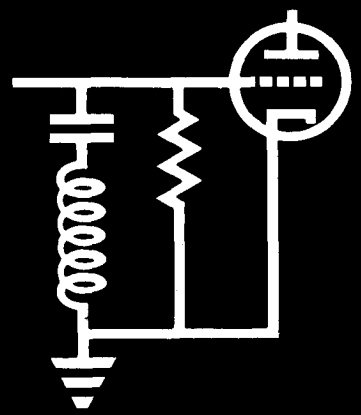
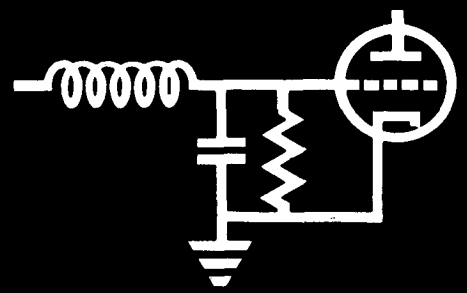


Fig. 16



A combination RF filter is shown in Figure 17 with the recommended values.

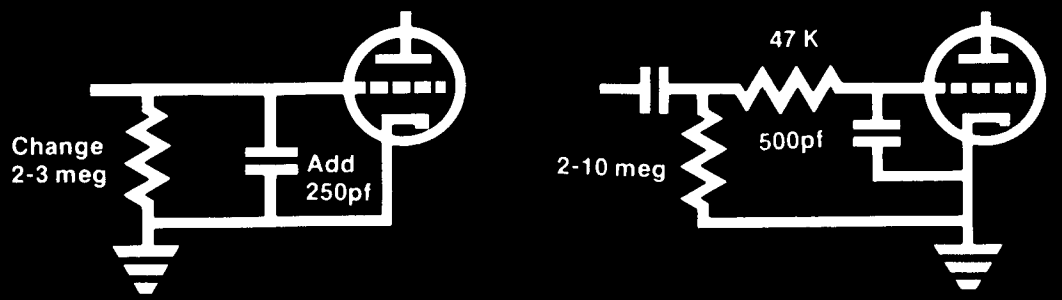


Fig. 17

2. The values of the capacitors used are not critical, but there are some pitfalls to look out for in using capacitors. For example, ceramic caps are best, whereas paper caps do not work at radio frequencies.

3. Leads should be kept as short as possible. Grounds should be made directly to the emitter and not to the chassis or other grounds, since they may have more RF than the signal lead. If the signal increases, then a ground loop has been created, and the inductor method should be tried.

4. In areas of high RF energy, the inductor approach is more effective than the shunt capacitor. An RF choke can be used in series with the input and output leads of the amplifier stage since the RF can enter a stage through either. This method and the values are shown in Figure 20.

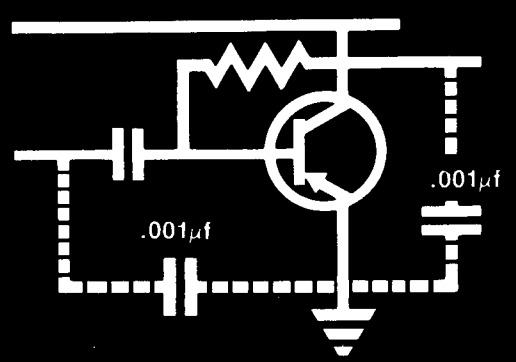


Fig. 18

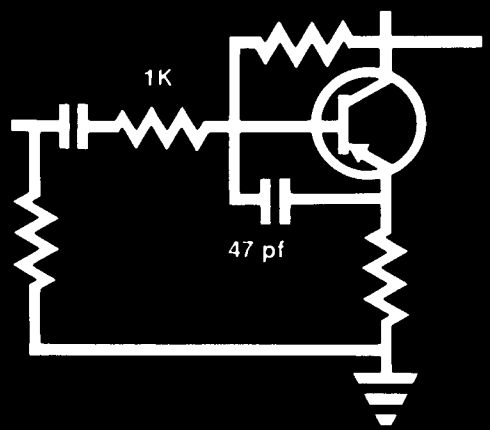
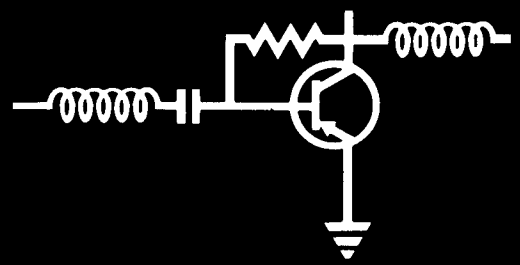


Fig. 19



1.5 mHy-up to 20 MHz
500 μHy-20 to 50 MHz
100 μHy-50 to 500 MHz

Fig. 20

Electronic Organs

1. Organ circuits can be isolated by the use of Swell Pedal, band box volume, or tabs (draw bars). By adjusting each one of these different controls, the effect on the interference can be noted. If the volume of the interference changes, the RF is being detected by the amplifier at a point before that particular control. If the volume of the interference does not change, then the interference is being detected after that control.
2. Using this method, the point at which the RF is entering the organ can be determined, and the appropriate filter, as described previously, can be inserted into the circuit.

References

1. *The Audio Cyclopedia* by Howard M. Tremline, Howard W. Sams and Co., Inc.
2. *Radio Handbook* by William I. Orr, Editors and Engineers, Ltd.
3. *The Radio Amateur's Handbook* by American Radio Relay League.
4. *Thomas Tech-Flash,* Thomas Organ Co., Sepulveda, California.
5. "Filtering RF Interference in Audio Equipment", by R.S. MacCollister from Journal of the Audio Engineering Society. April 1968, Pages 210, 212, 214.

Radio Transmitter Operator Guidelines 18

Resolution of Interference for Radio Transmitter Operators

Although some interference problems can be attributed to television receivers, many problems can also be traced to GRS radio transmitters. If you receive an interference complaint from your neighbour(s), you should take all possible steps to ensure that your radio transmitter is not causing the interference. Installing a low-pass filter, or taking other steps as outlined below, may eliminate the interference, and may prevent you from receiving an order from the Department to implement these measures. You are not, however, required to service or add filtering to the complainant's television, and should not take any such action without the full cooperation of your neighbours.

You are cautioned that the use of an amateur transceiver on the GRS Band is illegal. Further, the use of external RF power amplifiers with GRS transceivers is illegal. Both actions may subject you to Department actions or criminal penalties. Generally, transmitter equipment that is commercially manufactured and type-approved by the Department has precautions built into the set to reduce harmonic radiation. Harmonics are radiations that are multiples of the operating frequency. However, you should follow the steps outlined below to ensure that your radio equipment is operating properly.

1. If television interference is occurring, note which channels are affected.

a. Lower harmonics of GRS generally affect TV Channels 2, 5, 6, and 9. Therefore, if one or more of these channels are affected, your transmitter is probably radiating harmonics.

b. If all TV channels are affected, the problem is more likely to be in the TV receiver.

2. If the interference is caused by harmonics, a spectrum analyzer, a calibrated field intensity meter, or frequency selective voltmeter, can be used to accurately measure harmonic and spurious radiations from your transmitter. If any lead-in devices, such as standing wave ratio (SWR) meters are used, measurements should be made with the inline device both installed and removed. This may help identify the interference and lead you to the source. These are complex measurements and should normally be made only by experienced technicians.

3. If it appears that your transmitter is at fault, you should first make sure the chassis of the set is secured to the metal case of the radio by tightening the screws holding the chassis and case together. Then assure that the case of the transmitter is grounded to a good earth ground (metallic cold water pipe or 2.5m (8 foot) ground rod). Solid conductor wire of at least #10 gauge or copper ribbon should be used as a ground lead. The lead should be as short as possible.

4. By installing one or more low-pass filters in the transmitter antenna lead, you will reduce the chances of unnecessary harmonic radiation. A low-pass filter allows frequencies up to 30 or 50 megahertz (MHz), depending on brand, to pass through unattenuated to the antenna while effectively shorting out harmonic radiation. To make this test, connect the equipment as in Figure 21 and take a power reading. If only an SWR Bridge is available, calibrate it in the forward direction to the calibrate line in the meter. Then insert the low-pass filter and make another power measurement. DO NOT retune the transmitter.

5. If you notice a decrease in output power on a power meter, operating to a properly matched load, with the low-pass filter installed, this is an indication that harmonic content may be present. Even though the meter reading may be lower with the filter installed, it does not mean that the transmitter absolutely has harmonic radiation. Slight detuning of the transmitter by the filter may cause a lower indication.

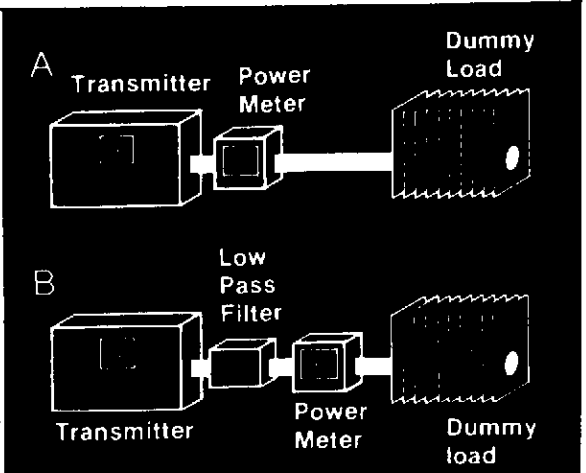


Fig. 21

6. At amateur power levels, corroded metal connections in the area of the transmitting antenna may act like diodes and generate hamonics which may radiate. This type of problem can be found by vibrating suspected offenders such as galvanized downspouts, metal fences, clothes lines, etc., while viewing the affected television set. Sudden changes in the interference pattern which correspond to the vibration should be noted. This test requires an observer at the TV receiver, someone to "shake" suspicious metal objects in the area, and another person to key (but NOT modulate) the transmitter involved.

7. Finally, some transmitters may actually be radiating harmonic and spurious energy from their cabinet or through the power lines. Try operating the transmitter into a shielded dummy load. If the

interference is still present, then cabinet or power line radiation is indicated. A power line filter should be installed. Several types are commercially available. For low power transmitters, the filter in Figure 5 may be used.

8. Continued interference with the power line filter installed points toward cabinet radiation. An earth ground should eliminate cabinet radiation.

9. Many local GRS clubs have interference committees who are dedicated to resolving interference problems involving GRS operation. These clubs can usually be located through other GRS operators.

Resolution of Interference for Amateur Transmitter Operators

1. If you have a linear amplifier on your amateur transmitting equipment, use two low-pass filters. One filter should be installed between the actual transmitter (exciter) and the input to the linear amplifier. (This prevents harmonics generated in the exciter from reaching the linear amplifier.) The second filter should be installed at the output of the linear amplifier to reduce harmonic and spurious content.

2. One unique interference problem to TV Channel 2 is from an amateur transmitter operating on the 6 meter band. This is due to the close proximity of the frequencies involved. You may wish to follow the procedures outlined in the Technical Information for Service Representatives section, page 11, to eliminate this type of interference. You are not, however, required to service or add filtering to the complainant's television, and should not take any such action without the full cooperation of your neighbour.

3. Many amateur radio clubs or associations have interference committees which are available to assist you in resolving interference problems. These can usually be located through other amateur operators in your area.

Radio Transmitter Operator Guidelines for Resolving Audio Interference

Although audio interference (often called audio rectification) is usually resolved by modification of the affected device, you as a radio operator can take certain steps to reduce the possibility of audio rectification by eliminating circulating radio frequency (RF) currents in grounds and metal objects in the area.

1. Your radio transmitting equipment should be effectively grounded to a metallic cold water pipe or a ground rod driven into the ground at least 2.5m (8 feet). The ground lead must be at least #10 wire or copper ribbon. The greater the surface area of the ground lead, the more effective it will be. Also, the ground lead should be as short as possible.

2. You are reminded that you are licensed to use only the amount of power necessary to establish communications. Operating with excessive power is likely to cause audio interference problems.

3. If you need assistance in performing the above modifications to your equipment, you can contact the dealer or manufacturer representatives.

Notes

21 Appendix

Department of Communications
District Offices

This appendix contains the adresses of all the DOC District Offices across Canada. If you have followed the recommendations in this brochure and still require DOC assistance, contact the District Office nearest you.
Before contacting us, please keep in mind the following points:
1. The Department has no legal authority to investigate complaints of audio interference, beyond ensuring that, if a radio transmitter is involved, it is operating within the conditions of its licence.
2. Malfunction of the affected equipment is often the cause of an apparent interference problem. Each year the Department receives several hundred complaints which, when investigated, prove to result in a mistuned, or defective receiver in need of repair. In order that we may do a better job of investigating real interference cases, please be sure that your receiver is functioning properly and is properly tuned to the station you wish to receive.
3. Department of Communications inspectors are *not permitted* to make any permanent modifications to your electronic equipment. Should such modifications be required, contact a service representative.
4. If you have a problem which is due to an inadequacy in your equipment, advise the manufacturer. He is responsible for the performance of his product, and unless he is aware that his customers have problems, he cannot be expected to take action to prevent them.
The last two pages of this publication contain a questionnaire. It is designed to collect information which will make it easier and faster to identify the cause of your problem. Fill it in completely and provide the service representative, manufacturer or, as a last step, your nearest DOC District Office, with the information.

Newfoundland

Corner Brook, Nfld.
Federal Building
P.O. Box 811
Main Street
A2H 6H6

St. John's, Nfld.
Sir Humphrey Gilbert Building
Room 612
Duckworth Street
A1C 5W1

Prince Edward Island

Charlottetown, P.E.I.
180 Kent Street
C1A 1N7

Nova Scotia

Halifax, N.S.
6009 Quinpool Road
B3K 5J7

Sydney, N.S.
500 King's Road
B1S 1B2

New Brunswick

Bathurst, N.B.
159 Main Street
E2A 3Z2

Moncton, N.B.
77 Vaughan Harvey Blvd.
E1C 8P9

Saint John, N.B.
189 Prince William Street
E2L 4S6

Quebec

Chicoutimi, Quebec
942 Chabanel Street
G7H 5W2

Montreal, Quebec
2085 Union Avenue
19th Floor
H3A 2C3

Noranda, Quebec
32 Frédéric Hébert Avenue
J9X 1V2

Quebec, Quebec
2 Place Quebec
Room 436
G1R 2B5

Sept Iles, Quebec
701 Laure Blvd
2nd Floor
G4R 1X8

Sherbrooke, Quebec
1650 King Street West
J1J 2C3

Trois Rivières, Quebec
1285 Notre Dame
Room 337
Public Building
G9A 5E3

Ontario

Hamilton, Ontario
135 James Street South
L8P 2Z6

Kenora, Ontario
Federal Building
Room 154
P9N 2X9

Kingston, Ontario
Federal Building
Room 273
Clarence Street
K7L 4X1

Kitchener, Ontario
30 Duke Street West
N2H 3W5

London, Ontario
451 Talbot Street
N6A 5C9

North Bay, Ontario
222 McIntyre Street West
Room 301
P1B 8J5

Ottawa, Ontario
473 Albert Street
K1R 5B4

Sault Ste. Marie, Ontario
421 Bay Street
P6A 5N3

Thunder Bay, Ontario
33 Court Street South
P7B 2W6

Toronto, Ontario
55 St. Clair Avenue East
M4T 1M2

Windsor, Ontario
880 Ouellette Street
N9A 1C7

Manitoba

Thompson, Manitoba
436 Thompson Drive
R8N 0C6

Winnipeg, Manitoba
2300 - One Lombard Place
R3B 2Z8

Saskatchewan

Regina, Saskatchewan
2101 Scarth Street
S4P 2H9

Saskatoon, Saskatchewan
206 Circle Drive East
S7K 0T5

Alberta

Calgary, Alberta
205 - 8th Avenue, S.E.
T2G 0K9

Edmonton, Alberta
10025 - 106 Street
T5J 1G6

Grande Prairie, Alberta
202-11117-100 Street
T8V 2N2

British Columbia

Cranbrook, B.C.
11 - 14th Street South
V1Ç 2W9

Kelowna, B.C.
471 Queensway
V1Y 6S5

Langley, B.C.
3884-192nd Street
P.O. Box 3396
V3A 3R7

Prince George, B.C.
1294 - 3rd Avenue
V2L 3E7

Prince Rupert, B.C.
Room 227, Federal Building
V8J 1G8

Vancouver, B.C.
325 Granville Street
Room 300
V6C 1S5

Victoria, B.C.
816 Government Street
V8W 1W9

Northwest Territories

Fort Smith, N.W.T.
Post Office Building
P.O. Box 540
X0E 0P0

Yellowknife, N.W.T.
Bellanca Building
P.O. Box 2700
X0E 1H0

Yukon

Whitehorse, Y.T.
Room 201 - 4133, 4th Avenue
Y1A 1H8

In requesting assistance from the manufacturer, dealer, or DOC District Office, the following information will be helpful in analyzing your problem.

Date

1. Your name: _____

   Address: _____

   _____

   Phone Number: _____

2. If known, radio transmitter operator's:

   Name: _____

   Address: _____

   _____

   Call Sign: _____

   Hours of Operation: _____

3. Type of interference identified:

   ☐ Radio Transmitter ☐ Electrical
   ☐ Co-channel ☐ FM
   ☐ Audio

4. **a.** TV Channels affected: _____

   _____

   b. AM/FM Frequencies affected: _____

   _____

5. If you are experiencing either FM or Co-channel interference, estimate the distance of the interfering station from the location of your home:

   _____(kilometers).

   _____

6. Were suggested home remedies made?

   ☐ Yes ☐ No

   Please explain (be specific): _____

   _____

   _____

   _____

7. **a.** Was service representative called:

   ☐ Yes ☐ No

   b. If yes, were suggested modifications made?

   ☐ Yes ☐ No

   Please explain (be specific): _____

   _____

   _____

   _____

8. **a.** If a radio transmitter is involved, was the operator contacted?

   ☐ Yes ☐ No

   b. If yes, what was the result of that conversation? _____

   _____

   _____

   _____

   c. Were suggested transmitter modifications made?

   ☐ Yes ☐ No

   Please explain (be specific): _____

   _____

9. At what time of day does the interference usually occur and how long does it last?

   _____

10. Give make, model number, and the year puchased, of your TV or AM/FM receiver. _____

11. Was the level of interference affected in any way by the modifications suggested in this brochure?

    ☐ Yes ☐ No

    Comments: _____

    _____

12. Describe fully the sound or noise made by the interference and, if the TV picture is affected, please provide a drawing of what the interference pattern looks like. (Use separate sheet.)

13. **a.** Are any of your neighbours experiencing the same type of interference?

    ☐ Yes ☐ No

    If yes, on a separate sheet, indicate their names, addresses, and type equipment receiving the interference; TV, AM/FM radio, electronic organ, etc.

    b. Was the information provided in this brochure shared with your neighbours?

    ☐ Yes ☐ No

    If yes, please explain what modifications were made to their equipment and if the modifications eliminated or reduced the level of interference. (Use separate sheet if necessary.)

    _____

    _____

    _____

    _____

14. Give any other pertinent information which you feel will assist us in analyzing your interference problem: _____

_____

_____

_____

Please leave the following space blank

_____

(For use by manufacturer, dealer, or DOC District Office.)

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